Abstract Submitted
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Student Excellence Award Finalist: Gas Breakdown: Across Length Scales and Frequency[1] AMANDA LOVELESS, ADAM DARR, ALLEN GARNER, Purdue University — Paschen's law (PL), based on the Townsend avalanche criterion, is a well-established condition for gas breakdown. Reducing gap sizes to microscale leads to deviations from PL that are hypothesized to arise due to ion enhanced field emission. We summarize a matched asymptotic analysis that quantifies the transition from field emission to Townsend avalanche to the classical PL. As device miniaturization further drives dimensions to nanoscale, the impact of surface roughness on field emission and length scales on the order of the electron mean free path will further alter the gas breakdown condition. We couple the one-dimensional Schrödinger equation to the microscale breakdown equation to estimate the conditions at which quantum effects become dominant. Finally, we assess the impact of frequency on gas breakdown, showing the transition of breakdown predictions from DC to RF to microwave conditions and deriving universal, analytic equations that demonstrate the relative insensitivity of the right-hand side of Paschen's curve to frequency. Implications of the results and the ultimate connection to microwave breakdown and other breakdown regimes, such as space-charge limited and streamers, will be discussed.

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