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HYBRID DISCHARGE IN HIGH SPEED GAS FLOWS *)

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Discharges in gas flows have been studied over the last decades within the framework of plasma aerodynamics [1]. The need to determine the mechanisms of the discharge plasma impact on high-speed flows and to develop methods for controlling this impact determines the relevance of the current research. In this work, a hybrid discharge (HD) in high-speed air and propane-air flows is studied experimentally. To create the discharge, a constant current source (voltage up to 4.5 kV and current strength up to 15 A) and a magnetron source with a frequency of 2.45 GHz, designed for operation at powers up to 5 kW in continuous mode, are used simultaneously. Experiments with stationary HD are known [2]. In contrast to them, we studied the features of a nonstationary discharge in high-velocity flows.

The structure of HD was registered using high-speed video recording. The features of HD that distinguish it from DC and microwave discharges are shown. These features can be useful for problems of plasma-assisted combustion. The dependences of the field in the plasma channel and the quasifrequency of the discharge on the flow velocity and current strength have been experimentally obtained. By the method of optical emission spectroscopy in the visible and near-UV region, the electron concentration ~10^{15} cm^{-3} and the characteristic gas temperature ~6000-9000K have been estimated. The effects related to the skin-layer thickness and the direction of the microwave field polarization relative to the flow velocity are demonstrated. The possibility of using an external microwave field to control the discharge plasma parameters in a high-speed air flow is shown. HD allows to ignite and maintain combustion of subsonic propane-air flow with velocities of 50-250m/s. Optical spectra of discharge in the ignited propane-air flow were obtained and analyzed.

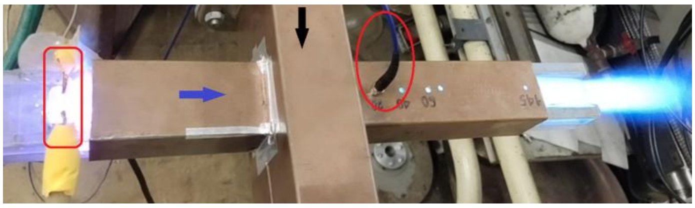

Fig. 1. Photo of propane-air flow ignited by HD. The black arrow is the direction of the incident microwave wave, the blue arrow to the right is the flow direction. The red rectangle highlights the insert with electrodes. The red ellipse indicates the diagnostic silica fiber. Experimental conditions: i=1.2A, p_0=2atm,p_{prop}=4atm, microwave power 5kW.

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