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Polarized neutron reflectivity of exchange inversion layers

Hwachol Lee[1], Jian Yu[1], Neha Pachauri[1], Sahar Keshavarz[1], Patrick R. LeClair[1], Gary J. Mankey[1], Hailemariam Ambaye[2] and Valeria Lauter[2]

1. Center for Materials for Information Technology
Department of Physics and Astronomy
University of Alabama
Tuscaloosa, AL, U.S.A.

2. Spallation Neutron Source
Oak Ridge National Laboratory
Oak Ridge, TN, U.S.A.

Bulk FeRh undergoes an antiferromagnetic to ferromagnetic phase transition as it is heated above room temperature. The addition of Pd lowers the phase transition temperature so that, in thin film form, the details of the phase transition can be studied while maintaining the same structural and morphological properties of the as-deposited film[1, 2]. $Fe_{47}Rh_{47}Pd_6$ thin films were prepared by DC magnetron sputtering in an ultraclean sputtering system. A $Fe_{47}Rh_{47}Pd_6$/Pt/$Fe_{47}Rh_{47}Pd_6$ trilayer was grown at 600ºC on an a-axis sapphire substrate with a Rh seed layer and a Pt buffer layer. The epitaxy of this 111-oriented thin film was confirmed by X-ray diffraction methods including standard high-angle diffraction, rocking curve analysis and pole figure analysis. The first-order metamagnetic phase transition and thermal hysteresis of the magnetic moment were examined by vibrating sample magnetometry.

To study the detailed magnetic structure of a trilayer with a Pt spacer between two epitaxial films we applied polarized neutron reflectivity (PNR). PNR is used to detect the magnetic moment distribution in layered structures[3]. Temperature-dependent PNR showed the dependence of ferromagnetic spin-splitting for the neutron reflectivity of the two spin polarization channels. Fitting of the PNR data shows a change of the spin splitting that is consistent with vibrating sample magnetometry data. PNR measurements at two different applied magnetic fields of 1 T and 5 mT revealed the dependence of magnetic splitting on applied magnetic field and a modification of the thermal hysteresis. This data confirms the strong field dependence of the magnetically stable state. Analysis of the off-specular neutron reflectivity data will show how the magnetic domains change with experimental conditions.

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