Networking in European Steel Research

EUROFER
European Confederation of Iron and Steel Industries

Preface

The European steel industry - after many privatisations and major restructuring operations - is the most modern in the world. It is a technological leader in its field, largely thanks to an elaborate and informal network of individuals and organisations active in the field of steel research and development.

The steel R&D network has been built up during almost 50 years of collaborative steel R&D under the auspices of the European Coal and Steel Community (ECSC) research and technical development programme. Consequently, the EU steel industry stands well prepared to meet the new challenges presented by the expiry of the ECSC Treaty in 2002 and the expanding EU Framework Programmes.

This booklet is intended to provide information about the existing steel R&D network in Europe as a basis for participation of the steel industry in future research programmes, be they European or national.

The production of the booklet was part of the EU-funded thematic network NEST (New Efficient Steel Technologies), which is being concluded in 2002 after three years of operation.

Numerous individuals at steel companies, institutes and universities listed in this booklet have made possible this listing by providing crucial information about current steel R&D - competencies, resources, and programmes. Their effort is gratefully acknowledged.

A special recognition is due to the working group responsible for developing the booklet[1].

Dietrich von Hülsen
Director General EUROFER

[1]

Mr. R. Bulthé	Arcelor/Sidmar
Dr. J. C. Charbonnier	Arcelor/Usinor
Mr. H. Herlitz, co-ordinator	Formerly EUROFER
Dr. M. Mirabile	Centro Sviluppo Materiali
Mr. W.H.L. Moonen	Corus
Dr. J. Stahl	ThyssenKrupp Stahl
Dr.-Ing. R. Steffen	Verein Deutscher Eisenhüttenleute

Table of Contents

Importance of Steel as a Material

Steel is the most important metallic material in the world today. Global steel production amounts to some 800 million tonnes per year - nearly 30 times the production of aluminium and five times that of plastics. With over 2500 varieties and a range of exceptional properties (strength, elasticity, formability, durability, recyclability, cost/performance ratio, etc.), steel is a modern and universally usable material which Europe's major industries cannot do without. The steel industry constitutes an essential element of the industrial framework of the European economy. It contributes significantly to the economic development of the Union in that it provides the fundamental material on which most of the industrial or manufacturing sectors of the economy depend.

People use products made of steel every day. Even products not containing steel require steel to make and transport them to the final customer. Steel plays an essential role in providing citizens with energy, transport, manufacturing, infrastructure, construction, home appliances, and many other products and services. Steel's unique range of chemical and physical attributes provides the combination of properties that can be tailored to demanding user applications at a lower cost compared to other manufacturing materials.

The European steel sector is constantly addressing the challenge of meeting customers' demands for technologically ever more sophisticated and more environmentally friendly high-performance materials, whether in steel construction work, in road, rail, and air travel, in energy and environmental technology, in the packaging industry, or in the household.

It is difficult to imagine a modern developed economy without a substantial steel industry. Thanks to the multitude of applications and its environmentally friendly and cost-effective characteristics, steel is and will remain the most important engineering and construction material in the modern world.

Steel as a material has made and continues to make a major contribution to sustainable growth, the development of environmental protection, infrastructure, and energy conservation systems. Steel products are environmentally friendly and are not only compatible with, but also necessary for, the success of sustainable growth. Not only is steel the most recycled material today, but the steel industry is committed to work with all in the steel cycle (e.g. suppliers and customers) as well as universities and research institutes to meet the challenges of sustainability.

Steel Products

The importance of steel as an engineering material is expected to endure, and the best alternative to steel is still in most cases a better steel.

As a result of extensive technological developments, the EU steel industry has been able to respond to and create customer demand for new steel products. Over fifty percent of the steel industry's current product range has evolved over the past ten years. Many of them have been generated in close co-operation with customers. Collaboration with customers is a major feature of the steel industry's new-product development, an essential element in the promotion of steel use. For this reason, expenditures spent by the industry for research and development include to an increasing extent applied research.

Commercial steel has undergone radical change and development over the past ten years. Traditional steel types have been refined with regard to both dimensional tolerances and level and uniformity of mechanical properties. At the same time, numerous steel grades have been developed for new applications. Examples are cold-forming structural steels and abrasion resistant steels, where Western Europe has a leading position. Cold-forming steels and structural steels can be delivered today with very high yield strengths (up to 1100 MPa) and with undiminished weldability.

The cold-forming steels' share of hot-rolled sheet has increased sharply in the past ten years. With their high cleanness, these steels can be bent into tighter radii than traditional steel grades. The steel user thereby obtains high-strength steels with good formability and weldability, permitting weight savings and finished products that are more economical. Hot-rolled cold-forming steels are used primarily in different types of vehicles and structures, e.g. trucks, haulers, and cranes. The properties of cold-rolled sheet have also been dramatically improved. The new ultra high-strength (UHS) steels combine very high strength with good cold-forming properties. For extremely difficult pressings, the soft cold-rolled press sheet has been further developed by the use of steel with carbon contents lower than 0.005 %.

Special steels with carbon contents between 0.2 and 0.8 % have been developed for applications requiring extremely hard steels such as springs and saw-blades.

To protect steel sheet against corrosion, a large variety of Zn-Al coated sheets has been developed, whilst additional corrosion protection is obtained by coating with different kinds of polymer-based paints.

The Ultra Light Steel Auto Body research project (ULSAB) set up by 35 leading steel makers has been received extremely positively by carmakers. The ULSAB project cuts car-body weight significantly while delivering a great gain in rigidity and reducing CO_2 emissions. A group of 26 steel companies set up a consortium to extend this successful research programme into areas such as closures, suspension systems, engine cradles, and safety systems.

Some further examples of new and advanced applications of steel:

- The 6.8 km Storebaelt suspension bridge connecting the islands of Sjælland and Fyn in Denmark, with a 1.6 km free span hanging from two 826 mm cables
- The steel masts suspending the roof of the Stade de France in Paris
- High-tech telescopic cranes that have revolutionised construction by allowing heavy lifting in tightly confined areas
- The high-speed rail station at Lyons Satolas
- The steel-roof construction at the Sony Center in Berlin
- The Guggenheim Museum in Bilbao, where the extraordinary titanium-covered curves and angles were made possible by a technically challenging steel frame.
- Composite stainless-steel tubes for use in recovery of process heat for production of electricity and district heating at waste-incineration plants
- High-purity stainless steels for the medical technology industry, for example implants

The globally most significant importance of steel in the building industry may lie in the field of modular construction, originally developed for temporary buildings but now increasingly used for permanent buildings. Modern cruise ships usually include cabin modules, and the idea is being extended into private and public buildings such as schools and hospitals. The lightweight steel-framed modules are simply lowered on top of steel piles driven into the ground with a metal plate welded across the top - avoiding the need to pour concrete foundations and to remove excavated soil from the site.

Steel is also a vital component in sophisticated medical procedures such as microsurgery, in which needles with holes as small as 0.05 mm are used to carry suture wires. Microchip manufacturing would be much more difficult without electro-polished steel surfaces where the maximum particle size is 250 times thinner than a human hair.

The overall trend of steel consumption is increasing in the EU even though specific consumption - i.e. the consumption of steel per unit (e.g. per car or machine) - is on a downward trend. As an example, an ULSAB car body requires 279 kg of steel compared with 372 kg for a traditional car. Specific consumption has changed and has often been reduced in response to technological changes, resulting in new qualities or types of steel with characteristics such as extra-high strength, allowing the use of less steel for the same application. Nevertheless, consumption levels, setting aside the normal cyclical fluctuations in demand, have remained in an upward trend.

There is a clear trend towards more high value-added products. For example, the proportion of alloyed steel has increased at the expense of ordinary carbon steel. The highest growth rate in the alloyed steel group is shown by stainless steel.

Steel Technologies

Worldwide the steel industry has made massive strides in efficiency since the early 1980s. The changes have been driven by corporate restructuring, privatisation, and dramatic changes in technology and organisation.

Over the past 40 years steelmakers in the advanced countries have replaced the traditional basic open-hearth furnace with modern basic oxygen furnaces (BOF) so that about 60 percent of all steel produced today is made via the blast furnace (BF)/BOF route. Several further technological changes are under way:

- Electric arc furnaces - many operated by "mini-mill" companies - are increasing their share of total production.
- Direct-reduction processes use mainly natural gas to produce iron pellets or briquettes, and have environmental advantages over traditional ironmaking. Production of direct-reduced iron is small in Europe but could potentially increase significantly if an economical coal-based process would be developed.
- Direct smelting makes liquid iron in one process from unprepared ore and ordinary coal. This eliminates the expensive preparation processes required by the BF/BOF processes, which need iron ore in the form of pellets or carefully sized lump ore, supplemented

by limestone and a charge of coke to provide reductant for the conversion of ore to iron. Many developments are under way to make such processes commercial.

- Thin-slab casting and direct strip casting are promising developments, partly entering the commercial phase at present. Because they reduce the number of process steps compared to conventional processes, they require less energy and lead to lower production cost. They also make the development of new steel grades possible due to high solidification rates.

Recycling and Environmental Impact

Few industrial products are more environmentally sound than steel. Steel is the world's most recycled material. Not only is it possible to recycle all the steel made in the world, whatever method is used to produce it, but scrap recycling is actually cheaper and more energy-efficient than primary production. Globally, about 45 percent of all steel produced is made from ferrous scrap, and this percentage is continually increasing.

Energy use is an important issue for steelmakers. The energy required to produce a tonne of European steel fell by 50 per cent between 1975 and 2000. This was achieved through closure of inefficient plants and through efficiency improvements such as continuous casting, process optimisation, better use of excess energy, near net shape technologies, better reheat furnaces, computer-controlled temperatures and so on. Further reductions of energy use are possible but require major process innovations.

The European Steel Industry

The European steel industry is leading in the world in terms of tonnes produced: approx. 160 Mt of crude steel per year, which represents about 20 percent of world production. The total production value is estimated at € 90-100 billion and the number of employees is around 275 000. The majority of the 1800 European steel stockholders and steel service centres are small and medium-sized enterprises, with about 3000 installations throughout Europe. Many of them also deal in other materials and industrial goods. Their combined annual turnover for steel alone is around € 35 billion. The sector of first processing, a substantial part of the steel industry's output, is of great significance for various branches of industry. Pipe and tube makers and various companies engaged in cold rolling and drawing account for 3000 firms, mostly SMEs, employing more than 150 000 workers and with an annual turnover estimated at over half of that of the EU steel industry. Steel production, and products made from steel, are thus an important source of employment and wealth creation in the EU.

The European steel industry is also among the best, worldwide, in terms of manufacturing skills, equipment performance, product quality, and innovative capacity. An exporting industry of high added-value products, it has contributed significantly to the European trade surplus. It is now leading the globalisation of the world steel industry.

However, it has not reached this position through gradual and evolutionary changes in which the industry adapted itself to the continuously evolving environment. Throughout the last two decades tremendous changes at all strands of the business were needed to wrest the European steel producers from pure battle for survival to being skilful players in the continuous search for competitive advantage. A few figures indicate the multiplicity of initiatives and actors in this transformation process. Within a time span of 25 years, the number of steel-industry employees in the 15 Member States decreased from 870 000 to 275 000, while annual production per employee increased 3.4 times, from 163 tonnes to 556 tonnes on average. Added value and quality, which are crucial elements in a modern, competitive environment, improved at the same time.

The changes that have been accomplished are most impressive. They took place in two waves.

The first wave was concerned with radical industrial restructuring. Its plain goal was to ensure survival in an open-market environment, and to do so in a socially acceptable way. State support was of considerable importance in this phase. It was launched with the declaration of a "state of crisis" by the European Commission, and it was terminated with the European approval of the last restructuring plans for Ireland, Italy and Spain in 1993. This crucial first phase prevented the collapse of the European steel industry and secured its orderly adaptation to new market structures. After two oil crises (1974 and 1980) the western economies had entered a new economic era, which transformed the steel market from a sellers market into a buyers market. It also signalled a definitive departure from state intervention in the management of the steel industry.

The second wave expresses the European steel industry's acknowledgement that permanent effort is critical to maintain and increase its international competitiveness. Besides constantly lowering costs, this has implied a deep cultural revolution in switching from a production-oriented to a customer-oriented culture, to offer clients the ever-increasing quality of products and services they request and deserve. This also means permanent adaptation to a globalising market. The impetus for this second wave has come from within the industry and has relied on its own forces to move in its self-elected direction.

The basic difference between these two waves is that the first one was essentially based on the shared responsibility of companies, national governments, and the European Community to achieve a drastic downsizing in a socially compatible way, whereas in the second wave, companies had to achieve substantial changes using their own resources. In doing so, their economic room to manoeuvre was one of a normal business operating in an open market. In the context of the industry, this shift might be described as a definitive shift away from political logic towards plain business logic. The second wave was fuelled by a strong entrepreneurial drive, motivated by the knowledge that change and innovation were there to stay.

For these reasons, European steel producers are focussing on enhancing the performance of their conventional products, developing new steels to meet new demands, and developing new processes. This has made it possible to:

- reduce energy usage (to approx. 5 MWh/t of hot metal, incl. coking plant, in BF and 0.5 MWh/t of crude steel in EAF)
- reduce coke consumption to 300 kg/t of hot metal by additional injection of fine coal

- increase the total yield from charge to hot strip (to over 90%)
- increase the productivity (e.g. from about 4.5 to 3 man-hours per tonne of crude steel in integrated mills)
- reduce production time and energy consumption by direct casting-rolling processes
- reduce CO_2 emissions (to a European average of approx. 1.3 tonne per tonne of crude steel)

The 1990s have been a time of dramatic change for the industry as it came to the end of a cushioned existence in a production structure based largely on protected national markets. In addition to the workforce reduction, EU steel industry since 1980 has cut more than 63 million tonnes of its capacity (though a smaller amount of more efficient capacity has also been installed). A number of companies have merged or formed alliances in the face of narrowing margins: British Steel in the United Kingdom with Hoogovens in The Netherlands (Corus), Germany's Thyssen and Krupp-Hoesch (ThyssenKrupp Steel), France's Usinor (which earlier merged with Belgium's Cockerill Sambre, including EKO Stahl in Germany) with Luxembourg's Arbed and Spain's Aceralia (Arcelor).

Attention is turning to the two great challenges facing the industry over the next decade: the expiry of the ECSC Treaty in July 2002, and the prospect of the enlargement of the EU to the east, taking in several countries with large but inefficient steel industries. The treaty will have lasted 50 years when it expires. Most observers agree that it has achieved its objectives of rationalising the European steel industry and promoting efficiency gains. The end of the ECSC poses, however, three challenges:

- What to do with the funds accumulated since 1952, largely though a levy on coal and steel products; and
- Maintaining the collaborative steel research and expanding the network of steel researchers; and
- How to ensure that the strict controls on state aid to national steelmakers in East European countries do not wither away with the treaty.

The discussions about ECSC funds utilisation has resulted in an agreement under which approx. € 35 million per year will be provided for collaborative steel R&D after the expiry of the treaty. This will be in addition to any support for R&D through the EU's Framework Programmes. However, the Fifth Framework Programme, 1999 to 2002, provided little extra funding for the steel industry. The Sixth Framework Programme opens up the participation in the new funding instruments Integrated Projects and Networks of Excellence.

By contrast, problems of enlargement are likely to take longer to resolve. All of the Central and East European candidates for EU membership have significant steel industries. Most are still in state ownership, and many are burdened with inefficient and outdated equipment, often leading to environmental problems that would be unacceptable in Western Europe. At the same time, the global steel market is becoming more demanding, forcing EU producers into ever more dramatic technical and corporate change in pursuit of greater efficiency and competitiveness.

Collaborative Research in the European Steel Industry

Most of the technical innovations that have reshaped the European steel industry originated or were substantially developed in the steel research programme organised by the European Coal and Steel Community. The ECSC Treaty called for research to be carried out on a collaborative basis to sustain the competitiveness of the industry and increase safety at the workplace. The first ECSC research project dates back to March 1955. Since then, researchers and engineers at steel companies, research institutes, and universities have become increasingly accustomed to working together in a growing European spirit. The steel industry, and hence European society in general, can benefit from this kind of collaborative research where efforts are co-ordinated and shared, and results are discussed with and made available to all interested parties. The result is an enhanced effect of scale in industrial innovation.

Impact on the European Steel Industry

According to a study[1] carried out for the European Commission by external experts, each euro spent on research into "iron and steel methods", generated approximately 22 euro in economic return, falling to 13 euro per euro spent if one adds the money spent by industry (in general 40% of the project cost). Regardless of the value of this figure, it is important to stress the vital role of research and technical development in technical innovations carried out in the European steel industry during the last few decades. It is not unreasonable to suppose that without the support of the ECSC, some research would not have been undertaken, even if this contribution today represents barely 7% of the money spent on research by the European iron and steel industry.

Through a vast network made up of the programme's Advisory Committee members, 19 Technical Committees, and all the researchers involved, the programme has created a framework for interactions within and between the industrial and scientific worlds. Thanks to this network, Community research has been able to play a catalytic role in the activities undertaken by the various industries and to ensure rapid application of the results of research for the benefit of all the participants.

This collaboration was extremely beneficial for the European iron and steel industry and its equipment suppliers. It was successfully associated with major technical changes in steel production. Research has made possible a very significant reduction in energy consumption, pollution, and the cost of the products produced, while improving working conditions and worker safety. The continuity of the research effort over a very long period has simultaneously allowed the progressive improvement of products and processes, and the development of radically innovative technology. The few examples of ECSC-supported projects mentioned below represent a sample of recent research work and show the dynamism of the European iron and steel industry.

Direct casting of steel strip with in-line rolling

The development and almost universal adoption of continuous strip casting represents the single most important technical achievement in steel processing technology in recent times. The technology is based on the "vertical twin-roll principle". With the strip-casting process, molten steel is rapidly solidified to hot strip, moves on to the rolling stand for shaping and then to a coiler.

Product dimensions directly from the casting process rival those of typical hot-rolled products at 1.3-1.8 mm. With additional in-line hot rolling, products thinner than 1 mm are easily attainable. Owing to the unique microstructure produced during rapid solidification, a single steel composition can produce a wide range of strength/elongation properties.

The process is ideally suited to production levels of approximately 500 000 t/year. The capital cost of the unit is comparable to thin-slab casting on a euro/annual tonne of installed capacity basis. Thus, the requirement for large capital outlay to enter the flat-rolled market is drastically reduced. In addition, production on the development plant has shown that operating costs are similar to or lower than conventional or thin-slab casting. At lighter gauges, i.e. less than 1.5 mm, the relative costs become significantly lower as compared to conventional methods. Thus, the process is ideally suited to the production of ultra-thin-gauge hot-rolled sheet.

[1] *"Assessment and evaluation of direct financial returns on ECSC steel research programmes", European Commission, Technical Steel Research. Report EUR 15828. Luxembourg, 1994.*

Significant reductions in both energy requirements and plant emissions are the key benefits that the Strip Casting process has over existing steel producing technologies. In fact, the total energy consumed to produce pickled hot-rolled product is estimated to be 60% and 50% less for the Strip Casting process as compared to slab casting and thin-slab casting, respectively. Likewise, greenhouse-gas emissions are estimated to be 40-50% less than with conventional casting routes. These improvements make the process much friendlier to the environment and should facilitate easier and shorter environmental permitting for both greenfield and brownfield developments.

Optimisation of a line for the production of coated sheet for the automotive industry

Since consumer demand in the automobile industry for increased quality and durability is growing, advanced processes like galvannealing are being called upon. Car manufacturers generally demand guaranteed corrosion resistance for 6-12 years. Steel producers are able to guarantee such protection through the use of various types of zinc coatings, each providing a different level of protection. The galvannealing process provides long-term protection against corrosion and involves the passing of a steel strip through a bath of molten zinc and then reheating the strip so as to produce a diffusion of the iron into the zinc coating. The result is a coated strip with a matt finish particularly well suited to painting.

With a new thermal treatment technique for producing galvannealed steel, the coated strip is reheated very rapidly, maintained at a constant temperature for a period, and then rapidly cooled. This so-called "square cycle" is achieved using a completely new technique for heating by induction and a novel cooling system resulting in higher and more uniform quality and higher resistance to chipping than conventional galvannealed steel. In addition, the speed of the production line can be increased by 30% and production can be made more flexible.

The use of zinc-coated steel sheets in automotive bodies produced in Western Europe increased from 45% in 1990 to 65% in 1995 and is expected to reach 70-75% in the years ahead.

Rapid treatment of iron oxides derived from the regeneration of pickling solutions

One of the unavoidable by-products in steel production is iron oxide sludge, a waste product resulting from the use of hydrochloric acid in the pickling of steel strips. Typically, part of this material is recovered for use in other applications. An R&D project successfully developed an improved treatment process for recovering iron oxide.

During the hot rolling of flat steel products, a layer of iron oxide forms on the surface and has to be removed before subsequent processing. This is done by means of pickling, which involves the passing of the steel strip through a bath containing hydrochloric acid. Once used, the hazardous pickling solution is treated and the hydrochloric acid recovered, leaving a residue in the form of iron oxide-rich sludge. This sludge is also treated and as much of the iron oxide as possible is recovered for use in other applications, including as an additive in concrete and glass production.

With the new process, iron oxides are first dried by vaporisation and then roasted. The roasting operation is rapid compared to conventional roasting methods. The resulting iron oxide powder is highly homogenous in structure, grain size and quality, making it an ideal material for the production of high-grade hard magnets for the electrical and electronics industries. The process itself represents a major leap forward in terms of product quality, increased productivity, energy savings and a related reduction of CO_2 emissions, compactness of the installation and low emission of dust and other noxious agents.

The European Research Area

The EU initiative "The European Research Area" offers a new horizon to scientific and technological activity, and to research policy in Europe. Its ambition is to create the necessary conditions for increasing the impact of European research efforts, by strengthening the consistency of the activities and research policies followed in

Europe. This requires a strengthening of the public and private research efforts in the Union, and also of the co-ordination of Member States' research efforts, both among themselves and with those of the Union. One of the objectives of the European Research Area initiative aims at improving the performance of European research, in particular by networking and co-ordinated implementation of national programmes. The characteristics of the ECSC steel R&D programme make it a good example of this.

The ECSC steel R&D programme is characterised by some specific features as compared to other research programmes:

- Collaborative nature with involvement also of suppliers, customers, users, and research institutions
- Multi-party, multi-national projects
- Pilot and demonstration projects as well as research projects
- Strong involvement of the industry in project selection and programme management
- Relatively simple administrative procedures
- Results are shared and generally made public.

Pooling resources at the European level multiplies the opportunities for undertaking high-risk R&D programmes that could not be afforded by a single company. This is particularly true as regards process research and pilot and demonstration programmes, which are essential for the constant improvement of the European steel industry's competitiveness.

The systematic exchange of R&D results is a specific consequence of this collaborative approach. During the last few years nearly all ECSC steel R&D projects have been multi-party projects.

The evolution of a European network of steel R&D experts has played a crucial role in the management and success of the ECSC R&D programme, because it facilitates the cross-fertilisation of ideas so important for innovation. Furthermore, the network provides a continual education of the researchers and it contributes significantly to a rapid dissemination of technical knowledge and experience and of best practices within the industry. In fact, the network of researchers can be seen as a virtual research centre.

This networking in collaborative R&D, built up during a long period, is why the ECSC steel R&D programme has contributed to steel research in Europe much more than could be expected from the fraction it accounts for in the global research endeavour of the European steel industry. The success of the ECSC steel R&D programme has been confirmed in several independent reviews; see the study referred to in the footnote on page 16 and the assessment of the ECSC R&D programme 1991-1995[2], which concluded that the programme had been highly successful.

It is evident that the European steel industry has a proven record of successful collaborative R&D, largely due to the experience gained from participation in the ECSC steel research programme and the network of researchers built up during decades of collaborative R&D. Consequently, a solid base exists for continuation of such collaborative steel R&D, amply proven so successful in the European Union. This is a strength of the EU steel industry in its competition with other sectors for EU funding of research and technical development, e.g. from the Framework Programmes.

[2] *"5 Year Assessment of the Specific Programme: The ECSC Steel RTD Programme", European Commission, 30 March 1999.*

The European Steel Research Landscape

In this section, a review is given of the R&D resources available to the European steel industry. The various organisations are linked to each other in an informal network, gradually established during decades of collaborative R&D. Practically all of these organisations have been involved in ECSC or Framework Programme projects.

It should be noted that only the main steel R&D resources are included here; it has not been practically possible to include all. For this reason, in some cases a company or institution is only named without any further details. In particular, many engineering companies and equipment suppliers have played crucial roles in steel R&D projects. They are not included in this booklet, but some major companies in this category are listed in the last section.

The study shows that the total number of people engaged in steel R&D within the EU in 2000 was more than 8300. The research was mainly conducted by the research facilities of the steel industry and the institutes dedicated to steel R&D (70% of personnel, 81% of costs), but also the institutes and universities with substantial steel R&D resources contributed substantially (21% of personnel; 14% of costs).

The companies, institutes and universities listed comprise 134 entities, but the real number of research facilities and laboratories is much higher because many companies have several or many R&D facilities and many universities have more than one institution engaged in steel R&D.

The data collected for this booklet indicate that the total number of people engaged in steel R&D in the EU represents about 3.5% of the EU steel industry's workforce. The industrial researchers (in steel companies and dedicated institutes) represent about 2.4% of the workforce.

The total steel R&D costs are mainly covered from the steel industry's own funds. The ECSC steel R&D programme - built up from levies on steel products - provides the most important public funding, amounting to 6-7 percent with some additional small EU contributions. Further funding comes through various national R&D programmes.

It should be noted that this booklet does not cover every European organisation involved in steel R&D. The coverage is estimated at about 90 percent of total EU steel R&D expenditures.

Steel Companies

ACERINOX is one of the few integrated plants in the world of stainless steel flat products.

Crude steel production 2001: 1.03 Mt

Employees 2000: 3736

Core Steel R&D Competencies

- Design and development of new stainless steels (low-Ni, N-based austenitic steels)
- Hot and cold formability
- Behaviour under complex service conditions
- Compatibility of stainless with the environment (metallic migration)
- Characterisation, treatment, and application of residues and by-products of stainless-steel manufacturing (slag, baghouse dust, sludge, etc.)

Steel R&D Staff

75, all at the Palmones Plant

Specialist Equipment for Steel R&D

- Induction furnaces of different capacities
- Hot-forging press
- Cold-rolling mill
- Gleeble thermo-mechanical simulator
- Thermogravimetry

Current Steel R&D Topics

- New austenitic stainless steels grades with enhanced mechanical and anti-corrosion features used in desalination plants, pulp industries, sea environments, etc.; refractory steels for gas-cleaning chambers, ceramic furnaces and heaters)
- New more ecological treatments for pickling
- Use of stainless steel in structural components enhancing the passive safety in automobiles
- Advanced microscopy and microanalysis technologies for exploration of microstructural characteristics of stainless steels
- Application of lasers to chemical analysis of stainless steels
- Fitness of stainless steel in the Food and Drink Industry from the viewpoint of cleanability, disinfection, and lack of undesirable effects (e.g. alteration of taste, colour) on food products in contact with stainless steel: comparison with other metallic materials

Contact Addresses
Dr. José-María BAENA
ACERINOX, S.A.
P.O. Box 83
ES - 11370 LOS BARRIOS-CÁDIZ, SPAIN
Tel.: +34 956 62 93 83; Fax: +34 956 62 94 28
E-mail: jbaenali@acxgrup.com
http://www.acerinox.es

Arcelor was formed in 2002 through the merger of Aceralia, Arbed, and Usinor. Arcelor is the first global steelmaker specialising in production, processing and distribution of flat carbon steel products, long carbon steel products, and stainless steel products.

Crude steel production 2001: 43.1 Mt

Employees 2000: 110 000

Arcelor has four divisions:
FLAT CARBON STEEL PRODUCTS
Arcelor has a full range of thin flat products: hot-rolled coil, cold-rolled coil, coated sheet, steels for packaging.
The automotive industry is the primary customer sector for flat carbon steels.
LONG CARBON STEEL PRODUCTS
The division comprises three main specialities (heavy long products, light long products and wiredrawing activities).
Arcelor has a full range of carbon steel long products, particularly for the construction sector.
STAINLESS STEELS
The division incorporates the production, processing and distribution of stainless steel flat and long products, nickel alloys and special plates.
Arcelor produces virtually the entire range of stainless steels for domestic appliances, automotive exhausts, and construction.
DISTRIBUTION-PROCESSING-TRADING
Distribution provides the link between the world of steel production and that of the steel-consuming manufacturing customers.
INNOVATION AND R&D: GLOBAL VIEW
Arcelor has extensive resources dedicated to R&D:
1382 persons in 16 research centres.

ACERALIA

1 research centre for flat products: CDT (Centro de desarrollo Technologico, Avilès, Spain)

Core Steel R&D Competencies

- Process improvement: reduce manufacturing and investment costs, improve process and product reliability, optimise and give flexibility to the production processes and develop new technologies
- Development of new product and applications: development of new steel grades, adaptation to customers' new transformation processes, and characterisation of materials of co-engineering

Steel R&D Staff 25

Specialist Equipment for Steel R&D

Process simulation

- Continuous annealing simulator
- Simulator of continuous tinplate annealing
- Experimental sintering plant

Corrosion resistance
- Test of accelerated corrosion
- Electrochemistry measurements

Computation
- Design and programming tools
- Programming tools

Forming ability
- Universal Erichsen ductility test rig
- Drop-forging press, 80 t
- Analysis of circles mesh deformation
- Stereoscopic system of tri-dimensional measurement of geometry and deformation states of stamping pieces

Current Steel R&D Topics

Product/Application R&D
- Techniques dealing with forming, welding, and joining of steels
- Coating and surface treatment
- Corrosion resistance and enamelling and painting properties
- Co-designing of formed parts with customers

Process R&D
- Product improvement and production-process optimisation by using mathematical models, artificial intelligence, and advanced control techniques, e.g. conoscopic holography
- System development and integration for plant automation and product-quality assessment
- Development and implementation of systems: Automatic Measurement, Surface and Inner Inspection, Predictive Maintenance
- Development and application of IT-based tools (Data Mining, Data Warehouse, etc.)

Contact Addresses
Faustino OBESO CARRERA, Head of Innovation & Research
Aceralia Corporación Siderúrgica
Centro de Desarollo Tecnológico
P.O. Box 90
ES - 33480 AVILES (Asturias), SPAIN
Tel.: +34 985 12 62 83; Fax: +34 985 12 63 75
E-mail: fobesoc@aceralia.es
http://www.aceralia.es

ARBED GROUP

1 research centre for long products, ProfilARBED in Luxembourg

Core Steel R&D Competencies
- Process control
- Rolling technology and roll-pass design
- Modelling and simulation
- Metallic construction and civil engineering
- Fire-safety engineering
- Recycling of steel-industry by-products

Steel R&D Staff 39

Specialist Equipment for Steel R&D
- Lead experimental mill
- Scanning electron microscope with energy-dispersive X-ray analyser

- Electron microprobe with wave-dispersive X-ray analyser
- Smit-WELD thermal cycle simulator
- Furnace for thermal treatment under controlled atmosphere
- Extensive computer and modelling facilities

Current Steel R&D Topics

Steelmaking process

- EAF modelling
- Characterisation of scrap
- Liquid heal measurement
- Reduction of by-products and CO_2

Rolling process

- Development of new sheet-pile series
- Modelling of beam-blank continuous casting

Structural shapes

- Characterisation of products elaborated by EAF - beam-blank casting route
- Optimisation of secondary cooling of beam blanks in continuous casting
- Study of beam-to-column connections in seismic conditions
- Development of new construction systems

Sheet piles

- New design approaches for steel sheet piles
- Anchoring of AZ sheet piles
- Development of a driving prediction method
- Study of water-jetting techniques

Contact Addresses
Mr Henri GROBER, General Manager
ProfilARBED Research and Development
66, rue de Luxembourg
L - 4009 ESCH-SUR-ALZETTE, LUXEMBOURG
Tel.: +352 5313 2100; Fax: +352 54 79 64
E-mail: henri.grober@profilarbed.lu
http://www.arbed.com

SIDMAR

1 research centre for flat products

OnderzoeksCentrum voor Aanwending van Staal Ghent, Belgium

Core Steel R&D Competencies

- Physical metallurgy: characterisation of precipitates, simulation
- Application behaviour of flat-rolled products: forming, welding, painting
- Strain-rate sensitivity
- Production and application of tailored blanks (laser-welded blanks)
- Sheet hydroforming

Steel R&D Organisation

OCAS employs a matrix organisation:

- Technology Cells or Program Management (Technologies)
  - Substrate development
  - Carbon steel
  - Stainless steel
  - Application development
  - Coating development

- Technical departments or resource departments
  - Chemistry
  - Mechanical Testing and Application
  - Modelling, Information and Communication

Steel R&D Staff

60 people are active at OCAS in Ghent, another 8 are working at OCAS GmbH (Bremen).

Specialist Equipment for Steel R&D

- Mechanical testing
  - Thermo-mechanical simulations up to melting temperature
  - Plane strain, biaxial tensile test
  - High strain-rate testing
- NDT/Dimensional analysis/Strain measurement
  - CMM, CASA
- Joining
  - Classical and high-frequency spot welding
- Forming/Tribology
  - Large-size industrial presses
  - Flat die, Draw Bead Simulator, U-bend test
  - Friction & wear testing
- Metallurgical models
  - Diffusion, precipitation, segregation

Current Steel R&D Topics

- Forming (deep drawing, hydroforming, etc.)
- Joining techniques (laser welding, adhesive bonding, tailor-welded blanks, etc.)
- Surface technology (metallic, ceramic, and organic coatings, etc.)
- Development of new steel grades with increased strength, enhanced formability, better corrosion resistance via new coatings.

Contact Addresses
OCAS N.V.
Prof. Ir. Christian STANDAERT - General Manager
John Kennedylaan 3
B - 9060 ZELZATE, BELGIUM
Tel.: +32 (0)9 345 12 11; Fax: +32 (0)9 345 12 04
E-mail: christian.standaert@ocas.be
http://www.ocas.be

USINOR

13 laboratories in France, Belgium (Liège) and Germany (Eisenhüttenstadt) are dedicated to both product development (12) and process (Irsid)

As Usinor's R&D approach is customer-focused rather than geographically based, four main centres of expertise are managed through the 13 laboratories. They are dedicated to:

- Surface and coatings
- Steel design for market applications
- Steel products metallurgy (carbon steels, alloyed and stainless steels)
- Forming and joining

The total number of research people at these 13 laboratories is 1250.

Names and location of the 13 laboratories:

CED: Centre d'Etudes et Développement, Montataire, France
CRDM: Centre de Recherche et de Développement Métallurgique, Dunkerque, France
CRG: Centre de Recherche de Geugnon, Geugnon, France

CRI: Centre de recherche d'Isbergues, Isbergues, France
CRMC: Centre de Recherche des Matériaux du Creusot, Le Creusot, France
CRPC: Centre de recherche des Produits à chaud, Fos-sur-Mer, France
CRU: Centre de Recherche d'Ugine, Ugine, France
CRY: Centre de Recherche Imphy, Imphy, France
ISOFORM: Nanterre, France
IRSID: Maizières-les-Metz, France
RDCS: Recherche et Développement de Cockerill Sambre, Liège, Belgium
LEDEPP: Laboratoires d'etudes et de développement des produits plats, Florange, France
FQZ: Forschungs-und Qualitäts Zentrum, Eisenhüttenstadt (EKO Stahl), Germany

Surface and coatings

Core Steel R&D Competencies

- Surface technology
- Corrosion protection
- Coatings

Steel R&D Organisation

CED, CRMC, CRU, CRI, CRY, IRSID, LEDEPP, RDCS

Steel R&D Staff

Included in the 1250 people

Specialist Equipment for Steel R&D

Coating equipment

- Hot-dip coatings simulators
- Electro-galvanised simulators
- PVD equipment and pilot lines
- Organic coating pilot lines

Corrosion testing facilities

- Classical corrosion testing facilities (different forms of attack)
- Specific hydrogen resistance testing facilities (high temperatures & high pressures, acidic media, etc.)
- Cold-cracking testing
- Instrumented pressurised vessel equipments
- Sophisticated electrochemistry equipment (SVET, Kelvin probe)

Surface analysis

- Various and complementary surface analysis equipment (GDOES, SIMS, ESCA, FTIR, GCMS, DSC)
- AFM equipment
- Adhesion measurement facilities

Current Steel R&D Topics

- Development of new coatings
- Alimentary and hygienic surfaces (stainless steels)
- New surface functions
- Life time prediction of coatings
- Improvement of surface properties
- Development of new stainless & alloyed steels with improved corrosion resistance
- Development of products for lightweight and thermal isolation

Contact Addresses
Danièle QUANTIN, Director of Products laboratories
USINOR
13 Cours Valmy - TSA 10001 - Immeuble La Pacific
F - 92070 LA DEFENSE Cedex, FRANCE
Tel.: +33 (0)1 41 25 91 05; Fax: +33 (0)1 41 25 67 70
E-mail: daniele.quantin@sollac.usinor.com
http://www.usinor.com

Steel design for market applications

Core Steel R&D Competencies

Steel design for market applications

Steel R&D Organisation

CED, CRDM, CRI, CRG, CRMC, CRU, CRPC, FQZ, ISOFORM, LEDEPP, RDCS

Steel R&D Staff

Included in the 1250 people

Specialist Equipment for Steel R&D

- Computerised equipment for conception and CAD. Classical and specific software
- Forming press, roll-forming facilities, bending equipment, hydro-forming press
- Thermal acoustics measurements
- Mechanical characterisation of structures
- Body maker for packaging

Current Steel R&D Topics

- Steel design solutions for automotive, domestic appliances, packaging, construction
- Development of specific steel design software
- Mechanical characterisation of steel solutions

Contact Addresses
Danièle QUANTIN, Director of Products laboratories
USINOR
13 Cours Valmy - TSA 10001 - Immeuble La Pacific
F - 92070 LA DEFENSE Cedex, FRANCE
Tel.: +33 (0)1 41 25 91 05; Fax: +33 (0)1 41 25 67 70
E-mail: daniele.quantin@sollac.usinor.com
http://www.usinor.com

Steel products metallurgy

Core Steel R&D Competencies

Steel products metallurgy (carbon steels, alloyed and stainless steels)

Steel R&D Organisation

CRDM, CRI, CRMC, CRU, CRY, IRSID, LEDEPP

Steel R&D Staff

Included in the 1250 people

Specialist Equipment for Steel R&D

- 80 kg liquid steel furnace
- 2 hot-rolling pilots, hot torsion pilot, Gleeble machine
- Cold-rolling pilot
- 4 continuous annealing furnaces, batch annealing furnaces, enamelling furnace
- 2 skin-pass pilots
- Dilatometer, plastodilatometer
- Thermoelectric power, internal friction measurement

Current Steel R&D Topics

- Very high strength steels for automotive industry
- High strength steels for packaging with enhanced ductility
- Design of new highly alloyed steels
- Design of magnetic steels
- Metallurgical modelling

Contact Addresses
Danièle QUANTIN, Director of Products laboratories
USINOR
13 Cours Valmy - TSA 10001 - Immeuble La Pacific
F - 92070 LA DEFENSE Cedex, FRANCE
Tel.: +33 (0)1 41 25 91 05; Fax: +33 (0)1 41 25 67 70
E-mail: daniele.quantin@sollac.usinor.com
http://www.usinor.com

In-use properties

Core Steel R&D Competencies

- Classical mechanical properties
- Forming
- Joining
- Abrasion
- Magnetic properties

Steel R&D Organisation

CED, CRDM, CRG, CRY, CRMC, CRU, IRSID, LEDEPP

Steel R&D Staff

Included in the 1250 people

Specialist Equipment for Steel R&D

- Arc, laser and resistance welding equipment
- Impact, fatigue and fracture testing
- Forming equipments from laboratory scale to prototype
- Electromagnetic properties

Current Steel R&D Topics

- Weldability of products
- New technologies for non-conductive products
- Modelling and control
- Rheology, tribology and abrasion
- Fatigue, fracture, impact testing, acoustics
- Electromagnetic properties

Contact Addresses
Danièle QUANTIN, Director of Products laboratories
USINOR
13 Cours Valmy - TSA 10001
Immeuble La Pacific
F - 92070 LA DEFENSE Cedex, FRANCE
Tel.: +33 (0)1 41 25 91 05; Fax: +33 (0)1 41 25 67 70
E-mail: daniele.quantin@sollac.usinor.com
http://www.usinor.com

IRSID
Groupe Arcelor

Core Steel R&D Competencies

Elaboration, transformation, forming and coating of steels (carbon steels and stainless steels):
- process control and optimisation
- process development for new products
- sustainable process development

Fields of expertise at Irsid: knowledge of the processes, physical chemistry, metallurgy, science and analysis of surfaces and coatings, organic, inorganic and analytical chemistry, process engineering, solid-state and fluid mechanics, heat transfer, electromagnetism, metrology, signal processing, numerical analysis, software engineering.

