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Development of neutron reflectometry tomography and its application to polymer interfaces

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Neutron reflectometry (NR) is a powerful technique to explore the structure of the surface and interfaces of materials. In a typical NR experiment, the sample surface/interface must be uniform over an area of more than 10 cm² due to the size of the neutron illumination. Therefore, conventional NR has been inapplicable for the structure analysis of the sample with in-plane inhomogeneity. We developed an NR imaging technique to examine the position-dependent NR profile. The spatially resolved NR profile perpendicular to the beam axis is directly measured with the sheet-like neutron illumination and a position-sensitive detector. An NR image is reconstructed by a computer tomography (CT) calculation for the reflectivity at a given momentum transfer, q, dependent on the in-plane rotation angle of the sample. The spatial resolution of the NR-CT method is determined by the collimation condition of the neutron beam and the resolution of the detector. With a neutron reflectometer SHARAKU in J-PARC, the achievable resolution is ca. 0.6 mm. The CT reconstruction images based on the reflectivity at various q provide the NR profile at each image pixel, and the depth structure of the neutron scattering length density can be evaluated at a local area as small as 0.1 mm². In this presentation, the application of the NR-CT to the analysis of laterally inhomogeneous interfaces of a polymer system is also demonstrated.

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Thin films and interfaces in soft matter and materials science

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