



RCPTM celebrates, with its partners, major achievements in particle and astro-particle research

Since its establishment in 2010, the Regional Centre of Advanced Technologies and Materials (RCPTM) has been involved in several major international projects addressing cutting-edge questions in particle and astro-particle physics, and building on long-term collaboration with experts from the Institute of Physics of the Czech Academy of Sciences. The scientists based at Olomouc are developing innovative optical devices that are key components of instruments for detecting particles of huge energies from CERN's Large Hadron Collider or particles from space detected by the Pierre Auger Observatory in Argentina. In this issue of our quarterly newsletter, we report on two landmark results of such projects.

The latest findings presented by the Pierre Auger Observatory Collaboration in *Science* (The Pierre Auger Collaboration [Science 357, 1266–1270, 2017](#)) confirm the extragalactic origins of cosmic rays with large statistical significance. The Olomouc group has delivered substantial parts of the mirrors for fluorescence telescopes of the observatory, designed its optoelectronic control system, and participates in its day-to-day operations.

In the CERN-ATLAS project, our group contributes to the joint work by analyzing proton collision data, studying top quarks, and participating in the construction of detection devices that will be installed in upcoming detector updates. The objectives of ATLAS include study of the so-called standard model particles and forces acting between them to test supersymmetry theories. The project's

findings may also explain why matter prevailed over antimatter in the early universe, and potentially help efforts to find candidates for the “dark” matter that cosmologists are so eagerly seeking. A fundamental contribution already made by ATLAS is confirmation of the existence of the Higgs boson, a particle responsible for the mass of other particles (The ATLAS Collaboration [Science 338, 1576–1582, 2012](#)). Other important results are also being acquired nearly every day, with the assistance of RCPTM scientists, such as the recent observation of light-by-light scattering (ATLAS Collaboration [Nat. Phys. 13, 852–858, 2017](#)).

Another major collaborative program involving participation of RCPTM experts is the Cherenkov Telescope Array (CTA): a next-generation ground-based observatory for very-high energy gamma-ray astronomy. The group from Olomouc has helped in the search for suitable areas to build the observatory with unique all-sky cameras, and the design, construction and tests of the telescopes.

The newsletter also provides interesting information about other research directions and events in our Centre, such as the collaborations with Nobel Laureates and achievements of efforts supported by ERC grants. I believe it will be an interesting read for you.

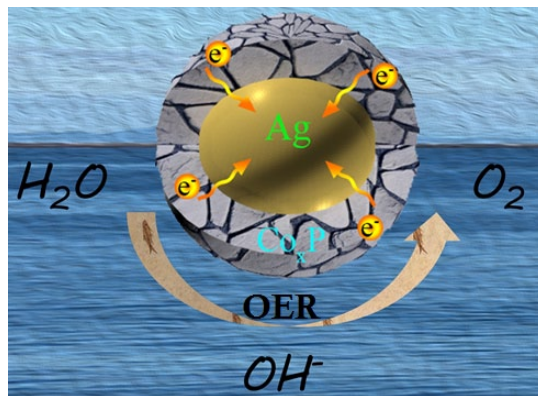
Ondřej Haderka
Scientific Director of RCPTM

Scientific Results

Development of highly efficient nanocatalysts for electrocatalytic water splitting

