Nanophysics and physical-chemical materials

Influence of $CoAl_2O_4$ on the properties of nanocrystalline powders in the ZrO_2-Y_2O_3-CeO_2-Al_2O_3-CoO system

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ZrO_2 based nanocrystalline powders in the ZrO_2-Y_2O_3-CeO_2-Al_2O_3-CoO system are perspective for microstructure design of high-performance materials of various purposes. The presence of CoO in this system accompanied by the formation of $CoAl_2O_4$, which colored the composites in blue. High strength and fracture toughness of composites based on ZrO_2 in that system promotes the creation of materials that replace colored metal construction materials.

The aim of this work is to investigate the variation nanocrystalline powder properties after producing and heat treatment in the temperature range $400^0C-1300^0C$. Nanocrystalline powders were synthesized by combined method of hydrothermal synthesis in an alkaline medium and mechanical mixing. Compositions for research are following: (wt.%) 90% $A_{10}ZrO_2$ (Y_2O_3, CeO_2) -10% Al_2CoO_4 (P1) and 70% A_{10} ZrO_2 (Y_2O_3, CeO_2) -30% Al_2CoO_4 (P2).

X-ray phase and differential thermal analysis, scanning electron microscopy, petrography and BET measurements for determination of specific surface area of powders were used.

It was found that after the hydrothermal synthesis the F-ZrO_2 low-temperature metastable solid solution was formed. After mechanical mixing the phase composition of bland was: F-ZrO_2, α-Al_2O_3, Co_3O_4. The primary particles size of F-ZrO_2 was d=10 nm; specific surface area of P1 - 88 m^2/g and P2 - 43 m^2/g.

During the heat treatment the phase transformation F-ZrO_2 → T-ZrO_2 finished at 850^0C and traces of M-ZrO_2 appeared. $CoAl_2O_4$ formed at $1200\ ^0C$. The powder specific surface areas varied from 88 m^2/g to 1,3 m^2/g for the sample P1 and from 59 m^2/g to 1.26 m^2/g for the sample P2. The primary particles size of T-ZrO_2 in both samples increased from 10 nm to 25 nm, the one of α-Al_2O_3 from 10 nm to 15 nm and of $CoAl_2O_4$ from 20 nm to 30 nm.