

DEFINITIONS AND ABBREVIATIONS

ac: Alternating current. Electrical current that has an alternating direction of flow, usually 50 or 60 cycles per second.

ACTIVATE: Remove passive film which is normally present or which forms quickly on certain metals. Usually conducted using an appropriate solution and forward current. Improves adhesion of the plating that follows.

ADHESION: The degree to which an electroplate is bonded or "sticks" to the base material.

ALLOY: A substance having metallic properties and being composed of two or more chemical elements of which at least one is a metal.

amp: Ampere. A measure of the rate at which electrical current flows through a conductor such as wire or a conductive solution. Comparable to rate (liters/gallons per minute) at which water flows through a pipe.

amp-hr: Ampere-hour. See **AMPERE-HOUR**.

AMPERE-HOUR: A measure of the quantity of electricity that flows through a conductor. Comparable to the quantity of water, liters or gallons, that flows through a pipe.

ANODE: Technically, the positive terminal in a solution. Metal ions in the solution flow away from the positive terminal. In the reverse direction, the workpiece is positive and there is a tendency to remove material or "etch" the workpiece. In the forward direction, the workpiece is negative and metal ions flow to the part, i.e. the workpiece is plated.

In common SIFCO Process terminology, the anode is the part of the plating tool that is intended to make electrical contact with SIFCO solutions.

ANODE-TO-CATHODE SPEED: The rate of movement of the plating tool relative to the surface being plated. The relative movement can be obtained by moving the tool, by moving the workpiece or by moving both.

ANODIC CORROSION PROTECTION: Corrosion protection offered by a deposit more noble than the base material. The deposit must be defect-free, since the base material will corrode in preference to the coating.

ANODIZED COATING: A non-conductive oxide coating formed on aluminum for corrosion protection and/or wear resistance. Thickness varies from 0.5 to 75 μm (0.000020 to 0.003 in.) depending upon the application. This type of coating must be removed prior to plating.

AREA (A): Surface to be plated in square centimeters or square inches. Used in SIFCO Process formulas.

AVERAGE CURRENT DENSITY (ACD): The current density at which a plating solution is used under average conditions. In the average case some conditions are not ideal; i.e., the plating solution is partially depleted, the plating tool or solution temperature is not optimum, and/or there is insufficient anode-to-cathode speed. Average current density values are generally used for SIFCO Process calculations and in the design of special tools. With a good set-up this value can be used as a guide as to the minimum current density that one should be able to draw.

BAKE: Heating a part for the time and temperature required to accomplish a purpose such as to improve adhesion or remove hydrogen.

BATH PLATING: Electroplating performed by immersing the workpiece in a tank of plating solution.

Bhn: Brinell Hardness Number. Also called Hardness Brinell or HB.

BONDING: See Preplating.

BURNED DEPOSIT: A loose, powdery, defective deposit applied by improper plating. Burned deposits tend to occur first at high current density areas, such as masked edges and sharp external corners, and can be recognized by being distinctly darker in color. A burned deposit can be covered, but the burned layer will have poor cohesion and the final surface will be rougher. Moderate, localized burning can be tolerated in most applications. Severe, overall burning requires that the plating operation be stopped to allow chemical, electrochemical, or mechanical removal of the burned layer. Plating can then be resumed after properly preparing the surface.

CARBURIZED: A part that has been case hardened by impregnating carbon in the surface and then heat treating the part.

CASE HARDEN: Hardening an iron base alloy, such as steel or cast iron, so that the surface layer or case is substantially harder than the interior.

CATHODE: Technically, the negative terminal in a solution. Metal ions in a solution flow to the negative terminal. In the "forward" or plating direction, the workpiece is negative and metal ions flow to it.

In common SIFCO Process terminology the cathode is the workpiece.

CATHODE EFFICIENCY: The percentage of current flow (amperes) or quantity of electricity (ampere-hours) that electroplates metal. The remainder of the total amperes or ampere-hours passed deposits hydrogen, most of which dissipates into the atmosphere.

CATHODIC CORROSION PROTECTION: Corrosion protection offered by a deposit more reactive than the base material. The deposit corrodes preferentially to the base material. The coating, therefore, does not have to be pore-free. Also called sacrificial protection.

CHROMATE COATING: A coating applied on many metals, often zinc and cadmium. The color of the coating varies from almost transparent to yellow or brown, and is applied for additional corrosion protection, decorative reasons, or as a base for paints.

COHESION: Tendency to hold firmly together as one piece.

CONSTANT FACTOR SOLUTION: A brush plating solution which yields a consistent volume of metal for a given amp-hr reading under variable current density and temperature conditions, as long as those conditions remain within the recommended ranges.

CONTACT AREA (CA): The area of contact made by a plating tool on the workpiece measured in square inches or square centimeters.

