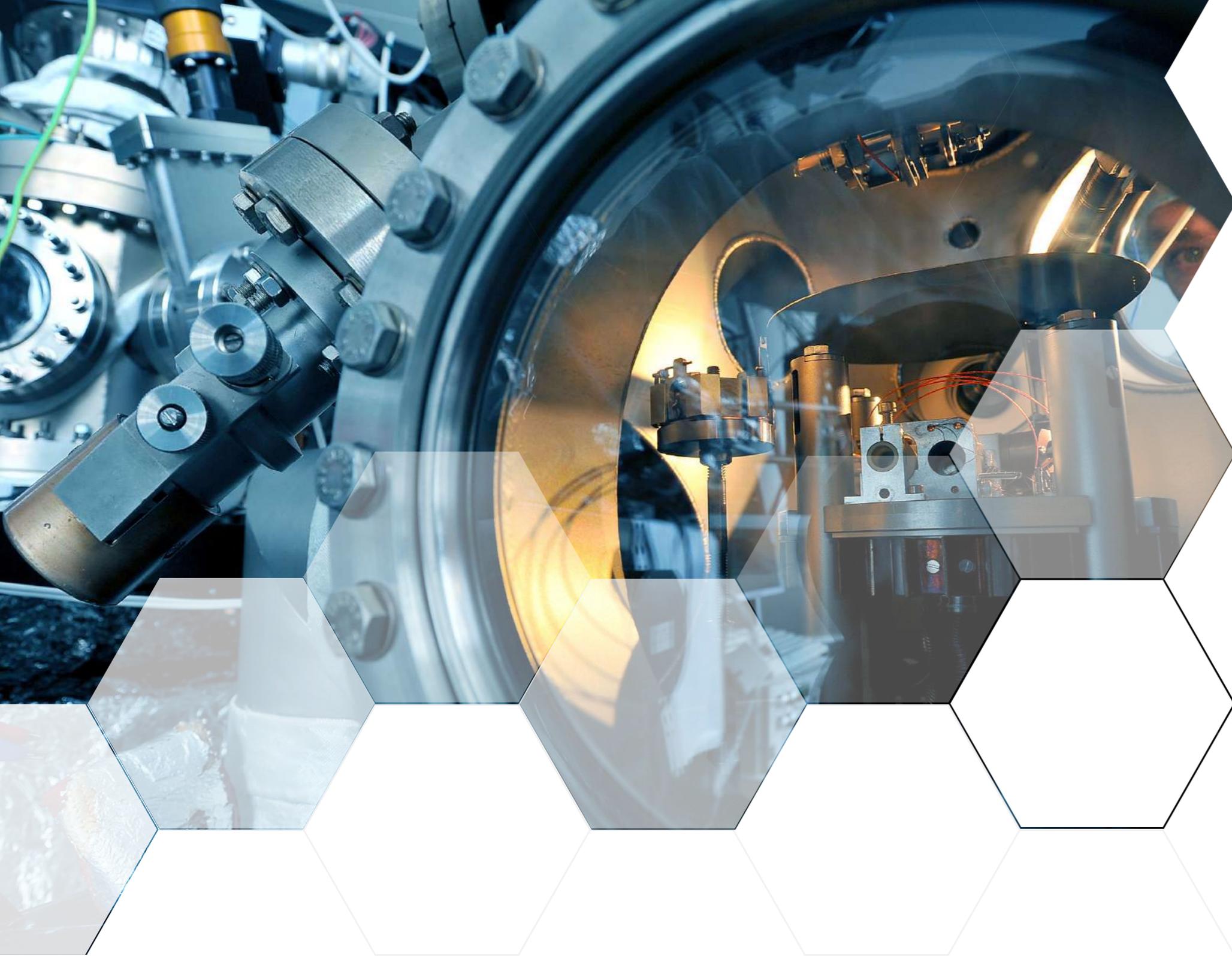


ANNUAL REPORT 2018



Central European Institute of Technology
BRNO | CZECH REPUBLIC





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Preamble

Dear Reader,

CEITEC BUT – Central European Institute of Technology is one of the most significant centres of its kind in Central Europe. Since its establishment in 2011, CEITEC represents the most successful investment in R&I in the Czech Republic in the past ten years, and has developed into a world-class research infrastructure, providing state-of-the-art equipment and ideal conditions for basic and applied research.

This basis has seen the Institute quickly develop in a relatively short time. It has become exceedingly more successful at attracting highly competitive funding from the Czech Republic and abroad. The Institute currently employs six ERC holders, and an ERA Chair, and leads several projects with top EU and international scientific establishments. CEITEC holds several open access research facilities unique to the country and region, and its publication and citations records are far exceeding the Czech average.

As CEITEC has grown in stature, it has developed an increasingly international fabric: around 40% of students come from abroad; 17% of the total workforce are from a foreign background; and further investment from international sources are approaching nearly one quarter of the total budget (the annual budget of CEITEC BUT alone is over 12M Euros).

Central to the founding vision of CEITEC is the development of solutions designed for modern day societal

challenges: producing new materials for data storage or energy harvesting; developing biosensors for early detection of diseases; and new instrumentation for advanced research and development or cybernetics for improved manufacturing processes.

Within these pages we offer a presentation of the research that is carried out by our groups at CEITEC BUT, and give some insight into the structure of the organisation. This brochure is designed to present our industrial and academic friends with the opportunity to find the appropriate support for their needs, and for prospective students looking for areas that best suit their academic interests. It is also a chance for our own colleagues and partners to find out more about the wider activities at CEITEC BUT.



Prof. Ing. Radim Vrba, CSc.



Selected Highlights in 2018

2018 has seen highly substantial developments at CEITEC which have raised the profile of the centre both domestically and abroad. Key to this growth is the welcome addition of six new research groups. Four of these were established as early as January and were soon followed by two more later in the year. The importance of these new groups is covered in detail in the Appointments section of this report.

Additionally, there have been several other significant events throughout the year which have contributed to this considerably successful year at CEITEC.

In **JANUARY** we started several new H2020 projects. The first of these is the PETER (Plasmon Enhanced Terahertz Electron Paramagnetic Resonance) project, from the highly competitive programme FET OPEN, where CEITEC plays the pivotal role of project coordinator under the supervision of **prof. Tomáš Šikola**. This project will create a mapping electron paramagnetic resonance instrument for the highly sensitive mapping of paramagnetic materials. Secondly, we were also honoured to announce two ERC grants: one for **prof. Vojtěch Adam** to study tumour metabolism processes, with particular focus on the role of a protein called metallothionein, and the second for **Dr. Petr Neugebauer**, for the development of the THz Rapid Scanning Electron Paramagnetic Resonance technique.

In **MAY** we started a new H2020 project called SECRE-

DAS (Cyber Security for Cross Domain Reliable Dependable Automated Systems), where CEITEC (under the group of **prof. Pavel Václavek**) plays a pivotal role in the development of advanced communication protocols and algorithms. In **JULY**, CEITEC, together with Institute of Physics, co-hosted the ICN+T international conference on nanoscience and nanotechnologies, where we welcomed 350 international participants.

Since **SEPTEMBER**, CEITEC has coordinated a Twinning project from the H2020 Widening programme SINNCE. Within three years we will benefit substantially from knowledge transfer and student and lecturer exchanges with top-level partners from the EU and Israel (Zurich, TU Vienna, and Weizmann Institute of Science).

Key to the future development of CEITEC is regular assessment of research and education by an independent evaluation body. The International Scientific Advisory Board's seven members, together with an additional 16 independent researchers from all over the EU, visited CEITEC in October for three days and evaluated each group according to predefined criteria, taking into account not only pure science but also the long term vision of each assessed research group, the PhD programme, and the ability to attract projects and private funding. The majority of the evaluated research groups successfully received the A category mark.

Also in **OCTOBER**, CEITEC took part in the annual "European Researchers' Night", where laboratories

are open to the general public. This year we welcomed over 750 visitors who enjoyed some real insight into the work we do. In the same month CEITEC also organized an international conference "Phase in Brno" under the coordination of prof. Radim Chmelik, and with keynote speakers coming from as far as KAIST in South Korea or CERVO in Quebec, Canada.

In **NOVEMBER** we started a new H2020 project called COSMOS (Coherent Support for Mobility E-Strategy) under the group of **prof. Pavel Václavek**. The results of this prestigious project will serve for future landscaping of EU research areas in E-Mobility in the upcoming framework programme.

Finally, it is important to mention the CEITEC Seminar Series, where distinguished international speakers are invited by the individual research group leaders to give a talk on a given topic. For 2018 we invited the following speakers:

VINICIUS SANTANA (16.01.2018)

São Carlos Physics Institute – University of Sao Paulo (IFSC/USP)

Exploring magnetic properties via Electron Spin Resonance

NINA OBRADOVIĆ (23.01.2018)

Institute of Technical Sciences of SASA, Belgrade, Serbia

Wollastonite-based ceramics for water purification

ANDRIY MARKO (30.01. 2018)

Institute of Physical and Theoretical Chemistry, Goethe University Frankfurt, Germany

Advances in PELDOR methodology and applications

JOY RICHMAN (20.02.2018)

Faculty of Dentistry, University of British Columbia, Canada

Diving into the Marianas Trench of human craniofacial development – Using 3D imaging to explore growth of the head in the middle trimester

ALEXANDER KROMKA (13.03. 2018)

Institute of Physics of the Czech Academy of Sciences

Synthetic diamond thin films: a brilliant in science

VOREOES JANOS (27.03.2018)

ETH Zurich Switzerland

Microstructured nanocomposite materials for bioelectronics

DAFINÉ RAVELOSONA (03.04.2018)

Center for Nanoscience and Nanotechnology (C2N), Université Paris Sud, France

Influence of disorder on domain wall dynamics in CoFeB-MgO structures with perpendicular anisotropy

ROMAN MOTIYENKO (17.04.2018)

University of Lille, Faculty of Sciences and Technologies, France

High-resolution terahertz spectroscopy of molecules of astrophysical interest

ZBIGNIEW SOJKA (24.04. 2018)

