Study of Aluminum Corrosion Inhibition Using Self-Assembled Layer of Schiff Base Ligand.

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1. Introduction

Aluminum corrosion is a major problem for many industrial uses, including in construction, automotive, and aerospace. The degradation of a metal surface brought on by chemical and electrochemical reactions with its surroundings is known as corrosion [1]. Although the fact that aluminum has a naturally occurring oxide layer covering its surface that protects it against corrosion in a variety of media, numerous studies have demonstrated that this layer may be damaged and that metal can corrode when exposed to solutions, particularly those that contain chloride. When exposed to chloride mediums, the most prevalent type of corrosion that commonly occurs in aluminum or aluminum alloys is pitting corrosion. Metal disintegrates during pitting corrosion, creating asymmetrical pits on the metal surface. Pitting corrosion primarily occurs when chloride anion is present. Because of its tiny size and great mobility, chloride has a strong propensity to attack the aluminum oxide layer. The process of pitting corrosion starts when chloride ions migrate via oxygen vacancies or permeate through faults in the natural aluminum oxide layer [2]. Corrosion inhibitors are frequently used to lessen the negative consequences of corrosion. They belong to a unique class of materials that have the ability to absorb onto metal surfaces to create a thin layer that stops corrosion. Organic compounds and surfactants are well-known organic inhibitors that are employed to provide this kind of defense. Self-assembled layers have become a viable option for inhibiting corrosion in recent years. The purpose of this study proposal is to examine how well self-assembled layers of Schiff base ligand can prevent metal from pitting corrosion.

2. Materials/Methodology

2.1 Synthesis of Schiff-base Ligand

The Schiff base ligand was synthesized by the reaction of 3,5-ditertbutyl-2-hydroxybenzaldehyde in absolute ethanol and p-chloroaniline in ethanol. The mixture was refluxed for 3 h, followed by cooling at room temperature. The orange color solid was filtered off and recrystallized from CH_2Cl_2: EtOH (1:3) and dried under vacuum [3]. Yield was 70%.

2.2 Preparation of Self-assembled Layer

Schiff base ligand was dissolved in absolute ethanol to form 0.1 $moldm^{-3}$ solution. Aluminum plates were washed with distilled water followed by absolute ethanol and dried. Then aluminum plates were immersed in previously prepared 0.1 $moldm^{-3}$ solution for 24 h. Immersed Aluminum plates were kept in a desiccator to dry [4].

2.3 Corrosion Analysis

The Impedance spectroscopy and Scanning Electron Microscope (SEM) images were carried out for Corrosion evaluation. Whereas SEM images give qualitative idea about the corrosion analysis impedance measurements give quantitative idea. All aluminum substrates were immersed in 3.5% NaCl solutions separately before the measurements.

3. Results and Discussion

3.1 Characterization of Schiff base Ligand

To characterize the synthesized Schiff base ligand, Fourier Transform Infrared (FTIR) spectroscopy, UV-Visible spectroscopy and CHN analysis were done. The FTIR spectra showed C=N stretching vibration around 1576 cm^{-1}, O-H stretching vibrations around 3440 cm^{-1}, C-O stretching vibrations around 1169 cm^{-1}, and aromatic C=C vibrations around 1616 cm^{-1} [1]. The spectrum of Schiff base ligand taken in the UV-visible region reveals absorption bands appear at 311 nm and 354 nm for n-π^* transition and 230 nm and 283 nm for π-π^* transitions. Elemental analysis also showed a good correlation between theoretical and experimental values.

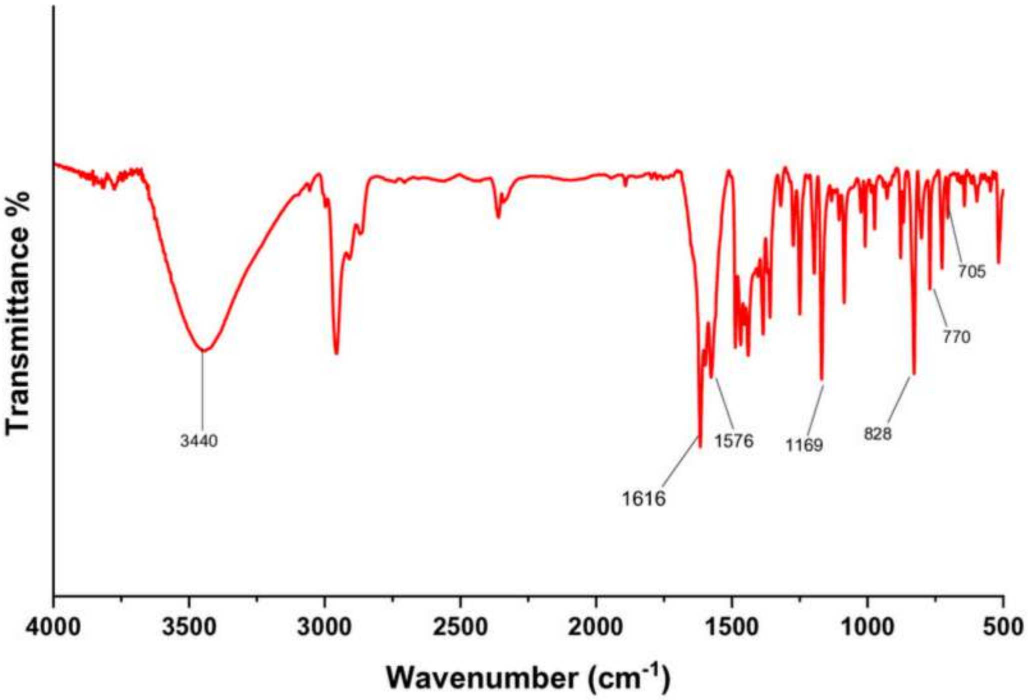

Figure1. FTIR spectrum of the Schiff base ligand.

