NEWSLETTER I
January 2018

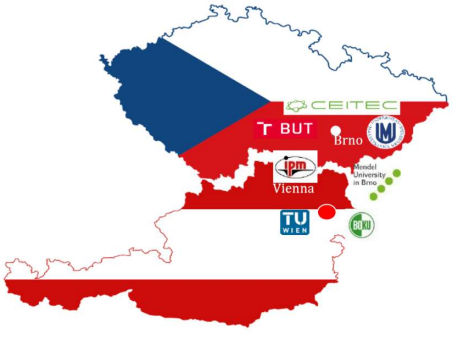
Issue I/January 2018

ABOUT BACK4FUTURE

The cooperation of top Austrian technical universities and the CEITEC institute should bring about the improvement of nanotechnology and biotechnology research at the Brno research centre. Thanks to the European Union's Horizon 2020 TEAMING program, Back4Future project, currently in its first phase, aims to deepen the already existing partnership with the Vienna Technical University (TU Wien) and the University of Natural Resources and Life Sciences (BOKU), simultaneously boosting the further development of the Centre of Scientific Excellence CEITEC.

Part of the first, ongoing phase is to prepare a plan for further development of the science centre, not only in the area of research but also in the field of human resource management and innovation strategies. Scientifically, the project should focus on the cross-field cooperation of nanotechnology and biotechnology, which is already featured on a highly prominent level at the Vienna universities.

If the Back4Future project succeeds in competition with 50 other projects (including a total of 6 in the Czech Republic) next year and will advance to the second stage, this success would mean the beginning of the CEITEC Centre's transformation: deepening synergies in the field of research impacting the wider region and also improving the innovation performance.



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PROJECT PROGRESS

Back4Future Kick-Off Meeting

Project general purpose flyer

Workshop and roundtable with industry – lab excursion

In January 2018, the project team enters its fifth month of work on the Back4Future project. The past four months were filled with intense collaboration of all participating institutions, regular meetings of the project work groups, as well as dissemination events such as workshops and public presentations. Below we summarize the highlights of achievements and milestones met during that period.

The Kick-Off meeting was held at September 25 in Brno. Approx. 50 invited guests from Vienna and Brno attended the morning ceremony followed by a lunch and closed meeting of the extended Scientific Committee.

The visual identity of the project has been created during September, including the project logo. Poster and flyers have been prepared for dissemination on public events.

The Scientific Committee met in Vienna at October 12 to discuss the project vision and set the groundwork for the preparation of Long term scientific vision of the Centre.

The Scientific Committee met in Vienna at November 13 to overview the collected Questionnaires and organize the following work. Analysis of the scientific potential has been outlined.

The Innovation group (Project coordinator, PM, WP2 leader, external consultants) met in Brno at November 14 to coordinate work in the WP2 package. The project's Market analysis and Innovation strategy have been outlined.

The Workshop and Roundtable with Industrial Stakeholders has been held in Brno at November 24, attended by the Centre's major industrial partners who discussed the possible venues of future cooperation and legal framework of contractual and collaborative research to be set up in the upgraded Centre.

The Scientific Committee met in Vienna at December 7 to overview the progress of work within the WP3. The draft of the Analysis of the scientific capacity has been approved and Long Term Scientific Vision/Research Strategy has been discussed.

PROJECT DISSEMINATION

Brno Researchers' Night 2017

International Engineering Fair Brno

CEITEC Christmas Workshop

The dissemination and communication efforts on the project are described in the Communication, Dissemination and Exploitation Plan, one of the project's deliverables. In this Plan, detailed roadmap of the project's interaction both with scientific and general public has been outlined. Below we present the highlights of the events, workshops and meetings that so far served to increase the general awareness of the project's existence and its potential.

The project has been presented to general public during Brno Researchers' Night, October 6, at the participating institutions (BUT, MENDELU, MU). Nanosciences and nanotechnologies present at CEITEC have been demonstrated to public by a series of tours and experiments.

Project presentation consisted a part of the CEITEC stall on the International Engineering Fair of 2017 in Brno.

