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Sputtered titanium dioxide thin films for galvanic corrosion protection of AISI 304 stainless steel coupled with carbon fiber reinforced plastics

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Abstract

Galvanic corrosion leads to high corrosion rates when AISI 304 stainless steel is coupled with carbon fiber reinforced plastics (CFRP) in electrolytes. The performance of very thin (70-350 nm) reactively sputtered TiO₂ coatings for improving the corrosion protection of AISI 304 was investigated in this work. The TiO₂ coatings exhibit a markedly improved galvanic corrosion protection of AISI 304 by reducing the galvanic current density by a factor of 10⁴. It will be shown that very thin TiO₂ films provide much better corrosion protection than thicker ones. Structural properties will be discussed as an explanation for this finding.

Keywords: AISI 304 stainless steel; Carbon fiber reinforced plastics (CFRP); Titanium dioxide coating; Corrosion protection; Electrochemical impedance spectroscopy (EIS); Transmission electron microscopy (TEM)

1. Introduction

Carbon fiber reinforced plastics (CFRP) are materials, that exhibit very good mechanical characteristics with respect to low weight, high strength and high stiffness. In very different fields of applications they are used in combination with metals to form hybrids, that benefit from the specific properties of both materials [1-6]. Whereas aerospace and automotive industry makes use of mainly aluminum or titanium, steel is the most widely used construction material in mechanical engineering. The reason for this lies in the extensive experience with regard to the processing of steel (e.g. forming, welding). Moreover, the variable material properties like hardness and ductility as well as economic factors made steel a well established material in mechanical engineering. The aspiration for high

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