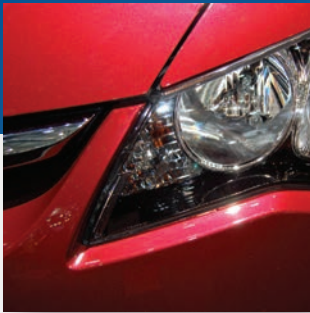


ULTRALUME®

**ALUMINIZED TYPE 1
PRESS HARDENABLE AND
PRESS QUENCHED STEEL**



**Advanced Part Designs
Improved Crash Management
Greater Weight Reduction
Complex Shapes
Minimal Springback**

ULTRALUME® PRESS HARDENABLE STEEL (PHS) and PRESS QUENCHED STEEL (PQS) is offered for applications where design strength, design flexibility and crash management are paramount. Hot-stamping technology is used for A- and B-pillar reinforcements, roof rails, side-wall members, bumpers, beams and other crash management components. The hot-stamping process addresses the forming and springback issues experienced in conventional cold forming in higher strength steels.

ULTRALUME 1500 is PHS, meaning the strength of the steel changes significantly after hot stamping. ULTRALUME 500 is PQS, meaning the strength of the steel does not increase and does not change so significantly after hot stamping. These unique products can be used in combination in advanced B-pillar designs, providing design engineers greater flexibility in crash management.

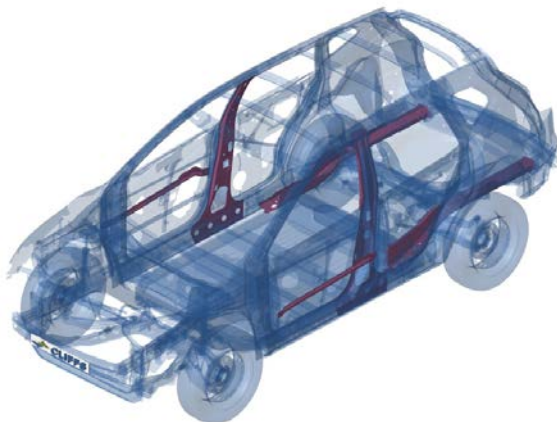
Product Description

ULTRALUME steels are Aluminized Type 1 hot stamped products intended for automotive applications where high strength, design flexibility and collision protection are critical. Blanks produced from ULTRALUME steels are heated in a furnace at 900 – 950 °C to transform to austenite. The blank is then transferred to a hot-forming press where the hot steel is formed into the desired shape and rapidly cooled in the water-cooled dies.

During this rapid cooling, or quenching, ULTRALUME 1500 undergoes a phase transformation, from austenite to a very high strength phase, martensite. This transformation significantly increases the tensile strength of the steel from approximately 600 MPa up to roughly 1500 MPa. Fully martensitic steels excel at preventing intrusions into the passenger compartment. During the hot-stamping process, ULTRALUME 500 transforms to austenite when heated and then transforms into ductile ferrite and small amounts of martensite upon quenching in the stamping press. This more ductile steel microstructure behaves differently in a crash event, absorbing more crash energy than the 100% martensitic ULTRALUME 1500. This allows for more complex part designs, such as a B-pillar made from a welded blank, containing these two distinct ULTRALUME grades. Such a B-pillar would contain both the very hard ULTRALUME 1500 with the more ductile ULTRALUME 500 product that will absorb more crash energy, giving OEMs greater flexibility in part designs and crash management.

For all ULTRALUME grades, since the steel is held in the dies during cooling, temperature-related distortion and part springback / shape issues are avoided. This is one of the advantages of hot stamping.

The crossover body-in-white image below shows typical applications of ULTRALUME steels.



