Chapter 8
Electroless Coating on Non-Conductive Materials: A Review

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ABSTRACT

This chapter attempts to make a review of electroless metal deposition over various non-conducting substrates like for its application in the field of medical research, electrical and electronics units, household aesthetics, automobile and textile industries. Electroless coating of metals over conducting substrates have been developed, critically reviewed, and proven its worth by showing excellent desired properties over the years. This review aims to discuss the techniques that have been applied by the researchers to overcome the difficulties of coating on these materials, their influence in their physical and mechanical properties, and their prospects of use in the industries. With the discussion of the underlying coating fundamentals and its historical backgrounds, the emphasis was put into the coating deposition with sensitizations and activations of various substrates, electroless baths, and the characteristically changed properties of the materials observed in the analysis.

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INTRODUCTION:

Electroless deposition is a uniform coating method of metallic layer on the substrate surface through chemical reduction. In this technique metals like, nickel, copper, silver and gold can be deposited on substrate surface without the use of electrical energy. The idea of coating metallic nickel, on mostly conducting materials from aqueous bath with the help of sodium hypophosphite came into existence, when Wurtz revealed it in 1844. Then the era of electroless nickel coating started with the rediscovery work of Brenner & Riddell (1947).It was also taken into account that Mallory and Hazdu in 1990 were successful in finding the reducing action of sodium hypophosphite which stood as a stepping stone to successful electroless nickel coatings over conductive materials in the future. Sharma, Agarwala and Agarwala (2006) investigated thoroughly upon the techniques of the coating that helped researchers to find interesting facts too. Extensive studies over nickel-phosphorus and nickel-boron coatings over metallic substrates were made with the use of their respective reducing agents such as sodium hypophosphite and sodium borohydride. With the aim to develop excellent wear, friction and corrosion resistant hard electroless nickel coating, their micro mechanical properties were studied by numerous researchers (Balaraju, Narayanan & Seshadri, 2006).The idea of incorporating a second phase particle into the electroless nickel bath dates back in the year 1960 when Oderkelen (1972) tried to impose a structure of intermediate layer which contained fine divided particles distributed within the metallic matrix. Likewise, the introduction of alumina particles in the nickel-phosphorus matrix was done by Metzer (1973).

Electroless coating on metals, which are fortunately conductive materials, have been being the scope of work for researchers till now. In this field of research, scientists got ample opportunity to study the techniques with dedicated involvements with their aim to get conductive materials with superior physicochemical surface properties. An electroless plating bath in general consists of source of metal ions, reducing and complexing agents, Stabilizers, Wetting and buffering agents. This bath is generally kept at suitable operating temperature. In previous works of scientists, involving electroless coating /plating of conductive materials (metals mostly) included metals like Copper, Nickel, Gold, Palladium, Silver, etc. were deposited over a metallic substrate. Researchers came a long way from single metal deposition to incorporation of phase, 1, 2, 3 element forming electroless alloy, alloy composites and nano-composites of conducting materials. Due to extensive use in industries, the electroless alloy composites of Nickel-Phosphorus or Nickel-Boron gained popularity and the percentage of its use being near to singularity or hundred. Thus, often synonymously the word “electroless” started to relate nickel/phosphorus alloys. From Sudagar, Lian & Sha (2013) one can get a critical review of the electroless nickel/Phosphorus and nickel/Boron alloys.

The applications of Electroless coated materials (conducting/metals) have been really wide considering the aspect of its uses in industries. They found the way in the sector of aerospace, aviation, electrical, electronics, textile, automotive and many more (Agarwala & Agarwala, 2003). The choice of electroless alloy/alloy composites in these industries were based on certain mechanical and physicochemical properties which showed highlighted predominance viz. (a) its characteristics of being uniform with respect to deposition over substrate as well as its physical and chemical properties, (b)Excellent corrosion and wear resistance, (c)The ability to get welded and soldered easily, (d)The structure possessing high hardness with microcrystalline deposits, and (e)even showing magnetic properties with resilience. Likewise, different alloys with economical electroless technique were coated for the desired properties, but among all, nickel singly turned out to be widely accepted and applied in the industries. Several electroless coated alloy of nickel became notably famous with the incorporation of third and fourth phase materials in the