



ArcelorMittal

Driving advanced automotive steel solutions

North American Automotive



# An unparalleled partner for automotive manufacturers

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Almost every car  
on the road contains  
ArcelorMittal steel.

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ArcelorMittal is the world's leading steel and mining company, with approximately 209,000 employees spanning 60 countries. We are the leading supplier of quality steel products in all major global steel markets, including construction, household appliances, packaging and automotive.

With a strong presence in North America, Europe, South America and South Africa, and an emerging presence in China, ArcelorMittal is the only automotive steel producer with a worldwide presence, delivering a large scale of products, solutions and services to automotive customers with the same quality focus in all regions. ArcelorMittal is the leader in automotive sheet steel technology, both in the breadth and depth of our product portfolio, and in our ability to supply these grades throughout the world.

ArcelorMittal is recognized as the supplier of choice for auto manufacturers, a testament of our commitment to working collaboratively with the customer to engineer advanced steel grades to meet their automotive needs.

ArcelorMittal is ranked amongst the world leaders in steel for research and development (R&D), with a significant focus on automotive applications, and we are committed to sustaining our leadership position well into the future. ArcelorMittal operates 12 research centers throughout the world, six that are dedicated fully or partly to the automotive market: East Chicago, Indiana, United States; Hamilton, Ontario, Canada; Vitória, Espírito Santo, Brazil; and Maizières, Montataire and Gandrange, France.

We are the leader in automotive steel. As the auto industry increasingly looks not for steel providers but solution providers, our technical know-how and leadership in advanced steel grades position us to help carmakers produce lighter, safer and more fuel-efficient vehicles.

# Providing innovative automotive steel solutions in North America

**"Through continued investment, innovation and network expansion, we have built both our geographical and technological leadership in the automotive market."**

*-Brian Aranha, head of global automotive and commercial coordination, ArcelorMittal*

ArcelorMittal North America boasts some of the most technologically advanced automotive operations in the world, incorporating a range of modern steelmaking technologies. In Canada, the United States and Mexico, ArcelorMittal operates 26 facilities that serve the automotive market. Two state-of-the-art R&D centers, located in East Chicago, Indiana and Hamilton, Ontario, are primarily devoted to research on flat products, including automotive, with global responsibility for process and product development.

Our R&D engineers work with automakers throughout the lifecycle of their products to develop automotive steels that are stronger yet lighter than existing materials. We also develop new, cost-effective coatings to improve corrosion resistance, paint appearance and application processes.

