# 44<sup>th</sup> Winter School on Wave and Quantum Acoustics

# PROGRAMME and ABSTRACTS

Organizers of WSWQA 2015

Upper Silesian Division of the Polish Acoustical Society

*in cooperation with the* **Committee of Acoustics of the Polish Academy of Sciences** 

Department of Optoelectronics at Silesian University of Technology and Institute of Physics Scientific-Didactics Centre

2nd to 6th March 2015, Hotel "Meta" Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

#### **Dear Participants**

## of 44<sup>th</sup> WINTER SCHOOL on WAVE and QUANTUM ACOUSTICS 2015

Organizers welcome All of You very cordially in Szczyrk, in the beautiful scenery of the Beskidy Mountains.

The 44<sup>th</sup> Winter School consists of:

- 11<sup>th</sup> Workshop on Acoustoelectronics;
- 11<sup>th</sup> Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods;
- 20<sup>th</sup> Workshop on Photoacoustics and Thermal Methods.

We wish all Participants of the 44<sup>th</sup> Winter School plenty of scientific satisfactions and many professional and social impressions.

Organizers

This book includes the Program of all Workshops and sending by Authors abstracts of their presentations.

## 44<sup>th</sup> Winter School on Wave and Quantum Acoustics

# 11<sup>th</sup> Winter Workshop on Acoustoelectronics (AE)

# **PROGRAMME** and **ABSTRACTS**

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## WSWQA 2015 - Workshop on Acoustoelectronics Szczyrk 02-05.03.2015

02.03.2015 Monday		
13:00	Dinner	
14:15	<b>OPPENING CEREMONY of the 10<sup>th</sup> IOS'2015 and 44<sup>th</sup> WSW&amp;QA Conferences</b>	
14:30-16:10	Common Session	
14:30-15:00	Plenary lecture	
	International Year of Light: 1000 years of optics and 100 years of photonics T. R. WOLIŃSKI	
15:00-15:30	Plenary lecture	
	Nitrogen-vacancy diamonds, a novel photonic material	
	W. GAWLIK, M. MRÓZEK, D. RUDNICKI	
15:30-15:50	Nanocrystalline boron doped diamond films on fused silica optical fibres for combined electrochemical and optical sensing devices	
	R. BOGDANOWICZ, M. FICEK, M. SOBASZEK, M. GNYBA, M. ŚMIETANA, J. RYL	
15:50-16:10	Boron-doped nanocrystalline diamond film for spectroelectrochemical measurements on fused silica substrates.	
	M. SOBASZEK, K. SIUZDAK, R. BOGDANOWICZ, Ł. SKOWROŃSKI, M. SAWCZAK, M. FICEK, J. PLUCIŃSKI	
16:10-17:00	Coffee break	
17:00-17:30	Invited lecture	
	Type II quantum well profile improvement in interband cascade lasers for mid-infrared optical gas sensing applications	
	М. МОТҮКА	
17:30-18:00	Invited lecture	
	Luminescence properties in co-doped glasses for active guided- wave applications	
	D. DOROSZ, J. ŻMOJDA, M. KOCHANOWICZ, P. MILUSKI, J. DOROSZ, A. LUKOWIAK, A. CHIASERA, A. CHIAPPINI, I. VASILCHENKO, M. FERRARI, G. RIGHINI	
18:00-18:20	Comparative analysis of upconversion luminescence in germanate glass and optical fiber co-doped with Yb3+/Tb3+	
	M. KOCHANOWICZ, J. ZMOJDA, D. DOROSZ, P. MILUSKI, M. SITARZ, P. JELEŃ	

18:20-18:35	Generation and management of intellectual property and technology tranfser as necessary bridge for cooperation between science and industry
	T. NASIŁOWSKI, M. BROCZKOWSKA, K. PAWLIK
18:35-19:00	Special Session of InPhoTech concerning ELECTRON MICROSCOPY
19:00	Supper

03.03.2015 Tuesday		
13:00	Dinner	
15:20-15:50	Plenary lecture	
	<b>Comparative analysis of PD measurements results achieved using electrical, acoustic emission and UHF methods</b> A. CICHOŃ, M. KUNICKI, T. BOCZAR, S. BORUCKI	
15:50-16:10	Identification of acoustic emission signals originating from the core magnetization of oil power transformer A. OLSZEWSKA, F. WITOS	
16:10-16:30	Properties of acoustic emission signals generated within the pressure vessel F. WITOS, Z. OPILSKI, G. SZERSZEŃ, A. OLSZEWSKA, M. SETKIEWICZ	
16:30-17:00	Coffee break	
17:00-17:20	<b>Experimental results and numerical analysis of the response of SAW sensors to CO concentration below 25 ppm</b> T. HEJCZYK, B. WSZOŁEK, W. JAKUBIK	
17:20-17:40	Acoustoelectronic method of helium detection K. JASEK, M. PASTERNAK, M. GRABKA	
17:40-18:00	Low power, low cost ultrasonic generator for dispersion process in liquids W. KARDYŚ, A. MILEWSKI, P. KOGUT, P. KLUK	
18:00-19:00	Poster session	
19:00	Supper	
20:00-20:45	Classical Music Concert	

04.03.2015 Wednesday		
13:00	Dinner	
15:00-15:20	Selected Aspects of Operation of the Piezoelectric Ultrasonic Transducer	
	T. GUDRA, M. BRZEZINSKI	
15:20-15:40	Temperature effect on the parameters of high power ultrasonic piezoceramic transducers	
	P. REUK, A. MILEWSKI, W. KARDIS, P. ROGUI	
15:40-16:00	<b>High power ultrasonic transducers nonlinear behavior</b> P. KOGUT, A. MILEWSKI, W. KARDYŚ, P. KLUK	
16:00-16:20	<b>On some tri-component media for antenna miniaturization</b> J. KAPELEWSKI, M. OKOŃ	
16:20-16:50	Coffee break	
16:50-17:10	Simulator of the electromagnetic decoys set for the protection of the radar against antiradiation missiles	
	A. K. RUTKOWSKI, A. KAWALEC, M. CZYŻEWSKI	
17:10-17:30	Shaping ambiguity surfaces of phase-coded radar signals by means of optimization methods	
	D. SZCZEGIELNIAK, A. MILEWSKI, M. SZCZEGIELNIAK	
17:30-17:50	Thermal imaging and conoscopic studies of working acoustooptical devices on the base of paratellurite	
	S.A. TRETIAKOV, A.I. KOLESNIKOV, R.M. GRECHISHKIN, K.B. YUSHKOV, E.V. SHMELEVA	
17:50-18:10	Anisotropic diffraction of bulk acoustic wave beams in lithium niobate	
	N. NAUMENKO, S. CHIZHIKOV, V. MOLCHANOV, K. YUSHKOV	
19:30	Festive Supper (Banquet)	

05.03.2015 Thursday				
8:00	Breakfast			

#### POSTER SESSION

Analysis of optical signals in the UV range generated by electrical discharges on cap insulator

I. URBANIEC, P. FRĄCZ, J. FOLTYS

The study of optical spectra emitted by partial discharges generated in insulating oil

M. KOZIOŁ, T. BOCZAR

Analysis of optical signals in the infrared range generated by electrical discharges occurring on bushing and support insulators

P. FRĄCZ, J. FOLTYS

Ionizing radiation generated by high power discharge

Ł. NAGI, D. ZMARZŁY

#### Application of cavitation meter to evaluate hydratable sewage sludge

M. SETKIEWICZ, M. GANCARCZYK

ABSTRACTS OF LECTURES

### Robert BOGDANOWICZ<sup>1</sup>, Mateusz FICEK<sup>1</sup>, Michał SOBASZEK<sup>1</sup>, Marcin GNYBA<sup>1</sup>, Mateusz ŚMIETANA<sup>2</sup> and Jacek RYL<sup>3</sup>

<sup>1</sup> Faculty of Electronics, Telecommunications and Informatics, Gdansk University of Technology, POLAND
<sup>2</sup> Institute of Microelectronics and Optoelectronics, Warsaw University of Technology, POLAND
<sup>3</sup> Dept. of Electrochemistry, Corrosion and Material Engineering, Gdansk University of Technology, POLAND

#### Nanocrystalline boron doped diamond films on fused silica optical fibres for combined electrochemical and optical sensing devices

The paper presents nanocrystalline boron-doped diamond (B-NCD) film as a coating for optical fibres. Seeding and growth processes of thin diamond films on fused silica optical fibres have been investigated. B-NCD films were deposited using Microwave Plasma Assisted Chemical Vapour Deposition (MW PA CVD).

Optical fibre pre-treatment by dip coating in detonation nanodiamond (DND) seeding media has been performed. For the coating purpose, the DND suspension in polyvinyl alcohol (PVA) was chosen [1]. The grain size distribution of nanodiamond particles in seeding medium was kept at approx. 10-50 nm.

The B-NCD surfaces were analysed using high-resolution scanning electron microscopy (HR-SEM). We have demonstrated that conformal B-NCD films deposited on fused silica fibres can be improved by hydrogen plasma pre-treatment and seeding in PVA-DMSO nanodiamond suspension with dip-coating method (see Fig. 1.).

The molecular structure of diamond has been examined with micro-Raman Spectroscopy. The analysis of Raman spectra demonstrated that the best conditions for diamond film deposition were achieved at the substrate temperature of 475 °C. The morphological analysis showed that up to 5 cm of fibre length can be coated with the uniform nanocrystalline structure of high sp3 phase content.



Fig. 1. SEM micrographs of the cross-sections of B-NCD-coated fibres. Magnification is 1,000x. Inset: SEM image showing B-NCD coating (magnification 20,000x).



Fig. 2. Response of LPG to external refractive index next in the sample (a) before and (b) after diamond overlay deposition.

Thickness, roughness and optical properties of the nanocrystalline diamond films in VIS-NIR wavelength range were investigated on reference samples using spectroscopic ellipsometry. High refractive index (range of 2.1-2.4) was achieved for B-NCD films deposited at 475 and 550 °C. The values of k obtained in this study were below 0.1 at  $\lambda$ =550 nm, indicating low absorption of the film over the whole length of optical fibre. The deviation of maximum thickness reached ca. 20%, with the mean surface roughness of 24 ± 1 nm. The

most reasonable explanation for the observed distribution is that the thickness of B-NCD film is highly affected by different kinetics of plasma surface chemistry at various distances from the electrode centre.

Cyclic voltammetry (CV) was applied to characterize and investigate the electrochemical properties of B-NCD modified optical fibres. Comparing the three electrochemical reaction models, we were able to determine how the structure of B-NCD coating affects the transfer of electrons. We have chosen positively (Fe2+/3+), negatively ([Fe(CN)6]3-/4-) and neutrally (Q/ H2Q) charged redox systems.

Moreover, the optical fibres with long-period gratings (LPGs) have been applied for measurements of concentration changes of several chemical solutions due to changes of refractive index of the solutions [2] ranging from 1.33 to 1.47. Thin B-NCD coatings significantly modifies sensitivity of the LPG device in selected refractive index range (see Fig 2.).

