

Structural and Magnetic properties of Co/Cr multilayers

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I. Introduction

Owing to their high out of plane magnetic anisotropy mainly related to a columnar growth and a hcp structure with its c axis perpendicular to the surface, thin films of CoCr alloys have for a long time been considered as good media for perpendicular magnetic recording (1,2) In well crystallize Co/Cr multilayers grown by various methods. Co and Cr have almost the same atomic size but very different bulk structures. Then the growth multilayers using this two constituents can lead to various epitaxial relationship between Co and Cr layers, depending essentially on the substrate orientation, deposition rate, and substrate temperature. Indeed, Co/Cr multilayers with different structures and textures have been observed. (3-5). Most of the work on Co/Cr multilayers has pointed out that in these artificial systems, unlike in Co/Cu and Co/Au multilayers, sharp interfaces and good crystallographic quality are very difficult to obtain conjointly. Indeed the substrate temperature required to allow a suitable surface diffusion is often sufficient to give rise to a significant interdiffusion.(4,5). In many multilayers, the intermixing has been shown to be determinant for the magnetic properties such as saturation magnetization (4-6) and anisotropy(6,7)

In this paper, we report on magnetic and structural properties of the Co/Cr multilayer grown by dc magnetron sputtering.

II. Experiment

The multilayer films $[\text{Co}_{1\text{nm}}/\text{Cr}_{1\text{nm}}]_{30}$, and $[\text{Co}_{3\text{nm}}/\text{Cr}_{3\text{nm}}]_{30}$ were grown on the SiO_2 substrate by dc magnetron sputtering with a base pressure $< 2 \times 10^{-6}$ Torr and Ar pressure of 8 mtorr. The film thickness was measured by Alpha-step Tencor P-11-Surface profiler and examined by transmission electron microscopy (TEM). The heat treatment of the specimens was carried out by conventional annealing process in the furnace with vacuum in 2×10^{-6} Torr at 400°C for the temperature of 30 min 90 min 150 min respectively. X-Ray Diffractometer (XRD) analysis was carried out at low angle from 0 to 10 degree. The magnetic properties measured by the vibrating sample magnetometer (VSM).

III. Result and Discussion

Structural properties of DC magnetron sputtered Co/Cr multilayer have been investigated by using X-ray diffraction, Atomic force microscope, and transmission electron microscope. Results have been correlated with magnetic characterization obtained by Vibrating sample magnetometer. Interdiffusion along $3.16 \times 10^{-6} \text{ mm}^2/\text{sec}$ occurs at the Cr on Co interface. A better structural

coherence is observed for the 3 nm layers system. The good structural quality of the film is confirmed by the occurrence of satellite peak in the X-ray diffraction patterns. In plan magnetization show a anti ferromagnetism coupling of the Co layer through the Cr layer.

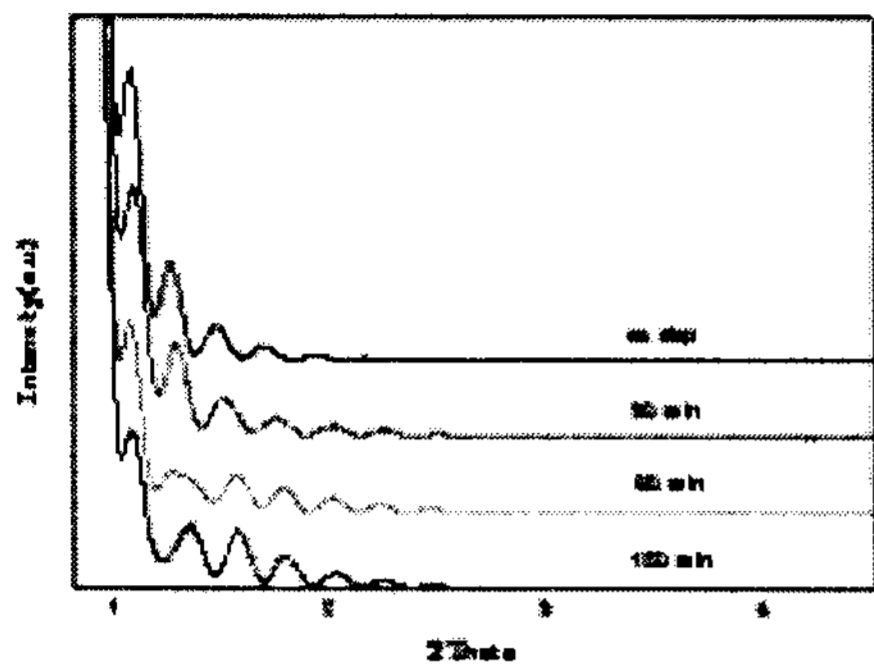


Fig. 1. Low angle of [Co₁Cr₁]₃₀ layers with different annealing time at 400^o C.

