

Energy and Sustainable Design Research at the University of Virginia: Presentation to Virginia Coal and Energy Commission



**Dr. Phil Parrish
Assistant VP for Research**

**Office of the Vice President for
Research and Graduate Studies**

University of Virginia

Research Groups

Engineering

- **Harsha Chelliah – Clean Coal and Alternate Fuels; Distributed Power**
 - Distributed combined heat and power systems
 - Lean premixed natural gas systems
 - Use of gasified coal – syn-gas
 - Alternate fuels – bio fuels
- **Robert Davis – Heterogeneous Catalysis**
 - Transition metal catalysts
 - New solid base catalysts for synthesis of biodiesel
 - Next generation catalysts for conversion of syngas to ethanol
- **Matthew Neurock – Computational Catalysis**
 - Conversion of carbohydrates on metal surfaces
 - Electrocatalysts for PEM fuel cells
 - Fundamental principles of catalysis
- **Steve McIntosh – Solid Oxide Fuel Cells**
 - High temperature fuel cells converting a variety of fuels
 - High temperature membranes for separations
 - Electrochemical sensors
- **Mool Gupta – Photovoltaics**
 - Laser crystallization of Si for solar cell efficiency improvement (NSF)
 - Organic solar cell efficiency improvement using carbon nanotubes (NSF)
 - Improvement of electrical contacts for solar cells (BP SOLAR)
 - Nanostructures for solar cell efficiency improvement

Architecture

- **Timothy Beatley – Sustainable Design**
 - Green urbanism; Urban planning and policy
 - Incorporation of locally produced renewable energy

Clean Coal and Alternate Fuels; Distributed Power



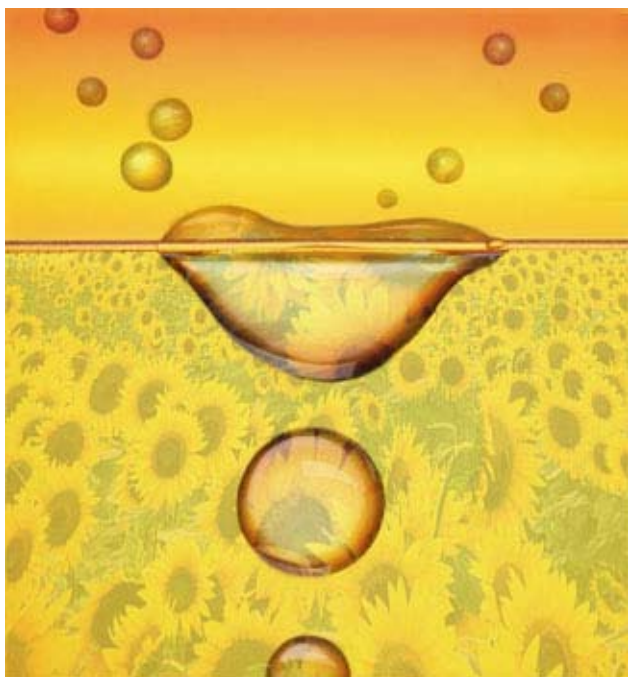
Coal thermal cycle efficiency has averaged 33% since the 1960s

Gasified coal:

