

APPENDIX 3

GLOSSARY OF TERMS

Abrasive Blasting.

A cleaning or finishing process by a means of an abrasive projected at the work piece at differing pressures and velocities.

Activation

Elimination of passive film on the surface of a substrate through chemical treatment generally in diluted acids.

Activated Carbon

High purity Granulated Charcoal in various sizes having good absorption power for organic compounds. Used for removal of organic contamination.

Addition Agent

A material added in small quantities to a solution to modify its performance. It is usually added to a plating solution for the purpose of modifying the appearance and properties of a deposit.

Adhesion

The force which attracts the chemically or electrochemically deposited metal to the base metal, and which can be measured as the force necessary to separate them.

Amorphous

Non crystalline, or devoid of regular structure.

Ampere

Current flowing at the rate of 1 coulomb per sec.

Ampere-hour

Product of amperage and time. Abbreviated to AH. Example: 1 AH = 1 Ampere flowing 1 hour.

Amps per decimetre squared (A/dm^2)

Measure of current density from applied current in Amperes per square decimetre of the substrate surface. Abbreviated to A/dm^2

Angstrom (\AA):

One ten billionth of a metre, or one ten millionth of a millimetre. Also one tenth of a nanometre. An atom is normally considered to be 1-3 Angstroms in diameter.

Anion

A negatively charged ion that will be attracted to an anode.

Comment [T1]: Just didn't like Anion: an ion....

Anode

The electrode in electrolysis, at which negative ions are discharged, positive ions are formed, or other oxidising reactions occur.

Anode Efficiency

A comparison between the theoretical and practical level at which an electrochemical reaction takes place at the anode.. In electrodeposition processes it normally refers to the efficiency of metal electrodisolution from the anode

Anodic current density

Current density in A/dm^2 applied to the anode.

Anodic cleaning

An electrolytic process with the substrate to be cleaned being the anode (positive electrode).

Anti Pitting Agent

An addition agent that reduces the surface tension of the solution to facilitate release of gas bubbles and prevent pits in a deposit.

Appearance

An object or material's manifestation through visual attributes such as size, shape, colour, texture, glossiness, transparency, opacity, etc.

Aromatic Compounds

A class of organic compounds which contain an unsaturated benzene ring of carbon atoms, including benzene, naphthalene, anthracene and their derivatives.

Asperity

An inclusion in a metal deposit that can cause surface roughness of a deposit and/or the uncontrolled growth of a deposit during metal deposition.

Atom

The atom can be considered as the smallest particle of an element. It is composed of electrons, neutrons, and protons.

Automatic Plant

Electrodeposition plant in which the work is automatically conveyed through successive cleaning and deposition tanks, usually under computer control.

Barrel Finishing (or Tumbling)

Bulk processing in barrels to improve the surface finish, either in the presence or absence of abrasives or burnishing shot.

Barrel Plating

The use of a barrel to retain and transport articles to be coated with a metal.

Basis Metal (or Material)

Material upon which coatings are deposited.

Beaumé Degrees

Measure of the specific gravity (density) of a solution, using a Beaumé hydrometer.

Blister

Peeling of the deposited layer at certain spots.

Bipolar Electrode

An electrode that is not directly connected to the power supply but is placed in the solution between the anode and the cathode so that the part nearest the anode becomes cathodic and the part nearest the cathode becomes anodic.

Bright Dip (Non electrolytic)

A solution used to brighten the surface of a metal.

Bright Plating

A plating process that produces an electrodeposit having a high degree of specular reflectance in the as-plated condition.

Bright Plating Range

The range of current densities over which a plating solution produces a bright deposit.

Brightener

An addition agent that leads to the formation of a bright deposit, or that improves the brightness of the deposit.

Brush Plating

A method of plating in an which the plating solution is applied with a pad or brush, within which is an anode and which is moved over the cathode to be plated.

Buffer

A compound or mixture added to a solution that causes the solution to resist changes to its pH. Each buffer has a characteristic limited range of pH over which it is effective.

