Experimental report

05/11/2019

Proposal: 5-32-878 **Council:** 4/2019

Title: Effect of magnetic dilution over electric polarization and short range magnetic ordering in Co5-xZnxTeO8

Research area: Physics

This proposal is a new proposal

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Experimental team:

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Samples: Co5TeO8
Co4Zn1TeO8

Instrument	Requested days	Allocated days	From	To
D7	7	4	04/10/2019	08/10/2019

Abstract:

We would like to investigate the influence of a magnetic dilution over Co5-xZnxTeO8 ordered spinel family with x = 0, 1. Co5TeO8 has two structural forms: classical Fd-3m spinel and ordered P4332. While the "disordered" polymorph is a ferrimagnet, the "ordered" one is exhibiting a complex behavior with two magnetic phase transitions: incommensurate conical at 45 K allowing magnetic polarization followed by the emergence of an additional ferrimagnetic component at 27 K. For Co5-xZnxTeO8 within $0 < x < 1$ magnetic dilution takes place exclusively at tetrahedral sites and fox x = 1 no long range ordering is observed up to 1.8 K. Neutron powder diffraction revealed strong magnetic diffuse scattering below 200 K and 100 K for Co5TeO8 and Co4Zn1TeO8 respectively. Previously D7 experiment on Co5TeO8 has revealed a conical nature of short-range ordering with no significant change in the behavior of spin-spin correlation function within temperature region between 90 K and 50 K. The aim of the current proposal is to finalize measurements on Co5TeO8, to characterize short-range ordering of Co4Zn1TeO8 and more generally, to reveal mechanisms of polarization within Co5-xZnxTeO8 family.

Experiment 5-32-878

Effect of magnetic dilution over electric polarization and short range magnetic ordering in $Co_{5-x}Zn_xTeO_8$

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Introduction

Co_5TeO_8 compound has a spinel structure and could be synthesized in two polymorphs: a classical *Fd-3m* and an ordered $P4_332$. While disordered polymorph has a single ferrimagnetic phase transition at 40 K, an ordered one demonstrates complex magnetic behaviour: first an incommensurate conical phase appears below 50 K, followed by emergence of collinear ferrimagnetic component and suppression of spiral component below 27 K. Nevertheless neutron powder diffraction reveal strong magnetic diffuse scattering in wide temperature range for ordered Co_5TeO_8, indicating a presence of short range magnetic ordering. That has become a reason for the first XYZ polarization analysis experiment carried out at D7 in a temperature range between 30 K and 90 K. Obtained diffuse magnetic scattering revealed a presence of short-range conical ordering above 50 K, moreover it was demonstrated that these short-range correlations are stable up to 90 K. Current experiment a continuation of a work to investigate the nature of short-range spin correlations and mechanisms of a long range ordering in Co_5TeO_8 compound.

Experimental

For XYZ neutron polarization analysis around 10g of ordered Co_5TeO_8 was packed into double wall cylindrical aluminium container in order to reduce absorption and multiple scattering effects. To probe magnetic scattering of a studied sample at various temperatures D7 diffuse scattering spectrometer was used with λ = 3.1 Å and scattering patterns were collected in Q region between 0 $Å^{-1}$ to 3.8 $Å^{-1}$, in order to get a good statistics non-spin flip to spin flip ratio was 1:4. Calibration and attenuation measurements were performed before the data collection. Studied sample was measured at T = 90 K, 110 K, 140 K, 170 K, 200 K, 230 K and 260 K. Data treatment is done with reverse Monte Carlo method by the SPINVERT package.

Preliminary results

XYZ polarization analysis performed at D7 allowed to extract magnetic component from the total magnetic signal. As it's shown on the figure 1 there is only diffuse scattering retained in the system above 90 K which is only decrease upon heating the sample. Nevertheless even at temperatures far above the temperature of long-range ordering T_{C1} = 50 K diffuse scattering patterns do not resemble pure paramagnetic scattering preserving some well-pronounced features.

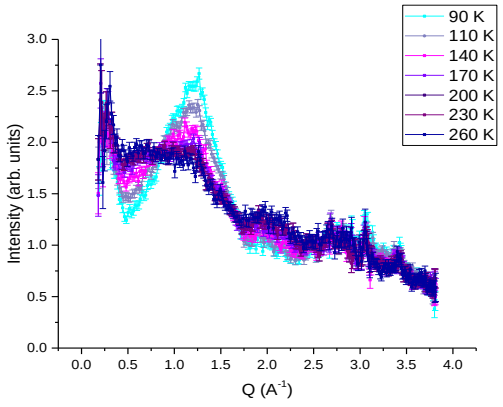

Figure 1. Temperature evolution of Co_5TeO_8 magnetic scattering

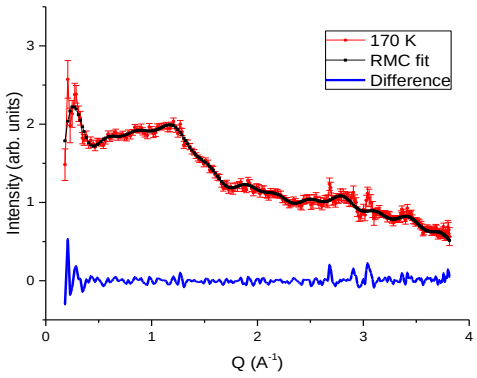

Figure 2. RMC fit of diffuse neutron scattering pattern collected at 50 K.

Reverse Monte-Carlo fitting (figure 2.) let us to obtain temperature evolution of a spin-spin correlation function which has revealed an appearance of significant qualitative changes in $\langle S_iS_j \rangle$ between 140 K and 170 K pointing out significant stability of short-range ordering within Co_5TeO_8 composition. Moreover it is seen that Co^{2+} spins in general preserve their relative orientation within the unit cell up to 260 K revealing a presence of magnetism in the system up to the temperatures close to the RT.

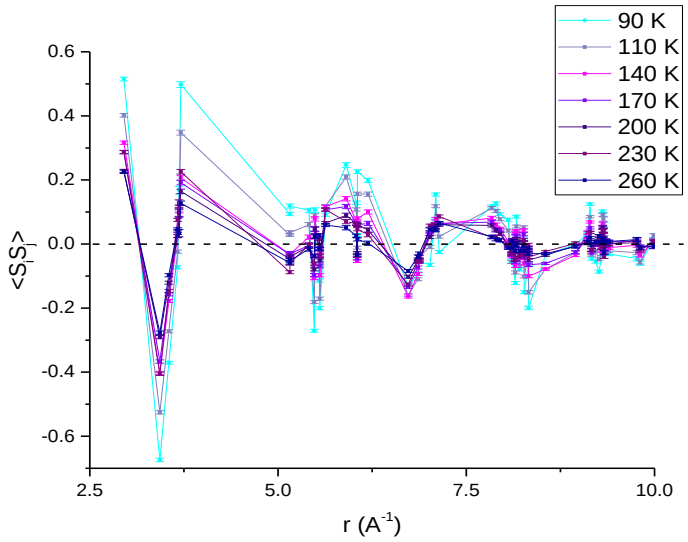

Figure 3. Temperature evolution of the radial spin-spin correlation function obtained with RMC fit.