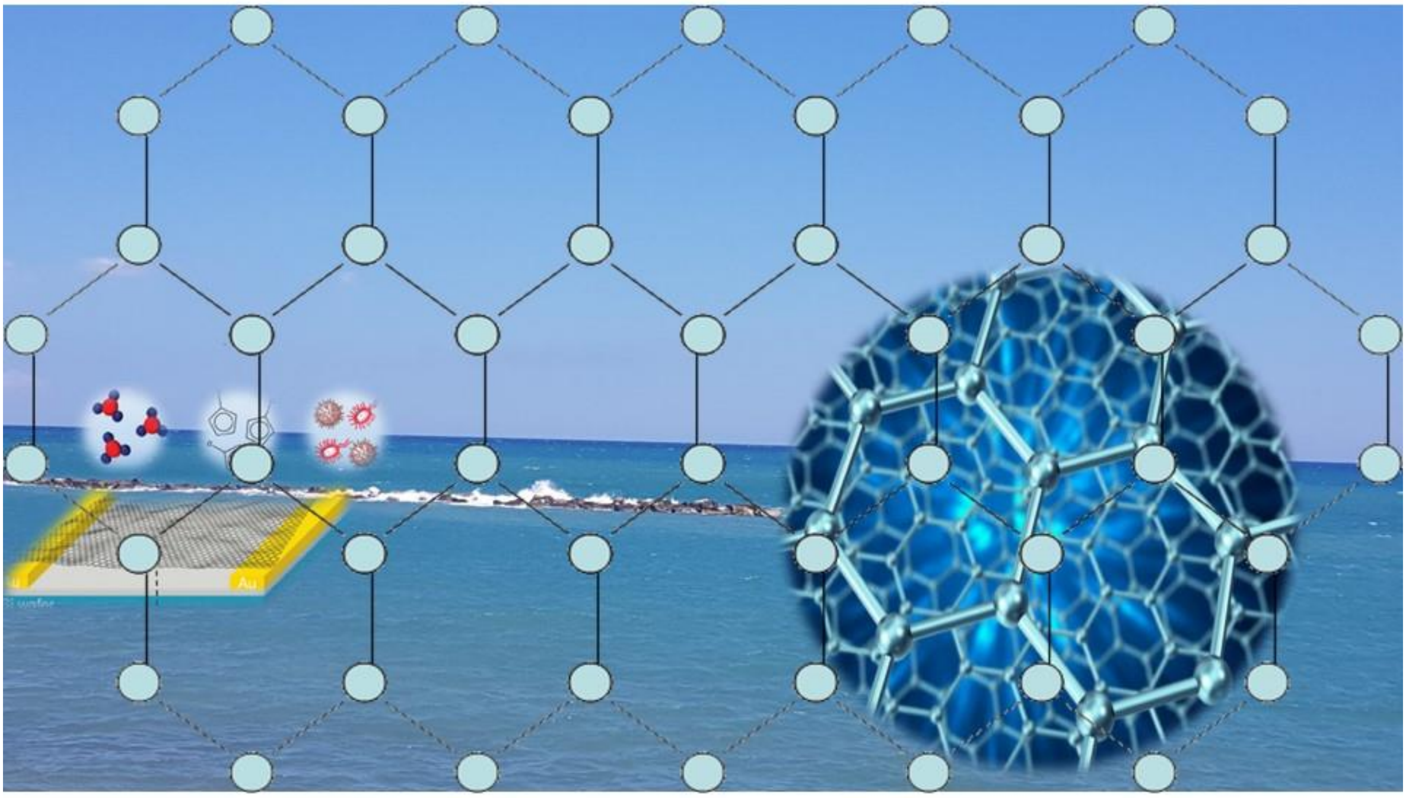

# TWINFUSYON NEWSLETTER V

## June 2018

Dear TWINFUSYON friends,

Spring semester is over and we would like to share our news with you within another issue of our Newsletter. With the holiday season approaching, we have dedicated this issue to the topics of sea water and air quality as well as monitoring the conditions of the environment. We would like to offer you articles focused on the site-specific biosensor network, a graphene-based sensor for environmental monitoring and coherence and interference.

In the following pages, you can also read about the activities organised within the first half of 2018 and experience of our researchers spending their time at TWINFUSYON partner institutions. Last but not least, we would like to introduce our plans for the following six months, which will be at the same time the last six months of our project.

***TWINFUSYON team***

# CONTENT



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# INTRODUCTION

Dear Reader,

With the incoming of the holiday season, we are also more sensible to sea water and air quality, which of course are parameters we use to choice our holiday place!

Monitoring the conditions of the environment and particularly how human activity affects different parts of the ecosystem is increasingly important as we gain more understanding into the extent of human impact.

The design of sensors for measuring environmental parameters is neither easy nor straightforward. The development of field devices to suit a target pollutant at the necessary detectability presents only one side of the problem, possibly solved by technology advancements.

After the implementation of the European Union (EU) Water Framework Directive (2000/60/EC) that introduces a general requirement for ecological protection on the basis of a minimum chemical standard that covers all surface waters, it became apparent, however, that[3]: (1) the determination of the 'physicochemical' status requires new tools that are suitable to assess the impact of pollutants on aquatic life and human health; (2) the implementation of operational monitoring in support of the environmental risk assessment concept should be adequate for characterizing exposure and impact at a reasonable cost; and (3) the use of disposal strategies, coupled with the search for environmentally more benign products/processes, should aim to minimize the intrusion of toxins and priority pollutants into the aquatic environment. Therefore, cost-effective and appropriate "*in situ*" technologies must be explored and implemented.

Biosensors, utilizing biological components (bioelements) coupled with signal transducers to imitate natural chemoreception may prove to be quite beneficial in i*n situ* monitoring, offering advantages over specificity (assigned by the bioelement), fast response times (determined by the transducer), miniaturization (mostly inherent by the nanosize of the bioelements), inherent signal amplification capabilities (determined by the bioelement-transducer interface), and a variety of mechanisms for signal generation, e.g. optical, electrical, etc. Combining the physical components of a sensor platform with highly specific and/or robust bioelements may allow biosensors to respond to both regulatory and practical requirements.

Among the investigated sensor platforms, sensors based on graphene and other 2D materials are an explored option!