Božena Čechalová (Project manager) and Vlastimil Křápek (WP6 leader) attended the Workshop on Business Plan preparation in Prague at October 19, organised by Czech Academy of Sciences, where they met with the representatives of other projects competing in Teaming phase 2 proposal preparation.

The project has been presented to general public and young generation of students as part of the Open Days at IPM, November 9, during the country-wide science festival 'Czech Week of Science'.

Pavel Krečmer (Steering Committee, BUT) and Božena Čechalová (Project manager) attended the Teaming Coordinators' Day in Brussels, November 9, where they met with Pepa Krasteva, the Project Officer.

The project has been presented at the annual CEITEC Christmas workshop, along with two other CEITEC-centered H2020 projects (RICAIP and PASSAGE), held at November 28, to the scientific community and CEITEC stakeholders.

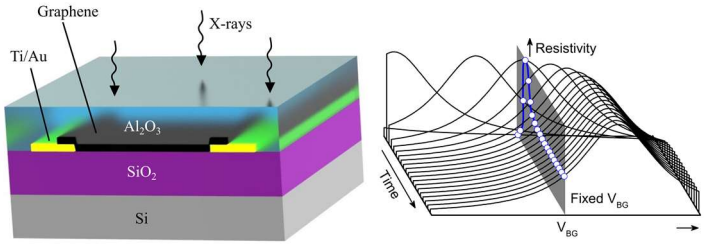
The Project Manager met with the head of PR department on CEITEC on December 5 to prepare a press release.

The organisational work around the Industry-Academia workshop (MS16) was commenced in December as well. For more information see the Upcoming events section of this newsletter.

What's new in the field of nanotechnology and advanced materials science?

Remote Graphene Doping

Graphene is a zero bandgap semiconductor. In this respect, by applying external electric field it is possible to control the charge carrier type (negative or positive) and its concentration in graphene, therefore to change its transport properties (e.g. resistance). This usually requires several fabrication steps, i.e. the fabrication of graphene effect transistor device.



Employing the graphene devices fabricated in CEITEC Nano Core Facility Pavel Procházka and his colleagues have found that the graphene can be doped using the X-ray radiation. Using this approach, the graphene properties can be remotely defined without need for any contact. Moreover, results of the study define the framework for correct X-ray characterization of graphene and can be developed into graphene radiation sensors.

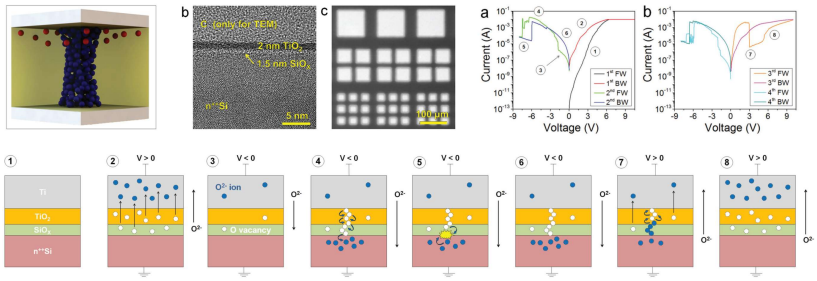
P. Procházka, D. Mareček, Z. Lišková, J. Čechal, T. Šikola: X-ray induced electrostatic graphene doping via defect charging in gate dielectric, Sci. Rep. 7 (2017), 563.

Memristive Memories

Resistive random access memories (RRAM) have emerged as the flagship element allowing future massive data storage due to their excellent performance and easy fabrication. To fulfill the information storage needs of modern societies, the performance of electronic nonvolatile memories (NVMs) should be continuously improved.

The devices fabricated at CEITEC Nano Core facility show the way how to further extend the performance of RRAMs.

Ti/2-nm-TiO_2/1.5-nm-SiO_X/n^{++}Si memristors exhibit unprecedented *I–V* characteristics with double hysteresis. This behavior is related to the coexistence of filamentary and distributed resistive switching. The simplicity of our design and the good compatibility of all the materials used (Ti, TiO_2, SiO_X, and n^{++}Si), with the silicon technology give promise that these findings will be quickly implemented in real devices.

