Thesis Title A Study of the Influence of Mixing Parameters on the Properties of Polypropylene and Soft Filler Composites

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ABSTRACT

This study involved an investigation of the effects of scrap dust characteristics and mixing parameters on the mechanical and rheological properties of blends with polypropylene (PP). The scrap dusts are produced during sports shoe soles manufacture : outsole dust (vulcanised rubber blend of NR, BR and SBR), midsole dust (vulcanised EVA foam), and laminate dust (a mixture of the midsole and outsole dusts after sole assembly). Two different mixers were compared, an internal mixer and an extruder connected in series to a self-driven cavity transfer mixer (SD-CTM). The operating conditions (mixing time, speed), type and the loading of scrap dust have been studied for their affect on the quality of mixing and properties of the resultant polymer blends.

The mechanical properties of PP filled with scrap dust were evaluated using Charpy notched impact testing, tensile testing and heat distortion temperature testing. Rheology was studied by melt flow

index (MFI) measurement. The blend microstructure was examined utilising optical and polarising microscopy. Differential scanning calorimetry (DSC) was used for determining the crystallisation behaviour of PP in blends.

No improvement in the mechanical properties was achieved by increasing the mixing time in the internal mixer or increasing the SD-CTM speed. Impact strength of blends was dependent on scrap dust type and level of addition. PP filled with 30 wt% midsole dust mixed by the internal mixer a higher impact strength than PP ca. 58% was achieved, while the ultimate tensile stress dropped ca. 32%. PP filled with 25 wt% midsole dust and mixed by the extruder connected with SD-CTM gave a similar impact strength and ultimate tensile stress to PP. PP/$CaCO_3$ blends gave the poorer mechanical properties than PP/scrap dust blends. Because the PP/$CaCO_3$ interface had a greater amount of stress concentration than the PP/scrap dust interface.

Longer mixing time in internal mixer or faster SD-CTM speed gave more subdivision of the mixture producing a more homogeneous mixture as reflected in the higher MFI and it indicated by less scatter of MFI data, impact strength data and tensile properties data. Both DSC and polarising microscopy studies indicated that the scrap dust acted as a nucleating agent for PP crystallisation. Transcrystallisation was observed in PP filled with the outsole and laminate dusts but did not occur in the PP filled with the midsole dust.