

LASER INITIATION OF NANOTHERMITES Al/CuO AND Al/Bi₂O₃

V. G. Kirilenko¹, L. I. Grishin^{2,3}, A. Yu. Dolgoborodov^{1,2,3}, and M. A. Brazhnikov¹

¹N. N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation

²Joint Institute for High Temperatures of the Russian Academy of Sciences, 13-2 Izhorskaya Str., Moscow 125412, Russian Federation

³National Research Nuclear University MEPhI, 31 Kashirskoe Sh., Moscow 115409, Russian Federation

Abstract: The characteristics of ignition and flame propagation in nanothermites caused by laser pulse radiation have been studied. Al/CuO and Al/Bi₂O₃, nanothermites manufactured with the use of ultrasonic mixer, have been tested. The samples are ignited by laser with wavelength 808 nm and average power of 3.5 W. For the termites, using two-channel pyrometer, the minimum ignition energy and average burning velocity vs. sample porosity are measured. The effect of compound aging on the sensitivity to the laser pulse has been studied. The results show a strong dependence of the burning rate and initiation energy on the porosity of the samples. Based on the obtained results, the assumptions on the mechanism of combustion reactions in nanothermites exposed to laser radiation, in particular, the assumptions on two stages of the reaction, have been put forward.

Keywords: nanothermites; laser ignition; burning rate; ignition delay

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Figure Captions

Figure 1 The SEM photo of Al/CuO nanothermite; Al particles are grey, CuO particles are white

Figure 2 A target for installing samples before (a) and after (b) the shot

Figure 3 Experimental setup

Figure 4 Typical signals of the control and laser pulses

Figure 5 Selection of duration of the initiating laser pulse; Al/CuO composition: shots Nos. 1839 (a) and 1840 (b)

Figure 6 Typical time-histories of radiation signals at initiation of nanothermites

Figure 7 Effect of Al/CuO powder aging on the results of laser initiation: 1 — flash delay; and 2 — radiant energy

Figure 8 Burning rate and energy of the initiating pulse vs. the porosity of Al/CuO nanothermite: 1 — the results of the present work; 2 — data of [15]; and 3 — data of [13]

Figure 9 The “dark” phase under initiation of Al/CuO termite (shot No. 1859)

Table Captions

Table 1 Thermodynamic properties of termites according to [6]

Table 2 The shapes and sizes of nanopowder particles

Table 3 Sensitivity of nanothermites to mechanical shock, friction, and ESD [18]

Table 4 Main parameters of a laser pulse

Table 5 The results of laser initiation of nanothermites

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Contributors

Kirilenko Vladimir G. (b. 1956) — Candidate of Science in physics and mathematics, senior research scientist, N. N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; vladkiril@gmail.com

Grishin Leonid I. (b. 1993) — research engineer, Joint Institute for High Temperatures of the Russian Academy of Sciences, 13-2 Izhorskaya Str., Moscow 125412, Russian Federation; Ph.D. student, National Research Nuclear University MEPhI, 31 Kashirskoe Sh., Moscow 115409, Russian Federation; lenya-grishin@mail.ru

Dolgoborodov Alexander Yu. (b. 1956) — Doctor of Science in physics and mathematics, chief research scientist, N. N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; head of laboratory, Joint Institute for High Temperatures of the Russian

Academy of Sciences, 13-2 Izhorskaya Str., Moscow 125412, Russian Federation; teacher, National Research Nuclear University MEPhI, 31 Kashirskoe Sh., Moscow 115409, Russian Federation; aldol@ihed.ras.ru

Brazhnikov Michael A. (b. 1966) — Candidate of Science in pedagogy, senior research scientist, N. N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; birze@inbox.ru