Nanostructured surface

Structural evolution of the ZrO_2 - 3 mol. % Y_2O_3 nanopowders system under the HP and temperature influence.

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It is known that oxide nanopowders have a great interest for practical applications because of they wide range of differerent properties. However, the production of nanopowders with given properties is a big problem, since the result in general depends on the methods and regimes of synthesis. It is requires an understanding of all the processes occurring for nanopowders obtaining.

In the present studie for the synthesis of yttria-stabilized zirconia nanopowders was used a technology which has been developed in the labouratory DIPE (Ukraine), by the co-precipitation method with a number of physical effects, in particular ultrasound, microwave and pulsed magnetic fields. In addition, the synthesis products were processed by high hydrostatic pressure and heat treatment. The investigation of the structure evolution and the state of the surface of zirconium hydroxide nanoparticles was carried out for the system ZrO_2 - 3 mol. % Y_2O_3 under the influence of HP (100-1000 MPa) and temperature (400-1000 °C). It was found that at the complex analysis (of FTIR, DSC, BET, TEM and SAXS methods) already at the early stages of nanoparticle synthesis in the amorphous zirconium hydroxide system takes place a self-organization process and a complex structure is formed. Based on the obtained data, a model of the amorphous zirconium hydroxide structure was proposed as a system of interrelated monodisperse particles with a developed hydrate shell, which has a significant proportion of interlayer water and pore space. It was found that a high HP in the range of 100-1000 MPa leads to the destruction of zirconium hydroxide, although usually nanopowders are compacted under pressure. This is due to the fact that the investigated zirconium hydroxide consists of two components - a solid amorphous part and an aqueous component. The nonmonotonic response of an aqueous component with an extremum in the region of 600 MPa was detected by FTIR, it is due to the phase transformations of water in accordance with the PT state diagram. It was shown that the behavior of an ensemble of oxide crystalline nanoparticles under the HP has determined by two factors: the magnitude of the pressure and the particle size. The obtained dependences of the HP effect and temperature can made it possible to reveal the parameters and control the process of nanoparticle consolidation.

Consequently, it was demonstrated that the structural characteristics of hydroxide nanoparticles and, in particular, the state and hydrate shell predetermined the properties of oxide nanopowders synthesized on their basis.