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Synthesis, Structural and Optical Characterization of Sol–Gel-Derived Y-Doped Mesoporous CeO_2

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Highly crystalline and thermally stable undoped CeO_2 and Y-doped mesoporous CeO_2 particles have been synthesized from cerium(III) nitrate hexahydrate [$Ce(NO_3)_3 \cdot 6H_2O$] by the sol–gel method. Mesoporous CeO_2 doped with 2 mol.% Y_2O_3 and calcined at 500°C possesses specific surface area of 130.39 m^2/g and retains a surface area of 91.84 m^2/g at 600°C. In comparison, undoped calcined materials have smaller specific surface areas of 43.23 m^2/g and 20.24 m^2/g at 500°C and 600°C, respectively. Results from x-ray diffraction (XRD) analysis, Raman spectroscopy, and selected-area electron diffraction (SAED) analysis indicated that the synthesized undoped CeO_2 and Y-doped mesoporous CeO_2 have the fluorite structure of bulk CeO_2. The crystallite size of CeO_2 is also considerably reduced by doping. The optical bandgap was found to be 3.24 eV for the undoped and 3.36 eV for the doped samples with calcination at 600°C. These results suggest that there are potential applications of Y-doped mesoporous CeO_2 with nanocrystals in the design of photocatalysts and optical devices.

Key words: CeO_2, yttrium, mesoporous, doping, sol–gel

INTRODUCTION

Ceria (CeO_2), the most significant oxide of the rare-earth elements in industrial catalysis, has a cubic fluorite structure with space group *Fm3m*. It has been widely used and investigated as a structural and electronic promoter to improve the activity, selectivity, and thermal stability of catalysts.[1] It is stable from room temperature to its melting point (2400°C), making it appropriate for high-temperature applications such as total oxidation reactions.[2,3]

The preparation of CeO_2 has received much attention during the past decade because of its remarkable electronic and optical properties. It was reported that CeO_2 with large surface area and high thermal stability has better catalytic ability.[4] In addition, CeO_2 with large surface area is well suited for facile mass transport.[5] Many researchers have tried to prepare nanostructured CeO_2 by various methods, such as the sol–gel method, combustion method, sonochemical method, precipitation process, microemulsion technique, and other related methods.[6–10] It has recently been reported that various kinds of mesoporous metal oxides are active for CO oxidation at low temperatures.[11–13] Mesoporous metal-oxide materials show much higher catalytic activity than the corresponding bulk materials.[14] Furthermore, mesostructures have promising applications in heterogeneous catalysis because channel branching within the mesostructures can

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