NSF Directorate for Engineering | Division of Chemical, Bioengineering, Environmental, and Transport Systems (CBET)

Environmental Engineering & Sustainability Cluster

Energy for Sustainability

Program Director - Greg Rorrer* - grorrer@nsf.gov

* Rotator from Oregon State University, Chemical Engineering (24 August 2009)

- Current Program Interest Areas
- Existing Award Portfolio
- Recent Proposal Activity
- Examples of Program Research Projects

National Science Foundation | Directorate for Engineering

Chemical, Bioengineering, Environmental, and Transport Systems Division (CBET)

Deputy Division Director
Bob Wellek

Division Director
John McGrath

Senior Advisor
Marshall Lih

Chemical, Biochemical, and Biotechnology Systems

- 1401 - Catalysis and Biocatalysis — Pending
- 1417 - Chemical and Biological Separations — Rose Wesson
- 1403 - Process and Reaction Engineering — Maria Burka

Bioengineering and Engineering Healthcare

- 5345 - Biomedical Engineering — Semahat Demir
- 7236 - Biophotonics, Advanced Imaging, and Sensing for Human Health — Leon Esterowitz
- 7909 – Biosensing — Alex Simonian
- 1491 - Biotechnology, Biochemical, and Biomass Engineering — Fred Heineken
- 5342 - Research to Aid Persons with Disabilities — Ted Conway

Environmental Engineering and Sustainability

- 7644 - Energy for Sustainability — Greg Rorrer
- 1440 – Environmental Engineering — Paul Bishop
- 1179 - Environmental Implications of Emerging Technologies — Cindy Ekstein
- 7643 - Environmental Sustainability — Bruce Hamilton

Transport and Thermal Fluids

- 1407 - Combustion, Fire, & Plasma Systems — Pending
- 1443 - Fluid Dynamics — Henning Winter
- 1414 – Interfacial Processes and Thermodynamics — Bob Wellek
- 1415 - Particulate and Multiphase Processes — Marc Ingber
- 1406 – Thermal Transport Processes — Ted Bergman

NOTE: Program Titles are arranged alphabetically within each cluster.

Current Program Interest Areas

Biomass Conversion, Biofuels & Bioenergy

Inter-disciplinary
- Collaborative proposals
- IDR proposals

International
- Conferences
- Workshops

Renewable Resources

Energy for Sustainability

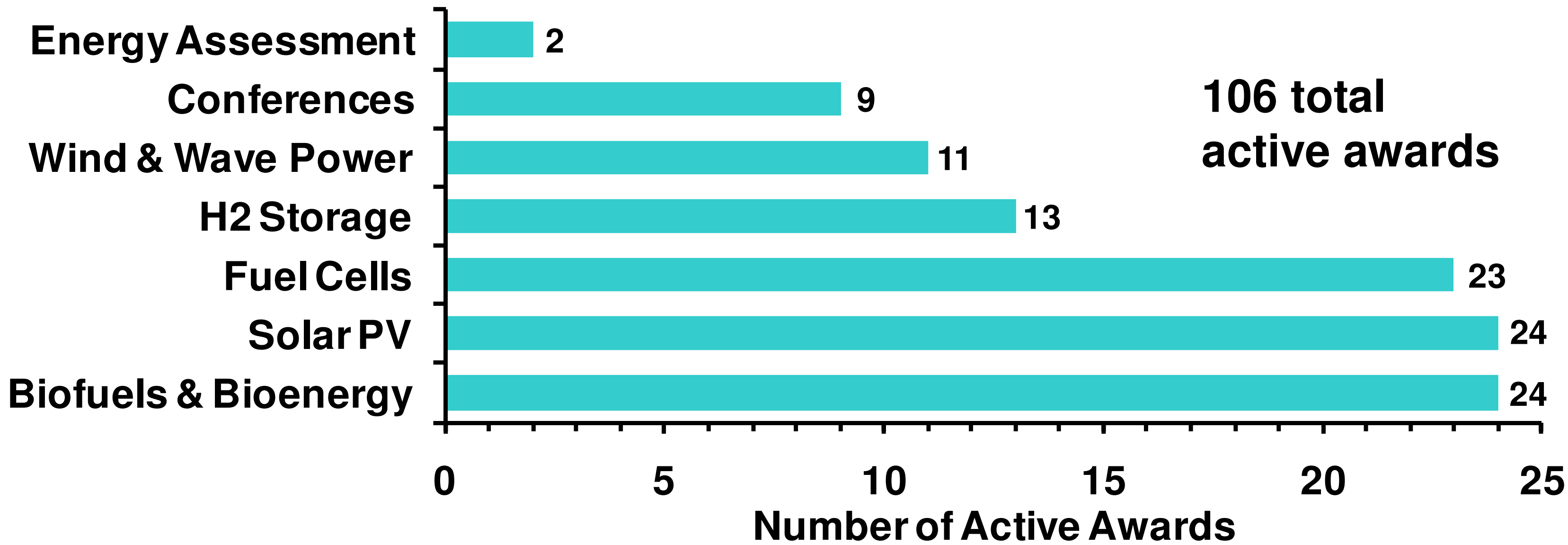
Environmentally Benign Materials & Processes

