TWINFUSYON

Twinning for Improving Capacity of Research in Multifunctional Nanosystems for Optronic Biosensing

TWINFUSYON NEWSLETTER II

December 2016

Dear TWINFUSYON friends,

one year has already passed from the initiation of the TWINFUSYON project and a half a year from the first TWINFUSYON Newsletter. In this Newsletter we would like to share our successes during the last half a year and our aspirations and plans for the future.

Within last six months we've organized a summer school, several guest lectures, and opened new sections of the website Next semester we plan to organize second summer school and further invited lectures and short seminars. All news are published in the next pages of this Newsletter.

TWINFUSYON team

CONTENT

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692034. This Newsletter reflects only the author's view and the Research Executive Agency is not responsible for any use that may be made of the information it contains.

SHORT PROJECT OVERVIEW

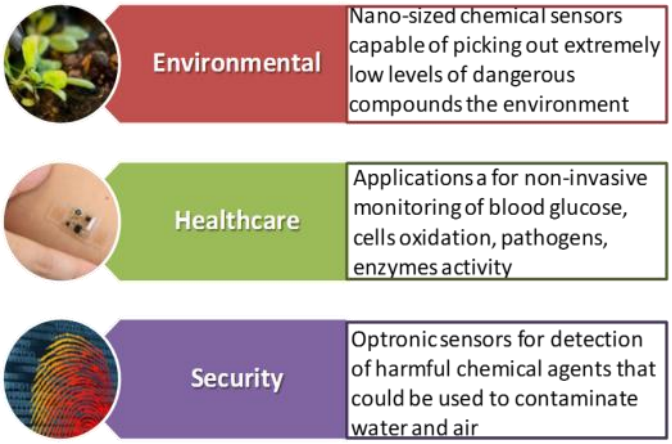
For those who haven't read the first Newsletter (which is available here), we would like to say a couple of words about the project. The Project ***Twinning for Improving Capacity of Research in Multifunctional Nanosystems for Optronic Biosensing*** (TWINFUSYON) is a 3-year H2020 TWINNING project initiated on 1st January 2016. The project mission is seeking opportunities in the development of nanotechnologies, new materials and structures with intelligent surfaces and exceptional mechanical, electrical, magnetic, optical, and biological properties to develop novel design of an optronic biosensor. It will be achieved through various networking and training activities, like workshops, summer schools and lectures of invited experts, exchange of scientists within consortium, secondments in industry, as well as other events for scientists, industry and general public.

More detailed information is available on the project website www.twinfusyon.eu.

WHAT'S UP IN BIOSENSING

A look into Biosensing

WP5 of the TWINFUSYON project focuses on biosensors configurations that can be exploited in the following three key areas:



The biosensors market size is predominantly influenced by rising demand for disposable, cost-efficient, and user-friendly devices. Owing to an interdisciplinary combination of approaches from medical science, chemistry, and nanotechnology, biosensors have paved their way rapidly in the medical field. Moreover, the use of these devices in the point of care testing, laboratories, and for self-testing should spur the industry growth.

Therefore, **Biosensors market size** was USD 14.8 billion in 2015, with 8% CAGR estimation from 2016 to 2024, as indicated in the Figure 1.

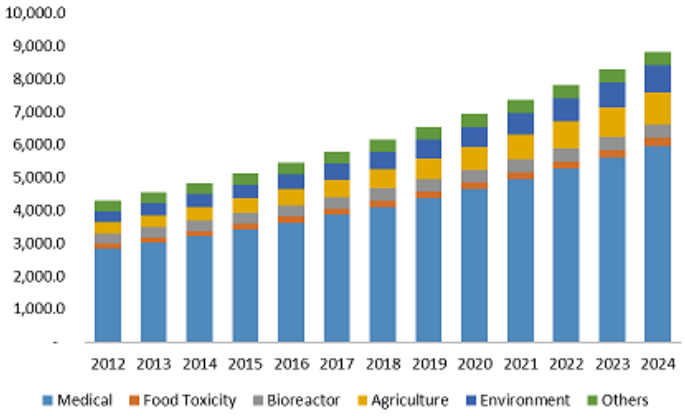


Figure 1. U.S. Biosensors Market Size, By Application, 2012 - 2024 (USD Million). Source: Global Market Insights Report, August 2016.

Technology Insights

Electrochemical sensors dominate the industry contributing to 71% of revenue share in 2015, and anticipated to exceed USD 21 billion by 2024. Easy miniaturization, robustness, and excellent detection limits are some advantages associated with these biosensors. Furthermore, these devices find extensive use in research initiatives involving accurate analysis of the contents of a biological sample.

However, optical biosensor market size is expected to grow at the fastest CAGR of 8.7% throughout the forecast period. Optical biosensors devices have revolutionized the environmental monitoring and early warning field by enhancing the ability to quantify and characterize environ-

mental pollutants, and this is expected to drive segment growth during the forecast period.

