

Effect of heat treatment on structure and phase transformation of RE₂Zr₂O₇ powders intended for plasma spraying of ceramic layers

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Abstract

In this article the results of zirconates powders (intended for plasma spraying of ceramic layers) investigations was presented. The studies were performed on commercial zircoante powders with gadolinium, lanthanum, neodymium and samarium. Thermal properties, phase transformation, crystal structure and cross-sectional morphologies of these materials were investigated. The thermal behaviour of the material was investigated from room temperature to 1500°C using the differential thermal analysis (DTA). DTA tests were carried out on the thermal SETSYS analyzer manufactured by Setram. In order to do the test, a TG-DTA head was used to measure the enthalpies of phase transformations that were taking place. To carry out the thermal differential analysis, the “S” Pt-Rh /Pt-Rh 10% thermocouple was used. The material was in the argon neutral atmosphere (Ar 99.999%). DTA curves were registered separately for the process of warming and cooling. The X-ray diffraction methods were used for the qualitative phase analysis. The X-ray diffraction patterns were collected using X-Pert Philips diffractometer equipped with a curved graphite monochromator on the diffracted beam and with the following slits (in the sequence from Cu tube to counter): Soller (2°), divergence (1/2°), antiscatter (1/2°), Soller (2°) and receiving (0.15 mm). The X-ray data collection was performed for 20-140° 2θ range with 0.04° step. The structure of the studied samples has been characterized by employing powerful Rietveld’s whole X-ray profile fitting technique using the DBWS 9807a program. The pseudo-Voigt function was used to describe diffraction line profiles at Rietveld refinement. The R_{wp} (weighted-pattern factor) and S (goodness-of-fit) parameters were used as numerical criteria for the quality of the fit of calculated to experimental diffraction data. The phase abundance was determined using the relation proposed by Hill and Howard. The SEM and EDS techniques were used in the ceramic samples morphology analysis and for their chemical composition, respectively. For example, in the case of Gd powder the research showed that further stages of annealing result in the phase transformation of the parent substances and the main phase Gd₂Zr₂O₇. It was found out that complete phase transformation into Gd₂Zr₂O₇ phase takes place only for the air plasma sprayed sample. The analysis of the morphology of the initial powder revealed the spherical shape of the powder particles, which have a porous internal structure.

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