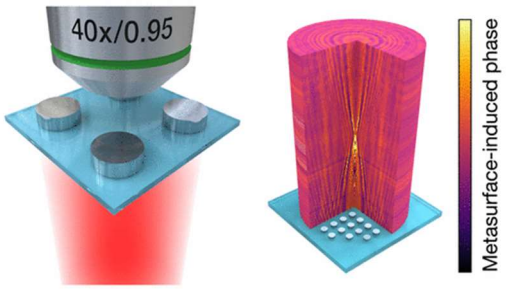


N. Xiao, M. A. Villena, B. Yuan, S. Chen, B. Wang, M. Eliáš, Y. Shi, F. Hui, X. Jing, A. Scheuermann, K. Tang, P. C. McIntyre, M. Lanza: Resistive Random Access Memory Cells with a Bilayer TiO2/SiOX Insulating Stack for Simultaneous Filamentary and Distributed Resistive Switching, Adv. Funct. Mater. 2017, 27, 1700384.

3D Phase Imaging

Phase-altering metasurfaces comprise a new class of artificial materials that allow to manipulate the wavefront of passing light and thus provide unprecedented functionalities in optics and nanophotonics.

On the metallic nanostructures fabricated at CEITEC Nano Core facility two CEITEC groups were able to perform quantitative 3D phase retrieval.



Using coherence-controlled holographic microscopy, authors can obtain information about the phase of light from the whole field of view of an optical microscope in a single measurement. Quantitative 3D phase map of fabricated plasmonic zone plate shows functional phase lens with thickness below 50 nm.

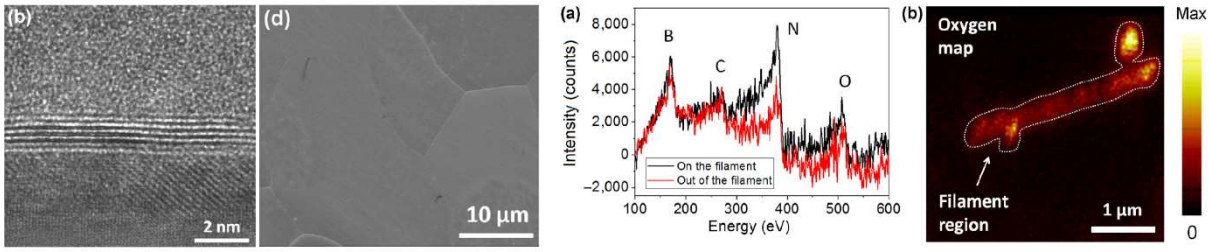
J. Babocký, A. Křížová, L. Štrbková, L. Kejík, F. Ligmajer, M. Hrtoň, P. Dvořák, M. Týč, J. Čolláková, V. Křápek, R. Kalousek, R. Chmelík, T. Šikola: Quantitative 3D Phase Imaging of Plasmonic Metasurfaces, ACS Photonics 2017, 4, 1389.

Boron nitride passivation layers

Passivation of metals using protective coatings is a widespread technology and represents a huge market that generates billions of US dollars every year. 2D material offer the possibility to provide efficient protection against environment while the properties of the metal being protected are retained.

The high spatial resolution chemical analysis performed at CEITEC Nano Core facility provides insight in the mechanism of surface passivation against water and air oxidation.

The results revealed that when exposed to H_2O_2, a monolayer h-BN film is as inefficient as graphene as a protective coating. In contrary, 5–7 layers-thick h-BN film showed good protection, probably because of the higher resistance to transverse electron transfer from the metal to the electrolyte.



L. Jiang, N. Xiao, B. Wang, E. Grustan-Gutierrez, X. Jing, P. Bábor, M. Kolíbal, G. Lu, T. Wu, H. Wang, F. Hui, Y. Shi, B. Song, X. Xie, M. Lanza: High-resolution characterization of hexagonal boron nitride coatings exposed to aqueous and air oxidative environments, *Nano Res.* 2017, **10**, 2046.

Special thanks for this section contributions to Jan Čechal, PhD, CEITEC BUT.

A Prospect of the Future of CEITEC *by Jiří Očadlík*

I come from a corporate environment, and I admit that I have never talked so much and so often about money and finances as of now and here at CEITEC. Therefore, if someone wanted to argue that only the business is about money, I am going to laugh a lot. Today, the science is especially about money!

