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HYDRODYNAMIC INSTABILITIES DURING ACCELERATION OF THIN CH-FILMS IN A LASER SHOCK TUBE WITH A KRF DRIVER *)

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A laser-driven shock tube (LDST) is a miniature device of 5×5×50 mm size in which strong shock waves (SW) and hypersonic flows of matter with Mach numbers $M \geq 10$ are generated by thin CH-films accelerated by the ablation pressure of laser plasma. Under UV irradiation of films with d = 1÷10 μm thicknesses by GARPUN KrF laser (100 J & 100 ns) at energy density of $\varepsilon \leq 80$ J/cm^2 (intensity ≤ 0.8 GW/cm^2) planner SWs in atmospheric air propagated along the LDST with an approximately constant velocity during an observation time of 2.5 μs, the velocity decreasing with the film thickness [1].

In the present research, we investigated a later stage of the hydrodynamic process at times up to 10 μs, when Rayleigh-Taylor and Richtmyer-Meshkov instabilities were developed during film acceleration and subsequent deceleration in the gas. Film fragmentation occurred, which led to a distortion of the flat SW front. In Fig. 1, the origin of coordinates corresponds to the initial film position, while laser radiation falls from the left. Films with d = 3 and 5 μm were disintegrated into particles with sizes of hundreds of μm, the cloud of which (2) supported the flat SW (1). Strong turbulent mixing of the film substance with air was observed behind the front while a multitude of conical SWs (3) arose in front of the flat SW, destroying its flat waveform (Fig. 1a).

(a)
d = 5 μm
ε = 38.4 J/cm^2
t = 6.25 μs

(b)
d = 10 μm
ε = 41.6 J/cm^2
t = 8.25 μs

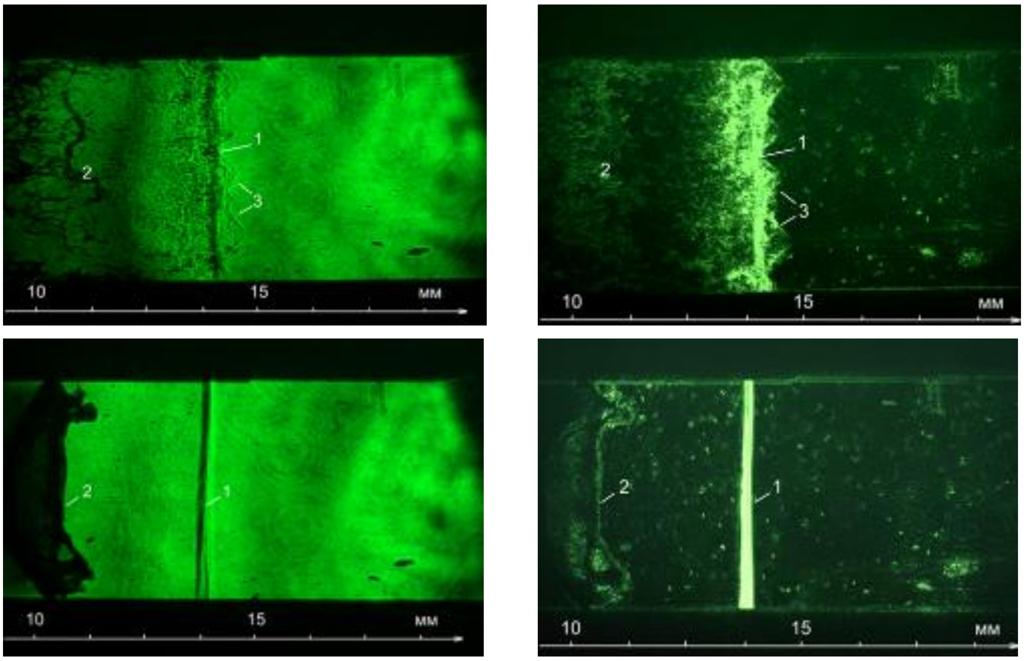

Fig.1. Shadow (left) and schlieren images (right) of hydrodynamic processes in LDST

The flat SW front was maintained throughout the registration time for films with $d \approx 1$ and 10 μm. Thin films were dispersed to micron-sized particles, while the thickest ones, on the contrary, remained almost unfragmented, although they strongly widened in thickness (Fig. 1 b). In this case, the flow of matter behind the flat SW front remained laminar.

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References

[1]. Zvorykin V.D., Veliev P.V., Kozin I.A., et al., Fundamental Plasma Phys., 2024, **10**, 10046.

*) abstracts of this report in Russian