Mechanical Engineering Department Seminar

3:35pm February 6, 2013
1130 Mechanical Engineering

Tuning Thermal Radiative Properties Via Mie Resonance-based Dielectric Metamaterials for Low Temperature Nanoscale-Gap Thermophotovoltaic Power Generation

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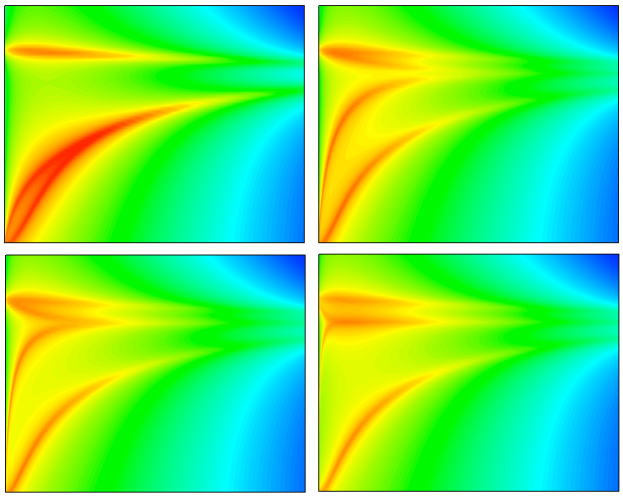
Metamaterials are composite structures made of sub-wavelength functional inclusions, also referred to as “meta-atoms”, displaying exotic properties such as negative index of refraction and negative magnetic permeability. The ability to engineer metamaterials with specific electric and magnetic response enables tailoring media with unique, user-defined thermal radiative properties. This seminar will focus on Mie resonance-based dielectric metamaterials, where the meta-atoms are dielectric resonators. It will be shown that quasi-monochromatic near-field thermal emission in the near infrared spectral band is achievable at a temperature as low as 400 K via metamaterials made of silicon nanoparticles, thus suggesting that direct conversion of low temperature waste heat into electricity is possible via nanoscale-TPV systems. More specifically, the first portion of the seminar will discuss nanoscale-gap TPV power generation and will highlight the fundamentals of radiation heat transfer at nanoscale. The second portion of the presentation will focus on predicting the thermal response of Mie resonance-based metamaterials both in the near- and far-field, as well as the fabrication and characterization of these man-made functional structures.



Bio: Mathieu Francoeur is an Assistant Professor in the Department of Mechanical Engineering at the University of Utah since 2010. He received his B.Eng. and M.Sc. degrees in Mechanical Engineering from Université Laval in 2002 and 2004, respectively, and he obtained his Ph.D. from the University of Kentucky in 2010. His expertise is in thermal radiation, and he is particularly interested in radiative exchange phenomena at nanoscale where energy transfer can exceed the blackbody limit by orders of magnitude. His current research focuses on dielectric-based metamaterials for controlling the thermal response of materials, nanoscale-gap thermophotovoltaic power generation for low temperature waste heat recovery, numerical solution of near-field thermal radiation in complex three-dimensional geometries and optical characterization of nanoparticles via scattered evanescent waves. He has produced more than 60 publications, including 22 journal papers and a book chapter for the fifth edition of Thermal Radiation Heat Transfer.