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Original Article

Crystal growth behavior and phase stability of rare earth oxides (4 mol.% $GdO_{1.5}$-4 mol.% $SmO_{1.5}$) doped zirconia nanopowders

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ABSTRACT

Nanocrystalline powders of 4 mol.% $GdO_{1.5}$-4 mol.% $SmO_{1.5}$ doped ZrO_2 (4Gd4SmSZ) has been synthesized by co-precipitation process. Their phase transformation and crystalline growth behavior was investigated by Thermo gravimetric-Differential Thermal Analysis (TG-DTA), X-ray Diffraction (XRD), Raman spectroscopy and High-Resolution Transmission Electron Microscopy (HR-TEM) after calcinations at different temperatures. The XRD, Raman spectra and HRTEM results confirm the nature of tetragonal zirconia (t-ZrO_2). The prepared 4Gd4SmSZ powders, remains in the single metastable tetragonal phase over the whole calcination temperature ranging from 873 K to 1273 K for 2 h. The crystallite size varies from 11.98 nm to 18.90 nm with increase of temperature from 873 K to 1273 K. The activation energy of the prepared powders at low temperature is considerably lesser than that at a higher temperature. The annealed 4Gd4SmSZ powders had shown excellent phase stability at 1573 K for 100 h.

1. Introduction

Zirconia (ZrO_2) shows good electrical, thermal and mechanical properties and it finds application in oxygen pumps and sensors [1,2], fuel cells [3,4] and thermal barrier coating (TBC) [5,6] applications. Zirconia has three polymorphs;room temperature monoclinic which is stable upto 1400 K, intermediate phase is tetragonal(t) and it is stable from 1400 K to 2570 K and the cubic(c) phase is stable between 2570 K and upto their melting point. The high-temperature t phase is the most important one from the standpoint of their structural engineering application where better mechanical properties are expected. However,an inherent drawback is theirpoor stabilityat low temperature. In order to stabilize the t phase at room temperature, stabilizers for ex., MgO, CaO, Y_2O_3 and other rare-earth oxides can be doped into zirconia. This non-transformable, supersaturated t phase is known as t'favorable

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