ALUMINUM WIRE EXPLOSION IN VACUUM: EXPERIMENTAL AND NUMERICAL STUDY

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Distribution of matter in the discharge channel formed upon a nanosecond electrical explosion of Al wire in vacuum was studied experimentally and theoretically. Simultaneous use of optical and UV diagnostics and numerical results made it possible to distinguish qualitatively different regions of the discharge channel, such as the current-carrying plasma layers and the region occupied by a weakly conducting cold matter.

Several series of experiments with 25 μm diameter 12 mm long wires were performed; the charging voltage and the current amplitude were U_0 = 20 kV and I_{max} ~ 10 kA, respectively[1]. Shadow and schlieren images of the discharge channel were obtained using optical probing at the second harmonic of a YAG:Nd^{+3} laser (λ = 0.532 μm, τ ~ 10 ns).

The simulations were performed by means of Lagrangian-Eulerian code RAZRYAD-2.5[2] implementing Braginskii model of two-temperature magneto hydrodynamics and devised on the base of homogeneous conservative implicit finite-difference MHD schemes. Multigroup spectral approximation is applied for the radiation energy transport computation with the use of diffusion model or ray-tracing method based on Shuster-Schwartzshild model. Heat- and electro- conductivity anisotropy in magnetic field is taken into account. The code allows utilization of data tables for thermal and optical matter properties. Aluminum thermal and optical properties data tables[3] were applied in the computations under consideration. We have investigated the influence of the radiative energy transfer upon the matter parameters (temperature, density) distribution and the electric current density in the discharge channel. Several variants were computed with different number of spectral groups included. Numerical results are analyzed via comparison with experimental data.

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* Work supported by the RFBR 08-08-00688, 09-02-01532, pr ograms 02.740.11.0447 and 2.1.1/5470 and the ESC FIAN