ACTION OF A RECTANGULAR PULSE OF A NEODIMIUM LASER ON POROUS METAL TARGETS

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By the method of laser probing the erosion products of porous metal targets of Al and W under the action of a rectangular radiation pulse of a neodymium laser are investigated. The diameters of metal particles in the erosion flame measured using an electron microscope and using laser probing are fairly close, which indicates the reliability of control of particle sizes in real time by the laser probing method. The possibility of decreasing the particle sizes by reevaporating them is shown.

The process of reevaporation of particles in a laser radiation field may serve as one of the methods of decreasing the particle sizes of finely dispersed powders. On the other hand, in experimental investigations problems in producing two-phase flows consisting of plasma and liquid-drop or solid particles as model media often arise. These processes can be realized under the action of laser radiation on targets produced by the method of powder compaction.

In the present work investigations on the action of pulse neodymium laser radiation on porous metal targets produced by compacting aluminum and tungsten powders are carried out. The neodymium laser enabled us to produce radiation pulses of approximately rectangular shape (Fig. 1) with a duration of 400-500 μsec and an energy up to 400 J. The production of these pulses is described in detail in [1]. Tablets of aluminum powder, tungsten powder, and a powder mixture of 30% W and 70% Al by weight produced with the aid of a mechanical press served as targets.

Since with this production method the targets were porous, their destruction differed from that of a target of monolithic metal. When acting on a porous target the heated gas, sharply increasing in volume, separates the particles and in the destruction products the major portion is comprised of the initial particles of the precompacted powder.

The destruction products were investigated using transverse probing of the erosion flame by radiation from an auxiliary ruby laser. The ruby laser generated in the regime of regular pulses of duration 10^{-6} sec each. The total time of generation was 2.6 × 10^{-3} sec. The ruby laser power density in the probing zone did not exceed 10^4 W/cm^2 lest the probed medium be disturbed. The target was placed in an integrating sphere, as a result of which we manage to simultaneously control the transmission coefficient of the erosion flame $K_{tr}(t)$, the scattering coefficient $K_{scat}(t)$, and the absorption coefficient $K_{ab}(t)$ in the experiment. This method is described in detail in [2]. Collection of information and its storage and processing are automated. In [3] one can find a description of how this is realized concretely.

Experiments on the action of neodymium laser radiation on targets of the tungsten and aluminum powder mixture showed that once a certain laser radiation power density is attained, selective evaporation of the target particles occurs in the erosion flame. The aluminum particles, by reevaporating, form the basic vapor and plasma medium in the flame and the tungsten particles remain unchanged. Figure 2 gives the time variations $K_{ab}(t)$ and $K_{scat}(t)$ in probing at different distances h from the surface for a target of aluminum and tungsten, the power density of the acting radiation being $2 \times 10^6$ W/cm^2. We point out that the start of the neodymium laser pulse is taken as the reference point.
As can be seen from Fig. 2, the scattered component of the probing ruby laser decreases with distance from the target, which indicates a decrease in the average size of particles in their motion toward the laser beam. Since the boiling point for aluminum is much lower than that for tungsten, the vapor phase must be comprised mainly of aluminum, and the tungsten particles must not undergo drastic changes. To elucidate this matter, experiments were performed on the action of laser radiation on targets compacted from aluminum powder alone and tungsten powder alone.

To control the size of the tungsten target particles, use was made of a procedure based on experimental ratios of the scattering and absorption coefficients of the probing radiation and the theoretical dependence of this ratio on particle size [4].