*The **CREA**tion of the Department of Physical Chemistry of Biological Sys**TE**ms [CREATE]*

666295 — CREATE — H2020-WIDESPREAD-2014-2015/H2020-WIDESPREAD-2014-2

3rd report on enhancement of IPC research quality

[Deliverable D.3.7]

Level of dissemination: Public

Warsaw, March 2021

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TABLE OF CONTENTS

I. AN OVERVIEW

This document contains the **description of the courses and effects of events intended for the whole IPC society, and – in particular – the synergetic groups** (i.e. research groups selected by the ERA Chair holder for collaboration and development of research goals adopted by the ERA Chair holder), i.e.:

- Laser Centre, prof. Czesław Radzewicz / dr. hab. Angulo Gonzalo
- Microfluidics and Complex Fluids, prof. Piotr Garstecki
- Soft Condensed Matter, prof. Robert Hołyst
- Surface Nanoengineering for chemo- and bio- sensors, dr hab. MEng. Joanna Niedziółka-Jönsson
- Group of Cooperative catalysis (CoopCat), dr. hab. Adam Kubas

These events results from the mentoring and tutoring programme of the ERA Chair holder took for the IPC research other groups members that took place between M41 – M66.

Tutoring and mentoring activities of ERA Chair holder towards his employees are not within the scope of this deliverable, and are reported separately under a deliverable 2.5: "*2nd report on tutoring and mentoring activity of ERA Chair holder towards his/her employees*" (M66).

In total, under the given period, the following no. of actions aimed at development of the research IPC staff (excluding members of the new department – i.e. the Department of Physical Chemistry of Biological Systems) was organized:

- **17 lectures:**
  - **6 scientific lectures**
  - **11 Innovation source lectures.**
- **17 person/lab visits**
- **4 person/study visits**
- **20 person/on-line training.**

II. ENHANCEMENT OF SKILLS & KNOWLEDGE OF IPC SOCIETY

a. CREATE lectures series (6):

Name:	**Prof. Gabor Forgacs**
Position/Institution:	**Professor of Biological Physics at the University of Missouri-Columbia and the Executive and Scientific Director of the Shipley Center for Innovation at Clarkson University, USA**
Date:	**7-8/05/2019**

Aim of the visit:

- ✓ deliver a scientific seminar and participate in meetings with synergetic teams, to support mentoring activity of the ERA Chair holder,
- ✓ take part in the consultations on required changes at IPC to improve our performance,
- ✓ discuss the idea of join grant application with ERA Chair holder.

"Bioprinting In The Life Sciences And Beyond"

Abstract of the seminar

Engineering of tissues and organs has seen spectacular progress in recent years. The associated technologies such as 3D printing and organ-on-the chip have provided invaluable tools for numerous applications. The technologies have also matured from academic research into commercialization. In basic research these structures are used as models to study early developmental processes, cellular interactions and disease in near-physiological conditions. In pharmaceutical applications today the engineered constructs are used in drug toxicity essays in preclinical studies. Tomorrow, animal trials that today precede human clinical trials will be replaced by model organisms representing combinations of bioprinted tissues. We will discuss applications of these technologies, either already on the market notably in pharmaceutics or soon to arrive there such as in therapeutics. Importantly, we present applications beyond the customary fields of regenerative medicine and drug development, examples of a novel paradigm, the biofabrication of animal products, such as leather and meat without the need to slaughter animal. We conclude with an attempt to provide a free-of-hype, realistic outlook on the future of the discussed technologies. One of the grand fundamental challenges of modern science is to reveal the basic operating principles of life. While we have extensive knowledge about the molecular building blocks that form the basis of modern life, we do not understand how these building blocks collectively operate to define life as we know it. Cellular life, which provides the fundament of all organisms,

appears to be the result of a collection of highly controlled, energy consuming, dynamic self-assembly and self-organization processes that lead to autonomous entities that can reproduce, transfer information, interact, and evolve.

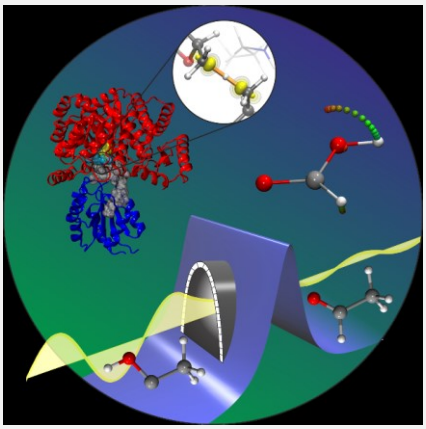
Name:	**Prof. Johannes Kästner *ERC grant holder***
Position/Institution:	**Professor of Computational Chemistry at the Institute for Theoretical Chemistry, University of Stuttgart, Germany**
Date:	**6-7/11/2019**

Aim of the visit:

- ✓ deliver seminar lecture on his studies;
- ✓ participate in meetings with synergetic and other IPC teams to support mentoring activity of the ERA Chair holder;

"Tunnelling Processes in Chemistry Simulated with Instanton Theory"

Abstract of the seminar



The tunnelling of atoms accelerates many chemical reactions from catalysis via biochemistry to astrochemistry. Most reactions involving hydrogen atoms will be influenced by tunnelling even at room temperature. Lower temperatures allow the tunnelling of heavier atoms. Among the different techniques to evaluate tunnelling rate constants, instanton theory is a promising compromise between accuracy and computational efficiency. The theory will be briefly reviewed along with applications such as the decay of carbenes, proton transport along Grotthus chains or water-formation reactions in the interstellar medium.

J. Meisner, J. Kästner, **Angew. Chem. Int. Ed**. 55, 5400 (2016)
S.R. McConnell, A. Löhle, J. Kästner **J. Chem. Phys**. 146, 074105 (2017)
J. Meisner, T. Lamberts J. Kästner **ACS Earth Space Chem**. 1, 399 (2017)

Name:	**Prof. Alexander Kuhn *ERC grant holder***
Position/Institution:	**Professor at Ecole Nationale Supérieure de Chimie, de Biologie et de Physique, University Bordeaux, France**
Date:	**12-13/11/2019**

Aim of the visit:

- ✓ deliver seminar lectures on his studies;
- ✓ participate in meetings with synergetic and other teams to support mentoring activity of the ERA Chair holder.

„ Unusual approaches for symmetry breaking in chemical systems"

Abstract of the seminar

Asymmetry is a very common feature of many systems, objects and molecules that we encounter and use in our daily life. Actually, it is in a majority of cases the absolutely crucial ingredient for conferring a certain useful property to a system, a prominent example being the chiral nature of pharmaceutically active compounds. Chemists have developed various approaches to generate asymmetry, from the molecular to the macroscopic scale, but are still facing major challenges when exploring efficient alternative physico-chemical concepts for symmetry breaking. Therefore, there is a strong need to explore, understand and optimize alternative approaches, which might lead in the long run to completely different but practically viable processes with economic potential. We we'll discuss in this presentation two quite unconventional concepts, allowing to break the symmetry in chemical systems at different scales, ranging from the molecular level to the macroscopic world. The utility of these concepts will be illustrated with a selection of very recent results concerning the detection, separation and synthesis of chiral molecules, as well as the elaboration and characterization of asymmetric, so-called Janus objects and systems with complex composition, behavior or functionality, based on the use of bipolar electrochemistry as a leading strategy.

