Automotive Worldwide
Product Offer for US

ArcelorMittal

Dual Phase Steels

Grade Availability

ArcelorMittal offers a full spectrum of dual phase (DP) steels with tensile strength levels ranging from 500 to 980 MPa.

Tensile Strength	Hot Rolled	Cold Rolled			
	Uncoated	Uncoated	EG	HDGI	HDGA
500 MPa	-	Yes	Yes	-	-
550 MPa	-	Yes	Yes	-	-
590 and 600 MPa	Dev	Yes	Yes	Yes	Yes
690 and 700 MPa	-	Yes	Yes	-	-
780 MPa	Dev	Dev	Dev	-	Dev
965 MPa	-	Yes	Yes	-	-
980 MPa	-	Dev	-	-	Dev

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
Yes: Products Commercially Available
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal produces two types of dual phase steel. The **DI-FORM™** grades are conventional DP steels with low yield-to-tensile-strength ratios. The **HI FORM** (HF) grades use additional solid solution strengthening in the ferrite phase to provide higher yield strength and, hence, higher yield-to- tensile- strength ratios. In addition several grades are, also, specially processed to provide high stretch flange ability (SF) and improved (or high) bendability (**DI-FORM HB™**).

Product Characteristics

DP steels are one of the important new advanced high strength steel (AHSS) products developed for the automotive industry. Their microstructure typically consists of a soft ferrite phase with dispersed islands of a hard martensite phase. The martensite phase is substantially stronger than the ferrite phase.

The **DI-FORM™** grades exhibit low yield-to- tensile- strength ratios, high initial work hardening (n-value), no yield point elongation (YPE) and significant bake hardening (even greater than low-carbon bake-hardening grades). The **HI FORM** (HF) grades exhibit high yield-to- tensile- strength ratios, some YPE and lower bake hardening than the **DI-FORM™** grades. These characteristics of dual phase steels allow the products to provide high strength, excellent formability, and high strain energy absorption capabilities.

With careful schedule selection, the DP steels are joinable by all current welding processes, including resistance spot, resistance seam, arc, and laser methods.

CAE structural engineers should be cautioned, however, that the unique high work hardening and bake hardening characteristics of DP steels require special treatment in finite element analysis crash models. Generally, accounting for high strain rate behavior and forming effects (thinning/thickening, work hardening, bake hardening) will yield more accurate crash simulations results. CAE engineers should contact ArcelorMittal for product-specific mechanical property information to use in these situations.

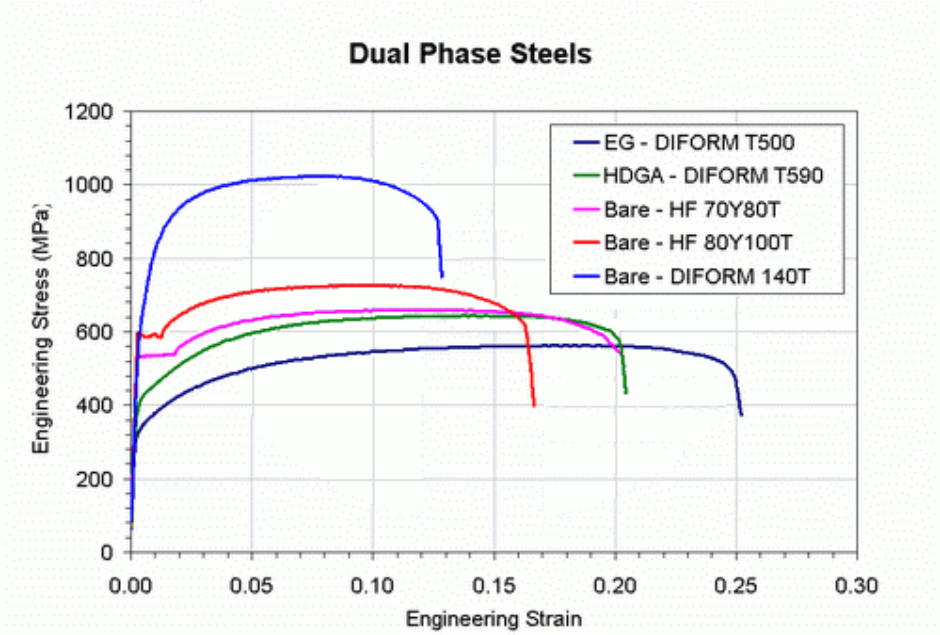
Application

DI-FORM™ T500 is intended primarily for exposed outer body panels (door, hoods, fenders). Its excellent formability and high work hardening and bake hardening behavior permit designers to reduce outer panel gauge and weight substantially while maintaining or improving dent resistance. It offers designers the opportunity to substantially reduce closure weight, and possibly avoid substitution of more costly lower density materials.

The low and intermediate tensile strength, low yield ratio grades (590 to 980 MPa TS) are frequently used in body structure applications requiring high energy absorption (i.e. the crumple zones – front and rear longitudinal rails and supporting structure). The low yield strength helps keep the initial deceleration pulse low, yet the high work hardening rate and excellent ductility absorb greater deformation energy than conventional steels. Good formability permits using these products in complicated shapes, and good weldability permits using these steels in tailored blank and hydroformed tube applications.

The intermediate to highest strength grades, including the high yield ratio DP steels, are typically used in applications requiring extremely high yield strength and adequate formability, such as passenger safety cage components limited by axial buckling or transverse bending. These components (rockers, pillars, pillar reinforcements, roof rails, and cross members) rely on high yield strength to prevent intrusion into the passenger compartment during a collision. Dual phase steels enable designers to apply high yield strength steels to safety cage components that are too complex to form with the higher strength martensite steels. The HF 80Y100T (690 MPa tensile strength) and **DI-FORM™** 140T (965 MPa tensile strength) are also used extensively for bumpers and door intrusion beams. Non-stiffness critical applications like seats can take advantage of high yield strength to reduce gauge and weight. The HF 80Y100T is used extensively in these applications.

Representative Dual Phase Steel Stress Strain Curves



Dual Phase - 500 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HDGI	HDGA
-	DEV DI-FORM™ T500	DEV DI-FORM™ T500	-	

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal offers cold rolled 500 MPa tensile strength dual phase grades with different coating conditions (bare or electrogalvanized). These grades are part of ArcelorMittal's **DI-FORM™** family of dual phase steels and exhibit low yield-to-tensile-strength ratios.

Application

DI-FORM™ T500 is intended primarily for exposed outer body panels (door, hoods, fenders). Its excellent formability and high work hardening and bake hardening behavior permit designers to reduce outer panel gauge and weight substantially while maintaining or improving dent resistance. It offers designers the opportunity to substantially reduce closure weight, and possibly avoid substitution of more costly lower density materials.

The cold rolled (uncoated) product can also be used for structural applications.

