47th Winter School on Wave and Quantum Acoustics

PROGRAMME and ABSTRACTS

Organizers of WSWQA 2018

Upper Silesian Division of the Polish Acoustical Society

in cooperation with the

Committee of Acoustics of the Polish Academy of Sciences

26th February to 2nd March 2018,
Hotel "META"
Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

Dear Participants of the 47th WINTER SCHOOL

on WAVE and QUANTUM ACOUSTICS 2018

The organizers of the WSWQA would like to welcome all of you very cordially to Szczyrk, the heart of the Beskidy Mountains.

The 47th Winter School consists of:

- 14th Workshop on Acoustoelectronics;
- 14th Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods.

We wish all the Participants of the 47th Winter School plenty of scientific satisfactions and many professional and social impressions.

This book contains Programmes of both Workshops and summaries of works which will be presented within 47th WINTER SCHOOL on WAVE and QUANTUM ACOUSTICS 2018.

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14th Winter Workshop on Acoustoelectronics (AE)

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PROGRAMME OF THE 14TH WORKSHOP ON ACOUSTOELECTRONICS

Szczyrk, 26 February – 1 March 2018

26.02.2018 Monday	
13:00	***Lunch***
14:30-14:35	**OPENING CEREMONY of conferences:** **47th WSW&QA** **46th WSEA&V** **13th IOS'2018**
14:35-15:00	**Jubilee of 45 years of scientific research and scientific acitivities of Professor Tadeusz Pustelny**
15:00-18:30	**SESSIONS DEDICATED TO PROF. TADEUSZ PUSTELNY**
15:00-15:30	*Invited lecture* **Theoretical and numerical researches on the propagation of waves in the shallow sea** E. KOZACZKA, G. GRELOWSKA
15:30-16:00	*Invited lecture* **New trends in the development of radar technology** A. KAWALEC
16:00-16:30	*Invited lecture* **Roadmap on liquid-crystal fiber optics and photonics** T. WOLIŃSKI, S. ERTMAN, K. RUTKOWSKA
16:30-17:00	***Coffee break***

17:00-18:30	**SESSION SHARED WITH IOS'2018**
17:00-17:30	**System for the spatial visualization of hypodermic blood vessels** Z. OPILSKI
17:30-17:50	**Optical fiber current sensor with external conversion in high voltage environment** K. BARCZAK, K. MAŹNIEWSKI, D. DUDA
17:50-18:10	**Broad-band planar waveguide interferometers** K. GUT
18:10-18:30	**Nonlinear optics in gas-filled photonic crystal fibers** Sz. PUSTELNY, A. UMIŃSKA, M. GRABKA, C. PERRELLA, P. LIGHT, A. LUITEN
19:00-20:00	***Supper***
20:00	**MUSIC GLANCE – moment with a string quartet**

27.02.2018 Tuesday	
8:00	***Breakfast***
13:00	***Lunch***
15:00-15:30	**Propagation of a sound wave through multi-port above the low frequency limit** A. SNAKOWSKA, J. JURKIEWICZ
15:30-16:00	**Automatic identification of breast cancer based on ultrasound tomography images** K. OPIELIŃSKI
16:00-16:30	**Distribution of acoustic field of ultrasonic multi-element ring probe** W. STASZEWSKI, T. GUDRA K. OPIELIŃSKI
16:30-17:00	***Coffee break***
17:00-17:30	**Measurement of mechanical properties of polymers using quartz crystal microbalance.** K. JASEK, M. GRABKA, M. PASTERNAK
17:30-18:00	**Experimental and numerical analysis of the recovery in non-steady step and steady stage of a SAW Structure with PANI+Nafion on action of carbon monoxide** T. HEJCZYK
18:00-18:30	**Application of acoustic emission for non-destructive testing of pressure vessels with hydrogen** F. WITOS, A. OLSZEWSKA, Z. OPILSKI, M. SETKIEWICZ
18:30-19:00	***Poster session – preparation of posters***
19:00-20:00	***Supper***
20:00	**POSTER SESSION**

	POSTER SESSION
20:00	**Spectral analysis of the noise spectrum of electric discharges, recorded using an acoustic camera** T. BOCZAR, T. MALEC, M. KOZIOŁ
	Evaluation of the effectiveness of selected clustering methods for identification of acoustic emission signals generated by partial discharges occurring in paper and oil insulation S. BORUCKI, J. ŁUCZAK, D. ZMARZŁY
	Variability of the Acoustic Emission Signals Generated by Partial Discharges under Long-Term AC Voltage M. KUNICKI, A. CICHOŃ
	Acoustic emission and ionizing radiation - a comparative analysis of partial discharges detection methods Ł. NAGI, M. KUNICKI, D. ZMARZŁY, P. FRĄCZ
	Analysis of acoustic emission signals emitted by partial discharges in transformer oil in the presence of gaseous inclusions S. WAWRZYNIAK, P. FRĄCZ