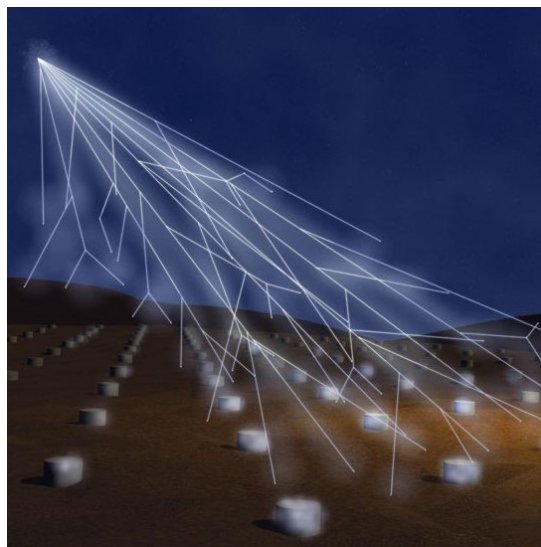
Electrocatalytic water splitting for the production of hydrogen and oxygen is considered a promising and sustainable alternative to natural gas and fossil fuel energy sources. Water-splitting involves two half-reactions: the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER), which occur on the cathode and anode, respectively. The overall efficiency of the electrocatalytic process is often limited by the energy-intensive OER, mainly due to the multiple proton-coupled electron-transfer steps involved and the correspondingly slow kinetics. IrO_2 and RuO_2 are the most efficient known water oxidation catalysts. However, the low abundance and high cost of noble metals have motivated researchers to investigate other catalysts. These studies have identified 3d transition-metal-based (e.g., Fe, Co, Ni) catalysts as promising candidates for stable, inexpensive OER electrocatalysts. An RCPTM research team led by Dr. Gawande, in collaboration with partners at Jilin University in China and Hokkaido University in Japan, have published a paper in *ACS Catalysis* dealing with the preparation of heterogeneous core-shell nanostructures consisting of an Ag core and Co_xP shell ($\text{Ag}@\text{Co}_x\text{P}$). Using this new form of catalyst, due to a specific electronic interaction between the noble metal core and transition metal shell, a reference current density of 10 mA/cm^2 was obtained at a very low input overpotential (310 mV). We believe that these findings will encourage other researchers to explore catalytic and energy

applications of core-shell nanomaterials, which are systematically studied in RCPTM (Gawande M.B. et al. *Chem. Soc. Rev.* **44**, 7540-7590, 2015).



Hou Y., Liu Y., Gao R., Li Q., Guo H., Goswami A., Zboril R., Gawande M.B., Zou X.: $\text{Ag}@\text{Co}_x\text{P}$ Core-Shell Heterogeneous Nanoparticles as Efficient Oxygen Evolution Reaction Catalysts, *ACS Catalysis* **2017**, *7* (10), 7038–7042. IF = 10.614

High-energy cosmic particles come from distant galaxies



The Pierre Auger Collaboration: Observation of a large-scale anisotropy in the arrival directions of cosmic rays above $8 \times 10^{18} \text{ eV}$, *Science* **2017**, *357*, 1266–1270. IF = 37.205

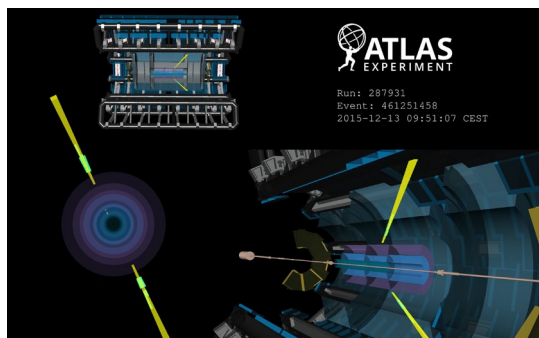
Scientists participating in the Pierre Auger Collaboration, including RCPTM researchers, have found important indications of the origin of cosmic radiation falling on the Earth. In an article published this September in *Science*, they presented experimental evidence that particles with extremely high energies (million times higher than those that can be produced by the largest terrestrial accelerator, LHC) do not come from our galaxy.

Astrophysicists studied more than 30,000 cosmic radiation particles detected by the observatory in Argentina. The direction of their arrival pointed to origins in a region of space hosting a relatively large number of distant galaxies. Although the work confirms the extragalactic origin of the particles, their precise sources cannot be determined yet. The study only shows a broad part of the sky from which the particles arrive. Nevertheless, this information is a significant advance for scientists.

Cosmic radiation particles are nuclei of chemical elements ranging from hydrogen (in this case, individual protons) to iron. In the area of energy over two joules, the frequency of their arrival is low, only at a rate of one particle per square kilometer per year, which corresponds to about one particle per area of a football pitch per century. They can be revealed only through the showers of secondary particles – electrons, hadrons, photons, and muons – that arise from interactions with the nuclei of atoms in Earth's atmosphere. Such showers spread through the air at almost the speed of light and take the form of a disc or "plate" with a diameter up to several kilometers. At the Pierre Auger Observatory, particles from these showers are detected using fluorescence and Cherenkov radiation.

