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Evolution of Stress with Film Thickness in Co Film on InP(001) Substrate

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Ferromagnetic metal/semiconductor (FM/SC) hybrid systems have been investigated intensively as potential systems due to possibility of application to spintronic devices [1-3]. For the application of FM/SC it is significant to understand ferromagnetic film stress on semiconductor in the interface between ferromagnetic metal and semiconductor, since it has a huge effect on the structural stability and the reliable operation of devices. In this work we have investigated stress evolution of Co/InP(001) by a highly sensitive optical deflection-detecting system in ultrahigh vacuum (UHV) chamber. Stress results are analyzed and discussed comparing growth morphology by scanning tunneling microscopy (STM) measurements and high resolution transmission electron microscopy (HRTEM). Figure 1 shows stress evolution of Co films on InP depending on the Co film thickness. Abrupt compressive stress, which is shown at the initial stage of growth, might be related to the adsorption of Co atoms on InP [4]. Subsequent tensile stress might be closely related to the formation of continuous film by coalescence of Co islands on InP as shown in STM images. In addition, it is observed from transmission electron microscopy images that elongation of hcp Co along c-axis by lattice relaxation have effects on tensile stress.

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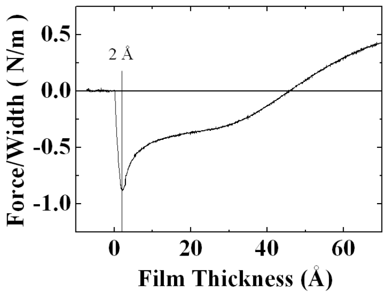

Fig. 1. Stress evolution of Co/InP.

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Four Stable Hall Resistance States on Fe Films Grown on Vicinal GaAs Substrates

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It has been reported that the ferromagnetic semiconductor with strong cubic anisotropy (i.e., GaMnAs) grown on vicinal GaAs substrate can provide opportunity for developing four state memory device.1 Unfortunately, the practical application of such interesting concept was hindered by low Curie temperature of ferromagnetic semiconductors. We have utilized Fe film, which is known as room temperature ferromagnet, to detour such inherent difficulty of ferromagnetic semiconductors, A series of Fe films were grown on various GaAs substrates to produce strong cubic anisotropy. The planar Hall resistance (PHR) were measure at room temperature for several Fe layers grown on standard (001) GaAs substrate and grown on the slightly tilted (001) GaAs substrate with three different vicinal angles 2°, 5° and 13°. In Fe layers grown on (001) GaAs substrate, a typical PHR hysteresis with two-step switching behavior between two distinct resistances are obtained, while asymmetric PHR hysteresis is observed in Fe layers grown on tilted substrate. The asymmetric hysteresis showed four distinct Hall resistance values at zero field due to the combining effect of the anomalous Hall effect (AHE) and the planar Hall effect, which introduced by tilted substrate. The asymmetry of PHR increases with tilted angle of substrates owing to the increase of contribution from AHE. These results provide the possibility of realizing practical four state memory devices working at room temperature.

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