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The Effect of Dibutyl phthalate plasticizer to Impregnation and Mechanical Properties of Biocomposite Sansevieria trifasciata/High Impact Polypropylene

Apang DjafarShieddieque*[1, 2 a)], Mardiyati[1, b)], Rochim Suratman[1, c)] and Bambang Widyanto[1, d)]

[1]Faculty of Mechanical and Aerospace Engineering, Bandung Institute of Technology, Ganesha 10, Bandung, 40132, Indonesia
[2]Faculty of Mechanical Engineering, Sekolah Tinggi Teknologi Wastukancana, Jln Cikopak No. 53, Purwakarta, 41151, Indonesia

[*] Coresponding Author: apang_djafar@yahoo.com

Abstract. The aim of this research was to investigate the effect of dibutyl phthalate plasticizer to impregnation and mechanical properties of biocomposite *sansevieria trifasciata*/high impact polypropylene and to analyze the morphology of interfacial bond between matrix and fiber. In this research, biocomposite *sansevieria trifasciata/*high impact polypropylene was manufactured by using a hot press method with temperature 180ºC and pressure 140 bar for 10 minutes. Fibers were extracted from *sansevieria trifasciata* by using mechanical retting. In this experiment, the fibers weree treated by NaOH 3% (wt%) solution at temperature 100ºC for an hour. The volume fractions of fiber used in this experiment were 0%, 15%, 25%, and 35% with unidirectional orientation. To improve impregnation of high impact polypropylene matrix, 2% dibutyl phthalate was added as plasticizer. Actual density and mechanical properties of biocompositesare conducted based on ASTM standard testing methods D792 and D3039.The results showed that tensile strength, modulus of elasticity and elongations of bio composite *sansevieria trifasciata/*high impact polypropylene with plasticizer were higher than without added plasticizer. The fracture analysis was investigated by scanning electron microscope (SEM). The highest tensile strength, modulus of elasticity and elongation of biocomposites were 65 Mpa, 2.31 GPa and 0.42% respectively. Their highest properties were obtained from bio composites with 35 % volume fraction of unidirectional alkaline treated fiberand 2% dibutyl phthalate. Morphological feature based on scanning electron microscope (SEM) observation showed that biocomposites with added plasticizer had better interface bond between matrix and fibers.

Keywords: Alkaline treatment, *Dibutyl phthalate*, High impact polypropylene, Plasticizer, *Sansevieriatrifasciata*

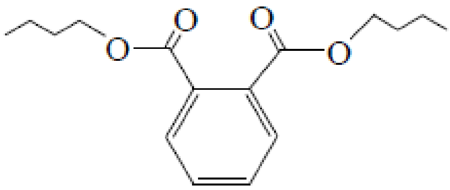
1. Introduction

Light weight vehicle has become very important nowadays due to depletion of the fossil fuel availability and increasing of CO_2 emissions [1–2]. To overcome those problems, the usage of lightweight materials in automotive to reduce vehicle weight which eventually reduce the fuel consumption and improve the performance as well [3]. Plastic has been developed as one of promising alternatives to replace the original materials [1]. However, plastic such as high impact polypropylene that has been developed has weakness due to its mechanical properties that still not suit up to the expected standard as material of vehicle components. Fibers have been used as reinforcement in plastic to improve the mechanical properties, named as composite. Natural fiber has been a better alternative than glass fiber as it offers a lower carbon footprint in manufacturing process and less energy required for production [2 – 4].Inthis research, *Sansevieria trifaciata* is used as to reinforce the high impact polypropylene matrix. *Sansevieria trifaciata* is common plant and can be found throughout Indonesia. To improve the mechanical properties of the composite, plasticizer has been added into the composite matrix (i.e polymer). Plasticizer is added toaid the polymer processing. The aim of this study was toinvestigate the effect of plasticizer addition on impregnation and mechanical properties of *Sansevieria trifasciata/*high impact polypropylene (STF/HIPP) biocomposites.

