Kenneth Reifsnider, J Mat. Sci. 2017, 5:6
DOI: 10.4172/2321-6212-C1-008

Multiphysics property aging as a disorder process in heterogeneous functional materials

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Heterogeneous material systems have become a dominant approach to the design of multifunctional materials, especially when combinations of mechanical, electrical, electrochemical and thermal properties control the success of the resulting device. Heterogeneous (composite) material systems are now the foundation for multifunctional applications in nearly every facet of applied science, including biomedical (e.g., prostheses and devices), structural (e.g., vehicles and urban infrastructure), energy (e.g., conversion and storage) and communications (e.g., semi-conductors and circuit boards). Nearly, all these systems operate in a dynamic environment and the characteristics and properties of most of the materials are dependent on the time and history of the environment and conditions under which they operate, a condition we will call aging as a general subject. Most heterogeneous material systems are designed and manufactured with some degree of order associated with their constituent phases. Sometimes the order is controlled by the thermodynamics of the formation process (e.g. the Morphology of a mixed Ionic and Electronic Conductor, MIEC) while other ordered systems are more rigorously ordered (e.g., continuous fiber reinforced composite materials used in the aerospace industry). Classically, ordered and disordered materials behave quite differently, with somewhat different rules for structure-property relationships and especially for defect-property relationships as the materials age during service. The present author has advanced several new concepts associated with this general problem, including a critical path concept for aging in MIECs and a heterogeneous fracture mechanics concept for disordered composite strength. The present paper will present an update on this field and discuss extensions of the concepts to the general subject of property aging in heterogeneous functional materials.

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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