28.02.2018 Wednesday	
8:00	***Breakfast***
13:00	***Lunch***
14:30-19:00	**SESSION SHARED WITH IOS'2018**
14:30-15:00	*Plenary lecture* **Formation and steering of vortex spatial solitons in soft matter** V. SHVEDOV, Y. IZDEBSKAYA, P. JUNG, K. CYPRYCH, W. KRÓLIKOWSKI
15:00-15:15	**Photonic sensors of the magnetic field using NV color centers in diamond** W. GAWLIK, A. KRUK, M. MRÓZEK, A. WOJCIECHOWSKI
15:15-15:30	**Boron-doped diamond nanosheets – A route towards transparent diamond-on-graphene heterojunction** M. FICEK, M. SOBASZEK, J. KARCZEWSKI, Ł. GOŁUŃSKI, A. NOSEK, M. BOCKRATH, A. Jaramillo-Botero, W. GODDARD, M. GNYBA, T. OSSOWSKI, R. BOGDANOWICZ
15:30-15:45	**Nanodiamond films for optical fiber sensors** D. MAJCHROWICZ, M. JĘDRZEJEWSKA-SZCZERSKA
15:45-16:00	**Optical response and applications of selected azo polymers** A. KOZANECKA-SZMIGIEL, J. KONIECZKOWSKA, D. SZMIGIEL, J. ANTONOWICZ, K. RUTKOWSKA, E. SCHAB-BALCERZAK
16:00-16:15	**Self-organizing, one-dimensional periodic structures in 5CB doped with gold nanoparticles** K. BEDNARSKA, P. LESIAK, K. ORZECHOWSKI, T. OSUCH, K. MARKOWSKI, M. WÓJCIK, W. LEWANDOWSKI, T. WOLIŃSKI
16:15-16:30	**Selected technological aspects of semiconductor samples preparation for Hall effect measurements** K. GORCZYCA, J. BOGUSKI, J. WRÓBEL, P. MARTYNIUK
16:30-17:00	***Coffee break***

17:00-17:30	*Plenary lecture* **Detection of single adsorbing nanoparticles by plasmon assisted microscopy** P. WRÓBEL, T. ŠPRINGER, J. HOMOLA
17:30-17:45	**Mobile biometric verification of passengers based on fingerprints** N. PAŁKA, M. SZUSTAKOWSKI, E. CZERWIŃSKA, J. MŁYŃCZAK, K. FIRMANTY, M. WALCZAKOWSKI, M. KOWALSKI, M. SOBCZAK, M. NAWROCKI, P. HOŁOWENKO, P. POŹNIAK, S. PACHLA, T. NISKI, M. KRASZEWSKI-CĄKAŁA, P. ŻYCKI, K. POPŁAWSKI
17:45-18:00	**Side-polished optical fiber sensor** N. MALINOWSKA, M. POPENDA, E. BEREŚ-PAWLIK
18:00-18:15	**A high-precision interferometric system for fast non-contact measurements of lens thickness** O. KARCZEWSKI, M. NAPIERAŁA, Z. HOŁDYŃSKI, K. WILCZYŃSKI, S. LIPIŃSKI, P. POLAK, T. STAŃCZYK, M. SZYMAŃSKI, T. NASIŁOWSKI
18:15-18:30	**Distributed Optical Fiber Sensors based on Photonic Crystal Fibers for Advanced Sensing Applications** A. DOMINGUEZ-LOPEZ, L. SZOSTKIEWICZ, M. NAPIERALA, T. NASILOWSKI
18:30-18:45	**Metal coated dual-core fiber for interferometric temperature measurement in high temperatures** K. MARKIEWICZ, A. MAKOWSKA (ZIOLOWICZ), L. SZOSTKIEWICZ, A. KOLAKOWSKA, J FIDELUS, T. STANCZYK, K. WYSOKINSKI, D. BUDNICKI, L. OSTROWSKI, M. SZYMANSKI, M. MAKARA, K. POTURAJ, T. TENDERENDA, P. MERGO, T. NASILOWSKI
18:45-19:00	**Distributed curvature measurements using C-OTDR and 7-core microstructured fiber** K. WILCZYŃSKI, Ł. SZOSTKIEWICZ, M. NAPIERAŁA, A. PYTEL, A. KOŁAKOWSKA, A. DOMINGUEZ-LOPEZ, T. NASIŁOWSKI
19:30	***Festive Supper (Banquet)***

1.03.2018 Thursday	
8:00	***Breakfast***

ABSTRACTS
FOR THE 14TH WORKSHOP ON ACOUSTOELECTRONICS

Optical fiber current sensor with external conversion in high voltage environment

Kamil Barczak[1], Krzysztof Maźniewski[2], Dominik Duda[2]

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The presented work is concentrated on investigation of electric properties of optical fiber current sensor with external conversion [1]. The sensor was examined in the presence of high voltage (up to 30 kV). Moreover, there was one high voltage trial at 70 kV for 1 min. [2].

High voltage tests showed very good insulating properties of the sensor. A leakage current was estimated. It's value was lower than for high-voltage ceramic insulator.

References:

[1] K. Barczak, K. Maźniewski, *Investigation of optical fiber current sensor with external conversion in AC magnetic field*, Proceedings of SPIE; vol. 10325 0277-786X, (2017).

[2] D. Duda, K. Maźniewski, M. Szadkowski, *Electro-insulating covers of rigid busducts 110 kV as part of the additional shock protection*, Przegląd Elektrotechniczny. No 10/2016, pp. 116-119, (2016).

Spectral analysis of the noise spectrum of electric discharges, recorded using an acoustic camera

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The article presents the possibilities of recording and analyzing the acoustic signal emitted by electrical discharges using an acoustic camera based on a spherical matrix. The tests were carried out in a laboratory conditions for three model sources of electric discharges, such as: a free-burning electric arc, surface discharges and discharges generated using a Tesla transformer. The generation of electric discharges was carried out in air with constant atmospheric parameters, such as: temperature, pressure and air humidity.

