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Electric Field Measurements in Nanosecond Pulsed Discharges[1]

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Nanosecond pulsed electrical gas discharges are generated by applying a voltage in excess of the breakdown threshold across two electrodes. The applied voltage creates an electric field responsible for accelerating the first free electrons present to higher energies, transferring electrical energy to electrons. This results in electron avalanches and in streamer formation, parts of the breakdown process. The electric field hence controls input energy partition in the plasma (vibrational and electronic excitation, dissociation, ionization) and also the rate of gas temperature increase. In return, the electric field in the plasma is controlled by the ionization, electron and ion transport, electron emission from electrodes and surface charge accumulation on dielectrics. Therefore high-resolution spatio-temporal electric field measurements are of great interest for insights into kinetics of ionization, charge transport and also for validation of kinetic models. In this work we use Stark splitting polarization spectroscopy and electric field-induced second harmonic (E-FISH) to perform spatio-temporal electric field measurements. The former technique is used for discharges in helium, investigating shifting of the He I line at 492.2 nm and of its forbidden counterpart in presence of an electric field. E-FISH is employed in a variety of discharges (surface DBD, quasi-2D DBD and pin-to-pin) with an absolute calibration provided by measurements of a known Laplacian field. E-FISH measurements were performed in air, argon and krypton plasmas and in plasmas-enhanced flames. Both picosecond and femtosecond laser pulses were used.

[1]Collaborators: Peter Bruggeman (UMN), Ed. Barnat (Sandia National Laboratories), Igor Adamovich (OSU). US DOE Plasma Science Center: "Predictive control of plasma kinetics: multi-phase and bounded systems"