

Heat flux evaluation of the atmospheric pressure microwave line plasma from spatio-temporal temperature measurement of the slot-plate



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1. Introduction

Atmospheric pressure (AP) plasma is attracting increasing attention because it is free from vacuum chambers and has many possible industrial applications. Among numerous AP plasma sources developed so far, AP microwave plasma generated in slots on waveguides has the appeal of low gas temperature and high plasma density [1]. Previously, our group has successfully produced a meter-scale AP microwave plasma source utilizing travelling wave and has reported the existence of energy flow within the waveguide slot along the z-direction [2]. In this study, we further investigate energy flow of the slot-type AP microwave plasma, by analyzing the temperature rise-up of the slot-plate due to the heat flux from the plasma. In addition, the result is discussed by a simple analytical model.

2. Experiment Setup

A gas-sealed waveguide (1.2m) with a slot (30cm length, 0.1mm width) is utilized for this experiment. Ar/N₂ gas (8slm/160sccm) introduced into the waveguide effuses from the slot and the plasma is produced in the slot by the microwave power (2.45GHz, pulse frequency 50kHz, and duty cycle 50%). For the measurement of the slot-plate temperature, black-body tape (emissivity: 0.95) is placed on the slot plate at the same spatial interval and is monitored by a thermography camera. A thermocouple is also placed at one position on the slot-plate for calibration of values obtained from the thermography measurement.

3. Results and Discussions

At a peak input power of 800W, spatial profile of the slot plate temperature as a function of a distance from the slot was measured at different timing (t) after turning on the plasma, as shown in Fig.1. By modeling the phenomenon using one-dimensional heat equation with appropriate boundary and initial conditions and by fitting the simulated result with the experiment, heat flux from the plasma to the slot-plate can be found analytically.

[1] H. Suzuki, S. Nakano, H. Itoh, M. Sekine, M. Hori, H. Toyoda: Appl. Phys. Express **8**, 036001 (2015).

[2] M.H. Chu, H. Suzuki, H. Toyoda: JSAP Autumn Meeting 2019, 20p-B11-2.

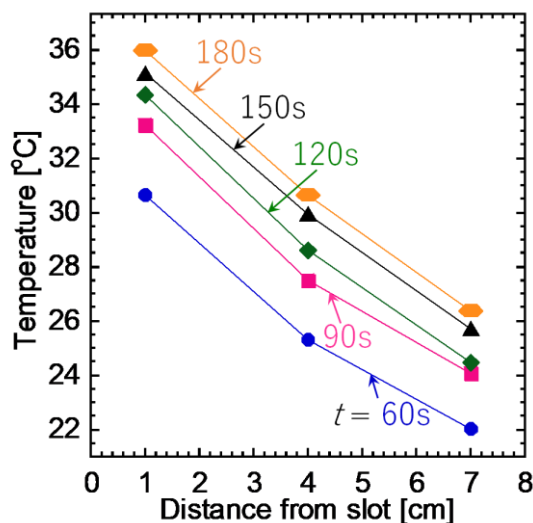


Fig 1. Slot-plate temperature spatial profile with respect to distance from the waveguide slot and time elapsed after turning on plasma