The fibre transmission in the wavelength range between the resonances was unaffected by the deposition process. This result proves that a relatively long high-temperature deposition process had a negligible effect on the fibre properties, i.e., possible diffusion of germanium dopant out of the fibre core. However, the deposition process had a significant influence on the response of LPG, namely, it resulted in a decrease of LPG resonance depth and the spectral shift for all investigated external refractive indices.

#### <u>Andrzej CICHOŃ</u>, Michał KUNICKI, Tomasz BOCZAR, Sebastian BORUCKI

Faculty of Electrical Engineering, Control and Computer Engineering, Opole University of Technology, Pruszkowska 76, Budynek 2, 45-578 Opole, Poland

## Comparative analysis of PD measurements results achieved using electrical, acoustic emission and UHF methods

This paper presents research's results related to measurements of partial discharges (PD) phenomena, which may occur in oil insulation systems of electric power transformers. Three measuring methods are considered: electrical (apparent charge - IEC60270), acoustic emission (AE) and ultra-high frequency (UHF) methods. Research works are proceeded under laboratory condition. PD are generated using special apparatus and spark gap configuration for surface PD modeling. Measurements are performed simultaneously for each of the regarded methods and are repeated for selected supply voltage levels. The electrical and UHF methods measurements are made using MPD measuring system from Omicron. The AE method measurements are made using a CH-3160 interface from Acquitec fed by a piezoelectric transducer WD AH 17 and a B&K's 8103 hydrophone, which are installed on the outer oil tank wall and immersed in the oil, respectively. Comparative analysis of signals gathered during research works are made. Possibilities of application of the three considered PD detection and identification methods for electric power systems with oil insulation are proposed. Fields of further research works, connected with correlation between all presented methods of PD source's detection and identification in oil insulation are also proposed.

#### Dominik DOROSZ<sup>1</sup>, Jacek ŻMOJDA<sup>1</sup>, Marcin KOCHANOWICZ<sup>1</sup>, Piotr MILUSKI<sup>1</sup>, Jan DOROSZ<sup>1</sup>, Anna LUKOWIAK<sup>2</sup>, Alessandro CHIASERA<sup>3</sup>, Andrea CHIAPPINI<sup>3</sup>, Iustyna VASILCHENKO<sup>3,4</sup>, Maurizio FERRARI<sup>3,5</sup>, Giancarlo RIGHINI<sup>5,6</sup>

 <sup>1</sup> Department of Power Engineering, Photonics and Lighting Technology, Bialystok University of Technology Wiejska 45D Street, 15-351 Bialystok, d.dorosz@pb.edu.pl
<sup>2</sup> Institute of Low Temperature and Structure Research, PAS, Okolna St., 50-422 Wroclaw, Poland
<sup>3</sup> IFN - CNR CSMFO Lab. and FBK, Via alla Cascata 56/C Povo, 38123 Trento, Italy

<sup>4</sup> Dipartimento di Fisica, Università di Trento, via Sommarive 14, Povo, 38123 Trento, Italy

<sup>5</sup> Enrico Fermi Centre, Piazza del Viminale 1, 00184 Roma, Italy.

<sup>6</sup> MipLAB. IFAC - CNR, Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy

## Luminescence properties in co-doped glasses for active guided-wave applications

The development of novel and advanced glasses co-doped with RE ions permits the implementation of new photonic devices for fiber and integrated optics. Especially, white light emission from material doped with lanthanides based on frequency upconversion process, which can convert near-infrared photons into visible photons via multiphoton processes [1-3]. On the fibers' side, the upconversion luminescence of antimony-germanate glasses co-doped with Yb<sup>3+</sup>/Tm<sup>3+</sup>/Ho<sup>3+</sup> is discussed here. Strong blue  ${}^{1}G_{4} \rightarrow {}^{3}H_{6}$  (Tm<sup>3+</sup>), green  ${}^{5}F_{4} \rightarrow {}^{5}I_{8}$  (Ho<sup>3+</sup>) and red  ${}^{5}F_{5} \rightarrow {}^{5}I_{8}$  (Ho<sup>3+</sup>) emission and its dependence on molar ratio of active ions and excitation power on the colour coordinates (CIE-1931) have been investigated.

Analysis of upconversion luminescence in double-core optical fiber co-doped with Yb<sup>3+</sup>/Tm<sup>3+</sup>, Yb<sup>3+</sup>/Ho<sup>3+</sup> and single-core fiber co-doped with Yb<sup>3+</sup>/Tm<sup>3+</sup>/Ho<sup>3+</sup> have been performed.On the integrated optics side, phosphosilicate glasses doped with erbium ions have been synthesized and studied. Their optical and thermal properties have been analysed, and planar waveguides have been produced by RF-sputtering deposition. Finally, the optical and spectroscopic characteristics of these Er - doped planar waveguides will be discussed.



Fig. 1 Luminescence spectra of the fabricated triply doped 1 Yb<sub>2</sub>O<sub>3</sub>/0.1 Tm<sub>2</sub>O<sub>3</sub>/0.5 Ho<sub>2</sub>O<sub>3</sub> optical fiber,  $\lambda_p$ =976 nm.

1. G. Hua, Y. Dianlai, Z. Xin, Y. Edwin, L. Hai, Optical Materials 32, 554-559 (2010)

The research activities were performed by the National Science Centre (Poland) granted on the basis of the decision No. DEC-2012/07/B/ST8/04019 and the CNR-PAS joint project "Nanostructured systems in opal configuration for the development of photonic devices" (2014-2016). The COST Action MP1401 "Advanced fibre laser and coherent source as tools for society, manufacturing and life science" is also acknowledged.

<sup>2.</sup> H. Xiaorui, S. Shengming, J. Tingting, L. Hui, T. Hao, J. of Alloys and Compounds 509, 2793–2796 (2011)

<sup>3.</sup> D. L. Yang, H. Gong,, E. Y. B. Pun, X. Zhao, H. Lin, Optics Express 18, (2010)

### Tadeusz GUDRA, Mateusz BRZEZIŃSKI

Chair of Acoustics and Multimedia, Faculty of Electronics, Wroclaw University of Technology, Wybrzeże Wyspianskiego 27, 50-370 Wroclaw, Poland

#### Selected Aspects of Operation of the Piezoelectric Ultrasonic Transducer

In the analysis of the operation of a piezoelectric transducer operating at thickness vibrations, aimed at the determination of the electrical equivalent circuit of the transducer, it is assumed that the vibrations of the transducer surface are considered as the vibrations of a piston placed in a baffle of an infinite size. A similar assumption applies to determination of the near-field and far-field and the directivity characteristics of the transducer. The actual manner of operation of, e.g., a piezoelectric disk differs substantially from such an assumption, in particular at frequencies near the main resonance.

The paper shows theoretical aspects of the piezoelectric transducer operation and the results of measurements of vibrations distribution on the surface of the piezoelectric disc operating in the air in a wide range of frequencies, as well as the manner of vibrations of such a transducer during radiation into the water layer for different water column heights. It has been demonstrated, inter alia, that the thickness of the water layer significantly affects the distribution of vibrations on the surface of the transducer.

### Tomasz HEJCZYK<sup>1</sup>, Bartłomiej WSZOŁEK<sup>1</sup>, Wiesław JAKUBIK<sup>2</sup>

<sup>1</sup> ENTE Sp z o.o. Gliwice, Gaudiego 7, Poland, <sup>2</sup>Institute of Physics SUT, Konarskiego 22B, Poland

## Experimental results and numerical analysis of the response of SAW sensors to CO concentration below 25 ppm

In the presentation the numerical results of the SAW gas sensor equivalent model is presented. The results are based on the steady state response of low concentrations below 25 ppm of CO gas. In the analysis the parameters of a thin films of Polyaniline (PANI) + Nafion has been used. Impedance replacement of sensor layer, taking into account the profile of the CO concentration in the film, has been implemented into the Ingebrigtsen equation. It enables obtaining of the analytical expressions for the relative changes in surface wave velocity in the response steady state. The results of the analysis show that there is an optimum thickness about 92 nm of CO layer sensor for which an acoustoelectric effect (change in the acoustic wave velocity) is the most effective for concentration below 25 ppm.

## Krzysztof JASEK<sup>1</sup>, <u>Mateusz PASTERNAK<sup>2</sup></u>, Michał GRABKA<sup>1</sup>

<sup>1</sup>Faculty of Advanced Technologies and Chemistry, <sup>2</sup>Faculty of Electronics Military University of Technology, 2 Gen. S. Kaliskiego Str., Warsaw, Poland

#### Acoustoelectronic method of helium detection

Helium is the lightest noble gas in the periodic table. It is commonly used in cryogenics (about a quarter of world production), industrial (as pressurizing and purge gas, protective atmosphere for arc welding, in crystals growing processes etc.) and as a lifting gas in balloons and airships (minor use). Helium is also very a good gas to use in leak detection systems, however on the other hand due to many applications of it the leak detection of *He* is necessary in many places. This makes the strong demand for helium detectors.

Unfortunately helium is completely inert. It does not form compounds or react with any other element so it is very hard to detect. However a few methods of electronic *He* detection have been developed starting from simplest one like bubble or ultrasound tests through the ionisation or thermal conductivity methods up to chromatography and radioactive technologies.

In the paper the new mechanism that may be useful for helium detection is described. It is based on Rayleigh waves leakage phenomenon into gaseous half-space in surface acoustic wave (SAW) devices. The effect is repeatable and distinct enough to be a basis of helium SAW sensor construction.

#### Jerzy KAPELEWSKI, Marta OKOŃ

Faculty of Electronic, Military University of Technology, gen. Sylwestra Kaliskiego 2, 00-908 Warsaw, Poland

#### On some tri-component media for antenna miniaturization

The paper is concerned with magnetodielectric materials as a prospective substrate to miniaturization of microwave devices. Controlling values of the permittivity and permeability allows reducing the size by saving the same bandwidth and gain of antenna, what is related with impedance matching. A concept of an application of material including graphenes layer in magnetodielectric planar material is developed. Such designed antennas radiation characteristics can be controlled by either its gate voltage and an external field changing effective parameter of whole structure. The report is supplemented with a scheme of the analytical treatment of the problem.

#### Witold KARDYŚ, Andrzej MILEWSKI, Paweł KOGUT, Piotr KLUK

Tele and Radio Research Institute, Ratuszowa 11, 03-450, Warsaw, Poland

#### Low power, low cost ultrasonic generator for dispersion process in liquids

Ultrasonic vibrations greatly increase efficiency of dispersion process in liquids. This type of process is widely used in various areas of industry including medicine and food processing. Depending on the process requirements an appropriately designed ultrasonic generator is essential for achieving correct and repeatable results. Most important generator parameters are small size, good electrical efficiency and low cost.

