UNIVERSITI TEKNOLOGI MARA

MECHANICAL AND THERMAL PROPERTIES OF POLYLACTIC ACID – KENAF FIBRE COMPOSITE FILLED WITH NANOCLAY

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ABSTRACT

In this study kenaf bast (KB) and kenaf core (KC) nanofibre reinforced poly lactic acid (PLA) composites were prepared at different nanofibre loading which are 2%, 4% and 6%. Montmorillonite (MMT) was introduced into PLA/KB and PLA/KC composites to produce hybrid composite at different MMT loading which are 1%, 3% and 5%. The composites were prepared using extruder followed by compression moulding method. Kenaf nanofibre was produced using chemi-mechanical method which underwent sodium hydroxide (NaOH) treatment and followed by cryo-crushing process. Mechanical properties were investigated using tensile, flexural and impact testing to obtain Young's modulus (MOE), ultimate tensile strength (UTS), modulus of rupture (MOR), flexural modulus and impact strength. Thermal properties were investigated using thermal gravimetric analysis (TGA) and differential scanning calorimetry (DSC). Microscopy observation of kenaf nanofibre was done by scanning electron microscopy (SEM). The results show that adding nanofibre increased the flexural modulus but at the same time decreased the MOR. The PLA/KB composite at 4% nanofibre loading and PLA/KC composite at 2% nanofibre loading obtained the optimum value of flexural modulus and impact strength. The flexural modulus value of PLA/KB and PLA/KC composite is 993 MPa and 1134 MPa respectively, while the impact strength value of PLA/KB and PLA/KC composite is 2.23 Kj/m^2 and 1.67 Kj/m^2 respectively. Hybrid composite has the same trend results as PLA/kenaf nanofibre composite. The addition of nanoclay into the composite increased the MOE and flexural modulus but decreased the ultimate tensile strength and MOR as compared to composite without nanoclay. The MOE value of PLA/kenaf bast (PKB) and PLA/kenaf core (PKC) hybrid composite at 1% nanoclay loading increase about 0.5% and 28% respectively. In the meantime, the increment of flexural modulus for PKB and PKC hybrid composite at 1% nanoclay loading are 112% and 124% respectively. Meanwhile, the results obtained from differential scanning calorimetry (DSC) analysis show that T_g of hybrid composite was shifted to lower value from 60 °C to 51 °C. The change in T_g of hybrid composites was due to several factors; the state of dispersion, the chemical structure of the polymer and the influence of MMT. However, the crystallization temperature (T_c) and melting temperature (T_m) almost remain the same which is ranging between 108°C - 109°C and 151°C - 152°C respectively. The highest value of ΔH_m for PKBH and PKCH is 37.78 J/g and 55.21 J/g respectively at 1% nanoclay loading. On the other hand, the highest value of X_c for PKBH and PKCH are 42.32 % and 60.57 % respectively.The addition of nanoclay into the composite influenced the decomposition temperature (T_D) and char residue of hybrid composite. Thermal gravimetric analysis (TGA) show the reduction in T_D and char residue for all hybrids composite compared to neat PLA. The TEM and SEM micrographs revealed that the fibre size was in a range of 100 nm and nanoclay was intercalated throughout the matrix, some of which was partially exfoliated respectively.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Nowadays, the whole world keeps doing research to develop new invention that is environmental friendly and biodegradable composite product. According to Pizzi *et al.* (2009); biocomposites have been an area of growing interest and a subject of active research due to both environmental concerns as well as to foresee future insufficiency of oil and oil-derived products. In addition; most presently marketed composites are made using material that are not biodegradable thus causing a serious disposal problem at the end of their life (Xiaosong and Anil, 2007). As a result, this will increase disposal waste and pollution. Natural resources have more advantages than synthetic fibres and polymers because plant-based polymers such as soybean protein, corn and starch are sustainable, yearly renewable, environmentally friendly and can be fully degradable by natural means. (Xiaosong and Anil, 2007).

Natural fibre reinforced materials play the same role as glass or carbon reinforced materials. Natural fibres also significantly upgrade the strength of polymeric materials. Composite materials with natural fibres are in demand for high-rigidity, low-weight compact mouldings, for instance in automotive engineering and body construction. Natural fibres are more flexible and lighter than the commonly used glass fibres. It is not so strong, but its share in the material can be increased because of their lower weight. The total weight and the material behaviour of glass and natural fibre reinforced materials are ultimately very similar. Bast fibres from flax and hemp are just as viable as the exotic fibres jute, kenaf, sisal and coconut, or regenerated cellulose.

Furthermore, in accordance with Mohanty et al. (2002) PLA is a highly versatile biopolymer and is highlighted because it is derived from a renewable resource such as corn, potato, sugar cane, sugar beet and various more. The use of products such as PLA as a cost effective alternative to commodity petroleum-based plastic will increase the