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Characterization of various plasma reactors dedicated to nanoparticle functionalization

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The treatment of nanoparticles (NPs) has gained much interest during the last decade because it has been shown an essential step in the synthesis of high added value polymer nanocomposite. Indeed, to avoid NPs agglomeration and create a strong bonding interface with the host matrix, surface modification of NPs is required to improve their compatibility with the polymer and promote a good dispersion of the nanofillers.
Among the very various existing methods used to modify the NPs surface, the deposition of an organic coating by plasma polymerization shows numerous advantages such as high versatility and easy control regarding the incorporation of a chemical functionality, little use of chemicals and wastes to treat, simple apparatus, short process time and easy scale-up to mass production.
Nevertheless, the plasma treatment of NPs is a challenging task because an effective way to mix the powders during the treatment has to be found in order to obtain a homogeneous coating around isolated NPs. In this purpose, we compare in this work the efficiency of two different types of homemade low-pressure plasma reactors to coat NPs with plasma polymers: a capacitive magnetron rotating drum reactor and a so-called “gravitational” reactor, where the NPs fall through an inductively-coupled plasma discharge. More specifically, we place the accent on the deposition of amine-based plasma polymers on zinc oxide NPs.
Plasma diagnostic is performed by optical emission spectroscopy and mass spectrometry to better understand the dissociation of the precursor in the different reactor configurations and optimize thin film properties. Deposition rates, yields, functionalization degree and thin film quality and homogeneity around NPs are assessed by XPS and HR-TEM and compared to highlight strengths and limitations of each configuration regarding industrial issues.

Keywords
Nanoparticle
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