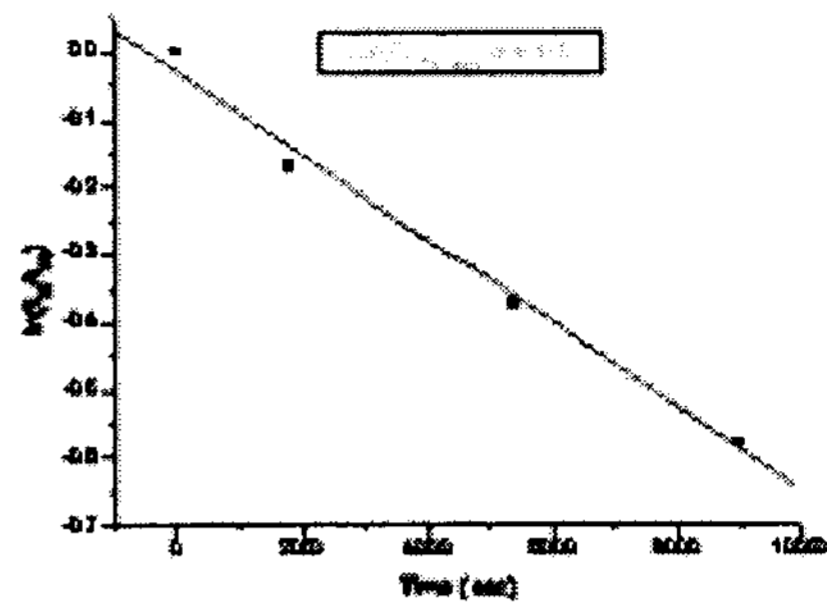


Fig. 2. Temperature dependence of interdiffusion coefficient in Co/Cr multilayer system.

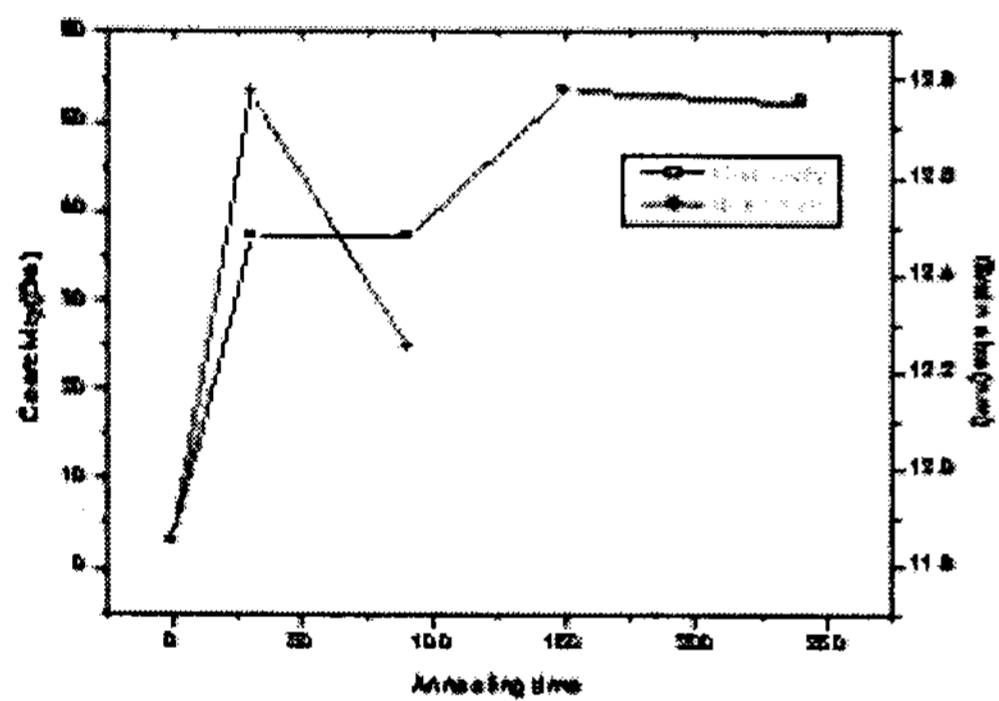


Fig. 3. Coercivity and grain size effect on annealing temperature.