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BRUSH PLATING - PRESENT STATE OF ART

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Brush plating was initially used to plate common metals like copper, nickel and gold. In this review recent literature available on brush plating has been updated. In this, it is indicated that it can be used for anodising, electropolishing and for alloy plating and it also includes the details about the basic equipments, anodes and solutions used in brush plating.

Keywords: Brush plating, reverse current, power pack, etching.

INTRODUCTION

An electroplating process performed with a hand held portable tool rather than a tank of solution is known as brush plating. The brush plating processes are also called as contact plating., selective plating or swab plating. In recent times it is termed as electrochemical metallizing. This term is justified because it involves deposition of a metal on a surface by electrochemical means. This is essentially a plating method, where the work is connected cathodically to the current source, the plating is then applied by means of a brush or swab, soaked with solution and connected to a flexible anode cable.

Equipment materials and solutions

Tank plating rectifiers and solutions can be used for brush plating only when a thin deposit is needed on a small area and quality is relatively unimportant. Details regarding equipments and solutions are well documented in [1-12]. All modern equipments specially designed for brush plating are proprietary. Brush plating equipment includes power packs, solutions, plating tools, anode covers and auxiliary equipments. The basic metallizing system is given in Fig. 1.

Power packs transform A C current into D C current . Although tank-plating rectifiers perform a similar function, power packs specifically designed for brush plating have several features which differ from rectifiers.

Power pack should be portable. The maximum output voltage should be 25 V under full load. Power packs should have

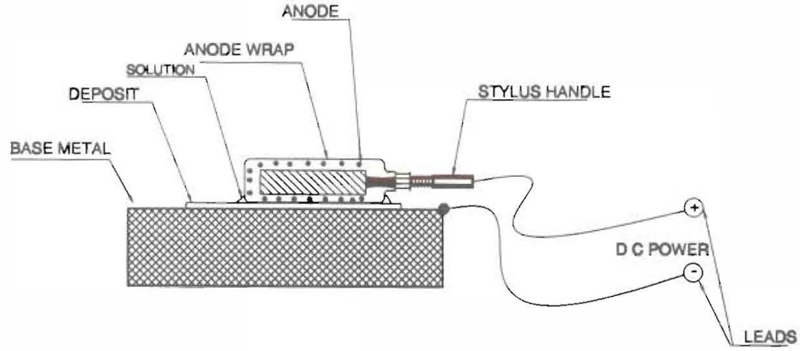

Fig. 1: Basic metallizing system

forward and reverse current switches so as to be able to change the direction of D.C. current. Present day power packs are microprocessor controlled. Included in the power pack is an on-board software programme, an operator can enter all data required to carry out a specific plating operation.

Plating tools

Tools used for brush plating are known as stylus. They are used to prepare as well as plate the surfaces. The plating tool consists of the following elements, a handle with electrical input connectors, an anode, an anode cover and some provision for cooling of anodes. Only insoluble anodes are used for brush plating. Graphite and platinum are generally used as anodes in brush plating. Selecting the correct tool also ensures the uniformity of plating thickness. An important aspect of the brush plating process is the selection of an anode cover. The cover insulates the anode from the part being plated thus preventing a short circuit from occurring which might damage the part. It also forces the D.C. to pass through the solution, which allows the electro cleaning and electroplating processes to occur. The cover holds the solution and uniformly distributes it where it is needed. It also mechanically scrubs the surface being plated, permitting sound deposits to be applied. Surgical cotton batting, glass wool and cellulose are used as anode cover.

Large amount of heat develops between the anode and the part being plated. Most tools incorporate some means of cooling the anode. For small styli air-cooling is done by incorporating cooling fins.

Brush plating solutions

The earliest solutions used for contact plating were the same solutions normally used in bath plating. The brush plating solutions are non-cyanide. They do not contain high concentration of mineral acids. The solutions available in the market are advertised as highly chelated, metallo-organic compounds to which have been added organic solvents, stabilizer wetting agents, with a pH between four and nine. In these solutions higher current densities can be used. Rapid movement of the brush or stylus against the work, the heat generated and the constant replenishment of brush solution result in higher allowable current densities. The characteristics of brush plating solutions and deposits are given in Table I.

Preparation of basis metal prior to brush plating

Surface preparation for brush plating consists of two to four steps, namely, precleaning, electrocleaning, activating and bonding. The first two steps are always required. The need for the last two depends on the basis metal and the deposit. Summary of preparation procedures of basis metal is given in [13-14].

Metallurgical properties

Selective plating deposits have somewhat different metallurgical properties from those encountered in ordinary plated work. All localized platings have an extremely low porosity. This low porosity is due to high concentration of metal ions in these solutions. Selective plating deposits are slightly dense and harder than bath deposits. Selective plated parts show negligible hydrogen embrittlement, low stress and less fatigue loss than equivalent deposits from a bath. The lower hydrogen content results from the fact that plating is taking place near the boiling point of the solution. The lower fatigue loss may be due to the absence of cyanides, which seem to have a detrimental effect on fatigue resistance. In addition to this the milder cleaning required prior to selective plating tends to have a less destructive effect on the surface skin of parts being plated.

