Automotive product catalogue
Bars and rods facilities

ArcelorMittal Europe
Long Products
Automotive products process flow

ArcelorMittal Duisburg

Pig Iron → Scrap → Ladle furnace → Vacuum Degassing (tank) → RH Degassing → Continuous casting blooms → Billets 155² → Bar & Billet mill → Wire Rod Mill → Wire Rod 5,5→25 → Wire Processing (annealing, pickling, phosphating) by local subcontractor → Heat Treatment (soft annealing, stress relieving, normalizing) → Bars Billets 100-170 → 63-200² → ArcelorMittal Gandrange

ArcelorMittal Warsaw

Scrap → Electric Arc Furnace → Ladle furnace → Vacuum Degassing → Continuous casting billets → Billets 140² 160² 220² → Bar Mill → Wire Rod mill → Wire Rod 15-52 → 14,3-42,5 → Bars 20-80 → Heat Treatment (soft annealing, stress relieving, normalizing, spheronising; Q+T) → ArcelorMittal Revigny

ArcelorMittal Warsaw

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ArcelorMittal Gandrange

Pig Iron → Hot Metal Desulphurisation → Oxygen Converter → Ladle furnace → Vacuum Degassing (tank) → RH Degassing → Continuous casting blooms → Billets 380x265 ≥ 320² → Bar & Billet mill → Inspection US test & TOM → Wire Rod Mill → Wire Rod 5,5-25 → Wire Processing (annealing, pickling, phosphating) by local subcontractor → Heat Treatment (soft annealing, stress relieving, normalizing) → Bars Billets 100-170 → 63-200² → ArcelorMittal Gandrange

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ArcelorMittal Revigny
ArcelorMittal Duisburg

Today the wire rod mill offers products on a high-end quality spectrum, and the billet mill produces advanced bainitic steels for hot forging.

The new rod mill is set to become European benchmark for high value added wire-rod in mechanical properties, tolerances, surface quality.

Facilities

- Steel plant:
  - Two oxygen converters (TBM process)
  - Ladle furnace
  - Steel ladle vacuum treatment: circulation degasser (RH) and tank degasser (VD), as per metallurgical need
  - Steel conditioning (Argon & Nitrogen stirring)
  - 2 casters bloom & billet
- Bar & Billet mill:
  - Reversing breakdown and finishing stand
- Inspection and finishing line for bars & billets:
  - Conditioning with ultrasonic and surface testing (Therm O’ Matic)
  - Annealing devices (up to 9 m length): soft annealing, normalising, Dimension control
  - Surface grinding (including robot)
- Wire rod rolling mill:
  - High speed single-strand 28 stands including pre–block
  - Thermo-mechanical rolling incl. loop
  - 104 m long stelmor line
- Wire rod processing (annealing, pickling, phosphating) upon request

Final applications

- Cold heading qualities:
  - steel for cold extrusion; fasteners
- Heat treatable steel grades:
  - components of common rail systems
- Carbon grade: offshore; pre-stressed steel
- Alloved spring steel: Valve springs; clutch springs
  - tension/ compression and axle springs
- Free–cutting steel:
  - special shape turned parts
  - shafts and hydraulic systems
- Bainitic steel:
  - front axle beams, steering levers & knuckle parts

Strengths

- Production of crude steel with lowest C content (< 100 ppm) and a defined alloy concentration.
- Refining of metal charges in 150 t converters due to a specific model calculation incl. management of lance status, oxygen flow rate and alloys.
- Ladle metallurgical centre for precise alloying, reduction of solute gases, desulphurisation and adjustment of melting temperature.
- Bloom and billet casters with re-oxidation prevention and mould stirring.
- Square blooms
- Most modern layout and equipment on a new single–strand wire rod mill like thermo–mechanical rolling and special cooling devices for a fine–grained structure.
- Special customer requirements upon request.

