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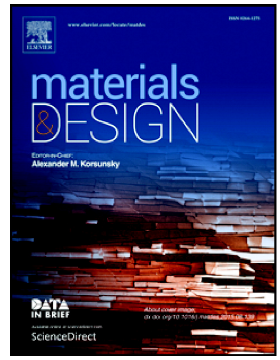

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Qiang Liu, Stepan V. Lomov, Larissa Gorbatikh

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Spatial distribution and orientation of nanotubes for suppression of stress concentrations optimized using genetic algorithm and finite element analysis

Qiang Liu*, Stepan V. Lomov, Larissa Gorbatikh

Department of Materials Engineering, KU Leuven, Kasteelpark Arenberg 44 bus 2450, 3001 Leuven, Belgium

Abstract: The spatial distribution and orientation of carbon nanotubes (CNTs) have significant effects on the mechanical properties of nanocomposites. But what is the ideal CNT network morphology to achieve a desired mechanical performance? To help answer this question, we propose a novel computational approach to optimize position and orientation of CNTs in a nanocomposite to reduce stress concentrations. The presence of stress risers (either intrinsic or intentionally introduced) is known to control failure of materials and structures at different scales. The present methodology is based on the combined implementation of genetic algorithm and finite element method. The optimization problem is formulated as minimization of a global measure of stress field, found to be more efficient than minimization of the stress concentration factor directly. For the nanocomposites with 0.15% and 0.30% of CNTs, the nanostructure optimization is responsible for 39.5% and 54.4% of stress-concentration reduction compared to unfilled polymer, and 35.6% and 48.9% compared to the polymer filled with uniformly distributed CNTs, respectively. The predicted nanostructures redistribute stresses in the material and decrease the volume of high-stress region. The proposed optimization approach supports ongoing developments in the field of 3D printing that made the design and production of

* Corresponding author.
E-mail address: Qiang.Liu@kuleuven.be (Qiang Liu).