X-ray Standing Wave Imaging and Its Application in Langmuir-Blodgett Films

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The present talk describes a powerful extension of the X-ray standing wave (XSW) technique that combines it with the capability of full-field X-ray fluorescence imaging, so that the impurity depth profiles at all different parts of a nanolayer material can be measured in parallel. The imaging capability improves the robustness and reliability of the XSW technique in investigating inhomogeneous 2D materials and soft interfaces. It can also visualize the 3D element-specific structure at a buried interface with a depth resolution at the nanometer level. The in-plane spatial resolution is 160 μm or better, which is capable to resolve the macroscopic in-plane inhomogeneity in many large-size nanolayer materials.

So far, the present technique has been successfully applied to investigate the distribution of iron impurities in a Ni/C periodic multilayer (Fig.1) [1]. To process large amounts of imaging data efficiently, a new method of feature mapping was proposed so that the comparison of the impurity depth profiles at all different parts of the sample can be directly visualized. The present technique is also able to probe the depth profile and in-plane uniformity of functional groups in Langmuir-Blodgett films.

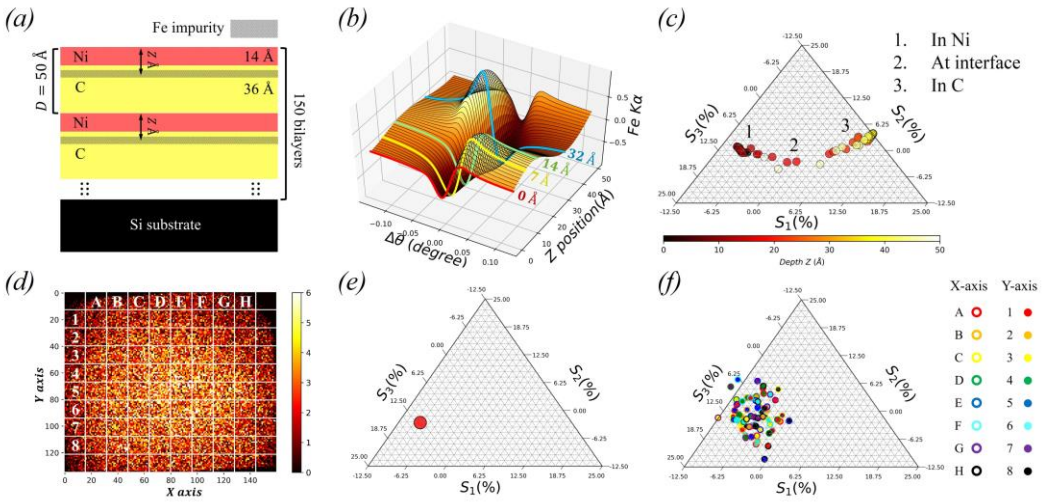

Figure 1. *(a)* Modelling the depth distribution of iron impurities in the Ni/C periodic multilayer. *(b)* Simulation of the Fe Kα intensity against the X-ray incident angle around the Bragg diffraction condition. The intensity profiles are quite sensitive to the relative depth *Z* of iron impurities in every Ni/C bilayer. *(c)* Feature mapping of the simulation. The shape of every intensity profile is represented by the position of its corresponding feature point in a ternary feature map. *(d)* Experiment results: one full-field Fe Kα image taken around the Bragg diffraction condition. In the experiment a series of such images were taken during the angular scan. The entire probing area is 5.5 mm × 4.7 mm and it is artificially divided into 10 × 10 micro regions for the sake of imaging analysis. *(e)* Feature point of the entire probing area. It only provides an average estimation. *(f)* Feature points of all micro regions. They disperse around one center which corresponds to nickel layers, indicating that the iron impurities are correlated to the nickel layers.

References:

[1] W. Zhao, K. Sakurai, Novel X-ray standing wave technique with spatial resolution: in-plane characterization of surfaces and interfaces by full-field X-ray fluorescence imaging, *Phys. Rev. Mater.* (**in process)**