POLISH SCIENTIFIC NETWORKS

POZNAŃ
September 19–21, 2019

POLISH SCIENTIFIC NETWORKS

ORGANIZERS:

AMU Akademia Młodych Uczonych POLSKA AKADEMIA NAUK

FNP Association of the Foundation for Polish Science Scholars

STRATEGIC PARTNERS:

PAN POLISH ACADEMY OF SCIENCES

FNP Foundation for Polish Science

POLITECHNIKA POZNAŃSKA

IFM PAN

PARTNERS:

GDAŃSK UNIVERSITY OF TECHNOLOGY

Cracow University of Technology

UTP University of Science and Technology

MEDIA PATRONAGE:

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LETTER TO PARTICIPANTS

Dear Participants,

We would like to welcome each of you to the 4th edition of the Polish Scientific Networks conference (PSN 2019) entitled "Science & Technology". The conference is devoted to modern technology and innovations in various aspects, ranging from social to natural sciences.

The aim of the conference is to create and nurture scientific networks. In Poznań you will meet researchers from many different areas, which constitutes a great opportunity to exchange ideas and build bridges across fields. We hope that it fosters interdisciplinary solutions to novel technologies.

During PSN 2019, recent scientific achievements will be presented in six areas: Energy, New Materials, Information Technologies, Healthcare, Social Media, and Big Scientific Facilities. There will be two discussion panels: the first, focused on Mentoring; and the second, on Artificial Intelligence. A debate with invited distinguished scientists will be held on the topic of Innovation. Finally, there will be an Oxford Debate where we will discuss whether electrical vehicles are part of a bright future or a hopeless wish.

A good conference must provide an opportunity for social interaction. We would like to invite you to a choir concert (Thursday) and dinner (Friday). We are confident that you will find the Old Town of Poznań a charming place for an evening walk.

The PSN 2019 is organized by the Polish Young Academy, the Association of the Foundation for Polish Science Scholars and the Ministry of Science and Higher Education. We would like to thank our strategic partners: the Polish Academy of Sciences, the Foundation for Polish Science, Poznan University of Technology, the Institute for Molecular Physics PAS, Cracow University of Technology and Gdansk University of Technology.

Thank you for attending the PSN 2019 conference and bringing your knowledge, skills and expertise to PSN.

Best wishes from the conference organizers,

Anna Bielec, Krzysztof Fic, Tomasz Klimczuk and Piotr Kuświk

ORGANIZERS

THE POLISH YOUNG ACADEMY (PYA) was constituted under the Polish Academy of Sciences (PAS) Parliamentary Act of April 30, 2010. It is a part of the PAS corporation and was established thanks to the effort of the PAS authorities inspired by the activity of similar bodies in other countries. One of the PYA's tasks is to promote the engagement of the young scientific community, in particular:

- participating in the creation of science policy
- promoting scientific excellence
- disseminating scientific results.

Selection procedure of the PYA members is based on the election procedures for the PAS members, the main criterion being the candidate's outstanding scientific achievements. PYA members are nominated for 5 years, without a possibility of re-election. Each PYA member can contribute to the work of the PAS by participating in the work of divisions, branches, scientific committees and task force committees.

PYA is formed by leaders in respective scientific disciplines – scientists that have typically already been honoured with other prestigious awards and distinctions, including recipients of the European Research Council grants, the Ministry of Science and Higher Education Scholarships or the Foundation for Polish Science programmes. Despite their young age, many of them have already been appointed or awarded a professor title.

PYA is actively involved in consultations regarding science and higher education policy, including "Law 2.0". PYA was represented in the Council of the National Congress of Science (NCS) and participated in the NCS conferences. Members of PYA were also involved in consultations conducted

by the Policy Support Facility, a group assigned by the Ministry of Science and Higher Education with a peer review of Poland's higher education and science system, and in consultations regarding programmes supporting internationalization of Polish science, proposed by the newly founded National Agency for Academic Exchange.

In an effort to promote scientific excellence, PYA supports the mobility of Polish scientists. This activity is illustrated e.g. by the report on national and foreign mobility of scientists, published in 2015 in cooperation with "Nauka Ludzka Rzecz" Initiative. Cooperation and mobility of scientists was also the main topic of the 1st edition of Polish Scientific Networks conference (PSN, Warsaw, June 16–18 2015), organized, as well as the next editions, in cooperation with the Ministry of Science and Higher Education and the Association of the Foundation for Polish Science Scholars. Intersectoral mobility was, in turn, the topic of the PSN: Science and Business meeting held in Wrocław a year later (June 30–July 1, 2016).

PYA also cares about building the competence of young scientists. For that purpose, PYA organizes annual summer schools Forge of Young Talents (Kuźnia Młodych Talentów) addressed to PhD students specializing in life and exact sciences and developing their so-called soft skills.

In order to encourage new generations to practice science, PYA actively supports outreach activities. For many years, PYA members have been taking part in Science Festivals in different Polish cities, in Warsaw Science Picnic, in European Researchers' Night in Olsztyn, etc. PYA has also initiated Flying Scientific Cafes (Latające Kawiarenki Naukowe), popular science meetings that are mainly addressed to children and school youth.

Currently, PYA counts 32 members – 17 new members joined us in June 2019.

More information about the PYA: http://www.amu.pan.pl/

Association of the Foundation for Polish Science Scholars

ASSOCIATION OF THE FOUNDATION FOR POLISH SCIENCE (FPS) SCHOLARS unifies laureates of postdoctoral scholarship programmes of the Foundation for Polish Science. Among the Association's aims are the interdisciplinary and intergenerational integration of FPS Scholars, actions aimed at supporting science and popularizing the ethos of a scientist and teacher, promoting of good scientific practice and improving qualifications, as well as supporting scholars in critical situations.

The Association, initially named Association of the Foundation for Polish Science Foreign Scholars, was founded in 2000, during a meeting organized by the Foundation for Polish Science attended by laureates of the Foundation postdoctoral scholarship programme KOLUMB. Originally, the Association was established as an informal group of young scientists, whose postdoctoral training in foreign research centres was financed by the Foundation. In April 2003, the Association was officially registered as an association. In December 2009 the Association, following the establishment of different postdoctoral scholarship programmes of FPS, was joined by laureates of several other Foundation programmes, such as Homing (later replaced by Homing-Plus), Focus, Ideas, Team, Master, Welcome, and – in May 2014 – by the laureates of the programme Bridge, who have completed at least 6 months long fellowship in a foreign research centre. Since May 2016, laureates of all types of TEAM programmes are also welcomed among FPS scholars. At the same time, in 2009, the association was renamed as the Association of FPS scholars.

The Association's activity manifests mainly in the organization of meetings and conferences, both informal and formal, that support scientific cooperation – interdisciplinary, international and intersectoral, including the series of Polish Interdisciplinary Symposia Inter-Mix and the Polish Scientific Networks conference, that addresses scholars interested in applying research in practice. Every year, in May members of the Association meet during the

Annual Alumni Congress, organized in different academic centres in Poland. The Congresses are an excellent occasion for the presentation of most recent research results, scientific discussions, as well as to maintain contacts and friendships. Additionally, members of the Association have been engaged in the debate about the reorganization of science in Poland for many years, as part of advisory bodies or as experts in panels and conferences dedicated to this issue.

The history of the Association has been marked with a painful event – a tragic death of dr Artur Rojszczak, founder and animator of the Association. In his memory, the Association has established an award named after dr Rojszczak. The award is granted to young doctors who stand out not only with prominent scientific achievements, but also with a humanistic attitude towards the world, broad horizons and the ability to break down barriers and to surpass the framework of narrow scientific specializations. The awarding ceremony of Artur Rojszczak Award takes place every year during the Annual Congress of the Association.

More information: klub-fnp.pl

STRATEGIC PARTNERS

POLISH ACADEMY OF SCIENCES (PAS), as the leading scientific institution in Poland, carries out comprehensive research activity aimed at the development, promotion, integration and popularization of science and the development of education, and also the enrichment of national culture. The Academy achieves these goals by carrying out advanced research of strategic importance for the development of science and economy, by organizing interdisciplinary research teams involved in the concentration of modern research apparatus, integrating Polish scientific community, educating academic staff, and by innovatively utilizing the results of scientific research, also in cooperation with economic entities, and by organizing scientific conferences and participating in science popularization events.

Structure of PAS unites traditional functions of autonomic scientific corporation with an academia that directly realizes research goals. This combination provides the possibility to create science by personal research involvement of PAS members affiliated in different research facilities. The corporation of scholars of the Academy includes:

- scientific committees, that on the grounds of their composition constitute the most representative scientific circle in the given discipline;
- task force committees, that are appropriately selected groups of experts, established to accomplish certain research tasks
- national committees, established in order to maintain and develop the cooperation with international scientific organizations,
- divisions, participating in the performance of tasks of the Academy within the scientific fields included in its scope, by the involvement of its members in the works of branches of the Academy, scientific committees, task force committees, and the boards of experts of the research institutions,

- territorial branches, established in order to perform the tasks of the Academy in a particular region of Poland, that above all integrate the academic life in the region of Poland in question,
- Scientific institutes, that are the basic organizational units of the corporation.

Gathered around departments, the institutes conduce international and internal research, both basic and applied, organize conferences, symposia and scientific lectures, provide financial services and perform the transfer of technology.

Recently, Polish Young Academy functions in the structure of PAS. Its tasks are centred around the activity for the activation of the young scientific community, by, among others, presentation of opinions and programmes related to the scientific issues, the organization of debates, discussions and scientific conferences, and the dissemination of scientific results.

Polish Academy of Sciences is also engaged in the publishing and expertise, provides access to the library, museum and archival stocks, organizes conferences, exhibitions and popular science lectures.

As the publishing activity, PAS ensures the continuity in the publishing of the scientific publications and journals most important in given specializations, a part of which are available in open access on the Academy's web page. Science popularization activity involves, above all, open popular science lectures "Wszechnica", participation in picnics and science festivals, nights of museums or book fairs; concerts and exhibitions are also organized periodically. PAS research units are actively involved in the preservation and restoration of material culture heritage and natural resources in Poland and abroad. The Academy's institutions possess in their collections, among others, printed literary treasures, dating back to 15th century, that include early editions of Hevelius' and Copernicus' works and Marie Skłodowska Curie's or Albert Einsteins' letters. Biological collections, comprising unique plants and seed banks, are also not without significance.

For outstanding achievements, the Polish Academy of Sciences grants: Medal of the Polish Academy of Sciences, Nikolas Copernicus Medal, Stefan Banach Medal of the Polish Academy of Sciences and the Polish Academy of Sciences Statuette.

More information at: pan.pl

FOUNDATION FOR POLISH SCIENCE (FPS) has been in operation since 1991. It is a non-governmental, non-political, non-profit institution and the largest source of science funding in Poland outside of the state budget.

Foundation's mission is to support outstanding scholars and research groups and to back innovative projects and the commercialization of research results.

The Foundation is offering prizes, scholarships and subsidies for scientists of any age, at all career stages, irrespective of the represented field of science.

Operating rules of FPS:

- to offer support directly to scholars and research groups
- all subventions, prizes and scholarships are awarded on the basis of a competition
- scientific excellence is the most important criterion in awarding of support
- assessment of the achievements of participants in the Foundation's competitions is made by Polish and foreign scientists recognized in their field (peer-review method)
- the support is awarded according to the "Hard money" principle (strict accounting procedures for funding awarded)

The Foundation actively supports and promotes scientific mobility and international research cooperation, and many FPS laureates achieve international success. FPS collaborates with over 45 foreign scientific institutions and organizations. We are a member of European Foundation Centre (EFC) and Science Europe.

Foundation's statutory activities are funded from its own resources, including donations of 1% of income taxes, private donations and European funds. In 2008, the Foundation began the realization of programmes founded by the European Regional Development Fund under the Operational Programme

Innovative Economy, and in 2011 it started the SKILLS project, financed from the Operational Programme Human Capital funds. At the end of 2015 and at the beginning of 2016, the Foundation launched new projects financed from the Operational Programme Smart Growth: International Research Agendas, TEAM, TEAM-TECH, FIRST TEAM, HOMING and POWROTY.

Detailed information on the programmes can be found on www.fnp.org.pl

POLITECHNIKA POZNAŃSKA

POZNAN UNIVERSITY OF TECHNOLOGY (PUT)

| **MISSION** AND VISION

The mission of the University is to educate students of all cycles of higher education and students of lifelong learning mode in close connection with scientific work as well as research and development projects carried out by the University in cooperation with prospective employers of PUT's graduates and in continuous contact with society. Our visionary goal is transformation of PUT into the country's leading technical university, known and acknowledged in Europe, an important and sought after partner of educational establishments of the world, a university that can offer high quality education and the world-class scientific work and research and development projects.

| **EUROPEAN** UNIVERSITY

Today Poznan University of Technology offers education at 10 faculties which provide students with a choice of 30 fields of study.16,000 students of I and II cycles, Phd students and participants of post-graduate programmes receive education here. More than 1,300 academic staff care about their education. Implementation of PUT's mission enables the vision to become reality – to be one of the best technical universities in Poland, which aspires to become an equipollent partner of other European schools in terms of education quality and high level of scientific research. PUT was the first Polish institution of higher education to become a member of CESAER (Conference of European Schools for Advanced Engineering Education and Research) – a European organisation that brings together the best technical schools. It is also a member of SEFI (Societe Europeenne pour la Formation des Ingenieurs), EUA (European University Association), ADUEM (Alliance of Universities for Democracy) and IAU (International Association of Universities).

SCIENCE

Poznan University of Technology is an important centre of scientific research. The proportion of funds for research projects grows year by year. The strong point of the University is its academic staff. Their achievements in science and numerous publications make a significant contribution to modern technical sciences. Many young members of academic staff and Phd students receive academic grants allowing them to improve their skills and gain new experience abroad. The University's researchers receive the most prestigious state awards for achievement in science. The Foundation of Polish Science, which awards the best Polish scientists, three times honoured professors of our University with the so-called "Polish Nobel Prize" – in 2000 it was awarded to professor Jan Węglarz, in 2005 to professor Roman Słowiński and in 2011 to professor Elżbieta Frąckowiak.

EDUCATION

PUT's education offer is modern, rich and specifically adapted to meet requirements of employers - both Polish and foreign ones. The University offers more than 100 specialisations within its 30 fields of study. Students choose to study at PUT attracted by high standards of education, thoroughly trained and experienced academic staff and a good possibility to realise fully their interests both in science and beyond as well as by friendly atmosphere. We are really proud of our students who successfully participate in international competitions and contests, in science circles and student organisations.

INSTITUTE OF MOLECULAR PHYSICS POLISH ACADEMY OF SCIENCES (IMP PAS) in Poznan was founded as an independent research unit in 1975. The IMP PAS is organized into 14 departments, which are grouped into 3 divisions, and employs 124 people, including 69 researchers (14 professors, 14 associate professors, 34 adjunct professors, 7 assistants) and 18 Ph.D. students. The Institute's research work mainly involves fundamental investigations in condensed matter physics, with research laboratories applying both experimental and theoretical methods. IMP PAS is the only Institute of the Academy, which has a scientific department located directly in the area of a manufacturing plant – the Odolanów's branch of GAZ-SYSTEM S.A., a Gas Transmission Operator of strategic importance for Poland's economy and energy security.

Each year the Institute's staff members publish approximately 100 articles in international journals and present about 180 papers at national and international conferences. Roughly half of those are developed in cooperation with foreign partners. The Institute's Scientific Council, which includes independent research employees in the Institute and eminent scientists from various Polish research centers, is authorized to confer Ph.D. and habilitation degrees in the field of physics.

The IMP PAS groups are experts in the fields of low dimensional and bulk systems; the laboratories are equipped with state-of-the-art equipment used for sample preparation and characterization.

The undergoing research at IMP PAS concentrates in condensed matter physics focused to:

- theoretical and experimental magnetism (thin films, amorphous magnetics, electronic structure);
- physics of ferroics (ferroelectrics, superprotonic conductors, electrets, piezopolymers) and multiferroics;

- liquid crystals (ferro- and anti-ferroelectric materials);
- crystalline molecular conductors and fullerenes;
- spintronics, meso- and nanoscopic systems;
- superconductivity and low-temperature physics;
- electron paramagnetic resonance (EPR);
- magnetic resonance micro-imaging (MRI);
- computational modelling (auxetics, colloids).

Additional goals of the Institute are to educate and guide early-stage researchers. Every year, students from Adam Mickiewicz University (UAM) in Poznan and Poznan University of Technology (PUT) prepare their dissertations under the counseling of the Institute's researchers. Because of the close cooperation between the IMP PAS, UAM and PUT; outstanding students can continue their education at the International Doctoral Studies and Doctoral School at IFM PAS. In addition, the NanoBioMedical Centre of UAM and the IMP PAS are co-leaders of the Interdisciplinary Doctoral Studies in Nanotechnology-Electronics and Photovoltaics Program funded by the European Union (POKL.04.03.00-00-015/12). As a part of this program, doctoral students are required to complete a six-month internship abroad. This can stimulate and support of young scientists in search for long-term collaboration with foreign institutions.

PARTNERS

GDAŃSK UNIVERSITY OF TECHNOLOGY (POLITECHNIKA GDAŃSKA)

Gdańsk University of Technology is the largest technical university in the Pomeranian Region and one of the oldest technical universities in Poland. At 9 faculties more than 1,300 lecturers educate over 16,000 students of all cycles in 34 undergraduate and 33 graduate fields of study, including 6 interfaculty, 4 interuniversity and 17 fields of study and specializations in English. Over 500 PhD students can choose from 12 disciplines taught in the Doctoral School. There are also c. 60 postgraduate fields of study. The number of the GUT graduates has reached over 137,000 and counting.

The Polish Ministry of Science and Higher Education ranked two GUT faculties in the highest category of A+ and five more in the A category as a result of the comprehensive evaluation of scientific research or research and development activity of scientific units. Two times in a row Gdańsk University of Technology was ranked on the 1st place in the ministry ranking of the universities which candidates to study choose the most often.

Modern Research and Development Centre

The Gdańsk University of Technology campus was voted one of the ten most beautiful in Europe. It is filled with cutting-edge laboratories and research centres, including the Immersive 3D Visualization Lab, the Nanotechnology Centre and the ProtoLab prototyping facility. In total, GUT owns over 250 didactic and research laboratories. The university also provides modern housing for more than 2 600 students in 12 dormitory buildings as well as possesses a high quality Academic Sports Centre.

The GUT library is the oldest and largest technical library in northern Poland, holding over 1,000,000 volumes, mainly textbooks, study guides and science

books, but also priceless historical publications, some of them belonging to the original Gdańsk Societas Physicae Experimentalis collection. Our state-of-the-art facilities coexist with historical buildings, in which authentic research apparatuses dating back to the university's early days can be found.

International Recognition

GUT belongs to numerous international associations, including CESAER, BSRUN, EUA and CDIO, as well as participates in programs such as Erasmus+, Erasmus Mundus, CEEPUS, EEA and Norway Grants. The number of international students at GUT increases year by year. Their current number is close to 900. They represent over 70 different nationalities.

MBA studies as well as the International Management graduate field of study at the Faculty of Management and Economics were awarded the international Association of MBAs (AMBA) certificate, obtained by only 2% of universities in the whole world. In 2019, the GUT MBA Programme was ranked for the first time in the international QS ranking, which classifies the best MBA executive programmes in the world. It included a total of 156 global executive MBA programmes and the GUT programme is the only one from Poland. The International MBA in Strategy, Programme and Project Management performed particularly well in Executive Profile Ranking and Career Outcomes Ranking.

In 2017 the European Commission has granted GUT the right to use the prestigious HR Excellence in Research logo. Gdańsk University of Technology was thus recognized as an institution that provides one of the best work and development conditions for researchers in Europe. The HR Excellence in Research logo is a symbol of quality assuring the highest standards in research and employment.

Twice in a row GUT was granted the ELSEVIER Research Impact Leaders award for its widely recognized scientific publications, which combine social and technical sciences. The awards are part of the international ELSEVIER initiative, promoting the scientific output of Polish universities in the world. Factors taken into consideration include the citation index, the number of publications in the most prestigious journals and the contribution of international authors.

Cracow University of Technology

CRACOW UNIVERSITY OF TECHNOLOGY (POLITECHNIKA KRAKOWSKA)

The biggest advantages of **Cracow University of Technology** (Politechnika Krakowska – CUT) are:

- over 70-year-old tradition of educating engineers,
- research and development teams, which are open to change, future oriented and hard working;
- overall goal of improving the level of Polish scientific research and technical applications.

These traits have won CUT a strong position and well established brand.

Currently, the university educates 14.5 thousand full-time and part-time students of BSc and MSc, PhD and postgraduate studies. Our educational offer comprises 31 programmes of BSc and MSc studies in Polish at 7 faculties and 7 programmes of study in English at 5 faculties. Such a wide range of programmes means variety of intellectual exploration and solving challenging tasks under the supervision of qualified scientific faculty.

Cracow University of Technology ensures the highest ethical standards and a high scientific level. Many of the nearly 1 200 researchers and tutors are outstanding professionals who participate in intercollegiate and international research teams. Their knowledge and expertise allow our university to maintain the high position in Polish and in the international scientific community.

The scientific-research and development works are carried out at the Cracow University of Technology as a part of the priority research directions covered by the National Framework Program, at the same time serving to shape and deepen the academic specialties of the university. They are implemented within strategic research areas:

I. Shaping space and protecting cultural heritage
II. Materials and nanotechnologies
III. Systems, devices and industrial processes
IV. Energy and the environment
V. Applied informatics and bioengineering
VI. Engineering constructions and infrastructure

Reserchers at Cracow University of Technology are open for new cooperation opportunities. Industry and scientific partners are welcome in central administration units subordinate to the Vice-Rector for Science, to get consultations and assistance in procedures of financing and implementation of projects that are run with CUT:

- Research Department in the field of national research projects and service research projects with external entities (expert opinions, R & D works)
- Center for Technology Transfer in the field of framework programs financed by the European Commission, European Structural Funds and international research projects, as well as in the commercialization of research results.

Center for Technology Transfer as an internal unit of Cracow University of Technology operates on the field of science to business cooperation such as:

- commercialization of the intellectual property,
- technology transfer,
- support within framework programs,
- services supporting SME development.

CTT focuses on implementation of research results of Cracow University of Technology to the industry. Our Center has an insight knowledge about the realities of the commercialization process, and thanks to active collaboration with entrepreneurs can clearly identify technical needs and business expectations of the industry.

Many years of activity in the gap between science and business allowed us to develop a suitable offer for both scientists and entrepreneurs. Depending on the individual needs of the customer we inform, advise, train, support the transfer of technology, elaborate technological innovation certificates, conduct technological audits, help to find foreign partners. We also provide professional support to entities, who wish to apply for international research and development programs funded by the European Commission.

From the very beginning we have been trusted by more than 45,000 customers, we have performed 130 international SME technology transfers, we have issued dozens of technological innovation certificates, we have conducted hundreds of technological audits. Over the past few years we have brought to conclusion over 30 license agreements for commercialization of research results generated at the Cracow University of Technology.

UTP University of Science and Technology

UTP UNIVERSITY OF SCIENCE AND TECHNOLOGY (UNIWERSYTET TECHNOLOGICZNO-PRZYRODNICZY)

UTP University of Science and Technology (Uniwersytet Technologiczno-Przyrodniczy – the UTP) in Bydgoszcz has more than 60 year-long tradition. In 1951, when the first school of higher education in Bydgoszcz was created – the Evening School of Engineering. Early in its history, it educated chemical and mechanical engineers. Having been converted into the Engineering School of Higher Education in 1964, full-time, evening and external programmes were offered by 4 technical faculties.

The development of agriculture studies was launched in 1969 by the establishment in Bydgoszcz of the branch of the Agricultural School of Higher Education from Poznań. This branch became independent in 1972 by turning into the Faculty of Agriculture with Animal Production Section. Pursuant to the decree of Prime Minister of August 20, 1974, those two schools were joined into the Jan and Jędrzej Śniadecki University of Technology and Agriculture in Bydgoszcz, renamed the UTP University of Science and Technology in 2006.

UTP University of Science and Technology is a multi-profile school of higher education; the only one in the region which integrates both agricultural and technological sciences and the only one in the region educating engineers. Throughout the 60-year-long history 38,000 students have graduated from the University, mostly majoring in civil engineering and machinery construction and agriculture.

ORGANIZING COMMITEE

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ANNA BIELEC

Office of the President
POLISH ACADEMY OF SCIENCES

POLISH YOUNG ACADEMY

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ASSOCIATION OF THE FOUNDATION FOR POLISH SCIENCE SCHOLARS

ADRIANA ZALESKA-MEDYNSKA

UNIVERSITY OF GDANSK

ZOFIA MADEJA

POZNAN UNIVERSITY OF LIFE SCIENCES

PROGRAMME

THURSDAY, 19.09.2019

15:00 – 16:00	Registration of participants [Reception desk]
16:00 – 16:30	Opening ceremony [Aula Magna]
16:30 – 17:30	Opening lecture [Aula Magna] Robert J. Cava "The Status and Promise of Quantum Materials"
17:30 – 18:30	**Debate** [Aula Magna] "Innovation: what does it mean?" Moderator: Prof. ADRIANA ZALESKA-MEDYNSKA Panelists: Sixto Malato Rodriguez, Robert J. Cava, Leon Gradoń
18:30 – 19:00	Coffee break
19:00	Concert [Aula Magna] "Volantes Soni" choir – Poznan University of Technology

FRIDAY, 20.09.2019

8:00–9:00 Registration of participants [Reception desk]

9:00–10:00 **Scientific session "ENERGY"** [Aula Magna]

Plenary lecture:
Elżbieta Frąckowiak "Challenges for aqueous electrochemical capacitors"

10:00–11:00 **Scientific session "SOCIAL MEDIA"** [Aula Magna]

Plenary lecture:
Kaja Prystupa-Rządca "Best Practices in virtual team management"

11:00–11:30 Coffee break

11:30–12:30 **Oxford debate** [Aula Magna]

"Electric vehicles – bright future or hopeless wish?"

