

Corrosion Glossary

885-°F (475-°C) embrittlement

Embrittlement of stainless steels upon extended exposure to temperatures between 400 and 510 °C (730 and 930 °F). This type of embrittlement is caused by fine, chromium-rich precipitates that segregate at grain boundaries: time at temperature directly influences the amount of segregation. Grain-boundary segregation of the chromium-rich precipitates increases strength and hardness, decreases ductility and toughness, and changes corrosion resistance. This type of embrittlement can be reversed by heating above the precipitation range.

elastic deformation

A change in dimensions directly proportional to and in phase with an increase or decrease in applied force.

elasticity

The property of a material by virtue of which deformation caused by stress disappears upon removal of the stress. A perfectly elastic body completely recovers its original shape and dimensions after release of stress.

elastic limit

The maximum stress that a material is capable of sustaining without any permanent strain (deformation) remaining upon complete release of the stress.

elastomer

A natural or synthetic polymer, which at room temperature can be stretched repeatedly to at least twice its original length, and which after removal of the tensile load will immediately and forcibly return to approximately its original length.

electrical conductivity

See *conductivity*.

electrical isolation

The condition of being electrically separated from other metallic structures or the environment.

electrical resistivity

The electrical resistance offered by a material to the flow of current, times the cross-sectional area of current flow and per unit length of current path; the reciprocal of the conductivity. Also called resistivity or specific resistance.

electrochemical admittance

The inverse of *electrochemical impedance*.

electrochemical cell

An electrochemical system consisting of an *anode* and a *cathode* in metallic contact and

electrolytic protection

See *cathodic protection*.

electromotive force

Electrical potential; voltage.

electromotive force series (emf series)

A list of elements arranged according to their standard *electrode potentials* (*Hydrogen electrode is a reference point and given the value zero*), with "noble" metals such as gold being positive and "active" metals such as zinc being negative.

electron flow

A movement of electrons in an external circuit connecting an *anode* and *cathode* in a corrosion cell; the current flow is arbitrarily considered to be in an opposite direction to the electron flow.

electroplating

Electrodepositing a metal or alloy in an adherent form on an object serving as a *cathode*.

electropolishing

A technique commonly used to prepare metallographic specimens, in which a high polish is produced by making the specimen the *anode* in an *electrolytic cell*, where preferential dissolution at high points smooths the surface.

electrotinning

Electroplating tin on an object.

embrittlement

Loss of load carrying capacity of a metal or alloy; The severe loss of *ductility* or *toughness* or both, of a material, usually a metal or alloy. Many forms of embrittlement can lead to *brittle fracture*. Many forms can occur during thermal treatment or elevated-temperature service (thermally induced embrittlement). Some of these forms of embrittlement, which affect steels, include *blue brittleness*, *885 °F (475 °C) embrittlement*, *quench-age embrittlement*, *sigma-phase embrittlement*, *strain-age embrittlement*, *temper embrittlement*, *tempered martensite embrittlement*, and *thermal embrittlement*. In addition, steels and other metals and alloys can be embrittled by environmental conditions (environmentally assisted embrittlement). The forms of environmental embrittlement include *acid embrittlement*, *caustic embrittlement*, corrosion embrittlement, creep-rupture embrittlement, hydrogen embrittlement, liquid metal embrittlement, *neutron embrittlement*, *solder embrittlement*, *solid metal*

