FLOW VISUALIZATION OF A DIELECTRIC BARRIER DISCHARGE PLASMA ACTUATOR

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ABSTRACT

The optimum operating conditions of dielectric barrier discharge (DBD) plasma actuators were determined using both the quantitative and qualitative methods. The quantitative study was carried out by estimating DBD discharge power using the theoretical and experimental methods. The theoretical analysis was carried out to find a mathematical model, which describe the discharge power of the DBD actuator. The estimated results from the mathematical model were compared with the experimental values obtained from Lissajous figures. The qualitative analysis was used for the plasma flow visualization. The effects of the DBD design parameters were studied through the images captured using a high speed charge-coupled device camera. Simulation work was done in order to obtain an insight of the electric field responsible for the plasma formation using the commercial computer software. The results revealed that the performance of the DBD plasma actuator was influenced by various design parameters, especially by dielectric thickness and controlled by the input voltage characteristics.

Keywords: plasma characteristics; plasma actuator; dielectric barrier; flow visualizations; mathematical model.

1. INTRODUCTION

Dielectric barrier discharge (DBD) is a phenomenon of electrical discharge between two electrodes separated by an insulating dielectric barrier plate [1]. It can be formed by the voltage differences between the electrodes through a succession of micro-discharges that are randomly distributed in time and space [2]. When a high voltage of 5 ~ 20 kV is applied to the electrode, a plasma discharge will appear on the insulator surface along one of the electrode lengths. Plasma is actually a region of ionized gas, which is the fourth state of matter [3]. The number of protons and electrons in plasma is equal. Therefore, it is electrically neutral and the particles are in a free-flowing state and the electric and magnetic fields have unique effects on plasmas. These fields influence plasmas to form consistent features, such as the ionic characteristics in gases [4, 5]. The ion drift velocity is a function of electric field, applied voltage, radio frequency, power density and electrode geometry. On the other hand, the phase velocity is a function of radio frequency, electrode spacing and number

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