3D printing Conductive filaments and feedstocks by the colloidal processing of high graphene contents into a thermoplastic polymer

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Among the AM technologies Material extrusion (ME) of solid filaments exhibited a wide range of capabilities in different industries such as aerospace, biomedical, electronic and, specially, in the energy storage field. ME provides new opportunities to develop a new generation of EESDs presenting a great potential and many advantages to manufacture different components: (1) shaping customized architectures that maximize the Electrochemical Active Surface Area (ECSA) by optimizing the porosity and interconnection of the electrode, (2) in one-step process fabrication, (3) providing direct integration of electrochemical storage devices (EESDs) and avoiding subsequent process and assembly steps. In this context it is well known that development of filaments and feedstock with electrical conductivity is achieved by adding graphene into a thermopolymer with high content of the inorganic load, since the percolation of the inorganic phase along the polymeric matrix must be continuous in order to obtain high conductivity values. In this regard, the increase of inorganic loading in the feedstock has become a key objective.
This work presents the fabrication of light conductive filaments for material thermal extrusion (MTE) by formulating PLA-based composites with a high content (10-25 vol%) of one commercial graphite and two commercial graphene powders. By the colloidal characterization and surface modification of the species, an improved distribution and enhanced platelet/polymer bond were achieved, provoking the inorganic phase's orientation during the extrusion process. Prepared filaments were characterized to analyse the influence of the microstructural anisotropy on thermal, thermorheological, mechanical, and electrical properties. Conductivity depends on on the piling level of the starting graphene as received powders as well as in the solid contents. The development of the thermoplastic feedstock with a high load of graphene, that is already commercialized by a 3D printing feedstock company (COLFEED4Print), allows to conductions levels as high as 1000 $S \cdot m^{-1}$.

Figures

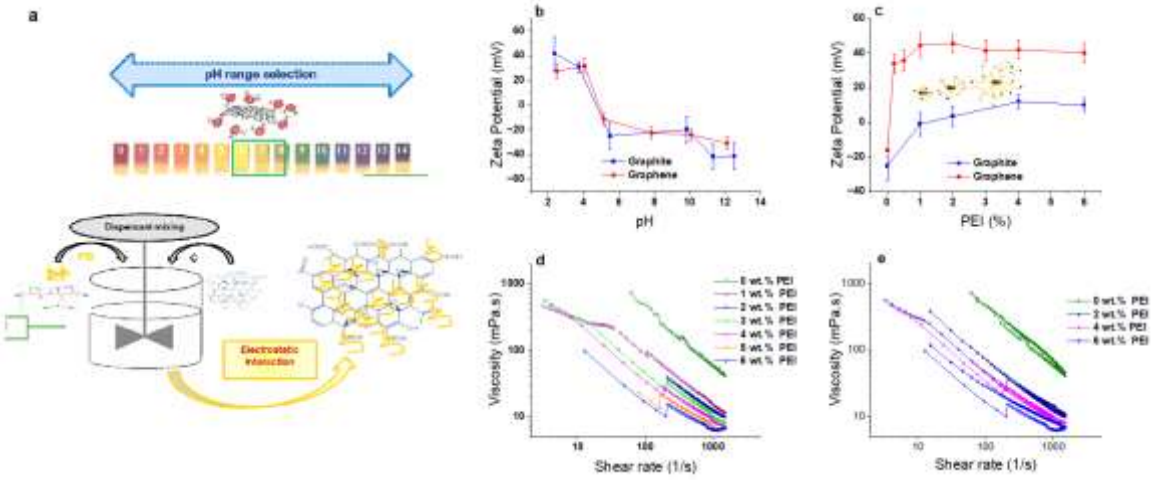

Figure 1: Colloidal studies of Zeta Potential and Viscosity for the dispersion of graphene in water for highly dispersion into the thermopolymer matrix.