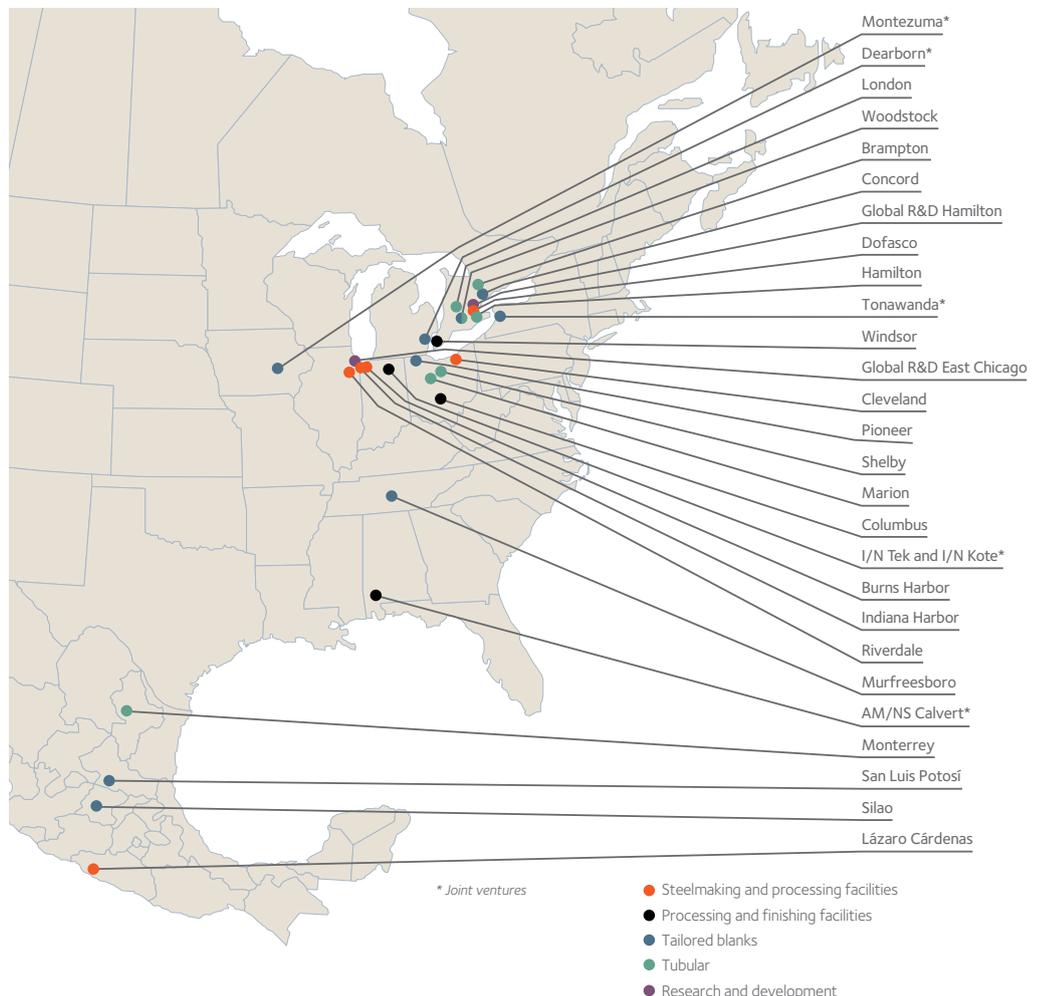
ArcelorMittal's commercially available advanced and ultra high strength steels, coupled with emerging and longer-term breakthrough steels, are at the forefront of the automotive industry. Our automotive steel solutions cover all metallurgical 'families' of steels – distinguished by their different properties and compositions.

ArcelorMittal also operates specialized business units for tubular products and tailored blanks, or laser-welded blanks – utilizing inventive engineering and manufacturing technologies that improve the performance of car parts in a vehicle. Custom-designed tailored blanks and tubular product solutions reduce weight and the number of welds in automotive applications – improving strength and enhancing crash performance.

Our automotive team is a multi-disciplined, focused and flexible organization proactively responding to our customers' needs. We do this by offering a wide range of products, an extensive supply chain and logistics network, and an industry leading sales and engineering support system.

This customer support spans the life cycle of each product beginning at the collaborative development of new automotive steel solutions, continuing through vehicle design and on to mass production.

