Pore-Scale Simulations of Effectives Properties of Porous Materials

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Abstract

Porous materials widely exist as natural substances and man-made porous materials are widely used in Science, Engineering, and Industry because of their high surface area and unique physical properties. However, it's challenging to simulate and estimate effective physical properties of porous materials that are critical in energy systems (thermal conductivity, mass diffusivity, intrinsic permeability etc.) because of the complex morphology and wide distributions of pore size. Most of existing model simulations and theoretical analyses simplify the pore morphology and assume isotropic properties.

This talk will present pore-scale simulations of anisotropic heat and mass transfer properties of porous materials based on high-resolution (~1 μm) micro-tomography of porous materials measured by a unique tomographic X-ray microscope (TXM) at KU. The pore-scale computational fluid dynamics (CFD) simulations and statistical models can elucidate how the phase distribution governs the heat transfer and fluid flow as well as anisotropic properties of porous materials by considering pore morphology, pore size and porosity as well as connectedness of the solid matrix and the filling fluid. This unique tool can be conveniently applied to both natural and man-made porous materials and facilitate R&D in reservoir engineering, hydrogeology, water percolation, additive manufacturing, energy conversion and storage, etc.

Speaker

Dr. Li joined the Mechanical Engineering Department of University of Kansas in 2014. His current research projects include developing direct methanol fuel cells for stationary applications (funded by U.S. Department of Energy), designing high-power & high-capacity Li-O_2 batteries (funded by NSF), providing thermal management solutions to rechargeable batteries (supported by industrial partners), as well as understanding pore-scale heat and mass transfer in novel thermal management Systems for space technologies (funded by NASA EPSCoR).

Dr. Li received his Ph.D. in Mechanical Engineering from the University of Connecticut in 2012, where he investigated the liquid-vapor two-phase heat and mass transfer coupled with electrochemical reactions in porous fuel cell electrodes. Before joining KU, Dr. Li served as Senior Scientific Engineering Associate at the Lawrence Berkeley National Laboratory. In this capacity, he was involved with full fuel cycle analysis of non-conventional natural gas production and usage, as well as technical analyses to support the development of energy efficiency standards for appliances and other commercial equipment. Dr. Li has published more than 40 refereed journal articles, multiple conference papers, and three U.S. Department of Energy and National Laboratory reports.