AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Advanced Solid State Electrochemistry

Academic year: 2019/2020 Code: ZSDA-3-0073-s ECTS credits: 3

Faculty of: Szkoła Doktorska AGH

Field of study: Szkoła Doktorska AGH Specialty: —

Study level: Third-cycle studies Form and type of study: Full-time studies

Lecture language: Polski i Angielski Profile of education: Academic (A) Semester: 0

Course homepage: http://home.agh.edu.pl/xi

Responsible teacher: dr hab. inż. Świerczek Konrad (xi@agh.edu.pl)

Module summary

Module has basic science, as well as practical aspect. Lectures and seminars cover selected, advanced topics in the field of solid state electrochemistry. Topics of seminars can be selected according to particular needs regarding research interest of participating Ph.D. students.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	Ph.D. student is aware of the necessity and is ready to critically evaluate his/her knowledge. Ph.D. student is able to participate in scientific and popular discussion, particularly in the aspect of solid state electrochemistry.	SDA3A_K01, SDA3A_K02	
Skills: he can			
M_U001	Ph.D. student is able to select proper characterization technique in order to study particular properties of solid state, especially regarding measurements of crystal structural and transport phenomena.	SDA3A_U06, SDA3A_U01	Presentation, Oral answer, Test, Activity during classes
M_U002	Ph.D. student is able to make critical evaluation of existing designs of electrochemical energy conversion and storage systems, in the aspect of limitations induced by application of solid state materials.	SDA3A_U02, SDA3A_U01, SDA3A_U04	Presentation, Oral answer, Test, Activity during classes
Knowledge: he knows and understands			

M_W001	Ph.D. student possesses advanced knowledge in a field of solid state electrochemistry, particularly concerning crystal and electronic structure of solids, defects, phase transitions, as well as transport properties. Ph.D. student possesses knowledge about modern characterization techniques of solid state and construction of advanced electrochemical energy storage and conversion devices.	SDA3A_W03, SDA3A_W02, SDA3A_W01	Presentation, Oral answer, Test, Activity during classes

Number of hours for each form of classes

	Form of classes										
Suma	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	15	0	0	0	0	15	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	Ph.D. student is aware of the necessity and is ready to critically evaluate his/her knowledge. Ph.D. student is able to participate in scientific and popular discussion, particularly in the aspect of solid state electrochemistry.	+	-	-	-	-	+	-	-	-	-	-
Skills: he can												
M_U001	Ph.D. student is able to select proper characterization technique in order to study particular properties of solid state, especially regarding measurements of crystal structural and transport phenomena.	+	-	-	-	-	+	-	-	-	-	-

M_U002	Ph.D. student is able to make critical evaluation of existing designs of electrochemical energy conversion and storage systems, in the aspect of limitations induced by application of solid state materials.	+	-	-	-	-	+	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Ph.D. student possesses advanced knowledge in a field of solid state electrochemistry, particularly concerning crystal and electronic structure of solids, defects, phase transitions, as well as transport properties. Ph.D. student possesses knowledge about modern characterization techniques of solid state and construction of advanced electrochemical energy storage and conversion devices.	+	-	-	-	-	+	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	10 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	10 h
Realization of independently performed tasks	10 h
Examination or Final test	1 h
Contact hours	1 h
Summary student workload	62 h
Module ECTS credits	3 ECTS

Additional information

Module content

Lectures

Selected, advanced topics in the field of solid state electrochemistry
Lectures cover selected, advanced topics in the field of solid state electrochemistry, discussed from a point of view of electrochemical energy storage and conversion devices.

Lecture 1 (2h). General introduction about class, participation rules and final score evaluation method. Introduction about topics of lectures. Solid state electrochemistry as interdisciplinary field of science.

Lecture 2 (2h). Crystal structure. Structural transitions. Defects in solids.
Lecture 3 (2h). Electrons in solids. Localized to itinerant behavior. Metal-insulator transitions.
Lecture 4 (2h). Diffusion of ions in solids. Mixed ionic-electronic conductivity.
Lecture 5 (2h). Surface of solids. Electrocatalysis.
Lecture 6 (2h). Advanced characterization techniques for solid state.
Lecture 7 (2h). Electrochemical reactors. Li-ion batteries. Fuel and electrolysis cells.
Lecture 8 (1h). State-of-the-art research and scientific reports in the field of solid state electrochemistry.