The article presents design and parameters of 50kHz, 50W generator intended for use with piezoceramic transducers in such processes. The generator incorporates an analog control circuit based on a frequency locked loop. Power stage of the unit is designed as a resonant converter with a half bridge switching circuit and a bootstrapping MOSFET driver. The generator is designed to tune to a transducer's parallel resonant frequency and follow this frequency even after a large change in the load level. This feature ensures reliable work of the transducer because the vibration amplitude doesn't change by a large factor during operation with a rapidly changing load. An overload protection shutdown and an automatic restart is also included in the device. Simplicity of this design allowed it to be very cost effective compared to previously used digital control generators although not as versatile and reliable.

#### Piotr KLUK, Andrzej MILEWSKI, Witold KARDYŚ, Paweł KOGUT

Tele and Radio Research Institute, Ratuszowa 11, 03-450, Warsaw, Poland

## Temperature effect on the parameters of high power ultrasonic piezoceramic transducers

The key element of ultrasonic welding and cutting systems is an ultrasonic stack consisting of a high power ultrasonic piezoceramic transducer, a booster, and a sonotrode. The quality and efficiency of the welding and cutting process is highly dependent on the ultrasonic transducer parameters such as resonant frequencies, electromechanical coupling factor and so on. Changes in the parameters can indicate the ultrasonic stack aging, wear or incoming malfunction. In order to provide high quality process the parameters should be monitored during the ultrasonic stack lifetime and compared with the reference values for diagnostic purposes. The main problem is relatively large temperature dependence of the piezoceramic transducer parameters. In order to take it into account in the diagnostic process one should model the temperature effect. In this paper the parameters measurement results for a set of three high power ultrasonic transducers have been presented. The measurements of transducers electrical impedance in the temperature range from 10 to 100 degrees Celsius with the 5 degrees step have been taken in a high precision thermostat. On the base of the electrical impedance the transducer parameters have been estimated. Finally, the temperature effect on the parameters have been modeled using a polynomial approximation.

#### Marcin KOCHANOWICZ<sup>1</sup>, Jacek ŻMOJDA<sup>1</sup>, Piotr MILUSKI<sup>1</sup>, Maciej SITARZ<sup>2</sup>, Piotr JELEŃ<sup>2</sup>, Dominik DOROSZ<sup>1</sup>

<sup>1</sup>Department of Power Engineering, Photonics and Lighting Technology, Bialystok University of Technology, Wiejska 45D Street, 15-351 Bialystok <sup>2</sup>Faculty of Materials Science and Ceramics, AGH University of Science and Technology, 30 Mickiewicza Av., 30-059 Krakow

#### Comparative analysis of upconversion luminescence in germanate glass and optical fiber co-doped with Yb3+/Tb3+

As a result of frequency conversion of infrared radiation into visible light the optical glasses and optical fibers doped with rare earth ions (RE) may be applied in numerous applications: data storage systems in HD quality, 3D displays, medical diagnostics, optical sensors, laser and ASE sources [1, 2]. Universal demand for compact glass fiber sources and amplifiers necessitates the pursuit for brand new low phonon, thermally stable glasses doped with RE elements. In the article the cooperative energy transfer in GeO2 – Ga2O3 – BaO glass co-doped with 0.7 Yb2O3/(0.07 - 0.7) Tb2O3 and made there from double – clad, offset core optical fiber under 976 nm laser diode pumping have been investigated.

Obtained upconversion emission spectrum consists of seven emission bands, resulting from the cooperative energy transfer form ytterbium ions and quantum transitions in the terbium structure. Luminescence bands at 489, 543, 586, 621 nm corresponding to 5D4 $\rightarrow$ 7FJ (J=6, 4, 3) transitions and luminescence at 381, 415, 435 nm resulting from 5D3, 5G6 $\rightarrow$ 7FJ (J=6, 5, 4) transitions were measured.



Fig. 1 Luminescence spectra of the fabricated glass and double-clad optical fiber co-doped with 0.7 Yb2O3/0.7 Tb2O3 ions,  $\Box p=976$  nm.



Fig. 2 Deconvolution of luminescence spectrum of the fabricated double-clad optical fiber codoped with 0.7 Yb2O3/0.7 Tb2O3 ions,  $\Box p=976$  nm.

Basic parameters of the manufactured optical fiber (fig. 2) were as follows: outer cladding diameter= $390 \mu m$ , core diameter= $10\mu m$ , NAcladding=0.58, NAcore=0.4.

Comparing the results in optical fiber with results obtained in bulk glass (fig.1) it can be seen that shape of the upconversion emission spectra of the optical fiber is significantly different from the luminescence spectra of bulk glass.

FWHM luminescence spectrum of the fabricated optical fiber is 5 nm greater than in the same bulk glass. Moreover, peak emission at 543 nm is shifted by 4 nm towards longer wavelengths. Based on the deconvolution of the emission spectra it can be seen that in the fabricated optical fiber radiative transitions from lower Stark sub-levels in 5D4 level is dominant and as a result main emission peak occurs at 547 nm. Moreover, intensity emission ratio (I547nm/I621nm) of the fabricated optical fiber increases with the increase of the length of the optical fiber. For a fiber length of 1 m it is 20.4 (16.5 - bulk glass).

The project was funded by the National Science Centre (Poland) granted on the basis of the decision No. DEC-2013/09/D/ST8/03987

1. D. Lande, S.S. Orlov, A. Akella, L. Hesselink, R.R. Neurgaonkar, Opt. Lett. 22, 1722 (1997) 2. A.S. Gouveia-Neto, L.A. Bueno, R.F. do Nascimento, E.A. da Silva Jr., E.B. da Costa. Appl. Phys. Lett. 91 091114 (2007)

#### Paweł KOGUT, Andrzej MILEWSKI, Witold KARDYŚ, Piotr KLUK

Tele and Radio Research Institute, Ratuszowa 11, 03-450, Warsaw, Poland

#### High power ultrasonic transducers nonlinear behavior

High power ultrasonic piezoceramic transducers driven at high level of electrical voltage exhibit strong nonlinearities. These effects includes known characteristic nonlinear behavior for piezoceramic materials such as jump phenomena and multiple harmonics. Nonlinear behavior of the transducer results into resonant frequency shifting, hysteresis effect and mechanical and electrical energy spreading. Detailed examination of this behavior is very important in a process of developing efficient control algorithms for industrial applications. Transducers parameters estimation is also expected to be examined not only under its linear behavior but under real conditions of the corresponding application. To came across this expectations authors developed a measurement stand adjusted to meet heavy duty conditions of the high power transducers working regimes. Authors outline measurement stand capabilities and discuss problems corresponding to nonlinear properties measurements. For paper purpose 20kHz high power transducer has been examined. The research has covered transducer nonlinear behavior near series resonant frequency of the longitudinal vibration mode caused by voltage excitation. The electrical current, mechanical displacement amplitude, electrical impedance and frequency shifting characteristics have been presented and discussed, as well as FFT analysis of the electrical current and mechanical amplitude signals in the function of the excitation voltage amplitude.

#### **Marcin MOTYKA**

Department of Experimental Physics, Faculty of Fundamental Problems of Technology, Wrocław University of Technology Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

#### Type II quantum well profile improvement in interband cascade lasers for mid-infrared optical gas sensing applications

Applications related to the sensing of hazardous and environmentally relevant gases drive the growing demands with respect to all the sensor components, requiring especially cheap, compact and fast laser sources. In many cases the suitable laser sources, which for a number of gasses fall into the mid infrared range, are not commercially available. The target range, which is usually about 3-5  $\mu$ m and up to 8  $\mu$ m, can potentially be achieved by several approaches. The common type I quantum-well-based laser diodes have not exceeded the 4  $\mu$ m emission range at room temperature, whereas quantum cascade lasers (QCLs) have been demonstrated down to 3  $\mu$ m already. Another solution is the so called interband cascade laser (ICL) [1] proven to be operational between 3 and 7  $\mu$ m and which can additionally offer significantly lower power consumption than the QCLs [2].

It has been investigated, both experimentally and theoretically, the active part of the ICL's based on InAs/Ga,In(As),Sb materials combination forming a broken gap system, i.e. confining electrons and holes in spatially separate layers (in InAs and GaIn(As)Sb, respectively)[3]. The presentation will be focused on opportunities and challenges regarding the extension of the emission range into the longer wavelengths, and the active region optimizations aimed at maximizing the optical transition oscillator strength via tailoring the electronic structure engineering [4]. Additionally, presentation will also cover the band offsets importance, transition intensity versus structure parameters [5] and the predominant carrier loss mechanisms [6]. For all investigations, several spectroscopic techniques have been used, both emission-like (photoluminescence) and absorption-like (modulated reflectivity spectroscopy)[7] supported by the energy level calculations employing a multiband kp formalism [8].

In summary, the investigated type II quantum wells will be discussed in the context of the optical sensing applications, e.g. remote monitoring of formaldehyde [9] as well as hydrocarbon leak uncovering [10] and remote detection of alcohol vapour in exhaled breath\*.

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#### Natalya NAUMENKO, Sergey CHIZHIKOV, Vladimir MOLCHANOV, Konstantin YUSHKOV

Acousto-Optical Research Center, National University of science and Technology "MISIS", 4 Leninsky prospekt, 119049 Moscow, Russia

#### Anisotropic diffraction of bulk acoustic wave beams in lithium niobate.

Lithium niobate crystals are widely used in acousto-optics and acousto-electronics. It is known that anisotropy of elastic properties results in obliquity of bulk acoustic wave (BAW) propagation. Anisotropy of diffraction of ultrasonic beams was not studied before in detail. We determine a planar tensor of BAW diffraction that is derived from the Christoffel equations. The eigenvalues of that tensor characterize the spreading of ultrasonic beams in two orthogonal directions. In the vicinity of acoustic axes of the crystal, one the diffraction coefficients tends to infinity.

We performed comprehensive analysis of diffraction coefficients for three BAW modes in lithium niobate. The values of the diffraction coefficients strongly depend on the piezoelectric coefficients of lithium niobate. Our analysis revealed that for both quasi-shear BAWs in lithium niobate there exist the directions where the diffraction spreading of ultrasonic beams is lower than in isotropic media. Special attention was paid to analysis of BAW diffraction in the YZ plane which can be used for design of novel acousto-optic devices. For the purpose of practical design of BAW-based devices, it is recommended to use the directions of beam propagation with minimum diffraction coefficients.

#### Aneta OLSZEWSKA, Franciszek WITOS

Department of Optoelectronics, Silesian University of Technology, Krzywoustego 2, 44-100 Gliwice, Poland

#### Identification of acoustic emission signals originating from the core magnetization of oil power transformer

The following paper covers the phenomena occurring during the magnetization of ferromagnetic materials, from which power transformers cores are composed. During the measurements acoustic emission (AE) signals were registered in chosen power oil transformers and then registered signals were analyzed. The analysis were consisted with, among others, analysis in domains of time, frequency and time-frequency, calculation of amplitude signal distributions, calculation of defined AE descriptors, working up the maps of descriptors on lateral walls of transformers and detailed analysis of selected fragments of the signals.

