COURSE DESCRIPTION CARD - SYLLABUS

Course name
POTENTIAL APPLICATIONS OF LAYERED MATERIALS

Course

Proposed by Discipline
Materials Engineering
Type of studies
Doctoral School
Form of study
full-time

Year/Semester
II/4, III/6
Course offered in
English
Requirements
elective

Number of hours

Lecture
4

Tutorials

Projects/seminars

Number of credit points

1

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:

Prerequisites

Knowledge: advanced knowledge in physics and chemistry. Basic knowledge of the electronic properties of materials.

Skills: ability to analyse analytically, to read and understand scientific papers, and be able to self-education.

Social competencies: understanding the need for self-education in terms of reading the literature in materials science and teamwork.

Course objective

Course lectures will cover topics related to the 2D materials, their processing, and applications. In detail, the course covers the selected aspects of growth methods of layered materials, their properties, characterisation techniques, and fabrication methods for simple electronic devices using: lithography, plasma, and magnetron deposition techniques. In addition, examples of simple electronic devices are discussed.

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:
1) scientific achievements covering selected specific issues of 2D materials, their processing, and applications that are relevant to the scientific disciplines studied at the doctoral school, to the extent that enables the revision of existing paradigms, [P8S_WG/SzD_W01]
2) scientific research methodology in disciplines represented at the doctoral school, [P8S_WG/SzD_W03]
3) principles of promoting scientific activity results, also in an open access mode, [P8S_WG/SzD_W04]
4) basics of knowledge transfer from scientific activity to socioeconomic environment. [P8S_WK/SzD_W07]

Skills

A PhD student who graduated from doctoral school can:
1) explain the fundamentals of nanomaterials and their applications in specific fields of technology, [P8S_UW/SzD_U01, P8S_UW/SzD_U05]
2) describe new developments, including 2D-materials and applications in electronic devices [P8S_UW/SzD_U05]
3) use the English language to allow active participation in the international scientific and professional community. [P8S_UK/SzD_U08]

Social competencies

A PhD student who graduated from doctoral school is ready to:
1) critically assess the achievements within materials science, [P8S_KK/SzD_K01]
2) acknowledge the importance of knowledge in solving practical problems, [P8S_KK/SzD_K03]
3) to fulfil the social obligations of researchers. [P8S_KO/SzD_K04]6) , [P8S_KO/SzD_K06]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

PQF code	Methods for verification of learning outcomes	Assessment criteria
W01, W03, W04, W07	Individual ratings in a discussion of general subjects related to the lecture	50.1% - 70.0% - (3.0) 70.1% - 90.0% - (4.0) 90.1% - 100.0% - (5.0)
U01, U05, U08	Individual ratings in a discussion of general subjects related to the lecture	50.1% - 70.0% - (3.0) 70.1% - 90.0% - (4.0) 90.1% - 100.0% - (5.0)
K01, K03, K06	Individual ratings in a discussion of general subjects related to the lecture	50.1% - 70.0% - (3.0) 70.1% - 90.0% - (4.0) 90.1% - 100.0% - (5.0)

Programme content

1. Introduction to 2D Materials
2. Growth methods of 2D materials
3. Properties of the layered materials classes and their experimental characterisation.
4. Fabrication methods of planar electronic devices.
5. Selected applications in sensors and electronics.

Course topics

Growth methods and properties of the 2D Materials
Processing of the layered materials
Selected application of the 2D materials

Teaching methods

Lecture: multimedia presentation including illustrations, examples and discussions.

Bibliography

Basic

[1] Das, S., Robinson, J.A., Dubey, M., Terrones, H., Terrones, M., 2015. Beyond Graphene: Progress in Novel Two-Dimensional Materials and van der Waals Solids. Annual Review of Materials Research 45, 1–27. https://doi.org/10.1146/annurev-matsci-070214-021034
[2] Mbayachi, V.B., Ndayiragije, E., Sammani, T., Taj, S., Mbuta, E.R., khan, A. ullah, 2021. Graphene synthesis, characterization and its applications: A review. Results in Chemistry 3, 100163. https://doi.org/10.1016/j.rechem.2021.100163
[3] Koczorowski, W., Kuświk, P., Przychodnia, M., Wiesner, K., El-Ahmar, S., Szybowicz, M., Nowicki, M., Strupiński, W., Czajka, R., 2017. CMOS- compatible fabrication method of graphene-based micro devices. Materials Science in Semiconductor Processing 67, 92–97. https://doi.org/10.1016/j.mssp.2017.05.021
[4] Liu, Shenghong, Wang, J., Shao, J., Ouyang, D., Zhang, W., Liu, Shiyuan, Li, Y., Zhai, T., 2022. Nanopatterning Technologies of 2D Materials for Integrated Electronic and Optoelectronic Devices. Advanced Materials 34, 1–22. https://doi.org/10.1002/adma.202200734

Additional

[1] Choi, W., Choudhary, N., Han, G.H., Park, J., Akinwande, D., Lee, Y.H., 2017. Recent development of two-

dimensional transition metal dichalcogenides and their applications. Materials Today 20, 116–130. https://doi.org/10.1016/j.mattod.2016.10.002
[2] El-Ahmar, S., Koczorowski, W., Poźniak, A.A.A., Kuświk, P., Przychodnia, M., Dembowiak, J., Strupiński, W., 2019. Planar configuration of extraordinary magnetoresistance for 2D-material-based magnetic field sensors. Sensors and Actuators A: Physical 296, 249–253. https://doi.org/10.1016/j.sna.2019.07.016
[3] El-Ahmar, S., Koczorowski, W., Poźniak, A.A.A., Kuświk, P., Strupiński, W., Czajka, R., 2017. Graphene-based magnetoresistance device utilizing strip pattern geometry. Applied Physics Letters 110, 043503. https://doi.org/10.1063/1.4974938

Breakdown of average student's workload

	Hours	ECTS
Total workload	25	1,0
Classes requiring direct contact with the teacher	4	0
Doctoral student's own work (literature studies, preparation for tutorials, project preparation) [1]	21	1,0

[1] delete or add other activities as appropriate