Fuel Cell Technologies Available at the Pacific Northwest National Laboratory

JAMIE HOLLADAY
FUEL CELL TECHNOLOGIES OFFICE SECTOR MANAGER

MIKE RINKER
EERE MARKET SECTOR MANAGER, EED

KRISTON BROOKS
CHIEF ENGINEER, EED

Fuel Cell Seminar
Nov 10-12, 2014
Location: Richland, WA

- 4,300 scientists, engineers and non-technical staff
- 98 Awards for Technology Transfer to market, 93 R&D 100 awards

Core Capabilities

- Solid Oxide Fuel Cells
- Institute for Integrated Catalysis
- Applied Materials Science & Engineering
- Systems Engineering & Integration
- Energy storage and conversion
- Supercomputing
- Environmental Molecular Sciences Laboratory User Facility
- Safety Codes and Standards / First Responder Training
PNNL’s microchannel technology enables exceptionally fast heat and mass transfer

Impact:

Microchannel technology results in up to 10x decrease in device size.

- Ideal for highly efficient heat exchangers
- Improved performance of heat or mass transfer limited reactions (i.e. endothermic)
- Perfect where size matters

Technical Point of Contact: Kriston Brooks – Kriston.Brooks@PNNL.gov

http://availabletechnologies.pnnl.gov/
Material Based Hydrogen Storage

PNNL developed new materials for safe, high density hydrogen storage

PNNL chemists developed new synthesis methods for ammonia borane and its derivatives - lithium amido-borane, EDAB

New materials have higher volumetric and gravimetric capacity than physical storage

Impact:
Material based H₂ is ideal for many fuel cell applications. It is:

- Low pressure
- High capacity (>80 g H₂/L)
- Safe, air and thermally stable
- PNNL developed new lower cost ammonia borane synthesis technology

Technical Point of Contact: Tom Autrey- Tom.Autrey@PNNL.gov

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Advanced High Performance Catalysts

PNNL’s Institute for Integrated Catalysis (IIC)

PNNL catalysis capabilities provide foundational knowledge for the development of highly active and durable catalysts.

Highly active catalysts are integrated into compact systems for hydrogen production technologies.

Impact:

PNNL’s highly active steam reforming catalysts for paraffinic hydrocarbons and catalysts for methanol:

- 10x increase in activity (paraffinic hydrocarbon reforming)
- Methanol reforming catalyst is non-pyrophoric
- Engineered forms developed for easy reactor integration

Technical Point of Contact: Yong Wang - Yong.Wang@PNNL.gov

http://availabletechnologies.pnnl.gov/
Low Cost Pressure Vessels

PNNL developed technology for pressure vessel cost reduction

Impact:
Our materials, engineering and design:
- Low cost glass and carbon fiber hybrid tanks
- Innovative designs to eliminate hydrogen waste and enable five minute fills
- >85% Conformability
- Design for low cost manufacturing

Technical Point of Contacts: Dave Gotthold and Ken Johnson-
Dave.Gotthold@PNNL.gov and KJ.Johnson@PNNL.gov
PNNL leads in the development of Solid Oxide Fuel Cell development

Impact:

- Oxide based anodes that are \( \text{O}_2 \) tolerant, less susceptible to sulfur, high activity, low cost
- Glass-ceramic seals for planar technology
- Reactive air brazing for joining ceramics to metals
- Gas-tight sealing methods

Technical Point of Contact: Jeffry Stevenson – Jeff.Stevenson@PNNL.gov

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Recent Collaborations in Fuel Cell Technologies

- Tank Manufacturers
  - Hexagon Lincoln
  - PPG

- Fuel Cell Companies
  - Protonex
  - Nuvera
  - Plug Power
  - FuelCell Energy
  - Delphi

- Hydrogen Storage Materials
  - Cella Energy

- OEMs
  - Ford
  - GM
  - Boeing

- Institutions
  - California Fuel Cell Partnership
  - H₂ USA

- Other Companies
  - Echogen
  - Infinia Technology Corporation
  - AOC Resins
  - Crosslink Technologies
  - Cormtech
  - TianChen
  - Emerald Energy NW
  - Virent
  - Air Products
  - Velocys
  - Dow

- Universities and Institutions
  - Boston College / Boston University
  - University of Alabama
  - University of Quebec
  - Michigan State University
  - Oregon State University
  - University of Connecticut
  - Washington State University
Mission
We transform the world through courageous discovery and innovation.

Vision
PNNL science and technology inspires and enables the world to live prosperously, safely and securely.

DISCOVERY in Action
CREATIVITY
VALUES
INTEGRITY
COLLABORATION
impact
COURAGE
PNNL is mission-driven

We

TRANSFORM

THE WORLD

through
courageous

DISCOVERY

and

INNOVATION.

- Operated by Battelle since 1965
- Unique S&T capabilities
- Mission-driven collaborations with government, industry and academia
Thank you

Jamie Holladay
Fuel Cell Technologies Office Sector Manager
509-371-6692
Jamie.holladay@pnnl.gov