Chemical Methodologies 3(2018) 346-353

Chemical Methodologies

Journal homepage: http://chemmethod.com

Original Research article

Studies on Mechanical and Thermal Properties of PP with *Natural* Carbon Powder

A.U. Santhoskumar*, N. Jaya Chitra

Depatment of chemical Engineering, Dr. MGR Educational Research Institute University, Chennai-95, India

ARTICLE INFORMATION

Received: 03 September 2018
Received in revised: 29 November 2018
Accepted: 10 December 2018
Available online: 01 May 2019

KEYWORDS

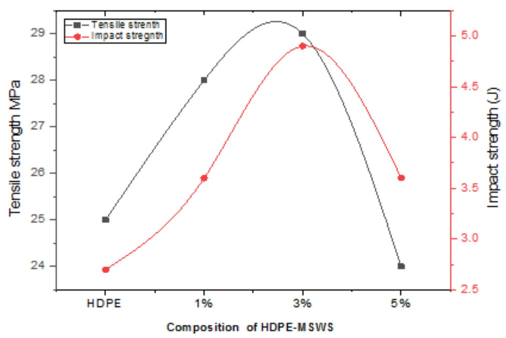
PB
WC
BBC
PP
Composites

ABSTRACT

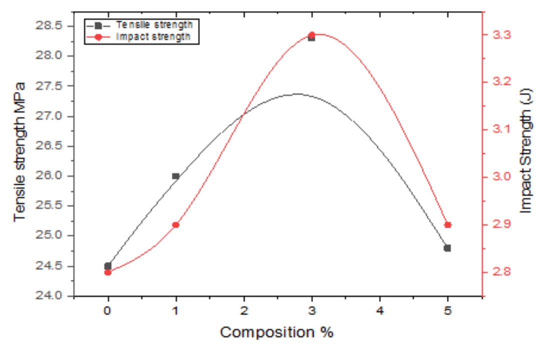
The work has to develop polypropylene (PP) mixed for the purpose of compatible into the *Prosopis juliflora* bark powder (PB), Wheat husk carbon powder (WC) and *Banyan* carbon powder (BBC) using renewable bio resources. PB, WC and BBC were used as filler. They are relatively inexpensive and abundantly available in nature. The waste management were collected the wasted. PB, WC and BBC have been incorporated with composites. The mechanical and thermal studies were carried out to evaluate the effect of filler content on PP. The above filler has been studied for the mechanical and thermal properties increase with an increase in the filler content at optimum level 3% by weight. The tensile property of treated composites shows a higher value than neat PP matrix. The properties has been analyzed the variation value depend upon the porosity of the carbon and mixing the polymer composites.

**Corresponding author: E-mail: santhosannauniv@gmail.com*
Depatment of chemical Engineering, Dr. MGR Educational Research Institute University, Chennai-95, India, Tel: + 9094328842

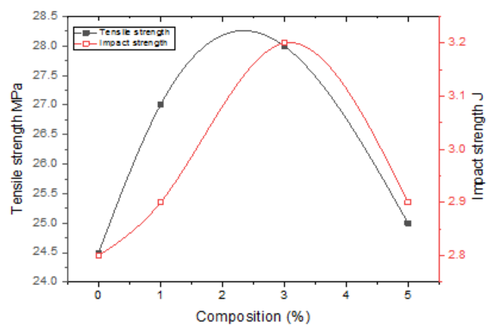
Graphical Abstract



The tensile and impact properties of PP-WC



The tensile and impact properties of PP-BBC



The tensile and impact properties of PP-PB

Introduction

During the recent years, polymeric composite materials are being used in a variety of applications due to their high strength and stiffness, lightweight and high corrosion resistance [1-15]. Most of the products are from non-biodegradable fibers, where the problem of disposal arises over the end use, this raised the attention of people for the use of natural, sustainable, biodegradable and renewable resources [16-18].