Steel R&D Organisation

- Ironmaking (incl. Cokemaking at CPM)
- Steelmaking
- Rolling & Forming
- Surface Engineering and Physical Chemistry
- Physical Metallurgy
- Heat Transfer, Electromagnetism & Fluid Dynamics
- NDE & Computer Science
- Design, engineering, technology

Steel R&D Staff

450 (included in the 1250 people)

Specialist Equipment for Steel R&D

- A wide range of mechanical and thermomecanical testing and simulation machines: tension (100 to 4000 kN), press (up to 6300 kN), torsion, hot torsion, and fatigue test equipment (25 to 1000 kN), plastodilatometer, Gleeble machine, high-speed hydraulic machine (4000 kN), etc. Test possibilities include controlled strain rates, temperature ranges between -196°C and 1200°C and frequency ranges between 0.01 and 2102 Hz.
- Fine-scale measurements of other bulk and surface properties:
  - tribological properties: tribometers up to 600°C
  - local electrochemical properties: μ-electrode SVET, Kelvin probe
  - gravimetric and microgravimetric analysis
  - infra-red interferometry
- Advanced measurement techniques:
  - gas analysis, mass spectrometers (incl. VOC),
  - pyrometry laboratory (optical, IR analysis, spectroradiometer)
  - ultrasonic laboratory (US, Lamb waves, laser ultrasonic devices), bench ASIS platform
  - magnetic laboratory (eddy current array, Bärkhausen noise),
  - microradiography bench
  - dynamic image analysis, radioactive tracing
  - signal processing, etc.
- Laboratory simulators are dedicated to investigating the mechanisms of phenomena occurring during the elaboration, solidification and transformation of steel:
  - counter current reduction of ores
  - directional solidification furnace
  - plasto-dilatometers simulating phase transformations
  - micro-Raman environment cell
  - annealing furnaces
  - cold hydraulic models, with PID measurements
- Pilot and semi-industrial scale simulations of the processes:
  - pilot 400-kg carburising furnace (at CPM)
  - scrap shredders, up to 400 kW power; magnetic separators
  - pilot sintering pot, with fumes and dust continuous analysis
  - melting furnaces (1-300 kg)
  - pilot integrated steelmaking plant at 6-t level (6-ton EAF vacuum inductively heated 6-t ladle, continuous casting simulators, direct thin-strip twin-roll casting machine)
  - hot- and cold-rolling mills, including lubrication
  - in-line melting-casting-rolling pilot
  - hydraulic descaling pilot plant
  - continuous annealing pilot plant; wrinkling and buckling of strip
  - compact annealing line, inductive heating
  - pilot for induction heating of bars, transverse flux heating of strips

- pilot plants for different coating processes (liquid metal, organic, PVD, PACVD), scale 1 pilot for immersed material

- Computation:
  - commercial programs: FLUENT, ASPEN, FLUX-EXPERT, ABAQUS, LAM3, etc.
  - custom software, ranging from understanding models, such as complex multiphase equilibrium models to process simulation models (MMBF, BILAFO, BILAFEC, TOP-AOD, CERBER, TACSI, etc.). These models are used at industrial sites for off-line optimisation, for on-line process control, or for plant set-up.
- Advanced systems for chemical analysis, for bulk and fine-scale observation, for surface and volume analysis, ranging from the nanometric and parts-per-million scale to the macroscopic scale:
  - SEM, FEG-SEM, FEG-TEM, microprobes
  - in situ XPS-Auger, SIMS, ISS, GDOES
  - XRD analysers

Current Steel R&D Topics

- Product oriented process: development and optimisation of new processes for new products, upgrading of existing processes for new steel grades
- Process improvement for increased reliability and flexibility: reduction of cost, limitation of material and energy resources, improvement of product quality (bulk, surface)
- Development of more flexible and shorter routes, release of process constraints, new casting technologies, etc.
- Assessment of environmental impact of existing and new processes, recycling of steel and by-products
- Development of specific on-line measurement and inspection techniques

Contact Addresses
Henri BLAFFART, Director
IRSID, Voie Romaine - BP 320
F - 57214 MAIZIERES-LES-METZ cedex, FRANCE
Tel.: +33 (0)3 8770 4061; Fax: +33 (0)3 8770 4001
E-mail: henri.blaffart@irsid.usinor.com
http://www.usinor.com

Forschungs- und Qualitätszentrum Brandenburg (FQZ) Germany

Forschungs- und Qualitätszentrum Brandenburg (FQZ, Research and Quality Centre) was founded in 1995 by outsourcing of the research and development department of the EKO Stahl GmbH. It is an affiliated company of the EKO Stahl GmbH.

Core Steel R&D Competencies

- Development and application of flat-rolled products
- Metallurgical process development and control
- Development of tailored blanking
- Development of light-weight components

Steel R&D Organisation

Product development

- LC / ULC / IF
- HSS / UHSS / DPS / TRIPS / MPS
- Metallic and organic coating of steels
- Enamelling steels
- Electrical steels
- Application investigations

Process development and quality management
- Liquid metallurgical process
- Cold and hot rolling
- Quality management
- Factory wide process and product quality data base
- Data base engineering
- Measuring and process control

Lightweight construction
- Laser welding
- Steel sheet structuring
- Civil engineering

Steel R&D Staff

41 (included in the 1250 people)

Specialist Equipment for Steel R&D

- On-line product and process measurement (IMPOK - mechanical properties, FTIR - temperature measurement and SORM3 - roughness)
- Joining: laser (CO_2, Nd:YAG), spot welding, butt welding, mechanical joining(TOX-press)
- Forming / tribology (FLC, universal press, strip friction testing)
- Special laboratory for testing of enamelling steel

Current Steel R&D Topics

- Development of new steel grades
- Measurement (mechanical properties, temperature, roughness)
- Joining (laser welding for tailored blanks)
- Surface technology (metallic / ceramic / non-organic / organic coatings)
- Lightweight construction (flat structured sheets)

Contact Addresses
Dr. Hansjörg HARTMANN - General Manager
FQZ Brandenburg GmbH
Industriepark EKO, Strasse 20
D - 15890 EISENHÜTTENSTADT, GERMANY
Tel.: +49 (0)3364 375 862; Fax: +49 (0)3364 375 871
E-mail: Hartmann@FQZ-Brandenburg.de

Arvedi

The Arvedi Group manufactures and markets unalloyed and micro-alloyed structural steels for cold forming, rolling, and pressing; weathering steels; quality carbon-steel Electrical Weld Resistance (EWR) tubes; Oil Country Tubular Goods (OCTG) pipes used in drilling equipment; stainless-steel tubes; stainless-steel precision-rolled strip and quality steel coils from the new workshop using the innovative In-line Strip Production (ISP) technology; and ultra-thin cold-rolled strips for special applications.

Crude steel production 2001: 1.2 Mt

Employees 2000: 1500

Core Steel R&D Competencies

- From thin-slab casting to ultra-thin cold-rolled strips
- Low-carbon forming steels - thin gauge to replace cold-rolled strip for drums, plate radiators, lamellar stacks, expansion vessels, and Cr-coated tubes
- Construction steels for air-compressor cylinders, gas bottles, fine blanking, and water-boilers (enamelling)
- HSLA steels for car-sector drawing, suspensions, wheel discs, brake backing plates
- Boron heat treatment steels for side-impact bars

Steel R&D Staff 10

Specialist Equipment for Steel R&D

- CAD and modelling instruments
- Water-mould models
- Soft-reduction simulator

Current Steel R&D Topics

EAF	Carbon and oxygen injection techniques
Casting	Fluid-dynamics processes in thin-slab casting
	Liquid-core reduction for medium/high-carbon steels
Rolling	Development of hot-rolled gauges less than 1 mm
Product	High-strength multi-phase steels
Carbon-steel tubes	Welded tubes suitable for hydroforming with high deformability characteristics
Stainless sheet	Pickling and passivation on ultra-thin stainless products

Contact Addresses
Mr Antonio GUINDANI
Quality and Research Manager
Acciaieria ISP di Cremona srl
Via Acquaviva, Zona Porto Canale
I - 26100 CREMONA, ITALY
Tel.: +39 0372 4781; Fax: +39 0372 478283
E-mail: quality.isp@arvedi.it
http://www.ferrettispa.it/arvedi.htm

AvestaPolarit manufactures and markets stainless steel products. The main end-uses include process industries such as pulp and paper, chemicals, the offshore oil industry, catering and household applications, transportation, building and architecture.
The operations are divided into three business areas:

Coil Products: Primary Products, Cold-Rolled Stainless Coil and Sheet

Special Products: Ferrochrome, hot-rolled plates, long products, tubular products and precision strips. Applications for precision strip include razor-blade manufacture, computer applications, process-plant industry, kitchen equipment, heating-element tube, and car components.

North America: Hot-Rolled Plate, Bar and Tube, also sales and distribution business.
Coil products accounted for 65% of 2000 revenues; special products 27% and North America 8%.

Crude steel production 2001: 1.6 Mt

Employees 2000: 8914

Core Steel R&D Competencies

- Process development
- Product development
- Use of stainless steel

Steel R&D Organisation

AvestaPolarit R&D has two R&D Centres, one in Avesta and one in Tornio.
R&D Centre Tornio comprises product development and process development, which is subdivided into steelmaking and rolling processes, and customer service.
R&D Centre Avesta includes the following departments: Physical metallurgy, mechanical metallurgy, wet corrosion, high-temperature materials, process development, process chemistry, and technical market development.

Steel R&D Staff

105 (40 at Tornio and 65 at Avesta)

Specialist Equipment for Steel R&D

Pilot plants and laboratory facilities for melting, re-heating, hot rolling, cold rolling, annealing, and de-scaling of stainless steel

Current Steel R&D Topics

- New equipment and processes, e.g. RAP process and closed-loop pickling
- Simulation and modelling of key processes
- Data generation to support sales, e.g. properties related to corrosion, high-temperature forming, and FEM modelling
- Development in offering a range of surface finishes - some to meet hygiene requirements (fingerprint-resistant surface to meet the requirements of the domestic appliance sector and discourage the build-up of bacteria in such applications as catering equipment), others to enhance aesthetic appeal and appearance
- Development of cold-rolled products in their various forms of end uses, from providing the corrosion-resistance solution in the petrochemical industry, to the polished strip for a consumer durable product, to the patterned sheet on a prestige building
- Corrosion and heat-resistant stainless steel high-integrity tubes used in process industries such as pulp and paper, chemical and petrochemical, food and beverage, and energy industries
- Discover new applications for decorative and structural type tubes for applications such as handrails and architectural uses, plus automotive tubes for exhaust pipes
- Control methods for ensuring extremely tight tolerances in small-diameter tubes used in heat exchangers and drinking-water pipe systems, and large-diameter, thick-walled tubes often used in the production of oil and gas, and pulp and paper

Contact Addresses

Jorma KEMPPAINEN, Senior Vice President R&D and Strategic Planning
AvestaPolarit
PO Box 270 (Linnoitustie 4 A)
FIN - 02601 ESPOO, FINLAND
Tel.: +358 (0)95 76 45 504; Fax: +358 (0)95 76 45 555
E-mail: jorma.kemppainen@avestapolarit.com
http://www.avestapolarit.com

BÖHLER UDDEHOLM

The Böhler-Uddeholm Group has four business areas:

Long Products: tool steel (worldwide market leader) and high-speed steel (worldwide number two) for use in automotive industry, machine-tool manufacture, consumer goods, and electronics industry. Special Steel Long Products are essentially manufactured by Böhler Edelstahl in Kapfenberg (Austria) and Uddeholm Tooling in Hagfors (Sweden).

Strip Steel: industrial blades, bimetallic strips for cutting metal, rule dies, and cutting and creasing lines for the paper, packaging, and printing industries. Special cold-rolled strips are used in manufacturing saws, razor blades, shears, and scalpels. Essentially Böhler Ybbstal Band in Austria and Uddeholm Strip Steel in Sweden manufacture strip products.

Welding Consumables: welding consumables such as electrodes and wires, materials for repair welding, and soldering materials.

Forging Technology: drop forged, open die forged, and precision forged.

The Group is a niche supplier: the worldwide use of tool steels equals roughly 0.1% of total annual consumption of steel. For tool steels, quality features such as durability, wear resistance, toughness, corrosion resistance, and polishing performance are important. The most important business driver for tool steels is the introduction of new models (autos, cellular telephones, PCs, etc.). These changeovers require new forms and tools, which, in turn, are made of tool steel.

Crude steel production 2001: 206 714 t

Employees 2000: 9071

BÖHLER EDELSTAHL

Core Steel R&D Competencies

- Product and process development for tool steel, high-speed steel and special materials like Ni-base superalloys, superaustenites, ferrites, and stainless duplex steels
- Physical and numerical modelling of deformation processes and microstructure development
- Metallurgical expertise for processes like melting, casting, remelting, and powder technology

Steel R&D Staff 30

Specialist Equipment for Steel R&D

- Hot-deformation simulator (Gleeble 3800)
- Deformation dilatometer
- Differential thermal analysis

Current Steel R&D Topics

A wide range of topics, dealing with development of new alloys, optimisation of material properties, and process development. Minimisation of costs and improving environmental performance.

Contact Addresses
Dipl. Ing. Hubert LENGER
Böhler Edelstahl GmbH & Co AG
Postfach 96
A - 8605 KAPFENBERG, AUSTRIA
Tel.: +43 (0)3862 20 7116; Fax: +43 (0)3862 20 7585
E-mail: hubert.lenger@bohler-edelstahl.co.at
http://www.bohler-edelstahl.at

UDDEHOLM

Uddeholm Tooling's annual production is about 50 000 tonnes of alloyed tool steels.

Core Steel R&D Competencies

Production and development of tool steels

Steel R&D Staff 50

Specialist Equipment for Steel R&D

Various equipments for metallographic, mechanical properties, and machinability investigations

Current Steel R&D Topics

Process and product development of tool steels, failure mechanisms in industrial tools and dies, and machining of hard steels, etc.

Contact Addresses
Dr Lars-Åke NORSTRÖM
Uddeholm Tooling AB, Research and Development
SE - 683 85 HAGFORS, SWEDEN
Tel.: +46 (0)563 170 00; Fax: +46 (0)563 174 61
E-mail: lars.norstrom@uddeholm.se
http://www.uddeholm.com/UTAB

In addition to the R&D mentioned above, Böhler-Uddeholm also conducts steel R&D in the areas of welding, forging, and strip steel. The staff involved was 70.

Cogne Acciai Speciali produces stainless steels, high-alloy steels, tool steels, and valve steels in the following shapes: wire rods, hot-rolled bars, cold-finished bars, large forged ingots, and semi-finished products.
Cogne Acciai Speciali is a leading and large producer of special heat-resistant steels for the manufacture of intake and exhaust valves for all types of internal combustion engines.

Crude steel production 2001: 160 600 t

Employees 2000: 1000

Core Steel R&D Competencies

- Thermodynamic control of UHP-EAF and AOD processes
- Automated continuous-casting process - control through mathematical model
- Modified and new material in large forged blocks and bars (alloyed steels in tooling field, duplex stainless steels in energy sectors, oil industry)
- Modified and new materials in rolled wire rods and bars (especially for exhaust valves in internal combustion engines, for concrete reinforcement)
- Finishing of tailor-made extremely long pieces for duty applications (over 20 m)
- Gas atomisation of gas-atomised superalloy powders

Steel R&D Staff 15

Specialist Equipment for Steel R&D

- Induction melting furnaces: 250 kg and 1000 kg for new alloys testing
- Hot isostatic press
- Experimental instrumented continuous-casting mould

Current Steel R&D Topics

Steelmaking Process

- Low slag generation steelmaking
- Continuous casting flow modelling for improved steel structures
- Development of ingot-forging process by controlled thermomechanical parameters
- Thermomechanical control of wire-rod rolling for improving stainless-steel quality
- Procedures dealing with cold working of high-duty stainless steel bars

Products

- New heat-resistant alloys
- New materials for reinforced concrete in building and civil works
- Advanced materials for die casting
- Improved structures of large forged duplex stainless steel bars
- Healing of defects in cast shapes by hot isostatic pressing

Contact Addresses
Aldo BENNANI, R&D Manager
Cogne Acciai Speciali srl
Via Paravera, 16
I - 11100 AOSTA, ITALY
Tel.: +39 0165 302 302; Fax: +39 0165 43779
E-mail: aldo.bennani@cogne.com
http://www.cogne.com

Corus, producing and selling steel and aluminium, was formed in 1999 through the merger of British Steel and Koninklijke Hoogovens. The majority of the Group's steel is rolled in its own mills although it supplies semi-finished steel products to other steelmakers for rolling into finished products. Corus has a 23% stake in the stainless steel producer AvestaPolarit. Carbon steel accounted for 75% of 2000 revenues, stainless steel 15%, and aluminium 10%.

Crude steel production 2001: 18.1 Mt

Employees 2000: 64 900

The research activities of the Corus Group are currently carried out at the IJmuiden Research Centre in the Netherlands and three Technology Centres in the UK. However, the UK sites will be replaced by a new Research Centre to be built in Rotherham and opened in autumn 2002. The Research Centres in the UK and the Netherlands operate as one organisational entity under a single management structure, with most departments spread over several sites.

IJmuiden Technology Centre (IJTC)

The IJmuiden Technology Centre is active in continuous improvement of existing processes and products as well as the development of new processes, products, and applications for both steel and aluminium. Market-oriented product and application development, often in collaboration with customers, is a major focus of the activities at IJTC, with an emphasis on applications in packaging, automotive, and other transport sectors. In the Product Application Centres for these sectors, research and development is extended to customer processes. A sound basis of expertise in metallurgy and other relevant areas of science is available as well; the centre also maintains close relationships with major universities and research institutes.

Core Steel R&D Competencies

- New process for coke-free ironmaking
- Thin-slab and direct rolling technology
- Modelling and simulation
- Ceramics technology
- Manufacture and testing of pilot series of products for application in packaging, automotive, and transport

Steel R&D Organisation

- Ironmaking
- Steelmaking
- Aluminium and Steel Casting
- Ceramics Research Centre
- Rolling Metal Strip
- Process Science
- Steel Metallurgy
- Aluminium Metallurgy
- Measurement Integration & Engineering
- Coated Products
- Packaging Applications
- Automotive Applications
- Engineering Applications

Steel R&D Staff 460

Specialist Equipment for Steel R&D

- Pilot rolling mill for steel and aluminium
- Thermo-mechanical treatment and continuous annealing simulators
- Coating pilot lines
- Pilot production of DWI cans
- Test-pack facilities
- Presses etc. for automotive parts
- Advanced stress and strain testing equipment
- Facilities for high-temperature measurements

Current Steel R&D Topics

A wide range of process and product developments aimed at:

- development of new and improved flat steel products
- providing the process capability for making new and improved products
- achieving consistently the required product quality
- minimising through costs
- extending the life of capital assets

Contact Addresses
Drs. Nico J.W. THIJSSEN
P.O. Box 10.000
NL - 1970 CA IJMUIDEN, THE NETHERLANDS
Tel.: +31 (0)251 495 221; Fax: +31 (0)251 471 107
E-mail: nico.thijssen@corusgroup.com
http://www.corusgroup.com

Technology Centres in the United Kingdom

The Teesside Technology Centre, situated at Grangetown near Middlesborough is the main focus of process research in the UK.
The Welsh Technology Centre at Margam, Port Talbot, South Wales, concentrates on product and product applications research, mainly for Corus' strip businesses.
Swinden Technology Centre, near Rotherham, concentrates on the development of steel products and its metallurgical and related engineering processes, environmental research, and applications research for applications as diverse as transport, construction, power generation and engineering.

Swinden Technology Centre (STC)

Core Steel R&D Competencies

- Product development
- Product engineering
- Metallurgical processes
- Metallurgical examination and environmental conservation

Steel R&D Organisation

- Construction Applications
- Engineering Applications
- Transport Applications
- Long Product Rolling
- Steel Metallurgy
- Coated Products
- Measurement & Engineering
- Environment

Steel R&D Staff 285

Specialist Equipment for Steel R&D

A wide range of metallurgical analysis equipment including electron probe micro-analysis, secondary ion mass spectrometry, machinability testing, metal forming, structural testing, fatigue and fracture testing, welding plants.

Current Steel R&D Topics

Major ongoing projects:

- Development of new and improved products
- Improvements to steel properties, e.g. by microstructural engineering
- Reducing pollution and improving the environment both within Corus' plants and externally

Contact Addresses
Dr Keith MELTON
Corus Research, Development & Technology
Swinden Technology Centre
Moorgate, Rotherham, South Yorkshire UK S60 3AR, UNITED KINGDOM
Tel.: +44 (0)1709 825 295; Fax: +44 (0)1709 825 337
E-mail: keith.melton@corusgroup.com
http://www.corusgroup.com

Teesside Technology Centre (TTC)

Core Steel R&D Competencies

- Ironmaking
- Steelmaking
- Casting
- Reheating
- Rolling and finishing
- Control and instrumentation
- Mechanical and process engineering
- Process science

Steel R&D Organisation

- Ironmaking
- Steelmaking
- Steel Casting
- Long Product Rolling
- Process Science
- Measurement & Engineering

Steel R&D Staff 160

Specialist Equipment for Steel R&D

- Pilot blast furnace
- Steelmaking (EAF & BOF) and casting facilities at a 3-tonne scale

Current Steel R&D Topics

Major ongoing projects include a range of process developments, aimed at providing the process capability for making new and improved products, achieving consistently the required product quality, minimising through costs, extending the life of installations, and improving environmental performance.

Contact Addresses
Dr Brian SMITH
Corus Research, Development & Technology
Teesside Technology Centre
PO Box 11
Grangetown, Middlesborough, Cleveland UK TS6 6UB, UNITED KINGDOM
Tel.: +44 (0)1642 770 091; Fax: +44 (0)1642 467 254
E-mail: brian.smith@corusgroup.com
http://www.corusgroup.com

Welsh Technology Centre (WTC)

Core Steel R&D Competencies

- Automotive applications
- Organic coatings
- Light construction
- Product development and process enhancement for strip products

Steel R&D Organisation

- Rolling Metal Strip
- Automotive Applications
- Steel Metallurgy
- Coated Products
- Measurement Integration & Engineering
- Construction Applications

Steel R&D Staff 120

Specialist Equipment for Steel R&D

- Hydroformer
- 8000 kN press
- Multiaxial fatigue rig
- Hot-dip simulator
- Fourier Transformed Infra-Red spectroscopy

Current Steel R&D Topics

Development of new products for the Corus strip businesses, including coated products (both metallic and organic), development and optimisation of plant processes, fundamental understanding of the performance of strip products for the correct application of those products with customers.

Contact Addresses
Dr Bernard HEWITT
Corus Research, Development & Technology
Welsh Technology Centre, Port Talbot SA13 2NG, UNITED KINGDOM
Tel.: +44 (0)1639 872 014; Fax: +44 (0)1639 872 351
E-mail: bernard.hewitt@corusgroup.com
http://www.corusgroup.com

Dalmine S.p.A. is part of the Tenaris Group, a strategic alliance between 8 established manufacturers of steel tubes : besides Dalmine (in Italy), AlgomaTubes (in Canada), Confab (in Brasil), NKKTubes (in Japan), Siat and Siderca (in Argentina), Tamsa (in Mexico) and Tavsa (in Venezuela).

Tenaris is part of Techint, an international group with operations around the world in five areas of business: steel industry, infrastructure projects, industrial plants and processes, energy and power field and - more recently the public services sector.

Today, Dalmine is the second largest European seamless steel tube producer, controlling 20% of the European market and 44% of the Italian market with an annual production capacity of 950 000 tonnes of finished products.
In Italy, Dalmine owns 5 plants producing seamless, welded, and cold-drawn tubes, and cylinders and bottles. Dalmine produces seamless tubes for all applications, with external diameters from 12 mm (after drawing) to 711 mm.

Dalmine's main markets are industrial (51%), petrochemical (39%), and oil (10%), providing:
- Products for industry: mechanical tubes, tubes for bearings, tubes for hydraulic circuits and cylinders, hollow bars, tubes for fittings, tubes for boilers, automotive applications, and gas cylinders
- Petrochemical products: tubes to transport fluids at high pressure and temperature
- Products for oil: tubes for extraction and transport.

Crude steel production 2001: 780 000 t

Employees 2001: 3272

Core Steel R&D Competencies

- Mechanical tubing
- Structural tubing (diameter 17.2 - 711 mm)
- OCTG
- Line pipes
- Tubes for petrochemical plants and power generation
- Pipe for high-temperature service
- Hollows for redrawing and fittings manufacturing

Steel R&D Organisation

- Primary steelmaking processes
- Hot-rolling technology for tube production
- Cold-forming technologies
- Mechanical, creep & corrosion properties
- Modelling and full-scale testing of in-service performance

Steel R&D Staff 32

Specialist Equipment for Steel R&D

- Hot tensile testing
- Ring-expansion test
- Collapse testing of pipes
- Drop-weight tear test
- Creep testing
- Corrosion lab including testing in autoclave

- Rolling fatigue testing for bearing steels
- Hydro-burst test for air bags
- SEM (Scanning Electronic Microscope)

Current Steel R&D Topics

- Steel cleanliness
- Improvement of billet quality (slag metallurgy, temperature control, casting powder, mould monitoring, electromagnetic stirring)
- Modelling of piercing and mandrel mill processes
- Metallurgy of hot rolling and in-line heat treatment of seamless pipes
- Development of acid-resistant casing and tubing
- Development of high performances linepipes
- Weldability of seamless pipes
- Development of pipes in high-Cr steels for petro-chemical applications
- Development of pipes for engineering applications and automotive components
- Premium connections for top performance of sealing in high-pressure/high-temperature downhole conditions

Contact Addresses
Dr. Claudio LEALI, Director - Quality and R&D
Dalmine S.p.A.
Piazza Caduti 6 luglio 1944, 1
I - 24044 DALMINE (Bergamo), ITALY
Tel.: +39 035 560 3242; Fax: +39 035 560 3464
E-mail: cleali@dalmine.it
http://www.dalmine.it

DILLINGER HÜTTE

Dillinger Hütte is a major European heavy-plate producer. In Dillingen (Germany) slabs and ingots are processed into plates, up to 36 m in length, over 5 m in width and thickness up to 500 mm. Finished heavy plates are supplied as rolled, thermo-mechanically rolled, normalised rolled, normalised, or quenched.
Plate outstanding features are found in the unusual dimensions and very special properties which are optimally geared towards later use in manufacturing pressure vessels, drilling platforms, pipelines, bridge beams, excavator shovels and ships.

Crude steel production 2001: 2.1 Mt

Employees 2000: 5064

Core Steel R&D Competencies

- Metallurgy of high-strength, high-toughness, weldable plates
- Rolling with automatic thickness control
- Accelerated cooling from top to bottom of the plates (Multi-Purpose Interrupted Cooling MULPIC) for thermo-mechanical rolling and direct quenching
- Surface-inspection technology with automatic, computer-controlled ultrasonic testing plant

Steel R&D Staff 50

Specialist Equipment for Steel R&D

- Heat treatment and surface hardening furnaces
- Optical system for surface inspection and flatness control
- Software for prediction of surface-crack formation during continuous casting
- Software for the control of BOF and alloying processes in ladle

Current Steel R&D Topics

Ironmaking

- Blast-furnace metallurgy and process technology
- Burden distribution

Steelmaking

- Hot-metal desulphurisation
- Primary and secondary metallurgy
- Process control and modelling

Plate Technology

- Product design
- TMCP steels
- Special steels / new products
- Process engineering
- Accelerated cooling processes

Contact Addresses
Dr. K.-H. TACKE, General Manager, Research and Development
AG der Dillinger Hüttenwerke
P.O. Box 1580
D - 66748 DILLINGEN/SAAR, GERMANY
Tel.: +49 (0)6831 47 3389; Fax: +49 (0)6831 47 4588
E-mail: kh.tacke@dillinger.de
http://www.dillinger.de

Buderus
EDELSTAHL

Edelstahlwerke Buderus of Wetzlar is one of Germany's leading producers of high-quality steels. The entire production process is conducted in-house, from melting through to the end product. The main products are rolled products, tool steels, and open and closed die forgings.

Crude steel production 2001: 411 100 t

Employees 2000: 9608

Core Steel R&D Competencies

- Production and processing of steel
- Material development
- Metallurgical processes
- Process control
- Product characterisation

Steel R&D Organisation

- Materials Development
- Process Engineering

Steel R&D Staff 12

Specialist Equipment for Steel R&D

Mechanical - technological tests

- Tension tests from RT to +1000°C
- Impact bending tests from -196°C to +300°C on all forms of sample
- Fracture mechanics testing
- Evaluation of transformation behaviour

Current Steel R&D Topics

- Production control
- Studies in material and process development
- Investigation of damage
- Heat treatment and hardening

Contact Addresses
Dipl.-Ing. Walter GRIMM
Edelstahlwerke Buderus AG
Quality Department
Buderusstr. 25
D - 35576 WETZLAR, GERMANY
Tel.: +49 (0)6441 374 643; Fax: +49 (0)6898 374 899
E-mail: GrimmW@edelstahl.buderus.de
http://www.buderus.de

ERASTEEL

Erasteel is a leading producer of high speed steel, both ingot and PM produced. Erasteel belongs to the French group Eramet.

Erasteel has five production sites (two in France, three in Sweden).

Crude steel production 2001: 39 587 t

Employees 2000: 1100

Core Steel R&D Competencies

- High-speed steels
  - Alloy design
  - Production and processing
  - Heat treatment and structure characterisation
  - Mechanical and performance properties and testing
  - Tool failure analysis

Steel R&D Staff 25

Specialist Equipment for Steel R&D

- Pilot plant for gas atomisation of powder
- Vacuum heat-treatment furnace
- High-frequency ultrasonic testing (macro inclusions)

Current Steel R&D Topics

- New and improved tool materials
- Tool performance in relation to structure and properties

Contact Addresses
Henry WISELL
Erasteel Kloster AB
R&D Department
P.O. Box 100
S - 81582 SÖDERFORS, SWEDEN
Tel.: +46 (0)293 17000; Fax: +46 (0)293 17262
E-mail: henry.wisell@erasteel.se
http://www.erasteel.com

Georgsmarienhütte GmbH · seit 1856 · Edelstahl

Georgsmarienhütte GmbH is a company in the Georgsmarienhütte Group, comprising more than thirty companies in the following business areas: raw materials recycling, steel, forging, casting, and plant engineering construction.
Georgsmarienhütte GmbH specialises in bar steel in rounds, squares, and flats through to heat-treated and bright steel. Products are mainly applied in the automotive, forging, bearing, and mechanical engineering industries. Other major customers are chain, tube, and screw manufacturers. The melting process is based on a 125-tonne DC electric arc furnace, followed by a ladle furnace, ladle vacuum degassing, and a 6-strand continuous casting or ingot casting.

Crude steel production GMH Holding GmbH 2001: 897 061 t

Employees 2000: 1300

Core Steel R&D Competencies

- Metallurgical process development
- Process control
- Material development

Steel R&D Staff 22

Specialist Equipment for Steel R&D

Chemical analysis

- Mass spectrometer for EAF offgas analysis

Mechanical - technological testing

- Tensile test, Hardness / Jominy test, Charpy / Brugger test

Metallography

- Microscopic testing: microstructure, decarburisation, micro-cleanness, sulphide shape, banding, spheroidizing, Mc Quaid Ehn size, grain size
- Dilatometry

Current Steel R&D Topics

- Process control of EAF
- Minimisation of slag carry-over during EAF tapping
- Casting-powder modification to improve surface quality of continuously cast blooms and billets
- Improvement of the inner structure of bearing steels
- High-strength ferritic-pearlitic engineering steel for precipitation hardening
- Improvement of steel flow in the tundish (co-operation with BFI)
- Improvement of NDT equipment for rolled bars

Contact Addresses
Dr.-Ing. Ingo KOLM
GEORGSMARIENHÜTTE GMBH
Dept. Process Technology and Development
Neue Hüttenstraße 1
D - 49124 GEORGSMARIENHÜTTE, GERMANY
Tel.: +49 (0)5401 39 4025; Fax: +49 (0)5401 39 4598
E-mail: ingo.kolm@gmh.de
http://www.gmh.de

ISPAT Hamburger Stahlwerke (IHSW)

IHSW (Germany) is part of Ispat International NV, a group which manufactures and markets steel in USA, Mexico, Trinidad, Canada, France, Germany, and Ireland.

Crude steel production 2001: 1.0 Mt

Employees 2000: 620

Core Steel R&D Competencies

- Direct-reduction process
- Wire rod rolling technology
- Modelling and simulation

Steel R&D Staff

4 people of IHSW staff + support by share of 35 people from Centre de Recherche de ISPAT Europe (CRIE) in France

Specialist Equipment for Steel R&D

Wire-drawing machine

Current Steel R&D Topics

DR Plant

- Reduction of energy consumption and CO_2 emissions

Steel plant

- New steel grades
- Improvement of carbon segregation
- Improvement of billet-surface quality
- Improvement of steel cleanness

Rolling mill

- Improvement of mechanical properties of wire rod by controlled cooling conditions
- Improved coiling
- Extended roll life

Contact Addresses
Dr. Karl STERCKEN
Ispat Hamburger Stahlwerke
Dradenaustr. 33
D - 21129 HAMBURG, GERMANY
Tel.: +49 (0)40 7408 311; Fax: + 49 (0)40 7408 313
E-mail: Karl.Stercken@ispat.com
http://www.ispat.com

ISPAT Stahlwerk Ruhrort

ISPAT Stahlwerk Ruhrort (Germany) is part of Ispat International NV, a group which manufactures and markets steel in USA, Mexico, Trinidad, Canada, France, Germany, and Ireland.

Crude steel production 2001: 1.35 Mt

Employees 2000: 883

Core Steel R&D Competencies

- Super-clean steel for valve springs, steelcord, etc.
- High-performance free-cutting steel and steel wool
- Forging steels with high tensile strength
- CHQ alloys for fasteners
- Modelling and simulation

Steel R&D Staff

5 people from ISPAT Stahlwerk Ruhrort GmbH + support by share of 35 people from Centre de Recherche de ISPAT Europe (CRIE)

Specialist Equipment for Steel R&D

- Machinability test (cutting pendulum)
- Automated SEM-EDX for analysis of steel cleanness

Current Steel R&D Topics

- New steel grades
  - High tensile forging steel with good machinability
  - Super Ultra High Tensile (Rm=50 000 MPa) steels for cord applications
  - High ductility for 8.8 fasteners
  - Lead substitute for free-cutting steels
- Improvement of segregation (soft reduction, fast cooling)
- Improvement of billet surface quality
- Improvement of steel cleanness
- Zero-defect process for fastener production

- Cooling strategies for high-ductility wire rod
- Improvement of wire-rod surface quality

Contact Addresses
Hans-Günther KRULL
ISPAT Stahlwerk Ruhrort
Vohwinkelstraße 107
D - 47137 DUISBURG, GERMANY
Tel.: +49 (0)203 606 7375; Fax: +49 (0)203 526 6363
E-mail: Hans-guenter.krull@ispat.com
http://www.ispat.com

LUCCHINI ASCOMETAL

The Lucchini Group is among the European producers to combine the integrated process and the electric furnace process for the production of long products. With its 17 productive plants located all over Europe (Italy, France, UK, Sweden, and Poland), Lucchini has a leading position in Europe in long rolled products (quality and special steels) as well as in diversified steels (forgings and castings).
Lucchini is a main supplier of the automotive sector in Europe and the only EU steel producer to be able to supply the railway sector with both rails (108 m rails for high-speed tracks) and all types of wheel sets (complete with axle boxes, brake disks, and drive units).

Crude steel production 2001: 3.8 Mt

Employees 2000: 13 084

Core Steel R&D Competencies

Metallurgy (especially steels for bearings, gearing, forging parts, springs, mechanical parts, energy and superclean steels, thermomechanical treatments and processes)
Machinability (wear tests, physical data acquisition during machining, reproducing customer cutting configurations in order to validate a metallurgy and to define the best conditions)
Hot, warm, and cold forging (forging fitness of special steels, validating the metallurgies of steels used for forging)
I***n-service properties*** (fatigue resistance of steels and train wheel sets in usage conditions, measuring and taking into account residual stresses, tribology, mechanical tests, and rupture mechanics
Mechanical studies (contributing to the optimisation with respect to metallurgy)

Steel R&D Organisation

The Lucchini Group has two R&D centres: Lucchini CRS in Italy and Ascometal CREAS in France. The railway sector research is localised primarily in Italy and long-product research both in Italy and in France.

Steel R&D Staff 80

Specialist Equipment for Steel R&D

Metallurgy

- Vats for inclusion detection using ultrasound

Machinability
- Measurement of cutting power, load, torque, and temperature during the different tests (turning, milling, piercing, broaching, etc.)

