SL 6.17

Rheology and Morphology of Rice Hull Ash-Filled PP

R. Khalil, A.G. Chryss, M. Jollands and S.N. Bhattacharya
Rheology and Materials Processing Centre (RMPC), RMIT University, Melbourne, Australia

Rice hull ash (RHA) is a by-product of the rice industry and is produced by high temperature incineration of rice hulls. RHA consists of approximately 98% amorphous silica and has the potential to be used as a filler in thermoplastics. Previous studies have reported poor mechanical properties of such composites attributed to poor compatibility and dispersion. Polypropylene (PP) composites filled with RHA of mean particle size of 10μm were prepared with three different concentrations of 20%, 30% and 40% by weight. To increase the filler-matrix compatibility and improve filler dispersion, three different concentrations of two types of silane, with vinyl and amino functional groups were used for filler surface treatment for 20% by weight of filler. From the literature, the two silanes 3-methacryloxypropyltrimethoxy (γ-MPS) and aminopropyltriethoxy (γ-APS) are the most compatible with PP. The state of dispersion and distribution of the filler in the PP matrix was evaluated by studying rheological properties as well as fractured surfaces. It was generally found that the filled systems exhibited enhanced viscoelastic properties compared to the unfilled PP as expected. The filled systems demonstrated pseudo-solid like behaviour with increasing ash content as shown by the enhancement of storage moduli at low frequencies. Dynamic viscosity showed a significant increase with the addition of filler. The silanated systems displayed anomalous behaviour where the dynamic viscosity and storage moduli were decreased at lower concentration of silanes but increased at higher concentrations. Environmental scanning electron microscopy showed that the filler was well distributed in the matrix but not very well dispersed for all filler loadings. This was attributed to irregularity in particle shapes and the wide range of particle sizes. The extent of reaction and silanation efficiency of silica ash was tested using thermogravimetric analysis (TGA). The results were consistent with two types of silane bonding being present; loosely bonded multilayers and tightly bonded single layer and the former being better in coupling the matrix and the filler.