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学位（博士）論文要旨

(Doctoral thesis abstract)

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論 文 題 目 (Title)	誘電体バリア放電プラズマアクチュエータの発熱・伝熱現象の解明 Clarification of Heat Generation and Heat Transfer Phenomena in Dielectric Barrier Discharge Plasma Actuators

論文要旨（2000 字程度）
(Abstract(400 words))
※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。
(in English or in Japanese)

Dielectric barrier discharge (DBD) plasma actuators are active flow control devices that have potential applications in heat transfer enhancement. Plasma actuators generate ion wind through electrical discharge and generate heat at the same time. Although heat generation is useful for deicing and preventing icing on aircraft, it is a problem from the perspective of convection cooling. Therefore, it is necessary to clarify and control the parameters related to heat generation. This study aims to understand heat generation and transfer phenomena in plasma actuators.

First, a similarity law was developed to characterize the surface temperature of a DBD plasma actuator in quiescent air. The similarity law for the time variation of surface temperature was formulated, assuming that the induced flow is heated by Joule heating, and the dielectric is heated by the airflow. The similarity law was derived from the one-dimensional heat conduction equation in the dielectric, expressing the spatially averaged normalized temperature as a function of the Biot and Fourier numbers. The induced flow temperature and heat transfer coefficient were estimated based on thrust and power consumption. The validity of the similarity law was investigated by substituting the surface temperature, thrust force, and power consumption obtained from the experiment. Results confirm the validity of the similarity law, irrespective of dielectric material, thickness, or applied voltage. This supports the hypothesis that the airflow is heated by Joule heating, and the dielectric is heated by forced convection.

Subsequently, the study investigated the surface temperature of the dielectric in external flow and characterizes it using the similarity law for external flow. A one-dimensional heat conduction equation within the dielectric was formulated, deriving similarity laws for the temporal variation of surface temperature. Boundary conditions for the heat flux were defined, considering Joule heating and ion flux heating as the governing mechanisms. Unknowns in the similarity laws are approximated by thrust and power consumption for experimental validation. Results confirm the appropriateness

of the similarity laws, with the one assuming Joule heating as the dominant mechanism being more suitable. This underscores Joule heating as a major factor in the heat generation of DBD plasma actuators.

Finally, the focus shifts to the heat transfer coefficient of the induced flow and the distribution of the temperature rise of the airflow, aiming to clarify the heat transfer enhancement characteristics of the plasma actuator. Density and velocity fields were measured using Background Oriented Schlieren (BOS) and Particle Image Velocimetry (PIV). Airflow temperature was obtained from the density and velocity fields under the assumption of constant pressure, and the obtained temperatures are discussed from a heat transfer perspective. As a result, focusing on the temperature distribution in the flow direction, it was suggested that the influence of ion flux heating could not be ignored.

（英訳）※和文要旨の場合(400 words)