Seminar classes

Selected, advanced topics in the field of solid state electrochemistry
Seminars will comprise presentations prepared by Ph.D. students on various topics of solid state electrochemistry, particularly those discussed during lectures, but also proposed by Ph.D. students. Topics will cover crystal structure of solids, transport properties of solids, surface properties of solids, diffusion, construction and usage of electrochemical devices, new trends in solid state electrochemistry, etc. Afterwards, each presentation will be discussed by teacher and by Ph.D. students in the aspect of correctness and clarity of presentation.

Teaching methods and techniques:

Lectures: The content is presented in a form of a multimedia presentation. Some examples will be written on blackboard. Real life examples and models will be also shown.
Seminar classes: The content is presented in a form of a multimedia presentation. Some examples will be written on blackboard. Real life examples and models will be also shown.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

Credit assessment for seminars (S) will be determined as the arithmetic mean of three grades obtained by Ph.D. students: two grades from prepared and presented two seminars and one grade from the final test covering selected topics presented during lectures and seminars. It is necessary to obtain passing grades for two seminars and the test. It will be possible to obtain additional points for activity during the lectures and seminars.

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:
– Attendance is mandatory: No
– Participation rules in classes: Ph.D. students participate in the classes, learning the content according to the syllabus. Any question regarding content should be asked during class. Discussion is welcome. Audiovisual recording of the lecture requires the teacher’s consent.
Seminar classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Ph.D. students participate in the seminars, learning the content according to the topic of particular presentation. Any question regarding content should be asked during class. Discussion is welcome. Audiovisual recording of the seminar requires the teacher’s and presenting student’s consent.

Method of calculating the final grade

Final grade is given as equal to the credit obtained from seminar-type classes (S).

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:

Unjustified absence during seminars is not permitted. In the case of justified absence during seminar or final test, Ph.D. student will have an opportunity to pass the test or present the seminar at an additional agreed date.

Prerequisites and additional requirements

Knowledge of chemistry, thermodynamics, physics and mathematics at the master level of technical studies. Knowledge of English language at the level needed to understand scientific publications. It is not required to pass any specific module before in order to participate in this module.

Recommended literature and teaching resources

1. K. Świerczek – lectures will be given to the Ph.D. students
2. P.G. Bruce (ed.), Solid State Electrochemistry, Cambridge University Press 1995
3. V.V. Kharton, Handbook of Solid State Electrochemistry, Vol. 1, Wiley-VCH 2009
4. J. Maier, Physical Chemistry of Ionic Materials, John Wiley & Sons, Ltd, 2004
5. N.F. Mott, Metal-insulator transitions, Taylor & Francis, 1990

Scientific publications of module course instructors related to the topic of the module

1. J. Molenda, K. Świerczek, rozdział p.t. „Strategies for perspective cathode materials for IT-SOFC” in J.T.S. Irvine, P. Connor (Eds.) „Solid Oxide Fuels Cells: Facts and Figures”, Springer, 2013, ISBN 978-1-4471-4455-7
2. K. Świerczek, „Projektowanie właściwości fizykochemicznych tlenkowych materiałów katodowych dla ogniw IT-SOFC oraz Li-ION”, Ceramika / Ceramics, 111 (2010), ISSN 0860-3340, ISBN 978-83-60958-68-1
3. Y. Zhang, H. Zhao, Z. Du, K. Świerczek, Y. Li, „High-performance SmBaMn2O5+δ electrode for symmetrical solid oxide fuel cell”, Chemistry of Materials 31(10) (2019) 3784-3793
4. A. Olszewska, Z. Du, K. Świerczek, H. Zhao, B. Dabrowski, „Novel ReBaCo1.5Mn0.5O5+δ (Re = La, Pr, Nd, Sm, Gd and Y) perovskite oxide: influence of manganese doping on crystal structure, oxygen nonstoichiometry, thermal expansion, transport properties, and application as cathode materials in Solid Oxide Fuel Cells”, Journal of Materials Chemistry A 6(27) (2018) 13271-13285
5. K. Zheng, K. Świerczek, „Evaluation of La2Ni0.5Cu0.5O4+δ and Pr2Ni0.5Cu0.5O4+δ Ruddlesden-Popper-type layered oxides as cathode materials for Solid Oxide Fuel Cells”, Materials Research Bulletin 84 (2016) 259-266

Additional information

No additional information available.