Uniwersytet Jagielloński, Poland

Computational EPR Spectroscopy of Randomly Oriented Materials

MAKSYM MYRONOV (22.05.2018)

Department of Physics, The University of Warwick, UK

High mobility strained Germanium low-dimensional systems

SHANGDA JIANG (29.5.2018)

College of Chemistry and Molecular Engineering, Peking University, China

Endohedral Fullerenes as Molecular Qubits

DAVID HAHN (06.06.2018)

Department of Mechanical and Aerospace Engineering, University of Florida, Gainesville, FLORIDA

3D Bioprinting: The Intersection of Engineering and Medicine

ANDRIY MILCHEV (12.06. 2018)

Inst. Phys. Chemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria,

Stiffness-guided motion of a droplet on a solid substrates

PIERRE MARQUET (23. 10. 2018)

CERVO, Brain Research Center in Mental Health, Québec, Canada

Exploring cell structure, dynamics and homeostasis with quantitative phase digital holographic microscopy: towards identifying specific cell phenotypes

OLIVER SCHMIDT (30. 10. 2018)

Institute for Integrative Nanosciences, Leibniz IFW Dresden, Germany

Nanophotonics with nanomembranes

RICO GUTZLER (4. 12. 2018)

Max Planck Institute for Solid State Research, Stuttgart, Germany

2D (Metal-)Organic Networks as Electrocatalysts for Energy Conversion

IGOR LACÍK (11. 12. 2018)

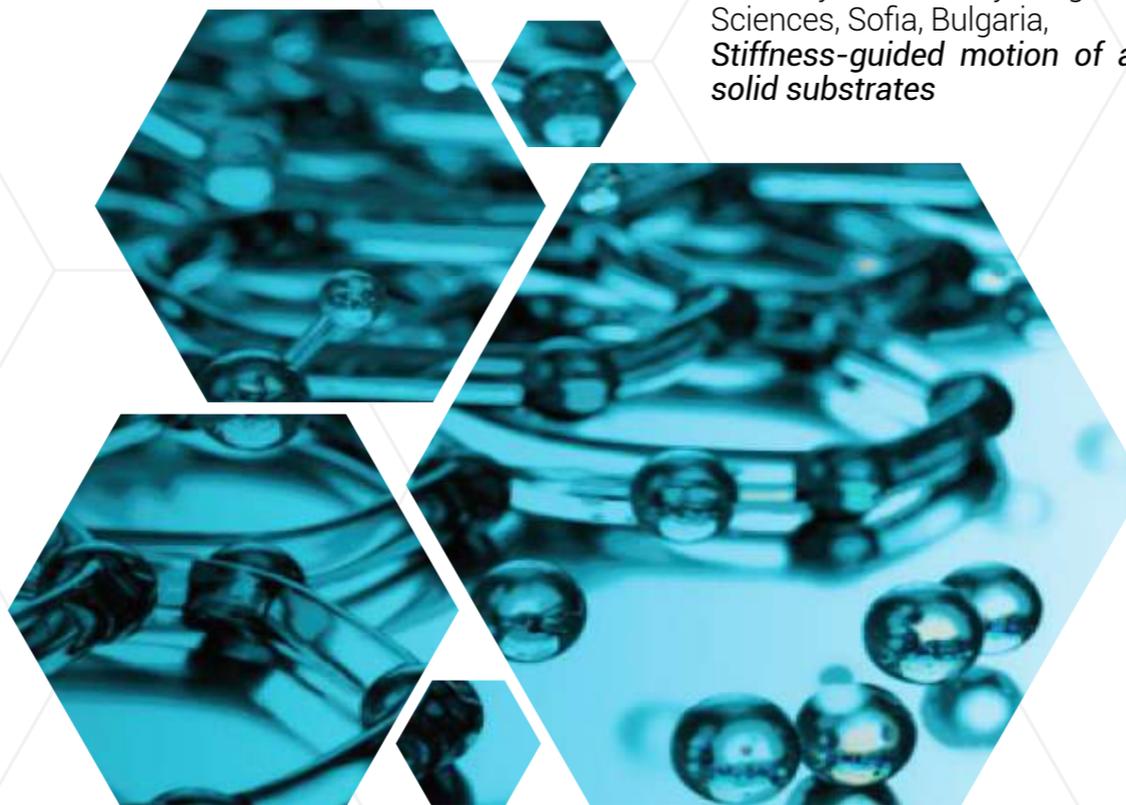
Slovak Academy of Sciences, Slovakia

Next generation diabetes treatment by encapsulated insulin-producing cells

ALIKSANDR BANDARENKA (9. 10. 2018)

Technical University Munich Germany

Identification of Catalytically Active Sites at Electrode Surfaces



CEITEC Nano in 2017-2018

CEITEC BUT operates one of the largest, shared nanofab facilities in the country. It currently operates over 70 instruments with a total value of around 28M€, wherein the majority of the equipment is approximately only 3 years old. The facility has attracted a substantial user community of 528 users from 28 nationalities, the majority of which are using the facility on a self-service basis (353 self-service), with 145 using full-service. Of these users, there are 187 registered students (97 PhD students, 90 undergraduate students) and 439 academic users from 37 institutions. 41 users are from 16 foreign institutions. Importantly, 89 users are from the commercial sector, from 55 companies, of which 10 users are from 10 foreign companies. Note, that if an international company has a Czech subsidiary, we count the user as local. The overall running cost of the facility has increased from 1,872M EUR in 2017 to 2,114M EUR in 2018, mainly due to an increase in salaries and service contracts. In 2018 substantial effort was made to consolidate the employees and eliminate shared contracts with other faculties, as these prove to be very difficult to manage. We have managed to ensure that the majority of staff have at least 0.8 FTE.

Overall, the CEITEC Nano facility is now a consolidated unit with a clearly defined mission to provide world class equipment and expertise to researches in a way that they can fully focus on the substance of their research. In 2018, we achieved a stable investment stream and motivated workforce.



Management

CEITEC BUT is led by the Director, who sits on the Board of Studies and Board for Research Infrastructure, and who is advised by seven executive heads. Together, the management team is responsible for key decision making at CEITEC BUT. This includes decisions regarding all key strategies such as planning and budget approval, road-mapping the direction of CEITEC BUT, approving new group leaders, dealing with key development plans and interactions with the BUT management.



/1/ PROF. RADIMÍR VRBA
Director

/2/ DR. PAVEL KREČMER
Deputy director, Head of Grant Office

/3/ PROF. TOMÁŠ ŠIKOLA
Coordinator of Research Programme 1

/4/ PROF. JOSEF JANČÁŘ
Coordinator of Research Programme 2

/5/ PROF. RADIM CHMELÍK, PHD.
Director of Studies

/6/ DR. JIŘÍ OČADLÍK PHD.
Head of Industrial Development

/7/ MICHAL URBÁNEK, PHD.
Head of CEITEC Nanofacility

/8/ JAN NEDVĚD
Financial Manager, Secretary of the Institute

International Scientific Advisory Board

CEITEC is regularly evaluated by the International Scientific Advisory Board (ISAB). This board consists of seven permanent members of the ISAB, one for each research area. The ISAB group meets annually and the permanent members also chair regular large CEITEC performance evaluations where each research programme is evaluated by an international board of renowned scientists in a given field. These large evaluations of research groups and CEITEC as a whole have been carried out in 2012, 2014 and 2018. Members of the ISAB for Research Programme's 1 and 2 for 2018 were:



Research Programme 1:
Prof. Gustaaf Borghs,
Leuven University, Belgium



Research Programme 2:
Prof. Oliver Diwald,
University of Salzburg, Austria

Appointments

2018 has also seen the establishment of six new research groups (RGL) selected upon an open international competition published in late 2017. From January we have established four research groups: **Dr. Petr Neugebauer**, a holder of a Starting ERC grant from the University of Stuttgart, has established a research group on Magneto-optical THz spectroscopy. The aim of this group is to develop a unique methodology in the broadband ESR technique. **Dr. Jan Čechal** has started a new group focused on the Molecular nanostructures on surfaces. The experimental activities will aim to develop knowledge on self-assembly and functional properties of supramolecular structures with particular research focus in catalysis and spintronics. A new group on nanomagnetism and spintronics will be led by **Dr. Vojtěch Uhlíř**, who will study magnetic and electronic phase changes in nanostructures, and finally, from early 2018, **Dr. Jan Macák** has started his research group on low-dimensional nanomaterials such as TiO₂ nanotubes and nanofibers, and their preparation and characterization for various applications, such as photovoltaics, catalysis and batteries.

Following the expansion in January, we were joined in March by **Dr. Hermann Detz** from TU Wien, who will lead the group in functional layers and nanostructures of semiconductors and metallic materials and also widen our cooperation with TU Wien. Last but not least, June 2018 saw the establishment of the new group of **Dr. Andreas W. Schell** on optical quantum technologies, expanding the CEITEC research portfolio into this rapidly developing field of science.



/1/ DR. PETR NEUGEBAUER, PHD.
Magneto-Optical and THz Spectroscopy



/2/ ASSOC. PROF. JAN ČECHAL, PHD.
Molecular Nanostructures at Surfaces



/3/ VOJTĚCH UHLÍŘ, PHD.
Nanomagnetism and Spintronics



/4/ DR. ING. JAN MACÁK
Advanced Low-Dimensional Nanomaterials



/5/ DIPL. ING. DR. TECHN. HERMANN DETZ
Epitaxial Materials and Nanostructures



/6/ DR. RER. NAT. ANDREAS WOLFGANG SCHELL
Quantum Optical Technology

Studying at CEITEC BUT

CEITEC is a centre for progressive and innovative education which encourages scientific creativity in its research groups and a fostering of the principles of engagement. There are currently nearly 100 PhD students active at the CEITEC BUT PhD school, coming from over 15 different countries (40% of all students are of foreign origin), ensuring a rich and diverse academic environment.

