Department of Chemical Engineering Presents:

HAJIM SCHOOL OF ENGINEERING & APPLIED SCIENCES
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Harvesting Solar and Thermal Energy with Photonic Nanostructures

Wednesday, January 18, 2012
2:15 p.m.
101 Goergen Hall

The energy and environmental challenges we face today require a radical transformation of energy conversion and storage systems to make them highly efficient, environmentally friendly, and inexpensive. Nanotechnology can potentially provide novel solutions for harvesting various forms of renewable energy including solar and thermal energy. In particular, nanophotonics will play a crucial role in solar photovoltaic and thermophotovoltaic systems. For solar photovoltaics, where sunlight is directly converted into electricity, the cost of solar cells needs to be reduced while their efficiency must be enhanced. I will discuss how photonic nanostructures can be used to trap sunlight efficiently and thus reduce the volume of expensive monocrystalline silicon required for silicon solar cells. We will see that the volume of the cells can be decreased by two orders of magnitude, marking a significant reduction in the material cost of silicon solar cells. I will also show how nanostructures can exceed the conventional light trapping limit in solar cells. For thermophotovoltaics, where thermal emission is converted into electricity, control over the thermal emission is a key to increasing the system efficiency. I will discuss how the thermal emission from photonic nanostructures can be tailored in a way that is potentially useful for solar and thermal energy harvesting. While the optimum thermal emission will depend on the specific energy system, I will show that we can achieve the extreme cases of thermal emission. For example, we will see that “laser-like” thermal beaming is possible simply by heating cleverly-designed photonic nanostructures. I will conclude the talk by discussing how nanophotonics will advance the frontiers of renewable energy harvesting.