Forming
- Instrumented hydraulic press
- Instrumented mechanical screw press
- Instrumented torsion bench (measure of rheological properties)

Mechanical
- Tension/compression torsion fatigue-test
- Rolling contact tests: ball flash washer type and ball raceway type
- Rolling/sliding contact tests

Modelling

Vibro-acustic labs
- Semi-anechoic room
- Portable system for complete track- and train-noise emission and vibration characterisation
- Trolley for rail-corrugation analysis

Full-scale test rig
- Dynamic test rig for train wheel sets
- Fatigue test rig for train and metro wheels
- Fatigue test rig for train axles
- Static test rig for train and tram wheels

Current Steel R&D Topics

Product/Application R&D
- Techniques dealing with forming and welding of steels
- Surface and thermal treatment
- New-product development and improvement (bearing steels, special grades for forging, special grades for surface treatments, special grades for petroleum drilling operations, lead-free high-machinability grades, spring steels, special grades for rails and train wheels and axles, special high-C steels for drawing)
- Co-designing of formed parts with customers
- Rail-wheel contact modelling

Process R&D
- Product improvement and production process optimisation by using mathematical models and advanced control techniques (ex.: TMC processes)
- System development and integration for plant automation and product-quality assessment (SPC and SQC)
- Superclean steel technique implementation in plants

Contact Addresses
Mariano SCEPI, Managing Director
Lucchini CRS S.r.l.
Via Oberdan, 1/a
I - 25128 BRESCIA, ITALY
Tel.: +39 030 3992221; Fax: +39 030 3992543
E-mail: m.scepi@lucchini.com
http://www.lucchini.com

Gerard LABBE, Manager
Ascometal CREAS
BP 70045
F - 57301 HAGONDANGE Cedex, FRANCE
Tel.: +33 (0)3 8770 7321; Fax: +33 (0)3 8770 7355
E-mail: g.labbe@ascometal.lucchini.com
http://www.lucchini.it

OVAKO STEEL

Ovako Steel manufactures and markets rolling-bearing and low-alloy constructional steels. The company is a part of SKF's Steel Division. The production mix includes hot-rolled and cold-worked products in the forms of bars, surface-removed wire, and seamless tubes. It also includes rolled and forged rings. The most important customer groups are rolling-bearing manufacturers, the automotive industry together with their subcontractors, suppliers of rock-drilling equipment, and the general engineering industry. The SKF Steel Division has production units in Sweden, France, and USA.

Crude steel production 2001: 388 225 t

Employees 2000: 2500

Core Steel R&D Competencies

- Process metallurgy
- Cutting technology
- Heating & furnace technology
- Quality & environmental technology
- Process development in steelmaking and in tube, bar, and ring manufacturing

Steel R&D Staff 100

Specialist Equipment for Steel R&D

Equipment for turning (soft and hard), drilling, and laser cutting

Current Steel R&D Topics

- New nitriding steel
- Air-hardening steel
- Clean steel

Contact Addresses
Jarl MÅRTENSON
Ovako Steel AB
Technology & Quality
SE - 813 35 HOFORS, SWEDEN
Tel.: +46 (0)290 25 000; Fax: +46 (0)290 25670
E-mail: Jarl.Martenson@skf.com

RAUTARUUKKI

The Rautaruukki Group comprises several companies in the iron and steel industry and related activities in 15 European countries. The major plants are located in Finland, Sweden, and Norway. Rautaruukki's main products are flat and long steel products. Steelmaking capacity is close to 5 million tonnes per annum. The Group is the biggest manufacturer of construction-system products, ship profiles, and chrome-plated bars in Europe. It also produces welded steel

tubes and hollow sections as well as coated steel-sheet products. Rolled products accounted for 39% of 2000 revenues, wires & bars 20%, prefabricated products 19%, tubes & pipes 12%, and construction & others 10%.

Crude steel production 2001: 4.17 Mt

Employees 2000: 13 000

Core Steel R&D Competencies

- All technologies concerning
  - Ironmaking
  - Steelmaking
  - Continuous casting
  - Reheating
  - Hot rolling
  - Cold rolling
  - Galvanising
  - Colour coating
  - Control and instrumentation
- Technologies concerning welded pipes
  - Pipe manufacture
  - Cold-formed structural sections
  - Components and systems for construction

Steel R&D Organisation

- Long-term research and development is done at corporate level in CRD (Corporate Research and Development)
- Short-term development is done in the industrial divisions

Resources are mainly located in Research Centres in Raahe and in Hämeenlinna. The former is focused on steelmaking and on hot-rolled strip and plate, the latter on cold-rolled and coated products and their applications.

Steel R&D Staff 210

Specialist Equipment for Steel R&D

- Pilot sintering plant (pot diameter 400 mm, bed height 400 - 600 mm)
- Ring expanding test equipment for pipes

Current Steel R&D Topics

Primary processes

- Coke structure and mineralogy and their influence on coke quality and blast-furnace performance
- Improved process control of a sinter plant, the quality of sinter
- Oxygen and oil injection into blast furnace, control of BF hearth operation and extension of hearth duration
- Modelling and development of process control of BOF steelmaking process, oxide metallurgy
- Thermodynamical and numerical modelling of flows in steel ladle
- Simulation models of continuous casting
- Crack formation in continuous casting, the influence of titanium on the hot ductility of slabs

By-products

- Slags in geotechnical engineering
- Optimal recycling of steelmaking dusts, scales, and sludges
- Dedusting of slag handling and by-product plants

Hot rolling of plate and strip

- Temperature homogeneity of slabs in reheating furnaces
- The application of microstructural models to hot rolling

- Profile, flatness, and ski-end control in plate rolling
- Integrated diagnostics system for plate rolling
- Ferritic-bainitic and TRIP steels for improved combination of strength and ductility

Finishing and coating

- Performance of coil-coated steel strip products under various conditions
- Advanced composite sandwich steel structures and their long-term durability
- Multilayer coatings with improved performance for construction applications
- Corrosion coatings based on polyaniline technology

Steel construction

- Steel construction in real fire
- Environmentally friendly construction technologies
- Pre-fabricated modular steel construction in the renovation of multi-storey residential buildings
- Steel in residential buildings for adaptable and sustainable construction

Contact Addresses
Dr Peter SANDVIK
Executive Vice President, Research and Development
Rautaruukki Oyj
P.O. Box 93
FI - 92101 RAAHE, FINLAND
Tel.: +358 (0)8 849 2535; Fax: +358 (0)8 849 2580
E-mail: peter.sandvik@rautaruukki.com
http://www.rautaruukki.fi

The Riva Group comprises a series of companies operating in the iron and steel industry and related activities. It is the largest group of the sector in Italy, the sixth in Europe and tenth in the world. This position was attained over half a century, as the result an expansion policy, which included the acquisition, restructuring, and revitalisation of several companies. The most important of these was the privatisation of ILVA from the IRI Group in 1995.
Today the Group owns 44 production and processing plants, 25 of which are located in Italy, where most of the steel (71%) is manufactured and 74% of the turnover is achieved.
It commands a considerable international presence with works in Germany, France, Belgium, Spain, and Greece as well as in Tunisia and Canada. The Riva Group also owns 27 service centres and trade companies.
The Group is present on the market for both flat and long products.

Crude steel production 2001: 15.05 Mt

Employees 2000: 25 781

Core Steel R&D Competencies

- Metallurgical process development and optimisation
- Customer-oriented development of new steel grades

Steel R&D Organisation

A centralised R&D organisation based in Genoa co-ordinates the activities performed by University Research Centres and Specialised Laboratories. This structure utilises engineers and technicians based in the production units for the development of the R&D programmes.

Steel R&D Staff 70

Specialist Equipment for Steel R&D

- Coal coking: experimental 300 kg coke oven
- Iron fines, iron ore: experimental pot grate
- Continuous annealing: experimental simulation equipment
- Enamelling: experimental processing line
- Deformations analysis: grid apparatus for drawing properties measurement

Current Steel R&D Topics

- Improvement of the processes and plants performances concerning energy savings and environmental aspects
- Development of new steel grades characterised by improved mechanical properties
- Studies for waste-materials recycling
- Development of novel sensors for enamelling steel behaviour prediction
- Organic-coating adhesion improvement for tinplate products
- Study of stress-corrosion phenomena in tinplate cans
- Neural networks and provisional model development for mechanical properties prediction
- Improvements of beam mechanical characteristics by thermomechanical treatments

Contact Addresses
Maurizio MINI, R.I.I. (R&D Dept.)
Riva Group - ILVA Genoa Works
Via Pionieri e Aviatori d'Italia, 8
I - 16154 GENOVA, ITALY
Tel.: +39 010 6078924; Fax: +39 010 6079953
E-mail: rapporti.internazionali@rivagroup.com
http://www.rivagroup.com

SAARSTAHL AG

Saarstahl specialises in the production of steel wire rod, sectional steel, and forgings. It supplies semi-finished products as well as wire rod, steel bars, wide flats, structural steel, broad flanged beams, colliery arches, and open-die forgings. The programme includes a wide variety of long and forged products in basic, high-grade, and special steels with three types of melting process and various conditions of delivery.

Crude steel production 2001: 2.5 Mt

Employees 2000: 5150

Core Steel R&D Competencies

- Production and processing of steel
- Process control

Steel R&D Staff 45

Specialist Equipment for Steel R&D

- Light microscopes and qualitative or quantitative image analysis of microstructure, grain size, purity, decarburization, and surface
- Energy and wavelength-dispersive X-ray analysis of phases and inclusions

Current Steel R&D Topics

- Environmental analysis
- Certification of primary and secondary inorganic reference material
- Heat treatment of all kinds from low-temperature aging to full annealing
- Hardening in water, oil, and salt bath
- Case hardening

Contact Addresses
Dr. Guenter ROTH
SAARSTAHL AG
Dept. Research and Development
Bismarckstr. 57-59
D - 66330 VÖLKLINGEN, GERMANY
Tel.: +49 (0)6898 10 4280; Fax: +49 (0)6898 10 4075
E-mail: guenter.roth@saarstahl.de
http://www.saarstahl.de

SALZGITTER AG
Stahl und Technologie

Under the umbrella of the management holding Salzgitter AG, the steel division (Salzgitter Stahl GmbH) comprises four operating companies with the works sites Salzgitter, Peine, and Ilsenburg: Salzgitter Flachstahl, Peiner Träger, Ilsenburger Grobblech, and Salzgitter Grossrohre. Furthermore, Salzgitter AG is owner of Mannesmann Röhrenwerke AG with different work sites all over Europe. Via the latter, Salzgitter has a share of Hüttenwerke Krupp-Mannesmann (HKM) in Duisburg. The main steel research activities of Salzgitter are carried out at Salzgitter Stahl and Mannesmann Forschungsinstitut.

Crude steel production 2001: 8.2 Mt

Employees 2001: 17 700

Steel R&D Staff 400

SALZGITTER STAHL

Salzgitter Stahl is a manufacturer of pig iron, crude steel, heavy profile steel sheets, hot-rolled wide strips and steel strips, heavy and medium-weight plates, sheet steel, surface-coated sheet steel, and large-diameter pipes.
The production of flat products, besides the liquid-phase production steps with blast furnaces and converter metallurgy, is concentrated at the Salzgitter works.
The Ilsenburg works produce heavy steel plates in a wide range of gauges and steel grades.
The long products are made at the Peine works with its high-end electric arc furnace.

R&D activities extend from optimising the use of raw materials and primary energy, including improvement of metallurgical processes, rolling, and heat treatment, to the development of innovative surface coatings. This includes research and development of surface finishing and corrosion protection systems on the basis of metallic, organic, and inorganic coatings.

Core Steel R&D Competencies

- Production and processing of steel and steel products
- Metallurgical process technology
- Development of new steel grades
- Material and product characterisation
- Application technology

Steel R&D Organisation

- Materials technology
- Materials development
- Application technology
- Testing technology

Specialist Equipment for Steel R&D

Laboratory equipment for simulation of production processes

Metallurgical process technology

- Sinter-plant simulator
- Metallurgical laboratory for simulating the blast-furnace process, testing of raw materials, e.g. coke and pellets and mixtures thereof
- Direct strip casting pilot plant

Rolling and heat treatment strategy

- Rolling stand for simulating hot and cold rolling
- Annealing simulator

Processing technology

- Simulation of hot-dip galvanising
- Electro-galvanising simulator
- Cathodic electro-deposition device
- Phosphating pilot line
- Laboratory-scale roll coater
- Paint-baking furnace
- Foil-lamination device
- Roll-coating devices for chemical pre-treatment and melting-adhesion coating
- Laser and laser-hybrid welding facility
- Simulator for enamelling of steel
- Corrosion simulator
- Forming simulator for testing tribology properties
- Forming dilatometer for simulating the combination of heat-treatment and forming processes

Testing technology

- Metals science
- Destructive testing
- Dilatometer for determination of forming properties at elevated temperatures
- Testing of refractories
- Hot-stage microscopy
- Determination of component behaviour
- Characterisation of surface-refined sheets
- Non-destructive testing and materials characterisation
- X-ray and γ-transmission analysis

Current Steel R&D Topics

- Optimisation of process parameters for quality enhancement and reduced use of energy and raw materials in the process chain: sintering plant, coking plant, blast furnace, converter, hot mill, cold mill, surface finishing, and further processing

- Direct strip casting
- Development of new methods for characterisation of products (off-line and on-line)
- Market-oriented development of new steel grades
- Application-oriented choice of material and use of modern processes that meet the material properties
- Judgement, optimisation, and development of procedures in the steel-processing industry
- New coating technologies like PVD and CVD techniques or nano-dispersive coatings
- Development of concepts for component engineering and processing meeting the demands of forming properties
- Development of surface-finished product
- Development of welding and alternative joining techniques

Contact Addresses
Gerd VOGTENRATH, Leiter Werkstoffzentrum
Salzgitter Flachstahl GmbH
Eisenhüttenstrasse 99
D - 38239 SALZGITTER, GERMANY
Tel.: +49 (0)5341 21 4436; Fax: +49 (0)5341 21 2008
E-mail: Werkstoffzentrum@Salzgitter-AG.com
http://www.salzgitter-ag.de

MANNESMANN RÖHRENWERKE
Mannesmann Forschungsinstitut

The Mannesmann Forschungsinstitut, a subsidiary of Mannesmannröhren-Werke AG (belonging to the Salzgitter Group), was established in Duisburg, Germany, in 1934 as an industrial and practice-oriented research and development institution for the Mannesmann Group. The MFI is located on the area of Hüttenwerke Krupp Mannesmann, with a strong link to this plant. The focus of MFI's work is on metallic materials and products, with the main emphasis on steel. Included among the institute's main customers - in addition to the subsidiaries and associated companies of the former Mannesmann Group - are the companies of Salzgitter Stahl. The institute also works for many other external companies in the areas of plant, pipeline, and steel construction, as well as the automotive industry.

Core Steel R&D Competencies

- Material development for tubes and tubular goods as well as plates, sheets, and strips
- Process development for steel mills, pipe mills, plate mills, strip mills, and subsequent processing
- Development and manufacture of equipments and facilities for non-destructive testing
- Failure analyses on structures made of metals or composites
- Lifetime assessment of metallic components

Steel R&D Organisation

- Metallurgy
- Materials Development, Welding Technology, Physical Metallurgy
- Corrosion and Corrosion Protection
- Engineering Technology, Mechanical Testing, Heat Treatment
- Technical Calculations, Forming Technology
- Automation and Testing Technology
- Marketing, R&D Co-ordination
- Patents and Licences
- Administration, Workshop / Maintenance

Specialist Equipment for Steel R&D

- Vacuum induction furnaces (100-300 kg melt weight)
- Hot flat rolling laboratory

- Creep-testing laboratory
- MIDAS cleanness testing
- Components testing (design verification)
- Mobile equipment for on-site measurement of physical parameters in the mills

Current Steel R&D Topics

Metallurgy

- Investigation on slag foaming in vacuum tank degassing reactors
- Decrease of the middle segregation and increase of the oxidic cleanness of slabs

Materials

- Development of line-pipe steels for service in acid environments
- New high-strength steels for line pipes
- New cold-forming high-strength steels for automotive applications
- New materials for the chemical industry
- Improvement of organic layers for corrosion protection

Engineering

- Development of new testing methods for tubular components for the automotive industry
- Development of safety regulations for large-diameter line pipe
- Improvement of product properties by means of modern computer simulation

Automation and testing technology

- Development of new ultrasonic sensors for failure detection and further development of contactless ultra-sound wall thickness measurement
- Development of filmless radiography
- Further development of laser-based hot wall thickness measurement

Contact Addresses
Dr. Ingo von HAGEN, Managing Director
Mannesmann Forschungsinstitut GmbH
Ehinger Str. 200
D - 47259 DUISBURG, GERMANY
Tel.: +49 (0) 203 999 3185; Fax: +49 (0) 203 999 4362
E-mail: info.service@mfi.de
http://www.mfi.de

SANDVIK Steel

Sandvik is an Engineering Group with 35 000 employees operating in 130 countries. The Group holds a leading position in three areas:

- Cemented-carbide and high-speed steel tools for metal working
- Machinery, tools, and service for rock excavation
- Seamless tubes, strip, wire, and bar made of stainless and special steels and alloys

Sandvik Steel, one of the Group's main operating units, is a producer of tube, strip, wire, and bar products made of stainless steel and special alloys. Sandvik Steel has 20 production plants in 13 countries all over the world.

Crude steel production 2001: 200 000 t

Employees 2000: 6500

Core Steel R&D Competencies

- Seamless tube and pipe of stainless and high-alloy steels intended for industries that make high demands on reliability in operation, corrosion resistance and mechanical properties. Some examples are the chemical- and petrochemical industries, the power industry, the oil & gas exploitation and the electronics industry
- Alloys of nickel, titanium and zirconium for advanced purposes such as tubes for the nuclear power and aerospace industries
- Strip and wire products in high-alloy steel grades used in various fields of application. Saws, razorblades, various types of stainless springs and welding consumables are some examples, as well as precision parts used in such diverse industrial fields as road vehicles, electronics and power, and for medical purposes.
- Stainless steel bar and hollow bar for machining

Steel R&D Staff 250

Specialist Equipment for Steel R&D

Together with computer simulations, laboratory- and production trials, new ideas and products are tested in co-operation with customers

Current Steel R&D Topics

AB Sandvik Steel has more than 900 different steel grades for production. New alloys as well as new applications for existing alloys are continuously developed, and each grade is tailor made with different properties to suit a specific environment or application. To ensure and to further strengthen the company's leading position, there is an ongoing focus on extensive research and development of new products and production methods.

Some examples of important areas:

- Advanced products and materials for the oil and gas industry
- High-purity materials for the medical technology industry
- Composite tubes for use in recovery of process heat for production of electricity and district heating at waste-incineration plants
- Precision components for the electronics industry
- Products for the fertiliser production industry, where the materials are exposed to very aggressive conditions
- Stainless steel bar and hollow bar for machining. The development work together with the sister company AB Sandvik Coromant, gives a unique possibility to offer materials and tools with an optimum compatibility

Contact Addresses

Dr Tomas THORVALDSSON, Vice President R&D
AB Sandvik Steel
SE - 811 81 SANDVIKEN, SWEDEN
Tel.: +46 (0)26 26 30 00; Fax: +46 (0)26 25 17 10
E-mail: tomas.thorvaldsson@sandvik.com
http://www.steel.sandvik.com

Sidenor is an independent international group based in Spain, Brazil, and Mexico, dedicated to the production of long products in engineering, stainless, tool, valve steels, and special alloys, as well as heavy forging and casting steel components and drop-forged automotive components.
The European production facilities are located in Spain: Basauri (rolled products), Vitoria (rolled products), Reinosa (rolled products, forgings, and castings) and Villalba (drop-forging machining).

Crude steel production 2001: 779 000 t

Employees 2000: 2400

Core Steel R&D Competencies

- Product design and development
- Steelmaking- and casting-process design and modelling
- Hot-forming process design and modelling
- Heat-treatment design for long products and final components

Steel R&D Staff 70

Specialist Equipment for Steel R&D

- Melting and solidification (Vacuum melting and casting furnace)
- Hot plasticity (hot plastometer, cold and hot upsetting press, termograph, pyrometers)
- Heat treatment (quenching dilatometer, heat-treatment furnaces)
- Fatigue testing (tension-compression machine, biaxial machine, 3 rotating bending fatigue machines, 10 rolling contact fatigue machines)
- Machinability (NC lathe, NC drilling - milling centre, cutting-force measuring equipment, profile projector)

Current Steel R&D Topics

- Machining behaviour: free-cutting, improved-cutting ,and unleaded steels
- Cold forming: pretreated steels
- Hot forming: micro-alloy steels, grain-size control, direct quenching
- Value-added products: high-strength spring steels, valve-spring steels, ball-bearing steels
- Stainless and valve steels: new grades
- Tool steels: new grades

Contact Addresses
Félix REPÁRAZ
Sidenor I+D, S.A.
Barrio Ugarte s/n
ES - 48970 BASAURI, SPAIN
Tel.: +34 944 871 880; Fax: +34 944 871 844
E-mail: felix_reparaz@sidenor.com
http://www.sidenor.es

SSAB is the main Swedish producer of commercial steel for demanding applications with emphasis on extra high-strength steels. The Group has two steel-production companies in Sweden:

- **SSAB Oxelösund** is an integrated steelworks at Oxelösund producing slabs and heavy plate with a core business in extra high-strength steels and abrasion-resistant steels
- **SSAB Tunnplåt** at Luleå and Borlänge produces strip steel, metal-coated strip steel, painted strip steel, and strip steel coated with plastic foil

The Group also includes companies for manufacturing of:

- Organically coated and profiled steel building sheet and systems for rainwater runoff
- Safety components for the car industry
- Prefinished steel sheet for the engineering industry

SSAB has sales and trading subsidiaries in many countries.

Crude steel production 2001: 3.82 Mt

Employees 2000: 9894

Core Steel R&D Competencies

- Plate-rolling technology
- Heat treatment
- Process control

Steel R&D Organisation

There are three R&D departments, one at each production site

Steel R&D Staff 190

Specialist Equipment for Steel R&D

Equipments for chemical and physical analysis, material characterisation, metal forming, welding, fatigue and fracture testing, corrosion testing

Current Steel R&D Topics

- Clean steel with low impurities
- Surface-defect elimination and high internal quality of slabs
- QT steels with extra high-strength and/or high abrasion resistance
- Application technology of QT steels
- Prediction of service life under wear conditions
- Development and optimisation of plant processes
- Correlation between engineering properties and customer needs
- Correlation between process parameters, microstructure and engineering properties

Contact Addresses
Dr Bertil AHLBLOM, Manager of Materials Development
SSAB Oxelösund
SE - 613 80 OXELÖSUND, SWEDEN
Tel.: +46 (0)155 254000; direct: +46 (0)155 254324
Fax: +46 (0)155 254082
E-mail: bertil.ahlblom@oxelosund.ssab.se
http://www.oxelosund.ssab.se

Dr Hans KLANG, Manager R&D
SSAB Tunnplåt AB
SE - 781 84 BORLÄNGE, SWEDEN
Tel.: +46 (0)243 70 000; direct +46 (0)243 71436
Fax: +46 (0)243 71548
E-mail: hans.klang@ssab.com
http://www.ssabtunnplat.com

ThyssenKrupp Steel is one of the world´s biggest steel producers consisting essentially of two business units: high-quality flat carbon steel and stainless steel. The product range is completed by nickel-based and other alloys to meet specific demands in extreme applications and by electrical steel. Production sites are concentrated in the German federal state of North Rhine Westphalia. Further major works for steel production and downstream operations are located in Brazil, China, France, India, Italy, Mexico, and the United States. Major customers come from the automotive, household appliance, construction and packaging industries.

ThyssenKrupp Steel´s research is focussed on continuous optimisation of steel production technologies, material development, and customer-specific, application oriented problem solving. The manifold R&D activities are carried out decentralised by the R&D and the business units of the different companies. The main research facilities (including Quality Engineering and Material Testing) are the R&D units of ThyssenKrupp Stahl, ThyssenKrupp Nirosta, ThyssenKrupp Acciai Speciali Terni, ThyssenKrupp Electrical Steel EBG, ThyssenKrupp VDM, Edelstahl Witten-Krefeld, Krupp Edelstahlprofile, and the R&D centre DOC Dortmunder Oberflächen-Centrum, which is specialised on surface technology.

Crude steel production 2001: 16.16 Mt

Employees 2000: 53 865

ThyssenKrupp Stahl is one of the major European producers of high-quality flat carbon steel. Crude steel production is around 15 Mt per year (including the 50 % share of Hüttenwerke Krupp Mannesmann). ThyssenKrupp Stahl operates Europe´s first casting-rolling facility in an integrated steel mill. R&D is carried out by the various R&D departments of the business units and the R&D Centre, Quality Engineering and Material Testing (FQP).

Located in Duisburg and Dortmund, FQP consists of eight departments and the Applied Development Centre which all are well equipped with a wide spectrum of test facilities and pilot plants completed by powerful computing and even some production capabilities. The Applied Development Centre concentrates on projects in close co-operation with customers, e.g. in the areas of forming and joining. Under the heading of "simultaneous and concurrent engineering" customers are offered consulting and practical assistance in system solutions for highly complex technologies such as automobile production which requires the combination of different disciplines like materials, production and vehicle technology.

Core Steel R&D Competencies

- Material, process and product development
- Simultaneous and concurrent engineering
- Forming, joining, and simulation techniques, tailored products

Steel R&D Organisation

- R&D Departments of Business Units
- R&D Centre FQP (including Applied Development Centre and SE-Automobile)

Steel R&D Staff 370

Specialist Equipment for Steel R&D

- Simulators and pilot plants for the entire process from smelting via rolling of hot and cold strip, to batch or continuous annealing
- Complete laboratory equipment and test stands, e.g. for the determination of metallurgical and mechanical properties, surface topographies, chemical analysis, and element distributions
- Complete equipment for application techniques, e.g. hydroformer, tube hydroforming equipment, hydraulic presses up to 6000 kN, 2/3-D laser systems (CO_2/YAG lasers up to 5 kW) for welding and cutting, 3-D testing machine

Current Steel R&D Topics

Development of new and improved products and processes, e.g.

- Tailoring multiphase steels to customers requirements
- New steel concepts for casting rolling plant, direct-strip casting
- Multi-material concepts
- Tailored tubes, blanks and strips, hydroforming
- Hybrid and sandwich blanks

Contact Addresses
Dr.-Ing. Peter KLOSE
ThyssenKrupp Stahl AG
D - 47161 DUISBURG, GERMANY
Tel.: +49 (0)203 52 44611; Fax: +49 (0)203 52 24191
E-mail: peter.klose@tks.thyssenkrupp.com
http://www.thyssen-krupp-stahl.com

DOC Dortmunder OberflächenCentrum

DOC is the competence centre of ThyssenKrupp Stahl in the field of surface technologies. The main part of the Centre is a pilot plant for strip in which new coating systems are developed and tested. Within the Centre there is a close co-operation with institutes of the Fraunhofer Gesellschaft in the area of plasma and beam technologies.

Core Steel R&D Competencies

- Metallic, anorganic and organic coatings, coil coating
- Physical (PVD) and chemical (CVD) vapour deposition
- Corrosion testing, surface analysis, process modelling

Steel R&D Organisation

- Surface treatment/corrosion automotive
- Surface treatment construction/household industry
- Metallic/anorganic coating automotive
- Chemical/physical analysis
- Quality assurance

Steel R&D Staff 35

Specialist Equipment for Steel R&D

- 80 m flexible strip-coating pilot line with pretreatment and cleaning section
- PVD, CVD and Chem/Sili-coater facilities
- Simulators for hot-dip galvanising and electrolytic deposition
- Facilities for coil-coating and cleaning simulations
- A wide range of special analysis and testing equipment

Current Steel R&D Topics

Development of new and improved surface technologies, e.g.

- Combination of improved, established processes with vacuum process technology
- Functional layers
- Green coatings

Contact Addresses
Dr.-Ing. Michael STEINHORST
DOC Dortmunder OberflächenCentrum GmbH
Eberhardstraße 12
D - 44145 DORTMUND, GERMANY
Tel.: +49 (0)231 844 3212; Fax: +49 (0)231 844 5969
E-mail: steinhorst@doc.thyssenkrupp.com

ThyssenKrupp Nirosta

With a total production of more than a million tonnes ThyssenKrupp Nirosta, together with the affiliated company ThyssenKrupp Acciai Speciali Terni, is one of the market leaders in stainless steel flat products. The product spectrum covers more than 100 different corrosion and heat-resistant steel grades of ferritic, austenitic and duplex grades. The R&D departments, located mainly at Krefeld and Düsseldorf, are well equipped with all necessary test facilities, pilot plants and computing capabilities. One focus of process development is work on an innovative near-net-shape casting process shortening the production route from liquid steel to hot strip. At Krefeld, ThyssenKrupp Nirosta operates the first European pre-industrial strip-casting plant.

Core Steel R&D Competencies

- Alloy development
- Process and production development
- Material testing
- Customer services and quality management

Steel R&D Organisation

- Material development
- Process development
- Metallography, chemical analysis and corrosion testing, measuring and testing

Steel R&D Staff 39

Specialist Equipment for Steel R&D

- Modern equipment for material development and testing.
- Lab simulation of further material processing

Current Steel R&D Topics

- Development of strip-casting technique
- Surface quality yield management
- New stainless steels for corrosive application
- New high-strength steels for light-weight construction
- New surface design for improved properties

Contact Addresses
Dr.-Ing. Alfred OTTO
ThyssenKrupp Nirosta GmbH
D - 47807 KREFELD, GERMANY
Tel.: +49 (0)2151 83 4900; Fax: +49 (0)2151 83 4613
E-mail: otto.alfred@ktn.thyssenkrupp.com
http://www.nirosta.de

ThyssenKrupp VDM

ThyssenKrupp VDM is a major producer of strips, sheets, bars and wires of nickel-based alloys and special steels. The R&D activities focus on these alloys and the processes from melting to manufacturing the semi-finished products.

Core Steel R&D Competencies

- Temperature and corrosion resistant alloys, alloys for heating elements, expansion alloys, and soft-magnetic alloys
- Ingot casting of Ni-based alloys and special steels, ESR, VAR, wide plates, cold rolling and drawing, wide foils, flat wires, punched products

Steel R&D Organisation

R&D Divisions: melting and casting, strip and components, plate, sheet, rod and bars, wire, coinage, R&D management

Steel R&D Staff 34

Specialist Equipment for Steel R&D

Various laboratory facilities for e.g. melting, hot and cold rolling, annealing, and all necessary analysis and testing equipment

Current Steel R&D Topics

- Remelting techniques and metallurgical cleanness
- Fe-Cr-Al and Ni-based alloys for high-temperature applications
- Ni-Fe alloys for electronic applications
- Alloys for welding applications and chemical plants

Contact Addresses
Dr. Angelika KOLB-TELIEPS
ThyssenKrupp VDM GmbH
P.O.Box 1251
D - 58742 ALTENA, GERMANY
Tel.: +49 (0)2392 55 2866; Fax: +49 (0)2392 55 2817
E-mail: AKolb-Telieps@vdm.thyssenkrupp.com
http:///www.kruppvdm.de

EDELSTAHL WITTEN-KREFELD GMBH

Edelstahl Witten-Krefeld is a leading producer of rolled and forged long products out of speciality steels such as tool steels, stainless acid and heat resistant steels, and engineering steels. Edelstahl Witten-Krefeld is the largest tool-steel manufacturer worldwide. The research activities are concentrated in the Customer Services, R&D and Quality Control Departments, so that developments are done in close co-operation with customers and the business units.

Core Steel R&D Competencies

- Product and process development for speciality steels (long products)
- Quality engineering and material testing

Steel R&D Organisation

- Customer servicing and R&D departments for engineering, stainless, acid- and heat-resistant steels
- Customer servicing and R&D departments for tool steels
- Material Testing & Release department

Steel R&D Staff 21

Specialist Equipment for Steel R&D

Various laboratory equipment e.g. for:

- Heat-treatment investigations
- Investigations to verify machinability
- Hot-deformation tests
- Metallurgical and physical properties
- Corrosion properties

Current Steel R&D Topics

A wide range of topics consistent with the business aims, dealing with optimisation of steel properties and process development

Contact Addresses
Dipl.-Ing. Volker SCHÜLER
Edelstahl Witten-Krefeld GmbH
D - 58449 WITTEN, GERMANY
Tel.: +49 (0)2151 83 2699; Fax: +49 (0)2151 83 3299
E-mail: schueler@ewk.thyssen.com
http:///www.edelstahl-witten-krefeld.de

voestalpine

voestalpine manufactures and distributes steel products in two main categories:

Flat products: hot- and cold-rolled flat-steel products, with a special emphasis on high-technology products, such as hot-dipped and electrochemically coated sheet, coated strips, steel sections and profile tubes, as well as tailor-made forging and casting products

Long products: rails including ultra-long rails and rails with hardened heads, rolled wire and seamless tubes.

Flat products accounted for 74% of fiscal 2001 revenues and long products 24%.

Division Stahl (Division Steel)

The core business of voestalpine Stahl is the production, processing, and sale of sophisticated steel products, including service, in the flat-products business sector.

Crude steel production 2001: 4.1 Mt

Employees 2001: 9232

Core Steel R&D Competences

- Process development and optimisation
- Customer-focused product development
- Process and product development targeted on further processing

Steel R&D Organisation

- Central strategic Research and Development
  - Co-ordination of R&D group activities and international partnerships
  - Strategic projects including future steelmaking processes and long-term perspectives in steel and alternative materials
- Raw-materials treatment and ironmaking R&D department
- Steelmaking and hot-rolling R&D department for flat products
- Cold-rolling, post-treatment, and processing R&D department for flat products
- Materials-testing and quality control R&D department

Steel R&D Staff 150

Specialist Equipment for Steel R&D

Laboratory simulation equipment, e.g. for cold rolling, continuous annealing, batch annealing, electrogalvanising, hot-dip galvanising, organic coating, UV curing.
For studies of product properties like forming, welding, joining, painting, or corrosion behaviour, all facilities - from a 530 t press up to outdoor exposure site - are available.

Current Steel R&D Topics

- Solid materials injection at blast furnace
- Injection of coke-oven gas into blast furnace
- Development of a computer-controlled tapping management system for blast furnace
- Hot-metal desulphurisation in steel meltshop
- Improvement of BOF refractory service life (slag splashing)
- Improvement of slab quality (slag metallurgy, temperature control, casting powder, mould monitoring)
- Development of high and super-high strength hot-strip steel grades with maximum forming property, ductility and good weldability like cold-formable TM grades as competitive materials with quenched-and-tempered steels
- Dual-phase (DP) steels, TRIP steels and complex phase (CP) steels
- Production of high-strength hot-rolled strip for crane jibs with tensile strength 980 MPa
- Development of high-permeability electric-quality sheets with reduced core loss
- Development of production routes for bake hardening
- Assurance of zinc-coatability for high and super-high strength steels by specific operation of annealing furnace
- Development and introduction of 2nd generation Cr-free, weldable, organically thin-coated sheets
- Development of pre-painted strip for modular automotive components
- Pre-development of alternative coating processes
- Development of material know-how for production of hydroformed parts for structural and chassis automotive components
- Development of laser hybrid welding equipment for tailored tubes
- Preparation of future scenarios for super-high strength materials
- Technology monitoring of alternative automotive materials
- Expansion of hot and cold-rolling simulation laboratory for future materials development

Contact Addresses
Dr. Peter SCHWAB
Research and Development - Group Activities / R&D-Management
voestalpine Stahl GmbH
Voest-Alpine-Strasse 3, P.O. Box 3
A - 4031 LINZ, AUSTRIA
Tel.: +43 (0)732 65 85 60 79; Fax: +43 (0)732 69 80 55 00
E-mail: peter.schwab@voestalpine.com
http://www.voestalpine.com

Division Bahnsysteme (Division Railway Systems)

voestalpine Railway Systems consists of four companies:

VOESTALPINE STAHL DONAWITZ GmbH, located at Donawitz (steel producer)

VOESTALPINE SCHIENEN GmbH & CO KG, located at Donawitz (rail producer)

VOESTALPINE AUSTRIA DRAHT GmbH, located at Donawitz (producer of wire rod) and Bruck (producer of cold-drawn and annealed wire)

VOESTALPINE STAHLROHR KINDBERG GmbH & CO KG, located at Kindberg (producer of seamless tubes).

Crude steel production 2001: 1.3 Mt

Employees 2001: 5030

Core Steel R&D Competencies

- Product and process development for the manufacturing of rails, wire rod, and seamless tubes
- Process development for the production of semi-finished material in these steel grades (iron-ore preparation, reduction metallurgy, primary and secondary metallurgy, continuous casting of blooms)

Steel R&D Staff 22

Specialist Equipment for Steel R&D

- Amsler bi-discs wear tester
- Full-size rail/wheel rolling-contact fatigue equipment
- Fracture-mechanics testing
- Fatigue-testing equipment for different loading conditions

Current Steel R&D Topics

- Injection of various solid materials into the blast furnace
- Study of the solidification of the steel shell in the continuous-casting mould
- Effect of FEMS in CC rounds on the segregations in the cast material
- Development of new steel grades for the rail, wire, and tube industry (e.g. wear-resistant rails)
- Development of new technologies and optimisation of the melting, casting, and rolling processes
- Cost minimisation and environmental improvement

Contact Addresses
Herbert SCHIFFERL
voestalpine STAHL DONAWITZ GMBH
Postfach 1
A - 8704 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 201 4620; Fax: +43 (0)3842 201 4926
E-mail: Herbert.Schifferl@voestalpine.com
http://valangprodukte.web.posimis.com/langproduktegruppe

Institutes Dedicated to Steel Research

Centre de Recherches Métallurgiques
Centrum voor Research in de Metallurgie

CRM is a non-profit association created in 1948 by the Belgian steel industry. CRM's partners include large international groups with operation sites in the Benelux countries and firms from Belgium and Luxembourg having a metal-related activity.

The active members monitoring together a common research programme are steel companies of the three groups ARBED, CORUS and USINOR.

The associated members (24 companies in 2001) are metallurgical companies, firms providing the metallurgical industry with goods or services, and firms transforming metallurgical products.

CRM comprises two main locations sited on the campuses of the Universities of Liège and Ghent.

Core Steel R&D Competencies

- Technical innovation in metal production and the application of new technologies
- Detailed knowledge on the relationships between process variables and steel properties
- Environmental aspects of technological developments

Steel R&D Organisation

Activity sectors
Primary processes
Melting, casting, and shaping
Rolling and rolled products
Finishing and coating
Resource departments
Metallurgical engineering
Metal science
Advanced techniques
New technologies in communication and modelling

Steel R&D Staff 165

Specialist Equipment for Steel R&D

- Rotary hearth furnace for direct reduction
- Pilot sintering plant
- Combustion test rig with coal injection and plasma heating
- Continuous casting simulator, including melting furnace
- Combined casting, rolling, accelerated cooling line
- Hot-rolling stands equipped with heating furnaces, coilers, lubrication units, ultra-fast strip cooling devices, etc.
- Pilot roll-cooling unit
- Ultra-short annealing simulator
- Continuous annealing and hot-dip coating line

Current Steel R&D Topics

Primary Processes

- Efficient and clean operation of the sintering process
- Advanced development and control of the blast furnace
- Direct-reduced iron (COMET process)
- In-plant transformation of wastes and valorisation of by-products

Melting, solidification and shaping

- Scrap recycling and tramp-elements effects
- Control of the electric arc furnace
- High-speed continuous casting for high-quality semis
- Improved cleanness for demanding steel grades

Rolling and rolled products

- Production of strips with prime-quality surface
- Roll-surface monitoring (Rollscope)
- Ferritic rolling with lubricated HSS rolls
- Fine-grain multiphase steels
- Thermo-mechanical treatment during hot rolling of bars (Tempcore), wire rods (EDC), rails (CHHR), shapes (QST), plates (MULPIC), strip (UFC)
- Novel steel grades by novel routes

Finishing and coating

- Improved efficiency of the hot-strip pickling line
- Thermal treatment and new technologies in continuous lines: annealing (HOWAQ), galvannealing (Square Cycle)
- High-strength steels by ultra-short annealing
- Roll texturing (LASERTEX)
- On-line microscopy
- Hot-dip process and coatings

Contact Addresses
Mr. Stéphan WILMOTTE, General Manger
CRM, rue Ernest Solvay, 11
B - 4000 LIEGE, BELGIUM
Tel.: +32 (0)4 254 6391; Fax: +32 (0)4 254 6464
E-mail: wilmotte@rdmetal.ulg.ac.be

BFI

Betriebsforschungsinstitut, VDEh-Institut für angewandte Forschung

BFI is the central industrial research institute of the German steel industry for applied research. It was founded in 1968. Shareholder is the Verein Deutscher Eisenhüttenleute (VDEh) with about 100 European member companies.