The CEITEC PhD school grew substantially in 2018 with the admission of 50 new PhD students, of which 24 were from abroad (including 8 Slovak students). 21 of these new students are graduates from outside the BUT. In 2018 we had a total of 109 active students; 37 from abroad (18 Slovaks) and 33 (30%) graduated from outside of BUT. Gender balance at the school is also improving. In 2018 as we admitted 12 new female PhD students, raising the number of female PhD students at CEITEC BUT to 34 (31.2%).

Seven of our PhD students received individual development projects and 22 were successful in obtaining a "Specific research project" from the BUT's internally run research programme.



Research

CEITEC research and its long-term sustainability is heavily dependent on competitive funding. In 2018 nearly 78% of our funding came from competitive sources (including national sustainability funds, which alone formed 22.2% of the total budget). During the year, there were 96 ongoing projects, of which 11 were from the H2020 programme, 21 TACR projects, 20 GACR projects and 17 MPO TRIO. During the year we were also successful in obtaining an additional 8 new international and 30 new national projects, ensuring the long-term financial stability of CEITEC.

CEITEC BUT budgeting (in EUR)

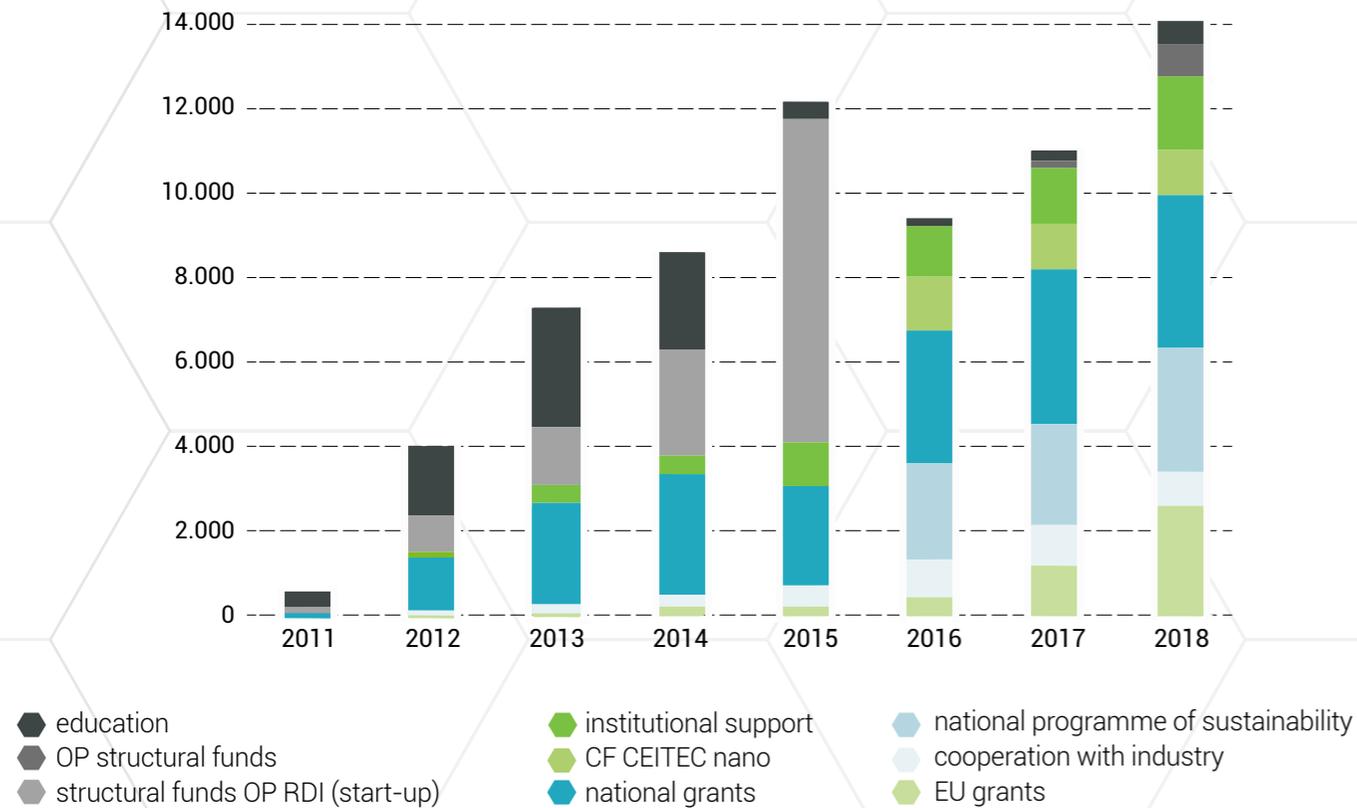


Fig.1 Structure of the annual budget of CEITEC BUT between 2011 and 2018

Facts and figures 2018

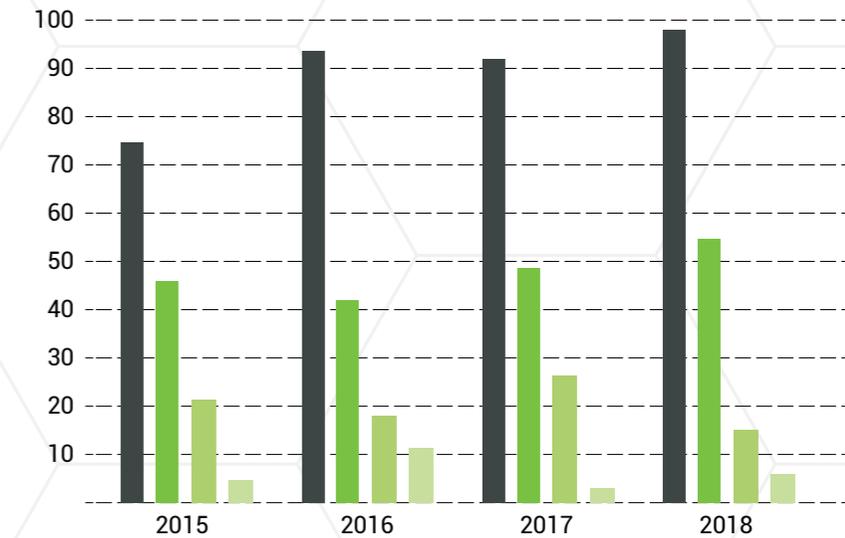
Staff	2015	2016	2017	2018
Total (FTE)	248.9	238.8	247.1	269.5
Scientific Staff (FTE)	101.1	110.2	114.9	114.1
Others* (FTE)	147.8	118.7	132.2	155.4

	2015	2016	2017	2018
Students (Doc. Programme)	50	69	79	109
Defences				10

* CF Staff, technicians, administrative staff...

Publications

- Q1
- Q2
- Q3
- Q4



CEITEC BUT Research Group Leaders

ADVANCED NANOTECHNOLOGIES AND MICROTECHNOLOGIES

1. Jaromír Hubálek, PhD.
Smart Nanodevices (BUT)
2. prof. Radim Chmelík, PhD.
Experimental Biophotonics (BUT)
3. prof. Tomáš Šikola, PhD.
Fabrication and Characterization of Nanostructures (BUT)
4. Petr Klapetek, PhD.
Development of Methods for Analysis and Measuring (CMI)
5. prof. Jozef Kaiser, PhD.
Materials Characterization and Advanced Coatings (BUT)
6. Petr Neugebauer, PhD.
Magneto-Optical and THz Spectroscopy (BUT)
7. Jan Čechal, PhD.
Molecular Nanostructures at Surfaces (BUT)
8. Vojtěch Uhlíř, PhD.
Nanomagnetism and Spintronics (BUT)
9. Dipl.-Ing. Dr.techn. Hermann Detz
Epitaxial Materials and Nanostructures (BUT)
10. Dr. rer. nat. Andreas Wolfgang Schell
Quantum Optical Technology (BUT)



ADVANCED MATERIALS

11. prof. Martin Trunec
Advanced Ceramic Materials (BUT)
12. prof. Pavel Václavek, Ph.D.
Cybernetics in Material Science (BUT)
13. prof. Josef Jančář
Advanced Polymers and Composites (BUT)
14. prof. Martin Trunec
Advanced Ceramic Materials (BUT)
15. Miroslav Černý, PhD. *
Advanced Metallic Materials and Metal-based Composites (BUT)
* Research Group Leader at IPM is Jan Klusák, PhD.

Smart Nanodevices



Research group leader

Jaromír Hubálek, PhD.

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Deputy

Prof. Vojtěch Adam, PhD.

Principal Investigators

Prof. Neužil Pavel

Dr. Mozalev Alexander

Drbohlavová Jana, PhD.

Pumera Martin, PhD.

Heger Zbyněk, PhD.

Richtera Lukáš, PhD.

Vaculovičová Markéta, PhD.

Zítka Ondřej, PhD.

Team members

98

PhD Students

11

Selected Publications

- Tvrdonova, M; Vlcnovska, M; Vanickova, LP; Kanicky, V; Adam, V; Ascher, L; Jakubowski, N; Vaculovicova, M; Vaculovic, T, 2019: Gold nanoparticles as labels for immunochemical analysis using laser ablation inductively coupled plasma mass spectrometry. ANALYTICAL AND BIOANALYTICAL CHEMISTRY 411(3), p. 559 - 564.

- Strejckova, A; Dvorak, M; Klejdus, B; Krystofova, O; Hedbavny, J; Adam, V; Huska, D, 2019: The strong reaction of simple phenolic acids during oxidative stress caused by nickel, cadmium and copper in the microalga

Research Focus

Miniaturized systems (on-chip systems covering modern electrochemical methods, electrophysiology for research of genetically engineered cells using MEA chips, microfluidic chips for in-vitro diagnosis in medicine as well as miniaturized devices for in-situ and in-vivo sensing and electronics including nano-electrodes, MEMS and Lab on a Chip)

Nanostructures and nanoparticles for smart nanodevices (synthesis of nano-materials such as metal-oxide nanofilms, quantum dots, magnetic nanoparticles, carbon nanotubes, graphene, modification of their surfaces for precise and targeted bonding with biomolecules, development of methods, techniques and technology for implementation of outputs into advanced nanodevices and nanoprobes for electronics, nanomedicine and diagnostics)

Molecular-biology of cancer pathogenesis and acquired chemoresistance of cancer diseases with subsequent design and development of smart nanoscaled vehicles (inorganic, organic and hybrid nature) for biologically active compounds to overcome these processes and to enhance the anticancer therapeutic options.

