Depth resolved chemical speciation of a superlatice

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Grazing incidence x-ray reflectivity (XRR) investigation together with x-ray standing wave (XSW) assisted grazing incidence x-ray fluorescence (GIXRF) measurements have been demonstrated as a sensitive probe to quantitatively evaluate the properties of a buried layer structure inside a superlattice structure. We have carried out depth resolved x-ray absorption near edge fine structure (XANES) studies near the W-L_3 absorption edge energy (E ~ 10207 eV) for a W-B_4C superlattice structure. Our results show that the XSW assisted fluorescence measurements are markedly sensitive to the location and interface morphology of a deep buried layer inside the W-B_4C superlattice [1, 2]. The technique offers a unique capability to reveal slight density variations or any atomic migration occurring in any layer deep inside the multilayer medium. The cross sectional transmission electron microscopy (TEM) results obtained on the same W-B_4C multilayer structure provide a deeper look on the overall reliability and accuracy of the XSW method.

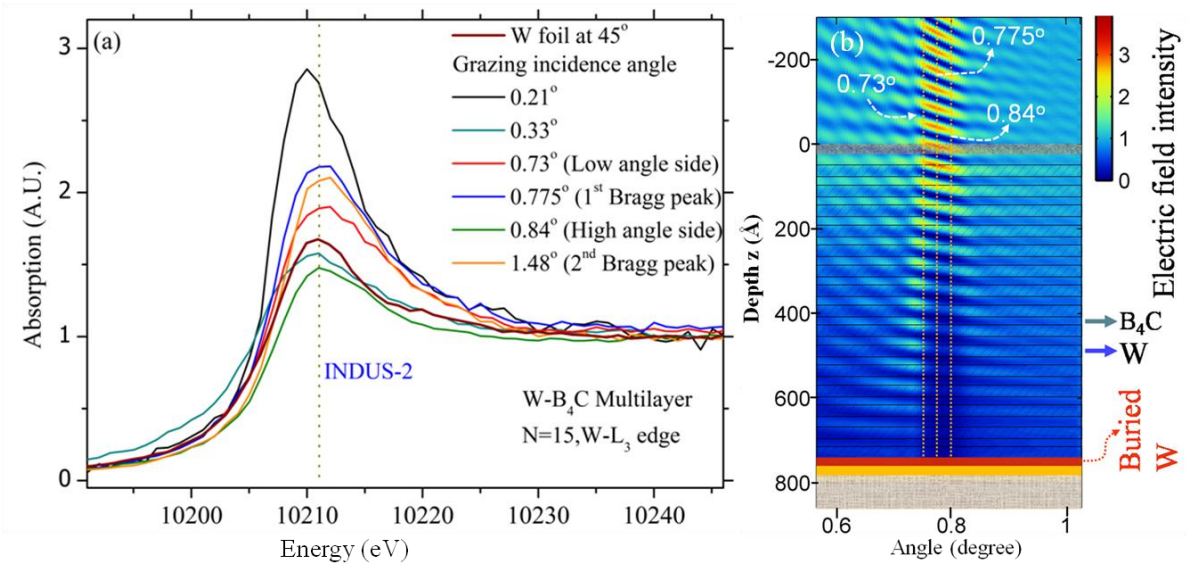

Figure 1. (a) X-ray standing wave induced XANES profiles of W-B_4C superlattice structure at L_3 edge of W. (b) Computed x-ray field intensity distribution inside the W-B_4C superlattice at 10230 eV x-ray energy in the vicinity of the 1st order Bragg peak.

Figure 1(a) shows the XSW induced XANES profiles recorded for the W-B_4C superlattice near W-L_3 edge at various grazing incidence angles. Interestingly, our results reveal the existence of unusual electronic state at the surface –interface boundary as compared to that of the bulk. The grazing incidence x-ray diffraction analysis carried out on the same W-B_4C multilayer provides the polycrystalline nature of W layer with a very small grain size boundary and support XSW results. Such measurements are found to be very useful in unravelling depth resolved chemical nature of various elements in the layered materials at atomic length scale resolution.

References

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