2. Materials and Methods

Materials

Sansevieria trifasciata leaves and high impact polypropylene were used in this research. The leaves were obtained from local residents in Citarum, Bandung, and high impact polypropylene was provided by PT Chandra Asri Petrochemical. *Sansevieria trifasciata* fibers were prepared from *Sansevieria trifasciata* leaves by mechanical retting and washed with water to remove leaves' component, then dried at room temperature. Plasticizer used in this study was dibutyl phthalate (DBP) from Sigma Aldrich. The chemical structure of DBP is shown in Fig.1



DBP ($C_{16}H_{22}O_4$)

Fig 1.The chemical structure of dibutyl phthalate (DBP) [5].

Alkaline Treatment

Sansevieria trifasciata fibers were treated by refluxing 10 grams of fibers in NaOH solution with ratio 1:100. The concentration of NaOH solution was 3% wt. Fibers were treated at 100°C for an hours. Then, the treated *Sansevieria trifasciata* fibers were washed with demineralized water and dried at room temperature about 1 day. The fibers orientation was set up into unidirectional orientation.

Manufacturing

In this research, *Sansevieria trifasciata*/high impact polypropylene (STF-HIPP) without and with 2%wt. of DBP were prepared. *Sansevieria trifasciata*/high impact polypropylene biocomposites were manufactured by using a hot compression molding at 180ºC with the pressure at 140 bar for 10 minutes. Fibers orientations were unidirectional with volume fraction of fiber 0%,15%, 25% and 35%.

Testing Method

The mechanical properties of *Sansevieria trifasciata*/high impact polypropylene biocomposites (STF/HIPP) were examined by using universal testing machine method (Tensilon). The density of composite was determined according to ASTM D792, constituent contents were determined according to ASTM D3171 and the void content of composites were determined according to ASTM D2734-94. The morphologies of the fracture surface were observed using Scanning Electron Microscope (SEM).

3. Result and Discussion

Mechanical properties of Composites

The density of unidirectional *Sansevieria trifasciata*/high impact polypropylene (STF/HIPP) with 2 wt. % DBP and without DBP are presented in Table 1. The tensile strength, the stiffness and elongation of the biocomposites are shown in Fig, 2. The results show that the addition of fraction of fiber will increase the density of biocomposites and void as well. The amount of voids can lead the stress consentration that can cause to failure, but because the void difference obtained for each kind of composite is considered small, the effect can be neglected [6-8].

Table 1 Density and void percentages of STF/HIPP biocomposites

No	Sample	Fiber Volume Fraction (%)	Density (kg/m3)	Void (%)
1	STF/HIPP without plasticizer	15	985	3.14
2		25	989	4.40
3		35	992	5.80
4	STF/HIPP + 2 wt.% DBP	15	988	3.12
5		25	990	4.00
6		35	995	5.5

The mechanical properties of biocomposites are shown in Fig. 2-4. The tensile and stiffness properties of STF/HIPP biocompositesincrease with increasing the volume fraction of fiber. The addition of volume fraction of *Sansevieria trifasciata* fibers up to 35 % into high impact polypropylene matrix increases the tensile strength from 10.8 MPa to 63.9 MPa. Biocomposites STF/HIPP with 2wt. % DBP have slightly higher tensile and stiffness strength as shown in Fig. 2 and Fig. 3.

