# In-situ observations reveal how nanoparticle catalysts lower operating temperatures in fuel cells

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Researchers from the NIST Center for Nanoscale Science and Technology and Arizona State University have used environmental transmission electron microscopy (ETEM) to explain the role of nickel nanoparticles in lowering the operating temperature of praseodymium doped ceria (PDC) anodes in solid-oxide fuel cells (SOFCs).

These fuel cells are a promising technology for efficiently converting chemical fuels into electricity, and PDC-based anodes have the potential to replace the more commonly used nickel and yttria-stabilized zirconia anodes, which operate at higher temperatures (typically in excess of 1000 °C) that unfortunately cause the anodes to degrade.

Nickel and PDC are being investigated as alternative anode materials because they operate at a relatively cool 500 °C to 700 °C, making the anodes more stable. Using the ETEM, the researchers were able to visualize nanometer-scale structural and chemical changes occurring at the interface between the nickel and the PDC as a function of temperature in an atmosphere of dry hydrogen at 130 Pa, mimicking the partial pressure of hydrogen in a SOFC.

Using energy-loss spectra, the researchers showed that the introduction of nickel nanoparticles lowered the reduction temperature of the PDC in a 20 nm-deep reduction zone around the interface between the two materials.

The formation and size of the reduction zone is consistent with two possible mechanisms, each involving the spillover of ambient atomic hydrogen from the nickel to the PDC.

The researchers believe that understanding and controlling how the nickel nanoparticles catalyze these lower-temperature reactions will enable the development of SOFCs that are both efficient and long-lived.

**More information:** Direct observation of hydrogen spillover in Ni-loaded Pr-doped ceria, V. Sharma, et al, Catalysis Today 180, 2-8 (2012).

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