



Standard Terminology Relating to Corrosion and Corrosion Testing¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This terminology covers commonly used terms in the field of corrosion. Related terms may be found in Terminologies D 16, D 4538, G 40, or other ASTM terminology standards. All terms defined by ASTM committees may be found in the *ASTM Dictionary of Engineering & Technology*.

2. Referenced Documents

2.1 ASTM Standards:²

- D 16 Terminology for Paint, Related Coatings, Materials, and Applications
- D 4538 Terminology Relating to Protective Coating and Lining Work for Power
- G 40 Terminology Relating to Wear and Erosion

3. Terminology

AC impedance—See **electrochemical impedance**.

active—the negative direction of electrode potential. (Also used to describe corrosion and its associated potential range when an electrode potential is more negative than an adjacent depressed corrosion rate [passive] range.)

anion—a negatively charged ion.

anode—the electrode of an electrolytic cell at which oxidation is the principal reaction. (Electrons flow away from the anode in the external circuit. It is usually the electrode where corrosion occurs and metal ions enter solution.)

anode corrosion efficiency—the ratio of the actual corrosion (weight loss) of an anode to the theoretical corrosion (weight loss) calculated by Faraday's law from the quantity of electricity that has passed.

anodic inhibitor—a corrosion inhibitor whose primary action is to slow the kinetics of the anodic reaction, producing a positive shift in corrosion potential.

anodic polarization—the change of the electrode potential in the noble (positive) direction due to current flow. (See **polarization**.)

anodic protection—a technique to reduce the corrosion rate of a metal by polarizing it into its passive region where dissolution rates are low.

anolyte—the electrolyte adjacent to the anode of an electrolytic cell.

auxiliary electrode—See **counter electrode**.

breakdown potential—the least noble potential where pitting or crevice corrosion, or both, will initiate and propagate.

cathode—the electrode of an electrolytic cell at which reduction is the principal reaction. (Electrons flow toward the cathode in the external circuit.)

cathodic corrosion—corrosion of a metal when it is a cathode. (It usually happens to metals because of a rise in pH at the cathode or as a result of the formation of hydrides.)

cathodic inhibitor—a corrosion inhibitor whose primary action is to slow the kinetics of the cathodic reaction, producing a negative shift in corrosion potential.

cathodic polarization—the change of the electrode potential in the active (negative) direction due to current flow. (See **polarization**.)

cathodic protection—a technique to reduce the corrosion rate of a metal surface by making it the cathode of an electrochemical cell.

catholyte—the electrolyte adjacent to the cathode of an electrolytic cell.

cation—a positively charged ion.

caustic cracking—stress corrosion cracking of metals in caustic solutions. (See also **stress-corrosion cracking**.)

caustic embrittlement—See **caustic cracking**.

cavitation—the formation and rapid collapse within a liquid of cavities or bubbles that contain vapor or gas or both.

cavitation corrosion—the conjoint action of cavitation-erosion and corrosion.

cavitation damage—the degradation of a solid body resulting from its exposure to cavitation. (This may include loss of material, surface deformation, or changes in properties or appearance.)

cavitation-erosion—loss of material from a solid surface due to mechanical action of continuing exposure to cavitation.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

chemical conversion coating—a protective or decorative nonmetallic coating produced *in situ* by chemical reaction of a metal with a chosen environment. (It is often used to prepare the surface prior to the application of an organic coating.)

concentration cell—an electrolytic cell, the emf of which is caused by a difference in concentration of some component in the electrolyte. (This difference leads to the formation of discrete cathode and anode regions.)

corrosion—the chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties.

corrosion fatigue—the process in which a metal fractures prematurely under conditions of simultaneous corrosion and repeated cyclic loading at lower stress levels or fewer cycles than would be required in the absence of the corrosive environment.

corrosion fatigue strength—the maximum repeated stress that can be endured by a metal without failure under definite conditions of corrosion and fatigue and for a specific number of stress cycles and a specified period of time.

corrosion inhibitor—a chemical substance or combination of substances that, when present in the proper concentration and forms in the environment, prevents or reduces corrosion.

corrosion potential—the potential of a corroding surface in an electrolyte relative to a reference electrode measured under open-circuit conditions.

corrosion rate—the amount of corrosion occurring in unit time. (For example, mass change per unit area per unit time; penetration per unit time.)

counter electrode—the electrode in an electrochemical cell that is used to transfer current to or from a test electrode.