Core Steel R&D Competencies

- Optimisation of production plants and development of new processes
- Application of modern control techniques
- Analytical and data-based process modelling
- Application of Artificial and Computational Intelligence
- Development of on-line measuring and testing systems
- Quality analysis and quality control

- Surface technology and tribology
- Flow optimisation for processes and plants
- Process analysis and continuous-measurement techniques for melts
- Combustion, process gas engineering, and internal gas utilisation
- Heat engineering and operational power economy
- Water technology and plant-water management
- Process technology for recycling, waste treatment, and materials circulation

Steel R&D Organisation

- Plant Engineering
- Automation
- AI Techniques and Data-Based Models
- Metal Forming
- Surface Technology
- Measuring Techniques and System Development
- Materials Testing
- Fluid Mechanics
- Heat Engineering and Power Economy
- Combustion and Gas Technology
- Environmental and Chemical Engineering
- Process Analysis
- Water Technology and Water Management

Steel R&D Staff 130

Specialist Equipment for Steel R&D

A wide range of pilot and laboratory equipment is available at BFI. The most important are listed below:

- Straightening machines for sections and strips
- Tension bridle equipped with tension leveller and shapemeter
- Measuring device for strip flatness, profile, and shape
- Torsion plastometer
- 4-stand experimental rolling mill
- Different wear-testing devices (e.g. abrasion, erosion, cavitation)
- Measuring and analysing system for surface structures
- Model facilities (up to full scale) with LDA/PDA/PIV and CFD-code (computing in parallel) for simulation of metallurgical and other systems
- Contactless torque-measuring device
- Laser system for vibration analysis
- Mobile test plants for process-gas cleaning
- Burner testing facilities, up to 5 MW
- Wide range of measuring equipment for operational high-temperature combustion systems (e. g. gas analysis, velocity, dust, dioxin, pulsations, telemetric datalogger)
- Sintering pallet with special ignition hood
- Pilot mixer-settler plants for solvent extraction of dissolved metals
- Mobile testing plants for emulsion treatment and waste-oil dewatering
- Pilot membrane-filtration plants for acid and water treatment
- Technical reactors for biological process-water treatment
- Processing units for residues, briquetting facility, and mobile equipment for injection of dusty and granulated solids recycling into cupola and blast furnace

Current Steel R&D Topics

- Analysis and optimisation of processes
- Planning, design, and maintenance
- Automation and monitoring of plants and processes
- Measuring techniques and materials testing
- Quality analysis and quality control
- Yield management

- Fluid mechanics and simulation methods
- Heat engineering and energy management
- Firing, combustion, and process gas technologies
- Environmental and chemical engineering
- Water, membrane separations, and bioprocessing technologies
- Water, emulsions, and waste management
- Recycling, reconditioning of metal/oil/water sludges and other residues
- Material properties

Contact Addresses
H. BLEILEBENS / R. STELZER / D. SUCKER
BFI Betriebsforschungsinstitut
VDEh-Institut für angewandte Forschung GmbH
Sohnstraße 65
D - 40237 DÜSSELDORF, GERMANY
Tel.: +49 (0)211 6707 0; Fax: +49 (0)211 6707 310
E-mail: bfi@bfi.de
http://www.bfi.de

Forschungsgemeinschaft Eisenhüttenschlacken

FEhS (Research Association for Iron and Steel Slags) was founded in 1968 as an association with a joint research institute by a merger of two other German associations covering research on the application of iron and steel slags.

Core Steel R&D Competencies

- Applied research and development on
  - slags from iron and steelmaking
  - residues (dust, sludges, spent refractories, etc.)
  - characterisation and properties of slags with regard to different fields of application (aggregates for road construction and hydraulic engineering, constituent of cement, fertiliser, etc.)
  - metallurgical investigations
- Official certified testing laboratory for cement, concrete, road, and waterway construction materials (aggregates, unbound mixtures, asphalt)

Steel R&D Organisation

- Cement and concrete for:
  - Road-making materials
  - Fertilisers
  - Residues from iron and steel production
- Metallurgical investigations

Steel R&D Staff 45

Specialist Equipment for Steel R&D

- X-ray diffraction, microscopy
- Laser granulometer
- Thermal analysis for heat of hydration
- Hg porosimeter
- Certified chemical laboratory with:
  - ICP (Inductive coupled plasma) analyser
  - HPLC (High Pressure Liquid Chromatograph)
  - AAS (Atomic Absorption Spectrometer) with FIAS (Flow Injection Analytic System)
  - TOC/TIC/H2O analyser
- Equipment for leachabiliy testing
- Equipment for granulation and pelletising

Current Steel R&D Topics

- Early strength of blast-furnace cements
- Alkali-silica reaction
- Sulphate resistance of cements
- Freeze-thaw resistance of concrete
- High-performance concrete, self-compacting concrete
- Development of test methods for slags
- Improving the volume stability and resistance against leachability of slags
- Enrichment of the phosphorus content in slags for the use as fertiliser
- Decreasing the scorification of chromium
- Recycling of dust and slags from secondary metallurgy and spent refractories
- New applications of slags from secondary metallurgy

Contact Addresses
Prof. Dr.-Ing. J. GEISELER, Managing Director
Forschungsgemeinschaft Eisenhüttenschlacken e. V.
Bliersheimer Straße 62
D - 47229 DUISBURG, GERMANY
Tel.: +49 (0)2065 9945 31; Fax: +49 (0)2065 9945 10
E-mail: j.geiseler@fehs.de
http://www.fehs.de

Max-Planck-Institut für Eisenforschung
(Max Planck Institute for Iron Research, MPIE)

The Max Planck Institute for Iron Research (MPIE), founded in 1917, performs interdisciplinary fundamental research on iron, steel, and related materials including intermetallics. The investigations focus on processes during production and forming, their effect on the microstructure, and their correlation with chemical and mechanical properties of the materials. The research aims at a better understanding of the basic phenomena as a starting point for improvement of materials, properties, and applicability by merging microstructure research and materials processing on the one hand and theory, simulation, and experiment on the other hand.

Core Steel R&D Competencies

- Modelling of metallurgical processes
- Simulation of microstructures and textures
- Experimental and theoretical analysis of phase equilibria and phase transformations

- Microstructure mechanics.
- Development and characterisation of new steel grades
- Characterisation of surfaces and interfaces

Steel R&D Organisation

- Metallurgy (N.N.)
- Materials Technology (G. Frommeyer)
- Microstructure Physics and Metal Forming (D. Raabe)
- Physical Metallurgy (P. Neumann)
- Interface Chemistry and Surface Technology (M. Stratmann)

Steel R&D Staff 179

Specialist Equipment for Steel R&D

Department of Metallurgy

- Two twin-roll set-ups (strip thickness 1-3 mm, strip widths of 65 and 120 mm; in-line rolling mill with a rapid hydraulic system)

Department of Materials Technology

- Transmission electron microscope (Philips CM 20)
- Field-ion microscope with atom probe for chemical analysis on an atomic scale

Department of Microstructure Physics and Metal Forming

- Hot-working simulator (WUMSI)
- Fully instrumented rolling and heat-treatment equipment
- Combined high-resolution scanning X-ray texture-stress diffractometer
- High-resolution field-emission scanning electron microscope with fully integrated EDX and EBSP
- Digital high-resolution surface-strain mapping devices, white-light and laser-based scanning confocal microscopes
- Atomic-force microscope
- Nanomechanical testing equipment

Department of Physical Metallurgy

- High-temperature X-ray diffraction
- Mechanical testing at low and high temperatures including long-term creep
- Crucible-free melting and directional solidification device

Department of Interface Chemistry and Surface Technology

- Characterisation of surfaces and interfaces by AES, SAM, ESCA, TOF-SIMS, STM, AFM, FTIR, Raman-microscopy, confocal laser microscopy, UV-VIS spectroscopy, ellipsometry, surface X-ray diffraction, etc.
- Preparation of idealised surfaces (plasma cleaning, plasma polymerisation, Langmuir-Blodett technique, spin coating, molecular beam epitaxy, single-crystal surfaces)
- Characterisation of the reactivity of surfaces and interfaces (scanning Kelvinprobe, variable-temperature scanning Kelvin probe, scanning Kelvinprobe, Force Microscope, electrochemistry, micro-electrochemistry, electrochemical STM/AFM, thermogravimetry)
- Applied techniques to test the stability of surfaces (salt-spray test, climatic chambers, electrochemical corrosion testing, high-temperature corrosion testing, adhesion testing like blister test)

Current Steel R&D Topics

Department of Metallurgy

- Continuous-casting simulation
- Experimental studies on strip casting

Department of Materials Technology

- Development of ultrahigh-strength and supra-ductile light steels
- Development of intermetallic alloys and TiAl-based alloys
- Rapidly solidified foils, fibres and wires [CrNi stainless steels, heat-resistant Ni3Al(B) and Ni(Fe)Cr wires; heat-resistant FeCr(Al) and Fe3Al(Cr) alloys, Fe-Al-foam semi-finished products]

Department of Microstructure Physics and Metal Forming

- Microstructure mechanics
- Optimisation of electrical steels

- Large-scale hot working
- Physically based finite-element prediction of plastic forming operations including complete update of microstructure and texture during forming (TCCP-FEM)
- Predicting the surface quality of mechanically loaded metal sheets, both as bulk and as layered material
- Basic understanding and optimisation of recrystallisation and grain-growth phenomena in conjunction with the prediction of resulting microstructures and mechanical properties

Department of Physical Metallurgy

- High-temperature materials (mechanical behaviour of multi-phase alloys and intermetallics, brittle-to-ductile transition, creep strength and creep mechanisms, interaction of deformation and microstructure ageing processes, prediction of long-term behaviour, microstructure optimisation by thermal and mechanical treatments, alloy development for high-temperature applications)
- Phase equilibria and transformations (crucible-free melting, crucible-free directional solidification, experimental determination of phase equilibria: diffusion couples, in-situ high-temperature X-ray diffraction, differential thermal analysis, phase transformations under controlled atmospheres, calculation of phase diagrams and of diffusion-controlled transformations, cluster-variation method, Monte-Carlo simulation, magnetic and atomic ordering, diffusion in complex phases)

Department of Interface Chemistry and Surface Technology

- Organic coatings (molecular aspects of polymer delamination, conducting polymers, plasma polymers)
- Corrosion (filiform corrosion of advanced structural materials, atomistic aspects, alloy dissolution)
- Galvanising of high-strength steel, corrosion in fuel cells
- Metal dusting, high-temperature corrosion induced by chlorides
- Adhesion and de-adhesion (molecular adhesion promoters)

Contact Addresses
Max-Planck-Institut für Eisenforschung GmbH
Max-Planck-Straße 1
D - 40237 DÜSSELDORF, GERMANY
Tel.: +49 (0)211 679 2216; Fax: +49 (0)211 679 2440
E-mail: neumann@mpie.de
http://www.mpie.de

SGA
Studiengesellschaft für Eisenerzaufbereitung

SGA (Research Centre for Iron Ore Beneficiation, Agglomeration and Metallurgical Testing of Burden Materials) is a joint venture of the German steel industry and was founded in 1922. Its purpose is the conduction of scientific investigations and practical testing in order to contribute to the economic application and metallurgical processing of iron ores and agglomerates. SGA offers services to its associates of the German steel industry and to third-party customers of the steel industry and iron ore industry world-wide.

Core Steel R&D Competencies

- Mineral dressing
- Agglomeration of iron ores
- Characterisation of BF and DR burden materials

Steel R&D Organisation

- Mineral processing of raw materials, rejects, and recycled materials
- Agglomeration, sintering, and pelletising
- Physical and metallurgical testing of burden material for blast furnace and direct-reduction processes
- Chemical laboratory

Steel R&D Staff 18

Specialist Equipment for Steel R&D

Mineral processing

- Grinding, dry/wet, batch and pilot scale
- Classifying, dry/wet
- Gravity and magnetic separation
- Electrostatic separation, laboratory scale
- Flotation, laboratory and pilot scale
- Dewatering by thickener and filtration

Agglomeration

- Mixers
- Re-rolling drum
- Disk pelletiser
- Pot-grate apparatus for pellet induration
- Laboratory-scale sintering pan

Quality control of burden materials

Blast-furnace burden:

Crushing strength, tumble strength and abrasion, decrepitation of lump ore, disintegration (static and dynamic tests), reducibility, swelling of pellets, reduction under load, softening, melting, and dripping, reactivity and strength of coke

Direct-reduction burden:

Disintegration, sticking, clustering, reducibility and metallisation

Chemical laboratory

- ICP for chemical analysis of about 70 elements
- Fe titration (Hg-free)

Current Steel R&D Topics

- Optimisation of iron-ore processing plants
- Increasing lump-ore screening efficiency
- Improvement of sintering productivity
- Characterisation of sintering behaviour of concentrates
- Improvement of disintegration behaviour of BF pellets
- Development of new DR pellet grades
- Effect of basicity on pellet quality at different Fe levels
- Improvement of blast-furnace pellet quality through an integrated analysis of the production chain and process modelling
- Critical review of the existing procedures for the characterisation of the metallurgical properties of blast furnace burden material at conditions of high injection rates

Contact Addresses
Dr.-Ing. Volker RITZ / Dr.-Ing. Ekkehart MERTINS
Studiengesellschaft für Eisenerzaufbereitung SGA
Grubenstr. 5
D - 38704 LIEBENBURG, GERMANY
Tel.: +49 (0)5346 99 01 0; Fax: +49 (0)5346 99 01 20
E-mail: sga@sga-liebenburg.de
http://www.sga-liebenburg.de

Centro Sviluppo Materiali S.p.A.

CSM is a unique example of a multi-corporate, multi-sectorial private R&D company established in the EU. Sixteen shareholders (of which 40% multinationals) represent several industrial sectors including steel producers, steel-plant manufacturers, refractory producers, steel users, and utilities.

This specific position allows the company to bid for a high level of technological services (including turn-key supply of plants and equipment) in several sectors (including aeronautics and machinery), transferring some know-how, experiences and innovative approach, for example from steel to aeronautics and reverse.

Core Steel R&D Competencies

- Process analysis of vacuum induction melting (VIM) and electroslag remelting (ESR)
- Advanced technologies for electric arc furnace (Consteel, Conarc, etc.)
- Thin-slab and strip-casting technologies (carbon as well as stainless and electrical steel)
- Surface technology (pickling, coating for anti-wear, anti-corrosion, thermal barrier purpose)
- Simulation of thermo-mechanical processes of plates (controlled rolled and accelerated cooling)
- Modelling of hydro-thixoforming material behaviour
- Utilisation of stainless steel for structural applications
- Full-scale burst tests on gas pipelines: crack-speed and dynamic fracture-toughness measurements
- Treatment of steelmaking wastes
- Hydrometallurgy

Steel R&D Organisation

- Process technology for steel, environment and energy
- Materials
- Special steels
- Special demonstration projects

The company has three locations in Italy (Rome, Terni, Dalmine) and one office in Brussels.

Steel R&D Staff 286

Specialist Equipment for Steel R&D

- Pilot plant for twin-roll strip casting
- Regenerative burners and combustion station
- VIM furnace
- ESR pilot plant
- Hydroforming press
- Mobile furnace equipped with plasma torch
- Road barrier station for containment test
- Work station for simulating decarburisation (AOD) process, crash behaviour of road barrier and vehicles, and in-service performance of seamless tubes in deep oil wells

Current Steel R&D Topics

Ironmaking: demonstration of hot-metal production from low-cost DRI production and smelting.
Steelmaking: continuous steelmaking concept, modelling and demonstration.
Continuous casting: twin-roll strip casting (participation in EUROSTRIP) and thin slab of stainless steel.

Metallurgy: modelling and application of ultrasteel concept.
Energy: the impact of hydrogen as energy carrier and reductant in steel production.
Environment: waste to energy concept and demonstration.

Contact Addresses
Dr. Manlio MIRABILE
CSM S.p.A.
Via di Castel Romano, 100
I - 00128 ROME, ITALY
Tel.: +39 06 505 5829; Fax: +39 06 505 5202
E-mail: info@c-s-m.it
http://www.c-s-m.it

MEFOS

MEFOS, the Foundation for Metallurgical Research, is an independent industrial research institute for applied R&D in metallurgy, heating, and metalworking. MEFOS offers research, development, education, and consulting services in the areas of process metallurgy, metalworking, energy efficiency, and environmental engineering for companies in the steel and metal industry as well as other interested organisations.

The institute has been active for nearly 40 years and has 40 member companies from the Nordic countries as well as four associated companies from other countries. MEFOS performs collaborative R&D for member companies and confidential contract work for companies worldwide.

Core Steel R&D Competencies

- Production and processing of iron and steel, non-ferrous metals, and ferro-alloys
- Process metallurgy
- Reheating and rolling technology
- Open-die forging
- Environmental engineering and energy saving technology
- Modelling
- Simulation of processes
- Measurement technology
- Process enhancement

Steel R&D Organisation

- Process metallurgy
- Heating and metalworking
- New technology and non-ferrous metals

Steel R&D Staff 75

Specialist Equipment for Steel R&D

- Extensive computer facilities for modelling and simulation
- 10-ton EAF-AC, 5-ton EAF- DC, 6-ton universal converter
- Walking-beam furnace (3 t/h), chamber furnace
- Electrostatic filter, wet venturi, bag filter, SO_2 scrubber
- 500 ton hydraulic forging press

- 500 ton reversible rolling mill (2-4 high) with accelerated cooling
- Grinding machine
- 3-stand small-section rolling mill

Current Steel R&D Topics

A wide range of process development projects involving:

- Development of new and existing processes (e.g. strip casting, EAF technology, profile and flatness in rolling, scale formation, open-die forging)
- Simulation and modelling of metallurgical and metalworking processes (CFD and FEM technique)
- Development of control systems and measurement technology (e.g. radio-wave interferometry)
- Development of technology for better energy efficiency
- Technology for solving environmental problems in metallurgy and related areas (e.g. recycling of waste products)

Contact Addresses

Åke SJÖSTRÖM
MEFOS
Box 812
SE - 971 25 LULEÅ, SWEDEN
Visiting address: Arontorpsvägen 1
Tel.: +46 (0)920 201 900; Fax: +46 (0)920 255 832
E-mail: ake.sjostrom@mefos.se
http://www.mefos.se

Research Institutions with Substantial Steel R&D Resources

Industrielle Kompetenzzentrum für Mechatronik und Automation
(Centre of Competence for Mechatronics and Automation, IKMA)

IKMA is a network of industrial and university competencies designed to raise the expertise in mechatronics along with problem-solving capacity to highest international level.

Core Steel R&D Competencies
- Increase of production reliability
- Improvement of product quality
- Automation and rationalisation
- System diagnosis
- Process simulation
- Automatic testing technique

Steel R&D Organisation
Partners at IKMA are several divisions of voestalpine AG (Steel, Industrieanlagenbau, Railway Systems), AUSTRIA METALL AG and Upper Austrian Technology and Marketing Corporation; industrial leadership is provided by VOEST-ALPINE Mechatronics GmbH (VATRON).

Along with an increasing number of associated members and three scientific partners, - Johannes Kepler University Linz (Institute for Mechatronics), Christian Doppler Research Association, and Upper Austrian College Transfer Corporation - the centre also concentrates on increased participation in international projects and the guidance of SMEs to sophisticated R&D-projects.

Steel R&D Staff 20

Specialist Equipment for Steel R&D
- Process simulation equipment
- Image processing laboratory

Current Steel R&D Topics
- Process automation and simulation
- Image processing

Contact Addresses
DI. Wilhelm HOFMANN
VATRON, VOEST-ALPINE Mechatronics GmbH
VOEST-ALPINE-Strasse 3
A - 4031 LINZ, AUSTRIA
Tel.: +43 (0)732 6585 62 49; Fax: +43 (0)732 6980 38 48
E-mail: wilhelm.hofmann@voest.co.at
http://www.vatron.at

University of Mining, Metallurgy and Materials

Department of Metallurgy and Metal Processing,
University of Mining, Metallurgy and Materials

Core Steel R&D Competencies

- Metallurgical processes, product development and environmental techniques
- Reduction processes, primary and secondary steelmaking, continuous casting, materials science and engineering
- Optimisation and development of production techniques by means of numerical and chemo-physical process modelling and simulation
- Optimisation and analysis of metal-forming processes via FEM simulation
- Experimental analysis of metal-forming processes, metal-forming machines, and plant machineries
- Development of plant machineries and components

Steel R&D Organisation

- Institute of Ferrous Metallurgy
- Institute of Plastic Deformation and Plant Machinery
- Institute of Modelling and Simulation of Metallurgical Processes (in progress)
- Institute of Metal Processing and Component Production (in progress)

Steel R&D Staff 40

Specialist Equipment for Steel R&D

- Smelting-reduction facility
- Various electric melting furnaces
- Fluidised bed, high-temperature volatilisation
- Cyclone reactors, rotary kilns, leaching equipment, aqueous and molten salt electrolysis
- Medium-frequency and vacuum melting up to 200 kg
- Tamann furnace
- Electric furnace (9 kW)
- Ingot casting and continuous-casting simulator
- Continuous vertical casting equipment with magnetic stirrer
- Cold-rolling mill (F max = 300 kN)
- Hydraulic press (F max = 1 MN)
- Heat treatment and surface treatment
- In-line analysis (spectrometer)
- High-temperature tensile testing
- Laser-Doppler-Velocimetry for fluid-flow measurement
- Analytical equipment: atomic absorption, dilatometry, differential thermo-analysis, gas analysis, metallography, thermobalance, all auxiliary measuring and control devices
- Strain measurement
- Sensors for force, distance and acceleration
- Software: Labview, Matlab, Mathcad, Simulink

Current Steel R&D Topics

- Development of a hydrogen smelting-reduction process
- Influence of secondary metallurgy parameters on the composition of non-metallic inclusions in the production of high-alloyed steels

- Modelling and simulation of metallurgical processes
- High-temperature mechanical properties of steels under continuous-casting conditions
- Influence of steel composition, casting parameters, flow pattern and refractory material on castability of steel
- Microstructure formation during solidification (rapid solidification)
- New high-strength hot-strip and cold-strip grades
- Development of new alloying concepts for tools steels
- Zinc-containing steel works flue dusts
- High-current density electrolysis (experiments and modelling)
- Cross-section control of rolled long products in continuous mills
- Front-end bending and warping in a 4.2 m four-high stand of voestalpine Grobblech GmbH
- Radial-pressure supported deep drawing

Contact Addresses
Univ.-Prof. Wilfried KRIEGER
Department of Ferrous Metallurgy
University of Mining, Metallurgy and Materials
Franz-Josef-Strasse 18
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 402 410; Fax: +43 (0)3842 402 611
E-mail: wilfried.krieger@notes.unileoben.ac.at
http://www.unileoben.ac.at

Institut für Metallphysik der Montanuniversität Leoben und Erich Schmid Institut für Materialwissenschaft der Österreichischen Akademie der Wissenschaften

(Institute of Metal Physics, University of Leoben and Erich Schmid Institute of Materials Science, Austrian Academy of Sciences)

Core Steel R&D Competencies

- Microstructural characterisation and evolution of microstructure (experimental investigation and simulation)
- Deformation and fracture under static and cyclic loading

Contact Addresses
Prof. Dr. Peter FRATZL
Montanuniversität Leoben
Institut für Metallphysik
Jahnstraße 12
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 45511 0; Fax: +43 (0)3842 45512 6
E-mail: metallph@unileoben.ac.at
http://www.unileoben.ac.at/institute/buero43.htm

Österreichische Akademie der Wissenschaften
Erich Schmid Institut für Materialwissenschaft
Prof. Dr. Peter FRATZL
Jahnstraße 12
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 45511 0; Fax: +43 (0)3842 45512 6
E-mail: akademie@unileoben.ac.at
http://www.oeaw.ac.at/esi/

Institut für Metallkunde und Werkstoffprüfung, Montanuniversität Leoben

(Institute for Metal Science and Materials Testing)

Core Steel R&D Competencies

- Development of tool steels and corrosion resistant steels for special applications
- Investigation of fatigue properties (LCF, HCF, crack propagation, crack closure, threshold) of different steels
- Deposition and characterisation of hard coatings onto steels

Contact Addresses
Prof. Dr. Dr.h.c. F. JEGLITSCH, Head of Department
Institut für Metallkunde und Werkstoffprüfung
Montanuniversität Leoben
Franz Josef Strasse 18
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842-402 431; Fax: +43 (0)3842 402 737
E-mail: imw@unileoben.ac.at
http://www.unileoben.ac.at

Institut für Mechanik, Montanuniversität Leoben

(Institute of Mechanics)

Core Steel R&D Competencies

Micromechanics of Materials

- Phase transformations in alloys (diffusive, martensitic)
- Microstructural changes due to deformation under heavy loads (wheel/rail or switch contact)
- Deformation behaviour of TiAl intermetallics

Eigenstresses and Residual Stresses

- Rails, rollers, etc.
- Buckling of plates

Impact Loading of Metallic Structures

- Explosions
- High-velocity forging

Fracture of Materials

- Modelling of ductile stable crack growth
- Configurational forces concept
- Modelling of brittle materials with voids

Contact Addresses
Prof. Dr. F.D. FISCHER
Institute of Mechanics
Montanuniversität Leoben
Franz-Josef-Straße 18
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 402 476; Fax: +43 (0)3842 46 0 48
E-mail: mechanik@unileoben.ac.at
http://www.unileoben.ac.at

Materials Center Leoben, Montanuniversität Leoben

Core Steel R&D Competencies

- Process optimisation for production of plain carbon steels
- Development of high-alloyed steels, especially tool steels

- Measurement and optimisation of the mechanical and thermo-physical properties of steels
- Materials selection of different fields of applications

Contact Addresses
Prof. Dr. R. EBNER
Materials Center Leoben
Franz Josef Str. 13
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 45922; Fax: 43 (0)3842 45922 5
E-mail: ebner-r@unileoben.ac.at
http://www.unileoben.ac.at

Institut für Allgemeinen Maschinenbau, Montanuniversität Leoben

(Institute of Mechanical Engineering)

Core Steel R&D Competencies

- Fatigue analysis of metallic components
- S/N curves by test and simulation

Contact Addresses
Prof. Dr. Wilfried EICHLSEDER
Montanuniversität Leoben
Institut für Allgemeinen Maschinenbau
Franz-Josef-Straße 18
A - 8700 LEOBEN, AUSTRIA
Tel.: +43 (0)3842 402 281; Fax: +43 (0)3842 402 289
E-mail: wilfried.eichlseder@notes.unileoben.ac.at
http://www.unileoben.ac.at/institute/maschbau.htm

LISm
LABORATORY FOR IRON AND STEELMAKING

Universiteit Gent

LISm, the Laboratory for Iron and Steelmaking, is part of the Department of Metallurgy and Materials Science at the University of Ghent. It is mainly in the field of ferrous-alloys research that the laboratory has grown considerably over the past few years. The current research work is oriented towards industrial processes and engineering materials and is largely conducted through a strong and lasting relationship with industrial partners.

Core Steel R&D Competencies

- Physical simulation of the steelmaking process
- Study of the effect of the process parameters on the microstructure and the properties of flat, hot and cold rolled steel products

Steel R&D Organisation

- Vacuum Metallurgy
- Strip Processing
- Materials Microanalysis
- Surface and Interface Modification of Engineering Materials

- Materials Failure Analysis
- Information Technology

Steel R&D Staff 37

Specialist Equipment for Steel R&D

- Laboratory hot- and cold-rolling mills
- Hot-torsion equipment
- High strain-rate compression machine
- Dilatometry
- Hysterograph
- Internal-friction laboratory (torsion pendulum, longitudinal waves)
- Atomic-force microscopy
- Hot-dip galvanising simulator
- Electroplating simulator

Current Steel R&D Topics

- Development of high-strength steels
- Physics of transformations in ferrous alloys
- Coating of sheet with Zn-based alloys
- Soft-magnetic materials manufacturing by solid-state diffusion
- High-Si ferrous alloys
- Development of low-magnetostriction materials
- The kinetics of the bainitic transformation
- Variant selection mechanisms in ferrous alloys
- Microstructure evolution during hot forming of ferrous alloys
- Hot formability of Fe-Cr-Ni alloys
- Metallurgy of N-alloyed stainless steels
- Sigma-phase formation mechanisms
- Zn-Fe phases formed during electroplating
- Application behaviour of Zn-Co coatings
- Galvanising and galvannealing of high-strength steels
- Texture dependence of coating formability
- Aging in bake-hardenable steels
- Properties and processing of dual-phase, ferrite bainite, and TRIP steels
- Strain-hardening properties of multi-phase steels
- The properties of interstitial-free ferrous alloys
- Duplex stainless steels
- Physics of engineering materials
- Modelling of materials processing
- Magnetic properties of soft-magnetic materials
- Structural phase-transformation kinetics
- Diffusion
- Precipitation
- Intermetallics in engineering alloys
- Mechanical properties of engineering alloys

Contact Addresses
Prof.dr.ir. Yvan HOUBAERT
Prof.dr.ir. B.C. de COOMAN
Department for Metallurgy and Materials Science
Faculty of Engineering, Ghent University
Technologiepark 9
B - 9052 GHENT, BELGIUM
Tel.: +32 (0)9 264 5773; Fax: +32 (0)9 264 5833
E-mail: yvan.houbaert@rug.ac.be
E-mail: bruno.decooman@rug.ac.be
http://metallur.rug.ac.be

(University of Liège, ULG)

Core Steel R&D Competencies

- Microstructure and phase transformation study
- Development of new materials with improved properties
- Thermal properties
- Wear and tribological properties
- Materials modelling and mechanics of metallic materials (thermo-mechanical properties: modelling and experimental determination; elasto-visco-plasticity, damage, cracks, low-cycle fatigue)
- Numerical simulation and modelling of metal-forming processes (sheet-metal forming and bulk forming)
- Metallic and composite (steel + concrete) structures: analysis and design, stability, non-linear elasto-plastic behaviour, design of connections, tubular structures, fire resistance, seismic design, etc.)
- Frictional and lubricated contact
- Crash and impact simulation
- Thermomechanical and large-deformation analysis of steel and steel products processing

Steel R&D Organisation

- Metallurgy and Material Science (ASMA Dept - MMS)
- Mechanics of Materials and Structures (M&S depart.)
- Continuum Media and Thermomechanics (ASMA Dept - MC&T)

Steel R&D Staff 26 (M&S) +10 (MC&T) + 9 (MMS)

Specialist Equipment for Steel R&D

Laboratory of Structures and Strength of Materials

- Several programmable tension-compression testing machines from 100 kN to 10 000 kN
- Horizontal buckling test machine of 1000 kN
- Torsion test machine 1500 Nm
- Several programmable fatigue machines in simple tension, tension-compression and torsion
- Test slab 11.18 m x 20.98 m equipped with reaction columns and beams and double effect jacks from 50 to 1000 kN
- Vibration measurement equipment
- Steel relaxation test machine 200 kN
- Test bench for pre-tensioned cables
- Test setup for application of horizontal static and dynamic loading up to 1000 kN at a 4 m height (earthquake simulation)

Laboratory of Fire Resistance

- Furnace with a vertical opening of 3 m x 3 m to test separating non-loaded elements: walls, partitions, doors, glazing, ducts, electrical cables
- Furnace with a vertical and a horizontal opening of 1.6 x 1.8 m to test the same type of elements, but smaller, and also loaded linear crossing elements such as short columns (protected or unprotected) and tensile bars

Wear laboratory

- Tribometers to study abrasion wear, erosion wear, thermal cracking, high-temperature wear (pin on disc), fatigue wear, impact wear
- A sclerometer (scratch test)
- Co-operative equipment with Pôle Métal de Wallonie

Laboratory of microstructure analysis and thermal properties characterisation

- Thermal treatment and vacuum furnaces (1300°C)

- Diffusimeter (laser flash)
- A dilatometer and a calorimeter coupled with a thermo-balance that allows differential thermal analysis (DTA), heat capacity calculation and thermogravimetry
- Metallographic equipments (optical and SEM, TEM microscopy)
- Durometers

Continuum Media and Thermomechanics

- Infrared thermography

Current Steel R&D Topics

- Finite-element modelling of continuous casting (thermo-mechanical-metallurgical effects in the mold and in the strand)
- Micro-macro modelling of crack initiation in micro-alloyed steels for continuous casting
- Micro-macro modelling of anisotropic elasto-plastic behaviour of steel during sheet metal forming
- Experimental determination of mechanical properties of metals at high temperature and high strain rate
- Study and development of cold-rolled profiles with local patch reinforcements
- Numerical prediction of springback during steel-sheet profiling
- Fatigue due to web breathing in slender plate and box girders
- Lateral torsional buckling of steel and composite beams
- Dynamic analysis of composite structures
- Development of new connection technologies: clinching, gluing
- Structural response of composite sway frames
- Experimental and numerical evaluation of the resistance of composite steel/concrete connections and elements to earthquakes (low-cycle fatigue)
- Assessment of steel and composite structures under earthquakes
- Experimental and numerical evaluation of the fire resistance of steel and composites structures and connections
- Numerical evaluation of steel high rack storages
- Wear: applications in the field of biomedical sciences (hip prosthesis, dental implants)
- Study of the kinetics of carbide development in alloyed steels and irons
- Contact heat transfer between a steel strip and a cooling roll (Roll Quench process)
- Effect of inclusions and carbides on high-alloy steels and irons under severe mechanical loadings
- High-temperature properties characterisation for metallic materials
- Computer simulation of lubrication in rolling processes, cold rolling/profiling, spring-back prediction, friction modelling, deep drawing, crash and impact

Contact Addresses

Université de Liège
Chemin des Chevreuils 1, Bât B52/3
B - 4000 LIÈGE 1, BELGIUM

Prof. Jacqueline LECOMTE-BECKERS
ASMA Department - MMS
Tel.: +32 (0)4 366 9118; Fax: +32 (0)4 366 9113
E-mail: jacqueline.lecomte@ulg.ac.be
http://www.ulg.ac.be/metaux

Prof. Michel HOGGE
ASMA Department - MC&T
Tel.: +32 (0)4 366 9126; Fax: +32 (0)4 366 9141
E-mail: M.Hogge@ulg.ac.be
http://www.ulg.ac.be/ltas-mct/index.html

Prof. Serge CESCOTTO
M&S Department
Tel.: +32 (0)4 366 9246; Fax: +32 (0)4 366 9192
E-mail: Serge.Cescotto@ulg.ac.be
http://www.msm.ulg.ac.be/www/cescotto.html

The University of Oulu is one of the largest and leading universities in Finland with more than 14 000 students.

Core Steel R&D Competencies

Research on the processing of ferrous materials takes place at the Laboratory of Process Metallurgy in the Department of Process and Environmental Engineering having the core competence in the following fields:

- Blast furnace phenomena
- Refractory materials
- Physical and numerical modelling of liquid flows
- Thermodynamical system analyses

Research related to manufacturing of steels and their properties and applications is carried out at the Materials Engineering Laboratory in the Department of Mechanical Engineering having the main competence in the following fields:

- Physical simulation of hot-working processes
- Modelling of hot-working processes by physical and neural models
- Development of reheating furnaces and technology
- Welding metallurgy
- Failure analysis

Steel R&D Organisation

The Faculty of Technology consists of six departments, at which the activities related to steel can be found, especially in the departments of Mechanical Engineering and Process and Environmental Engineering, although artificial neural network modelling is performed at the Department of Electrical Engineering as well.

The Department of Process and Environmental Engineering has ten laboratories: Bioprocess Engineering, Chemical Process Engineering, Control & System Engineering (2), Heat and Mass Transfer Process, Industrial Environmental Engineering, Mechanical Process Engineering, Water Resource and Environmental Engineering, Work Science, and Process Metallurgy.

The Department of Mechanical Engineering consists of five laboratories: Engineering Design, Engineering Mechanics, Machine Design, Materials Engineering, and Production Technology.

Steel R&D Staff 37

Specialist Equipment for Steel R&D

- Simultaneous DTA-TGA (Differential Thermal Analysis-Thermal Gravimetric Analysis)
- High-temperature viscosimeter
- Optical dilatometer
- Oxygen activity measurement from molten steel / refractory material finger test
- Laboratory rolling mill
- Gleeble thermo-mechanical simulator
- Implant and Transvare-straint testing jigs
- Long (9 m) welding station for high-speed welding trials
- Friction welding and friction surfacing machines
- Hydraulic bulging unit for sheets

Current Steel R&D Topics

The Laboratory of Process Metallurgy has many research projects under way in the field of reduction metallurgy, refining metallurgy, and refractory materials:

- Investigations of chlorine and alkali behaviour in the blast furnace and optimisation of BF slag with respect to alkali retention capacity
- Reduction of chromite ores
- Development of steel-belt sintering technology for ferroalloys
- Novel analysis and optimisation of blast-furnace burden material for cost-effective and high-iron capacity production
- Thermodynamical and numerical modelling of flows in steel ladle
- Oxide metallurgy
- Specifying of slab reheating by CFD (Computational Fluid Dynamics) modelling
- Effective blowing practice in AOD converter
- Modelling of LD converter
- Consistent BOS performance
- Effective continuous-casting metallurgy
- Inclusion engineering and grain-size control of steels
- Iron & Steel MMX (2010)
- Prediction of mechanical properties by means of hybrid modelling
- Hybrid methods in hot-rolling processes
- Constitutive modelling for complex loading in metal-forming processes
- Modelling of microstructure evolution in hot rolling
- Full-scale simulations of scale and flow conditions in reheating of steel slabs
- New ways to improve longitudinal temperature homogeneity of slabs in a reheating furnace
- Effect of graphite lubrication on hot rolling
- Processing, microstructure, and properties of ultra-fine grained steels
- Simulation of the forming and quenching process
- Hot-ductility of Ti-bearing steels
- New techniques for the characterisation of texture of steel sheets
- Methods of improving the deep-drawing properties of austenitic stainless steels
- Toughness properties of welds in modern high-strength steels
- Control of hydrogen cracking in high-strength steel weld metals
- Control and improving the weld penetration in mechanised welding of austenitic stainless steels
- Machinability of construction steels

Contact Addresses

Professor Jouko HÄRKKI
University of Oulu
Process Metallurgy Laboratory, Department of Process and Environmental Engineering
P.O. Box 4300
FIN - 90014 UNIVERSITY OF OULU, FINLAND
Tel.: +358 (0)8 553 2424; GSM: +358 (0)40 521 5655
Fax: +358 (0)8 553 2339
E-mail: jouko.harkki@oulu.fi
http://cc.oulu.fi/~pometwww

Professor L. Pentti KARJALAINEN
University of Oulu
Materials Engineering Laboratory , Department of Mechanical Engineering
P.O. Box 4200
FIN - 90014 UNIVERSITY OF OULU, FINLAND
Tel.: +358 (0)8 553 2140; GSM: +358 (0)40 704 7475
Fax: +358 (0)8 553 2165
E-mail: pentti.karjalainen@oulu.fi
http://me.oulu.fi/me.html

Teknillinen korkeakoulu
(Helsinki University of Technology, HUT)

The main tasks of the Laboratory of Metallurgy are to give courses on master's and doctoral level in pyrometallurgy, hydrometallurgy and high-temperature processes as well as to make high-level scientific research in the selected focus areas.

