CHAPTER III

GENERAL PRINCIPLES OF ELECTROPLATING

3.1 Electrochemical Terms (8)

Anode - The positively charged electrode. The electrode in electrolysis at which negatively charged ions, (anions) are discharged or positive ions are formed or other oxidising reactions occur.

Anion - Negatively charged atom or group of atoms (a radical) which on electrolysis is attracted to the anode.

Cathode - The negatively charged electrode. The electrode in electrolysis at which positives ions (cations) are discharged, or negative ions are formed or at which other reducing reactions occur.

Cation - Positively charged atom or group of atoms (a radical) which on electrolysis is attracted to the cathode.

Ion - Atom or group of atoms which has gained or lost one or more electrons and thus carries a negative or positive charge.

Electrolyte - A conducting medium in which the flow of current is accompanied by movement of matter. Most often an aqueous solution of acids, bases or salts. An electroplating electrolyte must contain dissolved salts of the metal that is to be deposited.

Electron(e) - A fundamental negatively charged particle, part of an atom. If an atom loses an electron, it becomes positively charged i.e., a cation, or if it gains an electron, it becomes negatively charged, i.e., an anion.

3.2 Electrodeposition

Electrodeposition is the application of metallic coatings to metallic or orther conductive surfaces by electrochemical processes.

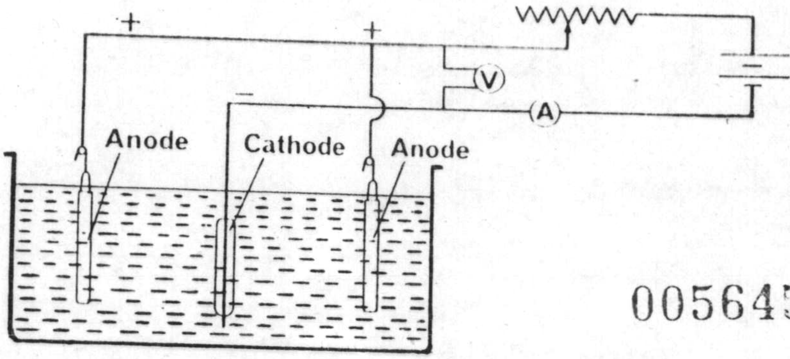

Fig. 6 Electroplating processes.[8]

The article to be electroplated is immersed in a solution containing dissolved salts of the metal to be deposited and made the cathode by connecting it to the negative lead of a low voltage D.C. supply. To complete the electrical circuit anodes are immersed in the solution and these are connected to the positive lead. Current from the D.C. supply is carried through the external circuit by electrons (electronic conduction) to the plating bath. In the bath electrolyte current is carried by ions (electrolytic conduction). At an electrode surface, charge (as electrons) is transferred between ions in solution and the electrodes; the same total charge per unit time flowing through both anode and cathode. The potential applied between anode and cathode is the driving force for the transfer of charge across the metal solution interface, and amongst other things its value determines the rate of charge transfer. The potential for commercial deposition processes is usually between 2 and 16 volts D.C. applied between anode and cathode and derived from a transformer-rectifier set. For small laboratory scale plating, accumulators or dry cells may be used.

3.3 pH of a Solution

The pH value is a convenient way of expressing the free hydrogen ion concentration and hence the active acidity or alkalinity of a solution. The scale extends from pH = 0 for completely hydrated strongly acid solutions to a pH value of 14 for strongly alkaline solutions, with a value of 7 for neutrality. In aqueous solutions a small proportion of the water molecules 'ionise' to give hydrogen and hydroxyl ions. The arithmetical product of the hydrogen ion and hydroxyl ion concentrations is a constant, thus if there is an increase in the hydrogen ion concentration (the solution becomes more acid), there is a corresponding fall in the hydroxyl ion concentration. In neutral solutions the hydrogen and hydroxyl ions are present in equal numbers. Acid solutions contain an excess of hydrogen ions and alkaline solutions a deficiency of hydrogen ions, i.e. an excess of hydroxyl ions. It is the hydrogen ion concentration which forms the fundamental basis of the pH scale. The actual value of the hydrogen ion concentration is however extremely low, and for convenience is expressed as its negative logarithm .

$$\text{i.e. } pH = -\log 10[H^{+}]$$

where $[H^{+}]$ is the active hydrogen ion concentration in gramme ions per litre.

Water, which is neutral, has a hydrogen ion concentration of 0.000000 1 or 10^{-7} gramme ions per litre. For simplicity this is described as having a pH of 7. As previously mentioned, the more acidic a solution becomes, the lower is the pH, and conversely the more alkaline the higher is the pH.

A pH change of 1 represents a tenfold increase of decrease in the hydrogen ion concentration, e.g.,

pH 4 = 0.000 1 gramme ions per litre

pH 5 = 0.000 01 gramme ions per litre

It is emphasized that pH is a measure of the free or active acidity or alkalinity of a solution, and not of the actual acid or alkali concentration. It is for this reason that additions of strong acids, such as sulphuric acid or hydrochloric acid have a much ageater relative effect upon the pH of a solution than weak acids, such as boric acid.