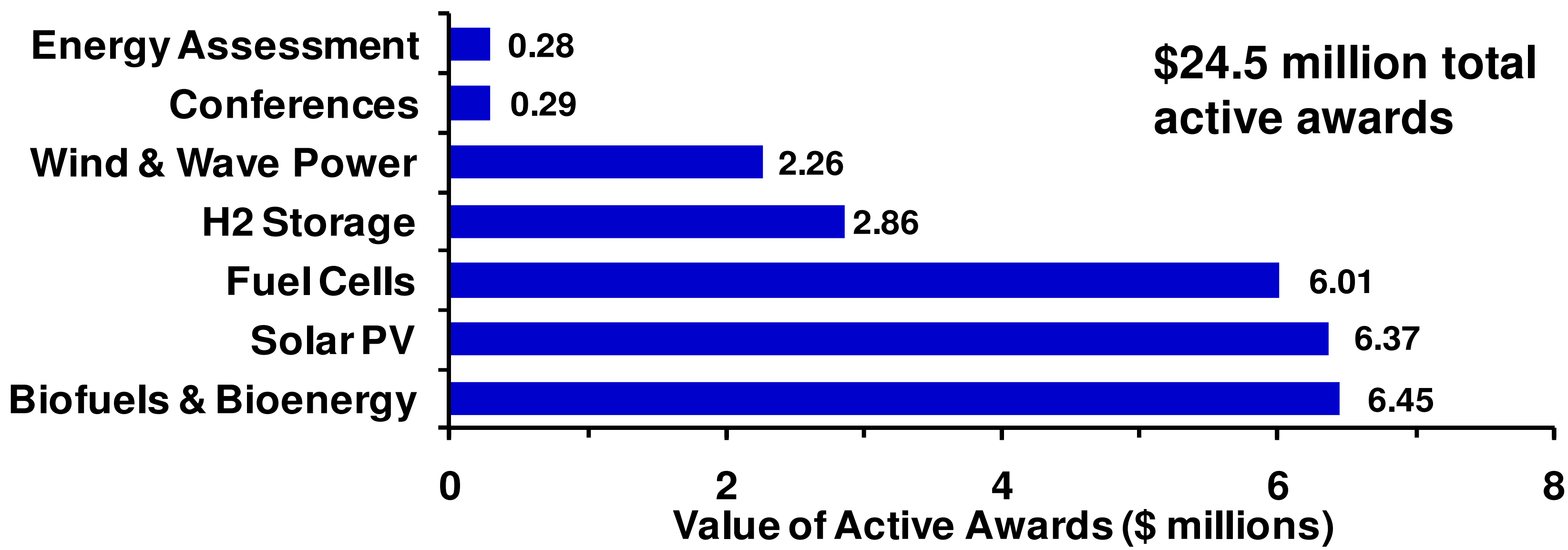
Multi-disciplinary
- Biological Eng
- Chemical Eng
- Electrical Eng
- Mechanical Eng
- Biosciences
- Chemistry
- Materials
- Physics

Wind & Wave Power

Solar Photovoltaic Power & Fuels

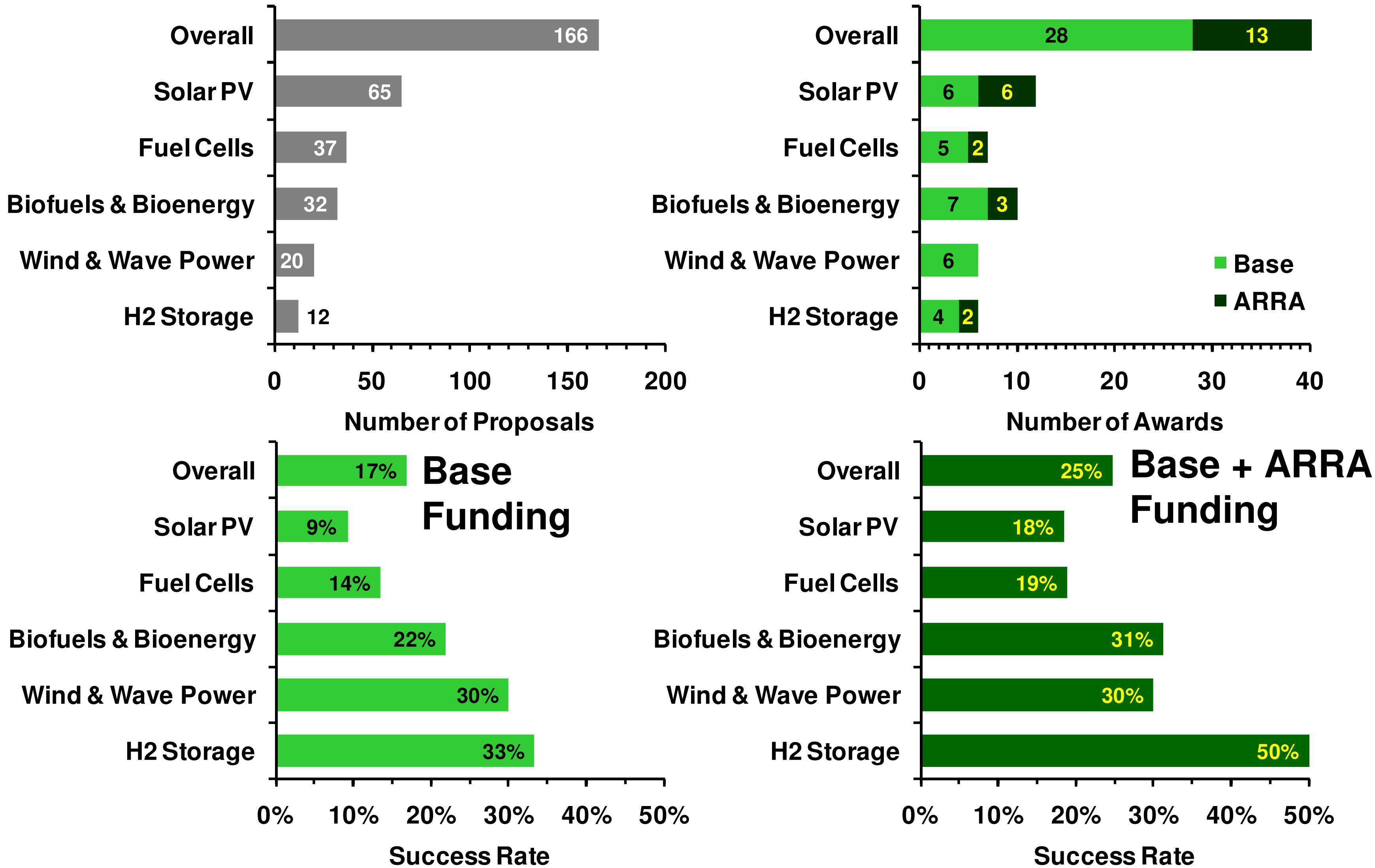
Energy for Sustainability Program: Existing Award Portfolio - (September 2009)





Energy for Sustainability Program: Recent Proposal Activity (March 2009 unsolicited)