In Czech Republic, the gross expenditures on research and development (GERD) have been growing relatively quickly over the last ten years. The development shows several trends that are worth noticing.

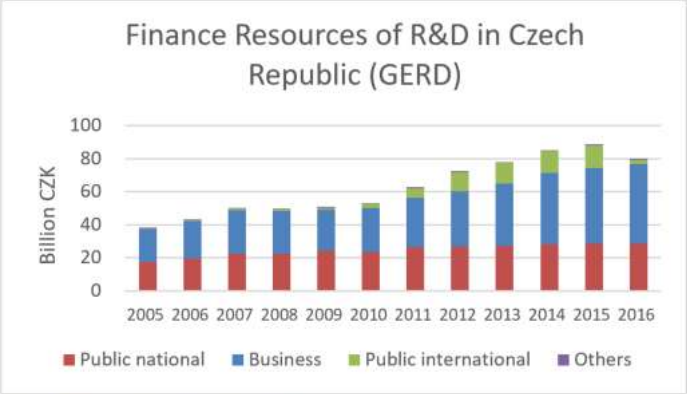


Figure 1 Source Czech Statistical Office

Funding from national public sources (national budget) does not vary and remains at the level of 26.5 to 28.5 billion (alternatively, about 1.5 % of State budget) in recent years. In the future, we cannot expect a significant increase in those funds. Despite the importance and irreplaceability of this funding source to a public research institution such as the CEITEC, we cannot expect and rely on its growth. There is a kind of "melee" about the State budget – with our rivals being, for example, the army with underfinanced status against NATO's commitment, the social welfare program and other powerful departments. Methods of funds redistribution within the Czech Republic are nowadays dependent on the results, publications, success in grant projects and national programs. In other words, we must be better than our peers from other institutions competing for the same resource bundle, providing the achievement of scientific excellence, in order to confidently rely our growth on continuing state funding.

Business enterprise resource funding is on the rise, however, slightly losing steam from the original dynamics of 12 % p.a. to 5 % p.a. in the last two years. Corporate resources have also slumped in the time of crisis around the year 2009. It turns out, however, that business companies are accustomed to spending their resources for R&D from 88 % themselves. Business sector displays a relatively small willingness to carry out R&D in the higher education sector and honestly, higher education sector is in many cases not capable of such activities. It is therefore not surprising that the activities of higher education sector (public research institutions) have been financed only from 4 to 5 % (or 900 million CZK) of the total 22 billion CZK business expenditure in the year 2015. However, in terms of resources required, business is the richest sector with the overall expenditure on R&D at the level of 48 billion CZK per year. Therefore, our efforts are going to have to go in this direction, meaning that we should become attractive to companies interested in contractual R&D.

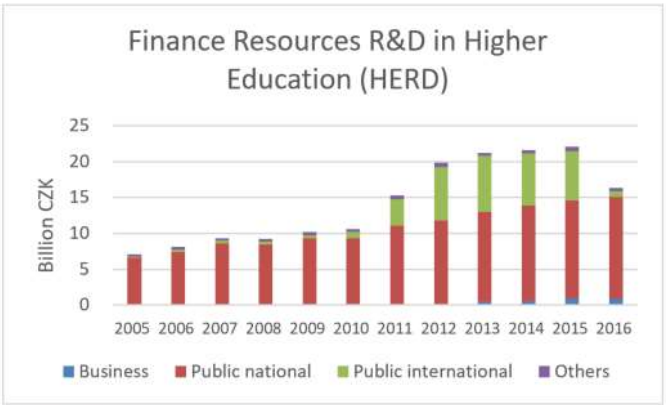


Figure 2 Source Czech Statistical Office

This endeavor will go a long way. Currently these activities bring us about 20 million CZK per year; we should be able to at least double this amount in a few years. This would give us better position for co-financing programs and all H2020 programs where co-financing is required. A significant number of programs also require the participation of an industrial partner. We cannot truly expect this policy to change and we should be instead prepared for an increase in this approach.

