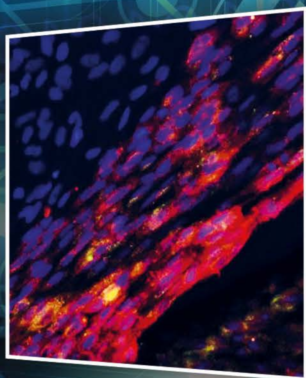
Military University of Technology

Institute of Optoelectronics



INSTITUTE OF OPTOELECTRONICS

Annual **Report** 2016

Annual Report IOE 2016

Institute of Optoelectronics
Military University of Technology

Editor: prof. dr hab. inż. Jan K. Jabczyński
DTP: Tomasz Wajnkaim

Printing: DRUKARNIA GRAFFITI
ul. Kolejowa 13, 05-092 Łomianki
www.drukarnia-graffiti.pl

Available from the Institute of Optoelectronics
Military University of Technology, 2 gen. Sylwestra Kaliskiego Street
00-908 Warsaw, Poland
tel. +48 261 83 94 30, fax: +48 22 666 89 50
www.ioe.wat.edu.pl

DOI:

Copy is welcomed, provided the source is acknowledged and an archive copy is sent to IOE

The following text contains information of a preliminary and /or tentative nature and must not be quoted in publications nor listed in abstract journals.

Table of contents

TABLE OF CONTENTS

PREFACE

The research and development works determined the activity of the Institute of Optoelectronics in year 2016 as it was in the previous years. The Institute has managed and carried out more than 70 R&D projects including: 9 financed by foreign organizations (EDA, EU, NATO), 23 financed by National Centre for Research and Development, 7 by National Centre of Science, 2 by Ministry of National Defence (MoD), and the others financed by Ministry of Science and Higher Education, Foundation for Polish Science, and domestic and foreign business establishments. As before the Institute was deeply involved in the projects serving a purpose of national security and defence. Among the most important programs and projects are: the strategic program "New Armaments Systems of Directed Energy", program TYTAN "Advanced Individual Warfare Systems", program PIORUN, a modernization of portable, anti-aircraft missile GROM, programs dedicated to precise munition development, active defence systems, detection of biological warfare agents, smart automated border control equipment.

The results of the projects were highly valued and awarded by many institutions. As an example the consortium consisted of MESKO S.A., CRW Telesystem-MESKO and Institute of Optoelectronics was granted with the Award of the President of Republic of Poland during the XXIV International Defence Industry Exhibition MSPO for the MANPADS Piorun.

We were also among the winners of IV. Competition for the best R&D works for defence organized by the MoD. Prof. Karol Jach from our Institute was a member of the team granted by 1-st degree Award in the group of R&D projects for „Armour penetration by subcaliber kinetic energy projectiles with solid and segmented penetrators". The award for the best patent and utitlity model was received by the IOE team headed by Prof. Henryk Madura for the project "Optoelectronic, multispectral airfield system intended to assist aircraft landing".

The Biomet system of Automated Border Control E-GATE was successfully tested on the border crossing in Terespol in May 2016. The system of biometric checking of person and documents developed in consortium led by the IOE has received very good opinion of travelers and achieved high valuation of Polish Border Guard Command.

The scientific achievements of our staff were also highly valued. Col Jacek Świderski D.Sc. has achieved the Prime Minister Award for the best habilitation "The MIR supercontinuum sources of high average power" Dr. Marta Michalska-Domańska has recieved in 2016 the Prime Minister Award for the best PhD thesis entitled "Influence of the material state on the Ni_3Al phase catalytic activity." and the Scholarship for Young, Outstanding Researchers from the Polish Ministry of Science and Higher Education. Our young scientists has achieved a few awards as well. Our PhD student Paweł Grześ was the award winner in the Polish nationwide competition Technotalenty 2016. For the outstanding contribution to the NATO STO Col Jacek Świderski was distinguished the Scientific Achievement Award in September 2016.

In November 2016 Col Krzysztof Kopczyński has once again achieved the certificate of recognition by the members of SET (Sensors & Electronics Technology) Panel of NATO STO. On the request of Chapter of Academic Honours of MUT the IOE director Col Krzysztof Kopczyński was distinguished by the entry to Gold Book of Achievements of MUT.

In 2016 there were organized in the IOE two workshops of EDA projects: TIPSI - THz Imaging Phenomenology Platforms For Stand-Off IED Detection and RAMBO - Rapid Air-particle Monitoring against BiOlogical threats and also COST activity - Nanospectroscopy Topical Meeting on Nanoparticles Synthesis, Assembly, Characterization and Applications.

Moreover, the 11-th Symposium on Laser Technology (SLT'2016) organized in collaboration with Warsaw University of Technology (WUT), Wrocław University of Science and Technology (WUScT) and University of Warsaw (UW) in Jastarnia in September 2016 was a significant success. That meeting is a cyclic scientific conference organized since 1984 with the purpose to exchange information and R&D knowledge on the laser technology in Poland. Scientific Committee was chaired by Prof. Zygmunt Mierczyk and supported by Vice-Chairmen: Prof. Krzysztof Abramski (WUScT), Prof. Michał Malinowski (WUT), Prof. Czesław Radzewicz (UW). The Honorary Committee has been composed of several prominent professors including the nestors of laser technology in Poland: Profs Zbigniew Puzewicz, and Wiesław Woliński, and Zdzisław Jankiewicz. 141 scientists, engineers and students from the main academic centers, research institutes and industry attended the symposium. There were presented 52 talks (including 15 invited) and 73 posters during that 3-day conference.

In October 2016 the President of Poland gave professor nominations to two of our colleagues: Professor of medicine Anna Elżbieta Trafny, the leading specialist in immunochemistry, microbiology and medical biology and Professor Waldemar Żendzian, the respected authority in quantum electronics and lasers. The Council of IOE has conducted three habilitation procedures. In a result three of our colleagues: Lt Col Jacek Kwiatkowski, Lt Col Norbert Pałka and Dr. Andrzej Bartnik were awarded D.Sc. degrees in electronics.

The education activity of our Institute has significantly increased in 2016. We have matriculated the second group of students on the 1-st stage of studies on space and satellite engineering. Presently, we have two groups of students on the 2-nd stage on electronics and telecommunication and on 3-rd stage of PhD studies in electronics.

We are conducting the collaborative studies with the Faculty of Electronics and Faculty of Mechatronics and Aviation of MUT. On behalf of agreement between the MUT, Lodz University of Technology and Warsaw University of Technology we have been conducting an inter-collegiate studies on the bio-economy. Three of our students (including two in the framework of Erasmus-Mundus program) have finished their PhD thesis in this year.

Despite the achievements and successes earned in 2016 we look with caution into year 2017. We are waiting for the results on categorization of scientific institutions. The projects financed by EU in the last prospects had been finished, we are strenuously working on the receiving new projects in Horizon 2020 and from other international and Polish institutions. The efficiency in winning of research projects in new prospects of EU will decide on a future development of the Institute.

płk dr inż. Krzysztof Kopczyński

Dyrektor Instytutu Optoelektroniki

1. ORGANIZATION STRUCTURE AND SCIENTIFIC TASKS OF INSTITUTE

1.0. ORGANIZATION STRUCTURE OF IOE

Table 1.1. Distribution of divisions and scientific groups

Organizational structure of the Institute of Optoelectronics in 2016 comprises 4 Divisions, Accredited Testing Laboratory and the Biomedical Engineering Center with 14 research groups (see Table 1.1)

Division	Group	Leader
Laser Technology Division	Laser Matter Interaction Group	prof. H. Fiedorowicz
	Solid State Lasers Group	prof. A. Zając
	Fiber Lasers Group	dr hab. J. Świderski
	Laser Optics Group	prof. J. Jabczyński
	Laser Application Group	dr inż. R. Ostrowski
Optoelectronic Technologies Division	Laser Teledetection Group	dr inż. M. Zygmunt
	Optical Technology Group	dr inż. P. Nyga
	Nanotechnology Group	dr B. Jankiewicz
	Optical Spectroscopy Group	dr inż. K. Kopczyński
Optoelectronic Systems Division	Optical Signal Detection Group	dr hab. inż. J. Wojtas
	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		mgr inż. A. Antonik
Biomedical Engineering Center		prof. Z. Mierczyk

At the end of 2016, the staff of the IOE consisted of 196 employees including 107 scientific workers, 15 professors, 11 D.Sc's, and 66 PhD.'s. Forty-one of these scientific workers were <35 years of age, among whom 14 were Ph.D. students at IOE. The Council of the Institute can award a D.Sc (doctor habilitatus) and Ph.D. degrees in electronics.

The structure of the finances was not changed in the 2016. The activity in research- development has remained the main source of incomes, however the activity in the education field was increased significantly. The R-D works, conducted in the framework of about 70 projects, were financed from several sources (see Fig. 1.1., chap. 6). The research results have been presents in 146 scientific publications and reports including 56 articles published in the journals included in the JCR list.

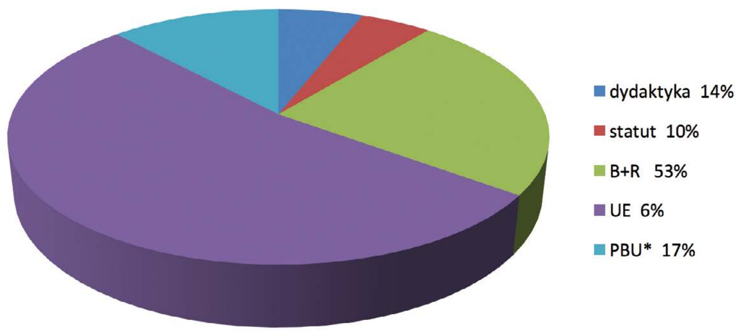


Fig. 1.1. Distribution of financial sources of the IOE in 2016

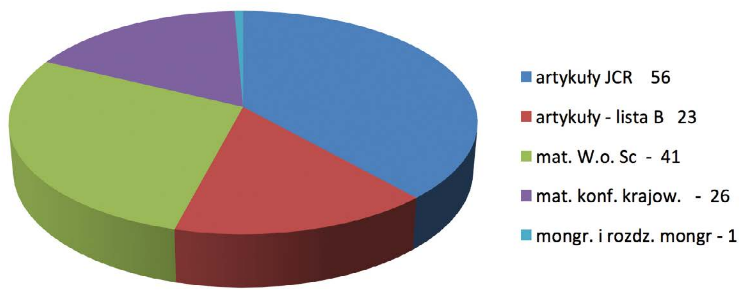


Fig. 1.2. Distribution of publications of the IOE in 2016 (total number 146)

1.1. LASER TECHNOLOGY DIVISION

The Laser Technology Division conducts fundamental and application studies related to the development of laser sources, laser-plasma soft X-ray (SXR) and extreme ultraviolet (EUV) sources, as well as studies carried out with the use of lasers in military technology, materials engineering, measuring techniques, medicine, and art renovation. The division carries out research on the broad subject of diode pumped lasers (DPL), including: the design of optical systems, resonators, and pulsed DPL 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

- Development and testing of high-efficiency stable sources of laser radiation and their applications in military, technology, and metrology equipment
- Development and testing of pulsed, tunable DPL generating in the 1 - 3 μm spectral range, and their applications in military, technology, and metrology equipment
- Research on fibre-based near- and mid-infrared lasers and 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
- Research on Laser Directed Energy Weapons Systems

Selected Achievements in last years

- diode pumped neodymium lasers Nd:YAG, Nd:YLF, Nd:YVO4, Yb:YAG, Yb:LUAG, lasers generating eye-safe radiation (Er:YAG, Tm:YLF, Tm:YAP, Tm:fiber, Ho:YAG, Ho:YLF), a series of nonlinear radiation conversion systems (OPO, harmonic generation, Raman lasers)
- unique all over the world high-power mid-infrared supercontinuum sources
- novel fibre lasers and amplifiers operating at 1.55 μm and 2 μm
- Creation of micro- and sub-micro-periodic structures on different surfaces, including biocompatible materials, using direct laser 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
- High-efficiency laser-plasma SXR and EUV radiation sources and their application in pulse radiography, microscopy, micro-treatment, and polymer surface modification

1. ORGANIZATION STRUCTURE
AND SCIENTIFIC TASKS OF INSTITUTE

1.2. OPTOELECTRONIC TECHNOLOGIES DIVISION

The Optoelectronic Technology Division conducts fundamental and application studies related to the development of optoelectronic materials and technologies for applications in security systems, defence, 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
- measurement of laser speed
- laser-plasma ion sources for nanotechnology and materials research
- laser-assisted fabrication of thin films and nanostructures using a pulsed laser deposition (PLD) method
- measurements of spectral characteristics of optical components
- optical technology of special laser and infrared elements and components
- thin film technologies
- plasmonic nanostructures for use in the detection of chemicals and biological materials
- spectroscopy in the UV-Vis-NIR range, Raman, Surface Enhanced Raman Scattering, and fluorescence spectroscopies
- biomaterials
- analytical procedures for determination of microelements and biologically active compound content in various samples
- cancer therapies and diagnostics
- optoelectronic components for space research

Selected Achievements in last years

- 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
- optoelectronic systems for fire control
- laser communication links
- UV dosimeters
- UV Solar Blind radiometers
- laser radiation warning systems
- optoelectronic systems for cancer diagnosis

1. ORGANIZATION STRUCTURE
AND SCIENTIFIC TASKS OF INSTITUTE

1.3. OPTOELECTRONIC SYSTEMS DIVISION

The research and development activities in the Optoelectronic Systems Division focus on applications of new optoelectronic detection systems, fibre, terahertz (THz) and biometric technologies in medicine, environment monitoring, critical infrastructure and state borders 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 vapour 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 fibre 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 of biometric systems for passport control at the borders of the European Union
- 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 in last years

- Development of optical sensors for trace detection of explosive materials
- Ultra-sensitive sensor of NO2
- Commercialization of a fibre system for perimetric protection of special objects
- Fibre optic sensor for protection of museum collections
- Single-photon sensor to protect and monitor the integrity of the fibre-optic link
- Integrated platform radar-camera for protection of military facilities
- Integrated maritime port security system
- Protection system against pirate ship attacks
- Stationary gate for passport check at the borders of the European Union
- Mobile passport check system at the borders of the European Union
- Smart Border system for testing at the borders of the European Union
- Modernization of anti-aircraft missiles
- 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. ORGANIZATION STRUCTURE
AND SCIENTIFIC TASKS OF INSTITUTE

1.4. INFRARED TECHNOLOGY AND THERMOVISION DIVISION

The research carried out 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. In recent years, the statutory tasks were dedicated to thermographic and spectroradiometric measurements of objects and the development of integrated optoelectronic sensor systems for military applications. The current research of the division 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 angular characteristics of infrared sensors
- Climatic measurements of infrared detection systems
- Modelling 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 in last years

- CTS-3 thermovision sight
- thermovision sight integrated with laser friend-or-foe (IFF) module
- thermovision sight for MANPADS GROM , PIORUN
- KT-1 camera with cooled detector for fire control systems
- LOP-1 multispectral binoculars for reconnaissance and enhanced situational awareness
- Optoelectronic, multispectral system for aircraft landing assistance

1.5. ACCREDITED TESTING LABORATORY

The Accredited Research Laboratory functions in accordance with quality management systems of research, meeting the requirements of standard PN-EN ISO/IEC 17025, since 1997. The management system is documented and has been issued a certificate (No. AB 109) by the Polish Centre for Accreditation. The results of 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 coefficient of optical materials
PB-07 – Assignment of safety classes for laser devices
PB-09 – Measurement of parameters related to thermal imaging devices, including: 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 has collaborations with national and foreign scientific centres in the area of optoelectronic metrology. The laboratory research team participated in several international EUREKA projects and developed and pursued their own research projects funded by the Ministry of Science and Higher Education. The laboratory is also working closely with business entities on the development and implementation of projects in the area of optoelectronic measurement systems and automation, which include:

- Material testing using laser-induced plasma spectroscopy
- Electronic sensors for measuring physical quantities
- Laser power and energy meter calibrators

1. ORGANIZATION STRUCTURE
AND SCIENTIFIC TASKS OF INSTITUTE

1.6. BIOMEDICAL ENGINEERING CENTER

In 2012, an interdisciplinary team, a Biomedical Engineering Center, was established at the Military University of Technology (MUT). The task of the team was to conduct the scientific projects related to biomedical engineering, to develop new innovative technologies and to design modern devices to be applied in medicine. At the end of 2012, a project entitled "Cluster Development of Biomedical Engineering Center " under the 5.1 POIG programme that aimed at diffusion of innovation from the MUT and other research institutions to companies associated with the cluster was started. At this time, the cluster comprised of 15 entities: companies, research organizations, institutes, universities and organizations from business environment. The aim of the cluster members was to strengthen the potential of the biomedical engineering industry through the networking of its participants, the promotion of innovation and the stimulation of innovative biomedical engineering solutions, as well as their commercialization. Today, the cluster has 75 entities, including 16 universities and research institutes. The cluster conducts several research projects, including:

- development of micro-sieves for the diagnosis and treatment of cancer;
- assessment of bactericidal activity of graphene;
- application of graphene in medical technology;
- investigation of the effect of electromagnetic fields on cancer, stem and healthy cells;
- study on the influence of magnetic field radiation on the human brain and use of electromagnetic fields in medical rehabilitation;
- search for nanoparticles to be used against cancer cells;
- application of low energy lasers to speed up the stem cells proliferation;
- diagnostics and photodynamic therapy in the treatment of cancer and cardiovascular diseases;
- use of laser technology for monitoring the bioaerosols in hospitals.

Up to now, the Biomedical Engineering Center has submitted eight patent applications, implemented two medical technologies and three new medical devices. Since 2016, the Center is an organizational unit of the Institute of Optoelectronics at MUT, and conducts scientific, research, educational, analytical and service activities in the field of Biomedical Engineering and related disciplines for state defence and security. Within the framework of a project financed by the Polish Agency for Enterprise Development, new and equipped for modern scientific research laboratories of the Biomedical Engineering Center were established, as follows:

1. Laboratory for Protection against Bioterrorist Hazard;
2. Laboratory for Lasers Application in Biomedical Engineering;
3. Laboratory of Electromagnetic Radiation Interactions with Matter;
4. Laboratory of Molecular Biology;
5. Laboratory of Biocybernetics (within the framework of an agreement with the Faculty of Cybernetics at MUT;
6. Laboratory of Biomechanics and Graphene Applications (within the framework of an agreement with the Faculty of Mechanical Engineering at MUT).

2. RESEARCH ON PLASMA PHYSICS AND LASERS

2.1. THULIUM FIBER LASER FOR MEDICAL APPLICATIONS

jacek.swiderski@wat.edu.pl

Fig. 2.1.1. Picture of thulium fiber laser module.

Fig. 2.1 2. Picture of laser medical device for low-invasive endoscopic and robotic surgery.

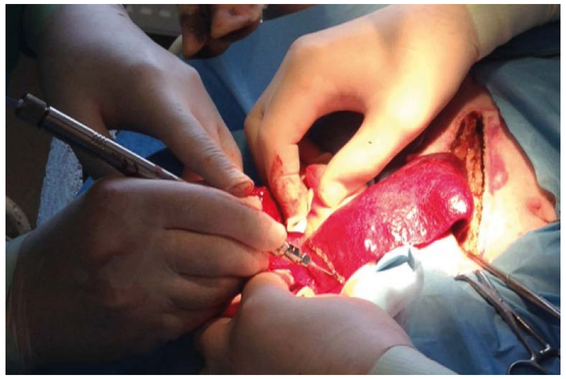


Fig. 2.1.3. Laser surgery with the use of the thulium fiber laser - doctors performing the incision of pig's organs.

Fig. 2.1.4. Measurement of parameters of radiation generated by the developed laser.

An all-fiber, diode-pumped, continuous-wave thulium fiber laser emitting 37.4 W of output power with a slope efficiency as high as 57% with respect to absorbed pump power at 790 nm was developed. The laser operates at ~1.94 μm and the output beam quality factor M^2 was measured to be ~1.2. The output beam is very stable with power fluctuations <1% measured over 1 hour. The laser module is a part of a medical device dedicated for low invasive endoscopic and robotic surgery. Currently, the laser system is investigated in animal studies. Furthermore, procedures related to obtaining CE certificate have been launched. The full commercialization of the medical device is planned to be in 2018.

The laser medical device has been developed by a consortium consisting of:

- Metrum Cryoflex Sp. z o.o., Sp. k., - consortium leader,
- Institute of Optoelectronics, Military University of Technology,
- Wroclaw Medical University.

The research was partially supported by the National Centre for Research and Development, under project No. Innotech-K3/IN3/55/225968/NCBR/14, co-financed from the European Union, Regional Development Fund.

The movie about Thulium Fiber Laser can be found at: https://www.youtube.com/watch?v=XKYjDYjchcQ

Acknowledgment: The medical laser device has been developed by a consorcium consisting of Metrum Cryoflex Sp. z o.o., Sp. k., Institute of Optoelectronics MUT and Wroclaw Medical University. The research was partially supported by the National Centre for Research and Development, under project No. Innotech-K3/IN3/55/225968/NCBR/14, co-financed from the European Union, Regional Development Fund.