ARRA American Recovery and Reinvestment Act

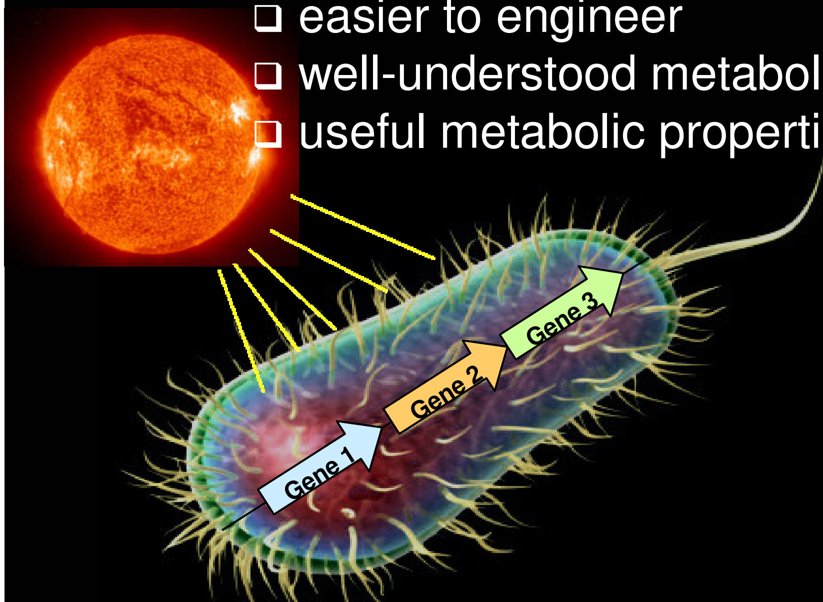


Engineering of a Microbial Platform for the Conversion of Light Energy into Chemical and Electrical Energy

Claudia Schmidt-Dannert - University of Minnesota

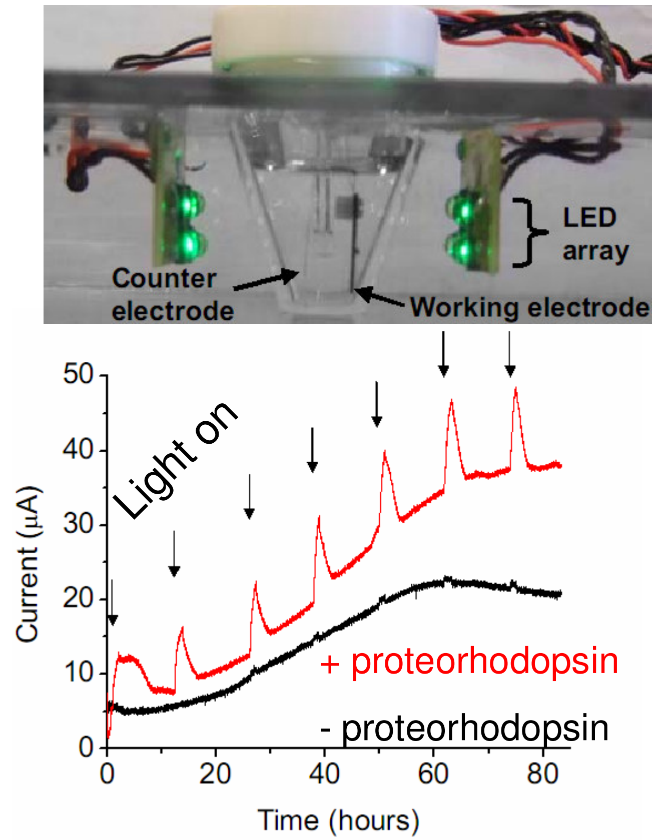
Non-photosynthetic microbes:

- ❑ easier to engineer
- ❑ well-understood metabolism
- ❑ useful metabolic properties



Utilization of light energy to:

- ❑ drive metabolically expensive reactions
- ❑ generate electricity



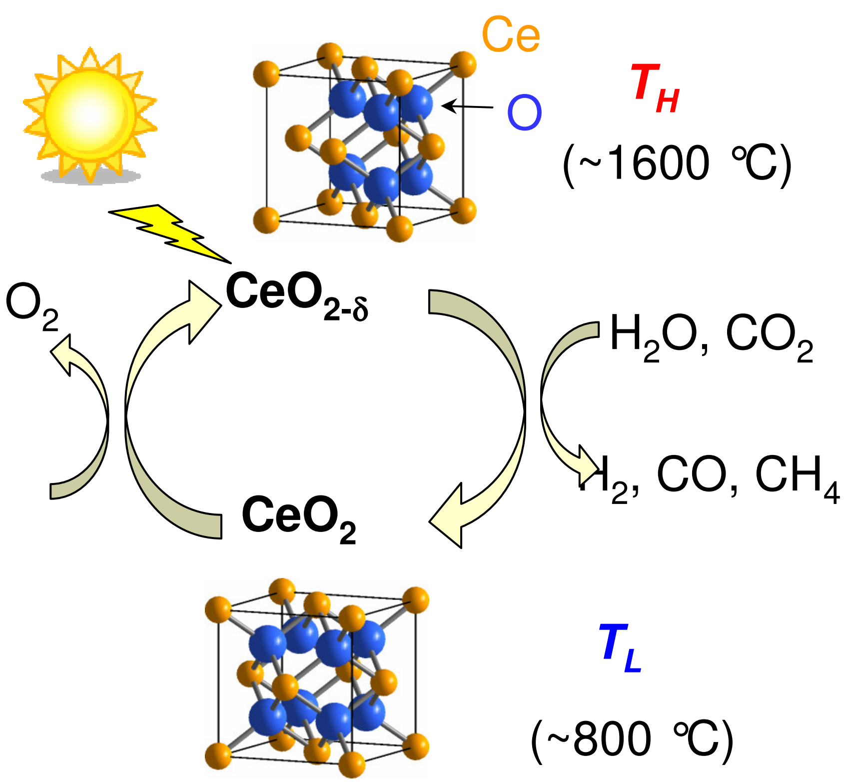
Goal: **Light-Energy Conversion in Engineered Non-Photosynthetic Bacteria**

Example: **Light-dependent current increase in electrochemical chambers containing engineered *Shewanella oneidensis* expressing proteorhodopsin**

