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A HIGH-RESOLUTION TRANSMISSION ELECTRON MICROSCOPY INVESTIGATION OF THE INTERFACIAL STRUCTURE OF CoNiCr/Cr BI-LAYER MAGNETIC THIN FILMS+

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The use of performance enhancement underlayers is a common practice in production of magnetic recording media[1]. In the case of Co-based alloy deposited on chromium underlayers, the enhancement in the in-plane coercivity is phenomenal. Conventional and High Resolution TEM are powerful tools in the investigations of structure of these films because of the very fine grain size of the films. Previous microdiffraction studies on these bi-layer films have revealed the apparent grain to grain orientation relationship (O.R.) between individual grains in the two layers in the plane view sections of these specimens[2]. Since the underlayer exerts such a great influence on the structure and properties of the overlayer, it is of great importance to study the interfacial structure of these bi-layer films. The lattice matching across the interface and the interfacial defects which formed could very well provide explanation(s) to the enhancement in the in-plane coercivity.

The system used for this study is the bi-layer CoNiCr/Cr thin films. They were produced by RF sputtering onto Corning 0211 glass substrate. Cross sectional specimens were made by first binding thin sections of specimen with epoxy, followed by mechanical thinning. The final thinning process was carried out by ion-milling. The specimens were studied in a JOEL 4000EX Electron Microscope.

Two O.R.s were observed in the cross section specimens with HRTEM in the hcp CoNiCr/ bcc Cr bi-layer thin films. The first one is that of Pitsch-Schrader (Fig.1): $(11\bar{2}0)$hcp//(001)bcc, [0001]hcp//[110]bcc. The Cr surface that is parallel to the plane of the film is (001). As a result of this O.R., the hcp c-axis lies preferentially in the plane of the film. The lattice spacing for (0002) CoNiCr and (110) Cr has a misfit of only 0.6% and thus most of the misfit occurs in the normal direction. The extra planes to accommodate the misfit are denoted by the white arrows. The obtuse contrast at the interface in between the arrows is believed to have been caused by the misfit strain/defect at the interface. Figure 2 is an image of the interface with the same O.R. but studied along another zone axis. The interface is not as sharp as in figure 1 and this is because the observed zone axis is not along that of best fit. The contrast can be attributed to the strain or defects at the boundary and it extends beyond two atomic layers at the interface. A total of between five to six atomic layers are involved in the strain relaxation process at the interface.

The other O.R. observed was that of Potter (Fig.3): $(10\bar{1}1)$hcp//$(1\bar{1}0)$bcc, $[\bar{2}110]$hcp//$[\bar{1}11]$bcc. In this case, the Cr (110) and the CoNiCr $(10\bar{1}1)$ plane is parallel to the interface. The HR image shows that the atoms in the bcc (110) and the hcp $(10\bar{1}1)$ planes line up with each other. Further studies of the atomic positions indicate that the bcc $[\bar{1}11]$ and hcp $[\bar{2}110]$ are parallel to each other and they lie at an angle of 35° with respect to the plane of the paper. No defect contrast was observed at this interface indicating extremely good matching. As a result of this epitaxial growth, the c-axis of the hcp CoNiCr is situated at 28° with respect to the interface.

References

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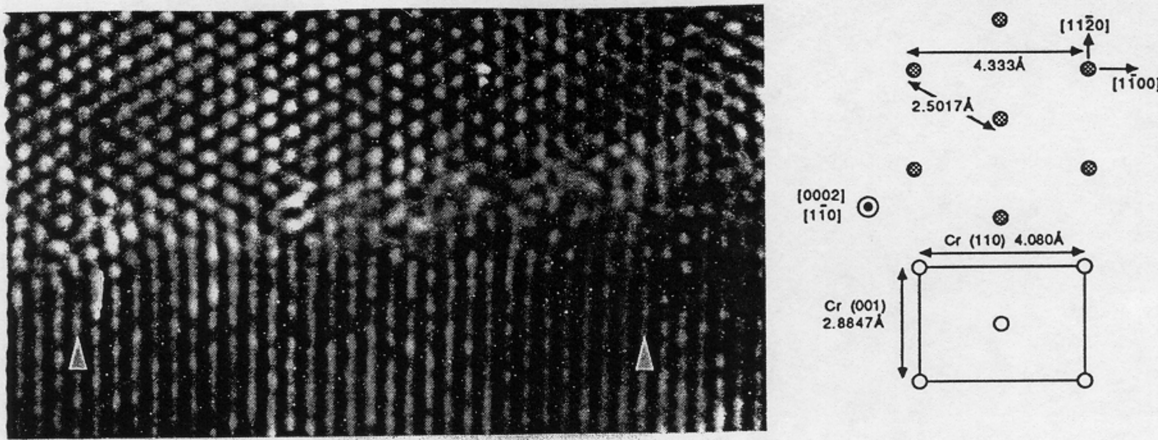

