

1. Introduction

Thermoplastic polymer composites is a mature field in which research has focussed on the mechanical behaviour of such materials. The emphasis has been on the use of fillers as reinforcing agents for a polymer matrix. In most cases the polymer formed the matrix material with the reinforcing agent suspended as discrete particles or fibres. The use of such reinforcing fillers can improve the thermal and mechanical properties of polymers. The choice of the particular filler will determine the ultimate properties that can be achieved. Most work was done for systems where the volume fraction of the polymer phase was above 70%. Very little research has been done for the case where the thermoplastic is present as the minor phase, i.e. volume fractions below 50%.

For commercial applications, the cost-performance ratio is an important criterium. Since the polymer is usually the more expensive component, effort is focussed on maximising filler content. However, there is a limit to the amount of filler that can be incorporated while still retaining thermoplastic processability. This limit depends on particle form, shape and size distribution. For monodisperse spherical particles the theoretical volume fraction limit is approximately 62%.

In some applications, where the polymer simply acts as a binder, the thermoplastic processability of the composite is of secondary importance. Such materials can be processed using techniques such as compression moulding to produce products in final form. Potential large scale applications include ceiling- and wall sheets.

Mica is a sheet-like mineral, commercially available in the form of muscovite or phlogopite. Muscovite is used in thermoplastic polypropylene compounds where its use leads to significant improvement in the heat deflection temperature. Phlogopite is seldom used as a reinforcing filler

owing to its dark brown colour. However, very large volumes of relatively pure phlogopite are produced as a mining by-product by Foskor in Phalaborwa. The interest in phlogopite, for the purposes of this study, is twofold. Firstly it is available in abundance and at a very low cost. Secondly it has outstanding properties with respect to fire and chemical resistance, that make it eminently suitable for the building industry, especially for low-cost housing.

In principle any thermoplastic can be used as binder for such composites. However, considering the processability and cost of the composite, linear low density polyethylene (LLDPE) was selected for its relatively low cost, excellent processability and a balance between toughness and rigidity. It was therefore decided to use this polymer, with appropriate modifications, as binder.

The present study considered three different aspects of compression moulded sheets:

- the optimisation of the formulation, i.e the selection of the binder, binder content and particle size of the phlogopite filler;
- the optimisation of the processing conditions, i.e the effect of temperature, pressure, compaction time and composite thickness;
- modelling of the mechanical properties, specifically the prediction of Young's modulus of such composite sheets in the plane of reinforcement orientation.

The study is, however, limited to small scale production under a controlled environment. The scaling up to larger composite material dimensions was not investigated.