CBET 0756296

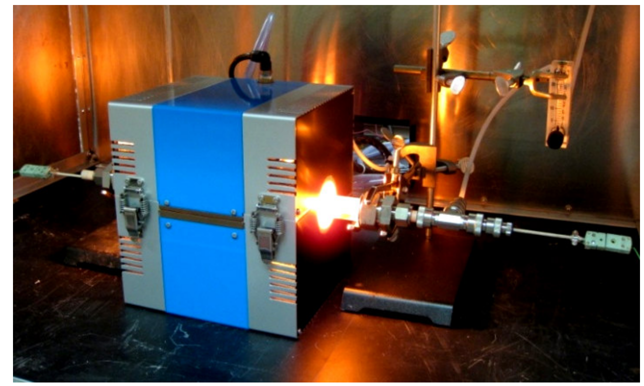
Thermochemical Production of Fuels: Solar Energy After Dark

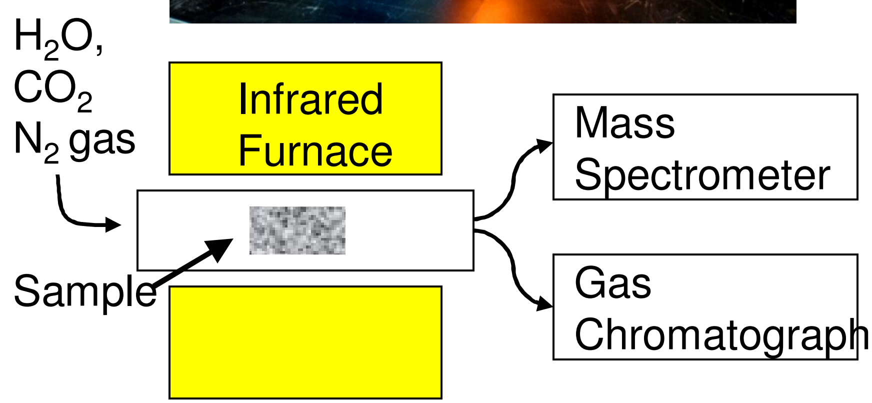
Sossina M. Haile - California Institute of Technology



Thermochemical cycling of ceria to produce solar fuels from CO_2 & H_2O

solar surrogate (infrared furnace)



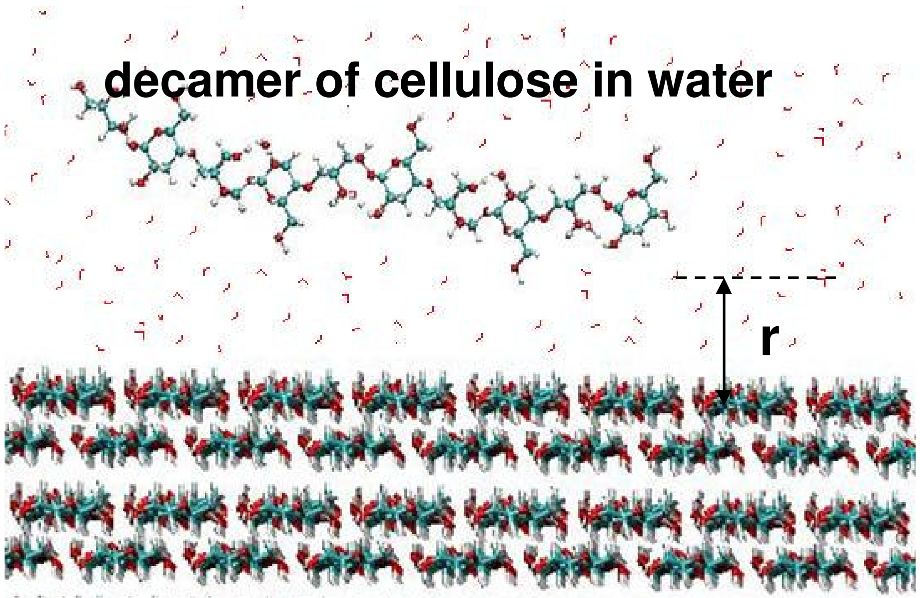


Thermochemical test station: dT/dt = 1000 ℃/min; gas analysis

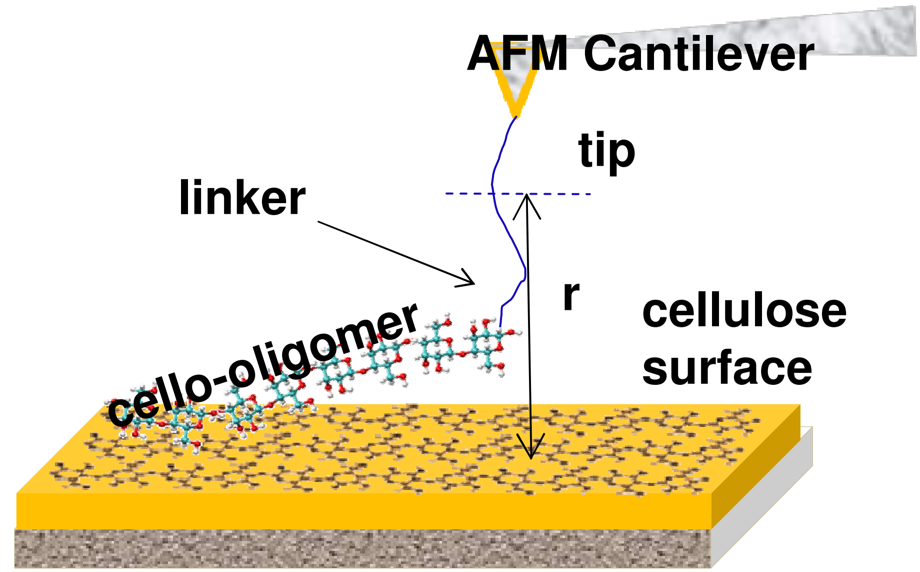
CBET-0829114

Computational and Experimental Studies of Cellulose Degradation for the Production of Biofuels

