46th Winter School on Wave and Quantum Acoustics

PROGRAMME and ABSTRACTS

Organizers of WSWQA 2017

Upper Silesian Division of the Polish Acoustical Society

in cooperation with the

Committee of Acoustics of the Polish Academy of Sciences

27th February to 2nd March 2017,
Hotel "META"
Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

Dear Participants,

of 46th WINTER SCHOOL on WAVE and QUANTUM ACOUSTICS 2017.

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

The 46th Winter School consists of:

- 13th Workshop on Acoustoelectronics;
- 13th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods.

We wish all Participants of the 46th Winter School plenty of scientific satisfactions and many professional and social impressions.

Organizers

This book contains Programmes of both Workshops and summaries of works which will be presented within 46th WINTER SCHOOL on WAVE and QUANTUM ACOUSTICS 2017.

46th Winter School on Wave and Quantum Acoustics

13th Winter Workshop on Acoustoelectronics (AE)

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PROGRAMME OF THE 13TH WORKSHOP ON ACOUSTOELECTRONICS

27.02.2017 Monday	
13:00	**DINNER**
14:15-14:30	**OPENING CEREMONY of the 46th WSW&QA Conferences and 12th IOS'2017**
14:30-15:00	**45th anniversary of the Winter School on Environmental Acoustics and Vibroacoustics**
15:00-16:20	**THE SESSION DEDICATED TO THE MEMORY OF PROFESSOR EUGENIUSZ JAN DANICKI**
15:00-15:20	**MEMORIES**
15:20-15:40	**An advanced technology for radar signal processing - the review** A. KAWALEC
15:40-16:00	**Determination of Some Kinetic Parameters of Fast Surface States in Semiconductors by Means of the Surface Acoustic Wave Method** T. PUSTELNY
16:00-16:20	**Seismometer based on Surface Acoustic Waves transducers** J. FILIPIAK
16:20-17:00	**Coffee break**
	SESSION SHARED WITH IOS'2017
17:00-17:30	**Novel photonic and quantum devices exploiting nonlinear and coherence phenomena in color centers in diamond** W. GAWLIK, M. FICEK, M. MRÓZEK, R. BOGDANOWICZ
17:30-17:50	**Micro-cavity in-line Mach-Zehnder interferometers for small-volume and high-sensitivity refractive-index sensing** A. K. MYŚLIWIEC, M. JANIK, M. KOBA, W. J. BOCK, M. ŚMIETANA
17:50-18:10	**Last advances in integrated planar optical waveguide interferometers** K. GUT
18:30	**REGIONAL SUPPER**
19:30-20:30	**Sleigh ride – group 1**
20:30-21:30	**Sleigh ride – group 2**

28.02.2017 Tuesday	
13:00	DINNER
15:20-15:50	**Comparative analysis of the results of snowfall level measurements performed using ultrasonic aerolocation method in real conditions in different climatic areas** T. GUDRA, D. BANASIAK, K. HERMAN, K. OPIELIŃSKI
15:50-16:10	**Ultrasound Tomography: Results of Breast Phantom Imaging** K. OPIELIŃSKI, P. PRUCHNICKI, M. WRZOSEK, J. NICPOŃ, P. PODGÓRSKI
16:10-16:30	**Project of SODAR with phased array antenna** T. ROGALA, A. KAWALEC
16:30-17:00	**Coffee break**
17:00-17:20	**Ultrasonic welding generator for frequency range from 16 to 60 kHz** W. KARDYŚ, A. MILEWSKI
17:20-17:40	**A wideband ultrasonic imaging sonar system** P. SERAFIN, M. OKOŃ-FĄFARA, M. SZUGAJEW, C. LEŚNIK, A. KAWALEC
17:40-18:00	**Prototype of wideband ultrasonic sonar based on STM32** M. OKOŃ-FĄFARA, A. KAWALEC, B. FĄFARA
19:30	**Festive Supper (Banquet)**
01.03.2017 Wednesday	
13:00	DINNER
15:30-15:50	**Acoustic emission testing of storage tanks** A. OLSZEWSKA
15:50-16:10	**Application of a Phase Resolved Partial Discharge Pattern Analysis for Acoustic Emission Method in High Voltage Insulation** M. KUNICKI, A. CICHOŃ
16:10-16:30	**Application of ADC and ADP descriptors to identify the acoustic emission signals generated by the partial discharges** G. SZERSZEŃ, F. WITOS
16:30-17:00	**Coffee break**
17:00-17:20	**Low temperature catalytic hydrogen SAW sensor** K. JASEK, M. PASTERNAK, M. GRABKA
17:20-17:40	**Experimental and numerical analysis of the response in non-steady response step and steady stage of a SAW structure with PANI+Nafion on action of carbon monoxide** T. HEJCZYK

17:40	**Closing Ceremony of 13th Winter Workshop on Acoustoelectronics 2017**
19:00	SUPPER
19:30-21:30	**POSTER SESSION** **Using clustering methods for the identification of acoustic emission signals generated by the selected form of partial discharge in oil-paper insulation** S. BORUCKI, J. ŁUCZAK, D. ZMARZŁY **Characterization of acoustic emission signals generated by partial discharges in high voltage current transformers** A. CICHOŃ **Simulation of infrasound waves emitted by wind turbine** D. WOTZKA
02.03.2017 Thursday	
8:00	BREAKFAST

ABSTRACTS
FOR 13TH WORKSHOP ON ACOUSTOELECTRONICS

Using clustering methods for the identification of acoustic emission signals generated by the selected form of partial discharge in oil-paper insulation

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The article presents the results of the use of clustering methods (cluster analysis) to identify the signals of acoustic emission (AE) generated by partial discharge (PD) in the paper-oil insulation. As part of the research qualitative analysis the following clustering methods of the registered AE signals were used: method of single bond (Single linkage), the full bond method (Complete linkage), the secondary connections method (Average linkage), the centroid method (Centroid linkage) and Ward's method (Ward linkage). The objective of the analysis was to find a test measurement of the series AE signals, derived from the different forms of PD elements, forming the aggregates (clusters), where in terms of a particular characteristic or established criteria for the components are as similar as possible and at the same time up other than in the other groups. Then, on the basis of clustering attempted, the evaluation of the effectiveness identification of the particular PD forms generated in power transformer paper-oil insulation system was made. Appropriate analyzes and simulations were performed using the computing environment Matlab and available in this environment of the clustering procedures. As part of the study analyzed the results of series AE signals generated of the basic PD forms, which were obtained in laboratory conditions using spark gaps modeling the defects of the power transformers insulation systems.