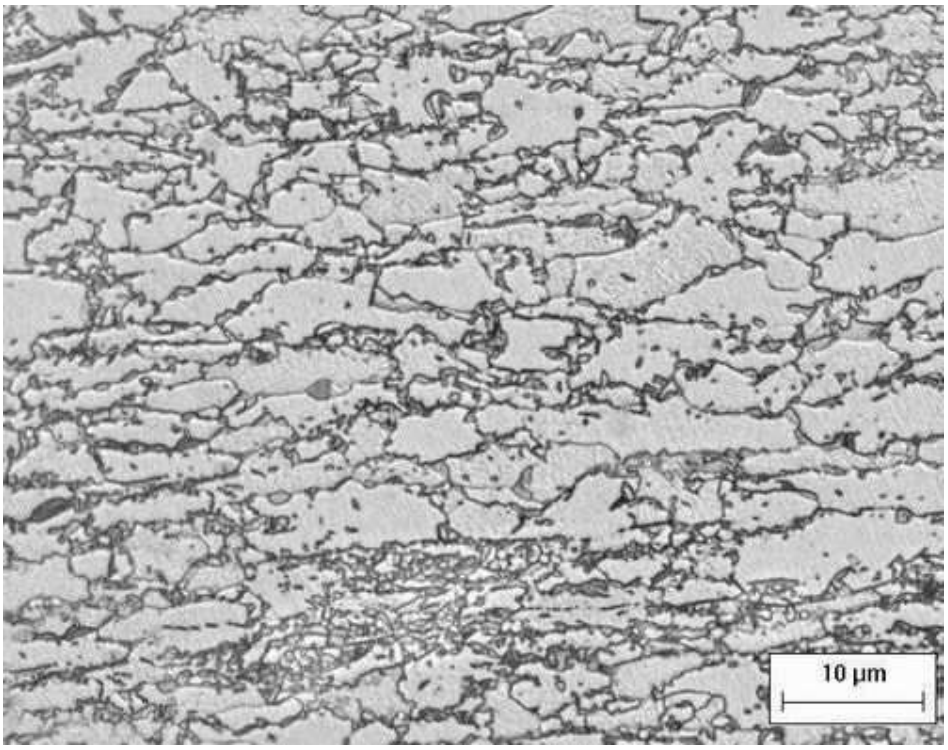
Chemistry

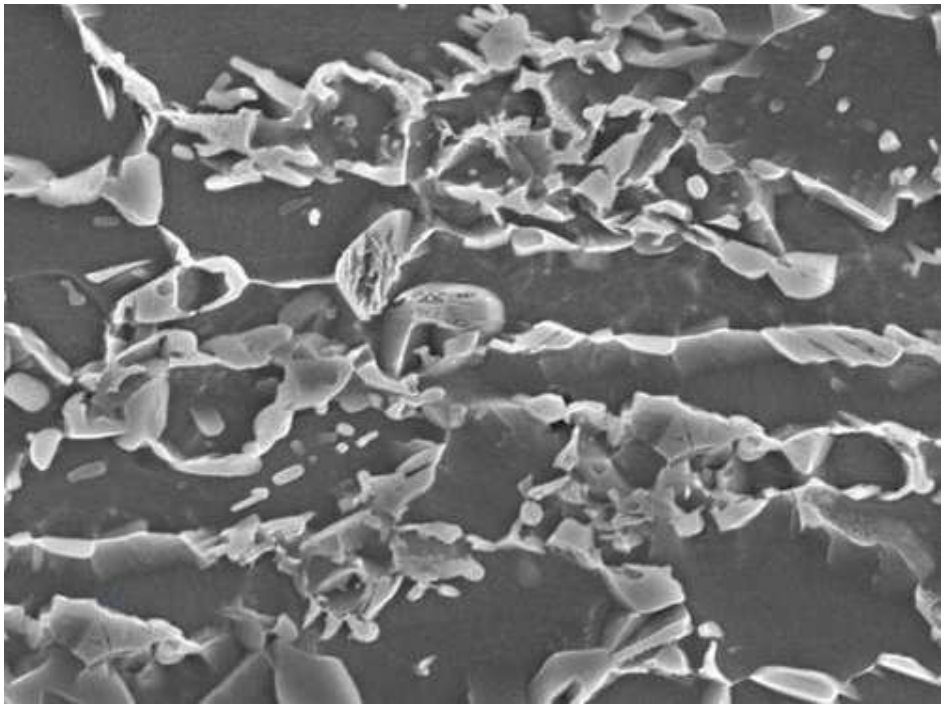
Product	Chemistry
DI-FORM™ T500	Low carbon steel with Mn, Si composition

Processing

The dual phase steels are produced using low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.

Typical Microstructure





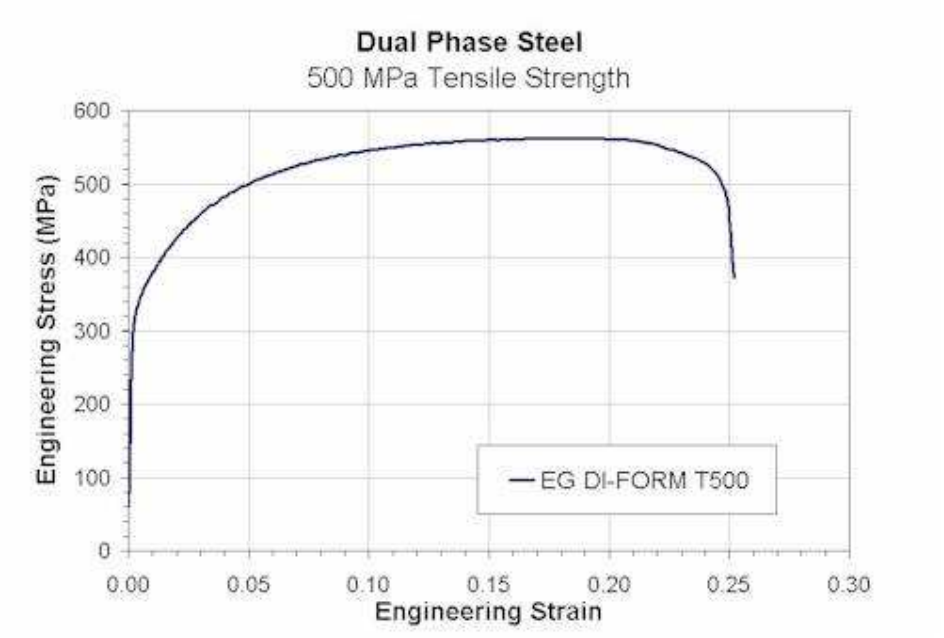
EG - DI-FORM™ T500 contains ferrite and martensite

Typical Mechanical Properties

Coating	Product	Yield Strength (MPa)	Tensile Strength (MPa)	Total Elongation (%)	R-bar	n [1]
Bare	DI-FORM™ T500	258	529	31	0.9	0.20
EG	DI-FORM™ T500	300	547	29	0.9	0.19

