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In-Plane Magnetic Anisotropy Dependence of MgO Growth Temperature in Fe/MgO on InAs(001) Substrates

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MgO tunnel barrier inserted ferromagnetic metal/semiconductor heterostructures have much attention to semiconductor-based spintronics applications. We have in-situ grown Fe/MgO/InAs(001) hybrid structures and investigated magnetic property of Fe layer as a function of MgO growth temperature ranged from room temperature to 400°C. Our previous work showed that the hybrid structure own the epitaxial relationship of Fe[110](001) // MgO[100](001) // InAs[100](001). When the 4nm thick MgO layer is grown at lower temperatures, a large lattice mismatch exists between MgO and InAs substrates. Therefore, the subsequent Fe grows in three-dimensional (3D) islands and the absence of the magnetic anisotropy. In contrast, 3D Fe island formation is suppressed on the MgO grown at the temperature above 300°C by means of the partial relaxation of MgO It is interesting that the cubic magnetic anisotropy appears upon the two-dimensional (2D) Fe layer. Based on the in-plane epitaxial relationship of the structure, the magnetic easy axis is along <100> direction of Fe and <110> direction of InAs, respectively. Our experimental results strongly suggest that the MgO growth temperature is one of dominant parameters determining the underlying strain for the subsequent Fe growth. Therefore, the morphology changes from 3D island to 2D layer and the cubic magnetic anisotropy appears at elevated MgO growth temperatures.

Key words : Fe, MgO, InAs, magnetic unisotropy, and epitaxial relation.

References

[1] H. J. Kim et al, The manuscript of "Strain-induced microstructural evolution in epitaxial Fe/MgO grown on (001) InGaAs substrate", will be submitted