Experimental report

07/09/2015

Proposal: **5-31-2330**

Council: 4/2014

Title: Determination of magnetic structure and magnetic phase diagram of room temperature multiferroic (PbZr0.52Ti0.48O3)x-(PbFe0.663W0.33O3)1-x

Research area: Materials

This proposal is a new proposal

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Experimental team: Leonard HENRICHS

Local contacts: Thomas HANSEN

Samples: (PbZr0.53Ti0.47O3)x-(PbFe0.67W0.33O3)1-x

Instrument	Requested days	Allocated days	From	To
D20 He3 Spin Filter	3	0		
D1B	0	2	14/10/2014	16/10/2014

Abstract:

Bulk ceramic samples of (PbZr0.53Ti0.47O3)x-(PbFe0.67W0.33O3)1-x (PZT-PFW) have been prepared via solid-state synthesis. They all show weak ferromagnetic behaviour (WFM) at room-temperature (RT) with particular high magnetizations for x = 0.6. In this system, this behaviour had only been known for thin-films where strong magnetoelectric coupling had been reported. For ceramics, this behaviour could not be confirmed by other groups and the structure was found to be different.
However, our results for magnetic behaviour and structure are similar to those reported for thin-films. This fact makes this system very interesting and a promising candidate for a RT multiferroic with strong magnetoelectric coupling.
Furthermore, perovskite RT multiferroics often exhibit AFM ordering and the WFM is often attributed to a canting of the AFM spins which results in a net magnetization. However, theoretical studies predict regions with ferrimagnetic ordering in the PZT-PFW and similar systems, which could explain those relatively high magnetizations. We hope that we can prove or falsify this important concept of the origin of magnetics in those systems with the proposed experiments.

Experimental report for proposal: 5-31-2330, Leonard Henrichs, University of Leeds

Determination of magnetic structure and magnetic phase diagram of room temperature multiferroic (PbZr0.52Ti0.48O3)x-(PbFe0.663W0.33O3)1-x

Instrument D1B, days: 2

Instead of cryostat and furnace, only the cryo-furnace was used. Two compositions were investigated with neutron diffraction from 1.5 – 550 K:

$(BiFe_{0.9}Co_{0.1}O_3)_{0.4}$-$(Bi_{1/2}K_{1/2}TiO_3)_{0.6}$ (BFC-BKT):

It was found after submission of the proposal, that this composition is very promising and was thus investigated. In agreement with other experiments (Magnetometry, Mössbauer spectroscopy) blocking behaviour was found at low temperatures. The presence of magnetic nanoregions showing the blocking behaviour as indicated by ZFC-FC curves, Mössbauer spectroscopy, was confirmed by neutron diffraction, via the broad shape of the antiferromagnetic peak occurring at low temperatures. Blocking temperatures from the three techniques are in good agreement while the size of the nanoregions was estimated to be 13.6 nm.

These results will be submitted for publication in near future.

To our surprise, antiferromagnetic order persisted even up to 550 K which was unexpected. Unfortunately, the furnace could not be installed in time to measure at higher temperatures. This would have been important to observe the Néel temperature and correlate this with other experiments. It would be very important to measure this in the future to unambiguously identify the intrinsic magnetic contribution of the material through correlation with magnetometry.

$(PbZr_{0.52}Ti_{0.48}O_3)_{0.6}$-$(PbFe_{2/3}W_{1/3}O_3)_{0.4}$

As expected from other experiments, antiferromagnetic order was also found in this system. The Néel temperature was found to be approx. 250 K. Those results were partly analysed and should be ready to be published after some additional complementing experiments.