CURRENT DENSITY (CD): The plating current being passed per square centimeter or per square inch of contact area. The value may be determined by dividing the plating current by the contact area. When 10 amperes are drawn with a tool making 32.5 square centimeters (5 square inches) of contact with a part, the current density is 0.3 amperes per square centimeter (2 amperes per square inch).

dc: Direct current. Electrical current that flows in only one direction

DECARBURIZATION: Loss of carbon from the material near the surface of a part caused by a heating operation.

DENSE DEPOSIT: A deposit without voids, cracks, or pores.

DESMUT: To remove a loose, powdery, darker surface film formed by a previous etching operation.

DIFFUSION: The movement of atoms in a solid, liquid, or gas, which usually tends to make the system uniform in composition.

DPH: Diamond Pyramid Hardness Number. Also called Hardness Vickers or HV. A micro-hardness test, which is suitable for testing the hardness of thin or small areas, such as an electrodeposit.

DRAG-OFF: The solution left on the workpiece when plating is completed. This solution will be lost in the following rinse operation.

DUCTILITY: The property of a material that permits it to be stretched permanently without fracture. The opposite of brittleness.

ELECTROCLEAN: Electrochemically remove dirt, oil, grease and other foreign films from surface to be plated.

ELECTROLESS PLATING: A bath plating process that uses a chemical reduction process rather than direct current to deposit a metal or alloy. Chemical, rather than electrochemical, reactions are the driving forces in electroless plating.

ELECTROPOLISH: To polish a surface while electrochemically etching with a special solution.

ESTIMATED PLATING AMPERAGE (EPA): Amperage calculated based upon the contact area and the average current density for a given plating solution.

ESTIMATED PLATING TIME (EPT): Time calculated based upon the required amp-hr and the estimated plating amperage for a given job.

ETCH: Electrochemically remove material from a surface. Conducted using appropriate solution and reverse current.

FACTOR (F): The ampere-hours required to deposit the volume of metal equivalent to one micron thickness on one square centimeter of area or one inch thickness on one square inch of area.

FLASH: An extremely thin electrodeposit.

FORWARD CURRENT: Direction of electrical current flow in which metal ions tend to move away from the plating tool and toward the workpiece. The plating tool is positively charged and the workpiece is negatively charged.

FPM: Recommended anode-to-cathode speed for a plating solution in feet per minute.

FRETTING: Wear occurring between two adjacent surfaces caused by a minute back and forth rubbing movement or vibration.

FRETTING CORROSION: Fretting accompanied by the formation of oxides from small, worn off particles.

GALLING: The damaging of one or both metallic surfaces by removal of particles from localized areas during sliding friction.

GASSING: Evolution of gas bubbles on the workpiece, either by activating, plating, or chemical attack.

GRAIN STRUCTURE: All metals have a granular or cellular structure. The grain sizes vary from microscopic to perhaps 3 mm (0.125 in.) in diameter. Grain structure refers to the overall appearance of the arrangement of grains.

HARDNESS: The ability of a material to resist indentation. Brinell and Rockwell C are common hardness tests.

HEAT TREATMENT: One or more thermal operations performed on metals to change the mechanical properties of a metal or alloy.

HIGH CURRENT DENSITY AREA: The external corners and masked edges of a surface. Metal tends to deposit preferentially at these points.

HYDROGEN EMBRITTLEMENT: Embrittlement of a material caused by absorption of hydrogen. Occurs only with certain **high strength steels**, titanium, and certain harder stainless steels.

HYDROGEN EMBRITTLEMENT BAKE: Baking parts to remove hydrogen. Also called an EMBRITTLEMENT RELIEF BAKE.

IMMERSION DEPOSIT: A metallic deposit, which forms without current on more reactive metals by chemical reaction with certain plating solutions. Immersion deposits ordinarily have poor adhesion. Severe damage may simultaneously occur to the surface to be plated and/or adjacent areas.

IONS: Electrically charged atoms or groups of atoms in a solution. Metal ions are charged positive and migrate toward the cathode.

KNOOP: A microhardness test, which is suitable for hardness testing thin or small areas such as an electrodeposit.

MATTE: A dull, satiny appearance resulting from a fine microroughness.

MAXIMUM AMPERAGE OUTPUT (MAO): Maximum amperage output of the power pack.

MAXIMUM CONTACT AREA (MCA): Area calculated based upon the maximum amperage output of the power pack and the average current density of a given solution.

MAXIMUM CURRENT DENSITY: The highest current density that can be employed with a plating solution when plating conditions are ideal.

METERS PER MINUTE (MPM): Recommended anode-to-cathode speed in meters per minute.

MICROPOROUS: A type of deposit structure in which numerous fine pores exist. The pores are so numerous and fine that they can be seen at only high magnification.

MICROCRACKED: A type of deposit structure in which numerous fine surface-to-base metal cracks exist. The cracks are so numerous and fine that they can be seen at only high magnifications.

MICROSTRUCTURE: The structure of a deposit when viewed at 50X magnification or higher.

MILKY: A type of deposit appearance that is almost bright, but which has a cloudy appearance due to a very fine microroughness.

