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Spatially-resolved diagnostics of 1-GHz microdischarges[1]

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This talk addresses the internal structure of atmospheric pressure microdischarges powered in the $f \sim 1$ GHz frequency regime. Microwave power is focused into a sub-millimeter discharge gap using a resonating microstrip transmission line. The advantages of microwave excitation over low frequency operation include low power and discharge voltage (<1W, < 100 V), no ion sputtering ($f > f_{pi}$), and stable steady-state cold plasma generation. Metastable argon density and the gas temperature were estimated by the optical absorption transition in Ar (1s$_5$-2p$_8$) at 801.4 nm using a laser diode focused to ∼30 microns. The gas temperature was estimated from the Ar line broadening due to collisions. Able inversion of the line-integrated density shows that the 200-micron wide central core of the microplasma is depleted of metastable atoms. Spatially-resolved continuum optical emission from electron recombination, however, shows that the microdischarge has a dense electron core. Gas temperatures are difficult to accurately extract from optical diagnostics due to the extreme depletion of commonly-used spectroscopic species from the microdischarge's central core (e.g., N_2, OH¸ Ar^m). In the case of the argon metastable line broadening, the higher density of Ar^m in the peripheral regions masks the line width within the core. Numerical modeling interpolates the microplasma's core temperature based on measurements around the periphery. The model shows that the core temperature exceeds 1600 K, even though spatially-averaged nitrogen rotational spectra suggest that the gas temperature is typically only 400 K. Diagnostics are important to the successful development of microplasma applications. The presentation concludes with an example of low-temperature microplasma deposition using acetylene at 1 atm, and a discussion of scaling single microplasmas to long linear arrays that are appropriate for roll-to-roll plasma processing at atmospheric pressure.

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