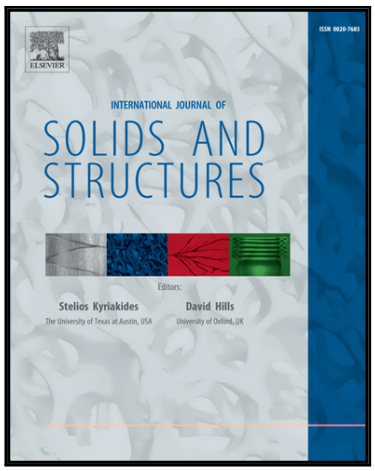

A Novel High Symmetry Interlocking Micro-Architecture Design for Polymer Composites with Improved Mechanical Properties

Sandip Haldar, Trisha Sain, Susanta Ghosh

PII: S0020-7683(17)30302-5
DOI: 10.1016/j.ijsolstr.2017.06.030
Reference: SAS 9637

To appear in: *International Journal of Solids and Structures*

Received date: 8 December 2016
Revised date: 20 June 2017
Accepted date: 23 June 2017

Please cite this article as: Sandip Haldar, Trisha Sain, Susanta Ghosh, A Novel High Symmetry Interlocking Micro-Architecture Design for Polymer Composites with Improved Mechanical Properties, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.06.030

A Novel High Symmetry Interlocking Micro-Architecture Design for Polymer Composites with Improved Mechanical Properties

Sandip Haldar[a], Trisha Sain[b,*], Susanta Ghosh[b,**]

[a]*IMDEA Materials Institute, Getafe, Madrid, Spain*
[b]*Mechanical Engineering-Engineering Mechanics, Michigan Technological University, Houghton, MI, USA*

Abstract

Development and design of novel materials based on their micro-structural arrangements are being intensely investigated due to their wide range of real and potential applications. One of the key objectives of such design is to achieve multiple properties, which are often competing in nature (such as high stiffness-high damping, high strength-high toughness etc.), within a single composite material. In the present work we propose a novel interlocking micro-architecture design to achieve high symmetry in a plane within a composite. The present study shows that constraining a very low volume fraction of high damping polymer within this micro-architecture, together with a stiff polymer, results in a simultaneously high stiffness and high damping polymer composite. The proposed micro-architecture design possesses high symmetry that is not commonly found in fiber-reinforced polymer composites. The interlocking feature avoids use of extra adhesives for holding two adjacent building blocks. Finite element simulations are performed by considering the micro-architecture made of two widely used polymeric materials such as polymethyl methacrylate (PMMA as the stiffer building block) and polyurethane (PU as the soft viscous material). Our numerical predictions show remarkable stiffness and damping properties for the design over a wide range of frequencies. Simulations are also performed considering contact between two polymer interfaces to establish the fact that the geometric interlocking works well without any use of adhesive for holding the blocks together. Further simulations are performed under *high* frequency impulse pressure load-

*Email: tsain@mtu.edu (address for Correspondence)
**Email: susantag@mtu.edu (address for Correspondence)
Email address: Sandip.Haldar@imdea.org (Sandip Haldar)