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INCORPORATING RESISTANCE INTO THE UNIFICATION OF FIELD EMISSION AND SPACE CHARGE-LIMITED EMISSION WITH COLLISIONS

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Electron emission plays a vital role in device design for systems with pressures ranging from vacuum to atmospheric pressure. This presentation outlines the theoretical unification of field emission modeled by the Fowler-Nordheim (FN) equation and space-charge limited emission (SCLE) represented by the Child-Langmuir (CL) law at vacuum and the Mott-Gurney (MG) law with collisions [1]. We show that the asymptotic solutions for FN, CL, and MG intersect at a triple point and that electron emission transitions to CL with increasing voltage independent of pressure. Since practical devices often include a series resistor, we extend this work to assess the impact of the resistor, as done previously for vacuum [2]. The triple point is uniquely defined by the electron mobility, gap distance, or voltage with an associated triple point gap impedance. For series resistance less than the triple point gap impedance, electron emission transitions from FN to MG to CL to Ohm's law with increasing applied voltage while SCLE is bypassed entirely at higher resistance.

1. A. M. Darr, A. M. Loveless, and A. L. Garner, "Unification of field emission and space charge limited emission with collisions,"Appl. Phys. Lett., vol. 114, 2019, art. no. 014103.
2. J. W. Luginsland, A. Valfells, and Y. Y. Lau, "Effects of a series resistor on electron emission from a field emitter,"Appl. Phys. Lett., vol. 69, pp. 2770-2772, 1996.

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