Title: Exploring the Morphology of Polypropylene Compounds

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Abstract:

Nowadays, polypropylene (PP) compounds offer many advantages for the automotive and new market industry segments due to their cost benefit, ease of processing, lightweight and later recycling. Most PP compound formulations employ a combination of high impact polypropylene (hiPP) base resins with elastomers to boost impact and talcum to increase stiffness. Due to the complexity of multiphases interaction in PP compound, morphology characterization of PP compounds remains quite challenge. On the other hand, morphology plays a crucial role on the PP compounds performance. Therefore in-depth characterization on morphology promotes better understanding of the relationship between PP compound compositions and properties and accelerates PP compound development and optimizations. Here we present the development of in-depth PP compound morphology characterization using different advanced atomic force microscopy (AFM) modes in combination with modulated DSC, paving the way for PP compound structure & properties relation understanding.

The morphology of PP compound is mainly related to the rubber phase dispersion in PP matrix. The rubber phase is mainly made from ethylene-propylene rubber (EPR) from the base resins, and the elastomer added. In this study, a systematic quantitative morphology study of various PP compound materials was performed using AFM and image analysis tool to obtain quantitative morphology information such as rubber domains size, rubber elongation and inter rubber distances. Then, in order to get more insight in elastomer and EPR rubber interactions and its influence on morphology, more advanced AFM based techniques such as AFM quantitative nano-mechanical mapping (AFM-QNM) and Intermodulation AFM mode were used to provide a comprehensive viscoelastic properties mapping of different phases of PP compounds at nano-scale. A modulated DSC method was also developed for precise characterization of elastomer crystallization behavior in PP compounds.

In combination of all advanced morphology characterizations, the results demonstrated that the rubber dispersion and rubber internal structures are strongly influenced by EPR phase, type and amount of elastomer and talcum added, and the viscosity of each composition. Correlations have been found between molded PP compounds impact properties and morphology, which contributes in building a transfer function for structure properties prediction. Furthermore, the skin-core morphology and nano-viscoelastic properties difference in molded PP compound samples were identified. The results provides more in-sight into understanding the impact and surface related performance of PP compounds as well.