AN *AB INITIO* APPROXIMATION FOR THE MODIFIED PASCHEN'S CURVE FOR BREAKDOWN IN MICROSCALE ELECTRODE GAPS

David B. Go and Rakshit Tirumala
Aerospace and Mechanical Engineering, University of Notre Dame
Notre Dame, IN, 46556 U.S.A.

Over the past decade, the nature of breakdown in microscale electrode gaps has begun receiving significant attention both because of the potential impact breakdown could have on MEMS devices and as the development of plasma devices trends to smaller and smaller scales. It has been shown that the traditional description of breakdown called Paschen's curve holds true for larger electrode gaps, in the range of approximately 3-15 μm, breakdown deviates significantly from this form. It is now generally accepted that electron field emission is the physical mechanism that causes this deviation to form the so-called modified Paschen's curve. While a simple mathematical formulation exists for Paschen's curve, there is no simple formulation for modified Paschen's curve. A form that includes the effect of ion-enhanced field emission has been previously suggested, but this form relies heavily on a fitting factor. In this work, the underlying physics and parameters of the fitting factor are investigated to formulate an *ab initio* form of the modified Paschen's curve. This formulation includes the factors of the Fowler-Nordheim equation, and an electrostatics approximation for the impact an ion approaching the cathode has on the electric field. The implications of this approximation, how well it compares to experimental data, and how it may be used for parameteric design are all discussed.