As part of the conducted research, the main source of acoustic emission was analyzed and characteristic spectral components for adopted systems generating electrical discharges were appointed. For selected components, the main places of acoustic wave generation are indicated. In addition, an attempt was made to determine individual parameters characterizing the acoustic signals emitted by electrical discharges, in order to determine the possibility and indication of the scope of application of a new measuring tool in the high-voltage diagnostics for air insulation systems.

Evaluation of the effectiveness of selected clustering methods for identification of acoustic emission signals generated by partial discharges occurring in paper and oil 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.

Broad-band planar waveguide interferometers

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Growing demand for efficient and inexpensive diagnostic devices in the healthcare and pharmaceutical industry is a major driving force behind the development of biochemical sensors. Different types of label-free biochemical sensors that are highly sensitive and can be miniaturized have been developed. Sensors of this type are non-invasive and resistant to external magnetic fields. Optical detection also allows a simultaneous measurement of several analytes. Biochemical optical label-free sensors utilize changes in the refractive index that occur near the surface on which the chemical reaction occurs or, more precisely, changes that occur within the field of penetration of

the evanescent field of the light propagated in the planar structure. Changes of the refractive index of the surface area cause changes in the physical parameters field of the light propagated in the planar structure

Relatively recently it proposed distribution a division of waveguide interferometers system into common and double path ones [1] (single channel and two channel ones [2]). 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 [1] 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 [3]. 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 [4,5].

Integrated Optical Broad-Band Difference Interferometer is introduced as an alternative and economical measurement method to integrated optical label-free affinity sensors. A detailed theoretical analysis of the method will be presented and the effects of the waveguide layer on the operation of the system will be shown. A very short operating distance of less than 0.5 mm allows miniaturization of the interferometer. The analysis was performed for Si3N4/SiO2 layers that can be obtained in standard microelectronics technological processes [6].

References:

[1] Kozma P. et al. Integrated planar optical waveguide interferometer biosensors: A comparative review BIOSENSORS & BIOELECTRONICS Vol. 58, pp. 287–307, (2014)
[2] Campbell D. Interferometric Biosensors, chapter in the book: Principles of Bacterial Detection, Springer (2008).
[3] Qi Z. et al. Spectropolarimetric interferometer based on single-mode glass waveguides OPTICS EXPRESS Vol. 16 (3) pp.2245-2251(2008).
[4] Kitsara M. et al. Integrated optical frequency-resolved Mach-Zehnder interferometers for label-free affinity sensing., OPTICS EXPRESS Vol.18 (8) pp. 8193-8206 (2010).
[5] Misiakos K. et al. Broad-band Mach-Zehnder interferometers as high performance refractive index sensors: Theory and monolithic implementation, OPTICS EXPRESS Vol.22 (8) pp. 8856-8870 (2014).
[5] Gut K. Broad-band difference interferometer as a refractive index sensor, OPTICS EXPRESS Vol.25 (25) pp. 31111-31121 (2017).

Experimental and numerical analysis of the recovery in non-steady 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 recovery 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 recovery 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 recovery 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.

Measurement of mechanical properties of polymers using quartz crystal microbalance

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Quartz crystal microbalance (QCM) was developed for small mass measurements using resonators operating with thickness-shear mode. Moreover, the device was successfully applied to measurement of thin films thickness, dynamic viscosity of liquids and chemical sensors construction. It can be also used to measure both the real and imagine parts of shear moduli of polymer films deposited on QCM surface as well as their rheological parameters. The knowledge of the polymer properties is very important in many science and technology domains. Especially, it is necessary for the semi-phenomenological modelling of polymer-based acoustic devices.

In the work QCM overtone oscillations spectrum analysis was applied to determination of polymer films moduli. The effect of deposited film on the response of quartz resonator were examined with respect to frequency response and electrical properties of the equivalent circuit. The usefulness of the proposed procedure was demonstrated for chosen examples of polymer films.

New trends in the development of radar technology

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The selected radar applications and radar types including MIMO radar architectures, passive radar, noise radar and the ground penetration radar are presented.

The analysis of a new trends such as the path towards future fully digital frontends and software defined radar are described in the paper. In the analysis adaptive antenna arrays and real time digital signal processing are taken into account. High performance digital signal processing and transmit/receive (T/R) modules have made possible to use active electronically scanned array (AESA) technology will also be discussed. The develop of the transmit/receive modules using gallium nitride (GaN) technology applied in a radar systems will also be presented.

Selected waveforms of radar signal are also important from the point of view of radar detection through its electromagnetic radiation. The application for the radar signal processing is demonstrated.

The new configuration have already showed interesting properties, especially at the detection of low RCS targets. This will make it possible to combine the benefits of the different types of radar systems.

The advances in computer science are important that can now provide data and signal processing in real time.

In this paper an advances technologies for future radar are outlined.

Theoretical and numerical researches on the propagation of waves in the shallow sea

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The work is devoted to the propagation of low frequency waves in a shallow sea. As a source of acoustic waves underwater disturbances produced by ships were adopted. Propagation of acoustic waves in shallow water is specific in that the closeness of boundaries of the limiting media characterized with different impedance properties results in the acoustic field coming from a source situated in the water layer being "deformed" by different phenomena. The distribution of the acoustic field in the real shallow sea is affected not only by multiple reflections, but also by stochastic changes in the shape of the free surface, and by the statistical changes in the shape and impedance of the seabed. In the paper, fundamental problems of modal sound propagation in the water layer over different types of bottom sediments are discussed. The basic task in this case is to determine the acoustic pressure level as function of distance and depth. Results of the conducted investigation can be useful in indirect determination of the type of bottom.

