Nanomaterials


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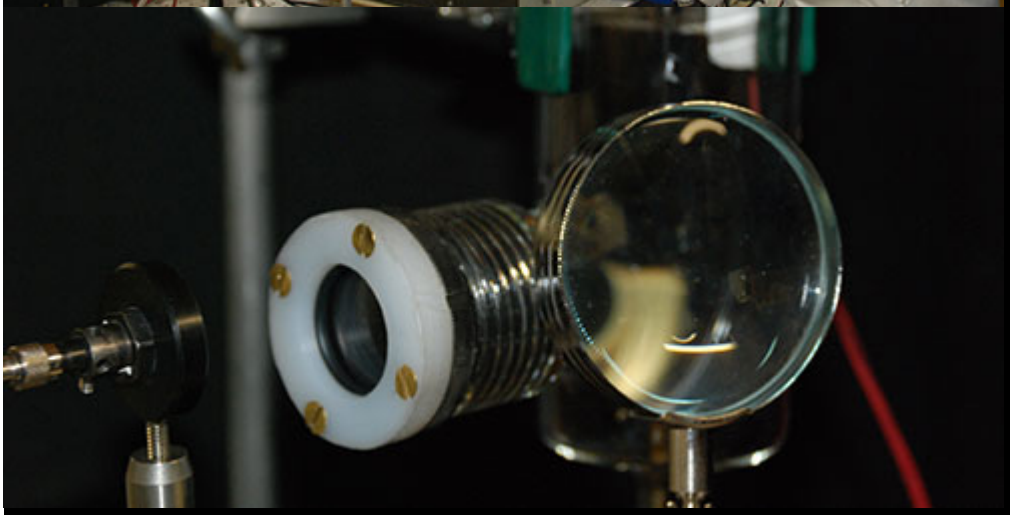
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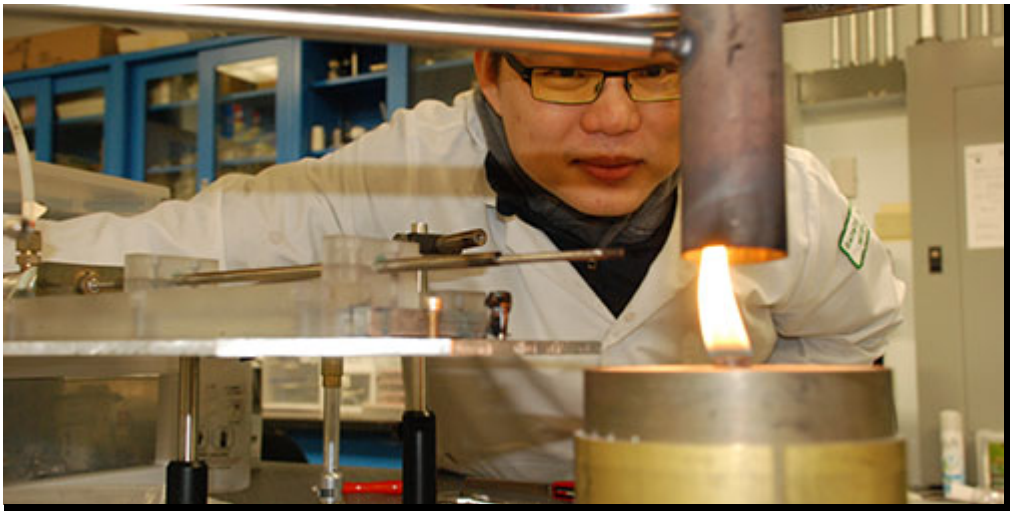
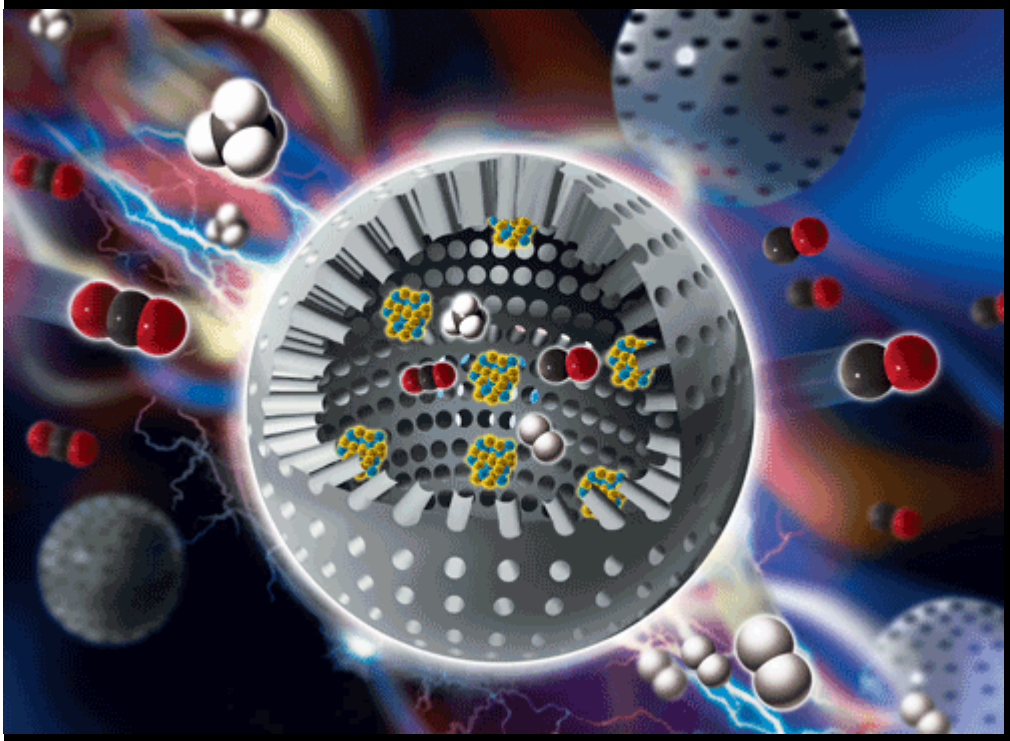
 [1]

