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

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Report on an upgrade of International PhD Studies programme

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1. Overview of the current PhD programme

The Institute of Physical Chemistry of the Polish Academy of Sciences (IPC) has been organizing **PhD Studies since 1965**. Since then, IPC awarded **few hundreds of PhD degrees**. The interdisciplinary nature, cooperative culture intertwined with excellent research is the core of the IPC Doctoral School. IPC strive to enhance quality of its PhD programme by the inclusion of contemporary scientific topics. Currently, IPC runs PhD projects in the field of:

- nanotechnology and new materials,
- photochemistry, photophysics and molecular spectroscopy,
- physical chemistry of solids, soft matter, and surface phenomena,
- supramolecular physical chemistry,
- chemical kinetics and catalysis,
- thermodynamics and statistical mechanics,
- quantum chemistry, mathematical modeling and molecular dynamics,
- electrochemistry, mechanisms of electrode processes, corrosion prevention,
- environmental chemistry,
- astrochemistry.

IPC doctoral fellows (ca. 90 persons at the moment, incl. 22 foreign students) perform experimental or theoretical studies to prepare a doctoral dissertation.

Awards and distinctions given to the IPC International Programme:

- *In 2009 the Institute won a prestigious competition, organized by* ***the Foundation for Polish Science****, which provided the financial support for the programme* ***"International Ph.D. Studies for Bio- and Nanotechnology".*** *It has become a rule that young PhDs of the Institute, wishing to dedicate themselves to a scientific career, undergo a research training or postdoctoral fellowships abroad.*
- *Several postgraduates of the IPC Doctoral School have already set up, at IPC, their own research groups (e.g. Prof. Garstecki after a visit to Harvard University built the laboratory of microfluidics, Prof. Fialkowski after a postdoc at the Northwesten University has successfully managed the group of "Nanoparticle Synthesis and Functionalization").*
- *Each year,* ***the Foundation for Polish Science*** *awards the best young researchers with post-doctoral* ***"Kolumb"*** *scholarships. Three postgraduates of the IPC Doctoral School have received this scholarship (Dr. Graca 2004, Dr. Garstecki 2002 and Dr. Palasyuk 2008).*
- *In 2016 IPC obtained a grant* ***under Cofund, MSCA initiative*** *to organize* ***"Interdisciplinary NAnoscience School: from phenoMEnology to applicationS"*** *('NaMeS').*

Despite being given a few awards (see table above for details), according to the previous analysis – IPC International Doctoral Programme lacks practical approach. PhD programme graduates may avoid application research what influences IPC research profile. Additionally, IPC needs adjustment of its PhD programme to a new IPC specialization (namely: chemistry/physics inspired by biology). Therefore among other challenges under the CREATE project (ERA Chair project), one of them is introduction the above mentioned amendments to the IPC International Doctoral Programme.

2. Recommendations of the ERA Chair holder

The ERA Chair holder, Professor Maciej Wojtkowski studied a regular programme of the International Doctoral Studies held at IPC (see here for detailed programme) and gave the following recommendations towards its upgrade:

- introduction to IPC of an "*implementation doctorate*" (i.e. doctorate focused on practical approach to research, aimed at application of research results),
- supporting internationalization of the PhD studies – among others:
  - ✓ introduction of educational offer on more contemporary scientific topics,
  - ✓ facilitating participation of the PhD students of IPC in a series of lectures "*Innovation source*" and interdisciplinary lectures under the CREATE project,
  - ✓ enhancing students' mobility – IPC programme "*Mobility of young researchers of IPC*": *Programme targeted at young researchers (incl. PhD students) who are seconded for a period of 1-month to cooperating international research units. PhD students and young doctors are selected for secondments based on submitted proposals.*
- introduction of more interdisciplinary approach to the educational approach – chemistry/ physics inspired by biology,
- change of a formula of PhD seminars among others towards critical review of scientific publications:

  Currently, the seminars serve to report the progress under individual research projects and each year a doctoral student is obliged to deliver a speech: the first speech gives a literature-based introduction to a given topic, the second and the third - bring forth acquired results, while the final presentation focuses on the very final results and on possible future extensions of the project. In fact, due to narrow field of majority of PhD projects, students do not benefit from participation in PhD seminars.