Nanomedicine (diagnostics methods, in-vivo imaging, tissue protein imaging, targeted drug delivery, molecular profile - cancer markers)

Scenedesmus quadricauda. NEW BIOTECHNOLOGY 48, p. 66 - 75.

- Tesarova, B; Charousova, M; Dostalova, S; Bienko, A; Kopel, P; Kruszynski, R; Hynek, D; Michalek, P; Eckschlager, T; Stiborova, M; Adam, V; Heger, Z, 2019: Folic acid-mediated re-shuttling of ferritin receptor specificity towards a selective delivery of highly cytotoxic nickel(II) coordination compounds. INTERNATIONAL JOURNAL OF BIOLOGICAL MACROMOLECULES 126, p. 1099 - 1111.

- Mozalev, Alexander; Hubalek, Jaromir, 2019: On-substrate porous-anodic-alumina-assisted gold nanostructure arrays: Meeting the challenges of various sizes and interfaces. ELECTROCHIMICA ACTA 297 p. 988-999.

- Chmela, O.; Sadilek, J.; Domenech-Gil, G.; Sama, J.; Somer, J.; Mohan, R.; Romano-Rodriguez, A.; Hubalek, J.; Vallejos, S., 2018: Selectively arranged single-wire based nanosensor array systems for gas monitoring. NANOSCALE 10 (19) p. 9087-9096

Experimental Biophotonics



Research group leader

Prof. Radim Chmelik

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Tel.: +420 54114 2795

Deputy

MUDr. Pavel Veselý

Principal investigators

Prof. Petráček Jiří
MUDr. Veselý Pavel
Zicha Daniel

Research Focus

Advanced light microscopy R&D

holographic and two photon microscopy
numerical simulation of coherence effects in holographic microscopy
development of advanced image-processing methods

Applications in cell biology, cancer and neuroscience research

identification and classification of behavioural patterns in live cancer cells
personalized cancer treatment
hemodynamic response of the brain

Nanotechnology

plasmonic phenomena observation in nanostructures

Team members

23

PhD Students

6

Selected Publications

- Chmelik, R; Duris, M; Strbkova, L, 2018: Quantitative phase imaging in turbid media by coherence controlled holographic microscopy. UNCONVENTIONAL OPTICAL IMAGING 10677

- Uhlířova, H; Tian, PF; Kilic, K; Thunemann, M; Sridhar, VB; Chmelik, R; Bartsch, H; Dale, AM; Devor, A; Saisan, PA, 2018: Neurovascular Network Explorer 2.0: A Simple Tool for Exploring and Sharing a Database of Optogenetically-evoked Vasomotion in Mouse Cortex In Vivo. JOVE-JOURNAL OF VISUALIZED EXPERIMENTS (135).

- Bouchal, P; Chmelik, R; Bouchal, Z, 2018: Dual-polarization interference microscopy for advanced quantification of phase associated with the image field. OPTICS LETTERS 43(3), p. 427 - 430.



Fabrication and Characterisation of Nanostructures



Management

prof. Tomáš Šikola

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Deputy

Prof. Jiří Spousta, Ph.D.

Principal Investigators

prof. Spousta Jiří, PhD.

Bábor Petr, PhD.

Kalousek Petr, PhD.

Kolíbal Miroslav, PhD.

Křápek Vlastimil, PhD.

Polat Özgür, PhD.

Průša Stanislav, PhD.

Team members

57

PhD Students

18

Research Focus

Fabrication of nanostructures using bottom-up methods

Fabrication of nanostructures using top-down methods (nanolithography)

Investigation of the functional properties of nanostructures

The development of analytical and measurement methods

Selected Publications

- Bouchal, P; Dvorak, P; Babocky, J; Bouchal, Z; Ligmajer, F; Hrton, M; Krapek, V; Fassbender, A; Linden, S; Chmelik, R; Sikola, T, 2019: High-Resolution Quantitative Phase Imaging of Plasmonic Metasurfaces with Sensitivity down to a Single Nanoantenna. NANO LETTERS 19(2), p. 1242 - 1250.

- Skalka, P; Slamecka, K; Montufar, EB; Celko, L, 2019: Estimation of the effective elastic constants of bone scaffolds fabricated by direct ink writing. JOURNAL OF THE EUROPEAN CERAMIC SOCIETY 39(4), p. 1586 - 1594

- Coskun, M; Polat, O; Coskun, FM; Durmus, Z; Caglar, M; Turut, A, 2019: Effect of Os doping on electrical properties of YMnO3 multiferroic perovskite-oxide compounds. MATERIALS SCIENCE IN SEMICONDUCTOR PROCESSING 91, p. 281 - 289.

Development of Methods for Analysis and Measuring



Management

Petr Klapetek, PhD.

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Deputy

Miroslav Valtr, PhD.

Team Members

5

PhD Students

0

Research Focus

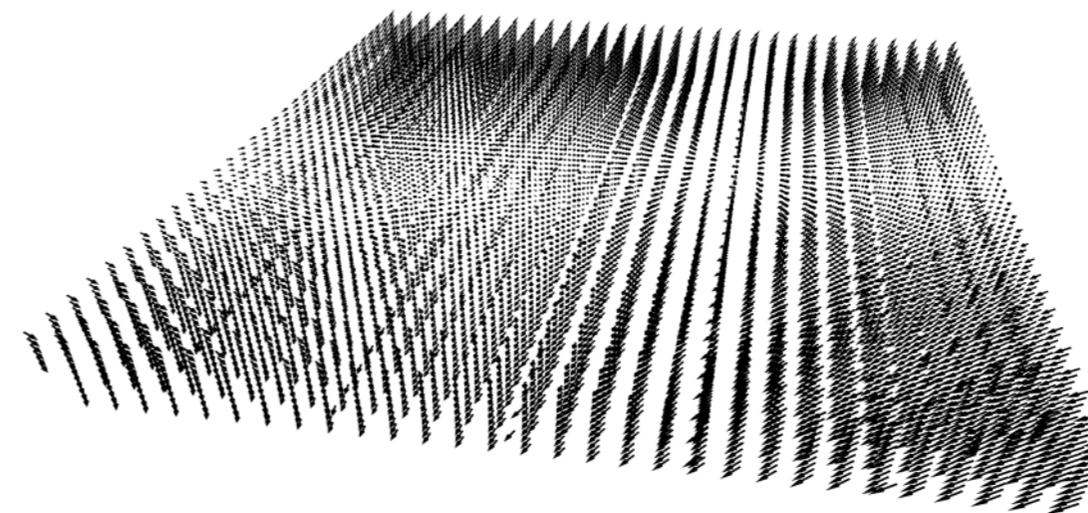
Quantitative scanning probe microscopy

Metrology

Numerical methods in nanoscale metrology

Research and development of analytical and measurement methods

Development of the techniques and methodologies for microscopy, analysis and metrology of nanomaterials/nanostructures, and for diagnostics of their properties – new techniques in nanometrology with SPM, optical methods, and combinations of other techniques (SEM, AFM, etc.)



Selected Publications

- Necas, D; Klapetek, P; Neu, V; Havlicek, M; Puttock, R; Kazakova, O; Hu, XK; Zajickova, L, 2019: Determination of tip transfer function for quantitative MFM using frequency domain filtering and least squares method. SCIENTIFIC REPORTS 9

- Yacoot, A; Klapetek, P; Valtr, M; Grollich, P; Dongmo, H; Lazzerini, GM; Bridges, A, 2019: Design and performance of a test rig for evaluation of nanopositioning stages. MEASUREMENT SCIENCE AND TECHNOLOGY 30(3)

- Bartosik, M; Kormos, L; Flajsman, L; Kalousek, R; Mach, J; Liskova, Z; Nezval, D; Svarc, V; Samoril, T; Sikola, T, 2017: Nanometer-Sized Water Bridge and Pull-Off Force in AFM at Different Relative Humidities: Reproducibility Measurement and Model Based on Surface Tension Change. JOURNAL OF PHYSICAL CHEMISTRY B 121(3), p. 610 - 619

Materials Characterization and Advanced Coatings



Management

Prof. Jozef Kaiser, Ph.D.
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Principal investigators

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prof. Křupka Ivan, Ph.D.
Čelko Ladislav, Ph.D.
Pořízka Pavel, Ph.D.
Procházka David, Ph.D.
Menelaou Melita, Ph.D.
Modlitbová Pavlína, Ph.D.
Montúfar Jimenéz Edgar Benjamin, Ph.D.
Novotný Jan, Ph.D.
Sedláková Vlasta, Ph.D.
Sedlák Petr, Ph.D.
Zikmund Tomáš, Ph. D.

Deputy

Čelko Ladislav, PhD.
Křupka Ivan, PhD.
Pořízka Pavel, PhD.
Sedláková Vlasta, PhD.
Zikmund Tomáš, PhD.

Research Focus

Development of novel approaches in materials characterization following today's demands, i.e. combination of micro- and nano-structural studies, optoelectronic characterization of micro- and nano-structures, tribology, Laser-Induced Breakdown Spectroscopy (LIBS) and Computed Tomography (μ CT, nanoCT).
Formation of advanced coatings with desirable functional characteristics via the application of advanced technologies and their characterization from macro- to nano-scale.

Total team members

71

PhD Students

16

Selected Publications

- Bijalwan, V; Tofel, P; Erhart, J; Maca, K, 2019: The complex evaluation of functional properties of nearly dense BCZT ceramics and their dependence on the grain size. CERAMICS INTERNATIONAL 45(1), p. 317 - 326.
- Pospiech, M; Zikmund, T; Javurkova, Z; Kaiser, J; Tremlova, B, 2019: An Innovative Detection of Mechanically Separated Meat in Meat Products. FOOD ANALYTICAL METHODS 12(3), p. 652 - 657.
- Horynova, M; Remesova, M; Klakurkova, L; Dvorak, K; Rocnakova, I; Yan, SK; Celko, L; Song, GL, 2019: Design of tailored biodegradable implants: The effect of voltage on electrodeposited calcium phosphate coatings on pure magnesium. JOURNAL OF THE AMERICAN CERAMIC SOCIETY 102(1), p. 123 - 135.

