Palladium doped cerium oxide and zirconium oxide nanoparticles engineered with a high defect density for redox catalysis

Technology #m09-041

Cerium and zirconium oxide nanoparticles act as catalysts in reduction-oxidation (“redox”) chemical processes, including methanol reformation, the water-gas shift reaction, and three-way catalysis (TWC). These catalysts comprise of metal oxides and combinations of precious metals, but suffer from low catalyst efficiency. Creating catalyst with high dopant densities can increase efficiency, but current methods are expensive and technically difficult. This technology presents a low-temperature, cost effective synthesis of palladium-doped cerium oxide or zirconium nanoparticles with a controllable, high dopant density.

Palladium doped cerium and zirconium oxide nanoparticles can be engineered at low temperatures with high dopant density and uniform chemical composition

This technology describes the synthesis of palladium doped cerium and zirconium oxide nanoparticles at low temperatures (up to 85°C degrees), reducing energy costs and resulting in highly doped palladium nanoparticles. The amount of palladium dopant can be controlled from the amount of palladium precursor added to the reaction, allowing for tuning of dopant density. Furthermore, because the reaction is aqueous, the costs involved with purchasing and disposing of organic solvents are minimized. Unlike other methods, performing the reaction in solution does not compromise dopant density. This technology can produce palladium doped cerium oxide, palladium doped zirconium oxide and palladium doped cerium-zirconium oxide alloys, all of which can act as catalysts in fuel cell technology (as a methanol reformer), industrial plants (for water-gas shift reactions), and catalytic converters (for TWC).

The synthesized nanoparticles were characterized by high-resolution transmission electron microscopy and x-ray diffraction to show both their high uniformity as well as their palladium concentration.

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Applications:

• These materials can be catalysts for methanol reforming, three-way catalysis and water-gas shift reactions
• As redox catalysts, materials made from these nanoparticles may be incorporated in three-way catalytic converters for automobile exhausts
• The material may also be used in fuel cell powered electric cars
• These nanoparticles might also have usage in cold starting of automobile engine, lasers, hydrocarbon conversion reactors, and air filters for the conversion of carbon monoxide, and indoor volatile organic compounds

Advantages:

• Straightforward method to produce homogenous nanoparticles with high dopant density
• These nanoparticles are resistant to phase separation up to 1000°C degrees
• Nanoparticle syntheses uses water instead of costly and toxic organic solvents
• This technology saves energy and money by using a low temperature process (85°C degrees)

Patent information:

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Related Publications:


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