# WHAT'S UP IN BIOSENSING

## Designing the site-specific biosensor network

*by Maria Losurdo*
*Institute of Nanotechnology, CNR-NANOTEC, Bari, Italy*

A multi-actor approach, where multidisciplinary teams can narrow knowledge gaps benefiting from the specialized knowledge that each participant contributes, is required nowadays in all research disciplines, considering that technical scientific solutions have to fulfil normative and regulation, as well as regulation needs to be update considering the latest technologies. And this also applies in environmental biosensing as well.

We point out a recent article by *C. G. Siontorou et al. [Journal Critical Reviews in Environmental Science and Technology, Vol. 47 (2017)]* addressing the importance of an ontological approach to risk assessment by means of designing and managing a network of biosensors to monitor the most critical ecological parameters in a cost-effective manner, an approach often neglected by the specificity of the technical science development. We learn from this article that the design of the biosensor network is a six-stage process, including (1) system description, (2) functional analysis, (3) systemic analysis, (4) physical analysis, (5) biosensor networking, and (6) optimization (as shown in the scheme:

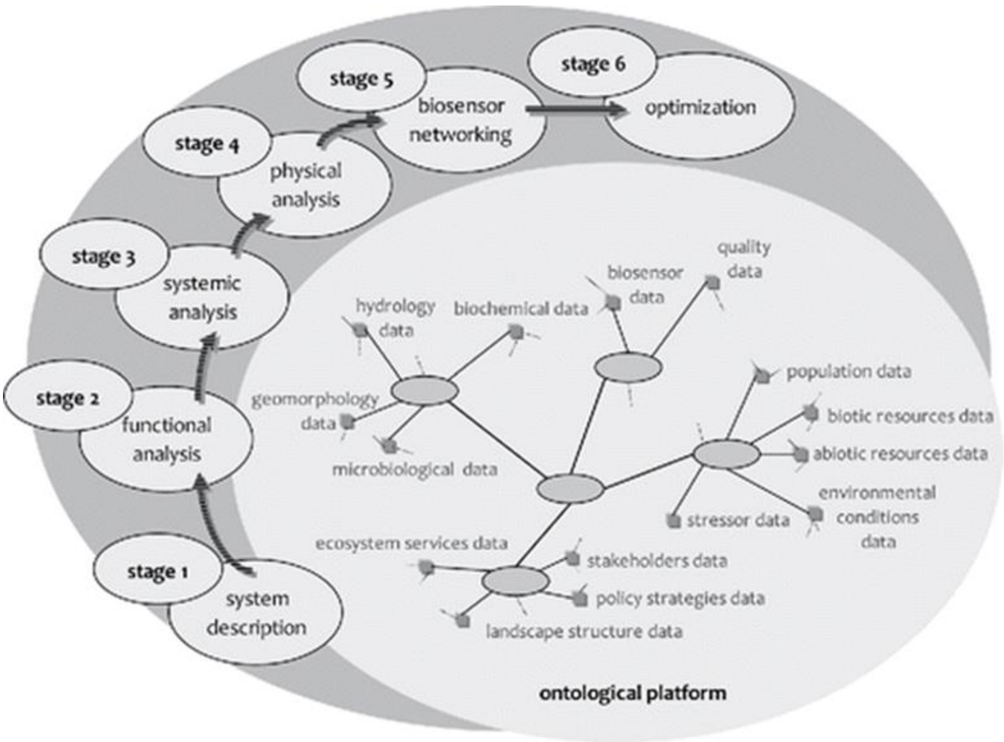



Figure: The six-stage ontological approach for designing site-specific biosensor monitoring networks based on multiscale aquatic ecosystem modelling [Source: *C. G. Siontorou et al. [Journal Critical Reviews in Environmental Science and Technology, Vol. 47 (2017)]*

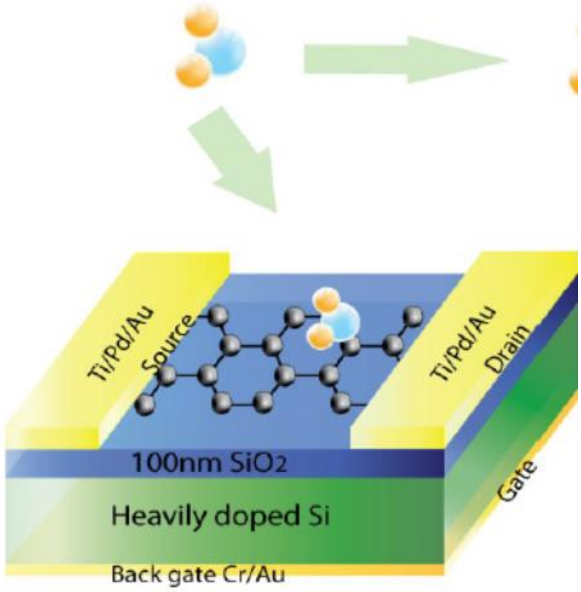
Stage (1) gathers and processes information related to the ecosystem under consideration, putting emphasis on the constituent sub-systems and their functional interrelation. Regulators, conservation groups, landowners, industries, and other stakeholders participate in this process by engaging in focused discussions regarding their interests and needs relative to water resources. It is important to identify key issues and concerns early in the process because such information provides all players with a basic understanding of the challenges that need to be addressed by the water managers.
The required information should provide an understanding of the structure, the function and the status of the aquatic ecosystem and associated water uses.
The purpose of stage (2) is to define the prioritized set of system functions that the model has to include in order to serve its intended scope, i.e., to support the management of the outcome of the events defined in the first stage.
In systemic analysis at stage (3), the functional model is reformed into an ontological matrix of intersected elements, where the nodes are the critical parameters describing each sub-system.
Physical analysis at stage (4) completes the model of the ecosystem by identifying the fluxes, boundaries,

and interfaces among the sub-systems.
The selection of biosensors at stage (5) is based on the prioritized variables to be monitored at all critical locations (nodes). As a first step, the pollution degradation pathway can be elucidated by placing detectors for the key metabolites characterizing each possible path.
At the optimization stage (6), the most relevant sensors remain at the monitoring site and the reliability of the network is determined. Depending on the data gathered, the system is regularly reviewed, and sensitivity and selectivity can be adjusted, regulated, or fine-tuned to suit any rising needs.
This multi-step approach reveals the complexity of the ontological platform involved in the development and acceptance of an environmental biosensing platform.
This motivates the dialogue of any scientific project, and of Twinfusyon as well, with stakeholders and policy strategies developers, a must nowadays for any scientist!