Name:	**Prof. Frank Glorius *ERC grants holder***
Position/Institution:	**Professor for Organic Chemistry at the Westfälische Wilhelms-Universität in Münster, Germany**
Date:	**13-14/02/2020**

Aim of the visit:

- ✓ deliver seminar lecture on his studies;
- ✓ participate in meetings with synergetic and other IPC teams to support mentoring activity of the ERA Chair holder;

"On discovery in catalysis"

Abstract of the seminar

Catalysis is a key technology of our modern societies, since it allows for increased levels of selectivity and efficacy of chemical transformations. While significant progress can be made by rational design or engineered step-by-step improvements, many pressing challenges in the field require the discovery of new and formerly unexpected results **(Figure 1)**. Arguably, the question "How to discover?" is at the heart of the scientific process. In this talk, strategies and discoveries from the Glorius group will be discussed. Topics will include the use of N-heterocyclic carbenes (NHCs)[1] in different fields of catalysis (such as arene hydrogenation[2] and on-surface chemistry[3]) and also discovery and reproducibility in photocatalysis.[4-6]

Figure 1: "Landing of Columbus at the Island of Guanahani, West Indies, 12 October 1492", John Vanderlyn, 1836-47

References:

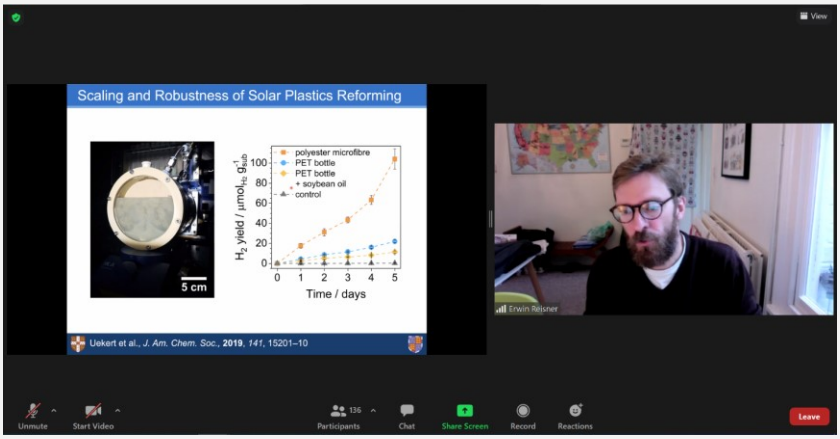
[1] M. N. Hopkinson, C. Richter, M. Schedler, F. Glorius, Nature 2014, 510, 485.

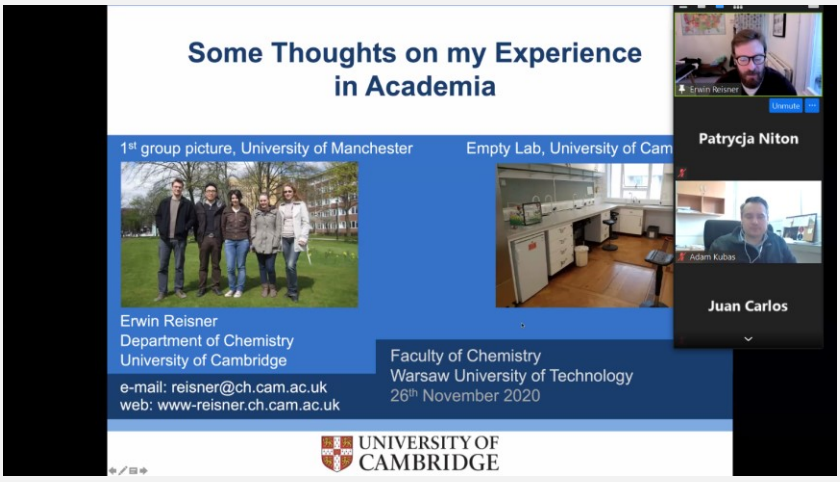
[2] M. P. Wiesenfeldt, Z. Nairoukh, W. Li, F. Glorius, Science 2017, 357, 908. Z. Nairoukh , M. Wollenburg, C. Schlepphorst, K. Bergander, F. Glorius, Nat. Chem. 2019, 11, 264.
[3] J. B. Ernst, C. Schwermann, G.-I. Yokota, M. Tada, S. Muratsugu, N. L. Doltsinis, F. Glorius, J. Am. Chem. Soc. 2017, 139, 9144. A. Bakker, A. Timmer, E. Kolodzeiski, M. Freitag, H. Y. Gao, H. Mönig, S. Amirjalayer, F. Glorius, H. Fuchs, J. Am. Chem. Soc. 2018, 140, 11889.
[4] a) M. N. Hopkinson, A. Gomez-Suarez, M. Teders, B. Sahoo, F. Glorius, Angew. Chem. Int. Ed. 2016, 55, 4361. b) F. Strieth-Kalthoff, C. Henkel, M. Teders, A. Kahnt, W. Knolle, A. Gómez-Suárez, K. Dirian, W. Alex, K. Bergander, C. G. Daniliuc, B. Abel, D. M. Guldi, F. Glorius, Chem 2019, 5, 2183.
[5] M. Teders, C. Henkel, L. Anhäuser, F. Strieth-Kalthoff, A. Goméz-Suárez, R. Kleinmans, A. Kahnt, A. Rentmeister, D. M. Guldi, F. Glorius, Nat. Chem. 2018, 10, 981.
L. Pitzer, F. Schäfers, F. Glorius, Angew. Chem. Int. Ed. 2019, 58, 8572.

Name:	**Prof. Erwin Reisner, *ERC grant holder***
Position/Institution:	**Professor of Energy and Sustainability at the University of Cambridge and a Fellow of St. John's College in Cambridge, UK**
Date:	**26/11/2020**

Aim of the virtual visit:

- ✓ deliver seminar lecture on his studies;
- ✓ delivered lecture on experiences from his own research career path;
- ✓ participate in meetings with synergetic and other IPC teams to support mentoring activity of the ERA Chair holder;





"Solar-driven Synthesis of Fuels and Chemicals from Biomass and Plastic Waste"

Abstract of the seminar

Artificial photosynthesis is a sustainable process that utilises solar energy to drive endothermic multi-electron chemical reactions for the production of fuels. A common drawback in photoelectrochemical systems is their reliance on expensive materials and device architectures, which challenges the development of ultimately scalable devices. Particulate photocatalysts provide a potentially lower-cost alternative, but their low efficiencies and common reliance on costly sacrificial redox reagents limit their commercial prospects.

This presentation will give an overview about our recent progress in developing semiconductor suspension systems to perform efficient full redox cycle solar catalysis using inexpensive components, and our approach for sustainable photo-reforming of waste biomass and plastics (Figure 1). The principles and design considerations for the solar-driven photo-reforming process will be compared to traditional artificial photosynthetic systems and benefits and disadvantages discussed.

