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EFFECT OF DIVINYLBENZENE AND DICUMYL PEROXIDE ON THE PROPERTIES OF STANDARD INDONESIAN RUBBER'S (SIR-3L) BLENDS

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ABSTRACT

The blend of standard Indonesian rubber (SIR-3L) and low density of polyethylene (LDPE) with a ratio of 50/50 (w/w%) had been prepared by varying the amount of divinylbenzene (DVB) and dicumyl peroxide (DCP). The properties of SIR-3L/ LDPE blends had been characterized using scanning electron microscopy (SEM), Fourier transform infrared (FT-IR), and mechanical properties. The addition of divinylbenzene and dicumyl peroxide affected the properties of SIR-3L/ LDPE blends.

Keywords: Standard Indonesian Rubber (SIR-3L), Low Density of Polyethylene (LDPE), Blend, Divinylbenzene, Dicumyl Peroxide

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INTRODUCTION

The standard Indonesian rubber 3L (SIR-3L) is one of the natural rubber products from Indonesia. The natural rubber has been known as good natural elastomeric material due to its low glass transition temperature. As the impact, natural rubber itself has good mechanical properties at room temperature, and it can be processed at room temperature or even at high temperature. Other than soft, flexible and elastic, natural rubber is also known as a good insulator and has high resistance to cracking.[1–3]

However, natural rubber has several drawbacks, the presence of unsaturated bonds on its chemical structure affects its durability against oxidation agents (sunlight, weather, ozone) and organic solvents. The blending process is the common and simple process that has been chosen to improve the properties of polymeric material through physical and or chemical interaction by combining it with other polymeric materials. Combining the natural rubber with a thermoplastic material, i.e. LDPE, can be an effective way to reduce the drawback effect due to the presence of unsaturated bonds.

A very useful product called thermoplastic elastomer (TPE) materials can be achieved in this study. This kind of material has properties and functions similar to vulcanized rubber at low temperatures, but can be melted like thermoplastics at high temperatures, this material can be used in a wide range of applications, such as the automotive industry.[4] Various TPE can be produced by exchanging the type of thermoplastic or the elastomer materials, this process can produce a million types of TPE with different properties. One of the commercial TPE products is polyethylene/ethylene-propylene-diene (PE/EPDM). However, EPDM is relatively more expensive compared to natural rubber, thus in this study natural rubber was used for replacing EPDM.

Mixing LDPE and natural rubber is believed to be more economical and has high tensile strength compared to PE/EPDM.[4–7] One issue that will be and commonly faced in the blending process is the compatibility of the end product. Several factors can generate this issue, i.e., polarity, molecular weight, etc. The objective of this study was to evaluate the effect of the addition of divinylbenzene (DVB) and dicumyl peroxide (DCP) on the properties of SIR-3L/ LDPE blends. DVB is one chemical that is normally utilized for modifying polymeric and natural rubber structures. In several studies, DVB has a unique interaction with polymer structure which can enhance the properties of the polymer. Natural rubber can form crosslinked structures with the help of a crosslinked agent, in the current study DVB was utilized as the crosslinked agent to obtain the crosslinked structure which has enhanced properties.

EXPERIMENTAL

Materials

Low-density polyethylene (Innovex) was obtained from PT. Petrochemical Nusantara Interindo. Natural rubber SIR 3L was received from PT. Bakrie Range. Dicumyl peroxide (DCP) and divinylbenzene (DVB) were purchased from Sigma Aldrich.

Preparation of SIR 3L/LDPE Blends

About 50 g of LDPE was processed in the internal mixer (Gonno Hydraulic press) at 180°C, after 20 minutes 50 g of SIR-3L was then mixed with the melted LDPE in the internal mixer for another 15 minutes. The obtained blends were then subjected to the preparation of the sheet by a hydraulic press machine at 35°C and were cut into dumbbell shape as per ASTM D-638 type IV.

The effect of divinylbenzene and dicumyl peroxide was evaluated by preparing the blends using the same protocol as above. Divinylbenzene and dicumyl peroxide were added together with SIR-3L, the amount of each component can be seen in Table-1.

Characterization

The blends were subjected to several analyses, i.e., FT-IR (Bruker), Scanning Electron Microscope (HITACHI TM4000), and mechanical properties (GmbH-Germany).

RESULTS AND DISCUSSION

Divinylbenzene and dicumyl peroxide affected the mechanical properties of SIR-3L/ LDPE blends, in this term tensile strength and elongation at break. Before the addition of those chemicals, this blend showed a low value of tensile strength and elongation at break, i.e., 2.20 MPa and 12.29%. When DVB and DCP at a ratio of 1:1 was added during the blending process, tensile strength and elongation at break of the blends were found increasing up to 2.48 MPa and 18.88%, respectively. The highest value of tensile strength and elongation was found when DVB and DCP were added at a ratio of 3:2 that gave a value of 3.31 MPa and 28.99%, respectively (Table-1). This result confirms that the addition of DVB and DCP may act as a compatibilizer in the blends of SIR-3L/ LDPE.

