MEASUREMENTS AND SIMULATIONS OF PLASMA EVOLUTION IN THE A-K GAP OF THE SELF-MAGNETIC PINCH DIODE FIELDED ON THE RITS-6 ACCELERATOR*

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Investigations are underway at Sandia National Laboratories’ RITS-6 accelerator on plasmas formed in the Self-Magnetic Pinch electron beam diode. The diode consists of a small diameter hollowed cathode rod, a centimeter-wide vacuum A-K gap, and a planar, high atomic number metal target anode. The current and voltage are typically 120 kA at 7 MeV, with current densities in excess of 1.5 MA/cm² on the anode, and pulse-widths of 70 ns. During the pulse, plasmas are formed on the metal electrode surfaces which propagate into the A-K gap. These plasmas are dynamic in nature and change dramatically during the course of the pulse. Several optical diagnostics are employed to measure the plasmas, and hybrid PIC/fluid simulations are used to model them. The diagnostics include: photodetectors, optical streak camera imaging, and optical spectroscopy using both streak cameras and ICCD cameras as detectors. The plasma properties are measured in both space and time throughout the pulse. Dense plasmas \((10^{17} \text{ cm}^{-3})\) are observed to form on the electrode surfaces which propagate into the gap at a rate of several cm/usec. The constituency of the early-time plasma is mainly carbon and hydrogen from surface contaminants in the system, followed later by the base electrode metal species. The expansion velocities of the electrode plasma match well with the decreasing impedance profile observed in the diode during the pulse as the effective A-K gap becomes smaller. In addition to the slowly decreasing impedance profile, some shots show a rapid impedance collapse which prematurely ends the radiation pulse. Models have been proposed regarding the mechanism responsible for this behavior, and these will be presented.


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