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Effect of anodizing parameters on the formation of TiO₂ nanotubes produced on titanium grade 5

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Introduction

Ti6Al4V (ASTM grade 5)



Most widely used biomaterial for orthopaedic implants...



Inert, non-toxic, corrosion resistant, good mechanical properties;



Cannot drive osteointegration or hinder infection;

TiO₂ nanotubes (TNTs)

Produced through... Surface modification can provide bioactivity...

- Nanoscale topography and features;
- Increased surface area;

- Can..
- Enhance osteointegration;
 - Hinder bacterial adhesion;

Electrochemical anodization

- Low temperature method;
- Low cost;
- Control over shape and length of the nanotubular structures by changing the electrochemical parameters;

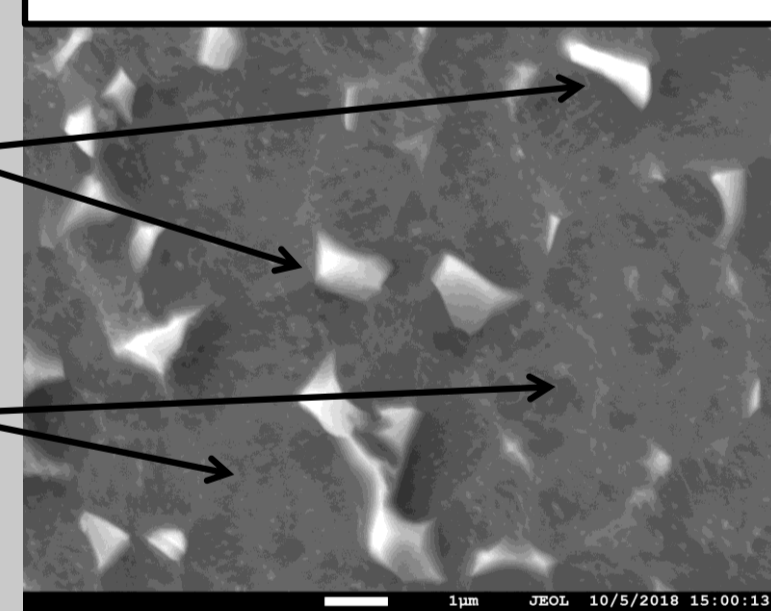
Methodology

Disks of Ti-6Al-4V alloy (diameter=3cm)

Etched with Kroll's etchant

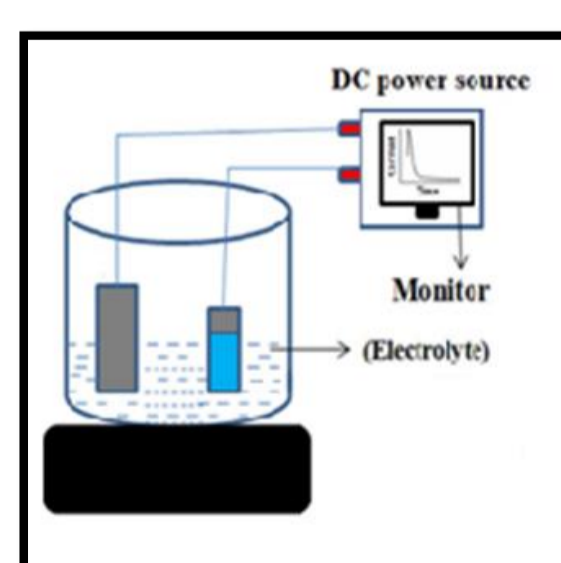
β phase
(V rich)

α phase
(Al rich)



Polishing, degreasing

Electrochemical anodization



Electrolyte: C₂H₆O₂ + 0.5%wt NH₄F + 2.5% V DI H₂O;
Temperature: 25°C;

