Graphene-Based Materials Incorporated as Nanofiller in 3D Printable Nanocomposites: Influence on Thermal and Mechanical Properties

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Graphene and its derivates represent one of the most impressive materials for 3D printing technologies, since among its properties we can find high electrical and thermal conductivity as well as high mechanical strength. Incorporation of graphene as a filler inside the polymer can be achieved by chemical and structural modification of the graphenic material, which consisted in the synthesis of chemically expanded graphite (CEG) and graphene oxide (GO), followed by lyophilization process, leading to an improvement in the dispersion of both components.[1,2] Synthesis of nanocomposites has been carried out following two strategies: **1.** direct integration of reduced graphene oxide (rGO) (previously synthesized with hydrazine or ascorbic acid) or CEG into the matrix of the polymer through solution in proper solvents and **2.** reduction *"in situ"* of the graphene oxide (GO) during the mixing process in the solution. Graphene loadings in nanocomposites are 4, 6, 9 and 12 wt%. Extensive characterization of the samples has been carried out (TG, Raman, STEM, SEM, and XPS), including conductivity measurements and WAXS and SAXS analysis employing the synchrotron radiation at ALBA in Barcelona. These techniques employed to evaluate the samples have show that reduction *in situ* of GO in the composite lead to better reinforcement of the polymers. Well dispersed rGO renders not only improves properties in relation to strength and fracture toughness, but also conductivity of the nanocomposites, which it's not possible to get by adding GO. Future work will involve the extrusion of the nanocomposites filaments for being used in 3D printing.

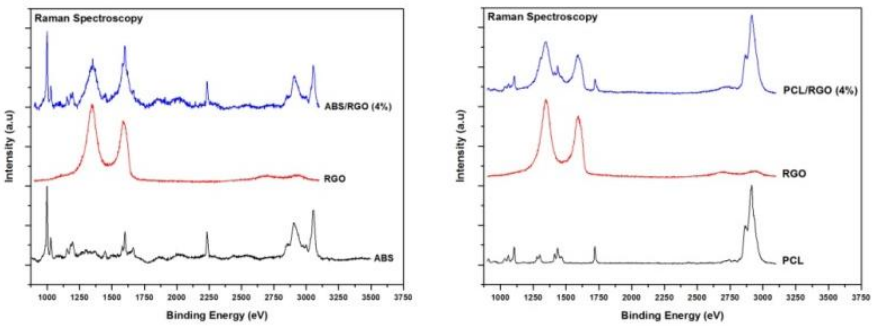

Figure 1. Raman spectra corresponding to the pure polymer matrix (PCL) and the PCL/graphene nanocomposite

[1] Tang, L.-C *et al*., ***Carbon***, 60, 16-27 (2013).

[2] Rafiee et al., ***ACS Nano***, 3(12): 3884-3890 (2009).