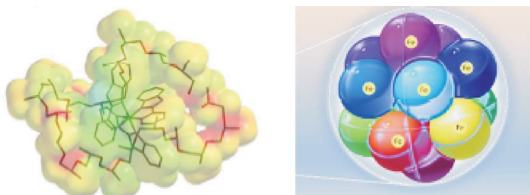
Scientists have seen a long-awaited phenomenon – photon–photon scattering

The Large Hadron Collider (LHC) at CERN is best known for the colliding proton beams, which enabled detection of the Higgs boson. However, a new discovery published in *Nature Physics* comes from the collisions of electron-free lead atoms in the LHC heavy-ion program. These ions have large electrical charges, and their electric field is further amplified by their ultra-relativistic movement. Physicists from the ATLAS project have been studying situations where colliding lead ions narrowly miss each other, so only the high-energy photons surrounding the ions interact with each other. In these interactions, they observed photon–photon scattering, a long-awaited phenomenon prohibited by classical electromagnetism, but predicted and allowed in quantum electrodynamics. In the future, photon–photon scattering events may be used to discover possible new particles, such as magnetic monopoles, which may occur as particles “running” in quantum loops and allowing light-by-light scattering.



ATLAS Collaboration: Evidence for light-by-light scattering in heavy-ion collisions with the ATLAS detector at the LHC, *Nature Physics* 2017, 13, 852–858. IF = 22.806

Molecular nanotraps for optoelectronic applications



Some coordination compounds of transition metals often exhibit the so called spin crossover behavior, when they undergo a spin transition activated by external stimuli. These include temperature, pressure, light, external magnetic field, etc. The spin transition occurs due to rearrangement of electrons on the orbitals, accompanied with the change in optical and magnetic properties of the complex. Such complexes can be then used as electric switches or in advanced optoelectronic and magnetooptic applications.

In a paper accepted for publication in *Chemistry of Materials* (Zoppellaro G. et al. *Chem. Mater.* 2017, DOI: 10.1021/acs.chemmater.7b03633), we present an elegant concept of molecular

nanotraps exploiting a suitable polymeric matrix for formation of nanoparticles of a coordination compound. Interactions among the molecules of the complex and molecules of a polymeric matrix result in a two-step spin transition with wide temperature hysteresis: features highly interesting for construction of a new generation of molecular switches. Using the matrix effects to control the non-covalent interactions offers a new strategy for generating multistep spin transitions in molecular nanoengineering applications. This work is rooted in long-term research on the spin transitions and tuning of coordination compounds at RCPTM (e.g., Bao X. et al. *Chem. Sci.* 3, 1629–1633, 2012; Liu W. et al. *Inorg. Chem.* 54, 8711–8716, 2015; Herchel R. et al. *Inorg. Chem.* 50, 12390–12392, 2011; Liu W. et al. *Chem. Commun.* 50, 4059–4061, 2014).

Zoppellaro G., Tuček J., Ugolotti J., Aparicio C., Malina O., Čépe K., Zbořil R.: Triggering Two-Step Spin Bistability and Large Hysteresis in Spin Crossover Nanoparticles via Molecular Nanoengineering, *Chemistry of Materials* 2017, in press, DOI: 10.1021/acs.chemmater.7b03633. IF = 9.466

Other publications from RCPTM

Malara F., Carallo S., Rotunno E., Lazzarini L., Piperopoulos E., Milone C., Naldoni A.: A Flexible Electrode Based on Al-Doped Nickel Hydroxide Wrapped around a Carbon Nanotube Forest for Efficient Oxygen Evolution, *ACS Catalysis* 2017, 7 (7), 4786–4795. IF = 10.614

Bartali R., Otyepka M., Pykal M., Lazar P., Micheli V., Gottardi G., Laidani N.: Interaction of the Helium, Hydrogen, Air, Argon, and Nitrogen Bubbles with Graphite Surface in Water, *ACS Applied Materials & Interfaces* 2017, 9 (20), 17517–17525. IF = 7.504