[1] The strain range for n-value is 10-20%

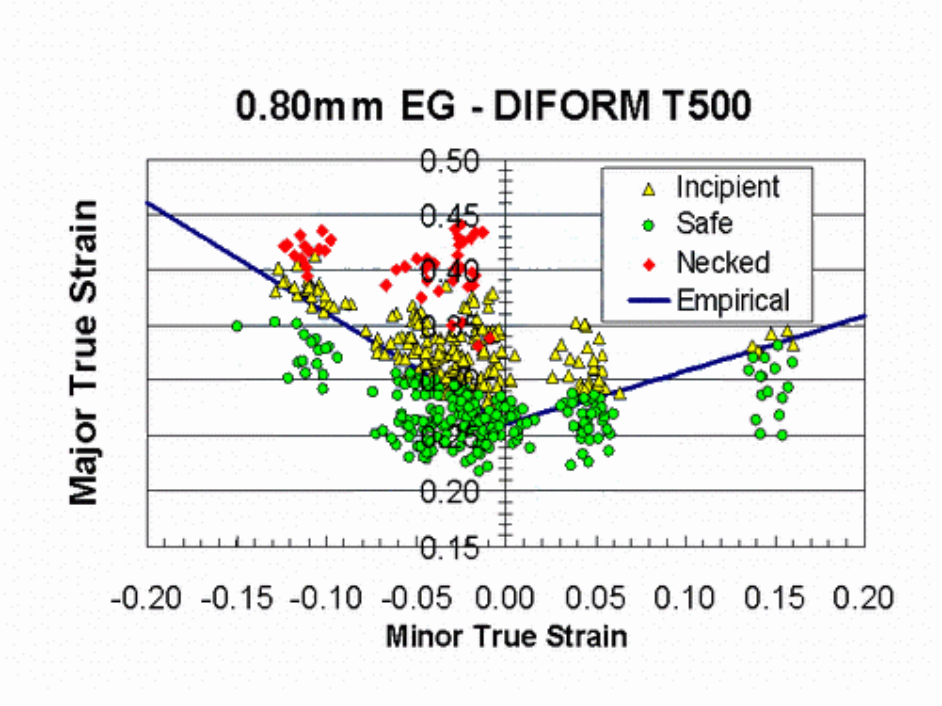
Representative Stress-Strain Curves



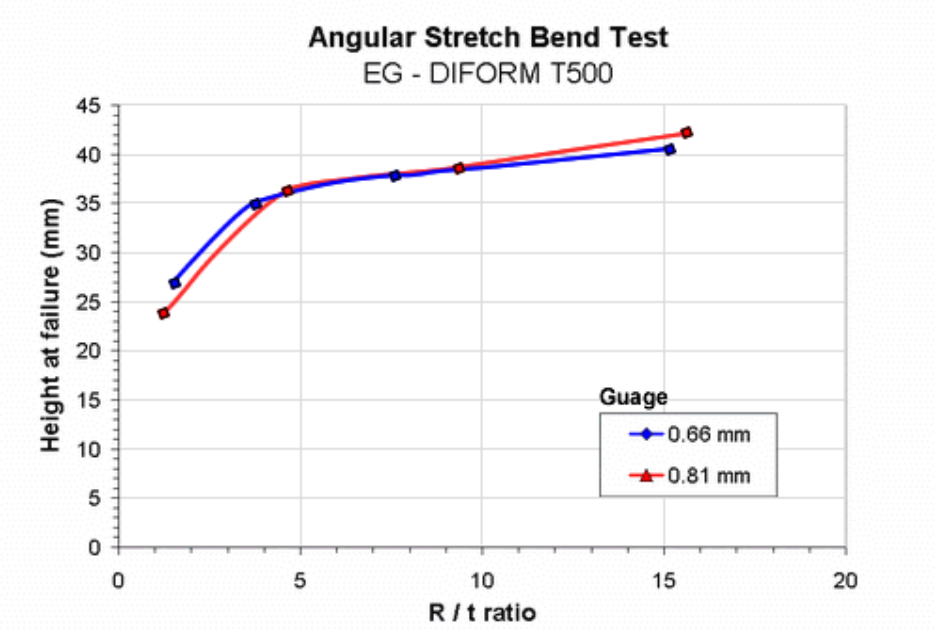
Stress-Strain curve data is available upon request.

Formability Behavior

Forming Limit Diagram



Angular Stretch Bend Test Results



Sheared Edge Stretching Test Results

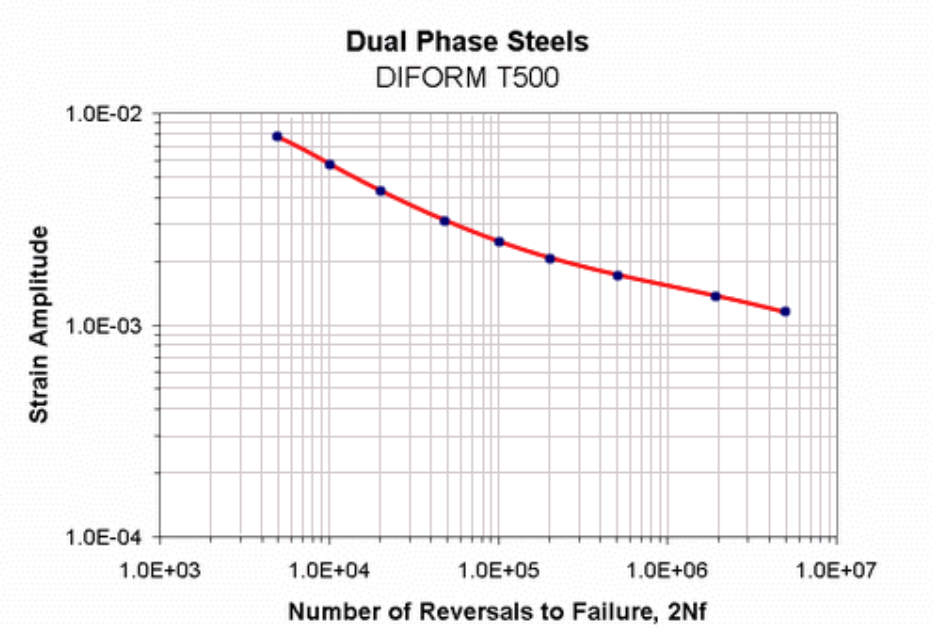
Product	Gauge (mm)	Average Hole Expansion (%)
EG-DI-FORM™ T500	0.66	56.0
EG-DI-FORM™ T500	0.81	57.2

Fatigue Behavior

Strain Life Parameters

Fatigue Strength Coefficient (MPa)	743
Fatigue Ductility Coefficient	0.648
Fatigue Strength Exponent	-0.081
Fatigue Ductility Exponent	-0.553
Cyclic Strength Coefficient (MPa)	739
Cyclic Strain Hardening Exponent	0.136

Strain Life Curve



Weldability of EG - DI-FORM™ T500

The resistance spot welds were made using a Sciaky 100 kVA pedestal air operated machine with RWMA class II (Cu-Cr) electrodes of face diameter 6.4 mm. For electrode conditioning, 175 to 250 welds were used.

Gauge (mm)	Power Mode	Electrode Cap Size (mm)	Electrode Force (lbs)	Weld Time (cycles)	Hold Time (cycles)	Expulsion Current (kA)	Current Range (kA)	Electrode Life (welds)
0.65	AC	6.4	640	12	30	11.26	1.29	2250+
0.81	AC	6.4	680	12	30	11.24	1.65	2000+

The current range of **DI-FORM™** T500 was found to be comparable to that of 210 MPa dent resistant bake hardening (BH210) steels. Higher electrode forces are required for **DI-FORM™** T500. as compared to BH210 steels, due to the higher strength of the DP steel.

