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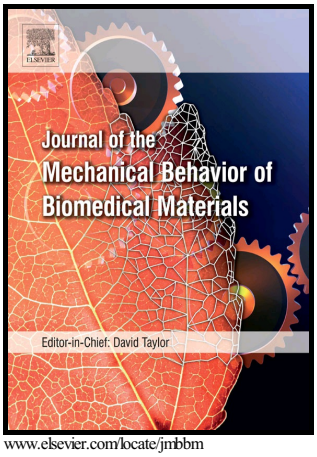

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Promising characteristics of gradient porosity Ti-6Al-4V alloy prepared by SLM process

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Abstract

Porous structures, manufactured of a biocompatible metal, mimicking human bone structure are the future of orthopedic implantology. Fully porous materials, however, suffer from certain drawbacks. To overcome these, gradient in structure can be prepared. With gradient in porosity mechanical properties can be optimized to an appropriate value, implant can be attributed a similar gradient macrostructure as bone, tissue adhesion may be promoted and also various modification with organic or inorganic substances are possible. In this study, additive technology selective laser melting (SLM) was used to produce three types of gradient porosity model specimens of titanium alloy Ti-6Al-4V. As this technology has the potential to prepare complex structures in the near-net form, to control porosity, pore size and shape, it represents a promising option. The first part of the research work was focused on the characterization of the material itself in the as-produced state, only with heat treatment applied. The second part dealt with the influence of porosity on mechanical properties. The study has shown SLM brings significant changes in the surface chemistry. Despite this finding, titanium alloy retained its cytocompatibility, as it was outlined by in vitro tests with U-2 OS cells. With introduced porosity yield strength, ultimate strength and stiffness showed linear decrease, both in tension and compression. With respect to the future use in the form of orthopedic implant, especially reduction in Young's modulus down to the human bone value (30.5±2 GPa) is very appreciated as the stress-shielding effect followed by possible implant loosening is limited.

Keywords

Ti-6Al-4V, selective laser melting (SLM), gradient porosity, implant, mechanical properties

1. Introduction