

Chronicle

48th Winter School on Wave and Quantum Acoustics XLVIIth Winter School on Environmental Acoustics and Vibroacoustics Szczyrk, Poland, February 25 – March 1, 2019

On behalf of Upper Silesian Division of the Polish Acoustical Society (main organizer) and Committee of Acoustics of the Polish Academy of Sciences (coorganizers) we are pleased to announce that according to many years of tradition the above-mentioned Conferences known as "Winter Schools" have been organized and carried out.

48th Winter School on Wave and Quantum Acoustics constituted platforms for sharing the results and achievements obtained in different branches of physical acoustics (e.g. molecular acoustics, quantum acoustics, acousto-optics, magnetoacoustics, photoacoustics, acoustics of solid state, acoustic emission etc.). Moreover, researches in some selected topics related to those mentioned above (e.g. optoelectronics, relaxation processes) were presented during the school. Conference consisted of 15th Workshop on Acoustoelectronics and 15th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods. However, there is a possibility of organizing workshops on other subjects in the future. We would like to invite scientific centers and groups to cooperate in organizing workshops on the subjects of their interests.

XLVIIth Winter School on Environmental Acoustics and Vibroacoustics was the forum for all environmental and vibroacoustics fields. Particularly it concerned traffic noise, vibroacoustics of machines, room acoustics, building acoustics, noise protection and similar problems. During the Conference in association with SVANTEK there were organised seminars on "Measurement of noise and vibration at the workplace", "Environmental noise monitoring" combined with measurement workshops.

The Conferences began with the special session dedicated to Professor Wiesław Woliński in jubilee's celebration.

Finally, 68 people participated within Conferences or seminars presenting 42 lectures and reports. In this issue one can find abstracts of some lectures and

posters, which were presented during the Conferences. Further information about Conferences is available on our website

<http://ogpta.pl>

Chairman of Organizing Committee

Franciszek Witos

Abstracts

15th Winter Workshop on Acoustoelectronics

**Choosing cheap MEMS accelerometers
for vehicle diagnostics
and condition monitoring**

BISMOR Dariusz

Institute of Automatic Control
Silesian University of Technology
Akademicka 16, 44-100 Gliwice, Poland

The article presents the outcome of a project on construction of a mobile platform for acquisition and recording of acoustic and vibration data in vehicles, using cheap MEMS sensors. The origin of the research is in necessity of monitoring certain vehicles in order to detect and predict possible failures. Usually, failures are preceded by changes in acoustic and vibration signals. The signals can be collected from various parts of a vehicle, and processed digitally to extract features of interest. However, the sensors traditionally used for acquisition of high-quality acoustic and vibration signals, are too expensive to allow for massive application of such hardware in the majority of vehicles. Therefore there is a need to explore possibility of use of cheap MEMS sensors, with smaller frequency ranges and resolutions, to such application.

* * *

Quartz tuning fork sensor of paramagnetic gases

BOROWSKI Tomasz¹

JASEK Krzysztof²

PASTERNAK Mateusz¹

¹ Institute of Radioelectronics

² Institute of Chemistry

Military University of Technology

Urbanowicza 2, 00-908 Warsaw, Poland

Contemporary the quartz tuning fork finds a variety of applications. It is eagerly used, beginning from oscillators in watches, through scanning probe microscopy sensors ending as traces gas transducers in photoacoustic spectroscopy – called Quartz Enhanced Photoacoustic Spectroscopy (QE PAS). One of the advantages of measuring transducers based on the quartz tuning forks is their narrowband operation characteristics. The high value of the quality factor in the resonance as well as the relatively high frequency of operation and high sensitivity make them less susceptible to acoustic interference and noise. This work presents the concept of a gas sensor based on the quartz tuning fork which can be used as a detector of paramagnetic gases, e.g. O₂, O₃, NO, NO₂.

* * *

New hydrogen bond acidic polymer polymethyl[4-(4-hydroxyphenoxy)butyl]siloxane as SAW sensor coating for DMMP detection

GRABKA Michał¹

JASEK Krzysztof¹

PASTERNAK Mateusz²

¹ Institute of Chemistry

² Institute of Radioelectronics

Military University of Technology

Urbanowicza 2, 00-908 Warsaw, Poland

In this work the design and analytical application of new sensor material polymethyl[4-(4-hydroxyphenoxy)butyl]siloxane were presented. PMOS is linear polysiloxane functionalized with pendant substituents with phenol groups in order to enhance its interactions with basic vapor (mainly nerve chemical warfare agents – CWA) via hydrogen bonds. The polysiloxane was deposited onto two-port 194MHz SAW quartz resonator by vacuum evaporation. The sensitivity of fabricated sensor toward dimethyl methylphosphonate (DMMP, commonly used nerve CWA simulant) was investigated. The sensor demonstrates relatively high sensitivity toward target analyte (compared to sensors with hydrogen bonds acidic (HBA) polymers developed earlier) and low limit of detection, significantly below toxic concentrations of nerve CWAs. What noteworthy, no decrease of sensitivity in elevated humidity conditions was observed. Significant loss of sensitivity in such conditions used to be the main problem in detection and determination of nerve CWAs with commercial SAW devices.