Variability of the Acoustic Emission Signals Generated by Partial Discharges under Long-Term AC Voltage

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The main purpose of the presented research is to investigate the partial discharge (PD) phenomenon variability under long-term AC voltage with particular consideration of the selected physical quantities changes while measured and registered by acoustic emission method (AE). During the research a PD model source generating surface discharges is immersed in the brand new insulation mineral oil. The high voltage (HV) electrode is 1cm thick brass plate with a diameter of 3 cm, while the grounded electrode is 1cm thick steel plate with a diameter of 12cm. There is also a square solid dielectric barrier made of 8mm thick Teflon (PTFE) and the size of 15x15cm placed between the both electrodes. The PD source is powered by an AC voltage with its relative level of 1.3 of the inception voltage (Ui) of the PD source within 168 hours. The AE method is applied for measurements on the signals generated by PDs. Post-measurement signal processing and analysis are proceeded by the Matlab software. Acoustic signals generated by the continuously occurred PDs within 168 hours are registered. Various qualitative as well as quantitative indicators that describe the PD variability in time are assigned. Furthermore some long-term characteristics of the applied PD model source in mineral oil are also presented according to acoustic signals emitted by the PD. Finally various statistical tools are applied for the results analysis and presentation. Despite there are various contemporary research papers dealing with long-term PD analysis, such complementary and multiparametric approach has not been presented so far, regarding the presented research. Usually electrical method is applied as well as a paper solid barrier (instead of PTFE) are commonly investigated. According to the presented research form among all assigned indicators there are discriminated descriptors that depend as well as not depend on PD long-term duration. On the grounds of the regression models analysis there are discovered trends that potentially allow to apply the results for modeling of the PD variability in time using acoustic emission method. Subsequently such approach may potentially support the development and extend the abilities of the diagnostic tools and maintenance policy in electrical power industry.

Acoustic emission and ionizing radiation - a comparative analysis of partial discharges detection methods

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The article presents results of measurements of the acoustic emission, electrical method and ionizing radiations generated during partial discharges. The research was carried out in a high voltage technique laboratory located at the Opole University of Technology. Model system is a tank filled with oil, and the point-point spark gaps placed inside. The presented results include the dependence of recorded signals on the distance between the electrodes for each method used.

Automatic identification of breast cancer based on ultrasound tomography images

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Nowadays, health-care centres are moving from heavy reliance on standard diagnostic tools to digital systems that can mediate in diagnosing automatically. Ultrasound methods offer many real-time modalities belonging to the most interesting methods for non-invasive imaging of tissue. Ultrasound tomography (UT) imaging provides both quantitative and qualitative information from ultrasound signals transmitted through breast structure and reflected around from it. Ultrasound speed is found to be greater in tumor breast tissue than in healthy tissue, and the speed characteristics allow differentiating fat, glandular tissue and compact masses. Increased scattering and absorption of ultrasound in malignant lesions causes ultrasound attenuation to increase. The combination of ultrasound speed and attenuation distribution provides an effective method for the discrimination between benign and malignant tumors. This work presents the method which allows in vivo visualization of a breast structure based on two transmission UT images and by automatically identifying areas of fat and glandular tissue, as well as areas of benign or malignant lesions, with the background of the reflection UT image of structures scattering ultrasound.

System for visualization of hypodermic blood vessels

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The paper presents the effects of the work carried out to build a device for spatial visualization of hypodermic blood vessels. The device was built using a illuminators using polarized light with the wavelength λ = 850 nm and two cameras in a stereoscopic set up equipped with polarizers and interference filters with transmission adjusted to illuminators. Images captured by cameras are analyzed by software that increases the contrast of blood vessels and extracts information about the distance from the hypodermic blood vessels to cameras. In this way extracted course of blood vessels is recorded in the DICOM format, widely used in medicine.

Nonlinear optics in gas-filled photonic crystal fibers

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Due to their unique properties (negative dispersion, endlessly single-mode propagation, controllable birefringence, etc.), photonic-crystal fibers (PCFs) are the subject of intense studies in many laboratories all over the world. On their own, however, the fibers do not support rise of spectrally-narrow optical resonances that are of crucial importance in various quantum-optic and photonic applications. On the other hand, such signals can be generated in gases, where control over parameters of light, drastic changes optical properties of the medium. This enables all-optical control over transmitted light intensity or drastic change of propagating light group velocity (sub- and superluminal light propagation).

During the talk, we will present our investigations on a hybrid system combining advantages of both PCFs and gases. We will present an experimental scheme, where extremely low-power light controls generation of spectrally narrow (nonlinear) optical resonances. We will discuss various challenges related with operation with such a system. Experimental results demonstrating the ability to control optical density of fiber filling media will be provided. We will conclude with presentation of experimental data demonstrating propagation of light pulse through the gas-filled PCFs with a group velocity larger than the speed of light in vacuum.

Propagation of a sound wave through multi-port above the low frequency limit

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The paper presents the new approach to analyse the acoustical systems containing one or more duct like elements (joints) connected by undefined elements called sometimes “black boxes”. This approach can be applied to systems containing one outlet, as in the case of a semi-infinite duct, but also two and more exhausts like in case of mufflers of complicated design. The N-port method (N=1, 2, 3...) can be developed based on a number of different formulations dependent on the choice of two state variables at each duct-like joint of a system. The state variables could be chosen from the sound pressure, the volume velocity or the sound pressures of waves propagating in and out. Depending on the state variables the formalisms are called: transfer matrix formalism, impedance matrix formalism, admittance formalism and the scattering matrix formalism. All of these formalisms mentioned above are equivalent and the unequivocal transformation from one to another was derived in the paper. In general, the considered acoustic system can be composed of a number K of joints connecting some subsystems/elements such as mufflers, branches or much complex elements, acoustic properties of which are detected indirectly based on relations between state variables on selected cross sections of joints coming out from the element in question. The elements can form a cascade, and then each of them is located between two joints, except the elements at the ends of the cascade. In this case the transmission matrix is the most suitable, but it is not applicable to systems containing other number of joints. Then the scattering matrix formalism, which is the most flexible, is applied most frequently. The analogy with electrical multi-ports is used within the study.