Buffing

The smoothing or polishing of a surface by means of a rotating flexible wheel to the surface of which fine, abrasive particles are applied in a liquid suspension, paste, or grease stick form.

Burnishing

The smoothing of surfaces by rubbing, accomplished chiefly by the movement rather than the removal of the surface layer.

Burnt Deposit

A rough, powdery or otherwise unsatisfactory deposit produced by the application of an excessive current density. The deposit usually contains oxides or other inclusions.

Bus (Bus Bar or Buss Bar)

A rigid conducting section, for carrying current to the anode and cathode bars.

Carryover

See drag out

Cathode

The electrode at which positive ions are discharged, negative ions are formed, or other reducing reactions occur.

Cathodic current density

Current density in Amperes per square decimetre applied to a substrate at the negative electrode.

Cathodic cleaning

An electrolytic cleaning process with the substrate to be cleaned being the cathode (negative electrode).

Cathodic Efficiency

A comparison between the theoretical and practical level at which an electrochemical reaction takes place at the cathode. In electrodeposition processes it is normally considered to be the ratio between the mass of the actually deposited metal and the mass of the metal which would have been deposited if all the applied current had been used for depositing the metal.

Example - a bright nickel process deposits nickel with a cathodic efficiency of 95%, i.e. 95% of the current is used in nickel plating and 5% in releasing hydrogen and in other reduction reactions.

Cation

Positively charged atom or ion which moves to the negative electrode or cathode during electrolysis. Metal ions are usually cations, e.g. Cu^{2+} and Ni^{2+}

Chemical Deposition

Deposition of metal layer by a chemical reaction using a reducing agent, the reaction of which is catalysed by the metal or alloy being deposited. (see electroless plating)

Chemical Polishing

The improvement in smoothness of a metal by simple immersion in a suitable solution. See Bright Dip (Non electrolytic).

Cleaning

The removal of oil, grease or other foreign material from a surface.

Complex Ion

An ion composed of two or more ions or radicals, both of which are capable of independent existence, usually a metal cation combined with anions, for example cuprocyanide $(\text{Cu}(\text{CN})_2)^-$.

Complexing Agent

A compound that will combine with metallic ions to form complex ions.

Conductance

The capacity of a medium, usually expressed in Siemens, for transmitting electric current. The reciprocal of resistance.

Conductivity Salt

A salt added to the solution to increase its electrical conductivity.

Conductivity - Specific Conductance

The current transferred across unit area per unit potential gradient. In the metric system, $K = \text{amperes per sq. cm divided by volts per cm}$. The reciprocal of resistivity.

Conversion Coating

A treatment either chemical or electro-chemical, of the metal surface to convert it to another chemical form which provides an insulating barrier of exceedingly low solubility between the metal and its environment, but which is an integral part of the metallic substrate. It provides greater corrosion resistance to the metal and increased adhesion of coatings applied to the metal. Examples are phosphate coatings on steel or zinc and chromate coatings on aluminium, zinc and zinc coated materials and anodised films on aluminium and magnesium.

Corrosion

The deterioration of metal or materials by chemical or electrochemical reaction resulting from exposure to weathering, moisture, chemicals, or other agents in the environment in which it is placed. The term environmental degradation is often used to embrace corrosion as defined here and environmentally induced breakdown of polymeric components and coatings.

In surface finishing, corrosion normally refers to the oxidation of a metal to form either salts, oxides or hydroxides of the metal.

Coulomb

The quantity of electricity that is transmitted through an electric circuit in 1 second when the current in the circuit is 1 amp.

Coulometer

An electrolytic cell arranged to measure the quantity of electricity by the chemical reaction produced in accordance with Faraday's law.

Covalency

A covalent bond is one where each atom donates an electron to form a shared pair of electrons in a molecular orbit

Covering Power

Describes the ability of an electrodeposition solution to deposit metal into deep recesses and other inaccessible areas. A solution with good covering power will deposit a good coating over all surfaces of a component of complex shape. (To be distinguished from throwing power.)