* * *

Comparison of the occurrence of partial discharges on the surface of a composite insulator by measurement of acoustic emission and measurement of UV radiation emission

GRYSZPIŃSKI Miroslaw, FRĄCZ Paweł

Institute of Electrical Power Engineering and Renewable Energy

Opole University of Technology

Prószkowska 76, 45-758 Opole, Poland

The paper presents the results of Partial Discharges (PD) tests occurring on the surface of medium voltage composite insulator. The Partial Discharges number was calculated with the use of a corona discharge camera, at the same time the acoustic emission was measured. The tests were carried out in established environmental conditions and comparative analysis of both methods was performed. The obtained results suggest a correlation between the measurements. The article also presents a description of the measurement methodology and conclusions from the obtained data. The concept of the influence of external conditions on the occurrence of PD phenomenon and the sensitivity of the measurement method in variable environmental conditions was also presented. Further research plans are described.

* * *

Experimental and numerical analysis of the steady stage of a new SAW structure with RR-P3HT in detection DMMP

HEJCZYK Tomasz¹, WROTNIAK Jarosław²

POWROŻNIK Paulina³, JAKUBIK Wiesław³

¹ The Academy of Creative Development – the Foundation Wyzwolenia 117, 44-321 Marklowice, Poland

² Institute of Electronics

³ Institute of Physics CSE

Silesian University of Technology

Konarskiego 22B, 44-100 Gliwice, Poland

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

Numerical results for the gas DMMP (CAS Number 756-79-6) for layer (RR)-P3HT in the steady state have been shown. The main aim of the investigations was to study a thin film interaction with the target gases in the SAW sensor configuration based on the diffusion equation for polymers. Numerical results for profile concentration in steady state were shown.

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

* * *

Surface acoustic wave sensor of paramagnetic oxygen

JASEK Krzysztof¹, GRABKA Michał¹
 PASTERNAK Mateusz², MILUSKI Witold³
 BOROWSKI Tomasz²

¹ Institute of Chemistry

² Institute of Radioelectronics

³ Faculty of Mechatronics & Aerospace
 Military University of Technology
 Urbanowicza 2, 00-908 Warsaw, Poland

The paramagnetic properties of oxygen are often applied for the construction of different oxygen sensors. The common and unfortunately inconvenient element of most of the sensors is large magnet necessary to obtain a magnetic field or a magnetic field gradient. And therefore, it is the main reason that the miniaturization of the paramagnetic oxygen sensors is difficult for realisation.

In the work a novel kind of sensor based on the surface acoustic wave (SAW) device is presented. It utilizes the influence of magnetic attracted oxygen particles on Rayleigh wave propagation at nickel coated substrate of two-port SAW resonator. The laboratory tests of the mechanism revealed very interesting results.

The theoretical background of the SAW oxygen paramagnetic sensor, its operating principle as well as results of preliminary measurements are presented.

* * *

An acoustic and Doppler radar localization of shooting objects

KAWALEC Adam, DANICKI Eugeniusz
 RUTKOWSKI Adam

Institute of Radioelectronics
 Military University of Technology
 Urbanowicza 2, 00-908 Warsaw, Poland

In dangerous, shooting objects detection systems, acoustic or radar methods are used to determine the coordinates object's position. These coordinates should be determined with high accuracy, otherwise the effectiveness of the system is significantly reduced. The work proposes methods for determining the position of a sniper or other firing targets, which are based on acoustic systems, using the shock wave generated by missiles or at the moment of shot and a specific configuration of Doppler radars with the use of these ranges estimates, the bullet position can be localized using the trilateration/multilateration method.

The most of antisniper systems or other systems designed for protection against firing use acoustic phenomena to locate the shooting object's position using a muzzle blast or a shock wave generated by the missile with a specific configuration of the microphone set. In this paper we present the next system that uses known measurements of Doppler radar. This is probably the only possible method of continuous observation of a large angular sector of the protected area. The radar system can find wider applications than the acoustic systems. Results of experiments were presented.

* * *

Examination of the bottom of the Gdańsk Bay by means of acoustic methods

KOZACZKA Eugeniusz, GRELOWSKA Grażyna

Faculty of Ocean Engineering and Ship Technology
 Gdańsk University of Technology
 Narutowicza 11/12, 80-233 Gdańsk, Poland

The interest in the seabed in various aspects is clearly increasing. This is determined by, among other things, cognitive aspects regarding the mapping of the shape of the bottom and its structure as well as objects lying on the bottom. No less important are practical aspects, such as knowledge of navigational obstacles necessary for sea transport or knowledge about the type of bottom sediments needed in the construction of offshore facilities. The type of bottom sediments also affects the extent of underwater noise spreading, especially in the shallow sea.

The paper presents the main methods and devices currently used in seabed surveys using acoustic waves. The results of own research carried out in the Gulf of Gdańsk will be presented. Particular emphasis will be placed on researching the upper layer of bottom sediments using nonlinear hydroacoustics. The influence of the selection of parameters of measuring devices and the way of processing data on the obtained images will be shown. Data obtained by acoustic methods will be compared with geological data.

