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Plasma Characterization in a Repetitively Pulsed Electron Beam Diode*

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Electron beam (e-beam) generation in high power vacuum diodes results in anode and cathode plasma formation. It is well documented that expansion of these plasmas into the A-K gap can adversely affect diode performance during the main e-beam pulse. However, ionized gases may exist for many microseconds afterward and can contribute to localized breakdowns in the diode gap if transient voltage reflections appear later in time. These post pulse discharges can be destructive to anode and cathode elements. Furthermore, weakly ionized and/or neutral gas remaining in the A-K gap can affect e-beam generation on subsequent shots in repetitively pulsed diodes. For a given, repetitively pulsed driver, diode physics will depend largely on the emitter material used in the cathode, the anode material, the electric field E, dE/dt, current density, vacuum pumping speed, the pulse width, and the pulse repetition frequency. For single shot and various pulse repetition rates on the NRL solid state pulser (200 kV, 5 kA, 250 ns, 1 –10 pps), the plasma density and AK gap closure velocity are measured for various cathode and anode materials. Materials include dielectric fiber velvet, carbon fiber flocked onto a carbon base, ceramic honeycomb secondary emitter with a carbon fiber base, and stainless steel. A fiber laser interferometer is used to measure the line density at the cathode and anode surfaces. Voltage and current probes are used to calculate the gap closure rate. A gated camera is fielded for nanosecond resolution of plasma emissions both at the cathode and anode.

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