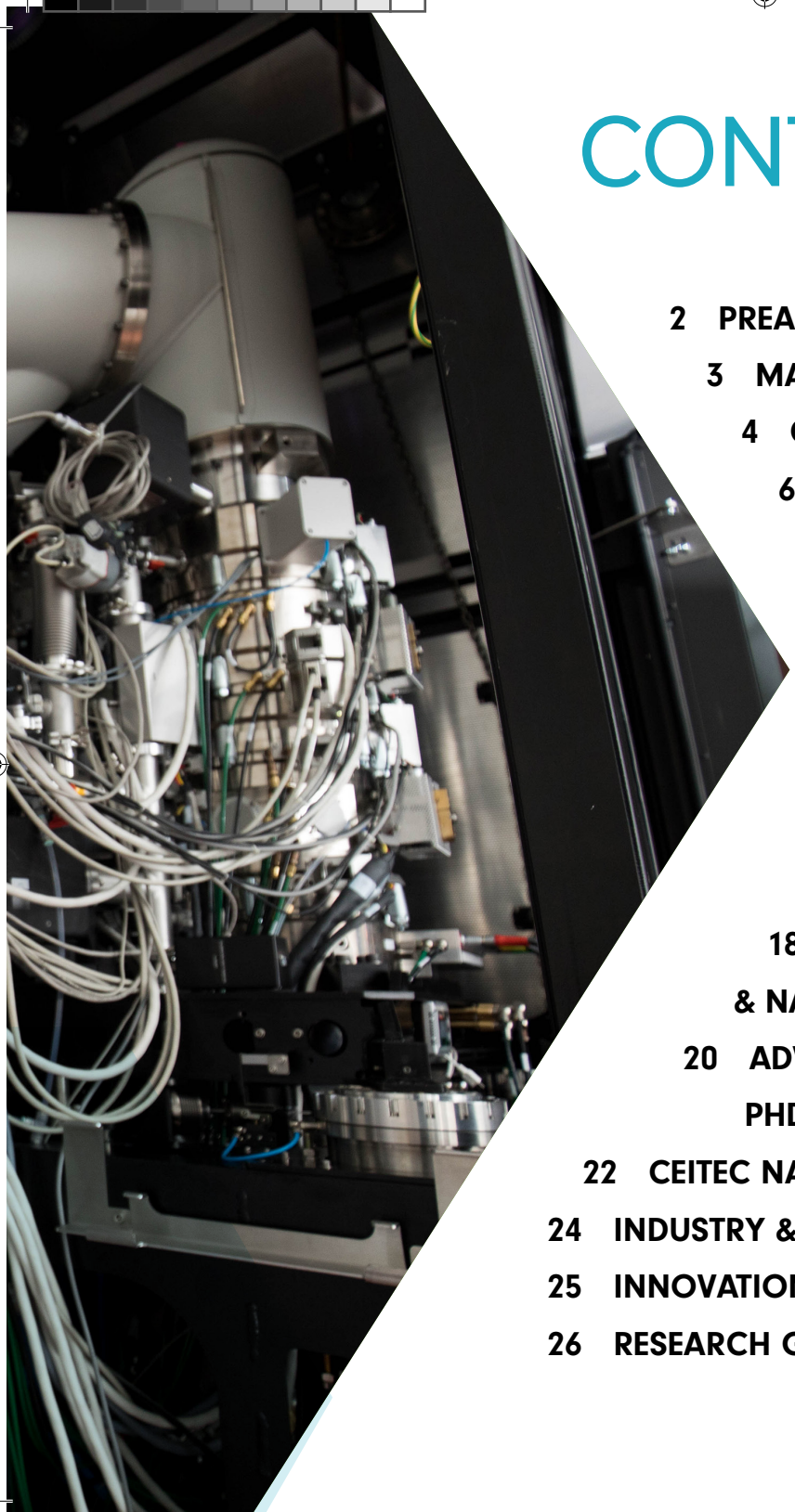
ANNUAL REPORT 2019

CEITEC

BRNO UNIVERSITY OF TECHNOLOGY



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PREAMBLE

Dear Reader,

Firstly, I would like to take this opportunity to thank everyone at CEITEC for a very successful 2019.

In 2019, CEITEC BUT not only achieved success in acquiring several prestigious projects, but also confirmed the ever-increasing level of its researchers and the research they are engaged in. In 2019, we published over 270 papers, with a majority of them in the most prestigious scientific journals, and often in cooperation with top research institutes worldwide. The ever-increasing citation rate of our works also plays a crucial role in the perception of the CEITEC organization as a whole. During the year, we also organized several important international conferences, scientific summer schools and hosted a number of lectures by leading scientists from all over the world.

I would also like to welcome new additions to our RGLs. In June, our organisation expanded with two new groups: Martin Pumera joined us with a group working in Future Energy and Innovation and Lucy Vojtova working on Advanced Biomaterials.

For the first time in CEITEC's nine-year history, the International Scientific Advisory Board (ISAB) has evaluated our impact on the wider society and economy. It was a turning point, shifting us from our traditional approach of focusing mainly on scientific excellence to a much wider understanding of our societal responsibility, in line with new worldwide trends.

Last but not least, we are proud to be hosting part of the 1.3 billion CZK project in industrial technology and Industry 4.0 – RICAIP, which over the next five years, will establish CEITEC as the state-of-the-art infrastructure of national importance in this area of science.

We hope the following pages will offer you a window into the promising developments we have made over the past year and also provide you with a chance to learn more about the excellent research undertaken here, and about our organization as a whole.

Prof. Ing. Radim Vrba, CSc.

MANAGEMENT

/1/ PROF. RADIMÍR VRBA
Director

/2/ PAVEL KREČMER, PHD.
Deputy Director

/3/ PROF. RADIM CHMELÍK, PHD.
Deputy Director for Science and Studies

/4/ PROF. TOMÁŠ ŠIKOLA
Coordinator of Research Programme 1

/5/ PROF. JOSEF JANČÁŘ
Coordinator of Research Programme 2

/6/ MICHAL URBÁNEK, PHD.
Head of CEITEC Nano Core Facility

/7/ JAN NEDVĚD
Financial Manager, Secretary of the Institute

CEITEC BUT IN NUMBERS 2019

16.24 mil. EUR
Overall Budget

325
Core Facility Users From
25 Countries

15
Research Groups

1
Core Facility

115
PhD Students

131
Ongoing Projects

47
New Projects

11
International Projects

International PhD Students
44.5 %


123
Scientific Employees (FTE)
Women (FTE)
28 %
International Researchers (FTE)
18.4 %
Publications With Corresponding Author
174
Q1
61.5 %
T5
6%
342
Publications

CEITEC BUT RESEARCH GROUPS

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
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/ Martin Pumera, PhD.
Future Energy and Innovation (BUT)

ADVANCED MATERIALS

/11/ Prof. Martin Trunec, PhD.
Advanced Ceramic Materials (BUT)

/12/ Prof. Pavel Václavek, PhD.
Cybernetics in Material Science (BUT)

/13/ Prof. Josef Jančář
Advanced Polymers and Composites (BUT)

/14/ Miroslav Černý, PhD. *
Advanced Metallic Materials and Metal-based Composites (BUT)

*Research Group Leader at CEITEC IPM is Jan Klusák, PhD.

/15/ Dr. Ing. Jan Macák
Advanced Low-Dimensional Nanomaterials (BUT)

/16/ Lucy Vojtová, PhD.
Advanced Biomaterials (BUT)

INTERNATIONAL SCIENTIFIC ADVISORY BOARD

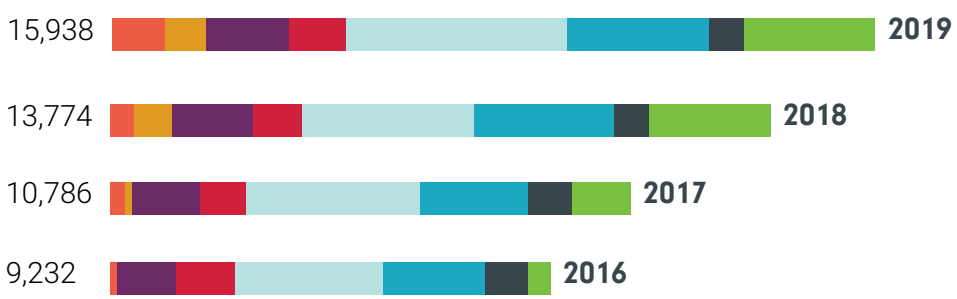
On the 14th and15 th of October 2019, the International Scientific Advisory Board was held for the first time in our history, with a primary focus on the economic and societal impact of CEITEC research. The aim of the meeting was to explore the wider implications of the scientific endeavours of CEITEC researchers, to emphasise the importance of research in solving actual societal challenges and also, in part, to address the implementation of Module 3 of the Methodology 17+.

ISAB members (new members were welcomed in 2019 – for RP1, Prof. Miriam Serena Vitiello from CNR-NANO – The Institute of Nanoscience of National Research Council, Pisa, Italy, and for RP2 Prof. Oliver Diwald, TU Vienna, Austria) and 13 additional experts from industry and public institutions met with research groups in seven round-table discussions. The aim was to identify CEITEC research activities with the potential of solving future societal and economic challenges, discuss the strengths and weaknesses of the current approach to CEITEC's impact and to emphasise the importance of the continuous support for the impact of science in the CEITEC curriculum.

SOURCES OF FINANCING

	2016	2017	2018	2019
EU Grants	457	1 194	2 588	2 685
Cooperation with Industry	886	939	772	853
National Programme of Sustainability	2 199	2 318	2 878	2 962
National Grants	3 092	3 590	3 505	4 643
CF CEITEC Nano	1 240	1 056	1 068	1 074
Institutional Support	1 181	1 278	1 686	1 676
OP Structural Funds	0	176	766	979
Education	176	234	512	1 067
Total in kEUR	9 232	10 786	13 774	15 938

* Main purpose resources



PROFIT AND LOSS ACCOUNT

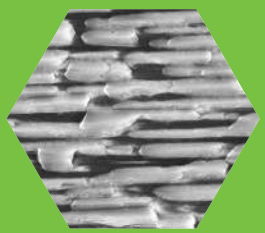
STATUS DECEMBER 31, 2019

Situtation on balance sheet date (in kEUR; 1EUR = 26CZK)

	Principal activity	Economic activity	Total
Expenses		x	
Used purchases of goods, purchased services	4 480	212	4 692
Changing stock level due to own activities, activation	-4	6	2
Personnel expenses	9 083	251	9 333
Taxes and fees	20	0	20
Other expenses	1 037	281	1 318
Depreciation, sold assets, financial eserves, provisioning	4 150	0	4,150
Provided contributions	12	0	12
Income tax	0	46	46
Total expenses	18 779	796	19 574
Profits			
Operating subsidies	14 090	0	14 090
Received contributions	64	0	64
Turnover beyond own activities and goods	112	941	1 053
Other profit	4 515	98	4 613
Turnover beyond sold assets			0
Total revenue	18 780	1 040	19 820
Economic result prior to taxation	1	290	291
Economic result after taxation	1	244	245

RESEARCH HIGHLIGHTS

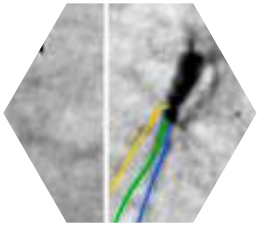
DISCOVERY OF A NEW METASURFACE



Experts from the Fabrication and Characterisation of Nanostructures research group from CEITEC BUT took part in exciting collaborative research. Together with their colleagues from the USA and Hong Kong they studied a special material – vanadium dioxide (VO2) – and possibilities how to use it for fabrication of optical metasurfaces on a large scale.

NEW MICROSCOPIC METHOD FOR IMAGING LIVE TUMOR CELLS BEHAVIOR

The observation and analysis of the invasive behavior of tumor cells may be possible even in the poorly transparent 3D environment of collagen gel that mimics the natural environment of the organism. This could be possible thanks to Experimental Biophotonics research group at CEITEC BUT.

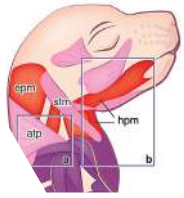


THE EUROPEAN CENTER OF EXCELLENCE FOR INDUSTRIAL ROBOTICS AND ARTIFICIAL INTELLIGENCE – RICAIP IS BEING CREATED

Utilization of artificial intelligence, decentralized laboratory connection, and networking for application development and validation in the modern, highly automated industry in Europe. The RICAIP project, thanks to the support of 1.3 billion crowns, will enable the creation of a research and innovation center at the CIIRC CTU in Prague and CEITEC BUT in Brno.

SCIENTISTS HAVE DISCOVERED HOW VERTEBRAL NECK MUSCLES ARE FORMED

Almost three years of collaboration between scientists from the Institute Pasteur and the CEITEC BUT researchers from the Materials Characterization and Advanced Coating has already produced concrete results and it is a typical example of the connection between the life and material sciences.



BONE ADHESIVE DEVELOPED COULD BE USED FOR COMPLICATED FRACTURES

Lucy Vojtová from Advanced Biomaterials achieved the first excellent results by successfully creating a prototype polymer composite bone adhesive. Its advantage is the ability to bond bone fragments, promote fracture healing and absorb over time.

NEW RESEARCH GROUPS

Two new research groups have started their activities at CEITEC BUT. Future Energy and Innovation, under the leadership of one of the world's most cited chemists, Martin Pumera, will focus primarily on new energy concepts.

Advanced Biomaterials led by Lucy Vojtová is dedicated to tissue engineering and biomaterial design for medicine.

POLYMERS IN ANTARCTICA AGE SLOWER THAN IN BRNO

The results showed that the Antarctic environment, despite its very low temperatures, is not nearly as friendly to the polymers as initially expected. The effect of the ozone hole transmitting a higher proportion of the UV component of global solar radiation has proved to be very significant.

NENOVISION WILL RECEIVE 20 MILLION CZK FROM Y SOFT

Representatives of the Brno company Y Soft have announced the intention to invest 20 million CZK in NenoVision, thanks to their new investment platform. NenoVision is the first ever CEITEC BUT spin-off

CEITEC SCIENTISTS HAVE CONSTRUCTED A UNIQUE MAGNETIC RESONANCE DEVICE

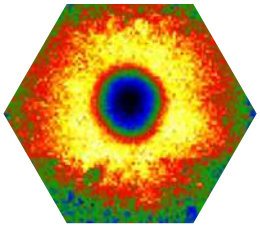
Significant progress in physics, chemistry and medicine. Petr Neugebauer and his team presented a unique device at CEITEC BUT that changes the principle of electron paramagnetic resonance measurement. They built the device themselves.

CONNECTING AI WITH INDUSTRIAL ROBOTICS – LAUNCH OF RICAIP PROJECT

In the presence of more than a hundred distinguished guests, the RICAIP Project was launched at CTU CIIRC. RICAIP pushes the boundaries of today's understanding of the automated industrial production towards the multisite flexible production.

