Synthesis of Complex Oxide Compounds and Oxide/Polymer Composites with High Temperature Superconducting and Others Especially Valuable Physicochemical Properties

S. Nedilko, A. Dzyazko, T. Voitenko, I. Fesych, M. Zelenko

Taras Shevshenko National University of Kyiv, 12 L'va Tolstogo Str., 01033 *Kyiv, Ukraine*

Properties of complex oxides compounds and oxide/polymer composites, which contain transition metals, are known to depend on synthesis method. A choice of one or the other technique allows us to vary valence state of a transition metal, crystallographic parameters, morphological characteristics (crystallinity degree, porosity, granule size), high temperature superconducting (HTSC), optical and catalytic properties [1]. However, numerous studies showed that there are difficulties at obtaining of the samples with the reproducible properties. In addition, properties of the ceramic materials depend on the temperature conditions of treatment, chemical composition, cation and anion substitutions medium and oxygen content in most cases.

Influence of synthesis method and synthesis conditions on cuprates, nickelates, cobaltate, vanadates, manganites with perovskite and perovskite-like crystalline structures (Ruddlesden-Popper phases, brownmillerite) and oxide/polymer composites with HTSC and others especially valuable physicochemical properties investigated. We studied possibility of synthesis these complex oxides compounds and oxide/polymer composites by solid-state reaction, co-precipitation, sol-gel and secondary induction heating technique [2].

Bi- and Y-containing HTSC cuprates was synthesis by solid-state method. HTSC ceramics of Bi-2212 composition doped with aluminum, zirconium, niobium and tantalum. For the bismuth ceramics samples, the T_c value changes considerably after addition of 5 mass percent Al_2O_3. Besides, a trend for ΔT_c increase observed. The size of particles was 0.5 – 1.5 μm. It was found that the $Y_3Ba_5Cu_8O_{18+\delta}$ (Y358) compound cannot be obtained by means of a method, which involves hydroxooxalate co-precipitation. At $T > T_c$ the $\rho - T$ plot for the Y358 compound, which has been obtained with a solid-state method, looks like that for semiconductors. At the same time, the compound synthesized with a carbonate co-precipitation method behaves like a metal. The results of physicochemical measurements allow us to suggest heterogeneity of the phase composition for the compounds obtained from solutions. Moreover, superconducting properties of the Y358 sample deteriorate (decrease of the T_c value from 92 K to 86 K and the superconducting transition width ΔT_c from 15 K to 9 K, respectively).

Barium cuprate was synthesized using secondary induction heating. It was found that the single-phase product is formed when the equimolar mixture of $Ba(NO_3)_2$ and CuO was kept in the induction furnace for 40 min at 1173 K.

Use of wet chemical methods leads to increase of oxygen indexes and average oxidation degree of transitions metal ions. It was found, that calcination temperature under solid state synthesis is much higher in a comparison with co-precipitation and sol-gel techniques, the period of heating is longer even taking into consideration a previous stage of precursor formation.

[1] S.A. Nedilko, A.G. Dzyazko, M.A. Zelenko, *High temperature superconductivity*, VPC "Kyiv University", Kyiv, 2010, p.191 (in Ukrainian).

[2] S.A. Nedil'ko, I.V. Fesych, O.G. Dzyazko, A.S. Bulachok, S.O. Solopan, T.O. Plutenko, Synthesis of Barium Cuprate by Secondary Induction Heating and its Electrical Properties, *Powder Metallurgy and Metal Ceramics* **55** (2016) 347.