Table-1: Mechanical Properties of SIR-3L/ LDPE Blends in the Presence of DVB and DCP

No	LDPE (g)	SIR-3L (g)	Divinyl Benzene (phr)	Dicumyl Peroxide (phr)	Strong (MPa)	Flexibility (%)
1	50	50	-	-	2.20	12.29
2	50	50	1	1	2.48	18.88
3	50	50	2	1	2.50	19.33
4	50	50	3	1	2.59	23.07
5	50	50	1	2	3.09	26.74
6	50	50	2	2	3.21	27.66
7	50	50	3	2	3.31	28.99

Morphological analysis was performed to confirm the effect of DVB and DCP as the compatibilizer. Fig.-1a and 1b can be used to compare the compatibility effect, in the uncompatibilized blend (Fig.-1a) have a larger pore size than in the compatibilized blend (Fig.-1b). The reduction of pore size in the compatibilized blend can be induced as the effect of the radical polymerization between DVB and DCP to form

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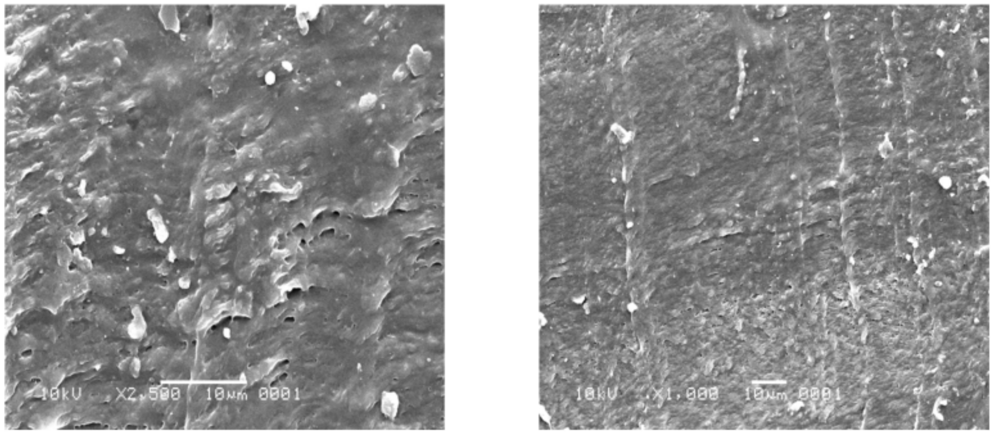
comonomers of DVB. In several studies revealed the presence of grafted comonomer can act as a compatibilizer and be able to enhance the mechanical properties of blends.[8,9]



(a) (b)

Fig.-1: SEM Images of (a) SIR-3L/ LDPE without DVB and DCP, (b) SIR-3L/ LDPE with DVB/ DCP (3:2)

An additional analysis, FT-IR, was performed to determine the functional group that appeared in the blends (Fig.-2). The infrared spectrum of LDPE has a typical wave number at 2950 cm^{-1} which confirmed the presence of C-H stretching band; and at 1460 and 720 cm^{-1} that indicated the presence of CH_2 stretching band. [4,10–12]

While the presence of SIR-3L in the blends can be identified by the presence of a band at 1875 and 1637 cm^{-1}, which confirmed the presence of C=C and C-H stretching bands. After the addition of DVB and DCP, a distinction band can be found at 1715 cm^{-1} that referred to the presence of C=O group and aromatic C=C. The presence of aromatic C=C can be found in the chemical structure of DVB, while C=O group can be assumed was formed during the thermo-blending process. During the blending process, DCP that acted as radical initiator was added and can induce the unspecific radical polymerization product, i.e., induce the formation C=O from C=C bond and also grafting product.[17-19]

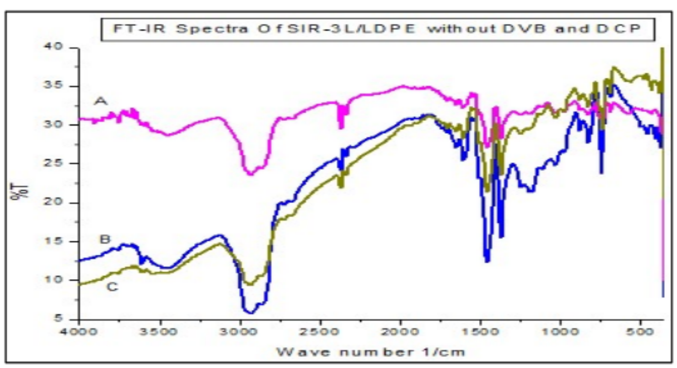


Fig.-2: FT-IR Spectra of (a) SIR-3L/ LDPE without DVB and DCP, (b) SIR-3L/ LDPE with DCP, (c) SIR-3L/ LDPE with DVB/ DCP (3:2)

CONCLUSION

The addition of divinylbenzene and dicumyl peroxide into the blends of SIR-3L/ LDPE acted as a compatibilizer that was confirmed from the mechanical properties and SEM images. The highest mechanical properties were found at the ratio of 3:2 of DVB and DCP, respectively. The improvement in the compatibility of the blends was confirmed by the decrease in the pore size of blends obtained from the SEM images.