* * *

Analysis on acoustic disturbance signals expected during partial discharge measurements in power transformers

KUNICKI Michał, CICHOŃ Andrzej
 BORUCKI Sebastian

Institute of Electrical Power Engineering and Renewable Energy
 Opole University of Technology
 Prószkowska 76, 45-758 Opole, Polska

Partial discharge (PD) is commonly known as one of the most destructive phenomena affecting high voltage insulation systems. Since adequately early PD detection in primal electric power equipment (e.g. power transformers) may reduce the probability of the system failure, thus it is a crucial issue regarding reliable electric power delivery. Acoustic emission method (AE) is known as one of the most non-invasive PD detection methods that may be applied during normal operating conditions with no need to cut-off the diagnosed apparatus. An on-site acoustical PD detection in power transformers is accompanied by numerous external and internal disturbance that may be presented around the diagnosed unit. In order to provide a proper interpretation of registered signals it is essential to distinguish PD generated signals from others. Therefore, a comparative analysis of various acoustic signals expected during the PD measurements in operating power transformer is presented in this paper. Selected examples of real-life AE signals registered in power transformers are showed and analysed. Several different signal processing are applied and compared in order to identify the PD signals. As a result a wavelet decomposition is found as the most reliable tool for PD sig-

nal identification. Furthermore a clustering method for PD identification based on the energy patterns is proposed.

* * *

The influence of the type of solid dielectric material on the generated partial discharges

NAGI Łukasz, KOZIOL Michał

Institute of Electric Power and Renewable Energy
Opole University of Technology
Prószkowska 76, 45-758 Opole, Poland

The article presents the results of measurements of partial discharges (PD) recorded by acoustic, electrical and optical methods. The tests were carried out in laboratory conditions in the laboratory of High Voltage Technique of the Opole University of Technology. The modelled source of PD is a spark gap in needle-plate system immersed in mineral oil. Between the electrodes there were placed solid dielectrics: glass, teflon and prespan. The aim of the research was to investigate the influence of the type of solid dielectric material on the generated partial discharges in order to determine the possible characteristic descriptors for the applied solid dielectrics. Well-known methods such as acoustic and electrical methods provide in this study both new information about the recognition of the PD depending on the applied solid insulator and is used to correlate the results obtained with the optical method based on the recording of the spectrum of electromagnetic radiation in the UV and visible light range.

* * *

Analysis of using multi-angle ultrasound scanning for efficient 3D object imaging

SABINIOK Maciej, OPIELIŃSKI Krzysztof J.
LIS Sylwia

Electronics Faculty
Wroclaw University of Science and Technology
Wybrzeże Wyspianskiego 27, 50-370 Wroclaw, Poland

The purpose of this work is to examine the possibility of using multi-angle B-mode ultrasound scanning to efficient imaging of 3-D structure of objects by the registration of 2-D images at fixed angular positions of the multi-element ultrasonic probe rotated in relation to the object submerged in water, in the selected configuration: vertical lateral, horizontal top or horizontal bottom one. In the vertical lateral configuration, the ultrasonic probe acquires 2-D images of object vertical projections, turning around its lateral surface. In the horizontal top or bottom configuration, the ultrasonic probe acquires 2-D images of object vertical projections, turning over the top or under the bottom surface of the object. Developed algorithms for 3-D imaging of the structure of the object in the entire area of the scan by MPR method (multi-projection reconstruction) and 3-D recording method of acquired images in the DICOM standard, were designed. Studies show the method in the horizontal bottom configuration could be successfully applied to the effective 3-D visualization of the structure of the female breast *in vivo*.

* * *

Effect of dynamic beam deflection and focus shift on acoustic field distribution inside ultrasound tomography ring array

STASZEWSKI Wiktor, GUDRA Tadeusz

OPIELIŃSKI Krzysztof J.

Electronics Faculty

Wroclaw University of Science and Technology
Wybrzeże Wyspianskiego 27, 50-370 Wroclaw, Poland

This paper presents the acoustic field distributions that were the results of simulation for the 1024-element ultrasonic ring probe, intended for diagnosis of female breast tissue with the use of ultrasound tomography. During analysis, a combined sum of all acoustic fields created by each elementary transducer was calculated. By changing the time of activation of individual transducers in the sector consisting of 32, 64 and 128 ultrasonic transducers, the natural position of the focus inside the ultrasonic ring probe was changed. Manipulating the position of the focus inside the probe enables to concentrate the ultrasonic beam in chosen area inside the transducer template. The goal of this research is to obtain as good as possible of images of cross-sections of the female breast. The results enable to choose an optimal focus, an optimal number of activated transducers and an optimal deflection of the ultrasonic beam.

* * *

The problems of the direction finding by air vehicles of the radars working with rotating antenna

RUTKOWSKI Adam, KAWALEC Adam

Institute of Radioelectronics
Military University of Technology
Urbanowicza 2, 00-908 Warsaw, Poland

The location of active radars in real environmental terms is a very important and complicated question. The particularly significant difficulties appear in case of observation of radars working with complex signals as well as with impulses having extremely small duration. In these cases the monopulse methods of the direction finding (DF) of microwave sources and devices of instantaneous phase measurement (IPhM) and instantaneous frequency measurement (IFM) of signals emitted by these sources are very useful. The efficiency of the direction finding of ground-based radars by air vehicles is dependent among other things on parameters of applied taking bearings apparatus as well as on construction and modes of running of observed radar's antenna system, and also on the properties of terrain around this radar. The exemplary shapes of radar antenna directional patterns and their relationships with possibilities of this radar remote detection were described in the work. It was paid attention on multi-path phenomenon, which can make difficult of direction finding of radar, but concurrently it can facilitate undesirable discovery of radar activity. The simulated shapes of signals received by recognition device as well as expected results of the monopulse direction finding accomplishing basing on these signals were presented.

