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6 – 12 June 2021
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B. Verkin Institute for Low Temperature
Physics and Engineering of NAS of Ukraine

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The formation of ZrO_2-Y_2O_3-nanoparticles from fluoride solutions

E.S. Gevorkyan[1], O.M. Morozova[1], D.S. Sofronov[2], V.P. Nerubatskyi[1], N.S. Ponomarenko[3]

[1]Ukrainian State University of Railway Transport, Feierbakh sq., 7, Kharkiv, 61050, Ukraine
[2]SSI "Institute for Single Crystals" NAS of Ukraine, Nauky ave. 60, Kharkiv, 61001, Ukraine
[3]Kharkiv National Medical University, Nauky ave. 4, Kharkiv, 61000, Ukraine
oksanabakan2012@gmail.com

High-tech characteristics of zirconium dioxide (ZrO_2) make it possible to use it to obtain highly refractory products, heat-resistant enamels, refractory glasses, various types of ceramics, pigments, solid electrolytes, catalysts. The latter serve as a material for the creation of heat shields for spacecraft, in fields of endoprosthetics and dentistry, in jewelry, fiber optics, as well as for the manufacture of cutting tools and abrasive materials [1,2]. The widespread use of the material in the technological industry involves the studying of the synthesis of ZrO_2-Y_2O_3-particles and their morphology, which was done in this work.

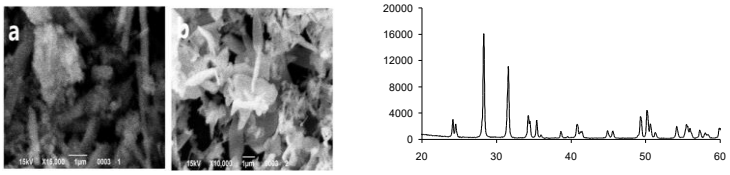
The hydrofluoric acid (HF), concentrated nitric acid (HNO_3), aqueous ammonia (NH_4OH), metallic zirconium and polyvinyl alcohol produced by Reakhim were used to obtain particles of ZrO_2-Y_2O_3. Distilled water was used for the preparation of solutions.

The exploring of the surface morphology of obtained powders was carried out by using a JSM-6390LV scanning microscope (SEM). IR spectra were obtained by a spectrophotometer SPECTRUM ONE (Perkin Elmer) in potassium bromide tablets.

Precursor particles are formed to obtain zirconium dioxide, which is formed mainly by small spherical particles with sizes less than 100 nm, as the result of the precipitating from a fluoride solution. In the process of thermal annealing of the precursor, a slight decrease in the particle size at 300 °C is observed. With a subsequent increase in temperature, the formation of strongly agglomerated shapeless particles occurs. They have sizes up to several micrometers and consist of spherical particles with sizes of about 100 nm.

The use of the supplements of polyvinyl alcohol in the synthetic mixture results in the formation of particles in the form of thin plates. In this case, the higher the concentration of the supplements, the larger plates are formed.

It was found that the synthesis temperature and the concentration of components in solution significantly affect on the formation of ZrO_2-Y_2O_3 - particles. An increase of the deposition temperature of the gel leads to the formation of rod-shaped particles up to several micrometers in length, the thickness of which varies depending on the additive content and varies in the range of 100-500 nm. With a decreasing of the concentration in 5 times (Figs. 1a, b), the effect is practically unnoticeable. According to XRD data, zirconium dioxide with a baddeleyite structure is formed.



a b c

Fig. 1. Micrographs of ZrO_2-Y_2O_3-nanoparticles obtained during deposition from an aqueous solution (a, b) and XRD of a ZrO_2-Y_2O_3 sample obtained after annealing at 800 °C with the addition of polyvinyl alcohol (c).

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