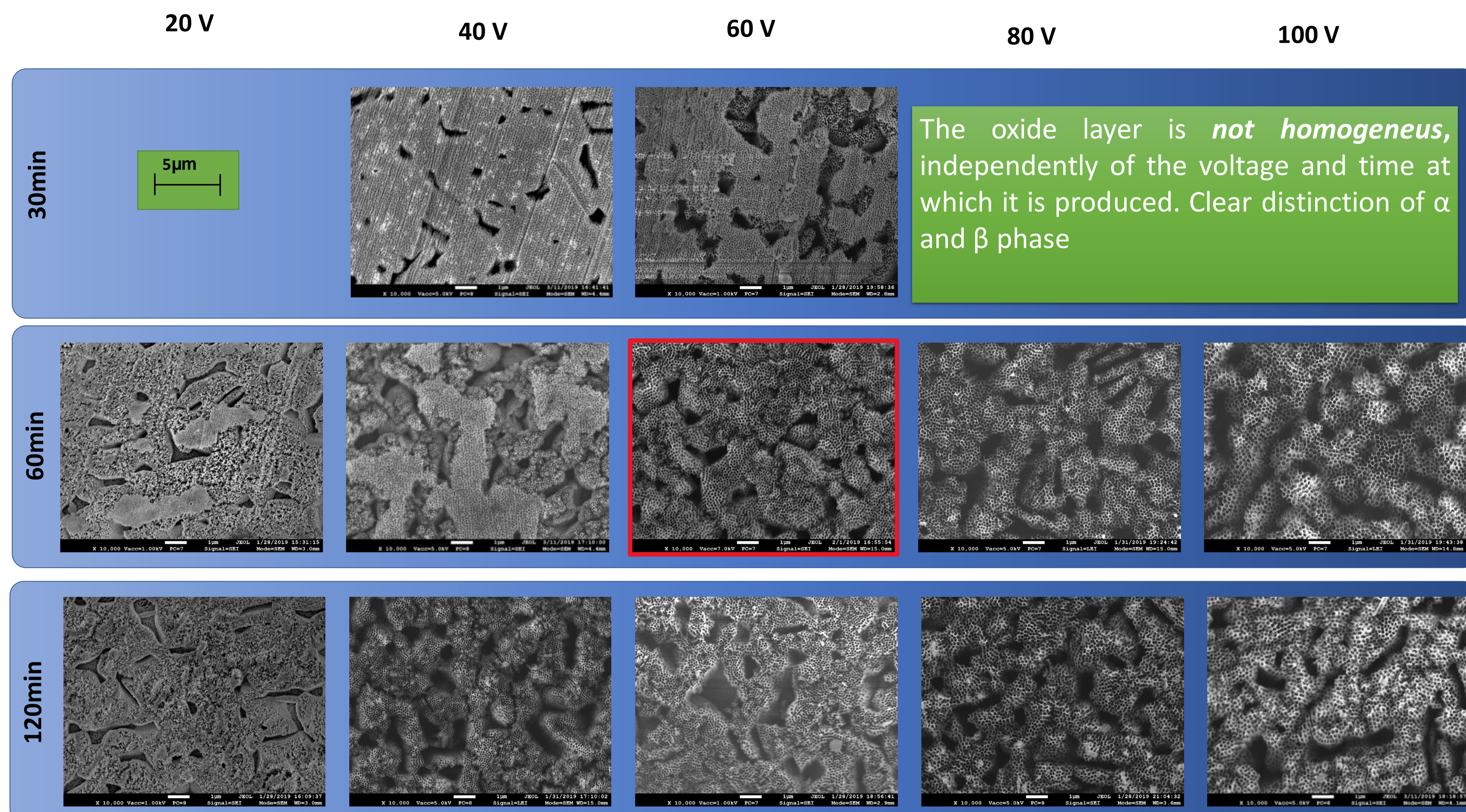
Tested Variables:

- Applied potential differences: 20-100 Volts;
- Time : 30-120 min;

