CHAPTER I

INTRODUCTION

Plating on Plastics

Since the begining of 1964 the ability to electroplate plastics has become an important consideration to a wide range of industrialist in all of the technically advanced countries. This may be attributed, in some respects, to the rapidly expanding electronics industry where the demands for metal-dielectric combinations have increased considerably. In the last ten years, a tremendous growth in the plating industry has been observed, but in no area concerning the plating of plastics. Simultaneously, progress has been made in the plastics field itself. For industrial and domestic products, companies and customers are canstantly searching for new ways to make products cheaper, better, more attractive, and more durable. One of the great steps forward has been the improved techniques for the adhesion of electrodeposited metals on to various plastic substrates.

The plating of plastics has proved to be one of the most significant developments in electroplating since the discovery of bright chromium. Today, the plating of plastics is of widespread interest in both the plating and the plastic industries all over the world. By using electroplated plastics, it is possible today to

utilise the advantages of both materials, metal and plastics, in combination. These include the car industry in applications ranging from knobs and emblems to complete facias and even bumpers; the building and allied industries for bathroom and kitchen fittings and accessories, door and drawer handle knobs, lighting fixture, locks and catches, shower heads, and bath control; in the home appliance industry for radio and TV cabinet fronts, knobs and trim parts for washing machines, refrigerators; and in a multitude of other applications.

There are many methods for electroplating plastics, a great deal of research has been concentrated on electroless technique, This process has been exploited commercially and can produce plated parts in vast quantities.

Electroless Plating of Plastics

Electroless deposition involves the continuous formation of metallic coating from metal ions by chemical reduction, without the use of electrical currents. Thus coatings can be produced on non-conducting surfaces. The distribution of the metal over an irregular shaped surface is very uniform. Electroless deposition requires that the substrate surface be made sufficiently conductive to make possible electrodeposition of metal. The surface should also be prepared to allow for good adhesion of the metal which is to plated on to the substrate. At present, chemical etching is the most

widely used technique to provide microroughness on the substrate to ensure good adhesion. After etching the plastic surface is sensitised and activated by treatment with tin solution and palladium or silver salts solutions, respectively. This surface will permit metal from electroless copper or nickel plating solution to deposit and further metallization can be performed by conventional electroplating process. Since electroless technique is an effective method of plating on plastics, it is instructive to study the effects of various parameters on the process, e.g. operating conditions and chemical compositions of the solutions use during the process.

Advantages of Electroplated Plastics

In the past, the use of electroplated plastics was purely for decorative purpose, but nowadays they fulfil a functional purpose as well. Various applications within the electronics industry require the combination of properties derived from both dielectric and metal substances, which neither can supply alone. The following list illustrates the advantages obtained from electroplated plastics.

1. Corrosion resistance is considerably enhanced. Most of the deterioration of plated metal results from corrosion of the basis material which causes the plating to disintegrate, peel and discolour. Selected plastic materials are not affected by normal corrosion attack and therfore the plated deposit will last longer and withstand harsher conditions, provided that it is properly applied.

2. By depositing a metal on the surface, the surface of plastics material becomes electrically conductive.

3. A vast improvement is obtained in the mechanical properties. Tensile, flexural and impact strength together with abrasion resistance are increased. In addition, heat distortion point occurs at higher temperature.

4. A large saving in weight is obtained, in application where electroplated plastics are used in place of metals. This is of particular importance in military equipments and space applications.

5. Various polymers are dissolved or attacked by certain solvents but an electroplated coating will protect them from such attack.

6. In some applications the plastic base material acts as a heat insulator so that it offers a technical advantage in the manufacture, for example, of domestic iron handles, oven door handles, etc..

Not all plastics are currently commercially plateable, commercially plateable plastics are essentially mixtures, the principal constituent is a polymer or more than one polymer either blended or copolymerised. One of the first polymer to be plated on a large scale is the acrylonitrile butadiene styrene plastics, the properties of which are discussed below (Muller, 1967).

Acrylonitrile Butadiene Styrene Plastic (ABS)

Recently, a new process has been developed whereby acrylonitrile butadiene styrene plastic (ABS) can be satisfactorily electroplated (Muller, 1967). ABS is a terpolymer containing the three monomer, acrylonitrile, butadiene and styrene. Differences in the various material grades and manufacture together with predetermined alteration in monomer ratio give rise to materials with a wide range of properties. In general, ABS has very good resistance to inorganic salts and alkalies, fair resistance to acid, but is not particularly good in organic solvents such as ketones, aldehydes, esters, and chlorinated hydrocarbons. It does not absorb moisture. It is subjected to stress cracking by certain chemicals like glacial acetic acid. The outstanding property of ABS plastic is the unusual combination of rigidity and high impact strength which makes it desirable for many applications. It is abrasion resistant and has excellent dimensional stability. The dissipation factor and dielectric constant of ABS plastic are fairly low and relatively independent of frequency over the range of 10 - 10^6 c/s. Electrical properties are not particularly affected by temperature and humidity. ABS is suitable for secondary insulation purpose, flammability of the material eliminating it foruse as primary insulator (Goldie, 1965).

ABS is the first polymer to be successfully plated on a large commercial scale. It is now accepted as the plastic that is most used for components that will require chromium electroplating. Other polymers have been plated satisfactorily on a small scale for special applications (Goldie, 1969).

Purpose and Scope of the Research Work

The present work is intended to study various parameters affecting the process of depositing metal on to plastic material. ABS plastic is selected to be used in studying the performance of chromium plating on plastic because of its high chemical resistance and excellent mechanical properties. The process is based on the electroless technique. This technique is divided into three main stages as follow:

1. Pretreatment; the plastic surface is prepared to allow good adhesion between plastic and metal layers.

1.1 Cleaning; degreasing and removing surface contamination from the plastic surface is carried out by using alkaline cleaning solution.

1.2 Etching; this step provides more cleaning and produces microroughness on the surface of the plastics. Suitable solutions have to be selected.

2. Electroless Plating; this stage is the application of conductive layer on to the surface of ABS plastic. It can be divided, respectively, as follow:

2.1 Sensitising; this step produces an unnoticeable organo-metallic compound layer on the surface of the plastic. Solution used in this process is a mixture of stannous chloride and hydrochloric acid.

2.2 Activating; two types of activating solutions are choosen, palladium chloride solution and silver solution.

2.3 Copper or Nickel Electroless Plating; copper or nickel is chemically deposited on the surface of the plastic and made the surface electrically conductive enough to follow by electroplating. Electroleas copper solution uses copper sulphate as the source of copper metal. Electroless nickel solution can use either nickel sulphate or nickel chloride as the source of nickel metal.

3. Electroplating; the final stage is carried out after the electroless plating. The specimens can be treated by conventional Ni - Cr electroplating.

The final phase of the work is to study to qualify the adhesion between plastic and metal layers. The experimental work is concentrated

on the effects of varying etching compositions which may effect the degree of plating adhesion. Adhesion between plastic and metal is examined by the peel strength test. The keying between plastic and metal is also investigated by microsectioning technique. Corrosion test (by CASS Test) is performed to study the corrosion resistance of the plating specimens (ASTM B-368-68).