

Hydrogen annealing effect on $L1_0$ ordering of CoPt thin films

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$L1_0$ -ordered CoPt is one of the next-generation ferromagnetic materials due to its high perpendicular magnetocrystalline anisotropy and high coercivity [1]. The ordered phase is attributed to phase transformation from $A1$ -disordered CoPt by thermal annealing. Rapid thermal annealing (RTA) is considered as a promising annealing technique to induce phase transformation and obtain $L1_0$ -ordered CoPt owing its high heating rate. Considering future applications to spintronic devices, hydrogen annealing is effective to enhance structural and magnetic properties of $L1_0$ -ordered CoPt [2]. Therefore, it is important to study the effect of hydrogen annealing of RTA on $L1_0$ ordering of CoPt. However, detail studies on the effect on crystal structures of CoPt thin films have not been reported.

In this study, we fabricate Co/Pt multilayer thin films on Si/SiO₂ substrates by electron-beam evaporation. These films are subsequently annealed by RTA under a vacuum or an Ar/H₂ atmosphere. Their crystal structures are characterized by grazing incidence X-ray diffraction (GI-XRD) using synchrotron radiation at KEK (BL-8B).

The GI-XRD patterns of the Co/Pt multilayer thin films after annealing by RTA under a vacuum and an Ar/H₂ atmosphere are shown in Fig. 1(a) and (b), respectively. For the film annealed under a vacuum, superlattice spot-like peaks originated from CoPt 001 and 110 , marked by the white arrows in Fig. 1(a), were observed at the annealing temperature of 900 °C, indicating $L1_0$ ordering of the films. On the other hand, for the film annealed under an Ar/H₂ atmosphere, the superlattice peaks originated from $L1_0$ -ordered CoPt, marked by the white arrows in Fig. 1(b), were observed at the annealing temperature of 600 °C. These results clearly show that the $L1_0$ ordering temperature of the films decreased by 300 °C owing to the hydrogen annealing.

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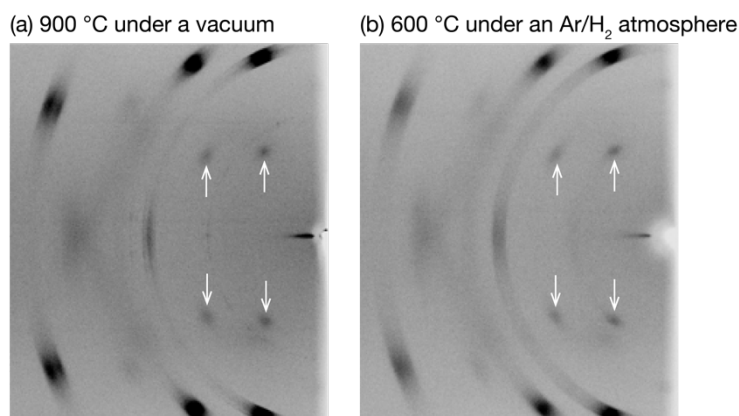


Fig. 1. GI-XRD patterns of the Co/Pt multilayer thin films (a) annealed at 900 °C under a vacuum and (b) annealed at 600 °C under an Ar/H₂ atmosphere by RTA. The superlattice peaks originated from $L1_0$ -ordered CoPt are marked by the white arrows.

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