LIMITS OF BABINET'S PRINCIPLE IN PLASMONICS EXPLORED BY TEAM FROM CEITEC AS THE FIRST IN THE WORLD

Michal Horák from the research group Fabrication and Characterization of Nanostructures has been involved for the fourth year in electron energy loss spectroscopy and transmission electron microscopy. He and his colleagues completed a project in which they investigated and mapped plasmon resonances in plasmonic nanoanthenes using the Babinet´s principle.



AWARDS & COOPERATION

Werner von Siemens Award for Veronika Grézlová

With her diploma thesis on optimization of antibacterial properties of polymer-phosphate bone fillings, Veronika Grézlová from the Advanced Biomaterials Research Group ranked 3rd in the category of Best Diploma Thesis.

Four of our Students Awarded Brno PhD Talent Award

The students received a scholarship of CZK 300,000 for their future research. From CEITEC BUT: Miroslav Ďuriš (Experimental Biophotonics), Jakub Holzer (Multiscale Modelling and Measurements of Physical Properties), Jana Midlíková (Magneto-Optical and THz Spectroscopy), Markéta Tesařová (Materials Characterization and Advanced Coatings).

Visit of Uteerat Chareontoh, Ambassador of the Kingdom of Thailand

Her Excellency Uteerat Chareontoh discussed with our institute the possibility of working with Thai scientists, developing student exchanges, and exchanging knowledge to build science and research centers.

Sebastian Díaz de La Torre Was Awarded the Honorary Doctorate

Since 2017, he has been the Director of the Research Center of the Institute of Innovation and Technology, Instituto Politécnico Nacional in Mexico. He has been intensively cooperating with CEITEC BUT.

Ulrike Diebold Was Awarded an Honorary Doctorate

Professor Ulrike Diebold works at the Institute of Applied Physics at the Technical University of Vienna. It was proposed by the CEITEC BUT for an honorary doctorate with whose experts it has been working for a long time.

CEITEC Student Talent Jakub Dokulil Was Awarded "Česká hlavička Award"

Jakub Dokulil led by Zbyněk Dostál (Experimental Biophotonics Research Group) succeeded with his work focused on the design and construction of an autofocus module for microscope, which he worked on within the CEITEC Student Talent program at CEITEC BUT.

Dominika Kalasová Received the Josef Hlávka Award for Best Students

The award is given for the most talented students who have demonstrated exceptional skills and thinking in their field Dominika Kalasová works in the research group Materials Characterization and Advanced Coatings.

Director's Award for Outstanding Scientific Contribution 2019

On the occasion of Traditional Christmas Punch our director Radimír Vrba presented awards for three CEITEC BUT scientists. The awards were received by PhD Student Dominika Kalasová for her research and achievements during her studies, Martin Pumera because of his TOP publication in 2019 and Pavel Václavek for acquisition of H2020 project RICAIP.

CEITEC Has Signed an Extension of the Cooperation Agreement with the Japanese Company Rigaku

Brno – Tokyo. The international cooperation of the research group on Materials Characterization and Advanced Coatings from CEITEC BUT with Rigaku has resulted in the signing of an agreement to extend cooperation. Rigaku is a global manufacturer and distributor of scientific, analytical and industrial X-ray equipment.

SELECTED EVENTS

MARCH 6-10

Days of Electron Microscopy

These days were dedicated to Electron Microscopy in Brno. CEITEC opened laboratories to the public.

MAY 6

CEITEC Hosted a Lecture by the Pioneer of Fracture Nanomechanics

Professor Kitamura introduced the current key challenges in the field of Fracture Nanomechanics.

MAY 28-29

GE Workshop For Non-destructive Testing Primarily For Automotive

The workshop set itself the task of bringing together industry, academic and manufacturing professionals to share knowledge within this field, explore developing requirements of industry and gain insight from experts.

MAY 25

CEITEC BUT Open Day

We celebrated the 120th Anniversary of the Brno University of Technology and opened our laboratories to all.

MAY 16-17

Czech-German Nano-technology Conference

About 150 participants, 4 scientific panels and 2 days of lectures and discussions. Guests from the Czech Republic and Germany started their program by visiting laboratories, followed by lectures and discussions on scientific topic.

JUNE 26

ERTRAC – European Road Transport Research Advisory Council

CEITEC BUT hosted a meeting of the ERTRAC - European Road Transport Research Advisory Council, on which occasion representatives of member countries were acquainted with CEITEC activities in the field of research of technologies for transport systems.

JUNE 26-28

9th International Conference on Materials Structure & Micromechanics of Fracture

Experts from 23 countries of the world came to Brno to share their ideas and discuss future progress in materials research.

SEP 8-13

Euro-Mediterranean Symposium on Laser-Induced Breakdown

Experts from around the world not only had the opportunity to share ideas and knowledge in the fi ld of laser spectroscopy, but also to discuss their interdisciplinary applications.

SEP 9

Researcher's Night

Public event dedicated to bringing researchers closer to the public. They showcase the diversity of research and highlight the impact of research on our daily lives. CEITEC BUT visited about 350 persons.

SEP 2-13

The European School on Magnetism

We prepared for a hundred students and experts from around the world a twelve-day program, which included lectures by renowned experts, workshops, practicals in labs, as well as exploring Brno and its surroundings.

OCTO 7-11

Robot Rescuer or Non-Destructive Testing on International Engineering Fair 2019

The International Engineering Fair is one of the most important industrial fairs in Central Europe. This year's theme was Industry 4.0 and the digital factory, i.e., the digitization of production, one of the main directions of the innovation process.

NOV 11

Opening of the Magneto-Optical Spectroscopy Laboratory

During the official opening of the laboratory, Petr Neugebauer and his team presented a unique device at CEITEC BUT that changes the principle of electron paramagnetic resonance measurement.

NOV 18-25

The EFEPR International School

The advanced EPR school is an initiative of the European Federation of EPR groups (EFEPR) to ensure the continuation of the successful development of EPR techniques and their applications.

DEC 4

CEITEC Nano User Meeting

A meeting of all users of CEITEC Nano Research Infrastructure. At CEITEC BUT we register more than 230 active self-service users and we implement more than 150 full-service projects per year.

ADVANCED MATERIALS & NANOTECHNOLOGY SEMINAR SERIES

October 15
Prof. Samuel SANCHEZ
Nanorobots as Novel Theranostic Tools: Smart Drug Delivery and Imaging
Barcelona Institute for Science and Technology and Catalan Institute for Research and Advanced Studies, Spain
Invited by: Martin PUMERA, PhD.

October 29
Dr. Shahragim TAJBAKHSH
Stem and Niche Cell Interactions During Development and Regeneration
Institut Pasteur, France
Invited by: Tomáš ZIKMUND, PhD.

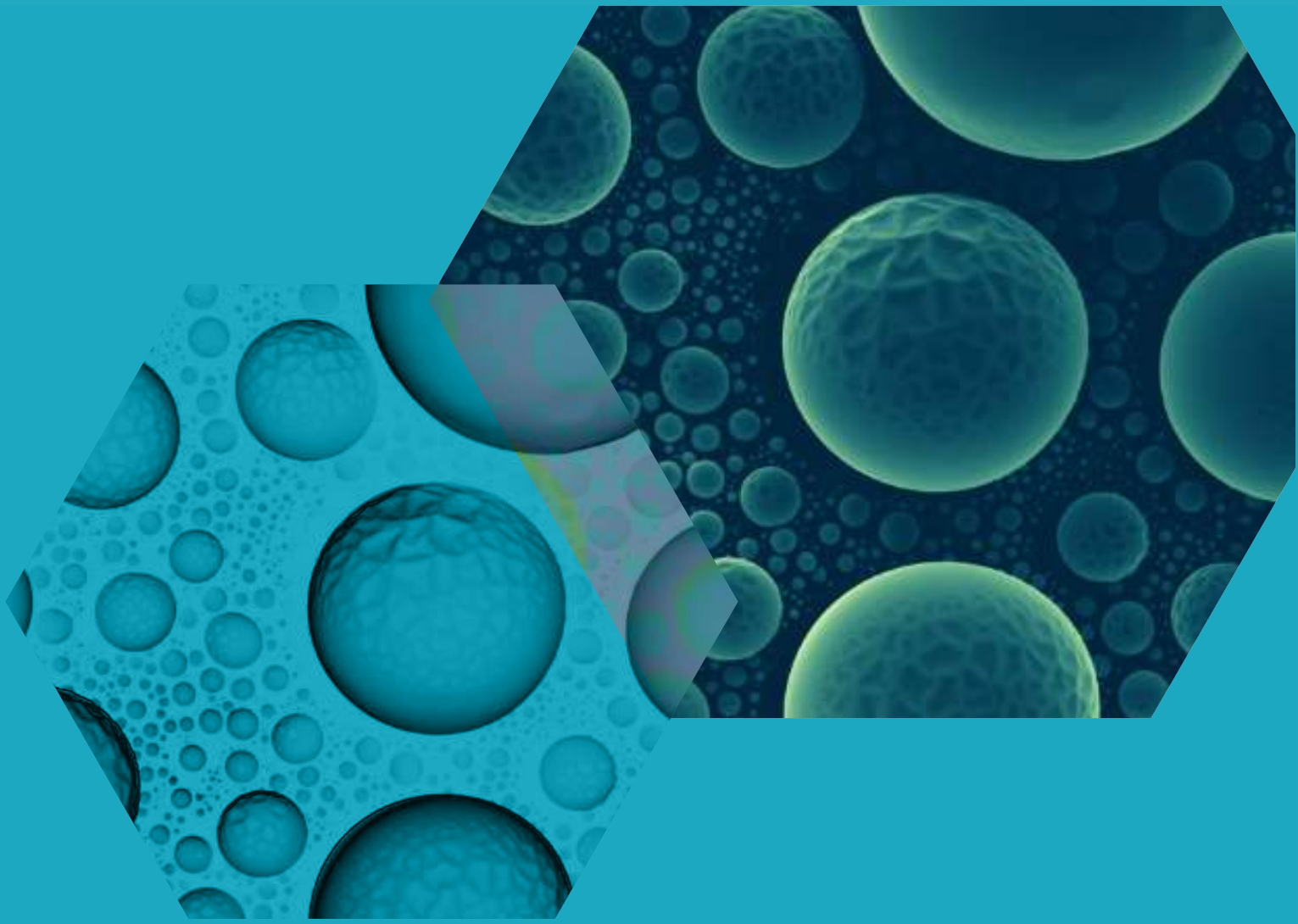
November 12
Prof. Dr. Mato KNEZ
Atomic Layer Processing: A Toolbox for Fabricating Novel Functional Hybrid Materials
NanoGune, Spain
Invited by: Dr. Ing. Jan MACÁK

December 3
Dr. Deborah CRAWFORD
Extrusion: An Efficient Technique for the Manufacture of Organic Compounds and Materials
Queen's University (Canada) – University of Leicester (UK) – University of Limerick (Ireland)
Invited by: David JECH, PhD.

December 10
Assoc. Prof. Dr. Bernhard GOLLAS
From the Lab to Technical Scale - Aluminum Electroplating from Ionic Liquids
Graz University of Technology, Austria
Invited by: Michaela REMEŠOVÁ

April 2
Assoc. Prof. Igor ADAMEYKO
How the Muscles in the Body Develop Their Orientation
Karolinska Institutet, Sweden
Invited by: Prof. Jozef KAISER

April 16
Prof. Takayuki KITAMURA
Challenge for Fracture Nanomechanics
Kyoto University, JAPAN
Invited by: Miroslav ČERNÝ, PhD.



May 7

Prof. Thierry DJENZIAN

Self-organized Titania Nanotubes for Advanced Li-ion Microbatteries

Ecole Nationale Supérieure des Mines de Saint-Etienne, France

Invited by: Dr. Ing. Jan Macák

May 21

Prof. Paolo VAVASSORI

Perspectives of Magneto-plasmonic Nanostructures and Crystals

NanoGune, Spain

Invited by: Vojtěch UHLÍŘ, PhD.

ADVANCED MATERIALS & NANOSCIENCES PHD SCHOOL

SELECTED PHD EVENTS

CEITEC, IMG and IST Joint Retreat 2019

25th to 26th June 2019, Hotel Luna, Kouty, Czech Republic

The Joint Retreat 2019 was a two-day conference that brought together PhD students and postdocs from all over CEITEC and partner institutions (IMG CAS, IST Austria) working in life sciences, materials sciences, chemistry and physics. 30 student talks and 6 invited talks were given in a typically informal environment conducive to friendly discussions.

CEITEC Science Mixer

14th March 2019, Absinth Bar Naproti

CEITEC Science Mixers are well known to the student community as great after-work networking events.

CEITEC PHD COMMITTEE

The role of the Student Committee is to give a voice to the students, such that the quality of their experience and training is enhanced. The Committee is to be student run and student led, with an objective of raising concerns related to their training, education, and research activities, and offering solutions as challenges arise. Additionally the Committee organizes events for students (mainly the annual PhD Re-treat and Science Mixers).

CEITEC BUT MEMBERS

Igor Turčan & Erik Képeš

CEITEC PHD YEAR 2019 IN NUMBERS:

115
PhD Students in Total

39 Female Students

51 International Students

13 Graduate Students

35 Annual Assessments

3 Defended Dissertations

CEITEC NANO CORE FACILITY

325 Users
46 Institutions
25 Nationalities

250 Self–service Users
98% Academic
2% Commercial

75 Full–service Users
48% Academic
52% Commercial

80 Instruments

> 15K Reservations
> 86K Booked hours

Most Popular Instruments
LITHOGRAPHY
& DEPOSITIONS
SEM/FIB, TEM, XPS, XRD

TOP PUBLICATIONS

Rienks, EDL.; Wimmer, S.; Sanchez-Barriga, J.; Caha, O.; Mandal, PS.; Ruzicka, J.; Ney, A.; Steiner, H. ; Albu, M.; Kothleitner, G.; Michalicka, J. ; Khan, SA.; Minar, J.; Ebert, H.; Bauer, G. ; Freyse, F.; Varykhalov, A.; Rad-er, O. Springholz, G. Large magnetic gap at the Dirac point in Bi2Te3/MnBi2Te4 heterostructures. NATURE. LONDON: NATURE PUBLISHING GROUP, 2019. p. 423-441. ISSN: 0028-0836.

Garlyyev, B.; Kratzl, K.; Rück, M.; Michalička, J.; Fichtner, J.; Macak, J. M.; Kratky, T.; Günther, S.; Cokoja, M.; Bandarenka, A. S.; Gagliardi, A.; Fischer, R. A., 2019: Optimizing the Size of Platinum Nanoparticles for Enhanced Mass Activity in the Electrochemical Oxygen Reduction Reaction. ANGEWANDTE CHEMIE INTERNATIONAL EDITION 58(28), p. 9596 - 9600, doi: 10.1002/anie.201904492
(TITAN)

INDUSTRY & SOCIETY

At CEITEC BUT, we innovate with the ambition to transform the industries, and to create new possibilities, and to shape our lives and communities.

