Health and performance assessment with nanocomposites + tomography

Biological systems, like structures, are susceptible to different types of damage and are influenced by changes in operating conditions. Lessons learned from structural health monitoring (SHM) can potentially help improve sensing and diagnostic capabilities in the biomedical domain. This presentation outlines a new paradigm shift in human health and performance monitoring, where sensors are designed from a materials perspective stemming from a “bottom-up” design methodology. In doing so, one can engineer multifunctional nanocomposites that possess a diverse suite of engineering functionalities, such as sensing of specific external stimuli (e.g., strain and pH). A few examples will be highlighted. The first case examines multifunctional nanocomposite thin films engineered with electrical properties that are sensitive to strain for monitoring human motion and activity. Scalable fabrication methods based on spray-coating and micro-plotting are proposed, so that they are amenable to mass production. In addition, by coupling the films with an electrical impedance tomography (EIT) algorithm, these “sensing skins” are able to sense and localize features over large spatial domains. The second example illustrates how one can leverage a different modality of electrical excitation to interrogate systems and characterize subsurface changes without physically probing the biological system. In that regard, nanocomposites embedded in the body, such as on implants and prostheses, then serve as passive elements that accentuate changes occurring in the tissue or human body (e.g., due to infection). An electrical capacitance tomography algorithm and interrogation system can map electrical property changes within the material, thereby enabling non-contact, non-invasive, surface and subsurface sensing. Numerical modeling and experimental results will be presented.

Biography
Kenneth J Loh is an Associate Professor in the Department of Structural Engineering and leads the Active, Responsive, Multifunctional and Ordered-materials Research (ARMOR) Lab at the University of California-San Diego. He has received his BS degree in Civil Engineering from Johns Hopkins University in 2004. His graduate studies were at the University of Michigan, where he completed two MS degrees in Civil Engineering (2005) and Materials Science and Engineering (2008), as well as a PhD in Civil Engineering in 2008. His research interests include multifunctional materials, nanocomposites, scalable nano-manufacturing, tomographic methods and human performance sensing. His recent honors include the NSF CAREER Award, Achenbach Medal, Fulbright Scholar, Joseph Wang Award and SPIE Senior Member honor.

kenloh@ucsd.edu