Rajesh Khare - Texas Tech University



cellulose crystal



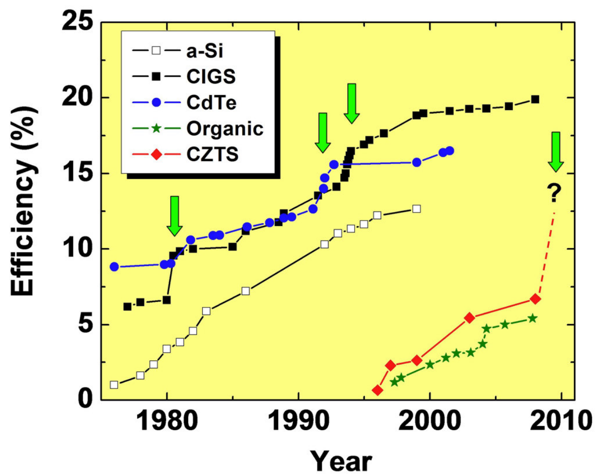
Molecular Modeling: Calculate the free energy required for separating cello-oligomers from cellulose crystal surface

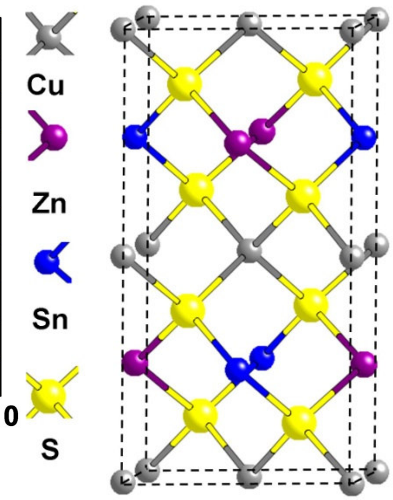
AFM Experiments: Determine the force required for separating cello-oligomers from cellulose crystal surface

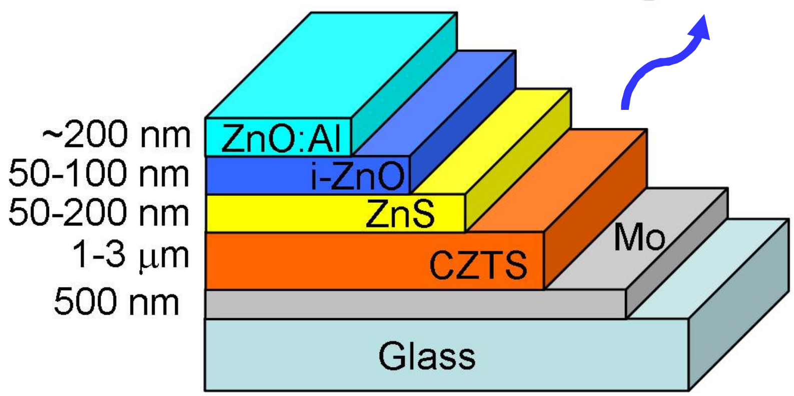
CBET 0854463

Copper Zinc Tin Sulfide (CZTS) Based Solar Cells

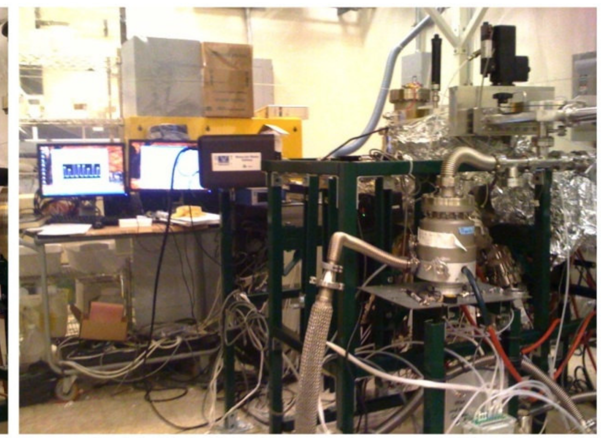
Eray S. Aydil & Stephen Campbell - University of Minnesota

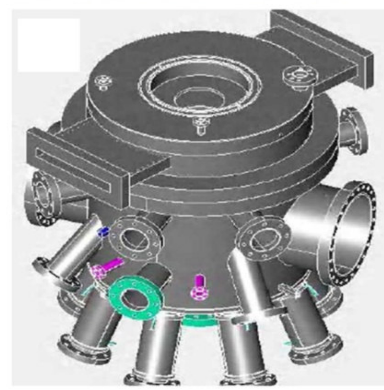


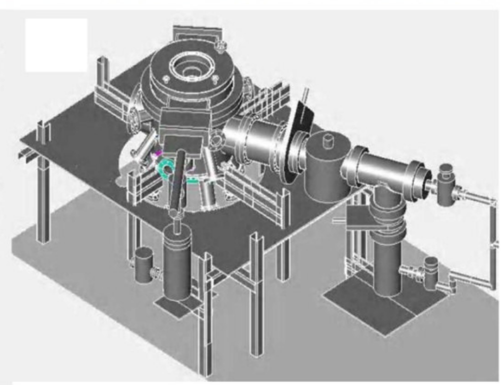




CZTS is a new and promising photovoltaic material that can be made from abundant and nontoxic elements.



