X-RAY FLUORESCENCE IMAGING OF BURIED INTERFACE

Wenyang Zhao[2,1] and Kenji Sakurai[1,2]
[1] National Institute for Materials Science, 1-2-1, Sengen, Tsukuba, Ibaraki 305-0047 JAPAN
[2] University of Tsukuba, 1-1-1, Tennodai, Tsukuba, Ibaraki 305-8577 JAPAN

The present paper reports a nondestructive technique to visualize the spatial distribution of elements at buried interfaces. In many cases, the inhomogeneous distribution of elements in a sample is of great interest, because many properties of the sample are more likely to be determined by some patterns or special distributions of the elements rather than the average concentration. The existing technique of grazing-incidence X-ray fluorescence (GI-XRF) [1] and X-ray standing wave (XSW) [2] combined with X-ray fluorescence (XRF) are able to measure the concentration of elements at different depth, especially the concentration of elements at specific interfaces in a multilayer sample. However, they are not able to reveal the inhomogeneous distribution of elements at the interfaces.

The present research combines the technique of XSW with full-field XRF fluorescence imaging. The sample is a periodic multilayer superlattice. The X-ray source is a thin X-ray beam collimated from a laboratory X-ray tube of molybdenum target. It illuminates a large area on the sample with a small grazing-incidence angle. A micro pinhole is placed in front of the sample to project fluorescent X-rays to the detector. The detector is a scientific CMOS camera. The camera serves as a 2D X-ray energy detector when it is used in single photon counting mode, and therefore it is able to measure the XRF spectra as well as the element-distinguishable XRF images.

In the experiment, the grazing angle between the X-ray beam and the sample surface is adjusted to satisfy the Brag Diffraction condition. In this condition, reflection X-ray wave is generated, and subsequently the XSW filed is created by the interference of the incident X-ray wave and the reflection X-ray wave. Because the depth of the XSW nodes is sensitive to the grazing angle, the intensity distribution of primary X-rays in the multilayer sample can be controlled by tuning the grazing angle. Thus, the element-distinguishable XRF images recorded by the camera change when the grazing angle is gradually changed. By modeling the correlations in the changing process, the distribution of elements at different buried interfaces is determined.

References

[1] R. Klockenkàmper and J. Knoth, *Anal. Chem.*, 1992, **64**, 1115–1123.
[2] J. Zegenhagen and A. Kazimirov, The X-ray standing wave technique: Principles and applications, World Scientific, 2009.