Analysis of maps of descriptors in the bands 20-70 kHz, 70-100 kHz and 100-200 kHz and analysis of properties of signals in the time and frequency domains was carried out. By means of this research AE signals coming from the magnetization of the power oil transformers core were identified. Finally for identification of these phenomena maps of ADC descriptors calculated in frequency band of 20-70 kHz (selecting measuring points in which there are no partial discharges sources) were used. In addition an analysis of magnetoacoustic emission (MAE) signals was carried out in bands of 70-100 kHz and 100-200 kHz. The analysis of signals in such extended frequency band (20-200 kHz) has led to determine fundamental properties of MAE signals coming from the cores plates of power oil transformers.

#### Adam Konrad RUTKOWSKI, Adam KAWALEC, Mirosław CZYŻEWSKI

Instytut Radioelektroniki WEL WAT, ul. Gen Kaliskiego 2, 00-908 Warszawa

## Simulator of the electromagnetic decoys set for the protection of the radar against antiradiation missiles

Using the anti-radiation missiles (ARM) is the one of the most dangerous way to destroy radars and other systems consisting electromagnetic transmitters. For this reason many teams work on the systems which enable to disrupt work of seeker of the anti-radiation missile. Very high effectiveness of the radar protection against ARM is achieved by using set of additional electromagnetic emitters deployed nearby radar is to protect. These additional emitters are called electromagnetic decoys. The efficacy of the electromagnetic decoys functioning depends on their quantity, location and distance from the radar being protected. One of the method of these factors investigations is using dedicated computer simulators. The version of such simulator was presented in the paper. Prepared simulator enables to analyse the electromagnetic environment around the radar working with pulse signals. The pulses taken into consideration may by so called simple e.g. without internal modulation or they can have linear frequency modulation (LFM). The protection system of the radar may consists of one to four electromagnetic decoys. The conditions and results of simulation can be shown on the display or they can be stored in the mass memory. These stored data can be used for the next detailed analysis and for mutual comparison of the different scenario of the radar's protection system operation. The results of the several simulations performed with various number of decoys were also presented in the work.

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### Michał SOBASZEK\*1, Katarzyna SIUZDAK2, Robert BOGDANOWICZ1, Łukasz SKOWROŃSKI3, Mirosław SAWCZAK2, Mateusz FICEK1 and Jerzy PLUCIŃSKI1

<sup>1</sup>Department of Metrology and Optoelectronics, Faculty of Electronics, Telecommunications and Informatics, Gdansk University of Technology, 11/12 G. Narutowicza St., 80-233 Gdansk, Poland <sup>2</sup>Centre for Plasma and Laser Engineering, The Szewalski Institute of Fluid-Flow Machinery, Polish Academy of Sciences, 14 Fiszera St., 80-231 Gdansk, Poland <sup>3</sup>University of Technology and Life Sciences, Institute of Mathematics and Physics, 7 Kaliskiego St., 85-789 Bydgoszcz, Poland

#### Boron-doped nanocrystalline diamond film for spectroelectrochemical measurements on fused silica substrates

Diamond film among outstanding properties have optical transparency in broad wavelength range from UV to far IR [1]. Natural diamond is wide band semiconductor  $E_g = 5.45$  eV than can be easily doped by boron atoms on *in situ* Microwave Plasma Assisted Vapour Deposition (MWPACVD) process [2]. Due to this properties boron-doped diamond films are promising material to optical transparency electrode that have various applications like: *e.g.* spectroelectrochemical measurements [3,4]. Fused silica substrates allows to work in wavelength range from 160 to 4000 nm, are resistant to hazardous media, however produce good quality continuous diamond films on this substrate is not easy.

The paper reports deposition of continuous thin nanocrystalline boron-doped diamond (B-NCD) films on fused silica substrates using a MWPACVD system. To achieve efficient optically transparent electrode on fused silica substrates, the highest possible refractive index of B-NCD film is needed. The thin B-NCD films were characterized by means of cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) in aqueous media, spectroscopic ellipsometry (SE), scanning electron microscopy (SEM) and Raman spectroscopy.



**Fig. 1** Refractive index of B-NCD film in wavelength range of 200 ÷ 4000 nm. Inset show RI of B-NCD-10 sample.



Fig. 2. Transmittance of B-NCD film in wavelength range of 200 ÷ 4000 nm.

The SE was used to estimate optical constants, transmittance and thickness of the films. The B-NCD refractive index shows values close to that of single-crystalline diamond n  $\approx 2.38$  (Fig. 1) in broad wavelength range (250 - 4000 nm). Maximum transmittance up to 72% were achieved (Fig. 2). The SEM images shows that the films are continuous with average grain size below 100 nm. The Raman spectra includes diamond peak at 1330-1333 cm<sup>-1</sup> and nanocrystalline diamond band at 1126-1143 cm<sup>-1</sup>. Moreover, the variations of boron level in the films was confirmed by intensity increase of the band placed at 1231 cm<sup>-1</sup> and drop of the signal intensity above 1650 cm<sup>-1</sup>. Such an effect is typical for highly boron-doped CVD diamond.

The CV and EIS was used to measurement formal potential ( $\Delta E$ ) and efficiency of the doping (N<sub>D</sub>). The lowest measured value of  $\Delta E$  is 79 mV (see Fig. 3) indicating a high reversibility of the redox reaction.



Fig. 3 Cyclic voltammetry curves recorded for BDD/Q electrodes immersed in 0.5M K2SO4/1 mM K3Fe(CN)6 with different scan rate: 10, 20, 50, 90, 120 and 150 mV/s

## Damian SZCZEGIELNIAK<sup>1</sup>, Andrzej MILEWSKI<sup>2</sup>, Marcin SZCZEGIELNIAK<sup>1</sup>

 <sup>1</sup> Faculty of Telecommunications, Computer Science and Electrical Engeneering, University of Science and Technology, Al. Prof. S. Kaliskiego 7, 85-796 Bydgoszcz, Poland
<sup>2</sup>Tele & Radio Research Institute, str. Ratuszowa 11, 03-450 Warszawa, Poland

#### Shaping ambiguity surfaces of phase-coded radar signals by means of optimization methods

An ambiguity function is widely used by radar system designers as a tool for research and analysis of various types of radar signals. Unfortunately, there are no analytical methods for the synthesis of a radar signal based on an assumed a priori ambiguity function.

The aim of this study was to examine to what extent the ambiguity surface can be shaped using the evolutionary algorithm combined with the local optimization method.

The achieved results confirmed the effectiveness of applied optimization methods to obtain the predetermined ambiguity surface and thus the synthesis signals with desirable characteristics. Furthermore, limitations of shaping the ambiguity function were presented in this paper.

## S.A. TRETIAKOV<sup>1</sup>, A.I. KOLESNIKOV<sup>1</sup>, R.M. GRECHISHKIN<sup>1</sup>, <u>K.B. YUSHKOV<sup>2</sup></u>, E.V. SHMELEVA<sup>1</sup>

<sup>1</sup> Tver State University, 33 Zhelyabova st., 170100 Tver, Russia <sup>2</sup> National University of Science and Technology "MISIS" 4 Leninsky prospekt, 119049 Moscow, Russia

#### Thermal imaging and conoscopic studies of working acoustooptical devices on the base of paratellurite

At present thermal imaging techniques are more and more employed in many R&D activities, in particular, for the control of temperature regimes of various acousto-optical (AO) devices such as deflectors, modulators, filters. Temperature gradients arising in the elements during the exploitation of AO devices may have a great effect on their performance. They can also cause destruction of corresponding devices. In the present work we performed a study of the temperature field distribution in AO elements using infrared thermal vision instruments and compared the results with those obtained by conoscopic observations made by means of custom-built laser interferometer. The latter technique is especially suited for the sensitive detection of optical anomalies arising due to temperature-induced variations of indices of ordinary and extraordinary refraction No and Ne inside the material. Collation of the thermal and optical patterns provided a possibility of attributing the occurrence of anomalous biaxiality with the effect of thermal stresses developing in the AO elements during their operation.

### <u>Franciszek WITOS</u>, Zbigniew OPILSKI, Grzegorz SZERSZEŃ, Aneta OLSZEWSKA, Maciej SETKIEWICZ

Department of Optoelectronics, Silesian University of Technology, Krzywoustego 2, 44-100 Gliwice, Poland

#### Properties of acoustic emission signals generated within the pressure vessel

This paper presents research's results related to measurements of properties of acoustic emission signals generated within the pressure vessel.

The metal plate (laboratory testing) and pressure vessel (research in the field) were research objects. During the study, the acoustic emission signals were recorded using authors 8AE-PD measuring system fed by D9241A piezoelectric transducers.

Used in the study author's eight-channel measurement system enables the monitoring of signals, registration signals in real time and analysis of the recorded signals. Results of the analysis are described by authors acoustic emission descriptors identifying signals by the stage of the signal.

The tests were performed using several times the following procedure: increasing the pressure, maintaining the resulting pressure level, further increasing the pressure and then maintaining the pressure at specified obtained level.

The study of the results of basic and advanced analysis of registered acoustic emission signals are presented.

Abstracts OF Posters
#### Paweł FRĄCZ, Joachim FOLTYS

*Faculty of Electrical Engineering, Automatic Control and Computer Science, Opole University of Technology, Prószkowska 76, 45-758 Opole, Poland* 

# Analysis of optical signals in the infrared range generated by electrical discharges occurring on bushing and support insulators

The aim of the research works, results of which are presented in this paper, was to determine the feasibility and to indicate the application scope of optical method in the diagnosis of high-voltage insulators. In this study infrared radiation emitted by surface discharges occurring on two models of bushing and two models of post insulators was analyzed. The tests were performed under laboratory conditions. Presented results regard two-and three-dimensional thermographic images of discharges generated on the considered bushing and support insulator models. Furthermore a comparative analysis of the achieved results is presented in the paper.

#### Michał KOZIOŁ, Tomasz BOCZAR

Faculty of Electrical Engineering, Automatic Control and Computer Science, Opole University of Technology, 76 Prószkowska St., 45-758 Opole, Poland

### The study of optical spectra emitted by partial discharges generated in insulating oil

The paper presents and discusses the results of measurements of optical spectra emitted by partial discharges in insulating oil. The study was conducted using a spark gap for modeling of surface partial discharge occurring in insulating oil. The spark gap construction consisted of two power supply electrodes: high voltage and ground, and of a glass plate that served as the dielectric material, on which discharges were generated. The measurements were performed using a spectrophotometer registering optical signals in the visible, ultraviolet and near-infrared range. Optical radiation was detected using a flame-resistant fiber probe combined with a high definition spectrophotometer and optical fiber of low attenuation.