Krepl M., Blatter M., Cléry A., Damberger F.F., Allain F.H.T., Spöner J.: Structural Study of the Fox-1 RRM Protein Hydration Reveals a Role for Key Water Molecules in RRM-RNA Recognition, *Nucleic Acids Research* 2017, 45 (13), 8046–8063. IF = 10.162

Figiel M., Krepl M., Poznański J., Gołąb A., Šponer J., Nowotny M.: Coordination between the Polymerase and RNase H Activity of HIV-1 Reverse Transcriptase, *Nucleic Acids Research* 2017, 45 (6), 3341–3352. IF = 10.162

Sigwalt D., Šekutor M., Cao L., Zavalij P.Y., Hostaš J., Ajani H., Hobza P., Mlinarić-Majerski K., Glaser R., Isaacs L.: Unraveling the Structure-Affinity Relationship between Cucurbit[n]urils (n=7, 8) and Cationic Diamondoids, *Journal of the American Chemical Society* 2017, 139 (8), 3249–3258. IF = 13.858

Tian Z., Zhang X.T., Li D., Zhou D., Jing P.T., Shen D.Z., Qu S.N., Zbořil R., Rogach A.L.: Full-Color Inorganic Carbon Dot Phosphors for White-Light-Emitting Diodes, *Advanced Optical Materials* 2017, in press, DOI: 10.1002/adom.201700416. IF = 6.875

Petala E., Georgiou Y., Kostas V., Dimos K., Karakassides M.A., Deligiannakis Y., Aparicio C., Tuček J., Zbořil R.: Magnetic Carbon Nanocages: An Advanced Architecture with Surface- and Morphology-Enhanced Removal Capacity for Arsenites, *ACS Sustainable Chemistry & Engineering* 2017, 5 (7), 5782–5792. IF = 5.951

Fihri A., Len C., Varma R.S., Solhy A.: Hydroxyapatite: A Review of Syntheses, Structure and Applications in Heterogeneous Catalysis, *Coordination Chemistry Reviews* 2017, 347, 48–76. IF = 13.324

Our Grants

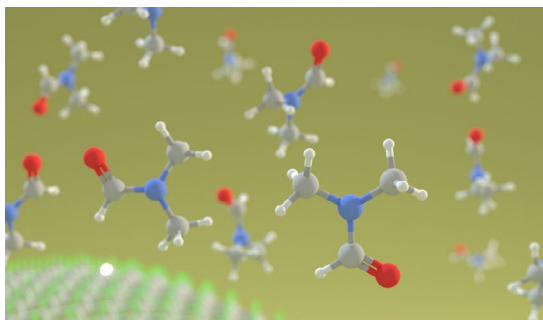
The journey into the depths of the world of 2D chemistry delivers first results

Gaining insight into the two-dimensional world of carbon materials, understanding its rules, and using them to prepare new highly functional materials, are goals of *Two-Dimensional Chemistry towards New Graphene Derivatives*: a major project being undertaken by Michal Otyepka's team with support of a European Research Council (ERC) grant. Significant results have been obtained during the first 14 months of the project, as reported in nine publications, with others in preparation or under review.

"Two-dimensional materials seem to have many peculiarities. The very core of the project is to find and understand the principles of two-dimensional chemistry, but we intend to go even further. We want to develop processes for elegant chemical modification of 2D materials and prepare a wide range of materials with unique physicochemical properties. Subsequently, we will layer them to form 3D structures and create kinds of 'molecular lasagna' with numerous potential applications in catalysis, separation technologies, and energy storage," explained Professor Otyepka, who participated in the discovery of fluorographene six years ago.

Fluorographene is often mentioned in connection with his project, as it has proven to be a suitable starting material for preparing diverse graphene derivatives, with new properties and behavior. A novel derivatization approach is being used to fundamentally alter graphene's attributes. In Otyepka's words: "We can control the electronic, magnetic, and surface properties of graphene. In addition, we have developed an entirely unique approach for synthesizing graphene derivatives and can prepare them in large quantities, which many foreign colleagues greatly appreciate. We are already sending our materials into the world to test them.

