Preparation and characterization of nanocomposites based on thermoplastic polymers with graphene

G. Colucci[1*], A. Caradonna[1], and C. Badini[1]

[1*] Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129, Torino, Italy

Graphene is one of the most exciting material and recently has attracted a great interest due to its unique properties [1]. For this reason, the graphene-based materials are having a remarkable impact on electronic devices, sensors, nanocomposites and energy storage [1,2].
In particular polymeric nanocomposites containing graphene can be tuned and tailored choosing the appropriate matrix in order to achieve the whole spectrum of physic-chemical, thermal, electrical and mechanical properties for a wide range of emerging demanding applications [3-5].

Among the several polymers, we choose to investigate thermoplastic systems employing matrices currently widely used in the automotive sector in order to establish if graphene-based nanocomposites can be used as well as new advanced materials.

The present work describes the preparation of polymeric nanocomposites based on different thermoplastic matrices containing graphene nanoplatelets.

The nanocomposites were prepared by melt blending using an internal batch mixer (Brabender) by adding 5 wt.% of two different kind of graphene, commercially available, (G_4 and G_{ABCR}) within three thermoplastic matrices: polypropylene (PP), acrylonitrile butadiene styrene (ABS) and thermoplastic polyurethane (TPU). The composites were then used to obtain specimens for the characterization tests by injection molding using a Babyplast machine, as sketched in Figure 1.

Specifically, the work is focused on the comparison between the microstructure, the mechanical behavior and the electrical and thermal conductivity of the nanocomposites obtained by dispersing different graphene nanosheets within the polymeric matrices.

In the first step we studied the properties of the graphene nanoplatelets by Raman spectroscopy and FE-SEM analysis. The results reveal that the G_4 show better properties with respect to the $G_{ABCR,}$ probably due to the higher characteristics of the raw GNPs, as reported in Figure 2.

Then the mechanical (Tensile tests), thermal (TGA and DSC), and morphological (FE-SEM) properties and thermal (Hot Disk) and electrical (Four Point tests) conductivity of the polymeric-graphene nanocomposites were investigated. The effect of the GNPs on the final properties was also studied on the basis of the dispersion and distribution of the graphene inside the matrices.

References

[1] V. Singh, Progress in Materials Science, 56 (2011) 1178.
[2] T. Kuilla, Progress in Polymer Science, 35 (2010) 1350.
[3] K. Hu, Progress in Polymer Science 39 (2014) 1934–1972.
[4] S. Scognamillo, Polymer, 53 (2012) 4019.
[5] M.E. Achaby, Polymer Composites, 33 (2012) 733.
[6] The authors wish to thank Dr. Mauro Giorcelli for Raman spectra.

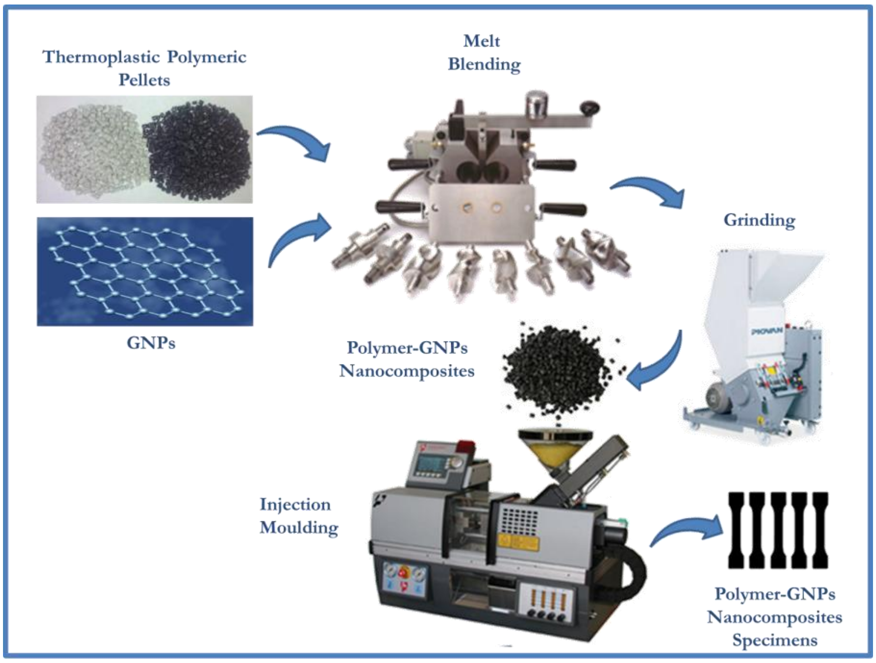

Figure 1: Schematic illustration of the preparation of graphene-thermoplastic polymer nanocomposites.

