Phase Transitions in Relaxor Ferroelectric Based Solid Solutions

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The phase diagrams of solid solutions of lead based complex perovskite relaxors with $PbTiO_3$ contain a morphotropic phase boundary (MPB) similar to that observed in the well known $Pb(Zr_xTi_{1-x})O_3$ (PZT) ceramics. This talk focuses on our recent work on the structural changes as a function of composition and temperature in one such system i.e., $(1-x)Pb(Mg_{1/3}\ Nb_{2/3})O_3$-x $PbTiO_3$ (PMN-xPT). Our results show [1, 2] that unlike the PZT system, the MPB composition range ($0.26<x<0.35$) in the PMN-xPT contains two monoclinic phase regions with Cm and Pm space groups, giving rise to two peaks in the variation of the physical properties with composition. Temperature dependent dielectric, piezoelectric resonance frequency, polarization and powder diffraction studies reveal several other interesting features: (i) relaxor nature of the transitions from the rhombohedral and the two monoclinic phases to the cubic phase, (ii) non-relaxor nature of the tetragonal to cubic transition, (iii) a transition from the tetragonal to the monoclinic Pm phase below room temperature, (iv) the monoclinic to cubic transition via an intermediate tetragonal phase above room temperature and (v) elastic instability associated with transitions between two ferroelectric phases. The role of polarization rotation and elastic matching at various phase boundaries will be discussed in relation to the high piezoelectric response of PMN-xPT in the MPB regions.

[1] Singh A.K., Pandey D., *Phys. Rev. B*, 2003, **67**, 064102. [2] Singh A.K., Pandey D., Zaharko O., *Phys. Rev. B*, 2003, **68**, 172103.

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