

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



University of Massachusetts

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Clean Energy Working Group

System-wide collaboration at the University of Massachusetts

Paul Kostecki (Chair)

Vice Chancellor for Research & Engagement
UMass Amherst

Craig Armiento

Head, Department of Electrical & Computer Engineering
UMass Lowell

Jeff Brancato

Associate Vice President for Economic Development
UMass Office of the President

Tom Chmura

Vice President for Economic Development
UMass Office of the President

Steve Goodwin

Associate Dean, College of Natural Resources & the Environment
UMass Amherst

Jim Kurose

Dean, College of Natural Science and Mathematics
UMass Amherst

David Levy

Professor, College of Management & Marketing
UMass Boston

Michael Malone

Dean, College of Engineering
UMass Amherst

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

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:

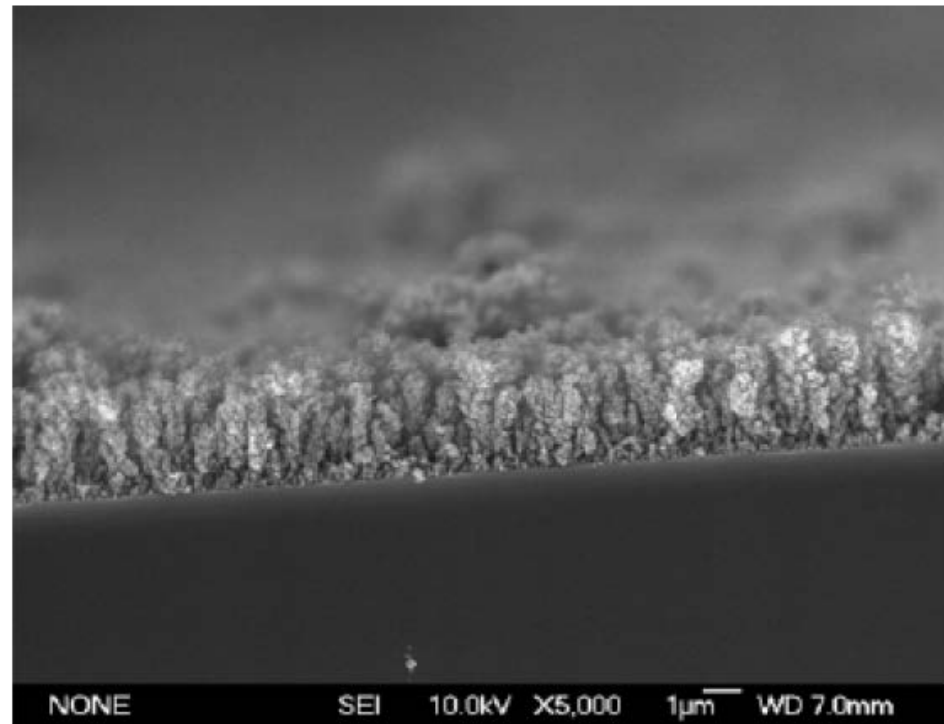
- Thin-film photovoltaics
- Nanostructured light-harvesting materials
- Ultra-capacitors
- Fuel cell membranes & electrodes
- Efficient LED lighting
- Soft electronics
- Hydrogen storage
- Portable microbial fuel cells

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



Opportunities: Research Centers & Institutes

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

Additional Resources

- Clean Energy for the Commonwealth
www.umass.edu/research
- Green Portal
www.umass.edu/green
- Clean Energy Connections, Nov 10
www.umass.edu/green

