Solution derived lead-free $(Bi_{0.5}\ Na_{0.5})_{1-x}Ba_xTiO_3$ thin films in the proximity of the Morphotropic Phase Boundary

M.D. Pérez-Mezcua, J. Ricote, D.Chateigner[1], C. Gutiérrez-Lázaro, I. Bretos, R. Jiménez, R. Sirera[2] and M.L. Calzada

Instituto Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Científicas (ICMM-CSIC). Cantoblanco. 28049 – Madrid. Spain.

[1] Laboratoire de Cristallographie et Sciences des Matériaux (CRISMAT). Ecole Nationale Supérieure d'Ingénieurs de Caen (ENSICAEN). Université de Caen. 14050 – Caen. France.

[2] Departamento de Química y Edafología. Facultad de Ciencias. Universidad de Navarra. 31080 – Pamplona, Navarra. Spain.

In the last years, an increasing interest is observed in the develoment of lead-free ferro-piezoelectric materials to substitute the well known $Pb(Zr_xTi_{1-x})O_3$ (PZT).[1] This would avoid the hazardous lead emission and would minimize cross-contamination during the electronic manufacturing.[2] In addition, the fabrication of these materials in thin film form is demanded for their integration in microelectronic devices.

Solid solutions of bismuth sodium titanate $(Bi_{1/2}\ Na_{1/2})TiO_3$ and barium titanate $BaTiO_3$ are considered good alternative lead-free materials to the PZT perovskite ceramics. These have a rhombohedral – tetragonal MPB, where bulk ceramics show enhanced dielectric, ferroelectric and piezoelectric properties.[3]

In this work, ferroelectric $(Bi_{0.5}Na_{0.5})_{1-x}Ba_xTiO_3$ (BNBT) perovskite thin films are prepared with different compositions (x=0.050, 0.650, 0.080, 0.100 and 0.150) onto $Pt/TiO_2/SiO_2/(100)Si$ substrates, by a hybrid solution route.[4,5] Stoichiometric solutions and others containing Na(I) and Bi(III) excesses have been prepared. The crystalline phases (tetragonal and/or rhombohedral crystal structures) developed in the BNBT thin films and in the powders derived from the corresponding solutions have been monitored by X-Ray Diffraction (XRD). From the analysis of the results we conclude that the position of the MPB depends on the Na and Bi excess added to the solution. Besides, the MPB in the BNBT thin films does not appear in the same range of compositions than that reported for bulk ceramics. Dielectric and ferroelectric measurements indicate an improvement of the properties of these films for a composition with x=0.10, where the MPB has been identified previously by XRD.[6]

These results are discussed based on the potential and reliability of these lead-free thin films integrated in microelectronic devices.

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