Military University of Technology

Institute of Optoelectronics

Annual **Report** 2014

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Institute of Optoelectronics
Military University of Technology

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PREFACE

The year 2014 was a period of dynamic and stable growth for the Institute of Optoelectronics, with both success and significant changes in its scientific and educational activities. The principal achievement for IOE was its earning of the right to award the habilitation degree in electronics. The Central Commission for Scientific Degrees and Titles granted this right to IOE, with the decision signed on 26 May 2014. This entitlement enabled IOE to commence two habilitation procedures this year and to organize regular Ph.D. studies, with the first recruitment occurring for the 2015/2016 year. Therefore, we have entered a "mature age" as the academic faculty focuses on scientific and educational activity in the field of optoelectronics and photonics technologies.

The Institute's structure and sources of finances did not experience significant changes this year. Research and development remains the foundation of our activity and incomes. More than 90% of the budget was obtained from R&D projects, which is more than half of the income from EU funds.

Great success was achieved in preliminary work on the long-term, strategic program "*New Systems of Weapon and Defense regarding Directed Energy,*" launched by the Ministry of Science and Higher Education and the Ministry of National Defence Republic of Poland at the end of 2014. This program consists of six main projects, with two of them coordinated by IOE: "*Methods and means for defense against the HPM pulses*" and "*Lasers systems of Directed Energy Weapons, laser systems of nonlethal weapons.*" Realization of that program required the appointment of an industrial-scientific consortium that included academia, national research institutions, and the defense industry. Moreover, the Institute has actively participated in the preparatory phase of a national program of satellite and space optoelectronic surveillance.

The participation of IOE in international projects is continuing at a high rate. On the Polish Road Map of Great Research Infrastructures, the Institute coordinates participation in "*ELI – Extreme Light Infrastructure*" in the framework of the European Road

Map ESFRI. In the framework of the European Defense Agency, we have participated in the projects RAMBO, AMURFOCAL, and TIPPSI, which focused on the detection of hazardous biological and chemical agents and IEDs. In 2014, we continued intense preparatory work aimed at gaining new projects in Horizon 2020.

We have significantly widened our scientific-technical collaboration with national industry, especially in the defense sector and the group of SME. According to the rules and strategy formulated in the National Operational Program of Intelligent Development, we conducted 23 R&D projects in the frameworks of programs INNOTECH, PBS, and PBR financed by the National Center for Research and Development, Foundation for Polish Science, and other institutions.

The scientific personnel at IOE have earned three prestigious scientific stipendiums founded by Ministry of Science, and Mjr. Przemysław Wachulak, D.Sc., was awarded the Medal of Young Scientist founded by Warsaw Technical University.

Beside our scientific and educational achievements, we have been recognized by industrial professional organizations. The Association of Suppliers for Polish Army has awarded our Institute the title *Leader of National Security*, and the Polish Agency of Enterprise Development awarded the Institute the Polish Award for Innovations.

In 2014, IOE participation in the educational process has increased. In cooperation with the Space Research Center Polish Academy of Sciences and other faculties of MUT, we commenced the organization of new studies on satellite and space engineering, which are to be launched in the 2015/2016 academic year. We have educated students conducting international Ph.D. studies on ERASMUS-MUNDUS and have participated in the doctoral studies of foreign students at the Faculty of New Technologies and Chemistry. Our educational activities for other faculties of MUT have increased as well.

The achievements and successes earned in 2014 allow us to look optimistically to the future of our Institute and its development.

Col. Krzysztof Kopczyński, PhD. Eng.

Director of Institute of Optoelectronics

PREFEACE

1.

ORGANIZATIONAL STRUCTURE AND SCIENTIFIC TASKS OF THE INSTITUTE

Table 1. Distribution of divisions and scientific groups

The organizational structure of the Institute of Optoelectronics comprises four Divisions, the Accredited Testing Laboratory, and the recently founded Biomedical Engineering Center with 15 research groups (see Table 1).

Division	Group	Leader
Laser Technology Division	Laser Matter Interaction Group	Prof. H. Fiedorowicz
	Solid State Lasers Group	Prof. A. Zając
	Fiber Lasers Group	Lt. Col. J. Świderski, D. Sc.
	Laser Optics Group	Prof. J. Jabczyński
	Laser Application Group	J. Marczak, D.Sc.
Optoelectronic Technologies Division	Laser Teledetection Group	M. Zygmunt, Ph.D.
	Optical Technology Group	Col. K. Kopczyński, Ph.D. Eng.
	Laser Nanotechnology Group	E. Michalski, D.Sc. W. Mróz, Ph.D. Eng.
	Optical Spectroscopy Group	M. Kwaśny, D.Sc.
	Biochemistry Group	A. Padzik-Graczyk, D.Sc.
Optoelectronic Systems Division	Optical Signal Detection Group	Prof. Z. Bielecki
	Security Systems Group	Prof. M. Szustakowski
	Quantum Electronics Group	Prof. Z. Puzewicz
Infrared Technology and Thermovision Division	Thermal Detection and Thermovision Group	Prof. H. Madura
Accredited Testing Laboratory		J. Janucki, Ph.D. Eng.
Biomedical Engineering Center		M. Łapiński, D.Sc., M.D.

At the end of 2014, the staff of the IOE consisted of more than 200 employees, including 104 scientific workers. Thirty-nine of these scientific workers were <35 years of age and, of those, 34 were Ph.D. students. The Council of the Institute (comprising 11 professors and 11 D.Sc.'s) can award D.Sc. (doctor habilitatus) and Ph.D. degrees in electronics.

The structure of the finances did not change in 2014. Research and development activity remained the main source of income; however, activity in the education field increased a little. The R&D work, conducted in the framework of 93 projects, was financed from several sources (see Figure 1.1, Appendix 1). Research results were presented in 206 scientific publications and reports, including 60 articles published in journals included in the JCR list (see Figure 1.2, Appendix 2.).

Chapters 2–4 present the selected results of R&D conducted in 2014, and the competence areas, scientific topics, and main achievements of divisions are presented below.

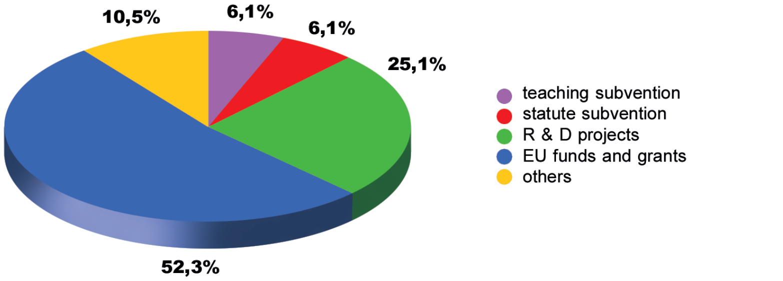

Figure 1.1. Distribution of financial sources of the IOE in 2014

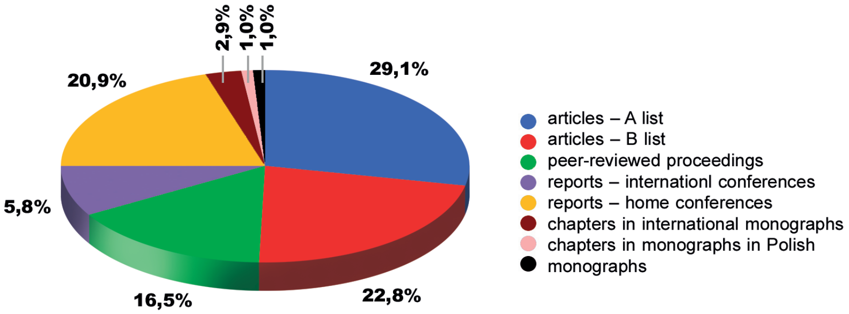

Figure 1.2. Distribution of publications of the IOE in 2014 (total number 206)

1.1. LASER TECHNOLOGY DIVISION

The Laser Technology Division conducts fundamental and applied studies related to the development of laser sources such as laser-plasma soft X-ray (SXR) and extreme ultraviolet (EUV) sources, as well as studies using lasers in military technology, materials engineering, measuring techniques, medicine, and art renovation. The division conducts research on the broad subject of diode pumped lasers (LPD), including the design of optical systems, resonators, and LPD pulse designs for special and industrial applications; characterization of new active media and nonlinear crystals; systems of nonlinear radiation conversion that include parametric generation and supercontinuum generation; and studies on the spatial distribution of laser beams. Highly qualified staff, modern laboratories, and extensive equipment ensure a high level of research and education.

RESEARCH TOPICS

- Research on pulsed, tunable LPD generation in the 1–3 μm spectral range, and its application in military, technology, and metrology equipment
- Research on fiber-based near- and mid-infrared supercontinuum sources
- Development, testing, and construction of power supplies and parameter control systems for laser sources
- Development of laser-plasma SXR and EUV radiation sources
- Application of laser-plasma radiation sources in material testing, microscopy, surface engineering, microtreatment, and nanolithography
- Research on the interaction of high-energy laser pulses with matter for military technology and nanotechnology
- Research on the process of laser ablation and applications of laser technology in art renovation

SELECTED ACHIEVEMENTS

- Development of coherently pumped, high peak power Ho:YAG, Ho:YLF, Cr:ZnSe lasers
- Development of novel high-power mid-infrared supercontinuum sources
- Development of fiber lasers and amplifiers operating at 1.55 μm and 2 μm
- Development of technology of micro- and submicro-periodic structures on different surfaces, including biocompatible materials, using laser-induced interference lithography

- Development and commercialization of technology for art renovation using laser ablation applied to sedimentary rock, gypsum, museum and construction ceramics, animal bones, elephant ivory, fabrics, metal braid, varnishes, and wood
- Development of high-efficiency laser-plasma SXR and EUV radiation sources and their application in pulse radiography, microscopy, micro-treatment, and polymer surface modification

1.2. OPTOELECTRONIC TECHNOLOGIES DIVISION

The Optoelectronic Technology Division conducts fundamental and applied studies related to the development of optoelectronic materials and technologies for applications in security systems, defense, environmental protection, medicine, and industry. The division is involved in the advanced construction and implementation of complex optoelectronic systems and devices, including systems of point and remote detection of hazardous chemicals and biological materials. Fundamental studies carried out in the division mainly involve materials and nanomaterials engineering, optical spectroscopy, materials characterization using advanced research methods, plasmonics, and biotechnology.

RESEARCH TOPICS

- Physics and optics of new types of lasers, in particular those with potential applications in military laser technology systems
- Coherent and incoherent optical detection
- Design of refractive, reflective, and diffractive optical systems
- Optical beam shaping
- Integration of military optoelectronic systems
- Measurement methods and standards for calibration, testing, and standardization of military optoelectronic equipment
- Spectroscopy methods for remote detection of atmospheric pollutants and contaminants, including chemicals and biological materials
- Optical point and stand-off detection of biological and chemical agents
- Laser range-finding
- Laser measurements of a vehicle speed
- Laser-plasma ion sources for nanotechnology and materials research
- Laser-assisted fabrication of thin films and nanostructures using pulsed laser deposition (PLD)
- Thin-film technologies
- Plasmonic nanostructures for detecting chemicals and biological materials
- Spectroscopy in the UV-Vis-NIR range, Raman, surface-enhanced Raman scattering, and fluorescence spectroscopies
- Biomaterials
- Analytical procedures for determining microelements and biologically active compound content in various samples
- Cancer therapies and diagnostics

SELECTED ACHIEVEMENTS

- LIDARs for stand-off detection of chemical and biological agents
- Laser rangefinders
- Laser speedometers
- Laser shooting and ballistic simulation systems
- Fire detection and explosion suppression systems
- Optoelectronics for fire control
- Laser communication links
- UV dosimeters
- UV solar-blind radiometers
- Laser radiation warning systems
- Optoelectronic solutions for cancer diagnosis

1.3. OPTOELECTRONIC SYSTEMS DIVISION

The research and development activities in the Optoelectronic Systems Division focus on applications of new optoelectronic detection systems, fiber and terahertz (THz) technologies in medicine, environment monitoring, and critical infrastructure protection.

RESEARCH TOPICS

- Design of low-noise, highly responsive photoreceivers working in the extreme ultraviolet to long-wavelength infrared radiation range
- Construction and investigation of devices for vapor preconcentration and thermal decomposition of explosive materials
- Design of free space optical transceivers that operate in the longer infrared wavelengths
- Investigation of ultrasensitive optoelectronic sensors for dangerous gases
- Development of air sampling units for breath analyses of people, using laser absorption spectroscopy
- Design of special current drivers for semiconductor lasers used in laser absorption spectroscopy or free space optic setups
- Development of fiber sensors for electronic protection of large objects
- Design, consulting, and commissioning of electronic protection systems for critical infrastructures
- Measurement methods and systems for investigating thermal imaging cameras, TV cameras, night vision devices, laser devices, and multisensor observation devices
- Measurement of the spectral signatures of dangerous materials (explosive materials, drugs) and characterization of composite materials using THz spectroscopy
- Investigations of integrated radar-camera systems for airport and seaport security
- Development related to the modernization of the homing heads of GROM short-range anti-aircraft missiles and P-22 medium-range water-to-water missiles
- Simulation studies of missile homing head subsystems working in the real configuration of the head, simulation of missile flight dynamics (also in the presence of organized jamming)
- Development, modernization, and manufacturing of training systems for operators of mobile short-range anti-aircraft missiles
- Modernization of missiles along with industry, laboratory, and field tests of developed equipment and participation in the modernization of equipment by the manufacturers

SELECTED ACHIEVEMENTS

- Development of optical sensors for trace detection of explosive materials
- Commercialization of a fiber system for perimetric protection of special objects
- Fiber optic sensor for protection of museum collections
- Single-photon sensor to protect and monitor the integrity of the fiber optic link
- Integrated platform radar-camera for protection of military facilities
- Integrated maritime port security system
- Protection system against pirate ship attacks
- Commercialization and modernization of GROM anti-aircraft missiles
- Development and commercialization of the UST-1 training system for the operators of GROM short-range anti-aircraft missiles (awarded the DEFENDER prize at the 7th International Defence Industry Exhibition MSPO Kielce in 2000)
- Modernization and commercialization of a seeker's detection module for the P-22 water-water type missile
- Development and commercialization of controls and measurement equipment for laboratory and field tests of short-range anti-aircraft missiles

1.4. INFRARED TECHNOLOGY AND THERMOVISION DIVISION

The research performed by the Infrared and Thermovision Technology Division covers non-contact temperature measurements, thermovision measurements, and infrared technology used in devices developed for the Polish Armed Forces. The funding for scientific research is provided mainly by the Ministry of Science and Higher Education in the form of statutory tasks, individual research grants, fellowships for doctoral students, development projects, and targeted projects. In recent years, statutory tasks were dedicated to thermographic and spectroradiometric measurements of objects and the development of integrated optoelectronic sensor systems for military applications. The division's current research focuses on the development of thermovision cameras with cooled and uncooled array detectors.

RESEARCH TOPICS

Military applications of infrared technology
- Thermo-detection systems for intelligent ammunition
- Multisensor detection systems

Infrared sensors for protection systems
- Detection systems for infrared objects
- Thermovision cameras with cooled and uncooled detectors
- Thermovision cameras for individual soldier equipment systems

Thermovision and infrared pyrometry of infrared radiation
- Thermovision measurements and thermal image analysis
- Development and fabrication of infrared pyrometers
- Development and fabrication of infrared radiation sources
- Calibration and standardization of infrared pyrometers
- Characterization of thermovision cameras, visible light cameras, and laser rangefinders

Testing of thermo-detection components and assemblies
- Measurement of spectral characteristics of infrared detectors
- Measurement of spectral characteristics of optical components
- Measurement of angular characteristics of infrared sensors
- Climatic measurements of infrared detection systems

Modeling and theoretical analyses
- Modeling of infrared radiation detection processes
- Simulated operation of thermo-detection systems and devices
- Determination of multispectral signatures of infrared objects
- Determination of the operating range of thermo-detection devices

SELECTED ACHIEVEMENTS

The recently completed targeted projects in collaboration with Przemysłowe Centrum Optyki S.A. resulted in the development of the following:
- CTS-1 thermovision sight
- KT-1 camera with cooled detector for fire control systems
- LOP-1 rangefinder-observation binoculars

1.5. ACCREDITED TESTING LABORATORY

Since 1997, the Accredited Research Laboratory has functioned in accordance with research quality management systems, meeting the requirements of standard PN-EN ISO/IEC 17025. The management system is documented and has been issued a certificate (No. AB 109) by the Polish Center for Accreditation. The results of the tests performed by the laboratory are recognized by the International Laboratory Accreditation Cooperation/Mutual Recognition Arrangement (ILAC/MRA).