2.2. MID-INFRARED SUPERCONTINUUM GENERATION IN A FLUOROINDATE FIBER

jacek.swiderski@wat.edu.pl

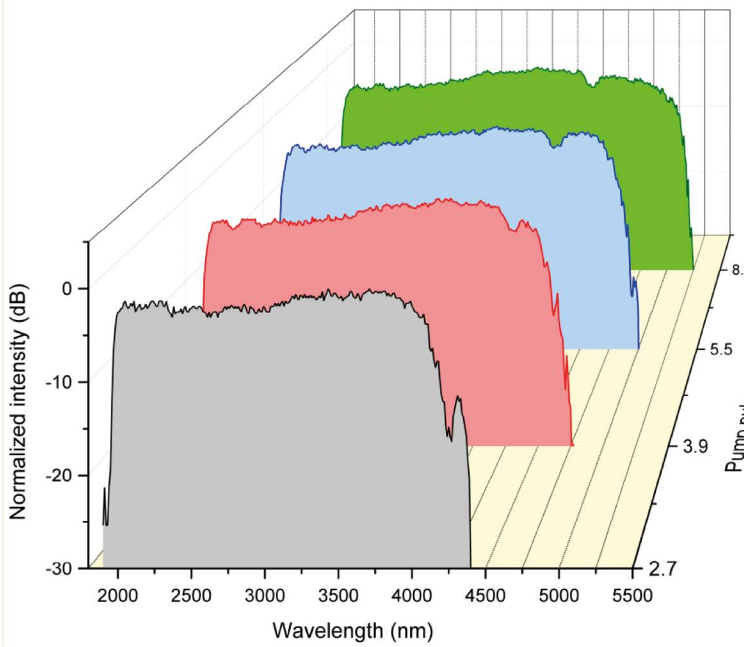


Fig. 2.2.1. Supercontinuum spectra obtained from a 9-m-long InF³ fiber pumped at 2.02 μm, recorded for injected pump pulse energies of ~ 2.7 μJ (36.3 kW), 3.9 μJ (52.4 kW), 5.5 μJ (73.9 kW), and 8.3 μJ (111.5 kW).

Broadband, mid-infrared supercontinuum generation in a step-index fluoroindate (InF_3) fiber was presented. By using ~70-picosecond laser pulses at 2.02 μm, provided by an optical parametric generator, a wide spectrum with a cut-off wavelength at 5.25 μm and a 5-dB bandwidth covering the entire 2-5 μm spectral interval was demonstrated for the first time. The behaviour of the supercontinuum was investigated by changing the peak power and the wavelength of the pump pulses. This allowed the optimal pumping conditions to be determined for the nonlinear medium that was used. Further spectral broadening was limited by the optical damage threshold of the fiber, which was experimentally determined to be ~200 GW/cm².

Acknowledgment: This work was supported by the National Science Centre (Project No. UMO-2014/14/M/ST7/00868). The research is carried out within the confines of NATO SET-224 Research Task Group “Coherent Mid-Infrared Fibre Source Technology”.

2.3. DIODE-PUMPED CONTINUOUS-WAVE TM:YAP LASER AS AN EFFICIENT 1940 NM PUMP SOURCE

jacek.kwiatkowski@wat.edu.pl

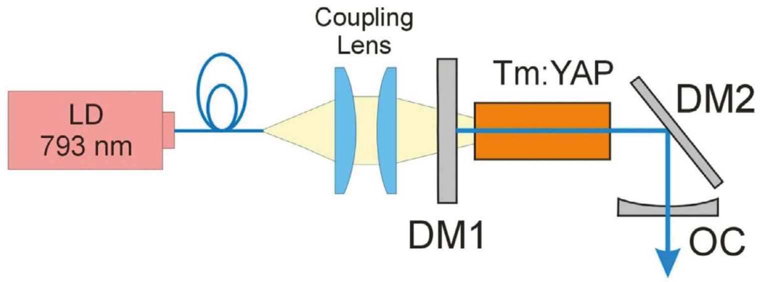


Fig. 2.3.1. Schematic diagram of the experimental setup.

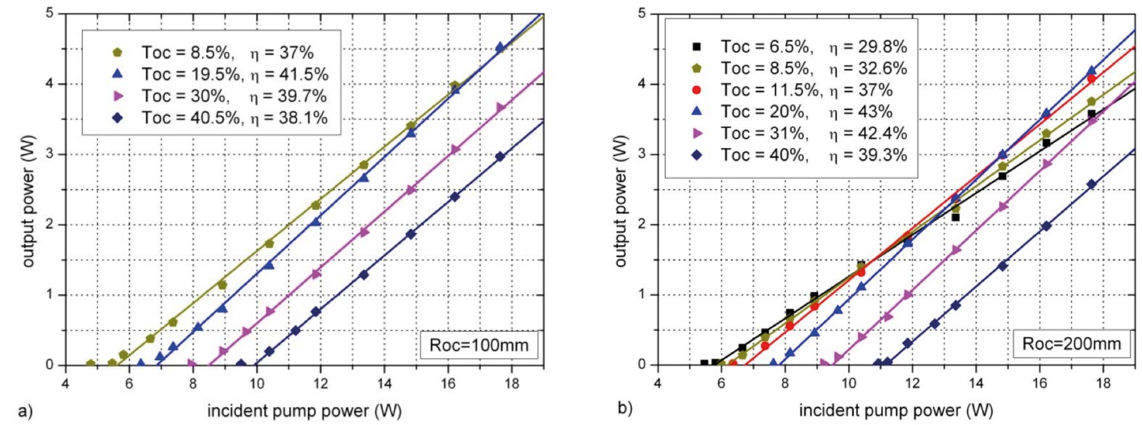


Fig. 2.3.2. Output powers of the Tm:YAP laser under different output mirror transmissions as a function of incident pump power for a radius of curvature of: a) 100 mm, b) 200 mm.

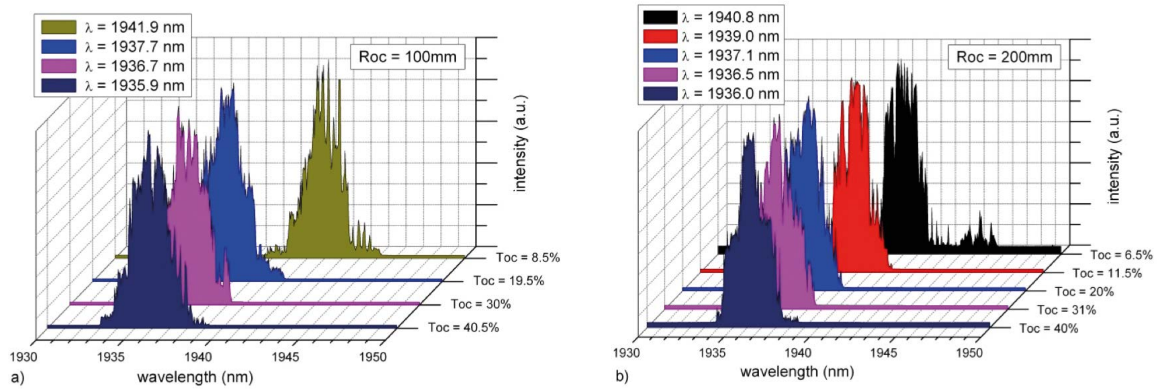


Fig. 2.3.3. Output spectra from the Tm:YAP laser in CW operation under different output mirror transmissions for a radius of curvature of: a) 100 mm, b) 200 mm.

RESEARCH ON PLASMA PHYSICS AND LASERS

An efficient single-pass diode-pumped Tm:YAP laser was demonstrated. The laser based on c-cut 3 at. % Tm:YAP crystal was experimentally examined and presented in the dependence on transmittance and radius of curvature of output coupling mirrors. A detailed spectral analysis was presented. The influence of a heat-sink cooling water temperature on the laser performance was studied. It seems that the best mode matching between pump and laser mode area was obtained for the R_{OC} of 100 mm. The best performance in terms of output power and optical-to-optical efficiency was achieved for the radius of curvature of 100 mm and transmittance of 19.5% of the output coupler. The maximum output power of 4.53 W with an incident pump power of 17.63W was achieved, corresponding to a slope efficiency of 41.5% and an optical-to-optical efficiency of 25.7%. Unfortunately the output laser wavelength was centered below 1940 nm. It seems that in order to achieve highly efficient generation of the Tm:YAP laser at 1940 nm without any additional elements inside the cavity output coupler transmittances of about 10% should be used in the scheme. The output powers received for lower output coupler transmittances were only a little lower than for optimal configuration. Additionally, no saturation in relation to slope efficiency was observed thus higher output powers can be achieved by increasing pump power or in the dual-end-pumping scheme. We have shown that the output spectrum at a certain wavelength (e.g. 1940 nm) for a given pump power can be realized via the change of resonator parameters (OC transmittance, mode size).

2.4. DIODE-SIDE-PUMPED ND:YAG LASER WITH SELF-ADAPTIVE RESONATOR

mateusz.kaskow@wat.edu.pl

A diode-side-pumped Nd:YAG slab laser with a novel self-adaptive closed-loop resonator was demonstrated. The pair of 2D laser diode arrays were used as a pumping source. 250 mJ of output energy in free-running generation was achieved. It corresponded to 97% of energy obtained in a linear resonator with the same length. The slope efficiency was measured to be 34.2%. It was almost twice higher value than in case of classic self-adaptive geometries. The output beam was near-diffraction-limited. The beam quality parameter was $M^2 < 1.6$.
For the first time, the nanosecond-wide-pulse generation in a proposed resonator was achieved. Passive Q-switching technique by means of Cr:YAG modulator was applied. The laser generated single pulses with an energy of 20 mJ and a pulse width of 24 ns. It corresponded to the peak power of 875 kW. The output beam was near-diffraction-limited with beam quality parameter M^2 less than 1.7.

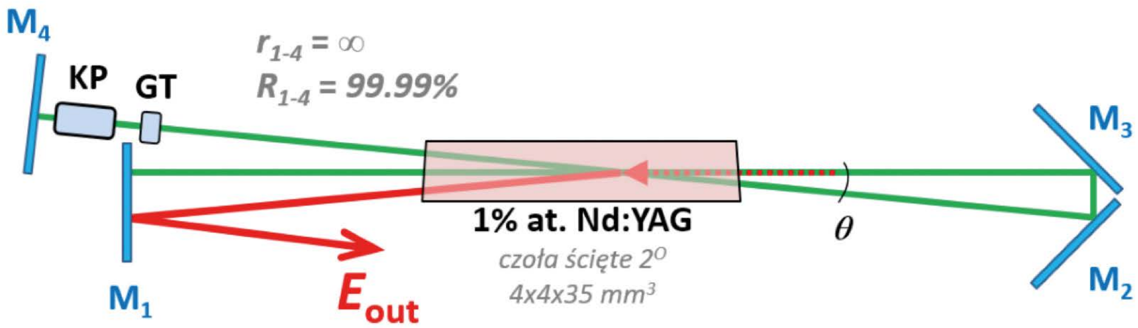


Fig. 2.4.1. The self-adaptive closed-loop resonator scheme.

Applying a single 2D laser diode array as a pumping source allowed to obtain the first nanosecond pulse generation in a self-adaptive closed-loop cavity, by means of an active Q-switching technique. A BBO Pockels cell was applied. The pulse energy was measured to be 18.3 mJ. The pulse width was 9.5 ns. It corresponded to 1.93 MW of peak power. The output radiation was near-diffraction-limited. The beam quality parameter was $M^2 = 1.4$.

2.5. INVESTIGATIONS OF PUMPING SCHEMES FOR DIODE-SIDE-PUMPED LASERS OF ENHANCED OUTPUT PARAMETER

mateusz.kaskow@wat.edu.pl

We have analyzed the side-pumping schemes of Nd-doped gain media, utilizing as the pumping units two novel, densely-packed laser diode arrays LDA-8 (DILAS N13N_8NN.2000-VO23.2) operating at 80x nm wavelength with output power of 2 kW. Single LDA consists of 8 bars separated by 0.425 mm pitch, with half-angle divergence of 35° and 5° in fast and slow axis, respectively. We have designed the following two versions.

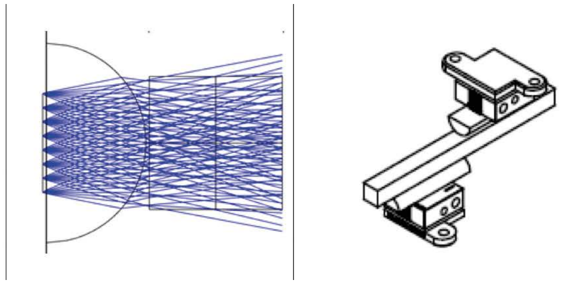


Fig. 2.5.1a. ZEMAX ray tracing plot in meridian plane - version 1.

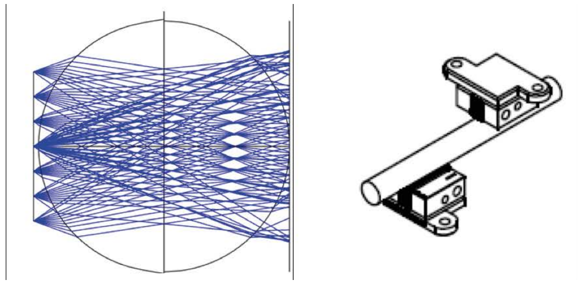


Fig. 2.5.1b. ZEMAX ray tracing plot in meridian plane - version 2.

Version 1: LDAs-8 are oriented along Nd:YAG 50x4x4 mm slab with cylindrical lens in fast axis; two pump units down and upside the slab (see Fig. 2.5.1a). Here above 90% of pump power is collected inside 4-mm width facet. Estimated pump beam size is 4x10 mm^2 with pump power density of 5.6 kW/cm^2.

Version 2: LDAs-8 are oriented along Nd:YAG rod (5 mm diameter, 50-mm long), two pump units down and upside the rod (see Fig. 2.5.1B). Here cylinder shape of rod enables efficient focusing inside. Almost 100% of pump power is focused inside 3-mm width of rod sidewall. Estimated pump beam size is 2.5x10 mm^2 with pump power density of 7.9 kW/cm^2.

The choice of two separate LDAs located upside-down enables a certain symmetrization of excited-state distribution. We have modeled the 2D gain distribution in two elaborated pumping scheme versions (see Fig. 2.5.2a,b)

For the same assumed mode of 3-mm diameter and 1.7 kW of pump power, version 2 offers higher small signal gain g0= 11 cm^{-1}. For the version 1 small signal gain is equal to g0 = 8.1 cm^{-1}. The lower sensitivity of output parameters to temperature in version 2 is caused by the fact, that we locate the center of mode in the middle of an active medium, eliminating the effect of gradients of absorbed pump density at the edge of gain element.

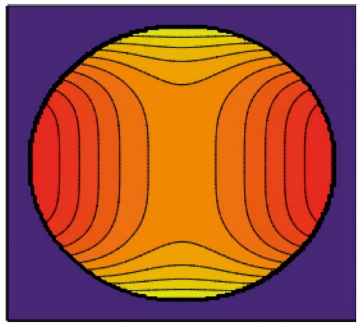


Fig. 2.5.2a. 2D gain distribution in Nd:YAG slab – version 1.

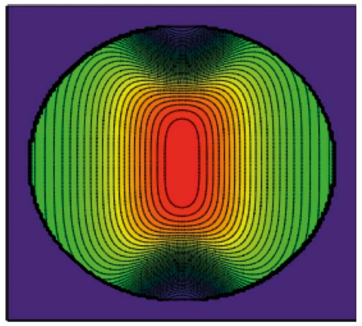


Fig. 2.5.2b. 2D gain distribution in Nd:YAG slab – version 2.

Acknowledgements:
This work was realized in consortium with TELESYSTEM-MESKO Sp. z o. o. and supported by the National Centre for Research and Development ; project PBS/B3/27/2015.

2.6. INNER-SHELL IONIZATION IN XENON, PHOTOIONIZED PLASMA

andrzej.bartnik@wat.edu.pl

Extreme ultraviolet (EUV) photons carry enough energy to release an inner-shell electron. As a result core- hole ions are created. Such state can decay through the EUV fluorescence or Auger emission. Probability of the latter effect is 3-4 orders of magnitude higher comparing to the EUV fluorescence, which means that the inner-shell ionization usually results in emission of at least 2 electrons. In case of high intensity of the driving EUV pulse photoionized plasma containing multicharged ions is being created.

In frame of investigations carried out in the Institute of Optoelectronics, emission spectra of such plasmas, produced in different gases, were measured. Inner-shell Xe fluorescence and Xe plasma emission spectra, shown in Figs. 2.6.1,2 respectively, were acquired in the wavelength range 10 ÷ 100 nm using an EUV spectrograph (McPherson, Model 251). Based on spectra obtained in the wavelength range 200 ÷ 780 nm employing the Echelle Spectra Analyzer ESA 4000 spectrometer, Boltzmann plots, allowing to determine the plasma electron temperature, were constructed. The measurements were performed for different time delays according to the driving EUV pulse, used for creation of photoionized plasmas. The corresponding results presented in Fig. 2.6.3 indicate for the relatively long plasma lifetime > 300 ns with the electron temperature 1÷ 2 eV. Based on the Stark broadening of the Balmer ß line originating from a small admixture of hydrogen the electron density was also determined. The density is a few orders of magnitude higher comparing to low temperature plasmas produced using standard generators employed in technological processes.

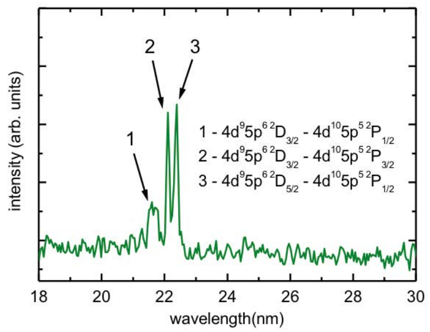


Fig. 2.6.1. N-shell fluorescence spectrum of Xe II ions, emitted from the EUV irradiated Xe gas. Accumulation of 4000 pulses.

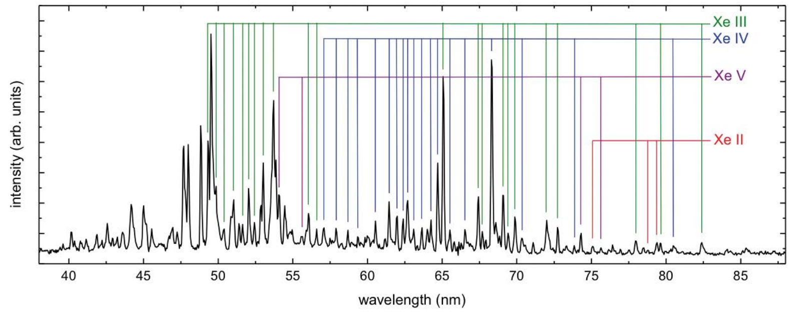


Fig. 2.6.2. A typical emission spectrum obtained for Xe II-V ions present in photoionized plasmas driven by intense EUV pulses, accumulation of 4000 pulses.

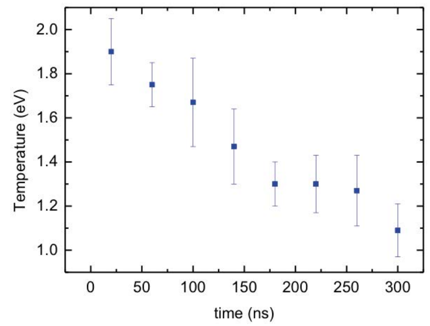


Fig. 2.6.3. The electron temperature evolution determined for photoionized Xe plasmas, based on spectral measurements in the UV/VIS range.

RESEARCH ON PLASMA PHYSICS AND LASERS

2.7. SHOCK WAVES INDUCED IN MATERIALS BY LASER RADIATION PULSES

marek.strzelec@wat.edu.pl

Properties of materials under conditions of dynamic deformation significantly differ from those in static conditions. They depend on rate of deformation, microstructure of the material and temperature. The study of processes occurring in materials at very high speed of deformation is possible using shock waves induced by high power laser pulses. Short pulse laser radiation and carefully selected absorption layer as well as inertial layers allow obtaining a shock wave pressure up to a few GPa. The dependence of pressure wave profile on material of the inertial layer, measured using polymer PVDF transducer is shown in Fig. 2.7.1a,b. The maximum pressure of around 1500 bars was attained for glass, due to its highest acoustic impedance.
In cooperation with the team from IPPT PAN, laser induced shock waves were used to evaluate of internal stresses of titanium layers (PVD deposition) on ANSI 304 steel samples with diameter of 10 mm and thickness of 0.5 mm. Nd:YAG laser pulse energies were controlled in the range of 0.5 – 1.2 J. Laser pulses (10 ns), through a transparent 1mm thick glass inertial layer were directed onto the thin graphite layer. Ti layer thickness of 3.4±0.4 mm and average roughness of Ra = 0.56 mm were determined using profilometric analysis with laser confocal microscope Keyence Vk 100. Fig. 2.7.1c shows surface of titanium layer with local detachment in the shape of bowl, caused by the stress wave.

