FTMC
10 METŲ

10 YEARS OF SCIENTIFIC
EXCELLENCE AND
HIGH-TECH INNOVATIONS

ANNUAL REPORT

2019

Message from Director:

10 YEARS OF SCIENTIFIC EXCELLENCE AND HIGH-TECH INNOVATIONS

Every year at this time we have a tradition to look back into the past, as a rule, for a one-year period, to estimate and reconsider **our scientific results, projects and high-tech innovations,** to highlight the **most significant achievements, progressive ideas and valuable attitudes.** However, **the Year 2020 is particular** – we have reached the first significant milestone – the **10 Year Anniversary** of FTMC. This fact inspired us to refresh our insights and turn back to our dim and distant past, into scientific roots (the Institute of Chemistry founded in 1945 and other institutes of Lithuanian Academy of Sciences), to re-examine our technological expertise, comprehensive know-how and assess versatile experience in catalyzation of high-tech innovation-driven companies.

In 2010 we announced **that Trailblazing should be our inherent feature.** This spirit has driven us from the beginning of FTMC development — a difficult, hard and exceptionally busy period of unification of the former Institutes of Physics, Chemistry and Semiconductor Physics – and encouraged us to create **synergies between different scientific activities** with intention to generate and develop the **high-tech business** as well as stimulate **knowledge-based economy** in Lithuania. This feature underlines our distinction from the universities of the country.

The years 2015 and 2016 were enriched with exciting time due to the essential changes – the majority of scientific laboratories have moved to new buildings equipped with modern technological infrastructure in Sauletekio (Sunrise) avenue. **The International Advisory Board** consisting of scientists of the highest academic reputation and representatives of leading companies was formed to embrace extensive know-how and supplement international expertise. **Science and Technology Park of Institute of Physics, Sunrise Valley Technology and Innovation Center** and **LITEK cluster** were created in Savanoriu Ave. 231 as a bridge between applied research and high-tech business.

The years 2017, 2018 and 2019 were full of intensive **evolution in quality, both scientific and technological.** FTMC has acted successfully as an efficient provider of high-tech services for international business and high-tech industry, developer of new prototypes and novel technologies. We have reconsidered our mission giving special emphasis on **generation and capitalisation of scientific knowledge in applied physics, chemistry, and technological sciences promoting thus the evolution of the high-tech industry.** We expressed our values – scientific excellence; versatility and flexibility; the broad but balanced spectrum of basic and applied research; knowledge and mind; effectiveness and networking – believing that it will bring us to success in attaining our ambitious aims.

Thus, the **Decade Annual Report represents an emphatic story of institutional evolution illustrated with the most significant achievements and essential events.**

Today it is my pleasure and obligation to inspire all of you for further hard and focused, persistent and honest work to improve ourselves aiming to extend **limits of knowledge,** smooth **interfaces between different disciplines** and induce **paradigm-changing advances.**

Gintaras Valušis

Director of Center for Physical Sciences and Technology

CENTER FOR PHYSICAL SCIENCES AND TECHNOLOGY

FIZINIŲ IR TECHNOLOGIJOS MOKSLŲ CENTRAS

FTMC 10 METŲ

Editorial board:
Gediminas Račiukaitis, Evaldas Tornau, Rasa Kromkutė

Large Scale Photos: © Hernandez and Sorokina
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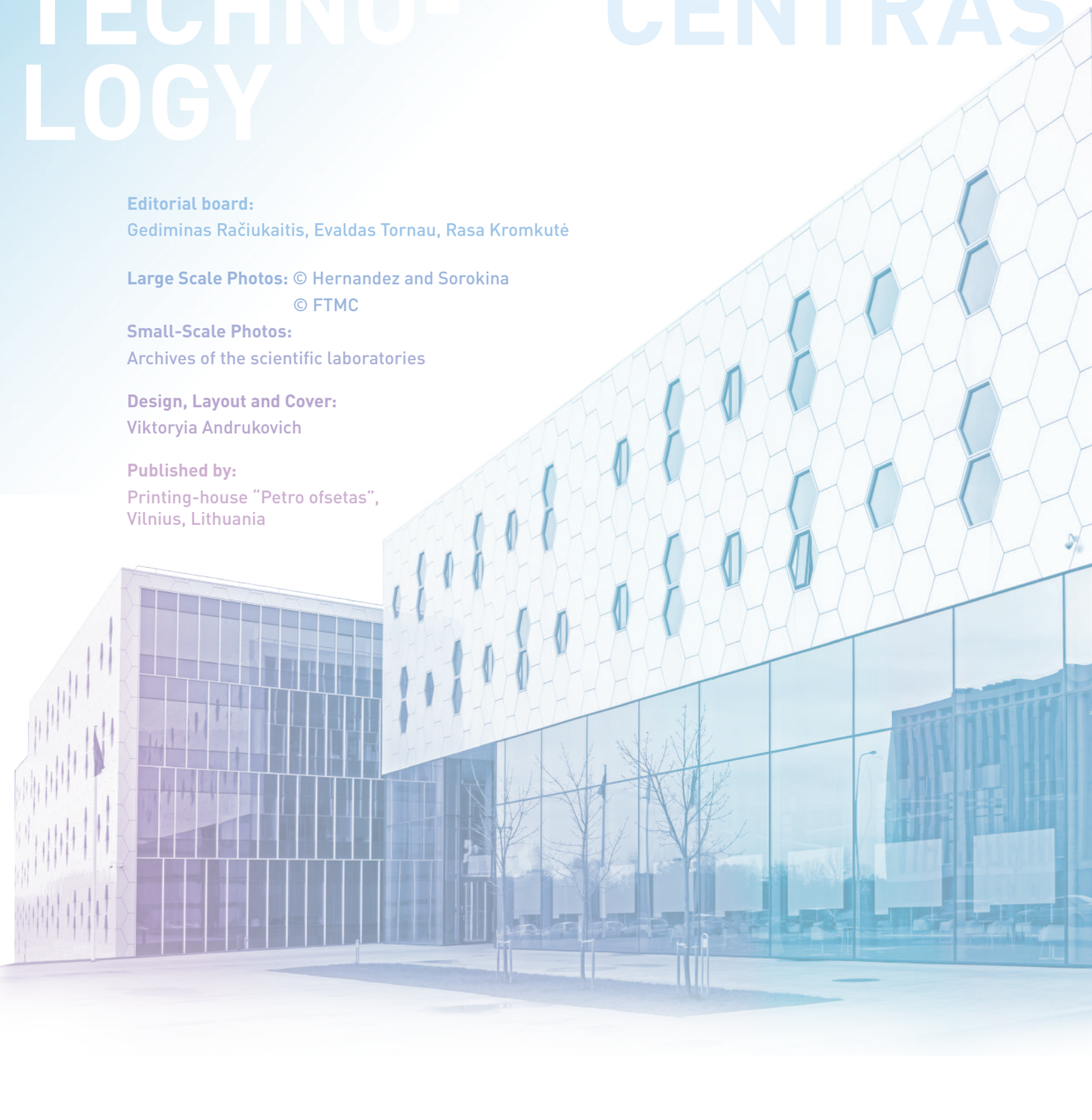
Small-Scale Photos:
Archives of the scientific laboratories

Design, Layout and Cover:
Viktoryia Andrukovich

Published by:
Printing-house "Petro ofsetas",
Vilnius, Lithuania



CONTENTS

10-YEAR ANNIVERSARY OF FTMC

History 4
Map of cooperation 6
FTMC in associations 8
Our spin-outs 10
Conferences we organised 12
Most cited publications and authors 13
Doctoral theses 15
FTMC in figures 2010-2019 21

FTMC IN 2019

Lasers technologies 24
Optoelectronics 30

Molecular physics 34
Nanoengineering 38
Spectroelectrochemistry 40

Functional materials and electronics 42
Nanostructures for applications 46

Astrophysics, Modeling 50
Nonlinear dynamics and chaos 54

Electrochemistry & tribology 56
Materials for catalysis 60

Environment 62
Nuclear 66
Textile technologies 70

Metrology 74
Open access facilities 76

Projects, Events, Awards 78
Publications 84

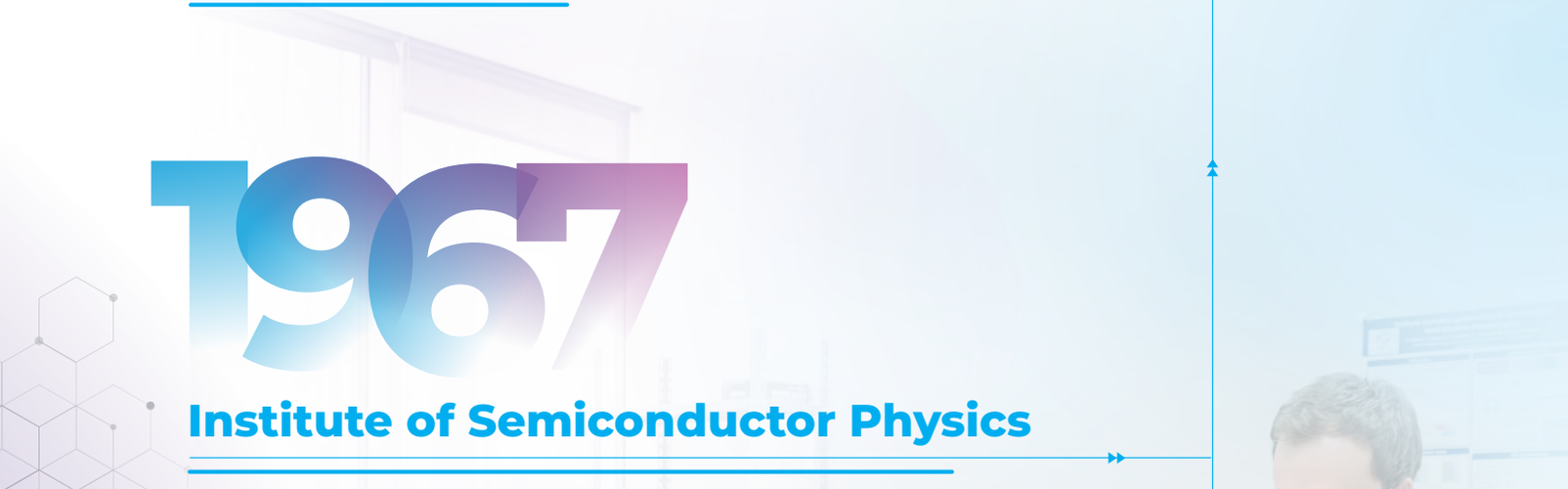
HISTORY

1945

Institute of Chemistry

1977

Institute of Physics



1967

Institute of Semiconductor Physics

1961

Institute of Textile

2011

Magnetic field sensor used for measuring World Record of magnetic field pulse.

Innovative technologies for precise material fabrication with ultrashort pulse lasers.

Development of advanced terahertz imaging techniques.

Method and apparatus for increasing the size of small particles.

2010

Founding of the Center for Physical Sciences and Technology

2012

Evaluation of the material backlog and radiological inventory of Kozloduy nuclear power plant, Bulgaria.

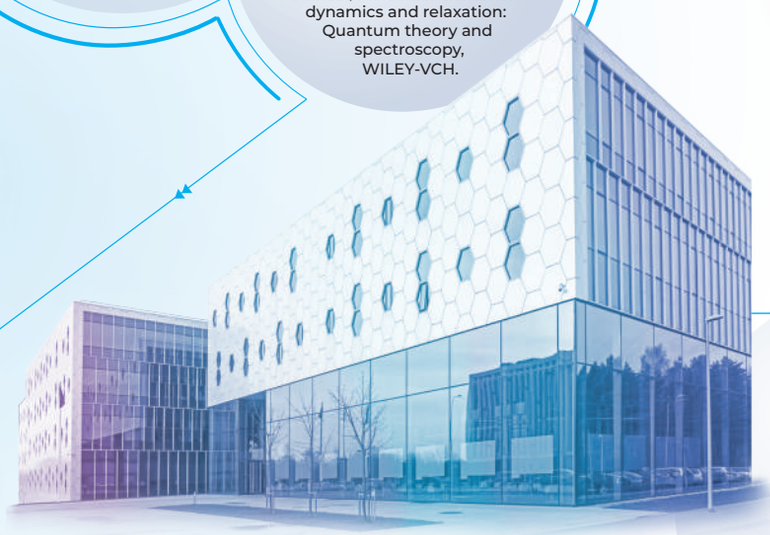
New method to distinguish between vibrational and excitonic wave-packet motion for analysis of 2D coherent electronic spectroscopy data.

Visualization by original technique of ultrafast charge transport in organic solar cells.

2013

Window for optimal operation of GaN power electronics supported by fast disintegration of hot phonons was found.

L. Valkūnas, D. Abramavičius, T. Mančal, Molecular excitation dynamics and relaxation: Quantum theory and spectroscopy, WILEY-VCH.



2014

Technology for making structural optical coatings.

New method for generation ultrashort light pulses.

First MBE grown multiple quantum well laser diodes with bismide layers.

Authorizaton to perform and implement the functions of the National Metrology Institute.

2015

First edition of Annual Reports.

Formation of International Advisory Board.

Electroless metal deposition on insulators using multivalent metal ions as reducing agents.

Development of Raman marker bands for structure and function analysis of adsorbed molecules at electrochemical interface.

A.Survila, Electrochemistry of Metal Complexes, Wiley-VCH.

2016

New campus of FTMC opened in Saulėtekio Ave. 3, Vilnius.

Terahertz frequency range emitters and detectors activated by femtosecond infrared laser pulses.

Method and device for detection of elemental gaseous mercury in air or in other gases.

2017

Development and application of low-dimensional models of large-scale neural networks.

2018

Development of smart, multifunctional textiles and protective garments for military and industry needs.

2019

Development of bismide based devices.

Introduction of nanostructured MoS_2 films with organic molecules as new hybrid materials for laser writing.

Development of computational techniques to solve the multi-mode dynamic Jahn-Teller problem.

S. Varnaitė-Žuravliova, The types, properties, and applications of conductive textiles, Cambridge Scholars Publishing

2024

MAP OF COOPERATION

Canada:
Ottawa - 1
Vancouver - 1

USA:
Albuquerque - 1
Ann Arbor - 1
Buffalo - 1
Cincinnati - 1
Denver - 1
Fremont - 1
Houston - 1
Indianapolis - 1
Ithaca - 1
Lubbock - 1
Mesa - 1
New Brunswick - 1
North Carolina - 1
Oakland - 1
Pennsylvania - 1
Queens - 1
Richmond - 1
Santa Barbara - 1
Stanford - 1
Tempe - 1
Valparaiso - 1
Washington – 1

Finland:
Lappeenranta – 1
Helsinki - 2
Jyvaskyla - 1
Joensuu - 1
Kuopio - 1
Aalto - 1
Espas - 1

Iceland:
Reykjavik – 1

Denmark:
Kongens Lyngby - 1
Kopenhagen - 1
Sønderborg - 1
Taastrup – 1

Ireland:
Dublin - 1
Galway - 1
Cork – 1

United Kingdom:
Cambrige – 1
Devon – 1
Didcot –
Durham – 1
Exeter – 1
Farnborough – 1
Glasgow – 1
Guildford – 1
Hertfordshire – 1
Hove – 1
Ipswich – 1
Kelso – 1
Leeds – 1
Leicester – 1
London – 4
Loughborough – 1
Manchester – 2
Moor Row – 1
Newcastle – 2
Oxfordshire – 1
Sheffield – 1
St. Andrews – 1
Workington – 1

Switzerland:
Duebendorf – 2
Neuchatel – 1
Baden – 1
Bleienbach – 1
Burgdorf – 1
Gumligen – 1
Lausanne – 1
Muttenz – 1
Schlieren – 1
Wallbach – 1
Wettingen – 1
Windisch – 1
Zurich – 1

Austria:
Vienna – 4

Poland:
Brzezinska – 1
Gliwice – 1
Olsztyn – 1
Poznan – 1
Warsaw – 5
Wroclaw – 2

Germany:
Aachen – 4
Berlin – 4
Boennigheim – 1
Bonn – 1
Chemnitz – 2
Cologne – 1
Denkerdorf – 1
Dortmund – 1
Dresden – 2
Dusseldorf – 1
Erlanger – 1
Essen – 1
Euskirchen – 1
Flensburg – 1
Frankenberg – 1
Frankfurt – 1
Freiburg – 1
Gelsenkirchen – 1
Gerlingen – 1
Greifswald – 2
Hamburg – 1
Heidelberg – 2
Huerth – 1
Juelich – 1
Ersingen – 1
Karlsruhe – 1
Kassel – 1
Kiel – 2
Leipzig – 3
Leverkusen - 1
Magdeburg - 1
Mainz - 1
Mannheim - 1
Marburg - 1
Munich - 1
Münster - 1
Osnabrueck - 1
Puchheim - 1
Rotenbach - 1
Sankt Augustin - 1
Siegen - 1
Ulm – 1

Spain:
Ajangiz - 1
Alcoi - 1
Aretxabaleta - 1
Barcelona - 3
Madrid - 6
Terrassa - 1
Valencia - 1
Saragossa – 1

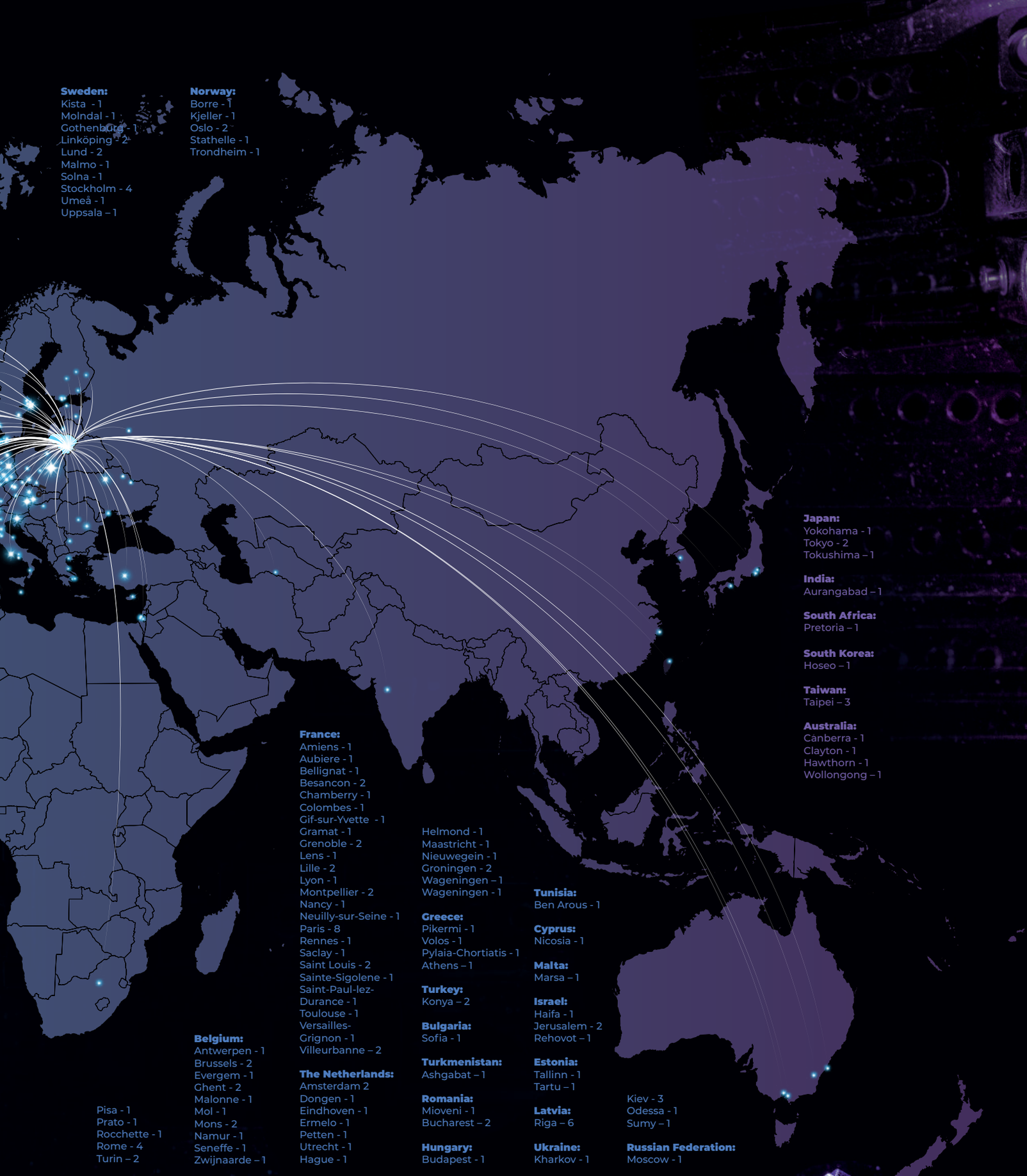
Portugal:
Coimbra - 1
Lisbon - 1
Porto - 6
Vila Nova de Famalicao - 1

Czech Republic:
Brno - 2
Dukelska - 1
Dvur Kralove - 1
Prague - 2
Rez – 1

Slovenia:
Ljubljana – 4

Slovak Republic:
Bratislava – 3

Italy:
Bologna - 3
Brescia - 1
Busto Arsizio - 1
Caserta - 1
Castelfidardo - 1
Cercenasco - 1
Florence - 1
Lamezia Terme - 1
Milan - 1
Naples - 1
Orbassano - 1
Piovene


Sweden:
Kista - 1
Molndal - 1
Gothenburg - 1
Linköping - 2
Lund - 2
Malmo - 1
Solna - 1
Stockholm - 4
Umeå - 1
Uppsala – 1
Norway:
Borre - 1
Kjeller - 1
Oslo - 2
Stathelle - 1
Trondheim - 1
Japan:
Yokohama - 1
Tokyo - 2
Tokushima – 1
India:
Aurangabad – 1
South Africa:
Pretoria – 1
South Korea:
Hoseo – 1
Taiwan:
Taipei – 3
Australia:
Canberra - 1
Clayton - 1
Hawthorn - 1
Wollongong – 1
France:
Amiens - 1
Aubiere - 1
Bellignat - 1
Besancon - 2
Chamberry - 1
Colombes - 1
Gif-sur-Yvette - 1
Gramat - 1
Grenoble - 2
Lens - 1
Lille - 2
Lyon - 1
Montpellier - 2
Nancy - 1
Neuilly-sur-Seine - 1
Paris - 8
Rennes - 1
Saclay - 1
Saint Louis - 2
Sainte-Sigolene - 1
Saint-Paul-lez-Durance - 1
Toulouse - 1
Versailles-Grignon - 1
Villeurbanne – 2
Belgium:
Antwerpen - 1
Brussels - 2
Evergem - 1
Ghent - 2
Malonne - 1
Mol - 1
Mons - 2
Namur - 1
Seneffe - 1
Zwijnaarde – 1
The Netherlands:
Amsterdam 2
Dongen - 1
Eindhoven - 1
Ermelo - 1
Petten - 1
Utrecht - 1
Hague - 1
Helmond - 1
Maastricht - 1
Nieuwegein - 1
Groningen - 2
Wageningen – 1
Wageningen - 1
Greece:
Pikermi - 1
Volos - 1
Pylaia-Chortiatis - 1
Athens – 1
Turkey:
Konya – 2
Bulgaria:
Sofia - 1
Turkmenistan:
Ashgabat – 1
Romania:
Mioveni - 1
Bucharest – 2
Hungary:
Budapest - 1
Tunisia:
Ben Arous - 1
Cyprus:
Nicosia - 1
Malta:
Marsa – 1
Israel:
Haifa - 1
Jerusalem - 2
Rehovot – 1
Estonia:
Tallinn - 1
Tartu – 1
Latvia:
Riga – 6
Ukraine:
Kharkov - 1
Kiev - 3
Odessa - 1
Sumy – 1
Russian Federation:
Moscow - 1
Pisa - 1
Prato - 1
Rocchette - 1
Rome - 4
Turin – 2

FTMC IN ASSOCIATIONS

European Association of Research and Technology Organisations (EARTO). Founded in 1999, EARTO promotes RTOs and represents their interest in Europe. EARTO network counts over 350 RTOs in more than 20 countries. EARTO members represent 150.000 of highly-skilled researchers and engineers managing a wide range of innovation infrastructures.

www.earto.eu

European Photonics Industry Consortium EPIC is the industry association that promotes the sustainable development of organisations working in the field of photonics in Europe.

www.epic-assoc.com

The European Technology Platform for the Future of Textiles and Clothing - a European-wide expert network, involving industry, research organisations, public authorities, financial institutions and other stakeholders.

www.textile-platform.eu/home/2014/11/27/european-technology-platform-for-the-future-of-textiles-and.html

The European Association of National Metrology Institutes (EURAMET), The mission is to develop and disseminate an integrated, cost-effective and internationally competitive measurement infrastructure for Europe.

www.euramet.org

Eurachem is a network of organisations in Europe, having the objective of establishing a system for the international traceability of chemical measurements and the promotion of good quality practices.

www.eurachem.org

Euro-Asian Cooperation of National Metrological Institutions (COOMET) is a regional organisation establishing cooperation of national metrology institutions of the countries of Central and Eastern Europe.

www.coomet.org

European Network of Textile Research Organizations (TEXTRANET) joins a number of well-positioned European institutions with world-class competencies involved in textile and clothing related research and innovation activities.

www.facebook.com/www.textranet.net/

Research Association Molded Interconnect Devices 3-D MID e.V The aim is the promotion and further development of Moulded Interconnect Devices (MID) technology. For this purpose, projects for joint research are carried out, the exchange of experience among the members promoted, and the implementation of new technical possibilities encouraged through appropriate public relations work.

www.3d-mid.de/en/

Lithuanian Laser Association

http://www.ltoptics.org

Laser and Engineering Technologies Cluster
http://litek.lt/

Lithuanian Engineering Industries Association LINPRA
https://linpra.lt/

Lithuanian Aerospace Association
http://space-lt.eu/

Lithuanian Apparel and Textile Industry Association
http://www.latia.lt/

Nacional Defence Industries Association of Lithuania
https://www.ngpa.lt

Lithuanian Defence and Security Industry Association
https://www.lgspa.lt

The International Society of Electrochemistry was founded in 1949 by leading European and American Electrochemists to serve the growing needs of electrochemistry in becoming a modern scientific discipline. It comprises about 3000 individual members and more than 20 Corporate Members (teaching institutions, non-profit-making research organisations and learned societies) and Corporate Sustaining Members (industrial and commercial organisations).

www.ise-online.org

SPIE, the international society for optics and photonics, was founded in 1955 to advance light-based technologies. Serving 255,000 constituents from 183 countries, the not-for-profit society advances emerging technologies through interdisciplinary information exchange, continuing education, publications, patent precedent, and career and professional growth. SPIE annually organises and sponsors approximately 25 major technical forums, exhibitions, and education programs in North America, Europe, Asia, and the South Pacific, where more than 35,000 scientists, engineers, and entrepreneurs showcase the latest innovations across a wide range of technologies.

www.spie.org

The Optical Society promotes and delivers scientific and technical information on optics and photonics worldwide that is authoritative, accessible and archived. Since 1916, OSA has been the world's leading champion for optics and photonics, uniting and educating scientists, engineers, educators, technicians and business leaders worldwide to foster and promote technical and professional development.

www.osa.org

The International Society of Electroporation – Based Technologies and Treatments (ISEBTT)

The mission of the International Society for Electroporation-Based Technologies and Treatments is to promote the advancement of scientific knowledge of the interactions of pulsed electric and electromagnetic fields and ionised gases with biological systems (cells, tissues, organisms, molecules and materials), with an emphasis on electroporation, and to facilitate the development of applications based on these phenomena in biology, medicine, biotechnology, and food and environmental technologies.

www.electroporation.net/council/

OUR SPIN-OUTS

UAB ELAS

www.e-lasers.com

Laser systems for precise micromachining

UAB Apertika

www.apertika.eu

Products and technologies, related to pulsed High Magnetic Field applications

UAB Erumpo

ww.w.erumpo.lt

Development of bio-chips for medical diagnostics

UAB Ferentis

www.ferentis.eu

Biosynthetic hydrogels for miniaturized screening, tissue engineering and regenerative medicine

UAB Luvitera

www.luvitera.com

Components for terahertz imaging and spectroscopy

MB Mėgintuvėlis

www.megintuvelis.lt

Education activities and popularization of chemistry science

UAB Devulco

www.devulco.eu/lt/

New technologies for waste rubber recycling

MB Probiomas

www.probiomas.lt

Development of lyophilization technology for food production.

2010 2011 2012 2013 2014

UAB Alanodas

www.alanodas.lt

Functional coatings on plastics and metals

UAB Integrali skaidulinė optika

www.ifoptics.com

Innovative integrated fibre-optic components

UAB Optola

www.optola.lt/industry/home-2/

Laser systems and services for industrial applications: Laser Cleaning, Laser Cutting and Laser Nano Machining

MB Šviesos tankis

www.lightdensity.eu/lt/

High-tech laser micro-fabrication solutions and service

UAB Namperus LT

www.namperus.com

Development of all-NASICON Na-ion electrode chemistries and water-based electrolytes suitable for cells used in stationary energy storage systems

UAB Optomenas

www.optoman.com

Design, development and manufacture of thin film coatings and laser optics

MB Lazeriniai taikymai

www.lazeriniaitaikymai.lt

Formation of bio-inspired functional surfaces by laser processing technology

UAB Astrolight

Classical and quantum optical communication equipment

MB Plazmonas

www.seedlasers.com

Ultrashort pulse fibre lasers

MB Plazmonika

www.plazmonika.com

Plasmonic-based substrates and sensors

MB Lazerinės fabrikavimo technologijos

Electronic circuit formation on free form dielectric surfaces

2015 2016 2017 2018 2019 2020

CONFERENCES WE ORGANISED

2010

14th International Symposium Ultrafast Phenomena in Semiconductors, 14-UFPS, August 23-25.

2011

ERPOS-12 Vilnius, July 11-13, 2011

12th International Conference Electronics and related properties of organic systems, ERPOS-12, July 11-13.

www.erpos-12.ff.vu.lt

2012

2013

15th International Symposium Ultrafast Phenomena in Semiconductors, 15-UFPS, August 25-28.

XXth Lithuania-Belarus seminar Lasers and Optical Nonlinearity, LON2013, November, 21-22.

2014

11th Nordic Femtochemistry Conference, May 26-27.

www.nordic2014.ftmc.lt

LPM2014 The 15th International Symposium on Laser Precision Microfabrication

15th International Symposium on Laser Precision Microfabrication, LPM2014, June, 17-20.

www.lpm2014.org

2015

2016

Conference 'Chemistry and Chemical Technology 2016', April 28-29.

http://www.selecta-etn.eu/events/64-chemistry-and-chemical-technology-2016-international-conference-of-lithuanian-society-of-chemistry

2017

ENVIRA 2017

International Conference on Environmental Radioactivity, ENVIRA2017, May 29 - June 2.

www.envira2017.ftmc.lt

appolo

APPOLO Summer School on Ultra-Short Pulse Laser Applications in Material Processing, UPLAMP 2017, July 3-7.

www.uplamp.ftmc.lt

24th International Conference on Noise and Fluctuations, June 20-23.

www.icnf2017.ff.vu.lt

2018

ISE

23rd ISE Topical Meeting „Electrochemistry for Investigation of Biological Objects: from Functional Nanomaterials to Micro/Nano-Electrodes", May 8-11.

www.topical23.ise-online.org

workshop on quantum effects in biological systems QUEBS 2018 July 10-13, Vilnius

Workshop on Quantum Effects in Biological Systems (QuEBS 2018), July 10-13.

www.quebs.org/quebs-2018

Unterstützt von / Supported by Alexander von Humboldt Stiftung/Foundation

Humboldt Kolleg: Controlling quantum matter: From ultracold atoms to solids, July 29 - August 2.

www.hk18.ff.vu.lt/#

ICPEPA

11th International Conference on Photo-Excited Processes and Applications, ICPEPA-11, September10-14.

www.icpepa11.com

The Conference Advanced Properties and Processes in Optoelectronic Materials - APROPOS 16, October 10-12.

www.apropos.ftmc.lt

Oxygen 2018 alia

International conference 'Oxygenalia 2018', October 11-13.

www.oxygenalia.chgf.vu.lt

International conference 'EcoBalt 2018', October 25-27.

www.ecobalt.chgf.vu.lt

2019

appolo

APPOLO Summer School on Ultra-Short Pulse Laser Applications in Material Processing, UPLAMP 2019, July 7-12.

www.uplamp.ftmc.lt

PL LT Phys Tech

Lithuania-Poland Workshop on Physics and Technology 'LithPol 2019' September 26-27.

www.lithpol2019.ftmc.lt

FTMC ARTICLES IN CA 2010 – 2019

Total Publications in 2010-2019 1,819;

6 high cited;

443 Open access

h-index 47 Average citations per item 8.35

Sum of Times Cited 15,196
Without self citations 12,574

Citing articles 11,200
Without self citations 10,164

The most cited researchers of FTMC

Jan Devinson	6916
Arūnas Ramanavičius	6050
Kęstutis Pyragas	5432
Leonas Valkūnas	3463
Gediminas Niaura	2867
Gintaras Valušis	2647
Albertas Malinauskas	2304
Andrius Alkauskas	2284
Arūnas Krotkus	2112
Vidmantas Gulbinas	2095

The best cited publications of FTMC 2010-2019

1. Ionic polarization-induced current-voltage hysteresis in CH3NH3PbX3 perovskite solar cells

By: S. Meloni, T. Moehl, W. Tress, **M. Franckevičius,** M. Saliba, Y.H. Lee, P. Gao, M.K. Nazeeruddin, S.M. Zakeeruddin, U. Rothlisberger, M. Graetzel, Nature Communications, 7, 10334 (2016)

Times Cited: **299 Highly Cited Paper**

2. Tracking of Airborne Radionuclides from the Damaged Fukushima Dai-Ichi Nuclear Reactors by European Networks

By: O. Masson, A. Baeza, J. Bieringer, K. Brudecki, S. Bucci, M. Cappai, F.P. Carvalho, O. Connan, C. Cosma, A. Dalheimer, D. Didier, G. Depuydt, L.E. De Geer, A. De Vismes, L. Gini, F. Groppi, K. Gudnason, R. Gurriaran, D. Hainz, O. Halldorsson, D. Hammond, O. Hanley, K. Holey, Zs. Homoki, A. Ioannidou, K. Isajenko, M. Jankovic, C. Katzlberger, M. Kettunen, R. Kierepko, R. Kontro, P.J.M. Kwakman, M. Lecomte, L. Leon Vintro, A.-P. Leppanen, B. Lind, G. Lujaniene, P. Mc Ginnity, C. Mc Mahon, H. Mala, S. Manenti, M. Manolopoulou, A. Mattila, A. Mauring, J.W. Mietelski, B. Møller, S.P. Nielsen, J. Nikolic, R.M.W. Overwater, S. E. Palsson, C. Papastefanou, I. Penev, M.K. Pham, P.P. Povinec, H. Rameback, M.C. Reis, W. Ringer, A. Rodriguez, P. Rulík, P.R.J. Saey, V. Samsonov, C. Schlosser, G. Sgorbati, B. V. Silobritiene, C. Soderstrom, R. Sogni, L. Solier, M. Sonck, G. Steinhauser, T. Steinkopff, P. Steinmann, S. Stoulos, I. Sykora, D. Todorovic, N. Tooloutalaie, L. Tositti, J. Tschiersch, A. Ugron, E. Vagena, A. Vargas, H. Wershofen, and O. Zhukova, Environmental Science & Technology, 45 (18), 7670-7677 (2011)

Times Cited: **241 Highly Cited Paper**

3. Nanowire Perovskite Solar Cell

By: J.-H. Im, J. Luo, M. Franckevičius, N. Pellet, P. Gao, T. Moehl, S.M. Zakeeruddin, M.K. Nazeeruddin, M. Gratzel, N.-G. Park, Nano Letters, 15 (3), 2120-2126 (2015)

Times Cited: **216, Highly Cited Paper**

4. Vibronic coherence in oxygenic photosynthesis

By: F.D. Fuller, JiePan, A. Gelzinis, V. Butkus, S.S. Senlik, D.E. Wilcox, C.F. Yocum, L. Valkunas, D. Abramavicius, J.P. Ogilvie, Nature Chemistry, 6 (8), 706-711 (2014)

Times Cited: **205 Highly Cited Paper**

5. Comparative Study of Random and Oriented Antibody Immobilization Techniques on the Binding Capacity of Immunosensor

By: A. Kausaite-Minkstimiene, A. Ramanaviciene, J. Kirlyte, A. Ramanavičius, Analytical Chemistry, 82 (15), 6401-6408 (2010)