Tables

TABLE 1 – TYPICAL CHEMISTRIES

Grade	C (wt. %)	Mn (wt. %)	Si (wt. %)	Cr (wt. %)	B (wt. %)	Other
ULTRALUME 500	0.07	1.45	0.25	—	—	Nb, Ti
ULTRALUME 1500	0.22	1.20	0.25	0.20	0.003	—

TABLE 2 – TYPICAL MECHANICAL PROPERTIES – ASTM LONGITUDINAL TO ROLLING DIRECTION

Grade		Yield Strength (MPa)	Tensile Strength (MPa)	Tensile Elongation (%)	n-Value
ULTRALUME 500 PQS	As coated by Cliffs	565	700	17	0.11
	After hot stamping*	380	590	18	—
ULTRALUME 1500 PHS	As coated by Cliffs	370	585	23	0.13
	After hot stamping*	1000	1470	6	—

*Processing guidelines are available. Contact Cleveland-Cliffs for more information.

TABLE 3 – AVAILABLE COATING WEIGHTS

Coating Designation	Coating Weight Min. (g/m ²)	Coating Thickness per side (μm)
30G20G (AS80 / AS30)	30	10 – 20
AS35G35G	35	13 – 20
60G60G (AS150 / AS60)	60	20 – 33

ULTRALUME steels are continuously hot-dip coated on both sides of the steel. The coating bath contains approximately 91% aluminum and 9% silicon. This metallic coating is metallurgically bonded to the steel substrate and protects the steel surface against decarburization and oxidation during hot stamping. As a result, the shot blasting operation required to remove scale from hot-stamped, uncoated steel parts is not needed. ULTRALUME PHS grades are available in gauges from 0.8 – 3.25 mm and widths up to 1524 mm. For specific gauge and width capability, please contact your Cleveland-Cliffs sales representative.

FIGURE 1

Photomicrograph showing the as-coated Aluminized Type 1 metallic layer on top of the steel substrate. The coating consists of an aluminum-silicon layer on top of the ULTRALUME 1500 steel substrate.

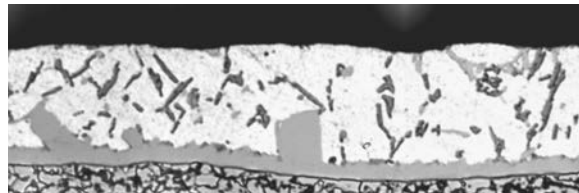
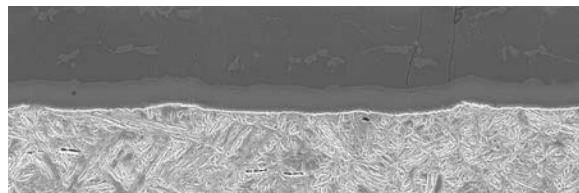


FIGURE 2

Photomicrograph showing ULTRALUME 1500 PHS after heat-treatment at 900° C, followed by hot stamping. The coating layer has fully alloyed with the substrate. As this is a press hardenable product, the steel substrate has transformed from ferrite and pearlite to 100% martensite, dramatically increasing the strength of the material.



Weldability

Typical automotive welding processes, such as resistance spot welding and Gas Metal Arc (GMA) welding, can be used for joining hot-stamped ULTRALUME products. The composition, combined with the high strength and martensitic microstructure of ULTRALUME 1500 after hot stamping, requires weld process development and joint evaluation. For additional information, contact your Cleveland-Cliffs technical representative.

ADDITIONAL PRESS HARDENABLE STEEL PRODUCTS AVAILABLE FROM CLEVELAND-CLIFFS

- Uncoated Hot Rolled PHS
- Uncoated Full Hard PHS
- Uncoated Annealed PHS

FIGURE 3

An advanced B-pillar design, manufactured from a welded blank, showing an upper portion made from ULTRALUME 1500 PHS and a lower portion made from ULTRALUME 500 PQS. This design will absorb more crash energy than a traditional fully martensitic B-pillar design, while still preventing intrusions into the passenger compartment.

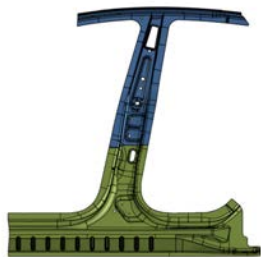


FIGURE 4

Hot-formed parts produced from ULTRALUME PHS in a water-cooled hydraulic-press line. The blanks are heated to 900 °C then quickly hot processed into complex shapes, as depicted in these examples



About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.