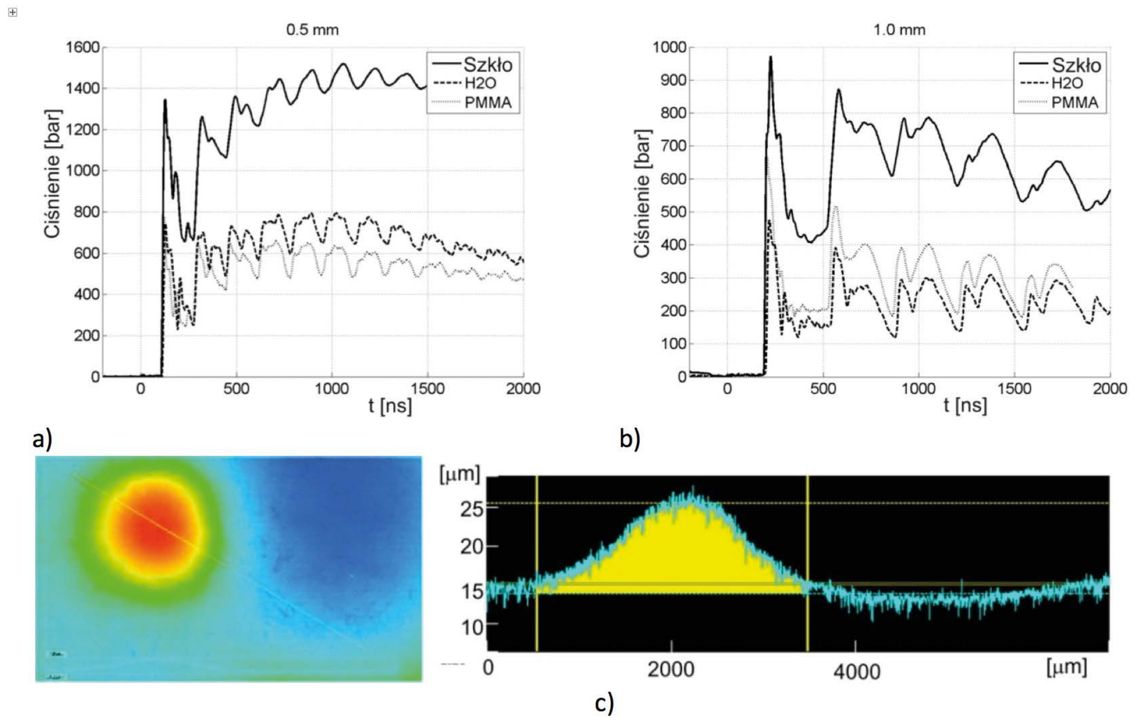


Fig. 2.7.1. Pressure profiles recorded using PVDF transducer. PMMA as an substrate layer, ANSI 304 steel as processed sample and glass, water and PMMA as inertial layers: a) steel thickness 0.5 mm; b) steel thickness 1 mm; c) Geometry of Ti layer detachment after irradiation using Nd:YAG laser pulse 1 J, 10 ns. Laser confocal microscope.

Acknowledgements:
This work was supported by the Polish National Science Centre in the frames of project 2013/09/B/ST8/03468 and partially by the National Centre for Research and Development in the framework of Strategic Program DOB-1-6-6/1/PS/2014.

RESEARCH ON PLASMA PHYSICS AND LASERS

3. APPLICATIONS OF OPTOELECTRONIC TECHNIQUES IN MEASUREMENTS

3.1. APPLICATIONS OF THE EXTREME ULTRAVIOLET COMPACT MICROSCOPE IN BIOLOGICAL SCIENCES AND NANOTECHNOLOGY

przemyslaw.wachulak@wat.edu.pl

In this work the compact, stand-alone extreme ultraviolet (EUV) microscopy system was developed and employed for imaging of real, biological samples and nanostructures The microscope system was developed under LIDER program.

A compact, table-top EUV microscopy system is based on a multilayer off-axis ellipsoidal condenser mirror and diffractive Fresnel zone plate lens objective. It is capable of imaging with spatial resolution of 48 nm and the exposure time of a few seconds up to 1 minute, in order to acquire single EUV image with nanometer spatial resolution [1].

Applications of such EUV microscope to imaging of biological samples and nanostructures was demonstrated [2].

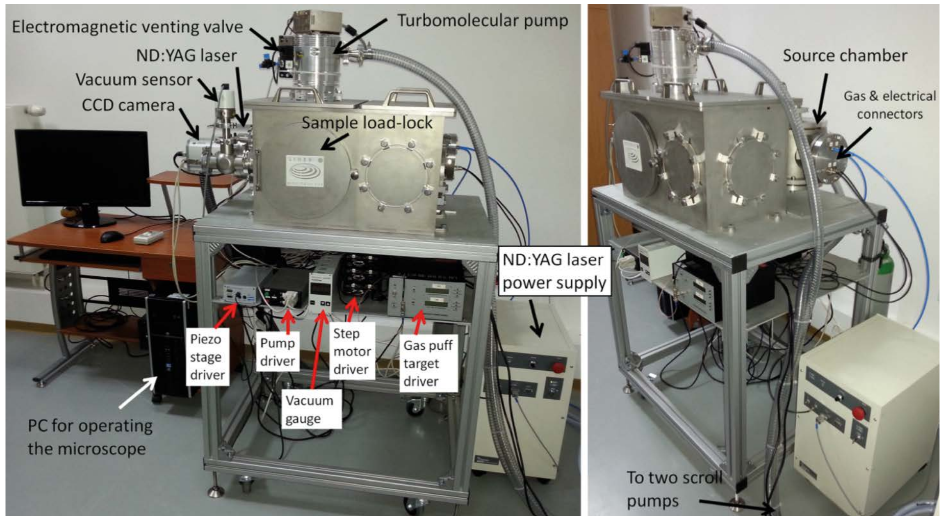


Fig. 3.1.1. Photo of the entire EUV microscope, with all major components.

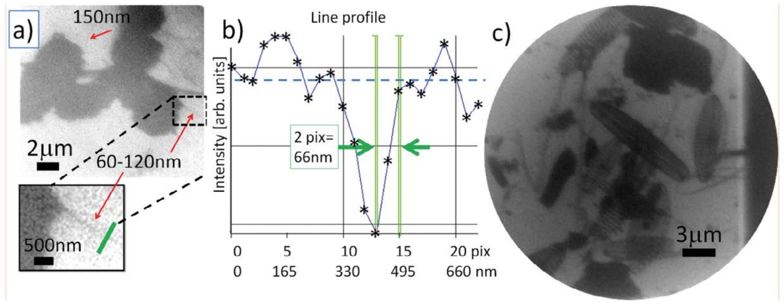


Fig. 3.1.2. The EUV image of CT 26 fibroblast cells a), line profile through the smallest visible feature b), 0-95% slope rise of 66 nm. EUV image of diatoms c), exposure of 200 EUV pulses (20 seconds), with visible features as small as 60 nm

Acknowledgements:
This work was supported by the National Centre for Research and Development, LIDER programme; award # LIDER/004/410/L-4/12/NCBR/2013 and the 7th FP Laserlab Europe III project (No. 284464).

References:

[1] P. W. Wachulak, et al. Applied Physics B 123:25, 1-5 (2017), DOI 10.1007/s00340-016-6595-5

[2] A. Torrisi et al., Journal of Microscopy 265, 2, 251-260 (2017), DOI: 10.1111/jmi.12494

3. APPLICATIONS OF OPTOELECTRONIC TECHNIQUES IN MEASUREMENTS

3.2. SXR COMPACT MICROSCOPE FOR APPLICATIONS IN BIOLOGY

przemyslaw.wachulak@wat.edu.pl

The water-window spectral range (λ = 2.3÷4.4 nm) [1] is particularly suitable for biological imaging (of cells, membranes, lipids, DNA plasmids, etc.) because it is possible to obtain high contrast images due to a significant difference in absorption of water (oxygen) and carbon - biological sample constituents.

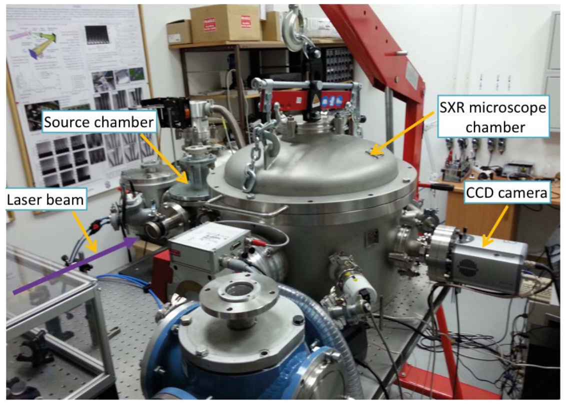


Fig. 3.2.1. Photograph of the SXR microscope.

In this work we show a SXR microscopy system, based on a laser-plasma source equipped with a double stream nitrogen gas puff target [2], and Fresnel zone plate objective. The microscope allows capturing magnified images of the objects, with 60 nm half-pitch spatial resolution, exposure time as low as a few seconds, desktop footprint, easy accessibility and simple operation. Some applications of such microscope to image biological samples are mentioned below.

Such system does not require sample preparation, exploits natural, optical contrast in the water-window spectral range, is adequate

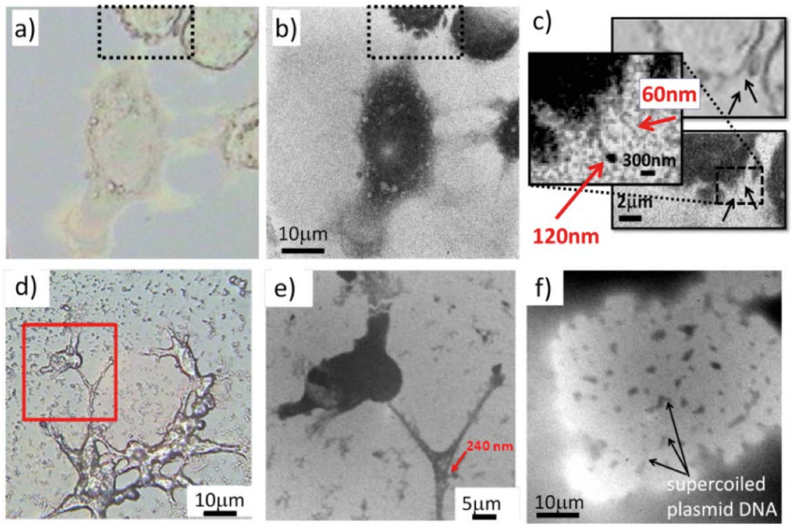


Fig. 3.2.2. Comparison of visible light microscopy image – a, d) and SXR images – b, e) of dehydrated CT 26 fibroblasts, with and without fixing procedure, respectively. Image c) shows comparison of small areas and smallest features in the visible light microscopy image and the SXR image. The SXR image e) was obtained in the region indicated by a red square in figure d). A supercoiled pBR322 plasmid DNA is imaged in – f). In all images, except c), the field of view (FOV) is 60x60 μm².

for biological imaging and may be considered as a complementary imaging tool to the already well established techniques. It was also shown that this compact SXR microscope is capable of imaging variety of different samples from various fields of science and technology, including, but not limited to, biology, material science and nanotechnology. The versatility of such microscope may open the possibility of widespread and commercialization of such systems in the near future.

Acknowledgements:
The research was supported the National Science Centre; award numbers UMO-2015/17/B/ST7/03718, UMO-2015/19/B/ST3/00435 and the National Centre for Research and Development, LIDER programme, award # LIDER/004/410/L-4/12/NCBR/2013.

References:

[1] Da Silva L B, et al., Science 258 269–71(1992)
[2] Wachulak P W, et al., Optoelectronics Review 24, 3, 144-154, (2016), doi: 10.1515/oere-2016-0018

3.3. "BOXCAR" SIGNAL PROCESSING SYSTEMS FOR PHOTORECEIVERS

janusz.mikolajczyk@wat.edu.pl

The main objective of this work was to develop laboratory setups employing the advanced optical signal detection methods. This is important issue for identify opportunities for improvement of optoelectronic technologies. It involves closely with military applications related to sensors and surveillance. A measurable effect of this work was to design and develop:

- the automated lab setup to study the possibility of double-integral technique application in the performed work related to the development of optical detection modules and sensors in which these modules are used,

a) b)

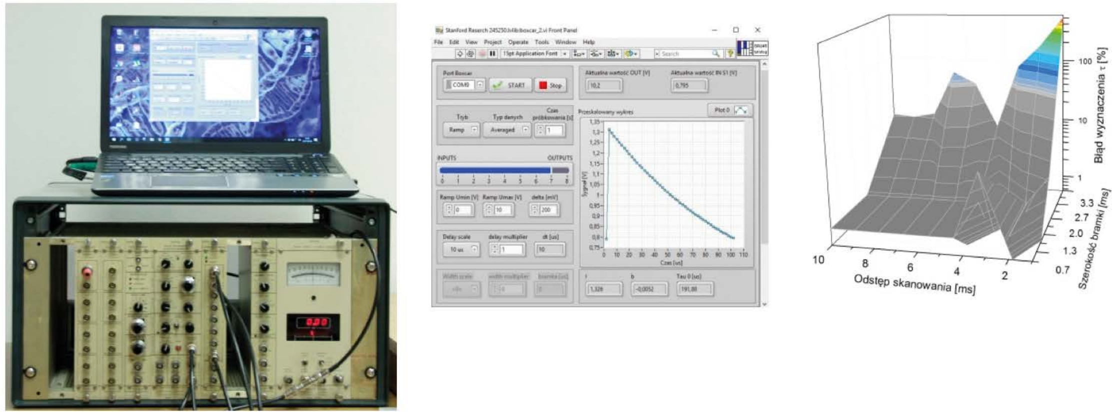


Fig. 3.3.1. View of the system (a) and user's panel with some test results (b).

- the construction concept of integrated Boxcar instrument for IR detection modules which makes it possible to increase the signal-to-noise ratio using a programmable averaging amplifier,

a) b)

Fig. 3.3.2. Lab model of the integrated Boxcar instruments (a) and 3D visualization of the switching integrator unit adopted to Arduino platform interface.

- project of a Boxcar-type amplifier with STM32 development programming platform. The amplifier can be used in construction of the optical detection modules and specialized signal processing units in laser absorption spectroscopy (LAS).

a) b)

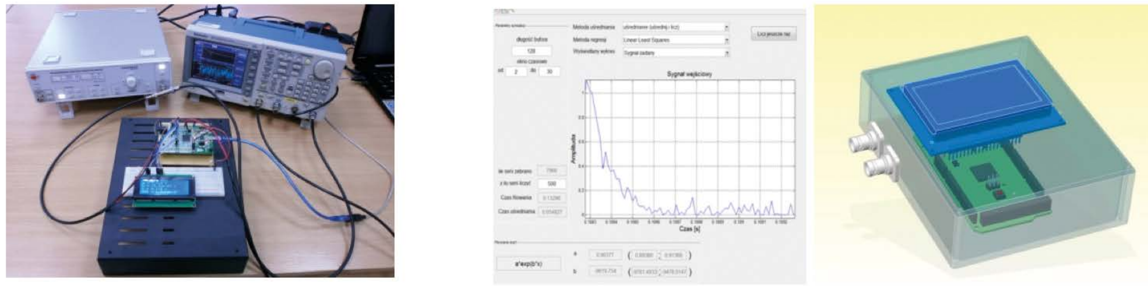


Fig. 3.3.3. View of lab model platform of Boxcar-STM32 (a) and user's panel of LAS data analyses, and 3D visualization of the Boxcar-STM32 instrument (b).

The developed instruments can provide valuable information, which will be applied to construct new detectors and photoreceivers, as well as their practical application.

3.4. DEMONSTRATOR OF THE ULTRASENSITIVE CARBON MONOXIDE SENSOR

jacek.wojtas@wat.edu.pl

In the frame of the project EDEN (ID 179616) financed by National Centre for Research and Development, demonstrator of the carbon monoxide (CO) optoelectronic sensor (EDEN-2015) was developed in the Institute of Optoelectronics (IOE). Cavity enhanced spectroscopy was implemented in the sensor. CO is dangerous air pollution and poses a direct threat to human health. CO is also considered as a biomarker syndrome resulting from coronary insufficiency, which causes disturbance of blood supply to the heart muscle called angina. Fig. 3.4.1 shows a block diagram and a photo of developed demonstrator.
The sensor uses the latest national developments in lasers and photodetectors technology: quantum cascade laser and detection

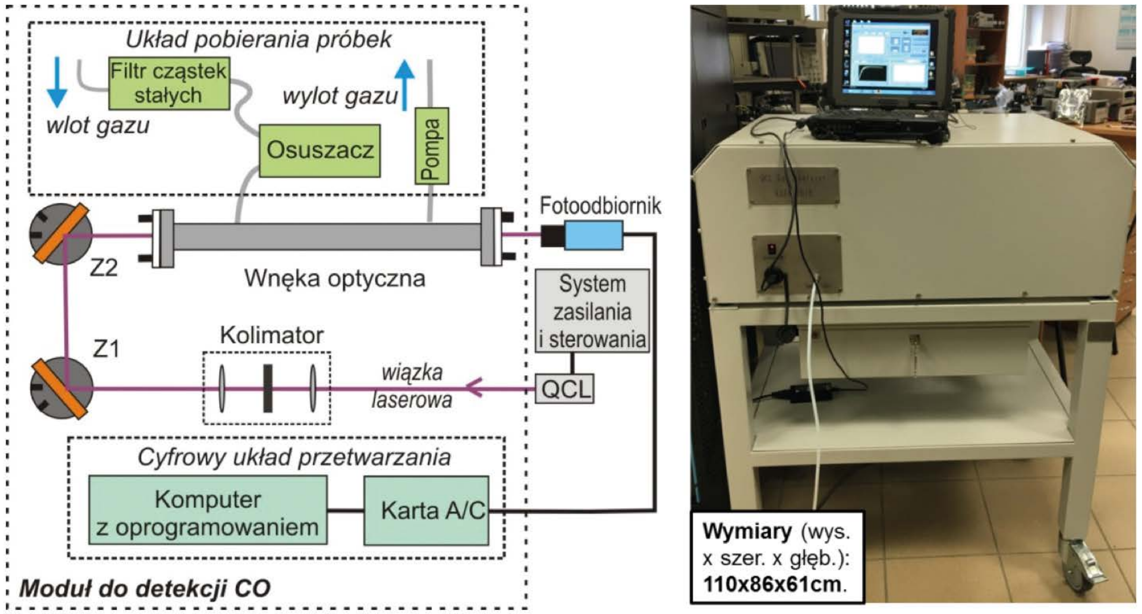


Fig. 3.4.1 . The block diagram (a) and photo of the EDEN-2015 demonstrator (b).

module with type-II superlattice detector (Fig. 3.4.2a), which were developed by the Project Leader - Institute of Electron Technology and Partners: Faculty of Microsystem Electronics and Photonics (Wroclaw University of Technology), Department of Electronics Fundamentals (University of Rzeszow) and the company VIGO System S.A. Developed in IOE carbon monoxide sensor reached the detection limit of 110 ppb. It was determined as a 1.645 SD (standard deviation) of the sensor signal measured with a 109 ppm CO calibration mixture (Fig. 3.4.2b).

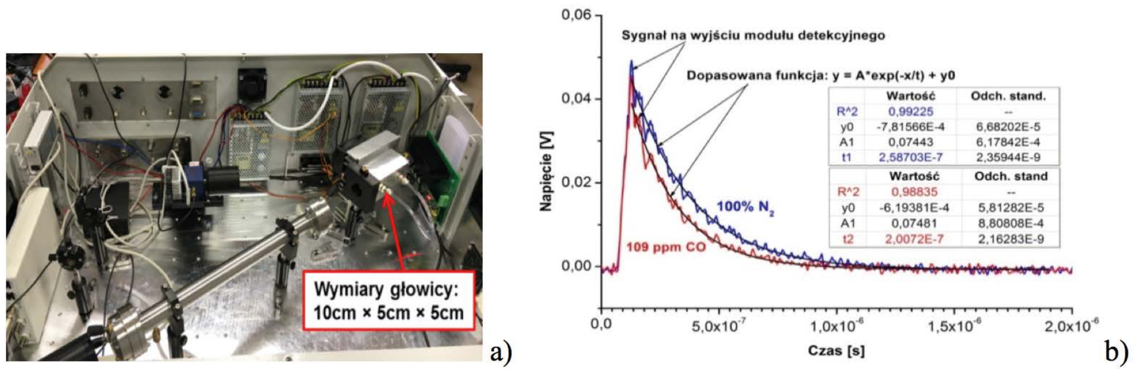


Fig. 3.4.2. Photo of the developed sensor (a) and example of the CO concentration measurement (b).

3. APPLICATIONS OF OPTOELECTRONIC TECHNIQUES IN MEASUREMENTS

3.5. OPTOELECTRONIC DETECTION SYSTEM FOR DISEASE BIOMARKERS IN EXHALED AIR

zbigniew.bielecki@wat.edu.pl

The optoelectronic detection system for disease biomarkers in the exhaled air was developed at the Institute of Optoelectronics, MUT in collaboration with Department of Physics (University of Warsaw), Department of Chemistry (Nicolaus Copernicus University in Toruń) and VIGO System S.A. The system consists of three units to collect breath samples, to detect disease biomarkers, to process and to analyze measurements signals. The task of the conditioning unit is to probe and to prepare air samples for detection procedures taking into account features of two applied optoelectronic sensors.
In construction of the detection unit, there were applied two techniques of laser absorption spectroscopy. The first one was designed to detect carbon monoxide and methane in two-sensing channel configuration with so-called MUPASS-WMS setup. For construction nitrous oxide sensor, Cavity Enhanced Absorption Spectroscopy technique was implemented. Determination of these biomarkers concentration is possible using processing unit, consisting of A/D card and a computer with a dedicated software.
Because of high sensitivity, the developed system can be used in medical screening for detection of some disease biomarkers in the exhaled air at the molecular level.