Finished products

- Wire rod (mm):
  - 5.5 to 25 (steps of 0.5 mm)
  - Coil length (mm) (max.): 2300
  - Coil weight (t) (max.): 3
    - 1.5t; 2t; 2.5t on request
- Bars (mm):
  - 63² to 200² (round corner square)
  - 100 to 170
- Length: 5–16 meters (3–5 m upon request)
- Strapping: 6 steel bands
- Bundle weight (t) (max.): 10
ArcelorMittal Warsaw

Mini-mill with a strong position in mechanical engineering and automotive markets.

Final applications

- Case hardening steels
  - Parts such as camshafts, gearbox shafts, engine parts
- Heat treatable steel grades
  - Components of steering system, braking system, axle hubs, front axles
- Cold heading qualities
  - Steel for cold extrusion, fasteners, screws, ball pins
- Carbon and micro-alloyed steel grades
  - Hot forging / stamping – flanges, conrods
  - Cold forming
- Carbon and alloyed spring steel
  - Tension/ compression and axle springs
- Bearing steel
  - Bearing rings

Strengths

- Production of wide range of steel grades
- Flexibility of mini-mill
- Steel with controlled/ regulated sulphur content
- Micro alloys steel with Nb, V, B
- Steel with ‘restricted hardenability’ (Jominy, 2/3 of band)
- Full downstream capability: heat treatment and peeling on bars

Facilities

- Steel plant:
  - Electric arc furnace with eccentric bottom tapping
  - Ladle furnace
  - Vacuum degassing
  - 4 strand billet caster
- Bar & Billet mill:
  - 18 stands in continuous system roll line
- Inspection and finishing line:
  - Straightening machines
  - Milling and chamfering devices
  - Surface control (Circograph, Circoflux)
  - Ultrasonic control device
  - Antimixing control - spectrotest devices, packaging, marking
- Bar processing:
  - Heat treatment: soft annealing, normalising, isothermal, spheroidising and stress relieving treatments, quenching and tempering (Q+T)
  - Peeling

Finished products

- Bars (mm): 20 – 80
- Length (m): 3.5 – 12
- Strapping: min. 3 steel bands
- Labelling: customer specifications (min. 2)
- Bundle weight (t) (max.): 10
ArcelorMittal Gandrange

Products for Automotive and Mechanical Engineering markets with a large range of bars and wire rods.

Final applications

- Carbon and micro-alloyed steel grades
  - Hot forging / stamping
  - Cold forming
- Cold heading qualities
  - Steel for cold extrusion; fasteners
- Free-cutting steel gards
  - Special shape turned parts
  - Shafts and hydraulic systems
- Heat treatable steel grades
  - Components of Common Rail systems
- Carbon and alloyed spring steel
  - Tension/compression and axle springs, torsion bars

Facilities

- Bar & Wire rod rolling mill:
  - Furnace with tight temperature control
  - Sizing block
  - On-line dimensional control
  - On-line surface control
  - Garrett coiling for wire rod
- Inspection and finishing line for bars:
  - Multi-roll straightener
  - Sawing and chamfering devices (45° or 60° from 0.2 up to 4mm)
  - Surface control (Circoflux)
  - Ultrasonic control device
- Bar processing upon request:
  - Peeling
- Wire rod processing (annealing, pickling, phosphating) upon request

Strengths

- Possibility to source steel from both BOF and EAF routes
- A wide range of grades and dimensions on Bars and Wire Rods
- State of the art Sizing Block and Bar Conditioning
- Mini-mill flexibility in order to meet customer needs
- Tolerances according EN10060 A to P, tighter tolerances upon request

Finished products

- Wire rod (mm):
  - 15 - 52 (steps of 0.1 mm)
  - 14.3 - 42.5 (hexagons)
- Bars (mm):
  - 15 - 100 (steps of 0.1 mm)
  - 14.3 - 70.4 (hexagons)

- Coil length (mm) (max.): 1500
- Standard coil weight (t) (max.): 2.5
- Other coil weights available upon request.

- Length (m): 5 - 16
- Strapping: 4 - 8 steel bands
- Labelling: 2 per bundle
- Bundle weight (t) (max.): 1.5 - 8
Cold drawn and peeled bars for Automotive and Mechanical Engineering markets with a large range of grades and sections.