Critical Current Density

A current density above which a new and sometimes undesirable reaction occurs.

Current Density (cd)

Current per unit area, e.g. amps per square decimetre (A/dm^2).

Current Efficiency

The proportion, usually expressed as a percentage, of the current that is effective in carrying out a specified process in accordance with Faraday's Law. Current efficiency refers to the electrochemical processes that take place at either an anode or cathode.

Deburring

The removal of burrs, sharp edges or flash by mechanical, chemical, or electrochemical techniques.

Density

The mass per volume of a material normally expressed as g/ml or kg/m³.

Degreasing

The removal of grease and oils from a surface.

Deionising

The removal of ions from a solution by ion exchange.

Detergent.

A surface active agent that possesses the ability to clean soiled surfaces. Can be anionic, cationic, amphoteric or non ionic.

Diaphragm

A porous or permeable membrane separating anode and cathode compartments of an electrolytic cell from each other or from an intermediate compartment.

Dilution

Reduction of original concentration. Example: Dilute 1:2 means lowering the concentration to 33% of the original one.

Drag-in

The water or solution that adheres to the objects and is carried into a solution.

Drag-Out

The solution that adheres to the objects removed from a solution.

Dummy Cathode

A cathode in a plating solution that is not to be made use of after plating. Often used for removal or decomposition of impurities.

Eductor

Nozzle incorporating a venturi design attached to the exit hose of a pump. The venturi increases the amount of fluid discharged from the nozzle providing vigorous directed solution agitation. Eductors are normally used as a fully submersible method of agitation.

Electrochemical Series

A list of the metals in order of their standard electrode potentials.

Electrochemical Equivalent

The weight of a metal electrodeposited during the passage of unit quantity of electricity, such as a Faraday, ampere-hour, or coulomb.

Electrochemistry

The branch of science and technology which deals with transformations between chemical and electrical energy.

Electrocoating

See electrophoretic painting

Electrode

A conductor through which current enters or leaves an electrolytic cell. The positive electrode is called the anode and the negative electrode the cathode.

Electrodeposition

The process of depositing a substance upon an electrode by an electrochemical reaction.

Electrode Potential

The difference in electrical potential between an electrode and the immediately adjacent electrolyte.

Electroforming

The production of articles by electrodeposition upon a mandrel that is subsequently separated from the deposit.

Electroless Plating (Autocatalytic Deposition)

Deposition of a metallic coating by a controlled chemical reduction reaction that is catalysed by the metal or alloy being deposited.

Electrolyte

A solution containing ions that is electrically conducting in which an electrochemical reaction occurs when an electric current is passed.

Electrolytic Purification

Removal of metallic contamination of a solution through low current density electrolysis. Example - Metals such as copper and zinc in a nickel bath deposit at lower current densities than that used for nickel. (see dummy cathode)

Electrolysis

Chemical reactions resulting from the passage of an electric current through an electrolyte.

Electrochemical Series.

A list of metals in order of their standard electrode potentials.

Electrophoresis

The movement of colloidal particles under the influence of an electric potential.

Electrophoretic painting (Electrocoating)

A method of paint application in which an electrically conducting article is made one of the electrodes in a tank of water-thinned paint. The other electrode is generally a metal such as stainless steel. The two electrodes are connected to a source of electric power, the polarity of the article to be coated being of the opposite sign to that on the particles in the liquid paint in the tank. The charged particles move towards the article under the influence of the electric field and the electrochemical reactions that occur at the article's surface cause the paint particles to deposit onto the surface and ultimately form a continuous film of paint.

Electroplating

The electrodeposition of an adherent metallic coating upon an electrode.

Electropolishing

Improving the surface finish of a metal by making it anodic in an appropriate solution so that the surface dissolves in a controlled fashion.

Etch

To roughen or modify a surface by chemical or electrochemical dissolution.

