Synthesis of zirconia powders with carbon nanotubes by sol-gel method

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Zirconia ceramics has been widely studied due to its mechanical and electrical properties that enable several applications. The target of several recent researches has been to obtain improvements on these properties, to produce nanocomposites of different ceramic materials incorporating carbon nanotubes (CNTs) into the ceramic matrix. However, there are few works that study this incorporation in zirconia matrix[1]. In this work, we present the synthesis of zirconia powders with the incorporation of multiwalled carbon nanotubes (MWCNTs) by sol-gel route. The big challenge to produce these nanocomposites is to obtain a good dispersion of the MWCNTs, because they have a highly hydrophobic nature. In order to find a way around this, we used a long chain surfactant (sodium stearate) to previously disperse the MWCNTs in water. The synthesis of the zirconia powders with carbon nanotubes was accomplished by using 5.0 mL of Zirconium(IV) propoxide (solution 70 wt. % in 1-propanol), 1.5 mL of Acetylacetone 99%, 4.0 mL of distilled water, 4.5 mL of 1-propanol and 1.5 mL of sodium stearate solution, where the MWCNTs were previously dispersed. The sol-gel solution was kept at rest for gelification and drying at room temperature for a week. After that the monoliths were comminuted to produce the powder. Several samples with different concentrations of MWCNTs were obtained by this procedure. In order to eliminate the organic residue from the zirconia matrix, the samples were calcined for 2h at 300°C and 500°C, in air. The characterization was performed by X-ray diffraction (XRD), transmission (TEM) and scanning (SEM) electron microscopy and TGA. X-ray diffraction patterns are shown in Figure 1 for the composite ZrO2/MWCNTs (0.0062 wt. %), calcined at 300 °C, showing an amorphous phase, and at 500 °C showing a tetragonal phase (JCPDS 17-923). It is interesting to notice that this phase is stable between 1170°C and 2370°C, for pure zirconia[2]. Figure 2 shows the TEM image of the sample with 0.0052 wt % of MWCNTs.

Figure 1: X-Ray pattern of composite ZrO2/MWCNTs (0.0052 wt. %) (bar = 50 nm)

Keywords: carbon nanotubes, zirconia nanocomposites, sol-gel method.

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