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Fabrication and Characterization of Diamond Field Emitter Array Cathodes

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This abstract reports on the status of the diamond field emitter array (DFEA) cathode project at Los Alamos National Laboratory (LANL). DFEA pyramids have nanometer scale tips and produce high currents with small emittance, making them a promising candidate for use in compact dielectric laser accelerators. At LANL, we recently established the capability to fabricate DFEA cathodes by using a mold-transfer method. First, we make a photomask with array patterns on the oxidized Si wafer. Then we transfer the pattern onto (100) Si wafer through anisotropic etching. Then we oxidize the wafer and perform diamond deposition. We braze the diamond film to a polished molybdenum substrate with the TiCuSil brazing material. Finally, the Si and SiO2 layers are removed by an etching process using KOH and buffered oxide etch (BOE). The arrays are finally imaged under a scanning electron microscope. We condition the arrays under a DC electric field to determine the emission uniformity and the number of emitting tips. Typically the number of emitting tips and emission current increase with time while operating at a constant electric field. We demonstrate that the pyramids produce high per-tip current (> 15 μA per-tip). We will present the details of the fabrication process and conditioning results of DFEA cathodes.

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