Faraday

The number of coulombs (96,487) required to deposit the electrochemical equivalent weight of a metal. It is often rounded up to 96,500 Coulombs for ease of calculation

Filter Aid

An inert, insoluble material absorbed onto the filter to assist filtration by trapping fine materials.

Flash Plate

A thin electrodeposit, usually less than 0.1 micrometres thick.

Free Cyanide

Concentration of sodium or potassium cyanide in copper or brass or silver electroplating solution, which has not combined with the copper and/or zinc cyanide or silver to form its soluble complex

Galvanic Series

See Electrochemical Series.

Gassing

The discharge of gasses from one or more of the electrodes during electrolysis

Grinding

Metal removal by means of rotating rigid wheel containing abrasive.

Grit Blasting

Abrasive blasting with small irregular pieces of abrasive projected at the surface at high speed.

Halogenated Solvents Organic solvents containing halogens (usually chlorine) have improved solvency compared with the hydrocarbons from which they are derived and, in addition, flammability is reduced. Some of these are highly toxic, and precautions must be taken to avoid inhalation of their vapours.

Hard Chromium

Chromium plated for engineering rather than decorative applications. Not necessarily harder than decorative chromium

Hull Cell

A trapezoidal box of nonconducting material with electrodes arranged to permit observation of cathodic or anodic effects over a wide range of current densities.

Hydrogen Embrittlement

Phenomenon which occurs in steel components, especially in high tensile steels. It is caused by absorption of hydrogen by the steel surface, making it hard and brittle. This phenomenon is generally observed after zinc or cadmium plating, cathodic cleaning, pickling and hard chromium plating. The effect may be eliminated through heat treatment in oven at a temperature of 200°C for at least 2 hours.

Hydroxyl Group

- OH. The chemical group characteristic of hydroxides and alcohols

Immersion Deposit

A metallic deposit produced by a displacement reaction in which one metal displaces another from solution, for example: $\text{Fe} + \text{Cu}^{++} \rightarrow \text{Cu} + \text{Fe}^{++}$ (copper replacing iron).

Insoluble or inert anode

An anode that is insoluble in an electrolyte under the conditions prevailing in the electrolysis.

Inhibitor

A substance used to reduce the rate of a chemical or electrochemical reaction such as corrosion or pickling.

Inorganic Compound

Designation of compounds that generally do not contain carbon. Inorganic compounds are normally obtained from matter that is not vegetable or animal. Examples: sulphuric acid and salt. Exceptions are carbon monoxide and carbon dioxide and their derivatives.

Ion

An electrically charged atom.

Ion Exchange

An exchange of ions between a solution and a solid. In practice, most commonly effected by ion exchange resins for the purification of water.

Ionic Bond

Ionic bonds are held together by the attraction of opposite electric charges. A metal will lose electrons to form positive ions, a non-metal will gain electrons to form negative ions, and thus there will be ionic attraction, e.g. sodium chloride $\text{Na}^+ \text{Cl}^-$

Jig

A frame for suspending and carrying articles and conducting current to the work during electrodeposition and related operations.

Kelvin (K)

Unit of measurement for temperature. The Kelvin scale starts from absolute zero, which is -273.15° Celsius.

Lacquer

A coating composition that is based on synthetic thermoplastic film-forming material dissolved in organic solvent that dries primarily by solvent evaporation to produce a clear or slightly tinted solid film.

Levelling

Characteristic of certain electrolytic processes producing a smoother and uniform deposit. This property is of essential importance to improve visual appearance. Bright acid copper and bright nickel processes, with high levelling power, account for cost reduction and better quality of the final product.

Levelling Agent (Leveller)

An additive made to electroplating and electroforming solutions that levels the deposit's surface to produce a smoother surface.

LIGA (Lithographic Galvanoformung Abformung)

A method for the fabrication of miniature devices that involves the following sequence of operations: a) lithography, b) electroforming c) moulding.

Limiting Current Density

The maximum current density at which satisfactory deposits can be obtained.

Micron or Micrometre(μm)

One millionth of a metre, or one thousandth of a millimetre (0.001 mm).

