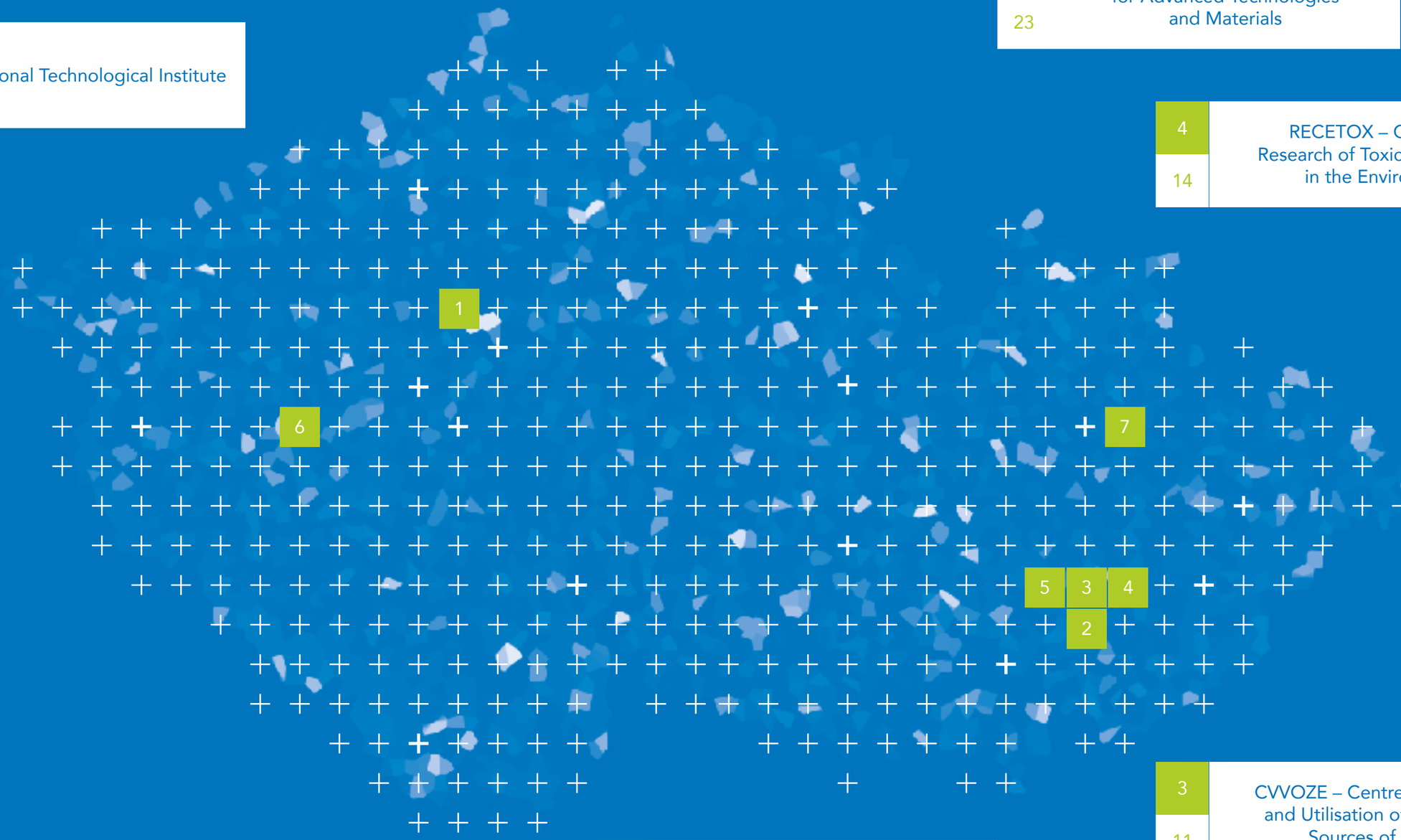
EEB CZ

Research and innovation infrastructure in energy-efficient construction

Find partner organisations
in the Czech Republic



1
4
UCEEB – University Centre for Energy Efficient Buildings

6
20
RTI – Regional Technological Institute

7
23
RCPTM – Regional Centre for Advanced Technologies and Materials

4
14
RECETOX – Centre for Research of Toxic Compounds in the Environment

3
11
CVVOZE – Centre for Research and Utilisation of Renewable Sources of Energy

5
17
CEPLANT – Regional R&D centre for low-cost plasma and nanotechnology surface treatments

2
7
AdMaS – Advanced Materials, Structures and Technologies

EEB CZ

By means of this publication, we wish to introduce excellent research centres focused on the area of energy-efficient buildings in the Czech Republic. The aim of this publication is to raise awareness of newly established research capacities supported from the European Structural Funds.

During the Programming Period 2009–2014, the European Commission supported the construction and equipment of more than 40 research centres in the Czech Republic, out of which 10 are more or less focused on research, development and innovation in the area of energy-efficient buildings.

We have subjected these research centres to a detailed qualitative analysis, and its results are concisely presented in this publication. Our goal is to facilitate your orientation in the Czech Republic's research domain and, most importantly, to highlight the availability of top-class research infrastructures. Due to the capacity limitation of this publication, we have only been able to pay attention to key aspects of the expert quality of each of the centre. The catalogue also includes contact details, which will help you obtain additional information from managers of each of the centre if needed.

The publication is a product of the project called "Support of International Research Profiling of the Czech Republic in Energy Efficient Buildings" ("PoMePro", LE14003) financed from LE-EUPRO II , programme of Ministry of Education, Youth and Sports of the Czech Republic.The PoMePro project aims at increasing involvement of Czech entities in international projects focused on research, development and innovation in the area of energy-efficient building.

On behalf of the PoMePro team, we wish you a pleasant read and successful establishment of contacts in the Czech Republic.

The EEB-CZ implementation team

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1

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Research program of the centre and significant researchers

The University Centre for Energy Efficient Buildings (UCEEB) is an interdisciplinary university institute of the Czech Technical University in Prague; its main objective is development of technologies for reducing energy demand and more efficient use of natural resources in renovations and new construction of buildings.

The research and development focuses primarily on:

+ innovative technologies and structural design of buildings and their components with integration of new materials, advanced sensors and renewable sources of energy;

+ optimisation of building and energy source control systems resulting in energy and material efficiency is complemented with a healthy interior environment;

+ use of renewable, recyclable and recycled domestic raw materials based on wood material, ceramic products, waste products such as fly ash from thermal power plants, low-grade sheep's wool, waste plastic, etc.;

+ drawing of concepts, methodologies, guidelines and technical standards for public administration and professional public.

The UCEEB trains students for practice from the level of diploma and dissertation theses, and involves them in international study programmes. At the same time, it focuses on commercialisation of research results and collaboration with industry.

Significant researchers:

+ **Prof. Ing. Zdeněk Bittnar, DrSc.**
bittnar@fsv.cvut.cz
Prof. Bittnar is an expert in the areas of structural dynamics, numerical methods and mathematical models of deformation and disruption of quasi-fragile materials. Chairman of the CSF Scientific Board.

+ **Prof. Ing. Petr Hájek, CSc.**
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Prof. Hájek focuses on research into environmental optimisation of concrete structures and assessment of buildings and their structures in terms of their entire lifecycle and comprehensive quality. He also fathered the Czech national certification tool SBToolCZ and is the Chairman of the Czech Sustainable Building Society, CSBS, iiSBE CZ.

+ **Doc. Ing. Tomáš Matuška, Ph.D.**
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Doc. Matuška deals with research and development of renewable sources of energy integrated into energy-efficient buildings. He studies innovative multifunction energy components for heat, cold and electricity supply, such as hybrid solar panels, advanced

Scanning electron microscope FEG

heat pumps, and efficient storage of heat and cold.

+ **Prof. Ing. Karel Kabele, CSc.**
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Prof. Kabele deals with energy systems and quality of building interior environment from the point of view of their design, modelling, simulation and optimisation as well as system-building interactions. Since 2008, he has been a member of the ČKAIT Board of Directors.

+ **Prof. RNDr. Evžen Amler, CSc.**
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Prof. Amler deals with development of smart composite nanosystems and materials for medical and technical applications (detection of pollutants, monitoring of interior environment status, etc.). He is also a head of the Charles University Second Faculty of Medicine Department of Biophysics, and a chief scientist of the Institute of Experimental Medicine of the CAS.

+ **Doc. Ing. Petr Kuklík, CSc.**
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Doc. Kuklík deals with technical standards in the area of wood construction and research and development of materials and structures at normal temperatures and during a fire. He is a member of the High Level Forum on Sustainable Construction of the European Commission. He was formerly the Chairman of the Czech Technical Standardisation Committee.

+ **Ing. Jan Včelák, Ph.D.**
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Ing. Včelák specialises on design of sensor networks and development of special sensors, electronic devices and control elements of smart buildings. He has long been pursuing non-destructive diagnostics of construction and other materials.

Unique research infrastructure of the centre

Experiments in the UCEEB building are characterised by testing on a real scale, providing reliable information about the functional parameters of materials, structures, energy systems and smart control systems designed, including their impacts on the quality of building interiors and the environment.

Key equipment:

+ **Solar radiation simulator**
A specially developed light source that makes the most accurate simulation possible of the solar radiation spectrum. It is used primarily for thermal and mechanical testing of solar panels and arrays.

+ **Scanning electron microscope FEG**
with a resolution of 0.7 nm, with EDS, WDS and EBSD detectors, including an extensive database of crystallographic data.

+ **Temperature and climate twin chamber**
designed for testing of structural compositions and construction components under various thermal and humidity conditions in both a stabilised and non-stabilised state, unique for its above-standard dimensions of 3×3 metres.

+ **Gas microturbine**
equipped with comprehensive metering of output and efficiency, including a compressor station for increasing the gas pressure. Usable for detailed metering of operating characteristics of microturbines in experiments, cooperation of distributed electricity production with the distribution grid, and heat storage for distributed use.


Temperature and climate twin chamber

+ **Acoustic laboratory**
offering sound reduction walls and ceilings, walking noise reduction ceilings, lateral transmission of sound propagating through air and of walking noise between adjacent rooms.

Top ranked publications

+ Žáčeková, E., Váňa, Z., & Cigler, J. (2014). Towards the real-life implementation of mpc for an office building: Identification issues. *Applied Energy*, 135, 53–62.

+ Caldová, E., Vymlátil, P., Wald, F., & Kuklíková, A. (2014). Timber Steel Fiber–Reinforced Concrete Floor Slabs in Fire: Experimental and Numerical Modeling. *Journal of Structural Engineering*, 141(9), 04014214.

+ Matuska, T., Sourek, B., Jirka, V., & Pokorny, N. (2015). Glazed PVT collector with polysiloxane encapsulation of PV cells: performance and

economic analysis. *International Journal of Photoenergy*, 2015.

+ Maierova, L., Borisuit, A., Scartezzini, J. L., Jaeggi, S. M., Schmidt, C., & Münch, M. (2016). Diurnal variations of hormonal secretion, alertness and cognition in extreme chronotypes under different lighting conditions. *Scientific Reports*, 6.

+ Chira, A., Kumar, A., Vlach, T., Laiblová, L., Škapin, A. S., & Hájek, P. (2016). Property improvements of alkali resistant glass fibres/epoxy composite with nanosilica for textile reinforced concrete applications. *Materials & Design*, 89, 146–155.