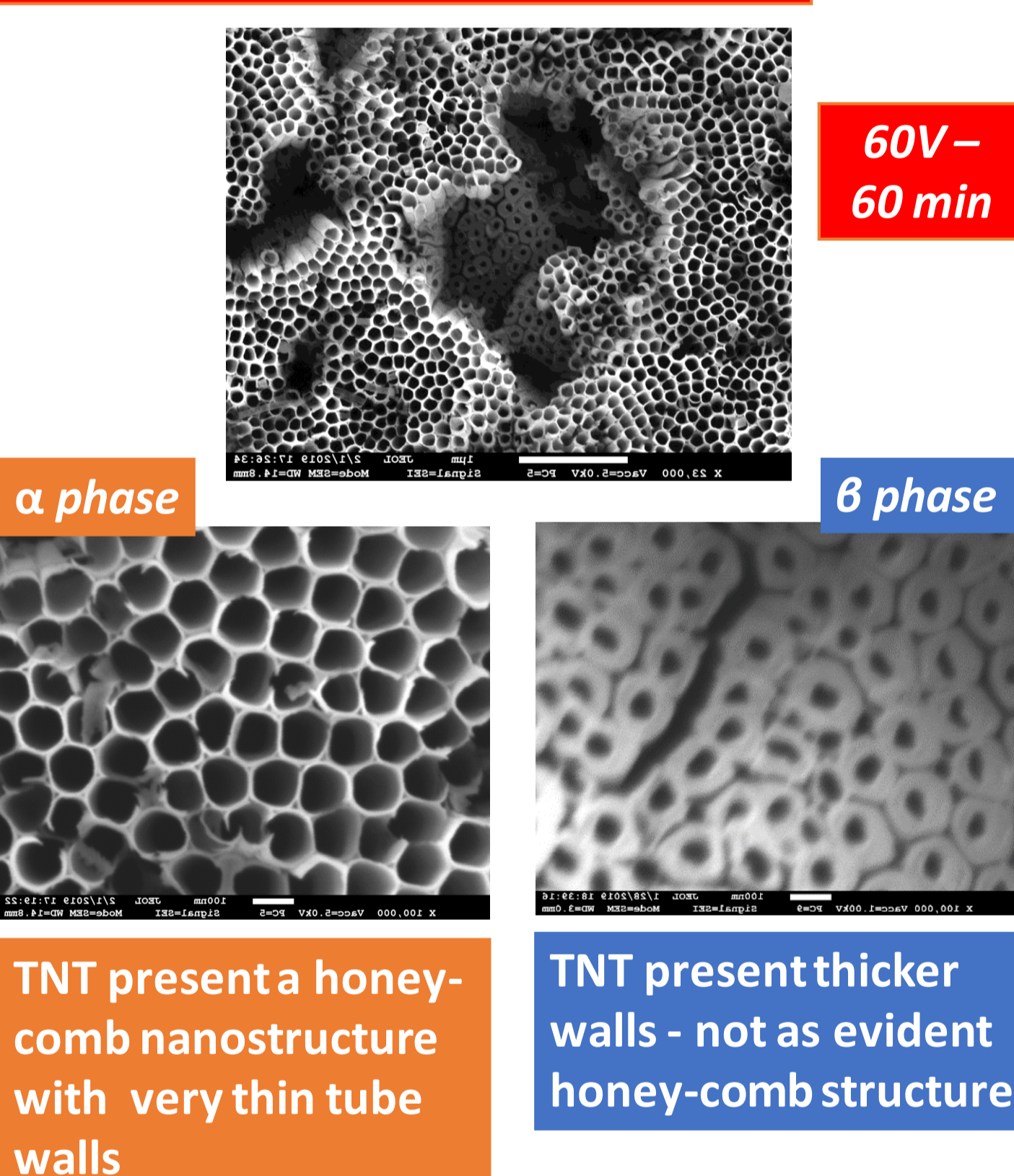
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