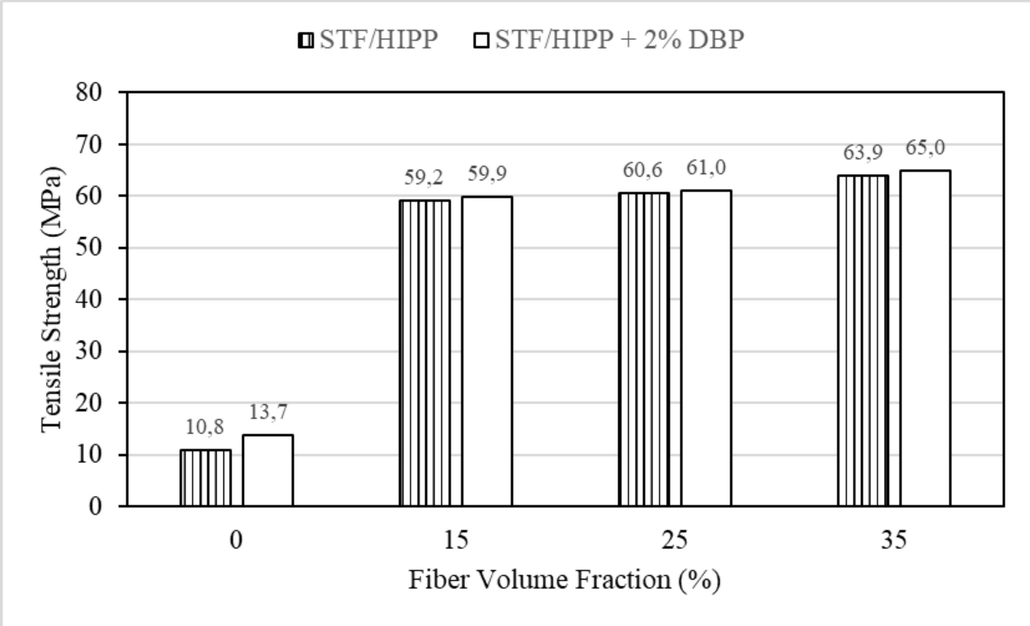


Fig. 2. Tensile Strength of Composites

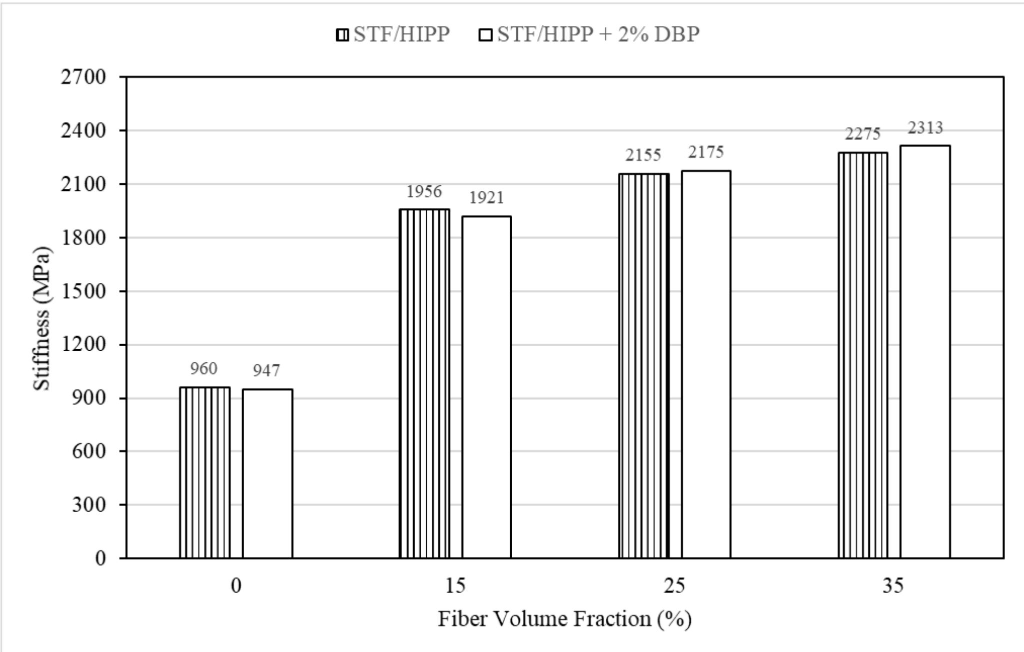


Fig. 3.Stiffness of Composites.

Figure 4 shows the elongation properties of STF/HIPP biocomposites. Biocomposites STF/HIPP with DBP addition has higher elongation compare with STF/HIPP biocomposites without DBP addition. In polymer processing, plasticizer is added to improve the film flexibility, reduce glass transition temperature, improve the impact strength, facilitate on molding, etc. [9]. Reducing the glass transition temperature will lead to improvement of ductility of polymer, therefore enhances the toughness and impact resistance of the polymer. In this study it is observed that addition small amount of DBP as plasticizer improve the elongation value for unidirectional STF/HIPP biocomposites with 15 % and 25 % vol. fraction of fiber. The elongation of unidirectional STF/HIPP biocomposites with 35 % vol. fraction of fiber shows slightly improvement that might be caused by the reinforcement effect of the fiber more dominant than the effect of plasticizer.