#### Łukasz NAGI, Dariusz ZMARZŁY

Faculty of Electrical Engineering, Automatic Control and Computer Science, Opole University of Technology, 76 Prószkowska St., 45-758 Opole, Poland

#### Ionizing radiation generated by high power discharge

The article presents a description of the method by which you can generate X-rays using a high power discharge. The system used for testing is very similar to the one used throughout the world. To generate a high-power discharges used Marx generator. Powered by a transformer with a power rating of 50 kV, and the discharge was obtained through the generator in the field of 100-700 kV. The paper presents the results have been obtained in other research centers in order to fully show the possibilities that used research obtained through the arrangement.

#### Maciej SETKIEWICZ, Mateusz GANCARCZYK

Silesian University of Technology, Gliwice

#### Application of cavitation meter to evaluate hydratable sewage sludge

Many physical and chemical processes, in which the ultrasounds are used, requires specific frequency and power. To determine this physical quantity, the mobile meter constructed . It's cooperating with the bead sensor operating according to the piezoelectric effect.

It measures the real-time distribution of acoustic emission emitted by the implosion of cavitation bubbles in one or multiphase substances. It has been used for research on the hydration ultrasonic sludge at the Institute of Water and Wastewater, Silesian University of Technology in Gliwice.

#### Ireneusz URBANIEC, Paweł FRĄCZ, Joachim FOLTYS

Faculty of Electrical Engineering, Automatic Control and Computer Science, Opole University of Technology, Prószkowska 76, 45-758 Opole, Poland

# Analysis of optical signals in the UV range generated by electrical discharges on cap insulator

The aim of the research works, results of which are presented in this paper, was to determine the feasibility and to indicate the application scope of optical method in the diagnosis of high-voltage cap insulators. Two kinds of cap insulators were analyzed: one made of glass and the second one made of a ceramic material. The measurements were performed during test under laboratory conditions using an UV camera. Surface discharges occurring on the cap insulators were registered, while the supply voltage value was increased. The presented analyses consider dependencies of the voltage value on the count number of discharges generated on the two kinds of cap insulators.

# 44<sup>th</sup> Winter School on Wave and Quantum Acoustics

11<sup>th</sup> Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods (MAR&CM)



Organizers of WSWQA 2015

Upper Silesian Division of the Polish Acoustical Society

*in cooperation with the* **Committee of Acoustics of the Polish Academy of Sciences** 

Department of Optoelectronics at Silesian University of Technology and Institute of Physics Scientific-Didactics Centre

3rd to 6th March 2015, Hotel "Meta" Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

# Workshop on Molecular Acoustics, Relaxationand Calorimetric Methods - Szczyrk 2015

3.03.2015 Tuesday	
13:00	Dinner
	In Memoriam Professor Stefan Ernst
14:30 - 14:40	Opening of the 11th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods
14:40 - 15:20	Mirosław CHORĄŻEWSKI <b>Professor Stefan Ernst: humble scientist and great teacher</b>
15:20 - 16:00	Marzena DZIDA , Udo KAATZE Acoustic and thermodynamic investigations of mixtures containing associating components
16:00 - 16:20	Stella HENSEL-BIELÓWKA, Żaneta WOJNAROWSKA, Katarzyna GRZYBOWSKA, Justyna KNAPIK, Edward ZORĘBSKI, Michał ZORĘBSKI, Marzena DZIDA, Marian PALUCH
	Primary and secondary relaxations of supercooled ionic liquids studied by broadband dielectric spectroscopy
16:20 - 16:50	Coffee break
16:50 - 17:30	Introduction to poster session (short presentation of posters)
	Poster session
17:30 - 19:00	1. Arkadiusz JÓZEFCZAK, Błażej LESZCZYŃSKI, Andrzej SKUMIEL, Tomasz HORNOWSKI
	A comparison between acoustic properties and heat effects in biogenic and magnetite nanoparticle suspensions
	2. Alena JURÍKOVÁ, Kornel CSACH, Jozef MIŠKUF, Natália TOMAŠOVIČOVÁ , Zuzana MITRÓOVÁ, Vlasta ZÁVIŠOVÁ, Martina KONERACKÁ, Peter KOPČANSKÝ, Milan TIMKO, Nándor ÉBER, Katalin FODOR-CSORBA, Aniko VAJDA
	Thermal stability of banana- and rod-shaped liquid crystal mixtures
	3. M. KONERACKÁ, M. KUBOVČÍKOVÁ, I. ANTAL, V. ZÁVIŠOVÁ, A. JURÍKOVÁ, J. KOVÁČ, P. KOPČANSKÝ
	Monitoring of colloidal stability of biocompatible magnetic fluids

	4. Małgorzata MUSIAŁ, Edward ZORĘBSKI, Monika GEPPERT-RYBCZYŃSKA Acoustic and volumetric characteristics of binary mixtures of Ionic Liquids w alkanols	vit
19:00	Supper	
20:00 - 20:45	Classical Music Concert	

4.03.2015 Wednesday	
13:00	Dinner
15:15 - 16:00	Bogumił B. J. LINDE, Ewa SKRODZKA Modal analysis of selected string instruments
16:00 - 16:20	Agnieszka BORUŃ, Adam BALD Conductometric studies of ionic liquids solutions
16:20 - 17:00	Coffee break
17:00 - 17:45	Andreas HEINTZ Short order effects in associated liquids. A new theory of Kirkwood factors of alcoholic solutions
17:45 - 18:05	Andrzej BURAKOWSKI, Jacek GLIŃSKI Simple hydrated salts in aqueous and methanolic solutions
19:30	Festive Supper (Banquet)

5.03.2015 Thursday	
13:00	Dinner
15:30 - 16:00	Peter KOPČANSKÝ Anisotropic liquids based on liquid crystals doped by magnetic nanoparticles
16:00 - 16:30	Milan TIMKO The hyperthermic effect in oil based magnetic fluids

16:30 - 17:00	Coffee break
17:00 - 17:30	Eugene B. POSTNIKOV Theoretical premises for the usage of fluctuational approach for modeling of derived thermodynamic properties of liquids
17:30 - 18:00	Vyacheslav VERVEYKO, Marina VERVEYKO Acoustic and thermophysical properties of aromatic liquid hydrocarbons and their halogenated in a wide range of state parameters
18:00 - 18:10	Closing of the 11th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods
19:00	Supper

	6.03.2015 Friday
8:00	Breakfast

ABSTRACTS OF LECTURES

# Agnieszka BORUŃ, Adam BALD

Department of Physical Chemistry, University of Łódź, Pomorska 163/165, Łódź, Poland

#### **Conductometric studies of ionic liquids solutions**

Ionic liquids are an innovative group of solvents extremely popular in academic and industrial research centers. The data of physical and chemical properties on ionic liquids are essential for both theoretical research and industrial application.

The lecture presents the most important physicochemical properties of ionic liquids, with particular attention to their conductometric properties. Conductometry is a reliable, affordable and convenient electrochemical technique, which provides valuable information on ion-solvent interactions, ion-ion association and solvent structure. Such studies are of considerable interest for the optimal use of ionic liquid solutions in high energy batteries and other electrochemical systems and chemical reactions.

We will present the results of conductance investigations of 1-ethyl-3methylimidazolium tetrafluoroborate [emim][BF<sub>4</sub>] and 1-butyl-3-methylimidazolium tetrafluoroborate [bmim][BF<sub>4</sub>] in various polar solvents (N,N-dimethylformamide, 1-propanol, water, acetonitrile, dimethylsulphoxide) in low ILs concentrations range and various temperatures.

## Marzena DZIDA<sup>1</sup>, Udo KAATZE<sup>2</sup>

<sup>1</sup>University of Silesia, Institute of Chemistry, Szkolna 9, 40-006 Katowice, Poland <sup>2</sup>Drittes Physikalisches Institut, Georg-August-Universitaet Goettingen, Friedrich-Hund-Platz 1, 37077 Goettingen, Germany

In Memoriam Professor Stefan Ernst

#### Acoustic and thermodynamic investigations of mixtures containing associating components

Ernst et al. [1-18] showed that speed of sound and absorption coefficient are quantities in which some structural features of liquids are reflected e.g. intermolecular interactions and distances, they expanded speed of sound measurements as the only direct method for determination isentropic compressibility. It allows to obtain many important thermodynamic properties such as isothermal compressibility, isochoric heat capacity. Additionally, speed of sound under high pressures allows to determine the *pVT* data [19-23]. Systems under test include highly associating mixtures of polyhydroxyalcohols such as glycerol + 1,3-butanediol, + 1-methyl- 2,4-pentanediol, + 1,5-pentanediol [14], mixtures of water + alcohols [24] as well as mixtures of glycerol + 1-butanol [14]. For such systems negative excess molar isentropic compression was observed. Also negative, but ten times less effect was observed for mixtures of two alcohols for example 1-pentanol + 1-octanol. Volumetric properties of this system was interpreted on the basis of the homomorph concept [17]. Thus the volumetric properties 1-pentanol + 1-octanol was compared with mixtures of hexane+1-octanol, 1-pentanol+nonane and The reference systems hexane+nonane. for mixtures of two associating components are the mixtures containing one associating component such as heptane + alcohols [20-23, 25-28] and cyclohexane alcohols [29-31]. molar isentropic compression decreases with increasing The excess length of the carbon chain of the alcohol. The shapes of the curves change regularly from ethanol to positive curve of the ethanol 1-decanol: the almost symmetric mixtures becomes clearly asymmetric for the mixtures of 1-propanol with alkanes. For the 1-butanol, 1-pentanol mixtures, S-shaped  $Ks^{E}$  curves are observed, for the higher alcohols, the curves become negative with small positive deviations in the alkane rich region, and for 1-octanol 1-decanol becomes negative all over the mole fraction range. While and for isomeric propanols and butanols with cyclohexane excess molar isentropic compression positive interstitial is in all mole fraction range. The

accommodation and orientational ordering of the molecules lead to a more compact structure and thereby to a decrease of the excess molar compression, while the disruption of intermolecular hydrogen bonds increases the excess molar compression. The magnitudes of the various contributions to the compressibility depend markedly on the relative molecular sizes of the components.

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## Andrzej BURAKOWSKI, Jacek GLIŃSKI

#### Simple hydrated salts in aqueous and methanolic solutions

Hydrated salts, MgCl<sub>2</sub>.6H<sub>2</sub>O, CuCl<sub>2</sub>.2H<sub>2</sub>O and EuCl<sub>3</sub>.6H<sub>2</sub>O when dissolved in methanol, conserve their original coordination numbers, probably dissociating two chloride anions (magnesium chloride), stepwise in equilibrium reactions (copper chloride) or only one Cl- (europium chloride). Water hydrating molecules are fully removed from the coordination shell only in the case of MgCl<sub>2</sub>.6H<sub>2</sub>O. The above conclusions were drawn from analyzing the acoustic and densimetric properties of the title systems and confirmed by conductivity tests. The results are compared to those in aqueous solutions.

