Nanoscale topography analysis of Titanium disks

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ABSTRACT

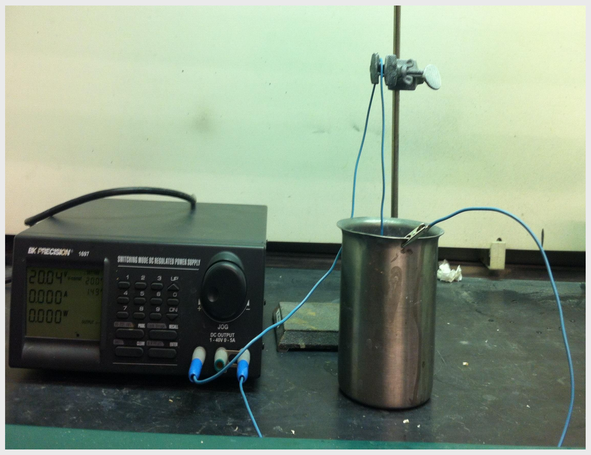
Titanium implants used for various clinical conditions are relatively effective but still need significant improvement with respect to their capacity to secure rapid and long-lasting integration in tissues. To address these challenges, anodization is extensively used to modify titanium surfaces in ways to control the cellular events at the material-host tissue interface that ultimately determine the biological outcome of a biomedical implant. A prerequisite to exert such a selective control on cell activities is achieving the capacity to modulate the nanotopography of titanium.

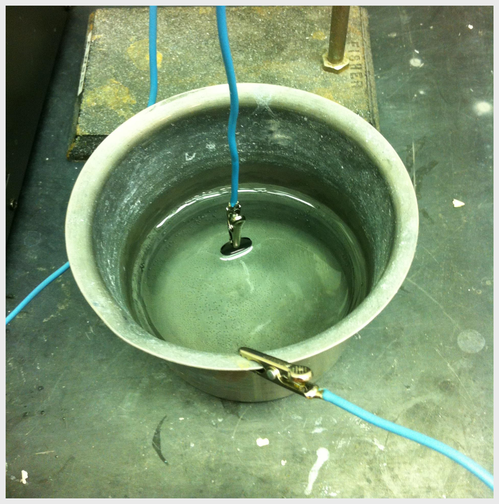
INTRODUCTION

In this age of technology, novel biomedical advancements are a way to tackle mobility disabilities and provide these men and women a dream to participate in the Paralympic games. Fortunately, studying the interface between titanium surfaces and a degenerate human tissue at the nanoscopic level is interesting, and moreover useful.

The nanotopography of titanium can be regulated through anodization. The main objective of this research project is capitalizing on previous results and optimizing anodization to precisely design the nanoscale topography of titanium surfaces. The study will optimize the experimental setup required for carrying out the anodization process.

METHODS AND MATERIALS





A titanium disk was submerged in 0.5% w/w HF. One alligator clip was used to hold the titanium disk in the acid, whereas, the second clip was attached to the metallic beaker (anode) to complete the circuit and allow for anodization to occur for various times and voltages.

RESULTS

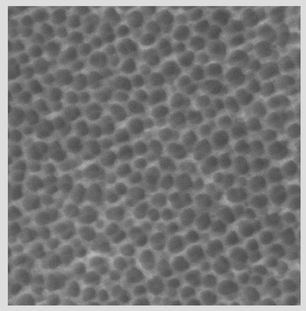


Figure 1. 5V, 60min

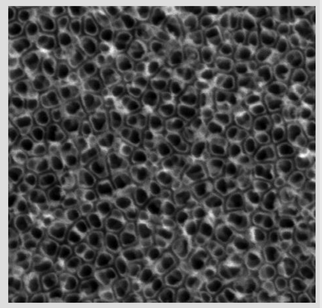


Figure 2. 10V, 30min

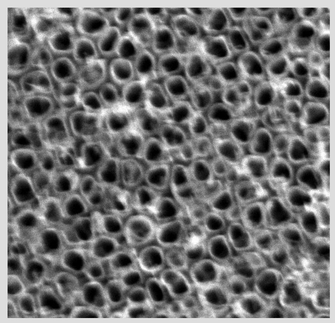


Figure 3. 15V, 40min

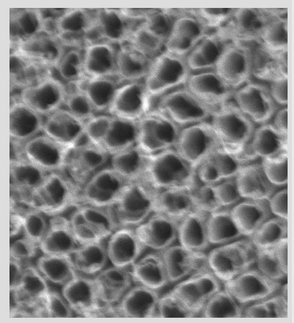


Figure 4. 20V, 30min

Voltage (V)	Time (min)	Tube diameter (nm)	Circularity
5	60	18	0.912
10	30	37	0.757
15	40	18	0.884
20	30	22	0.908
30	25	56	0.826
40	15	38	0.858

Table 1. Anodization parameters for titanium disks.

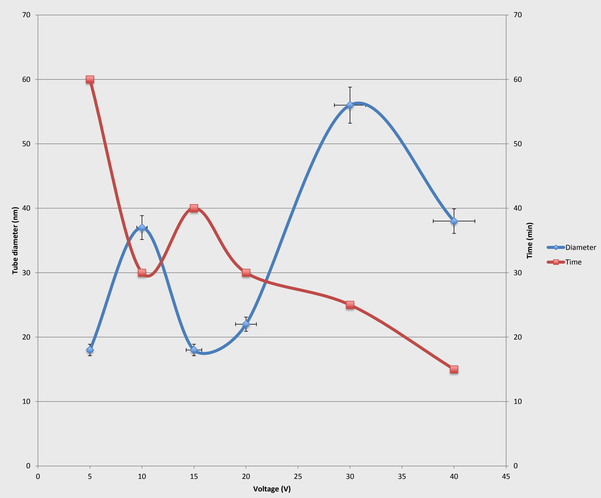


Chart 1. Relationship between voltage, time, and tube diameter.

DISCUSSION

This research project originated the required knowledge about chemical approaches for precise control of the physical features of titanium surfaces. Results from this study will now permit to generate various nanotopographies that will be exploited to study how cells respond to nanoscale cues.

Treatment parameters (i.e. exposure length, electrolyte's composition, voltage and current) were varied to precisely assess their effects on the nanoscale topography of titanium. To this end, Scanning Electron Microscopy (SEM) coupled with image analysis permitted to correlate experimental parameters to the characteristics (e.g. pore diameter, length, and spacing) of the resulting nanotubular surfaces, ultimately engendering a viable protocol to engineer the nanotopography of titanium.

CONCLUSIONS

Medical science has proven time and again that when the resources are provided, great progress in the treatment, cure, and prevention of disease can occur.

Anodization is an effective way to generate various nanotopographies to study how cells respond to nanoscale cues.

This basic research is a stepping-stone to the endless possibilities waiting to be explored in the realm of biomedical-mechanical engineering.

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