

Iron Incorporation Into Ferroelectric Lead Titanate

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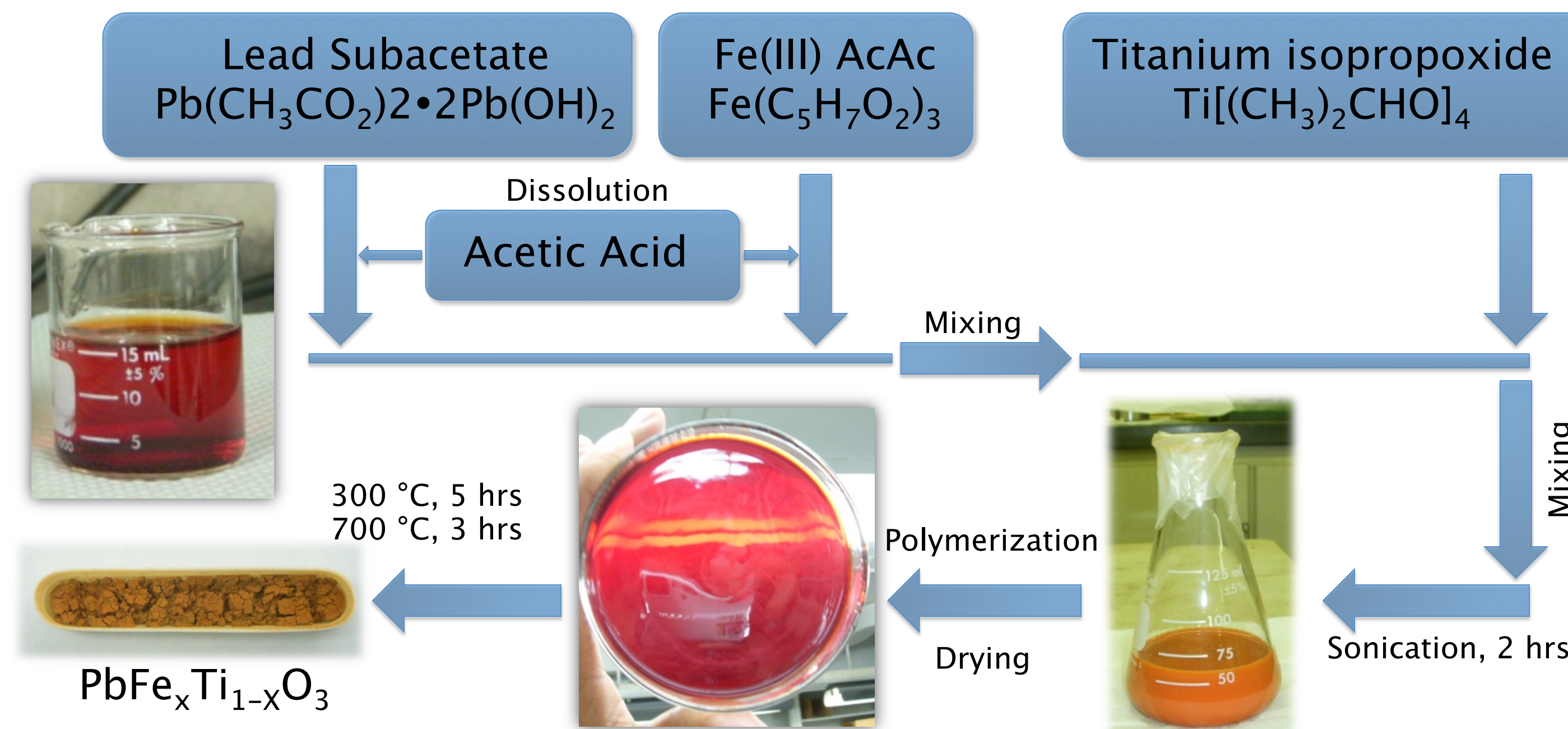
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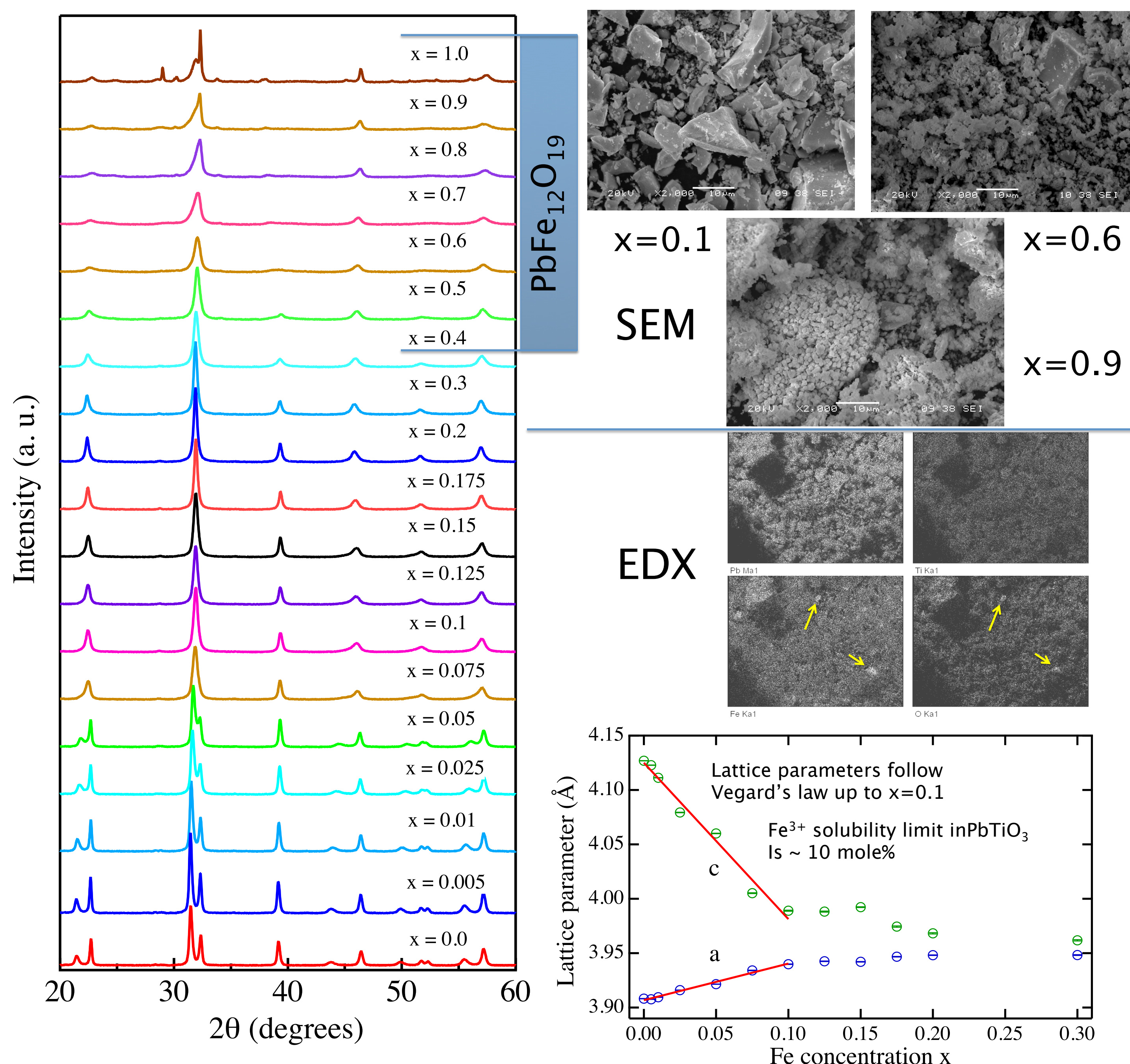
Introduction