We believe contract research and collaboration with industry leaders are the key components for innovation. We therefore emphasize the importance of increasing the amount of contract research nationally as well as internationally. CEITEC BUT has there-fore entered into cooperation with the Czech National Business and Investment Development Agency (CzechInvest) to broaden its cooperation with the international industrial leaders as well as Czech corporates.

€ 790.242 Turnover of Contracted Research for 2019

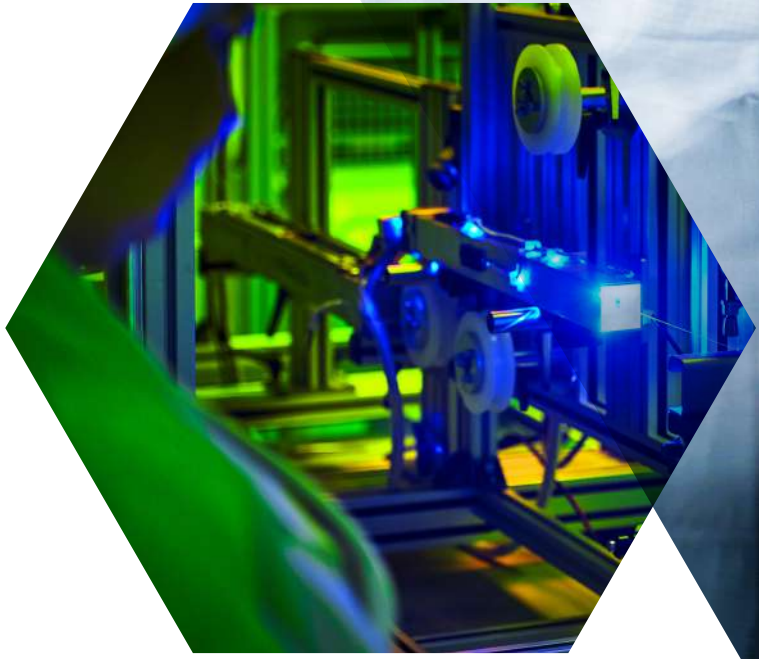
Selected Industrial Partners:

ABB, almé, EDWARDS, Garrett ADVANCING MOTION, GE, Hanon Systems, MANN+HUMMEL, meopta, Rigaku, ŠKODA, TENNECO, TESCAN PERFORMANCE IN NANOSPACE, wellU, ZENTIVA

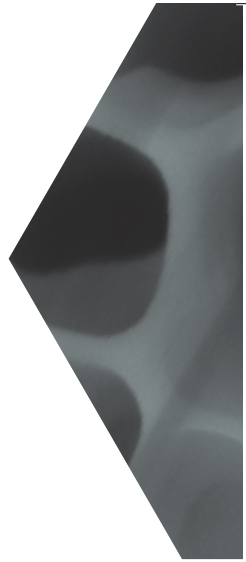
INNOVATION ECOSYSTEM

Creating an innovation ecosystem is necessary for the aspiration of researchers to turn inventions into market-ready technologies. CEITEC BUT encourages its researchers to pursue endeavors to become potential company founders, and successfully commercialize their solutions.

- **35 patents and other IPRs**
- **1 license**
- **1 Spin-off / Start up company**



SMART NANODEVICES



Research Group Leader
Hubálek Jaromír, PhD.
Contact: jaromir.hubalek@ceitec.vutbr.cz

Deputy
Prof. Adam Vojtěch, PhD.

Principal Investigators
Prof. Neužil Pavel
Prof. Adam Vojtěch, PhD.
Dr. Mozalev Alexander
Drbohlavová Jana, PhD.
Heger Zbyněk, PhD.
Richtera Lukáš, PhD.
Vaculovičová Markéta, PhD.
Zítka Ondřej, PhD.

Researchers: 30

Technicians: 27

PhD Students: 45

Administrative Staff: 3

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 nanoelectrodes, MEMS and Lab on a Chip).

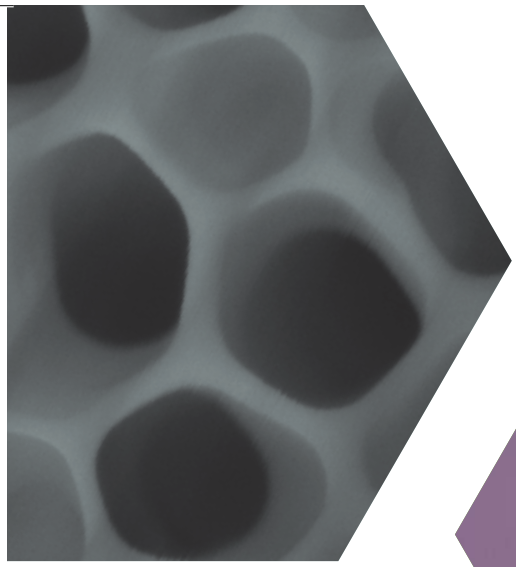
Nanostructures and nanoparticles
For smart nanodevices (synthesis of nanomaterials such as metal-oxide nanofilms, quantum dots, magnetic nanoparticles, carbon nanotubes, graphene, modification of their surfaces for precise and targeted bonding with biomolecules, development of methods, techniques and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

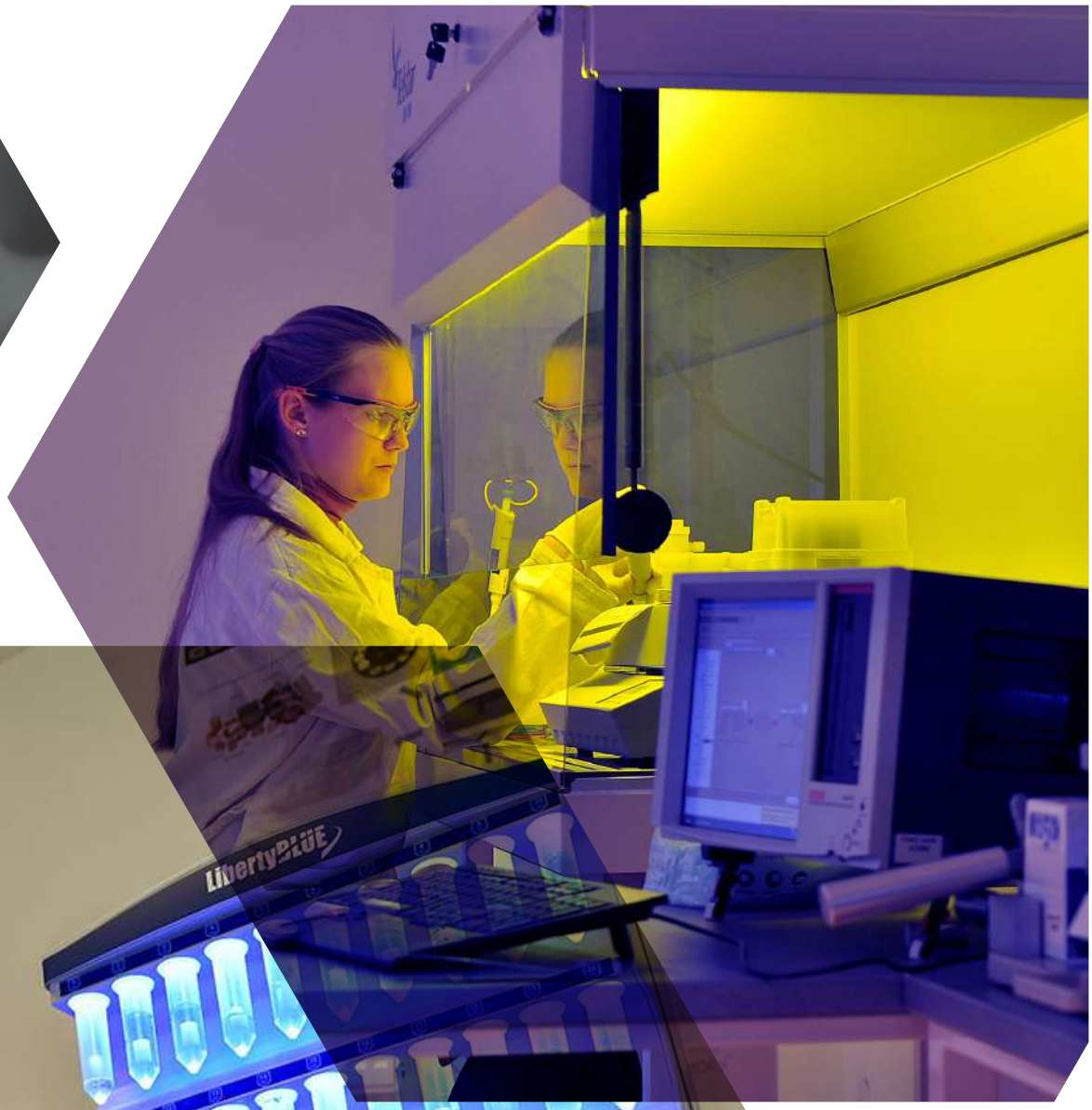
Nanomedicine
Diagnostic methods, in-vitro testing, in-vivo imaging, targeted drug delivery, activatable nano-probes, molecular profile – cancer markers.

Nanotransporters
Drug transporters, synthesis of liposomes, modification of liposomes and apoferritin.

Top Publications

- ALVES, M.; MIRO, M.; BREADMORE, M.; MACKA, M. Trends in analytical separations of magnetic (nano)particles. TRAC-TRENDS IN ANALYTICAL CHEMISTRY, 2019, vol. 114, no. 1, p. 89-97. ISSN: 0165-9936.
- Haoqing Zhang, Ying Xu, Zdenka Fohlerova, Honglong Chang, Ciprian Iliescu, Pavel Neuzil. LAMP-on-a-Chip: Revising Microfluidic. TRAC-TRENDS IN ANALYTICAL CHEMISTRY, 2019, no. 5, p. 44-53. ISSN: 0165-9936.
- KHEZRI, B.; MOHSEN BELADI, M.; KREJČOVÁ, L.; HEGER, Z.; SOFER, Z.; PUMERA, M. Ultrafast Electrochemical Trigger Drug Delivery Mechanism for Nanographene Micromachines. ADVANCED FUNCTIONAL MATERIALS, 2019, vol. 29, no. 4, p. 1-10. ISSN: 1616-301X.





EXPERIMENTAL BIOPHOTONICS

Principal Investigators
Prof. Petráček Jiří
Veselý Pavel, MD, PhD.
Zicha Daniel PhD.

Researchers: 10

Technicians: 1

PhD Students: 5

Administrative Staff: 1

Research Group Leader

Prof. Chmelik Radim, PhD.
Contact: radim.chmelik@ceitec.vutbr.cz
Web: biophotonics.ceitec.cz

Deputy

Veselý Pavel MD, PhD.

Research Focus

Advanced light microscopy R&D: Holographic Incoherent Quantitative Phase Imaging (hiQPI)

- novel optical systems (geometric-phase optics)
- novel imaging approaches (3D hiQPI and imaging through turbid-media)
- novel image processing methods (evaluation of dynamics imaged in time series, artificial intelligence approach)

Vision: to establish hiQPI as a typical technique of advanced light microscopy

Applications of hiQPI in nanotechnology, cell biology and cancer research

- study of phase effects of nanostructured metasurfaces
- study of live cancer cell behavior (biopsy-derived cells, intracellular mass dynamics as a biomarker of the malignant cell phenotype)
- strategy for personalized cancer treatment (DANTE: Dynamic Analysis for Neoplasia Treatment with Explants)

Vision: hiQPI assessment of live cancer biopsy cells reactions to therapeutics under consideration as well as preclinical evaluation of potentially new anticancer drugs particularly of migrastatic type

Highlighted Activities

Radim Chmelík & Daniel Zicha were appointed members of **ELMI 2019 Scientific Committee.**
CEITEC Student Talent Jakub Dokulil led by Zbyněk Dostál (the research group member) was Awarded **Česká hlavička Award**.

Top Publications

- BOUCHAL, P.; KAPITÁN J.; KONEČNÝ M.; ZBONČÁK M.; BOUCHAL Z., 2019, Non-diff acting light in nature: Anomalously reflected self-healing Bessel beams from jewel scarabs. APL Photonics 4, 126102 (2019).
- BOUCHAL, P.; ŠTRBKOVÁ, L.; DOSTÁL, Z.; CHMELÍK, R.; BOUCHAL, Z, 2019: Geometric-phase microscopy for quantitative phase imaging of isotropic, birefringent and space-variant polarization samples. Scientific Reports 9 (1), p. 3608.
- BOUCHAL, P.; DVOŘÁK, P.; BABOCKÝ, J.; BOUCHAL Z.; LIGMAJER, F.; HRTOŇ M.; KŘÁPEK. V.; FAßBENDER, A.; LINDEN, S.; CHMELÍK, R.; ŠIKOLA, T, 2019: High-Resolution Quantitative Phase Imaging of Plasmonic Metasurfaces with Sensitivity down to a Single Nanoantenna. Nano Letters 19 (2),1242-1250. DOI: 10.1021/acs.nanolett.8b04776
- CHMELÍK, R., 2019: Is Holographic Incoherent Quantitative Phase Imaging an Oxymoron? ELMI 2019 conference, 4-7 June 2019, Brno, Czech Republic. Invited lecture.

FABRICATION & CHARACTERISATION OF NANOSTRUCTURES

Research Group Leader

Prof. Šikola Tomáš
Contact: tomas.sikola@ceitec.vutbr.cz

Deputy

Prof. Spousta Jiří, PhD.

Principal Investigators

Bábor Petr, PhD.
Bartošík Miroslav, PhD.
Kalousek Radek , PhD.
Kolíbal Miroslav, PhD.
Křápek Vlastimil, PhD.

