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Growth mode and interface structure of Co ultrathin films evaporated on h-BN/Ni(111)

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Magnetic tunneling junction (MTJ) structures, where ferromagnetic electrode layers sandwich an insulating barrier layer, show tunnel magnetic resistance (TMR) effect that is widely applied for spintronics devices such as magnetic random access memory. One of important performance factors of TMR element is magnetic resistance (MR) ratio, which is sensitive to not only electronic and magnetic status in the magnetic electrode layers but also the interface structure between the barrier layer and each magnetic layer. Conventionally, metal oxide layers like aluminum oxide have been utilized for the barrier layer in the device structures, where improvement of MR ratio is limited because of disorder of crystal structures at the interface, arises from lattice mismatch, inter-diffusion or defect inclusion. In recent years, much attention and intensive studies have been devoted to hexagonal boron nitride (h-BN) whose structure is composed of two dimensional honeycomb layers formed by stable chemical bonding. Monolayer h-BN is one of good candidates for the ideal burrier layer of TMR devices because the h-BN layer is expected to form a sharp and abrupt interface without pinhole defects with typical magnetic elements. A ultrathin MTJ structure of Co/h-BN/Ni(111) is also considered to form ideal interface from good lattice matching between the h-BN layer and magnetic transition metals. Although the commensurate interface of h-BN/Ni(111) is well established by previous studies, the growth mode and interface structure for Co/h-BN has not been clarified as yet.

In this study, we have investigated growth mode of Co films on h-BN/Ni(111) in manner of quantitative analysis of Auger electron intensity that is depending on Co thickness in several monolayer region. The sample of Co/h-BN/Ni(111) was prepared in ultra-high vacuum by means of MBE evaporation of Co on h-BN/Ni(111), where high quality h-BN monolayer was fabricated on the clean surface of Ni(111) by cracking of borazine ($B_3N_3H_6$) [1]. Figure 1 shows intensity ratio of Co (LMM) to Ni (LMM) in Auger electron spectra (AES), whose thickness dependence is clearly revealed. Simple exponential expansion of Co signal has not found from data fitting analysis, leading to a failure of complete layer-by-layer growth. We can suggest initial islanding growth followed by two dimensional epitaxial growth above 4 ML.

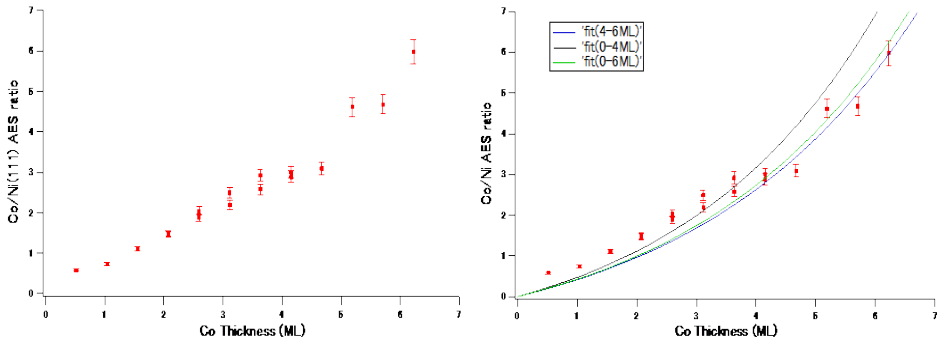

FIGURE 1. Co thickness dependence of intensity ratio of Auger electron of Co (LMM) to Ni (LMM) obtained from differential Auger electron spectra from Co/h-BN/Ni(111). Some of fitting models are also shown on the right panel.

REFERENCES

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