The use of various natural reinforcing fibers in thermoplastics with the fibers such as hemp, jute, flax, sisal, and kapok had gained acceptance in commodity plastics and applications of these materials during the past decade and been reported in the literature. However, still various fibers and particulate fillers need to be explored and amongst the thermoplastic materials; PP is an outstanding commercially available thermoplastic material with a wide range of applications. In this research work carried out polypropylene (PP) by weighing treated *Prosopis juliflora* bark powder to make PP composites [18-23.].

Experimental

Material and methods

Prosopis juliflora bark (PB) was collected from local area with the help of local people in Chennai. The collected PB materials were sun dried for 2 days and then finely powdered with grinding machine in local mill. The powered materials were washed with distilled water for several times to remove all the dirt particles. The powdered PB was oven-dried at 110 °C for 10 hrs to remove excess moisture. The powdered PB was sieved to get uniform particle size of 150 mesh then the powder was treated with con. sulphuric acid for 2 hours then filtered and then washed with water to get rid of excess acid. The product was kept in a muffle furnace for about 2 hours and the temperature was maintained at 800 °C. The resulting powder was used for adsorption experiment. *Banyan* carbon black has been following the above procedure.

The leaves of *Prosopis juliflora* were collected from various places in Chennai, Tamil Nadu, and India. The leaves were boiled in pure water for 5 mins to take the natural green color present in the leaves. Then they were sun dried for 2 days and oven dried at 75 °C for 24 hrs to extract the moisture content prest in the leaves. The dried leaves were grinded in a mixer. The powdered leaves was sieved to get uniform particle size of 150 mesh. The chemical treatment of the leaves were done by soaking 50 gm of *Prosopis juliflora* in 40 mL of phosphoric acid (30%) for 24 hrs. Then 3 wash was done in distilled water to extract the acid content from the leaves. The treated *Prosopis juliflora* leaves were activated in muffle furnace for 2 days.

The wheat husk used in the present investigation was obtained from the local countryside. The collected materials were washed with distilled water for several times to remove all the dirt particles. Then it was dried at 70 °C for 24 hrs. Then it was grounded to get reduced sized particles. The grounded *Wheat* husk was sieved to get uniform particle size of 150 mesh. Chemical treatment of *Wheat* husk was done by soaking 75g of *Wheat* husk in 75 mL of phosphoric acid (30%) for 24 hrs. Then it was dried in muffle furnace at 500 °C to convert it into activated carbon.

Mechanical properties

Tensile stress-strain data were obtained at 25 °C and 50% relative humidity as per the ASTM standard D-638. 58 dumbbell specimens (ASTM type IV) were tested in the zwick UTM at a constant crosshead speed of 50 mm/min.

The sample, in the 150×150×3 mm dimensions, prepared press machine in mould placed in a laboratory conditions for 72 hours. The preparing of the sample and pre-experiment were then made like what was mentioned. The thickness of samples was measured about ±0.01 mm sensitive from least tree place and the smallest value was recorded. The sample was moved single-sided and was nicked in the 2.45 mm deep and 45° dimensions, the shape is V. The sample was put into apparatus and the maximum degree was recorded. The average of results were calculated.

The unnotched Izod impact strength of each sample was tested as per ASTM D 256-88. All the samples were tested as unnotched so that they would be more sensitive to the transition between ductility and brittleness. Specimens, having thickness 3.2 mm with 10 mm cross-section and 64 mm long were clamped at the base of the pendulum testing machine so that they were cantilevered upward. The pendulum was released and the force consumed in breaking the sample was calculated.

Thermal properties

Thermal analysis differential scanning calorimetric (DSC) analyses were carried out in a Shimadzu DSC-50 (Shimadzu, Kyoto, Japan) thermal analyzer in nitrogen atmosphere. The samples were heated from 25 °C to 200 °C at 10 °C min^{-1}. Melting (Tm) temperatures and enthalpies were determined from the second scan. Tm was considered to be the maximum of the endothermic melting peak from the heating scans. The heat of fusion (ΔH_f) were determined from the areas of melting peaks.

