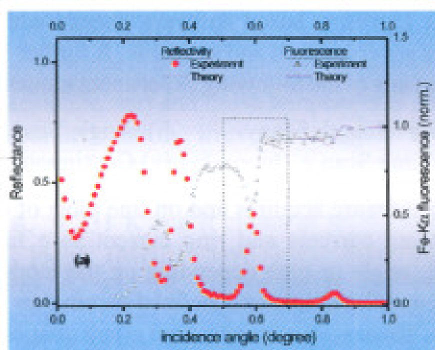

***Fig. A.8.1** Variation of Fe-Kα fluorescence intensity (triangle) fitted GI XRF profile (blue line) and measured reflectivity (circle) and fitted reflectivity profile (gray line) for a Fe/Si multilayer*

distinctly shows XSW oscillations up to three Bragg reflections. The experimental reflectivity and fluorescence profiles match closely with calculated profile at 0.03^0 beam divergence. This observed value of primary beam width agrees with expected value of beam divergence of 0.026^0 as we have used our first slit of 40μm at a distance of 110 mm from X-ray tube window.

(Contributed by: M K Tiwari; mktiwari@cat.ernet.in, S.R. Naik, G.S. Lodha, R.V. Nandedkar)

A.9 Development of soft x-ray/ extreme ultra violet Mo/Si multilayer mirrors and their characterization using Indus-1

Multilayer (ML) mirrors are playing an important role in the exploitation of soft x-ray/extreme ultra violet (XUV) region of the electromagnetic spectrum, and have received attention due to both the science and technology interests. Such mirrors have found wide applications in synchrotron radiation beam lines, materials science, astronomy, x-ray microscopy, x-ray laser, x-ray lithography, polarizer and plasma diagnostics. High reflectivity with moderate spectral bandwidth at normal/near normal incidence can be achieved by using alternate layers of high and low density materials with periodicity in nanometer range. Their fabrication requires the capability to deposit uniform, ultra thin (few angstrom) films of different materials with thickness control in atomic scale. Thus one requires a proper understanding of substrate surfaces, individual layers, chemical reactivity at interfaces and finally ML structure for particular applications. The performance of the XUV ML is limited by contrast in optical constants of the two materials, interfacial roughness and chemical reactivity of two materials and the thickness errors of individual layers.

Our present focus is on the physics of MLs and development of XUV ML optical devices for synchrotron radiation applications, and present some of Mo/Si XUV MLs fabricated using the indigenously developed ultra high vacuum electron beam evaporation system. The MLs have been characterized using hard x-ray reflectivity (XRR) and the performance of MLs is tested on Indus -1 synchrotron radiation (SR) source.

We show in fig. A.9.1, a typical hard XRR spectrum measured using Cu Kα (λ=1.542 Å) of Mo(30Å)/Si(60 Å) ML with number of layer pairs, N=30. Bragg peaks up to fifth order clearly shows a well-defined layer structure of the ML. The measured reflectivity spectrum is fitted using Parratt formalism with four-layer model. The best-fit results show Mo-on-Si interlayer thickness is 10 Å whereas Si-on-Mo interlayer thickness is 8 Å.

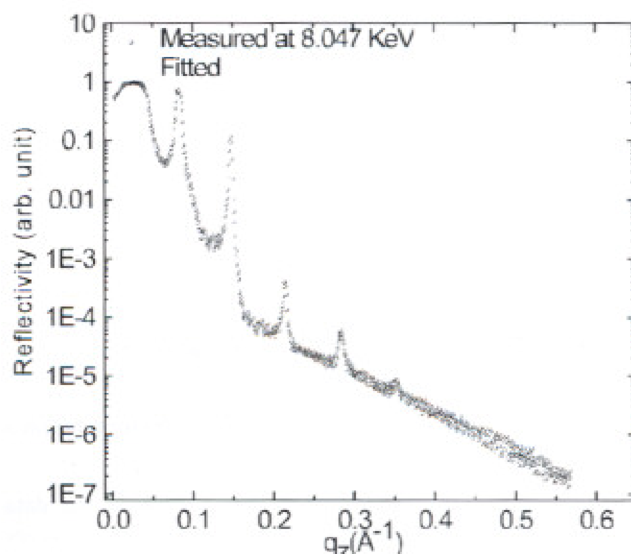

***Fig. A.9.1** X-ray reflectivity of Mo (30Å)/Si (60Å) ML with N=30 at 8.047 KeV. The best-fit results reveal Si roughness is 8 Å and Mo roughness is 10 Å*

The actual performance of MLs is tested using reflectivity beamline on Indus -1 SR source. Fig.A.9.2 shows, wavelength dependent reflectivity of Mo/Si ML at 46^0 incidence angle. 45 % reflectivity with spectral bandwidth 2.9 Å is achieved for this ML. Fig. A.9.3 shows, the measured Bragg peak reflectivity for 115 to 160 Å wavelength using Indus -1 SR. The reflectivity decreases drastically below Si L-absorption edge (~124Å). ML has good reflectivity at Brewster angle (close to 45^0) and can be used as XUV polarizor for Indus -1 SR. These polarizers have wide application in XUV ellipsometry.

