

Lecture 1

Nanoparticle Ink based route for Efficient Thin Film Solar Cells

November 12, Tuesday / 4:30 PM

The production of low-cost solar cells from earth abundant elements is necessary for the use of solar electricity on a large scale. The creation of a suitable inorganic colloidal nanocrystal ink for use in a scalable coating process is a key step in the development of low-cost thin film solar cells. We have developed novel methods for the synthesis copper indium gallium disulfide (CIGS) and $\text{Cu}_2\text{ZnSnS}_4$ (CZTS) nanoparticles. The nanoparticles are then formulated as inks. The nanoparticle ink solution is applied directly on molybdenum coated soda lime glass to form a thin film coating. The nanoparticles are then consolidated into large crystalline chalcopyrite domains by a brief thermal treatment under Se vapor. Solar cells are prepared from the sintered films and characterized for their optoelectronic properties.

In this talk we will present some of our recent results on CZTS nanoparticle synthesis, absorber film sintering and optoelectronic characterization of the resulting solar cells. Furthermore, the ability to engineer the bandgap of the CZTS nanocrystals using Ge and the resulting solar cell performance will be discussed. Insitu sintering studies using a synchrotron beam that sheds light on the process of sintering will be highlighted.

To date we have achieved 15% total area power conversion efficiency for CIGS and 9.4% for CZTS based solar cells. These results are exciting as they provide us the insights that will eventually lead to highly efficient low-cost solar cells.

Lecture 2

Engineering a Sustainable Energy Future

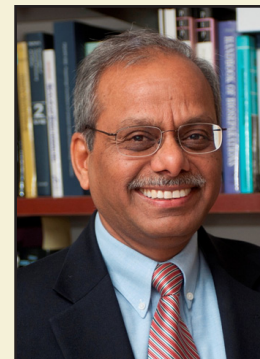
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In the long run, it is likely that all the basic human needs will be met by renewable sources like solar energy. However, there are several challenges associated with harness, storage and use of solar energy to meet our daily needs for food, chemicals, heat, electricity and transportation. In a sustainable future, all these usage must coexist.

We will first present some results from our energy systems modeling highlighting the synergistic interactions that exist for transportation sector and production of chemicals. This will be followed by a brief discussion and analysis of candidate processes to produce hydrogen from solar energy and our modeling results for energy storage at giga Watt-hour levels.

An exciting aspect of producing fuels and chemicals from biomass is learning to produce the array of molecules that we need with minimum process transformation steps and energy use while maximizing biomass carbon recovery. In this aspect, recent advancements at Purdue by a team of chemists, biologists and chemical engineers will be presented. We will show the new pathways and the associated catalysts that have been developed for the production of fuel and chemicals.

Finally, if the time permits, we will touch upon the continuing advancements made in the traditional fields such as separations that will still play a vital role in the processes slated for any sustainable energy future.



**Dr. RAKESH
AGRAWAL**

Rakesh Agrawal is Winthrop E. Stone Distinguished Professor, School of Chemical Engineering, Purdue University. Previously, he was an Air Products Fellow at Air Products and Chemicals, Inc., where he worked until 2004.

A major thrust of his research is related to energy issues and includes novel processes for fabrication of low-cost solar cells, biomass to liquid fuel conversion, and energy systems analysis. His research further includes synthesis of multicomponent separation configurations including distillation, membrane and adsorption based processes, basic and applied research in gas separations, process development, gas liquefaction processes and cryogenics.

He has published 118 technical papers and has given over 154 invited lectures. He holds 119 U.S. and more than 500 foreign patents. These patents are used in over one hundred chemical plants with total capital expenditure in multibillion dollars. He has received several awards including, Shreve Award for teaching excellence from the graduating seniors of the Chemical Engineering Department at Purdue University, J & E Hall Gold Medal from the Institute of Refrigeration (UK), Presidential Citation for Outstanding Achievement from the University of Delaware, Industrial Research Institute (IRI) Achievement Award, C. K. Murthy Memorial Lecture (IChE), and from the AIChE: the Gerhold award in separations, Excellence in Industrial Gases Technology, Institute Lecture, Chemical Engineering Practice, Fuels and Petrochemicals Division, and Founders awards. He was a Regents Lecturer at University of California, Los Angeles in 2004. He was a member of the NRC Board on Energy and Environmental Systems (BEES) and a member of the AIChE's Board of Directors and also its Energy Commission. He is a member of the US National Academy of Engineering, a Fellow of the American Academy of Arts and Sciences and a foreign Fellow of the Indian National Academy of Engineering. Agrawal received the National Medal of Technology and Innovation from the U.S. President in 2010.