# <u>Stella HENSEL-BIELÓWKA</u><sup>1</sup>, Żaneta WOJNAROWSKA<sup>2</sup>, Katarzyna GRZYBOWSKA<sup>2</sup>, Justyna KNAPIK<sup>2</sup>, , Edward ZORĘBSKI<sup>1</sup>, Michał ZORĘBSKI<sup>1</sup>, Marzena DZIDA<sup>1</sup>,Marian PALUCH<sup>2</sup>

<sup>1</sup>Insitute of Chemistry, University of Silesia, ul. Szkolna 9, 40-006 Katowice, Poland stella.hensel-bielowka@us.edu.pl

<sup>2</sup>Institute of Physics, University of Silesia, ul. Uniwersytecka 4, 40-007 Katowice, Poland Silesian Center for Education and Interdisciplinary Research, 75 Pulku Piechoty 1A, 41-500 Chorzow, Poland

# Primary and secondary relaxations of supercooled ionic liquids studied by broadband dielectric spectroscopy

Broadband dielectric spectroscopy is a powerful method to study relaxation dynamics of supercooled liquids and glasses. It allows for simultaneous observation of reorientational movements of dipoles and translational motions of ions. Moreover, due to very broad frequency range accessible in this method it is possible to trace both phenomena over many decades of changes starting at temperatures much higher than  $T_g$  and going down deep into the glassy state.

Ionic liquids are very interesting materials and attract great interests of both scientific and industrial society. Usually, at least one of the ions is a bulky, asymmetric, organic molecule with a pronounced dipole moment. Their twofold (ionic/dipolar) nature is reflected in the observed dynamics. In this presentation the relaxation dynamics of ionic liquids in a supercooled and glassy state obtained by means of dielectric spectroscopy will be discussed. The results will be supplemented by the data obtained with use of other experimental methods (calorimetric, ultrasonic and rheological).

## P. KOPČANSKÝ

Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, Kosice, Slovakia

### Anisotropic liquids based on liquid crystals doped by magnetic nanoparticles

Liquid crystals (LCs) are a class of soft condensed matter characterized by fluidity, a long-range orientational order and a resulting anisotropy of the physical properties. This anisotropy makes liquid crystals behave differently compared to ordinary fluids when subjected to external stresses, and thus serves as the basis for their successful commercial exploitation. Typical devices, which utilize the anisotropic optical properties of LCs, are the widely used liquid crystal displays. Liquid crystals, due to their large dielectric anisotropy, respond very sensitively to application of an external electric field, whereas they are only weakly sensitive to the magnetic field due to very low magnetic susceptibility anisotropy. A possible way of improving that sensitivity is doping LCs with magnetic nanoparticles. As a result, stable colloidal suspensions of LCs with relatively low concentrations of magnetic nanoparticles (called ferronematics, ferrocholesterics, ferrosmectics, etc.) can be produced. We will review our experimental work and theoretical analysis of obtained results of structural transitions ie Freedericksz transitions in these systems as well as in special class of lyotropic biological LCs (amyloid structures) . The influence of magnetic particles on the isotropic-nematic phase transition temperature in these fluids will be reported too

# Bogumił B.J. LINDE<sup>1</sup>, Ewa SKRODZKA<sup>2</sup>

<sup>1</sup>Institute of Experimental Physics, Gdańsk University <sup>2</sup>Institute of Acoustics, A. Mickiewicz University

#### Modal analysis of selected string instruments

Two main aims of the presented paper were to show differences in natural vibrations between two violins and guitars and to check their linearity by comparison of mechanical and optical measurements. The only intentionally introduced difference was a thickness of a back plate, varnishing etc. Some experiments were performed on front and back plates: mechanical modal analysis (version with a fixed response point) and optical measurements of plate's velocities in modal frequencies found in the first experiment (simplified modal analysis experiment with a fixed excitation point).

Thickness changes of the back plate caused changes in some modal frequencies, however first two well pronounced modal frequencies of the thicker back plate were the same as the corresponding frequencies of the thinner plate and as well as the second modal frequency of top plates. Remaining modal frequencies of the thicker plate were equal, higher or lower than the corresponding frequency of the thinner plate. Similar observation was made for top plates. From visual inspection no significant differences in mode shapes were found in modal experiment and optical measurements. Thus, instruments can be treated (with a great care) as linear systems provided modal damping is small.

#### **Eugene B. POSTNIKOV**

Research Center for Condensed Matter Physics, Kursk State University, Russia

## Theoretical premises for the usage of fluctuational approach for modeling of derived thermodynamic properties of liquids

The presentation discusses the area of applicability of the approach based on the consideration of the inverse reduced fluctuations (inverse ratio of relative volume fluctuation to its value in the hypothetical case where the substance acts as an ideal gas for the same temperature-volume parameters) [Eur. J. Phys. B, (2013) 86: 357] to the derived thermodynamic prosperities such as the isothermal and isobaric compressibilities, the speed of sound, and the isobaric expansivity.

It has been shown that the hole model, which adequately describes the coexistent saturated liquid and vapour, can be extended into single phase region; corresponding intervals of the temperature, the pressure and the density are estimated via the comparison of calculational and experimental data for organic liquids. As one of results of this analysis, it is argued that the speed of sound prediction corresponds to a special case of polynomial cut-off of the used fluctuation exponential.

#### Milan TIMKO

Institute of Experimental Physics Slovak Academy of Sciences, Watsonova 47,Kosice, Slovakia

#### The hyperthermic effect in oil based magnetic fluids

The heating ability of magnetic fluids based on various transformer oils with different density and viscosity of carrier liquid was studied. The calorimetric measurements were carried out in an alternating magnetic field up to 5 kA/m amplitude and of 500 kHz frequency. The revealed  $H^n$  law-type dependence of the temperature increase rate, (dT/dt)t=0, on the amplitude of the magnetic field indicates the presence of superparamagnetic nanoparticles in the tested samples since n = 2 for all samples. The specific absorption rate (SAR) defined as the rate of energy absorption per unit mass increases with a decrease of the volume fraction of the dispersed magnetite phase and carrier liquid density. This can be explained by the formation of aggregates in the samples with a higher concentration of magnetic particles.

#### Vyacheslav VERVEYKO, Marina VERVEYKO

Research Center for Condensed Matter Physics, Kursk State University, Radishcheva 33, 305000 Kursk, RUSSIA

## Acoustic and thermophysical properties of aromatic liquid hydrocarbons and their halogenated in a wide range of state parameters

Authors carried out the measurements of the ultrasound speed and the density for benzene, toluene, and their halogenated in the ranges of pressures 0.1 - 600 MPa and temperatures 293 - 423 K and revealed a non-linear character of obtained dependences at high temperatures and low pressures.

The introduction of halogen atoms results in a decrease of speed's derivatives with respect to the temperature and the pressure and in an increase of these derivatives from the density.

It has been found that the derivatives change rates are higher for larger molar masses, densities and critical temperatures. Moreover, the curves of the speed of sound and the density drawn along isobars and isotherms even could crosssect. Some deviations from this dependence are observed for fluorobenzene only. This phenomenon could be explained by the weakening of intermolecular interactions by fluorine atoms in a contrast to other halogens.

The adiabatic and isothermal compressibilities, the heat capacity ratio, and the internal pressure are calculated via the standard thermodynamic equalities and their complex behavior dependent on the state parameters is discussed.

This work was supported by the Ministry of Education and Science of the Russian Federation (Governmental assignment number 2014/349, project number 1437).

Abstracts Of Posters

# <u>Arkadiusz JÓZEFCZAK<sup>1</sup></u>, Błażej LESZCZYŃSKI<sup>1,2</sup>, Andrzej SKUMIEL<sup>1</sup>, Tomasz HORNOWSKI<sup>1</sup>

<sup>1</sup>Institute of Acoustics, Faculty of Physics, Adam Mickiewicz University, Poznań, Poland <sup>2</sup>NanoBioMedical Centre, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań

## A comparison between acoustic properties and heat effects in biogenic and abiotic magnetite nanoparticle suspensions

Superparamagnetic iron oxide *nanoparticles* (*SPION*) and composite materials based on them show unique properties and find many applications because of possibility to control (manipulation) them using external magnetic field. The magnetic nanoparticles are usually synthesized chemically and modification of the particle surface is necessary. Natural sources – various magnetotactic bacteria such as *Magnetospirillum magnetotacticum* are another source of magnetic nanoparticles. Biogenic magnetoparticles (magnetosomes) represent an attractive alternative to chemically synthetized iron oxide particles because of their unique characteristics and a high potential for biotechnological and biomedical applications. This work presents a comparison between acoustic properties of biogenic and abiotic magnetite nanoparticle suspensions. Ultrasonic spectroscopy offers the possibility to characterize these systems without any special sample treatment. Experimental studies have shown the influence of a biological membrane on the ultrasound properties of magnetosomes suspension. Finally the heating effect in synthetic and biogenic magnetic nanoparticles is also discussed.

This work was supported by a Polish National Science Centre grant, no DEC-2011/03/B/ST7/00194.

# <u>Alena JURÍKOVÁ<sup>1</sup></u>, Kornel CSACH<sup>1</sup>, Jozef MIŠKUF<sup>1</sup>, Natália TOMAŠOVIČOVÁ<sup>1</sup>, Zuzana MITRÓOVÁ<sup>1</sup>, Vlasta ZÁVIŠOVÁ<sup>1</sup>, Martina KONERACKÁ<sup>1</sup>, Peter KOPČANSKÝ<sup>1</sup>, Milan TIMKO<sup>1</sup>, Nándor ÉBER<sup>2</sup>, Katalin FODOR-CSORBA<sup>2</sup>, Aniko VAJDA<sup>2</sup>

<sup>1</sup> Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, Košice, Slovakia <sup>2</sup> Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Hungarian Academy of Sciences, H-1525 Budapest, P.O.B. 49, Hungary

#### Thermal stability of banana- and rod-shaped liquid crystal mixtures

Banana-shaped mesogens represent a novel class of thermotropic liquid crystals which have become targets of extensive studies in the last decade. Mixtures of suitable banana and rod-shaped molecules can form liquid crystalline phase at room temperature and thus can be useful in possible practical applications. In the work we studied phase transitions of different binary mixtures of a banana-shaped (10DClPBBC) and a rod-shaped (6OO8) liquid crystal using differential scanning calorimetry. For the binary mixture of banana-shaped molecules with 50 wt% of rod-shaped compound, the nematic to smectic transition occurred below the temperature of 40 °C and crystallization was shifted to sub-ambient temperature.

The influence of doping of the studied liquid crystals with different type magnetic nanoparticles (spherical and rodlike magnetite nanoparticles and magnetite labeled single wall carbon nanotubes (SWCNT/Fe<sub>3</sub>O<sub>4</sub>) at weight concentrations of about  $7.5 - 8.5 \times 10^{-4}$ ) on the phase transitions was studied. The most significant influence of the magnetic particle doping was observed for the melting process in the pure banana-shaped liquid crystal. The phase transition temperatures were changed with varying cooling rate (ranging from 2 to 32 K/min). It was found that crystallization was the phase transition with the lowest apparent activation energy in all studied samples of liquid crystals.