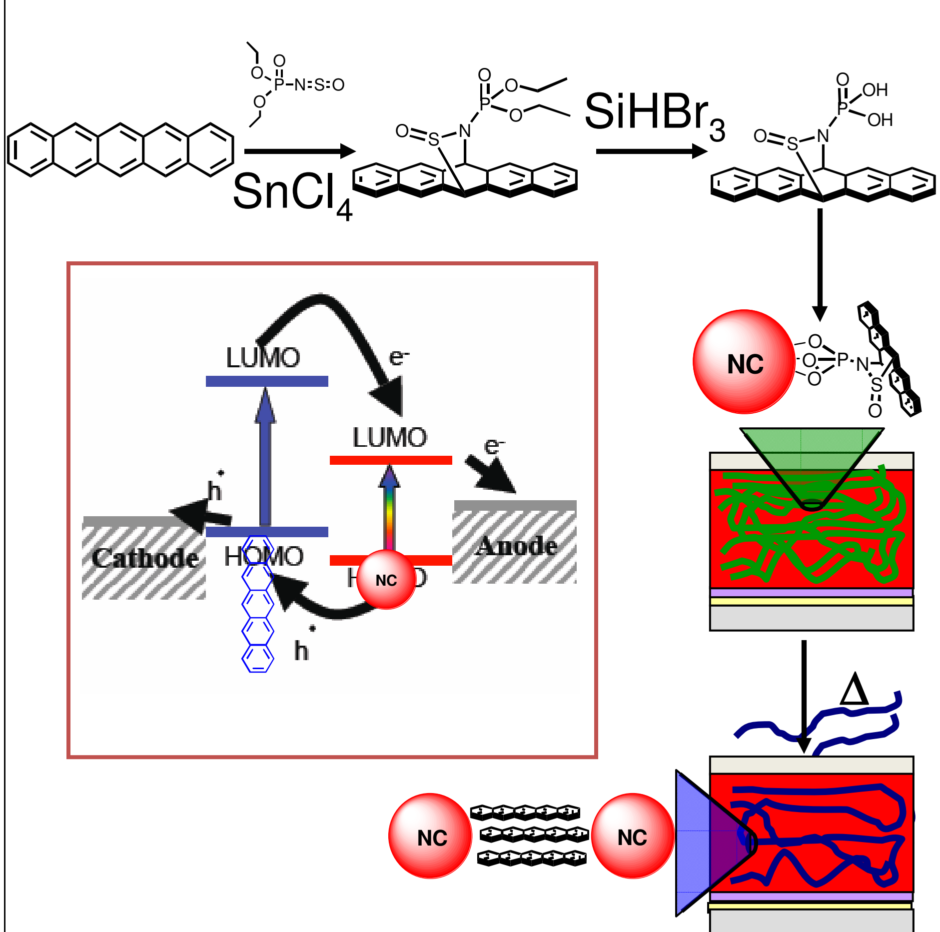




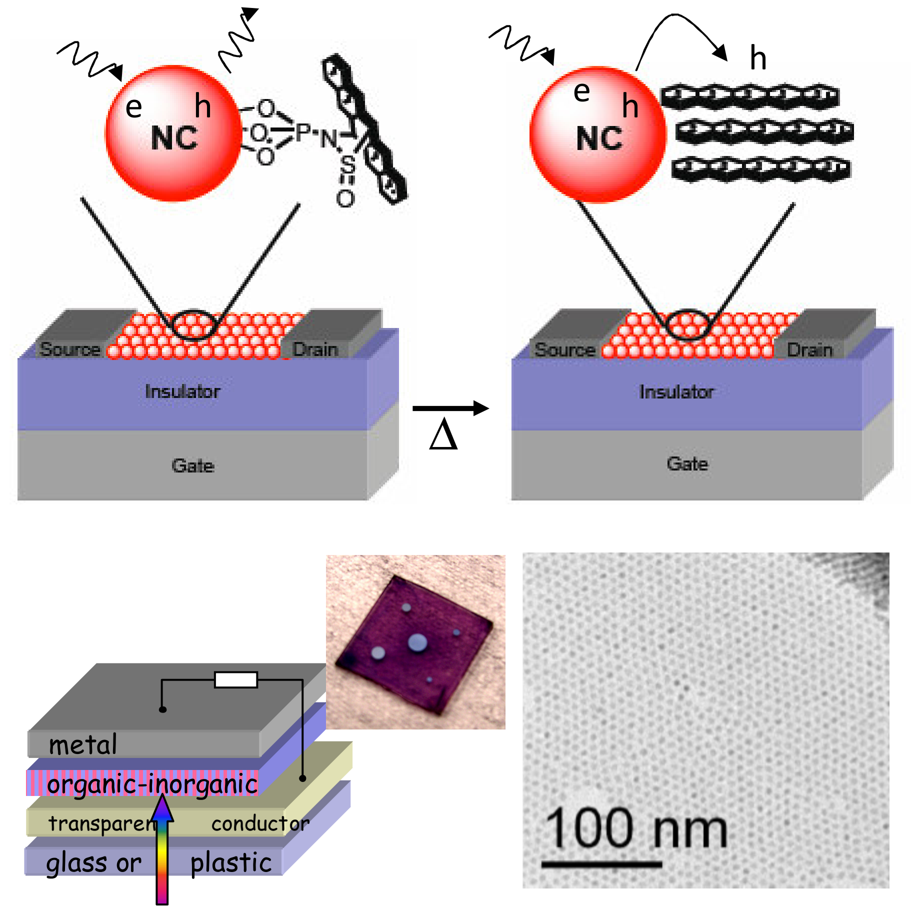
The goal is to develop thin film deposition methods that will lead to breakthroughs in CZTS based solar cells.

Engineering Organic-Inorganic Hybrid Materials for the Conversion of Solar Energy

Cherie R. Kagan - University of Pennsylvania



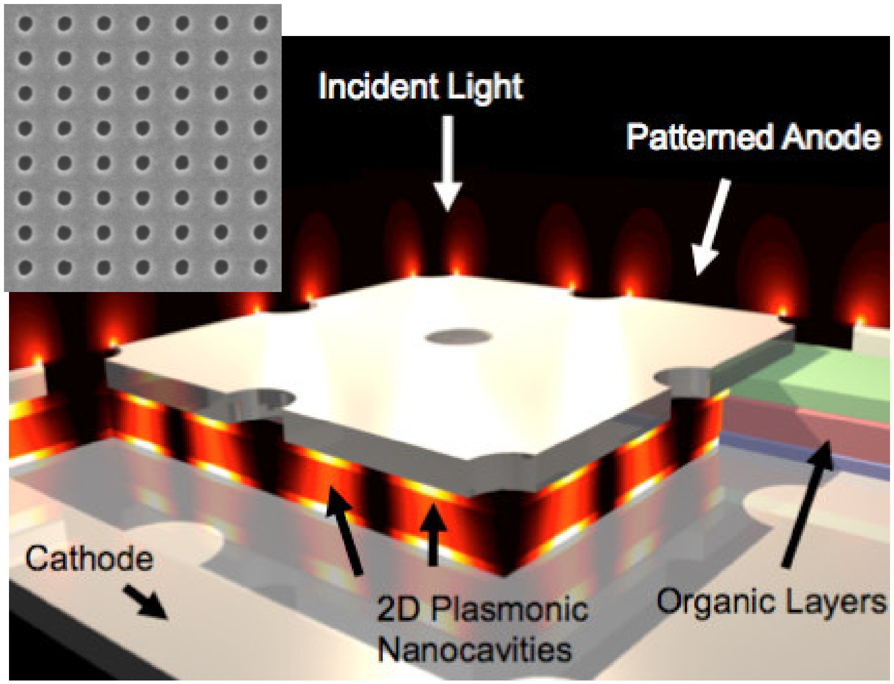
Tailoring morphology and electronic structure in organic-inorganic hybrids