MEASUREMENT PROCEDURES

PB-01 – Measurement of laser pulse energy
PB-02 – Measurement of the power of continuous laser radiation
PB-03 – Analysis of the irradiation distribution in laser beam cross sections
PB-04 – Measurement of laser radiation pulse duration and determination of its asymmetry factor
PB-05 – Verification of correction factors and the nonlinearity of laser energy and power meters
PB-06 – Measurement of the absorption factor of optical materials
PB-07 – Assignment of safety classes for laser devices
PB-09 – Measurement of parameters related to thermal imaging devices, including the signal transfer function; components of the 3D noise model; components of the simplified noise model, including 1/f noise, non-uniformity, and noise equivalent power; signal-to-noise ratio; modulation transfer function and contrast transfer function; minimum resolvable temperature difference; and field of view
PB-10 – Measurement of parameters related to TV, LLLTV cameras, and night vision devices, including signal-to-noise ratio, modulation transfer function, contrast transfer function, spatial resolution, minimum resolvable contrast, and field of view

The laboratory collaborates with national and foreign scientific centers in the area of optoelectronic metrology. The laboratory research team participated in several international EUREKA projects and has developed and pursued their own research projects funded by the Ministry of Science and Higher Education. The laboratory also works closely with business entities on the development and implementation of projects in the area of optoelectronic measurement systems and automation. These include

- Material testing using laser-induced plasma spectroscopy
- Electronic sensors for measuring physical quantities
- Laser power and energy meter calibrators
- Microprocessor control systems and data processing of measurements

1.6. BIOMEDICAL ENGINEERING CENTER

The Biomedical Engineering Center (BEC), established in 2013, conducts projects related to biomedical engineering and designs innovative technologies as well as equipment in the field of medicine. One project implemented by the BEC is a part of the 5.1 IE OP under the name "Cluster Development Center for Biomedical Engineering." The aim of this project is to diffuse innovation from the Military University of Technology as well as other research institutions to companies associated with the cluster. The cluster was established by 44 companies, enterprises, research organizations, scientific institutes, universities, and the business support institution. Currently, BEC is in the final stage of personnel training and is also organizing and establishing new testing laboratories.

RESEARCH TOPICS

- Development of methods to diagnose and treat cancer and cardiovascular diseases using photodynamic therapy
- Detection of pathogens in hospital environment using optoelectronic methods
- Elaboration of techniques to increase proliferative capacity of stem cells and promote their differentiation using low-energy lasers
- Advancement of computer software for use in medicine
- Studies on the impact of electromagnetic fields on the human body
- Development of the innovative technology of molecular sieves for diagnosis and treatment of cancer
- Use of graphene for medical applications

2. BASIC RESEARCH IN OPTICS AND PHOTONICS

2.1. HIGH POWER SUPERCONTINUUM GENERATION WITH VERY EFFICIENT POWER DISTRIBUTION TOWARD THE MID-INFRARED

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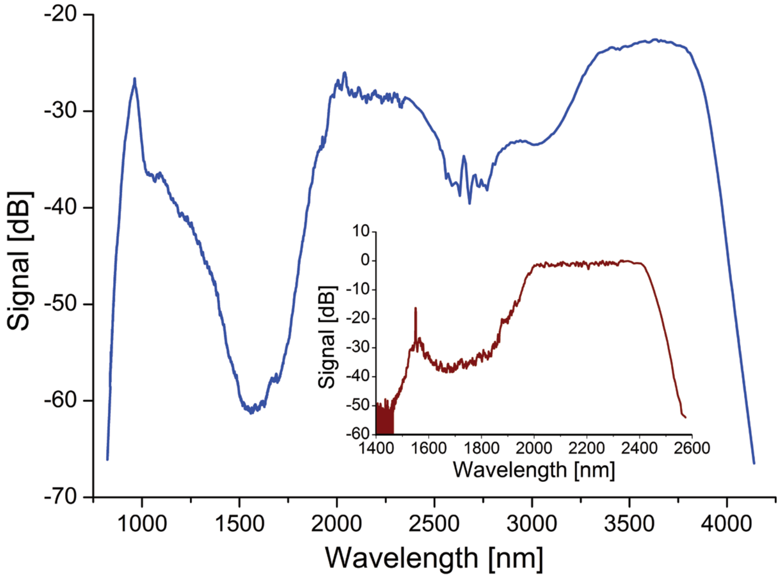

Figure 1. Spectrum of SC generation in ZBLAN fiber at output power of 2.24 W

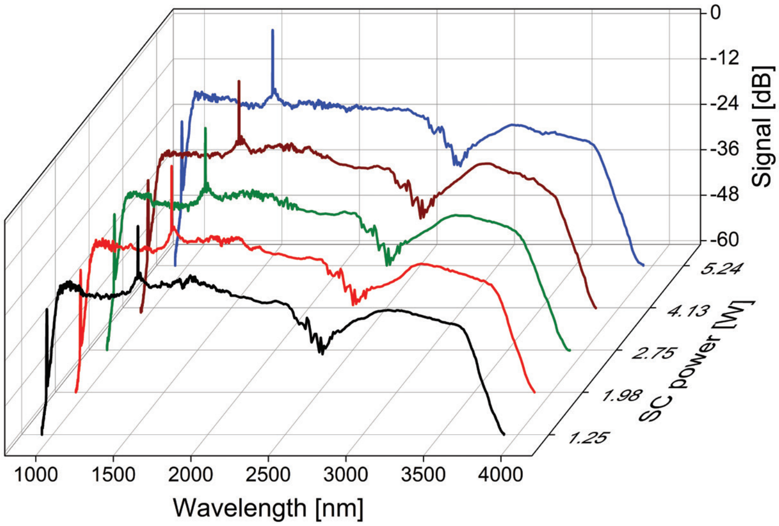

Figure 2. Spectrum of SC generation in ZBLAN fiber for different powers up to 5.24 W

The purpose of this work was to develop high-power supercontinuum (SC) sources based on ZBLAN fibers. Pumping the fluoride fiber with 2.75 W of power provided by a thulium-doped fiber amplifier led to the achievement of a continuous spectrum extending from ~0.85 to 4.2 µm, with 2.24 W of average output power. Over 61% (1.37 W) of the total output power corresponded to wavelengths longer than 3 µm, which showed the highest power conversion efficiency toward the mid-IR spectral band in relation to the output spectrum width. Linear SC power scalability up to 5.24 W at a spectral band of ~0.9–4 µm was also demonstrated. This had a repetition rate and pump power provided by a 1.55 µm fiber-based master-oscillator power amplifier system.

2.2. HIGH POWER SUPERCONTINUUM GENERATION IN ZBLAN FIBERS PUMPED WITH 2 µm OPTICAL PULSES

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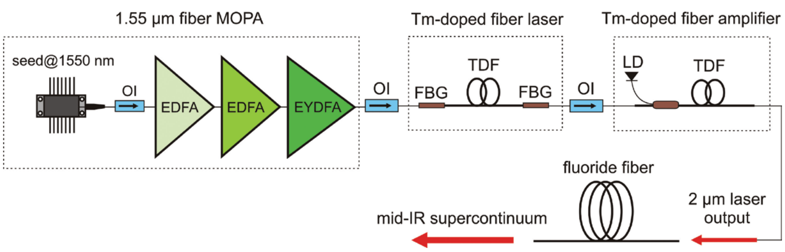

Figure 1. Scheme of Tm fiber Master Oscillator and Amplifier

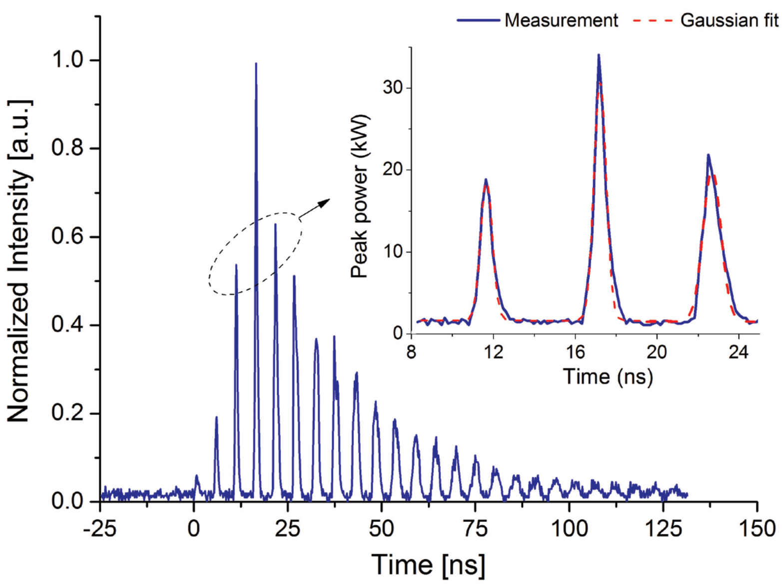

Figure 2. Train of optical pulses for pumping the ZBLAN fiber in process of SC generations

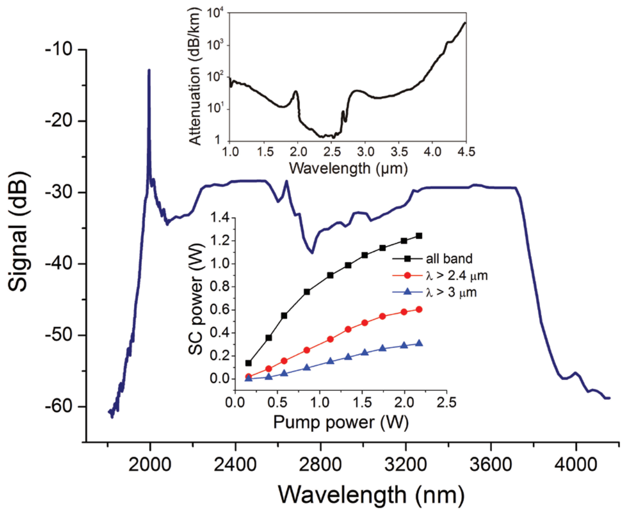

Figure 3. Spectrum of SC generation in ZBLAN fiber

This work developed supercontinuum sources based on ZBLAN fibers pumped with 2 µm optical pulses and delivered by a gain-switched Tm-doped fiber laser and amplifier system. Averaged output powers of 1.25 W in the ~ 1.8-4.15 µm spectral band and 1.82 W in the ~ 1.8–3.65 µm band were demonstrated. The output power and spectrum bandwidth of the developed SC systems can be made scalable by applying a higher pump power with a simultaneous shortening of the pump pulse width.

2.3. FIRST EXPERIMENT ON HIGH AVERAGE POWER SUPERCONTINUUM GENERATION IN A FLUOROINDATE FIBER

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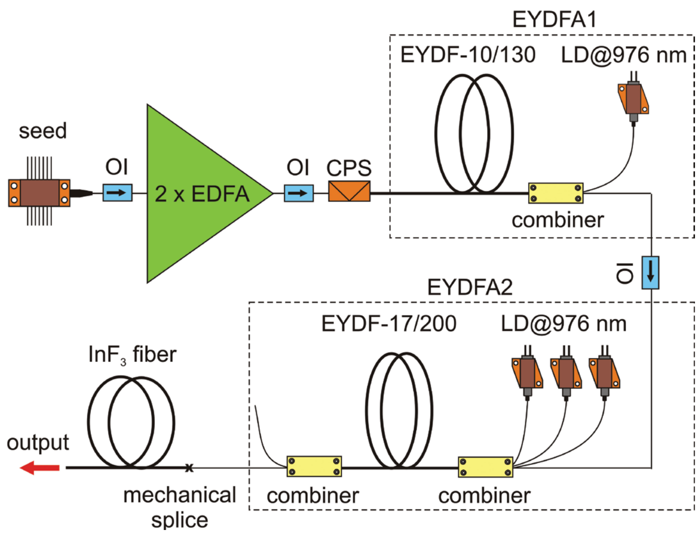

Figure 1. Scheme of SC generation setup in InF_3 fiber

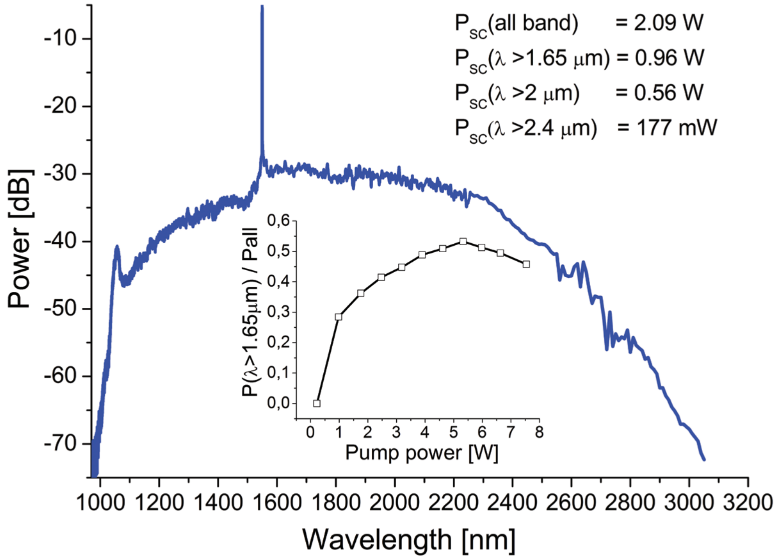

Figure 2. Spectrum of SC generation setup in InF_3 fiber

This work was the first demonstration of watt-level supercontinuum (SC) generation in a step-index fluoroindate (InF_3) fiber pumped by a 1.55 μm fiber-based master-oscillator power amplifier (MOPA) system. The pump MOPA system can operate at a changeable repetition frequency, delivering up to 19.2 W of average power at 2 MHz. When the 8 m InF_3 fiber was pumped with 7.54 W at a repetition rate of 420 kHz, then we achieved an output average SC power as high as 2.09 W with 27.8% slope efficiency. The SC spectrum spread from 1 to 3.05 μm.

2.4. 10 KW-LEVEL GAIN-SWITCHED TM-DOPED FIBER LASER AND AMPLIFIER SYSTEM

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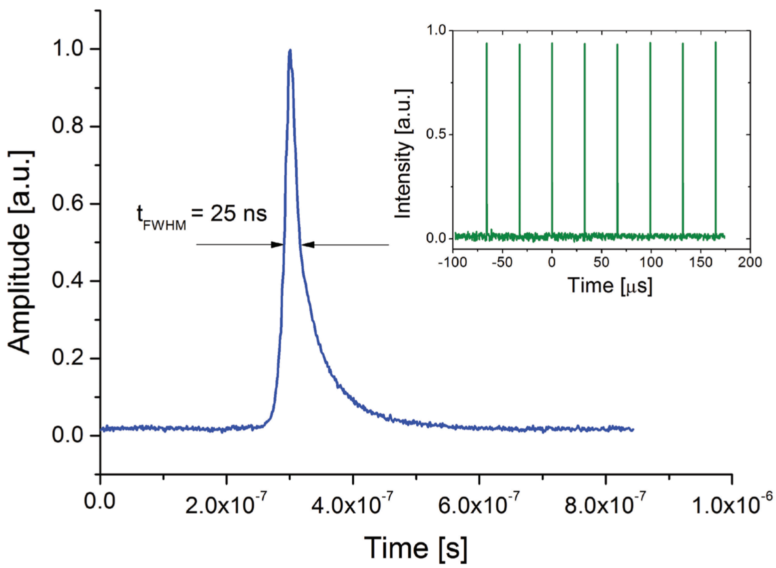

Figure 1. Train of optical pulses of 10.53-kW peak power emitted by Tm fiber Master Oscillator and Amplifier

This work developed an all-fiber, gain-switched, Tm^{3+}-doped silica fiber laser and amplifier system generating a train of pulses at a wavelength of 1994.4 nm. When operating at a pulse repetition frequency f = 100 kHz, the system delivered a maximum average power as high as 9.03 W with a slope efficiency of 36.4%. At f = 26 kHz, we obtained stable 25 ns pulses with an energy of 0.28 mJ corresponding to a peak power of 10.5 kW.

2.5. ALL-FIBER-BASED, PULSED LASER SYSTEM OPERATING IN THE “EYE-SAFE” SPECTRAL REGION

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This work resulted in a high-efficiency, single-mode, all-fiber pulsed laser system built in a master oscillator power amplifier format. It operates in the eye-safe (1,549 nm) spectral range, providing over 1 W of average output power with up to 51 dB of total signal gain. It features the flexibility of smooth pulse duration control from single ns to 260 ns, as well as an independently tunable repetition rate ranging from 40 kHz to 1 MHz. We demonstrated pulses as short as 4 ns with up to 20 µJ energy and a corresponding peak power of 5 kW. The laser system delivered a nearly diffraction-limited beam with M^2 ~1.