Core Steel R&D Competencies
- Thermodynamics and kinetics of high-temperature processes
- Flow, mass, and heat transfer phenomena including both experimental and modelling research of numerous metallurgical processes and casting

Steel R&D Organisation
Laboratory of Metallurgy in the Department of Materials Science and Rock Engineering.

Steel R&D Staff 23

Specialist Equipment for Steel R&D
- X-ray diffractometer with computer control and the full ICDD database
- A viscosimeter for high-temperature melts (T_{max} = 1750°C) with free choice of atmosphere
- A Balzers quadrupole mass spectrometer combined with a vacuum furnace for vapour-pressure measurements in a Knudsen effusion cell
- A quadrupole mass spectrometer equipped for in-line process analysis to be used in combination with an IR gas analyser
- Three thermogravimetric setups with maximum sensitivity of 1 mg, maximum temperature of 1600°C and controlled atmospheres
- Two optical dilatometers for studying wetting phenomena, sintering, etc.
- A vacuum induction furnace with maximum temperatures up to 3000°C, frequencies of 2-10 kHz, and maximum charge of about 5 kg
- A Tamann-type furnace (T_{max} = 2600°C) with graphite heating elements and vacuum facilities
- An RF-induction plasma installation of 60 kW plasma power with adaptable reactors and full instrumentation
- A vertical tube furnace up to 1700°C with X-ray transmission facility for imaging of melting and interfacial phenomena in a crucible
- Various commercial software for thermodynamic calculations, modelling fluid flow, heat transfer, materials properties, etc.
- Steady state heat-transfer model and on-line control model for continuous casting
- Simulation model for chemical and thermal evolution of BOF-converter heats

Current Steel R&D Topics
- New alternative iron and steelmaking processes
- Computational and experimental modelling of steel-converter processes and development of control systems
- Oxide metallurgy
- Kinetics and mechanisms of inclusion transformation
- Inclusion engineering and grain-size control of steels
- Efficient and delivery-reliable continuous casting

- Real-time rating of continuously cast semis by hybrid quality models
- Optimisation of cooling parameters in casting processes
- Improvement of casting fluxes and slags by minimisation of environment-polluting and corrosive constituents (fluorine, alkali)
- Development of simulation models for steel casting
- Bubble bursting in gas/metal/slag systems
- Simulation of the distribution of radioactive isotopes accidentally entering into a steelmaking shop
- Methods on evaluating process-integration efficiency

Contact Addresses
Professor Lauri HOLAPPA
Laboratory of Metallurgy
Vuorimiehentie 2, ESPOO, FINLAND
P.O. Box 6200
FIN - 02015 HUT, FINLAND
Tel.: +358 (0)9 451 2757; Fax: +358 (0)9 451 2798
E-mail: Lauri.Holappa@hut.fi
http://www.metallurgy.hut.fi

VTT Manufacturing Technology

VTT Manufacturing Technology is one of the eight VTT (Technical Research Centre of Finland) institutes in Finland.

Core Steel R&D Competencies

- Sheet-metal forming, deep drawing
- Welding engineering
- Laser- and electron-beam welding, cutting and surface treatment
- Design and modelling of materials and processes
- Surface treatment
- Materials in process environments
- Materials in nuclear environments
- Radiation embrittlement
- NDE research and in-service inspections
- Surface-film electrochemistry
- Structural dynamics
- Structural integrity, vehicles
- Structural integrity, power plants
- Production technology

Steel R&D Organisation

- Materials and Manufacturing
- Maritime and Mechanical Engineering
- Operational Reliability and Materials
- Structural Engineering

Steel R&D Staff 130

Specialist Equipment for Steel R&D

- Nd:YAG-, diode-laser, and electron-beam workstations for welding, cutting, and surface treatment
- Hydroforming equipment
- Hot-dipping simulator
- HIP equipment
- TEM with EDX, PEELS and GIF
- Scanning electron microscopy with EDX-analyser
- Advanced technology for determining surface-film electrochemistry
- Numerous special and standard corrosion-testing equipments
- Wear testing, tribology laboratory
- Servohydraulic machines for fracture and fatigue testing
- Creep testing
- Computer simulation of deep drawing, galvanising, casting and welding
- Foundry for casting of steel and non-ferrous alloys
- Non-destructive tests (ultrasonic, radiography, eddy current, etc.)

Current Steel R&D Topics

- New generation manufacturing methods to optimise product properties and manufacturing processes
- Future solutions to enhance performance, operability, and durability of products
- Intelligent products and systems
- Networking R&D, production and use of products
- Virtual techniques in design, production, and testing
- Safety and reliability
- Life-cycle assessment

Contact Addresses
Prof. Simo-Pekka HANNULA
VTT Industrial Systems
P.O. BOX 1703
FIN - 02044 VTT, FINLAND
Tel.: +358 (0)9 456 5400; Fax: +358 (0)9 463 118
E-mail: simo-pekka.hannula@vtt.fi
http://www.vtt.fi

Cemef

ECOLE DES MINES DE PARIS

Centre de Mise en Forme des Matériaux, École Nationale Supérieure des Mines de Paris
(Centre for Material Forming, CEMEF)

Founded in 1974, the Centre for Material Forming is one of the 18 research centres of École Nationale Supérieure des Mines de Paris. It has been associated with CNRS, the French National Center of Scientific Research, since 1979.

CEMEF specialises in the field of research on materials processing. Approximately 130 people - among whom 50 PhD students - are working on research designed to get in-depth understanding of forming processes.

Core Steel R&D Competencies

- Forming processes (forging, flat and shape rolling, ring rolling, cold and hot stamping, casting)
- Numerical modelling: development of forming process software and process optimisation
- Physical and structural metallurgy, recrystallisation and recovery, phase change
- Hot and cold large strain material behaviour, fracture and damage
- Tribology, lubrication and tool-part interface
- Heat treatment and induction heating

Steel R&D Organisation

- CIM (High Performance Computing in Forming Processes)
- IEN (Computer Science and Numerical Analysis)
- TMP (Thermal and Mechanical Analysis of Metal Forming)
- MSR (Metallurgy, Structure and Rheology)
- SET (Surface and Tribology)

Steel R&D Staff 21

Specialist Equipment for Steel R&D

Forming

- Pilot rolling mill (20 m/s)
- Stamping press (30 ton)
- Hydroforming press (tubes and sheets) (2000 bar)
- Multistand hot-forging set-up

Microscopy

- Transmission electron microscope with heating platen
- 2 scanning electron microscopes: an environmental one with in-situ heating equipment up to 1500°C and automatic EBSD

Material analysis and physical parameters

- Spectrometers: EDX, XPS, TOF-SIMS
- Heat-exchange measurement
- 3-D strain-field measurement using pattern correlation

Mechanical properties and friction

- Combined tension-torsion
- Compression or tension: Instron (± 100 kN, heating equipment 1200°C video strain measurement), Dartec (± 300 kN)
- Video-controlled tensile and compression tests
- High-velocity tension-compression test machine (0.5 - 20 m/s, ±20 kN, up to 250°C, LN2) and fast high-resolution CCD video (up to 2500 images/s)
- Torsion with heating equipment 1200°C
- Mini-torsion with resistance heating
- Planar friction test
- Rotational tribometer with flat contact
- Thermomechanical fatigue
- Wear test for tool steels
- Metal-polymer friction-coefficient measurement

Current Steel R&D Topics

- Continuous casting
- Ingot casting
- Forging (from ingot or slab to final product)
- Hot rolling (flat, shape and ring rolling)
- Induction heating and heat treatments
- Hot stamping of quenchable steels
- Cold rolling
- Stamping of mild and stainless steels
- Assembly of steel and non-steel components (other metals or polymers)

- Metallurgical evolution, phase transformation, polycrystalline plasticity in large strain
- Solid and semi-solid constitutive laws
- Damage and fracture
- Tribology, surface and interface chemistry, lubrication (hot and cold), friction
- Development of finite-element software
  - 3-D large strain thermomechanical numerical modelling of all the processes listed above
  - automatic remeshing
  - parallelisation
  - inverse analysis and process optimisation
  - induction heating
  - multi-material component and structure mechanics

Contact Addresses
Jean-Loup CHENOT / Yvan CHASTEL
École des Mines de Paris, CEMEF
BP207
F - 06904 SOPHIA ANTIPOLIS Cedex, FRANCE
Tel.: +33 (0)4 93 95 75 75; Fax: +33 (0)4 02 38 97 52
E-mail: Jean-loup.chenot@cemef.cma.fr
yvan.chastel@cemef.cma.fr
http://www.cemef.cma.fr

Centre Technique Industriel de la Construction Métallique
(Industrial Technical Centre for Metallic Construction, CTICM)

CTICM is a non-profit organisation for research and testing of metallic constructions, founded in 1962.

Core Steel R&D Competencies
- Design of steel and composite constructions
- Applied research
- Fire testing
- Fire-safety engineering
- Software development

Steel R&D Organisation
- Steel Construction Department (RDT, design activities)
- Fire and Testing Department

Steel R&D Staff 15

Specialist Equipment for Steel R&D
- 7 fire-testing furnaces (2-150 m^3)
- 1 calorimetric hood
- 1 mechanical test rig (static and fatigue)
- Extensive computer and modelling facilities (ANSYS)

Current Steel R&D Topics

- Steel-concrete composite structures (buildings, bridges)
- Steel in housing
- Fatigue, brittle fracture
- Bridge-design optimisation
- Old-bridge assessment
- Beams with openings
- Fire modelling
- Natural fire-safety concept
- Stainless steel in construction

Contact Addresses
Mr J-H BORGEOT, General Manager
CTICM
BP 64, Domaine de Saint Paul
F - 78470 SAINT REMY LES CHEVREUSE, FRANCE
Tel.: +33 (0)1 30 85 25 00; Fax: +33 (0)1 30 52 75 38
E-mail: dgjhb@cticm.com
http://www.reseau-cti.com/html/body_cticm.html

CENTRALE PARIS

The École Centrale Paris (ECP) is one of the major French graduate engineering schools.

Core Steel R&D Competencies

- Metallurgy and modelling (reduction process, steelmaking, hot and cold rolling, forging, pickling, annealing, galvanising, etc.)
- Heating processes (combustion and heat transfers)
- Physical and structural metallurgy of steel (precipitation, recrystallization and recovery, phase transformations, etc.)
- Mechanical properties of steel (mechanics and metallurgy of plasticity, damage, fatigue, fracture, etc.)
- Corrosion and hydrogen embrittlement (electrochemical corrosion, tribocorrosion, biocorrosion, etc.)
- Modelling of dynamical behaviour of steel structures (cars, railway vehicles and rails, buildings, cables, etc.)

Steel R&D Organisation

- Materials Processing Laboratory (Pr Jean-Bernard Guillot)
- Combustion and Heat Transfer Laboratory (Prof. Nasser Darabiha)
- Mechanics Laboratory (Prof. Philippe Bompard)
- Corrosion and Hydrogen Laboratory (Prof. Jacques Galland)

Steel R&D Staff 19

Specialist Equipment for Steel R&D

Hot Metal Elaboration and Steel Transformation

- High-temperature laboratory furnaces (up to 2500°C)
- Sophisticated Netzsch thermobalance (up to 1600°C)
- Experimental models and devices to study solid flow of granular materials in reactors
- High-speed hot- and cold-deformation simulating equipment (1.5 m/s, 50 t, 1500°C)

Heating Processes

- Numerous devices for flames analysis (CCD cameras, lasers, analysers, velocimeters, etc.)
- Numerous experimental devices for combustion and heat-transfer studies

Physical and Structural Metallurgy

- Three scanning electron microscopes, one with automatic EBSP system and FEG gun
- Two transmission electron microscopes, one with high resolution
- Tunnel-effect and atomic-force microscope
- Internal friction-measurement equipment
- X-ray diffraction equipments
- Microcalorimeter

Mechanical Properties

- Hydraulic and mechanical testing machines covering a wide range of monotonous and cyclic loading conditions (speed, temperature, etc.)

Corrosion and Hydrogen

- Electrochemical corrosion equipments and corrosion cells
- Tribometer under controlled environment
- Surface-topography measurement system
- Hydrogenation cells and hydrogen analysers

Computing Resources

- A 64-processor Silicon Graphics parallel computer
- Numerous Silicon Graphics and Sun work stations
- Access to CNRS/IDRIS supercomputer
- Finite element software packages

Current Steel R&D Topics

- Modelling of reduction reactors
- Modelling of granular solids flow in reactors
- Experimental study and modelling of galvanising process
- Prediction of structural evolution and forces in hot-rolling process
- Elimination and recycling of metallic elements in pickling baths
- Dynamic strain ageing of welded junctions
- Evaluation of fracture toughness from instrumented Charpy tests
- Localisation of plastic deformation in low-C steels
- Initiation and propagation of fatigue cracks (IF steels, duplex aged stainless steels, etc.)
- Stability of precipitates in ODS steels
- Hot tearing of stainless steels during welding
- Physical modelling of fracture mechanisms in nuclear steels (brittle-ductile transition, intergranular fracture, etc.)
- Microstructure/properties relations in HSS wires for tyres
- Intergranular corrosion of austenitic stainless steels
- Tribocorrosion of duplex stainless steels
- Corrosion of reinforcing steels in concrete
- Biocorrosion of stainless steels under seaside conditions
- Propagation and dissipation of dynamic loads in car structures
- Variability in damping of vibrations in spot-welded structures

Contact Addresses
Hervé BIAUSSER, Dean of Research
École Centrale Paris
Grande Voie des Vignes
F - 92295 CHÂTENAY-MALABRY, FRANCE
Tel.: +33 (0)1 41 13 15 164; Fax: + 33 (0)1 41 13 14 37
E-mail: biausser@ads.ecp.fr
http://www.ecp.fr

École des Mines de Nancy

Steel R&D is conducted at the Laboratoire de Science et Genie des Materiaux et de Metallurgie (Laboratory of Science and Engineering of Materials and Metallurgy, LSG2M).
LSG2M is associated with the National Center of Scientific Research (CNRS) and the National Polytechnic Institute of Lorraine (INPL).

Core Steel R&D Competencies

- Steel production and processing techniques
- Material properties, especially mechanical
- Mechanisms of heat and mass transfer
- Kinetics of transformations and their effect on microstructures and properties

Steel R&D Organisation

- Materials process engineering
- Solidification (casting and processing)
- Thermodynamics, mechanics and microstructures
- Iron powder

Steel R&D Staff 49

Specialist Equipment for Steel R&D

- Melting and casting under vacuum or controlled atmospheres (15 kg)
- Devices for controlled solidification
- Furnaces for solid-state heat treatment (up to 2400°C) with controlled cooling
- Thermomechanical simulators and high-temperature dilatometers
- Mössbauer spectroscopy
- X-ray diffractometers (structure, texture, stresses), up to 1000°C
- Differential scanning calorimetry and thermal analysis (up to 1600°C)
- Thermal diffusivity measurement (up to 1500°C)
- Method of Sieverts for the study of interactions between gas and liquid metals
- Mass spectrometry and gas chromatography
- Thermogravimetry (up to 2400°C)
- Mechanical alloying and sintering devices (up to 1600°C)
- TEM - SEM - SIMS
- Software (Sysweld, Phoenics, Fluent, Thermocalc, etc.)

Current Steel R&D Topics

- Formation and morphology of dust generated by splitting gas bubbles at the surface of a metallic liquid bath
- Movement of equiaxed crystals and formation of microstructures and segregations during solidification of big steel ingots
- Segregations induced by the thermomechanical behaviour of the solidifying ingot surface during continuous casting
- Mathematical modelling of solidification in continuous casting of steel, optimisation of casting systems
- Transformation of residual austenite under thermal and thermomechanical loading
- Modelling of the bainitic treatment for automotive mechanical parts
- Modelling of the tempering of quenched steels, effect on microstructure, thermomechanical behaviour and residual stresses

Contact Addresses
Jean Marie DUBOIS
Laboratoire de Science et Génie des Matériaux et de Métallurgie
École des Mines de Nancy
Parc de Saurupt
F - 54042 NANCY Cedex, FRANCE
Tel.: +33 (0)3 83 58 42 28; Fax: +33 (0)3 83 57 63 00
E-mail: petit@mines.u-nancy.fr
http://www.lsg2m.org

(National Graduate School of Electrochemistry and Electrometallurgy at Grenoble, ENSEEG)

ENSEEG is a graduate engineering school financed by the French Ministry of Education as a department of the «Institut National Polytechnique de Grenoble» (INPG).

Core Steel R&D Competencies

- Thermodynamics of liquid and solid metals and alloys
- Solidification of metals
- Plastic deformation and mechanical properties
- Corrosion, oxidation and adhesion science and technology

Steel R&D Organisation

Two laboratories, both members of CNRS (French National Center of Scientific Research) are doing steel research:

- LTPCM: Thermodynamics and physical chemistry of metals
- LEPMI: Electrochemistry

Furthermore, a special working group (GEDAI: Groupe d'étude de la durabilité des alliages inoxydables), focuses on cross coupling between academic and industrial research, with long-term industrial partners.

Steel R&D Staff 23

Specialist Equipment for Steel R&D

- Melting shop, rapid-quenching devices, powder metallurgy, etc.
- X-ray equipment for phase, stress, textures and structure analysis
- Atomic force microscopy (AFM) and Scanning Tunnelling Microscopy (STM)
- Surface Science laboratories with appropriate equipment, including Auger/ESCA spectrometers, surface energy measurements, etc.
- Corrosion laboratory, with appropriate electrochemical devices, EIS, photo-electrochemistry, slow-strain rate tensile test machine for SCC investigations, etc.
- Oxidation laboratory with appropriate equipment

Current Steel R&D Topics

Metallurgy

- Phase transformations
- Effect of hot working on further phase transforms of austenite

- Mechanisms of mechanical breakdown
- Precipitation microstructures and modelling
- Material selection
- Thermodynamic database for complex alloys

Surfaces and Corrosion

- Oxidation resistance of stainless steels
- Metallurgical effects on localised corrosion resistance of stainless steels
- Modelling and simulation of corrosion processes
- Physics of passive films of stainless steels
- Adhesion and wettability of metal surfaces

Contact Addresses
Jean Charles JOUD, Professor
GEDAI/LTPCM/ENSEEG
rue de la piscine, 1130 - domaine universitaire
BP 75
F - 38402 Cedex SAINT MARTIN D'HERES, FRANCE
Tel.: +33 (0)4 76 82 65 07; Fax: +33 (0)4 76 82 67 67
E-mail: Jean-Charles.Joud@ltpcm.inpg.fr
http://www.enseeg.inpg.fr

Ecole Nationale Supérieure des Mines SAINT-ETIENNE

The «École Nationale Supérieure des Mines de Saint-Etienne» (ENSM-SE) is a graduate engineering school financed by the French Ministry of Industry.

Core Steel R&D Competencies

- Production of high-purity iron and steels
- Processing of steels by plastic deformation
- Corrosion - deformation interactions

Steel R&D Organisation

The SMS Division (Sciences of Material and Structures) of ENSM-SE comprises six research departments. Three of these departments form a CNRS (French National Center of Scientific Research) Laboratory 'Plasticity, Damage and Corrosion of Materials' (PECM):

- MHP: High-purity metals and alloys department
- MMF: Microstructures and processing department
- MPI: Physical mechanics and interfaces department

Steel R&D Staff 24

Specialist Equipment for Steel R&D

- Ultra-high purity iron, nickel and chromium obtained by chemical purification and melting in a cold crucible, production of high-purity steels, forming and chemical analysis of the products
- Thermomechanical processing laboratory: traction-compression machines equipped with high-temperature uniaxial and plane stress compression tests, torsion machine
- X-ray generators with texture goniometer and high-temperature diffraction modules. Dosophatex devices of X-ray diffraction for phase, stress and structure analysis

- 3 scanning electron microscopes, including SEM-FEG with EDX + EBSD
- CM200 transmission electron microscope, with EDX microanalysis and nanotexture measurements
- Auger/ESCA/GDOES spectrometers
- Specific devices of plastic strain under potentiostatic control (2 servo-hydraulic machines, 3 electromechanical machines for fatigue)
- Slow strain-rate tensile tests machines (4 electromechanical machines) under controlled atmospheres (aqueous media, autoclaves, high-temperature oxidising, vacuum)
- Workstations with finite element programs

Current Steel R&D Topics

High purity

- Studies of the effect of additions of selected impurities on the properties of ultra-high purity steels
- International inter-comparison circuit for trace analysis and impurity characterisation in iron

Processing of steel

- Thermomechanical processing
  - Experimental simulations of forging and rolling, in conjunction with quantitative studies of microstructural and textural changes in steels
  - Study of the damage of stainless steels during hot rolling.
- Low-temperature processing
  - Study of microstructures and textures after deformation, and relationship with the mechanical properties

Corrosion - deformation interactions

- Measurement, analysis and description of SCC and corrosion fatigue in different industrial environments/steels conditions: mechanisms analysis and numerical modelling
- Definition and implementation of tests for industrial steels for materials selection

Contact Addresses
Régis BLONDEAU, Senior Manager
Material Science Division
École Nationale Supérieure des Mines de Saint-Etienne
158, Cours Fauriel
F - 42023 SAINT-ETIENNE Cedex 02, FRANCE
Tel.: +33 (0)4 77 42 00 85; Fax: +33 (0)4 77 42 01 57
E-mail: blondeau@emse.fr
http://www.emse.fr

LABORATOIRE DE PHYSIQUE ET MECANIQUE DES MATERIAUX

(Laboratory of Physics and Mechanics of Materials, LPMM)

The city of Metz hosts three important academic institutions doing research in materials and mechanical sciences: the University of Metz, the École Nationale d'Ingénieurs de Metz, and the École Nationale Supérieure d'Arts et Métiers (ENSAM). These institutions share their research facilities in the field of Mechanical Engineering within the Laboratory of Physics and Mechanics

of Materials (LPMM). This Laboratory, founded in 1982, is also a Research Unit of the CNRS (the French National Center of Scientific Research) since 1985. A close relation in metal forming has been developed with the steel industry since many years.

Core Steel R&D Competencies

- Micro-mechanical modelling of the behaviour of polycrystalline steels
- Micro-mechanical modelling of phase transformation
- Micro-structural characterisation
- Behaviour of sheet metal at high impact velocity
- Instabilities in metal forming
- Finite-element simulations of metal forming processes
- Numerical method for non-linear «eigenvalue» problems
- Vibrations of long repetitive structures

Steel R&D Organisation

- Behaviour of materials applied to metal forming
- Behaviour of materials applied to high-speed machining
- Behaviour of smart materials and structures

Steel R&D Staff 36

Specialist Equipment for Steel R&D

- Electro-mechanical testing machines (20 kN, 10 kN, 5 kN)
- High-speed hydraulic tension-torsion testing machine
- Hopkinson bars (tension, compression, torsion, shearing)
- Scanning electron microscopes, with EDX and EBSD
- X-ray diffraction (residual stress analysis)

Current Steel R&D Topics

- Simulation of the thermal-mechanical behaviour of TRIP steel
- Micro-structural characterisation of strain mechanisms in TRIP steel
- Micro-mechanical approach to the thermal elastic visco-plastic behaviour of steel
- Numerical simulation in sheet-metal forming
- Simulation of deep drawing with an asymptotic numerical method
- Strain hardening at large strains
- Vibrations of damped sandwich structures
- Behaviour of sheet steel at low and high strain rate

Contact Addresses
Etienne PATOOR, Professor at ENSAM, Director of the LPMM
Ile du Saulcy
F - 57045 METZ, FRANCE
Tel.: +33 (0)387 31 53 60; Fax: +33 (0)387 31 54 66
E-mail: patoor@lpmm.univ-metz.fr
http://www.lpmm.univ-metz.fr

RWTH AACHEN

Rheinisch-Westfälische Technische Hochschule Aachen

Institut für Eisenhüttenkunde (IEHK), RWTH Aachen
(Department of Ferrous Metallurgy)

Core Steel R&D Competencies

- Teaching and research assignment in the field of iron and steel
- Evolution of new production techniques for iron and steelmaking
- Development of new materials with improved properties
- Prediction of the behaviour of steel components
- Modelling and simulation of microstructure development and phase transformation

Steel R&D Organisation

- Chair of Metallurgy of Iron and Steel (Prof. Dr.-Ing. Dieter Senk)
- Chair of Materials Technology (Prof. Dr.-Ing. W. Bleck)

Steel R&D Staff 115

Specialist Equipment for Steel R&D

- Medium-frequency and vacuum melting up to 500 kg
- Electro-slag laboratory melting
- Blast-furnace injection simulation
- Equipment for hot-gas cleaning and corrosion studies
- BET analysis for surface examination of powders
- DTA facility
- Pounding test
- Deforming-dilatometer
- Corrosion laboratory (e.g. with 0.4 m^3 climate cabinet)
- Hot-forming and continuous-casting simulator
- Hot-dip coating simulator, pilot plant for continuous annealing of sheets
- High-speed tensile testing
- Sheet testing (e.g. 2-dimensional flow curves)
- Fracture-mechanical testing and structural-component testing (up to 12 MN load)
- “In-service” strain measuring

Current Steel R&D Topics

Process technology

- Laser measurement in the blast tuyere
- Injection of coke, ore, and plastic scrap in the blast furnace
- Direct analysis of steel melts with laser
- Recycling of zinc-containing dusts
- Dioxin emission from sintering belts

Metallurgy

- Mass transfer from liquid steel to the slag phase
- Degree of cleanness of liquid steel
- Removal of steel impurities
- Treatment of slags
- Strip and thin-slab casting

Materials Science

- High-temperature properties of the strand shell
- Thermomechanical treatment
- Softening during austenitic and ferritic rolling
- Thixo-forming

- Development of new case-hardening steels
- Laser surface treatment
- Hot-dip coating of high-strength steels
- Ultra-short annealing
- Simulation of phase transformation and microstructure
- Numerical analysis of stresses and strains in structural components
- Corrosion behaviour of high-alloy steels

Materials testing and applications

- Registration and mathematical modelling of flow curves
- Forming behaviour of TRIP steels
- High-speed tensile testing for crash simulation
- Registration of flow curves under multiaxial charging during the bulge test using video-laser measurement
- Fracture-mechanical characterisation of high-strength steels and welded joints
- Development of security concepts for steel components
- Modelling of service-life prediction
- Structural component testing
- Sheet steel-aluminium foam compound and steel foam
- New high-strength cold-strip and hot-strip grades
- Shadow-mask materials for improved cathodic tubes

Contact Addresses
Univ.-Prof. Dr.-Ing. Wolfgang BLECK
Tel.: +49 (0)241 80 95782; Fax: +49 (0)241 80 92224
E-mail: bleck@iehk.rwth-aachen.de

Univ.-Prof. Dr.-Ing. Dieter SENK
Tel.: +49 (0)241 80 95792; Fax: +49 (0)241 80 92368
E-mail: dieter.senk@iehk.rwth-aachen.de

Department of Ferrous Metallurgy (IEHK) of RWTH-Aachen
Intzestrasse 1
D - 52072 AACHEN, GERMANY
http://www.iehk.rwth-aachen.de

Institut für Bildsame Formgebung (IBF), RWTH Aachen

(Institute of Metal Forming)

Core Steel R&D Competencies

- Optimisation of metal-forming processes via process shortening, thermo-mechanical treatment, re-use, net shape, simulation (computer and physical)
- Development of new metal-forming processes and products (lightweight structures). Minimisation of energy, costs, and material consumption

Steel R&D Organisation

- Casting/forming (twin-roll casting)
- Hot forming (thixo-forming, open-die forging, incremental forging, ring rolling, longitudinal rolling, extrusion)
- Cold forming / lightweight construction (producing and processing of Tailor Rolled Blanks and, shot-peen forming, drawing)
- Simulation and optimisation (physical and FEM simulations for process optimisation, computer-aided optimisation)
- Material data (determination of material data (flow stress) and boundary conditions for the simulation of metal-forming processes), determination of surface defects

Steel R&D Staff 32

Specialist Equipment for Steel R&D

- Twin-roll caster, in-line rolling mill
- Open-die forging centre, hydraulic forging press, 6-axis forging robot, heating facilities
- Thixo-forming centre
- Radial-axial ring rolling mill
- Rolling mill I with strip coiler and laser thickness measurement devices, rolling mill II
- Shot-peening facilities (5-axis CNC control) for components up to 5000 x 2400 x 1000 mm^3
- Rod-drawing bench, wire-drawing bench
- Servohydraulic deep-drawing press
- Computer-controlled servohydraulic testing machine and fast robot-aided thermal treatment unit
- Surface-inspection system
- Strain-analysis measurement system

Current Steel R&D Topics

- Optimisation of the strip-casting process, influence on strip quality by cooling and rolling
- Thixo-forging, thixo-transverse impact extrusion, thixo-extrusion of aluminium and steel
- New and improved ring-rolling processes
- FEM simulation of forging, extrusion, thixo-forming, sheet-metal forming, ring rolling, longitudinal rolling, development of optimisation tools
- Determination of material data (flow stress) and boundary conditions (emissivity, heat-transfer coefficient, and friction coefficient)
- Integration of microstructure models (phenomenological/physical approaches) into FEM simulation to follow the microstructural evolution during multi-step hot-forming processes
- Producing and processing of tailor-rolled blanks, lightweight sandwich sheets, and composite structures
- Double-sided shot-peen forming
- Analytical investigation on behaviour of surface defects during cold rolling

Contact Addresses
Prof. Dr.-Ing. Reiner KOPP
RWTH Aachen
Institut für Bildsame Formgebung
Intzestraße 10
D - 52056 AACHEN, GERMANY
Tel.: +49 (0)241 80 95907; Fax: +49 (0)241 80 92234
E-mail: kopp@ibf.rwth-aachen.de
http://www.ibf.rwth-aachen.de

Lehrstuhl für Werkstoffchemie, RWTH Aachen

(Chair of Materials Chemistry)

Core Steel R&D Competencies

- Chemical thermodynamics (calculation of multi-component phase equilibria and diffusion processes; data assessment)
- Kinetics of metallurgical processes
- Electric arc metallurgy
- Plasma-materials interactions
- Chemical and physical vapour deposition (deposition kinetics, film characterisation, metastable phases, thermal stability, functional film properties)

Contact Addresses
Prof. Dr.-Ing. Jochen SCHNEIDER, Head of Department
Lehrstuhl für Werkstoffchemie, RWTH Aachen
Kopernikusstr. 16
D - 52056 AACHEN, GERMANY
Tel.: +49 (0)241 80 25966; Fax: +49 (0)241 80 22295
E-mail: schneider@lth.rwth-aachen.de
http://www.lth.rwth-aachen.de

Institut für Industrieofenbau und Wärmetechnik im Hüttenwesen (IOB), Lehrstuhl für Hochtemperaturtechnik, RWTH Aachen

(Department of Industrial Furnaces and Heat Technology)

Core Steel R&D Competencies

- Process and plant technology
- Heat transfer
- Fluid dynamics
- Off-gas measurement
- Process modelling and simulation
- Environmental technologies

Contact Addresses
Univ.-Prof. Dr.-Ing. Herbert PFEIFER
RWTH Aachen
Institut für Industrieofenbau und Wärmetechnik im Hüttenwesen
Kopernikusstraße 16
D - 52074 AACHEN, GERMANY
Tel.: +49 (0)241 80 5935; Fax: +49 (0)241 80 22289
E-mail: pfeifer@iob.rwth-aachen.de
http://www.rwth-aachen.de/iob

(Freiberg University of Mining and Technology, TU Freiberg)

Institut für Eisen- und Stahltechnologie, TU Freiberg

(Institute of Iron and Steel Technology)

Core Steel R&D Competencies

Fundamental and application-oriented research in the field of iron and steel making/ processing and related fields.

Steel R&D Organisation

- Theory of Metallurgical Processes, Iron and Steelmaking, Material Recycling
- Special Steel Technology and Iron-Based Materials

Steel R&D Staff 35

Specialist Equipment for Steel R&D

- Refining, casting, solidification and powder/coating equipment
- Remelting and heat treatment equipment
- Equipment for:
  - High-temperature material investigations
  - Material phase transformations
  - Electrochemical testing and chemical analysis

Current Steel R&D Topics

Melting, Refining and Casting/Solidification

- Reduction of tramp and trace elements
- Separation of non-metallic inclusions
- Optimisation of casting fluxes
- Modelling of dynamic flow
- Optimisation of as-cast structures

Scrap and Residual-Materials Recycling

- Injection of residuals into blast furnaces
- Detinning of tin-plate scrap
- Purification of scrap-based melts under vacuum

High-Temperature Properties of Metallurgical Substances

- Viscosity, surface tension, and melting behaviour of slags, dusts, and residuals
- Refractory ceramics for melting and casting systems
- High-temperature sensor materials
- Development of metal ceramics

Metallurgical Measuring Techniques

- Sensor concepts for continuous monitoring of trace elements
- Sensor concepts for continuous temperature measurement

Investigation and Modelling of Phase Transformations

- Correlation of structures and properties
- Quantitative structure analysis
- Modelling of steel structures
- Precipitation and dissolution behaviour of secondary phases

Heat Treatment of Steels

- Hardening by excess-pressure gas quenching
- Optimisation of heat-treatment techniques

Steel Management

- Material competition
- Statistical developments in steel and related industries
- Economic and ecological aspects of material production

Contact Addresses
Prof. Dr.-Ing. habil. Dieter PEISKER, Director of Institute
Institut für Eisen- und Stahltechnologie
TU Bergakademie Freiberg
Leipziger Str. 34
D - 09599 FREIBERG, GERMANY
Tel.: +49 (0)3731 39 3100; Fax: +49 (0)3731 39 2416
E-mail: ja@iest.tu-freiberg.de
http://www.tu-freiberg.de
http://www1.tu-freiberg.de/~wwwfe/index.html

Institut für Metallformung, TU Freiberg

(Institute for Metalforming, TU Freiberg)

Core Steel R&D Competencies

- Deformation processes of steel, non-ferrous materials and alloys
- Rolling, forging and drawing technology
- Hot and cold deformation processes
- Heat treatment
- Characteristic values of materials
- Modelling and simulation of deformation processes
- Microstructure evolution, etc.
- New materials and technologies, powder metallurgy

Steel R&D Organisation

- Characteristic values of materials
- Development of materials and technology of flat products
- Development of materials and technology of long and massive products
- Numerical simulation of deformation processes and development of microstructure res. mechanical properties
- Test and pilot facilities

Steel R&D Staff 40

Specialist Equipment for Steel R&D

- Four-stand continuous high-speed experimental mill
- Reversing mill (applicable for rolling of rods, beams, plates, and strips)
- Three-stand three-high train
- Two-high and four-high mills for cold rolling of strips
- Forging press
- Torsion plastometers
- Facilities for tensile upsetting and deep-drawing tests
- Drawing machines
- Furnaces for thermal treatment

Current Steel R&D Topics

Rolling Process (rod and bars)

- Thermomechanical treatment of rods and bars
- Basic elements of modern forming processes

Rolling Process (strips)

- Technology of hot and cold rolling of modern steels and alloys
- Surface properties of hot and cold rolled strips
- Microstructure and texture evolution
- New production technologies, including direct rolling and forging, reduction in process steps

Modelling

- Modelling of material flow, microstructure evolution and properties during rolling
- Development of numeric simulation systems for description of material behaviour at production, further processing, and on finished product

Contact Addresses
Prof. Dr-Ing. Rudolf KAWALLA, Director of Institute
Institut für Metallformung
Bernhard-von-Cotta-Str. 4
D - 09596 FREIBERG, GERMANY
Tel.: +49 (0)3731 39 24 79; Fax.: +49 (0)3731 39 36 56
E-mail: kawalla@imf.tu-freiberg.de
http://www.imf.tu-freiberg.de

(Technical University of Clausthal)

Several institutes of the Technical University Clausthal conduct various research activities in high-temperature technology, metallurgy, and materials science. Research in steel technology covers the complete spectrum from reduction processes and steelmaking up to problems related to the use and the processing of steel. The type of research ranges from fundamental research and modelling up to pilot-plant operation. The information given below is on the Institute of Metallurgy and the Institute of Energy Processing and Fuel Technology where there is also an emphasis on steel research.

