Surface Modifications of Titanium Alloys for Biomedical Applications

Abstract:

Individuals who are impacted by underlying bone diseases have a need for orthopaedic implant materials, which have gathered considerable demand over the years. One of the main obstacles to address is the frequency of revision surgeries due to implant failure. A promising approach is in the development of an implant with nano-rough surface topography that is comparable to bone.[1] This would enhance mechanical interlocking between the bone and implant, while stimulating bone cell growth and osseointegration. This can be achieved electrochemically by anodisation of titanium alloys, resulting in the formation of nanotubes under certain conditions. Metallic oxide coatings consisting of nanotubes are advantageous for implant materials due to their comparable tensile strength with bone, corrosion resistance, and biocompatibility. Modification of TiO_2 nanotubes features the inclusion of bone-growth promoters, *e.g.* Mg^{2+} and Ca^{2+} ions. These ions stimulate growth of hydroxyapatite (HA), which aids in osseointegration. As TiO_2 nanotubes possess self-sealing abilities (**Figure 1**), the inclusion and the controlled release of these ions provides an attractive approach for the functionalisation of the TiO_2 nanotubular layer for biomedical applications.

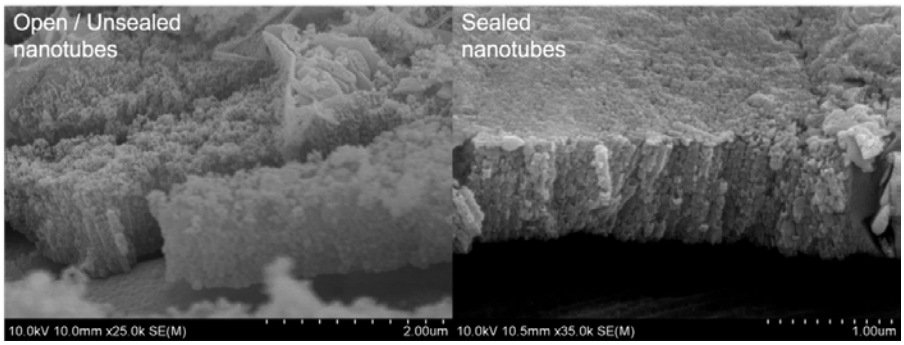

Figure 1: TiO_2 nanotubes formed from anodisation of Ti6Al4V.

References

1. Variola, F., Brunski, J., Orsini, G., Oliveira, P. T. De & Nanci, A. Nanoscale surface modifications of medically-relevant metals: state-of-the art and perspectives. *Nanoscale* **3**, 335–353 (2012).

Main analytical techniques:

- Surface characterisation: Scanning electron microscopy, optical microscopy
- Compositional analysis: Energy dispersive x-ray spectroscopy, Raman spectroscopy, X-ray diffraction analysis (powder and thin film)
- Electroanalytical techniques: Cyclic voltammetry

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