Poster

HYDROTHERMAL SYNTHESIS OF 1D $BATIO_3$ NANOSTRUCTURES: THE INFLUENCE OF TITANIUM PRECURSOR

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Barium titanate ($BaTiO_3$) has found widespread applications specially in multi-layer ceramic capacitors (MLCCs) and embedded decoupling capacitors (EDC).The miniaturization of such devices requires manufacturing processes that allow preparation of high-purity, homogeneous, weakly agglomerated nanosized powders which are subsequently applied and deposited by different techniques. The cubic (paraelectric) to tetragonal (ferroelectric) $BaTiO_3$ polymorph transition is reported to be dependent on the particle size and morphology. One-dimensional (1D) ferroelectric oxides are ideally suitable for fundamental studies of nanoscale dependence of ferroelectricity. Among several methodologies hydrothermal procedure has been reported as an easy and low cost method for the preparation of barium titanate nanostructures. [1,2]

In this work we report a systematic study that has been carried out in our laboratory in order to establish the relations between the processing conditions and the morphological characteristics of 1D BaTiO3 nanostructures prepared by hydrothermal synthesis. Several $BaTiO_3$ nanostructures were prepared in Teflon line autoclaves, at the temperature range of 80 to 200 ºC, using water as solvent and barium hydroxide as Ba^{2+} source. Sodium and protonic titanate nanotubes, anatase nanotubes, anatase nanorods and commercial available anatase were used to study the influence of the shape and chemical nature of the titanium precursor on the formation of pure $BaTiO_3$.

The crystallographic and morphological evolution was followed by X-ray powder diffraction, Raman spectroscopy, scanning electron microscopy and high resolution transmission electron microscopy. The chemical and stoichiometry control was performed, using inductive coupled plasma (ICP) and energy dispersive spectroscopy techniques.

The use of titanium based nanotubes or nanorods did not guaranty the formation of BaTiO3 with the same shape and morphology. The temperature of reaction is an important parameter on the reaction mechanism. Tetragonal $BaTiO_3$ structure was obtained when layered $A_2Ti_2O_5 \cdot H_2O$ ($A=Na^+$ and H^+) nanotubes were used. Anatase nanotubes, nanorods or commercial source originate spherical $BaTiO_3$ nanoparticles with predominate cubic structure. The results clearly indicate that the $BaTiO_3$ structure and crystal size are strongly dependent on titanium precursor crystallographic phase rather than on its morphology.

References:

[1] Joshi, U. A.; Yoon, S.; Balk, S.; Lee, J. S. ;J. Phys. Chem. B, **110** (**2006),** 12249-12256.
[2] Mao, Y.; Banerjee, S.; Wong, S. S. ;Chem. Commun. (**2003),** 408-409.