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Additive manufacturing of Ti6Al4V lattices for spinal fusion cages

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Selective Laser Melting is rapid prototyping technique which enables prompt modelling of parts with high bulk density on the base of individual three dimensional data. In this study, we will test the SLM produced samples with on the basis of Ti6Al4V alloy for its applicability in spinal fusion cages. Great modulus of spinal fusion cages causes an accumulation of stress on implant and this cause stress shielding problem which results in long term damage to vertebral bodies. This study considers the effect of stress shielding on the bone-implant interaction and optimize the stiffness of titanium scaffolds. When the loads on the implants could not be transferred to the bone due to the higher elastic modulus of the implant than bone, so stress shielding effect appears on the interface of bone and implant. Optimization of cell topologies of titanium scaffolds will optimize the stiffness and give a value close the stiffness of cancellous bone. Compressive tests will prove that the stiffness of the porous structures. Both experimental and modeling of compression test was done to compare both results. This study will aim to understand the effect of pore geometry on the in vitro biological behavior of bone cells seeded on selective laser-melted Ti6Al4V bone scaffolds. Pentamode lattice structure was selected with 70%, 80% and 90% porosities. Produced scaffolds were characterized by two-dimensional optical microscopy and Scanning Electron Microscopy (SEM). 3-Dimensional cell culture test will be practiced with MLO-A5 cells on selected titanium scaffolds. This test is for the identification of the best unit cell model and pore size of titanium scaffolds for the enhanced bone matrix production and facilitated long-term static culture.

Importance of Research:

This research contributed the technology of additive manufacturing of metals. Additive Manufacturing is a process of 3D printing technology of welding materials to produce parts from the 3D CAD model design data in conversion with conventional techniques. The AM process has great advantages with the custom-made parts with the help of the tool, computer-controlled self-assembly by melting powder layers using either laser beam or an electron beam technology. Various positive results of the AM such as cost-effective and final shape fast production to accurately control the inner architecture and complex architectures. AM techniques use laser or electron beams as a heat source as their working method is the same with welding. These power sources selectively melt or fuse the alloy powder with a method of powder bed fusion process. Mechanical properties of the scaffolds have been evaluated with the accuracy factor, strut diameter and unit cell size. Moreover, the fabricated properties are controlled by the pore geometry and alloy composition of the scaffolds. Hence, mechanical properties can be customized for the patient private demand, e.g. elastic modulus, human cortical bone can be produced, 15-20 GPa. This study will aim to understand the effect of pore geometry on the in vitro biological behavior of bone cells seeded on selective laser-melted Ti6Al4V bone scaffolds.

Biography

Tuba Kizilirmak has received his bachelor degree from Eskisehir Technical University in Turkey. She studied barite mineral in final year research project. The research title was High Purity Powder Synthesis from Barite Mineral. She achieved to complete master degree at University of Leicester. She gained experience on modeling techniques such as SolidWorks, COMSOL, MATLAB. She completed master thesis on molecular dynamics simulation of particle interactions. This research used the technology of LAMMPS simulation program. She is currently doing PhD research at University of Sheffield. Her research project title is Additive Manufacturing of Ti6Al4V Lattices for Spinal Fusion Cages. Her research project covers the topic of biomaterials.

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