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Dynamic investigation of surface magnetic structure with high brightness and highly spin polarized electrons

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Imaging of the surface magnetic domain structure is quite important to characterize spintronics materials. There are several magnetic imaging techniques. Spin polarized low energy electron microscopy (SPLEEM) is one of them, and it is suitable to investigate the magnetic structure in situ during the formation process of the magnetic thin film. We have developed a spin polarized electron source with high brightness (1.3×10^7 A/cm^{2}sr) and high spin polarization (90%) [1], which makes real time imaging of the surface magnetic structure by SPLEEM possible [2]. A novel three dimensional spin manipulator has been also developed to control spin direction freely [3]. The figure shows one example of the investigation of in-plane and out-of-plane magnetic images taken during the growth of a Co/Ni_2 multilayer on a W(110) surface [4]. At the beginning of the growth, alternative switching of the magnetization direction between in-plane ([1-10]) and out-of-plane ([110]) takes place. In-plane magnetization is favorable after Co deposition and out-of-plane magnetization after Ni deposition. The perpendicular magnetization, however, becomes stable even after Co deposition after several Co/Ni_2 stacks. This behavior was observed for Co/Ni_3 (different Ni thickness) and Ni_2/Co (different order) multilayers too. Therefore it can be concluded that the Co/Ni interface anisotropy strongly influences the magnetic properties of Co/Ni multilayers, which is supported by a XMCD study which has shown that the orbital magnetic moment anisotropy of Ni governs the perpendicular magnetic anisotropy of this system. [1] X.G. Jin et al., Appl. Phys. Express 1, 045002 (2008); X.G. Jin et al., J. Cryst. Growth 310, 5039 (2008); N. Yamamoto et al., J. Appl. Phys. 103, 064905 (2008). [2] M. Suzuki et al., Appl. Phys. Express 3, 026601 (2010). [3] T. Yasue et al., Rev. Sci. Instrum. 85, 043701 (2014). [4] M. Suzuki et al., J. Phys.: Condens. Matter. 25, 406001 (2013).