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1P04

Simulation of Temperature Distribution on a Spherical Target during Plasma Immersion Ion Implantation

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Ion implantation has been shown to be an effective surface modification technique without the sacrificing the bulk properties. The modification results are, however, influenced not only by the implantation voltage, incident dose, but also the treatment temperature, particularly in elevated temperature ion implantation into metals with lower temper temperature. During the treatment, both the sample temperature and its history contribute to the final surface properties. In this paper, we investigate the temperature distribution on a spherical target during plasma immersion ion implantation (PIII) using numerical simulation. The majority of the heat input into the target is shown to originate from the energetic ions accelerated by plasma sheath. Our simulation results also demonstrate that the implantation voltage, pulsing frequency, pulse duration and plasma density exert different influence on the temperature rising rate in addition to the equilibrium temperature. The influence of the target size is also simulated, since it critically affects the heating and cooling characteristics of the process. Our model is important to the understanding of the local temperature variation and heating rate of both planar and non-planar samples during plasma immersion ion implantation.

1P05

MODELING OF TRANSIENT EFFECTS IN RESONANT DISCHARGES

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In a resonantly sustained discharge, a plasma is maintained with an RF field driven at the series resonance - the frequency at which the capacitive sheaths of the plasma resonate with the inductive looking bulk. Such a discharge has many unique properties including resistive V-I characteristics (V-I phase difference near zero), scaling laws (density is proportional to the cube of the drive frequency) and heating mechanisms (strongly kinetic). In PIC-MCC simulation studies of resonant discharges [1] (which recreate an experiment conducted in [2] with good agreement), phenomena such as mode jumping and hysteresis between capacitive, resistive and inductive V-I characteristics were observed as RF drive parameters were slowly varied. Furthermore, an abrupt transition between the initial decaying capacitive looking plasma into a sustained resistive looking plasma was observed. During this transition, dramatic changes occur including the V-I phase angle going from capacitive to resistive, the plasma potential a electron temperature more than doubling. After this transition, the unique electron heating profile develops with high velocity electron bunches being formed in the sheath regions of the device. Scaling laws for the transition are not exponential; rather, they go as $1/(t-t_0)^{1/3}$ where t_0 is the transition time. A slow time scale ringing is also seen in the average power delivered to the device after the transition.

A simplified model of the discharge is being developed to explain these transient effects. The model is an extension of homogeneous model used for calculation of discharge steady state parameters given in[3]. Initial results look promising - giving qualitative agreement with the some effects discussed above. The model results will be compared with simulations and experiments.

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[2] V.A. Godyak. Paper 3C9. ICOPS 1994.
[3] A.J. Lichtenberg and M.A. Lieberman. Principles of Plasma Discharges and Materials Processing. 1994.