Distribution of acoustic field of ultrasonic multi-element ring probe

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In the paper the results of simulation universal method of determining the distribution of acoustic field of multielement probes with 1024 piezoelectric transducers designed for applications in ultrasound transmission tomography (UTT) are presented. The main idea of this method is summing the acoustic fields generated by elementary transducers by means of geometrical transformations of coordinates of location of discussed points of the acoustic field against each of the transducers. This method allows us to calculate the acuostic field for different sectors of the probe with assigned geometry of elementary transducers' location. The ring probe was devided into 32 sections, each containing 32 transducers. In order to verify the cslculations, the results were compared with previously performed measurements of the acoustic field distribution. Simulations were performed for one sector of the multi-element ring probe. The tests will be able to check the consistency of the acoustic field inside the ring probe. On the basis of the obtained results it will be possible to optimize the method of stimulation of elementary transducers of the ring probe. The results will be used in the visualisation of internal structures of biological tissues in the ultrasound transmission tomography.

Analysis of acoustic emission signals emitted by partial discharges in transformer oil in the presence of gaseous inclusions

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This paper presents analysis of acoustic emission signals (AE) generated by partial discharges (PD) in transformer oil. In the first part of the measurement the AE signals emitted by PD in transformer oil were recorded. In the second part only AE signals emitted by gaseous inclusions in that oil. Then a third measurement was made - AE signals generated by PD in the insulating oil in the presence of gaseous inclusions. Two research objectives have been set. The first - to check whether there are differences in the AE signals generated by PD in the presence of gaseous inclusions (air bubbles) and without them through frequency and time-frequency comparative analyzes. The second is to develop a methodology for isolating the AE signal of PD from the interfering signal generated by of gaseous inclusions by indicating useful analysis bands that will allow to isolate PD signals from the background. In the longer term, the application of the proposed denoising of AE signals from PD can potentially be used for non-invasive diagnostics of electrical power devices.

Application of acoustic emission for non-destructive testing of pressure vessels with hydrogen

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The paper discusses microscopic and macroscopic sources of acoustic emission (AE) in metals and the Kaiser effect, Felicity effect and Dunegan corollary describing the state of the investigated metals or objects made of metals. The research methodology with a view to determining the state of metallic pressure vessels using acoustic emission as a non-destructive testing method is presented.

It is presented built measuring system with an integral part in the form of a 36-channel AMSY-6 measurement system from Vallen in an intrinsically safe version and built mobile AE laboratory dedicated to the study of selected industrial facilities

An analysis of test results for 3 pressure vessels with hydrogen are presented. Each study requires the construction of a network of AE sensors ensuring the location of AE sources and the implementation of the planned course of pressure changes in the examined object. The analysis includes counts, events and localized events recorded during "stops" and during "changes" in two cycles of loads performed in the study. In addition, selected AE pulses are analyzed. The final results of the analysis present the classification of sources and the forecast of the state of the object under study.

Roadmap on liquid-crystal fiber optics and photonics

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The roadmap provides an outlook on the field of liquid-crystal fiber optics and photonics. It starts from early works with classical optical fibers modified with liquid crystals and ends up with the latest achievements in nanoparticles-enhanced photonic liquid crystal fibers. Potential applications as well advances in science and technology required to meet future challenges are shortly addressed.

47th Winter School on Wave and Quantum Acoustics

14th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods (MAR&CM)

PROGRAMME and ABSTRACTS

Organizers of WSWQA 2018

Upper Silesian Division of the Polish Acoustical Society

in cooperation with the

Committee of Acoustics of the Polish Academy of Sciences

26th February to 2nd March 2018,
Hotel "META"
Szczyrk - Beskidy Mountains, POLAND

http://ogpta.pl

PROGRAMME OF THE 14TH WORKSHOP ON MOLECULAR ACOUSTICS, RELAXATION AND CALORIMETRIC METHODS

Szczyrk, 26 February – 1 March 2018

26.02.2018 Monday	
13:00	***Lunch***
14:30-14:35	**OPENING CEREMONY of conferences:** **47th WSW&QA** **46th WSEA&V** **13th IOS'2018**
14:35-15:00	**Jubilee of 45 years of scientific research and scientific acitivities of Professor Tadeusz Pustelny**
15:00-18:30	**SESSIONS DEDICATED TO PROF. TADEUSZ PUSTELNY**
15:00-15:30	*Invited lecture* **Theoretical and numerical researches on the propagation of waves in the shallow sea** E. KOZACZKA, G. GRELOWSKA
15:30-16:00	*Invited lecture* **New trends in the development of radar technology** A. KAWALEC
16:00-16:30	*Invited lecture* **Roadmap on liquid-crystal fiber optics and photonics** T. WOLIŃSKI
16:30-17:00	***Coffee break***