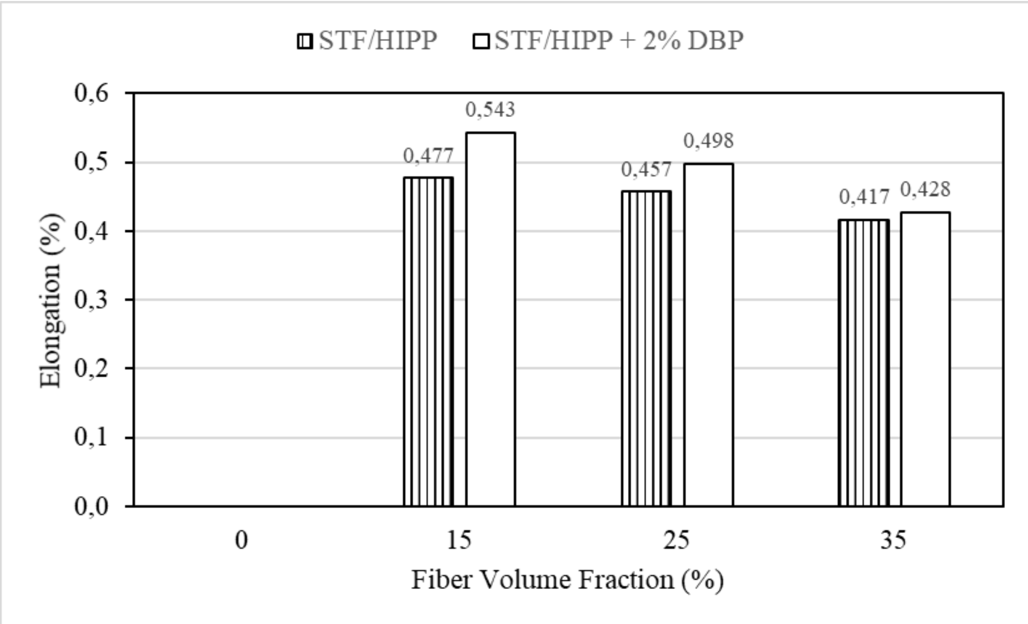
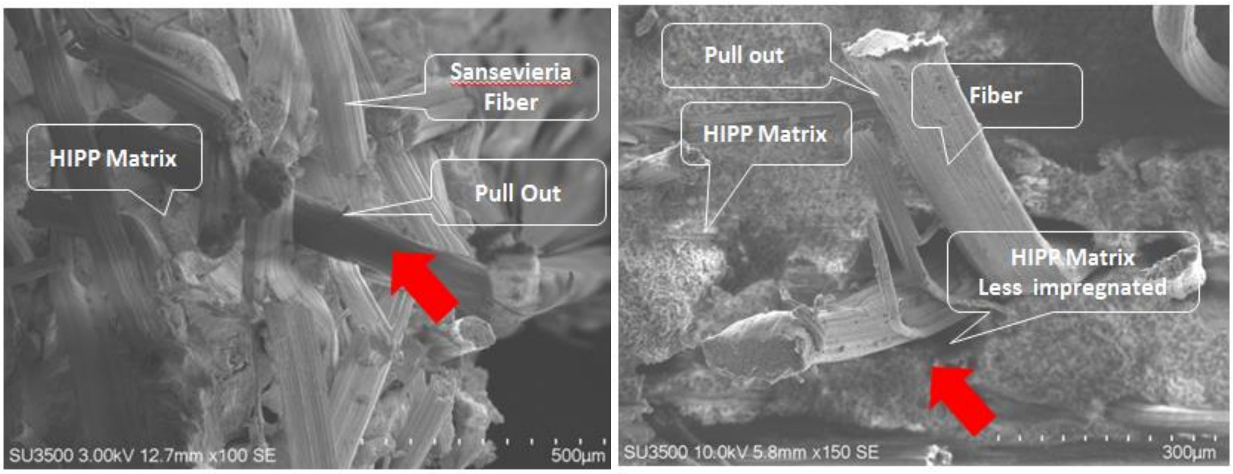


Fig. 4 Elongation of Composites.