Researchers: 14

Technicians: 8

PhD Students: 18

Administrative Staff: 4

Research Focus

Fabrication of nanostructures using bottom-up and top-down methods (nanolithography)

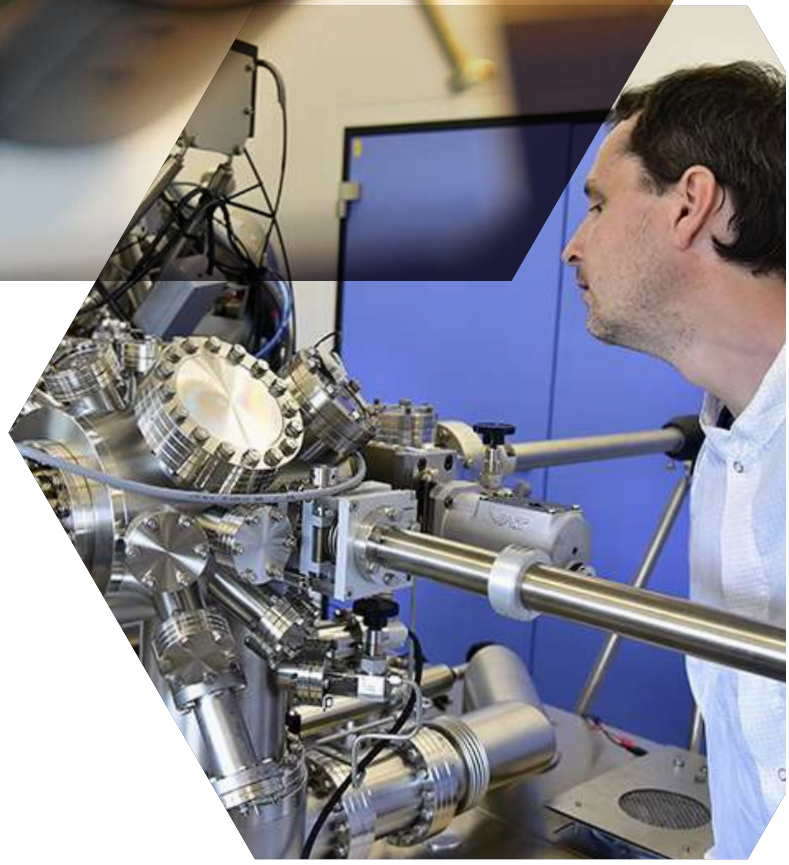
Development of methods for the fabrication of nanostructures: planar physical and plasmochemical methods using EBL, UV lihography, FIB, SPM lithography, and imprint technology. MBE, CVD, ALD, PECVD, hybrid methods for selective growths, etc. All the methods developed are utilized directly for fabrication of nanostructures, advanced planar materials and devices.

Investigation of the functional properties of nanostructures

Specification and optimization of the functional properties of nanostructures for nanoelectronics, nanophotonics and (bio)sensing their correlation with geometrical/structural parameters of nanostructures and operational parameters. Novel and unique properties of nanostructures not observable in conventional materials and microstructures open the ways for qualitatively new applications.

Research and development of analytical and measurement methods

Development of techniques and methodologies for microscopy, analysis and metrology of nanomaterials/nanostructures, and for diagnostics of their properties – new techniques of nanometrology by SPM, optical methods, combination of more techniques (SEM, AFM, etc.). This will be used to meet the other objectives of the Advanced Nanotechnologies and Microtechnologies Research Programme and for the characterization of nano- and microstructures generally.



Top Publications

- BOUCHAL, P.; DVOŘÁK, P.; BABOCKÝ, J.; BOUCHAL, Z.; LIGMAJER, F.; HRTOŇ, M.; KŘÁPEK, V.; FAßBENDER, A.; LINDEN, S.; CHMELÍK, R.; ŠIKOLA, T. High-Resolution Quantitative Phase Imaging of Plasmonic Metasurfaces with Sensitivity down to a Single Nanoantenna. NANO LETTERS, 2019, vol. 19, no. 2, p. 1242-1250. ISSN: 1530-6984.
- MACH, J.; PIASTEK, J.; MANIŠ, J.; ČALKOVSKÝ, V.; ŠAMOŘIL, T.; FLAJŠMANOVÁ, J.; BARTOŠÍK, M.; VOBORNÝ, S.; KONEČNÝ, M.; ŠIKOLA, T. Low temperature selective growth of GaN single crystals on pre-patterned Si substrates. Applied Surface Science. 2019. p. 1-7. ISSN: 0169-4332.
- STÖGER-POLLACH, M.; BUKVIŠOVÁ, K.; SCHWARZ, S.; KVAPIL, M.; ŠAMOŘIL, T.; HORÁK, M. Fundamentals of cathodoluminescence in a STEM: The impact of sample geometry and electron beam energy on light emission of semiconductors. Ultramicroscopy, 2019, vol. 200, no. 1, p. 111-124. ISSN: 0304-3991.

DEVELOPMENT OF METHODS FOR ANALYSIS & MEASURING

Researchers: 4

PhD Students: 1

Research Group Leader

Klapetek Petr, PhD.
Contact: petr.klapetek@ceitec.vutbr.cz

Deputy

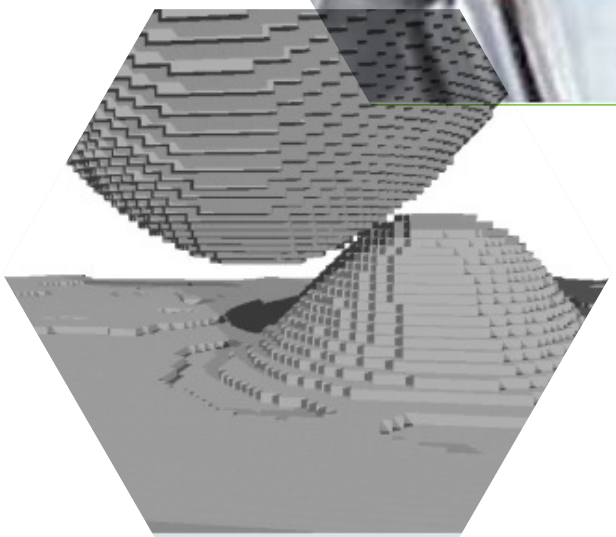
Valtr Miroslav, PhD.

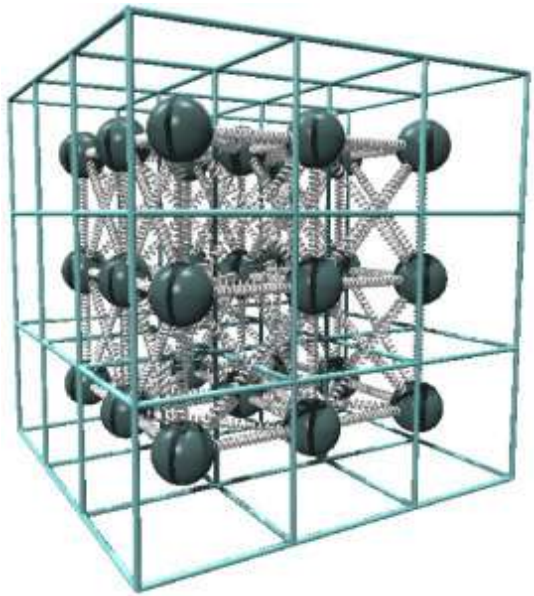
Research Focus

- Development of methods and methodologies for the analysis and metrology of nanomaterials, nanostructures, for measuring their properties and the development of new analytical/diagnostic equipment and components.
- Testing manufacturing results of other CEITEC research groups.
- To surpass the limits of individual methods and the ambiguities of their results on the local characterization of individual nanoobjects, the combinations of other analytical techniques and procedures will be tested as well (e.g. SEM and SPM).

Top Publications

- NEČAS, D.; KLAPETEK, P.; NEU, V.; HAVLÍČEK, M.; PUTTOCK, R.; KAZAKOVA, O.; HU, X.; ZAJÍČKOVÁ, L. Determination of tip transfer function for quantitative MFM using frequency domain fil ering and least squares method. Scientific eports, 2019, no. 9, p. 1-15. ISSN: 2045-2322.
- MARTINEK, J.; CHARVÁTOVÁ CAMPBELL, A.; BURŠÍKOVÁ, V.; KLAPETEK, P. Modeling the influen e of roughness on nanoindentation data using fini e element analysis. INTERNATIONAL JOURNAL OF MECHANICAL SCIENCES, 2019, vol. 161-162, no. 105015, p. 1-17. ISSN: 0020-7403.





MATERIALS CHARACTERIZATION & ADVANCED COATINGS

Research Group Leader

Prof. Kaiser Jozef, PhD.
Contact: jozef.kaiser@ceitec.vutbr.cz

Principal Investigators

Prof. Grmela Lubomír
Prof. Křupka Ivan, PhD.
Prof. Švejcar Jiří
Čelko Ladislav, PhD.
Chamradová Ivana, PhD.
Menelaou Melita, PhD.
Modlitbová Pavlína, PhD.
Montufar Jimenez Edgar Benjamin, PhD.
Novotná Marie, PhD.
Novotný Jan, PhD.
Pořízka Pavel, PhD.
Prochazka David, PhD.
Sedlák Petr, PhD.
Sedláková Vlasta, PhD.
Zikmund Tomáš, PhD.

Researchers: 28

Technicians: 15

PhD Students: 20

Administrative Staff: 1

Developers: 6

Research Focus

- Development of novel methodological approaches in materials characterization following recent demands, i.e. combination of micro- and nano-structural studies, optoelectronic char-acterization of micro- and nano-structures, tribology, Laser-Induced Breakdown Spectroscopy (LIBS) and Computed Tomography (μCT, nanoCT).
- Development of state-of-the-art analytical instrumentation for LIBS.
- Formation of advanced coatings with desirable functional characteristics via the application of advanced technologies and their characterization from macro- down to nanoscale.

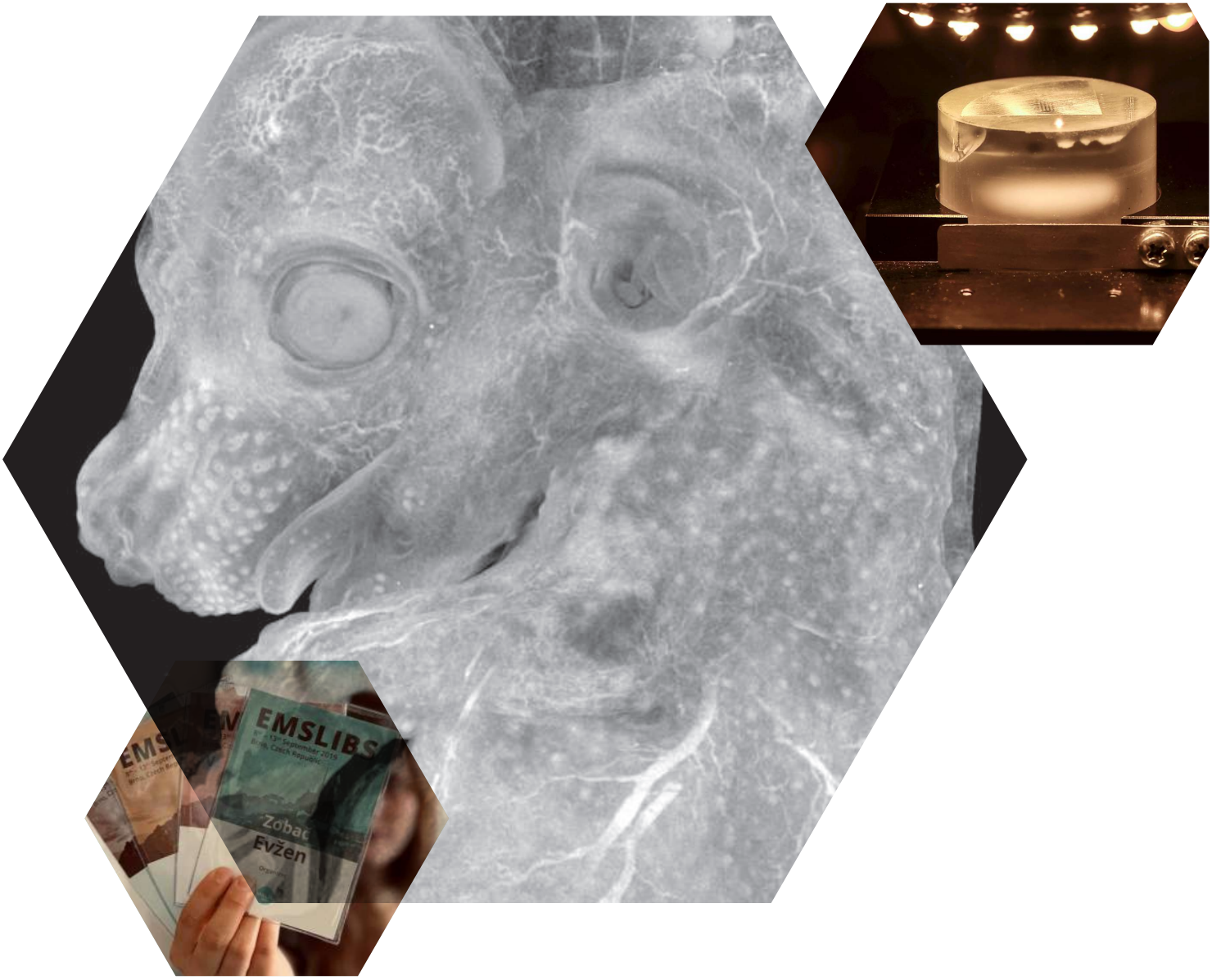
Research Teams

- Laser Spectroscopy (libs.ceitec.cz, POŘÍZKA Pavel, PhD.)
- Advanced Coatings (coatings.ceitec.cz, ČELKO Ladislav, PhD.)
- X-ray micro CT and nano CT (ctlab.ceitec.cz, ZIKMUND Tomáš, PhD.)
- Nano and micro Tribology (KŘUPKA Ivan, PhD.)
- Optoelectronic Characterization of Nanostructures (SEDLÁKOVÁ Vlasta, PhD.)

Highlighted Activities

- Research Group organized **GE workshop** for non-destructive testing in the automotive industry (May 28-29, Brno, Czech Republic)
- **Euro-Mediterranean Symposium on Laser-Induced Breakdown Spectroscopy** (EMSLIBS 2019)

Experts from around the world not only had the opportunity to share ideas and knowledge in the field of laser spectroscopy, but also to discuss their interdisciplinary applications (September 8–13, Brno, Czech Republic)



Top Publications

- SEDLÁKOVÁ, V.; ŠIKULA, J.; SEDLÁK, P.; ČECH, O.; URRUTIA, L. A Simple Analytical Model of Capacity Fading for Lithium–Sulfur Cells. IEEE TRANSACTIONS ON POWER ELECTRONICS, 2019, vol. 34, no. 6, p. 5779-5786. ISSN: 0885-8993.
- DU PLESSIS, A.; LE ROUX, S.; WALLER, J.; SPERLING, S.; ACHILLES, N.; BEERLINK, A.; MÉTAYER, J.; SINICO, M.; PROBST, G.; DEWULF, W.; BITTNER, F.; ENDRES, H.; WILLNER, M.; DRÉGELYI-KISS, Á.; ZIKMUND, T.; LÁZŇOVSKÝ, J.; KAISER, J.; PINTER, P.; DIETRICH, S.; LOPEZ, E.; FITZEK, O.; KONRAD, P. Laboratory X-ray tomography for metal additive manufacturing: Round robin test. Additive Manufacturing, 2019, vol. 30, no. 1, p. 1-15. ISSN: 2214-8604.
- MODLITBOVÁ, P.; FARKA, Z.; PASTUCHA, M.; POŘÍZKA, P.; NOVOTNÝ, K.; SKLÁDAL, P.; KAISER, J. Laser-Induced Breakdown Spectroscopy as a Novel Readout Method for Nanoparticle-Based Immunoassays. Microchimica Acta, 2019, no. 629, p. 186-196. ISSN: 0026-3672.

