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PROTECTIVE COATINGS FOR CORROSION CONTROL

BY

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Abstract

Corrosion - a phenomena by which a metal or alloy is degraded or oxidized to its most stable form. Corrosion prevention is an age-old technology but still research is being carried out in this field due to mostly the economic impact and the technical importance. Various methods are available for corrosion prevention and they have found their own commercial applications. Among these various methods electroplating or electrodeposition has established itself as one of the important method to prevent corrosion due to its ease of mass production and adaptability to the environment.

Electrodeposition of Zn metal is one way of obtaining a sacrificial coating, by addition of few noble metals like nickel or cobalt the protective property of these coatings can be increased to a certain extent. In this study an attempt is made to increase the efficiency of the electroplating process by two different agitation processes that is sonication and air agitation.

Experimental results reveal that zinc nickel deposits obtained under sonicated condition has high nickel content when compared to the deposit obtained under air agitated condition. SEM, EDAX, AFM, open circuit potential measurements are the experiments carried out to study the morphological changes induced by the change in mode of agitation.

Sonication of zinc cobalt deposition results in a coating, which is less noble compared to the air agitated coating. At low plating current densities sonication of zinc cobalt deposition leads to a crystalline deposit. AFM results of the zinc nickel deposit obtained under sonicated condition show the deposition of nickel as a separate phase at higher plating current densities. These results prove that the deposition assisted by sonication would become a more viable method of plating. The importance of deposition under sonication would be due to the higher concentration of the nickel at comparatively lower current, in the case of

zinc-nickel alloy deposition. For zinc-cobalt alloy, concentration of cobalt is uniform with variation in plating current densities.

Thin films of multi element metal oxide are grown on mild steel substrate. The film was obtained by spray pyrolysis technique starting materials are zinc nitrate and ferric chloride solution. Thin films were obtained at various temperatures and the changes in the properties of the film with the increase in processing temperature were studied. The film obtained at 400 °C was found to be Zinc Ferrite- a mixed oxide of zinc and iron.

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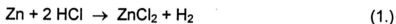
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they have very stable covalent bonding, primarily between carbon atoms. The degradation of such materials does not come under the definition of corrosion.

1.1 Fundamentals of corrosion

As said above, "corrosion is a result of chemical reaction between a metal or metal alloy and its environment, usually a destructive one", this destructive reaction in an aqueous solution involves electron or charge transfer. The electron activity or availability at a metal surface has been found to have an effect on the rates of corrosion reactions. Thus corrosion reactions are said to be electrochemical and it can be shown by the reaction of zinc with hydrochloric acid:



Zinc reacts with the acid solution forming soluble zinc chloride and liberating hydrogen bubbles on the surface. In ionic form the reaction is

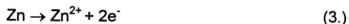


Eliminating the Cl^- from both sides of the reaction gives



Thus, the same corrosion reaction would occur in sulfuric acid.

Reaction (2) can be separated as follows:



Reaction (3) defined as the anodic reaction, is an oxidation

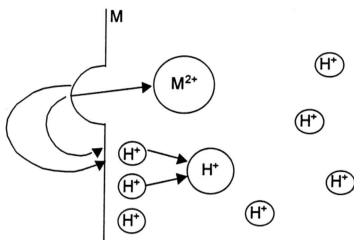


Figure 1.1 Schematic diagram of dissolution of metal M

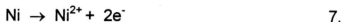
reaction in which zinc valence increases from 0 to +2, liberating electrons, e^- , while reaction (4), defined as the cathodic reaction, is a reduction reaction in which the oxidation state of hydrogen decreases from +1 to 0, consuming electrons. The composite reaction involving charge transfer or exchange of electrons is shown schematically in Figure 1.1. The metal dissolves by reaction (3) liberating electrons into

the bulk of the metal which migrate to the adjoining surface, where they react with H^+ in solution to form H_2 by reaction (4). Water is required as the carrier for ions, such as Zn^{2+} and H^+ and is called the electrolyte. Thus all the corrosion reactions are considered to be electrochemical. Most corrosion reactions involve water in either the liquid form or condensed vapor phases. Even some "dry" corrosion reactions without water involve charge transfer in a solid state electrolyte and are considered still to be electrochemical.

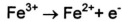
For corroding metals the anodic reaction invariably is of the form



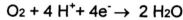
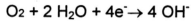
Following are the examples:



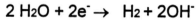
Cathodic reduction reactions significant to corrosion are few in number, reduction of an oxidized ion in solution by a so called redox reactions; the most common example is reduction of ferric to ferrous ions,



The reduction of dissolved oxygen is often observed in neutral and acid solutions exposed to ambient air. The respective reduction reactions are:



In the absence of all other reduction reactions, water will be reduced to



Which is equivalent to (4), assuming dissociation of water to H^{+} and OH^{-} and subtracting OH^{-} from both sides of the reaction.

1.2 Forms of corrosion

Though corrosion in general can be considered as an electrochemical based on the above discussion, it comes in different forms depending on the environment to which the metal is subjected to, each form of corrosion is described briefly as follows.