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Mechanical Properties of Acrylonitrile-Butadiene Rubber (NBR)/Poly (Vinyl Chloride) Resin Binary Blend

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Abstract

Changes in the mechanical properties of Acrylonitrile-Butadiene Rubber (NBR)/Poly (vinyl chloride) resin binary blend were investigated. Poly (vinyl chloride) resin additives were within range (0 - 70) wt.%, and the measured mechanical properties included tensile strength, elongation, and compression strength. The obtained results showed that the tensile and elongation value of NBR starts to decrease with the addition of PVC resin to reach the maximum decrease at 70%, where the tensile strength was reduced by 85.23% and elongation by 90.44%. On the other hand, the compression strength of NBR improved after PVC resin addition and the optimum improvement was 82.55% at 70% PVC resin.

Subject Areas

Composite Material, Material Experiment

Keywords

Binary Blend, NBR, PVC Resin, Mechanical Properties

1. Introduction

In recent decades, researchers have been working to develop new properties of polymeric materials or improve their original properties, and this development or enhancement is not dependent on the fillers [1] [2] [3] [4], but by the formation of a mixtures between a group of polymers to form a hybrid polymeric material, which is known as blends [5] [6] [7] [8] [9]. The blends may be a poly-

mer-polymer or a polymer-rubber or rubber-rubber, and it can also be binary, ternary or quaternary depending on the application in which the hybrid blend is used (such as electrical, mechanical, chemical application, etc) [10]-[15]. The critical parameter determining the success or failure of the polymeric blend (from the point of view of the properties obtained) is the degree of miscibility between the blend's components [16] as shown in **Figure 1** which represents the miscibility of a binary polymeric system [17]. And in order to obtain an optimal hybrid blend all components must be fully miscible and the whole degree of miscibility depends on the type of polymers mixed [18] [19] [20], the percentages of mixed polymers where they should be not high, free energy, and the degree of glass transition where any defect in these factors will occur separation between phases [10] [17] [21] [22].

Rubber blends are used with other polymers in many engineering applications, which include: hose cover linings, footwear, conveyor belt covers, cable jackets, gaskets, cellular products, etc. [23]. It has been found through research that Acrylonitrile-Butadiene Rubber has a plasticizing effect on poly(vinyl chloride), so it can be used together to produce insulated cables with high insulating efficiency, also poly (vinyl chloride) additives will develop other properties of Acrylonitrile-Butadiene Rubber such as chemical resistance, thermal aging, and abrasion resistance [24] [25] [26] [27].

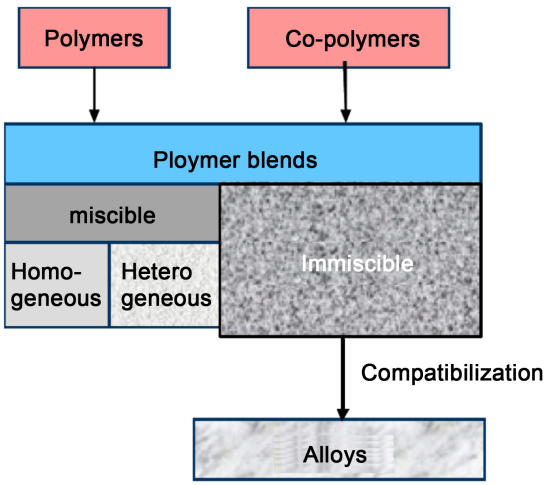

Figure 1. Miscibility of a binary polymeric system [17].

2. Experiment

2.1. Materials

1) Acrylonitrile-Butadiene Rubber (NBR-30% AN) supplied by Jingjiang Concord New Materials Technology Co., Ltd., China.

2) Poly (vinyl chloride) resin type S-5070 with trademark Ongrovil® which produced and supplied by Borsod ChemZrt., Hungary.

3) Zinc oxide was supplied by the Turkish company Saha Metal San. Tic. Ltd. Şti.

4) Stearic acid supplied by the Chinese company Hefei TNJ Chemical Industry Co., Ltd.

5) Carbon black 660 supplied by the Chinese company Tianjin Lizheng International Trade Co., Ltd.

6) Accelerator MBTS supplied by Richest Group, China.

7) Sulfur supplied by the Chinese company Leader Technologies Co., Ltd.

2.2. The Processing of Materials

Eight blends were prepared by using laboratory roll mill machine type Schwabenthan as sheets found at Borsod ChemZrt. with 0.4 mm thickness. Then, these sheets were pressed by using hydraulic press type Bürkle found at Borsod-ChemZrt. with processing conditions at 300 and 20 bar pressure and 150˚C temperature to form a square-shape plate. The last step is to cut these sheets into test samples.

2.3. Preparation of Samples

The compression strength samples were prepared according to ASTM D 1229 standards [28] and the samples of tensile strength prepared according to ASTM D412-16 standards [29].

2.4. Mechanical Testes

Instron 5560 instrument at University of Miskolc was used to perform the tensile test and calculate the tensile strength. In order to estimate the compression strength, a compression tester at University of Miskolc was used for this purpose (Table 1).

3. Results and Discussion

The results obtained from the tensile test are shown in Figure 2, which represents the tensile strength of the binary blend as a function of the poly (vinyl chloride) resin weight percentage. From this figure, we notice that the tensile strength of Acrylonitrile-Butadiene Rubber begins to decrease once the poly (vinyl chloride) resin is added and form the binary blend and the reduction in tensile strength increases as the proportion of the poly (vinyl chloride) resin addition

Table 1. The materials used in NBR-PVC blends.