Final applications

- Steels for general engineering
  - head rest support – stabiliser bar – green good applications
- Free-cutting steels
  - components for camshaft – injector pieces – temperature sensors
  - ABS parts – hydraulic couplings
- Case hardening steels
  - Air conditioning parts
- Steels for quenching and tempering
  - components for shock absorber struts – gearbox fork

Strengths

- Production of wide range of diameters
- Tight quality control
- Various upstream supply routes – wide range of product choice
- High supply flexibility due to tight relation with the rolling mills of ArcelorMittal Duisburg & Gandrange
- 3 Service Centres in Italy, France & Germany

Facilities

- Cold drawing
- Peeling
- Grinding
- Inspection
  - Eddy current control (Circograph – Defectomat)
  - Ultra-sonic testing

Finished products

- Bright bars (mm):
  - 5 - 80 (special shape on request)
  - 5.5 - 75 (hexagons)
- Peeled bars (mm):
  - 20 - 100
- Grinded bars (mm):
  - 6 - 50

Length (m): 3 – 6
Strapping: 3 - 6 steel bands
Labelling: 1 - 2 per bundle
Bundle weight (t) (max.): 2
ArcelorMittal Europe - Long Product (non-exhaustive products offer)

Improved Machinability Steels

Improved Machinability Steel grades have small amounts of additional alloying elements to improve machinability. Alloying elements are added during secondary steelmaking specifically to modify the steel inclusion population. Some elements form controlled inclusions to promote chip formation and break-up during subsequent machining, while others melt locally at the tool / work piece interface acting as a lubricant and reducing tool wear. Possible additions include Sulphur, Lead, Tellurium, Bismuth and Selenium.

Specifications

<table>
<thead>
<tr>
<th>Grade designation</th>
<th>Duisburg (as rolled)</th>
<th>Gandrange (as rolled or peeled)</th>
<th>Warsaw (as rolled, peeled or heat-treated)</th>
<th>Revigny (as drawaned or peeled)</th>
<th>Comments</th>
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<tbody>
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Quenched and Tempered Steels

Quenched and Tempered Steel grades have greater hardenability than structural carbon steels. The grades contain specific amounts of alloying elements to favour transformation of austenite into martensite during the quenching process. After forging, the work piece is quenched in water, polymer or oil to increase the hardness even in thick sections (through-hardening). The tempering process allows to obtain the best compromise between strength, ductility and toughness.

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</tbody>
</table>
Bainitic Steels

Bainitic Steels are designed for applications requiring a good compromise between Tensile Strength and Ductility, and offer the added benefit of eliminating the final Quench and Tempering process usually performed to achieve high properties. Controlled cooling after forging steers the Austenite transformation into the Bainitic region. The fine tuning of alloying elements will enable to reach the desired level of strength, taking into account the customer process and the size of the part.

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</tr>
</thead>
<tbody>
<tr>
<td>SOLAM® B1100</td>
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<td>●</td>
<td>UTS &gt; 1100 MPa  - Truck Front Axle Beam, Steering Knuckle, Steering Arm</td>
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<td>SOLAM® B1150-IH</td>
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<td>UTS &gt; 1150 MPa  - Crankshaft (Induction Hardened)</td>
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<td>SOLAM® B1200</td>
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<td>UTS &gt; 1200 MPa  - Common rail, Axle Beam, Steering Lever (hot forged parts 30–100 mm)</td>
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<td>●</td>
<td>●</td>
<td>UTS &gt; 1200 MPa  - Injectors, Injection Nozzles</td>
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</table>

Cold Heading Steels

Cold heading steels are designed to fulfill the most demanding customer specifications. So, the formability, ductility and strength required for producing by cold deformation the most complex parts is offered by a wide range of low carbon, alloyed, micro-alloyed and boron grades produced according to international standards. Closely controlled rod manufacturing practices ensure their good internal soundness and their defect-free surface. For specific grades, a close control of the chemical composition and post-rolling cooling allow the achievement of requested mechanical properties of the parts even by cold heading without final heat treatment.

