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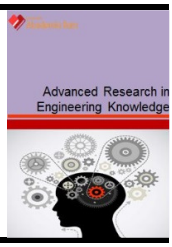

Characterization of Recycle Acrylonitrile Butadiene Rubber (rNBR) Glove

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ABSTRACT

The characterization of recycle acrylonitrile butadiene rubber (rNBR) glove have been analysis. The rNBR were matriculated by using two roll mills machine. After that, the NBRr were grinded and sieved to obtain particle size of below 150 µm. The rNBR power then have been analysed using Scanning Electron Microscopy (SEM) for surface morphology, Fourier Transform Infrared (FTIR) for chemical analysis and Thermogravimetric analysis (TGA) for thermal degradation of rNBR powder. The morphology show the rNBR have irregular shaped particles with more fibrous form with irregular edges. The rNBR particle shown a non-precise shape due to presence of various additives and cross-linked precursors in rNBR glove beside good inherit elasticity properties of the NBR. The observation from FTIR spectrum indicates the olefinic stretching frequency just about 2917.8 cm-1, CH2 bending vibration at above 1437.45 cm-1, the vibration C≡N at 2237.54 cm-1 from NBRr structure and C-H out of plane bending frequency at 967.09 cm-1. The absorption of carbonyl (C=O) is 1771.41cm-1. The TGA and DTG curve, the the temperature at 70% weight loss,T70% of rNBR was 446.26 °C and the char residue of rNBR was 40.27 %. The rNBR also have high degraded temperature at 444.00 °C.

1. Introduction

Acrylonitrile butadiene rubber (NBR) is one of synthetic rubber. It has excellent oil resistant properties over a wide range of temperatures. NBR is also well known for its superior strength, excellent resistance to abrasion, water, alcohols and heat. Disadvantages of NBR are poor dielectric properties and resistance to ozone [1]. As such, blends of acrylonitrile butadiene rubber/polypropylene are an important class of TPE material which exhibit excellent oil resistant properties as a result of the presence of NBR and excellent mechanical and processing characteristics due to the presence of PP [2,3]. They can be successfully used for high temperature, oil resistance applications [4]. Acrylonitrile Butadiene (NBR) is use widely variety of application are requiring oil,

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fuel, and chemical resistance. On the industrial side, the NBR find uses in conveyor belting, hydraulic hose, roll cover, oil field packer and seals for all kind of plumbing and appliance application. The nitrile rubber gloves are one of appliance of NBR. Currently, Malaysia caters between 60 % to 65 % of the world's natural glove market and also supplies about half of the world's nitrile glove market. Malaysia is the leading supplier of examination and surgical gloves, satisfying 45% of the world's demand. According to Department of Statistics of Malaysia, in year 2005 the value export of gloves including surgical and other gloves were 3,793.23 million Malaysian Ringgit and rise accordingly to 5,991.92 million ringgit Malaysia in year 2009 [5]. This can be resulting the waste of the by glove will be increase and can cause the environmental problem.

Therefore, the characteristic of the rNBR have been study to development of new class of thermoplastic elastomer material by using polyolefin mix with rNBR from the waste nitrile glove generate by nitrile glove industry. Hopefully, it can reduce the waste of NBR produces and the final product that will be developed would find useful application in building, construction and other industries.

2. Methodology

Recycled Acrylonitrile Butadiene Rubber (rNBR) with 33% acrylonitrile content were processed from the used nitrile gloves obtained from Juara One Resources Sdn. Bhd. Penang, Malaysia. The nitrile gloves were matriculated by using two roll mills machine. After that, the NBRr were grinded and sieved to obtain particle size of below 150 µm. The rNBR power then have been analysed using Scanning Electron Microscopy (SEM) for surface morphology, Fourier Transform Infrared (FTIR) for chemical analysis and Thermogravimetric analysis (TGA) for thermal degradation of rNBR powder.

2.1 Scanning Electron Microscopy (SEM)

Studies on the morphology of the composites were performed using a Scanning Electron Microscope (SEM). All samples were coated with a thin platinum layer using Sputter Coater Polaron SC 515 to avoid electrostatic charging and poor image resolution during the examination. The morphological studies of characterization of rNBR shape is evaluated.

