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Plasma-fluid and plasma-surface interactions of nanosecond pulsed plasmas

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Interactions with fluids and surfaces are key avenues for improving the effectiveness of nanosecond pulsed plasmas for atmospheric-pressure applications in materials science, among other areas. To investigate such interactions, we combine space- and time-resolved optical diagnostics: emission microspectroscopy of plasmas, in-situ Raman microspectroscopy of surfaces, and particle image velocimetry of fluid flow. The first part of the talk will concern nanosecond repetitively pulsed (NRP) microplasmas generated in air at atmospheric pressure, which achieve arc-like levels of ionization while maintaining a strong degree of non-equilibrium. In the presence of a metal substrate biased to high dc voltage, the microplasma generates an electrohydrodynamic (EHD) flow between itself and the substrate. Ions generated by the microplasma create an immediate acceleration of the fluid, followed by the development of plume-like convective flow. The relative importance of the thermal versus EHD character of the plume is adjustable in a straightforward fashion. The second part of the talk will cover NRP discharges in atmospheric air generated using a surface discharge geometry. We will focus on how the presence of the plasma affects the properties of various propagating surfaces such as dielectric films and semiconductors, with an emphasis on transient changes during plasma-surface interaction.