ELECTROCHEMICAL STUDY OF THE CORROSION BEHAVIOR OF ZINC SUBSTRATES MODIFIED BY MONO OR BIMOLECULAR PROTECTIVE ORGANIC FILMS

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Zinc is one of the most extensively used metals for indoor and outdoor atmospheric applications because of its corrosion resistance. In particular, zinc has been used for coating or galvanizing ferrous metal products due to its better resistance to atmospheric corrosion than carbon steel. However, zinc and zinc coated products still corrode in moist atmospheres recovering with white corrosion products. To avoid this white rust formation, inorganic formulations containing chromate solutions are commonly used as they offer good corrosion inhibition. However, recent environmental restrictions, because of carcinogenic effects of chromate, require replacement with other reagents. In that context, the chemistry of self-assembly presents a great potential because the presence of a dense organic film at the surface of an oxidizable metal can significantly decrease its corrosion rate.

In this study, Self-Assembled Monolayers (SAMs) formed by chemisorption of 3(mercaptorpopyl)trimethoxysilane (MPTS), $(MeO)_3Si-(CH_2)_3-SH$, on zinc substrates have been investigated. SAMs are formed by immersion of mechanically polished zinc substrates in 10^{-2}M MPTS (toluene) solution after proper conditioning. As the MPTS molecule is made of two reactive functions, a trimethoxysilane ($-Si(OMe)_3$) and a thiol group (–SH), its grafting on zinc substrate is not straightforward. Electrochemical reduction of the native oxide of the zinc surface has been performed in order to enhance formation of thiolate bonds with the metal supplying $-Si(OMe)_3$ groups, pointing out at the surface, predisposed to undergo further modifications.

The next critical step has been the research of appropriate conditions for hydrolysis of the trimethoxysilane groups leading to the creation of a silicon oxide network as shown at Figure 1.

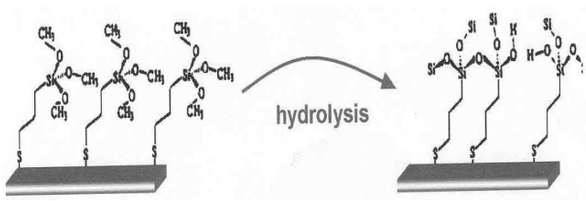

Figure 1: schematic view of hydrolysis process of the MPTS film formed on zinc substrate

To further protect the substrate from corrosion, formation of bilayers by absorption of other molecules, like the (3-heptafluoroisoproposy)propyltrichlorosilane (HIPS), $SiCl_3-(CH_2)_3-O-CF(CF_3)_2$, have been carried out on such network. X-ray Photoelectron Spectroscopy (XPS) and contact angle measurements were used throughout this work in order to characterize the zinc modified samples while electrochemical techniques like cyclic voltammetry or polarization curves were used as tools to evaluate the effect of the chemical modifications on corrosion protection.

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