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Materials Seminar

"Ceria-based catalysts for hydrodeoxygenation of bio-oils and selective oxidation of methane"

Monday
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3:30 p.m.
Seminar Hall
(1315 Chemistry)

Ceria-based catalysts are receiving considerable attention due to their high activity in redox reactions. The redox activity of ceria can be increased further by addition of zirconia and other promoters. Applications of ceria-based catalysts include three-way catalysts for automotive pollution control, fluid catalytic cracking, and fuel cells. This talk will highlight two studies of the use of ceria-zirconia based catalysts for hydrodeoxygenation (HDO) of bio-oils and the direct conversion of methane to higher alcohols.

HDO is a promising route for converting complex mixtures of oxygenates in bio-oils to biofuels. The process provides oils with reduced reactivity and corrosiveness and increases the energy density of the product. In HDO, oxygen-containing functional groups are replaced by hydrogen, and water is formed as a by-product. This process can be performed over sulfided NiMo or CoMo catalysts. However, co-feeding of toxic H_2S is required to keep these catalysts in their active sulfide phase under HDO conditions. To avoid the use of H_2S, our group developed reducible ceria-zirconia catalysts that are capable of promoting similar surface reactions. The active sites on these catalysts are oxygen defects, which are formed in the presence of H_2 under typical reaction conditions (250 – 400 °C). The formation of oxygen defects and the availability of dissociatively adsorbed hydrogen are studied in detail to identify the most promising catalysts. These catalysts are used for HDO of guaiacol.

Ceria-zirconia based catalysts also show remarkable performance for the selective oxidation and coupling of methane. In particular, NiO cluster on ceria-zirconia are capable of activating methane. The resulting surface methyl groups undergo coupling reactions to longer alkyl chains. In the presence of steam, these alkyl chains are hydrolyzed to form higher alcohols.