Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2019/2020

Wydział Inżynierii Materiałowej i Fizyki

Kierunek studiów: Nanotechnologie i Nanomateriały — Profil: Praktyczny

Forma sudiów: stacjonarne — Kod kierunku: NtiNm

Stopień studiów: I

Specjalności: Inżynieria nanostruktur

1 Informacje o przedmiocie

Nazwa przedmiotu	Nanotechnologia w nauce i przemyśle
Nazwa przedmiotu w języku angielskim	Nanomaterials: preparation, properties, and applications
Kod przedmiotu	WIMiF NTINM pIS F11 19/20
Kategoria przedmiotu	Przedmioty wybieralne
Liczba punktów ECTS	3.00
Semestry	1

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Ćwiczenia	Laboratorium	Laboratorium komputerowe	Seminarium	Projekt
1	15	15	0	0	0	15

3 Cele przedmiotu

Cel 1 To provide the basic knowledge in the rapidly developing field of nanotechnology, familiarize students with the history of nanoscience and nanotechnology, characteristic size and types of nanoobjects, architecture of nanostructures in one, two, and three dimension

Cel 2 To describe top-down and bottom-up approaches for the synthesis of nanomaterials, physical and chemical

techniques for nanoparticle (metal, magnetic, semiconductor) preparation, self-assembling of various nanostructures, nanolithography techniques

Cel 3 Familiarize students with tools and experimental techniques for studying of nanomaterials, electron and probe microscopy, spectroscopy

Cel 4 To discuss optical and electronic properties of nanoparticles and nanostructures, Mie theory calculations of the extinction spectra of nanoparticles, transport phenomena in 2D materials

Cel 5 To discuss variety of practical applications of the nanomaterials in chemistry, biophysics and medicine, photonics, photovoltaics, etc.

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 Basic knowledge in physics, optics, electrical engineering, chemistry

5 Efekty kształcenia

EK1 Wiedza Student has a knowledge about history of nanoscience and nanotechnology, aware of the basic concepts in the field of nanotechnology; student is able to explain the main characteristics of nanoobjects and nanostructures architecture

EK2 Wiedza Student has a knowledge about top-down and bottom-up approaches for the synthesis of nanomaterials, physical and chemical techniques for nanoparticle preparation, self-assembling of nanoparticles, nanolithography techniques

EK3 Wiedza Student has a knowledge about Mie theory calculations of the extinction spectra of nanoparticles, the optical and electronic properties of nanoparticles and nanostructures, transport phenomena in 2D materials

EK4 Umiejętności Student has ability to qualitatively analyze optical spectra of metal nanoparticles, calculate optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions

EK5 Wiedza Student has a knowledge about practical applications of nanomaterials based on their unique properties: sensors, biomarkers, drug delivery and cancer therapy, photovoltaics

6 Treści programowe

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	History of nanoscience and nanotechnology. Characteristic size of nanoobjects. Surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles. Architecture of nanostructures in one, two, and three dimension, nanocomposites. Different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.	3
W2	Synthesis of nanomaterials techniques. Top-down and bottom-up approaches in nanomaterial fabrication. Physical and chemical techniques for nanoparticle (metal, magnetic, semiconductor) preparation: laser ablation, mechanical grinding, chemical synthesis. Fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography	3

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W3	Tools for studying of nanomaterials: SEM, TEM, AFM, optical microscopy (dark field), spectroscopy	2
W4	Optical properties of nanoparticles and nanostructures. Mie theory calculations of the extinction spectra of nanoparticles. Localized surface plasmon resonance in metal nanoparticles. Optical efficiency of metal NP, local field enhancement. Electronic properties and transport phenomena in 2D materials	4
W5	Practical applications of nanomaterials based on their unique properties. Sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies	3

Projekt		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P1	Projects related to the subject of the lectures	15

Ćwiczenia		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
C1	Calculations related to the subject of the lectures	15

7 Narzędzia dydaktyczne

N1 Wykłady

N2 Ćwiczenia laboratoryjne

N3 Ćwiczenia projektowe

N4 Konsultacje

8 Obciążenie pracą studenta

Forma aktywności	Średnia liczba godzin na zrealizowanie aktywności
Godziny kontaktowe z nauczycielem akademickim, w tym:	
Godziny wynikające z planu studiów	45
Konsultacje przedmiotowe	30
Egzaminy i zaliczenia w sesji	15
Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:	
Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury	30
Opracowanie wyników	30
Przygotowanie raportu, projektu, prezentacji, dyskusji	0
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**150**
Sumaryczna liczba punktów ECTS dla przedmiotu	3.00