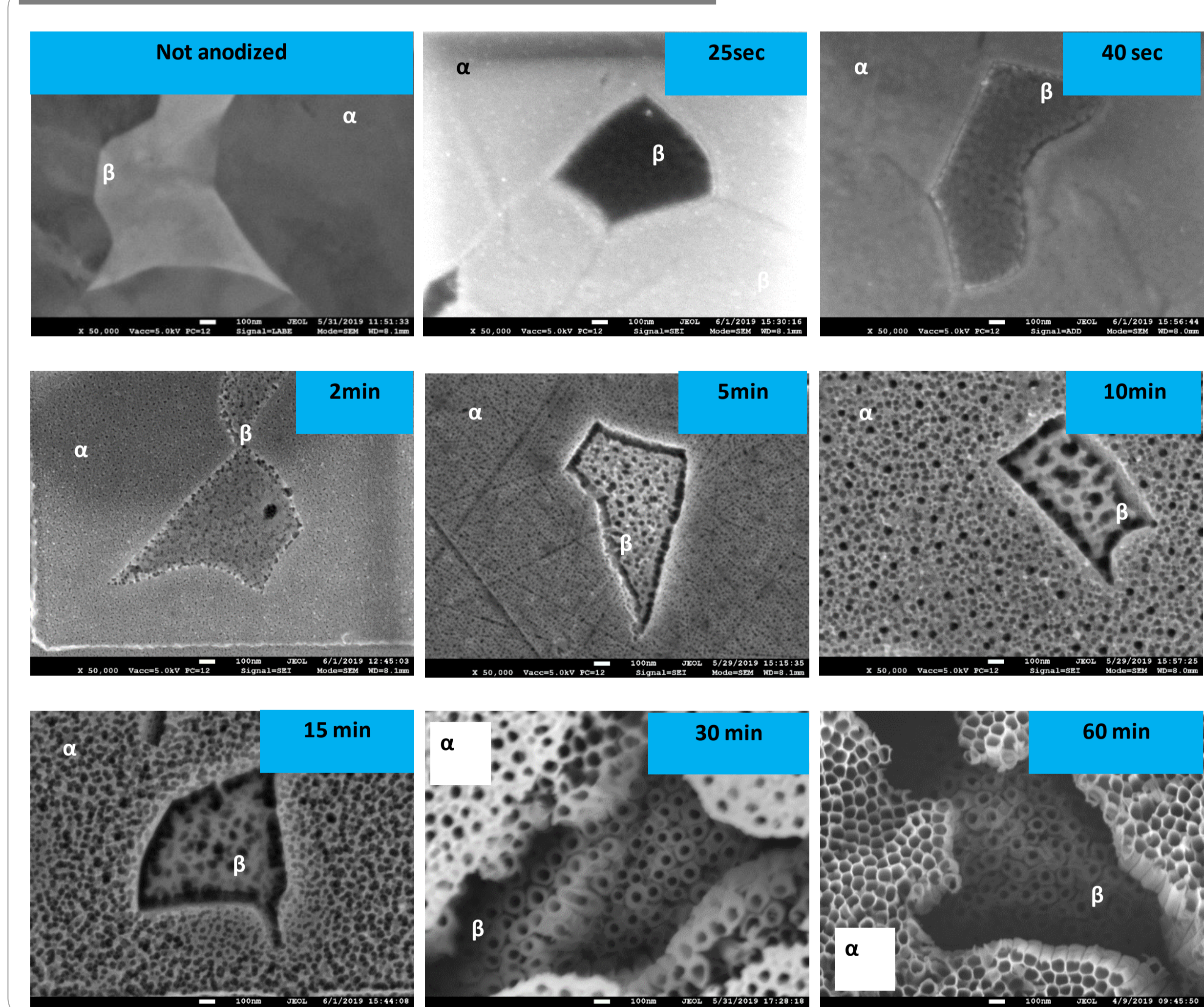
Results



