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Corrosion protection performance of silicon-based coatings on carbon steel in NaCl solution: a theoretical and experimental assessment of the effect of plasma-enhanced chemical vapor deposition pretreatment†

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Using a plasma-assisted chemical vapor deposition (PACVD) process, carbon steel samples were coated with an organosilicon layer less than 2.5 microns thick. Ellipsometry, Fourier transform infrared (FTIR) spectroscopy, contact angle, scanning electron microscopy (SEM), and atomic force microscopy (AFM) were used to analyze the films. Additionally, gravimetric experiments were used to determine the electrochemical properties of the organosilicon coatings. Organosilicon-coated carbon steel specimens demonstrated significantly enhanced resistance to corrosive conditions, such as 3% aqueous sodium chloride solutions. The surface preparation method has a considerable influence on the morphological and electrochemical properties of the steel. Argon pretreatment significantly enhances the corrosion resistance of organosilicon-coated steel. Gravimetric research demonstrated that pretreatment with argon plasma resulted in less weight loss and corrosion than pretreatment with nitrogen plasma. The link between quantum computing and experimental data using density functional theory (DFT) and molecular dynamics (MD) was used.

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1. Introduction

Metals that rust can't be utilized in key sectors like aircraft and transportation because of the natural process known as corrosion. Corrosion is a common problem for metallic alloys in industrial applications because of the conditions in which they are used. Applying a protective coating or paint is highly recommended as the most cost-effective and practical strategy to prevent corrosion. Even though coatings and paints are relatively thin, they may be quickly applied over broad areas and provide protection. In most cases, the cost of materials and labor is less than the value of what is being protected. Corrosion-resistant coating and paint technology have advanced consistently over the past 150 years, resulting in a diverse spectrum of solutions for preserving a variety of substrates in a variety of situations. The coatings industry, a mature field, is continually developing novel substrates and application procedures to meet new needs. Coating technology has advanced dramatically during the previous three decades to respond to environmental concerns. As a result, new coating systems and application procedures are being developed.

Organic coatings and anticorrosive paint mixes are a common means of preventing corrosion on metal surfaces.