Material	Wt.%
NBR	100 (Decreases gradually as the PVC percentage increases by 10 g per blend)
PVC	0 - 70
Carbon black 660	40
MBTS	0.7
Sulfur	1.5
Zinc oxide	3
Stearic acid	1

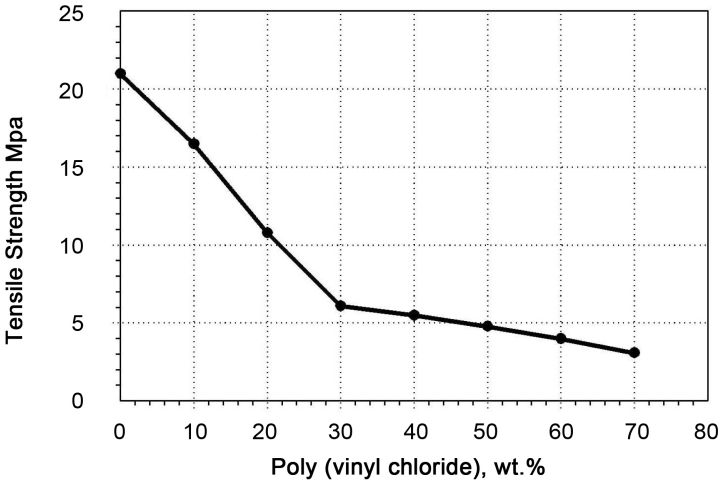

Figure 2. Tensile strength of NBR-PVC binary blend.

increases. The reason for this behavior is due to the polymer restricts the elasticity of Acrylonitrile-Butadiene Rubbermolecular chains so that its movement becomes not free under stress and the distance between them will increase as a result of lack of crosslinking.

On the other hand, the elongation of Acrylonitrile-Butadiene Rubber decreases with the addition of the poly (vinyl chloride) resin and this behavior can be seen in **Figure 3** which represents elongation of NBR-PVC binary blend. The reason for this state is that the applied stresses will be concentrated mainly on certain molecular chains which are (C-C, C-H and C-CL), while the C-S and S-S bonds will be exposed to a small fraction of stresses, resulting in ruptures in bonds where stresses are highly concentrated and begin to break.

In the case of compression strength for rubber, it improved after the addition of the poly (vinyl chloride) resin and can be clearly distinguished from **Figure 4** which represents the compression strength of NBR-PVC binary blend. It is known that the rate of permanent deformation in polymers is higher than rubber after the removal of applied load, so when the poly (vinyl chloride) resin is added to Acrylonitrile-Butadiene Rubber, the polymer will subject to a permanent deformation higher than rubber, which will increase the compression strength of the binary blend.

4. Conclusion

Poly (vinyl chloride) resin reduces the elasticity of Acrylonitrile-Butadiene Rubber molecular chains, causing stresses to concentrate on certain chains resulting break down of these chains, and significantly reduced tensile strength and elongation of the binary blend. On the other hand, the compressive strength of Acrylonitrile-Butadiene Rubber increases with the addition of poly (vinyl chloride) resin due to the different permanent deformation between them as poly (vinyl chloride) resin is exposed to the higher permanent deformation compared to Acrylonitrile-Butadiene Rubber.

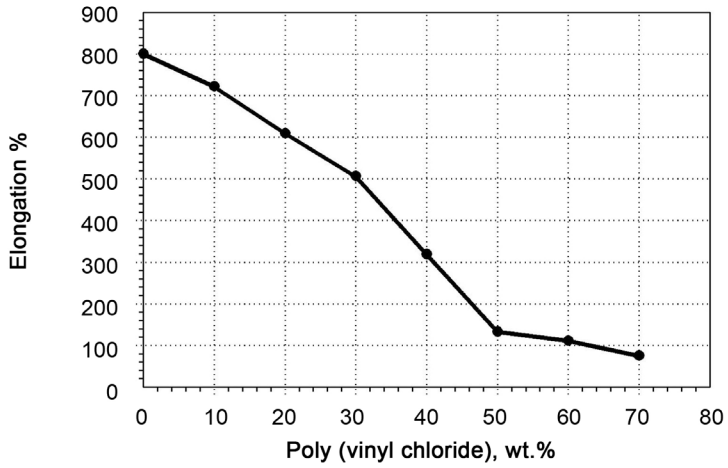

Figure 3. Elongation of NBR-PVC binary blend.

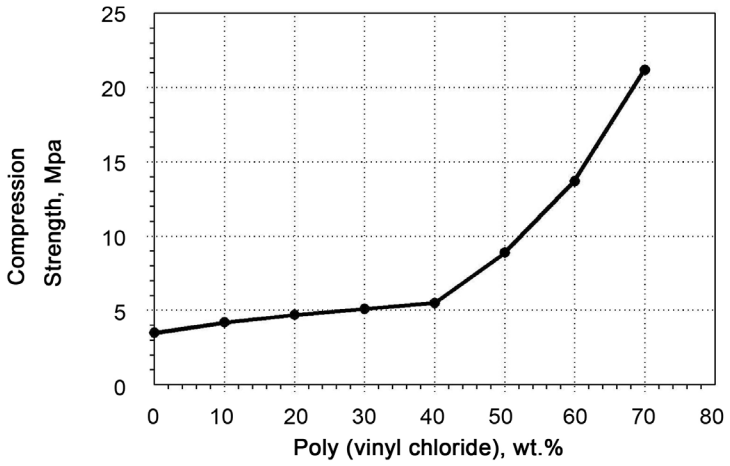

Figure 4. Compression strength of NBR-PVC binary blend.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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