An usability, a direction and an outline of changes was consulted with:

- **Professor Robert Kołos** – the Head of International Doctoral Studies at IPC,
- **Professor Robert Hołyst** – the CREATE Project Coordinator,
- **Professor Pavel Jungwirth** – the Head of research group at the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences in Prague, co-organizer of "*Dream Chemistry Award*", at the occasion of a lecture delivered at IPC,
- **Agnieszka Tadrzak** – the CREATE Project Manager,
- **PhD students self-government**,
- **Directors of IPC**.

Taking into account results of the abovementioned consultations as well as institutional and external chances and constraints (mainly resulting from the Polish law, incl. necessity to obtain approval of the Scientific Council of IPC), the ERA Chair holder decided to propose implementation of a parallel path of conducting PhD studies supporting completion of an "*implementation doctorate*". Evolutionary, rather than revolutionary strategy of introducing changes was proposed basing on the assumption that better research and educational programme would drives out the worse one, allowing for a smooth change.

3. New programme of International Doctoral Studies

Basing on the abovementioned assumptions and results of consultations the following International Doctoral Programme was proposed:

Mandatory courses	ECTS credits				Form of completion	ECTS sum
	1st year	2nd year	3rd year	4th year		
Lecture courses: 1) Modern experimental techniques I[1)] 2) Modern experimental techniques II[1)] 3) Advanced informatics [2)]	6	3	-	-	*Examination by a lecturer*	9
3 specialized lecture courses (optional - determined by the doctoral supervisor) 30 h each; finalized with exam[3)]	3	3	3	-		9
Lectures on intellectual property protection and patenting practice [4)]	1				*Credit awarded by a lecturer*	1
Lectures in additional subject [5)], options: Philosophy or Economy	1					1
Specialized seminar or conference presentations (min. 2 presentations)	1		1		*Credit awarded by a tutor or a doctoral supervisor*	2
Doctoral seminars [6)] (4 presentations)	1	1	1	1	*Credit awarded by the Head of PhD Studies*	4
Industrial apprenticeship 40 h	4				*Credit awarded by a tutor or a doctoral supervisor, a representative of a university, or an industrial partner*	4
					Total	30

Explanations and comments:

[1)] Modern experimental techniques – lecture with demonstrations conducted by experts familiar with ins and outs of methods and apparatus (3x45 min) 15 meetings, equal to 45 h, annually organized lectures, e.g.:

a. Preliminary lecture
b. Optical detection
c. Microfluidics systems
d. Plasmons
e. Raman techniques
f. AFM

g. Electron microscopy
h. Surface functionalization methods / biochemistry
i. Spectroscopy
j. Roentgen Structural Analysis Methods
k. Chromatographic methods
l. NMR spectroscopy and imaging techniques
m. Surface analysis
n. Analysis of molecular layers
o. Methods for studying the structure of soft matter;

[2)] Advanced informatics (3x45), e.g.:

- programming laboratory (programming languages e.g. Python, C, Labview, MathLab)
- specialized software (e.g. Origin, graphics design, visual information, Zemax, CAD);

[3)] Specialized lecture courses 3x 30h on e.g. optional - doctoral supervisor responsible for organizing the courses;

[4)] Lecture organized once in 2 years;

[5)] Lectures organized annually, provided the declared participation of at least 4 PhD students;

[6)] Attendance obligatory to all students. In the course of the studies each PhD student will deliver 4 speeches: 1) outline of a PhD project, 2-3) critical review of a scientific publication not necessary resulting from the speaker's PhD project (selected publications should have the potential of being instructive to all IPC doctoral students – either because of its unquestionable seminal character, because of an interesting controversy it already aroused or because of certain methodological flaws; the speaker should try to excite the attention and curiosity of his/her fellow PhD students and stir the discussion.), 4) final results of the PhD project.

Subsequently, the proposed PhD programme aimed at introducing implementation doctorate will be presented for approval of the Scientific Council (after holiday break), and would become available starting from the nearest academic year.