

## HEATING AND IGNITION OF HNIW BY CONTINUOUS NEAR-INFRARED LASERS

L. V. Bachurin<sup>1</sup>, V. I. Kolesov<sup>2</sup>, A. N. Konovalov<sup>3</sup>, V. A. Ul'yanov<sup>3</sup>, and N. V. Yudin<sup>2</sup>

<sup>1</sup>Institute of Forensic Expertise of Moscow University of the Ministry of Internal Affairs of Russia, 12 Acad. Volkov Str., Moscow 117437, Russian Federation

<sup>2</sup>D. Mendeleev University of Chemical Technology of Russia, 9 Miusskaya Sq., Moscow 125047, Russian Federation

<sup>3</sup>Federal Scientific Research Center "Crystallography and Photonics," Russian Academy of Sciences, 17A Butlerova Str., Moscow 117342, Russian Federation;

**Abstract:** Heating and ignition of  $\varepsilon$ -modification of 2,4,6,8,10,12-hexanitro-2,4,6,8,10,12-hexaazaisowurtzitane (HNIW) by continuous-wave lasers in near-infrared range (0.98, 1.56, and 1.94  $\mu\text{m}$ ) with fiber-optic radiation delivery has been investigated. The rate of initial temperature rise and ignition delay time have been measured. The increase in heating efficiency and reduction of the ignition delay time by more than a factor of 10 was achieved by applying laser absorbing coatings based on nanosized CuO.

**Keywords:** energetic materials; fiber lasers; explosives; laser ignition; combustion

### Acknowledgments

The work was supported by the Russian Foundation for Basic Research, Grant No. 16-29-01072-ofi.

### References

1. Brish, A. A., I. A. Galeev, E. A. Sbitnev, and L. V. Tatarintsev. 1969. Mechanism of initiation of condensed explosives by laser radiation. *Combust. Explo. Shock Waves* 5(4):326–328.
2. Akhmetshin, R., A. Razin, V. Ovchinnikov, A. Skripin, T. Tshipilev, V. Oleshko, V. Zarko, and A. Yakovlev. 2014. Effect of laser radiation wavelength on explosives initiation thresholds. *J. Phys. Conf. Ser.* 552(1):012015.
3. Gerasimov, S. I., M. A. Ilyushin, and V. A. Kuz'min. 2015. A laser diode beam initiates a high-energy mercury perchlorate-polymer complex. *Tech. Phys. Lett.* 41(4):338–340.
4. Woods, S., M. Daka, and G. Flin. 2008. Volokonnye lazery sredney moshchnosti i ikh primeneniye [Medium power fibre lasers]. *Fotonika* 4:6–10.
5. Minaev, V. P., and K. M. Zhilin. 2009. *Sovremennye lazernyye apparaty dlya khirurgii i silovoy terapii na osnove poluprovodnikovykh i volokonnykh lazerov* [Modern laser apparatus for surgery and power therapy based on semiconductor and fiber lasers]. Moscow: Balanov. 47 p.
6. Sinditskiy, V. P., V. Yu. Egorshv, M. V. Berezin, V. V. Serushkin, Yu. M. Milekhin, S. A. Gusev, and A. A. Matveev. 2003. Zakonomernosti goreniya vysokoenergeticheskogo karkasnogo nitramina geksanitrogeksaazizovyurtsitana [Regularities in combustion of high-energy framework nitramine of hexanitrohexaazaisowurtzitane]. *Chem. Phys. Rep.* 22(7):69–74.
7. Welch, A. J., and M. J. C. van Gemert. 2011. *Optical-thermal response of laser irradiated tissue*. Dordrecht: Springer. 946 p.
8. Turcotte, R., M. Vachon, Queenie S. M. Kwok, Ruiping Wang, David E. G. Jones. 2005. Thermal study of HNIW (CL-20). *Thermochim. Acta* 433(7):105–115.
9. Nakanishi, K. 1963. Infrared absorption spectroscopy: Practical. San Francisco, CA: Holden. 233 p.

Received June 19, 2017

### Contributors

**Bachurin Leonid V.** (b. 1971) — teacher, Institute of Forensic Expertise of Moscow University of the Ministry of Internal Affairs of Russia, 12 Acad. Volkov Str., Moscow 117437, Russian Federation; susanna-bachurin@mail.ru

**Kolesov Vasily I.** (b. 1965) — Candidate of Science in chemistry, assistant professor, D. Mendeleev University of Chemical Technology of Russia, 9 Miusskaya Sq., Moscow 125047, Russian Federation; Kolesov2116@mail.ru

**Konovalov Alexey N.** (b. 1972) — Candidate of Science in physics and mathematics, senior research scientist, Federal Scientific Research Center "Crystallography and Photonics" of the Russian Academy of Sciences, 17A Butlerova Str., Moscow 117342, Russian Federation; ank27.ift@mail.ru

**Ul'yanov Valery A.** (b. 1953) — Candidate of Science in technology, head of laboratory, Federal Scientific Research Centre “Crystallography and Photonics” of the Russian Academy of Sciences, 17A Butlerova Str., Moscow 117342, Russian Federation; vaul595@mail.ru

**Yudin Nikolay V.** (b. 1971) — Candidate of Science in chemistry, assistant professor, D. Mendeleev University of Chemical Technology of Russia; 9 Miusskaya Sq., Moscow 125047, Russian Federation; yudin@rctu.ru