LASER INDUCED FLUORESCENCE IN A HIGH POWER ARGON HELICON PLASMA*

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A flowing argon helicon plasma is formed in a 10 cm diameter, 1.5 m long Pyrex chamber with an axial magnetic field in nozzle or flat configuration, variable up to 1 kG in the source region. Experimental upgrades including a new expansion chamber have been implemented and initial laser induced fluorescence (LIF) results including ion velocities and temperatures are presented. RF pulsing including frequency variation during the pulse (between 12 MHz and 15 MHz) is used to improve matching. Diagnostics including microwave interferometry, collisional radiative spectroscopic codes and diamagnetic loops are used to measure electron density and temperature. Electron temperature scaling with RF power is investigated at higher RF powers. The ion distribution function is examined and the effect of magnetic field expansion variation and system pressures as well as the axial variation of acceleration due to neutral depletion. Possible double layer creation and sustainment in the downstream (relative to the RF antenna) transition to the expansion chamber is also examined at low flow rates and high RF powers.

Low-pressure discharge initiation results are also summarized [1] and new experiments at higher powers and lower flow rates (1-20 sccm) are discussed. A static magnetic field threshold for discharge initiation is seen at low flow rates, where discharges will not start above a certain magnetic field value that depends on RF power and flow rate. This threshold is a consequence of the multipactor effect, which is the dominant mechanism for breakdown when the electron-neutral collisional mean free path is longer than the system dimensions. A magnetic field ramping technique for starting discharges at these low flow rates is described.

1. M. Wiebold, H. Ren, C. M. Denning, J. E. Scharer. "Low pressure helicon discharge initiation via magnetic field ramping." *IEEE Transactions on Plasma Science* vol. 37, no. 11, 2009.

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