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Resilient 3D printed Shellualr Metamaterials

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ABSTRACT

Shellular materials with triply periodic minimal surfaces (TMPS) demonstrate high surface-to-volume ratio, pore connectivity, and variable thermal conductivity with potential applications in biomedicine, photovoltaic, and electrochromic devices. However, further exploration of shellular surface by perforation is never discussed, which might provide a promising method to obtain unprecedented mechanical properties. In this study, we explore theoretically and experimentally the topology-property relationship of shellualr materials with periodic perforated metasurfaces. The Schwarz Primitive (P) is selected as an underlying shellular material while conformal-mapped holes with alternative aspect ratios and sizes are generated on the constitutive shell surface. The digital light processing (DLP) technology is used to 3D print the perforated metamaterials. The numerical and experimental compression tests affirm a significant enhancement in the reusability of energy absorbers manifested by this new class of mechanical metamaterials compared to the conventional shellulars. This study paves the way towards the development of high-performance and resilient 3D printed shell-like metamaterials.

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