FERRIUM® S53®

Corrosion Resistant Ultrahigh-Strength Steel for Aerospace Structural Applications

Ferrium® S53® Chemical Composition (nominal wt. %)

Fe	C	Co	Cr	Ni	Mo	W	V
Bal.	0.21	14	10	5.5	2	1	0.3

Ferrium S53 Mechanical Properties (typical)

YS (ksi)	UTS (ksi)	El (%)	Ra (%)	Hardness (HRC)	CVN (ft-lb)	K_{Ic} $(ksi\sqrt{in})$
225	288	15	57	54	18	65

Other Key Properties

- Corrosion resistance has been measured using a variety of test methods. General corrosion resistance of S53 is similar to 440C.
- Fatigue testing at a number of R values and stress levels has shown equivalent performance to typical 300M values.
- S53 yields a Class A Weld. Welding studies have shown minimal impact on mechanical properties.

Materials by Design® Objective

Steels currently used in numerous aerospace applications, specifically landing gear, are not corrosion resistant and therefore require a protective cyanide-based cadmium plating process. Cadmium, a known carcinogen, represents significant environmental risks in both primary aerospace manufacture and at overhaul and repair facilities. The design objective of *Ferrium*® S53 was to create an ultra high-strength corrosion-resistant steel that would eliminate the need for toxic metal plating.

Description

Ferrium S53 is a corrosion resistant ultra high-strength steel for structural aerospace applications. *Ferrium* S53 was designed to provide mechanical properties equal to, or better than, conventional ultrahigh-strength steels such as 300M and SAE 4340 with the added benefit of general corrosion resistance. This eliminates the need for cadmium coating processes, which are environmentally unfriendly and require subsequent hydrogen bake-out operations in order to avoid hydrogen embrittlement. *Ferrium* S53 has a greatly improved resistance to stress-corrosion cracking (SCC) over 300M and SAE 4340.

Ferrium S53 utilizes an efficient M_2C strengthening dispersion precipitated through tempering while avoiding other carbides. This maximizes strength, wear resistance, and toughness; resulting in a unique combination of mechanical properties for a corrosion resistant steel.

Ferrium S53 uses a stable passive oxide film for optimum corrosion resistance. It also has high hardenability, permitting less severe quench conditions for a given section size and resulting in less distortion during heat treatment.

For additional information regarding QuesTek's Ferrium S53 email info@questek.com or call 847.328.5800.

Processing

Processing of *Ferrium* S53 is similar to other quench and tempered martensitic secondary-hardening steels. Vacuum heat treatment and vacuum tempering is recommended to avoid surface decarburization. After quenching to room temperature *Ferrium* S53 is subjected to cryogenic treatment to assure a complete martensitic transformation. *Ferrium* S53 is typically double-step tempered around 900°F (482°C) and has excellen t thermal resistance approaching this temperature. This allows for higher grinding speeds without risk for grinding burns and more reliability in service.

Heat treatment recommendation: Heating to 1985°F ±27 (1085°C ±15), holding at heat for 60 minutes +10, -0, quenching in oil (or equivalent), cooling to -100°F (-73°C) or lower, holding at temperature for 1 hour +2, -0, and warming in air to room temperature; and double tempered by heating to 934°F ±12 (501°C ±7), holding at heat for 3 hours ±0.5, quenching in oil (or equivalent), cooling to -100°F (-73°C) or lower, holding at temperature for 1 hour +2, -0, and warming in air to room temperature, reheating to 900°F ±18 (482°C ±10), holding at heat for 12 hours +2, -1, and cooling in air (or equivalent).

Corrosion Resistance

The general corrosion resistance of *Ferrium* S53 is similar to 440C stainless steel. Linear polarization testing of *Ferrium* S53 measured an average corrosion rate of 0.40 mils per year versus a saturated Ag/AgCl reference electrode in 3.5% sodium chloride (NaCl) solution at ambient temperature. *Ferrium* S53 is rust resistant in 3.5% NaCl solution.

Density

The density of *Ferrium* S53 is 7.98 g/cc.

Product Forms

Ferrium S53 may be manufactured in typical ingot, bar, and billet forms. Sheet and plate also available upon request.

Availability

Ferrium S53 is produced and distributed by Carpenter Technology Corporation and Latrobe Specialty Steel under license from QuesTek Innovations LLC.

Other

U.S. Patent Number: 7,160,399
Aerospace Material Specification: AMS5922
UNS Number: S10500
MMPDS-04 CN-1

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