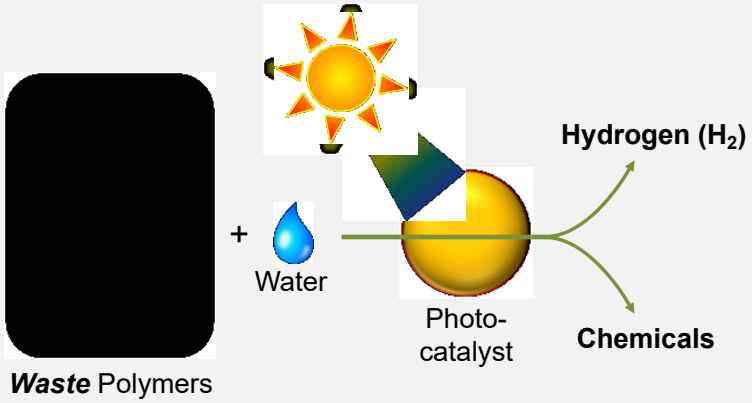


Figure 1: Solar-driven reforming enables the conversion of waste biomass and plastics into H_2 fuel and bulk chemicals.

Specifically, CdS/CdO_x quantum dots and carbon-based materials such as carbon nitride have been recently established as suitable photocatalysts for the photo-conversion of lignocellulosic biomass and synthetic polymers such as polyethylene terephthalate (PET) and polylactic acid (PLA) in aqueous medium into H_2 fuel and organic chemicals (in particular organic acids and monomeric building blocks of the polymer substrate).[1-5] Thus, this ambient-temperature photo-reforming process offers a simple and low-energy means for transforming polymeric waste into fuel and bulk chemicals.

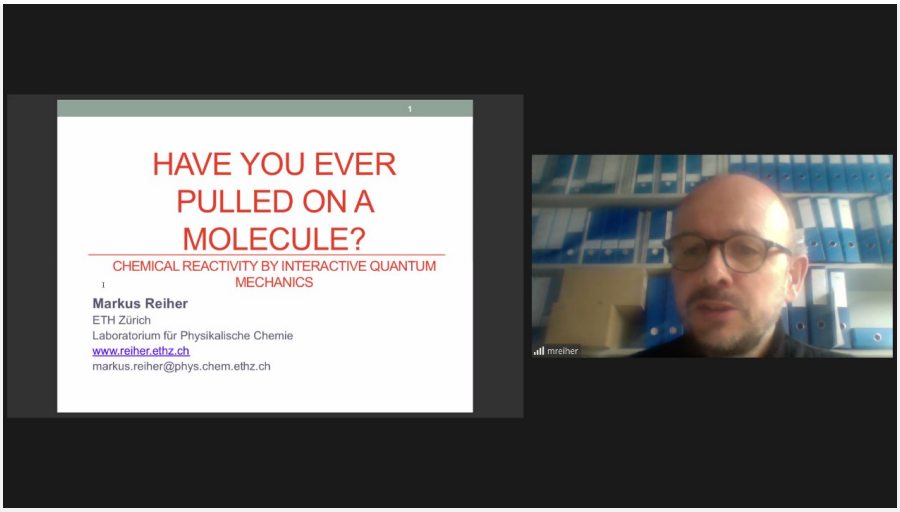
Representative publications:

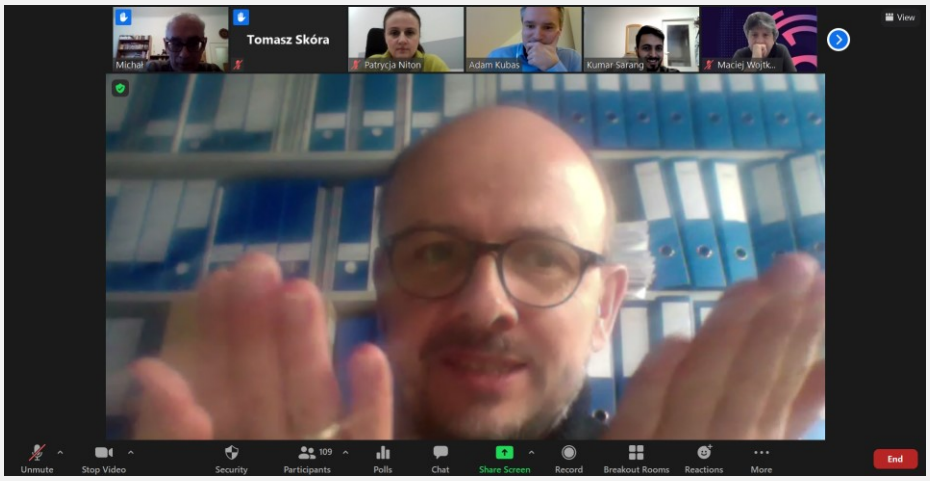
[1] Uekert, Kasap, Reisner, J. Am. Chem. Soc., 2019, 141, 15201.
[2] Kasap, Achilleos, Huang, Reisner, J. Am. Chem. Soc., 2018, 140, 11604.
[3] Uekert, Kuehnel, Wakerley, Reisner, Energy Environ. Sci., 2018, 11, 2853.
[4] Kuehnel, Reisner, Angew. Chem. Int. Ed., 2018, 57, 3290.
[5] Wakerley, Kuehnel, Orchard, Ly, Rosser, Reisner, Nature Energy, 2017, 2, 17021.

Name:	**Prof. Markus Reiher**
Position/Institution:	**Professor at the Department of Chemistry and Applied Biosciences in ETH Zürich, Switzerland**
Date:	**10/12/2020**

Aim of the virtual visit:

- ✓ deliver seminar lecture on his studies;
- ✓ delivered lecture on his personal thoughts on group leading and building a successful strategy in mentoring;
- ✓ participate in meetings with synergetic and other IPC teams to support mentoring activity of the ERA Chair holder;





"Have you ever pulled on a molecule? - Chemical Reactivity by Interactive Quantum Mechanics"

Abstract of the seminar

Our capability to describe molecular structures based on the first principles of quantum mechanics has reached a breathtakingly high degree of sophistication, maturity, and feasibility. At the same time, theoretical chemistry as a research field has diversified dramatically over the years. Significant progress has been made in all its diverse subfields. Its capabilities, as well as the open challenges, are very well understood. Moreover, many unexpected new concepts - in electronic structure theory, vibrational spectroscopy, data-driven chemistry, quantum information and quantum computing, etc. – developed in the past twenty years highlight the enormous current impetus and momentum of the field.

In my talk, I will reflect on some of these developments and then focus on our new concept of real-time quantum chemistry that allows one to get immersed into molecular reactivity through interactive quantum mechanics.

b. **"Innovation source" lectures (11):**

Name:	**Rafał Bator**
Position/Institution:	**Partner, Enterprise Investors, Poland**
Date:	**31/05/2019**

Rafał Bator specializes in technology investments. He has been with Enterprise Investors, the leading private equity fund in CEE, for 17 years. Before joining Enterprise Investors, Rafał worked for two of Poland's leading IT companies, and for Price Waterhouse (today PwC). His most important projects to date include AVG Technologies, PBKM and Intive. He invested in AVG Technologies (antivirus software provider) in 2005 when the company had revenue of $10m. The company grew its revenue to $400m at the time of an IPO on the main floor of the NYSE in 2012. AVG become the market leader in the US by number of protected computers. The IPO of AVG was the first IPO of a technology company from CEE in the US (and the only one, to date). PBKM is the largest European stem cell bank. Rafał led this investment from a small Polish based company through serious of acquisitions to be the leader, in Europe. Intive is a software house specializing in bespoke software for R&D of large international companies (automotive, bank, telecommunication). The company employees 1500 developers in Poland, Germany, Argentina and the US. 2008-2019 Rafał was the president of Enterprise Venture Fund providing expansion capital of EUR 2-10m for companies in CEE. The fund was fully invested and successfully closed in 2019. He has led about 20 investment and exits (including 5 IPOs).

