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Active Separation Flow Control Experiments in Weakly Ionized Air

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High voltage electrostatic gas discharges from a spanwise corona wire placed 2.5 cm in front of the conducting leading edge of a dielectric wing with 50 cm span width are applied to control the separation in low Reynolds number air flows. The chord Reynolds number range is from 6,500 to 130,000 which equals a velocity range from 0.5 to 11 m/s typical for micro-aerial vehicles (MAVs). The average electrical power expenditure is 8 Watt per 50 cm corona wire positively charged with 16 17 kV and a maximum current of 0.5 mA.

The air flow is visualized with continous smoke generated from a hot wire. Laser light sheet techniques were used to illuminate the fine paraffin oil smoke in a cross-sectional view of the flow field.

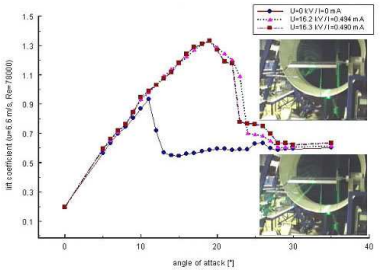

Figure 1: Lift diagram for air velocity u=6.6 m/s.

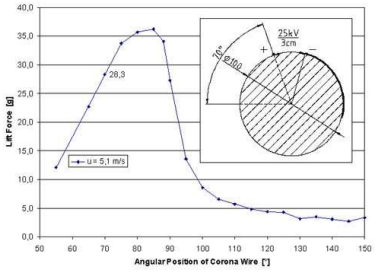

Figure 2: Electroaerodynamic lift by cylinder.

Fig.1 shows a lift diagram at incoming velocity of 6.6 m/s. Without electric field actuation, the flow separates at an angle of attack of 11 degrees. After switch-on of the electrostatic field, the separation is delayed to 19 degrees. The resulting lift enhancement is 127 percents. The drag coefficient decreases by 18 percents. At zero angle of attack electrostatic forcing causes drag reduction by 10 percents.

Fig.2 shows first results on electrostatic cylinder wake flow control at a velocity of 5.1 m/s. Lifting mass forces up to 36 grams could be measured. This can be dramatically increased by using phase plasma actuators.