Observations of plasma dynamics in a gas-embedded compressional Z-pinch

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Abstract:
A series of experiments carried out in a gas embedded compressional Z-pinch are presented. A dc micro discharge of 150 /spl mu/A between two conical sharp edged electrodes is established to produce a hollow cylindrical discharge. A few nanoseconds before the application of the main voltage, a pulsed laser is focused through the anode onto the cathode. With this preionization scheme an initial coaxial current structure is established. H/sub 2/ and D/sub 2/ at a pressure of 1/3 atm were used as a working gas. The experiments have been carried out using a pulse power generator capable of delivering current of up to I/spl sim/200 kA with a dI/dt>10/sup 12/ A/s. The use of H/sub 2/ and D/sub 2/ allows the study of discharges with the same electrical properties, but with different dynamics. At early times this preionization scheme produces a coaxial double column pinch, which as current rises, coalesces into a single column becoming a gas embedded compressional Z-pinch. Diagnostics used are current and voltage monitors, single frame holographic interferometry and shadowgraphy, visible streak camera, and single frame image converter camera. Electron density, line density, pinch radius, and plasma motion are obtained from the optical diagnostics. It was found that the maximum electron density achieved on axis is greater than twice the expected value according with the filling pressure used in the discharges, which contrasts with a traditional gas embedded pinch in which the density is lower than the expected value from filling pressure. The expansion rate of the plasma column is reduced to a third of the observed value for the single channel laser initiated gas embedded pinch. These measurements agree with the existence of a central current channel in this new configuration of gas embedded pinch. The experimental results clearly show that compression is achieved with the composite preionization scheme.

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