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Dielectric nanomethods for assessment of composite material integrity and properties

Composite materials are essential for many modern applications, including airplanes and cars, energy conversion and storage devices, medical prosthetics and civil structures. The properties and long-term performance of such materials are determined by the integrity of internal material interfaces at the nanolevel and under mechanical loading by a complex sequence of progressive nucleation, accumulation and coalescence of micro-damage that is always related to the micro-morphology of the constituents and their properties. Although detecting and modeling all the discrete details at the local level is quite difficult and in some cases not feasible, it would be very useful to identify observable local parameters that directly reflect the global properties and integrity of such materials and specially to detect and predict the onset of different stages of damage development so that remaining strength and life could be estimated. The present paper reports the discovery of such a method and the construction of fundamental local concepts and relationships that define the global properties and performance of composite materials and methods of interpretation that define the boundary between the distributed nucleation of defects and the interaction and joining of individual defects to create micro-cracks and eventually unstable fracture planes. The new concepts are based on the application, understanding/modeling and interpretation of the dielectric response of such materials to low-frequency, low voltage input fields which results in very clear indications of changes in the global dielectric constants of a fibrous composite material. Conceptual, computational and physical foundations for the new concepts are discussed. Applications of the concepts are suggested in diverse situations, from structural mechanics to fuel cells to the durability of nuclear waste forms.

Biography

Kenneth Reifsnider is a graduate from Johns Hopkins University in the general field of materials and has served on the faculties of Virginia Tech, University of Connecticut, University of South Carolina and the University of Texas. He is the Director of the Institute of Predictive Performance Methodologies at UT Arlington and a Member of the National Academy of Engineering in the US. He has more than 300 archival publications and has given invited guest lectures in more than 20 countries.

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