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REFERENCES

1. C. Nakason, A. Worlee, S. Salaeh, *Polymer Testing,* **27(7)**, 858(2008), https://doi.org/10.1016/j.polymertesting.2008.06.011
2. O. P. Grigoryeva, J. K Kocsis, *European Polymer Journal,* **36(7)**, 1419(2000), https://doi.org/10.1016/S0014-3057(99)00205-0
3. X. Xu, J. Qiao, J. Yin, Y. Gao, X. Zhang, Y. Ding, Y. Liu, Z. Xin, J. Gao, F. Huang, Z. Song , *Journal of Polymer Science, Part B: Polymer Physics*, **42(5)**, 1042(2004), https://doi.org/10.1002/polb.10694
4. T. Yasin, S. Khan, Y. C. Nho, R. Ahmad, *Radiation Physics and Chemistry,* **81(4)**, 421(2012), https://doi.org/10.1016/j.radphyschem.2011.12.008
5. Y. Kusumastuti, N. R. E. Putri, D. Timotius, M. W. Syabani, Rochmadi, *Heliyon,* **6(11)**, 1(2020), https://doi.org/10.1016/j.heliyon.2020.e05280
6. T. D. Kusworo, N. Ariyanti, D. P. Utomo, *Journal of Water Process Engineering,* **35**, 1(2020), https://doi.org/10.1016/j.jwpe.2020.101190
7. I. P. Mahendra, B. Wirjosentono, Tamrin, H. Ismail, J. A. Mendez, V. Causin, *Journal of Polymer Research*, **26(1)**, 1(2019), https://doi.org/10.1007/s10965-019-1878-2
8. I. P. Mahendra, B. Wirjosentono, T. Tamrin, H. Ismail, J. A. Mendez, V. Causin, *Journal of Thermoplastic Composite Materials*, **79(3)**, 1(2020), https://doi.org/10.1177/0892705720959129
9. R. P. Quirk, D.L. Pickel, 2013, Polymerization: Elastomer Synthesis. The Science and Technology of Rubber, Elsevier Inc, Amsterdam, 27-113, https://doi.org/10.1016/B978-0-12-394584-6.00002-9
10. J. Deng, W. Yang, *European Polymer Journal,* **41(11)**, 2685(2005), https://doi.org/10.1016/j.eurpolymj.2005.05.022
11. Y. Choi, M. Kang, S. Kim, J. Cho, S. Moon, *Journal of Membrane Science*, **223(3)**, (2003), https://doi.org/10.1016/S0376-7388(03)00339-9
12. T. Zaharescu, E. Feraru, C. Podin, *Polymer Degradation and Stability,* **87(1)**, 11(2005), https://doi.org/10.1016/j.polymdegradstab.2004.04.016
13. N. Phewthongin, P. Saeoui, C. Sirisinha, *Polymer Testing,* **24(2)**, 227(2005), https://doi.org/10.1016/j.polymertesting.2004.08.005
14. N. Yang, Z. C. Zhang, N. Ma, H. L. Liu, X. Q. Zhan, B. Li, W. Gao, F. C. Tsai, T. Jiang, C. J. Chang, T. C. Chiang Shi, *Results in Physics,* **7**, 969(2017), https://doi.org/10.1016/j.rinp.2017.02.030
15. T. A. Lin, B. Limin, M. C. Lin, J. Y. Lin, C. W. Lou, J. H. Lin, *Journal of Materials Research and Technology*, **8(4)**, 3389(2019), https://doi.org/10.1016/j.jmrt.2019.03.015
16. R. N. Zhang, Datta, J. W. M. Talma, Noordermeer, *European Polymer Journal,* **46(4)**, 754(2010), https://doi.org/10.1016/j.eurpolymj.2009.12.020
17. A. Ibrahim, M. Dahlan, *Progress in Polymer Science,* **23(4)**, 665(1998), https://doi.org/10.1016/S0079-6700(97)00052-X
18. S. Shankar, B. Anil, K. Bhowmick, *Polymer,* **57**, 105(2015), https://doi.org/10.1016/j.polymer.2014.12.016
19. M. Kodal, N. Karakaya, A. Alchekh, W. G. Ozkoc, 2019, Chapter Eleven - Thermal Properties (DSC, TMA, TGA, DTA) Of Rubber Nanocomposites Containing Carbon Nanofillers, Elsevier Inc, Amsterdam, pp. 325-361, https://doi.org/10.1016/B978-0-12-817342-8.00011-1

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