MAGNETO-OPTICAL & THZ SPECTROSCOPY

Research Group Leader

Petr Neugebeuer, PhD.
Contact: petr.neugebauer@ceitec.vutbr.cz

Principal Investigators

Nemec Ivan, PhD.
Santana Vinicius, Dr.
Zhang Xixia, PhD.

Researchers: 11

PhD Students: 9
Master/Bachelor students: 8

Administrative Staff: 2

Research Focus

- The aim of this 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).

Highlighted Activities

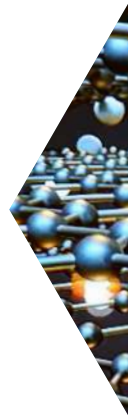
- Jana Midlíková awarded the **PhD Talent**
- Adam Vondráček received **CEITEC Student Talent Award**
- Research Group organized the **8th School of the European Federation of EPR Groups on Advanced EPR** on 18-25 November 2019 for a total of 140 participants

Selected Publications

- MOLAS, MR.; SLOBODENIUK, AO.; NOGAJEWSLCI, K.; BARTOS, M.; BALA, L.; BABINSKI, A.; WATANABE, K.; TANIGUCHI, T.; FAUGERAS, C.; POTEMSKI, M. Energy Spectrum of Two-Dimensional Excitons in a Nonuniform Dielectric Medium. Physical Review Letters, 2019, vol. 123, no. 13, p. 136801-1 (136801-6 p.)ISSN: 0031-9007.
- GUSEV, A.; NEMEC, I.; HERCHEL, R.; RIUSH, I.; TITIŠ, J.; BOČA, R.; L YSSENKO, K.; KISKIN, M.; EREMENKO, I.; LINERT, W. Structural and magnetic characterization of Ni(II), Co(II), and Fe(II) binuclear complexes on a bis(pyridyl-triazolyl)alkane basis. Dalton Transactions, 2019, vol. 48, no. 28, p. 10526-10536. ISSN: 1477-9234.
- BLOOS, D.; KUNC, J. ; KAESWURM, L.; MYERS-WARD, RL. ; DANIELS, K.; DEJARLD, M.; NATH, A.; VAN SLAGEREN, J.; GASKILL, DK.; NEUGEBAUER, P. Contactless millimeter wave method for quality assessment of large area graphene. 2D Materials, 2019, vol. 6, no. 3, p. 035028-035028. ISSN: 2053-1583.

MOLECULAR NANOSTRUCTURES AT SURFACES

Research Group Leader
Čechal Jan, PhD.
Contact: jan.cechal@ceitec.vutbr.cz
Web: surfaces.ceitec.cz



Principal Investigators
Wagner Margareta, Dr.

Researchers: 4

PhD Students: 5

Administrative Staff: 1

Research Focus

Functional supramolecular nanostructures at surfaces

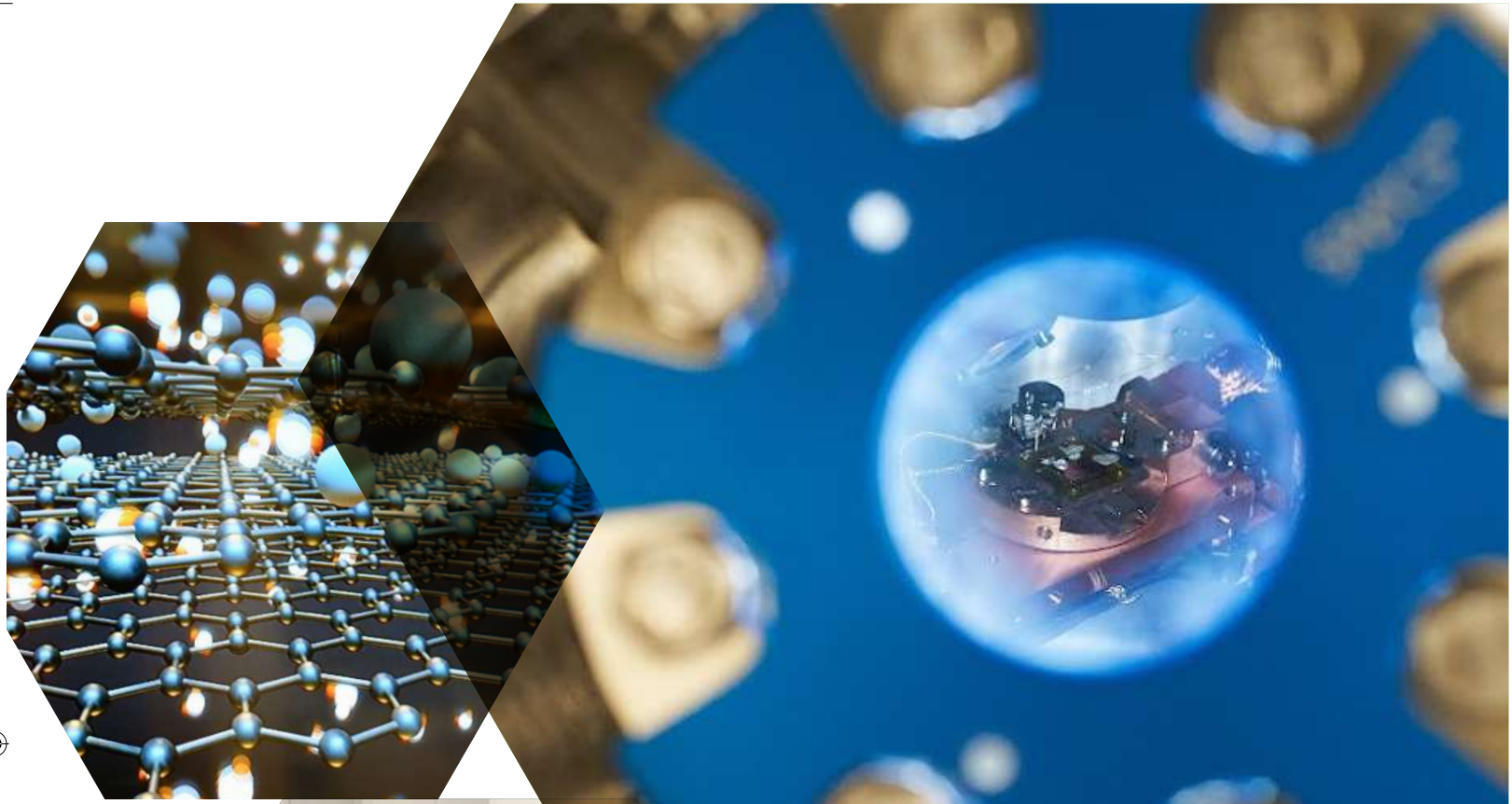
Graphene for control electronic structure of adsorbates

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 supra-molecular 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.

Top Publications:

REDONDO, J., LAZAR, P., PROCHAZKA, P., PRŮŠA, S., LACHNITT , J., , CAHLÍK, A., MALLADA, B., BERGER, J., ŠMÍD, B., KORMOŠ, L., JELÍNEK, P., ČECHAL, J., ŠVEC, M.
Identification of two-dimensional FeO2 termination of hematite α-Fe2O3(0001) surface.
J. Phys. Chem. C 123 (2019), 14312.



NANOMAGNETISM & SPINTRONICS

PhD Students/Postdocs: 3
Master/Bachelor Students: 6

Administrative Staff: 1

Research Group Leader

Uhlíř Vojtěch, PhD.

Contact: vojtech.uhlir@ceitec.vutbr.cz

Web: magnetism.ceitec.cz

Research Focus

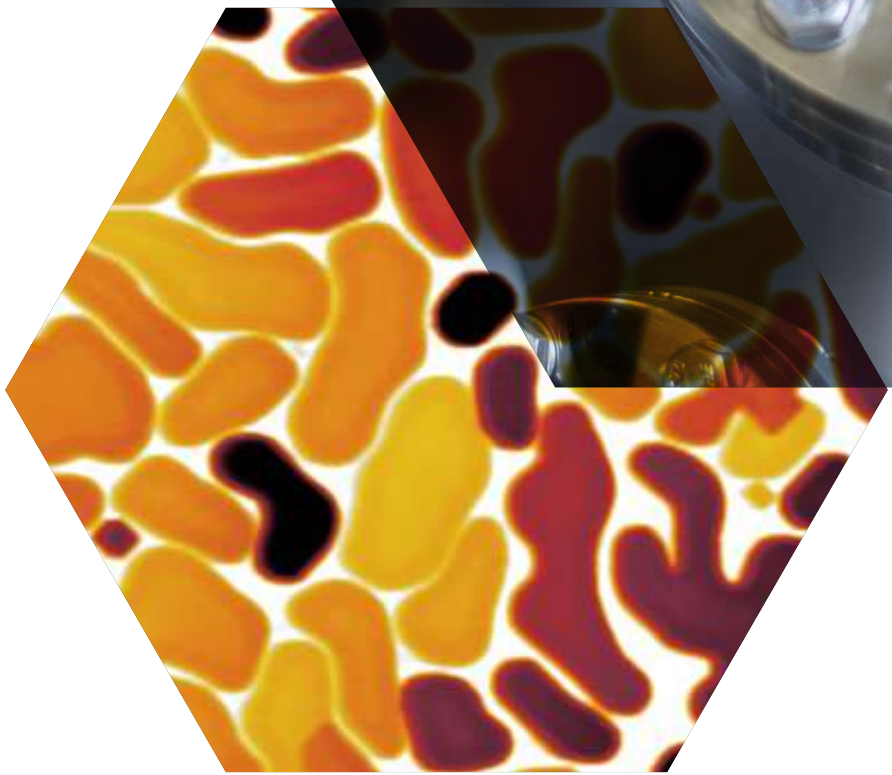
- Magnetic materials are ubiquitous in current electronics, sensors and power systems. Their high tunability offers a multitude of new approaches to non-volatile data storage, high-speed information transfer, energy recovery, drug delivery, and sensing.
- Our research is focused on how the spatial confinement 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 tunable properties.

Highlighted Activities

- RG **explored the formation of large-area single-layer graphene on the surface of epitaxial FeRh thin films,** which provide a platform for uniquely modifying the graphene properties via interaction with different magnetic orders.
- **Ultrafast generation of magnetic order using femtosecond laser pulses and related fundamental phenomena** were investigated in collaboration with research groups at the X-FEL facility in Hamburg.
- RG co-organized **The European School on Magnetism**, the main focus was "experimental techniques".

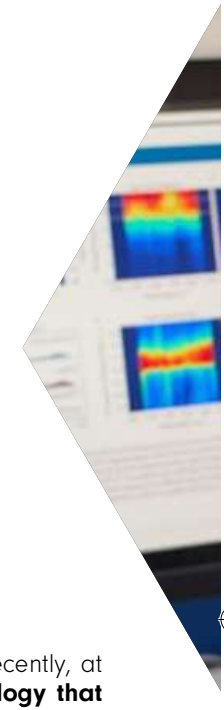
Top Publications

- GLOSS, J.; HORKÝ, M.; KŘIŽÁKOVÁ, V.; FLAJŠMAN, L.; SCHMID, M.; URBÁNEK, M.; VARGA, P. The growth of metastable fcc Fe78Ni22 thin films on H-Si(100) substrates suitable for focused ion beam direct magnetic patterning. Applied Surface Science, 2019, vol. 469, no. 1, p. 747-752. ISSN: 0169-4332.



EPITAXIAL MATERIALS & NANOSTRUCTURES

PhD Students/Postdocs: 3



Research Group Leader

Dipl.-Ing. Dr. techn. Detz Hermann
Contact: hermann.detz@ceitec.vutbr.cz

Research Focus

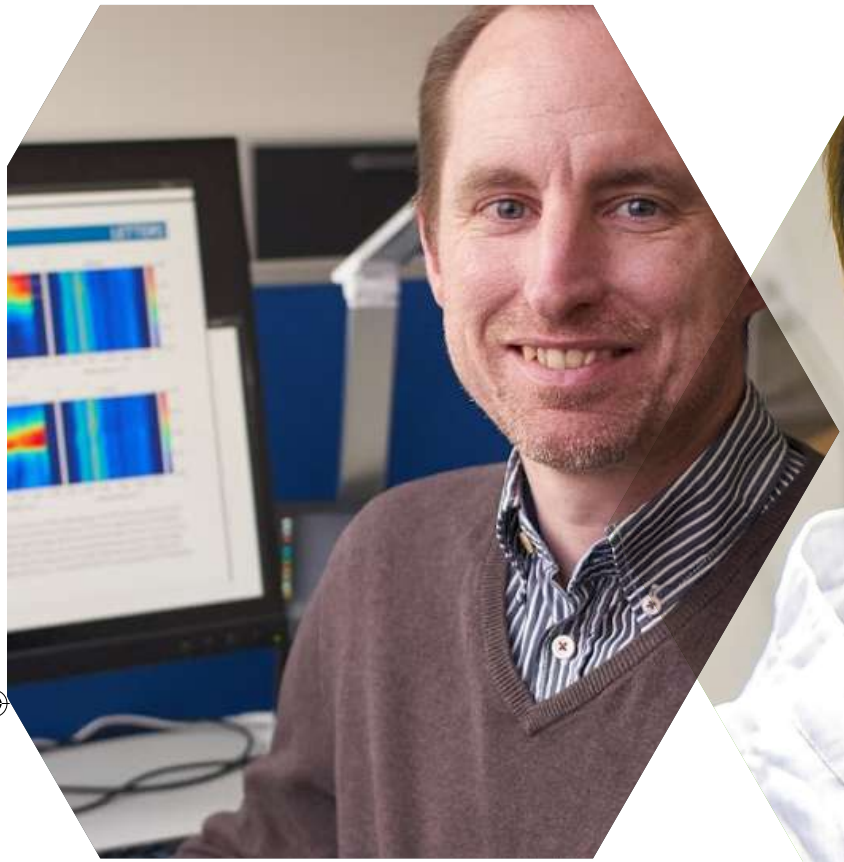
- Fabrication of Epitaxial Materials and Nanostructures
- Integration of Functional Materials with Semiconductor Heterostructures
- Multi-Scale Material Modeling

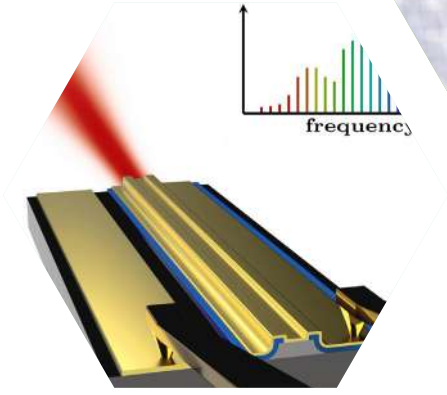
Highlighted Activities

Dr. Hermann Detz contributed within a team of researchers at TU Wien and recently, at CEITEC BUT as well, to **develop a mid-infrared laser and detector technology that can be integrated on a single chip.**

Top Publications

- HILLBRAND, J.; ANDREWS, A.; DETZ, H.; STRASSER, G.; SCHWARZ, B. Coherent injection locking of quantum cascade laser frequency combs. Nature Photonics, 2019, vol. 13, no. 2, p. 101-104. ISSN: 1749-4885.
- SHWARZ, B.; HILLBRAND, J.; BEISER, M.; ANDREWS, AM.; STRASSER, G.; DETZ, H.; SCHADE, A.; WEIH, R.; HOFLING, S. Monolithic frequency comb platform based on interband cascade lasers and detectors. Optica, 2019, vol. 6, no. 7, p. 890-895. ISSN: 2334-2536.
- BENTER, S.; DUBROVSKII, VG.; BARTMANN, M.; CAMPO, A.; ZARDO, I. ; SISTANI, M.; STOGER-POLLACH, M.; LANCASTER, S. ; DETZ, H.; LUGSTEIN, A. Quasi One-Dimensional Metal-Semiconductor Heterostructures. Nano Letters, 2019, vol. 19, no. 6, p. 3892-3897. ISSN: 1530-6992.





