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Dielectric Surface Flashover at Atmospheric Conditions under High Power Microwave Excitation[1]

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Due to recent advances in the peak output power densities and pulsewidths of high power microwave (HPM) devices, the ability to radiate this power into the atmosphere is limited by surface plasma formation at the vacuum-air interface. In applications such as high power radar or electronic warfare, the 'air' side of the window may rest at pressures from atmospheric down to approximately 90 Torr. Very little is known about window breakdown under HPM environments and this paper reports one such study. Due to the high (THz) elastic collision frequencies of the electrons with the neutral gas molecules and added energy loss channels through molecule excitation, the well-established lessons on VACUUM-surface flashover cannot be directly applied to the dielectric-AIR flashover. For example, dielectric flashover in an atmospheric environment has a lower threshold than flashover in vacuum. This paper further discusses that a typical transition point from vacuum to atmospheric flashover occurs at $\sim$ 1 Torr, where proven concepts of vacuum flashover, such as multipactoring electrons, have to be abandoned. It will describe new experimental and modeling results of MW/cm^2 pulsed power densities at 2.85 GHz and 110 GHz. Spectroscopic measurements confirm that the N_2 molecular vibrational temperature is $\sim$ 2,700 K, while the rotational temperature is $\sim$ 300 K, thus indicating the non-thermalized nature of the flashover plasma kinetics. A universal scaling law has been shown to exist between the flashover electric field strength divided by pressure, E/p, and the gas pressure times the flashover delay time, $p\,\tau$ over an extremely large parameter space. The impact of UV radiation on the flashover path is determined. Quantitative comparisons of data with most recently developed theoretical models and computer codes are given.

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