Hierarchical Patterning of Nanomaterials for *In Situ* Discretized Damage Sensing Applications

Z. R. MELROSE*, S. M. MASTERS and E. T. THOSTENSON

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Abstract:

Ever increasing performance demands on composite materials has necessitated the development of new approaches and subsequent manufacturing techniques to consolidate various system functionalities within the confines of the composite structure. Opportunity exists to produce the first generation of smart composites, by re-imagining the individual plies of a composite as a functional space onto which sensors can be patterned for assessing damage locality and severity. The exceptional mechanical and electrical properties found in nano-scale reinforcements can be selectively employed on the macro-scale for composites using various nanomaterial processing techniques.

A new approach to selectively modify the electromagnetic properties of composite fibers is employed to deposit carbon nanotube and graphene filled inks through an adapted screen printing process. Ink rheological concerns are addressed for different nano-ink compositions through the incorporation of additives to control viscosity and surface tension. This printing technique enables the hierarchical patterning of piezo-resistive damage sensors as fully integrated components on glass fiber plies to form a discretized sensor network. Electrical isolation between printed regions and the non-conductive fibers & resin permits the inclusion of additional functionalities within the composite, such as energy storage devices.

* Department of Mechanical Engineering and Center for Composite Materials, University of Delaware, Newark, DE 19716, USA; e-mail: ZMelrose@udel.edu