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プラズマを伴う中性期待噴流の乱流化の解明に向けた研究
Study on turbulence phenomena of the neutral gas flow induced by the plasma production

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1. Introduction

Recently, plasma production experiments have been carried out under atmospheric-pressure with the aim of applying the results to improved combustion[1)], medical equipments[2,3)], material surface processing, and so forth. In many cases, the atmospheric-pressure plasma is produced using rare gases or nitrogen[4)], which flow through the equipment[5)]. The typical gas flow speed is in the range of 1 – 10 m/s, which is much slower than that of a plasma jet. Interaction phenomena between charged particles and neutral particles are very important, since the particle number of ambient gases is much larger than that of charged particles. In this study, we visualized the behavior of neutral gases along a plasma jet using a Schlieren optical system with a high-speed camera under several conditions.

2. Experimental Setups

A Schlieren optical system and a high-speed video camera are used for visualization study of neutral gas flow. The former is composed of continuum light source (Xe lump) and convex lens, pinhole and concave lens, knife edge. The later is using Shimadzu HTV-1, interframe time is set up between 4 μs-16 ms, and expose time is set up 1/8 times of interframe time. The image resolution was 312 (horizontal) × 260 (vertical) pixels.

In our experiments, a plasma equipment based on the dielectric barrier discharge is used[6)]. A cylindrical quartz tube used as a dielectric, and the gas flows through the tube. A powered electrode is installed in part of the dielectric, and is completely covered by the dielectric and a grounded electrode. This type of plasma source produces glow like plasma with good directivity that in principle, does not undergo a transition to an arc discharge.

To study dependencies of neutral gas flow characteristics on the electrostatic effect, copper electrode is arranged as schematically illustrated in Fig. 1. A stainless bolt is covered by the kapton polyimide film, and a plate is fixed by the insulated nuts. Nozzle of the plasma equipment is set parallel to the copper plate.

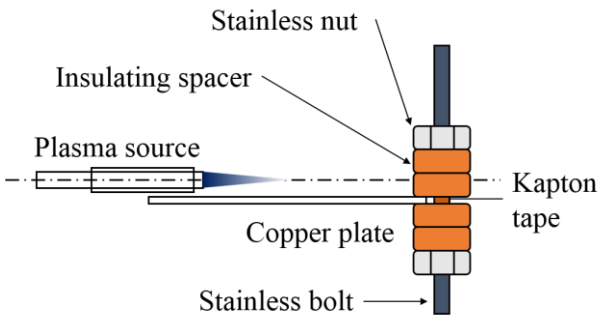

Fig. 1. Schematic drawing of an arrangement to study the electrostatic effect on the neutral gas flow. In this experiment, the copper plate is grounded.

3. Experimental Results

The helium gas flow parallel to the copper plate without the plasma discharge was found laminar flow and straight behavior. The helium gas flow parallel to the copper plate with the plasma discharge was found that not only the plasma jet, but also neutral helium gas flow bent toward a copper plate. Here, the plate is grounded, gas flow rate is 1 *l*/min, and distance between the copper plate and the nozzle axis line is 6 mm.

At present, to understand interaction phenomena between neutral gas flow and charged particles, dependencies of neutral gas flow on the electrostatic force are studied.

4. Conclusions

We visualized the behavior of neutral gases along a plasma jet using a Schlieren optical system with a high-speed camera. In the result, not only the plasma jet, but also neutral helium gas flow bent toward a grounded copper plate.

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