Advantages of brush plating over bath plating

When only a small area of plate has been damaged, it is much simpler to retouch than to strip and replate. Components must often be disassembled before bath plating and some will be too large for doing plating using tanks. Many parts like assembled electronic components (e.g. printed circuits) and wired electrical assemblies couldn't be immersed because solutions would contaminate existing components. In these cases only brush plating should be used. On many occasions it may be more convenient to bring metal deposition facilities to the component rather than take

TABLE I: Characteristics of brush plating solutions and deposits

Metal or solution	Properties of solutions: Current density conventional bath	A/sq. ft basic solution A[a]	B[b]	Approx metal content g/l	Avg time to deposit 0.001 in sec
Cadmium	10-50	700	1400	202.203	25.4
Copper	25-250	900	5600	71.145	25.4
Gold	2-250	300	1900	89.868	76.2
Chromium	100-400	1900	3700	82.379	63.5
Nickel	10-100	1200	4700	97.357	25.5
Silver	5-100	700	1200	254.626	50.8
Zinc	5-100	900	2800	97.357	25.5

a = not cooled or slightly air cooled; b = water cooled anode the component to the facilities. Brush plating has been used on church domes, electrical power lines and flood control dams in remote areas.

Brush plating permits greater adhesion to refractory metals, aluminium, stainless steel and carbon when compared with conventional plating. Brush plating needs no elaborate masking on complicated components needing build up on limited areas only.

Reverse-current applications

Electrochemical metallizing normally deposits metal and are frequently called a metal put on tool. Recent development shows that it can be used for reverse current applications and also for metal removal. Reverse current electrochemical method can be used (1) for metal removal for precision resizing purposes; (2) for etching metal surfaces to expose crystalline structure and provide a matte surface or a better base for bonding; (3) for micro deburring; (4) for flash or smear removal; (5) for removing heat stains from welded stainless steel; (6) for electropolishing; (7) for etching through a stencil for marking purposes; and (8) for brush anodizing.

Basically the same equipments and tools can be used for metal removal as well as for metal deposition. A flick of the reversing switch and a change-over from metallizing solutions to etching, activating or electropolishing solutions are all that is required.

Electrochemical etching and resizing

Reverse current etching with electrochemical metallizing equipment removes amorphous or smeared metal or broken crystals from the surface and exposes the crystalline structure of the underlying metal. Since superior molecular bonding of subsequent deposits is obtained when the crystal border of the deposited metal is a continuation of the crystal border of the base metal, etching strongly improves metal to metal adhesion.

Such etching, however need not be just a deposit preparation technique. By refracting light, the exposed crystalline structure imparts a matte finish to the component surface. Coarse matte or fine matte finishes are possible, depending on the speed of etching. Coarse matte finishes provide a high friction surface or a better bonding base for paints or flame spray deposits. A fine matte finish is cosmetically more pleasing. This method is said to be normally faster and more precise than mechanical methods of machining. Oversized shafts, undersized bores or other cylindrical parts can be sized while being rotated in a drill chuck. Surfaces may be reduced to millionths of an inch (0.25) or less. Electrochemical metallizing also removes and deposits metal for precision balancing of rotating assemblies.

Smear and stain removal

The metal removal process can salvage motors whose commutators or cores have become "smeared" during mechanizing. The metallic smears partially short circuit the windings and reduce the motor's efficiency. To salvage the motors a strong acid takes away the bulk of the metal and a milder solution then provides a fine surface finish. Stain removal is also a viable application for reverse electrochemical metallizing. Brazing of stainless steel always gives heat discoloration of adjacent surfaces such stains are readily removed by using reverse current and a properly formulated etching solution.

Marking

Used with stencils reverse-current etching can mark guidelines for identifications of metal parts. Fine-line demarcation is possible on instruments, in holes, slits, or other places that are not accessible for mechanical equipment.

Electrochemical polishing

Electropolishing takes place because rough surfaces consist of microscopic high and low points. The reverse-etching operation of the electropolishing solution preferentially removes metal from high points, where the current density is highest. Dissolved metal from these high points goes into solution and the resulting metal salts tend to collect in the "valleys" or microscopic low areas further increasing resistance to current flow. Additional dissolution thus is concentrated at high points and the leveling action is accelerated. The movement of the stylus anode over the surface assists this procedure, since it pushes the concentrated salts off the tops of the high points, exposing them to electrolytic action. The end result is a smoother more "polished" surface.

Optimum voltages ranging from 5 to 40 V (mostly 5 to 15 V) are used for electropolishing depending on the electropolishing solution. Current densities of the order 1000 to 1500 ampere or more per square foot of anode-cathode surface contact are common. Different electropolishing solutions are used for copper, aluminium, stainless and carbon steel [15].

Tin alloy coatings of aluminium bearings by brush plating

Current diesel engine developments require increased load carrying capacity with thin hydrodynamic films and an improved resistance to wear and seizure. Extremes of wear resistance/fatigue strength and seizure tend to be virtually incompatible requirements in an engine bearing and hence a compromise is inevitable. One of the preferred options to meet these requirements is the over lay plated aluminium alloy that usually receives electrodeposits of either lead-tin or lead-tin-copper. To achieve adequate adhesion, zincate immersion process followed by a thin nickel electrodeposits is necessary. However, pure nickel does not have good anti-scuffing properties and seizure may occur under circumstances of rapid wear; its omission from the sequence would be beneficial. Recently brush plating was used [16-18] as a novel means of electrodeposition on to plain bearing. One of the potential advantages of brush plating is due to electrodeposition of the overlay on to the aluminium eliminating not only zinc alloy film and nickel but also part of the cleaning process [19-20].

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