Fig. 3.5.1. Photography of lab system

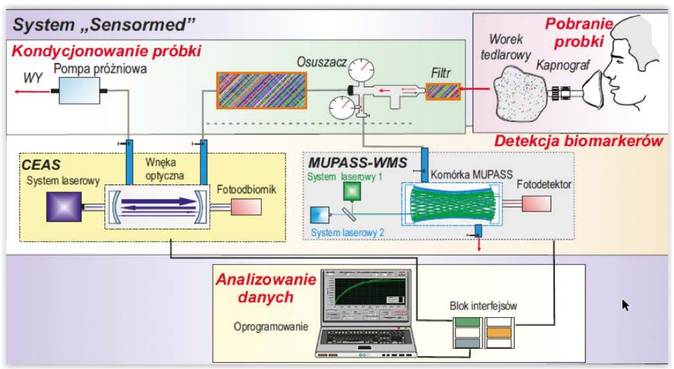


Fig. 3.5.2. Block scheme of system

Table 3.5.1. Parameters of the biomarkers detection system

Biomarker	Wavelength [μm]	Typical concentration	Exemplary diseases	Lowest limit of detection [ppb]
Nitrous Oxide	5,263	35 - 50 ppb	Asthma, angina, chronic pneumonia	30
Carbon Oxide	2,33373	10 - 20 ppm	Asthma, angina, oxidative stress, hiperbilirubinemia	100
Methane	2,25366	< 2 ppm	Intestinal bacteria	100

3.6. THERMAL FACE RECOGNITION

marcin.kowalski@wat.edu.pl

Biometrics refers to metrics related to human characteristics. Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals. It is widely applied for identification of people at the border crossing points.
One of the most popular and the most natural human identifier is face. Face is a unique pattern that allows to automatically verify an identity of a person. There are many face recognition methods based on visible, infrared, two- or three-dimensional images. Face recognition in visible range of light is a very active area of research and is widely applied. However, after decades of research there are still areas for improvement.
The aim of our studies is to develop effective facial recognition algorithms based on the analysis of thermal infrared images (7μm – 14 μm). Thermal infrared imagery seems to be a promising alternative or complement to visible range imaging due to its relatively high resistance to illumination changes. Thermal cameras are passive thus they do not require additional sources of radiation for image acquisition and may be used for low-light or night-time acquisition of facial images.
The facial recognition algorithms extract unique patterns from images. Application of multiple image processing techniques leads to digital face representation in the thermal domain. This representation is used for identity verification.
Thermal-to-thermal and thermal-to-visible face recognition are the two possible schemes of utilizing spectral properties of face that we are investigating.
Face recognition in the thermal domain is investigated under the PROTECT project: **P**ervasive and Use**R** **FO**cused Biome**T**rics Bord**E**r Proje**CT**, financed under the European Commission's Horizon 2020 programme, and is a part of a future border control system based on contactless biometric technologies for identity verification.

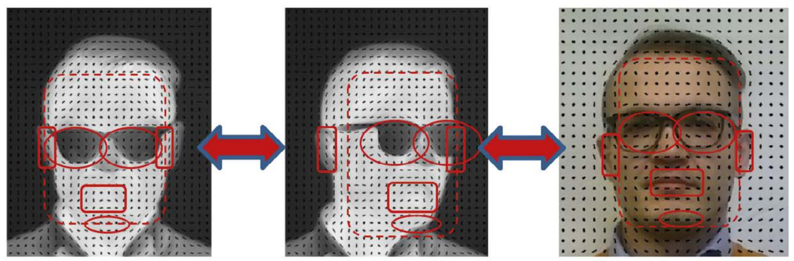


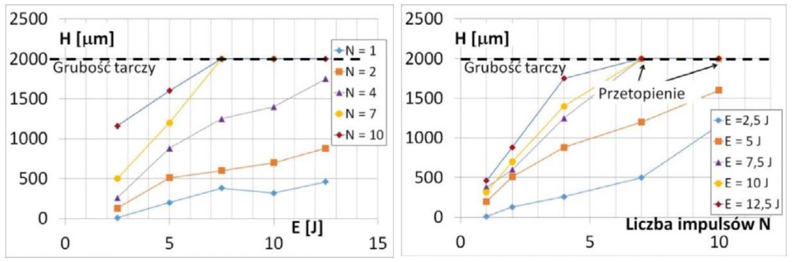
Fig. 3.6.1. Uni-modal and cross-spectral face recognition. Images of two corresponding faces, thermal-to-thermal approach, thermal-to-visible approach.

Acknowledgements:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 700259.

3.7. INVESTIGATIONS OF INTERACTION OF HIGH-ENERGY LASER BEAMS WITH MATERIALS

marek.strzelec@wat.edu.pl

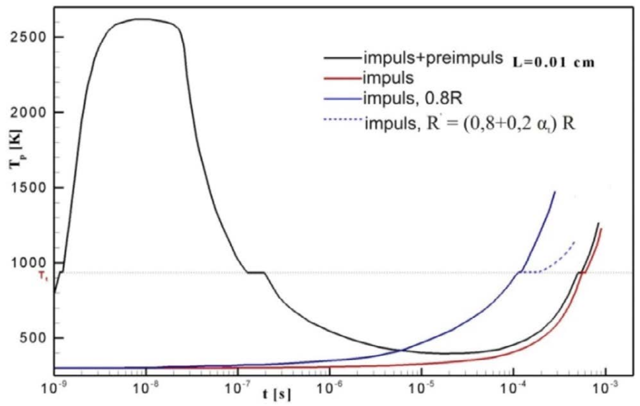
The demonstrator of stand for analyses of high-energy laser beams interaction with materials and military devices has been built and operated. Among others, experimental stand for laser-matter interaction with a Nd:YAG laser, working in a free-running quasi-cw regime, generating pulses with energy up to 10 J and time duration of up to 2 ms, with superimposed nanosecond giant pre-impulses. Stand is equipped with several diagnostics systems was completed. Geometrical dimensions of created (after material evaporation) craters in solid targets and time of burning out of metal foils were analyzed. Radiation spectra of laser induced plasma (LIBS) for long and nanosecond radiation pulses were also recorded. Fig. 3.7.1 shows experimentally measured dependence of the depth of crater created in titanium target in the function of the energy of incident laser radiation.



Rys. 3.7.1. Dependence of crater depth, created by laser radiation in titanium target: a) on laser pulse energy (for constant number of pulses); b) on number of pulses (for constant energy).

A number of experimental results have been utilized in the development of theoretical interaction models (Fig.3.7.1a). Both experimentally and theoretically has been demonstrated that nanosecond pre-impulse is not influencing on the time of burning out of metal target with the use of high-energy, quasi-cw radiation. Slight influence can be seen only in the first phase of interaction, during around 1 ms (Fig. 3.7.2).

Acknowledgements:
This work was supported, by the National Centre for Research and Development in the framework of Strategic Program DOB-1-6-6/1/PS/2014.



Rys. 3.7.2. The value of temperature Tp of reflecting surface in the function of time of laser heating of aluminium layer with thickness of 0.01 cm.

3.8. CHARACTERIZATION OF SPECTRAL PROPERTIES OF TOBACCO

miron.kaliszewski@wat.edu.pl

Nicotine is an organic compound from the pyridine alkaloid group. It occurs naturally in the leaves and roots of noble tobacco (Nicotiana tabacum). Nicotine consists of two heterocyclic rings, pyridine and pyrrolidine, whose carbon atom at position 2 is a chiral center (naturally occurring nicotine is an S-enantiomer). It is a strong neurotoxin, outweighing the toxicity of many illegal drugs. It is also applied in mixtures with other compounds as an insecticide. The LD50 dose is about 1-1.5 mg per kg of body weight.
The nicotine content in cigarette tobacco is in the order of 1-2% of the dry matter, while in the cigarette smoke in the order of 0.2-1 mg / cigarette (depending on the type and brand of cigarettes).
The following measurements methods were applied:

- Laser induced fluorescence (LIF);
- Infrared absorption (ATR);
- Raman scattering;
- Fourier Transform Infrared Spectroscopy (FTIR);

FTIR and RAMAN methods are highly sensitive for tobacco products analysis. The low volatility of nicotine makes recording of gas spectra problematic. Lack of chromophores makes the LIF technique inapplicable.

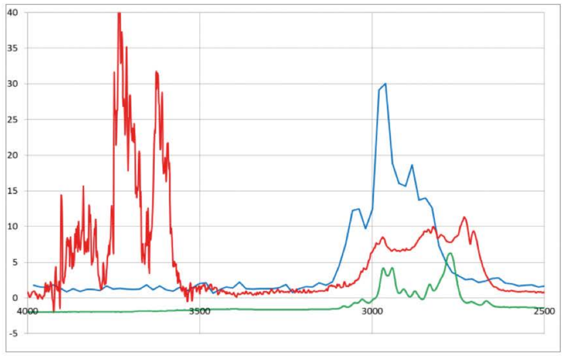


Fig.3.8.1. Absorption spectra of nicotine and tobacco vapours compared to liquid nicotine.

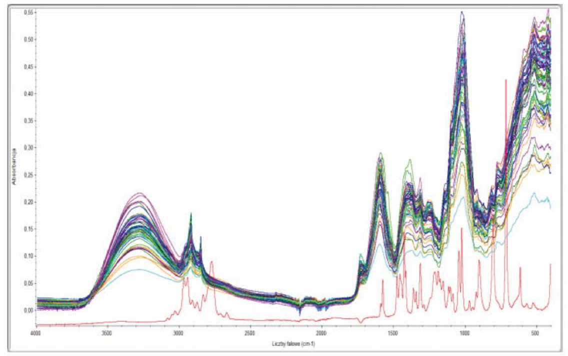


Fig.3.8.2. IR absorption spectra of tobacco samples

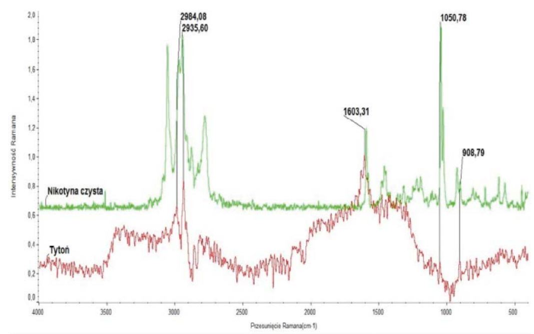


Fig.3.8.3. Raman scattering spectra od nicotine and tobacco

3.9. REAL-TIME DETECTION AND ANALYSIS OF BIO-AEROSOLS

miron.kaliszewski@wat.edu.pl

In 2016 we continued our research on air monitoring device (BARDet – BioAeRosol DETector) using laser induced fluorescence (LIF) for detection of biological contamination. It uses 375 nm CW laser for excitation of fluorescence of individual particles. Each particle is characterized by size and fluorescence measured in 7 bands. The device was equipped with 'built-in' computer allowing real time data acquisition and analysis. We measured over 30 aerosols of biological (pollens, fungi, spores, flours) and non-biological origin. The data were analyzed in real time with application of Principal Component Analysis, Linear Discriminant Analysis and neural networks. The analysis showed outstanding classification effectiveness for most analysed samples reaching 70-90%. It shows that the device can be used for real time warning against biological air pollution as well as a part of a pollen monitoring system.

Fig. 3.9.1. BARDet general view

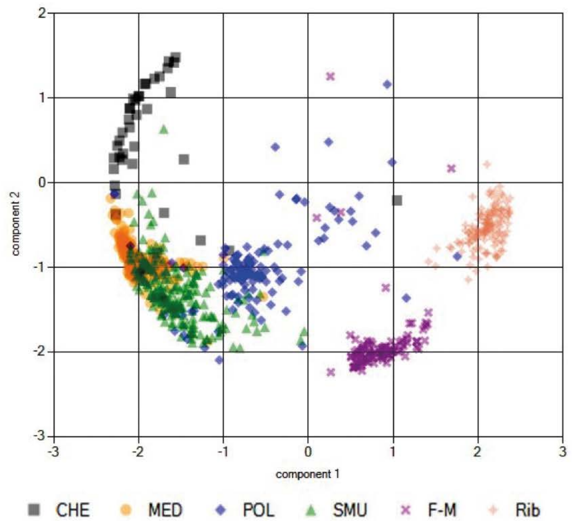


Fig. 3.9.2. Real-time PCA analysis of various bio-aerosols

Table 3.9.1. Classification effectiveness. The percentages of correctly classified elements within the group of substances are presented on diagonal of the table.

	CHE	MED	POL	SMU	F-M	Rib
CHE	70	19	2	4	2	0
MED	0	87	1	11	0	0
POL	0	3	74	11	9	0
SMU	2	27	9	59	0	0
F-M	0	0	1	0	97	1
Rib	0	0	0	0	0	100

3.10. TESTS OF THE BIODETECTION SYSTEM DEVELOPED DURING REALISATION OF THE EDA JIP CBRN RAMBO PROJECT

bartlomiej.jankiewicz@wat.edu.pl

Fig. 3.10.1. Pictures from the EDA JIB CBRN RAMBO project tests, which took place at MUT, showing collection of samples from the bio-aerosol samples, analysis of samples in mobile microbiology laboratory of CRE SZ RP, and presentation of the performance of the two RAMBO biodetection system modules, PCR and SERS.

In 2016 main efforts of the Nanotechnology group were devoted to realisation of the final stage of the project RAMBO - Rapid Air Particle Monitoring Against Biological Threats carried out in the frame of the European Defence Agency Joint Investment Programme on CBRN Protection. The Group was leading the Work Package dedicated to tests of the RAMBO biodetection system components. The main tests and the demonstration of the RAMBO system components performance took place in the laboratories of IOE MUT and at drill ground of MUT. In addition to the members of the consortium (Leonardo, ENEA, CREO, Microfluidic ChipShop and Université Claude Bernard Lyon 1) meeting was also attended by EDA CBRN CapTech & HF Officer, Shahzad Ali. The organisation of the tests and demonstration was greatly supported by the teams of the Epidemiological Reaction Centre of Polish Armed Forces (CRE SZ RP). The realisation of the RAMBO project fits in one of the main research directions of the group, application of the Surfaced Enhanced Raman Spectroscopy to detection of hazardous materials.
In 2016, we continued also our research studies on the chemical fabrication, characterization and applications of various types of plasmonic nanostructures. The main efforts were focused on studies on the fabrication and characterization of core-shell nanostructures, based on titanium dioxide and noble metals, having great potential for application in photocatalysis and photovoltaics.

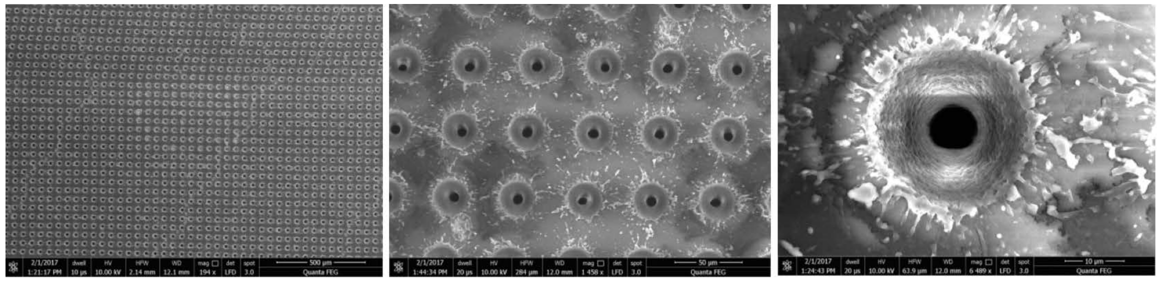
3. APPLICATIONS OF OPTOELECTRONIC TECHNIQUES IN MEASUREMENTS

4. NANO & BIOTECHNOLOGIES

4.1. LASER MANUFACTURING OF MICROSIEVES FOR APPLICATIONS IN BIOTECHNOLOGY

marek.strzelec@wat.edu.pl

Team from the Laser Applications Group, in cooperation with the Biomedical Engineering Center continued R&D works on microsieves for separation of blood cells. Sieves are produced using laser drilling in several metal and polymer foils. The laser system consisted of picosecond Nd:YAG laser model PL2210/SH/TH/ from EKSPLA, Lithuania, electromechanical shooter model SC-10 from Thorlabs, galvanometric scanner model SS-IIE-10 [TY] from RAYLASE, Germany, and beam shaping optics. The most frequently used wavelength was 3rd harmonics of Nd:YAG laser (355 nm). Pulse energy was usually decreased from nominal value of 1400 mJ to even 10 μJ. It caused elongation of the microsieve manufacturing time to almost two hours, but significantly improved the microsieve isoporousity (distribution of holes diameters). Actually manufactured microsieves contain around 100 thousands of microholes inside a sample of 17-mm diameter. The single apertures can vary from 6 mm for the lowest laser energy, to around 12 μm for energy of 100 μm. These microsieves are tested in the processes of isolation from the whole blood and diagnostics of circulating tumour cells (CTC). Fig. 4.1.1 shows SEM microphotographs of sieves produced from polyethylene terephthalate (PET) – thermoplastic polymer from the polyester group. The advantage of PET is preservation, after filtration, alive cancer cells for further investigations. The arrangement of cells at sieve was indicated using immunochemical methods and recorded by confocal and fluorescent microscope (Fig. 4.1.2).



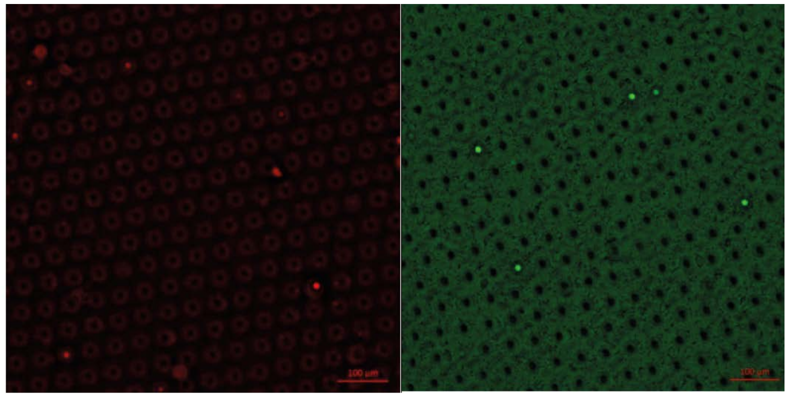


Fig. 4.1.1. SEM microphotographs of sieve produced by a laser beam in PET polymer. Laser pulse Energy 22μJ, repetition frequency 1 kHz, number of pulses in one place – 50. Holes diameter 8,28 ± 0,51 μm. Photographs recorded in the Biomedical Engineering Centre using scanning electron microscope Quanta 250 FEG from Fei.

Fig. 4.1.2. The cells of prostate cancer DU-145 at the surface of microsieve. Photographs recorded in the Biomedical Engineering Centre using fluorescence microscope Eclipse Ci from Nikon. DU-145 cells stained using the LIVE/DE-AD® Viability/Cytotoxicity Kit.

4.2. APPLICATIONS OF EPR SPECTROSCOPY IN BIOMEDICAL ENGINEERING

elzbieta.trafny@wat.edu.pl

EPR (electron paramagnetic resonance) spectroscopy is a method used in biology, chemistry, physics and medicine. In biology EPR spectroscopy is applied for research of cells and tissues. Innovative studies are also conducted on whole organisms. This methods is used in the study of paramagnetic substances such as metalloproteins, metalloenzymes, flavoprotein, melamine or free radicals involved in e.g. photosynthesis and enzymatic reactions. An odd number of electrons in the molecule cause resultant spin different from zero. Paramagnetic centers occur in paramagnetic molecules such as radical ions, free radicals, ions of transition metals and rare earth elements, defects in crystal lattice of the solid, electrons in an electronic conductors, particles which electronic structure has unpaired electrons (NO, NO_2) and molecules in triplet state e.g. $^3O_2$.

EPR spectroscopy in biology use two methods: spin labeling and spin trapping. Method of spin labeling is used in the study of paramagnetic biological systems as lipids, proteins, nucleic acids, membranes, cells and tissues. This technique allows studies of the structure and function of these systems. Method of spin trapping is used in the studies of short-lived radicals due to formation of permanent paramagnetic adducts.

EPR spectroscopy is used in chemistry for research of radicals, which are formed by chemical, photochemical or radiolytic reaction. The method is also applied in the studies of the redox processes involving free radicals biradical, trilpet state, atoms or ions of transition metals, the conductivity of semiconductors, and also in the investigation of defects and impurities in crystals.

Fig.4.2.1. The resonance cavity of EPR spectrometer.

Fig. 4.2.2. Electron resonance spectrometer EMXplus, Bruker.

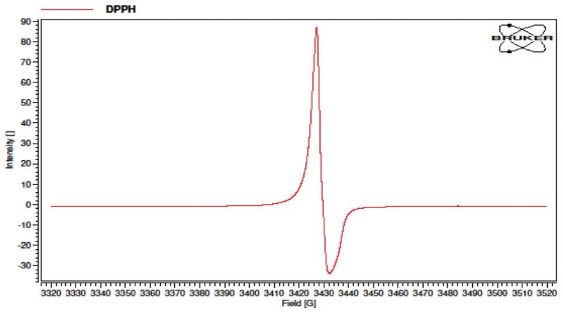


Fig. 4.2.3. The EPR spectrum for DPPH.

4. NANO & BIOTECHNOLOGIES

4.3. THE INFLUENCE OF A MAGNETIC FIELD ON HUMAN CANCER CELLS

elzbieta.trafny@wat.edu.pl

The aim of the experiments was to determine the effect of magnetic field on tumor cell lines such as T-47D (breast cancer) and DU 145 (prostate cancer) and on human mesenchymal stem cells (hMSC). Cells were treated with magnetic field in the range of 0.1 ÷ 0.7 mT and 50 Hz for 2, 4 and 6 hours. The incubator was placed in a anechoic chamber which isolate cells from the external electromagnetic field. The results were referred to two types of controls. The first one (sham control) were the cells placed on the lower shelf of the incubator (under Helmholtz coils), where the magnetic induction was assumed to be close to zero. The second control were the cells grown in a separate incubator outside the anechoic chamber. After exposure the cells to the magnetic field, a cell viability test was performed (PrestoBlue).

