VISUALIZATION OF THE FLOW STRUCTURE BEHIND THE SHOCK FRONT USING TALBOT INTERFEROMETRY TECHNIQUE

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ABSTRACT: The development of optical diagnostics of turbulent flows is a separate independent branch of fluid dynamics and provides for a deeper understanding of the physics of turbulent phenomena. In this paper, the effect of self-reproduction, or Talbot effect is the basis of the proposed method of diagnostics [1]. In this case the local angles of deflection are determined at any point of the phase object with high spatial resolution, which is determined by the period of the Talbot grating. The advantages of this method are simplicity of implementation, the possibility of studying the entire flow field and the automatic processing of Talbot images. In the works [2, 3] the Talbot effect was used to determine the distribution of helium average concentrations in the case of axisymmetric and two-dimensional jets outflows freely into the ambient air. The purpose of this study was investigation of the flow structure behind the incident shock front using the method described above.

Fig. 1 shows the experimental setup and the optical scheme, developed for these studies. The square shock tube with a cross section 50×50 mm was used to generate shock waves in the air with intensities corresponding to the Mach numbers M = 1.3–1.6. Grids with square cells (12×12 and 3.5×3.5 mm) were used to initiate turbulence in the flow behind the shock wave.

The calculated distributions of time-averaged density of the air throughout the whole flow field under investigation for the 12×12 and 3.5×3.5 mm grids are presented in Fig. 2. It is found that the thickness of the boundary layer in the observation area is about 7–9 mm, and the density of the air in the boundary layer behind the shock front raises sharply. This leads to an increase of 6–7% of the average density of the flow at ≈3 mm from the shock tube wall.

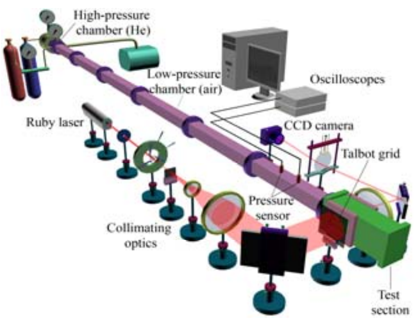

Figure 1. Experimental setup and optical scheme

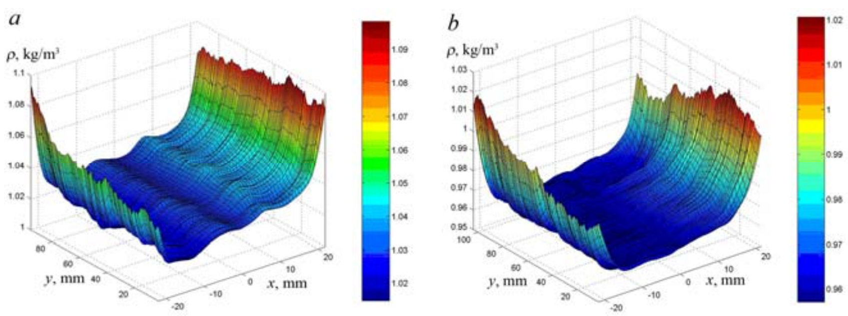

Figure 2. The distribution of the averaged air density in the flow behind the incident shock wave. Cell size: *a*) 12×12 mm; *b*) 3.5×3.5 mm

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