17:00-18:30	SESSION SHARED WITH IOS'2018
17:00-17:30	**System for the spatial visualization of hypodermic blood vessels** Z. OPILSKI
17:30-17:50	**Optical fiber current sensor with external conversion in high voltage environment** K.BARCZAK, K. MAŹNIEWSKI, D. DUDA
17:50-18:10	**Broad-band planar waveguide interferometers** K. GUT
18:10-18:30	**Nonlinear optics in gas-filled photonic crystal fibers** Sz. PUSTELNY, A. UMIŃSKA, M. GRABKA, C. PERRELLA, P. LIGHT, A. LUITEN
19:00-20:00	***Supper***
20:00	**MUSIC GLANCE – moment with a string quartet**

27.02.2018 Tuesday	
8:00	***Breakfast***
13:00	***Lunch***
14:15-14:25	**Opening of the 14th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods**
14:25-18:25	**SESSION DEDICATED TO PROFESSOR BOGUMIŁ B. J. LINDE IN CELEBRATION OF HIS 70TH BIRTHDAY**
14:25-15:10	**Relaxation in several derivatives of benzene** BOGUMIŁ B. J. LINDE
15:10-15:30	**Hydration of polyethylene glycol monododecyl ethers in their diluted aqueous solutions** ANDRZEJ BURAKOWSKI, JACEK GLIŃSKI, MARCUS RIEDERER
15:30-16:10	**Conductometric studies on the ionic association of selected imidazolium ionic liquids in various solvents** AGNIESZKA BORUŃ
16:10-16:30	**Densities, refractive indices and express properties of tetrachloromethane with 2-methoxyethanol at various temperatures** DOROTA CHĘCIŃSKA-MAJAK
16:30-17:00	***Coffee break***
17:00-17:45	*Invited lecture* **Drops with particles: physical mechanisms for particle assembly** ZBIGNIEW ROZYNEK, ALEXANDER MIKKELSEN
17:45-18:05	**Destruction of amyloid structures with the help of ultrasonics, hyperthermia and radiation treatments in the presence of magnetic nanoparticles** PETER KOPČANSKÝ, KATARINA SIPOSOVA, MATUS MOLCAN, MILAN TIMKO, ARKADIUSZ JÓZEFCZAK, ANDRZEJ SKUMIEL, BŁAŻEJ LESZCZYŃSKI, IVAN HAYSAK

18:05-18:25	**New composites based on liquid crystals with superionic nanoparticles: development, preparation dielectric and acoustic properties** MILAN TIMKO**,** PETER KOPČANSKY, IHOR P. STUDENYAK, OLEXANDER V. KOVALCHUK
18:30-19:00	***Poster session – preparation of posters***
19:00-20:00	***Supper***
20:00	**POSTER SESSION**
20:00	**POSTER SESSION** **Manipulation of microparticles in oil droplets by ultrasonic and electric fields** PETER KESA, ARKADIUSZ JÓZEFCZAK, ZBIGNIEW ROZYNEK **Fabrication of particle capsules and their manipulation in electric and acoustic fields** JOANNA BANASZAK, ARKADIUSZ JÓZEFCZAK, ZBIGNIEW ROZYNEK

28.02.2018 Wednesday	
8:00	***Breakfast***
13:00	***Lunch***
15:00-15:50	*Invited lecture* **Theranostic ultrasound** ARKADIUSZ JÓZEFCZAK
15:50-16:10	**Heating induced by focused ultrasound (FUS) in the presence of magnetic nanoparticles** KATARZYNA KACZMAREK, ARKADIUSZ JÓZEFCZAK, BERNADETA DOBOSZ, TOMASZ HORNOWSKI
16:10-16:30	**Monitoring of Pickering emulsions formation by optical microscopy and ultrasounds** RAFAŁ BIELAS, ARKADIUSZ JÓZEFCZAK, ZBIGNIEW ROZYNEK
16:30-17:00	***Coffee break***
17:00-17:20	**Thermodynamic speed of sound in Ionic Liquids-principles** MAŁGORZATA MUSIAŁ, MARZENA DZIDA, EDWARD ZORĘBSKI, MICHAŁ ZORĘBSKI
17:20-17:40	**Thermodynamic speed of sound in Ionic Liquids-applications** MARZENA DZIDA, MAŁGORZATA MUSIAŁ, EDWARD ZORĘBSKI, MICHAŁ ZORĘBSKI
17:40-18:00	**Ionanofluids as heat transfer fluids in new generation heating and cooling systems** KAROLINA BAŁUSZYŃSKA, MICHAŁ ZORĘBSKI, MARCIN LIBERA, MARZENA DZIDA
18:00-18:05	**Closing Ceremony of the 14th Winter Workshop on Molecular Acoustics, Relaxation and Calorimetric Methods**
19:30	***Festive Supper (Banquet)***

1.03.2018 Thursday	
8:00	***Breakfast***

ABSTRACTS

FOR 14TH WORKSHOP ON MOLECULAR ACOUSTICS, RELAXATION AND CALORIMETRIC METHODS

Ionanofluids as a heat transfer fluids in new generation heating and cooling systems

Karolina Bałuszyńska, Michał Zorębski, Marcin Libera, Marzena Dzida

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The effectiveness of heating and cooling systems are often limited by insufficient heat transfer by working fluids. The optimal working fluids should have high heat capacity and thermal conductivity, relatively low viscosity and density, high stability in a broad range of temperature and low toxicity. This work describes the use of the Ionanofluids, consist of Al2O3 nanoparticles dispersed in imidazolium ionic liquids as a heat transfer fluids in a new generation of heating and cooling systems. Our research revealed that systems of

1-etyl-3-methylimidazolium ethyl sulfate and 1,3-diethylimidazolium ethyl sulfate with Al2O3 nanoparticles exhibit high heat capacity and energy storage density in comparison with commercially available heat transfer fluids working in similar temperature range. Moreover, working fluids based on ionic liquids have an advantage among other working fluids due to its broad liquidity range. The structure of obtained Ionanofluids was investigated using transmission electron microscopy after cooling in liquid ethane. Long-term stability, acceptable density and viscosity cause that investigated Ionanofluids are promising candidates as heat transfer fluids.