Moderator: ANETTA PŁATEK, PAULINA BUJEWSKA

12:30–13:00 Lunch

13:00–14:00 Poster session (part 1) – ENERGY, SOCIAL MEDIA, INFORMATION TECHNOLOGY

14:00–15:00 **Scientific session "INFORMATION TECHNOLOGY"** [Aula Magna]

Plenary lecture:
Thomas Lippert "European's Grand Challenges for High Performance Computing"

15:00 –17:00 **Scientific session "ENERGY"** [Room no. 021]

Invited talk: Monika Kwoka "Oxide nanomaterials for photovoltaic application"

- Weiwei Xie "Chemistry Perspectives to Novel Superconductors"
- Monika Wilamowska-Zawłocka "Composite Electrode Materials for High-Power and High Energy Density Storage Devices"
- Karolina Kordek "Hydrogen and oxygen evolution activity of cobalt-based films prepared by pulsed laser deposition"
- Małgorzata Graś "Study of Fuel Efficiency in Direct Borohydride Fuel Cell"
- Sylwia Zięba "Physical properties of imidazole-based proton conductors"
- Michał J. Winiarski "Frustrated magnets based on the anion-centered OCu_4 units"

Chairman: Krzysztof Fic

15:00 –16:45 **Scientific session "INFORMATION TECHNOLOGY"** [Room no. 029]

Invited talk: Jan Martinek "Quantum Computing – Opportunities and Challenges"

- Izabela Perenc "Compiler Error Categorisation for Assessing Automated Tests and Exams in C Language"
- Szymon Grabia "GPU-accelerated identification of reference genes"
- Adam Zadrożny "Towards Understanding Polish Court Verdicts"
- Piotr Łuczak "Optimisation of Weight Agnostic Neural Network structure using Rosenbrock method"
- Błażej Osiński "Model-based Reinforcement Learning for Atari"

Chairman: Norbert Meyer

17:00 – 17:30 Coffee break

17:30 – 18:30 **Discussion panel** [Aula Magna]

"Mentoring – navigation through the academic labyrinths"

Moderator: JOANNA NIEDZIÓŁKA-JÖNSSON

Panelist:
Maciej Wojtkowski, Janusz Bujnicki, Krystyna Malińska, Beata Małachowska

19:00 Dinner & networking session

SATURDAY, 21.09.2019

8:00–9:00 Registration of participants [Reception desk]

9:00 – 10:00 **Scientific session "HEALTH CARE"** [Room no. 1]

Plenary lecture:
Dipanjan Chowdhury, Wojciech Fendler "MicroRNA-based diagnostic tests – translational medicine in a transatlantic setting"

10:00 – 11:00 **Scientific session "MODERN MATERIALS"** [Room no. 1]

Plenary lecture:
Dorota A. Pawlak "Novel photonic materials enabled by crystal growth"

11:00 – 11:30 Coffee break

11:30 – 12:30 **Scientific session "BIG SCIENTIFIC FACILITIES"** [Room no. 1]

Plenary lecture:
Stefan Eisebitt "Seeing Ultrafast Processes in Magnetic Materials – Combining Unique Capabilities of Large X-ray Facilities and Experiments "at home"

12:30 – 13:00 Lunch

13:00 – 14:00 Poster session (part 2) – HEALTH CARE, MODERN MATERIALS, BIG SCIENTIFIC FACILITIES

14:00 – 15:00 **Discussion panel** [Aula Magna]

"Artificial intelligence – threat or opportunity?"

Moderator: ANNA FABIJAŃSKA

Panelists:
Krzysztof Krawiec, Rafał Urbaniak, Jakub Bochiński

15:00 – 16:45 **Scientific session "HEALTH CARE"** [Room no. 021]

Invited talk: Joanna Gościańska "Ordered mesoporous carbon materials with defined structure as a new carriers for active pharmaceutical ingredients"

- Agnieszka Kamińska "Biomedical and analytical applications of SERS"
- Beata Miksa "Trojan horse delivery conjugates to a cancer treatment"
- Beata Małachowska "Computational biology predicts new K-Ras inhibitor intracellular mechanism of action"
- Albertyna Paciorek "Vagus nerve stimulation in disorders of consciousness"
- Magdalena Osial "Superparamagnetic iron oxide based nanoparticles for magnetic hyperthermia"

Chairman: Zofia Madeja

15:00 – 16:45 **Scientific session "MODERN MATERIALS"** [Room no. 123]

Invited talk: Tomasz Dietl "Why topological materials?"

- Shintaro Ishiwata "High pressure synthesis of black and red phosphorus analogues with magnetic ions"
- Małgorzata Szczerska "Photonic structure in optical phantoms mimicking tissue"
- Anna Dettlaff "Impedimetric Detection of Influenza Virus on Boron-Doped Nanocarbon Electrodes"
- Taras Zhezhera "Spectroscopic properties of Bi_3TeBO_9 microcrystal powders doped with rare earth ions"
- Hubert Głowiński "Low damping $Co_{25}Fe_{75}$ film with perpendicular anisotropy"

Chairman: Tomasz Klimczuk

15:00 – 16:45 **Scientific session "BIG SCIENTIFIC FACILITIES"** [Room no. 029]

Invited talk: Paweł Olko "Trans-National Access to modern scientific facility – Cyclotron Centre Bronowice"

- Andrzej Wawro "XAS, XLD and XMCD studies of magnetic Co/Mo layered structures"
- Sebastian Molin "Synchrotron Tomography Studies of Advanced Porous Alloys for Energy Conversion"
- Piotr Mazalski "Magnetic properties of different ultrathin films studied by synchrotron radiation"
- Natalia Olszowska "UARPES – high resolution photo-electron spectroscopy beamline at NSRC Solaris"
- Michał Ślęzak "Resolving the Spin Structure of Antiferromagnets in SOLARIS"

Chairman: Piotr Kuświk

16:45 – 17:15 Coffee break

17:15 – 18:00 Flash talks [Room no. 1]

- Błażej Anastaziak "Local modification of magnetic properties by plasma oxidation of Au/Co/Ni thin films"
- Bartosz Walter "Software aging in the era of cult of youth"
- Jędrzej Chrzanowski "Seasonal patterns of glycemic variability identified with continuous glucose monitoring in pediatric type 1 diabetes"
- Daniel Rumiński "Three-dimensional visualization of the crystalline lens sutures for the assessment of ageing processes in the eye"
- Antoni Lis "Superparamagnetic nanoparticles as an epirubicine carriers"
- Damian Łukawski "Preparation and applications of electrically conductive wood layered composites"
- Krystian Lankauf "Characterisation of Fe/Cu doped spinel MnxCo3-xO4 prepared by modified Pechini method for oxygen evolution reaction in alkaline water electrolysis"
- Bartosz Holowko "Electrical degradation of anodic substrates fabricated by wet infiltration for IT-SOFC"
- Katarzyna Szwabińska "Carbon cathode materials for electro-Fenton process"

Chairman: Piotr Kuświk

18:00 – 19:00 Closing lecture [Room no. 1]:

Jakub Bochiński "Move fast and study things. How technology enables new models of research and development"

19:00 Closing ceremony [Room no. 1]

Prof. **ROBERT J. CAVA**
Department of Chemistry, Princeton University

OPENING LECTURE

The Status and Promise of Quantum Materials

Sometimes there is an idea in science that takes hold of a whole community at what seems like the same time. "Quantum Materials" is one of those ideas. It is not so easy to trace this idea back to its origins, because the work in this field is so widespread now, but the first I recall hearing the phrase was through what I think has to be called a visionary research program funded by the Gordon and Betty Moore Foundation in the US. Their program, "EPiQS", started 5 years ago, as the response of a private foundation that doesn't generally fund materials physics to what many might perceive as a significant shortcoming in the way that research in that area is funded in the USA. There could actually be a completely different origin for the whole thing; I am not a historian of science after all, I am just describing my personal perceptions. Like many of the best general concepts, I bet that the quantum materials classification is so successful because it worked to tie together ordinarily disparate research topics and put them under a single umbrella.

Quantum materials seems like it could be a class of materials that is hard to define, and, like the famous anecdote of blind people asked to define an elephant, it likely means different things to different scientists, but in my opinion these are materials whose electronic or magnetic properties are best explained by the concepts of quantum mechanics, originally formulated in the early 20th century, as opposed to those of classical physics, which of course can explain much about the way our world works. The whole idea has really come to the fore in the past decade through the study of "topological insulators" and related materials, where a concept (topology) whose influence

is not described in original formulations of quantum mechanics rules the day, and what were once unpredictable properties for solid matter have now been observed.

I am a solid state chemist, not a physicist, and so my understanding of the quantum physics involved is sketchy at best, but, I imagine like in all collaborative fields, finding a common language for communication across boundaries is important, and leads to the exhilaration of discovery. What has developed in this field has both opened the eyes of people who care to see, and promised possible applications far down the road if some of the ideas and materials that embody them can be developed.

Keywords: quantum materials, topological insulators

Prof. ROBERT J. CAVA, the Russell Wellman Moore Professor of Chemistry at Princeton University was Chair of the Department of Chemistry from 2004–2010 and was Acting Director of the Princeton Materials Institute from 2001–2002. Cava's research, in solid state chemistry, emphasizes the relationships between chemistry, crystal structure, and electronic and magnetic properties of non-molecular solids. Superconductors, magnetic materials, thermoelectrics, topological insulators, geometrically frustrated magnets, and correlated electron systems are his current interests. He received his Ph.D. in Ceramics from MIT in 1978, after which he was a Postdoctoral Fellow at the National Institute of Standards and Technology. He began at Princeton in 1996 after working at Bell Laboratories for 17 years, where he was a Distinguished Member of the Technical Staff. He is an active board committee of the Royal Society. He is a Fellow of the American Physical Society, the American Ceramic Society, and the Neutron Scattering Society of America, and a member of the U.S. National Academy of Sciences. He has received a variety of awards for his research, and at Princeton he has been a recipient of the President's Award for Distinguished Teaching, the Phi Beta Kappa Teaching Award and three teaching awards from the Princeton Engineering Council. His hobby is amateur astronomy.

Dr. **JAKUB BOCHINSKI**
Science Advocates Association

CLOSING LECTURE

Move fast and study things. How technology enables new models of research and development.

Remotely controlled instruments, robotic laboratories, big data, the cloud, smart spaces, agile research methodologies, telepresence, distance teaching, design-based research, digital twins, machine learning, IoT. For some of us these are just buzzwords. For others – necessary tools in life of a modern researcher. In this talk I will share some of the recent advances in technology that are already driving the change in the research community with tips on how to join the ongoing revolution.

Keywords: R&D, science, methods, technology

Dr. JAKUB BOCHINSKI, PhD – astronomer, designer and constructor of robotic telescopes, discoverer of several new planets outside of the Solar System, specialist in the areas of science communication, R&D management and talent development for high-tech industries.

Jakub pursued his academic career at University College London and The Open University in Great Britain, publishing in top journals such as Nature and the Astrophysical Journal. In Poland, he managed large R&D centers in Copernicus Science Centre and Sollers Consulting. Jakub served also as an advisor to the European Space Agency and a head of its ESERO office in Poland. He co-founded the Polonium Foundation, which aims to network polish scientists around the world. In his free time, Jakub leads the Science

KEYNOTE SPEAKERS

Advocates Association, a collaboration of 50 top science communicators in Poland, and runs a trademark course in astronomy at Akademeia Tutorial College. As an avid communicator, Jakub loves sharing his experiences – in form of over a thousand talks and workshops presented worldwide, including at such events as infoShare, TEDx, Women in Tech Summit and BBC Stargazing Live.

DISCUSSION PANEL I

INNOVATION: WHAT DOES IT MEAN?

Innovation is, according to the definition, new idea, creative thoughts, new imaginations in form of device or method. Innovation is often also viewed as – the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. But we will discuss the topic and asnwer the question what innovation means to us – scientists.

MODERATOR

Prof. **ADRIANA ZALESKA-MEDYNSKA**
University of Gdansk

Prof. Adriana Zaleska-Medynska is a Professor in Chemical Technology at the University of Gdansk and head of the Department of Environmental Technology. She obtained a Ph.D. in 2000 in the field of chemical technology at Gdansk University of Technology (Poland). Following appointment as Visiting Scientist at University of Utah (UT, USA) and California Institute of Technology (CA, USA), she was appointed as adjunct at Faculty of Chemistry at Gdansk University of Technology. During this time she started to study correlation between surface properties and visible light induced photoactivity of TiO2-based materials. She completed D.Sc. (habilitation) in 2009 and in 2012 she became a head of the new research group at University of Gdansk followed by promotion to Full Professor at the same university in 2014. She is a co-author of 116 papers, 1 book, 16 chapters in books and monographs, 12 patents, 5 patent applications, 177 short communi-cations. Her current interests concern functional material synthesis and characterization, heterogeneous photocatalysis, environmental technology, air treatment and nanotechnology.

Prof. **SIXTO MALATO RODRIGUEZ**
University of Almería-CIEMAT, Spain

Prof. Sixto Malato Rodriguez since 1990 works at the Plataforma Solar de Almeria (PSA-CIEMAT) in all the EU R&D projects linked to the Solar Treatment of Water, being involved in 23 International, 30 National R&D Projects and different Contracts with Private Companies.

Since 2006, he has been Director or Co-Director of Joint Research Center (Univ. Almería-CIEMAT) of R&D in Solar Energy (CIESOL http://www.ciesol.es). In 2012–2017, he was Director of Plataforma Solar de Almeria (www.psa.es) and he has been Head of Research Unit at CIEMAT since 2012.

He is author of 1 book and co-author of 18 books as well as > 50 chapters in others. He has also co-authored more than 250 publications in indexed international journals, and more than 350 contributions to different International Congresses and 5 patents. He has participated in >90 Workshops and Conferences and participated as speaker in > 60 specialized courses and masters. He has directed 15 PhD Thesis. > 17000 cites, h-index: 75.

Ass. editor Environmental Chemistry Letters (Springer) and Photochemical and Photobiological Sciences. (RSC Publishing) up to now. Journal of Advanced Oxidation Technologies (Sci.& Technol. Network, Inc.; 2008–2016). Member of editorial board: Catalysis Today (Elsevier), up to now.

The Jury's Grand Prix of "European Grand Prix for Innovation Awards". 11 December 2004, Mónaco. http://www.european-grandprix.com/index_en.htm.

Jaime I Price (Most important in science in Spain) in Environmental Protection, 2011. http://www.fvea.es/medioambiente.html.

PANELISTS

Prof. **ROBERT J. CAVA**
Department of Chemistry, Princeton University

Prof. Robert J. Cava, the Russell Wellman Moore Professor of Chemistry at Princeton University was Chair of the Department of Chemistry from 2004–2010 and was Acting Director of the Princeton Materials Institute from 2001–2002. Cava's research, in solid state chemistry, emphasizes the relationships between chemistry, crystal structure, and electronic and magnetic properties of non-molecular solids. Superconductors, magnetic materials, thermoelectrics, topological insulators, geometrically frustrated magnets, and correlated electron systems are his current interests. He received his Ph.D. in Ceramics from MIT in 1978, after which he was a Postdoctoral Fellow at the National Institute of Standards and Technology. He began at Princeton in 1996 after working at Bell Laboratories for 17 years, where he was a Distinguished Member of the Technical Staff. He is an active board committee of the Royal Society. He is a Fellow of the American Physical Society, the American Ceramic Society, and the Neutron Scattering Society of America, and a member of the U.S. National Academy of Sciences. He has received a variety of awards for his research, and at Princeton he has been a recipient of the President's Award for Distinguished Teaching, the Phi Beta Kappa Teaching Award and three teaching awards from the Princeton Engineering Council. His hobby is amateur astronomy.

Prof. **LEON GRADOŃ**
Warsaw University of Technology, Poland

Prof. Leon Gradoń born 11 April 1947 in Szczekociny. A specialist in chemical engineering, he is a graduate of Warsaw University of Technology (WUT)'s Faculty of Chemistry (1969) and the University of Warsaw's Faculty of Mathematics and Mechanics (1975). In 1976 he completed his doctorate at WUT, in 1978–1979 he completed a postdoctoral visit to the University of Houston, and in 1981 he gained his habilitation degree. He was made a full professor in 1996. Prof. Gradoń works at the WUT Faculty of Chemical and Process Engineering, where he served as dean between 1999 and 2005. He was a Fulbright scholarship holder at the University of Cincinnati (1993–1994), and has been visiting professor at a number of institutions internationally: University of Buffalo (USA), Delft University of Technology Netherlands), University of Salzburg (Austria), and University of Hiroshima and Doshisha University (Japan). His research is on the mechanics of aerosols and using the fundamental mechanisms of processes of momentum, mass and energy to explain the phenomena taking place in multi-phase systems. His original hypotheses, the result of research of a fundamental character, have led to innovative technologies being implemented in production. These solutions are focused primarily on the subject of protection of health, in particular that of people in the work environment (related to e.g. protection of the respiratory system, treatment of drinking water, construction of personal inhalers and collective inhalers for cleansing the lungs in mines, dust reduction in areas in which mining combines are in use and, lastly, initiation of production of filters reducing pollution from diesel engines. He is the author or co-author of 15 monographs and chapters in monographs of international scope, seven academic textbooks, over 180 articles in renowned scientific journals and over 200 reports in international and domestic conference materials, as well as the

author or co-author of 64 patents. The technical solutions based on his research are or have been applied in many Polish and international companies and enterprises (e.g. vacuum distillation of fatty acids for the Institute of Industrial Chemistry and the Pollena company, water and other fluids filter technology for Microspun Products, implementation of production of CCV filters for diesel engines for Cummins Filtration (USA), preparation for implementation of a powder inhaler for GlaxoSmithKline, and membrane filters for cleaning food products for Biodesign (UK). Prof. Gradoń is active in a number of scientific advisory and editorial boards, and is a member of bodies including the International Society Aerosols in Medicine, of which he was a member of the board in 1991–1993, Gesellschaft für Aerosolforschung (since 2004 also a member of the board) and the American Filtration Society. Editorial boards include that of the Journal of Aerosols in Medicine, Chemical and Process Engineering, International Journal Occupational Safety and Ergonomics and Advanced Powder Technology (Japan). He is the winner of many awards for his scientific work. Including the Marian Smoluchowski Award in 1989 (prize given by the International Society for Aerosol Research in Vienna); Rockefeller Foundation Prize for work on the role of surfactant in process of gaseous exchange in the lungs: Gold Medal at the EUREKA International Innovation Exhibition in Brussels in 1998; Japan Society for Promotion of Sciences in 2001 (for the automised sequence for filter production in cleaning water and other fluids and implementation of production on an industrial scale); title of Cummins Filtration Professor in 2006 (awarded by industrial corporations, in this case the American company Cummins, a global producer of diesel engines) for achievements in filtration and development of new technologies used for filtration of fuel, air and exhaust fumes. In 2006 he was awarded the Prize of the Foundation for Polish Science. Decorated with honours including the Gold Cross of Merit (1993), the Medal of the Commission of National Education (1993) and the Knight's Cross of the Order of Polonia Restituta. Member of the FNP Council since September 2012.

DISCUSSION PANEL II

MENTORING – NAVIGATION THROUGH THE ACADEMIC LABYRINTHS

Mentoring – for a young scientist it can be hard to navigate the academic labyrinths. How can a good mentor help you find your way? What is a good mentor?

MODERATOR

Dr. **JOANNA NIEDZIÓŁKA-JÖNSSON**
Institute of Physical Chemistry PAS

Association of the Foundation for Polish Science Scholars

Dr. Joanna Niedziółka-Jönsson, chemist, since 2012 leader of the Surface Nanoengineering research group at the Institute of Physical Chemistry, Polish Academy of Sciences. Her scientific interests are focused on analytical chemistry, and in particular surface modification of electrodes with the aim of creating new chemical and biochemical sensors. For this purpose, it is necessary to search for new materials and / or modify their surface properties and apply appropriate detection methods. The synthesis and modification of metallic nanoparticles is of particular importance because these can be used as optical signal transducers due to their localized surface plasmon resonance, connecting chemical processes with detection techniques such as fluorescence microscopy, UV-spectrophotometry or surface-enhanced Raman spectroscopy. Lately much of her work has been directed to the study of plasmonic properties of nanomaterials to expand this toolbox. Dr. Niedziółka-Jönsson is co-author of more than 80 publication, 5 patents, a recipient of scholarships from the Foundation for Polish Science, the Ministry of Science and Higher Education and was awarded with the Wojciech Świętosławski prize of 2nd degree in 2017.

Prof. **MACIEJ WOJTKOWSKI**
Nicolaus Copernicus University, Poland

Prof. Maciej Wojtkowski (b. 1975) is active in the field of biomedical imaging. His research interest includes optical coherence tomography and low coherence interferometry applied to biomedical imaging. Maciej Wojtkowski has significant impact on development of Fourier domain OCT (FdOCT) technique. The first FdOCT instrument for in vivo retinal imaging was designed and constructed by dr Wojtkowski and his colleagues from the Medical Physics Group at Nicolaus Copernicus University Poland in 2001. Maciej Wojtkowski also contributed in development and construction of three clinical prototype high speed and high-resolution OCT instruments which are in use in ophthalmology clinics: in Collegium Medicum in Bydgoszcz, Poland, New England Eye Center, Boston, USA, and UPMC Pittsburgh. He is an author of more than 160 publications including 100 full papers in peer reviewed journals. During his academic career Maciej Wojtkowski served short internships in Vienna University and University of Kent. He also worked for two years as postdoctoral fellow in joint project between Massachusetts Institute of Technology and New England Eye Center. Currently prof Wojtkowski is a head of the Department of Physical Chemistry of Biological Systems at Institute of Physical Chemistry of the Polish Academy of Sciences where he also leads his own research team (Physical Optics and Biophotonics Group).

PANELISTS

Prof. **JANUSZ MAREK BUJNICKI**
International Institute of Molecular and Cell Biology
in Warsaw, Poland

Prof. Janusz Marek Bujnicki, Professor of Biology, head of a research group in the International Institute of Molecular and Cell Biology in Warsaw, Poland. His research combines bioinformatics, structural biology, and synthetic biology, and currently focuses on RNA structure determination and design. His scientific achievements include the development of methods for computational modeling of protein and RNA 3D structures, discovery and characterization of enzymes involved in RNA metabolism, and engineering of proteins with new functions. Author of > 300 publications, cited ~9,000 times. Member of the Polish Academy of Sciences, EMBO, and Academia Europaea. Graduated from the Leadership Academy for Poland. Has been involved in Citizens of Science, the Young Academy of the Polish Academy of Sciences, and the Science Policy Committee (KPN). Member of the Committee for the Evaluation of Science (KEN). Executive editor of Nucleic Acids Research. Chair of the University Council at the University of Warsaw. Member of the Group of Chief Scientific Advisors within the European Commission's Scientific Advice Mechanism. Poland's representative in the European Science Advisors Forum (ESAF). The "founding father" of PSN.

BEATA MAŁACHOWSKA
Medical University of Lodz, Poland

Beata Małachowska is a 4th year PhD student at the Department of Biostatistics and Translational Medicine (Medical University of Lodz, Poland) under supervision of prof. Wojciech Fendler. She also graduated from Post-Graduate School of Molecular Medicine (Medical University of Warsaw, Poland).

Her scientific work started in 2011 at the Polish Registry for Pediatric and Adolescent Diabetes project headed by prof. Wojciech Młynarski. Now, she is a principal investigator of PRELUDIUM grant funded by National Science Centre and Scientific grant from Diabetes Poland. Also, she participates in many external scientific projects as data analyst i.a. for Dana-Farber Cancer Institute (Harvard Medical School). She is an author of 35 research publications indexed in Medline including ones in prestigious Nature Communications and Science Translational Medicine.

After graduation, in 2014, she received i.a. Polish Student Nobel Prize at Medical Sciences, then in 2017, Scholarship of the Polpharma Scientific Foundation, in 2018, L'Oreal-UNESCO for Women in Science Poland, and in 2019, START Scholarship from Foundation for Polish Science.

PANELISTS

Dr. **KRYSTYNA MALIŃSKA**
Częstochowa University of Technology

Dr. Krystyna Malińska, an environmental engineer, works as a researcher and an academic lecturer at the Faculty of Infrastructure and Environment at Częstochowa University of Technology. She graduated from Cracow University of Agriculture (MSc in Food technology), Silesian University (MSc in Business English), Częstochowa University of Technology (PhD in Environmental Engineering) and University of Warsaw (Postgraduate studies on intellectual property rights). She is also a Fulbright Scholar, a USDA Norman Borlaug Program fellow and a beneficiary of Top 500 Innovators Program.

Her work focuses mainly on research in the field of environmental engineering and organic and vegan agriculture. Krystyna's interests also include R&D project management, intellectual property rights, commercialization of scientific results and English for scientific communication. Currently, Krystyna is involved in two Horizon 2020 research projects: Organic+ (2018–2022 https://organic-plus.net/) and utri2Cycle (2018–2022 https://www.nutri2cycle.eu/).

Through teaching courses and doing research Krystyna tries to encourage students to search for passion and help them to find their own career path. This is also the mission of the TopMinds training and mentoring program for students (www.topminds.pl) which she has been coordinating together with the alumni from Top 500 Innovators and Fulbright programs. Krystyna is also actively engaged in promoting the academia-industry cooperation through the initiatives of the Association of Top 500 Innovators and consultations for the Ministry of Science and Higher Education, the National Center for Research and Development and European Commission.

DISCUSSION PANEL III

ARTIFICIAL INTELLIGENCE – THREAT OR OPPORTUNITY?

Artificial intelligence (AI) has been increasingly affecting many areas of today's life. Ideas that several years ago were seen only in science-fiction novels have now become reality. As AI continues to develop more and more questions arises what risk it can bring for humankind. Is thus artificial intelligence threat or opportunity?

MODERATOR

Dr. **ANNA FABIJAŃSKA**
Lodz University of Technology
Polish Young Academy

Dr. Anna Fabijańska, Ph.D., D.Sc. (born in 1982) is an Associate Professor in computer science at the Institute of Applied Computer Science of the Lodz University of Technology, Poland where she is also holding the position of the Institute's vice director for the development. She received her master of engineering degree (2006), doctoral degree (2007) and habilitation degree (2013) in computer science from the Faculty of Electrical, Electronic, Computer and Control Engineering of the Lodz University of Technology. She also gained her scientific experience abroad at the University of Kent (UK), Claude Bernard University Lyon 1 (France) and University of Clermont Auvergne (France).

Her scientific interests focus on digital image processing and analysis, machine vision and artificial intelligence (especially deep learning). In particular, they concern the development of the dedicated image processing pipelines for computer-aided diagnosis systems and applications of computer vision in various fields of science and industry. She has authored/co-authored over 100 scientific papers which have been cited over 700 times.

She was a beneficiary of the Ministry of Science and Higher Education fellowship for outstanding young scientists in the years 2013–2015, a beneficiary of the Foundation for Polish Science (FNP) START fellowship in 2011 and the leader of scientific grants including the project within the framework of the Iuventus Plus programme in the years 2013–2015. Since 2016 she has been the member of The Polish Young Academy of the Polish Academy of Sciences and the member of the Committee on Informatics of the Polish Academy of Sciences. She has also served as an independent reviewer for the Polish National Science Center (NCN), The National Centre for Research and Development (NCBR) and the Netherlands Organisation for Scientific Research (NWO-WOTRO). Recently, she has been supervising 3 Ph.D. students in computer science.

Prof. **KRZYSZTOF KRAWIEC**

Poznan University of Technology

Krzysztof Krawiec is a Professor of Computer Science at Poznan University of Technology, Poland, where he serves as a Deputy Head for Science. His research areas include computer vision and program synthesis, with applications in medicine and software engineering. Prof. Krawiec is the author of over 100 publications on the above and related topics, and an associate editor of Genetic Programming and Evolvable Machines. He received the Fulbright Senior Advanced Research Award and was a visiting professor at University of California and Massachusetts Institute of Technology.

PANELISTS

Dr. **RAFAŁ URBANIAK**

University of Gdansk

Dr. Rafał Urbaniak is interested in applications of formal methods to philosophical and social problems, such as those related to legal applications of probabilistic methods, algorithmic fairness, theories of rationality & belief revision. Nowadays, his main research project pertains to the use of probabilistic methods in juridical fact-finding.