Applied research results

+ **Light wood-based external envelope Envilop** makes use of wood and its modern derivatives for various functions in the envelope. Resistant, thermally treated wood protects from weather, layered beams comprise the main load-bearing frame, and wood-fibre insulation provides necessary thermal technical parameters. In some details, the system makes use of latest insulation materials (vacuum insulation, aerogel). Integration of active shading components, preparation for integration of photovoltaic or photothermic panels and ventilation equipment goes without saying. The UCEEB is the owner of the ENVILOP trademark. **More information HERE.**

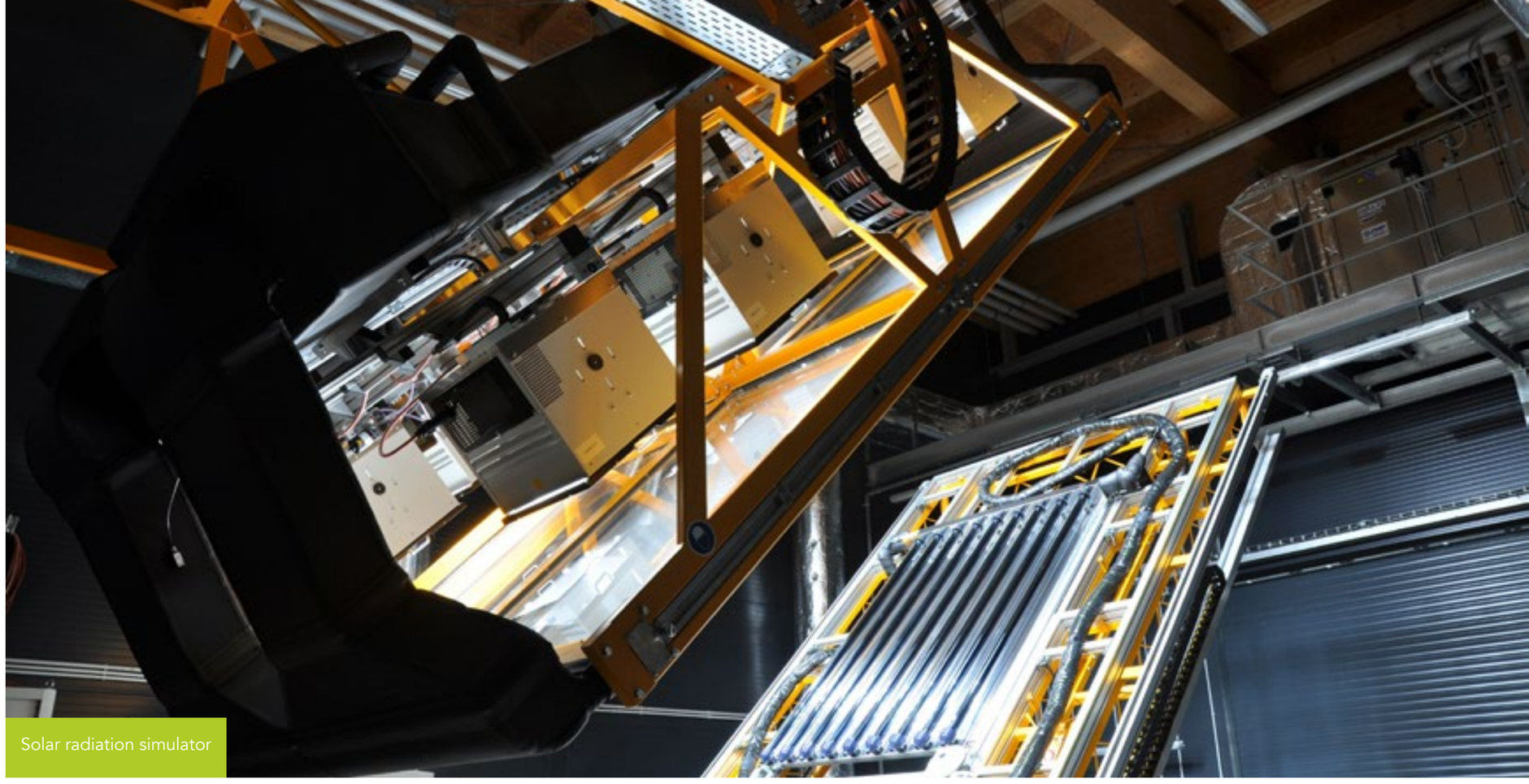

Camera

+ **WAVE micro power station and Organic Rankine Cycle (ORC)**
A micro power station for power and heat generation from biomass, awarded with the ČEEP 2015 in the Projects category, will be marketed as an energy source for apartment buildings and smaller district boiler houses. The device is based on a technology developed at the CTU UCEEB and works on the Organic Rankine Cycle (ORC) principle. In 2015, the WAVE micro power plant won the Environmental Oscar award for the best idea, and its development is supported in the long term by the energy utility E.ON.

+ **Solar panel for transformation of solar radiation into heat and electricity**
A panel producing both electricity and heat from a single surface. Thanks to a combined heat and power generation (solar CHP), the hybrid PV panel is capable of producing more total energy than separate designs (photovoltaic panels and solar panels separately) with the same built-up area.

+ **MOISTURE GUARD system for comprehensive assessment of moisture in building structures**
A system for continuous monitoring of moisture in building structures. Won the ČEEP 2015 Czech Energy and Environmental Project Award in the Innovation category. The system is used in construction of wood buildings and can reveal problems with increased moisture in time, and approximately localise the moisture epicentre. **More information HERE.**

+ **Photovoltaic bench**
demonstrates utilisation of renewable sources and island systems. Besides relaxation, it offers wireless Internet connection and charges mobile devices via a USB connector or absolutely wireless by means of induction. At the same time, it monitors air quality. It provides all its functions thanks to solar power. The UCEEB is the technology partner for the photovoltaic bench made by Full CapaCity.


Solar radiation simulator

International and domestic recognition of the centre

+ 3rd place in the overall rating of the Solar Decathlon 2013 in Orange County Great Park, California for the project AIR House – energy self-sufficient experiment house.

+ The Envilop project has won several awards. In 2013, it won the main prize in the Innovation category in the nationwide competition Czech Energy and Environmental Project (ČEEP) 2012 and the ERSTE CORPORATE BANKING award. In 2015, it was nominated for the finals of the E.ON ENERGY GLOBE AWARD, also known as the "Environmental Oscar".

+ Czech Energy and Environmental Project (ČEEP) 2014 award for unique structures for research into energy-efficient buildings in the category of energy-efficient and environment-friendly projects and buildings for the 3rd millennium for the University Building in Buštěhrad itself.

+ In 2015, the WAVE micro power plant for heat and power generation from biomass won the E.ON ENERGY GLOBE AWARD, also known as the "Environmental Oscar", in the Idea category.

+ Two Czech Energy and Environmental Project (ČEEP) 2015 awards for the WAVE micro power plant in the Projects category, and for the Moisture Guard in the Innovation category.

Important international research projects and involvement in professional networks

+ **European Real Life Learning Lab Alliance – EURL3A (01/2013 – 08/2014)**
EURL3A was a pilot project under the European initiative University – Business Cooperation, aiming at promoting collaboration between the education, research and business sectors. The project partners were the ZUYD University, Huygen Installatie Adviseurs of the Netherlands, Ljubljana University and Metronik of Slovenia.

+ **H2020 More Connect (01/2015 – 12/2016)**
The UCEEB together with RD Rýmařov are partners in this European project, aiming at developing a system of prefabricated panels for comprehensive renovation for existing apartment buildings and houses. The project coordinator is the Dutch company Huygen Installatie Adviseurs. The project involves other businesses and universities in the Netherlands, Denmark, Estonia, Latvia, Portugal and Switzerland.

+ **Interreg EUROPE FINERPOL (01/2015 – 12/2016)**
New policies for growth and employment combining money from the European Regional Development Fund with financial instruments for energy investment in buildings – UCEEB and the Capital City Prague are joint partners of this European project aiming at promotion of new policies or improvement to existing policies focused on establishment of financial instruments, particularly instruments supported by the European Regional Development Fund and the European Commission for energy investment in buildings. The coordinator of the four-year project is the Spanish company Extremadura Energy Agency. The project involves other agencies and managing bodies from the United Kingdom, Greece, Italy, Portugal and Germany.

Photovoltaics

AdMaS – Advanced Materials, Structures and Technologies

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AdMaS
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Research program of the centre and significant researchers

AdMaS (Advanced Materials, Structures and Technologies) is a modern research institution in the area of construction industry, which is part of the Brno University of Technology Faculty of Civil Engineering. It focuses on research, development and application of advanced construction materials, structures and technologies not only in the construction industry but also transport systems and municipal infrastructures. The research compound consists of four buildings: three laboratory pavilions and one testing hall.

The objective of the AdMaS Centre is to ensure application of current results of primary research in the form of applied research in practice in the form of new or innovated construction materials and technologies with better utility properties, lower production costs and limited negative environmental impacts during the material lifecycle.

The Centre research consists of two research programmes: Research Programme 1 (Development of advanced construction materials) and Research Programme 2 (Development of advanced structures and technologies).

+ **RP 1** focuses on achievement of new results in the area of advanced durable construction materials by developing both new materials and new methods of their destructive and non-destructive testing as well as applicable technical procedures and standards.

+ **RP 2** deals with several interconnected thematic areas. The main objective of the Programme is design of progressive building structures and technologies in terms of their increased reliability, durability and economy during their entire lifecycle. In the area of technologies, the Programme objective is drawing of effective methods in structural diagnostics, identification and quantification of effects on structures, design of structures and technologies in the area of the environment (e.g., municipal water and waste management).

Significant researchers:

+ **Prof. Ing. Rostislav Drochytka, CSc., MBA**
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Prof. Drochytka has long dealt with development of new advanced construction materials, particularly autoclaved aerated concrete, polymers in the construction industry, corrosion, degradation and generally durability of construction materials, faults and defects of construction materials, concrete rehabilitation, building surface finishes, waste recycling, and importantly, reuse of various types of waste in the form of secondary raw materials, and property appraisal.

Furnaces for fire testing

+ **Prof. Ing. Drahomír Novák, DrSc.**
novak.d@fce.vutbr.cz
Prof. Novák works notably in the following areas: Reliability of building structures, stochastic calculation mechanics, risk engineering, stochastic fracture mechanics of continuum, Monte Carlo simulation methods, concrete structure modelling, stochastic finite element method, disruption of quasi-fragile materials, probability optimisation of structures, random fields in mechanics of continuum, degradation and lifetime of bridge structures.

+ **Prof. Ing. Petr Hlavínek, CSc., MBA**
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Prof. Hlavínek specialises in wastewater drainage and treatment, WWTP sludge processing, selected waste technologies, water purity and energy intensity of WWTP. He has long dealt with presence and technologies for elimination of medicines from wastewater.

+ **Prof. Ing. Jan Kudrna, CSc.**
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Prof. Kudrna is an expert on road research. He focuses on research and application of new testing methods and materials, functional testing of road construction materials, use of secondary materials and recycling technologies. He deals with issues of reducing accident rates and transport noise by means of non-skid and noise-reducing road covers. He consistently deals with road diagnostics, implementation of new laser and radar technologies for road quality assessment, designing of maintenance and repairs, including systems for maintenance and repair planning and management (pavement management systems).

+ **Doc. Ing. Pavel Schmid, Ph.D.**
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Doc. Schmid is focused, in the area of professional, research and scientific interests and activities, on planning and implementation of laboratory testing in terms of both testing of basic physical mechanical and fracture parameters of construction materials and experimental analysis on construction components, models and real-world structures. Besides, he deals with preparation and implementation of on-site experimental analysis of structures, including comprehensive diagnostics of existing building structures. He has been a member of the Supervisory Committee of ČKAIT since 2011, and of the Supervisory Board of ČKAIT since 2014.