* * *

Measurement and testing of the occurrence of partial discharges on the surface of a ceramic insulator using the method of UV radiation emission and acoustic emission

SZPULAK Piotr

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

The results of the tests, which were presented in the article, concern partial discharges (PD) on the surface of a medium voltage ceramic insulator.

In order to check how the environmental variables, the insulator material and the applied method affect the amount of PD, the tests on the emission of UV radiation were carried out with the use of corona discharge camera and at the same time the measurement on the acoustic emission, with the use of a specialized acoustic camera was applied.

The article also describes the block diagram of the measuring system, methodology of measurements and a description of the methods used and their comparison. Obtained results are presented in the form of tables and graphs on the basis of which comparative analysis was carried out, which allows to observe the occurrence of certain relationships and correlations. The analysis of the concept of the influence of external conditions on the occurrence of PD phenomenon and the influence of changing environmental conditions on the sensitivity of the applied measurement method was also made. On the basis of the results obtained, the sensitivity of the applied test methods was also estimated.

Conclusions and further research plans have been presented in the last chapter.

* * *

Wavelet selection for discrimination of acoustic signals emitted by partial discharges in oil insulation

WAWRZYNIAK Stanisław
KUNICKI Michał

Institute of Electrical Engineering and Renewable Energy
Opole University of Technology
Prószkowska 76, 45-758 Opole, Poland

Partial discharges (PD) have a devastating effect on the insulation of high voltage equipment. One of the non-invasive methods of PD detecting in insulation systems is the acoustic emission method (AE). The paper presents laboratory tests of PD in oil insulation with air bubbles as an interfering signal and their AE signals analysis. For this purpose the AE signals emitted by: PD in oil insulation, PD in oil insulation with air bubbles and only air bubbles signals have been recorded. Various types of wavelets were analysed to identify signals coming from PD in the presence of interfering signals, i.e. air bubbles. The wavelet families and orders were found which might be optimal to indicate PD based on energy patterns.

* * *

Properties of amplitude distributions of acoustic emission signals generated in pressure vessel during testing

WITOS Franciszek

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

The results of investigations on the properties of acoustic emission signals generated in a tested pressure vessel are presented. The investigations were performed by repeating several times the following procedure: an increase in pressure, maintaining a given pressure level, a further increase in pressure, and then maintaining the pressure at new determined level. During the tests the acoustic emission signals were recorded by the measuring system 8AE-PD with piezoelectric sensors D9241A. The used eight-channel measuring system 8AE-PD enables the monitoring, recording and then basic and advanced analysis of signals.

The results of basic analysis carried out in domain of time and the results of advanced analysis carried out in the discrimination threshold domain of the recorded acoustic emission signals are presented in the paper.

In the framework of the advanced analysis, results are described by the descriptors defined by the author with acronyms: ADC, ADP and ADNC. Such description is based on identifying the properties of amplitude distributions of acoustic emission signals by assigning them the level of advancement. It is shown that for signals including continuous AE or single burst AE signals descriptions of such registered signals by means of ADC, ADP and ADNC descriptors and by U_{pp} and U_{rms} descriptors provide identical ordering of registered acoustic emission signals. For complex signals, the description using ADC, ADP and ADNC descriptors based on the analysis of amplitude distributions of recorded signals gives the order of signals with more accurate connection with deformational processes being sources of acoustic emission signals.

* * *

Analysis of the properties of acoustic emission signals generated in oil power transformers

WITOS Franciszek¹, OLSZEWSKA Aneta¹
SZERSZEŃ Grzegorz², OPILSKI Zbigniew¹
LISOWSKA-LIS Agnieszka³

¹ Department of Optoelectronics
Faculty of Electrical Engineering
Silesian University of Technology
Krzywoustego 2, 44-100 Gliwice, Poland

² Department of Electronics and Telecommunications

³ Department of Electrical Engineering
State Higher Vocational School in Tarnów
Mickiewicza 8, 33-100 Tarnów, Poland

The work presents methodology and results of analyses of partial discharges tests in oil power transformer conducted by means of the acoustic emission method. The basis for this research is author's patented research method. The elements of the research are the original 8AE-PD measurement system, the determination of the network of measuring points on the side walls of oil transformer tank, AE

sensors mounting, checking the mounting quality of individual sensors using the Hsu-Nielsen method, analysis of the properties of acoustic emission signals generated during Hsu-Nielsen tests, data registration, determination of the author's descriptor maps on the side walls of the tank of the transformer under test along with the location of areas with increased acoustic emission activity, analysis of the properties of acoustic emission signals registered at measurement points located in areas designated as local maxima on the descriptor maps.

