Electron hop funnels have been constructed of Low Temperature Co-fired Ceramic (LTCC) to enhance the performance of gated field emitter arrays (FEAs). Electrons are emitted into the wide end of the funnel, transmitted through the funnel, and exit through the narrow opening. An electrode, referred to here as the hop electrode, is placed around the narrow end of the funnel to create the electric field necessary to sustain electron transport through the funnel.

One characteristic of a hop funnel is the transmitted current versus the hop voltage, referred to here as the “IV” curve. The IV curve of a specific hop funnel provides a measurement of the electrons that are allowed to transmit through the funnel for a given hop voltage. From the IV characteristics the electric field needed to cause electron hopping transport in the funnel and the secondary electron emission characteristics of the funnel material can be studied.

A hysteresis has been identified when measuring the IV characteristics of these hop funnels. When the hop voltage is swept from a high to low potential the current measurement is different than the measurement made when the potential is swept from low to high.

The particle trajectory code Lorentz2E has been modified to describe the electron hopping transport mechanism. Original simulations conducted to obtain the IV curve simulated a set of hop voltages for a particular hop funnel design using an initial uncharged funnel wall for each voltage tested. Using an initial condition of an uncharged surface does not model the observed hysteresis.

New simulations have been created that use the surface charge initial conditions that model hysteresis. At each discrete voltage step the initial condition of the wall’s surface charge is set to the surface charge results of the previous voltage step. The results of these simulations will be presented and compared to experimental data. This comparison will allow conclusions to be drawn on the effectiveness of modeling hysteresis and hop funnels effectiveness to increase FEAs performance.

The IV characteristics of funnels constructed with different materials and geometries will also be presented. Materials with known secondary electron characteristics will be used, allowing a more accurate model. The simulation results will then be compared to experimental work to determine the effect of material selection and geometry in hop funnel designs.

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