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High Oxygen Mobility in Rare Earth Doped Ceria Compounds at Low Temperatures

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Ceria based oxides are regarded as the key materials for energy and environmental applications, such as three way catalyst in automobile emission systems, heterogeneous catalysis, oxygen sensors, solid oxide fuel cells etc. The great versatility in applications is achieved by the unique combination of oxygen transport capacity together with the ability to shift easily between reduced and oxidized states (i.e Ce3+-Ce4+). Doped ceria materials preserve the fluorite type structure which facilitate the rapid and complete refilling of oxygen vacancies upon redox reactions. Oxygen storage Capacity (OSC), decreasing the catalytic activation temperature and increase thermodynamic stability of these materials is enhanced by doping with other rare earth elements; particularly with its neighbour praseodymium. The change in the valence state of both Ce and Pr from 4+ to 3+ creates a defect ordered route for the mobility of oxygen anions within the lattice. Although, it is known that the oxygen vacancy concentration in Ce1-xPrxO2-δ increases with increased Pr content, the exact nature of the alteration in vacancy concentration and its effect on redox properties is not yet conclusive.
The goal of this project is to identify the valence states of Ce and Pr in various Ce1-xPrxO2-δ systems by XANES experiments using high brilliance synchrotron radiation. This information brings us closer to the description of the lattice defect formation. The study will be supported by diffraction experiments to identify the crystal phases, spectroscopic methods as a function of temperature to identify the phonon modes of defect formation as well as the catalytic activation at which the vacancy migration occur in Temperature Controlled Isotope 16O/18O Exchange Raman Spectroscopy.

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