Rafal completed his PhD in Logic and Philosophy of Mathematics in 2008 at the University of Calgary (working with Prof. R. Zach), focusing on the development of mereological foundations of mathematics. Since then, he has been a postdoctoral fellow of the Research Foundation Flanders at the Centre for Logic and Philosophy of Science at Ghent University in Belgium, Long Room Hub Fellow at Trinity College Dublin, Visiting Research Fellow at Banaras Hindu University, and British Academy Fellow at Bristol University. He is now an Associate Professor at the Department of Philosophy, Sociology and Journalism at the University of Gdansk, leading a Sonata Bis research project "Conceptual, formal and practical aspects of forensic and judicial applications of probabilistic tools." More details and papers are available at http://ugent.academia.edu/RafalUrbaniak.

Dr. **JAKUB BOCHINSKI**
Science Advocates Association

Dr. Jakub Bochinski, PhD – astronomer, designer and constructor of robotic telescopes, discoverer of several new planets outside of the Solar System, specialist in the areas of science communication, R&D management and talent development for high-tech industries.

Jakub pursued his academic career at University College London and The Open University in Great Britain, publishing in top journals such as Nature and the Astrophysical Journal. In Poland, he managed large R&D centers in Copernicus Science Centre and Sollers Consulting. Jakub served also as an advisor to the European Space Agency and a head of its ESERO offi ce in Poland. He co-founded the Polonium Foundation, which aims to network polish scientists around the world. In his free time, Jakub leads the Science Advocates Association, a collaboration of 50 top science communicators in Poland, and runs a trademark course in astronomy at Akademeia Tutorial College. As an avid communicator, Jakub loves sharing his experiences – in form of over a thousand talks and workshops presented worldwide, including at such events as infoShare, TEDx, Women in Tech Summit and BBC Stargazing Live.

OXFORD
DEBATE

MODERATORS:

ANETTA PŁATEK

PAULINA BUJEWSKA

Rules and principles:

1. Question raised during the debate is as follows:

   "Electric vehicles – bright future or hopeless wish?"

2. There are two debate groups: **Affirmative Team** (for) and **Negative Team** (against).
3. The person responsible for technical issues (time control etc.) is so-called Chair/Marshal or Attorney Moderator.
4. Debate is evaluated by judges, which at least one is an expert in the field of discussion.
5. Each person taking part (either during his/her presentation or asking questions) in the debate **needs to introduce him/herself and ask the Attorney Moderator for a free voice**, i.e., *Dear Judges, Dear Moderator, Dear opponents. My name is Anna Kowalska and I would like to rise a question…*
6. There is a strict time regulation for each person speaking. Irrespective of amount of group members, only 4 representatives of each group are going to speak.

7. Procedure of the debate looks as follows:

Opening of the debate

raising the main question and introducing the two teams by Attorney Moderator

Affirmative Team	Negative Team
1st speaker **presents argumentation** which **agrees** with the question raised	1st speaker **presents argumentation** which **disagrees** with the question raised
2nd speaker **responds** to the argumentation of 1st speaker from Negative Team	2nd speaker **responds** to the argumentation of 1st speaker from Affirmative Team
3rd speaker **refers** to the already presented *pro and con* arguments	3rd speaker **refers** to the already presented *pro and con* arguments
4th speaker **summarizes** the statement of Affirmative Team	4th speaker **summarizes** the statement of Negative Team

Questions **to both teams from the audience**

Questions **to Affirmative Team from Negative Team** and *vice versa*.
(**20 min**)

Attorney Moderator is **closing the debate**.

Judges are going to choose winning team on the basis of their essential argumentation, way of presentation (language and appropriate phrases), time control and interaction with a person asking a questions

Each speaker has **5 min** to present the argumentation or to respond to the argumentation of the speaker from the other group.

The judges are given **the evaluation cards**. They take into account:

- appeal,
- preparation to the presentation,
- problem analysis,
- argument and evidence,
- rebuttal (in the case of 2nd, 3rd and 4th speakers),
- construction of the speech,
- originality,
- logical manner of the presentation,
- scientific point of view,
- Q&A.

FLASH TALKS

The Scientific Committee has decided to honor authors of high-quality abstracts by offering them the opportunity to present their work during the flash talks session. These three-minute-long presentations will briefly showcase the main findings or research focus of the honored participants. We believe that this form of presentation gives the general public an overview of the wide range of topics covered by the Polish Scientific Networks 2019 conference.

HOST:

Dr. **PIOTR KUŚWIK**

LOCAL MODIFICATION OF MAGNETIC PROPERTIES BY PLASMA OXIDATION OF Au/Co/Ni THIN FILMS

B. Anastaziak[1,2], P. Kuświk[1], F. Stobiecki[1]

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Magnetic thin films with perpendicular magnetic anisotropy (PMA) have attracted significant attention due to their potential use in spintronic and in magnetic recording devices [1]. For these applications, magnetic patterning is often required consisting of a local change of characteristics magnetic. One of the promising methods is a plasma oxidation (PO).

Here, we study magnetic properties of Ti/Au/Co/Ni layered systems, after PO. All samples are deposited by magnetron sputtering system. After deposition, the samples are expose to oxygen plasma to form NiO on top of the Co layer. The samples were investigated by polar magneto-optical Kerr effect (PMOKE), vibrational sample magnetometer, and X-ray absorption spectroscopy (XAS). Comparing the intensity of the distinguishing peaks of XAS spectra at Ni $L_{2,3}$ edges measured before and after PO, we found that the thickness of NiO increases along with oxidation time. Creation of NiO layer cause changes in the magnetic anisotropy of the system. Based on those results we proposed a new method for magnetic patterning, in which the local modification is achieved by PO through a photoresist mask. Using this technique, we have fabricated the square lattice patterns characterized by different magnetic state of matrix and structures. Depending on parameters of the PO process and thickness of the Ni and Co layers magnetic state of patterned areas (PMA, in-plane anisotropy, non-ferromagnetic) can be controlled.

Keywords: Au/Co/Ni system, local plasma oxidation, magnetic properties

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SOFTWARE AGING IN THE ERA OF CULT OF YOUTH

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Software has become not only ubiquitous, but also indispenable element of modern world. However, the rapidly changing and growing user needs trigger an endless loop of updates and fixes applied to software systems, which contribute to gradual erosion of the software architecture, called software aging. This phenomenon hinders further evolution of the system, and subsequent changes become more costly and difficult, which is unacceptable for the market and the users. To prevent that, we need to invest additional effort in maintaining the software in a shape that allows for its further evolution. Currently, the maintenance cost comprises majority of expenses related to operating software systems. To reduce it, we need to look for robust methods for predicting, applying and verifying changes.

In other domains the problem of evolution of various subjects has been already explored. For example, we know effective methods of ammending and extending legal systems that prevent the law from becoming overly complex and contradictory. In medicine, procedures for identification, diagnosing and treating various illnesses have been also developed. From that perspective, software systems are not much different from the other subjects, and the methods existing for these subjects could be potentially ported or adapted to a new domain of software development and maintenance.

As a result, we are continuously looking for metaphors that could help us in understanding the processes of software aging, based on methods and approaches developed and used in other domains of science. They would allow for more effective evolving new and existing software systems.

Keywords: software evolution and maintenance, software aging

SEASONAL PATTERNS OF GLYCEMIC VARIABILITY IDENTIFIED WITH CONTINUOUS GLUCOSE MONITORING IN PEDIATRIC TYPE 1 DIABETES

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Introduction: Monitoring of blood glucose is the mainstay of successful therapy of type 1 diabetes (T1D). Continuous glucose monitoring (CGM) is increasingly being used for everyday glycemic control, allowing for glycemic variability (GV) assessment in long-term observations. We aimed to determine GV indices' seasonal nature, in light of previously reported seasonal characteristics of T1D.

Methods: This is a retrospective analysis of long CGM records in children (< 18 y.o.) with T1D (for >6 months) between November 2015 and February 2019. GV indices were calculated with our published software GlyCulator 2.0. Meteorological data was obtained from the National Institute of Meteorology and Water Managment. Between-seasons differences of GV indices were compared using ANOVA test. We identified patient-specific seasonal patterns by unsupervised clustering based on patient-specific correlations between GV indices and meteorological factors. The periodicity was evaluated using power spectrum analysis.

Results: We included 29 children [median record length 381 days (25–75%: 166–679)], age 4 to 14 y.o. Hierarchical clustering identified two groups of 13 and 16 patients, with different patterns in risk of hypoglycemia (Time Below Range Target < 54mg/dL: $p < 0.0001$) and GV indices (SD and CV: $p < 0.0001$, $p < 0.0001$) correlated with mean daily temperature. Among 16 patients whose GV indices presented high autocorrelations, a period of 12 months was identified as dominant, with recurrent periods of high GV.

Conclusions: We report the first analysis of seasonal patterns of GV indices based on long-term CGM recordings. A subgroup of children with T1D showed a seasonal pattern of GV hinting at a mechanism explaining variable incidence of hypoglycemia and acute complications of diabetes.

Keywords: Diabetes, Continuous Glucose Monitoring, Glycemic Variability

THREE-DIMENSIONAL VISUALIZATION OF THE CRYSTALLINE LENS SUTURES FOR THE ASSESSMENT OF AGEING PROCESSES IN THE EYE

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Human lens is a principal component in the vision process. To perform its role, it has to be transparent and have the capacity to rapidly alter its shape during accommodation process. Underlying lens function is lens structure. Gross analysis of all vertebrate lenses reveals that they are composed of long fiber-like cells connected in characteristic sutures pattern [1].

Each type of suture exerts a different quantifiable negative influence on lens optical quality. In addition, abnormal development of sutures has been shown to be associated with specific types of cataract. Finally, while some ocular

surgeries (trabeculectomy and vitrectomy) result in post-surgical alterations in lens sutures that precede cataract formation.

Cataract is the leading cause of blindness worldwide and it is a condition characterized by the progressive loss of the transparency of the crystalline lens that results in visual impairment. Multiple factors, such as aging, disease, genetics, nutritional or metabolic deficiencies, trauma, congenital factors, and environmental stress, can contribute to the development of cataracts, with age being the major contributor [2, 3].

So far sutures investigation was performed using light and electron microscopy. The aim of this study is to demonstrate a novel technique that aims at in vivo visualization of the crystalline lens sutures. The system was based on optical coherence tomography (OCT) with enhanced depth imaging modality. Proposed data processing scheme (data registration and image segmentation) enables to visualize anterior and posterior crystalline subtle lens sutures architecture.

In conclusion, OCT depth enhanced imaging device allows for visualization of in vivo lens sutures microarchitecture within different age groups. We believe that presented methodology could establish ophthalmic diagnostic tool in investigation of the age-related changes in lens microstructure.

Keywords: biomedical imaging, ophthalmology, crystalline lens, optical coherence tomography

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SUPERPARAMAGNETIC NANOPARTICLES AS AN EPIRUBICINE CARRIERS

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One of the most common cause of deaths are various tumor diseases. In spite of progress in oncology tumor cells are often not vulnerable on some anticancer drugs. Facing this problem the main idea of the project is to fight with antitumor cells insensivity and offer theraphy which contains three mechanisms of cells necrosis: magnetic hyperthermia effect, endoradiotheraphy and drug theraphy. All those effects at the same time working synergistically.

Our studies based on the synthesis of magnetic nanoparticles doped with holmium, which were covered with organic compounds as linkers with common anticancer drug – epirubicine. That way, there were created nanoparticles being anticancer drug carriers. We investigated their morphology, creditibility of drug connection, magnetic properties and magnetic hyperthermia capabilities. We also performed cytotoxicity tests.

The morophology was investigated with Transmission Electron Microscopy and Dynamic Light Scattering Techniques. Drug connection creditibility was checked with Zeta Potential setup, Infrared Spectroscopy and Thermogravimetry. Magnetic properties were measured by magnetometry analysis. Magnetic hyperthermia consisted of measuring the increase of temperature of sample under variable magnetic field. The in vivo tests were investigated with use of mouse breast tumor cells.

Those studies allowed us to estimate our average nanoparticles size as 12 nanometers and their magnetic properties as superparamagntetic. Initial hyperthermia measurments encourages us to futrher studies in vivo.

Keywords: nanomaterials, antitumor drugs, magnetism

PREPARATION AND APPLICATIONS OF ELECTRICALLY CONDUCTIVE WOOD LAYERED COMPOSITES

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Carbon nanotube (CNT) and graphene-based coatings were applied on wood and wood-based composites surfaces. The superhydrophobic [1] electically conductive [2] coating is capable of bringing a wide range of new functionalities to traditionally passive wooden construction elements, including furniture and flooring. The nano/microthin heaters integrated with wood was developed for heating or drying of moist construction wood Furthermore, a set of examples of wood-based electronic applications potentially useful in a wood industry context were proposed. These include liquid, pressure and temperature sensors for such applications as flood, occupancy or fire detection. Additionally, superhydrophobic CNT-based coating will prevent mechanical weakening caused by water soaking by wood. Various coatings and deposition methods were tested against the surface properties of wood/wood-based materials and specific application requirements.

Keywords: carbon nanomaterials, multifunctional composites, wood

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CHARACTERISATION OF Fe/Cu DOPED SPINEL $Mn_xCo_{3-x}O_4$ PREPARED BY MODIFIED PECHINI METHOD FOR OXYGEN EVOLUTION REACTION IN ALKALINE WATER ELECTROLYSIS

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The demand for energy grows constantly with the development of human civilisation. Due to the growing global warming threat, there is an urgent search for renewable energy sources. One of the promising solutions is the usage of hydrogen to generate power in fuel cells. Water electrolysis seems to be a suitable method for clean hydrogen production and making it affordable is crucial. Precious metals IrO_2 and Pt have been identified as the most active catalysts for water splitting reactions, the oxygen and hydrogen evolution, respectively. Nevertheless, the low abundance of those elements in the Earth's crust makes their application in electrolysis unprofitable. Recently there is a growing interest in a group of transition metal oxides with a spinel crystallographic structure, especially $Mn_xCo_{3-x}O_4$, due to its high catalytic activity. Moreover, doping the spinel with other metals such as iron, copper or nickel can significantly enhance electrocatalytic properties of the material [1].

In this project, the influence of the content of the metals (Me) such as Fe/Cu in $(Mn_xCo_{3-x})_{1-y}Me_yO_4$ on the morphology and catalytic properties toward oxygen evolution reaction (OER) is investigated. $(Mn_xCo_{3-x})_{1-y}M_yO_4$ spinels (for y = 0.05, 0.10, 0.20) are synthesised by a modified Pechini method which allows obtaining oxides with homogeneously dispersed metals [2]. Adjustment of synthesis parameters or stoichiometry may change the electrical and physiochemical properties. The catalysts in a form of ink are deposited on nickel foam and studied with respect to their OER catalytic properties in alkaline aqueous medium of 1 M KOH.

It is observed, that changing the spinel structure influence much the morphology and catalytic properties of the material. The results show that spinels doped with other transition metals exhibit significantly improved OER performance compared to raw $Mn_xCo_{3-x}O_4$.

Implementation of relatively low-cost transition metal oxides in alkaline water electrolysis is a promising strategy for making this technology a common method for hydrogen production.

Keywords: electrolysis, spinel, water splitting

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ELECTRICAL DEGRADATION OF ANODIC SUBSTRATES FABRICATED BY WET INFILTRATION FOR IT-SOFC

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Nowadays, the infiltration of porous YSZ skeletons with catalytic materials is a good and widely used method for producing efficient and stable ITSOFCs [1]. It allows achieving nanocatalytic grains of an electron conductor, which increases the triple phase boundary length for efficient electrochemical reactions. In this work, NiO and NiO with the addition of CeO_2 were introduced by infiltration into the structure of porous YSZ in various volume ratios. Cerium

oxide is used as a sintering inhibitor and prevents the growth of the nickel grains and their agglomeration [2]. In order to evaluate the influence of infiltration method on anode performance, the conductivity of the conventional anode substrates and those prepared using the infiltration technique were investigated using the Van der Pauw method for 100 h at temperatures in the range of 600–800°C. Moreover, Scanning Electron Microscope was performed both before and after the measurement to determine the changes in the microstructure. X-ray diffraction was used to prove the lack of incorporation of nickel into the fluorite structure of cerium oxide. The results show that for infiltrated anodes less nickel is needed to create percolation paths than for conventional electrodes.

Keywords: SOFC, wet infiltration, anode, agglomeration

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CARBON CATHODE MATERIALS FOR ELECTRO-FENTON PROCESS

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The electro-Fenton process is one of the electrochemical advanced oxidation processes (EAOPs) which enables removal of non-readily biodegradable organic pollutants from wastewater [1].

As in the case of Fenton process, the degradation of organic compound results from its reaction with in situ generated hydroxyl radical which is the second strongest oxidant known after fluorine and is the product of Fenton reaction between hydrogen peroxide and Fe^{2+} ion [1].

Hydrogen peroxide, which is essential to obtain reactive hydroxyl radicals, is sourced continuously from oxygen electroreduction with transfer of only two electrons to oxygen molecule. The cathodes at which oxygen reduction occurs are often made of various kinds of carbon materials what triggers high hydrogen evolution overpotential and low catalytic activity towards decomposition of hydrogen peroxide produced at this electrode [2].

The aim of conducted research was to compare carbon materials with diverse structure, i.e. carbon nanotubes and activated carbon (both heteroatom-doped and non-doped) with respect to the possibility of their application as cathode material in electro-Fenton process.

In addition to the hydrogen peroxide generation efficiency, which was determined by rotating disk electrode method, different carbon materials were also evaluated in terms of the degree of degradation of organic compound subjected to electrochemical advanced oxidation on the grounds of chemical oxygen demand.

Keywords: oxygen electroreduction, rotating disk electrode

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SCIENTIFIC SESSION

ENERGY

PLENARY LECTURE

Prof. **ELŻBIETA FRĄCKOWIAK**
Poznan University of Technology, Institute of Chemistry and Technical Electrochemistry

Challenges for aqueous electrochemical capacitors

Electrochemical capacitors EC (named also electrical double-layer capacitors or supercapacitors) are the devices based on the reversible storage of energy by electrostatic (capacitive) attraction of ions. Performance of EC are determined by electrode materials, i.e. activated carbons but also strongly governed by the type of electrolytes, namely aqueous (acidic, basic, neutral), organic and ionic liquids. As a consequence, practical voltage range of EC in these electrolytes varies from 0.8 V to 3.5 V, respectively. The type of current collector will also affect EC voltage values.

Capacitive charge storage can be increased by faradaic reactions, frequently called pseudocapacitive effects. It must be underlined that only redox reactions which present capacitive behavior should be considered, i.e., capacitance should be proportional to the charge accordingly to formula $C = dQ/dE$. Faradaic contribution can be originated from electrode materials but also from electrolytic solutions. Typical electrode materials with pseudocapacitive character consist of: i) electrically conducting polymers, ii) carbon materials rich in heteroatoms (oxygen, nitrogen, sulphur), iii) carbon with electrosorbed hydrogen.

Exploring redox active species from electrolytic solution is another possibility for energy increase by pseudocapacitive effects. A big variety of redox couples could be used for this target, e.g. iodide/iodine, bromide/bromine, vanadium species etc. Practical application of such redox pairs will be determined by the reversibility, pH of solution, concentration, price, availability, toxic character. Some of them can be used only as an additive to electrolyte. Taking into account the values of redox potential, different couples could be used for positive and negative electrode. In this case separation of both electrodes is crucial.

Considering the energy values, aqueous electrochemical capacitors seem to be competitive to supercapacitors based on organic medium, however, there are still issues to be solved (cycling, selfdischarge).

ELŻBIETA FRĄCKOWIAK is a full professor in the Institute of Chemistry and Technical Electrochemistry at the Poznan University of Technology, Poland.

Her research field is energy storage/conversion with special emphasis on electrochemical capacitors, lithium-ion batteries, fuel cells and hydrogen electrosorption in carbon materials. She is particularly interested in electrode materials from activated carbons, carbon nanotubes, carbons enriched with heteroatoms (nitrogen, oxygen), graphene materials, conducting polymers and composites.

E. Frąckowiak coordinated a few international projects – NATO project Science for Peace SfP 973849 (1999–2005), Marie Curie Action FP7-PEOPLE-2011-IAPP – "Energy Caps" (2011–2015), FP7 project "NEST" (2012–2016), Polish-Swiss project "INGEC" (2012–2016).

She served as a Chair of the Electrochemical Energy Conversion and Storage Division in the International Society of Electrochemistry for the term 2009–2014. She was a winner of the Foundation for Polish Science Prize (2011). She received Officer Cross Restituta Polonia for scientific achievements (2011). She was a Member of the National Centre Science Council (2012–2015). Since 2013 she serves as a President of the Polish Carbon Society.

In 2013 she became a member of the Polish Academy of Sciences (vice-president 2015–2018). Since 2014 she is a Fellow of the Royal Society of Chemistry. In 2016 she was appointed as a member of the Executive Board of EuroCASE (European Council of Academies of Applied Sciences, Technologies and Engineering). At present, she is associate editor of Carbon journal (Elsevier).

E. Frąckowiak has authored more than 155 publications, has a significant number of patents (ca. 50), and 22 book chapters. Her scientific papers have received over 18 000 citations (H = 57).

INVITED TALK

Dr. **MONIKA KWOKA**
Silesian University of Technology in Gliwice, Faculty of Automatic Control, Electronics and Computer Science

Oxide nanomaterials for photovoltaic application

Photovoltaics technology, which converts solar energy into electricity is expected to be the most promising strategy among the common clean renewable energy sources. It is well known that already the fourth generations of the photovoltaic cells based on the various type inorganic and organic semiconductor nanostructures (hetero-junctions) have been elaborated [1]. Apart from above, the most important parts of every solar cell are the transparent electrodes, the light trapping layers, as well as electron transport layers, which are commonly based on the transparent conductive oxides (TCO), and directly determined its final efficiency.

In this work a novel trends in the technology and characterization of the low dimensional TCO nanostructures for above mentioned potential photovoltaic application will be reviewed, including mainly zinc oxide ZnO, titanium dioxide TiO_2 and tin dioxide SnO_2, with a special emphasis on their specific surface/interface properties playing a crucial role in electron charge transport inside the solar cells.

Keywords: photovoltaics, transparent electrodes, oxide nanostructures

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MONIKA KWOKA, Ph.D., D.Sc. is a Professor at the Silesian University of Technology in Gliwice and the vice-dean of the Faculty of Automatic Control, Electronics and Computer Science. She is a specialist in solid-state electronics, with particular emphasis on nanotechnology of materials for electronics, photovoltaics and healthcare.

She obtained master's degree in Technical Physics – the specialty of Opto-electronics at the Faculty of Mathematics and Physics, then PhD in 2007 in the field of physical sciences, and in 2015 at the Faculty of Automatic Control, Electronics and Computer Science of the Silesian University of Technology in Gliwice, the academic degree of habilitated doctor in the field of technical sciences in Electronics. Since 2017 she is an associate professor at the Silesian University of Technology, coordinating research work on the nanotechnology of electronic materials.

She obtained Scholarship of the Minister of Science and Higher Education for Outstanding Young Scientist in the years 2012–2014, and the 1st Degree Award of the Minister of Science and Higher Education for scientific achievements in habilitation in 2016. In addition, she was awarded twice the 1st Prize in the Nationwide Competition for them. J. Groszkowski under the auspices of the Polish Vacuum Society for the best master thesis and a doctoral dissertation in the field of vacuum (2004 and 2008). She was involved in several international research projects of the European Commission (including GOSPEL Network, EuNetAir Network and Clear-Up, in which she was one of the main contractors as well as managing and coordinating some of the Project task). She has been a leader of few national research projects,

including the Ministry of Development (InTechFun project as part of OP IE – contractor for 3 research packages), National Science Center, and Ministry of Science and Higher Education. Most of the above mentioned projects included advanced research issues with relevant practical aspects, mainly in the aspect of applications in environmental monitoring. She has experience and achievements in the field of international scientific cooperation. She cooperated, among others with research centers from Germany (University of Tuebingen), Italy (University of L'Aquila, University of Brescia), Hungary (University of Technology in Budapest) and Turkey (Institute of Technology, Gebze) in the field of research related to nanotechnology of electronic materials in the aspect of their potential applications in photovoltaics and toxic gas sensing. The effect of this cooperation is, among others a series of over a dozen scientific publications in renowned world magazines from the JCR database (Philadelphia List).

She is the vice-chairperson of the Academy of Young Scientists of the Polish Academy of Sciences in the term 2016–2020. In addition, she is a member of the Commission of the Polish Academy of Sciences for the dissemination of science in the period of 2016–2022. In addition, she is a member of the Board of the Polish Vacuum Society, the Chairwoman of the Surface Science Section in the term 2016–2019. She is also the Director of a world-wide scientific conference – International Workshop on Semiconductor Gas Sensors, and she was Guest Editor in the journal Thin Solid Films (Elsevier, Amsterdam) and chairman of cyclic international scientific conferences in the field of microelectronics (SSP Workshops) and sensory (SGS Workshops).

CHEMISTRY PERSPECTIVES TO NOVEL SUPERCONDUCTORS

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Design and discovery of new quantum materials will accelerate the development of new technologies in the future. I will report my group research progress in the past year, mainly focusing on the new superconductors containing magnetic elements and new magnetic topological quantum materials. Superconductors are naturally an ideal platform for quantum information processing (QIP), as they realize electrons to be entangled by forming cooper pairs. Both cuprates and iron-based high-Tc superconducting families can be considered as inducing superconductivity at the edge of structural and magnetic instabilities. Similar approach is used in our group to suppress the "fragile" magnetic orderings observed in the 4f rare earth metal and consequently induce superconductivity. I will describe how to design and prove the material candidate as a new MTQM from both experimental and theoretical aspects and show how topological electronic states and magnetism interplay in the new material.

Keywords: Superconductors, New Compounds

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COMPOSITE ELECTRODE MATERIALS FOR HIGH-POWER AND HIGH ENERGY DENSITY STORAGE DEVICES

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Increasing energy consumption and climate changes push scientists to search for new solutions for efficient and durable energy storage systems. To achieve a combination of high power and high energy density in one device, there is a need for new electrode materials [1].

In this work, synthesis and characterisation of novel composite materials dedicated to Lithium-Ion Capacitors (LIC) are presented. LIC are devices that combine two electrodes of different mechanism of accumulation of charge. Silicon oxycarbide/graphite composites of various compositions are proposed as a negative electrode. Silicon oxycarbides belong to a family of polymer derived ceramics (PDCs) and can be easily synthesised by the sol-gel method. PDCs exhibit high electric capacity values and good rate capability. PDCs are widely investigated as anodes for Li-ion batteries. Their main drawback, however, is the significant irreversible capacity of the first charge-discharge cycle. The addition of graphite is to diminish this problem. On the other hand, as positive electrode materials, pseudocapacitive ternary nanocomposites based on conducting polymer, graphene oxide and functionalized carbon nanotubes, are proposed. The advantage of the combination of three components over analogous binary composites [2] is presented.

