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THE ACRYLONITRILE-BUTADIENE-STYRENE EFFECT AS AN IMPACT MODIFIER ON POLY(VINYL CHLORIDE) / ACRYLONITRILE-BUTADIENE-STYRENE (PVC/ABS) BLENDS PROPERTIES

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ABSTRACT

PVC/ABS blends show a very important commercial consideration due to the complementarities of the properties of the base polymers, such as a good resistance to impact strength and a dimensional stability at high temperatures. The aim of this study is to investigate the behavior of these blends by performing a thermal and mechanical characterization of samples prepared using a plastograph. The torque at equilibrium portion obtained from the plastograms was plotted versus different temperatures. The intersection of the curves of the two polymers represents an optimum processing temperature. The obtained results showed a phase inversion between the two polymers and a synergism effect on the mechanical properties. However, the maximum impact strength was obtained at 75 (wt %) of ABS. Finally an increase of the ABS concentration in the blend decreased its hardness.

Key words: Blends, PVC, ABS, impact modifier, properties.

INTRODUCTION

Polymer blending is one of the most important ways for the development of new polymeric materials. The main goal of combining two or more polymers is to obtain a material with high performances and lower cost. The obtained materials present many advantages in the plastics industry.

Nowadays, poly(vinyl chloride) becomes very attractive for buildings and construction market [1-5], its application fields are wide and include floors coverings, window frames, pipes; but its low thermal stability, its low impact strength and the fact to be inclined to occasional brittleness make necessary to blend it with other polymers [6-8]. In order to enhance the material properties and to overcome these problems, this polymer must be blended with rubbery materials like ABS.

Usually, polymer blends exhibit properties that are superior to any one of the component polymers alone. The most relevant properties of PVC/ABS blends are its high impact strength and its excellent thermal stability.

Acrylonitrile-Butadiene-Styrene (ABS) is one of most largely used engineering plastics due to its excellent properties such as mechanical, thermal, electrical and chemical ones. This polymer can be used for outstanding surface finishing, high impact resistance, and metal plating [9].

Maiti et al. [10] studied the polyblend of PVC/ ABS. They discovered that this polyblend possesses advantages like the tensile strength and rigidity of PVC and impact strength of ABS. TGA analysis revealed an improvement in thermal stability of PVC/ABS blends over that of PVC.

Jin et al. [11] studied the compatibility enhancement of ABS/PVC blends. They found that when a compatibilizer, SAN 25 was added into the blend, the compatibility was enhanced and about twofold increase of impact strength was observed.

Bensemra and Bedda [12] studied the properties of PVC/ABS blends. They concluded that addition of plasticizer, di(ethyl-2hexyl) phthalate into the blends has greatly improved the impact properties where the higher the PVC content, the higher the impact value.

Baijun Liu et al. [13] studied the Effect of the matrix plasticization behavior on mechanical properties of PVC/ABS blends. They found that the notched Izod impact test results indicated that the amount of polybutadiene (PB) rubber needed for the brittle-ductile transition (BDT) increases together with the molecular weight of PVC when milled at 165°C. Increasing the operation temperature and adding the plasticizer dioctyl phthalate (DOP) could change the matrix plasticizing extent and the BDT.

In this study, PVC/ABS blends were elaborated in order to investigate the effect of adding ABS as an impact modifier into PVC. Various samples of PVC/ABS at blend composition of 100/0, 85/15, 75/25, 65/35, 50/50, 35/65, 25/75, 15/85 and 0/100 were used.

The different formulations were prepared using a plastograph. The use of this technique is needed for a well comprehension of the behavior of the blends during their process. The effect of many factors which influence the process and the evaluation of the degree of compatibility are studied using the tensile test, hardness….

EXPERIMENTAL

Materials

Table 1 Materials used in this study

Compound	Commercial name	Source
PVC	4000 M	ENIP-SKIKDA (Algeria)
ABS	TERLURAN 877 T	BASF (Germany)
Dicarboxylic acid ester (G60)	Primary Lubricant	BASF (Germany)
non-polar hydrocarbon wax (Cire Gs)	Secondary Lubricant	BASF (Germany)
Thermal stabilizer	Primary Stabilizer	BASF (Germany)
Thermal stabilizer	Secondary Stabilizer	BASF (Germany)

Blend Preparation

The used polymers were the PVC (4000 M) produced by ENIP-Skikda in Algeria and the ABS (Terluran 877 T) provided from BASF in Germany. First rigid PVC (PVC + Stabilizers + Lubricants) was prepared in a dry mixer then blends of PVC/ABS Blends of variable composition from 0 to 100 wt. % were prepared using the plastograph-Brabender (OHG-Duisburg-Germany) (see Figure1). The ABS which was dried at 75 °C during 24 hours, was introduced first to avoid equipment degradation. Finally the PVC was incorporated after pre-melting of ABS. Melt mixing was performed at 190 °C for 6 min at a rotation speed of 20 rpm. The blends were then pressed in a hydraulic press at 205 °C for 5 min under a pressure of 200 bar.

