CHARACTERIZATION OF BREAKDOWN DELAY AND MEMORY EFFECTS IN HIGH POWER MICROWAVE DIELECTRIC WINDOW DISCHARGES*

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Development of high power microwave (HPM) distributed discharge limiters relies critically on minimizing the delay time between HPM incidence and diffuse plasma creation. We present a series of pulsed plasma experiments conducted in neon, argon, and a 9:1 mixture of the two gases from 50-760 torr. Breakdown is achieved by illuminating a gas cell with a train of ~25kW, ~2 kV/cm, 800ns-long pulses at 41Hz repetition rate. The results suggest that surface charge accumulation on the gas cell’s polycarbonate window from many low density precursor discharges eventually results in rapid (<30ns), high density, discharge formation. The number of precursor pulses required to form these high density discharges is significantly reduced following a previous high-density discharge.

Our experiments show that this charging effect has a decay time on the order of hours, vastly greater than that associated with common radiative lifetimes of neon and argon metastables (τ =14.73s for neon \(^3\)P\(_2\); τ = 44.9s and 55.9s for argon \(^3\)P\(_0\) and \(^3\)P\(_2\) respectively). Based on these timescale considerations and the significant gas flow rates used in our studies, the evidence strongly implicates that window surface charge accumulation is responsible for seeding the breakdown rather than metastables which were associated with discharge memory effects elsewhere.

Finally, we present progress towards the design of a high-frequency, multi-antenna array and signal acquisition system developed to characterize time-varying plasma shape and density dynamics from the scattered-wave information. Progress towards development of a circuit analog absorber designed to provide greater than 30dB attenuation with a thickness of less than 2cm, for use with this acquisition system, is also presented.


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