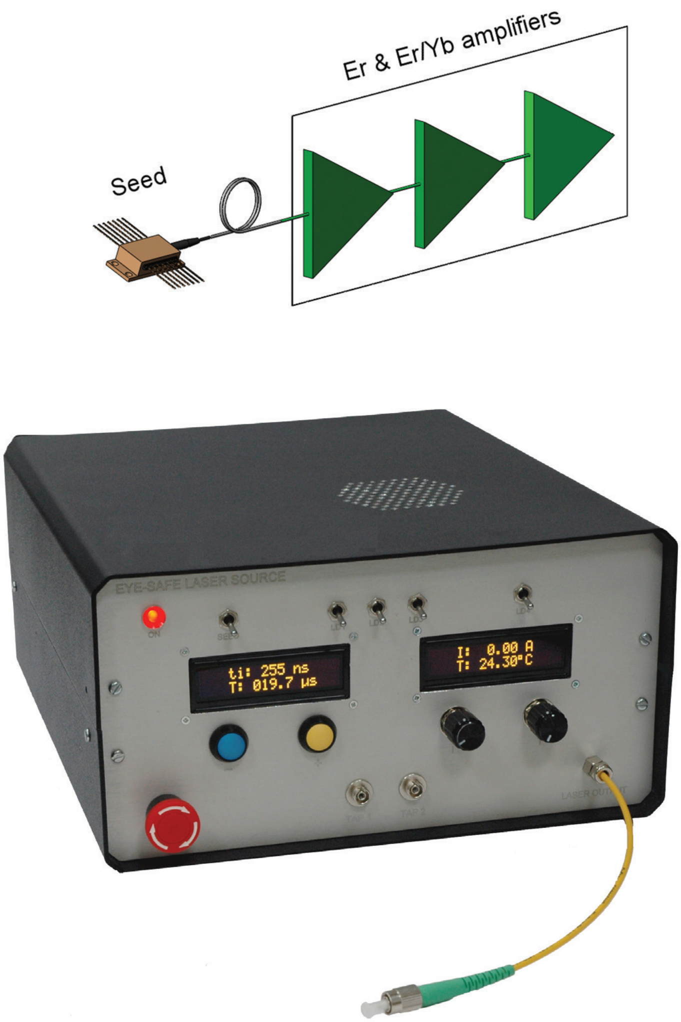

Figure 1. Scheme and photograph of ‘eye-safe’, pulsed fiber laser system emitting at 1,55 µm

2.6. ARBITRARY PULSE SHAPING IN ER-DOPED FIBER AMPLIFIERS

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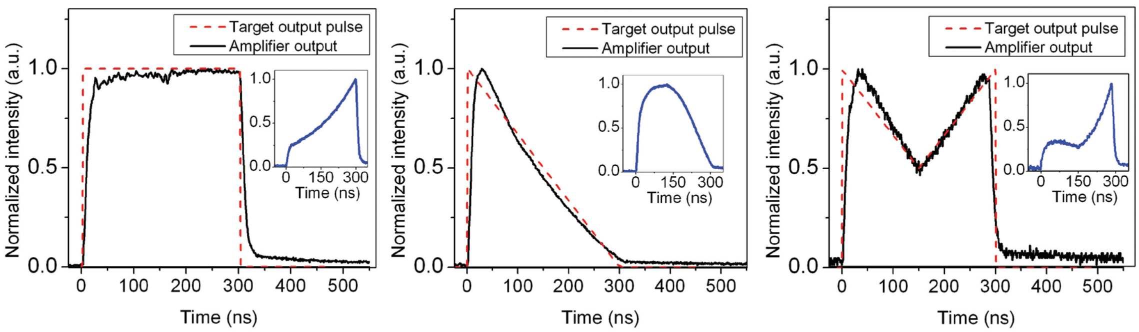

Here, we developed a simple compensation method of temporal pulse distortion based on direct current modulation using an arbitrary function generator (AFG). The appropriate shape modification of the input pulse leads to an output amplified pulse with any desired shape. The main limitation of pulse shaping in a fiber amplifier seeded by a narrow linewidth laser diode was found to be stimulated Brillouin scattering (SBS). The pulse-shaping method can also improve the amplifier performance by increasing the power threshold of SBS.

Figure 1. Examples of generation of optical pulses of arbitrary shapes

2.7. HIGH PEAK POWER COHERENTLY PUMPED Cr^{2+}:ZnSe LASER

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The main objective of this work was to develop and analyze a pulsed laser based on a polycrystalline zinc selenide compound doped with divalent chromium ions (Cr^{2+}). This provided an operation at wavelengths above 2.2 microns. In this framework, we conducted a theoretical analysis of quasi-three-level lasers and gain-switched lasers. A laboratory model of a q-switched Tm^{3+}:YLF laser was developed. The laser parameters were optimized for use as an optical pump for a Cr^{2+}:ZnSe active medium. Based on an analysis of the literature and the results of computer simulations, a laboratory model of the Cr^{2+}:ZnSe laser pumped by a pulsed Tm^{3+}:YLF laser was developed. In addition, we conducted experimental research on these laser systems. The results confirmed the correctness of both theoretical models and proved the feasibility of the scheme for achieving high-peak-power generation with efficiency close to the quantum limit.

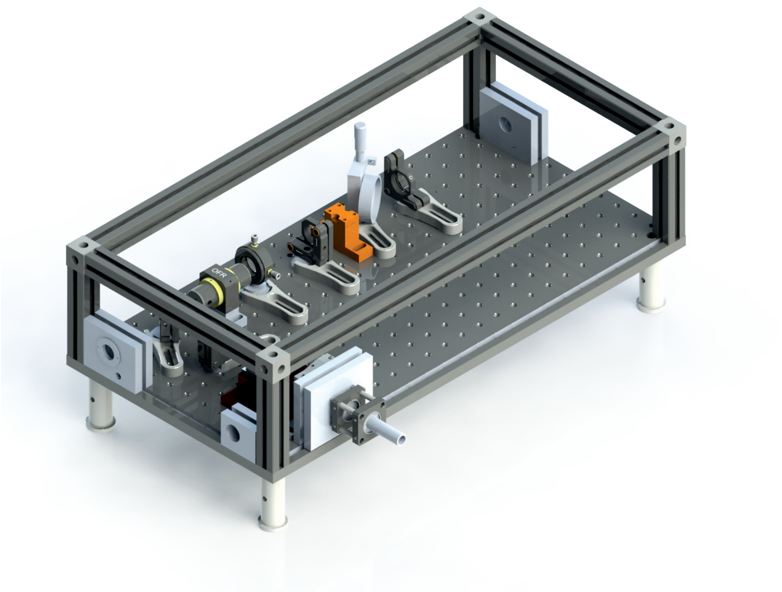
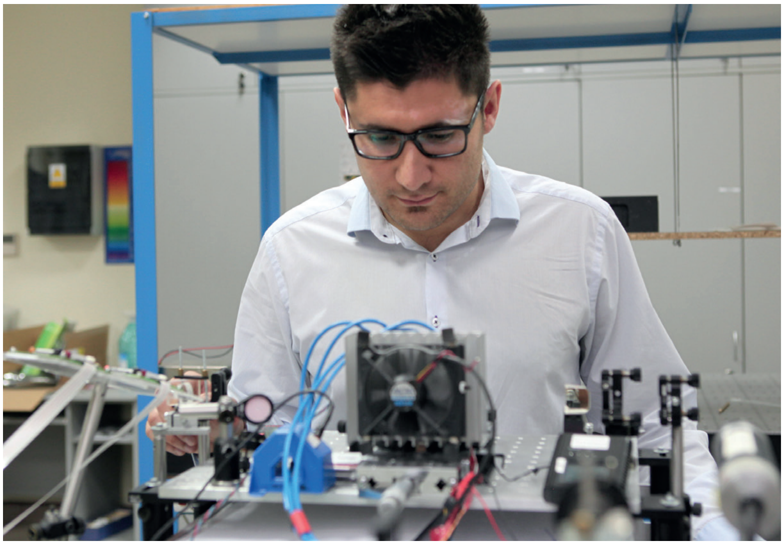


Figure 1. 3D model of Cr:ZnSe laser pumped by Tm:YLF laser

2.8. Q-SWITCHED, SIDE PUMPED, GRAZING INCIDENCE $Nd:YVO_4$ LASER



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This work developed an actively Q-switched $Nd:YVO_4$ laser with grazing-incidence bounce geometry, side-pumped with a 2D laser diode matrix. The laser setup is presented in Figure 1. Because an extremely high gain-length product was obtained in that configuration, a BBO Pockels cell was applied for the Q-switching regime.

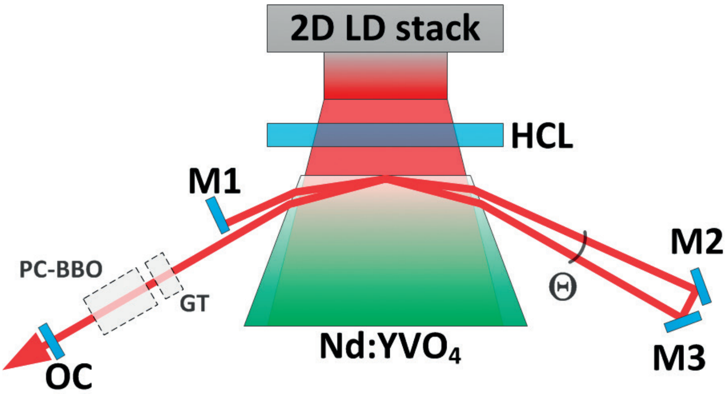

Figure 1. Scheme for the $Nd:YVO_4$ laser with double bounce resonator: HCL - cylindrical lens, OC - output coupler, PC-BBO - Pockels cell, GT - polarizer

5x5x15 mm^3, 0.5 at% doped $Nd:YVO_4$ slab was applied as an active medium. We used a novel 2D laser diode array that was able to deliver up to 2.4 kW of peak power with a maximum duty factor of 2%. Figure 2 depicts the energetic characteristics in free-running operation, and Figure 3 shows the pulse energy and pulse width versus incident pump energy in the Q-switching regime.
A near-diffraction-limited beam with parameter M^2 = 1.25 was achieved. We demonstrated a generated output pulse energy of 8.5 mJ and a 8 ns pulse duration at 50 Hz repetition rate.

2.9. Ho:YLF LASER IN-BAND PUMPED BY A LINEARLY POLARIZED TM:FIBER LASER

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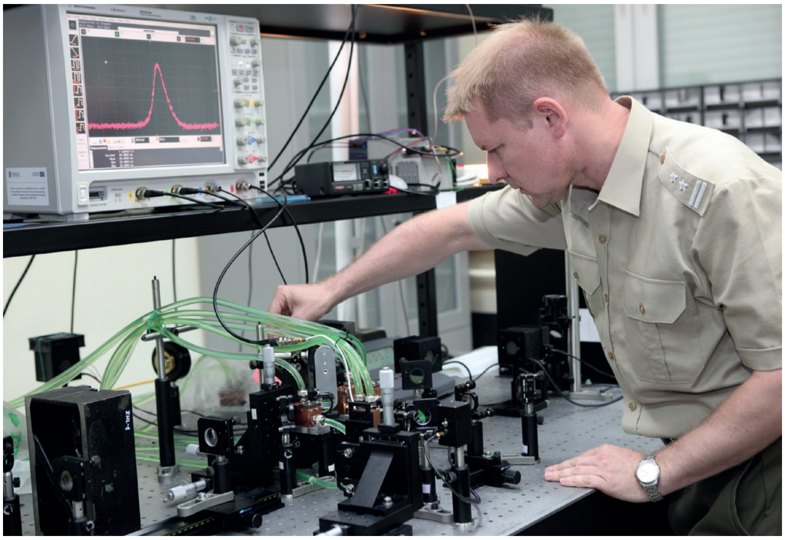
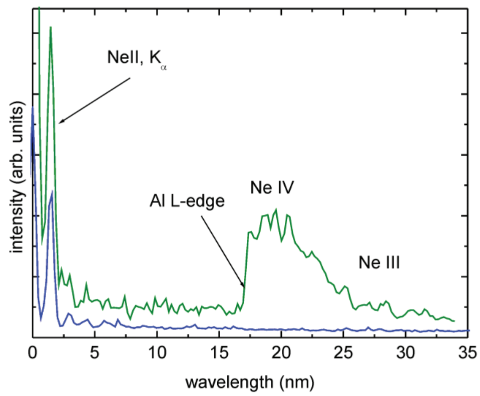
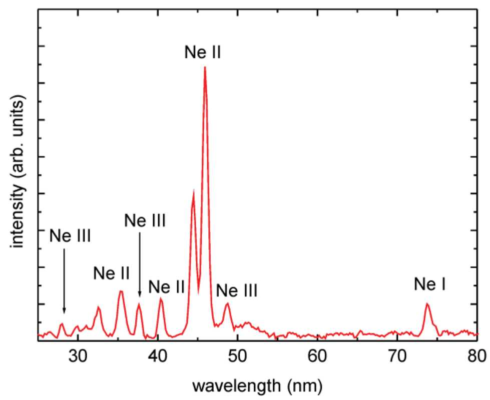
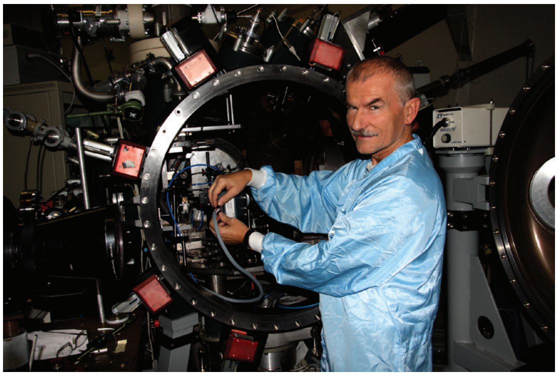


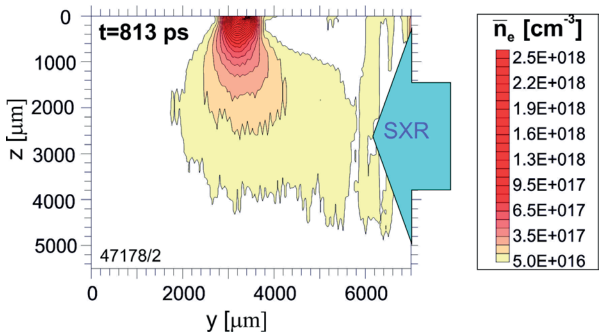
We developed a compact set-up of a Ho:YLF laser “in band” pumped by a high-power linearly-polarized Tm:fiber laser, and we examined it for both free-running and Q-switching operations. The research considered two crystals of the same length but with different Ho doping concentrations (0.5 at%, 3x3x30 mm; and 1.0 at%, 5x5x30 mm). In free-running operation for a higher holmium doping concentration crystal, up to 14.5 W output power was demonstrated that corresponded to a slope efficiency of 53.4% with respect to the incident pump power. For Q-switched operation, in a CW pumping regime, we obtained an average power of 14.2 W at the pulse repetition frequency of 10 kHz. For 1 kHz PRF, we recorded pulse energies of 5.7 mJ with an 11 ns FWHM pulse width corresponding to almost 520 kW peak power. The laser operated at a wavelength of 2050.08 nm and a FWHM line width of 0.86 nm, delivering a near-diffraction-limited beam with M^2 values of 1.05 and 1.09 in the horizontal and vertical directions, respectively.

2.10. INVESTIGATIONS OF PHOTOIONIZED PLASMAS









andrzej.bartnik@wat.edu.pl

A joint project, led by Dr. Andrzej Bartnik, investigated photoionized plasmas. These investigations were performed by researchers from the Institute of Optoelectronics and the Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland, at the PALS Research Center, Prague, Czech Republic. The project was financed by the EU within the LASERLAB Europe program. Photoionized plasmas were created by the interaction of an intense soft X-ray beam with gases. The soft X-ray radiation was emitted from laser plasmas induced in a gas puff target by high-power laser pulses. The emission spectra from the photoionized plasmas were investigated and electron density interferometric measurements were performed. The interferometric measurements, performed for the first time, used a femtosecond laser system synchronized with the PALS laser. The electron concentration measured in the experiment was lower than the initial atomic concentration, indicating the creation of a low-temperature plasma containing neutral atoms. Despite the low temperature, the photoionized plasma emitted soft X-rays originating from inner shell radiative transitions (Ne II, Kα). Such conditions are not encountered in laser-produced or discharge plasmas.