Fig. 1 Plastograph-Brabender (OHG-Duisburg-Germany)

RESULTS AND DISCUSSION

The curve in Fig. 2 shows that the strength at break of the blends is greater than that of the homopolymers (PVC, ABS). The blend having 10-30wt. % of ABS content showed high values. A synergism effect was observed for the strength at break of the blends.

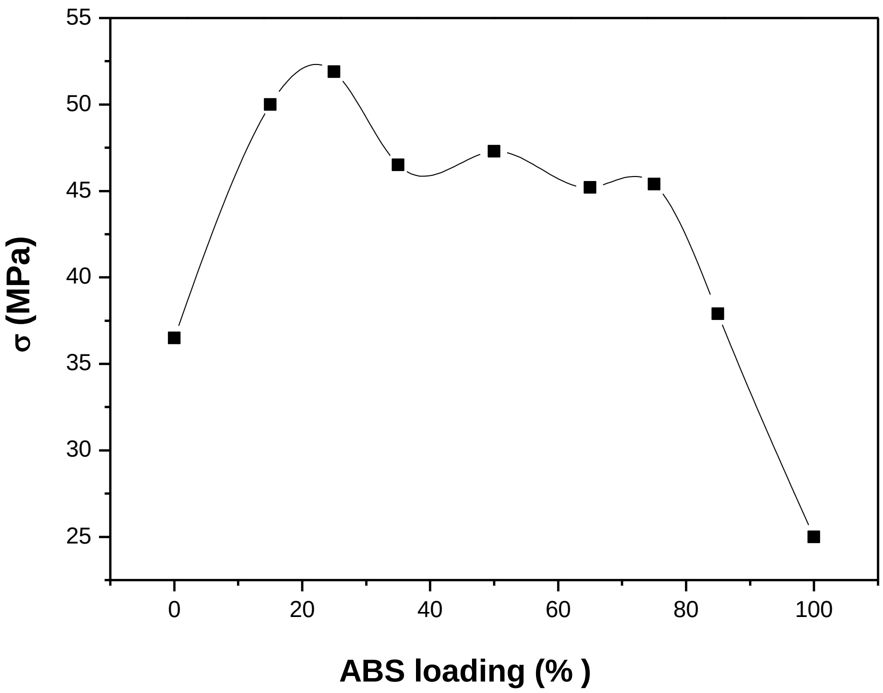

Fig. 2 Strength at break of PVC/ABS blends as a function of ABS content

The modules of elasticity of the blends (Fig. 3) are lower than that of the based polymers (antagonism effect). This result is due to the existence of separation phase sites which increase the deformation of the blends (at constant strength).

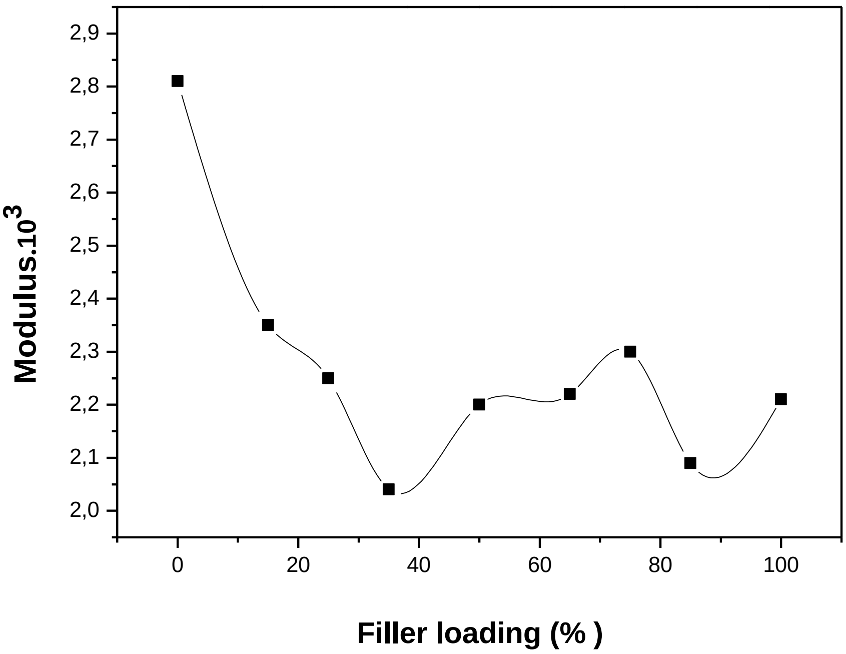

Fig. 3 Modulus of elasticity of PVC/ABS blends as a function of ABS content

The impact strength of the blends, for the notched samples, increases as a function of the ABS content (Fig. 4). This is due to the fact that the PVC is more glassy than the Styrene acrylonitrile (SAN) of the ABS; so it is more sensitive to the notch effect. Moreover, the butadiene rubber phase (BR) of the ABS increases the impact resistance of the blends.

At 75 % of the ABS content, a synergism effect was observed. This result is due to the high electrostatic force interactions between α hydrogen of the PVC and the free electron of Nitrogen (C≡ N).

