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A theoretical link between voltage loss, field-enhancement-factor reduction, and Fowler-Nordheim-plot saturation

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When an individual post-like field emitter (modelled as standing on one of a pair of parallel planes) is sufficiently resistive, and current through it sufficiently large, then voltage loss occurs along it. This Poster shows this voltage loss is directly and inextricably linked to a reduction in the field enhancement factor (FEF) at the post apex. A formula relating apex-FEF reduction to this voltage loss was obtained by Minoux et al. [1] by fitting to numerical results from a Laplace solver. This Poster derives the same formula analytically, using a "floating sphere" model. The analytical proof brings out the underlying physics more clearly, and shows the effect is a general phenomenon, related to reduction in the magnitude of the surface charge in the most protruding parts of an emitter. Voltage-dependent FEF-reduction is one cause of "saturation" in Fowler-Nordheim plots. Another is a voltage-divider effect, due to measurement-circuit resistance. An integrated theory of both is presented. Both together, or either by itself, can cause saturation. Other putative causes exist, so the present theory is a partial story. Its extension seems possible, and could lead to a more general physical understanding of saturation.
E. Minoux et al., Nano Lett. 5, 2135 (2005).

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Field Emission

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