Fabrication of particle capsules and their manipulation in electric and acoustic fields

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Particle capsules are promising candidates for superior materials to be used in variety of applications, including drug delivery, food industry and material science. Such capsules can be formed by locking particles in Pickering drops, e.g. by sintering. Electric fields can be utilized to form Pickering drops with shells composed of highly ordered and jammed nano- or microparticles. Here we use electric field induced convective flows to assemble particles into a packed layer at a drop interface. This leads to formation of a Pickering drop, from which we make a particle capsule. We then study the mechanical properties of such capsules by using electric field generated stresses. Finally, we investigate the possibilities of using ultrasounds for directional release of an encapsulated liquid.

Monitoring of Pickering emulsions formation by optical microscopy and ultrasounds

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An emulsion is a thermodynamically unstable system that phase separate over time. Surface active agents or solid particles are typically used to tackle the kinematic instability of emulsions, i.e. to prevent drop coalescence. Covering droplets with particles rather than surfactants may be advantageous, particularly when low toxicity or stimuli-responsiveness are under consideration. Such particle stabilized emulsions are called Pickering emulsions, and can be used in variety of applications, including drug delivery, food industry and material science.

In our research, we prepare oil-in-oil Pickering emulsions using polymer microparticles. The process of Pickering emulsion formation is monitored by both optical microscopy and ultrasounds. In my presentation, I will be discussing possibilities of using ultrasound methods to either prepare emulsions or to monitor the emulsion formation process, as well as the use of ultrasounds in studying different properties of Pickering emulsions. I will also present our experimental results and demonstrate usefulness of ultrasound approach to monitoring Pickering emulsion fabrication.

Conductometric studies on the ionic association of selected imidazolium ionic liquids in various solvents

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Considering the ionic nature of ionic liquids, ionic association should be expected in their solutions. However, a survey of literature indicated that no systematic conductometric studies had yet been conducted on the phenomenon of ionic association and solvation in solutions of ionic liquids in various solvents, as a wide range of temperatures and low IL concentration range. It is important to emphasize the significance of the infinite-dilution limit of such data in understanding the ion-ion and ion-solvent interactions and the possibility of predicting the behavior of ILs in a specific application.

This work summarizes the conductometric studies on the ionic association and solvation of imidazolium ionic liquids 1-ethyl-3-methylimidazolium tetrafluoroborate [emim][BF4] and 1-butyl-3-methylimidazolium tetrafluoroborate [bmim]BF4] in water, propan-1-ol, propan-2-ol, butan-1-ol, N,N-dimethylformamide, N,N-dimethylacetamide and dichloromethane in a wide range of temperatures. The following points are discussed: the effect of structure and solvent properties, cation of IL and temperature on the limiting molar conductivity and ionic association, ion transport processes and thermodynamic properties of ionic association.

Hydration of polyethylene glycol monododecyl ethers in their diluted aqueous solutions

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Long-chained ethers with relatively high relation of the number of ether groups to the chain length are interesting because of their ability to form micellar aqueous solutions even in very low concentrations. This behavior has been practically exploited in plant protection products, where micelle-forming components facilitate dissolution of the active ones. The acoustic properties of these ethers are evidently related to the specific hydration of the micelle-forming compounds. In this work the acoustic method was applied to determine the hydration numbers of two members of the family of the long-chained ethers. It was found that formation of micelles is responsible for the hydration numbers lower than theoretically calculated ones.

Densities, refractive indices and express properties of tetrachloromethane with 2-methoxyethanol at various temperatures

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The weak non-covalent interactions in solution play an important role in chemistry, biochemistry, biology or pharmacology. One of the most extensively investigated non-covalent interactions is the hydrogen bond (HB), but there is another interesting type of non-covalent interaction with shorter intermolecular contacts, called halogen bond (XB). It is an attractive, highly directional interaction between a covalently bonded halogen atom and a negative site on an atom or group of atoms. The physico-chemical properties like density and refractive indices of liquid mixtures are essential for understanding of the nature and strength of interactions, and can provide knowledge of structure rearrangement.

The paper presents the study of mixtures of tetrachloromethane (CCl4) with 2-methoxyethanol (ME). Densities (ρ) and refractive index (n) were measured over the whole composition range from 283.15 K to 308.15 K at 5 K intervals. The experimental values of density were used to determine the molar volume, Vm , the excess molar volume VmE, molar refraction, Rm, deviations from additivity of molar refraction, ΔRm and reduced free molar volume, Δ(Vm/R). The results were analyzed mainly in terms of the formation of intermolecular complexes by directional hydrogen and halogen bonds.

Theranostic ultrasound

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Theranostic nanomedicine is a combination of therapy and diagnostics functions in the same nanoparticles. For theranostic treatment it is possible to use ultrasonic waves. Ultrasound imaging can be easily integrated with ultrasound therapeutic modality for diagnosing, introducing targeted treatment, and monitoring efficiency to therapy. Various materials have been explored for ultrasound imaging and therapy, including magnetic nanoparticles. Next, by surface chemical modification, nanoparticles can be coated, functionalized, and integrated with different applications. Magnetic nanoparticles improve the efficiency of ultrasonic hyperthermia and thermal ablation for anti-cancer treatments and improve the imaging contrast (USG, MRI).

