Analysis of thin films interfaces by X-ray fluorescence and scattering using total reflection

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Controlling interfaces of thin films is a key technology in realizing properties which are unlikely for bulk materials. For analyzing the surface and interface of thin films, grazing incidence X-ray experiments are powerful because of the high sensitivity due to the shallow penetration of X-rays around the critical angle. A new grazing incidence X-ray spectro-reflectometer has been designed for the present research program, and is shown in Fig. 1. Detailed instrumental design has been described elsewhere [1]. One of the most important features is the high accuracy in angular scans, and the other advantage is a versatility in the combined measurements of X-ray fluorescence and scattering/reflection to analyze the roughness, the degree of chemical gradation of interfaces and the depth profile of trace metals [2].

The whole equipment was installed at the beamline in March, 1998. Besides the off-line adjustment and tests for the goniometer, the stages and the chamber, the commissioning for the horizontal axis geometry (Fig.1) was performed using 10 keV monochromatic X-rays (ID gap 14.46 mm) with the size of 0.03 x 2 mm^2, during the beam time for the present program. Higher order harmonics were rejected by means of the beamline Pt mirror (5 mrad). Two ionization chambers (N_2 for incident monitor and Ar for reflection/scattering detection) were used for the preliminary scattering measurements. While some successful transverse and radial diffuse scans were achieved, because of the restriction of the time, it was not possible to test the vertical rotation axis geometry. Consequently, further commissioning of the equipment is necessary.

References

[1] K.Sakurai, S.Uehara and S.Goto, J. Synchrotron Rad. (in press).

[2] K.N.Stoev and K.Sakurai, Rigaku Journal Vol.14, No.2, 22 (1997).

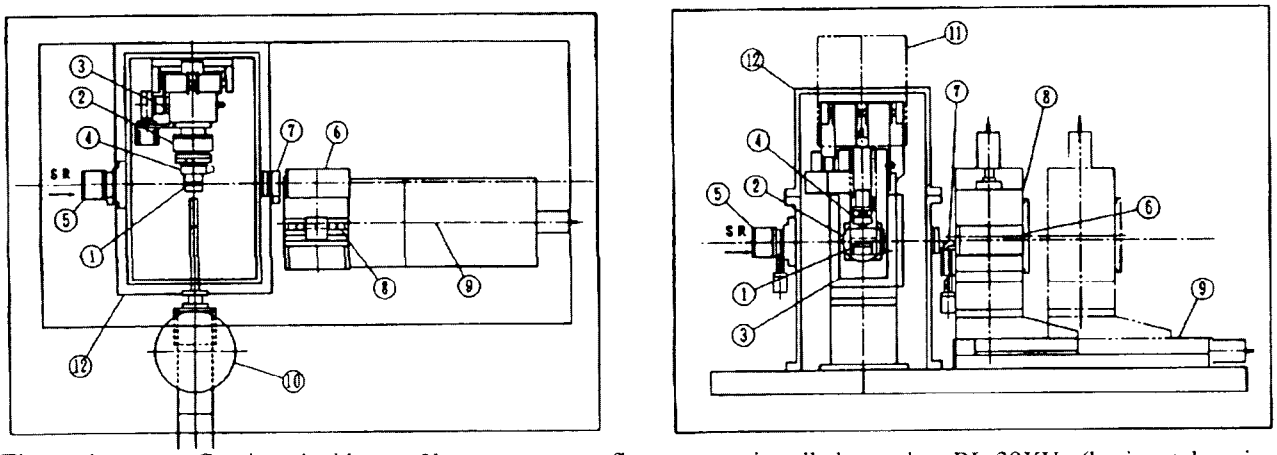

Figure 1 Grazing incidence X-ray spectro-reflectometer installed at the BL-39XU (horizontal axis geometry). 1. Sample, 2. Goniometer, 3. Stage for positioning the goniometer center, 4. Stage for positioning the sample surface, 5. Incident X-ray monitor with entrance slit, 6. Reflection detector with receiving slit, 7. Direct beam stopper and the stage, 8. Stage for reflection detector scan, 9. Stage for adjusting angular resolution, 10. Fluorescence detector, 11. Fluorescence detector (direction convertible type), 12. Vacuum chamber.