Magneto-optical and THz Spectroscopy



Management

Ing. Petr Neugebauer, PhD.

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Principal investigators

Němec Ivan, Ph.D.

Santana Vinicius, Dr.

Zhang Xixia, Ph.D.

Team members

17

PhD Students

6

Research Focus

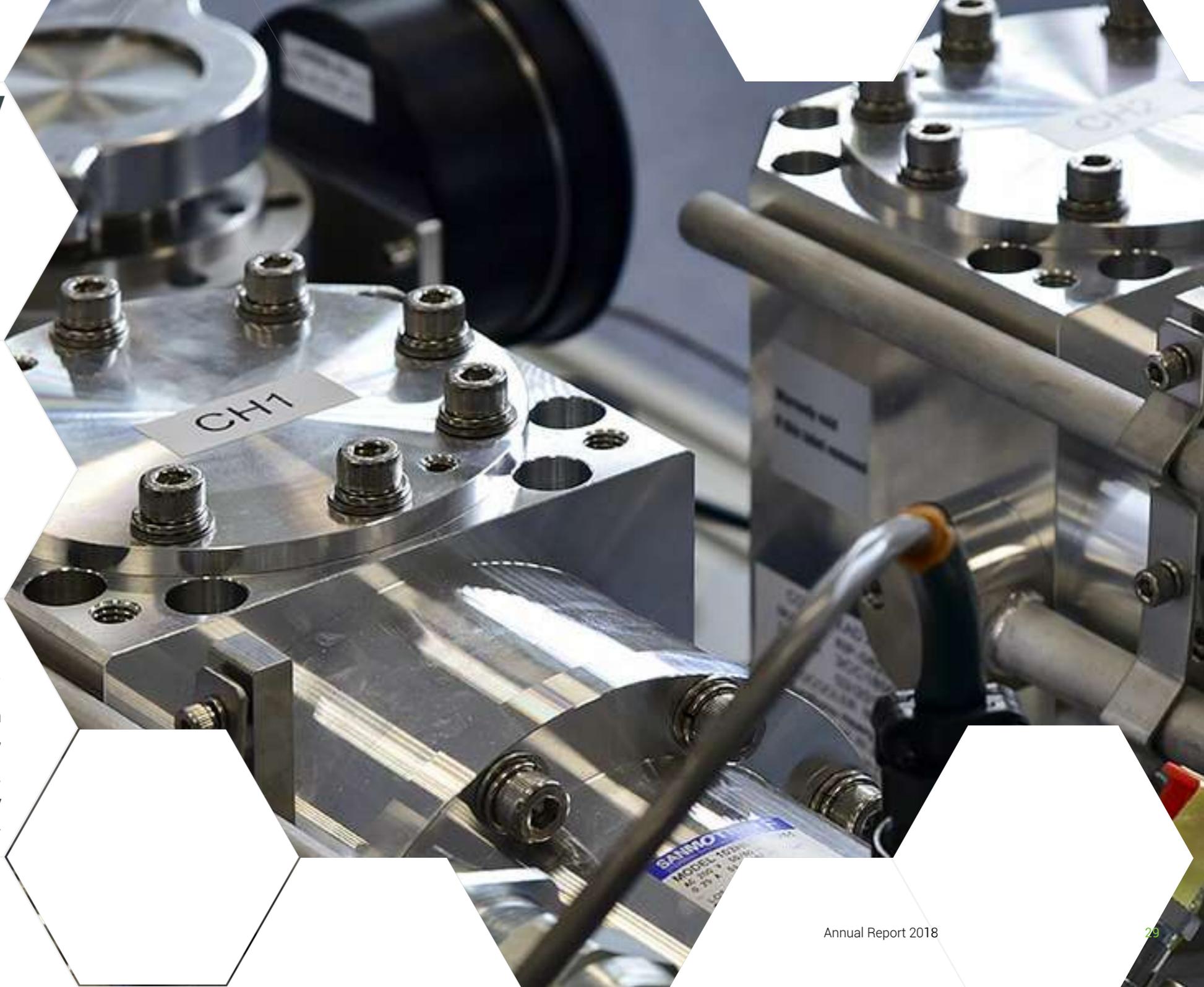
The aim of this research group is to establish the first modern THz magneto-optical spectroscopy group in central Europe, with focus both on method development and on applications in material- and bio-sciences. Possibilities to perform experiments on a variety of samples ranging from biomolecules, over coordinated metal centers to magnetic and solid-state materials, in a very broad spectral range from GHz frequencies to UV-VIS range, at cryogenic temperatures (1.8 K – 320 K) and high magnetic fields (16 T).

Selected Publications

- I. Salitros, L. Pogány, B. Brachňáková, J. Moncol, J. Pavlik, I. Nemeč, Z. Trávníček, M. Mazúr, L. Bučinský and L. Suchánek, *Chem. Eur. J.*, ASAP article (2018).

- I. Nemeč, R. Herchel and Z. Trávníček, Two polymorphic Co(II) field-induced single-ion magnets with enormous angular distortion from the ideal octahedron, *Dalton Trans.*, ASAP article, (2018).

- P. Neugebauer*, D. Bloos, R. Marx, P. Lutz, M. Kern, M. Tuček, D. Aguilà, J. Vaverka, C. Dietrich, O. Ouari, R. Clérac and J. van Slageren: Ultra-broadband EPR in field and frequency domains for applications from dynamic nuclear polarisation to single-molecule magnets. Submitted to: *Phys. Chem. Chem. Phys.*



Molecular Nanostructures at Surfaces



Management

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Team members

6

PhD Students

2

Research Focus

Functional supramolecular nanostructures at surfaces

Graphene for control electronic structure of adsorbates

Multimethod surface analysis: LEEM, STM, XPS and ARPES

Core scientific activities in our group joins two attractive fields: field of molecular self-assembly and field of graphene. In particular, we prepare supramolecular nanostructures on metal and graphene substrates and study both self-assembly process itself and functional properties of supramolecular layers in connection with molecular spintronic and catalysis.

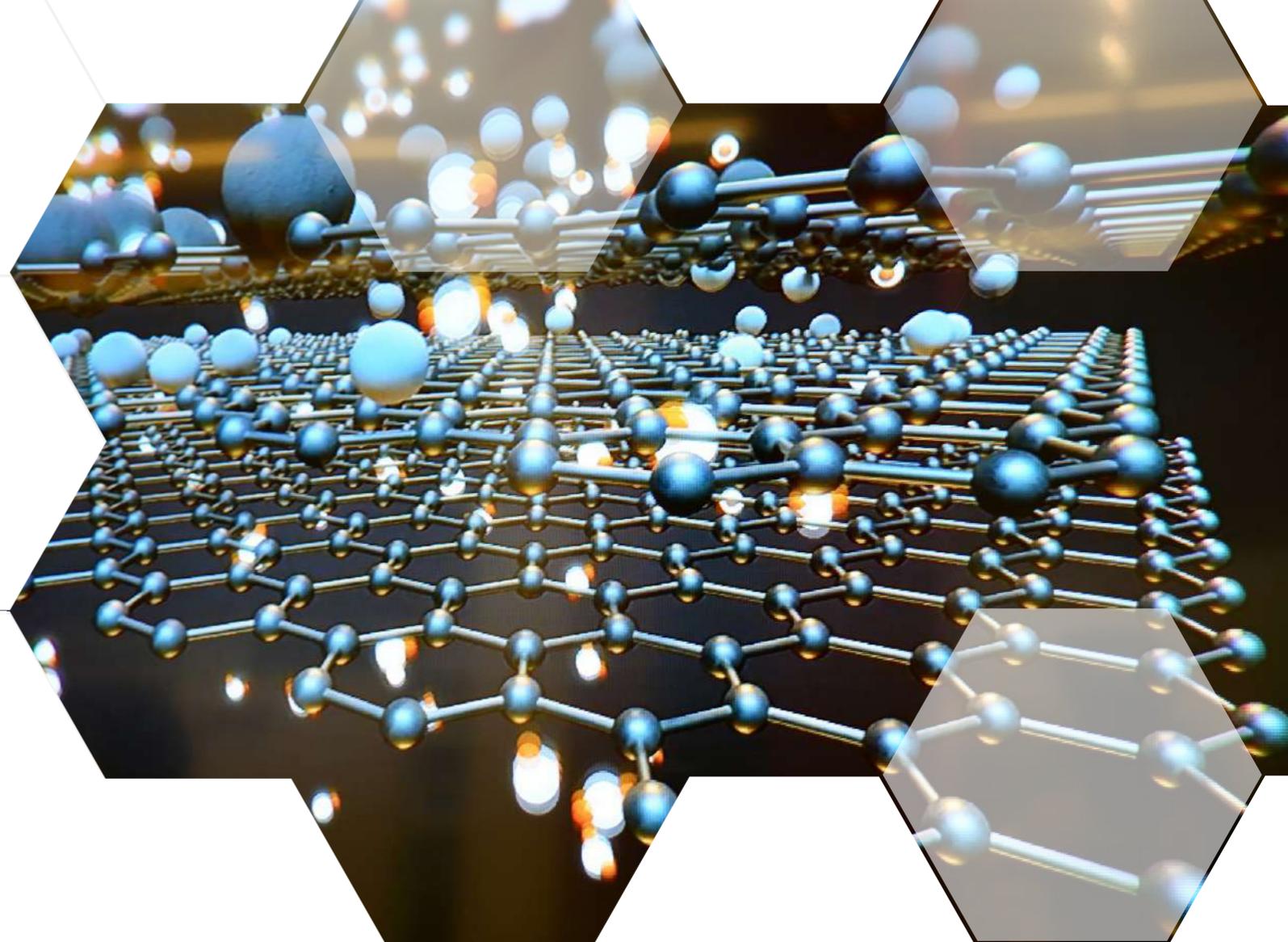
Further, we offer our expertise on surface analysis, in particular, analysis of chemical composition by X-ray photoelectron spectroscopy to collaborating partners.

