Experimental Report

19/06/2013

Proposal:	**9-10-1333**	**Council:**	10/2012	
Title:	Polarized neutron diffraction study of the spin structure in MnO and FePt@MnO heterodimer nanoparticles			

This proposal is a new proposal

Researh Area: Physics

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Samples: FePt
MnO

Instrument	Req. Days	All. Days	From	To
D7	6	5	01/06/2013	06/06/2013

Abstract:

Magnetic nanoparticles (NPs) have attracted much attention for decades. Particularly interesting are NPs consisting of an antiferromagnetic (AF) material. A fascinating novel type of nanomagnet is a 'heterodimer nanoparticle' being composed of two different NPs in close contact. We follow an approach, where a ferromagnetic (FM) NP is magnetically stabilized by an AF particle by exchange bias interaction. We focus on FePt@MnO heterodimers consisting of a FM FePt particle (ca. 5nm) in contact to an AF MnO particle (ca. 15nm). The proposed experiment aims to study the spin structure inside single MnO NPs and inside the MnO subunit of FePt@MnO heterodimers using polarized neutron diffraction. We focus in particular on the AF order parameter as function of temperature, and in dependence of the MnO particle size and strength of exchange coupling to the FePt unit.

The experiment aimed to study the spin structure in FePt@MnO dimer nanoparticles, and to investigate the influence of the exchange bias inside FePt@MnO dimers onto the spin structure in MnO nanoparticles. The order parameter was measured as function of temperature (above/below T_N, and above/below the blocking temperature).

We studied the FePt@MnO nanoparticles of different sizes using the magnetometry in previous experiments. Figure 1 shows the zero field cooled (ZFC) and field cooled (FC) as function of the temperature measured by SQUID. The ZFC curve shows a peak at about 28K, which is similar to the results on single MnO nanoparticles. We performed the polarized neutron scattering to investigate the spin structure in the FePt@MnO dimer nanoparticles and to be compared with single MnO nanoparticles. We measured four samples with ca. 10 mg each sample, the FePt nanoparticles are about 6 nm diameter and the sizes of MnO nanoparticles vary from 8 to 16nm. The samples were dried on Aluminum foil. We folded the Aluminum foil like a ring of 2cm diameter and 1.0 -1.5cm height. Four samples are marked and put into the sample holder at different height. The FePt@MnO dimer nanoparticles were measured at 4K, 20K, 60K, 100K and 140K.

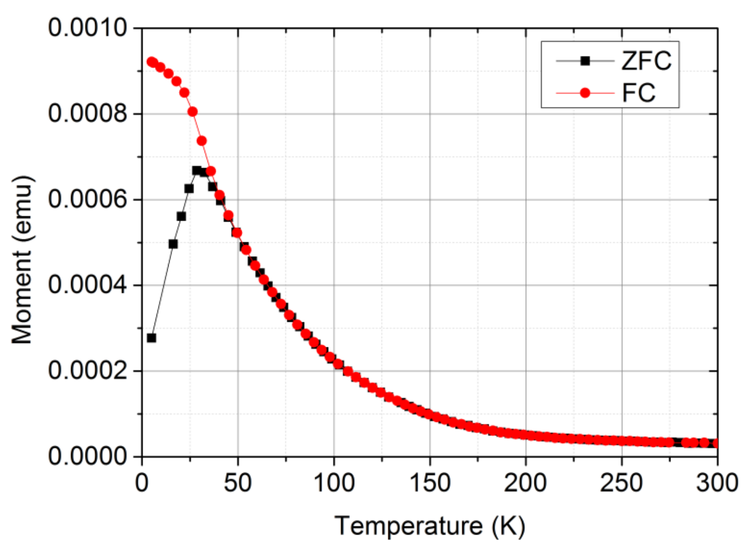

Figure 1: ZFC and FC magnetization of FePt@MnO nanoparticle (6nm@11nm) at 100mT magnetic field

The separated magnetic neutron scattering at 4K are shown in Figure 2. Even though the amount of sample is very small (40mg), a magnetic Bragg peak can be observed after a long counting time. Compared with the single MnO nanoparticles, the magnetic Bragg peak located at the same Q value. Several nuclear peaks are measured at 4K, some of them match the previous MnO nanoparticle data measured by DNS at FRMII Garching in Germany.

