Analysis of thin films by X-ray scattering at grazing incidence

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A new grazing incidence X-ray spectro-reflectometer [1] has been installed at the beamline 39XU, and the commissioning was carried out from March to May, 1998. The present report gives the preliminary results on grazing incidence X-ray scattering from thin films.

Both the horizontal and vertical axis arrangement were tested with 10 keV monochromatic X-rays (ID gap 14.46 mm). Higher order harmonics were rejected by the beamline Pt mirror (5 mrad). Two ionization chambers (N_2 for incident monitor and Ar for reflection/scattering detection) were used. The environment is vacuum (ca. 100 mTorr).

Figure 1 shows specular reflection and diffuse scattering from Cr/Au thin film. Because of the interference effect caused by multiple reflection at each interface [2], Kiessig fringes [3] were observed in specular reflection, which includes information on the layer thickness and interface roughness. One can find the interference oscillation in diffuse scattering as well. It is possible to determine the nm-scale shape of the surface and interfaces based on the self-affine description. Figure 2 shows diffuse scattering from a vacuum deposited Gd thin film. Some fine structures are found in the vicinity of the specular position (8.75 mrad). They reflect the particle size at the surface, and have been correlated to atomic-force microcopy measurements. Since the instruments seem now almost completed and are in good condition, in the next opportunity, we would plan combined measurements of diffuse scattering and fluorescent X-rays from trace metals, which could give detailed information of interfaces.

References

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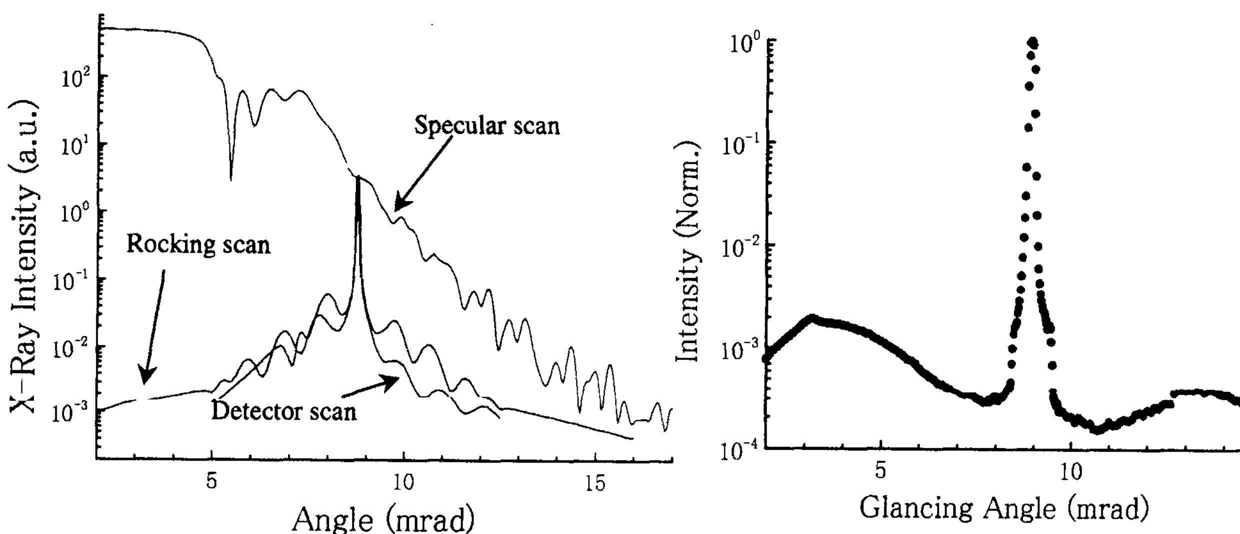

Figure 1 (left) Grazing incidence specular reflection and diffuse scatter from Cr[51.8nm]/Au[100nm]/Cr[20nm]/Glass (Sub) sample. Horizontal axis geometry was used (beam size 0.03(H) x 2(V) mm^2).

Figure 2 (right) X-ray scattering from Gd thin film evaporated in vacuum. Rocking scan at 17.5 mrad (1 deg) scattering angle. Vertical axis geometry was used (beam size 2(H) x 0.04(V) mm^2).