Funding from public international sources (especially the ESIF) showed a significant increase, however, the late approval of the national operational programs in the year 2015 and subsequent missing of the program calls have caused a lack of research institutions and enterprises drawing on these resources. This source of funding will run dry after the year 2022 and, therefore, about 15 billion CZK for the funding of the corporate, academic and higher education sector will be missing.

It is not hard to guess what we will have to do. There are two other sources of funding available to us: ERC grants, and also the finances of the companies interested in H2020 programs. In addition, there are advanced countries in our neighborhood, such as Austria and Germany, who spend more on R&D both as a percentage of the GDP and in absolute value, including

a higher level of cooperation with the corporate sector research organizations. Our aim should be to deepen the cooperation with these countries; this becomes our next milestone. As of now, some enterprises and institutions from these countries are already our partners.

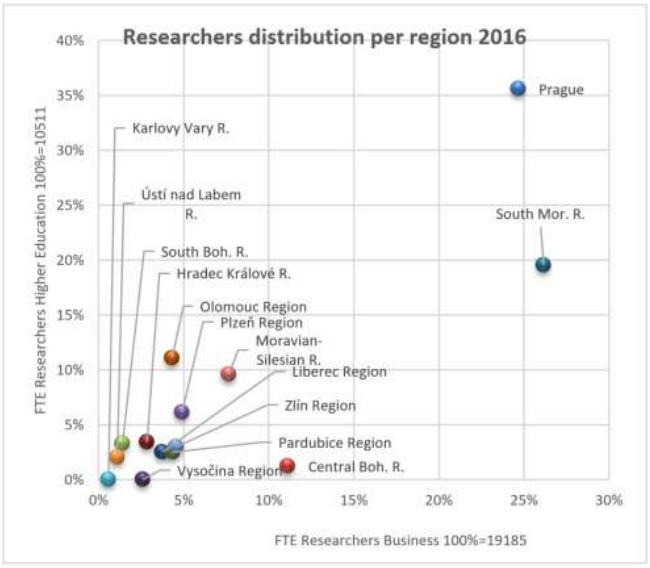


Figure 3 Source Czech Statistical Office

However, we should not forget our roots, to our city and region. South Moravian region is 'the promised land' for researchers and innovative enterprises. There is the highest concentration of research in the Czech Republic here, after Prague. Every fifth research fellow of the higher education (total 2000) as well as less than every fourth researcher from the corporate sector (total 5000) is from the South Moravian region. This is a significant outlook for many sharing options, mutual interaction and learning. Here, the knowledge can "ferment" and we are in at the center point of it. I think this is the right time to start over in a targeted manner to ensure the future success of CEITEC. We're off to a good start. After all, given its short history, our institution is still in its infancy. It is up to us, whether we get on the sunny side or end up in the shade.

I like the sun, and that's why I am here!

Jiří Očadlík, CEITEC BUT

COOPERATION WITH INDUSTRY

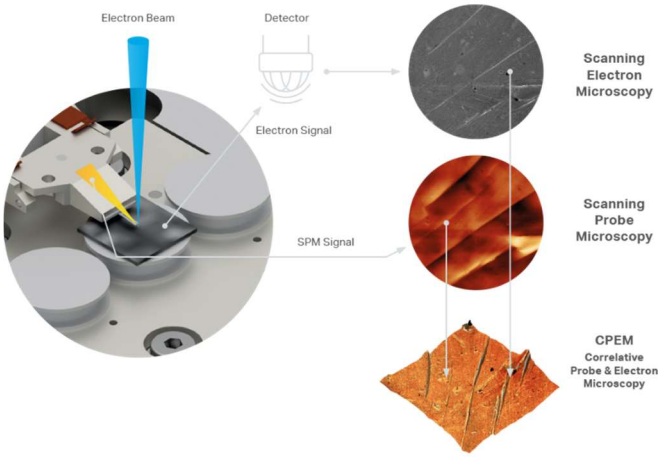
NenoVision – a successful example of cooperation *by Jan Neuman*

NenoVision was established in 2015 as a spin-off of the Brno University of Technology (BUT) and Central European Institute of Technology (CEITEC) in the Czech Republic. The company was founded by Jan Neuman, Zdeněk Nováček and Michal Pavera, former Ph.D. students in the research group of prof. Tomáš Šikola at BUT and CEITEC. The goal of NenoVision was to continue in the results achieved at the university in the field of Scanning Probe Microscopy (SPM) equipment development. The technology transfer to the newly built company was approved by the Technology License and Cooperation department in 2016.