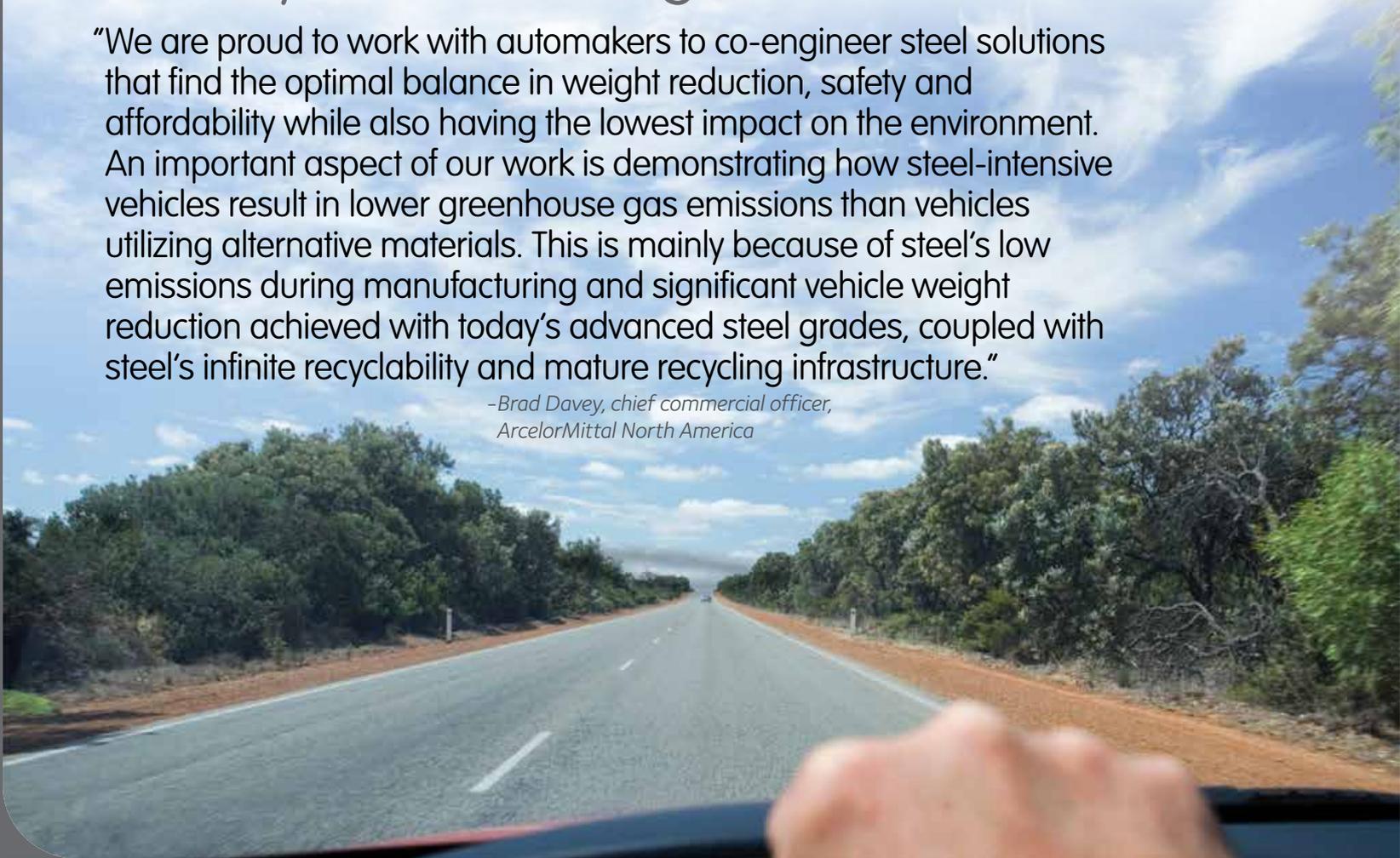
## North American automotive facilities: Strategically located to serve our customers



# Steel: Achieving ideal balance in weight, cost and safety, while reducing carbon emissions

“We are proud to work with automakers to co-engineer steel solutions that find the optimal balance in weight reduction, safety and affordability while also having the lowest impact on the environment. An important aspect of our work is demonstrating how steel-intensive vehicles result in lower greenhouse gas emissions than vehicles utilizing alternative materials. This is mainly because of steel’s low emissions during manufacturing and significant vehicle weight reduction achieved with today’s advanced steel grades, coupled with steel’s infinite recyclability and mature recycling infrastructure.”

—Brad Davey, chief commercial officer,  
ArcelorMittal North America



Regulatory and customer expectations for lighter weight vehicles are rising to meet new fuel economy requirements such as the Corporate Average Fuel Economy (CAFE) standards. Our advanced steel solutions provide the lightness and strength automakers need to create sustainable mobility solutions that minimize emissions across the entire life cycle of the vehicle and ensure the safety of vehicle users, all at a lower cost.

Typically, standards focus on emissions during the use phase of the vehicle’s life – also known as tailpipe emissions. At ArcelorMittal, we believe that an entire life cycle analysis (LCA) of the vehicle, including both production and material use, should be taken into account when setting emission targets.