Core Steel R&D Competencies

- Thermodynamics of reactions and mixtures
- Constitution of alloys and slags
- Computation of phase diagrams
- Physical properties of materials
- Mechanisms and microkinetics of metallurgical reactions
- Interface reactions and high-temperature corrosion
- Transport of heat, mass, and momentum in metallurgical systems and processes
- Solidification, micro- and macrosegregation, precipitation and structure formation
- Forming of metals, theory of plasticity
- Mathematical modelling

Steel R&D Organisation

- Institute of Metallurgy
  - Thermodynamics and microkinetics
  - Extractive metallurgy
  - Process metallurgy
  - Foundry technology
  - Material forming
- Institute of Energy Processing and Fuel Technology
  - Heating technology and industrial furnaces
  - Technical thermodynamics and energy conversion
  - Technology of fuels

Steel R&D Staff

Institute of Metallurgy: 23
Institute of Energy Processing and Fuel Technology: 6

Specialist Equipment for Steel R&D

- Levitation melting, flash heating, induction furnaces (from 20 kg to 1.3 t melt size), resistance furnaces
- Cold- and hot-model reactors
- Strip-casting pilot plant
- Shape-casting facilities
- Set-up for heat-transfer measurement at hot surfaces, e.g. in spray cooling and in mold cooling
- Set-up for investigation of scale formation at different cooling and surrounding conditions
- Hot- and cold-rolling facilities, foil rolling, cladding, wire drawing, deep drawing, heat-treatment devices

- Material testing
- Metallography
- Analytical facilities: SEM (EDX, WDX), SIMS, XRD (small angle, < 1500°C), gas chromatography

Current Steel R&D Topics

- Thermodynamics, constitution and materials properties
  - Thermodynamic modelling of multi-component alloy systems, calculations and experiments on stable and metastable phase equilibria
  - Oxide phase diagrams
  - Long-term oxidation behaviour of alumina-forming steels [FeCrAl(RE) type] for power plant and automotive catalyst support applications.
- Reduction, melting, refining processes and recycling
  - Kinetics of fluidised-bed reactions
  - Precipitation, agglomeration, and floatation of inclusions in deoxidation of liquid steel
  - Kinetics of degassing reactions
  - Mass transfer across liquid/liquid interfaces
  - Scrap preheating in the EAF process
  - Slag foaming in the EAF process
  - Cokeless cupola furnace
- Solidification processes
  - Mold heat transfer in continuous casting
  - Scale formation in continuous casting, hot rolling, and heat treatment
  - Modelling of solidification, segregation, precipitation, and structure formation
  - On-line modelling for process control and quality monitoring
  - Development of the DSC strip-casting process, strip casting of TRIP/TWIP steels, strip casting of steels with increased content of tramp elements
- Metal forming and materials processing
  - Modelling the effect of chemical composition on the metallurgy of cold-strip production
  - Steel-wire drawing with improved wire rod and lubricants

Contact Addresses

Prof. G. BORCHARDT, Prof. H. PALKOWSKI, Prof. W. PLUSCHKELL, Prof. R. SCHMID-FETZER, Prof. K.-H. SPITZER
Institut für Metallurgie
Technische Universität Clausthal
Robert Koch Str. 42
D - 38678 CLAUSTHAL-ZELLERFELD, GERMANY
Tel.: +49 (0)5323 72-2267 / -3188 / -2014
Fax: +49 (0)5323 72-3120 / -3184 / -3527
E-mail: guenter.borchardt@tu-clausthal.de
http://carbonix.imet.tu-clausthal.de

Prof. R. SCHOLZ
Institut für Energieverfahrenstechnik und Brennstofftechnik
Agricolastr. 4
D - 38678 CLAUSTHAL-ZELLERFELD, GERMANY
Tel.: +49 (0)5323 72 2032; Fax: +49 (0)5323 72 3155
E-mail: Scholz@ievb.tu-clausthal.de
http://www.tu-clausthal.de/forschung/CLZ41302.shtml

Nederlandse Organisatie voor toegepast-natuurwetenschappelijk Onderzoek

TNO is a Dutch contract research organisation with more than 5100 professionals. Steel research is conducted mainly in two units:

TNO-Industry: Institute for Industrial Technology

TNO-MEP: Institute for Environment, Energy and Process Innovation

Core Steel R&D Competencies

- Steel structural integrity and material performance
- Steel corrosion and antifouling research
- Environmental performance benchmarking
- Emission monitoring and modelling
- Recycling and Life Cycle Analysis of ferrous materials

Steel R&D Organisation

- TNO-Industry, Metals Technology Dept. and Dept. of Corrosion and Antifouling
- TNO-MEP, Dept of Emissions Assessment, Dept. of Environmental Quality and Dept. of Processes and Applications

Steel R&D Staff

TNO-Industry: 45
TNO-MEP: 15

Specialist Equipment for Steel R&D

- Natural seawater testing laboratory
- Electrochemical testing equipment
- Corrosion testing equipment
- Testing equipment for exposure of full-size steel components to high pressure, high temperature, and gas mixtures
- Equipment for tensile, fatigue, and creep testing
- Environmental laboratories for chemical analysis
- Software models

Current Steel R&D Topics

- Low-alloyed steels for maritime applications
- Corrosion testing and monitoring for the chemical and off-shore industry
- Development of protective coatings for steel structures (anticorrosion and antifouling)
- Research and development of steel grades for high-temperature applications (e.g. hydrogen)
- Mechanical testing of structural integrity and performance of welds and steel grades during use
- Emission assessment, measurements and monitoring
- Environmental performance benchmarking of steel industries
- Recycling of steels for packaging

Contact Addresses
Mr. H.J.F. (Eric) CREEMERS
TNO-MEP
PO Box 342
NL - 7300 AH APELDOORN, THE NETHERLANDS
Tel.: +31 (0)55 549 3382; Fax: +31 (0)55 549 3252
E-mail: e.creemers@mep.tno.nl
http://www.mep.tno.nl/homepage_eng_mep.html
http://www.ind.tno.nl/homepage.html

Netherlands Institute for Metals Research

The Netherlands Institute for Metals Research (NIMR) is an independent institute jointly funded by partners from the Dutch metals industry, partners from the knowledge infrastructure and the Ministry of Economic Affairs. The mission of the NIMR is to improve the competitive position of the Dutch metals industry by carrying out strategic research in the fields of metals science, metals production, and metals engineering.

Core Steel R&D Competencies

The NIMR strategic research programme is made up of some 60 projects that constitute a coherent whole, and all of them cover part of the stages between production and use of the metal. To ensure optimum interaction between researchers and industrial partners the research programme has been grouped into several clusters. The clusters relevant to steel research are the following:

- Steel production
- Modelling of forming of metal and laminate products
- Fundamentals of forming
- Welding
- Corrosion
- Surface and interface engineering

Steel R&D Organisation

See above.

Steel R&D Staff 64

Specialist Equipment for Steel R&D

- High-resolution transmission electron microscopes
- Scanning electron microscopes
- Confocal microscopy
- Atomic-force microscopy
- Dual-focussed ion beam system
- Electron probe microanalysis
- Gleeble systems (including Maxstrain unit)
- Biaxial tensile testing machines
- PVD equipment
- Laser welding equipment

Current Steel R&D Topics

Cluster Steel Production

- Optimisation of the grain-boundary character distribution in metals
- Thermo-mechanical loading response of iron-based alloys
- The effect of plastic deformation on the transformation kinetics in steel
- New process routes for TRIP steels
- Modelling of martensitic and bainitic reactions in engineering steels
- Recovery and recrystallisation processes in low-alloy steels
- The resistance against Environment Induced Cracking (EIC) in high-strength steel fasteners

Cluster Modelling of Forming of Metal and Laminate Products

- Mathematical-numerical methods for simulation of metal forming processes
- Modelling of sheet-metal forming
- Plate forming
- Friction and roughness transfer in rolling and metal-forming processes
- Forming of laminates
- Development of production processes for laminates
- Joining of laminates
- Residual strength of fibre metal laminates
- Stability and large local deformations of laminate

Cluster Fundamentals of Forming

- Discrete dislocation and crystal plasticity modelling
- Multi-level FEM
- Forming of micro-parts
- Mixed experimental-numerical method for finite plasticity
- Mathematical modelling of microstructural changes during forming
- Higher-order coupled plasticity-damage formulations for metal-forming processes
- Fatigue failure of metal components: a CDM approach
- From ductile damage to ductile fracture in forming processes
- Non-uniform straining and forming limits
- Fundamental and technological aspects of micro-forming of ultra-thin sheet

Cluster Welding

- Laser-assisted arc welding
- Acoustic emission analysis during welding
- Numerical modelling of laser-welded joints
- Diode laser welding of unalloyed steel and stainless steel
- Laser welding of HSLA steel

Cluster Corrosion

- Delamination in metal/polymer interfaces
- Microgalvanic cells at grain boundaries
- Intergranular corrosion

Cluster Surface and Interface Engineering

- Surface composites and functionally gradient materials with high-power lasers
- Stress and dislocations in thin layers
- Fundamental and applied aspects of interfaces between dissimilar materials
- Laser cladding of metals
- Adherence of metal coatings onto metallic substrates: zinc coatings on high-strength steels

Contact Addresses

Prof.dr.ir. S. RADELAAR, Scientific Director / General Manager
Netherlands Institute for Metals Research
Rotterdamseweg 137
P.O. Box 5008
NL - 2600 GA DELFT, THE NETHERLANDS
Tel.: +31 (0)15 278 25 35; Fax: +31 (0)15 278 25 91
E-mail: info@nimr.nl
http://www.nimr.nl

TU Delft
Delft University of Technology

The Laboratory of Materials Science at the TU Delft houses the principal research groups working in ferrous metallurgy. The laboratory has strong links with both the faculty of Applied Sciences (TNW) and the faculty of Mechanical Engineering (OCP). The research covers steel production, steel properties, and the behaviour of steel during usage. In general the research is of a fundamental and generic nature and less directed towards specific applications. Part of the research is done in collaboration with the Netherlands Institute for Metals Research (NIMR) but European steel projects and bilateral projects with foreign institutes or companies are very important too. The application of steel in large civil engineering constructions is studied in the group Steel Constructions at the faculty CiTG. Some unique facilities for measuring microstructure development using (polarised) neutrons have been developed in collaboration with the Interfaculty Reactor Institute in Delft.

Core Steel R&D Competencies

- Microstructure control in steel via thermomechanical processing
- Powder metallurgy
- Welding technology
- Corrosion technology
- Surface and microstructure characterisation
- Fracture mechanics
- PVD coatings on ferrous substrates

Steel R&D Staff 50

Specialist Equipment for Steel R&D

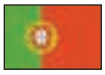
- High-resolution electron microscopy
- FEG scanning electron microscopy with EBSD
- Dual-focussed ion-beam system
- Scanning laser confocal microscopy with hot stages
- Deformation dilatometry
- Combined axial-torsional dilatometry
- Plane strain compression testing
- Multi-axial deformation testing
- PVD equipment at semi-industrial scale
- Laser-welding facilities (3 and 0.75 kW)
- Arc-welding facilities
- HIP installation
- Tensile-testing facilities at very low, normal and high testing speeds
- Atomic-force microscopy
- Scanning Kelvin probe
- Localised corrosion-test facilities
- HIP facilities
- PIM facilities
- Neutron depolarisation

Current Steel R&D Topics

- Modelling microstructure development in steels via thermomechanical processing
- Intercritical rolling of steel strip, including texture formation
- TRIP-steel development
- Ultra-fast cooling routes for steel-strip production
- Recrystallisation kinetics in steels
- Characterisation of zinc-coated steels

- Laser welding of HSLA and other multiphase steels
- Localised corrosion of coated steel
- Development of techniques for in-situ studies of microstructure formation
- PVD coatings on tool and stainless steels
- Modelling of laser-welding processes
- Laser-assisted arc welding
- Powder injection moulding of stainless and tool steels
- Die-steel development using powder metallurgy
- Fatigue fracture in welded steels
- Hydrogen embrittlement in bolt steels
- Microstructure characterisation using polarised neutrons

Contact Addresses
Prof.dr.ir. A. BAKKER (fracture mechanics)
Dr.Ir. J. DUSZCZYK (powder metallurgy)
Prof.dr. I.M. RICHARDSON (welding)
Prof.dr. J.H.W. de WIT (corrosion)
Prof.dr.ir. S. van der ZWAAG (microstructure formation)
Laboratory for Materials Science
TU Delft
Rotterdamseweg 137
NL - 2628 AL DELFT, THE NETHERLANDS
Tel.: +31 (0)15 278 3976; Fax: +31 (0)15 278 6730
E-mail: S.vanderZwaag@tnw.tudelft.nl
http://www.tudelft.nl



Instituto Nacional de Engenharia e Tecnologia Industrial (INETI)

Department of Materials and Production Technologies

Core Steel R&D Competencies

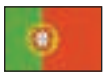
Powder technology

- Pressing and sintering
- Powder injection moulding
- Hot isostatic pressing
- Direct metal laser sintering (DMLS)
- Water atomisation
- Particle-size distribution, surface-area analysis, density (true, apparent and tap), flowability

Characterisation

- Mechanical tests
- X-ray diffraction
- Differential thermal analysis
- Dilatometry
- Non-destructive testing
- Failure analysis
- Coatings, by physical, chemical and physic-chemical methodologies, including electrochemical methods and several surface analyses

Environmental technologies



Surface Treatments and Coatings

- New ecological surface treatments for metal-coated steel surfaces
- New metallic, organic and hybrid anticorrosive steel coatings
- Steel/coating interaction studies
- Degradation studies of coated steel in different natural and artificial environments
- Selection of surface treatments and coatings for anticorrosive applications

Steel R&D Organisation

- Material Engineering
- Surface Treatment and Coatings
- Production Technologies
- Prevention Technologies & Recycling
- Materials Characterisation
- Materials Electrochemistry

Steel R&D Staff 18

Specialist Equipment for Steel R&D

- Water atomiser
- Uniaxial and isostatic presses
- Injection machine
- Rheometer for feedstock characterisation
- Sintering furnaces (vacuum and controlled atmosphere)
- Hot isostatic press
- DMLS equipment
- SEM with Energy Dispersive Spectrometer (EDS)
- Scanning Vibrating Electrode Technique (SVET)
- Photo-acoustic detector associated to FTIR and microscope (PAS/FTIR)
- Atomic Force Microscope (AFM)
- XRD and XRF
- Electrochemical Impedance Spectroscopy (EIS)
- Salt spray, SO_2, humidity and temperature with and without continuous condensation, UV radiation and other cyclic and artificial weathering chambers
- Natural atmospheric exposure sites

Current Steel R&D Topics

- Development of new high-speed steels with improved sinterability and mechanical properties
- High-speed steel matrix composites for tribological applications
- Nanostructured materials (nanostructured steel powders consolidated by hot extrusion)
- Automotive PM components (press and sintering and injection moulding of steel powders)
- Biomedical applications (stainless steel)
- Rapid prototyping
- Rapid tooling
- Metal injection moulding
- Corrosion and protection of steel
- Surface treatments
- Anticorrosive coatings

Contact Addresses
José Miguel FIGUEIREDO
INETI-DMTP
Estrada do Paço do Lumiar
PT - 1649-038 LISBON, PORTUGAL
Tel.: + 351 (0)21 716 5181; Fax: + 351 (0)21 716 6568
E-mail: jose.figueiredo@ineti.pt
http://www.ineti.pt

(National Centre for Metallurgical Investigations, CENIM)

Formed in 1963 by the union of three pre-existing institutes, CENIM belongs to CSIC, National Council for Scientific Research, the largest Spanish research organisation.
CENIM's main activities are basic or applied research and technological co-operation with industry. Technical assistance to private companies and to public and private institutions is given and, furthermore, teaching and scientific information activities are carried out.

Core Steel R&D Competencies

Primary and secondary metallurgy

- Physical metallurgy
- Processes engineering
- Corrosion and protection
- Recycling

Steel R&D Organisation

- Corrosion and Protection
- Physical Metallurgy
- Primary Metallurgy and Materials Recycling
- Materials Engineering, Degradation and Durability
- Support units: Chemical Analysis, Drafting & Projects, Mechanical Testing, Electronics, Metallography & Photography, Computing & Communication, Workshop

Steel R&D Staff 214

Specialist Equipment for Steel R&D

- XRD, SEM, TEM
- Hot torsion and ultrafast dilatometer equipments
- Fatigue and fracture mechanics testing
- Rapid solidification
- Mass spectroscopy with induced plasma coupling (IPC)
- X-ray photoelectron spectroscopy (XPS)
- Special melting techniques: plasma and electroslag
- Electrochemical corrosion facilities
- Welding equipments
- Hot and cold isostatic pressure systems
- Hot-extrusion press
- Gas atomiser
- High-energy planetary mill
- Pilot plants for pressurised leaching, solvent extraction, sintering and combustion
- CO_2 laser equipment
- Pilot plant for hot-dip galvanising

Current Steel R&D Topics

Physical Metallurgy of Materials

- Mechanical properties
- Solid-state transformations
- High-temperature deformation
- Powder metallurgy, composite materials, intermetallics, nanomaterials and dynamics of aerosols

Primary Metallurgy and Recycling of Materials
- Mineral treatments
- Basic metallurgical processes
- Ferroalloys
- Characterisation and treatment of wastes
- Purification of industrials effluents
- Degradation and energy exploitation of wastes

Deterioration of Materials and Surface Treatment
- Protective coatings, passivation
- Atmospheric corrosion
- Surface & physical-chemistry modification
- Corrosion of reinforced-concrete structures

Process Engineering
- Modelling and simulation of metallurgical processes
- Simulation of forming processes
- Metallurgy of welding and cutting
- Fracture mechanics
- Advanced joining techniques
- Development of analytical methods

Contact Addresses
CENIM
Avda. Gregorio del Amo, 8
Ciudad Universitaria
ES - 28040 MADRID, SPAIN
Tel.: +34 91 553 8900; Fax: +34 91 534 7425
E-mail: director@cenim.csic.es
http://www.cenim.csic.es

inasmet fundación

Inasmet is a private, non-profit making technology centre, founded in 1962, with the purpose of serving the industrial community through technology transfer.

Inasmet centres its activities on Materials Technology, Industrial Processes, and the Environment, at two sites (San Sebastian and Irun), which house the laboratories and the various pilot plants for prototype manufacture.

Core Steel R&D Competencies

- Metallurgical processes
- Pilot plant for rolling mill: medium-frequency induction/oxycombustion and plasma ladle furnaces
- Rolling mill and ancillary equipment
- Metallography
- Process control
- Rolling technology and roll-pass design
- Metallic construction (reinforced bars)
- Failure analysis, modelling, and simulation

- Product characterisation
- Recycling of steel industry by-products

Steel R&D Organisation

- Marketing
- Characterisation
- Materials and Processes
- Chemical Technology and Environment
- Engineering and Consulting

Steel R&D Staff 58

Specialist Equipment for Steel R&D

Metallic Materials

- Pilot plant for superplastic forming and rolling mill
- Induction, oxycombustion, and plasma ladle furnace

Chemical & Environmental Technologies

- Gas and liquid chromatography
- UV-visible absorption spectrophotometry

Composites

- Extrusion-mixing equipment, grinders, hot presses, sintering oven

Surface Technologies

- Metallographic, corrosion, scratch, and pull-off adhesion testing laboratory
- Optical profilometer
- Dynamic nano-hardness tester

Joining Technologies

- Automatic application PTW 300 torch for plasma welding

Current Steel R&D Topics

- Superplastic, hydro, and thixoforming
- Food-can tinplate properties
- Lightweight components for the transport industry
- Beams and reinforced construction bar, «sandwich» structures
- Steels for power generation and ultra-high carbon steels
- Structure-properties of ferritic-pearlite and bainite steels
- Stainless steels and HSLA, dual-phase, IF, BH steels
- Thermomechanical treatment, rolling and forging steels
- Thermal, joining, vibration, stresses and cooling numerical modelling
- Wear, machinability and corrosion improvement in steels
- Electrolytic techniques in stainless steel pickling
- Recycling of baghouse dust and volume reduction of low-level radioactive (Cr^{6+}) waste
- Refractory materials
- Improved materials for security chain and lock components and improved materials for better steel process equipments
- Development of new advanced intermetallic materials
- High-performance bipolar ferrite magnets

Contact Addresses
Mr. Félix PEÑALBA, Physicist, Ph. D.
INASMET Foundation
Iron and Steel Division Director
Mikeletegi Pasealekua, 2
Parque Tecnológico
ES - 20009 SAN SEBASTIÁN, SPAIN
Tel.: + 34 943 003704; Fax: +34 943 003800
E-mail: fpenalba@inasmet.es
http://www.inasmet.es

Fundación ITMA is a non-profit private R&D technological centre working in the field of materials (metallic and non-metallic) since 1991. Directly related to the materials industries, ITMA services range from raw materials to the final product and in-service behaviour through the production and design phases. Steel and transformed products are the main areas, but refractory, plastic, and composite materials are also covered.

Core Steel R&D Competencies

- Design and production of raw materials
- Mechanical and microstructural characterisation
- Metallography
- Joining technologies
- Surface technologies
- Wear technology
- Organic and inorganic protective coatings
- Coating processes
- Corrosion
- Numerical simulation of thermal processes
- Modelling
- Ceramics
- Refractory materials

Steel R&D Organisation

- In-service behaviour of materials and components
- Joining technologies and microstructural characterisation
- Plastic and composite materials
- Surface technologies
- Design and production of raw materials
- Numerical simulation

Steel R&D Staff 30

Specialist Equipment for Steel R&D

- Dilatometer for thermal simulations
- SEM with EDAX adapted
- X-ray diffractometer
- Vacuum and controlled-atmosphere induction furnaces
- Scanning reference electrochemistry technique (SRET)
- Corrosion chambers
- Potentiostats. Electrochemical corrosion equipments
- Stress-corrosion cracking machine
- Climatic chambers
- Heating microscope
- Computer-simulation facilities
- Pilot coating plant
- Continuous hot-dip galvanising simulator (Rhesca).
- Pilot cold-rolling equipment
- Pilot plants for simulation of painting steel sheets: Phosphating and cathaforesis processes
- High-frequency tribometer (up to 500ºC)
- Coulter Omnisorp Isothermal analyser
- Thermo-balance for characterisations by means of thermo-gravimetrical techniques, and Differential Sweep Calorimetry (DSC)

Current Steel R&D Topics

In-service behaviour of materials and components

- Corrosion behaviour and development of new corrosion-damage evaluation methods
- Fracture mechanics
- Sub-critical crack growth mechanisms
- Stress-corrosion cracking testing and analysis
- Structural-integrity analysis and end of life studies in materials and components
- Wear behaviour for selection and testing of materials
- Coatings and lubricants

Joint technologies and microstructural characterisation

- Phase transformation
- Thermal treatments
- Coating characterisation
- Casting processes: new roller-quality development
- Cladding and joining technologies

Surface technologies

- Development of new clean steel and casting grades
- Study of properties in tin-plate double reduction
- Pilot simulation of galvanising and galvannealing processes for automotive and food industry
- Study of application of permanent and non-permanent coatings
- Pilot simulation of painting processes by electrodeposition (Cathaforesis) and phosphating steel sheets
- Thin-steel product transformation for the food and automotive industry
- Mechanical and microstructural characterisation of zinc-base coatings

Plastic and composite materials

- Varnishing, paintings, and organic-coatings for steel sheets characterisation
- Plastic, polymer, and composite-materials characterisation
- Chemical and mechanical research on advanced joining techniques by adhesives for thin sheets
- Degradation of plastics and composites
- Selection, application, and assessment of plastic and composite components and goods (automotive, chemical vessels, orthopedic components, aeronautics)

Design and production of raw materials

- Characterisation of scrap
- Efficiency measurement of additives for cleanness
- Characterisation of refractory and ceramics materials
- Development of refractory materials for steelmaking
- Development of materials for service at high temperatures (above 1600°C)
- Recycling of metallic waste from the steel industry

Numerical simulation

- Modelling and simulation of heating
- Solidification and cooling process
- Mould design
- Thermal analysis
- Joining-process simulation
- Thermally induced residual-stress simulation
- Structural analysis
- Structural integrity and assessment of structures and detailed components

Contact Addresses
Mr. Enrique CUESTA, Director
Fundación ITMA
Parque Tecnológico de Asturias
ES - 33428 LLANERA, ASTURIAS, SPAIN
Tel.: +34 985 26 53 07; Fax: +34 985 26 55 74
E-mail: e.cuesta@itma.es
http://www.itma.es

Fundación LABEIN is a private non-profit technological research centre in Bilbao, Spain with more than 45 years of experience in supporting enterprises and administration bodies in their technological and innovation needs. Labein is active in different technological areas: Structures and Buildings, Mechanics, Information Technologies, and Environment. It is working mainly for the construction, iron and steel, metal-mechanics automotive, and energy sectors. The total staff is about 200, 70% of which with a university degree and 23 doctors.

Core Steel R&D Competencies

- Process improvement: incorporation of information and communication technologies (modelling, monitoring, and control)
- Development of new products and applications, reinforcement of the value of current products by modelling

Steel R&D Organisation

- Structures & Materials
- Building & Civil Engineering
- Mechanics
- Experimental Mechanics
- Electrical Equipment
- Metrology
- Environment
- Quality

Steel R&D Staff 50

Specialist Equipment for Steel R&D

- Simulation tools for CFD-FEM couple analysis, stamping and hydroforming process simulation, forging simulation, product-process performance couple modelling
- Computer-aided system for tolerance analysis with application in the design, assembly, and quality-assurance processes
- Test machines and actuators, electrodynamic vibrators, FFT multichannel analysers, hydraulic press
- Water model laser doppler anemometry equipment for continuous casting physical modelling and forming limit diagram

Current Steel R&D Topics

- Process improvement: incorporation of information and communication technologies (modelling, monitoring, control) in steel making, continuous casting and rolling. Related to environmental impact, air conditions, defect identification and quality, real-time acquisition and diagnosis systems
- Reduction of NO_x emissions in furnace burners
- Development of new products and applications, reinforcement of the value of current products by modelling in steel for building and civil engineering, for automotive products, and for ships and offshore

Contact Addresses
Roberto GRACIA, General Manager
LABEIN
Cuesta de Olabeaga, 16
ES - 48013 BILBAO, SPAIN
Tel.: +34 94 489 2400; Fax: +34 94 441 1749
E-mail: gracia@labein.es
http://www.labein.es

SIMR (Swedish Institute for Metals Research) develops and improves metallic materials and processes for the production of materials and studies the behaviour of new materials in production engineering and in mechanical structures.

The Institute is one of the leading industrial research institutes in the Nordic region. Research and development work takes place in close co-operation with Swedish and international companies in the steel, metal, production engineering, and power industries.

Core Steel R&D Competencies

- Process-Microstructure-Properties
- Simulation-Prediction-Computational Methods
- Forming
- Joining
- Surfaces-Interfaces

Steel R&D Organisation

SIMR has four research departments and a department for technical and administrative support. There are a total of 18 research teams in the research departments, each with special expertise. The four departments are:

- Chemistry
- Technological Properties
- Mechanical Metallurgy
- Stainless Steels and Casting Technology, Powder Metallurgy

Steel R&D Staff 100

Specialist Equipment for Steel R&D

Chemical Analysis Methods

- Spectrometers (GDOES, FTIR)
- Inductively coupled plasma time of flight mass spectrometry (ICP-TOFMS)
- Laser ablation system
- Atomic-absorption spectrometer and potentiometer spectrophotometer
- Surface carbon analyser (IMC)

Materials Characterisation

- Thermogravimetry/differential thermal analysis (TG/DTA)
- Electron microscopes
- VGHB 501, Leo Gemini 1530, JEOL JSM-T330 and 6400
- Aqueous corrosion testing
- High-temperature corrosion testing
- Laser ultrasonics

Materials Processing

- Quenching and deformation dilatometer
- Hot/cold working simulation
- Welding simulation, multi-process welding machine
- Machinability testing
- Gas-atomisation unit
- Heat-treatment simulation
- Laser surface treatment
- Vacuum melting furnaces, casting and solidification equipment
- Sintering furnaces
- Rotating furnace for powder treatment
- Dilatometer for sintering studies
- Uniaxial powder, hydraulic and hot isostotic press
- Self-piercing riveting

- Equipment for pilot-plant pickling, quantitative analysis of pickling baths
- Tribological testing

Mechanical Testing

- Creep-testing machines
- Creep-crack growth testing machines
- High-temperature fatigue in gaseous environments

Current Steel R&D Topics

- Standardisation
- Optical spectrometry
- Surface technologies
- Heat treatment
- Fatigue
- Sheet technology
- Materials for machining
- High-temperature materials
- Joining technology
- Materials processing for cold forming
- Quantitative metallography
- Properties of structural and HSLA steels
- Casting and solidification
- Corrosion and welding of stainless steels and nickel-base alloys
- Electrochemistry
- Computational thermodynamics
- Powder metallurgy

Contact Addresses
Dr. Staffan EKELUND, Director
Institutet för Metallforskning
Drottning Kristinas väg 48
SE - 114 28 STOCKHOLM, SWEDEN
Tel.: +46 (0)8 440 48 00; Fax: +46 (0)8 440 45 35
E-mail: staffan.ekelund@simr.se
http://www.simr.se

VETENSKAP OCH KONST
KTH

Kungliga Tekniska Högskolan
(Royal Institute of Technology, KTH)

The Department of Materials Science and Engineering

Core Steel R&D Competences

- Micro- and macro-modelling of metallurgical processes
- Thermodynamic and thermophysical properties of steelmaking slags
- Simulation of steelmaking processes
- CFD calculations
- Inclusion engineering

- Metal forming
- Structural and phase-diagram aspects of steels
- Diffusion
- Mechanical properties and optimisation of structure-property relationships
- Development of new steel grades for various applications
- Corrosion

Steel R&D Organisation

The department is organised in 11 divisions:

- Metallurgy
- Metal Forming
- Physical Metallurgy
- Mechanical Metallurgy
- Computational Thermodynamics
- Ceramics
- Materials Technology
- Materials Chemistry
- Applied Material Physics
- Engineering Material Physics

Apart from these, the department has a competence forum, the Brinell Centre, financially supported by the Swedish Foundation of Strategic Research.

Steel R&D Staff 140

Specialist Equipment for Steel R&D

- Measurement facilities for high temperature thermodynamic properties, viscosities, thermal diffusivities, surface and interfacial tensions, and thermobalances
- Vacuum induction furnaces
- Metallographic microscopes
- SEM, TEM, AFM
- Equipments for measurement of mechanical properties, magnetic measurements
- Impedence spectroscopy can be mentioned among those available in the instrument park of the department.

Current Steel R&D Topics

- Measurement and modelling of:
  - thermodynamic properties
  - sulphide capacities and viscosities of steelmaking slags
  - steel refining
  - interfacial phenomena in slag/metal reactions
  - the AOD process
  - blast-furnace reactions
  - inclusions in continuous as well as billet casting
  - structure and thermodynamics of complex steels
  - mechanical properties of steels and development of new steel varieties
  - applications of steel as a construction material
  - corrosion of steel
  - phase tranformations
  - diffusion reactions in complex alloys
- Synthesis and properties of gradient materials
- Ab initio calculation of defect structures in solids
- Sintering of cemented carbides

Contact Addresses

Professor Pär JÖNSSON
Head of the Department of Materials Science and Engineering
Royal Institute of Technology
SE - 100 44 STOCKHOLM, SWEDEN
Tel.: +46 (0)8 790 8375; Fax: +46 (0)8 14 93 38
E-mail: par@met.kth.se
http://www.met.kth.se

LULEÅ UNIVERSITY OF TECHNOLOGY

(LuTH)

The Dept. of Material Science and the Dept. of Chemical and Metallurgical Engineering conduct research related to iron and steelmaking. Two Centres of Excellence are also hosted within this department, i.e. MiMeR (Minerals and Metals Recycling Research Centre) and Agricola Research Centre. MiMeR does research on recycling of metallurgical waste and scrap while Agricola Research Centre primarily carries out basic research with emphasis on surface phenomena within mineral processing and metallurgy. The information below refers to the activities within the Dept. of Chemical and Metallurgical Engineering, with relevance to the iron and steel industry, namely the Division of Process Metallurgy, the Division of Mineral Processing, and the two research centres MiMeR and Agricola.

Core Steel R&D Competencies

- Production and processing of iron and steel, especially related to iron making, waste generation, waste recycling, scrap recycling, slag chemistry, and surface phenomena
- Mineralogical characterisation and particle characterisation

Steel R&D Organisation

- Div. of Process Metallurgy
- Div. of Mineral Processing
- MiMeR (Minerals and Metals Research Centre)
- Agricola Research Centre (ARC)

Steel R&D Staff 15

Specialist Equipment for Steel R&D

- A number of different furnaces and laboratory equipment for high-temperature laboratory studies as well as leaching studies
- Equipment for studies of most unit operations in physical upgrading and comminution
- New modern equipment for TG-DTA, TG-DTA-MS, XRD as well as different equipments for surface characterisation
- Thermodynamic as well as CFD modelling tools

Current Steel R&D Topics

- Recycling of steelmaking wastes such as dust, oily mill scales, hydroxide sludge, etc.
- Slag formation in iron and steelmaking, injection of slag formers in BF
- Development of alternative uses for steelmaking slag
- Process modelling through advanced combinations of neural-network and fuzzy logic
- Combined CFD and water-model simulation of ladle operations

Contact Addresses
Bo BJÖRKMAN, Professor, Div. of Process Metallurgy and Head of MiMeR
Luleå University of Technology
SE - 971 87 LULEÅ, SWEDEN
Tel.: +46 (0)920 491 292; Fax. +46 (0)920 491 199
Mobile Tel.: +46 (0)70 664 1656
E-mail: bo.bjorkman@km.luth.se
http://www.luth.se

The Welding Institute

TWI is a large independent research and technology organisation with over 400 staff giving technical support in welding, joining and associated technologies such as NDT, surfacing, and cutting. Services include confidential contract R&D, technical information, advice and consultancy, technology transfer, training and qualification.

Core Steel R&D Competencies

- Welding process selection
- Welding procedure development
- Failure analysis
- Metallography
- Corrosion testing
- Mechanical testing
- Design for fabrication
- Cutting process selection
- Other joining processes
- Surfacing
- Dissimilar material joining
- Structural integrity analysis
- Risk assessment

Steel R&D Organisation

- Metallurgy, Corrosion and Arc Processes
- Structural Integrity
- Laser and Sheet Processes
- Electron Beam and Forge Welding
- Manufacturing

Steel R&D Staff 150

Specialist Equipment for Steel R&D

- High-power CO_2 laser
- High-power Nd:YAG laser
- All arc-welding processes
- All friction-welding processes
- Resistance welding
- Robotics
- Mechanical fastening
- Large friction stir welding
- Large EB welding vacuum chamber
- Large partial vacuum EB facility
- Fatigue testing, small to full scale
- Crack-tip opening displacement testing
- Scanning electron microscopy
- Adhesives laboratory
- H_2S corrosion testing
- All non-destructive testing methods

Current Steel R&D Topics

- Defect assessment
- Long-range NDT methods
- Modelling of joints
- Modelling of microstructure
- Requirements for heat treatment
- Fume generation and risk to health
- Laser and hybrid laser-arc techniques
- Resistance welding high-strength steels
- High-power electron beams

Contact Addresses
Dr D. McKEOWN, Marketing Manager
TWI Ltd
Granta Park
Great Abington
CAMBRIDGE CB1 6AL, UNITED KINGDOM
Tel.: +44 (0)1223 891 162; Fax: +44 (0)1223 892 588
E-mail: twi@twi.co.uk
http://www.twi.co.uk

Research Institutions with Some Steel R&D Resources

Christian Doppler Forschungsgesellschaft
(Christian Doppler Research Association, CDG)

Core Steel R&D Competencies

- Simulation and automation topics
- Material science
- Selected automotive research areas

Contact Addresses
Mag. Johannes DOBINGER - General Secretary
Christian Doppler Research Association (CDG)
Weyeringergasse 33
A - 1040 VIENNA, AUSTRIA
Tel.: +43 (0)1 504 22 05; Fax: +43 (0)1 504 22 0520
E-mail: dobinger@mails.ffw.univie.ac.at
http://www.cdg.ac.at/cdg/cdgext/index1.html

Kompetenzzentrum für Angewandte Elektrochemie
(Centre of Competence «Applied Electrochemistry», ECHEM)

Core Steel R&D Competencies

- Electrochemical surface treatment (coating, protection against corrosion)
- Energy storage and transformation (new batteries and fuel cells)
- Electrochemical recycling and environmental technology

Contact Addresses
Dr. Erich KNY
ECHEM
Viktor Kaplan Straße 2
A - 2770 WR. NEUSTADT, AUSTRIA
Tel.: +43 (0)2622 222 66; Fax: + 43 (0)2622 222 6650
E-mail: erich.kny@echem.at
http://www.echem.at

Centre d'Etudes Wallon et du Contrôle des Matériaux
(Walloon Centre for Study and Inspection of Materials, CEWAC)

Core Steel R&D Competencies

- Process adjustment to specific applications (products, materials)
- Qualification of assembly process
  - Study of process to extrapolate outside applicable field
  - Development of new technologies
  - Study, development and realisation of industrial prototypes
- Automation and robotisation
- Calculation, design, design verification, fracture evaluation, repair, choice of welding process (technical and economical aspects)
- Study and realisation of pre-series of products and/or materials
- Surface treatment by thin- and thick-layer cladding with process associated with welding and brazing

Contact Addresses
Ir P. MAWET
Centre d'Etudes Wallon et du Contrôle des Matériaux
Campus du Sart Tilman, B56
B - 4000 LIEGE, BELGIUM
Tel.: +32 (0)4 361 5979; Fax: +32 (0)4 361 5970
E-mail: p.mawet.cewac@polemetal.be

Facultés Polytechniques de Mons
(Technical University of Mons, FPMs)

Core Steel R&D Competencies

- Heat transfer and combustion
- Refining and continuous casting
- Stainless-steel processing - Recycling of by-products
- Non-linear modelling and control of industrial processes
- Classical and predictive process control

Contact Addresses
Prof. Paul LYBAERT, Prof. Yves RIQUIER, Prof. Marcel REMY
Facultés Polytechniques de Mons
9, rue de Houdain
B - 7000 MONS, BELGIUM
Tel.: +32 (0)65 374 111; Fax: +32 (0)65 374 200
E-mail: Paul.Lybaert@fpms.ac.be (Heat transfer and combustion)
Yves.Riquier@fpms.ac.be (Metallurgy)
Marcel.Remy@fpms.ac.be (Process control)
http://www.fpms.ac.be

Katholieke Universiteit Leuven
(Catholic University of Leuven)

Department of Metallurgy and Materials Engineering

Core Steel R&D Competencies

Processing

Application of thermodynamics in steel processing:

- Modelling of extractive and refining processes
- Metal and slag interactions with refractory materials
- The study of non-metallic inclusions in liquid metal processing

Application of steel

Relationship between crystallographic texture, microstructure, and mechanical behaviour. Know-how on low-carbon and IF steel, currently developing on pearlitic and TRIP steel as well:

- Quantitative measurement of crystallographic texture and of residual stress
- Characterisation of the microstructure after large plastic deformation; effect of microstructure or nanostructure on plastic deformation
- Work hardening or softening, also at changing strain path
- Micromechanical modelling of plastic deformation in order to predict deformation textures, work hardening, transitory effects at changing strain path
- Formability: prediction of r-values and forming limit diagrams on the basis of texture, microstructure, work hardening, and strain rate sensitivity; for monotonic and non-monotonic loading
- Implementation of texture- and microstructure-based constitutive models in finite-element codes for the simulation of sheet-metal forming and wire drawing
- Fundamental study of recrystallisation upon annealing

Surface technology

- Development of composite coatings and alloy coatings on steel
- Tribology (materials aspects): friction and wear of steel surfaces in sliding and vibrating contacts

Non-destructive testing

Development of acoustic-optical technique for detecting defects

Contact Addresses
Prof. P. VAN HOUTTE
Katholieke Universiteit Leuven
Kasteelpark Arenberg 44
B - 3001 LEUVEN, BELGIUM
Tel.: +32 (0)16 32 13 14; Fax: +32 (0)16 32 19 90
E-mail: chairman@mtm.kuleuven.ac.be
http://www.mtm.kuleuven.ac.be

Université Catholique de Louvain
(Catholic University of Louvain, UCL)

Steel research is carried out at the divisions «Unité de Physico-Chimie et d'Ingéniérie des Matériaux» (PCIM), «Centre for Systems Engineering and Applied Mechanics» (CESAME), and «Laboratoire des Hauts Polymères» (POLY).