FUTURE ENERGY & INNOVATION

PhD Students/Postdocs: 10

Research Group Leader

Pumera Martin, PhD.
Contact: martin.pumera@ceitec.vutbr.cz
Web: energy.ceitec.cz

Research Focus

Advanced Electrochemical Energy Systems

We carry out fundamental research on why the materials are electrocatalytic in the first place. We investigate how to employ electrochemistry (clean energy) in the production of carbon-free fuels as well as catalysts for CO2 reduction. Research on electrochemical properties of layered materials and 2D materials is particularly attractive because the high electron conductivity, fast heterogeneous electron transfer rate (at edge and defect sheet sites), high surface area and scalable production routes, represent advantageous features for the fabrication of improved electrochemical devices. We employ our findings in real-world mobility solutions.

Flexible Wearable Electronics

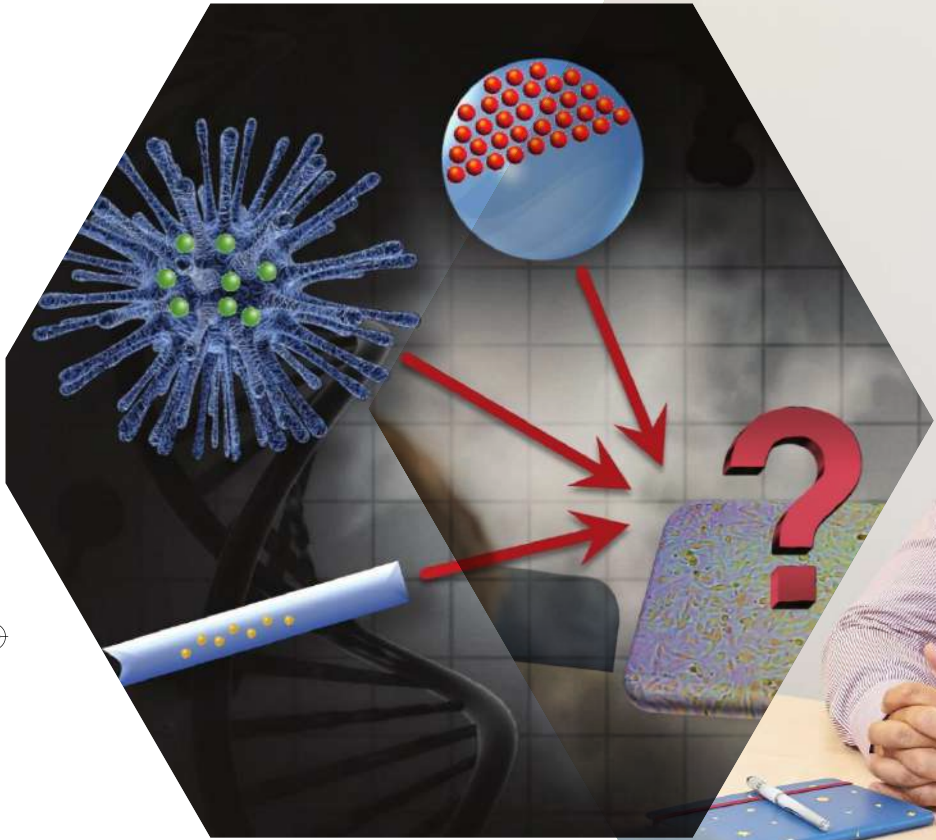
We develop electrochemical wearable sensors and self-powered devices to create a new generation of wearables.

3D printing for Electrochemical Energy and Sensing Devices

We develop 3D printing for construction of catalytic systems for energy storage and energy generation devices as well for bioanalytical chemistry devices.

Top Publications

- BROWNE, M.; PLUTNAR, J.; POURRAHIMI, A.; SOFER, Z.; PUMERA, M. Atomic Layer Deposition as a General Method Turns any 3D-Printed Electrode into a Desired Catalyst: Case Study in Photoelectrochemisty. Advanced Energy Materials, 2019, vol. 9, no. 26, p. 1900994-1900994. ISSN: 1614-6832.
- VILLA, K.; PUMERA, M. Fuel-free light-driven micro/nanomachines: Artificial a tive matter mimicking nature. CHEMICAL SOCIETY REVIEWS, 2019, vol. 48, no. 19, p. 4966-4978. ISSN: 0306-0012.
- NOVOTNÝ, F.; PLUTNAR, J.; PUMERA, M. Plasmonic Self-Propelled Nanomotors for Explosives Detection via Solution-Based Surface Enhanced Raman Scattering. ADVANCED FUNCTIONAL MATERIALS, 2019, vol. 29, no. 33, p. 1903041-1903041. ISSN: 1616-301X.



ADVANCED CERAMIC MATERIALS

Principal Investigators
Prof. Cihlář Jaroslav
Prof. Maca Karel
Prof. Vanýsek Petr
Dzik Petr, PhD.
Salamon David, PhD.
Veselý Michal
Klára Částková, PhD.

Researchers: 19

Technicians: 3

PhD Students: 10

Administrative Staff: 2

Research Group Leader

Prof. Trunec Martin

Contact: martin.trunec@ceitec.vutbr.cz

Web: ceramics.ceitec.cz

Deputy

Částková Klára, PhD.

Research Focus

Biomaterials

- The development of novel composite biomaterials that can induce the growth of connective tissue on the surface of implants and thus accelerate healing and improve the strength and biological stability of the implant-tissue connection (ceramic materials for replacement of soft and hard tissues, materials for orthopaedic devices).

Materials for energetics and ecology

- The development of novel composite materials with functionally graded structures for improving the efficiency and lifetimes of components and devices for energetics (conductive ceramic materials for electrodes, catalysts for the decomposition of gaseous pollutants).

Structural materials

- The development of novel ceramics and ceramic composites with excellent mechanical and thermal properties for structural applications (transparent ceramic materials, thermally and chemically resistant ceramic composite materials, impact-resistant ceramic composites).

Top Publications

- NOVOTNÁ, L.; KUČERA, L.; HAMPL, A.; DRDLÍK, D.; CIHLÁŘ, J.; CIHLÁŘ, J. Biphasic calcium phosphate scaffolds with controlled pore size distribution prepared by in-situ foaming. Materials Science and Engineering C-Materials for Biological Applications, 2019, vol. 95, no. 1, p. 363-370. ISSN: 0928-4931.
- DZIK, P.; SVOBODA, T.; KAŠTYL, J.; VESELÝ, M. Modification of photocatalyst morphology by ball milling and its impact on the physicochemical properties of wet coated layers. CATALYSIS TODAY, 2019, vol. 328, no. SPEA10, p. 65-70. ISSN: 0920-5861.
- ŠŤASTNÝ, P.; SEDLÁČEK, R.; SUCHÝ, T.; LUKÁŠOVÁ, V.; RAMPICHOVÁ, M.; TRUNEC, M. Structure degradation and strength changes of sintered calcium phosphate bone scaffolds with different phase structures during simulated biodegradation in vitro. Materials Science and Engineering C-Materials for Biological Applications, 2019, vol. 100, no. 1, p. 544-553. ISSN: 0928-4931.
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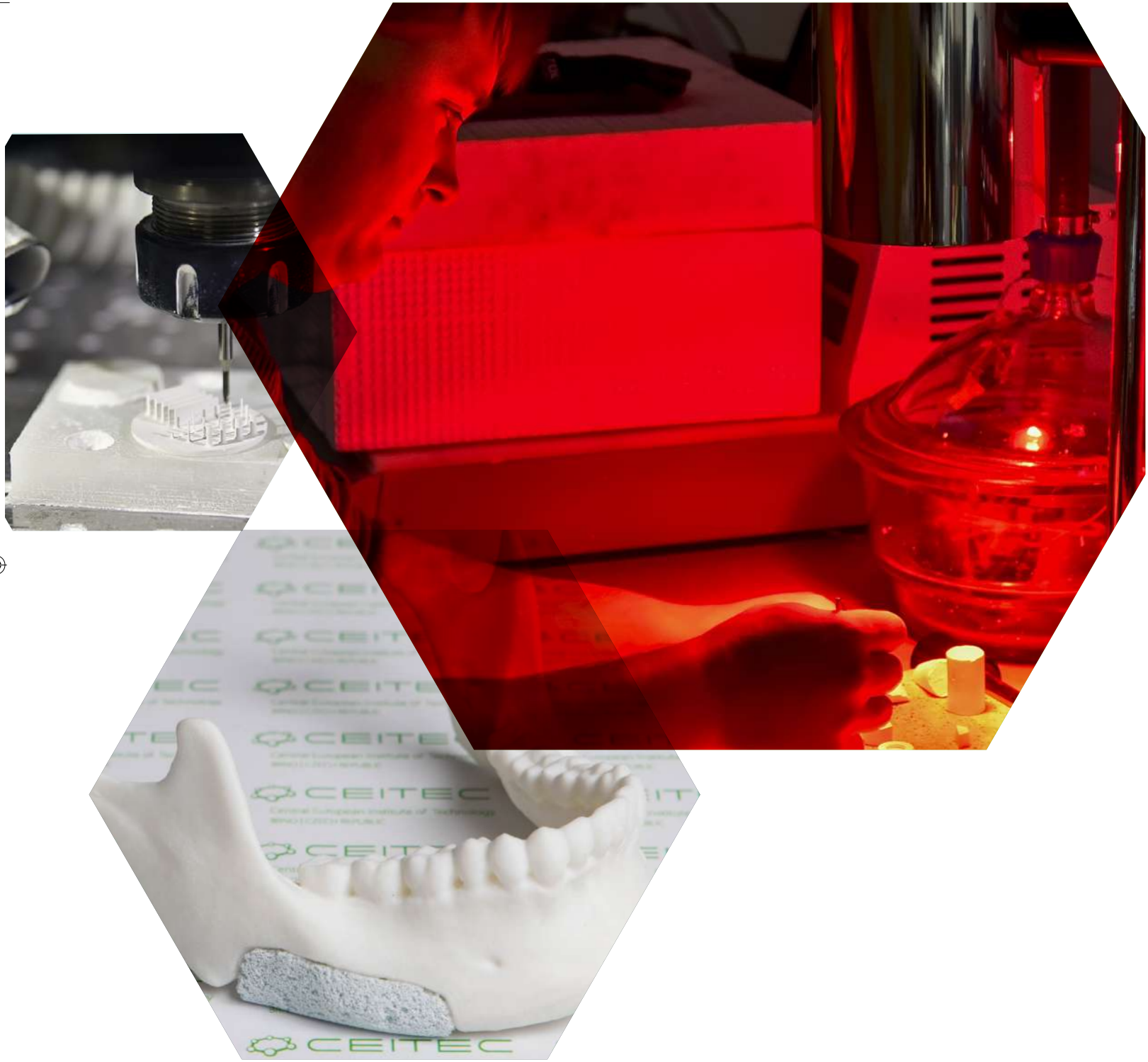


CYBERNETICS IN MATERIAL SCIENCE

Principal Investigators
Prof. Diblík Josef
Prof. Jura Pavel
Prof. Šolc František
Prof. Vrba Radimír
Prof. Žalud Luděk
Beneš Petr, PhD.
Bradáč Zdeněk, PhD.
Dokoupil Jakub, PhD.
Fiedler Petr, PhD.
Havránek Zdeněk, PhD.
Kadlec Jaroslav, PhD.
Klíma Bohumil, PhD.
Kuchta Radek, PhD.
Šmarda Zdeněk

Researchers: 67

Technicians: 1

Administrative Staff: 2

Research Group Leader
Prof. Václavek Pavel, PhD.
Contact: pavel.vaclavek@ceitec.vutbr.cz

Deputy
Blaha Petr, PhD.

