załącznik do Regulaminu programu „visiting professor”

Osoba zgłaszająca z PW	
Tytuł i stopień naukowy	Prof. dr hab. inż.
Imię i nazwisko	Halina Szatyłowicz
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The person proposed as a visiting professor	
Title and degree	Dr. HDR (equivalent of Polish habilitation)
Name and surname	REISS Peter
Exact affiliation	Univ. Grenoble Alpes, CEA, CNRS, IRIG-SyMMES, 17 avenue des Martyrs, 38000 Grenoble, France
E-mail address	peter.reiss@cea.fr
Description of achievements (1/2-1 page)	Peter Reiss is a research director at the interdisciplinary research institute (IRIG) of CEA Grenoble, France, and Deputy Head of the SyMMES laboratory, which focuses on molecular systems and nanomaterials for energy and health. He graduated from University of Karlsruhe (Germany) in Chemistry and Physics, and earned his PhD in Inorganic Chemistry under the supervision of Prof. Dieter Fenske (2000). After a post-doc at the fundamental research department of CEA he was hired as a permanent researcher in 2002. His research activities focus on colloidal semiconductor quantum dots and metal halide perovskite nanocrystals, including their applications in various fields such as biological imaging, LEDs, photodetectors, energy conversion and storage. Dr. Reiss acts as an associate editor or editorial board member for three journals and co-organizes the biennial conference NaNaX – Nanoscience with Nanocrystals (cf. http://nanax.org), one of the major meetings in the field. He published around 150 articles, 16 patents and 7 book chapters and is the cofounder of the startup company Enwires. In 2024, he was awarded the Clément Codron prize by the French Academy of Sciences.

Code of the course	4606-VP-ES-00027	Name of the course	Polish	**Półprzewodniki organiczne i nieorganiczne dla optoelektroniki i przetwarzania energii**
			English	**Organic and inorganic semiconductors for optoelectronics and energy conversion**
Type of the course	Specialty subject/~~researcher's workshop~~			
Course coordinator	Peter REISS	Course teacher	Peter REISS	
Implementing unit	Faculty of Chemistry WUT	Scientific discipline / disciplines*	chemical sciences, chemical engineering, materials engineering	
Level of education	Doctoral Schools	Semester	15 Oct – 15 Dec 2025 (online)	
Language of the course	English			

Type of assessment	Pass	Number of hours in a semester	60	ECTS credits	5
Minimum number of participants	10	Maximum number of participants	30	Available for students (BSc, MSc)	Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week					
	in a semester	30		30		

* does not apply to the Researcher's Workshop

1. Prerequisites
Students should have passed the first year of a bachelor program in chemistry.

2. Course objectives
Chemically synthesized, solution processable organic and inorganic semiconductors are recent classes of materials combining unique optical and electronic properties with high promises for next-generation applications in various fields including energy conversion and consumer electronics. The main objective of this course is to provide the students with the theoretical background related to the synthesis and properties of these materials and to give state-of-the-art examples of their use. In parallel, the challenges will be highlighted which need to be currently addressed. Exercises and project classes will deepen the knowledge from the course, enlarge the social competences of the students, and give concrete experience with diverse characterization and data analysis methods. They will also allow for addressing course-related interdisciplinary subjects of current importance such as sustainability and scientific integrity.

3. Course content (separate for each type of classes)
Lecture
The online classes comprise 10 lectures setting the theoretical background as well as 10 interactive lectures with exercises and project classes to deepen the knowledge in the period of October 15th to December 15th, 2025) addressing the following topics:

I) Organic semiconductors for printed electronics and energy conversion (5 lectures of 3 hours) covering:

1) Introduction to the domain of organic semi-conductors and printed electronics

2) Properties of pi-conjugated molecules and polymers

Band structure of organic semi-conductors

Determination of HOMO and LUMO levels

Optical properties: absorption and emission

Charge transport in pi-conjugated materials

Methods for the structural characterization

4) Design and preparation of semiconducting molecules and polymers

Main synthetic approaches to obtain pi-conjugated materials

Condensation reactions

Palladium catalyzed reactions for polymerization

5) Processing of organic semi-conductors

Deposition methods, printing techniques

Doping of organic semiconductors

6) Applications of pi-conjugated molecules and polymers in opto-electronics and photovoltaics

