Innovative nanocomposites for 3D printing: the effect of carbonaceous fillers segregated morphology on structural and functional properties

M. Lavorgna[a,e], C. Santillo[a], A.P. Godoy[b], A. Ronca[a,e], G. Rollo[a,e] RJ. Espanhol Andrade[b], R.K. Donato[c], G. Fei[d], G.G. Buonocore[a], H. Xia[d.a]

[a]*Institute for Polymers, Composites and Biomaterials-CNR, 80155 Portici, Italy*
[b]*MackGraphe, Mackenzie University, Rua da Consolação, 930, São Paulo, SP, Brazil*
[c]*Centre for Advanced 2D Materials, National University of Singapore, 117546 Singapore*
[d]*Polymer research Institute, Sichuan University, 610065 Chengdu, China*
[e]*Institute for Polymers, Composites and Biomaterials-CNR, 23900 Lecco, Italy)*
Corresponding author Marino Lavorgna marino.lavorgna@cnr.it

The development of polymer-based nanocomposites for 3D printing application based on graphene and its derivatives and/or carbon nanotubes is addressed to the tailoring and optimization of functional properties of printed manufacts, such as thermal dissipation and EMI shielding [1]. It is well known that in the preparation of nanocomposite filaments for Fused Deposition Modeling (FDM) technology, the dispersion of fillers into the polymeric matrix plays a key role in determining the processability and final properties of the printed object. On the other side, in the preparation of powder for Selective Laser Sintering (SLS) technology, is the homogenous deposition of conductive filler onto the particle surface which is essential to enhance the functional properties of printed objects, due to the formation of a percolating 3D structure during laser sintering [2]. In this study new competitive conductive nanocomposite materials for FDM and SLS 3D printing, based respectively on modified polyvinyl alcohol (HAVOH) and thermoplastic polyurethane (TPU), carbon nanotubes (MWCNTs) and graphene derivatives (GE) as filler and Benzyl Imidazole Chloride (BenzImCl) as IL, have been designed, prepared and characterized in terms of printability and final properties.

The results demonstrate that both HAVOH-MWCTs filament and TPU/GE powder are suitable for the production of FDM and SLS printed structures. The developed materials exhibit a filler segregated morphology, ascribed both to the confinement of filler at the interface of sintered particles (TPU, SLS) and the effect of ILs to promote $\pi-\pi$ interaction between carbonaceous fillers (HAVOH, FDM). This peculiar filler morphology enables the obtainment of a right balance between mechanical and functional properties of the printed structures, which in turns hold great potential to be used as highly sensitive piezoresistive sensors in wearable devices.

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References

[1] Gnanasekaran K., Heijmans T., van Bennekom S., Woldhuis H., Wijnia S., de With a G., Friedrich H. *Applied Materials Today* 9, 21–28 (2017).
[2] Li, Z.; Wang, Z.; Gan, X.; Fu, D.; Fei, G.; Xia, H.; *Macromol. Mater. Eng*. 1700211 (2017).
[3] Santillo C., Godoy A.P., Donato R., Espanhol Andrade R.J., Buonocore G.G., Xia H., Lavorgna M., Sorrentino A., *Comp. Sci. Tech*., 207, 108742 (2021).