RUTILE NANOPOROUS MICROSPHERES FORMED IN WATER SOLUTION

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Fabrication of mineral-like synthetic crystals in a nanosize range is a paramount task of modern materials science because of unusual physical and chemical properties due to micro- and nano- morphology valuable for numerous applications in nanochemistry, photocatalysis, and electrochemistry. There are several polymorph modifications known for TiO_2 such as orthorhombic brookite and tetragonal anatase and rutile. Solution-based techniques designed for TiO_2 precipitation typically leads to anatase structure formation. Titanium (IV) oxide is widely studied functional material due to exellent chemical stability and interesting electronic structure. It have promising application for water-splitting photocatalyst resulting in hydrogen generation, support for geteroneneous catalyst, electrode for dye-sensitized solar cells, nanoelectronic applications. Present study is aimed to inquire into potentials of low-temperature solution way (T = 100°C) for obtaining of nanoporous TiO_2 microspheres with high-temperatute rutile crystal structure.

Synthesis of TiO_2 microspheres was carried out by the two-stage synthesis. Firstly commercial TiO_2 (99.99 %) was dissolved in the strong ammonia water solution under the stirring and heating at T = 100°C. So prepared ammonium titanate water solution was filtered with filter paper. Then the solution with pH = 14 was acidated to pH = 1 with nitric acid under continuous stirring and heating at T = 100°C. The final powder-like deposit was washed by distilled water up to pH = 6 of wash water and dried in air at room temperature. The phase composition of the samples was determined by powder x-ray diffraction (XRD) method. The morphology of TiO_2 nanoporous microsphere crystals was examined by scanning electron microscopy (SEM) by a LEO 1430 (CKP Nanostructures) device. As a result, white monosized microspheres with typical diameter ~20 μm were fabricated as shown in Fig.1. The SEM images of the microspheres show developed nanoporous structure with radially extending pores. The pore sizes are very uniform with ~10 nm diameter. Phase composition of the precipitate has been confirmed by XRD analysis as rutile ($P4_2/mnm$, PDF 21-1276).

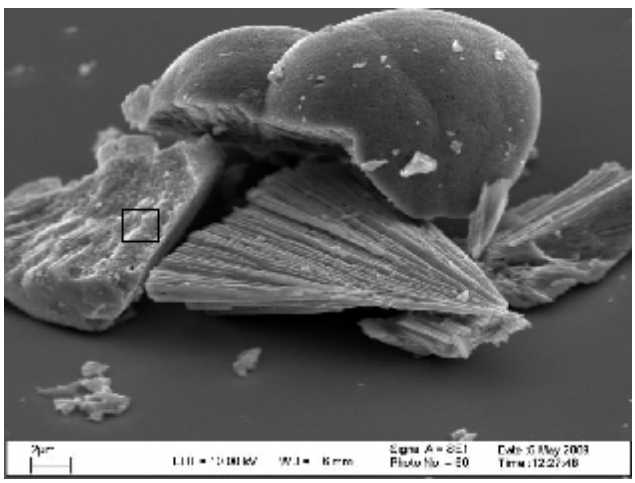

Fig.1. SEM image of splitted TiO_2 microspheres.