Dual Phase - 550 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HD-GI	HD-GA
-	HF 70Y80T	HF 70Y80T	-	-

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanalized
HDGA: Hot-Dip-Galvannealed

ArcelorMittal offers cold rolled 550 MPa tensile strength dual phase grades with different coating conditions (bare or electrogalvanized). These grades are part of ArcelorMittal's **HI FORM** (HF) family of dual phase steels and exhibit high yield-to-tensile-strength ratios.

Application

These grades are used in automotive body structures, reinforcements and brackets where sufficient strength is needed to achieve optimum part performance.

Chemistry

Product	Chemistry
HF 70Y80T	Low carbon steels containing Mn and Si

Processing

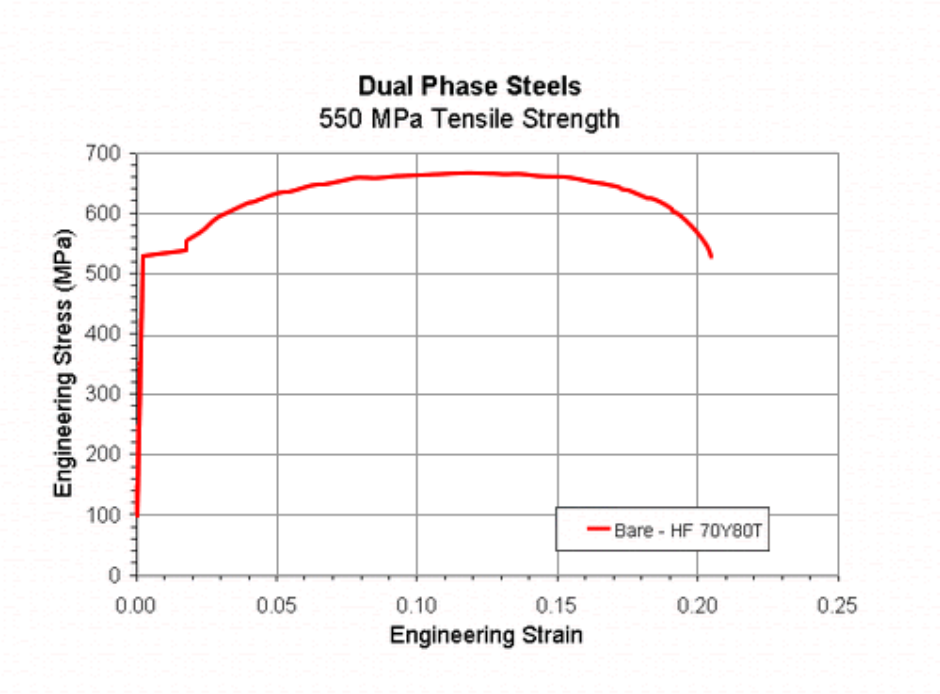
These steels are produced using regular low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.

Typical Mechanical Properties

Coating	Product	Yield Strength (MPa)	Tensile Strength (MPa)	Total Elongation (%)	R-bar	n [1]
Bare	HF 70Y80T	532	660	20	0.9	0.12

[1] The strain range for n-value is 10-20%

Representative Stress-Strain Curves



Stress-Strain curve data is available upon request

Dual Phase - 590 and 600 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HDGI	HDGA
DEV HFT 590 SF	-	-	-	-
-	DEV DI-FORM™ T590	-	-	DEV DI-FORM™ T590
-	DEV DI-FORM™ T600	DEV DI-FORM™ T600	DEV DI-FORM™ T600	DEV DI-FORM™ T600

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal offers hot rolled and cold rolled 590 and 600 MPa tensile strength dual phase grades with different coating conditions. ArcelorMittal's **DI-FORM™** family of dual phase steels exhibit low yield-to-tensile-strength ratios. A hot rolled 'SF' grade is under development and intended for stretch flanging applications. The hot rolled grade is part of ArcelorMittal's **HI FORM** (HF) family of steels.

Application

The dual-phase microstructure results in a high-strength product with excellent formability. These grades have also been shown to exhibit significant bake hardening, and this phenomenon can be used to effectively design parts for optimum performance.

These grades are used for automotive structural parts, pillars and rails. All products are for unexposed applications only.

The stretch flanging grades will be targeted for automotive structural and chassis parts.

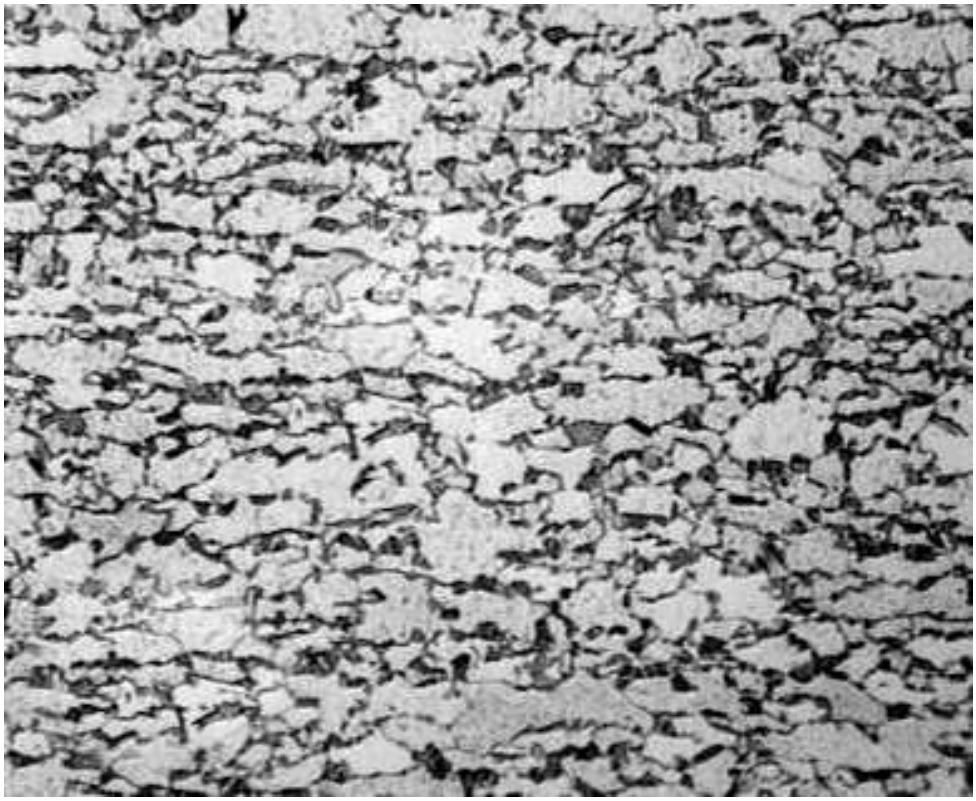
Chemistry

Product	Chemistry
HFT 590 SF	Composition under investigation
DI-FORM™ T590	Low carbon steels containing Mn and Si composition
DI-FORM™ T600	