Times Cited: **151**

6. Vibrational vs. electronic coherences in 2D spectrum of molecular systems

V. Butkus, D. Zigmantas, L. Valkunas, D. Abramavicius, Chemical Physics Letters, 545, 40-43 (2012)

Times Cited: **134**

7. Number size distributions and seasonality of submicron particles in Europe 2008-2009

By: A. Asmi, A. Wiedensohler, P. Laj, A.-M. Fjaeraa, K. Sellegri, W. Birmili, E. Weingartner, U. Baltensperger, V. Zdimal, N. Zikova, J.-P. Putaud, A. Marinoni, P. Tunved, H.-C. Hansson, M. Fiebig, N. Kivekäs, H. Lihavainen, E. Asmi, V. Ulevičius, P. P. Aalto, E. Swietlicki, A. Kristensson, N. Mihalopoulos, N. Kalivitis, I. Kalapov, G. Kiss, G. de Leeuw, B. Henzing, R. M. Harrison, D. Beddows, C. O'Dowd, S. G. Jennings, H. Flentje, K. Weinhold, F. Meinhardt, L. Ries, M. Kulmala, Atmospheric Chemistry and Physics, 11 (11), 5505-5538 (2011)

Times Cited: **130**

8. Visualizing charge separation in bulk heterojunction organic solar cells,

By: D. Amarasinghe Vithanage, A. Devižis, V. Abramavičius, Y. Infahsaeng, D. Abramavičius, R.C.I. MacKenzie, P.E. Keivanidis, A. Yartsev, D. Hertel, J. Nelson, V. Sundstrom, V. Gulbinas, Nature Communications, 4, 2334 (2013)

Times Cited: **113**

9. CMOS Integrated Antenna-Coupled Field-Effect Transistors for the Detection of Radiation From 0.2 to 4.3 THz

By: S. Boppe, A. Lisauskas, M. Mundt, D. Seliuta, L. Minkevičius, I. Kašalynas, G. Valušis, M. Mittendorff, S. Winner,V. Krozer, H.G. Roskos,

IEEE Transactions on Microwave Theory and Techniques, 60 (12), 3834-3843 (2012)

Times Cited: **111**

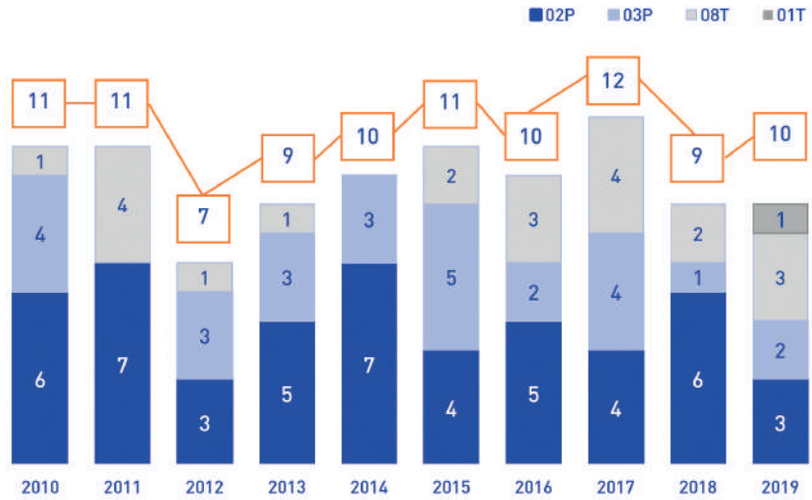
10. Tutorial: Defects in semiconductors-Combining experiment and theory

By: A. Alkauskas, M.D. McCluskey, C.G. Van de Walle, Journal of Applied Physics, 119 (18), 181101 (2016)

Times Cited: **92, Highly Cited Paper**

DOCTORAL THESES

100 theses were defenced in total in 2010-2019 at FTMC



2010

Artūr Šimukovič – Investigation DC, microwave characteristics and noise of SiGe and A_3B_5 heterojunction bipolar transistors *(02P)*

Scientific supervisor: Dr. P. Sakalas

Gediminas Molis – Investigation of the terahertz pulse generation from the narrow band gap semiconductor surfaces *(02P)*

Scientific supervisor: Prof., Habil. Dr. A. Krotkus

Laureate of the best dissertations 2010

Rasa Suzanovičienė – Investigation of carrier kinetics in semiconductors by terahertz radiation pulses *(02P)*

Scientific supervisor: Prof., Habil. Dr. A. Krotkus

Virginijus Bukauskas – Applications of scanning probe microscopy for development and investigation of gas sensitive nanosystems integrated with the ultra-thin metal oxide films *(08T)*

Scientific supervisor: Prof., Dr. A. Šetkus

Kristina Brazdžiuvienė – Studies of conducting polymer-modified electrodes and their application for electroanalysis *(03P)*

Scientific supervisor: Prof., Habil. Dr. A. Malinauskas

Julija Uljanionok – Role of Cu(I) complexes in the electrochemical reduction of glycinate and maleate Cu(II) complexes *(03P)*

Scientific supervisor: Prof., Habil. Dr. A. Survila

Živilė Stankevičiūtė – Studies of synthesis and cyclization reactions of alkylated 5-cyano-2-methylsulfanyl-4(3H)-pyrimidinones *(03P)*

Scientific supervisor: Prof., Habil. Dr. A. Malinauskas

Skirmantas Keršulis – Magnetic and electrical field effects in polycrystalline $La_{1-x}Sr_xMnO_3$ films *(02P)*

Scientific supervisor: Prof., Habil. Dr. N. Žurauskienė

Rūta Araminaitė – Study of electrocatalytic processes at Prussian blue modified glassy carbon electrode *(03P)*

Scientific supervisor: Prof., Habil. Dr. A. Malinauskas

Donatas Narbutis – Star Clusters in the M31 Galaxy Southwest Field. Photometric Survey and Population Properties *(02P)*

Scientific supervisor: Prof., Dr. V. Vansevičius

Laureate of the best dissertations 2010

Jan Devenson – InAs/AlSb short wavelength quantum cascade lasers *(02P)*

Scientific supervisor: Prof., Habil. Dr. G. Valušis

The best dissertation of 2010

2011

Andrius Devižis – Charge carrier transport in conjugated polymer films revealed by ultrafast optical probing *(02P)*

Scientific supervisor: Prof., Habil. Dr. V. Gulbinas

The best dissertation of 2011

Marijus Brikas – Microprocessing of silicon and metals with high-pulse-repetition-rate picoseconds lasers *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Michail Grishin – Dynamic of continuously pumped regenerative laser amplifiers *(02P)*

Scientific supervisor: Prof., Habil. Dr. V. Gulbinas

Mindaugas Gedvilas – Self-organization in thin metal films under laser irradiation *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Nerijus Slavinskis – Short pulse Q-switched longitudinally diode pumped solid state minilasers: generation, characterization and application *(08T)*

Scientific supervisor: Prof., Habil. Dr. A. Dementjev

Marius Treideris – Formation and investigation of hybrid nanostructures *(08T)*

Scientific supervisor: Assoc. Prof., Habil. Dr. I. Šimkienė

Nina Prokopčiuk – Application of probabilistic methods for ionizing radiation dose assessment *(02P)*

Scientific supervisor: Dr. T. Nedveckaitė

Tatjana Gric – Electromagnetic field and dispersion characteristic calculations of open waveguides made of absorptive materials *(02P)*

Scientific supervisor: Prof., Habil. Dr. L. Nickelson

Audrius Pašiškevičius – Synthesis of the vanadium oxide compounds and investigation by X-ray photoelectron spectroscopy method *(02P)*

Scientific supervisor: Habil. Dr. V. Bondarenka

Andrius Garbaras – Study of aerosol particle origin and dispersion by isotope ratio mass spectrometry *(02P)*

Scientific supervisor: Prof., Habil. Dr. V. Remeikis

Oliver Liebfried – Electromagnetic launchers using colossal magnetoresistance sensors *(02P)*

Scientific supervisor: Prof., Habil. Dr. S. Balevičius

2012

Andrius Bičiūnas – Semiconductor materials for components of optoelectronic terahertz systems activated by femtosecond 1 μm wavelength lasers pulses *(02P)*

Scientific supervisor: Prof., Habil. Dr. A. Krotkus

Česlav Paškevič – Investigation of electric properties of semiconductor heterostructures for microwaves electronics *(02P)*

Scientific supervisor: Prof., Habil. Dr. S. Ašmontas

Eglė Kazlauskienė – Sorption of metal complex dyes onto ion exchange resins *(03P)*

Scientific supervisor: Dr. D. Kaušpėdienė

Ramūnas Nedzinskas – Modulated reflectance and photoluminescence spectroscopy of epitaxial InGaAs quantum dot structures *(02P)*

Scientific supervisor: Prof., Habil. Dr. G. Valušis

Paulius Gečys – Ultrashort pulsed laser processing of thin-films for solar cells *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Laureate of the best dissertations 2012

Virginija Kepenienė – Investigation of peculiarities of electroless copper plating systems using hydroxycarboxylic acids as Cu(II) ligands *(03P)*

Scientific supervisor: Prof., Habil. Dr. E. Norkus

Ala Chodosovskaja – Influence of cobalt oxide nanostructuring on electrochemical pseudo-capacitance *(03P)*

Scientific supervisor: Prof., Habil. Dr. E. Juzeliūnas

2013

Kęstutis Prušinskas – Investigation of the autocatalytic Cu(II) reduction processes in the systems with natural polyhydroxylic compounds as ligands *(03P)*

Scientific supervisor: Prof., Habil. Dr. E. Norkus

Paulius Ragulis – Development, research and application of wide band resistive sensors *(02P)*

Scientific supervisor: Habil. Dr. Ž. Kancleris

Saulius Tumėnas – Optical response of ZnMgRE quasicrystals *(02P)*

Scientific supervisor: Dr. V. Karpus

Aidas Aleknavičius – Investigation of composite laser active elements with thin doped layers *(08T)*

Scientific supervisor: Dr. A. Michailovas

Jonas Reklaitis – Development of Mössbauer spectroscopy for magnetic nanomaterials and dynamics of macromolecules *(02P)*

Scientific supervisor: Habil. Dr. D. A. Baltrūnas

Renata Česūnienė – Adsorption of chromium complex dye and copper (II) ions by activated carbons *(03P)*

Scientific supervisor: Dr. A. Gefenienė

Domantas Peckus – Ultrafast excition and charge carrier dynamics in nanostructured molecular layers *(02P)*

Scientific supervisor: Prof., Habil. Dr. V. Gulbinas

Viktorija Nargelienė – Research and application of GaAs/$Al_xGa_{1-x}As$ heterostructures for microwave detection *(02P)*

Scientific supervisor: Prof. Habil. Dr. A. Sužiedėlis

Ieva Matulaitienė – Vibrational spectroscopic study on the structure and interaction with solution components of monolayers with pyridinium functional group adsorbed on metal surface *(03P)*

Scientific supervisor: Habil. Dr. G. Niaura

2014

Rolandas Verbickas – Investigation of heavy metal determination using electroanalytical stripping analysis *(03P)*

Scientific supervisor: Prof., Habil. Dr. E. Norkus

Inga Garbarienė – Origin, chemical composition and formation of submicron aerosol particles in the atmosphere *(02P)*

Scientific supervisor: Dr. K. Kvietkus

Evaldas Stankevičius – Fabrication of periodic microstructures in polymers by interference lithography and modification of their properties by photo- grafting technique *(02P)*

Scientific supervisor: Dr. G. Račiukaitis

Laureate of the best dissertations 2012

Viktor Novičenko – Development and application of phase reduction and averaging methods to nonlinear oscillators *(02P)*

Scientific supervisor: Prof., Habil. Dr. K. Pyragas

Zita Sukackienė – Investigation of peculiarities of cobalt and its alloys electroless deposition *(03P)*

Scientific supervisor: Prof., Habil. Dr. E. Norkus

Irma Liaščukienė – Lipid films on nanostructured aluminium substrate: mechanism of formation, stability and effect on surface properties *(03P)*

Scientific supervisor: Dr. S. Asadauskas

Kęstutis Juškevičius – Investigation of optical and physical properties of dielectric thin films and optimisation of their deposition technologies *(02P)*

Scientific supervisor: Dr. R. Drazdys

Simonas Kecorius – Application of aerosol spectrometry to define processes which change atmospheric aerosol particle properties *(02P)*

Scientific supervisor: Dr. V. Ulevičius

Gediminas Šlekas – Investigation of electrodynamic properties of small-scale objects using finite-difference time-domain method *(02P)*

Scientific supervisor: Habil. Dr. Ž. A. Kancleris

Anton Koroliov – Semiconductor characterization by terahertz radiation pulses *(02P)*

Scientific supervisor: Prof., Habil. Dr. A. Krotkus

2015

Rita Mažeikaitė – Search for synthetic methods of compounds containing thiophene, indole and pyrazole framework *(03P)*

Scientific supervisor: Dr. L. Labanauskas

Raimonda Celiešiūtė – Formation of electrochemical (bio)sensors applying micro- and nanostructures and their characterisation *(03P)*

Scientific supervisor: Dr. R. Pauliukaitė

Rokas Kondrotas – Electrochemical deposition of Cu-Zn-Sn precursor and formation of $Cu_2ZnSnSe_4$ solar cell *(03P)*

Scientific supervisor: Prof., Dr. R. Juškėnas

Vaclovas Klimas – Electrochemical synthesis and investigation of nanostructured anodic layers on iron *(03P)*

Scientific supervisor: Dr. A. Jagminas

Tatjana Charkova – Synthesis and Investigation of Functionalized Alkyloligo (Ethylene Oxides) *(03P)*

Scientific supervisor: Dr. O. Eicher-Lorka

Vadimas Dudoitis – Source Apportionment of Fine and Carbonaceous Aerosol Particles in Urban and Background Environments *(02P)*

Scientific supervisor: Dr. V. Ulevičius

Juozas Adamonis – Terahertz optoelectronics components of semiconductor materials with deep defects *(02P)*

Scientific supervisor: Prof., Habil. Dr. A. Krotkus

Bogdan Voisiat – Formation of frequency selective surfaces using laser ablation methods and characterisation of their properties *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Romualdas Trusovas – Formation and modification of graphene layers using laser irradiation *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Andrius Arlauskas – Investigation of semiconductor materials and their structures by terahertz excitation and picosecond photoconductivity spectroscopy methods *(02P)*

Scientific supervisor: Dr. R. Adomavičius

Tomas Ščiglo – Sorption of cesium, americium and plutonium radionuclides on synthetic and natural sorbents *(02P)*

Scientific supervisor: Dr. G. Lujanienė

2016

Irina Černiukė – Fabrication and investigation of the heterostructures based on manganites and organic semiconductors *(08T)*

Scientific supervisor: Assoc. Prof., Dr. B. Vengalis

Simonas Kičas – Fabrication, characterization and application of dispersive gradient refractive index multilayered systems *(08T)*

Scientific supervisor: Dr. R. Drazdys

Rasa Godliauskienė – Research of persistent organic pollutants in food and feed using mass spectrometry method *(03P)*

Scientific supervisor: Dr. E. Naujalis

Jolita Jablonskienė – Formation and studies of graphene- metal particles nanocomposites and their application for fuel cells *(03P)*

Scientific supervisor: Dr. L. Tamašauskaitė-Tamašiūnaitė

Karolis Viskontas – Fabrication and characterization of low dimensional nanomaterial saturable absorbers for mode-locking of fiber lasers *(08T)*

Scientific supervisor: Dr. K. Regelskis

Irmantas Ratas – Algorithms for inhibition and desynchronization of neural systems *(02P)*

Scientific supervisor: Prof. Habil. Dr. K. Pyragas

Linas Minkevičius – Terahertz imaging arrays for room temperature operation *(02P)*

Scientific supervisor: Prof., Dr. V. Tamošiūnas

The best dissertation of 2010

Rimvydas Venckevičius – Compact spectroscopic terahertz imaging solutions using GaAs/AlGaAs and InGaAs semiconductor nanostructures *(02P)*

Scientific supervisor: Prof., Habil. Dr. G. Valušis

Ernesta Meinorė – Variation of the physical and chemical properties of submicron atmospheric aerosol particles *(02P)*

Scientific supervisor: Dr. K. Kvietkus

Vytenis Barkauskas – Impact of nuclide composition evolution to RBMK spent fuel nuclear safety and irradiated graphite radiation safety characteristics *(02P)*

Scientific supervisor: Dr. A. Plukis

2017

Yury Malevich – Transient anisotropic photoconductivity and terahertz pulse generation from semiconductors *(02P)*

Scientific supervisor: Dr. R. Adomavičius

Rokas Danilevičius – Fiber laser-based technologies for high energy femtosecond wavelength-tunable optical parametric chirped pulse amplification systems *(02P)*

Scientific supervisor: Dr. A. Michailovas

Tomas Tolenis – Modelling, formation and characterization of nano-sculptured thin films *(08T)*

Scientific supervisor: Dr. R. Drazdys

Vytenis Pranculis – Charge transfer dynamics in bulk-heterojunction organic solar cells *(08T)*

Scientific supervisor: Prof., Habil. Dr. V. Gulbinas

Valdemar Stankevič – Formation and characterization of micro -opto-mechanical 3D devices for sensor application in transparent materials *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Aldona Balčiūnaitė – New materials for alkaline fuel cells: synthesis, characterization and properties *(03P)*

Scientific supervisor: Dr. L. Tamašauskaitė-Tamašiūnaitė

Jelena Kovger – Study on titanium anodic films decoration with visible light absorbing semiconductor nanostructures *(03P)*

Scientific supervisor: Dr. A. Jagminas

Romualdas Striela – Synthesis and properties of polyfunctional pyridines *(03P)*

Scientific supervisor: Dr. L. Labanauskas

Julijanas Želudevičius – Optimization of pulsed fiber lasers, nonlinear pulse combining and optical frequency conversion *(08T)*

Scientific supervisor: Dr. K. Regelskis

Nijolė Remeikaitė-Nikienė – Distribution of organic matter and metals in the south-eastern Baltic Sea (Lithuanian zone) *(03P)*

Scientific supervisor: Dr. G. Lujanienė

Ignas Nevinskas – Emission of terahertz pulses from the narrow-gap semiconductor structures *(02P)*

Scientific supervisor: Prof., Habil. Dr. A. Krotkus

Dainius Pavilonis – Magnetoresistance and electrical resistance relaxation in La-Sr(Ca)-Mn-O nanostructured films *(02P)*

Scientific supervisor: Prof., Habil. Dr. N. Žurauskienė

2018

Elena Adomaitienė – Development of methods for controlling equilibrium and synchrony of nonlinear dynamical system *(02P)*

Scientific supervisor: Habil. Dr. A. V. Tamaševičius

Saulius Frankinas – Controlling of temporal and spectral characteristics of ultrashort fiber lasers by nonlinear effects *(02P)*

Scientific supervisor: Dr. A. Michailovas

Ieva Kulakauskaitė – Synthesis of magnetic nano-sorbents, their characterization and investigation of sorptive properties *(03P)*

Scientific supervisor: Dr. G. Lujanienė

Simonas Indrišiūnas – Formation of light harvesting structures for photovoltaics using laser interference ablation *(08T)*

Scientific supervisor: Dr. G. Račiukaitis

Milda Tamošiūnaitė – Impact of external effects on terahertz applications for telecommunications *(02P)*

Scientific supervisor: Prof., Habil. Dr. G. Valušis

Vytautas Cėpla – Hydrogels for biofabrication: synthesis, chemical and physical characterization *(02P)*

Scientific supervisors: Dr. R. Valiokas, Prof., Dr. M. Griffith

Vytautas Jakštas – Compact terahertz emitters and detectors based on AlGaN/GaN heterostructures *(02P)*

Scientific supervisor: Dr. I. Kašalynas

Sergej Šemčuk – Application of graphene oxide-based nanocomposites and Šaltiškiai clay for radionuclides removal from contaminated solutions *(02P)*

Scientific supervisor: Dr. G. Lujanienė

Armandas Balčytis – Fabrication of subwavelength functional components by means of lithographic methods *(08T)*

Scientific supervisor: Dr. R. Petruškevičius

2019

Sandra Stanionytė – Growth of $Ga_yIn_{1-y}As_{1-x}Bi_x$ layers by molecular beam epitaxy for optoelectronic applications *(T008)*

Scientific supervisor: Dr. V. Pačebutas

Karolis Ratautas – Laser-assisted formation of electro-conductive circuit traces on dielectric materials by electroless metal plating technique *(T008)*

Scientific supervisor: Dr. G. Račiukaitis

Edgaras Markauskas – Laser processes for monolithic interconnection formation in thin-film solar cells *(T008)*

Scientific supervisor: Dr. G. Račiukaitis

Andrius Rimkus – Optical properties of InGaAs heterostructures *(N002)*

Scientific supervisor: Dr. B. Čechavičius

Marijonas Tutkus – Single-molecule fluorescence microscopy for protein dynamics studies *(N002)*

Scientific supervisor: Prof., Habil. Dr. L. Valkūnas, Dr. G. Trinkūnas

Aušrinė Zabielaitė – Composites of metal nanoparticles for fuel cells *(N003)*

Scientific supervisor: Dr. L. Tamašauskaitė-Tamašiūnaitė

Ieva Žičkienė – Investigation of semiconductor nanostructures using terahertz and optical pulses *(N002)*

Scientific supervisor: Dr. R. Adomavičius

Vytautas Mačaitis – Design and investigation of nanometric and submicron integrated circuits for voltage and digital controlled oscillators *(T001)*

Scientific supervisor: Prof., Habil. Dr. R. Navickas

Andrius Paulauskas – Total internal reflection ellipsometry in metal and/or dielectric hybrid nanostructures *(N002)*

Scientific supervisor: Prof., Dr. Z. Balevičius

Scientific fields:

02P Physical Sciences, Physics

03P Physical Sciences, Chemistry

08T Technological Sciences, Material Engineering

Since 2019

N002 Natural Sciences, Physics

N003 Natural Sciences, Chemistry

T001 Technological Sciences, Electrical and Electronic Engineering

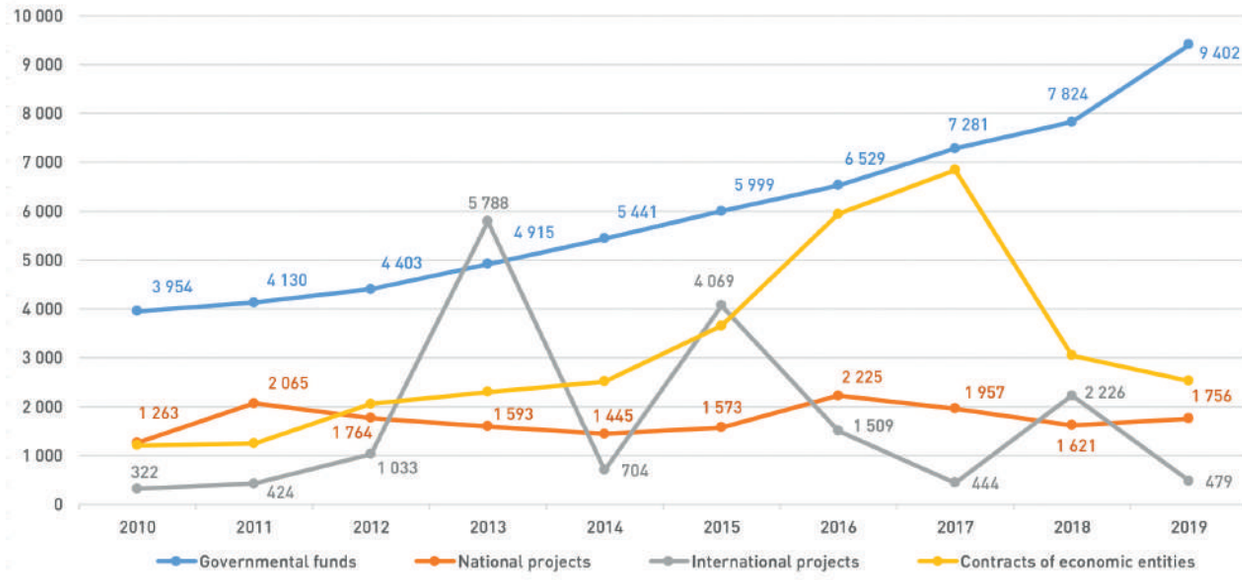
T008 Technological Sciences, Material Engineering

Teofilius Kilmonis – Synthesis of PtM/graphene (M = W, Mo, Mn, Co, Ru) nanocomposites, their characterization and application in fuel cells *(N003)*

Scientific supervisor: Dr. L. Tamašauskaitė-Tamašiūnaitė

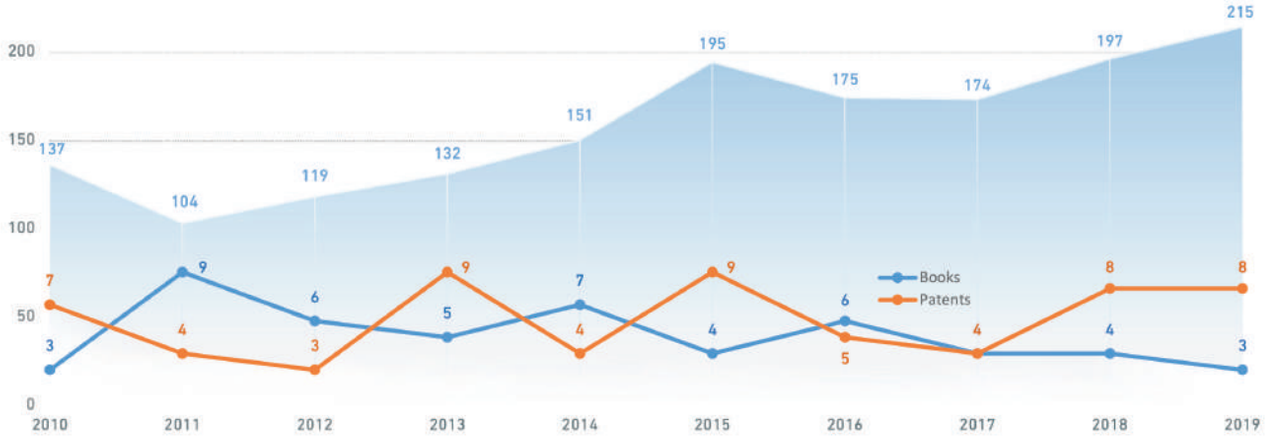
FTMC IN FIGURES 2010 - 2019

Budget dynamics, kEur

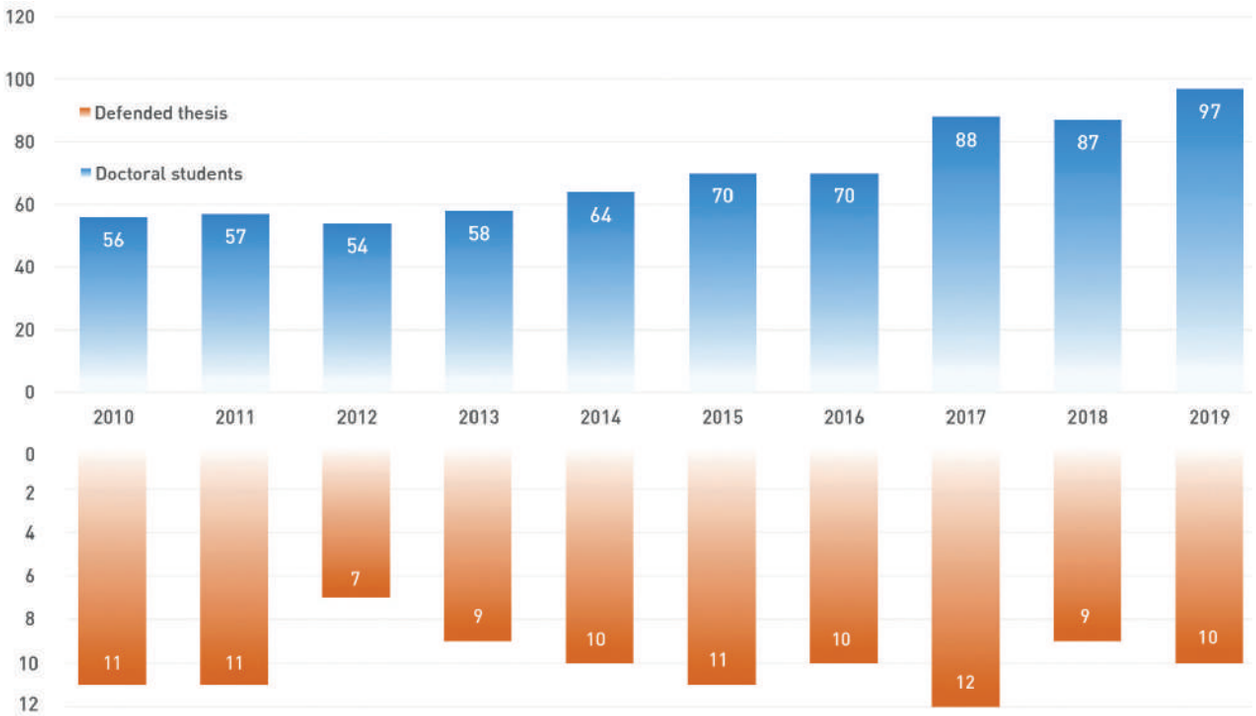


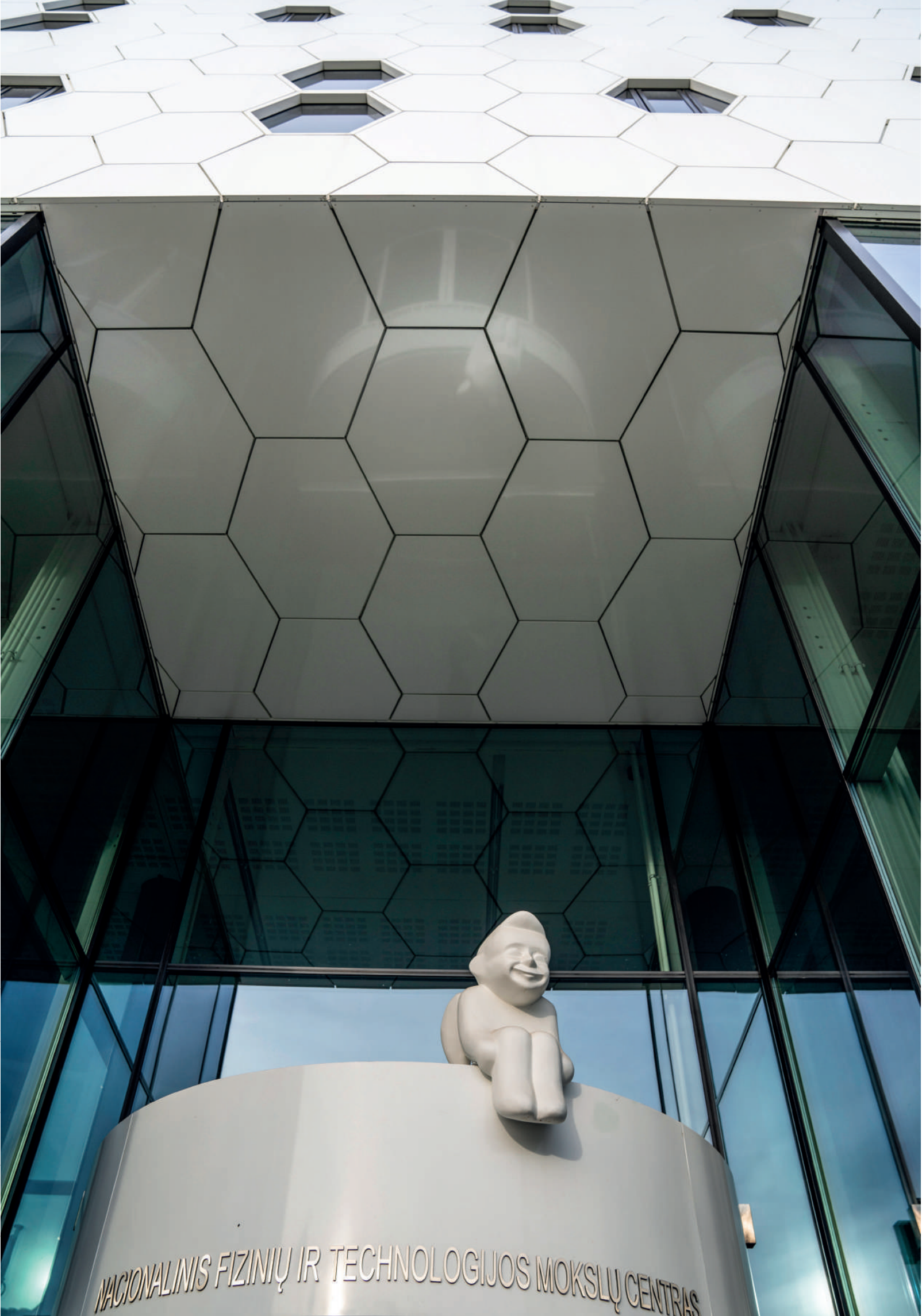
Employees

Highly ranked publications

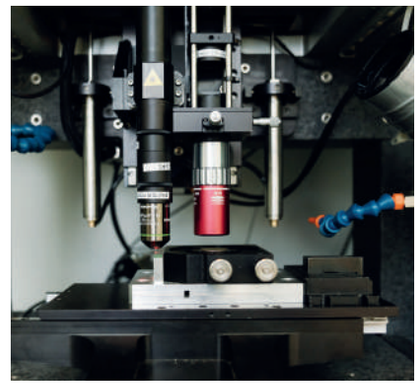


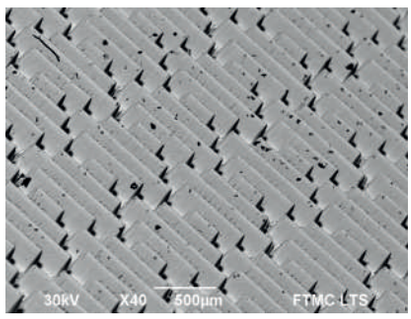
Doctoral students & defended thesis

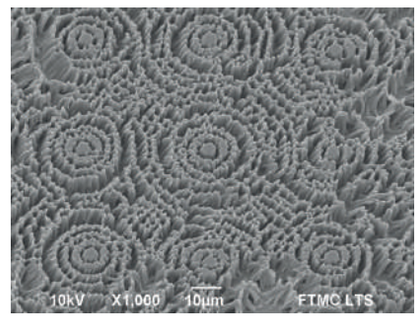


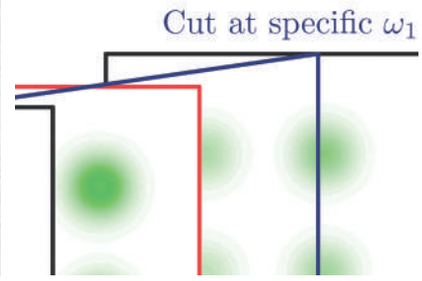

NACIONALINIS FIZINIŲ IR TECHNOLOGIJOS MOKSLŲ CENTRAS

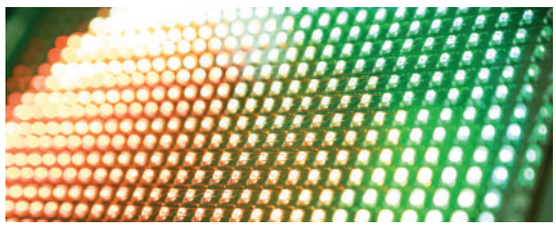
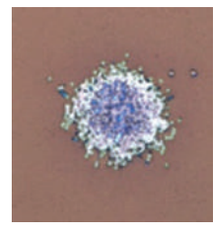
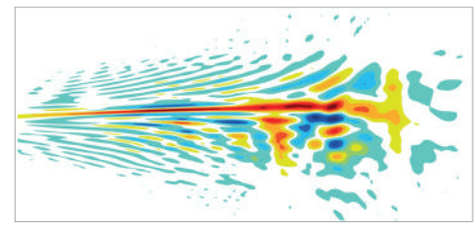
LASER TECHNOLOGIES







Optical coatings, solid-state and fibre lasers, laser material processing, plasmonics and nanophotonics

The Department of Laser Technologies with its six laboratories covers a significant part of the photonics related activities, ranging from newly discovered optical effects to laser machines, and stepping through all technology readiness levels. The smart optical coatings developed in the Laboratory of Optical Coatings convert the pieces of glass into valuable products able to control spectral and temporal properties of the light. New laser sources, under development in the Fiber Lasers and Solid-State Lasers Laboratories based on tiny fibres, or active bulk crystals provide not only new wavelengths of coherent radiation but high peak power, ultra-short pulses and controlled wavefront as well. Combining of the coherent beams makes the lasers even more powerful. Efficient surface texturing utilising laser beam interference, glass processing with smart pulsed lasers or distorted Bessel beams, nano-textures decorated by nanoparticles, 3D metal sculpturing by subtractive and additive technologies, laser-induced transformations in graphene-like materials make up the main working topics of the of Laser Microfabrication Laboratory. The scope in the material processing using ultrashort pulse lasers includes the investigations of the laser-matter interaction as well as hardware development in the 3D Technologies and Robotics Laboratory. Significant progress was made in the validation of novel processes for electroless plating of laser-modified polymers and glasses. In 2019, we expanded our capacities in nanophotonics by combining forces from a few research groups to the renewed Plasmonics and Nanophotonics Laboratory dealing with nanostructures and sub-wavelength effects in materials and surfaces for sensing applications. The Department keeps close collaboration with colleagues from other departments of FTMC, photonics companies in Lithuania and abroad gaining new ideas for joint projects and applications. The year 2019 was fruitful for the Department of Laser Technologies with new projects and scientific publications in high-ranked peer-review journals.

