Effect of Compatibilizer on Mechanical and Physical Properties of Green Composites Based on High Density Polyethylene and Date Palm Fiber

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Key words: green composites, compatibilizers, Date Palm, Fiber.

Summary. *Date palm leaves and wood are common wastes in the middle east. These natural fibers can be used as additives for polymers to develop new desired properties; they also have important economic and environmental advantages. The major problem in the addition of the natural fiber to the polymer matrix is the poor interface between the hydrophilic lignocellulosic fiber and the hydrophobic polymer matrix. Compatibilizers are usually used to overcome this problem. This work is focusing on the effect of the date palm filler size and origin (leaf or trunk) from female (Ikhlas) on the high density polyethylene matrix. The following interfaces were used to compatibilize the matrix and the fillers: Polyethylene-co-methacrylic acid (PEMA), Polyethylene-graft-maleic anhydride (PEgMA) and Polyethylene-co-methacrylic acid zinc salt (PEMA-Zn) with 1, 2 and 3 wt.%. Morphologies of composites were carried out by Scanning Electron Microscope (SEM). The mechanical and thermal properties of different samples were evaluated by tensile and TGA apparatus respectively. Samples based on 1 wt.% PEMA shown the highest Young's modulus This behavior is may due to the increase in the interfacial adhesion and dispersion of the palm fillers within the polymer matrix, and confirmed by SEM micrographs. Thermal stability as limited by the compatibilizers due to the low thermal stability of the natural fillers itself.*

1 INTRODUCTION

Natural fiber composites are (mainly) price-driven commodity composites that provide useable structural properties at a relatively low cost. The use of natural fibers has many advantages such as, being derived from a renewable resource; they require low energy inputs in their manufacture. Currently, natural fibers as reinforcements in technical applications are mainly used in the automobile and packaging industries in parts where a high load carrying capacity is not required [1-2]. Great potential was obtained with natural fiber reinforced composites in different automotive primary structures and infrastructure [3].

There are many types of natural fibers such as flax, jute, banana, hemp, coir, date palm fiber. Many aspects can affect the performances of composites based on natural fiber such as the effect of fiber content, the transformation way (extrusion, injection, RTM…) and the interface between the material and the filler. Regarding the difference of polarity of the different materials, compatibilizers have to be used to enhance the dispersion and the adhesion between the palm fiber and the polymer matrix [8].

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A large variability in the chemical composition (amount of cellulose, lignin, hemicelluloses, etc.) and in the supramolecular structure (micro-fibrillar angle, size of cells) of natural fibers [4,5] strongly influence their overall mechanical properties (tensile strength, flexibility) and thermophysical ones as well [4,6,7]. This paper is focusing on the effect of the date palm filler (PF) size and origin from female date palm tree (Ikhlas) on mechanical and thermophysical properties of high density polyethylene composites.

Figure1 is shown the mechanical properties of HPDE/PF composites compatibilized by PEMA, PEgMA and PEMA-Zn. It can be noticed that the Young's modulus of the compatibilized composites are enhanced compared to the HDPE/PF materials. The highest value was obtained with -PEMA-Zn compatibilizer compared to others due to its accessible oxygen which can easily react with the cellulosic fiber to establish a hydrogen bound with it. However, HDPE/PF with 1wt.% of PEgMA composite recorded somewhat the same behavior of PEMA-Zn group.

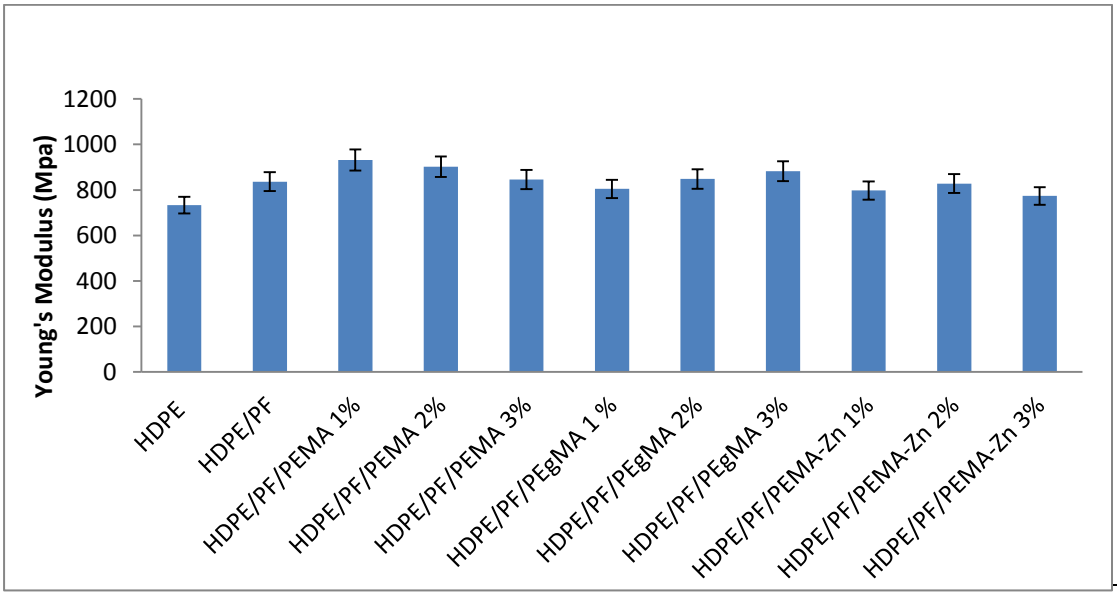

Fig. 1 The Young Modulus of HDPE-PF with 1,2,3 wt % of different compatibilizers.

REFERENCES

1. Prabhu K, 2002. In: Proceedings of the 23rd Ris international symposium on materials science. Denmark: Roskilde.
2. T. H. Lee, F.Y. C. Boey, and K.A. Khor,1995. On the determination of polymer crystallinity for a thermoplastic PPS composite by thermal analysis . Composite Science and Technology 53 , pp.250-274.
3. Kayode Adekunle, Sung-Woo Cho,1 Richard Ketzscher, Mikael Skrifvars1,2012. Mechanical Properties of Natural Fiber Hybrid Composites

Based on Renewable Thermoset Resins Derived from Soybean Oil, for Use in Technical Applications. Journal of Applied Polymer Science, Vol. 124, pp.4530–4541.

4. Bledzki AK, Gassan J,1999.Composites reinforced with cellulose based fibres. Prog Polym Sci; 24,pp. 221–74.
5. Bismarck A, Mishra S, Lampke T,2005. Plant fibers as reinforcement for green composites. In: Mohanty AK, Misra M, Drzal LT, editors. Natural fibers biopolymers and biocomposites. USA: Taylor & Francis; pp. 37–108.
6. Oksman K, Mathew AP, Lꞏngstr◌̊m R, Nystr◌̊m B, Joseph K, 2009. The influence of fibre microstructure on fibre breakage and mechanical properties of natural fibre reinforced polypropylene. Compos Sci Technol, 69,pp. 1847–53.
7. Puglia D, Terenzi A, Barbosa SE, Kenny JM, 2008. Polypropylene–natural fibre composites. Analysis of fibre structure modification during compounding and its influence on the final properties. Compos Interface,;15, pp.111–29.
8. Zhidan L., Chao C., Zixian G., Shaozao T., Xiuju Z.,2011.A Compatibilized Composite of Recycled Polypropylene Filled with Cellulosic Fiber from Recycled Corrugated Paper Board: Mechanical Properties, Morphology, and Thermal Behavior,Journal of Applied Polymer Science, 122, pp. 2789–2797.