Structure-property correlations of textile-reinforced cast Polyamide 6

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Abstract

The injection moulding production of plastic-based structural components is currently carried out by forming thermoset or thermoplastic continuous fibre-reinforced plastic semi-finished products and then back-injecting them (1, 2). The disadvantage here is the high viscosity of molten PA 6 leads to a limiting effect on the flowability and hinders the complete wetting and impregnation of the fibres. This results in the presence of dry spots and air voids in the composite component, which will negatively impact the structural integrity and mechanical performance. To overcome the mentioned drawbacks, an alternative approach would be direct impregnation of glass fibre textiles by a molten mixture of ϵ-caprolactam, catalyst and activator through an anionic ring-opening polymerisation process. In contrast to conventional PA 6 melts, ϵ-caprolactam in its initial low-molecular-weight state exhibits a lower viscosity before polymerisation, which enables improved flowability and better wetting of the fibres, which results in a more homogeneous and potentially pore-free impregnation of the textile structure.
The investigations were conducted at laboratory scale, where different glass fibre textiles were impregnated with a reactive mixture of molten ϵ-caprolactam, catalyst, and activator in a heated mould, enabling in-situ polymerisation of PA 6, to produce composite plates (80 $\times$ 100 mm). The material quality will be evaluated through macro-mechanical testing and morphological analyses to assess fibre-matrix interaction and fracture behaviour. By means of DSC, TGA and solution viscosimetry the crystallinity, thermal stability and molecular weight of PA 6 were determined.

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