Fig. 4.3.1. A signal generator, NI PXIe-1085, National Instruments.

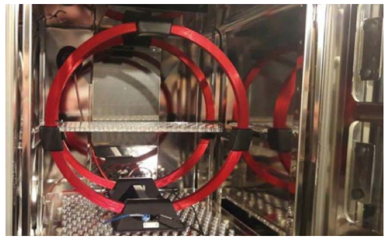


Fig.4.3. 2. Helmholtz coils placed inside the incubator

During long magnetic field exposure (6 hours) a decrease of the viability of DU 145 cells was observed. The largest decrease in cell count was observed for 50 Hz and magnetic induction of 0.4 mT. For breast cancer cell line T-47D no repetitive relationship was observed. Experiments have also showed a significant increase in the rate of proliferation of stem cells placed in the electromagnetic field. The observed effect is important for regenerative medicine, where the fast multiplication of stem cells is needed. Although there have been many reports in recent years about the influence of the magnetic field on the cells, the exact mechanism of this phenomenon has not yet been elucidated. The optimization of magnetic field parameters and further study of the nature of this phenomenon can contribute to the initiation of a new and selective treatment of cancer diseases.

4.4. ASSESSMENT OF METABOLIC ACTIVITY OF HUMAN CELLS BY MEASUREMENT OF INTENSITY OF THEIR AUTOFLUORESCENCE IN VITRO

elzbieta.trafny@wat.edu.pl

Autofluorescence is an optical phenomenon that results from irradiation on the compounds (fluorophores) commonly found in mammalian cells. When the fluorophores are excited, the light emits. The cellular fluorophores include, but are not limited to: amino acids (tryptophan, tyrosine), proteins (elastin, collagen), coenzymes of metabolic reactions (flavan, FAD, NADH, NAD(P)H), intermediates of the heme synthesis (porphyrins), and products of lipid metabolism (lipofuscin). Oxidized mitochondrial flavins, lipofuscin, and reduced flavinadenin dinucleotide (NAD(P)H) are the main sources of autofluorescence. The metabolic activity of four cell lines was assessed by monitoring their autofluorescence with a plate reader. The cells autofluorescence was measured at 366/450 nm (NAD(P)H) and at 460/540 nm (oxidized flavine compounds and lipofuscin) for excitation and fluorescence emission, respectively. The autofluorescence of human mesenchymal stem cells (hMSC), mammary epithelial cells (MCF 10A), breast cancer epithelial cells (T-47D), and prostate cancer cells (DU 145) were measured for 16 days. It has been demonstrated that NAD(P)H autofluorescence was similar in all four cell lines tested during this period of time. A significant increase in autofluorescence intensity in the range of 140 to 175% of control was noted for oxidized flavine and lipofuscin in hMSC cells. The autofluorescence was also recorded during a 28-day process of hMSC differentiation into osteoblasts and adipocytes and the redox coefficient was calculated. A gradual decrease in redox coefficient was observed during the last 8 days of osteogenesis and adipogenesis.

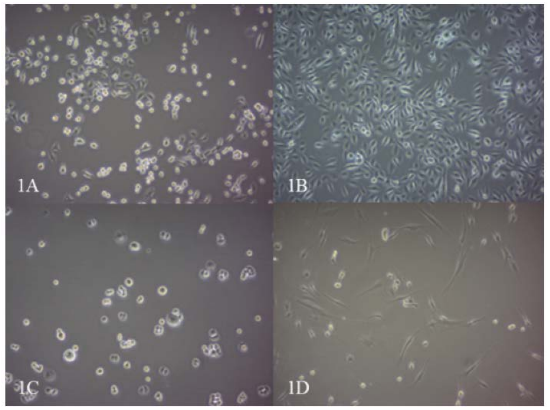


Fig. 4.4.1. Morphology of four cell lines at day 3 of culture at a density of 1×104 cells / ml. A) DU-145, B) MCF 10A, C) T-47D, D) hMSC. 100 × magnification

Fig. 4.4.2. Differentiation of hMSC cells, photos taken at day 28 of culture. A) hMSC cells - control sample; B) hMSC cells after differentiation into osteoblasts. The images were taken with a Laser Scanning Confocal System LSM 700 Zeiss Axio Observer Z, fluorescence induced with a wavelength of 492 nm and read at 520 nm, pitch = 100 µm

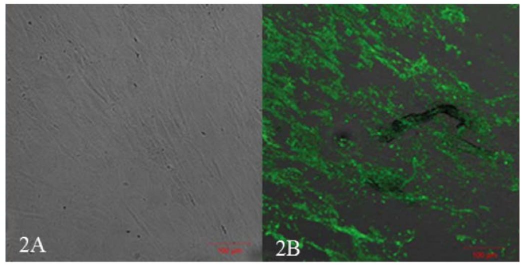
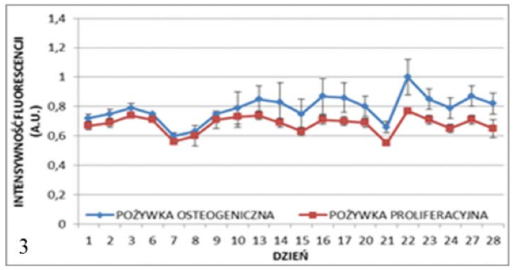


Fig. 4.4.3. Comparison of fluorescence intensity of hMSC grown on osteogenic and proliferative medium. Measurements were conducted for 28 days. The fluorescence of the flavin compounds and lipofuscin was induced with a wavelength of 460 ± 15 nm and read at 540 ± 20 nm. ± SD (n = 8).



4.5. AN IN VIVO EFFECT OF LIGHT EMITTING DIODE IRRADAITION ON STIMULATION OF HUMAN MESENCHYMAL STEM CELLS PROLIFERATION

elzbieta.trafny@wat.edu.pl

The previous studies concerned with the influence of LED irradiation on mesenchymal stem cells (hMSCs) proliferation were continued. The purpose of these studies was to find the optimum stimulatory dosimetric parameters of LED irradiation on the hMSCs proliferation.

The best results were obtained with using of LEDs array composed of 12 LED lamps, operated at a wavelength of 630 nm under irradiation at energy density 4 J/cm^2 and at power density 17 mW/cm^2. The increase of cell proliferation was noticeable higher in comparison to corresponding non-irradiated cells (control). At the same dosimetric parameters, the measurement of hMSCs proliferation expressed as DNA cells' content was performed. The increase of DNA content in comparison to the corresponding controls was also observed at both 5 and 9 day. Moreover, when the cells were irradiated in PBS the stimulation of proliferation was more efficient when compared to the cells irradiated in culture medium. After single LED irradiation, the increase of cell proliferation even by 44% was observed in comparison to corresponding controls.

On the other hand, triple LED irradiation under the same dosimetric parameters resulted in the rate of proliferation at the similar level on day 5 and 9, when compared to the cell proliferation after irradiation with a single dose. Additionally, as it has been demonstrated with use of flow cytometry, after irradiation the MSCs kept theirs characteristics immunophenotype and were still capable of differentiating into a bone, cartilage, and fat cells. Therefore, the stem mesenchymal cells were not destroyed by LED irradiation under the parameters described above.

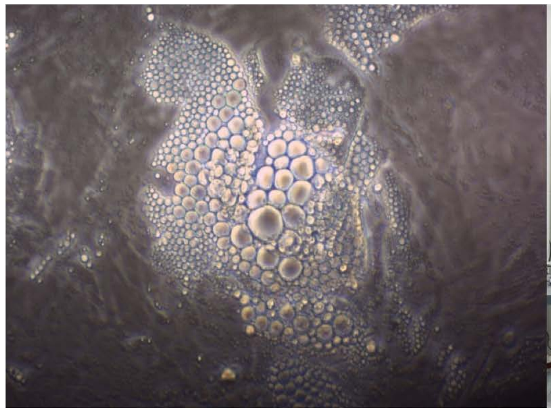


Fig. 4.5.1. Adipocyte cells differentiated from HMSC cells irradiated from LED.

Fig. 4.5.2. Measurement of immunophenotype of hMSC cells by flow cytometry

4.6. FORMATION OF PERIODICAL STRUCTURES ON THE SURFACE OF MATERIALS USING DIRECT INTERFERENCE LITHOGRAPHY

marek.strzelec@wat.edu.pl

The method of direct laser interference lithography is one of the techniques of material surface layers modification. Multi-beam interference has been realized in a prismatic optical arrangement with Nd:YAG laser source and transformation of wavelength to 2^{nd} and 3^{rd} harmonics of fundamental wavelength of 1064 nm. The system was able to create periodical structures with long range order and exactly defined period using single laser pulses. The period can be easily changed by control of the distance between prism and irradiated sample. Multiple irradiation of samples with pulse energies below the ablation threshold allows in turn structuring of soft materials.

Many periodical structures were manufactured, including simple Bragg structures, but also complex hierarchical architectures. The period of these structures varied from around 0.6 mm to almost 100 mm. The high possible laser pulse energy of 1.5 J, and variable wavelength (1064 nm, 532 nm and 355 nm) allowed efficient treatment in one step of almost all, even hard materials on the surface of almost 1 cm^2 (in one shot).

Developed technology allows production of structures for practical applications. Created periodical (linear) structures were applied in titanium implants. Interference profiles on thin DLC layers are actually tested in the Institute of Metallurgy and Materials Science, Polish Academy of Science in Cracow for cells culturing. The surface modifications allow control of cells growth and rate/orientation of development, which is shown as an example in Fig. 4.6.1. In cooperation with the Faculty of Metals Engineering and Industrial Informatics at AGH, Cracow, the technique of laser interference lithography has been also utilized for modification of magnetic properties of amorphous alloys FeSiB, FeCuSiB i FeNbCuSiB.

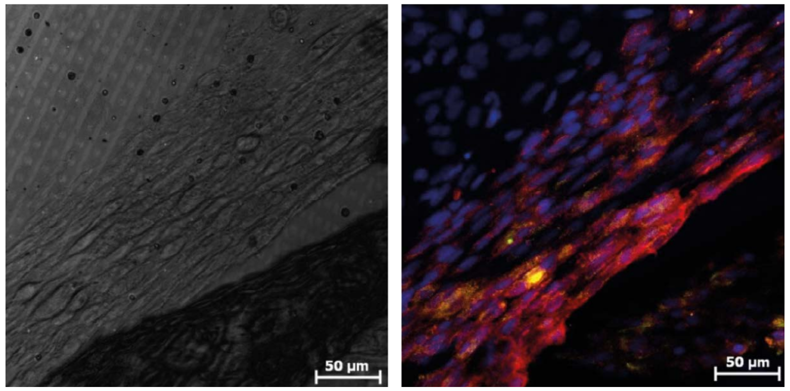


Fig. 4.6.1. Structure created on DLC surface (dots with lines among rows of dots) and growing cells in direction turned 25-30° against structure axis

4.7. FABRICATION OF NANOSTRUCTURED TITANIUM OXIDE LAYERS THROUGH ELECTROCHEMICAL PROCESS

marta.michalska@wat.edu.pl

In 2016 studies on anodic titanium oxide (ATO) fabrication by an anodization of titanium foil were conducted. The layers of nanostructured ATO (Fig. 4.7.1) were prepared in organic-based electrolytes (ethylene glycol, glycerol and ethanol) with NH_4F and different water content. The temperature and applied voltage values which resulted in nanoporous or nanotubular morphology of anodic titanium oxide were defined. The influence of viscosity and water content in the electrolyte solution on the ATO morphology were investigated. The parameters for formation of nanoporous and nanotubular titanium oxide in a new ethanol-based electrolyte, containing NH_4F and a variable amount of water, were determined. ATO layers with different colors (Fig. 4.7.2) were obtained in ethanol-based electrolyte by controlling the anodization conditions. The optical properties of those layers were characterized (Fig. 4.7.3).

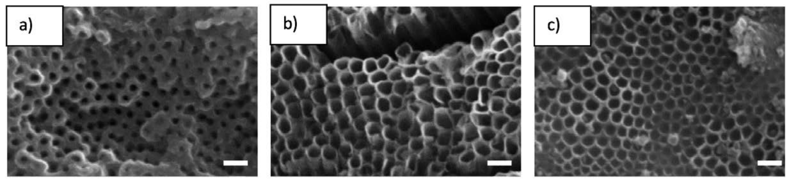


Fig. 4.7.1. The ATO film morphology depending on the electrolyte viscosity (0,3 M NH4F, 2 vol% H2O). The anodization was conducted in ethanol (a) ethylene glycol (b) and glycerol (c) based electrolyte. The bar is 200 nm.

Fig. 4.7.2. Different color anodic titanium oxide layers fabricated by electrochemical oxidation of titanium.

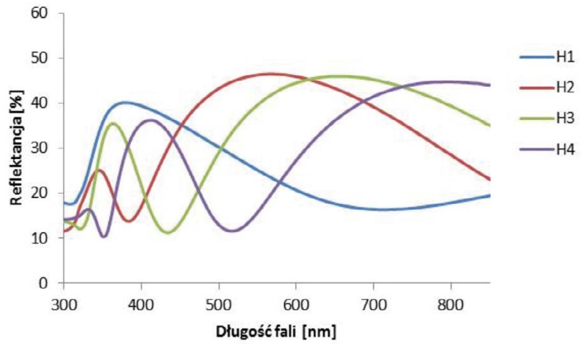


Fig. 4.7.3. The diffuse reflectance spectra of the samples presented in Fig. 4.7.2.

Acknowledgements: The research was financed by the National Science Centre, Poland, under grant no UMO-2015/17/D/ST8/02432 and by the National Centre for Research and Development, Poland, under grant no PBS3/A5/53/2015. M. Michalska-Domańska cordially acknowledges financial support from the Polish Ministry of Science and Higher Education (Scholarship for Young, Outstanding Researchers 2016–2019, agreement no. 1013/E-410/STYP/11/2016).

5. OPTOELECTRONIC DEVICES AND SYSTEMS

5.1. AUTOMETED BORDER CONTROL E-GATE

mieczyslaw.szustakowski@
wat.edu.pl

The e-gate was developed to speed up the border control process at border crossing points by means of modern biometric technologies. At the beginning, a traveller places its biometric passport into the reader and his/her personal and biometric data (facial image and fingerprints) are downloaded. At this stage, the system also verifies the reliability of the passport and detects its possible forgery. In the second step, an facial image of the traveller is acquired. Finally, the traveller has to put an indicated finger to the fingerprint reader. In parallel, advanced algorithms implemented in the system compare the images taken from the traveller with those read from the passport. Proper verification of both the originality of the passport and the comparison of the two images (the finger and face) determine positive verification of the traveller as a legal owner of the passport. In the background, the system can also connect to databases and identify a suspicious person or a lost document.

Fig. 5.1.1 presents the system during tests at Warsaw-Modlin Airport. About 600 checks were carried out with effectiveness of about 95%. This effectiveness depends mainly on the willingness of travellers to cooperate.

The border check is supervised by an officer of the Border Guard. The screen of the tablet (Fig. 5.1.2) presents images of the face and finger: downloaded from the passport (left) and acquired from the traveller (right). On the right side you can also see personal data of the traveller and photos of the passport made in various lighting conditions, which is to verify its originality.

Fig. 5.1.1. The system during tests at Warsaw-Modlin Airport

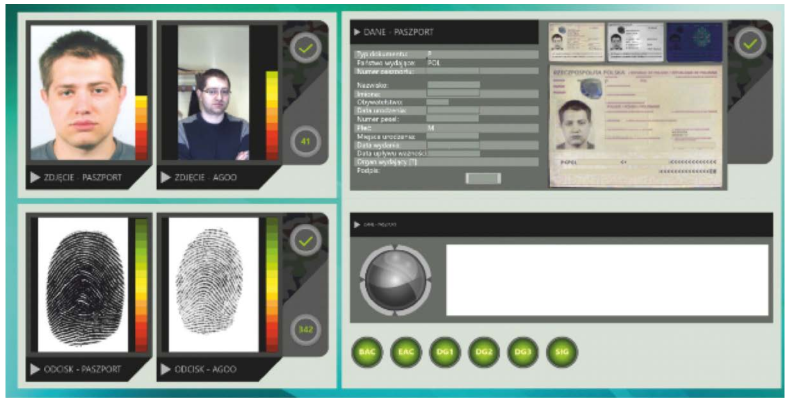


Fig. 5.1.2. The screen of the tablet of e-gate

5. OPTOELECTRONIC DEVICES AND SYSTEMS

5.2. HANDHELD LASER PHOTO-SPEEDOMETER

marek.zygmunt@wat.edu.pl

We optimized and prepared for commercial implementation the handheld speedometer, developed as a result of Project No PBS1/B3/10/2012 (The National Centre for Research and Development). The modification covered mainly the image recording unit, which also serves as an electronic viewfinder. In the current version of the device, commercially available camera unit was used, which in addition to obvious advantages such as small dimensions and large optical zoom, was characterized by a signal processing time of about 300 ms. Such delay, in specific measurement conditions made it difficult to aim at fast-moving objects, which was not acceptable. For this reason, in the current version, the camera module will be developed by ourselves. Benefiting from the optimized raw video processing method, delay times of several milliseconds have been achieved. In addition, physically larger sensor is used, which, while maintaining resolution, will improve the noise characteristics of the recorded images, thus enabling the automatic recognition of vehicles plates. The design of the device will be also slightly modified, which will show a minimal inclination of the main display.

Fig. 5.2.1. Photo of handheld speedometer.

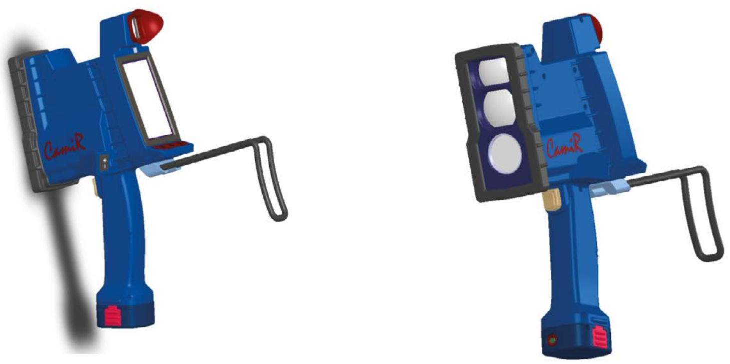


Fig. 5.2.2. 3D visualization of the latest (commercial) version.

5.3. LASER WARNING SYSTEM, OBRA++

marek.zygmunt@wat.edu.pl

Fig. 5.3.1. Photograph of laboratory set up for system OBRA++ characterization.

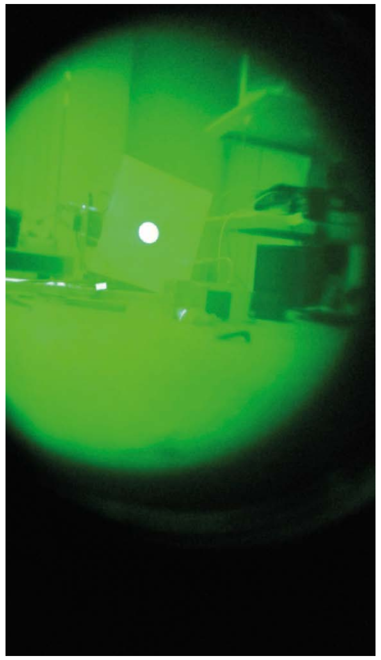


Fig. 5.3.2. NIR image of the calibration tests (reference laser beam can be seen).

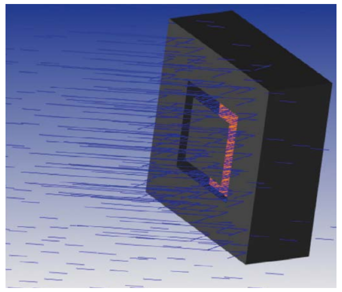


Fig. 5.3.3. Screenshot from stray light modelling application.

We continued optimization of the laser warning system, code name "Obra^{++}", aiming at high angular resolution, large dynamics of the system, while maintaining a sufficient sensitivity ensuring detection of modern "sub-noise" laser rangefinders, which are common in the contemporary battlefield. Optimization is based on numerical analysis, followed by experimental verification of variants based on different optical geometry and using different anti-reflective solutions, which are responsible for suppressing unwanted stray light. The algorithm for signal analysis in the context of calculating the angle of incidence of the laser beam has also been improved.

5.4. OPTOELECTRONICS FOR INTELLIGENT ANTI-MISSILE

marek.zygmunt@wat.edu.pl

Fig. 5.4.1. Photos of the system during field tests.

We performed numerous field tests of passive optoelectronic module for the so-called intelligent anti-missile, which is designed to counteract enemy's fire. The key strengths of the proposed system result from the unconventional optical system responsible for ensuring the unique temporal signatures of the approaching missiles and high processing speed of the applied electronics solutions. Those benefits, in conjunction with the proposed system logics, enable for low-false-alarm and rapid decision making process, concerning anti-missile detonation.