Mandrel

The former or template onto which metal is deposited when electroforming.

MEMS (Micro Electro Mechanical Systems)

Miniature devices which have surface features with dimensions of a few micrometres.

Molecules

Molecules are compounds made up of specific combinations of atoms. Familiar substances may theoretically be divided into single molecules but no further. Like a strict recipe in which atoms are the ingredients, each molecule has a chemical formula. If any ingredients are subtracted or changed, the molecule becomes something completely different.

Nanometre (nm)

One billionth (one thousand millionth) of a metre or one millionth of a millimetre. It is also equal to 10 Angstroms

NEMS (Nano ElectroMechanical Systems)

Miniature devices that have surface features with nanoscale dimensions (10^{-6} mm). Sizes are normally measured in nanometres (nm)

Noble Metal

A metal that does not readily dissolve or corrode nor easily enter into such reactions as oxidations, etc. The opposite of base metal.

Nodule

A rounded protrusion formed on a cathode during electrodeposition.

Non-permanent mandrel (Sometimes known as a disposable mandrel)

A mandrel that is damaged or destroyed when it is separated from the electroform. Examples of non-permanent mandrels are waxes which are removed by melting them and zinc or aluminium which can be removed by chemical dissolution.

Organic Compound

Designation of any chemical compound containing carbon, usually combined with elements such as hydrogen, oxygen and nitrogen. (Some of the simple compounds of carbon such as carbon dioxide, are frequently classified as inorganic compounds.) Over eight million synthetic and naturally-occurring organic compounds are known. (There are approximately 100,000 known inorganic compounds.) Organic compounds are not usually ionised in water and frequently show the phenomenon of isomerism. The molecules of organic compounds used for coatings are usually very complex, containing large numbers of atoms.

Oxidation

A reaction in which electrons are removed from a reactant. (e.g. $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$). Sometimes, more specifically the combination of a reactant with oxygen.

Oxidising Agent

A compound that causes oxidation, thereby itself becoming reduced.

pH

A unit representing the hydrogen ion concentration of a solution: Scale 1 to 14. Where 7 is neutral; <7 acidic; >7 basic or alkaline.

The exact scientific definition is “the negative decimal logarithm of the reciprocal of the hydrogen ion concentration, in grams per litre”.

Paint

Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer which is converted to an opaque solid after application.

Peeling

The separation or partial separation of a coating from a basis metal or undercoat.

Periodic Reverse Plating

A method of plating in which the current is reversed periodically. The cycles are usually no longer than a few minutes and may be much less.

Permanent mandrel

A mandrel that is not damaged when it is separated from the electroform and can therefore be used repeatedly.

Photoresist

A material applied to a metal surface that can be patterned by exposure to light and subsequent chemical development. Used extensively in the manufacture of printed circuits to prevent reaction of the underlying metal during chemical or electrochemical processes. Used in electroforming for the manufacture of razor foils and meshes and for the fabrication of MEMS and NEMS devices.

Pickle

A solution used to remove oxides or other compounds from the surface of a metal by chemical or electrochemical action.

Pickling

Removal of oxides or other compounds from a metal surface, by means of chemical or electrochemical reactions. In the case of alkaline solutions, process called "Alkaline pickling", and with acid solutions is called "Acid pickling".

Pit

A small depression or cavity, often produced in a surface layer during the coating process. It can also be caused by corrosion.

Pitting

Very tiny superficial holes (pits) spread over the surface. Defect often occurs in deposits from bright nickel and bright acid copper plating solutions. Often caused by hydrogen bubbles which adhere to surface of the substrate which can be eliminated by adding wetting agent to solution. Sometimes a result of inadequate cleaning of the substrate before coating

Plastisol

A suspension of a finely divided resin in a plasticiser that can be converted to a continuous film by the application of heat. Distinct from baking enamels, etc, in that substantially all the original mixture becomes a part of the film; there is no significant evaporation of solvent. The films are usually much thicker than those obtainable from paint coatings which depend on the evaporation of a volatile solvent

Plating Range

The current density range over which a satisfactory electrodeposit can be obtained.