Highly-efficient laser texturing of drag-reducing bio-inspired shark-skin-like riblets on pre-heated Teflon

Bio-inspired surfaces decrease friction with gases and liquids, and the most recognisable textures are shark-skin-like riblets. Such surfaces can be formed by direct laser ablation with high flexibility options. The bio-inspired riblet surfaces were formed using picosecond ultraviolet laser ablation on pre-heated Teflon at various sample temperatures. The ablation of hot Teflon was found to be 30% more efficient than the conventional laser structuring at the room temperature. The functional properties and surface morphologies of the laser fabricated textures were found close to the simplified geometry of shark-skin. The friction of structured Teflon surfaces with the flowing air was investigated by using a drag measurement setup. Results show the decrease of friction force by ~ 6% with dimensionless riblet spacing around 14-20.

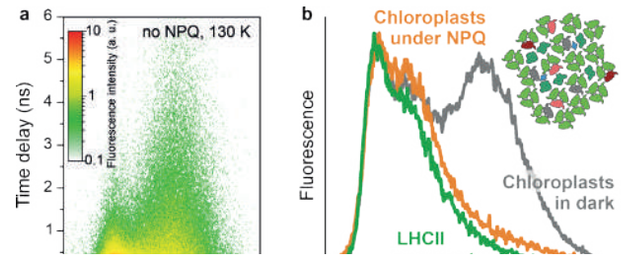


Fig. 1. (a) Laser ablation rate of pre-heated Teflon dependence on the beam scanning speed at different temperatures, (b) the drag reduction of laser-textured Teflon dependence on non-dimensional riblet period at different physical spacing.

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Rapid highly-efficient ultrafast laser ablation for 3D applications

Ultrafast laser pulses are widely used in material processing due to high flexibility and precision, but to be competitive with conventional technologies, the processing throughput should be increased. A lot of technological laser processing parameters were optimised together with the utilisation of high-frequency bursts consisting of ultrashort light pulses. The highest ever published laser milling ablation efficiency of copper was achieved. The high material removal efficiency led to superior ablation quality. Highly-efficient laser milling was used for 3D layer-by-layer engraving and structuring of cylindrical parts by 5-axes laser processing machine.

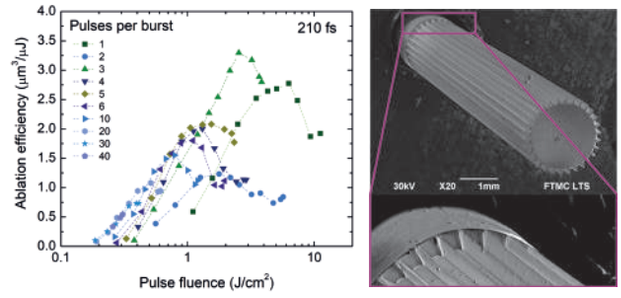

Fig. 2. (left) Highly-efficient laser ablation by bursts of ultrashort light pulses, (right) The material removal efficiency of copper and 3D processing examples.

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Design, preparation and characterisation of antireflective coatings using oxynitride films

Deposition of aluminium oxynitride films using a single metallic target in a various gas mixture was investigated, and optimised preparation conditions for such reactive sputtering were found. Active feedback was utilised to control the reactive deposition process. Dependence between gas composition and changes of nitrogen concentration in the films and their optical properties were investigated. The increase of nitrogen content in films leads to increases in extinction coefficient in the UV region and refractive index in the whole investigated wavelength range. It was shown the possibility of using oxynitride films for anti-reflective coating (AR) deposition. The coating was composed of three layers of oxynitrides with changing composition. It has low surface roughness and low compressive stress.

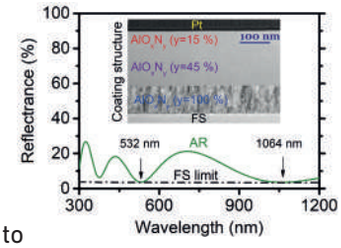

Fig. 3. Reflectance spectra and SEM photo (inset) of the AR coating composed from aluminium oxynitride layers with various compositions.

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Glass dicing with elliptical Bessel beam

The Bessel beam ellipticity can be controlled by an axicon tilt. Such a configuration results in asymmetric modifications in the glass with controllable transverse crack formation direction. This effect is essential for glass dicing applications, since by orientating these cracks in parallel to the dicing direction, significant process improvements can be possible. In particular, investigation of dicing experiments was realised with controllable Bessel beam ellipticity together with sample bending test measurements. We found that the lowest modified glass flexural strength value of 4 MPa was induced when the axicon was adjusted to 0 deg (elliptical beam). When axicon was adjusted to 10 deg, giving symmetrical Bessel beam pattern, the modified glass flexural strength increased up to 53 MPa. Our investigations show that the Bessel beam pattern ellipticity plays a significant role in the glass dicing process. The possibility to control the transverse crack propagation direction is a very attractive property of this technology.

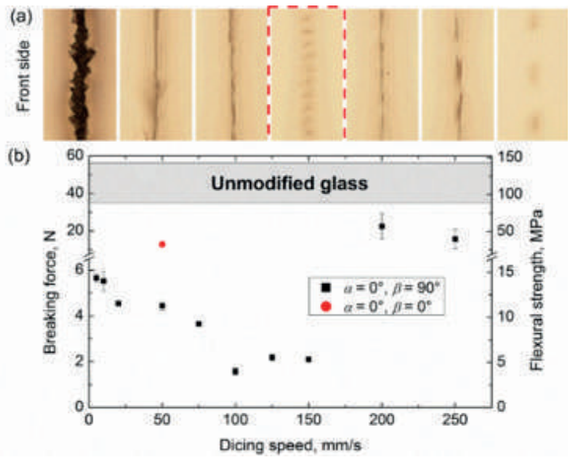

Fig. 4. (a) Optical microscope images of the front surface of diced samples with different speed and transverse cracks orientation, (b) bending force needed to fracture the Bessel beam modified glass as a function of dicing speed.

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Coherent beam combining of pulsed fibre amplifiers by noncolinear sum-frequency generation

One way of scaling average power and pulse energy of fibre amplifiers is by combining multiple amplifier outputs into a single diffraction-limited beam. By conducting extensive research, a novel approach for coherent beam combining was investigated, and its capabilities demonstrated experimentally. Picosecond pulses, amplified in four separate fibre amplifiers, were combined in space and time into a single beam utilising sum-frequency generation in LBO nonlinear crystal, set in the noncollinear phase-matching configuration. Coherent combining was achieved by implementing active optical phase control loop in one of the amplifier channels. Experimental setup allowed to achieve combining efficiency up to 49 % and generate sum-frequency beam with 97 W average power and pulse energy of 108 µJ. Achieved pulse energy surpassed nonlinear-effect-caused limitations of single fibre amplifier, proving the advantages of the proposed combining scheme.

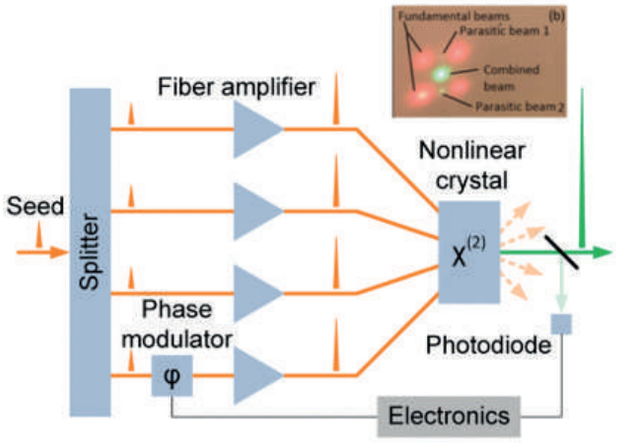

Fig. 5. Simplified scheme of experimental beam combining architecture. Inset - photo of all beams after the crystal is seen on visualisation card.

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Graphene layer formation in pinewood by nanosecond and picosecond laser irradiation

Potential applications of graphene-based materials in nanoscale electronic devices depends heavily on the versatility of synthesis and modification methods. We investigated the laser-induced formation of graphene layers in pinewood by utilising 1064 nm picosecond (10 ps) and nanosecond (10 ns) pulses. Raman measurements showed the formation of high-quality few-layer graphene structures with I(2D)/I(G) and I(D)/I(G) ratios of 1.10 and 0.69, respectively, at the nanosecond-laser irradiation dose of 662 J/cm^2 (Fig. 6). The average in-plane crystallite size estimated from the Raman data was found to be 31 nm. Sheet resistance measurements showed a correlation with Raman data and revealed a significant decrease in electric resistance for the ns-laser prepared sample with the highest I(2D)/I(G) ratio. It was found that nanosecond laser produces less defected graphene layers.

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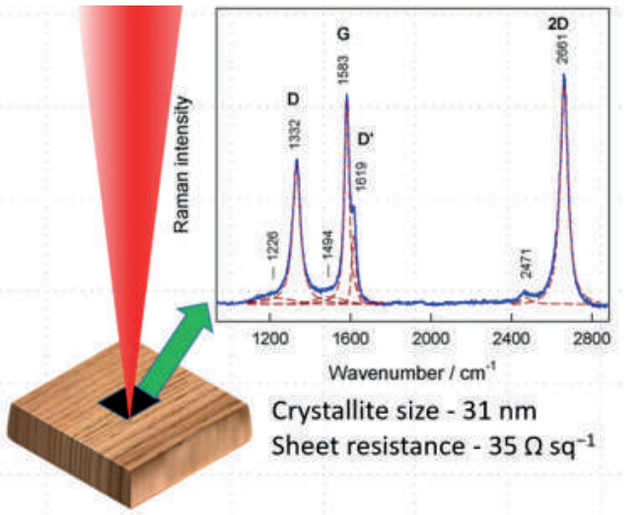

Fig. 6. Raman spectrum, corresponding crystallite size and minimal sheet resistance achieved with optimal 662 J/cm^2 irradiation dose of nanosecond laser.

Laser-assisted selective copper deposition by catalytic electroless plating – process and activation mechanism

Here we present the results of the in-depth experimental analysis of the laser-assisted local copper deposition on polyamide. Picosecond lasers were validated for surface modification of the polymer, followed by silver (I) activation and finished by autocatalytic electroless copper plating on the laser-modified areas. Detailed investigations were dedicated to finding out the origin of selective metal plating, including the surface profiling and wettability dynamics, XPS analysis and electric resistance measurements of the deposited copper layer. Based on the experimental data, the mechanism of the polymer surface activation by laser modification is proposed.

The selective plating mechanism can be explained by the combined process of silver ion adsorption by increased wettability of the laser-treated surface and ability of this surface to reduce silver ions to a neutral atom. Therefore, the selectivity of electroless copper plating on the investigated plastic was achieved by a proper picosecond laser treatment, a consequent ethanol and water rinsing and the use of the comparatively weak activation silver (I) nitrate solution.

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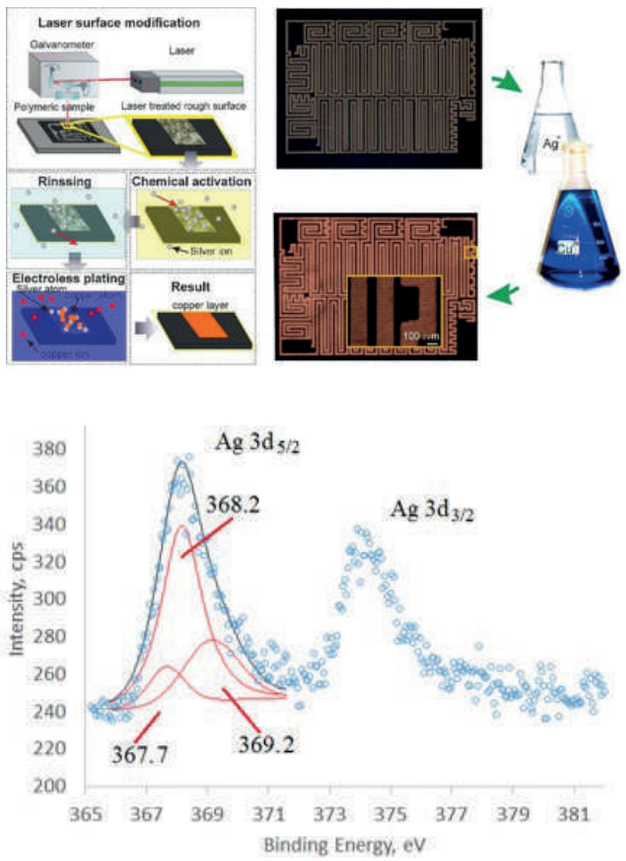

Fig. 8. High-resolution XPS spectrum of the laser-treated polyamide area after its activation with silver.

Sputtered HfO_2 and HfO_2-SiO_2 mixture-based UV mirrors enhanced by high-temperature annealing

Performance of dielectric high reflectance multilayer stacks plays an essential role in high power laser systems. The thermal post-deposition treatment above the crystallisation temperature of hafnia and hafnia-silica mixture layers was demonstrated effectively to increase the reflectance of mirror coatings at 266 nm wavelength up to 99.5%. No surface roughness degradation was registered after thermal treatment using selected temperatures. Moreover, laser-induced damage after thermally induced crystallisation increased 2.5-3 times, compared to as-deposited samples. Obtained results demonstrate the potential of high-temperature annealing above crystallisation point of hafnia-silica mixture-based coatings for considerable increase of laser induced damage threshold (LIDT) and optical property improvement at UV spectral range.

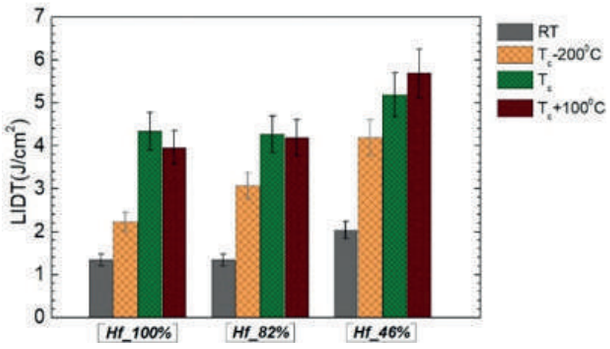

Fig. 9. LIDT (test 1-on-1) at λ=266 nm of deposited (RT) and annealed HR coatings, based on hafnia (Hf_100%), and on different hafnia mixtures (Hf_82%, Hf_46%). Three different annealing temperatures were used – maintaining amorphous structure (T_c-200°C), and two – inducing crystallisation (T_c and T_c+100°C).

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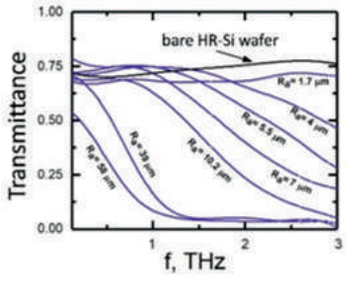
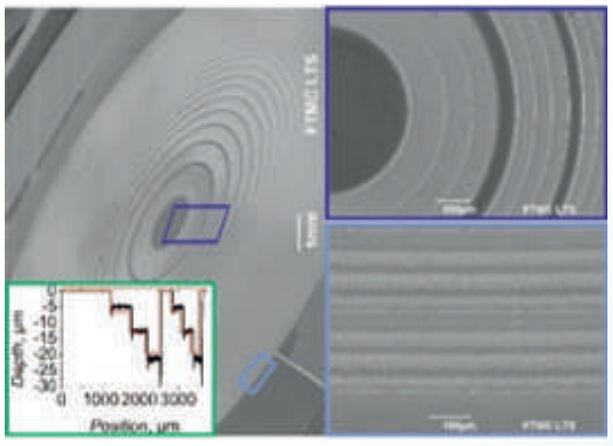
Laser fabricated diffractive silicon optics for terahertz radiation

The demand for compact terahertz (THz) components is continuously increasing due to emerging new applications, including art conservation, astronomy, material research and medicine. A huge variety of THz systems employs THz lenses. Diffractive lenses can be used to make such setups more compact and integration friendly. Here, we developed diffractive silicon optics for the astronomically important frequency of 4.7 THz by employing direct laser ablation (DLA) technology. To ensure reasonable optical quality, the investigation of optical losses in the THz region of the laser-ablated silicon was carried out. The influence of laser pulse duration and processing environment was found to be negligible, and it was demonstrated that optical losses in the laser-ablated silicon mostly arise from scattering when the roughness of the ablated surface is sufficiently increased. DLA fabrication conditions suitable to avoid unwanted scattering were established, and diffractive lenses for the 4.7 THz frequency were fabricated. Laser manufactured diffractive lenses provide excellent focusing characteristics (focusing gain up to 29 dB). Thus, the DLA has great perspectives for further development of compact components and alignment-free spectroscopic imaging systems for the entire THz range.

Fig. 10. (top) The transmittance of a silicon wafer for different laser-ablated surface roughnesses in the 0.1 – 4.7 THz frequency range; (bottom) Diffractive lens for the 4.7 THz frequency, fabricated using DLA.





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Gas nozzles for Laser Wakefield Acceleration manufactured by hybrid laser processing techniques

Gas nozzles are used in many laser-plasma experiments for Laser Wakefield Acceleration (LWFA), secondary X-ray, and ɣ-light generation. With the development of ultrashort few-cycle femtosecond lasers, the dimensions of the plasma target have to be controlled with the accuracy of several micrometres. The impact of the wall roughness of the cylindrical micronozzles on the concentration profiles of the gas targets for LWFA was investigated. Micronozzles were manufactured using three different laser processing techniques – nanosecond laser rear-side (RS) machining (with and without the subsequent etching in the potassium hydroxide solution) and hybrid laser machining technique - the combination of nanosecond laser rear-side machining and femtosecond laser-assisted selective etching (FLSE). The wall roughness has an effect on the subsonic and ultrasonic gas flow if the height of the roughness structure exceeds 1-2% of the diameter of the cylindrical nozzle or the diameter of the throat of de Laval nozzle.

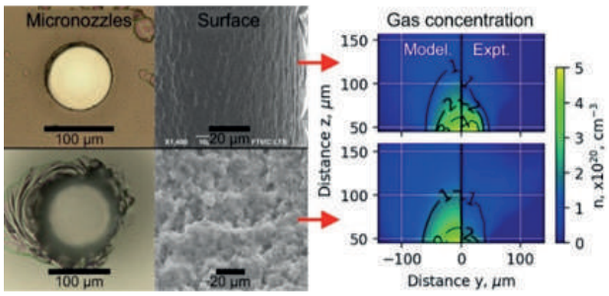

Fig. 11. Optical microscope images of nozzles, manufactured via different techniques; their SEM cross-section pictures and simulated (left side) and reconstructed (right side) transversal N_2 concentration profiles through the nozzles manufactured by FLSE technology, and the nanosecond rear-side machining technique at 60 bar of backing pressure at the valve.

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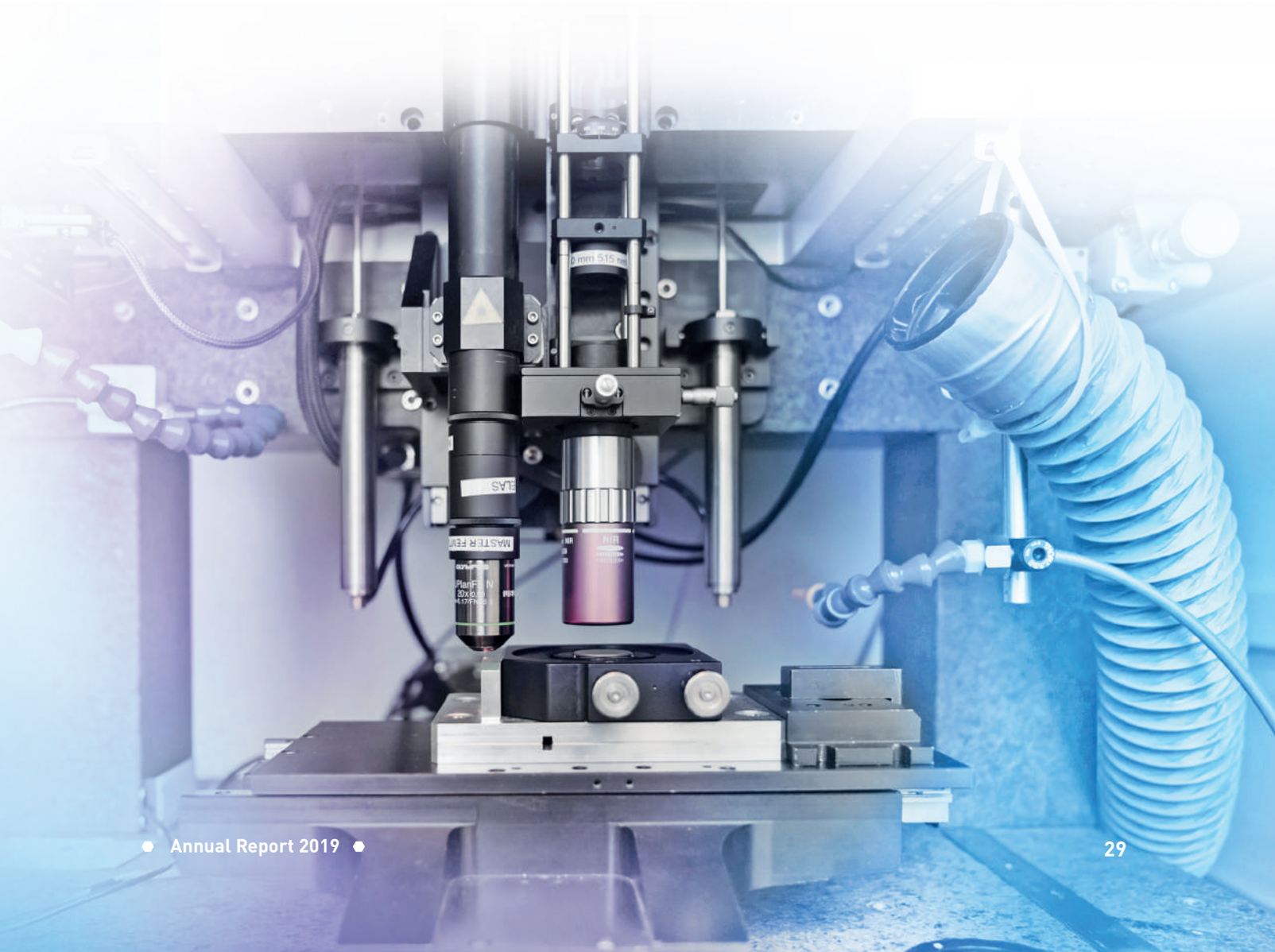

OPTOELECTRONICS

Scientists working in *(clockwise from left top corner)* Optoelectronic Technology, Terahertz Photonics, Semiconductor Optics and Ultrafast Optoelectronics Laboratories of the Optoelectronics Department.

Photonics – along with microelectronics and software – is assumed to be as one of the Key Digital Technologies

Scientific contribution of the Department into topic of Optoelectronics, a large part of photonics, is mainly focussed in two directions: i) design and epitaxial growth technology of semiconductor nanostructures, their comprehensive investigation and elaboration of devices for mid- and far-infrared spectral ranges and ii) terahertz (THz) physics and spectroscopy, development of compact spectroscopic THz imaging systems, and their applications. In addition, the Department drives the most comprehensive set of standard optical characterisation techniques equipped with low-temperature facilities that are intensely exploited also by other Lithuanian research groups and high-tech companies. Moreover, the Department has established and successfully employs THz photonics and technology Cluster – interlaboratory unit – which includes modern THz experimental facilities for the development of THz technology and THz photonics components as well as investigation of novel materials properties using various THz techniques – both femtosecond lasers-based as well as different continuous wave-based THz set-ups. The cluster is the unique place of comprehensive experimental THz investigation and successful completion of various type of projects. The facilities and exceptional techniques are becoming increasingly attractive for foreign scientists to perform their investigations in our center, FTMC, in Vilnius. Researchers from the UK, Belarus, Finland, Ukraine, Poland, Russia, China, Portugal and Estonia are frequent guests or even employees in the laboratories of the Optoelectronics Department.

Developed products are commercialised by two companies that have been started by the researchers of the Department.

Charge traps in GaN/AlGaN HEMT structures

Wide-bandgap AlGaN/GaN heterostructures with a two-dimensional electron gas open novel avenues for applications of high-electron-mobility (HEMT) transistor in a higher power, broadband frequency scale and wide temperatures. We have proposed a contactless method based on the THz electroluminescence spectroscopy that estimates the level of shallow impurities in AlGaN/GaN HEMT structures. The experimental results for low-frequency noise have revealed the direct correlation between effective trap density obtained by secondary-ion mass spectrometry and THz electroluminescence data. Moreover, the noise level and effective trap density in our AlGaN/GaN HEMTs are of the same order of magnitude as those reported in Si MOSFETs with high-k dielectric constant. We are working toward new developments of more sensitive and stable THz detectors and more powerful THz emitters.

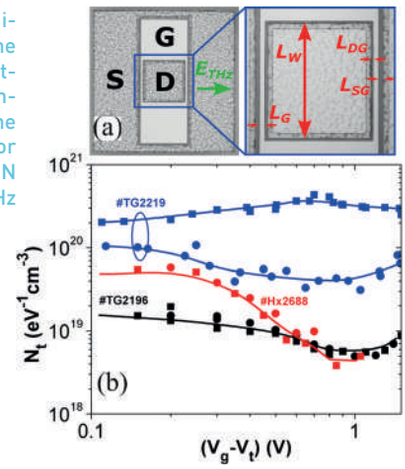

Fig. 1. Top: optical microscope image of the AlGaN/GaN HEMT. Bottom: effective trap density dependence on the gate voltage swing for different AlGaN/GaN HEMTs used as the THz detectors.

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Efficient diffractive lenses for THz frequencies

We developed the efficient diffractive lenses for the frequency range 0.3 - 4.7 THz. Original direct laser ablation (DLA) technology allowed to demonstrate a different type of diffractive optics including the Soret zone plate lens (SZPL) and the multi-level phase-correcting Fresnel lens (MPFL) fabricated of a metal foil and crystalline silicon, respectively. The binary-phase profile lenses demonstrated the values of the focusing gain up to 25 dB with a diffraction-limited beam size. The increase of the phase quantisation level up to eight increased the values of the focusing gain up to 29 dB without a measurable increase of optical losses. The reciprocal relationship between the transmission brightness and the surface roughness at discrete THz frequencies was determined. It was experimentally demonstrated that the majority of optical losses in silicon with the laser modified surface are induced by the scattering of the THz waves, rather than the absorption in silicon-compounds formed during the laser ablation. This was the first direct demonstration of the DLA technology as an efficient tool to functionalise the silicon surface without the introduction of absorption losses.

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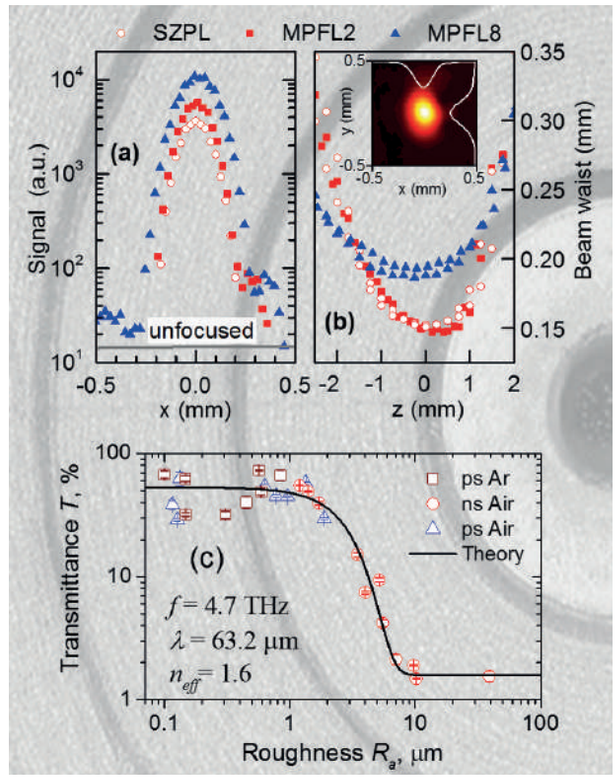

Fig. 2. Focusing performance of the SZPL and MPFL samples: (a) beam intensity at the focal plane, (b) waist change along an optical axis - focal depth, (c) lens transmittance dependence on the surface roughness of the silicon surface laser processed in the ns- or ps- regime in ambient air or inert Ar gas.

Advanced THz imaging techniques

We developed the advanced THz components and systems for enhanced imaging purposes. Recently, Bessel THz imaging employing a pair of thin silicon multi-phase diffractive optical elements was demonstrated in continuous wave mode at 0.6 THz. The Bessel zone plate (BZP) design, a discrete axicon containing 4 phase quantisation levels, was proposed and fabricated on high-resistivity silicon by using a direct laser ablation technology. The developed Bessel THz imaging system allowed to extend the focal depth up to 20 mm. The compact THz imaging system in transmission geometry revealed a possibility to inspect the objects thicker than 10 mm with enhanced contrast and increased resolution up to 0.6 of the wavelength by applying numerical deconvolution algorithms.

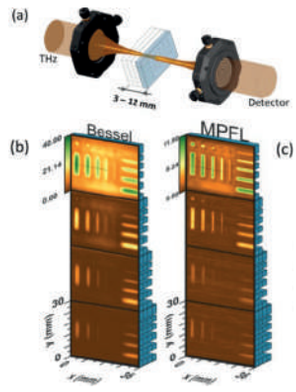

Fig. 3. (a) THz system based on two silicon BZPs designed to image thick objects with a needle-shaped focus of THz radiation. Imaging by using the BZPs (b) and conventional MPFLs (c) of the sample of various thickness, the stack of 1 to 4 identical targets with the thickness of 3 mm each.

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THz excitation spectroscopy uncovers band structure details

Majority of the materials emit THz radiation transients when their surfaces are excited by femtosecond laser pulses. This effect is caused by a dynamical photocurrent due to ballistically propagating photoexcited electrons. We have demonstrated that spectral dependences of the generated THz transient amplitude could be used to reveal energy band structure details of various semiconductors and semiconductor heterostructures. During the year such investigations were performed on germanium crystals, epitaxial GaInAsBi, InN, and GaInN layers, wurtzite type InAs nanowires, as well as on hybrid organic-nonorganic perovskites.

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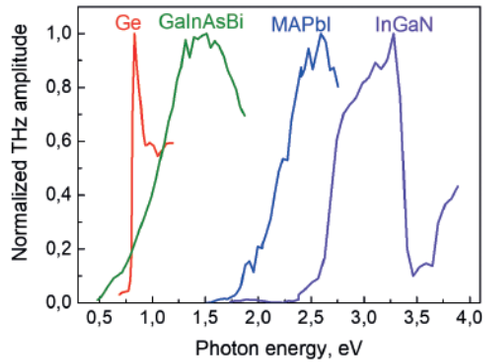

Fig. 4. THz excitation spectra measured on several semiconducting materials. In germanium crystals, such a measurement was used for determination of electron intervalley scattering rates, in various dilute bismide alloys and wurtzite type InAs nanowires (not shown) for establishing the energy position of the heavy electron conduction band minima, whereas in lead iodide perovskite films was a complementary tool in investigating surface defects.

Spontaneous atomic-ordering and optical anisotropy in GaAsBi

The Optoelectronics Technology Laboratory was one of the pioneers worldwide in the development of Bi containing group III-V semiconductor alloys and their utilisation in infrared and THz radiation devices. Recent studies revealed that the properties of GaAsBi may be further tailored via an additional route - the control of Bi atomic ordering. A systematic investigation of the synthesis conditions, the use of selectively offcut wafers, and the advanced methods of material characterisation demonstrated that the large ordered domains can be stabilised. This has led to surprising findings demonstrating previously unobserved optical anisotropy of these alloys which is linked to the electronic-structure perturbations. The on-going experimental and theoretical work together with the Semiconductor Optics Laboratory is performed to establish underpinnings of these effects.

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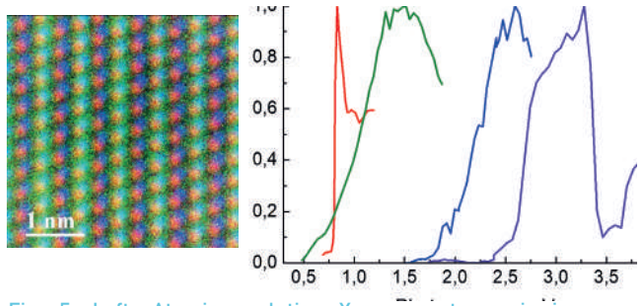
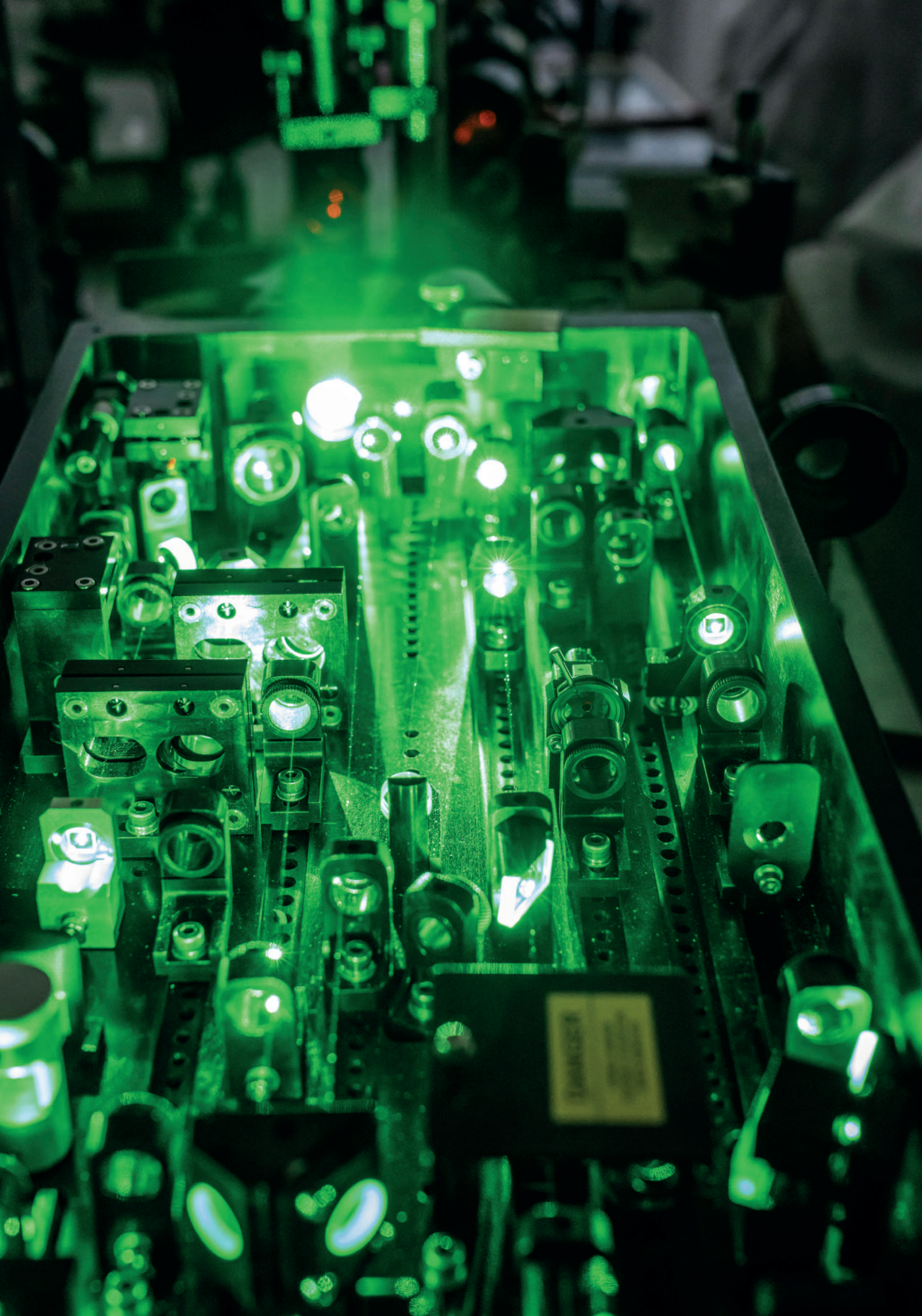
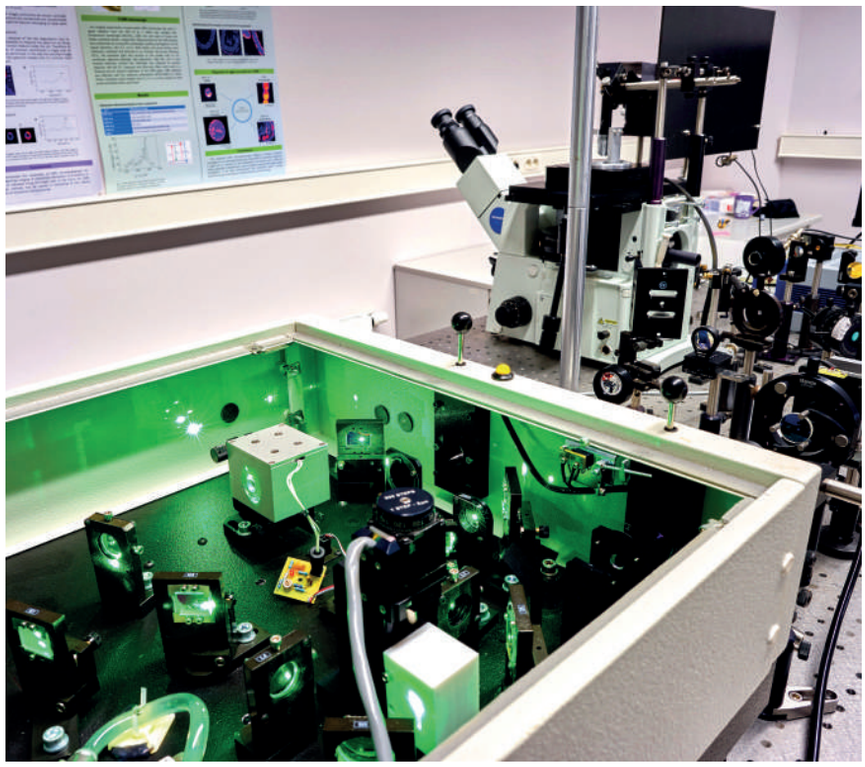
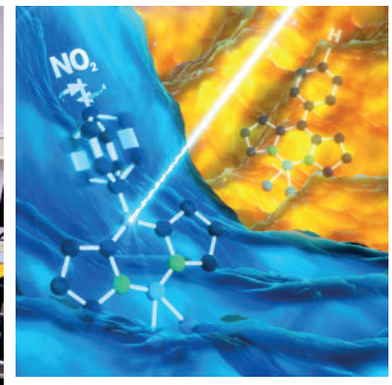


Fig. 5. Left: Atomic-resolution X-ray spectroscopic image of GaAsBi demonstrating the ordering of Bi atoms on every second (111) plane (Ga signal-red, As-blue, Bi-green). Right: Photo-modulated transmission spectra of GaAsBi indicating in-plane polarisation direction-dependence which reflects the spontaneous ordering induced structure modulations.