Keywords: Lithium Ion Capacitors, Composite Materials, Polymer Derived Ceramics, Electroactive Polymers

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HYDROGEN AND OXYGEN EVOLUTION ACTIVITY OF COBALT-BASED FILMS PREPARED BY PULSED LASER DEPOSITION

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Alkaline water electrolysis is an attractive method of pure hydrogen generation without consumption of fossil fuels. However, the sluggish kinetics of two electrode reactions occurring during this process, namely hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) increases significantly the energy input in the process. Therefore new and possibly cheap electrocatalysts, which decrease the activation energies of those reactions are currently subject to intense research.

Herein, we present a series of electrocatalytic electrodes prepared by pulsed laser deposition from pure cobalt target on carbon fibre cloth. By varying the deposition parameters of substrate temperature, number of pulses and composition of background gas, we have prepared series of electrodes with variable compositions, structures and morphologies and evaluated their electrocatalytic properties towards HER and OER in alkaline medium. The results indicate the minor influence of the changes in morphology or chemical composition of the deposited films on the OER properties. Contrarily, the material morphology and electrochemically active surface area has shown a significant impact on the activity towards hydrogen evolution. No correlation was found between the chemical composition of the films and HER activity.

Keywords: water splitting, electrocatalyst, carbon fibre, electrolysis

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STUDY OF FUEL EFFICIENCY IN DIRECT BOROHYDRIDE FUEL CELL

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Humans consume more energy than ever before in history. There are predictions that in 2035 year, the demand for electricity will increase almost twice than in year 2008 [1]. The direct borohydride fuel cell (DBFC) is fed with an aqueous alkaline solution of borohydride. Sodium borohydride offers a large specific energy density (9.3 Wh/kg) owing to its high hydrogen content (10.8wt.%). Borohydrides (MBH_4, M = Na, K, Li) are attractive chemical compounds because they are chemically stable and not flammable [2]. Furthermore, metal hydride compressors make it possible to replace the liquid or compressed hydrogen fuel tanks by a solid fuel tank [3]. Because the borohydride oxidation reaction competes with hydrogen evolution reaction, not only the nature of electrocatalyst but also its structure play a significant role in the final efficiency improvement. The aim of the study was to determine the effect of anode material composition, based on multicomponent hydrogen storage alloy with silicon powder, carbon nanotubes and graphite using sodium borohydride as a fuel. The simultaneous use of materials with physicochemical properties favoring hydrogen sorption processes with an effective inhibitor of fuel hydrolysis, significantly improved the working conditions of DBFC.

Keywords: borohydrides, fuel cells, hydrogen evolution

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PHYSICAL PROPERTIES OF IMIDAZOLE-BASED PROTON CONDUCTORS

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For decades, scientists have been continually looking for different sources of energy, ways of storing it and its efficient use for the benefit of humanity. Proton conducting materials have potential applications in solid-state hydrogen fuel cells [1]. Heterocycles are an interesting class of compounds for crystals due to their ability to form moderate and weak hydrogen bonds. The physical properties of the newly synthesized proton conducting materials: imidazolium benzoate (salt **1**), imidazolium salicylate (**2**), and imidazolium phthalate (**3**) [2] were investigated. For these materials, thermal stability, electric conductivity, and vibrational properties were analyzed. What is more, the paths of hydrogen bonds were analyzed with the use of the quantum theory of atoms in molecules (QTAiM) and Hirshfeld surface analysis method.

The study of critical points and structure of these crystals shows that there are two types of intermolecular hydrogen bonds: weak hydrogen bonds (C–H···O) and medium strength hydrogen bonds (N–H···O). These intermolecular hydrogen bonding systems allow us to describe conductive properties using

the Grotthuss mechanism. The melting temperature is equal to 374, 403, and 422 for salt **1**, **2**, and **3**, respectively. The electrical conductivity equals $2 \cdot 10^{-6}$ for salt **1** and **2**, and $2 \cdot 10^{-1}$ (S/m) for salt **3**.

Keywords: Proton conductors, Carboxylic acids, X-Ray structure

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FRUSTRATED MAGNETS BASED ON THE ANION-CENTERED OCu_4 UNITS

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We have successfuly synthesized and studied synthetic analogues of two Cu^{2+}-bearing minerals, averievite and cupromolybdite, whose crystal structures are composed of interlinked OCu_4 tetrahedra: in the synthetic phosphate averievite – $(CsX)Cu_5O_2(PO_4)_2$ (X = Cl, Br, I) – they form a capped-kagomé network, which results in a strong magnetic frustration [1], while in the synhtetic cupromolybdite $Cu_3O(MoO_4)_2$ they are arranged into a pseudo-1D infinite chains, resulting in a low-dimensional magnetism. The whole family of OCu_4-based compounds is an interesting toolbox for studying the effects of frustration, dimensionality and chemical composition on the magnetic properties of materials.

Keywords: frustrated magnetism, anion-centered tetrahedra

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SUPERIOR HYDROGEN STORAGE AT ROOM TEMPERATURE IN Mg/Pd THIN FILMS WITH ULTRATHIN CARBON INTERLAYER

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The strong interest in pure Mg as hydrogen storage material arises from the fact that Mg is lightweight and can absorb and desorb a large amount of hydrogen (7.6 wt.%). Magnesium based thin film materials are also subject of intensive studies due to their potential use as switchable mirrors and hydrogen sensors. To improve the hydrogenation kinetics we have deposited an ultrathin (0.5–2.5 nm) carbon interlayer between 100 nm – Mg and 10 nm – Pd top layer.

Mg/C/Pd trilayers were prepared at room temperature (RT) on transparent glass substrates using UHV DC/RF magnetron sputtering. The structure of the samples was examined by standard θ–2θ X–ray diffraction. X–ray photoelectron spectroscopy showed that after ultrathin carbon layer deposition on Mg thin film, the magnesium carbide alloy was formed at the interface. For carbon layer thickness (d_C) greater than 0.5 nm we also observed formation of top pure carbon. Absorption kinetics at a hydrogen pressure of about 1000 mbar was studied at RT using transmittance and four–point resistivity measurements. Additionally, the samples were loaded electrochemically at RT in 6M KOH using a three-electrode cell with simultaneous transmittance measurements. Results showed that the fastest initial rise in transmittance (hydrogen concentration) was observed for d_C between 1.2 and 1.8 nm for both gas phase and electrochemical loading. The best samples were completely loaded after 2 h. On the other hand, the hydrogen concentration increases much slower for d_C below 1.2 nm and above 1.8 nm.

Keywords: hydrogen absorption, multilayers, Mg thin films

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INFLUENCE OF HYDROGEN ABSORPTION ON HIGHER-ORDER INTERLAYER EXCHANGE COUPLING IN V/Fe AND Nb/Fe MULTILAYERS

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Interlayer interactions, both long-ranged magnetostatic, and short-ranged exchange coupling play an important role in the properties of magnetic materials. However, the origin and nature of this short-ranged exchange coupling are not sufficiently clear. In this contribution, we report results on exchange coupling studies in (110) oriented V/Fe and Nb/Fe multilayers (MLs). The samples were prepared at room temperature (RT) on Si(100) wafers with an oxidised surface using UHV magnetron sputtering. A capping layer of 5 nm Pd was used to avoid oxidation of the top Fe sublayers and catalyse hydrogen absorption and desorption in the V and Nb sublayers. The hysteresis loops revealed antiparallel alignment of the magnetic moments of the Fe sublayers and were fitted using bilinear (J_1), biquadratic (J_2) and cubic (J_3) exchange constants. Results show that the biquadratic and cubic interlayer exchange coupling play an important role in magnetisation reversal of the MLs. The higher-order interactions (J_2 and J_3) are especially important for Nb and V spacer containing more than 7 monolayers. Furthermore, the hydrogen absorption in the Nb spacer at RT below 1 bar can only suppress cubic interaction. The above effect is reversible and after hydrogen desorption, the

cubic interaction appears again. In conclusion, the cubic interlayer exchange coupling is sensitive to hydrogen absorption under mild conditions.

Keywords: hydrogen absorption, magnetic multilayers, exchange interactions

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HYDROGEN STORAGE PROPERTIES OF Mg-Ni ALLOY THIN FILMS AND Mg/Ni LAYERED STRUCTURES

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Magnesium based thin film materials are subject of intensive studies due to a potential application as switchable mirrors and hydrogen sensors. In this contribution we study hydrogen absorption and desorption kinetics at room temperature (RT) and a pressure of about 1000 mbar using four-point resistivity measurements.

100 nm – Mg single layer, 100 nm – Mg/d_{Ni} – Ni ($0 < d_{Ni} < 6$ nm) bilayers, and Mg_2Ni, MgNi, $MgNi_2$ alloy thin films were prepared at RT by UHV RF/DC magnetron sputtering. The chemical composition of all the layers and alloying effect at Mg Pd interface were studied *insitu* using X-ray photoelectron spectroscopy (XPS). Furthermore, the XPS valence bands were measured for all the prepared alloy thin films.

Before hydrogenation all the thin film samples were covered *in-situ* by 10 nm – Pd layer. Results showed that hydrogenation of single Mg layer

covered by Pd layer needed about 200 h for saturation. However, deposition of an additional 3 nm – Ni interlayer decreased the hydrogenation time well below 4 h. The MgNi and $MgNi_2$ alloy thin films revealed no hydrogen absorption at RT. On the other hand, the fastest rise in resistivity was observed for Mg_2Ni alloy thin film. The resistivity reached 90% of the maximal value after 30 s of hydrogenation. The sample was completely loaded after about 1 h.

Keywords: hydrogen absorption, Mg based thin films, XPS

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HYDROGEN ABSORPTION IN Mg/Al/Pd TRILAYERS UNDER MILD CONDITIONS

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Magnesium based hydrides are attractive hydrogen storage candidates due to their high hydrogen capacity. However, slow kinetics and low equilibrium hydrogen pressures at room temperature (RT) remain difficulties in potential applications. In this contribution, we show results on hydrogenation kinetics of Mg/d-Al/Pd trilayers at RT and under a pressure of about 1000 mbar. Trilayers with constant thicknesses of Mg (100 nm) and Pd (10 nm), and various thicknesses of Al (d) were prepared on transparent glass substrates using UHV DC/RF magnetron sputtering. The chemical composition of all the layers and alloying effect at Mg Al and Al – Pd interfaces were studied *insitu* using X-ray photoelectron spectroscopy (XPS). The structure of the samples was examined

exsitu by standard θ-2θ X-ray diffraction (XRD). Hydrogenation kinetics as a function of Al layer thickness was studied at RT using transmittance and fourpoint resistivity measurements. XPS studies revealed a significant alloying effect at the Al – Pd interface. XRD experiment before and after hydrogen absorption confirms a good hcp Mg(002) and tetragonal MgH_2(002) texture, respectively. The best hydrogenation kinetics we have observed for an Al layer thickness of about 0.5 nm. For d < 0.5 nm the Al layer deposited on Mg is probably not continuous, and for d > 1 nm the Al-Pd alloy at the Al/Pd interface blocks diffusion of absorbed hydrogen atoms. In conclusion, results on transmittance and resistivity measurement showed that the hydrogen storage properties were significantly modified with addition of the Al interlayer.

Keywords: hydrogen absorption, multilayers, XPS

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EVALUATION OF ELECTROCHEMICALLY SYNTHESIZED MULTI-METAL OXIDES/HYDROXIDE NANOFILMS FOR OXYGEN EVOLUTION REACTION IN ALKALINE ELECTROLYZERS

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The development of efficient oxygen evolution reaction (OER) catalysts is needed to provide efficient water splitting process in alkaline electrolyzers [1]. Recently there is a huge effort to fabricate nanostructured electrocatalysts based on earth-abundant elements. The promising among such materials have become oxides/hydroxides based on transition metals [2].

Thus, in this work a set of various kinds of oxides/hydroxides based on a combination of different metals such as Mn, Co, Cu, Ce, Fe, Ni or Pr are studied as potential catalyst for OER in alkaline environment. The catalysts are synthesized in a one-step electrochemical deposition process, what allows for a direct deposition of the material on nickel foam without the need of binders, which can hinder the active site of the catalyst.

It is observed, that depending on the metal combination in catalyst, different electrocatalytic performance of the material toward OER can be obtained. Moreover, it is shown that not in each case combination of more than one metal in composition enhances electrocatalytic properties of the material, like it is presented in the literature.

Keywords: alkaline electrolyzers, oxygen evolution reaction, electrodeposition

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ACID LEACHING OF SPENT LITHIUM-ION BATTERIES

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Lithium-ion batteries, due to their properties and numerous application options, are currently the most popular group of rechargeable cells. The increasing number of produced and used Li-ion cells determines the constantly growing amount of their waste. Because of harmful substances contained in

them, they are treated as hazardous waste. Therefore, a very important issue of effective waste management is proper processing of spent batteries, including Li-ion. One of the most effective and most advantageous ways of processing used Li-ion cells is the hydrometallurgical recovery of metals contained in the cathode powder.

In reference to current research trends, a number of laboratory tests were carried out regarding the recovery of metals from spent Li-ion batteries by acid leaching. Their effects are presented in this work. The used leaching agents, reducers and optimal process conditions were discussed, as well as the recovery of different metal ions were analyzed.

Keywords: spent batteries, metals, recovery, acid leaching

THE ANALYSIS OF THE HYDROGEN-BOND NETWORK IN THE NEW PROTON CONDUCTOR – HEMIMELLITIC ACID AND PYRAZOLE SALT

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In recent years, materials which could be used as fuel cells become very popular. One of the parts of the fuel cell is an electrolyte. Proton conductors could be used in constructing this electrolyte. Hydrogen bonds in proton conductors should be weak and medium strength. In this work, the subject of research is a group of new proton conductors synthesized from heterocyclic molecules: pyrazoleas a base and hemimellitic acid. The presented study includes several experiments: the crystallographic structure analysis, investigation of optical properties using Raman scattering and infrared absorption techniques. Besides, the hydrogen-bond network analysis was performed by using the

quantum theory of atoms in molecules (QTAiM) [1] and the Hirshfeld surface analysis [2].

The salt of hemimellitic acid and pyrazole was synthesized for the study. The salt crystallizes in the monoclinic system and C2/c space group. Parameters of the elementary cell are equal: $a = 31.2140(9)$ Å, $b = 11.7836(4)$ Å, $c = 6.8121(2)$ Å, $\alpha = \gamma = 90^{\circ}$, $\beta = 91.394^{\circ}$. The topological analysis of electron density at critical points within Bader theory and crystallographic structure studies have shown that there are hydrogen bonds of medium and weak strength in the structure of the investigated salt. Also, the analysis of the hydrogen bonding network has shown that it is possible to diffuse a proton through the crystal that can be described by the Grotthuss mechanism.

Keywords: proton conductors, Raman and IR spectroscopy, hydrogen bonding

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ELECTRICAL CONDUCTIVITY AND ELECTRON STRUCTURE INVESTIGATIONS OF THE NEW POLYPYRROLE DERIVATIVES

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The polymers are organic materials which can be exploited for many applications, e.g., in thin-film organic field-effect transistors, in energy storage, and conversion devices [1–3]. Among them, polypyrroles are potentially useful due to their favorable mechanical and electrical properties. In such type of materials, the motion of the delocalized electrons occurs through the conjugated system. The knowledge of the HOMO and LUMO energy levels is essential in the

description of the electrical properties of polymers. The DFT calculation of the energy levels, electron affinity, and ionization energy were performed with Gaussian 09 Revision D01. The geometries of the investigated species were fully optimized using B3LYP hybrid density functional and 6–31G(d) Pople style basis sets. The level of theoretical calculations used in the investigated systems is commonly used for polymers. The ionization potential (I = -6.68 eV) and the electron affinity (A = -2.18 eV) for poly(pyrrole-3-4-dicarboxylic acid) have been obtained. Hence, it follows that the molecular fundamental gap equals 4.5 eV. To verify the theoretical data, the absorption spectra were measured in the spectral region in which electron excitations are observed.

Keywords: electrical properties, polypyrrole derivatives, DFT calculations

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Calculations were carried out in the Warsaw Supercomputer Center (ICM) (G53-7).

THERMOELECTRIC PROPERTIES OF TmNiSb/TmNiSn COMPOSITES

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Half-Heusler (HH) alloys and compounds, crystallizing in the cubic MgAgAs-type structure (space group *F-43m*, no. 216), have been recognized as important thermoelectric (TE) materials for mid-temperature waste heat recovery. Most of the hitherto research was focused on *M*NiSn, *M*CoSb (*M* = Ti, Zr, Hf) and *X*FeSb (*X* = V, Nb, Ta) compositions, and much less studied remain the corresponding rare-earth (RE) based HH phases with similarly prospective TE characteristics. In this work, we investigated the electrical transport

properties of composites based on the HH antimonide TmNiSb. Searching for possible enhancement in the thermoelectric properties the latter material was combined with the orthorhombic stannide TmNiSn. The samples of $(TmNiSb)_{1-x}(TmNiSn)_x$ were prepared via one-step arc-melting procedure. The electrical resistivity (ρ) of the composites was found favorably smaller than that of pure TmNiSb, systematically decreasing with increasing the content of TmNiSn. Despite the Seebeck coefficient (*S*) of the composites was found to decrease in a similar manner, the reduction of ρ was more significant than the degradation of *S*, hence yielding considerably enhanced the power factor ($PF = S^2/\rho$). The best thermoelectric performance was established for the sample with $x = 0.25$, which showed $PF = 1.3 \times 10^{-3}$ W/mK at 1000 K, i.e., about 70% larger than PF of TmNiSb at the same temperature. The observed improvement of the TE performance is likely a result of formation in the composite system of a specific microstructure, in which semiconducting-like particles of TmNiSb are covered with metallic layers of TmNiSn.

Keywords: Thermoelectrics, half-Heusler alloys, composites

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APPLICATION OF MUON SCATTERING TOMOGRAPHY TO CHARACTERIZATION OF NUCLEAR WASTE CONTAINERS IN THE HORIZON 2020 CHANCE PROJECT

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Muon Scattering Tomography (MST) uses cosmic rays to generate three-dimensional images based on muon scattering in a volume of interest [1]. By

measuring the muon trajectory before entering and after leaving the object, it is possible to determine a density distribution of a sample, and thus to determine its internal structure.

Cosmic muons travel through matter with little interactions, thus MST allows imaging objects of large thickness and density. MST has a wide range of application, for instance detecting smuggling of radioactive materials or non-destructive testing of packages of conditioned radioactive waste, for example concrete-lined containers with spent fuel from nuclear power plants. Non-destructive assay of such packages is of special interest for the operators of interim storage of radioactive materials.

A new system for non-destructive control of the content of large volume nuclear waste using muon scattering tomography is being developed in the CHANCE project [2]. We will present the current status of the new detector system and performance studies of material identification using MST.

Keywords: cosmic rays, muon scattering tomography, nuclear power

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ELECTROSYNTHESIS OF Ni NANOWIRES FROM DEEP EUTECTIC SOLVENT

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Nickel and nickel-based nanomaterials are widely considered as electrode materials for electrochemical capacitors [1] and water-splitting systems [2]. It is thought that they can be further improved by being shaped into nanowire

arrays – highly ordered structures with a large working surface area, that can be prepared directly on a conducting substrate, without additional binders.

Nanowire arrays are often synthesized by electrodeposition into porous anodic aluminum oxide (AAO) membranes. However, aqueous solutions typically used in electrosynthesis of nickel-based materials have several limitations which may cause brittleness or sponginess of structures [3, 4]. These problems can be overcome by using non-aqueous solutions, like those based on deep eutectic solvents (DESs), which offer extended potential windows and low toxicity and are easy to prepare.

This research aims to show that Ni nanowire arrays of good quality can be synthesized in a DES-based environment and, after modifications, can show improved performance as electrode materials compared to non-ordered nickel-based nanomaterials.

Keywords: Ni nanowire arrays, electrodeposition, deep eutectic solvents

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IMMORTALITY OF ELECTROCHEMICAL CAPACITORS – DREAM OR REALITY?

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Besides batteries (e.g., Li-ion, Ni-MH), electrochemical capacitors (ECs) are one of the main energy storage devices used in our daily life. They are characterized

by one of the highest power density among all energy storage devices. Thus, they are capable to deliver the energy in domain of seconds. However, their energy density is still moderate. Therefore, the scientist attention is put towards boosting energy density value toward the level of battery systems and while retaining their long cycle life. The principle of electrochemical capacitor operation is based on electrostatic attraction between charged electrode surface and oppositely charged ions (from electrolyte). As a result, electric double-layer (EDL) is formed at the electrode/electrolyte interface. It is also claimed that due to pure physical interactions in EDL, long cycle-life is provided by ECs. Therefore, our scientific interest can be presented in two simple questions: Are those systems immortal? and if not, how can we extend their lifetime?

Our research scope is based on the comparison of ageing process in various ECs. Conclusion drawn from our study shows that each system behaves individually, and the ageing mechanisms strongly depend on the electrolyte, electrode composition and electrochemical protocol applied (type of life-time test, voltage and current density). Therefore, each energy storage device needs to be optimized independently in order to find 'know-how' for ageing process inhibition. Luckily, it seems that long time operation at lower voltage can be provided by ECs and each user can adjust its demand with operational parameters.

Keywords: ageing of electrochemical capacitors, aqueous electrolytes, ex-situ analysis, electrode material

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HI-TECH OPERANDO TECHNIQUES FOR ENERGY STORAGE DEVICES

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Novel technologies have a high potential in our daily life. Nonetheless, its main advantage could be seen in R&D field, where various phenomena and mechanisms might be observed and thus explained. Therefore, hi-tech *operando* techniques have been applied in electrochemical capacitors investigations, essentially for in depth understanding of the electrode and electrolyte role in energy storage processes. Comparison of four *operando* techniques is presented; electrode volume change measured by electrochemical dilatometry (ECD) and scanning electrochemical microscopy (SECM); mass change has been monitored by electrochemical quartz crystal microbalance. Finally, structural changes and chemical bonds creation/breakdown have been investigated by Raman spectroscopy. The subject of this study was carbon-based aqueous electrochemical capacitor. Commercial activated carbons with micro- and mesopores, played a role of the electrode material; various aqueous electrolytes with sulphate, nitrate and iodide anions have been applied. It is demonstrated that hi-tech *operando* techniques allow various processes at the electrode/electrolyte interface to be observed: ionic fluxes have been designated, electrode volumetric changes have been measured and structure/composition changes have been observed.

Keywords: electrochemical dilatometry, electrochemical quartz crystal microbalance, Raman spectroscopy, scanning electrochemical microscopy

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ELECTRICAL ENERGY STORAGE SYSTEMS – PERSPECTIVES FOR THE FUTURE

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The effective and reliable energy storage is a missing element in renewable energy source technologies. If this problem is solved, full electrification of transport sector will be possible and, in turn, reduction of the environmental pollution may occur.

Currently, the main devices for energy storage are lithium-ion batteries (Li-ion). They ensure high energy density, however, the power ratings are strictly limited. The alternative is so-called electric double-layer capacitor (EDLC), which owing to its unique charge storage mechanism, offers high power output. Electrochemical capacitors store the charge in electric double-layer, which can be charged and discharged very quickly, without production of extensive heat and reduction of cycle life. However, they are characterized with low energy per mass parameter.

It seems easy to combine (hybridize) the benefits of these two technologies and thus create one new device. On the other hand, scientists still see the potential in capacitors to boost their parameters. Most frequently there are addition of redox couples, manufacturing of asymmetric devices or modification of electrode materials.

In the frame of our experiments and considerations, we present the future directions of energy storage systems evolution, especially EDLCs. The work provides the overview on their future application as well as the forecasted advances in the increase of battery and capacitor performances.

Keywords: energy storage devices, electrochemical capacitors, batteries, carbon materials

European Research Council is acknowledged for financial support within the Starting Grant project (GA 759603) under European Unions' Horizon 2020 research and innovation programme.

SCIENTIFIC SESSION
INFORMATION TECHNOLOGY (IT)
AND **SOCIAL MEDIA**

PLENARY LECTURES

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European's Grand Challenges for High Performance Computing

Almost ten years ago the PRACE partners started with advanced HPC services for European science. PRACE is supported by the PRACE Member States, and by the EU through a number of implementation projects, and thus has been able to create a common European umbrella over the national HPC ecosystems. It is quite a task to list all the achievements PRACE has made in the meantime, when we can count over 70 partner institutions, 7 top-class systems, 700 large-scale projects, over 100 petaflop/s accumulated peak performance, 12000 trainees in PRACE advanced training courses, seasonal schools, numerous companies supported, peer review on the European level, a unified set of pan-European operational services comprising many satellite centers, support of Industry, the High Level Support teams, market watch, support for CoEs, and so force. "In Service for HPC in Europe"! This is PRACE in short. Since 2010, PRACE offers a comprehensive range of services and support activities to promote the European HPC ecosystem. PRACE is established as the link between the HPC infrastructures of the European member states and our most excellent European HPC users, with their provenience from a very broad range of fields in science and industry. This is strongly emphasised by the latest scientific case study of the PRACE Scientific Steering Committee, the PRACE SSC, that provides a comprehensive overview of the strategic importance of high-performance computing in a growing number of scientific and technical fields and for important industries. It furthermore gives convincing arguments for the convergence of simulation, large-scale data analysis and the importance of HPC for progress in artificial intelligence, in particular deep learning and continual learning. I will give an overview of PRACE as it has evolved its operations. I will describe important contributions

of PRACE to Europe`s Grand Challenges in HPC, and I will sketch first ideas of PRACE plans as to a third operation phase starting in 2021. I will talk about new services to help our users successfully mastering the future simulation and data analytics Challenges entering the Exascale realm.

Keywords: HPC, PRACE, exascale

Prof. Dr. Dr. THOMAS LIPPERT, Director of the Institute for Advanced Simulation, Head of Jülich Supercomputing Centre. Thomas Lippert received his diploma in Theoretical Physics in 1987 from the University of Würzburg. He completed Ph.D. theses in theoretical physics at Wuppertal University on simulations of lattice quantum chromodynamics and at Groningen University in the field of parallel computing with systolic algorithms. He is director of the Jülich Supercomputing Centre at Forschungzentrum Jülich, member of the board of directors of the John von Neumann Institute for Computing (NIC), and he holds the chair for Computational Theoretical Physics at the University of Wuppertal. His research interests include lattice gauge theories, quantum computing, numerical and parallel algorithms, and cluster computing, chair oft he PRACE Council (Partnership of Advanced Computing in Europe).

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PLENARY LECTURES

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Best Practices in virtual team management

Globalization and ICT development enhanced new forms of organizational collaboration – virtual teams. Most commonly, they are defined as a group of people sharing common goals virtually, where at least two members are situated at different locations [1]. Distance between them may range from being located at different offices to being located on different continents [2]. Virtual teams are present in all business sectors and academic life as well.

Despite positive aspects of virtual teams, such as cost reduction and faster product delivery, this new organizational structure has brought many challenges that may hamper its effectiveness. Virtual collaboration differs significantly from traditional face-to-face interaction as it delivers less context and data necessary for human cooperation. As a result virtual teams are more prone to conflicts [3]. Team members strive with weak interpersonal bonds, unshared context and poor information sharing [4].

The outlined findings focus on unrevealing best practices in virtual team collaboration based on three yearlong qualitative study among both young Millennials entering job market that participated in virtual team simulation game and employees from companies that employed virtual teams as the main element of organizational structure.