According to the World Steel Association, the production of new, advanced steel generates less than 20 percent of the greenhouse gas (GHG) emissions than those of competing materials. With GHG emissions during use phase being reduced through power train efficiency and fuel economy improvements, the manufacturing phase emissions are

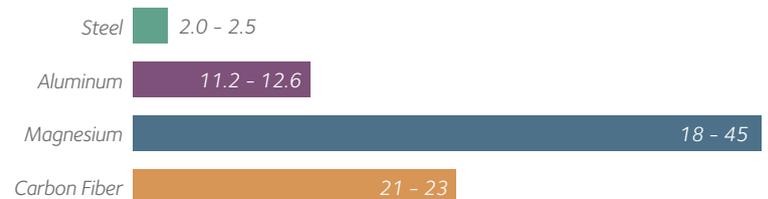
becoming a more significant contributor to total lifetime GHG emissions of vehicles. As a result, vehicles constructed of advanced high strength steels (AHSS) and ultra high strength steels (UHSS) produce less GHGs over their life than those constructed from alternative materials.

At the same time, steel offers the most cost effective solution for achieving fuel efficiency standards. The weight reduction offered by AHSS provides the single largest improvement in efficiency per dollar spent than any other fuel economy improvement technology. AHSS can provide a significant fuel economy improvement at little or no additional cost to the automaker, which is up to five times more cost effective

than aluminum. Cars made from advanced steel grades can also be produced using the auto manufacturer’s existing infrastructure with little need for additional investments in retooling auto production facilities. Many alternative materials require new equipment and a greater investment of time and money for production.

ArcelorMittal’s automotive steels provide solutions to the challenges our automotive customers face.

## Greenhouse gas from material production (in kg CO<sub>2</sub>e/kg)



Note: All steel and aluminum grades included in ranges.

Source: WorldAutoSteel

# S-in motion: Commercially available steel solutions

“Our S-in motion® solutions available today provide sufficient weight reduction which, when combined with power train developments, help the automotive industry achieve the current and future fuel and emission standards in all types of vehicles. Steel is and always will be the complete package to help automakers achieve the fuel efficiency targets set before them. It’s the most affordable solution for our customers and the consumer, and it’s the best choice for the environment.”

–Dr. Blake Zuidema, director,  
automotive product applications,  
ArcelorMittal

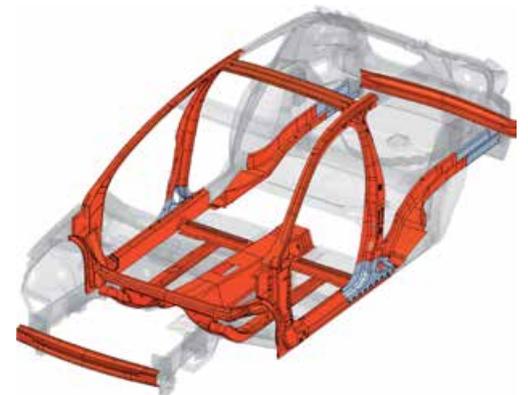
S-in motion® is a set of commercially available steel solutions for car makers who wish to create lighter, safer and more environmentally friendly vehicles for the 21st Century. The project demonstrates ArcelorMittal’s ongoing commitment to the automotive sector with a catalogue of steel parts and solutions that can be used to help reduce vehicle weight while maintaining crash safety, all with no cost increase to customers.

S-in motion® originally launched in 2010 with the introduction of 63 steel parts for a standard, c-segment vehicle. The catalogue of steel solutions utilizes a range of different press hardened steels (PHS) and advanced high strength steels (AHSS), as well as long products for chassis and suspension components. Together, these 63 solutions offer a body-in-white (BIW) weight reduction of 20 percent, and a 6.23 gram drop in CO<sub>2</sub> emissions per kilometer, when compared to the 2009 baseline vehicle.

