COMPARISON OF INJECTION MOULDED, NATURAL FIBRE REINFORCED COMPOSITES WITH PP AND PLA AS MATRICES

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ABSTRACT

Poly(lactic acid) (PLA) and polypropylene (PP) were comparatively investigated as matrices for injection moulded composites containing small (1-3 wt.%) amounts of short sisal fibre. The polymers and fibres were mechanically mixed, followed by extrusion at 190 °C and injection moulding at the same temperature. The morphology, thermal and mechanical properties, and degradation characteristics were investigated using scanning electron microscopy (SEM), Fourier-transform infrared (FTIR) spectroscopy, polarised optical microscopy (POM), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), dynamic mechanical analysis (DMA) and tensile testing. From the POM photos it seems as if the fibres are equally well dispersed in the PLA and PP matrices. The SEM photos, however, show more intimate contact and better interaction between the fibres and PLA. This improved interaction was confirmed by the FTIR results that show the presence of hydrogen bonding interaction between PLA and the fibre. This improved interaction did not seem to have a significant influence on the yield stress, stress at break or tensile modulus of PLA. In the case of PP, however, the stress at break reduced observably, while the tensile modulus almost doubled in the presence of the fibre. The thermal stability (as determined through TGA) of both polymers increased with increasing fibre content, with a more significant improvement in the case of PP. The DSC results show a significant influence of the presence of the fibre on the crystallization behaviour of PLA, because both the melting temperature and melting enthalpy decreased with increasing fibre content, even at low fibre contents of 1-3%. This is the result of the strong interaction between PLA and the fibre, which immobilizes the PLA chains. The influence of the fibre on the melting characteristics of the PP was negligible. Both the storage and loss moduli of the PLA decreased with increasing fibre content below the glass transition of PLA, but the influence on the loss modulus was more significant. The DMA results clearly show cold crystallization of PLA around 110 °C, and the presence of fibre gave rise to higher modulus values between the cold crystallization and melting of the PLA. The presence of fibre also had an influence on the dynamic mechanical properties of PP. The biodegradation of PLA and its composites was determined by keeping the samples in water at an elevated temperature for up to 10 days. The composites initially showed a larger mass loss than pure PLA, but after 10 days the pure PLA seemed to be more degraded. The SEM results of biodegraded samples show complete collapse of the surface of the PLA matrix after ten days.