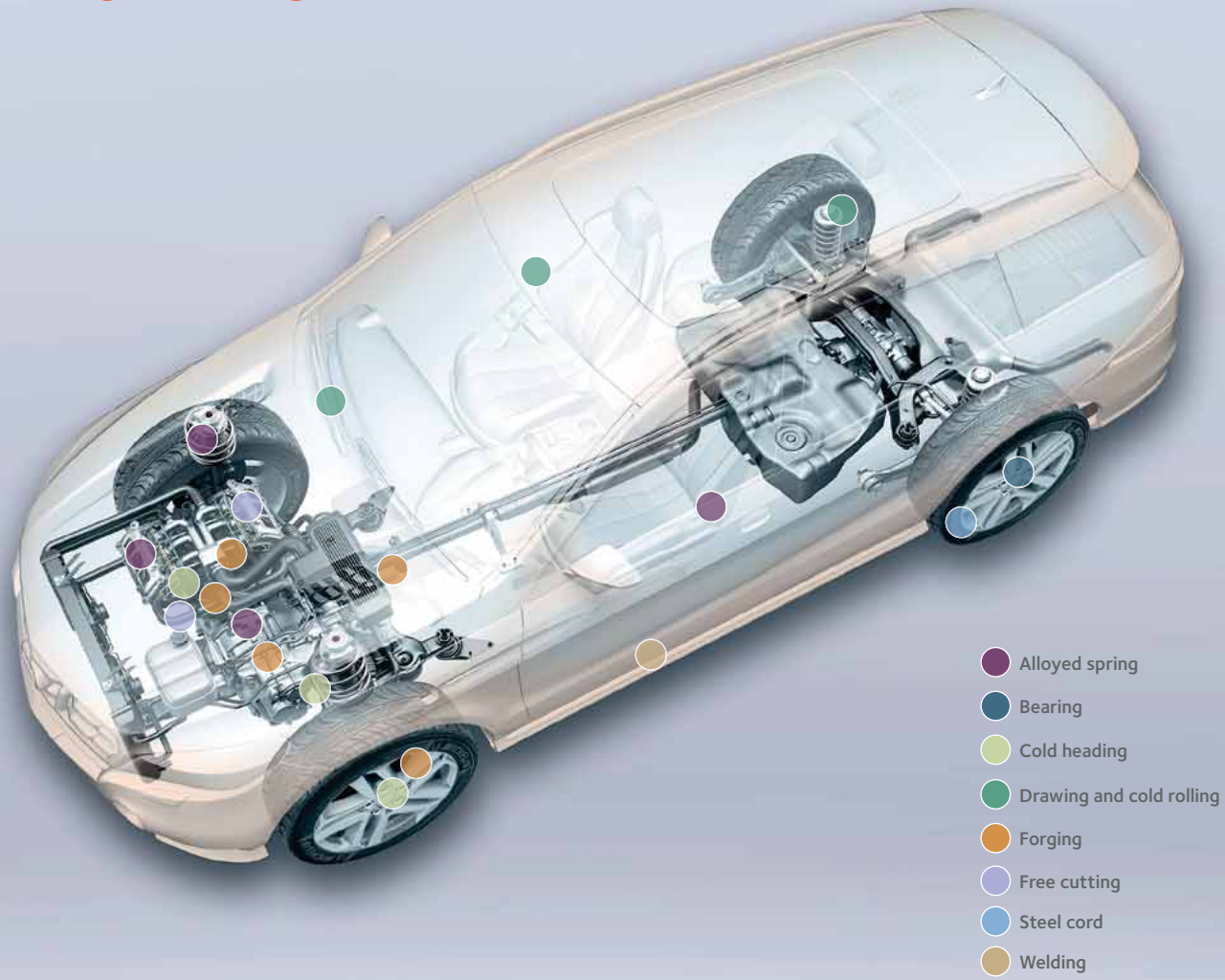
ArcelorMittal Europe
Long Products

ArcelorMittal

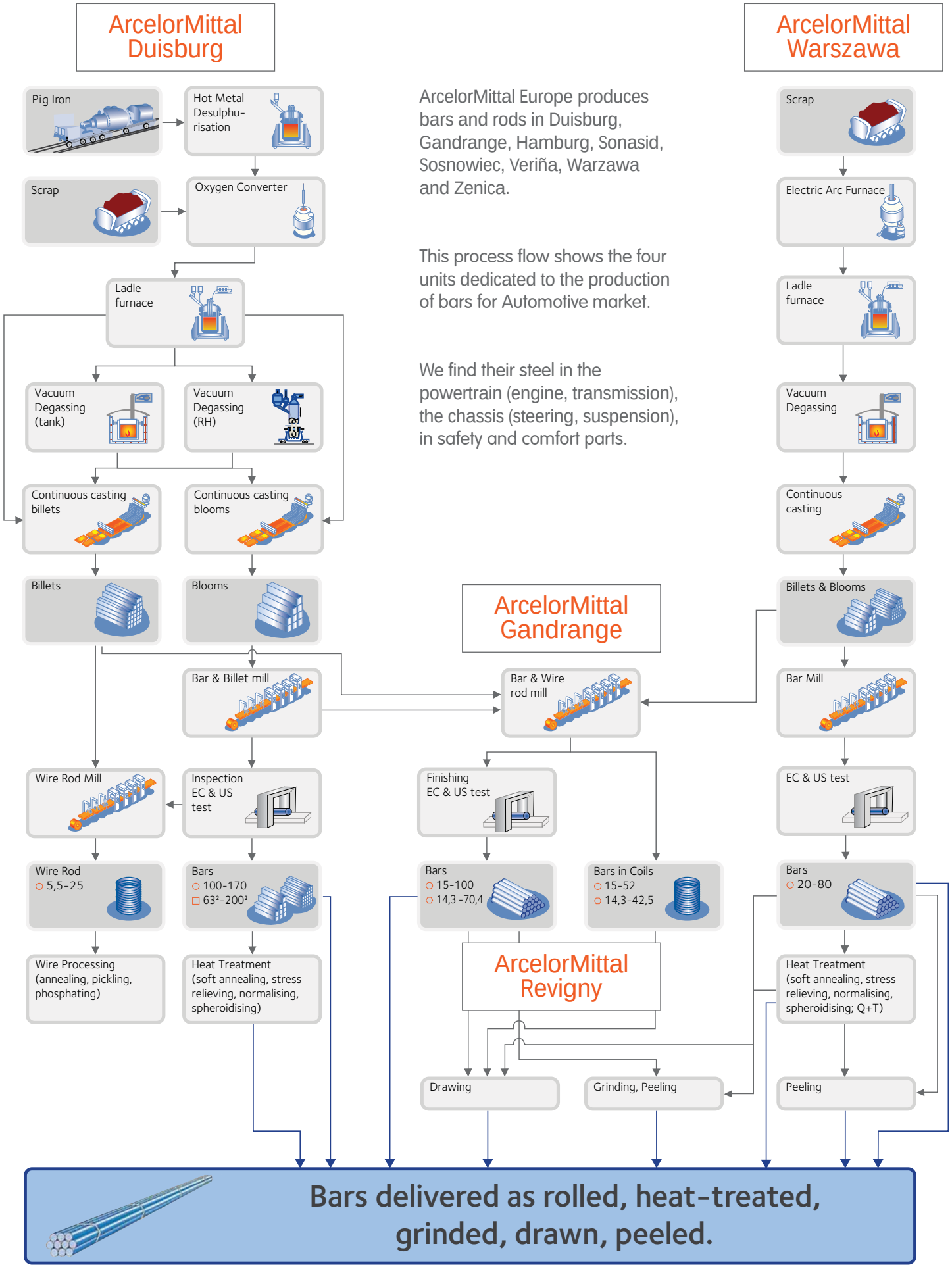
Automotive applications

165 kg of long steel ...



... power your vehicle.

ArcelorMittal Europe - Bars Process Flow



ArcelorMittal Europe produces bars and rods in Duisburg, Gandrange, Hamburg, Sonasid, Sosnowiec, Veriña, Warzawa and Zenica.