MOLECULAR PHYSICS





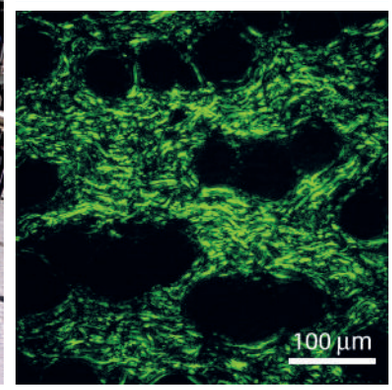


Photo-induced excitation and charge carrier dynamics in natural and artificial molecular and hybrid systems

'Molecular system' is a term, which we in the first place, associate with natural biological objects. Photosynthesis and vision are very well known biological photonic phenomena realised by very complex natural molecular mechanisms. This complexity of biological systems ensures efficient and reliable performance, which fascinates researchers attempting to understand relations between functions and structure and also give inspirations for the development of artificial molecular devices. However, blind mimicking of biological operation principles in artificial devices very rarely leads to success. Instead, we witness the fascinating development of silicon electronics based on very different operation principles. On the other hand, molecular or hybrid organic-inorganic devices are also very attractive and are widely used, particularly in biology and medicine related applications.

Molecular electronics that merge the operation principles of molecular and inorganic semiconductors offer new device functionalities, a cheaper fabrication and even better efficiency in some cases. Molecular materials are particularly attractive for the fabrication of large-area photonic devices, such as solar cells, displays and illumination installations. Unlimited variety of molecular compounds and material morphologies provides a large scale of possible device architectures and thus provides new directions for development.

The activity of the Department of Molecular Compounds Physics is related to molecular photonics ranging from the investigation of natural and artificial molecular systems utilising optical techniques to the development of molecular and hybrid devices. We seek a better understanding of photoinduced processes in biological and artificial molecular systems, optimisation of the material properties and photoinitiated processes in photonic devices. Advanced experimental techniques such as ultrafast spectroscopy, nonlinear and single-molecule microscopy, optoelectrical methods are used together with theoretical calculations to address complex excited-state dynamics and progressions of electronic events in optically excited molecular and hybrid systems. Objects of our investigation range from biological photosynthetic and protein-DNA complexes, molecular viscosity sensors, to organic and perovskite solar cells among others.

2D electronic spectroscopy

Detailed studies of the excitation dynamics in photosynthetic pigment-proteins require an application of a wide range of spectroscopic methods. In the last fifteen years, two-dimensional (2D) electronic spectroscopy was developed. It has significant advantages over other methods, in particular higher temporal resolution available and higher signal-to-noise ratio. Even though it provides considerable opportunities in research, both its experimental realisation and theoretical description are rather complicated, making it somewhat challenging to understand and apply. We attempt to fill this gap by providing an accessible introduction to the concepts, principles and possible applications of the 2D spectroscopy, aimed at those members of the research community with less spectroscopic experience.

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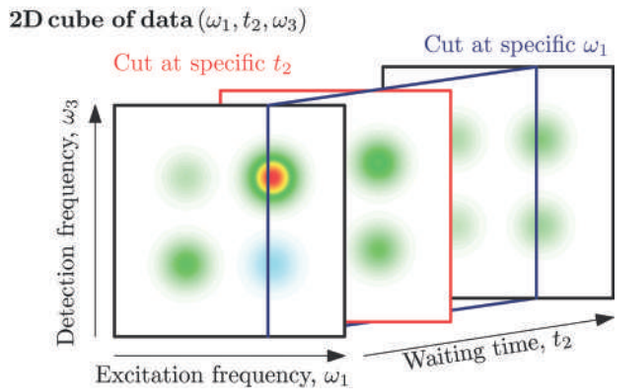

Fig. 1. Illustration of a different way to present 2D electronic spectra. Measuring 2D electronic spectroscopy data leads to a cube of data with different axis representing excitation frequency (ω_1), waiting time (t_2) and detection frequency (ω_3). The usual way to present the data is to present the cuts at specific t_2 values as two-dimensional maps, yet other ways of presenting the data exist.

Time-resolved fluorescence of intact chloroplasts

The photosynthetic apparatus of plants is a robust molecular system. Under strong sunlight, it switches into a photoprotective mode to avoid overexcitation by via nonphotochemical quenching (NPQ). Complex organisation impede the study of natural NPQ under in vivo conditions. Thus, usually artificially prepared antennae have been studied instead. However, it has never been shown directly that the origin of fluorescence quenching observed in these artificial systems underlies natural NPQ. To fill this gap, we performed the time-resolved fluorescence measurements of intact chloroplasts. We show that their spectral response matches that observed previously in the aggregates of major light-harvesting complexes (LHCII), thus demonstrating that the latter in vitro system preserves the properties of natural photoprotection.

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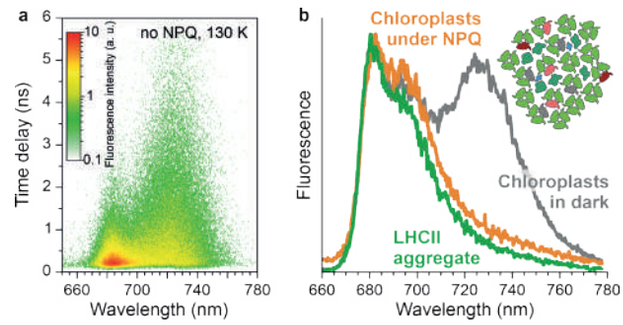

Fig. 2. Picosecond fluorescence spectroscopy of intact chloroplasts. (a) The measured time-resolved fluorescence of dark-adapted intact chloroplasts from wild-type Arabidopsis thaliana at 130 K temperature. (b) Comparison of the fluorescence spectra of intact chloroplasts under dark and NPQ conditions as well as artificial LHCII aggregates. The inset on the right shows the proposed model of the light-harvesting antenna.

Electroluminescence overshoot in perovskite solar cells

High performance of both photovoltaic and electroluminescent devices requires low nonradiative recombination losses. In perovskites, such loses strongly depend on the carrier traps related to the mobile ions and vacancies. To address the dynamics of the mobile ions, we investigate the electroluminescence time evolution in perovskite solar cells under constant and pulsed voltage conditions. We demonstrate the appearance of a high-intensity short electroluminescence peak (overshoot pulse) immediately after termination of the electrical pulse. The generation of a giant overshoot pulse suggests a simple way to achieve high pulsed luminescence intensity with a low current density, which opens new prospects toward optical gain and implementation of electrically pumped lasers.

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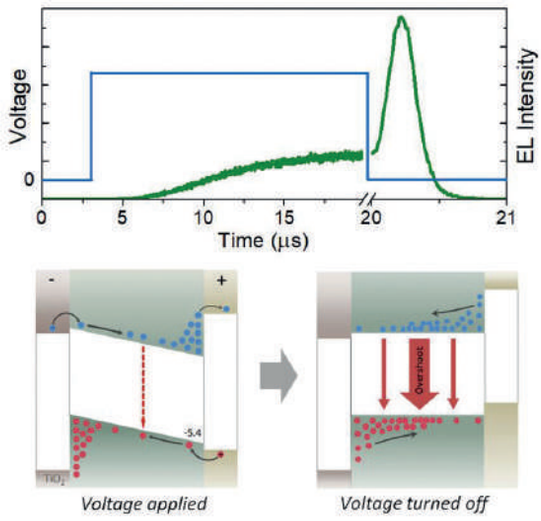

Fig. 3. Top: transient electroluminescence kinetics (green) obtained with the application of 20 μs duration rectangular voltage pulse. Bottom cartoons illustrate the electroluminescence overshoot pulse formation when applied voltage (left) is switched-off (right).

CARS microscopy of squalene and boron nitride as a precursor material for drug delivery carrier

Organic squalene and inorganic boron nitride are well studied as promising materials for drug delivery. Typically, drug carriers based on these materials are stained with fluorescent dyes and visualised using a fluorescence microscope. However, such materials not always can be loaded with a fluorescent agent. Here, we demonstrated the advantages of CARS microscopy as a label-free imaging technique enabling visualisation of such particles without staining. Both F-CARS and P-CARS schemes of the signal acquisition allowed high contrast imaging of squalene and boron nitride. Sub-micron particles of boron nitride could be detected with a satisfactory contrast. This result demonstrates that CARS technology can be used to visualise nano-sized structures.

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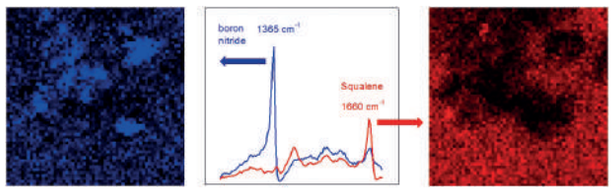
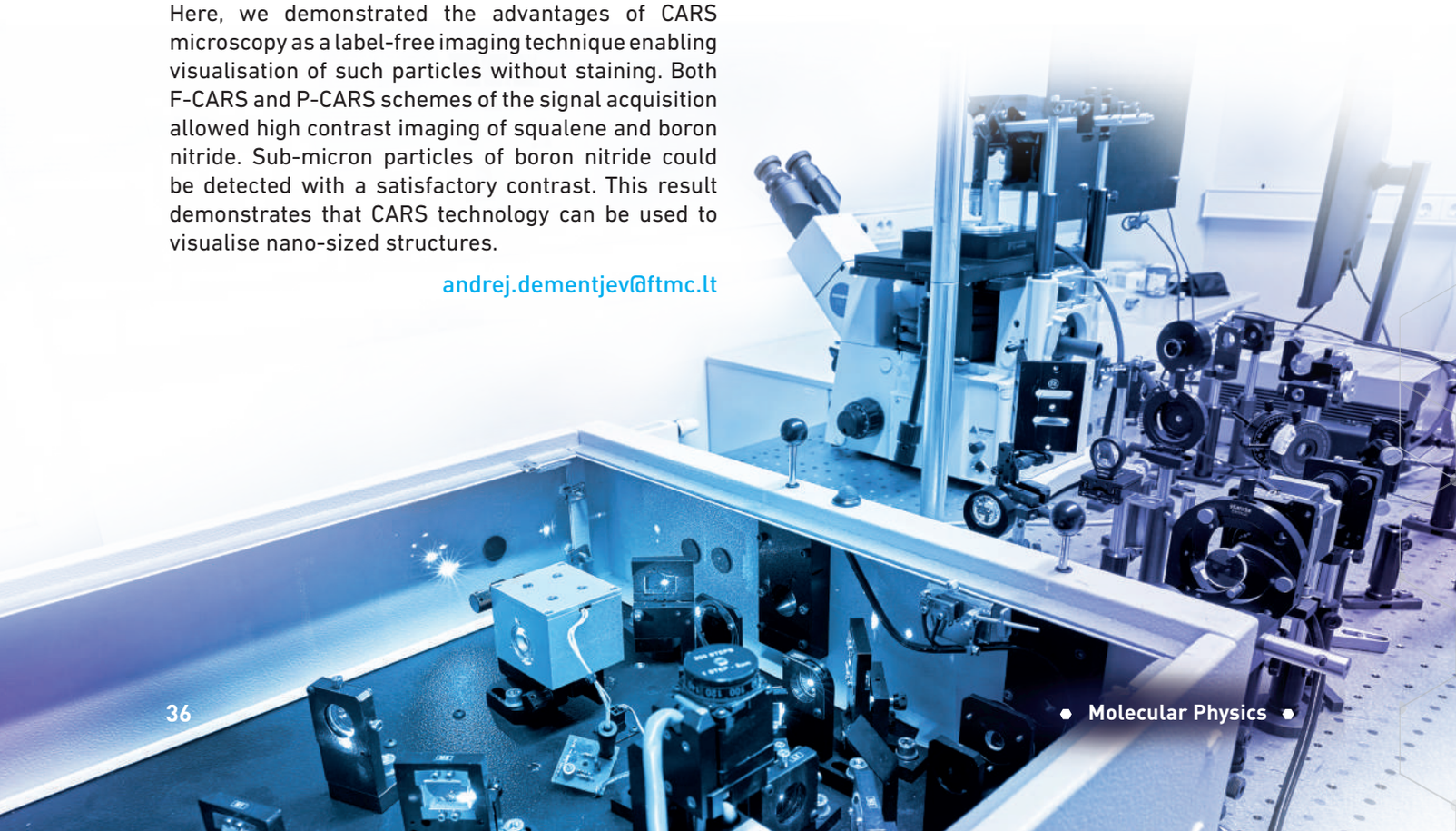


Fig. 4. Squalene-Boron nitride suspension drop deposited between coverslips. Vibrational images recorded at 1365 cm^{-1} (blue) and 1660 cm^{-1} (red) wavenumber allow separate mapping of these materials. CARS spectra measured in the left image at a bright spot belongs to boron nitride (blue curve) and measured in the right belongs to squalene (red curve). Image size is 20 x 20 μm^2, acquisition time 20 seconds.



Improved efficiency and stability of mixed 2D/3D perovskite light-emitting diodes

Perovskite light-emitting diodes (PeLEDs) have reached external quantum efficiencies (EQE) over 21%. Their EQE, however, drops at increasing current densities (J) and their lifetime is still limited to just a few hours. Here, we demonstrate improvement in EQE, EQE roll-off and lifetime of PeLEDs by tuning the balance of electron/hole transport into a mixed 2D/3D perovskite emissive layer. The mixed 2D/3D perovskite layer induces exciton confinement and beneficially influences the electron/hole distribution inside the perovskite layer. By tuning the electron injection to match the hole injection, we reach a reduced EQE roll-off until J=250 mA/cm^2 and a half-lifetime of ~47 h. We propose a model to explain these improvements, that accounts for the spatial electron/hole distributions

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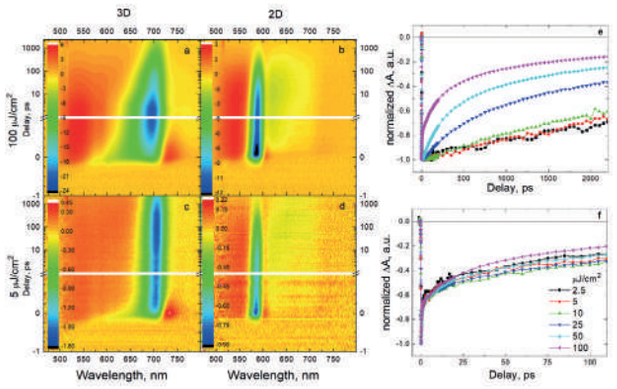

Fig. 5. Transient absorption kinetics for 3D and 2D perovskite films. Three-dimensional transient absorption plots for 3D and 2D perovskite films at different excitation intensities (left) and absorption bleaching at 700 nm decays (right) show very different decay dependence on the excitation intensity. In contrast to 3D films (right, top), 2D samples (right, bottom) show excitation intensity independent decays indicating suppressed carrier recombination.

Enhancing the viscosity sensitive range of a BODIPY molecular rotor by two orders of magnitude

Molecular rotors are a class of fluorophores that enable convenient imaging of viscosity inside microscopic samples. Here, we report that by adding heavy electron-withdrawing –NO_2 group, the viscosity sensitive range of a BODIPY probe is drastically expanded from 5–1500 cP to 0.5–50 000 cP. The improved range makes it, to our knowledge, the first hydrophobic molecular rotor applicable not only at moderate viscosities but also for viscosity measurements in highly viscous samples. Overall, besides reporting a new viscosity probe with remarkable properties, the results show a way to use the knowledge of the molecular action mechanism for augmenting viscosity sensing properties of molecular rotors.

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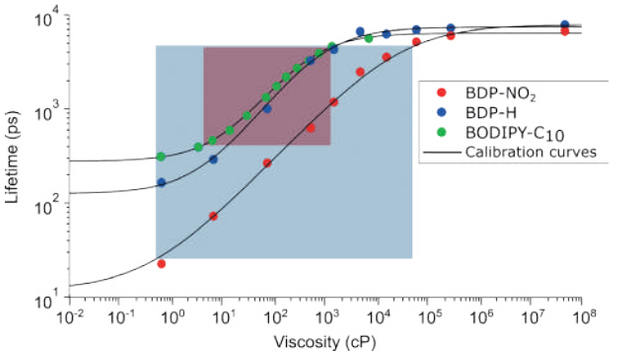
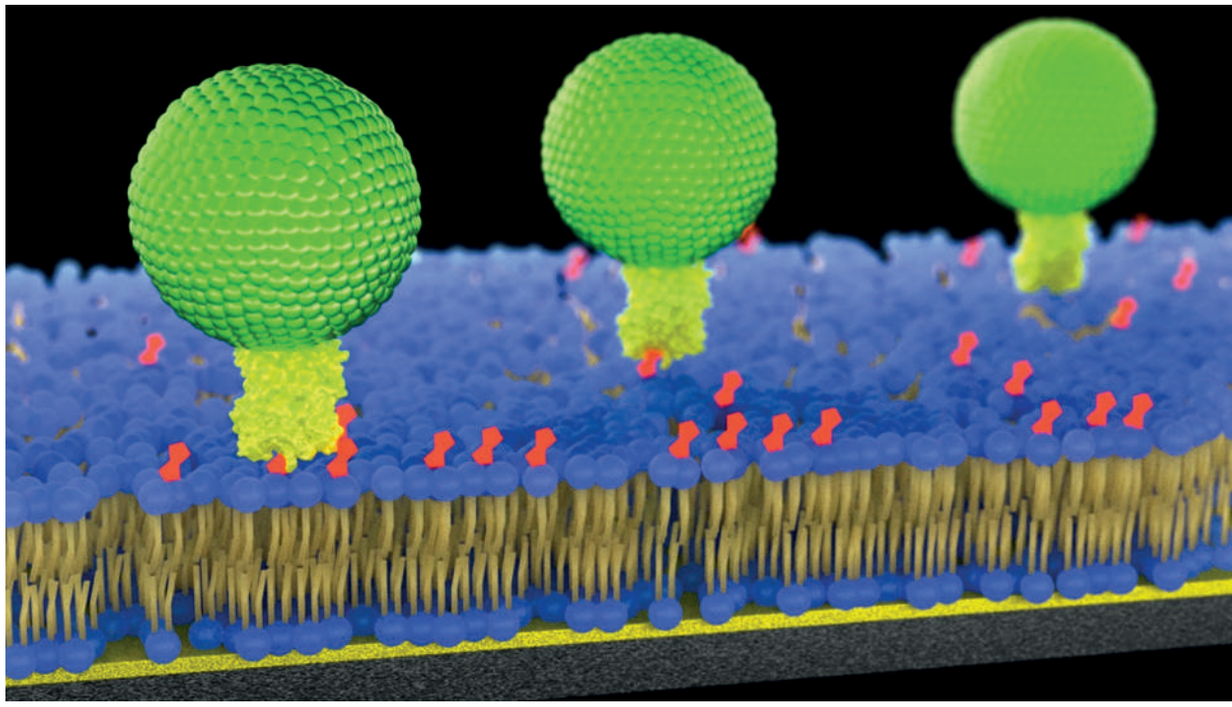


Fig. 6. Fluorescence lifetime-viscosity dependence of BDP-H (blue), BODIPY-C_{10} (green) and the new probe BDP-NO_2 (red). The calibration curves were obtained by fitting the shown data points with the theoretically expected viscosity-lifetime dependence. The rectangles denote lifetime dynamic ranges and viscosity-sensitive ranges for BDP-NO_2 (cyan) and BODIPY-C_{10} (cherry red).

NANOENGINEERING



Department of Nanoengineering focuses on new tools and processes for fabrication of functional nanoarchitectures for broad applications: from photonics to life sciences and medicine. One of our long-term interests is the development of reliable miniaturised platforms for biophysical studies at different levels: proteins, single cells and tissues. Also, we aim at establishing cost-effective and easy nanofabrication platforms, suitable for patterning and functionalisation of new nano- and biomaterials. Among our achievements of the past decade we can name high-speed atomic force microscopy and nanolithography, new supramolecular architectures and cell membrane-mimetic assemblies, nanobiochips for single-cell analysis, electrochemical and optical devices for biosensing, micro and nanopatterned hydrogels for tissue engineering.

Electrochemical polymerisation for functionalised graphene and electrochemical sensing

He we present electrochemically synthesised poly-L-lysine (PLL), which is employed to attach functionalised graphene (fG) to the electrode surface. The electro-polymerization conditions such as pH, monomer concentration, potential scan rate and the number of cycles were optimised. The best electrochemical properties of the electrode were obtained using layer-by-layer deposited fG/PLL/fG/PLL/GCE (glassy carbon electrode). Such an electrode was sensitive to dopamine determination in the presence of ascorbic and uric acids as interferants.

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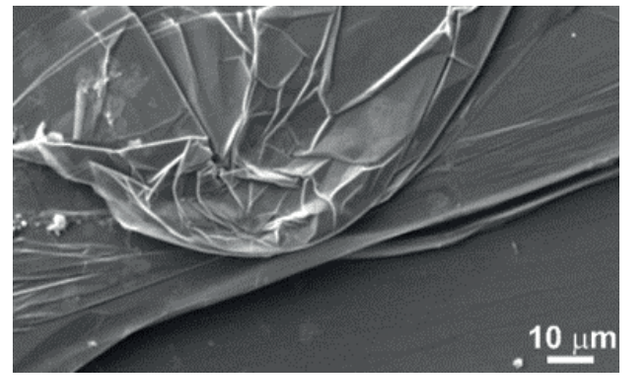

Fig. 1. SEM image of electrochemically synthesised poly-L-lysine on highly oriented pyrolytic graphite (PLL/HOPG) surface at the edges of the substrate.

Chemical lithography based on lipid nanofluidics

We have successfully implemented a new strategy for rapid chemical writing on solid surfaces by the scanning probe (SP). The fundamental limitation of the so-called dip-pen nanolithography- the slow writing speed was solved. The approach is based on using the nanometre-scale lipid flow as efficient means for delivery of surface-pining compounds and serving as the dynamic environment for controlling chemical reactions and the molecular self-assembly. The force spectroscopy data reveals that the lipid molecules organise themselves into the structures resembling those of the living systems, i.e. bilayer and multilamellar phases. In such an environment the bifunctional compounds of interest (thiols in our case) are jetted to the AFM tip-surface contact zone reaching surprisingly high transport rates. Even at writing speeds as high as 100 μm s^{-1}, we could obtain spatially localised surface chemical reactions and controlled formation of stable molecular domains (lithographic patterns). Our study paves the way to the development of new desk-top nanofabrication process that can be implemented in the majority of regular AFM setups. In our proof-of-principle experiments, we successfully performed rapid prototyping of metallic lithographic layouts reaching a pattern fidelity of 7.6 % and the ultimate process resolution close to 50 nm. Also, our data indicate the high potential of the developed nanolithographic technique for biofunctional patterning.

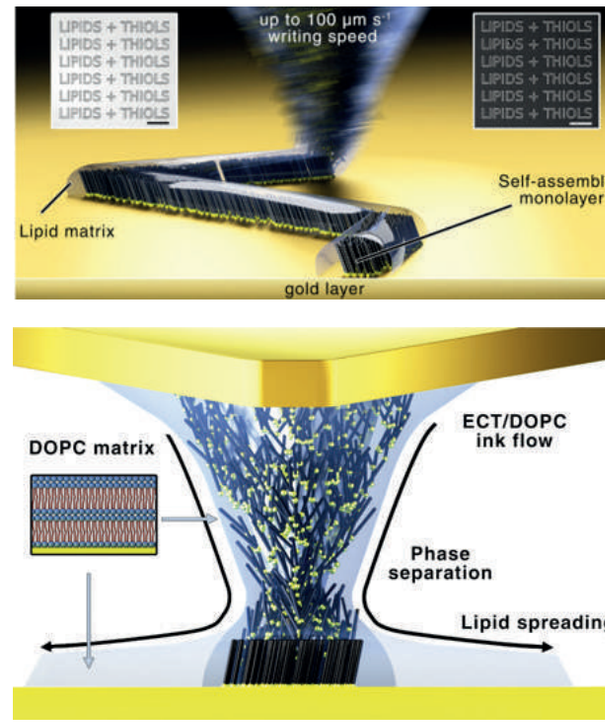

Fig. 2. The qualitative mechanism of rapid molecular writing with the scanning probe.

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Fixed DNA molecule arrays for high-throughput single DNA–protein interaction studies

A new experimental strategy to fabricate single DNA molecule arrays for extremely precise experimental biophysics as well as for future nanodevices and sensor applications is presented. The system allows monitoring of hundreds of single DNA molecules under dynamic liquid flow, or, when preferred, under static conditions. By a proof-of-principle experiment, it was demonstrated the possibility to employ the fabricated DNA arrays for analysis of DNA-protein interactions. The study shows the vast versatility of the alternative fabrication techniques that overcome several limitations of the metallic nanotemplates usually obtained by the commodity fabrication tools. Instead, the described process for single DNA array (DNA curtains) production can be implemented without the necessity to use highly sophisticated cleanroom instrumentation. The difference between the previously published DNA curtain arrays and our system is in several aspects:

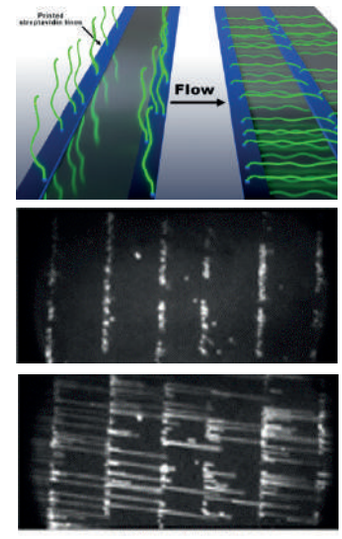

Fig. 3. TIRF microscopy images showing arrayed single-tethered λ DNA molecules, which were stained with SYTOX green. Images were acquired without (top) and with (bottom) buffer flow.

i) DNA molecules are immobilised in a fixed and stable fashion, making possible long-term experiments;

ii) the system extends the range of commercially available objective-based TIRF microscopy setups that can be employed for single-molecule and super-resolution analysis of protein-DNA interactions;

iii) the molecular assembly strategy opens for a variety of chemical modifications, modular nanoengineering and studies of molecular machinery.

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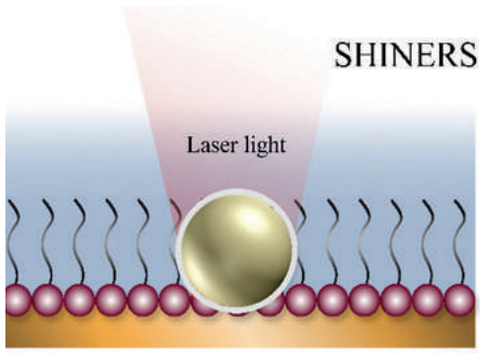
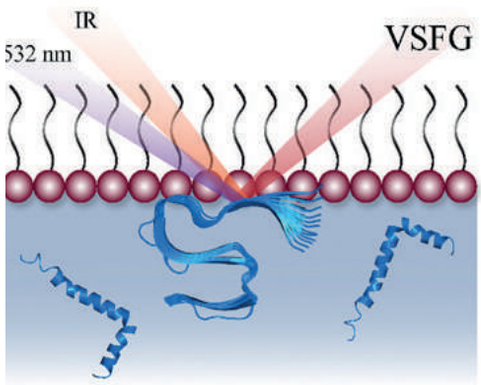
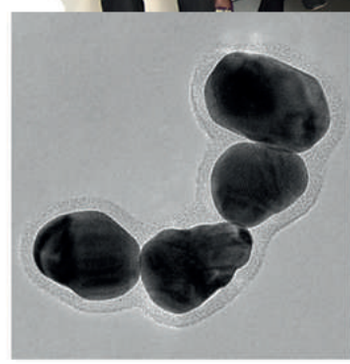
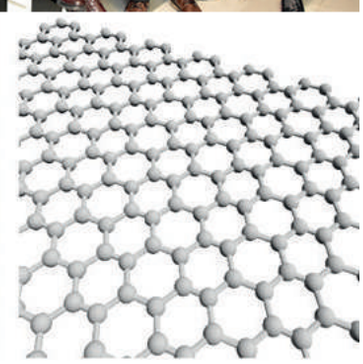
SPECTROELECTROCHEMISTRY









Spectroscopy of adsorption and biochemical processes at surfaces and interfaces

Electron transfer reactions, electrocatalysis, functioning of biomolecules, self-assembly, and various biochemical processes take place predominantly at the surfaces and interfaces. To predict and control the way those processes will proceed, a molecular level understanding is required. Our group employs and develops novel spectroscopic techniques that enable to probe complex liquid and solid interfaces that are difficult to study with most common spectroscopic techniques. Shell-isolated nanoparticle enhanced spectroscopy (SHINERS) is the most promising vibrational surface-enhanced Raman technique. It was developed in order to overcome the limitations of a substrate use in surface enhanced Raman spectroscopy (Tian et al. 2010). Our group produces thin silicon dioxide layer coated Au and Ag nanoparticles. The shell layer plays two very important roles: it protects the nanoparticles from degradation and prevents unwanted interactions between nanoparticles and probe molecules. Recently, our group used SHINERS to study potential-induced changes in the molecular structure of self-assembled molecules. We also successfully characterized the surface of functionalized graphene and a biological system of yeast cells using SHINERS. Vibrational sum-frequency generation spectroscopy (VSFG) is a unique technique with an intrinsic surface specificity. It enables to record the vibrational spectrum explicitly of the surface without any interference with a signal from the bulk material. It is a very versatile technique that can be used to study many different surfaces and interfaces such as solid/air, solid/liquid, liquid/air. We applied VSFG to study hole transporting self-assembled monolayer that was formed on a perovskite solar cell (read more on the next page). The greatest potential of VSFG lies in its ability to measure liquid surfaces with a sensitivity of a few molecular layers. Currently, we are studying the aggregation of proteins at the surface of model lipid membranes by means of VSFG. The aim of our study is to answer one of the most important questions in biology and chemistry: what is the role of protein-membrane interaction in protein aggregation process?

Study of redox and protonation processes of polyaniline by the differential multiwavelength Raman spectroelectrochemistry

Polyaniline layer has been deposited at a gold electrode subjected to differential multiwavelength Raman spectroelectrochemical study. A broad set of laser line excitation wavelengths was used, including UV (325 nm), blue (442 nm), green (532 nm), red (633 nm), and far red (785 nm). From measurements performed, potential-difference Raman spectra, related to small-step changes of electrode potential were derived, and specific spectral and structure features were obtained and analysed. Similarly, pH-difference spectra for solution pH changes were obtained. A strong resonance enhancement of Raman spectra for reduced form of polyaniline at UV and blue line excitations, and for oxidized forms at red and far red excitations was observed and analysed. The 442-nm excited potential-difference resonance Raman spectra revealed presence of intermediate oxidation state compound formed during the electrooxidation of leucoemeraldine with characteristic vibrational bands at 1622, 1187, 881, and 817 cm^{-1}.

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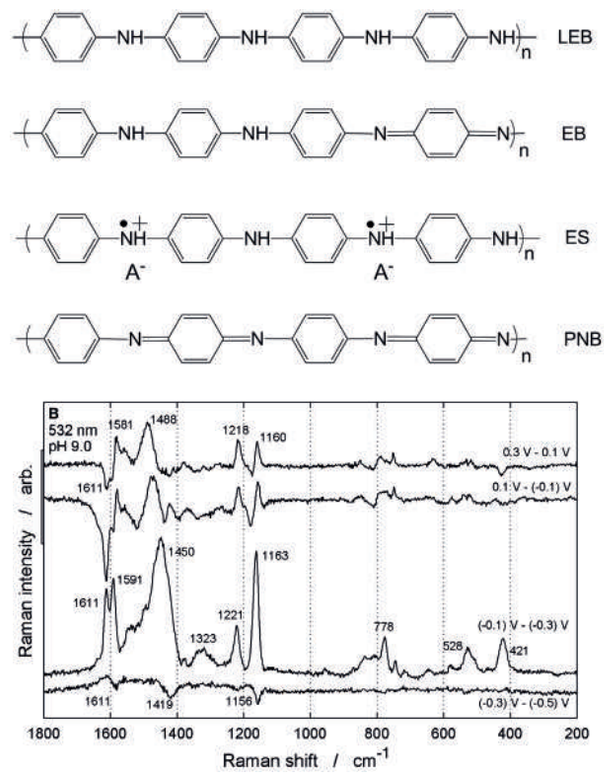

Fig. 1. Top: Chemical structures of polyaniline in its different redox forms. Bottom: Differential Raman spectra showing interconversions of different redox forms of polyaniline upon electrochemical oxidation and reduction.

Conformal monolayer contacts with lossless interfaces for perovskite single junction and monolithic tandem solar cells

In this work, a team from HZB (Helmholtz-Zentrum Berlin) and KTU (Kaunas University of Technology) has synthesized the novel molecules able to form self-assembled monolayer (SAM) which was used as an electrical contact layer for perovskite solar cells. The molecules were functionalized with a phosphonic group via which anchor to an oxide substrate and form a dense and compact monolayer. The molecular structure and stability of SAM was characterized by our group using reflection-absorption infrared spectroscopy (RAIRS) and density functional theory (DFT) calculations. Vibrational bands that correspond to characteristic modes of carbazole ring structure and surface bound phosphate group were identified. Such characterization was crucial in order to show that molecules actually bind to the oxide surface and to link the quality of the SAM with the improvement of the overall efficiency of the perovskite solar cell. The simplicity and diverse substrate compatibility of the SAMs might help to further progress perovskite photovoltaics towards a low-cost, widely adopted solar technology.