Spectroscopic and optoelectronic measurements of charge separation and transport important in solar cells

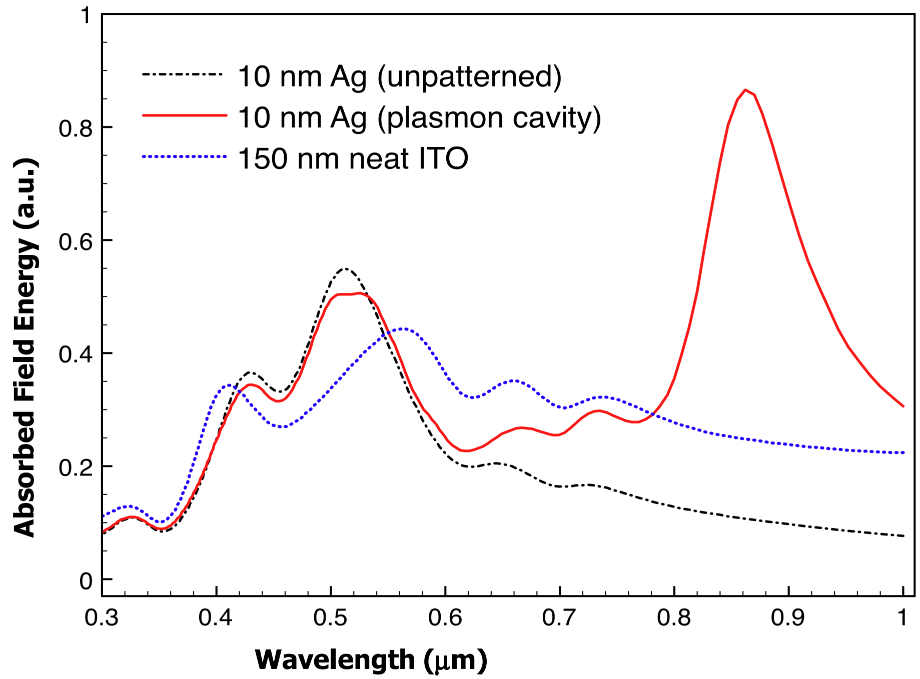
Nanostructured Plasmonic Contacts for Enhanced Efficiency in Organic Photovoltaic Cells

Russell J. Holmes & Sang-Hyun Oh - University of Minnesota



Organic photovoltaic cells (OPVs) are limited by poor optical absorption

Metallic nanostructures permit improved control over the internal optical field (Inset: 200 nm nanoholes in Ag by FIB)



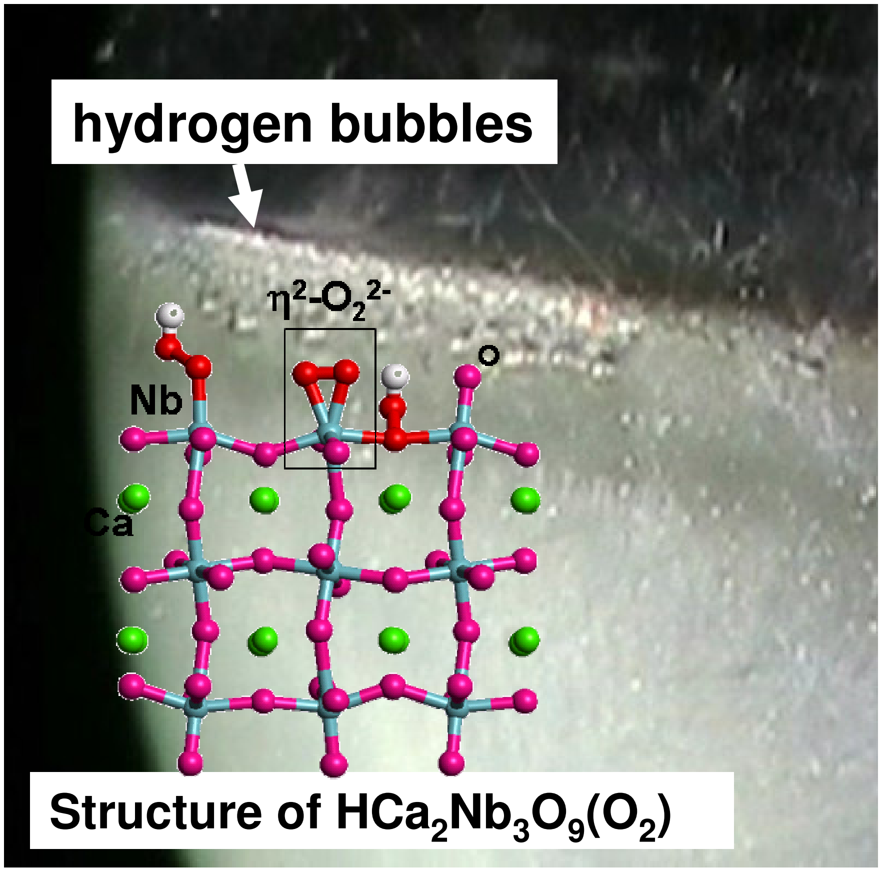
Simulation of OPV on nanoslits shows enhanced absorption with patterning

Performance could exceed that of conventional transparent conductors like indium tin oxide (ITO)

