International Conference
Nanotechnology and Innovation in the Baltic Sea Region

Book of Abstracts
Book of Abstracts
of the International Conference

NANOTECHNOLOGY AND INNOVATION IN THE BALTIC SEA REGION

14-16 June 2017, Kaunas, Lithuania
Organizers:
The Mads Clausen Institute at University of Southern Denmark, Denmark (SDU)
North German Initiative Nanotechnology Schleswig-Holstein, Germany (NINa SH)
Kiel University, Germany (CAU)
Kaunas University of Technology, Lithuania (KTU)
Lithuanian Materials Research Society, Lithuania (LT-MRS)
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International Conference
Nanotechnology and Innovation in the Baltic Sea Region
Programme

14 June 2017, Wednesday
08:30 Registration
MOTIVATION DAY

Morning session:
Welcome
Chair: Prof. Franz Faupel

09:00-10:00 Prof. Asta Pundzieńė, Vice-rector for research and innovations, KTU (Lithuania)
Prof. Sigita Tasulevicius, Director, Institute of Materials Science, KTU (Lithuania)
Prof. Franz Faupel, Chair, Multicomponent Materials, CAU and NINa SH (Germany)
Prof. Horst-Günter Rubahn, Director, Mads Clausen Institute, SDU (Denmark)

Keynote speeches (invited speakers)
Chair: Prof. Franz Faupel

10:00-10:30 Prof. Eckhardt Quandt / Dr. Dirk Meyners, “Love Wave Magnetic Field Sensors”, Inorganic Functional Materials, CAU (Germany)

10:30-10:50 Coffee break

10:50-11:20 Dr. Emil Højlund-Nielsen, "Nanotechnology - There’s Plenty of Room in Established Markets", CEO Copenhagen Nanosystems (Denmark)

11:20-11:50 Prof. Arūnas Ramanavičius, "Conducting Polymers in Design of Sensors", Vilnius University (Lithuania)

11:50-13:00 Lunch

Afternoon session:
Parallel topical forum
Forum 1 (Section A): Thin Films, Coatings and Nanomaterials
Chair: Prof. Horst-Günter Rubahn

13:00-13:30 Assoc. Prof. Frank Balzer, "Phenylene and Squaraine Organic Thin Films: Polarization Optics and Aging", University of Southern Denmark (Denmark)

13:30-14:00 Dr. Mark Baker, "Thin Film Solar Cells for Large Area Space Applications", University of Surrey (UK)
14:00-14:30 Dr. Cenk Aktas, “Nanostructured Surfaces for Functional Applications”, CAU (Germany)

14:30-15:00 Coffee break

15:00-15:30 J. Purans¹, M. Zubkins¹, K. Pudzs¹, A. Vembris¹, A. Belajevs², A. Anzenovs², “R&D Multifunctional Cluster Tool for Vacuum Deposition Inorganic and organic Thin Films”, ¹Institute of Solid State Physics of University of Latvia (Latvia), ²Sidrabe Inc. (Latvia)

15:30-16:00 Prof. Väino Sammelselg, "Challenges of Nanotechnology for Metal Surfaces", University of Tartu (Estonia)

16:00-16:30 Dr. Tarmo Tamm, "Smart Responsive Nanomaterials and Systems", University of Tartu (Estonia)

Forum 2 (section B and C): Photonics and Nanotechnology/Nanomedicine
Chair: Prof. Sigitas Tamulevičius

13:00-13:30 Assoc. Prof. Vilma Petrikaitė, “Nanoparticles for Targeting Drug Delivery in Chemotherapy”, Lithuanian University of Health Sciences (Lithuania)

13:30-14:00 Prof. Jyrki Tapio Heinämäki, "Electrospun Medicated Nanofibrous Systems", University of Tartu (Estonia)

14:00-14:30 Assoc. Prof. Jonathan Brewer, "Nanoscopy as a Tool for Understanding Transdermal Drug Delivery", University of Southern Denmark (Denmark)

14:30-15:00 Coffee break

15:00-15:30 Dr. Joel Henzie, “Approaching Challenges in Optics Through the Lens of Colloidal Chemistry”, National Institute for Materials Science (NIMS) (Japan)

15:30-16:00 Dr. Rodrigo Sato, “Observation of Optical Bistability in Noble Metals”, National Institute for Materials Science (NIMS) (Japan)

16:00 Discussion round
Chairs: Sigitas Tamulevičius, Franz Faupel, Horst-Günter Rubahn

18:00 Welcome reception

15 June 2017, Thursday

08:30 Registration

INNOVATION DAY

Morning session:
Success stories from industry (contributed speakers)
Chair: Prof. Horst-Günter Rubahn

09:00-09:20 Dr. Linas Giniūnas, “Femtosecond Lasers for Surface and Volume Nano Modifications”, Light Conversion / UAB MGF
09:20-09:40  **Dr. Ala Cojocaru**, “Technology Transfer: from Laboratory to Industry”, FUMT R&D Functional Materials GmbH (Germany)

09:40-10:00  **Dr. Jörg Wiesmann**, “Innovative Products Feat. by Nanotechnology: How Ultra-Thin Multilayer Optics Are Changing Modern X-ray Analytics”, Incoatec GmbH (Germany)

10:00-10:20  **Dagmar Schneider**, “The Impact of Smart Surface Modifications on Cleaner Oceans: NANDATEC® CLEANS1”, CEO nandatec GmbH (Germany)

10:20-11:00  **Coffee break**

11:00-11:30  **Prof. Mohammed Es-Souni, IMST**, “Technology Aspects and Application Potentials of Supported Anisotropic Nanostructures”, University of Applied Sciences, Kiel (Germany)

11:30-11:50  **Evaldas Pabrėža**, “Don’t Call Me a “Surface Enhanced Raman Scattering Substrate”!”, JSC “Integrated Optics” (Lithuania)

11:50-12:10  **Gediminas Koryzna**, “Driving Innovation – We Have the Right DNA”, PE “Invest Lithuania” (Lithuania)

12:10-12:30  **Tomas Buzas**, “Breakthrough Technologies and Successful Business”, Kaunas Free Economic Zone (Lithuania)

12:30-12:45  **Dr. Artūras Mickus**, “Baltic TRAM Project – The New Tool To Strengthen the Relationship between Analytical Research Institutions and Business in BSR”, Kaunas Science and Technology Park (Lithuania)

12:45-13:30  **Lunch**

**Afternoon session:**

**Matchmaking**

Chair: Aivaras Knieža

13:30-14:45  Pitch talks from industry (1:1 talks)

*This part will be organized by European Enterprise Network represented by Kaunas Chamber of Commerce, Industry and Crafts.*

*The idea of this event is matchmaking based on Business, Technology and Research cooperation. In order to streamline the matchmaking process the additional platform for registration for the matchmaking will be opened.*

**Entrepreneurship forum**

Chair: Dr. Kęstutis Morkūnas
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<td>14:45-15:00</td>
<td><strong>Edgaras Leichteris</strong>, “Public Support Schemes for Effective Technology Transfer. How Enterprise Europe Network Can Help?”, Lithuanian Innovation Center (Lithuania)</td>
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<td>15:00-15:15</td>
<td><strong>Dr. Cenk Aktas</strong>, Entrepreneurship scene in Germany, CAU (Germany)</td>
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<td>15:15-15:30</td>
<td><strong>Frederik Gottlieb</strong>, “Bridging Entrepreneurship and Tech Innovation in Denmark - Educating the Tech Entrepreneurs of the Future”, Mads Clausen Institute, SDU (Denmark)</td>
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<td>15:30-16:15</td>
<td>Discussion forum on cross border (BSR) entrepreneurship</td>
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<td>16:15-16:30</td>
<td><strong>Coffee break</strong></td>
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<td>16:30-18:00</td>
<td>Poster session Chair: Assoc. Prof. Eglė Fataraitė-Urbonienė</td>
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<td>16:30-18:00</td>
<td>Workshop of Interreg Baltic Sea Region program project #R019 “Power Electronics for Green Energy Efficiency (Green PE)” organized by Kaunas Science and Technology Park</td>
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<td>Conference dinner (best poster award)</td>
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**16 June 2017, Friday**

**Morning session:**

*Chairs: Dr. Jacek Fiutowski, Dr. Tomas Tamulevičius*

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<td>09:15-09:30</td>
<td><strong>Adrien Chauvin, Jean Yves Mevellec, Bernard Humbert, Pierre Yves Tessier, Abdel-Aziz El Mel</strong>, “Synthesis of Nanoporous Gold for the Detection of Small Molecules”, Université de Nantes (France)</td>
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<td>09:30-09:45</td>
<td><strong>Agnese Brangule¹,², Karlis Agris Gross¹</strong>, “FTIR Spectroscopy for the Differentiation of Nanosized Calcium Phosphates”, ¹Riga Technical University, ²Riga Stradiņš University (Latvia)</td>
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<td>09:45-10:00</td>
<td><strong>Ramūnas Levinas¹, Natalija Tsyntsaru², Henrikas Cesiulis¹</strong>, “Electrodeposition of Molybdenum Sulfide for Hydrogen Evolution Reaction Catalysis”, ¹Vilnius University (Lithuania), ²Institute of Applied Physics of ASM (Moldova)</td>
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<td>10:00-10:15</td>
<td><strong>Hendrikje R. Neumann, Hannes Westerhaus, Michael Timmermann, C. Selhuber-Unkel</strong>, “Gold Nanodot Printing for Microsensor Surface Functionalization”, Christian-Albrechts University of Kiel (Germany)</td>
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10:15-10:30  W. Dawidowski¹, B. Ściana¹, I. Zborowska-Lindert¹, M. Badura¹, K. Bielak¹, D. Radziewicz¹, D. Pucicki¹, K. Żelazna¹, M. Mikolášek², M. Florovič², J. Kováč² and M. Tłaczała¹, “Application of Dilute Nitrides in Photovoltaics”, ¹Wrocław University of Science and Technology (Poland), ²Slovak University of Technology (Slovakia)

10:30-10:50  Coffee break

10:50-11:05  Mindaugas Juodėnas¹, Tomas Tamulevičius¹, Joel Henzie², Dainius Virganavičius¹, Svajūnas Korsakas¹, Sigitas Tamulevičius¹, “Laser Modification of Self-Assembled Nanocube Arrays”, ¹Kaunas University of Technology (Lithuania), ²International Center for Materials Nanoarchitectonics (WPI-MANA), National Institute for Materials Science (Japan)

11:05-11:20  Evelina Jaselske, Diana Adliene, “Free Standing Dose Gels: First Approach to Ionizing Radiation Based 3D Printing”, Kaunas University of Technology (Lithuania)

11:20-11:35  Regina Paszkiewicz, Bogdan Paszkiewicz, Marek Tłaczała, “AlGaN/GaN HEMT-Type Transducers for Gas- and Chem-Sensing Applications”, Wrocław University of Science and Technology (Poland)


11:50-12:05  Elżbieta Karolina Sobolewska¹, Leszek Jozefowski², Tomasz Kawalec², Till Leißner¹, Horst-Günter Rubahn¹, Jost Adam¹, Jacek Fiutowski¹, “Excitation of Surface Plasmon Polaritons by Fluorescent Light from Organic Nanofibers”, ¹University of Southern Denmark (Denmark), ²Jagiellonian University (Poland)

12:05  Short presentations from best poster award, poster session (open end)

13:00  Excursion

POSTERS


P2  Linas Samardokas, Remigijus Ivanauskas, “Formation and Optical Properties of Tl-M-Se (M = Ga, Cu, Ag) Layers on Polyamide
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<td>Darta Ubele, Karlis-Agris Gross</td>
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<td>Electrospun Nanofibrous Webs and Their Structure Estimation</td>
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<td>Anna Brudzisz, Agnieszka Brzózka, Karolina Gawlak, Grzegorz D. Sulka</td>
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<td>Formation of Periodic Nanostructures Using Lloyd’s Mirror Interferometer</td>
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<td>Lina Grinevičiūtė, Rytis Buzelis, Andrius Melninkaitis, Tomas Tolenis</td>
<td>Highly Resistant UV Waveplates Based on Nano-Structured Anisotropic Coatings</td>
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<td>Tomas Tolenis, Lina Grinevičiūtė, Andrius Melninkaitis, Rytis Buzelis, Lina Mažulė, Ramutis Drazdys</td>
<td>All-Silica Based Optical Coatings Produced by Tailoring the Porosity in Thin Films</td>
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P12 Brigita Abakevičienė¹, Mantas Lukauskas¹, Dalius Jucius¹, Algirdas Lazauskas¹, Viktoras Grigaliūnas¹, Mindaugas Gedvilas², Mantas Gaidys², Gediminas Račiukaitis², “Structural Properties of Temperature-UV Affected Fluorinated Ethylene Propylene Film”, ¹Kaunas University of Technology (Lithuania), ²Center for Physical Sciences and Technology (Lithuania)

P13 Eisuke Fujiwara, Hiroshi Fukudome, Ryohei Ishige, Shinji Ando, “Pressure Induced Changes in Aggregation Structures of Polyimide Films Probed by Florescence Spectra”, ¹Tokyo Institute of Technology (Japan)

P14 Erika Rajackaitė, Rimantas Gudaitis, Sigitas Tamulevičius, “Synthesis of Graphene by Microwave Plasma Enhanced Chemical Vapor Deposition”, Kaunas University of Technology (Lithuania)