Polarisation

The change in the potential of an electrode during electrolysis, such that the potential of an anode always becomes more noble and that of a cathode becomes less noble than their respective static potentials

Polishing

The smoothing of a metal surface by means of the action of abrasive particles attached by adhesive to the surface of wheels or endless belts usually driven at a high speed.

Powder Coating

A 100% solids coating applied as a dry powder and subsequently formed into a film with heat.

Primary Current Distribution

The distribution of the current over the surface of an electrode in the absence of polarisation.

Pulse Plating

Electrodeposition using very short pulses (typically a few milliseconds) at high current density separated by longer intervals of zero current or reversed current.

Rack

See jig

Rectifier

Equipment that converts alternating current into direct current.

Reducing Agent

A compound that causes reduction, thereby itself becoming oxidised.

Reduction

A reaction in which electrons are added to a compound or more specifically, the addition of hydrogen or the abstraction of oxygen. Such a reaction takes place, for example, at the cathode during electrolysis.

(e.g. $2\text{ZnO} + \text{H}_2 \rightarrow 2\text{Zn} + \text{H}_2\text{O}$ or $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}^0$.)

Resist

A material applied to a part of the surface of an article to prevent reaction of the underlying metal during chemical or electrochemical processes.

Reverse Osmosis

A method of purifying water by applying pressure across an osmotic membrane.

Robber

An auxiliary cathode so placed as to divert to itself some current from portions of the work which would otherwise receive a too high current density.

Roughness

Co-deposition of conducting or non-conducting particles contaminating the process solution, perceived by eyesight and by touch.

Saponification

The alkaline hydrolysis of fats whereby a soap is formed; used to solubilise oils and greases in aqueous cleaning solutions

Shield

A nonconductor for altering the current distribution on an anode or cathode.

Solubility

Quantity of a salt which dissolves at a certain temperature in a set volume of water until achieving saturation point. For example: solubility of boric acid in bright nickel bath is approximately 50 g/litre at 60°C.

Solvent

A liquid, usually volatile, which is used to dissolve or disperse the film-forming constituents of a coating and which evaporates during drying and therefore does not become part of the dried film.

Specific Gravity see density

Stalagmometer

Apparatus for determining surface tension.

Strike Coating

A thin metal coating to be followed by other coatings.

Strip

Removal of a coating from a basis metal or an undercoat

Surfactant

Acronym for SURFace ACTive AgeNT
See Surface Active Agent.

Surface Active Agent

A substance that markedly reduces the surface energy of solutions even when present at very low concentration.

Surface Tension

Property arising from molecular forces of the surface film of all liquids which tends to alter the contained volume of liquid into a form of minimum surface area. The usual unit of measurement is Newtons per cm. The older unit is dynes per cm

Tarnish

The dulling, staining, or discoloration of metals due to superficial corrosion.

Throwing Power

A measurement of the thickness distribution of a coating over an article of complex shape

Through Hole Plating

Technique for depositing metal, usually copper, on the walls of holes drilled through a double sided printed circuit board.

Treeing

An uncontrolled and rapid deposition of metal during the deposition process. It can occur in both electrodeposition and electroless metal deposition. Treeing originates from asperities on the deposit's surface and looks like a fern or tree.

Viscometer

An instrument for measuring flow properties.

Volatile Organic Compounds - VOCs

Solvents, thinners, and diluents based upon organic liquids that rapidly evaporate.

Water Break

The appearance of a discontinuous film of water on a surface indicating surface contamination.

Wet Blasting

A process for cleaning or finishing by means of an abrasive slurry directed at high velocity against the work pieces.

Wetting Agent

A substance that reduces the surface tension of a liquid.

Whiskers

Metallic filamentary growths, often microscopic, sometimes formed during electrodeposition and sometimes spontaneously during storage or service.

Work

The material being coated or treated.