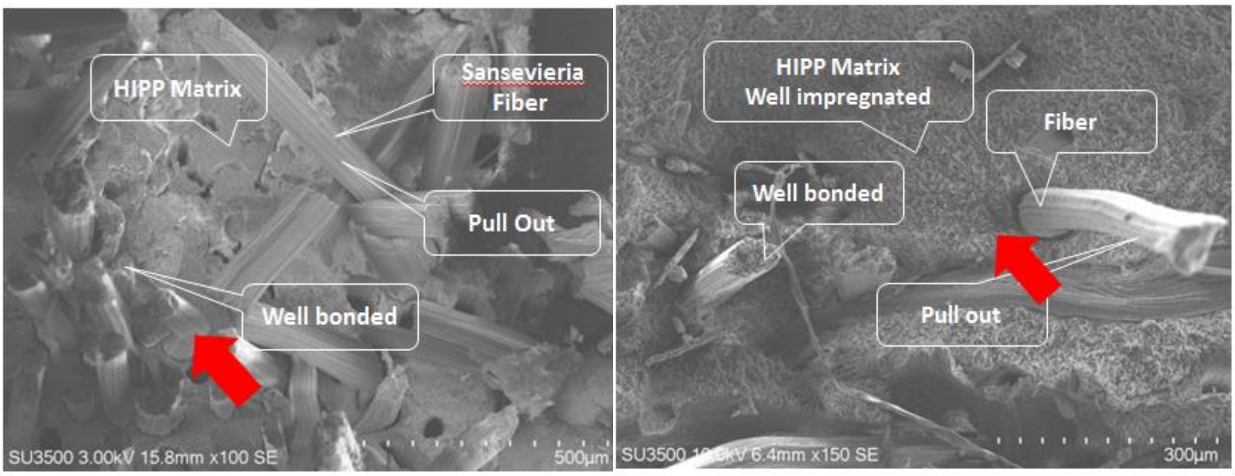
Morphology of Fracture Surfaces

The morphology of the fracture surface of the unidirectional STF/HIPP biocomposites are shown in Fig. 5 and Fig. 6. There were gaps and cavities in all images of fracture surface that associated with the pull out of the fiber from the matrix. Pull out fibers are observed on the fracture surface of the unidirectional STF/HIPP biocomposite without DBP plasticizer and with addition of DBP plasticizer as shown in Fig. 5a and Fig 6a. However, the well bond *Sansevieria trifasciata* fibers are more likely found on the fracture surface of unidirectional STF/HIPP biocomposite with the 2 wt. % of DBP (Fig. 6a). The addition of DBP improves the impregnation of the matrix into fiber, results in increasing the mechanical properties as mentioned above. The less impregnation of matrix can be seen on existing of the gap or cavity around the fiber as a result of pull out in Fig. 5b, meanwhile the gap or cavity is not found around the pullout fiber of the unidirectional STF/HIPP biocomposites with DBP addition as seen in Fig. 6b. It is clear the addition of DBP can improve the impregnation matrix into fiber.



(a) (b)

Fig. 5 SEM images of fracture surface of unidirectional STF/HIPP



(a) (b)

Fig. 6 SEM images of fracture surface of Unidirectional STF/HIPP with 2% DBP

4. Conclusions

In this study, the effect of dibutyl phthalate (DBP) addition as plasticizer on the mechanical properties of *Sansevieria trifasciata*/high impact polypropylene is investigated**.** In this research, it is found that tensile strength, modulus of elasticity and elongations of biocomposite *Sansevieria trifasciata*/high impact polypropylene with plasticizer was higher than without added plasticizer. The fracture analysis was investigated by scanning electron microscope (SEM). The highest tensile strength modulus of elasticity and elongation of biocomposites were 65 MPa, 2.31 GPa and 0.42% respectively, obtained from biocomposites with volume fraction of unidirectional alkaline treated fiber 35% and added 2% dibutyl phthalate as plasticizer. Morphological feature based on scanning electron microscope (SEM) observation shows that by added plasticizer had better interface bond between matrix and fibers, so that better mechanical properties and processing can be obtained.

5. Acknowledgements

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