Graphene-based thermoplastic nanocomposites: toward a way to fully overcome the *valley of death*

Marco Monti
Marta Zaccone

Proplast, Strada Savonesa 9, 15057 Rivalta Scrivia (AL), Italy

marco.monti@proplast.it

Since the discovery of graphene, great interest was paid to the possibility in exploiting its extraordinary properties by the addition to polymers, in other words developing a graphene-based polymer nanocomposite.
Although in the scientific literature a lot of outstanding results have been reported regarding the use of graphene in polymers [1-3], only few technical applications have reached the market and therefore the fully exploitation of the industrial world (see e.g. [4-6]).
This is most likely due to technical and economic bottlenecks that are related to the use of graphene, that can be basically summarized in (1) cost of the raw material and (2) the specific attention to the process which is needed. The price of the graphene is still quite high and can be considered as the main factor that hinders the massive use in polymers. In fact, in the plastic market, special care is always given to the cost, since plastics is traditionally considered to be cheap by common people: the introduction of an expensive material needs to be strongly motivated by the technicians (obtainable performance) and the marketing (advantage perceived by the end users). The process of a graphene composite needs to be specifically tailored, in order to obtain the best exfoliation possible, without compromising the other characteristics (e.g. defectiveness and surface area), and fully take advantage of the graphene.

In the thermoplastic polymers, the dispersion of an additive in the matrix is commonly performed by extrusion, in which both the screw profile and the temperatures can be varied for modifying the morphology of the produced mixture.
One of the most common way to produce a thermoplastic component is injection molding, where the molten polymer is push into a mold and then cooled down below the melting temperature, before the extraction. Even in this case, the morphology of the composite can be modified by tuning the processing parameter. Moreover, innovative technology of injection molding, such as the heat&cool technology, can be successfully used to further modify the morphology and to obtain the best performance.
In this talk, an overview will be given on the experience carried out by Proplast in the last period regarding the processing of graphene-based thermoplastic nanocomposites, with special attention to the importance of the processing for overcoming the so-called *valley of death*.

References

[1] J.R. Potts, D.R. Dreyer, C.W. Bielawski, R.S. Ruoff. Polymer 52 (2011), 5-25.
[2] W. K. Chee, H.N. Lim, N.M. Huang, I. Harrison. RSC Adv, 5 (2015) 68014-68051
[3] M. Melucci, S. Ligi, V. Palermo. Sigma Aldrich open access publication.
[4] https://www.vittoria.com/it/graphene-evidence/
[5] Dassi builds the world's first graphene bicycle frame. Bikesoup Magazine (2016).
[6] Head Graphene XT Speed Pro Racquet Review. Tennis warehouse (2015).