Keywords: virtual teams, distributed teams, communication, trust

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Quantum Computing – Opportunities and Challenges

In quantum computers one can use of quantum-mechanical phenomena such as superposition and entanglement to perform computation. In nineties, there were published first algorithms that are able to efficiently solve some important problems that are considered hard for classical computers. Since that for last three decades there are steady studies on theoretical background (quantum information theory) as well as on experimental realization of quantum computers. There are several proposal of technological realizations. One of the greatest challenges of these technologies is reducing quantum decoherence. This usually means isolating the system from its environment as interactions with the external world cause the system to decohere. As described in the quantum threshold theorem, if the error rate is small enough, it is thought to be possible to use quantum error correction to suppress decoherence. Academic and industrial research is concentrated on near-term intermediate-scale device and the demonstration of "quantum supremacy", while large-scale universal quantum computers are likely decades away. The main applications are expected to be: encryption and security, quantum machine learning, and quantum chemistry simulation. Quantum machine learning is based on amplitudes rather than probabilities, providing more sophisticated decision-making. Quantum chemistry has the potential impact on medicine, material sciences as well as basic research. The important step required for the construction of a solid-state quantum computer is to get entangled state of electrons. One of the proposals to obtain entangled pair of electrons is use of superconductor, which is a natural source of such pairs, so called Cooper pairs, and separating them in double quantum dot system.

This type of system can be used in the manufacture of logic gates and in spin quantum electronics.

Keywords: quantum computers; superconductors; quantum dots

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Prof. JAN MARTINEK was obtaining his PhD from Institute of Molecular Physics, Polish Academy of Science in Poznan, Poland. He was then working as a postdoctoral fellow at the Karlsruhe Institute of Technology in Germany and the Tohoku University in Sendai in Japan. During 2008–2015 he had an appointment with Institute of Molecular Physics, PAS in Poznan as an associate professor. He was a visiting professor several times in Japan, Spain, and CRNS France. Since 2015 he is a full professor at the same institute. His works concern mainly spintronics, mesoscopic physics, quantum dots, quantum point contact, strongly correlated systems, superconductivity, Kondo physics, strongly correlated systems, and theory of quantum information and communication. He was awarded with the Marian Smoluchowski prize.

COMPILER ERROR CATEGORISATION FOR ASSESSING AUTOMATED TESTS AND EXAMS IN C LANGUAGE

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Programming is a crucial skill in the modern world. Especially it is useful and necessary in domains such as data analysis, banking, medicine, etc. High demand for programming skills requires also a strong supply in the form of efficient education. Proper programming classes should ensure the rapid gain of knowledge associated with profound revisions of already acquired material. A compiler and automated tests can verify students' assignments to some extent, however it is usually not enough to ensure an efficient learning outcome. Such a system – Dante [2] – was developed in the author's University and while testing student's assignments, it was used to collect data for estimating of how to enhance and equilize student's training process in an automatized manner.

The students' responses, collected by Dante were analyzed in search for most common compiler errors. During the investigation a set of 606,501 programs from 2 years were analyzed where 98,623 had compile-time and 7,092 had consolidation-time errors. Assignments were done by 720 students of Computer Science and Electronics and Telecommunications during Introduction to Programming course in C language.

It was found that the major problem, which students encounter on the beginning of programming learning is understanding of compiler error messages [1]. We have presented a categorization of errors that can be inferred from GNU C compiler diagnostic messages with description of possible misinterpretations. Within proposed taxonomy the frequency of errors made by students was investigated. Some of them tend to group in clusters with specific errors more frequently while others seem to be detached.

While it is impossible to distinguish a global pattern or a tendency in error's occurrences due to the variable difficulty of consecutive topics during the

course, we have analyzed the correlation between errors made during the whole semester with those from final exams. The conclusions drawn from the conducted research were supported by questionnaire filled by students about tools used during writing, testing and debugging their programs.

Finally, a set of enhancements for the C language teaching system Dante was proposed in order to improve learning process, prevent discouragement and allow better overall performance analysis.

Keywords: computer programming, compiler error messages, novice programers

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GPU-ACCELERATED IDENTIFICATION OF REFERENCE GENES

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Transcriptomic studies typically follow a scenario of a high-throughput experiment performed on a limited group and replicated in a broader, targeted analysis of a few genes of interest in a larger group of patients. Normalization is an indispensable step of data analysis in both kinds of studies, since it removes unwanted, non-biological variability from data. In targeted qPCR

assays normalization is typically performed with respect to reference genes. A criterion for choice of such references is how their expression levels are invariable between different samples and conditions – this requires the identification of suitable normalizers for a particular experiment, which is not trivial, particularly in biofluid studies. Averaging expression of 2 and 3 genes seems to produce references with higher stability in comparison to single genes, but finding the optimal combination and evaluating its stability is necessary. This generates a considerable computational load due to the number of possible combinations. Existing implementations of normalization algorithms (geNorm, BestKeeper and NormFinder) perform poorly in large datasets and may require days to compute stability values for all potential references. We implement those algorithms in a parallel manner by utilizing GPU-based programming model on the CUDA platform. After initial testing on 8 datasets containing from 50 to 400 genes (subsets of GSE75389), the times of executions decreased 18.3±0.6 (mean±SD), 101.4±3.5 and 76.1±2.2 times for geNorm, BestKeeper and NormFinder with respect to multi-thread Python implementation. Additionally, to allow for easy access to normalization pipeline we are preparing an online platform where a user could normalize their datasets based on the automatically selected references.

Keywords: GPU acceleration, CUDA, reference genes

TOWARDS UNDERSTANDING POLISH COURT VERDICTS

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We have developed an artificial intelligence (AI) powered system for understanding legal texts of Polish court verdicts. Using novel AI methods and our state-of-the-art natural language processing tools we were able to

construct a system that was able to search for most relevant court verdicts for a given legal question. The texts of court verdicts were extracted from public databases [1, 2, 3]. Our system was tested on cases prepared for a tax advisor exam and solved multiple of them. Since summer 2019, the system in the beta version has been used by a few legal companies.

Keywords: Legaltech, Natural Language Processing, Predictive Analytics

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OPTIMISATION OF WEIGHT AGNOSTIC NEURAL NETWORK STRUCTURE USING ROSENBROCK METHOD

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Recently, it has been hypothesised that the performance of a neural network may be much more influenced by its structure than previously anticipated [1]. Further research in this area revealed the potential of achieving a higher than random performance based purely on architecture with randomly initialized weights [2]. Weight Agnostic Neural Networks are a novel alternative to classical neural architecture search that propose to forgo the training of neural networks and instead evaluate their fitness purely on the basis of their structure [3]. We propose an optimised method of traversing through

the weight agnostic search space that decreases the time required to obtain a satisfactory solution. The proposed method is based on Rosenbrock's approach and treats the possible alteration of the network structure as the orthogonal base for step evaluation. Through the addition of a variable step length, the presented approach is capable of reaching the satisfactory solution faster than current, fixed step approach. The step multiplier acts as both the number of discrete modifications to be carried out and as the probability at which said type of modification is executed.

Keywords: neural networks, neural architecture optimisation

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MODEL-BASED REINFORCEMENT LEARNING FOR ATARI

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Model-free reinforcement learning (RL) can be used to learn effective policies for complex tasks, such as Atari games, even from image observations [1]. However, this typically requires very large amounts of interaction – substantially

more, in fact, than a human would need to learn the same games. How can people learn so quickly? Part of the answer may be that people can learn how the game works and predict which actions will lead to desirable outcomes. In this paper, we explore how video prediction models can similarly enable agents to solve Atari games with fewer interactions than model-free methods. We describe Simulated Policy Learning (SimPLe), a complete model-based deep RL algorithm based on video prediction models and present a comparison of several model architectures, including a novel architecture that yields the best results in our setting. Our experiments evaluate SimPLe on a range of Atari games in low data regime of 100K interactions between the agent and the environment, which corresponds to two hours of real-time play. In most games SimPLe outperforms state-of-the-art model-free algorithms, in some games by over an order of magnitude.

Keywords: model-based reinforcement learning

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COMPARISON OF LINEAR METHODS USED IN CALIBRATION OF ELECTROCHEMICAL GAS SENSORS

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Electrochemical gas sensors find their application mostly in air quality monitoring systems, due to their availability, low price, long lifetime and small size. There are many studies that have been done to evaluate their performance in outdoor environments [1–3]. The main problem faced by the gas sensors is drift, low stability and poor selectivity. This is due to the fact that the sensors not only react to their target gases but also show strong interference with other gases. This makes calibration of these sensors very challenging.

Our research shows two approaches to sensor calibration: linear regression (LR) and multivariate linear regression (MLR) with the use of six electrochemical gas sensors. We found that considering additional terms in regression models can significantly improve sensors performance.

Keywords: gas sensor, amperometric sensor, cross-sensitivity, multivariate calibration

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POSTER PRESENTATIONS

TELESCOPE PRIME: AN OPEN SOURCE, 3D PRINTED, TELESCOPE DEVELOPMENT PLATFORM

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We present *TelescopePrime*, a powerful, open-source, 3D printed, low-cost telescope platform for beginners. We built it with two design principles in mind – to be accessible (price-wise and skills-wise) while fitting well into our XXI century, increasingly digitally connected lives. The result is a large, prime focus telescope with integrated digital camera and an onboard image processing/streaming computer. The telescope is affordable (starting cost from 235 EUR), easy to setup (assembly time < 8 hrs) and accessible to a complete beginner – providing a rich night-sky observing experience, which can be recorded and easily shared online.

We decided to share plans for the telescope on our website [1] and provide all information needed for anyone to build it by oneself. It is available for download under *Creative Commons Attribution, Non-Commercial, ShareAlike 4.0 International* licence. As such it can be also modified, upgraded and re-shared into a central repository, allowing the platform to evolve over time both in terms of hardware and software. In time, we hope this project to reach a level of maturity, when telescopes such as this one start replacing small, undriven, amateur off-the-shelf reflectors – providing easier access to the night sky to the beginners.

Keywords: telescope, open source, 3D printed, astronomy

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Athors would like to acknowledge support of the Akademeia High School and Akademeia Tutorial College (Warsaw) in initiating and providing a workshop space to develop this project as well as Sygnis Technologies for printing out prototype telescope parts and assisting us with valuable comments and insights into the word of 3D printing.

USE MIND MAPPING AND DESIGN THINKING TO DESIGN SOCIAL INNOVATION

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The purpose of the work was to design and create social innovation in the field of lifelong learning. The target group of the proposed solution were microentrepreneurs.

Creating social innovation Design Thinking method was used. This method first of all focuses on defining the problems and needs of recipients. Only then it designed a solution that will solve a problem or meet a need.

The problem that arises when using the design thinking method is a large amount of information that needs to be analyzed.

To improve this process, the map mapping method was used.

One large mind map was created (with dimensions of 1 x 4 m). All necessary information was collected on the mind map and a solution for the analyzed problem was drawn.

The analyzed problem was the difficulties of micro-entrepreneurs with systematic education and development of the company.

The main difficulties that have been defined are lack of time, lack of support, lack of concentration and lack of consistency.

Based on the interviews and analyzes carried out, a solution was proposed. The innovation product is an application for smartphones, which contains educational materials in the field of effective learning, personal development and entrepreneurship and innovative tools that can be useful for micro-entrepreneurs. The application is also equipped with functions that encourage you to process materials and to create goals and select priorities.

The combination of the design thinking and map mapping methods allows for the quick use of collected materials and accelerates product design.

Keywords: mind mapping, design thinking, social innovation, application

SCIENTIFIC SESSION

HEALTH CARE

PLENARY LECTURES

Dr. **WOJCIECH FENDLER**
Department of Biostatistics and Translational Medicine,
Medical University of Lodz

Department of Radiation Oncology,
Dana-Farber Cancer Institute

Prof. **DIPANJAN CHOWDHURY**
Department of Radiation Oncology,
Dana-Farber Cancer Institute

MicroRNA-based diagnostic tests – translational medicine in a transatlantic setting

Translational medicine is a broad term encompassing all studies that aim at bridging the gap from the laboratory bench to the bedside. Typically, mechanistic studies published in high profile journals that reach maximum exposure present advances in basic science, but limited follow-up of such stories makes the patients devoid of any concrete or immediate gain. Our teams have collaborated for 7 years now on various biomarker studies aiming to close the scientific and clinical worlds for the patients' benefit. The main area of our focus is detection of radiation exposure and the focus to harness the potential of miRNAs associated with this for diagnostic use. Initial studies in mice showed that a signature of irrevocable bone marrow destruction may be defined and proven through in depth mechanistic studies, that such microRNAs are a specific feature of bone marrow stem cells losing their potential to repopulate the irradiated individual leading to death unless allogenic bone marrow is transplanted [1]. The translational potential of such a test was obvious, but obvious ethical considerations precluded the calibration of it on humans. To bring it closer to the bedside we devised a framework for diagnostic test design and validation and supported our

claim with bioinformatic analyses of evolutionary conservation predicting the test to work in humans. Given the test excellent performance we hypothesized that circulating microRNAs could be used for diagnostics of malignancies and turned our attention to ovarian cancer. Due to the inherent clinical complexity of human studies, we decided to perform experiments on non-human primates [2]. This project necessitated the use of high-level data mining techniques and multilevel validation procedures documenting the appropriateness of biomarker and classification method selection, the universality of the chosen miRNAs when quantified using different molecular techniques, their specificity towards ovarian cancer and finally, the accuracy of the test on a separate clinical group [3]. Ultimately, the project was wrapped up with a website for easy access of researchers and doctors alike. The projects described above outline the process of devising applicable biomarker tests and highlight the need for seamless integration of biological, clinical, statistical and bioinformatic approaches to solve modern health challenges.

Keywords: microRNA, biomarkers, radiation oncology, translational medicine

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PLENARY LECTURES

Dr. WOJCIECH FENDLER was born in 1982 in Lodz. His research interests expanded during medical studies and culminated in the Primus inter Pares award for the best medical student in Poland. After finishing his medical internship (008) he devoted fully to his scientific pursuits working in Professor's Mlynarski group on monogenic diabetes. Dr. Fendler's PhD thesis (2011) concerned neonatal diabetes caused by mutations of the proinsulin gene. Expanded, nationwide epidemiological study on the matter resulted in the assembly of the most numerous group of patients with monogenic diabetes worldwide, spurring several publications in top diabetological journals and allowing dr Fendler to obtain his habilitation degree in 2013.

After setting up his independent scientific group, through the actions of the Mentoring programme of the FNP dr Fendler started a collaboration with the Dana-Farber Cancer Institute in Boston and expanded on his interest in circulating microRNAs. This collaboration resulted in publications in several high ranking journals: Science Translational Medicine (2015, 2017), Nature Communications (2017) and eLife (2017).

Right now dr Fendler leads his own research group at the Department of Biostatistics and Translational Medicine funded by the FNP's First TEAM programme "Predictive biomarkers of radiation toxicity (PBRTox)".

During his scientific career he obtained several prestigious awards for young researchers including two START scholarships, Medtronic-ISPAD Young Investigator Award and the Wierzuchowski's lecture-award of Diabetes Poland – the highest award for scientific merit granted by this society.

Prof. DIPANJAN CHOWDHURY, PhD, is an Associate Professor of Medicine at Harvard Medical School, and Chief of the Division of Radiation and Genomic Stability in the Department of Radiation Oncology at Dana-Farber Cancer Institute and Associate Member of Broad Institute of Harvard and MIT. He is the Brigham &Women's Hospital Distinguished Chair in Radiation Oncology. He is also an Affiliate Faculty Member of the Department of Biochemistry and Molecular Pharmacology and the Department of Immunology at Harvard Medical School. Dr. Chowdhury's research focuses on deciphering cellular response to DNA damage, particularly DNA double strand breaks, with the goals of generating strategies for personalized radio and chemotherapy, and countering accidental radiation exposure. His work is supported by the NIH and several foundations, including the American Cancer Society, Ann-Fuller Foundation, Tina Brozman Foundation, Claudia Adams Barr program for Innovative Cancer Research and the Leukemia Lymphoma Society.

Dr. Chowdhury received his Bachelor of Science in Chemistry from St. Xavier's College, Kolkata; his Master of Science in Biochemistry from Calcutta University, and his Doctor of Philosophy in Molecular Biology from Brandeis University.

INVITED TALK

Dr. **JOANNA GOŚCIAŃSKA**
Faculty of Chemistry of Adam Mickiewicz University (AMU) in Poznań

Ordered mesoporous carbon materials with defined structure as a new carriers for active pharmaceutical ingredients

In the area of design of active pharmaceutical ingredients (API) delivery systems, one of the most important problems is finding stable and selective carriers that would meet the criteria of classical auxiliary substances as to the safety of use. The application of a proper carrier material and suitable method of API introduction onto its surface can prevent recrystallization of API and improve their bioavailability, reduce side effects and extend the time of activity of a given API. Porous carriers of active pharmaceutical ingredients can be classified into three groups. According to IUPAC (International Union of Applied Chemistry) notation, microporous materials have pore diameters of less than 2 nm, mesoporous materials containing pores with diameters between 2–50 nm and macroporous materials have pore diameters of greater than 50 nm. For stabilizing amorphous active pharmaceutical ingredients, only mesoporous carriers are suitable. Microporous materials (e.g. zeolites, activated carbons) have strong interaction with API molecules which causes complete filling of pores. The uptake of the molecules is constrained by accessible pore volume only and reduces the loading capacity of the microporous carriers. Macroporous materials (e.g. metal oxides) have wide pores which act like a flat surface for adsorbing molecules. In the case of mesoporous carriers, the adsorption of API depends on the interaction between pore walls and adsorbate as well as between API molecules. In the present studies ordered mesoporous carbons of defined structure and controlled morphology were applied as carriers in the adsorption and controlled release of active pharmaceutical ingredients (e.g. paracetamol, benzocaine, ibuprofen). In the first stage, the materials were synthesized

by the hard and soft template methods and then modified with organic functional groups (hydroxyl, carboxyl, amine). Mesoporous carbons were characterized with respect to morphology (scanning electron microscopy), structure (X-ray diffraction, transmission electron microscopy), characteristic functional groups (FT-IR spectroscopy), acid-base nature of surface groups (Boehm titration), parameters of the porous structure (low-temperature nitrogen adsorption) and thermal stability (TG analysis). This was followed by a series of tests of adsorption and release of the active pharmaceutical ingredients whose pharmacological effectiveness needs the algorithm of frequent dosing. The materials characterization confirmed that all obtained carbons have mesoporous ordered structures. Pristine carbons exhibited well-developed surface area and large pore volume. Their functionalization with different organic functional groups led to a reduction of these textural parameters. All mesoporous carbons showed high adsorption capacity towards active pharmaceutical ingredients. The sorption capacity of materials was mainly affected by BET surface area and the structure/size matching between adsorbent and adsorbate. The release behaviour of API was highly dependent on the physicochemical properties and structure of mesoporous carbons. The release rate of API could be regulated by introduction of functional groups and by changing the pH of receptor medium.

Acknowledgements

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Dr. JOANNA GOŚCIAŃSKA is an adjunct at the Faculty of Chemistry of Adam Mickiewicz University in Poznań (AMU). She obtained the Master's degree in 2005 and doctoral degree in 2009 in the field of chemistry. During her PhD studies, she participated in three research internships at Laboratoire Catalyse & Spectrochimie in Caen (France). She received a number of prestigious awards, including MAXIMA CUM LAUDE, the distinction for the Aleksander Zamojski Award, the "Scholarship of the City of Poznań for young researchers",

INVITED TALK

"Scholarship for Outstanding Young Scientists of the Minister of Science and Higher Education", team awards of the Rector of AMU for achievements in scientific, didactic and organizational work. In 2018 she became a laureate of the habilitation fellowship entitled: „L'ORÉAL-UNESCO FOR WOMEN IN SCIENCE". Her principal interest is focused on synthesis, modification and characterization of porous materials (e.g. metal oxides, ordered mesoporous silica and carbons). Importantly, she is passionate to translate the performance of the materials prepared in laboratories into macroscopic real-world applications. In addition to her research, she enjoys teaching. She takes great and sincere pleasure to arouse student curiosity and encourage them to take leaps into the unknown of science. She is co-author of 95 publications and 148 presentations at international and national conferences.

BIOMEDICAL AND ANALYTICAL APPLICATIONS OF SERS

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The novel tool utilizing: (i) the microfluidic device with (ii) incorporated photovoltaic (PV) based SERS-active platform for simultaneous separation and label-free analysis of circulating tumour cells CTCs in the blood specimens with high specificity and sensitivity has been developed. Our approach with all its advantages has huge potential for developing the personalized cancer treatment. The SERS is also a powerful technique for the detection and identification of pathogenic bacteria in food samples and can be introduced into ISO standards as an alternative method. This strategy enables avoiding the time-consuming methods routinely used in the laboratory and reducing the time of analysis at least by a half. The PCA calculations were done to demonstrate the opportunities offered by SERS strategy and its applicability in detection and identification of food-borne bacteria.

Keywords: SERS, bacteria, circulating tumor cells, microfluidic device

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TROJAN HORSE DELIVERY CONJUGATES TO A CANCER TREATMENT

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The purpose of the present investigation is to extend Trojan horse delivery nanotechnology to the fluorescent phenosafranin dye (PSF; **3,7-Diamino-5-phenylphenazinium chloride**) used as a scaffold for the covalent attachment of a biotin moiety (Biot; *cis*-hexahydro-2-oxo-1-H-thieno (3,4-d) imidazole-4-pentanoic acid; vitamin H). Biot is necessary for normal metabolism and important in biochemical processes.[1] Unfortunately, Biot does not manifest ultra-violet (UV) absorption spectrum[2], thus we made attempt to labelled it by the conversion to a fluorescent compound. Biotinylation of PSF allows to obtain a photosensitive conjugate with high fluorescence which is useful in an imaging. At the same time, the ability of proteins (i.e. avidin, streptavidin) to bind derivatives forms of biot (PSF-Biot) can lead to their widespread use in diagnostic assays that require formation of an essentially irreversible and specific linkage (by hydrogen bonds) between biomacromolecules and the Biot ureido group or a possible interaction between Bio sulfur and compounds with hydroxyl groups. Moreover, phenazine dyes (e.g. PSF) can generate singlet oxygen, which is the essential active agent in a photodynamic anticancer therapy (PDT).

Conclusion: We developed the new PSF-Biot bioconjugate for dual synergistic effects of integrin cell-penetrating and imaging in PDT for cancer chemotherapy.

Keywords: phenosafranin conjugates, biotin in targeted therapies

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COMPUTATIONAL BIOLOGY PREDICTS NEW K-RAS INHIBITOR INTRACELLULAR MECHANISM OF ACTION

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Introduction: *KRAS* mutations are known to be an important factor in the pathogenesis of pancreatic (PAC) and lung adenocarcinomas (LAC). Therefore, effective inhibitors of mutated K-Ras (iKRas) were actively sought with limited success thus far due to emerging resistance and progressive loss of efficacy over time. **Aim of the study:** To identify intracellular changes during iKRas treatment in cellular models of PAC and LAC. **Materials and methods:** Proteomic analysis was performed using tandem-mass-tagged mass spectrometry on MIA PaCa-2 (PAC cell line) and H358 (LAC cell line) cells cultured with an iKRas for 24 hours and 7 days on cells incubated in dimethyl sulfoxide as a control. Additionally, published RNA-Seq data (Janes et al. 2018 Cell) on H358 and LU65 (LAC cell line) cells were used. Gene Set Enrichment Analyses, Enrichment maps and Connectivity Map tools were used for computational biology analysis. **Results:** After 7 days of treatment in both H358 cells and MPDAC cells first signs of drug resistance were observed – up-regulation of cell cycle genesets (versus 24 hours timepoint). After 24 hours of K-Ras treatment, 15 genes/proteins were constantly up-regulated and 2 were down-regulated across all cell lines. We found that the profile of protein expression changes incurred by iKRas action after 24h and after 7 days was positively correlated with that of IGF-1 inhibitors and of PI3K inhibitors. When analyzing individual drug action, AZD-8055 (mTOR inhibitor) and PP-30 (RAF inhibitor) were found to be positively correlated with iKRas action shortlisting them as potential drugs that could overcome or stall iKRas resistance. **Conclusions:** iKRas show a similar intracellular action mechanism in both PAC and LAC models. Computational biology tools are useful in understanding

intracellular mechanisms of novel drug actions and shortlising drugs for drug repositioning studies.

Keywords: K-Ras; pancreatic adenocarcinoma; omic data; computational biology

VAGUS NERVE STIMULATION IN DISORDERS OF CONSCIOUSNESS

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Disorders of consciousness (DC) include a range of conditions where consciousness has been affected by damage to the brain. Types include, e.g., vegetative state (VS), when a person can be awake but shows no signs of awareness, or minimally conscious state (MCS) when a person shows minimal or inconsistent awareness. Neurologically, DCs are caused by lesions in the cortex, the brainstem, the thalamus and the white matter resulting in disconnections in long-range cortico-cortical and thalamo-cortical pathways. The likelihood of recovering consciousness after one year of unresponsiveness is low, thus there is a need to explore novel ways of rehabilitating lost consciousness. We present a clinical study using a promising new method: noninvasive vagus nerve stimulation (tVNS). Vagus nerve stimulation increases metabolism in the forebrain and thalamus. It also enhances neuronal firing in the locus coeruleus and leads to increased release of norepinephrine in the thalamus and hippocampus, a noradrenergic pathway important for arousal and alertness. [1] reported promising results on a single patient in VS who responded to stimulation via a surgically implanted stimulator. We extend this line of research with two patients (one in persistent VS and one in MCS-)

and utilize a non-invasive stimulator counterpart from 'tVNS Technologies©'. Additional EEG and psychophysiological measures are collected, together with regular behavioural assessment via the Coma Recovery Scale-Revised. Our research sits in the broad context of 'electroceuticals', a rapidly growing field of bioelectrical and bioelectronics medicine and health science.

Keywords: coma, vagus nerve, tVNS, electroceuticals

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SUPERPARAMAGNETIC IRON OXIDE BASED NANOPARTICLES FOR MAGNETIC HYPERTHERMIA

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Superparamagnetic nanoparticles based on the iron oxide (SPIONs) are widely investigated, because of their tunable magnetic properties and potentials in nanomedicine like targeted drug delivery diagnostics, MRI bioimaging, and magnetic hyperthermia. According to magnetic hyperthermia SPIONs heat up in alternating magnetic field what enables cancer tissue destruction and remote biological interfacing.

In our project we have successfully synthesized SPIONs doped with holmium [1] as heat mediators for magnetic hyperthermia and bioconjugated them with antitumor drug – trastuzumab. For any particular biomedical application of synthesized SPIONs it is necessary to create them with desired shape, size and magnetic properties. After bioconjugation SPIONs displayed spherical shapes with 15 nm diameter and high subphase potential. TEM imaging shows the organic shell covering nanoparticles after conjugation with anti-cancer drug.

The TGA and IR studies confirmed bioconjugation. Magnetic hyperthermia experiments reveal that SPIONs heat up to 42-46°C through AC magnetic field in a few minutes, making them promising materials given the wide range of medical application availabilities.