There are numerous phenomena that generate acoustic signals in oil power transformers. Research on acoustic signals generated by modelled sources leads to the following conclusions:

- in the 100–200 kHz band, acoustic emission signals derived from acoustic phenomena accompanying partial discharges are dominated,
- in the 20–100 kHz band, there are acoustic signals coming from many phenomena, among others from acoustic phenomena accompanying partial discharges, from phenomena related to the process of magnetizing ferromagnetic materials and acoustic phenomena generated during transformer oil circulation,
- the 20–40 kHz band is the dominant band for acoustic signals generated during phenomena related to the magnetization process of ferromagnetic materials and during some types of partial discharges.

The work presents maps of descriptors with ADP and ADC acronyms determined for registered signals subjected to filtration in three frequency bands, i.e. 100–200 kHz, 60–100 kHz and 20–60 kHz and the results of analysis of acoustic emission signals registered at selected measurement points located in areas designated as local maxima on the descriptor maps. The results of the analyses were referred to the results of thermovision tests carried out in the tests.

* * *

Acoustical studies of polymer (RR)-P3HT type for the determination of DMMP in air

WROTNIAK Jarosław¹, JAKUBIK Wiesław²
 POWRÓNIK Paulina², STOLARCZYK Agnieszka³
 MAGNUSKI Mirosław¹

¹Institute of Electronics, Silesian University of Technology
 Akademicka 16, 44-400 Gliwice

² Institute of Physics CSE
 Silesian University of Technology
 Konarskiego 22B, 44-100 Gliwice

³ Department of Physicochemistry and Technology
 of Polymers
 Strzody 9, 44-100 Gliwice

This paper presents the preliminary investigations using the SAW method for the detection of trace amounts of DMMP molecules (Dimethylmethylphosphate) in air mixtures, which is commonly used to simulate the presence of warfare agents like sarin gas. The sensor element is a layer of polymeric poly(3-hexylthiophene) of regioregular type ((RR)-P3HT) produced by airborne sputtering on the free surface of the SAW module. An important factor enhancing the ability of DMMP detection was lighting of the poly-

mer by means of many LED diodes with different lighting colours.

* * *

14th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods

The influence of various sonosensitizers on ultrasonic heating

BIELAS Rafał, KACZMAREK Katarzyna
 SILUK Małgorzata, PORZAK Szymon
 JÓZEFCZAK Arkadiusz

Institute of Acoustics, Faculty of Physics
 Adam Mickiewicz University
 Umultowska 85, 61-614 Poznań, Poland

Ultrasonic waves have been commonly used in different types of medical procedures including thermal therapies, e.g. hyperthermia and thermal ablation. It is possible to improve their efficiency by adding the supplementary materials that enhance the absorption of the medium and, as a result, temperature elevation. Due to the presence of these materials – *sonosensitizers*, one is able to obtain higher temperature rise with the same acoustic energy employed in the heating process.

In the presentation, different types of nanoparticles will be proposed as sonosensitizers in ultrasonic heating. Apart from previously reported magnetic nanoparticles, laponite and silicone dioxide nanoparticles were added to the agar-based tissue-mimicking phantoms. The results of temperature elevation indicate that materials used indeed improve thermal effect of ultrasonic waves.

This work was supported by the Polish National Science Centre grants: NCN/2015/17/B/ST7/03566 and NCN/2017/27/N/ST7/00201.

* * *

Synthesis of sp^{2+ε}-carbon nanoallotropes as dispersed phase in IoNanoFluids

BONCEL Sławomir¹, DZIDA Marzena²
 JĘDRYSIAK Rafał¹, JÓZWIAK Bertrand¹
 KOLANOWSKA Anna¹, KUZIEL Anna¹
 WĄSIK Patrycja¹, ZOREBSKI Edward²
 ZOREBSKI Michał², GOLBA Adrian²

¹ Faculty of Chemistry, Silesian University of Technology
 Krzywoustego 4, 44-100 Gliwice, Poland

² Institute of Chemistry, University of Silesia in Katowice
 Szkołna 9, 40-006 Katowice, Poland

IoNanoFluids – systems composed from finely dispersed nanoparticles (NPs) in ionic liquids (ILs) – are currently considered as perspective heat transfer media exhibiting the synergy effect between NPs and ILs. Carbon nanomaterials, and particularly those of *quasi*-one-dimensional morphology and high aspect ratio, e.g. carbon nanotubes (CNTs), have recently emerged as intriguing NPs of multi-functionality and physicochemical tunability *via* organic reactions.

Here, selected sp^{2+ε}-carbon nanoallotropes (high *versus* low aspect ratio multi-wall CNTs, helical CNTs, graphene)

were synthesized *via* catalytic chemical vapour deposition (c-CVD), functionalized by wet-chemistry methods (carboxylation, formylation, hydroxylation, halogenation, etc.) and comprehensively analysed toward their further exploitation in IoNanofluids. The pre-elaborated synthetic protocols open the route to obtaining novel heat transfer media of enhanced thermophysical properties.

Authors are grateful for the financial support from the Polish National Science Centre Grant No. 2017/27/B/ST4/02748 in the framework of OPUS program.

