Division of Multidisciplinary Chemistry
– Polymer Materials Science –

http://www.scl.kyoto-u.ac.jp/~polymat/index.html

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Scope of Research

The structure and molecular motion of polymer substances are studied, mainly using scattering methods such as X-ray, neutron, and light with intent to solve fundamentally important problems in polymer science. The main projects are studied on 1) the morphologies and the dynamics of self-assembling processes in block copolymers, 2) the hierarchical structures in crystalline polymer and rubber-filler systems, 3) the viscoelastic effects in glassy materials, 4) formation processes and ordering structures in polymer thin films.

KEYWORDS

Polymer Physics
Self Assembly
Hierarchical Structure
Polymer Properties
Softmatter

Selected Publications

Wang, Y.-C.; Wakabayashi, M.; Hasegawa, H.; Takenaka, M., 3D-TEM Study on the Novel Bicontinuous Microdomain Structure, *Soft Matter*, **13**, 8824-8828 (2017).
Wang, Y.-C.; Inoue, A.; Hasegawa, H.; Takenaka, M., The Formation of OTDD Network Structure in PS-b-PI-b-PDMS Triblock Terpolymer Authors, *Macromol. Chem. Phys*., **218,** 1700008(1-7) (2017).
Ogawa, H.; Nishikawa, Y.; Takenaka, M.; Fujiwara, A.; Nakanishi, Y.; Tsujii, Y.; Takata, M.; Kanaya, T., Visualization of Individual Images in Patterned Organic-inorganic Multilayers Using GISAXS-CT, *Langmuir*, **33,** 4675-4681 (2017).

3D-TEM Study on the Novel Bicontinuous Microdomain Structure

An ordered bicontinuous double-diamond (OBDD) morphology was found in Polystyrene-*block*-(poly-4-vinylphenyldimethylvinylsilane-*graft*-polyisoprene), PS-*b*-(PVS-*g*-PI), block-graft copolymer. We obtained 3D image of the microdomain structure formed in PS-*b*-(PVS-*g*-PI) by using 3D-TEM method. The 3D image shows the polystyrene (PS) phase consists of two independent and interwoven networks. The structures of two networks are identical and tetrapod units form a planar six-membered ring in the networks. The features of the networks agree with those in OBDD, indicating the morphology of PS-*b*-(PVS-*g*-PI) is an ordered three-dimensional OBDD networks of PS phase in polyisoprene (PI) matrix phase. The grafted PI chains induce the frustration of PS chains and thus the effects of specific interface are more dominant that those of the packing frustration in the formation of the morphology and OBDD phase is thus stabilized.

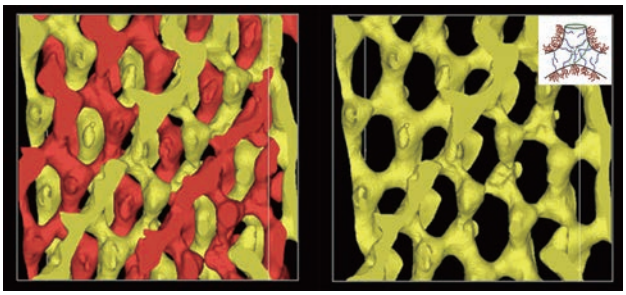

Figure 1. 3D TEM image of OBDD in PS-*b*-(PVS-*g*-PI).

Visualization of Individual Images in Patterned Organic-inorganic Multilayers Using GISAXS-CT

Grazing-incidence small-angle X-ray scattering (GISAXS) have been used for nanometer level structural analysis of thin organic and in-organic films. Two-dimensional (2D) patterns of GISAXS enable quantitative morphological analysis on the length scales ranging from 1 nm to 100 nm. In the case of GISAXS coupled with CT, owing to the reconstruction based on the scattering intensities, it is possible to obtain spatial distribution images of nanostructures in thin film samples on the substrate. GISAXS-CT was employed for characterizing Au and PS-*b*-P2VP multilayers. Owing to the difference between total reflection angles of Au and PS-*b*-P2VP, the scattering profiles for Au nanoparticles and self-assembled nanostructures of PS-*b*-P2VP could be independently obtained by changing the X-ray angle of incidence. Reconstruction of scattering profiles allows to separately characterize spatial distributions in Au and PS-*b*-P2VP nanostructures.

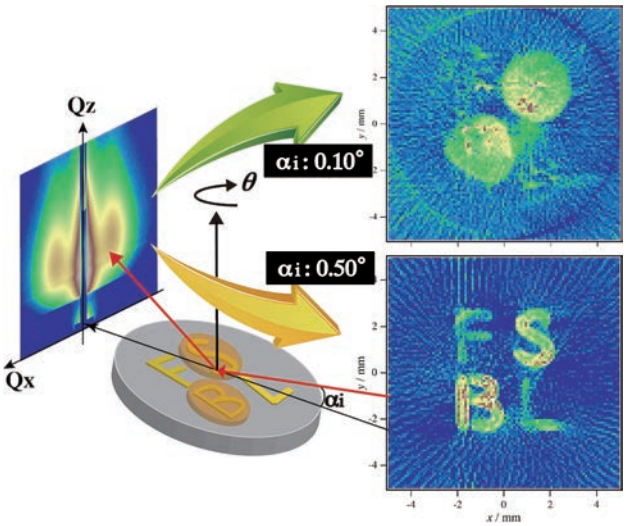

Figure 2. Reconstruction images from Au layer buried under a thin PS-*b*-P2VP layer.