Dr. Agrawal received a B. Tech. from the Indian Institute of Technology, in Kanpur, India; a M.Ch.E. from the University of Delaware, and an Sc.D. in chemical engineering from the MIT.

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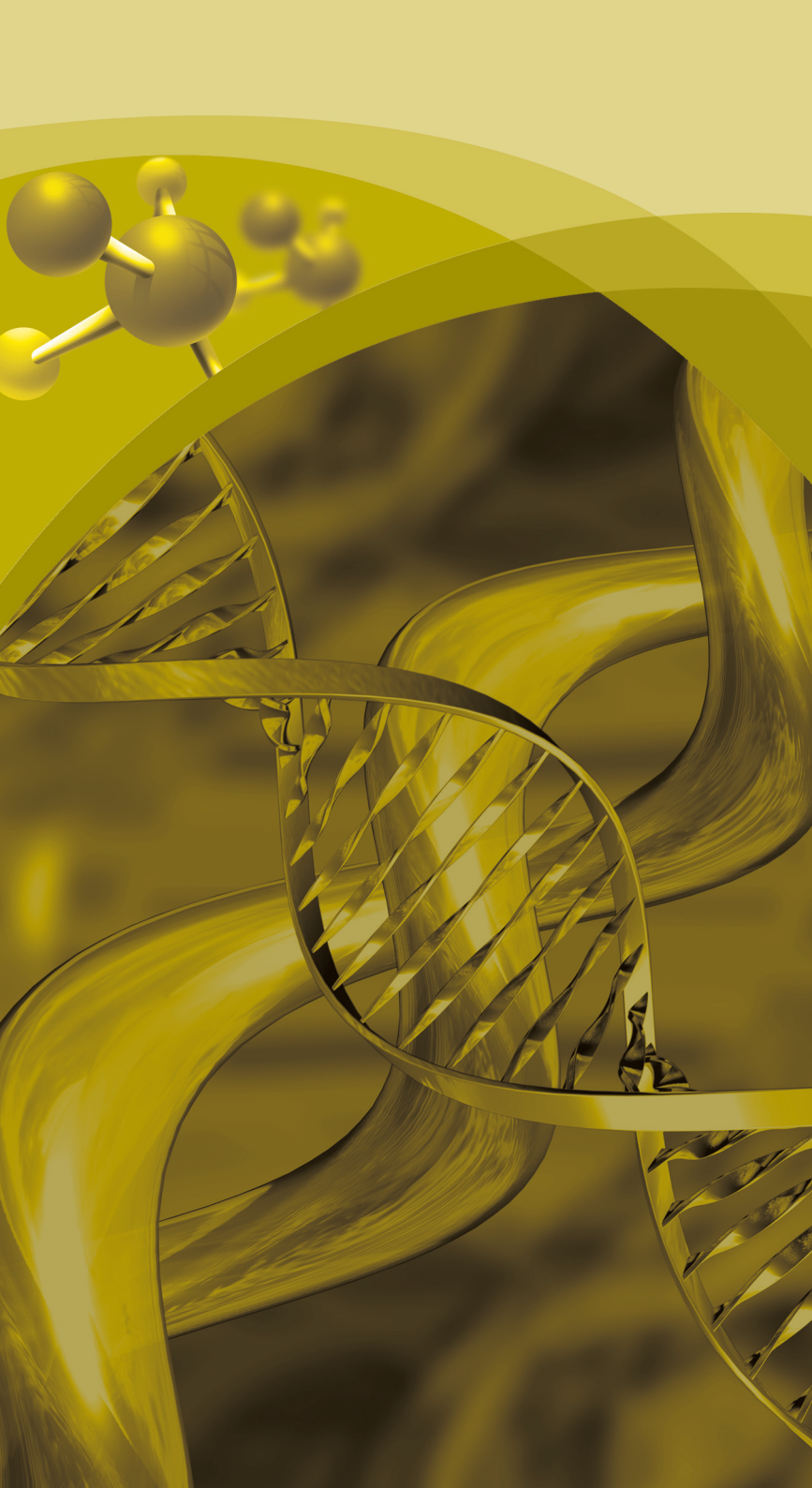
W1-3 Building /

Multimedia Hall

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