

Lamellar Structural Changes of Crystalline Polymer Blends during Heating and Cooling Processes

Akira KAITO*¹, Yongjin LI¹, Masaki SHIMOMURA¹, and Shuichi NOJIMA²

¹National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, 305-8565 Japan

²Department of Polymer Chemistry, Tokyo Institute of Technology, Tokyo, 152-8552 Japan

Introduction

Miscible crystalline/crystalline polymer blends have been of particular interest with respect to the lamellar morphologies, which depend upon composition and crystallization conditions. The crystal lamella of one component is sometimes incorporated into the interlamellar regions of another component (interlamellar inclusion) (Fig.1a), whereas the lamellae of the both components are segregated from each other in the interfibrillar regions in other cases (interlamellar exclusion) (Fig.1.b). In this work, in-situ SAXS measurements are applied to study the changes in lamellar structure of miscible crystalline polymer blends of poly[3-hydroxybutyrate] (PHB) and poly(vinylidene fluoride) (PVDF) [1,2] during heating, isothermal, and cooling processes.

Experimental

The two polymers were blended in DMF solution. The blend films were melt-pressed and rapidly cooled in ice water. The oriented films of PVDF/PHB=30/70 blend were obtained by uniaxially drawing the blend film to a draw ratio of 5.7.

In-situ SAXS measurements were conducted at the BL-10C beam line in the photon factory of the High Energy Accelerator Research Organization.

Results and Discussion

Figure 2a shows the changes in SAXS profile of PVDF/PHB = 30/70 blend at every 8°C during heating process. A SAXS peak is observed at $q=0.88 \text{ nm}^{-1}$ before heating, indicating that the long period, L , of the as-drawn sample is 7.1nm. This peak is assigned to the interlamellar exclusion structure of the lamellar stacks of PVDF and PHB. This peak shifts to a lower q -range at higher temperatures indicating that the long period increases with a rise in temperature. Figure 2b shows the changes in SAXS profile of PVDF/PHB=30/70 blend at every 4°C during cooling process. The peak position of the $q=0.6 \text{ nm}^{-1}$ peak does not change much. But a new peak arises at $q=0.32 \text{ nm}^{-1}$ ($L=19.5\text{nm}$) during cooling process and is intensified with a decrease in temperature. This peak is interpreted as originating from the interlamellar inclusion structure, because the long period of the structure is approximately the sum of the long periods of PBSU and PVDF.

References

- [1] L-Z Liu et al., J. Polym. Sci., Part B, 38, 2296 (2000).
[2] J. Liu et al., J. Polym. Sci., Part B, 42, 974 (2004).

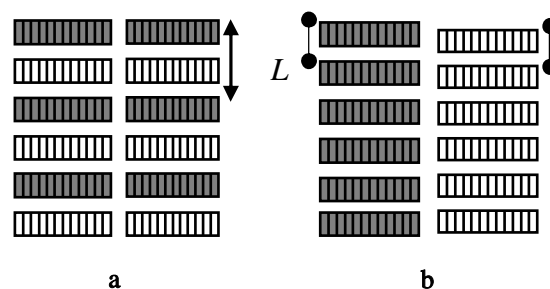


Fig. 1(a) interlamellar inclusion structure and (b) interlamellar exclusion structure

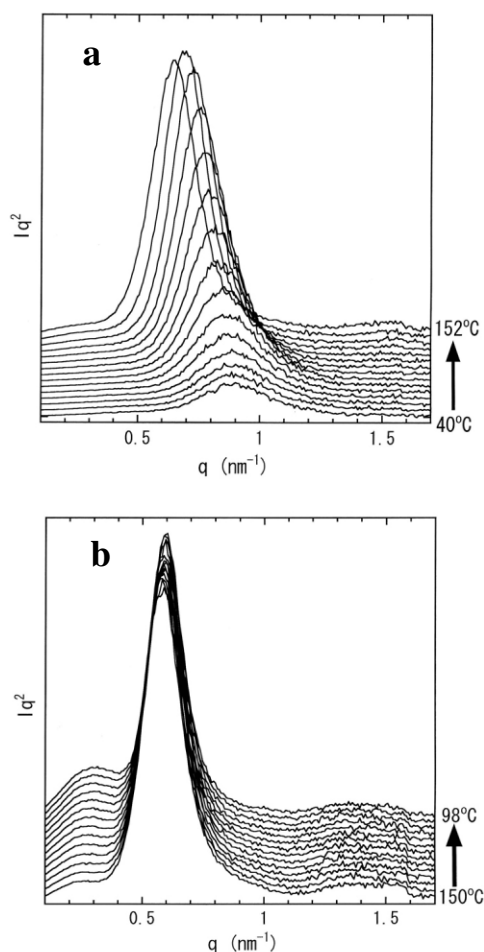


Fig. 2 Changes in SAXS profiles of PVDF/PHB=30/70 blend during heating (a) and cooling (b) processes.