## Graphene-Based Sensor for NO2 Monitoring for Water and Air Quality

*by Prof. April Brown, ECE Dept. Duke University, NC, USA*
*Maria Losurdo, CNR-NANOTEC, Italy*

Graphene is a novel carbon material with great promise for a range of applications due to its electronic and mechanical properties. Its two-dimensional nature translates to a high sensitivity to surface chemical interactions thereby making it an ideal platform for sensors.
We have demonstrated a graphene NO2 sensor on a solid substrate (100nm SiO2/heavily doped silicon). Three different methods, including mechanical exfoliation, CVD and epitaxial growth using SiC, were used to synthesize graphene and the sensor fabrication process was optimized accordingly. A graphene FET structure is used for the sensor platform. A SiO2 substrate is used for both the mechanically exfoliated graphene and transferred CVD graphene, as shown in the Figure. Water is used as a controllable p-type dopant in graphene to study the relationship between doping and graphene's response to NO2. Experimental results show that interface water between graphene and the supporting SiO2 substrate induces higher p-doping in graphene, leading to a higher sensitivity to NO2, consistent with theoretical predications (Zhang, Y. et al., *Nanotechnology* 20(2009) 185504).



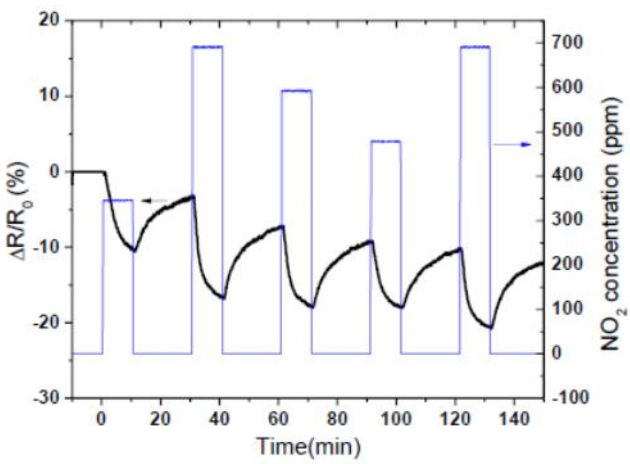




*Figure 1: (left) Scheme of the graphene FET sensor to NO2. (right) Graphene sensor's response of NO2*

The Figure also shows the response of a graphene device to NO2. The graphene sensor is exposed to the NO2/N2 gas mixture with varying NO2 concentrations for 10 minutes and then pure N2 for 20 minutes. The resistance of the graphene sensor is measured during the exposure cycles.

The figure also demonstrates that reversible NO2 detection at a response time of less than 1 minute in the ppm range can be achieved. Though the resistance cannot be fully recovered after each NO2/N2 and N2 cycle.

Since the current (10uA) supplied is small, the graphene sensor also has low power consumption.

Future applications based on the exceptional quenching ability of GO should push the detection limit resolution of water sensors beyond the current state-of-the-art. To move forward, chemists from various backgrounds will be needed to develop strategies for further tuning the properties of graphene or GO.

## COHERENCE AND INTERFERENCE

*by Kurt Hingerl, Johannes Kepler University, Linz, Austria and Josef Humlicek, CEITEC MU, Brno, The Czech Republic*

Interference is a topic in optics which undergraduate physics, optics and EE students already learn in their second year. Assuming that the electric field behaves as a plane wave, one can explain well the colors of thin coatings, diffraction effects of the type introduced by Huygens, the spectral response of Bragg gratings, and many more optical phenomena. We all learn (and teach) in undergraduate courses that one has to sum the electric field vectors. However, writing down a plane wave and using the mathematical techniques does usually not give the correct explanations for some experiments. Plane waves, behaving as $\vec{E}(\vec{r},t) = \vec{E}_0 e^{i\vec{k}.\vec{r}-i\omega t-\varphi}$, are solutions of Maxwell equations in any homogeneous region, but they do not grasp the physics of real wave trains or photons in two respects. Using them one assumes:

1) Along the propagation direction the field (photon) is infinitely long;
2) and perpendicular to the propagation direction the field (photon) is infinitely wide;

Despite for understanding some physical effects plane waves are helpful, there are two shortcomings inherently connected with them

1) There is no photon (or wave train) which has in infinitely long coherence length, but the expression above gives the impression that the phase is well defined for any instant and any point in space along the propagation direction. We all know from experience that each wave (photon) has a finite coherence length. The colorful pattern of a thin oil film on water or from a thickness variation of an oxide layer on silicon (see Fig. 1) arises from this effect; however, when asking students why a thicker oil film (> ~1 µm) does not show such interference colors anymore, many explanations are proposed, but seldom the correct one that the coherence length of light is already too small to yield interference (with our eyes as broadband detector and the photons from the sun as broadband source!).
2) Furthermore, there is also no wave field which has normal to the propagation direction a definite and well defined phase. Experimentally it turns out that the correlation of the fields vanishes also perpendicular to the propagation direction , which is shown with Young's double slit experiment if the two slits are far apart. This has been used by two astronomers Hanbury-Brown and Twiss to determine the size of stars in other galaxies.[1,2] In other words: even if strictly monochromatic light is used, each photon has also a finite coherence area $\Delta A = Q^2 = R^2 \lambda^2/\Delta S$ with the areal size of the light source $\Delta S$, the distance $R$ and the quasimonochromatic wavelength $\lambda$. The quantity $\sqrt{\Delta A}$ is also sometimes called coherence distance.

