TiO_2 Nanotube Growth Mechanism Studied with Scanning Auger Spectroscopy

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Anodic TiO_2 nanotubes offer unique properties for a wide range of applications including energy conversion, photocatalysis and biomedical devices[1, 2, 3]. It is widely accepted that the initial growth of the nanotubes is based on the formation of a compact anodic oxide followed by the formation of etching grooves and pores in the oxide[4, 5]. The mechanism of steady state growth of the nanotubes from the embryonic pores has, however, remained a topic of debate. To evaluate a flow model[1, 6] for the formation of the tubular structures, high spatial resolution Scanning Auger Spectroscopy data is used to elucidate the compositional variations across TiO_2 nanotube layers grown in a fluoride containing ethylene glycol electrolyte. The layers were fractured parallel to the axes of the nanotubes and quantitative spectra, line scans and elemental maps were acquired along the walls of the nanotubes. The Auger data indicates the presence of a fluoride rich layer located between the tube walls, and in particular, the triple points of the hexagonally ordered nanotube arrays. This data supports fluoride dissolution as the reason for a transition from a porous oxide layer to tubular structures. This data also supports a flow model as a mechanism for the formation of the tubular morphology.

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