CHARACTERIZATION OF SURFACE MODIFICATION OF TI-6AL-4V CELL STRUCTURES PRODUCED BY ADDITIVE MANUFACTURING

Talita Kathleen Correia de Sousa [1]
Guilherme Arthur Longhitano [2]
Ana Paula Rosifini Alves Claro [3]

ABSTRACT

Additive Manufacturing (AM) is a technology that allows the fabrication of three-dimensional objects from a 3D computational model, particularly useful for Medicine 4.0, as it produces highly complex objects, making it a study tool for the biomaterials area. Cellular structures are supports that can help bone regeneration, but have highly complex architectures, difficult or impossible to produce using traditional manufacturing techniques. Currently, there are several AM techniques for metallic materials that are viable for the fabrication of these cell structures. However, the geometry of the cell structure and the composition of the material alone are not enough to induce bone regeneration. Surface modification techniques have been studied for years to improve cellular response and aid bone regeneration. The electrochemical technique called anodic oxidation or anodizing is widely used and consists of surface treatment and/or modification inducing the growth of an oxide layer on the surface of a metallic material. The purpose of this research is to evaluate the influence of anodic oxidation surface treatment on cellular structures of Ti-6Al-4V alloy produced through additive manufacturing, using *Direct Metal Laser Sintering* (DMLS) and *Electron Beam Melting* (EBM) techniques. The cell structures were designed in a computational model in the *Materialise Mimics*® software using unit cell in diamond, cubic and hexagonal shape, exported to .STL format and custom-made from Ti-6Al-4V alloy powder using the technique of DMLS and EBM. The anodizing study was carried out in the laboratory of biomaterials at the Faculty of Engineering of Guaratinguetá

[1] Mestranda do curso de Engenharia Mecânica da Faculdade de Engenharia de Guaratinguetá, Universidade Estadual Paulista "Júlio de Mesquita Filho" (FEG/UNESP) - SP, talita.kathleen@unesp.br;
[2] Co-orientador da pesquisa: Doutor em Engenharia Mecânica, Centro de Pesquisa Renato Archer (CTI) - SP, guilonghita@gmail.com;
[3] Professor orientador: Doutora em Engenharia Mecânica, Faculdade de Engenharia de Guaratinguetá, Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP) - SP, paula.rosifini@unesp.br.

(FEG/UNESP) and several variations in the composition of the electrolyte were tested. To prepare the solution, ethylene glycol, ammonium fluoride (NH4F) and deionized water were used, with a voltage of 20V for 3 hours. Calcination of anodized samples was carried out in a muffle furnace, with a heating rate of 5ºC/minute maintained for 1 hour at 450ºC, followed by slow cooling in the oven. Surface treated and untreated samples were analyzed using scanning electron microscopy (SEM). Images were collected by microscope with tungsten filaments belonging to the Materials Images Laboratory (FEG/UNESP). In both AM techniques, it is observed that the as-built samples have dust particles not fully sintered on their surface, which can be harmful in the bloodstream. Surface finishing methods must be adopted in order to get around this problem, such as cleaning and chemical polishing. In the anodizing study, the same parameter was applied to both techniques and a nanostructured surface with titanium nanotubes (TiO_2) was observed in the SEM. The use of these different technologies in the future, for the production of implants, adding surface treatments can help improve the quality and life expectancy of patients, being of great importance for the field of medicine 4.0 and biomaterials.