- immersed in an *electrolyte*. (The anode and cathode may be different metals or dissimilar areas on the same metal surface.)
- electrochemical corrosion**
Corrosion that is accompanied by a flow of electrons between cathodic and anodic areas on metallic surfaces.
- electrochemical equivalent**
The weight of an element or group of elements oxidized or reduced at 100% efficiency by the passage of a unit quantity of electricity. Usually expressed as grams per coulomb (1 amp/s).
- electrochemical impedance**
The frequency-dependent complex-valued proportionality factor ($SE/\omega i$) between the applied potential or current and the response signal. This factor is the total opposition (11 or 111 cm⁻¹) of an electrochemical system to the passage of charge. The value is related to the *corrosion rate* under certain circumstances.
- electrochemical potential**
The partial derivative of the total electrochemical free energy at a constituent with respect to the number of moles of this constituent where all factors are kept constant. It is analogous to the *chemical potential* of a constituent except that it includes the electric as well as chemical contributions to the free energy. The *potential* of an electrode in an electrolyte relative to a *reference electrode* measured under open circuit conditions.
- electrochemical series**
Same as *electromotive force series*.
- electrode**
(1) An electronic conductor used to establish electrical contact with an electrolytic part of a circuit. (2) An electronic conductor in contact with an ionic conductor.
- electrode polarization**
Change of *electrode potential* with respect to a reference value. Often the *free corrosion potential* is used as the reference value. The change may be caused, for example, by the application of an external electrical current or by the addition of an oxidant or reductant.
- electrodeposition**
The deposition of a substance on an *electrode* by passing electric current through an *electrolyte*.
- electrode potential**
The *potential* of an *electrode* in an *electrolyte* as measured against a *reference electrode*. The electrode potential does not include any resistance losses in potential in either the solution or external circuit. It represents the reversible work to move a unit charge from the electrode surface through the solution to the reference electrode.
- electrode reaction**
Interfacial reaction equivalent to a transfer of charge between electronic and ionic conductors. See *embrittlement*, and *stress-corrosion cracking*.
- endurance limit**
The maximum stress that a material can withstand for an infinitely large number of fatigue cycles; maximum cyclic stress level a metal can withstand without fatigue failure. See also *fatigue strength*.
- environment**
The surroundings or conditions (physical, chemical, mechanical) in which a material exists.
- environmental cracking**
Brittle fracture of a normally ductile material in which the corrosive effect of the environment is a causative factor. Environmental cracking is a general term that includes *corrosion fatigue*, *high-temperature hydrogen attack*, *hydrogen blistering*, *hydrogen embrittlement*, *liquid metal embrittlement*, *solid metal embrittlement*, *stress-corrosion cracking*, and *sulfide stress cracking*. The following terms have been used in the past in connection with environmental cracking, but are becoming obsolete: caustic embrittlement, delayed fracture, season cracking, static fatigue, stepwise cracking, sulfide corrosion cracking, and sulfide stress-corrosion cracking. See also *embrittlement*.
- environmentally assisted embrittlement**
See *embrittlement*.
- epoxy**
Resin formed by the reaction of bisphenol and epichlorohydrin.
- equilibrium (reversible) potential**
The *potential* of an electrode in an electrolytic solution when the forward rate of a given reaction is exactly equal to the reverse rate. The equilibrium potential can only be defined with respect to a specific electrochemical reaction.
- erosion**
Destruction of metals or other materials by the abrasive action of moving fluids, usually accelerated by the presence of solid particles or matter in suspension. When corrosion occurs simultaneously, the term *erosion-corrosion* is often used.
- erosion-corrosion**
A conjoint action involving *corrosion* and *erosion* in the presence of a moving corrosive fluid, leading to the accelerated loss of material.
- eutectic**
(1) An isothermal reversible reaction in which a liquid solution is converted into two or more intimately mixed solids on cooling, the number of solids formed being the same as the number of components in the system. (2) An alloy having the composition indicated by the eutectic point on an equilibrium diagram. (3) An alloy structure of intermixed solid constituents formed by a eutectic

also *anodic reaction* and *cathodic reaction*.

electroalvanizing
The *electroplating* of zinc upon iron or steel.

electrokinetic potential
This *potential*, sometimes called zeta potential, is a potential difference in the solution caused by residual, unbalanced charge distribution in the adjoining solution, producing a double layer. The electrokinetic potential is different from the *electrode potential* in that it occurs exclusively in the solution phase; that is, it represents the reversible work necessary to bring a unit charge from infinity in the solution up to the interface in question but not through the interface.

electroless plating
A process in which metal ions in a dilute aqueous solution are plated out on a substrate by means of autocatalytic chemical reduction.

electrolysis
Production of chemical changes of the *electrolyte* by the passage of current through an *electrochemical cell*.

electrolyte
(1) A chemical substance or mixture, usually liquid, containing ions that migrate in an electric field.
(2) A chemical compound or mixture of compounds which when molten or in solution will conduct an electric current.

electrolytic cell
An assembly, consisting of a vessel, electrodes, and an electrolyte, in which *electrolysis* can be carried out.

electrolytic cleaning
A process of removing soil, scale, or corrosion products from a metal surface by subjecting it as an *electrode* to an electric current in an electrolytic bath; process of cleaning, degreasing, of a metal by making it an electrode in a suitable bath.

reaction.

eutectoid
(1) An isothermal reversible reaction in which a solid solution is converted into two or more intimately mixed solids on cooling, the number of solids formed being the same as the number of components in the system. (2) An alloy having the composition indicated by the eutectoid point on an equilibrium diagram. (3) An alloy structure of intermixed solid constituents formed by a eutectoid reaction.

exchange current
When an electrode reaches dynamic equilibrium in a solution, the rate of anodic dissolution balances the rate of cathodic plating. The rate at which either positive or negative charges are entering or leaving the surface at this point is known as the exchange current.

exchange current density
The rate of charge transfer per unit area when an electrode reaches dynamic equilibrium (at its reversible potential) in a solution; that is, the rate of anodic charge transfer (oxidation) balances the rate of cathodic charge transfer (reduction).

exfoliation
Corrosion that proceeds laterally from the sites of initiation along planes parallel to the surface, generally at grain boundaries, forming corrosion products that force metal away from the body of the material, giving rise to a layered appearance.

external circuit
The wires, connectors, measuring devices, current sources, etc. that are used to bring about or measure the desired electrical conditions within the test cell. It is this portion of the cell through which electrons travel.