Keywords: Include a maximum of 4 words/phrases

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PREPARATION OF Ti-6Al-4V ELI TITANIUM ALLOY AND OCTADECYLPHOSPHONIC ACID SOLUTION (ODPA) TO CREATE AN ORDERED ODPA LAYER ON THE ALLOY SURFACE

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Titanium and its alloys have a wide range of use in medicine. Titanium is a building material for bone osteointegration plates and screws, while titanium alloys form various types of endoprostheses. Titanium alloys doped with aluminium and vanadium are characterized by high corrosion resistance in the tissue environment and have good mechanical properties at low density. In addition, their preferred ratio of tensile strength to yield strength is often cited. These are also non-magnetic materials. Titanium alloy Ti-6Al-4V ELI, made under the ASTM F 136/1472 standards is currently one of the few materials recommended for surgical applications [1]. The aim of the research is to modify the surface of titanium alloy Ti-6Al-4V ELI with octadecylphosphonic acid (ODPA). The ODPA layer is to support the process of osteointegration between biomedical material (e.g. endoprosthesis) and bone [2]. At the moment, the key step is to properly prepare the surface of the alloy - giving it the right roughness. Obtaining too low or too high surface roughness may result in problems in the process of bone tissue obstruction [3] and also in the deposition of the ODPA layer itself.

Keywords: endoprosthesis, osteointegration, titanium alloy, drug delivery,

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THE EXPERIMENTAL ALHEIMER'S DISEASE DRUG REGULATES p53 IN CANCER CELLS

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Neurodegenerative and cancer diseases remain the leading causes of death in developed countries. A common feature of these diseases may be dysregulation of glycogen synthase kinase 3 (GSK-3), involved in multiple cellular processes associated with various diseases including cancer, and Alzheimer disease (AD). The GSK-3 function may be connected with p53 pathway. The p53 is responsible for transactivation of numerous target genes involved in the cell cycle arrest, cell invasiveness or cell death. We observed, that two substances: actinomycin D and nutlin-3a, which stimulate p53 by different mechanisms, when act simultaneously (A+N), induce synergistic activation of p53 in different cancer and normal cell lines. As a result, many p53-dependent genes are synergistically upregulated. We detected, that specific inhibitor of GSK-3 (CHIR-98014), inhibited A+N-induced phosphorylation of p53 on Ser46 and prevented strong upregulation of a group of genes, e.g. *TREM2* – involved in the pathogenesis of AD and invasiveness of tumor cells. Based on this observation, we decided to identify p53 target genes, which are sensitive to the inhibitory influence of CHIR-98014. The first part of this project was to measure the level of gene expression by transcriptome sequencing (RNA-Seq) in non-stressed A549 cells and in cells exposed for 30 hours to A+N, A+N in

the CHIR -9814 and in cells treated with the inhibitor alone. As a result, we identified genes whose activation by A+N was attenuated by CHIR-98014. Analysis of the results demonstrated that there are three groups of p53 target genes. The first, large group is not influenced by the inhibitory effect of CHIR-98014. This group includes many well-known p53-regulated genes involved of cell death. The second group contains the genes, whose A+N-induced expression is attenuated by the inhibitor approximately by half. The third group, contains genes whose upregulation by A+N is almost completely prevented by CHIR-98014. This group includes many genes involved in innate immunity in neurodegenerative diseases and in negative regulation of apoptosis. We hypothesize, that CHIR-98014 in some conditions sensitizes cells to death. Thanks to this ongoing project, we have the opportunity for understanding the functional impact of an experimental AD drug on the p53 pathway.

Keywords: Cancer and diseases, p53 pathway, glycogen synthase kinase 3 pathway

This work was supported by grants no. 2017/27/N/NZ5/01079 to BŁ-S from the National Science Centre, Poland (NCN).

HOMOLOGOUS REPAIR DEFICIENCY AND miRNAs IN OVARIAN CANCER

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Homologous Recombination (HR) deficiency arising from mutations in *BRCA1* and other HR genes sensitizes tumors to DNA damaging agents, predisposing to a targeted therapy with PARP inhibitors. Identification of patients eligible for such treatment is critically important. Here, we aimed to create a miRNA-based signature of HR deficiency.

We acquired miRNA expression profiles of ovarian tumor samples from The Cancer Genome Atlas repository. We annotated samples as HRD if they had somatic or germline mutations in HR-related genes; other samples were classified as HRP.

Out of 204 samples with known HR mutational status and available miRNA expression, 97 were classified as HRD and 105 as HRP. At FDR < 0.05, 21 miRNAs were differentially expressed. Using functional enrichment analysis (DIANA mirPath v.3 online software), 8 out of 21 miRNAs were determined to be tightly connected with the function of HR-pathway genes (miR-182, let-7b, miR-17, miR-15a, miR-30d, miR-30e, miR-181c, miR-183).

Eight microRNAs were selected by Correlation-based Feature Selection with 10-fold cross validation. A neural network was used to distinguish HRD from HRP tumors yielding an accuracy of 90.78% with AUC equal to 0.97 (95CI: 0.95–0.99) on the training set and 80.43% accuracy on the testing set. These data suggest that a miRNA-based classifier could be used to identify HR dysfunction in ovarian cancer.

Keywords: homologous recombination, microRNAs, ovarian cancer

DO WE KNOW WHAT WE EAT? A COMPARISON OF SELECTED ANTIOXIDANT COMPONENTS AND LIPIDS OF DRIED AND FRESH GOJI FRUITS

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Goji fruits (*Lycium barbarum* L.), commonly used in Traditional Asian medicine, are usually consumed in Western countries as „functional food" or „superfood". Wolfberry possesses high nutritive value due to the content of fiber, monocarbohydrates, amino acids, lipids, carotenoids, phenolic acids,

flavonoids, alkaloids, vitamins and essential elements [1–2]. Further, a wide range of has been found in *L. barbarum* [2]. Dried fruits can be characterized by high antioxidant activity in comparison to raisins or dried cranberries [3].

For our health it is crucial to compare the nutritional properties of dried and fresh berries. Since there is even a lack of information about the precise qualitative lipid composition of wolfberry fruits, we see the need for further research. Therefore, the goal of the study was a complex screening of dried and fresh goji fruits with the use of LC-MS/MS and GC-MS techniques and in order to define the benefits of the introduction to the diet dried or fresh goji fruits.

In the effect, the presence of the above-mentioned groups of metabolites was confirmed. Interestingly, with the use of a simple foodomics approach, we were able to determine artifacts of the berries drying process. The semi-quantitative differences in obtained lipid profiles of dried and fresh goji fruits were observed.

Keywords: goji fruits, LC-MS/MS, antioxidants, lipids

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CZY RYZYKO JEST WYZWANIEM KOMUNIKACYJNYM? CZYLI POROZMAWIAJMY O ŚMIERCI

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Mówienie o ryzyku nie jest adekwatne do mówienia o tym, co kiedyś nazywano Losem. Ryzyko się kalkuluje, zmniejsza, mierzy, a z Losem się nie da tego zrobić, bo przerasta człowieka. Jeśli tak, to można uciekać od rzeczywistości, można

też przekładać to na ryzyko. To szczególnie ważne w medycynie, która musi podjąć ryzyko, a często podjąć go nie chce czy nie może. Dla lekarza ryzyko oznacza przede wszystkim śmierć pacjenta lub nieodwracalne pogorszenie jego stanu zdrowia. Z tego punktu widzenia 2% ryzyka czy 90% może być tym samym dla pacjenta i lekarza, bo nie możemy wykluczyć, że właśnie ten konkretny pacjent umrze. Ergo, uważamy, że rozmowa o ryzku jest przede wszystkim rozmową o śmierci, choć nie zawsze jest to wprost wyrażone. I tym chcielibyśmy się zająć. Zamierzamy odwołać się do pracy Elisabeth Kübler-Ross. Kübler-Ross była amerykańską lekarką szwajcarskiego pochodzenia, twórczynią, współtwórczynią tego, co dziś się nazywa tanatologią, osobą uważaną też za prekursorkę opieki paliatywnej.

Czas popularności Kübler-Ross w Polsce to czas po 1989 roku. Sama zaś Kübler-Ross po sukcesie *Rozmów o śmierci i życiu* pisała dalej o śmierci, prowadziła warsztaty, by ostatecznie stać się „Damą śmierci"[1].

„I remember as a child the death of a farmer."[2]

„Pamiętam z dziecinnych lat śmierć zamożnego gospodarza."[3] To naszym zdaniem jedno z najsłynniejszych zdań, jakie napisano w XX wieku o śmierci. Dla Kübler-Ross wspomnienie umierania tego szwajcarskiego gospodarza było i kluczowe, i inicjacyjne. Powróciła do niego w swojej autobiografii, nieco innymi słowami opowiadając to zdarzenie. Nie było to wszak jej jedyne ważne spotkanie ze śmiercią na drodze, która doprowadziła ją do *Rozmów*. Takich spotkań, intensywnych i zmieniających, było sporo, m. in. wiązały się też one z Polską, z Majdankiem i z jej drogą do zostania lekarza. Wspominamy o tym, by pokazać, że Kübler-Ross była dobrze przygotowana życiowo i zawodowo, by zająć się śmiercią i uczynić „umieranie swoją specjalnością"[4]. Ten moment wypadł w szczególnym czasie. Po pierwsze, bardzo intensywnych kulturowych

[1] E. Kübler-Ross, *Koło życia. Autobiografia*, dz. cyt., s. 9. Sama się dystansowała od tego określenia. Por. tamże.
[2] E. Kübler-Ross, *On Death and Dying*, dz. cyt., s. 9.
[3] E. Kübler-Ross, *Rozmowy o śmierci i umieraniu*, dz. cyt., s. 15.
[4] D.J. Rothman, *Strangers at the bedside: A history of how law and bioethics transformed medical decision making*, Aldine de Gruyter, New York 2003, s. 132.

przemian, które w Ameryce (i Europie) eliminowały w śmierć z pola ludzkiego i kulturowego doświadczenia. Pisali o tym m.in. G. Gorer i Ph. Ariès[5]. Po drugie, na przemiany w systemie opieki medycznej, które bardzo intensywnie było widać w Stanach Zjednoczonych, a które sprawiały, że chory stawał się anonimowy, odizolowany od życia i bliskich ludzi, jego leczenie przebiegało w rytm wymagań sprzętu i szybkich decyzji lekarzy, mających coraz mniej czasu dla chorego[6]. Niemniej Kübler-Ross podjęła wyzwanie połączenia problematyki śmierci z przemianami kulturowo-cywilizacyjnymi.

Punktem wyjścia stało się dla niej uznanie po pierwsze pacjenta za istotę ludzką, a po drugie, za **nauczyciela śmierci**[7]. (RŚŻ, 9[8]) Nauczyciela, który ma nauczyć lekarzy, personel medyczny, pracowników socjalnych, jak podchodzić tak do śmierci[9], jak i do ludzi, którzy umierają lub są jej bliscy...

Słowa kluczowe: Ryzyko, śmierć, rozmowa, Kübler-Ross

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[6] Por. np. D. J. Rothman, *Strangers at the bedside.*, dz. cyt., s. 127 i n. [DHK – przekład mój]
[7] U Kübler-Ross jest „umierający jako nauczyciel". E. Kübler-Ross, *Rozmowy o śmierci i umieraniu*, dz. cyt., s. 34.
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HIGH-RESOLUTION IN VIVO VISUALIZATION OF OPACIFICATIONS OF THE HUMAN EYE VITREOUS

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The vitreous is a hydrophilic gel constituting the largest volumetric component of the eye globe. Since the vitreous is optically a transparent tissue, the vitreous body represents one of the the most challenging of all ocular structures to image. The main challenges of vitreous imaging include: need to compensate the refractive status of the eye (limiting the field of view), extremely low light scattering and long imaging depth required.

The aim of this study is to demonstrate a novel imaging platform that aims at in vivo enhanced visualization of vitreous The instrumentation is based on optical coherence tomography (OCT) and implements focus tunable optics.

We designed an interface of the optical system. The optimized solution was tested experimentally in a high speed SS-OCT instrument operating at a central wavelength of 1050 nm. The performance of the tool was presented in artificial model eyes and in human eyes in vivo. The assessed parameters include: depth range, axial and lateral resolution, field of view and system

sensitivity to detect back-scattered photons. The obtained images revealed liquefied regions

In conclusion, implementation of focus tunable optics into SS-OCT allows for visualization of in vivo microstructure of the vitreous body, primarily as related to opacifications. The proposed imaging platform can be a new-generation ophthalmic diagnostic tool in the fundamental studies as well as for objective clinical evaluation and management of vitreous-related diseases.

Keywords: biomedical imaging, ophthalmology, optical coherence tomography

The study is supported by the European fund within the Smart Growth Operational Programme 2014–2020 (TEAM Programme, # POIR.04.04.00-00-5C9B/17-00).

MPROVEMENT OF BACTERIAL CELLULOSE PRODUCTION BY SUPPLEMENTATION OF MEDIUM WITH VEGETABLE OIL

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Bacterial cellulose (BC), produced by *Komagataeibacter xylinus*, has numerous applications to medicine and industry [1]. A major limitation of BC use is relatively low production rates and high culturing media costs [2]. Therefore, the aim of this of this study was to improve the BC production by supplementation of medium with vegetable oil.

For the biosynthesis of BC different strains of *Komagataeibacter xylinus* were used. The synthesis was carried out in a stationary condition for 7 days at 28°C using a Hestrin-Schramm (H-S) medium with addition of oil. After purification process, parameters characterized the structure of BC, was analyzed.

By supplementing culture media with 1% vegetable oil, we achieved BC yield exceeding 500% over the yield obtained in standard media. BC properties were similar to cellulose cultured in standard methods with regard to

cytotoxicity, but displayed significantly higher water swelling capacity and mechanical strength. As we demonstrated herein, this significantly increased BC yield is the result of microscopic and macroscopic physiochemical processes reflecting a complex interaction between K. xylinus biophysiology, chemical processes of BC synthesis, and physiochemical forces between BC membranes, oil and culturing vessel walls [3]. Our findings have significant translational implications to biomedical and clinical settings and can be transformative for the cellulose biopolymer industry.

Keywords: bacterial cellulose, increased yield, culture medium modification, vegetable oil

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REKRUTACJA

SCIENTIFIC SESSION

MODERN MATERIALS

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of Warsaw

Novel photonic materials enabled by crystal growth

We will demonstrate how to utilize the crystal growth methods for manufacturing of novel composite materials for various applications and especially photonics (metamaterials, plasmonic materials [1–7]), and energy conversion [8–9]. We will focus on two novel bottom-up manufacturing methods: (i) method based on directionally-grown self-organized eutectic structures [1, 5–9]; and (ii) NanoParticles Direct Doping method (NPDD) [2–4] based on directional solidification of dielectric matrices doped with various nanoparticles. In both of these methods we can easily use all available resonant phenomena to develop materials with unusual electromagnetic properties. Eutectic composites are simultaneously monolithic and multiphase materials forming self-organized micro/nanostructures, which enable: (i) the use of

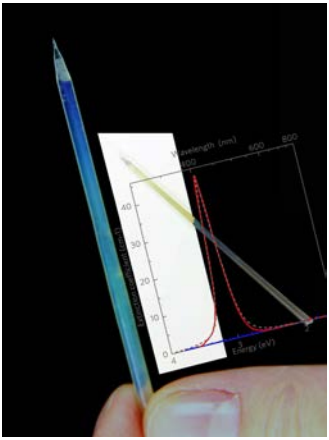

Fig. 1. Nanoplasmonic material obtained by novel NanoParticle Direct Doping method [2].

various component materials including oxides, semiconductors, metals, (ii) the generation of a gallery of geometrical motifs and (iii) control of the size of the structuring, often from the micro- to nanoregimes. On the other hand, the novel method of NanoParticles Direct Doping enables doping of dielectric matrices with various nanoparticles (varying chemical composition, size and shape) and with the possibility of co-doping with other chemical agents as eg. optically active rare earth ions or quantum dots.

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Acknowledgments: This work was supported by Foundation for Polish Science under TEAM project, as well as the National Science Centre under MAESTRO and HARMONIA projects.

Prof. DOROTA A. PAWLAK is Professor at the Institute of Electronic Materials Technology (ITME) of Warsaw, and at the Chemistry Department, the University of Warsaw, both in Poland. She is currently head of the Department of Functional Materials at ITME and leader of the Laboratory of Materials Technology at the Chemistry Department. Prof. Pawlak's research is linked to technology development for the manufacturing of new functional materials, such as plasmonic materials, metamaterials, materials with special electromagnetic properties, materials for solar energy conversion. She currently focuses on bottom-up methods such as directional solidification and crystallization, nanoparticles direct doping method and associated research.

She is chemist from education with all degrees (MSc, 1999 – PhD, 2011 – habilitation) made at the Chemistry Department at the University of Warsaw, however currently her work is considering mainly materials science. In 2000–2001 she was a postdoc at the Tohoku University in Japan.

She coordinated various prestigious projects including: (i) The first FP7 Collaborative Project in the NMP Area coordinated by Poland (2008–2012, ~5 mln EUR); (ii) US Air Force Office for Scientfic Research funded project; (iii) Era. NET RUS PLUS; (iv) two TEAM projects; (v) MAESTRO and currently she and her consortium will lead a Teaming for Excellence H2020 Project (one out of three in Poland).

Within the Teaming for Excellence programme a Centre of Excellence for nanophotonics, advanced materials, and crystal growth-based technologies – ENSEMBLE3 will be created in Warsaw. The Centre will be created in collaboration with the Institute of Electronic Materials Technology in Warsaw; University of Warsaw, Karlsruhe Institute of Technology in Germany, Sapienza University of Rome in Italy, and CIC nanoGUNE in Spain.

She is a member of the Scientific Board of ITME (2008–2019); a Director in the Director Board of the Metamorphose Virtual Institute for Artificial Electromagnetic Materials and Metamaterials METAMORPHOSE VI AISBL – terms of office: 2007–ongoing, http://www.metamorphose-vi.org/index.php/association/structure; a member of 'Association-National Committee of Coordinators of EU Projects'. She was the president of Polish Society for Crystal Growth (2013–2016), currently ex-president (2017–2019). DAP is a member of the Scientific Reports (Nature group), and J. Phys. D editorial boards. She is the co-founder of 3C CRYSTALS sp. z o.o – an SME started with members of her research group in 2014.

Prof. **TOMASZ DIETL**

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WPI-Advanced Institute for Materials Research

Why topological materials?

General properties and opportunities offered by various families of topological materials will be surveyed emphasizing novel physics associated with the presence of edge states [1], magnetic impurities [2, 3], and metal/topological semiconductor interfaces [4].

Keywords: topological materials, magnetic semiconductors, superconductivity

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Prof. TOMASZ DIETL is a Head and an Ordinary Professor at the International Centre for Interfacing Magnetism and Superconductivity with Topological Matter – MagTop, funded by a grant from the Foundation for Polish Science, and carried out at the Institute of Physics, Polish Academy of Sciences in Warsaw. He holds also a part-time Principal Investigator and Professor position at the Advanced Institute for Materials Research, Tohoku University in Sendai.

INVITED TALK

His current research interests are focused on the development of material systems and device concepts for nanospintronics of topological materials, ferromagnetic and antiferromagnetic semiconductors, and of hybrid metal/semiconductor nanostructures. In 2008 Tomasz Dietl obtained an Advanced Grant (FunDMS) of ERC. He is the author or co-author of over 400 publications, cited over 20 000 times, and resulting in the h-factor over 50 (WoS). Dietl has presented over 200 invited talks at international meetings, including 9 plenary talks at major physics conferences. In 1998 he became a member of the Polish Academy of Sciences; in 2002 he was elected to the International Union of Pure and Applied Physics, Commission on Low Temperature Physics, in 2004 and 2015 he was nominated Fellow of the Institute of Physics, UK and of the American Physical Society (APS), respectively, while in 2009 Dietl was elected to the Polish Academy of Arts and Sciences as well as to the Warsaw Science Society and in 2011 to Academia Europaea. In 2011 he was appointed by the European Commission to the Scientific Council and to the Steering Committee of the European Research Council (ERC) for the term 2011–2014.

He is recipient of Maria Skłodowska-Curie Award in Poland (1997); Alexander von Humboldt Research Award in Germany (2003); Agilent Technologies Europhysics Prize (2005) with David D. Awschalom and Hideo Ohno, for pioneering works that paved the way for the emergence of semiconductor spintronics; Foundation for Polish Science Prize (2006), and the Marian Smoluchowski Medal of the Polish Physical Society (2010). In 2019 Dietl was selected as an Outstanding Referee of APS.

HIGH PRESSURE SYNTHESIS OF BLACK AND RED PHOSPHORUS ANALOGUES WITH MAGNETIC IONS

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It is known that many allotropes exist in simple phosphorus, and they are diverse, such as white phosphorus consisting of P_4 clusters, red phosphorus having a one-dimensional polymer structure, black phosphorus consisting of a buckled honeycomb lattice, etc. Among these, black phosphorus has long been studied as a narrow gap semiconductor containing high mobility p electrons. Recently, the attention to the black phosphorus has been rapidly increasing because it exhibits topological transition to Dirac semimetal by pressure application.

We focused on the facts that α-SrP_3 has a layered structure very similar to that of black phosphorus and it can be obtained by the high-pressure synthesis method, and then attempted high-pressure synthesis of α-EuP_3 as a new magnetic "black phosphorus" compound. With a single crystal of about 0.5 mm obtained by high pressure syntheses, we found that a huge anomalous Hall effect is observed in a specific crystal orientation, which can be associated with the magnetic field induced topological transition forming Weyl points [1]. If time allows, we also report the structure and physical properties of a new magnetic phosphorus compound, which can be regarded as a red phosphorus analogue.

Keywords: High pressure synthesis, phosphorus, topological semimetal, Weyl semimetal

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This work has been done with the collaborators, M. S. Bahramy, A. Nomoto, H. Sakai, and José A. Flores Livas. This work is supported by Asahi Grass Foundation, and the JSPS Grant-in-Aid for Scientific Research (A) Grant No. 17H01195.

PHOTONIC STRUCTURE IN OPTICAL PHANTOMS MIMICKING TISSUE

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Optical phantoms of biological tissues are primarily produced for calibration and verification of the proper operation of optoelectronic devices used for measurements and imaging [1,2]. Their application allows to compare metrological parameters of devices and measurement techniques used to investigate the propagation of optical radiation in complex, often multi-layered, systems of tissues or organs [3,4]. It seems, however, that the main group of biological tissues phantoms are still the ones in liquid form, based on the use of Intralipid (Intralipid – fatty emulsion applied in infusion). The major disadvantages of such phantoms are: short usefulness time, lack of possibility of introducing additional structures and creating multilayer systems.

The application of photonic crystals in the optical phantom mimicking a biological tissue creates new possibility to produce phantoms, which will have the same optical characteristics as simulated tissues while preserving their optical characteristics over long periods of time as well as mechanical properties.

Keywords: optical phanomts, phantoms mimicking tissue, photnic crystals

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IMPEDIMETRIC DETECTION OF INFLUENZA VIRUS ON BORON-DOPED NANOCARBON ELECTRODES

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According to the WHO, each year influenza virus causes 3 to 5 million cases of severe illness resulting in up to 650 000 deaths. Thus, the development of rapid and sensitive detection techniques is necessary.

Herein we demonstrate a electrochemical biosensor for influenza virus based on the boron-doped diamond electrodes. The determinantion of the virus biomolecules was based on the interactions between an antibody (anti-M1) and antigen – virus protein (M1). Hence, for M1 protein detection, the surfaces of the electrodes were functionalized with anti-M1. The qualitative and quantitative study was done by the electrochemical impedance spectroscopy. As a result, we prepared fast, highly specified and sensitive system for influenza virus determination with limit of detection achieving 1 fg ml^{-1}.

Keywords: boron-doped diamond, electrochemical impedance spectroscopy, cyclic voltammetry, pathogen detection

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SPECTROSCOPIC PROPERTIES OF Bi_3TeBO_9 MICROCRYSTAL POWDERS DOPED WITH RARE EARTH IONS

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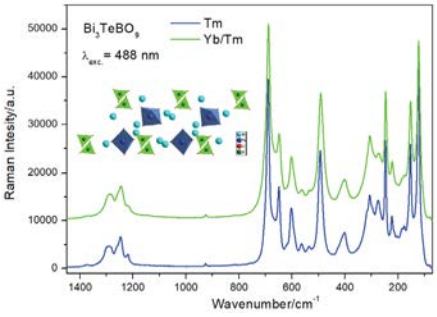
Bifunctional Bi_3TeBO_9 powders doped with selected rare earth ions exhibit excellent non-linear optical properties as well as luminescence properties, which make them very useful for applications in optoelectronic devices. The investigated powders were synthesized by means of the modified Pechini method [1].



XRD measurements of Bi_3TeBO_9 confirmed its hexagonal structure, $P6_3$ space group (Z=2) [2,3].

In this work, we present the results of measurements of luminescent and vibrational properties of Bi_3TeBO_9 doped Tm and Yb/Tm ions using Raman and optical spectroscopy methods.

Keywords: Bi_3TeBO_9, luminescence, rare earth ions, Raman spectroscopy

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LOW DAMPING $Co_{25}Fe_{75}$ FILM WITH PERPENDICULAR ANISOTROPY

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Thin films with perpendicular magnetic anisotropy (PMA) and low damping of magnetization precession are crucial for novel application in spintronic and magnonic devices. Both parameters are related to spin-orbit coupling (SOC). It has been experimentally observed that both PMA and damping increases while layer thickness decreases. Therefore, achieving low damping material with PMA is a challenging task, especially that the relation between PMA, damping and SOC is still under deep debate.

Recently it was found that $Co_{25}Fe_{75}$ alloy film can have ultra-low damping [1]. In particular it has been shown that $Co_{25}Fe_{75}$ film deposited onto Cu buffer layer has intrinsic damping as low as 0.0005 [1, 2]. In our studies we focus on deposition of $Co_{25}Fe_{75}$ layer onto Au buffer layer and cover it with either Au or NiO, because both capping layers support PMA of $Co_{25}Fe_{75}$ layer. Moreover, the Au layers are also known to cause low spin pumping effect due to lack of d-states on Fermi surface, which is a good candidate not only to achieve low damping and PMA, but also as a layer protecting ferromagnetic layer from natural oxidation.

Keywords: damping of magnetization precession, perpendicular magnetic anisotropy

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FUNCTIONAL POLYHEDRAL OLIGOMERIC SILSESQUIOXANES (POSS) FOR BIOMEDICAL APPLICATIONS

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Inorganic nanoparticles, such as polyhedral oligomeric silsesquioxanes (POSS), have a high potential for drug delivery, gene therapy and molecular imaging due to the ease of adjustment of their reactivity and surface properties that can be obtained by modifying the substituents in silicon atom. [1–3] The small size of the octahedral POSS cage relative to e.g. silica particles, gold nanoparticles or biocompatible polymers is extremely important to increase the efficiency of transport of biologically active compounds to cancer cells. It was calculated that a cubic cage constructed only of silicon and oxygen atoms in a ratio of 1: 1.5 has only 0.6 nm. POSS is biocompatible and non-toxic. In cells, it hydrolyses to biologically neutral silicic acid.