Research Focus

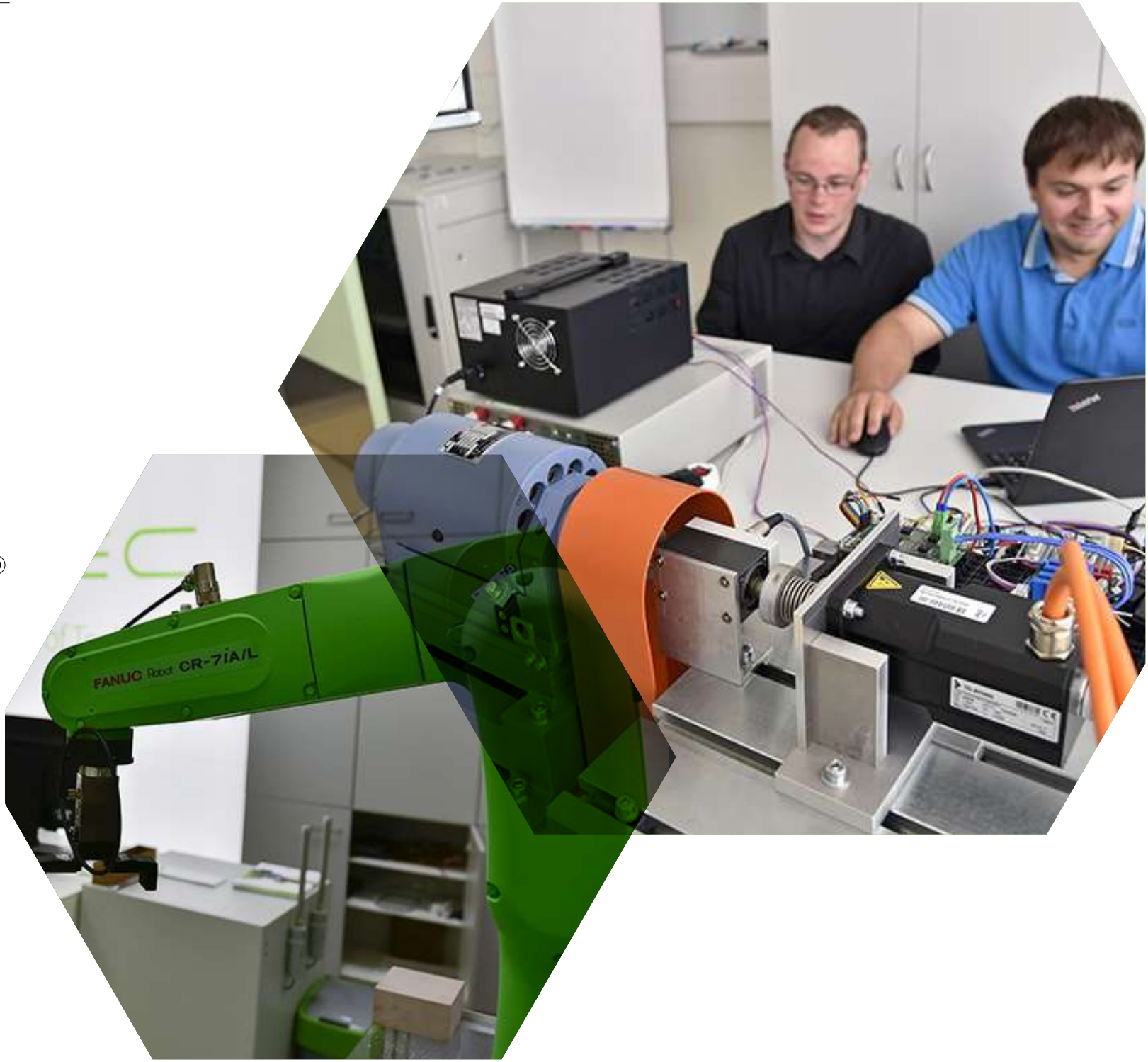
- Smart sensors and signal processing, sensors design using new materials
- Advanced control technologies, electrical actuators control
- Mobile robotic systems, reconnaissance robotics, telepresence
- Embedded systems and communication technologies

Highlighted Activities

- Research Group received **two prestigious H2020 projects**. One of them is **RICAIP** (Research and Innovation Centre on Advanced Industrial Production). As part of this project, the group together with partners from Germany (DFKI and ZeMA) and CIIRC CTU in Prague will launch a new area of research focused on Technology 4.0 at CEITEC BUT, including building a new research infrastructure - testbed for verification and demonstration of developed technologies.

Top Publications

- DIBLÍK, J. Relative and Trajectory Controllability of Linear Discrete Systems With Constant Coeflcients and a Single Delay. IEEE TRANSACTIONS ON AUTOMATIC CONTROL, 2019, vol. 64, no. 5, p. 2158-2165. ISSN: 0018-9286.
- SKALSKÝ, M.; HAVRÁNEK, Z.; FIALKA, J. Efficient Modulation and Processing Method for Closed-Loop Fiber Optic Gyroscope with Piezoelectric Modulator. SENSORS, 2019, vol. 19, no. 7, p. 1-18. ISSN: 1424-8220.



ADVANCED POLYMERS & COMPOSITES

Principal Investigator
Zárybnická Klára

Research Group Leader
Prof. Jančář Josef
Contact: josef.jancar@ceitec.vutbr.cz

Deputy
Tocháček Jiří

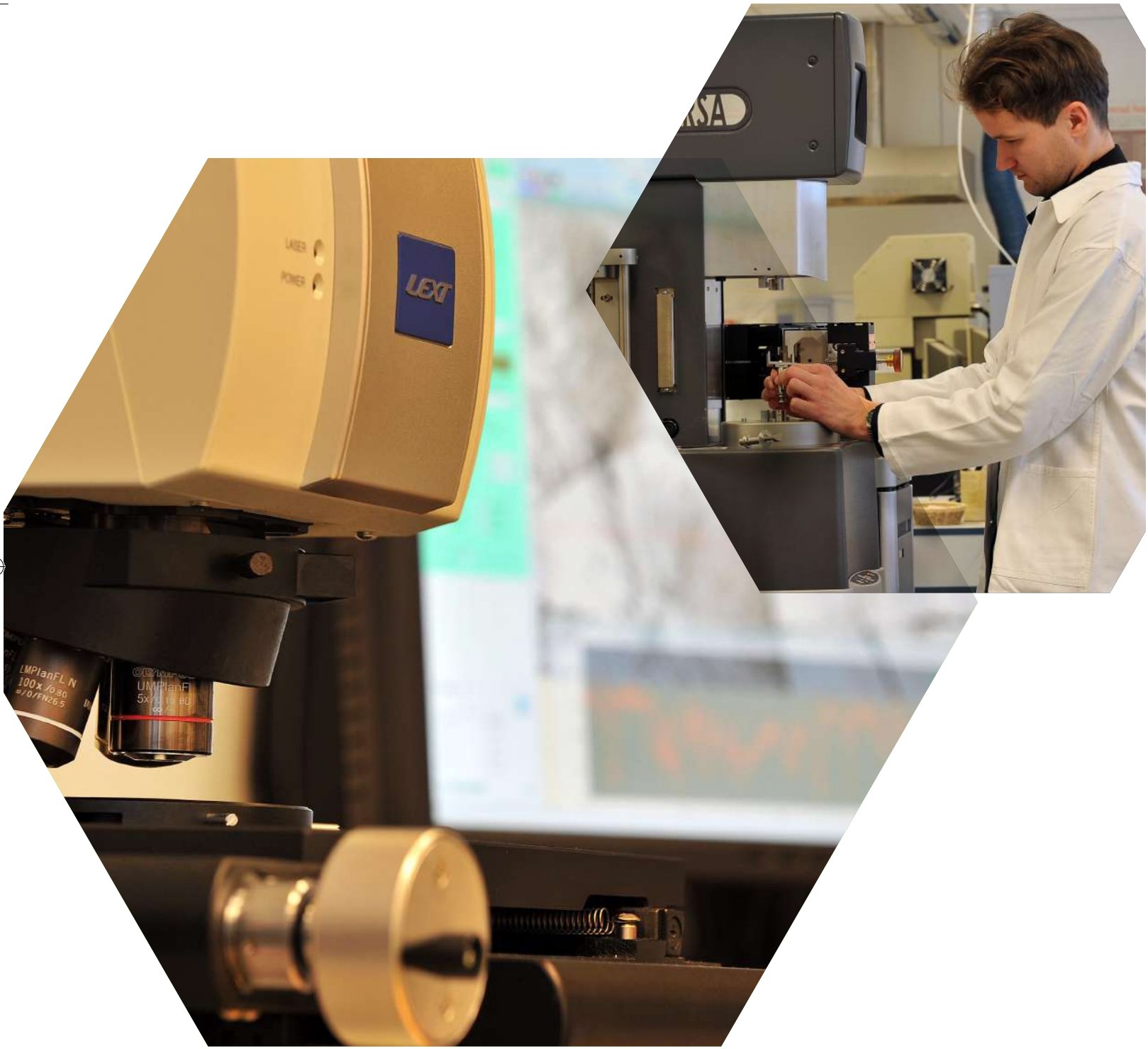
Researchers: 10

Technicians: 5

PhD Students: 15

Top Publications

- ABDELLATIF, A.; ABDELRAHMAN, R.; KUBĚNA, I.; KOBĚRA, L.; SPOTZ, Z.; ZBONČÁK, M.; PŘIKRYL, R.; BRUS, J.; JANČÁŘ, J. Chitosan-glucan Complex Hollow Fibers Reinforced Collagen Wound Dressing Embedded with Aloe vera. Part I: Preparation and Characterization. Carbohydrate Polymers, 2019, vol. 5, no. 25, p. 101-117. ISSN: 0144-8617.
- ONDREÁŠ, F.; LEPCIO, P.; ZBONČÁK, M.; ZÁRYBNICKÁ, K.; GOVAERT, L.; JANČÁŘ, J. Effect of Nanoparticle Organization on Molecular Mobility and Mechanical Properties of Polymer Nanocomposites. MACROMOLECULES, 2019, vol. 52, no. 16, p. 6250-6259. ISSN: 0024-9297.
- ABDELLATIF, A.; PAVLIŇÁK, D.; ČILEKOVÁ, M.; LEPCIO, P.; ABDEL-RAHMAN, R.; JANČÁŘ, J. Electrospinning of Hyaluronan/Polyvinyl Alcohol in Presence of in-situ Silver Nanoparticles: Preparation and Characterization. INTERNATIONAL JOURNAL OF BIOLOGICAL MACROMOLECULES, 2019, vol. 139, no. 139, p. 730-739. ISSN: 0141-8130.



ADVANCED METALLIC MATERIALS AND METAL-BASED COMPOSITES

Principal Investigators
Prof. Kotoul Michal
Prof. Pokluda Jaroslav
Prof. Šandera Pavel
Horníková Jana, PhD.

Members at BUT: 13

Research Group Leader at IPM
Klusák Jan, PhD.

Group Leader at BUT
Černý Miroslav, PhD.

Contact: miroslav.cerny@ceitec.vutbr.cz

Research Focus

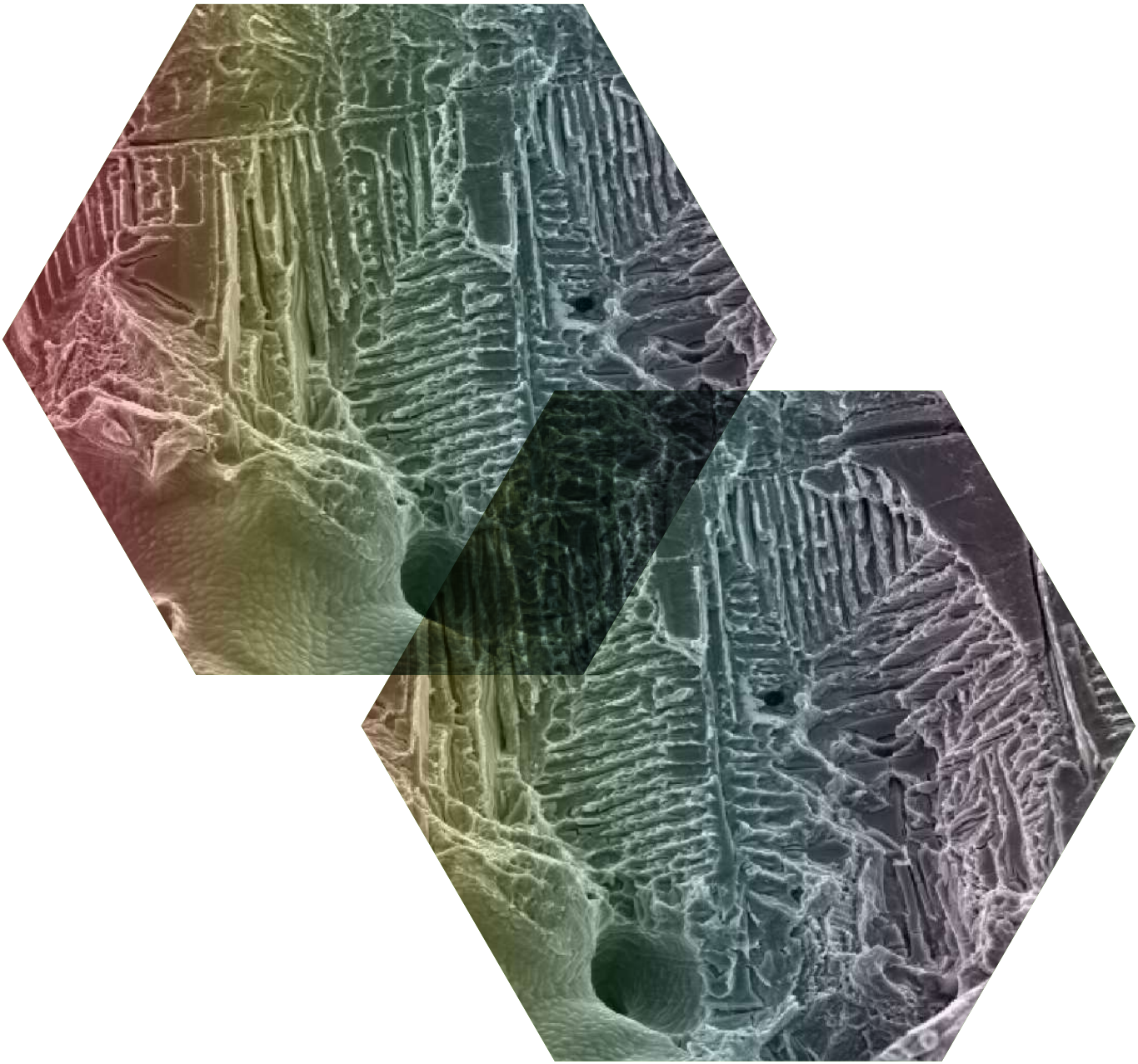
- Basic mechanisms of fatigue, brittle fracture and their combination in relation to microstruc-ture of advanced metallic materials and composites.
- Theoretical studies of crack behaviour in metallic materials and composites and components.
- Multiscale simulation of deformation and fracture processes, quantitative fractography and prediction of fatigue life under multiaxial loading.
- Atomistic and multiscale studies of elasticity and strength of crystals, interfaces and thin surface layers, computational analysis of electronic structure and magnetism in solids.

Highlighted Activities

9th International Conference on MATERIALS STRUCTURE & MICROMECHANICS OF FRACTURE (MSMF9), Brno, Czech Republic, June 26–28, 2019 (178 registered participants from 23 countries)

Top Publications

- KOTOUL, M.; SKALKA, P.; PROFANT, T.; ŘEHÁK, P.; ŠESTÁK, P.; ČERNÝ, M. & POKLUDA, J.
- A novel multiscale approach to brittle fracture of nano/micro-sized components
- Fatigue & Fracture of Engineering Materials & Structures, 2019 vol. 43, p. 1630-1645
- VOJTEK, T.; POKORNÝ, P.; KUBĚNA, I.; NÁHLÍK, L.; FAJKOŠ, R.; HUTAŘ, P. Quantitative dependence of oxide-induced crack closure on air humidity for railway axle steel. INTERNATIONAL JOURNAL OF FATIGUE, 2019, vol. 123, no. 1, p. 213-224. ISSN: 1879-3452.
- KOUTNÁ, N.; ŘEHÁK, P.; CHEN, Z.; BARTOSIK, M.; FALLMANN, M.; ČERNÝ, M.; ZHANG, Z.; FRIÁK, M.; ŠOB, M.; MAYRHOFER, P.H.; HOLEC, D. Correlating structural and mechanical properties of AlN/TiN superlattice films. SCRIPTA MATERIALIA, 2019, vol. 165, no. 3, p. 159-163. ISSN: 1359-6462.