Characterization of acoustic emission signals generated by partial discharges in high voltage current transformers

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High voltage current transformers (HVCT) are commonly used apparatus in electrical power distribution systems. HVCT insulation system design is quite complex. High voltage and grounded parts are separated by porcelain insulation. Inside of the porcelain there are windings covered with an oil paper insulation, furthermore a proper electric field distribution is provided by some additionally mounted electrodes. Due to insulation system ageing process some degradation of dielectrics may occur which usually leads to local partial discharge (PD) generation. Various combustible gasses production is accompanied by PD generation as well as a significant pressure increase may also be noticed inside of a HVCT. In some exceptional circumstances an internal pressure may exceed a critical value and a porcelain insulator may explode thus a fire of the entire insulation system is also possible.

Laboratory measurement results on the J110-4a type HVCT with nominal voltage of 110 kV are presented in the paper. A severe insulation system fault is detected during research. An acoustic emission (AE) method is applied for PD source detection and localization measurements. Some exemplary AE signals generated by internal PDs during various supply voltage levels are registered by wideband piezoelectric AE joint sensor mounted on the porcelain insulator surface. Selected fundamental descriptors of AE signals in time, frequency and time-frequency domain are applied for detailed source signals characterization. Apart from AE measurements, additionally an electrical method PD measurements are proceeded simultaneously. Finally, presented results may also be taken as a benchmark for further measurements on apparatus under normal on-site operation conditions.

Seismometer based on Surface Acoustic Waves transducers

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The paper will be presented the concept of a seismometer based on surface acoustic waves (SAW). The base of the system design are three SAW transducers arranged along three orthogonal axes. Each transducer is composed of two SAW delay lines. The seismometer consists of high frequency generator, phase detector and three SAW transducers. It allows to measure constant and time dependent accelerations in three orthogonal directions with the operating band up to 150Hz. We will show an analysis of main system parameters i.e. amplitude frequency response, resonant frequency and sensitivity including cross-sensitivity. We will discuss temperature influence on these parameters, also. We will present experimental results of the seismometer transducer and compare them with theory.

Currently used seismometers in seismology, mine seismology and reflection seismology are design based on system of mechanic pendulums. We will compare these systems with presented above in terms of technical performance, prices and installations.

Comparative analysis of the results of snowfall level measurements performed using ultrasonic aerolocation method in real conditions in different climatic areas

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This paper addresses the problem related to the interpretation of the results of actual snowfall measurements performed with two different configurations of the compensation methods for changeable climatic conditions. The paper also presents the operating principle of an ultrasound sensor for monitoring snow layer (on the air-side). In particular, the paper includes a graphic representation of the results of measurements performed in measurement stations located in Poland and at Spitsbergen. The two compensation methods (temperature and parametric) were tested for their effectiveness in different, changeable climatic conditions. The measurement results confirm that the applied compensation methods are useful in minimizing the measurement error for snow layer thickness measured on the air-side.

Novel photonic and quantum devices exploiting nonlinear and coherence phenomena in color centers in diamond

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The color center may couple an electron to become negatively charged (SiV– or NV–) with spin S=1. The nonzero spin is responsible for paramagnetic properties of the center. The vacancies may be created in diamond powders or in a bulk CVD or HTHP diamond. Due to photo-conversion between the charged and neutral forms of the center and its light-power dependence, the NV centers are very attractive for applications in various quantum devices. However, there is a serious problem of their coupling with photonic cavities or other devices. These issues are investigated by research teams in Oxford, Berkeley, MIT, Melbourne, Ulm, Mainz. Recently the Oxford - Grenoble-Alpes group demonstrated efficient coupling between the NV centers in open Fabry-Perot cavities at 77 K [1]. Recently. the Melbourne team demonstrated coupling of NV spherical micro-resonator of a high Q-factor with nanodiamond integrated in tellurite glass [2].

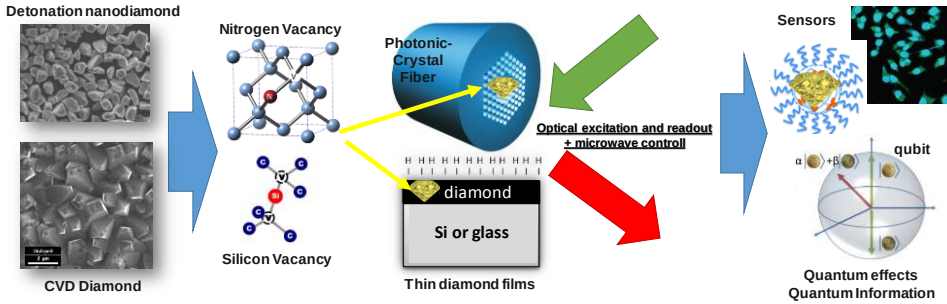

Fig. 1. The photonic and quantum devices based on color centers in diamond.

The main objectives of this study is development of new technological solutions for the creation of photonic structures and quantum devices based on color centers in diamond (Figure 1) and to develop novel dedicated spectroscopic methods for studying their optical and microwave properties. Moreover, we intend to investigate the application perspectives of the achieved results and technological potential for

development of novel sensors based on nonlinear and quantum optics (biosensors/biomarkers, quantum information processing and quantum cryptography).

The proposed method relies on synthesis of diamond with integrated color centers and/or synthesis of photonic fibers with NV centers and has not been used by any other team. It will be developed in two directions: (i) filling the PCF fiber with DND-NV suspensions and (ii) synthesis of PCF fiber precoated with DND-NV suspensions (empty PCF and NVs in the fiber walls) [3]. The sample characterization will be based on optical (absorption, emission, Raman) and microwave spectroscopy with high spatial (confocal, ~µm3) and spectral (sub-Hz) resolution. The measurements will be performed using a technique of optical detection of magnetic resonance (ODMR) improved by development of the microwave hole burning technique [4].

