Structural and electromechanical properties of high Tc Pb(In1/2Nb1/2)O3-PbTiO3 solid solutions ceramics

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Abstract

Lead-based relaxor ferroelectric solid solution ceramics with (1-x)Pb(B1B2)O3-xPbTiO3 formula exhibit excellent dielectric and electromechanical properties, especially at compositions near the morphotropic phase boundary (MPB). Such complex perovskites are of greater interest for electronic ceramic devices, piezoelectric actuators and underwater systems. Over the years, much of the interests have been focused on (1-x)Pb(Mg1/3Nb2/3)O3-xPbTiO3 ceramics. One of the disadvantages of PMN-PT near its MPB (x=0.33) is its relatively low rhombohedral-tetragonal transition temperature Trt=80°C and Curie temperature Tc=170°C which lead to temperature dependant properties [1]. It has been reported that the (1-x)Pb(In1/2Nb1/2)O3-xPbTiO3 system near its MPB (x=0.37) presented a high Curie temperature Tc=300°C [2]. Dense (1-x)PIN-xPT ceramics were synthesised by hot forging and thermal grain growth. (1-x)PIN-xPT phase diagram was investigated by a X-ray study. A mixture of phases was observed for 0.63PIN-0.37PT at room temperature. With increasing the temperature, a transition from the low temperature phases to a pure tetragonal phase was observed for the same composition at T=150°C, followed by a transition to a cubic phase at Tc=290°C. The MPB zone was found to be between a rhombohedral phase region for low PT contents and a tetragonal phase region for high PT contents. Among the studied compositions of (1-x)PIN-xPT, x=0.37 exhibits the best properties: Pr=0.344 C/m^2, e33T(1kHz)=2670 (poled value), d33=413 pC/N, kp=0.571 and kt=0.466. The complete elasto-piezo-dielectric matrix of 0.63PIN-0.37PT is reported. The temperature dependence of the planar coupling coefficient kp and the remanent polarisation Pr of 0.63PIN-0.37PT are presented. A diminution of kp related to a loss of polarisation through T=150°C was observed. A comparison between electromechanical properties of 0.63PIN-0.37PT and 0.67PMN-0.33PT is finally reported.