AMPL-2021

PULSED LASERS AND LASER APPLICATIONS

September 12–17, 2021
Tomsk, Russia

ABSTRACTS

GENERAL SPONSOR

Special Systems. Photonics, St. Petersburg, Russia

CONFERENCE ORGANIZERS

Institute of Atmospheric Optics SB RAS
Institute of High Current Electronics SB RAS
Tomsk State University
Tomsk Polytechnic University

CONFERENCE SPONSORS

Ministry of Education and Science of Russian Federation, Russia
Russian Academy of Sciences, Russia
Siberian Branch of Russian Academy of Science, Russia
Laser Association, Russia

CONFERENCE SPONSORS

TOPAZ Research and Inculcation Enterprise, Tomsk, Russia
Young Scientists Counsil IAO SB RAS, Tomsk, Russia
SP Equipment, Novosibirsk, Russia
Azimut Photonics, Moscow, Russia
LOTIS TII, Minsk, Belarus
Special Systems. Photonics, St.-Petersburg, Russia
CLZ Ltd, Moscow, Russia
Leningrad Laser Systems, St.-Petersburg, Russia

MEDIA SPONSORS

Atmospheric and Oceanic Optics Journal, Tomsk, Russia
Photonics Journal, Moscow, Russia

Scientific & Technical Translations
STT
PUBLISHING
Tomsk, 2021

(wavelengths 266 and 355 nm, average power 25.5 mV, repetition frequency 3 Hz, pulse duration 10 ns, peak power 10–12 mW/cm^2). When CV is exposed to radiation from both the 4th and 3rd harmonics of a Nd:YAG laser (wavelengths of 266 and 355 nm), the formation of triplet states of CV is observed. The maximum triplet triplet absorption is at 460 nm.

Project No. FSWM-2020-0033 of Russian Ministry of Science and Education.

Y-18

NUMERICAL SIMULATION OF THE ZnSe CRYSTAL DOPING PROFILE INFLUENCE ON THE THRESHOLD FOR THE PARASITIC LASING DEVELOPMENT IN A DISK ZnSe:Fe^{2+} LASER

E.E. Alekseev[1], N.M. Andronova[2], S.Y. Kazantsev[2,3], O.V. Kolesnikov[2], and S.V. Podlesnykh[2,4]

[1]NRC "Kurchatov Institute", 1 Kurchatov Ave., 123182, Moscow, Russia, a.e.e.1407@gmail.com;
[2]Moscow Technical University of Communications and Informatics, 8a Aviamotornaya St., Moscow, 111024, Russia, n.m.andronova@mtuci.ru, s.i.kazantsev@mtuci.ru, o.v.kolesnikov@mtuci.ru;
[3]Moscow Polytechnic University, 38 Bolshaya Semyonovskaya St., 107023, Moscow, Russia;
[4]General Physics Institute RAS, 38 Vavilov St., 119991, Moscow, Russia, winrad@yandex.ru

The results of numerical simulation of the parasitic lasing occurrence in a disk laser based on a ZnSe:Fe^{2+} crystal are presented. Similarly to [1], the conditions for the appearance of parasitic lasing in a disk ZnSe:Fe^{2+} laser are analyzed numerically at different doping profiles. Two types of conditions are considered. In the first one iron ions are assumed to be uniformly distributed in one thin layer located either on the surface of the crystal or inside the crystal. In the second one doping is carried out in four parallel inner layers in disconnected regions [2]. The dependences of the maximum pump spot size at which parasitic lasing does not develop in the direction transverse to the optical axis on the pump energy density are obtained. The finite element method is used to investigate thermoelastic deformations arising during optical pumping in ZnSe and ZnS crystals. It is shown that a piecewise-discontinuous doping profile [2] can significantly increase the maximum output energy of ZnSe:Fe^{2+} and ZnSe:Fe^{2+} lasers with disk geometry of the active element due to the increase in the pump spot size and the decrease in optical distortions in the crystal.

1. *Dormidonov A.E. et al.* // Appl. Phys. B. 2016. **122**. 211.
2. *Alekseev E.E., Kazantsev S.Yu. and Podlesnikh S.V.* // Opt. Mater. Express. 2020. **10**. P. 2075–2084.