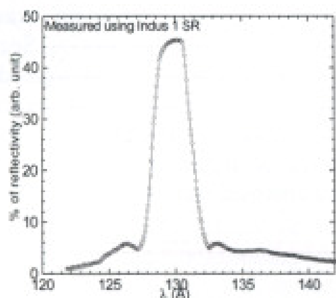

Fig. A.9.2 Wavelength dependence of Mo/Si ML at 46° incidence angle

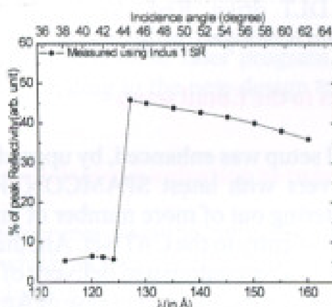

Fig. A.9.3 Wavelength dependence of peak reflectivity of Mo/Si ML (N=30)

(Contributed by: M. Nayak; nayak@cat.ernet.in, G.S. Lodha and R.V. Nandedkar)

A.10 Diffuse reflectance analysis of dyes with FTIR spectrometer

Fourier transform infrared (FTIR) spectrometer installed in our lab has provision to accommodate diffuse reflectance assembly. Solid organic compounds with dipole moment absorb IR radiations depending upon number of bonds, atomic arrangements and functional groups. Diffuse reflectance (DR) analysis is a simple and convenient substitute of other solid sample analysis techniques. It is used for structural studies and presence of impurities of the IR active molecules. Organic dyes dissolved in solvents such as water or alcohols, due to their high polarity, make it difficult to study individual components (fig.A.10.1 & A.10.3). Most of the components merge together and produce spectrum, which does not disclose either complete structure or presence of impurities in the molecule. With DR we studied pH sensitive, anodizing and Rhodamine 6G dyes. These spectra clearly show individual components present in the dyes (fig. A.10.2 and A.10.4). Anodizing dyes are being used in the chemical treatment facility and Rhodamine 6 G in the dye lasers. Both these dyes were dissolved in solid and dehydrated spectroscopic grade potassium bromide matrix and scanned between 400 to 4000 cm^{-1} wave numbers (mid IR region). The spectra shows presence of – NH, Benzene ring modes, C – O – C, CO, CH_2, CH_3 and C = C, etc. absorption bands.

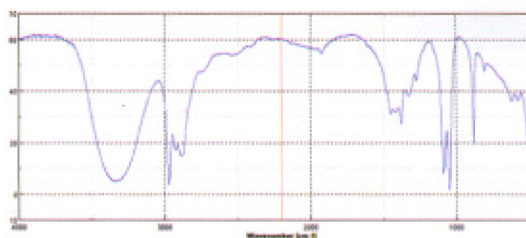

Fig. A.10.1 Spectrum of Rhodamine 6 G in ethanol

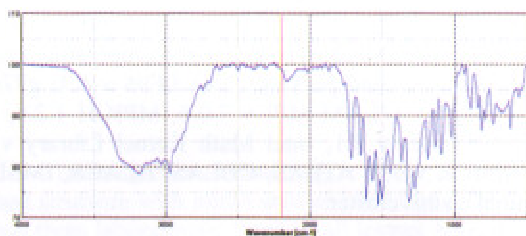

Fig. A.10.2 DR Spectra of Rhodamine 6

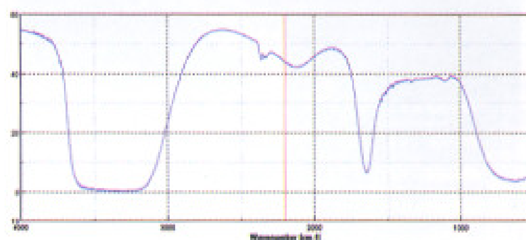

Fig. A.10.3 Spectrum of anodizing dye in water

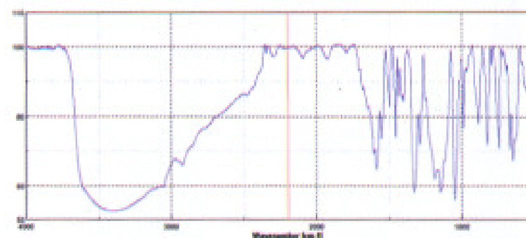

Fig. A.10.4 DR Spectra of anodizing dye

The spectra shows presence of bonded (carboxylic acid) and free – OH, Benzene ring modes, CH_3 symmetric and asymmetric stretches and C = C, etc. absorption bands. Peak area at a particular wave number shows concentration of individual component in the molecule. On this basis quantification of dyes is also possible.

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