ADVANCED LOW-DIMENSIONAL NANOMATERIALS

Research Group Leader
Dr. Ing. Macák Jan
Contact: jan.macak@ceitec.vutbr.cz

Principal Investigator
Alijani Mahnaz, MSc.
Ince Erdem Ahmet, MSc.
Říhová Martina, PhD.

Researchers: 6

PhD Students: 5

Administrative Staff: 1

Research Focus

Self-organized valve metal oxide nanostructures by electrochemical anodization
- development of novel tubular shapes and morpologies
- investigation of various Ti and Ti-based substrates for nanotube synthesis
- improvement of the tube ordering towards ideal hexagonal ordering
- understanding their structure/properties/application relationship

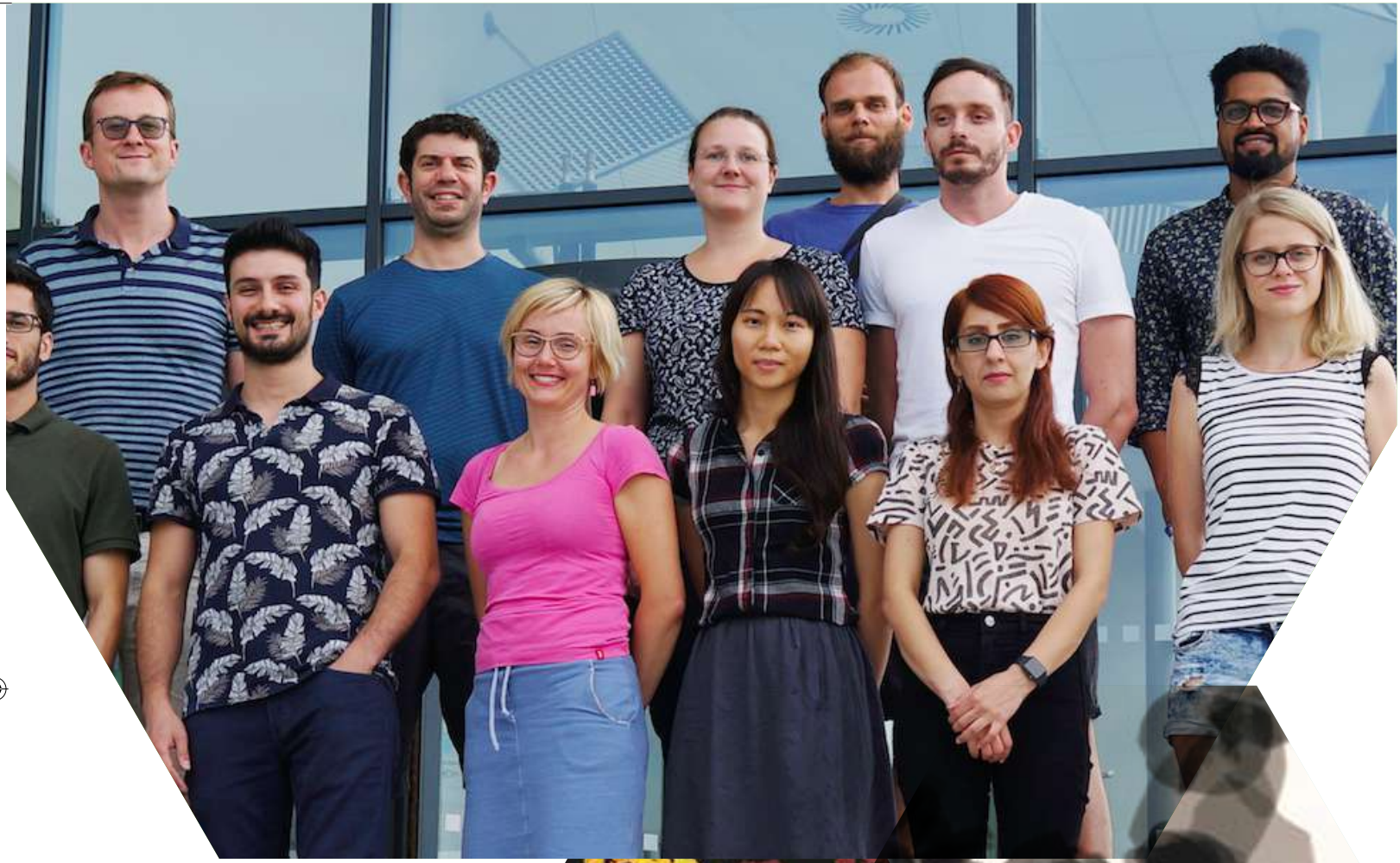
Atomic layer deposition of various functional coatings
- functionalization of nanomaterials by secondary materials
- development of new precursors and processes for new advanced coatings
- realization of complete functional devices

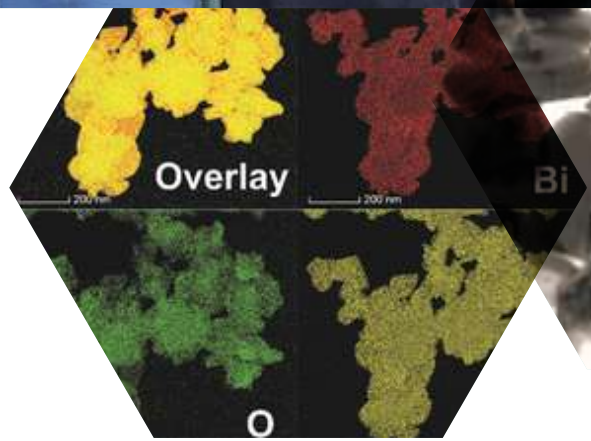
Inorganic and polymeric nanofibers and microfibers
- new formulations of solutions for inorganic fibers by centrifugal spinning and electrospinning
- synthesis vs. calcination vs. property relationship
- evaluation of the potential for various applications

Top Publications

- KRBAL, M., NG, S., MOTOLA, M., HROMADKO, L., DVORAK, F., PROKOP, V., SOPHA, H., & MACAK, J. M. (2019). Sulfur treated 1D anodic TiO2 nanotube layers for significant photo- and electroactivity enhancement. Applied Materials Today, 17, 104-111,
- SALIAN, G. D., KRBAL, M., SOPHA, H., LEBOUIIN, C., COULET, M. -V., MICHALICKA, J., HROMADKO, L., TEFAYE, A. T., MACAK, J.M., & DJENIZIAND, T. (2019). Self-supported sulphurized TiO2 nanotube layers as positive electrodes for lithium microbatteries. Applied Materials Today, 16, 257-264. doi:10.1016/j.apmt.2019.05.015

MOTOLA, M., BAUDYS, M., ZAZPE, R., KRBAL, M., MICHALICKA, J., RODRIGUEZ-PEREIRA, J., PAVLINAK, D., PRIKRYL, J., HROMADKO, L., SOPHA, H., KRYSA, J., & MACAK, J.M. (2019). 2D MoS2 nanosheets on 1D anodic TiO2 nanotube layers: An efficient co-catalyst for liquid and gas phase photocatalysis. Nanoscale, 11(48), 23126-23131. doi:10.1039/c9nr08753b





ADVANCED BIOMATERIALS

Research Group Leader

Vojtová Lucy, PhD.

Contact: lucy.vojtova@ceitec.vutbr.cz

Web: biomaterials.ceitec.cz

Principal Investigator

Brtníková Jana, PhD.
Michlovská Lenka, PhD.
Pavliňáková Veronika, PhD.

Researchers: 4

PhD Students: 11

Technicians: 1

Research Focus

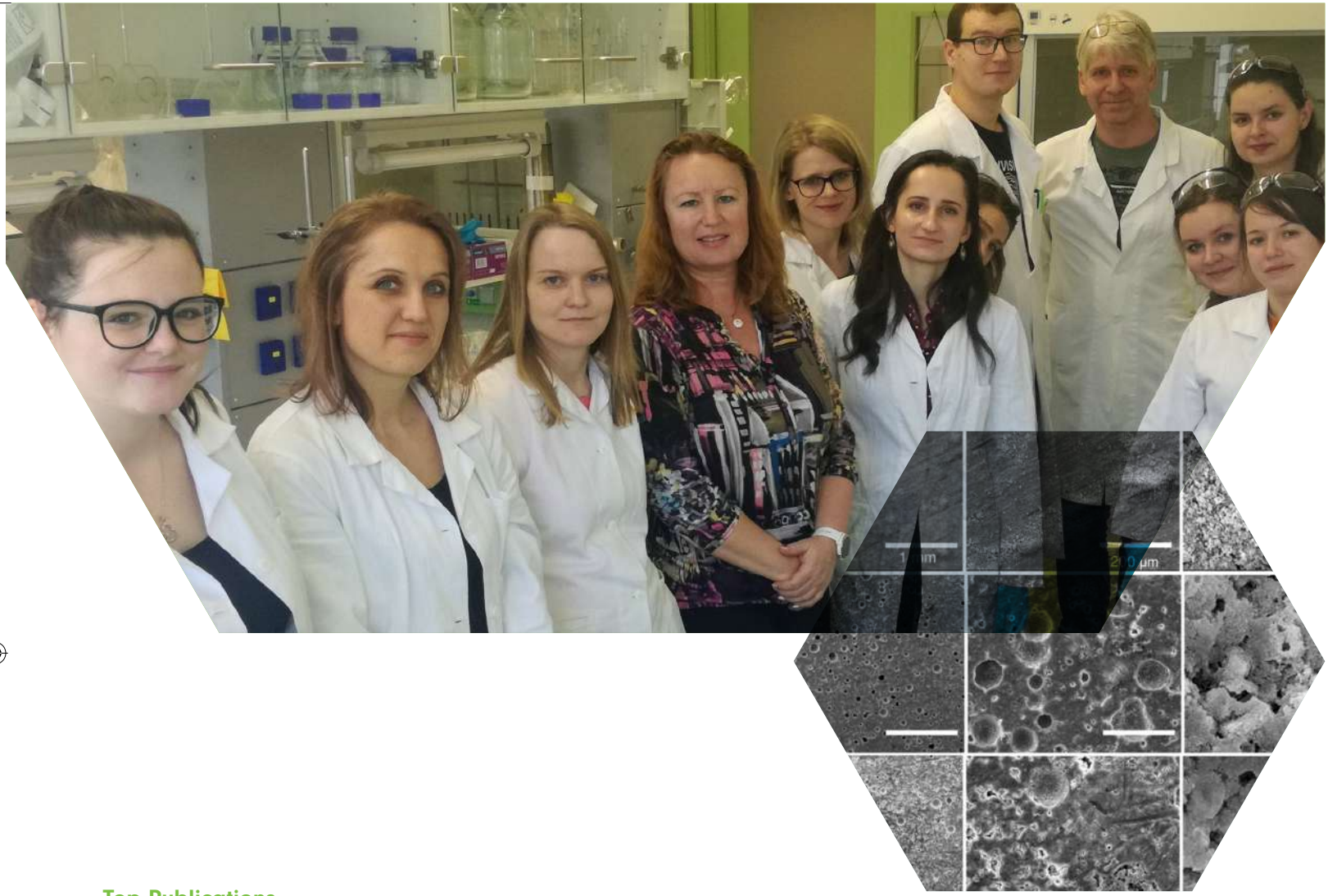
The focus of the group is research and development of resorbable biomaterials with controlled release of bioactive substances (e.g. proteins, peptides, drugs, ions, nanoparticles) for the accelerated healing, preventing infection and promoting tissue regeneration. Advanced syntheses, modifications, stabilizations and modern technologies are applied on synthetic and natural polymers and additives resulting in nanostructured polymer-composite biomaterials (in the form of hydrogels, fibers, films, aerogels and 3D printed structures) for healing or the replacement of soft and hard tissues, especially skin and bones.

Awards

- 3rd place in **Werner von Siemens Award 2019** for Veronika Grézlová (PhD student)
- **Brno PhD Talent 2019** Award for Katarína Kacvinská (PhD student)

Other Activities

- **Exhibition** "Až na kost!" / "Get to the Bone!" – (6-9/2019) at the Technical Museum Brno about the role of bones in the body and new trends in bone implants (co-organization)
- **XI. International Conference:** Bioimplantology 2019. Trends and Visions in Biomplantology (co-organization)
- **Czech–Slovak Congress:** Interdisciplinary Approaches in Wound Healing, Lednice (28/11/2019) – New workshop organization



Top Publications

- VOJTOVA, L; MICHLOVSKA, L; VALOVA, K; ZBONCAK, M; TRUNEC, M; CASTKOVA, K; KRTICKA, M; PAVLINAKOVA, V; POLACEK, P; DZUROV, M; LUKASOVA, V; RAMPICHOVA, M; SUCHY, T; SEDLACEK, R; GINEBRA, MP; MONTUFAR, EB, 2019: The Effect of the Thermosensitive Biodegradable PLGA-PEG-PLGA Copolymer on the Rheo-logical, Structural and Mechanical Properties of Thixotropic Self-Hardening Tricalcium Phosphate Cement. INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES 20(2), doi: 10.3390/ijms20020391
- BABRNAKOVA, J; PAVLINAKOVA, V; BRTNIKOVA, J; SEDLACEK, P; PROSECKA, E; RAMPICHOVA, M; FILOVA, E; HEARNDEN, V; VOJTOVA, L, 2019: Synergistic effect of bo-vine platelet lysate and various polysaccharides on the biological properties of collagen-based scaffolds for tissue engineering: Scaffold preparation, chemo-physical characterization, in vitro and ex ovo evaluation. MATERIALS SCIENCE ENGINEERING C-MATERIALS FOR BIOLOGICAL APPLICATIONS 100, p. 236 - 246, doi: 10.1016/j.msec.2019.02.092
- VOJTOVA, L; ZIKMUND, T; PAVLINAKOVA, V; SALPLACHTA, J; KALASOVA, D; PROSECKA, E; BRTNIKOVA, J; ZIDEK, J; PAVLINAK, D; KAISER, J, 2019: The 3D imaging of mesenchymal stem cells on porous scaffolds using high-contrasted x-ray computed nanotomography. JOURNAL OF MICROSCOPY 273(3), p. 169 - 177, doi: 10.1111/jmi.12771
- POSTULKOVA, H; NEDOMOVA, E; HEARNDEN, V; HOLLAND, C; VOJTOVA, L, 2019: Hybrid hydrogels based on polysaccharide gum karaya, poly(vinyl alcohol) and silk fibroin. MATERIALS RESEARCH EXPRESS 6(3), doi: 10.1088/2053-1591/aaf45d

Central European Institute of Technology
Brno University of Technology
Purkyňova 123
612 00 Brno
Czech Republic
www.ceitec.eu