

Complex phase and multi-phase steels

Data sheet

Grade availability

ArcelorMittal's complex phase and multi-phase hot roll (HR) and hot dip galvanize (GI) grade offerings currently include products with 780 MPa and 980 MPa tensile strength, as shown in the table to the right.

Product	Grade
HR	HR780T/660Y
GI	CR780T/440Y-MP
GI	CR780T/600Y-CP
GI	CR980T/800Y-CP

Product characteristics

Multi-phase and complex phase steels are cold formed to make lightweight structural elements. When discussing multi-phase and complex phase steels, it is appropriate to consider dual phase grades as the baseline for comparison. The progression of value added by the physical properties of these products is: 1) dual phase (DP), 2) multi-phase (MP), and 3) complex phase (CP).

- At a given tensile strength level:
 - Dual phase steel provides a higher total elongation and lower yield strength. It has limitations of hole expansion and bendability.
 - Complex phase steel provides a much higher yield strength, a much better hole expansion ratio and superior bendability as compared to the DP steel. It has lower total elongation than a DP steel.
 - Multi-phase steel provides mechanical properties in between DP and CP steels.



HR780 suspension arm

Applications

Given their high energy absorption capacity and fatigue strength, these grades are particularly well suited for automotive safety components requiring good impact strength, and for suspension system components. Multi-phase and complex phase grades can meet forming requirements for applications where a dual phase grade may not be adequate. This would most likely be related to hole expansion and/or bendability needs.



980CP door beam



780CP tunnel stiffener

Chemistry – Typical (HR)

Product	Grade	C	Mn	P	S	Cr	Other
HR	HR780T/660Y	0.05	1.5	<0.02	0.003	0.6	Ti, Nb

Chemistry – Typical (GI)

Grade	Max C	Max Mn	Max Si	Max Cr+Mo	Max Ti+Nb	Max P	Max S	Max B
CR780T/440Y-MP	0.18	2.7	1	1	0.15	0.05	0.01	0.005
CR780T/800Y-CP	0.18	2.7	1	1	0.15	0.05	0.01	0.005
CR980T/800Y-CP	0.18	2.7	1	1	0.15	0.05	0.01	0.005

Mechanical properties – Ranges or Target Minimums as compared to DP grades at same tensile strength

Grade	Yield strength min, MPa	Tensile strength min, MPa	Minimum total elongation A50, %	Bend ratio r/t	Hole expansion %
HR780T/660Y	660	780	11%	n/a	≥ 45%
CR780T/420Y-DP	420	780	14%	≤ 3.0	≥ 20%
CR780T/440Y-MP	440	780	13%	≤ 2.0	≥ 30%
CR780T/600Y-CP	600	780	11%	≤ 1.0	≥ 45%
CR980T/550Y-DP	550	980	8%	≤ 3.0	≈ 20%
CR980T/800Y-CP	800	980	7%	≤ 2.0	≥ 40%



Bend test, 980CP

The pictures below depict hole expansion tests on 780 MPa tensile products. The photos reflect the completion of the test. Note the increasing diameter, and thus improving formability, when progressing from 780DP to 780CP.



