Synchrotron Grazing Incidence X-ray Scattering and Its Applications in Polymer Nanotechnology

Moonhor Ree, Byeongdu Lee, Jinhwan Yoon, Kyuyoung Heo, Kyeong Sik Jin, Sangwoo Jin, Hyunchul Kim, Ghahee Kim, Seung Chul Choi, Weontae Oh, Young-Hee Park, Yongtaek Hwang, Jong-Seong Kim, Jehan Kim, Kwang-Woo Kim, Taihyun Chang*

Department of Chemistry, Pohang Accelerator Laboratory, National Research Laboratory of Polymer Synthesis and Physics, Division of Chemistry, BK21 Program, and Polymer Research Institute, Pohang University of Science and Technology, Pohang 790-784, Republic of Korea
(E-mail: ree@postech.edu)

A schematic optical setup of grazing incidence X-ray scattering (GIXS) is given and compared with that of conventional transmission X-ray scattering (TXS) in Fig. 1. Synchrotron GIXS has several important advantages over transmission X-ray and neutron scattering as well as scanning and transmission electron microscopies: (i) a highly intense scattering pattern is always obtained, even for films of nanoscale thickness as well as nanostructures on substrates, because the X-ray beam path length through the film plane is sufficiently long; (ii) there is no unfavorable scattering from the substrate on which the film is coated; and (iii) easy sample preparation [1-9]. For these advantages, in recent years the GIXS has become the major analytical tool for characterizing structures and properties of a variety of nanostructures and nanoscale thin films in a single and multilevels. However, the quantitative analysis of measured GIXS data requires developing a new proper scattering theory because of the complexity of GIXS phenomenon due to the scatterings from the transmission and reflected X-ray and the refraction effect, which is very far from the conventional transmission and reflection X-ray and neutron scattering. We have newly developed a GIXS theory and its data analysis method [1,2]. In our study GIXS measurements with synchrotron radiation sources were conducted statically and in-situ for a series of nanoscale thin films prepared from nanoporous dielectrics, block copolymers, brush polymers, and molecular assemblies (Fig. 1) [1-9]. All GIXS measurements were performed at the Pohang Accelerator Laboratory (PAL) (Fig. 2) [10]. The measured scattering data were analyzed in detail by using the newly developed GIXS scattering theory. All GIXS results will be discussed in details with considering the materials chemistry and nanostructure formation process parameters.

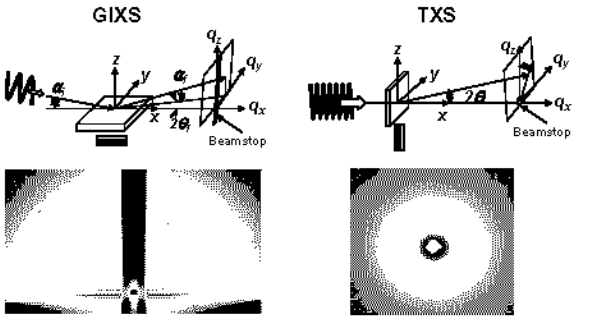

Figure 1. Schematic diagrams of GIXS and TXS.

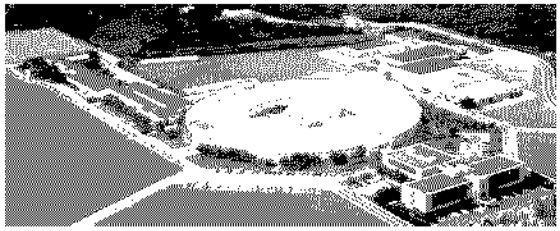

Figure 2. Synchrotron facility of Pohang Accelerator Laboratory

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