Polypropylene/Organoclay Based Nanocomposites: The Influence of Processing Conditions on the Filler Dispersion State

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Over the past few years, organoclay based nanocomposites have drawn a lot of attention in the scientific field. Since nylon 6/clay nanocomposites have been prepared in the Toyota laboratories [1], and proved to show great mechanical properties such as stiffness and impact resistance for only 4 wt% of clay addition in the matrix [2], the use of organoclay has widely increased. Polymer/organoclay nanocomposites can be prepared via different methods but melt-mixing has proven to be the most effective, and also the most adaptable at an industrial scale. The impact of the melt processing conditions on the dispersion state of the clay in a polypropylene matrix has been recently investigated [3], showing the wide range of processing parameters that can impact the microstructure and the properties of the nanocomposites.

This study looks at the preparation of organoclay-based nanocomposites by melt mixing with polypropylene (PP) in a twin-screw extruder. We are interested in the influence of extrusion parameters (screw speed and barrel temperature) on the state of dispersion of the organoclay. The influence of the PP viscosity is also investigated. A polypropylene grafted with maleic anhydride (PP-g-MA) was used as compatibilizing agent. The nanocomposites formulation was: 85 wt% PP / 10 wt% PP-g-MA / 5wt% organoclay. Dead-stop experiments have been performed, allowing to collect samples all along the screws. The samples were analyzed through scanning electron microscopy, X-Ray diffraction and rheology in small amplitude oscillatory shear. These different techniques allow us to characterize the dispersion state of the organoclay at different scales. The results show that screw speed has a strong impact on the clay exfoliation but is limited by matrix degradation. This degradation is hardly reduced when decreasing barrel temperature and is enhanced with a more viscous matrix. It also appears that intercalation and exfoliation develop early along the screw profile. Depending on the processing conditions, the final dispersion state can be obtained within the first mixing zones and is no more improved afterwards.

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