One of the first outputs of work funded by the grant was preparation of a highly functionalized graphene derivative, hydroxofluorographene, which has magnetic ordering. "It is a nonmetallic magnet, and to explain its magnetism we have developed a new model based on the communication of diradical motifs enclosed within a graphene network. I am glad that the first work on the ERC project has already brought such crucial results



(Tuček J. et al. *Nat. Commun.* **8**, 14525, 2017)," Otyepka commented, adding that research in this area will continue. "We would like to support our model by new experiments and prepare other derivatives."

New materials with properties tailored for specific applications in electronics, catalysis, energy storage, or sensorics (e.g., the detection of environmental pollutants or determination of signaling biomolecules) are being developed and tested. They are also used in nanocomposites for separation technologies, and preparation of super-strong nanofibers.

Otyepka's team can be proud of other results. "We have recently submitted an article explaining some of the oddities of fluorographene chemistry that we could not understand for a long time. New experiments have opened our eyes. Now we know how the whole process works. This has helped us to start new experiments, and I believe we will be able to control graphene derivatives' properties much more gently. I'm impatiently waiting for new results," discloses Otyepka. So far, scientists have prepared a wide range of new materials, apart from hydroxofluorographene, including cyanographene, graphene acid and its amides (Bakandritsos A. et al. *ACS Nano* **11**, 2982–2991, 2017), alkylated and arylated graphenes (Chronopoulos D.D. et al. *Chem. Mater.* **29**, 926–930, 2017). Information on other materials is being prepared for publication, and new people have joined the team: three foreign employees in postdoc positions and in September the first PhD students.

Awards

Aristeidis Bakandritsos from RCPTM receives a prestigious medal

Aristeidis Bakandritsos, a chemist from RCPTM, received a prestigious IAAM Scientist Medal at the European Advanced Materials Congress, held at the end of the summer this year in Stockholm. This is an award presented by the International Association of Advanced Materials in recognition of excellent research results in materials science published during the preceding year.



"The award means to me recognition of hard and great team work, which can lead to nice results when performed in a well-organized, modern, and internationally competitive research environment. But it is mainly a motivation for me to continue doing what I love to do, despite the demanding nature of the job," said the laureate.

The University of Athens graduate has been working at RCPTM in the Magnetic Nanostructures group since 2015. He focuses on materials

chemistry, especially development of carbon nanomaterials exploiting the possibilities offered by fluorographene chemistry. In collaboration with his colleagues he designs new materials and hybrids thereof, then explores their properties and performance in various applications.

"This award reflects the novelty and impact of the research performed at RCPTM and published in 2017. It is mainly related to the pathways discovered for the development of new graphene derivatives. These findings are very important. The obtained materials have properties that could improve performance, offer new possibilities of use, or significantly lower the cost of the nanomaterials used in applications such as spintronics, (electro)catalysis, and energy-related applications," added Bakandritsos.

IAAM is the main international organization for research scientists in the field of advanced materials. The organization's aim is to provide scientific and educational forums for this rapidly developing scientific discipline. It organizes regular conferences, awards excellent scientists, and publishes research and other information on materials science in various channels. IAAM has around 50,000 members employed (or with backgrounds) in academia, research laboratories, and industry.

Interview

"RCPTM is a base for my scientific plans"

Jiří Šponer, a chemist from Brno and one of the most highly cited Czech researchers, has been collaborating with colleagues from Olomouc for more than a decade, mainly in studies of the structure and dynamics of nucleic acids and RNA catalysis. Currently, they are jointly exploring aspects of prebiotic chemistry: the origins of life on Earth. New experiments at RCPTM could confirm some contemporary hypotheses.

You study the origin of life on Earth and formation of the first RNA molecule. Can you briefly introduce your work?

I should emphasize that this research is mainly my wife's domain. The aim is to find out how organic molecules such as bases, sugars, and amino acids could have originated from inanimate molecules present in the atmosphere of the young Earth, or any other planet anywhere in the universe. And then how, by some unclear process, the first biopolymer capable of Darwinian evolution was selectively created from these organic molecules, thus managing to copy itself while trying different variations of its copies. The moment you have reproduction of a biopolymer with sequence variation (this is a definition of life by Edward Trifonov), more capable individuals automatically appear in the population and their presence starts evolution. The most valuable step for us is to find out how to make cyclic nucleotides, RNA monomers, self-polymerize, that is, spontaneously make RNA. This mainly experimental research was started by colleagues in Italy a few years ago and we have come to join them. To the surprise of everyone, and in the face of fierce resistance from those who tried more complicated ways, it turned out that cyclic guanosine monophosphate, particularly, has inherent capacity — it can polymerize without the help of other molecules under a relatively wide range of conditions.