MRU(G): Maximum recommended use of solution in terms of ampere-hours per gallon.

MRU(L): Maximum recommended use of solution in terms of ampere-hours per liter.

NITRIDED: A case hardened surface on certain steels formed by heating in a nitrogen containing material. Nitrogen diffuses into the surface, which results in a hard case.

NOBLE METALS: Metals may be classified according to their tendency to be corroded or chemically attacked. The noble metals are less easily corroded or chemically attacked. Refer to Part II, Section 2, Table 2-5.

NODULAR: A type of deposit structure having rounded projections on the surface, which are visible upon close examination by the naked eye.

OPTIMUM CONTACT AREA (OCA): The lesser of the PCA or the MCA.

OXIDE: Reaction product of a metal with oxygen.

pH: A measurement value of the acidity or alkalinity of a solution. Zero (0) for example, is strongly acidic, 4 less acidic, 7 neutral, 10 mildly alkaline and 14 strongly alkaline. Severe damage may be caused to certain metal surfaces by strongly acidic or alkaline solutions.

PASSIVATE: To form a thin, invisible oxide film on certain metals that impairs adhesion of a following electroplate.

PHOTOMICROGRAPH: Photograph of an object at higher than 10X magnification usually to show the structure of a material.

PIT: A small depression or cavity produced by corrosion or during electrodeposition.

PLATING AMPERAGE (PA): The amperage being used while plating.

PLATING IN COVER: A noticeable metal build-up in the cover material, which occurs during the plating operation with certain plating solutions and cover materials, and during long-run plating operations. Plating in the cover will result in climbing plating amperage as the cover becomes more conductive. It will tend to cause the plated deposit to become shiny, due to the burnishing effect of the metal in the cover rubbing against the plated deposit. Finally, plating in the cover will result in less metal than desired being deposited on the part.

PLATING RATE: The rate at which a deposit builds up. In this manual it is expressed in inches per hour or microns per hour.

PORES: Small random holes just barely visible to the naked eye.

POROUS DEPOSIT: A type of deposit that contains pores.

PRACTICAL CONTACT AREA (PCA): The amount of plating tool to workpiece contact area that is physically practical or possible, given the shape and size of the part to be plated.

PREPLATING: Applying a thin preliminary deposit using a bonding solution other than the final desired solution. Preplating is used to improve adhesion and/or as a diffusion barrier.

PREWET: Applying solution to the surface before applying current. This is usually done by placing the plating tool on the part for a few seconds with the plating tool lead disconnected or the power pack shut off. Other parts of this manual indicate where prewetting is desirable or undesirable. Significant improvements in etching, plating, etc., will result by following these instructions. Where no specific instructions are given, prewetting is optional and has no significant effect in a preparatory or plating operation. Also called swab.

R_C: Rockwell C Hardness Number.

REACTIVE METALS: Metals may be classified according to their tendency to be corroded or chemically attacked. The reactive metals are more easily corroded or chemically attacked, and include metals such as aluminum, magnesium, steel, and zinc.

REACTIVATION: Preparation of a plated deposit to receive an additional layer of the same or of a different deposit.

REVERSE CURRENT: Direction of electrical current flow in which metal ions flow away from the workpiece and toward the plating tool. The plating tool is negatively charged and the workpiece is positively charged.

SACRIFICIAL CORROSION PROTECTION: Cathodic corrosion protection.

SCALE: Heavy surface oxidation on a metal resulting from heating in air or in an oxidizing atmosphere.

SEIZING: Same as GALLING.

SMEARED METAL: Deformed material near the surface resulting from machining, grinding or wear.

STRESS: Pressure (force per unit area) existing in a deposit. Tensile stress is a "pulling apart" type of stress. Compressive stress is a "pushing together" type of stress.

STRESS CRACK LIFTING: The type of deposit structure resulting from the development of surface-to-base metal cracks due to tensile stress in the deposit and then curling up of the edges due to poor adhesion. Can be seen visually, or at low magnification. Similar in appearance to a dried up, clay lakebed.

STRESS CRACKS: Random cracks running from the plated surface to the base material. Can be seen visually or at low magnification. Detrimental, normally, only when corrosion protection is desired of the plating.

STRIKE: Same as **PREPLATE**.

STRIPPING: Removing an electroplate from a workpiece by chemical or electrochemical means.

TANK PLATING: Same as **BATH PLATING**.

THICKNESS (T): Thickness of the deposit to be plated, stated in terms of inches or microns.

VARIABLE FACTOR SOLUTION: A brush plating solution which yields varying volumes of metal for a given amp-hr reading under variable operating conditions, such as freshness of solution, current density, and temperature.

VOLT: Unit of measure of electrical potential. The higher the electrical resistance in the system, the higher the electrical potential that is required to maintain a given current flow.

WATER BREAK: The breaking of a water film into beads such as on a waxed car, which indicates that the surface is not clean.