Label-free biosensors are relatively new in biochemical and pharmaceutical laboratories. Unlike other biochemical methods, fluorescent or radioactive labels are not needed for these biosensors, which makes it easier to conduct an experiment, and also reduces the likelihood of erroneous data due to the effects that labels have on biochemical reactions. The main applications of this technology are in pharmaceutical and scientific research, medical diagnostics, food quality control and the detection of toxins. The advantages of this method are explained by the fact that the kinetics of the biochemical reactions of the ligand (active substance) with different targets can be observed in real time, which allows researchers to obtain more accurate data about the reaction rates.

Most label-free biosensors are based on the use of surface plasmon resonance (SPR) spectroscopy.

Materials Insights

Sensor chips currently use two types of linking layer technology that were developed more than 20 years ago and are based either on a layer of self-assembled thiol molecules, or a layer of hydrogel (usually carboxymethyl dextran).

An alternative to existing sensor chips for biosensors based on surface plasmon resonance. Under certain conditions, the use of graphene or graphene oxide as a linking layer between metal film and a biological layer comprised of molecule targets is able to significantly improve the sensitivity of biodetection. The use of graphene increases the sensitivity of analyses conducted using SPR spectroscopy more than 25 times, as found by Stebunov at al. [see ref. in Figure 2, reported here for dissemination purposes].

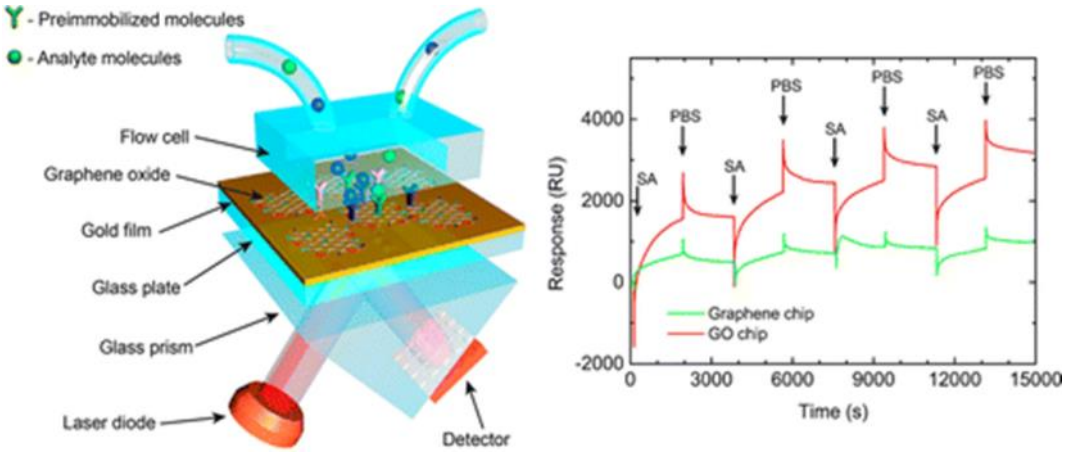


Figure 2. Y. V. Stebunov, O A. Aftenieva, A. V. Arsenin, V. S. Volkov. Highly Sensitive and Selective Sensor Chips with Graphene-Oxide Linking Layer. ACS Applied Materials & Interfaces, 2015; 7 (39): 21727 DOI: 10.1021/acsami.5b04427

Graphene is thought to become especially widespread in biosensors and diagnostics, as indicated by the figure. The large surface area of graphene can enhance the surface loading of desired biomolecules, and excellent conductivity and small band gap can be beneficial for conducting electrons between biomolecules and the electrode surface. Biosensors can be used, among other

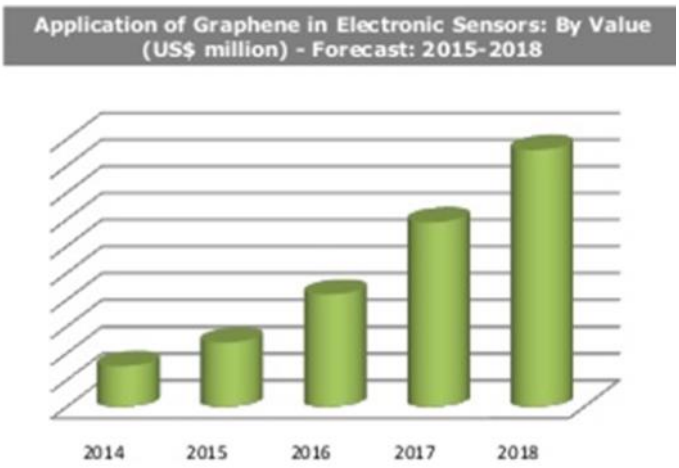
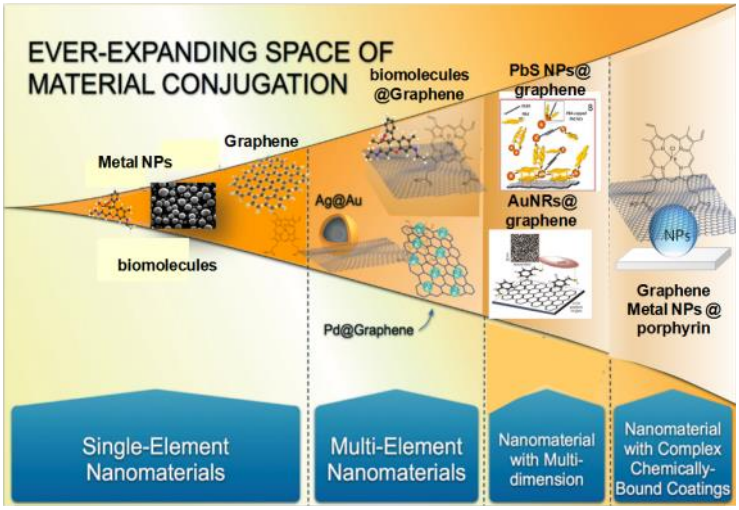


Figure 3. Global Graphene Market: Trends and opportunities (2014-2018) – New Report by Daedal Research

things, for the detection of a range of analytes like glucose, glutamate, cholesterol, hemoglobin and more.