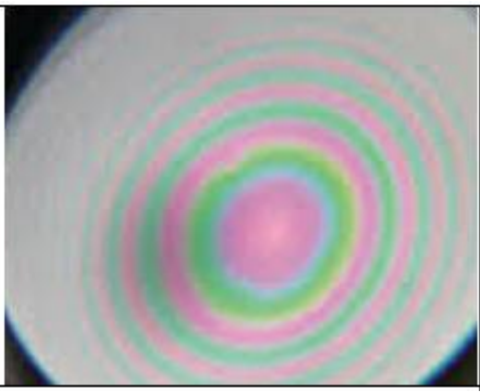


*Fig.1: Newton's rings, produced through slight and continuous thickness variations of an oxide film on silicon. One can see the vanishing colour of the rings (i.e. temporal decoherence), which indicates that the coherence length of light is approximately of the same order than the oxide thickness.*

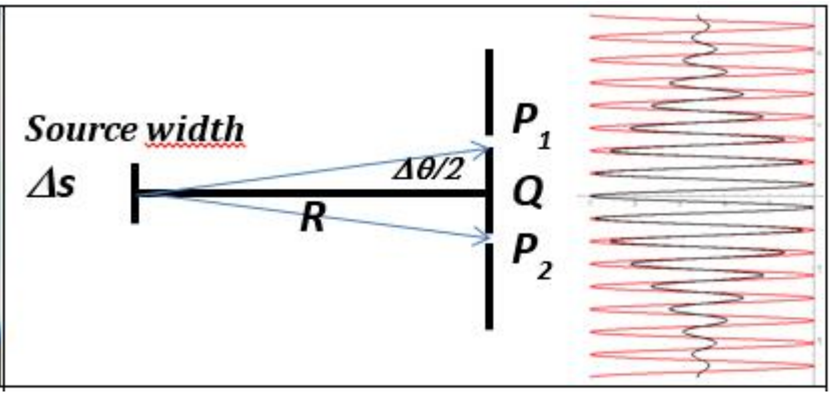



Fig.2: Schematic sketch of Young's interference fringes. The red line shows the intensity variations (on a screen in the far field) calculated with assumed infinite coherence, the black line the true experimental result. The finite coherence area, yielding to a damping of interference fringes(i.e. spatial decoherence), is given by $\Delta A = Q^2 = R^2\lambda^2/\Delta S$ , with ΔS as (vertical) extension of the light source, R, λ for the distance and monochromatic wavelength, yielding a finite coherence area ΔA.

## ONLY INTENSITIES ARE MEASUREABLE QUANTITIES

Any optical detector for optical radiation never measures the field, all measure **intensities**! And because each intensity measurement takes long against the oscillation period of light $(\sim 10^{-15}s)$ always intensities are measured. (Perhaps fast sampling oscilloscopes work up to 10 GHz, but this is still far away from optical frequencies.) So, in the case of two interfering fields, e.g. from a Michelson interferometer, or from two different slits in Young's experiment, (respectively Huygen's principle), the measured intensity is always $I = \varepsilon_0\, n\, c \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} \left(\vec{E}_1(t) + \vec{E}_2(t)\right)^2 dt$ .

Provided $\vec{E}_1(t), \vec{E}_2(t)$ are deterministic and well defined quantities over time and space, the square of the sum can be formed straightforward yielding interference terms; however, if $\vec{E}_1(t), \vec{E}_2(t)$ are not well correlated any more due to a finite coherence length / distance, and their **mutual correlation** vanishes, then instead of coherence terms yielding a cosinusoidal intensity variation, the sum of intensities is measured. All the arguments above are only classical and I just note in passing that quantum optics yields $\Delta N \Delta\phi \geq 1$ , with ΔN as standard deviation for the photon number, (which implies that beams with a definite photon number have a totally undefined phase).

## EFFECT ON POLARIZATION

Until now we have just argued with scalar electrical fields and discussed for intensity measurements autocorrelation functions $< E_x(\vec{r}, t+\tau) E_x^*(\vec{r}', t) >$ which manifest their correlation by the sharpness (visibility) of fringes in Michelson's (temporal) or Young's (spatial) interference experiments. Polarization measurements are usually done by measuring the (time averaged) correlations **of different components of the electric field at a single point in time and space** (loosely written as $< E_i(\vec{r}, t) E_j^*(\vec{r}, t) >$). In optics, we do not measure the electric fields, since the available detectors are much too slow, but their statistical second moments (see the correlation function 2 lines above). Based on a proposal by J. Humlicek in chapter 1.4 of ref.3 , R. Ossikovski and K. Hingerl recently published[4,5] two papers how the effect of decoherence can be formulated analytically to describe the effect of decoherence on depolarization. For both cases, it turns out that the intensity measurement, or better the four intensity measurements to determine the Stokes parameters, can be predicted by 16 measurements (Müller Matrix elements) for all possible input and output polarization vectors.

## References


[1] L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics*, (Cambridge University, 1995)
[2] J. W. Goodman, *Statistical Optics* (Wiley, 1985)
[3] J. Humlicek, chapter1, *Handbook of Ellipsometry,* Eds.: H.G. Tompkins and E. A. Irene, Springer (2005)
[4] K. Hingerl and R. Ossikovski, Opt. Lett. **41**, 219, (2016)
[5] R. Ossikovski and K. Hingerl, Opt. Lett. **41**, 4044, (2016)


# Biosensing instrumentation at CEITEC-Nano

*by Jan Dvořák, CEITEC MU, Brno, The Czech Republic*

Spectroscopic ellipsometry is routinely used in semiconductor industry and material science. Even though this technique is very sensitive, it reaches its limits when one tries to determine the physical or binding properties of a thin (multi)biolayer on a substrate with complicated structure. To achieve the detection sensitivity needed for liquid measurements of biomolecules in physiological concentrations, the surface plasmon resonance (SPR) must be involved in the total internal reflection (TIRE) configuration. In addition, very low noise levels must be maintained together with long-term stability of the instrument of the same order. Thanks to our custom-build SPR-TIRE extension, we are able to fulfill these conditions and use the ellipsometer for many different biosensing measurements. The aim of this text is to introduce our upgrade and to present some exemplary results.

Our instrumentation comprises the commercial ellipsometer V-VASE made by Woollam Company on which we build the microfluidic system based SPR-TIRE extension (Fig. 1). The microfluidic system starts with syringe pump (if needed, several pumps can be used to mix buffers or to achieve continuous change of the refractive index). Next in the system is the vacuum degasser (necessary to remove air bubbles from buffer) followed by an injection valve with sample loop (usually 100 μl injection). Finally, as measuring cell we use one of our home-made disposable 3D printed cells (Fig. 2). It is very convenient to prepare the cells in-place thanks to high variability of the design achievable: all dimensions and number of inputs can be altered including possibility to have an input for thermometer (useful for monitoring, suppression of the buffer effect, and possibly for close-loop control), etc. Printing of one cell takes only several minutes and the cost is very low (tens of cent) so new cell can be printed for each measurement to avoid any contamination and to increase variability of application. The cells are placed on ellipsometer in special holder also printed on 3D printer (not shown in the pictures).  The parts of the microfluidic system are interconnected with PEEK tubing. Due to small volume of the cell (typically 1 mm x 1 mm, depth 0.2 mm), the use of focusing probes (200 μm spot diameter) proves indispensable.

