Ceria in catalysis

Gregory Huff

The rare earth metal oxide Ceria (CeO_2) has been studied in the context of heterogeneous catalysis for several decades. Its ability to switch from Ce(IV) to Ce(III) with only minor structural changes results in facile oxygen storage and release. This feature facilitates its utility both as support for other catalysts and as a catalyst in its own right.

This project deals with ceria samples doped with various first-row transition metals (as well as molybdenum). Doping of ceria is known to drastically alter its properties, for instance its catalytic activity towards CO oxidation is greatly enhanced by copper ions. A correlation between the reducibility of the dopant ion and catalyst performance has been proposed to explain this effect.

Our group has extended previous studies of doped ceria to the catalytic oxidative dehydrogenation of propane. Ceria was doped using incipient wetness impregnation to the level of about 3% of nine different dopant metals. The samples containing Ni, Cu, V and Mo all show much higher activity than the parent un-doped ceria.

A variety of *operando* spectroscopic techniques are being applied to further understanding the reaction mechanisms of these catalysts. In particular, Raman spectroscopy has been shown to be very useful for examining metal oxide catalysts under reaction conditions. Intermediates such as peroxide and superoxide species can be observed. Furthermore, the Raman spectrum of ceria is well understood and can be informative about defect formation. It is also possible to detect formation of dopant metal oxides on the ceria surface by their Raman bands.