The values of the hardness test (Fig. 5) show that the hardness of the blends decreases as function of the ABS content. The presence of the rubber phase (BR) increases the chains flexibility. The highest value of the hardness was observed for an ABS content of 50 wt. % although the ABS Tg is greater than that of the PVC.

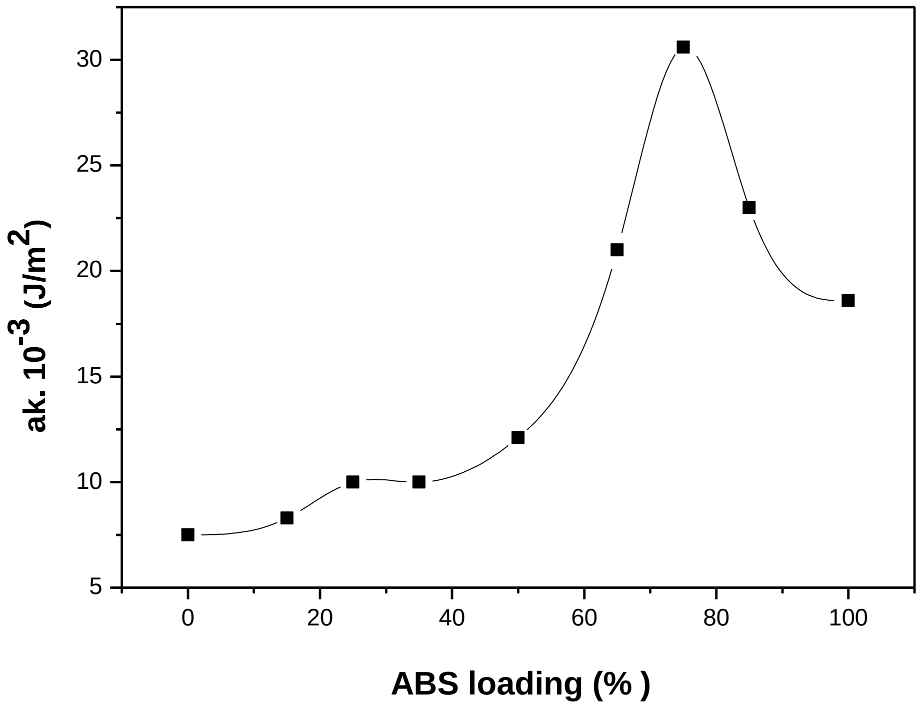

Fig. 4 Impact strength of PVC/ABS blends as a function of ABS content

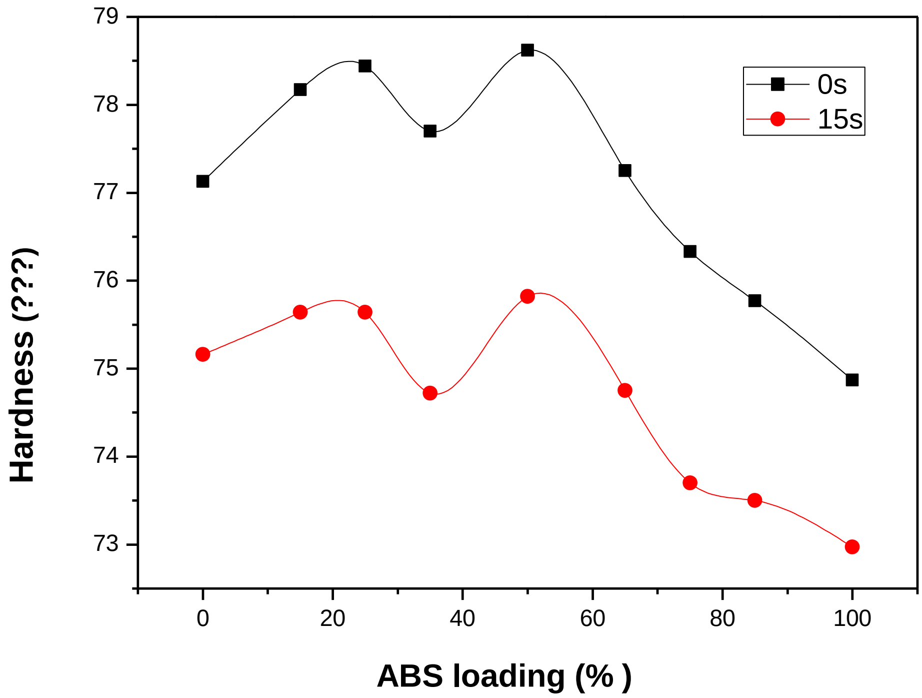

Fig. 5 Hardness Shore D of PVC/ABS blends as a function of ABS content

CONCLUSION

From the obtained results, it can be concluded that:

- The mechanical tests show the existence of a synergism effect in the blends properties.
- The highest value of the impact strength was observed at 75 wt. % of ABS content.
- The hardness of the blends decreases as a function of the ABS content.

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