Optimising the performance and processing window of PHB co-polymers using rheology and thermal analysis

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Poly(3-hydroxybutyrate) (PHB) and its copolymers have generated interest from the packaging industry as a result of their sustainable and biodegradable properties [1,2]. These polymers are formed by bacteria fed on a sugar source and extracted and processed into useable material with initial properties comparable to commercial polymers such as poly(propylene) (PP) and poly(ethylene terephthalate) (PET)[3-6]. High crystallinities in the range 50-80%[7], resulting in poor mechanical properties, have necessitated the use of PHB copolymers, most commonly poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHB-co-HV). The addition of low molecular weight poly(ethylene glycol) (PEG) to PHB copolymers has been shown to reduce the rate of secondary crystallisation resulting in a more robust material [8,9].

The high crystallinity of PHB-co-HV makes it difficult to assess the miscibility of the polymers by the conventional method of differential scanning calorimetry (DSC) as the glass transition temperature is often not visible. This oral presentation analyses the melt miscibility of PHB-co-HV and PEG to assess the effect of PEG on thermal stability. As a result of the poor thermal stability of PHB-co-HV a modified rotational test procedure is implemented to create Han plots and enable assessment of the miscibility. This approach showed PHB-co-HV and PEG to be miscible within the concentrations and molecular weights studied lending itself to the fine tuning of the properties of PHB-co-HV in order to produce the most suitable and stable packaging material. The incorporation of PEG also enabled processing at lower temperatures significantly reducing the degradation rate and widening the narrow processing window commonly found with this polymer.

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