Abstract Submitted
for the GEC12 Meeting of
The American Physical Society

Properties of a field emission-driven Townsend discharge PAUL RUMBACH, DAVID GO, University of Notre Dame — For half a century, it has been known that the onset of field emission in direct current (DC) microplasmas with gap sizes less than 10 μm can lead to breakdown at applied voltages far less than predicted by Paschen's law. It is still unclear how field emission affects other fundamental plasma properties at this scale. In this work, a one-dimensional fluid model is used to predict basic scaling laws for fundamental properties such as ion density, electric field due to space charge, and current voltage relations in the pre-breakdown regime. Computational results are compared with approximate analytic solutions. It is shown that ionizing collisions by field-emitted electrons produce significant ion densities well before Paschen's criteria for breakdown is met. When positive space charge densities become sufficiently large, the effect of ion-enhanced field emission leads to breakdown. Defining breakdown mathematically using a solvability condition leads to a full modified Paschen's curve, while defining it physically in terms of a critical ion density leads analytically to an effective secondary emission coefficient, γ', of the form initially suggested by Boyle and Kisliuk.[1]

[1]Boyle, W.S. and Kisliuk, P., Phys. Rev. **97**, 255 (1955).

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Date submitted: 15 Jun 2012 Electronic form version 1.4