P15 Lukas Ramalis, Justas Petrauskas, Asta Guobienė², “Formation and Analysis of Periodic Metalceramic Nanocomposite Structures”, Kaunas University of Technology (Lithuania)

P16 Tomas Tamulevičius¹, Lukas Stankevičius¹, Domantas Peckus¹, Mindaugas Juodėnas¹, Hongpan Rong², Joel Henzie², Sigitas Tamulevičius¹, “Excitation of Optomechanical Resonances in Monodisperse Plasmonic Nanocubes”, ¹Kaunas University of Technology (Lithuania), ²National Institute for Materials Science (Japan)

P17 A. V. Felsheruk, T. I. Makovskaya, A. L. Danilyuk, “Terahertz Surface Plasmons in Gated Graphene Heterostructure”, Belarusian State University of Informatics and Radioelectronics (Belarus)


P19 Mindaugas Juodėnas, Tomas Tamulevičius, Linas Šimatonis, Sigitas Tamulevičius, “Microchannel Formation in Fused Silica via Ultra-Short Pulse Laser Induced Chemical Etching”, Kaunas University of Technology (Lithuania)

P20 Paweł Piotr Cielecki¹, Elżbieta Karolina Sobolewska¹, Oksana Kostiuočenko¹, Till Leißner¹, Tomas Tamulevičius², Sigitas Tamulevičius², Horst-Günter Rubahn¹, Jost Adam¹, Jacek Fiutowski¹, “Preservation of Plasmonic Interactions in DLC Protected Robust Organic-Plasmonic Hybrid Systems”, ¹University of Southern Denmark (Denmark), ²Kaunas University of Technology (Lithuania)

(Germany)

P22 Agnė Janonienė¹, Zehua Liu², Lina Baranauskiene¹, Hongbo Zhang², Vilma Petrikaite¹,³, Hélder A. Santos², “Modified Porous Silicon Nanoparticles for Cancer Targeting via Carbonic Anhydrase IX”, ¹Institute of Biotechnology (Lithuania), ²University of Helsinki (Finland), ³Lithuanian University of Health Sciences (Lithuania)

P23 Anna Pawlik¹, Marie Hubalek Kalbacova², Grzegorz D. Sulka¹, “Modified Nanoporous TiO₂ Layers as Drug Delivery Systems and Scaffolds for Osteoblasts-Like Cells Culturing”, ¹Jagiellonian University in Krakow (Poland), ²Charles University (Czech Republic)

P24 Akvilė Andziukevičiūtė-Jankūnienė¹, Saimonas Mureika¹, Aistė Lisauskaitė¹, Ramunė Bobinaitė², Dalia Urbonavičienė², Virginija Jankauskaitė¹, “The Plant Residue Particles Influence on the Polydimethylsiloxane Properties”, ¹Kaunas University of Technology (Lithuania), ²Lithuanian Research Centre for Agriculture and Forestry (Lithuania)


P26 A. Palaveniene, A. Kunciute, J. Liesiene, “Topical Semi-Solid Preparations with Powdered Cuttlebone for Treatment of Chemical Burns”, Kaunas University of Technology (Lithuania)
ORAL PRESENTATIONS
Love Wave Magnetic Field Sensors

Dirk Meyners, Eckhard Quandt

Inorganic Functional Materials Group, Institute for Materials Science, Kiel University, Kaiserstrasse 2, 24143 Kiel, Germany

Surface Acoustic Wave (SAW) sensors are based on piezoelectric substrates such as Quartz or LiNbO$_3$. Opposing interdigital transducers generate and receive electromechanical waves propagating along the substrate surface. In the delay-line configuration, changes of the wave amplitude or phase serve as the measurement signal in response to an external stimulus. As SAW sensors are characterized by a high sensitivity to surface effects, several application scenarios have been elaborated in recent past including pressure [1], temperature [2] measurements, and biochemical analysis [3]. Here, we report on the utilization of SAW devices as magnetic field sensors. For this purpose, the delay-line in between the transducers is coated with a soft-magnetic, magnetostrictive material like FeCoSiB. In response to an external magnetic field, the magnetostrictive material changes its elastic properties, which in turn results in a change of the wave velocity and phase.

In the presentation, we focus on the concept of a SAW magnetic field sensor exploiting shear (Love) waves [4]. The shear waves are concentrated close to the surface by a 4.5 µm amorphous SiO$_2$ guiding layer on top of which the magnetostrictive layer is grown. First measurements in a shielded environment show a high sensitivity of more than 1000°/mT and a detection limit in the order of 250 pT/Hz$^{1/2}$ for low frequency magnetic fields.

**Keywords:** surface acoustic wave, magnetic field sensor.

**References:**
Nanotechnology – There's Plenty of Room in Established Markets

Emil Højlund-Nielsen

Copenhagen Nanosystems, Centrifugevej 356, Dk-2800, Kongens Lyngby, Denmark

Some years ago, nanotechnology was forecasted to become the “next big thing”, but new companies within the industry struggle and most concepts do not make it beyond the research state. As the publication rate within the field is starting to saturate [1], the term today seems closer to being a marketing buzzword for funding applications than a uniting banner for a new global industry.

In contrast to the global development, a Danish top-down-based nanoindustry is emerging around the Department of Nanotechnology at the Technical University of Denmark and the associated 1350 m^2 semiconductor cleanroom. During the past 25 years, 27 spinout companies have been established and 22 of these are still in business [2]. A survival-rate of more than 80% over 25 years is quite remarkable for university spinouts. In 2015, the spinout companies generated a total turnover of DKK 500 million with 98% export. The spinouts currently employ 430 people and new commercial cleanrooms facilities are being planned across the Copenhagen area.

This talk highlights the development of three products starting as ideas at the university, including the NanoCuvette™-series from Copenhagen Nanosystems for laboratories and production control, and provides an in-depth analysis behind the cases. The analysis shows a common underlying industry-oriented mindset originating from a deeply rooted department culture and secondly the importance of key strategic equipment decisions for the university cleanroom supporting mass-production methodologies, which have allowed competitive pricing without up-front investments. In short, the success of the emerging nanoindustry in Copenhagen is based on developing products for already established markets and having access to public state-of-the-art infrastructure for support in the first critical years.

Keywords: Nanotechnology, spinout, nanoindustry, cleanroom, established markets.

References:
2. Data from survey conducted by the Department of Nanotechnology, Technical University of Denmark, 2015-16.
Conducting Polymers in Sensor Design

Arūnas Ramanavičius¹, Inga Vilkončienė², Aušra Valiūnienė¹, Lina Mikoliūnaitė¹, Juratė Petronienė¹, Asta Rekertaitė¹, Jaroslav Voronovič², Urtė Bubnienė¹, Povilas Genys¹, Eivydas Andriukonis¹, Asta Kaušaitė², Almira Ramanavičienė²

¹ Department of Physical Chemistry, Faculty of Chemistry and Geosciences, Vilnius University, Naugarduko Str. 24, LT–03225, Vilnius, Lithuania
² NanoTechnas – Centre of Nanotechnology and Material Science, Faculty of Chemistry and Geosciences, Vilnius University, Naugarduko Str. 24, LT–03225, Vilnius, Lithuania

Methods of conducting polymer synthesis will be overviewed. Electrochemical [1], chemical [2] and biochemical [3-6] synthesis of conducting polymers. Applicability of conducting polymer based functional layers in the design of various types of electrochemical biosensors will be overviewed [6]. Significant attention will be focused on the application of conducting polymers in glucose biosensors. Glucose oxidase (GOx) E.C. 1.1.3.4. from Penicillium vitale is mostly in design of glucose sensors applied biocatalyst. GOx is forming hydrogen peroxide that initiates polymerization of some conducting polymers. It was shown that this method is suitable for the synthesis of polypyrrole [3], polyaniline [4], polytiophene [5] and some other conducting polymer based layers and nanoparticles. It was demonstrated that both dissolved and immobilized enzymes could be successfully applied in the enzymatic synthesis of conducting polymer-based nanoparticles. Here reported synthesis of nanostructures based on conducting polymers belongs to ‘green synthesis’ since except monomer required for the formation of conducting polymer any other environmentally dangerous materials are applied in this polymerization process. We also have demonstrated that formed nanostructures and nanoparticles shows good biocompatibility with living cells and when implanted in mice. We have demonstrated that during such kind of synthesis of nanoparticles and/or nanostructured layers the enzymes becomes entrapped within conducting polymer layer. We have also demonstrated that redox processes that are part of metabolism of living cells can be applied for the synthesis of conducting polymer – polypyrrole (Ppy), and formed Ppy nanoparticles could be entrapped within cell wall of yeast cells [6]. Therefore such nanoparticles and nanostructured layers can be suitable for the design of amperometric glucose biosensors, biofuel cells and some other bio-devices.

Keywords: glucose biosensor, conducting polymer, polypyrrole, polytiophene, polyaniline.

Acknowledgement: This project was financially supported by Lithuanian Scientific Council. Project SEN-21/2015

References:
Phenylene and Squaraine Organic Thin Films: Polarization Optics and Aging

Frank Balzer¹, Manuela Schiek²

¹University of Southern Denmark, Alsion 2, DK6400 Sønderborg, Denmark
²University of Oldenburg, Institute of Physics, Carl-von-Ossietzky-Str. 9-11, D26129 Oldenburg, Germany

Organic thin films and aggregates have a huge application potential in electronics, photonics, and even biology and medicine [1]. Polarized light has proven to be a valuable tool for their characterization [2]. Together with complementary techniques such as X-ray diffraction, electron diffraction, and atomic force microscopy, the analysis of the polarized fluorescence emission as well as birefringence and dichroism provides detailed insights into, e.g., epitaxial growth and H-/J-aggregate formation. Two prototypical examples will be discussed: epitaxially grown nanofibers from rod-like organic molecules such as phenylenes and thiophenes, Figure 1(a), and ferns and platelets from a spin-coated squaraine molecule blended with PCBM, Figure 1(b).

Fig. 1. (a) Fluorescence microscope image of vacuum grown para-hexaphenylene nanofibers. (b) Polarization microscope image of spin-coated squaraine ferns and platelets

Time-resolved atomic force microscopy reveals the aging of the aggregates on the timescale of days. Phenylene nanofibers change morphology via Ostwald ripening, induced by atmospheric water vapor. The squaraine films are stable in air and in the dark, but decompose under intense white light illumination and in physiological liquids [2,3].

Keywords: nanofibers, phenylenes, squaraines, polarized light.

References:
Thin Film Solar Cells for Large Area Space Applications

R. Grilli\textsuperscript{1}, D. A. Lamb\textsuperscript{2}, S. J. C. Irvine\textsuperscript{3}, C. Underwood\textsuperscript{3}, J. Hall\textsuperscript{4}, R. Kimber\textsuperscript{5}, M. A. Baker\textsuperscript{1}

\textsuperscript{1}The Surface Analysis Laboratory, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, Surrey, UK
\textsuperscript{2}Centre for Solar Energy Research, Glyndŵr University, St Asaph, UK
\textsuperscript{3}Surrey Space Centre, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, Surrey, UK
\textsuperscript{4}Qioptiq Space Technology Ltd, Glascoed Road, St Asaph, UK,
\textsuperscript{5}Surrey Satellite Technology Ltd, 20 Stephenson Road, Surrey Research Park, Guildford, UK

For large area space applications, CdTe solar cells deposited directly on flexible and UV radiation absorbent cerium-doped microsheet glass (CMG) offer a reduction in weight and an increase in the specific power compared to current triple junction solar cells. CdTe solar cells have been deposited by metal organic chemical vapor deposition (MOCVD) in a superstrate configuration with the following multilayer structure: CdTe/CdZnS/CdS/ZnO/AZO/CMG.

The thin film solar cells have been characterized by means of x-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), x-ray diffraction (XRD), energy dispersive x-ray (EDX) and scanning transmission electron microscopy (STEM). The AZO, ZnO and CdZnS/CdS exhibit hexagonal wurzite structures and the CdTe is cubic zincblende. SEM plan view and cross-section images were recorded for the deposited AZO and ZnO layers. The 700 nm AZO layer exhibits a compact columnar structure with dome shaped surface features varying in diameter between 20 and 200 nm. The 150 nm ZnO buffer layer acts to reduce micro-shunts due to pinholes in CdS. This ZnO layer is a much less compact layer which does not exhibit a columnar structure and is comprised of small spherical grains of 30-50 nm in diameter, clustered together in agglomerates of sizes from a few hundreds nm up to 1-2 µm. STEM cross-sectional images show the presence of voids at the ZnO/CdZnS interface. Nevertheless, pull-off adhesion tests show good mechanical integrity for the thin film structures on the CMG. The XPS depth profiles and STEM images provide confirmation of the expected multilayered structure.

Currently, the highest efficiency obtained for these solar cells is 15.3%. The resistance of these CdTe based cells to irradiation is at least one order of magnitude better than the triple junction solar cells and following high proton doses they show excellent efficiency recovery after 1 week exposure at 100 °C.