Result and Discussion

Mechanical properties

In Figure 1. (a, b and c) tensile strength of the blend as a function of filler loading. The tensile strength increases with addition from 1 to 3 phr of filler due to the addition of PB, WC and BBC fillers reinforced polypropylene composites. Beyond the level of incorporated filler, the tensile strength gradually decreases with filler loading due to the agglomeration.

The tensile strength of PB, WC and BBC powder polypropylene composites show an increased tremendously upto 3 wt% and then decreased on the 5%. The PP to the PB, WC and BBC powder resulting in higher strength. Therefore, the composite can sustain higher load before failure compared to the PP. However, at higher loading, the tensile strength decreased when compare to that of 3% loading. The impact strength values for neat, coupled and treated PB, WC and BBC powder polypropylene composite.

The result of impact test shows an improved the impact strength at around 3.4-3.6 KJ/m^2 properties for maximum filler content of 3 wt%, thereby increasing the toughness properties of the composite material. This may be probably due to the addition of filler material might have filled the small voids and the regions of particle corners there by improving the impact strength when compared to that of 1 and 5 phr.

The mechanical properties of PP-PB, WC and BBC composite, the PP-BBC composite higher strength when compare to that of PP-PB and WC.

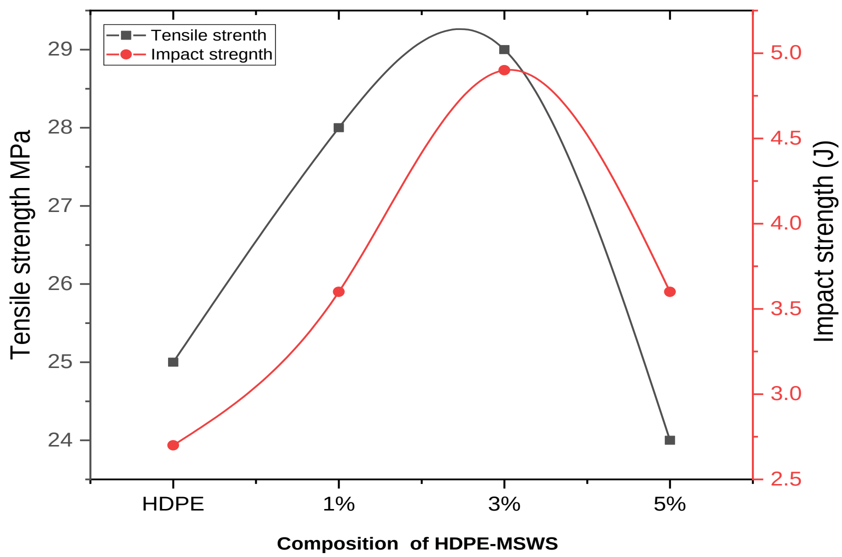


Figure 1(a). The tensile and impact properties of PP-WC