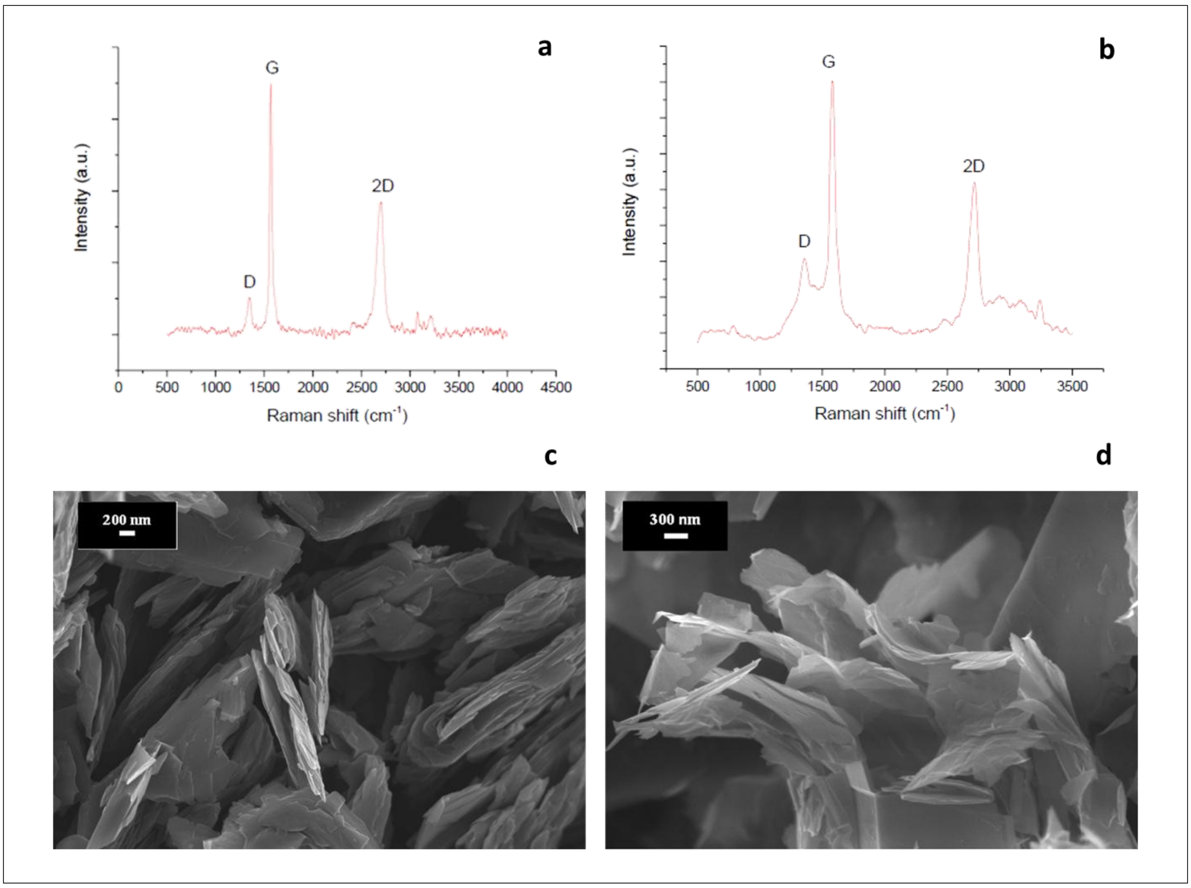

Figure 2: Raman spectra and FE-SEM images of GNPs of G_4 (a,c) and G_{ABCR} (b, d).