| ESRF | **Experiment title: Structural distortion driven by magnetic order in MnO embedded in nano-channels of silica matrices.** | **Experiment number**: **HS-2472** |
|---|---|---|
| **Beamline**: ID31 | **Date of experiment**: from: 11.06.04 to: 13.06.04 | **Date of report**: |
| **Shifts: 9** | **Local contact(s)**: **François Fauth** | *Received at ESRF:* |

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## Report:

X-ray measurements were performed of the classic antiferromagnet MnO confined to nanochannels (24-87 Å) of the novel mesoporous matrices MCM-41 type, which form a regular array of nanochannels. The experiments were carried out in the frame of program of investigation of magnetic and dielectric materials embedded in different porous media, supported by CEE (INTAS project-2001-0826).

At the Néel temperature of 122 K MnO undergoes a magnetic transition accompanied by a rhombohedral distortion. For MnO confined within the channel matrices, the distortion was measured by neutron diffraction with poor accuracy. The objectives of our first x-ray studies at ESRF were to carry out measurements at low temperatures below the magnetic transition, in order to investigate the nature and T dependence of the distortion. We also searched for additional tetragonal distortions.

During these experiments we investigated 4 samples of MnO embedded in the channel type matrices with different diameters and different filling factor, i.e. the quantities of embedded MnO in a crystalline state. Since MnO confined within the channels presents also exists in an amorphous state, all samples differ by the ratio of crystalline and amorphous fractions.

All measurements were performed in the warming mode, i.e. first the sample was cooled to the lowest temperature and after it is gradually warmed. For the samples with high filling factor, we observed a smooth increase of the distortion with decreasing temperature (as for a second order transition), proportional to the magnetic moment as in MnO embedded in a porous glass [1]. Here, neutron and x-ray data coincide. However for two samples with small filling factors, we unexpectedly discovered that below about 60 K the distortion decreases to very small values (Figure 1b and 1c), showing re-entrant like behaviour, unusual for a classic antiferromagnet. This behaviour was not observed by neutron diffraction.

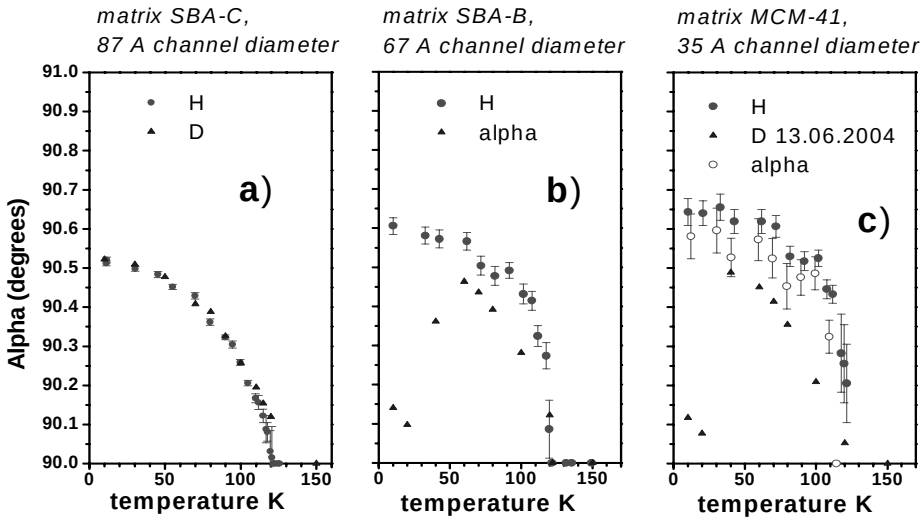


Figure 1. Rhombohedral distortions (alpha) vs. temperature, measured by neutrons (red circles) and x-ray (blue triangles) for different matrices. Errors (e.s.d.) do not exceed the symbol size, if not shown.

Immediately after ESRF experiments we re-measured the distortion in one of the samples with unusual behaviour by neutron diffraction at the diffractometer G6-1 of LLB and found that the temperature dependence of a distortion is the same as measured two years ago (figure 1c, open and solid red circles), although the intensity is reduced because the embedded MnO further transformed into the amorphous phase within the two years. So the observed effect is not connected with any destruction of the sample. The discovered “re-entrant behaviour” was observed for the samples with a small fraction of crystalline MnO. We think that this unusual effect is a result of “restricted geometry” for the specific channel confinement, possibly connected with surface disorder and /or with the close proximity of the amorphous phase.

[1] I. Golosovsky, I Mirebeau et al., Phys. Rev Letters, **86**, (2001), 5783-5786.