# Experimental report

05/05/2017

**Proposal:** 5-31-2489 **Council:** 4/2016

**Title:** Novel Polar and Magnetic Spinels

**Research area:** Chemistry

**This proposal is a new proposal**


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**Local contacts:** Maria Teresa FERNANDEZ DIAZ


**Samples:** Co5TeO8
Zn2Co3TeO8
ZnCo4TeO8

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| D2B | 2 | 2 | 07/06/2016 | 09/06/2016 |
| D20 | 2 | 2 | 08/06/2016 | 10/06/2016 |


## Abstract:

Multiferroic materials are materials that present simultaneous magnetic and ferroelectric ordering. They have attracted much attention in the last years due to their potential technological applications. We explored novel promising multiferroic materials crystallizing in acentric space groups and we discovered a new family of spinel-like compounds of general formula A2B4O8, and compositions Co2Co3TeO8, (ZnCo)Co3TeO8 and Zn2Co3TeO8. The materials are novel polar and magnetic spinels, with the crystal structure of LiFe4O8 (cubic symmetry with the acentric space group P4332) due to 3:1 ordering between Co and Te cations in the octahedral sublattice. The magnetic properties show magnetic-ordering temperatures around 30 K for Co2Co3TeO8 and 25 K Zn2Co3TeO8. Preliminary NPD data collected in test time for Co5TeO8 show the appearance of magnetic satellites, characteristic of a complex incommensurate structure.

Multiferroic materials are materials that present simultaneous magnetic and ferroelectric ordering. They have attracted much attention in the last years due to their potential technological applications. We explored novel promising multiferroic materials crystallizing in acentric space groups and we discovered a new family of spinel-like compounds of general formula $A_2B_4O_8$, and compositions $Co_2Co_3TeO_8$, $(ZnCo)Co_3TeO_8$ and $Zn_2Co_3TeO_8$. The materials are novel polar and magnetic spinels, with the crystal structure of $LiFe_4O_8$ (cubic symmetry with the acentric space group $P4_332$) due to 3:1 ordering between Co and Te cations in the octahedral sublattice.

In the present experiment at D2B we studied the crystal structure of the three samples with high resolution, $\lambda = 1.594$ Å, at room temperature. This was made counting for 2 hours.
The crystal structures are all the cubic symmetry in the space group $P4_332$. The lattice parameters are similar for the three phases. The three samples are given in figure 1, 3 and 5.

In the experiment at D20 we studied the NPD pattern at decreasing and increasing temperatures with a wavelength of , $\lambda = 2.41$ Å and a take off angle of $90^o$.
This revealed an interesting magnetic structure of $Co_2Co_3TeO_8$ with the appearance of magnetic satellites, characteristic of a complex incommensurate structure as illustrated in figure 2. The solution of this complex magnetic structure is under study. The magnetic phase transition appears at 50 K with clear magnetic peaks increasing at decreasing temperatures. This is confirmed by magnetization measurements.

The experiment at D20 for the two other phases, $(ZnCo)Co_3TeO_8$ and $Zn_2Co_3TeO_8$, reveal only some diffuse magnetic scattering as illustrated in figure 4 and 6. According to magnetization measurements, the magnetic phase transitions should happen at 15 K and 11 K, respectively. This can hardly be detected on the NPD patterns and replacement of the magnetic Co-atoms with the non-magnetic Zn-atoms are believed to disturb the long range magnetic ordering taking place in $Co_2Co_3TeO_8$.

A solution of the crystal structures and investigations of these together with the magnetic structure and behaviour will be made in the future combined with other measurements of the magnetic behaviour and eventual electric polarization.

