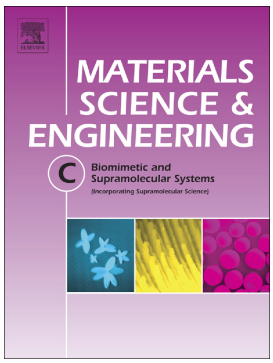

Compressive characteristics of radially graded porosity scaffolds architectured with minimal surfaces

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Compressive characteristics of radially graded porosity scaffolds architectured with minimal surfaces

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Abstract

Scaffolds with gradient pore characteristics have received a great deal of attention as they can better mimic the structure of the native tissues and concurrently meet both biological and mechanical requirements. In the present study, the effects of porosity geometry and porosity gradient patterns on the deformation mechanism and compressive mechanical properties of the structures were investigated in the context of stretching (I-WP and P surfaces) versus bending dominated (D surface) triply periodic minimal surface (TPMS) based architectures. Different gradient patterns were found to significantly alter the deformation mechanism. Radial gradient patterns (perpendicular to loading direction) provide higher deformability while longitudinally graded scaffolds suffer from low failure strain. In the stretching dominated architectures vertical cracks propagated under compression due to the materials transverse expansion under compression. Deformations in the bending dominated architectures, however, were accompanied by a progressive collapse owing to the shearing of the struts. In general, stretching dominated structures showed the higher mechanical properties and provided more efficiency under mechanical loads. Finite Element simulations also demonstrated a high capability for predicting the deformation as well as mechanical responses (especially for elastic properties) and can be used as a tool for designing multifunctional gradient porous scaffolds.

Keywords: Porous Scaffolds; Gradient Porosity; Mechanical Characterization; Failure Mechanisms; Additive Manufacturing.

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