The Behavior of ion current in the high-power pulsed sputtering Penning discharge plasma device.

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Abstract

A high-power pulsed sputtering (HPPS) penning discharge can generate metal plasmas of high ionization rate. This is featured that the plasma is generated at a narrow gap consisting of a pair of cathodes as sputtering target in parallel each other. The magnetic field is provided by setting a set of permanent magnets behind the targets and the electric field is parallel to the magnetic field. The plasma density is as high as 1018 m-3 due to high power consumption on the order of 0.5 kW/cm2 passed through copper target electrodes at the argon gas pressure of 2 Pa and applied voltage of -800 V. However, the HPPS source is disadvantage in a narrow pressure range on the plasma production, and in particular, the lower limit of the pressure is 2 Pa or higher. This problem has been solved by setting an electrically-grounded electrode at the central region of the plasma source. In this report, a resistor was inserted between this internal electrode and grounding, and the influence of its resistance on the discharge was considered experimentally. As result, it was found out that ion current is dependent on resistance. The ion current observed at the distance of 50 mm from the plasma source became the maximum when grounding resistance was about 80 Ω, at the argon gas pressure of 0.5 Pa. In this case, the peak value of ion current density is 10 mA/cm2 at applied voltage of -800 V, pulse duration of 50 μs and repetition rate of 500 Hz. This is approximately 1% of the plasma-driven current.

Keywords: Pulsed discharge plasma, Glow discharge, Penning discharge, High power pulsed sputtering, Plasma ion process

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