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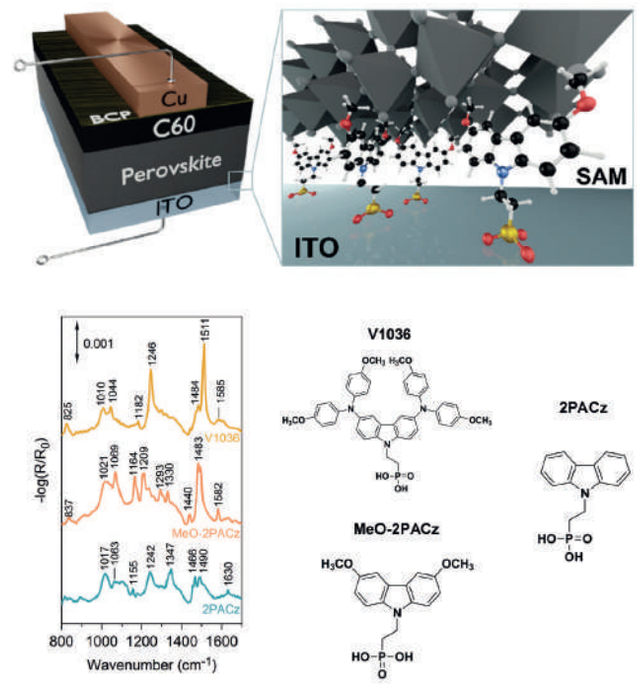
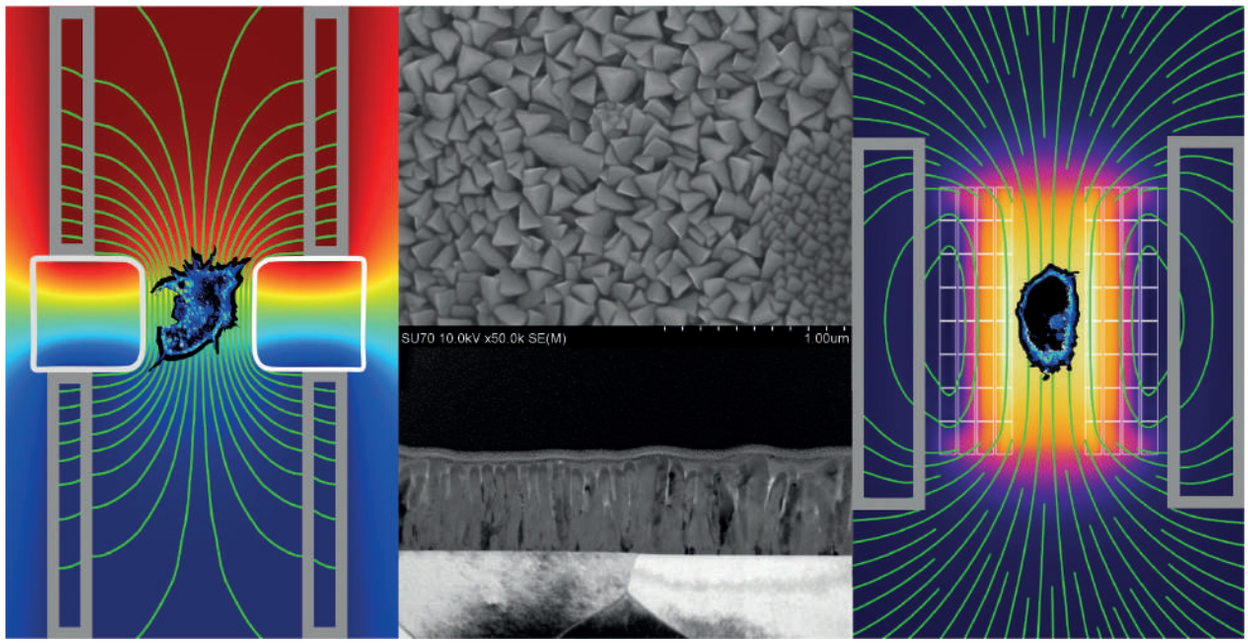


Fig. 2. Top: Solar cell device architecture. Bottom: Reflection absorption infrared spectra (RAIRS) of self-assembled monolayers at ITO substrate and chemical structures of SAM forming molecules.

FUNCTIONAL MATERIALS AND ELECTRONICS



(Left) Electric field distribution in cross-flow treatment chamber during cell electroporation. (Right) Magnetic field distribution in a pulsed coil magnet. (Middle) Electron scanning microscopy and transmission electron microscopy images of magnetoresistive La-Sr-Mn-O nanostructured film.

Advanced functional materials for magnetic, chemical and bio-sensors, microwave absorbers and bioelectric applications

In the last decade the increasing demand in various sensors and sensor systems has resulted in the development of novel technologies for fabrication of advanced functional materials, thin films and nanostructures. The department of Functional materials and electronics is developing technologies of growing advanced materials and thin films with special properties to use them in various areas of applications. The physical, chemical and biological properties are investigated and combined in developed components and systems. The numerical calculations as well as experimental investigations of prepared structures and biological cells are performed using various computational tools and experimental techniques, and responses of these materials to external stimuli (electrical, magnetic, light, microwaves, etc.) are studied for wide range of applications.

Towards direct enzyme wiring: a theoretical investigation of charge carrier transfer mechanisms between glucose oxidase and functional materials

High and balanced rate of charge carriers (holes and electrons) transfer between the active site of enzyme and surface of functional materials is the most challenging factor in the design of electrochemical biosensors. In this study, Marcus–Hush theory and density functional theory (DFT) were applied to evaluate the potential transfer of charge carriers between glucose oxidase (GOx) and organic semiconductors as functional materials. Fig. 1 demonstrates two mechanisms of multistep hopping of charge carriers through the flavin cofactor and aromatic redox-able amino acids in GOx and direct tunnelling between the cofactor of the enzyme and the organic semiconducting modified electrode surface. These theoretical results

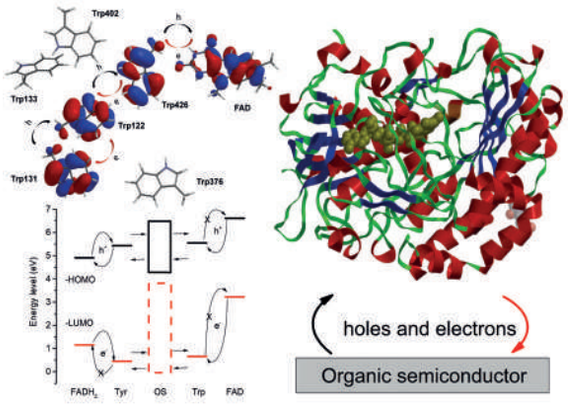


Fig. 1. Structural model of charge carrier hopping pathways within GOx with the representation of corresponding HOMO-N orbitals and theoretically estimated frontier energy levels of the redox-able sites.

agree with the experimental data and provide a promising opportunity for the design and construction of stable and effective third generation biosensors based on GOx and p-type organic semiconductors.

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New technology for *in situ* formation of conductive polymer layers

A conductive composite layer on non-conductive substrate was fabricated by chemical polymerization of pyrrole with entrapped ferric chloride (FeCl3) in adhesive polymer matrix (Fig. 2). Four different polymer matrices were used for polypyrrole (PPy) distribution: PVA, PVAc, PVB and PSSA. The surface of fabricated conductive material was characterized using FIB-SEM, FT-IR and XPS analysis. The conductivity of PPy composites was measured using microwave absorption method (frequency range 8-38 GHz). Our study reveals different conductivity of in situ synthesized composites for different adhesive matrix. This technology is patented. The PPy

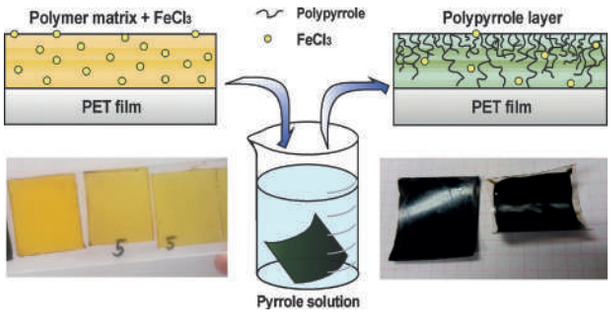

Fig. 2. Fabrication technology of conductive polymer layers on non-conductive substrates by chemical polymerization of pyrrole with entrapped ferric chloride in adhesive polymer matrix.

conductive composites can be used for producing flexible conductive composite wires, smart textiles, microwave absorbing materials or, due to high levels of composites capacitance, energy storing materials.

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Tuning the optical sensing properties of polyaniline-based organic semi-conductor layers by electrochemical copolymerization of aniline with o-phenylenediamine

The effect of copolymerization with o-phenylenediamine on polyaniline optical pH sensing properties is studied in this paper. The polyaniline and o-phenylenediamine based copolymers were formed electrochemically by potential cycling. Molecular structures of the deposited copolymer layers were investigated by Fourier-transform infrared spectroscopy. The pH sensing properties of resulting copolymer layers were studied by spectrophotometric titration as the function of o-phenylenediamine concentration in the polymerization solution. It was determined that pH at which the deposited polymer film exhibited the highest change in absorbance with respect to the change in solution acidity could be adjusted from pH 5.9 to pH 6.7 by the addition of the small amount of o-phenylenediamine to the polymerization solution (Fig.3). The potential applicability of the presented findings has been also discussed. The simplicity of here presented method could be found useful in the design of optical pH and gas sensing systems dedicated for various applications.

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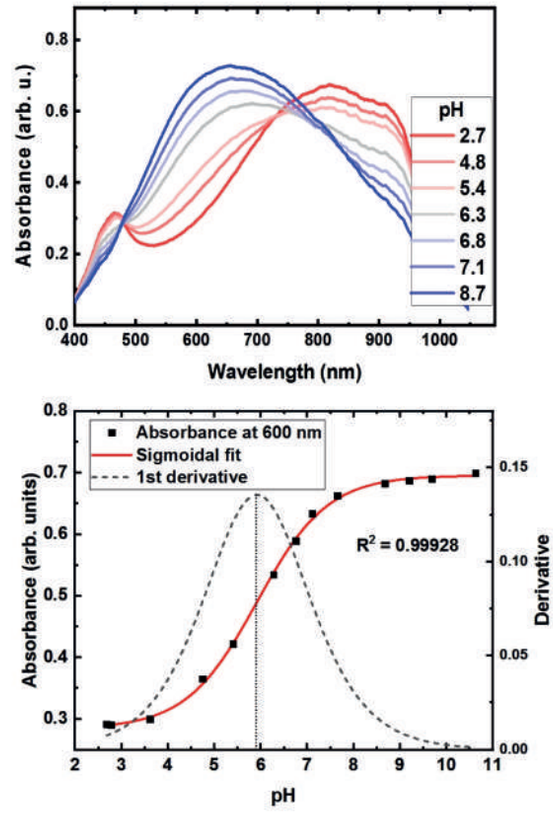

Fig. 3. (Top) UV–Vis absorption spectra of polyaniline film at different pH values. (Bottom) PANI absorption at 600 nm dependence on pH. Dashed line – the first derivative of sigmoidal fit function.

Another brick in the wall. Bioelectrics of yeast envelope

An investigation of the yeast cell resealing process after pulsed electric field (PEF) action was performed by studying the absorption of the tetraphenylphosphonium (TPP+) ion by the yeast Saccharomyces cerevisiae (Fig.4). It was shown that the main barrier for the uptake of such TPP+ ions is the cell wall. An increased rate of TPP+ absorption after treatment of such cells with PEF was observed only in intact cells, but not in spheroplasts. The investigation of the uptake of TPP+ in PEF treated cells exposed to TPP+ for different time intervals also showed the dependence of the absorption rate on the PEF amplitude. The modelling of the TPP+ uptake recovery has also shown that the characteristic decay time of the non-equilibrium (PEF induced) pores was approximately a few tens of seconds and this did not depend on the PEF amplitude. A further investigation of such cell membrane recovery process using a florescent SYTOX Green nucleic acid stain dye also demonstrated that such membrane resealing takes place over a time that is like that occurring in the cell wall. It was thus concluded that the similar characteristic lifetimes of the non-equilibrium pores in the cell walls and membranes after PEF action shows a strong coupling between these parts of the cell.

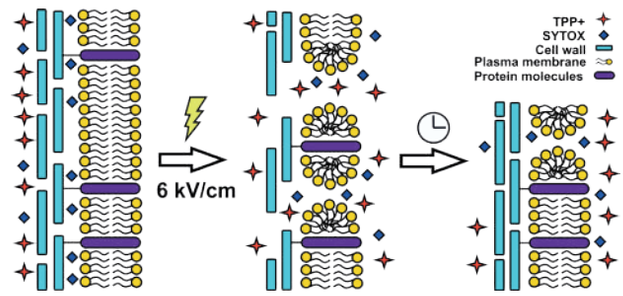

Fig.4. Schematic overview of the cell wall and the resealing of the cell membrane after the PEF treatment.

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Magnetoresistive sensors based on hybrid graphene/ manganite structures

Magnetic field sensor based on a manganite/Al_2O_3-substrate/three-layer graphene structure operating in the range of (0.1-20) T was designed and fabricated. The $La_{0.9}Sr_{0.1}Mn_{1.2}O_3$ (LSMO) manganite film and graphene layers prepared on the opposite sides of polycrystalline Al2O3 substrate enabled to scale the effective volume of the device (~0.16 mm^2) (Fig.5). The combination of two materials - one with positive (graphene) and the other with negative (manganite) magnetoresistive effects - led to a significant increase of the response signal and sensitivity in comparison with individual graphene or manganite sensors. This was achieved by increasing the magnetoresistance (MR) of individual manganite and graphene elements. The MR of LSMO was increased by using a special pulsed-injection MOCVD regime based on two precursor sources with tunable vapor supersaturation and growth rate. The MR of three-layer graphene was optimized by changing width/ length ratio of rectangular planar configuration and scaling dimensions from millimeters to few hundred micrometers, what resulted in achievement of maximal sensitivity (72 mV/VT) in the range of magnetic flux density of (1-3) T.

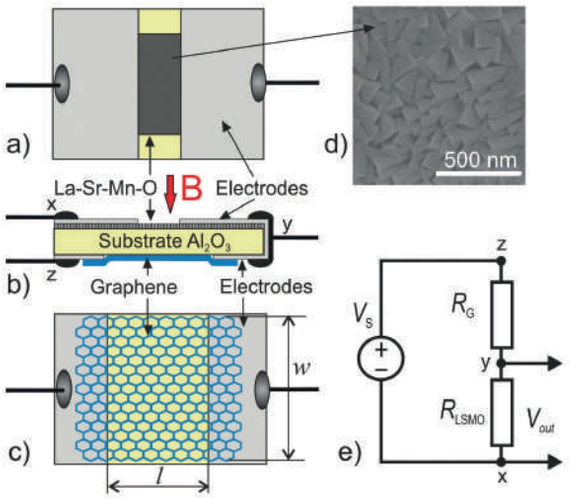

Fig.5 (a)-(c) Schematic representation of compact manganite/ graphene sensor. (d) SEM image of LSMO film. (e) Electrical circuit of the sensor. RG and RLSMO are resistances of graphene and manganite, respectively. VS=1.25 V.

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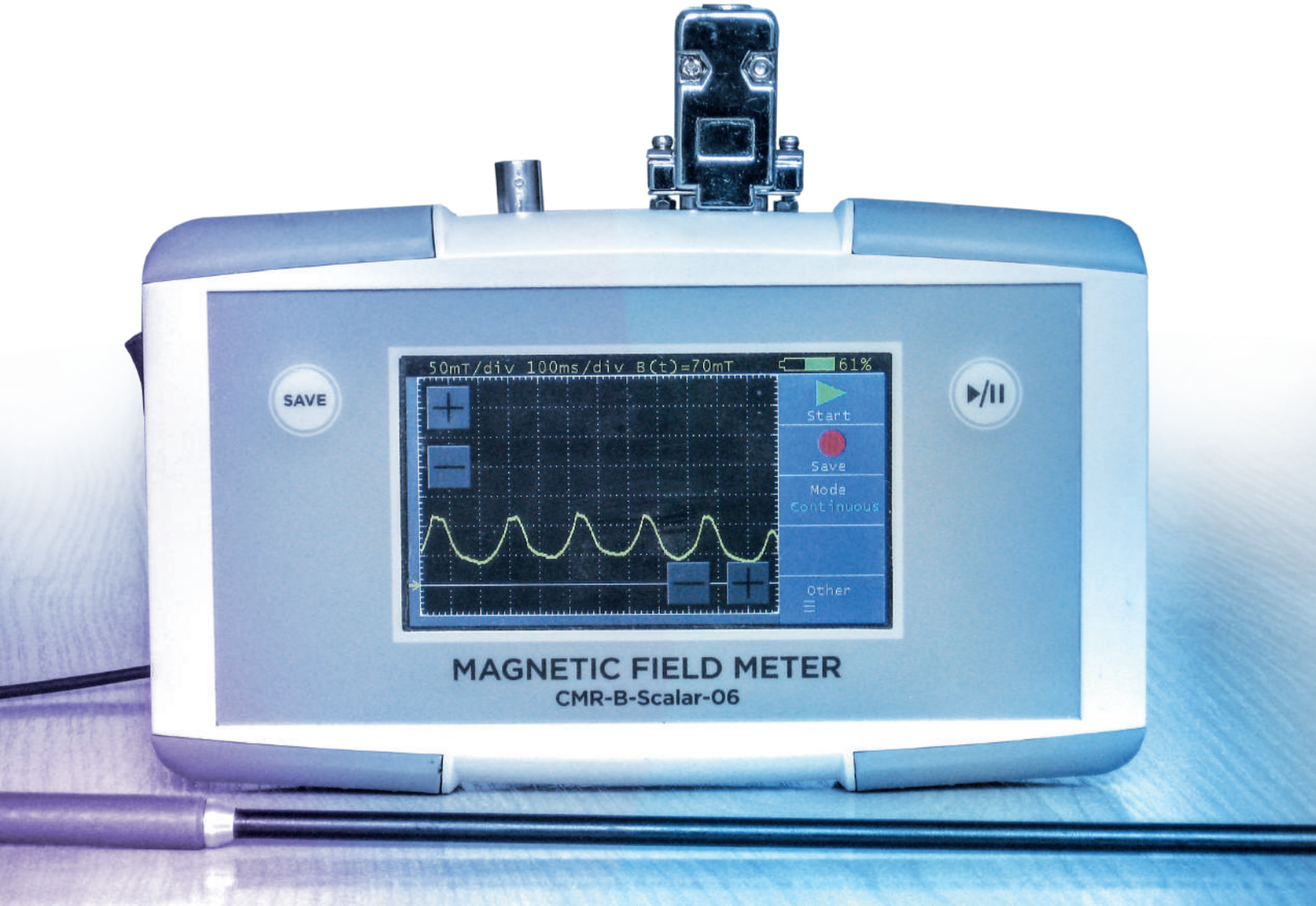
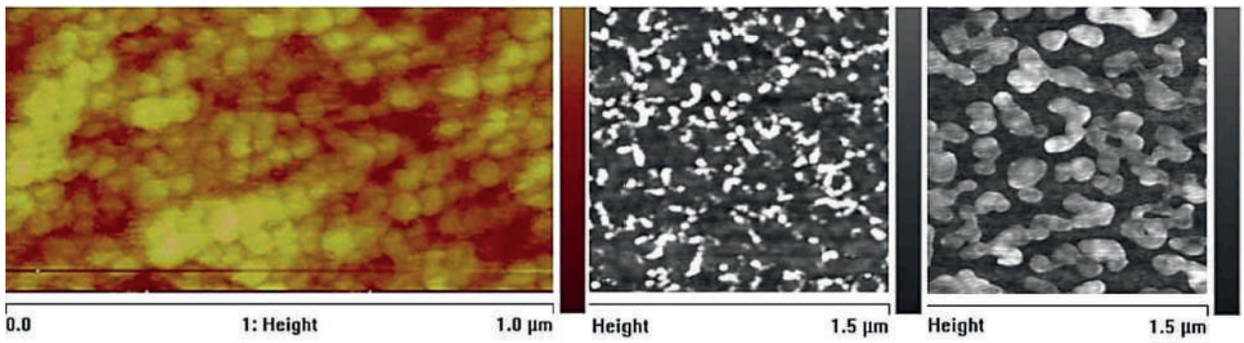


NANOSTRUCTURES FOR APPLICATIONS



Intentional modification of the functional properties of the combined layered systems and integrated devices is the driving force for our research and development (R&D) of the technologies for the nano- and micro-structured materials. We are focused on four main topics in material engineering and applied research.

First, our investigations create the basis for the strictly controlled deposition technologies of the two-dimensional (2D) materials adaptable to the bottom-up approach in the device fabrication. Two classes of the materials are typically used in these investigations including the crystalline and nano-crystalline graphene and transient metal dichalcogenides such as molybdenum disulphide (2D-MoS_2). Understanding of a relationship between the growth conditions and the properties of the 2D-materials is the primary challenge in our R&D of the structures acceptable to modify the optoelectronic elements and sensors. We found it crucial to control the defects that have to be visualised and characterised with sufficient accuracy. One of the types of local defects is illustrated for the 2D-MoS_2 layers by the STM images in the headline figure.

The second topic of our research work is the development of the device models with intentionally created characteristics. Our experimental and digital modelling results are acceptable to propose the approaches for modification of electrical and optical (from the visual to the far-infrared waves) properties for the large area devices. An exciting way to control the interaction between the electromagnetic waves and the metamaterials is described in the highlight of the Fano resonance.

The third topic of our R&D activities is related to the application of laser technologies for transformation of thin films and materials to nanostructures with desired properties. Aiming at the development of the photonic-based sensors, we study plasmonic response of the artificial nanostructures and demonstrate their conformational changes by using ellipsometry and Raman spectroscopy techniques.

Fabrication of the working device prototypes with the aim of their integrations into practical systems and testing of the functioning of these systems in conditions of real applications is the fourth topic of our R&D activities. Therefore, the prototype systems have to be compatible with the intelligent data collection and analysis, and have to be acceptable for integration into the so-called Internet of Everything (IoE). The target applications drive us to development of the combined self-powered functional modules based on the 2D-materials, ultra-thin layers and epitaxial quantum structures. The modules must be easily integrated into small volume devices, small robots, gadgets and even used as the smart dust.

Generation of gold nanoparticles on ITO glass substrate using nanosecond laser treatment

The one-step generation of gold nanoparticles (Au NPs) on ITO glass by using nanosecond laser pulses is demonstrated in Fig. 1. This method opens a new way for the development of highly sensitive and cost-effective electrochemical sensors or the surface-enhanced Raman spectroscopy (SERS) substrates. The diameters and density of the generated gold nanoparticles on ITO glass strongly depend on the thickness of the gold film when it is less than 10 nm. The thicker gold film, the larger diameter, the higher size dispersion and the lower density of the generated AuNPs (Fig. 2). The exhibited AuNPs are insensitive to laser processing parameters.

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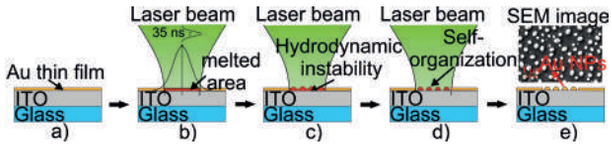


Fig.1. The principle of Au nanoparticle generation on ITO glass

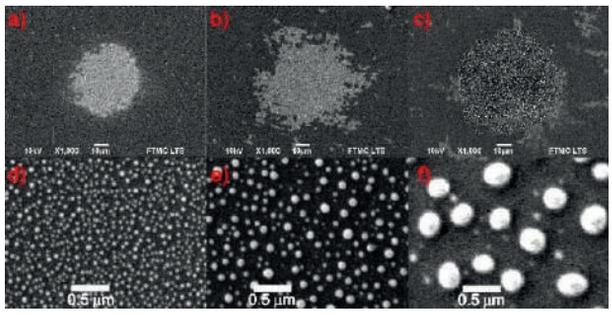
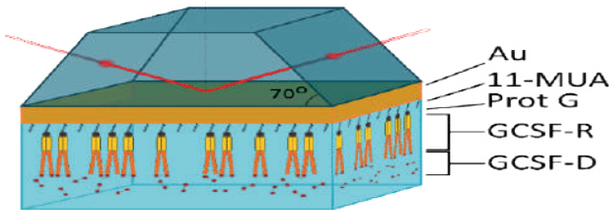


Fig. 2. SEM micrographs of Au coatings affected by a single laser pulse when coatings thickness is 3 nm (a, d), 5 nm (b,e), and 20 nm (c, f). The laser processing parameters in all cases were the same.

Plasmonics and nanophotonics based optical biosensors

The plasmonic-based optical sensor, in combination with spectroscopic ellipsometry, was applied for in situ registration of the analytical signal generated by the interaction of three structurally-different homologues of genetically-engineered GCSF ligands with the immobilised GCSF-receptor. The experimental results and further calculations of association and dissociation constants have shown that an increase of the mass of GCSF-based molecules by the fusion of two GCSF molecules significantly changes the formation and dissociation characteristics of complexes between these molecules and GCSF-receptors. This approach also provides some information about conformational changes, which have a direct influence on the drug-target residence time and pharmacokinetic characteristics.

Another type of optical sensor was used for Bovine leukaemia virus (BLV) proteins gp51, which are serving as antigens for specific antibodies against BLV proteins (anti-gp51). The efficiency of the immobilisation of BLV proteins gp51 on ZnO nanorod modified glass surface was evaluated. The formation of the antigen-antibody complex was investigated by changes in ZnO photoluminescence. Bovine serum albumin (BSA) was applied for the modification of sensing gp51 layer to form gp51&BSA layer with excellent selectivity.



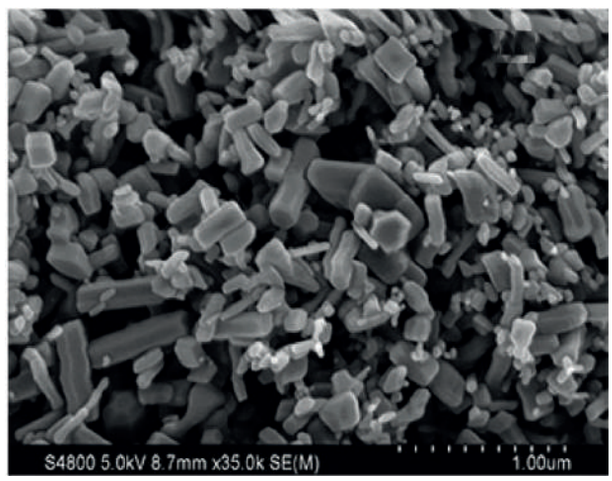


Fig. 2. (top) Principal scheme of experiment with GCSF ligands. (bottom) SEM micrograph of ZnO nanorods used for BLV proteins biosensor.

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Fano resonance arising due to direct interaction of plasmonic and lattice modes in a mirrored array of split-ring resonators

We demonstrate that direct interaction of plasmonic and lattice modes leads to the Fano-type resonance in a mirrored array of simple split-ring resonators (Fig. 3). It appears as a consequence of an overlapping of the frequencies of the lowest lattice mode and the broadband plasmonic mode, which plays the role of a continuum, whereas the lattice mode manifests itself as a discrete-state. The overlapping is achieved by the mirror-symmetric orientation of two adjacent split-ring resonators twicely increasing the lattice period. Further increase of the period of the modified array leads to a shift of the Fano resonance to a lower frequency. A high-quality factor of Fano resonance (around 100) is evidenced experimentally. Observed tunable resonance might be used for sensing and other applications of THz metasurfaces.

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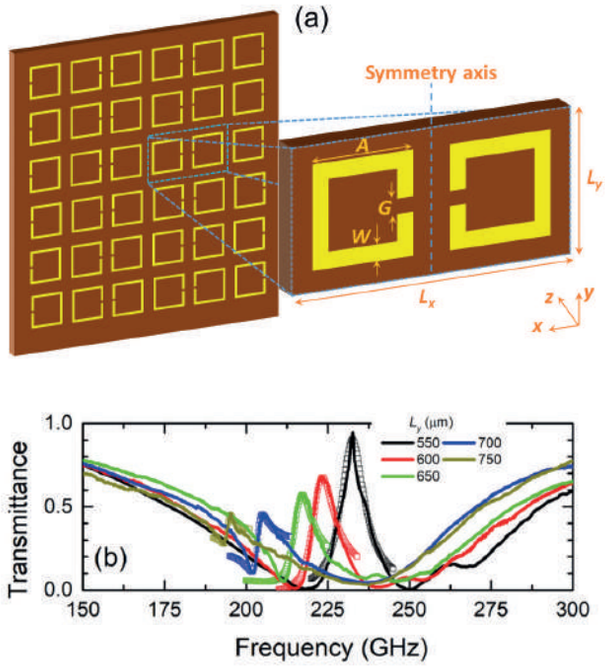

Fig. 3. (a) Mirrored array of split ring resonators Lx = 2 Ly, (b) Measured transmittance spectra for different size of the unit cell. The points show the Fano fit.

Mechanism of pillars formation using four-beam interference lithography

The experiment was carried out using the four-beam interference lithography (Fig. 4, top) with a different number of laser pulses (from 500 to 5000) in various environments (Ar, N_2, air or low vacuum). The repetition rate of laser pulses was equal to 1 kHz in all experiments. The average laser power was selected ~100 mW for the 300 ps duration pulses. A comparison of the structures fabricated using various number of laser pulses in diverse ambient conditions is shown in Fig. 4, bottom. Morphology of the pillars in all cases was different. The pillars fabricated in Ar gas were broader and higher compared with the pillars fabricated in N_2, low vacuum or air. The shape of all fabricated pillars in all cases was the same: wider at the bottom than at the top. It indicates that the pillar bottom widening is not affected by the depletion of atmospheric oxygen.

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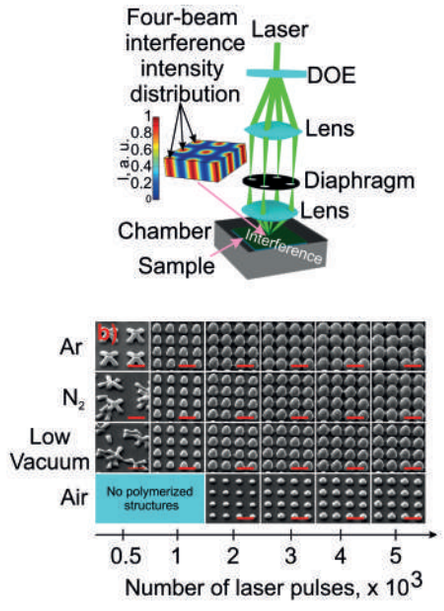
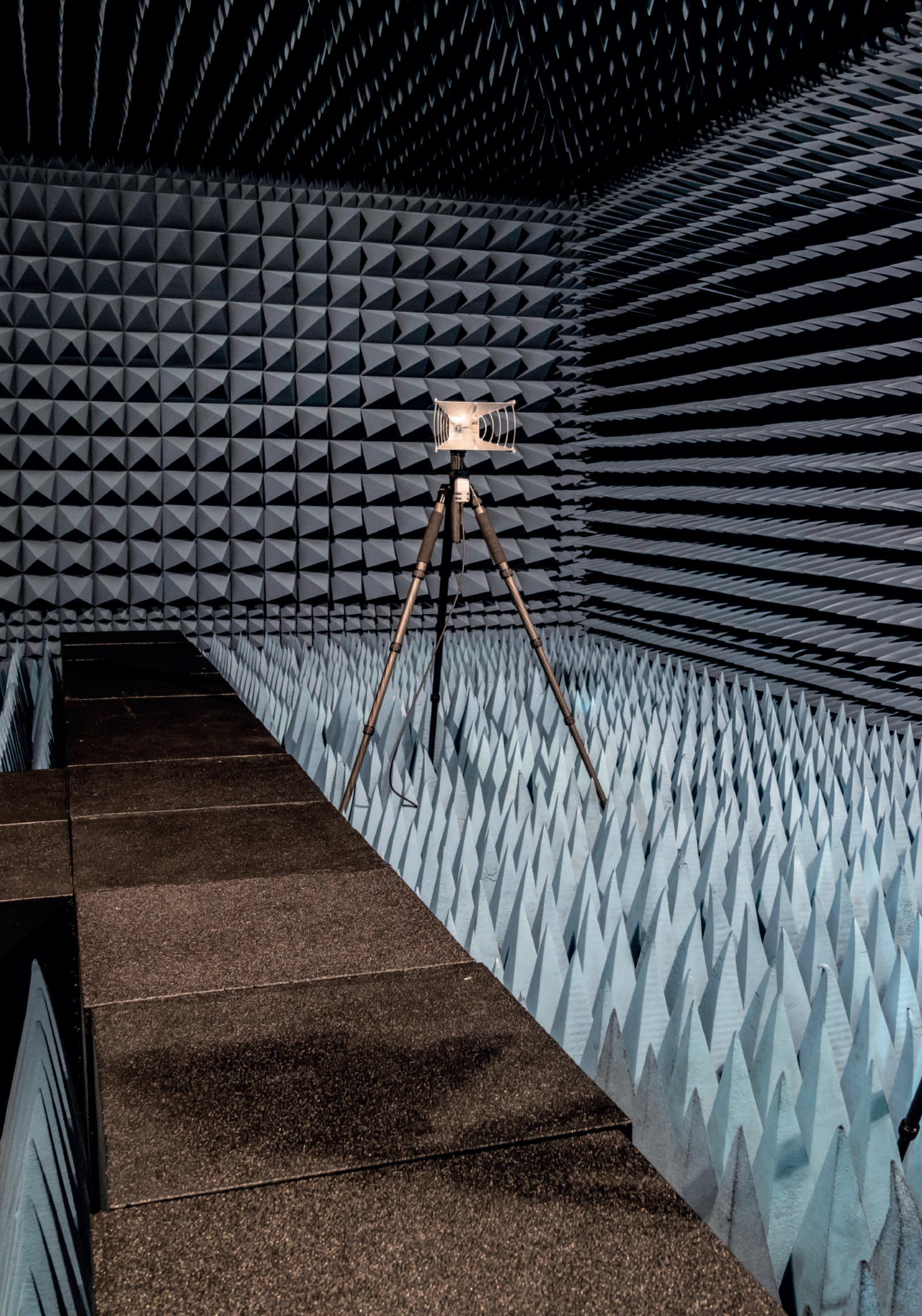
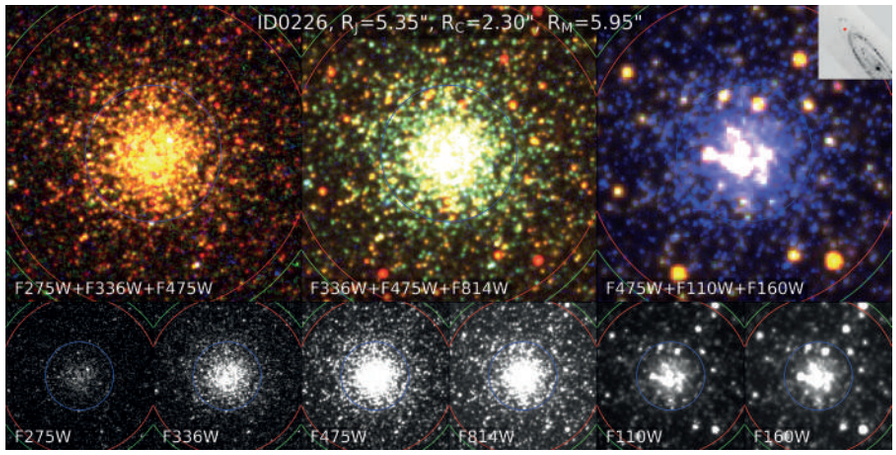


Fig. 4. (top) Experimental setup of four-beam interference lithography, (bottom) Morphology of the pillars fabricated in Ar, N_2, low vacuum and air by using a different number of laser pulses (from 500 to 5000). Scale bars represent 10 μm.



ASTROPHYSICS



We study complex systems, from star clusters to galaxies, by employing ground- and space-based observations, as well as computer simulations.

Star clusters in the Andromeda galaxy (Hubble Space Te lescope)

Star clusters in the dwarf irregular galaxy Leo A

Leo A is an isolated gas-rich dwarf irregular galaxy of low stellar mass and metallicity residing at the outskirts of the Local Group. Ages of the stellar populations in Leo A range from ~10 Myr to ~10 Gyr. We report the discovery of the first 5 star clusters in the Leo A galaxy. Two clusters are of a young age (~20 Myr) and low in mass (≥400 $M_\odot$ and ≥150 $M_\odot$), the other three clusters are older (≥100 Myr) and also of low mass (≥300 $M_\odot$).

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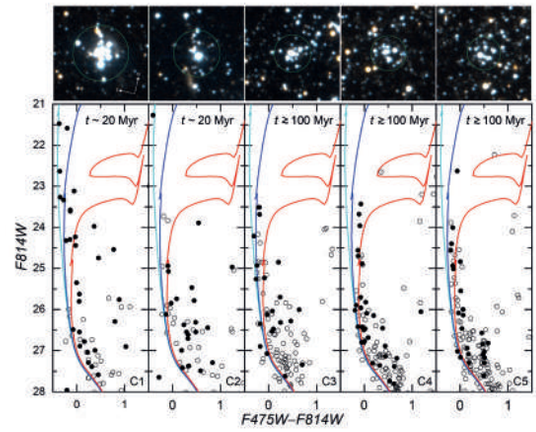

Fig. 1. Colour images of the clusters and their colour magnitude diagrams showing the star-like objects residing inside the green circle marking the cluster itself (filled bl.ack circles) and star-like objects residing in the field (open circles). The colour images of clusters are constructed from the HST ACS frames. The isochrones of Z = 0.0007 metallicity and ages of 20 Myr (the cyan line), 100 Myr (the blue line), and 500 Myr (the red line) are shown in all panels

Slow and massive: low-spin supermassive black holes (SMBHs) can grow mor

Active galactic nuclei probably control the growth of their host galaxies via feedback in the form of wide-angle wind-driven outflows. These establish the observed correlations between SMBH masses and host galaxy properties, e.g. the spheroid velocity dispersion σ. Analytical models predict a correlation M ~ σ4, which is shallower than the observed M ~ σ5. We showed how this discrepancy arises during the final stages of SMBH growth and results in SMBH mass growth beyond the predicted correlation. We also demonstrated that slow-spinning SMBHs should reach higher masses than rapidly-spinning ones.