crevice corrosion—localized corrosion of a metal surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of close proximity between the metal and the surface of another material.

critical anodic current density—the maximum anodic current density observed in the active region for a metal or alloy electrode that exhibits active-passive behavior in an environment.

critical humidity—the relative humidity above which the atmospheric corrosion rate of some metals increases sharply.

critical pitting potential—the least noble potential where pitting corrosion will initiate and propagate. (See breakdown potential.)

current density—the electric current to or from a unit area of an electrode surface.

current efficiency—the ratio of the electrochemical equivalent current density for a specific reaction to the total applied current density.

deactivation—the process of prior removal of the active corrosive constituents, usually oxygen, from a corrosive liquid by controlled corrosion of expendable metal or by other chemical means, thereby making the liquid less corrosive.

dealloying—See **parting**.

depolarization—not a preferred term. (See **polarization**.)

deposit corrosion—localized corrosion under or around a deposit or collection of material on a metal surface. (See also **crevice corrosion**.)

dezincification—See **parting**; specific to copper-zinc alloys.

differential aeration cell (oxygen concentration cell)—a concentration cell caused by differences in oxygen concentration along the surface of a metal in an electrolyte. (See **concentration cell**.)

diffusion limited current density—the current density, often referred to as limiting current density, that corresponds to the maximum transfer rate that a particular species can sustain due to the limitation of diffusion.

electrochemical admittance—the reciprocal of the electrochemical impedance, $\Delta I/\Delta E$.

electrochemical cell—an electrochemical system consisting of an anode and a cathode in metallic contact and immersed in an electrolyte. (The anode and cathode may be different metals or dissimilar areas on the same metal surface.)

electrochemical impedance—the frequency dependent, complex valued proportionality factor, $\Delta E/\Delta I$, between the applied potential (or current) and the response current (or potential) in an electrochemical cell. This factor becomes the impedance when the perturbation and response are related linearly (the factor value is independent of the perturbation magnitude) and the response is caused only by the perturbation. The value may be related to the corrosion rate when the measurement is made at the corrosion potential.

electrochemical noise—fluctuations of potential or current, or both, originating from uncontrolled variations in a corrosion process.

electrochemical potential (electrochemical tension)—the partial derivative of the total electrochemical free energy of the system with respect to the number of moles of the constituent in a solution when all other factors are constant. (Analogous to the chemical potential of the constituent except that it includes the electrical as well as the chemical contributions to the free energy.)

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.)

electrolysis—production of chemical changes of the electrolyte by the passage of current through an electrochemical cell.

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.

Electromotive Force Series (EMF Series)—a list of elements arranged according to their standard electrode potentials, with “noble” metals such as gold being positive and “active” metals such as zinc being negative.

embrittlement—the severe loss of ductility or toughness or

both, of a material, usually a metal or alloy.

environmentally-assisted cracking—the initiation or acceleration of a cracking process due to the conjoint action of a chemical environment and tensile stress.

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—the progressive loss of material from a solid surface due to mechanical interaction between that surface and a fluid, a multi-component fluid, or solid particles carried with the fluid.

erosion-corrosion—a conjoint action involving corrosion and erosion in the presence of a moving corrosive fluid, leading to the accelerated loss of material.

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, and so forth, that are used to bring about or measure the desired electrical conditions within the test cell.

filiform corrosion—corrosion that occurs under some coatings in the form of randomly distributed threadlike filaments.

fretting corrosion—the deterioration at the interface between contacting surfaces as the result of corrosion and slight oscillatory slip between the two surfaces.

galvanic corrosion—accelerated corrosion of a metal because of an electrical contact with a more noble metal or nonmetallic conductor in a corrosive electrolyte.

galvanic couple—a pair of dissimilar conductors, commonly metals, in electrical contact. (See **galvanic corrosion**.)

galvanic current—the electric current between metals or conductive nonmetals in a galvanic couple.

galvanic series—a list of metals and alloys arranged according to their relative corrosion potentials in a given environment.

galvanodynamic—refers to a technique wherein current, continuously varied at a selected rate, is applied to an electrode in an electrolyte.

galvanostaircase—refers to a galvanostep technique for polarizing an electrode in a series of constant current steps wherein the time duration and current increments or decrements are equal for each step.

galvanostatic—an experimental technique whereby an electrode is maintained at a constant current in an electrolyte.

