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Aramid Nanofibers for Multiscale Fiber Reinforcement of Polymer Composites

Brendan A. Patterson[†], Mohammad H. Malakooti[‡], Jiajun Lin[§], Angelica Okorom[#], Henry A. Sodano[‡,#,]*

[†]Materials Science and Engineering, University of Florida, Gainesville, Florida 32611, USA
[‡]Aerospace Engineering, University of Michigan, Ann Arbor, Michigan 48109, USA
[§]Macromolecular Science and Engineering, University of Michigan, Ann Arbor, Michigan 48109, USA
[#]Material Science and Engineering, University of Michigan, Ann Arbor, Michigan 48109, USA

**Corresponding Author: hsodano@umich.edu*

Abstract: While aramid fibers have been innovative for ballistic protection because of their high energy absorption, minimal usage has been applied to continuous fiber reinforced polymer (CFRP) composites in structural applications. One of the challenges with aramid fibers results from their processing, which yields smooth and chemically inert surfaces that limit the ability of the fibers to adhere to polymeric matrices. Here, it is shown that aramid nanofibers can adhere to the surface of macroscale aramid reinforcements to improve the strength of the composite interface and reinforce the matrix as well. Aramid nanofibers are formed through the dissolution of aramid fibers followed by isolation and dispersion into an epoxy matrix. When employed in CFRP, aramid nanofibers prove to be effective reinforcement agents through improvement in both matrix properties as well as modifying the interfacial shear strength, which leads to improved interlaminar shear strength and fracture toughness. The interface enhancements are attributed to hydrogen bonding and π-π coordination between the aramid nanofibers and the macro fibers providing improved transfer load from the fiber to the matrix. This work demonstrates that aramid nanofibers may provide the robust mechanical properties that are necessary for structural applications while utilizing a cost-effective and convenient nanoscale building block.

Keywords: aramid fiber, composite interfaces, nanofiber, interfacial strength