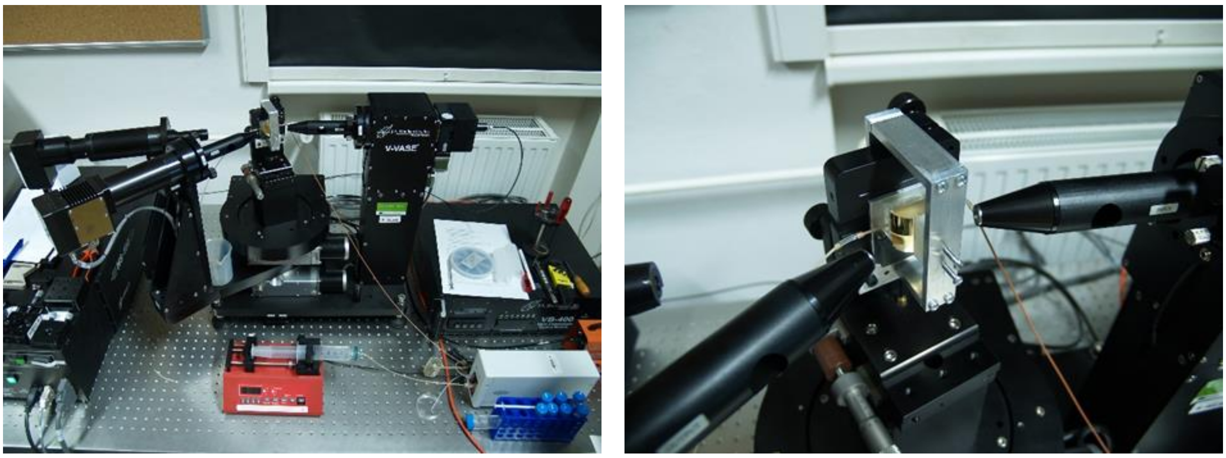


*Figure 1: V-VASE based SPR-TIRE instrumentation*

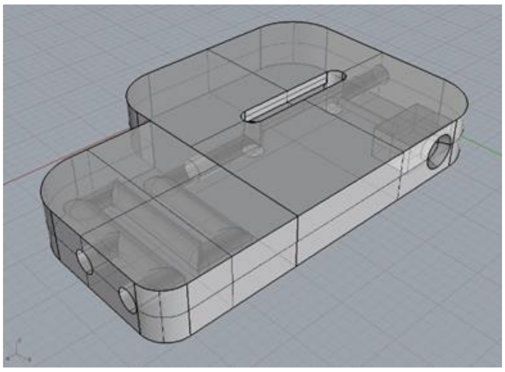


*Figure 2: Home-made TIRE cell: a two-way mixing part (left block) followed by a TIRE channel (right block); note the temperature gauge inlet (right-most opening).*

We have picked a couple of exemplary results to demonstrate our capabilities: buffer effect measurement, albumin immobilization and PEI/PSS/PAH bindings.

First, we show test measurements of an intentional buffer effect. The following picture (Fig. 3) shows dynamic scan of the ellipsometric angles over two hours. Here, 50 nm thick plasmon resonance enabling layer of gold over BK7 glass was used as substrate in water ambient. The six peaks correspond to the induced buffer effect after injection of NaCl solution at marked concentrations. The inset shows full spectrum of ellipsometric angles before injections started; the wavelengths of highest sensitivity, used in the main figure, are noted by dotted lines. One can notice high sensitivity to very small changes in the refractive index ($\Delta n = 10^{-6}$) of the buffer.

Second, we show immobilization of bovine serum albumin (BSA). We introduce several injections of 10 µM BSA at 0.05 ml/min flow rate; the volume of every injection was 100 µl. Rinsing by mild salt solution was done after each injection with no observable effect. In this measurement we present the difference spectra (Fig. 4) between subsequent injections: the changes caused by binding of albumin are barely visible in classical spectra but each addition is well identifiable in the difference spectrum.

