International Conference
Advanced Laser Technologies

ALT'16

The 24th Annual International Conference on Advanced Laser Technologies ALT'16

Galway, Ireland
September 12–16, 2016

BOOK of ABSTRACTS

Contents

Organizers and Sponsors

Program and Organizing Committees

Plenary Talks

SECTION BP. Biophotonics

SECTION LDS. Laser Diagnostics and Spectroscopy

SECTION LM. Laser–Matter Interaction

SECTION LSM. Laser Systems and Materials

SECTION PA. Photoacoustics

SECTION SN. Sensors

SECTION THz. THz Sources and Applications

Key for Authors

Organizers and Sponsors

General Physics Institute
of Russian Academy of Sciences
Russia

National University of Ireland
Galway, Ireland

Lomonosov Moscow State University
Russia

Fáilte **Ireland**
National Tourism Development Authority
Ireland

Science Foundation
Ireland

National Research Nuclear University
MEPhI, Russia

Center of Laser Technology
and Material Science, Russia

Conference Chairman

Ivan SHCHERBAKOV, Russia

Program Committee Co-Chairs

Vitaly KONOV, Russia
Gerard O'CONNOR (Ireland)

International Program Committee

Liam BARRY (Ireland)
Ekaterina BORISOVA (Bulgaria)
Hugh BYRNE (Ireland)
J.-L. COUTAZ (France)
Aladar CZITROVSKY (Hungary)
Boris DENKER (Russia)
Dan DUMITRAS (Romania)
Costas FOTAKIS (Greece)
Thomas GRAF (Germany)
Sergey GARNOV (Russia)
Leonid GOLOVAN (Russia)
Patrick HAYDEN (Ireland)
Fatih HUSEYINOGLU (Turkey)
Lan JIANG (China)
Izabela NAYDENOVA (Ireland)
Pavel KASHKAROV (Russia)
Tia KEYES (Ireland)
Yuri KULCHIN (Russia)
Pascal LANDAIS (Ireland)
Yong Feng LU (USA)
Vladimir MAKAROV (Russia)
John MCINERNEY (Ireland)
Ion MIHAILESCU (Romania)
Kyung Hyun PARK (Korea)
Ivan PELIVANOV (USA)
Valentin PETROV (Germany)
Alexei POPOV (Finland)
Alexander PRIEZZHEV (Russia)
Valerio ROMANO (Switzerland)
Philippe DELAPORTE (France)
Marc SENTIS (France)
Alexander SHKURINOV (Russia)
Nikolai A. SOBOLEV (Portugal)
Vadim VEIKO (Russia)
Alexey ZHELTIKOV (Russia)
Ioanna ZERGIOTI (Greece)

Organizing Committee Co-Chairs

Vladimir PUSTOVOY (Russia)
Martin LEAHY (Ireland)

International Organizing Committee

Sergey ALEXANDROV (Ireland)
Roshan DSOUZA (Ireland)
James MCGRATH (Ireland)
Cerine LAL (Ireland)
Natalia KHAKAMOVA (Russia)
Kai NEUHAUS (Ireland)
Tatiana VOLYAK (Russia)

THz-2-3 (Invited)

Down-conversion in doped GaSe for spectroscopic applications

Z. Huang[1], J. Huang[1], Y. Gao[1], Q. Yang[1], Yu. Andreev[2,3,4], K. Kokh[5], G. Lanskii[2,3,4], V. Svetlichnyi[3,4], J. Molloy[2,6]

1 – National Laboratory for Infrared Physics, Shanghai Institute of Technical Physics CAS, 500 Yutian Road, Shanghai, 200083, China

2 - Laboratory of Advanced Materials and Technologies, Siberian Physical–Technical Institute of Tomsk State University, 1 Novosobornaya Sq., Tomsk, 634050, Russia

3 - Institute of Monitoring of Climatic and Ecological Systems SB RAS, 10/3 Akademicheskii Ave., Tomsk, 634055, Russia

