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The Electrode Configuration and Dielectric Temperature effects on the Performance of Plasma Actuator

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1 Abstract

The single dielectric barrier discharge plasma actuators have shown their positive effectiveness amongst the other active flow control methods with the advantageous of no moving parts. They have been studied extensively for past ten years although preliminary research was started in the 1950s. They have shown their ability to delay separation on airfoils and turbine blades, control of separation on the stationary and oscillating airfoils, wake of cylinder modification leading to reduced noise levels and many other applications. Unfortunately, to date, they have been used at micro air vehicle Reynolds numbers (e.g. on small unmanned aircrafts) and for hypersonic flow applications and their benefits have not been fully utilized on a large scale since the applicability of plasma actuators is limited by the maximum induced velocity it can achieve. It is essential for plasma actuators to produce higher induced jet velocities and as a result impart more momentum to be applicable in higher Reynolds number flows. In this research further experimental studies have been conducted for a new configuration of the Multiple Encapsulated Electrodes (MEE) actuator. The MEE actuator consists of an encapsulated electrode split into smaller electrodes and distributed through the dielectric. This type of actuator has been shown previously to produce performance superior to the standard actuator design. This makes them more desirable as flow control devices. Using particle image velocimetry to visualize and quantify the flow field, the new configuration has been applied individually and in pairs, and compared to another MEE configuration and the standard design. The results show that further manipulation of the encapsulated electrode can improve performance when compared to other MEE designs. The actuators have also been operated under three different surface temperature conditions. Operating the actuator at higher temperatures provided improved performance by increasing the induced velocity while consuming only slightly higher power.