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Effect of PVC additives on the electrical resistivity of NBR

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Effect of PVC additives on the electrical resistivity of NBR

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Abstract. The effect of PVC additives (30, 50, 70 wt.%) on the electrical resistivity of the NBR at different voltages (1, 2.5, 5)kV was studied in this paper. The results obtained showed an increase in electrical resistance with increased PVC content. Interestingly, a voltage, i.e. electric field dependence was also observed. The field dependence is the highest in case of lowest test voltage (1kV).

1. Introduction

The simplest definition of electrical resistivity for all materials, not just polymers is that it is a characteristic that determines the ability of a material to conduct or resist current flow through the cross-section for that material (see Figure 1). It is known to all that polymers and elastomers are inherently insulating materials, therefore, the researchers conducted many studies to understand the mechanism of electrical conductivity and find ways to increase the conductivity or insulation of these materials depending on the application. In addition, the researches carried out were not limited to pure researches only but also can be applied, where industrialists invested the efforts of researchers in various fields seek to improve their products by attempting to create new materials or to develop new generations materials from those currently present in the form of blends with properties totally different from the original materials used. The principal aim for all these is creating new applications and increases the efficiency of existing ones [1-8].

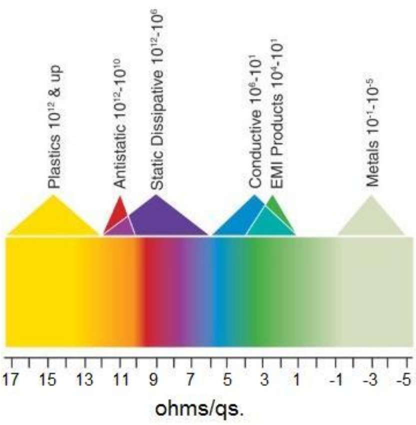

Figure 1. Resistivity chart of materials [2]

The study of the electrical behavior of the elastomers has great importance because it is possible to identify the molecular structure of the elastomers and polymers, and also can identify the effect of the structure of these materials on their properties. Another important thing is the manufacture of electrical insulators that can withstand the surrounding conditions with high efficiency. And one of the methods used to change the electrical properties of elastomers is by mixing together to form new blends with distinctive characteristics as shown in Figure 2 [9-14].

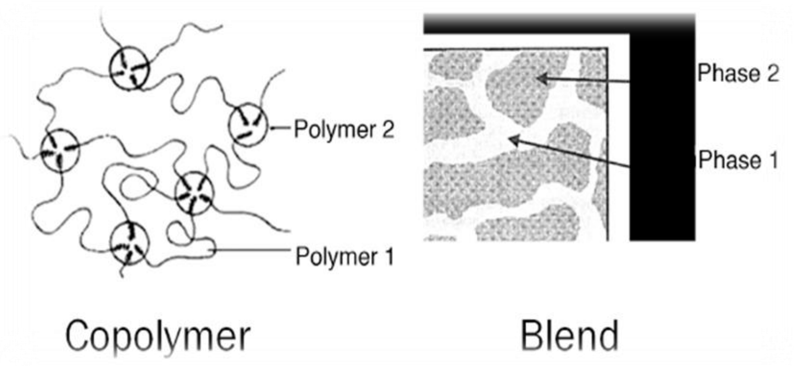

Figure 2. TPE copolymer and TPE blend [11]

2. Materials and methods

Acrylonitrile Butadiene Rubber (30% AN) and PVC, were used in this study. The mixing process was accomplished by Comerio Ercole Busto Arsizio roll mill machine with materials percentages shown in Table.1. The samples have prepared as a disc shape with 15 mm in diameter and 3 mm thickness. The electrical resistivity was measured by using Keithly electrometer type 616C at 40ºC.

Table 1. Composition of batch (pphr)

Material	Content , pphr
NBR	100
ZnO	3
Stearic acid	1
DOP	1
TMTD	1.5
6PPD	1.5
S	1.5
PVC resin (wt.%)	30, 50, 70

3.Results and Disscusion

The Electrical resistivity of NBR as a function of PVC content, and as shown in this figure, the electrical resistivity of NBR increases with the increase of PVC additions. The random copolymer nitrile rubber of 30 to 35% acrylonitrile content is thermodynamically compatible with the PVC. However, the actual phase structure is determined both by the mixing and by the structure, monomer sequence of the NBR.