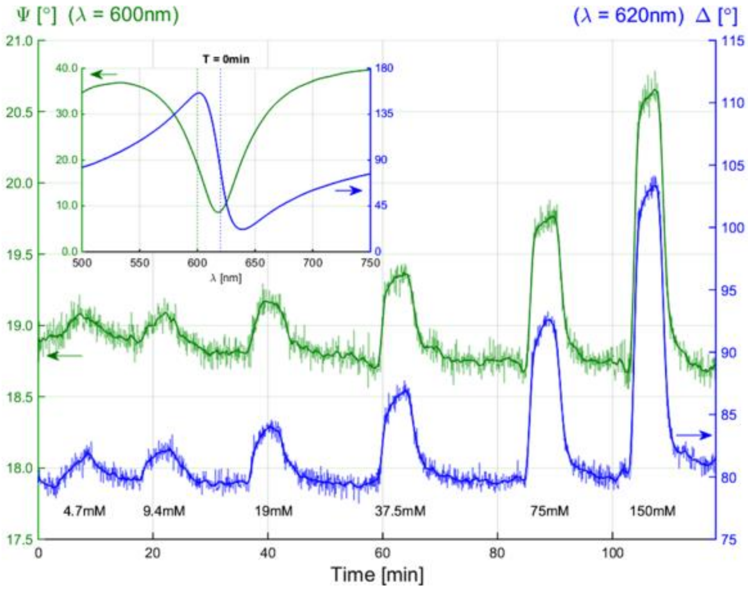



*Figure 3: Buffer effect measurement.*

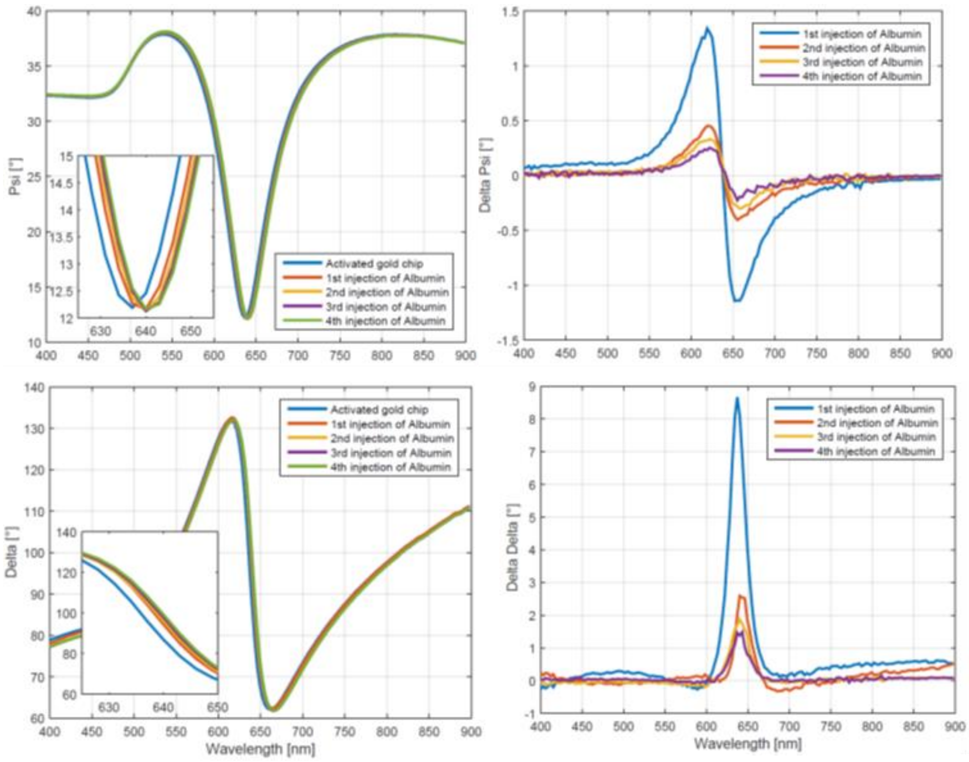



*Figure 4: Albumin immobilization; left are classical SPR spectra (Ψ, Δ), right are the difference spectra of subsequent albumin injections.*

Finally, we show PEI/PSS/PAH polyelectrolyte multilayer formation. PEI is the binding mediating agent with affinity towards gold, PSS and PAH has opposite charges, so they bind only on one another in turn (see Fig. 5). The effect of each layer formation is well visible, confirming that PAH does not bind to itself at all (the injections marked with side up and down triangles in the figure).

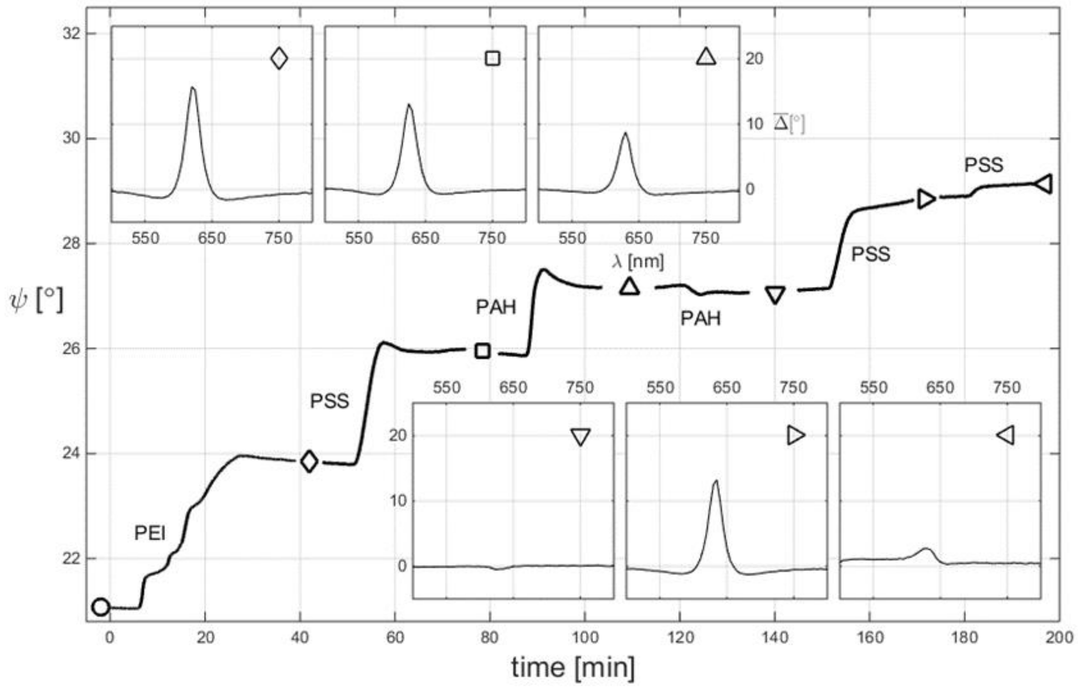



*Figure 5: TIRE monitoring of the PEI-PSS-PAH polyelectrolyte multilayer formation.*

In conclusion, our SPR-TIRE extension has proven very useful in detection of biomolecules binding and is able to extend the capabilities of conventional spectroscopic ellipsometry. Every researcher interested in ellipsometry and/or SPR is welcome to visit/contact us in Brno.

## TWINFUSYON NEWS

### TWINFUSION secondments at ZONA, JKU LINZ

*by Karel Kubíček, CEITEC MU, Brno, Czech Republic*

Structural biology has recently made a dramatic progress in unravelling structures of biomolecules and large biomolecular complexes, so called molecular machines (e.g. RNA Polymerases, ribosome etc.). However, the goal of structural biology is not only determination of so far unknown structures (or improvement of the known ones) but - even more importantly - to understand the biological function of the studied molecules.

Increasing size and complexity of the studied systems requires new approaches and combination of techniques and methodologies that analyse molecules in liquid or solid state (e.g. nuclear magnetic resonance - NMR, X-ray crystallography - X-ray, cryo-electron microscopy - cryoEM, atomic force microscopy - AFM).