Unique research infrastructure of the centre

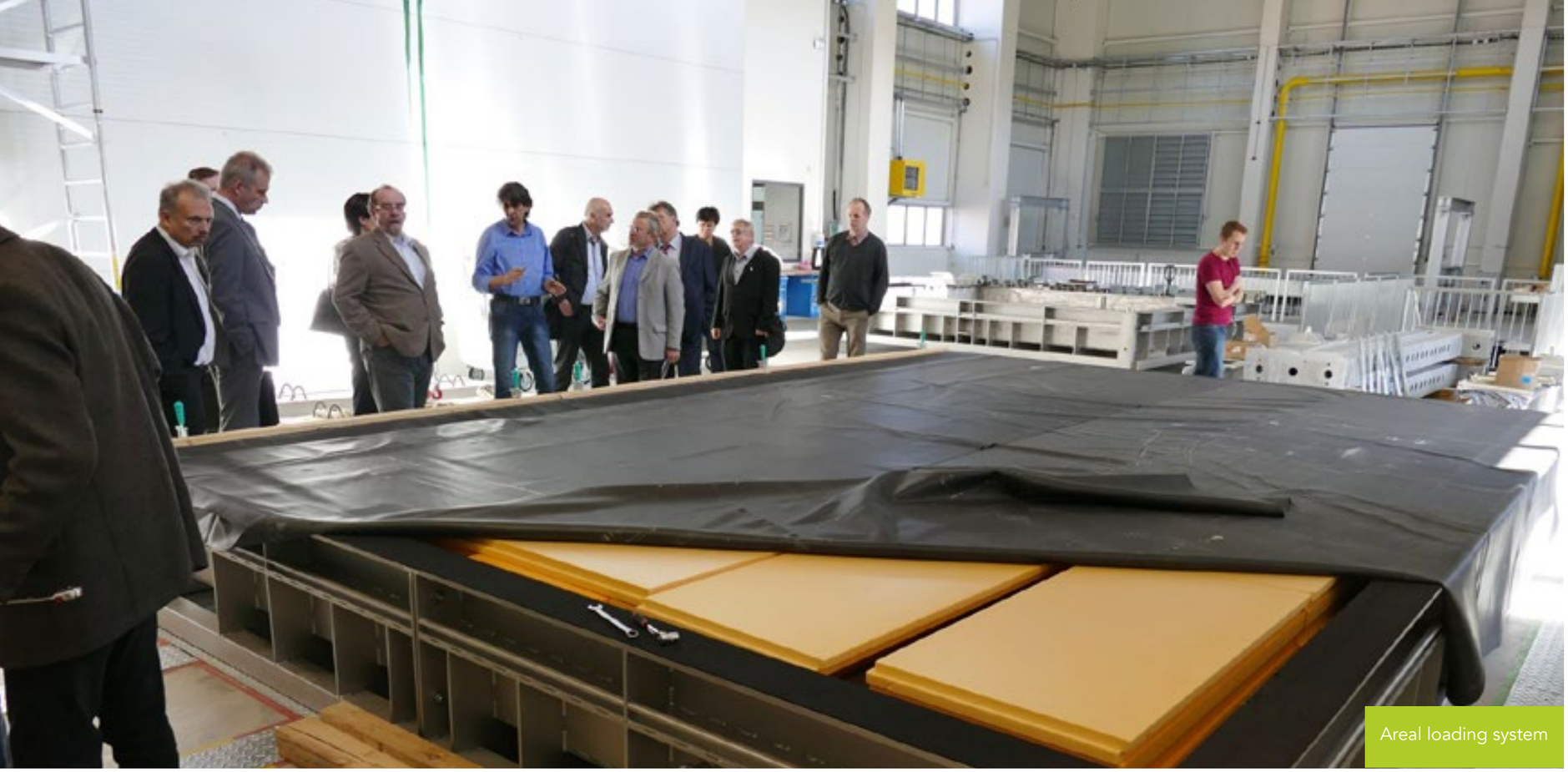
The Centre has available modern laboratory facilities with top-class equipment with more than 250 instruments, which cardinally expands the capacities for collaboration with contractual partners. The Centre compound comprises three laboratory pavilions, a testing hall and a testing area for exterior experiments. The laboratories are accessible without barriers to heavy handling equipment and equipped with bridge cranes. The Centre's equipment embraces the whole range of construction industry, it has standalone facilities such as a fully equipped road testing laboratory, a hall for extreme loading of components and structures, a set of testing furnaces and instruments for determination of fire resistance rating, an accredited concrete pouring laboratory and a material engineering laboratory with top-class analytical instruments.

Key equipment:

+ **X-ray tomograph – v|tome|x m300**
The computer X-ray tomography method enables three-dimensional models of samples in a non-destructive and contactless way. It also permits non-destructive examination of internal microstructures of samples. In connection with top-class software, the method can be used for reconstruction of internal structures of materials, as well as for unique metrological applications, development of new materials, etc.

+ **Furnaces for fire testing**
A fire furnace for studying behaviour of materials at high temperatures, a furnace for

X-ray tomograph – v|tome|x m300



Areal loading system

testing fire-resistance of construction materials, a furnace for combustion heat testing, a furnace for floor covering tests, a furnace for testing exposure to thermal effects of a single burning item (SBI test), a furnace for testing flammability of construction products exposed to direct effects of flames.

+ **Areal loading system**
This is a comprehensive system of effective areal loading of structural components and sections under laboratory conditions. The loading is applied to components being tested primarily by negative pressure (vacuum) with optional combination of areal effects with linear effects or point effects applied by a system of hydraulic cylinders. Depending on the device (vacuum pump) capacity, the system is capable of exerting loads at different loading levels up to a maximum loading capacity of 100 kN/m². The system includes a comprehensive measuring system registering intensities of areal, linear and point loading. In selected areas of the sample being tested, horizontal and vertical deformations can be registered as well, including permanent deformation of different materials in critical areas of the components.

+ **Mobile mapping system Riegl VMX-450**
Used for detailed spatial documentation of cities and roads. The output is a high-density cloud of laser points and georeferenced colour photos, used for creation of 3D models of cities, documentation of roads, road condition analysis including safety inspections, property passports and inventorying. The data can also be used for monitoring of linear structure construction, urbanist studies and analyses, 3D surveying of passability of railway lines and roads.

+ **3D printing of extra-large functional prototypes**
Device for quick production of extra-large functional prototypes consisting of the largest FDM printer on the market and an optical scanner. The maximum printing dimensions are 690×690×1900 mm and resolution from 2.5 microns.

Top ranked publications

+ Hlavínek, P., Stříteský, L., Pešoutová, R., & Houdková, L. (2016). Biogas production from algal biomass from municipal wastewater treatment. *Waste and Biomass Valorization*, 7(4), 747–752.

+ Holomek, J., Bajer, M., Barnat, J., & Schmid, P. (2015). Design of composite slabs with prepressed embossments using small-scale tests. *Structural Concrete*, 16(1), 137–148.

+ Novák, D., Vořechovský, M., & Teplý, B. (2014). FReET: Software for the statistical and reliability analysis of engineering problems and FReET-D: Degradation module. *Advances in Engineering Software*, 72, 179–192.

+ Krivenko, P., Drochytka, R., Gelevera, A., & Kavalerova, E. (2014). Mechanism of preventing the alkali–aggregate reaction in alkali activated cement concretes. *Cement and Concrete Composites*, 45, 157–165.

+ Balek, V., Bydžovský, J., Drochytka, R., Buntsewa, I. M., & Beckman, I. N. (2013). Hydration of tricalciumsilicate (Ca3SiO5) investigated by emanation thermal analysis. *Journal of thermal analysis and calorimetry*, 111(1), 335–339.

Applied research results

+ **Research into concrete technologies**
In this segment, the Centre focuses primarily on temperature control in high-performance concrete, study of behaviour of concrete and cement composites exposed to high temperatures. To improve utility properties and reduce costs, we have dealt with partial replacement of cement with zeolite in aerated concretes. A lot of attention has also been paid to fluidised-bed (FBC) and high-temperature fly ash, designing a new hydraulic bonding agent based on FBC, FBC as an ingredient for Portland cement, and maximum substitute for cement for high-performance floor screeds.

+ **Jointing compound with variable modulus of elasticity**
The tunnel rehabilitation project resulted in the development of a new jointing compound designed so that its modulus of elasticity is in a certain relation to the modulus of elasticity of the jointed masonry, reducing the strain on the joint or at the interface between

Mapping car

the brickwork and the jointing compound, thus preventing its mechanical degradation. The jointing compound is protected by utility model no. 28735 and a patent application has been filed.

+ **Design of a functional prototype of a special cooling circuit**
The device will be used for cooling server rooms or entire data centres. The development is based on CFD simulations of air flow, simulations of cooling capacity of different evaporator geometries.

+ **Solidified mixture containing inorganic waste for use in construction industry**
The subject matter of the technical solution is a solidified mixture containing inorganic waste, using secondary raw materials as the solidifying bonding agent, environmentally wholesome and suitable for use in the construction industry thanks to its properties.

+ **Equipment for modifying asphalts with rubber granules from used tires, including work procedures for production of special asphalt mixtures**
The result of results into implementation of new thin road layers with noise-reducing properties and higher resistance to all types of road cracking, including technique and equipment for production of asphalts modified with rubber granules with just-in-time delivery.

Important international research projects and involvement in professional networks

The Centre closely collaborates with major European research universities (Bauhaus University in Weimar, Technical University of Vienna, Technical University of Stuttgart, Danish Technical University, Buch International University of Sarajevo, Universitat Politècnica de Catalunya) and scientific centres (BAM Federal Institute for Materials, Research and Testing, CSTB Scientific and Technical Construction Centre) as well as similar centres in new EU member states and candidate states (Croatia, Serbia).

+ **Research into coupled sheet-concrete slabs**
In collaboration with the Universitat Politècnica de Catalunya, we did research of coupled sheet-concrete slabs, and have published results of vacuum testing (bending tests applying areal loading) as well as small shearing tests on manufactured samples. The persons in charge of collaboration are Ing. Josef Holomek and Doc. Ing. Miroslav Bajer, CSc.

+ **Aspects of quasi-fragile materials**
Teams from Brno UT and TU Vienna collaborate on research into aspects of fracture in quasi-fragile materials, determination of relevant values of fracture mechanical parameters of models used in structural analyses, and characterisation of materials with respect to fault spreading, including description of the fault process zone. The persons in charge of collaboration are Prof. Ing. Zbyněk Keršner, CSc. at the Brno UT and Dipl.-Ing. Dr. techn. Ildiko Merta, MSc. at the TU Vienna.

3

CVVOZE – Centre for Research and Utilisation of Renewable Sources of Energy

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Research program of the centre and significant researchers

The Centre for Research and Utilisation of Renewable Sources of Energy (CVVOZE) is a research institution of the Brno University of Technology Faculty of Electrical Engineering and Communication Technologies. Four expert institutes are involved in its operation: Department of Power Electrical Engineering and Electronics, Department of Control and Instrumentation, Department of Electrical and Electronic Technology and Department of Electrical Power Engineering.

The global objective of the CVVOZE is to gradually evolve into a top-class research institution with research and development capacities for handling of comprehensive issues of renewable sources of energy, including the areas of electrochemistry, electromechanics, electrical technology, electrical power engineering, electrical actuators, automation, metering and industrial electronics.

The strategic tools for achieving this objective are:

+ conduct of top-class primary and applied research in the promising area of renewable sources of energy, including applications;
+ scientific training of highly qualified employees, doctoral graduates, for the industry;
+ close collaboration with the application sphere.

The Centre's focus covers the whole range of disciplines in the area of electrical engineering in connection to the current topic of renewable sources of energy and their efficient utilisation in manufacturing, transport and the energy industry.

Significant researchers:

+ **Prof. Ing. František Zezulka, CSc.**
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  Prof. Zezulka is a head of the research programme "Optimisation of electromechanical energy conversion". He is an expert on experimental power networks.

+ **Prof. Ing. Jiří Kazelle, CSc.**
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  Head of the research programme "Chemical and photovoltaic sources of energy". His main research activities include electrochemical sources of electrical energy, optimisation of alkaline storage batteries and new electrode materials for alkaline storage batteries.

+ **Doc. Ing. Petr Toman, Ph.D**
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  Head of the research programme "Generation, transmission, distribution and use of electricity" and expert on electricity distribution and security of electricity networks.

+ **Doc. Ing. Petr Bača, Ph.D**
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  Head of the Department of Electrical and Electronic Technology. Expert in the area of conventional electrochemical sources of current, particularly lead storage batteries.

Climate chamber with vibration excitation

+ **Doc. Ing. Petr Beneš, Ph.D**
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Head of the accredited Measurement Laboratory and expert in the area of measurement of electric and non-electric quantities.

+ **Ing. Ondřej Vítek, Ph.D**
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Head of the Department of Power Electrical Engineering and Electronics. Expert in the area of design and efficiency optimisation of electric machines.

Unique research infrastructure of the centre

Top-class instrumentation and laboratory equipment were acquired under the Operational Programme Research and Development for Innovation, guaranteeing excellent research and development results. An example is the Switchgear Laboratory (short-circuit laboratory) with parameters unique in the Central European region. The Centre's research work is done in three buildings of the TU campus on the site Pod Palackého vrchem in Brno – Královo Pole, on the premises of the Faculty of Electrical Engineering and Communication Technologies. The CVVOZE

PowerLab is located in the Professor List Science and Technology Park.

Key equipment:

+ **Electric machine testing workplace**, used for testing electric machines up to a mechanical output of 85 kW. It consists of an ASD P085 dynamometer with a power supply, a frequency converter with a sinusoidal filter and adjustment transformer for powering of tested motors, an output analyser for measurement of electric quantities, and units for measuring winding resistance and temperature using Pt100 sensors and thermocouples.

+ **Climate chamber with vibration excitation**
A measuring system enabling certified testing of various equipment at temperatures between -70 °C and 180 °C, relative humidity between 10 % and 95 %, and vibrations of up to 100 g. The equipment permits testing of properties and parameters of technical equipment under various precisely defined ambient conditions.

+ **Photovoltaic panel tester**, part of the PVLab accredited laboratory. It is used for determining electric parameters of photovoltaic panels under standard measuring conditions.