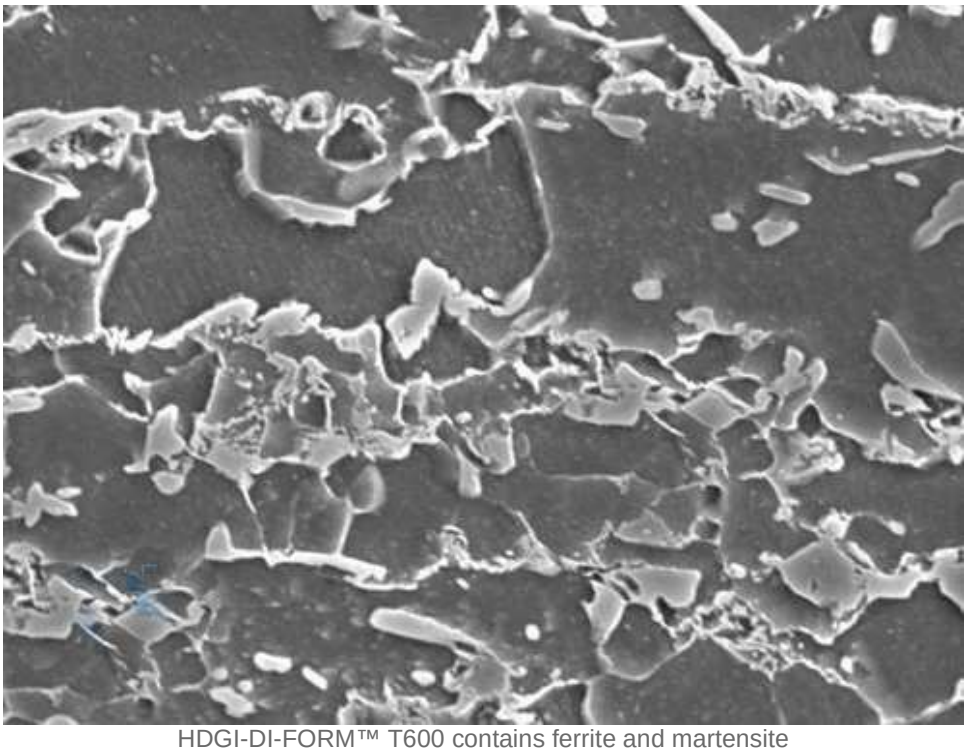
Processing

The dual phase steels are produced using low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.

Typical Microstructure



Bare-DI-FORM™ T600 containing ferrite and martensite



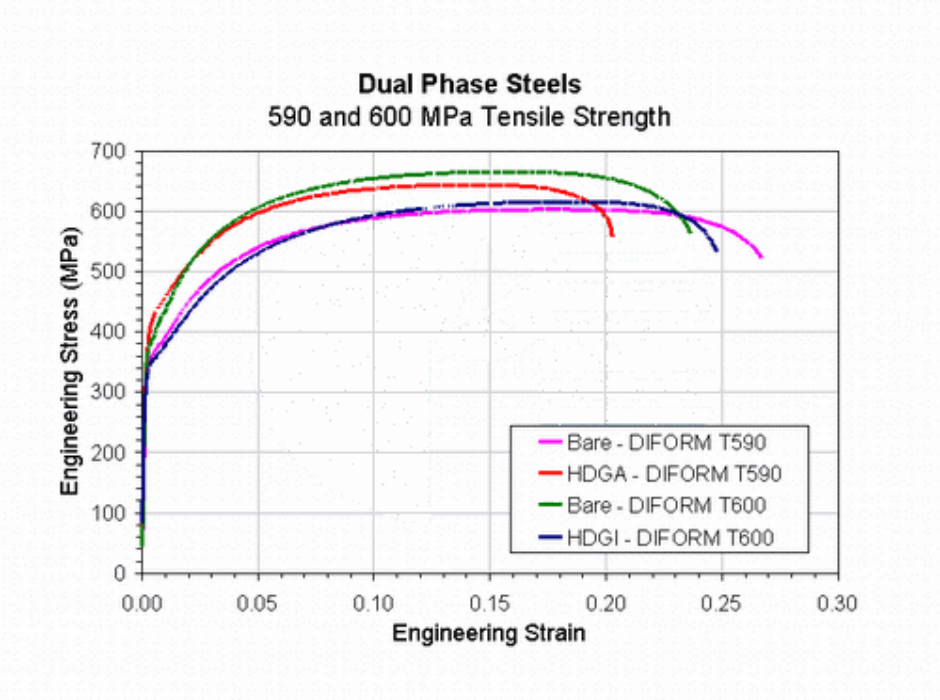
HDGI-DI-FORM™ T600 contains ferrite and martensite

Typical Mechanical Properties

Coating	Product	Yield Strength (MPa)	Tensile Strength (MPa)	Total Elongation (%)	R-bar	n [1]
Bare	DI-FORM™ T590	370	602	27	0.9	0.16
HDGA	DI-FORM™ T590	355	615	24 J	0.9	0.15
Bare	DI-FORM™ T600	377	665	24	0.9	0.16
HDGI	DI-FORM™ T600	333	614	26	0.9	0.16