To fully understand and master (not only) the above-mentioned techniques, one has to invest lot of time and energy. As a long-term NMR spectroscopist and chemist by education with very low experience with AFM, I appreciate very much the possibility of secondment to JKU in Linz (Austria) within the project TWINFUSYON - learn from experts in the field in their labs both theoretical background and get acquainted with the techniques.

Besides scientific discussions and studying new techniques, prof. Hingerl arranged a meeting with Univ.

Prof. Mag. Dr. Norbert Müller Dr.h.c. who is the dean of Faculty of Engineering &

Natural Sciences of JKU. Discussion and sharing experiences about management of human resources, securing money and grants for the faculty and future development of the faculty is also very useful added value of my scientific stay at JKU in Linz.

When planning the secondment in Linz, I thought that five months is a lot of time, however, now I see that I could have come for longer period and be more courageous in planning my scientific "upgrade". At this point, I would like to thank Mrs. Evelyn Sonntag and prof. Kurt Hingerl who made my arrival, accommodation and adaptation in Linz very smooth process and I wish everybody within the TWINFUSYON made similarly good experience.

## TWINFUSYON secondments at ZONA, JKU Linz

*by Jiří Chaloupka and Juraj Rusnačko, CEITEC MU, Brno, Czech Republic*

In the past decades, low-dimensional materials have established themselves as an extremely rich source of novel functionality, with particularly appealing applications in electronics, photonics, and various kinds of sensors including the magnetic ones and the ones involving biofunctionalized interfaces. By restricting the electronic interactions to one or two directions in the three-dimensional solid-state lattice, entirely new physical phenomena may emerge. What is more, state-of-the-art fabrication techniques enable to bring together various functional materials in a form of heterostructures with a potential to develop yet another functionality.

In our research, we mainly focus on the microscopic modeling of a particular class of 2D-TMOs with graphene-like honeycomb lattice. Our aim is the understanding of the role of the entanglement of spin and orbital degrees of freedom that gives rise to unusual bond-anisotropic interactions in the material.

The current secondment at ZONA, JKU Linz, lead by Prof. Kurt Hingerl, who has a strong background in the characterization of advanced low-dimensional materials, gives us an excellent opportunity to interact with a group of experts actively participating at the forefront of the research in the field.  By obtaining training from JKU people and attending internal seminars and colloquia, we are learning about the innovative approaches and know-how of the JKU partner. The enlightening discussions with Prof. Hingerl, who is always available to us, are the most valuable source of inspiration.


On the other hand, the secondment at JKU allows us to share our methodological expertise with our host. Right at the beginning of his stay, Juraj was given the chance to deliver two guest seminar talks attended by the relevant experts not only from ZONA but also from the other physics departments. The topics presented in the talks initiated very lively debates that provided a unique feedback for the young Ph.D. student. We are looking forward to several other opportunities that are already planned in the future.

All in all, despite some natural worries before entering such a long secondment, we now really enjoy the warm hospitality of Prof. Hingerl, who not only takes care of us scientifically, either in person or by "lending" us his group members and making contacts to relevant scientists at JKU, but also involves us in the social activities of the group. Thank you very much, Kurt!

## TWINFUSYON guest lectures

In the Spring semester 2018, following TWINFUSYON lectures were organised at CEITEC MU and partner institutions:

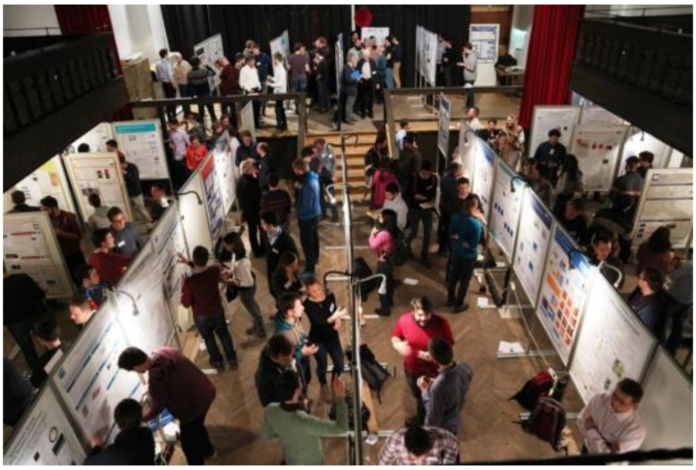
- Seminar R6 by Christian Bernhard on 4th April at Masaryk University, Brno
- *Nanoflash memories: A dream might become true* by Dieter Bimberg on 5th May at Masaryk University, Brno
- *Layered systems for detection in near- and mind-infrared renge; Fast communications channels using light from the 2-5 micron intervals* by Jindong Song and Min Chul Park on 28th—29th May at Masaryk University, Brno

## Winter School and Winter Workshop on Advances in Single-Molecule Research for Biology & nanoscience

Winter School took place from January 30th to February 1st 2018 in the Institute of Biophysics of the Linz University, Austria and three days long workshop followed it. Within three sessions of the school (introductory lectures, demo sessions and hands-on sessions) the participants were familiarised with actual research trends in novel diagnostic tools in biosensing, problems of application of scanning and electrical probing techniques in the area of biosensing and with novel analytical solutions. This gave the participants, who were mostly young researchers, an opportunity to assimilate the key concepts that allowed them to follow and understand better the advanced talk topics exchanged during the subsequent workshop. The Workshop focused on biological single-molecule research and nanoscience, including force and optical microscopy/spectroscopy techniques as well as novel approaches and materials for biosensing. It also included special sessions on nano-medicine to provide a common platform for industry and academia. The whole events consisted of talks as well as two poster sessions, where young researchers and students could discuss in depth their work and results and get advice from international experts.

## International Winterschool on New Developments in Solid State Physics

The winter school took place from February 25th to March 2nd 2018 in the Mauterndorf Castle situated in the idyllic region Lungau, Austria. With a rather large public (250 attendants), the school was organized in the form of a conference. In order to appeal to the rather broad audience of experts and young scientists, the talks were organized on a theme base; a tutorial talk would generally precede the presentations about the latest advancements in the field. A total of 32 scientific talks were given, including the kick-off speeches of two Nobel Prize winners; Klaus von Klitzing and Frederik Duncan Michael Haldane. Among the topics covered belong topological systems, 2D materials, photonics, quantum dots, nanowires, quantum transport and quantum sensing.

