

## High Conductive Nano-structured Ceria-based Materials and Thin Films

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Nanophase ceramics are inorganic materials with typical microstructural dimensions of less than 100 nm, especially, when the ceramic is formed of nanocrystallinities less than 10 nm, surface atoms become preponderant in the structure, yielding an improved surface adsorption, conduction and diffusion as well as catalytic and electrochemical properties towards gas phases and ionic/electronic transport processes.

Nanophase materials and thin films based on ceria, e.g.,  $M_x\text{Ce}_{1-x}\text{O}_2$ ,  $\text{CeO}_2\text{-Al}_2\text{O}_3$  and  $\text{CeO}_2\text{-SiO}_2$  are new functional ceramic composites, have been successfully prepared via the precipitation reaction or sol-gel process. Both ionic and mixed conducting properties can be designed targeting specific applications. The domains of the ionic and electronic conduction of the nanophase composites and thin films can be adjusted by changing the material components and composition. Such nanostructured materials and thin films showed higher oxygen ion and mixed conduction at lower operating temperatures, which are of great interest for both fundamental and applied research. The nano-phase materials of  $\text{CeO}_2\text{-Al}_2\text{O}_3$ ,  $\text{-SiO}_2$  and  $\text{-Y}_2\text{O}_3$  functioned for intermediate temperature (400 to 700° C) solid oxide fuel cells also achieved excellent fuel cell performances at lower operation temperature compared to that using the gadolinium doped ceria electrolyte. The ceria-based nano-thin films were tested in electrochromic devices, exhibiting excellent electrochemical properties. These could be attributed to the special nano- and thin film structure that is essentially different from the chemically identical bulk materials. The ionic conduction in the ceria-based thin films, and the ionic insertion/extraction process provides a basis for studies of low-(or two) dimensional processes and thin film nano-electrolytes and nano-electrochemistry. These nano-structured thin films based on the ceria also possess a great potential for thin film SOFC applications.

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