Keywords: CdTe, solar cell, space, large area, characterisation.
3D Porous Structures with Unusual Wetting Properties for Functional Applications

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The fabrication of surfaces with new properties by means of the controlled manipulation of the topography and the surface chemistry is an emerging interdisciplinary field which attracts the attention of researchers from different disciplines including physics, chemistry, biology and materials science. Especially the control of the wetting on surfaces has several practical impacts which are already realized in several commercial products such as water repellent paints, anti-bacterial shoes, easy-to-clean textiles and similar many technologies. On the other hand, the stability of the hydrophobicity and the control of the transition between Cassie and Wenzel states are still challenging issues. Here we present synthesis of 3D porous materials which exhibit extreme wetting and non-wetting behaviours). The characterisation of the prepared surfaces and their potential use in different fields are presented briefly.
R&D Multifunctional Cluster Tool for Vacuum Deposition Inorganic and Organic Thin Films

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Research tools nowadays tend to become more and more complicated and narrowly specialized. But what if a researcher needs to broaden his possibilities in terms of using new technologies in one tool? Or perhaps what if several layers need to be deposited using different methods without breaking the vacuum? These are the questions SAF multifunctional cluster tool tries to answer.

Sidrabe Inc. in collaboration with the Institute of the Solid State Physics developed a multifunctional R&D cluster tool named SAF. SAF stands for Simple-Accessible-Flexible with the idea of easily upgradable and expandable machine. The SAF tool is intended for research and development works, feasibility studies and general academic work in the field of thin film technologies. The coater has 5 process chambers, 1 trasport chamber with robotic handler and one load/unload chamber combined with MBraun glovebox. Each chamber in the tool stands for its own PVD technology. This way there is minimum cross contamination between chambers and robotic handler in the central chamber makes manufacturing of multilayer coating without introduction of the sample to the air possible.
Challenges of Nanotechnology for Metal Surfaces

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In the presentation the results of studies of novel technologies, incl. low-temperature atomic layer deposition (ALD) [1], nano-characterization, incl. microscopy and surface spectroscopy, and complex testing, incl. electrochemical and mechanical methods, for different thin coatings on Al- and Ti alloys, and stainless steels will be introduced. The component list counts of the hybrid or composite nanostructured coatings, electrodeposited polypyrrole, CVD grown large area graphene or mechanochemically prepared graphene nanoplatelets, anodic oxide layers, ALD prepared inorganic films and their laminates (Fig. 1). Pre-treated surfaces and coatings were thoroughly characterized and tested. Biocompatibility of different finishing was checked by in-vitro cell growth and studies. Excellent corrosion protection of the coatings was demonstrated.

Fig. 1. SEM image of a FIB-made cross-section of a thin ALD coating

Keywords: surface pre-treatment, amorphous thin film, corrosion protection, biocompatibility, surface functionalization.

References:
A key trend in modern material science is the development of multifunctional materials capable of fulfilling several roles in parallel. A construction material could function as energy storage or an energy harvester, regulate humidity or temperature, it could be a sensor or a signal output device. Smart multifunctional materials sense their surrounding and respond to specific stimuli by either a response signal or adapt their behaviour.

The fascinating characteristics of modern high-performance materials often start from nanoscale, or even below, their atomic level structure. To further the fundamental understanding of the generation of material properties as well as to aid in the development and optimization of new materials, atomistic simulations at different levels of theory can be applied. However, simulation of nanomaterials at atomistic levels can be challenging as nanoparticles, while small in material sense, still comprised hundreds of thousands or millions of atoms. We have recently developed a unique set of theoretical full-particle nano-descriptors for deriving quantitative nanoparticle – property/activity relationships, to aid in the design of functional nanoparticles.

The nanostructure of ionic electroactive polymer composites plays a key role in the behaviour of these functional materials, which are expected to find application as sensors, actuators or energy harvesters in soft robotics, micro devices, etc. The principle interactions in these systems are those between the host electrode material, often nanostructured carbons, and charge carrying particles, like ions from room temperature ionic liquids.

Several aspects of the development and application of such materials from atomistic simulations to real-world devices in the Intelligent Materials and Systems Lab, University of Tartu, will be discussed in the presentation.
Nanoparticles for Targeted Drug Delivery in Chemotherapy

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Nanoparticle-based targeted drug delivery has been an interesting topic for researchers during several past decades. Sophisticated delivery systems are especially important in cancer chemotherapy to localize the drug at specific site of the body and reduce toxic effects. However, many nanoparticles for cancer treatment are passively targeting systems and based on the enhanced permeation and retention (EPR) effect [1]. In this case majority of nanoparticles may accumulate in such organs, as liver, spleen, and lungs. Alternatively, actively targeting nanoparticles are conjugated with a ligand/carrier interacting with the specific target in cancer cells, and this strategy could improve drug localization in tumor [2].

Most solid tumors are characterized by hypoxia, and it is a prognostic indicator of a poor clinical outcome for patients [3]. Many hypoxia-targeted cancer therapies are based on carbonic anhydrase IX (CA IX), a membrane protein which is highly overexpressed in numerous cancers, but is largely absent in normal tissues. Several inhibitors selective to CA IX have been synthesized. A sulphonamidic compound VD11-4-2 possesses a high affinity (about 50 pM) and excellent selectivity towards CA IX [4].

We applied VD11-4-2 as a specific cancer targeting agent in both passive and active targeting nanosystems. It was used as a modulator of anticancer drug doxorubicin and its liposomal pegylated formulation penetration into cancer cell 2D and 3D models, and also it was applied as a ligand in a multifunctional hypoxia cancer cells targeting nanoplateformbased on porous silicon (PSi) nanoparticles uploaded with doxorubicin.

We proved that inhibitor VD11-4-2 could be used to enhance liposomal doxorubicin transport into cancer cells and spheroids at lower pH. Developed cancer targeted nanoplateform with CA IX inhibitor exhibits controlled drug release and improved anticancer effect.

**Keywords:** targeted delivery, hypoxia, carbonic anhydrase IX, liposomal doxorubicin, porous silicon nanoparticles.

**References:**
Electrospun Medicated Nanofibrous Systems

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Polymeric nanofibrous mats have found uses in many pharmaceutical and biomedical applications such as wound dressings, tissue engineering scaffolding, and tissue templates [1,2]. This lecture will review the recent developments and applications of electrospinning in fabricating polymeric nanofibrous systems. The effects of different materials and process parameters on the performance of nanofibrous platforms, are discussed. A novel ultrasound-enhanced electrospinning technique (USES) is described for fabricating polymeric nanofibers and nanofibrous mats (Fig. 1).

Fig. 1. (A) The Ultrasound-Enhanced Electrospinning (USES) Setup and the Nanofibrous Networks with Payload; (B) Intelligent Wound Dressings.

The US-modulated electrospinning technique permits temporal and spatial ultrasonic actuation of individual nanofibers at the orifice of the spinner, which translates into morphological anisotropy along the fiber in nano- or microscale steps [3]. The USES could allow production of constructs with better spatial control over anisotropic properties, e.g. gradients in nanofiber thickness to control drug release profile or to modify the mechanical or topological properties of the nanofibers for tissue engineering purposes. Such constructs could be the basis for tomorrow’s intelligent wound dressings and tissue engineering (Fig. 1).

The lecture will also review some selected state-of-the-art applications of nanofibrous systems in drug delivery and tissue engineering with a special reference set to wound healing applications.

Keywords: nanofibers, electrospinning, wound dressing, tissue engineering.

References:
Nanoscopy as a Tool for Understanding Transdermal Drug Delivery

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The penetration properties of substances across biological barriers and membranes are vital for many areas of research. The barrier in human skin is primarily found in the stratum corneum and consists of protein-enriched cells surrounded by a lipid membrane-enriched intercellular spaces. Characterization of the structural and dynamical processes occurring across the skin barrier is essential for understanding healthy and diseased skin and for designing successful transdermal drug delivery strategies. In this study we use Stimulated emission depletion (STED), two photon excited STED and Förster Resonance Energy Transfer (FRET) microscopy to probe the structure of human skin and a combination of super resolution optical microscopy and a multiphoton excitation based fluorescence fluctuation spectroscopy method, namely raster image correlation spectroscopy (RICS), to study the mechanism of action for liposomes as a transdermal drug delivery system in excised human skin. STED microscopy enables resolving structures in the skin below 60 nm allowing visualization of the stratum corneum intercellular lipid matrix and individual liposomes. To further probe the nanoscopic structure of the intercellular lipids and the nanoscopic diffusion routes of hydrophilic and hydrophobic particles through the skin barrier we use FRET measurements of lipophilic and hydrophilic dye pairs.

Our results suggest that the liposomes do not act as carriers that transport their cargo directly through the skin barrier, but in fact mostly burst and fuse with the lipid layers of the stratum corneum. It was also found that the flexible liposomes showed a greater delivery of the fluorophore into the stratum corneum, indicating that they functioned as permeability enhancers.
Approaching Challenges in Optics Through the Lens of Colloidal Chemistry

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The optical properties of metal nanoparticles depend on collective excitations of free electrons called surface plasmons. The dynamics that occur inside a single metal nanoparticle following the absorption of a photon results in a chain of photophysical processes that end in the energy being dissipated to the environment. I will explain how nanoparticle shape determines many aspects of this dissipation process, and discuss some of our efforts to create high frequency chemical sensors and plasmon-enhanced catalysts.

Fig. 1. Silver (Ag) nanocubes support intense, highly localized plasmon resonances at energies that depend on both size and shape. The spectrum above shows the optical properties of a single Ag cube with an edge length of ~100-nm (inset, top). At resonant wavelengths, the intensity of the electromagnetic field is greatly enhanced (inset, bottom)

Keywords: plasmonics, nanophotonics, optomechanics, colloidal synthesis.

References:
All-Optical Modulation by Plasmonic Metal Nanostructures

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Nonlinear plasmonics are of great importance for a wide range of active functionalities in nanophotonics, including biosensing, quantum information and ultrafast lasers [1-3]. Despite a growing number of studies being performed, a fundamental understanding of the underlying mechanisms that give rise to the optical nonlinearities is needed. Previous studies were mainly performed at single wavelength and have led to conflicting results [4]. Better understanding of the nonlinear mechanisms would allow novel nanostructures to balance losses and maximize nonlinearities, and therefore, move the nanophotonics concepts forward to real-world applications. We will focus on the third-order nonlinear process, known as optical Kerr effect. This process results in changes of the refractive index and allows the all-optical modulation.

Here, combining pump-probe spectroscopy with spectroscopic ellipsometry [5], the nonlinear optical properties of plasmonic nanoparticles were investigated. In contrast to the standard single wavelength Z-scan technique, the changes in the refractive index obtained range from 350 to 1300 nm. In light of these results, we discuss the modification in the third-order nonlinearity owing to size quantization and intrinsic optical bistability in noble metal particles. The intrinsic third-order susceptibility $\chi^{(3)}_m$ of an Ag particle exhibits spectral and size dependences. For particle diameters ranging from 15 to 3.0 nm, a substantial 100-fold increase in the $|\chi^{(3)}_m|$ is observed, indicating discretization of conduction electrons (quantum size effects) [5]. Critical particle size for quantum confinement was observed at 15 nm. Also, the capability of an Ag particle to modulate its optical resonance condition, by optical nonlinearity, without an external feedback system was observed [6]. By this modulation and using the particle itself as an optical cavity, it is possible to achieve optical bistability.

\textbf{Keywords:} plasmonics, nonlinear optics, pump-probe spectroscopy, third-order susceptibility.

\textbf{References:}
The Light Conversion offers multiple scientific and industrial femtosecond laser systems capable of broad range of parameters. The aim of this talk is to present overview of variety of applications where these lasers can be used in the field of nanotechnology. During the last decade new methods such as sub-micrometre scale polymerization, surface and volume modifications have opened new windows for science and industry [1]. Here is worth mentioning such the applications as inscription of laser induced birefringence for fabrication of sophisticated optical devices and 5D memory [2], modification of the surface properties, cutting, scribing and drilling of brittle materials and cold material ablation. Few examples of application of femtosecond lasers in new developments for eye surgery will be presented.

**Keywords:** femtosecond, material processing, nanofabrication.

**References:**
Technology Transfer: from Laboratory to Industry

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During the last decades, the knowledge exchange between research institutions and industry became more and more important. As a rule, universities are the main source of the new ideas, of new improvements and inventions, in one word, the origin of innovations. On the other hand, the industry is the principal customer for the utilization of these innovations as there is a high need of new ideas, new solutions and improvements of existing products. As a result, the technology transfer from academic institutions and research laboratories to industry is a very important process. An effective technology transfer promotes always positive benefits through the development of new products, medical treatments, services, and other innovations. One of the main objectives of the company FUMT R&D Functional Materials GmbH is to intensify the communication between research institutions and industry in order to promote the practical use of research results gained in the laboratory. For example, our intensive cooperation with the Faculty of engineering of the Christian-Albrechts-University Kiel (CAU) provides access to the latest research results. Additionally, as a result of a joint project planning and direct contact to the customers, we are able to provide aim oriented and time-efficient transfer of innovations from university directly to the customer. All in all, this provides competitive advantages for the customer.

Nevertheless, the partnerships between university and industry in the field of science and technology are very complex and may develop through a large number of collaboration mechanisms and possibilities. One example of such collaborations based on experiences will be presented in this report.

