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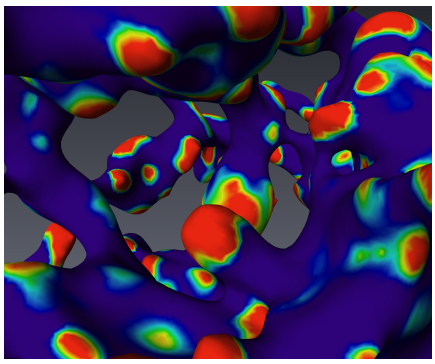
The Role of 3-D Structure on Heat and Mass Transfer in Energy Materials

Wilson K. S. Chiu
Department of Mechanical Engineering
University of Connecticut
Storrs, CT 06269-3139, USA
wchiu@engr.uconn.edu

Abstract: Advances in materials increasingly rely on the 3-D characteristics of its structure and its role in transport phenomena. This presentation will review 3-D imaging techniques that measure microstructural and chemical properties, and discuss its influence on material function and reliability [1]. The presentation will then focus on how three-dimensional structures will affect transport phenomena in several example energy materials. In fuel cells, the transport of mass species coupled with electronic and ionic transport in the electronic and ionic material phases, respectively, and the importance of localized Joule heating in the 3-D structure will be discussed [2]. In gas separation membranes, the importance of percolating dual phase electronic and ionic conducting materials is presented and studied to improve gas permeance [3]. The third sample will focus on the thermal transport in open-cell metal foams used for electronic cooling and volumetric absorbers for concentrated solar power [4]. The critical conjugate heat transfer effects through conduction-convection in electronic cooling and radiation-conduction-convection in concentrated solar power requires an intelligently designed 3-D foam structure that will enable the best heat transfer rate across all three modes. The goal of this research will be to obtain a scientific and engineering understanding into how structure-induced transport mechanisms govern performance, with a long-term goal to improve current materials and create new materials that will enable improved device performance and increased long-term reliability for advanced engineering applications.



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