Biologically-inspired sensing skins for distributed sensing of structural behavior and damage

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Abstract

Structural health monitoring (SHM) systems offer cost-effective health management solutions for aging civil infrastructure systems. Current SHM systems are characterized by the use of sensors that measure behavior at a specific point in the system. In contrast, this proposal explores the creation of a distributed sensing skin that provides direct spatial mapping of damage. The sensor paradigm proposed is inspired by the human dermatological system which offers distributed, multimodal sensing of the environment. Controlled molecular assembly employing carbon nanotubes and polyelectrolytes yields a homogenous multi-layered thin film in which four sensing modalities are simultaneously embedded: strain, pH, humidity and ionic uptake. To measure the spatial distribution of conductivity changes corresponding to each stimulus, electrical impedance tomography is adopted. EIT provides spatial maps of strain, plastic deformation and corrosion in incredible detail providing infrastructure owners actionable data that accelerates the decision making process.

Bibliography

Dr. Jerome Lynch is an Assistant Professor of Civil and Environmental Engineering at the University of Michigan; he also holds a courtesy appointment in the Department of Electrical Engineering and Computer Science. Dr. Lynch completed his graduate studies at Stanford University where he received his PhD in Civil and Environmental Engineering in 2002, MS in Civil and Environmental Engineering in 1998, and MS in Electrical Engineering in 2003. His current research interests are in the areas of wireless structural monitoring, active sensing, damage detection and decentralized structural control algorithms. Some of Dr. Lynch's more current research has been focused on the design of nanoengineered materials for smart structure applications including carbon nanotube-based thin film wireless sensors for structural health monitoring. Dr. Lynch was recently awarded the 2005 Office of Naval Research Young Investigator Award, 2007 University of Michigan Henry Russel Award, and the 2008 University of Michigan College of Engineering 1938E Award.