[1] The strain range for n-value is 10%-20% or Uniform Elongation
[J] JIS test

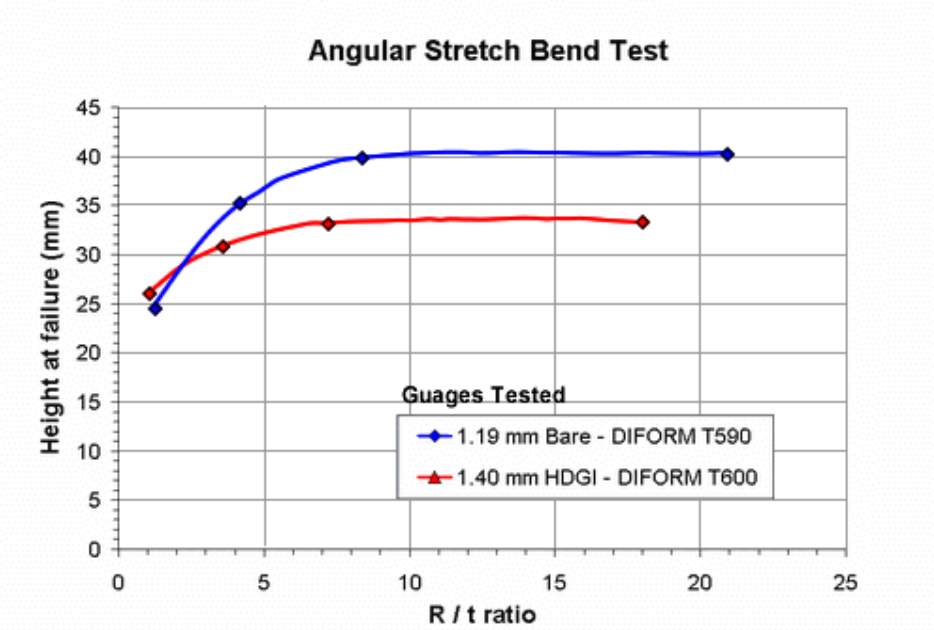
Representative Stress-Strain Curves



Stress-Strain curve data is available upon request

Formability

Angular Stretch Bend Test Results



Sheared Edge Stretching Test Results

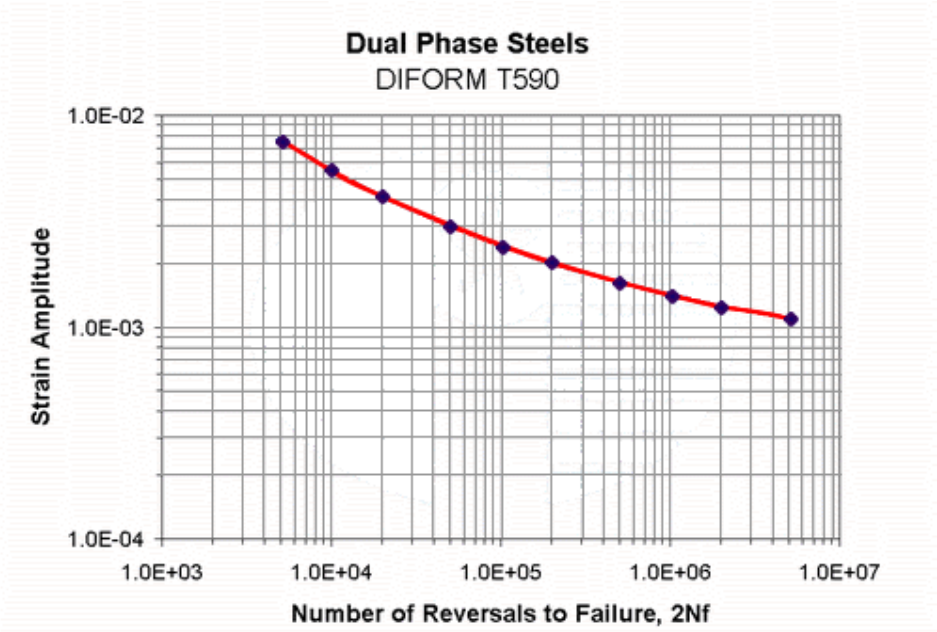
Product	Gauge (mm)	Average Hole Expansion (%)
Bare-DI-FORM™ T590	1.19	51.1
HDGI-DI-FORM™ T600	1.40	27.1

Fatigue

Strain Life Parameters

Fatigue Strength Coefficient (MPa)	1179
Fatigue Ductility Coefficient	1.179
Fatigue Strength Exponent	-0.112
Fatigue Ductility Exponent	-0.633
Cyclic Strength Coefficient (MPa)	1078
Cyclic Strain Hardening Exponent	0.167
Endurance Limit, 5 x 10^6 cycles (MPa)	228

Strain Life Curve



Dual Phase - 690 and 700 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HDGI	HDGA
-	HF 80Y100T	HF 80Y100T	-	-
-	DEV DI-FORM HB™ T700	DEV DI-FORM HB™ T700	-	-

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal offers cold rolled 690 and 700 MPa tensile strength dual phase grades with different coating conditions (bare or electrogalvanized). These grades exhibit high yield-to-tensile-strength ratios. The **DI-FORM HB™** grade is also designed to provide superior (or high) bendability.

Application

These grades are used in automotive body structures, reinforcements and brackets. The grade can used for rollforming and stamping of door-intrusion beams, bumper-reinforcement beams, and various seating components, such as tracks, pillars, risers and towers.

The high bendability (HB) grade offers part manufacturing to tighter bend radii thereby providing improved part performance.

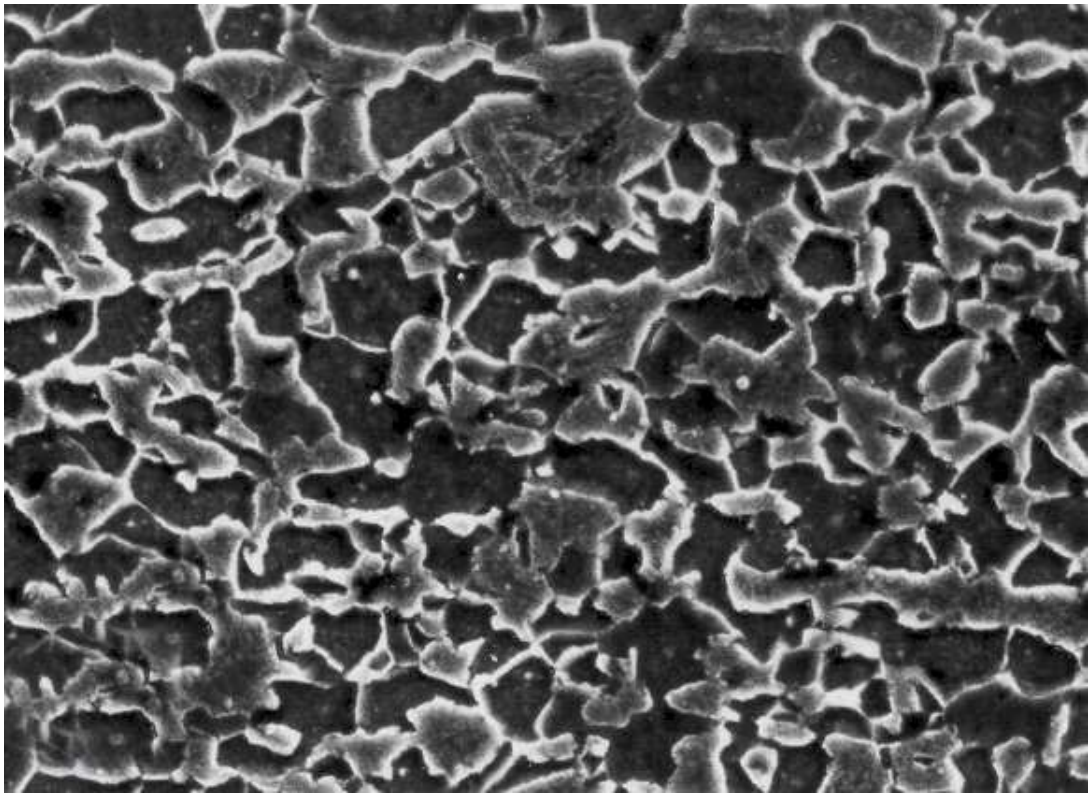
Chemistry

Product	Chemistry
HF 80Y100T	Low carbon steels containing Mn and Si
DI-FORM HB™ T700	

Processing

High Strength Steels are produced using regular low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are then cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.

Microstructure



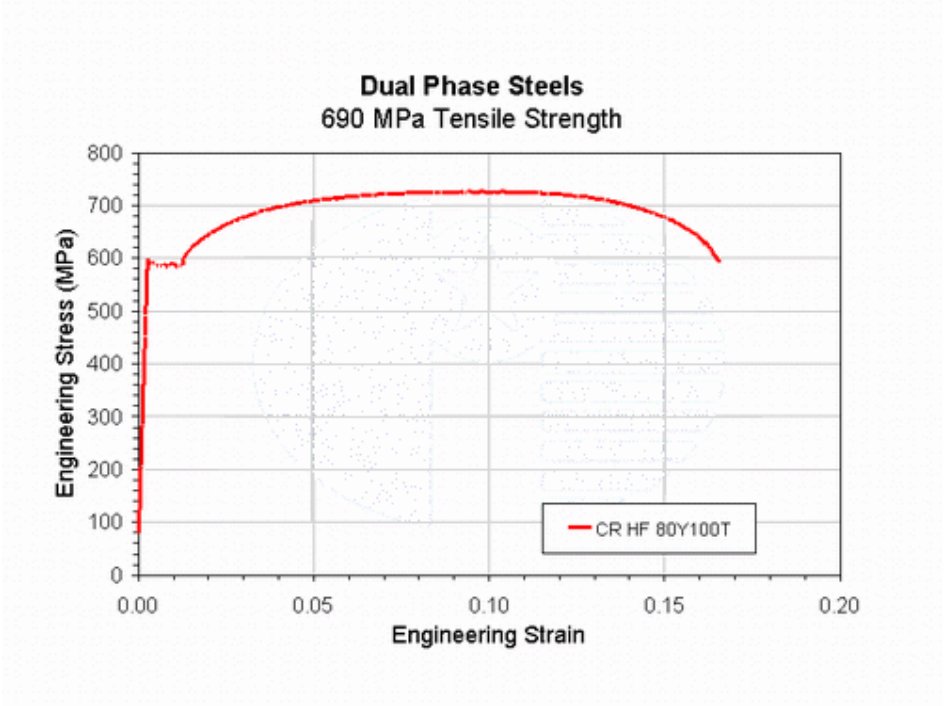
HF 80Y100T contains ferrite and martensite.

