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Fused Deposition Modeling Printing of Bioinspired Triply Periodic Minimal Surfaces Based Polyvinylidene Fluoride Materials for Scaffold Development in Biomedical Application

Authors : Farusil Najeeb Mullaveettil, Rolanas Dauksevicius

Abstract : Cellular structures produced by additive manufacturing have earned wide research attention due to their unique specific strength and energy absorption potentiality. The literature review concludes that pattern type and density are vital parameters that affect the mechanical properties of parts formed by additive manufacturing techniques and have an influence on printing time and material consumption. Fused deposition modeling technique (FDM) is used here to produce Polyvinylidene fluoride (PVDF) parts. In this work, patterns are based on triply periodic minimal surfaces (TPMS) produced by PVDF-based filaments using the FDM technique. PVDF homopolymer filament Fluorinar-H™ and PVDF copolymer filament Fluorinar-C™ are printed with three types of TPMS patterns. The patterns printed are Gyroid, Schwartz diamond, and Schwartz primitive. Tensile, flexural, and compression tests under quasi-static loading conditions are performed in compliance with ISO standards. The investigation elucidates the deformation mechanisms and a study that establishes a relationship between the printed and nominal specimens' dimensional accuracy. In comparison to the examined TPMS pattern, Schwartz diamond showed a higher relative elastic modulus and strength than the other patterns in tensile loading, and the Gyroid pattern showed the highest mechanical characteristics in flexural loading. The concluded results could be utilized to produce informed cellular designs for biomedical and mechanical applications.

Keywords : additive manufacturing, FDM, PVDF, gyroid, schwartz primitive, schwartz diamond, TPMS, tensile, flexural
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