# Modeling the influence of graphene Nanosheets on the Mechanical and Electrical Properties of polyamide 6/ Acrylonitrile–Butadiene–Styrene Blends

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## Abstract

In this work, we explain the preparation by batch system of Polyamide 6 (PA6) and acrylonitrile butadiene styrene blend reinforced by graphene nanosheets (GNs) nanocomposites that is hot-compressed to get samples for different tests. The PA6/ABS blend reinforced with different amounts (1, 2, 3, 4 wt%),the mechanical properties (Young's modulus) increase with increasing GNs content, on the other hand, it is observed stability in the tensile strength, The electrical properties have shown that the evolution of the properties runs through a threshold loading charge. Among the advantages of GN ensuring the adhesion between the two polymers. The objective is the modeling of results obtained using Matlab.

**Keywords**: Graphene, Graphene nanosheets, Polymer Nanocomposite; Electrical properties; Mechanical properties

## 1. Introduction

Graphene have a particular interest in the field of polymer nanocomposites due to their exceptional thermal and mechanical properties. Graphene is a single layer of carbon packed in a honeycomb-type 2D lattice. Some effective methods have been developed for the production of graphene in the form graphene nanosheets in large quantities (agglomerated powder), they are produced by direct exfoliation of graphite or exfoliation reduction of graphite oxide, also the graphene nanosheets must be dispersed and distributed homogeneously within Polymer matrices. We are currently in the process of simulating these results

## 2. Materials and Methods

### Materials

PA6 was obtained from Ultramid O-BASF the chemical company, (density: 1.13 g/ml and melting temperature: 220°C). ABS terpolymer was purchased from SODEVIC, (density: 1.04 g/ml and melting temperature: 220°C). Natural flake graphite (surface enhanced, grade no. 3775) was provided from Asbury Carbons. Sulfuric acid, $H_2O_2$, HCl (37%), $N_2H_4.H_2O$ (80%), and formic acid (FA) were purchased from Sigma-Aldrich and used as received.

### Graphene Preparation

GO was prepared from natural graphite powder by chemical oxidation using the method developed by Hummers [1]. The most promising methods for the production of graphene nanosheets in large quantities are based on the exfoliation and reduction the graphite oxide (GO). The graphite is oxidized using the Oxidizing agents such as $KMnO_4$, $KClO_3$, and $NaNO_3$ in the presence of sulfuric acid (H2 SO4), These reactions can disturb the electron structure graphite and impart a variety of oxygen-based chemical functions to the surface of each graphite plane .The exfoliation by sonification treatment of (GO) has produced graphene oxide which is reduced by chemical reducing agent (Hydrazine) in graphene nanosheets.[2]

## 2.1 Results and discussions

### Electrical Properties

For measuring the electrical conductivity by applying a high voltage (V) and its corresponding current (I).The electrical conductivity, r, was calculated
with the equation:

$$\sigma = d\,I/SV \qquad [3]$$

Such as d is the sample thickness and S is the cross sectional area perpendicular to the current direction in the sample.

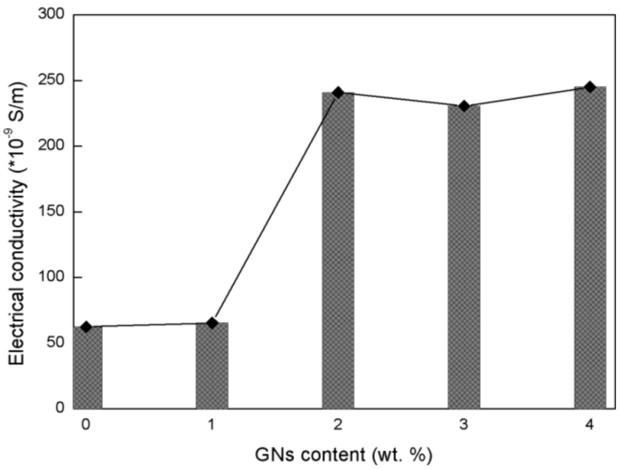


**Fig.1**. Conductivity of PA6/ABS/ GNs nanocomposites versus volume fraction of GNs nanocharge.

Figure 1.shows the evolution of electric conductivity as function of GNs content. At a low GNs content the conductivity is weak (1 wt. %) it has increased linearly between 1 and 2 wt% GNs content (percolation threshold), There is a stabilization between 2 and 4 wt%. Finally the low observed percolation threshold is attributed to the high specific surface area of the graphene, [2]

**Mechanical properties**

Graphene has been widely used as a mechanical reinforcement to develop nanocomposites with very improved properties. The nanocomposite obtained with graphene showed significant improvements in Young's modulus and tensile strength with low charge content.

**Table 1**. Results of mechanical properties: Young’s modulus, tensile strength and Elongation at break of PA6/ABS/GNs nanocomposites.

| GNs content Wt% | Samples (PA6-ABS-GNs) | Young’s Modulus , (Mpa) | Tensile strength , (Mpa) | Elongation at break (%) |
|---|---|---|---|---|
| 0 | 55-45-0 | 1327.4 | 27.4 | 0.078 |
| 1 | 55-35-10 | 1442.8 | 29.9 | 0.074 |
| 2 | 55-25-20 | 1557.9 | 29.5 | 0.059 |
| 3 | 55-15-30 | 1703.9 | 30.2 | 0.046 |
| 4 | 55-10-40 | 1967.2 | 23.5 | 0.026 |

Table 1 shows the variation of Young Modulus, the tensile strength and Elongation at break of PA6/ABS/GNs nanocomposites. The Young’s modulus was increased with increasing the graphene loading and for tensile strength there is stabilization till 3 wt% of graphene nanocharge to be reduced by 2% from the average tensile strength values. .[2]

The elongation at break of the nanocomposite decreases with increasing the graphene loading.

The increases in Young's modulus and the tensile strength observed into the PA6/ABS blend is due to the good dispersion / distribution quality of (GNs) and strong interfacial interaction between GNs and PA6/ABS this is important in increasing the rigidity of nanocomposite

**Conclusion**

This work has shown a significant influence of graphene nanosheets on the mechanical and electrical proprieties of the PA6/ABS blend. These proprieties evolve according to the different amounts (1, 2, 3, 4 wt%) and distribution of GNs into the blend, the results obtained will be simulated using Matlab.

## Références

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