Typical Mechanical Properties

Coating	Product	Yield Strength (MPa)	Tensile Strength (MPa)	Total Elongation (%)	R-bar	n [1]
Bare	HF 80Y100T	584	740	17	0.9	0.12

[1] The strain range for n-value is 10%-Uniform Elongation.

Representative Stress-Strain Curves



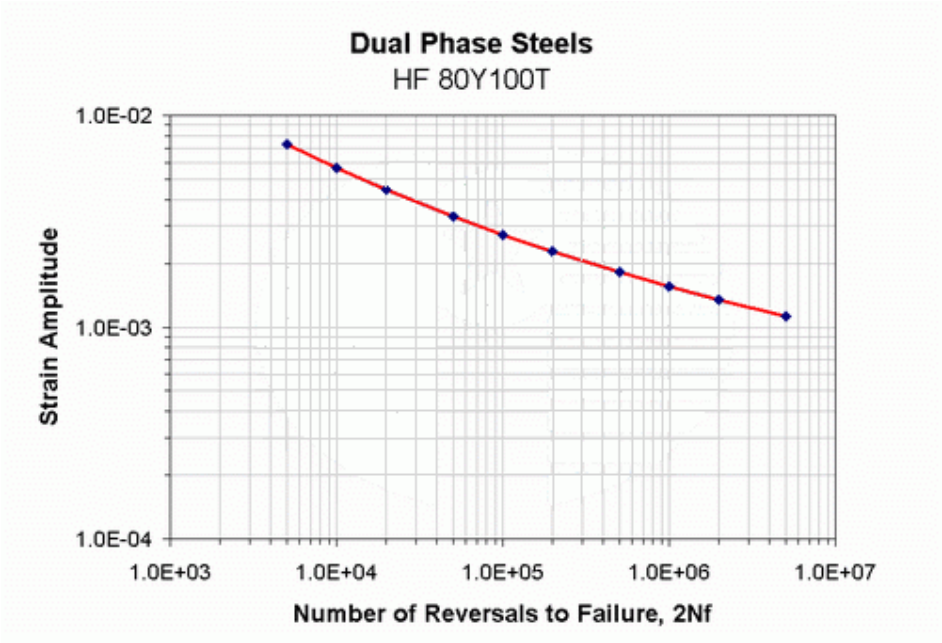
Stress-Strain curve data is available upon request.

Fatigue Behavior

Strain Life Parameters

Fatigue Strength Coefficient (MPa)	1682
Fatigue Ductility Coefficient	0.329
Fatigue Strength Exponent	-0.139
Fatigue Ductility Exponent	-0.498
Cyclic Strength Coefficient (MPa)	2211
Cyclic Strain Hardening Exponent	0.272
Endurance Limit, 5 x 10^6 cycles (MPa)	207

Strain Life Curve



Dual Phase - 780 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HDGI	HDGA
DEV DI-FORM™ SF T780	DEV DI-FORM™ T780	-	-	DEV DI-FORM™ T780

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal offers hot rolled and cold rolled 780 MPa tensile strength dual phase grades with different coating conditions (bare or hot-dip-galvannealed). These grades are part of ArcelorMittal's **DI-FORM™** family of dual phase steels. A stretch flange able (SF) hot rolled product is under development.

Application

The dual-phase microstructure results in a high-strength product with excellent formability. These grades have also been shown to exhibit significant bake hardening. These grades are used for unexposed automotive structural parts where high strength and formability is essential and where significant part performance and durability is desired.

Chemistry

Product	Chemistry
DI-FORM™ T780	Low carbon steel with a Mn, Si composition
DI-FORM™ SF T780	Composition being evaluated

Processing

The dual phase steels are produced using low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.

Dual Phase - 965 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HDGI	HDGA
-	DI-FORM™ 140T	DI-FORM™ 140T	-	-
-	DEV DI-FORM HB™ T965	DEV DI-FORM HB™ T965	-	-

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal offers cold rolled 965 MPa tensile strength dual phase grades with different coating conditions (bare or electrogalvanized). These grades are part of ArcelorMittal's **DI-FORM™** family of dual phase steels and exhibit low yield-to-tensile-strength ratios. A grade with improved (or high) bendability (**DI-FORM HB™**) is also available.

Application

DI-FORM™ 140T is a cold rolled, dual phase steel. This product exhibits a low yield-to-tensile-strength ratio, high strain hardening and high bake hardening in strained areas. These products can be used in both rollformed and moderate stamping applications.

Typical applications are:

- bumper reinforcement beams
- door intrusion beams
- seating components
- structural cross members

The high bendability (**DI-FORM HB™**) grade offers part manufacturing to tighter bend radii thereby providing improved part performance.

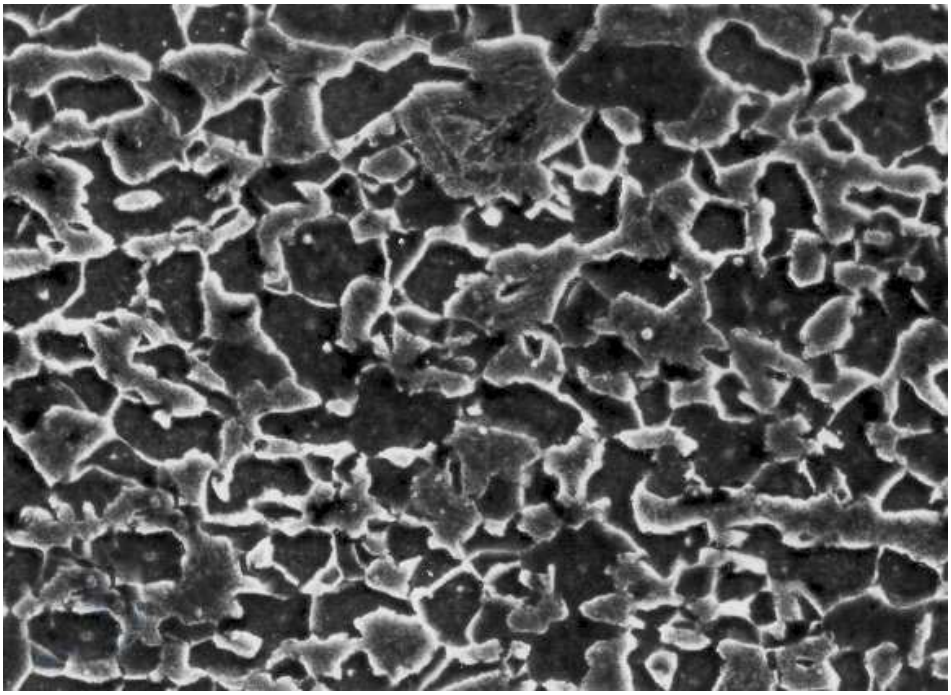
Chemistry

Product	Chemistry
DI-FORM™ 140T	Low carbon steels containing Mn, Si composition

Processing

The dual phase steels are produced using low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.