The company is located in Brno, which is a university city with a long and proud tradition in the development of scientific instruments. Brno is also referred to as the "Mecca of electron microscopy" because of its historical involvement in the development and production of electron microscopes. Three global manufacturers of electron microscopes are located in Brno - ThermoFisher Scientific (FEI), TESCAN, and DELONG Instruments. South Moravia region is also known for the local start-ups support and innovation activities organized by the South Moravian Innovation Center (JIC). NenoVision took full advantage of this unique environment and local support. The trust and potential of the company was approved by an investment of the JIC Venture fund, with the JIC becoming a partner in the company with 2,5 % of shares.

In June 2016, NenoVision launched its key product LiteScope. LiteScope is small compact Scanning Probe Microscope designed for an easy integration into the electron microscopes. The combination of complementary SPM and SEM techniques enables to make use of the advantages of both commonly used microscopy techniques. With LiteScope, customers can carry out measurements of the sample surface topography (3D), electrical properties, magnetic properties and others, all the while performing electron microscopy. LiteScope has also won several awards like Gold medal on the International Engineering Fair in Brno in 2016 and at Nanocon 2017. LiteScope project has achieved the Seal of Excellence certificate provided by the European commission as the approval of the top promising technologies.

As a world unique technology, NenoVision introduced measurement techniques called Correlative Probe and Electron Microscopy (CPEM), which enable simultaneous measurement and precise correlation of 3D images obtained by SPM and various images obtained by SEM. CPEM technique has been patented and already presents several unique applications in the field of nanotechnology, material science and semiconductor industry.



NenoVision has already created a global sale network via local distributors and via TESCAN, the key partner for integrated solutions. LiteScope is being used in various customer applications. You can meet NenoVision at scientific conferences or contact them via webpage www.nenovision.com.

WOMEN IN MATERIALS SCIENCE

Gender Equality in Science *by Andrea Lassenberger, Universität für Bodenkultur Wien (AT)*

The number of women in science, especially leading positions is still far from being balanced in comparison to that of male group-leaders or other leading position. These differences are striking in research areas traditionally seen as masculine and hard sciences such as physics and engineering and are less pronounced in life and medical sciences.[1] Even if the percentage of female PhD graduates (level 6 in the international standard classification of education ISCED) in natural science, mathematics and computing studies today is 42 %, this number is not yet reflected in the number of women in higher academic positions where women represent only a third of researchers and a fifth of top-level academics.[2] This imbalance reflects more than the time it takes to translate a balance at junior positions into a balance at research leading positions. According to the EC, a bias exists that men are more likely to be employed as researchers than women, who are more likely to be employed as

technicians and other supporting staff. However, a positive trend can be observed; the number of female heads of higher research institutions in the EU rose from 15.5 to 20 % in 2014[1] but there is still a long way to go before reaching gender equality.

The reasons for this inequality can be identified in three areas:

(i) science as an 'unfriendly' environment for women,
(ii) science as gender-insensitive branch (science is gendered as 'masculine') and
(iii) male-dominated dynamics in scientific leaderships.

Without specifically addressing these sources of inequality and proactive policies it will take decades to close the gender gap and bring a higher degree of gender equality.[2]

This can be reached by considering and implementing the principles of gender mainstreaming, which was defined in 1997 by the United Nations Economic and Social Council (ECOSOC) as such:

"Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality."

All research institutions that participate in the B4F project have a broad experience in and a progressive approach to maintaining and achieving gender equality, ensuring that gender mainstreaming will be of central importance in the B4F project as only the best research can be done if equal opportunities for the best researchers are provided.

1. 2017 Report on Gender Equality between Men and Women in the European Union; Belgium, 2017.
2. She Figures 2015; Publications Office of the European Union: Luxembourg, 2016.

