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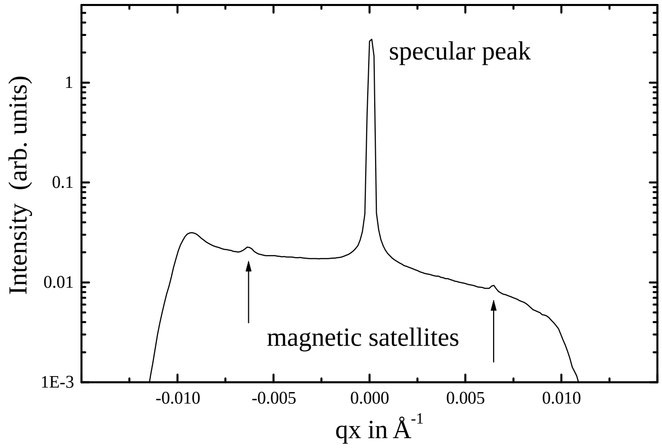
Report:

We have studied chemically ordered FePd films using resonant magnetic scattering at the Pd L-edge. To grow these films Fe and Pd are evaporated simultaneously onto a heated MgO substrate. Samples grown in this way can show varying degrees of chemical order and perpendicular magnetocrystalline anisotropy (PMA). [1] In moderately ordered samples, competition between PMA and shape anisotropy leads to samples with striped domains with a perpendicular magnetisation profile ↑↓↑↓↑ in the film. This domain structure was previously studied with Fe L-edge resonant magnetic scattering.[2,3] Here we report the observation of resonant magnetic scattering from the weak magnetically induced Pd moments.

Data were obtained using a Daresbury 2-circle diffractometer; the sample was aligned with the striped domains perpendicular to the incident beam of 3174 eV photons. Figure 1 shows a rocking curve obtained by keeping the detector at a fixed angle and tilting the sample. Two weak peaks can be seen symmetrically around the central specular peak. These satellites are entirely due to magnetic scattering from the striped domains; the momentum transfer of 0.0069 $Å^{-1}$ corresponds to a real space periodicity of 910 Å, in good agreement with MFM observations.

Using the magnetic satellite peak it was possible to obtain a magnetic rod scan from the sample. Figure 2 shows both the specular reflectivity (measured by scanning the detector and the sample, keeping incident and exit angle equal), and the “magnetic” reflectivity obtained by rocking the sample across the magnetic satellite at a series of detector angles. The diffuse background was then subtracted and the peak intensity integrated for each data point.



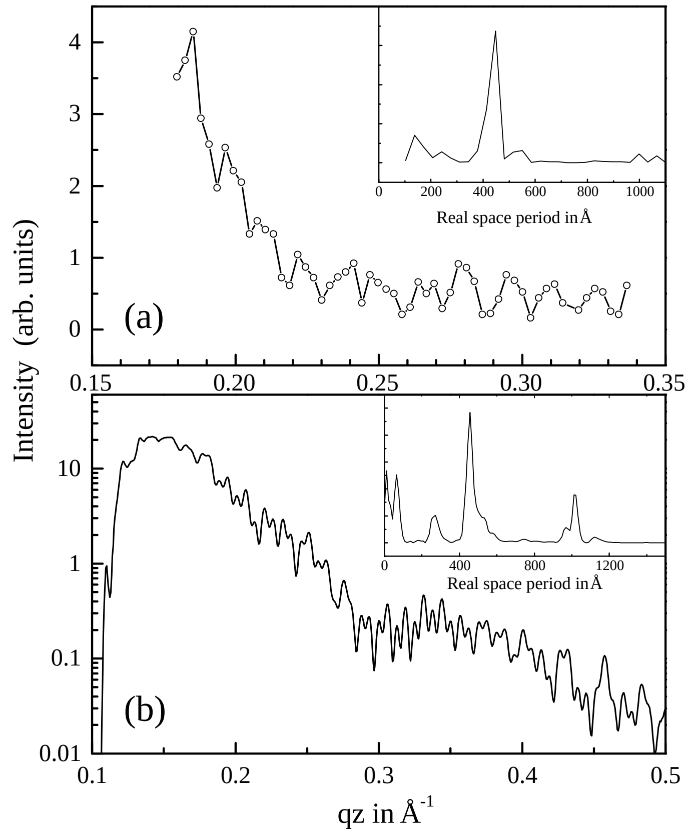


Fig. 1 (above): Satellite peaks from the striped magnetic domains can be seen in this rocking scan. They are only visible at the Pd L_3 edge due to resonant magnetic scattering.
Fig. 2 (right): Rod scans of the magnetic satellite peak at $q_x = 0.0069\text{Å}^{-1}$ (a), and of the specular reflectivity (b). The insets show the Fourier transform of the rod data.

Both the specular and magnetic reflectivity show very clear oscillations with q_z. The insets in Fig. 2 show Fourier transforms of the two profiles. The specular rod has two main components, corresponding to real space periods of 1020Å and 420Å. The magnetic rod, on the other hand, only shows the 420Å component. The sample studied here consists of a MgO substrate, with a buffer layer of 60Å Cr and 700Å Pd. The magnetic FePd layer is 420Å thick, and covered with a 20Å Pd capping layer.

The two main contributions to the specular scattering can be ascribed to the interference between the top and the botton of the entire Pd-containing multilayer (responsible for the 1020Å peak in the Fourier transform), and the interference of light reflected from the top and bottom of the FePd layer, producing the 420Å contribution. For the magnetic scattering on the other hand, only the magnetic FePd layer is “visible”, resulting in the single 420Å contribution to the Fourier spectrum. With further analysis of the rod data from the resonant x-ray scattering, it should be possible to obtain detailed magnetic depth profiles.

References

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