2.2 Fourier Transform Infrared (FTIR)

Fourier Transform Infra-red (FTIR) analysis is done to evaluate the chemical composition of raw materials rNBR. The rNBR powder about 5 mg of specimen are mix with 95 mg of potassium bromide (KBr) prior to compacting into thin pellets with a hydraulic press using 8 tons of force and maintain for 3 minute. FTIR spectra are record by plotting wavelength against absorbance. The spectrum resolution is 4 cm^{-1} and the scanning range is from 550 to 4000 cm^{-1}.

2.3 Thermogravimetric analysis (TGA)

Thermogravimetric analyses of the composites were conducted with a Perkin-Elmer Pyris 6 TGA analyser according to ASTM D3171. The samples were weighed around 10-12 mg. The samples were scanned under a nitrogen flow of 50 mL/min at a heating rate of 10 °C/min from 30 °C to 600 °C.

3. Result and Discussion

3.1 Morphological Study

The morphological of rNBR have been studied by using scanning electron microscopy (SEM) in this research. Fig. 1 shown the SEM micrographs of rNBR powder (a) 100x magnification and (b) 1000x magnification. Based on Figure 1, the rNBR particles consist of irregular shaped particles with more fibrous form with irregular edges. The rNBR particle shown a non-precise shape due to presence of various additives and cross-linked precursors in rNBR glove beside good inherit elasticity properties of the NBR.

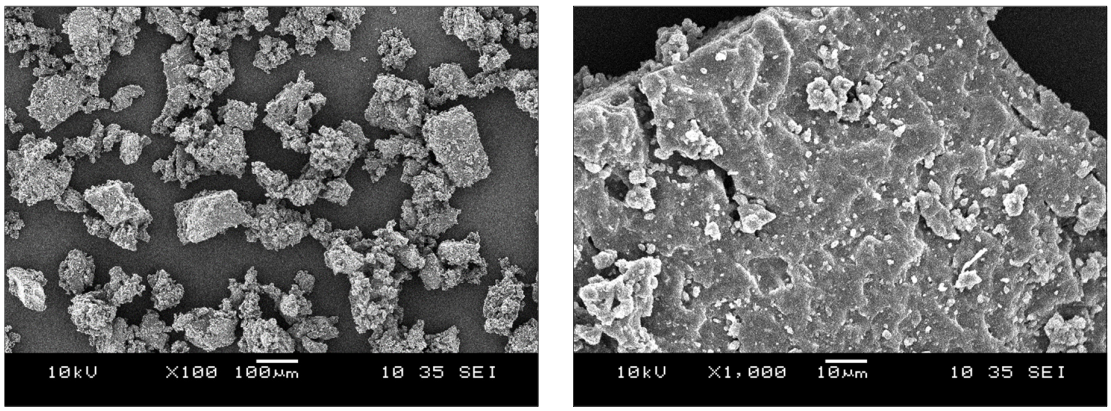

Fig. 1. SEM micrographs of rNBR powder (a) 100x magnification and (b) 1000x magnification

3.2 Fourier Transform Infrared (FTIR) Analysis

The Fig. 3 FTIR spectrum of rNBR glove. The observation from FTIR spectrum indicates the olefinic stretching frequency just about 2917.8 cm^{-1}, CH_2 bending vibration at above 1437.45 cm^{-1}, the vibration C≡N at 2237.54 cm^{-1} from NBRr structure and C-H out of plane bending frequency at 967.09 cm^{-1} [6]. The absorption of carbonyl (C=O) is 1771.41cm^{-1}. However the presence of unreated acceletor in NBR glove was also identified. The acceletor was represented by function group of N-H, and CH_2 were believed to be from N-cyclohexyl-2-benzothiazyl sulphonamide. Non-hydrogen bonded of N-H bending vibrations at 1605.88 cm^{-1}. Absorption band at 2917.76 cm^{-1} is representing CH_2 of cyclohexane of structure [7]. Fig. 2 shown the chemical structure of NBR [8].

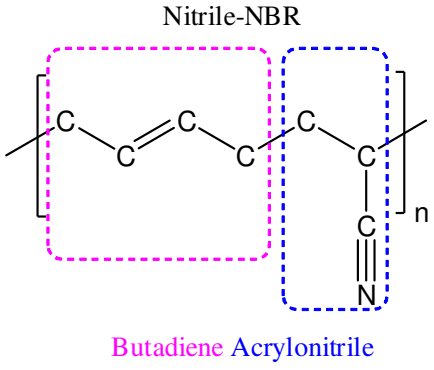

Fig. 2. Chemical structure of NBR [8]