* * *

Conductivity of carboxylic acid solutions and their salts. Experimental and theoretical problems

BORUŃ Agnieszka

Department of Physical Chemistry, University of Łódź
Pomorska 165, 90-236 Łódź, Poland

Investigations of electrical conductivity of carboxylic acid solutions are one of the most difficult issues of conductometry of electrolyte solutions. The reasons for this are as follows: difficulties in obtaining substances of very high purity, the necessity of working with very dilute solutions, the use of water of exceptional purity, conducting measurements in an inert gas atmosphere, e.g. argon. Many factors affect the quality of experimental results, but also the determination of the limiting conductivity and association constants values of the electrolyte create many difficulties. Therefore, most often, together with the conductivity measurements of carboxylic acid solutions, the conductivity measurements of salt solutions of these acids are carried out. In this work, the limiting molar conductivities of anions of carboxylic acids as a function of number of carbon atoms in the hydrocarbon chain of the anion were analysed.

* * *

Modification of ionic liquids by carbon nanostructures as efficient method of improving physicochemical properties for use as heat transfer fluids

DZIDA Marzena¹, BONCEL Sławomir², ZOREBSKI Edward¹
ZOREBSKI Michał¹, ŻARSKA Monika¹, GOLBA Adrian¹
JĘDRYSIAK Rafał², KOLANOWSKA Anna²
JÓZWIAK Bertrand², KUZIEL Anna²

¹ Institute of Chemistry, University of Silesia in Katowice
Szkolna 9, 40-006 Katowice, Poland

² Faculty of Chemistry, Silesian University of Technology
Krzywoustego 4, 44-100 Gliwice, Poland

Due to the exciting properties of ionic liquids with dispersed nanoparticles (IoNanofluids) such as high thermal conductivity, high isobaric heat capacity, non-flammability, non-volatility they can be potentially used as efficient heat transfer fluids in heating and cooling systems and in chemical engineering. The IoNanofluids containing carbon nanomaterials are particularly interesting because carbon nanomaterials exhibit many unique properties, e.g. high thermal conductivities. Unfortunately, preparation of IoNanofluids is a bit troublesome and a very delicate process which should be standardized to obtain comparable results.

The modification of 1-ethyl-3-methylimidazolium ethyl sulfate by in-house MWCNTs (diameter of 54±31 nm, length of 200±50 µm, BET surface of 34 m²g⁻¹, iron content 5.80 wt %) resulted in an increase of isobaric heat capacity.

This work was financially supported by the Polish National Science Centre Grant No. 2017/27/B/ST4/02748.

* * *

Influence of pressure and alkyl chain length in cation on speed of sound in bis(trifluoromethylsulfonyl)imide-based ionic liquids

DZIDA Marzena, MUSIAŁ Małgorzata
ZOREBSKI Edward, ZOREBSKI Michał

Institute of Chemistry, University of Silesia in Katowice
Szkolna 9, 40-006 Katowice, Poland

Systematic studies of the influence of pressure and alkyl chain length in cation on the speed of sound in series of ionic liquids with different cation and anion structures are rather scarce. Under atmospheric pressure minimum of the speed of sound dependence on the alkyl chain length in cation ($u(n)$) occurs in ionic liquids (ILs) with large, weakly coordinating bis(trifluoromethylsulfonyl)imide anion, i.e. 1-alkyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imides ($[C_nC_1im][NTf_2]$, $n = 2-8$), 1-alkyl-1-methylpyrrolidinium bis(trifluoromethylsulfonyl)imides ($[C_nC_1pyr][NTf_2]$, $n = 3, 4, 6, 8$), and *N*-alkylpyridinium bis(trifluoromethylsulfonyl)imides ($[C_npy][NTf_2]$, $n = 2, 3, 4, 6, 8$). As far as the minimum is rather shallow for the first two homologous series, in the latter case minimum is clearly observed for $[C_6py][NTf_2]$. The minimum is not visible for other series of ILs based on a smaller anion and higher charge density (even for trifluoromethylsulfonate) compared to the ILs with bis(trifluoromethylsulfonyl)imide anion. The increasing pressure shifts the minimum of $u(n)$ dependence to lower alkyl chain in the cation both for series of $[C_nC_1im][NTf_2]$ ($n = 2-6$) and $[C_npy][NTf_2]$ ($n = 2, 4, 6$).

* * *

Effect of pressure on the classical ultrasound absorption for ionic liquids

DZIDA Marzena¹, MUSIAŁ Małgorzata¹
ZOREBSKI Edward¹, ZOREBSKI Michał¹
WOJNAROWSKA Zaneta², PALUCH Marian²

¹ Institute of Chemistry, University of Silesia in Katowice
Szkolna 9, 40-006 Katowice, Poland

² Institute of Physics, SMCEBI
University of Silesia in Katowice
75 Pułku Piechoty 1A, 41-500 Chorzów, Poland

High-pressure ultrasound absorption for ionic liquids has never been measured to this day/so far. Results of ultrasound absorption under atmospheric pressure for very limited number of ionic liquids show that the ratio of experimental to classical absorption (in the low-frequency non-relaxation region) equals to about 2 and the ultrasound absorption coefficient per squared frequency $\alpha \cdot f^{-2}$ decreases with increasing temperature. Thus, knowledge of classical ultrasound absorption ($\alpha_{class} \cdot f^{-2}$) under high-pressure

should allow to estimate roughly high-pressure ultrasound absorption coefficient.

