Dias, Ana
PhD Student – APPLAuSE [Técnico Lisboa]
ines.vieitas@tecnico.ulisboa.pt

PhD Thesis Abstract

Plasma based assembly and engineering of 2D and 3D carbon nanostructures

Plasma environments constitute powerful tools in materials science by allowing the creation of innovative materials and the enhancement of long existing materials that would not otherwise be achievable. The remarkable plasma potential derives from its ability to simultaneously provide dense fluxes of charged particles, chemically active molecules, radicals, heat, photons and electric fields in sheath domains which may strongly influence the assembly pathways across different temporal and space scales, including the atomic ones. The unique chemically active plasma environment provides suitable conditions to dissociate/atomize molecules in order to synthesize extraordinary 2D nanostructures in a unique way. Therefore, this project relies on optimizing the 2D carbon nanostructures production by further elaboration of the microwave-plasma based method for graphene synthesis developed in Plasma Engineering Laboratory (PEL). The method is based on the injection of hydrocarbons/alcohols into a surface-wave sustained argon plasma environment, where the decomposition of the precursor takes place and atomic and molecular carbons are created and then converted into solid carbon nuclei in the "colder" nucleation zones. A theoretical and experimental study on atmospheric pressure microwave plasma based assembly of free-standing carbon nanostructures using different precursors has been done. Furthermore, graphene functionalization and nitrogen doping is the other objective of the plan. Slot antenna excited, surface wave plasma source at low pressure conditions was used to synthesize N-graphene. The N-doping process consists on placing the graphene sheets on a substrate in a remote zone of N_2-Ar plasma. The samples were treated at different exposure times and different compositions of N_2-Ar gas mixture. Theoretical model describing N_2-Ar large scale plasma source has been used to calculate nitrogen fluxes towards treated nanostructures. The N-doped graphene sheets have been analysed applying several material characterization techniques. In order to extend the 2D properties of graphene into a third dimension the work on assembling of unique networks of vertically aligned graphene sheets on silicon substrates had started. A preliminary investigation is being done on silicon nanograss support production via Ar-H_2 plasmas treatment of negatively charged silicon wafers (poly or single crystalline).