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# SHOCK TUBE WITH KRF LASER DRIVER: EXPERIMENTAL IMPLEMENTATION AND FIRST RESULTS *)

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The report is devoted to the implementation of a laser-driven shock tube (LDST) for generating strong shock waves (SW) and high-speed gas flows. The principle of operation of the LDST (see Fig.1) is based on the acceleration of a thin CH-film by ablative plasma pressure, which is created when irradiated by high-energy UV pulses of the GARPUN KrF laser (100 J & 100-ns) [1,2]. The film serves as a piston that pushes the SW in the gas filling the LDST, which has a cross section of 5× 5 mm and a length of 50 mm. An optical system based on a multi-element prism raster and a lens provides focusing of KrF laser radiation into a 7×7 mm square spot with an energy density of up to 100 J/cm$^2$ (intensity up to 1 GW/cm$^2$) and a film irradiation inhomogeneity of less than a few percent. The walls of the LDST made of quartz glass prevent lateral unloading and provide a plane geometry of SW propagation. At the same time, they serve as windows for probe radiation of the 2nd harmonic Nd: YAG laser, whose 10-ns pulses are used for frame-by-frame shadow and Schlieren photographing hydrodynamic processes in the LDST.

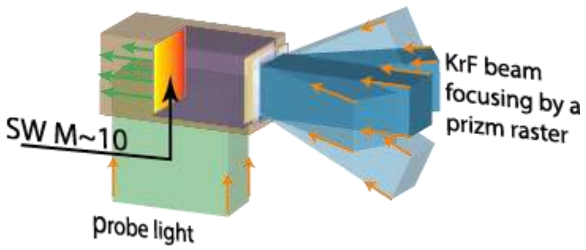


Fig. 1

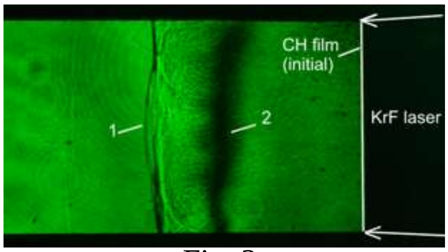


Fig. 2

For CH-films with thicknesses from 0.9 to 20 μm, SW velocities in atmospheric air (see 1 in Fig. 2) were measured, the maximal value of 4.6 km/s was several times higher than the speeds in shock tubes with explosive initiation. Turbulence of a supersonic gas flow with a characteristic scale of inhomogeneities of ~ 100 μm was observed behind the SW front. At the same time, rapid expansion and defragmentation of the film (2) occurred due to the explosive nature of its evaporation and the hydrodynamic instabilities of Rayleigh-Taylor and Richtmayer-Meshkov which developed along with repeated SW passage through the film thickness at the acceleration stage. The influence of the roughness of the LDST walls on the hydrodynamics of the supersonic gas flow was also investigated: roughness within 6 μm did not significantly affect the SW; inhomogeneities with a height of ~ 200 μm produced turbulences nearby the walls due to the Kelvin-Helmholtz instability, which region expanded to the LDST axis.

Present experiments have shown that the LDST with KrF laser driver is an effective tool for studying a number of hydrodynamic phenomena, such as hydrodynamic instabilities and transition to turbulence, the flow around bodies with hypersonic velocities with Mach numbers $M > 10$, reflection and cumulation of strong SWs.

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## References

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*) abstracts of this report in Russian