5.5. INTEGRATION OF MILITARY OPTOELECTRONICS SENSORS

marek.zygmunt@wat.edu.pl

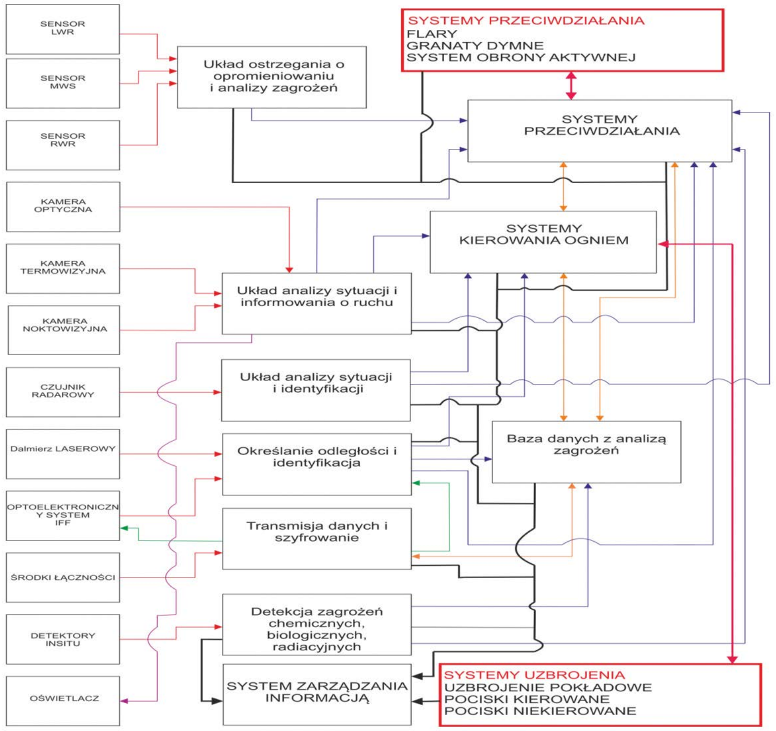


Fig. 5.5.1. Block diagram of military optoelectronic sensors fusion architecture.

A detailed feasibility study in terms of modern military optoelectronic sensors fusion into larger architecture has been made. The purpose of such integration is to enhance the functionality of combined optoelectronics platform comparing to the solutions in which individual sensors operate independently. Investigated components included: Laser Warning Systems (LWR), Missile Warning Systems (MWS), Radar Warning Receivers (RWR), optical cameras, thermal cameras, infrared (NIR) cameras, radars, rangefinders, identification friend-or-foe (IFF) modules, chem/bio/fire detectors and laser illumination systems.

6.
SCIENTIFIC PROJECTS

6.1. STRATEGIC PROGRAMS FINANCED BY NATIONAL CENTRE FOR RESEARCH & DEVELOPMENTS

PST1; DOB-1-3/1/PS/2014; Metody i Sposoby Ochrony i Obrony przed Impulsami HPM; kierownik: prof. dr hab. Zygmunt Mierczyk; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

PST2; DOB-1-6/1/PS/2014; Laserowe Systemy Broni Skierowanej nergii, Laserowe Systemy Broni Nieśmiercionośnej; kierownik: dr Krzysztof Kopczyński; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

6.2. BASIC RESEARCH PROJECTS

BP1; 2013/09/N/ST7/01248; Analiza teoretyczna oraz badania właściwości generacyjnych pompowanego koherentnie, impulsowego lasera Cr:ZnSe, przestrajalnego w paśmie widmowym około 2400 nm; kierownik: dr Łukasz Filip Gorajek; Projekt naukowy finansowany przez Narodowe Centrum Nauki; PRELUDIUM; edycja 5

BP2; 2013/09/B/ST2/01625; Fotojonizacja ośrodków gazowych impulsami promieniowania plazmy laserowej; kierownik: dr hab. Andrzej Stanisław Bartnik; Projekt naukowy finansowany przez Narodowe Centrum Nauki; OPUS; edycja 5

BP3; DOB-BIO6/07/40/2014; Opracowanie środowiska do wdrożenia koncepcji Smart Borders; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BP4; 2014/13/B/ST7/00442; Badenie generacji supercontinuum w paśmie widmowym średniej podczerwieni z użyciem wybranych światłowodów nieliniowych oraz nowoczesnych laserowych układów światłowodowych generujących pikosekundowe impulsy promieniowania o długości fali ~2000 nm; kierownik: dr hab. Jacek Świderski; Projekt naukowy finansowany przez Narodowe Centrum Nauki; OPUS; edycja 7

BP5; 2015/17/D/ST8/02432; Wpływ morfologii i struktury plazmonicznej fotoanody na bazie tlenku tytanu na jej aktywność w reakcji dysocjacji wody pod wpływem energii słonecznej; kierownik: dr Marta Ewa Michalska-Domańska; Projekt naukowy finansowany przez Narodowe Centrum Nauki; SONATA; edycja 9

BP6; 2014/14/M/ST7/00868; Badanie generacji supercontinuum w światłowodach fluoroindowych pompowanych impulsami optycznymi o czasie trwania z zakresu femtosekund, pikosekund oraz nanosekund; kierownik: dr hab. Jacek Świderski; Projekt naukowy finansowany przez Narodowe Centrum Nauki; HARMONIA; edycja 6

BP7; 2015/19/B/ST3/00435; Badania absorpcji promieniowania rentgenowskiego i skrajnego nadfioletu w pobliżu krawędzi absorpcji, generowanego z plazmowych źródeł kompaktowych, w celu charakterystyki subtelnych struktur materii.; kierownik: dr hab. Przemysław Wojciech Wachulak; Projekt naukowy finansowany przez Narodowe Centrum Nauki; OPUS; edycja 10

BP8; 2015/19/D/ST7/01373; Badania generacji parametrycznej w zakresie widmowym średniej podczerwieni w nieliniowym krysztale fosforku cynkowo germanowego pompowanym laserami włóknowymi.; kierownik: dr Łukasz Filip Gorajek; Projekt naukowy finansowany przez Narodowe Centrum Nauki; SONATA; edycja 10

BP9; 2016/21/B/ST7/02225; Detekcja impulsów promieniowania o małej intensywności z zakresu skrajnego nadfioletu; kierownik: dr hab. Andrzej Stanisław Bartnik; Projekt naukowy finansowany przez Narodowe Centrum Nauki; OPUS; edycja 11

6.3. RESEARCH & DEVELOPMENT PROJECTS

BR1; LIDER/015/479/L-4/12/NCBR/2013; Metoda i system do wykrywania obiektów z użyciem polarymetrii obrazowej w zakresie dalekiej podczerwieni; kierownik: dr Grzegorz Tadeusz Bieszczad; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Inny program (Lider)

BR2; DOBR/0017/R/ID1/2012/ 03; Usprawnienie procesu odprawy granicznej osób przy wykorzystaniu biometrycznych urządzeń do samokontroli środków transportu przekraczających granicę zewnętrzną UE.; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR3; PBS1/A3/7/2012; Optoelektroniczny system sensorów markerów chorobowych.; kierownik: prof. dr hab. Zbigniew Bielecki; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program Badań stosowanych

BR4; DOBR-BI04/057/13245/2013; Mobilna kontrola graniczna z wykorzystaniem technik biometrycznych dostosowana do wymogów i zaleceń UE; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR5; PBS2/B3/22/2013; Opracowanie energooszczędnego zestawu biometrycznego do mobilnej kontroli dokumentów i osób z użyciem systemów akustycznych i zobrazowania twarzy; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program Badań stosowanych

BR6; LIDER/004/410/L-4/12/NCBR/2013; Mikroskop EUV z nanometrową rozdzielczością przestrzenną do zastosowań we współczesnej nauce i technologii; kierownik: dr hab. Przemysław Wojciech Wachulak; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Inny program (Lider)

BR7; PBS1/A9/11/2012_178362; Wielopikselowy detektor promieniowania THz zrealizowany z wykorzystaniem selektywnych tranzystorów MOS i jego zastosowanie w biologii, medycynie i systemach bezpieczeństwa.; kierownik: dr Przemysław Piotr Zagrajek; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program Badań stosowanych

BR8; INNOTECH-K3/IN3/57/229263/NCBR/15; Opracowanie nowatorskiego czujnika detekcji upadku osób wraz z systemem sterowania inteligentnym budynkiem; kierownik: dr Marek Tomasz Życzkowski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program INNOTECH

BR9; DOBR-BIO4/031/13249/2013 PBR/15-097/2013/WAT WEL/WML; Inteligentny antypocisk do zwalczania pocisków przeciwpancernych" - Kryptonim. „JAZPP"; kierownik: dr inż. Marek Zygmunt; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR10; DOB-BIO7/16/03/2015; System przeciwdziałania i zwalczania zagrożeń powstałych w wyniku bezprawnego i celowego użycia platform mobilnych (latających, pływających); kierownik: dr Mariusz Włodzimierz Kastek; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekty rozwojowe

BR11; 227971; Spektrometr ramanowski z heterodyną optyczną; kierownik: dr Krzysztof Kopczyński; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program INNOTECH

BR12; INNOTECH-K3/IN3/55/225968/NCBR/14; Lasery chirurgiczne wysokiej mocy pracujące na długości fali 1470 nm i 1940 nm do zastosowań w małoinwazyjnej chirurgii endoskopowej i robotycznej; kierownik: dr hab. Jacek Świderski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program INNOTECH

BR13; DOB-BIO6/1/26/2014; 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; kierownik: prof. dr hab. Henryk Jan Madura; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR14; LIDER/020/319/L-5/13/NCBR/2014; Detektory promieniowania THz wytworzone z wykorzystaniem tranzystorów polowych do zastosowania w komunikacji bezprzewodowej; kierownik: dr Przemysław Piotr Zagrajek; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Inny program (Lider)

BR15; DOB-BIO7/25/02/2015; Budowa zautomatyzowanego systemu optycznej obserwacji i śledzenia obiektów w przestrzeni kosmicznej; kierownik: dr Krzysztof Kopczyński; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR16; DOB-BIO7/23/02/2015; System zdalnego kierowania oraz monitoringu pracy psów służbowych do działań granicznych i specjalnych; kierownik: dr Mariusz Włodzimierz Kastek; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR17; PBS3/B3/30/2015_244640; Aktywny sub-THz skaner 3D do zastosowań antyterrorystycznych; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program Badań stosowanych

BR18; DOB-BIO8/01/01/2016; Hybrydowe łącze otwartej przestrzeni; kierownik: dr Janusz Andrzej Mikołajczyk; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR19; DOB-BIO7/22/02/2015; Symulatory szkoleniowe w zakresie zwalczania pożarów wewnętrznych; kierownik: dr Krzysztof Firmanty; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

BR20; 2015/17/B/ST7/03718; Promieniowanie z zakresu „okna wodnego" do nano-obrazowania obiektów biologicznych i trójwymiarowej rekonstrukcji gęstości elektronowej w zastosowaniach bioinżynieryjnych i materiałoznawstwie.; kierownik: dr hab. Przemysław Wojciech Wachulak; Projekt naukowy finansowany przez Narodowe Centrum Nauki; OPUS; edycja 9

BR21; 245812; Pompowany diodowo, modułowy zestaw laserowy do zastosowań specjalnych; kierownik: prof. dr hab. Jan Karol Jabczyński; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Program Badań stosowanych

6.4. PROJECTS FINANCED BY EUROPEAN UNION

M1; POIG.01.03.01-14-033/12; Kompozytowy system pasywnej i aktywnej ochrony obiektów infrastruktury krytycznej; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt o charakterze badawczym finansowany w ramach programu operacyjnego; Program Operacyjny Innowacyjna Gospodarka

M2; Umowa grantu nr 284464; Laserlab Europe; kierownik: prof. dr hab. Henryk Fiedorowicz; Projekt w ramach programu ramowego Unii Europejskiej; Projekty 7-go Programu Ramowego

M3; A-1152-RT-GP; Rapid Air-particle Monitoring against BiOloogical threats (RAMBO); kierownik: dr Bartłomiej Jerzy Jankiewicz; Projekt finansowany przez zagraniczną instytucję publiczną, powołaną w celu wspierania działalności naukowej lub badawczo-rozwojowej; Projekty finansowane przez agencje Unii Europejskiej, w tym przez EURATOM, European Institute of Innvation and Technology (EiT), European Defence Agency (EDA), Consumers oraz Health and Food Executive Agency (CHAFEA)

M4; EDA-TIPPSI v. 20130716; Terahercowe platformy obrazujące do zdalnej detekcji IED (improwizowanych ładunków wybuchowych) (TIPPSI); kierownik: dr hab. Norbert Pałka; Projekt finansowany przez zagraniczną instytucję publiczną, powołaną w celu wspierania działalności naukowej lub badawczo-rozwojowej; Projekty finansowane przez agencje Unii Europejskiej, w tym przez EURATOM, European Institute of Innvation and Technology (EiT), European Defence Agency (EDA), Consumers oraz Health and Food Executive Agency (CHAFEA)

M5; A-1152-RT-GP-JIP CBRN; Aktywna Wielowidmowa Detekcja Sygnatur Trwałych Związków Chemicznych (AMURFOCAL); kierownik: dr Mariusz Włodzimierz Kastek; Projekt finansowany przez zagraniczną instytucję publiczną, powołaną w celu wspierania działalności naukowej lub badawczo-rozwojowej; Projekty finansowane przez agencje Unii Europejskiej, w tym przez EURATOM, European Institute of Innvation and Technology (EiT), European Defence Agency (EDA), Consumers oraz Health and Food Executive Agency (CHAFEA)

M6; 3621/GGPJ/H2020/2016/0; Innowacyjne koncepcje oraz narzędzia dla wydajnych oraz bezpiecznych lądowych przejść granicznych; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt w ramach programu ramowego Unii Europejskiej; Projekty realizowane w ramach Horyzont 2020 (ERC, działanie Research & Innovation Action, Innovation Action, działania Marie Skłodowskiej-Curie)

M7; 3622/GGPJ/H2020/2016/0; Zorientowany na użytkownika, oparty na atrybutach mobilny i wirtualny ekosystem tożsamości; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt w ramach programu ramowego Unii Europejskiej; Projekty realizowane w ramach Horyzont 2020 (ERC, działanie Research & Innovation Action, Innovation Action, działania Marie Skłodowskiej-Curie)

M8; 700259; Powszechny i zorientowany na użytkownika projekt biometrycznej granicy (PROTECT); kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt w ramach programu ramowego Unii Europejskiej; Projekty realizowane w ramach Horyzont 2020 (ERC, działanie Research & Innovation Action, Innovation Action, działania Marie Skłodowskiej-Curie)

M9; 329710; Powszechny i zorientowany na użytkownika projekt biometrycznej granicy (PROTECT); kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt w ramach programu ramowego Unii Europejskiej; Projekty realizowane w ramach Horyzont 2020 (ERC, działanie Research & Innovation Action, Innovation Action, działania Marie Skłodowskiej-Curie)

6. SCIENTIFIC PROJECTS

6.5. STATUTE RESEARCH PROJECTS

PST1; DOB-1-3/1/PS/2014; Metody i Sposoby Ochrony i Obrony przed Impulsami HPM; kierownik: prof. dr hab. Zygmunt Mierczyk; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

PST2; DOB-1-6/1/PS/2014; Laserowe Systemy Broni Skierowanej Energii, Laserowe Systemy Broni Nieśmiercionośnej; kierownik: dr Krzysztof Kopczyński; Projekt finansowany przez Narodowe Centrum Badań i Rozwoju; Projekt w zakresie badań naukowych lub prac rozwojowych na rzecz obronności i bezpieczeństwa państwa

ST1; PBS/23-905/2014/WAT; Analiza porównawcza symulatorów lotów przenośnych rakiet przeciwlotniczych krótkiego zasięgu; kierownik: prof. dr Zbigniew Puzewicz; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST2; PBS/23-908/2014/WAT; Laserowe i plazmowe technologie mikro-i nano - obróbki warstwy wierzchniej materiałów; kierownik: dr hab. Andrzej Stanisław Bartnik; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST3; PBS/23-907/2014/WAT; Militarne zastosowania laserów pompowanych wiązkami światła; kierownik: prof. dr hab. Waldemar Żendzian; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST4; PBS/23-906/2014/WAT; Multispektralne urządzenia optoelektroniczne w systemach bezpieczeństwa; kierownik: prof. dr hab. Mieczysław Szustakowski; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST5; PBS/23-903/2014/WAT; Optoelektroniczne metody wytwarzania i charakteryzacji nanostruktur dla potrzeb techniki wojskowej; kierownik: dr Andrzej Dariusz Gietka; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST6; PBS/23-902/2014/WAT; Optoelektroniczne rozpoznanie pola walki; kierownik: dr Marek Zygmunt; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST7; PBS/23-904/2014/WAT; Zabezpieczenie metrologiczne optoelektroniki; kierownik: dr hab. Jan Aleksander OWSIK; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST8; PBS/23-921/2015/WAT; Obserwacyjne kamery termowizyjne dla autonomicznych platform bojowych z niechłodzonymi matrycami detektorów podczerwieni o dużej rozdzielczości; kierownik: dr Tomasz Kazimierz Sosnowski; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

ST9; PBS/23-920/2015/WAT; Układy przetwarzania sygnałów do detektorów promieniowania optycznego; kierownik: prof. dr hab. Zbigniew Bielecki; Projekt finansowany przez Ministerstwo Nauki i Szkolnictwa Wyższego; dotacja na utrzymanie potencjału badawczego

6.6. STATUTE RESEARCH PROJECTS FOR YOUNG SCIENTISTS' DEVELOPMENT

RMN1. Zastosowanie matrycowych detektorów mikrobolometrycznych do zdalnego zobrazowania i wykrywania substancji chemicznych, kierownik: dr inż. G. Bieszczad

RMN2. Wytwarzanie ultrakrótkich impulsów spójnego promieniowania w zakresie widmowym skrajnego nadfioletu (EUV) W wyniku oddziaływania femtosekundowych impulsów laserowych z tarczami gazowymi o zmiennym rozkładzie gęstości. Automatyzacja stanowiska laserowych z tarczami gazowymi o zmiennym rozkładzie gęstości. Automatyzacja stanowiska laboratoryjnego. kierownik: mgr inż. T. Fok

RMN3. Wytwarzanie ultrakrótkich impulsów promieniowania rentgenowskiego w zakresie keV w wyniku oddziaływania femtosekundowych impulsów laserowych z tarczą gazową zawierającą klastery, kierownik: mgr inż. Ł. Węgrzyński

RMN4. Zastosowanie metody ablacji laserowej (PLD – pulsed laser deposition) do metalizacji powierzchni nanocząstek wykonanych z różnych materiałów, kierownik: mgr inż. B. Budner

6. SCIENTIFIC PROJECTS

7.
PUBLICATIONS, AWARDS, PATENTS

7.1. SCIENTIFIC ARTICLES IN JCR JOURNALS – A – LIST OF MINISTRY OF SCIENCE AND HIGHER EDUCATION

1. D. Adjei, A. Wiechec, P. Wachulak, M.G. Ayele, J. Lekki, W.M. Kwiatek, A. Bartnik, M. Davídková, L. Vyšín, L. Juha, L. Pina, H. Fiedorowicz "DNA strand breaks induced by soft X- ray pulses from a compact laser plasma source" Radiat. Phys. Chem. 2016, 120, 17-25.
2. I.U. Ahad, H. Fiedorowicz, B. Budner, T.J. Kaldonski, M. Vázquez, A. Bartnik, D. Brabazon "Extreme ultraviolet surface modification of polyethylene terephthalate (PET) for surface structuring and wettability control" Acta Phys. Pol. A 2016, 129, 241-243
3. M.G. Ayele, J. Czwartos, D. Adjei, P. Wachulak, I.U. Ahad, A. Bartnik, Ł. Wegrzynski, M. Szczurek, R. Jarocki, H. Fiedorowicz, M. Lekka, K. Pogoda, J. Gostek "Contact microscopy using a compact laser produced plasma soft X-ray source" Acta Phys. Pol. A 2016, 129, 237-240.
4. A. Bartnik, P. Wachulak, H. Fiedorowicz, W. Skrzeczanowski, R. Jarocki, T. Fok, Ł. Wę grzyński „ EUV induced low temperature SF6-based plasma". Instrum. 2016, 11 (3), C03009.
5. A. Bartnik, P. Wachulak, H. Fiedorowicz, W. Skrzeczanowski "Kr photoionized plasma induced by intense extreme ultraviolet pulses" Phys. Plasmas 2016, 23, 043512.
6. N. Belghachem, J. Mlynczak "Estimation method of the optimal reflection of the output coupler for cw generation over a range of pump power for three level microchip lasers" Optik, 2016, 127, 1320–1322.
7. N. Belghachem, J. Mlynczak, K. Kopczynski, Z. Mierczyk, M. Gawron "Thermal analysis of a diffusion bonded Er3+,Yb3+:glass/Co2+: MgAl2O4 microchip lasers" Opt. Mater. 2016, 60, 546-551.
8. K. Czyz, J. Marczak, R. Major, A. Mzyk, A. Rycyk, A. Sarzyński, M. Strzelec "Selected laser methods for surface structuring of biocompatible diamond-like carbon layers" Diam. Relat. Mater. 2016, 67, 26-40.
9. S. Dyjak, W. Kiciński, M. Norek, A. Huczko, O. Łabędź, B. Budner, M. Polański "Hierarchical, nanoporous graphenic carbon materials through an instant, self-sustaining magnesiothermic reduction" Carbon 2016, 96, 937–946.
10. W.D. Furlan, V. Ferrando, J.A. Monsoriu, P. Zagrajek, E. Czerwińska, M. Szustakowski "3D printed diffractive terahertz lenses" Opt. Lett. 2016, 41, 1748-1751.
11. I. Jankowska-Sumara, M.-S. Jeong, J.-H. Ko, A. Majchrowski, J. Żmija "Phase transitions in PbZr0.72Sn0.28O3single crystals studied by Raman spectroscopy" Phase Transitions 2016, 89, 768-776.
12. M. Kaliszewski, M. Włodarski, J. Młyńczak, M. Leśkiewicz, A. Bombalska, M. Mularczyk-Oliwa, M. Kwaśny, D. Buliński, K. Kopczyński "A new real-time bio-aerosol fluorescence detector based on semiconductor CW excitation UV laser" J. Aerosol Sci. 2016, 100, 14-25.
13. M. Kaśków, L. Gałecki, W. Żendzian, L. Gorajek, J.K. Jabczyński "Side-pumped neodymium laser with self-adaptive, nonreciprocal cavity" Opto-Electron. Rev. 2016, 24, 10-14.
14. P. Kopyt, B. Salski, P. Zagrajek, D. Janczak, M. Sloma, M. Jakubowska, M. Olszewska-Placha, W. Gwarek "Electric Properties of Graphene-Based Conductive Layers from DC Up to Terahertz Range" IEEE Trans. Terahertz Sci. Technol. 2016, 6, 480-490.
15. M. Kowalski, M. Życzkowski "Data encryption of optical fibre communication using pseudorandom spatial light modulation" Opto-Electron. Rev. 2016, 24, 75-81.
16. M. Kowalski, M. Kastek "Comparative studies of passive imaging in terahertz and midwavelength infrared ranges for object detection" IEEE Trans. Inf. Forensic Secur. 2016, 11, 2028 - 2035.
17. A. Krajewska, K. Oberda, J. Azpeitia, A. Gutierrez, I. Pasternak, M. F. López, Z. Mierczyk, C. Munuera, W. Strupinski "Influence of Au doping on electrical properties of CVD graphene" Carbon 2016, 100, 625–631.