The original S-in motion® innovation has been refined and expanded to help meet the specific challenges facing the North American light truck market. In September 2014, ArcelorMittal announced the S-in motion® Steel Pick-Up, which offers two sets of steel solutions to reduce the average weight of

pick-up trucks. The first set uses currently available AHSS and PHS grades such as Usibor® 1500 and Ductibor® 500 and can reduce BIW weight by up to 23 percent compared with a 2014 baseline vehicle. Reducing the average weight of pick-ups by this amount saves more than 14 grams of CO<sub>2</sub>-equivalent emissions per kilometer, ensuring pick-up trucks meet regulatory standards in the EU and US. The second set uses emerging steel grades which are in the final stages of development.

Leveraging the strong S-in motion® brand and our reputation as a steel solutions provider, all of our automotive solutions now fall under the S-in motion® umbrella including: our battery electric and plug-in hybrid vehicles; the industry’s first laser-welded hot stamped door ring; and the ultra lightweight steel door. In fact, 13 unique automotive steel solutions now exist under the S-in motion® program, providing automakers with the best value for our materials – achieving weight reduction requirements at a lower cost and with less environmental impact than competing materials, without compromising safety, style or performance. And, the solutions can be implemented without the OEM needing major capital investment or new manufacturing infrastructure.



Possible hot-stamped solutions



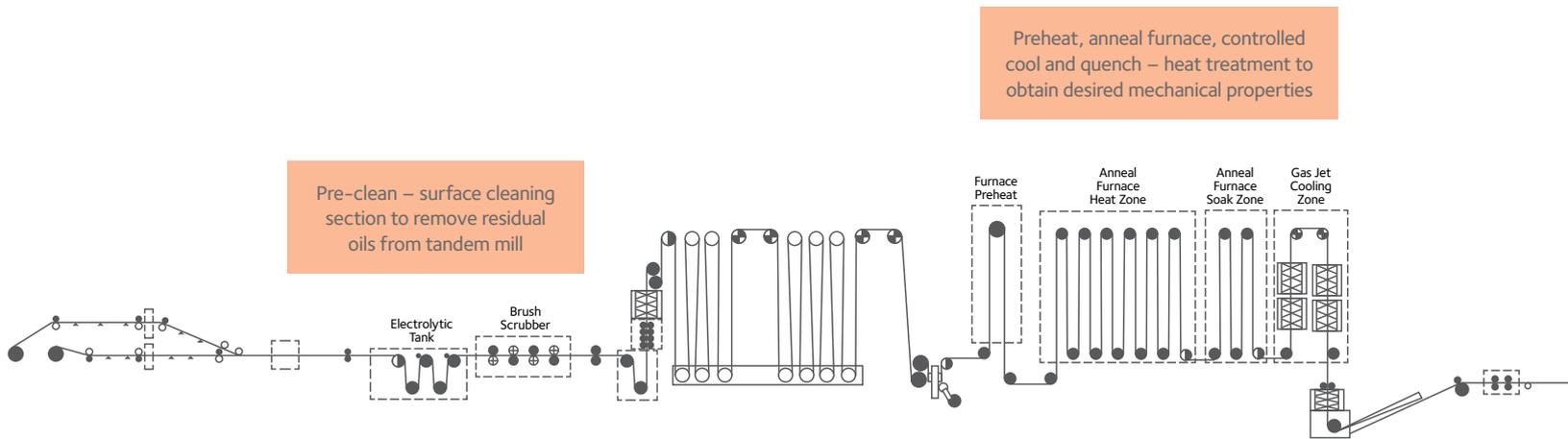
Possible laser-welded blank solutions

# Continuous heat treating: A sophisticated process



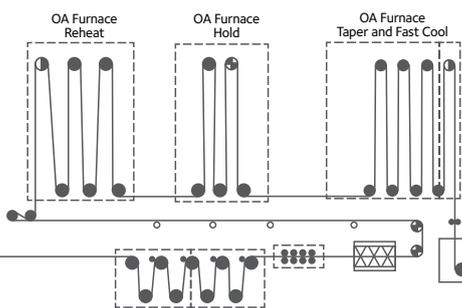
ArcelorMittal's continuous heat treating line plays a leading role in the creation of cold rolled, advanced high strength steels. The diagram below provides a step-by-step look at the

sophistication used to produce advanced steel grades desired by automakers for use in vehicles of today and tomorrow.

