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Study of Corrosive Behaviour of TiO₂ Coated Aluminium 6061

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ABSTRACT: This study investigates the corrosive behavior of TiO₂ coated Aluminium 6061 alloy, focusing on its potential to enhance corrosion resistance in various environments. Aluminium 6061, widely used for its strength and lightweight properties, is prone to corrosion, which limits its application. TiO₂ coatings are explored for their protective capabilities due to their chemical stability and inertness. This research encompasses the preparation of TiO₂ coatings using sol-gel and dip-coating methods, followed by comprehensive corrosion testing in different solutions. Results indicate a significant improvement in corrosion resistance, suggesting TiO₂ coatings as a viable solution for extending the service life of Aluminium 6061 in corrosive environments.

KEY WORDS: TiO₂ coatings, Aluminium 6061, corrosion resistance, sol-gel method, dip-coating, electrochemical impedance spectroscopy (EIS), scanning electron microscopy (SEM).

I. INTRODUCTION

Aluminium 6061 is a versatile alloy utilized in aerospace, automotive, and construction industries due to its excellent mechanical properties and good weldability. However, its susceptibility to corrosion is a significant drawback. This study explores TiO₂ coatings as a potential solution to enhance the corrosion resistance of Aluminium 6061. Corrosion is a pervasive challenge faced by materials in various industrial and environmental settings, leading to substantial economic losses and structural integrity compromises. Al6061, a widely used aluminum alloy, is susceptible to corrosion in aggressive environments. To mitigate this issue, researchers have explored the use of protective coatings to enhance the corrosion resistance of Al6061. Among these coatings, titanium dioxide (TiO₂) has emerged as a promising candidate due to its exceptional chemical stability, mechanical strength, and biocompatibility.

The introduction of TiO₂ coatings on Al6061 represents a strategic approach to enhancing the alloy's resistance to corrosion, offering potential advantages in terms of longevity, durability, and overall performance. As we embark on this investigation, we anticipate uncovering not only the protective capabilities of TiO₂ coatings but also potential challenges and opportunities for further optimization. This work holds promise for advancing our understanding of corrosion mitigation strategies and, ultimately, contributing to the development of more resilient and sustainable materials for a wide range of applications.

II. METHODOLOGY

Substrate: Al6061 aluminum alloy

Coating Material: Titanium dioxide (TiO₂)

Surface Preparation: Clean the Al6061 samples to remove any contaminants.

Use mechanical polishing (grinding with various grades of sandpaper) to achieve a smooth surface.

Coating Application: Apply TiO₂ coating using methods like:

Sol-Gel Process: Involves dipping the substrate in a TiO₂ sol followed by heat treatment.

Spray Coating: Spraying a TiO₂ suspension onto the substrate.

3. Corrosion Testing: Electrochemical Methods: Potentiodynamic Polarization: Measures the corrosion potential and current density to assess corrosion rates. Electrochemical Impedance

4. Post-Corrosion Analysis: Surface Examination: SEM and EDS: Re-examine the surface to identify corrosion products and coating degradation.

Materials - Aluminium 6061 alloy samples

- Titanium dioxide(TiO₂)
- Ethanol and acetic acid as solvents
- Deionized water

III. EXPERIMENTAL WORK

Preparation of TiO₂ Coatings

Coating Procedure:

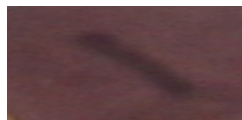
Al6061 coupons of dimension 2.5 x 2.5 x 0.2 cm were cut and TiO₂ and Inconel718 alloy powders were plasma sprayed on Al6061 substrate separately. Alumina particles of 20 mesh size were used for grit blasting the substrate before coating. During plasma spraying, the spray gun was stationary and the specimen was mounted on a rotating table.