18. K. Kucharski, P. Zagrajek, D. Tomaszewski, A. Panas, G. Głuszko, J. Marczewski, P. Kopyt „An influence of silicon substrate parameters on a responsivity of MOSFET-based terahertz detectors" Acta Phys. Pol. A 2016, 130, 1193-1195.

19. D. Kuczyńska, P. Kwaśniak, J. Marczak, J. Bonarski, J. Smolik, H. Garbacz "Laser Surface treatment and the resultant hierarchical topography of Ti grade 2 for biomedical application" Appl. Surface Sci. 2016, 390, 560-569.

20. M. Michalska, W. Brojek, Z. Rybak, P. Sznelewski, M. Mamajek, J Swiderski "Highly stable, efficient Tm-doped fiber laser—a potential scalpel for low invasive surgery" Laser Phys. Lett. 2016, 13, 15101.

21. M.Michalska, J.Mikolajczyk, J.Wojtas, J. Swiderski, "Mid-infrared, super-flat, supercontinuum generation covering the 2–5 µm spectral band using a fluoroindate fibre pumped with picosecond pulses" Sci. Rep. 2016, 6, 39138.

22. J. Mikołajczyk, Z. Bielecki, T. Stacewicz, J. Smulko, J. Wojtas, D. Szabra, Ł. Lentka, A. Prokopiuk, P. Magryta "Detection of gaseous compounds with different techniques" Metrol. Meas. Syst. 2016, 23, 205-224.

23. J. Mikołajczyk, J. Wojtas, Z. Bielecki, T. Stacewicz, D. Szabra, P. Magryta, A. Prokopiuk, A. Tkacz, M. Panek "System of optoelectronic sensors for breath analysis" Metrol. Meas. Syst.2016, 23, 481-489

24. L. Misseeuw, A. Krajewska, I. Pasternak, T. Ciuk, W. Strupinski, G. Reekmans, P. Adriaensens, D. Geldof, F. Blockhuys, S. Van Vlierberghe, H. Thienpont, P. Dubruel, N. Vermeulen „Optical quality controllable wet-chemical doping of graphene through a uniform, transparent and low roughness F4-TCNQ/MEK layer" RSC Adv. 2016, 6, 104491-104501.

25. J. Mlyńczak, N. Belghachem, K. Kopczyński, J. Kisielewski, R. Stepien, M. Wychowaniec, J. Galas, D. Litwin, A. Czyzewski "Performance analysis of thermally bonded Er3+, Yb3+:glass/Co2+:MgAl2O4 microchip lasers" Opt. Quant. Electron. 2016, 48(4), 247.

26. J. Młynczak, J. Kubicki, K. Kopczynski, J. Mierczyk „Assessment of the application of cascade lasers to stand-off detection of alcohol vapors in moving cars" J. Appl. Remote Sens. 2016, 10(4), 046010.

27. K. Moraczewski, W. Mróz, B. Budner, R. Malinowski, M. Żenkiewicz "Laser modification of polylactide surface layer prior autocatalytic metallization" Surf. Coat. Technol. 2016, 304, 68-75.

28. M.F. Nawaz, M. Nevrkla, A. Jancarek, A. Torrisi, T. Parkman, J. Turnova, L. Stolcova, M. Vrbova, J. Limpouch, L. Pina, P. Wachulak "Table-top water-window soft X-ray microscope using a Z-pinching capillary discharge source" J. Instrum. 2016, 11(7), P07002.

29. M. Norek, G. Łuka, M. Włodarski "Plasmonic enhancement of UV emission from ZnO thin films induced by Al nano-concave arrays" Appl. Surf. Sci. 2016, 384, 18-26.

30. O. Olszewska-Sosińska, B. Zielnik-Jurkiewicz, M. Stępińska, M. Antos-Bielska, M. Lau-Dworak, K. Kozłowska, E.A. Trafny "Persistence of nontypeable Haemophilus influenzae in the pharynx of children with adenotonsillar hypertrophy after treatment with azithromycin" Pathog. Dis. 2016, 74(1), ftv106.

31. T. Orżanowski „Nonuniformity correction algorithm with efficient pixel offset estimation for infrared focal plane arrays" SpringerPlus 2016, 5, 1831.

32. N. Palka, A. Rybak, E. Czerwinska, M. Florkowski "Terahertz Detection of Wavelength-Size Metal Particles in Pressboard Samples" IEEE Trans. Terahertz Sci. Technol. 2016, 6, 99-107.

33. N. Palka, R. Panowicz, M. Chalimoniuk, R. Beigang "Non-destructive evaluation of puncture region in polyethylene composite by terahertz and X-ray radiation" Composites Part B (2016), 92, 315-325.

34. N. Palka, E. Czerwinska, M. Szala "Characterization of prospective explosive materials using Terahertz Time Domain Spectroscopy" Appl. Opt. 2016, 55, 4575-4583.

35. N. Palka, M. Szala "Transmission and reflection terahertz spectroscopy of insensitive melt-cast high explosive materials" J. Infrared Millim. Terahertz Waves, 2016, 37, 977-992.

36. E.J. Prazmo, M. Kwaśny, M. Łapiński, A. Mielczarek "Photodynamic therapy as a promising method used in the treatment of oral diseases" Adv. Clin. Exp. Med. 2016, 25 (4), 799-807.

37. Z.U. Rehman, H. Suk, K.A. Janulewicz "Optical breakdown-driven mesostructure in bulk of soda-lime glass" J. Non-Cryst. Solids 2016, 448, 68-73.

38. Z.U. Rehman, K.A. Janulewicz „Structural transformation of monocrystalline diamond driven by ultrashort laser pulses" Diamond Relat. Mater. 2016, 70, 194-200.

39. A. Siemion, A. Siemion, J. Suszek, A. Kowalczyk, J. Bomba, A. Sobczyk, N. Palka, P. Zagrajek, A. Kolodziejczyk, M. Sypek "THz beam shaping based on paper diffractive optics", IEEE Trans. Terahertz Sci. Technol. 2016, 6, 568-575.

40. A. Siemion, P. Kostrowiecki-Lopata, A. Pindur, P. Zagrajek, M. Sypek "Paper on Designing Costless THz Paper Optics" Adv. Mater. Sci. Eng. 2016, 9615698.

41. V.C. de Silva, P. Nyga, V.P. Drachev "Optimization and photomodification of extremely broadband optical response of plasmonic core-shell obscurants" J. Colloid. Interface Sci. 2016, 484, 116-124.

42. T. Stacewicz, Z. Bielecki, J. Wojtas, P. Magryta, J. Mikolajczyk, D. Szabra "Detection of disease markers in human breath with laser absorption spectroscopy" Opto-Electron. Rev. 2016, 24,82-94.

43. W.J. Stępniowski, J. Choi, H. Yoo, M. Michalska-Domańska, P. Chilimoniuk, T. Czujko "Quantitative fast Fourier transform based arrangement analysis of porous anodic oxide formed by self-organized anodization of FeAl intermetallic alloy" Mater. Lett. 2015, 164, 176-179.

44. W.J. Stępniowski, M. Norek, B. Budner, M. Michalska-Domańska, A. Nowak-Stępniowska, A. Bombalska, M. Kaliszewski, A. Mostek, S. Thorat, M. Salerno, M. Giersig, Z. Bojar "In-situ electrochemical doping of nanoporous anodic aluminum oxide with indigo carmine organic dye" Thin Solid Films 2016, 598, 60–64.

45. W.J. Stepniowski, J. Choi, H. Yoo, K. Oh, M. Michalska-Domańska, P. Chilimoniuk, T. Czujko, R. Łyszkowski, S. Jóźwiak, Z. Bojar, D. Losic "Anodization of FeAl intermetallic alloys for bandgap tunable nanoporous mixed aluminum-iron oxide" J. Electroanal. Chem. 2016, 771, 37-44.

46. W.J. Stepniowski, M. Moneta, M. Norek, M. Michalska-Domańska, A. Scarpellini, M. Salerno „ The influence of electrolyte composition on the growth of nanoporous anodic alumina"' Electrochim. Acta 2016, 211, 453-460.

47. W.J. Stępniowski, T. Durejko, M. Michalska-Domańska, M. Łazińska, J. Aniszewska "Characterization of nanoporous anodic aluminum oxide formed on laser pre-treated aluminium" Mater. Character. 2016, 122, 130–136.

48. K. Szkudlarek, M. Sypek, G. Cywiński, J. Suszek, P. Zagrajek, A. Feduniewicz-Zmuda, I. Yahniuk, S. Yatsunenko, A. Nowakowska-Siwińska, D. Coquillat, D.B. But, M. Rachoń, K. Wegrzyńska, C. Skierbiszewski, W. Knap "Terahertz 3D printed diffractive lens matrices for field-effect transistor detector focal plane arrays" Opt. Express 2016, 24 (18), 20119-20131.

49. A. Torrisi, P. Wachulak, M.F. Nawaz, A. Bartnik, D. Adjei, Š. Vondrova, J. Turnova, A. Jancarek, H. Fiedorowicz "Applications of a compact "water window" source for investigations of nanostructures using SXR microscope" Acta Phys. Pol. A 2016, 129, 169-171.

50. A. Torrisi, P. Wachulak, M.F. Nawaz, A. Bartnik, Ł. Wegrzyński, A. Jancarek, H. Fiedorowicz "Characterization and optimization of images acquired by a compact soft X-ray microscope based on a double stream gas-puff target source" J. Instrum. 2016, 11 (4), C04003.

51. A. Torrisi, P. Wachulak, L. Torrisi, A. Bartnik, Ł. Wegrzyński, H. Fiedorowicz "Plasma characterization of the gas-pufftarget source dedicated for soft X-ray microscopy using SiC detectors" Nukleonika 2016, 61, 139-143.

52. L. Torrisi, L. Calcagno, M. Cutroneo, J. Badziak, M. Rosinski, A. Zaras-Szydlowska, A. Torrisi "Nanostructured targets for TNSA laser ion acceleration" Nukleonika 2016, 61, 103-108.

53. L. Torrisi, A. Italiano, A. Torrisi "Ancient bronze coins from Mediterranean basin: LAMQS potentiality for lead isotopes comparative analysis with former mineral" Appl. Surface Sci. 2016, 387, 529-538.

54. P.W. Wachulak "Recent advancements in the "water-window" microscopy with laser-plasma SXR source based on a double stream gas-puff target" Opto-Electron. Rev. 2016, 24, 144-154.

55. P.W. Wachulak "Contributed Review: The novel gas puff targets for laser-matter interaction experiments" Rev. Sci. Instrum. 2016, 87, 091501.

56. N.R. Vinueza, B.J. Jankiewicz, V.A. Gallardo, G.Z. LaFavers, D. DeSutter, J.J. Nash, H.I. Kenttämaa "Reactivity Controlling Factors for an Aromatic Carbon-Centered σ,σ,σ-Triradical: The 4,5,8-Tridehydroisoquinolinium Ion" Chem. Eur. J. 2016, 22, 809-815.

7.2. SCIENTIFIC ARTICLES IN JOURNALS B – LIST OF MINISTRY OF SCIENCE AND HIGHER EDUCATION

1. M. Nowakowski, D. Szabra, P. Margryta, R. Mędrzycki, A. Prokopiuk „Optoelektroniczny system sensorów biomarkerów zawartych w wydychanym powietrzu (Optoelectronic sensor system for biomarkers contained in exhaled air)" Elektronika 2016, 9, 51-54.
2. D. Chmielewska, R. Gebel, A. Olszyna, B. Synowiec, J. Marczak, A. Sarzyński, M. Strzelec „Czynniki wpływające na jakość powierzchni barwnych farb ceramicznych utrwalanych techniką laserową na podłożu szklanym" Szkło i Ceramika 2016, 67, 18-22.
3. T. Drozd, Z. Mierczyk, M. Zygmunt, J. Wojtanowski „Metoda optycznej transmisji danych z wykorzystaniem laserów impulsowych (Free space optical communication based on pulsed lasers)" Elektronika 2016, 11, 17-21.
4. J. Grzelak, A. Krajewska, B. Krajnik, D. Jamiola, J. Choma, B. Jankiewicz, D. Piątkowski, P. Nyga, S. Mackowski "Hybrid silica--gold core-shell nanoparticles for fluorescence enhancement" Nanospectroscopy 2016, 2, 1–6.
5. J.K. Jabczyński, R.S. Romaniuk „Rozwój techniki laserowej w Polsce – 2016 (Development of laser technology in Poland – 2016)" Elektronika 2016, 11, 3-12.
6. M. Kaszczuk, Z. Mierczyk, M. Zygmunt, T. Drozd, A. Gawlikowski, A. Gietka, M. Jakubaszek, P. Knysak, A. Młodzianko, M. Muzal, R. Ostrowski, W. Piotrowski, J. Wojtanowski „Wielospektralny skaner laserowy w ochronie i monitoringu środowiska (Multispectral laser scanner for environmental monitoring and protecion)" Elektronika 2016, 11, 26-27.
7. P. Knysak, Z. Mierczyk, M. Zygmunt, J. Wojtanowski, M. Traczyk „Metoda optycznej transmisji danych z wykorzystaniem laserów impulsowych (Free space optical communication based on pulsed lasers)" Elektronika 2016, 11, 22-25.
8. P. Kotowski, M. Kwaśny, A. Gietka „Diody superluminescencyjne (sLED) dla terapii Fotodynamicznej (Superluminescent diodes (sLED) in photodynamic therapy)" Elektronika 2016, 11, 29-33.
9. J. Kubicki, J. Młyńczak, K. Kopczyński, J. Mierczyk "Opportunities of detection of alcohol vapours in cars with unknown windows using cascade lasers | [Możliwości wykrywania par alkoholu w kabinach samochodów z szybami o nieznanych parametrach] Prz. Elektrotech. 2016, 92 (9), 272-278.
10. J. Kubicki „Jarzeniowy promiennik CO2" Informatyka, Automatyka, Pomiary w Gospodarcei Ochronie Środowiska 2016, 1, 16-20.
11. M. Leśkiewicz, M. Kaliszewski, Z. Mierczyk, M. Włodarski „Porównanie liniowych metod PCA (Principal Component Analysis) i LDA (Linear Discriminant Analysis) zastosowanych do klasyfikacji matryc wzbudzeniowo-emisyjnych wybranych grup substancji biologicznych (Comparison of Principal Component Analysis and Linear Discriminant Analysis applied to classification of excitation-emission matrices of the selected biological material)" Biuletyn WAT 2016, 65(1), 15-31.
12. M. Michalska, W. Brojek, Z. Rybak, P. Sznelewski, J. Świderski „Światłowodowy laser tulowy do zastosowań medycznych (An all-fiber thulium doped fiber laser for medical application)" Elektronika 2016, 11, 13-15.
13. M. Miczuga, K. Kopczyński, J. Pietrzak „Badania nad poprawą czułości systemów detekcji śladowych ilości zanieczyszczeń gazowych metodą komórek wieloprzejściowych (Studies on the sensitivity improvement of measuring system dedicated to detection of trace amounts of gaseous impurities by using multi--path cel method)" Elektronika 2016, 9, 32-34.
14. J. Mikołajczyk „Badania układów detekcji promieniowania optycznego w zakresie od skrajnego nadfioletu do dalekiej podczerwieni (Research of optical detection systems in the spectral range from extreme ultraviolet to infrared)" Elektronika 2016, 11, 48-51.
15. M. Muzal, J. Wojtanowski, Z. Mierczyk, M. Zygmunt, T. Drozd, M. Jakubaszek, P. Knysak, W. Piotrowski, M. Traczyk „Laserowy miernik prędkości pojazdów (Laser measurement of the speed of vehicles)" Elektronika 2016, 11, 38-40.
16. M. Piszczek „Finding the distance to the object using the method of spatial-temporl framing (Wyznaczanie odległości do obiektu z użyciem metody kadrowania przestrzenno-czasowego)" Przegląd Elektrotech. 2016, 92, 75-78.
17. M. Piszczek „Positioning of objects for real-time application of virtual reality (Pozycjonowanie obiektów w czasie rzeczywistym dla zastosowań wirtualnej)" Prz. Elektrotech. 2016, 92, 79-82.
18. A. Sarzyński, J. Radziejewska, J. Marczak, M. Strzelec, R. Ostrowski, A. Rycyk, K. Czyż „Laserowa mikroobróbka materiałów (Laser micromachining of materials)" Elektronika 2016, 11, 42-47.
19. T. Stacewicz, J. Wojtas, P. Margryta, T. Ligor, D. Szabra, A. Prokopiuk, Z. Bielecki, B. Buszewski, J. Mikołajczyk, M. Nowakowski, R. Mędrzycki „Sensory optoelektroniczne do detekcji markerów chorobowych z laserami przestrajalnymi w zakresie < 2,5 μm (Optoelectronic sensors for disease markers detection with lasers tunable below 2,5 μm range)" Elektronika 2016, 9, 66-69.

7. PUBLICATIONS, AWARDS, PATENTS

20. T. Stacewicz, P. Margryta, Z. Bielecki, J. Wojtas „Multipleksacja i demumultipleksacja sygnałów optycznych do celów spektroskopii (Multiplexation and demultiplexation of optical signals for spectroscopy)" Elektronika 2016, 9, 70-72.

21. Ł. Węgrzyński, P. Wachulak, T. Fok, A. Bartnik, H. Fiedorowicz „Układ do wytwarzania tarcz gazowo-klasterowych wykorzystywanych do oddziaływania promieniowania laserowego z materią (Experimental setup for producing gas-cluster puff target dedicated for laser matter experiments)" Elektronika 2016, 11, 34-37.

22. J. Wojtas, J. Mikołajczyk, D. Szabra, B. Zakrzewska, A. Prokopiuk, A. Tkacz, S. Chojnowski, Z. Bielecki „ Zastosowanie spektroskopii strat we wnęce optycznej do detekcji śladowych ilości tlenku węgla (Application of cavity enhanced spectroscopy in detection of trace amounts of carbon monoxide)" Elektronika 2016, 9, 28-31.

23. J. Wojtas, Z. Bielecki, T. Stacewicz, A. Tkacz, A. Prokopiuk, P. Margryta „Wybrane zastosowania spektroskopii absorpcyjnej (Selected applications of the absorption spectroscopy)" Elektronika 2016, 9, 58-61.

7.3. PUBLICATIONS IN PEER-REVIEWED MATERIALS OF INTERNATIONAL CONFERENCES INDEXED IN WEB OF SCIENCE

1. J. Bareła, M. Kastek, K. Firmanty, M. Krupiński „Analysis of the variation of range parameters of thermal cameras" Proc. SPIE 2016, 9987, 998711.

2. A. Bartnik, T. Pisarczyk, P. Wachulak, T. Chodukowski, T. Fok, L. Wegrzynski, Z. Kalinowska, H. Fiedorowicz „Low temperature plasmas created by photoionization of gases with intense radiation pulses from laser-produced plasma sources" Proc. SPIE 2016, 10159, 1015909.

3. G. Bieszczad „SoC-FPGA embedded system for real-time thermal image processing" Proceedings of the 23rd International Conference Mixed Design of Integrated Circuits and Systems, MIXDES 2016, 2016, Article No. 7529788, Pages 469-473.

4. M. Dobrzyńska, M. Stępińska, R. Lewandowski, A. Gietka, M. P. Łapiński, E.A. Trafny "Autofluorescence of human cells in vitro as a biomarker of their metabolic activity" Proc. SPIE 2016, 10159, 101590F.

5. T. Drozd, Z. Mierczyk, M. Zygmunt, J. Wojtanowski „Free space optical communication based on pulsed lasers" Proc. SPIE 2016, 10159, 1015911.

