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COMPUTER SIMULATION AND THE PHYSICS OF MIRAM CURVES

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The Miram curve for a specific cathode surface describes the normalized current density as a function of cathode temperature. Understanding and predicting this curve is key to understand the performance vs. lifetime of many electrons gun sources [1]. As the cathode lifetime decreases rapidly with increased operating temperature, in many practical devices, the electron gun is operated just over the onset of space-charge-limited emission in the Miram curve. We have made significant progress toward understanding the shape of the Miram curve through simulation using the MICHELLE code [2] based on work function sampling of the surface. These simulations shed new light on the primary mechanisms that determine the Miram curve shape in terms of the work function makeup of the surface.

In a Miram curve, the emitted current density qualitatively follows the thermionic Richardson-Laue-Dushman law at lower temperatures which shows a strong exponential growth with temperature. As the temperature rises the 2D Child-Langmuir space-charge-limited effect eventually takes over [3] and the total emitted current mostly reaches a plateau that is weakly affected by further temperature increase, or by the detailed distribution of the work function. We will present our findings and will compare and contrast these MICHELLE "first-principles"predictions with a recently developed semi-analytical model.

1. A. S. Gilmour, Microwave Tubes, Artech House (1986).
2. John Petillo, et al., IEEE Trans. Plasma Sci. 30, 1238 (2002); IEEE Trans. Electron Devices 52, 742 (2005).
3. R. J. Umstattd and J. W. Luginsland, Phys. Rev. Lett. 87, 145002 (2001).
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