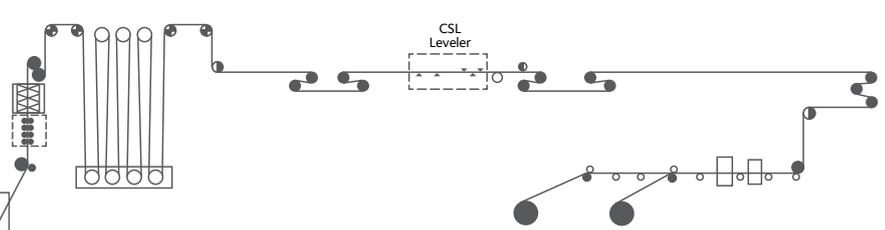




Reheat, hold and rapid quench – secondary heat treatment to enhance and finalize desired mechanical properties



Flatness control – improved flatness resulting from uniform heating and cooling assisted by tension leveling

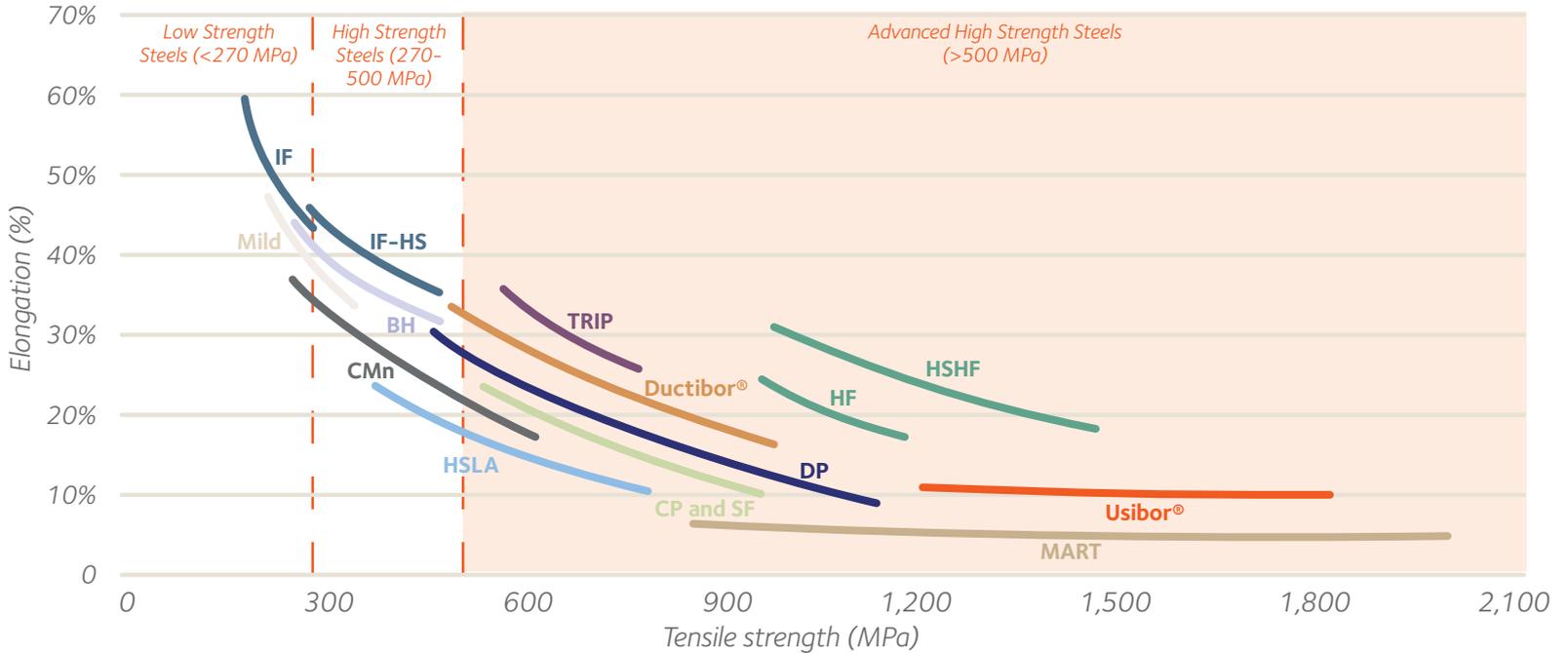


# ArcelorMittal R&D: Expanding the limits in formability and strength of steel

This chart demonstrates the traditional trade-off between formability and strength, and how ArcelorMittal has developed and