This work was supported by the projects Nos. 26220120021 and 26110230097 provided in the frame of Structural funds of the European Union.

# M. KONERACKÁ, M. KUBOVČÍKOVÁ, I. ANTAL, V. ZÁVIŠOVÁ, A. JURÍKOVÁ, J. KOVÁČ, P. KOPČANSKÝ

Institute of Experimental Physics, Slovak Academy of Sciences, Watsonova 47, Košice, Slovakia

#### Monitoring of colloidal stability of biocompatible magnetic nanoparticles

Biocompatible magnetite nanoparticles are a kind of novel materials widely used in the biomedicine. In order to implement them, the particles must have combined properties of high magnetic saturation and colloidal stability. Studied biocompatible magnetic nanoparticles consisting of magnetite nanoparticles stabilized by sodium oleate and modified by Bovine Serum Albumin were prepared and characterized by infrared spectroscopy (FTIR), magnetic measurements, scanning electron microscopy (SEM) and dynamic light scattering (DLS). The FTIR spectra confirmed sodium oleate and Bovine Serum Albumin molecules binding to magnetite. Magnetic measurements proved the superparamagnetic behaviour of magnetite nanoparticles. SEM analysis showed a narrow size distribution of spherical biocompatible nanoparticles with a mean diameter of 75 nm. DLS analysis confirmed monodispersed biocompatible nanoparticle production with DHYDR of 80 nm. To monitor colloidal stability of prepared samples the temperature induced transitions of colloidal suspensions of these nanoparticles were studied through a combination of differential scanning calorimetry (DSC), DLS and AC susceptibility measurements. In the biocompatible magnetic fluids excellent agreement was found for a transition temperature of 60oC by DLS and DCS methods. Moreover, AC susceptibility measurements indicated no aggregation, which was also apparent from the DLS results. The findings make BMNPs appear to be promising for biomedical application.

### Małgorzta MUSIAŁ, Edward ZORĘBSKI, Monika GEPPERT-RYBCZYŃSKA

# Acoustic and volumetric characteristics of binary mixtures of Ionic Liquids with alkanols

The excess speed of sound, excess molar volume and excess molar isentropic compressibility of some binary systems containing IL and alkanols at 298.15 K were calculated and analyzed. The second components were methanol, or ethanol, or 1-propanol, or 2-propanol, or 1-butanol. The properties of binary mixtures of IL with alkanols were chosen due to their popularity in literature and practical applications in separation processes. The relative excess quantities (XE/Xid), or Balankina's excess quantities, were also determined. Their meaning is often regarded in terms of reduction of structure differences between the components to the absolute excesses. The result are discussed in term of variations of alcohols or ionic liquid (of different cation and anion) and some patterns of behavior for investigated quantities with respect to IL's cation/anion or alkanol have been found. For example, it has been found observed that absolute and relative excess quantities of some groups of ILs in mixtures with the same alkanol are very similar. These results allow for opportunities to find all basic information on the behavior of similar mixtures without doing an experimental work, especially alcohols are mixed with Ionic Liquid containing if bis(trifluoromethylsulfonyl)imide anion.

# 44<sup>th</sup> Winter School on Wave and Quantum Acoustics

20<sup>th</sup> Winter Workshop on Photoacoustics and Thermal Waves Methods (PA&TWM)



#### Organizers of WSWQA 2015

Upper Silesian Division of the Polish Acoustical Society

*in cooperation with the* **Committee of Acoustics of the Polish Academy of Sciences** 

Department of Optoelectronics at Silesian University of Technology and Institute of Physics Scientific-Didactics Centre

3rd to 6th March 2015, Hotel "Meta" Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

# **20<sup>th</sup> Workshop on Photoacoustics and Thermal Wave Methods** Szczyrk 03-06.03.2015

03.03.2015 Tuesday	
13:00	Dinner
17:00-17:30	<i>Opening Lecture</i> <i>Modeling of heat transport in thermal probe – sample system by</i> <i>using electrical analogies</i> <u>J. BODZENTA</u> , M. CHIRTOC, J. JUSZCZYK
19:00	Supper
20:00-20:45	Classical Music Concert

04.03.2015 Wednesday	
13:00	Dinner
15:00-15:30	Photothermoelectric(PTE)detectionofphasetransitions.Application to triglycinesulphate (TGS)D. DADARLAT, C. TUDORAN, V. SURDUCAN, P. MISSE, E. GUILMEAU
15:30-16:00	Local thermal properties of graphene investigated by scanning thermal microscopy <u>A. KAŹMIERCZAK-BAŁATA</u> , J. BODZENTA, J. JUSZCZYK, W. STRUPIŃSKI
16:00-16:30	Symmetrical photoacoustic Helmholtz cell with counterphase light stimulation <u>T. STARECKI</u> , S. PANECKI
16:30-17:00	Coffee break
17:00-18:00	Poster session
19:30	Festive Supper (Banquet)

05.03.2015 Thursday	
13:00	Dinner
15:30-16:00	Photodeflection Response of Gyrotropic Superlattice with Excitation of Sound by Bessel-Gaussian light Beam
	<u>G. S. MITYURICH</u> , V. V. KOZHUSHKO, E. V. CHERNENOK, A. N. SERDYUKOV

16:00-16:30	Numerical simulations and experimental results of quantitative SThM measurements for thin layer samples
	<u>J. JUSZCZYK</u> , J. BODZENTA
16:30-17:00	Coffee break
17:00-17:30	Photothermal Measurements of the Sulfur Influence on ZnSSe Mixed Crystals
	<u>J. ZAKRZEWSKI</u> , K. STRZAŁKOWSKI, F. FIRSZT, M. MALIŃSKI
19:00	Supper

06.03.2015 Friday		
8:00	Breakfast	

#### POSTER SESSION

# Simultaneous measurement of thermal diffusivity and Seebeck coefficient for thermoelectrics by lock-in thermography

M. STREZA, M. DEPRIESTER, D. DADARLAT, K. TOUATI, K. STRZALKOWSKI,

E. GUILMEAU

# Determination of thermal parameters of CuFeInTe3 thin films by optimized beam deflection technique

D. KORTE, H. CABRERA, M. FRANKO

A photopyroelectric comparative study on diesel fuel, chemical biodiesel and a new biodiesel fuel obtained by cold plasma assisted transesterification technology

C. TUDORAN, <u>D. DADARLAT</u>

Influence of the imbalanced light irradiation on the properties of a symmetrical photoacoustic Helmholtz cell with counterphase light stimulation

<u>A. GERAS</u>, T. STARECKI

ABSTRACTS OF LECTURES
## Jerzy BODZENTA<sup>1</sup>, Mihai CHIRTOC<sup>2</sup>, Justyna JUSZCZYK<sup>1</sup>

 <sup>1</sup> Institute of Physics-CND, Silesian University of Technology, Konarskiego 22B, Gliwice 44-100, Poland
 <sup>2</sup> Multiscale Thermophysics Lab GRESPI-CATHERM, Universite de Reims Vhampagne-Ardenne URCA, Reims, France

# Modeling of heat transport in thermal probe – sample system by using electrical analogies

A planning of experiment and proper analysis of its potentialities for determination of sample parameters require a model of processes occurring in experimental setup. In case of thermal measurement a heat transport in the sample – probe system must be described. The thermal model of a nanofabricated thermal probe (NTP) used in scanning thermal microscopy is proposed. A starting point for building the model was analysis of heat fluxes in the system based on numerical modeling by finite element method. The heat exchange channels between electrically heated probe, a sample and their surroundings were considered. Three zones in the probe-sample system were distinguished. Because of complexity of the system electrical analogies of heat flow were used. As a result the system was represented through a chain of quadrupoles built from thermal resistances and thermal capacitances. It allows derivation of the analytical transfer functions of the system. It is shown that in most cases reduced chain of two thermal quadrupoles with merged RC elements is sufficient for thermo-electrical modeling of the complex architecture of a NTP, with a minimum of independent parameters (two resistance ratios and two time constants). The validity of the model is confirmed by comparing computed values of discrete RC elements with results of finite element simulations and with experimental data.

## <u>Dorin DADARLAT<sup>1</sup></u>, Cristian TUDORAN<sup>1</sup>, Vasile SURDUCAN<sup>1</sup>, Patrick MISSE<sup>2</sup>, Emmanuel GUILMEAU<sup>2</sup>

 <sup>1</sup> National R&D Institute for Isotopic and Molecular Technologies, Donat Str. 67-103, Cluj-Napoca, Romania
 <sup>2</sup> Laboratoire CRISMAT, UMR6508 CNRS/ENSICAEN, 6bd Marechal Juin, 14050Caen Cedex 4, France

#### Photothermoelectric (PTE) detection of phase transitions. Application to triglycinesulphate (TGS).

A recently introduced photothermal method, the photothermoelectric (PTE) calorimetry is proposed in order to detect phase transitions. The detection configuration is the back one (BPTE) with sample optically opaque and sample and TE sensor thermally thick. In such a configuration, the information can be collected from both amplitude and phase of the BPTE signal, but the amplitude has as main feature the possibility of amplifying the critical anomaly of the thermal parameters. Using this method, the ferro-paraelectric phase transition of TGS, tacking place at about 49<sup>o</sup>C, was investigated. Comparison with photopyroelectric (PPE) method (applied in the same detection configuration) is performed.

## Justyna JUSZCZYK<sup>1</sup>, Jerzy BODZENTA<sup>1</sup>

<sup>1</sup>Institute of Physics, Silesian University of Technology, Krzywoustego 2, 44-100 Gliwice, Poland

#### Numerical simulations and experimental results of quantitative SThM measurements for thin layer samples

Scanning Thermal Microscopy (SThM) is a technique used to investigating local thermal properties. Application of nanofabricated thermal probes (NThP) with thin-film resistive temperature sensor ensures high spatial and thermal resolution. One of the problems associated with the use of SThM for quantitative measurements is the lack of a satisfactory model describing processes occurring in the probe – sample system. This is especially important for NThP, for which the complex geometry does not allow the creation of even approximate analytical description. In this case an interesting tool for the analysis of processes in the probe – sample system is the finite element method (FEM).

We present the probe-sample FEM model allowing accurate modeling of the basic physical processes occurring during the measurement. It enables an estimation of the dynamic range of signal changes, determining the highest sensitivity regime, and analyzing the potential sources of errors.

In this work we present the results of numerical simulations of SThM measurements of thin layer samples. Simulations mainly concern the influence of various factors, such as the type of substrate, the thickness and thermal conductivity of the layer, on the SThM signal. In the case of sub-micron layer thickness the thermal properties of the substrate influence the apparent thermal conductivity obtained directly from experimental data. Based on the results obtained from the simulation, a general procedure has been developed which allows the correction of "primitive" thermal conductivity value obtained in the experiment, taking into account the thickness of the investigated layer. Experimental results carried out for  $SiO_2$  and  $BaTiO_3$  thin layers complement the numerical analysis.

