DESCRIPTION FOR THE GENERAL PUBLIC

The most common sensory disability in the world is hearing impairment. In Europe it affects a significant part of the population, across the age range. The two main forms of hearing loss are: conductive loss, when the ossicles inside the middle ear are destroyed, and sensorineural loss, when there are abnormalities in the inner ear, most often caused by ageing. The result of damage in the middle ear requires surgery or use of an implantable device. Current prostheses for ossicular chain reconstructions have some limitations in addition to their undeniable advantages. One problem is implants separating from the ossicles, because of poor implant/bone connection. Due to the implant's construction and function in sound transmission, otolaryngologists state that the surface of the prosthesis must demonstrate the gradient of the properties. In selected areas of the implants, integration with the bone should occur faster. This project focuses on this issue and seeks to develop a hybrid method of surface treatment to deliver a controlled increase of middle ear implant ossointegration.

The hypothesis of this project is as follows: there is a combination of surface treatments of titanium grade 2, allowing for the creation of multimodal surface roughness and locally controlled growth of calcium-phosphate layers.

The main objective of this project is to identify the features of the topography and physicochemical surface properties responsible for the rapid integration process of the implant surface with bone tissue. Knowing these parameters enables a faster and more controllable bone growth process in certain areas of the prosthesis surface. The SBF immersion tests, imitating the bone mineralisation process in extracorporeal condition, will provide data and insight for a qualitative and quantitative description of the growth kinetics of calcium-phosphate layers. The interaction of bone tissue strongly depends on the surface characteristics, such as topography, chemical/phase composition, wettability and surface energy. Shot penning, etching and a combination of the two, will be used to modify the surface of titanium samples. The aim of these treatments is to purify and homogenise (uniform distribution of surface characteristics) surface topography. Next, samples will be locally modified by Direct Laser Interference Lithography (DLIL) in order to obtain periodically repeating patterns on titanium. In the project, two different patterns are proposed – grooves and island – because these topographies are the most commonly used periodic structures for bone implants. The geometry of surface structures also falls with the ambit of this project and will be optimised for bone implants. In the literature multiple surface topographies were analysed for rapid osseointegration, but it is now thought that the most promising method to modify implant surface is to imitate bone surface morphology after the bone resorption process. The use of hybrid treatments will produce multimodal surface topography in a wide range of roughness from nano- to micrometers and may also result in homogenisation of the grain, which may cause a change in the physicochemical properties of the titanium surface.

The proposed project is of high scientific importance and concerns the latest trends in materials science in the field of biomaterials for bone implants, especially middle ear implants. While the issues analysed in this project constitute basic research, the results will provide insight in otolaryngology. A review of the literature revealed that surface modification dedicated to ear implants is rare. The results obtained in this project will lay the foundations for future research on implant development and design of an optimal surface for use in middle ear prosthesis.