In this Context, TWINFUSYON is investigating plasmonic hybrid graphene coupled to plasmonic nanoparticles (NPs) of gold, silver, and gallium, which are further functionalized with functional biomole-

cules. The graphene is grown by chemical vapour deposition (CVD) and then transferred to glass and flexible plastic substrates. Then metal NPs are deposited by sputtering and evaporation. As functionalizing biomolecules, we consider the cationic dye rhodamine B (R6G) as a model of a drug, and Hemin, a well-known protoporphyrin found at the activesites of heme proteins, that plays a key role in biochemical reactions and electron-transport chain, as schematised in the figure 4. We invetigate aspects related to the synthesis and functional properties of these graphene-based plasmonic bio-hybrids.



Polarimetric response of structured samples

Many researchers stated that the 20th century was the century of electrons, whereas the present one will be the century of the photon. Optics has a long history, but in the context of nanooptics and nanophotonics this statement has been proven true in the first decade. Improved fabrication facilities and technologies have allowed research and industry to manipulate light by micro and nano structures, such as photonic crystals, gratings, wave couplers, and, in past years, also negative index materials. As the feature sizes of the artificial structures, which are all summarized as metamaterials, determine the operation frequencies, a miniaturization is necessary for the move towards smaller wavelengths, for subwavelength materials structures changing the light propagation in the visible range.

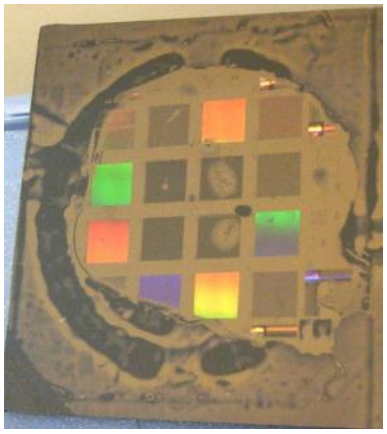


Figure 1. A piece of a reference wafer with an area of gold evaporated on fields with different periodicity. At the edges of the wafer no metal was evaporated and, therefore, the thickness of natural silica on top of silicon can be determined. The grating yields colorful optical effects to our eyes, depending on the different pitchs of each field.

This article basically reviews the research done in ZONA group at University Linz, which has dealt and still deals with spectroscopic ellipsometry (SE) applied to the investigation of metallic or dielectric structured samples, e.g. gratings. (see Figure 1). SE is fast, non-invasive and non-destructive and the spectra of stratified layers are easily compared with theoretical simulations. For diffracting systems, rigorous coupled wave analysis (RCWA) is used as numerical solver for the Maxwell equations. It is rigorous in the sense that for a large enough number of Fourier coefficients all diffraction orders are derived exactly. Many of these structures are also used in bioanalytics.

One of the most famous companies for these purposes is Biacore - a life science products company, based in Sweden. In June 2006 GE Healthcare acquired Biacore [1]. Biacore specialized in measuring biomolecular interactions, including protein-protein interactions, small molecule/fragment-protein interactions, etc. and was often used to measure not only binding affinities, but kinetic rate constants and thermodynamics as well. Biacores technology is based on surface plasmon resonance (SPR), an optical phenomenon that enables detection of unlabeled biomolecules in real time. The SPR-based biosensors can be used in the determination of active concentration as well as characterization of molecular interactions in terms of both affinity and chemical kinetics.[1]

In the case of Biacore setup, a surface plasmon resonance is excited on planar, homogeneous structures, but also on structured samples, e.g.

metallic gratings an SPR can be coupled in, with the so-called Kretschmann method[2]. Some authors call these localized surface plasmon polaritons. Metallic gratings are simple structures with only a few geometrical parameters and the comparison between theoretical and experimental spectra provide a useful basis for more complicated metamaterials. In addition, the metallic grating allows the excitation of surface plasmons. Due to the periodic structure, an additional momentum transfer is provided which is necessary to excite surface plasmons with incident light. These excitation frequencies are clearly visible in the ellipsometric spectra due to a phase shift and the ratio of reflected intensities between s- and p- polarization.