**Keywords:** innovation, technology transfer.

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Incoatec develops and manufactures sophisticated multilayer and total-reflection X-ray optics as well as microfocus X-ray sources for in-house crystallography and synchrotron applications.

In this contribution we will be giving an overview on current developments of multilayer optics for analytical X-ray applications in the lab as well as for synchrotron applications. We will be explaining the manufacturing process of the optics, summarizing the different types of optics and giving some examples of typical applications which benefit from the new possibilities, especially in combination with modern microfocus X-ray sources.

For synchrotrons we developed coatings with a length of up to 150 cm for beam conditioning (together with our partners from HZG), multi-stripe multilayer optics for tomography beamlines and 2-dim beamshaping multilayer optics, so called Montel-Optics, for inelastic scattering applications. We will be showing first results of a 50 cm laterally graded scattering applications. We will be showing first results of a 50 cm laterally graded scattering applications. We will be showing first results of a 50 cm laterally graded multilayer optic, developed for a special mini-synchrotrons and a multi-stripe multilayer optic with an optimized coating for different beam energies in the range of 10 to 45 keV which is used at the tomography beamline at the Swiss Light Source.

In the home-lab multilayer based Montel Optics are widely used as an essential component in modern X-ray diffractometers. These optics consist of bent substrates with shape tolerances below 100 nm, upon which multilayers are deposited with single layer thicknesses in the nanometer range and up to several hundred of layer pairs. The multilayers are designed with lateral thickness gradients within ± 1% deviation of the ideal shape. Very low shape tolerances below 100 nm and figure errors below 5 arcsec are required for multilayer mirrors to ensure a superb flux density of more than $4 \times 10^{11}$ photons/s/mm$^2$ in combination with very high-brightness microfocus X-ray sources, such as the novel liquid metal jet X-ray source.

We use sputtering technology for deposition, optical profilometry in order to characterize the shape and X-ray reflectometry in order to characterize the multilayer thickness distribution both laterally and as in-depth. For X-ray analytics the important beam parameters are monochromaticity, flux, brilliance and divergence. They demonstrate the quality of the combination of suitable X-ray sources with selected multilayer optics.

*Keywords:* thin films, magnetron sputtering, X-ray analytics.
The Impact of Smart Surface Modifications on Cleaner Oceans: NANDATEC® CLEANS1

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Nanomaterials as surface modifications offer many benefits compared to known chemicals. Benefits are the higher sustainability in production processes and the replacement of biocides in antifouling compounds. Oxidative stress, toxicity and the unknown long-term impact on the environment are side effects that need to be considered appropriately when developing new nanomaterials for surface modifications [1]. In biocompatibility studies under lab conditions the interactions of nanomaterials with the marine environment are not represented sufficiently [2]. Therefore, a marine model, NANDATEC®mare, was established. The marine model contains water probes from North- and East Sea and lakes Trave and Schwentine, which naturally differ in salt, chemical-, mud- and suspended particle concentration. Two nano-surface modifications were incubated in the collected water probes for 4 h to 72 h and up to 2 weeks. The stability of the nano-surface modifications and their interactions were monitored and analysed by Photon Cross-correlation Spectroscopy (PCCS) and flow cytometry (FACS). The results indicate that the stability and reactivity of new nano-materials in harsh conditions determine their biocompatibility. Furthermore, stable surface modifications induce less floating particles and do not interact with their environment. The material composition and their stability are key factors that determine biocompatibility. According to these results we conclude, that the replacement of biocides in antifouling compounds by NANDATEC® CLEANS1 provides an impact on ocean and lake water quality via reduced environmental pollution.

Fig. 1. Comparison of surface treated GFK with biocide-free antifouling compound NANDATEC® CLEANS1 (a) and GFK with paint containing ZnO antifouling (b), incubation in algae and microbes tank for 1 year at 18 °C

Keywords: marine, antifouling, biocide-free, biocompatible, nanomaterials.

References:
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Technology Aspects and Application Potentials of Supported Anisotropic Nanostructures

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Large-area ordered nanorod (NR) arrays of various functional materials can be easily and cost-effectively processed using on-substrate anodized porous aluminum oxide (PAO) films as templates. However, reproducibility in the processing of PAO films is still an issue because the PAO films are prone to delamination, and control of fabrication parameters such as electrolyte type and concentration, anodizing voltage and time, is critical for making robust templates and subsequently mechanically reliable NR arrays. In the present talk we first systematically investigate the effects of the fabrication parameters on pore base morphology, pore size and gap and devise a method to avoid delamination, and control of pore structure of PAO films on gold under-layers. Via systematic control of the anodization parameters, particularly the anodization current density and time, we follow the different stages of void development and discuss their formation mechanisms. We then move to the processing of NRs of different functional materials, including noble metals, nanoalloys, oxides and nanocomposites using these templates and show some promising applications in molecular detection, electrocatalysis and energy storage. We also show how NR morphology and microstructural characteristics can dramatically impact the properties of the nanostructures.

Keywords: porous alumina template films, supported nanostructure arrays, noble metals, nanoalloys, nanocomposites, electrocatalysis, energy storage.

References:
Don’t Call Me a ‘Surface-Enhanced Raman Substrate’!

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AtoID is a spin-off from Center for Physical Sciences and Technology (Vilnius, Lithuania). The main product and technology is related to Surface Enhanced Raman Scattering phenomena, wherein weak Raman scattering can be enhanced by a million times and be registered with smaller and cheaper devices, such as portable Raman spectrometers. It is particularly useful in measuring low concentrations of analyte molecules in solutions.

Fig. 1. SERS substrate products for material analytics

AtoID was established based on effort to commercialize the invention and manage related intellectual property.

The path towards commercial success involves a number of conclusions, one of them is that we should stop calling them and selling them as ‘SERS substrates’. So how they should be called instead?

\textbf{Keywords:} SERS, Raman spectroscopy.
Driving Innovation – We Have the Right DNA

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Lithuanians has a long history when it comes to industrial innovation. With developmental experience dating back to the invention of the laser our technology and skills are at the forefront of many industries. With the advantage of being a small nation where solutions are quick and networks are instant, we have the environment which is just right for innovation.

Over the last years Lithuania has experienced a significant influx of foreign investment into technologically advanced sectors: electronics manufacturing, life-sciences, ICT. What did those companies find in Lithuania and what are the key “take-aways” for future investors and local contributors?
The key question we want to address is how do you transfer your invention to an industry and make it a successful business. Kaunas Free Economic Zone has been designed to attract investors and help develop Kaunas and its region. Due to strong background of Kaunas technical academic milieu, large scale traditional production plants have been establishing in KFEZ. However, acknowledging the talent and potential of R&D developers in Kaunas and more widely in BRS region, we aspire to look further beyond traditional manufacturing. New technologies and inventions that are born in laboratories need to have a better interaction with industries and businesses. Thus, we see it as a necessity to put best efforts in creating a high-tech cluster in the city/region. Strong academic institutions with relevant expertise together with progressive businesses and relatively low costs of operations are two sides of the same coin. What needs to be brought about are the access points or framework where these two parties could continuously cooperate. This would create conditions to achieve all rounded results: competition for better solutions and more advanced innovations, establishment of new businesses and increased productivity.

**Keywords:** business, opportunity, cluster, economic zone, industry, R&D.
TRAM Project – the New Tool to Strengthen the Relationship between Analytical Research Institutions and Business in BSR

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This presentation aims to present new opportunities for cooperation between research and business within the frame of the Baltic TRAM project. The overall objective of the project is to boost innovation, secure the implementation of smart specialization strategies, and encourage entrepreneurship by supporting small and medium size enterprises, thus contributing to the regional effort of making the Baltic Sea Region innovative, sustainable and competitive. The specific objective is to secure sustainable demand for research infrastructures, to address the concept of open data access, and ensure the existence of cooperation structures between analytical research institutes and companies at national, regional and international level.

The project will facilitate and expand the cooperation between national Industrial Research Centres to serve as interfaces between analytical research institutes and companies. Invited companies will be provided with consultations and access to research facilities to test their ideas and products. Furthermore, the project will provide a benchmarking analysis on the national roadmaps for research infrastructures and smart specialization strategies, and provide recommendations to policymakers.
Public Support Schemes for Effective Technology Transfer. How Enterprise Europe Network Can Help?

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The Enterprise Europe Network helps businesses innovate and grow on an international scale. It is the world’s largest support network for small and medium-sized enterprises (SMEs) with international ambitions. The Network is active in more than 60 countries worldwide. It brings together 3,000 experts from more than 600 member organisations – all renowned for their excellence in business support. Teams of Network experts in each member organisation offer personalised services to businesses. They know the local business environment and have contacts for business opportunities worldwide. The Network can also offer a targeted approach aimed specifically at your business sector. Its expert groups cover all key economic sectors, from healthcare to agrofood, from intelligent energy to fashion and textile.

**Keywords:** Technology transfer, Enterprise Europe Network
Entrepreneurship Scene in Germany

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Bridging Entrepreneurship and Tech Innovation in Denmark – Educating the Tech Entrepreneurs of the Future

Frederik Gottlieb

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In his talk, Frederik Gottlieb will focus on Entrepreneurship and Innovation practice and research at the Mads Clausen Institute in Sonderborg, DK. In the institute’s newly inaugurated Innovation Lab, the researchers are bringing together internal and external competencies in the education of engineers with a strong entrepreneurial profile. The Innovation Lab at the Mads Clausen Institute is a hub for researching and practicing entrepreneurship across disciplines. Through the 4 phases of Idea Development, Prototyping, Operations and Commercialization, the lab and its staff provides an enabling environment for new and established businesses to engage in workshops in these different stages of their innovation process. In this talk, Frederik Gottlieb will provide an overview of how such initiatives can contribute to nurturing local entrepreneurship and also talk about the challenges in establishing an enabling environment to support innovation in new ventures and in established organizations as well as in the education of future tech entrepreneurs.

Fig. 1. Co-creation in the Innovation Lab

Keywords: entrepreneurship, innovation, co-creation.
TALKS OF PhD / POSTDOC-STUDENTS AND STUDENTS
Supported Porous Thin Film Carbon-Nanocomposites for Supercapacitor Applications

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Porous polyvinylidene fluoride (PVDF) [1] or porous PVDF-multi walled carbon nanotubes (MWCNT)-nanocomposite [2] films are processed on stainless steel substrates using a solution-based coating method. Subsequent pyrolysis of the films at the fairly low temperature of 550°C leads to amorphous porous nanocarbon films [3] or nanocarbon-MWCNT-nanocomposites [2,4]. In addition the surface of the carbon films can be modified with single walled CNT (SWCNT) and Ni(OH)$_2$-nanoparticles [4,5]. The application of these films as supercapacitors is explored with supercapacitance values ranging from 80 to 690 F g$^{-1}$ (in 1M KOH), depending on microstructure. Supercapacitors in ethylene glycol based electrolytes deliver energy densities of up to 10.2 Wh kg$^{-1}$ and power densities of up to 5 kW kg$^{-1}$ with a potential working range of 2 V. In all cases long term charge-discharge stability is demonstrated.

**Keywords:** porous carbon, surface modification, nanocomposite, supercapacitor.

**References:**
Synthesis of Nanoporous Gold for the Detection of Small Molecules

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Nanoporous gold is of great interest for various applications including the detection of small molecules using the SERS effect [1,2]. Dealloying is the most simple and practical approach to prepare nanoporous gold. In case of gold-based binary alloys, dealloying describes the removal of the less noble element allowing creating nanoporous gold with a sponge-like structure [3]. In this contribution we show that the fabrication of nanoporous gold by dealloying is not limited to alloys but can be rather applied to stacked nanolayers of gold and copper deposited by magnetron sputtering in pure argon plasma. We further show that using this new concept of dealloying, one can prepare nanoporous gold thin films with a nanolayered structure (Figure 1a, b). The degree of the material’s porosity can be controlled by tuning the thickness and the number of the gold/copper stacked nanolayers. Furthermore, we demonstrate that, taking benefit of the SERS effect, this material with such a special architecture can be used as a powerful platform for the detection of isolated small molecules such as 2-2bipyridine (Figure 1c).

Keywords: nanoporous, gold, SERS.

References:
FTIR Spectroscopy for the Differentiation of Nanosized Calcium Phosphates

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Infra-red spectroscopy is an invaluable method. Different Fourier transform infrared spectroscopy (FTIR) sampling methods are commonly used to identify functional groups in calcium phosphates [1]. This study compares four different FTIR characterization methods: cantilever-enhanced PAS, DRIFT, ATR, and transmission. An analysis of the spectra will be conducted by multivariate statistics (Principal component analysis (PCA), Pearson product-moment correlation coefficient (PPMCC) and Cluster Analysis (CA)) [2].

Fig. 1. PCA of FTIR spectra with different level of crystallinity

Using statistical methods, we found: 1. The importance of spectral analysis: normalization, baseline correction, Fourier self-deconvolution, selection of spectral regions; 2. A crystallinity degree of calcium phosphate affects the shape of FTIR spectra, independently from FTIR sampling method, what is proved by PCA and shown by PCA biplot (Fig. 1).

