Surface and Interface Structure of (Deuterated Polystyrene with Silsesquioxane End Group/Polystyrene) Blend Thin Films

Kyota Miyamoto, Nao Hosaka, Motoyasu Kobayashi, Atsushi Takahara
Institute for Materials Chemistry and Engineering, Kyushu University

Polymer thin films have numerous technological applications which require the presence of a homogeneous film. However, producing stable films is problematic since the polymer thin films tend to dewet from the substrate. Previous study revealed that the addition of polyhedral oligomeric silsesquioxanes (POSS) to the polystyrene (PS) thin films led to an inhibition of dewetting in the films [1]. This inhibition effect can be attributed to the changes of the energetics of the surface and interface of the film by the segregation of POSS. Furthermore, the enhancement of the PS thin films by the addition of POSS-terminated PS (PS-POSS), prepared to improve the affinity of POSS with PS, was also demonstrated [2]. In this study, neutron reflectivity (NR) technique is used to characterize the surface and interfacial structures of the deuterated PS-POSS (dPS-POSS)/PS blend thin film.

dPS-POSS2.9k (Mn = 2900, Mw/Mn = 1.09)/PS44k (Mn = 44000, Mw/Mn = 1.04) (32/68 w/w) blend thin film was spin-coated from the toluene solution onto acid-cleaned Si wafer. The film was annealed under vacuum at 393 K for 3 hours. NR measurement was carried out using MINE at JRR-3M with 0.88nm of incident neutron beam. Figure 1 shows the NR profile of the dPS-POSS2.9k/PS44k (32/68 w/w) blend thin film. The solid line denotes the fitting curve based on the model scattering length density (b/V) profile, as shown in the inset of Figure 1. Increase in the b/V values was observed at the both of surface and interface of the film, which suggested that dPS-POSS was enriched at the interface as well as the surface. Similar results were also observed in the different deuteration contrast film (PS-POSS2.5k (Mn = 2500, Mw/Mn = 1.11)/deuterated PS38.5k (Mn = 38500, Mw/Mn = 1.07) blend)reported in our previous study. From these results, it can be concluded that the segregation of POSS moiety was not due to the deuteration effect. The segregation of PS-POSS, which changes the surface and interfacial free energy of the film, can be an important factor in the dewetting inhibition effect.

References

[1] N. Hosaka, N. Torikai, H. Otsuka, A. Takahara, Langmuir, in press.
[2] K. Miyamoto, N. Hosaka, H. Otsuka, A. Takahara, Chem. Lett., 36, 1098-1099 (2006).

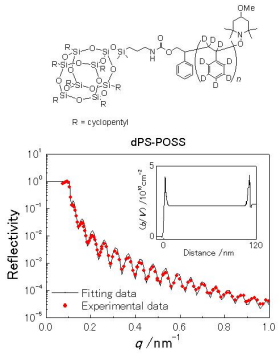

Fig. 1. Neutron reflectivity profile of dPS-POSS2.9k/PS44k (32/68 w/w) blend thin film. The inset shows the scattering length density profile of the film.