Resonant reflectivity as a non-destructive tool to study interface in x-ray multilayer mirrors

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Abstract

X-ray reflectivity shows a resonant behavior near the atomic absorption edges[1] because of the strong variation of the atomic scattering factor near the edges[2]. Elemental specificity of resonant XRR would be achieved by tuning the energy of x-rays to the absorption edge of the element being investigated, and is suited for the investigation of buried interfacial layers[3]. With the availability of tunable monochromatic x-rays from synchrotron source, the use of x-ray technique based on resonant scattering becomes viable. While the imaginary part of the scattering factor used in the x-ray absorption fine structure spectroscopy and related techniques, more attention has given to the use of its real part recently [4]. In this study we present the possibility of the application of soft x-ray resonant reflectivity (SXRRR) for the characterization of buried interfaces in low-Z containing x-ray multilayer structures, using the fine structure features of energy-dependent atomic scattering factor near the atomic absorption edges of constituent low-Z elements. SXRRR measurements were carried out using Indus-I synchrotron radiation source. We have determined interlayer composition at the interfaces with sub-nanometer scale sensitivity. Near the absorption edge, atomic scattering factor is sensitive to composition, and can be exploited for compositional analysis of buried interfaces. We demonstrate this for a well-characterized Mo-Si multilayer system, using simulations, and by SXRRR measurements, tuning the incident photon energy to near the Si L-edge. It is shown clearly that SXRRR has greater sensitivity to composition of interlayers than normal hard x-ray measurements. Our best-fit soft x-ray results reveal (Fig.1) that the $MoSi_2$ composition is formed at both the interfaces viz. Mo-on-Si and Si-on-Mo, in good agreement with results obtained using depth-graded XPS measurements.

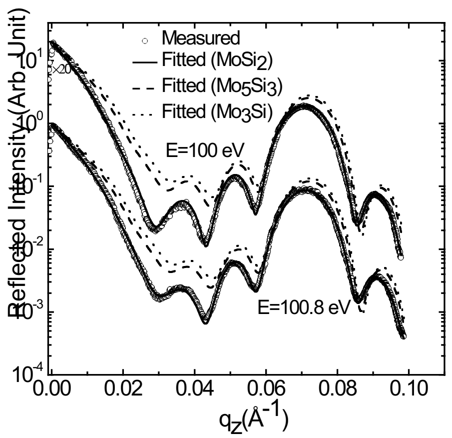

Fig1. Measured and fitted soft x-ray reflectivity of $[Mo/Si]_5$ ML with periodicity 9 nm and gama value 0.3 at selected photon energies near Si L-edges (L_{II} =100.47 eV and L_{III}=99.9eV) using Indus-1 SR source. The best fit is obtained for $MoSi_2$ composition.

References:

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