**Keywords:** FTIR, PAS, DRIFT, nanosized calcium phosphate, Multivariate statistics.

**References:**
Electrodeposition of Molybdenum Sulfide for Hydrogen Evolution Reaction Catalysis

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This study was aimed at the electrodeposition of molybdenum sulfide films and their application in hydrogen evolution catalysis. The employed methodology has been proposed in other studies as well [1,2]. A common precursor tetrathiomolybdate / MoS\(_4^{2-}\) was used as a source of both sulfide and molybdenum ions in the deposition bath. Cyclic voltammetry has been performed in a 40 mM MoS\(_4^{2-}\) solution to investigate film deposition. A control test in 0.1M Na\(_2\)SO\(_4\) (see Fig. 1 solid line) showed anodic and cathodic peaks, caused by the formation of copper oxides, but the current was otherwise stable. Upon addition of tetrathiomolybdate, current densities increase significantly. After 25 cycles a broad peak at -0.3 V became apparent, which indicates the anodic deposition of amorphous MoS\(_3\). When the potential is scanned cathodically, the film partially dissolves, and a reductive deposition of amorphous MoS\(_2\) can occur.

The as-deposited films have been tested for their HER, as well as photocatalytic activity.

![Cyclic voltammograms of MoS\(_x\) deposition on a copper substrate over 25 cycles; c(MoS\(_4^{2-}\)) = 40 mM. 0.1M Na\(_2\)SO\(_4\) as the supporting electrolyte. Scan rate – 50 mV s\(^{-1}\). Solid line – no MoS\(_4^{2-}\).](image)

**Fig. 1.**

**Keywords:** electrodeposition, molybdenum sulfide, hydrogen evolution reaction.

**References:**
Gold nanodot printing for microsensor surface functionalization

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Understanding cell adhesion as key event for eukaryotic cell contact with the extracellular matrix or other cells, is of central interest for the development and mimicking of cell-inspired materials. In consequence, a variety of different techniques to analyze the adhesion process and upcoming forces have been developed within the last years, such as traction force microscopy and soft PDMS micropillar arrays [1], [2], [3].

However, none of the known methods offer the possibility to measure forces exerted by cells locally on different areas of the cell surface and in three dimensions at once. For that reason, a novel surface-integrated thin film microsensor system is designed and developed. A major challenge in measuring the cellular forces is a well-established interaction between the cell and the fixation platform of the sensor system. For that reason, the platform surface is biofunctionalized by block-copolymer micelle nanolithography (BCMN), which is a self-assembly based method to prepare hexagonal patterns of metal nanodots [4].

Due to the very sensitive structure of the sensor, standard procedures for BCMN based on sputtering or spin-coating had to be replaced by a new approach based on cantilever-based gold-nanodot printing. The results show that the printing of nanodots in micropatterns is feasible and has the potential to lead to much more flexibility and cost-efficiency in the preparation of micro-nanostructures compared to conventional methods.

Keywords: nanodot printing, surface functionalization, micelle nanolithography, biocompatible surfaces, force sensing.

References:
In this work we present the atmospheric pressure metal organic vapour phase epitaxy (AP MOVPE) growth of dilute nitride semiconductors for application in solar cells. Dilute nitrides were proposed in nineties by Weyers and Kondow, who were looking for new semiconductor material for telecommunication laser. They are GaAs or InGaAs with small amount of nitrogen, which incorporations into host material drastically changes the optical, electronic and structural properties of GaAsN and InGaAsN alloys.

Here we present the growth details of a few dilute nitride based solar cell epistuctures and their characterization by the means of optical (photoluminescence, modulated reflectance spectroscopy), structural (high resolution X-ray diffraction) and electrical (photocurrent spectroscopy and electrochemical capacitance-voltage profiling) methods. Then, we describe fabrication process of test solar cell device in both configuration: mesa and with partially transparent top electrode and their temperature dependent I-V characteristics. Finally, we compare different types of solar cells and their output parameters short circuit current $j_{sc}$, open circuit voltage $V_{oc}$, fill factor FF and efficiency $\eta$.

Keywords: dilute nitrides, epitaxy, solar cell, I-V characteristics.
Laser Modification of Self-Assembled Nanocube Arrays

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An increased demand for methods of nanoparticle self-assembly is driven by advanced nanoparticle shapes and materials being developed [1]. In particular, singular nanoparticle placement capabilities on nanoscale resolution templates offers improvements for plasmonics, photonics and chemistry research which can directly be injected into new biomedical and energy applications [2].

One of the most efficient methods for precise nanoparticle manipulation utilizing templates is capillary force assisted assembly (CAPA) [3]. Briefly, a droplet of nanoparticle colloid solution is confined between a patterned template and a stationary glass slide. A combined evaporation induced flux and capillary force confinement effect produces conditions where nanoparticles can be assembled into predefined positions, even controlling their orientation.

Here we present our achievements using this method, ranging from micron sized polystyrene beads down to tens of nanometers sized plasmonic silver nanocubes (Fig. 1). Deposition transition from low to high yield was investigated using fluorescent beads. Furthermore, assembled arrays of silver nanocubes were exposed to ultra-short pulse laser radiation, resulting in changes of light scattering properties observed under dark field microscopy (Fig. 2).

Fig. 1. 100 nm edge length Ag nanocubes assembled into pits (SEM)

Fig. 2. Ag nanoparticles after laser irradiation (KTU represents illuminated areas, optical dark field image)

Keywords: nanoparticles, plasmon resonance, CAPA, laser modification.

References:
Free Standing Dose Gels: First Approach to Ionizing Radiation Based 3D Printing

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Kaunas University of Technology (KTU)

The interest to application of 3D printing issues is growing up, since this technique might be used for the fabrication of differently shaped and very complicated objects, including medical phantoms and applicators. However, to produce any shape one needs to have 3D printer, object related printing algorithm and printing material, which is not tissue equivalent.

Nearly tissue equivalent dose gels are known and used for a long time in high energy external radiotherapy for in situ dose assessment and as the phantoms - tumour imitators, for securing quality of the treatment procedure. When irradiated to high energy beams, free radicals created in the gel induce polymerization within restricted region thus forming volumetric shapes of the polymerized gels. The properties of polymerized gels depend on chemical components and their concentrations as well as on gel production technology and irradiation conditions. It is needed to notice that polymerized gel shapes are created inside the tightly closed vessel and are surrounded by gelatin matrix. Assessment of the created polymerized gel shape and dose distribution in it is usually performed taking the whole gelatin volume into consideration, thus contributing to the enhancement of measurement uncertainties and limiting their application in clinical field.

The aim of this work was to develop ionizing radiation based 3D printing method for fabrication of nearly tissue equivalent free standing 3D dose gel medical phantoms (tumour imitators) having the size and shape of a real tumour. (Concept of this method was firstly proposed in our previous publication in 2015 [1].

Special dose gels (patent is pending) were used as „printing material“ for the processing of free standing dose gel shapes. There was no any request for a special 3D printing equipment or development of the additional object formation algorithm. Varying dose gel content and selecting radiation processing parameters of radiation treatment facility in accordance with a pre-planned cancer patient irradiation procedure, 3D shapes of the polymerized gel volume, corresponding to the real size of the irradiated (treated) volume were fabricated (3D printing) in gelatin. Polymerized gel volume (tumour imitator) representing free standing object was easily separated from the gelatin, thus making direct measurements of dose gel physical and chemical characteristics possible. Investigation results on these issues will be provided and discussed.

Keywords: 3D printing, free standing dose gels.

References:
AlGaN/GaN HEMT-Type Transducers for Gas- and Chem-Sensing Applications

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In recent years an increase is observed in application of nitrides for gas and bio-chemical sensors. In this sensor two essential elements could be distinguished: transducer part and receptor part. In a result of interaction of analyte with receptor part specific physico-chemical reactions occur in it that cause changes in the properties of the transducer part. Depending on the type of applied transducer the chemical information is changed on other type of energy in form of electrical, optical or acoustic signal. Typically, the semiconductor transducers utilize the field effect. The operation of MISFET (MOSFET), MESFET and HEMT transistors are based on this effect. In the general case, the transistors could be used as a transducer in which the metallic gate was replaced by receptor part. From many years the silicon ISFET transistors were used as a transducer. In recent years, because of higher electrons mobility, the ISFET transistors are replaced by HEMT transistors. Because of chemical and thermal stability the nitrides were proposed for HEMT transistors fabrication process. AlGaN/GaN heterostructure with AlGaN or AlN or GaN cap layer could be applied for this purpose [1]. The operation of AlGaN/GaN HEMT transistors is based on the modulation of the sheet carrier concentration of 2DEG, in triangular potential well, that is formed in the GaN layer near the AlGaN/GaN interface. The electrical response of AlGaN/GaN HEMT-type transducer could be the change of the channel resistance, alteration of the drain saturation current or the change of pinch-off voltage of the channel. Depending on the type of applied receptor layer the HEMT type AlGaN/GaN transducers could be used as a gas sensors or for sensing of various types of biological and chemical substances. There was also found that exposed surface of transducers reacts on changes of electrolyte pH [2] that should enable elaboration of semiconductor pH sensor. However, in hydrogen sensor as a receptor part the thin metal layer of palladium or platinum are applied that catalyse the dissociation of gas molecules.

Keywords: AlGaN/GaN HEMT transducers, 2DEG, piezotronic.

Acknowledgments:
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References:
Analysis of the Acoustic Waves Propagation Conditions in High Electron Mobility Transistors

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AlGaN/GaN heterostructures are a basic element of High Electron Mobility Transistors (HEMT). Additionally, they are applied for fabrication of different types of electromechanical devices. First mentioned application, is based on the phenomena of potential well formation on the AlGaN/GaN interface, inside which two-dimensional electron gas (2DEG) is located and forms HEMT’s transistor channel. The operation of electromechanical devices is based on the utilization of the piezoelectric effect that exists in nitride (AlIIIN) materials. Both applications areas are joint since the classical AlGaN/GaN HEMTs are fabricated in AlGaN/GaN heterostructures of (0001) crystallographic orientation and during HEMT operation electric potential gradient is aligned with the direction of piezoelectric susceptibility. As a result, during their operation, acoustic waves might be induced between source, drain, and gate areas of the transistor that could propagate both in surface and bulk modes. Numerous literature data confirm the existence of this coupling effect and propose to utilize it for the designing of various type of the devices such as resonators or transducers [1-3]. However, the published articles are mostly focused on the designing of different sensor types. On the contrary, the presented research results aim to describe emission conditions of different modes of the acoustic waves that are created as a result of the interaction between 2DEG carriers and transistor electrodes, and their propagation along the substrate. The possibility of acoustic waves coupling between different elements on the same substrate is also evaluated. This topic is essential for further advancement of GaN applications especially for fabrication of monolithically integrated devices that combine active electrical elements and MEMS modules.

Keywords: nitrides, high electron mobility transistors, semiconductor acoustic.

References:
Excitation of Surface Plasmon Polaritons by Fluorescent Light from Organic Nanofibers

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Micro- and nano-scale systems with defined active elements acting as local surface plasmons polariton (SPP) sources are crucial for the development of future plasmonic circuits. We demonstrate SPP excitation by fluorescent light from crystalline organic para-hexaphenylene nanofibers deposited on a dielectric/metal surface. We characterize the SPPs using angle-resolved leakage radiation spectroscopy, in the excitation wavelength range 420 - 675 nm, corresponding to the nanofiber photoluminescence band. The nanofiber arrangement’s capability to act as an SPP coupler for coherent as well as non-coherent excitation indicates its prospect for future integrated systems. To support our experimental results, we investigate the proposed geometries by analytical calculations and finite-difference-time-domain (FDTD) modelling. The experimentally obtained angular leakage radiation peak positions can readily be predicted by our analytical calculations. Nevertheless, the experimental results exhibit a distinct asymmetry in the peak intensities. In agreement with our FDTD calculations, we address this asymmetrical SPP excitation to the nanofiber molecule orientation. The proposed structure’s high flexibility, the ease of selective positioning of organic nanofibers, together with the gained insight into its photon-SPP coupling mechanism show great promise towards future local SPP excitation-based integrated devices.

Fig. 1. Experimental setup scheme and sample structure

Keywords: surface plasmon polaritons, organic nanofibers, leakage radiation spectroscopy, surface plasmon coupled emission.

References:
POSTER PRESENTATIONS
P1. Tuning of the Optical Properties of Alloy Nanoparticles with Varied Compositions Sputtered from One Target

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Optical properties like particle plasmon polaritons of elemental noble metal nanoparticles were well studied over the past years. Recently, alloy metal nanoparticles have generated increasing interest due to their additional functionalities. In this work the optical properties of multiple stacks of silver-gold alloy nanoparticles in a transparent matrix are investigated. Nanoparticles were deposited using a Haberland type single DC magnetron gas-aggregation-source and are incorporated into a silicon dioxide matrix (pulsed reactive DC magnetron sputtering). UV-vis transmission spectra were obtained on samples where the gold concentration in the nanoparticles was varied from 60 to 75 at% leading to corresponding shifts of the plasmon resonance peak positions. Furthermore, the influence of nanoparticle agglomeration on the appearance of the plasmon absorption band was analyzed which could allow optical control of the deposition process.
P2. Formation and Optical Properties of Tl-M-Se (M = Ga, Cu, Ag) Layers on Polyamide 6

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Thallium chalcogenide semiconductors are not only of great current scientific interest but also are prospective materials for modern applications. TIMX₂ crystals reveal essential optical activity. Owing to this, they are stable in a wide temperature range, up to several hundred degrees centigrade. Therefore, they are considered prospective materials for application in optoelectronics, for example, in the design of Terahertz detectors [1]. But very few attempts have been made for the investigation of thallium selenide films prepared by using CBD method.