The development and applications of quantum technologies and nonlinear spectroscopy for studies of color centers in diamonds is very fast. Thanks to the stable crystallographic and electron structure of diamond, NV-color centers exhibit very stable electronic spectra, not much sensitive to various perturbations. Their excellent optical and spin properties (paramagnetism) allow one to use different resonance and spintronic methods of and enable precision metrology.

This work was supported by the Polish National Science Centre (NCN) under the Grants No. 2014/14/M/ST5/00715 and 2016/21/B/ST7/01430. The DS funds of Faculty of Electronics, Telecommunications and Informatics of the Gdansk University of Technology are also acknowledged.

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Last advances in integrated planar optical waveguide interferometers

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In the group of optoelectronic application of planar waveguide structures in metrology with respect to the possibility of realizing metrological system a high, and even very high sensitivity considerable role is played by interference systems [1]. According to the opinion of one of the leaders of modern optoelectronics (photonics) - prof. Paul Lambeck in terms of practical applications interferometers can be divided into the following [2] :

- Mach–Zehnder interferometer;
- Young interferometer;
- Michelson interferometer;
- difference interferometer.

In all these systems, we are dealing with overlapping (interference) of two electromagnetic waves with a visible spectral range, propagate through the waveguides. Changing the conditions of propagation of optical circuits revealed a change in velocity - as a result of the change of the phase difference of interfering beams.

Relatively recently it proposed distribution a division of waveguide interferometers system into common and double path ones [3] (single channel and two channel ones [4]). In his paper differential interferometers I consistently described as common path interferometers.

In a typical double path waveguide interferometer mode of the same order and polarization propagates along two laterally separated path: measured path (where the measuring agent affects the phase) and the reference path (which is isolated of this effect). The recorded signal inform about a change in the phase affected by factor of measurements (cover).

In a common path interferometer the waveguide mode propagate along one path and the measurement factor affects the phase of all the guided modes. The modes may differ in the state of polarization (TE, TM) or the order (TE_0, TE_1, TM_0, TM_1, ..). In such systems, it is important that there be as large as possible a difference in sensitivity between modes selected for interference.

Interferometers of this type constitute the base of constructing many kinds of sensors of physical, chemical and biological [3] quantities. Usually in investigations the waveguide structure is optimized in order to get the highest differential sensitivity.

An interesting solution permitting a magnification of even some hundred times is the application of an additional layer with a thickness of some scores of nanometers (with a high index of refraction), deposited on the waveguide

As described above, the structures it analyzed phenomenon of common path interference for one wavelength. The signal recorded by the detector is a function of the sine of the phase difference between modes (because it is a periodic function, there are such differences in the phase at which the light intensity at the output is the same). In 2008 published a work in, which describes spectropolarimetric common path interference in planar waveguide structure [5]. In the waveguide was excited mode both polarizations of the entire range of visible wavelengths and at the output of the spectrometer recorded broadcast spectrum.

Monotonic change of phase (between mods) causes monotonic shift of the recorded the spectral distribution. This method of detection also used in planar double path interferometers [6,7].

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Experimental and numerical analysis of the response in non-steady response step and steady stage of a SAW structure with PANI+Nafion on action of carbon monoxide

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The paper presents the results of numerical analyses of the SAW gas sensor in the steady and non-steady in response state. The effect of SAW velocity changes vs. the surface electrical conductivity of the sensing layer is predicted. The conductivity of the porous sensing layer above the piezoelectric waveguide depends on the profile of the diffused gas molecule concentration inside the layer.

Numerical results for the gas CO for layer (Polyaniline) PANI+Nafion in the steady state and non-steady state in response step have been shown. The main aim of the investigations was to study thin film interaction with target gases in the SAW sensor configuration based on diffusion equation for polymers. Numerical results for profile concentration of the response in non-steady state use Finite Difference method have been shown.

The results of numerical analyzes allow to select the sensor design conditions, including the morphology of the sensor layer, its thickness, operating temperature and layer type. The numerical results basing on the code written in Python, are described and analyzed. The theoretical results were verified and confirmed experimentally.

Low temperature catalytic hydrogen SAW sensor

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Hydrogen is used as a reducing agent and a carrier gas in the various technological processes. It is also known as an ecologic fuel and highly explosive gas. For this reasons the need for constructing a sensor for fast, selective and highly sensitive hydrogen detection at room or near room temperature is still topical. A number of different kinds of hydrogen sensors have already been developed. The devices are based on various physical phenomena; hydrogen particles change mechanical, thermal, electrical, optical or acoustical properties of the detector.

In the paper a new kind of sensitive film for surface acoustic wave (SAW) hydrogen sensing is proposed. The film is based on Nafion® matrix containing electrosprayed platinum particles. It utilises catalytic hydrogen oxidation; water produced as a result of this process is absorbed via Nafion sulfonate groups and this causes both mechanical and electrical changes of film properties influencing the SAW parameters.

A laboratory model of sensor was fabricated based on two-port resonator structure on quartz STX substrate working at operating frequency of about 197 MHz and electrosprayed thin Nafion/Pt film. The device was tested using a dedicated electronic system and a gas chamber with temperature and gas-flow control. The obtained results show that at temperatures over 40°C the sensor is highly sensitive to low concentration of hydrogen and it exhibits very fast response, good sensitivity and short-term repeatability.

Ultrasonic welding generator for frequency range from 16 to 60 kHz

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The paper presents high power ultrasonic generator for welding and cutting processes developed by Tele & Radio Research Institute. The device is used for manufacturing various products such as: PE pipes with aluminum insert, battery packs, car components, trowels, dust masks, corner beads and many other. The new generator can provide up to 5 kW of electrical power to ultrasonic transducer in frequency range from 16 kHz up to 60 kHz with regulation step down to 0.1 Hz. The device utilizes innovative microcontroller with built-in high resolution timing blocks that enable direct synthesis of control signals for generator's resonant converter without the need of external DDS unit or programmable device. This new approach to designing ultrasonic generators can benefit in greater flexibility and reliability of the device. New algorithms with cycle by cycle parameter control and precise regulation of output frequency and power delivery have been developed. Various parameters of ultrasonic stack such as impedance and resonant frequency are measured by the generator in real time and can be used to diagnose the stack and detect its damages.