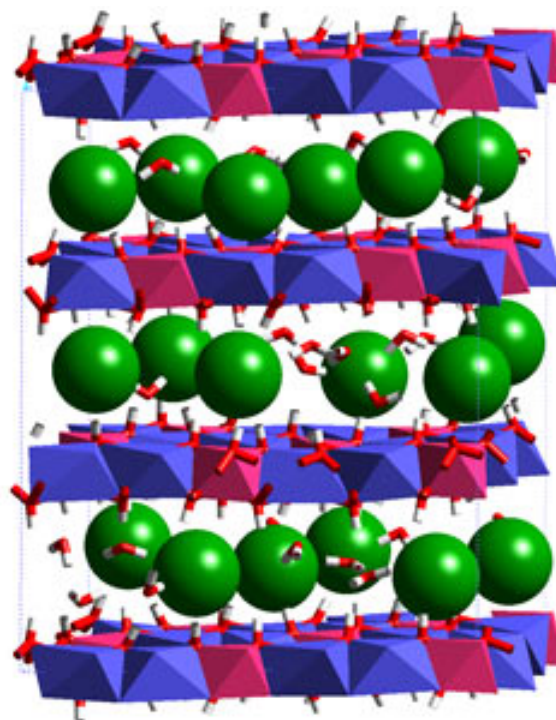
- can improve cycle efficiency up to 38% efficient
- Removes >99% of SO₂
- Possible to eliminate NO_x emissions
- Can be combined with advanced gas turbines and fuel cells to achieve >60% efficiency