*"**How to deal with the investment of a Venture Capital fund**"*

Abstract of the seminar

Time to market has become the key factor for growing successful companies to leading positions/ a leading position on the global market. A growth can be accelerated by external financing, including funding by venture capital funds. How to approach a potential investment from a VC fund? What is 'a value added' by VC fund? How to work with them? Understanding of above questions is important for successful cooperation with potential investors/a potential investor who usually stays in the company as an investor, for 4-6 years. The venture capital industry has been the worst asset class in Europe for the past 20 years. It is full of losers and bureaucrats/bureaucracy. How to recognize and avoid them?

Name:	**Prof. Tomasz Ciach**
Position/Institution:	**Professor at the Warsaw University of Technology, head of the BioMedLab and the division of Biotechnology and Bioprocess Engineering at the Faculty of Chemical and Process Engineering, Poland**
Date:	**11/06/2019**

Prof. Tomasz Ciach has broad experience in applying scientific knowledge in practice. He founded his first company during his doctoral studies. The profile of the company was design and manufacture of custom made electronic equipment for laboratories worldwide. Some results of his PhD thesis served as base for water filter production facility at Amazon UK. His scientific carrier was focused on medical biotechnology and biomedical engineering.

He has developed a few technologies that were launched into the European medical market. The first of these technologies was the coating technology for drug eluting coronary stents that prevent stent restenosis. This technology was introduced at Balton company - a manufacturer of disposable medical equipment for anesthesia, dialysis, surgery, gynecology, cardiology, radiology and urology. Products developed using this technology are sold in and outside the EU. The second technology was a biocompatible coating for urological catheters, this coating eliminates pain during catheterization and prevents bacterial infections of the urinary tract. This technology was introduced at Galmed - company specializing in the production of disposable medical equipment. The catheters produced by this technology are sold in the EU, mainly in Germany and the UK.

Professor Ciach has also funded or co-founded a few university spin-off and start-up companies.

"From labs to hospitals, a long and complex journey"

Abstract of the seminar

Lecture "From labs to hospitals, a long and complex journey" describes the current situation in knowledge transfer from academic and scientific institutes to industrial practice and finally to hospitals. It presents typical routes: patenting, licensing, founding spinoff and startups, as a way to make use of scientific research results in industry and business. Lecture also includes description of the driving force for the process of knowledge transfer – national and private money sources as well as universities and companies incomes and licensing rates. The lecture will mainly focus on problems and examples from medical biotechnology and bioengineering areas. All data and examples are presented as comparison between America, Europe and Polish scientific and business environments with examples of researchers

and companies, presenting successful and unsuccessful stories from these markets. It is also a source of practical information for everybody who wants to follow the dark side of science.

Name:	**Prof. Leon Gradoń**
Position/Institution:	**Professor at Warsaw University of Technology, Poland**
Date:	**19/06/2019**

Professor Leon Gradoń is a specialist in the field of chemical engineering. He has a 1969 Diploma in Chemical Engineering from Warsaw University of Technology, Poland, and in 1975 Diploma in Mathematics and Mechanics, Warsaw University. He has a 1976 PhD from Warsaw University of Technology. Leon Gradoń is in the faculty of the Warsaw University of Technology from 1976, from 1990 as a tenure professor. He published 280+ papers, 20+ monographs and chapters and 60+ patents. Leon Gradoń has intensively cooperated with chemical industry in Poland and abroad. It resulted in establishment of a numerous of small companies, which use Leon Gradoń's technological solution in filtration and separation, and inhalation drug delivery. He is the author and co-author of several types designed "easy breath" dust-masks (produced by Secura BC Inc. with rate of production 1 mln/year), liquid filters (produced by Amazon Filters Ltd, England) - used in water treatment, food, electronics and fine chemical industries, and filter used for protection of nanomembranes during the oil production in the offshore facilities. Recently his solutions were used in the construction of the technological line for production of the CCV coalescers used in Diesel engines by the largest producer of such engines – Cummins Company (USA) with production ability 3 mln filters/year.

„ From phenomenological investigations towards industrial applications. Production of CCV filters for automotive industry"

Abstract of the seminar

Separation of the liquid droplets from the stable mist system is a crucial process in industrial technologies natural gas cleaning, crank case ventilation CCV systems in Diesel engines, and many other applications.

The most efficient devices for such separations are fibrous filters (coalescers). A properly designed structure, defined through the space distribution of the local porosity and filter diameter in the filter volume, involves the phenomena of a droplet coalescing in the bulk, deposition of droplets on the fiber, coalescing of moved droplet on the fiber and the drainage of the loaded filter fibers. Theoretical analysis of the droplet behavior in the micro- and mesoscale is extended to the model describing the entire filter

performance with its filtration efficiency, pressure drop and the lifetime of the filter.

The knowledge of the filtration process defines the filter structure, and then involvement of the process of formation of designed fibrous structure. The advanced melt-blown technique is used for filter production. The defined filter structure is produced on line in the system where fiber is formed in the nozzle and extended to the required diameter due to tangential stress resulting from the hot air flow around melted polymer filament. Final fiber, after solidification, is collected on the mandrel and formed to desired filter shape. Controlled process parameters determine local porosity and fiber distribution of the filtration layer. Incidentally our research on coalescers comes together with new regulations by Environmental Protection Agency for necessity of reduction of volatile organic compounds in the Diesel engine exhaust gases.

The biggest producer of Diesel engines, Cummins Inc. (USA), was looking for the best solution of the problem. In the multi-stage procedure our proposal won. We have built technological line for production of coalescers with the production ability 3 mln filters/year. All steps of the above will be presented.

Name:	**Prof. Jakub Gołąb**
Position/Institution:	**Professor in the Department of Immunology at the Medical University of Warsaw, Poland**
Date:	**25/06/2019**

Professor Jakub Gołąb graduated from the Faculty of Medicine, Medical University of Warsaw (MUW) in 1998. He obtained his Ph.D. in 1999 in the Institute of Biostructure Research, MUW. He had postdoctoral trainings in Harvard Institutes of Medicine and University of Texas Southwestern Medical School. Since 2009, Prof. Jakub Golab heads the Department of Immunology at WUM.