+ **Switchgear laboratory (short-circuit laboratory)**
A comprehensive laboratory enabling research in the area of switchgear and other electrical engineering equipment during passage of large short-circuit currents (up to 150 kA). It is a unique laboratory setup in the academic sphere, at least on the Central European scale.

+ **Very high voltage sources**
A system of voltage sources for research into behaviour of electrical engineering equipment at high voltage levels (pulse source up to 1 MV, alternating source up to 300 kV) enabling measurement of partial discharges.

Very high voltage sources

Top ranked publications

+ Křivík, P., Micka, K., Bača, P., Tonar, K., & Tošer, P. (2012). Effect of additives on the performance of negative lead-acid battery electrodes during formation and partial state of charge operation. *Journal of Power Sources*, 209, 15–19.

+ Solčanský, M., Macháček, M., Boušek, J., & Poruba, A. (2009, September). Chemical passivation of a silicon surface for minority carrier bulk-lifetime measurements. In *24th European Photovoltaic Solar Energy Conference Hamburg*.

+ Fialka, J., & Beneš, P. (2013). Comparison of methods for the measurement of piezoelectric coefficients. *IEEE Transactions on instrumentation and measurement*, 62(5), 1047–1057.

+ Mastny, P., Moravek, J., & Drapela, J. (2015). Practical experience of operational diagnostics and defectoscopy on photovoltaic installations in the Czech Republic. *Energies*, 8(10), 11234–11253.

+ Kazda, T., Vondrák, J., Di Noto, V., Sedlaříková, M., Čudek, P., Omelka, L., … & Kašpárek, V. (2015). Study of electrochemical properties and thermal stability of the high-voltage spinel cathode material for lithium-ion accumulators. *Journal of Solid State Electrochemistry*, 19(6), 1579–1590.

Switchgear laboratory

Applied research results

Patents:

+ Method of regulation for the camera shutter activation time and equipment for carrying out the method.
  Patent number: 303282, patent granted on: 11. 7. 2012, patent owner: Brno UT.

+ Current metering transformer.
  Patent number: 304406, patent granted on: 5. 3. 2014, patent owner: Brno UT.

+ Assessment method for determination of probability of location of asymmetrical faults in power grids and monitoring system designed for carrying out the method.
  Patent number: 305209, patent granted on: 29. 4. 2015, patent owner: Brno UT.

+ Vibration generator for generation of electricity.
  Patent number: 305591, patent granted on: 18. 11. 2015, patent owner: Brno UT.

Prototypes:

+ Hájek, V.; Kuchař, L.; Vítková, E.: P2SZ; DC motor, diameter 80 mm. 2012, (FR-TI1/067), ATAS elektromotory Náchod a.s.

+ Hájek, V., Vítková, E., Krtička, J.: Asynchronous motor 60–100 W, 230 V rationalised. 2012, (FI-IM4/053), ATAS elektromotory Náchod a.s.

+ Baxant, P., et al.: Luminance Distribution Analyzer – LDA 1.0, Technické sítě Brno, a.s.

+ Bradáč. Z., Přikryl R.: Electronic communication system KkWEBMON, 2012, (FR-TI1/528), Beta Control s.r.o.

International and domestic recognition of the centre

+ The CVVOZE PowerLab is a part of the Roadmap of Large Infrastructures for Research, Experimental Development and Innovation of the Czech Republic for 2016–2022.

+ One of the most influential exhibits of the AMPER 2014 trade fair was the "Design range of compact driving axles for light vehicles with integrated power actuation", developed by EVEKTOR, spol. s r.o. A significant contribution to this achievement, recognised with the GOLD AMPERE award, was made by the CVVOZE research team headed by Doc. Pavel Vorel under project no. TA01011060 (TA CR).

Important international research projects and involvement in professional networks

+ **"Nanoelectronics for an Energy Efficient Electrical Car (E3Car)"**
  The project took place in 2009–2012 as part of the platform ENIAC JOINT UNDERTAKING, SUB-PROGRAMME 2,4 Semiconductor, Automotive, Industrial, Avionics, involving 33 institutions from 11 EU countries.
  The subject matter of the project was research and development of nanoelectronic technologies, components, circuit architectures and modules for electric cars and vehicles, and demonstration of these modules in a final system.

+ **"Internet of Energy for Electric Mobility (IoE)"**
  The project, part of the ARTEMIS programme, took place in 2011–2014. The project involved 40 research institutions from 10 EU countries. The subject matter of the IoE project was research in the area of charging infrastructure for electric cars with a focus on application of the Smart Grids approach. The Centre's research teams focused on development of own power and control circuits of the quick charger.

+ **CVVOZE PowerLab**
  is integrated in the international network European Distributed Energy Resources Laboratories (DERlab).

Photovoltaic panel tester

RECETOX – Centre for Research of Toxic Compounds in the Environment

Faculty of Science,
Masaryk University of Brno

Kamenice 753/5, pavilon A29
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Czech Republic

Research Centre
for Toxic Compounds
in the Environment

Ředitelka:
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Research projects:
Prof. RNDr. Luděk Bláha, Ph.D.
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RECETOX.MUNI.CZ

Research program of the centre and significant researchers

The REsearch CEntre for TOXic Compounds in the Environment, RECETOX) is an autonomous department of the Masaryk University Faculty of Science. It was established in 2010 with support from the project CETOCOEN of the EU Structural Fund, Operational Programme "Research and Development for Innovation".

It consists of four scientific programmes, three core research infrastructure facilities and two application centres. The Centre's research activity proceeds in ten working groups associated in four scientific programmes:

+ **Environmental Chemistry and Modelling**
+ **Organic Photochemistry and Supramolecular Chemistry**
+ **Protein Engineering**
+ **Ecotoxicology**

The Centre's highly qualified team of international experts continues more than a quarter century of experience in the area of study of environmental and health risks associated with toxic compounds.

Our objective is to respond to societal needs defined in strategic documents and supply reliable information about contamination in air, water, soil and food and its impact on human health, biological diversity and ecosystems.

Our widely based research combining chemical, biological, ecological and epidemiological approaches is supported by modern research infrastructure. We offer open access to this infrastructure for the international scientific community, aiming to contribute to further development and integration of environmental research for sustainable development.

Significant researchers:

+ **Prof. RNDr. Jana Klánová, Ph.D.**
  klanova@recetox.muni.cz
  Prof. Klánová heads the programme Environmental Chemistry and Modelling. In her work, she combines laboratory experiments with field study (study of sources and behaviour, distribution and transport, exposure and bioacumulation of chemicals and associated risks) and leads towards a broader understanding of mechanisms of environmental processes and their impacts.

+ **Prof. RNDr. Petr Klán, Ph.D.**
  klan@sci.muni.cz
  Prof. Klán is the head of the programme Organic Photochemistry and Supramolecular Chemistry. In his research, he focuses on

mechanistic organic photochemistry with an emphasis on interdisciplinary problems in chemistry, physics and environmental sciences, e.g., by means of studying photoprocesses occurring on snow and ice, and development of so-called photo-activated compounds.

+ **Prof. Mgr. Jiří Damborský, Ph.D.**
jiri@chemi.muni.cz
Prof. Damborský heads the Protein Engineering programme, which studies the basic principles of enzyme catalysis and develops new protein and cellular biocatalysers applicable in the environment, chemistry and biomedicine. He also focuses on development of new methodological procedures and software tools for effective design of protein structure.

Cascade impactors

+ **Prof. RNDr. Luděk Bláha, Ph.D**
blaha@recetox.muni.cz
Prof. Bláha heads the Ecotoxicology programme. He studies mechanisms and long-term impacts of acute and chronic exposure to toxic compounds in contaminated environmental components – water, sediments, atmosphere and soil, issues of bioacumulation and biological availability of toxic chemicals and natural products (cyanobacterial toxins) from the molecular and cellular level up to organisms and ecosystems.

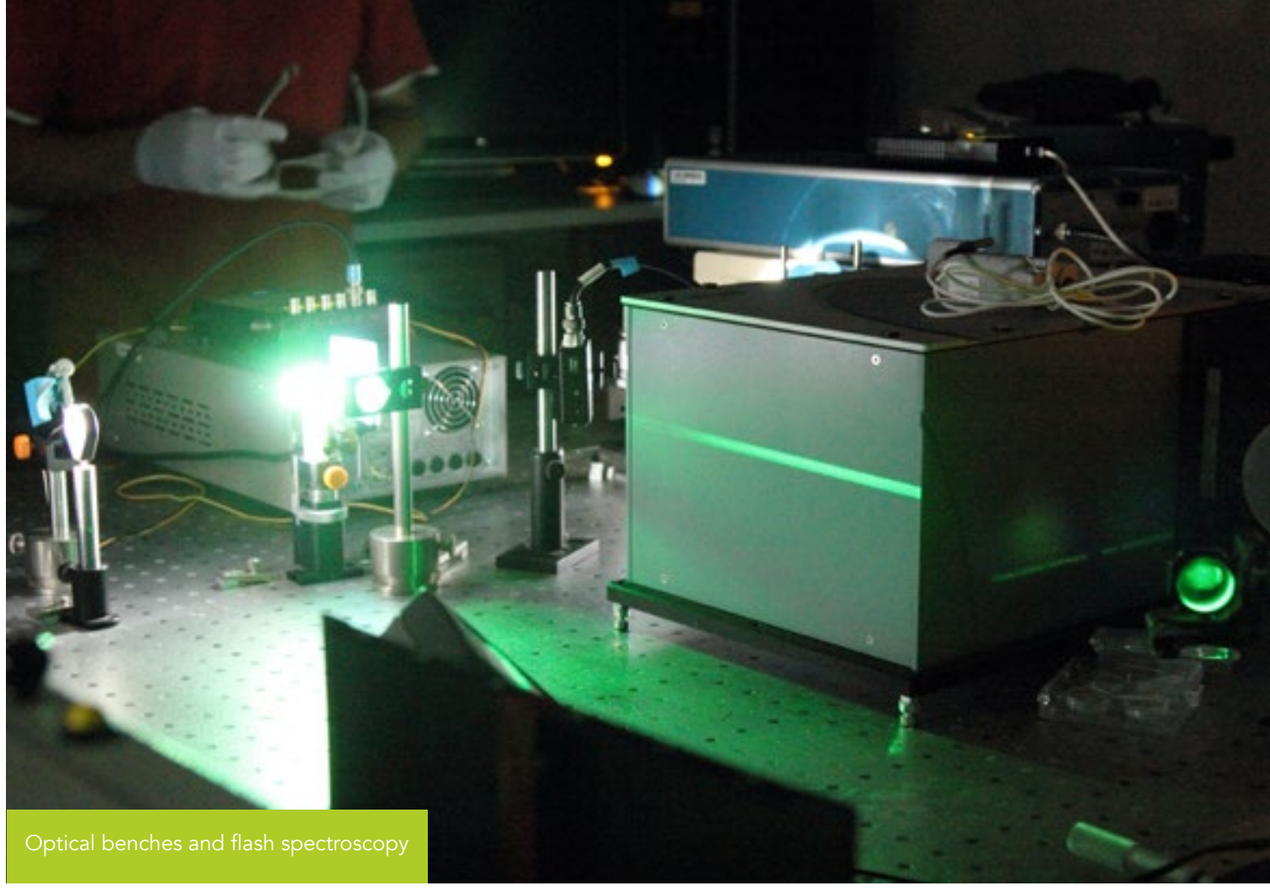
Unique research infrastructure of the centre

The RECETOX research infrastructure has been included since 2010 in the Czech Road Map of Research Infrastructures, and has defended its inclusion in 2015. It supports research programmes, implements its own research projects, and is freely accessible to the international scientific community in an "open access" regime. It is effectively divided among different scientific teams, and partly centralised in three core facilities:

+ Trace analytical laboratories (accredited under ČSN EN ISO/IEC 17025:2005)
+ GENASIS information system
+ ELSPAC long-term study epidemiological database

Key equipment:

+ **Optical benches and flash spectroscopy** for measuring rapid kinetic effects
+ **Franz diffusion cell** for in vitro assessment of dermal exposure



