

# ACOUSTIC AND MECHANICAL PROPERTIES OF PVC/GTR COMPOSITES

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## Introduction

Over the past 80 years, PVC has been used for the manufacture of many articles and different applications in all areas, due to its versatile properties. However, the large consumption of this polymer has generated the need to recover, recycle and reuse the large amount of waste generated. Studies of compatibility between PVC and other recycled polymers have spread during recent years. [1]. GTR (Ground Tire Rubber) is other interest material that has been used as reinforced in composite materials [2-4].

In this work, a new material composed by a recycled PVC matrix, compounded with GTR was studied, thereby providing another way of reducing the stock of used tyres and PVC waste. Acoustics and Mechanical properties of several compositions were determined.

## Experimental

### Materials

Recycled PVC was supplied by “Extrugom” an extruded company located in Polinyà, Spain. Melt flow index was 1.35 g/min and density of 1370 kg/m<sup>3</sup>. GTR with a size of 200 µm were supplied by GMN from Maials (Spain).

### Apparatus and Procedures

The tensile test was carried out at room temperature with an Instron-type tensile testing machine 3355. The crosshead speed was 10 mm/min and the initial gauge length was 50 mm. The acoustic properties have been measured using a two microphone impedance tube Brüel & Kjaer type 4206 in the frequency range 100-6500 Hz.

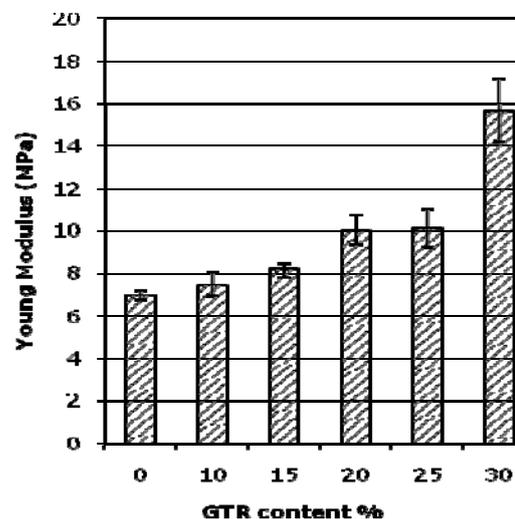
## Results and Discussion

### Mechanical properties

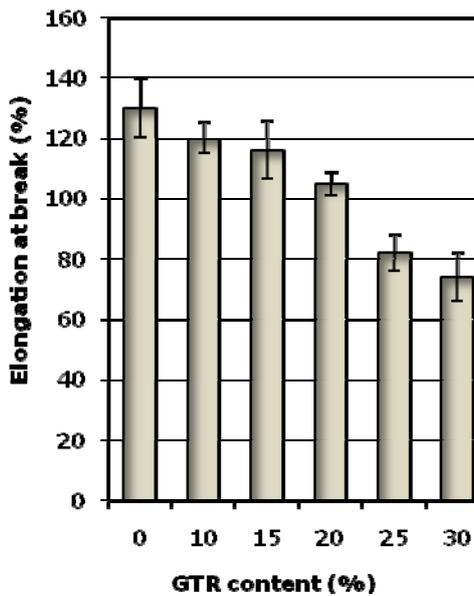
As shows the attached table the mix of 25/75 with PPVC RPVC defines a new PVC with properties far removed from the RPVC, with a much lower Young's Modulus (YM) and a very high elongation at break from 2.5 to 130 %.

Mechanical Properties	R PVC (st dev)	P PVC (st dev)	PVC (25/75) (st dev)
Young Modulus (MPa)	2733 (138)	2,3 (0,06)	6,97 (0,22)
Tensile Strength (MPa)	28,5 (1,9)	6,7 (0,33)	5,7 (0,4)
Deformation at break (%)	2,5 (0,3)	367 (12,7)	130 (10)
Toughness (J)	0,44 (0,07)	9,69 (0,7)	3,3 (0,44)

The values of YM of composites made by PVC reinforced with GTR increases when the percentage of GTR increase. Until 25 % the increase of YM remains more or less constant, but with 30% de values increase from 10 MPa to 16%. The presence of GTR with a maximum size of 200 µm increase the rigidity, although the compatibility is not enough good, as demonstrated in previous work[ref].



The figure 2 shows the evolution of elongation at break. At the same of elongation at break, tensile strength and toughness decrease. This decrease in PVC/GTR composites is due to the properties of the PVC matrix, which is a very plastic type, provides ductility, whereas the GTR, which is very rigid, exhibits a more brittle behaviour with a subsequent loss of toughness, tensile strength and elongations at break in this composite.