2.11. SOFT X-RAY MICROSCOPY IN THE "WATER WINDOW" SPECTRAL RANGE WITH NANOMETER SPATIAL RESOLUTION

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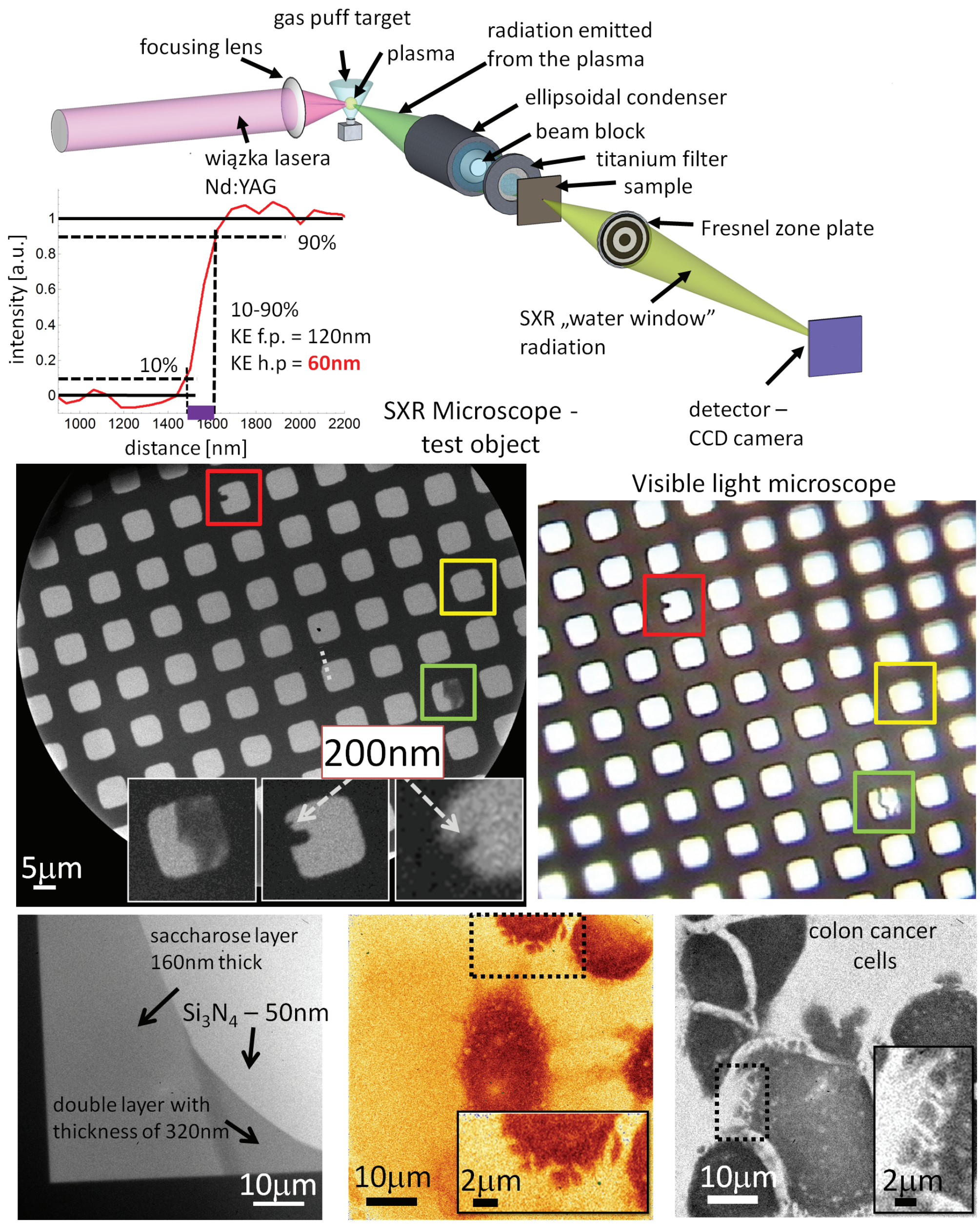
This research involved the imaging of nanostructures using a laser-plasma gas puff target source emitting radiation in the soft X-ray spectral range. To accomplish this, an experimental SXR microscopy system was developed that operates in the "water window" spectral range (wavelength of 2.3–4.4 nm). This range is particularly suitable for imaging biological material due to intrinsic contrast between the water and carbon – the basic constituents of living organisms. The sample was illuminated in the microscope by quasi-monochromatic radiation emitted from the nitrogen plasma (λ = 2.88 nm). The system was equipped with an ellipsoidal, axisymmetric condenser mirror and a Fresnel zone plate objective made from silicon nitride, which allowed the visualization of test objects with a spatial resolution of 60 nm. Applications of this novel microscopy system were demonstrated in material science (a study of thin layers) and in biology (a study of plasmid DNA samples). The microscope has a very compact design and allows for very short exposure times, ranging from a few seconds for the test samples and tens of seconds for real samples. It also allows for a quick adjustment of the system and refocusing in the 1 Hz repetition mode.

Figure 1. Experimental system for soft X-ray microscopy operating in the "water window"


gas puff target
focusing lens
plasma
radiation emitted
from the plasma
ellipsoidal condenser
beam block
titanium filter
sample
wiązka lasera
Nd:YAG
Fresnel zone plate
intensity [a.u.]
90%
10-90%
KE f.p. = 120nm
KE h.p = 60nm
10%
SXR „water window”
radiation
distance [nm]
SXR Microscope -
test object
detector –
CCD camera
Visible light microscope
200nm
5μm
saccharose layer
160nm thick
Si3N4 – 50nm
double layer with
thickness of 320nm
10μm
10μm
2μm
colon cancer
cells
10μm
2μm

3. OPTICAL, NANO AND BIO TECHNOLOGIES

3.1. MANUFACTURING OF PERIODIC 1D AND 2D STRUCTURES IN MATERIALS USING DIRECT LASER INTERFERENCE LITHOGRAPHY (DLIL)

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On the basis of our own research and published data, it can be concluded that a topographic modification of the surface of biocompatible materials enhances their interaction with cells. The natural consequence is an increase in cell adhesion to the substrate, leading to an enlarged area of cell spread (proliferation) as well as orientation of their growth.

The technique of direct laser interference lithography (DLIL) consists of selective laser ablation in interference maxima, resulting in the creation of micro-patterns or micro-wells that are dependent on the number of interfering laser beams. The undisputed advantage of this method in comparison with random structuring is full control of the desired dimensions on the surface of biomaterials (periodicity, height, depth, and width of lines or dimples) through the control laser beam parameters. The DLIL method has been used to modify surfaces of different biocompatible materials, such as gold layers, titanium alloys, and diamond-like carbon (DLC) layers on silicon and polystyrene substrates.

A classical Ti_6Al_4V bio-alloy was patterned using DLIL to improve its properties as a material for hearing implants. Another new $Ti_{13}Nb_{13}Zr$ bio-alloy was subjected to interference micromelting to study the influence of its surface properties on the adhesion of hydroxyapatite (HAp) layers (Figure 1). The regular, post-processing surface roughness, partially following the interference patterns, doubled the increase in the HAp adhesion with a substantial decrease in the HAp layer thickness.

The two photographs in Figure 2 show the laser interference preparation of the DLC layers on a polystyrene substrate for studies of nucleation and growth of smooth muscle cells. The directional development of cells appears according to the linear template on the DLC substrate. Figure 3 shows in turn the results of cell deposition and culturing on a dotted 2D structure for a similar DLC layer.

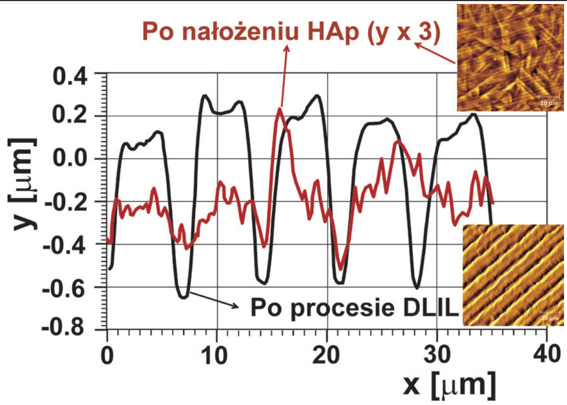

Figure 1. AFM images and surface profiles of a biocompatible $Ti_{13}Nb_{13}Zr$ alloy after interference structuring and after HAp deposition. The laser energy density was 430 mJ/cm^2 at wavelength of 1064 nm

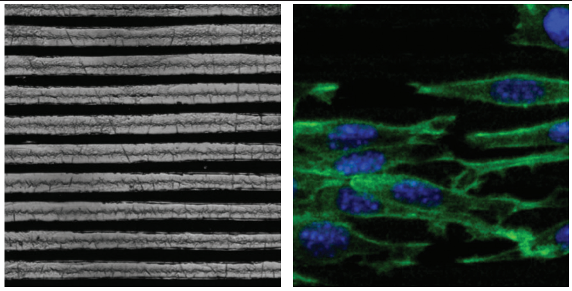

Figure 2 a) Optical microscopic image of linear periodic structure (2nd harmonic of Nd:YAG laser) on DLC layer (polystyrene substrate). b) Image from confocal microscope of directional growth of smooth muscle cells on structure from a)

The migration of cells can also be observed in the direction of the properly modified surface material. Further examination revealed polarization of the cell's membrane and ejection of lamellipodia (actin projections).

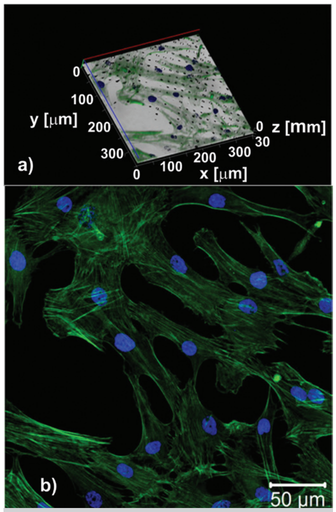

Figure 3. The results of culturing smooth muscle cells on dotted periodical structures, created by the DLIL technique at a DLC layer a) Spatial image with partially hidden dot grid b) Magnified fluorescence image of cell development

3.2. DIFFRACTIVE OPTICS FOR LASER BEAM SHAPING

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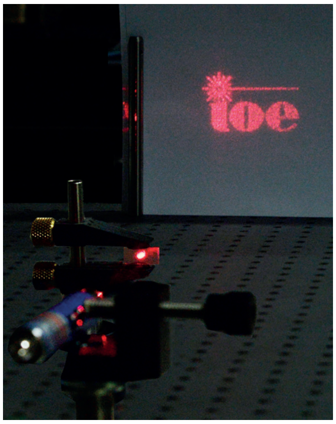
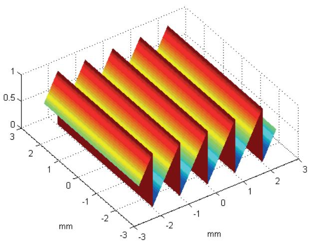
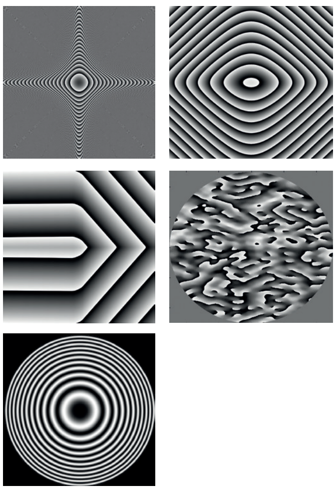
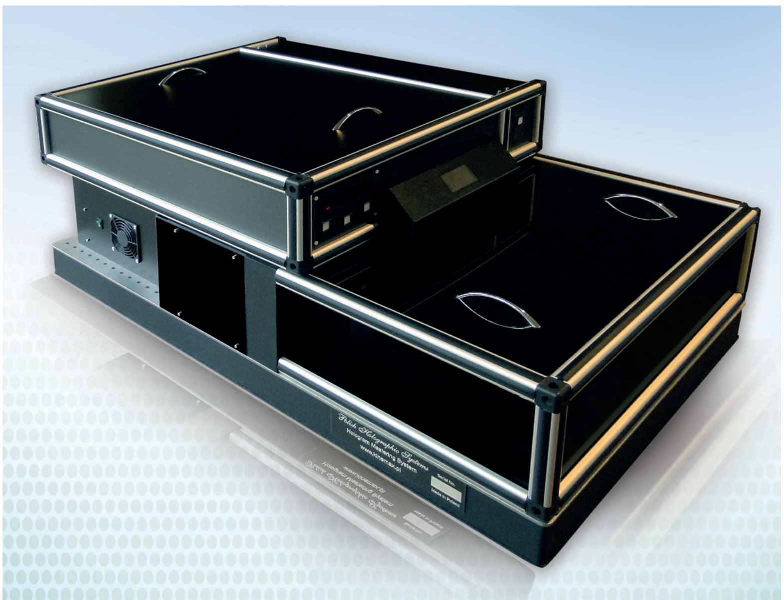
We created a computational platform for the design and optimization of diffractive optical elements (DOEs) oriented for laser transmitter beam shaping in the far field. The designed phase distributions were fabricated as trial kinoform DOEs by the application of direct writing using a photoresist technique. For the optical beam shaping, diffractive optics provides much more freedom compared to conventional refractive (or reflective) components, even when accounting for aspheric surfaces.

The main goal in developing this technology was to obtain results from laser teledetection solutions that are based on high-power pulsed semiconductor lasers. Such lasers provide a low-quality beam, and the corresponding far field optical distribution of the transmitters is characterized by both discretization and asymmetry, which is a drawback for some application. DOEs allow for beam quality improvement and divergence control. Due to the far field regime, our DOEs were designed within the Fraunhofer approximation region. Computational algorithms were based on the iterative Fourier transform algorithm (IFTA), simulated annealing (SA), or stationary phase methods. The quality of the fabricated surfaces was verified by the application of atomic force microscopy (AFM).









3.3. TECHNOLOGY OF REFRACTIVE BEAM SHAPERS

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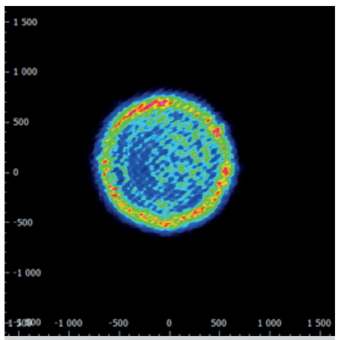
One of the challenges in laser optics is the effective, coherent transformation of the Gaussian profile of a laser beam into a different profile (e.g., "top-hat") with perfect wavefront correction. Such setups have wide applications in laser technology (photo-lithography, laser drilling, cutting), coherent laser pumping, optical parametric oscillators, high energy/power laser systems, etc. In a classical beam shaper scheme, two special, aspheric elements arranged in a Gallileo type telescope are applied. A semi-analytical method for designing such system has been devised and successfully applied. Two different beam shapers were designed using this method. The Q22-XE machine utilizing magneto-rheological finishing (see Figure 1) was used to polish the aspheric profile. Manufactured elements were characterized for coherent and partially coherent laser beams (Figures 2). Manufacturing errors were estimated and conclusions drawn regarding the design, manufacturing, and montage of such systems.

