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High Resolution Depth Profiling for Studying Titanium Oxidation

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High Resolution Depth Profiling for Studying Titanium Oxidation
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Titanium has many important applications in both scientific research and industry.
Our aim is an understanding of the mechanism of electrochemical oxidation of Ti, especially in the ultra-thin film limit. This is crucial if Ti is to be properly incorporated into technological devices.

A thin film of Ti was deposited by magnetron sputtering, onto a Si (001) substrate followed by exposure to isotopic O18 water to form a TiO2 ultra-thin layer. Next, TiO2/Ti/Si(001) samples were electrochemically oxidized in H216O water. By observing the relative concentration of the oxygen isotopes as a function of depth, it allows us for a determination of potential oxygen exchange reactions and insight into general oxide growth from diffusion (metal or oxidant species).

X-ray photoelectron spectroscopy (XPS) and medium energy ion scattering (MEIS) were used to determine the chemical environment of the sample's surfaces and film stoichiometry as a function of depth respectively.

The oxidation states of Ti are consistent with MEIS depth profiles. The depth profiles suggest that O18 appears in much greater concentrations near the surface, of Ti oxide while O16 appears in greater concentrations at TiO2/Ti interface. This is suggestive of a mechanism of diffusion for O16 that results without strong interaction within the Ti oxide layer. The kinematics of the oxidation process are contingent on whether the process is limited by diffusion through the oxide or by the exchange reactions themselves. Although typically oxidation is seen as diffusion controlled. Further details of the mechanism will be discussed.

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