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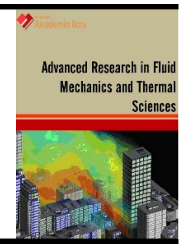

Structure Analysis on Polypropylene Maleic Anhydride (PPMAH) / Polypropylene (PP) / Recycled Acrylonitrile Butadiene Rubber (NBRr) / Banana Skin Powder (BSP) Composites Treatment

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ABSTRACT

Recently, researchers have shown an increased interest in materials treatment in order to improve the characterization and thermal properties of composite. In this paper, the effect of recycled acrylonitrile butadiene rubber (NBRr) loadings and compatibilization of polypropylene maleic anhydride (PPMAH) in the polypropylene (PP) / recycled acrylonitrile butadiene rubber (NBRr) / banana skin powder (BSP) composites were studied. The composites for both uncompatibilized and compatibilized polypropylene maleic anhydride (PPMAH) were mixed through thermal process technique using heated two roll mill at 180°C with six different NBRr loadings rate. A few materials assessment was obtained such as tensile properties and Scanning Electron Microscopy (SEM) micrograph in order to prove the interaction of BSP fillers in PP/NBRr matrix. The results show that the incorporation of PPMAH has improved the tensile properties of the composites. The result from the SEM micrograph of the tensile fracture indicates that better adhesion was observed for all PPMAH compatibilized composites.

Keywords:
Polypropylene, recycled acrylonitrile butadiene rubber, banana skin, compatibilizer

1. Introduction

Nowadays, blending of the thermoplastics and the elastomers have become a famous trend among the researchers and industries communities. This blend is termed as a thermoplastics elastomers (TPE$_S$) [1-3]. The aimed of this blend is to improve their physical properties as well as thermal and mechanical properties [4-5]. Besides that, the blends of these two materials promise an effectiveness in term of production cost and also in the modification of the processing characteristic [6-7]. Polypropylene is one of the polymeric composites that have good processing ability that makes

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it convenient towards many types of synthetic and natural fillers [8-11]. Natural fillers have been a favorite choice as reinforcement in the polymer composites. Recently, there were many types of natural fillers that have been used such as rice husk [12], oil palm [13], fruit bunch [14], pineapple leaf fibre [15], sugarcane bagasse [16] and banana fibre [17]. The natural filler is naturally less abrasive, biodegradable, the low requirement on processing equipment and low energy consumption [18]. Besides that, natural fillers are the renewable source [19] and utilization of this type of filler promising an environmental sustainability.

Considering the environmental advantages, the recycling of waste could one of the idealistic ways. Recycling of acrylonitrile butadiene rubber (NBR) is one of the possible applications of waste recycling since Malaysia produce a high amount of NBR waste [19]. A few researchers have been conducted on the used of NBRr as an addition to the PP composites with a use of natural fillers as a reinforcement [20-21]. The mixture of the PP and NBRr seem to be incompatible due to the non-polar of polyolefin (PP) and polar NBRr [22]. Besides that, the addition of hydrophilic naturals fillers [19] make it naturally not compatible with most polymers and give poor adhesion within the composites materials [23]. Thus, PPMAH compatibilizer can be used to graft the polymer matrices with the fillers [24].

In this paper, a novel experiment based on the effect of recycled acrylonitrile butadiene rubber (NBRr) loadings and compatibilization of polypropylene maleic anhydride (PPMAH) in the polypropylene (PP) / recycled acrylonitrile butadiene rubber (NBRr) / banana skin powder (BSP) composites were investigated. The primary goal of this study is to improve the materials characterization based on analysis such as properties based on tensile and SEM. The rest of the paper is organized as follows: Section 2 explains the methodology of the experiment. Section 3 describes the result and discussion and finally, section 4 concludes this work.

2. Experimental

2.1 Materials

PP Grade 6331 and recycled Acrylonitrile Butadiene rubber (NBRr) was supplied by Titan Pro Polymers (M) Sdn. Bhd. and Juara One Resources Sdn. Bhd. was used as a matrix. Banana peels were used as fillers were collected from Jejawi area. The NBRr was masticated into a smaller size using a two roll mill machine model X(S) K-160X320. Next, it was grinded into a finer powder using a grinder machine model RT-34 from Rong Tsong Precision Technology Co. Banana skin was cut into small size before dried into the oven at 80 $^{\theta}$C for 24 hours. The dried BS was then grinded using the same grinder machine into a powder form. Then, both NBRr and BS were sieved to 150-300 μm using a Siever machine model T1-101405.

