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Optimization of Dielectric Barrier Discharge Plasma Actuators at Atmospheric and Subatmospheric Pressures ALEXANDER LIKHANSKII, MIKHAIL SHNEIDER, SERGEY MACHERET, RICHARD MILES, Princeton University — Asymmetric dielectric barrier discharge (DBD) plasma actuators are known to be effective in aerodynamic control. We describe a comprehensive kinetic model for asymmetric DBD actuators in air. Application of the model shows that charging of the dielectric surface plays a crucial role, acting as a harpoon. The tangential force on the gas is shown to be directed downstream in both cathode and anode half-cycles. Inefficiency of gas acceleration is due to the motion of positive ions toward the exposed electrode in the cathode half-cycle. A near-optimal voltage waveform is proposed, consisting in high repetition rate short pulses of negative voltage in combination with positive dc bias applied to the exposed electrode. Computations show that repetitive-pulse waveform can induce gas velocities similar to those in conventional sine-voltage DBD actuators at considerably lower voltages and smaller plasma sizes. Increasing the peak pulsed voltage should increase the wall jet velocity by an order of magnitude. However, at some threshold voltage the reverse (backward-directed) breakdown occurs. A modified voltage waveform is proposed and studied that would prevent the reverse breakdown. Results of modeling for low-pressure operation are also presented.

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