

NOTE

Self-Assembly of Polycarbonate/Acrylonitrile–Butadiene–Styrene/Montmorillonite Nanocomposites

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INTRODUCTION

We have developed acrylonitrile–butadiene–styrene (ABS)/clay nanocomposites by melt-mixing technique in which ABS molecule chains have intercalated into the clay layers.¹ Other reports about polycarbonate (PC)/ABS alloy, ABS/clay, and PC/clay nanocomposites have been published by Lee et al., Huang et al., Choi et al., and Mitsuo et al.^{2–5} In this study, we synthesized PC/clay and PC/ABS/clay nanocomposites through the direct melt intercalation process, and first report the self-assembly of silicate layers in these two components.

EXPERIMENTAL

Materials

The materials examined in this study were PC (K-73000, Hiroshima, Japan) and ABS (PA-757, Qimei Stock Company, Tainan, Taiwan). Organophilic montmorillonite (OMT) was prepared from montmorillonite (MMT, with a cation exchange capacity of 122 meq/100 g) by ion exchange reaction using hexadecyl trimethyl ammonium bromide (C16) in water according to the reported method.⁶

Preparation and characterization of nanocomposites

Samples (Table I) were prepared by melt-mixing using a twin-roll mill (XK-160, Jiangsu, China) for 10 min to yield

hybrids. The dispersibility of the silicate layers in the polymer matrix was evaluated using an X-ray diffractometer (XRD, Japan Rigaku D/max –rA) and bright field transmission electron microscopy (TEM, JEOL JEM-100SX).

RESULTS AND DISCUSSION

Figure 1 shows the XRD patterns of PC–OMT, PC/ABS(4/1)–OMT, PC/ABS(3/2)–OMT, PC/ABS(1/4)–OMT, and ABS–OMT. Table I shows results of XRD patterns for MMT, OMT, and PC/ABS–OMT composites. The peaks correspond to the (001) plane reflections of the clays. From the analysis of XRD patterns in Figure 1, with the increasing content of ABS, the d_{001} peaks of PC–OMT, PC/ABS(4/1)–OMT, PC/ABS(3/2)–OMT, and PC/ABS(1/4)–OMT are almost the same, about 3 nm, and have 0.8 nm gallery height increase compared to that of OMT, indicating an intercalated structure, while the d_{001} peak for ABS–OMT is 3.3 nm.

In the TEM photograph, the gray continuous region corresponds to PC phase and the ABS appears as deep gray islands. The black lines correspond to clay layers. The TEM microscopy for PC/ABS(3/2)–OMT nanocomposite (Fig. 2) shows that the clay layers were almost dispersed in ABS phase (deep gray islands). Moreover, in the interphase region [Fig. 3(B)], a higher density of dispersed clay particles is observed compared to the density inside the ABS phase [Fig. 3(C)]. This segregation phenomenon may be related to the choice of the polymers and the melting temperature, and we will report on this later. Since the silicate layers were mainly dispersed in ABS phase, in PC/ABS–OMT nanocomposites, the relative content of clay in ABS phase is more than that in ABS–OMT nanocomposite, so the gallery height of clay layers in PC/ABS–OMT nanocomposites is lower than that in ABS–OMT nanocomposites.

This is the first time that we observed the self-assembly of clay layers in the PC/ABS matrix. It is well known that the presence of acidic or basic impurities will enhance the depolymerization of carbonic ester in PC.⁷ However, OMT can produce Lewis or Bronsted acid sites in the aluminosilicate when heated over 200°C,^{8,9} which have a catalytic effect on

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TABLE I
Summary of Polymer/Clay Compounds

Compound	Melt-mixing temp. (°C)	PC (wt %)	ABS (wt %)	OMT (wt %)	Main diffraction peak (d_{001}) (Å)
MMT		—	—		13
OMT		—	—		22
PC-OMT	225	95	—	5	29.5
PC/ABS(4/1)-OMT	225	76	19	5	30
PC/ABS(3/2)-OMT	225	57	38	5	30
PC/ABS(1/4)-OMT	225	19	76	5	29.9
ABS-OMT	175	95	—	5	33.4