Selected Publications

- Kormoš, L.; Procházka, P.; Šíkola, T.; Čechal, J., 2018: Molecular Passivation of Substrate Step Edges as Origin of Unusual Growth Behavior of 4,4'-Biphenyl Dicarboxylic Acid on Cu(001). THE JOURNAL OF PHYSICAL CHEMISTRY C 122(5), p. 2815 - 2820.

- Redondo, J.; Telychko, M.; Procházka, P.; Konečný, M.; Berger, J.; Vondráček, M.; Čechal, J.; Jelínek, P.; Švec, M., 2018: Simple device for the growth of micrometer-sized monocrystalline single-layer graphene on SiC(0001). JOURNAL OF VACUUM SCIENCE & TECHNOLOGY A: VACUUM, SURFACES, AND FILMS 36(3), p. 031401-1 - 031401-6.

- Stará, V.; Procházka, P.; Mareček, D.; Šíkola, T.; Čechal, J., 2018: Ambipolar remote graphene doping by low-energy electron beam irradiation. NANOSCALE 10(37), p. 17520 - 17524



Nanomagnetism and Spintronics



Management

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Team members

4

PhD Students

0

Research Focus

Research is focused on how the spatial confinement affects magnetic and electronic phase transitions in nanomagnets and heterostructures of functional materials, Studying the dynamic behavior of magnetic nanostructures driven by magnetic field, electric field, electric current, strain, temperature gradients and ultrafast laser pulses, formation of new functional systems by assembling individual structures with well controlled properties into 2D and 3D arrays to design magnetic materials with tuneable properties.

Selected Publications

- Arregi, J. A.; Horký, M.; Fabianová, K.; Tolley, R.; Fullerton, E. E.; Uhlíř, V., 2018: Magnetization reversal and confinement effects across the metamagnetic phase transition in mesoscale FeRh structures. JOURNAL OF PHYSICS D: APPLIED PHYSICS 51(10), p. 105001-1 - 105001-11.

- Pressacco, F.; Uhlíř, V.; Gatti, M.; Nicolaou, A.; Bendounan, A.; Arregi, J. A.; Patel, S. K. K.; Fullerton, E. E.; Krizmancic, D.; Sirotti, F., 2018: Laser induced phase transition in epitaxial FeRh layers studied by pump-probe valence band photoemission. STRUCTURAL DYNAMICS 5(3), p. 034501-1 - 034501-11.



Epitaxial Materials and Nanostructures



Management

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Team members

2

PhD Students

0

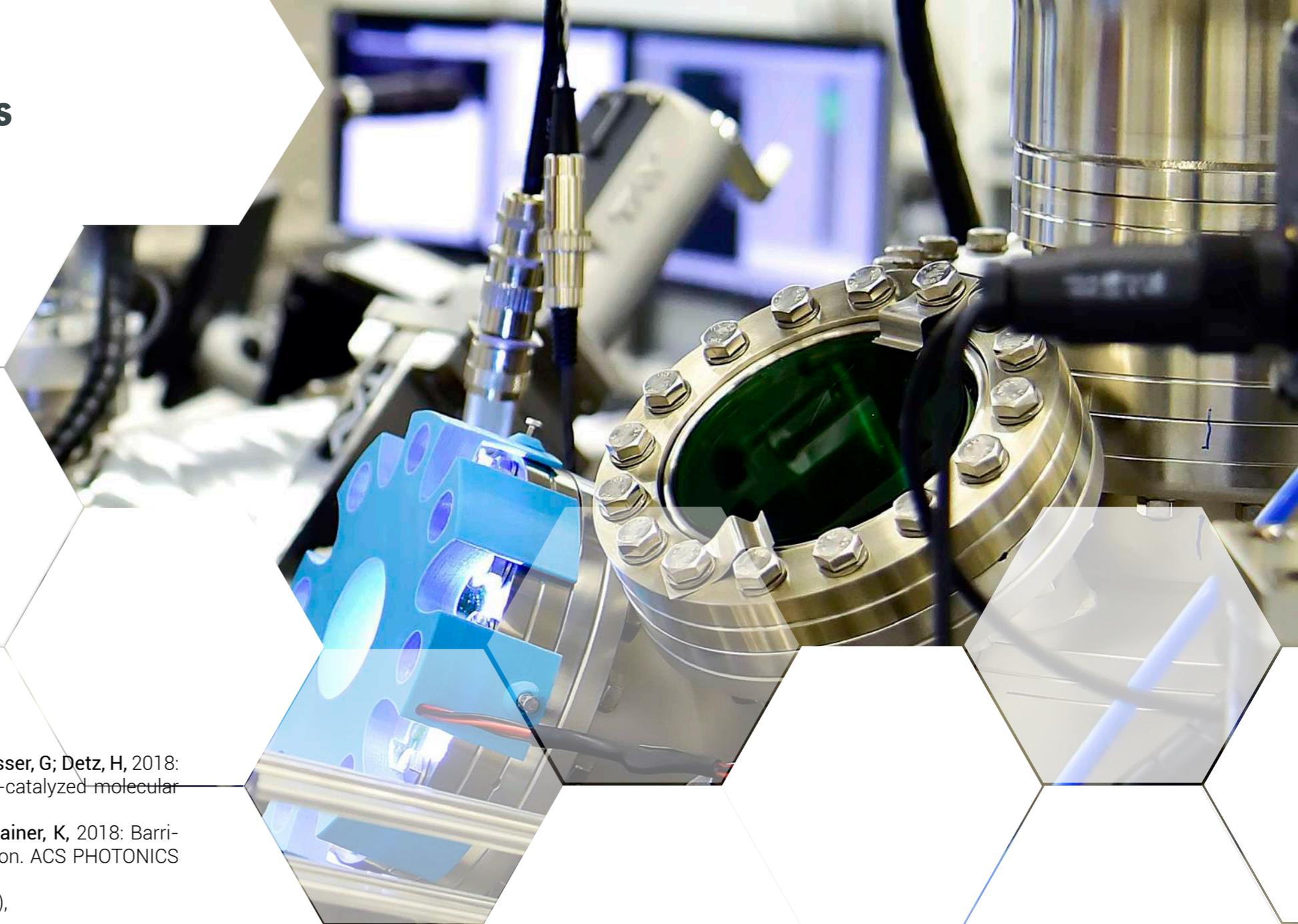
*Research group established in 2018

Research Focus

Fabrication of Epitaxial Materials and Nanostructures
Integration of Functional Materials with Semiconductor Heterostructures
Multi-Scale Material Modeling

Selected Publications

- Lancaster, S; Groiss, H; Zederbauer, T; Andrews, AM; MacFarland, D; Schrenk, W; Strasser, G; Detz, H, 2018: Suppression of axial growth by boron incorporation in GaAs nanowires grown by self-catalyzed molecular beam epitaxy. NANOTECHNOLOGY.
- Kainz, MA; Schonhuber, S; Andrews, AM; Detz, H; Limbacher, B; Strasser, G; Unterrainer, K, 2018: Barrier Height Tuning of Terahertz Quantum Cascade Lasers for High-Temperature Operation. ACS PHOTONICS 5(11), p. 4687 - 4693.
- xtalsim – atomistic simulation package for III-V semiconductor materials (MIT license), github.com/hermanndetz/xtalsim.git



Quantum Optical Technology



Management

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Team members

2

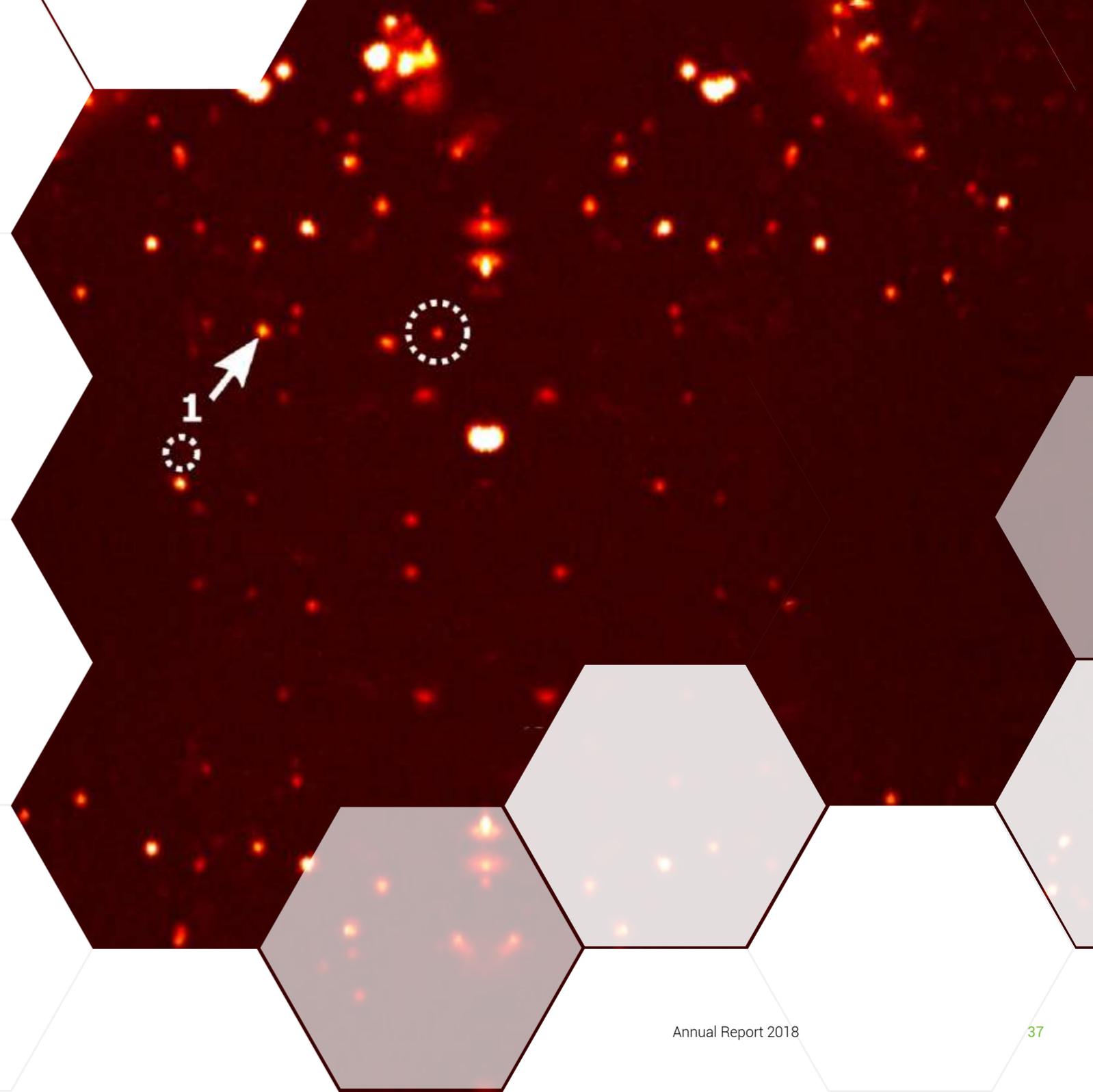
PhD Students

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*Research Group established in 2018

