MISSOURI S&T

Opportunity

Seeking a licensing and development partner to advance this regenerable anode technology toward commercial solid oxide fuel cell systems.

Development Stage

Validated in the lab.

Intellectual Property

Granted U.S.
Patent No. 10,516,170

Publications

US 2017/0309922 A 1

IDF#

15-MST-025

Cyclic regeneration of nanostructured composites for catalytic applications

Fatih Dogan, PhD

PROBLEM STATEMENT

Solid oxide fuel cells (SOFCs) offer fuel flexibility, high efficiency, and the ability to co-generate heat and power. Wide adoption has been limited by anode materials that lose performance over time. Catalytic activity in SOFC anodes depends on nanosized metal particles with high surface area. These particles coarsen at operating temperatures, shrinking their surface area and reducing catalytic activity and power density as the cell ages. Once coarsened, conventional anode materials cannot recover their original performance. Anode materials therefore need to be regenerable so catalytic activity can be restored over repeated duty cycles.

SOLUTION

Researchers at Missouri University of Science and Technology have developed a cermet anode material that regenerates itself through simple oxidation and reduction steps. The anode starts as a metal oxide solid solution, such as copper molybdate, infiltrated into a porous zirconia scaffold or deposited directly on a dense electrolyte. In a reducing atmosphere, the oxide separates into nanosized metal and metal oxide particles that drive catalytic activity, typically 1 to 500 nanometers in size. As the cell operates, these particles coarsen to 0.5 to 3 micrometers and lose activity. Oxidizing the anode reforms the original solid solution, and reducing it again redisperses the particles back down to nanoscale size. For the copper molybdate system, this cycle runs at 400°C for reduction and 600°C for oxidation, both within standard SOFC operating conditions. More broadly, the approach can be tuned by pairing copper, nickel, cobalt, or titanium with molybdenum, tungsten, or cerium oxides to target different operating temperatures and fuels.

VALUE PROPOSITION

This technology addresses a core barrier to SOFC durability. Anode particles coarsen with use, and catalytic activity falls off over time. Rather than replacing a degraded anode, its performance can be restored through straightforward redox cycling. Cells built with this anode have been fabricated and tested between 400°C and 800°C, running on hydrocarbon fuels including methane, propane, and vaporized gasoline, not just hydrogen. The materials platform also supports oxide combinations with higher melting points and lower vapor pressure for higher-temperature operation.