3.2 Contact angle Measurement

Contact angle measurements were used to examine hydrophobicity of the aluminum surfaces. Schiff base ligand coated aluminum substrate showed 102.602° angle while bare aluminum substrate showed only 72.944° angle by proving ligand-coated aluminum substrate is more hydrophobic.

3.3 Corrosion Analysis

Scanning Electron Microscopic images

To observe pitting corrosion of the aluminum substrate, bare aluminum substrate and Schiff base ligand coated aluminum substrate both were immersed in 3.5% NaCl solution for 5 days separately and Scanning Electron Microscopic images were recorded and analyzed [5]. An abundance of pits could be seen on the surface of the bare aluminum substrate, but the aluminum substrate coated with Schiff base ligand prevented corrosion.

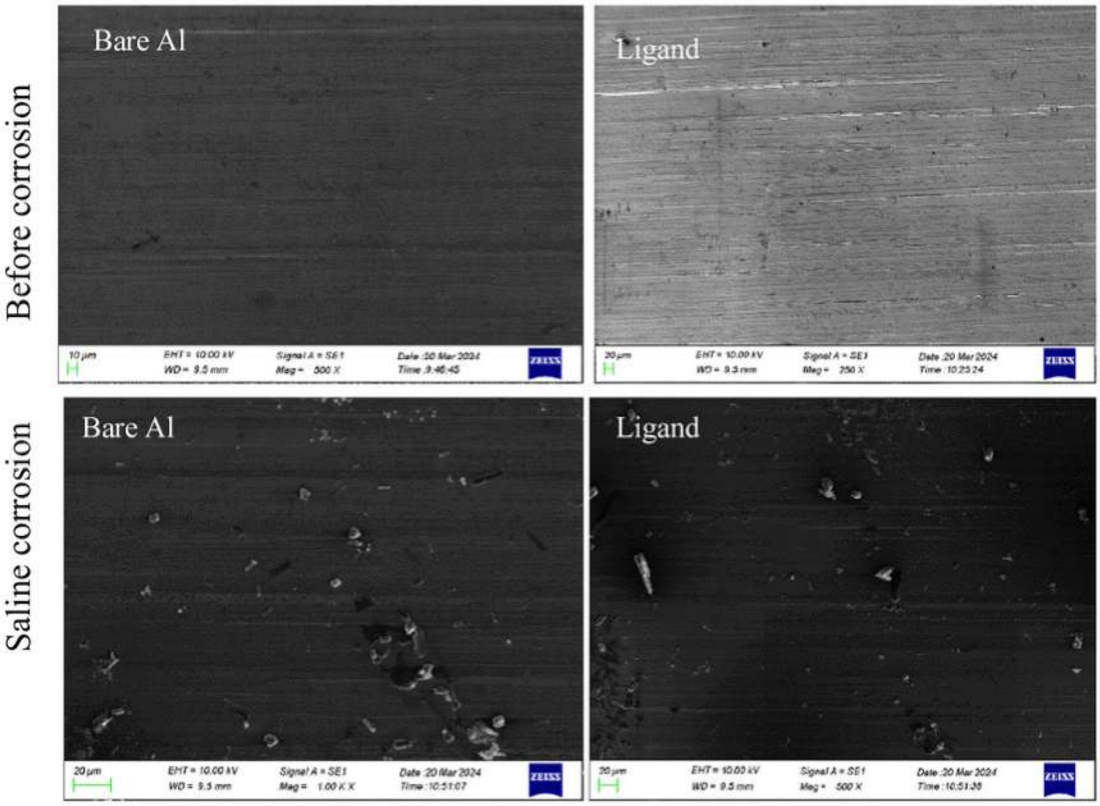

Figure2. SEM images (10 μm) of Al substrates: bare and ligand coated before and after immersed in 3.5% NaCl solution.

Impedance Spectroscopy

Electrochemical impedance spectroscopy (EIS) was used to further examine the corrosion resistance characteristics. In 3.5% NaCl, all data were gathered at the open circuit potential. Using a Nyquist plot to assess the data, R_{ct} values for the ligand-coated and bare aluminum substrates independently were determined. The corrosion reaction's charge transfer resistance at the metal/solution contact is known as Rct. Higher corrosion resistance is indicated by a higher R_{ct} value. Compared to the bare, unprotected substrate, aluminum substrates coated with Schiff base ligand exhibited a noticeably higher R_{ct} value.

Conclusion

Aluminum substrates were protected by coating with Schiff base ligand using Self-assembled layer technique. SEM images and the Impedance measurements were used to confirm that pitting corrosion of aluminum can be inhibited by coating of Schiff base ligand on aluminum substrate.

Keywords: Schiff base, Aluminum corrosion, Corrosion inhibition, Self-assembled layer

References

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