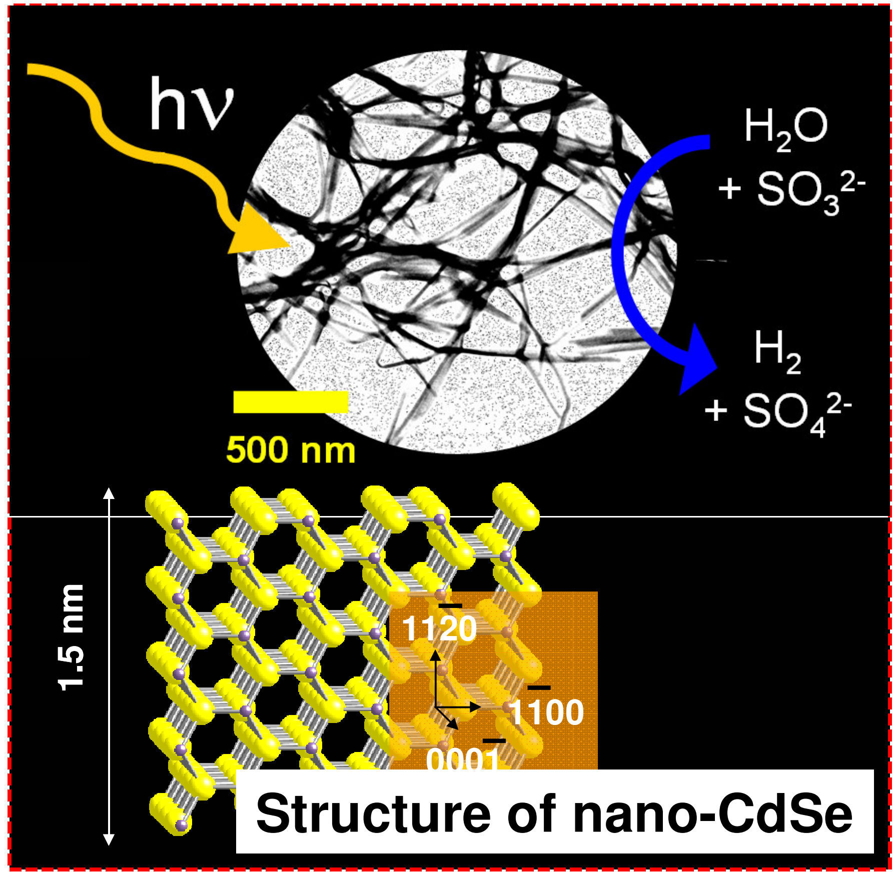
CBET 0946723

Modular Construction of Nanostructured Catalysts for Solar Hydrogen Generation from Water

Frank E. Osterloh - University of California-Davis



Catalyst-Bound Peroxide Identified as Deactivating Reagent

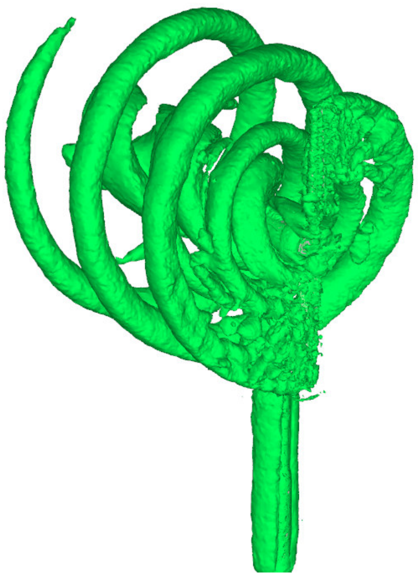


Quantum Size Effect Activates nano-CdSe for Photocatalytic H_2 Evolution under Visible Light

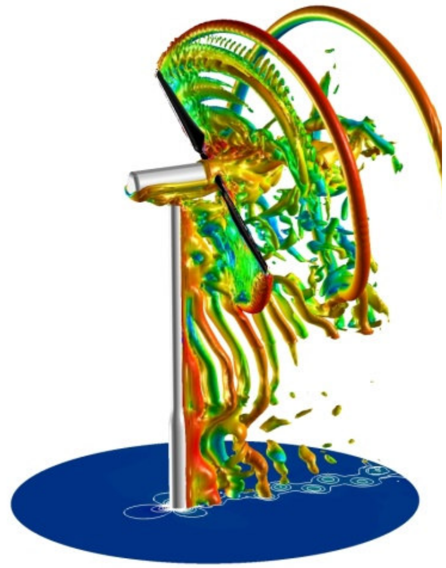
CBET 0829142

Advances in Wind Turbine Analysis and Design

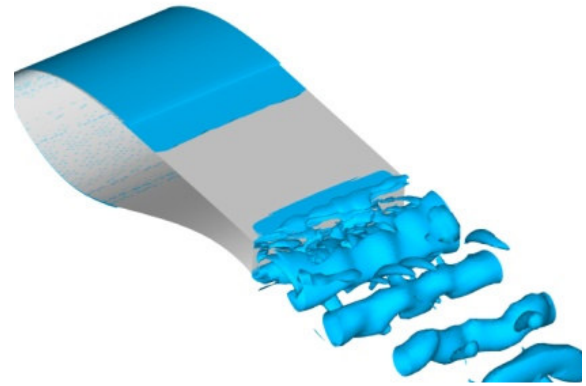
Marilyn J. Smith - Georgia Institute of Technology



FUN3D unstructured overset simulations of upwind HAWT



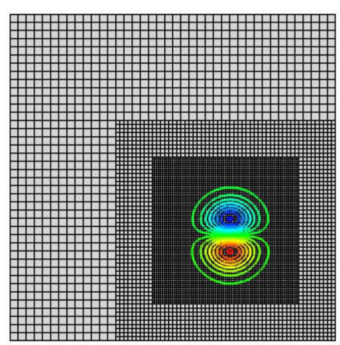
OVERFLOW-2 overset simulation of downwind HAWT



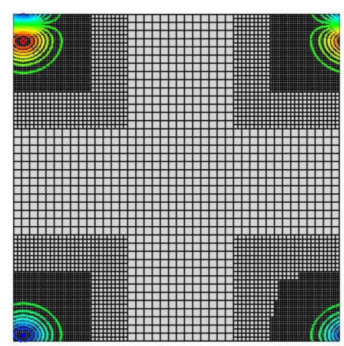
Unsteady vortex shedding of a HAWT rotor at moderate angles of attack

Clockwise from top left: Simulations of full wind turbines; Example of vortex shedding from HAWT airfoil, Improved vortex propagation using SAMR

t = 2 sec



t = 20 sec



Inviscid vortex convection:

- **Periodic domain**
- **Free-stream velocity is 45º angle**
- **4 levels of refinement**

CBET-0731034