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Nanostructured Oxide Layer by Anodization on Austenitic Stainless Steels: Structural and Corrosion Insights

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Abstract : Austenitic stainless steels are widely recognized for their exceptional corrosion resistance and mechanical properties, rendering them indispensable materials across various industries from construction to biomedical applications. However, in chloride and high temperature atmosphere it to further enhance their surface properties, anodization has emerged as a promising surface treatment technique. Anodization modifies the surface of stainless steels by creating a protective oxide layer, improving corrosion resistance and imparting additional functional characteristics. This paper explores the structural and corrosion characteristics of anodized austenitic stainless steels (AISI 304) using a two-step anodic technique. We utilized a perchloric acid-based electrolyte followed by an ammonium fluoride-based electrolyte. This sequential approach aimed to cultivate deeper and intricately self-ordered nanopore oxide arrays on a substrate made of 304 stainless steel. Electron Microscopic (SEM and TEM) images revealed nanoporous layered structures with increased length and crack development correlating with higher voltage and anodization time. Surface composition and chemical oxidation state of surface-treated SS were determined using X-ray photoelectron spectroscopy (XPS) techniques, revealing a surface layer rich in Ni and suppressed Cr, resulting in a thin film composed of Ni and Fe oxide compared to untreated SS. Electrochemical studies demonstrated enhanced corrosion resistance in a strong alkaline medium compared to untreated SS. Understanding the intricate relationship between the structural features of anodized stainless steels and their corrosion resistance is crucial for optimizing the performance of these materials in diverse applications. This study aims to contribute to the advancement of surface engineering strategies for enhancing the durability and functionality of austenitic stainless steels in aggressive environments.

Keywords : austenitic stainless steel, anodization, nanoporous oxides, marine corrosion
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