This process flow shows the four units dedicated to the production of bars for Automotive market.

We find their steel in the powertrain (engine, transmission), the chassis (steering, suspension), in safety and comfort parts.

ArcelorMittal Duisburg

The wire rod mill offers products on a high-end quality spectrum.

The bars & billet mill offers range of products up to 200 mm^2 or Ø 170 for rerolling or for forging. This is particularly adapted to truck market or off-road vehicules.

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
- Alloyed 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
  - heavy duty: crankshafts

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, mould stirring, MSR.
- Square blooms
- Most modern layout and equipment on a new wire rod mill like thermo-mechanical rolling and special cooling devices for a fine-grained structure.
- Special customer requirements upon request.

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)
  - 1 billet caster
  - 1 bloom caster with Soft Reduction
- 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

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): ■ 63^2 to 200^2 (round corner square)
  ● 100 to 170

Length: 5-16 meters (3-5 m upon request)
Strapping: 6 steel bands
Labelling: content upon request

Bundle weight (t) (max.): 10

ArcelorMittal Warszawa

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

Warszawa offers heat-treated bars and peeled bars.

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, hub bearings

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" (2/3 of band, 1/3 of band, controlled narrow Jominy band)
- Full downstream capability: heat treatment and peeling on bars

Facilities

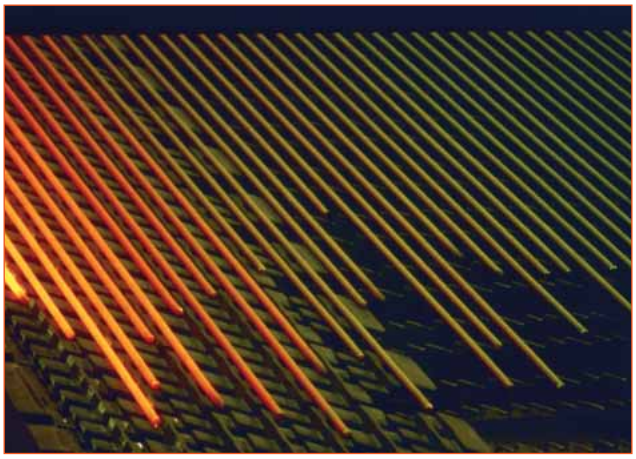
- Steel plant:
  - Electric arc furnace with eccentric bottom tapping
  - Ladle furnace
  - Vacuum degassing
  - 4 strand billet caster
- Bar & Billet mill:
  - 18 stands in continuous system roll line
- Inspection and finishing line:
  - Straightening machines
  - Milling and chamfering devices
  -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

Strongly positioned in the field of bars and rods in coils products

Products for Automotive, Energy and Mechanical Engineering markets (forging, cold heading, bright drawing...).

Final applications

- Carbon and micro-alloyed steel grades
  - Hot forging / stamping
  - Cold forming
- Cold heading qualities
  - Steel for cold extrusion; fasteners
- Free-cutting steel gardes
  - 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

Strengths

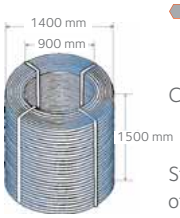
- Possibility to source steel from both BOF and EAF routes
- A wide range of grades and dimensions on Bars and Wire Rods
- State of the art Sizing Block and Bar Conditioning
- Mini-mill flexibility in order to meet customer needs
- Tolerances according EN10060 A to P, tighter tolerances upon request

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

Finished products

- Wire rod (mm): ● 15 - 52 (steps of 0.1 mm)
  ⬢ 14.3 - 42.5 (hexagons)



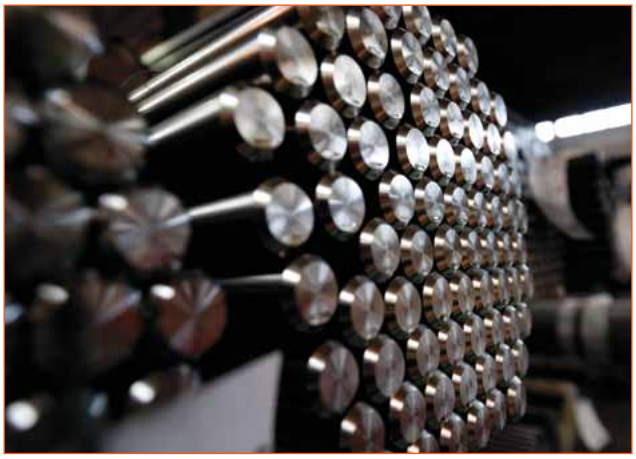
Coil length (mm) (max.): 1500

Standard coil weight (t) (max.): 2.5
other coil weights available upon request.