galvanostep—refers to a technique in which an electrode is polarized in a series of current increments or decrements.

grain dropping—the dislodgement and loss of a grain or grains (crystals) from a metal surface as a result of intergranular corrosion.

graphitic corrosion—the deterioration of metallic constituents in gray cast iron, which leaves the graphitic particles intact. (The term “graphitization” is commonly used to identify this form of corrosion but is not recommended because of its use in metallurgy for the decomposition of carbide to graphite.)

hot corrosion—an accelerated corrosion of metal surfaces that results from the combined effect of oxidation and reactions with sulfur compounds and other contaminants, such as chlorides, to form a molten salt on a metal surface which fluxes, destroys, or disrupts the normal protective oxide.

hydrogen blistering—the formation of blisters on or below a metal surface from excessive internal hydrogen pressure. (Hydrogen may be formed during cleaning, plating, corrosion, and so forth.)

hydrogen embrittlement—hydrogen-induced cracking or severe loss of ductility caused by the presence of hydrogen in the metal.

immunity—a state of resistance to corrosion or anodic dissolution of a metal caused by thermodynamic stability of the metal.

impingement corrosion—a form of erosion-corrosion generally associated with the local impingement of a high-velocity, flowing fluid against a solid surface.

impressed current—an electric current supplied by a device employing a power source that is external to the electrode system. (An example is dc current for cathodic protection.)

intensistatic—See **galvanostatic**.

intercrystalline corrosion—See **intergranular corrosion**.

intergranular corrosion—preferential corrosion at or adjacent to the grain boundaries of a metal or alloy.

internal oxidation—the formation of isolated particles of corrosion products beneath the metal surface. (This occurs as the result of preferential oxidation of certain alloy constituents by inward diffusion of oxygen, nitrogen, sulfur, and so forth.)

knife-line attack—intergranular corrosion of an alloy, usually stabilized stainless steel, along a line adjoining or in contact with a weld after heating into the sensitization temperature range.

local action corrosion—corrosion caused by local corrosion cells on a metal surface.

local corrosion cell—an electrochemical cell created on a metal surface because of a difference in potential between adjacent areas on that surface.

localized corrosion—corrosion at discrete sites, for example, pitting, crevice corrosion, and stress corrosion cracking.

long-line current—electric current through the earth from an anodic to a cathodic area of a continuous metallic structure. (Usually used only where the areas are separated by considerable distance and where the current results from concentration-cell action.)

Luggin probe or Luggin-Haber capillary—a device used in measuring the potential of an electrode with a significant current density imposed on its surface. (The probe minimizes the IR drop that would otherwise be included in the measurement and without significantly disturbing the current distribution on the specimen.)

macrocell corrosion—corrosion of a metal embedded in porous media (for example, concrete or soil) caused by concentration or galvanic cells which exist on a scale at least as large as the smallest major dimension of the corroding item (for example, the diameter of a bar or pipe).

metal dusting—accelerated deterioration of metals in carbonaceous gases at elevated temperatures to form a dust-like corrosion product.

metallizing—See **thermal spraying**.

microbial corrosion—corrosion that is affected by the action of microorganisms in the environment.

microbiologically influenced corrosion (MIC)—corrosion inhibited or accelerated by the presence or activity, or both, of microorganisms.

mixed potential—the potential of a specimen (or specimens in a galvanic couple) when two or more electrochemical reactions are occurring simultaneously.

noble—the positive (increasingly oxidizing) direction of electrode potential.

noble metal—a metal with a standard electrode potential that is more noble (positive) than that of hydrogen.

occluded cell—an electrochemical cell created at a localized site on a metal surface which has been partially obstructed from the bulk environment.

open-circuit potential—the potential of an electrode measured with respect to a reference electrode or another electrode when no current flows to or from it.

overvoltage—the change in potential of an electrode from its equilibrium or steady state value when current is applied.

oxidation—loss of electrons by a constituent of a chemical reaction. (Also refers to the corrosion of a metal that is exposed to an oxidizing gas at elevated temperatures.)

parting—the selective corrosion of one or more components of a solid solution alloy.

parting limit—the minimum concentration of a more noble component in an alloy, above which parting does not occur in a specific environment.

passivation—the process in metal corrosion by which metals become passive. (See **passive**.)

passivator—a type of inhibitor which appreciably changes the potential of a metal to a more noble (positive) value.