Therefore, it is of high importance to investigate silicon, gold and silver gratings and analyze them with respect to their geometrical and material parameters, and compare measured and simulated spectra. Deviations in the structure are identified and it is shown that RCWA and SE constitute a powerful combination to analyze nanostructures. Furthermore, the surface plasmon excitation frequencies for metallic structures are identified in the SE spectra and calculated with a simple theoretical model[3]. Here we use a Wollam ellipsometer, figure 2a shows the measurement system, figure 2b the grating structure and figure 2c shows selected, angle of incidence dependent, ellipsometric spectra. The resonant structures can be clearly discerned and correspond to localized surface plasmons. It can be shown that vertical and horizontal surface plasmons can be distinguished. The characterization of metallic gratings is essential, e.g. for solar cells to enhance absorption of incoming photons or for sensing features due to the field enhancement by surface plasmons. The same computational and experimental techniques are also utmost important in the microelectronic industry[4].

Despite spectroscopic ellipsometry is currently widely used to describe the polarimetric response of structured media for a variety of applications from biology to the microelectronic industry, it has to be mentioned that conceptional shortcomings exist. They are discussed e.g. in ref. [5]. using numerical solutions of Maxwell's equations. Fresnel's relations and Snell's law are, strictly speaking, not valid anymore. The effects occurring at non-horizontal interfaces between different materials

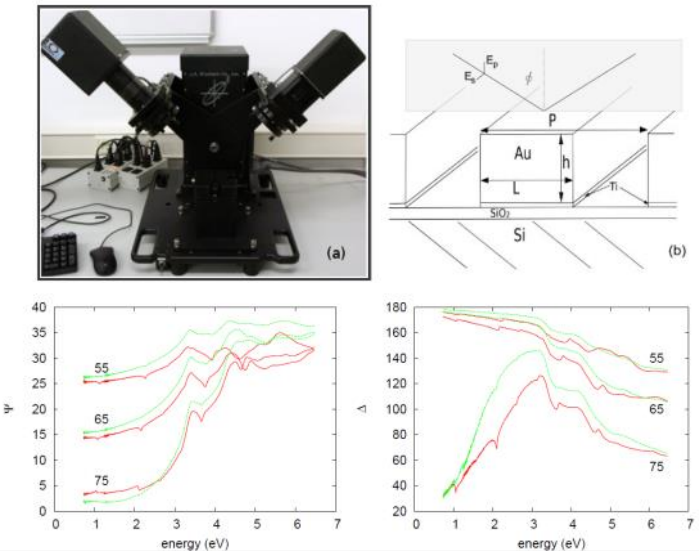


Figure 2. (a) The M-2000 Woollam ellipsometer is a rotating compensator system with a spectral range between (0.73- 6.5) eV . (b) Schematic sketch of a gold grating. The lines with a width L of the grating consist of metal. They are periodically arranged with a period P. The height of the grating is denoted by h. The shaded plane indicates the plane of incidence which defines the polarization. If the electric field is parallel to the plane, the light is p-polarized whereas electric fields perpendicular (or German "senkrecht") to the plane of incidence are named s-polarized light. (c) SE spectra (y and D for the field with P = 1200 nm for two different sample sets with a linewidth L= 720 nm: in red, the height of the grating is h = 35 nm and in green h = 20 nm.

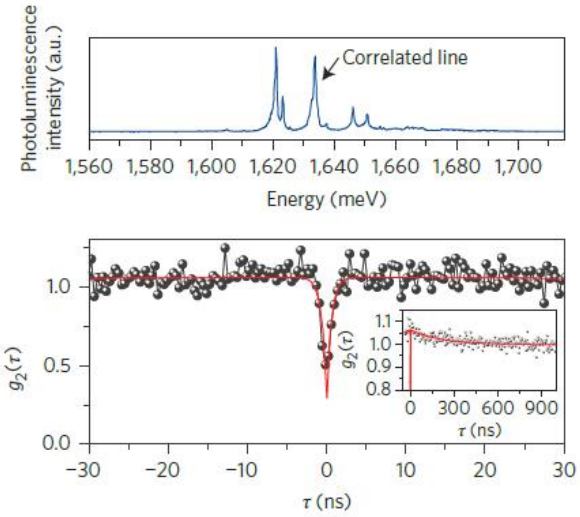
are explained via simple physical models there. At such interfaces, evanescent fields occur and modify the still well-defined complex specular reflectivities for s- and p- polarization. As the fields for s- and p- polarization couple the electric field vector directions via the boundary conditions for oblique incidence with a polarization neither parallel nor perpendicular to the interface, cross-polarization arises from the different spatial behavior of the evanescent fields. [5]

References:

[1] https://en.wikipedia.org/wiki/Biacore
[2] Die Bestimmung optischer Konstanten von Metallen durch Anregung von Oberflächenplasmaschwingungen. E. Kretschmann: Zeitschrift für Physik. 241, 1971, S. 313–324, doi:10.1007/BF01395428.
[3] "Spectroscopic Ellipsometry on Metallic Gratings", by M. Bergmair, K. Hingerl, P.Zeppenfeld in Ellipsometry at the Nanoscale, Editors: Maria Losurdo, Kurt Hingerl, Springer, Berlin (2010)
[4] "Modeling ellipsometric measurement of novel 3D structures with RCWA and FEM simulations" S. O'Mullane, N. Keller, A. C. Diebold, Proc. SPIE 9778, Metrology, Inspection, and Process Control for Microlithography, 977805 (April 21, 2016); doi:10.1117/12.2219270
[5] J.-P. Perin and K. Hingerl, Appl. Surf. Sci., in press.