commercialized advanced high strength steels and ultra high strength steels to expand these limits in order to provide our customers with

grades of steel that support the design of lighter, safer, more energy-efficient vehicles for today and the future.



## Advanced and ultra high strength steels: Currently available and in development

	Grade Designation		Hot Rolled (HR)	Cold Rolled (CR)			
	Generic	North America		Uncoated/Electro-galvanized (EG)	Hot Dip Galvanized (GI)	Galvannealed (GA)	Aluminized
<b>Dual Phase Steels</b>	DP500	T490Y280					
	DP590	T590Y340, T590Y305					
	DP590 HY	T590Y340 (590R has Y450)					
	DP690 HY	T690Y550 (HFT690, 80Y100T)					
	DP780	T780Y420					
	DP780 LCE	T780Y420					
	DP965/980	T965Y550, T980Y550					
	DP980	T980Y600					
	DP980 LCE	T980Y600 (980LCE)					
	DP980HY LCE	T980Y700 (980LCE)					
	980HF						
	DP1180	T1180Y850					
	1180HF						
DP1270							
<b>Complex Phase/ Multiphase Steels</b>	CP800/MP800 HY						
	CP1000						
<b>Ferrite-Bainite/ Stretch Flangeable Steels</b>	590SF						
	780SF						
<b>TRIP</b>	TR590						
	TR690						
	TR780						
<b>MARTINSITE®</b>	M900	T900Y700 (M130)					
	M1100	T1100Y860 (M160)					
	M1300	T1300Y1030 (M190)					
	M1500	T1500Y1200 (M220)					
	M1700	T1700Y1350					
<b>Press Hardened Steels</b>	Usibor® 1500						
	Usibor® 2000						
	Ductibor® 500						
	Ductibor® 1000						
	22MnB5						