His research is focused on experimental oncology, especially on improving anticancer activity of various therapeutic approaches, including proteasome inhibitors and statins. He is an expert in the fields of photodynamic therapy and monoclonal antibodies. Prof. Golab has also been active in privately funded drug development initiatives

"Academic exploring industry - a case study"

Abstract of the seminar

Life consists of many accidental opportunities. It is expected that you choose wisely, but in fact you

never know what is the best path. In 2010 I was elected to become a member of the first Research Council of National Science Centre. I joined the board as a successful researcher with lots of ideas and numerous research projects carried out with an expanding group of excellent researchers. During one of the first meetings, for the sake of transparency, we voted that the members of the Research Council will not be allowed to apply for funds from NCN. It meant that I will not be able to get funding for my basic research for the next 4 years! Fortunately at that time I still had a decent grant from Foundation for Polish Science (TEAM) and an additional funding within MISTRZ programme of the same institution. However, the perspectives for further grants in basic research seemed rather murky. Together with members of my team we decided to apply to NCBiR with a brilliant idea to develop a novel technology for human antibodies production. We have started a small company called HUMON, but despite huge efforts of the team we failed to develop the technology. But in 2011 I received a call from prof. Ryszard Ostaszewski from the Institute of Organic Chemistry, Polish Academy of Sciences in Warsaw, with whom I was developing novel anticancer compounds, that two of his colleagues (Adam Gołębiowski and Staszek Pikul) that worked for many years in the pharma industry in the USA would like to start a drug discovery company in Poland and Ryszard has recommended me as a suitable partner in the biology field. I was very intrigued and soon after I was called by Dr. Jacek Olczak, a third member of the forming group, who was running a typical chemical CRO company in Lodz (Trimen Chemicals). Jacek visited me in my lab and we had a very interesting conversation that convinced me that joining this group of excellent medicinal chemists will be a good choice. After dozens of phone calls, meetings and hundreds of e-mails we have finally started OncoArendi Therapeutics. With a huge organizational effort OncoArendi has become one of the most successful Polish drug discover companies that develops drugs for asthma, chronic inflammatory diseases and cancer. Two years ago I left the company to stay in academia. I was not able to commit my full time for a company. But the experience and lessons learned from this experience led me to join Jacek Jemielity, Joanna Kowalska and Dominika Nowis with a new idea to develop personalized cancer vaccines based on cap-modified mRNA delivery. We have started ExPLoRNA Therapeutics, a spin-off company from Warsaw University that will soon deliver new therapeutics to cancer patients. The presentation will cover these industrial adventures with pros and cons from academic perspective.

Name:	**Sarai Kemp and dr Nitza Kardish**
Position/Institution:	**Trendlines company, Israel**
Date:	**28/10/2019**

On October, 28 a course on "***How to become an entrepreneur"*** was held under "*Innovation source*" open lecture series. The event consisted of **two seminars** and a **workshop**, delivered by **Sarai Kemp,** and **dr. Nitza Kardish –** representatives of *Trendlines*, an Israeli company offering commercialisation services at the field of life sciences. **Dr. Nitza Kardish** has 20 years of experience working at senior management positions at life science companies. **Sarai Kemp** has experience in business development, including fund-raising strategies for early-stage companies developing innovative technologies and products. In particular, this event aimed to support a transfer of ideas generated at our institute to business.

The first lecture, entitled "***Israeli 'Startup Nation' landscape and what it takes to become a successful entrepreneur***", was delivered by **Sarai Kemp.**

Sarai described the Israeli entrepreneurship environment and gave an overview of key parameters contributing to the opinion that Israel is a Startup Nation. She also explained what it takes to become a successful entrepreneur. She started with examples of start-up companies such as *Waze (universal navigation software), Mobileye (vision-safety technology)* and a description of their path to success – i.e. acquisition by global companies like Google or Intel. Israel is in the top 12 Most Innovative Economics. It is a worldwide leader in innovation. Sarai Kemp indicated components of such a flourishing ecosystem. The seminar ended with a discussion in which Polish researchers' real problems engaged in commercialisation were thoroughly discussed. The government's role in supporting inventions was emphasised.

The second lecture: ***"The process of tech transfer from academia to a start-up"*** was delivered by dr. Nitza Kardish. She gave a detailed overview of the feasibility study of a technology developed in academia. Dr. Kardish shared her experiences in moving the invention from academia to start up and explained, "*How much academia change the world*". She stressed the great importance of basic sciences in the innovation process. She also emphasised that academia is the engine of a global transformation. She also listed the main challenges for innovation. Dr. Kardish stressed that it is crucial to assess the innovation at its early stage quickly. For the implementation factor, dr. Kardish indicated that people and their professionalism are the most critical elements.

Name:	**Prof. Yoon-Kyoung Cho**
Position/Institution:	**Professor in Biomedical Engineering at UNIST, Republic of Korea**
Date:	**31/10/2019**

Prof. Yoon-Kyoung Cho is a full professor in Biomedical Engineering at UNIST and a group leader in the Center for Soft and Living Matter at the Institute for Basic Science (IBS), Republic of Korea. She received her Ph.D. in Material Science and Engineering from the University of Illinois at Urbana-Champaign in 1999, after obtaining M.S. and B.S. in Chemical Engineering from POSTECH in 1994 and 1992,

respectively. She worked as a senior researcher (1999–2008) at Samsung Advanced Institute of Technology (SAIT), where she participated in the development of in vitro diagnostic devices for biomedical applications. 2008, she joined UNIST and was a chairperson of the school of Nano-Bioscience and Chemical Engineering (2008–2014) and the school of Life Sciences (2014–2015), and the director of World Class University (2009–2013) and BK21 (2013–2015) programs. She is an associate editor of the journal 'Lab on a chip' and a fellow of the Royal Society of Chemistry. She serves as a scientific advisory board member of Clinomics and Labspinner, S. Korea. Among her currently studied research topics are: lab-on-a-disc for the detection of rare cells and extracellular biomarkers, quantitative analysis of single cells, and system analysis of cellular communication.

"Microfluidic chips to study cell to cell communication and translational research towards precision medicine"

Abstract of the seminar

In the tumor microenvironment, various tumor-associated cells such as vascular, fibroblast, and immune cells interact with tumor cells to promote the development of cancer cells, indicating ***the importance of understanding the communication between these different cell types in developing cancer therapeutics***. In this presentation we will discuss our recent studies on extracellular vesicles (EVs)-based cancer diagnostics inspired by widespread recognition that EVs may be pivotal in intercellular communication. We examine clinical samples by analyzing multiple kinds of proteins and RNA of EVs from cancer patient's plasma or urine samples and show that the EVs could be a potentially useful biomarker in cancer diagnostics. Next, we introduce the microfluidic chip equipped with biologically interfaced platelet membrane-cloaked surface (PLT-Chip), which could specifically capture EVs from multiple types of cancer cell lines than the normal cell-derived EVs and clearly distinguish the plasma of cancer patients from that of normal healthy controls. We believe that this revolutionary method can contribute to accelerate the acceptance of CTC or EV-based cancer diagnostics as a standard practice in clinical settings. ***Based on the presented academic research, the key technologies including lab-on-a-disc systems equipped with the fluid-assisted separation technology (FAST) are now translated into liquid biopsy products commercialized by two start-up companies. In this talk, the personal experience of translational research both at industry (Samsung) and academia (UNIST) will be discussed***. Taken all together, we believe understanding the critical role of cell-to-cell communication in cancer progression will provide insights critical to not only the development of improved cancer therapeutics (societal impact) but to basic science of cell biology (basic science).

