Thickness dependence of Ti underlayer on ordering of CoPt on Si substrates

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Pt-based binary alloy of CoPt with $L1_0$ chemical ordered phase shows strong perpendicular magnetocrystalline anisotropy and large coercivity (H_c), which leads to application to spintronic devices such as magnetoresistive random access memory and ultrahigh-density hard disk drives. We have reported the formation of $L1_0$-ordered CoPt on Si/SiO_2 substrates using electron-beam (EB) evaporation and rapid thermal annealing (RTA).[1,2] The $L1_0$-ordered CoPt showed a maximum out-of-plane H_c of 15 kOe, which exhibited isolated grain structures due to weak adhesion between CoPt and SiO_2 surface of the substrates.[3]

To enhance adhesion of $L1_0$-ordered CoPt on Si/SiO_2 substrates, an introduction of an adhesion layer such as Ti is one of the options. However, we have found that, in the film with a 3-nm-thick Ti underlayer after RTA at 900 °C in a vacuum, $L1_2$-ordered $CoPt_3$ was formed, showing a small in-plane H_c of 500 Oe.[2] Therefore, fabrication conditions such as Ti underlayer thickness should be optimized in order to realize the formation of $L1_0$-ordered CoPt even in the presence of a Ti underlayer.

In this study, we demonstrate the formation of $L1_0$-ordered CoPt on Si substrates in the presence of a Ti underlayer by tuning the Ti underlayer thickness.[4] Co/Pt multilayer thin films with a Ti underlayer with different thicknesses were fabricated on Si/SiO_2 substrates by EB evaporation and were annealed by RTA. Their crystal structures were characterized by grazing incidence X-ray diffraction (GI-XRD). In the film with a 3-nm-thick Ti underlayer, $L1_2$-ordered $CoPt_3$ was confirmed together with Co-rich $A1$-disordered CoPt by GI-XRD. In contrast, when the thickness of the Ti underlayer decreased to less than 3 nm, superlattice peaks corresponding to $L1_0$-CoPt *001* and *110* were observed. These results indicate that $L1_0$-ordered CoPt can be formed on Si substrates even in the presence of a Ti underlayer by tailoring the Ti underlayer thickness.

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