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Probing Heterogeneous Structures on Surfaces by X-ray and Neutron Reflection Tomography

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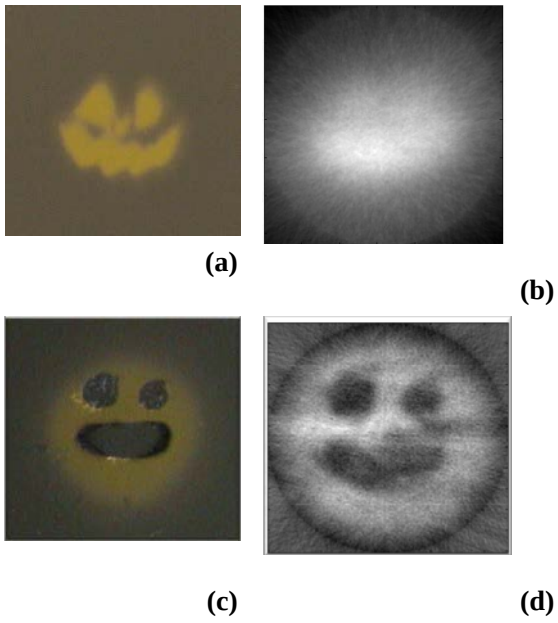
With the advent of nanotechnology, devices are increasingly built to smaller and smaller scales because of the ability of nano-structures (films, dots, wires) to have better properties as compared to the bulk. X-ray and neutron reflectivity are standard methods in characterizing nano-scale thin films and layered materials and one of the most important non-destructive probe for the surface and interface. These techniques are considered to be complementary as X-rays interact with electrons while neutrons interact with the nucleus and gives information on magnetism and sensitive to light elements. However, reflectivity lacks spatial resolution as it looks at a large surface area of the sample (mm^2-cm^2) such that it only gives “average” information on the whole surface. Reflectivity cannot possibly obtain information on the location and distribution of heterogeneous structures on the surface/buried interface such as nanopatterns, clustering or inhomogeneity of thin films. By utilizing the concept of standard computerized tomography (CT) imaging [1], X-ray/neutron reflectivity can be used to image heterogenous structures on/in a sample. Reflection tomography is based on the measurement of line integrals of the object reflectivity function. The forward specular reflection from the object, at grazing incidence, is being recorded and by rotating the sample in-plane, reflectivity line integral projections can be used to reconstruct the two-dimensional pattern on the surface/interface. We report here our simulation work of reflection tomography using a phantom image as well as experimental results with X-rays and neutrons.



(a) **(b)**

(c) **(d)**

Figure 1: Actual sample and reconstructed images for neutron reflection (a & b) and for X-ray reflection (c & d) tomography.

Reference:

[1] G.T. Herman, Image Reconstruction from Projections: The Fundamentals of Computerized Tomography