Name:	**Prof. Hywel Morgan**
Position/Institution:	**Professor of Bioelectronics in the School of Electronics and Computer Science, University of Southampton, UK**
Date:	**4-5/11/2019**

Professor Hywel Morgan studied Electronic Engineering at the University of Wales, Bangor, after which he completed a PhD in biophysics, graduating in 1985. After a post-doc at the Hebrew University of Jerusalem, Israel, he moved to the University of Glasgow in 1993 and was appointed professor at Glasgow in 2001. 2003, he moved to Southampton to take a position of Professor of Bioelectronics. From 2013 till 2017 he was a Royal Society Industry Fellow with Sharp Labs Europe. His research interests focus on microfluidics with its applications in medical and environmental sciences. He published seminal papers in AC electrokinetics. He is associate editor of "Microfluidics and Nanofluidics", and "Scientific Reports". He published over 250 journal papers (H-index = 60) and co-authored a text-book on AC electrokinetics. He is founder and director of Vivoplex, a spinout that develops implantable wireless sensors to continually record vital signs. 2004 he was awarded the Desty Memorial Prize for Innovation in Separation Science. He is a fellow of the Institute of Physics, the Royal Society of Chemistry and the IET. He holds as well the Royal Society Wolfson research merit award.

"From Smartphones to Diagnostics"

Abstract of the seminar

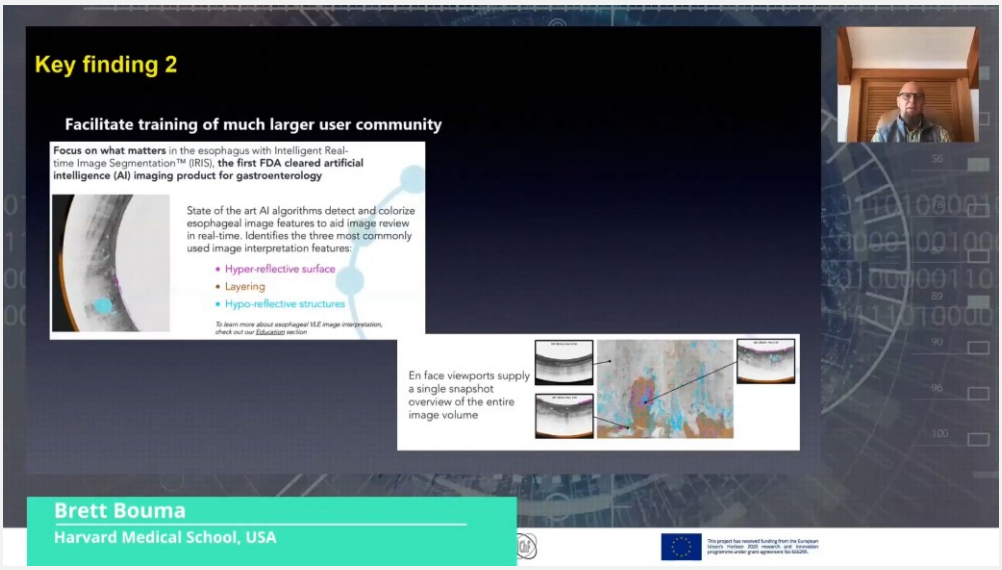
We have been developing miniature analytical systems that exploit low-cost consumer electronics for both sample processing/manipulation and sensing. In a collaboration with Sharp Labs, we have developed a new generation of digital microfluidic (DMF) platforms for programmable droplet manipulation. Unlike conventional microfluidic systems, DMF manipulates and processes hundreds of discrete nanolitre droplets of liquid. The chips contain thousands of electrodes, manufactured using Thin Film Transistor (TFT) technology as used in mobile phone screens.

The system supports a wide range of different chemical and biochemical assays, for example immuno-assays and genomic data analysis. The talk will describe recent developments in electrical impedance cytometry for label-free analysis of single cells and bacteria at high speed. The technique has been used to analyse a wide range of cells, but we are now exploring applications in areas such cell mechanics. We

have also recently developed an impedance-based rapid antimicrobial susceptibility test (AST) that can analyse the resistance profile of infectious agent in 30 minutes compared with the current 48 to 72 hours. Finally, I will describe our research in the development of a miniature wireless and battery-less implantable sensor that continuously monitors biophysical parameters in-vivo, and the route to the commercialisation of this product.

Name:	**Prof. Brett Bouma**
Position/Institution:	**Professor of Dermatology and Health Sciences and Technology, Harvard Medical School Physicist, Massachusetts General Hospital Director, USA**
Date:	**7/10/2020**

Prof. Brett Bouma has published over 230 manuscripts that have collectively accumulated over 53,000 citations, reflecting an h-index of 67 (Web of Science) and 106 (Google Scholar). Dr. Bouma's research has led to over 300 issued/allowed patents, with over 100 additional patent applications pending. Many of his patents have been licensed to four different companies, resulting in 5 distinct medical devices on the market. In addition, he serves on the scientific advisory boards of several companies.



"The development and commercialization of endoscopic OCT technology"

Abstract of the seminar

The lecture will include an overview of the clinical challenges associated with esophageal adenocarcinoma and its precursor condition Barrett's Esophagus. The requirements for screening and surveillance were identified as primary motivators that drove the development of endoscopic OCT. The image features associated with dysplasia and intramucosal cancer were presented, and the strategy for imaging and laser marking was discussed. The pathway of commercialization that has resulted in the clinical availability of OCT systems for endoscopic use was reviewed.

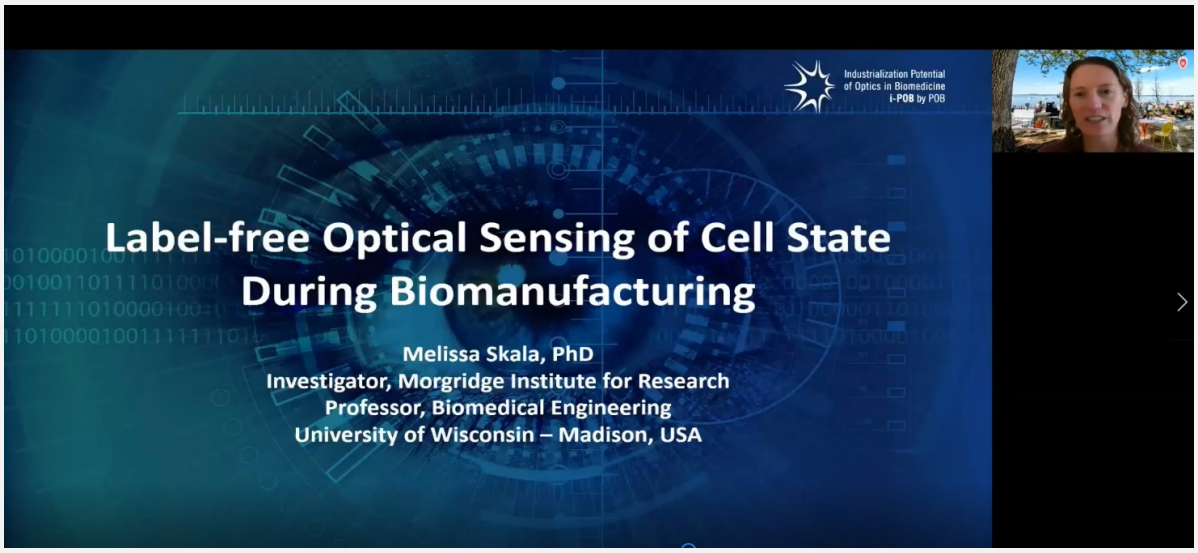
Name:	**Prof. Melissa Skala**
Position/Institution:	**Professor at Morgridge Institute for Research, University of Wisconsin, USA**
Date:	**7/10/2020**

Melissa Skala received her Ph.D. in Biomedical Engineering at Duke University in 2007. Her postdoctoral training was also in Biomedical Engineering at Duke University, from 2007-2010. From 2010-2016, she was an Assistant Professor of Biomedical Engineering at Vanderbilt University. Since 2016 she has been

an Investigator at the Morgridge Institute for Research, and an Associate Professor of Biomedical Engineering at the University of Wisconsin – Madison.

