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Modeling transient and DC microdischarges

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The considerable recent interest in "microdischarges" (discharges in small, spatially-confined geometries) is largely due to their remarkable stability. That is, stable, non-thermal, high-pressure plasmas can be generated and maintained in electric discharges in small geometries operating in controlled atmospheres or in open air. Various ways of increasing the plasma volume have been investigated, including arrays of micro discharges or 3-electrode systems (an additional anode). Further interest in microdischarges is due to the fact that plasma jets, initiated from microdischarges operating with pulsed or RF excitation and with an axial helium flow, can propagate some centimeters in open air. Modeling has been an important tool for developing an understanding of these microdischarges and in helping guide the experimental optimization of devices based on microdischarges. This talk will focus on results from fluid modeling. Issues to be discussed include the extent to which pd (pressure x distance) and pt (pressure x time) scaling laws are valid for transient and DC microdischarges. That is, how do these microdischarges differ from their larger, lower-pressure counterparts? Nonlinearities due to gas heating, step-wise ionization, surface and high-pressure gas phase chemistry, and the high electric field strength at the cathode are factors that can cause departures from pd and pt scaling. Results from fluid models have also provided a framework for understanding of pulsed or rf plasma jets, but models allowing the prediction of the plasma chemistry in plasma jets are still evolving.