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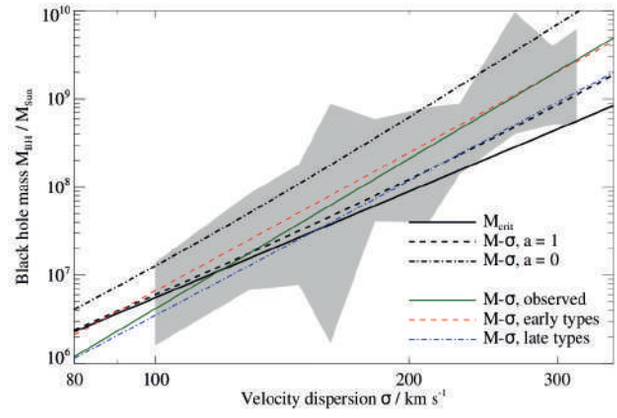

Fig. 2. The observed relations between SMBH mass and σ are shown in coloured lines, with the grey area encompassing most individual SMBH mass measurements. Our predictions for slow- and fast-spinning SMBHs are shown in dot-dashed and dashed black lines, respectively; both are steeper than the simpler analytical prediction, shown in black solid line.

MODELLING

Quantum defects by design

In recent years, there has been a tremendous increase in research and practical applications of quantum information technologies. The major pillars of these technologies are quantum computing, quantum communication, and quantum sensing. Rather surprisingly, point defects in wide-bandgap semiconductors (see Fig. 1) have been one of the leading building blocks of quantum technologies, in particular in the field of quantum sensing and, to a lesser degree, quantum communication. Historically, the study of quantum point defects has been limited to a relatively small set of host materials and defect systems. In this manifesto-type article, the potential for identifying defects in new materials is considered, either to advance known applications in quantum science or to enable entirely new capabilities. It is proposed that, in principle, it should be possible to reverse the historical approach, which is partially based on accidental discovery, to design quantum defects with desired properties suitable for specific applications.

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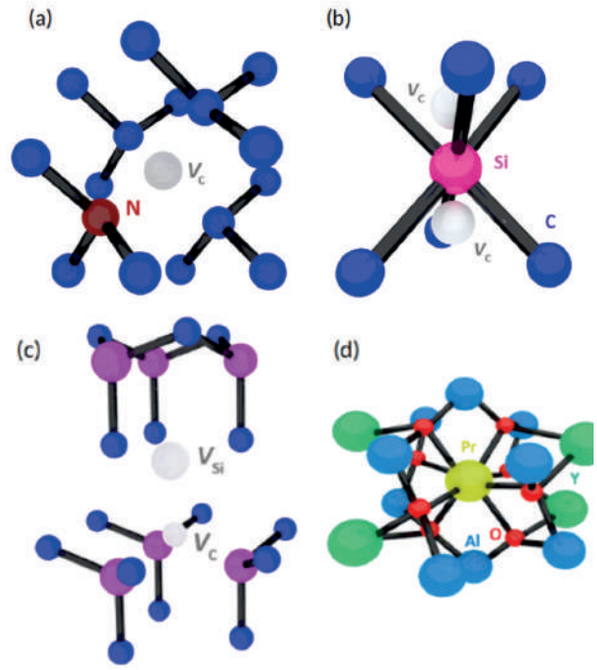

Fig. 1. Examples of prominent quantum point defects: (a) nitrogen-vacancy centre in diamond, (b) silicon-vacancy centre in diamond, (c) divacancy in silicon carbide, (d) substitutional Praseodymium (Pr) atom in yttrium-aluminium garnet (YAG).

Figure courtesy of M. Mackoit-Sinkevičienė.

Trimesic acid molecule in a hexagonal pore: central versus non-central position

Self-assembly of trimesic acid (TMA) molecules into the honeycomb structure with filled pores and the resulting host–guest chemistry are studied by the density functional theory (DFT) and Monte Carlo (MC) simulations. The DFT calculations demonstrate that a guest TMA molecule prefers a non-central position in a relaxed hexagonal pore formed of six TMA molecules, and it is binded by two intermolecular interactions. The symmetric central position of the guest molecule is energetically favorable only in the honeycomb structure, which is compressed by more than 3%. Based on the estimated host–guest dimeric interactions, a model is proposed to identify the conditions for central and non-central positioning of TMA molecules within the pore during their ordering into the honeycomb structure with partly filled pores. The MC simulations reveal that increase of the molecule–substrate interaction in the center of the pore or interactions of the central molecule with the cage molecules have a significant effect in preserving the central position of the guest molecule. However, if these interactions are not too strong, the noncentral position is favored due to multiplicity of noncentral arrangements in a hexagonal cage.

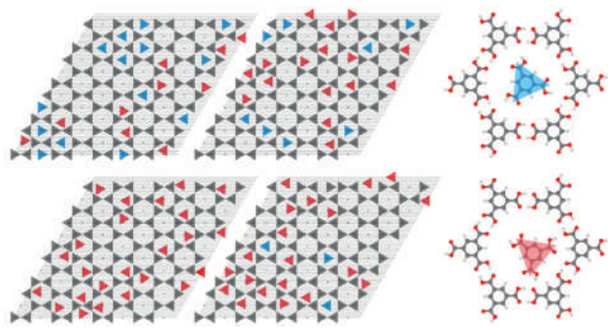

Fig. 2. Snapshots of Monte Carlo calculations demonstrating a change of preference from a non-central to central position of a guest molecule in a hexagonal pore with decrease of temperature (top row, from right to left). This effect is obtained for strong interaction between the hexagonal pore molecule and guest molecule at the center of the honeycomb, ec. For smaller values of ec, the non-central position is preserved (bottom row). In the right-hand column the legend is given.

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Dispersion relation of surface plasmon polaritons in non-local materials

A non-local environment employing a plasmonic nanowire metamaterial system was theoretically analyzed. Such a system was employed to allow for a topological transition between elliptic and hyperbolic dispersions. The effective medium formalism for local and non-local approaches of a composite metamaterial has been described. An analytical approach, providing sufficient explanation of electromagnetism in nanowire metamaterials and considering non-local optical response, based on homogenization technique, has been presented. The methodology to fulfil additional boundary conditions in nanowire composites has been provided. To get a full picture, the unit cell geometry of the composite has been varied (Fig. 3). Moreover, the metamaterials with different unit cell types (rectangular and hexagonal) have been considered.

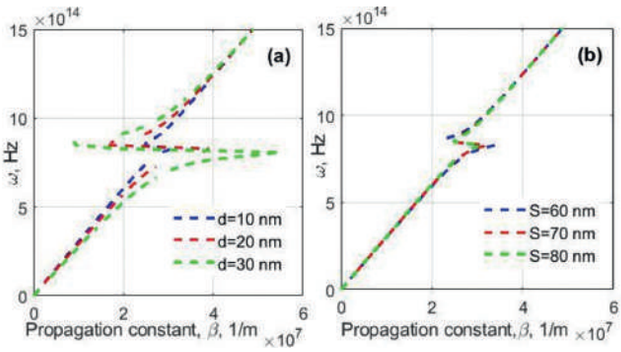

Fig. 3. The influence of the pore diameter (a) and distance S (b) on the modes pattern

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Interaction of intense ultrashort terahertz pulses with narrow-gap semiconductors

Electron dynamics and impact ionisation have been investigated by Monte Carlo simulation in narrow-gap semiconductors irradiated by intense ultrashort terahertz (THz) pulses. It was found that electron motion has nearly ballistic character when subjected to intense THz radiation of subpicosecond duration. The studies of current carriers and impact ionization dynamics were performed in n-type InAs at room temperature. The sequence of hot electron transfers between the Γ and upper L and X valleys was established: hot electrons of the Γ valley transfer first to the L valley, and then to the X valley. Electron population in the valleys and characteristic time of their redistribution between the Γ, L and X valleys was investigated in strong electric fields. The threshold electric field of impact ionisation was found to increase for shorter THz pulses. The process of impact ionisation was shown to be the dominant energy loss mechanism for hot electrons with the energy larger than the threshold energy of impact ionisation. Good agreement between the calculated results and available experimental data was found. The obtained results can be applied for development of high power and high frequency modern electronic devices.

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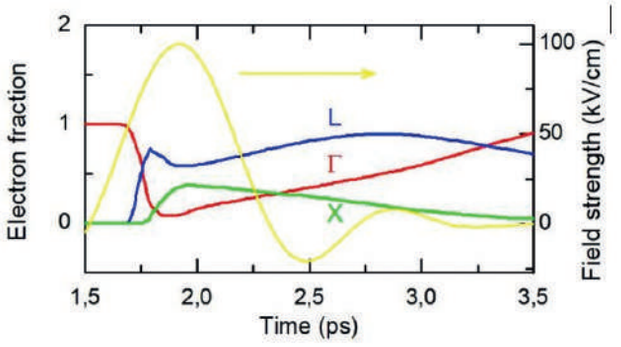

Fig. 4. The dynamics of electron population in the Γ, L and X valleys of InAs sample at 300 K.

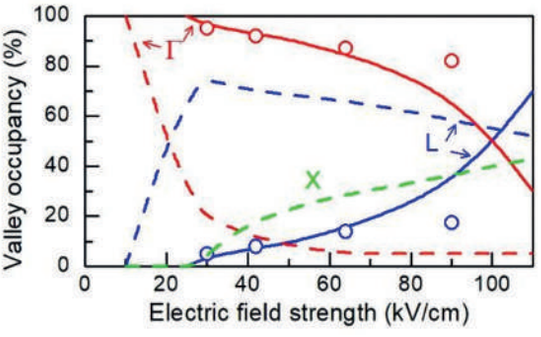

Fig. 5. The relative population of electrons in the Γ, L and X valleys of InAs as a function of the peak electric field. Monte Carlo simulation is represented by solid lines for 150 fs-long THz pulse, and by dashed lines for 0.8 ps-long pulse. The open circles are experimental data points.

NONLINEAR DYNAMICS AND CHAOS

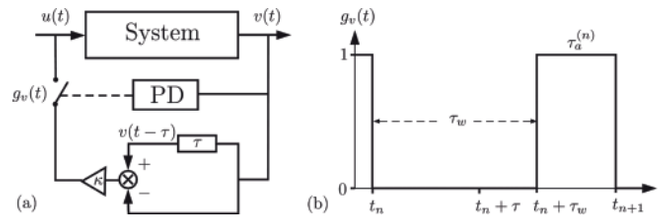

Fig. 1. (a) A block diagram of a state-dependent act-and-wait time-delayed feedback control (TDFC) method. The bottom feedback loop is a standard TDFC controller. The block PD is a phase detector that registers the phase of the output signal in the waiting intervals. The PD controls the switch $g_v(t)$ that opens and closes the TDFC loop. (b) Time evolution of a state-dependent act-and-wait switching function $g_v(t)$. The length τ_w of the waiting interval is constant, while the length τ_a of the acting interval depends on the phase of the signal detected at the preceding waiting interval.

State-dependent act-and-wait time-delayed feedback control algorithm

TDFC method is one of the most popular experimental tools used for stabilization of unstable periodic orbits (UPOs) in nonlinear dynamical systems. The method does not require any detailed information about the target orbit except for its period. TDFC uses a control signal in the form of the difference between the current output signal of the system and the same signal delayed by the period of the target UPO. The algorithm is noninvasive, since the control perturbation vanishes whenever the system settles on the target orbit.

Although TDFC is easy to experimentally implement, the theory of the method is complex because TDFC-driven systems evolve in an infinite-dimensional functional space. We modified the TDFC by appending a feedback loop with a state-dependent switch (Fig. 1). The switch closes and opens the feedback loop ("act-and-wait" control concept) depending on the phase of the output signal, which is measured by a specially designed phase detector (PD). The modification allows to reduce the phase space dimension of the feedback system with a time delay, so that the number of Floquet exponents of the controlled UPO remains the same as for the system without control. These exponents can be efficiently manipulated by control parameters and a very deep minimum can be attained in the spectral abscissa. As a result, the modification extends the operating range of the usual TDFC, that is, the act-and-wait TDFC works in the situations where a conventional TDFC fails. We demonstrated the

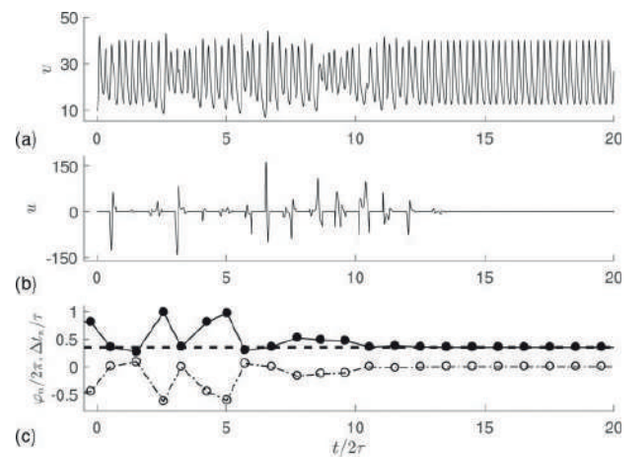

Fig. 2. State-dependent act-and-wait time-delayed feedback control of the Lorenz system. The initial conditions are taken on a chaotic attractor. (a) Stabilization of an output variable. (b) The dynamics of a state-dependent control perturbation that asymptotically converges to zero. (c) The dynamics of the current phase (black filled circles) of the UPO, found by the PD, and the dynamics of the correction of the length of the acting period (white open circles). The phase of the orbit converges to the optimal value (horizontal black dashed line), and the correction vanishes.

effectiveness of the proposed algorithm with chaotic autonomous Roessler and Lorenz systems as well as with a non-autonomous Duffing oscillator. In all cases, we used control configurations for which the conventional TDFC algorithm does not work. We have also shown that our algorithm is noise resistant and robust against a slow drift of the phase of a driving force in non-autonomous systems. Fig. 2 shows the results of applying the state-dependent act-and-wait TDFC to the Lorenz system.

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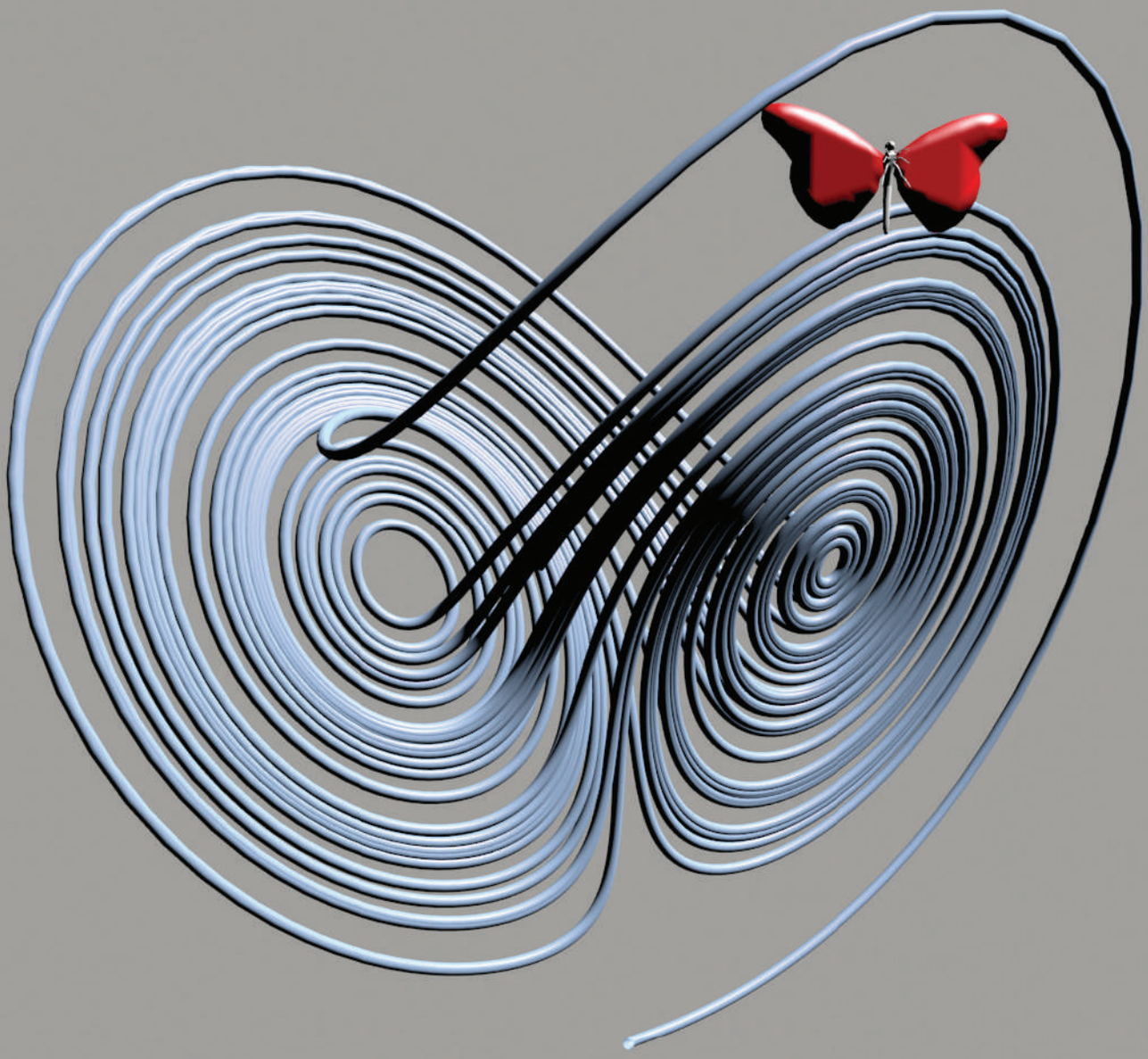
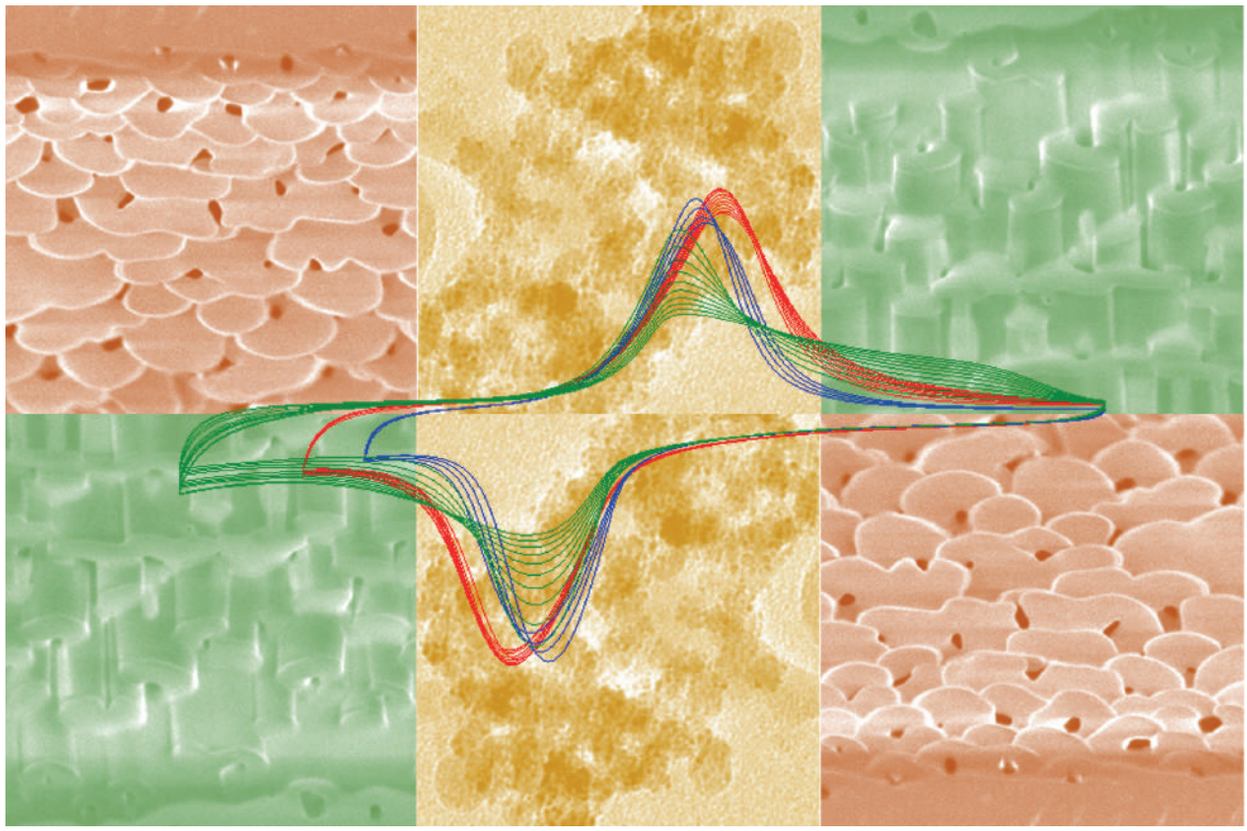


ELECTROCHEMICAL MATERIAL SCIENCE



Technologies for electrochemical energy conversion and storage, electrocatalysis, solar-driven electrochemistry, smart anticorrosive coatings

Electrochemical energy conversion and storage technologies offer attractive solutions to many contemporary renewable energy-related issues. The R&D activities in this area at the Department of Electrochemical Material Science and Department of Chemical Engineering and Technologies are focused on the development and profound understanding of materials, processes and devices for aqueous Na-ion batteries, (photo) electrochemical production of hydrogen or other value-added chemicals, electrochemical synthesis of silicon nanostructures and other materials, including superparamagnetic and luminescent nanoparticles with possible applications in photovoltaics, nanomedicine, etc. Electrochemical, chemical as well as physical (magnetron sputtering, atomic layer deposition) methods are applied for the surface modification and production of smart materials with exceptional electrocatalytic, anticorrosive, magnetic, mechanical or other properties. The integral part of the process of new materials development is a thorough characterisation of their structure, morphology and chemical composition. Environmental friendliness is imperative for all newly developed technologies.

Corrosion, tribological, physical and electrochemical studies on the interaction of biofuels (ethanol, biodiesel, biolubricants) with metal surfaces are carried out as well. These activities include a search for tribologically efficient materials for new type anodic aluminium coatings with exceptional resistance to friction and attrition. The results are tested directly in the Anodization pilot plant, located in the Chemical Engineering and Technologies department. Smart coatings with active corrosion protection ability for metals in aggressive environments are being developed. Corrosion tests are carried out in the accredited Corrosion Testing Laboratory at FTMC, which performs characterisation and evaluation of the corrosion-caused changes in metals, alloys, composite coatings, paints and lacquers in natural and artificial atmospheres and can also assess the microbially induced corrosion of materials in ambient atmosphere or model media.

MoS_2 with organic fragment – a new hybrid material for laser writing

New nanostructured metasurfaces, capable of changing the composition and physical properties upon pulse laser excitation, recently received marked attention in nanophotonic technologies. In this study, the laser-induced selective phase transition procedure was performed to investigate the influence of green (λ=532 nm) ns-laser illumination on the structural and compositional transformations of hybrid-type MoS_2-based nanoplatelet films. For the first time, it has been determined that hydrothermally synthesised molybdenum disulfide nanoplatelet-shaped species and films, heterostructured with organic fragments by hydrothermal synthesis, can be ascribed to metamaterials and applied for ns-laser writing. To detect the insertion of organic molecule fragments between MoS_2 nanoplatelets and their detachment upon ns-laser illumination, time-of-flight secondary ion mass spectrometry (ToF-SIMS) results were obtained in collaboration with the researchers in Mons University and Materia Nova Research Center, Mons (Belgium).

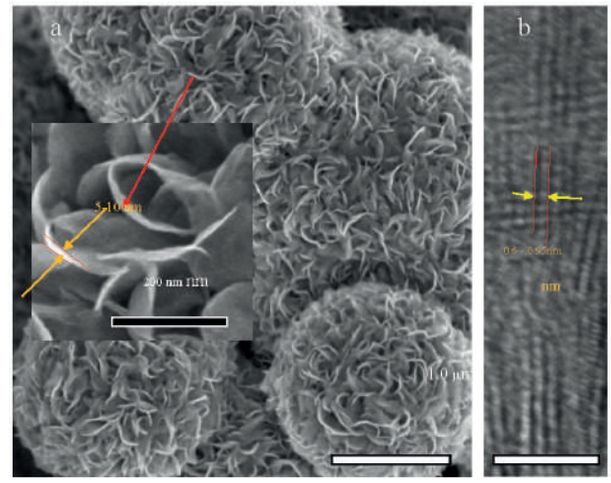


Fig. 1. (a) SEM and (b) HRTEM views of molybdenum disulphide-based nanoplatelet-shaped species as a new laser writing material.

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Electrolytic splitting of saline water: durable nickel oxide anode for selective oxygen evolution

Increasing generation of renewable electricity offers a source of green electric power, which can be exploited for the sustainable production of hydrogen through the electrolysis of water. Scarcity of fresh water resources promotes the search for electrode materials, which could be used for the splitting of saline water into H_2 and O_2 without the formation of hazardous chlorine compounds, and also withstand highly aggressive chloride medium. We demonstrate that a nickel oxide layer formed utilising simple spray-pyrolysis technique on the conductive glass substrate can be used as corrosion-resistant and 100 % O_2-selective anode for the electrolysis of alkaline chloride solution. Dimensional stability and durability of the anode are secured by the absence of the metallic phase, whereas selectivity towards oxygen evolution and absence of chloride oxidation is shown to be controlled thermodynamically. The obtained experimental evidence, that hydrogen peroxide is formed as intermediate in oxygen evolution reaction under conditions investigated, has led to new mechanistic insights, and the mechanism of Ni(IV)-mediated electrocatalytic oxidation of water molecules in alkaline chloride medium has been proposed.

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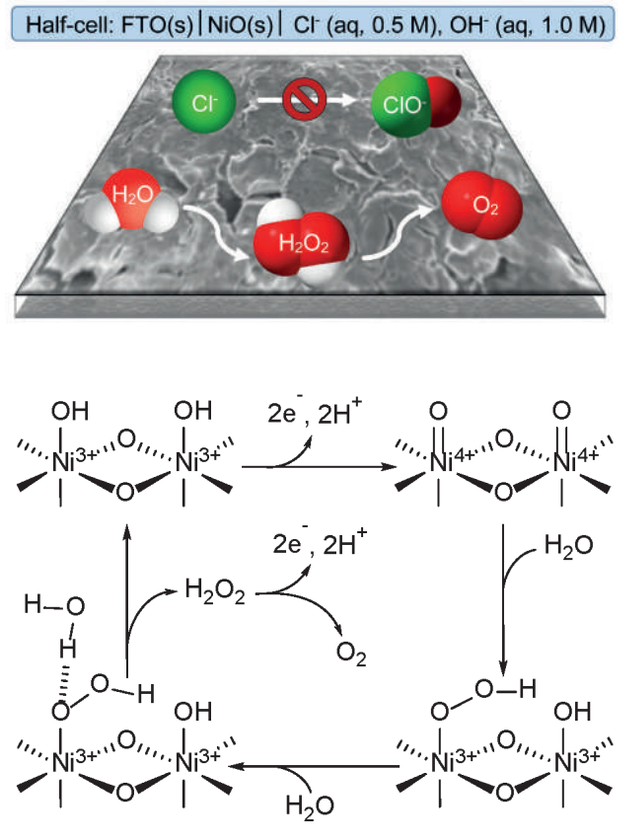

Fig. 2. Fabrication technology of conductive polymer layers on non-conductive substrates by chemical polymerization of pyrrole with entrapped ferric chloride in adhesive polymer matrix.

Silicon electrochemistry in molten salts

Silicon electrochemistry has the potential to advance sustainable energy solutions by offering environmentally friendly and secure technologies that can contribute to the low-carbon economy. Electrochemical methods use electrons directly as reducing agents, eliminating the need for harmful chemicals, and offering simpler, one-step, process control. Silicon currently dominates the solar energy market, and could continue to do so for the next few decades. Our research addresses molten salt electrochemistry of silicon focusing on the subjects of technological significance such as the production of silicon by silica electro-deoxidation, the formation of photoactive layers as well as synthesis of semiconductors and nanostructures for energy applications. The research is performed in collaboration with colleagues from the Department of Materials Science and Metallurgy of Cambridge University (UK).

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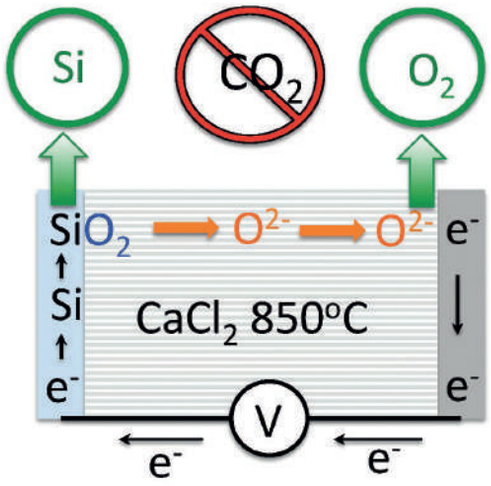
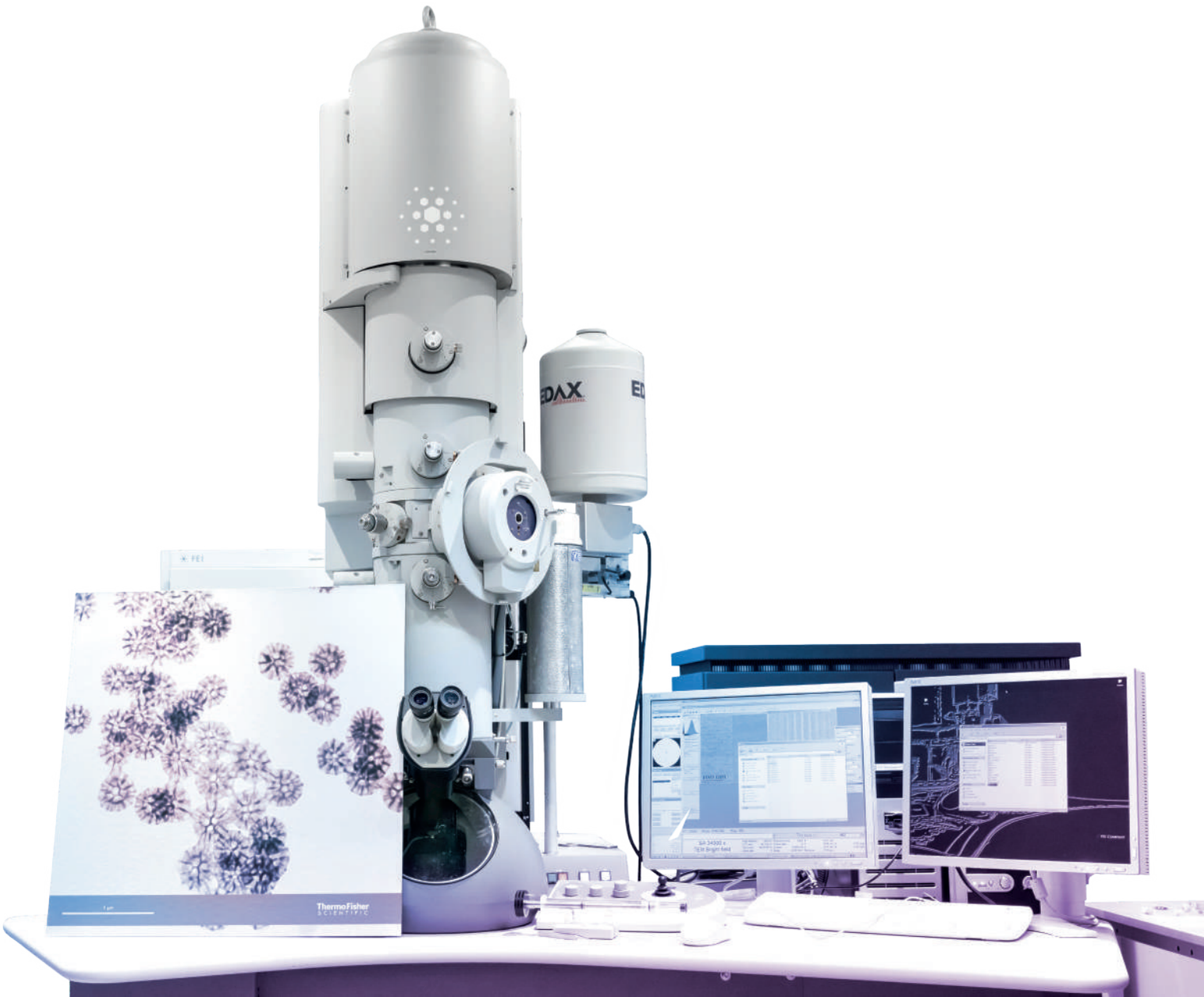


Fig. 3. Electrochemical silica deoxidation and oxygen generation in molten salt electrolyte avoiding CO2 emission

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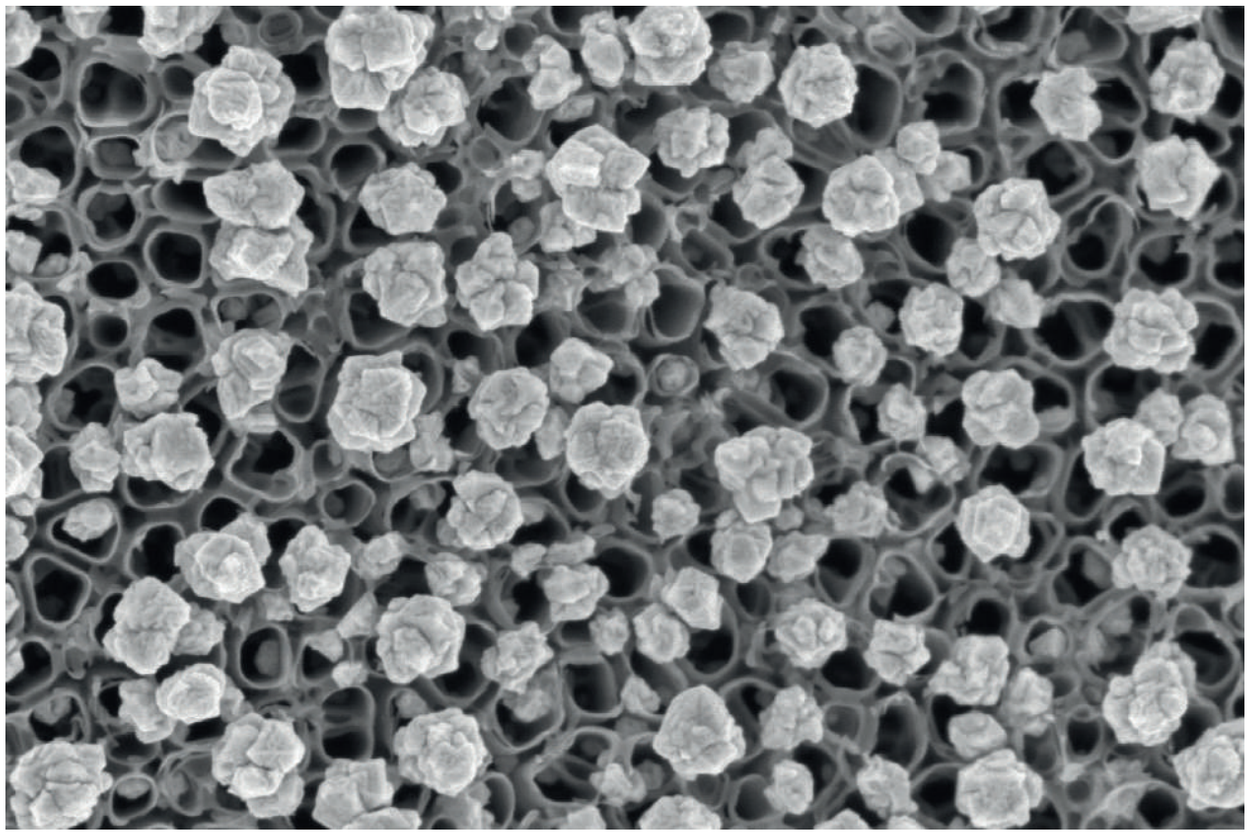
MATERIALS FOR CATALYSIS



Electroless metal deposition: from fundamental research to application for microelectronics, fuel cells and other areas

Electroless metal plating is a well-known method for deposition of metal coatings by a controlled chemical reduction and formation of small (nano-scale) metal particles. The autocatalytic metal ion reduction systems are widely used for decorative and functional purposes, i. e. for deposition of a conductive metal layer on dielectrics, semiconductors or on conductors with a complicated configuration without external current. The selection of a suitable reducing agent and conditions of the reaction (temperature, concentration of reacting substances, etc.) plays a crucial role for creating of stable solutions and obtaining coatings with required characteristics, such as purity and surface roughness. The use of conventional hydrogen-containing reducing agents is connected with environmental and technological problems: (i) the plating bath cannot be recycled, i. e. the reducing agent oxidises irreversibly; (ii) the plating rate and solution stability are not high enough. For these reasons, the search and investigations of a new type of reducing agents, e. g. charge-transfer reducers, namely the different oxidation state metal-ion redox couples, are actual nowadays, and they are developed and applied in the Department of Catalysis. The main reducing agents used are Ti(III) and Co(II), which oxidise during the electroless plating processes to Ti(IV) and Co(III). An additional advantage of such systems, where no hydrogen is formed during the electroless plating process, is the possibility to reduce the oxidised form of the reducing agent to the initial state. The R&D activities of our Department in this area are focused on the development of new electroless metal plating processes as well as fundamental studies of reactions occurring in autocatalytic metal ions reduction systems using electrochemical quartz crystal microgravimetry. The electroless metal plating method is also successively used for fabrication of new catalytic materials for fuel cells. The non-noble metal and noble metal catalysts with a low amount of noble metal-supported titanium, titania nanotube arrayed surfaces, carbon, graphene powder or other supports with enhanced activity towards the oxidation of various fuels, have been developed. The catalysts obtained are promising anode materials and can be used in the practical fuel cells.