In this work, mixed Tl-M-Se (M = Ga, Cu, Ag) type selenide layers on polyamide 6 were formed using modified CBD method, involving three steps process. In the first stage, PA 6 samples were selenized in K₂SeS₂O₆ salt solution. Next, to form thallium selenide layers, selenized samples were treated in thallium (I) sulfate salt bath. Finally, the samples were immersed in Ga(III), Cu(II/I) or Ag(I) salt solutions. Transmission and reflection spectra were performed in the 200-1100 nm range to obtain the values of band gap (E₉) and band tail width (Urbach energy, Eₚ) of the localized states [2]. This exponential tail appears in the low crystalline, poor crystalline, the disordered and amorphous materials [3]. Red shift in absorption edge and reduction of the bandgap energy were observed after treatment in Ga(III), Cu(II/I) or Ag(I) salt solutions. The optical absorption of investigated layers may be classified under direct forbidden transitions. The optical bandgaps obtained using Tauc plot [4, 5] correspond to the onset of optical absorption, observed in the optical density plot. Relatively lower Urbach energy of Tl-Cu-Se indicates minimal local structural disorder and defects in the structural bonding [3].

<table>
<thead>
<tr>
<th>Compound</th>
<th>Direct E₉, eV</th>
<th>Indirect E₉, eV</th>
<th>Eₚ, eV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tl-Se</td>
<td>2.16</td>
<td>1.84</td>
<td>0.54</td>
</tr>
<tr>
<td>Tl-Ga-Se</td>
<td>1.13</td>
<td>0.82</td>
<td>0.66</td>
</tr>
<tr>
<td>Tl-Cu-Se</td>
<td>1.86</td>
<td>1.70</td>
<td>0.33</td>
</tr>
<tr>
<td>Tl-Ag-Se</td>
<td>1.34</td>
<td>1.12</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Keywords: thallium selenide layers, polyamide, CBD, optical bandgap.

References:
P3. Characterization of Al$_2$O$_3$ Ceramic Coatings Prepared by Plasma Spraying

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Nowadays it is quite common to see degeneration of metallic surfaces arising from continuous use and is quite perilous. [1] One of the ways to counteract this is by employing ceramic coatings prepared by atmospheric plasma spraying (APS), the reason pertaining to a high flame temperature coupled with a high degree of particle velocity as to produce a condition of high melting point. APS depends pretty much on the torch power of operation which in turn defines the characteristic quality of the coating [2].

Al$_2$O$_3$ ceramic coatings were deposited on stainless-steel substrates using the atmospheric plasma spraying technique [3]. The flow rates of air and hydrogen were set at 4.7 g/s and 0.1 g/s respectively. The employed torch powers were ~37.3, ~40.4 and ~43.1 kW. The surface roughness of the alumina coatings was measured using a Mitutoyo Surftest-SJ-210-Ver2.00 profilometer. The surface morphology was examined using a scanning electron microscope (SEM) Hitachi S-3400N. The elemental composition of the coatings was realized using energy dispersive X-ray spectroscopy (EDS) Bruker Quad 5040 spectrometer. The tribological properties of the samples were measured using a CETR-UMT-2 tribometer.

It could primarily be noted that with increase in torch power the surface roughness increased from 3.79 µm to 4.56 µm and the root mean square roughness from 4.68 µm to 5.57 µm. With increase in torch power it could also be noticed from EDS measurements that the normalized atomic percentage of oxygen had increased from 54.3% to 55.8%. The surface order of the samples was clearly disordered with increase in torch power as seen from SEM. Considering the tribological properties, with increase in torch power the friction coefficient increased from 0.718 (at ~37.3 kW) to 0.729 (at ~43.1 kW) and the normalized wear rate decreased from 12.3 x 10$^{-5}$ mm$^3$/Nm (at ~37.3 kW) to 8.17 x 10$^{-5}$ mm$^3$/Nm (at ~43.1 kW).

**Keywords:** plasma spraying, ceramic coatings, tribological properties.

**References:**
P4. Influence of α-Tricalcium Phosphate Crystallinity on Cement Formation

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INTRODUCTION: Calcium phosphates have been used in orthopaedic surgery for several decades. Due to their similarity to the natural bone, calcium phosphate cements (CPC) are able to successfully adapt to the body as well as integrate into the bone structure, filling bone defects. Different level of reactant crystallinity made by synthesis and heat treatment have not yet been investigated for the influence on the rate of cementation. Our goal is to produce porous calcium deficient hydroxyapatite from the hydrolysis of tricalcium phosphate [1] using source materials with a different crystallinity. Alfa tricalcium phosphates (α-TCP) when mixed with water undergoes the following hydrolysis reaction:

$$3\alpha-Ca_3(PO_4)_2 + H_2O \rightarrow Ca_9(HPO_4)(PO_4)_5OH.$$ 

MATERIALS AND METHODS: Powder was prepared by precipitation of calcium nitrate and dibasic ammonia hydrogen phosphate solutions in alkaline medium, filtration, washing and drying at 120 °C. To obtain α-TCP at different levels of crystallinity, synthesized powder was heated at elevated temperatures (625-900 °C) for 10 min. Cementation reactions were carried out by mixing α-TCP powders with water and placement in a humid environment at 38 °C for different time periods (1-24 h). XRD and FTIR methods were used to characterize the starting powder and determine the cementation reaction. Further analysis was completed by Rietveld analysis of XRD data and deconvolution of FTIR spectra.

RESULTS AND DISCUSSION: XRD results showed that crystallinity of α-TCP increased with temperature, as confirmed by Rietveld refinement. Cementation results showed the formation of CDHA at shorter times for smaller crystal size containing powder - cementation was faster for powders heated at lower temperatures.

Fig. 1. XRD diagrams of α-TCP powders showing crystallinity increase by increasing the temperature (left); cementation reactions of α-TCP powder heated at 700 °C (right)

Keywords: calcium phosphate cements, cementing reaction, crystallinity.

References:
P5. Electrospun Nanofibrous Webs an Their Structure Estimation

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Electrostatic fiber spinning (electrospinning) basically belongs to the field of nanotechnology. First appearance of this technology are the patents of Cooley and Morton submitted in 1902. The method was later perfected by the inventions of Formhals in the 1930’s but in the absence of modern characterization methods and due to the limited potential fields of application in begining of 20th century the electrospun nanofibers gained considerable attention only in the past two decades. Electrospinning is remarkably a simple and versatile method for producing nanofibres [1]. During the electrospinning the web of nanofibres is manufactured by means of electrostatic forces between two electrodes. The diameters of nanofibres usually differ and they depend on various parameters. The diameter of nanofibres can vary from 10 nm to >1000 nm. In electrospinning, most of the attention is focused on producing fibres with a uniform diameter. It is very important to understand how the diameter and its distribution vary with the materials used and the processing parameters [2, 3].

In the electrospinng a web of nanofibres usually consisting of nanofibres of different diameters. There is no one opinion about the reasons for such phenomena as the distribution of the nanofibre diameter is also very sophisticated. An analysis of various works shows that the distributions of the nanofibre diameter are always different and usually not close to a normal distribution. Thus it is very difficult to compare average values when the dispersions of diameters are different. The main problem is that the measurements of the diameter are distributed in an unclear distribution and to characterise webs mathematically and evaluate the shape of the distribution obtained is not easy [4, 5]. The different fineness of fibres influences the structure of the web and herewith the end-use properties of such kind of nanomaterial.

Another parameter which characterise the structure of nanofibrous web is porosity. The porosity can be described as maximum value of pore diameter in electrospun web. Especially such evaluation is important for nanofibrous webs of barrier application, which are used, for example, for antimicrobial protection. Analysis of webs show a very big inequality of pores diameters in different places of nanowebs.

Keywords: electrospinning, nanofibers, structure.

References:
1. N. Tucker et al., Jeff Journal Vol. 7 (2012).
Halogenated organic compounds (HOCs) have been frequently used in industry and disposed into wastewater despite their toxicity and suspected mutagenicity. Due to HOCs refractoriness to typical oxidative water remediation techniques, they became one of the most problematic group of pollutants. As an alternative, reduction of halogenated organic compounds was successfully employed in electrosynthesis and abatement of environmental pollutants by their conversion to less harmful compounds [1,2]. However, it occurs at very negative potentials in aprotic media, what is disadvantageous due to the high energy requirement. It also requires transfer of HOCs from aqueous media to aprotic media. The scope of this study was to reduce HOCs in water environment/aqueous solutions and to examine the possibility of direct elimination of HOCs without a need for electrolyte change. To shift the reduction threshold to less negative potentials, materials with enhanced electrocatalytic activity toward HOCs reduction (eg. silver) are intensively studied. It is surprising that Ag nanowire arrays have only once been used for electrocatalytic reduction of HOCs directly in water [3]. We postulated, that Ag nanowire array electrodes should exhibit better electrocatalytic properties toward reduction of chloroform directly in water in comparison with bulk silver electrode.

The aim of this research was to synthesize and investigate electrocatalytic reduction of chloroform directly in aqueous solutions at nanostructured Ag electrodes with different morphologies, and compare the obtained results with a silver bulk electrode. The two-step anodization process and voltage detachment method was used in order to obtain highly ordered, through-hole anodic aluminum oxide (AAO) membranes that served as templates to synthesize silver nanowires. The electrocatalytic properties of synthesized nanostructured Ag electrodes were investigated by various voltammetric techniques. We have proven unique properties of the Ag nanowire array electrodes toward reduction of chloroform in water. Due to reduction potential threshold less negative then potential of water decomposition, our novel electrodes can be successfully used in future as sensors for chloroform in aqueous solutions. Due to the lower energy consumption requirement they can be also used in aprotic media for organic synthesis.

Acknowledgement:
The research was financed by the Polish National Science Centre (Decision number: DEC-2015/19/N/ST4/00313)

References:
Holographic lithography (HL) is a relatively cheap and highly efficient technology suitable to pattern periodic structures of pitch sizes ranging from a few microns to a few nanometers [1]. Even though HL is not suitable for general purpose lithography it has acquired significance for its efficiency in fabricating gratings, hole and pillar arrays that have numerous applications in forming microsieves, nanowires, photonic crystals, etc.

In this work a Lloyd’s mirror interferometer setup is used. The setup utilizes a solid state UV (λ=371 nm) laser (CrystaLaser) with a coherence length of at least 20 m and a spatial filter to expand a beam before it reaches the interferometer stage. Achievable pitch sizes range from 200 to 800 nm.

The grating structures were imposed in positive tone photoresist film (ma-P 1205, micro resist technology GmbH) spin-coated on silicon substrates (6000 rpm, thickness <0.5 µm). Exposed photoresist developed 10 s in MF-26A developer (MicroChem Corp.). The Figure 1 shows an SEM images of typical samples with 250 nm pitch sizes of line and hole arrays.

Fig. 1. SEM micrographs of the patterned structure: 250 nm pitch line array (a) and 250 nm pitch hole array (b)

The periodic structures can be formed over a patterning area of a few cm².

**Keywords:** holographic lithography, Lloyd’s mirror, interference lithography, ma-P 1205, periodic nanostructures.

**References:**
P8. Highly Resistant UV Waveplates Based on Nano-Structured Anisotropic Coatings

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²Vilnius University, Laser Research Center, Saulėtekio Ave. 10, LT-10223 Vilnius, Lithuania

Polymers, solid or liquid crystals and other materials with anisotropic refractive index can be used for production of waveplates. Unfortunately, most of aforementioned materials are fragile, unstable when environmental conditions changes, difficult to apply in microsystems or has low resistance to laser radiation. Retarders, fabricated by evaporating sculptured anisotropic thin films, do not consist any of these drawbacks. A thin films based waveplate can be deposited on micro optics or other optical elements, essentially improving compact optical systems.

Fig. 2. a) Principal illustration and SEM image of anisotropic and dense layers
b) Transmission of evaporated λ/4 waveplate

Researches indicate that the continuous deposition of nano-structured silica layer results in considerable optical losses. The expansion and coalescence of individual columns causes significant light scattering in UV spectral region. A novel approach was devised to overcome this drawback. Combination of homogenous and anisotropic thin films (Fig. 1a) resulted in multilayer waveplate with low optical losses and high transmission (Fig. 1b) at the wavelength of 355 nm (T~99%). The design also enables to produce all-silica based UV waveplate with high laser induced damage threshold: 24.4 J/cm² for the wavelength of 355 nm (pulse duration – 5.4 ns, beam diameter – 59 µm).

Keywords: sculptured thin films, waveplates, evaporation, high-power lasers.
P9. All-Silica Based Optical Coatings Produced by Tailoring the Porosity in Thin Films

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Optical coatings have been widely used in laser systems for control of light intensity or polarization state. Standard coating designs are limited by constituent materials refractive indexes. Therefore, inducing the porosity in thin films expands the indexes of choice and allows to form more advanced multilayer optical coatings. Glancing angle deposition (GLAD) have been used to produce various so-called sculptured thin films. Porosity have been artificially engineered by forming vertical columnar nano-structure (Fig. 1). Multilayer anti- and high-reflection coatings have been produced by tailoring the refractive index of silica (Fig. 2) in constituent layers.

