INVESTIGATION OF ELECTROLESS DEPOSITION FOR THIN FILMS IN INTEGRATED CIRCUITS

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CHAPTER 1

INTRODUCTION

The major methods for thin-film deposition are electroplating, chemical plating, thermal growth, anodization, vapour phase deposition, vacuum evaporation, sputtering and stencil screening. Several of these methods are used on a commercial scale, and many other techniques having important future applicability are still under investigation.

Most types of film required can be produced by the vapour phase, evaporation and sputtering methods. However, these methods use more expensive equipment and should be avoided if only a limited amount of funds are available. The choice of method depends on compatibility, the quality of component required and cost. Uniformity of film thickness, composition, electrical characteristics and good adhesion to the substrate are the major requirements for good thin films.

In electroplating, a metal ion in a suitable solution is reduced to the corresponding metal at a suitable cathode and deposited as a metallic coating by the use of an electric current. The rate of deposition is chiefly dependent on the current density. On the contrary chemical plating does not use an external current source to reduce metal ions but employs several other ways of reducing metal ions. The principal reactions of chemical plating are as follows:

1.1 Displacement

Campbell[3] said, "If one metal is immersed in a solution containing another metal it is possible to obtain dissolution of the one and the deposition of the other in its place. The deposition is essentially electrolytic in action and generally results in an uneven deposit." e.g.

$$CuSO_4 + Fe \rightarrow Cu + FeSO_4$$

1.2. Non-Catalytic Deposition

Formaldehyde (HCHO) is a very strong reducing agent in alkaline solutions. Add HCHO to silver nitrate ($AgNO_3$) and ammonia (NH_4OH) solutions. The substrate surface in the bath gets a metallic silver deposit by reducing this solution with HCHO. This process differs from electroless deposition because plating thickness cannot be built up. Silver is not a catalyst for this reducing agent. Only a limited number of metals deposit in this way.

$$Ag^{+} \xrightarrow{HCHO} Ag + e$$

1.3. Electroless Deposition

Brenner[2] has written, "the development of the electroless plating process came about as the unexpected result of an electroplating experiment. The process is a unique method of chemical plating which differs from the displacement processes and the familiar silver reduction process in that thick coatings can be built up. In this respect it resembles electroplating and for that reason, has been given the name electroless plating. The process is a controlled autocatalytic reduction of nickel or cobalt ion by hypophosphite ion on certain catalytic surfaces and results in the production of a sound coherent coating of metal. Since nickel and cobalt catalyze the process, deposition of metal continues on nickel or cobalt deposits after they have once been laid down. The process has three distinct advantages over electrodeposition: 1. Coating deposit with uniform thickness in recesses as well as on exposed parts of objects. 2. No build-up of coating occurs on points or edges. 3. No electrical equipment is required."