Photo of Q22-XE machine
for magneto-rheological finishing



2D image of laser beam after beam shaper

3.4. BIODETECTOR (BARDet)

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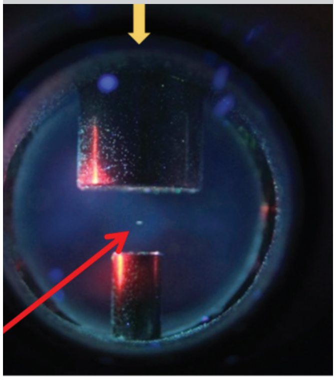
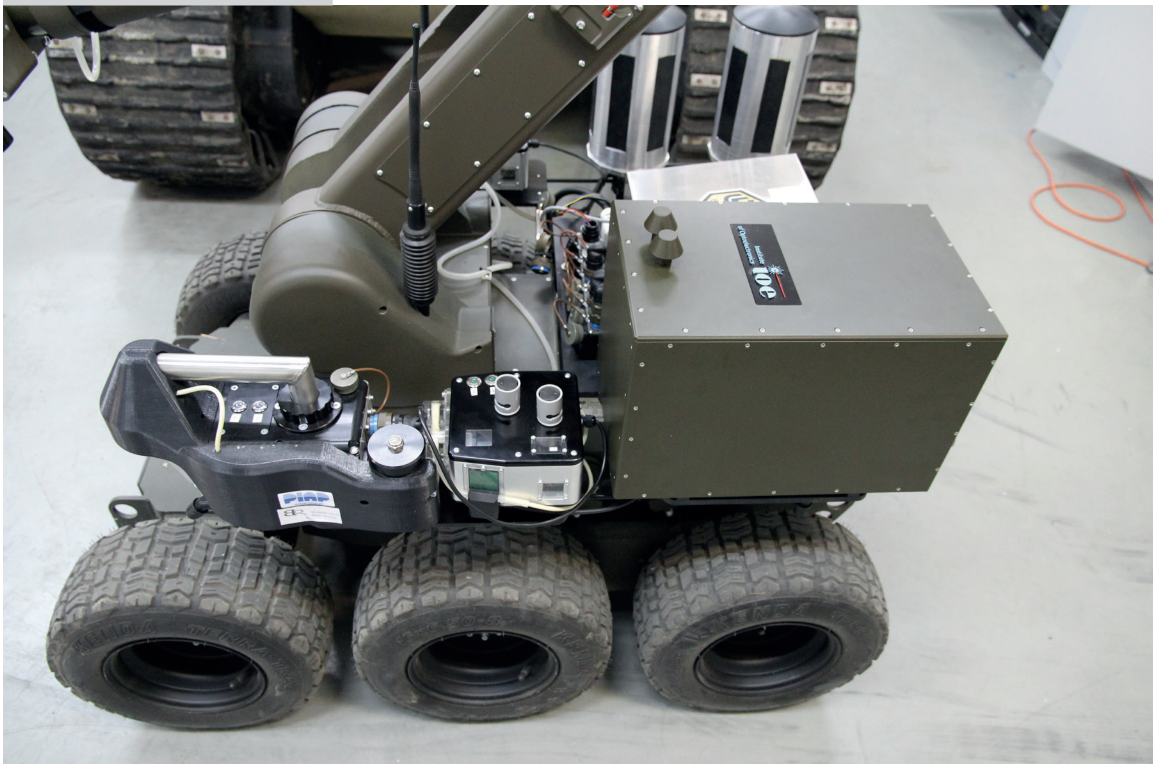
Fluorescence of biological material in BARDet chamber



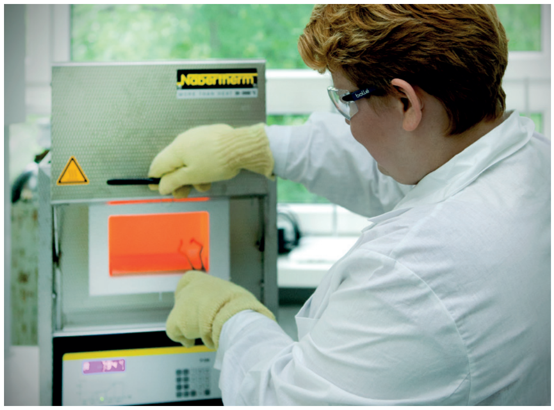
In recent years, there has been increased interest in air monitoring systems using laser-induced fluorescence (LIF) for the detection of biological contamination. The advantage of these devices compared to microbiological and biochemical tests is their ability to detect single molecules in the air in real time. Another advantage is that they can estimate the number, size, and fluorescent properties of particles in a defined volume. An instrument for early warning against biological contamination (BARDet BioAeRosol Detector) was developed at the Institute of Optoelectronics. This device measures the fluorescence and scattering properties of individual particles of microorganisms in real time. The central part of the device is an aerosol chamber, in which the laser beam interacts with individual bioaerosol particles. The fluorescence characteristics recorded from individual particles are analyzed in real time and an independent algorithm sends an alarm signal to the operator.

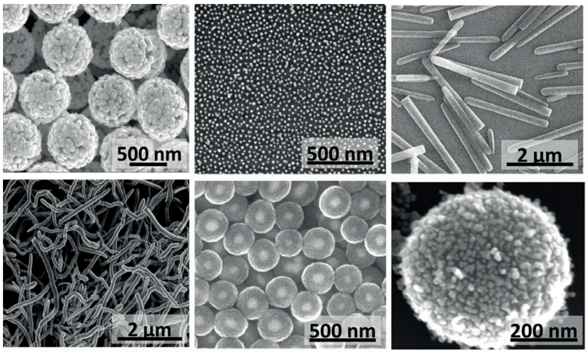
The biodetector can be used either as a module mounted on the PIAP robot, or as a desktop device constantly monitoring the air for the presence of potential pathogens. The biodetector successfully passed laboratory and field validation tests at the Military Institute of Hygiene and Epidemiology in Puławy.

Biodetector BARDet mounted on PIAP robot platform



3.5. PLASMONIC NANOSTRUCTURES FOR APPLICATIONS IN SURFACE-ENHANCED SPECTROSCOPIC TECHNIQUES, PHOTOCATALYSIS, AND PHOTOVOLTAICS





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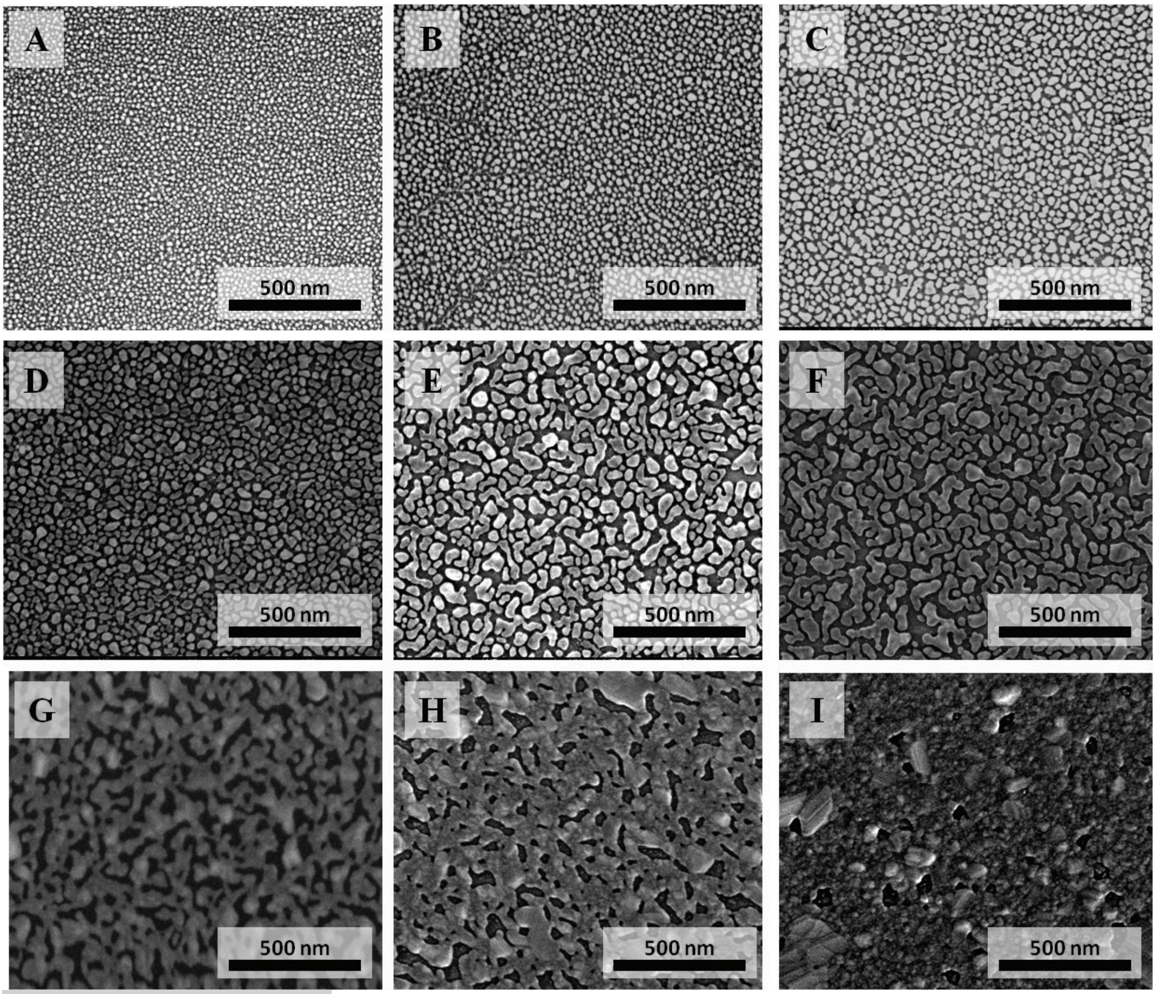
In 2014, we continued our research studies on the fabrication, characterization, and applications of various types of plasmonic nanostructures fabricated using chemical methods. The main efforts were focused on studies of the fabrication and characterization of core-shell nanostructures based on titanium dioxide and noble metals. These have great potential for applications in photocatalysis and photovoltaics. In addition, we conducted research studies on the development of new methods for the synthesis of metallic nanoparticles. Studies on the applications of fabricated plasmonic nanostructures were focused mainly on their use in the surface enhancement of Raman scattering of biological materials.

3.6. FABRICATION OF LAYERS OF PLASMONIC NANOSTRUCTURES BY PVD



Scanning electron microscope images of silver films with different mass thicknesses

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We continued our work on the fabrication of substrates with plasmonic nanostructures using the physical vapor deposition (PVD) technique. We optimized the process for metal island films (MIF) made of silver. Through the control of deposition conditions and parameters, we were able to fabricate layers of narrowband (on the order of 200 nm) and broadband (visible and near infrared) absorption, which have an origin in the specific morphology of silver nanostructures formed on substrates. MIFs have been tested as substrates for surface-enhanced Raman scattering SERS spectroscopy.

3.7. DIAGNOSTICS AND PHOTODYNAMIC THERAPY

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The development and clinical implementation of a photo-diagnostic method and photodynamic therapy is one of the Biomedical Engineering Cluster's projects. The research tasks include:

- Clinic examinations and registration of a Polish preparation for dermatology based on ALA acid
- Physical and chemical examinations and tests of a photo-sensitizer on cellular lines
- Applications of PDD/PDT in stomatology
- Synthesis of new photo-sensitizers
- Design and implementation of modern diagnostics and a therapeutic apparatus for the PDD/PDT method

The most important limitation in the development of PDD/PDT methods in clinical dermatological practice in Poland is access to an inexpensive photo-sensitizer. General usage of this method in dermatology is made possible through the development of synthesis technology, ALA purification, final storage as an ointment, confirmation of the efficiency of the PDT/PDD treatment in clinical conditions, and preparation of the (ointment) registration procedure.

The second elaborated part of this medical product is a light source, built out of sLED matrices with unique properties that allow for more efficient photodynamic therapy.

The constructed head of the PDT illuminator allows the illuminated surface to be adjusted with the shape of the body parts. The implemented operating mode of the illuminator (constant, impulse, discontinuous, soft start) prevents a drastic decrease in oksyhemoglobin level during illumination.

Led matrix illuminator

Apparatus for luminescence spectrum and lifetime measurements in the UV-VIS-NIR range including the singlet oxygen marking

3.8. "IN VITRO" DIAGNOSTICS OF OXIDATION STRESS IN CANCER CELLS

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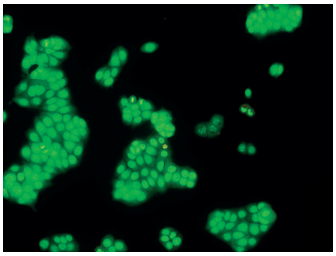
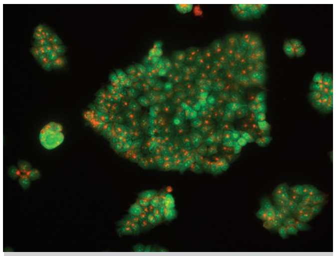
One of the aims of the Biomedical Engineering Center is to establish the impact of electromagnetic fields on the human body. Current research focuses on in vitro studies of various human cancer cell lines, including prostate cancer, cervical cancer, and breast cancer.

The main goal of this project is to examine oxidative stress in cells, which is defined as disturbances in the imbalance between the generation of reactive oxygen species (ROS) and antioxidant capacity. Our laboratory is equipped with an electron paramagnetic resonance (EPR) for the quantitative measurement of free radicals with the highest sensitivity. The principle of this method is based on the detection of substances containing one or more unpaired electrons.

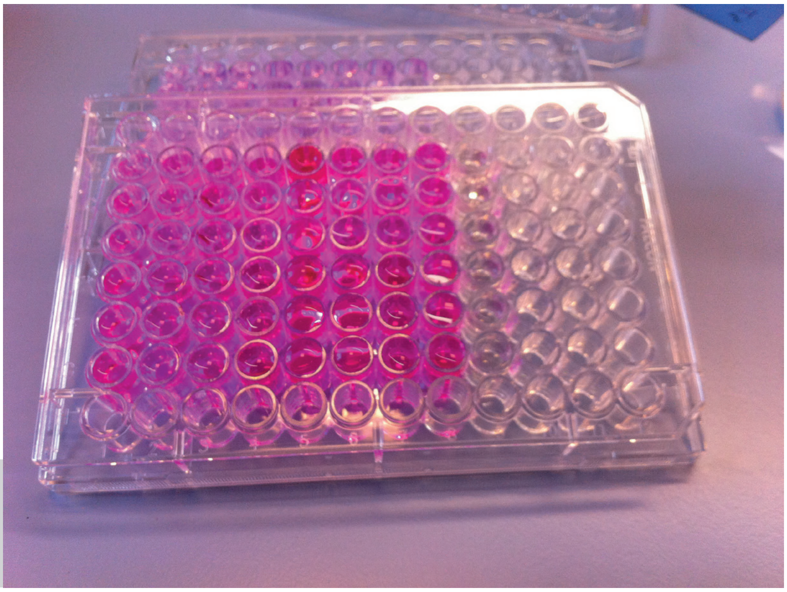
To visualize the subcellular localization of the reactive oxygen species in cancer cells, we also use an automated fluorescence microscopy system. Microscope-controlled software enabled the automatic machine learning-based detection of rare events in living cells and the unattended operation of complex imaging assays.

The study of oxidative stress in cancer cells can be useful in searching for new therapeutic strategies for cancer diseases.





Breast cancer cells stained with ethidium bromide and acridine orange



Assessment of breast cancer cells viability using MTT assay

4.

OPTOELECTRONIC TECHNOLOGIES AND SYSTEMS

4.1. MODERNIZATION OF MULTISPECTRAL REFLECTANCE LASER PROFILOMETER

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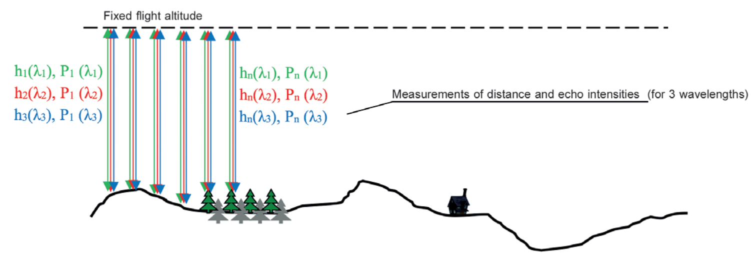
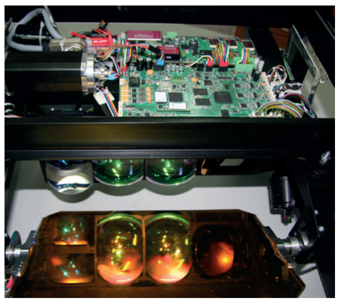
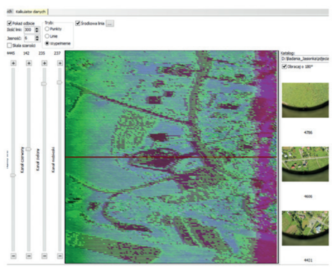
We developed an optimized version of a laser reflectance profilometer. This system enables the collection of unique data of the analyzed terrain that are not obtainable by conventional techniques (photography, thermovision). Measurements are based on terrain laser scanning at three wavelengths simultaneously: 850 nm, 905 nm, and 1550 nm. Apart from the surface elevation, additional data is acquired from the relative ratios of the measured optical echo intensities at a.m. wavelengths.







