

PAPER • OPEN ACCESS

## Effects on MAPP Compatibilizer on Mechanical Properties of Kenaf Core Fibre/Graphene Nanoplatelets reinforced Polypropylene Hybrid Composites

To cite this article: I.N. Sabri *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **596** 012023

View the [article online](#) for updates and enhancements.



EEG/ECOG AMPLIFIERS  
& ELECTRODES  
ELECTRICAL/CORTICAL  
STIMULATORS  
REAL-TIME PROCESSING

**g.tec**  
gtec.at/shop  
**SHOP NOW**

# Effects on MAPP Compatibilizer on Mechanical Properties of Kenaf Core Fibre/Graphene Nanoplatelets reinforced Polypropylene Hybrid Composites

I.N. Sabri<sup>1</sup>, M.B. Abu Bakar<sup>1\*</sup>, S.H. Mohd<sup>1</sup>, N.A.H. Nik Rosdi<sup>1</sup>, M. Mohamed<sup>1</sup>  
M.A. Sulaiman<sup>1</sup>, M. N. Masri<sup>1</sup> and S. Chuangchote<sup>2</sup>

<sup>1</sup>Faculty of Bioengineering and Technology, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli Kelantan Malaysia

<sup>2</sup>The Department of Tool and Materials Engineering, King Mongkut's University of Technology Thonburi, 126 Pracha Uthit Rd, Bang Mot, Thung Khru, Bangkok 10140, Thailand

E-mail: bashree.ab@umk.edu.my

**Abstract.** Natural fibre has high potential to be used as reinforcement due to more save, greener and environmentally friendly compared to synthetic fibre. In this research, kenaf core fibre (KCF)-graphene nanoplatelets (GNP) reinforced polypropylene (PP) composites were melt blending using Brabender internal mixer and fabricated by compression moulding. This research aims to fabricate and study the effect of different amounts of MAPP on the mechanical properties of the PP/KCF/GNP composites. The difference amount of maleic anhydride grafted polypropylene (MAPP) as a compatibilizer in hybrid composite was added to enhance the mechanical properties by improving the interfacial adhesion of matrix and KCF. The pure polypropylene (PP) matrix was used as a control. The mechanical properties (tensile and flexural test) were determined using Universal Testing Machine (UTM). Overall, the results show that the presence of MAPP compatibilizer successfully enhanced the mechanical properties as a result of improvement of the fibre-matrix adhesion between the KCF and PP matrix.

## 1. Introduction

Hybrid composite means two types of reinforcement materials are used in the matrix or the matrix made up of two polymers. In this study, reinforcements used were kenaf fibre and graphene nanoplatelets as filler. The natural fibre reinforced composites (NFRC) are rapidly developing in engineering technology. The most critical issues of synthetic fibres are heavy, non-biodegradable, and costly. Therefore, natural fibres are seen as safer, greener, and environmentally friendly to use as reinforcement. Kenaf has catch researches attention as a cheap, renewable, recyclable, and biodegradable alternative to synthetic polymers [1-3]. Many studies have been done on kenaf fibre reinforced plastic composites, but the study on the use of hybrid layers of kenaf fibre/GNP is still limited.

The hydrophilic fibres and hydrophobic thermoplastic and thermoset matrices required appropriate treatments to enhance the adhesion between fibre and the matrix. MAPP as the compatibilizer is to improve the bonding between natural fibre that is hydrophilic to be merged or embedded into PP matrix that is hydrophobic in nature [4]. The addition of compatibilizer, which could improve the interfacial adhesion between the hydrophilic fibres and hydrophobic matrix, also enhances mechanical properties. Idumah and Hassan [5] reports polypropylene has low stiffness and flexural modulus and poor thermal properties. Therefore, a nanofiller called GNP in this study may overcome the problem faced by the NFRC, as reported by Mohan et al. [6] due to superior properties of graphene-like thermal conductivity, mechanical strength, electron mobility, and high surface area.



## 2. Experimental

### 2.1. Materials

This study was used kenaf core fibre (KCF) and graphene nanoplatelets (GNP) as the reinforcement materials for the hybrid composites. Polypropylene (PP) was used as matrix. Maleic anhydride grafted polypropylene (MAPP) also known as maleated polypropylene, was used as compatibilizer.

### 2.2. Methods

PP/KCF/GNP hybrid composites were fabricated with different amounts of MAPP, according to Table 1. KCF was dried in the oven with 105°C/ 2 hours. PP/KCF/GNP/MAPP were mixed in the Brabender internal mixer and compressed in compression moulding 200°C in which 10 min preheat, 5 min for hot press moulding and 5 min cooling. The dimension of the sample was 150mm x 25mm x 3mm. The mechanical properties (tensile and flexural test) were conducted using UTM.