Optical benches and flash spectroscopy

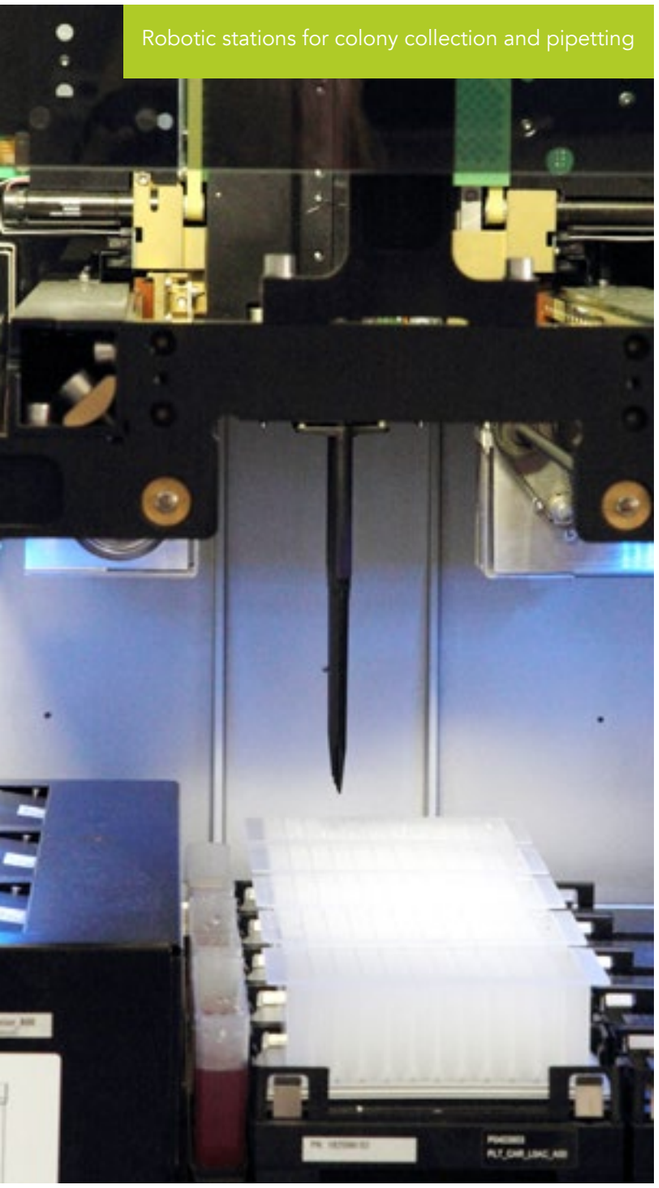
+ **Cascade impactors** for selective sampling of size-differentiated atmospheric particles
+ **Robotic stations for colony collection and pipetting**
+ **Passive air samples**

Top ranked publications

+ Havel, V., Yawer, M. A., & Sindelar, V. (2015). Real-time analysis of multiple anion mixtures in aqueous media using a single receptor. *Chemical Communications*, 51(22), 4666–4669.
+ Ghosh, T., Slanina, T., & König, B. (2015). Visible light photocatalytic reduction of aldehydes by Rh (III)–H: a detailed mechanistic study. *Chemical Science*, 6(3), 2027–2034.
+ Amaro, M., Brezovský, J., Kováčová, S., Sýkora, J., Bednář, D., Němec, V., ... & Paruch, K. (2015). Site-specific analysis of protein hydration based on unnatural amino acid fluorescence. *Journal of the American Chemical Society*, 137(15), 4988–4992.
+ Jarošová, B., Javůrek, J., Adamovský, O., & Hilscherová, K. (2015). Phytoestrogens and mycoestrogens in surface waters – Their sources, occurrence, and potential contribution to estrogenic activity. *Environment international*, 81, 26–44.
+ Zheng, Q., Nizzetto, L., Li, J., Mulder, M. D., Sáňka, O., Lammel, G., ... & Zhang, G. (2015). Spatial distribution of old and emerging flame retardants in Chinese forest soils: sources, trends and processes. *Environmental science & technology*, 49(5), 2904–2911.

Applied research results

RECETOX scientists have developed a number of patents, e.g., a US patent for methods of preparation and use of derivatives of macrocyclic compounds of glycoluril (team of Doc. Vladimír Šindelář, Ph.D.), US patent by the team of Prof. Damborský for research into stabilisation of proteins by designing access tunnels, and patents for several water and air sampling devices under the Environmental Chemistry programme.



Robotic stations for colony collection and pipetting

Another type of outcome is the **GENASIS** environmental database, consisting of a repository of data on the environment and providing comprehensive information about its chemical contamination, including temporal and spatial context, and making data accessible intelligibly and clearly in a map format on a visualisation portal. Interest in using the GENASIS database and its sibling products (**ELSPAC** epidemiological database) has been shown domestically and by international organisations such as the UN Environment Programme (UNEP) and the World Health Organisation (WHO) and other institutions dealing with the environment.

International and domestic recognition of the centre

+ The team of Prof. Damborský won, in May 2014 and in 2015, the MU Chancellor's Award for extraordinary research results of international importance (J. G. Mendel Award) for research into stabilisation of proteins by designing access tunnels.

+ Second place in the competition Best Collaboration of the Year between businesses and the research sphere (US Chamber of Commerce) for the project Bionsensor for monitoring toxic compounds in the environment (November 2014).

+ Werner von Siemens Award in 2014 and 2015.

+ Prof. RNDr Petr Klán, Ph.D. – Rudolf Lukeš Award (2014) for excellent results of international importance in the area of organic, bioorganic and medical chemistry (Czech Chemical Society).

Important international research projects and involvement in professional networks

+ **Arctic Health Risks: Impacts on health in the Arctic and Europe owing to climate-induced changes in contaminant cycling (ArcRisk) (7th FP, 2009–2013)**
The project provided new information on chemical properties and environmental behaviour of typical contaminants in Arctic conditions, results of models describing, under selected climate scenarios, transfer of chemical contaminants from source regions to the Arctic and their further development, including entry into food chains, and comparison of information from Arctic health studies with results of studies focused on effects of contamination on populations in selected areas of Europe.

+ **Solutions for present and future emerging pollutants in land and water resources management – SOLUTIONS (603437), (7th FP, 2013–2018)**
The project objective is to establish a conceptual framework for water and environmental policy. It combines innovative chemical and effect-based monitoring tools with a complete range of exposure, impact, risk and assessment models. The European consortium is headed by the Helmholtz Centre for Environmental Research UFZ.

+ **RECETOX has operated passive air sampling networks in the CR since 2003, in Europe since 2006 (in cooperation with EMEP and other partners) and in Africa since 2008.**
More HERE.

Passive air samples

Franz diffusion cell

5

CEPLANT – Regional R&D centre for low-cost plasma and nanotechnology surface treatments

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Contractual research:
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CEPLANT.CZ

Research program of the centre and significant researchers

The CEPLANT Centre was established at the Masaryk University of Brno, Institute of Physical Electronics, in December 2010. The main focus of the Centre is applied research into plasma sources and plasma modification of surfaces for large-scale industrial clients, with which the Masaryk University successfully follows on more than 50 years of tradition of applied research into physics of plasmas at its own Institute of Physical Electronics.

The CEPLANT provides fast, flexible and highly professional solutions to requirements primarily of innovative small and medium-sized businesses in the area of applied research into low-cost plasma technologies and nanotechnological surface treatments. The Centre offers the following services:

+ plasma surface treatments – refinement of material surface using modern, environmentally friendly and economic plasma technologies that modify surface properties while retaining original volumetric properties of materials;

+ "turnkey" designs of plasma sources – on customer request, we build a required plasma source, including preceding comprehensive testing and optimisation of plasma treatments, and equipment installation and operator training;

+ deposition of thin layers – development of a wide range of functional layers for obtaining required surface properties (deposition of hard and protective layers, production of nanocomposite materials, etc.);

+ surface and volumetric analysis of materials – study of surface morphology and imaging, measurement of mechanical, chemical and optical properties of surfaces, physical/chemical diagnostics (component/molecular composition, bonding states of molecules).

The CEPLANT is a reliable partner in searching for solutions to technological problems of companies and implementation of scientific research projects.

Significant researchers:

+ **Prof. Mirko Černák, CSc.**
cernak@physics.muni.cz
Prof. Černák is the Director of CEPLANT scientific research centre and manager of all the Centre's scientific activities. He is the father of the plasma technology known as DCSBD (Diffuse Coplanar Surface Barrier Discharge), which is a strong competitor to industrial plasma source such as the corona. He specialises in physics of plasmas, plasmatic chemistry, applied electrostatics, fundamental and applied research into discharge mechanism under atmospheric pressure.

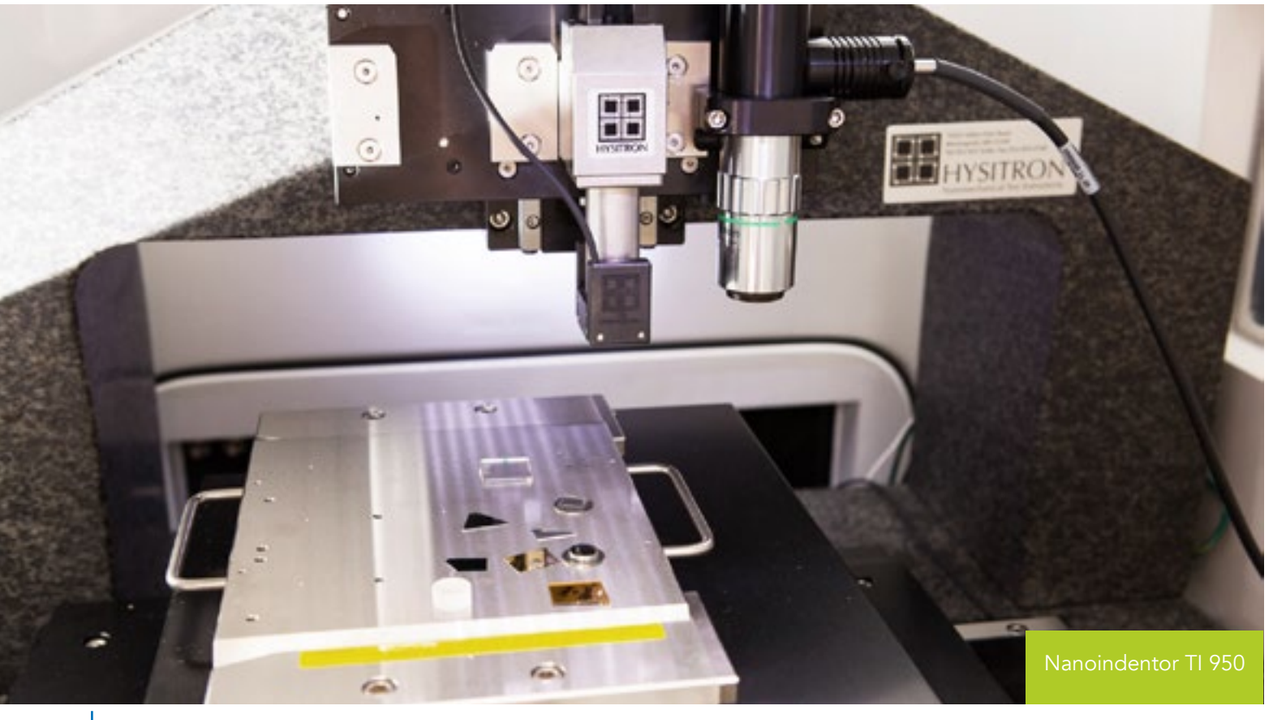
+ **Doc. RNDr. Vilma Buršíková, Ph.D.**
vilmab@physics.muni.cz
She works as a head of the material surface diagnostics group at the CEPLANT. Doc. Buršíková is an expert in the area of mechanical properties of thin layers and plasma-treated materials. Her team consists of quality scientists, who have available top-class technical equipment for comprehensive surface analysis of materials, both physical and chemical. Besides the above, her domain is deposition of thin layers in plasmas.

+ **Mgr. Dusan Kováčik, Ph.D.**
dusan.kovacik@mail.muni.cz
The research area of Dr. Kováčik is development of plasma sources under atmospheric pressure, plasma surface treatments (hydrophilising, plasma-induced grafting, plasma polymerising) of various materials, such as polymers, nonwoven fabrics, sheets, nanofibres. Besides, he is responsible at the CEPLANT for transfer of research results into practice and industry.

+ **Doc. Mgr. Petr Vašina, Ph.D.**
vasina@physics.muni.cz
At the CEPLANT, Doc. Vašina heads the research group on thin layer deposition. His specialisation is study of elementary processes, diagnostics and modelling of reactive plasmas, study of the hybrid PVD-PECVD process and its application to preparation of thin layers, sputtering deposition with high-capacity pulses and preparation of thin layers.

