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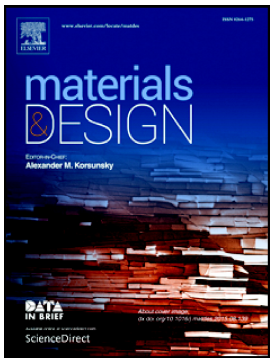

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Morphological and mechanical characterization of topologically ordered open cell porous iron foam fabricated using 3D printing and pressureless microwave sintering

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Abstract

Topologically ordered porous structures (TOPS) have shown great potential in biomedical application. For biodegradable application, TOPS can prove to be advantageous especially for iron-based biodegradable materials. However, limited work has been reported which discusses the fabrication and characterization of iron-based TOPS. Hence, in the present work, topologically ordered open cell porous iron foam (TOPIF) was developed using a novel fabrication procedure consisting of 3D printing and pressureless microwave sintering. Different unit cell structures namely cubic, truncated octahedron and pyramid were used. Porosities in the range of 45.6-86.9 % and 5-22 % variation in dimensions were obtained. Compressive modulus of elasticity, plateau stress and ultimate compressive strength of TOPIF with 45.6-86.9 porosity were found in the range of 218.67-854.04 MPa, 4.24-21.60 MPa and 13.16-52.06 MPa respectively. Moreover, flexural modulus of elasticity and ultimate flexural strength in the range of 161-753 MPa and 9-38 MPa respectively were obtained. Analysis based on Gibson-Ashby model was performed and good agreement with experimental results was obtained. A comparative study showed that the fabricated TOPIF samples possessed ideal properties as required for an augmentation procedure of a human cancellous bone.

Keywords: Porous iron; 3D printing; microwave sintering; morphology; mechanical characterization.