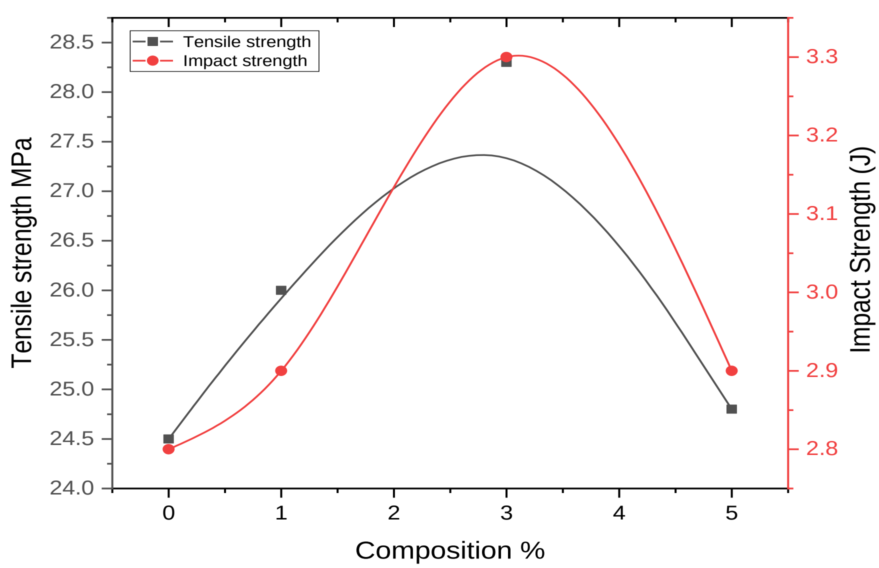


Figure 1(b). The tensile and impact properties of PP-BBC

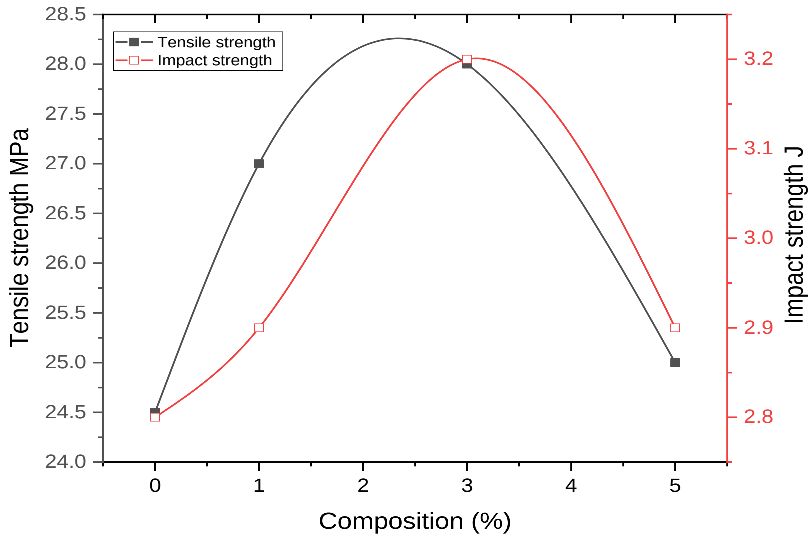


Figure 1(c). The tensile and impact properties of PP-PB

Thermal properties of polypropylene (PP) composite

The PP shows its melting point at 162 °C. By the incorporation of 3% PB, WC and BBC, the melting point is higher due to the presence of filler interaction in PP as presented in Table 1. (a, b and c). In case of the PP with 5 Phr of PB, WC and BBC powder samples a marginal decrease in the melting point from 167 °C to 162 °C is observed. This could be due to the non compatible PB, WC and BBC. In this case, of PP with PB, WC and BBC powder content there is much difference in the melting point when compared to that of virgin PP.

Table 1(a). Tensile strength of HDPE with MSWS filler

Serial No.	Samples Details	Tensile strength (MPa)
1	HDPE	25
2	HDPE with 1% MSWS filler	28
3	HDPE with 3% MSWS filler	29
4	HDPE with 5% MSWS filler	24

Table 1(b). Impact strength of HDPE with MSWS filler

Serial No.	Samples Details	Impact strength (K/Joule)
1	HDPE	2.7
2	HDPE with 1% MSWS filler	3.6
3	HDPE with 3% MSWS filler	4.9
4	HDPE with 5% MSWS filler	3.6

Table 3(c). Melting temperature of HDPE with MSWS filler

Serial No.	Sample Details	ΔH_f (J/g)	T_m (°C)
1	HDPE	135.0	131.0
2	HDPE with 1% MSWS filler	103.5	133.3
3	HDPE with 3% MSWS filler	161.9	136.7
4	HDPE with 5% MSWS filler	133.5	131.2

Conclusion

The mechanical and thermal properties increase with increase in the filler content at optimum condition at 3 % by weight.

