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A REVIEW ON CORROSION PROTECTION OF SILANE COATINGS MODIFIED BY CARBON NANOTUBES ON STAINLESS STEEL

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A Review on Corrosion Protection of Silane Coatings Modified By Carbon Nanotubes on Stainless Steel

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Abstract – Silane based products are becoming an interesting material for pre-treatment deposition, because, for the environmental compatibility, they can be used as substitutes of traditional pre-treatments like chromates. Silanes have been studied as new pre-treatments before organic coating deposition for many different metals, including aluminium, copper and zinc. Silane coatings, with added functionalities for improved performance and durability, were designed to increase the corrosion protection of magnesium alloys. The corrosion behavior of the coated AZ31 was studied through electrochemical impedance spectroscopy (EIS) in 0.05 M NaCl.

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INTRODUCTION

The chromate conversion coatings are an effective pre-treatment technology for corrosion protection on metals [1, 2]. The traditional technology with good performance and low cost has been restricted due to the toxicity and carcinogenic nature of Cr^{6+} [3]. Therefore, to develop an environmentally friendly pre-treatment method for corrosion protection on stainless steel is urgent.

Silanes as coupling agent have attracted much attention because of paint adhesion property, good corrosion inhibition and environmental friendly property [4-7]. Silane hydrolyzes when mixed into water and ethanol aqueous solution. During this process, the alkoxy groups of the silane molecules are converted into hydrophilic silanol (SiOH) groups. And these SiOH groups are easily absorbed on metal surfaces by the formation of hydrogen bonds between the SiOH groups and the surface metal hydroxyls (MOH), and the excess SiOH groups forming a siloxane network (Si-O-Si) that exhibit chemical stability and resistance to corrosive species. W.J.van Ooij[8] and Hu[9-10] had prepared the silane film on the metal surface successfully by dip-coating and electrodeposition method respectively. Some studies indicated that the silane film not only enhanced the adhesion property between the metal substrate and film, but also provided a barrier which can prevent the diffusion of corrosion ion and oxygen [11-14]. However, these films could not offer stable and long-term corrosion protection because of the presence of micropores, cracks, and areas with low cross-link density.

REVIEW OF LITERATURE:

In addition, several works [5, 15-19] about adding nanoparticles or metal salt into the silane film for effectively reducing the defects of the silane film were reported. K.Aramaki et.al.[15] introduced cerium to the organic silane film layer to form cerium nitrate passivation film by reaction on the metal surface. Vignesh Palanivel et.al [5] investigated the protective effect of the BTESPT silane film that added SiO_2 nanoparticles on aluminum alloy. TiO_2 nanoparticles were added into silane in J.M.Hu's works [16]. These studies indicated that the corrosion protection properties had been improved significantly by introducing nanoparticles. In the composite films, the nanoparticles suffer corrosion prior, when the nanoparticles are corroded absolutely, the silane film will lose the protective properties.

Chromate steel sheet/anti-finger steel sheet:

The chromate treatment has long been used for surface treatment of steel sheets. It has been widely used as an inexpensive yet effective method for primary rust prevention of galvanized sheet (keeping the galvanized sheet surface rust-free from the time the sheet is manufactured till the time it is converted into the final product) and for the treatment of substrate. Chromate treatment prevents the galvanized sheet surface from being exposed to corrosive factors such as oxygen and moisture. In addition, even if the coating film surface is damaged, causing the zinc layer to be exposed, the corrosion of zinc is restrained by the self-repairing function of this treatment. Chromate steel sheet subjected to chromate treatment has been widely used in home appliances. However, in many cases, the chromate sheet for external parts, which are held directly by hand, is used painted since fingerprints tend to stand out on the sheet surface. Under this condition, a new anti-finger steel sheet having an organic film coated on the chromate-treated surface was developed.

Since the newly-developed fingerprint-resistant steel sheet can be used unpainted not only for internal parts but also for external parts, such as the bottom and back panels, it has become possible for customers to omit the painting process.

Development of chromate-free steel sheet the chromate steel sheet and the anti-finger steel sheet mentioned above contained hexavalent chromium. On the other hand, the demand for a new surface-treated steel sheet without hexavalent chromium an environmentally hazardous substance—boosted in the 1990s. Nippon Steel & Sumitomo Metal Corporation developed a chromate free film and successfully commercialized a chromate-free steel sheet ahead of other steelmakers.

CARBON NANOTUBES:

Carbon nanotubes (CNTs) were applied in various fields due to their unique structural, mechanical, electronic and thermal properties [20-21]. The CNT-doped composites show favorable intensity, stress and fatigue resistance [22] and CNTs have been used as excellent hydrogen storage materials, chemical sensors and electrodes [23-24]. When used as adulterants, CNTs have been added into polyaniline coating to decrease the permeability of coating for oxygen and corrosive solution [25] and have been added into epoxy coating to increase adhesion and cohesion between coatings and metal substrates [26-27]. Although silane/CNTs composites had been studied, in their work, silane was used to modify carbon nanotubes to enhance the performance and the dispersive ability of CNTs in epoxy [28].

CONCLUSION:

Introducing CNTs into silane film as the doped particles to improve the corrosion resistance of the metal substrate has rarely been studied. CNTs with long chain structures can be filled in the area of flaw and pore, delaying the crack growth in the film, so it hopefully enhances the overall compactness of the film layer.

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