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Estimation of mechanical property degradation of poly(lactic acid) and flax fibre reinforced poly(lactic acid) bio-composites during thermal processing

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Abstract: Thermal degradation and chemical degradation are among the key issues affecting mechanical properties and ultimately utilization of natural fibre reinforced polymer (NFRP) bio-composites. In our previous work, mathematical models were used to identify thermal processing boundaries and to recognize an optimized window for NFRP bio-composites. In this study, a correlation relating the tensile strength of flax/PLA bio-composite to the processing temperature history is proposed. For the first time, an existing linear model, which corresponds to the tensile strength of natural polymers and their degree of polymerization, has been combined with reaction kinetics to predict the tensile strength of NFRP bio-composites as a function of processing temperature history. In addition, a non-linear model has been proposed which shows a significant improvement for longer periods of time, compared with the linear model. The model is based on the underlying thermo-chemical degradation processes occurring during manufacture of NFRP bio-composites. The model is capable of predicting the tensile strength of the bio-composite within 10% error.

Keywords: Bio-polymer composites; Chemical degradation; Degree of polymerization; Natural fibres; Mechanical properties; Thermal degradation

Abbreviations

acrylated epoxidised soybean oil (resin) (AESO)

carbon fibre (CF)

circular cross-sectional area (CSA)

degree of polymerization (DP)

fibre area correction factor (FACF)

glass fibre (GF)

natural fibre reinforced polymer (NFRP)

non-woven (NW)

poly (lactic acid) (PLA)

poly (propylene) (PP)

plain weave (PW)

rules-of-mixture (RoM)

unidirectional (UD)

v/o (fibre) volume percentage

w/o (fibre) weight percentage