**Table1.** Formulation of samples

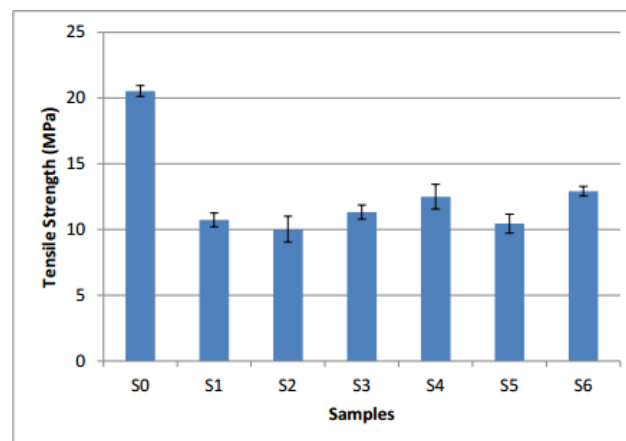
Samples	Hybrid composites formulation			
	KCF	PP	GNP	MAPP*
S0	-	100	-	-
S1	30	70	-	-
S2	30	67	3	0
S3	30	67	3	1
S4	30	67	3	3
S5	30	67	3	5
S6	30	67	3	7

\* % relative to the weight percentage of the KCF

## 3. Results and Discussion

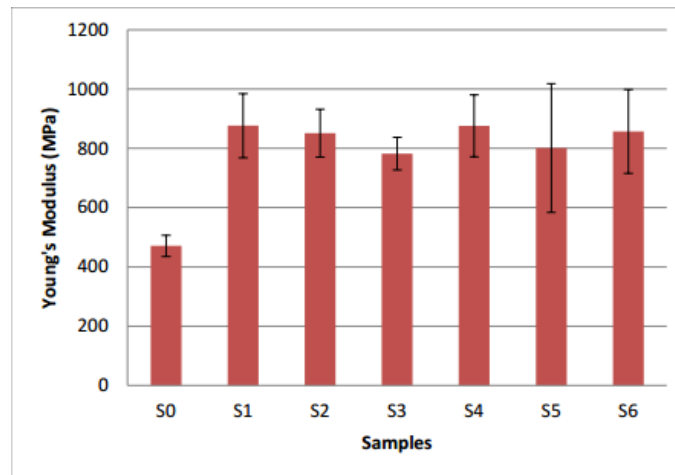
### 3.1. Effect MAPP in Tensile Properties

The tensile strength value for PP was the highest around 20.5 MPa. As expected, the lower tensile strength for PP/KCF and PP/KCF/GNP than PP due to the weak interfacial adhesion, poor dispersion of reinforcement, and high interfacial tension between matrix and reinforcement. In Figure 1, the difference between 3% MAPP and 7% MAPP was not so noticeable.



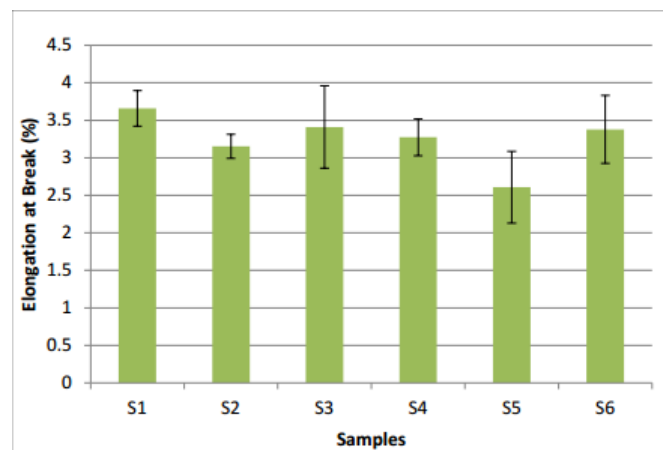
**Figure 1.** Tensile strength of PP hybrid composites

PP has the lowest young's modulus. It was reported by Lee et al. [7] that PP does not have any fibre or filler acting as a load-bearing component in the composites. Based on the trend Figure 2, it can be said that the addition of MAPP as a compatibilizer in S3, S4, S5, and S6 does not give much difference compare to PP/KCF likely due to the high amount of KCF while the amount of MAPP quite low.



