Magnetic Imaging with Neutron Spin Interferometry

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Stress-induced magnetization change in Permalloy foils was observed using neutron spin interferometry.

Without samples in a spin interferometer, phases and visibilities of interference patterns are stable and almost fixed to their initial values. If a sample which has magnetic field B is placed or a field B is applied in the interferometer, the field rotates neutron spin around itself and consequently gives rise to phase shifts and visibility damping. By analyzing phase shifts and visibility damping, we can obtain both amplitude and direction of field. In addition, 2-dimensional field distributions can be observed by measuring interference patterns with a position sensitive detector (PSD) and analyzing phase shifts and visibility damping at each pixel of the PSD. In our experiment, we utilized a 2-dimensional PSD with ^{6}Li scintillator glass.

We prepared three Permalloy foils (A,B,C) of 100 μm in thickness. The foil A and B were stressed by bending and stretching them just once. The angles of bent were different for the two foils, 45 degree for foil A and 180 degree for foil B. The foil C was as is.

A foil was placed vertically in the interferometer and illuminated by monochromatic (8.8 Å) neutron beam of 25 mm (H) × 1 mm (W). As for foils A and B, they were placed so that the bend lines are horizontal.

The figure shows the phase shifts and relative visibilities of foil A and B as functions of vertical position. The red lines show data from foil A and the blue lines foil B. Phase shifts are obtaind by subtracting phases of foil C and relative visibilities by dividing by visibilities of foil C.

It is seen that all lines have a dip at 16.5 mm, where the bend line exists. The dips mean magnetization changes, in amplitude and direction, at the bend lines of Permalloy foils. The fact that Foil B, bent with the higher angle, shows the deeper dips in phase and visibility might show the stress-dependence of the magnetization change.

We have also obsereved phase shifts and visibility damping due to a magnetic field induced by two parallel electric currents.

Detailed analysis of these data is now underway and the results will appear elsewhere.

In summary, we showed the capability of neutron spin interferometry to identify magnetic field and magnetization distribution. It could be used to explore the current distribution in fuel cells, magnetization properties of ferromegnetic foils and other applications.

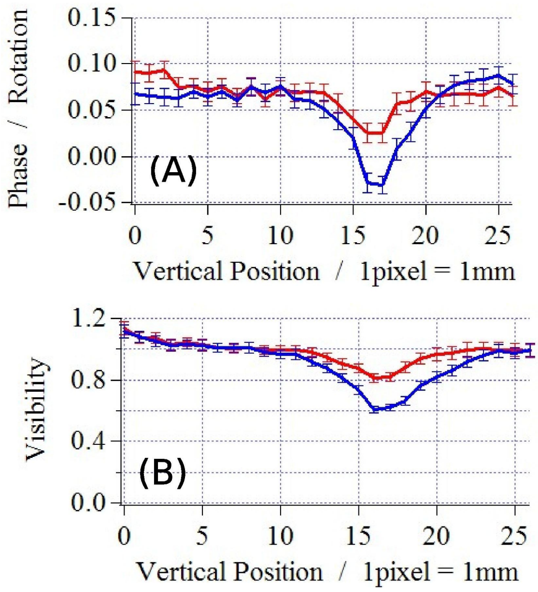

Fig. 1. (A) Phases and (B) Visibilities as functions of vertical position : (Red) 45deg-bent permalloy (Blue) 180deg-bent permalloy