

# ***Clean Energy for the Commonwealth Powered by UMass***

**Natick Soldier System Center  
S&T Board Meeting**

Paul T. Kostecki  
Vice Chancellor for Research & Engagement  
UMass Amherst

April 15, 2009

# Clean Energy Working Group

## System-wide collaboration at the University of Massachusetts

**Paul Kostecki (Chair)**

Vice Chancellor for Research & Engagement  
UMass Amherst

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Head, Department of Electrical & Computer Engineering  
UMass Lowell

**Jeff Brancato**

Associate Vice President for Economic Development  
UMass Office of the President

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Associate Dean, College of Natural Resources & the  
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UMass Amherst

**Jim Kurose**

Dean, College of Natural Science and Mathematics  
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**David Levy**

Professor, College of Management & Marketing  
UMass Boston

**Michael Malone**

Dean, College of Engineering  
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**John Miller**

Director of Operations/ATMC  
UMass Dartmouth

**Robert Peck**

Dean, College of Engineering  
UMass Dartmouth

**John Ting**

Dean, Francis College of Engineering  
UMass Lowell

**Marcellette Williams**

Senior Vice President for Academic Affairs,  
Student Affairs and International Relations  
UMass Office of the President



# Clean Energy Working Group Progress

## 2006-07:

- Inventory of clean energy activities system-wide
- Group meetings build inter-campus ties

## 2008:

- “Clean Energy for the Commonwealth: Powered by UMASS”
- MOU signed between President Wilson and Sec. Bowles

## 2009

- Collaboration with newly formed MA Clean Energy Center
- Inter-campus research partnerships in clean energy

# Matrix of clean energy applications (columns) and selected UMASS research areas (rows).

| Solar/Geothermal  | Fuel Cells/Batteries   | Biofuels  | Wind/Ocean   | Efficiency/Emmissions  |
|---|--|---|--|--|
| <b>Advanced Polymers and Nanomaterials</b>  |  |   |  |  |
| Organic optoelectronics<br>Nanofabrication using block copolymer templates<br>Conductive nanotubes/quantum dots<br>Polymer-inorganic nanocomposites | Nano-Imprint lithography<br>Nanomagnetics<br>MEMS  | Nanoporous membranes<br>Biohybrid materials<br>Zeolite membranes<br>Nanostructured catalysts  | High-strength lightweight materials  | Nanoparticle-polymer combo. (OLEDs)  |
| <b>Electrical Systems</b>   | <b>Hydrogen Storage</b>  | <b>Chemical Catalysis</b>   | <b>Mechanical Eng.,<br/>Mechatronics &amp;<br/>System Design</b>   | <b>Energy Management</b>   |
| Quantum electronics<br>Semiconductor thin films<br>Microelectronics   | Nano/Micro-electronic sensor design<br>Novel nanostructured materials<br>High-surface-area porous materials    | Fundamental biofuels reactions:<br>- Heterogeneous catalysis<br>- Fast pyrolysis (to bio-oils)<br>- Microwave control of catalysis<br>Catalyst synthesis/characterization<br>Bio-oils refining to fuels & chemicals<br>Biomass gasification | Wind resource assessment<br>Offshore wind energy<br>Hybrid systems design<br>Wind-produced hydrogen<br>Energy storage<br>Prognostics and Health Management (PMH) & control sys.<br>Geotechnical evaluation | Hierarchical power management<br>Low-power device networks<br>Energy scavenging                                      |
| <b>Thermodynamics</b>   | <b>Microbial Biotechnology</b>   |   |  | <b>Enviro. Engineering</b>   |
| Energy analysis<br>Theoretical thermodynamics<br>Heat transfer  | <i>Geobacter sulfurreducens</i>  | <i>Clostridium phytofermentans</i><br><i>In-silico</i> modeling<br>Directed evolution<br>Metabolic engineering  |  | Wastewater energy recovery, re-use   |
|   | <b>Plant Biotechnology</b>   |   | <b>Meteorology</b>   | <b>Building Design</b>   |
|   |  | Biochem., Cell wall struct., Agronomy<br><i>Crambe abyssinica</i> – energy crop   | Remote sensing<br>Turbulence in stratified flows<br>Climate modeling   | Heat transfer, Fenestration<br>Energy efficient and environmentally benign materials                                 |
|   | <b>Photocatalysis</b>  |   |  | <b>Carbon Capture</b>  |
|   | Solar-powered H <sub>2</sub> generation<br>Solar-electrolyzer H <sub>2</sub> fuel cell storage                 |   |  | Pollution control technologies<br>CO <sub>2</sub> sequestration (deep ocean/geo)<br>Enhanced oil recovery/extraction |
| <b>Geologic Assessment</b>  | <b>Charge Storage/Conv.</b>  | <b>Process Engineering</b>  | <b>Ocean Science</b>   | <b>Flame Modeling</b>  |
| Analytical geology<br>Passive seismic analysis<br>Inventory of New England bedrock geology  | Electrochemical storage cells<br>Nanostructured conducting polymers<br>Redox charge storage<br>Supercapacitors | <b>Biomanufacturing</b>   | Coastal environ. sensing/modeling<br>Quantitative marine carbon cycling  | Combustion chemistry<br>Molecular-beam mass spectrometry   |
|   |  | Fuel injection (atomization) modeling   | <b>Computational Fluid Dynamics</b>  |  |
|   |  |   | Dynamics of stably stratified flows  | Turbulence modeling  |
| <b>Environmental, Economic, Industry, Market, and Policy Analyses</b>   |  |   |  |  |