**Figure 2.** Young's modulus of PP hybrid composites

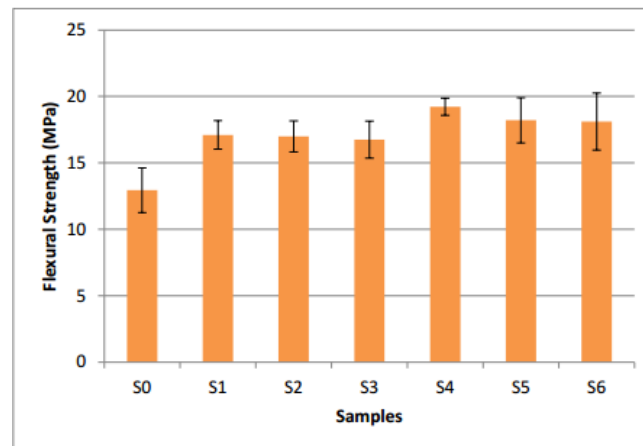
PP underwent about 152.21% of elongation at break. PP/KCF and PP/KCF/GNP was dropped. It might be due to the KCF stiffness increases the brittleness of material and also effect from the hybridization of KCF and GNP. However, there is no significant difference on the elongation at break of hybrid composites with 1, 3, and 7% MAPP in Figure 3



**Figure 3.** Elongation at break of PP hybrid composites (PP = 152.21%)

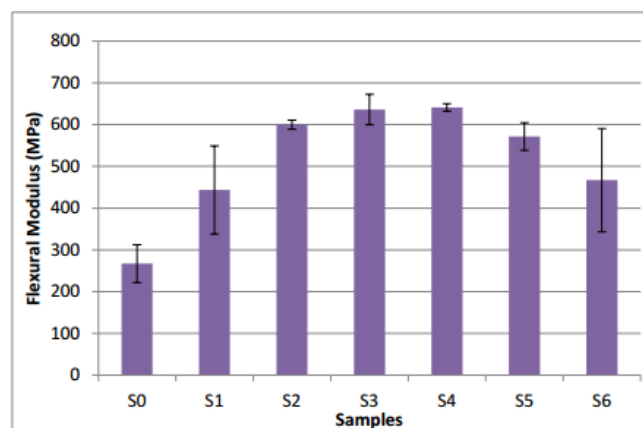
### 3.2. Effect MAPP in Flexural Properties

In Figure 4, flexural strength PP is the lowest 12.94 MPa and PP/KCF increase around 17.10 MPa. The trend shows that the flexural strength increased until the optimum amount of MAPP, which is 3% MAPP.



**Figure 4.** Flexural strength of PP hybrid composites

Based on Figure 5, the graph flexural modulus of PP and the hybrid composites with 1-7% of MAPP is bell shape. It shows 3% of MAPP is enough to improve both strength and modulus properties. Research by Razak et al. [8] the excess MAPP has reduced the mechanical properties of hybrid composites.



**Figure 5.** Flexural modulus of PP hybrid composites

#### 4. Conclusion

In the conclusion, the fabrication of the hybrid kenaf core fibre-graphene nanoplatelet reinforced polypropylene composites with different amount of MAPP was successfully done. Overall, it can be concluded that the mechanical properties of PP hybrid composites improved with the addition of MAPP compatibilizer. The optimum value of MAPP was obtained in which 3% of MAPP demonstrated the highest performance in both properties.

#### Acknowledgement

The authors would like to express our gratitude to UMK, LKTN, UiTM Perlis, and PSU Surat Thani Thailand for providing the materials and equipment during this research.

## References

- [1] Bachtiar D, Sapuan S M and Hamdan M M 2009 The influence of alkaline surface fibre treatment on the impact properties of sugar palm fibre-reinforced epoxy composites *Polymer - Plastics Technology and Engineering* **4** 379-383
- [2] Zahra D, Abdan K, Jawaid M, Khan M A, Behmanesh M, Dashtizadeh M, Cardona F and Ishak M 2017 Mechanical and thermal properties of natural fibre based hybrid composites: A review *Pertanika J. Sci. & Technol* **25** 1103-1122.
- [3] Akil H M, Omar M F, Mazuki A A M, Safiee S, Ishak Z A M and Bakar A A 2011 Kenaf fiber reinforced composites: A review *Materials and Design* **32** 4107-4121.
- [4] Amir N, Zainal A K A and Shiri F M 2017 Effects of fibre configuration on mechanical properties of banana fibre/PP/MAPP natural fibre reinforced polymer composite *Procedia Engineering* **184** 573-580.
- [5] Idumah C I and Hassan A 2016 Characterization and preparation of conductive exfoliated graphene nanoplatelets kenaf fibre hybrid polypropylene composites *Synthetic Metals* **212** 91-104.
- [6] Mohan V B, Lau K T, Hui D and Bhattacharya D 2018 Graphene-based materials and their composites: A review on production, application and product limitations *Composites Part B: Engineering* **1** 200-220.
- [7] Lee C H, Sapuan S M and Hassan M R 2017 Mechanical and thermal properties of kenaf fiber reinforced polypropylene/magnesium hydroxide composites *Journal of Engineered Fibers and Fabrics* **2** 50-58.
- [8] Razak Z, Sulong A B, Muhamad N, Haron C H C, Mohd Khairol M K F, Tholibon D and Ismail N F 2018 The effects of maleic anhydride grafted PP (MAPP) on the mechanical properties of injection moulded kenaf/CNTs/PP composites *Sains Malaysiana* **6** 1285-1291.