4.2. HANDHELD LASER PHOTO-SPEEDOMETER

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An integrated system of a laser speedometer and image acquisition unit was developed. The formal requirement for these devices is a capability for simultaneously acquiring a speed measurement and a corresponding image (or video) showing the vehicle measured.

The speedometer includes a laser module for a precise distance measurement, which is based on a pulsed semiconductor laser and digital camera. For the speed evaluation, the system performs multiple distance measurements, each obtained by the application of the TOF (Time of Flight) method. The device communicates with the user via two color displays (the main and the near-eye). A keyboard and additional buttons are located both on the body and on the handle. The main 4.3” LCD display provides a touch screen. The speedometer offers precision at the level of 1 km/h and a maximum range of 1 km.

4.3. AUTOMATED BORDER CONTROL (ABC)

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The ABC system compares the fingerprint and face photograph coded in a biometric passport with the same data directly registered from the passenger. Additionally, the possibility that this document can be forged can be analyzed by this system in three spectral ranges. Applying this solution in practice will increase border traffic control and will contribute to the improved safety of EU borders. The ABC system was developed in cooperation with two companies: Optel and MLabs.

4.4. DIAGNOSIS OF STEAM TURBINE BLADES USING ACTIVE IMAGING

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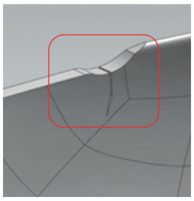
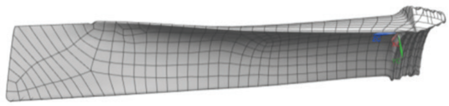
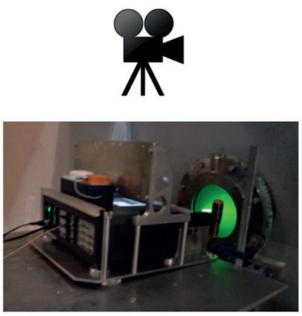
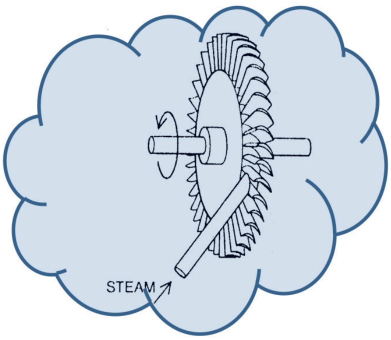
An experimental vision system is applied to monitor the degradation of the steam turbine 13k225, with the aim of detecting cracks on the surface of the blades. The UFL system uses the



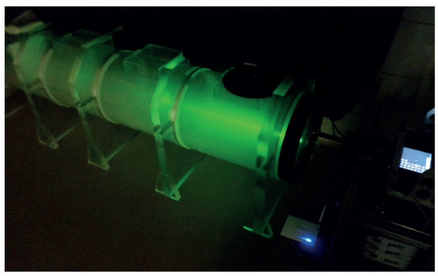


Active imaging camera





Real environment



Simulated measurement environment

space-time framing method, which allows an observation of objects under dynamic conditions in the presence of a scattering medium. The proposed solution can be used to reduce the failure of power blocks. Tests have been conducted at the Jaworzno III Power Station. The system is implemented in cooperation with HardSoft and ZRE Katowice.

4.5. FREE SPACE OPTICAL LINK WITH QUANTUM CASCADE LASER

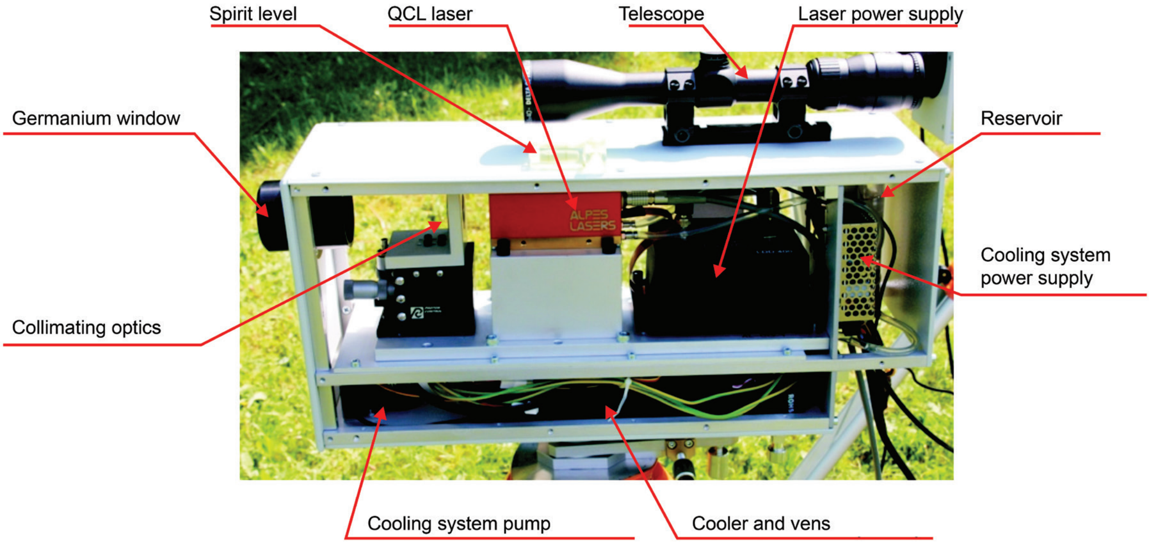


Photo of the FSO transmitter module

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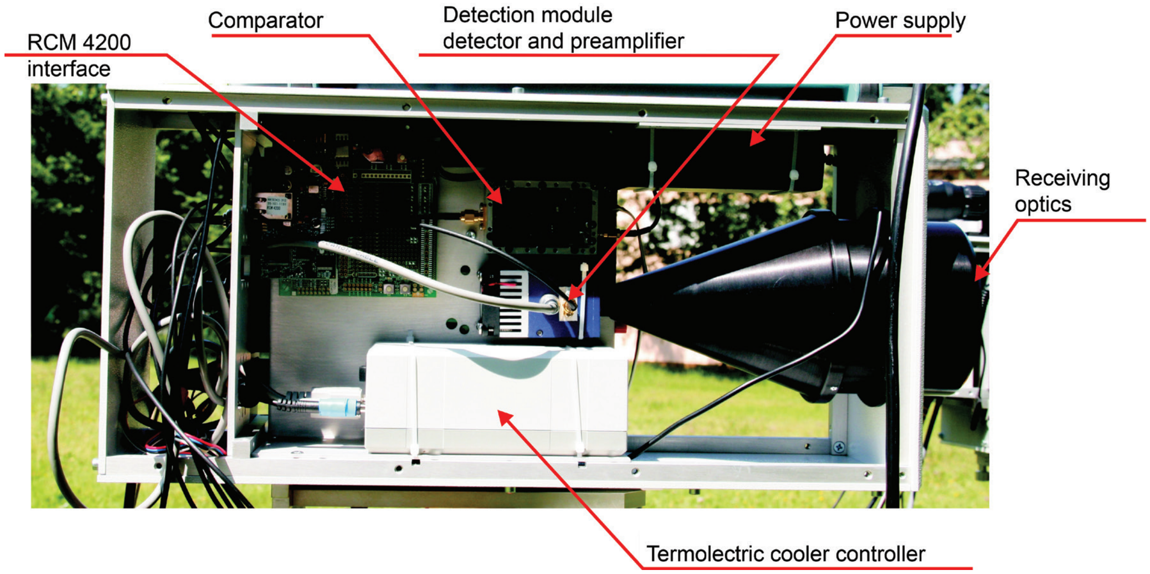
With the invention of quantum cascade lasers (Quantum Cascade Lasers - QCL) and HgCdTe detectors, it is now possible to develop a third generation optical link in an open space (Free Space Optics - FSO) operating in the spectral range of 8–12 microns.
It has been shown that the developed system has superior transmission characteristics in the case of poor visibility, i.e., weak rain or fog, and it is less sensitive to atmospheric turbulence compared with commercial systems.
Comprehensive research into the FSO receiver and transmitter modules was performed and used to select the optimal working conditions of these modules in order to obtain a minimum bit error rate, maximum range, and maximum capacity of the FSO system.

Photo of the FSO receiver module



4.6. SYSTEM FOR HUMAN BREATH SAMPLING

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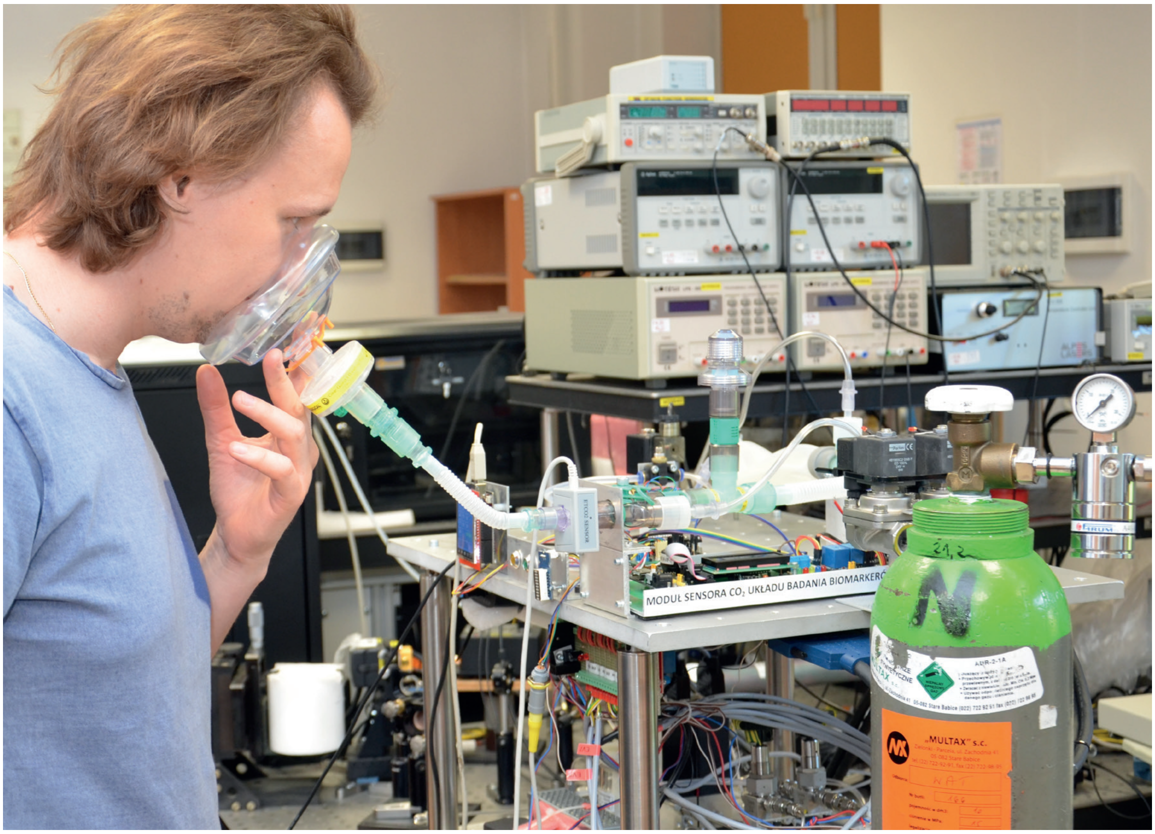
The field of modern medical diagnostics has increased interest in human breath analysis. This technique has the potential to detect some diseases based on biomarkers or gases collected during patient screening, as their concentration relates to the patient's state of health. To improve both the accuracy of the concentration measurements and the reliability of the results, appropriate human breath sampling and proper conditioning is needed.

A system developed for breath sampling probes the exhaled air coming from the lower respiratory tract. These air probes are most valuable for medical diagnosis. To minimize the influence of interfering substances such as water or carbon dioxide, the system dries the samples (up to value of RH = 2%) and reduces their pressure (up to level of 50 mbar).



4.7. MEASUREMENT STAND FOR THE TESTING OF INFRARED CAMERAS WITH FOCAL PLANE ARRAYS

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The imaging quality of an infrared camera depends on several factors: the sensitivity, NETD, detector non-uniformity, and its effective correction (NUC correction). The important figures of merit and coefficients of a NUC correction can be determined using a specialized measurement stand. Such a stand, designed to test infrared cameras with FPA detectors, has been developed in the Infrared Technology and Thermovision Section. The measurement set-up consists of four main elements:

- reference blackbodies
- linear motion module and its control unit
- IR Capture data acquisition device
- computer with IR Diag software

a) b)

Automatic test stand for the measurement of basic characteristics and calibration of infrared cameras. a) With linear motion module, b) with rotary table

The automatic change of a blackbody in the camera's field of view is realized by mounting the camera on a linear motion module, driven by a programmable controller. The module assures precise and repeatable camera positioning in front of the selected blackbody. Alternatively, a rotary table and a slightly different blackbody setup can also be used. In both cases the camera positioning is controlled by IR Diag software.

This software, specially developed at IOE MUT, also supervises the recording of the measurement data required to determine NUC correction coefficients, and performs a statistical analysis of the image data by calculating the mean value of the registered temperature, standard deviation, and histogram.

4.8. METHOD AND SYSTEM FOR OBJECT DETECTION WITH USE OF IMAGING POLARIMETRY IN LONG-WAVE INFRARED

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This project is developing a unique apparatus and method for object detection that uses long-wave infrared radiation polarization state analysis techniques. Long-wave infrared radiation is the same range of electromagnetic radiation used in well-known thermal imaging cameras, for example, those used for non-contact temperature measurements. However, unlike traditional thermal cameras, this device will analyze the polarization state of radiation coming from an object, allowing the detection of specific properties of the observed objects.

Its principle of operation is based on the phenomenon that occurs when there is partial reflection of light hitting a surface of a different optical medium. If the angle of incidence is nonzero, there is partial polarization of the reflected wave. This phenomenon is described with Fresnel equations and can be commonly observed, for example, in the form of a mirage on a hot road or reflections from a windowpane. A well-equipped photographer using a polarizer filter or driver with polarizing glasses can reduce such unpleasant reflections. The principles are the same in the infrared electromagnetic radiation range and the detection of polarized radiation can provide interesting information about the observed scene. For example, naturally occurring objects are texturized and mostly reflect unpolarized radiation, while artificial objects are often smooth and present polarimetric signatures. Due to this property, there is the possibility of distinguishing natural objects from hidden artificial objects. Sometimes there may be the opposite situation when polarized light comes from the smooth surface of the water, and unpolarized light comes from an object (e.g., a survivor) swimming on its surface. The remote sensing method will be implemented in a device consisting of a custom-built optical system, a detection system with a microbolometric focal plane array, and a signal processing module.

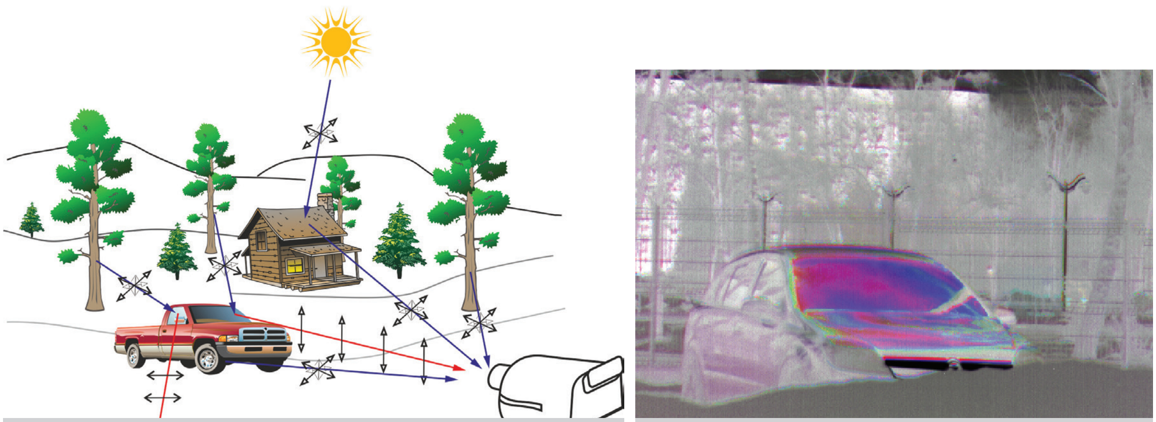

Figure 1.
a) The principle of operation of the constructed device
b) Visualization of polarization state measurement results in the LWIR range

5.

