SYNTHESIS AND CHARACTERIZATION OF GADOLINIUM DOPED CERIA OXIDE CERAMIC

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The increasing ecological requirements force scientists to look for new energy conversion systems, which will either partly replace or improve the existing applications. One of the possible choices could be a solid oxide fuel cells (SOFCs) that are clean and efficient technology enabling the conversion of chemical energy to the electricity by the electrochemical reaction. In this case, the hydrogen gases are used as a fuel that is converting to the water molecules under the electrochemical oxidation. Despite the optimistic vision, this system also possesses several disadvantages such as the high cost of individual components and high operating temperature of the final electrochemical cell. According to these drawbacks, the production of solid electrolyte that operates at a lower temperature is highly desirable [1]. Nowadays, the most popular electrolytes for SOFCs are zirconia oxide (ZrO_2), yttria-stabilized zirconia (YSZ) and lanthanum based materials. However, these ceramic electrolytes require high-operating temperatures (~1000°C) to obtain high oxide-ion conductivity and this could cause seal in high temperature, interface reaction between components of SOFC, the sintering of the electrodes and more [2]. In addition, there are some requirements for SOFC electrolytes: chemical and physical stability and compatibility with other cell components, high oxygen-ion conductivity, similar thermal expansion to avoid cracking during the cell operation, dense ceramic to prevent gas mixing, low cost and other [3-4].

Solid solutions of cerium dioxide with rare earth (RE) elements (Gd, Sm, Y etc.) are promising materials for application in SOFC as electrolytes in lower temperatures. Moreover, it was also found that doping ceria dioxide with RE elements increases the concentration of oxygen vacancy due to the reduction of Ce^{4+} to Ce^{3+}. According to the literature, the best oxygen-ion conductivity could be achieved doping CeO_2 by gadolinium or samarium. Many experiments were made to find an ideal doping ratio and an appropriate ion to balance stability. Finally, it was found that the highest value of ionic conductivity could be achieved after the doping of cerium dioxide by 10 mol% of gadolinium [1, 5-6].

In this work, we present the aqueous tartaric acid assisted syntheses of Ce–Gd–O tartrate gel precursor for $Ce_{1-x}Gd_xO_{2-\delta}$ (x=0.1, 0.2, 0.3, and 0.4) ceramic. In order to obtain the dense and fully crystalline oxides, the as-prepared gels were heat-treated at the temperatures of 1,000, 1,200, 1,350 and 1,500 °C, respectively. The thermal decomposition mechanism of the as-prepared Ce–Gd–O tartrate gel precursors was investigated by thermogravimetric (TG) and differential scanning calorimetric (DSC) analysis. X-ray diffraction (XRD) analysis was performed in order to determine the crystal structure of the heat-treated ceramic materials. The microstructure and surface morphology was analyzed by scanning electron microscopy (SEM). Finally, the Fourier transform infrared spectroscopy (FT-IR) was applied for the determination of the functional group vibrations in the sample powders.

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