

## 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 solution 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 dm<sup>2</sup>**

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

**Anion**

An ion having a negative charge that will be attracted to any anode.

**Anode**

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

**Anode Efficiency.**-Current efficiency of a specified anodic reaction.

**Anodic current density**

Current density in A/dm<sup>2</sup> applied to the anode.

**Anodic cleaning**

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

**Anodic Coating**

A protective, decorative, or functional oxide coating, formed by the electrolytic oxidation of the surface of a metal.

**Anodising**

An electrolytic oxidation process in which the surface of a metal, when anodic, is converted to an oxide coating having desirable protective, decorative, or functional properties.

**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.

**Atom**

The atom can be considered as the smallest particle of matter though it is composed of electrons, neutrons, and protons.

**Automatic Plating Plant**

Plating plant in which the work is automatically conveyed through successive cleaning and plating 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 (or Cleaning)**

Plating or cleaning in which the work is processed in bulk in a rotating container.

**Base Metal**

A metal that readily corrodes or dissolves to form ions. The opposite of noble 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 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)**

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**

Is 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. that 95% of the current is used in nickel plating and 5% in releasing hydrogen and in other reduction reactions.

**Cation**

Positive charged atom or ion which moves to the negative electrode or cathode during electrolysis. Iron and copper etc., are cations.

**Chemical Deposition**

Deposition of metal layer by a chemical reaction using a reducing agent, the reaction of which is catalysed by the metal or by the alloy under which the metal layer is formed.

**Chemical Polishing**

The improvement in an smoothness of a metal by simple immersion in an 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,  $K$  = 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 of concrete 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.

## **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 electroplating 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.

## **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.

## **Deburring**

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

## **Density**

The mass per volume of a material normally expressed as g/ml or kg/m<sup>3</sup>.

**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 possess the ability to clean soiled surfaces. Can be anionic, cationic 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.

**Diffusion Coating**

An alloy coating produced by heating the coated component so that the coating diffuses into the substrate.

**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 an 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

**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.

**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.

**Electrogalvanising**

Electrodeposition of zinc coatings.

**Electroless Plating**

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 article to be coated which is an electrical conductor is made, 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 articles under the influence of the electric field, and when they give up their charge at the electrode (article) they are deposited 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.

**Electrorefining**

The process of anodically dissolving a metal from an impure anode and depositing it cathodically in a purer form.

**Electrowinning**

The electrolytic production of metals by using insoluble anodes in solutions derived from ores or other materials.

**Etch**

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

**Faraday**

The number of coulombs (96,490) required to deposit the electrochemical equivalent weight of a metal.

**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.

**Galvanising**

Application of a zinc coating, usually refers to hot dip galvanising.

**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 abrasive projected at the surface at high speed .

**Halogenated Solvents** The 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. 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).

**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. Source: matter other than vegetable or animal. Examples: sulphuric acid and salt. Exceptions are carbon monoxide and carbon dioxide and their derivatives.

**Ion**

A charged atom.

**Ion Exchange**

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

**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.

**Jig**

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

**Kelvin (K)**

Unit of measurement for temperature. The Kelvin scale starts from absolute zero, which is -273° 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.

**Limiting Current Density**

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

**Mat Finish (Matte Finish)**

A dull finish.

**Micron or Micrometre( $\mu\text{m}$ )**

One millionth of a metre, 0.001 mm.

**Mill Scale**

The heavy oxide layer formed during hot fabrication or heat treatment of metals.

**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.

**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.

**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. Sometimes, more specifically the combination of a reactant with oxygen.

**Oxidising Agent**

A compound that causes oxidation, thereby itself becoming reduced.

**pH.** - A unit of measure depicting the hydrogen concentration of a solution: Scale 1 to 14. Where 7 is neutral; <7 acidic; >7 basic.

**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 an a coating from a basis metal or undercoat.

**Periodic Reverse Plating**

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

**Photoresist**

A material applied to a metal surface that can be patterned by exposure to light subsequent chemical development. Used extensively in the manufacture of printed circuits to prevent reaction of the underlying metal during chemical or electrochemical processes.

**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 solution, process called "Alkaline pickling", and with acid solutions is called "Acid pickling".

**Pit**

A small depression or cavity produced in a metal surface during electrodeposition or 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 electroplate can be deposited.

**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 in an electrolysis.

**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.

**Robber**

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

**Roughness**

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

**Sacrificial Protection**

Corrosion protection where the coating corrodes in preference to the substrate, thereby protecting the latter from corrosion, e.g. a zinc based coating on steel.

**Saponification**

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

**Satin Finish**

A surface finish that behaves as a diffuse reflector.

**Scale**

An adherent oxide coating that is thicker than the superficial film referred to as tarnish.

**Sealing (of Anodic Coating)**

Process which, by absorption, chemical reaction, or other mechanism, increases the resistance of an anodic coating to staining and corrosion, improves the durability of colours produced in the coating, or imparts other desirable properties.

**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

**Surface Active Agent (Surfactant)**

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

**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.

**Viscometer**

An instrument for measuring flow properties.

**Volatile Organic Compounds - VOCs**

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