Elucidating the plasticizing effect on mechanical and thermal properties of poly(lactic acid)/carbon nanotubes nanocomposites

H. Norazlina[a], *Y. Kamal*[b]

[a] Faculty of Engineering Technology, University College TATI, Jalan Panchor, Teluk Kalong, 24000, Kemaman, Terengganu Darul Iman, Malaysia

[b] College of Engineering, Universiti Malaysia Pahang, 26300, Pekan, Pahang Darul Makmur, Malaysia

ABSTRACT

Poly(lactic acid) (PLA) is a biodegradable plastic and grabs attention in several applications such as biomedical implantation, film, packaging and clothing. Instead, PLA itself has a characteristic of brittleness, resulting in poor mechanical properties, and its slow ability in degradation leads to waste disposal problem. The present research aims to develop material in such a way to have a good combination of properties and optimum degradation ability. The PLA nanocomposites were prepared via melt blending that consisted of two types of carbon nanotubes (CNTs): unmodified carbon nanotubes (CNTs) and modified CNTs (mCNTs). The effect of 5 wt% poly (ethylene glycol) (PEG) as plasticizer on nanocomposites with CNTs material loading at 0.5 wt%, 1.0 wt%, 1.5 wt% and 2.0 wt% was studied. The analysis of physical properties was done using hardness testing and melt flow index (MFI). Neat PLA only gave around 69.0–77.6 Shore *D* in hardness test, while MFI exhibited around 36.1–39.4 g/10 min. PLA/mCNTs and PLA/PEG/mCNTs at 1.5 wt% exhibited the highest values of hardness testing which were 86.0 and 85.9 Shore D, respectively. In MFI study, the results were 70.0 g/10 min for PLA/mCNTs and 80.3 g/10 min for PLA/PEG/mCNTs. This proved that the PEG is useful in reducing the brittleness of nanocomposite. The full exfoliation of CNTs and mCNTs in the matrix observed from the X-ray diffraction analysis supported the excellent hardness and MFI properties. These nanocomposites also showed high thermal stability as obtained from differential scanning calorimetry and thermogravimetric analysis studies compared with neat PLA. The morphology study by field emission scanning electron microscopy analysis confirmed these findings through the existence of a smooth fracture surface, especially when PEG was loaded as evidence of good distribution of nanofiller in the matrix was established. Based on all analyses done, PLA/PEG/mCNTs were chosen as the good nanocomposite among others.

KEYWORDS

Poly(lactic acid); Carbon nanotubes; Plasticize; Melt blending; Degradation behavior

ACKNOWLEDGMENTS

The authors thankfully acknowledge University College TATI and Universiti Malaysia Pahang for providing laboratory facilities and giving supports for this study.