Molten salt synthesis of conducting and superconducting ceramics

Kamil Kolincio, Katarzyna Gdula, Aleksandra Mielewczyk, Maria Gazda

Faculty of Applied Physics and Mathematics, Gdansk University of Technology, Narutowicza 11/12, 80-233 Gdansk,

Manufacturing of such materials like high temperature superconductors, ionic conductors and ceramics of ferroelectric, piezoelectric or magnetic properties requires developing methods of controlling their microstructure. Their functional properties are the best if the materials are dense and have ordered or at least partially ordered microstructure. It may be achieved by using the so-called template grain growth (TGG) technology. In this method, a type of a composite sample is prepared. A composite consists of a small amount of single crystals (templates) dispersed and aligned in a matrix of very fine grains. Sintering of the composite results in the material densification and growth of the templates. In order to obtain the ceramics with ordered grains, single crystals which serve as templates should be easily aligned. Therefore, they should have a plate-like or rod-like shape. One of the methods of producing such single crystals is a molten-salt synthesis.

In this work we present the results of the application of the molten salt synthesis to the (Bi,Pb)-Ca-Sr-Cu-O high temperature superconductors, Bi-Ca-Co-O magnetic dielectrics and Ba-(Ce,Zr)-O and (Ca,La)-Nb-O proton conducting materials.

The details of the molten salt synthesis (MSS) of the particular samples depends on the sample composition, however the general sequence of steps is similar in all cases. First, oxides, nitrates or carbonates were mixed in stoichiometric proportions and ball milled with KCl in approximately the 1:2 ratio. Then, the powders were calcinated at temperature above the melting point of KCL, that is, between 800^{o} C and 1100^{o} C for 3h. After cooling to room temperature KCl was removed from the products by repeated washing with hot deionised water. After drying the powder was pressed into pellets and calcinated at temperatures between 820^{o} and 1500^{o} C. The phase composition and the crystallite anisotropy of the samples were studied by X-ray diffraction (XRD).

The results of the MSS application to the studied samples are quite promising. For instance, partially ordered ceramics of the zirconium- doped 2223 superconductor and large single crystals of the Bi-Ca-Co-O have been synthesized. Also in case of the Ba-(Ce,Zr)-O and (Ca,La)-Nb-O proton conducting materials the ceramics microstructure differed from the microstructure obtained with a conventional solid state reaction.