generation of TURBULEnce BY the surface DIELECTRIC BARRIER DISCHARGE

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One of the promising applications of a dielectric barrier discharge is flow control in various problems of aerodynamics. In particular, plasma actuators are investigated as sources of controlled perturbations in problems the laminar-turbulent transition delay [1–3]. One of the key requirements for actuators in these tasks is the low level of broadband pulsations generated by the discharge. Broadband excitation can excite eigen nonstationary modes of the boundary layer, which can lead to stimulation of the transition to turbulence. In this paper, we study the main mechanisms that can lead to the emergence of turbulence in plasma actuators based on a dielectric barrier discharge.

Using a hot-wire anemometer, the spectra of pulsations produced by an actuator in a subsonic (20–40 m/s) laminar boundary layer were measured. The discharge was powered by a sinusoidal voltage with a frequency of 110 kHz and an amplitude of up to 5 kV. It is shown that the discharge creates pulsations in the boundary layer in a wide frequency band, at least from 200 Hz and higher, whose amplitude increases with increasing supply voltage. Under the conditions of this experiment, these pulsations are damped in the boundary layer.

In order to find out whether the dynamics of microdischarges are a source of a low-frequency broadband signal, a cross spectrum was calculated between the PMT signal installed above the electrode and the hotwire signal. It has been shown that broadband pulsations in the boundary layer behind the discharge correlate with discharge optical emission, while disturbances propagate in the boundary layer with a characteristic speed of 0.6U∞, and the width of the correlation peak increases as it moves downstream. In addition, this technique allowed us to estimate the initial amplitude of disturbances, which in this case was about 0.6 m/s.

In addition, a study of the flow structure induced by the actuator at a low oncoming flow velocity was performed. It was shown that in the vicinity of the electrode a rather complicated flow with the formation of a separation zone is observed. In the following, it is supposed to estimate the effect of the shear layer at the boundary of this region on the generation of disturbances.

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