Ceria Dramatically Increases the Lifetime of a PEM Fuel Cell Membrane

**Introduction**
Polymer electrolyte membrane fuel cells (PEMFC), also known as proton exchange membrane fuel cells, hold promise as a source of clean energy, but none of the currently available membranes withstand the harsh conditions of a hydrogen fuel cell environment long enough to pass the 5000 hour test required for automotive applications. Perfluorosulfonic acid membranes are the leading choice for PEM fuel cells, for their high mechanical and thermal stability with high proton conductivity, but degrade in the presence of radicals formed during fuel cell operation that cause premature fuel cell failure.

**Advantages**
By adding cerium oxide (ceria) as a radical scavenger, UCF researchers have demonstrated a way to dramatically mitigate this degradation and keep fuel cell membranes practically free of damage in up to 500 hour tests (the longest test conducted by the researchers) while control membranes experienced catastrophic failure. This exceptional improvement indicates the possibility of a membrane able to pass the 5000 hour test. The new means of extending fuel cell lifetime can be easily and inexpensively incorporated into current production methods with no negative impact on performance.

**Technical Details**
Fuel cell membrane electrode assemblies (MEAs) with ceria nanoparticles incorporated have shown a seven-fold decrease in open-circuit voltage decay and three orders of magnitude decrease of decay-indicating fluoride emission rates in 94 hour tests. Ceria prevents membrane degradation by decreasing platinum (or other precious metal group catalyst) precipitation in the membrane: two to three times larger particles, tenfold fewer particles, and a three-to-tenfold decrease in area coverage. In researchers’ tests, the ceria-containing MEA showed these signs of improved fuel cell lifetime paired with unchanged performance and hydrogen crossover, remaining effectively pristine while the compared baseline MEA became unusable.¹

**UCF Inventors**
Benjamin P. Pearman, Ph.D.; R. Paul Brooker, Ph.D.; Nahid Mohajeri, Ph.D.; Marianne Rodgers, Ph.D.; Darlene Slattery, Ph.D.

**Related Publications**

**Benefits**
- Dramatically increased PEM fuel cell membrane lifetime
- No decrease in performance
- Easy and inexpensive incorporation into current production methods

**Applications**
- PEM fuel cells
- Water electrolyzers
- Flow battery membranes for cation-based flow battery technologies: e.g., vanadium and/or hydrogen/bromine
- Supercapacitors

**Tech Fields**
Clean Technology
Hydrogen Fuels

**Keywords**
PEM, PEMFC, proton exchange membrane fuel cells, polymer electrolyte membrane fuel cells, transportation, zero-emissions vehicle, ZEV, hydrogen, automotive, water electrolyzer, flow battery membrane, cerium oxide, nanoceria