APPENDIX 1. LIST OF RESEARCH AND DEVELOPMENT PROJECTS IN 2014

A1.1. PROJECTS FINANCED BY EU AND OTHER INTERNATIONAL ORGANIZATIONS

M1. PUM/09-041/2013/WAT, Terahercowe platformy obrazujące do zdalnej detekcji IED (improwizowanych ładunków wybuchowych) (TIPPSI), EUROPEJSKA AGENCJA OBRONY EDA, Kierownik: PAŁKA Norbert

M2. PUM/09-058/2013/WAT, RAMBO, EUROPEJSKA AGENCJA OBRONY EDA, Kierownik: JANKIEWICZ Bartłomiej

M3. PUM/09-153/2014/WAT, „AMURFOCAL -Active Multispectral Reflection Fingerprinting of Persistent Chemical Agents", EUROPEJSKA AGENCJA OBRONY EDA, Kierownik: KASTEK Mariusz

M4. PMW/35-002/2013/WAT, Wytwarzanie laserem promieniowania rentgenowskiego i skrajnego nadfioletu (EUV) do zastosowań w inżynierii materiałowej i biomedycynie LASERLAB-EUROPE, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: FIEDOROWICZ Henryk

M5. PRUE/31-089/212/WAT, Laserlab Europe III, KOMISJA WSPÓLNOT EUROPEJSKICH, Kierownik: FIEDOROWICZ Henryk

M6. NCN/36-433/2013/WAT, Impulsowe lasery na ośrodkach quasi-III-poziomowych pompowanie poprzeczna 2D stosami diod laserowych dużej mocy, NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: JABCZYŃSKI Jan

M7. FS/32-015/2013/WAT, Rozwój Klastra Centrum Inżynierii Biomedycznej, POLSKA AGENCJA ROZWOJU, Kierownik: ŁAPIŃSKI Mariusz

M8. FS/32-069/2009/WAT, Innowacyjne technologie wielofunkcyjnych materiałów i struktur dla nanoelektroniki, fotoniki, spintroniki i techniki sensorowych (InTechFun)., INSTYTUT TECHNOLOGII ELEKTRONOWEJ, Kierownik: KOPCZYŃSKI Krzysztof

M9. FS/32-391/2010/WAT, Rozbudowa bazy laboratoryjnej Instytutu Optoelektroniki Wojskowej Akademii Technicznej, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: SZCZUREK Mirosław

M10. FS/32-480/2013/WAT, Kompozytowy system pasywnej i aktywnej ochrony obiektów infrastruktury krytycznej, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: SZUSTAKOWSKI Mieczysław

A1.2. PROJECTS FINANCED BY NATIONAL SCIENCE CENTRE

BP1. NCN/07-023/2011/WAT, Badania niskostratnego sposobu łączenia włókien optycznych I wykonywania wybranych komponentów światłowodowych., NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: MACIEJEWSKA Maria

BP2. NCN/07-145/2012/WAT, Badanie procesu zatężania I dekompozycji w optoelektronicznym sensorze par materiałów wybuchowych, NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: RUTECKA Beata

BP3. NCN/07-148/2012/WAT, Mikroskopia w zakresie skrajnego nadfioletu oraz miękkiego promieniowania rentgenowskiego, NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: WACHULAK Przemysław

BP4. NCN/07-150/2012/WAT, Wpływ budowy plazmonowych monostruktur core-shell na bazie tlenku tytanu i metali szlachetnych na ich właściwości optyczne i fotoelektryczne, NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: JANKIEWICZ Bartłomiej

BP5. NCN/07-169/2012/WAT, Badania wpływu zjawisk laserowych i optycznych z wykorzystaniem pompującego tulowego lasera światłowodowego dużej mocy na uzyskanie wydajnej generacji laserowej w hybrydowych impulsowych laserach Ho:YLF wykonanych w konfiguracji MOPA, NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: KWIATKOWSKI Jacek

BP6. NCN/07-381/2013/WAT, Nowe lasery ciała stałego z samo-adaptującymi rezonatorami wykorzystujące efekt cztero-falowego mieszania w ośrodku czynnym., NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: ŻENDZIAN Waldemar

BP7. NCN/07-124/2014/WAT, Analiza teoretyczna oraz badania właściwości generacyjnych pompowanego koherentnie, impulsowego lasera Cr:ZnSe przestrajalnego w paśmie widmowym około 2400 nm., NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: GORAJEK Łukasz

BP8. NCN/07-125/2014/WAT, Fotojonizacja ośrodków gazowych impulsami promieniowania plazmy laserowej, NARODOWE CENTRUM NAUKI KRAKÓW, Kierownik: BARTNIK Andrzej

A1.3. PROJECTS FINANCED BY NATIONAL CENTRE FOR RESEARCH AND DEVELOPMENT AND MINISTRY OF SCIENCE AND HIGHER EDUCATION

BR1. PBR/15-599/2011/WAT, Femtosekundowy laser terawatowy bazujący na wzmacnianiu parametrycznym., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: FIEDOROWICZ Henryk

BR2. PBR/15-047/2011/WAT, Nowoczesne technologie dla/w procesie karnymi ich wykorzystanie – aspekty techniczne, kryminalistyczne, kryminologiczne I prawne., NARODOWE CENTRUM BADAŃ I ROZWOJU WYDZIAŁ CYBERNETYKI (Uniwersytet Białostocki), Kierownik: SZUSTAKOWSKI Mieczysław

BR3. 15-037/2012/WAT, Mobilne laboratorium do poboru próbek środowiskowych i identyfikacji zagrożeń biologicznych, NARODOWE CENTRUM BADAŃ I ROZWOJU WYDZIAŁ MECHANICZNY (Wojskowy Instytut Higieny i Epidemiologii), Kierownik: KOPCZYŃSKI Krzysztof

BR4. PBR/15-055/2012/WAT, Opracowanie metod technologii wspomagania ochrony perymetrycznej terenów granicznych i portów lotniczych w oparciu o zaawansowaną analizę sygnałów akustycznych i obrazów wizyjnych., NARODOWE CENTRUM BADAŃ I ROZWOJU (AKADEMIA MARYNARKI WOJENNEJ), Kierownik: SZUSTAKOWSKI Mieczysław

BR5. PBR/15-291/2012/WAT, Celownik termowizyjny kompatybilny z systemem C4ISR ISW TYTAN, zintegrowany z wyświetlaczem nahełmowym, modułem laserowego systemu identyfikacji „swój-obcy" (IFF) z możliwością zdalnego sterowania głównymi funkcjami celownika., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: SOSNOWSKI Tomasz

BR6. PBR/15-305/2012/WAT, Kamery obserwacyjno-rozpoznawcze o szerokim zakresie natężenia światła LLL/CCD TV kompatybilne z systemem C4ISR ISW TYTAN, NARODOWE CENTRUM BADAŃ I ROZWOJU (BUMAR ŻOŁNIERZ S.A.), Kierownik: MADURA Henryk

BR7. PBR/15-301/2012/WAT, System monitorowania integralności łącza światłowodowego w celu ochrony przed nieautoryzowanym dostępem do informacji niejawnych., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: ŻYCZKOWSKI Marek

BR8. PBR/15-314/2012/WAT, Uprawnienie procesu odprawy granicznej osób przy wykorzystaniu biometrycznych urządzeń do samokontroli środków transportu przekraczających granicę zewnętrzną UE., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: SZUSTAKOWSKI Mieczysław

BR9. PBR/15-316/2013/WAT, Środki ochrony wzroku i sprzętu przed wysokoenergetycznym promieniowaniem elektromagnetycznym, w tym laserowym, w szerokim zakresie widma zgodnie z ISW TYTAN., NARODOWE CENTRUM BADAŃ I ROZWOJU (WYDZIAŁ NOWYCH TECHNOLOGII I CHEMII), Kierownik: ZYGMUNT Marek

BR10. PBR/15-098/2013/WAT, Mobilna kontrola graniczna z wykorzystaniem technik biometrycznych dostosowana do wymogów i zaleceń UE., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: SZUSTAKOWSKI Mieczysław

BR11. PBR/15-097/2013/WAT, Inteligentny antypocisk do zwalczania pocisków przeciwpancernych, NARODOWE CENTRUM BADAŃ I ROZWOJU WYDZIAŁ MECHANICZNY, Kierownik: ZYGMUNT Marek

BR12. PBR/15-114/2014/WAT, Narzędzie wspomagające prowadzenie postępowania przygotowawczego i wykonywanie czynność w procesie wykrywczym poprzez odtwarzanie wyglądu miejsca zdarzenia i okoliczności zdarzenia., NARODOWE CENTRUM BADAŃ I ROZWOJU CGS, Kierownik: KASTEK Mariusz

BR13. PBR/15-067/2014/WAT, Innowacyjny hełm strażacki zintegrowany z obserwacyjnym systemem termowizyjnym i systemem umożliwiającym monitorowanie funkcji życiowych strażaka ratownika oraz wyjściem do transmisji obrazów i danych do urządzeń zewnętrznych., NARODOWE CENTRUM BADAŃ I ROZWOJU CENTRALNA SZKOŁA PAŃSTWOWEJ STRAŻY POŻARNEJ CZĘSTOCHOWA. PRZEDSIĘBIORSTWO SPRZĘTU OCHRONNEGO ,ASKPOL S.A., Kierownik: MADURA Henryk

BR14. PBR/15-072/2014/WAT, Opracowanie środowiska do wdrożeń koncepcji SmartBorders., NARODOWE CENTRUM BADAŃ I ROZWOJU JAS TECHNOLOGIE GEMALTO SP Z O.O., Kierownik: SZUSTAKOWSKI Mieczysław

BR15. PBST/27-054/2013/WAT, Opracowanie energooszczędnego zestawu biometrycznego do mobilnej kontroli dokumentów i osób z użyciem systemów akustycznych i zobrazowania twarzy, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: SZUSTAKOWSKI Mieczysław

BR16. PBST/27-086/2012/WAT, Emitery i detektory podczerwieni nowej generacji do zastosowań w urządzeniach do detekcji śladowych ilości zanieczyszczeń gazowych, NARODOWE CENTRUM BADAŃ I ROZWOJU (Instytut Technologii Elektronowej), Kierownik: BIELECKI Zbigniew

BR17. PBST/27-225/2012/WAT, Wielopikselowy detektor promieniowania THz zrealizowany z wykorzystaniem selektywnych tranzystorów MOS i jego zastosowanie w biologii, medycynie i systemach bezpieczeństwa., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: ZAGRAJEK Przemysław

BR18. PBST/27-238/2012/WAT, Opracowanie głowicy skanującej z układami nadawczo-odbiorczymi nowej generacji do wielospektralnego laserowego profilometru reflektancyjnego umożliwiającego określanie rzeźby i charakterystyk fizykochemicznych pokrycia terenu . Do zastosowania na platformie powietrznej., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: PIOTROWASKI Wiesław

BR19. PBST/27-239/2012/WAT, Optoelektroniczny system sensorów markerów chorobowych., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: BIELECKI Zbigniew

BR20. PBST/27-281/2012/WAT, Opracowanie warunków wytwarzania spinela magnezowego MgA1204,skandowo-magnezowego ScMgA104,oraz szkła Er, Yb, do zastosowania w mikrolaserach dalmierczych, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: MŁYŃCZAK Jarosław

BR21. PBST/27-345/2012/WAT, Ręczny fotoradar laserowy., NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: WOJTANOWSKI Jacek

BR22. INT/19-142/2012/WAT, System zdalnego wykrywania par alkoholu w poruszających się pojazdach., NARODOWE CENTRUM BADAŃ I ROZWOJU (AWAT.), Kierownik: KOPCZYŃSKI Krzysztof

BR23. INT/19-388/2013/WAT, Opracowanie kompleksowej technologii wytwarzania magneto-zwierciadeł dla precyzyjnych wyrobów z dziedziny mechatroniki stosowanych w giroskopowych systemach naprowadzania rakiet na cel., NARODOWE CENTRUM BADAŃ I ROZWOJU (Instytut Metalurgii Żelaza Gliwice.), Kierownik: NOGA Janusz

BR24. INT/19-045/2014/WAT, Lasery chirurgiczne wysokiej mocy pracujące na długości fali 1470nm i 1940 nm do zastosowań w małoinwazyjnej chirurgii endoskopowej i robotycznej., NARODOWE CENTRUM BADAŃ I ROZWOJU (METRUM CRYOFLEX S z o.o., sp.k.), Kierownik: ŚWIDERSKI Jacek

BR25. PPFN/34-198/2012/WAT, Nanostruktury plazmonowe do zastosowań w fotowoltaice i optoelektronice, MINISTESSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: NYGA Piotr

BR26. PPFN/34-038/2013/WAT, Metoda i system do wykrywania obiektów z użyciem polarymetrii obrazowej w zakresie dalekiej podczerwieni, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: BIESZCZAD Grzegorz

BR27. PPFN/34-049/2013/WAT, Mikroskop EUV z nanometrową rozdzielczością przestrzenną do zastosowań we współczesnej nauce i technologii, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: WACHULAK Przemysław

BR28. PPFN/34-068/2014/WAT, Detektory promieniowania THz wytworzone z wykorzystaniem tranzystorów polowych do zastosowania w komunikacji bezprzewodowej, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: ZAGRAJEK Przemysław

BR29. PBG/12-620/2011/WAT, Badania czasów życia fluorescencji symulatorów i interferentów bojowych środków biologicznych metodą stroboskopową, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: KALISZEWSKI VEL KIELISZEWSKI Miron

BR30. PBG/12-628/2011/WAT, Laserowe interferencyjne kształtowanie warstw powierzchni metali, NARODOWE CENTRUM BADAŃ I ROZWOJU, Kierownik: MARCZAK Jan

BR31. FNP/18-083/2012/WAT, Światłowodowy nadajnik laserowy wykonany w technologii all--fiber, generujący promieniowanie w paśmie widmowym ”bezpiecznym dla wzroku”., FUNDACJA NA RZECZ NAUKI POLSKIEJ, Kierownik: MACIEJEWSKA Maria

A1.4. SCIENTIFIC STIPENDIUMS FOR EXCELLENT YOUNG SCIENTISTS

SN1. PPFN/34-000/2011/WAT, Finansowanie stypendium naukowego decyzją Ministra z dnia 20.10.2011 dla wybitnego młodego naukowca, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, WACHULAK Przemysław

SN2. PPFN/34-001/2012/WAT, Finansowanie stypendium naukowego decyzją Ministra z dnia 31.10.2012 dla wybitnego młodego naukowca, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, NYGA Piotr

SN3. PPFN/34-004/2014/WAT, Finansowanie stypendium naukowego decyzją Ministra z dnia 31.10.2012 dla wybitnego młodego naukowca, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, JANKIEWICZ Bartłomiej

A1.5. STATUTE RESEARCH PROJECTS FINANCED BY MINISTRY OF SCIENCE AND HIGHER EDUCATION

ST1. PBS/23-670/2012/WAT, Zastosowanie laserów kaskadowych w spektroskopii strat we wnęce optycznej, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: BIELECKI Zbigniew

ST2. PBS/23-671/2012/WAT, Analiza i badania obserwacyjnych systemów do wielowidmowej detekcji w podczerwieni, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: KASTEK Mariusz

ST3. PBS/23-672/2012/WAT, Analiza i przetwarzanie sygnałów w obserwacyjnych kamerach termowizyjnych o dużej rozdzielczości przestrzennej, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: SOSNOWSKI Tomasz

ST4. PBS/23-673/2012/WAT, Metody badawcze i stanowiska do pomiaru wybranych parametrów matryc detektorów podczerwieni i wyznaczania współczynników do ich korekcji, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: ORŻANOWSKI Tomasz

ST5. PBS/23-902/2014/WAT, Optoelektroniczne rozpoznanie pola walki., MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: ZYGMUNT Marek

ST6. PBS/23-903/2014/WAT, Optoelektroniczne metody wytwarzania i charakteryzacji nanostruktur dla potrzeb techniki wojskowej., MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: GIETKA Andrzej

ST7. PBS/23-904/2014/WAT, Zabezpieczenie metrologiczne optoelektroniki., MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: J. Janucki

ST8. PBS/23-905/2014/WAT, Analiza porównawcza symulatorów lotów przenośnych rakiet przeciwlotniczych krótkiego zasięgu., MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: PUZEWICZ Zbigniew

ST9. PBS/23-906/2014/WAT, Multispektralne urządzenia optoelektroniczne w systemach bezpieczeństwa, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: SZUSTAKOWSKI Mieczysław

ST10. PBS/23-907/2014/WAT, Militarne zastosowania laserów pompowanych wiązkami światła, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: ŻENDZIAN Waldemar

ST11. PBS/23-908/2014/WAT, Laserowe i plazmowe technologie mikro-i nano - obróbki warstwy wierzchniej materiałów, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: BARTNIK Andrzej

