INDUSTRIAL PARTNERSHIP FOR RESEARCH IN INTERFACIAL AND MATERIALS ENGINEERING

Renewable Energy Materials Program

Sustainable generation, conversion, storage, and utilization of energy using abundant and nontoxic materials are among the most significant challenges we face in the 21st century. Accordingly, the renewable energy materials (REM) research team is engaged in discovery, synthesis and characterization of a wide range of materials with applications in photovoltaics, thermoelectrics, thermo-photovoltaics, energy storage and catalysis. The REM team seeks to develop a fundamental understanding of these materials and to demonstrate their uses in a variety of devices including solar cells, thermoelectric converters, batteries and chemical reactors.

In photovoltaics, the group is engaged in a diverse range of strategies for low-cost solar-to-electric energy conversion. Specifically, our research encompasses synthesis and characterization of materials as well as assembly and characterization of devices including (i) Si solar cells from Si nanoparticles, (ii) small molecule organic solar cells, (iii) polymeric solar cells, (iv) dye-sensitized solar cells and (v) quantum-dot solar cells. We aim to establish the fundamental connections among materials synthesis, device assembly methods and device performance in order to improve the latter. In organic solar cells, areas of emphasis include new low bandgap materials to harvest more of the solar spectrum, controlling donor/acceptor film morphology, and understanding the spectrum of factors affecting the open circuit voltage. In nanoparticle based solar cells, areas of emphasis include, synthesis of a variety of group IV and II-VI nanoparticles through both gas phase and solution based techniques, developing methods for making thin film solar cells and establishing the principles of how these solar cells operate.

In thermophotovoltaics, the aim is to learn and to demonstrate how structuring materials on optical length scales can modify their thermal emission. Possible applications of these structured metamaterials include the elimination of unwanted heat from the filament in a light bulb and improving the efficiency of thermophotovoltaic devices for converting solar, geothermal or industrial waste heat into electricity. In thermoelectrics, we also seek to develop materials that efficiently convert waste heat into electricity. The emphasis is on nanostructured materials because quantum confinement in nanocrystals enhances thermopower (Seebeck effect) and thermal conductivity is significantly reduced with respect to bulk materials.

In catalysis, the group focuses on the structural and mechanistic characterization of inorganic molecular sieve catalytic materials useful for energy conversion and petrochemical synthesis. Specifically, the research is aimed at (i) developing low-temperature catalytic routes suitable for conversion of biomass feedstocks, such as C3-C6 sugar monomers, to chemicals and (ii) developing catalytic and reactor technologies for concurrently processing biomass and alkane feedstocks for the production of fuels. Moreover, we are examining a new class of nanostructured photocatalysts with the aim of converting carbon dioxide and water to methane using sunlight.

Principal Investigators and their primary areas of expertise:

Uwe Kortshagen (Mechanical Eng.) Program Co-Leader	Si nanoparticle based solar cells & thermoelectrics
Eray Aydil (CEMS) Program Co-Leader	Solar cells, batteries & photocatalysis
Aditya Bhan (CEMS)	Catalysis, biofuels, biomass conversion & photocatalysis
C. Daniel Frisbie (CEMS)	Organic solar cells
Russell Holmes (CEMS)	Small molecule organic solar cells
David Norris (CEMS)	Thermo-photovoltaics & nanostructured solar cells

Contact

To learn more about the Renewable Energy Materials program & IPRIME, contact Bob Lewis, Director of Technology Transfer, at 612-625-1269 or lewis@cems.umn.edu.
Please visit the IPRIME website at www.iprime.umn.edu

UNIVERSITY OF MINNESOTA