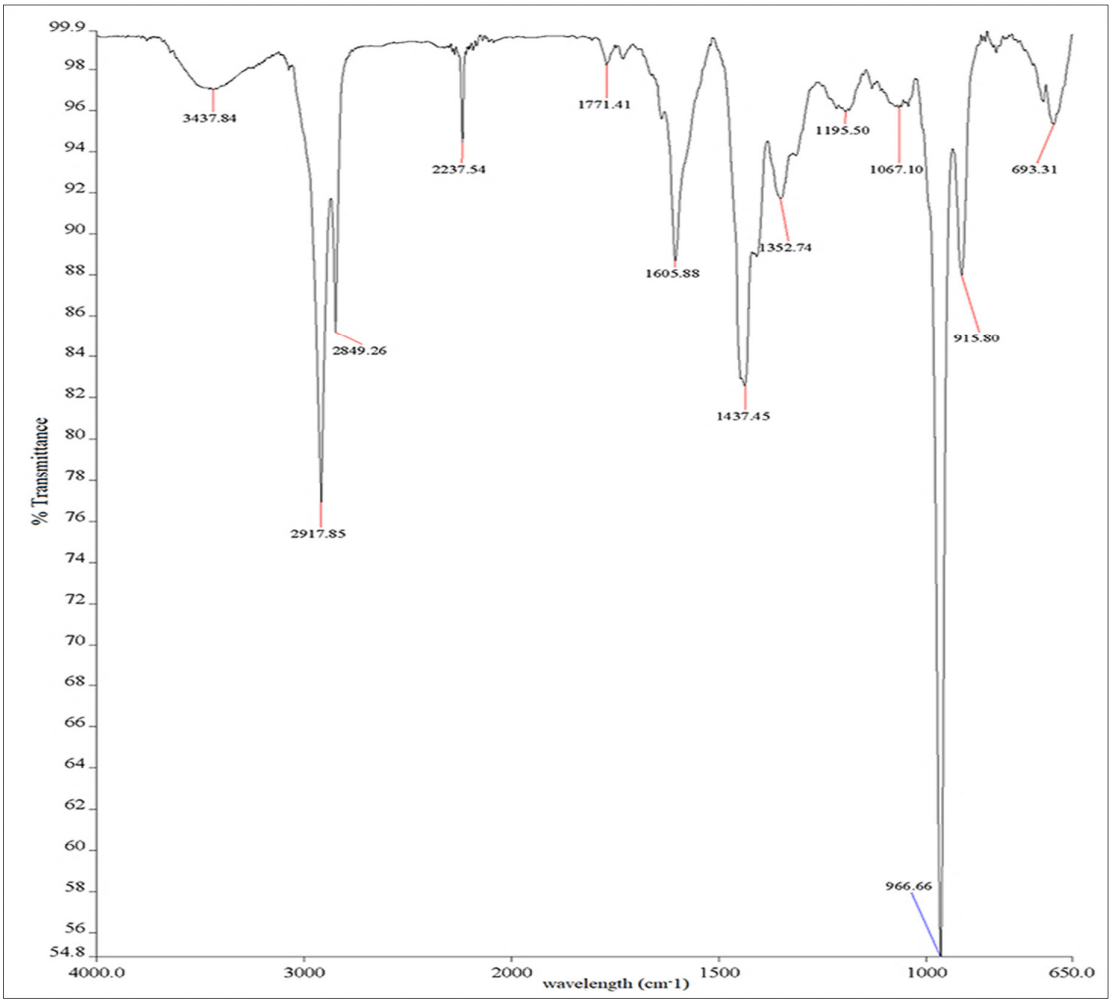

Fig. 3. FTIR of rNBR

3.3 Thermogravimetric Analysis (TGA)

Weight loss of NBRr is determined by the TGA technique and is an irreversible process due to thermal degradation. TGA and DTG curve of the NBRr are shown in Fig. 4. Frrom the GA curve, the temperature at 70% weight loss, $T_{70\%}$ is 446.26 °C. Meanwhile, the char residue of NBRr at 600 °C is 40.274 %. The DTG curve of NBRr, there are two (2) degradation curve were observed. The first curve at 388.90 °C and second curve at 444.00 °C respectively. According to Pruneda *et al*., [9], the first and second are associated to complex rubber decomposition influenced by the different additives. During the first degradation, oxidation, cross-linkage and chain scission may occur at the same time, and the main reaction may be oxidation and cross-linkage. In this case, mass loss is slower [10]. During the second process, the main reaction is oxidative degradation and obvious the main mass loss occurs [11].

