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COMPUTATION OF MULTIPLY CHARGED ION TRANSPORT IN CURVED MAGNETIC FIELD

D. T. K. Kwok[1], M. Keidar[2], P. K. Chu[1], and I. G. Brown[3]

[1] Department of Physics and Materials Science, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong SAR, China.

[2] College of Engineering, University of Michigan, 2049 FXB, 1320 Beal Avenue, Ann Arbor, Michigan 48109

[3] Lawrence Berkeley National Laboratory, University of California, Bldg. 53, Berkeley, California 94720, USA

A vacuum arc is an excellent source of multiply charged metal ions. A curved magnetic field is used to separate the plasma from liquid droplets or solid particle (macro-particles) that are also generated by the vacuum arc. The electric field in the quasi-neutral plasma is generated due to separation between the magnetically confined electrons and relatively mobile ions. Due to the existence of an electric field in the quasi-neutral plasma, the ions with different charge can be spatially separated. This effect is studied theoretically in the present work.

A two-dimensional hydrid PIC (particle-in-cell) - fluid model has been developed to simulate the vacuum arc plasma jet containing multiply charged ions. The electron component model is based on the fluid approach making it possible to calculate the radial electric field in the plasma duct with varying magnetic field. This electric field consists of two terms determined by the plasma density gradient, plasma velocity, and magnetic field. In order to calculate the electric field distribution at the initial iteration step, the plasma density and velocity distribution from the PIC calculation are used. The plasma density and velocity distribution are updated based on this electric field. This method allows us to derive the plasma density, velocity, and electric field distribution in a self-consistent manner.

Our calculation shows that the radial potential drop is about 10V. Taking into account that the ion directed energy in the vacuum arc jet is about 20-50eV, one can conclude that the radial electric field may have some effects on the ion motion in the duct. The radial electric field affects multiply charged species more significantly (since electric force is proportional to charge). This effect leads to different charged species separation in a quasi-neutral plasma.

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Numerical modeling of an ATLAS-like liner experiment driven by an explosive magnetic generator.

R.J. Faehl, W.L.Atchison, R.K. Keinigs, and I.R. Lindemuth
Plasma Applications Group
Los Alamos National Laboratory, Los Alamos, New Mexico 87545

The first experiment to implode a solid liner under driving currents comparable to full ATLAS currents was recently completed using an explosive magnetic generator (EMG) designed and built at VNIIEF. Diagnostics, including faraday rotation coils, VISAR, optical pins, and inductive magnetic probes, were jointly fielded in a collaboration between LANL and VNIIEF. We present one- and two-dimensional MHD calculations that were done in support of this experiment. The calculations are consistent with data, but demonstrate a sensitivity to conductivity models. Both data and calculations concur that the final liner velocity exceeded 12 km/s and that the inner surface of the liner was still intact at the time of impact with a Central Measuring Unit. The calculations showed a high level of fluid Rayleigh-Taylor disruption on the outer surface of the liner. The occurrence of this level of instability had little effect on the quality of the inner surface. The calculations indicated that most of the liner had melted before impact, but that the region near the inner surface should still be unmelted. Detailed comparisons between data and calculations will be presented.