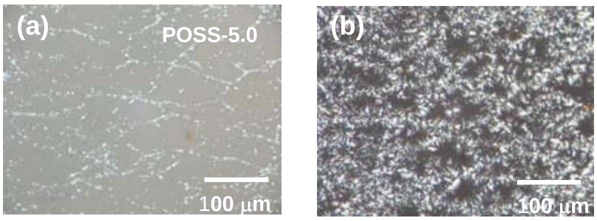
Isothermal Crystallization Behavior and Morphology Development of Isotactic Polypropylene/Polyhedral Oligomeric Silsesquioxane Nanocomposites

Jean-Hong Chen (陳建宏), Wen-Bin Su (蘇文彬), and Ru-Zheng Lin (林儒政)

Department of Polymer Materials, Kun Shan University, Tainan, Taiwan

It is well known that the use of nucleating agents in polymers are extensive and become importance process because of to control the crystallization behavior ana to modify the microstructure that retards or enhances the physical properties of polymers. Therefore, the blended with nucleating agents in polymer attract much interests because the relationship between the structure of nucleating agents and the physical properties of polymer matrix is very complicated. Recently, the cage-shaped polyhedral oligomeric silsesquioxane (POSS) molecules are new classes of nanoparticles in the polymer science and attract much research group's interest. The POSS molecules can be dispersed in many polymers by the adjustment of the functionalized substituents on the POSS cage. The X-ray diffraction data were collected using synchrotron radiations at NSRRC BL17B3 beam lines.



Nucleate

Growth for 3 min

Figure 1. Spherulite morphologies of isothermal crystallization process of POSS-5.0 composites with various POSS content at 130°C, magnification×400: (a) nucleate, (b) growth for 3min, respectively.

It is interesting to notice that the nucleation process of POSS-5.0 presents the dispersed POSS molecules arranges to form the POSS nanocrystal in the initial stage of crystallization, and than those dispersed POSS nanocrystals aggregates to from the thread-like or network structure inducing the heterogeneous nucleation at the secondary stage of crystallization. Finally, the molten iPP molecular event assisted by the POSS nanocrystals and then spherulite growth of iPP in the melted iPP region retarding by dispersed POSS molecules. (Fig. 1)

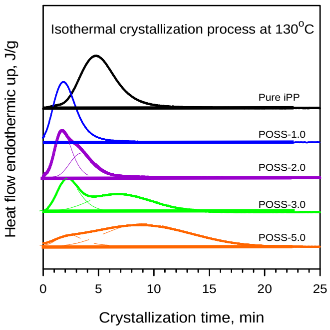


Figure 2. Influence the POSS content on the isothermally crystallization mechanisms of iPP/POSS composites at 130°C.

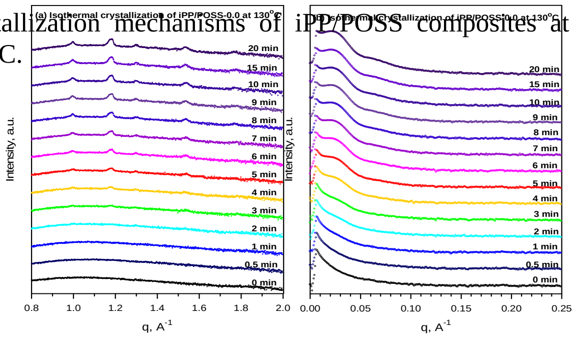


Figure 3. The isothermal crystallization behavior of neat iPP homopolymer at 130°C for 20min after melted: (a) WAXS profile; and (b) SAXS profile.

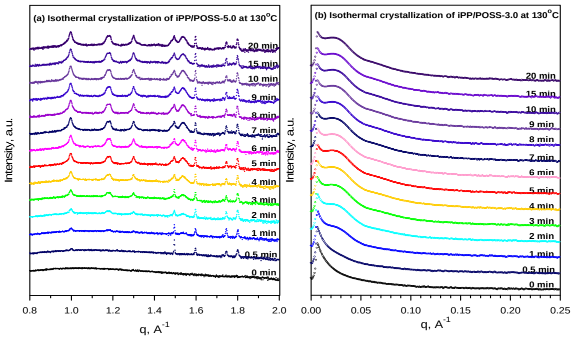


Figure 4. The isothermal crystallization behavior of POSS-5.0 at 130°C for 20min after melted: (a) WAXS profile; and (b) SAXS profile.

These results of Figs.2-4 indicates that at higher POSS contents show to be more favorable aggregates to form the thread- or network-like structures of dispersed POSS and retards the mobility or diffusion ability of molten iPP chain during crystallization. From above result, therefore, we postulated that the strongly interaction between POSS molecules (dipole-dipole interaction between oxygen atoms on the POSS cage) and weakly interaction between POSS and iPP matrix (dispersion force between methyl groups on the POSS cage and polypropylene) dominated the isothermal and unisothermal crystallization behaviors of iPP/POSS composites at quite low loading of POSS due to the major POSS nanocrystals morphologies appeared an effective nucleating agent and promoted the nucleation rate of iPP, whereas the minor dispersed POSS molecules that slight miscibility between iPP retarded the nucleation and growth rates of iPP in the remaining bulk region during crystallization.