ST12. SPUB/26-159/2014/WAT, Laboratorium laserowo-plazmowych źródeł promieniowania rentgenowskiego i skrajnego nadfioletu wysokiej intensywności -HIXEL, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: BARTNIK Andrzej

ST13. SPUB/26-161/2014/WAT, Utrzymanie w 2014 roku specjalnego urządzenia badawczego (SPUB) pn. Stanowisko badań dynamicznych (SPD) modułów funkcjonalnych przeniesionych rakiet przeciwlotniczych, MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: NOGA Janusz

ST14. PRMN/08-663/2011/WAT, Analiza parametrów i badania układów do zatężenia i termicznej dekompozycji par materiałów wybuchowych., MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: RUTECKA Beata

ST15. PRMN/08-978/2014/WAT, Modyfikacja parametrów warstwy powierzchniowej polimerów o niskiej temperaturze degradacji metodami plazmowymi., MINISTERSTWO NAUKI I SZKOLNICTWA WYŻSZEGO, Kierownik: BUDNER Bogdan

A1.6. RESEARCH PROJECTS FINANCED BY OTHER SOURCES

PBU1. PBU/01 /598 2011/WAT, Modernizacja przenośnego przeciwlotniczego zestawu rakietowego „GROM", BUMAR AMUNICJA S.A., Kierownik: PUZEWICZ Zbigniew

PBU2. PBU/01-122/2012/WAT, Wykonanie 19 szt. Układów detekcyjnych FAD Mod.1 do głowicy samonaprowadzającej na promieniowanie podczerwone rakiety morskiej P-22, zwanej dalej „towarem"., CENZIN SP. Z O.O., Kierownik: NOGA Janusz

PBU3. PBU/01-195/2012/WAT, System amunicji precyzyjnego rażenia do 120 mm moździerza kryptonim RAK i System amunicji precyzyjnego rażenia dla samobieżnych haubic kal.155 mm kryptonim KRAB,KRYL., BUMAR AMUNICJA S.A., Kierownik: PUZEWICZ Zbigniew

PBU4. PBU/01-356/2012/WAT, Cytadela Bezpieczeństwa Statków – system ochrony jednostek pływających przed atakami pirackimi., Przedsiębiorstwo Produkcyjno – Usługowe INTERMET Sp. z o.o., Kierownik: SZUSTAKOWSKI Mieczysław

PBU5. PBU/01-040/2013/WAT, Przeprowadzenie badań przemysłowych będących częścią projektu „Opracowanie koncepcji meta masztu z własnym zasilaniem energią wiatrową, o nowych parametrach funkcjonalności i wielobranżowym zastosowaniu", Centrum Badawcze CLEAR AIR Sp. z o.o., Kierownik: ZYGMUNT Marek

PBU6. PBU/01-118/2014/WAT, Usługi badawcze: Opracowanie dokumentacji transmiterów....,opracowanie dokumentacji stacji monitoringowej...., TOWERNET SYSTEM, Kierownik: ZYGMUNT Marek

PBU7. PBU/01-205/2014/WAT, Wykonanie badań kamery termowizyjnej w warunkach laboratoryjnych systemu SKO-DRAWA-T., Wojskowy Instytut Techniki Pancernej i Samochodowej, Kierownik: KASTEK Mariusz

PBU8. PBU/01-172/2014/WAT, Zadanie 1 Analiza problemu diagnostycznego dotyczącego degradacji łopatek turbin -opracowanie metody pomiarowej i wymagań dla innowacyjnego laserowego systemu wizyjnego. W ramach realizacji projektu" Innowacyjne laserowe metody diagnostyki oraz technologie naprawy łopatek turbin parowych", Zakład Remontowy Energetyki Katowice Spółka Akcyjna, Kierownik: PISZCZEK Marek

PBU9. PBU/01-036/2014/WAT, Badania i pomiar parametrów zestawu 12 kamer termowizyjnych w zakresie określonym w zał. Nr 1., Bracia Strzelczyk, Kierownik: KASTEK Mariusz

PBU10. PBU/02-254/1999/WAT, Poufna, BUMAR AMUNICJA S.A., Kierownik: PUZEWICZ Zbigniew

PBU11. PBU/02-189/2014/WAT, Zaawansowane Indywidualne Systemy Walki(ZISW) kr. TYTAN, Skarb Państwa Inspektorat Uzbrojenia, Kierownik: ZYGMUNT Marek

PBU12. PBN/03-110/2014/WAT, Pomiary i badania kamery termowizyjnej SOPHIE ZS, Spółka Thales Polska sp. z o.o., Kierownik: MADURA Henryk

PBU13. PBN/03-130/2014/WAT, Badania wizualizacji oddziaływania silnych impulsów laserowych z materiałami, PAN, Kierownik: MARCZAK Jan

PBU14. PBN/03-137/2014/WAT, Instrumentalna analiza warunków i efektów powierzchniowych utrwalania laserowego w automatycznym układzie nanoszenia środków barwnych na podłoża szklane., Instytut Ceramiki i Materiałów Budowlanych, Kierownik: RYCYK Antoni

PBU15. PBN/03-155/2014/WAT, Doradztwo w procesie wyłonienia Wykonawcy w organizowanym przez spółkę postępowaniu na zaprojektowanie i wykonanie technicznego systemu ochrony perymetrycznej Lotniska Warszawa/Modlin oraz uczestnictwo w ocenie należytego wykonania umowy z wyłonionym w wyniku postępowania wykonawcą., Spółka Mazowiecki Port Lotniczy Warszawa Modlin Sp. z o.o., Kierownik: SZUSTAKOWSKI Mieczysław

PBU16. PBN/03-192/2014/WAT, Pomoc ekspercka w organizacji i przeprowadzaniu postępowania o udzielenie zam. publiczne., Kancelaria Sejmu, Kierownik: SZUSTAKOWSKI Mieczysław

PBU17. PBN/03-203/2014/WAT, Wykonanie badań za pomocą mikroskopii cyfrowej 3D oraz analiz pigmentów użytych w pięciu obrazach olejnych na płótnie metodą LIBS., Muzeum Pałacu Króla Jana III w Wilanowie, Kierownik: W. Skrzeczanowski

PBU18. PBN/03-025/2014/WAT, Opracowanie urządzenia do wytwarzania dwustrumieniowej tarczy gazowej przeznaczonej do badań w zakresie oddziaływania impulsów laserowych z gazem pod wysokim ciśnieniem oraz wytwarzania promieniowania w zakresie widmowym skrajnego nadfioletu (EUV)., Inframet Krzysztof Chrzanowski, Kierownik: FIEDOROWICZ Henryk

PBU19. PBN/03-027/2014/WAT, Wykonanie badań i testów laserowego usuwania wtórnych nawarstwień z polichromii drzwiczek od kaptura zabytkowego zegara o numerze inwentarzowym Wil 932, Muzeum Pałacu Króla Jana III w Wilanowie, Kierownik: MARCZAK Jan

PBU20. PBN/03-048/2014/WAT, Wykonanie badań laboratoryjnych kamery termowizyjnej i kamery dziennej TV wyrobu ZMO-1, zastosowanego w ZSMU, w zakresie określenia zasięgu wykrycia, rozpoznania i identyfikacji celu dla wąskiego i szerokiego pola widzenia., Wojskowy Instytut Techniki Pancernej i Samochodowej, Kierownik: KASTEK Mariusz

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APPENDIX 2.
LIST OF PUBLICATIONS IN 2014

A LIST – ARTICLES PUBLISHED IN JOURNALS OF JCR LIST

A1. J. Świderski, „High-power mid-infrared supercontinuum sources: Current status and future perspectives”, Progress in Quantum Electronics, 38 (5), 189-235 2014

A2. W.J. Stępniowski, A. Nowak-Stępniowska, A. Presz,T. Czujko, R.A. Varin., „The effects of time and temperature on the arrangement of anodic aluminum oxide nanopores.”, Materials Characterization., 91, 1-9. 2014

A3. N. C. Monserud, E. B. Malm, P. W. Wachulak, V. Putkaradze, G. Balakrishnan, W. Chao, E. Anderson, D. Carlton, M. C. Marconi, „Recording oscillations of sub-micron size cantilevers by extreme ultraviolet Fourier transform holography”, Optics Express, 22, 4161–4167 2014

A4. P. W. Wachulak, Ł. Węgrzyński, Z. Zápražný, A. Bartnik, T. Fok, R. Jarocki, J. Kostecki, M. Szczurek, D.N. Korytár, H. Fiedorowicz, „Extreme ultraviolet tomography using a compact laser–plasma source for 3D reconstruction of low density objects”, Optics Letters, 39, 532-535 2014

A5. 2. J. Gao, B. J. Jankiewicz, J. Reece, H. Sheng, Ch. J. Cramer, J. J. Nash, H. I. Kenttämaa, „On the Factors That Control meta-Benzyne Analogs Reactivity”, Chem. Sci., 5, 2205-2215 2014

A6. J. Świderski, M. Michalska, „High power supercontinuum generation in a ZBLAN fiber with very efficient power distribution towards the mid-infrared”, Optics Letters, 39 (4), 910-913 2014

A7. W. Zendzian, M. Kaskow, J. K. Jabczynski, „Diode-pumped, actively Q-switched Nd:YAG laser with self-adaptive, reciprocal, closed-loop resonator”, Opt. Express, 22, 30657-30662 2014

A8. J. Suszek, A. M. Siemion, N. Błocki, M. Makowski, A. Czerwiński, J. Bomba, A. Kowalczyk, I. Ducin, K. Kakarenko, N. Pałka, P. Zagrajek, M. Kowalski, E. Czerwińska, C. Jastrzebski, K. Świtkowski, J.-L. Coutaz, A. Kolodziejczyk, M. Sypek, „High order kinoforms as a broadband achromatic diffractive optics for terahertz beams”, Optics Express, 22(3), 3137-3144 2014

A9. P. Kwaśniak J, J. Pura, M . Zwolinski, P. Wieciński, H. Skarżyński, L. Olszewski, J. Marczak, H . Garbacz, K.J. Kurzydlowski, „Laser and chemical surface modifications of Titanium grade 2 for medical application", Applied Surface Science, 2014

A10. Ul Ahad, I., Bartnik, A., Fiedorowicz, H., Kostecki, J., Korczyc, B., Ciach, T., Brabazon, D, „Surface modification of polymers for biocompatibility via exposure to extreme ultraviolet radiation", Journal of Biomedical Materials Research - Part A, 102, 3298-3310 2014

A11. M. Trzebiatowska-Gusowska, E. F. Plinski, J. Baran, M. J. Walczakowski, P.P. Jarzab, K. Nowak, B. Fuglewicz, M. Mikulic, N. Pałka, M. Szustakowski, „Terahertz and Raman spectra of non-centrosymmetrical organic molecular crystals", Optical Materials, 37, 28-35 2014

A12. M. Michalska-Domańska, M. Norek, P. Jóźwik, B., J. Jankiewicz, W. J. Stępniowski, Z. Bojar, „„Catalytic stability and surface analysis of microcrystalline Ni_3Al thin foils in methanol decomposition", Appl. Surface Sci., 293, 169–176 2014

A13. J. Świderski, F. Théberge, M. Michalska, P. Mathieu, D. Vincent, „High average power supercontinuum generation in a fluoroindate fiber", Laser Physics Letters, 11 (1), 015106 2014

A14. M. Kaskow, W. Zendzian, J.K. Jabczynski, L. Gorajek, J. Kwiatkowski, M. Piasecki, „Passively Q-switched Nd:YAG laser with diffractive output resonator", Laser Physics Letters, 11 (11), 115813 2014

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A18. J. Młyńczak, K. Kopczyński, „Comparison of parameters of q-switching saturable absorbers estimated by different models and the impact of accuracy of input data on the results of the estimation", Optical Materials, Vol. 36, pp. 867-872, 2014

A19. Majchrowski, A., Wojciechowski, A., Kityk, I.V., Chrunik, M., Jaroszewicz, L.R., Michalski, E., „Photoinduced nonlinear optical effects in Nd-doped δ-BiB $_3O_6$ crystals", Journal of Alloys and Compounds, Volume 610, 15 Pages 82-85 2014

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A22. J. Wojtanowski, M. Zygmunt, M. Muzal, P. Knysak, A. Młodzianko, A. Gawlikowski, T. Drozd, K. Kopczyński, Z. Mierczyk, M. Kaszczuk, M. Traczyk, A. Gietka, W. Piotrowski, M. Jakubaszek, R. Ostrowski., „Performance verification of a LIF-LIDAR technique for stand-off detection and classification of biological agents", Optics & Laser Technology., Volume: 67 Pages: 25-32 2014

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A24. P. W. Wachulak, Ł. Węgrzyński, Z. Zápražný, A. Bartnik, T. Fok, R. Jarocki, J. Kostecki, M. Szczurek, D. Korytár and H. Fiedorowicz, „Extreme ultraviolet tomography of multi-jet gas puff target for high-order harmonic generation", Applied Physics B, 117, 253-263 2014

A25. R. Rakowski, A. Barna, T. Suta, J. Bohus, I. B. Földes, S. Szatmári, J. Mikołajczyk, A. Bartnik, H. Fiedorowicz, C. Verona, G. Verona Rinati, D. Margarone, T. Nowak, M. Rosiński, L. Ryć, „Resonant third harmonic generation of KrF laser in Ar gas", Review of Scientific Instruments, 85, 123105 2014

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A30. J. Kwiatkowski, W. Zendzian, J.K. Jabczynski, J. Swiderski, „Continuous-wave and high repetition rate Q-switched operation of Ho:YLF laser in-band pumped by a linearly polarized Tm:fiber laser", Optics & Laser Technology, 63, 66-692014

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A37. B. Grześkiewicz, A. Sierakowski, J. Marczewski, N. Pałka, E. Wolarz, „Polarization-insensitive metamaterial absorber of selective response in terahertz frequency range", Journal of Optics, 16, 105104 2014

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A41. J. Lorkiewicz, R. Nietubyć, M. Barlak, R. Mirowski, A. Bartnik, J. Kostecki, J. Sekutowicz, A. Malinowska, P. Kneisel, J. Witkowski, „Deposition and optimization of thin lead layers for superconducting accelerator photocathodes", Physica Scripta, T161, 014071 2014

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A44. M. Długaszek M., K. Kopczyński, „Correlations between elements in the fur of wild animals", Bulletin of Environmental Contamination and Toxicology, 93(1), 25-30 2014

A45. J. Młyńczak, J. Kubicki, K. Kopczyńsk, „Stand-off detection of alcohol in car cabins", Journal of Applied Remote Sensing, Vol. 8, No. 1, pp. 083627-1- 083627-7, 2014

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A47. J. Świderski, M. Michalska, W. Pichola, M. Mamajek, „Generation of 25-ns pulses with a peak power of over 10 kW from a gain-switched, 2-μm Tm-doped fibre laser and amplifier system", Quantum Electronics, 44 (4), 294-297 2014

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A51. N. Pałka, „Identification of concealed materials, including explosives, by terahertz reflection spectroscopy", Optical Engineering, 53(3), 031202 2014

A52. Krupiński M., Bieszczad G., Sosnowski T., Madura H., Gogler S., „Non-uniformity correction in microbolometer array with temperature influence compensation", Metrology and Measurement Systems, Vol. XXI (2014), No. 4, pp. 709-718 2014

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A54. M. Długaszek, W. Skrzeczanowski, M.Kaszczuk, „Age-related mineral status of females and males hair in human health risk assessment", Trace Elements and Electrolytes, 31, 131-140 2014

A55. A. Padzik-Graczyk, W. Kasprzycka, A. Romiszewska, A. Nowak-Stępniowska, P. Osuchowska., „Porównanie zawartości Ca, Mg, Zn, Cu i Fe w badaniach populacji polskiej w latach 1996-2004 i 2005-2013", Journal of Elementology, vol. 19 no. 2, str. 146, 2014

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A58. B. Fuglewicz, E.F. Plinski, P.P. Jarzab, S. Plinska, M. Cebrat, K. Nowak, L. Augustyn, M.J. Walczakowski, M. Mikulics, N. Pałka, M. Szustakowski, „Selected nonapeptides in terahertz light", Optica Applicata, 44, 159-171 2014

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B6. J. Kwiatkowski, J. Świderski, W. Zendzian, J.K. Jabczynski, L. Gorajek, M. Kaskow, „A resonantly pumped, Q-switched Ho:YLF laser with an output energy of 5 mJ at 1 kHz”, Photonics Letters of Poland, VOL. 6(1), 5-7 2014

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