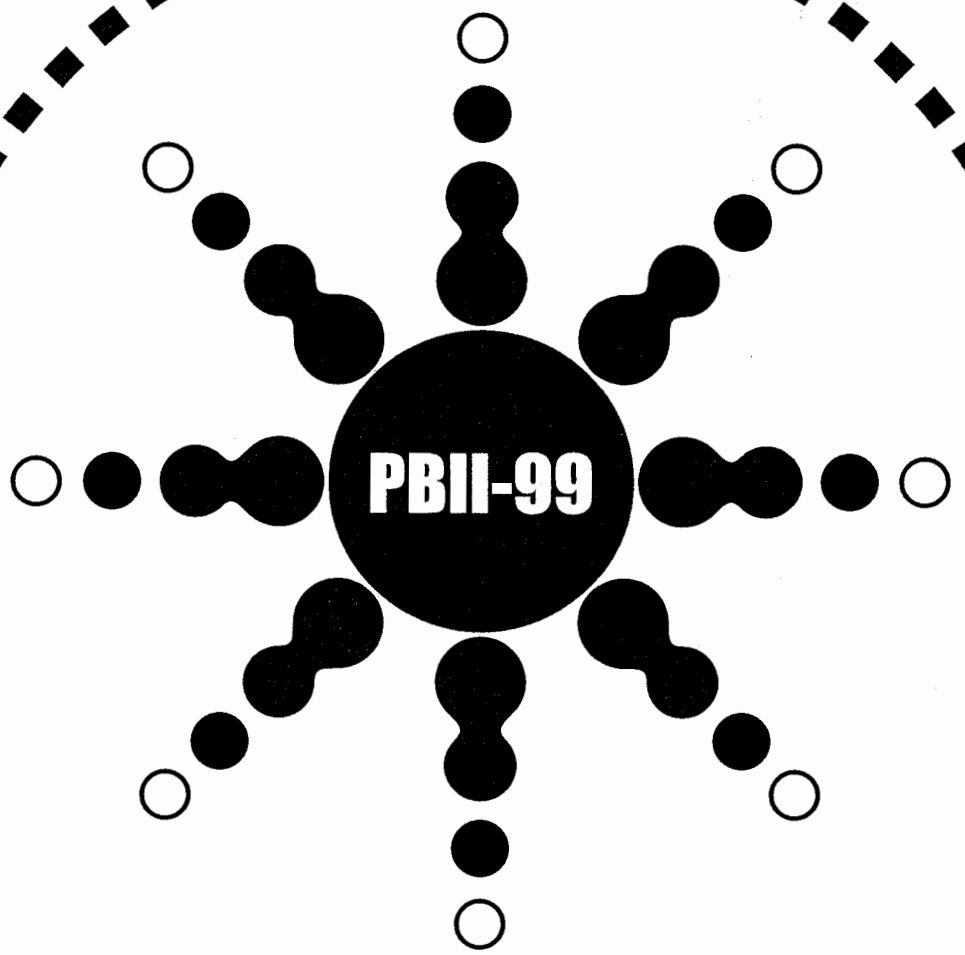

Fifth International Workshop on Plasma-Based Ion Implantation (PBII-99)

December 13-16, 1999
Keihanna-Plaza
Seika-cho, Kyoto, Japan

ABSTRACTS

P-02

Experimental investigation of electron oscillation inside the duct of a vacuum arc source

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Cathodic arc metal duct sources are employed to deposit thin metal films and metallurgical coatings. The metal plasma is formed when an arc discharge is triggered between two metal electrodes in vacuum. Contamination by macroparticles micrometers in size is one of the major disadvantages of vacuum arc plasma sources in industrial applications. A curved magnetic field duct can remove the macroparticles from the metal plasma since they will collide with the duct walls due to their inertia. One drawback of the magnetic duct is the reduction of the plasma flux, but the outer duct can be biased to improve its efficiency.

Electron motion inside the duct of the vacuum arc metal source is an important factor. The electron density is usually two to three times that of the ion density. The magnetized electrons will follow the magnetic field lines. It is computed that under the combined effects of the electric (created by the biased plate) and magnetic (created by the duct coils) fields, the electrons will oscillate, that is, travel back and forth, along the center axis inside the duct tube. Some of the electrons will not leave the duct tube. The distribution of the ions will be more concentrated when leaving the duct. The oscillating electrons will increase the chance of scattering and collision with the ions. Hence, the charge state of the ions will increase. In this work, experiments are conducted the electron oscillation phenomenon inside the vacuum arc plasma duct source. Electrons are generated by hot filaments and diffuse into the duct. It is shown that without the influence of positive ions, the electrons are trapped as a result of the combined effects of the electric and magnetic field. Plastic transparencies are placed at the end of the vacuum duct to collect the metal ions. A clear focusing effect of the ions is observed when a positive biased voltage is applied to the duct wall. It indicates that the electrons are concentrated at the center axis of the duct. Time-of-fight experiments are used to verify the three charge states of the Ti plasma, and we do not observe any increased of the mean charge state of the ions. The collision/scattering between the ions and oscillated electrons is hidden by the normal transport behavior of metal plasma with different ion charge states.