Could this be considered the most important progress that you have ever achieved in this field?

We value the abovementioned discovery of RNA "self-polymerization" most highly. Several months ago, we formulated a hypothesis that guanine RNA synthesis itself could suffice. Nucleic acids are everywhere in nature now, and synthesized in laboratories with the help of another nucleic acid molecule, a template, by Watson-Crick base pairing. However, the first RNAs could not have had a template. The idea we suggested, and want to develop experimentally, is that short guanine oligomers could potentially have brought the remaining nucleic acid bases into play as indirect templates.

What do you work on in this field at RCPTM?

Using the unique instrumentation at RCPTM, we want to develop all the experimental techniques we apply. Perhaps it sounds paradoxical, but studying the origin of life does not need very sophisticated instruments. Smart experiments are more important. Therefore, our needs are quite modest, in the context of RCPTM's facilities, which are geared to the fierce competition in materials science and applied research.

You have collaborated with colleagues from Olomouc for more than ten years. What have you come to together?

It is difficult to point out just one thing. There are already dozens of scientific publications. Essentially, one can say that we created a common laboratory and brought together all our knowledge. Instead of competing and being harmful to each other, we created perhaps the best laboratory in the world for molecular modelling of nucleic acids.

You work at the Institute of Biophysics of the Czech Academy of Sciences in Brno. Why is it important for you to be part of the team of the research centre in Olomouc?

More than a decade ago I was desperately searching for a partner who could understand proteins. I contacted Michal Otyepka, who at that time was an early-career scientist. Thanks to him and our other colleagues, a scientific team grew out of this collaboration. In many respects the team reached a leading international position in the field of nucleic acids. Then RCPTM was initiated. I have to say that, due to my notorious

scepticism about the level of Czech science, I never dreamed that a workplace of this quality could exist there. Its director, Radek Zbořil, has done an absolutely unique job in the Czech context. So, the tables turned. While I initially thought that the colleagues in Olomouc could be grateful for participating in my research, nowadays it is exactly the opposite. The stronger facilities and colleagues you have, the stronger you are. Thus, RCPTM and the Department of Physical Chemistry are for me great bases from which I can implement my scientific plans. In the Institute of Biophysics our collaboration is strongly supported, because we realize that we need a close relationship with universities and we all will benefit from it. Together we increase our competitiveness in a tough international arena, and increase chances of discovering new things. To my taste, there is too much unhealthy competition and too little cooperation in contemporary science.

Which scientific infrastructure do you use the most here?

Computational clusters, high-performance liquid chromatography (HPLC) equipment, and a mass spectrometer. We are building a unique apparatus, which we hope will enable us to reach breakthrough results regarding the origin of the first RNA molecules.

You and your wife Judit became ambassadors for a film *Voyage of Time: Life's Journey* by an independent American director, Terrence Malick. It is about the origin, evolution and end of the Universe, solar system's life cycle, and the birth of organisms up to the emergence of human civilization. What do you think about the documentary?

It can be understood in two ways. On one hand, it is an impressive film in terms of visual effects, which can draw the viewers' attention to evolution in the universe from the beginning to the emergence of civilization. If you understand the origin of life, you will appreciate that the film is scientifically accurate. You can spend long hours identifying scenes in the film and particular scientific findings they are based upon. At the same time the documentary poses many philosophical questions, and (I think) intentionally does not provide answers to them: it is up to the viewers to form the answers. We have clearly seen during discussion after the film's premiere in Lucerna cinema in Prague, and the planetarium in Brno, that people really find their own interpretations. In my opinion, the film says that evolution is the way it is: neither good nor bad. It is a process of logical changes in matter and energy in the universe, and a human is part of the process. Whether this is also Malick's interpretation, I don't know. Probably no one knows.