The tensile property of treated composites shows a higher value than neat PP matrix. Impact strength also increase with filler content but improved strength is obtained for maximum filler composite material at optimum percentage. These composites will be desirable for making house hold products due to their considerable stability and strength properties.

Reference

[1] Shawkat, M.S., Khazall A.Q., Majeed M.R, Iraq Journal of Science, 2011, 52, (4), 456-463

[2] Mohammed L., Ansari M.N.M., Pua G., Jawaid M., Saiful Islam M. *Int. J. Polym. Sci*., Article ID 243947, 15 pages

[3] Kakroodi A.R., Cheng S., Sain M., Asiri A. *J. Nanomater*., 2014, Article ID 903498, 7 pages

[4] Sreekala M.S., Kumaran M.G., Thomas S. *Mater. Lett.,* 2001, **50**:263

[5] Ren B., Mizue T., Goda K., Noda J. *Compos. Struct*., 2012, **94**:3457

[6] Pan Y., Zhong Z. *Mechan. Mater*., 2015, **85**:7

[7] Jayamani E., Hamdan S., Rahman R., Bakri M.K.B. *Proc. Eng*., 2014, **97**:545

[8] Boopathi L., Sampath P.S., Mylsamy K. *Compos. Part B: Eng*., 2012, **43**:3044

[9] Ramesh M., Atreya T.S.A., Aswin U.S., Eashwar H., Deepa C. *Proc. Eng*., 2014, **97**:563

[10] Venkateshwaran N., Elaya Perumal A., Arunsundaranayagam D. *Mater. Design*, 2013, **47**:151

[11] Monteiro S.N., Satyanarayana K.G., Ferreira A.S., Nascimento D.C.O., Lopes F.P.D., Silva I.L.A., Bevitori A.B., Inácio W.P., Bravo Neto J., Portela T.G. *Matér.*, 2010, **15**:488

[12] Ismail H., Rozman H.D., Jaffri R.M., Mohd Ishak Z.A. *Eur. Polym. J*., 1997, **33**:1627

[13] Jawaid M., Abdul Khalil H.P.S. *Carbohy. Polym*., 2011, **86**:1

[14] George M., Mussone P.G., Abboud Z., Bressler D.C. *Appl. Surface Sci*., 2014, **314**:1019

[15] Wongsriraksa P., Togashi k., Nakai A., Hamada H., Adva. Mech Eng., 2013,1-10

[16] Gassan J., Bledzki A.K. *Compos. Sci. Technol*., 1999, **59**:1303

[17] Rong M.Z., Zhang M.Q., Liu Y., Yang G.C., Zeng H.M. *Compos. Sci. Technol*., 2001, **61**:1437

[18] Tran T.P.T., Bénézet J.C., Bergeret A. *Ind. Crops Prod.,* 2014, **58**:111

[19] Hossain S.I., Hasan M., Hasan M.N., Hassan A. *Adv. Mater. Sci. Eng*., 2013, Article ID 824274, 6 pages

[20] O'Donnell A., Dweib M.A., Wool R.P. *Compos. Sci. Technol*., 2004, **64**:1135

[21] Luo H., Xiong G., Ma C., Chang P., Yao F., Zhu Y., Zhang C., Wan Y. *Polym. Test*., 2014, **39**:45

[22] Ismail H., Rusli A., Rashid A.A. *Polym. Test*., 2005, **24**:856

[23] Paul A., Joseph K., Thomas S. *Compos. Sci. Technol.*, **57**:67

How to cite this manuscript: A.U. Santhoskumar*, N. Jaya Chitra. Studies on Mechanical and Thermal Properties of PP with *Prosopis Juliflora* Bark (PB), Wheat Husk Carbon Powder (WC) and *Banyan* Bark Carbon Powder (BBC). Chemical Methodologies 3(3), 2019, 346-353. DOI: 10.22034/chemm.2018.147034.1082.