Keep-in-Touch meeting
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Graphene-Based Hybrid Nanostructures Production Using Plasma-Based Methods

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One of the main challenges in the materials nanoscience research area lies in the sensitivity and complexity of the synthesis processes. Plasmas are an alternative and sustainable strategy to synthesize disruptive nanostructures since they allow the effective control over the nucleation and assembling mechanisms at atomic scale level.

In the present work a microwave plasma-based method [1][2] at atmospheric pressure conditions is used to produce multiple free-standing carbon nanostructures, i.e., N-graphene and N-graphene-metal-based composites (NGMCs), possessing unique features that make them valuable in a wide range of applications. Precursor chemistry, gas mixtures fluxes, supplied power and chamber design play a significant role in the production process. The plasma reactor's geometry meets specific thermodynamic conditions in the assembly zone, i.e., thermal fluxes, gas velocity, residence time, etc. Hence, to produce N-graphene sheets a methylamine-methane gas mixture is injected into a 2.45 GHz surface wave sustained argon plasma. Furthermore, to synthesize the NGMCs, metal oxide micron size particles are injected in the plasma reactor at different positions. To better understand the nucleation processes several plasma characterization techniques were employed, including FTIR and optical emission spectroscopy. Transmission and scanning electron microscopy (TEM & SEM), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), near edge X-ray absorption fine structure spectroscopy (NEXAFS) and X-Ray diffraction (XRD) were used to characterize the synthesized nanostructures. Few layer pristine graphene sheets with residual oxygen presence (<1 at.%), N-graphene with a nitrogen doping level of 8 at.% and N-graphene sheets decorated with manganese oxide nanoparticles are some of the nanostructures successfully produced with the presented method.

[1] E. Tatarova, A. Dias et al. "Towards large-scale in free-standing graphene and N-graphene sheet", Scentific Reports 7 (2017) 10175, 2017.

[2] N. Bundaleska, A. Dias et al. "Prospects for microwave plasma synthesized N-graphene in secondary electron emission mitigation applications", Scentific Reports 10 (2020) 13013.