Unique research infrastructure of the centre

The Centre has available a wide range of modern scientific instruments that can compete with the best European research institutions. Moreover, the composition of the instruments is totally unique and permits provision of comprehensive and highly expert services in the area of plasma nanotechnologies and surface diagnostics. The Centre's infrastructure includes modern plasma sources in various configurations for various materials and surface shapes.



Nanoindentor TI 950

The diagnostic instruments for subsequent analysis and detection of changes in material surfaces are the second part of the infrastructure built.

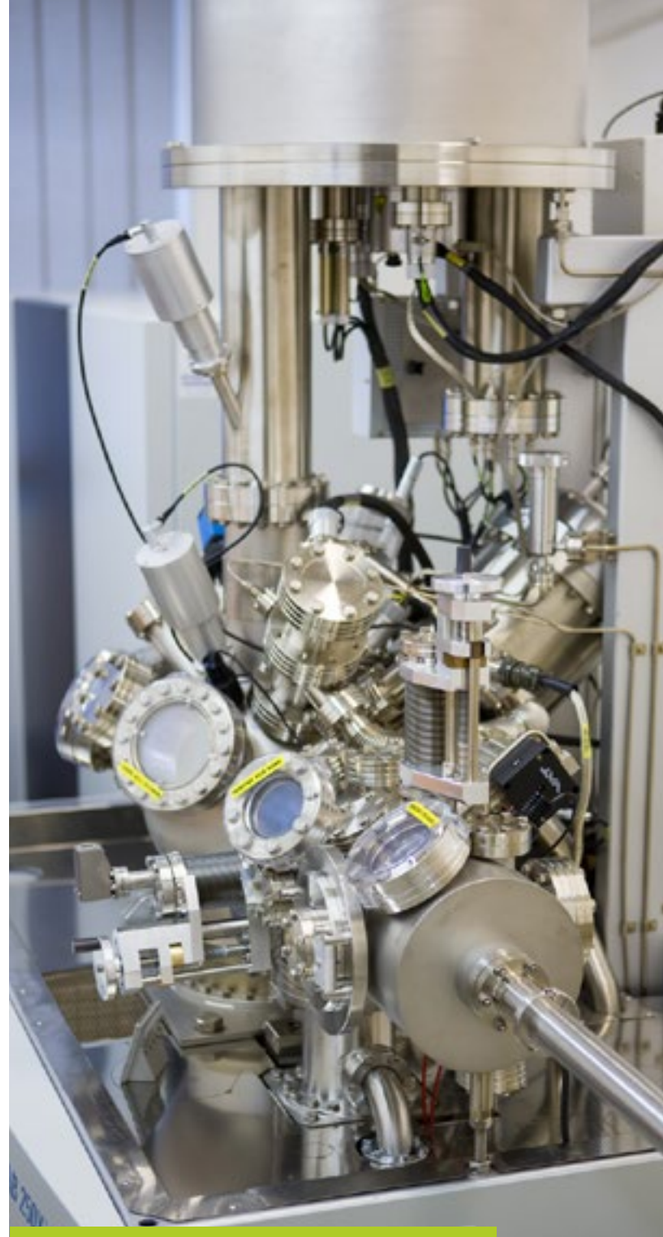
Key equipment:

+ **DCSBD plasma sources in various configurations**
DCSBD plasma sources generating "cold plasma" and permitting non-destructive material surface treatment under normal atmospheric pressure. They are available at the Centre in many configurations for different materials and customer requirements (material dimensions, surface shape and structure, treatment speed, etc.). Moreover, scaling-up is possible for sizeable samples and high treatment speeds.

+ **Magnetron sputtering system**
The latest multifunction sputtering equipment optimised for both high capacity and versatile uses. The equipment can be used for research and development of new materials as well as routine metallisation, preparation of samples, etc.

+ **X-ray photoelectron spectroscopy XPS Escalab**
Multi-instrumental XPS spectrometer with unique analytical parameters enabling highly surface-sensitive and non-destructive analysis capable of providing comprehensive information about the electron structure and chemical material composition up to a depth of 3–10 nanometres.

+ **Scanning electron microscope FEG-SEM MIRA 3**
Microscope enabling imaging of objects at a resolution up to 1 nanometre. Moreover, EDX and WBS detectors enable detailed examination of elementary composition of materials.


X-ray photoelectron spectroscopy XPS Escalab

+ **Nanoindentor TI 950**
A new generation of nanomechanical instruments enabling excellent resolution and overall performance. It enables many mechanical test and material surface tests (nano-incision and nano-abrasion tests, surface scanning, dynamic measurements, etc.).

Top ranked publications

+ Černák, M., Kováčik, D., St'ahel, P., Zahoranová, A., Kubincová, J., & Tóth, A. (2011). Generation of a high-density highly non-equilibrium air plasma for high-speed large-area flat surface processing. *Plasma Physics and Controlled Fusion*, 53(12), 124031.

+ Žemlička, R., Jílek, M., Vogl, P., Souček, P., Buršíková, V., Buršík, J., & Vašina, P. (2014). Understanding of hybrid PVD–PECVD process with the aim of growing hard nc-TiC/aC: H coatings using industrial devices with a rotating cylindrical magnetron. *Surface and Coatings Technology*, 255, 118–123.

+ Voráč, J., Dvořák, P., Prochazka, V., Ehlbeck, J., & Reuter, S. (2013). Measurement of hydroxyl radical (OH) concentration in an argon RF plasma jet by laser-induced fluorescence. *Plasma Sources Science and Technology*, 22(2), 025016.

+ Hnilica, J., Potočňáková, L., Stupavská, M., & Kudrle, V. (2014). Rapid surface treatment of polyamide 12 by microwave plasma jet. *Applied Surface Science*, 288, 251–257.

+ Skácelová, D., Stupavská, M., Sťahel, P., & Černák, M. (2014). Modification of (111) and (100) silicon in atmospheric pressure plasma. *Applied Surface Science*, 312, 203–207.

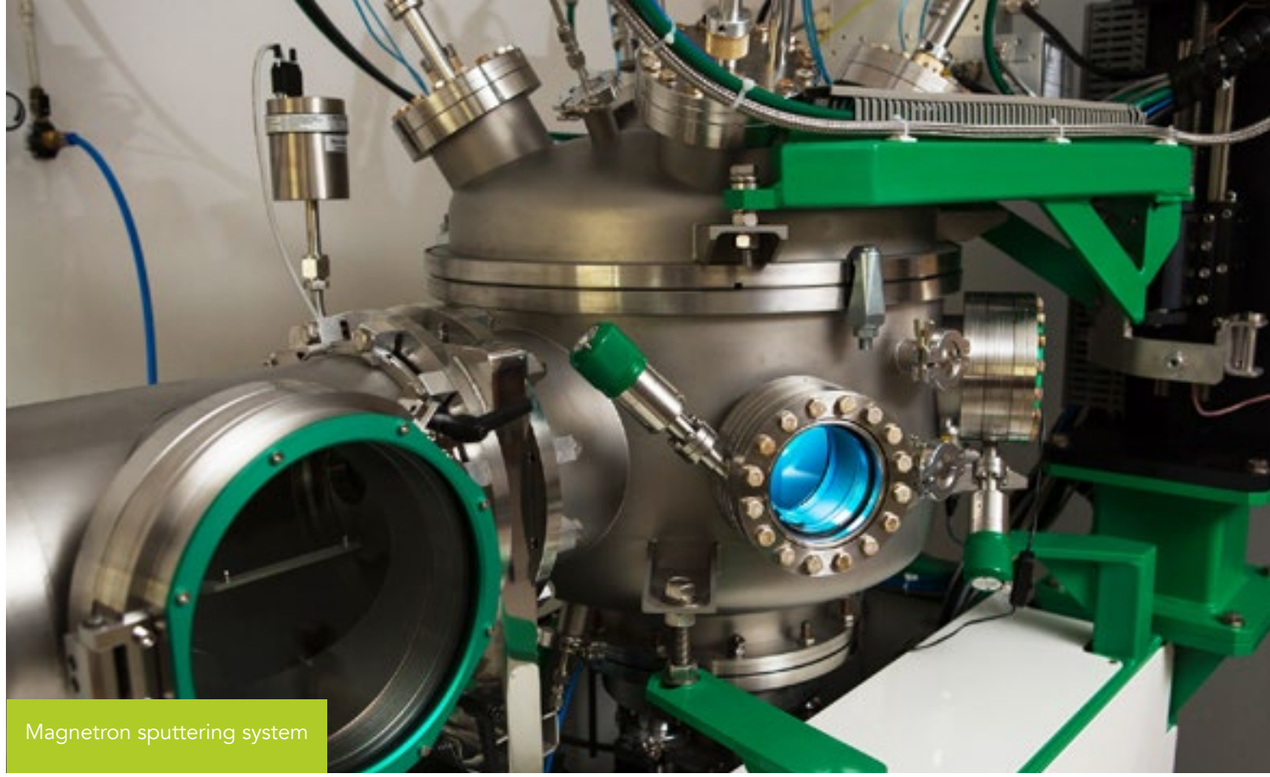
Applied research results

+ TONAK a.s. – leading European manufacturer of hare felt hats; new technology replaced chemical treatment unfriendly to the environment and, most importantly, employees who were in contact with them.

+ SEMO a.s. – treatment of plant seeds to increase their germination ability.

+ KrampeHarex CZ s.r.o. – plasma treatment of polypropylene reinforcement fibres for concrete to reduce occurrence of microcracks in early stages of concrete settling.

Scanning electron microscope FEG-SEM MIRA 3



Magnetron sputtering system

+ TESCAN Orsay Holding a.s. – decontamination of vacuum instrumentation using photocatalytic surfaces in the instruments.

The CEPLANT has become a partner to many more organisations and businesses (in CR and abroad) in development and implementation of DCSBD technology for various specific applications (paper, foils, metals, plastics), but they cannot be listed here due to trade secrets.

International and domestic recognition of the centre

+ Collaboration of the Year award for a project between the CEPLANT team and TONAK, a.s., dealing with implementation of plasma technology in production and replacement of existing environmentally unfriendly and costly chemical methods.

+ The CEPLANT is the only non-German member invited as a partner to join the INPLAS network associating German businesses and scientific research institutions in the area of research and development of plasma generated under atmospheric pressure and implementation of this technology in industry. The German institutions are considered experts in this specific area worldwide.

Important international research projects and involvement in professional networks

The CEPLANT is a member of the INPLAS network, associating primarily German research organisations and business focused on nanotechnologies and plasma technologies for surface treatment, providing their mutual communication and technology transfer to businesses. Moreover, the CEPLANT is a member of CEST, the Austrian competence centre for electrochemical surface technologies, linking business needs with research projects at scientific institutions.

RTI – Regional Technological Institute

Faculty of Mechanical Engineering,
University of West Bohemia in Plzeň

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306 14 Plzeň,
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FACULTY OF MECHANICAL ENGINEERING UNIVERSITY OF WEST BOHEMIA
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Research program of the centre and significant researchers

RTI – Regional Technological Institute is a modern mechanical engineering and technology research centre of the UWB Faculty of Mechanical Engineering in Plzeň. Construction of the research centre started in early 2011 and it has been in full operation since 1 July 2015. Its newly built laboratories, testing facilities and offices currently employ almost 100 researchers, who have available latest experimental equipment, software and computer technology.

The research and development takes place in 11 laboratories and testing facilities with modern equipment and focuses primarily on the following research areas:

+ Modern design of vehicles, including their drivetrain systems: virtual prototyping of modern vehicle designs, vehicle and component testing, research into properties and behaviour of mechanical components of drivetrain systems, etc.

+ Production machines, including upgrading: virtual prototyping of production machines, research into applications of unconventional materials and technologies in design of production machines, etc.

+ Forming technology: analysis of material behaviour during forming processes, creation of new process chains, optimisation of technological parameters of production processes, etc.

+ Research and development of tooling technologies: tooling of complex-shaped surfaces, virtual production process preparation, adjustment to geometry of cutting tools, tooling strategy design, contact and contactless 3D scanning, etc.

Significant researchers:

+ **Doc. Ing. Petr Heller, CSc.**
pheller@rti.zcu.cz
Associate Professor Heller is the head of the research programme Research and development of modern design of vehicles, including their drivetrain systems. He has many years of experience in the area of rail vehicles and has authored numerous patents and utility models applied in the discipline.