Core Steel R&D Competencies

- Physics and mechanics of high-performance steels (dual-phase steels, TRIP-assisted multiphase steels, high-manganese steels, austenitic stainless steels)
- Advanced automatic control of hot-rolling mills, in particular steel cooling control on run-out tables
- Adhesion of paints for the automotive industry and organic coatings for coil coating

Contact Addresses
Prof. Francis DELANNAY
Université catholique de Louvain
Unité PCIM
Place Sainte Barbe, 2
B - 1348 LOUVAIN-LA-NEUVE, BELGIUM
Tel.: + 32 (0)10 47 24 02; Fax: +32 (0)10 47 40 28
E-mail: delannay@pcim.ucl.ac.be
http://www.ucl.ac.be

Université Libre de Bruxelles / Vrije Universiteit Brussel
(University of Brussels)

Departments of Metallurgical Engineering, Industrial Chemistry, and Materials Science and Electrochemistry at Université Libre de Bruxelles

Core Steel R&D Competencies

- Iron and steel metallurgy
- Molten-slag properties
- Hot-dip galvanising
- Hardness measurement (from macro to nano scale)
- Non-destructive testing (ultrasound, etc.)
- Tribology and characterisation of surface composition and properties
- High- and low-pressure plasma surface treatment

- Electrochemical surface coating, treatments, and corrosion
- Waste treatment

Contact Addresses
Prof. Luc SEGERS
Université Libre de Bruxelles
Faculté des Sciences appliquées/école polytechnique - Métallurgie, Matériaux
avenue F.D. Roosevelt 50
B - 1050 BRUSSELS, BELGIUM
Tel.: +32 (0)2 650 2993; Fax: +32 (0)2 650 3653
E-mail: lsegers@ulb.ac.be
http://www.ulb.ac.be/rech/inventaire/unites/ULB360.html
http://www.ulb.ac.be/polytech/sme/

Department of Metallurgy, Electrochemistry and Materials Science at Vrije Universiteit Brussel

Core Steel R&D Competencies

- Surface science and engineering of metalllic or organic-coated metals such as steel, aluminium, magnesium, and zinc
- Study of the electrochemical behaviour of metals for understanding plating and corrosion reactions of metallic surfaces

Contact Addresses
Prof. Jean VEREECKEN
Vrije Universiteit Brussel
Vakgroep Metallurgie
Pleinlaan 2
B - 1050 BRUSSELS, BELGIUM
Tel.: +32 (0)2 629 3254; Fax: +32 (0)2 629 3200
E-mail: jvereeck@vub.ac.be
http://dtwws1.vub.ac.be/meta

Université de Mons-Hainaut
(University of Mons-Hainaut, UMH)

Centre for Research in Molecular Modelling (part of the centre of excellence Materia Nova):

Core Steel R&D Competencies

- Non-destructive surface analysis
- Surface treatment
- Surface energy component determination
- Surface engineering
- Molecular engineering
- Molecular modelling
- Image treatment and analysis

Contact Addresses
Prof. Joël DE CONINCK
University of Mons-Hainaut/Materia Nova ASBL
Centre for Research in Molecular Modelling
Parc Initialis, Av. Copernic, 1
B - 7000 MONS, BELGIUM
Tel.: +32 (0)65 37 38 80 Fax: +32 (0)65 37 38 81
E-mail: joel.de.coninck@galileo.umh.ac.be
http://crmm.umh.ac.be

Centre des Matériaux, École Nationale Supérieure des Mines de Paris
(Materials Centre, ENSMP)

The Centre des Matériaux has a long experience in metallurgy, in particular in the analysis of the relationships between microstructure and mechanical properties.

Core Steel R&D Competencies

- Phase transformations and heat treatments. Simulation of heat-affected welded zones in carbon steels
- Embrittlement of duplex stainless steels due to thermal ageing
- Mechanical behaviour, in particular Transformation Induced Plasticity (TRIP) effect observed during phase transformation under applied stress
- Stress-relief heat cracking of welded austenitic stainless steels
- Deformation and damage (mechanical twinning and cleavage cracks) during metal forming of hot-dipped galvanised steel sheets
- Brittle and ductile fracture. Simulation of Charpy V impact test

Contact Addresses
Jean-Pierre TROTTIER, Director
Centre des Matériaux
École des Mines de Paris
B.P. 87
F - 91003 EVRY Cedex, FRANCE
Tel.: +33 (0)1 60 76 30 01; Fax: +33 (0)1 60 76 31 50
E-mail: Jean-Pierre.Trottier@mat.ensmp.fr
http://www.mat.ensmp.fr

École Nationale Supérieure d'Électricité et de Mécanique
(National Graduate School of Electrical and Mechanical Engineering, ENSEM Nancy)

ENSEM Nancy is a national engineering school in electrical and mechanical engineering of the National Polytechnic Institute of Lorraine (INPL). Steel research is conducted at the Laboratoire d'Énergétique et de Mécanique Théorique et Appliquée (LEMTA).

Core Steel R&D Competencies

- Fluid dynamics for water cooling by jet impingement on moving strip - both experimental and numerical facilities
- Physical modelling of heat transfer in collaboration with Technical University of Berlin
- Measurement systems
  - Polarographic probes (wall shear stress and mass transfer)
  - Bubbles generation and trajectography
  - Particle Image Velocimetry and Laser Doppler Velocimetry
  - Heat transfer by inverse method technique

Contact Addresses
Professor Michel LEBOUCHÉ and Michel GRADECK
LEMTA
2, avenue de la Forêt de Haye
B.P 160
F - 54504 VANDOEUVRE-LÈS-NANCY, FRANCE
Tel.: +33 (0)3 83 59 55 52; Fax: +33 (0)3 83 59 55 51
E-mail: michel.lebouche@ensem.inpl-nancy.fr
michel.gradeck@ensem.inpl-nancy.fr
http://www.inpl-nancy.fr/francais/rp_lemta.htm

École Nationale Supérieure des Industries Chimiques
(National Graduate School of Chemical Industries, ENSIC Nancy)

ENSIC Nancy is a national engineering school in chemical and process engineering of the National Polytechnic Institute of Lorraine (INPL). Steel research is conducted at the «Laboratoire des Sciences du Génie Chimique (LSGC)» and the «Département de Chimie Physique des Réactions (DCPR)».

Core Steel R&D Competencies

- Gas, water and soil treatment: VOC, SO_x, PAH, metals, etc.
- Chemical reaction engineering and separation processes
  - Mixing and precipitation
  - Absorption
  - Adsorption
  - Membrane
- Electrochemistry
- Abatement of dioxins and VOC by total oxidation
- Combustion, incineration, and thermal treatment

Contact Addresses
Christine ROIZARD and Paul-Marie MARQUAIRE
LSGC - ENSIC
BP 451
F - 54001 NANCY cedex, FRANCE
Tel.: +33 (0)3 83 17 51 90; Fax: +33 (0)3 83 32 29 75
E-mail: Christine.Roizard@ensic.inpl-nancy.fr (LSGC)
Paul-Marie.Marquaire@ensic.inpl-nancy.fr (DCPR)
http://www.ensic.u-nancy.fr

Institut de Chimie des Surfaces et Interfaces
(Institute for the Chemistry of Surfaces and Interfaces)

Core Steel R&D Competencies

Adhesion between polymer and steel surfaces

Contact Addresses
Prof. Jacques SCHULTZ / Maurice BROGLY
Institut de Chimie des Surfaces et Interfaces
15, rue Jean Starcky, BP 2488
F - 68057 MULHOUSE Cedex, FRANCE
Tel.: +33 (0)3 89 60 87 00; Fax: +33 (0)3 89 60 87 99
E-mail: J.Schultz@univ-mulhouse.fr; M.Brogly@univ-mulhouse.fr
http://www.icsi.uha.fr

Institut Fresnel Marseille

The Institut Fresnel Marseille is an institute for optical, electromagnetic, and imaging science and technology.

Core Steel R&D Competencies

Non-destructive testing

Contact Addresses
Claude AMRA
Institut Fresnel
D.U. St Jérôme
F - 13397 MARSEILLE Cedex 20, FRANCE
Tel.: +33 (0)4 91 28 80 70; Fax: +33 (0)4 91 28 80 67
E-mail: claude.amra@fresnel.fr
http://www.fresnel.fr

Laboratoire de Physico-Chimie de l'Etat Solide
(Laboratory for Solid-State Physical Chemistry, LPCES)

LPCES, with about 30 researchers, teachers, engineers and technical staff belongs to the chemical science department of the CNRS (French National Center of Scientific Research) and to the ICMMO (Institut de Chimie Moléculaire et Matériaux d'Orsay) of the University of Paris-Sud, Orsay. Its major activity is material science with one of its key activities being the study of the hydrogen behaviour in materials with a specific attention paid to the interactions of hydrogen with the microstructure of structural metals and the related problem of hydrogen induced embrittlement of alloys used in the nuclear, petroleum and aerospace industries.

Core Steel R&D Competencies

Hydrogen-microstructure interactions: consequences on hydrogen embrittlement and stress-corrosion cracking of metals

- Hydrogen, deuterium and tritium cathodic charging (20-200°C)
- H diffusion and outgassing measurements (electrochemical permeation of hydrogen with and without dynamic tensile straining, deuterium profiling by secondary ion mass spectroscopy)
- H trapping localisation; quantification of local H concentrations (tritium autoradiography and ß counting with/without dynamic straining)
- Mechanical testing after or during H(D) charging (tensile straining 20-600°C, electrochemical/inert gas/moisture)
- H content measurements (argon-carrier-fusion thermal conductivity method)
- Surface and microstructure characterisation (XPS, SEM, TEM, neutron scattering, etc.)

Contact Addresses
Anne-Marie BRASS
Laboratoire de Physico-Chimie de l'Etat Solide, CNRS UMR 8648 - Bâtiment 410
Université Paris-Sud
F - 91405 ORSAY, FRANCE
Tel.: +33 (0)1 69 15 47 87; Fax: +33 (0)1 69 15 78 33
E-mail: anne-marie.brass@lpces.u-psud.fr
http://www.u-psud.fr/chimsol

LMT Cachan

Core Steel R&D Competencies

Mechanics of solids and structures

Contact Addresses
Director: Pierre LADEVEZE, Professeur à l'ENS de Cachan
LMT Cachan
61 Avenue du Président Wilson
F - 94 235 CACHAN Cedex, FRANCE
Tel.: +33 (0)1 47 40 22 38; Fax: +33 (0)1 47 40 22 40
E-mail: directio@lmt.ens-cachan.fr
http://www.lmt.ens-cachan.fr

Université Henri Poincaré

The Henri Poincaré University conducts steel-related research at the «Laboratoire de Chimie Physique et Microbiologie pour l'Environnement», LCPME.

Core Steel R&D Competencies

Chemistry and Spectrochemistry of Interfaces

Contact Addresses
B. HUMBERT and Cedric CARTERET
LCPME
Université Henri Poincaré
405, rue de Vandoeuvre
F - 54600 VILLERS-LÈS-NANCY, FRANCE
Tel.: +33 (0)3 83 91 63 00; Fax: +33 (0)3 83 27 54 44
E-mail: humbert@lcpe.cnrs-nancy.fr
carteret@lcpe.cnrs-nancy.fr
http://www.lcpe.cnrs-nancy.fr

Université de la Méditerranée

The University of the Mediterranean conducts steel-related research at the «Laboratoire de Caractérisation Non Destructive», LCND.

Core Steel R&D Competencies

Non-destructive characterisation

Contact Addresses
Joseph MOYSAN
LCND
Université de la Méditerranée - IUT
413, Av. Gaston Berger
F - 13625 AIX-EN-PROVENCE Cedex 1, FRANCE
Tel.: +33 (0)4 42 93 90 34; Fax: +33 (0)4 42 93 90 84
E-mail: moysan@iut.univ-aix.fr
http://www.mediterranee.univ-mrs.fr

Université Pierre et Marie Curie

Laboratoire de Physique des Liquides et Électrochimie

Core Steel R&D Competencies

Electrochemistry and corrosion of steels

Contact Addresses
Michel KEDDAM, Directeur de Recherche
Université P. et M. Curie, Tour 22, 5e étage
4 Place Jussieu
F - 75252 PARIS Cedex 05, FRANCE
Tel.: +33 (0)1 44 27 41 48; Fax: +33 (0)1 44 27 40 74
E-mail: mke@ccr.jussieu.fr
http://www.ccr.jussieu.fr/lple/

Université de Rouen

Groupe de Physique des Matériaux

Core Steel R&D Competencies

Atomic microscopy for very fine microstructural investigation

Contact Addresses
Didier BLAVETTE
Sonde Atomique et Microstructure
Groupe de Physique des Matériaux - UMR 6634 CNRS
Faculté des Sciences de Rouen - Place Emile Blondel
F - 76 821 MONT SAINT AIGNAN, Cedex - FRANCE
Tel.: +33 (0)2 35 14 68 80; Fax: +33 (0)2 35 14 66 52
E-mail: Didier.Blavette@univ-rouen.fr
http://www.univ-rouen.fr/gpm

Université de Technologie de Troyes

Laboratoire des Systèmes Mécaniques et d'Ingénierie Simultanée (LASMIS)

Core Steel R&D Competencies

Tribology applied to rolling

Contact Addresses
Khemais SAANOUNI
Laboratoire des Systèmes Mécaniques et d'Ingénierie Simultanée
Université de Technologie de Troyes
Département Génie des Systèmes Mécaniques
12 rue Marie Curie, BP 2060
F - 10010 TROYES Cedex, FRANCE
Tel.: +33 (0)3 25 71 56 71; Fax: +33 (0)3 25 71 56 75
E-mail: khemais.saanouni@utt.fr
http://www-lasmis.utt.fr

Applikations- und Technik-Zentrum (Application and Technology Centre, ATZ-EVUS)

ATZ-EVUS is a research and development centre located in Sulzbach-Rosenberg, Germany. Upon foundation in 1990, parts of the former Klöckner Stahlforschung GmbH were integrated into the new organisation. Today, ATZ-EVUS is working in four fields, three of which are (partially) related to the field of metallurgy. Metallurgical research/development covers about 60% of the total activities.

Core Steel R&D Competencies

- Development of post-combustion processes/techniques
- Application of hot air in metallurgical processes
- Regenerative generation of hot gases
- Application of bottom blowing in metallurgical processes
- Modelling of converter processes
- Recycling of by-products from steel and other industry
- Regenerative thermal off-gas treatment
- Metallography
- Gas and rotating disc atomisation techniques

- Powder metallurgy
- Thermal spraying of metallic and non-metallic surfaces
- Laser treatment of metallic and non-metallic surfaces
- Numerical simulation of fluid dynamic processes

Contact Addresses
ATZ-EVUS
Kropfersrichter Straße 6-8
D - 92237 SULZBACH-ROSENBERG, GERMANY
Tel.: +49 (0)9661 908 400; Fax: +49 (0)9661 908 469
E-mail: info@atz-evus.de
http://www.atz-evus.de

Deutsches Institut für Feuerfest und Keramik
(German Institute of Refractories and Ceramics, DIFK)

Core Steel R&D Competencies

- Testing and characterisation of ceramic raw materials, refractories, and ceramics
  - chemical analysis
  - physical-technological testing
  - mineralogical investigation
  - metallurgical investigation
- Research and development
  - new refractories and their technical behaviour
  - metal/slag/refractory reactions
  - glass/refractory reactions, etc.

Contact Addresses
Prof. Dr.-Ing. habil. J. PÖTSCHKE, Director
DIFK Deutsches Institut für Feuerfest und Keramik GmbH
An der Elisabethkirche 27
D - 53113 BONN, GERMANY
Tel.: +49 (0)228 91508 23; Fax: +49 (0)228 91508 55
E-mail: info@difk.de
http://www.difk.de

Fraunhofer-Institut für Betriebsfestigkeit
(Fraunhofer Institute for Structural Durability, LBF)

Core Steel R&D Competencies

Component-related material behaviour

- Investigations of material behaviour and life evaluation of components under cyclic loading conditions in vehicles, machines, industrial equipment and facilities, bridges, aeroplanes, and aerospace structures
- Determination of material properties and optimisation of the structural durability of components

Stress analysis and strength evaluation

- Measurement, recording, and analysis of complex operational loading conditions and component stresses of individual parts, sub-assemblies, or complete structures, especially on road and rail vehicles, sub-structures, and systems
- Evaluation and validation of data, development of appropriate cumulative load and stress time histories, lifetime calculations, and test programs
- Optimisation of service life and design, increasing safety and reliability of components, structures, and systems in early stages of the development

Load analysis and numerical simulation
Identification and characterisation of operational loading conditions acting on mechanical structures, the resulting stresses and strains within individual parts of the structure determined by measurements, simulations, and numerical calculations

Contact Addresses
Prof. Holger HANSELKA, Director
Fraunhofer-Institut für Betriebsfestigkeit (LBF)
Bartningstr. 47
D - 64289 DARMSTADT, GERMANY
Tel.: +49 (0) 61 51 / 7 05 1; Fax: +49 (0) 61 51 / 7 05 2 14
E-mail: info@lbf.fhg.de
http://www.lbf.fhg.de

Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung
(Fraunhofer Institute for Manufacturing Technology and Applied Material Research, IFAM)

Bereich Endformnahe Fertigungstechnologien (Division Near Net Shape Production Technologies):

Core Steel R&D Competencies
- Powder technology and metallurgy
- Casting technology
- Porous materials
- Hybrid joining
- Composites
- Surface technology

Contact Addresses
Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung
Wiener Straße 12
D - 28359 BREMEN, GERMANY
Tel.: +49 (0)4 21 22 46 400; Fax: +49 (0)4 21 22 46 430
E-mail: info@ifam.fhg.de
http://www.ifam.fhg.de

Fraunhofer-Institut für Lasertechnik
(Fraunhofer Institute for Laser Technology, ILT)

Core Steel R&D Competencies
- Design, construction, and installation of laser measurement and testing devices
- Process and system know-how for joining (soldering and welding of various materials), cutting, drilling, ablation, and surface treatment (alloying, hardening, remelting, dispersing, structuring, rapid prototyping, and cleaning) using lasers
- Design, development, and installation of complete laser plants with process control

Contact Addresses
Herrn Axel BAUER
Fraunhofer-Institut für Lasertechnik
Steinbachstr. 15
D - 52074 AACHEN, GERMANY
Tel.: +49 (0)241 8906 194; Fax: +49 (0)241 8906 121
E-mail: Bauer@ilt.fhg.de
http://www.ilt.fhg.de

Fraunhofer-Institut für Werkstoffmechanik
(Fraunhofer Institute for Material Mechanics, IWM)

Core Steel R&D Competencies

- Safety, reliability and life of structural components
- Deformation and failure of materials and structural components
- Strength and toughness of materials and structural components
- Welding
- Hot forming
- Surface coating

Contact Addresses
Fraunhofer-Institut für Werkstoffmechanik
Wöhlerstraße 11
D - 79108 FREIBURG, GERMANY
Tel.: +49 (0)761 5142 0; Fax: +49 (0)761 5142 110
E-mail: info@iwm.fraunhofer.de
http://www.iwm.fhg.de

Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren
(Fraunhofer Institute for Non-Destructive Testing Methods, IZFP)

Core Steel R&D Competencies

Development of non-destructive testing techniques and equipment for the characterisation of materials and inspection and testing of finished products.

Contact Addresses
Fraunhofer Institut Zerstörungsfreie Prüfverfahren
Universität, Gebäude 37
D - 66123 SAARBRÜCKEN, GERMANY
Tel.: +49 (0)681 9302 0; Fax: +49 (0)681 9302 5901
E-mail: info@izfp.fhg.de
http://www.izfp.fhg.de

Gerhard-Mercator-Universität Duisburg

Institut für Angewandte Materialtechnik
(Institute for Applied Materials Technology)

Core Steel R&D Competencies

- Research and development of refractories for steel ladles and metallurgical processes
- Measurement of temperature-depending emissivities
- Computation of temperature fields and thermal stress fields
- Standard tests of refractory materials for the iron and steel industries
- Drying processes
- Heat transfer, fuel, and combustion technology
- Electrical heating, refractories, construction and operation of furnaces, kilns, and high-temperature plants

Contact Addresses
Prof. Dr.-Ing. Wolfgang BAUER
Institut für Angewandte Materialtechnik
Gerhard-Mercator-Universität Duisburg
D - 47048 DUISBURG, GERMANY
Tel.: +49 (0)203 379 3449; Fax: +49 (0)203 379 3614
bauer@ihg.uni-duisburg.de
http://www.ihg.uni-duisburg.de/energieeinsatz

Stiftung Institut für Werkstofftechnik
(Foundation Institute for Materials Science, IWT)

Core Steel R&D Competencies

Material science
- Heat treatment
- Surface technology
- Mechanical properties
- Physical analysis
- Metallographic analytical methods

Process engineering
- Chemical processes and analytical methods
- Laser measurement techniques
- Fluid atomisation
- Powder metallurgy
- Multi-phase flow/heat and mass transfer and chemical reaction

Manufacturing technologies
- Abrasive machining
- Machining with geometrically defined cutting edge
- Micromachining, ultraprecision technologies
- Process modelling and simulation
- Environmentally sound manufacturing
- Metal forming

Contact Addresses
Managing Director Prof. Dr.-Ing. habil. Peter MAYR
IWT Stiftung Institut für Werkstofftechnik
Badgasteiner Str. 3
D - 28359 BREMEN, GERMANY
Tel.: +49 (0)421 218 5301; Fax: +49 (0)421 218 5474
E-mail: iwt@iwt-bremen.de
http://www.iwt-bremen.de

Universität Dortmund

Lehrstuhl Unformtechnik (LFU), Fakultät Maschinenbau der Universität Dortmund
(Chair of Forming Technology, Faculty of Mechanical Engineering, University of Dortmund)

Core Steel R&D Competencies

- Production of sheet metal with complex geometry by focus on formability, product quality, and lightweight construction
- Use of optimised and adapted tool systems
- Application of FEM within research and development of metal-forming processes

Contact Addresses
CHAIR OF FORMING TECHNOLOGY
Universität Dortmund
Baroper Str. 301, Geschoßbau IV, Raum 407
D - 44227 DORTMUND, GERMANY
Tel.: +49 (0)231 755 2680; Fax: +49 (0)231 755 2489
E-mail: office@lfu.mb.uni-dortmund.de
http://www.lfu.mb.uni-dortmund.de

Universität Hannover

Institut für Umformtechnik (IFUM), Universität Hannover
(Institute for Metal Forming and Metal Forming Machine Tools, University of Hannover)

Core Steel R&D Competencies

- Sheet-metal forming
- Precision forging
- FEM simulation

Contact Addresses
Institut für Umformtechnik und Umformmaschinen
Universität Hannover
Welfengarten 1A
D - 30167 HANNOVER, GERMANY
Tel.: +49 (0)511 762 2164; Fax: +49 (0)511 762 3007
E-mail: doege@ifum.uni-hannover.de
http://www.ifum.uni-hannover.de

Institut für Werkstoffkunde (IW), Universität Hannover
(Institute for Material Science, University of Hannover)

Core Steel R&D Competencies

- Welding
- Casting
- Jet cutting
- Non-destructive testing
- Dismantling
- Surface engineering
- High-pressure water-jet and under-water joining methods

Contact Addresses
Prof. Dr.-Ing. Fr.-W. BACH
Universität Hannover
Institut für Werkstoffkunde
Appelstr. 11a
D - 30167 HANNOVER, GERMANY
Tel.: +49 (0)511 762 4311; Fax: +49 (0)511 762 5245
E-mail: bach@iw.uni-hannover.de
http://www.iw.uni-hannover.de

Institut für Fertigungstechnik und Spanende Werkzeugmaschinen (IFW), Universität Hannover
(Institute of Production Engineering and Machine Tools, University of Hannover)

IFW is one of the leading research institutes in the domain of Production Engineering. About 70 researchers are working on different areas in manufacturing processes, machines and controls, and production management. The IFW is directed by Prof. Dr.-Ing. Dr.-Ing. E.h. mult. H. K. Tönshoff.

Core Steel R&D Competencies

- Processing of steel (milling, turning, drilling, grinding)
- Process control
- Metallography
- Surface and sub-surface characterisation
- Dry machining
- Hard machining

Contact Addresses
Dr.-Ing. Thomas FRIEMUTH
Institut für Fertigungstechnik und Spanende Werkzeugmaschinen
Schlosswender Strasse 5
D - 30159 HANNOVER, GERMANY
Tel.: +49 (0)511 762 2533; Fax: +49 (0)511 762 5115
E-mail: ifw@ifw.uni-hannover.de
http://www.ifw.uni-hannover.de

Universität Stuttgart

Staatliche Materialprüfungsanstalt (MPA)
(State Material Testing Institute)

Core Steel R&D Competencies

- Theoretical and experimental activities in all fields of
  - material science and damage studies
  - materials technology
  - materials application and joining technology
  - strength calculations including those for systems and plants and destructive and non-destructive testing of materials
  - design
  - adaptation of design principles to new materials
- Availability and safety analyses, risk assessments
- Materials database for steel
- Information, training, and further educational facilities in the data-processing and technology-transfer centre of MPA Stuttgart

Contact Addresses
Professor Dr.-Ing. habil. E. ROOS, Director
State Material Testing Institute (MPA)
University of Stuttgart
Pfaffenwaldring 32
D - 70569 STUTTGART, GERMANY
Tel.: +49 (0)711 685 2604; Fax: +49 (0)711 685 2635
E-mail: eberhard.roos@mpa.uni-stuttgart.de
http://www.mpa.uni-stuttgart.de

Central Laboratory of Public Works

Core Steel R&D Competencies

Testing of mechanical properties of reinforced steel bars, cement, steel structure elements, and concrete

Contact Addresses
Mr. Sotirios TESSERIS
Central Laboratory of Public Works
Hellenic Ministry for the Environment, Physical Planning and Public Works
Pireos 166
GR - 11854 ATHENS, GREECE
Tel.: +30 (0)10 346 2230; Fax: +30 (0)10 345 8919
E-mail: kede@hol.gr

National Technical University of Athens

Laboratory of Metallurgy and Laboratory of Physical Metallurgy

Core Steel R&D Competencies

- Pre-treatment and reduction of lateritic iron ores
- Production of raw ferronickel
- Phase transformations in steels (stainless, duplex)
- Welding of reinforcing concrete steel bars. Static and dynamic mechanical tests (impact, fatigue)
- Plasma transferred-arc (PTA) surface treatment, alloying and coating
- Corrosion resistance, tribology

Contact Addresses
Prof. Dr.-Ing. Paraskevi NEOU-SYNGOUNA
Laboratory of Metallurgy / Laboratory of Physical Metallurgy
Department of Mining and Metallurgy
National Technical University of Athens
GR - 15780 Zografou, ATHENS, GREECE
Tel.: +30 (0)10 772 2169; Fax: +30 (0)10 772 2218
E-mail: neou@metal.ntua.gr
http://www.ntua.gr

University of Patras

Core Steel R&D Competencies

- Development of fine bubblers for inclusion floating for super-clean steel production
- Oxygen and EAF steelmaking metallurgy
- Process control by LIBS slag analysis
- Recycling of metallurgical slags and dusts
- Physical chemistry of steelmaking and process optimisation
- Coating of metallic surfaces in fluidised bed
- Recycling of FeNi-production ERF slags and R/K dusts
- Conversion of liquid FeNi to stainless steel in OBM converter

Contact Addresses
Prof. Dr.-Ing. Demetrios PAPAMANTELLOS
Chemical Engineering Department
School of Engineering
University of Patras
GR - 26500 RION PATRAS, GREECE
Tel.: +30 (0)610 997 514 509; Fax: +30 (0)610 997 513 / 990 917
E-mail: pap@chemeng.upatras.gr
http://hephaestus.chemeng.upatras.gr

Politecnico di Milano

Dipartimento di Ingegneria Strutturale (D.I.S.)
(Department of Structural Engineering)

Core Steel R&D Competencies

Structures and materials modelling and testing

Contact Addresses
Prof. Alberto FRANCHI
Dipartimento di Ingegneria Strutturale
Politecnico di Milano
Piazza Leonardo da Vinci
I - 32 20133 MILANO, ITALY
Tel.: +39 02 2399 4245; Fax: +39 02 2399 4220
E-mail: alberto.franchi@polimi.it
http://www.stru.polimi.it

Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna

Core Steel R&D Competencies

Development of software products for iron and steel industry: process-model development, optimisation, and implementation.

Contact Addresses
Doc. Eng. Valentina COLLA
Scuola Superiore Sant'Anna
Via Carducci 40
I - 56127 PISA, ITALY
Tel.: +39 050 883445; Fax: +39 050 883210
E-mail: colla@sssup.it
http://www.sssup.it

Università di Pisa

Dipartimento di Ingegneria Chimica, Chimica Industraile e Scienza dei Materiali
(Department of Chemical Engineering, Industrial Chemistry, and Material Science, University of Pisa)

Core Steel R&D Competencies

- Materials characterisation and testing
- Advanced materials processing
- Mathematical modelling of materials and processes

Contact Addresses
Professor A. SOLINA
Dipartimento di Ing. Chimica, Chim. Industriale e Scienza dei Materiali
Università di Pisa
Via Diotisalvi, 2
I - 56100 PISA, ITALY
Tel.: +39 050 511111; Fax: +39 050 511261
E-mail: a.solina@ing.unipi.it
http://diccism.ing.unipi.it

Dipartimento di Ingegneria Strutturale
(Department of Structural Engineering, University of Pisa)

Core Steel R&D Competencies
- Mathematical modelling, characterisation and testing of materials
- Experimental tests and numerical analysis of models and structures

Contact Addresses
Prof. Luca SANPAOLESI
Dipartimento Di Ingegneria Strutturale
Università di Pisa
Via Diotisalvi 2
I - 56126 PISA, ITALY
Tel.: +39 050 835 711; Fax: +39 050 554 597
E-mail: sanpaol@ing.unipi.it
http://www.ing.unipi.it/dis/

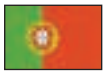
Bouwen met Staal
(Dutch Steel Construction Institute, BmS)

BmS organises collective research on the application of steel in constructions, e.g. fire resistance, engineering software, cold-formed beams and plates, and steel/concrete constructions. Through publication, the research results are made available to the Dutch building industry.

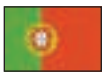
Core Steel R&D Competencies
- Steel-construction design
- Design of steel/concrete structures
- Fire resistance in steel constructions
- Vibration and sound insulation in steel constructions

Contact Addresses
Bouwen met Staal
Stationsplein 45
NL - 3001 GB ROTTERDAM, THE NETHERLANDS
Tel.: +31 (0)10 411 50 70; Fax: + 31 (0)10 412 12 21
E-mail: info@bouwenmetstaal.nl
http://www.bouwenmetstaal.nl
http://www.woonen.nl

Instituto de Soldadura e Qualidade
(Institute for Welding and Quality, ISQ)



Core Steel R&D Competencies
- Testing and characterisation of materials
  - metallurgical
  - mechanical behaviour
  - chemical analysis
  - non-destructive testing
  - failure analysis



- Welding and joining technologies
- Environmental technologies
  - recycling
  - waste treatment
  - emissions

Contact Addresses
Eduardo DIAS LOPES
Director, Research and Development Division
ISQ - Instituto de Soldadura e Qualidade
Av. Prof. Dr. Cavaco Silva, N 33
Talaíde
Tagus Park - Apartado 119
PT - 2780-920 PORTO SALVO, PORTUGAL
Tel.: +351 (0)21 422 8179; Fax: +351 (0)21 422 9018
E-mail: edlopes@isq.pt
http://www.isq.pt

Instituto Superior Técnico

Core Steel R&D Competencies

- Coatings
  - Studies of corrosion of painted steel (substrate: steel, hot-dip galvanised, galfan)
  - Environmentally friendly pre-treatments
  - Electrochemical testing
- Stainless steel
  - Analytical and structural characterisation of passive films
  - Pitting corrosion

Specialist Equipment for Steel R&D

- Electrochemical impedance measurements
- Electrochemical noise measurements
- Kelvin probe
- Scanning vibrating electrode technique (SVET)
- Salt spray and prohesion testing cabinet
- Electron microscopy
- Atomic-force microscopy
- Auger and XPS spectrometer
- FTIR spectrometer
- Raman spectrometer

Contact Addresses
Prof. Mário FERREIRA / Prof. Alda SIMÕES
Instituto Superior Técnico
Department of Chemical Engineering
Av. Rovisco Pais, 1
PT - 1049-001 LISBOA, PORTUGAL
Tel.: +351 (0)2 1841 7234; Fax: +351 (0)2 1840 4589
E-mail: mgferreira@ist.utl.pt
http://gecea.ist.utl.pt

Centro de Estudios e Investigaciones Técnicas de Gipuzkoa
(Gipuzkoa Centre for Technical Studies and Research, CEIT)

CEIT is a non-profit research organisation set up in 1982, which carries out contracted applied research and development work.

Core Steel R&D Competencies

- Hot ductility
- Thermomechanical processing
- Modelling and simulation of industrial processes
- Product characterisation
- Microstructure-mechanical property relationships
- Optimisation of metallurgical processes and microstructures

Contact Addresses
Alejo AVELLO ITURRIAGAGOITIA, Director General
Assistant Director General: José Ignacio de Carlos Gandasegui
CEIT address:
Paseo de Manuel Lardizabal, 15
ES - 20018 SAN SEBASTIÁN, SPAIN
Tel.: +34 943 212800; Fax: +34 943 213076
E-mail: Alavello@ceit.es or Icarlos@ceit.es
http://www.ceit.es

Centro Internacional de Métodos Numéricos en Ingeniería
(International Center for Numerical Methods in Engineering, CIMNE)

CIMNE is a research organisation in Barcelona created in 1987 specialised in the development of mathematical methods and software for analysis of metal forming, structural and fluid-flow problems using finite element techniques.

Core Steel R&D Competencies

- Advanced mathematical models and finite element based computational methods for analysis and design of metal-forming processes
- Development of finite element methods and software combining advanced constitutive models and stochastic techniques for computer simulation of:
  - sheet-metal stamping process
  - sheet hydroforming processes
  - mould filling solidifications and cooling in casting processes
  - powder-compaction processes
  - forging processes
  - rolling
  - extrusion processes
- Finite element based methods and software for analysis and design of steel structures

Contact Addresses
Prof. Eugenio OÑATE
International Center for Numerical Methods in Engineering
Edificio C1, Campus Norte UPC
Gran Capitán s/n
ES - 08034 BARCELONA, SPAIN
Tel.: +34 93 2057016; Fax: + 34 93 4016517
E-mail: onate@cimne.upc.es
http://www.cimne.upc.es

Instituto de Agroquímica y Tecnología de Alimentos - CSIC

Department of Food Preservation and Quality - Packaging Laboratory

Core Steel R&D Competencies

- Study and characterisation of packaging materials
  - Barrier, mechanical, and thermal properties of polymeric materials
  - Corrosion behaviour of metal cans for industrial canned products
  - Application of electrochemical techniques for evaluation of metal containers
- Food-package interactions
  - Permeability of gases, water, and aromas in polymeric materials
  - Determination of migration levels from the package
  - Retention of food components in the package
  - Corrosion of metallic materials
- Development of new materials and food packages
  - Design of packaging requirements for specific applications
  - New active packaging for food

Contact Addresses
Ramón CATALÁ
Instituto de Agroquímica y Tecnología de Alimentos - CSIC
Apartado de Correos 73
ES - 46100 BURJASSOT (VALENCIA), SPAIN
Tel.: +34 96 390 0022 (extension 2212); Fax: +34 96 363 6301
E-mail: rcatala@iata.csic.es

Mondragon Unibertsitatea

Core Steel R&D Competencies

- High-perfomance machining
  - Cutting-process modelling
  - High-speed milling
- Advanced shaping processes
  - Automatic control of forming processes
  - Forming of tailored blanks
  - Steel-grades forming characterisation
- Surface-properties optimisation

Contact Addresses
Mr. Txema PEREZ
Escuela Politécnica Superior
University - Mondragon Unibertsitatea
Loramendi, 4
ES - 20500 ARRASATE (GIPUZKOA), SPAIN
Tel.: +34 943 79 47 00 / +34 943 71 21 86
Fax: +34 943 79 15 36
E-mail: txperez@eps.muni.es
http://www.mondragon.edu

Universidad de Cantabria

Materials Science and Engineering «LADICIM»

Core Steel R&D Competencies

- Micromechanics of cracking under fatigue or environment-related processes (hydrogen)
- Toughness and cracking-resistance optimisation

- Crack-arrest behaviour
- Fatigue of components
- Structural integrity assessment

Contact Addresses
E.T.S. de Ingenieros de Caminos, C. y P.
Avda de Los Castros s/n
ES - 39005 SANTANDER, SPAIN
Tel.: +34 942 201 819; Fax: +34 942 201 818
E-mail: gsolana@unican.es

Universidad Carlos III de Madrid

Materials Science and Metallurgical Engineering Department

Core Steel R&D Competencies

- Powder metallurgy: low-alloy steels, stainless steels, high-speed steels, steel-base composites
- Corrosion
- Wear of metallic materials
- Metal-injection moulding of steels
- Starch consolidation of metallic powders
- High-boron steels

Contact Addresses
José Manuel TORRALBA
Universidad Carlos III de Madrid
Departamento de Ciencia de Materiales e Ingeniería Metalúrgica (Materials Science and Engineering Department)
Grupo de Investigación de Tecnología de Polvos (Powder Technology Group)
Avda. de la Universidad 30
ES - 28911 LEGANÉS MADRID, SPAIN
Tel.: +34 91 624 9963; Fax: +34 91 624 9430
E-mail: torralba@ing.uc3m.es
http://www.uc3m.es

Universidad Complutense de Madrid

Core Steel R&D Competencies

- New austenitic and duplex stainless steels grades with high mechanical and anti-corrosion properties
- Corrugated steels, metallic glasses, and aluminium matrix composites
- Electrochemical techniques, microscopy and microanalysis technologies for the exploration of corrosion resistance and microstructural characteristics of materials

Contact Addresses
Dra. Concepción MERINO
Dpto. Ciencia de Materiales e Ing. Metalúrgica
Facultad de Ciencias Químicas
Universidad Complutense de Madrid
ES - 28040 MADRID, SPAIN
Tel.: +34 913 944 348; Fax: +34 913 944 357
E-mail: cmerinoc@quim.ucm.es
http://www.ucm.es

Universidad de Málaga

Laser Laboratory, Department of Analytical Chemistry

Core Steel R&D Competencies

- Chemical characterisation of materials with fast and accurate laser techniques
- Characterisation of surfaces and interfaces using laser plasmas
- Laser processing of materials

Contact Addresses
Universidad de Málaga
SCAI -LASER
Campus de Teatinos, s/n
ES - 29071 MALAGA, SPAIN
Tel.: +34 95 213 2369; Fax: +34 95 213 2376
E-mail: laser@uma.es
http://laser.uma.es

Universidad de Navarra

Department of Structural Analysis & Design, and Institute of Civil Engineering

Core Steel R&D Competencies

- Advanced methods for structural analysis and design
- Advanced non-linear and plastic analysis of steel and composite structures
- Development of computational tools for advanced analysis
- New design methods and techniques in steel and composite construction
- Architectural-based design of steel structures
- Fire-resistant steel structures
- Earthquake-resistant structures
- Structural testing capabilities for large-scale structures as well as individual members and slabs

Contact Addresses
Professor Dr.-Ing. Eduardo BAYO
Head of the Department of Structural Analysis and Design
University of Navarra
ES - 31080 PAMPLONA, SPAIN
Tel.: +34 948 425 600; Fax: +34 948 425 629
E-mail: ebayo@unav.es
http://www.unav.es/estructuras
http://www.tecnun.es

Universidad de Oviedo
(University of Oviedo)

The University of Oviedo - with centres in Oviedo, Gijón and Mieres - has some 43 000 students. The university is active in different technological areas, some of them related to steel.

