Contribution ID: **1021** Type: **Oral**

Shaped Beams from Diamond Field-Emitter Array Cathodes

Thursday 27 June 2019 14:30 (30 minutes)

We present the first experimental demonstration of production and transport of a shaped electron beam from a diamond field emitter array (DFEA) cathodes in an RF gun. DFEAs are arrays of diamond pyramids with exquisitely sharp tips and micron-scale bases that produce high current densities. These arrays can be fabricated in arbitrary shapes, ranging from single tips to many millions of tips, so that they produce an inherently shaped electron beam. Each tip emits a modest current, but large dense arrays can produce many Amps. These cathodes are currently being studied for use in dielectric wakefield accelerators, however they may also be applicable to vacuum microwave tubes. Recently, shaped beam production and transport has been demonstrated in the 1.3 GHz RF gun at the Advanced Cathode Test Stand at Argonne. Current was measured on a faraday cup, and the beam imaged on a YAG screen with various peak electric field gradients on the cathode from 12 –35 Mv/m. Three cathode geometries were tested, one sparse 5x5 square array with 20 micron base and 400 micron pitch, a 1 mm equilateral triangle with 7 micron base pyramids and 10 micron pitch, and a 1 mm equilateral triangle with 10 micron base and 25 micron pitch. The two dense arrays emitted 35 nC bunch charge at 35 MV/m and 13 nC bunch charge at 27 MV/m field respectively, while the sparse array emitted 0.36 nC bunch charge at 15 MV/m.

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Session Classification: 3.1 Plasma, Ion, and Electron Sources II

Track Classification: 3.1 Plasma, Ion and Electron Sources