The decrease in all the mechanical properties is lower in PVC / GTR composite than in polyolefin matrix/GTR composite due mainly to the short size of the GTR particles to the increase of the chemical interaction between GTR and a polar matrix and finally to the better dispersion to poor compatibility between components when the matrix is non polar (HDPE)[1,4].

#### Acoustic properties

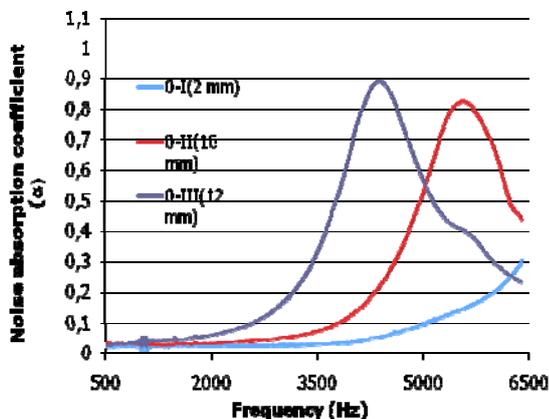


Figure 3.- Absorption coefficient of PVC for different thickness

The measured sound absorption coefficients, in 1/3 octave bands, of the PVC/GTR composites samples are presented in figure. 3-5. None of the samples show good results at low frequencies and acceptable results are only found above 2500 Hz. Figure 3 shows the comparative absorption coefficient of PVC alone among three different thickness (2, 10 and 12 mm). The results show us that by increasing the thickness increases the absorption coefficient and the maximum is shifted to lower frequencies.

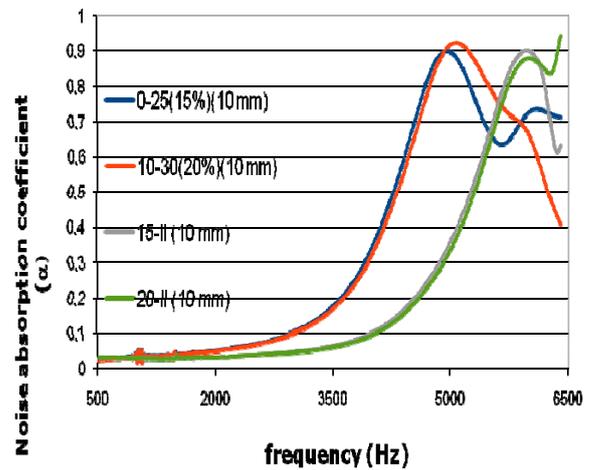


Figure 4.- Absorption coefficient of PVC for different GTR percentages

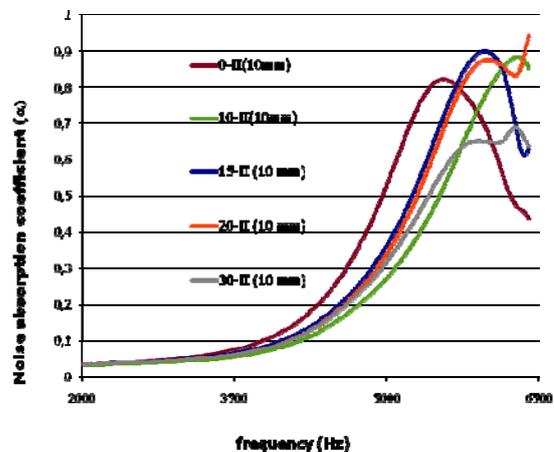


Figure 5.- Absorption coefficient of PVC for different GTR percentages and layers.

Figures 4 and 5 show the evolution of the different PVC/GTR composites as a function of GTR percentage, thickness and layers (with small air gaps). Figure 4 compares four samples, two of them with 15 and 20% of GTR without gap with 10 mm of thick and the others with the same content of GTR and with four small gaps with a thick of 10 mm. The results show that both the amount of GTR and the presence of gaps have a very great influence in the absorption coefficient. The presence of gaps in the layered samples shifts the maximum of absorption to low frequencies (from 5800 Hz to 4750 Hz) and the increase of GTR from 15 to 20% illustrate the presence of a shoulder that expand the frequencies range.

#### References

1. X. Colom et al. Composites part A (38) 2007
2. X. Colom et al. Journal of Applied Polymer Science (112) 2009
3. J. Orrit et al. AFINIDAD (541) 2009
4. J. Cañavate et al. Journal of Composite Materials (2009)