Title

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CRES Author

Fan Zhang

Abstract

The tensile strength and ductility of fiber-reinforced composites containing ductile metal fibers is studied using a multiscale approach and compared to the performance of an identical composite containing elastic fibers. A finite element model of stress redistribution around a single fiber break shows ductile fibers to have lower near-neighbor stress-concentration factors than elastic fibers. These results are used in a mesoscale Green's function model to simulate tensile strength, and a size-scaling model is used to extend the simulation results to macroscopic sizes. Composites composed of ductile fibers are found to have only slightly larger tensile strengths as compared to otherwise identical elastic fibers. However, the macroscopic composite ductility is enhanced, reflecting the response of the underlying fibers. Composites composed of ductile fibers are thus predicted to be more reliable and provide additional toughening while still providing high strength and stiffness, and may therefore be useful in a variety of applications where the increased density of metal fibers is offset by the increased ductility and damage tolerance.

Keywords

Fibers, Plastic deformation, Strength, Finite element analysis (FEA), Green function model