In this contribution, we present two examples of the use of inorganic POSS cages in biomedicine. The water-soluble POSS-daunorubicin conjugates are a potential prodrug in cancer therapy. The second example is cationic POSS marked with phenosafranin dye for use as a nanocarrier for cell therapy and imaging. The new conjugates were characterized using ^{1}H, ^{13}C, ^{29}Si NMR, FTIR spectroscopy, SEM, MALDI-Toff and ESI-HR-MS analysis.

Keywords: functional POSS, carriers of anticancer drugs, imaging

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XPS VALENCE BAND STUDIES OF $Ti_{n+1}AlC_n$ (n = 1, 2) ALLOY THIN FILMS

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Recently, the synthesis, properties, and applications of 2D materials have become a leading area of interest in the field of solid state physics, material science and engineering. There are three ternary phases within the Ti-Al-C system. Two are MAX phases, namely Ti_2AlC and Ti_3AlC_2, and one is a perovskite, Ti_3AlC. MAX phases are a family of ternary carbides and nitrides. In this contribution we report on valence band studies of Ti_2AlC and Ti_3AlC_2 alloy thin films using X-ray photoelectron spectroscopy (XPS). As a substrate we have used c-axis-oriented Al_2O_3(0001) with 20 nm TiC(111) buffer layer. The alloy thin films were prepared in three different ways using ultra high vacuum (UHV) magnetron DC/RF sputtering. The first series was deposited at a substrate temperature of about 600 K by co-sputtering. The second series was prepared at 600 K by co-sputtering and then annealed in UHV for 2 h at 1050 K. The third series was prepared as Ti/C/Al elemental multilayer stacks deposited by sputtering followed by UHV annealing at 1100 K for 0.5 h. The total thickness of the alloy thin film samples was about 100 nm. Such "as prepared" thin films were practically not transparent. The transmittance considerably increases after UHV annealing. Results also showed that the position of the maxima of the XPS valence bands strongly depends on the preparation conditions of the samples and ex-situ functionalization. The above behaviour is in good agreement with earlier theoretical calculations [1].

Keywords: Ti_2AlC and Ti_3AlC_2 alloy thin films, 2D materials, XPS valence band

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SPIN WAVE AMPLIFIER AND AMPLITUDE MODULATOR BASED ON CHARGE-MEDIATED MAGNETOELECTRIC EFFECT

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Spin waves are a promising candidates as a carriers for the next-generation low-energy signal processing devices. Here, we present the operation and we analize the performance of the device which amplifies and modulates the spin wave by the ac electric field.

The system consists of two high-κ dielectric thin-film capacitors separated by ferromagnetic bilayer. The magnetization dynamics is affected non-resonantly with an ac voltage applied to such heterostructure by the spin accumulation. The spin accumulation is generated by the charge-mediated magnetoelectric effect (i.e., spin-dependent surface screening) and interacts with magnetization through the so-called field-like and anti-damping spin transfer torques. The spin transfer torques lead to the periodic spin wave ampilfication and attenuation with the frequency of the applied ac voltage. We show the criteria for the effective amplification and dependences of the obtained gain on the applied voltage amplitude and spin wave frequency.

The generation of nonequilibrium spin density through dynamic spin-dependent surface screening in the proposed magnetoelectric heterostructure allows to reduce the thickness of fixed magnetization layer used in conventional spin valve to a few nanometers, thus the proposed effect can significantly contribute to miniaturization of the spintronic devices.

Keywords: *spintronics, magnetoelectric effects, spin waves, spin current*

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STRONG INTERFACIAL COUPLING IN FERROMAGNETIC/FERRIMAGNETIC MULTILAYER SYSTEMS

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Ferrimagnetic (FI) multilayers (MLs) or alloys consisting of Rare Earth – Transition Metal (RE-TM) are in great interest because of their unique properties, e.g., compensation temperature, perpendicular magnetic anisotropy (PMA), high coercive field and strong interfacial coupling with ferromagnetic (F) layers [1, 2].

Here, we studied the coupling between F with PMA and FI layers in F/FI system where F = (Au-1nm/Co-0.8nm)$_3$ and FI = (Tb-wedge 0-2nm/Fe-0.66nm)$_6$ or (Tb-wedge 0-2nm/Co-0.66nm)$_6$. Wedge sublayers of Tb allow us to characterized magnetic properties as a function of the Tb thickness (t_{Tb}). The shape of the hysteresis loop indicates that FI MLs for $t_{Tb} \geq 0.15$nm (Tb/Fe) and $t_{Tb} \geq 0.26$nm (Tb/Co) exhibit PMA. When t_{Tb} approach to a thickness where magnetic moments of the RE and TM sublayers are compensated ($t_{Tb} = 1.13$nm for Tb/Fe ML and $t_{Tb} = 1.08$nm for Tb/Co ML), magnetic field required to switch the magnetization of F MLs increase up to few kOe. This indicate that by proper choice of t_{Tb}, this field can be easily tunable in a wide range, which is very promising for applications in spintronic devices. Additionally, we found that coupling between F and FI across wedge-shaped Au spacer shows the oscillatory behavior suggesting existence of the RKKY-like coupling.

Keywords: thin layers, exchange bias, ferrimagnetic multilayers, spintronics

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TUNING THE STRUCTURE OF 2D LAYERS GROWN ON A STRONGLY-INTERACTING SUBSTRATE: FeO AND EPITAXIAL GRAPHENE ON Ru(0001)

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2D materials epitaxially grown on single-crystal substrates are characterized by high structural order and low defect density. However, due to the interaction with the substrate, the properties of the supported 2D layers are usually far from those of the corresponding free-standing 2D sheets. Ru(0001) is one of the very few substrates on which a plethora of well-ordered and closed 2D layers can be fabricated, including epitaxial graphene (EG) [1], hexagonal boron nitride [2], silicine [3] and 2D iron oxide (FeO) [4]. On the other hand, it is also very strongly interacting. Recent studies concentrate on (1) the decoupling of the 2D layer from Ru(0001) and (2) tuning the properties of the coupled and decoupled layers towards potential applications. Our group contributes to this topic by studying the influence of various post-growth treatments, e.g. vacuum annealing, atomic oxygen exposure or metal intercalation, on the structure and properties of EG and FeO on Ru(0001). The experiments are performed in idealized ultra-high vacuum (UHV) conditions using scanning tunneling microscopy and spectroscopy (STM/STS), low energy electron diffraction (LEED) and X-ray photoelectron spectroscopy (XPS). Such combination of experimental tools allows us to get insight into the fundamental physical and chemical processes that occur in these systems at the atomic level.

Keywords: 2D materials, surfaces, structure, properties

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ANTI-CORROSIVE PROPERTIES OF SILOXANE COATINGS

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Until recently, corrosion protection was mainly based on the introduction of heavy metals (as the corrosion process inhibitors) to metalworking and coatings. Promising candidates that could take their place in the anti-corrosive branched of the market seems to be organofunctional silanes. Due to their structure, they are organic-inorganic hybrids that combine features of both organic and inorganic compounds, which makes them capable of forming covalent bonds with inorganic substrates such as glass or metal, and with organic polymers [1–3].

In this study we present a new approach to silane (siloxane) coatings deposited on the surface of 316L stainless steel. Anti-corrosive properties of silane-based coatings were examined using different electrochemical techniques. It was observed that the silane coatings effectively inhibit corrosion on the surface of 316L stainless steel. The values of the corrosion potential of the modified samples were more positive (more nobel) than the corrosion potential of bare steel. Due to the presence of passive oxide film on the steel surface, metal-O-Si bonds are formed, thus creating an intermediate layer between the passive oxide film and the outermost siloxane layer (Si-O-Si). Furthermore, presence of long aliphatic chain of silane compounds increases steel surface hydrophobicity.

Keywords: Corrosion, siloxane coatings, stainless steel

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ENVIRONMENTALLY FRIENDLY CATHODE MATERIALS WITH NASICON AND ALLUAUDITE STRUCTURES FOR Na-ION BATTERIES

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The constantly increasing demand for mobile devices as well as hybrid and electric cars based on Li-ion technology is contributed to the rapid reduction of the world's lithium resources [1] and it initiated the search for alternative. Currently, sodium-ion batteries are one of the most intensely studied energy storage systems. However, sodium possesses the larger ionic radius and the higher molar mass compared to lithium and thus it could only partially replace the Li-ion technology in certain applications, e.g. large-scale energy storage.

Due to its thermal and chemical stability resulting from PO_4^{3-} anions, the wide abundance of the elements and their non-toxicity, materials from the group NASICON-$Na_3Fe_{2-y}Mn_y(PO_4)_3$ and *alluaudites*-$Na_{1.5}Fe_{3-y}Mn_y(PO_4)_3$ seem to be one of the most promising cathode materials for sodium-ion batteries. In addition, their three-dimensional crystal structure allows for reversible sodium intercalation/deintercalation without significant changes in the structural framework.

Here we present the comparison of two abovementioned structures: NASICON and *alluaudite* in the aspect of applications as cathode materials for sodium-ion batteries. We show the structural, microstructural and electrochemical performance of NASICON-$Na_3Fe_{2-y}Mn_y(PO_4)_3$ and *alluaudites*-$Na_{1.5}Fe_{3-y}Mn_y(PO_4)_3$ systems.

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ADDITIVE EXCHANGE BIAS COUPLING AND PERPENDICULAR MAGNETIC ANISOTROPY IN NiO/Co/NiO MULTILAYERS

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In the last two decades, the exchange bias (EB) coupling has been widely studied in magnetic thin films due to its wide application range (e.g. in magnetic random-access memories, hard drive read heads, etc.). Recent studies show the important role that layered systems with perpendicular magnetic anisotropy (PMA) and EB coupling play in new applications [1]. Heavy Metal (HM)/ferromagnet(FM) /antiferromagnet(AFM) systems are frequently used to achieve PMA together with exchange bias effect. A translation symmetry breaking occurs at the interface between the FM layer and the HM layer and causes PMA. Additionally, there must be EB at the FM/AFM interface. In summary, for these systems each interface is responsible for one specific property of the ferromagnetic layer.

In contrast, previous studies on Au/Co/NiO layered systems showed that NiO enhances PMA in addition to inducing EB. Therefore, here we focus in NiO/Co/NiO systems to quantify the separate role of NiO on the PMA enhancement [2]. In this system PMA is observed up to Co thicknesses of 1 nm together with a large EB field (H_{EB} = 300 Oe). This indicates strong EB coupling between both interfaces, NiO/Co and Co/NiO. Moreover, we found that the perpendicular effective anisotropy is strengthened by a strong surface contribution equal to ($K_S^{NiO/Co}$+$K_S^{Co/NiO}$) = 0.76 mJ/m^2. These results show that Co layers sandwiched between NiO layers can be attractive for applications due to the additive interfacial contributions of both: EB and PMA.

Keywords: exchange bias effect, thin layers, perpendicular magnetic anisotropy, magnetic properties

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POSTER PRESENTATIONS

CONTACT ANGLE MEASUREMENTS FOR THE SURFACE CHARACTERISTICS OF CONDUCTIVE MATERIALS

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Modification of the surface of conductive materials with organic molecules creates opportunities for obtaining new sensors and biosensors used in many areas of life, and also allows tracking of interactions of biomolecules using electrochemical techniques. The properties of the newly obtained sensory layers should not only be the same as the molecules in the ground state, but also should have the ability to transmit the signal resulting from the analyte detection process.

The characteristics of the obtained surfaces allow both to confirm the effectiveness of the modification process itself as well as to determine the properties of the obtained layer. For this purpose, many physicochemical methods are used, including methods that are the latest in material analysis. Wettability is a measure of the liquid's interaction with a solid – the ability of a liquid to maintain contact with a hard surface. This parameter determines the degree of hydrophilicity or the hydrophobicity of a surface [1, 2].

In the presented studies, the surface of different electrodes (e.g. gold, glassy carbon, FTO, ITO, BDD) were characterized by measurements of the contact angle. Their wettability, hydrophobicity/hydrofilicity and surface free energy will be discussed in aspect of their electrochemical properties.

Keywords: contact angle, conductive material, modification, surface

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DZYALOSHINSKII-MORIYA INTERACTION IN BILAYERS WITH PERPENDICULAR MAGNETIC ANISOTROPY

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Dzyaloshinskii-Moriya interaction (DMI) is of large interest in magnonics due to its nonreciprocal character. Its stronger variant appears at the interfaces of ultrathin ferromagnetic layer with heavy metal. Additionally, in the case of these thin films also perpendicular magnetic anisotropy can play significant role and can lead to change of the spin wave propagation and even the magnetization direction.

We studied experimentally multilayers composed of Pt/Co/W and Pt/Co/Ta/Co/Pt using Brillouin light scattering method and magneto-optical Kerr effect microscopy to analyze the magnetization configuration and dispersion relation. In Pt/Co/W structures with Co layer thickness under 2 nm we observe out-of-plane magnetization in the absence of the external magnetic field. Dispersion relations show linear dependences around zero wavevector with the slope resulting from DMI. In Pt/Co/Ta/Co/Pt multilayer, reversed alignment of Co/Pt bilayers leads to opposite sign of DMI parameter. Numerical analysis shows, that in all structures the spin wave frequencies are significantly decreased due to the perpendicular magnetic anisotropy and the DMI parameter reaches 1 mJ/m^2.

Keywords: magnonics, thin film, anisotropy

This study was partially supported by National Science Center of Poland project Metasel UMO-2015/17/B/ST3/00118.

FUNCTIONALIZED NANOPARTICLES AS TOOLS IN ANTI-CANCER TREATMENT

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Background

Traditional cancer treatment is based mainly on the use of chemotherapeutics that are characterized by a high efficiency. However, these drugs may cause many side effects because they are distributed throughout the whole body and only a small part of them reach the place affected by the disease. Therefore, many studies are conducted on the development of new methods of the delivery of such chemotherapeutics directly to the desired place. Magnetic nanoparticles seem to be an interesting carrier due to the possibility of their targeting using an external magnetic field.

Methods

In the studies magnetic nanoparticles with functionalized surface were synthesized by two-step method involving Massart synthesis and the functionalization of obtained particles. Next, prepared nanomaterials were subjected to the toxicity analyses such as MTT reduction assay and the assessment of pro-inflammatory activity.

Results

According to the ISO standards, materials that do not induce the cytotoxicity higher than 30% may be considered as non-cytotoxic ones. Based on the analysis it can be said that prepared nanomaterials did not exhibit cytotoxicity towards tested cell lines (L929 murine fibroblasts). Furthermore, analyzed nanomaterials did not show pro-inflammatory activity.

Conclusions

Nanoparticles due to their functionalized surface which enables to combine with specific drugs as well as to the possibility of their targeting by an external

magnetic field may be considered as potential carriers for chemotherapeutics. Moreover, obtained nanomaterials did not exhibit neither cytotoxicity to tested cell lines nor pro-inflammatory activity.

SYNTHESIS OF PEDOT/LIGNIN COMPOSITE USED FOR THE DETERMINATION OF ENVIRONMENTAL POLLUTANTS

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In recent years, electroconducting polymers have attracted increasing attention of the scientific community. Similarly, growing interest has been found in the field of biopolymers due to their various advantages like biodegradation or biocompatibility. Lignin, which is the third biopolymer (after cellulose and hemicellulose) in the world by mass, has found many aplications due its unique properties resulting from high functional group content [1]. The combination of these two polymeric compounds can be used in supercapacitors [2] and batteries [3].

The main aim of this study is to produce a highly adsorptive PEDOT/lignin composite film on a stainless steel carrier with the use of electrochemical polymerisation. Sorptive properties of the synthesized material were tested for six endocrine disruptive compounds: bisphenol A and five of its potential substitutes bisphenol S, bisphenol F, bisphenol AF, bisphenol E and bisphenol B.

Optimalization process was performed using standard solutions of bisphenols to test whether there is a possibility to use the new sorbent in solid-phase microextraction. It was found that the PEDOT/lignin composite has higher sorption of bisphenols than the PEDOT itself. The high recovery of analytes from environmental samples has also been confirmed except for the most polar bisphenol S. Analysis of environmental samples revield the presence of

BPA and BPS in all tested river water samples while other bisphenols have not been detected.

Keywords: bisphenol, PEDOT/lignin, monitoring, EDC

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SYNTHESIS, STRUCTURE AND PHYSICAL PROPERTIES OF NEW INTERMETALLIC COMPOUNDS RE_2PdGe_3 (RE=Tb and Dy)

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New intermetallic compounds $Tb_2Pd_{1.25}Ge_{2.75}$ and $Dy_2Pd_{1.25}Ge_{2.75}$ have been synthesized using the arc-melting method. The crystallographic, magnetic, electronic transport and thermal properties are reported. The crystal structure obtained from powder X-ray diffraction analysis suggests that these compounds crystallize in the AlB_2-type structure in a space group P6/mmm (191) with the lattice parameters a = 4.22853(5) / 4.23054 (2) Å and c = 3.94225(9) / 3.94552(5) Å for a compound with Tb and Dy respectively. The ac and dc magnetic susceptibility studies reveal spin-glass behavior, with freezing temperature T_f = 10.5 K for $Tb_2Pd_{1.25}Ge_{2.75}$ and 4.5 K for $Dy_2Pd_{1.25}Ge_{2.75}$. These data are in good agreement with the heat capacity measurements.

Keywords: spin-glass, intermetallic compounds, AlB_2-type structure

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ACTIVATION BARRIERS FOR CREATION AND ANNIHILATION OF MAGNETIC DROPLET SOLITONS

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Droplet solitons are magnetization fluctuations that preserve their shape as they precess with uniform frequency ω=0. They satisfy a delicate balance between anisotropy and exchange interactions, and decay in the presence of dissipation. To prevent this, a spin polarized current σ can be applied via a nanocontact of radius ρ*. The magnitude of the current can be increased to induce switching between uniform precession at the ferromagnetic resonance frequency (ω = 1), and a stable precession at a frequency larger than the Zeeman frequency (ω = 0, in zero applied field).

In the absence of dissipation, conservative solitons of frequency ω_0 are described by a function $\Theta(\rho;\omega_0)$, where Θ is the angle of the magnetization with the easy axis and ρ is the distance to the center of the nanocontact[1].

We introduce an effective energy ξ that quantifies the work done (against damping and spin torque) to create a fluctuation of arbitrary shape Θ(ρ). We show that, for specific values of σ, some conservative soliton solutions are saddles of ξ. This allows us to calculate activation barriers Δξ between uniform precession at the ferromagnetic resonance and stable solitons. We present results of Δξ as a function of σ for a variety of nanocontact radii ρ* and spin-torque anisotropy parameters ν.

Keywords: Magnetic Droplet Soliton, Thermal Stability, Spin Torque Oscillator, Nanocontact

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SUPERCONDUCTING AND MAGNETIC PROPERTIES OF THE Ir – RICH COMPOUNDS MIr_3 (M=Ce, Th and Nd)

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Intermetallic compounds based on rare-earth (*RE*) and transition metals (*T*) have been and still remain of considerable interest in many fundamental and industrial studies. Ir-containing materials are particularly interesting, since their electronic properties are often dominated by strong spin–orbit coupling (SOC).

Recently we have synthesized and studied $CeIr_3$, $NdIr_3$ and $ThIr_3$, binary intermetallic compounds that are members of the $RE_{2m+n}T_{4m+5n}$ family (m, n > 0), where *RE* stands for an early rare earth metal and *T* is a transition metal. The bulk nature of the superconducting transitions for $CeIr_3$ and $ThIr_3$ are evident from the visible anomalies at T_c = 2.5 K and 4.4 K, respectively. The heat capacity experiment revealed that $CeIr_3$ is a weak-coupling BCS superconductor ($\lambda_{e\text{-}p}$= 0.65 and $\Delta C/\gamma T_c$ = 1.24) and $ThIr_3$ is a moderately coupled type-II superconductor ($\lambda_{e\text{-}p}$= 0.74 and $\Delta C/\gamma T_c$ = 1.45). Theoretical calculations indicate a multi-band character for the Fermi surfaces, with the dominating contribution to the density of states at the Fermi level coming from the 5*d* states of Ir.

In the case of $NdIr_3$, our measurements indicate a ferromagnetic ground state with the Curie temperature T_C = 10.6 K. The heat-capacity anomaly at T_C confirms the bulk nature of the transition, though ΔC_p = 11.7 J $mol^{-1}K^{-1}$ is lower than expected for J = 9/2 and instead close to that of a J = 1/2 system. This suggests that the Nd ions are subject to a crystalline electrical

field that removes spin degeneracy and leaves the Nd ions in a doublet ground state.

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CHARACTERIZATION AND LIPOSOMAL FORMULATION OF PHOTOCHROMIC SURFACTANTS

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Azobenzene and its derivatives are widely used in designing light-responsive materials for applications ranging from photonics to biotechnology. Surfactants based on azobenzene moiety are promising materials that can be used in photosensitive drug delivery systems [1]. Azobenzenes undergo a clean photophysical and reversible *trans-cis-trans* isomerization upon which the molecules exhibit large spectral and geometrical changes [2]. The kinetics of the process depends on substituents as well as the molecular environment.

In the present work, we investigated the photochromia in a series of surfactants containing azobenzene group in their structure. The isomerization reaction rate constants were determined based on spectroscopic studies. The presentation will show how azobenzene derivatives can be used to remotely (by light) control the surface tension. We verified the possibility of producing liposomes with the participation of the photochromic surfactants. The kinetics

of the photochromic reaction in azosurfactants in liposomal formulation was also examined. Moreover, the effect of photochromic surfactant concentration on the size of liposomes was investigated.

Keywords: azobenzene derivatives, isomerization, light-responsive materials

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STIMULATED EMISSION MICROSCOPY – A VERSATILE TOOL FOR ULTRAFAST NANOSCOPY

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The majority of spectroscopic techniques used to study nano-samples and single quantum emitters rely on spontaneous emission. Spontaneous emission, however, is typically slow, occurring on a nanosecond time scale. Consequently, it does not allow for ultrafast time-resolved probing of the excited state dynamics, which occur on femto to picosecond time scales. We demonstrate that femtosecond detection of stimulated emission can be successfully used for imaging and probing the excited state dynamics in individual CdSe/CdS quantum dots. In our experiments simultaneous

detection of the time-dependent PL and SE signals give direct access to the exciton relaxation time, which for the studied quantum dots amounts to 500 fs. Our spectrally resolved excitation-detection scheme allows us to directly disentangle the ground state depletion and stimulated emission processes.

Based on stimulated emission rather than spontaneous emission this microscopy approach holds a great potential for imaging and studying ultrafast processes in non-fluorescent or weakly fluorescent systems. The presented ultrafast detection scheme is a coherent variant of the commonly used transient absorption and as such it opens up a range of interesting experiments on charge dynamics, coherent effects and nanolasing.

Keywords: stimulated emission, ultrafast microscopy, quantum dots

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PHONONS' AND MAGNONS' STUDY IN $[Ni_{80}Fe_{20}/Au/Co/Au]_{10}$ MULTILAYERS

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The properties of surface acoustic waves and spin waves propagating in magnetic $[Ni_{80}Fe_{20}/Au/Co/Au]_{10}$ multilayers on silicon substrate have been investigated by high resolution Brillouin spectroscopy. The behavior of spin waves was studied in two experimental geometries: Backward Volume (BV) geometry and Damon-Eshbach (DE) geometry. The thickness of cobalt (Co) layer was different for each sample and the influence of the layer's thickness

on the dispersion relation has been tested. The samples were decorated with non-magnetic aluminum (Al) periodic structures. The crossing of phonon and magnon dispersion relations has also been examined. Additionally, the theoretical dispersion dependences have been obtained from simulations performed with finite element method.

Keywords: BLS, phonons, magnons

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This study was partially supported by National Science Centre of Poland Grant No. UMO-2016/21/B/ST3/00452.

Au/Ag NANOALLOY AS PROMISING MATERIAL FOR PLASMONIC APPLICATION

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For several years now, much attention has been paid for plasmonic platforms synthesis. Exceptional optical properties induced by localized surface plasmons in metallic nanoparticles yield a wide range of applications in various fields. Well known candidates for plasmonic platform purpose ie. gold and silver are thoroughly researched. In recent years however, increasing interest in tuning optical properties is being observed. One of ways to achieve great tunability possibilities is mixing together those metals to achieve nanoalloys.

In the present work, results of Au/Ag plasmonic platforms synthesis control are being presented. Nanoislands were fabricated through dewetting of Au/Ag thin layers using thermal treatment with temperatures well below theirs melting temperature. Achievement of platforms in a possibly most controllable way required investigation of optical properties dependence on initial film thickness and temperature of annealing. Optical parameters were analyzed using UV-Vis spectroscopy, while surface morphology was investigated by means of SEM and TEM. Basing on plasmon resonance position and intensity, the influence of fabrication parameters on their optical parameters was assessed.

Keywords: dewetting, nanoalloys, plasmonic platforms

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VIBRATIONAL PROPERTIES OF SINGLE CRYSTALLINE FILM OF PEROVSKITE

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The interest of the materials for scintillation technology stimulates a search for new generation of high light yield scintillators. Among other the single crystalline films (SCF) of perovskites synthesized by the liquid phase epitaxy method (LPE) are very promising. The crystalline layers obtained by the LPE method have much less structural defects arising in the crystallization proces as compared to single crystals (SC) obtained using the Czochralskimethod [1–3].

In this paper we present Raman spectroscopy study of Ce^{3+} doped $YAlO_3$ (YAP) and Eu^{3+} doped $GdAlO_3$ (GdAP) SCFs grown onto YAP substrate. The evolution of Raman spectra recored for particular parts of the cross-section of the sample allows a distinction between SCF and the substrate and furthermore allows the indefication of a transition layer between SCF and the YAP substrate.

Keywords: Raman spectroscopy, perovskites, single crystalline films

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CHARACTERIZATION OF SELF-ASSEMBLED MONOLAYERS OF ORGANIC THIOLS ON THE SURFACE OF GaSb

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In here we report a creation of self-assembled monolayer of organic thiols on the surface of gallium antimonide (GaSb). GaSb is a semiconducting compound that is well recognized for its application in novel photonic devices, especially in a manufacturing of an infrared superlattice photodetectors. The thiolated coating on the surface of the GaSb acts as a passivation layer, and is

supposed to protect the face of GaSb from external factors. It has also been reported that the passivation layer reduces the surface states density and thus it improves the performance of a GaSb detector [1,2].

The presence of the passivation layer was confirmed and characterized by a comparison of Raman spectra of a reference GaSb surface, an organic thiol sample and the passivated GaSb.

Keywords: modern materials, passivation, organic thiols, Raman spectroscopy

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SOL-GEL METHOD AS AN ECONOMICAL METHOD FOR ACHIEVING ZnO-BASED MATERIALS FOR OPTOELECTRONICS

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The research focused on finding the economical materials for modern electronics seems to be one of the main goals for material science. Due to their wide bang gap, II-IV compounds seem to be applicable in innovative electronics [1]. One of them is zinc oxide (ZnO). ZnO exhibits wide band gap around 3.3 eV (which occurs at crystallization to wurtzite-type structure), high conductivity and low optical absorbance [2]. As grown, ZnO shows n-type conductivity, nevertheless thin film deposition techniques allow p- and n-type doping [3].