2.2 Preparation of the Composites

The composites were prepared using a heated two roll mill machine model DW 5110 at temperature 180 $^{\theta}$C with 10 rpm of rotor speed. Firstly, enter the PP materials into the machine and after 4 minutes NBRr was added and finally, mix BSP until 6 minutes. The total mixing time is 10 minutes and for the compatibilized series the PPMAH was added simultaneously with PP. The formulation of PP/NBr/BSP and PP/NBRr/BSP-PPMAH composites was tabulated in Table 1.

Table 1
Formulation of PP/NBRr/BSP and PP/NBRr/BSP-PPMAH composites

Materials	PP/NBRr/BSP (%wt)					PP/NBRr/BSP-PPMAH (%wt)				
PP	100	80	70	60	50	100	80	70	60	50
NBRr	0	20	30	40	50	0	20	30	40	50
BSP	10	10	10	10	10	10	10	10	10	10
PPMAH	-	-	-	-	-	5	5	5	5	5

2.3 Compression Molding

The prepared samples were compressed using a hot press machine model GT-7014-A30C. The mold was preheated for 3 minutes before the samples were compressed for 10 minutes with a constant compression for the last 3 minutes. Then, 1 mm thickness composites produced were cooled using a cool press for 3 minutes.

2.4 Tensile Properties

The tensile test was carried out according to the ASTM D381 using a universal tensile machine Instron 5569 at room temperature. The initial jaw separation distance is 50 mm and the samples were tested at a crosshead speed of 5 mm/min. The test was recorded for the tensile strength, Young Modulus and elongation at break (E_B) directly from the computer of each test. Prior to the testing, the samples of 1 mm thickness were cut into dumbbell shape using a Wallace die cutter model S6/1/6.A. Each sample was prepared for five duplications.

2.5 Morphological Properties

The morphological studies were done using a Scanning Electron Microscope (SEM) instrument model JSM-6460LA. All the tensile fracture surface samples for the study were coated with a thin gold palladium layer to avoid electrostatic charging and poor image resolution during the experiment.

3. Results and Discussion

3.1 Tensile Properties

Figure 1 and Figure 2 shows the tensile strength and Young's modulus of PP/NBRr/BSP composites. Based on observation, the tensile strength and Young's modulus of the composites decreased with increasing NBRr loadings. The result showed that the addition of the NBRr able to reduces the composites rigidity. The composites rigidity and strength of the composites depend on the crystallinity of the PP, thus the addition of NBRr has reduced the crystallinity of the composite since NBRr is elastic and soft materials [25]. The similar findings have been reported by Ismail *et al.*, [26] that the tensile strength and Young's modulus for the compatibilized composites are higher than the uncompatibilized composites. This proved that the PPMAH compatibilizer has improved the interfacial adhesion that leads to the better attachment between the PP and NBRr matrices with the BSP filler. The same result was found by Kim *et al.*, [24] in the investigation of the effect of types of Maleic Anhydride-grafted Polypropylene (MAPP) on the interfacial adhesion properties of bio-flour-filled polypropylene composites.