+ **Doc. Ing. Václava Lašová, Ph.D.**
lasova@rti.zcu.cz
Associate Professor Lašová is the head of the research programme Research and

Carl Zeiss Prismo 7 Navigator portal measuring machine

Equipment for development of incremental forming

development of production machines, including upgrading. She specialises on finite element method calculations and draws on her practical experience in the area.

+ **Prof. Dr. Ing. Bohuslav Mašek**
masekb@rti.zcu.cz
Professor Mašek is the head of the research programme Research and development of forming technologies. He has raised a number of young scientists in his discipline, and involves them in international collaboration, primarily with German technical universities and research institutes.

+ **Doc. Ing. Jan Řehoř, Ph.D.**
rehor4@rti.zcu.cz
Associate Professor Řehoř is the head of the research programme Research and development of tooling technologies. His team excels in collaboration with industrial businesses and, besides tooling, deals with development of additive technologies and super-accurate plant metrology.

Unique research infrastructure of the centre

Each of the Centre's research laboratories is equipped with specialised technical devices for activities in the specific area of research and development. The key equipment includes, for example:

+ **Carl Zeiss Prismo 7 Navigator portal measuring machine**
One of the most accurate machines for high-speed scanning.

+ **Equipment for development of incremental forming**
Equipment permitting heating and rapid cooling of rolled material and formation of cylindrical, conical and other shapes with rotational symmetry.

+ **CTX BETA 1250 multifunction lathe centre**
Multifunction lathe centre designed for comprehensive tooling of highly complex components.

+ **EOS M290 3D printer**
3D printer permitting production of metal components and prototypes of any desired outer and inner shapes.

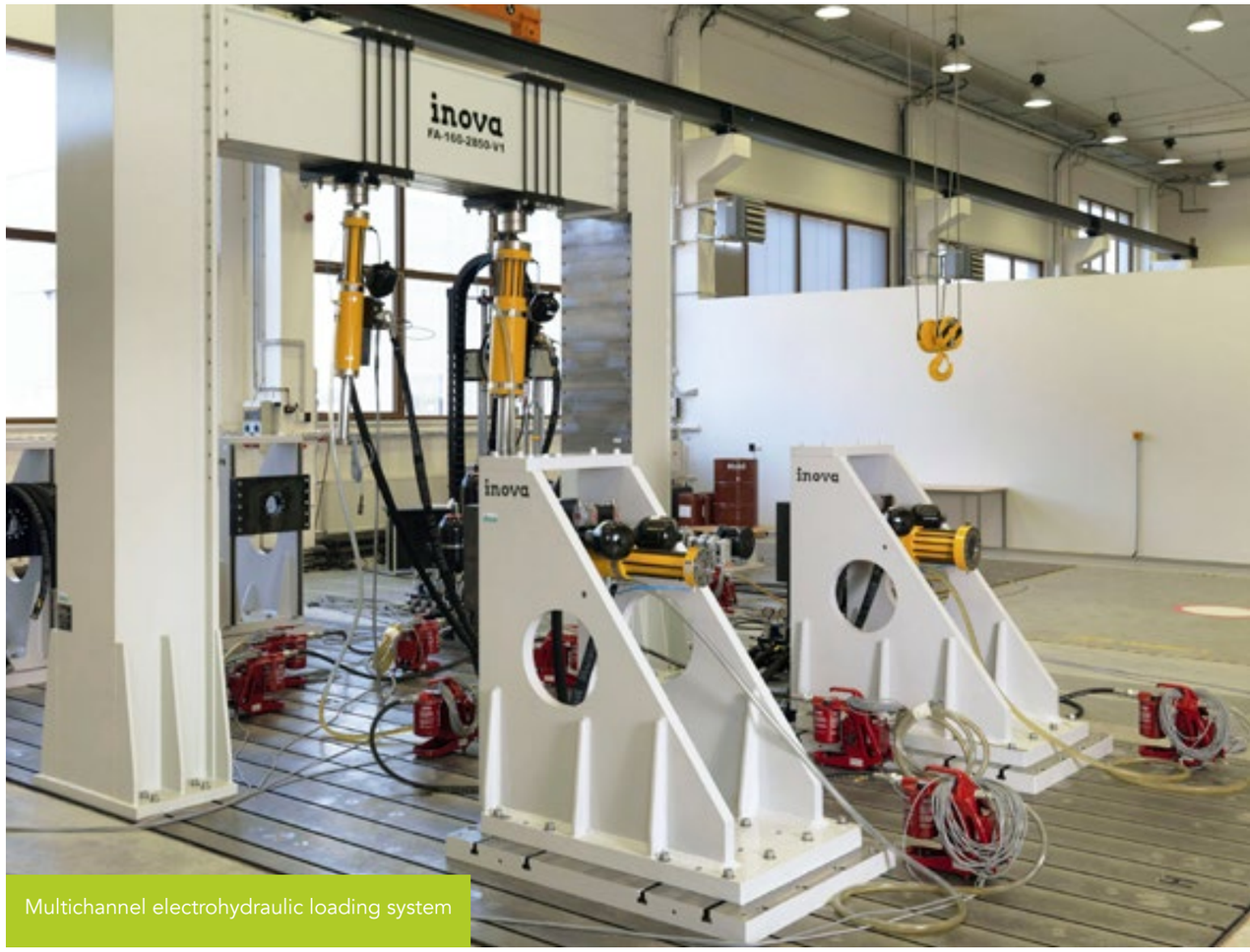
+ **Multichannel electrohydraulic loading system**
A set of autonomous loading cylinders and support structures for dynamic testing of structural components and material samples.

Top ranked publications

+ Spirk, S., & Kepka, M. (2015). Tests and simulations for assessment of electric buses passive safety. *Procedia Engineering*, 114, 338–345.

+ Hnatik, J., Kutlwaser, J., & Sklenicka, J. (2014). Měření řezných sil při obrábění metodou iMachining. *Strojírenská technologie*, 2014, roč. XIX, č. 2, s. 78–82. 1211–4162.

+ Melichar, M., & Kutlwašer, J. (2014). The issue of contactless setup before measuring process. *Procedia Engineering*, 69, 1088–1093.



Multichannel electrohydraulic loading system

+ Zetek, M., & Zetková, I. (2015). Increasing of the Cutting Tool Efficiency from Tool Steel by Using Fluidization Method. *Procedia Engineering*, 100, 912–917.

+ Kucerova, L., Jirková, H., & Masek, B. (2015). Various Approaches to Accelerated Carbide Spheroidization of 54SiCr Steel. *Key Engineering Materials*, 647, 3.

+ Chval, Z., & Cechura, M. (2014). Optimization of power transmission on mechanical forging presses. *Procedia Engineering*, 69, 890–896.

Applied research results

+ **Patent: Hybrid housing for a rail vehicle**
The hybrid design of the shell of the housing for a rail vehicle uses individual housing components made of different materials. The appropriate properties of these materials enable achievement of a weight saving of approx. 1000 kg compared to a steel design. Another unique feature is the use of glue-screw joints in the connection of the composite side parts with the steel substructure, reducing the labour intensity compared to a welded steel design.

+ **Utility model: Device for model material cooling during material and technology modelling**
The technical device for cooling of samples consists of a cantilever fitted with castors at the bottom, and at least two guns are attached to the upper portion of the cantilever.

+ **Functional specimen: Visible component for aerospace**
The functional specimen is used for verification of qualitative properties of a tooled surface on a selected shape from an aerospace aluminium alloy with a very low wall thickness compared to the large surface area.

CTX BETA 1250 multifunction lathe centre

EOS M290 3D printer

+ **Prototype: LMZP 2500 forging press**
The design for a prototype of a crank forging press, characterised by a wide work table and high rigidity.

+ **Functional specimen: Device for calibration of steel pipes after forming**
An innovative tool enabling accurate calibration of pipe diameter along the entire required length in a single stroke.

International and domestic recognition of the centre

+ Professor Bohuslav Mašek received Award of the Minister of Education, Youth and Sports for extraordinary results in research, experimental development and innovation for 2014. In the same year, he received the Award of the German Federal Ministry of Economy and Energy for transboundary cooperation of small and medium enterprises in the area of research, development and education.

+ Associate Professor Petr Heller with his students has repeatedly succeeded in various competitions organised by industrial businesses for the best dissertation, diploma and bachelor's thesis, e.g., in the annual competition for the Emil Škoda Award.

Important international research projects and involvement in professional networks

+ The Regional Technological Institute represents the UWB in Plzeň in the International Association for Public Transport UITP (*Union Internationale des Transports Publics*). Under the auspices of the UITP and in cooperation with ŠKODA ELECTRIC, it is involved in the project FP7-605485-ZeEUS-Zero Emission bUs Systems. The project objective is to demonstrate the advantages of electric mobility in public transport.

+ The Regional Technological Institute is intensively involved in advancing regional Czech-Bavarian cooperation in research and development. Particularly with the Ostbayerische Technische Hochschule Amberg-Weiden and other German organisations in the region, it is working on several joint projects and more are in the pipeline.

7

RCPTM – Regional Centre for Advanced Technologies and Materials

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Research program of the centre and significant researchers

The RCPTM was established in 2010 and follows up on the history of five departments of the Faculty of Science with the objective to concentrate the best research, technical and human potential in the area of nanotechnologies, chemistry and physics. Today, the RCPTM is an autonomous unit integrated into the structure of the Palacký University Olomouc Faculty of Science. The main objective of the RCPTM is excellent research and transfer of advanced products and technologies into diverse areas of everyday life (healthcare, industry, environment) with a special emphasis on the Centre's involvement in international networks and collaborations.

The RCPTM scientific team consists of experts from all around the world. The Centre employs approx. 120 scientists, 25 % of whom come from fifteen different countries. The Centre's activities annually involve dozens of master's and doctoral students. The Centre publishes more than 300 impact-factor publications in professional journals annually. In 2015, publications with an impact factor higher than 5 made up approximately 40 % of all the Centre's publications.

The RCPTM has long been extraordinarily successful in obtaining national and international grants, including the ERC and FP7 (or H2020) projects, which have contributed more than EUR 27 million to the Centre's budget (2010–2015). The Centre contributes to large prestigious scientific collaborations in the area of particle physics (e.g., CERN-ATLAS and Pierre Auger Observatory). The Centre is also actively involved in the University's education activities at every level of study. Even at the bachelor's level, students are involved in the Centre's research teams and the best graduates then become Centre employees as "junior researchers". Last but not least, the Centre implements regular transfer of results into technology practice. In 2011–2015, the Centre collaborated with more than 170 industrial partners, including big companies such as Procter&Gamble (USA), Waters (Germany) and Nanocomposix (USA).

Significant researchers:

+ **Prof. RNDr. Radek Zbořil, Ph.D.**
General Director of the RCPTM, received Award of the Minister of Education, Youth and Sports for extraordinary results in research, experimental development and innovation in 2011. One of the three most cited Czech scientists in 2015 (more than 2200 citations in 2015). Member of the National Innovation Platform in the section Medicines and Medical Technology, and member of the scientific board in the area of chemistry of the Neuron Foundation supporting science. He is also the Director of the Competence Centre for Environmentally Friendly Nanotechnologies and Biotechnologies for Water and Soil Purification established with the support of the Technology Agency of the CR.

+ **Prof. RNDr. Michal Otyepka, Ph.D.**
Holder of ERC-CoG-2015 grant, winner of Neuron Impuls 2014 award for chemistry, where he succeeded with his project Graphene – Biomolecule Interface as a Path to Cyborgs. He is a member of the editorial board of the journal Scientific Reports (of the Nature family). Co-author of NATURE CHEMICAL BIOLOGY, vol.5, iss. 10, pp. 727–733. He has been a scientist at the Centre since its establishment and heads the group Carbon Nanostructures, Biomolecules and Simulations.

+ **Dr. Rajender S. Varma**
Winner of the prestigious 2015 Sustainability Award given by the Environmental Protection Agency (USA). Dr. Varma is a pioneer in the area of "green chemistry" and application of microwaves in organic synthesis and catalysis. He has been a scientist at the Centre since 2014 as the head of the research programme Nanocatalysis in the group Environmental Nanotechnologies.

+ **Prof. Ing. Pavel Hobza, Dr.Sc., FRSC, dr.h.c.**
Included on the list of the world's most cited scientists – Highly Cited Researchers – in both 2014 and 2015 according to Web of Science. The most cited scientist working in the CR. Winner of the most important Czech scientific award – "Czech Head" National Award – for 2008. He has been a scientist at the Centre since its establishment and, besides involvement in scientific activities, he is the coordinator of international cooperation.