To produce cold headed fasteners, threaded rods, wheel bolts, rivets, studs, nuts, U-bolts & welded studs and other complex formed parts for automotive, engineering and construction industries.

<table>
<thead>
<tr>
<th>Grade designation*</th>
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<th>Gandrange</th>
<th>Warsaw</th>
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<td>FREEFORM® B 10.9 IT</td>
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<td>UTS 1000–1200 Mpa  - Wheel Spindle, Ball Joint, Fastener</td>
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<td>●</td>
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<td>Screw</td>
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</tbody>
</table>

* Sulphur levels on request

- ● Industrial in all dimensions
- ○ In development (part trial or produced)
- ▼ In-house development
## Spring Steels

Spring Steels are Medium or High Carbon Steels with very high Yield Strength. This property allows the part formed with these grades to return to their original shape after significant bending or twisting. The principal alloying elements to achieve the high yield strength are Silicon and Manganese. For the very demanding applications, the grades are processed with high cleanliness level: hence, a very good fatigue behaviour.

### Specifications

<table>
<thead>
<tr>
<th>Grade designation</th>
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<th>Revigny</th>
<th>Comments</th>
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<tr>
<td>55SiMo8</td>
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<tr>
<td>52SiCrNi5</td>
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<tr>
<td>51SiCr7</td>
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<td>54SiCr6</td>
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<td>54SiCrV6</td>
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</tr>
<tr>
<td>60SiCrV7</td>
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<tr>
<td>SOLAM ® M 2050 S-Cor</td>
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<td></td>
<td></td>
<td>UTS &gt; 2050 MPa - Suspension Spring (Corrosion Resistant)</td>
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<td>SOLAM ® M 2000 S</td>
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<td>UTS 2200-2300 MPa - Suspension Spring (High Characteristics)</td>
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<tr>
<td>54SiCr6 super clean</td>
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<td>UTS &gt; 1980 MPa - Valve Spring (High Characteristics)</td>
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<tr>
<td>60SiCr8</td>
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</tr>
<tr>
<td>60SiCr ++</td>
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<td></td>
<td></td>
<td></td>
<td>UTS &gt; 2200 MPa - Clutch Spring (High Characteristics)</td>
</tr>
</tbody>
</table>

## Case Hardening Steels

Case Hardening Steels are used for parts requiring high surface wear resistance but retaining a soft core that absorbs stresses without cracking. After forging, the outer layer is carburised (diffusion of carbon) and/or carbo-nitrided and then locally hardened by quenching. The grades are Low-Carbon steels with addition of suitable alloying elements. These additions typically include Chrome and Manganese, but also Nickel and Molybdenum can be involved to increase the through-hardening for larger cross-sections. A special characteristic of this kind of grade is the Jominy curve, which needs to be well controlled.

### Specifications

<table>
<thead>
<tr>
<th>Grade des.*</th>
<th>Duisburg</th>
<th>Gandrange</th>
<th>Warsaw</th>
<th>Revigny</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>20Mn5</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>16MnCr5</td>
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<td>16MnCr5Pb</td>
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<td>25MoCr4</td>
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</tr>
<tr>
<td>12NiCr3</td>
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<td>14NiCr14</td>
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<tr>
<td>18NiCrMo6</td>
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<td>15CrNi6</td>
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<td>14NiCrMo13</td>
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<td>23MnCrMo4</td>
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</tr>
<tr>
<td>17CrNiMo6</td>
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</tr>
</tbody>
</table>

Axles / Shafts
Pinions
Gears
**ArcelorMittal Europe - Long Product (non-exhaustive products offer)**

### Micro-Alloyed Steels

Micro-Alloyed Steel grades allow to produce parts with higher strength obtained as forged. Typical additions include Niobium, Vanadium and Titanium. These additions increase yield strength by precipitation hardening, and also offer finer grain structures. These 2 effects increase the strength of the forged parts compared to conventional Carbon steels.

