GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00070903		
Field of study	Informatics		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Optoelectronics -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Robert Bogdanowicz	
	Teachers	prof. dr hab. inż. Robert Bogdanowicz dr inż. Adrian Olejnik dr inż. Mateusz Ficek dr hab. inż. Michał Sobaszek	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	45	0.0	0.0	45

Subject objectives	
	The lecture aims to familiarize students with theoretical foundations of electronic materials fabrication methods (crystal growth, PVD, CVD, MBE, electrospinning, electrodeposition, screen printing) and electrical characterization principles (impedance spectroscopy, resistance measurements, dielectric properties). Students will learn technological process mechanisms, equivalent circuit models, and relationships between process parameters and material properties.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W08] knows and understands, to an increased extent, the fundamental dilemmas of modern civilisation, the main development trends of scientific disciplines relevant to the field of education	The student understands development trends in electronic materials (miniaturization, sustainable production, quantum technologies) and dilemmas related to recycling and environmental impact of technological processes.	[SW1] Assessment of factual knowledge
[K7_W10] knows and understands, to an increased extent, the basic processes occurring in the life cycle of equipment, objects and technical systems, as well as methods of supporting processes and functions, specific to the field of study	The student knows electronic material degradation processes, quality control methods in production cycles, and computer-aided fabrication and characterization processes.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
[K7_U12] is able, to an increased extent, to analyze the operation of components and systems related to the field of study, as well as to measure their parameters and study their technical characteristics, and to plan and carry out experiments related to the field of study, including computer simulations, interpret the obtained results and draw conclusions	The student can analyze electronic material parameters, plan characterization experiments using impedance spectroscopy and electrical measurements, and interpret results in the context of material properties.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture

1. **Semiconductor materials** - Properties of Si, GaAs, GaN, SiC; crystal and band structure; vacuum technology
2. **Single crystal growth** - Czochralski method and float zone; defect control; crystallographic orientation
3. **Semiconductor wafer preparation** - Cutting, grinding, polishing; RCA chemical cleaning; surface quality control
4. **Thermal oxidation** - Oxidation kinetics; Si/SiO interface; gate dielectric properties
5. **Semiconductor doping** - Thermal diffusion; ion implantation; doping profiles
6. **PVD processes - evaporation** - Thermal and e-beam evaporation; deposition rate control; layer adhesion
7. **PVD processes - sputtering** - Magnetron and ion sputtering; reactive evaporation; contact metallization
8. **Thermal CVD processes** - Atmospheric and low pressure CVD; pyrolysis; surface reaction kinetics
9. **Plasma CVD processes** - PECVD; plasma effects on layer properties; low temperature deposition
10. **Electrospinning** - Fiber formation mechanisms; process parameters; material types
11. **Electrodeposition** - Electrochemical material deposition; morphology control; electronics applications
12. **Screen printing** - Screen printing technology; conductive pastes; printed electronics applications
13. **Basic electrical measurements** - Resistance measurements (2-point, 4-point, Van der Pauw); Hall effect
14. **Thin film characterization** - Thickness measurements; structure analysis; layer defects; stress
15. **Dielectric properties and applications** - Dielectric constant; composites; micro- and optoelectronic applications

Course content – laboratory

1. **Si wafer preparation and characterization** - RCA cleaning; contact angle measurement; surface cleanliness control
2. **PVD layer deposition** - Vacuum evaporation of metals; thickness and sheet resistance measurement
3. **Characterization of carbon and silicon materials** - Diamond, graphene, property measurements; doped silicon analysis; electrochemical characterization
4. **Basic electrical measurements** - Four-point probe method; I-V characteristics; carrier concentration measurement
5. **Impedance spectroscopy in practice** - Material impedance measurements; equivalent circuit fitting; results interpretation

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Report	50.0%	50.0%
Test	50.0%	50.0%

Recommended reading	Basic literature	Campbell, Stephen. *The Science and Engineering of Microelectronic Fabrication*. 2nd ed. New York, NY: Oxford University Press, 2001. ISBN: 0195136055. Vossen, John, and Werner Kern, eds. *Thin Film Processes*. Burlington, MA: Academic Press, 1978. ISBN: 0127282505. Vossen, John, and Werner Kern. *Thin Film Processes*. Burlington, MA: Academic Press, 1991. ISBN: 0127282513. Mayer, James W., and Sylvanus S. Lau. *Electronic Materials Science: For Integrated Circuits in Si and GaAs*. New York, NY: Macmillan, 1990. ISBN: 0023781408. Pierret, Robert, and George W. Neudeck. *Modular Series on Solid State Devices*. Vol. 1-5. Upper Saddle River, NJ: Prentice Hall, 1987, 89, and 90. ISBN: 0201122979. Pierret, Robert. *Advanced Semiconductor Fundamentals*. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN: 013061792X.
	Supplementary literature	n/a
	eResources addresses	
Example issues/ example questions/ tasks being completed	n/a	
Practical activites within the subject	Not applicable	

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