

# *SOCIEDAD POLIMÉRICA DE MÉXICO*



*Riviera Maya, Quintana Roo del 23 al  
27 de octubre de 2016.*

*XXIX Congreso Nacional de la S.P.M.*

## BIODEGRADABLE POLYMERIC PLA/GO COMPOSITES WITH ENHANCED THERMO MECHANICAL PROPERTIES

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### Introduction

PLA mixed with particles can experiment a modification in its properties.<sup>1</sup> Among the fillers that offer many different characteristics is graphite. The graphite is a material consisting of a sheet like structure (graphene), which has excellent properties. By a chemical treatment of the graphite as the Hummer's method,<sup>2</sup> graphite oxide (GO) can be obtained. GO presents numerous oxygenated functional groups that can be used to covalently bind it to polymers. The aim of this work is to investigate the effect of the inclusion of expanded graphite (EG) and graphite oxide (GO) with different oxidation grades into a poly-lactide (PLA) matrix on the thermo-mechanical properties of the composite.

### Experimental Part

Poly (L,L – lactide) (2002D) –PLA–, supplied by NatureWorks LLC, was employed as the polymer matrix. Expanded graphite (EG) Grafoil TG-679 supplied by Graftech International was employed as filler particle. Graphite Oxide (GO) at two different oxidation times was obtained by the Hummer's method<sup>2</sup>. For the incorporation of GE and GO in the PLA matrix the graphite was milled by a high energy ball miller. The PLA/GE and PLA/GO were obtained by melt blending in an internal mixing chamber at a graphite concentration of 0.1 wt%. The mixing temperature was 190°C under a mixing velocity program: 2min 30 rpm, 10 min 90 rpm, employing blades type CAM. The obtained composites were ground and later molded by hot press compression to obtain films for characterization.

Films were characterized by DMA in a tension film geometry. A temperature ramp was done from 20 to 140°C at a 0.1% applied strain and 1 Hz of frequency. After that films were heated a constant temperature of 110°C during 30 min to observe the variation of Elastic modulus due to the crystallization of the matrix.

### Results and Discussions

The storage modulus ( $E'$ ) of the neat PLA at 25°C is  $2.67 \times 10^9$  Pa with the filler addition this module is increased in up to 28% when it is the graphite with longer oxidation time GO(3), Figure 1. In the rubbery zone, it is observed the presence of cold crystallization, that is greater for the composites with GO particles, this suggests that the cold crystallization is favored by the oxidation of the graphite. This can be attributed to separation of the graphene layers due to oxidation. Also it is interesting the fact that the  $E'$  value for the

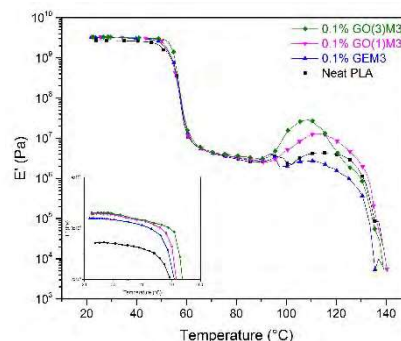


Figure 1. Temperature Ramp of PLA/GE/GO composites

PLA/GO composites starts to drop at a temperature slight higher than the neat PLA.

Figure 2 shows that during cold crystallization the  $E'$  is improved depending on the oxidation of the graphite.

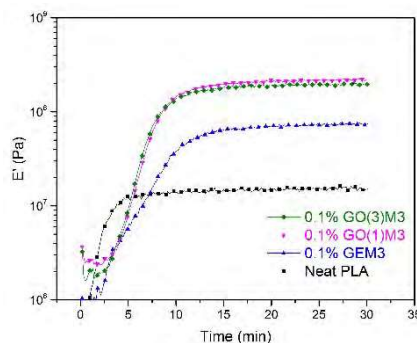


Figure 2. Time Sweep of PLA/GE/GO composites

### Conclusions

The thermo-mechanical properties of the composites were improved with the addition GO. Additionally it was found that the crystallization velocity depends on the oxidation of the graphite suggesting that the functional groups obstaculize de cristal formation.

### References

1. Dubois Ph, Murariu. JEC Composites Magazine. No/45 October 2008
2. Hummers and Offeman; Journal of American Chemical Society (1958).