■ Currently available ■ In development

# ArcelorMittal automotive steels: Specification descriptions

## Steel specification

## Overview

MILD	Commercial Steel (CS)	Typically produced using low carbon content, CS is used in applications with more limited forming requirements.
	Drawing Steel (DS)	DS is a readily available specification which offers good formability. DS is aluminum killed and typically has lower carbon or controlled processing resulting in improved formability.
	Deep Drawing Steel (DDS)	A specification of steel with excellent formability characteristics which is recommended for difficult forming applications. DDS is also available in standard and extra low carbon forms. It is sometimes produced using ultra low carbon (ULC) or interstitial free (IF) steels.
	Extra Deep Drawing Steel (EDDS)	A highly formable specification of steel ideal for the most difficult forming applications where other steels lack sufficient ductility. This product is produced using IF steel, requiring the use of a degasser in steelmaking as well as close control of alloy additions.
Bake Hardenable (BH)		These specifications are unique in that they are designed to increase yield strength after the paint curing process, providing the benefit of both superior formability over traditional high strength steels and higher part strength than previously described specifications. They acquire their added strength via the amount of strain generated in the part during stamping, and through the time and temperature inherent in the paint curing process.
High Strength Low Alloy (HSLA)		HSLA specifications offer higher strengths for applications where forming requirements are not as severe as previously described specifications. The product is sold to guaranteed mechanical properties of yield strength, tensile strength and elongation. The strength is obtained not only through carbon and manganese but also through the addition of one or more microalloys (Cb, Ti, V) coupled with controlled processing.
Carbon Manganese (CMn)		Carbon steels containing more than 1.2 percent up to approximately 1.8 percent manganese are referred to as Carbon Manganese steels. The manganese content in carbon steels is increased for the purpose of increasing depth of hardening and improving strength and toughness.
Dual Phase (DP)		DP steels offer an outstanding combination of strength and initial drawability as a result of their microstructure, in which a hard martensitic or bainitic phase is dispersed in a soft ferritic phase. These steels have high strain hardening capacity. As a result, finished part mechanical properties, especially yield strength, are superior to those of the initial blank. These steels have excellent fatigue strength and good energy absorption capacity, making them suitable for use in structural parts and reinforcements.
Ferrite-Bainite/Stretch Flangeable (SF)		SF grades extend the HSLA range of micro-alloyed steels to include products combining high tensile strength (UTS) with excellent formability and hole expansion (stretch flangeability) based on their ferrite-bainite microstructure. As a result of their high tensile strength and microstructure, these grades exhibit good fatigue strength. Applications are cold stamped automotive parts with applications including control arms, cross members, and wheels.
Transformation Induced Plasticity Steels (TRIP)		TRIP steels offer an outstanding combination of strength and ductility as a result of their microstructure. They are suitable for structural and reinforcement parts of complex shape. The microstructure of these steels is composed of islands of hard residual austenite and carbide-free bainite dispersed in a soft ferritic matrix. Austenite is transformed into martensite during plastic deformation, making it possible to achieve greater initial elongations. High strain hardening capacity and high mechanical strengths lend these steels excellent energy absorption capacity. TRIP steels also exhibit a strong bake hardening effect following deformation, which further improves their crash performance. TRIP steels are particularly well suited for automotive structural and safety parts such as cross members, longitudinal beams, B-pillar reinforcements, sills and bumper reinforcements.
Press Hardened Steels (PHS)		PHS are designed to be heat treated and then quenched during the hot stamping process. The mechanical properties of the final part make significant weight savings possible. The very high yield strength of these steels after heat treatment and hot stamping make them suitable for anti-intrusion components such as fender beams, door reinforcements and B-pillars.
	Usibor®	Usibor® has an aluminum-silicon pre-coating and was developed to protect the metal from oxidation (scale) and decarburization during the hot stamping process. The coating offers excellent resistance to oxidation resulting from the hot stamping heat treatment process. Final parts using this forming technology have improved corrosion resistance after painting.
	Ductibor®	When Ductibor® Al-Si coated products, e.g., Ductibor® 500 and 1000, are combined in a laser welded blank application, i.e., mated to Usibor® 1500, “softer zones” in the finished/hot-stamped finished part are obtained without having to alter the hot-stamping parameters. These “soft zones” are areas where increased crash ductility is either a desirable or required characteristic.
Martensitic Steels (MART)		ArcelorMittal's MARTINSITE® ultra high strength steels consist of fully martensitic microstructures offering some of the highest strength levels available in the marketplace. These steels offer much higher strength-to-weight ratios than conventional cold rolled steels. Although limited in formability, alternative available manufacturing technologies such as roll-forming are used to fabricate these grades. Typical applications for MARTINSITE® grades are bumper reinforcement beams, door intrusion beams, rocker panel inner and reinforcements.

# Steel: The world's most recycled material



Steel is the most recycled material in the world – more than aluminum, paper, glass and plastic combined. The global steel recovery rate for automotive recycling is 85 percent.

Steel is a sustainable metal. It can be recycled again and again without losing any of its properties. Few materials have this level of recycling efficiency.

In North America alone, more than 80 million tons of steel are recycled or exported for recycling annually. This constitutes a recycling rate of 69 percent – more than paper, aluminum, plastic and glass combined.<sup>1</sup> Global steel recovery rates for recycling are estimated at 85 percent for automotive, 85

percent for construction, 90 percent for machinery and 50 percent for electrical and domestic appliances.<sup>2</sup>

The diagram to the right shows the life cycle of a vehicle, from raw material extraction and manufacturing to use phase and end of life. We are committed to working with our automotive partners to create steel products that are lighter, safer and long-lasting while ensuring that they are easy to reuse and recycle at the end of their useful life.

## The life cycle of steel



Source: World Steel Association

1 – American Iron and Steel Institute

2 – World Steel Association



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