Mechanical Properties of Additively Manufactured Auxetic Structures

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Abstract

Auxetic materials/structures expand laterally when stretched and contract laterally when compressed, exhibiting negative Poisson's ratio (NPR). In this study, a recently developed 2D auxetic structure with a combination of the topological features of re-entrant honeycomb and chiral honeycomb has been fabricated from Nylon-12 using Multi Jet Fusion (MJF) 3D Printing process. The external surfaces and dimensions have been examined using an optical stereomicroscope. The microscopic measurements show that MJF 3D printing process is able to produce robust parts with precise dimensions. The mechanical properties of the proposed structure under both quasi-static and dynamic loads have been investigated experimentally and numerically. A number of experimental tests have been conducted to study the load carrying capacity and Poisson's ratio of this structure under various loading velocities using different test machines such as Zwick Roell and high-speed Instron testing machine. Finite element (FE) models have been established using ABAQUS/Explicit and validated by the experimental results. Numerical simulations have been conducted in order to examine the effects of velocity and geometrical parameters of the proposed structure. The stress-strain curves, Poisson's ratio and energy absorption of this structure have been presented and compared with those of the two popular auxetic structures, re-entrant honeycomb and chiral honeycomb.

Biography

Professor Dong Ruan obtained her Bachelor and Master degrees from Shanghai Jiaotong University, China. She was awarded PhD degree from Swinburne University of Technology, Australia in 2005. She has subsequently worked as a Postdoctoral Fellow and a full time academic staff at Swinburne University from 2005 and 2008 respectively.

Dong's research interest is impact engineering. Her primary research fields include (1) characterisation of the mechanical properties of materials at high strain rates; (2) evaluation of the mechanical response of structures (such as multi-layered panels and tubes) under dynamic loadings; (3) additive manufacturing. She has published over 200 academic papers in leading international journals and prestigious international conferences. Ruan has secured over $5 million research grants from Australian Research Council (ARC), Defence Materials and Technology Centre (DMTC), Cooperative Research Centre for Advanced Automotive Technology (AutoCRC), and Rail Manufacturing CRC, among others. Ruan has supervised more than 20 PhD students.

Dong has been the Vice-secretary of *International Society of Impact Engineering* (the peak body in impact engineering) since 2016. She is a member of the Editorial Advisory Board for *International Journal of Impact Engineering*. Dong received a national award, the 2013 Eureka Prize, as a team member of DMTC's Armour Application Program.