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Laser Induced florescence study of a plasma immersion ion implantation system

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Plasma Immersion Ion Implantation (PIII) consists in immersing in a plasma a negatively biased target (or electrode) with high voltage (HV) pulse in order to drive ions into the target and change the target surface structure and/or composition. This process has broad applications in the field of materials processing as well as semiconductor manufacturing. Improving PIII operational efficiency depends on a precise control of the ion fluence which itself relies on a rigorous empirical knowledge of the plasma behaviour during the HV pulses and in close proximity (˜1 mm) to the electrode surface. The aim of this research is to study the behaviour of plasma parameters (electron density, electron and ion temperature, plasma potential and ion velocity) in a low-temperature inductively coupled plasma (ICP) chamber used for PIII. In order to obtain spatially resolved information with minimal plasma disturbance, Laser-Induced Fluorescence (LIF) was chosen to study the ion velocity distribution function. LIF measurements of the ion velocity distribution function during PIII have never been done, and will provide crucial insight into poorly known plasma dynamics. By monitoring the ion velocity in the region around the pulsed electrode, technologies such as semiconductor processing may become more efficient, less wasteful, and even more precise.

Ion temperature measurements were made in the bulk plasma during steady state operation for a range of power and pressure values (350-500W and 0.8-2 mTorr). It was found that ion temperature increases with increasing pressure. This is counter-intuitive considering increased pressure means more neutral gas particles, which would imply more collisions between ions and neutrals, thereby reducing ion temperature. LIF was also used to perform spatially resolved measurements of the ion velocity distribution function in the vicinity of the pulsed HV electrode in order to measure the average ion velocity near the electrode, deduce the sheath structure and measure the Bohm velocity, Cs. It was found that the ion velocity reaches Cs at 2 mm from the electrode surface. This falls within the theoretical estimate of the sheath length according to the electron density and temperature measured by means of Langmuir probes. This result is significant since the ion velocity and sheath length are essential parameters in an ICP used for PIII. Future experiments will focus on time-resolved measurements of the plasma under PIII relevant conditions.

Keyword-1

Sheath

Keyword-2

Laser Induced fluorescence

Keyword-3

plasma

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