Development and Performance Investigation of Dual-Grounded Tri-Electrode Plasma Actuator

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DBD plasma actuator (DBDPA), which produces a wall-surface jet by utilization of the dielectric barrier discharge (DBD), gets much attention as an advanced active flow control device in aerodynamic application field[1]. It consists of two electrodes; one is exposed to ambient gas and the other is insulated under the dielectric. Alternating voltage with several kHz and several kV applied to the exposed electrode generates DBD over the dielectric, and plasma generated by DBD induces the wall-surface jet. However, it has not been put into practical use yet because the strength of the induced jet is not sufficient, therefore performance improvement is indispensable. We proposed a new type of tri-electrode type DBDPA; the new tri-electrode DBDPA has an additional (third) insulated GND electrode over the exposed electrode; it is called Dual-Grounded Tri-Electrode Plasma Actuator (DGTEPA). An insulated wire can be used as the third electrode.

In this study, the performance of DGTEPA was experimentally investigated. Reaction force arising from the wall-surface jet induction and the electric power consumption were measured for evaluating the performance. Reaction force that works on DGTEPA was measured as thrust force using an electronic balance. The power consumption was measured by a resistor or a capacitor inserted into the circuit in series.

In this study, focusing on the configuration characteristics of DGTEPA, performance investigation was conducted varying the distance between the exposed electrode edge and the third GND electrode. As a result, the performance of DGTEPA exceeded that of the conventional DBDPA in both terms of thrust force and thrust-power ratio. The thrust-power ratio means conversion efficiency from electric consumption power to thrust force. The distance between the electrodes greatly influenced the performance of DGTEPA; When the third GND electrode (the insulated wire) was at the closest position to the exposed electrode edge, the thrust force and the thrust-power ratio becomes maximum; the thrust force and the thrust-power ratio were larger than those of conventional DBDPA by two and three times, respectively.

[1] Martiqua L. Post; Thomas C. Corke, *AIAA Journal*, Vol. 42, No. 11 (2004), pp. 2177-2184