Development of electroless cobalt plating processes

Electroless metal deposition (also called autocatalytic metal deposition) is a commonly used chemical approach to prepare metallic layers on various substrates without external electrical current. Cobalt films are widely applied in the modern industry due to their magnetic and corrosion-resistive properties. Investigation of the electroless deposition process of cobalt films using dimethylamine borane (DMAB) as a reducing agent and different amines (diethylenetriamine (dien), triethylenetetramine (trien), propylene diamine (prop), tetraethylenepentamine (ttren), pentaethylenehexamine (pnten)) has been carried out in more detail utilising electrochemical quartz crystal microgravimetry (EQCM). The effects of pH, temperature and concentration of the reactants on the deposition rate of cobalt films have been determined.

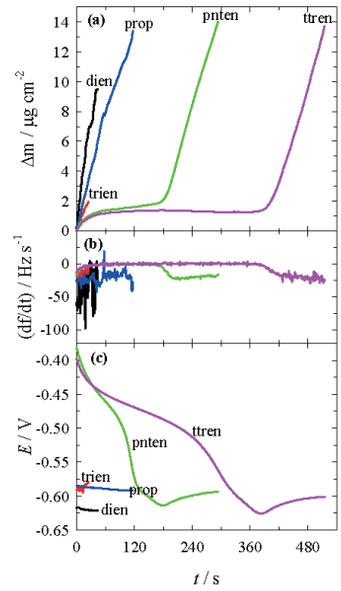


Fig. 1. Effect of amines on parameters of electroless cobalt plating process on a copper electrode: (a) change in mass gain, (b) frequency change rate and (c) open-circuit potential. Solution composition (mol l–1): amine – 0.005; DMAB – 0.2; $CoSO_4$ – 0.05; CH3COOH to pH = 5; 50 °C.

It was found that the induction period of the deposition of cobalt films depends on solution composition, temperature, and the presence of different amines. Small amounts (milimol level) of aliphatic amines, such as propylene diamine, diethylenetriamine, triethylenetetramine reduce the duration of the induction period of the process of electroless cobalt plating.

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High-efficient materials for catalytic purposes

Methods of electric energy generation, conversion and storage using biomass as a precursor attract scientific interest worldwide. The main reason for this is ongoing research dealing with new energy sources and ecological problems, such as CO_2 evolution when fossil fuels are burned. This work outlines a prospective direction for the development of highly effective, cheap and electrochemically active nano-carbon materials (Fig. 2a) for energy storage and conversion applications, by using wood biomass (Fig. 2b) as a renewable and sustainable source of carbon. Carbonaceous materials have been obtained by thermochemical activation with NaOH followed by doping with nitrogen using dicyandiamide (DCDA). The activity of materials has been evaluated for oxygen reduction (ORR) (Fig. 3).

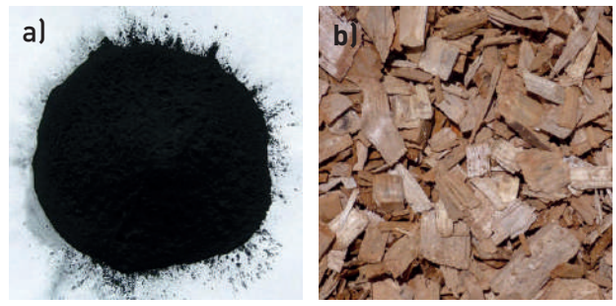

Fig. 2. Images of nitrogen-doped carbon (a) and alder wood chips (b).

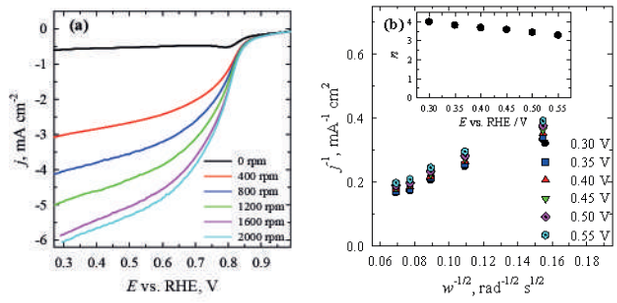

Fig. 3. (a) Linear sweep voltammograms curves of N-doped carbon obtained at varied rotating rates in the O_2-saturated 0.1 M NaOH solution at a scan rate of 10 mV s^{-1}. (b) Represents Koutecky – Levich plots derived from rotating disc electrode data. The inset shows the potential dependence of the number of electrons (n).

The results of this study demonstrate that nitrogen-doped activated biomass-based carbons are promising materials for application in fuel elements for oxygen reduction and can be as active as expensive commercial Pt/C materials.

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ENVIRONMENT

The environmentally-friendly technologies for observation, simulation, prevention and mitigation of atmospheric pollution, and relation to the climate change

Modern environmental research relies on solutions that bring together the recent achievements in technologies and sciences that underpin our understanding of the Nature to deliver a sustainable environmental future and economic growth. In the Department of Environmental Research, the main focus is directed towards investigations of changing atmospheric composition impact on air quality, climate change and ecosystems. By conducting the fundamental and applied research, we are aiming to find long-term solutions, especially in experimental techniques devoted to develop and apply methods determining the dynamics, balance and sources of atmospheric compounds in environmental components by combining mass and size spectrometry, spectroscopy, stable isotope analysis and chromatographic methods.

Objectives: To develop and improve principles, means and technologies of the environment quality evaluation and to ensure the scientific competence in the fields of environmental physics and chemistry, understanding of key factors influencing the climate change and air quality. Tasks: Development of technologies, modelling approaches and equipment for the environment protection quality control as well as methods and experimental basis for the investigation of micro impurities dynamics and balance in the environment components. Evaluation of the impact on climate change of transformation, composition, formation, evolutionary processes of atmospheric chemical compounds.

Long-term black carbon variation in the south-eastern Baltic region in 2008-2015

Black carbon (BC) is a carbonaceous component of the atmospheric aerosol which has a considerable impact not only on visibility but also manifold effects on climate change, human health and the quality of environment. Long-term continuous measurements of equivalent black carbon (eBC) mass concentration from the coastal – background site in Preila, Lithuania, have been analysed. The method of least mean squares (LMS) was applied. A positive linear trend for the whole period was estimated to range from +1.97 % to +5.35 % per year. The second-order trend calculated with LMS had a maximum in 2013 (Fig. 1). The frequency distribution of the data was fitted with lognormal modes. Cold and warm seasons were parameterised with three and two modes, respectively. The presence of three modes with the flatter frequency distribution in winter and autumn showed higher variability of eBC mass concentration in long-range air masses contributing to or diluting the concentrations from local and regional sources.

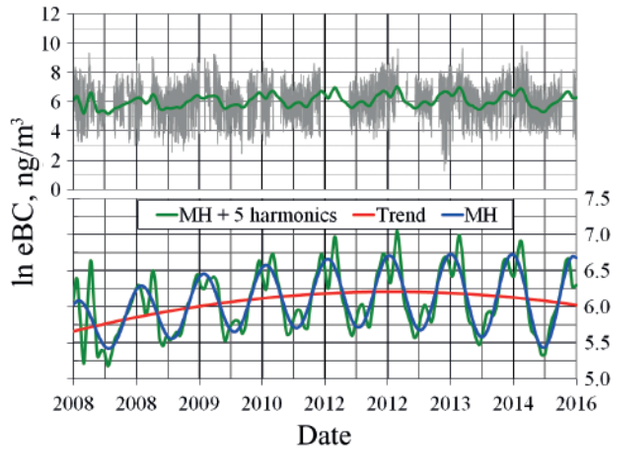

Fig. 1. Hourly mean of measured eBC mass concentration in Preila (a grey slim line) and calculated MLS approximations: trend (red); the main harmonics, MH (blue); the MH combined with five harmonics (green).

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Study of Cu(II), Co(II), Ni(II) and Pb(II) removal from aqueous solutions using magnetic Prussian blue nano-sorbent

Magnetic Prussian blue (MPB) nanoparticles (12 nm) were synthesised and applied as a sorbent for the efficient removal of heavy metals (Cu(II), Co(II), Ni(II) and Pb(II)) from aqueous solution. The experimental results, fitted to Langmuir, Freundlich and Dubinin-Radushkevich models with high regression coefficients, showed high sorption capacities compared to other sorbents. The kinetics data were expressed by pseudo-first-order, pseudo-second-order and intraparticle diffusion models. The removal mechanism revealed to be chemisorption (H+ exchange) and/or physisorption (ion trapping). The influence of initial concentration, sorbent dosage and time on the heavy metals sorption efficiency was studied using response surface methodology (RSM). Analysis of variance (ANOVA) was included to assess the adequacy of the model. The results indicated that initial metal concentration and sorbent dosage are the most critical factors (Fig. 2). The increase in both factors contributes to the increment of the uptake.

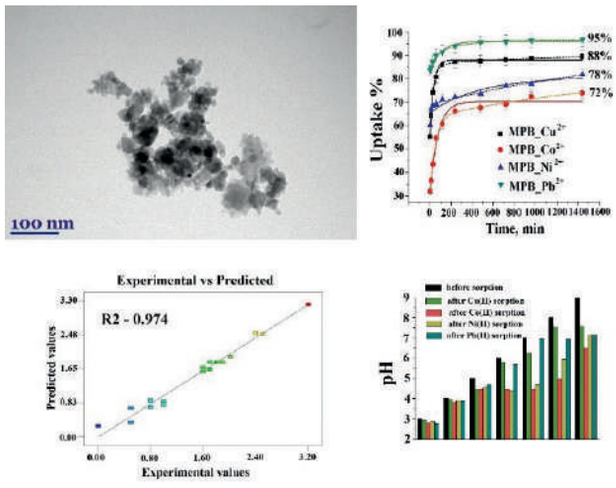

Fig. 2. Clockwise: TEM image of MPB sorbent; effect of time to sorption uptake; experimental versus predicted results; comparison of solution pH values before and after sorption.

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Characterisation of aerosol mass spectra responses to temperature over a forest site in Lithuania

The chemical composition of submicron aerosol particles was characterised by using an aerosol chemical speciation monitor (ACSM) at a mixed-mature forest site at the Aukštaitija Integrated Monitoring Station in the eastern part of Lithuania. As expected, organics contribution to non-refractory particular matter NR-PM1 was dominant and reached 69% (5.75 μg m^{-3} (standard deviation (SD) = 5.73 μg m^{-3})) of the total loading. The mass concentrations of the sulphate, nitrate and ammonium compounds were significantly lower: 1.39 μg m^{-3} (SD = 1.83 μg m^{-3}) (17%), 0.50 μg m^{-3} (SD = 0.67 μg m^{-3}) (6%) and 0.63 μg m^{-3} (SD = 0.92 μg m^{-3}) (8%), respectively. The positive matrix factorisation (PMF) analysis of ACSM organic aerosol (OA) mass spectra resolved four OA factors: semi-volatile oxygenated OA (SVOOA, the contribution to the total OA mass concentration was 33%), low-volatile oxygenated OA (LVOOA, 39%), cooking-related OA (COA, 15%) and biomass burning OA (BBOA, 13%). Secondary organic aerosol (SOA) has been identified as one of the most important contributors to the submicron particle (PM1) mass concentration (Fig.3). A comparison between SVOOA and submicron forest organic aerosol mass was performed, and a good correlation (0.75) was found.

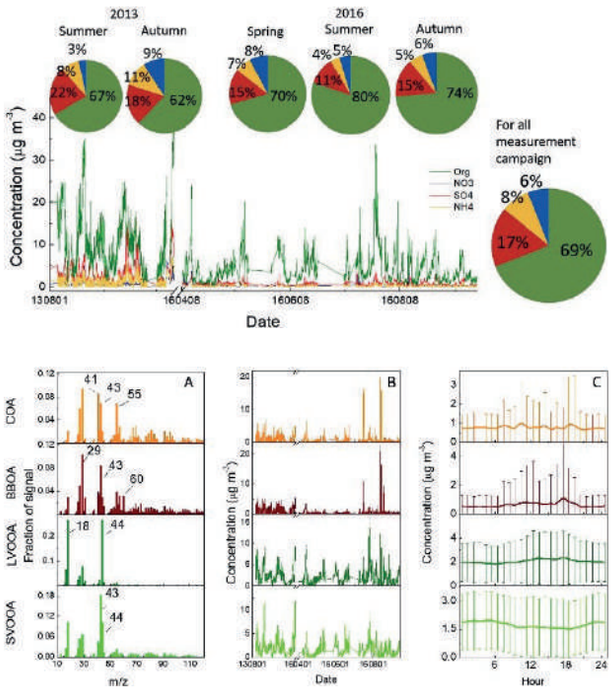

Fig. 3. Time trends and relative contributions of organics, sulphate, nitrate and ammonium to NR-PM1 chemical species. PMF solutions: mass spectra of COA, BBOA, LVOOA and SVOOA factors, their time series, diurnal time trends together with standard deviations.

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NUCLEAR

Nuclear research for actual applications today and innovative technologies for future

The Department of Nuclear Research develops and applies known and innovative technologies and methods in the fields of experimental nuclear spectroscopy, nuclear energy safety, radiation protection, radiochemistry, mass spectroscopy, Mössbauer spectroscopy, ion beam analysis and material modification. The keystones of the safety field are the safe operation assurance of nuclear facilities, the optimisation of radioactive waste management, the assessment of shielding materials and comprehension of processes of radionuclides transport through engineering barriers to enable nuclear facility safety. The special attention is paid to environmental impact assessment of energy generating facilities, elemental and isotopic analysis of groundwater, food fabrics and products and also industrial stocks, medical samples with sensitivity up to 1 ppq (for non-interfered isotopes). Application of stable isotope ratio analysis ($\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$ and $\delta^{34}S$) in environmental, biomedical and food samples stimulates new promising technologies. ^{14}C measurements open the potentially new field of activity related to carbon dating and analysis of triple carbon ratio for dedicated samples. Complementary information on material properties (magnetic properties, oxidation and corrosion of iron compounds) is determined by Mössbauer spectroscopy, particularly for better characterisation of magnetic properties of materials containing iron compounds (multiferroics). Development of ion beam methods for material analysis and modification is an essential part of our activities having intersection both with semiconductor materials and applications for lasers. Investigation of organic scintillator films opens new possibilities of simple scintillator material application for detection and spectroscopy of ionising radiation particles. In search of future practical applications, the high energy electromagnetic radiation generation is investigated using ultrashort laser pulses.

Assessment of radioactive contamination in the primary circuit of nuclear power plant (NPP)

BInternal radioactive contamination of main circulation circuit of Kozloduy NPP (Bulgaria) reactor WWER440/230 has been assessed by using computer code OSCAR which takes into account the material composition, operational parameters and power history. The results have been analysed in the light of the scaling factor approach, to demonstrate the modelling capabilities to identify the possibility of scaling factor application and to reproduce the activity correlation between difficult to measure and key nuclides. Modelling results presented here show that the application of the scaling factors and nuclide vector approach is reasonable and can be demonstrated by the modelling in advance to the surface activity measurements. Also, the modelling can be useful to analyse the distribution of surface contamination and to disclose the necessity of introduction of more than one scaling factor for some particular radionuclides, e. g., ^{90}Sr.

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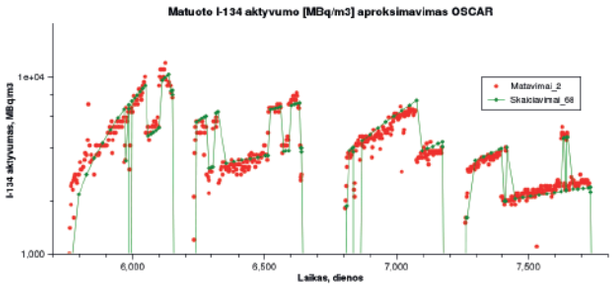

Fig.3. Modelling (green) and measurement (red) results of 134I activity.

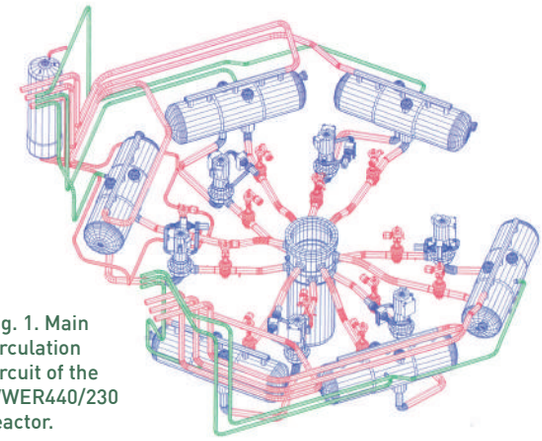

Fig. 1. Main circulation circuit of the WWER440/230 reactor.

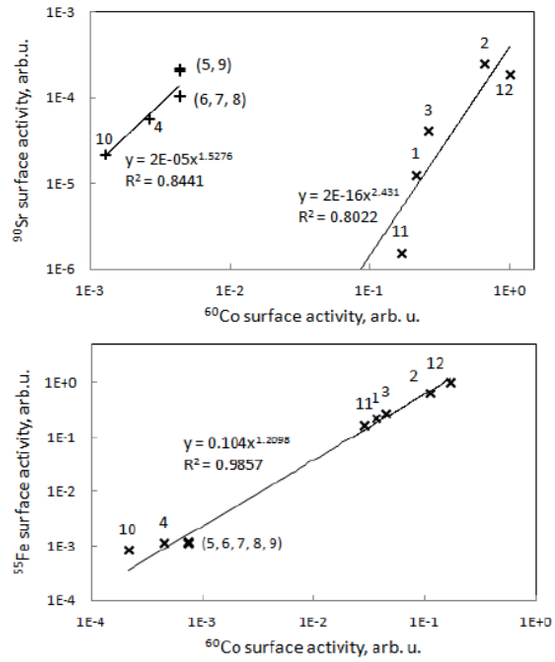

Fig. 2. Correlation of ^{60}Co and ^{55}Fe, ^{90}Sr activity for main circulation circuit equipment of WWER440/230 reactor.

Assessment of the contamination by ^{14}C airborne releases in the vicinity of the Ignalina NPP

The ^{14}C activity analysis in the tree rings around Ignalina nuclear power plant (NPP) has been carried out to test the hypothesis to use $^{14}C^{tree}$ ring analysis data as a tool for the reconstruction of gaseous releases from NPP to the environment. Tree ring samples for ^{14}C analysis were collected, prepared and measured using the Single Stage Accelerator Mass Spectrometer (SSAMS). Data analysis demonstrates observable Ignalina NPP influence: ^{14}C increases up to 15 pMC (percent modern carbon) in tree rings. The correlation between the ^{14}C concentration and wind direction was obtained.

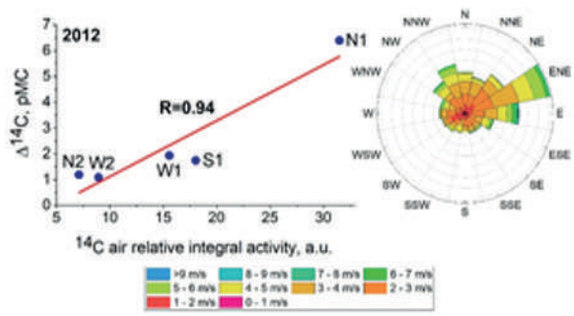

Fig. 4. Typical scatterplots between measured ^{14}C excess activity in tree rings and assessed by Gaussian model annual air integral activities $C_{sectorj,n}(x)$ for the sampling locations around Ignalina NPP.

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Nuclear graphite investigation for radioactive graphite waste management and disposal

Structural investigation of RBMK nuclear graphite modified by $^{12}C+$ ion implantation and subsequent thermal treatment was performed to reveal the structural damage in irradiated graphite waste before its management/disposal. Neutron irradiation in graphite-moderated nuclear reactors induces the radiation damage in the graphitic core components. To generate the defects similar to those induced by neutrons in the RBMK-1500 nuclear reactor, the raw RBMK graphite samples were implanted with $^{12}C+$ ions. The implantation ion energy and fluence were chosen to emulate the damage effect of carbon recoil ions with the energy of 700 keV analogous to the RBMK-1500 reactor neutron interaction. The 1.25 μm layer of the sample was affected by implantation ions. The interaction depth profile was obtained by using SRIM-2013 simulation. Ion implantation resulted in a strong disorder of the graphite samples surface, while the thermal treatment led to recrystallisation at the fluencies of 7.2×10^{15} ions/cm^2 and lower (see Fig. 5 (bottom).

The main advantage of this method is that samples are not activated, while the same displacement damage can be obtained in much shorter time (few to tens of hours instead of years in the reactor). Another advantage is the ability to control the experimental parameters to observe defect dynamics. The study reveals ^{14}C spatial distribution of spent RBMK-1500 graphite.

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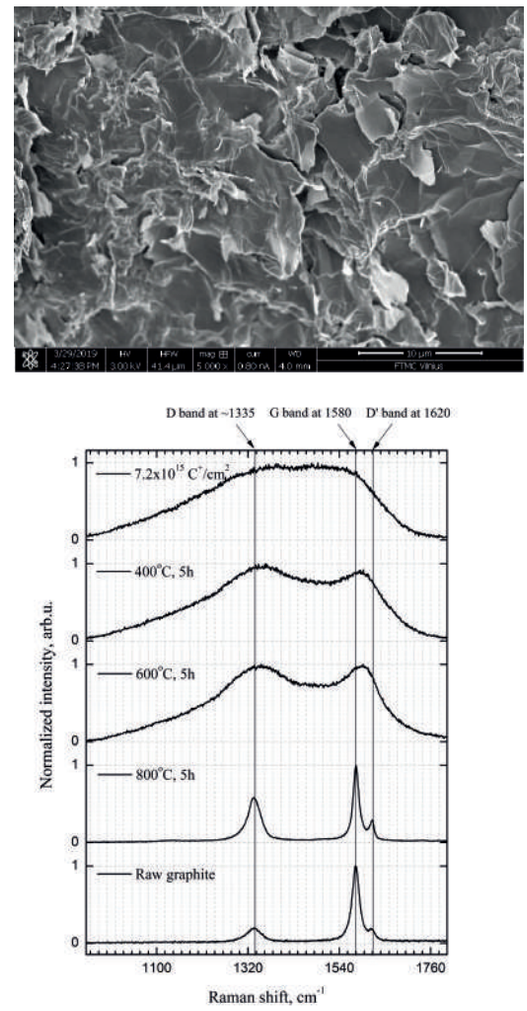

Fig. 5. Top: SEM images of raw graphite samples. Bottom: Raman spectra of the raw RBMK graphite implanted with $^{12}C+$ ions at the energy of 700 keV and the fluence of 7.2×10^{15} ions/cm^2 and annealed at various temperatures (excitation wavelength of 633 nm).

Stable isotope ratio mass spectrometry for food authentication

Stable isotope composition is not always constant in the environment and can change in the same area depending on seasonal variations. The impact of water and food sources on oxygen, carbon, and nitrogen stable isotope ratio ($^{18}O/^{16}O$, $^{13}C/^{12}C$ and $^{15}N/^{14}N$) distribution and fractionation in cow milk in different seasons of the year was studied. We found that the carbon stable isotope ratios were correlated with the contribution of dietary sources (fresh grass in summer and dried hay in winter). Meanwhile, nitrogen stable isotope ratios did not differ significantly during the year. Overall, combined $\delta^{18}O$, $\delta^{13}C$ and $\delta^{15}N$ analysis of cow milk provides valuable information about the origin of milk and the dietary regime of animals and can be helpful for studies of milk product authentication.

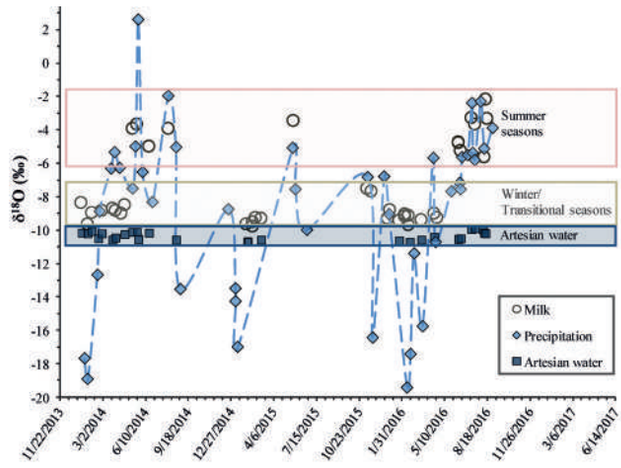

Fig. 6. Seasonal variation in $\delta^{18}O$ values in milk water, artesian water and precipitation water in the rural site in Lithuania during 2014–2016. Dashed blue line integrates measured $\delta^{18}O$ values.

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X-ray generation using ultrashort, high-power femtosecond laser pulses

An attractive technique in the ultrafast technology field was introduced by generating X-rays using ultrashort, high-power femtosecond laser pulses. X-ray emission obtained with this technique demonstrated unique characteristics, such as short pulse duration, small source size and high brilliance.

We obtained hard X-ray generation of K_α lines in platinum and tungsten using the 1 kHz repetition rate TW-class femtosecond laser pulses (Fig. 8). The main advantage of the high repetition rate laser systems is in acceleration of experiments (possibility to repeat the experiment and accumulate the statistics faster).

Such a high energy pulse X-ray source can be used for industrial, medicine and material science applications, e. g. cancer therapy or elemental transmutation.

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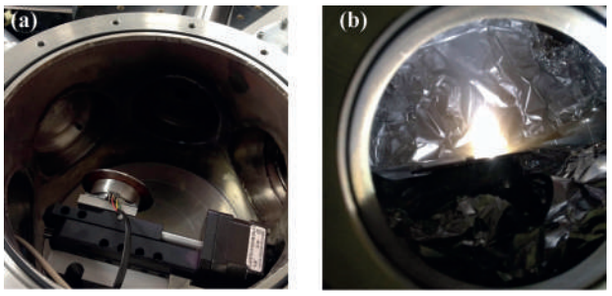


Fig. 7. (a) X-ray generation chamber and (b) metal target during the laser irradiation.

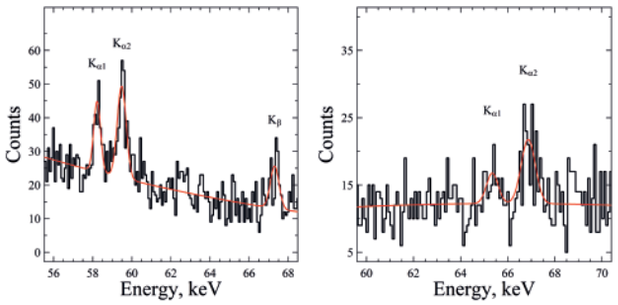
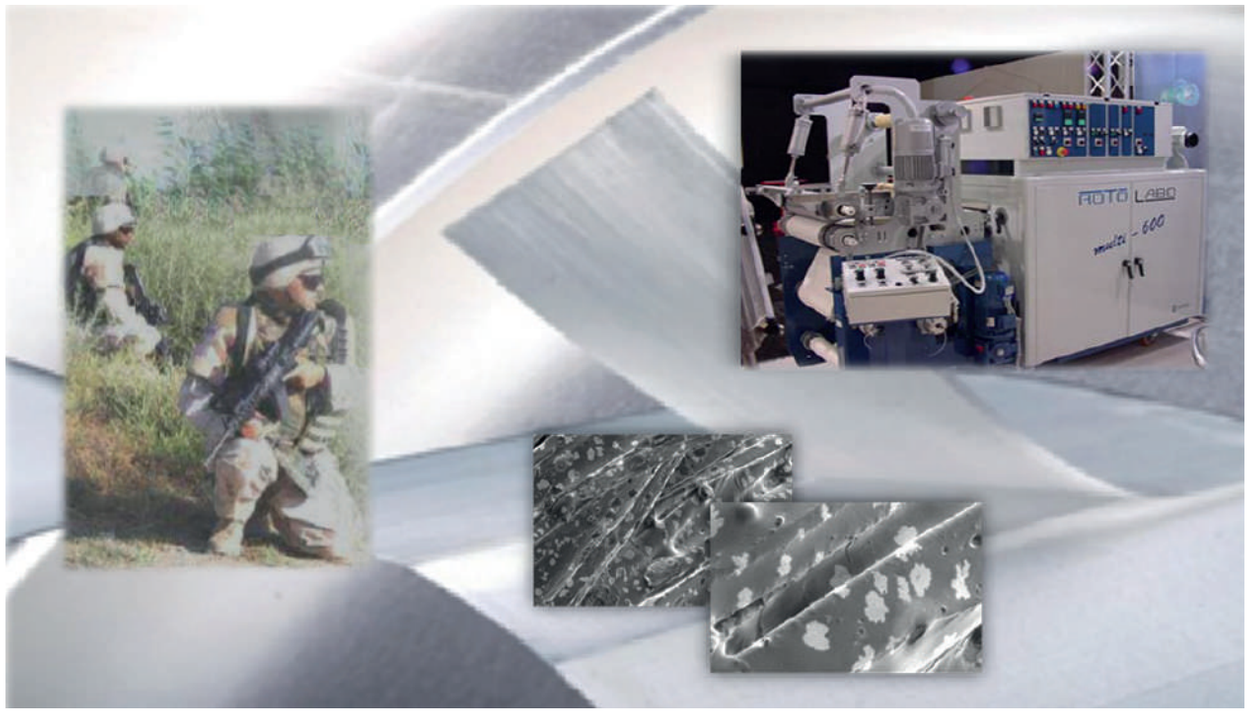


Fig. 8. The X-ray emission spectra of W (left) and Pt (right).

TEXTILE TECHNOLOGIES



Research of FTMC Textile Institute (TI) is based on nowadays requirements for sustainable goods and production processes. Dynamic climate changes and environmental protection require new research and development particularly in finishing processes of textile and creation of new smart materials and garments with low consumption of raw materials and concurrently enhanced comfort features. Consequently, the core of new textile research is an investigation of smart bio-based polymers for functional coating and development of sustainable technologies for smart protective clothing with improved wearing comfort. An illustration of this research trend can be the investigation of electro-spinning process and morphological, thermal and electrical properties of nanofibers from pure chitosan and its blends with synthetic biodegradable polyethylene oxide, which was performed in collaboration with scientists from Tallinn University of Technology. This research was directed for developing of new application fields for sustainable nanomaterials and has a strong link to EU Smart Specialisation Platform.

Development of personal protective equipment is the key research topic of TI which is successfully applied for military and security aims. For moving further towards high quality functional and smart sustainable products, new investments in technological laboratory scale equipment, using the financial support of the European Regional Development Fund (ERDF), was made. The project Strengthening of The Researcher's Interdisciplinary Competences Directing Them toward the Development of Smart Protective Textile Products was started. The objective of this project is to strengthen the competences of scientists, to enhance the collaboration between different FTMC departments and to target them for the development of sustainable and smart protective garments. Creation of the garment protected against ballistic impact, with an integrated thermoregulatory active, electronic, temperature control system and EMR shielding properties, is a challenge for scientists because of the strong requirement for the low weight of such protective equipment. Moreover, in the frame of this project, a new area of research in the development of reinforced composites was started and ERDF funding was used to purchase the advanced vacuum membrane press with low energy consumption. Three national industrial companies already showed their interest to use the results of this project.

The textile departments of TI have close cooperation with industry. Besides a wide range of services, provided for business companies and state institutions, industry orientated research and projects with industrial partners supported by MITA are carried out.

TI is also active in international collaboration. The membership in the European Network of Textile Research Organizations TEXTRANET gives an opportunity for the scientists to gain international experience and find partners for joint research projects. The ongoing project, initiated by the European Defence Agency and funded by the EU Commission, is an example of a successful international cooperation with 6 world-known research institutions and industrial companies.

Services provided:

- testing of textile materials in accredited laboratory and certification of protective clothing at the notified body,
- quality examination of textile materials,
- prototyping of woven and knitted fabrics and garments.

Electrospinning of chitosan biopolymer and polyethylene oxide blends

The objective of this study was to investigate the morphological (scanning electron microscopy), thermal (differential scanning calorimetry), and electrical (conductivity) properties and to carry out compositional analysis (Fourier-transform infrared) of produced nonwoven fibrous materials adapted in biomedical applications as scaffolds. The orientation of produced nanofilaments was investigated as one of the essential features of a perfect tissue scaffold. Viscosity and electrical conductivity of solutions, used in the manufacturing process, were also marked out because these properties highly influence the morphological properties of produced nanofibers. The nanofibrous scaffolds were fabricated from biopolymer, synthetic polymer, and their blends. The chitosan (CS) was chosen as biopolymer and polyethylene oxide (PEO) of low molecular weight as a synthetic biodegradable polymer. Solutions from pure CS were unspinable: beads instead of nanofibers were formed. The fabrication of pure PEO nanomats from solutions of 10 wt%, 15 wt% and 20 wt% concentrations (in distilled water) turned out to be successful. The blending of composed CS solutions with PEO in ratios of 1:1 optimised the parameters of nanofibers providing the opportunity to fabricate CS/PEO blend nanofibers. The concentration of acetic acid (AA) used to dissolve CS finely fabricated the nanofibers from blended solutions and influenced the rate of crystallisation of manufactured fibre mats. The concentration of PEO in solutions, as well as viscosity of solutions, also influenced the diameter and orientation of formed nanofibers. The beadless, highly oriented and defect-free nanofibers from CS/PEO solutions with the highest concentration of PEO were successfully prepared. By varying the concentrations of AA and low molecular weight PEO, it was possible to fabricate beadless and highly oriented nanofiber scaffolds (see Fig. 1).

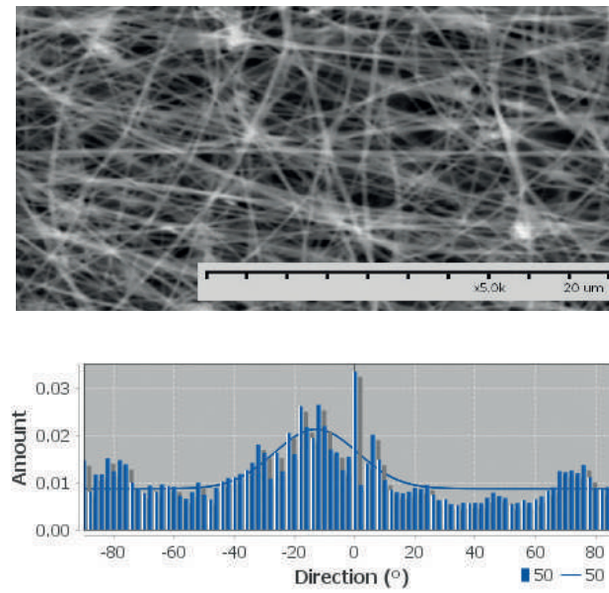


Fig. 1. Image analysis of 3CS in 50AA+20PEO fiber mat: a) SEM image; b) directionality distribution (slice 50%, direction -13°, dispersion 14°, amount 0.46, goodness 0.55), made with Directionality function of ImageJ software.

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Development and evaluation of 3D knitted fabrics to protect against mechanical risk

In this research, eight different 3D weft-knitted fabrics were developed and evaluated. The fabrics have been knitted on circular weft-knitting machines of two different gauges, 20E and 28E. Three different raw materials were used for the fabrics production: high molecular mass polyethylene (HPPE) yarn and 0.05 mm diameter steel wire in the outer layers (for the front and reverse) and polyamide yarn in the binding layer. The experiments with 3D knitted fabrics were conducted to determine their resistance to mechanical risks (circular blade cut, puncture and abrasion) and to evaluate the comfort parameter (air permeability). It was found that the best results in terms of the resistance to circular blade cut, puncture and abrasion were obtained by using HPPE yarn twisted with a more significant amount of steel wire (higher mass per unit area). According to the standard EN 388:2003, the three samples of developed 3D weft-knitted fabrics had the highest (5^{th}) blade cut and the highest (4th) abrasion resistance level (see Fig. 2). All of them had the highest fourth level of puncture resistance (see Fig. 3, 4). The 3D fabrics knitted on the gauge 28E circular weft-knitting machine ensured 1.3 ÷ 2.1 times greater blade cut and 4.9 ÷ 12.1 times greater abrasion resistance than the fabrics knitted on gauge 20E, due to higher stitch density, higher mass per unit area and fabrics' thickness, but at the same time lowered air permeability by 20.2 ÷ 43.0 %.

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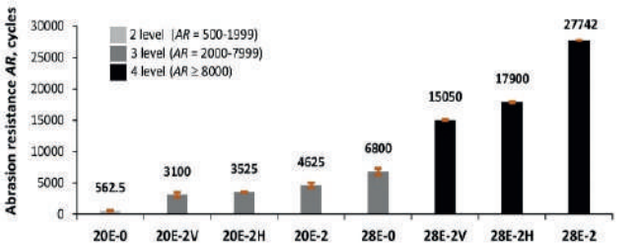


Fig. 2. Abrasion resistance of developed 3D weft-knitted fabrics (coefficient of correlation, CV = 0.03 ÷ 8.51%).