The $\alpha_{\text{class}} \cdot f^{-2}$ at high-pressure was calculated from the Stokes formula for 1-butyl-2,3-dimethylimidazolium bis(trifluoromethylsulfonyl)imide ($[\text{C}_4\text{C}_1\text{C}_1\text{im}][\text{NTf}_2]$), 1-butyl-3-methylimidazolium acetate $[\text{C}_4\text{C}_1\text{im}][\text{OAc}]$, and 1-ethyl-3-methylimidazolium diethyl phosphate $[\text{C}_2\text{C}_1\text{im}][\text{DEP}]$ using measured high-pressure speed of sound, high-pressure density determined by acoustic method and high-pressure viscosity estimated (using Walden rule) from experimental high-pressure electrical conductivity.

The $\alpha_{\text{class}} \cdot f^{-2}$ increases by about 40–50% with increasing pressure up to 100 MPa. The $\alpha_{\text{class}} \cdot f^{-2}$ increases as follows: $[\text{C}_4\text{C}_1\text{C}_1\text{im}][\text{NTf}_2] < [\text{C}_4\text{C}_1\text{im}][\text{OAc}] < [\text{C}_2\text{C}_1\text{im}][\text{DEP}]$.

* * *

Pressure and temperature dependence of density for isopropyl myristate and isopropyl palmitate obtained by acoustic method

DZIDA Marzena, ŻARSKA Monika
ZOREBSKI Edward, ZOREBSKI Michał

Institute of Chemistry, University of Silesia in Katowice
Szkolna 9, 40-006 Katowice, Poland

At atmospheric pressure, the curves for the dependence of density on temperature intersect at 371.65 K and at 345.96 K for methyl and ethyl esters of fatty acids, respectively. The observed intersection temperatures are out of our high pressure-temperature investigation capabilities. Extension of the $p\rho T$ data obtained by the acoustic method to higher temperatures using the Tait equation indicates that this effect probably exists also under high pressure.

In this investigations, the isopropyl esters of fatty acids were selected to confirm the abovementioned intersection point under high pressure using the acoustic method. The crossing point of the curves of temperature dependence of density for isopropyl myristate and isopropyl palmitate was found at 303.15 K under atmospheric pressure. Moreover, it was proved that the crossing point exists at high pressures. Simultaneously, with increasing pressure it moves toward higher temperature, i.e. it equals 316.88 K at 10 MPa and 332.27 K at 20 MPa.

* * *

The investigations of complexation of α -D-glucose by DMSO in pseudo-binary system using ultrasounds

KACZMAREK-KLINOWSKA Milena, HORNOWSKI Tomasz
JÓZEFCZAK Arkadiusz

Institute of Acoustics, Faculty of Physics
Adam Mickiewicz University
Umultowska 85, 61-614 Poznań, Poland

Complex organic compounds are widely used in medicine, because they not only permit the transport of drugs in living organism, but also eliminate the undesirable components from many substances. The paper reports the study of the complexation processes in aqueous solution of α -D-glucose and DMSO. The purpose of this study was to determine whether α -D-glucose has the ability to connect to the larger ring particles allowing to create inclusion complexes similar to those formed by cyclodextrins which

– as it is already known – have this property. This hypothesis is based on the fact that alpha-cyclodextrin consists of six particles of α -D-glucose. The possibility of replacing the α -cyclodextrin by α -D-glucose would lower the costs of obtaining such complexes.

There is much information concerning the process of formation complex organic compound in liquid phase that can be gathered by the measurements of ultrasound speed as a function of the mixture composition. In this study the speed of sound was measured by the resonance method using Resoscan™System apparatus. Some collateral data such as density and heat capacity of the system have also been measured. On the basis of the experimental data the excess adiabatic compressibility was determined. The extremes of the excess adiabatic compressibility function for different mixture compositions allowed us to establish the composition of molecular complexes formed in the solution. The obtained results suggest the formation of the α -D-glucose with DMSO inclusion complexes with chemical stoichiometric ratio value of 1:1.

* * *

Influence of tissue-mimicking phantom compressibility on effectiveness of magnetic hyperthermia

KACZMAREK Katarzyna¹, MRÓWCZYŃSKI Radosław²
HORNOWSKI Tomasz¹, JÓZEFCZAK Arkadiusz¹

¹ Institute of Acoustics, Faculty of Physics

² NanoBioMedical Centre, Adam Mickiewicz University
Umultowska 85, 61-614 Poznań, Poland

Magnetic hyperthermia is a novel thermal therapy. During magnetic hyperthermia magnetic nanoparticles placed in AC magnetic field become the source of heat. It has been shown that in fluid suspensions magnetic particles move freely and easily generate heat. However, in tissues of different mechanical properties, nanoparticles movement will be limited and generated heat will only increase slightly their temperature. Therefore it is crucial to conduct magnetic hyperthermia experiments in conditions highly similar to human body. The effect of tissue-mimicking phantom compressibility on effectiveness of magnetic hyperthermia was investigated. Single and cluster nanoparticles were used as a magnetic material. Results show that the greater the compressibility, the greater the thermal effect of magnetic hyperthermia.

