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(G*) Characterization of aerosol-assisted low pressure plasma deposition processes

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Plasma-enhanced chemical vapor deposition is widely studied for deposition of functional thin films. For some applications, multifunctionality is a pre-requisite, and this can be achieved using a number of methods, among which is aerosol-assisted plasma deposition. Using an injector-reactor, stable but volatile liquids can be injected and pulsed into the discharge, resulting in a time-dependent plasma. The impact of pulsing argon into a low-pressure argon RF plasma was recently studied by optical emission spectroscopy with regards to the time-resolved electron number density and temperature. The present study builds on these results and characterizes the physics of a low-pressure capacitive RF plasma process assisted by pentane aerosols formed by pulsed liquid injection. In particular, time-resolved line emission intensities, pressure, and self-bias voltage of the plasma are measured. Low-pressure aerosols are injected either as mist (0.01-0.1 mL/min), mist plus droplets (0.1-1 mL/min), or only droplets (1-3 mL/min). Results show that increasing the amount of aerosol injected either by increasing the pulse frequency (while keeping the amount of liquid injected during a pulse fixed) or the amount of liquid injected during a pulse (while keeping the pulse frequency fixed) influence differently the pressure increase and self-bias voltage during each pulse. Over the range of experimental conditions investigated, the deposition rate of C_xH_y coatings rises with the liquid injection rate. However, by correlating plasma deposition rates with detailed aerosol characterization obtained by light scattering, it is found that droplet size plays a significant role in the plasma deposition dynamics.

Primary authors: SIMONNET, Claire; STAFFORD, Luc; Mr CLERGEREAUX, Richard (Laboratoire LAPLACE)

Presenter: SIMONNET, Claire

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