An advanced technologies for radar signal processing - the review

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The selected applications of the surface acoustic wave devices in the area of the signal processing are presented. The analysis of the surface acoustic wave (SAW) filter is described in the paper. In the analysis based on the spectral theory is taken into account. The analysis of the effective surface permittivity significantly simplifies the theoretical analysis of the interdigital transducer. The calculation of the complex effective surface permittivity can be used to estimate the band of the possible (undesirable) bulk waves. The synthesis of the dispersive line based on the theoretical analysis results is presented. The experimental characteristics for the quartz based dispersive line as an application for the radar signal processing is demonstrated. Dispersive delay lines can be applied in chirp pulse compression system characterized low side-lobe level and in SAW spectrum analyser as well.

The paper is dedicated to the memory of Professor Eugeniusz Danicki.

Application of a Phase Resolved Partial Discharge Pattern Analysis for Acoustic Emission Method in High Voltage Insulation Systems Diagnostics

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An acoustic emission (AE) method is widespread and willingly applied in high voltage insulation systems diagnostics, especially in fields of partial discharge (PD) source detection and localization. According to contemporary applied techniques, an alternative method for PD generated AE signals analysis based on a correlation between voltage phase run and AE pulses, so-called phase resolved PD pattern (PRPD), is presented in the paper. PRPD pattern is a well-known analysis tool commonly used in such PD diagnostic methods as conventional electrical method as well as UHF method. Moreover it yields various signal analysis abilities and allows a direct correlation indication between measurement results achieved using different methods. An original PRPD measurement methodology applied for AE method as well as some exemplary measurement results and further data analysis capabilities are announced in the paper. Also a comparative analysis of PRPD patterns achieved using various measurement methods and different PD source configurations is investigated in the research. All presented experiments are proceeded under laboratory conditions.

The main purpose of the presented research is to indicate an all-embracing analytical tool that yields an ability to AE measurement results direct comparison (qualitative as well as quantitative) with other commonly applied PD measuring methods. Presented results give a solid fundamental for further research works concerned with a direct correlation method for AE and other described in the paper diagnostic methods, mainly in order to PD phenomena analysis and assessment in real-life high voltage apparatus insulation systems under normal on-site operation conditions.

Micro-cavity in-line Mach-Zehnder interferometers for small-volume and high-sensitivity refractive-index sensing

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High refractive index (RI) sensitivity typically requires large sensing surface and does not allow for spatially high-definition sensing. A solution to this instance may be sought in highly sensitive in-fiber RI sensors capable of investigating possibly small volumes of liquids. To meet these needs many sensors based on the Mach-Zehnder Interferometer (MZI) principle have been proposed, where the cavity is most commonly micro-machined using femtosecond laser. Generally, in such a micro-cavity in-line MZI (µIMZI) structure, a beam of light in the fiber core encounters two optically different regions at which it tends to superpose. In the sensing configuration, the two regions might be looked at as two paths where one is a sensing path (the micro-cavity path), and the other one is a reference path (the fiber core path) [1].

The structures in a form of cylindrical micro-cavities were fabricated in standard Corning SMF28 fibers with a Solstice Ti:sapphire femtosecond laser operating at 795 nm (Fig. 1). The fibers were irradiated by 80 fs-long pulses, with repetition rate of 10 kHz. In order to make the micro-cavity, the laser beam was directed to suitably designed micromachining setup based on the Newport's uFab system. The micro-cavities were then examined under the Olympus LEXT OLS3100 confocal laser scanning microscope. The physical dimensions of the micro-cavities obtained from the microscopic scans were about 30 to 80 µm and 30 to 100 µm in depth and width, respectively. The optical transmission of the µIMZI was monitored in the spectral range of 1150-1650 nm using Leukos SM30 supercontinuum source and Yokogawa AQ6370B optical spectrum analyzer. The RI sensitivity measurements were performed using a set of liquids (mixtures of water and glycerin) of n_D varying in the range of 1.333-1.440 RIU. The n_D was measured using Rudolph J57 automatic refractometer working with the accuracy of $2 \cdot 10^{-5}$ RIU.

The obtained structures show constant sensitivities in specific RI ranges depending on the traced interference fringe and span from 12,000 (n_D between 1.333 and 1.360 RIU), to over 23,000 nm/RIU (n_D between 1.420 and 1.440 RIU), which is according to the best of the authors' knowledge the highest value reported for any µIMZI structures (Fig. 2) [2].

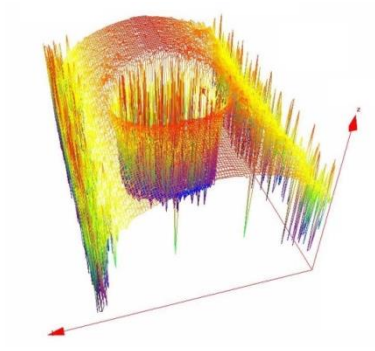

Fig. 1. Microscopic visualization of one of the fabricated µIMZI structures

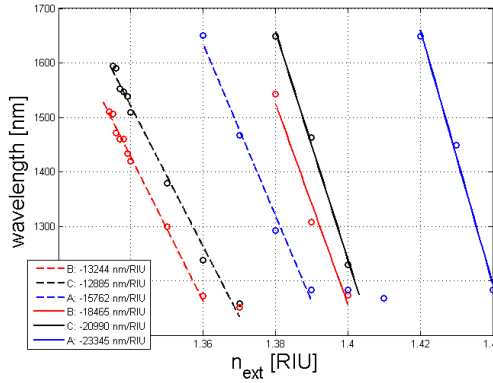

Fig. 2. Sensitivity plots of three differing in size µIMZI structures

This work was supported by the Polish National Science Centre (NCN) as a part of 2014/13/B/ST7/01742 project and Polish Ministry of Science and Higher Education in years 2014-2017 as a research project under “Diamentowy Grant” program.