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

Heating induced by focused ultrasound (FUS) in the presence of magnetic nanoparticles

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One of the earliest medical applications of ultrasound is the therapeutic heating of tissues. Using focused ultrasound the temperature increase can be induced in a very precise manner in a small area of tissue. Additionally, the effectiveness of ultrasound in hyperthermia therapy can be improved by using so-called sonosensitizers – materials which can maximize the effect of ultrasonic irradiation. In our study, we used superparamagnetic nanoparticles as such material. The influence of magnetic nanoparticles on thermal effect was measured in the focal area and at different distances from the center in a tissue-mimicking phantom. The experimental results confirm that the presence of magnetic nanomaterial in phantoms increases the thermal effect of hyperthermia. The acoustic power increase contributes to the increase in temperature rise. The most significant increase in the ultrasonic hyperthermia efficiency is in the focus because nanoparticles concentrate heat.

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

Manipulation of microparticles in oil droplets by ultrasonic and electric fields

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Particle designed assembly inside drops or at their surfaces holds promise for a variety of practical applications, in particular for generation of new complex structures, such as patchy particles or capsules. There are different methods for structuring particles, including electric or magnetic field-driven approaches. Here we use a synergetic action of electric and ultrasonic fields to manipulate particles of different kinds in either silicone oil or water drops formed in castor oil. We primarily use two physical phenomena, namely electrohydrodynamic convective flows and acoustic radiation force, to either arrange particles into vertically positioned particle ribbons or form columnar phase of packed particle discs. Both the ultrasound wave amplitude and frequency determine the structure formation. Various aspects of our approach for particle assembly, including the role of particle size, material type and particle concentration, are studied in detail.

Destruction of amyloid structures with the help of ultrasonics, hyperthermia and radiation treatments in the presence of magnetic nanoparticles

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Protein amyloid fibrils are one of the causes of the neurodegenerative diseases development, such as Alzheimer's and Parkinson's. It will be shown, that magnetic nanoparticles have a considerable impact on the aggregation process, especially depolymerization and inhibition effects. Magnetic nanoparticles with different surfactants and size have various effects on lysozyme and insulin amyloid fibrils that were observed using atomic force microscopy, TEM and fluorescency methods. In addition the antiamyloid activity using ultrasonics, hyperthermia and radiation in presence of magnetic nanoparticles was studied also. Due to heat conduction from particles as a result of relaxation processes in magnetic hyperthermia experiment the destruction/shortening of amyloid fibrils was analyzed. The present findings represents starting point for the application of the selected active magnetic nanoparticles as therapeutic agents targeting amyloidosis.

Thermodynamic speed of sound in Ionic Liquids

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Ionic liquids (ILs) are dissipative liquids because of their high or very high viscosities. The most of ILs characterise moderate or high absorption and the velocity dispersion. Thus, special care should be taken during speed of sound investigations. The reported speed of sound often cannot be regarded as thermodynamic property, thus it is not possible to use the Newton-Laplace equation and to determine the thermodynamic quantities. This approach is especially important when measurements are provided at relatively low temperatures and under high pressures (both the temperature and pressure shift the relaxation regions). Unfortunately, this problem is often ignored and the values that are measured by commercial apparatuses (developed for non-dispersive liquids) are treated as thermodynamic values.

In this study, we present the methods for selecting the right conditions outside the regions of dispersion. To select temperature range, the analysis of c(T) dependence and the classical ultrasound absorption at atmospheric pressure was done together with a comparison of group speed of sound with phase speed of sound. To narrower the pressure range, an initial analysis on the basis of calculated classical absorption at high pressure was done.

Drops with particles: physical mechanisms for particle assembly

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Controlled structuring of particles on droplet surfaces and inside drops holds promise for many practical applications, including synthesis of functional materials. In my talk, I will demonstrate and explain how oil droplets behave when subjected to external electric fields and ultrasound waves. Especially how electrohydrodynamic, electrorheological effects, and ultrasonic radiation force in such droplets can be used to structure and dynamically control colloidal and granular particle assemblies inside a droplet or at drop interfaces. This includes electric-field-assisted convective assembly of jammed colloidal “ribbons”, electrorheological colloidal chains confined to a two-dimensional surface, spinning colloidal domains, and particle discs forming columnar phases. I will also present different approaches to fabricating homogenous and patchy particle shells and capsules, as well as the results of our experimental investigation on mechanical properties of such structures.

New composites based on liquid crystals with superionic nanoparticles: development, preparation, dielectric and acoustic properties

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Dielectric and acoustic properties of the composites based on the planar oriented 6CHBT and 6CB liquid crystals with Cu6PS5I superionic nanoparticles were studied in the 10–106 Hz frequency range. The concentration of the nanoparticles with the average size of 35 nm in the liquid crystals was 0.01, 0.05, and 0.1 mg/ml. Introduction of the nanoparticles is shown to result in an increase of the electric conductivity. Contrary to 6CHBT liquid crystal, the conductivity monotonously depends on the nanoparticles concentration. Moreover the conductivity of 6CB with Cu6PS5I nanoparticles is much higher than the conductivity of 6CHBT at the same concentration of nanoparticles. The main reason of the much greater influence of Cu6PS5I nanoparticles on the 6CB conductivity in comparison with 6CHBT is related to a greater dissociation coefficient of Cu6PS5I in 6CB than in 6CHBT.

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