Project title: Functionalisation of titanium alloy surfaces
Research Theme: Engineering and Medical
Key words: Biocompatible, implant, thermal oxidation, peptide, surface
Supervisory team: James Bowen, Richard Moat, Amir Shirzadi

Project Highlights:
- Thermal oxidation of titanium alloys yields anatase and rutile surface coatings.
- Covalent functionalisation depends on chemical moieties presented at the surface.
- Peptide coatings will improve biocompatibility and in vivo attachment to native tissue.

Overview:
The global market value for prosthetics was estimated at $1.6 billion in 2015, with an estimated growth of 5% per year until 2026. Areas of activity include cochlear implants, artificial organs, and retinal implants. Titanium alloys are widely used for orthopaedic prosthetics. They exhibit strong potential for use in the above-mentioned areas.

Recently performed studies on titanium alloy TiAlV have revealed a complex surface heterogeneity which evolves as a function of thermal oxidation (TO) conditions. The titanium oxides anatase and rutile can develop on the surface, as well as oxides of vanadium and aluminium. The newly created surfaces displayed pH responsive behaviour, and promoted the electrostatic attachment of amphiphilic peptide coatings from aqueous solutions of pH 5-7. The robustness of the coating was compromised by large changes in environmental pH.

This project will firstly explore the influence of TO conditions at temperatures in excess of 400 °C. The effect of treatment time and temperature will be explored in detail, to generate a systematic understanding of the relationship between (i) surface chemical composition, (ii) the increase in surface roughness, and (iii) pH response. Secondly, the covalent attachment of peptide coatings will be investigated. Synthetic strategies will include (i) direct attachment of peptide-containing polymers, and (ii) the use of an intermediate bridging layer between alloy surface and peptide.

Methodology:
Mirror polished titanium alloys will be subjected to thermal oxidation; variables include duration, temperature, and vapour phase composition. The change in surface physicochemical properties will be assessed using state-of-the-art interrogation techniques including X-ray spectroscopies and sub-optical microscopies.

Functionalisation of the alloy surfaces will be attempted using suitable reaction conditions; the efficacy of the transformation will be quantified. The newly-created surfaces will present covalently bound peptide aptamers, suitable for enhancing biocompatibility and mammalian cell attachment, including osseointegration.

Partners and collaboration
Dr Artemis Stamboulis (University of Birmingham), an internationally renowned expert in the biomedical applications of metals and ceramics.

Figure 1. Topography of TiAlV surface with mirror-like finish.
Dr Nazia Mehrban (University College London), an expert in the use of peptides for enhancing mammalian cell attachment and proliferation.

**Further reading:**

**Further details:**
Students should have a strong background in materials research and enthusiasm for learning state-of-the-art materials characterisation techniques. Experience of biomedical materials is desirable. The student will join a well-established research group at the Open University, whose expertise includes surface modification and materials characterisation.

The applicant must be willing to travel occasionally to attend international conferences, or to use international research facilities, if and when required.

Please contact Dr James Bowen for further information [james.bowen@open.ac.uk].

Applications should include:
- A 1,000 word cover letter outlining why the project is of interest to you and how your skills match those required.
- An academic CV containing contact details of three academic references.
- SETS test scores where English is an additional language (Secure English Language Test).

Applications should be sent to STEM-EI-Research@open.ac.uk by 19 February 2018.