Ta underlayer effect on ordering of CoPt on Si substrates

◦Ryo Toyama[1], Shiro Kawachi[2,3,4], Jun-ichi Yamaura[2,3], Youichi Murakami[3], Hideo Hosono[2], and Yutaka Majima[1,2]

[1] Laboratory for Materials and Structures, Tokyo Institute of Technology,

[2] Materials Research Center for Element Strategy, Tokyo Institute of Technology,

[3] Institute of Materials Structure Science, KEK

[4] Graduate School of Science, University of Hyogo

E-mail: toyama.r.ab@m.titech.ac.jp

$L1_0$-ordered CoPt is one of the promising candidates for spintronic devices such as magnetoresistive random access memory and ultrahigh-density hard disk drives, owing to its large coercivity (H_c) and strong perpendicular magnetocrystalline anisotropy. Recently, we have studied the $L1_0$-ordering of CoPt in CoPt multilayer thin films on Si substrates using electron-beam (EB) evaporation and annealing.[1,2)]

To enhance adhesion of $L1_0$-ordered CoPt on Si/SiO_2 substrates after annealing, we have introduced a Ti underlayer and have investigated the effect of Ti underlayer on the ordering of CoPt.[2)] However, we have found that an introduction of an EB-deposited 3-nm-thick Ti underlayer resulted in the formation of off-stoichiometric $L1_2$-ordered $CoPt_3$ after annealing at 900 °C in a vacuum,[2)] which could be due to the diffusion of Ti atoms into the CoPt films by annealing, leading to the inhibition of $L1_0$-ordering of CoPt. To avoid the undesirable diffusion of underlayer, metal underlayers with high melting point such as Ta could be a possible candidate.

In this study, we investigate the effect of a Ta underlayer on the ordering of CoPt on Si substrates. We also compare the crystal structures of the films with a Ta underlayer with the ones of the films with a Ti underlayer in our previous study. $[Co\ (1.2\ nm)/Pt\ (1.6\ nm)]_4$ thin films with a Ta underlayer with different thicknesses up to 3.0 nm were fabricated on Si/SiO_2 substrates by EB evaporation and were annealed under a hydrogen atmosphere by a rapid thermal annealing apparatus (MILA-5000UHV, Advance Riko). The crystal structures of the films were characterized by grazing incidence X-ray diffraction (GI-XRD; Rigaku) at BL-8B of Photon Factory, KEK. In the films with a Ta underlayer annealed at 800 °C, superlattice peaks originating from $L1_0$-ordered CoPt *001* and *110* were observed by GI-XRD, indicating the $L1_0$-ordering of CoPt with a Ta underlayer.

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