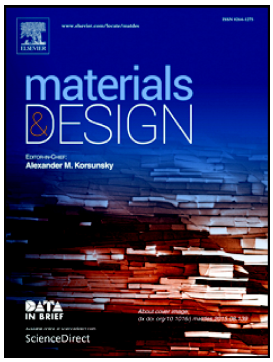

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Porosity Control in 316L Stainless Steel using Cold and Hot Isostatic Pressing

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Abstract

Porous biomedical implants are known for their improved osseointegration due to the ingrowth of bone tissues, combined with a lower elastic modulus to solid implants, resulting in a reduced likelihood for stress shielding and implant loosening. In this work, the control of the porosity content in capsule-free powder hot isostatic pressing (CF-HIPing) of 316L stainless steel was investigated. The proposed approach utilises cold isostatic pressing (CIPing) to form green compacts using rubber moulds, followed by CF-HIPing under suitable conditions. Porosity control was attained via the selection of the powder particle size used in creating the green compacts. The microstructural and mechanical properties development of the CF-HIPed structures was studied using optical and scanning electron microscopy, micro-computer tomography, hardness, and compression testing. The occurrence of powder necking was visualised using electron backscattered diffraction. The results showed a significant increase in the pore fraction of the samples with increasing the particle size of the powder. However, increasing the particle size was also associated with a drop in the elastic modulus, compressive strength, ductility, and hardness of the final structures. Nonetheless, porous structures with elastic modulus between 17-30 GPa were successfully produced using a powder particle size range of 32-50 µm, matching the elastic modulus of human bones.

Keywords: Hot Isostatic Pressing; Cold Isostatic Pressing; Porous Material; Austenitic stainless steel; Microtomography