COURSE DESCRIPTION CARD - SYLLABUS

Course name
Optoelectronic Material [S1FT2>MO]

Course

Field of study
Technical Physics

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge in electronics, condensed matter physics, and molecular physics at the level of courses conducted for the Technical Physics program. The ability to integrate knowledge acquired during previous courses to understand issues related to optoelectronic materials. The ability to efficiently collect information from the provided sources.

Course objective

To provide students with detailed knowledge regarding materials used in optoelectronics. To develop students' skills in solving optoelectronics problems based on the gained knowledge.

Course-related learning outcomes

Knowledge:
Knowledge of the physical properties of materials used in optoelectronics
Knowledge of the current state of advancement and the latest development trends in optoelectronics
Knowledge and understanding of the designing and manufacturing process of simple electronic and optical devices

Skills:
The ability to select optoelectronic materials for laboratory and engineering applications
The ability to use, with understanding, indicated sources of knowledge (list of basic literature) and to acquire knowledge from other sources

Social competences:
Understanding the need to inform society about achievements in the field of optoelectronics

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written/Oral Exam:
Grade 3 for 51%-70.0%
Grade 4 for 70.1%-90.0%
Grade 5 from 90.1%

Programme content

Materials for organic electronics:
a) Classification of materials for applications in organic electronics
b) Model of diffusive charge carriers motion
c) Models of charge carrier injection
d) Electrical current in organic materials
e) Organic electroluminescent diodes, organic photovoltaic cells.
Liquid crystals:
a) Chemical structure and basic physical properties of liquid crystals
b) Phases of thermotropic liquid crystals
c) Long-range ordering in uniaxial liquid crystal phases
d) Selected electro-optical effects occurring in liquid crystal layers
e) Liquid crystal displays (LCDs) - structure and operating principles, applications.

Course topics

I. Materials for organic electronics
1. Energy of interaction between two non-polar molecules.
2. Energy of interaction between two polar molecules.
3. Types of molecular structures.
4. Elasticity, compressibility and thermal expansion of molecular materials.
5. Molecular dynamics in crystals (vibrations).
6. Types of structural defects.
7. Charge carrier traps created in molecular crystals by structural defects.
8. Charge carrier traps created in molecular crystals by dopants.
9. Types of energy bands in molecular structures.
10. Types of excitons in molecular structures and their general characteristics.
11. Diffusion model of exciton migration.
12. Excitonic processes.
13. Diffusion model of the movement of charge carriers in molecular crystals in an electric field.
14. Mobility of charge carriers and methods of its determination.
15. Methods of injecting electric charge carriers into molecular materials.
16. Current in the molecular material limited by electrode injection.
17. Current in a molecular material limited by space charge.
18. Currents of charge carriers of two characters in molecular materials.
19. Recombination of charge carriers of two characters and the Langevine model.
20. Conditions for efficient radiative recombination (electroluminescence) for two-character charge carriers.

II. Liquid crystals
1. Characteristics of the liquid crystal state.
2. Division of liquid crystals: thermotropic and lyotropic.
3. Chemical structure of thermotropic liquid crystals
4. Different types of liquid crystal phases.

5. Methods of identifying liquid crystal phases.
6. Long-range order in uniaxial liquid crystal phases.
7. Experimental techniques for determining the orientational order of the mesophase.
8. Selected electro-optical effects in liquid crystals.
9. Applications of liquid crystals: liquid crystal displays, optical fibers.
10. Examples of applications of lyotropic liquid crystals.

Teaching methods

Lecture: Multimedia presentation, presentation illustrated with examples given on the board.

Bibliography

Basic:
1. H. Klauk (ed.), Organic Electronics: Materials, Manufacturing, and Applications, Wiley-VCH, Weinheim 2006.
2. H. Klauk (ed.), Organic Electronics II: More Materials and Applications,Wiley-VCH, Weinheim 2012.
3. J. Godlewski, Wstęp do elektroniki molekularnej, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2008.
4. A. Ulman, An Introduction to Ultrathin Organic Films: From Langmuir Blodgett to Self Assembly, Academic Press, Boston 1997.
5. W. Cai, V. Shalaev, Optical Metamaterials. Fundamentals and Applications, Springer, New York Dordrecht Heidelberg London 2010.
6. P.J. Collings , M. Hird, Introduction to Liquid Crystals, Taylor and Francis, 1997.
7. S. Kumar, Liquid Crystals: Experimental Study of Physical Properties and Phase Transitions,Cambridge University Press, 2001.

Additional:
1. P. G. de Gennes, The Physics of Liquid Crystals, Clarendon Press, Oxford 1974.
2. H. Stegemeyer (ed.), Liquid Crystals, Springer, Steinkopff New York1994.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00