Dr Skala's lab uses photonics-based technologies to develop personalized treatment plans for cancer patients including breast, pancreatic, colorectal, neuroendocrine, oral, and other cancers.

Recently, she has been honored with the OSA Fellowship.



„ Label-free Optical Sensing of Cell State During Biomanufacturing"

Abstract of the seminar

Cell-based therapies have the potential to treat or even cure a myriad of diseases. However, these complex biological products display intrinsic variability within a tightly regulated industry. Process optimisation and thorough product characterization prior to clinical development is critical. Typical quality assessments require labels to characterize functional subsets of cells. However, standard analytics are laborious, time-consuming, susceptible to reagent quality variability, and may potentially alter cell function. To improve the fidelity of quality assessments, we have developed a label-free, nondestructive optical detection approach to quantify overall cell state, viability, and activation with single-cell resolution. The technology is based on the autofluorescence lifetime of the metabolic co-enzyme NAD(P)H. T cells isolated from human peripheral blood and activated in culture using tetrameric antibodies against the surface ligands CD2, CD3 and CD28 showed specific activation-state-dependent patterns of autofluorescence NAD(P)H lifetime. Logistic regression models and random forest models classified T cells according to activation state with 97–99% accuracy and according to activation state (quiescent or activated) and subtype (CD3+CD8+ or CD3+CD4+) with 97% accuracy. The hardware, optics, and analytical algorithms are readily integrated into a variety of quantitative imaging technologies, such as flow and image cytometry, enabling non-destructive assessment for early stage cell manufacturing process optimization and streamlining product development as therapies transition to commercial scale manufacture.

Name:	**Dr. Eric Buckland**
Position/Institution:	**Founder and CEO at Translational Imaging Innovations, USA**
Date:	**7/10/2020**

Dr Eric Buckland is a Founder and CEO of Translational Imaging Innovations, Inc. He has 30 years of experience in developing and commercialising optical technologies for imaging, metrology and

telecommunications. He is a founder and CEO of Bioptigen, an international brand recognised for superior imaging systems in translational research, pediatric, and surgical ophthalmology, sold to Leica Microsystems in 2015. Dr. Buckland has 70 patents, 5 Phase II SBIRs.

"Romancing the Start-up: Starting the Entrepreneurial Journey on the Right Foot"

Abstract of the seminar

Start-ups are romantic, even mythical. There is perhaps nothing more exciting in a career than capturing a Unicorn with the better-mousetrap we invented during our Ph. D. programs. The problem is that Unicorns are rare, and better mousetraps seem to be everywhere. To succeed with sanity intact, we need to come down to earth and get real. Taking the right steps from the beginning maximises our chance at building not just a better mousetrap, but a business worthy of growing into that elusive Unicorn. We will discuss the earliest stages of business formation, starting with our co-founders, and proceeding through our first phases of funding, development, and market validation. We will discuss essential topics such as founder agreements, intellectual property rights, and negotiating licenses from our institutions, establishing product-market fit, and early-stage financing. Our objective is to remove the mythology from the start-up experience. We can retain the romance.

III. ACTIONS AIMED AT ENHANCEMENT OF IPC PhD STUDENTS & JUNIOR RESEARCH STAFF:

Among recommendations of Professor Wojtkowski was **internationalization of PhD programme and an increase visibility of IPC PhD students at internationally significant conferences, and other events.** As a result, starting from 2016, **a new programme was initialized** - "***Mobility of young researchers of IPC***". Under this programme (financed by IPC) young researchers (incl. PhD students) are sent for 1-month secondments to cooperating international research units. PhD students and young doctors are selected based on submitted proposals. In the period related to this Deliverable (M41-M66) another 12 young researchers (2 doctors and 10 PhD students) were selected for secondments, and 10 young researchers paid a visit. List of the visits is presented below:

No.	Name and Unit	Place of secondment	Date
1	**Agata Kolodziejczyk, PhD student** Environmental Chemistry Group	Leibniz Institute for Tropospheric Research, Leipzig, Germany	06/01/2019 – 08/02/2019
2	**Paulina Jeleń, PhD student** Charge Transfer Processes in Hydrodynamic Systems Group	University of Bath, Bath, UK	01/03/2019 – 01/04/2019
3	**Marta Podrażka, PhD student** Charge Transfer Processes in Hydrodynamic Systems Group	Curtin University, Perth, Australia	15/03/2019 – 17/04/2019
4	**Marco Costantini, PhD** Soft Granular Matter and Tissue Engineering Group	The University of Tokyo, Tokyo, Japan	27/05/2019 – 23/06/2019
5	**Jyoti Jyoti, PhD student** Modified electrodes for potential application in sensors and cells	Université de Technologie de Compiègne, Compiègne, France	01/07/2019 – 31/07/2019
6	**Natalia Olejnik-Feher, PhD student** Coordination metal complexes and functional materials	Florida State University, Tallahassee, USA	03/08/2019 – 23/08/2019
7	**Emilia Witkowska-Nery, PhD** Charge Transfer Processes in Hydrodynamic Systems Group	École polytechnique fédérale de Lausanne (EPFL), Switzerland	25/08/2019 – 28/08/2019
8	**Krzysztof Kupiec, PhD student** Modified electrodes for potential application in sensors and cells	Tatung University, Tajpej, Japan	26/10/2019 – 30/11/2019
9	**Rashmi Runjhun, PhD student** Coordination metal complexes and functional materials	Technische Universität Darmstadt, Darmstadt, Germany	28/11/2019 – 31/12/2019
10	**Patrycja Łach, PhD student** Functional Polymers Group	University of Leiceste, Leicester, UK	31/12/2019 – 01/02/2020

IV. FOSTERING DEVELOPMENT OF IPC RESEARCH TEAMS

a. "Lab visits under CREATE project" competition

To strengthen the expertise in the field of optics, necessary to increase the level of communication between IPC PAS research groups and the newly established Department of Physical Chemistry of Biological Systems, ERA Chair Holder decided to open a **"Lab visits under CREATE project"** competition. Within the framework of the competition, the following researchers (excluding members of the Department of Physical Chemistry of Biological Systems) carried out the lab visits to reputable research institutions:

