# Experimental Investigation of the Asymmetric Surface Dielectric Barrier Discharge Driven by AC/DC Voltage

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The effects of AC and DC voltages on asymmetric surface dielectric barrier discharge were examined regarding to the offset voltage, surface charge deposition and induced electric wind velocity. The surface potential, the electric wind velocity and the produced thrust were measured. Our results showed that by increasing the DC voltage of the lower electrode, the surface potential increases and the electric wind velocity decreases. On other hand, by applying the AC voltage to the upper electrode and the DC offset to the lower one, higher wind velocity induces. The direction of the electric wind is independent of the applied voltages, but its magnitude and the surface potential depend on the amplitude and polarities of the applied voltage.

## 1. Introduction

The surface dielectric barrier discharge which is a common used method to generate atmospheric non-thermal plasma, was proposed for the first time by Roth *et al*. to apply in flow control applications [1]. It is composed of two asymmetric planar electrodes that one of them is exposed to the air and the other one is encapsulated by a dielectric layer [2]. The generated plasma in this structure can cause momentum transfer to the ambient gas. The resulting electric wind can modify the boundary layer properties. In this work, we investigate the effect of the AC and the DC offset voltages applied simultaneously to the lower and upper electrodes on the surface potential and the induced electric wind velocity.

## 2. Experimental setup and measurements

At first, a sinusoidal AC high voltage with 20 $kV_{PP}$ at 5.5 kHz was applied to the upper electrode, while a DC offset simultaneously was applied to the lower electrode. Then the applied voltages were exchanged. The surface potential and the electric wind velocity measurements were carried out by using an electrostatic voltmeter probe and the pitot tube technique. A schematic picture of the experimental setup was shown in figure 1.

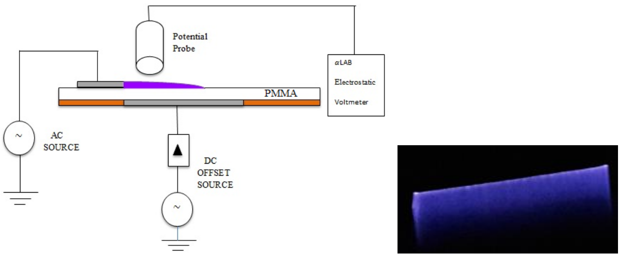


Figure 1: schematic picture of the electrical arrangement and the generated plasma.

## 3. Results

As shown in figures 2 and 3, by increasing DC offset voltages the magnitudes of the surface potential increases and the electric wind velocities decrease in downstream of the electrode. As can be seen in figure 2, the electric wind velocity and subsequently its extension for the negative DC offset were greater than the positive case. The sign of the potential was negative for the positive DC offset and always positive for the ground and the negative one. By changing the electrode voltages the electric wind velocity induced by the negative DC offset was very low with maximum value of about 2 m/s. This result was illustrated in figure 3. Moreover, the maximum thrust was obtained for the ground case, which was approximately 18 mN/m.

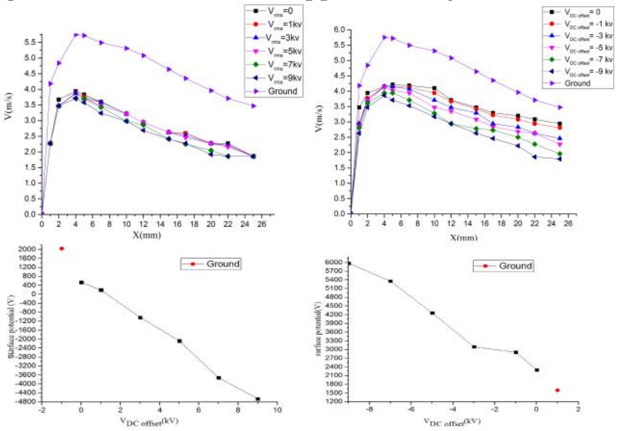


Figure 2: velocity and surface potential of the AC voltage applied to the upper electrode and positive(left)/negative (right) DC offset voltages to the lower one.

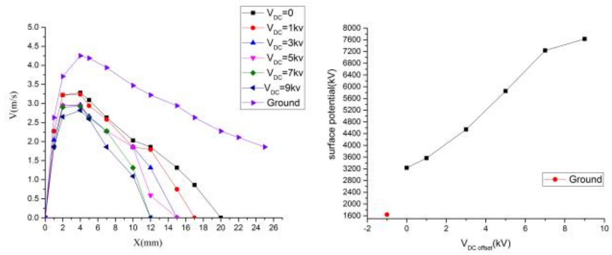


Figure 3: positive DC offset voltage applied to the upper electrode and AC voltage to the lower one.

## 4. References

[1] J. R. Roth, Phys. Plasmas **10** (2003) 2117.

[2] E. Moreau, J. Phys. D: Appl. Phys. **40(3)** (2007) 605–636.