9 Sposoby oceny

Ocena formująca

F1 Kolokwium

F2 Test

F3 Projekt indywidualny

Ocena podsumowująca

P1 Średnia ważona ocen formujących

Warunki zaliczenia przedmiotu

W1 Test

W2 Projekt indywidualny

Ocena aktywności bez udziału nauczyciela

B1 test

Kryteria oceny

Efekt kształcenia 1

Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles
Na ocenę 3.5	61%-70% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles
Na ocenę 4.0	71%-80% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles
Na ocenę 4.5	81%-90% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles
Na ocenę 5.0	91%-100% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles
Efekt kształcenia 2	
Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography
Na ocenę 3.5	61%-70% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography
Na ocenę 4.0	71%-80% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography

Na ocenę 4.5	81%-90% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography
Na ocenę 5.0	91%-100% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography
Efekt kształcenia 3	
Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% of knowledge about Mie theory calculations of the extinction spectra of nanoparticles, optical and electronic properties of nanoparticles and nanostructures, transport phenomena in 2D materials
Na ocenę 3.5	61%-70% of knowledge about Mie theory calculations of the extinction spectra of nanoparticles, optical and electronic properties of nanoparticles and nanostructures, transport phenomena in 2D materials
Na ocenę 4.0	71%-80% of knowledge about Mie theory calculations of the extinction spectra of nanoparticles, optical and electronic properties of nanoparticles and nanostructures, transport phenomena in 2D materials
Na ocenę 4.5	81%-90% of knowledge about Mie theory calculations of the extinction spectra of nanoparticles, optical and electronic properties of nanoparticles and nanostructures, transport phenomena in 2D materials
Na ocenę 5.0	91%-100% of knowledge about Mie theory calculations of the extinction spectra of nanoparticles, optical and electronic properties of nanoparticles and nanostructures, transport phenomena in 2D materials
Efekt kształcenia 4	
Na ocenę 2.0	lack of ability to analyze optical spectra of metal nanoparticles, calculate of optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions
Na ocenę 3.0	55%-60% of ability to analyze optical spectra of metal nanoparticles, calculate of optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions
Na ocenę 3.5	61%-70% of ability to analyze optical spectra of metal nanoparticles, calculate of optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions
Na ocenę 4.0	71%-80% of ability to analyze optical spectra of metal nanoparticles, calculate of optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions
Na ocenę 4.5	81%-90% of ability to analyze optical spectra of metal nanoparticles, calculate of optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions

Na ocenę 5.0	91%-100% of ability to analyze optical spectra of metal nanoparticles, calculate of optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions
Efekt kształcenia 5	
Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies
Na ocenę 3.5	61%-70% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies
Na ocenę 4.0	71%-80% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies
Na ocenę 4.5	81%-90% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies
Na ocenę 5.0	91%-100% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies

10 Macierz realizacji przedmiotu

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK1	K1_W04 K1_W05 K1_W08 K1_W09 K1_W10	Cel 1	W1 P1 C1	N1 N2 N3 N4	F1 F2 F3 P1
EK2	K1_W04 K1_W05 K1_W08 K1_W09 K1_W10	Cel 2	W2 P1 C1	N1 N2 N3 N4	F1 F2 F3 P1

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK3	K1_W04 K1_W05 K1_W08 K1_W09 K1_W10 K1_K01 K1_K02	Cel 3	W3 P1 C1	N1 N2 N3 N4	F1 F2 F3 P1
EK4	K1_W04 K1_W05 K1_W08 K1_W10 K1_U03 K1_U04 K1_U06 K1_U07 K1_U08	Cel 3 Cel 4	W3 W4 P1 C1	N1 N2 N3 N4	F1 F2 F3 P1
EK5	K1_W05 K1_W08 K1_W09 K1_W10	Cel 3 Cel 5	W5 P1 C1	N1 N2 N3 N4	F1 F2 F3 P1

11 Wykaz literatury

Literatura podstawowa

[1] Guozhong Cao — *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, London, 2004, Imperial College Press

Literatura uzupełniająca

[1] Edward L. Wolf — *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*, , 2006, Wiley-VCH

Literatura dodatkowa

[1] Earl Boysen, Nancy C. Muir, Desiree Dudley, Christine Peterson — *Nanotechnology For Dummies*, Miejscowość, 2011, Wiley Publishing, Inc.

12 Informacje o nauczycielach akademickich

Osoba odpowiedzialna za kartę

dr hab. prof.PK. Zoryana Usatenko (kontakt: zusatenko@pk.edu.pl)

Osoby prowadzące przedmiot

1 dr hab. prof. NAA Sergij Malynycz (kontakt: s.malynych@gmail.com)

13 Zatwierdzenie karty przedmiotu do realizacji

(miejscowość, data) (odpowiedzialny za przedmiot) (dziekan)

Przyjmuję do realizacji (data i podpisy osób prowadzących przedmiot)

.....