# Key Renewable Energy Research Areas

- **Wind and Marine Energy - Amherst, Dartmouth, Lowell, Boston**
- **Advanced Polymers and Nanomaterials for Photovoltaics, Fuel Cells, and Batteries - Amherst, Lowell, Dartmouth**
- **Cellulosic Biofuels and the Integrated Biorefinery - Amherst, Dartmouth**
- **Microbial Fuel Cells: Waste to Electricity - Amherst, Dartmouth**
- **Geothermal Energy: The Untapped Potential of New England Bedrock - Amherst**
- **Sustainable Design and Green Construction - Amherst**
- **Business, Competitiveness, and Policy Analysis of Clean Energy and Climate Change - Boston, Amherst**

# Soldier Systems: Portable Power Research

## Applications:

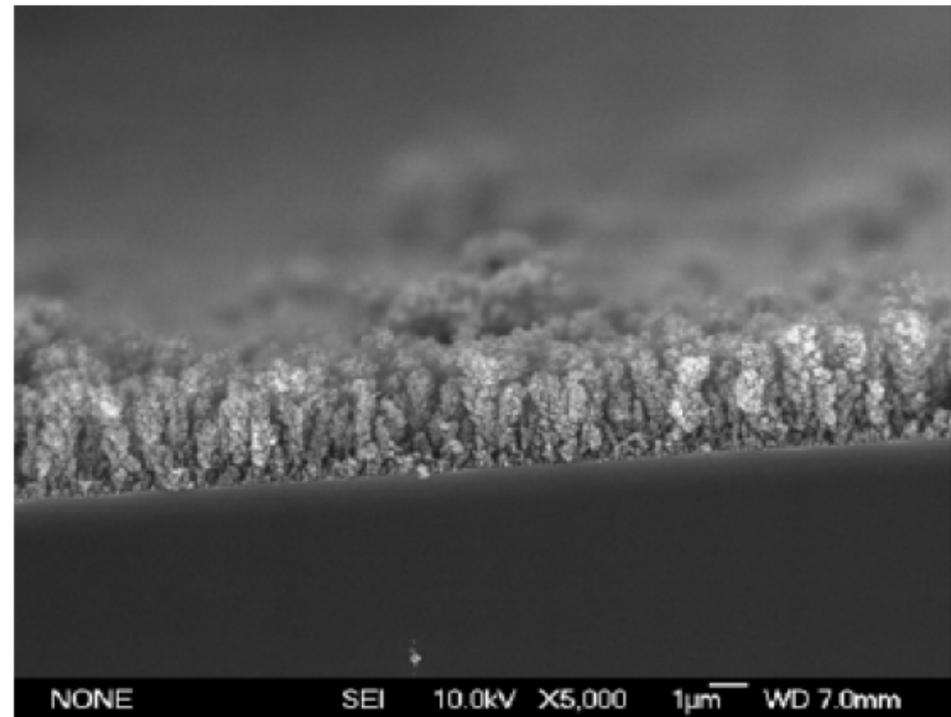
- Thin-film photovoltaics
- Nanostructured light-harvesting materials
- Ultra-capacitors
- Fuel cell membranes & electrodes
- Efficient LED lighting
- Soft electronics
- Hydrogen storage
- Portable microbial fuel cells

