Physico-Chemical nanomaterials science

Physicochemical properties of nanocrystalline α-Al_2O_3 powder doped with hydrothermal powder ZrO_2 (Y_2O_3, CeO_2)

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The composites properties, based on Al_2O_3, reinforced with ZrO_2 solid solution (ZTA), are determined by the combination of the component properties. This allows to produce materials with high hardness, strength and fracture toughness. The composite properties are determined by the starting powders properties, which in turn, depend on their production methods.

The main objective of the present study is to investigate the varying of physical and chemical properties of nanocrystalline powder produced by combined method: hydrothermal synthesis in the alkaline medium / mechanical mixing and to investigate the properties after thermal treatment in the temperature range 400-1450°C. The powder composition is (% wt.): 58.5 α-Al_2O_3 - 41,5 ZrO_2 (Y_2O_3, CeO_2) (AZ4).

Properties of produced powders were investigated by differential thermal analysis (DTA), scanning electron microscopy (SEM), X - ray diffraction (XRD) and BET.

The nanocrystalline powder of solid solution based on ZrO_2 (mol%): 90ZrO_2 - 8CeO_2 - 2Y_2O_3 was produced by hydrothermal synthesis in alkaline medium. The nanocrystalline powder AZ4 was produced by mechanical mixing of the powder of solid solution ZrO_2 and nanocrystalline powder α-Al_2O_3 during 10 hours in a ball milling.

It was defined that specific surface area of the starting powder AZ4 is 60,57 m^2/g. The phase composition of powder is α-Al_2O_3 and low-temperature metastable cubic solid solution of ZrO_2 (F-ZrO_2) with traces of T-ZrO_2. F -ZrO_2 → T -ZrO_2 transformation is completed at 850°C. Sintering of the powder begins at 1000°C. After annealing at 1450°C specific surface area of powder decreased to 1,28 m^2/g and phase composition was represented by α-Al_2O_3 and T-ZrO_2 (with traces of M-ZrO_2). The morphology of produced powder after thermal treatment varies topologically continuously.

The produced powder will be used for microstructure designing of high-performance composites in the Al_2O_3-ZrO_2-Y_2O_3-CeO_2 system.