+ **Prof. RNDr. Miroslav Hrabovský, DrSc.**
RCPTM representative in the major global consortia ATLAS-CERN, Pierre Auger Observatory and Cherenkov Telescope Array. He has headed RCPTM teams involved in these collaborations, co-author of the concept of unique optical components of the Pierre Auger Observatory. Holder of numerous medals for scientific deeds, such as the Czech Technical University Medal and the Comenius Medal of the Ministry of Education, Youth and Sports. He has been a scientist at the Centre since its establishment and heads the group Optical and Photon Technologies.

Unique research infrastructure of the centre

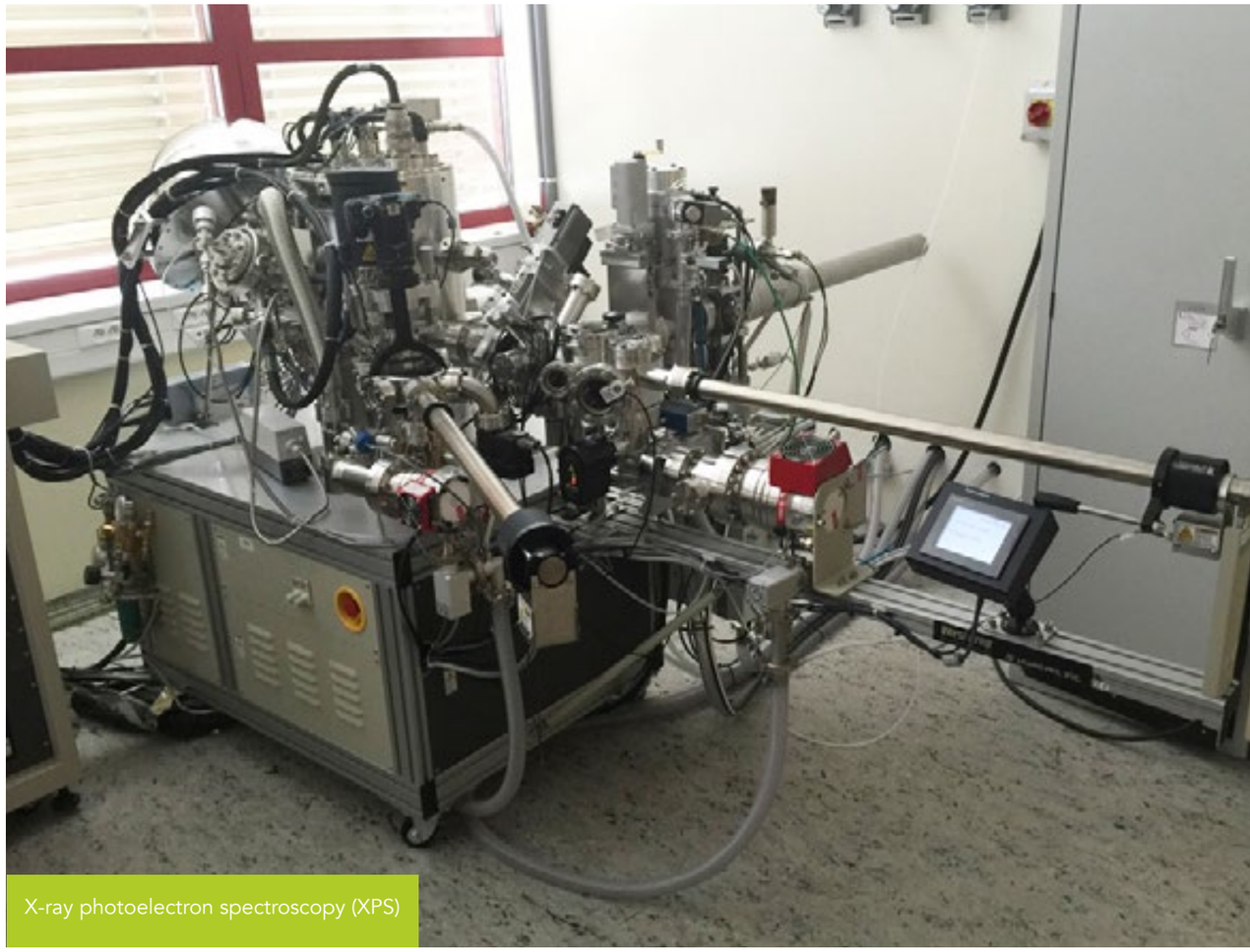
The Regional Centre for Advanced Technologies and Materials has an extensive and modern instrumentation, which it constantly expands and innovates. The Centre offers vacant capacity of its instrumentation infrastructure for partners from industry and government and public institutions to carry out bespoke measurements or analytical operations. The Centre generally offers the services of its eight laboratories: Microscopic Technique Laboratory, Outer Magnetic Field Analysis Technique Laboratory, Structural and Phase Analysis X-ray Technique Laboratory, Spectroscopy, Chromatography and Thermal Methods Laboratory, Material Dimensional and Surface Property Analysis Laboratory, Optical Laboratory, Computational Chemistry Laboratory, and Synthetic Laboratory.

Key equipment:

HR-TEM – High-resolution transmission electron microscope
A transmission electron microscope with high resolution and optional cryo-application with accelerating voltage min. 200 kV, designed for material research, notably observation of structures of objects down to the atomic level. Applications include primarily research, particularly in the areas of powder nanomaterials and biomacromolecules. The equipment has a set of CCD cameras, EDX and EELS analytical techniques and an energy filter (post-column). The system enables maximum level automation and integration of hardware and software (fully integrated digital camera, energy filter, EELS, EDX, etc.). The equipment meets all requirements of technical and safety standards applicable in the CR to this type of equipment.

X-ray photoelectron spectroscopy (XPS)
X-ray photoelectron spectroscopy (XPS) is an advanced technique used for chemical analysis of surfaces of solid substances (also known as ESCA – electron spectroscopy for chemical analysis) or frozen samples. The VersaProbe II (made by Physical Electronics) enables measurement of angle-specific X-ray photoelectron spectroscopy, identification of element contents depending on depth (depth profiling) and planar mapping of surfaces.

Combined system of AFM and Raman spectroscopy
The device includes not only modules designed for description of surface topography, but also modules for study of magnetic properties of surfaces or their electric conductivity. An integral component is a spectroscopy section consisting of Raman spectroscopy. Its integration enables chemical characterisation of the surface of the material in terms of chemical bonds present. The Raman spectrometer is equipped with optical elements achieving a spectral resolution of 0.5 cm^{-1}. The fine-tuned combination of the AFM and the Raman section also enables so-called TERS analysis (tip-enhanced Raman spectroscopy), which provides a spectral map of the sample with a spatial resolution not exceeding 20 nm.



X-ray photoelectron spectroscopy (XPS)

PPMS Dynacool

The system thus permits parallel topographic mapping of surfaces alongside its chemical mapping.

PPMS Dynacool physical property measurement system
The device permits examination of selected physical properties of materials and molecular systems within a temperature range of 1.9 to 400 K, even in magnetic fields up to 9 T. The available measuring modules are designed for obtaining information about thermal capacity, magnetisation, magnetic torque, and electro-transport properties (electrical resistance, Hall effect, I-V curves).

Tooling of optical surfaces
The CNC equipment is designed to permit generation of various shapes of optical surfaces from planar surfaces to general shapes. The surface tooling is done in several steps, from rough surface shaping to final polishing operations, providing the surface with its final shape with surface roughness in the order of single nanometres. A substantial component of these technology centres is diagnostic equipment for assessment of shapes of effective surfaces of the optical components tooled.

Top ranked publications

+ Georgakilas, V., Otyepka, M., Bourlinos, A. B., Chandra, V., Kim, N., Kemp, K. C., … & Kim, K. S. (2012). Functionalization of graphene: covalent and non-covalent approaches, derivatives and applications. *Chemical reviews*, 112(11), 6156–6214.

+ Tuček, J., Sofer, Z., Bouša, D., Pumera, M., Holá, K., Malá, A., … & Zbořil, R. (2016). Air-stable superparamagnetic metal nanoparticles entrapped in graphene oxide matrix. *Nature Communications*, 7.

+ Tuček, J., Błoński, P., Sofer, Z., Šimek, P., Petr, M., Pumera, M., … & Zbořil, R. (2016). Sulfur Doping Induces Strong Ferromagnetic Ordering in Graphene: Effect of Concentration and Substitution Mechanism. *Advanced Materials*, 28(25), 5045–5053.

+ Kment, S., Schmuki, P., Hubicka, Z., Machala, L., Kirchgeorg, R., Liu, N., … & Gregora, I. (2015). Photoanodes with fully controllable texture: the enhanced water splitting efficiency of thin hematite films exhibiting solely (110) crystal orientation. *ACS nano*, 9(7), 7113–7123.

+ Tucek, J., Kemp, K. C., Kim, K. S., & Zboril, R. (2014). Iron-oxide-supported nanocarbon in lithium-ion batteries, medical, catalytic, and environmental applications. *ACS nano*, 8(8), 7571–7612.

Applied research results

+ European patent no. EP2164656: "Method of synthetic of nanopowder iron with a protective oxidic skin of natural and synthetic nanopowder ferrous oxides and oxyhydroxides"

+ Patent no. US20150290677: R. Zboril, J. Soukupova, "Immobilization method of silver nanoparticles to solid substrates" Also as patent no. 303502.

+ Development of special optical components. They include especially cameras for night sky observation (installed, e.g., in Argentina at the Pierre Auger Observatory, and at the Cherenkov Telescope Array).

+ **Mössbauer spectrometers**, commonly distributed worldwide today. The development rests on numerous patents: Patent no. 302439, patent no. 302779.

+ Long-term contractual collaboration with Procter & Gamble US. This collaboration is the result of long-term excellent results in the area of computational chemistry. The collaboration with P&G is based on development of numerical methods of simulation of penetration of chemicals through the upper skin layer.

International and domestic recognition of the centre

+ Prof. Radek Zbořil (General Director of RCPTM) is a member of the Learned Society of the Czech Republic.

+ Prof. Zbořil is a winner of the Award of the Ministry of Education, Youth and Sports for excellent scientific success and innovation.

+ Dr. Manoj B. Gawande is the winner of the most prestigious award of the Indian Government for Indian scientists working abroad – the Gandhi Pravasi Samman Award 2014.

+ Success in the country's largest scientific contest for doctoral students, organised by the Embassy of France in the Czech Republic, is the pride of two young RCPTM scientists, Kateřina Holá (second place in the competition for the Jean-Marie Lehn Award) and Markéta Paloncýová (third place in the competition for the Joseph Fourier Award).

Important international research projects and involvement in professional networks

The Regional Centre for Advanced Technologies and Materials, specifically Prof. RNDr. Michal Otyepka, Ph.D., was a successful applicant for a project to the European Research Council, and since 1 June 2016, he has been the manager of the project ERC-Consolidator grant 2DChem. The project, titled Two-Dimensional Chemistry Towards Graphene Derivatives, aims to understand the chemical rules of the two-dimensional world of carbon materials, particularly fluorographene.

The research and development of unique materials based on graphene and its derivatives is also connected with the RCPTM involvement in the multinational professional consortium Graphene Flagship. Graphene Flagship drives primary research and associated technologies beyond the limits of the silicon era and shifts graphene and other 2D materials from academic research into industrial production and applications for society.

Research infrastructures, including e-infrastructures, are one of the central pillars of national research and innovation systems of each European Union member state, the European Research Area as a whole, and other macroregional and global formations; the RCPTM is proud of being able to contribute with its work to the activity of five such research infrastructures. Specifically, they are as follows: NanoEnviCz, AUGER-CZ, CERN-CZ, CTA-CZ, ELIXIR-CZ.

Acknowledgments

We would like to thank the managers of each of the research centre for their support and helpfulness in the information collection, as well as provision of images for this publication.

Our thanks also go to the Ministry of Education, Youth and Sports of the Czech Republic, without whose financial support the project could not have been implemented. The financial support for the project implementation is drawn from two funding sources, namely the State Budget of the Czech Republic and the project implementer's (Czech Technical University in Prague) own sources.

Finally, we are grateful to the PoMePro implementation team, who did the processing of the analytical information and graphic design of the publication in the form in which it is currently presented to the broad professional public across the EU.

EEB CZ

Contact us

Do you need to establish cooperation with international entities in the area of EEB?

Do you wish to develop a joint research project?

Are you planning to move on and test your idea for broader application?

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