HIGH WAVE VECTOR SPIN WAVES IN ULTRATHIN Fe/W(110) FILMS

J. Prokop, Y. Zhang, W. Xin Tang, I. Tudosa, J. Kirschner
Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle, Germany

Spin polarized electron energy loss spectroscopy (SPEELS) is a unique and novel technique enabling the studies of the high wave vector spin waves (SW) in thin films and surfaces [1,2]. Recently, pronounced peaks of the large wave vector spin wave have been observed in the SPEEL-spectra for 2 monolayers (ML) Fe/W(110) film, and for the first time, the spin wave dispersion has been measured up to the surface Brillioun zone boundary [3]. In this contribution, we present the results of the SPEELS measurements for the Fe/W(110) films of different iron thicknesses, varying from 1 to 24 monolayers (ML). The iron films were prepared using molecular beam epitaxy in ultra high vacuum at room temperature. The spin wave dispersions have been measured along the [001] direction.

In contrary to the 2 ML Fe case, the magnon peaks in the iron monolayer show up in the SPEELS spectra as fine features emerging from a shoulder of an elastic peak. We find that the SW excitations in the Fe ML are much softer than that in the 2 ML Fe film. The reduction of the SW energies and a severe damping of the SW in the ML can be related to a strong influence of the W substrate on the ML electronic structure according to the calculations performed within the itinerant electron theory [4].

For thicker Fe films ($\geq$ 3 ML), we find that the spin-wave excitations are slightly softer than the SW in 2 ML Fe. The SW peaks reveal characteristic broadening at higher energy losses what can be attributed to the Stoner excitations or to the excitations of the higher modes. The energetic positions of the SW peaks vary as a function of Fe thickness in correlation with the modifications of the films electronic structure. The thickness dependence of the spin wave stiffness coefficient changes non-monotonously with the Fe film thickness, in very good agreement with the calculations performed within the framework of itinerant electron theory [5].

[1] M. Plihal, D. L. Mills, and J. Kirschner, Phys. Rev. Lett. **82**, 2579 (1999).
[2] R. Vollmer, M. Etzkorn, P.S. Kumar, H. Ibach, and J. Kirschner, Phys. Rev. Lett. **91**, 147201 (2003).
[3] W. X. Tang, Y. Zhang, I. Tudosa, J. Prokop, M. Etzkorn, J. Kirschner, Phys. Rev. Lett. **99**, 087202 (2007).
[4] R. B. Muniz and D. L. Mills, Phys. Rev. B **66**, 174417 (2002).
[5] R.B. Muniz, A.T. Costa, and D.L. Mills, J. Phys.: Condens. Matter **15,** S495 (2003).