Towards single-photon emitters based on 2D materials

Single photon emitters – a corner stone of current quantum technologies dealing with generation and processing of light – are sources of radiation, which emit photons one by one and are thus clearly distinguished from other, nowadays common light emitters, where photons are produced either in coherent states (lasers) or come in bunches (thermal sources). At present, single photon emitters were realized in system of cold atoms, but, more importantly, for practical use in various solid-state materials. The latter group includes systems such as natural atomic-like defects (color centers) in bulk semiconductors and insulators, quantum dots or carbon nanotubes [1]. Nevertheless, an intensive search for other single photon emitters continues, with a clear aim to enhance their reliability, simplify their fabrication and achieve operation at room temperature.



Narrow-line photoluminescence centres as sources of single photon emission (upper panel). A typical property of a single photon emitter, so-called anti-bunching, is demonstrated in the lower panel, where the photon correlation experiment shows a lowered probability for emission of two photons at the same time. Adapted from Ref. 4.

Recently, we have witnessed a serendipitous discovery of a novel class of single photon emitters. These were identified in optical emission experiments based on novel 2D materials. The original discovery was done on mono- and a few-layer structures prepared by exfoliation of WSe2 [2-6], but the following experiments proved their existence in 2D system based on other transition-metal dichalcogenides. Very recently, single photon emitters were also discovered in single sheets of hexagonal boron nitride [7] and their operation was demonstrated even at room temperature. The exact nature of single photon emitters in 2D materials still remains unclear that the moment. Most often, the localized defect (quantum dot-like structures) states are supposed to be responsible for this behavior – nevertheless, already now it is clear that 2D materials may in future find an interesting application in optoelectronics, different from widely discussed valleytronics.

References:

[1] I. Aharonovich et al., Nature Photonics 10, 631 (2016)
[2] A. Srivastava, A. et al., Nature Nanotechnology 10, 491 (2015)
[3] Y.-M. He et al., Nature Nanotechnology 10, 497 (2015)
[4] M. Koperski et al., Nature Nanotechnology 10, 503 (2015)
[5] C. Chakraborty et al., Nature Nanotechnology 10, 507 (2015)
[6] V. Perebeinos, Nature Nanotechnology 10, 485 (2015)
[7] T. T. Tran et al., Nature Nanotechnology 11, 37 (2016)

TWINFUSYON ASSOCIATED COMPANIES

BVT Technologies, a.s.

BVT Technologies (joint-stock company) is a private company based in the Czech Republic. BVT was founded by Dr. Jan Krejčí in 2000 and it commercializes his long term expertise in the field of electrochemical sensors and biosensors.

The company develops and manufactures a wide range of electrochemical sensors, enzyme biosensors (AChE and GOx) and related laboratory equipment including connectors, flow cells, pumps, potentiostats, software and other devices. BVT specializes in thick film technology for the production of screen printed electrochemical sensors. BVT can deliver wide variety of sensors in very low quantities. BVT has more than 20 years of experience in

this field. The company founder was one of the first in the world to use screen printed electrodes (1983). Over the last ten years of its existence, BVT

has gained customer confidence through interactive understanding and maintaining high degree of operational flexibility, customization, new product development or large scale project involvement. We even offer technological training on an in-house project basis for our customers.

A whole range of further products and accessories integrating the sensor response to user-communicable results are offered to customers. The offer includes data acquisition systems, PC analysis software packages, miniaturized pumps, microflow system, special connectors, adapters etc.

Our customers are primarily researchers within academic research, research institutes, or industrial laboratories. Our customers produce world-class research and develop technologies that are used in novel products and applications within the medical diagnostics, renewable energy, materials testing and research fields.

BVT supports its customers in long term projects. These projects are focused on further development of electrochemical sensors and biosensors technology, as well as the development of new methodologies of sensor application.

Article from: http://www.bvt.cz/home-1/home/company-profile

STRATEC Biomedical AG

STRATEC Biomedical AG (www.stratec.com) designs and manufactures fully automated analyzer systems for its partners in the fields of clinical diagnostics and biotechnology. Furthermore, the company offers sample preparation solutions, integrated laboratory software, and complex consumables for diagnostic and medical applications. STRATEC covers the entire value chain – from development to design and production through to quality assurance.

In July 2016 STRATEC Biomedical AG acquired all of the shares of the Sony DADC BioSciences business which operates now under the name of STRATEC Consumables GmbH. STRATEC Consumables is a leading global OEM supplier of smart consumables for diagnostics, life sciences, and medical technology applications. The company has a unique combination of skills and technologies including nano- and microstructuring, coating technologies, polymer sciences, and automated assembly. STRATEC Consumables has a certified production facility and a global logistics network and covers as its mother the entire value chain, from development and design via production and quali-