Name and Unit	Lab visit	Date
Xuzhu Zhang, PhD Soft Condensed Matter Group	New York University, Prof. Rothenberg's lab New York, USA	25/11/2018-9/03/2019
Łukasz Piątkowski, PhD Dynamics of photoinduced bimolecular reactions	Max Planck Institute for Biochemistry, the group of Prof. Petra Schwille Planegg, Germany	1-15/04/2019
Izabela Kamińska, PhD Photophysics and spectroscopy of photoactive systems	Institute of Photonic Sciences - group of Prof. Valerio Pruneri / Ludwig Maximilians-Universität - group of Prof. Tinnefeld, Barcelona, Spain / München, Germany	4-19/04, 30/04-26/05, 19/07-11/08/2019
Haijing Meng, PhD Soft Condensed Matter Group	Mineral Physics Institute (MPI) at Stony Brook University, New York, USA	23/07-26/08/2019
Joanna Zapała, PhD Laboratory astrochemistry	California Institute of Technology, NASA, astrochemical laboratory of Prof. Murthy Gudipati Pasadena, USA	01/07-22/10/2019
Airit Agasty, PhD student Soft Condensed Matter Group	Max-Planck Institute of Polymer Research, Department of SoftCcondensed Matter, Mainz, Germany	01-26/09/2019
Yu-Kai Lai, PhD student Microfluidics and Complex Fluids Research Group	Quantum and Molecular Photonics Laboratory (LPQM), Clément Lafargue's group Paris, France	08/06-21/07/2019
Adam Kubas, PhD Cooperative catalysis	University of California Irvine, Center of Translational Vision Research, Irvine, USA	4-17/08/2019
Adam Opalski, PhD student Microfluidics and Complex Fluids Research Group	Tallinn University of Technology, laboratory of Professor Scheler, Tallinn, Estonia	1-31/08/2019
Idaresit Mbakara, PhD student Photophysics and spectroscopy of photoactive systems	University of Geneva, the Physical Chemistry Department Geneva, Switzerland	1/09-02/12/2019

Kumar Sarang, PhD student Environmental Chemistry Group	Leibniz Institute for Tropospheric Research (TROPOS) Leipzig, Germany	24/09-23/12/2019
Yu-Ting Kao, PhD student Microfluidics and Complex Fluids Research Group	Institute for Laser Technology in Medicine and Measurement Technique Ulm, Germany	01/09-30/11/2019
Łukasz Richter, PhD Soft Condensed Matter Group	École Polytechnique Fédérale de Lausanne, Laboratory of prof. Francesco Stellacci Lausanne, Switzerland	11-30/08/2019
Karolina Księżarczyk, PhD student Soft Condensed Matter Group	Kyushu Institute of Technology Fukuoka, Japan	14/10-14/12/2019
Karolina Paszkowska, PhD student Soft Condensed Matter Group	Ecole Polytechnique Federale de Lausanne, prof. Francesco Stellacci group, Lausanne, Switzerland	26/10-21/12/2019
Natalia Pacocha, PhD student Microfluidics and Complex Fluids Research Group	Harvard University, Professor David Weitz's group Cambridge, USA	8/01-15/03/2020
Krzysztof Bielec, PhD student Soft Condensed Matter Group	Ecole Polytechnique Federale de Lausanne, the group of Professor Pablo Rivera-Fuentes Lausanne, Switzerland	27/02-23/03/2020 01/10-18/12/2020

The above-mentioned lab visits are described in more details in deliverable 2.5: "*2nd report on tutoring and mentoring activity of ERA Chair holder towards his/her employees*" (M66).

b. "Study visits under CREATE project" competition

Study visits are actions aimed at breaking barriers that inhibit international cooperation of IPC with foreign leading scientific units. This chapter lists study training activities of the members of synergetic groups and other research groups of the Institute of Physical Chemistry PAS (IPC). Some of them were paid as a result of positively assessed proposals submitted under the competition "Study visits under the CREATE project":

Name and Unit	Place of Study visit	Date
Witold Postek, PhD Microfluidics and Complex Fluids Research Group	Broad Institute of MIT and Harvard, Cambridge, USA	8-29/02/2020
Magdalena Wiloch, PhD Charge transfer processes in hydrodynamic systems	University of Limerick, Limerick, Ireland	4-11/03/2020
Izabela Kamińska, PhD Photophysics and spectroscopy of photoactive systems	Ludwig Maximilians-Universität München, München, Germany	25/07-09/08/2020
Jyoti Jyoti, PhD student Modified electrodes for potential application in sensors and cells	Leibniz Institute for Solid State and Material Research, Dresden, Germany	02/01-02/02/2021

The above-mentioned study visits are described in more details in deliverable 4.6: "*2nd Report on study visits*" (M66).

c. "On-line training courses under the CREATE project" competition

Due to hampered international mobility caused by the pandemic, after the consultations with the Project Officer for the CREATE project, we decided to transfer a part of a budget from study visits to **on-line training organised by excellent scientific institutions or leading training centers**.

For this reason, in 2020 the ERA Chair holder launched the competition *"*On-line training courses under the CREATE project*"*. All researchers and specialists employed at the IPC were invited to participate in the competition. The programme cover costs of the fees of on-line training in the field of technology transfer, project/team management, acquiring external funds for research & commercialisation, and quantitative biology or applying physical chemistry to biology or others if resultant from the ERA Chair research agenda. Within the framework of the competition, the following IPC employees (excluding members of the Department of Physical Chemistry of Biological Systems) carried out on-line training courses:

- ✓ **13th International Course on "Time-resolved Microscopy and Correlation Spectroscopy" (PicoQuant)** – training in time-resolved fluorescence microscopy with a focus on life science applications.

  Training participants: Aneta Karpińska, Karolina Kucharska, Karina Kwapiszewska, Robert Hołyst, Tomek Kalwarczyk, Alicja Kijewska, Marta Pilz, Grzegorz Bubak

- ✓ **High Impact Leadership (University of Cambridge)** – Project/Team Management Training. Course participants get new perspectives, knowledge, and get acquitted with strategies maximising their leadership skills and competencies in the individual, team, and organisational contexts.

  Training participants: Tomasz Ratajczyk

- ✓ **Python w Data Science (Kodołamacz/SAGES)** – this course deals with the world's most popular programming language, focusing on one of the most growing data science branches - Data Science. It is an interdisciplinary discipline dealing with methods and tools for processing and analysing data, and in general, extracting useful knowledge from it, allowing to solve specific problems.

  Training participants: Paweł Albrycht, Krzysztof Bielec

- ✓ **Certified Product Manager (CGE – Certified Global Education Sp. z o.o./ Warsaw University of Technology Faculty of Management)** – training provides the participants with the knowledge supporting research commercialisation in the form of spin-off/out from the research unit. The participants learn to build effective product marketing strategy - product marketing plan, manage product on sale, shape strategy of placing the product on the market and build a competitive advantage.

  Training participants: Monika Księżopolska-Gocalska

- ✓ **Finance and Accounting from the Basics (Kozminski University)** – training in the field of finance and MBA, includes classes in two modules: Accounting from the scratch and Enterprise Finance.

  Training participants: Monika Kuczyńska-Wydorska

- ✓ **LabVIEW for Beginners Self – Paced Training (Grafitects™)** – training in LabVIEW software. LabVIEW is a graphical programming environment that has become prevalent throughout research labs, academia, and industry. It is a versatile analysis and instrumentation software system for measurement and automation in research laboratories.

  Training participants: Agnieszka Jamrozik

- ✓ **<u>Multivariate Classification with Unscrambler training</u> (Camo Analytics)** – training provides the participants with the knowledge of supervised and unsupervised chemometric techniques for data analysis such as PCA, SIMCA, PLS-DA, SVM, LDA.

  Training participants: Ariadna Nowicka

- ✓ **<u>Management Essential (Harvard Business Course)</u>** - training in project/team management provides tools and strategies for effective leadership, decision-making, strategy implementation, stimulating the institution's learning process, and change management.

  Training participants: Agnieszka Tadrzak, Patrycja Nitoń, Adam Kubas, Wojciech Nogala, Karina Kwapiszewska