Formation of silica network structures using sol-gel reaction in polypropylene amorphous region as template.

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Properties of polymer based-nanocomposites have been known to be dramatically influenced by the formation of a percolation network, which originates from either polymer-filler or filler-filler interaction. The percolation threshold having the minimum content of filler to form a network structure is largely affected by dispersion state of filler. Akcora et al. successfully controlled the dispersion of spherical filler in amorphous polystyrene by utilizing self-assembly of the filler particles, and concluded that low-dimensional aggregates such as one-dimensional string or two-dimensional sheet morphology resulted in much higher reinforcement and lower percolation threshold as compared with zero-dimensional uniform dispersion or three-dimensional compact aggregates [1].

However, the aploar nature of polypropylene (PP) makes it extremely difficult to control the dispersion of an inorganic filler because of its severe agglomerate in the PP matrix. To overcome this difficulty, the impregnation of silicon alkoxide into PP using supercritical carbon dioxide (sc-CO_2) and the subsequent sol-gel reaction were employed in this study [2]. Since the silicon alkoxide is impregnated only into the continuous amorphous region, a filler network is formed in the region. Furthermore, it is expected to design various network structures by controlling amorphous region as a template. The purpose of this study is to introduce an inorganic network in PP through sol-gel reaction and to examine a relationship between the formed structure and mechanical properties of the resultant nanocomposites.

An initial amorphous structure of PP was controlled by crystallization temperature. The structure of formed silica was analyzed by small angle X-ray measurements. The mass fractal dimension (D_m) showing the morphology of silica (1: bar, 2: disc, 3: sphere) was decreased with amorphous thickness (l_a). It indicates the formation of more anisotropic silica (Figure 1) probably because the formation of silica was confined by the higher order structure of PP. The viscoelastic properties of resultant nanocomposites were found to be affected not only by amorphous structure but also by spherulite size based on the shape and dispersion of synthesized silica.

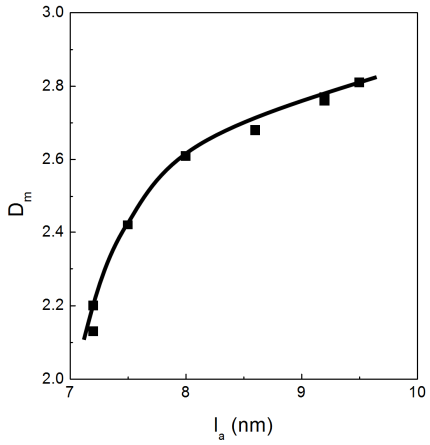

Figure 1. Relationship between amorphous thickness (l_a) and mass fractal dimension (D_m).

References:

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2. Takeuchi, K.; Taniike, T.; Terano, M. *Polymer* **2014**, *55*, 1940.