Research Focus

In order to make use of the advantages the laws of quantum mechanics offer it is mandatory to achieve precise control over quantum states. Photons can be easily controlled, but their production (emission) in a defined state is more difficult. A variety of systems which are capable of controlled emission of photons exist, with single atoms being the most obvious one. For a future quantum optical network and other quantum optical applications solid-state emitters are an alternative, as they can be more easily integrated into photonic circuitry.



Advanced Ceramic Materials



Management

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Veselý Michal

Team members

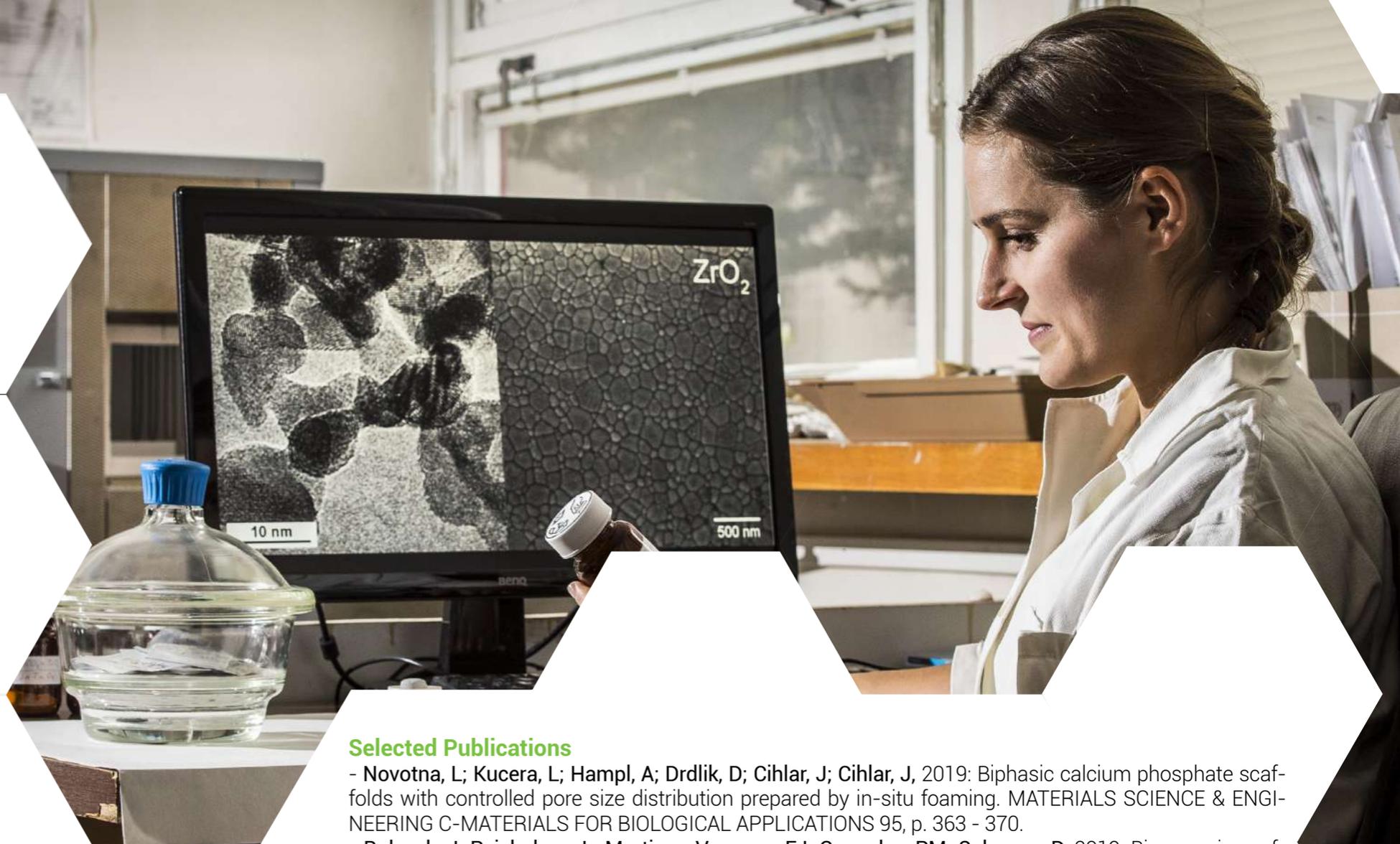
28

PhD Students

9

Research Focus

The research of our group is focused on the development of new processing routes for ceramic materials and development of novel ceramic materials with enhanced properties, particularly biomaterials, structural ceramic materials and materials for energetics and ecology.



Selected Publications

- Novotna, L; Kucera, L; Hampl, A; Drdlik, D; Cihlar, J; Cihlar, J, 2019: Biphasic calcium phosphate scaffolds with controlled pore size distribution prepared by in-situ foaming. MATERIALS SCIENCE & ENGINEERING C-MATERIALS FOR BIOLOGICAL APPLICATIONS 95, p. 363 - 370.
- Rolecek, J; Pejchalova, L; Martinez-Vazquez, FJ; Gonzalez, PM; Salamon, D, 2019: Bioceramic scaffolds fabrication: Indirect 3D printing combined with ice-templating vs. robocasting. JOURNAL OF THE EUROPEAN CERAMIC SOCIETY 39(4), p. 1595 - 1602.
- Bijalwan, V; Tofel, P; Erhart, J; Maca, K, 2019: The complex evaluation of functional properties of nearly dense BCZT ceramics and their dependence on the grain size. CERAMICS INTERNATIONAL 45(1), p. 317 - 326

Cybernetics in Material Science



Management

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Blaha Petr, Ph.D.

Bradáč Zdeněk, Ph.D.

Dokoupil Jakub, Ph.D.

Havránek Zdeněk, Ph.D.

Kadlec Jaroslav, Ph.D.

Klíma Bohumil, Ph.D.

Kuchta Radek, Ph.D.

Soběslav Valach

Šmarda Zdeněk

Team members

76

PhD Students

1

Research Focus

Smart sensors and signal processing, sensors design using new materials

Advanced control technologies, electrical actuators control

Mobile robotic systems, reconnaissance robotics, telepresence

Embedded systems and communication technologies

Selected Publications

- Dokoupil, J; Vaclavek, P, 2018: Data-Driven Stabilized Forgetting Design Using the Geometric Mean of Normal Probability Densities. 2018 IEEE CONFERENCE ON DECISION AND CONTROL (CDC) , p. 1403 - 1408

- Kaczmarczyk, V; Kuchta, R; Kuchtova, Z; Kadlec, J; Bastan, O, 2018: Data processing platform for indoor localization framework. IFAC PAPERSONLINE 51(6), p. 508 - 513

- Buchta, L; Otava, L, 2018: Compensation of Dead-Time Effects Based on Kalman Filter for PMSM Drives. IFAC PAPERSONLINE 51(6), p. 18 - 23



Advanced Polymers and Composites



Management

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Principal investigators

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Vojtová Lucy, Ph.D.

Team members

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PhD Students

15

Research Focus

Synthesis of specialty organic and organic-inorganic polymers and copolymers

Multi-scale structure-property relationships in polymers and polymer composites

Development of advanced functional materials based on nanostructured hierarchical polymers

Syntheses of controlled life-span polymers, resorption of biomedical polymers, service life-time period predictions for commodity plastics

Physics of heterogeneous polymer systems, deformation and fracture phenomena in polymers reptation dynamics, nanocomposite viscoelasticity, self-assembly

Synthesis of biopolymeric materials for tissue engineering and drug delivery



Selected Publications

- Kupka, V; Benesova, P; Obruca, S; Brtnikova, J; Marova, I; Jancar, J; Vojtova, L, 2019: Biodegradation of polyurethane-polyhydroxybutyrate elastomeric composite investigated from morphological and structural viewpoint. JOURNAL OF APPLIED POLYMER SCIENCE 136(1).

- Pavlinak, D; Galmiz, O; Pavlinakova, V; Polacek, P; Kelar, J; Stupavska, M; Cernak, M, 2018: Application of dielectric barrier plasma treatment in the nanofiber processing. MATERIALS TODAY COMMUNICATIONS 16, p. 330 - 338.

- Levchuk, I; Kralova, M; Rueda-Marquez, JJ; Moreno-Andres, J; Gutierrez-Alfaro, S; Dzik, P; Parola, S; Sillanpaa, M; Vahala, R; Manzano, MA, 2018: Antimicrobial activity of printed composite TiO₂/SiO₂ and TiO₂/SiO₂/Au thin films under UVA-LED and natural solar radiation. APPLIED CATALYSIS B-ENVIRONMENTAL 239, p. 609 - 618.

