Experimental report

10/05/2017

Proposal: 5-54-199 **Council:** 4/2015

Title: Investigation of Exchange Bias in NiO(111)/EuO(001) Bilayer

Research area: Physics

This proposal is a new proposal

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Samples: NiO(111), EuO(001), MgO(111) and Au

Instrument	Requested days	Allocated days	From	To
D17	3	3	07/06/2016	10/06/2016

Abstract:

The aim of the experiment is to study the contributions of the pinned and unpinned antiferromagnetic (AF) domains to the exchange bias (EB) occurring at the interface of the NiO(111)/EuO(001) system using specular polarised neutron reflectivity (PNR). D17 with a polarised monochromatic beam is the ideal instrument for this experiment, because EB is an interface effect and it can only be measured with a depth-sensitive technique. Furthermore, it is well known that naturally occurring Eu due to the large proportion (~47.86%) of the isotope 151Eu shows a strong energy dependence of the coherent scattering length [1].

Investigation of Exchange Bias in NiO(111)/EuO(001) Bilayer

Directly involved in the measurements: Razan Aboljadayel, Nina-Juliane Steinke, Max Hawkins, Adrian Ionescu and Thomas Saerbeck

Co-Proposers: Christy Kinane, Kurt R.A. Ziebeck, Crispin H.W. Barnes and Sean Langridge

Introduction:

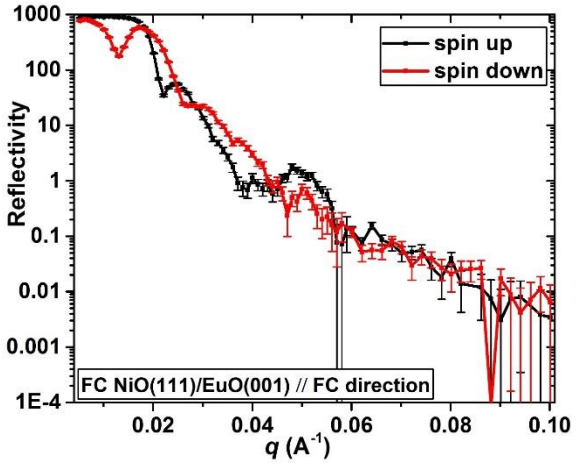
The aim of the experiment is to study the contributions of the pinned and unpinned antiferromagnetic (AF) domains to the exchange bias(EB) occurring at the interface of the NiO(111)/EuO(001) system using specular polarised neutron reflectivity (PNR). D17 with a polarised monochromatic beam is the ideal instrument for this experiment, because EB is an interface effect and it can only be measured with a depth-sensitive technique. Furthermore, it is well known that naturally occurring Eu due to the large proportion (~47.86%) of the isotope 151Eu shows a strong energy dependence of the coherent scattering length [1].

Experiment:

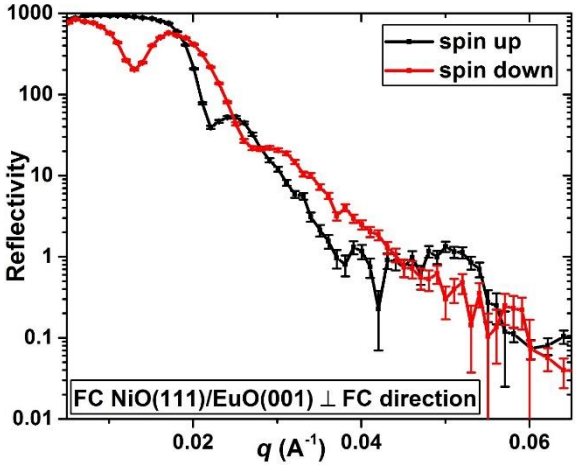
To investigate the depth profile of the net magnetisation which arises from the pinned AF domains and to study the effect of the AF domains parallel to the interface, the non-spin flip (NSP) and spin flip (SF) reflectivities in the aligned EB and randomised EB states was measured [3,8]. A 1 cm x 2 cm NiO [20nm] film was grown at 623 K on a MgO(111) substrate by MBE. The samples was then cooled through T_N (T_N of NiO=525K) to RT in a static field of 0.05 T applied in plane, to induce a uniaxial anisotropy in the AF layer for the aligned EB state. After that the samples are transferred into our DC/RF magnetron sputtering system to grow an EuO film [50nm] at RT by co-sputtering of Eu_2O_3 and Eu and capped with Au film [15nm]. This method of obtaining an EB state is adopted to prevent oxygen diffusion through the interface during post growth annealing and to obtain as sharp as possible interface. The PNR measurements on the sample was carried out at 5 K and 67 K. The sample was measured in 0.06 T parallel to the initial FC direction and then rotated in plane, perpendicular to FC. This practice separates the pinned and unpinned AF spins in the aligned EB state.

Preliminary Results:

- The NSF PNR measurement of the FC NiO(111)/EuO(001) parallel FC direction give an induced magnetic moment of 1.14 μ_B/molecule in the NiO layer 3.12 nm from the interface.



- An induced magnetic moment of 0.89 μ_B/ molecule in the NiO layer 1.3 nm from the interface is deduced from the NSF channels when the sample is aligned perpendicular to FC direction.



- The SF channels show that there is no magnetization induced in the NiO(111)/EuO(001) in the direction perpendicular to the magnetic field applied during the experiment.