4 - High Current Electronics Institute SB RAS, 2/3, Akademicheskii Ave., 634055, Tomsk, Russia

5 - Laboratory of Crystal Growth, Institute of Geology and Mineralogy SB RAS, 3 Koptyug Ave., Novosibirsk 90, 630090, Russia

6 - National Physical Laboratory, Hampton Rd., Teddington TW11 0LW, UK,

zmhuang@mail.sitp.ac.cn, john.molloy@npl.co.uk

Physical properties of nonlinear p-type ε-GaSe crystal have paid great attention due to its outstanding ability to generate broadband emission from the near IR through the mid- and far-IR (THz) and further into the mm-range. This lecture introduces the current state of the art of the solid solution synthesis and growth technology of pure, light and heavy doped GaSe single crystals, the physical properties and the results achieved for the applications in laser frequency conversion into the mid-IR and THz range, and standoff detection of generated emission of 0.5-1 mm wavelength at distances over 110 m. To improve the optical quality of the synthesized GaSe material, the synthesis was conducted in heavily charged, up to 65% by volume, quartz ampoules to decrease the quantity of rest gases. The quartz ampoules were covered by pyrolytic carbon to decrease interaction of melts with the ampoules impurities. Modified vertical Bridgman growth technology includes application of a rotating heat field to achieve high melt uniformity and thin crystallization front resulting in high optical quality of crystals. To further improve optical quality and strengthen the lattice structure, GaSe was doped with different impurities. Significant improvement of optical quality was achieved for the first time by identified optimal doping with isovalent elements that form isostructural binary compounds. The best result was achieved by doping with small atomic size S atoms that allowed formation of solid solution $GaSe_{1-x}S_x$ single crystals with mixing ratio x up to 0.44. Accumulative effect was found in the improvement of optical quality after double element doping independent on the type of doping element. Doping with Al demonstrated the possibility to control plasma frequency and absorption, which finally allowed control dispersion properties in THz regime. It also resulted in the efficient lattice strengthening possibly through formation of strong chain-type guest atoms bounding. As a result, S & Al doping in layered and extremely soft GaSe result in the crystals to avoid of cracking under strong mechanical or optical impact. Optical properties were also studied over the entire transparency range and criterion for selection adequate measurement data recorded in the THz region. It was also shown that visual criterion cannot be used in the determination of the optical damage threshold.

The most important results achieved in frequency conversion include multistage frequency conversion of non selective CO laser in single GaSe sample with fixed position into wide range (2.3–8.5 μm), demonstrating the equality of GaSe and $ZnGeP_2$ nonlinear susceptibility coefficients and standoff detection of narrow bandwidth (<0.1 cm^{-1}) THz emission generated by DFG of Nd:YAG and near IR KTP OPO systems within 0.5-1 mm region at distances over 110 m. Two model of room temperature Schottky diodes were used, as well as LHe cooled Si bolometer. Other results will be presented in details.

Acknowledgment. This work was supported in part by NFS of China under Grant Nos. 61274138 and 61290302 and the Russian Science Foundation under project No. 15-19-10021.

[1] J. Guo, J. Xie, D. Li, G. Yang, F. Chen, C. Wang, L. Zhang, Yu. Andreev, K. Kokh, G. Lanskii, V. Svetlichnyi, Doped GaSe crystals for laser frequency conversion (Review), Light: Science & Applications, Vol. 4. e362, (2015); K. Kokh, J. Molloy, M. Naftaly, Yu. Andreev, V. Svetlichnyi, G. Lanskii, I. Lapin, T. Izaak, A. Kokh, Growth and optical properties of solid solution crystals $GaSe_{1-x}S_x$, Materials Chemistry and Physics, Vol. 154, pp. 152-157 (2015); M. Naftaly, J. Molloy, Yu. Andreev, K Kokh., G Lanskii., V. Svetlichnyi, Dispersion properties of sulfur doped gallium selenide crystals studied by THz TDS, Optics Express, Vol. 23, No. 25, pp. 32820–32834, (2015).