Recently, the Nobel Laureates in Chemistry for this year were announced. You co-authored a publication with one of them. What was your collaboration like?

With Joachim Frank we have solved one of the flexible parts of ribosomes. Ribosomes are molecular factories, which synthesize proteins in all the cells that exist nowadays. We combined the data from his cryo-electron microscopy (J. F. received his Nobel Prize for this method) with our molecular simulations (Řeblová K. et al. *Nucleic Acids Res.* 38, 1325–1340, 2010). Collaboration with him was amazing. I even visited him at home. Although we have not collaborated since then, I was a guest at his 70th birthday celebration. Actually, I have co-authored publications with two Nobel Laureates from two completely different fields. This clearly illustrates the interdisciplinarity and quality of our research. The other laureate is the biochemist Arieh Warshel, who was awarded a Nobel Prize in Chemistry together with his colleagues in 2013 for the development of theoretical methods for calculations of complicated chemical systems (Florián J. et al. *J. Phys. Chem. B* 103, 884–892, 1999).



For Our Students

New projects will contribute to the modernization of PhD studies and instrumentation

Strengthening the practical experimental skills of PhD students and enabling them to use advanced instruments competently are the main objectives of two educational projects supported by the Operational Programme Research, Development and Education, with total funds amounting to approximately 177.1 million CZK. Together with other workplaces at the Faculty of Science, RCPTM has participated in these projects. According to the management of the science center, these are key ways to prepare the emerging generation of scientists for the challenges awaiting them in the future.

"I see the education of the younger generation as an integral part of RCPTM's activities. Many students do work towards their theses here, and thus need access to state-of-the-art technology and know-how. It is absolutely crucial to pass on our knowledge and experience to the young generation and instill in them the basic principles of scientific work soon enough. Learning by doing research is one of the most effective ways to achieve this," said Michal Otyepka, Deputy Director of RCPTM. During the seven years of the Centre's existence, RCPTM employees have participated in the education of approximately 150 masters and 50 doctoral students.

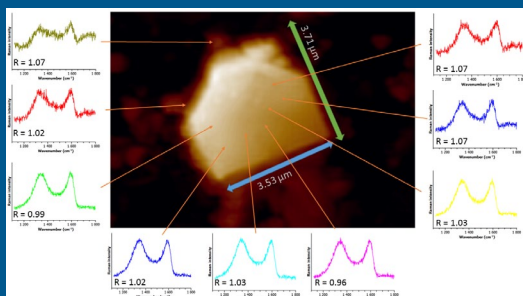
The project *Modernization of the Doctoral Studies of Physics, Chemistry, and Biochemistry* at the Faculty of Science of Palacký University is also focused on the creation of new doctoral study programs. Emphasis is placed on ensuring that PhD students acquire detailed knowledge

of, and competence in, state-of-the-art experimental techniques. An important partial goal of the project is to support selected PhD students who will go for internships to prestigious foreign institutions.

Thanks to the project, it is possible to acquire the state-of-the-art equipment needed for experimental teaching and students' research in modernized or newly created doctoral study programs in Optics and Optoelectronics, Applied Physics, Biophysics, Biochemistry, Nanomaterials Chemistry, and Nanotechnology. The new equipment includes, for example, instruments for measuring chemisorption and physisorption for describing the porosity and surface properties of materials, high-precision thermal analysis, gas chromatography–mass spectrometry, and a 400 MHz NMR spectrometer, which we will use mainly to study catalytic processes.



Introducing a Scientific Infrastructure



Topography of a graphene derivative with simultaneous measurement of Raman spectra in different areas of a sample.

