# Ceria Nanoparticles Catalyze Reactions for Cleaner-Fuel Future

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Experiments on ceria (cerium oxide) nanoparticles carried out at the U.S. Department of Energy's Brookhaven National Laboratory may lead to catalytic converters that are better at cleaning up auto exhaust, and/or to more-efficient ways of generating hydrogen - a promising zero-emission fuel for the future. Brookhaven chemist Jose Rodriguez will present results from two studies exploring the composition, structure, and reactivity of these versatile nanoparticles during the 229th National Meeting of the American Chemical Society.

After using a novel technique to synthesize the ceria nanoparticles, Rodriguez and coworkers Xianqin Wang and Jonathan Hanson used bright beams of x-rays at the National Synchrotron Light Source to study how their composition, structure, and reactivity changed in response to doping with zirconium in one case, and impregnation with gold in another.

"In a catalytic converter, ceria acts as a buffer, absorbing or releasing oxygen depending on the conditions of the engine to maintain the catalyst in its optimum operating condition for converting harmful emissions such as carbon monoxide and nitrogen oxide to carbon dioxide and nitrogen gas," Rodriguez said. Others have found that adding zirconium improves ceria's ability to store and release oxygen.

The synchrotron studies at Brookhaven explain why: Zirconium changes the ceria's structure to increase the number of oxygen "vacancies" — or places for oxygen uptake and release. Furthermore, Rodriguez says, "the

ceria nanoparticles we studied have much better performance, higher chemical reactivity, than the bulk form of ceria currently used in catalytic converters." Thus, this research holds promise for more-efficient catalytic converters — and cleaner air.

In the second study, Wang, Hanson, and Rodriguez deposited gold on the surface of ceria nanoparticles and used x-rays at the synchrotron to determine the catalyst's "active phase" — the conformation responsible for the catalytic activity — in the conversion of water and carbon monoxide to hydrogen gas and carbon dioxide. This "water-gas shift" reaction is important for generating hydrogen, which can be used for chemical transformations and as a fuel in a hydrogen-based economy. Hydrogen is one of the leading energy sources being investigated by scientists sponsored by the Department of Energy as part of its mission to ensure the nation's future energy needs.

"In both cases, we are learning about the fundamental conditions necessary for optimal operation of the catalysts," Rodriguez said. "This kind of knowledge eventually will lead to a rational design of even more effective catalysts."

Jose Rodriguez will present his results on Tuesday, March 15, at 8:15 a.m. in room Del Mar A of the Hyatt Regency, San Diego, California.

Source: Brookhaven National Laboratory