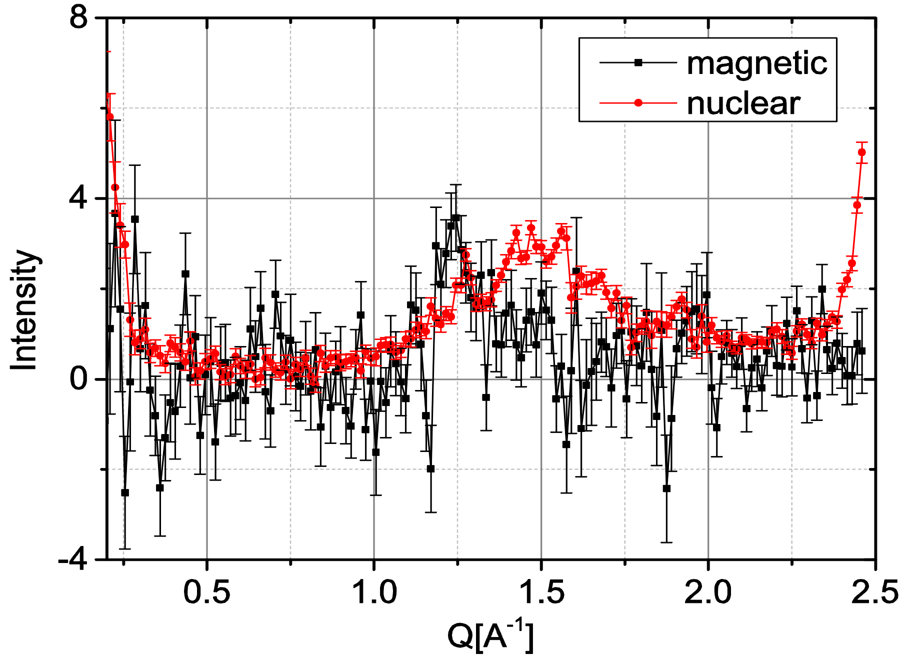

Figure 2: Separated polarized neutron diffraction data of FePt@MnO nanoparticles at 4K

Figure 3 shows the magnetic peak measured at different temperatures. The intensity of the magnetic peak shows no change within the error bars in the range from 4K to 60K. At higher temperatures the intensity of the peak starts to decrease. No Bragg peak can be observed above the Néel temperature of MnO at 120K. In this experiment we were able to identify the magnetic (1/2, 1/2, 1/2) Bragg peak of MnO, which hints at AF order of the MnO subunits. Obviously the FePt subunit does not destroy the AF order inside MnO.

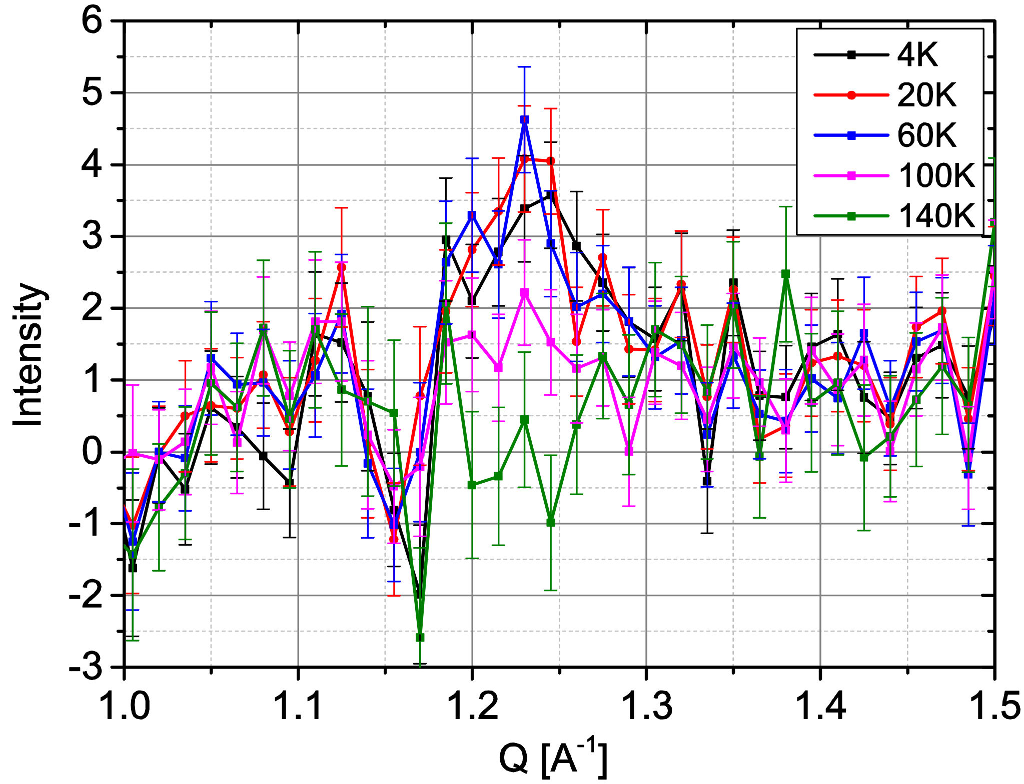

Figure 3: Magnetic (1/2, 1/2, 1/2) Bragg peak at (a) 4K (b) 20K (c) 60K (d) 100K (e) 140K