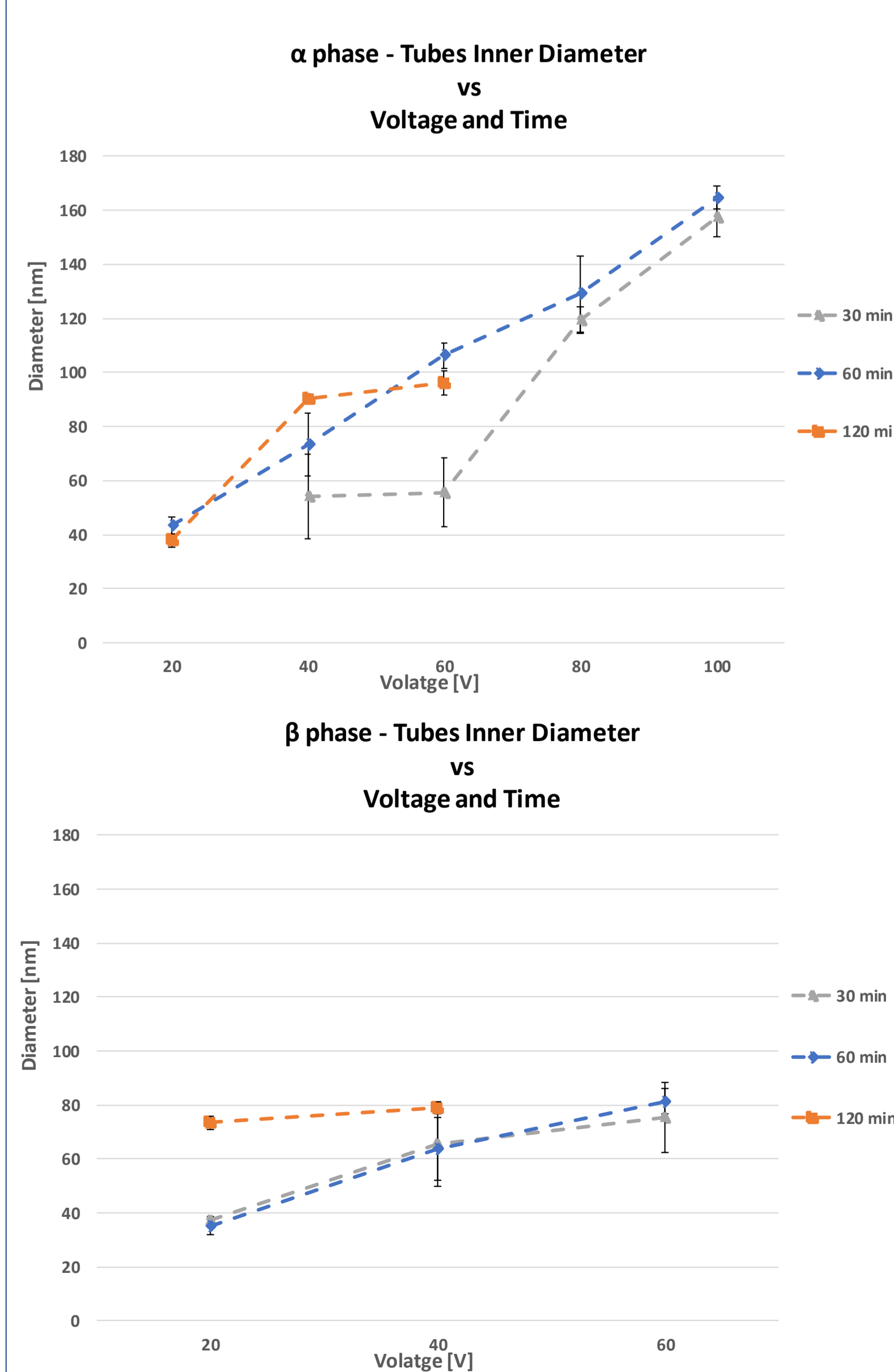
TNT morphology on α and β phase



TNT growth with time on α and β phases – 60V



Tube dimension



An increase in voltage leads to an increase in the inner diameter of the nanotubes;

Conclusions

- TNTs grow with different kinetics in the α and β phase, during the anodization process and, as a result, present different morphologies.
- In general, β phase presents thicker walls, lower inner diameters and a less defined morphology;
- By adjusting both time and applied potential difference, it is possible to obtain "well ordered" nano-tubular structures and tune the inner diameters of the tubes.
- However, it is not possible to achieve uniform nanotubular morphology in both α and β phase only by tuning time and the applied potential difference;



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 764977