Nanostructured surface

Surface state changing and structure organization of zirconium hydroxide nanoparticles under high pressure

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Last years high-pressure (HP) is considered as effective method of nanotechnology, for example, in the technology of nanoscale mechanical oscillators or nanoresonators for the terahertz range devices [1]. Particularity of such oscillators is the simultaneous presence in the system of physically and chemically bound water. The amorphous xerogel zirconia hydroxide is an ideal model system for studying the effect of HP modification conditions on the state of hydration shell nanoparticles and its organization. The aim of this work is revealing the relationship between the surface state and the structural organization of the xerogel zirconia hydroxide.

It is shown that the amorphous zirconia hydroxide xerogel is a complex system formed by interconnected amorphous particles and by containing a considerable fraction the aqueous components (46%). The aqueous component is formed by the chemically and physically bound water and the condensed water in the pores. For examine the processes which was occurred in a system of interconnected particles of zirconia hydroxide by HP influence were used small-angle X-Ray scattering methods, infrared spectroscopy and DSC.

It was found that in the phase interfaces zirconia - water were occured shear stresses. This is due to the compressibility of different phases, which increases monotonically with increasing HP. It was revealed that the hydration shell structure (namely the ratio of terminal and bridging hydroxyl groups) non-monotonic change with an increasing HP. It has been shown that non-monotonic behavior of the xerogel in conditions of HP due to the influence of the pressure on its water component. The issues of mutual competition processes occurring in the two components (amorphous nanoparticles and water components) such a complex system in terms of its HP modifications and their influence on the formation of zirconia nanoparticles.

1. S. Lucien, M. Denis, M. Alain, B. M. Daniel, A. Sergey, M.Jérémie, D. Frédéric, A. Moustapha, Marна del Carmen Marco de Lucas Quasi-free nanoparticle vibrations in a highly compressed ZrO2nanopowder J. Phys. Chem. C 116, 22043 (2012).