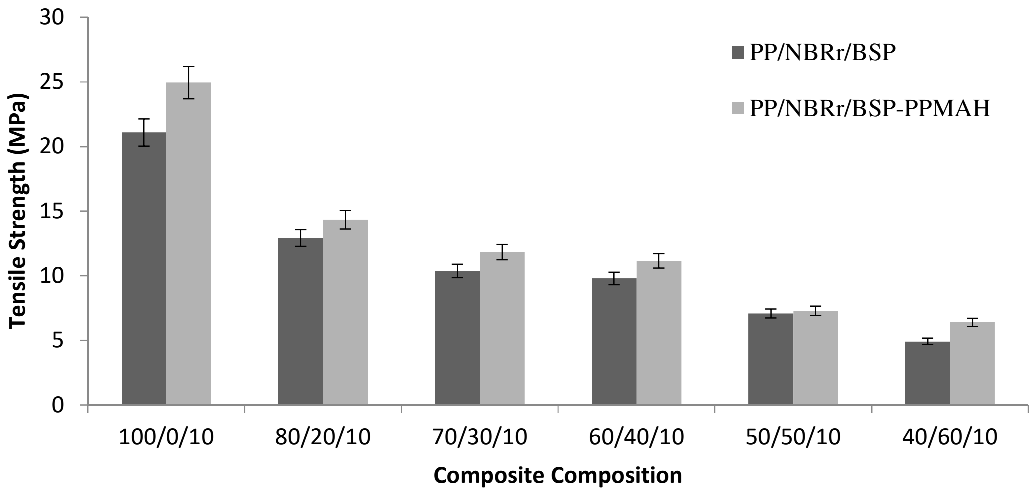


Fig. 1. Tensile strength of the PP/NBRr/BSP composite

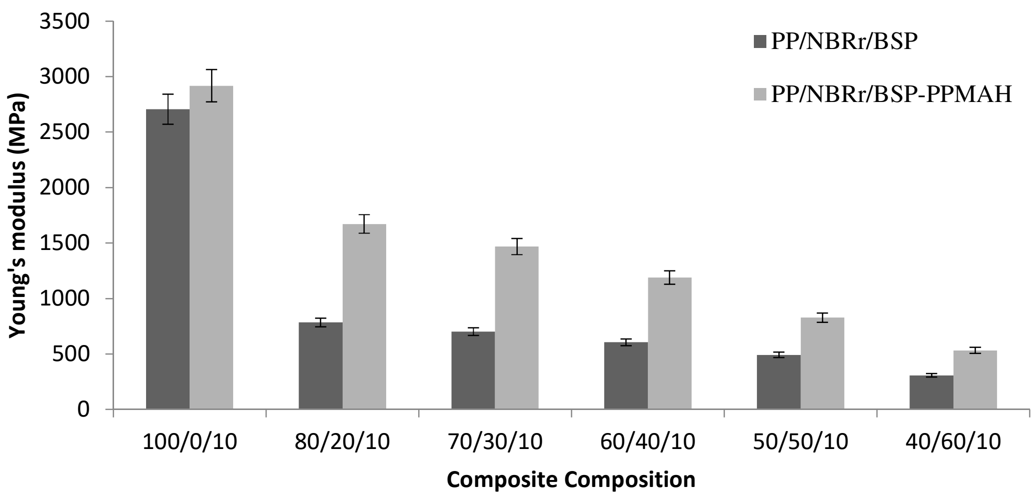


Fig. 2. Young’s modulus of the PP/NBRr/BSP composite

Figure 3 shows the elongation at break of PP/NBRr/BSP composite. Based on Figure 3, the E_b of the composites increased when the NBRr content increased. The addition of the NBRr into the composites reduced the composite resistance to elongation. Moreover, the increase of NBRr content in the composite also reduced the composites stiffness and brittleness [5]. Besides that, the compatibilized composites show the higher E_b compared to the control composites. Khalf *et al.*, [27] stated that the compatibilizer reduces the interfacial energy between dipolar PP and NBRr matrix phases, thus enhanced the interfacial adhesion. Similar findings were reported in the blend of waste poly (vinyl chloride) (PVCw) and acrylonitrile butadiene rubber (NBR) together with maleic anhydride as a compatibilizer [5].

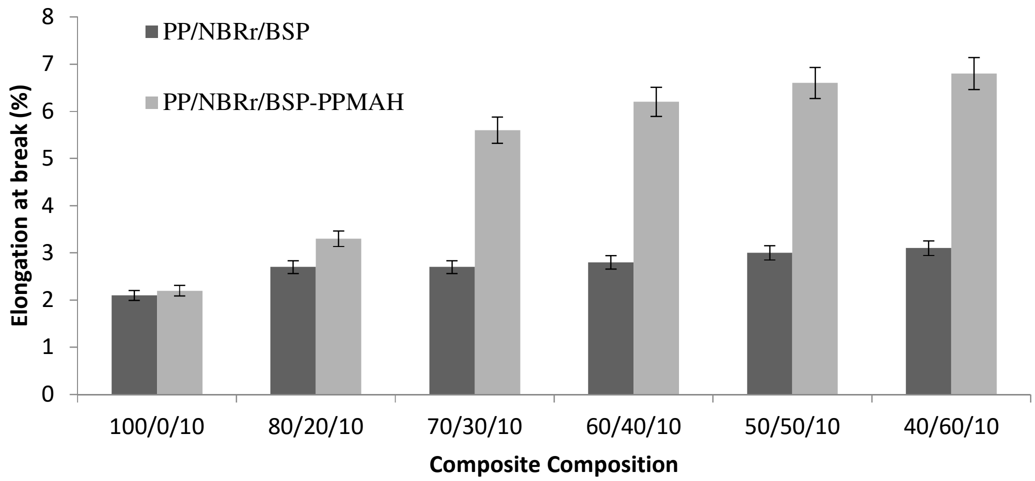
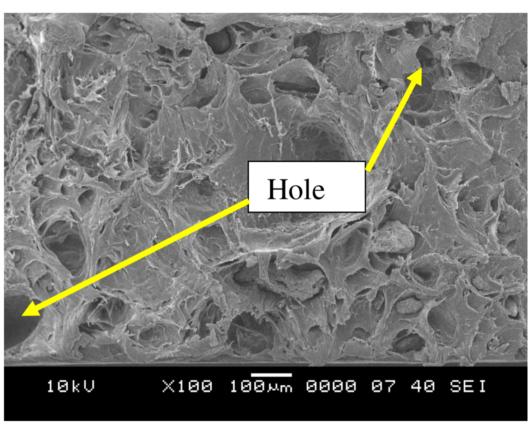


