

## Growth and Physical Properties of High Purity $\text{PbTi}_{1-x}\text{Fe}_x\text{O}_3$

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$\text{PbTi}_{0.5}\text{Fe}_{0.5}\text{O}_3$  has recently been shown to have magneto-ferroelectric properties [1, 2]. A strong coupling is thought to exist between magnetism and ferroelectricity in this system, as indicated by the fact that the magnetic moment varies with the applied poling electric field. Multi-mode scanning probe microscopy has further demonstrated the presence of co-existing ferroelectric and magnetic domains in thin films of  $\text{PbTi}_{0.5}\text{Fe}_{0.5}\text{O}_3$  [2]. However, the nature and the origin of magnetism are not yet understood. Among the questions is whether  $\text{PbTi}_{1-x}\text{Fe}_x\text{O}_3$  can be synthesized as a single phase for all  $x$ .

We have used a novel sol-gel technique to synthesize the entire series  $\text{PbTi}_{1-x}\text{Fe}_x\text{O}_3$ . Careful Rietveld analysis of x-ray diffraction indicates that Fe can be introduced into the Ti site up to  $x = 0.5$  while retaining the same structure as  $\text{PbTiO}_3$ . In this range, we find no other phases in the sol-gel derived samples. High temperature x-ray diffraction indicates that the tetragonal structure becomes cubic at higher temperature, as expected for the ferroelectric transition of  $\text{PbTiO}_3$ . Here, we report our studies of magnetization as a function of temperature ( $M$  vs  $T$ ) and applied magnetic field ( $M$  vs  $H$ ), Raman spectra, ferroelectric loop studies, dielectric spectroscopy, x-ray photoemission spectroscopy and x-ray absorption spectroscopy with varying temperature in this system. We also report studies of sol-gel derived  $\text{PbFeO}_3$ . Results of the near-edge x-ray absorption structure are being reported separately [3].

1. V.R. Palkar et al, *Solid State Comm.* 134, 783 (2005).
2. V.R. Palkar, S. C. Purandare, S. Gohil, J. John, and S. Bhattacharya, *Appl. Phys. Lett.* **90**, 172901 (2007).
3. Y. Zou, S. Sen, S. Chattopadhyay, T. Shibata, D. Gelting, S.K. Ray, M.S. Williamsen, and P. Guptasarma, *Synchrotron Radiation Center Users' Meeting* (2007).