The fabrication of high quality FeCo alloy ultra-thin films via the nitrogen-surfactant effect toward fabrication of $L1_0$-FeCo thin films

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$L1_0$-type ordered alloy is attracting attention as a rare earth free high-performance magnet and magnetic storage device because of its high magnetic anisotropy, saturation magnetization, and high Curie temperature. Among them, an $L1_0$-type ordered FeCo alloy ($L1_0$-FeCo) without noble metals was theoretically predicted to have extremely high perpendicular magnetic anisotropy [1]. Previously, $L1_0$-FeCo thin films were prepared by the precisely-controlled growth of alternating Fe and Co monolayers using pulsed laser deposition [2]. However, the perpendicular magnetization has not yet been achieved because $L1_0$ atomic structure at the Fe/Co interface is not sufficiently ordered. For realizing high quality $L1_0$-FeCo films, we here focus on the fabrication method utilizing the nitrogen surfactant effect in the thin-film growth of transition-metals. High lateral lattice stability of the monatomic-layer nitrides such as Fe_2N on Cu (001) [3], and nitrogen surfactant effect during the deposition of Fe and Co monolayers can suppress the diffusion at the Fe/Co interface. These will lead to atomically flat and homogeneous surface and interface in the $L1_0$-FeCo thin films.

In the present study, we investigated structural and magnetic properties of monolayer-Co deposited Fe_2N/Cu (001), the initial step for the fabrication of the $L1_0$-FeCo thin films using scanning tunneling microscopy combined with x-ray magnetic circular dichroism (XMCD). First, the strong in-plane magnetic anisotropy of bare Fe_2N was confirmed by the XMCD measurements as in the previously report [4]. We have estimated the Fe magnetic moment of the Fe_2N monolayer and Co-deposited Fe_2N layer by the XMCD sum-rules [5,6], and the value for Co-deposited Fe_2N monolayer is larger than that of the Fe_2N monolayer. The result suggests that the nitrogen atoms shift from Fe_2N to the deposited Co atoms because of the nitrogen surfactant effect. We propose that the surfactant effect is very useful for preparing the atomically flat surface/interface in the layer-by-layer growth of the $L1_0$-FeCo thin films by suppressing the interdiffusion at the Fe/Co interface.

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