- Bars (mm): ● 15 - 103 (steps of 0.1 mm)
  ⬢ 14.3 - 70.4 (hexagons)

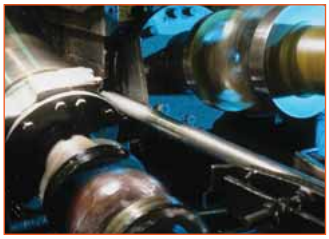
Length (m): 5 - 16
Strapping: 4 - 8 steel bands
Labelling: 2 per bundle

Bundle weight (t) (max.): 1.5 - 8



ArcelorMittal Revigny

Main French Bars supplier for bright drawn, peeled and grinded bars for Automotive and Mechanical Engineering markets.



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
- 2 Service Centres in 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 - 8
Strapping: 3 - 6 steel bands
Labelling: 1 - 2 per bundle

Bundle weight (t) (max.): 2

Product offer (non-exhaustive)

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

Grade designation	Duisburg (as rolled)	Gandrange (as rolled or peeled)	Warsaw (as rolled, peeled or heat-treated)	Revigny (as drawned or peeled)	Comments
Usimax ® D10				●	UTS 400-700 MPa drawn -High Speed Free Cutting Steel (without lead)
Usimax ® D38				●	UTS 700-850 MPa drawn - Free Cutting Steel for Heat Treatment
Usimax ® D950				●	UTS 950-1100 MPa drawn - High Resistance Free Cutting Steel
11SMn30	●	●	●	●	
11SMnPb30	●	●		●	
11SMn37	●	●	●	●	
11SMnPb37	●	●		●	
36SMnPb14	●	●		●	
38SMn28	●	●	●	●	
35S20	●	●	●	●	
46S20	●	●	●	●	
44SMn28	●	●	●	●	Camshaft Sleeve
C15Pb	●	●		●	
C35Pb	●	●		●	
C45Pb	●	●		●	Camshaft

Quenched and Tempered Steels Alloyed Steels

Quenched and Tempered Steel grades have greater hardenability than structural carbon steels Q&T C22, C60. 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.

Specifications

Grade designation*	Duisburg (as rolled)	Gandrange (as rolled or peeled)	Warsaw (as rolled, peeled or heat-treated)	Revigny (as drawned or peeled)	Comments
38Cr2	●	●	● (Q+T)		
37Cr4	●	●	● (Q+T)		
34Cr4	●	●	● (Q+T)	●	
41Cr4	●	●	● (Q+T)	●	
18CrMo4	●	●	● (Q+T)		Common Rail
25CrMo4	●	●	● (Q+T)		
30CrMo4	●	●	● (Q+T)		
34CrMo4	●	●	● (Q+T)		UTS > 1100 MPa - Rocker Arms, Pistons, Crankshaft
42CrMo4	●	●	● (Q+T)	●	
36MnCr5	●	●	● (Q+T)		
34CrNiMo4-6	●	●	● (Q+T)		Rocker Arms, Crankshaft
36CrNiMo4	●	●	● (Q+T)		
30CrNiMo8	●	●	● (Q+T)		
42CrMo4 NiV	●	●	● (Q+T)		UTS > 1200 MPa - Crankshaft
51CrV4	●	●	● (Q+T)		
15Mo3	●	●	● (Q+T)		
40NiCrMo4	●	●	● (Q+T)		Crankshaft

Product offer (non-exhaustive)

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.