Conversion of Biorenewable Resources

Heterogeneous catalysis for fuels and chemicals

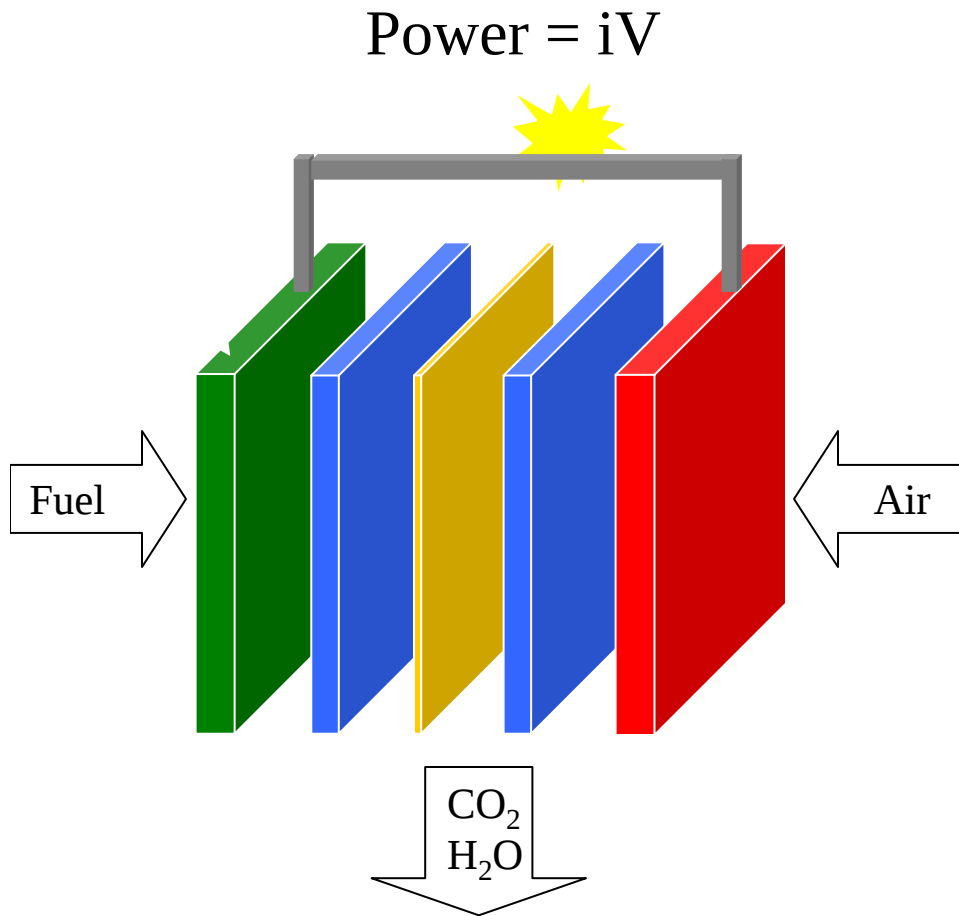


**Synthesis of BioDiesel Fuel
using solid base catalysts**

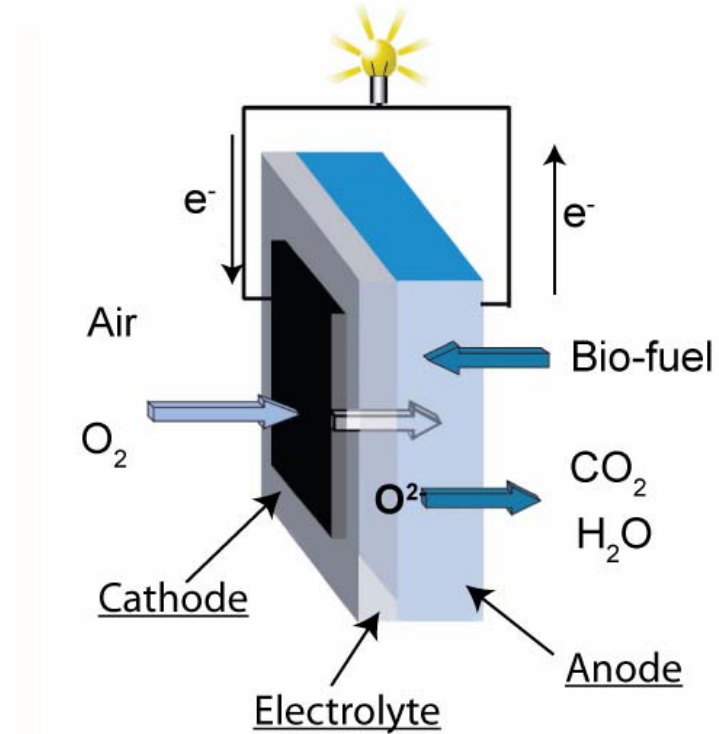


New solid base catalysts
- *Hydrotalcite*: A Precursor for
Mg-Al Mixed Oxides

Fuel Cells for Generation of Power

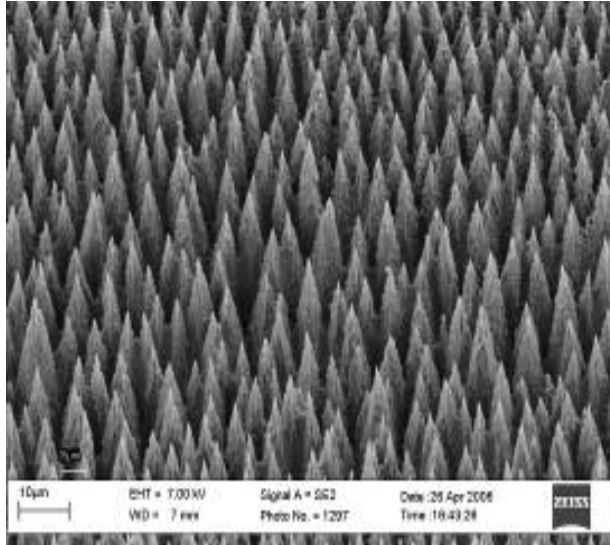


Direct Methanol Fuel Cell (DMFC)
(Low Temperature)



Solid Oxide Fuel Cell (SOFC)
Flexibility in Fuel Source
(High Temperature)

Photovoltaic Research



Laser textured silicon surface for efficient solar light absorption.

Capabilities Include:

- **Thermal evaporation system for depositing organic solar cell materials**
- **Laser processing apparatus for solar materials processing**
- **Cleanroom facilities for solar cell device fabrication.**
- **Carbon nanotube dispersion for solar cell nanostructures**
- **Optical quantum & broad efficiency measurement.**
- **Multi-wavelength optical scattering and reflectance measurement**

Sustainable Design



Designing Cities and the Built Environment to Reduce Energy Consumption
Incorporating Solar and other Renewable Energy Systems

Funding Sources Include

Department of Energy

BP SOLAR

National Science Foundation

Army Research Office

PNNL EMSL Supercomputer Center