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Title: HIGH TEMPERATURE POLYMER ELECTROLYTE MEMBRANE FUEL CELL ELECTRODE COMPOSITION

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Tech Snapshot Advanced Materials

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HIGH TEMPERATURE POLYMER ELECTROLYTE MEMBRANE FUEL CELL ELECTRODE COMPOSITION

*Durable Fuel Cell Power under Anhydrous
Conditions*

BENEFITS

This invention results in high power independent of temperature and humidification level. This is desirable because a single solution that serves multiple fuel cell market segments enables an economy of product design and manufacturing scale.

- No acid loss in the presence of water
- Resists electrode flooding
- Enhances cathode reaction activity and efficiency
- Engineers a uniform reaction site and uniformity of current generation

SUMMARY

Innovators/Researchers at Los Alamos National Laboratory have developed an electrode composition that improves fuel cell performance under anhydrous conditions above 100 °C. It has demonstrated great durability in humidified conditions under 100 °C as well. It holds promise for use in fuel cells for heavy duty vehicles while retaining utility for portable and stationary power applications. In coming years this flexibility may be a breakthrough improvement over conventional compositions.

MARKET

The combination of high power at high temperature is beneficial because it reduces the complications that accompany humidified systems, such as the needs for large radiators and active humidification controls to accomplish heat removal. The LANL ionomer's combination of power and durability characteristics has particular benefits for heavy duty truck designs, as it positions operators to be responsive to statutory and regulatory goals for reducing greenhouse gas emissions from vehicle fleets.

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WHY WE ARE BUILDING HIGH TEMPERATURE POLYMER ELECTROLYTE MEMBRANE FUEL CELL ELECTRODE COMPOSITION

In vehicle applications, High Temperature Polymer Electrolyte Membrane Fuel Cells (HT PEMFC) that operate with no humidification have balance of plant advantages for vehicles through reduction in radiator size, elimination of humidifying control units, and enhanced reaction kinetics for improved power performance at operating temperatures greater than 100 °C. These advantages may prove beneficial for marine and dockside power as well.

WHAT'S BEHIND OUR TECHNOLOGY

HT PEMFC electrode performance has been measured by incorporation of the LANL ionomer composition into Laboratory-scale Membrane Electrode Assemblies (MEAs) and exercising them in Laboratory test stands. Estimates of durability have been arrived at through hundreds of hours of nonstop, steady-state testing and through accelerated aging methods, such as repeatedly cycling from active to inactive states. The composition's chemical stability is well explained by scientific theory.

OUR COMPETITIVE ADVANTAGES

High power density (Watts/square centimeter) permits compact fuel cell assemblies, and LANL's ionomer composition outperforms both Nafion and commercial phosphoric acid-doped electrodes even under completely anhydrous conditions. At 120 °C the LANL ionomer surpasses Nafion electrode power density, and is 20% greater than phosphoric electrode power density. At 160 °C Nafion's power has fallen to nearly zero, and at 200 °C the LANL MEA's power density is 100% greater than commercial HT PEMFCs.

OUR TECHNOLOGY STATUS

Los Alamos scientists have developed this innovation in response to the national priorities set by the Fuel Cell Technologies Office of the US Department of Energy, Office of Energy Efficiency and Renewable Energy. The method of making the composition is replicable at laboratory bench scale. Functional performance and durability test results are repeatable. The Laboratory would be pleased to discuss collaborative research concepts meant to advance the innovation's commercial readiness.

PUBLICATIONS AND IP

This announcement highlights a pending patent for High Temperature Polymer Electrolyte Membrane Fuel Cells (HT PEMFC). **Interested parties should contact The Richard P. Feynman Center for Innovation (FCI) to express interest** in: Electrode Composition for High Temperature Polymer Fuel Cells, Docket Number S133780.

Relevant publications include:

1. The Energetics of Phosphoric Acid Interactions Reveals a New Acid Lose Mechanism, Albert S. Lee, Yoong-Kee Choe, Ivana Matanovic, Yu Seung Kim*, *Journal of Materials Chemistry A*, 7, 9867-9876 (2019).
2. Intermediate Temperature Fuel Cells via an Ion-Pair Coordinated Polymer Electrolyte, Kwan Soo Lee, Sandip Maurya, Yu Seung Kim*, Cortney R. Kreller, Mahlon Scott Wilson, Dennis Larson, S. Elangovan and Rangachary Mukundan*, *Energy & Environ. Sci.*, 11, 979-987 (2018).
3. An Operationally Flexible Fuel Cell based on Quaternary Ammonium-Biphosphate Ion Pairs, Kwan-Soo Lee, Jacob S. Spendelow, Yoong-Kee Choe, Cy Fujimoto, Yu Seung Kim*, *Nature Energy*, Article No. 16120 (2016).