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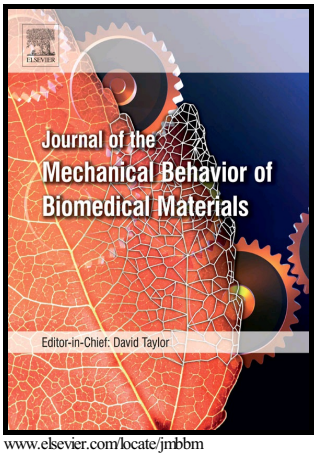

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Continuous functionally graded porous titanium scaffolds manufactured by selective laser melting for bone implants

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Abstract: A significant requirement for a bone implant is to replicate the functional gradient across the bone to mimic the localization change in stiffness. In this work, continuous functionally graded porous scaffolds (FGPSs) based on the Schwartz diamond unit cell with a wide range of graded volume fraction were manufactured by selective laser melting (SLM). The micro-topology, strut dimension characterization and effect of graded volume fraction on the mechanical properties of SLM-processed FGPSs were systematically investigated. The micro-topology observations indicate that diamond FGPSs with a wide range of graded volume fraction from 7.97% to 19.99% were fabricated without any defects, showing a good geometric reproduction of the original designs. The dimensional characterization demonstrates the capability of SLM in manufacturing titanium diamond FGPSs with the strut size of 483-905 μm. The elastic modulus and yield strength of the titanium diamond FGPSs can be tailored in the range of 0.28-0.59 GPa and 3.79-17.75 MPa respectively by adjusting the graded volume fraction, which are comparable to those of the cancellous bone. The mathematical relationship between the graded porosity and compression properties of a FGPS was revealed. Furthermore, two equations based on the Gibson and Ashby model have been established to predict the modulus and yield strength of SLM-processed diamond FGPSs. Compared to homogeneous diamond porous scaffolds, FGPSs provide a wide range of mutative pore size and porosity, which are potential to be tailored to optimize the pore space for bone tissue growth. The

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