passive—the state of the metal surface characterized by low corrosion rates in a potential region that is strongly oxidizing for the metal.

passive-active cell—a corrosion cell in which the anode is a metal in the active state and the cathode is the same metal in the passive state.

pitting—corrosion of a metal surface, confined to a point or small area, that takes the form of cavities.

pitting factor—ratio of the depth of the deepest pit resulting from corrosion divided by the average penetration as calculated from weight loss.

polarization—the change from the open-circuit electrode potential as the result of the passage of current.

polarization admittance—the reciprocal of polarization resistance (di/dE).

polarization resistance—the slope (dE/di) at the corrosion potential of a potential (E)–current density (i) curve. (It is

inversely proportional to the corrosion current density when the polarization resistance technique is applicable.)

potentiodynamic—refers to a technique wherein the potential of an electrode with respect to a reference electrode is varied at a selected rate by application of a current through the electrolyte.

potentiostaircase—refers to a potentiostep technique for polarizing an electrode in a series of constant potential steps wherein the time duration and potential increments or decrements are equal for each step.

potentiostat—an instrument for automatically maintaining an electrode in an electrolyte at a constant potential or controlled potentials with respect to a suitable reference electrode.

potentiostatic—the technique for maintaining a constant electrode potential.

potentiostep—refers to a technique in which an electrode is polarized in a series of potential increments or decrements.

poultice corrosion—See **deposit corrosion**.

Pourbaix diagram (electrode potential-pH diagram)—a graphical representation showing regions of thermodynamic stability of species in metal-water electrolyte systems.

primary passive potential (passivation potential)—the potential corresponding to the maximum active current density (critical anodic current density) of an electrode that exhibits active-passive corrosion behavior.

protection potential—the most noble potential where pitting and crevice corrosion will not propagate.

redox potential—the potential of a reversible oxidation-reduction electrode measured with respect to a reference electrode, corrected to the hydrogen electrode, in a given electrolyte.

reduction—the gain of electrons by a constituent of a chemical reaction.

reference electrode—electrode having a stable and reproducible potential, which is used in the measurement of other electrode potentials.

rest potential—See **open-circuit potential**.

rust—a corrosion product consisting primarily of hydrated iron oxide. (A term properly applied only to ferrous alloys.)

sample—a portion of material taken from a larger quantity and representative of the whole, to be used for test purposes.

season cracking—See **stress-corrosion cracking**.

sensitization—a process resulting in a metallurgical condition which causes susceptibility of an alloy to intergranular corrosion or intergranular environmentally assisted cracking in a specific environment.

specimen—a prepared portion of a sample upon which a test is intended to be performed

stray current corrosion—the corrosion caused by electric current from a source external to the intended electrical circuit, for example, extraneous current in the earth.

stress-corrosion cracking—a cracking process that requires the simultaneous action of a corrodent and sustained tensile stress. (This excludes corrosion-reduced sections which fail by fast fracture. It also excludes intercrystalline or transcrystalline corrosion which can disintegrate an alloy without either applied or residual stress.)

subsurface corrosion—See **internal oxidation**.

sulfidation—the reaction of a metal or alloy with a sulfur-containing species to produce a sulfur compound that forms on or beneath the surface of the metal or alloy.

Tafel slope—the slope of the straight line portion of a polarization curve, usually occurring at more than 50 mV from the open-circuit potential, when presented in a semi-logarithmic plot in terms of volts per logarithmic cycle of current density (commonly referred to as volts per decade).

thermal spraying—a group of processes wherein finely divided metallic or nonmetallic materials are deposited in a molten or semimolten condition to form a coating. (The coating material may be in the form of powder, ceramic rod, wire, or molten materials.)

thermogalvanic corrosion—the corrosive effect resulting from the galvanic cell caused by a thermal gradient across the metal surface.

transpassive region—the region of an anodic polarization curve, noble to and above the passive potential range, in which there is a significant increase in current density (increased metal dissolution) as the potential becomes more positive (noble).

tuberculation—the formation of localized corrosion products that appear on a surface as knoblike prominences (tubercles).

uniform corrosion—corrosion that proceeds at about the same rate over a metal surface.

weld decay—not a preferred term. Intergranular corrosion, usually of stainless steels or certain nickel-base alloys, that occurs as the result of sensitization in the heat-affected zone during the welding operation.

working electrode—the test or specimen electrode in an electrochemical cell.

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