# Nanostructured Light-Harvesting Materials

## Spray on Nanostructured Films

UMass Amherst Center for  
Hierarchical Manufacturing

- Professor Jim Watkins,  
Polymer Science and  
Engineering, Director
- Spray-on technique efficiently  
creates nanostructured films  
(titanium dioxide shown).



Panel Spray with Robotic Arm

# Microbial Fuel Cells: Waste to Electricity

## UMass Amherst *Geobacter* Project

- Professor Derek Lovley, Microbiology Department

Organic Compounds

Carbon Dioxide

Anode

DOE GENOMICS:GTL  
ACCELERATING  
DISCOVERY FOR ENERGY  
AND ENVIRONMENT  
OFFICE OF SCIENCE  
U.S. DEPARTMENT OF ENERGY

NSF

DEPARTMENT OF THE NAVY  
ONR  
Science & Technology

TOYOTA

## Opportunities: Research Centers & Institutes

- MassNanotech Institute / Center for Hierarchical Manufacturing: [www.umass.edu/massnanotech](http://www.umass.edu/massnanotech)
- Fueling the Future Center for Chemical Innovation  
[www.chem.umass.edu/masscrest/fuelingthefuture](http://www.chem.umass.edu/masscrest/fuelingthefuture)
- *Geobacter* Project / Environmental Biotechnology Center  
[www.geobacter.org](http://www.geobacter.org)
- Center for High-Rate Nanomanufacturing  
[www.uml.edu/nano](http://www.uml.edu/nano)

# Opportunity: *Carbon Negative* series

- Inaugural seminar: June 11, 4:30 pm  
Foley Hoag Emerging Enterprise Center, Waltham
- Topic: Optimizing fuel cell performance
- Featured Speakers:
  - S. “Thai” Thayumanavan, PhD.  
UMass Amherst Professor of Chemistry and  
Director, Fueling the Future Center for Chemical Innovation
  - Paul Osenar, PhD. Chief Technology Officer,  
Protonex, Inc.

# For more information: Portable Power Research

## Faculty excerpted from “Clean Energy for the Commonwealth”

| Name                    | Department                          | Application                              | Campus    |
|-------------------------|-------------------------------------|--|-----------|
| Thayumanavan, S. “Thai” | Chemistry                           | Fuel cell membranes                      | Amherst   |
| Therrien, Joel          | Electrical and Computer Engineering | Hydrogen storage                         | Lowell    |
| Qu, Deyang              | Chemistry                           | Hydrogen storage, ultracapacitors        | Boston    |
| Lovley, Derek           | Microbiology                        | Microbial fuel cells                     | Amherst   |
| Watkins, Jim            | Polymer Science & Engineering       | Nanostructured light-harvesting material | Amherst   |
| Emrick, Todd            | Polymer Science & Engineering       | Organic LED                              | Amherst   |
| Russell, Thomas         | Polymer Science & Engineering       | Organic PV                               | Amherst   |
| Mead, Joey              | Plastics Engineering                | Organic PV                               | Lowell    |
| Ramaswamy, Nagarajan    | Plastics Engineering                | Organic PV                               | Lowell    |
| Kumar, Jayant           | Physics                             | Organic PV                               | Lowell    |
| Calvert, Paul           | Materials & Textiles                | Soft electronics                         | Dartmouth |
| Tuominen, Mark          | Physics                             | Ultracapacitors (nanomagnetics)          | Amherst   |

# Additional Resources

- Clean Energy for the Commonwealth  
[www.umass.edu/research](http://www.umass.edu/research)
- Green Portal  
[www.umass.edu/green](http://www.umass.edu/green)
- Clean Energy Connections, Nov 10  
[www.umass.edu/green](http://www.umass.edu/green)