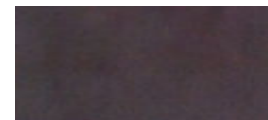
a. Uncoated Al6061



b. TiO₂ coated Al6061



c. Inconel 718 coated Al6061



d. TiO₂-30Wt%Inconel 718 coated Al6061

Salt Spray Corrosion Testing

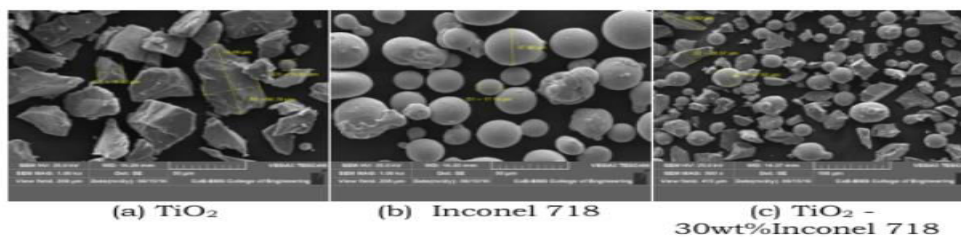
Salt spray is one of the most commonly used testing methods in the industries to evaluate corrosion resistance of the surface or coating. It is also called as the salt fog test. Industries rely on various testing methods to bring quality in their processes and outcomes. Salt spray testing is one of the many methods being employed by industries to ensure credibility of their products and gain market recognition



IV. RESULTS AND DISCUSSION

Morphology of Starting Materials

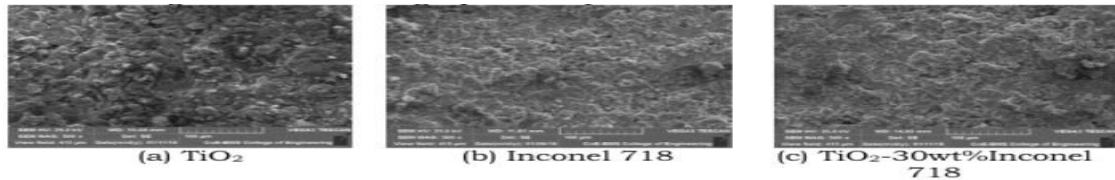
Titania powders as shown in figure 4.1 (a) have an average particle size of 5-50µm with sharp cornered and irregularly shaped morphology. inconel 718 which is a face-centered cubic (fcc) austenitic γ matrix had the particle size varying from 5 µm to 90 µm. As shown in figure 4.1 (b), the Inconel 718 powders had a well-defined spherical morphology with an average particle diameter of 20-40 µm. Figure 5.1 (c) shows the planetary ball milled composite tio₂-30 wt% inconel 718 powder which shows almost similar morphology as that of individual powder ones.



SEM of feedstock powders

Surface Analysis

The TiO₂ coating is relatively rough surface with lot of semi molten particles and melted particles. However at few places pores were also seen mostly around un-melted particles. Similarly for Inconel 718 coated substrate showed similar morphology as that of TiO₂ coated substrate with rough surface