Fig. 1. SEM image of silica thin film cross-section, deposited at 85° angle

Fig. 2. Refractive indexes of silica by depositing at different angles

All-silica based optical coatings, produced by GLAD method, indicated high resistance to laser radiation. Anti-reflection coatings, for the wavelength of 355 nm exhibited 16 J/cm² laser induced damage threshold [1]. The production of high reflectivity mirrors resulted in coatings, capable to withstand more than 65 J/cm² for the wavelength of 355 nm in nanosecond regime. Both optical coatings have been fabricated by tailoring the porosity of high band gap material and analyzed in detail by various methods.

Keywords: sculptured thin films, silica, evaporation, laser damage.

References:
P10. Structuring of CVD Grown Graphene by Femtosecond Laser

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Phototiesists impurities robustly affect graphene charge carrier concentrations and mobility trough doping and scattering, respectively. Therefore, photoresist free structuring methods of graphene is strongly desirable for further technology development. In this work, we present our study on microstructuring of graphene by femtosecond laser. Graphene was grown by atmospheric pressure CVD method using n-decane as a precursor and further transferred on SiO₂/Si substrate by wet method [1]. The structuring was performed by 400 fs, 1030 nm laser with 200 Hz repetition rate. The matrix of 30 x30 ablated areas where the laser power and the density of spots gradually changed was made in order to verify the optimum conditions for graphene patterning. Finally, based on the evaluated conditions, 70 μm width graphene channel was made (Fig. 1a). Raman spectroscopy investigations (Fig. 1b) reviled the absence of graphene and low damage level of SiO₂ in ablated area.

Fig. 1. Optical image of the graphene structure made by pulsed fs laser (a) and l₂D/l₆ map of the central part of the channel.

Keywords: graphene, lithography, pulsed laser.

References:
Ultrafast Dynamical Electrooptical Properties of New Dendritic Molecules Comprising Various Cores and Triphenylamine-Based Arms

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An electron transfer process and subsequent twisting of organic molecular fragments, that consist of the electron donating (D) and accepting (A) parts linked by a single bond, which occurs upon photoexcitation, is called twisted intramolecular charge transfer (TICT) [1]. This phenomenon is attractive due to its wide range of applicability, including sensing, photoswitches, organic light emitting diodes (OLEDs), solar energy conversion with twisted D–A systems [1].

Excited state dynamics of trinary star-shaped triphenylamine-based dendritic compounds (TPA-TPA, TPA-TPB, TPA-TRZ) with different cores were investigated in different polarity solvents by means of steady-state and time-resolved fluorescence and transient absorption spectroscopy methods.

The analysis of dendritic compounds shows that TPA-TRZ consists of strong donor and acceptor parts, TPA-TPA strong donor-strong donor and TPA-TPB strong donor-weak acceptor. That corresponds with steady-state and time-resolved fluorescence spectra dependence on solution polarity of the solvent. TPA-TRZ is the most sensitive to the polarity of solvent while TPA-TPA shows the least sensitivity of all the compounds.

**Keywords:** twisted intramolecular charge transfer, solvatochromism, transient absorption, time-resolved fluorescence, D-A system.

**References:**
P12. Structural Properties of Temperature-UV Affected Fluorinated Ethylene Propylene Film

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Due to the high thermochemical stability, transmittance in UV-VIS-IR spectral range and resistant to aging fluoropolymer materials find many applications in piping, textile, aerospace, automotive, medical industry [1]. Fluoropolymers are very attractive compounds because of their versatility and their unique physical and chemical properties.

In this work, a piezo-actuated testing device has been developed for measuring the elastic and plastic properties of fluorinated ethylene propylene (FEP) (see Fig. 1). The tensile test results revealed a major difference in the material deformation mechanism as the stress was applied in the different direction of the polymer chains. The microstructure changes of the temperature, and temperature-UV affected fluoropolymer were investigated by XRD. Additional nanosecond pulsed laser treatment of FEP polymer were used. The diameters of the laser-ablated areas were measured with an optical microscope. The results confirmed the ability of the custom-built equipment for the measurements of very small load and displacement levels, which are a prerequisite for such type of investigations. Crystallinity of the FEP varies between 43 and 45 % depending on processing conditions. The ablation threshold values decrease with increasing the number of pulses. The threshold values are smaller for the heat treated FEP polymer by the factor of ~ 10.

**Keywords:** crystallinity, microtensile, fluoropolymer, ablation threshold.

**References:**
Pressure Induced Changes in Aggregation Structures of Polyimide Films Probed by Fluorescence Spectra

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Polyimides (PI) are widely used as high-performance engineering plastics exhibiting high thermal stability and mechanical strength. Recently, PIs having isomeric structures have attracted interests due to their unique thermal and optical properties. We have reported the relationships between the aggregation structures and optical properties of aromatic PIs analysed by synchrotron wide-angle X-ray diffraction and optical spectroscopy at very high pressure up to 8 GPa [1-3]. In this study, pressure-induced changes in aggregation structures of PIs having bent structures in the main chains were investigated based on the fluorescence spectra at elevated pressures.

The structures of PIs used in this study are shown in Fig. 1a. To generate high pressure up to 8 GPa, PI films were loaded into a diamond anvil cell (DAC) (Fig. 1b). The fluorescence spectra of aBPDC-3HPA PI under high pressures are shown in Fig. 2a. A significant reduction in the fluorescence emitted from the end group (3-HPA) was observed, which is originated from the enhanced intermolecular energy transfer due to the compression of inter-chain free volume. The normalized fluorescence intensities of sBPDC-3HPA and aBPDC-3HPA PIs are plotted against the pressure (Fig. 2b). The latter PI having a bent structure showed more significant reduction, indicating a looser aggregation structure than the former. As a consequence, fluorescence properties are useful to examine the amount of free volume at atmospheric pressure as well as the pressure-induced variations in aggregation structures of PIs having isomeric structures.

Keywords: polyimide, high pressure, aggregation structure, fluorescence.

P14. Synthesis of Graphene by Microwave Plasma Enhanced Chemical Vapor Deposition

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The application of graphene for next generation nanotechnology requires high quality films with low defect density and high uniformity. Among various synthesis techniques, microwave plasma enhanced chemical vapor deposition (MWP CVD) in an atmosphere of methane/hydrogen mixture is regarded as the most promising method to produce high quality monolayer graphene with complete surface coverage. The copper is commonly used as the catalytic substrate for graphene growth, which is the thin film prepared by physical vapor deposition or commercial bulk foil. The carbon solubility in copper is imperceptible and graphene grows on copper by a surface reaction process. Different methods such as Cu electropolishing, pre-growth annealing and selection of Cu (111) orientation highly improves the quality of graphene growth process.

![Image of Raman spectrum and plasma system]

**Fig. 1.** a) Raman spectrum of graphene on SiO₂/Si substrate; b) “Iplas” innovative plasma system

A typical Raman spectrum of graphene (Fig. 1a) confirms its nature. The intensity ratio 2D/G ≈ 2 testifies single layer graphene. Microwave plasma enhanced chemical vapor deposition method has advantage over other synthesis techniques, which enables the formation of high quality and uniform graphene films over large area.

**Keywords:** graphene, microwave plasma enhanced CVD, Raman spectroscopy.

**References:**
P15. Formation and Analysis of Periodic Metalceramic Nanocomposite Structures

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The membranes of Anodic Aluminium Oxide (AAO) display a wide range of applications due to cylindrical nanopores in the structure. By applying a regular anodizing process, the distribution of pores become irregular, but a two-step anodizing process produce regular distribution of hexagonal nanopores, which reaches nanometric scale.

AAO membranes are often used as a frame seed for production of various nanomaterials: Nanodots, Nanowire, Nanotubes and other. It might be applied also in biomedicine as an excellent filter for separation of biomolecules. For specific uses AAO membranes can be modified: coating with thin films or nanoparticles, integrating nanoparticles inside the nanopores. This way a metaloceramic nanocomposite is produced, which display unique structural and optical properties.

In this work a AAO membrane is formed from a plate of pure aluminium by applying a standard two-step anodizing technology. The result was a surface hexagonal structure, where the width of one structural element is 110 nm, diameter of pores is around 90nm (Fig. 1).

To fill the pores of the membrane a solution of 30-40 nm diameter spherical silver nanoparticle (Fig. 1b) was synthesized and by submerging a mataloceramic nanocomposite was formed. Presenting its structural and optical properties.

**Keywords:** anodic aluminium oxide membrane, nanopores, nanoparticles, nanocomposite.
P16. Excitation of Optomechanical Resonances in Monodisperse Plasmonic Nanocubes

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Plasmonic properties of metal nanoparticles have received great interest in the scientific community because of their unique optical, electrical, and catalytic properties. Due to these features, they can be used as components in diverse applications including photonics, optoelectronics, catalysis, photovoltaics, nanomedicine, as well as chemical and bio-sensing [1]. It is known that plasmonic nanostructures support coherent mechanical oscillations that can be observed with transient absorption spectroscopy (TAS) [1]. In this work, we examined monodisperse solutions of Ag nanocubes with different edge lengths ranging from 40 nm to 100 nm. We observed coherent oscillations that could be modeled as frequencies of a damped oscillator. The results suggest that oscillation period (20-500 ps), damping time (30-160 ps), phase and Q factor (6-22) all depend sensitively on the nanocube edge length. Fourier analysis revealed number of mechanical resonances that could be related to different eigenmodes. Theoretical Ag nanocube thermal expansion analysis in the frequency domain was performed by Finite element analysis (Fig. 1).

![Fig. 1. Dominant mechanical eigenmode of a 36 nm nanocube at 56 GHz](image)

**Keywords:** localized surface plasmons, transient absorption spectroscopy (TAS), Ag nanocubes, mechanical oscillations.

**References:**
We present the results of simulation of plasmon effects in graphene/dielectric/metal heterostructure, where metal layer serves as a gate and tunes chemical potential and charge carrier concentration. The dynamic conductivity \( \sigma(\omega) \), being a function of carrier concentration and chemical potential, also depends on gate potential and its variation leads to changes in parameters of electromagnetic radiation (EMR) interaction with graphene, namely in the transmission and absorption coefficients.

In this article, the transmission and absorption coefficients for EMR in terahertz domain (0.5-12 THz) are calculated as a function of gate potential \( V_G \), dielectric thickness, temperature, and the density of surface states at the graphene/dielectric interface. The equations describing EMR interaction with graphene are evaluated from Maxwell equations, whereas the conditions for nontrivial solutions [1] are applied for these equations in order to evaluate the dispersion relation containing the transmission and absorption coefficients. The dynamic model [1,2] is used for simulation of graphene conductivity as function of chemical potential, \( \mu \). In its turn, the value of \( \mu \) is determined by gate potential, \( V_G \). In order to express \( \mu(V_g) \) function, we use integral equation for charge carrier concentration as a function of chemical potential together with electrostatic equation of the heterostructure, that links gate potential, charge carrier concentration, capacities of dielectric \( C_{ox} \) and surface states \( C_{it} \) [3].

The results obtained for \( \mu(V_g) \) dependence allow to evaluate the pattern describing variation of dynamic conductivity \( \sigma(\omega) \) with gate potential and properties of heterostructure materials. In the framework of this model, the transmission and absorption coefficients of EMR for graphene heterostructure together with plasmon wavelengths are calculated based on the dynamic conductivity dependence on heterostructure parameters \( (V_G, C_{ox}, C_{it}) \) and parameters of graphene (relaxation time, \( \tau \), and Fermi velocity, \( v_F \)). Finally, we demonstrate that for certain combinations of the parameters the frequency dependences of the transmission and absorption coefficients have resonances.

Keywords: graphene, plasmons.

References:
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Colourful images and animation effects seen by the observer looking at the various kinds of the holographic security means can be explained using conical diffraction formalism [1]. It is a type of diffraction that occurs when the light incident on a diffraction grating is not perpendicular to the grooves of the diffraction grating. One of the most widely used technology for producing of anticounterfeit security labels are dot-matrix holograms [2]. Holograms are usually comprised of an array of spots that contain diffraction gratings with selected pitch and orientation that are imposed on the reflecting surface. Rendering of the images formed by these holograms as perceived by a human observer (or by a detector that is sensitive to one or many wavelengths of light, Fig. 1) can have range of practical applications in the fields of production and authorization of the dot-matrix holograms by an image specific recognition at predefined illumination conditions.

The proposed rendering algorithm considers the parameters of the hologram itself such as grating pitch, relative orientation, and the diffraction efficiency for different wavelengths as well as the hologram illumination conditions such as the angle of incidence and spectrum of incident light. Designed holograms will be produced via femtosecond laser beam interference ablation on different metal surfaces and images of the imposed holograms will be validated employing experimental setup. The code will be implemented in an application for the mobile device.

Fig. 1. A computer rendered true colour image of a dot-matrix hologram

Keywords: conical diffraction, dot-matrix hologram, image render.

References:
Ultra-short laser pulse interaction with matter is a fascinating field that has attracted a lot of attention over the recent years [1]. High peak power, ultra-short electromagnetic pulses interact with matter in a non-linear way, thus creating potential for advanced 3D micro-machining technologies. Specifically, for transparent materials, i.e. fused silica (FS), sapphire, a technique called femtosecond laser induced chemical etching (FLICE) has emerged [2-4].