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Prototype of wideband ultrasonic sonar based on STM32

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The paper presents a project of a low-cost prototype version of an ultrasonic wideband sonar and the problems occurring during the development process. The aim of this work was to design a short range sonar capable of the transmission of an arbitrary shape wideband signal. The chosen transmitting sensor typically works in pulsed operation modes. The dedicated output circuits had to be designed to expand its capabilities without information losses. The transmission and reception of the signals is managed by a Discovery evaluation board with a STM32 microcontroller. The receiving data are saved on a SD card and processed of-line.

Acoustic emission testing of storage tanks

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The paper presents the use of the acoustic emission (AE) method for diagnostic testing of above ground storage tanks (AST). This method allows evaluation and location of active corrosion damages of bottom material and micro leaks in the operating conditions of the tested object. To prepare object for AE testing it is not necessary to drain the storage medium from tested tank, which provides a high state of security at significant diagnosis and operation cost savings.

The methodology and AE test results carried out on the three storage tanks of crude oil are presented. Recorded during the measurements data have been analyzed. The conclusions drawn from this analysis, give the location of the AE sources and the evaluation of the integrity of the studied tanks bottom. Additionally, the effects of external conditions (sunlight and wind) on the obtained results are shown.

Moreover, evaluation criteria of technical condition of the tanks based on acoustic emission signals are presented, on the basis of which evaluation of the state of the tested tanks was carried out and operating time for the next test has been estimated.

Ultrasound Tomography: Results of Breast Phantom Imaging

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In order to improve breast cancer detection rates, new and better imaging methods are required. Currently, the ultrasound tomography as non-invasive and safe hybrid method may contribute to achieving a new standard for breast cancer diagnostics. The aim of the paper was to analyze the imaging ability of tissue-like media structure found in female breast using the developed novel ultrasound computer-assisted tomographic scanner. Measurements was performed on commercial breast biopsy phantoms due to their well defined structure with inclusions mimicking glandular tissue with lesions. Obtained magnetic resonance images of the same phantoms were used for comparison as the gold standard.

Determination of Some Kinetic Parameters of Fast Surface States in Semiconductors by Means of the Surface Acoustic Wave Method

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Among the methods of investigations of semiconductor surfaces, there are no methods of investigating the kinetic properties of electrical carries in fast and very fast surface states. The existing methods allow only investigations of the surface sates with a carrier life-time τ of above 10^{-8} s. In the case of extrinsic semiconductors the surface states may, however, be considerably faster (the carrier life-time in surface traps is usually less than 10^{-8} s). In such cases the existing methods of determining the parameters of fast surface states allow only to estimate these parameters, since the obtained results exhibit a considerable uncertainty. For this reason, investigations of the kinetic properties of fast surface states are not popular and there aren't any new results concerning their determination.

For some years attention has been paid to the influence of the physical state of the near-surface region of a semiconductor on the results of investigations of the acoustoelectric effects in piezoelectric-semiconductor systems. The attention has been paid to the possibility of applying Rayleigh's surface acoustic waves SAWs for investigations of various surface parameters of solid states.

The theoretical and experimental results of the application of acoustoelectric effects (longitudinal and transverse) for the determination of carrier properties in near surface region (e.g. the surface electrical potential, carrier concentration, electrical conductivities,…) have been presented. Problems connected with the determination of the chemical and mechanical means of surface treatments in the first step of preparation of semiconductor plates for technology on their kinetic properties have not often been taken up. The quantitative data concerning the effective life-time τ and the velocity of carrier trapping g are very seldom presented in literatures of semiconductor surfaces. Presented results are new and original.

Project of SODAR with phased array antenna

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This article is dedicated to the presentation of the project of remote sensing device, which is SODAR (Sound Detection And Ranging). In this article will be presented theoretical knowledge of work rules of SODAR there will be also described previous achievements and solutions to be implemented in the future.

SODAR is a remote sensing device, which by usage of sound waves allows to measure parameters such as altitude, speed and direction of the wind. SODAR operates in pulse mode. That is, in the atmosphere is transmitted short pulse probe, followed by a echo listening phase. The project of SODAR involves the use of phased array antenna in the form of a matrix of sound transmitters, which allows digital beam forming. The transmitted signal is a signal with internal modulation or manipulation of frequency which aims to increase its bandwidth.

So far, there were made some prototype components of the apparatus. One of the first prototypes was the transmit path. The purpose of this test was to check the capabilities of powering piezoelectric transducers via integrated audio power amplifier. The indirect aim was also to examine the mechanical strength of the transmitters. The next step was to develop the receiving track. It was based on the use of integrated microphone amplifiers MAX9814. Each of the designed transceiving modules are based on STM32F407 microcontroller.

Current work focuses on receiving and registering the actual echo signal. Sampled echo signal is used for research on signal processing algorithms and to design the shape of the transmitted signal. Activities carried out so far show wide opportunities for further development of the project, as evidenced by increasingly favorable results of research and testing.

A wideband ultrasonic imaging sonar system

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Acoustic echolocation systems provide information on distance to observed objects. However, typically the ultrasonic transducers posses relatively wide transmitting or receiving patterns, which does not allow to achieve high resolution images of the objects in the cross range direction.

In synthetic aperture sonar (SAS) systems the acoustic sensor is mounted on a platform that in classical configuration moves perpendicularly to the observation direction. The sensor emits the sounding signals, receives the echo signals along the platform's trajectory and stores them in its memory. The signals are subsequently processed as if they were received by a long antenna which allows to obtain very high cross-range resolution images that is comparable with used wavelength. The range resolution of the image depends on the bandwidth of the transmitted signal.

The paper presents an experimental high resolution imaging acoustic system based on a prototype wideband ultrasonic sonar sensor. The results of the system's performance are presented.

