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INVESTIGATION OF THE STRUCTURE OF SUPERSONIC FLOW OF AIR WITH OPTICAL PULSED DISCHARGE

A.N. MALOV, A.M. ORISHICH,

Khristianovich's Institute of Theoretical and Applied Mechanics SB RAS

cCorresponding author: Tel.: Tel.: +7 383 3307 342; Fax: +7 383 3307 342; Email: malex@itam.nsc.ru

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Visualization method(s): shadow photography
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ABSTRACT: Establishment of the ITAM SB RAS repetitively pulsed CO2 - laser with a mechanical Q-switching has opened the prospect of formation of an optical discharge in a supersonic flow of air for the experiments in supersonic wind tunnels actual Mach number M> 1 [1]. The development work required to perform additional research into the processes of absorption of laser energy in supersonic flows of air. Modeling of processes of optical breakdown and absorption of laser radiation was performed in a free supersonic jet with a diameter of 10 mm in the mode of Mach 1.7 ... 3.7. The appearance of the work area by an optical breakdown is shown in the photograph in Fig. 1. Shadow picture of flow at a pressure of 1.5 MPa in the settling chamber in the presence and absence of breakdown is shown in Figure 2. Investigated the value of the absorption coefficient of laser radiation in a plasma of optical breakdown of the supersonic air flow and obtained a value of this parameter up to 60%. For the first time shown that the threshold density of air, corresponding to a sharp rise of the absorption efficiency is equal to 1.8 ... 2 kg/m3 and is independent of Mach number. There have been measurements of the thermal jet trail after the plasmoid. Thus in Figure 3a, b shows the measured dynamic pressure *(P)* in the jet at different distances from the plasma formation. A characteristic feature of the graph given in Figure 3 and is available in mid-stream 4 mm dip by more than one third of the total dynamic head for the flow in the vicinity (4 mm) from the zone of the optical discharge. At greater distances (40 mm from the plasma) found that the failure is smoothed, and the total dynamic head in the middle of the jet decreases. As a result of temperature measurements in the thermal track along the center line of the jet with the inclusion of an optical discharge was obtained gradually decreases dependence on distance, with values of temperature $\Delta T \approx 95^0$ C with the close of the plasmoid (4 mm) and ~ 30 ° C away from the plasmoid (40 mm). Evaluation of temperature increase in the thermal energy release following the trail into a supersonic flow, carried out with the real nature of the flow of the jet, the flow rate of air flowing through the zone of energy release, thermal properties of air in good agreement with the value of the absorbed energy.

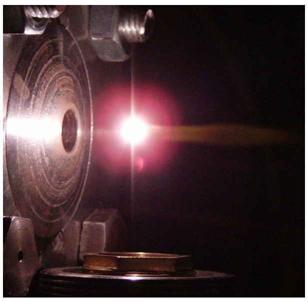
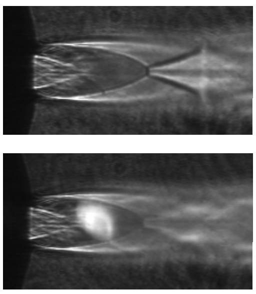


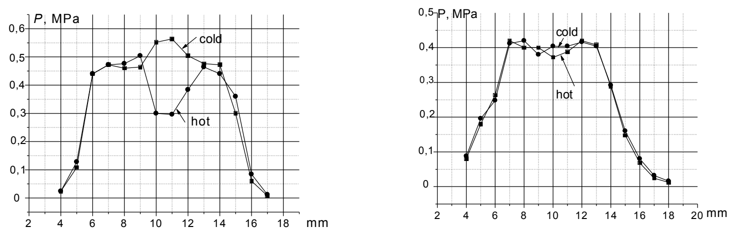
Fig. 1 Appearance of the working area by an optical discharge in a supersonic air stream



a

b

Fig.2 The shadow flow pattern: a plasmoid-free, b-in the presence of a plasmoid



a

b

Fig. 3. The dependence of the dynamic pressure (P) from the location across the jet at a - a distance of 4 mm from the plasma formation, b - 40 mm from the plasma formation

References

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