ICCES, 2024, vol.29, no.2
DOI: 10.32604/icces.2024.011375

PROCEEDINGS

Tunable Energy Absorption of Thermoplastic Polyurethane P-type TPMS Lattice Structure via Trimming

Haoming Mo[1,*], Junhao Ding[1] and Xu Song[1]

[1]Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong, China
[*]Corresponding Author: Haoming Mo. Email: hmmok@link.cuhk.edu.hk

ABSTRACT

Triply periodic minimal surface (TPMS) shell-lattices are attracting increasing attention because of their exceptional mechanical and geometric characteristics. Additive manufactured TPMS structures using thermoplastic polyurethane (TPU) have great application potential in energy absorptions, for which the mechanical properties can be conveniently adjusted to meet diverse requirements. Nevertheless, there is a need for further improvement in the stability and adjustability of energy absorption capacity. This is due to the significant impact of the buckling effect and induced stress fluctuations when the structure is subjected to compression. To alleviate the buckling effect and tune the capability of energy absorption, we propose a method to adjust the mechanical properties of the P-type TPMS lattice structure by trimming holes, which were carried out by intersections between mesh and implicitly defined cutting zones. The compression behavior of the lattice structure is thoroughly investigated by finite element (FE) simulation and experimental testing. For the original structures, the localized deformation, such as layer-by-layer and significant stress fluctuations were occurred, which are captured by both FE simulation and experimental testing. Comparatively, via trimming holes, the stress distribution becomes more uniform, and localized resilience becomes trivial, resulting in a more stable stress curve without obvious fluctuations. Compared with original TPMS structures, the trimmed one demonstrates higher mechanical properties and superior energy absorption adjustability potential. Especially, the yield stress, stress-strain curves, and energy absorption capability can be precisely controlled via changing the size of holes at different locations. Overall, this work highlights the superiority of the trimming method in design of tunable TPMS structures for energy absorption applications.

KEYWORDS

TPMS Lattice Structures; energy absorption; stress fluctuations

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.