WOMEN IN MATERIALS SCIENCE

A Woman in Surface Science *by Ulrike Diebold, Vienna University of Technology (AT)*

The roles of women in materials science are as rich and diverse as the field itself. A good overview is given in the recent book by Lynnette Madsen, "Successful Women Ceramic and Glass Scientists and Engineers: 100 Inspirational Profiles", which describes the biographies of outstanding women, their successes, and also the challenges they had to face.

As for me, I could not have wished for a more rewarding career and professional life. I work in the area of surface science, a wonderfully interdisciplinary research field. Surfaces and interfaces are everywhere around us, and are also instrumental in almost all modern technologies – or, as Nobel Laureate Herbert Kroemer so elegantly phrased it "the interface is the device". In my lab we try to understand the properties of surfaces at atomic scales, using Scanning Probe Microscopy and a whole array of surface spectroscopies. Since surfaces in the ambient environment are immediately

covered with a layer of grime and dirt, almost all our experiments are conducted in ultrahigh vacuum. We also use single-crystalline samples, and these two idealizations provide us physicists with deep insights into the workings of surfaces and the chemical reactions that take place on them. We mainly focus on surfaces of metal oxides, a particularly versatile class of materials that covers a wide range of physical and chemical properties. Our research is fundamental in nature, but our results are relevant for many technologies, ranging from catalysis to sensors to fuel cells to novel electronic devices.

I studied engineering physics at the TU Wien, and already during my masters thesis I was concerned with surfaces – my project was to investigate the electronic structure of graphite. I used scotch tape to peel off the first layers, inadvertently producing graphene, which I threw away. Others were smarter, and won the Nobel Prize for studying this great material. After my PhD thesis I moved to the US, where I started my own research group in surface science. The years abroad have shaped me both personally and professionally. Science is an international enterprise, and I strongly advise young scientists to use the opportunity to work abroad for a period of time.

Of course there were ups and downs in my professional life, but I would not attribute any obstacles that I have faced to the fact that I am a woman. On the contrary: **I think it is a great time to be a woman in science, specifically in materials science.** Because there are still so few of us, female researchers are automatically more visible. Of course one has to work hard to achieve excellence in research. But with the right mix of expertise, knowledge, and determination (and a good pinch of luck), one can leverage this into a great opportunity.

UPCOMING EVENTS

Industry-Academia Workshop at CEITEC

The Back4Future project is organising the **Industry-academia workshop**, which will be held on 15th March 2018. The goal is to provide the representatives of the industry and general public, as well as students and junior researchers from affiliated institutions, with an opportunity to visit CEITEC, get to know its infrastructure and research program and meet the researchers.

The workshop topic will focus on the cooperation of CEITEC with the industrial and business sector, mainly the many possible frameworks of cooperation that are open to us.

Workshop will take place from 10:00 to 12:30 in the main meeting room of building S (Purkyňova 123, 62100 Brno).

After the lunch, the core facilities labs will be opened to general public. The registration for a tour will be available in the second half of January on the Back4Future website http://back4future.ceitec.cz.

CONTACTS

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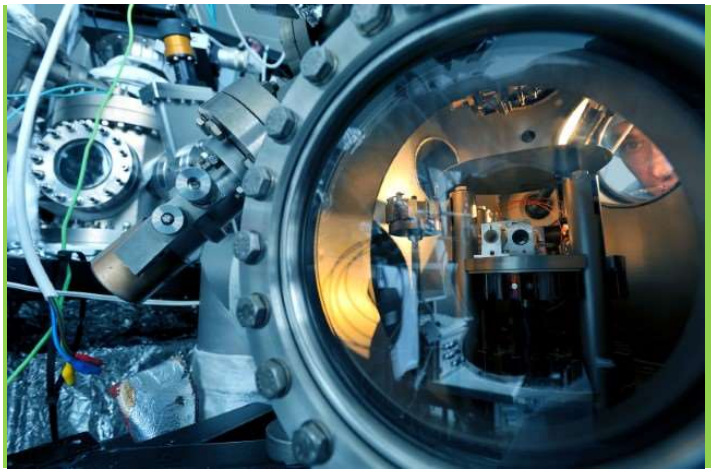

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BACK FOR THE FUTURE