Accepted Manuscript

Enhanced fracture toughness in architected interpenetrating phase composites by 3D printing

Tiantian Li, Yanyu Chen, Lifeng Wang

PII: S0266-3538(18)30713-9
DOI: 10.1016/j.compscitech.2018.08.009
Reference: CSTE 7342

To appear in: *Composites Science and Technology*

Received Date: 26 March 2018
Revised Date: 22 June 2018
Accepted Date: 9 August 2018

Please cite this article as: Li T, Chen Y, Wang L, Enhanced fracture toughness in architected interpenetrating phase composites by 3D printing, *Composites Science and Technology* (2018), doi: 10.1016/j.compscitech.2018.08.009.

Enhanced Fracture Toughness in Architected Interpenetrating Phase Composites by 3D Printing

Tiantian Li*, Yanyu Chen, and Lifeng Wang*

State University of New York at Stony Brook, Stony Brook, New York, 11794, USA

*Corresponding author:

Lifeng Wang, Email: Lifeng.wang@stonybrook.edu

Tiantian Li, Email: tiantian.li.1@stonybrook.edu

Abstract:

Interpenetrating phase composite (IPC), also known as co-continuous composite, is one type of material that exhibits an unusual combination of high stiffness, strength, energy absorption, and damage tolerance. Here we experimentally demonstrate that IPCs fabricated by 3D printing technique with rationally designed architectures can exhibit a fracture toughness 16 times higher than that of conventionally structured composites. The toughening mechanisms arise from the crack-bridging, process zone formation and crack-deflection, which are intrinsically controlled by the rationally designed interpenetrating architectures. We further show that the prominently enhanced fracture toughness in the architected IPCs can be tuned by tailoring the stiffness contrasts between the two compositions. The findings presented here not only quantify the fracture behavior of complex architected IPCs but also demonstrate the potential to achieve tailorable mechanical properties through the integrative rational design and the state-of-the-art advanced manufacturing technique.

Keywords: architected materials, interpenetrating phase composites, fracture toughness, 3D printing, multifunctional

1. Introduction

Structural systems in the defense, aerospace, automotive, energy, and semiconductor industries are often subjected to complex loading conditions, such as multi-axial loading, vibration, shock, and high-velocity impact. This triggers the demands for the development of innovative structural materials, possessing a