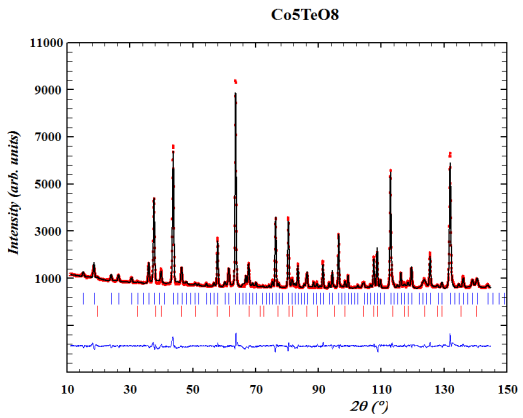


*figure 1:NPD of Co2Co3TeO8 at room temperature at D2B*

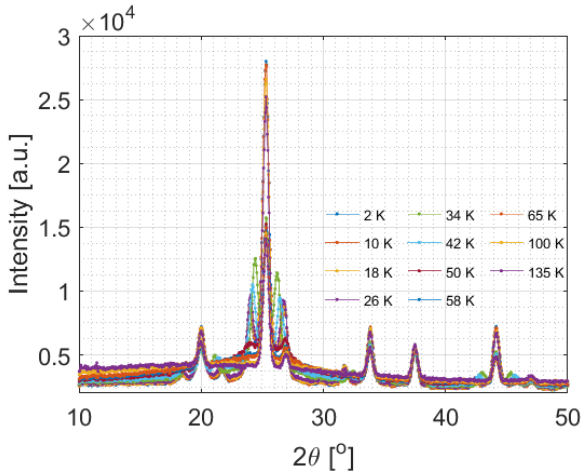


*figure 2:NPD of Co2Co3TeO8 at increasing temperatures at D20.*

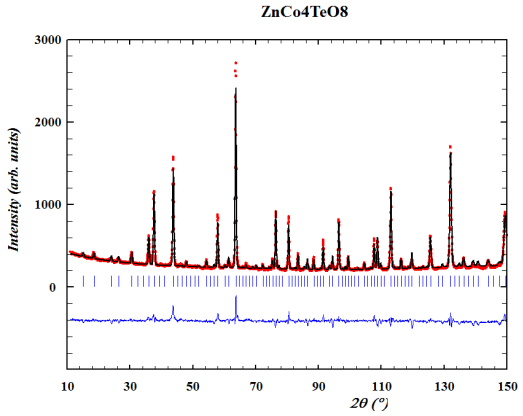


*figure 3:NPD of (ZnCo)Co3TeO8 at room temperature at D2B.*

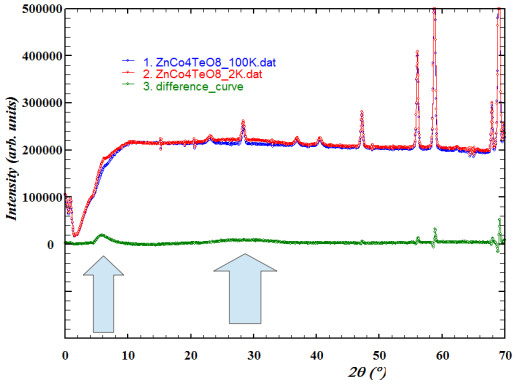


*figure 4:NPD of (ZnCo)Co3TeO8 at high and low temperatures at D20. The green line is the difference of 2 K and 100 K. Diffuse scattering is marked by arrows.*

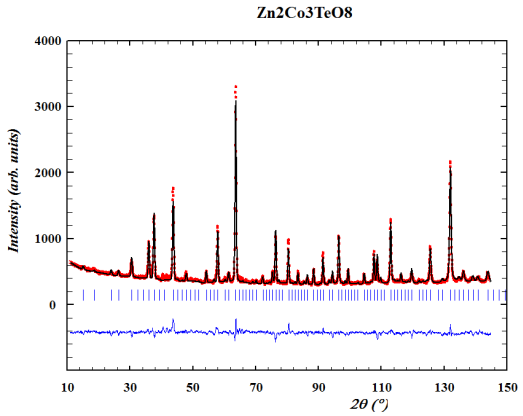


*figure 5:NPD of Zn2Co3TeO8 at room temperature at D2B.*

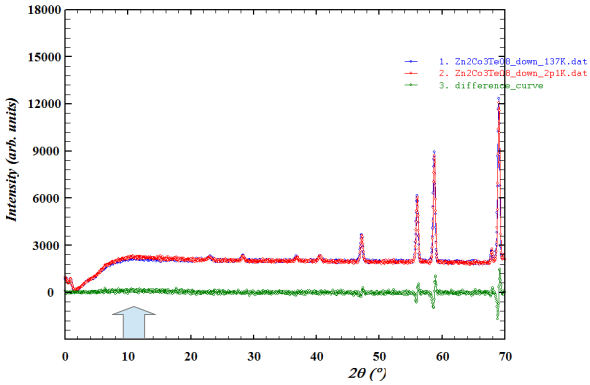


*figure 6:NPD of (ZnCo)Co3TeO8 at high and low temperatures at D20. The green line is the difference of 2 K and 137 K. Diffuse scattering is marked by an arrow.*