Perpendicular Magnetic Anisortropy Properties of $[Co_{60}Cu_{40}/Pt]_6$ Multilayers

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Magnetic tunnel junctions with perpendicular magnetic anisortropy (PMA) have attracted a lot of research interests. This is because distinct advantages of this system over in-plane magnetic anisotropy are found in the reduced critical current density (J_c) for magnetization switching with high thermal stability. Among the various PMA materials, Co/Pt multilayers are promising candidate owing to its high anisotropy energy (K_u). However, in order to make commercially viable device using this material, it would be desirable to decrease the M_s for feasibility of reducing J_c. Although conventional Co/Pt multilayers consisted of thick Pt with thin Co layer coincide with this requirement, it should be lead to degradation of PMA during post annealing process. In this respect, low M_s material, $Co_{60}Cu_{40}$(~37% smaller M_s than pure Co [1]) was considered in this study and an effort to constitute thermally stable multilayers having low M_s was made by inverted layer structure of thick CoCu with thin Pt layer.

The structure of Ta / Pt / Ru / $[Co_{60}Cu_{40}(t_{CoCu})/Pt(0.2\ nm)]_6$ / Ru was fabricated on a Si/SiO_2 substrate using a DC magnetron sputtering system. The base pressure was 7×10^{-8} Torr while working pressure was fixed at 2×10^{-3}Torr. Post annealing was carried out temperature range of ~500℃ and magnetic properties were measured by vibrating sample magnetometer.

As shown in Fig. 1(a) the values of K_u are mainly affected by t_{CoCu}. For the as-deposited sample, increase of K_u is observed from 0.33 to 1.12×10^6erg/cc as increasing the t_{CoCu} of 0.3~0.5nm. Although these values are slightly increased by the post annealing process, the effect is not prominent. In the case of M_s, however, quite different dependencies on post annealing are observed. As shown in Fig. 1(b), the values of M_s are nearly proportional to t_{CoCu}, variation trends of which are similar to the case of K_u. However, post annealing at 500℃ effectively reduce the M_s values over the whole t_{CoCu} range. Transmission electron microscopy results demonstrate that layer intermixing between CoCu and Pt is attributed to reduced M_s. As a consequence, the most desirable properties of strong PMA (K_u~1.39×10^6erg/cc) with low M_s value (340 emu/cc) is obtained from $[Co_{60}Cu_{40}$(0.5nm)/Pt (0.2nm)$]_6$ structure annealed at 500℃.

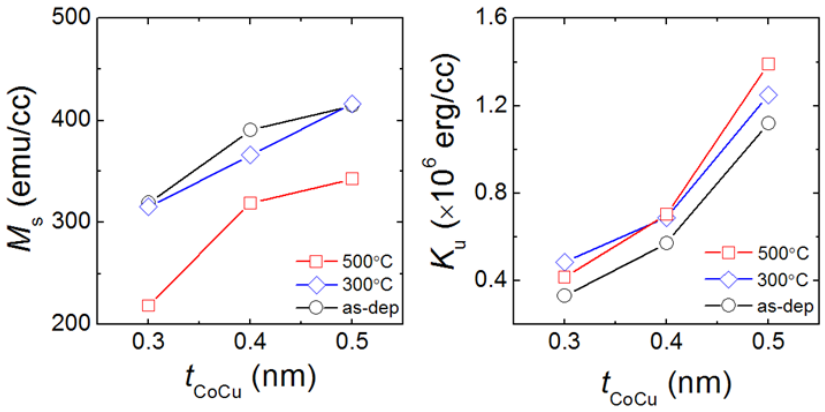

Figure1. The change in (a) Ku and (b)Ms as a function of tCoCu.

Reference

[1] Yuan *etal*,.J.Appl.Phys.**108**,113909(2010).

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