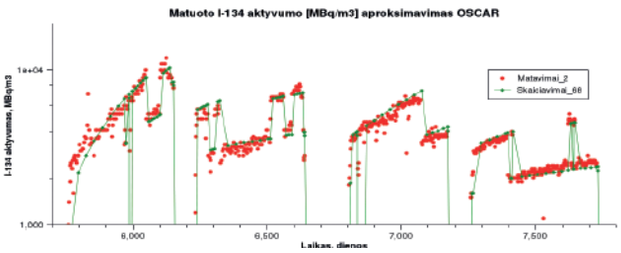


Fig. 3. Puncture resistance of developed 3D weft-knitted fabrics (CV = 1.71 ÷ 6.44%).

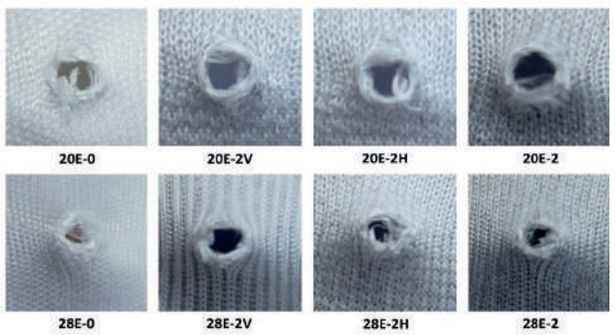
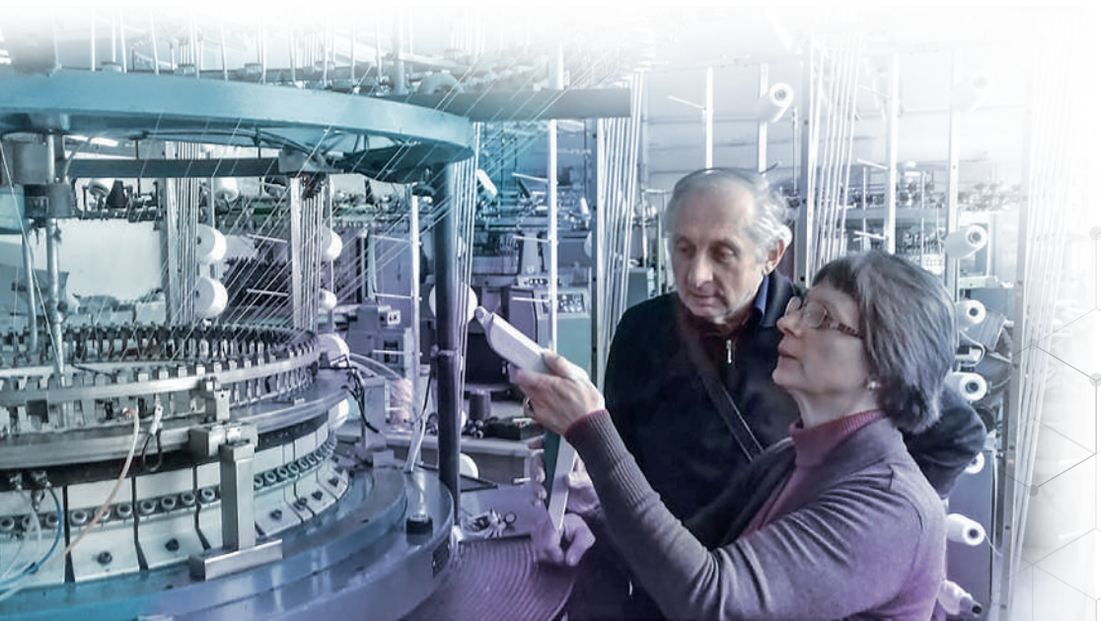
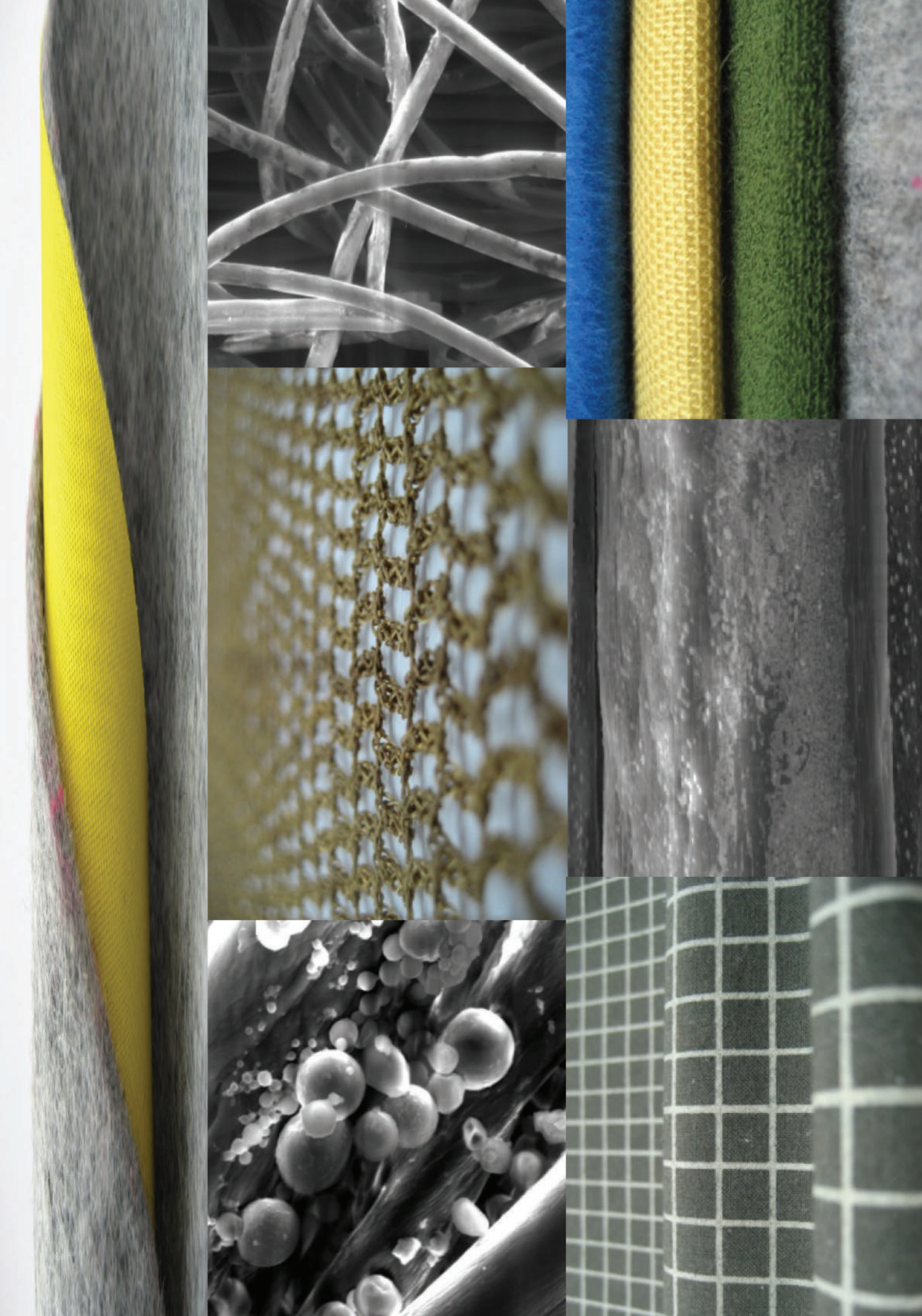


Fig. 4. Pictures of the punctured 3D weft-knitted fabrics.





METROLOGY

National Metrology Institute of Lithuania

'One accurate measurement is worth a thousand expert opinions' (Grace Hopper)

FTMC Metrology Department was authorised to perform and implement functions of the National Metrology Institute (NMI) since 1 July 2014. The year 2019 was historical for all metrology community and scientists all over the world - **the new definitions of the kilogram, the ampere, the kelvin and the mole - the units of the International System of Units** (SI) **came into force on 20 May 2019,** as a decision of the 26th General Conference on Weights and Measures.

FTMC Metrology Department maintains **national standards in seven areas of measurements.** It has been published 65 CMCs approved within the CIPM Mutual Recognition Arrangement in the KCDB of BIPM. That means the international recognition of Lithuanian NMI among associate and member countries of The Metre Convention (Convention du Mètre). Metrology Department has implemented and peer-reviewed QMS fulfilling the requirements of ISO/IEC 17025 standard which is recognised by EURAMET. This year Metrology Department started the implementation of the ISO17034 standard. NMI is actively participating in the establishment of Nordic-Baltic European Metrology Network (EMN), strengthening regional cooperation between other NMIs, looking forward to a new European Metrology Partnership - the program for research and innovation in metrology area under the Horizon Europe 2021-2027.

Time and Frequency Standard Laboratory (TFSL) is reproducing values of the unit of time, the second (s), and the unit of frequency- hertz (Hz). Its mission is representation of Lithuanian Coordinated Universal Time UTC(LT), ensuring the traceability of the magnitudes reproduced to the International System of Units (SI), disseminating them to Lithuanian scientific establishments, personal and legal bodies by calibrating their working standards and measurement devices, disseminating Lithuanian time scale, and other relevant means.

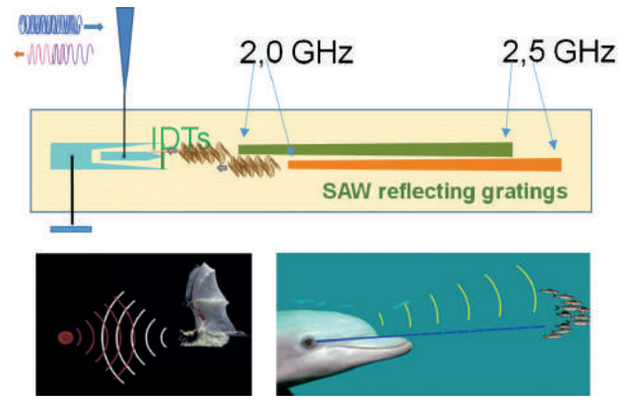


Fig.1. System of passive SAW sensor.

TFSL in cooperation with the JSC BaltStamp provides qualified time-stamping services, which meet the eIDAS regulations and the ETSI standards. The time-stamping service is issuing up to two million time stamps per month for Lithuanian governmental organisations and European users. The laboratory in cooperation with the Swiss company GVR Trade and the Lithuanian JSC MitSoft finished the implementation of EUROSTARS-2 project entitled System of passive SAW sensors exploiting UWB hyperbolically frequency-modulated Signals (UWB_SENS) (Fig.1). In the frame of this project, a laboratory prototype of the temperature measurement sensor system exploiting Ultra Wide Band (UWB) Hyperbolically Frequency Modulated (HFM) signals (a patent of GVR, the NILSAW Eurostars project) has been developed. The network of 10 passive SAW sensors (working without batteries) can be simultaneously communicated by one 'reader' radiating very low (<10 mW) EM power. HFM signals simplify communication algorithm between the reader and the sensors and reduce the RF power needed. Low RF power radiation makes the system suitable for medical applications. The Time and Frequency Standard Laboratory, in cooperation with LITNET and PIONIER academic networks, established the fibre link connection between Lithuanian and Poland atomic clocks and started the comparison of UTC(LT) and UTC(PL) time scales using two ways optical communication technology.

The mission of the **Electrical Standards Laboratory (ESL)** is maintaining and developing the standards of unit of voltage, the volt (V), and unit of resistance, the ohm (Ω), ensuring their traceability to the SI, calibrating working standards and measurement devices, pursuing research in the field of measurement of voltage, resistance and electrical current.

The mission of the **Temperature Unit Standard Laboratory (TUSL)** is realising the international temperature scale ITS-90 and the value of the unit of temperature, the kelvin (K), ensuring their traceability to SI. Lithuanian National Standard of the temperature unit in the range from -195 °C to +961.78 °C is the primary level standard and +1084.62 °C reference point of the freezing point of Cu is the secondary level standard.

The Government of the Republic of Lithuania by its Resolution No.10 of 9 January 2019, transferred the **National Standards of Mass and Length** to FTMC. The mission of the national gauge blocks standard is maintaining and transferring length unit in the range from 0.5 mm to 100 mm with 0.0001 mm uncertainty ensuring its metrological traceability to the SI.

The mission of the national mass unit standard is maintaining and developing the standards of the unit of mass ensuring the traceability to the SI in the range from 1 mg to 20 kg with uncertainty from 0.4 mg to 3.2 mg.

Metrology is not restricted only to the standards of physical units. The reliable, traceable and accurate chemical measurements in different sectors of health care, safety and environment protection could be provided by the **Laboratory for Metrology in Chemistry (LMiC).** LMiC is participating in the ALCOREF Project 16RPT02 Certified forensic alcohol reference materials in the frame of European Metrology Programme for Innovation and Research (EMPIR). The consortium of 10 partners of NMIs from 10 different countries was formed with the coordination of the Federal Institute for Materials Research and Testing (BAM, Germany). The main objectives of the project are aimed on accurate measurements, homogeneity, short and long term stability estimation for certification of ethanol/water certified reference materials and new regional metrological capacity for CRMs for breath alcohol control.

The **Ionizing Radiation Metrology Laboratory (IRML)** was piloting the EURAMET Technical Committee Project No. 1437 The follow-up interlaboratory comparison of the radionuclide calibrators, and the final report was prepared and submitted to EURAMET. The activities of radionuclides applied in nuclear medicine (^{18}F, ^{67}Ga, ^{99}mTc, ^{111}In, ^{123}I, ^{125}I, ^{131}I, ^{201}Tl and ^{223}Ra) have been measured in the range from 1 MBq to 360 MBq within this project. The measurements were traceable to the secondary standard ionisation chamber of the Czech Metrology Institute (ČMI). The calibration factors obtained for the ionisation chambers Fidelis and Capintec 15R (FTMC standards) enabled low measurement uncertainties for all radionuclides used in the comparison. These results were used as supportive evidence for the publication of Calibration and Measurement Capabilities of Lithuanian NMI in the KCDB database of BIPM. That will enhance nuclear medicine applications in Lithuania by ensuring high accuracy (uncertainties less than 5 %) of the measurements of the activities of radiopharmaceuticals used in hospitals for diagnostics and therapy. Results of the comparison were also presented in a conference of the International Committee on Radionuclide Metrology in Salamanca, Spain (2019). The experience of IRML was shared in EURAMET-BIPM Training Course on Organisation and Piloting of Intercomparisons in Ionising Radiation held on 9-11 October 2019 in United Kingdom.

EMPIR
EURAMET
The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

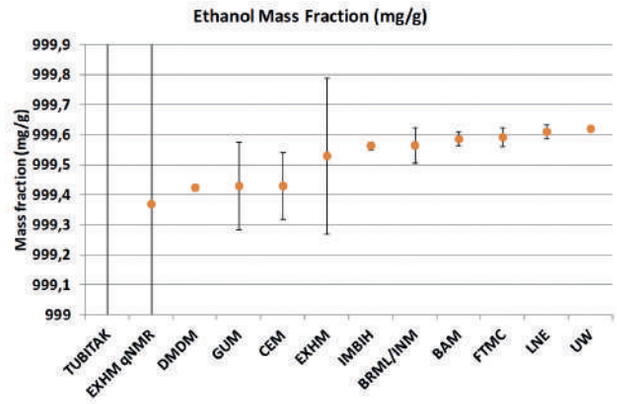
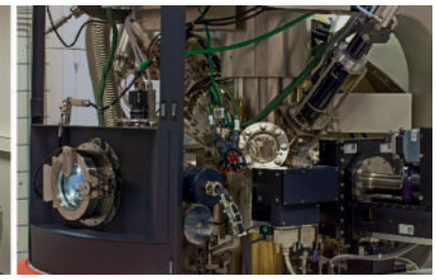


Fig.2. Ethanol mass fraction comparison results reported by ALCOREF project partners.

OPEN ACCESS FACILITIES

Electron microscopy, X-ray spectroscopy and XRD open-access center (OAC)





OAC offers open access facilities for cha-racterisation of solid material surface structure, morphology, inner and crystalline structure, chemical and phase composition. The OAC infrastructure has been improved significantly during last 10 years, and now is equipped with modern electron microscopes (FE-SEM-FIB and TEM), X-ray diffractometers, X-ray fluorescence (WD-XRF), X-ray photoelectron (XPS) and Auger electron spectrometers. The OAC provi-des characterisation services of solid materials for customers from academic institutions and industry in Lithuania and abroad. Among the customers, there are universities of Southampton, Hoseo (South Korea), Riga, Vilnius and Kaunas. OAC provided structure characterisation services for such companies as Translucent Inc (from Palo Alto), IQE (North Carolina), Brolis Semiconductor, Altechna, Optolita and many others. For more information, please visit https://litexbeam.ftmc.lt.

Prototype formation and integration

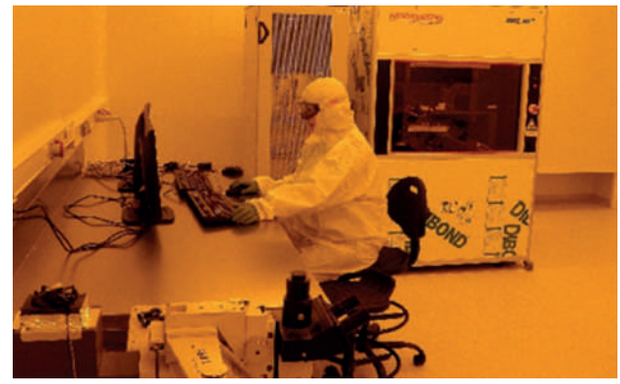
Clean room technology for prototyping of semiconductor-based devices

Based on a collaboration between the Departments for Physical Technologies and Optoelectronics, a complete cycle of the clean room (CR) micro-processing line has started to function. It is ready to produce the working models and the demonstration prototypes of chemical and photo-sensitive devices as single units and as limited batches of products. The prototyping of innovative devices is based on a few key enabling technologies including the PECVD/CVD for the synthesis of 2D materials, namely graphene and MoS2, multi-mode magnetron sputtering for deposition of multicomponent functional films and molecule beam epitaxy for GaAs based optoelectronic devices.

The CR services include: 1) CR (ISO7–ISO5 about 300 m^2) operations, 2) photolithography, 3) laser lithography, 4) wet chemical processing, 5) thermal processing, 6) metal and oxide coatings, 7) assemblage and testing.

Characterisation and testing of prototypes

The R&D projects in the OAC can range from proof of concepts (TRL – Technological Readiness Level- 3),



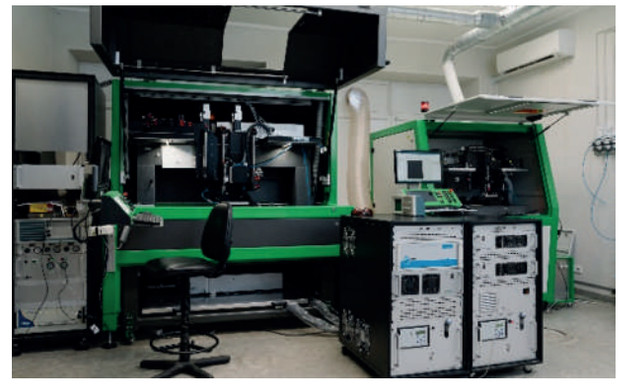
validation of technologies in the laboratory (TRL 4) or relevant environment (TRL 5), and up to demonstration in a relevant environment (TRL 6). In specific cases, collaboration can reach prototyping in an operational environment (TRL 7). For this, we use the methods acceptable to characterise the components and devices at the nanometre scale level and the level of the complete unit.

The characterization includes: 1) topography, force spectroscopy, tunnelling current spectroscopy by scanning probe microscopy, 2) standard I-V and C-V characteristics in the dc- and ac-modes by the probe station, 3) photovoltaic parameters with the A1.5 solar source by special set-up, 4) gas response in the synthetic atmosphere under strictly controlled conditions by gas flow control system. We also carry out special set of tests to determine the response and resistivity to the microwave irradiation.

BALTFAB processing technologies

is a joint open user facility between departments of Laser technologies and Nanoengineering, offering a full range of nano/micro and macro fabrication as well as laser patterning, marking and cutting on any required material. State of the art laser microfabrication workstations are equipped with full variety of industrial ns-, ps- and fs- lasers. The BALTFAB team include experts to set-up, test and develop laser micro-machining processes and systems. Soft nano-lithography tools for rapid creation of nano-structures are tested to be live cell compatible. The patterns are routinely applied to improve the bio-compatibility of medical devices. The team is developing tools for detection of molecules on surfaces, to fasten the testing and evaluation of cells or drugs. More: see www.baltfab.com

Services include: 1) Laser processing: in-Glass marking; laser beam interference ablation; laser direct writing; ultrashort pulse laser ablation. 2) Molecular:



dip pen nanolithography; microcontact printing; piezoelectric inkjet printing; colloidal nanolithography. 3) Analytical: bio AFM; electrochemical sensors; imaging surface plasmon ellipsometry.

Available equipment:

Multi-axis workstations with ultrashort pulse lasers for experimentation, rent and user training services.

Dip pen nanolithography and imaging ellipsometry for creating and imaging of molecular surfaces.

Converse and chemical coatings

specializes in aluminium and its alloys anodization, galvanic precious metals plating and related fields. The services provide: electrodeposition of protective, decorative as well as technical converse (anodic) coatings, structural etching of decoration elements, adsorption colouring of anodized surfaces, modification of aluminium and its alloys surfaces with a passivation film that ensures the required conductivity, protection and other properties, chemical deposition of passivation coatings onto alloy steels.

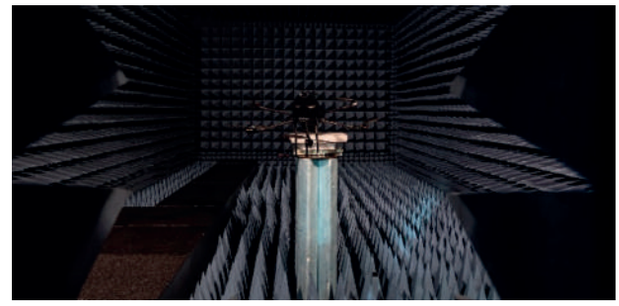
Available equipment:

Experimental equipment for environment-friendly galvanic processes, anodizing line.

Chemical passivation line for chromium-free passivation process of aluminium and its alloys, IRIDITE NCP.

Microwave transmission, reflection and absorption

In the new microwave anechoic chamber we developed a setup for microwave transmission and reflection measurement in a frequency range from 1 GHz to 18 GHz. Measured sample is placed in the aperture of the absorbing panel. Using this technique, it is possible to measure microwave properties of various modern materials: windowpanes, absorbing textiles, shielding materials, etc.



Setup for microwave signal transmission, reflection and absorption in an anechoic chamber.

PROJECTS

Research Executive Agency (REA), delegated by the European Commission project “Camelina&crambe Oil Crops as Sources for Medium-chain Oils for Specialty Oleochemicals” (COSMOS)

S. Asadauskas

Horizon 2020 programme project “PHotonics enhanced fAB LABS supporting the next revolution in digitalization“ (PHABLABS)

S. Orlovas

Research Executive Agency (REA), delegated by the European Commission project “Graphene-Manganite nanostructures for novel pulsed magnetic field sensors” (GRAMAS)

R.Lukošė

European Space Agency (ESA) project “IntraRed Bismuth-based Sources” (IRBIS)

R.Butkutė

Research Executive Agency (REA) project “A multi-spectroscopic approach to probe amyloid aggregatiion at biological surfaces” (MultiSpecAMYLOID)

S. Strazdaitė

European Space Agency (ESA) project “Directive transistor-based THZ detectors” (THzFET)

I. Kašalynas

European Defence Agency (EDA) project “Adaptive Camouflage for the Soldier II” (ACAMSII)

A. Abraitienė

European Commission project “Advancing Science and TEchnology thRough dIamond Quantum Sensing” (ASTERIQS)

A. Alkauskas

European Commission project “In-built Triggered Enzymes to Recycle Multi-layers: an Inovation for Uses in Plastic-packaging (TERMINUS)

S. Asadauskas

Research Executive Agency (REA) project “Dirac Semimetals based Terahertz Components (DiSeTCom)

G. Valušis

European Space Agency (ESA) project “Bismide-based Intersubband Devices for Mid-Infrared Applications” (BISMIRA)

J.Devenson

European Space Agency (ESA) project “Terahertz Time Domain Gas-Phase Spectroscopy”

R.Adomavičius

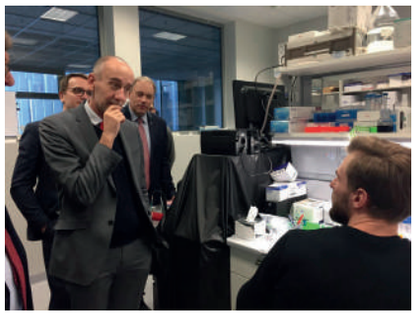
European Commission project “European Joint Research Programme in the management and disposal of radioactive waste” (EURAD)

R.Plukienė

EVENTS

Mr. Jean-Eric Paquet, EC Director-General for Research and Innovation, visited the FTMC

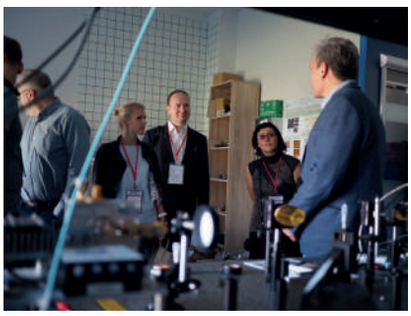
/2019 01 24/


Mr. J.-E. Paquet visited Lithuania to participate in the conference New Opportunities for Lithuanian Researchers for 2021-2027. HORIZON EUROPE. The event was dedicated to presentation of Lithuania's results in Horizon 2020 and preparation for the new EU program European Horizon 2021-2027. Mr. J.-E. Paquet has met up with science and innovation policy makers, scientists and business representatives, visited Vilnius University Life Sciences Center and FTMC. Recognizing the scientific achievements, current projects, as well as the technological solutions of the infrastructure and architecture, he urged Lithuanian scientists to be active in both writing the projects and proposing new ideas to improve ongoing research programs.

Optics and Medicine - the future of treatment

/2019 05 23-24/



The Conference and matchmaking event Photonics for Health has been held at FTMC. The representatives of the photonics and medical science discussed with businessmen the possibilities of realization of new ideas, cooperation, integration, application and development of innovative technologies. The events like Photonics for Health help the photonics innovators to communicate with the target audience - medical professionals, in order to better understand their needs, find the most appropriate solutions and the most effective ways for commercializing of products. Activities were presented by Lithuanian scientists as well as by promising Lithuanian photonics companies (Ekspla, Photosana, Femtika, Elas). Participants visited the laboratories of FTMC and the Laser and Engineering Technology Cluster.

Research and Technology Organization in Lithuania

/2019 06 04/


Leading research centers of Lithuania - FTMC, Lithuanian Energy Institute (LEI), Lithuanian Research Center for Agriculture and Forestry (LAMMC) and Science and Technology Park of FTMC - have established a Lithuanian Research and Technology Organization (LRTO) to act as an association consolidating potential of the country in applied research by expanding the high value-added industrial sector while maintaining the organizational flexibility of the centers. LRTO (1) has high-level scientific potential, international-level applied research and R&D activities, innovative services and expertise in high-tech enterprise generation and incubation; (2) are guided by high quality science and rational balance between fundamental and applied research, close cooperation, flexibility and practicality; (3) strive to develop effective institutional synergies by finding systemic solutions based on diverse scientific and technological competences. The organization is open and invites all those who share the goals, attitudes and values outlined above.

New opportunities enabled by EARTO membership

/2019 09 26-27/

FTMC became a member of the European Association of Research and Technology Organizations (EARTO). After extensive expertise, the EARTO network welcomed 2 new members in July: FTMC from Lithuania and INTI from Argentina. The EARTO is the European trade association of Research and Technology representing around 350 members across Europe. The list of EARTO members includes VTT in Finland, TNO in the Netherlands, IMEC in Belgium, and Fraunhofer Fellowships in Germany. The EARTO promotes and champions the interests of RTOs in Europe by reinforcing their profile in the minds of EU decision-makers, and by seeking to ensure that European R&D and innovation programmes are best attuned to their interests. The association also provides added-value services to its members to improve their professional practices and business performance, as well as information and advice about European R&D and innovation programme funding opportunities.

Lithuania-Poland Workshop on Physics and Technology

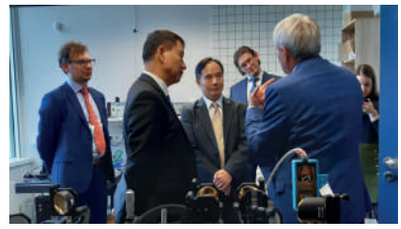
/2019 09 26-27/



A scientific workshop of neighbouring countries, dedicated to the 450th Anniversary of the Lublin Union, was organized by FTMC at the majestic Palace of the Grand Dukes of Lithuania. The event was aimed to broaden the frontiers of scientific cooperation, enrich the topics of project applications and find more items which would unite, but not separate the scientists of both countries. Intensive scientific cooperation between us and our Polish colleagues opens up new opportunities both for joint scientific applications to the European Commission and creation and development of high added-value products or scientific services internationally, emphasized the FTMC director G. Valušis.

Visit of the Deputy Director General of the WTO

/2019 10 04/


The Deputy Director General of World Trade Organization (WTO) Xiaozhun Yi was the keynote speaker at the international conference Shaping the Future of Trade, organized by the Ministry for Foreign Affairs of Lithuania in Vilnius, and before the conference he and other important guests visited FTMC. They were acquainted with the premises and scientific research of the Center by the FTMC director G. Valušis. An excursion to the Terahertz photonics and Microwave laboratories followed the meeting. "We are delighted to visit the FTMC, which we can safely call a highest quality scientific research and innovation development center. Scientists and technology creators in FTMC are talents that your country should be proud of", commented the visit Xiaozhun Yi.

FTMC signed the Memorandum with Shandong Academy of Sciences

/2019 11 05-09/


The delegation of FTMC participated in the Lithuanian-Chinese conference Sino-Lithuanian Forum on Advanced Laser Technologies and Applications. The event was held in Jinan, China and was designed to promote the development of laser science, technology and applications between Shandong province of China, FTMC and Vilnius University. During the forum, FTMC and Shandong Academy of Sciences signed a Memorandum of Understanding, a symbolic agreement between both institutions to cooperate in laser research and application. The Memorandum of Understanding is an important step, which opens up new avenues for cooperation between Lithuanian and Chinese scientists, in development of joint bilateral projects, implementation of high added-value innovations, said the FTMC director G. Valušis, who signed the document.

FTMC Chess Tournament

/2019 12 13/



The first FTMC Chess Tournament was organized by local and Vilnius Chess Club. Everyone who played chess at least once was invited to compete with colleagues. The event was opened by FTMC director prof. Gintaras Valušis and Grandmaster (awarded by FIDE) Viktorija Čmilytė-Nielsen.

AWARDS

Ramutis Drazdys

– for life achievements

For establishment and development of optical coating technologies. For successful commercialization of products and services. For foundation and expansion of high-tech companies. For persistence in research and development activities. For searching young talents and their encouragement to create know-how. For unique and further evolving scientific school of optical coating technologies.

Ramutis Drazdys, senior researcher at the Optical Coatings Laboratory, Department of Laser Technologies. Diploma in Physics (Vilnius University, 1970). PhD thesis "Electronographic camera for astrophysical investigations" (Institute of Physics, 1986). Initiator of optical coating technologies in Lithuania, founder of the first successful company (UAB Optida, 2001). Scientific interests: atomic layer deposition technique (current), vacuum technology, optical coatings technology and investigations, characterization and metrology of the optical and laser components, laser-matter interaction.

Arūnas Jagminas

– for scientific achievements

For synthesis and characterization of various nanostructured materials. For successful implementation of laser excitation in tailoring nanostructured metasurfaces and their physical properties. For persistent and wide scale search for applications in fabricated materials. For international scale of cooperation and development of scientific school in materials engineering.

Arūnas Jagminas, head of Nanostructures laboratory, chief research fellow at the Department of Electrochemical Material Science. PhD in chemistry 1979. Works in the fields of metals anodising, thin films design, synthesis of nanostructures materials and their application. Published about 100 papers in high impact journals in last two decades, was awarded Jim Cape silver medal for the best year publication in the metal finishing area in 2004 and A. Matulis prize of the Lithuanian Academy of Sciences. An expert of more than 20 international journals and a member of the Experts Committee at ESF.

Irmantas Kašalynas

– for innovations

For a large variety of terahertz technology related projects in the Terahertz Photonics laboratory. For inexhaustible enthusiasm searching new scientific topics and technological approaches. For successful implementation of obtained results. For providing an international dimension for a staff of the laboratory.

Irmantas Kašalynas: chief research fellow at the Department of Optoelectronics, head of Terahertz Photonics Laboratory. B.S. degree in electrical engineering (Vilnius Technical University, 1995). M.S. and Ph.D. degrees in physics from Vilnius University (1997 and 2004, respectively). Since 2006, he is with a THz Atelier group in Semiconductor Physics Institute, later FTMC. Research interests: THz device physics, THz optics and plasmonics, spectroscopic THz imaging, and application of THz waves.

Tomas Tolenis

– winner of Breakthrough Junior Challenge

For successful and enthusiastic leadership of Optical Coatings Laboratory. For attracting technological projects and development of new technologies, for ambitious international activities and, in particular, for sincere and versatile care of the team in revealing their talents and increasing their skills, knowledge and erudition.

Tomas Tolenis, head of Optical Coatings laboratory, Department of Laser Technologies. PhD in physics Modelling, formation and characterization of nano-sculptured thin films, 2017. Research activity: optical coatings for laser applications. One of the inventors of all-silica multilayer coatings withstanding extreme laser intensities. Research interests: nano-structured thin films, e-beam evaporation, thin film characterization and related topics.

Marius Vinciūnas

– for scientifically invisible activity

For his remarkable work in managing scientific projects, for tremendous progress in development of technology transfer activities and his exceptional activities in making projects administration as simple as possible for scientists.

Marius Vinciūnas delivers internal consultancy and hands-on support in project management and the pursuit of commercial opportunities. Before joining FTMC in 2011, Marius got an MBA degree at Vilnius University and worked for a consultancy company providing services to various international and national companies, scientific institutions. Currently, he helps researchers through the whole process of turning an idea into a final project and its implementation as well as the management of the intellectual property and possible technology commercialization.

Rasa Pauliukaitė

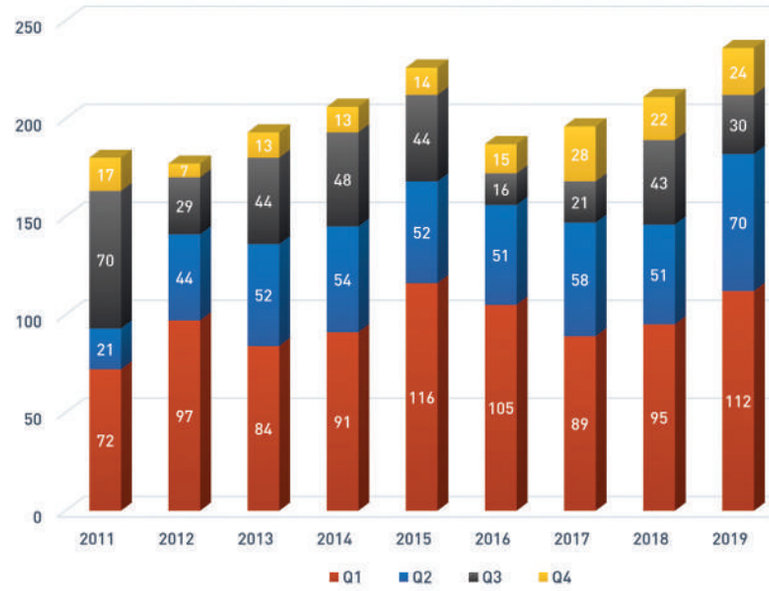
– recipient of the Special Award

for the creation and composition of the impressive book "Chemistry in Poems" dedicated to learning and providing elegant insights into Chemistry in a language of Arts.

Rasa Pauliukaitė, chief research fellow at the Department of Nanotechnologies. PhD thesis Equilibria and electrocatalytic redox reactions in alkaline solutions of Cu(II) complexes and formaldehyde (Institute of Chemistry, 1998). Post-doc at Karl-Franzens University, Graz, Austria; National Institute of Chemistry, Ljubljana, Slovenia; Swiss Federal Institute of Technology Zurich, Switzerland; University of CoimZbra, Portugal. Fields of interest: physical chemistry, electroanalytical chemistry, different modes of electrochemical methods, including electrochemical impedance spectroscopy, electrochemical sensors and biosensors. Grotthuss medal award in 2018.

PUBLICATIONS

Publications with FTMC affiliations in 2019 in the top quartile (Q1) journals



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