MECHANICAL PROPERTIES OF INJECTION MOULDED POLYLACTIC ACID – KENAF FIBRE BIOCOMPOSITES

H. Anuar, A. Zuraida

Department of Manufacturing & Materials Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, P.O. Box 10, 50728 Kuala Lumpur, Malaysia.

Introduction

Petroleum-based polymers are known to cause an environmental problem due to non-degradable of disposal daily items such as food utensils, packaging containers and trash bags. In line with this, researches are now focusing on environmental friendly plastic, so called bioplastic for green environment.

In order to maintain the degradable properties as well as to enhance properties of biopolymer, one promising candidate of natural fibre, kenaf fibre (KF) or *Hibiscus cannabinus, L*. may be incorporated into polylactiac acid (PLA). Kenaf fibre offers lightweight, renewability, high specific properties, impact resistance and flexibility, low cost and biodegradability. Kenaf bast fibre is grouped together with flax and hemp fibre and has been reported to have comparable mechanical properties to synthetic fibre such as glass fibre [1-4].

This paper describes the preparation and characterization of mechanical properties of PLA-KF biocomposite using extruder and injection molding machine. The effect of kenaf fibre content from 0-20 wt% on mechanical properties was investigated.

Experimental

Preparation of PLA-KF Biocomposite

Poly(lactic acid), PLA 3051D in the pellet form was manufactured by Nature Works. The kenaf bast fibre was supplied by Kenaf Natural Fiber Industries Sdn. Bhd, Kelantan, Malaysia. Poly(lactic acid) and kenaf fibre have been manually mixed and then extruded using twin screw extruder. The biocomposites were then injection moulded for various shape of specimens.

Characterization of PLA-KF Biocomposite

Tensile testing was characterized using Z020 Universal Tensile Tester according to EN ISO 527-5:1999. The strain rate used was 50 mm/min. Flexural testing was carried out using Z020 Universal Tensile Tester with span length of 64 mm and the compression speed was 5 mm/min. Unnotched Charpy impact test has been conducted according to EN ISO179 using CEAST tester.

Results and Discussion

The effectiveness of kenaf fibre as reinforcing agent is obviously seen at higher kenaf fibre content. As observed in Fig 1, tensile strength kept on increasing and reaching maximum at 20 wt% approximately about 74 MPa, which is about 18% higher than unreinforced PLA.

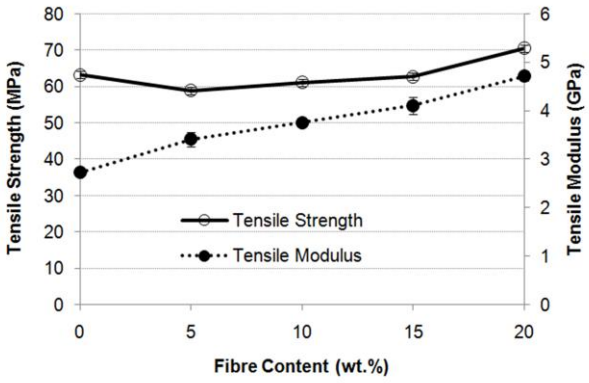

Fig. 1 The effect of fibre content on tensile properties of PLA-KF biocomposites.

The flexural strength of the PLA/KF biocomposites as a function of fibre content is illustrated in Fig. 2. The same trend is seen as in tensile properties where flexural strength decreases by about 4.1 MPa at 5 wt% kenaf fibre. Referring to light density of kenaf fibre, it can be suggested that kenaf fibre was acting as filler at lower fibre content. However, at higher kenaf fibre content flexural strength increases and reaching maximum value at 20 wt% KF which is almost 11.1% higher than unreinforced PLA.

Fig. 3 shows impact strength and force maximum versus kenaf fibre content. Impact strength decreases with kenaf fibre content. The impact strength obtained is however far more higher than value of impact strength reported on PLA-flax bicomposite [5]. This finding shows that kenaf fibre has absorbed better impact strength than flax fibre.

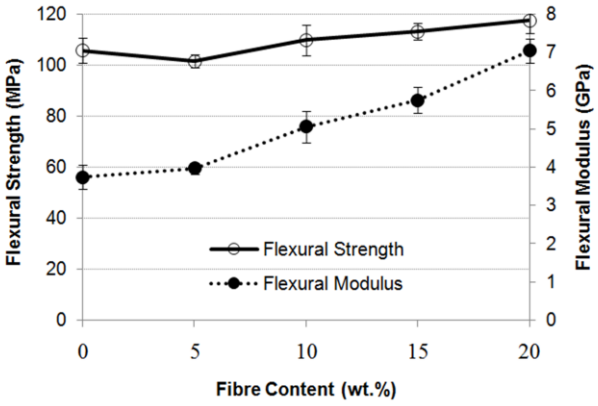

Fig. 2 The effect of fibre content on flexural properties of PLA-KF biocomposites.

Conclusion

Biocomposite made of PLA reinforced with kenaf fibre has been successfully fabricated by extrusion and injection moulding processes. PLA-KF biocomposite has the potential as an ecologically beneficial alternative to natural reinforced composites with petroleum-based matrices in the future. Kenaf fibre has proven to be a good reinforcement for PLA by enhancing the tensile strength, tensile modulus, flexural strength and flexural modulus.

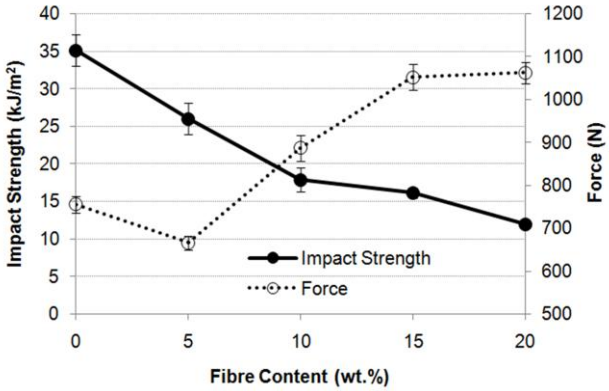

Fig. 3 The effect of fibre content on impact strength of PLA-KF biocomposites.

1. H. Anuar, S. H. Ahmad, R. Rasid, A. Ahmad and W. N. Wan Busu. Mechanical Properties and Dynamic Mechanical Analysis of Thermoplastic-Natural-Rubber-Reinforced Short Carbon Fiber and Kenaf Fiber Hybrid Composites. Journal of Applied Polymer Science 107 (2008) 4043–4052.

2. Anuar, H., Wan Busu, W.N., Ahmad, S.H. and Rasid, R. Reinforced thermoplastic natural rubber hybrid composites with Hibiscus cannabinus, L and short glass fiber – Part I: Processing parameters and tensile properties. Journal of Composite Materials 42(11) (2008)1075-1087.

3. C.W. Chin, B.F. Yousif. Potential of kenaf fibres as reinforcement for tribological applications. Wear 267 (2009) 1550–1557.

4. Bonnia, N.N., Ahmad, S.H., Zainol, I., Mamun, A.A., Beg, M.D.H., Bledzki, A.K. Mechanical properties and environmental stress cracking resistance of rubber toughened polyester/kenaf composite. Express Polymer Letters 4(2) (2010) 55-61.

5. Tao Yu, Jie Ren, Shumao Li, Hua Yuan, Yan Li. Effect of fiber surface-treatments on the properties of poly(lactic acid)/ramie composites. Composites: Part A 41 (2010) 499–505.