Core Steel R&D Competencies

- Production and processing of steel
- Metallurgical processes
- Metallography

- Process control
- Rolling technology and roll-pass design
- Modelling and simulation
- Product characterisation
- Metallic construction and civil engineering
- Recycling of steel industry by-products

Contact Addresses
Mario DÍAZ FERNÁNDEZ, Vicerector de Investigación
Universidad de Oviedo
Plaza de Riego, Nº4 Edificio Histórico
ES - 33.003 OVIEDO, SPAIN
Tel.: +34 985 10 40 61; Fax: +34 985 10 40 40
E-mail: viceinvestigacion@rectorado.uniovi.es
http://www.uniovi.es

Universidad del País Vasco

Core Steel R&D Competencies

- Metallurgical processes and product development
- Optimisation of production processes and heat treatment processes
- Metallurgical and mechanical behaviour optimisation of steels

Contact Addresses
Prof. José Luis ARANA, Dr. I.I.
Department of Mining, Metallurgy and Materials Science Escuela Superior de Ingenieros (UPV-EHU)
C/Alameda de Urquijo, s/n
ES - 48013 BILBAO, SPAIN
Tel.: +34 946 014 081; Fax: +34 946 014 180
E-mail: iiparbij@bi.ehu.es
http://www.bi.ehu.es

Universidad Politécnica de Madrid

DISAM (División Ingeniería de Sistemas y Automática)

Core Steel R&D Competencies

- Automatic visual inspection of materials
- Computer vision for manufacturing
- Visual information management systems
- 3-D computer vision

Contact Addresses
Rafael ARACIL
Escuela Tecnica Superior de Ingenieros Industriales
DISAM (División Ingeniería de Sistemas y Automática)
c/ José Gutierrez Abascal, 2
ES - 28006 MADRID, SPAIN
Tel.: +34 91 261 69 89 ; Fax: + 34 91 564 29 61
E-mail: aracil@etsii.upm.es
http://www.upm.es/

Universidad Politécnica de Valencia

Core Steel R&D Competencies

- Design and evaluation of lightweight multilayer partition systems as airborne sound insulators
- Simulation of the acoustic field generated by several sources, in enclosures
- Acoustical intensimetry, applied to the analysis of noise generated by industrial equipments

Contact Addresses
Jaime LLINARES
Universidad Politécnica de Valencia
Departamento de Física Aplicada
E.T.S. Arquitectura
Camino de Vera s/n
ES - 46022 VALENCIA, SPAIN
Tel.: + 34 96 387 75 22 ; Fax: + 34 96 387 95 25
E-mail: jllinare@fis.upv.es
http://www.upv.es/

Universidad La Rioja

Department of Mechanical Engineering

Core Steel R&D Competencies

- Data mining
- Advanced modelling of processes
- Design and analysis of steel buildings, including weight optimisation
- Acoustic analysis
- Advanced numerical simulation, including non-linear effects

Contact Addresses
Joaquin ORDIERES MERÉ
Catedrático de Proyectos de Ingeniería
Departamento de Ingeniería Mecánica
c/ San José de Calasanz s/n
ES - 26004 LOGROÑO, LA RIOJA, SPAIN
Tel.: +34 941 299 518; Fax: +34 941 299 478
E-mail: joaquin.ordieres@dim.unirioja.es

Universidad de Sevilla

Core Steel R&D Competencies

- Surface characterisation by means of X-ray photoelectron spectroscopy and Auger electron spectroscopy
- Depth profile of materials surfaces
- Chemical characterisation of both composition and structure using X-ray fluorescence spectroscopy (XRF), GDOES, and X-ray diffraction (XRD)
- IR, UV, and Raman spectroscopy
- Surface engineering: pyrolysis of aerosols, magnetron sputtering, and ion implantation

Contact Addresses
Prof. Dr. José-Antonio ODRIOZOLA
Grupo de Química de Superficies y Catálisis
Instituto de Ciencia de Materiales de Sevilla
Universidad de Sevilla
Av. Américo Vespuccio, s/n
ES - 41092 SEVILLA, SPAIN
Tel.: +34 954 489 544; Fax: +34 954 460 665
E-mail: odrio@us.es
http://www.us.es

Korrosionsinstitutet
(Swedish Corrosion Institute)

Core Steel R&D Competencies

Research and development at the Swedish Corrosion Institute cover most fields of corrosion and corrosion protection. This is a major advantage, allowing us to study corrosion from a comprehensive perspective. We cover both R&D and consultancy, which means that theory and practice are closely linked and that our results rapidly find practical use.
The institute is accredited by SWEDAC for many standardised corrosion-testing methods.

Contact Addresses
Managing Director Björn LINDER, blr@corr-institute.se
Research: Dominique THIERRY, dt@corr-institute.se
Consultancy: Bertil SANDBERG, bsa@corr-institute.se
Korrosionsinstitutet
Kräftriket 23A
SE - 10405 STOCKHOLM, SWEDEN
Tel.: +46 (0)8 6741700; Fax: +46 (0)8 6741780
E-mail: info@corr-institute.se
http://www.corr-institute.se

City University, London

Mechanical, Civil and Aeronautical Engineering Department

Core Steel R&D Competencies

Hot ductility and structure/ property relationships

Contact Addresses
Prof. B. MINTZ
Dept. Mechanical, Civil and Aeronautical Engineering
City University
Northampton Square
LONDON EC1 VOHB, UNITED KINGDOM
Tel.: +44 (0)207 477 8928; Fax: +44 (0)207 477 8566
E-mail: B.Mintz@city.ac.uk
http://www.city.ac.uk

Imperial College

Department of Materials

Core Steel R&D Competencies

- Materials chemistry
- Materials processing
- Physical metallurgy
- Materials characterisation
- Measurement of materials physical and mechanical properties
- Materials failure processes including corrosion
- Materials modelling for processing
- Structure/property relationships and lifing

Contact Addresses
Prof. J.A. KILNER
Department of Materials
Imperial College
LONDON SW7 2BP, UNITED KINGDOM
Tel.: +44 (0)20 7594 6733; Fax: +44 (0)20 7584 3194
E-mail: j.kilner@ic.ac.uk
http://www.mt.ic.ac.uk

Loughborough University

Institute of Polymer Technology and Materials Engineering

Core Steel R&D Competencies

- Organic and metallic coated steels (zinc and chromium coatings)
- High-temperature steels
- Creep resistance and remnant life
- Automotive materials
- Microstucture modelling
- Grain boundaries

Contact Addresses
Mr John HARPER
Institute of Polymer Technology and Materials Engineering
Loughborough University
LOUGHBOROUGH, Leicestershire LE11 3TU, UNITED KINGDOM
Tel.: +44 (0)1509 223 331; Fax: +44 (0)1509 223 949
E-mail: J.F.Harper@Lboro.ac.uk
http://www.lboro.ac.uk/departments/iptme/index.html

Sheffield Hallam University

Materials Research Institute

Core Steel R&D Competencies

- Smart and hard coatings
- Modified and enhanced surfaces
- Materials characterisation, simulation and modelling
- Corrosion science and technology

- Hydrogen embrittlement
- Innovative spectroscopy, microscopy and analysis
- Surface and bulk analysis

Contact Addresses
Prof. Jack YARWOOD
Materials Research Institute
Sheffield Hallam University
City Campus
Howard Street
SHEFFIELD S1 1WB, UNITED KINGDOM
Tel.: +44 (0)114 225 3500; Fax: +44 (0)114 225 350
E-mail: j.yarwood@shu.ac.uk
http://www.shu.ac.uk/mri/index.htm

The Steel Construction Institute

The Steel Construction Institute (SCI) is an independent, member-based organisation. The objective is to develop and promote effective use of steel in construction.

The SCI was formed in 1986 to provide technological information on steel construction and to work with industry to develop new ways of using steel efficiently in both onshore and offshore structures. Although some of the SCI work for clients is confidential, many projects are carried out with the specific intention of the results being disseminated as widely as possible. This is done via publications, courses and, increasingly, via web-based learning and information dissemination media.

Core Steel R&D Competencies

- Bridge and civil engineering
- Explosion model evaluation
- Fabrication
- Fire and explosion engineering
- High-strength steels
- Stainless steels
- Light gauge steel and modular construction
- Steel and steel/composite products
- Vibration

Contact Addresses
The Steel Construction Institute
Silwood Park
ASCOT, Berkshire SL5 7QN, UNITED KINGDOM
Tel.: + 44 (0) 1344 623 345; Fax: +44 (0) 1344 622 944
E-mail: reception@steel-sci.com
http://www.steel-sci.org

University of Birmingham

School of Metallurgy and Materials

Core Steel R&D Competencies

- Microstructure - property links in steels
- Fracture and fatigue in steels
- Microstructural development during continuous casting
- Performance of rails

- Weld and HAZ microstructure and properties
- On-line measurement of phase transformation
- Corrosion
- Machinability
- Heat treatment and surface hardening

Contact Addresses
Dr Claire DAVIS
School of Metallurgy and Materials
University of Birmingham
EDGBASTON, BIRMINGHAM B15 2TT, UNITED KINGDOM
Tel.: +44 (0)121 414 5174; Fax: +44 121 414 5232
E-mail: c.l.davis@bham.ac.uk
http://www.bham.ac.uk/metallurgy
http://www.irc.bham.ac.uk

University of Cambridge

Department of Materials Science and Metallurgy

Core Steel R&D Competencies

- Microstucture modelling
- Phase transformations in steels
- Bainite
- Wear resistant materials
- Cold rolling of steel
- Surface hardened rolls
- High-temperature steels
- Laser-welded steels
- Chemistry of steelmaking and galvanising processes
- Composite steel structures

Contact Addresses
Prof. H.K.D. BHADESHIA
Department of Materials Science and Metallurgy
University of Cambridge
Pembroke Street
CAMBRIDGE CB2 3QZ, UNITED KINGDOM
Tel.: +44 (0)1223 334 300; Fax: +44 (0)1223 334 567
E-mail: hkdb@cus.cam.ac.uk
http://www.msm.cam.ac.uk

University of Leeds

Department of Materials

Core Steel R&D Competencies

Ferrous Physical Metallurgy

- Structure/Property relationships in structural steels
- Microalloying (Nb,V,Ti, Al) and solubility relationships in structural steels
- Controlled rolling of steels, recrystallisation and grain growth

- Physical metallurgy of:
  - Engineering & medium carbon steels
  - Advanced bainitic steels
  - High-carbon pearlitic steels
  - Cast irons, ductile and austempered

Welding and Fabrication
- Hydrogen measurement
- Design of welding consumables for high-strength steels
- Acicular ferrite formation in welds

Corrosion
- Carbonic acid corrosion mechanisms

Phase transformations
- Kinetics of transformations in steels
- Graphitisation in steels

Contact Addresses
Professor D.V. EDMONDS, Head of Department
Department of Materials
School of Process, Environmental and Materials Engineering
University of Leeds
LEEDS LS2 9JT, UNITED KINGDOM
Tel.: +44 (0)113 233 2348; Fax: +44 (0)113 242 2531
E-mail: d.v.edmonds@leeds.ac.uk
http://www.leeds.ac.uk

University of Liverpool

Core Steel R&D Competencies

- Radiation damage in steels
- Laser welding
- Crystallography
- Sandwich structures
- UK centre for materials education

Contact Addresses
Professor David BACON, Head of the Department of Engineering
University of Liverpool
LIVERPOOL L69 3GH, UNITED KINGDOM
Tel.: +44 (0)151 794 6801; Fax: +44 151 794 4930
E-mail: djbacon@liv.ac.uk
http://www.liv.ac.uk/engfac/depts.htm

University of Manchester

Manchester Materials Science Centre

Core Steel R&D Competencies

- Residual stress and damage characterisation
- Microstructure modelling and characterisation
- Recrystallisation
- Microstucture evolution and texture
- Ultra-fine grain size
- Formability

- Fracture and fatigue
- Corrosion
- Stress corrosion
- Internet microscope

Contact Addresses
Prof. Gordon LORIMER
Manchester Materials Science Centre
Grosvenor Street
MANCHESTER M1 7HS, UNITED KINGDOM
Tel.: +44 (0)161 200 3553; Fax: +44 (0)161 200 3586
E-mail: gordon.lorimer@umist.ac.uk
http://www.umist.ac.uk/MatSci

University of Nottingham

School of Mechanical, Materials, Manufacturing, Engineering and Management

Core Steel R&D Competencies

- Cold forging and net-shape forming
- Surface engineering
- Thermal spraying
- Creep of welded joints
- Creep - fatigue
- Stress analysis

Contact Addresses
Professor Thomas HYDE
School of Mechanical, Materials, Manufacturing, Engineering and Management
University of Nottingham
University Park
NOTTINGHAM NG7 2RD, UNITED KINGDOM
Tel. +44 (0)115 951 3830; Fax: +44 (0)115 951 3800
E-mail: thomas.hyde@nottingham.ac
http://www.nottingham.ac.uk/school4m

University of Oxford

Department of Materials

Core Steel R&D Competencies

- Materials characterisation and testing
- Phase transformations
- Advanced materials processing
- Mathematical modelling of materials and processes
- Electron microscopy
- Solidification
- Nano-structures
- Surface science
- Magnetic materials

- Sprayform tooling
- Corrosion

Contact Addresses
Professor G D W SMITH, Head of Department
University of Oxford, Department of Materials
Parks Road
OXFORD OX1 3PH, UNITED KINGDOM
Tel.: +44 (0)1865 273 737; Fax: +44 (0)1865 273 738
E-mail: george.smith@materials.ox.ac.uk
http://www.materials.ox.ac.uk/research

University of Sheffield

Department of Engineering Materials

Core Steel R&D Competencies

- Microstructural and mechanical process engineering
- Thermomechanical processing
- Trobology of metal forming
- Recrystallisation
- Precipitation
- Thixoforming
- Rolls

Contact Addresses
Prof. John BEYNON
Department of Engineering Materials
Sir Robert Hadfield Building
Mappin Street
SHEFFIELD S1 3JD, UNITED KINGDOM
Tel.: +44 (0)114 222 5467; Fax: +44 (0)114 222 5943
E-mail: J.h.beynon@sheffield.ac.uk
http://www.shef.ac.uk

University of Strathclyde

Core Steel R&D Competencies

- Micro-alloyed steels
- Surface engineering
- Welding of austenitic and duplex steels
- Wire drawing/rolling/forging
- Composite structures

Contact Addresses
Prof. Neville BAKER
Department on Mechanical Engineering
University of Strathclyde
James Weir Building
Montrose Street
GLASGOW G11XJ, UNITED KINGDOM
Tel.: +44 (0)141 548 3101; Fax: +44 (0)141 5525105
E-mail: nbaker@mecheng.strath.ac.uk
http://www.strath.ac.uk/mecheng

University of Surrey

Core Steel R&D Competencies

- Design and development of materials
- Design and development of new processes
- Equilibrium and non-equilibrium processing of materials
- Characterisation, analysis, and modelling of materials
- Materials degradation
- Life-cycle analysis
- Life-cycle product design

Contact Addresses
Professor Panos TSAKIROPOULOS
School of Engineering
University of Surrey
Guildford
SURREY GU2 7XH, UNITED KINGDOM
Tel.: +44 (0)1483 689 610; Fax: +44 (0)1483 876 291
E-mail: P.Tsakiropoulos@surrey.ac.uk
http://www.surrey.ac.uk/eng

University of Wales Swansea

Department of Materials Engineering

Core Steel R&D Competencies

- Steel process development, including 'right-first-time' modelling of hot-rolling operations
- Welding and joining, including spot welding and adhesive bonding, laser welding, etc.
- Corrosion protection, covering metallic and organic coatings and corrosion inhibition
- Steel product development, including HSLA and IF steels
- Environmental issues, including analysis of leachates from steel buildings and decontamination of landfill sites
- Creep and fatigue testing, including computer-based techniques for life-time prediction and remnant life assessment
- Techno-economic forecasting, including the use of neural networks for prediction of future demand in various market sectors

Contact Addresses
Professor Jonathan PARKER
Department of Materials Engineering
University of Wales Swansea
Singleton Park
SWANSEA SA2 8PP, UNITED KINGDOM
Tel.: +44 (0)1792 295 23; Fax: +44 (0)1792 295 244
E-mail: j.d.parker@swansea.ac.uk
http://www.swan.ac.uk/mateng

Major Engineering Companies and Equipment Suppliers Involved in Steel R&D

ANDRITZ AG
Statteggerstrasse 18
A - 8045 GRAZ, AUSTRIA
Tel.: +43 (0)316 6902 2979; Fax: +43 (0)316 6902 425
E-mail: michael.buchbauer@andritz.com
http://www.andritz.com

RHI AG
Twin Tower
Wienerbergstrasse 11, P.O. Box 143
A - 1100 WIEN, AUSTRIA
Tel.: +43 (0)50 213 0; Fax: +43 (0)50 213 6213
E-mail: rhi@rhi-ag.com
http://www.rhi.at

VOESTALPINE Industrieanlagenbau GmbH & Co
P.O. Box 4
A - 4031 LINZ, AUSTRIA
Tel.: +43 (0)70 6592 2951; Fax: +43 (0)70 6980 8632
E-mail: Contact@vai.at
http://www.vatech.at

FRIEDRICH KOCKS GMBH & CO
P.O.Box 100 743
D - 40707 HILDEN, GERMANY
Tel.: +49 (0)2103 79 00; Fax: +49 (0)2103 5 12 49
http://www.kocks.de

LOI THERMPROCESS GmbH
Moltkeplatz 1
D - 45138 ESSEN, GERMANY
Tel.: +49 (0)201 18911; Fax: +49 (0)201 1891 321
E-mail: info@loi.de
http://www.loi.de

LURGI AG (Holding)
Lurgiallee 5
D - 60295 FRANKFURT, GERMANY
Tel.: + 49 (0)69 5808 0; Fax: + 49 (0)69 5808 3888
E-mail: kommunikation@lurgi.de
http://www.lurgi.com

SMS DEMAG AG
Eduard-Schloemann-Straße 4
D - 40237 DÜSSELDORF, GERMANY
Tel.: +49 (0)211 881 0; Fax: +49 (0)211 881 4902
http://www.sms-demag.de

DANIELI Headquarters
Via Nazionale, 41
I - 33042 BUTTRIO (UD), ITALY
Tel.: +39 0432 59 81; Fax: +39 0432 59 8289
Telex 450022 Daniel I
E-mail: info@danieli.com
http://www.danieli.com

PAUL WURTH S.A.
32, rue d'Alsace
P.O. Box 2233
L - 1022 LUXEMBOURG
Tel.: +352 4970 1; Fax: +352 4970 209
E-mail: paulwurth@paulwurth.com
http://www.paulwurth.com

ABB Group Headquarters
Affolternstr. 44
P.O. Box 8131
CH - 8050 ZURICH, SWITZERLAND
Tel.: +41 (0)1 317 7111; Fax: +41 (0)1 317 7958
http://www.abb.com

CONCAST STANDARD AG
Toedistrasse 9
CH - 8027 ZURICH, SWITZERLAND
Tel.: +41 (0)1 204 6511; Fax: +41 (0)1 202 8122
E-mail: sales@concast.ch
http://www.concast-standard.com

HECKETT MULTISERV-EAST
Harsco House
Regent Park
299 Kingston Road
LEATHERHEAD, Surrey KT22 7SG, UNITED KINGDOM
Tel.: +44 (0)1372 381 400; Fax: +44 (0)1372 381 499
E-mail: info@heckettmultiserv.com
http://www.heckettmultiserv.com

KVAERNER PLC
Kvaerner House, 68 Hammersmith Road
LONDON W14 8YW, UNITED KINGDOM
Tel.: +44 (0)20 7339 1000; Fax: +44 (0)20 7339 1100
http://www.kvaerner.com

Acronyms

AAS	Atomic Absorption Spectrometer
AES	Auger Electron Spectroscopy
AFM	Atomic Force Microscopy
AI	Artificial Intelligence
ANSYS	Commercial finite element method software
AOD	Argon Oxygen Decarburization
ARC	Agricola Research Centre (Luleå, Sweden)
ASIS	Automatic Surface Inspection System
ASP	Acier Speciaux par métallurgie des Poudres (Special powder metallurgical steel); also ASEA-STORA Process
ATZ-EVUS	Applikations- und Technik-Zentrum (Application and Technology Centre, Sulzbach-Rosenberg, Germany)
AZ	(Arbed sheet-pile product designation)
BF	Blast Furnace
BFI	Betriebsforschungsinstitut (Institute for Operations Research, Düsseldorf, Germany)
BmS	Bouwen met Staal (Dutch Steel Construction Institute, Rotterdam, The Netherlands)
BOF	Basic Oxygen Furnace
BOS	Basic Oxygen Steelmaking
CAD	Computer-Aided Design
CASA	Computer Aided Strain Analysis
CC	Continuous Casting
CCD	Charged Couple Device
CDG	Christian Doppler Forschungsgesellschaft (Christian Doppler Research Association, Vienna, Austria)
CDM	Continuum Damage Mechanics
CDT	Centro de Desarrollo Technologico (Technical Development Centre, Arcelor/ Aceralia, Avilès, Spain)
CED	Centre d'Etudes et Développement (Centre for Studies & Development, Arcelor, Montataire, France)
CEIT	Centro de Estudios e Investigaciones Técnicas de Gipuzkoa (Gipuzkoa Centre for Technical Studies and Research, San Sebastián, Spain)
CEMEF	Centre de Mise en Forme des Matériaux (Centre for Material Forming, École Nationale Supérieure des Mines de Paris, France)
CENIM	Centro Nacional de Investigaciones Metalúrgicas (National Centre for Metallurgical Investigations, Madrid, Spain)
CESAME	Centre for Systems Engineering and Applied Mechanics, Catholic University of Louvain, Louvain-La-Neuve, Belgium
CEWAC	Centre d'Etudes Wallon et du Contrôle des Matériaux (Walloon Centre for Study and Inspection of Materials, Liège, Belgium)
CFD	Computational Fluid Dynamics
CFD-FEM	Computational Fluid Dynamics - Finite Element Method
CHHR	Continuous Head Hardening Rails
CHQ	Cold Heading Quality
CIMNE	Centro Internacional de Métodos Numéricos en Ingeniería (International Center for Numerical Methods in Engineering)
CMM	Co-ordinate Measuring Machine
CNC	Computer Numerical Control
CNRS	Centre National de la Recherche Scientifique (The French National Center of Scientific Research, France)
CPM	Centre de Pyrolyse de Marienau (Pyrolysis Research Centre)

CRDM	Centre de Recherche et de Développement Métallurgique (Centre for Metallurgical Research & Development, Arcelor, Dunkerque, France)
CREAS	(Ascometal research centre, Hagondange, France)
CRG	Centre de Recherche de Geugnon (Geugnon Research Centre, Arcelor, Geugnon, France)
CRI	Centre de Recherche d'Isbergues (Isbergues Research Centre, Arcelor, Isbergues, France)
CRIE	Centre de Recherche de ISPAT Europe (Gandrange, France)
CRM	Centre de Recherches Métallurgiques / Centrum voor Research in de Metallurgie (Metallurgical Research Centre, Liège, Belgium)
CRMC	Centre de Recherche des Matériaux du Creusot (Creusot Materials Research Centre, Arcelor, Le Creusot, France)
CRPC	Centre de Recherche des Produits à Chaud (Research Centre for Hot Products, Arcelor, Fos-sur-Mer, France)
CRS	(Lucchini research centre, Brescia, Italy)
CRU	Centre de Recherche d'Ugine (Ugine Research Centre, Arcelor, Ugine, France)
CRY	Centre de Recherche Imphy (Imphy Research Centre, Arcekor, Imphy, France)
CSIC	Consejo Superior de Investigaciones Científicas (National Council for Scientific Research, Spain)
CSM	Centro Sviluppo Materiali (Materials Development Centre, Rome, Italy)
CTICM	Centre Technique Industriel de la Construction Métallique (Industrial Technical Centre for Metallic Construction, Saint Rémy Lès Chevreuse, France)
CVD	Chemical Vapour Deposition
DC	Direct Current
DCB	Double Cantilever Beam
DIFK	Deutsches Institut für Feuerfest und Keramik (German Institute of Refractories and Ceramics, Bonn, Germany)
DIS	Dipartimento di Ingegneria Strutturale (Department of Structural Engineering, Politecnico di Milano, Milan, Italy)
DISAM	División Ingeniería de Sistemas y Automática (Division of Engineering for Systems and Automation)
DMLS	Direct Metal Laser Sintering
DP	Dual Phase
DPS	Dual Phase Steel
DR	Direct Reduction
DSC	Differential Scanning Calorimetry / Direct Strip Casting
DTA	Differential Thermal Analysis
DTA-TGA	Differential Thermal Analysis-Thermal Gravimetric Analysis
DWI	Drawn and Wall Ironed
EAF	Electric Arc Furnace
EB	Electron Beam
EBSD	Electron Backscatter Diffraction
EBSP	Electron Backscatter Pattern
ECHEM	Kompetenzzentrum für Angewandte Elektrochemie (Centre of Competence «Applied Electrochemistry», Wr. Neustadt, Austria)
ECP	École Centrale Paris, France
ECSC	European Coal and Steel Community
EDAX	(Brand name for an EDX system)
EDC	Energy Distribution Curves
EDX (=EDS)	Energy Dispersive X-ray Analysis/Spectroscopy
EIC	Environment Induced Cracking
EIS	Electrochemical Impedance Spectroscopy
ENSAM	École Nationale Supérieure d'Arts et Métiers (National Graduate School of Arts and Craft, Metz, France)
ENSEEG	École Nationale Supérieure d'Electrochimie et d'Electrométallurgie de Grenoble (National Graduate School of Electrochemistry and Electrometallurgy at Grenoble, France)

ENSEM Nancy	École Nationale Supérieure d'Électricité et de Mécanique (National Graduate School of Electrical and Mechanical Engineering, Nancy, France)
ENSIC Nancy	École Nationale Supérieure des Industries Chimiques (National Graduate School of Chemical Industries, Nancy, France)
ENSMP	Centre des Matériaux (Materials Centre, École Nationale Supérieure des Mines de Paris, France)
ENSM-SE	École Nationale Supérieure des Mines de Saint-Etienne, France
ERF	Electro Reduction Furnace
ESCA (=XPS)	Electron Spectroscopy for Chemical Analysis
ESH	Electro Slag Heating
ESR	Electro Slag Remelting
EU	European Union
EUROFER	European Confederation of Iron and Steel Industries
EWR	Electrical Weld Resistance
FEG	Field Emission Gun
FEG-SEM	Field Emission Gun - Scanning Electron Microscope
FEG-TEM	Field Emission Gun - Transmission Electron Microscope
FEM	Finite Element Method
FEMS	Final Electro Magnetic Stirring
FIAS	Flow Injection Analytical System
FLC	Forming Limit Curve
FPMs	Facultés Polytechniques de Mons (Technical University of Mons, Belgium)
FQP	Forschung, Zentrales Qualitäts- und Prüfwesen (ThyssenKrupp Stahl Centre for R&D, Quality Engineering and Material Testing in Dortmund and Duisburg, Germany)
FQZ	Forschungs-und Qualitäts Zentrum, (Research & Quality Centre, Arcelor / EKO Stahl, Eisenhüttenstadt, Germany)
FTIR	Fourier Transform Infrared Spectroscopy
GCMS	Gaschromatography Mass Spectrometer
GDOES	Glow Discharge Optical Emission Spectrometry
GIF	Gatan Imaging Filter
HAZ	Heat Affected Zone
HCF	High Cycle Fatigue
HIP	Hot Isostatic Pressing
HKM	Hüttenwerke Krupp-Mannesmann
HOWAQ	Hot Water Quench
HPLC	High Pressure Liquid Chromatograph
HSLA	High Strength Low Alloy
HSS	High Speed Steel / High Strength Steel
HUT	Helsinki University of Technology (Helsinki, Finland)
IBF	Institut für Bildsame Formgebung (Institute of Metal Forming, RWTH Aachen, Germany)
ICDD,	The International Centre for Diffraction Data,
ICMMO	Institut de Chimie Moléculaire et Matériaux d'Orsay (Orsay Institute of Molecular Chemistry and Materials, University of Paris-Sud, France)
ICP	Inductively Coupled Plasma
ICP-TOFMS	Inductively Coupled Plasma - Time Of Flight Mass Spectrometry
IEHK	Institut für Eisenhüttenkunde (Department of Ferrous Metallurgy, RWTH Aachen, Germany)
IF	Interstitial Free
IFAM	Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung (Fraunhofer Institute for Manufacturing Technology and Applied Material Research, Bremen, Germany)
IFUM	Institut für Umformtechnik (Institute for Metal Forming and Metal Forming Machine Tools, University of Hannover, Germany)
IFW	Institut für Fertigungstechnik und Spanende Werkzeugmaschinen (Institute of Production Engineering and Machine Tools, University of Hannover, Germany)

IHSW	ISPAT Hamburger Stahlwerke (Hamburg, Germany)
IJTC	IJmuiden Technology Centre (Corus, IJmuiden, The Netherlands)
IKMA	Industrielle Kompetenzzentrum für Mechatronik und Automation (Centre of Competence for Mechatronics and Automation, Linz, Austria)
ILT	Fraunhofer-Institut für Lasertechnik (Fraunhofer Institute for Laser Technology, Aachen, Germany)
IMC	(Method for determination of carbon-containing residues on metal surfaces, developed by SIMR)
IMPOK	In Motion by Pulse Magnetic Method (non-destructive mechanical testing)
INPG	Institut National Polytechnique de Grenoble (National Polytechnic Institute of Grenoble, France)
INPL	Institut National Polytechnique de Lorraine (Polytechnic Institute of Lorraine Vandoeuvre lès Nancy, France)
IOB	Institut für Industrieofenbau und Wärmetechnik im Hüttenwesen (Department of Industrial Furnaces and Heat Technology, RWTH Aachen, Germany)
IPC	Induced Plasma Coupling
IRSID	Institut de Recherches de la Sidérurgie (Steel Research Institute, Arcelor, Maizières-les-Metz, France)
ISOFORM	(Arcelor laboratory, Nanterre, France)
ISP	In-line Strip Production
ISQ	Instituto de Soldadura e Qualidade (Institute for Welding and Quality Porto Salvo, Portugal)
ISS	Ion Scattering Spectrometry
IW	Institut für Werkstoffkunde (Institute for Material Science, University of Hannover, Germany)
IWM	Fraunhofer-Institut für Werkstoffmechanik (Fraunhofer Institute for Material Mechanics Freiburg, Germany)
IWT	Stiftung Institut für Werkstofftechnik (Foundation Institute for Materials Science Bremen, Germany)
IZFP	Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren (Fraunhofer Institute for Non-Destructive Testing Methods Saarbrücken, Germany)
LASERTEX	Laser Texturing
LASMIS	Laboratoire des Systèmes Mécaniques et d'Ingénierie Simultanée (Laboratory for Mechanical Systems and Simultaneous Engineering, Technical University of Troyes, France)
LBF	Fraunhofer-Institut für Betriebsfestigkeit (Fraunhofer Institute for Structural Durability Darmstadt, Germany)
LC	Low Carbon
LCF	Low Cycle Fatigue
LCND	Laboratoire de Caractérisation Non Destructive (Laboratory for Non-Destructive Characterisation, University of the Mediterranean Aix-En-Provence, France)
LCPME	Laboratoire de Chimie Physique et Microbiologie pour l'Environnement (Laboratory for Physical Chemistry and Environmental Microbiology, Henri Poincaré University Villers-Lès-Nancy, France)
LD	Linz Donawitz (basic oxygen steelmaking process)
LDA	Laser Doppler Anemometry
LEDEPP	Laboratoires d'etudes et de développement des produits plats (Laboratory for Studies & Development of Flat Products, Arcelor, Florange, France)
LEMTA	Laboratoire d'Énergétique et de Mécanique Théorique et Appliquée (Laboratory of Energy Technology and Theoretical and Applied Mechanics, ENSEM Nancy, France)
LFU	Lehrstuhl Unformtechnik (Chair of Forming Technology, Faculty of Mechanical Engineering, University of Dortmund, Germany)
LIBS	Laser Induced Breakdown Spectrometry
LISm	Laboratory for Iron and Steelmaking (at Ghent University, Belgium)
LPMM	Laboratoire de Physique et de Mécanique des Matériaux de Metz (Laboratory of Physics and Mechanics of Materials, Metz, France)

LSG2M	Laboratoire de Science et Genie des Materiaux et de Metallurgie (Laboratory of Science and Engineering of Materials and Metallurgy, École des Mines de Nancy, France)
LuTH	Luleå Tekniska Högskola (Luleå Technical University, Luleå, Sweden)
MEFOS	Metallurgiska Forskningsstationen (The Foundation for Metallurgical Research, Luleå, Sweden)
MFI	Mannesmann Forschungsinstitut (Mannesmann Research Institute, Duisburg, Germany)
MIDAS	Mannesmann Inclusion Detection and Assessment System (also called surfboard technique)
MiMeR	Minerals and Metals Recycling Research Centre (Luleå, Sweden)
MMX	(Year 2010 in roman numbers)
MPA	Staatliche Materialprüfungsanstalt (State Material Testing Institute Stuttgart, Germany)
MPIE	Max-Planck-Institut für Eisenforschung (Max-Planck Institute for Iron Research, Düsseldorf, Germany)
MPS	Multi Phase Steel
MULPIC	Multi-Purpose Interrupted Cooling
NDE	Non-Destructive Evaluation
NDT	Non-Destructive Testing
NIMR	Netherlands Institute for Metals Research (Delft, The Netherlands)
OCAS	OnderzoeksCentrum voor Aanwending van Staal Research (Centre for Steel Use, Ghent, Belgium)
OCTG	Oil Country Tubular Goods
ODS	Oxide Dispersion Strengthened Steels
PACVD	Plasma Assisted Chemical Vapour Deposition
PAH	Poly-Aromatic Hydrocarbon
PAS	Photo Acoustic Spectrometer
PCIM	Unité de Physico-Chimie et d'Ingéniérie des Matériaux (Physical Chemistry and Materials Engineering Division, Catholic University of Louvain, Louvain-La-Neuve, Belgium)
PDA	Phase Doppler Anemometry
PEELS	Photo Electron Energy Loss Spectrometry
PID	Proportional Integration Differential
PIM	Powder Injection Moulding
POLY	Laboratoire des Hauts Polymères (High Polymers Laboratory, Catholic University of Louvain, Louvain-La-Neuve, Belgium)
PTA	Plasma Transferred Arc
PTW	Plasma Torch Welding
PVD	Physical Vapour Deposition
QST	Quench and Self Tempering
QT	Quenched and Tempered
R&D	Research and Development
R/K	Rotary Kiln
RAP	(Brand name for process in stainless steelmaking)
RDCS	Recherche et Développement de Cockerill Sambre (Cockerill Sambre Research & Development Centre, Arcelor, Liège, Belgium)
RWTH	Rheinisch-Westfälische Technische Hochschule (Rhine-Westphalia University of Technology, Aachen, Germany)
S/N	Stress-Number of cycles to failure
SAM	Scanning Auger Microscopy
SCC	Stress Corrosion Cracking
SCI	The Steel Construction Institute (Ascot, Berks, United Kingdom)
SEM	Scanning Electron Microscope
SGA	Studiengesellschaft für Erzaufbereitung (Research Centre for Iron Ore Beneficiation, Agglomeration and Metallurgical Testing of Burden Materials, Liebenburg, Germany)
SIMR	Swedish Institute for Metals Research (Stockholm, Sweden)

SIMS	Secondary Ion Mass Spectroscopy
SME	Small and Medium-Size Enterprise
SORM3	Super-fast Optical Roughness Measurement system
SRET	Scanning Reference Electrochemistry Technique
STC	Swinden Technology Centre (Corus, Rotherham, United Kingdom)
STM	Scanning Tunnelling Microscope
STM/AFM	Scanning Tunnelling Microscopy / Atomic Force Microscopy
SVET	Scanning Vibrating Electrode Technique
TCCP-FEM	Texture-Component Crystal-Plasticity Finite Element Method
TEM	Transmission Electron Microscope
TG/DTA	Thermogravimetry / Differential Thermal Analysis
TG-DTA-MS	Thermogravimetry - Differential Thermal Analysis - Mass Spectrometry
TIC	Total Inorganic Carbon
TNO	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk Onderzoek (Dutch Organisation for Applied Scientific Research, Apeldoorn, The Netherlands)
TOC	Total Organic Carbon
TOF-SIMS	Time of Flight - Secondary Ion Mass Spectrometry
TOX	(Brand name for a mechanical joining system without moving parts)
TRIP	Transformation Induced Plasticity
TRIPS	Transformation Induced Plasticity Steel
TTC	Teesside Technology Centre (Corus, Middlesbrough, United Kingdom)
TU	Technische Universität / Technisch Universiteit (Technical University)
TWI	The Welding Institute (Cambridge, United Kingdom)
TWIP	Twinning Induced Plasticity
UCL	Université Catholique de Louvain (Catholic University of Louvain, Louvain-La-Neuve, Belgium)
UFC	Ultra Fast Cooling
UHP	Ultra High Power
UHS	Ultra High Strength
UHSS	Ultra High Strength Steel
ULC	Ultra Low Carbon
ULg	Université de Liège (University of Liège, Belgium)
ULSAB	UltraLight Steel AutoBody
UMH	Université de Mons-Hainaut (University of Mons-Hainaut, Belgium)
UV	Ultra Violet
UV-VIS	Ultra Violet - Visible Light Spectroscopy
VAR	Vacuum Arc Remelting
VDEh	Verein Deutscher Eisenhüttenleute (German Iron and Steel Institute, Düsseldorf, Germany)
WDX	Wavelength Dispersive X-ray Analysis
VIM	Vacuum Induction Melting
VOC	Volatile Organic Compound
WTC	Welsh Technology Centre (Corus, Port Talbot, United Kingdom)
XPS (=ESCA)	X-ray Photoelectron Spectroscopy
XRD	X-Ray Diffraction
XRF	X-Ray Fluorescence

Acknowledgements

Published by

EUROFER
Association sans but lucratif

All information and figures were provided by the industry, institutes and universities.

In the section "Steel Companies" the source of crude steel production is the International Iron and Steel Institute (IISI) except for Arvedi (source: Arvedi) Dalmine (source: Dalmine), Edelstalwerke Buderus, Ispat Hamburg and Ispat Ruhrort (source: Wirtschaftsvereinigung Stahl), Salzgitter (source: Salzgitter), Sandvik Steel (source: Sandvik Steel), Sidenor (source: Sidenor), voestalpine (source: voestalpine).

Photographs are courtesy of Corporate Factory; photographer: Studio Pons.

EUROFER is the European Confederation of Iron and Steel Industries. Its members and associate members are steel companies and national steel federations throughout the European Union (EU) and the Central and Eastern European Countries (CEEC). Together they represent more than 95% of total steel production in the EU and CEEC.
The objectives of EUROFER are co-operation amongst the national federations and companies in all matters, which contribute to the development of the European steel industry, and representation of the common interests of its members vis-à-vis third parties, notably the European institutions and other international organisations.

NEST (New Efficient Steel Technologies) is a thematic network - within the context of the European Union's RTD programmes on Industrial and Material Technology - encompassing selected projects in the Brite/Euram and ECSC programmes. Its main aims are to contribute specifically to the competitiveness, quality, safety and environmental performance of the steel industry and the overall sustainability of the industry's products by increasing the extent and effectiveness of steel-related research, technical and process development and innovation.