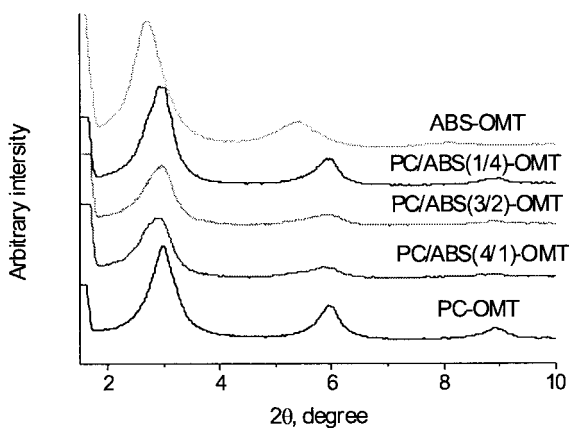


Figure 1 XRD patterns for PC-OMT, PC/ABS(4/1)-OMT, PC/ABS(3/2)-OMT, PC/ABS(1/4)-OMT, and ABS-OMT.

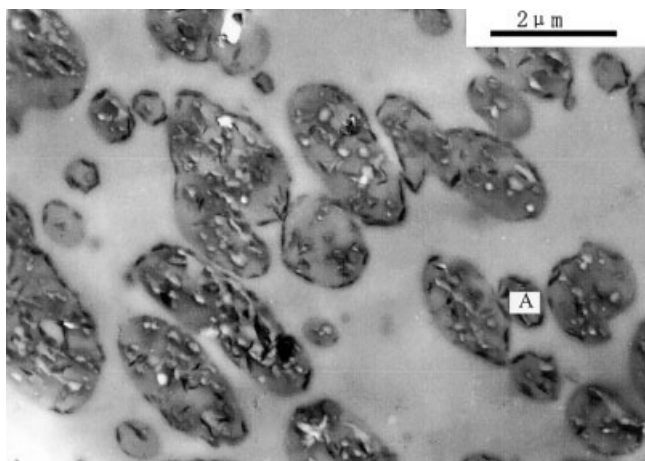


Figure 2 TEM photograph of PC/ABS(3/2)/OMT nanocomposite (A) ABS phase.

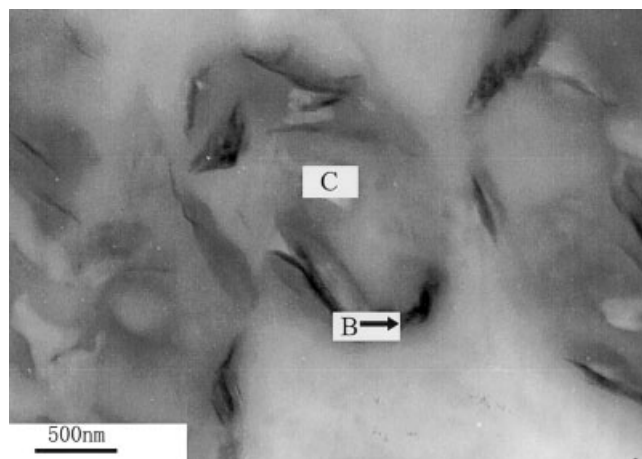


Figure 3 High-magnification TEM photograph of PC/ABS(3/2)/OMT nanocomposite.

the thermal degradation of PC. So, the selected dispersion of clay layers in ABS phase may be helpful for avoiding the catalytic effect of clay on PC when decomposition and enhance the thermal stability of PC/ABS.

References

1. Wang, S.; Hu, Y.; Song, L.; et al. *Polym Degrad Stabil* 2002, 77, 423.
2. Jang, L. W.; Kang, C. M.; Lee, D. C. *J Polym Sci, Part B: Polym Phys* 2001, 39, 719.
3. Huang, X.; Lewis, S.; Brittain, W. J. *Macromolecules* 2000, 33, 2000.
4. Choi, H. J.; Park, S. H.; Kim, J. K.; Jun, J. I. *J Appl Polym Sci* 2000, 75, 417.
5. Notomi, M.; Kishimoto, K.; Wang, T.; Shibuya, T.; *Key Eng Mater* 2000, 183-187, 779.
6. Hu, Y.; Song, L.; Xu, J.; Yang, L.; Chen, Z.; Fan, W. *Colloid Polym Sci* 2001, 279, 819.
7. Lee, L.-H.; *J Polym Sci: Part A* 1961, 2, 2859.
8. Xie, W.; Gao, Z.; Pan, W.-P.; et al. *Chem Mater* 2001, 13, 2979.
9. Zanetti, M.; Camino, G.; Canavese, D.; et al. *Chem Mater* 2002, 14, 189.