# <u>Anna KAŹMIERCZAK-BAŁATA<sup>1\*</sup></u>, Jerzy BODZENTA<sup>1</sup>, Justyna JUSZCZYK<sup>1</sup>, Włodzimierz STRUPIŃSKI<sup>2</sup>

<sup>1</sup> Institute of Physics-CND, Silesian University of Technology, Konarskiego 22B, Gliwice 44-100, Poland
<sup>2</sup> Institute of Electronic Materials Technology, Wólczyńska 133, 01-919 Warsaw, Poland
\*Corresponding author: Anna Kaźmierczak-Bałata, akazmierczak@polsl.pl

# Local thermal properties of graphene investigated by scanning thermal microscopy

A Scanning Thermal Microscopy (SThM) was used to examine graphene deposited on SiC substrate. The graphene layers were deposited on insulating and conductive SiC substrates by the CVD method. This commonly used technique is applied to produce high quality thin films or solid materials, and is less sensitive to SiC surface defects in comparison to the epitaxial growth of graphene by Si sublimation. A reference sample of SiC was also measured.

The local thermal properties of graphene were determined by thermal imaging according to modified SThM. The measurements were realized using a standard XE-70 AFM (Park Inc.) equipped with the thermal module and data access module. The resistance KNT-SThM-1an thermal probe (Kelvin Nanotechnology) was used in the experiment. The probe was driven by DC current and with a small AC component imposed on it. The amplitude of AC component was about 5% of the DC current value (1.5 mA). The measurements were performed at constant frequency equal to 190 Hz. The probe voltage signals proportional to the amplitude and phase components were measured with a lock-in amplifier (SR 830 DSP, Stanford Research) and then were used for thermal imaging.

#### <u>George S. MITYURICH</u>, Victor V. KOZHUSHKO, Ekaterina V. CHERNENOK, Anatoliy N. SERDYUKOV

#### Photodeflection Response of Gyrotropic Superlattice with Excitation of Sound by Bessel-Gaussian light Beam

The investigation of superlattices, which consist of the periodically repetitive layers of nanosized thickness, is in the focus of numerous researchers [1-3]. These layered structures can reveal the effects of the spatial dispersion such as natural and induced (Faraday's effect) optical activity, natural and magnetic circular dichroism. The examples of these structures are one-dimensional magnetophoton crystals and films based on the ferrite garnets [4-5], which are used for the optimization of the microresonator structures in the devices of magnetophotonics and plasmonics.

This paper considers the features of the excitation of photodeflection signal in naturally gyrotropic superlattice when it is irradiated by TE-polarized mode of Bessel-Gauss light beam (BGLB). It is shown that an angle of the obliquity of axicon, which is responsible for the forming of the spatial structure of the light beam, extremely appreciably influences the photodeflection response. The using of the axicons with adjustable angle of obliquity or application of the optical scheme with tunable obliquity of quasi-diffraction-free light beams allows realization of the methods of the control of the magnitude of the photodeflection signal. The further development of the methods of control of the processes of the photodeflection transformation with employment of BGLB is very promising for the nondestructive testing and diagnostics of low-dimensional structures, including the media possessing gyrotropy.

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#### **Tomasz STARECKI**, Szymon PANECKI

# Symmetrical photoacoustic Helmholtz cell with counterphase light stimulation

In the presentation we discuss design and operation of a symmetrical photoacoustic Helmholtz cell in which counterphase light stimulation was applied. Basic physical background and models which describe properties and behaviour of the cell are presented. It turns out that use of symmetrical structure and counterphase light stimulation results not only in increase of the photoacoustic signal, but also in narrowband filtering properties of the cell.

#### <u>Jacek ZAKRZEWSKI</u>, Karol STRZAŁKOWSKI, Franciszek FIRSZT, Mirosław MALIŃSKI

#### Photothermal Measurements of the Sulfur Influence on ZnSSe Mixed Crystals

Photothermal spectroscopy has found the wide range of application as a method of monitoring nonradiative recombination of excited carriers generated by optical absorption in semiconductors. One of them is surface quality monitoring after different procedure of sample preparation. Mechanical, chemical and thermal treatment of surface can create the damaged subsurface layer which introduces additional defects states in the material. The paper presents results of both experimental and theoretical piezoelectric studies of ZnSSe crystals for different method of surface preparation and different content of sulfur. The investigated crystals were grown by the high pressure Bridgman method under argon overpressure. The obtained crystals were cut into 1-1.2 mm thick plates and mechanically grounded, polished and chemically etched. The influence of sulfur content and preparation method on the amplitude and phase spectra are observed. The quantitative analysis of the photothermal piezoelectric spectra was performed using a modified Blonskij model. Numerical analysis of the amplitude and phase spectra, identification of the surface defects and the thickness of damaged layer.

Thermal diffusivities of the investigated specimens have been determined by means of photopyroelectric technique. Measurements were performed in the back configuration, where the modulated laser beam illuminates the sample placed onto the sensor.

Abstracts Of Posters

#### Cristian TUDORAN, Dorin DADARLAT

National R&D Institute for Isotopic and Molecular Technologies, Donat Str. 67-103, Cluj-Napoca, Romania

### A photopyroelectric comparative study on diesel fuel, chemical biodiesel and a new biodiesel fuel obtained by cold plasma assisted transesterification technology

A comparative study of the thermal properties (specific heat, thermal conductivity, diffusivity and effusivity) of standard mineral diesel fuel, a biodiesel fuel processed by chemical transesterification and a biodiesel fuel obtained by a transesterification reaction assisted by cold plasma is performed. The thermal parameters have been measured using the photopyroelectric (PPE) technique, which allows to directly measuring the thermal diffusivity and effusivity; the remaining two thermal parameters were calculated using standard relationships.

The biodiesel fuel sample obtained by cold plasma assisted transesterification was processed in our patented reactor system in which the methyl-ester is obtained from a primary mixture of methanol and vegetable oil without any kind of chemical catalyst substances.

The room temperature values of the thermal parameters for our biodiesel fuel (processed in our cold plasma reactor) are similar with the values of the other two samples: mineral diesel fuel and chemical biodiesel fuel. This first step confirms that the biodiesel fuel obtained by cold plasma assisted transesterification is very compatible with the standard diesel fuel and can be used as an alternative eco-friendly option.

# M. STREZA<sup>1\*</sup>, M. DEPRIESTER<sup>2</sup>, <u>D. DADARLAT<sup>1</sup></u>, K. TOUATI<sup>2</sup> K. STRZALKOWSKI<sup>3</sup>, E. GUILMEAU<sup>4</sup>

 <sup>1</sup> National Institute for Research and Development of Isotopic and Molecular Technologies, 65-103 Donath Str., 400293 Cluj-Napoca, Romania
 <sup>2</sup> ULCO, UDSMM (EAC CNRS 4476), MREI-1, 59140 Dunkerque, France
 <sup>3</sup> Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University, Grudziadzka 5, 87-100 Torun, Poland
 <sup>4</sup>Laboratoire de Christallographie et Sciences des Materiaux, Universite de Caen, France
 \* streza.mihaela@gmail.com

#### Simultaneous measurement of thermal diffusivity and Seebeck coefficient for thermoelectrics by lock-in thermography

Thermal energy is the highest source of wasted energy. Thermoelectrics offer the possibility to capture this energy and to convert it into electrical energy through Seebeck effect. Thus, the Seebeck coefficient along with thermal and electrical conductivity measurements are of paramount importance in order to get thermoelectric materials exhibiting a high figure of merit.

Since the thermal contact between a solid sample and a sensor is a problem, noncontact methods are often preferred. Modern IR cameras based on quantum detectors provide very fast and accurate temperature measurements of an object located in the sensors' field of view.

The aim of this work is to simultaneously measure the thermal diffusivity and Seebeck coefficient for TiS<sub>3</sub> and Bi<sub>2</sub>Te<sub>2.4</sub>Se<sub>0.6</sub> crystals at room temperature by lock-in thermography technique. The thermal diffusivity values are  $\alpha$ =11.8x10<sup>-7</sup>m<sup>2</sup>/s for TiS<sub>3</sub> and  $\alpha$ =9.5x10<sup>-7</sup>m<sup>2</sup>/s for Bi<sub>2</sub>Te<sub>2.4</sub>Se<sub>0.6</sub>. The Seebeck coefficient values are about S≈-700µV/K for TiS<sub>3</sub> and respectively S≈-300µV/K for Bi<sub>2</sub>Te<sub>2.4</sub>Se<sub>0.6</sub>.

To validate the results obtained from lock-in thermography concerning the thermal parameters, the thermal diffusivity and effusivity of these samples were also investigated by IR radiometry. Both measurement techniques lead to similar results. One benefit of IR radiometry is that this technique is able to provide information regarding the thermal conductivity of the samples once the thermal diffusivity and effusivity are obtained.

#### Antonina GERAS, Tomasz STARECKI

# Influence of the imbalanced light irradiation on the properties of a symmetrical photoacoustic Helmholtz cell with counterphase light stimulation

Design of the symmetrical photoacoustic Helmholtz cell with counterphase light stimulation assumes that both cavities of the cell are irradiated with identical light intensity. The presentation shows how properties of the cell are influenced by the imbalance of irradiation of the cavities.

#### Dorota KORTE, Humberto CABRERA, Mladen FRANKO

#### Determination of thermal parameters of CuFeInTe<sub>3</sub> thin films by optimized beam deflection technique

Semiconductor materials, due its unique optical and electronic properties, are promising materials for many applications especially as electronic and optoelectronic devices. These properties can be further improved by making composite of their different kinds and/or metal particles.<sup>1</sup> In such a way advanced materials with multiple functionalities stemming from the unusual materials combinations are achieved.

CuFeInTe<sub>3</sub> are direct gap semiconductor, which band gap is around  $E_g = 1$  eV. Although its optical and electrical properties are relatively well known,<sup>2-3</sup> their thermal properties have barely been investigated, even though they play a significant role in the cooling of electronic systems and are the integral components of the overall thermal management process, especially in times when there is constant push for minimizing the size of electronic devices and maximizing the speed of their operation. What is more, the transition from macro- to micro scale requires to consider its effect on material's thermal properties since the assumption of being bulk ones is not accurate any more.<sup>4</sup>

The purpose of this work was to investigate the thermal properties of  $CuFeInTe_3$  thin films by beam deflection spectroscopy (BDS) coupled to multiparameter fitting of a theoretical model to the experimental data.<sup>5</sup> The theoretical description was performed by the use of complex geometrical optics equations<sup>5</sup> and takes into account the deflection of the probe beam on the refractive index gradients and its phase change due to the change of its optical path. What is more, the experimental condition were optimized by putting the sample into liquid solution with low thermal conductivity, thanks to which the enhancement factor of the system was increased and thus the determination sensitivity was improved.

As conclusion it should be mention that when developing new materials with better optical and electrical properties or enhancing already existing ones, an attention must be also paid to their thermal parameters since they determine the effectiveness of thermal management in electronic devices what is especially important in times when device power dissipation in on steady rise.

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