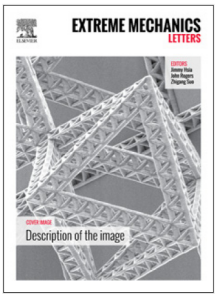
Accepted Manuscript



Elastically-isotropic elementary cubic lattices composed of tailored hollow beams

Thomas Tancogne-Dejean, Dirk Mohr

PII: S2352-4316(18)30024-5
DOI: https://doi.org/10.1016/j.eml.2018.04.005
Reference: EML 365

To appear in: *Extreme Mechanics Letters*

Received date : 13 February 2018
Revised date : 9 April 2018
Accepted date : 23 April 2018

Please cite this article as: T. Tancogne-Dejean, D. Mohr, Elastically-isotropic elementary cubic lattices composed of tailored hollow beams, *Extreme Mechanics Letters* (2018), https://doi.org/10.1016/j.eml.2018.04.005

Elastically-isotropic Elementary Cubic Lattices Composed of Tailored Hollow Beams

Thomas Tancogne-Dejean[1] and Dirk Mohr[2]

[1]*Impact and Crashworthiness Laboratory, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge MA, USA*

[2]*Department of Mechanical and Process Engineering, ETH Zurich, Switzerland*

Abstract. In previous works, mechanical metamaterials exhibiting isotropic elastic properties have been obtained using combinations of the *elastically-anisotropic* elementary cubic truss lattices (simple-cubic, body-centered cubic or face-centered cubic truss lattice structures). In the present work, a new family of *elastically-isotropic* elementary cubic truss lattice structures is developed, eliminating the need of combining elementary structures to achieve elastic isotropy. Depending on the direction of loading, the nature of the mechanical response of cubic elementary trusses changes smoothly from bending-dominated to stretching-dominated. It is thus possible to tailor the apparent anisotropy at the macroscopic level by changing the ratio of bending-to-axial stiffness of the constituent beams. Here, the latter is achieved by changing the ratio of inner-to-outer diameter of hollow tubes. It is shown through unit cell simulations that an optimal diameter ratio exists achieving elastic isotropy for all three elementary cubic trusses for the full range of relative densities considered (1 to 50%). Selected polymer trusses are additively-manufactured using stereolithography and subjected to uniaxial compression along different directions of loading to provide a partial experimental validation of the proposed design maps.

Keywords: Mechanical metamaterial, truss lattice, isotropic elasticity, additive manufacturing, cubic lattice

---