Polarized Neutron Reflectometry at the Spallation Neutron Source

M.J. Walock$^1$, C. Papusoi$^1$, F. Klose$^2$ and G.J. Mankey$^1$

$^1$MINT Center and Department of Physics and Astronomy, The University of Alabama
$^2$The Spallation Neutron Source, Oak Ridge National Laboratory

This project was funded by grants from DOE & NSF-DMR 0213985.

Statement of Research Problem

Fe$_{70}$Co$_{30}$/Pd multilayers may exhibit higher saturation magnetizations than Fe$_{70}$Co$_{30}$ alone. This may be due to the enhancement of Fe atoms in the FCC matrix of Co and Pd, along with an induced moment in the Pd. However, precise measurements of the elemental moments has yet to be realized. We plan to utilize the Magnetic Reflectometry beamline at the Spallation Neutron Source (SNS), complimented with X-ray Magnetic Circular Dichroism (XMCD) in order to gain insight into the cause of moment enhancement in multilayer structures.

Introduction to Polarized Neutron Reflectometry

Polarized neutron reflectivity (PNR) has been widely used to determine magnetic and chemical characteristics of thin films and bulk materials. For material science studies, neutrons with wavelengths from 1-3 Å (cold) and 3-30 Å (thermal). These neutrons allow us to probe numerous magnetic systems, such as dilute magnetic semiconductors, superconductors, interfacial coupling, and multilayers.

Detectors

Since neutrons are neutral, they cannot be directly “seen.” An intermediary interaction is necessary. For the “cold” neutrons used at the SNS Magnetic Reflectometer, $^3$He gas is used. For each neutron, the following reaction takes place:

\[ n + ^3\text{He} \rightarrow ^4\text{He} + ^1\text{H} + 0.764 \text{ MeV} \]

The secondary particles are “seen” by charge-coupled devices (CCD’s).

Arrays of individual detectors allow spatial resolution and time of flight measurements.

Future Work

The Spallation Neutron Source was completed in June 2006. At the present time, the individual beamline stations are preparing for their general users. For us, the samples of Fe$_{70}$Co$_{30}$/Pd need to be made and sent to SNS for testing. This is scheduled for 4-6 Nov 2006. We are slotted to be the first general user of the SNS.

References