The obtained phase structure is fixed by cross-linking of the NBR. It is supposed that the phase thickness of PVC has a broad distribution. If the PVC phase is thin the higher conductivity (lower resistivity) of the NBR dominates. At higher test voltage the electric field exceeds a critical value. At high PVC concentration, the phase thickness of the PVC is also increased therefore the field remains below this critical value, the resistivity increase.

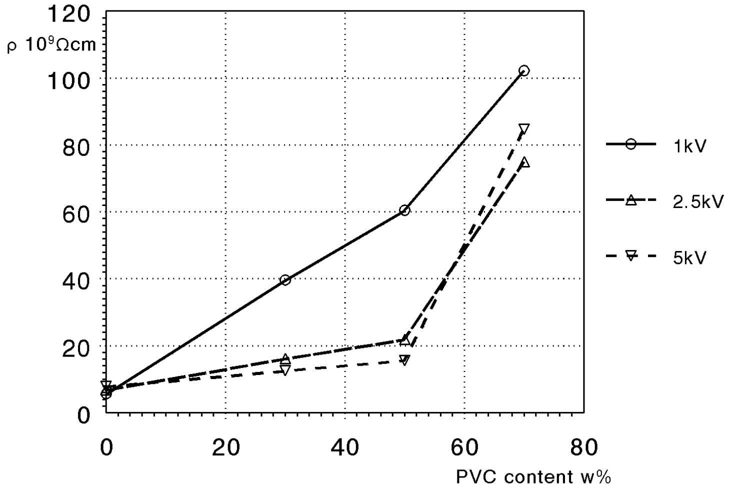

Figure 3. Electrical resistivity of NBR vs. PVC content

4.Conclusion

1. Modifying NBR with PVC is advantageous, because PVC increases the electrical resistivity (specific volume resistance) of NBR.
2. Interestingly, the effect is voltage dependent, the lower is the voltage the higher is the efficiency of PVC.

Reference

[1] A I Al-Mosawi, A H A Abed and A M Adib 2013 *Int. Journal of Advanced Research* **1** (6) 265
[2] J Markarian 2008 *Plastics, Additives and Compounding* **10** (5) 22 https://doi.org/10.1016/S1464-391X(08)70172-7
[3] S Hammani, A Barhoum, S Nagarajan and M Bechelany 2019 *Electrical Conductivity Materials* **12** 3062. https://doi.org/10.3390/ma12193062
[4] C Ellingford, H Smith, X Yan, C Bowen, Ł Figiel, T McNally and C Wan 2019 *European Polymer Journal* **112** 504. https://doi.org/10.1016/j.eurpolymj.2019.01.029
[5] A I Al-Mosawi, K Marossy 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **613** 012029. https://doi.org/10.1088/1757-899X/613/1/012029
[6] A I Al-Mosawi, K Marossy 2018 *Építőanyag-JSBCM* **70** 86 http://doi.org/10.14382/epitoanyag-jsbcm.2018.16
[7] O Mysiukiewicz, T Sterzyński, P Ławniczak, and M Rogodzińska 2017 *Journal of Applied Polymer Science* **134** (46) 45512. https://doi.org/10.1002/app.45512
[8] Y Gao, J Li, Y Li, Y Q Yuan, S H Huang, and B X Du 2017 *8th International Symposium on Electrical Insulating Materials*, Japan. https://doi.org/ 10.23919/ISEIM.2017.8166554
[9] J Zheng, J Tan, H Gao, C Wang and Z Dong 2014 *Rubber Chemistry and Technology* **87** (2) 360 https://doi.org/10.5254/rct.13.86963
[10] A T McPherson 1963 (2014 online) *Rubber Chemistry and Technology* **36** (5) 1230 https://doi.org/10.5254/1.3539647
[11] J Jansen 2016 Comparing thermoplastic elastomers and thermoset rubber, Plastics Engineering, *The Madison Group*, Madison, Wisconsin, USA.
[12] C A Fuke, P A M and S R Chowdhury 2019 *Journal of Applied Polymer Science* **136** (29) 47787 https://doi.org/10.1002/app.47787
[13] E Cuttaz, J Goding, C Vallejo-Giraldo, U Aregueta-Robles, N Lovell, D Ghezzi and R A Green 2019 *Biomater. Sci.* **7** (4) 1372. https://doi.org/10.1039/C8BM01235K
[14] J Vaicekauskaite, P Mazurek, S Vudayagiria and A L Skov 2019 *Journal of Materials Chemistry C* **7**. https://doi.org/10.1039/C9TC05072H