<table>
<thead>
<tr>
<th>Grade designation*</th>
<th>Duisburg</th>
<th>Gandrange</th>
<th>Warsaw</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10MnV6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 550 MPa</td>
</tr>
<tr>
<td>17MnV5</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 650 MPa</td>
</tr>
<tr>
<td>22MnV6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 750 MPa</td>
</tr>
<tr>
<td>27MnSiV6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 850 MPa</td>
</tr>
<tr>
<td>30MnSiV6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 850 MPa</td>
</tr>
<tr>
<td>49MnV3</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 850 MPa</td>
</tr>
<tr>
<td>38MnSiV5-6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 850 MPa - Crankshaft, Pistons</td>
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<tr>
<td>44MnSiV6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 900 MPa - Rocker Arms</td>
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<tr>
<td>C70Si6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>UTS &gt; 900 MPa - Splittable Connecting Rod</td>
</tr>
</tbody>
</table>

### Bearing Steels

Bearing Steels are High-Carbon grades with very high mechanical properties achieved by quench and tempering combined with a very high wear resistance. Depending on the type of applications, different levels of cleanliness will be required to avoid inclusions that initiate fatigue during rolling contact.

<table>
<thead>
<tr>
<th>Grade designation*</th>
<th>Duisburg</th>
<th>Gandrange</th>
<th>Warsaw</th>
<th>Revigny</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>100Cr6</td>
<td>●</td>
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<td>●</td>
<td>Mechanical Application / Tooling</td>
</tr>
<tr>
<td>100Cr6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>Bearing Ring</td>
</tr>
<tr>
<td>100CrMn6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>Bearing Ring</td>
</tr>
<tr>
<td>100CrMo7</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>Bearing Ring</td>
</tr>
<tr>
<td>C55</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>Hub bearing</td>
</tr>
<tr>
<td>C70</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>Hub bearing</td>
</tr>
</tbody>
</table>

### Carbon Steels

Carbon Steel grades are the combination of 3 families: Low, Medium and High Carbon. Low Carbon steels: Carbon range between 0.1 to 0.25%. One of the most common type of steels used for general purposes and are inherently easier to cold-form and handle (draw, bend, etc.) due to their soft and ductile nature.

Medium Carbon steels: approximately 0.30 to 0.59% Carbon content. Can be heat treated to have a good balance of ductility and strength. These steels are typically used in large parts, forgings, machined and automotive.

High Carbon steels: above 0.60% of Carbon content. High Tensile and Yield strengths. Used for applications in which high strength, hardness and wear resistance are necessary, such as wear parts, gear wheels, chains, brackets.

<table>
<thead>
<tr>
<th>Grade designation*</th>
<th>Duisburg</th>
<th>Gandrange</th>
<th>Warsaw</th>
<th>Revigny</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10 to C25</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>Camshaft, Injectors, Joint Casing</td>
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<tr>
<td>C30 to C60</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>Drive shafts, Tripod Tulip</td>
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<tr>
<td>C68 to C92</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
</tbody>
</table>

* Industrial in all dimensions

* In development (part trial or produced)

* In-house development

* Sulphur levels on request
**Main missions**

- Contribute with ArcelorMittal Europe – Long Products to strategic development of Automotive, Energy & Construction markets for Bars & Wires products
- Support plants in process improvement & new process developments
- Innovate to supply new steel solutions generating high value creation

**Main activities**

- Develop new solutions & new products: Conception of new steel grades (SOLAM®, FreeForm®, Maflex®…)
- Design of thermal treatments to achieve desired microstructure
- Surface treatment and coatings development (galvanising, galfanising, paints, lacquers, powder…)
- Qualify manufacturing & service properties of products
- Expertise process/ product, to provide technical support to the plants & customers
- Contribute to conception & optimisation of processes by using Finite Element and other specific models: liquid metallurgy, casting, hot rolling, hot and cold forming, heat treatment, ...
- Support for instrumentation of industrial processes (Thermal camera, pyrometers, force sensors…)

**Strengths**

- Numerical modelling from liquid metallurgy, casting to hot rolling & cold forming
- Product characterisation at micro & macro scale (Field Emission Gun SEM, macro-probe, torsion & fatigue machines, dilato-plastometry, corrosion chambers…)
- Process pilots for machinability, drawing and heat treatment
- Steel Design
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