Application of ADC and ADP descriptors to identify the acoustic emission signals generated by the partial discharges

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In this paper, there are presented the research results of partial discharge in the systems with modeled sources, carried out by calibrated acoustic emission method. Within the method named as the calibrated acoustic emission method, measurements are carried out simultaneously by means of two methods i.e. acoustic emission and electric. Finally the results of partial discharge research obtained by means of acoustic emission method are refered to results of measurements of apparent charge introduced by the acting source of partial discharge (obtained by means of electric method).

There are described designed and constructed modeled sources of partial discharge and the measurement stand consisting of a vat of oil with mounted modeled sources, the test set for generating high voltage, author measurement system 8AE-PD (acoustic emission method) and system TE571 (electric method). Research methodology is presented, too.

For the recorded signals, phase-time characteristics, averaged phase characteristics, averaged Short-Time Fourier Transform spectrograms and the frequency characteristics were calculated. Basing on calculated characteristics, there were carried out qualitative analysis of signals registered in the measurement channels with wideband and resonant sensors and quantitative analysis of the selected signal parameters, in particular the authors descriptors of acronyms ADC and ADP.

Noise signals were compared with signals generated by partial discharge. Analysis showed the possibility of distinguishing of signals generated by partial discharge and noise. Description of signals using of ADP and ADC descriptors showed additional capabilities to confirm the presence partial discharge sources within the examined object.

Simulation of infrasound waves emitted by wind turbine

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The subject matter considers generation and propagation of infrasound waves emitted by wind turbines and in particular with their simulation using computational software. Nowadays computers and software tools enable for integration of existing equations, describing physical phenomena from various fields, including mechanics, acoustics and aerodynamics into one multiphysical numerical model and to analyze the model dynamics in time and space. The presented results are related to development of the computer model of a wind turbine, with adequately defined parameters, for to enable study of low-frequency acoustic wave generation and propagation in the near and far field. The model integrates various physical phenomena responsible for the generation of low frequency noise by wind turbines, into a single model. Theoretical analysis of the impact of weather conditions (wind speed and direction, temperature, humidity, atmospheric pressure) and the topography of the land surrounding the wind turbine (type of ground, absorption and reflection from the surface, shielding by obstacles) on the path of propagation (trajectory) of low-frequency acoustic waves is presented and discussed.

46th Winter School on Wave and Quantum Acoustics

13th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods (MAR&CM)

PROGRAMME and ABSTRACTS

Organizers of WSWQA 2017

Upper Silesian Division of the Polish Acoustical Society

in cooperation with the

Committee of Acoustics of the Polish Academy of Sciences

27th February to 2nd March 2017,
Hotel "META"
Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

PROGRAMME OF THE 13TH WORKSHOP ON MOLECULAR ACOUSTICS, RELAXATION AND CALORIMETRIC METHODS

27.02.2017 Monday	
13:00	**DINNER**
14:15-14:30	**OPENING CEREMONY of the 46th WSW&QA Conferences and 12th IOS'2017**
14:30-15:00	**45th anniversary of the Winter School on Environmental Acoustics and Vibroacoustics**
15:00-16:20	**THE SESSION DEDICATED TO THE MEMORY OF PROFESSOR EUGENIUSZ JAN DANICKI**
15:00-15:20	**MEMORIES**
15:20-15:40	**An advanced technology for radar signal processing - the review** A. KAWALEC
15:40-16:00	**Determination of Some Kinetic Parameters of Fast Surface States in Semiconductors by Means of the Surface Acoustic Wave Method** T. PUSTELNY
16:00-16:20	**Seismometer based on Surface Acoustic Waves transducers** J. FILIPIAK
16:20-17:00	**Coffee break**
17:00-17:10	**Opening of the 13th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods**
17:10-18:10	**The session dedicated to the memory of Professor Adam Bald**
17:10-17:30	**Memories**
17:30-17:50	**Conductance and ionic association of imidazolium ionic liquids in alcohols** A. BORUŃ, A. BALD
17:50:18:10	**The application of a four segment composition model for excess molar volume and excess compressibility coefficient of 2-alkoxyethanols - water mixtures in a wide temperature range** K. KLIMASZEWSKI, A. BALD
18:30	**REGIONAL SUPPER**
19:30-20:30	**Sleigh ride – group 1**
20:30-21:30	**Sleigh ride – group 2**

28.02.2017 Tuesday	
13:00	DINNER
15:00-15:50	**Relaxation in several derivatives of benzene** B. LINDE
15:50-16:10	**Rao equation analysis in ionic liquids under high pressure** B. JASIOK, M. CHORĄŻEWSKI
16:10-16:30	**Structure – property relationship for surface tension of task specific ionic liquids** M. GEPPERT-RYBCZYŃSKA
16:30-17:00	**Coffee break**
17:00-17:20	**Physico-chemical characterization of magnetoferritin and its potential bio-applications** P. KOPČANSKÝ
17:20-17:40	**Structure and hyperthermia characterization of bacterially synthesized magnetic nanoparticles** M. TIMKO
17:40-18:00	**The enhancement of the thermal effect in hyperthermia due to nanoparticle application** K. KACZMAREK, A. JÓZEFCZAK, T. HORNOWSKI, M. KUBOVČÍKOVÁ, A. SKUMIEL, Z. ROZYNEK, M. TIMKO
19:30	**Festive Supper (Banquet)**
01.03.2017 Wednesday	
13:00	DINNER
15:40-16:10	**The automated device for studying the acoustic and thermophysical properties of liquids** V. N. VERVEYKO, M. V. VERVEYKO, D. V. VERVEYKO, A. YU. VERISOKIN, N. S. CHEBROV
16:10-16:30	**High pressure acoustic and thermodynamic properties of 2-methylfuran + isooctane, the second generation biofuel blends. Experiments and PFP modeling** M. DZIDA, S. JĘŻAK
16:30-17:00	**Coffee break**
17:00-17:20	**Determination of dimerization constants using acoustic method: mixtures of benzene, cyclohexylamine and aniline with cyclohexane** J. GLIŃSKI, A. BURAKOWSKI
17:20-17:40	**Chlorobenzene + 2-chlorotoluene – almost ideal liquid system** A. BURAKOWSKI, J. GLIŃSKI