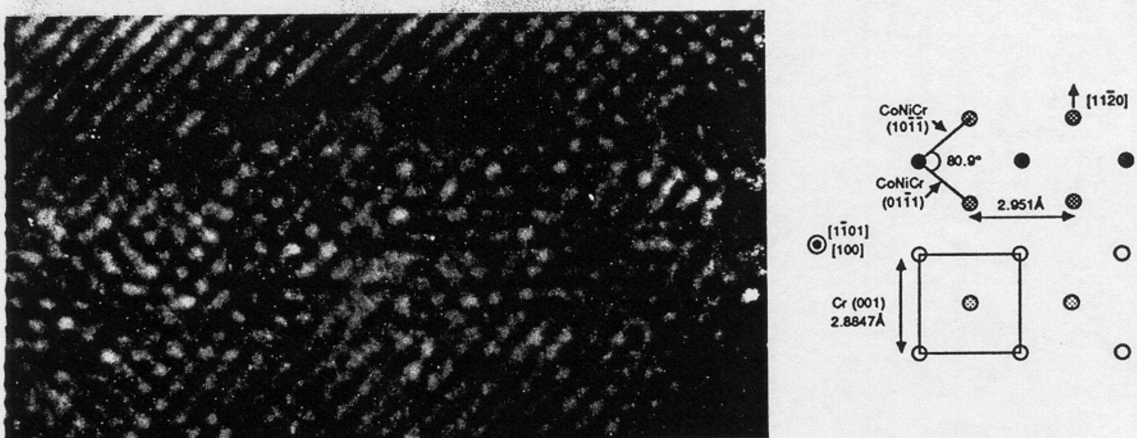

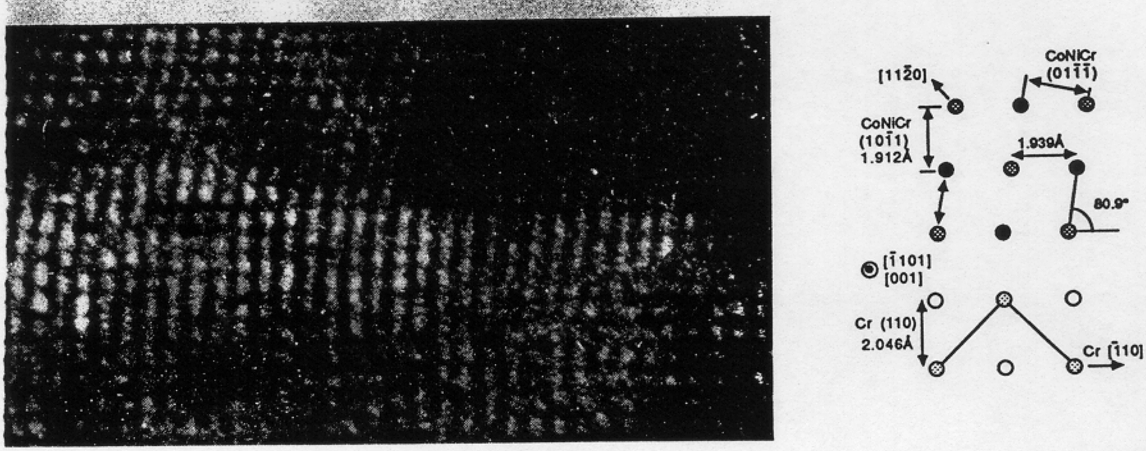

ure 1. Cross section of a CoNiCr/Cr bi-layer thin film with the Pitsch-Schrader O.R.:: (11$\bar{2}$0)CoNiCr//(001)Cr, [0001]CoNiCr//[110]Cr. The extra planes in the Cr underlayer are indicated by the white arrows.

ure 2. Cross section of a CoNiCr/Cr bi-layer thin film with the Pitsch-Schrader O.R. The observation zone axes for the two layers are [1$\bar{1}$01] and [100] respectively.

ure 3. Cross section of a CoNiCr/Cr bi-layer thin film with the Potter O.R.: (10$\bar{1}$1)CoNiCr//(1$\bar{1}$0)Cr, [$\bar{2}$110]CoNiCr//[$\bar{1}$11]Cr.