Structure and magnetic properties of [Co/Pt] single crystal and bicrystal superlattice

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The $[Co/Pt]_n$ superlattice film is a promising material for magneto-optical and perpendicular magnetic recording because it displays a large Kerr rotation angle in the short-wave band and a strongly perpendicular magnetic anisotropy, respectively. [1] The magnetic properties are correlated with the interface effect and order-disorder transition in superlattice and alloy films, respectively.

In this study, both FCC(111) single crystal and bicrystal $[Co(3Å)]/Pt(10Å)]_{23}$ superlattice films have been successfully grown on sapphire(0001) and yttria-stabilized cubic zirconia, YSZ, (100) substrates, respectively, by molecular-beam epitaxial technique with varying the substrate temperature between 25°C and 300°C. As previous reports, high quality FCC(111) [Co/Pt] superlattice films were obtained on the sapphire(0001) substrates with 10nm Pt seeding layers. The coercivity of single crystal films decreased monotonically as elevating the deposition or annealing temperature. For example, the coercivity of as deposited and 500°C annealed samples was 3500Oe and 800Oe, respectively. Obviously, that was resulted by the interfacial diffusion between Co and Pt layers. For the [Co/Pt] superlattice films on YSZ(100) case, the reflection high-energy electron diffraction investigation show that [Co/Pt] superlattice films possessed an in-plane 12-fold symmetry that resulted by two FCC(111) crystals with in-plane 30° rotation. The detail epitaxial relationship is YSZ(100)[010] || Co/Pt (111)[0-11] or Co/Pt (111)[2-1-1]. Interestingly, bicrystal films displayed a larger coercivity and a better squareness than the single one under high annealing temperature. Moreover, the coercivity did not decrease until the annealing temperature reached 500°C. The atomic force microscopy and high-resolution transmission electron microscopy observed that bicrystal films possessed a columnar structure that was resulted by the formation of (111) twin boundaries. The correlation between columnar structure and magnetic properties will be discussed in detail. In summary, we have observed the structural and magnetic variation of [Co/Pt] FCC(111) single crystal and bicrystal, experimentally the first time, superlattice by molecular-beam epitaxial technique with varying the deposition and annealing temperature.

References

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