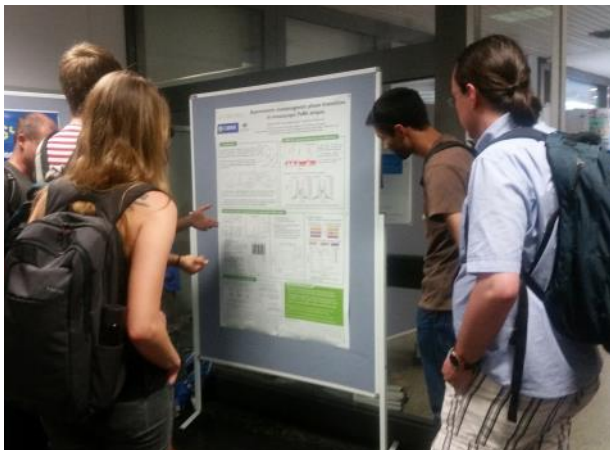
ty assurance through to logistics. The company meets all regulatory requirements in the relevant target markets. Its customers include global players in highly regulated markets as well as innovative start-ups. Furthermore, the company has numerous partnerships with universities and research institutes. Alongside its headquarters in Anif near Salzburg in Austria, the company has sales offices in both Asia and America.

Information and picture provided by STRATEC Biomedical AG.

TWINFUSYON NEWS

Advanced School On Modelling and Statistics for Biology, Biochemistry and Biosensing

The Advanced School on Modelling and Statistics for Biology, Biochemistry and Biosensing took place at JKU, Linz from 11th to 19th September 2016. The school brought together students from the various disciplines of chemistry, biology, genetics, biophysics, physics and mathematics. The aims of this 1st summer school were to twin students from various disciplines; give an overview of the importance of statistic and stochastic in the analysis of biosensing processes; give the basic mathemathical concepts to understand statistics & stochastics, and give hands-on experience in applications of statistics and stochastics to the analysis of physical, chemical, biological, biosensing and neuroscience phenomena.



Some lectures and study materials are available in the TWINFUSYON e-lab.

Two school participants are sharing their experience below.

Peter Pfann & Gerold Kristanz, PhD students at Deptartment of Physics JKU, Linz

Preface

This book will perhaps only be understood by those who have themselves already thought the thoughts which are expressed in it – or similar thoughts. it is therefore not a text-book. Its object would be attained if it afforded pleasure to one who read it with understanding.

These are the first few lines of Ludwig Wittgenstein's *Tractatus logico-philosophicus*, but I deem them appropriate as a preface to the lecture notes I took during the summer school too. It all started rather harmlessly on Sunday, Prof Hingerl introduction to classical thermodynamics made us physics students all feel comfortable. How difficult can this get when it is meant for biologists, chemists and physicists alike, right? What followed was pretty sophisticated physics and "three semesters worth of stochastics condensed to two and a half days", to put it in our professor's own words. But this is not the whole story: Besides perceived countless hours sweating inside the lecture hall at best weather, trying to wrap one's mind around heavy stuff, we enjoyed captivating lectures most notably the ones about machine learning and interesting readily understood talks about statistics in neurosciences. While content-wise it felt a bit hodgepodge and unnecessarily detailed at times, the framework and organization were impeccable: From the warm and familiar atmosphere to the generous catering, the well-organized trip to Gmunden and lake Traunsee, and the engaging communal school dinner, it was all very enjoyable. We had plenty of opportunities to get in contact with one another in coffee breaks or at lunch and talk to people of various departments from a multitude of backgrounds. Though there were some rough edges that could do well with a smoothing, all in all it was a very worthwhile experience.

Sudhir Kumar Pal, PhD student at Biomolecular Chemistry research group, CEITEC MU

During the second week of September many renowned scientists, researchers and student gathered together on the vibrant knowledge hub of JKU to attend the Advanced School on Modelling and Biostatistics organised by the TwinFusyon Project. Students of multi nationalities and different fields of Science (Biotechnology, BioChemistry, Physics, Chemistry, and Genetics) together attended the lectures on Thermodynamics, Statistics, and Physics, and Machine learning to enhance their knowledge and to understand the important of interdisciplinary and translational studies in the current and future Science.

Professors imparted their knowledge to the students and put as much effort as they could to make them understanding from the basic to higher level concepts. Although, it was an effort to gather beautiful brains together, the logical concept of combining the information diverted to the individual core sciences. Some students with a Biology and Genetics background who never encountered the huge pile of core Physics and Mathematics felt at some point a bit lost during the lectures. Despite the huge efforts of Professors, the topics were too abstract to be understood and framed in the application based point of view in the different fields.

The poster session was also very informative. 3 young researchers presented their work and it was a great moment to know about what fellow researchers and scientist are working on. During the poster session, I underwent a pleasant discussion with colleagues and students from Masaryk University, Brno and Linz University. During the discussion, we realised that the research work we are doing is related in terms of methodology and techniques used. Obviously, there are certain big differences but we exchanged quite great ideas which will definitely be a help in the progression and succession of our individual research. Especially the poster presented by Tereza Gerguri on the MD simulation was quite interesting for me. I wish her best of luck for her future. She promised me to help me in my analysis.

This is profound for generating new collaborations and incorporating new ideas in your running projects to make science even better.

After this school, I am curious to learn more and deeper concepts of Machine learning, Quantum Chemistry (Quantum Mechanics). These are crucial for my research and I would like to suggest to the organisers to include more of these concepts and also the exercises in the future events (more in the closed relation to the practical Biology).