Research at the EMS Energy Institute is aligned with future challenges for energy and material needs in the areas of energy storage, conservation, transfer, efficiency, control, and generation.The philosophy of the EMS Energy Institute?s Nanomaterials Program is that the elementary steps of **energy transformation, storage, efficiency, conservation, control, conversion, and generation** (e.g. charge transfer, molecular rearrangements, chemical reactions, etc.) take place on the nanoscale, as interfacial processes. Therefore nanomaterials acting as interfacial modifiers can profoundly alter the energy landscape. At the Institute, our research involves:

- Developing new nanoscale materials by model, design and experiment,
- Using electron microscopy and spectroscopy based methods to characterize these materials, and
- Employing physical and chemical processes to manipulate and assemble them, followed by performance evaluation either as a material or integrated into a device/system.

Research



Journal of Materials Chemistry A, 2015, 3, showcasing a general and robust strategy to prepare coke resistant catalysts for dry reforming of CH4 and multi-metallic catalysts with well-dispersed nanoparticles by Prof. Chunshan Song of Pennsylvania State University and Dalian University of Technology, Prof. Chuan Shi at Laboratory of Plasma Physical Chemistry and Prof. Xinwen Guo at School of Chemical Engineering, Dalian University of Technology.

Energy Transformation

- Electrochemical energy conversion in fuel cells and water electrolyzers
- Reforming of hydrocarbon and alcohol fuels for syn-gas and H_2 production
- Synthesis and testing of nanostructured catalysts for hydrocarbon & biomass processing
- Shape-selective catalysis for synthesis of fine organic chemicals
- Catalysis in fuel processing for fuel cells
- Computational studies of metal oxides for direct hydrocarbon solid oxide fuel cells

Energy Storage

- New nanostructured macro-scale carbons for capacitor, battery, and gas storage materials
- Computationally aided design of ionic polymer electrolytes for lithium ion batteries
- Customization of novel materials for a particular application
- Investigation of novel gas ? solid interaction mechanisms, including hydrogen spillover, reversibly hydrogenation, and gas trapping

Energy Efficiency

- Lubrication studies of oil aging and breakdown mechanisms

- Electrolyte/electrode interfacial structure on performance of proton exchange membrane fuel cells

Energy Conservation

- Lightweight composites for transportation vehicle efficiency

Energy Control

- Process control using metal oxide (based) gas sensors

Energy Generation

- Photon capture and conversion processes for electricity by energetic electrons
- Thin film materials synthesis for photovoltaic devices

Other Areas of Expertise

- Analytical methods - microplasmas, laser-based analytical methods, and gas adsorption
- Laser processes - laser driven processes, photochemistry and spectroscopy for species and temperature e.g. LIF, LII, CRD, and DFWM
- Materials Chemistry - nanomaterial syntheses (e.g. CVD, plasma, electrospinning, combustion, aerosol, mechanical and ablation), characterization and application testing