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(G) (POS-54) Quantifying radiolysis effects for in-situ Rutherford backscattering spectrometry (RBS)

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The titanium oxide surface is responsible for many of the properties associated with the metal because it creates a hard, uniform, and thermodynamically stable protective coating over metallic titanium. Because of the characteristics of the oxide film, titanium has found uses in biomedical implants, aerospace engineering, industrial piping for corrosive environments, and other areas where high strength and low weight are required. Our project is aimed at understanding the atomistic mechanisms of TiO2 formation, including oxidation rates and the role of anodization potential on Ti oxide layer structure and morphology, using Rutherford backscattering spectrometry (RBS) for elemental depth profiling during oxide growth, complemented by other surface-sensitive techniques.

Our research involves using a specially designed in-situ cell with an ion-permeable silicon nitride window to provide a barrier between the ultra-high vacuum (UHV) required to perform RBS and the electrolyte solution required for electrochemical analysis and anodization. The thin silicon nitride window is coated with titanium and exposed to an electrolyte solution; RBS measurements are taken as the titanium metal is anodized to titanium oxide. To determine information about the growth mechanism of titanium, in-situ anodization during RBS is performed, providing information about the growth mechanism of titanium oxide. In-situ RBS results show a significant increase in the oxidation rate of titanium compared to equivalent ex-situ measurements, as well as spontaneous TiO2 film growth, without applied potential, in the presence of high-energy He+ particles interacting with the electrolyte solution. Additionally, a significant change is observed between benchtop electrochemical impedance spectrometry experiments and those performed under high energy He+ flux. Direct and indirect alpha radiation exposure measurements are performed to determine the enhanced titanium oxide growth rate generated via radiation and radiolysis effects. The quantification of these effects allows for a reliable comparison of in-situ RBS anodization experiments with ex-situ benchtop anodization experiments.

Keyword-1

Rutherford Backscattering RBS

Keyword-2

Titanium Oxide

Keyword-3

In-situ

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