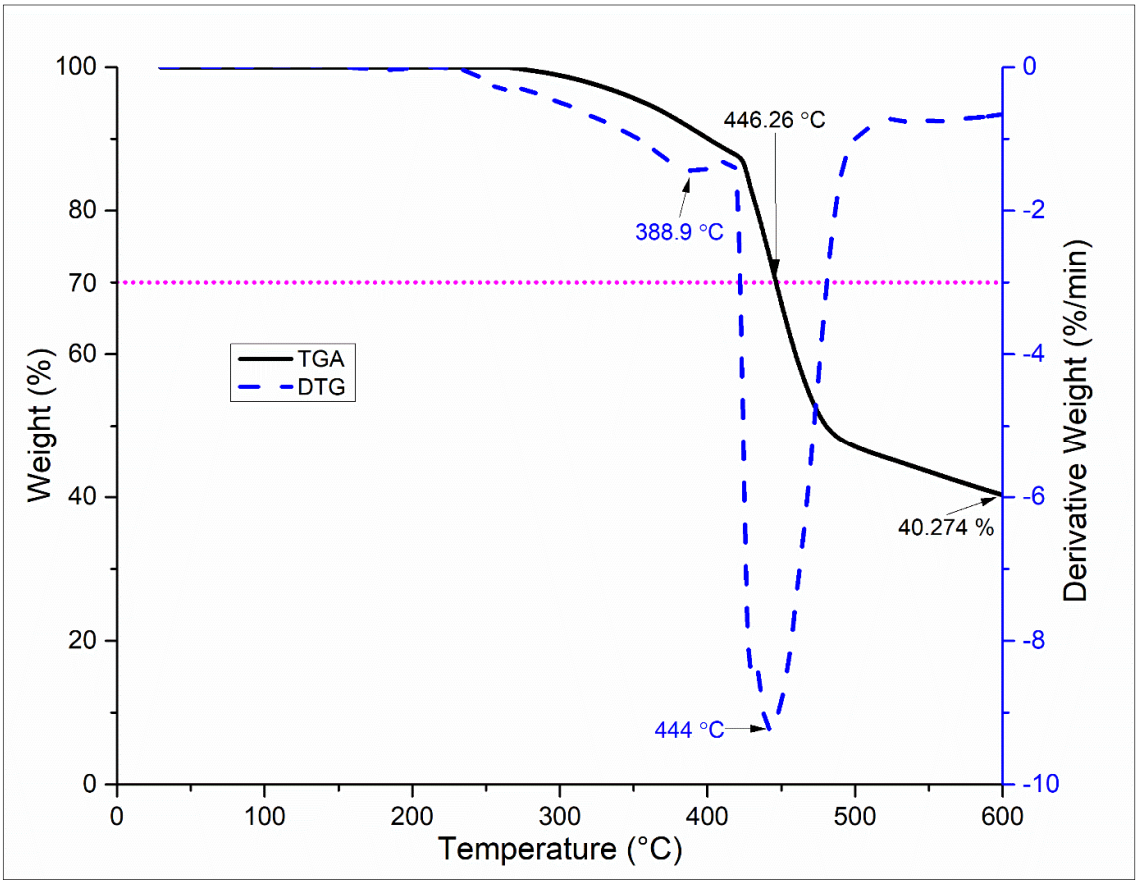

Fig. 4. TGA and DTG curve of rNBR

4. Conclusion

In this research, the surface morphology and FTIR and thermal properties of rNBR were analysed. The rNBR have irregular shaped particles with more fibrous form with irregular edges. The rNBR particle shown a non-precise shape due to presence of various additives and cross-linked precursors in rNBR glove beside good inherit elasticity properties of the NBR. The observation from FTIR spectrum indicates the olefinic stretching frequency just about 2917.8 cm^{-1}, CH_2 bending vibration at above 1437.45 cm^{-1}, the vibration C≡N at 2237.54 cm^{-1} from NBRr structure and C-H out of plane bending frequency at 967.09 cm^{-1}. The absorption of carbonyl (C=O) is 1771.41cm^{-1}. The TGA and DTG curve, the $T_{70\%}$ of rNBR was 446.26 °C and the char residue of rNBR was 40.27 %. The rNBR also have high degraded temperature at 444.00 °C. The. Hopefully, the analysed will help to create thermoplastic elastomer composite by using NBR glove in order to minimize the NBRr glove waste produces.

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