MS56.O06

In-Situ Neutron Reflectometry on Polymer Thin Films in Different Environments

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Neutron reflectometry is indispensable for the studies on material interfaces and thin films, since it can probe the interfaces non-destructively with a quite high depth resolution. Here, the interfacial structures of polymer thin films in different environments: hot and wet, were examined by means of in-situ neutron reflectometry. The neutron reflectivity measurements were performed on a time-of-flight reflectometer SOFIA [1, 2] at the Japan Proton Accelerator Research Complex (J-PARC). The depth distribution of components was investigated for binary blend thin films of polystyrenes with different molecular weights to clarify the mechanism of de-wetting suppression effect by blending a small amount of the longer homologue. It was found by static measurements that the longer chains deplete from the air surface of the film, while they slightly localize at the interface with the substrate. The time evolution of the component distribution was also examined by in-situ measurements above the glass transition temperature in a vacuum. The structural change of lamellarly-ordered styrene-2-vinylpyridine (PS-P2VP) diblock copolymer thin film in contact with solvent was explored by in-situ neutron reflectometry with a conventional solid/liquid cell. During the block copolymer thin film was in contact with methanol, which is selective for P2VP, some of methanol penetrated into the film causing the structural change. However, the original structure was almost recovered after drying, though annealing effect was slightly observed. When toluene was made contact, which is selective for PS, the block copolymer thin film was immediately dissolved into, and never recovered.

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Keywords: In-situ neutron reflectometry, Polymer thin film, Interfacial environment