Typical Microstructure



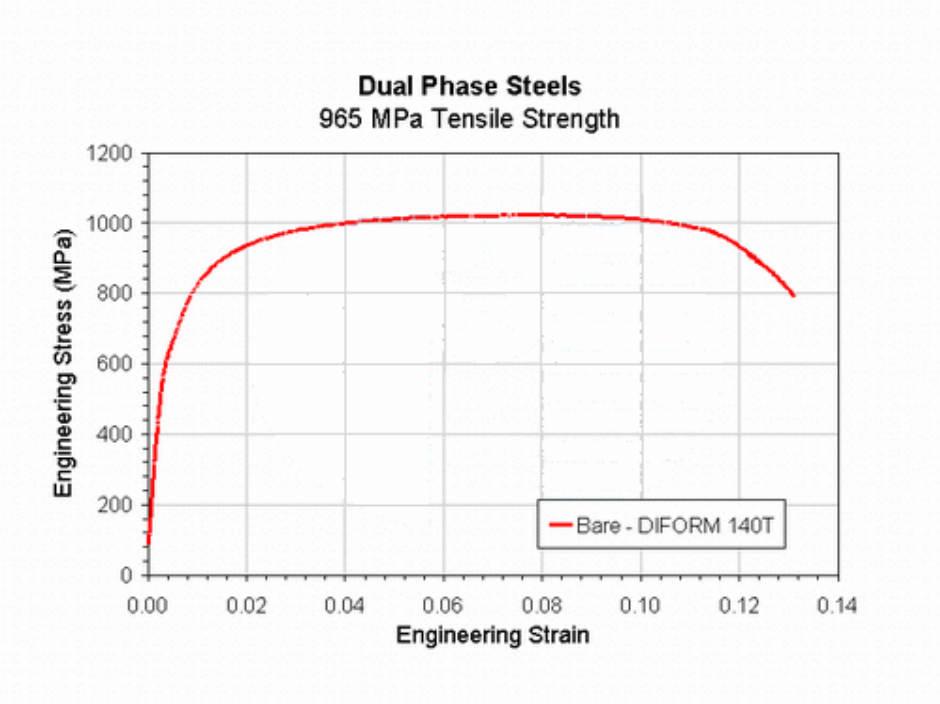
DI-FORM™ 140T contains ferrite and martensite. Mag: 5000X

Typical Mechanical Properties

Coating	Product	Yield Strength (MPa)	Tensile Strength (MPa)	Total Elongation (%)	R-bar	n [1]
Bare	DI-FORM™ 140T	662	1024	13	0.9	0.10

[1] The strain range for n-value is 4%-6%.

Representative Stress-Strain Curves



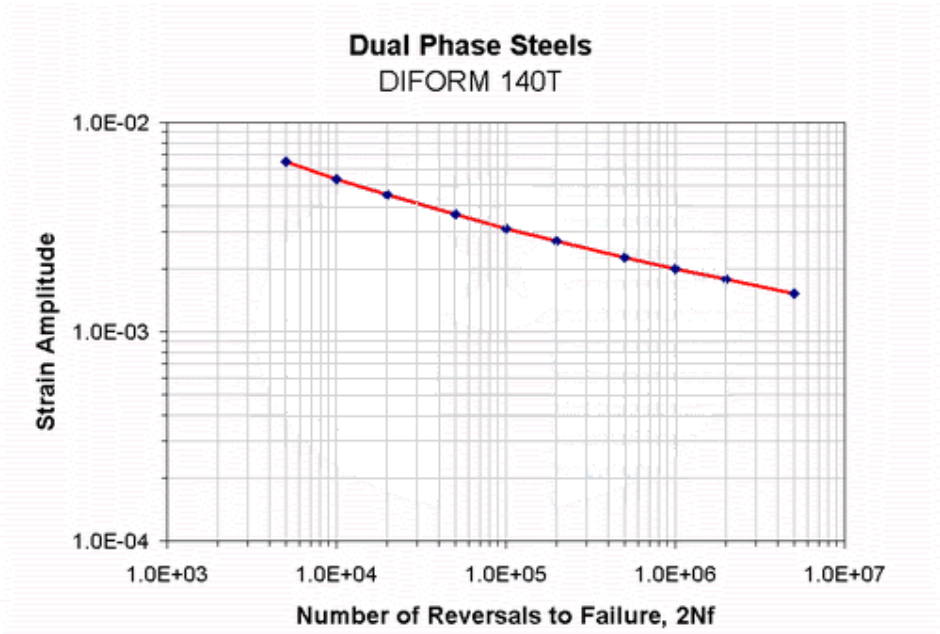
Stress-Strain curve data is available upon request.

Fatigue

Strain Life Parameters

Fatigue Strength Coefficient (MPa)	2303
Fatigue Ductility Coefficient	0.159
Fatigue Strength Exponent	-0.135
Fatigue Ductility Exponent	-0.469
Cyclic Strength Coefficient (MPa)	3706
Cyclic Strain Hardening Exponent	0.279
Endurance Limit, 5 x 10^6 cycles (MPa)	345

Strain Life Curve



Dual Phase - 980 MPa TS Steels

Grade Availability - ArcelorMittal Products

Hot Rolled	Cold Rolled			
Uncoated	Uncoated	EG	HDGI	HDGA
-	DEV DI-FORM™ T980	-	-	DEV DI-FORM™ T980
-	DEV DI-FORM™ SF T980	-	-	-

EG: Electrogalvanized
HDGI: Hot-Dip-Galvanized
HDGA: Hot-Dip-Galvannealed
'DEV' products are under development or in limited production.
Please inquire about the status and availability of these products.

ArcelorMittal offers cold rolled 980 MPa tensile strength dual phase grades with different coating conditions (bare or hot-dip-galvannealed). These grades are part of ArcelorMittal's **DI-FORM™** family of dual phase steels. A stretch flange able (SF) hot rolled product is under development.

Application

The dual-phase microstructure results in a high-strength product with excellent formability. These grades have also been shown to exhibit significant bake hardening. These grades are used for unexposed automotive structural parts where high strength and formability is essential and where significant part performance and durability is desired.

Chemistry

Product	Chemistry
DI-FORM™ T980	Low carbon steels with a Mn, Si composition

Processing

The dual phase steels are produced using low-carbon compositions strengthened with manganese (Mn) and silicon (Si). Steels are cast into slabs and hot rolled. Hot rolled coils are further processed and cold reduced into lighter gauges. The cold reduced product is then further processed using continuously annealing technology.