Advanced Metallic Materials and Metal-based Composites



Research Group Leader at IPM
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Team members

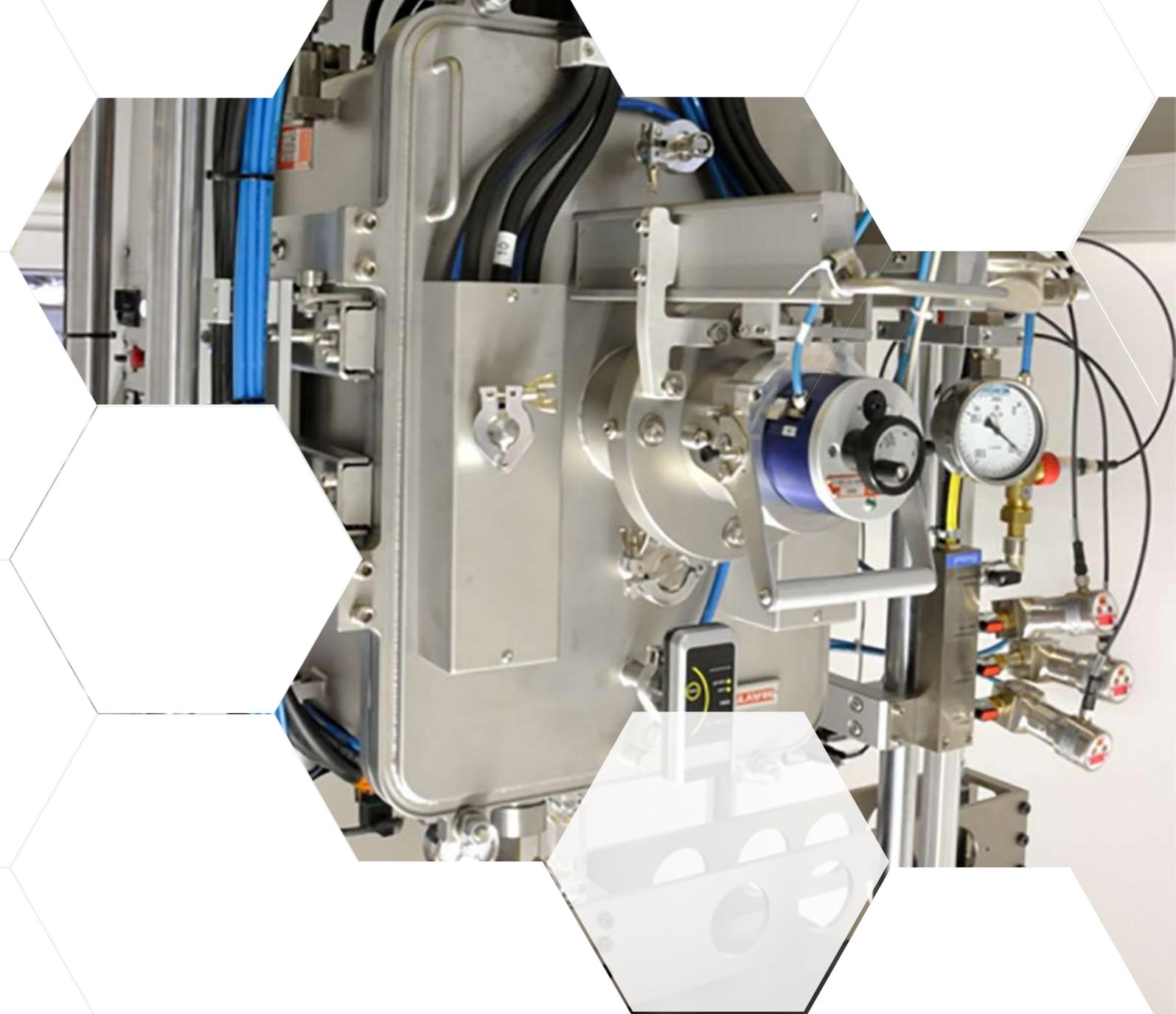
11

PhD Students

1

Selected Publications

- Cerny, M; Sestak, P; Rehak, P; Vsianska, M; Sob, M, 2019: Atomistic approaches to cleavage of interfaces. MODELLING AND SIMULATION IN MATERIALS SCIENCE AND ENGINEERING 27(3)
- Tinoco, HA; Holzer, J; Pikalek, T; Buchta, Z; Lazar, J; Chlupova, A; Kruml, T; Hutar, P, 2019: Determination of elastic parameters of Si₃N₄ thin films by means of a numerical approach and bulge tests. THIN SOLID FILMS 672, p. 66 - 74
- Skalka, P; Slamecka, K; Montufar, EB; Celko, L, 2019: Estimation of the effective elastic constants of bone scaffolds fabricated by direct ink writing. JOURNAL OF THE EUROPEAN CERAMIC SOCIETY 39(4), p. 1586 - 1594



Advanced Low-dimensional Nanomaterials



Management

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Team members

8

PhD Students

2

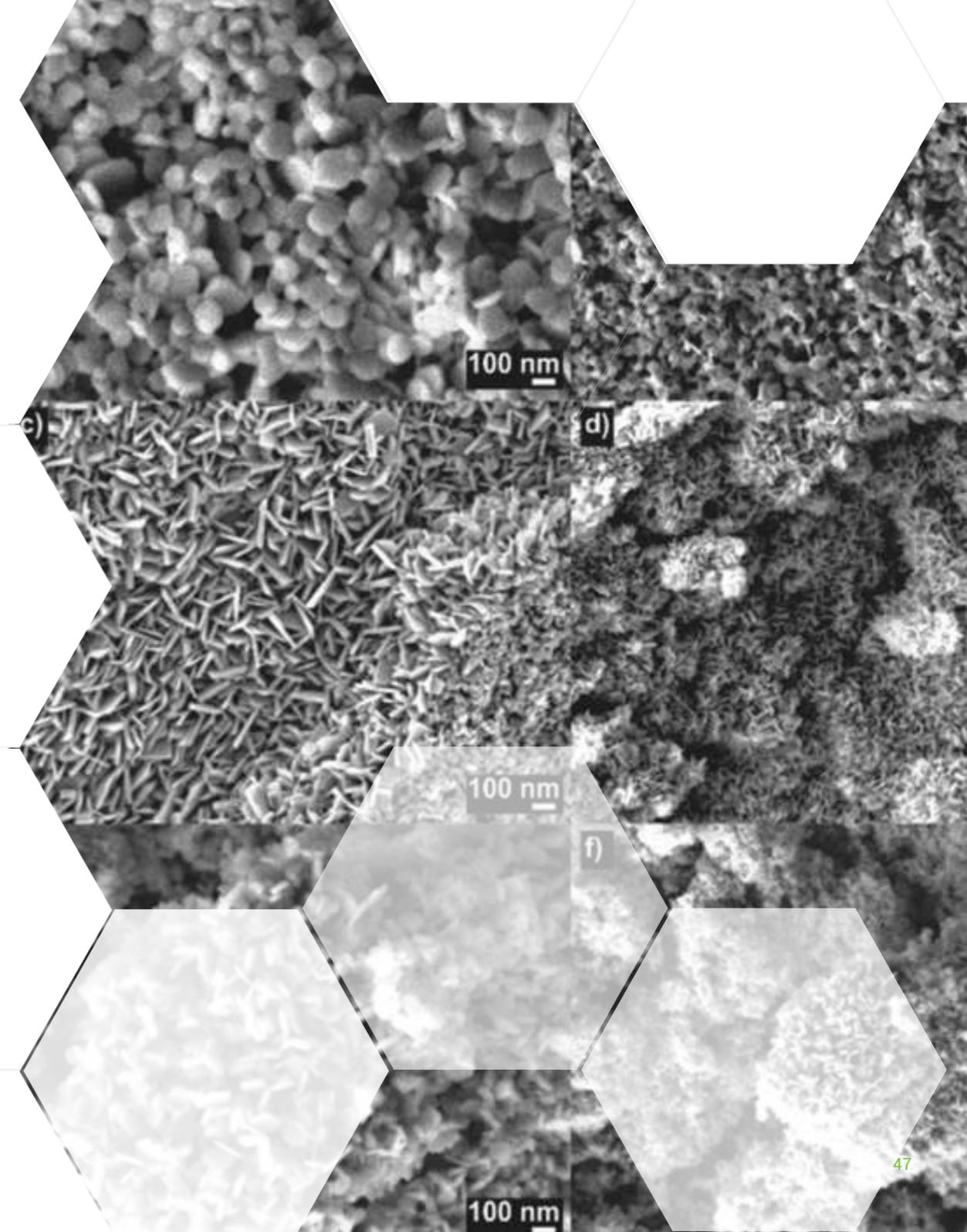
Research Focus

Nanomaterials with low dimensions (100 nm and below) for applications in power engineering, biology and catalysis.

The main objective of the research is a synthesis of new low dimensional structures, such as nanotubes, nanolayers, nanofibers, by various means. It includes also the necessary investigation of the structure-property relationship of these materials. The most promising materials are explored in various fields, such as photovoltaics, catalysis, batteries, etc. together with cooperating partners.

Selected Publications

- **Sopha, Z; Spatz, Z; Michalicka, J; Hromadko, L; Bulanek, R; Wagner, T; Macak, J. M**, 2019: Bismuth Oxychloride Nanoplatelets by Breakdown Anodization. CHEMELECTROCHEM 6(2), p. 336 - 341.
- **Krumpolec, R; Homola, T; Cameron, DC; Humlicek, J; Caha, O; Kuldova, K; Zazpe, R; Prikryl, J; Macak, JM**, 2018: Structural and Optical Properties of Luminescent Copper(I) Chloride Thin Films Deposited by Sequentially Pulsed Chemical Vapour Deposition. COATINGS 8(10).
- **Dvorak, Zazpe, R; Krbal, M; Sopha, H; Prikryl, J; Ng, Siowwoon; Hromadko, L; Bures, F; Macak, J. M**, 2018: One-dimensional anodic TiO₂ nanotubes coated by atomic layer deposition: Towards advanced applications. APPLIED MATERIALS TODAY 2019(14), p. 1 - 20.





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