This work was supported by the Polish National Science Centre grants: NCN/2015/17/B/ST7/03566 and NCN/2017/27/N/ST7/00201.

* * *

Ferronematics-liquid crystalline materials for sensing of magnetic fields

KOPČANSKÝ Peter

Institute of Experimental Physics
Slovak Academy of Sciences
Watsonova 47, 040 01 Košice, Slovakia

Suspensions of magnetic nanoparticles (MNPs) in nematic liquid crystals (LC), the so-called ferronematics (FNs), have become a promising material with enhancing

sensitivity to magnetic field. Assuming that a stable, optically transparent, and homogeneous FNs are synthetized, it would give a strong push for the development of many kinds of new magnetically controlled LC-devices. As an illustration, this is the way to obtain magnetovision camera with the possibility of mapping the magnetic field in space. The variety of physical processes in magnetic suspensions, complexity of the system and potential applications encourage scientists to continue studies of these materials, despite the fact that the main features of the magnetic LC suspensions were established almost 40 years ago.

The presentation illustrates the basic theory of FNs as well as the recent experimental works that reflect the modern trends of the FNs research with a special attention to understanding of major physical mechanisms responsible for the influence of MNPs on the properties of LCs.

* * *

High pressure acoustic spectroscopy of Kneser liquids

LINDE Bogumił B.J.¹, ESANOV Umbar M.²

¹ University of Gdańsk

Bażyńskiego 8, 80-309 Gdańsk, Poland

² Turkmenistan Academy of Sciences

Bitaraplyk şaýoly, Aşgabat 744000, Turkmenistan

The research of acoustic parameters of chemical compounds depending on temperature and pressure, the magnitudes which have a big influence on the equilibrium state of fast physical and chemical processes, allows to obtain more accurate and correct information on the mechanisms of intra- and intermolecular interactions and energy transfer paths in liquid molecules. Thermodynamic conditions have a very significant effect on the processes of relaxation in liquids. High pressure can significantly change the distances between molecules, and therefore the conditions for energy transmission are heavily changed.

The processes mentioned above can be successfully tested using acoustic spectroscopy methods. Acoustic measurements depending on the pressure help in determining the type of processes that are mainly responsible for acoustic absorption and facilitate the detection of Kneser-type processes so-called energy transfer between translational and vibrational degrees of freedom.

This paper presents a pressure cell for an acoustic spectrometer and a study of the influence of high pressure on acoustic absorption in Kneser liquids (tetrahydrothiophene, bromobenzene etc.) in the frequency range 30–110 MHz and pressures between 0.1 and 100 MPa.

The investigations of the absorption of ultrasonic waves depending on the pressure for a series of liquids confirm earlier assumption that acoustic relaxation in these is caused by Kneser's processes.

The following conclusions can be withdrawn from the investigations: acoustic absorption decreases and the relaxation time decreases with increasing pressure. This is consistent with the prediction of the vibrational relaxation theory. The increase in pressure decreases the distance between molecules, which increases the number of collisions

per unit of time. And this causes an increase in the probability of energy transfer, i.e. shortens the relaxation time and reduces acoustic absorption.

The obtained results from experimental tests were interpreted in accordance with the theory of isolated binary collisions.

* * *

Magnetic field effect on thermal, dielectric and viscous properties of a transformer oil-based magnetic nanofluid

TIMKO Milan

Institute of Experimental Physics

Slovak Academy of Sciences

Watsonova 47, 040 01 Košice, Slovakia

Liquid dielectrics in power engineering provide electrical insulation, cooling, and serve as a diagnostic medium in electrical apparatus. Extreme efforts are being put into modifying the transformer oils (TO) by preparation of nanofluids. Magnetic nanofluids (MNFs) are of special interest, as their flow and heat transfer are controllable by magnetic field. Under the applied field, the magnetic nanoparticles (MNPs) may form assemblies resulting in the change of the nanofluid's physical properties.

In this paper, we report on experimental study of magnetic nanofluid based on transformer oil MOL TO 40 and magnetite nanoparticles. An unusual anisotropy in thermal conductivity of the nanofluid in magnetic field is presented in regard to the field geometry. Magneto-dielectric and magneto-viscous effect in the prepared nanofluid was observed too. Suitability of the studied nanofluid for potential application in electrical engineering is considered.

* * *

The structural properties of benzene, toluene and their halogen-substituted compounds at high pressures

VERVEYKO Vyacheslav N., VERVEYKO Marina V.

Kursk State University

Radischeva 33, 305000 Kursk, Russia

Clusters are present in liquids and define their structural and physical properties. Using the cluster model and experimental data on the density of the liquids we have calculated the most probable, average and root-mean-square number of particles in the clusters of analysed aromatic hydrocarbons depending on the temperatures 293–423 K and pressures 0.1–600 MPa. It has been established that the dependencies for benzene and its halogen-substituted compounds are similar for toluene and its halogen-substituted compounds. Increase in pressure and decrease in temperature lead to increase in the number of particles in the clusters. The introduction of halogens leads to increase in the number of particles in the clusters (exception is fluorine), being correlated to the molar mass.

* * *