GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00039652		
Field of study	Materials Engineering, Materials Engineering, Materials Engineering		
Date of commencement of studies	February 2022	Academic year of realisation of subject	2022/2023
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Instytut Nanotechnologii i Inżynierii Materiałowej -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Agnieszka Witkowska	
	Teachers	dr hab. inż. Agnieszka Witkowska	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	15.0	30

E-learning hours included: 0.0

Optyczne właściwości materiałów 2022 - Moodle ID: 22573
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=22573

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	30	5.0	15.0	50

Subject objectives

The aim of the course is to familiarize students with the optical properties of materials and the physical basis of these properties and to introduce the theoretical and practical aspects of optical spectroscopy.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_W04	The optical properties of materials are presented and discussed systematically and mainly in connection with the structural and physico-chemical properties of materials. The emphasis is both on the presentation of physical fundamentals and on the experimental methods of optics.	[SW1] Assessment of factual knowledge
K7_U01	The course consists of lectures (knowledge verification is carried out in the form of a final written test) and seminars prepared by students, thanks to which the student acquires the ability to find information from literature, databases and other sources properly selected, also in English, can compile the obtained information, interpret them, formulate and justify conclusions and opinions.	[SU5] Assessment of ability to present the results of task [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information

Subject contents	**Lecture:** 1. Nature of light, electromagnetic spectrum. 2. Light and colour: vision, colour perception, additive and subtractive coloration, colour models. 3. Matter: terms and energy levels of atoms and molecules, solid state structure (rotational, vibrational and electron transitions, interband transition, phonons). 4. The interaction of light with matter. 5. Spectral and structural division of optical materials. 6. Processes and parameters characterizing the optical properties of materials: a. reflection and reflectance; b. refraction and refractive index, dispersion and dispersive power, negative refractive index; c. transmission and transmittance; d. absorption, absorbance and absorption coefficient; e. scattering: Rayleigh scattering, Mie scattering, non-selective scattering. 7. Relations between optical and non-optical parameters (polarsability, density, porosity, size). 8. Optical spectroscopy: a. IR and Raman spectroscopy (rotational-vibrational spectroscopy), b. UV-Vis spectroscopy (electron and vibronic spectroscopy), c. emission spectroscopy: fluorescence and phosphorescence . **Examples of seminar topics:** 1. Invisible animals, optical camouflage and mirages 2. Holography and holograms 3. Smart windows: chromogenic materials and more 4. Liquid crystals: synthesis, structure and optical properties 5. Colour due to scattering: Tyndall blue, Lycurgus cup and stained glasses 6. Photobiology: pigments and natural colorants (the colour of red wine and autumn leaves), photosynthesis

	7. Photomedicine: photodignosis and photodynamic therapy 8. Colour and light in art 9. Spectroscopy methods vs art and cultural heritage 10. Optical sensors and colour-change sensors of temperature, pressure and presence of metal ions and viruses
Prerequisites and co-requisites	Courses in general physics, solid state physics (physics of materials), quantum mechanics and inorganic chemistry.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written test	51.0%	60.0%
Seminar preparation and presentation	50.0%	40.0%
Attendance at the seminar and participation in the discussion	60.0%	0.0%

Recommended reading

Basic literature	[1] R.J. Tilley, *Colour and the optical properties of materials*, Willey, 2011 [2] J. Sadlej, *Molecular spectroscopy*, WNT, Warszawa (in Polish)
Supplementary literature	[3] J. Singh (Ed.), *Optical properties of condensed matter and applications*, Willey, 2006 [4] D.L. Pavia i in., *Introduction to Spectroscopy*, Brooks/Cole
eResources addresses	

Example issues/ example questions/ tasks being completed	1. Additive and subtractive coloration. 2. Describe how light can interact with matter. 3. Describe the reflection process and parameters related to it. 4. Describe the refraction process and parameters related to it. 5. Total internal reflection. 6. Describe two methods for measuring the refractive index. 7. Explain the normal and anomalous dispersion. 8. Define dispersive power and Abbe number. 9. Define transmittance, absorbance, absorption coefficient and relations between them. 10. Lambert-Beer law and attenuation length of electromagnetic radiation. 11. List and briefly discuss mechanisms of light absorption in an isolated atom and the molecule. 12. List mechanisms of light absorption in solid state matter. Briefly discuss two of them. 13. Light absorption by the glass: transmission window and colour in glass. 14. Describe the light scattering process and parameters related to it. 15. Describe the relation between refractive index and polarisability. 16. Explain the origin of the metallic gloss in the visible light and metal transparency in ultraviolet. 17. Describe the relation between refractive index and density. 18. Describe the spectral structure of vibration-rotation transitions. 19. What is the origin of colour of the transition metals complexes? 20. Define luminescence. List and describe briefly three types of luminescence.
Work placement	Not applicable