Specifications

Grade designation*	Duisburg	Gandrange	Warsaw	Revigny	Comments
SOLAM® B1100	●	●	●	●	UTS > 1100 MPa - Truck Axle Beam, Steering Knuckle, Steering Arm
SOLAM® B1150 IH	●	◉	●	●	UTS > 1150 MPa - Crankshaft (Induction Hardened)
SOLAM® B1200	◉	◉	●	●	UTS > 1200 MPa Common rail, Axle Beam, Steering Lever
20MnCrMo7	●	●	●	●	UTS > 1200 MPa - Injectors, Injection Nozzles

Cold Heading Steels / Cold Forging Steels

These 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 manufacturing practices ensure their good internal soundness and their defect-free surface. For specific grades for cold heading, 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. Finishing on bars are proposed: annealing, spheroidising and peeling.

Specifications

Grade designation*	Duisburg	Gandrange	Warsaw	Revigny	Comments
FREEFORM® Dual 800	●	●			
FREEFORM® B1000 IT	◉	◉			UTS 1000-1200 Mpa - Wheel Spindle, Ball Joint, Fastener
FREEFORM® B1000	◉	◉			UTS > 1000 Mpa - Ball Joint, Fastener
FREEFORM® M 1500 H2	●				UTS > 1500 MPa Conrod Screw (High Characteristics) - Suspension Screw
C4	●	●	●	●	
C10	●	●	●	●	
C22	●	●	●	●	
17B2	●	●	●	●	
18B2	●	●	●	●	
17MnB4	●		●	●	
19MnB4	●		●	●	
20MnB5	●	●	●	●	UTS > 800 Mpa - Wheel Screw
23MnB4	●		●	●	
27MnB5	●	●	●	●	
35B4	●		●	●	
28MnCrB7-2	●		●	●	Ball pin
27MnCrB5-2	●		●	●	Ball pin - Shaft
32CrB4	●		●	●	Screw
36CrB4	●		●	●	Screw
36CrNiB4	●		●	●	Screw

● Industrial in all dimensions
◉ In development (part trial or produced)
○ In-house development

* Sulphur levels on request

Product offer (non-exhaustive)

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

Grade designation	Duisburg	Gandrange	Warsaw	Revigny	Comments
SOLAM ® M 2050 S-Cor	○				UTS > 2050 MPa - Suspension Spring (Corrosion Resistant)
SOLAM ® M 2200 S	○				UTS 2200-2300 MPa - Suspension Spring (High Characteristics)
54SiCr6 super clean	●				UTS > 1980 MPa - Valve Spring (High Characterisics)
60SiCr ++	○				UTS > 2200 MPa - Clutch Spring (High Characteristics)
45SiCrV6	●		●		
45MnSiCrV6	●		●		
46SiCrMo6	●		●		
55Cr3	●	●	●		
51CrV4	●		●	●	
58CrV4	●		●		
58CrMoV4	●		●		
55SiMo8	●		●		
52SiCrNi5	●		●		
51SiCr7	●		●		
54SiCr6	●		●	●	UTS > 1900 MPa - Suspension Spring
54SiCrV6	●		●		UTS > 2030 MPa - Suspension Spring
60SiCrV7	●		●		
60SiCr8	●		●		

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

Grade designation*	Duisburg	Gandrange	Warsaw	Revigny	Comments
20Mn5	●	●	●	●	These grades are usually adapted for Axles / Shafts / Pinions / Gears The Bars can be delivered with special annealing treatments on request
16MnCr5	●	●	●	●	
16MnCrS5Pb	●	●		●	
20MnCr5	●	●	●	●	
27MnCr5	●	●	●	●	
25MoCr4	●	●	●	●	
23MnCrMo4	●	●	●	●	
17Cr3	●	●	●	●	
15CrNi6	●	●	●	●	
16CrNi4	●	●	●	●	
17CrNi6	●	●	●	●	
18CrNi8	●	●	●	●	
12NiCr3	●	●	●	●	
14NiCr14	●	●	●	●	
18NiCrMo6	●	●	●	●	
20NiCrMo2	●	●	●	●	
14NiCrMo13	●	●	●	●	
17CrNiMo6	●	●	●	●	

Product offer (non-exhaustive)

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.