6. H. Fiedorowicz, A. Bartnik, P.W. Wachulak, R. Jarocki, J. Kostecki, M. Szczurek, I.U. Ahad, T. Fok, A. Szczurek, Ł. Węgrzyński ? Application of laser plasma sources of soft X-rays and extreme ultraviolet (EUV) in imaging, processing materials and photoionization studies? Springer Proc. Phys. 2016, 169, 369-377.

7. J. Jabczynski, R. Romaniuk "Front Matter: Volume 10159" Proc. SPIE 2016, 10159, 1015901.

8. J. Jabczyński, M. Kaśków, W. Żendzian, K. Kopczyński, Z. Puzewicz „Analysis of pumping schemes for high brightness diode-side-pumped lasers" Proc. SPIE 2016, 10142, 101420H.

9. K. Jach, J. Marczak, R. Świerczyński, M. Strzelec, R. Ostrowski, A. Sarzyński, W. Skrzeczanowski, A. Rycyk, K. Czyż „Modeling of remelting processes of metal targets using pulses of continuous laser with pre-impulses" Proc. SPIE 2016, 10159, 101590O.

10. Z. Jankiewicz, J.K. Jabczyński, R.S. Romaniuk „Development of laser technology in Poland: 2016" Proc. SPIE 2016, 10159, 1015902.

7. PUBLICATIONS, AWARDS, PATENTS

7. PUBLICATIONS, AWARDS, PATENTS

11. M. Kaliszewski, M. Włodarski, J. Młyńczak, Z. Zawadzki, M. Mularczyk-Oliwa, A. Bombalska, K. Kopczyński „The laser detector of bio-aerosols" Proc. SPIE 2016, 10159, 101590G.

12. P. Knysak, Z. Mierczyk, M. Zygmunt, J. Wojtanowski, M. Traczyk „Laser data transmission with the application of reflectance modulator" Proc. SPIE 2016, 10159, 1015910.

13. C. Kolacinski, D. Obrebski, M. Zbiec, J. Marczewski, P. Zagrajek „Complete multichannel readout device for THz measurements without lock-in technique" International Conference on Infrared, Millimeter, and Terahertz Waves, IRMMW-THz, 2016-November, 7758630.

14. K. Kopczyński, J. Kubicki, J. Młynczak, J. Mierczyk, K. Hackiewicz „Stand-off detection of alcohol vapours in moving cars" Proc. SPIE 2016, 10159, 101590Z.

15. P. Kopyt, B. Salski, P. Zagrajek, J. Marczewski „Affordable sub--THz band-pass mesh filters" 21st International Conference on Microwave, Radar and Wireless Communications" MIKON 2016, Article number 7492134.

16. P. Kopyt, B. Salski, P. Zagrajek, D. Obrebski, J. Marczewski „Accurate modeling of silicon based substrates for sub-THz antennas" International Conference on Infrared, Millimeter, and Terahertz Waves, IRMMW-THz, 2016-November, 7758629.

17. M. Krupiński, J. Bareła, M. Kastek, K. Chmielewski „Test stand for determining parameters of microbolometer camera" Proc. SPIE 2016, 9987, 998712.

18. M. Kujawińska, P. Łapka, M. Malesa, K. Malowany, M. Prasek, J. Marczak „Investigations of high power laser beam interaction with material by means of hybrid FVM-FEM and digital image correlation methods" Proc. SPIE 2016, 10159, 1015916.

19. M. Kwaśny, A. Gietka, P. Kotowski, Z. Mierczyk "Light sources currently used in photochemotherapy" Proc. SPIE 2016, 10159, 101590C.

20. J. Kwiatkowski, W. Zendzian, J.K. Jabczynski „Investigative study of a diode-pumped continuous-wave Tm:YAP laser as an efficient 1.94 μm pump source" Proc. SPIE 2016, 10159, 1015904.

21. R. Lewandowski, E.A. Trafny, M. Stępińska, A. Gietka, P. Kotowski, M. Dobrzyńska, M. P. Łapiński „The selection of light emitting diode irradiation parameters for stimulation of human mesenchymal stem cells proliferation" Proc. SPIE 2016, 10159, 101590E.

22. M.C. Marconi, N. Monserud, E. Malm, P. Wachulak, W. Chao "Time-resolved holography with a table top soft X-ray laser" Springer Proc. Phys. 2016, 169, 233-238.

23. J. Marczewski, D. Obrebski, C. Kolacinski, M. Zbiec, K. Kucharski, P. Zagrajek, P. Kopyt „Development of multi-pixel NMOS--based THz detectors and readout system targeted for spectroscopy applications" Proceedings of the 23rd International Conference Mixed Design of Integrated Circuits and Systems, MIXDES 2016, 2016, Article No. 7529730, Pages 191-196.

24. M. Michalska, W. Brojek, Z. Rybak, P. Sznelewski, M. Mamajek, S. Gogler, J. Swiderski "Thulium fiber laser for the use in low-invasive endoscopic and robotic surgery of soft biological tissues" Proc. SPIE 2016, 10159, 1015906.

25. M. Michalska-Domańska, P. Jóźwik, B.J. Jankiewicz, B. Bartosewicz, D. Siemiaszko, W.J. Stepniowski, Z. Bojar "Study of Cyclic Ni_3Al Catalyst Pretreatment Process for Uniform Carbon Nanotubes Formation and Improved Hydrogen Yield in Methanol Decomposition" Mater. Today: Proc. 2016, 3, S171-S177.

26. M. Miczuga, K. Kopczyński „Application of cascade lasers to detection of trace gaseous atmospheric pollutants" Proc. SPIE 2016, 10159, 101590X.

27. J. Młyńczak, K. Kopczyński, N. Belghachem, J. Kisielewski, R. Stępień, M. Wychowaniec, J. Galas, D. Litwin, A. Czyżewski „Pulse laser head with monolithic thermally bonded microchip operating at 1.5 μm wavelength" Proc. SPIE, 2016, 10159, 1015905.

28. M. Mularczyk-Oliwa, A. Bombalska, M. Kwaśny, K. Kopczyński, M. Włodarski, M. Kaliszewski, J. Kostecki „Optoelectronic methods in potential application in monitoring of environmental conditions" Proc. SPIE 2016, 10159, 101590Y.

29. M. Muzal, Z. Mierczyk, M. Zygmunt, J. Wojtanowski, W. Piotrowski „Measurement of vehicles speed with full waveform lidar" Proc. SPIE 2016, 10159, 1015914.

30. M.L. Naurecka, B.M. Sierakowski, M. Kwaśny "Spectroscopic properties of second generation photosensitizers for photo--diagnostics and photo-dynamic therapy" Proc. SPIE 2016, 10159, 101590B.

31. P. Nyga, S. Chmiel, M. Szczurek, M. Liszewska, M. Stefaniak, J. Firak, M. Michalska-Domanska, J. Mierczk, M. Norek „Silver nanoparticles in titanium dioxide host plasmonic absorbers" 18th International Conference on Transparent Optical Networks (ICTON) 2016.

32. D. Obrebski, C. Kolacinski, M. Zbiec, P. Zagrajek „The multi--channel small signal readout system for THz spectroscopy and imaging applications" 2016 IFIP/IEEE International Conference on Very Large Scale Integration, VLSI-SoC 2016, 1-6.

33. P.N. Osuchowska, A. Sarzyński, M. Strzelec, Z. Bogdanowicz, J. Marczak, M.P. Łapiński, E.A. Trafny „Characterization of microsieves recovery efficiency in isolation of circulating tumor cells" Proc. SPIE 2016, 10159, 101590D.

34. N. Palka, W. Ciurapinski, J. Wrobel, L. Jodlowski, M. Szustakowski, D. Miedzinska, R. Gielata, R. Beigang „Non-destructive testing ofpolyethylene composite by terahertz radiation" 21st International Conference on Microwave, Radar and Wireless Communications, MIKON 2016, Article number 7492002.

35. M. Panek, J. Mikolajczyk „Gas analysis software for selected techniques of laser absorption spectroscopy" Proc. SPIE 2016, 10034, 1003405.

36. A. Rycyk, K. Czyż, A. Sarzyński, W. Skrzeczanowski, R. Ostrowski, M. Strzelec, K. Jach, R. Świerczyński „Research on quasi-cw and pulse interaction of strong laser radiation with the military technical materials" Proc. SPIE 2016, 10159, 101590P.

37. A. Sarzyński, J. Marczak, M. Strzelec, A. Rycyk, K. Czyż, D. Chmielewska "Laser microstructuring of surfaces for applications in materials and biomedical science" Proc. SPIE 2016, 10159, 101590A.

38. V.C. de Silva, P. Nyga, V.P. Drachev "Scattering suppression, and optimization of extremely broadband plasmonic core-shell obscurants", Books of Abstracts, Joint Meeting of the Four Corners and Texas Sections of the American Physical Society, October 21–22, 2016; Las Cruces, New Mexico, B2.00003.

39. J. Suszek, M. Sypek, A. Siemion, A. Nowakowska-Siwińska, P. Zagrajek, G. Cywinski, K. Szkudlarek, I. Yahniuk, S. Yatsunenko, D.B. But, D. Coquillat, W. Knap „Diffractive optics for GaN terahertz detectors arrays" 21st International Conference on Microwave, Radar and Wireless Communications, MIKON 2016", Article number 7492049.

40. P. W. Wachulak, A. Torrisi, A. Bartnik, L. Wegrzynski, T. Fok, Z. Patron, H. Fiedorowicz „Soft X-ray microscope with nanometer spatial resolution and its applications" Proc. SPIE 2016, 10159, 101590W.

41. P. Zagrajek, J. Marczewski, D. Tomaszewski, D. Obrebski, K. Kucharski „FET based THz detector with integrated antenna and source follower" International Conference on Infrared, Millimeter, and Terahertz Waves, IRMMW-THz, 2016-November, 7758631

7.4. REPORTS PRESENTED AT HOME SCIENTIFIC CONFERENCES

1. P. E. Kozioł, M. Walczakowski, T. Baraniecki, 'Laserowa selektywna strukturyzacja powierzchni przewodzących', XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016.

2. R. Ostrowski, M. Traczyk, 'Ochrona wzroku przed promieniowaniem laserowym' , XXX Międzynarodowa Konferencja Naukowo-Techniczna „EKOMILITARIS 2016", Zakopane, 13-16 września 2016r

3. R. Ostrowski, A. Cywiński, 'Rozpoznanie optoelektroniczne' , IX Konferencja Naukowa „Kierowanie Ogniem Systemów Obrony Powietrznej (Przeciwlotniczej)" KOSOP 2016, Ustka, 22-24.06.2016r

4. R. Ostrowski, H. Garbacz, E. Fortuna-Zaleśna, A. Zatorska, M. Strzelec, W. Skrzeczanowski, A. Rycyk, A. Sarzyński, A. Koss, J. Mróz, Ł. Ciupiński, T. Onyszczuk, G. Żukowska, 'Fizyko-chemiczne analizy wybranych, metalowych obiektów archeologicznych' , XVI Konferencja Naukowa „Analiza Chemiczna w Ochronie Zabytków", Warszawa, 1-2.12.2016r

5. K. Czyż, P. Wachulak, 'Direct Laser Interference Lithography form 2 to N beams Interference' , XXXIV Konferencja Elektroniki, Telekomunikacji i Energetyki Studentów i Młodych Pracowników nauki SECON 20146, Warszawa 18-19 kwietnia 2016r.

6. K. Czyż, P. Wachulak, 'Struktury periodyczne i hierarchiczne na biozgodnych warstwach DLC' , IX Międzyuczelniane Seminarium Kół Naukowych, Warszawa 19 – 20 maja 2016

7. K. Czyż, P. Wachulak, 'Wytwarzanie struktur hybrydowych za pomocą bezpośredniej laserowej litografii interferencyjnej' , IX Międzyuczelniane Seminarium Kół Naukowych, Warszawa 19 - 20 maja 2016

8. A. Rycyk, K. Czyż, J. Marczak, A. Sarzyński, W. Skrzeczanowski, R. Ostrowski, M. Strzelec, K. Jach, R. Świerczyński, 'Badania quasi-ciągłego i impulsowego oddziaływania silnego promieniowania laserowego na materiały techniki wojskowej' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

9. K. Czyż, R. Ostrowski, A. Sarzyński, A. Rycyk, M. Strzelec, R. Major, P. Wilczek, 'Ablacja laserowa w zastosowaniu do bioinżynierii' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

7. PUBLICATIONS, AWARDS, PATENTS

10. J. Radziejewska, A. Sarzyński, K. Jach, J. Marczak, A. Rycyk, M. Strzelec, 'Pomiary przemieszczeń płytek metalowych napędzanych przez impuls promieniowania laserowego' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

11. K. Jach, J. Marczak, R. Świerczyński, R. Ostrowski, A. Sarzyński, W. Skrzeczanowski, M. Strzelec, A. Rycyk, K. Czyż, 'Modelowanie procesów przetapiania tarcz metalowych impulsami lasera ciągłego działania z preimpulsami' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

12. A. Sarzyński, K. Czyż, J. Marczak, A. Rycyk, M. Strzelec, D. Chmielewska, 'Laserowe mikro-strukturowanie powierzchni do zastosowań w inżynierii materiałowej i biomedycznej' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016 (2016)

13. P. Osuchowska, A. Sarzyński, M. Strzelec, Z. Bogdanowicz, J. Marczak, M. Łapiński, E. Trafny, 'Sita molekularne jako metoda izolacji krążących komórek nowotworowych' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

14. A. Bartnik, W. Skrzeczanowski, T. Pisarczyk, P. Wachulak, T. Chodukowski, Z. Kalinowska, I. Saber, Ł. Węgrzyński, T. Fok, H. Fiedorowicz, 'Wytwarzanie plazmy niskotemperaturowej w wyniku fotojonizacji gazu impulsami promieniowania źródeł laserowo-plazmowych' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

15. G.A. Wubetu, T. J. Kelly, P. van Kampen, P. Wachulak, A. Bartnik, W. Skrzeczanowski, H. Fiedorowicz, J.T. Costello, 'Czasowo-rozdzielcza spektroskopia emisyjna plazmy laserowej stopu aluminium w powietrzu' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

16. A. Antonik, W. Skrzeczanowski, J. Janucki, R. Ostrowski, 'Niepewności pomiaru w akredytowanych badaniach mocy i energii promieniowania laserowego' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30 września 2016

17. T. Stacewicz, J. Wojtas, P. Magryta, T. Ligor, D. Szabra, A. Prokopiuk. Z. Bielecki, B. Buszewski, J. Mikołajczyk, M. Nowakowski, R. Mędrzycki, 'Sensory optoelektroniczne do detekcji markerów chorobowych z laserami przestrajalnymi w zakresie <2,5 μm' , XV Krajowa Konferencja Elektroniki. Darłówko-Wschodnie 06-10 czerwca 2016r

18. T. Ligor, B. Buszewski, Z. Bielecki, T. Stacewicz, 'Układy wzbogacania próbek w oznaczaniu markerów chorobowych z powietrza wydychanego' , XV Krajowa Konferencja Elektroniki. Darłówko-Wschodnie 06-10 czerwca 2016r

19. T. Stacewicz, P. Magryta, Z. Bielecki, J. Wojtas, 'Multipleksacja i demultipleksacja sygnałów optycznych do celów spektroskopii' , XV Krajowa Konferencja Elektroniki. Darłówko-Wschodnie 06-10 czerwca 2016r

20. J. Wojtas, J. Mikołajczyk, D. Szabra, B. Zakrzewska, A. Prokopiuk, A. Tkacz, S. Chojnowski, Z. Bielecki, 'Zastosowanie spektroskopii strat we wnęce optycznej do detekcji śladowych ilości tlenku węgla' , XV Krajowa Konferencja Elektroniki. Darłówko-Wschodnie 06-10 czerwca 2016r.

21. J. Wojtas, Z. Bielecki. T. Stacewicz, A. Tkacz, A. Prokopiuk, P. Magryta, 'Wybrane zastosowania spektroskopii absorpcyjnej' , XV Krajowa Konferencja Elektroniki. Darłówko-Wschodnie 06-10 czerwca 2016

22. 63. T. Stacewicz, Z. Bielecki, B. Buszewski, J. Wojtas, T. Ligor, W. Gawron, J. Mikołajczyk, D. Szabra, M. Nowakowski, P. Magryta, A. Prokopiuk, R. Mędrzycki, 'System optoelektronicznych sensorów do wykrywania markerów w wydychanym powietrzu' , VII Kongres metrologii. Lublin-Nałęczów, 28.06-01.07. 2016

23. T. Stacewicz, Z. Bielecki, J. Wojtas, J. Mikołajczyk, D. Szabra, P. Magryta, 'Optoelektroniczny system wykorzystujący spektroskopię laserową do wykrywania markerów chorobowych w oddechu ludzkim' , XI Sympozjum Techniki Laserowej, Jastarnia ,26-30.09.2016

24. J. Mikołajczyk, M. Panek, P. Magryta, Z. Bielecki, T. Stacewicz, J. Wojtas, 'Wybrane algorytmy analizy i przetwarzania sygnałów w spektroskopii strat we wnęce optycznej' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30.09.2016r

25. M. Panek, M. Chodnicki, A. Tkacz, S. Chojnowski, J. Mikołajczyk, J.Wojtas, 'Układ przetwarzania sygnału dla spektroskopii strat we wnęce optycznej' , XI Sympozjum Techniki Laserowej, Jastarnia 26-30.09.2016

7. PUBLICATIONS, AWARDS, PATENTS

7.5. AWARDS

1. Nagroda Prezesa Rady Ministrów za rozprawę habilitacyjną „Źródła super continuum zakresu widmowego średniej podczerwieni o dużej wyjściowej mocy średniej" płk dr hab. inż. Jacek Świderski
2. Nagroda Prezesa Rady Ministrów za rozprawę doktorską: „Wpływ stanu materiału na aktywność katalityczną stopów na osnowie fazy międzymetalicznej Ni_3Al" dr Marta Michalska-Domańska
3. Nagroda Ministra Obrony Narodowej za całokształt dorobku naukowego prof. dr hab. inż. Henryk Madura
4. Nagroda Ministra Obrony Narodowej I stopnia za osiągnięcia naukowe w 2015 r. ppłk dr hab. inż. Jacek Wojtas
5. Stypendium naukowe Ministra Nauki i Szkolnictwa Wyższego 2016-2019 dla wybitnych młodych uczonych dr Marta Michalska-Domańska
6. Wyróżnienie Ministra Obrony Narodowej za najlepszy patent lub wzór przemysłowy, chroniony prawem własności przemysłowej, uzyskany w wyniku realizacji badań naukowych lub prac rozwojowych, w postaci nagrody Ministra Obrony Narodowej w wysokości 10 000 zł oraz rzeczowej Prezesa Urzędu Patentowego RP dla wykonawców pracy badawczej nt. „Optoelektroniczny, wielowidmowy system wspomagający lądowanie samolotów" Zespół badawczy w składzie: prof. dr hab. inż. Henryk Madura, dr inż. Tomasz Sosnowski, dr inż. Grzegorz Bieszczad, dr inż. Mariusz Kastek, dr inż. Tomasz Orżanowski –Instytut Optoelektroniki WAT; prof. dr hab. inż. Edward Sędek, mgr inż. Lech Niepiekło, mgr inż. Rafał Słomski – PIT RADWAR S.A.; dr inż. Tadeusz Sondej – Wydział Elektroniki WAT; mgr inż. Alicja Zarzycka, mgr inż. Tomasz Sienkiewicz – PCO S.A.,
7. Nagroda NATO STO 2016 Scientific Achievement Award, płk dr hab. inż. Jacek Świderski
8. Wyróżnienie za duży wkład w prace grupy zadaniowej NATO/STO Sensors & Electronics Technology, płk dr inż. Krzysztof Kopczyński

7.6. PATENTS AND PATENTS APPLICATIONS

Patents

P.1, Nr pat. 223437, data zgł. 2016-10-31, Sito molekularne, Krzysztof Kopczyński, Zygmunt Mierczyk, Zdzisław Wacław Bogdanowicz, Mariusz Piotr Łapiński , Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Instytut Optoelektroniki

P.2, Nr pat. 223883, data zgł. 2016-11-30 , , Sposób formowania kształtu impulsu prądowego diody laserowej' , Maria Michalska, Marcin Mamajek, Wiesław Pichola, Jacek Świderski , Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Instytut Optoelektroniki

P.3, Nr pat. 225266, data zgł. 2016-10-05 , , System obrony aktywnej, Piotr Kędzierski, Zygmunt Mierczyk, Tadeusz Marian Niezgoda, Robert Kazimierz Panowicz, Adam Marian Kawalec, Przemysław Arnold Kupidura, Roman Ostrowski, Andrzej Młodzianko, Piotr Knysak, Andrzej Gawlikowski, Zbigniew Kazimierz Leciejewski, Radosław Krzysztof Trębiński, Mirosław Zahor, Zbigniew Dariusz Surma , Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Instytut Optoelektroniki, Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Wydział Mechatroniki i Lotnictwa, Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Wydział Mechaniczny

Patents applications

ZP.1, Nr zgł. 415946, data zgł. 42397 , , Światłowodowy układ laserowy do generacji paczki krótkich impulsów optycznych, Maria Michalska, Jacek Świderski, Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Instytut Optoelektroniki

ZP.2, Nr zgł. 416703, data zgł. 42460 , , Układ oraz sposób detekcji gazów wykorzystujący multipleksację i demultipleksację sygnałów optycznych do spektroskopii laserowej , , Zbigniew Bielecki, Jacek Wojtas, Paweł Magryta, Tadeusz Stacewicz, Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego; Instytut Optoelektroniki, Uniwersytet Warszawski

7. PUBLICATIONS, AWARDS, PATENTS