R2-O-045901

ELECTRICAL NATURE OF THE HOT SPOTS FORMATION IN PRESSED POWDERS OF ENERGETIC AND INERT MATERIALS UNDER LASER IRRADIATION

V.P. TSIPILEV[1], V.I. OLESHKO[1], A.N. YAKOVLEV[2], E.V. FORAT[1], N.A. ALEKSEEV[1]

[1]National Research Tomsk Polytechnic University, Tomsk, Russia
[2]Kuzbass State Technical University, Kemerovo, Russia

The question of the initiation mechanisms of the explosive decomposition reaction under laser excitation is one of the main questions in the energetic materials explosion physics. Currently two main models concerning the mechanism of explosion excitation are considered: non-thermal (chain) [1] and thermal [2-4]. The thermal micro hot-spot model is a well-established model for the energetic materials initiation by an external impulse. The hot spots are created due to the interaction of laser radiation with optical inhomogeneities (impurities and defects of various nature). However, the mechanism of hot spots formation under laser irradiation remains undefined by now.

In this work we study the mechanism of hot spots formation in pressed samples of energetic and inert materials by the first harmonic radiation of a Nd laser. Dependences of the luminescence intensity of these materials on the energy density of the laser pulse on the samples surface were obtained in the range from 10^{-3} to 10 J/cm^2. In this case, the luminescence intensity increases by nine orders of magnitude. An analysis of these dependences allows us to conclude that in the range of laser radiation energy densities from 1 to 30 mJ/cm^2, hot spots are formed as a result of optical (electrical) micro breakdown in the vicinity of absorbing inhomogeneities contained in the studied materials. In the range from 1 to 10 J/cm^2, the well-known mechanism of optical macro breakdown occurs with the formation of a plasma jet, surface destruction, and a characteristic "click" sound. The kinetic, spectral and spatial characteristics of the hot spots glow of energetic (PETN, PETN with soot and Al additives, ammonium perchlorate with aluminum) and inert (magnesium and titanium oxides, sugar) materials have been studied. Photographs of hot spots under a single and multi-pulse exposure are given. A conclusion is made about the optical (electrical) mechanism of initiation of energetic materials.

REFERENCES

[1] B.P. Aduev, E.D. Aluker, G.M. Belokurov, A.N. Drobchik, Y.A. Zakharov, A.G. Krechetov, A.Y. Mitrofanov, "Preexplosion phenomena in heavy metal azides," Combust., Explos. Shock Waves, vol. 36, no. 5, pp. 622-632, 2000.

[2] E.I. Aleksandrov, A.G. Voznyuk, "Initiation of lead azide with laser radiation," Combust., Explos. Shock Waves, vol. 14, no. 4, pp. 480-484, 1978.

[3] E.I. Aleksandrov, O.B. Sidonskii, V.P. Tsipilev, "Influence of combustion in the vicinity of absorbing inclusions on the laser ignition of a condensed medium," Combust., Explos. Shock Waves, vol. 27, no. 3, pp. 267-272, 1991.

[4] V.I. Tarzhanov, A.D. Zinchenko, V.I. Sdobnov, B.B. Tokarev, A.I. Pogrebov, A.A. Volkova, "Laser initiation of PETN," Combust., Explos. Shock Waves, vol. 32, no. 4, pp. 454-459, 1996.