Fig. 3. Elongation at break of PP/NBRr/BSP composite

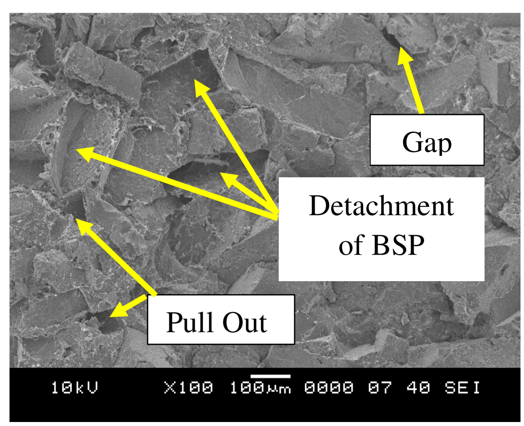
3.2 Morphological Properties

Figure 4 (a-b) shows the SEM micrograph of tensile fracture of the uncompatibilized PP/NBRr/BSP composites at 100x magnification. Based on the SEM micrograph, the addition of NBRr to the composites caused poor adhesion of the BSP filler with PP and NBRr matrix. Poor adhesion is indicated by the pullout and detachment of the BSP fillers. According to the Ismail *et al.*, [26], the lower adhesion will effect on the poor stress transfer across the interface. The similar findings were reported in the blend of PP and NBRr and compatibiliziing effect of EP [26].

Figure 5 (a-b) shows the SEM micrograph of tensile fracture of the compatibilized PP/NBRr/BSP composites at 100x magnification. The figure shows that the incorporation of the compatibilizer improved the dispersion and adhesion of filler in PP/NBRr/BSP composites. This is because the compatibilizer contributes to the reduction of dipolar energy between the PP and NBRr phase [26]. Hence, the interfacial adhesion and dispersion of BSP filler are improved. The result was supported by Yang *et al.*, [28] on the reinforcement of rice husk flour in PP composites using maleic polypropylene (MAPP) as a compatibilizer.

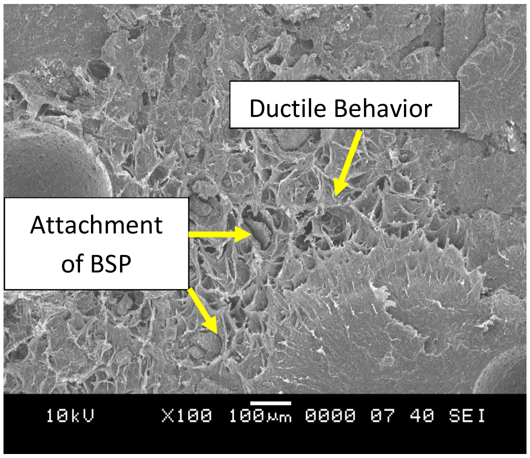


(a) 100/0/10

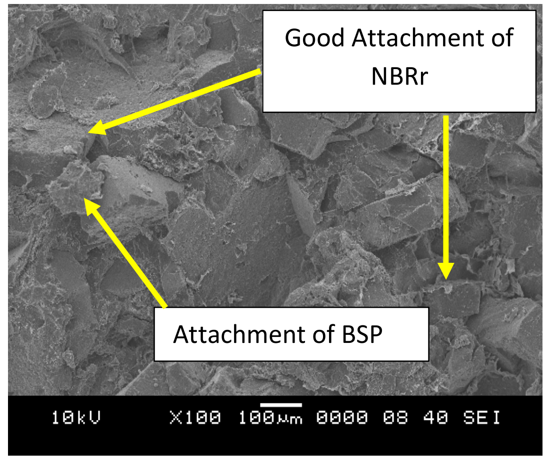


(b) 50/50/10

Fig. 4 (a-b). SEM micrograph of tensile fracture of the uncompatibilized PP/NBRr/BSP composites at 100x magnification



(a) 100/0/10



(b) 50/50/10

Fig. 5 (a-b). SEM micrograph of tensile fracture of the compatibilized PP/NBRr/BSP composites at 100x magnification

4. Conclusions

The present study was experimented to analysis the polypropylene maleic anhydride (ppmah) / polypropylene (pp) / recycled acrylonitrile butadiene rubber (nbrr) / banana skin powder (BSP) composites treatment. Based on the result, the tensile properties of the PP/NBRr/BSP showed that the addition of NBRr into the PP/NBRr/BSP composites reduced the stiffness, brittleness and rigidity of the composites. On the other hand, PPMAH compatibilization improved the adhesion of the BSP filler with PP and NBRr matrix. The improvement was shown by the SEM micrograph of tensile fracture. Future research should concentrate on the analysis of the other, such as water absorption, thermal properties and Fourier Transform Infra-Red (FTIR).

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