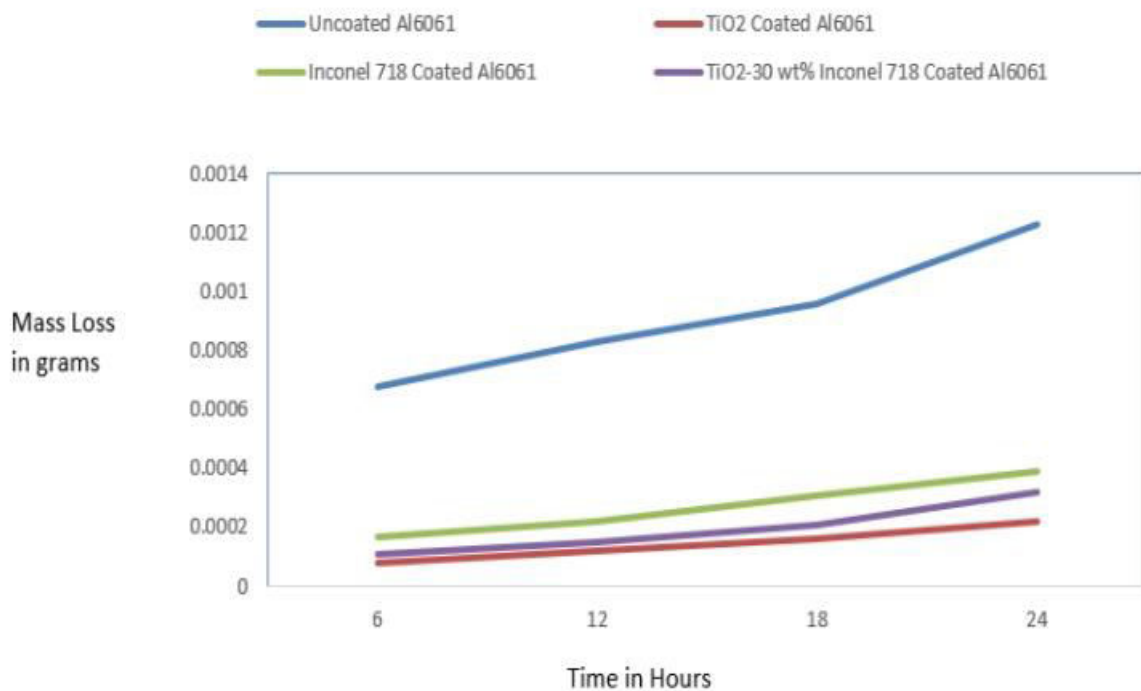


SEM micrographs of top surface of coated Al6061

Corrosion Test

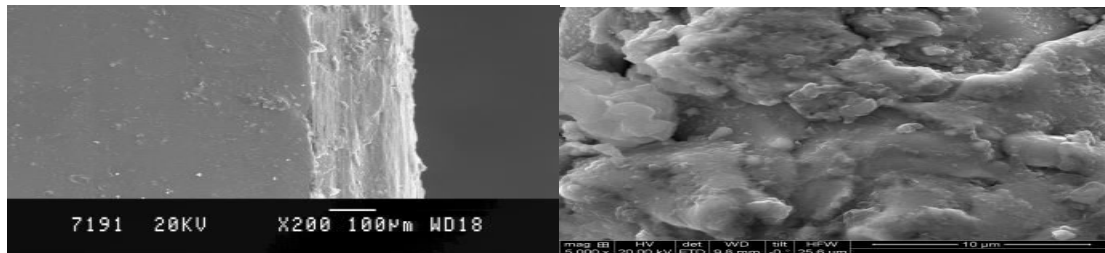
Time in hours	Mass loss in grams			
	Uncoated Al6061	TiO ₂ Coated Al6061	Inconel 718 Coated Al6061	TiO ₂ -30 wt% Inconel 718 Coated Al6061
6	0.0008	0.00008	0.00017	0.00011
12	0.0012	0.00012	0.00022	0.00015
18	0.0019	0.00016	0.00043	0.00021
24	0.0023	0.00022	0.00056	0.00032

Mass Loss for Uncoated specimen due to Corrosion



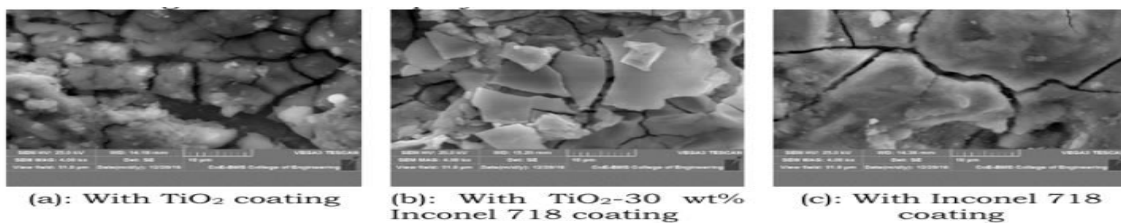
Mass Loss for specimen due to Corrosion

Scanning Electron Microscopy



SEM across coating thickness

SEM as coated



Worn out surfaces of coated specimen post salt spray test

V. CONCLUSION

The application of TiO₂ coatings on Aluminium 6061 alloy via the sol-gel dip-coating method significantly improves its corrosion resistance. This improvement is attributed to the barrier properties of the TiO₂ layer, which effectively protects the substrate from corrosive agents. These findings suggest that TiO₂ coatings are a promising approach to mitigate corrosion in Aluminium 6061, extending its applicability in harsh environments.

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