Multiferroics are materials that exhibit a combination of ferromagnetic, ferroelectric, and piezoelectric properties. [1] The co-existence of both ferroelectric and ferromagnetic properties in one material provides fertile ground for fundamental research as well as technological applications. [2] There has been speculation that, owing to its large tetragonal distortion of ($c/a = 1.064$), lead titanate would be capable of retaining ferroelectric properties even at large magnetic B-cation concentrations. We have made series of $\text{PbTi}_{(1-x)}\text{Fe}_x\text{O}_{3-\delta}$ sample in the range $0 \leq x \leq 1$, using wet chemical synthesis. Rietveld refinement of the data ($0 \leq x \leq 0.3$) showed a rapid reduction in tetragonal splitting. XAS was utilized to provide local structure solutions and detect impurity phase formation.

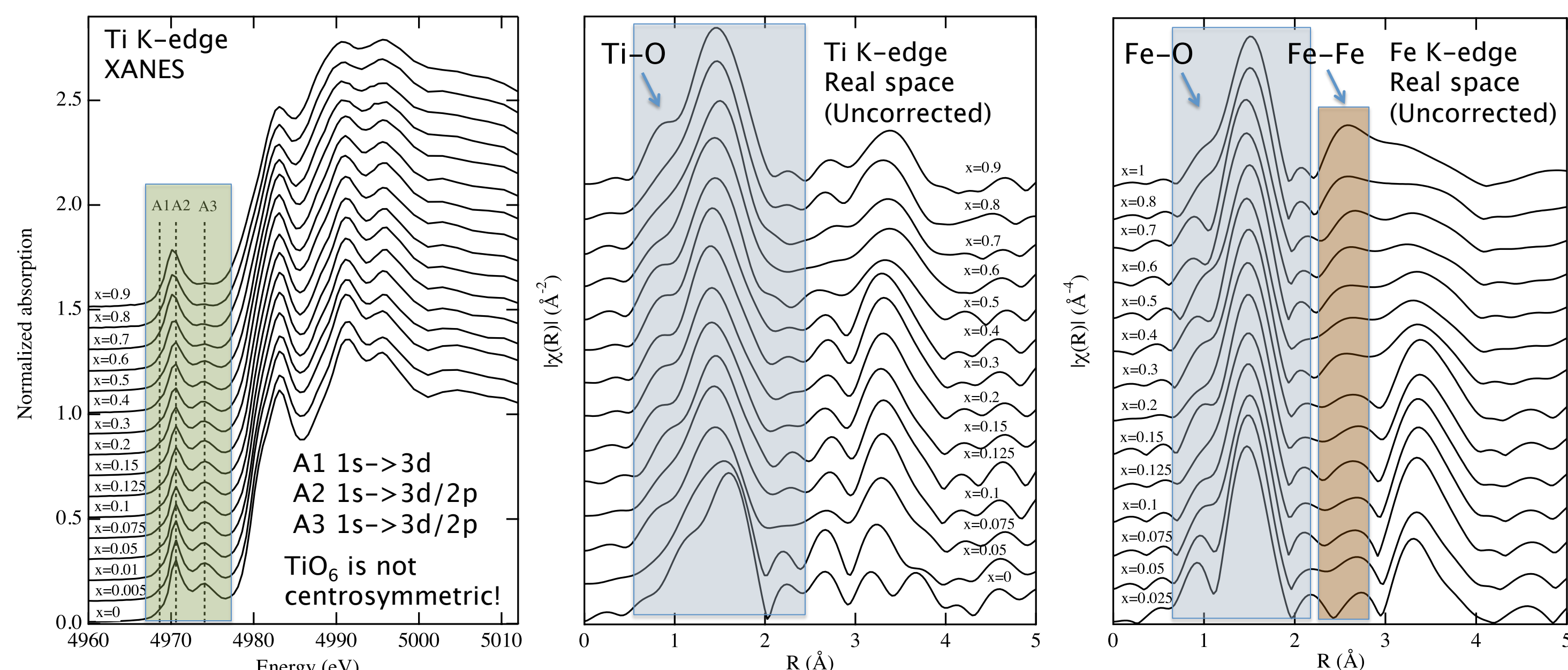
Sample Preparation



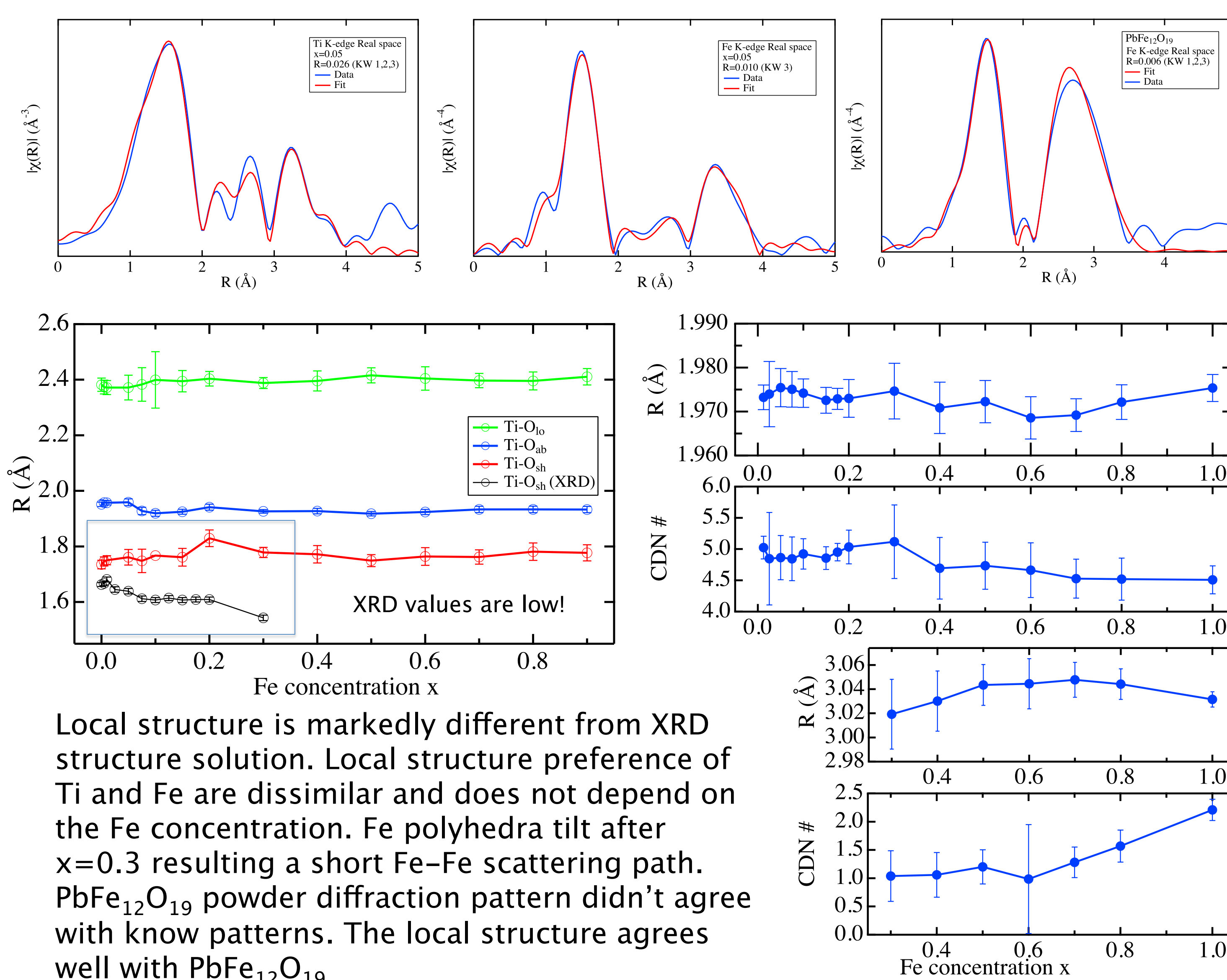
XRD, SEM and EDX



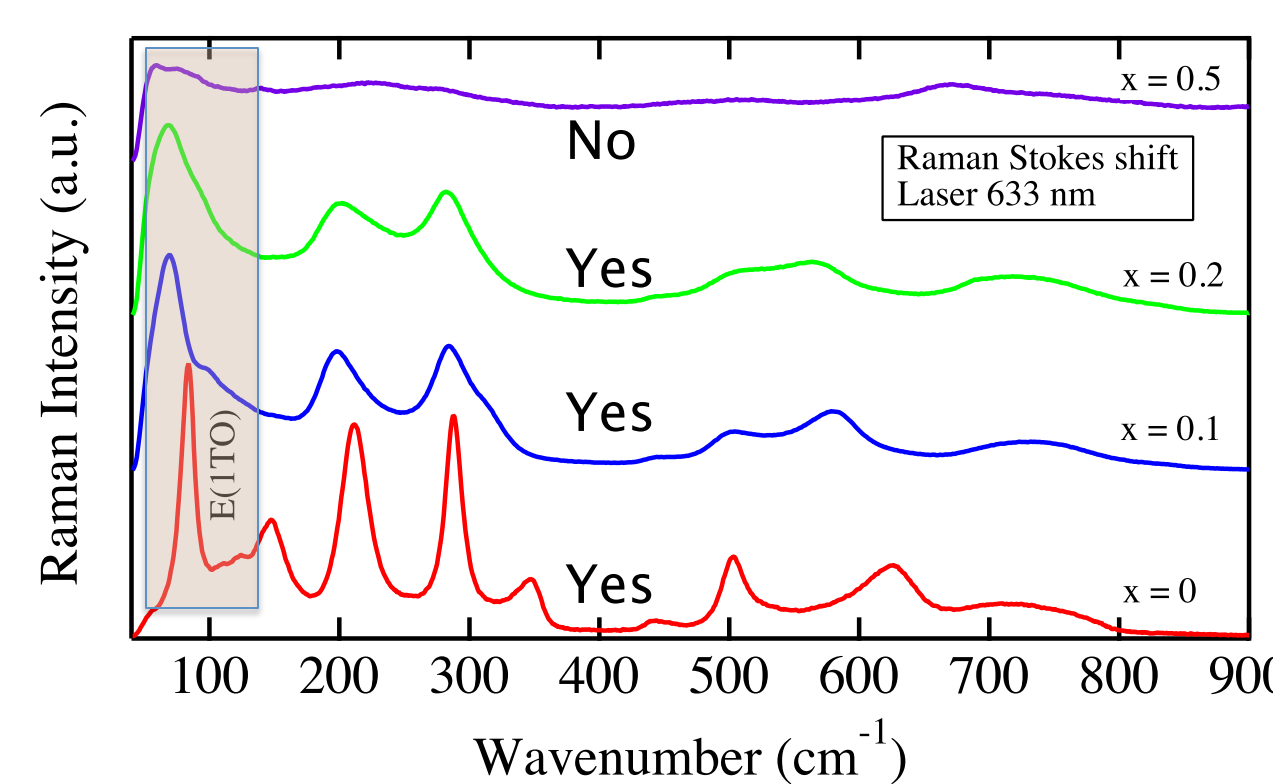
XAFS



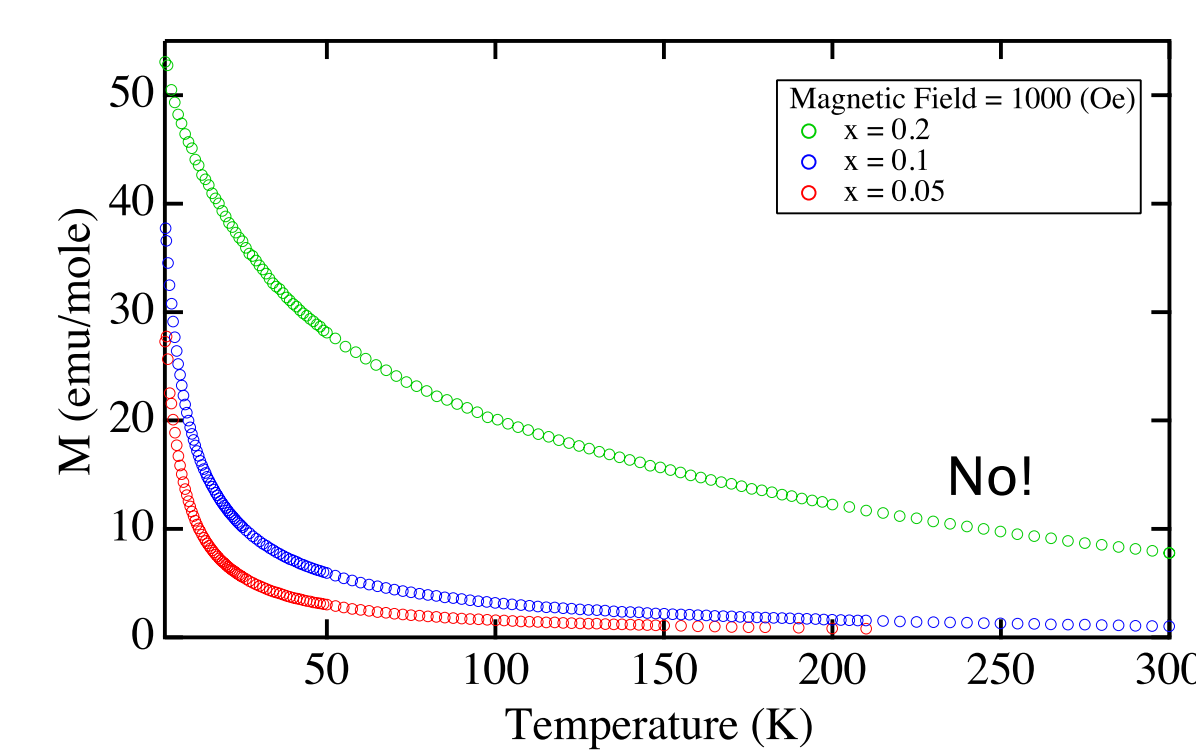
XAFS Results



Ferroelectric?



Ferromagnetic?



High temperature (1000 °C) sintering causes phase segregation into Ti-rich and Fe-rich phases. In this case ferroelectric and ferromagnetic properties may exist in two or more different phases.

Summary

The solubility limit of Fe^{3+} in lead titanate host, according to Vegard's law, is approximately 10%. Rapid reduction in c lattice parameter with x -composition suggests that uniform distribution of dopants has been achieved by sol-gel synthesis. No pyrochlore or iron oxide type phases have been observed. Ti and Fe local structures are significantly different. Ferromagnetic properties could be related to the tilting of Fe polyhedra and the formation of $\text{PbFe}_{12}\text{O}_{19}$ detected using XAFS.

Acknowledgement

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[1] Z. Ren et al., *Applied Physics Letters*, vol. 91, no. 6, p. 063106, 2007.
[2] W. Eerenstein, N. D. Mathur, and J. F. Scott, *Nature*, vol. 442, no. 7104, pp. 759-65, Aug. 2006.