A Multilevel, Integrated Approach for Developing Enhanced Electroceramics and Fuel Cells

NETL-RUA Regional University Alliance

Challenges and Motivation

Reliable, rugged, and low-pollution energy conversion technologies are desired for electricity generation and storage. Electroceramic and fuel cell technologies address the complex challenges of electricity storage/generation with minimal environmental impact.

Technology/Capability Overview

Advanced electroceramic (EC) devices and fuel cells (FC) can directly ***convert any form of chemical energy (fuel) to electrical energy (electricity)***. EC and FC integrated devices that ***produce electricity*** are generally ***more fuel flexible, higher efficiency / lower pollution, more scalable, and more distributable than traditional electricity generation technologies***. Devices operate at high temperature (400 C-800 C) and are **chemically robust and mechanically durable**.

Solid oxide fuel cells

- SOFC operate on natural gas, shale gas, hydrogen, or syngas to produce DC electricity at 50%+ efficiency, even at the "household" scale of approximately 1 kW

Direct carbon fuel cells

- DCFC operate on coal, methane, liquefied hydrocarbons and liquid fuels,biomass, and carbonaceous wastes to produce DC electricity and thermal energy

Key Opportunities

Co-development of:

1) **SOFC operating on direct shale-gas**
2) **Electrode infiltrate materials and production scale technology**
3) **Direct carbon fuel cell**

Technologies available for transfer and major capabilities

Electrode infiltration technology

Low-cost electrode infiltrate stabilizes electrochemical cell / fuel cell performance and improves durability

Electroceramic device concept development (concept → commercialization)

Advanced performance modeling

Prototype generation and device provenance

Industry Significance

Electrode infiltration technology

- Scalable and configurable for any commercial EC/FC electrode
- Large potential market - every commercial EC/FC cell
- Continuous revenue stream

Electroceramic R&D capability

- Decrease rate of concept → market transfer (existing capability)
- Generation of statistically significant data sets
- Improved Gen II prototyping

Benefits to Partner

Access to significant expertise in materials development

- Engineering and materials faculty from top universities
- Advanced analytical and component testing facilities including access to SEM/EDS, XRD, (HR)TEM, FIB-SEM, FIB-OIM
- Existing relationships with industry and affiliated research groups

Research facilities

10,000 sq. ft of laboratory space at NETL, including high-bays for at-scale testing
Multiple partner laboratories: West Virginia Univ, Carnegie Mellon, and Penn State
Hybrid Performance (HyPer) test bay – 600 kW integrated IGFT HIL simulator

Development Status

Electrode infiltration technology

Seeking development partners and capital for scale-up / commercialization

Electroceramic device concept development

Seeking development partners for pursuit of DCFC and M/MO battery

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