Y-19

DARK CURRENT AND DETECTIVITY OF MULTILAYER Ge/Si PHOTODETECTOR WITH QUANTUM DOTS

R.M.H. Douhan, A.P. Kokhanenko and K.A. Lozovoy

Tomsk State University, 36 Lenin Ave., 634050, Tomsk, Russia, rahaf.douhan@gmail.com

Since the demonstration of molecular beam epitaxy which widened the ability to establish more applications based on semiconductor materials, and after the big success of quantum well structures for infrared detection, a lot of attention has been paid to the quantum discoveries [1], this has stimulated the development of quantum dot structures and its ability for infrared detection. In the past decades the quantum dot structure has proven their efficiency in comparison to other types of semiconductors and they have become an interesting field for research because of their high photoconductive gain, low dark current and the ability to operate under increasing temperature conditions.

Near room temperature semiconductor detectors have become the required optical detection approach in a variety of developing application areas especially in the visible and short-wave infrared spectral regions. QDIPs have been used in a range of quantum photonic applications, including

experiments in quantum foundations, fiber and free-space quantum communications demonstrations [2].

In applications such as light detection, silicon-based detectors have also emerged as one of the best technology candidates due to the high sensitivity and the short time temporal response which has resulted in enhanced and improved Si detectors to become large format detector arrays with integrated electronics. This low-cost technology has allowed systems to be adapted and developed for use in the automotive and smartphone industries [3].

This work will describe the behavior of multilayer Ge/Si photodetector with quantum dots and its parameters under several factors. The calculation of some parameters for such photodetectors is carried out: the dark current, photocurrent and detectivity were calculated. The results are highlighted to compare them with the parameters of other types of photodetectors, the difference between them is considered. It is predictable that the multilayer photodetectors with quantum dots can provide better performance, namely higher operating temperature (due to the large lifetime of carriers), low dark current and high coefficient of photoelectric gain.

As a result of simulating the proper equations [4, 5] and choosing the right parameters [6], the dark current, photocurrent and detectivity are represented as function of temperature and applied electric field in this work.

The results of the calculation will lead us to conclude that Ge/Si multilayer photodetectors based on germanium quantum dots can perform better than other photodetectors under the specific conditions, the dark current of Ge/Si QDIP will be less than other detectors, the detectivity is also higher.

Thus, we can conclude that multilayer Si/Ge quantum dots photodetectors are suitable to use in the high temperature conditions because they showed better performance than other detectors.

1. *Stylianos S., Dongfang L. and Haobei W.* High performance germanium quantum dot photodetectors in the visible and near infrared // Materials Science in Semiconductor Processing. 2019. V. 92. P. 19–27.
2. *Pugh C.J., Kaiser S. and Bourgoin J.P.* Airborne demonstration of a quantum key distribution receiver payload // Quan. Sci. Technol. 2017. V. 2. 024009.
3. *Takai I., Matsubara H. and Soga M.* Single-photon avalanche diode with enhanced NIR-sensitivity for automotive LIDAR systems // Sensors. 2016. V. 16. 459.
4. *Hongmei L. and Jianqi Z.* Performance investigations of quantum dot infrared photodetectors // Elsevier, Infrared Physics & Technology. 2012. **55**. P. 320–325.
5. *Martyniuk P. and Rogalski A.* Insight into performance of quantum dot infrared photodetectors // Tech. Sci. 2009. V. 57, No. 1. P. 103–116.
6. *Douhan R.M.H., Kokhanenko A.P. and Lozovoy K.A.* Parameters of photo-sensitive structures based on Ge/Si nanogeterostructures // Rus. Phys. J. 2018. V. 61, No. 7. P. 1194–1201.

Y-20

OPTICAL PROPERTIES OF DARK TITANIUM DIOXIDE PREPARED VIA PULSED LASER ABLATION IN WATER

Z.P. Fedorovich, E.D. Fakhrutdinova and VA. Svetlichnyi

Tomsk State University, 36 Lenin Ave., 634050, Tomsk, Russia, zhanna.fedorovich.99@gmail.com

Titanium dioxide is widely studied as a promising semiconductor that finds application in the conversion of solar energy as an active photocatalyst. However, the photocatalytic activity of TiO_2 is limited to the absorption in ultraviolet region (3.0–3.2 eV). Recent studies show that the creation of various defects state such as oxygen vacancies (appearance of Ti^{3+} state) can reduce the band gap and enhance photocatalytic processes under visible light irradiation. In this work, titanium dioxide was prepared by laser ablation of a titanium metal target in water exposed to pulsed radiation from a Nd:YAG laser (1064 nm, 7 ns, 20 Hz, 160 mJ/pulse). After ablation the colloidal solution was subjected to additional irradiation with the same laser. Then colloidal solutions were dried in air to obtain powders and then annealed at temperatures of 250–800 °C. According to the X-ray analysis data, the samples mainly consist of the anatase phase with a small admixture of rutile. Powders have