Titanium Dioxide Nanotubes Fabricated Via Two-Step Anodic Oxidation

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Introduction

Titanium dioxide (TiO_2) nanotubes are particularly versatile structures with a wide range of technological applications, such as in solar panels and gas detectors. These nanotube arrays can be fabricated through electrochemical polishing, followed by anodization, during which chemical reactions occur that produce ordered nanostructures on the titanium surface.

In order to investigate the microscopic topography of our samples, a scanning electron microscope (SEM) is used to image the surface. Energy dispersive X-ray spectroscopy (EDS) is used to probe the chemical compositions of our samples.

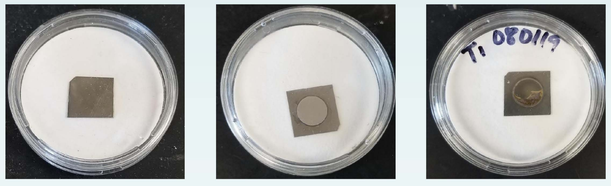

Fig. 1. A 99.5% pure titanium substrate (left), 2 cm x 2 cm, after electrochemical polishing (middle) , and after two-step anodization (right).

Future Work

- Improve the surface smoothness of electrochemically polished titanium substrate
- Investigate the effect of the length of anodization time and water content in the electrolyte on the quality of TiO_2 nanotubes

Acknowledgments

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Methodology

- Electrochemical polishing and anodization were conducted in a teflon cell connected in a circuit with an electrolyte solution.

Fig. 2. The teflon cell setup for electrochemical polishing and anodization.

- An SEM is a type of electron microscope that produces images of a surface by emitting a beam of electrons with a voltage of 4-10 kV in our images.
- The Oxford AZtec software conducts an EDS analysis to determine the composition of the imaged sample.

Fig. 3. The SEM (Hitachi S-3000N) and Oxford EDS utilized in the Keck Microanalysis Laboratory.

Results

The most effective electrolyte solution for anodization utilized was 0.27 M NH_4F in ethylene glycol.

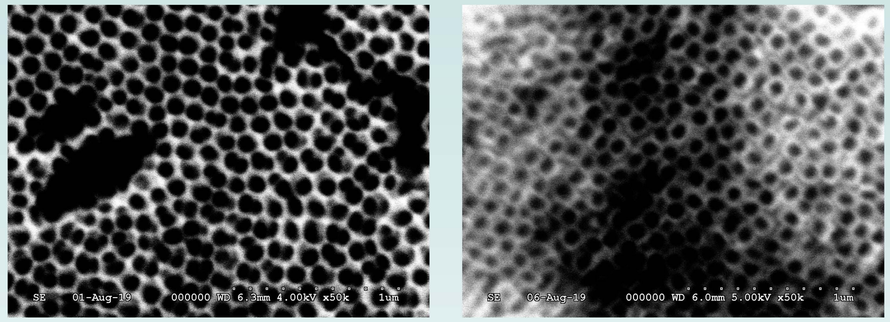

Fig. 4. SEM images at 50 K magnification of the titanium substrates after two-step anodization at 50 V (left) and at 70 V (right).

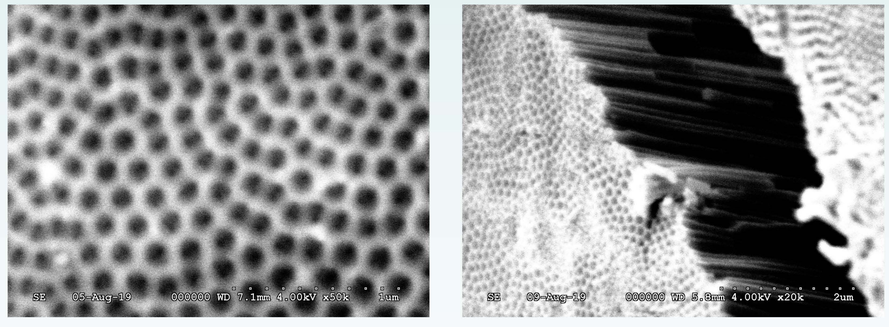

Fig. 5. SEM images of the titanium substrate after two-step anodization at 60 V (left) and the cross-sectional view of the nanotubes (right).

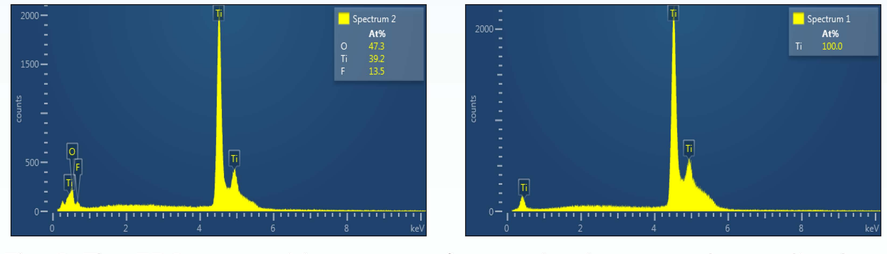

Fig. 6. The EDS composition spectra from a titanium sample anodized at 60 V (left) and the titanium substrate only (right).