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PhD Thesis Abstract

Vacuum ultraviolet spectroscopy of microwave plasmas and 2D carbon nanostructures

Plasmas provide highly reactive environments, rich in charged particles, chemically active molecules, radicals, heat, and radiation from visible to ultraviolet, vacuum ultraviolet and even X-rays. Radiation emitted in the far ultraviolet region (λ < 200 nm), i. e. extreme and vacuum ultraviolet, is of particular interest because the energies are high enough to break most organic chemical bonds, initiate surface reactions and modify surface properties. Plasmas operating at microwave frequencies have the potential to become effective sources of extreme and vacuum ultraviolet (EUV/VUV) radiation. Due to the effective power dissipation, microwave discharges provide high electron and excited species densities, which can promote numerous radiative decay processes of interest, namely radiative decay from high energy levels (energies above 10 eV) giving origin to energetic photons with EUV and VUV wavelengths. However, experimental results in this spectral region, in particular concerning microwave discharges, are quite scarce. In this context, the emission of extreme and vacuum ultraviolet radiation by microwave driven discharges at low-pressure conditions has been investigated as a function of the operational conditions. Classical surface-wave-driven discharges operating at 2.45 GHz in argon, hydrogen and helium have been investigated. EUV/VUV emission spectroscopy was performed using the experimental setup available in the Plasma Engineering Laboratory in IPFN. A state-of-the art spectrometer (Horiba Jobin-Yvon Plane Grating Monograph 1000) coupled to a silicon diode detector was used to collect radiation emitted by the plasma for wavelengths in the 8 – 125 nm region. Spectral lines in this region were identified for microwave driven discharges in argon, hydrogen and helium. The variation of the emission spectra of each gas discharge was investigated as a function of pressure and total power delivered to the plasma. For the case of argon and hydrogen discharges, the experimental results have been compared with model predictions as obtained from detailed radiative-collisional theoretical models. The electron density as well as the gas and excited species temperatures were determined by means of optical emission spectroscopy.