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Field Emission Microscopy of Diamond and Nanotube Materials

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Spatially resolving electron emission from field emission cathode surface is a crucial step to characterize and quantify emission uniformity and emission area, and therefore, beam brightness and current density. It is especially important for mm-wave/terahertz sources for which narrow beam is a must, or for miniaturized field emission devices where high current density is required. It is also important to compare theoretical and experimental results that can only be connected through using the electric field and current density.

With these intentions, we developed experimental and computational methodologies that allow us to transversely image electron beams in dc and rf environments, evaluate and assess emission properties that include quasi time resolved breakdown dynamics and emission area, as well as perform realistic end-to-end beam dynamics of field emission that are in excellent agreement with imaging.

Examples of field emission microscopy and associated breakdown behavior of diamond and nanotube materials will be given. Additional emphasis will be placed on a fast image processing algorithm that can detect number of emitters and calculate emission area. Obtained results demonstrate deficiency of using Fowler-Nordheim (FN) law to describe emitters but, at the same time, allow to propose new hypotheses to overcome the existing deficiencies. High field high charge behavior of emitters beyond FN law will be given using details of charge transport through emitter bulk and 2D emission physics of the emitter surface.

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