

Thermal probe measurements of energy flux onto a substrate in inductively coupled plasmas

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Abstract

Substrate heat influx density in an inductively coupled plasma assisted magnetron discharge has been measured by using a home-made thermal probe. The measured heat influx density was in good agreement with theoretically calculated value within 30% error. Both the experimental and theoretical heat influx densities showed the same tendency against the change in substrate bias.

Introduction

We have been studying deposition process of AZO films by using inductively coupled plasma (ICP) assisted magnetron sputtering. As a result, we succeeded in obtaining good quality AZO thin films when we increased ICP Power so far. To reveal substrate heating effect during the ICP assisted magnetron sputtering, we have investigated the energy flux from the plasma to the substrate by using a thermal probe. In this paper, experimental and theoretically calculated values are compared.

Experimental and Results

The energy influx to the substrate was measured by a home-made thermal probe. The main body of thermal probe is composed of a thin copper plate, ceramics rod, and aluminum rod. Two thermocouple sensors are attached to the ceramics rod body and aluminum rod body respectively with a small gap to measure the axial temperature difference. The main body and the thermocouple sensors are all covered with heat insulation tubes to avoid radial heat influx. The energy influx is given by the relation $J = -k \Delta T / \Delta x$, where Δx denotes a gap distance of two thermocouple sensors in m, ΔT temperature difference in K, and k heat conductivity of ceramics (=1.6 Wm⁻¹K⁻¹). As a result, it was found the measured heat flux densities by the probe were consistent with the expected values from a theoretical calculation.

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References

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