17:40	**Closing Ceremony of the 13th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods**
19:00	SUPPER
19:30-21:30	**POSTER SESSION** **Heating induced by therapeutic ultrasound in the presence of magnetic nanoparticles** K. KACZMAREK, T. HORNOWSKI, A. JÓZEFCZAK
02.03.2017 Thursday	
8:00	BREAKFAST

ABSTRACTS

FOR 13TH WORKSHOP ON MOLECULAR ACOUSTICS, RELAXATION AND CALORIMETRIC METHODS

Conductance and ionic association of imidazolium ionic liquids in alcohols

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Physical properties of solvents such as density, viscosity, relative permittivity, and the capability of hydrogen bond formation as well as the ion−solvent and solvent−solvent interactions influence the conductance behavior of electrolytes in solutions. Ion−solvent interactions stabilize the ion by solvating it, which affects the ionic association. Therefore, in order to investigate the effect of the nature of the ions, the structure of the solvent medium or the relative permittivity on the solvation and ionic association, the conductivity measurements are often used.

We present the conductometric properties of dilute solutions of [emim][BF4] and [bmim][BF4] in methanol, propanol, propan-2-ol and butanol over a wide temperature range. The ILs show moderate ion association in methanol and strong in other alcohols. The values of limiting molar conductivities for the ILs in alcohols generally follow the order: MeOH > PrOH > 2-PrOH > BuOH, which correlates well with decrease in viscosity of the solvent. In turn, the association constant values change in the reverse order than Λo values, which correlates well with an increase in relative permittivity of the solvent. The thermodynamics of the association process were also evaluated and discussed.

Chlorobenzene + 2-chlorotoluene – almost ideal liquid system

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Density and sound speed were measured in liquid mixtures of chlorobenzene with 2-chlorotoluene in the temperature range 288.15 to 308.15 K Additionally the refractive indices were measured at 298.15 K. The results are compared with those in Lanshina et al. [1, 2]. The deviations of molar volumes, adiabatic compressibilities and refraction indices from ideality are analyzed and interpreted. It was concluded that the system under investigations is very close to ideality, much closer than, for instance, mixtures of non-substituted hydrocarbons. This allows to treat it as a model system, which can find application in testing different theories and models of ideality of liquid mixtures.

[1] L.V. Lanshina, A.I. Abramovich, Russ. J. Phys. Chem. A **82** (2008) 1851
[2] A.I. Abramovich, E.S. Alekseev, T.V. Bogdan, L.V. Lanshina, J. Struct. Chem. **55** (2014) 651

High pressure acoustic and thermodynamic properties of 2-methylfuran + isooctane, the second generation biofuel blends. Experiments and PFP modeling

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The 2-methylfuran can be obtained from cellulosic biomass and is indicated as a potential bioethanol or petroleum-based fuels substitute. As a blending component for 2-methylfuran, isooctane (2,2,4-trimethylpentane) was chosen. Isooctane is used as a model fuel in a wide range of applications; it even serves as the reference standard for the "Research Octane Number". Optimization of the fuel injection process requires knowledge of densities, speeds of sound, heat capacities, isobaric thermal expansions, isentropic and isothermal compressibilities. A thermophysical study is important to understand properties depending on intermolecular interactions and the structure of chemicals. Thus, the first objective of this work is to examine the influence of the temperature and pressure on the above-mentioned properties as well as on excess volumes, excess isentropic and isothermal compressibilities, excess isobaric thermal expansions, and excess heat capacities of 2-methylfuran + isooctane mixtures. The next objective is to study intermolecular interactions and structure of the mixtures under test basing on the Prigogine-Flory-Patterson (PFP) theory.

Structure – property relationship for Surface Tension of Task Specific Ionic Liquids

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In this work, the surface tension, sigma, of chosen Ionic Liquids (ILs) is presented. Substances analyzed here contain some substituents in cation, or have a kind of anion that provide task specific functionality such as chirality, or activity against bacteria or fungi, and others. They are regarded homologues series of Ionic Liquids or ILs with groups, which influence the symmetry of cation. The relation between surface tension and ions structure in homologues series is discussed and compared with those found for the other most popular ILs homologues series: 1-alkyl-3-methylimidazolium tetrafluoroborates, [CnC1im][BF4], bis(trifluoromethyl-sulfonyl)imides, [CnC1im][NTf2] and hexafluorophosphates, [CnC1im][PF6]. A parachor concept is applied for "sigma" prediction assuming additivity in relation to constitution of ions. Despite of complex structure of investigated substances surface tensions calculated in this work are in agreement with experimental values.

Determination of dimerization constants using acoustic method: mixtures of benzene, cyclohexylamine and aniline with cyclohexane

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The model developer recently [1] was applied to determine the dimerization constants of the title solutes when dissolved in cyclohexane solvent. This model assumes that the acoustic properties of a mixture of cyclohexane with solute containing ring in its molecule are determined by the equilibrium reaction of formation of dimers of the latter, while cyclohexane remains inert and does not associate. The presented model allowed to estimate the values of the dimerization constants of the title solutes in cyclohexane. However, the results suggest that in more concentrated solutions associates formed are bigger than dimers, while in diluted mixtures the solute-solvent interactions dominate.

[1] J. Gliński, J. Chem. Phys. 123 (2005) 074507

Heating induced by therapeutic ultrasound in the presence of magnetic nanoparticles

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Ultrasound (US) can be used for biomedical applications such as imaging and therapy. One of the earliest medical applications of ultrasound is the therapeutic heating of tissue. The effectiveness of ultrasound in hyperthermia therapy can be significantly improved by using the so-called sonosensitizers dispersed in heating tissue. Many different inorganic and organic substances can be used as sonosensitizer which can maximize the effect of ultrasonic irradiation, e.g. superparamagnetic iron oxide nanoparticles (SPIONs) with mean sizes of 10–300 nm. The objective of this study is to assess the utility of using magnetite nanoparticles during ultrasound hyperthermia to enhance heating at low US power. The effect of SPION concentration on heating rate was investigated in a tissue-mimicking phantom using an ultrasound system with planar transducer. The influence of penetration depth on temperature increase was also studied experimentally and theoretically.

