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Low temperature low pressure low power reactive plasmas for 2D and multimaterials

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Reactive plasmas are used for the deposition of various types of materials for decades. New generation of applications from flexible electronics, use of materials in extreme conditions from energy applications to sensors, re-flamed the development of new-old categories of interest- such as 2D materials as multimaterials (in extreme conditions), and (re)opened new questions in diagnostics and understanding of plasmas.

This talk addresses the use of in-situ diagnostics in reactive plasmas, targeted towards a successful synthesis of novel (advanced) materials, especially organic or metalorganic multimaterials.

The results will present comparison between experiment and simulations and provides insight in plasma processes given by e.g, in-situ Raman spectroscopy, optical emission spectroscopy, microwave interferometry vs material characterization in-situ or ex-situ by synchrotron analysis.

The main results of our observations are, for example, that plasma processes show extreme importance of proper wall conditioning, and sample preparation which can be decisive for the growth of the 2D materials.

Chamber cleaning protocol can result even with conditions of the walls that provide seeding for the graphene growth, or can (due to residues of oxygen, water molecules, nitrogen etc.) actively participate in functionalization of materials during their synthesis, or thereafter.

The observations of the growth on various materials on samples such as Si (monocrystalline, p or n-doped), stainless steel, carbon cloths, different metals, ceramics and oxides show also differences with and without catalysts. Hydrogen plasma treatments or argon plasma treatments of samples before synthesis, for example, change fully the physico-chemical characteristics of the synthesized materials (e.g. make distinction between growth of nanotubes or nanowalls). Gas flow and heating play, as well, an extremely important role in the plasma case- these parameters can decide if we have predominantly volume, or predominantly surface processes, that are important for the control of the synthesis of nanoparticles, which are often a part of any process including reactive plasmas. Control of the nanoparticles synthesized in the volume of plasmas used for the synthesis of 2D materials, their etching, or functionalization/doping is crucial for applications; they either present pollution for the process, or an additional element which can be well used, important for SERS applications.

Playing with plasma parameters, thus, can enable higher stability on different substrates, change conductivity, or change topology, for example enabling the growth of mesoporous 2D carbon structures.

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