Using this technique, a tightly focused femtosecond laser beam is scanned inside a transparent material. Due to non-linear interaction, part of the light is absorbed. In case of fused silica, three types of material alterations are possible [4]. The second type modification related to formation of silicon rich areas demonstrates reasonable etching selectivity in HF or KOH. By providing proper windows for the etchant to reach laser-exposed parts, any arbitrary 3D shape can be formed. However, there are several laser writing parameters to consider when searching for optimal fabrication speed. In this research, dependencies of pulse density, scanning speed and pulse energy on the etching rate of fused silica in KOH are investigated.

Figure 1 depicts channels in fused silica etched by KOH after a single-pass scan of differently spaced individual lines using a second harmonic of Yb:KGW femtosecond laser PHAROS (Light Conversion) and XYZ sample translation performed by laser microfabrication setup FemtoLAB (Altechna R&D). Achieved validation of FLICE technique will enable to further investigate non-linear processes of light-matter interaction and develop an advanced technology for realization of novel 3D microfluidic channels towards lab-on-a-chip devices.

Fig. 1. Microchannels formed in fused silica employing FLICE technique – single line passes with varying spacing (5 µm, 3 µm, 1 µm)

Keywords: femtosecond laser, chemical etching, fused silica, microchannels.

References:
P20. Preservation of Plasmonic Interactions in DLC Protected Robust Organic-Plasmonic Hybrid Systems

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Gold is the most commonly used plasmonic material, however soft and prone to mechanical deformations. It has been previously shown that the durability of gold plasmonic substrates can be improved by applying a protective diamond-like carbon (DLC) coating [1]. In this work, we investigate the influence of such protective layers on plasmonic interactions in organic-plasmonic hybrid systems. We consider systems, consisting of 1-Cyano-quaterphenylene nanofibers on top of gold nano-square plasmonic arrays [2], coated with protective layers of varying thickness. We investigate the spectral position of surface plasmon polariton resonances as well as electric field intensity, as a function of protective layer thickness, using the finite-difference time-domain method. To confirm the numerically indicated field enhancement preservation on top of protective layers, we experimentally map the second harmonic response of organic nanofibers. Subsequently, we experimentally characterize the plasmonic coupling between organic nanofibers and underlying substrates by time-resolved photoluminescence spectroscopy. Our findings reveal that the optimal thickness for DLC coating, in terms of mechanical protection while preserving plasmonic interactions, is in the range of 25 to 55 nm. This is of a great interest for the fabrication of new plasmonic components with increased durability.

Fig. 1. Left: helium-ion microscopy image of complete DLC protected organic-plasmonic hybrid system - CNHP4 nanofiber on top of DLC coated nano-square array. Right: second harmonic map of CNHP4 fibers on top of DLC coated (25 nm) plasmonic structures. White dashed line indicate the location of the nano-square plasmonic array.

Keywords: organic plasmonic hybrids; diamond-like carbon (DLC) protective layer; second harmonic mapping; time-resolved photoluminescence, Finite-Difference Time-Domain FDTD.

References:
P21. How to Detect Magnetically Labeled Cells Using Magnetoelectric Sensors

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The detection of magnetically labeled cells has been of great interest in recent years and holds significant possibilities in the field of biomedical sciences for the nondestructive and non-invasive imaging of cells in 3D scaffolds. Here, a new detection method using magnetoelectric (ME) sensors is introduced where, similar to magnetic particle imaging (MPI), the nonlinear magnetization behavior of magnetic particle ensembles is used to detect higher harmonic excitations. These ME sensors, consisting of magnetostrictive and piezoelectric layers on a cantilever, show very high sensitivity anisotropy and sharp mechanical resonance, which leads to selective signal acquisition with regard to spatial orientation and excitation frequency. Using such inherent features of the sensor and the nonlinear magnetization behavior of nanoparticles, the objective is to detect and locate cells by scanning over the sample with the detector while applying a homogeneous alternating magnetic field. To achieve this objective, we formulate the restrictions and necessities of the detection system and show the feasibility of this approach.
Nanosystems that specifically target tumours are expected to rise as a new generation of anticancer therapy [1] which could enhance therapy efficacy and reduce the side effects of anticancer drugs [2]. Carbonic anhydrase IX (CA IX) is a promising protein for cancer targeting as it is expressed in cancer cells under hypoxia conditions and is localized on the outer cell membrane [3]. We developed a porous silicon (PSi) based nanosystem for targeted cancer therapy.

Firstly, PSi NP functionalized with carboxyl group were conjugated with the amine functionalized polyethylene glycol (PEG) using EDC/NHS coupling [4]. Then a selective CA IX inhibitor VD11-4-2 was conjugated to PEG modified PSi nanoparticles (NPs) using CDI based chemical reaction [5]. Conjugation was confirmed using FTIR. NPs were characterized by measuring zeta potential and size during and after synthesis. TEM imaging revealed monodispersity of the NPs.

CA IX binding and inhibition properties as well as in vitro anticancer effect were tested for the developed nanoparticles (NP). Fluorescent thermal shift assay (FTSA) was used to evaluate NPs binding to CA IX. VD11-4-2 modified PSi showed protein inhibition. $K_d$ for modified NP was 0.14 nM compared 0.05 nM for free VD11-4-2. This minor difference could be caused by a part of immobilized compound being inaccessible to the protein. VD11-4-2 modified NP capability to inhibit CA IX was measured using stopped-flow CO$_2$ hydration method. NP inhibited protein with $K_d$ value of 4 nM (free VD11-4-2 $K_d$ was 0.5 nM).

NP were uploaded with DOX and ATP-luminescence based anticancer activity of the NP was measured on MCF-7 breast cancer cells in normoxia and hypoxia conditions. The results showed the free DOX resistance of the hypoxia cells. However, our nanosystem exhibited high activity in hypoxia conditions.

PSi NPs modified with CA IX is a promising nanosystem for further development not only for its targeting ability but also for its promise in fighting against hypoxia caused drug resistance.

**Keywords:** porous silicon nanoparticles, carbonic anhydrase IX, hypoxia targeting, anticancer therapy.

**References:**
P23. Modified Nanoporous TiO\textsubscript{2} Layers as Drug Delivery Systems and Scaffolds for Osteoblasts-Like Cells Culturing

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Nanoporous anodic titanium oxide (TiO\textsubscript{2}) layers have drawn scientists’ attention as potential materials for cell growth and drug delivery systems. It is reported that the topography and physicochemistry of anodic layers determine the cell adhesion, shaping, proliferation and fate [1]. In addition, the modification of TiO\textsubscript{2} layers has the impact on the interaction with drug molecules.

Nanoporous TiO\textsubscript{2} layers were synthesized via a three-step anodization process in an ethylene glycol electrolyte containing NH\textsubscript{4}F and H\textsubscript{2}O. The sodium titanate was formed by soaking the as-prepared TiO\textsubscript{2} layers in a 0.5 M sodium hydroxide solution for 15 min. In order to modify the amorphous TiO\textsubscript{2} samples with 3-aminopropyltriethoxysilane (APTES) the two-step process was applied. The first step included the modification with NaOH. Then, the NaOH-modified TiO\textsubscript{2} samples were immersed in a 1% solution of APTES in absolute ethanol for 2 h. As a result, -NH\textsubscript{2} groups were created on the TiO\textsubscript{2} surface. For biological studies, the osteoblast-like cell line SAOS-2 was used. The cells were seeded on the samples and incubated for 2, 24 and 72 h. In addition, for cells incubated for 2 hours, a medium with or without fetal bovine serum (FBS) was used. The metabolic activity of cells was measured by MTS assay. The osteoblast cell adhesion was examined using a fluorescent microscope. Ibuprofen, a nonsteroidal anti-inflammatory drug, was loaded inside nanopores. The release studies were carried out in a phosphate buffer solution at 37 °C. A desorption-desorption-diffusion model of the drug release was fitted to the resulting profiles. Apatite-forming abilities of ATO layers were examined for non-modified and modified samples. The samples were immersed in the stimulated body fluid (SBF) for 1, 3, 5 and 7 days. The modified nanoporous titanium dioxide layers were characterized by Scanning Electron Microscopy and EDX spectrometry.

**Keywords:** titanium dioxide, APTES, cell culturing, drug delivery systems (DDSs).

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**References:**
P24. The Plant Residue Particles Influence on the Polydimethylsiloxane Properties

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Polydimethylsiloxane (PDMS) is a biocompatible polymer with excellent thermal and chemical resistance, hydrophobicity, gas permeability and other properties. Therefore, PDMS is widely used in different industries, especially in biomedicine and orthopedic applications. However, PDMS show low tensile strength and hardness, high deformability. Various dispersive materials are used to modify silicone rubber structure and properties. Scientists of Institute of Horticulture of Lithuanian Research Centre for Agriculture and Forestry investigate the extracts of various plants. Remaining various plants residue is not efficient used, although it is rich of valuable materials, like fibres, antioxidants, trace elements, etc. Furthermore, the plant residue may possess antimicrobial properties as well. The goal of this study is to investigate raspberries and industrial hemp residue dispersed particles influence on the mechanical properties of PDMS.

Used plant residue particles are irregular shaped and tend to form aggregates. Their size varies in the range of 10 – 200 μm. The hydrophobic nature of particles reduces the PDMS composite surface wettability in 20-35 %. Dispersed particles of raspberries and industrial hemp residue marginally decrease tensile strength of PDMS composites, while their influence on deformation depends on the plant nature. It can be suspected that raspberry particles interact with macromolecules of PDMS and increase elasticity of the network.

**Keywords:** polydimethylsiloxane, plants residue particles, wettability, mechanical properties.
P25. Cr$^{3+}$ and Tb$^{3+}$ Co-Doped YAG: Promising Phosphors for Solid-State Lighting

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Luminescent materials, also known as phosphors, are widely used today. Major applications are used in optical technologies, emissive displays, fiber-optic telecommunication system, lasers and so on and so forth. In last two decades a lot of phosphors were invented. Inorganic phosphors are composed of an inert host lattice and optically excited activator, for example 3d or/and 4f electron metal, such as Ce$^{3+}$, Cr$^{3+}$, Eu$^{3+}$, Tb$^{3+}$ [1-3].

For a successful growth of plant need to satisfy photo-physiological processes, which require light in far-red (700 – 760nm), red (620 – 680nm), and blue (400 – 500 nm) spectral ranges [4]. It is well known that yttrium aluminium garnet (YAG) doped Cr$^{3+}$ possess a broad absorption peak around 450nm and 650nm. These peaks correspond to $^4A_2\rightarrow^4T_1$ and $^4A_2\rightarrow^4T_2$ transitions, respectively. Emission originates in far-red spectral region with $^2E\rightarrow^4A_2$ transition at around 610 – 800 nm. It is noticed that co-doping YAG:Cr$^{3+}$ with Tb$^{3+}$ ions occurs energy transfer from Tb$^{3+}$ to Cr$^{3+}$ ions. In garnets Tb$^{3+}$ [Xe]$4f^8$→[Xe]$4f^75d^1$ low and high spin transitions is observed at around 250nm and 320nm, respectively. Emission originates in red (610 – 635nm ($^5D_4\rightarrow^7F_3$)), orange (580 – 610nm ($^5D_4\rightarrow^7F_4$)), green (535 – 565nm ($^5D_4\rightarrow^7F_5$)) and blue (480 – 510nm ($^5D_4\rightarrow^7F_6$)) spectral regions [2, 5-9].

The energy transfer Tb$^{3+}\rightarrow$Cr$^{3+}$ in garnets was first mentioned in our work group paper [10, 11]. The aim of this study is to continue the started investigation in more detailed way. The synthesis was made by sol-gel route, which is advantageous and useful to get single phase garnets [12].

Keywords: phosphors, optical materials, energy transfer, sol-gel chemistry.

References:
Chemical skin burns are fairly frequent in industry, agriculture and even household setting. One should recognise the importance of first aid and professional treatment provided after an incident. Any delay of first aid treatment after a contact with a particular chemical agent, such as acids, could cause life-threatening burns or even the lethal outcome [1]. For this reason, an immediate application of sodium/calcium-enriched hydrogels is strongly recommended. Additionally, hydrogels containing wound healing active ingredients are commonly used during further ambulant treatment of most chemical skin burns.

Cuttlebone (CB) is a potential marine-derived source of natural calcium. It also consists of other bioinorganic elements, such as magnesium, zinc and iron, and polysaccharide chitin, which all are known as promoters of injured skin healing. In semi-solid preparations, a reduced size of insoluble particles is therein preferred as a guarantee of improved permeability and bioavailability profile [2].

In this work semi-solid preparations for topical treatment were developed on a basis of hydroxyethylcellulose (HEC) and powdered CB. The potential of the prepared HEC-CB hydrogels was evaluated by the biopharmaceutical test in vitro and accelerated stability tests (Fig. 1).

The results showed physicochemical stability of prepared samples and accelerated diffusion of CB particles within a simulated cutaneous layer. Prepared HEC-CB hydrogels could therefore be a promising candidate for complementary topical treatment of wounds caused by chemical burns.

**Keywords:** cuttlebone particles, semi-solid preparation, chemical burns.

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