780DP Hole expansion test



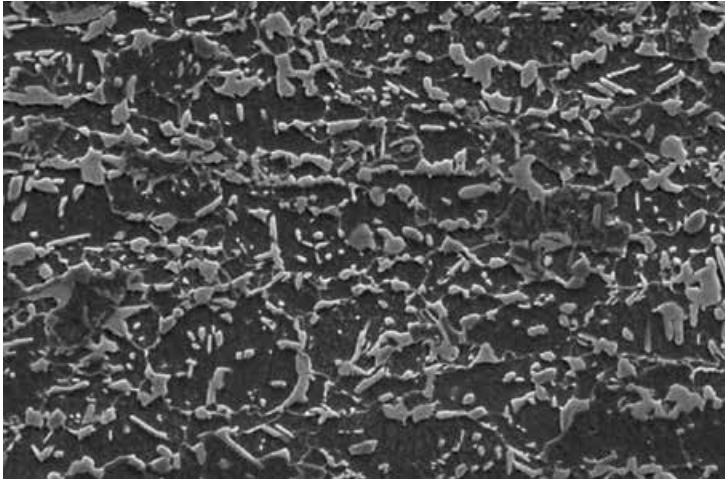
780MP Hole expansion test



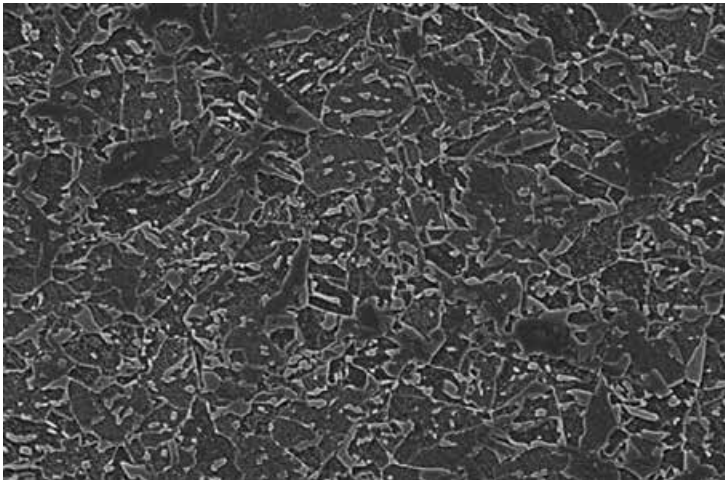
780CP Hole expansion test

Metallography

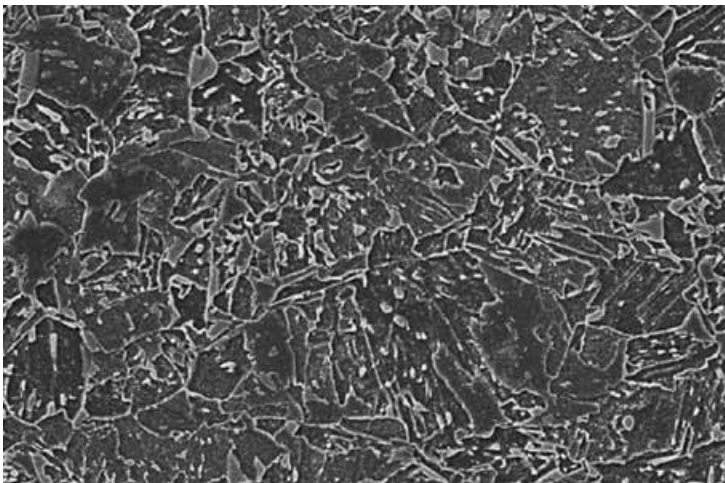
For comparison, let's examine products at the 780 MPa tensile strength level, in order of increasing formability.



780DP: ferrite, bainite, fresh martensite



780MP: ferrite, bainite, fresh martensite (comparable to 780DP but with less fresh martensite)

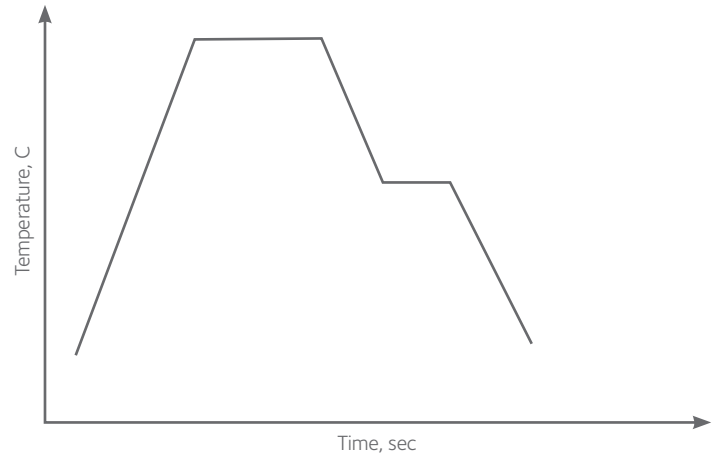


780CP: ferrite, bainite, martensite and fresh martensite

Mill processing

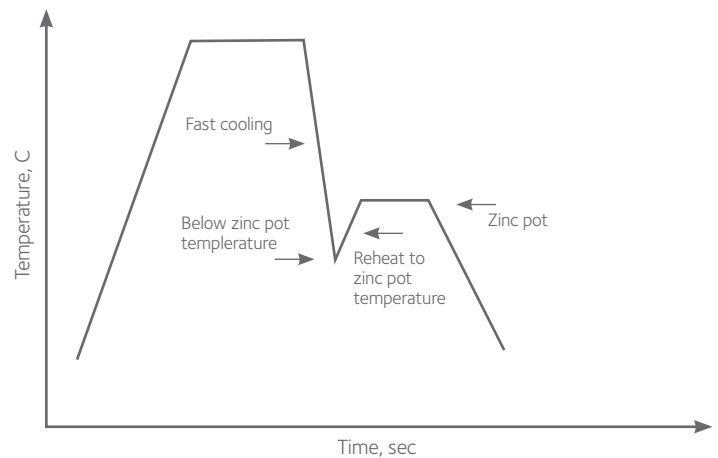
The mill processing necessary to achieve a multi-phase or complex phase microstructure is unique, requiring a process called low-end cooling. A traditional or typical continuous anneal process cannot achieve the necessary steel temperatures that would result in the formation of a multi-phase or complex phase microstructure. A unique anneal practice with specialized equipment is necessary.