Field Effect Transistors

Light-emitting diodes

Thermoelectric devices

Organic solar cells

Dye-sensitized solar cells

II) Inorganic semiconductors for optoelectronics and energy conversion (5 lectures of 3 hours) covering:

1) Introduction to the fundamental properties of colloidal semiconductor quantum dots (QDs)

- historical overview, Nobel prize in Chemistry 2023
- optical, electronic & structural properties
- materials classes: binary & ternary semiconductors, metal halide perovskites

2) Synthetic approaches for QDs

- nucleation and growth, theoretical background
- size, composition and shape control of QDs in the organic and aqueous phase
- heterostructures
- machine learning in the development of QD syntheses

3) Application of QDs in solar energy conversion

- solar cells, device architectures
- luminescent solar concentrators
- photocatalysis

4) Application of QDs in thermoelectrical energy conversion and photodetectors

- basics of thermoelectrics with QDs, opportunities and challenges
- different classes of QD photodetectors, function principles and performances

5) QDs in light emission, displays and telecommunication

- QLED function principle
- Towards lasing with QDs
- Towards quantum light emitters

III) Exercises and project classes (10 lectures of 3 hours): 1) Scientific papers analysis Research papers, perspective & review articles 2) Analysis and interpretation of characterization data: NMR spectroscopy, UV-vis spectroscopy, photoluminescence spectroscopy, FTIR spectroscopy, electrochemistry, powder X-ray diffraction, TEM, dynamic light scattering, XPS. Use of open-source tools for data analysis (cf. below "Laboratory"). 3) Analysis and interpretation of device data (J/V curves, EQE spectra, etc.) 4) Project classes (cf. below)
Laboratory
Hands-on experience in data analysis could be gained by the use of open-source tools for the analysis of electron microscopy images, crystal structure representations, and solar cell simulations.
Project classes
The project classes, based on the main course, will take place in the second half of the latter. Their contents could cover subjects such as sustainable research, eco-conception, life-cycle analysis, safer-by-design approaches and scientific integrity. They can be adapted to specific interests of the students.

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	theoretical foundations of the scientific topics	SD_W1	Report & presentation evaluation
K02	major trends of the scientific discipline and understanding of the related research methodology	SD_W2	Report & presentation evaluation
K02	sustainable research in the scientific topic, eco-conception, life-cycle analysis, safer-by-design approaches scientific integrity	SD_W3	active participation during classes, presentation evaluation
Skills			
S01	critical analysis and evaluation of the results of research; understanding of characterization methods and their complementarity, hands-on experience on some methods of data treatment	SD_U1	active participation during classes, report & presentation evaluation
Social competences			
SC01	Work in sub-groups, taking initiative, adapt to a collective of different scientific, social and cultural background	SD_K1	active participation during classes, report & presentation evaluation

*Allowed learning outcomes verification methods: exam; oral exam; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Assessment is based on the combined evaluation of the interactive classroom participation + the exercise reports + the final presentations of the research projects. The grades that can be obtained are: FAIL, or PASS, or EXCELLENT.

6. Literature

Primary references:

1) Reiss, P.; Carrière, M.; Lincheneau, C.; Vaure, L.; Tamang, S., Synthesis of Semiconductor Nanocrystals, Focusing on Nontoxic and Earth-Abundant Materials. *Chem. Rev.* **2016,** *116* (18), 10731-10819.

2) García de Arquer, F. P.; Talapin, D. V.; Klimov, V. I.; Arakawa, Y.; Bayer, M.; Sargent, E. H., Semiconductor Quantum Dots: Technological Progress and Future Challenges. *Science* **2021,** *373* (6555), eaaz8541.