Full text with students' opinions about the school is available HERE.

TWINFUSYON guest lectures

This summer TWINFUSYON partners coordinators held guest lectures at the Faculty of Science, Masaryk University:

- *Cd3As2: a 3D analogue of graphene* by Dr. Milan Orlita (CNRS-LNCMI)
- *Plasmonic Graphene-metal nanoparticles hybrids: possibilities for biosensing* by Dr. Maria Losurdo (CNR-NANOTEC)
- *Modelling Decoherence and Depolarization via temporal and spatial coherence* by Prof. Kurt Hingerl (JKU)

In November Dr. Milan Orlita returned to Brno to give his lecture on *Cyclotron resonance in Dirac-type materials*.

TWINFUSYON web updates

We are thrilled to inform you that new features were added to the TWINFUSYON website. The new web services – Observatory, E-library, E-lab, and Web forum – are now available for everyone interested. We will continuously update them with new materials throughout the project.

E-LIBRARY

The TWINFUSYON E-library is an electronic database accumulating research publications, book chapters, and presentations at conferences by scientists from TWINFUSYON partner institutions, as well as seminars given by invited guests of TWINFUSYON. Also descriptive videos of TWINFUSYION partners' core facilities, as well as PhD theses are available there.

E-LAB

The TWINFUSYON E-lab aims to provide PhD students and young researchers with useful information for their studies and research. Tutorial videos, prepared by TWINFUSYON partners, are available in the video archive. Study materials section includes various tutorials and presentations from TWINFUSYON guest lectures and schools. The "Call an expert" feature provides PhD students and young researchers with an opportunity to post questions and get assistance, suggestions, and guidance from experts in TWINFUSYON team.

OBSERVATORY

The TWINFUSYON Observatory provides a collection of information and analysis from the user community, literature, internet, markets, projects, in order to establish future needs and trends in label-free biosensing technology. It also provides a link to the patent data website with the most recent patent information. These materials are being regularly updated on the webpage

WEB FORUM

The TWINFUSYON Web forum provides a space for exchange of ideas related to new trends and latest applications in biosensing, nanomaterials, and related technologies and processes. We are looking for your questions and comments!

TWINFUSYON secondments

During last half a year TWINFUSYON also organised its first secondment. Jan Dvořak – a PhD student from the Research group Functional Properties of Nanostructures at the Centre for Advanced Nanotechnologies and Microtechnologies – spent 2 months at Johannes Kepler University, Linz. Jan Dvořak shares his experience below.

To find out about secondment possibilities for MU students and researchers within the TWINFUSYON project contact Mrs. Pavla Pospíšilová.

Jan Dvořak, CEITEC MU

One of the goals of the TWINFUSION project is to provide a platform for students and young researchers to undergo a well-rounded PhD education and by that to strengthen the scientific competence of technical staff. As PhD student at the Department of Condensed Matter Physics at Masaryk University in Brno, and part-time employee at CEITEC, I got a chance to experience two months of internship at Johannes Kepler University (JKU) in Linz. I am focusing on surface plasmon resonance (SPR) in my doctoral thesis, but during my research we were aware of the necessity of using complementary methods to meet our goals. Atomic force microscopy (AFM) has been found as the most suitable instrument thanks to its variability in measurement modalities.

The TWINFUSYON project gave me the opportunity to visit the Institute of Biophysics (IB) at JKU which is specializing exactly on applications of AFM. During my internship I had the chance to cooperate with several researchers. I worked every week with new colleague on his or her project, and by that I gained the necessary knowledge about the used techniques. Thanks to that I got an important overview over all projects and methods that are ongoing at IB JKU (force spectroscopy, HS-AFM, TREC, etc.). Even though the aim of my internship was working with AFM, I have also learned a lot about other methods. For example about crystal microbalance (QCM), which I am about to use also in my own PhD research. Apart from the above I also attended block of lectures where group-leaders were presenting departmental projects for new PhD students.

There has been quite long tradition in cooperation between our department and Central Surface and Nanoanalytics Institute at JKU, but collaboration with IB hasn´t been any significant. The TWINFUSYON project has contributed to bring our two departments closer. Professor Peter Hinterdorfer, the head of IB, has already agreed with taking a lecture at our department during next semester.

UPCOMING EVENTS

Winter School and Workshop New Frontiers in 2D materials: Approaches & Applications

WHEN: 15-20 January 2016

WHERE: Villard-de-Lans, France

TOPIC: The winter school and workshop New Frontiers in 2D materials: Approaches & Applications will bring together young researchers involved in the developing field of novel 2D materials. The school and workshop will cover theoretical, experimental but also technological aspects of current research on novel 2D materials (graphene, silicene, transition-metal dichalcogenides, topological insulators & semiconductor nanostructures) and other emerging systems (multiferroics, materials for spintronics, semiconductor quantum dots and quantum fluids in polariton structures).

More information and programme are available on the school and workshop official website.

The Advanced School on Theory and Approaches to Plasmonics, Nanomaterials, and Nanofabrication Serving Biosensing

WHEN: Summer 2017

WHERE: CEITEC MU, Brno, the Czech Republic

TOPIC: The goal of the school is to familiarise young scientists with research trends and problems in the spectroscopy of layered structures and the applications of optical techniques in biosensing, and to promote future implementations of the concepts.

