COURSE DESCRIPTION CARD - SYLLABUS

Course name
Scintillators and photoconverters based on crystalline materials [S2FT2>KSiF]

Course

Field of study
Technical Physics

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

1,00

Coordinators

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Lecturers

Prerequisites

Knowledge of solid state physics and experimental physics, with particular emphasis on the elements of crystallography, properties of crystal structures and basic spectroscopic methods.

Course objective

The aim of the course is to provide knowledge in the field of structural and optical properties of materials, methods of obtaining bulk, layered and micropowder crystalline materials and processes of doping with rare earth ions. In addition, the experimental methods used for the characterization of optical materials will be discussed. Another aim of the lecture is to develop students' skills in solving basic problems, planning the use of materials for selected applications and performing simple experiments and analyzing the results based on the acquired knowledge.

Course-related learning outcomes

Knowledge:
1. The student knows the achievements, challenges and limitations of selected, complex advanced issues of physics and physicochemistry that are applied in modern technologies.
2. The student has in-depth, theoretically based and advanced knowledge of selected issues of

characterization and production of functional materials on the nano, micro and macro scale and their potential applications in modern technology.

Skills:
1. The student is able to design and conduct research leading to the characterization of functional materials.
2. Based on analytical and experimental methods, the student is able to select advanced and new materials with appropriate physicochemical and structural properties.

Social competences:
1. The student understands the need and knows the possibilities of continuous training and he is able to critically evaluate the knowledge possessed and the content received and is aware of the need to use the knowledge of experts when solving engineering tasks in a scope beyond one's own competences.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

50,1-60% dst;
60,1-70% dst+;
70,1-80% db;
80,1-90% db+;
od 90,1% bdb.
The grade is based on individual written work or an oral response.

Programme content

1. Structural studies, vibrational spectroscopy and high-resolution luminescence - experimental equipment.
2. Technologies for manufacturing crystalline materials: Czochralski method and micro-pulling down, liquid phase epitaxy (LPE) and Pechini method.
3. Single crystalline films of perovskites doped with rare earth ions deposited on crystalline substrates - structural and optical studies, applications.
4. Single crystalline films of garnets doped with rare earth ions deposited on crystalline substrates - structural and optical studies, applications.
5. Single crystals of mixed garnets doped with praseodymium ions - structural and optical studies, applications.
6. Borate Crystal Powders - structural and optical studies, applications

Course topics

1. X-ray diffraction, Raman and infrared absorption spectroscopy, high-resolution luminescence spectroscopy - theoretical description of the X-ray diffraction phenomenon, light scattering phenomenon, Raman scattering and infrared absorption, selection rules, luminescence of rare-earth dopants, experimental apparatus.
2. Construction of systems for the production of bulk and layered crystal structures used in the Czochralski, micro-pulling down and liquid-phase epitaxy methods as well as for the production of powder forms of materials obtained by the Pechini method.
3. Single crystalline films of perovskites doped with rare earth ions deposited on crystalline substrates - liquid phase epitaxy method, morphology of single crystalline films of perovskites, study of Raman spectroscopy and high-resolution luminescence of the cross-section of perovskite structures.
4. Single crystalline films of garnets doped with rare-earth ions deposited on crystalline substrates - morphology of single crystalline films of garnets, Raman spectroscopy and high-resolution luminescence studies of the cross-section of garnet structures.
5. Single crystals of mixed garnets doped with praseodymium ions obtained by the micro-pulling down method in single- and five-capillary systems - structural and optical studies, applications.
6. Borate crystalline powders - crystal structure of borate crystals, Raman spectroscopy and high-resolution luminescence studies.

Teaching methods

Lecture: multimedia presentation, visualizations and animations of molecular systems and crystal structures.

Bibliography

Basic:
1. Ch. Kittel - Wstęp do fizyki ciała stałego, PWN, Warszawa, 1999.
2. G. Turrell - Infrared and Raman spectra of crystals, Academic Pr., London, 1972.
3. D.L. Rousseau, R.P. Bauman and S.P.S. Porto, Normal mode determination in crystals, Journal of Raman Spectroscopy 10 (1981), 253.
4. K.A. Gschneidner, Jr., J.-C.G. Bunzli, V.K. Pecharsky, Handbook on the Physics and Chemistry of Rare Earths, Elsevier, Amsterdam, 2009.

Additional:
1. W. Dewo, V. Gorbenko, A. Markovskyi, Y. Zorenko, T. Runka, Photoconversion, luminescence and vibrational properties of Mn and Mn, Ce doped Tb3Al5O12 garnet single crystalline films, Journal of Luminescence 254 (2023), 119481-1-9.
2. W. Dewo, V.Gorbenko, Y. Syrotych, Y. Zorenko, T. Runka, Mn-Doped XAlO3 (X = Y, Tb) Single-Crystalline Films Grown onto YAlO3 Substrates: Raman Spectroscopy Study toward Visualization of Mechanical Stress, The Journal of Physical Chemistry C 125(29) (2021) 16279-16288.
3. W. Dewo, K. Łuczyńska, Y. Zorenko, V. Gorbenko, K. Drużbicki, T. Runka, In silico Raman spectroscopy of YAlO3 single-crystalline film, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 231 (2020) 118111-1-7.

Breakdown of average student's workload

	Hours	ECTS
Total workload	25	1,00
Classes requiring direct contact with the teacher	15	0,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	10	0,50