Influence of the synthesis parameters on thoria nanoparticles size and crystallinity

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It is widly known that nanostructured materials could be used for improving the physical, chemical and mechanical properties of bulk materials. Thorium oxide is used in catalysis, as solid electrolytes and in nuclear industry. Despite of the wide range of possible applications, there are some knowledge gaps in a field of factors controling the crystallinity, morphology and size of the thoria. The goal of our research is to link the conditions of thoria nanoperticles precipitation on its morphology, size distribution and structure.

Thorium oxide nanoparticles were prepared from thorium nitrate pentahydrate ($Th(NO_3)_4 \cdot 5H_2O$) stock solution and sodium hydroxide by rapid chemical precipitation. Effects of $Th(NO_3)_4$ concentration and pH on the morphology of thoria nanoparticles were studied. As prepared samples was treated under hydrothermal conditions at temperature range from 120 to 210°C.

The obtained thoria samples were investigated using high resolution transmission electron microscopy (HRTEM) and X-ray diffraction (XRD). The Rietveld refinement of the unit cell parameters for thoria samples was appled to determine cell parameters as a function of ThO_2 nanoparticle size. The ζ-potential of nanoparticles was measured.

According to HRTEM data ultrafine ThO_2 nanoparticles with fluorite crystal structure were formed. Suspension stability in water solutions for all samples was observed at pH<5 and pH> 7.5; the pH_{IEP} was established as 7.0. A strong correlation between concentration of NaOH and nanoparticle size was observed. Herein it was establish that hydrothermal process is the best way to controll nanothoria particle size and micromorphology. The thoria unit cell parameter is shown to increase as the particle size decreases.