Graphene reinforced thermoplastic polymer composites for the transport sector

Cosimo Anichini[1]
Sanjay B. Thorat[1], Sebastiano Bellani[1], Francesco Bonaccorso[1,2]
[1]*BeDimensional S.p.A., Via Lungotorrente Secca 30R, 16163 Genova, Italy*
[2]*Istituto Italiano di Tecnologia, via Morego 30, 16163 Genova, Italy*
c.anichini@bedimensional.it

The transport sector is facing different challenges: on the one hand, the climate crise imposes the reduction of the carbon footprint of transportation and on the other hand the users ask for greater safety and comfort[1]. The implementation of graphene-based polymers composites (GPCs) into structural elements of aerial and terrestrial transportation is devoted to tackle both challenges. Thanks to their high strength and stiffness,[2,3] the use of GPCs allows for a physical reduction of the structural elements, and consequently a decrease of the weight. GPCs show also high resistance to wear,[2] ultimately extending the lifespan of the components based on pristine polymers. Furthermore, compared to bare polymers, GPCs have demonstrated improved dumping capacities, lower flammability, electrical and thermal conductivity, which may result in a safer and more comfortable travel experience for the users.[4]
In this view, we designed and produced graphene-loaded thermoplastic polymer filaments and pellets for their use in additive manufacturing and injection moulding. Polyamide12 (PA12), polypropylene (PP) and polyether ether ketone (PEEK) composites containing up to 25% wt. of few-layer graphene (FLG)[5], as well as additional fillers such as carbon black (CB), carbon fibres and few-layer h-BN flakes, were produced by melt-compounding and extrusion. The optimized GPCs have shown an improvement in elastic modulus and strength up to ~130% and ~50%, respectively (PA12 containing 14% of FLG+CB) compared to the pristine polymers. Furthermore, the designed GPCs exhibited electrostatic discharge properties (electrical conductivity in the 0.1-1 S/m range) and improved thermal conductivity (up to 2-fold increase compared to pristine counterpart). Therefore, the exploitation of GPCs filaments will produce lighter structural components with added multifunctionalities.

References

[1] F. Creutzig et al., *Science*, 350 (2015) 911
[2] X. Sun et al., *Adv. Mater.*, 33 (2021) 2001105
[3] V. Palermo et al., Adv. Mater., 28 (2016)6232
[4] N. Izzaty et al., *IOP Conf. Ser.: Mater. Sci. Eng.*, 536 (2019) 012133
[5] A. E. Del Rio Castillo et al., *Mater. Horiz.*, 5 (2018) 890

Figures

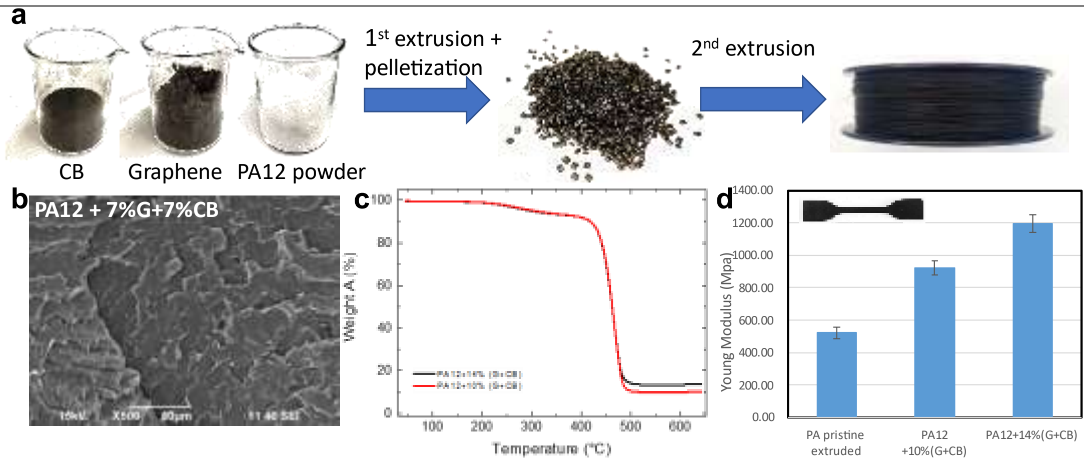

Figure 1: (a) Scheme of the GPCs filament production. (b) Scanning electron microscopy image of PA12+14% (FLG+CB). (c) thermogravimetric analysis of PA12+10% and 14% (FLG+CB) (d) flexural modulus of pristine PA12 and of the composite PA12+10% and 14% (FLG+CB).

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement GrapheneCore3 – 881603.