Traditional hot dip thermal profile



This traditional anneal process would produce, for example, 780DP.

Modified hot dip thermal profile



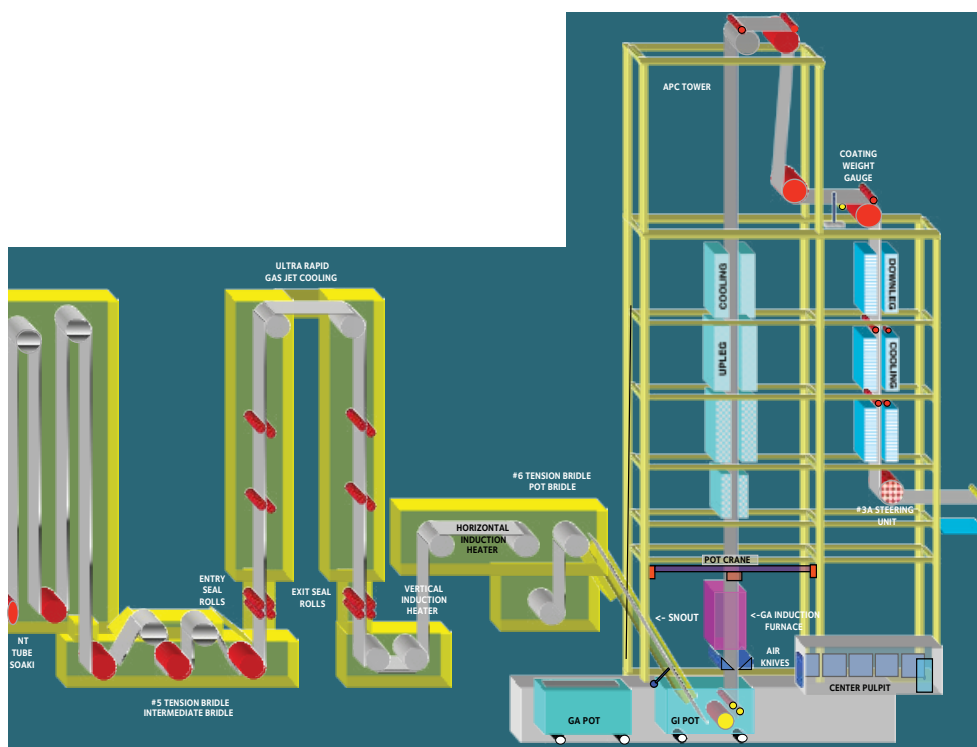
This anneal process produces MP and CP microstructures.

Our hot dip coating line at our Cleveland facility was upgraded in 2019 to facilitate production of multi-phase and complex phase steels. This added capability did not reduce or alter the prior product offerings off the line.

Low-end cooling (LEC) is a heat-treating process in which the steel is fast cooled below zinc pot temperature and then heated up again before being coated with zinc.

In an LEC process, bainite and/or tempered martensite formation is promoted before the steel enters the zinc pot. This also minimizes the formation of fresh martensite. The resultant microstructure is beneficial for better local formability, namely superior hole expansion and bendability.

As a comparison, in the conventional production of a dual phase product, the steel is slowly cooled to zinc pot temperature and is then zinc coated. A large fraction of fresh martensite is formed in the cooling section after the zinc pot. It is this fresh martensite that is detrimental to hole expansion and bendability. The unique thermal processing achieved with a low-end cooling practice avoids most fresh martensite formation.



The additional gas jet cooling capacity added as part of the upgrade facilitate the production of multi-phase and complex phase steels.

Size availability – Hot rolled

t(mm)	Max. width
nom	HR780
<=2.5	Inquire
2.6 - 2.8	1086
2.9 - 3.1	1210
3.1 - 3.9	1200
4.0	1300
>= 4.1	Inquire

Size availability – Hot dip GI

t(mm)	Maximum width	
nom	780MP	780CP
0.76 - 0.96	Inquire	Inquire
0.97 - 1.16	1215	1080
1.17 - 1.37	1260	1120
1.38 - 1.96	1305	1160
1.97 - 2.05	1215	1080
2.06 - 2.29	1125	1000

Size availability – Hot dip GI

t(mm)	Max. width
nom	980CP
0.90 - 1.0	Inquire
1.01 - 1.60	960
1.61 - 2.00	1040
2.01 - 2.10	1080
2.11 - 2.30	Inquire

Note: These are consolidated listings. We are capable of producing some cross sections not included in this table. Please inquire for availability.

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