NUMERICAL STUDY OF PLASMA FORMATION FROM CONDUCTORS EXPOSED TO MEGAGAUSS MAGNETIC FIELDS*

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Recent aluminum rod experiments[1, 2] driven by 1-MA Zebra generator at University of Nevada, Reno (UNR) have provided a benchmark for magnetohydrodynamic (MHD) modeling. The innovative 'hourglass' and 'barbell' load geometries used in the experiments made it possible to distinguish between plasma formation due to Ohmic heating, which can be studied numerically utilizing MHD codes, and plasma formation due to high electric fields, by introducing a large-diameter contact with the electrodes. This prevents the explosive electron emission (EEE) at the contacts which triggers initial plasma formation in the conventional rod explosion experiments.

The UNR megagauss rod experiments were modeled by employing the state-of-the-art radiation-magneto-hydrodynamic code MHRDR. Numerical simulations were performed for a wide range of rods, varying from 100 to 580 microns in radius. A "cold start" initiation was employed in order to create initial parameters close to the experimental conditions. Material properties of aluminum, crucial for such simulations, were modeled employing a set of well tested SESAME format equations-of-state (EOS), ionization, and thermal and electrical conductivity tables. The cold start initiation also allowed observation of the numerical phase transitions of the aluminum rod, from solid to liquid to vapor and finally to low density plasma as it is ohmically heated by the megaampere driving current. Numerical results indicate that plasma forms at the surface of the expanding low density aluminum vapor, when and where the magnetic field is about 2.7 MG. This result is in agreement with a previous simulation by Garanin[3] et al., as well as with data from the UNR rod experiments.

1. S. Fuelling, et *al*, 'A Zebra experiment to study plasma formation by megagauss fields,' IEEE Trans. Plasma Sci. **36**, 62 (2008).
2. R.E.Siemon, et *al*, 'The challenge of wall-plasma interaction with pulsed megagauss magnetic fields,' J. Fusion Energy, http://www.springerlink.com/content/c01q368w00408571
3. S.F. Garanin, et *al*, 'Diffusion of a Megagauss Field into a Metal,' J. Appl. Mech. Tech. Phys. 46, 153 (2005).

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