This work was supported by a Polish National Science Centre grant, no DEC-2015/17/B/ST7/03566.

The enhancement of the thermal effect in hyperthermia due to nanoparticle application

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Ultrasonic and magnetic hyperthermia are very popular medical procedures used nowadays in many cancer treatments. Both of these methods cause a temperature rise of cancer cells. As a result of the temperature increase, cancer cells are weakened or destroyed.

In our study we conducted both type of hyperthermia treatments on agar phantoms which mimic soft tissues of the human body. In the first part, we studied the influence of magnetic fluid on the thermal effect of ultrasonic hyperthermia. Theoretically, the addition of scattering material like nanomagnetic particles can lead to additional heat due to supplementary scattering. In the second part, we investigated magnetic hyperthermia with use of the same magnetic fluid as previously. We also conducted a synergic experiment with a combination of both types of hyperthermia. The obtained results confirm theoretical assumptions that the addition of scattering material can enhance ultrasonic hyperthermia.

This work was supported by a Polish National Science Centre grant, no DEC-2015/17/B/ST7/03566.

The application of a four segment composition model for excess molar volume and excess compressibility coefficient of 2-alkoxyethanols - water mixtures in a wide temperature range.

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The course of excess molar volume and compressibility factor can be described using Redlich-Kister's or Ott's equations. For more complex curve courses describing with one equation for the entire range of concentrations becomes impossible. Presentation shows the application of four-segment structure model of a mixed solvent prepared by Douheret, Davis and Høiland to describe excess molar volume and excess compressibility coefficient of mixtures of 2-alkoxyalkohols with water over a wide temperature range. The coverage analysis of the different areas (water-rich, pseudolamellar, transitional and organic-rich segment) for homologous series alkoxyalkohols was conducted over wide temperature range.

Physico-chemical characterization of magnetoferritin and its potential bio-applications

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Magnetoferritin (MFer) is biological complex composed of protein shell, apoferritin, and synthetically prepared magnetic iron oxides inside. Due to ist unique properties (superparamagnetic behavior, nanoscale size and biological origin) it is believed to have various biomedical application (e.g. a drug carrier in the targeted transport). Small Angle X-ray (SAXS) and Neutron (SANS) Scattering studies have shown partial shell destruction of MFer and increasing of polydispersity with the loading factor (LF: average number of iron atoms per one complex) growth. Presence of magnetic nanoparticles in MFer could play an important role at observed ability to reduce the size and amount of lysozyme amyloid fibrils (LA), confirmed by SAXS and fluorescence measurements. Next investigations using UV-VIS spectrophotometry have confirmed peroxidase-like activity of MFer. Preliminary calorimetric measurements have shown the increase in temperature during exposition of MFer in AC magnetic field during magnetic hyperthermia tests. Presence of magnetic nanoparticles in MFer affects also the contrast at Magnetic Resonance Imaging (MRI), that could be useful for diagnosis associated with magnetic nanoparticles formation in damaged ferritin at neurodegenerative or cancer diseases.

Relaxation in Several Derivatives of Benzene

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Acoustical spectroscopy at frequencies up to 10GHz gives the possibility of the investigation of liquid substances, where the relaxation process observed is caused by energy transfer between the degrees of freedom.

The presented results of research in five halides of benzene as well as toluene and aniline are discussed and compared to benzene. Based on investigations by the author as well as by other people, and taking into account experimental and literature data concerning a great number of compounds, one can draw a conclusion that almost all acoustic relaxation processes in liquids can be described using a single relaxation time. It also seems that all vibrational degrees of the molecule take part in this process.

It is known that the appearance of differences in transition probabilities could be caused by additional attraction in interactions of molecules having dipole moments. Halides have higher values of dipole moments than benzene. This difference could be responsible for the difference of transition probabilities and changes in the relaxation times.

However, benzene derivatives with amino, nitro, and methyl groups and halides show the other type of relaxation.

Structure and hyperthermia characterization of bacterially synthesized magnetic nanoparticles

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The magnetosomes were prepared by biomineralization process of magnetotactic bacteria Magnetospirillum sp.AMB-1 with specific length depending on the number of individual nanoparticles found in the chain. Structure characterization of magnetosome chains after isolation (IM) from bacteria and after treatment isolated sample by sonication effect (SM) was done by dynamic light scattering (DLS), small-angle neutron (SANS) and X-ray (SAXS) scattering. Experimental scattering curves of magnetosome samples, indicate the presence of polydisperse particles in the samples. The values of forward scattering intensities confirm the differences in average sizes of samples prepared by various methods. For the sonicated sample the coercive force is lower as a consequence of the existence partly individual particles. This fact causes the decrease of magnetocrystalline anisotropy and so changes in magnetic and hyperthermia properties. In consequence of this changes the energy loss and specific absorption rate are noticeable reduced in sonicated sample and thereby indicates variation in the relaxation process and heat distribution.

The automated device for studying the acoustic and thermophysical properties of liquids

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The existing devices for studying the acoustic and thermophysical properties of substances have a number of drawbacks such as the excitation of the piezoelectric transducer by shock rectangular pulses which can lead to distortion of the signal emitted by the piezoelectric transducer or by continuous high frequency signal whereby the piezoelectric transducer is not in the free vibration mode but it is in forced vibration mode; a large number of functional blocks.

The authors have created the electronic block of generating, receiving and processing of the signals based on programmable logic integrated scheme (PLIS). The block operation control, the ultrasound speed measurements and calculation of thermophysical values carried out by means software installed on a personal computer. Visual observation and monitoring of the signals is carried out on a computer screen.

Increasing of action speed, accuracy and reliability of measurements achieved by using of modern high-speed electronic components and by exciting of piezoelectric transducer through packages of sinusoidal pulses that allows it to oscillate at the natural resonance frequency with the maximum possible amplitude without distortion of the signal.

This work was supported RFBR, project number 16-08-01203.

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