Engineering of catalytic materials based on rare earth elements for energy and environmental applications

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Rare earth elements have been largely used in the last decade in catalyst formulations for a variety of processes in the area of both chemicals (refining of petrochemical products) and environment (especially dedicated to treatment of exhaust gases from mobile sources). The most significant of the rare earth elements are certainly lanthanum and cerium, their oxides being used as structural and electronic promoters in several applications in the field of environmental catalysis. La_2O_3 is well known as surface area stabilizer of supports based on alumina and zirconia, while the major benefit of cerium oxide is to increase oxygen storage/release properties of three-way catalyst formulations, often in combination with ZrO_2 and other rare earth oxides like PrO_x and TbO_x.

There are also several emerging applications or processes for which rare earth oxides are currently being actively investigated. More specifically cerium oxide is used in several applications for the energy sector as a key component in catalyst materials for reforming, partial oxidation and water gas shift reaction. Other energy-related uses are in the fuel cell technology where CeO_2 and other rare earth materials are fundamental components to reduce the operating temperature of solid oxide fuel cells.

As a contribution to these areas, we have been investigating in the last few years a number of issues concerning the design of mixed transition metal rare earth oxides and vanadates as active materials for fuel cell applications and for use in catalytic reactions involving elimination of soot and NO_x from diesel engine emissions. Some of these issues will be reviewed here, with a special focus on the design and modification of the properties of catalytic materials based on their fundamental structural/morphological characteristics.