A recently acquired Ntegra Spectra scanning tunneling microscope from NT-MDT Corp. enables study not only of samples' topography but also selected physicochemical characteristics, including magnetic properties in an MFM (Magnetic Force Microscopy) mode or conductivity in a C-AFM (Conductive Atomic Force Microscopy) mode. The microscope can work in ambient regimes, when the sample is measured in air, but under conditions when the arm is fully submerged in liquid. Liquid mode is suitable mainly for work with biological systems (cells, tissues) and studies of interactions of biomolecules (e.g., DNA or RNA oligonucleotides or proteins) with the surface of a sample. A great advantage is the possibility to simultaneously combine atomic force and Raman microscopy, enabling description of topography in parallel with chemical sample mapping. Thus, *inter alia*, information can be obtained about the spatial distribution of selected functional groups on the surface of the analyzed material. The system is also designed to afford tip-enhanced Raman spectroscopy (TERS - Tip Enhanced Raman Spectroscopy), in which Raman spectral signals are significantly amplified due to the interaction of the laser beam with the nanostructurally modified AFM tip. An AFM system coupled with Raman spectroscopy is used in RCPTM, for example, for morphology description, 3D imaging and chemical mapping of graphene derivatives, and to describe the interaction of 2D nanomaterials with biomolecules.

Selected publications:

Froning J.P., Lazar P., Pykal M., Li Q., Dong M., Zbořil R., Otyepka M.: Direct mapping of chemical oxidation of individual graphene sheets through dynamic force measurements at the nanoscale, *Nanoscale* 2017, 9 (1), 119–127. IF = 7.367

Coming Next...

RCPTM will have a strong presence at the Nanocon conference



As in previous years, the 9th [Nanocon international conference](#), to be held at the Voroněž Hotel in Brno from the 18th to 20th of October, will focus on nanomaterials

research and applications, and their possible impact on the environment and human health. Radek Zbořil, General Director of RCPTM, who traditionally participates in organization of the conference, will be the General Chairman. One of the invited speakers will be Jiří Tuček, leader of the Magnetic Nanostructures group from Olomouc.

The Nanocon conference is the most important event of its kind in the Czech Republic, and one of the largest in Central Europe. Around 370 participants from 30 countries have registered for this year's event so far. The program will be divided into several sections, where participants will focus on the use of nanomaterials for electronic, magnetic, and optical applications, industrial and environmental technologies, biotechnology, and medicine. Time will also be allocated to nanomaterials' toxicity monitoring and description of advanced methods for preparing and characterizing nanosystems.

Two plenary lectures will be presented at the conference. Paolo Fornasiero, Professor of Inorganic Chemistry from the University of Trieste, a specialist in materials chemistry and advanced applications of nanomaterials in energy and environmental heterogeneous catalysis, will speak on the topic *Opportunities and challenges of well-defined nanocatalysts*. Head of the Electron Crystallography group from the Institute of Physics of the Czech Academy of Sciences, Lukáš Palatinus, will introduce a method that allows determination of the structure of individual nanocrystals with unprecedented accuracy and reliability. Within the framework of the requested lectures, RCPTM representative Jiří Tuček will give a presentation on *Imprinting Self-Sustainable Magnetism into Graphene: Doping and sp^2 Functionalization*. Other members of the Centre, including Manoj B. Gawande, Štěpán Kment, Aristeidis Bakandritsos, Alberto Naldoni, Jan Filip, Veronika Urbanová, Václav Ranc, will talk about results of their research.

The Science and Technology Week at RCPTM offers excursions and lectures on 2D chemistry

RCPTM is participating again in the Czech Academy of Sciences' *Science and Technology Week* after last year's great experience. The aim is to acquaint the public, especially high school students, with the dynamically developing field of nanoparticles and nanotechnologies, as well as the specialized activities at the research center in Olomouc. The Open Days will take place from 8th to 10th November. Visitors will be able to see the laboratories where excellent science is carried out and interesting experiments will be prepared for them.

On Thursday, November 9, Michal Otyepka, Deputy Director of RCPTM, will take the high school students to the world of 2D chemistry. In a lecture called *Too Flat a World?* presented in the Fort Science in Olomouc, he will talk not only about graphene and its significant role in nanomaterials research and nanotechnologies, but also about more recently developed members of the 2D materials family. The visitors have to register for both events in advance. Detailed information is also available on the [Science and Technology Week](#) website.



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Published by: Regional Centre of Advanced Technologies and Materials, 2017
Editor: Martina Šaradinová
Photo: Viktor Čáp, Martin Pykal, RCPTM archive
Graphics: Ondřej Růžicka

