Experimental report

05/11/2019

Proposal: **5-31-2644** **Council:** 10/2018

Title: Magnetic properties of Co3-xZnxTeO6 series: effect of the magnetic dilution on the multiferroic compoundCo3TeO6

Research area: Materials

This proposal is a new proposal

Main proposer: **Stanislav PODCHEZERTSEV**

Experimental team: Juan RODRIGUEZ-CARVAJAL
Nicolas BARRIER

Local contacts: Oscar Ramon FABELO ROSA
Emmanuelle SUARD

Samples: $Co_{2.83}Zn_{0.17}TeO_6$
$Co_{2.67}Zn_{0.33}TeO_6$
$Co_{2.5}Zn_{0.5}TeO_6$
$Co_{2.33}Zn_{0.67}TeO_6$

Instrument	Requested days	Allocated days	From	To
D9	12	5	17/06/2019	24/06/2019
D2B	2	2	12/07/2019	14/07/2019
D1B	2	2	17/07/2019	19/07/2019

Abstract:

Co_3TeO_6 is a type-II multiferroic compound that presents rare inversion f entire ferromagnetic and ferroelectric domain patterns. Nevertheless, its complex magnetic order is still today is subject to studies and debates since three successive and close antiferromagnetic transitions occur under 26 K. Bellow this temperature the magnetic phase diagram always correspond to a mixture of at least two magnetic structures, incommensurate and commensurate. By magnetic dilution with non-magnetic cations (Zn^{2+}) we can simplify of the magnetic order of Co_3TeO_6 and isolate magnetic structures from each other. For this study, we ask neutron diffraction beam time on powder and single-crystals in order to characterize the magnetic properties of the series $Co_{3-x}Zn_xTeO_6$ (x = 0.33, 0.67 and 1).

Experiment 5-31-2644

Magnetic properties of $Co_{3-x}Zn_xTeO_6$ series: effect of the magnetic dilution on the multiferroic compound Co_3TeO_6

S. Podchezertsev, N. Barrier, J. Rodriguez-Carvajal.

Introduction

Co_3TeO_6 is a transition metal orthotellurate presenting a rare inversion of an entire ferromagnetic and ferroelectric domain patterns. RT nuclear structure of the compound is monoclinic *C2/c* cryolite-related one with a structural network based on three different Co^{2+} coordination environments. Such cation arrangement is giving rise to a complex magnetic behaviour which still today is the subject of studies and debates. The difficulties to study the magnetic ordering comes from the close magnetic phase transitions and the coexistence of several magnetic phases at the same temperature regions. Control magnetic dilution with nonmagnetic cations may help to isolate magnetic structures from each other. For example, it is well known that Zn2+ can easily substitute Co^{2+} cations and at low level of substitution Zn^{2+} goes preferentially into the tetrahedral sites instead of octahedral sites. So eventual goal of the current project is understanding the mechanism of magnetic phase transition within the system and the role of different exchange interactions in establishing the magnetic order.

Preliminary results

First, the single crystal of $Co_2Zn_1TeO_6$ was measured at D9 diffractometer at 35 K. Refinement of the obtained data revealed that the sample is of an exact composition and Zn^{2+} cations substitute Co^{2+} within the whole network except one tetrahedral site. Preliminary experiment at cyclops showed an emergence of a set of magnetic reflections that couldn't be indexed with a set of commensurate or a single incommensurate propagation vector at 10 K.

Second, high resolution powder diffraction was carried out at D2B was carried out on four samples $Co_{3-x}Zn_xTeO_6$.Rietveld refinement has determined x-values for studied sample row, so eventually the samples are $Co_{2.92}Zn_{0.08}TeO_6$, $Co_{2.73}Zn_{0.27}TeO_6$, $Co_{2.32}Zn_{0.68}TeO_6$ and $Co_{2.01}Zn_{0.99}TeO_6$.

Low temperature neutron powder diffraction at D1B has shown that for each studied sample magnetic ordering has a complex incommensurate nature. The sample with the lowest content of Zn^{2+} resembles the parent compound the most however magnetic bragg peaks can't be indexed with the same set of k-vectors. Moreover there's a strong evolution of a magnetic scattering upon increase of zinc in the system: some peaks are being suppressed entirely while for the $Co_{2.01}Zn_{0.99}TeO_6$ a new magnetic peak arise at $2\theta \approx 25^o$ (figure 1).

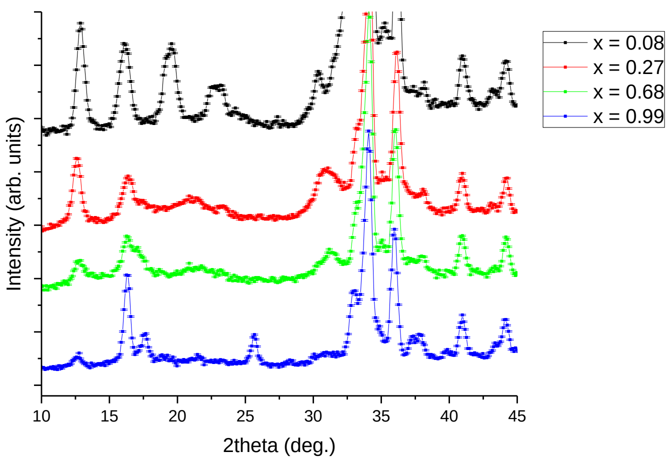

Figure 1 – Neutron powder diffraction patterns at T = 1.6 K