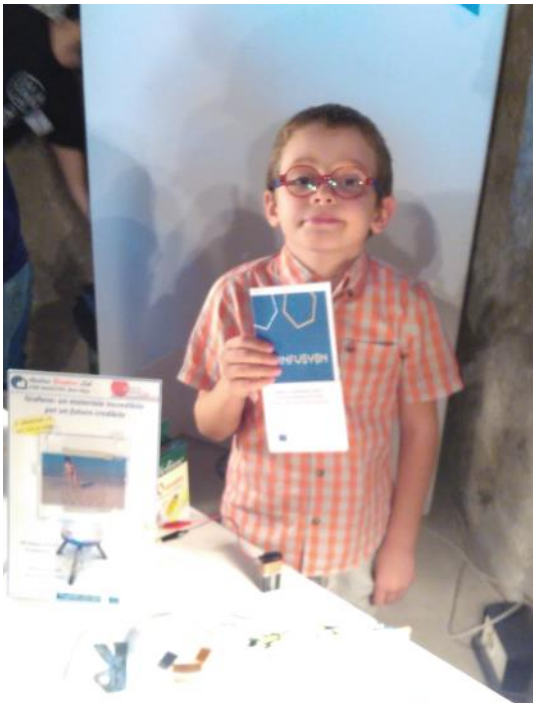
More information will be available in the Upcoming events.

CEITEC

PROJECT DISSEMINATION

TWINFUSYON dissemination activities

CNR-NANOTEC presented the project TWINFUSYON to the general public during the Researchers' Night 2016 in Bari, Puglia. We had a brilliant night at Castle in Bari with over 50 research stations, as well as spotlight talks and shows! The events were run by our team of Postgraduate and Undergraduate Science Scouts. The Researchers of the TWINFUSYON team had great fun participating in the event giving a talk to the general public including kids, parents and local policy representatives on one of the materials, which are the focus of TWINFUSYON: "Graphene: an incredible material for a credible future". More information HERE.



To disseminate information about the BISON project we've prepared TWINFUSYON poster. It has already appeared at the JKU summer school and at CEITEC MU during Masaryk University Festival 15.9, Researcher's Night in Brno 30.9.

Additionally project brochures were developed in order to target TWINFUSYON stakeholder groups, including scientific community, industry, and general public.

INTERESTING PUBLICATIONS

Plasma strategies for graphene functionalization and tuning of transport properties
G.V. Bianco - M. Losurdo, M. M. Giangregorio, P. Capezzuto, G. Bruno (Istituto di Nanotecnologia, CNR-NANOTEC, Dipartimento di Chimica, Università degli Studi di Bari, Via Orabona 4, 70126 Bari), M. Grande, A. D'Orazio (Dipartimento di Ingegneria Elettrica e dell'Informazione, Politecnico di Bari, Via Re David, 200, 70125), L. La Notte, E. Villari, A. Reale (CHOSE (Centre for Hybrid and Organic Solar Energy), Department of Electronic Engineering, University of Rome Tor Vergata, via del Politecnico 1, 00133 Rome, Italy). Materiali. It Catania, Italy, December 12 - 16, 2016

A Versatile Graphene-Plasmonic Metals-Porphyrines Platform M. M. Giangregorio
G.V. Bianco, P. Capezzuto, G. Bruno and M. Losurdo - (Istituto di Nanotecnologia, CNR-NANOTEC, Dipartimento di Chimica, Università degli Studi di Bari, Via Orabona 4, 70126 Bari), Materiali. It Catania, Italy, December 12 - 16, 2016

Epitaxial growth of gapped graphene and tungsten disulfide
G. V. Bianco, M. Losurdo, M. M. Giangregorio, A. Sacchetti, P. Capezzuto and G. Bruno (Istituto di Nanotecnologia, CNR-NANOTEC, Dipartimento di Chimica, Università degli Studi di Bari, Via Orabona 4, 70126 Bari), Materiali. It Catania, Italy, December 12 - 16, 2016

Graphene, an incredible material: the role of chemistry in realizing the promise of technological innovation
G. V. Bianco (Istituto di Nanotecnologia, CNR-NANOTEC, Dipartimento di Chimica, Università degli Studi di Bari, Via Orabona 4, 70126 Bari), NANOINNOVATION 2016, 20-23 september ,2016, ROME., Italy

RELATED UPCOMING CONFERENCES IN THE SPOT

- *7th Euro Biosensors & Bioelectronics Conference* July 10-12, 2017 Berlin, Germany
- *International Conference on Environmental Chemistry and Engineering* July 27-28, 2017 Rome, Italy
- *2nd Annual Conference on Biomaterials* March 27-28, 2017 Madrid, Spain
- *5th International Conference on Bio-Sensing Technology* May 7-10, 2017 Riva del Garda, Italy
- *19th International Conference on Biosensors and Bioelectronic*s August 20-21, 2017 London, UK
- *10th German BioSensor Symposium* March 20-23, 2017 POTSDAM, Germany

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692034. This Newsletter reflects only the author's view and the Research Executive Agency is not responsible for any use that