FERRARI
Stainless and Alloys

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Glossary of Stainless Steel Terms

Active: Surface has lost its ability to resist corrosion (the passive state) under the prevailing conditions.

Annealing: A softening heat treatment done to restore machinability or cold formability, usually following cold working. Solution annealing dissolves precipitated particles (e.g. carbides, sigma phase) to optimise corrosion resistance.

Austenite: A phase in the steel with the smallest building block of atomic structure of 'face centred cubic' (fcc) ie one atom at the eight corners of a cube and one in the centre of each of the six faces. Austenitic stainless steels with this structure include 1.4301 (304) and are characteristically non-magnetic. This structure gives improved weldability, formability and low temperature toughness.

Austenitising: The first stage during the hardening / strengthening heat treatment of martensitic stainless steels. Normally followed by a tempering treatment after cooling down to ambient temperatures.

Bright Annealing: An annealing process done in a protective atmosphere to prevent surface tarnish or oxidation. A cracked ammonia gas is usually used during bright annealing of strip (coil) at the steel mill. The resulting finish is 2R (BS EN 10088-2), also known as BA.

Cathodic Protection: Methods of increasing the corrosion resistance of the surface, over a wider range of conditions, for example on 316 types in some seawater applications. Impressed voltage methods are widely used, lowering the electrode potential of the metal surface.

Chlorides (halides): Ions formed from chlorine (fluorine, bromine, iodine) atoms. Often corrosive when in solutions. Can be the cause of localised attack mechanisms such as crevice, pitting and stress corrosion cracking.

Cold Working: Deformation (forming, machining) below the recrystallisation temperature of the steel, resulting in a progressive increase in strength and hardness as more working is done.

Corrosion: An electrochemical process where metal atoms are removed from the surface of the steel. Stainless steels have good general

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corrosion resistance but can suffer from localised corrosion mechanism such as crevice, pitting and stress corrosion cracking.

Creep: Slow, time dependent, deformation normally at temperatures above 600 C. Stress levels that result in creep are significantly below the short term proof strength for a particular temperature.

Deep Drawing: A cold forming method where a sheet is drawn into a die by a press tool to make deep cup or bowl shapes. The side wall of the pressing is not deliberately thinned during forming cf stretch forming. Grade 1.4301(304) is used widely for deep drawn saucepans

Duplex: Steels with a mix of austenite and ferrite phases, intended to produce higher mechanical strength steels with better stress corrosion cracking resistance than the austenitic types.

Fatigue (endurance): A progressive mechanical failure mechanism resulting from oscillating (cyclic) stresses (eg vibration) over a large number of stress reversals. Martensitic steels can be susceptible to fatigue, other types are more resistant.

Ferrite: A phase in the steel with the smallest building block of atomic structure of 'body centred cubic' (bcc) ie one atom at the eight corners of a cube and one in the centre of the cube. Ferritic stainless steels with this structure include 1.4016 (430) and are characteristically magnetic.

Hardening: Normally associated with heat treatment processes (austenitising and tempering) but cold work also increases the hardness of austenitic stainless steels. Hardness is the resistance to indentation or scratching, cf strengthening which is an increase in tensile properties.

Hot Working: Deformation (forging) above the recrystallisation temperature of the steel. Here the metal continuously anneals itself as the work progresses. There is no increase in strength on cooling to ambient temperature and annealing is not needed after hot working.

L Grades: Mostly applied to 304L (1.4307) and 316L (1.4404). Steels with less than 0.030% carbon to prevent sensitisation during thermal cycling, notably welding.

Martensite: A phase in the steel with a characteristic high hardness, but which can be brittle. Formed when carbon/chromium (martensitic stainless steels) are cooled rapidly from their austenitising temperature during heat treatment. Martensitic stainless steels include

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grades 1.4021 (420).

Normalizing: A form of sub-critical temperature annealing process used where some of the structural breakdown during previous cold working is to be retained.

Passive: Surface condition making the steel corrosion resistant ie the passive film is stable under the prevailing conditions. Stainless steels are intended to be used under conditions where they maintain their passive condition.

Passivation: Surface oxidising treatments, normally done using nitric acid, to promote the formation of the transparent protective corrosion resisting layer on the surface of the steel. These treatments are only needed for complex machined parts intended for immediate service where the natural passivation process may be hindered.

Permeability: A magnetic property of materials related to their ability to be attracted by a permanent magnet or influenced by a magnetic field. Austenitic stainless steels eg 1.4301(304) when annealed have relative permeability levels just above 1 and are said to be non-magnetic. The magnetic permeability can be increased by cold work or cooling to sub-zero temperatures due to the formation of the magnetic martensitic phase.

pH: A scale for showing the hydrogen ion concentration of solutions. Acids have pH values between 1 and 6, bases (alkalis) between 8 and 14 and water (neutral) has a value of 7.

Pickle (pickling): Chemical (usually acid) treatments that remove a thin layer of surface metal. Pickling with nitric acid is also used to remove iron contamination from stainless steel surfaces.

Pinch Pass: Also, known as skin pass. A final cold rolling operation in the production of coil (strip) to improve shape and flatness. Resulting finish is 2B.

Pitting: A form of localised corrosion (attack) often associated with the presence of chlorides in the environment.

Precipitation Hardening: A strengthening mechanism produced by heat treatment. Can only be done on specially formulated steels eg 1.4542 (17/4PH), 1.4594 (FV 520B). High strengths are achieved with better impact toughness than with ordinary martensitic steels eg

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1.4021 (420), 1.4057 (431). Corrosion resistance is generally comparable to type 1.4301 (304).

Scaling Temperature: Temperature above which an arbitrary rate of surface oxidation in air occurs. Often expressed in a weight gain per unit surface area per specified time unit eg gm/cm2/hour.

Sensitisation: A potential reduction in corrosion resistance (normally associated with intercrystalline attack) due to holding or passing through particular high temperature ranges. Weld decay is an old term for this. It is the loss of Cr from the steel matrix due to the formation of chromium carbide.

Stabilisation: Making the steel more resistant to intercrystalline corrosion sensitisation by adding small amounts of either titanium or niobium to the steel. Grades 1.4541 (321), 1.4550 (347) and 1.4571 (316Ti) are examples of stabilised grades.

Stress Relieving: Heat treatment done to reduce internal (residual) stresses, following cold working. Done to improve resistance to stress corrosion cracking.

Stretch Forming: A cold forming method where a sheet is drawn into a die by a press tool and where the edges of the sheet are restrained to make deep cup or bowl shapes. The side wall of the pressing is thinned during forming but the cold working induced prevents fractures in these areas cf deep drawing. Sinks produced from one sheet of steel are typically stretch formed using a specially formulated 1.4301 (304) type.

Tempering: The second stage during the hardening/strengthening heat treatment of martensitic stainless steels. Improves the toughness but with some loss in strength and hardness.

Toughness: The ability of a material to withstand sudden impacts. Although all stainless steels have an acceptable level of toughness at normal temperatures, most stainless steels, in common with carbon and alloy steels, show a transition to brittle behaviour at low temperature. In contrast, austenitic stainless steels do not show this behaviour and consequently are used for cryogenic applications.

Credits: British Stainless Steel Association