Interface characterization in Pt/C x-ray multilayer

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Platinum/ carbon x-ray super mirrors are being developed on gold and platinum replica foil mirror backed with aluminum substrate for high-energy astrophysics measurement [1]. The low interfacial roughness (< 3A) is an essential requirement for this development. X-ray specular, non- specular and standing wave measurements have been performed for detailed characterization of interfaces in Pt/C multilayers with period length of 30~50A and number of layer pairs of 10~50.

Wavelength and energy dispersive specular reflectivity measurements were performed over a broad energy range (1.5 to 50 keV) using laboratory x-ray source and Spring 8 synchrotron radiation facility. RMS interfacial roughness for Pt/C multilayers and super mirrors deposited on replica foil mirrors and float glass were obtained from these measurements to be ~3A over a broad energy range.

Non-specular scattering measurements were performed at 32 keV using Spring 8 SR source. Non specular component was measured at critical angle, just below Bragg peaks, at Bragg peaks and just above Bragg peaks. These measurements provided information on the lateral correlation and conformity of the roughness at the interfaces. For these measurements detector scans (fixed incident angle and detector angle varying) were preferred over rocking curve scans (detector angle fixed and incident angle varying). In detector scans the field distribution inside the multilayer remains fixed during measurement. In this case, the structure observed is only caused by phase superposition of scattered beam. These measurements are also important for imaging applications, to study the diffused halo around the image point.

Standing wave fluorescence measurements were performed at 17 keV. Pt L fluorescence yield was measured in association with specular reflectivity measurement. The phase and fluorescence modulation provides a measure of mean position and width of atom distribution within the period length d. These measurements provide quantification of interfacial effects and yield substantial information about multilayer perfection. First order model fitting shows presence of about 10% dissolved platinum in the carbon layer.

[1] "Supermirror hard x-ray telescope" K Yamashita et al, Applied Optics 37(34) (Dec. 98) 8067 -8073