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Nanoporous powders for high-performance fuel cells and electrolyzers

Stanford researchers have developed a conductive nanoporous powder technology that dramatically enhances electrode stability and efficiency for fuel cells and electrolyzers. These materials offer over 30 percent greater stability and 20 percent higher performance than current alternatives for electrode materials by optimizing surface area, pore structure, and catalyst integration, enabling more sustained and energy-efficient electrochemical reactions.

Hydrogen fuel cells and electrolyzers are used extensively in energy production, but existing electrode materials degrade significantly over time and demonstrate suboptimal catalyst utilization. The inventors' nanoporous powder provides an electrochemically stable support with a high surface area that markedly improves catalyst dispersion and retention. Protective metallic coatings prevent degradation, thereby extending electrode lifespan and reducing costs across industrial, automotive, and renewable energy applications.

When deployed in membrane electrode assemblies, this novel material supports high power generation rates, exhibits superior catalytic activity and stability relative to the state of the art, and retains over 90 percent of its power generation performance after 90,000 stress test cycles. Compatible with scalable manufacturing processes, the inventors' technology offers a promising solution for high-performance fuel cell vehicles, stationary power systems, and industrial hydrogen production.

Stage of Development
Prototype — The researchers' invention has been proven in a working fuel cell, resulting in enhanced electrode stability and increased energy density.

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Applications

- High-performance electrodes with increased efficiency and durability for fuel cells, water electrolyzers, and additional energy devices
- Clean energy technology for industrial adoption in the automotive and energy spheres
- Nanoporous carbon as a high-surface-area catalyst support for anodes, cathodes, and membrane electrode assemblies

Advantages

- Heightened stability (+30%) and performance (+20%) for long-lasting fuel cell and electrolyzer efficiency
- Optimized pore structure for enhanced catalyst utilization
- Compatible with multiple deposition methods, enabling development of scalable, high-activity electrodes with strong industrial potential

Patents

- Published Application: 20250112247

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