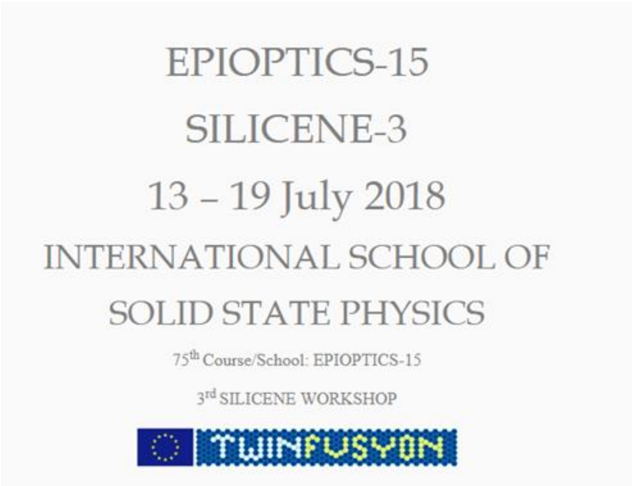


## UPCOMING EVENTS

### EPIOTICS-15 International School of Solid State Physics (co-organised)

**WHEN:** 13 — 19 July 2018

**WHERE:** CNR, Rome, Italy




**TOPIC:** The school/workshop will bring together researchers from universities and research institutes who work in the fields of (semiconductor) surface science, epitaxial growth, materials deposition and optical diagnostics relevant to (semiconductor) materials and structures of interest for present and anticipated (spin) electronic devices. The school is aimed at assessing the capabilities of state-of-the-art optical techniques in elucidating the fundamental electronic and structural properties of semiconductor and metal surfaces, interfaces, thin layers, and layer structures, and assessing the usefulness of these techniques for optimization of high quality multilayer samples through feedback control during materials growth and processing. Materials of particular interest are silicene, Collective Excitations in Advanced Nanostructures semiconductor-metal interfaces, semiconductor and magnetic multilayers and III-V compound semiconductors.

More information will be available in the Upcoming events.

## Summer School: Science in High Magnetic Fields

The summer School: Science in High Magnetic Fields, organized by the European High Magnetic Field Laboratory (EMFL) in the collaboration with the TWINFUSYON project, will be held from 26 to 30 September 2018 in Arles, which is an old Roman city in the south of France nearby the Camargue region.

The school will be dedicated to recent advances in science in high magnetic fields. A series of lectures given by renowned scientists will guide participants through the various areas of current physics, chemistry and material science in high magnetic fields. The school is open primarily to young scientists, master & doctoral students and to postdoctoral researchers, but also to senior scientists willing to get an overview about current research in high magnetic fields. Participants will have an opportunity to present their own results in a specially dedicated poster session.

**Invited speakers and topics:**

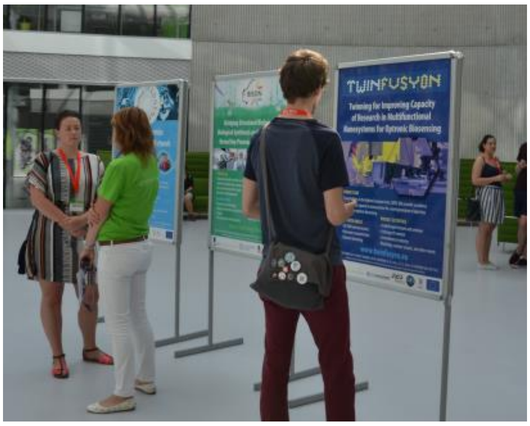
Denis M. Basko (Grenoble): *2D materials - theory*
Julien Bobroff (Paris-Orsay): *Scientific outreach*
Hartmut Buhmann (Wűrzburg): *Topological materials*
Alexey Chernikov (Regensburg): *2D materials - experiments*
Peter Christianen (Nijmegen): *Soft matter*
Amalia Coldea (Oxford): *HTc superconductivity*
Mark O. Goerbig (Paris-Orsay): *Quantum Hall effect*
Nigel Hussey (Nijmegen): Superconductivity
Alois Loidl (Augsburg): *Mutiferroics*
Hadrian Mayaffre (Grenoble): *Low dimensional magnetism*
Alix McCollam (Nijmegen): *Heavy fermions systems*
Robin J. Nicholas (Oxford): *Novel semiconductors*
Alexandre Pourret (Grenoble): *Metals and Fermi surfaces*
Geert Rikken (Grenoble/Toulouse): *High-field technology & experimantal techniques*
Joris van Slageren (Stuttgart): *Molecular magnets*
Dmitri Yakovlev (Dortmund): *Semiconductor nanostructures*

More information can be found at the webpage of the summer school.

# PROJECT DISSEMINATION

During the first half of 2018, the TWINFUSYON project was actively disseminated during the project events as well as by TWINFUSYON researchers travelling to other events. Besides this, TWINFUSYON has also been promoted at events for non-scientific public organised at CEITEC MU, e.g. at CEITEC Open Day.

The TWINFUSYON website, which is the main communication channel to our key stakeholders (scientific community, industry stakeholders, policy-makers, authorities and the general public) was upgraded into a brand new modern design. Our new webpage is available HERE.





**TWINFUSYON participated to Select Biosciences Lab-on-a-Chip and Microfluidics Europe 2018, Rotterdam, 5th and 6th of June,** bringing together researchers and industry participants from both academia and industry focusing on technology and innovation in the Lab-on-a-Chip (LOAC) and Microfluidics fields. CNR and STRATEC Consumables GmbH used this chance to present their joint collaboration within the EC Project TWINFYSON: results on next generation biosensors based on metal enhanced fluorescence, but also high innovative approaches like sensors based on graphene.

On the one hand such research setups already achieved impressive detection limits, on the other hand side still a lot of effort is needed to transfer these technologies to industrial scale processes and finally to applications, which will bring a breakthrough in the diagnostic and life science market.

CNR as well as STRATEC Consumables are aware that this goal is still 5-10 years away, but projects like TWINFYSON will bring success step by step by merging high level researchers and leading industry within Europe.

*by Dr. Iris Prinz*
*Head of Sales&Business Development EMEA / Director Global Key Accounts*
*STRATEC Consumables GmbH*

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