3) Akkerman, Q. A.; Rainò, G.; Kovalenko, M. V.; Manna, L., Genesis, challenges and opportunities for colloidal lead halide perovskite nanocrystals. *Nature Materials* **2018,** *17* (5), 394-405.

4) A.Pron, P.Gawrys, M.Zagorska, D.Djurado, R.Demadrille, "Electroactive materials for organic electronics: Preparation strategies, structural aspects and characterization techniques" Chem. Soc. Rev., **2010**, 39, 2577-2632.

5) M.N. Gueye, A. Carella, J. Faure-Vincent, R. Demadrille, J.P Simonato, "Progress in understanding structure and transport properties of PEDOT-based materials: a critical review" Progress in Materials Science 108, **2020**, 100616

Secondary references:

1) Ortega, S.; Ibáñez, M.; Liu, Y.; Zhang, Y.; Kovalenko, M. V.; Cadavid, D.; Cabot, A., Bottom-up engineering of thermoelectric nanomaterials and devices from solution-processed nanoparticle building blocks. *Chem. Soc. Rev.* **2017,** *46* (12), 3510-3528.

2) Yuan, J.; Hazarika, A.; Zhao, Q.; Ling, X.; Moot, T.; Ma, W.; Luther, J. M., Metal Halide Perovskites in Quantum Dot Solar Cells: Progress and Prospects. *Joule* **2020,** *4* (6), 1160-1185.

3) García de Arquer, F. P.; Armin, A.; Meredith, P.; Sargent, E. H., Solution-processed semiconductors for next-generation photodetectors. *Nature Reviews Materials* **2017,** *2* (3), 16100.

4) Pan, Z.; Rao, H.; Mora-Seró, I.; Bisquert, J.; Zhong, X., Quantum dot-sensitized solar cells. *Chem. Soc. Rev.* **2018,** *47* (20), 7659-7702.

5) Yang, Z.; Gao, M.; Wu, W.; Yang, X.; Sun, X. W.; Zhang, J.; Wang, H.-C.; Liu, R.-S.; Han, C.-Y.; Yang, H.; Li, W., Recent advances in quantum dot-based light-emitting devices: Challenges and possible solutions. *Mater. Today* **2019,** *24*, 69-93.

6) O. Bardagot, P. Kubik, T. Marszalek, P. Veyre, A. A. Medjahed, M. Sandroni, B. Grévin, S. Pouget, T. N. Domschke, A. Carella, S. Gambarelli, W. Pisula, R. Demadrille, "Impact of Morphology on Charge Carrier Transport and Thermoelectric Properties of N-Type FBDOPV-Based Polymers", *Advanced Functional Materials*, 30, 21, 2000449, **2020.**

7) M.Godfroy, J.Liotier, VM. Mwalukuku, D.Joly, Q.Huaulmé, L.Cabau, C.Aumaitre, Y. Kervella, S.Narbey, F.Oswald, E.Palomares, CAG. Flores, G. Oskam, R. Demadrille, "Benzothiadiazole-based photosensitizers for efficient and stable dye-sensitized solar cells and 8.7% efficiency semi-transparent mini-modules". *Sustainable Energy Fuels*, **2021**, 5, 144-153

8) Y A. Avalos-Quiroz, O. Bardagot, Y. Kervella, C. Aumaître, L. Cabau, A. Rivaton, O. Margeat, C. Videlot-Ackermann, U. Vongsaysy, J. Ackermann, R. Demadrille, "Non-Fullerene Acceptors with an Extended π-Conjugated Core: Third Components in Ternary Blends for High-Efficiency, Post-Treatment-Free Organic Solar Cells" *ChemSusChem*, 14, 17, 3502-3510, **2021**

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	60
2	Hours of consultations with the academic teacher, exams, tests, etc.	10
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	30
4	Amount of time devoted to the preparation for exams, test, assessments	20
	Total number of hours	**120**
	ECTS credits	**5**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	2
Number of ECTS credits earned by a student in a practical course	2