The main goal of the presentation is to introduce the developed method of ZnO thin films growth with sol gel technique, which was chosen due to reducing production costs. The obtained research focused on the influence of thin layers growth in different conditions on their structural and optoelectronical properties using microscopic and spectroscopic studies.

Keywords: zinc oxide, sol gel, spectroscopic studies

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SYNTHESIS OF NANOPOROUS ALUMINUM OXIDE MEMBRANES – OPTIMIZATION OF THE CATHODIC DELAMINATION PROCESS

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The synthesis of bilaterally opened aluminum oxide membranes includes, among others, processes such as: anodization [1], cathodic delamination [1], and chemical etching [1]. Two-step anodization is performed in order to obtain highly-ordered nanoporous Al_2O_3 layers. Further, cathodic delamination and subsequent chemical etching results in the formation of through-hole Al_2O_3 membranes. Since the possibility of fabrication of porous alumina templates on both sides of Al substrate seems to be especially attractive, a double-sided cathode delamination would be an innovative approach for the large-scale synthesis of nanoporous Al_2O_3 membranes. This method is characterized

by its simplicity and low costs and allows the formation of good quality membranes. In addition, unlike analogous methods such as the potential shock method, the reagents used are environmentally friendly. The conditions of the delamination process have not been sufficiently well characterized in the available literature. Therefore, an attempt was made to optimize two factors – the temperature and the degree of electrolyte usage. To illustrate the morphology of obtained membranes, a field-emission scanning electron microscope (FE-SEM) was used. The pore diameter of Al_2O_3 was estimated using ImageJ software [2].

Keywords: nanporous aluminium oxicde, anodization, catodic delamination

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NANOCRYSTALLINE DIAMOND SHEET AS A COATING FOR OPTICAL FIBER END-FACE

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Interferometric sensors applying optical fibers are widely used in many fields of science and industry [1]. The proper protection of the optical fiber end-faces can further extend possibilities of their use due to better resistance to mechanical and chemical damage, and prolonged lifespan. Hence the need for new materials sufficient as coatings for fiber-optic end-faces. In this work we

present the application of a new material – nanocrystalline diamond sheet – as a coating of optical fibers. The samples were produced in the Microwave Plasma Assisted Chemical Vapor Deposition System [2]. A method of sample deposition, its characterization, technique of transferring it onto the fiber end-face and the sensors' response are presented in this work. The measurement setup is built as a Fabry-Perot interferometer using a broadband light source, an optical spectrum analyzer, an optical coupler and optical-fibers.

Keywords: optical fiber, nanocrystalline diamond sheet, interferometric sensor

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FIBER-OPTIC REFRACTIVE INDEX MICROSPHERE-BASED SENSORS COATED WITH ZnO ALD

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In this paper, application of fiber-optic microsphere with Zinc Oxide (ZnO) coating as a sensor is investigated [1]. Presented microsphere, of approximately 240 µm in diameter, was fabricated on single-mode optical fibers via optical fiber tapering method. The distance between the end of the fiber core and

the outer surface of the microsphere serves as a cavity of fixed length. ZnO coating was deposited on the fabricated microspheres by Atomic Layer Deposition (ALD) [2]. Theoretical modelling was performed to asses validity of the sensor. The device was examined using Scanning Electron Microscopy (SEM) and by low-coherent experimental setup operating in the reflective mode with a superluminescent diode used as a light source. Increased sensitivity of a refractive index can be achieved by applying ZnO ALD coating. Utilization of the microsphere-based sensor also allows to control integrity of its structure in real time.

Keywords: fiber-optic sensors, microsphere, Atomic Layer Deposition, refractive index

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DS Programs of the Faculty of Electronics, Telecommunications and Informatics of the Gdansk University of Technology.

ELECTROCHEMICAL PERFORMANCE OF 1,4-DIAMINO-9,10-ANTHRAQUINONE FUNCTIONALIZED PHOSPHORENE

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Two-dimensional (2D) materials have ignited attention due to their a promising optical, electrochemical and mechanical properties in comparison to their counterparts with diverse dimensionality[1]. Phosphorene is one of the representatives of 2D materials, exhibits anisotropy, which is intrinsic for its high carrier mobility, mechanical, thermoelectric and optical properties [2]. In addition, phosphorene has been demonstrated good biocompatibility [3].

Unfortunately, a linker such as anthraquinone derivatives is needed to combine the phosphorene with biomolecules.

In this work, phosphorene have been prepared by liquid exfoliation with functionalization by 1,4-diamino-9,10-anthraquinone at the same time.

The electrochemical properties of functionalized phosphorene electrode were investigated by cyclic voltammetry. Additionally the electrodes were characterized by scanning electron microscopy and X-ray photoelectron spectroscopy (XPS).

Keywords: phosphorene, liquid exfoliation, linker

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INFLUENCE OF POLYMER INCLUSIVE MEMBRANE (PIM) THICKNESS ON THE TRANSPORT OF COPPER AND COBALT IONS

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The recovery of metal ions is important for industries such as: hydrometallurgy, biotechnology, wastewater treatment and others. The innovative solution in this cases is the use of polymer inclusion membranes (PIM) . The extraction of metals by PIM can be a good alternative to solvent extraction and bulk liquid membranes. This process is characterized by low consumption of toxic

solvent, and thus reduces the harmfulness of the process to the environment. In addition, the PIM process is characterized by the use of small amounts of the extractant [1–2].

PIM's are made by mixing a solution containing an extractant, a plasticizer and a base polymer such as, e.g., cellulose triacetate (CTA). The volume ratio of the CTA base polymer to the ONPOE plasticizer and the 1-alkyl-1,2,4-triazole carrier were 6:2:2; 5.25:1.75:1.75; 4.5:1.5:1.5; 3.75:1.25:1.25; 3:1:1 v/v. The resulting membrane was weighed and its thickness was measured with an accuracy of 0.1 µm (PosiTector, DeFelsko, USA).

The transport of copper (II) ions and the transport of cobalt ions (II) through the PIM membrane were investigated depending on the thickness of the membrane.

Keywords: polymer inclusive membrane (PIM), copper ions, cobalt ions, thickness of the membrane

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SINGLE CRYSTAL GROWTH AND HOMOEPITAXIAL GROWTH OF ß-Ga_2O_3: NUMERICAL CALCULATIONS

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ß-Ga_2O_3 is a transparent semiconducting oxide (TSO) with a wide energy gap of about 4.85 eV. Therefore, it is a promising candidate for high power electronics.

At IKZ single crystals are grown from melt using the Czochralski method [1]. The thermoelastic stress field is of great interest because of the cleavage planes, giving rise to cracking during growth.

We developed a comprehensive modelling strategy to finally compute the stress in the crystal [2]: it starts with an axisymmetric heat transport analysis of the entire furnace and proceeds with a 3D heat transport and fluid flow computation in the central part of the furnace by using the results of the first step as boundary conditions. Finally a 3D calculation of the thermal stress is performed for the crystal.

The wafers of the grown single crystals are used as substrates for performing homoepitaxial growth using MOVPE [3]. For a better understanding of the growth kinetics we have performed kinetic Monte Carlo (KMC) computations. The KMC programme was especially developed to incorporate the details of the adsorption, diffusion, and desorption on the (100) plane. Results from transmission electron microscope (TEM) investigations have been used for set up the basic dynamics in KMC.

Keywords: Crystal Growth, Epitaxy, Numerical Simulation

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1
MTK

SCIENTIFIC SESSION

BIG SCIENTIFIC FACILITIES

PLENARY LECTURE

Prof. **STEFAN EISEBITT**
Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy

Seeing Ultrafast Processes in Magnetic Materials – Combining Unique Capabilities of Large X-ray Facilities and Experiments "at home"

Tailoring magnetic materials on the nanometer lengthscale has led to many applications, continuously allows to observe further novel physical effects and thus also holds promise for further advanced applications in the future, e.g. in the areas of data storage and processing. An understanding of the dynamics of the elementary processes is crucial in this context – this implies the observation of processes as fast as a few femtoseconds in complex nanostructured systems made up from many constituent elements.

Large scale x-ray facilities – namely synchrotron radiation sources and free electron x-ray lasers – offer unique pulse parameters to study problems in femto- and nanomagnetism. They are, however, not "unbeatable" and for particular requirements, experiments with lasers pulses or soft x-rays generated by lasers can outperform the large scale facilities – with convenient regular access in the home lab. In fact, the combination of both approaches leads to significant added value for both types of experiments, allowing for better prepared experiments and a more complete view on the particular object of study.

I will discuss the possibilities and demonstrate the synergy in this combined approach, discussing nanometer sized magnetic skyrmions and their manipulation with current pulses [1–3] as well as the ultrafast manipulation of magnetic order with light [4–6], both processes which are currently primarily of fundamental interest but exhibiting potential for future applications in data storage.

Keywords: magnetic skyrmion, ultrafast magnetism, optical switching, data storage

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Prof. STEFAN EISEBITT is a Director at the Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy in Berlin, Germany and a Professor at the Technische Universität Berlin. His main research interests are transient phenomena in solids on ultrashort temporal and nanometer spatial scale, such as the manipulation of magnetic spin textures by current, spin or laser pulses. In his work, he combines time resolved spectroscopy, scattering and imaging using in particular coherent soft x-rays in combination with short laser pulses. Regarding the session topic "big scientific facilities", Stefan Eisebitt has pioneered the use of resonant as well as time-resolved x-ray holography at synchrotron radiation sources and free electron x-ray lasers for the use in solid state physics. He has been the chairman of the scientific advisory board of the European XFEL, is a member of advisory bodies of several large scale x-ray facilities and has represented the German synchrotron radiation community as the former chairman of the Committee Research with Synchrotron Radiation.

A full CV and publication information can be found at https://mbi-berlin.de/contact.

INVITED TALK

Prof. **PAWEŁ OLKO**
Institute of Nuclear Physics PAS

"Trans-National Access to modern scientific facility – Cyclotron Centre Bronowice"

Trans National Access (TNA) is free of charge access to a Research Infrastructure to selected researchers or research teams having no access to such an infrastructure in their own country. This includes free use of the facilities as well as administrative, logistical, technical and scientific support. The TNA programme of European Union also covers travel, subsistence and local accommodation costs within available budget.

Cyclotron Centre Bronowice is a modern, technologically up-to-date research and proton therapy facility at the Institute of Nuclear Physics with 230 MeV isochronous cyclotron, three modern treatments room for proton therapy, experimental room and laboratories for preparation and handling of experiments including radiobiological experiments. At the experimental room a set of detectors and reaction chambers is installed which is used for broad range of experiments in nuclear physics.

Since start of operation in 2014 in CCB experiments for 25 Polish and 19 international research projects were performed in which 39 European research institutions were involved. 264 scientists used the facility for their research. Since 2016 in cooperation with medical partners about 300 cancer patients were treated with proton radiotherapy. Within two running Horizon 2020 projects (INfraStructure in Proton International REsearch – INSPIRE, European Nuclear Science and Applications Research – ENSAR2) scientists from abroad have now free access to the entire facility. CCB is currently the one of the most frequently used Polish research facility in the European Research Area.

Keywords: Trans National Access (TNA), cyclotron, proton therapy, nuclear physics

INVITED TALK

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Prof. PAWEL OLKO is a Polish physicist, active in the field of proton radiotherapy, medical physics, dosimetry and microdosimetry. He is Professor of Physics at the Institute of Nuclear Physics Polish Academy of Sciences and the Head of Division of Applied Physics in this institute.

He was graduated in physics from AGH University of Science and Technology, Krakow, Poland. He was a fellow (1986–1989) at the Institute for Medicine Nuclear Research Centre KFA Juelich, Germany, received his Ph.D. in physics from the Institute of Nuclear Physics Krakow in 1990, habilitation in 2003 and the Polish state professorship title in 2010. In 1998–1999 he worked at the International Atomic Energy Agency in Vienna. Between 2005 and 2016 he was a scientific director at the Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN) and between 2012 and 2016 the director of the Bronowice Cyclotron Centre, the first proton therapy center in Poland.

He is involved in activities of numerous national and international committees and organizations: council member of the European Radiation Dosimetry Group EURADOS, expert of European Commission at Luxemburg, commisioner of the International Commission of Radiation Measurements and Units, ICRU and the member of the advisory committee of the European Network for Light Ion Hadron Therapy, ENLIGHT.

XAS, XLD AND XMCD STUDIES OF MAGNETIC Co/Mo LAYERED STRUCTURES

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Structural features, responsible for magnetic anisotropy, and induced magnetic moment at the atoms of nonmagnetic spacer in Co/Mo layered structures are investigated by means of synchrotron techniques: absorption spectroscopy (XAS), linear dichroism (XLD) and magnetic circular dichroism (XMCD).

Spin reorientation transition (SRT) from in-plane to perpendicular alignment, observed with the thickness increase of a Co layer, d_{Co}, depends on a type of adjacent bottom and top covers, e.g. Au or Mo. Particularly, the Co layer grown on the Mo(110) surface exhibits lower critical thickness d_{SRT} in comparison to Au(111) buffer. It results not only from different chemical profile of the interfaces but also from the epitaxial relations determined by the misfit of crystallographic symmetry and the lattice constants. Combined structural analysis of the Co layer deposited on the Mo buffer by reflection high energy electron diffraction RHEED, XLD and XAS shows that in the initial stage the growth of the Co film is pseudomorphic, which induces strong anisotropic in-plane strains as high as 25% [1]. These strains are responsible for additional in-plane two-fold magnetic anisotropy with well distinguished easy (EA) and hard (HA) axes. With increase in the Co layer thickness, an abrupt lattice relaxation and evolution from metastable fcc to bulk-like hcp structure are observed. On the contrary, the Co layer grown on Au buffer is isotropic in the plane due to the same symmetry. The strains induced by the 14% lattice mismatch slowly relax across the magnetic layer thickness.

Co/Mo multilayers in the range of Mo spacer thickness 0.5 nm < d_{Mo} < 1.0 nm exhibit strong antiferromagnetic (AF) magnetization coupling of individual Co layers [2]. Moreover, XMCD measurements evidence induced magnetic moment at Mo atoms due to proximity effect. This moment is observed in the AF-coupled multilayers (m_S = -0.03 μ_B). However it is much weaker than that for the reference $Co_{96}Mo_4$ alloy (m_S = -0.21 μ_B). Observed suppression may suggest antiparallel alignment of the induced moments expanding across atomic layers of the Mo spacer by analogy to Fe/W system [3]. In the context of relatively strong interlayer coupling with simultaneous weak low magnetoresistance, the exchange interaction across the Mo spacer is considered as a mechanism responsible for AF coupling enhancing usually accepted Ruderman–Kittel–Kasuya–Yosida (RKKY) interaction.

Keywords: synchrotron techniques, magnetic anisotropy, interlayer magnetic coupling, induced magnetic moment

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SYNCHROTRON TOMOGRAPHY STUDIES OF ADVANCED POROUS ALLOYS FOR ENERGY CONVERSION

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Advanced porous alloys find use in important energy conversion technologies, e.g. high temperature fuel cells or filters. During work at high temperatures,

thermodynamically stable oxide scale forms on the surface of the alloy particles, changing the porosity and gas pathways. At high temperatures, e.g. > 700°C the oxide formation can completely block the gas channels even after relatively short exposures (~100 hours).

In order to understand structural and morphology changes in the porous alloys during oxidation, especiallly to visualize gas channels, it is necessary to perform studies providing information in three dimensions, which can be achieved by means of tomography. High intensity monochromatic light available at synchrotrons offers the possibility to not only visualize in 3D the porosity and gas pathways, but also to distinguish between the metallic and oxide phases, which allows for high quality observation of the sample microstructure and calculation of respective phases content.

Keywords: porous alloy; tomography; high temperature corrosion;

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MAGNETIC PROPERTIES OF DIFFERENT ULTRATHIN FILMS STUDIED BY SYNCHROTRON RADIATION

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Great interest in magnetic thin films with perpendicular magnetic anisotropy (PMA) is caused by development of novel spintronic devices, where PMA is strongly required, e.g. for data storage and information processing. We found that Ga^+ ion irradiation drives both vanishing and creation of PMA in ultrathin Pt/Co/Pt trilayers [1, 2]. PMA in such system strongly depends on proper choice of Co thickness and Ga ions fluence. Additionally, this effect can be tuned by capping layer – Au instead of Pt modify strength of PMA induced by ion irradiation. To study the possible mechanism responsible for observed magnetic changes, the X-ray absorption spectra and X-ray magnetic circular dichroism (XMCD) on K and L edges were performed on ion irradiated samples. However, when Co layer is surrounded by Au and NiO layers, the system shows not only the PMA but also Dzyaloshinskii-Moriya interaction [3], which is crucial for novel application based on skyrmions (nanometric chiral spin structure) as a medium for data recording. Observation of such small objects can be performed by XMCD-PEEM technique. Such measurements were performed to show the evolution of magnetic domain structure as a function of temperature in Au/Co/NiO trilayers – increasing temperature (approaching to Neel temperature of NiO layer) the magnetic anisotropy decreasing favoring formation of skyrmion-like domains.

Keywords: ultrathin films, XMCD/PEEM, magnetic anizotropy

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UARPES – HIGH RESOLUTION PHOTOELECTRON SPECTROSCOPY BEAMLINE AT NSRC SOLARIS

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Angle-Resolved Photoelectron Spectroscopy (ARPES) technique allows for measurements of fundamental quantities, i.e. energy and momentum, describing a photoelectrons states outside of a solid sample. From this one can deduce the band (electronic) structure of the solid *E(k)*. The knowledge about the band structure is nowadays extensively employed for tailoring of functional materials and heterostructures for quantum-, opto-, spin- and magneto- electronic devices.

The beamline name UARPES arises by adding the letter *U* standing for *Ultra* to the usual acronym ARPES to indicate that the research installation is constructed for the efficient angle resolved photoelectron spectroscopy studies with the ultimate energy and angular resolution. Due to wide photon energy range and the full control over the UV beam polarization it facilitates the measurements of the full 3D band structure, i.e. $E(k_x, k_y, k_z)$, identification of surface and bulk states, and studies of some particular electron states by their selective excitation.

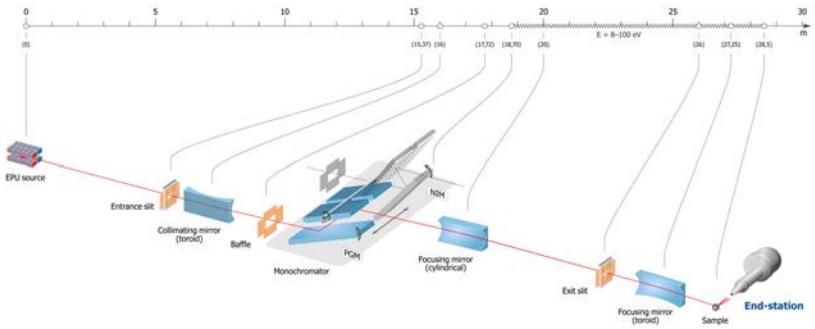

Figure 1. UARPES layout.

The UARPES installation has been designed to provide UV radiation in energy range 8-100 eV with photon flux on the sample > 5×10^{11} photons/s at full resolving power.

Description and basic parameters of the beamline can be found at: https://synchrotron.uj.edu.pl/en_GB/linie-badawcze/uarpes.

Keywords: APRES, photoemision, band structure, synchrotron

RESOLVING THE SPIN STRUCTURE OF ANTIFERROMAGNETS IN SOLARIS

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X-ray magnetic linear and circular dichroism (XMLD and XMCD) measurements performed at the XAS end-station in Polish synchrotron SOLARIS enabled us to follow the magnetic properties of epitaxial CoO(111)/Fe(110) and NiO(111)/Fe(110) bilayers. We find that in both studied cases FM sublayer plays a dominant role and determines the magnetic state of the neighboring AFM, however completely different interaction mechanisms are involved. In CoO/Fe bilayers the AFM spins are totally frozen although their orientation is imprinted by magnetization of Fe layer when the system passes the Neel temperature of CoO. Once the Fe layer gratfs the particular magnetic anisotropy (MA) into the CoO overlayer, it later remains frozen and insensitive to external factors like external magnetic field or Fe magnetization direction [1]. In contrast, for NiO/Fe bilayers we find that due to the weak intrinsic MA of NiO, the NiO spins are rotatable and always follow the reorientation of Fe magnetization that can be controlled by external magnetic field or via the temperature and thickness driven spin reorientation of Fe(110). In the case of

the temperature induced spin reorientation transition in Fe(110), it allowed us to implement all-temperature, zero-field switching of AFM moments in NiO/Fe bilayers.

Keywords: antifferomagnets, magnetic anisotropy, Polish synchrotron SOLARIS

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STABILITY OF SURFACE CRYSTALLOGRAPHIC STRUCTURE OF SINGLE CRYSTALS OF Bi_2Te_3 TOPOLOGICAL INSULATORS PROBED BY X-ray SPECTROSCOPY

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The best recognized feature of topological insulators (TI) is the existence of metallic states whenever the TI material breaks its continuity, e.g. on the surface. This results in the remarkable property: surface electrons cannot be back-scattered, i.e. they are robust against perturbations. This fact can be utilized in spintronic applications and in devices carrying quantum information where avoiding decoherence is of outmost importance. However, little is known about the influence of nanoengineering processes, namely ion etching and deposition of metal contacts, on the near-surface crystal structure, which is crucial in definition of the extraordinary electronic transport of TI.

Employing highly polarized beam of monochromatic X-rays delivered by synchrotron source local crystal structure can be probed with high precision. The technique of choice was X-ray Natural Linear Dichroism (XNLD) at Te *M*-edge – a variation of X-ray Absorption Spectroscopy (XAS). When probed with total electron yield detection it is sensitive to structural anizotropy of Te sites within few nanometer thick surface volume of Bi_2Te_3 single crystals. Measurements performed in-situ on crystals undergoing Ar etching and Au deposition reveal good structural stability of these materials.

Keywords: topological insulators, synchrotron radiation, XAS, XNLD

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- Przygotowujemy do prezentacji projektu w Brukseli
- Organizujemy warsztaty dotyczące ERC

KORZYSTAMY ZE WSPARCIA LAUREATÓW I PANELISTÓW ERC

- Pomagamy napisać dobry wniosek ERC
  Przesłane nam wnioski sprawdzamy pod kontem ich zgodności z zasadami ERC. Analizujemy zarówno ich strukturę, jak i obecność wszystkich elementów merytorycznych wymaganych przez panele oceniające. Pomagamy jak najkorzystniej przedstawić zarówno pomysł na projekt, jak i dorobek naukowy. Dopracowane wnioski, za zgodą kandydata, przesyłamy do specjalistów z poszczególnych dziedzin w celu weryfikacji CV oraz opisu naukowego.

- Rozwiązujemy problemy budżetowe i prawne
  Nasz zespół posiada wiedzę i doświadczenie w zakresie realizacji i rozliczania projektów finansowanych ze środków europejskich. Dzięki temu skutecznie wspieramy osoby piszące wnioski ERC w planowaniu budżetu oraz rozwiązywaniu problemów pojawiających się na styku prawa krajowego i zasad finansowych ERC.

- Udostępniamy przykładowe wnioski projektowe
  Zgromadziliśmy pokaźną bibliotekę wniosków o granty ERC, które możemy udostępniać do wglądu osobom przygotowującym własne projekty. Nasz zbiór obejmuje wnioski reprezentujące wszystkie grupy paneli i stale się powiększa.

- Przygotowujemy do prezentacji projektu w Brukseli
  Osoby, które startują w konkursach Starting ERC Grants oraz Consolidator ERC Grants i przeszły do drugiego etapu oceny proszone są o zaprezentowanie swojego projektu przed panelem oceniającym w Brukseli. Dla takich osób organizujemy próbne prezentacje z udziałem specjalistów z odpowiednich dziedzin, w tym laureatów i panelistów ERC.

- Organizujemy warsztaty dotyczące ERC
  Cyklicznie organizujemy dwa rodzaje warsztatów. Pierwsze to duże spotkania, na których zaproszeni laureaci i paneliści, a także osoby reprezentujące administrację instytucji osiągających znaczne sukcesy w pozyskiwaniu grantów ERC dzielą się swoimi doświadczeniami związanymi z ERC. Drugie to kameralne warsztaty „Wniosek ERC krok po kroku" obejmujące takie zagadnienia jak zespół w projektach ERC, struktura wniosku, profil laureata, proces ewaluacji, kwestie etyczne, budżet.

SOURCES OF PHOTOGRAPHY:

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POZNAN UNIVERSITY OF TECHNOLOGY "VOLANTES SONI" choir is an active continuator of the rich traditions of choral music in Poznań. It was formed in 1999 as the initiative of the Monika Kusz. Since 2005 the choir has been conducted by dr Paweł Łuczak, a professor of Ignacy Jan Paderewski Academy of Music. Since its beginnings it has been under patronage of PUT's Centre of Culture. The choir brings together talented students, graduates and young members of staff from PUT and other Poznań's schools and universities, all of them have one thing in common – a passion for singing. "Volantes Soni" performs during important events organised at Poznan University of Technology. The choir promotes the University at the same time enriching cultural life of Poznań by giving concerts at major scenes of the city.

The choir also takes part in numerous charity events in churches, hospitals, special needs schools and children's care homes and is also involved in their organisation.

Aleksandra Grzelak has been the conductor's assistant since 2016.

The choir often participates in numerous choral competitions and festivals both in Poland and Europe – in Czech Republic, Spain, Bulgaria, Macedonia, Northern Ireland or Italy – and they can boast with many prizes such as:

2018 First Prize on 8th National Choir Festival "Ars Liturgica" in Gniezno;

2017 Second Prize on Józef Świder's Second International Festival of Music in Cieszyn;

2017 First Prize on 23rd National Festival of Marine Song in Wejherowo;

2016 First Prize in the Academic Choirs category at the 2nd National Festival of Religious Song "Pater Noster" in Strzepcz;

2016 Special award for the best performance of the song "Pater Noster" at the 2nd National Festival of Religious Song "Pater Noster" in Strzepcz;

2015 Second Prize at the 4th National Competition Choirs in Aleksandrów Kujawski;

2014 First Prize at the 3rd National Festival of Song Marian "Ave Maria" in Chojnice;

2013 First Prize in the folk music category at the 3rd International Festival and Choir Competition „Canco Mediterrania" in Lloret de Mar in Spain;

2013 First Prize in the sacred music category at the 3rd International Festival and Choir Competition „Canco Mediterrania" in Lloret de Mar in Spain.

The patriotism of the conductor influences on the selection of the repertoire. It is dominated by compositions of local composers such as Andrzej Koszewski, Jacek Sykulski, Antoni Gref, Zbigniew Kozub, Marek Raczyński and Dominik Puk. In addition, the band reaches for compositions of other Polish composers. The choir›s repertoire also includes sacral music as well as versions of traditional folk and pop music. "Volantes Soni" takes up serious artistic challenges dealing with great vocal-instrumental forms such as „Misa Criolla" by Ariel Ramirez, „Quo vadis" by Feliks Nowowiejski, „Wesele lubelskie" by Tadeusz Szeligowski, "Requiem d-moll" by W.A. Mozart and performed in 2018 a premiere of Zbigniew Kozub's "Marian Hymns to the words of Roman Brandstaetter".