Specifications

Grade designation*	Duisburg	Gandrange	Warsaw	Comments
10MnV6	●	●	●	
17MnV5	●	●	●	UTS > 550 MPa
22MnV6	●	●	●	UTS > 650 MPa
27MnSiV6	●	●	●	UTS > 750 MPa
30MnSiV6	●	●	●	UTS > 850 MPa
49MnV3	●	●	●	UTS > 850 MPa
38MnSiV5-6	●	●	●	UTS > 850 MPa - Crankshaft, Pistons
44MnSiV6	●	●	●	UTS > 900 MPa - Rocker Arms
C70S6	●	●	●	UTS > 900 MPa - Splittable Connecting Rod

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.

Specifications

Grade designation*	Duisburg	Gandrange	Warsaw	Revigny	Comments
100Cr6	●	●	●	●	Mechanical Application / Tooling
100Cr6			●		Bearing Ring
100CrMn6			●	●	Bearing Ring
100CrMo7			●	●	Bearing Ring
C56E2			●		Hub bearing
C70			◉	●	Hub bearing

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.

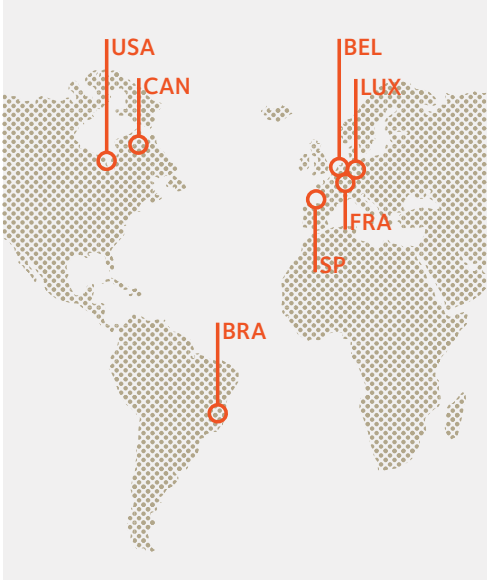
Specifications

Grade designation*	Duisburg	Gandrange	Warsaw	Revigny	Comments
C10 to C25	●	●	●	●	Camshaft, Injectors, Joint Casing
C30 to C60	●	●	●	●	Drive shafts, Tripod Tulip
C68 to C92	●	●	●		

● Industrial in all dimensions
◉ In development (part trial or produced)
○ In-house development

* Sulphur levels on request

Product & process development



Global R&D

Over 1.400 full-time researchers in 12 Labs, spending in 2017 amounting to $278 million of which 33% is dedicated to Auto.

Missions

- Pro-active approach of future needs in automotive industry
- Innovative solutions taking advantage of Flat & Long synergies
- Development of products, steel solutions and processes from their pre-design phase through their implementation and lifetime at our customers and at our plants
- Assistance to plants for complex technical issues

Activities

- Broad, comprehensive portfolios and programmes addressing business needs
- Expanding Worldwide network of research sites in Europe & America
- Partnerships with focused engineering schools & universities research sites

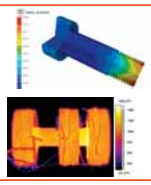
4 steps to go from customer needs to industrialisation

Listen to customers

Market & customer needs & expectations OEM, tier 1, tier 2

↓

Define final steel properties



Solution conception

Define chemistry & process
Data base, know how, modelling...
-> Customer contact

Solution validation

Cast, roll or forge laboratory ingots

↓

Small scale trials
Trials with customer (partnership)

↓

Laboratory investigations

↓

Fine-tuning of chemistry & process
-> Customer contact

Industrialisation

Industrial heat

↓

Product homologation

↓

Serial production

ArcelorMittal's product development approach is based on long term co-development agreements. From Global Research & Development Centres at group level to European plants, our experts are committed to invent new steel products and to improve steel processing and engineering. Our research and development teams provide also support to our customers to establish a sound knowledge on the key expectations from our products, such as cleanliness, structure homogeneity, mechanical characteristics, machinability, corrosion resistance, etc.

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