STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Nanocarbons and carbon/polymer composites	**1010702211010702655**

Field of study	Profile of study (general academic, practical)	Year /Semester
Chemical Technology	**general academic**	**1 / 1**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Composites and Nanomaterials	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
Second-cycle studies	**full-time**

No. of hours						No. of credits
Lecture:	**15**	Classes:	**-**	Laboratory:	**45**	Project/seminars: **15**	**5**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
other	**university-wide**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**5 100%**
Technical sciences	**5 100%**

Responsible for subject / lecturer:

prof. dr hab. Elżbieta Frąckowiak
email: elzbieta.frackowiak@put.poznan.pl
tel. 616653632
Faculty of Chemical Technology
ul. Berdychowo 4 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	A preliminary knowledge in organic chemistry is required; student should be familiar with nomenclature of aromatic compounds and their physicochemical properties.
2	**Skills**	Student should be communicative in English and should be able to study proposed literature with understanding.
3	**Social competencies**	Student should realize the need of knowledge improvement.

Assumptions and objectives of the course:

Presentation of different types of nanomaterials such as: nanoporous carbons, graphenes, carbon nanotubes, carbon nanohorns, fullerenes, related materials, nanotubes from other elements. Carbon/polymer composites. Practical application of nanomaterials and composites.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student should be familiar with backgrounds of organic chemistry - [K_W02]
2. Student should be familiar with backgrounds of material chemistry - [K_W03]

Skills:

1. Student should be familiar with chemical vocabulary in English - [K_U03]

Social competencies:

1. Student should be able for self-education - [K_K06]
2. Student should be familiar with backgrounds of material chemistry - [K_K04]

Assessment methods of study outcomes

Examination tests after lecture, short test before laboratory practice

Course description

General characteristics of nanomaterials and their peculiar chemical and physical properties (microtexture, structure, conductivity, chemical reactivity, mechanical strength ?). New trends in nanotechnology. Elaboration of nanomaterials: catalytic method, chemical vapor deposition, template technique, mechanical milling and others. Application of sol/gel technique for elaboration of hierarchical structures with perfectly defined parameters. Description of fundamental parameters which determine effective and large-scale production of nanostructures such as a type of catalyst and its support, temperature, precursor. Methods of purification, separation and material modification by thermal treatment, mechanical milling in the different media, etc. Chemical and physical activation of carbon materials for development of specific surface area. Plasma treatment for functionalization of carbon materials. Electrochemical modification of carbon materials. Practical application of advanced nanomaterials: energy storage, field emission, biocomposites, etc. Biocompatibility of nanomaterials, eventual health risk, safety and ecological problems. Functionalization of nanomaterials and preparation of their composites with organic and inorganic compounds. Production of carbon/polymer composites, characterization of composites and their application as construction materials.

Basic bibliography:

1. Carbons for Electrochemical Energy Storage and Conversion Systems, F. Beguin, E. Frackowiak eds., CRC Press, Boca Raton, FL, USA, 2010

2. Nanomaterials Handbook ed. Y. Gogotsi, Taylor and Francis, Florida, 2006

Additional bibliography:

1. Carbon Materials ? Theory and Practice, ed. A.P. Terzyk, P.A. Gauden, P. Kowalczyk, Research Signpost, Kerala, India, 2008.

Result of average student's workload

Activity	Time (working hours)
1. Lecture	15
2. Consultations to lecture	5
3. Seminars	15
4. Consultations to seminars	10
5. Laboratory classes (practice)	45
6. Consultations to laboratory	15
7. Exam	2
8. Self-education in the field	18

Student's workload

Source of workload	hours	ECTS
Total workload	125	5
Contact hours	105	0
Practical activities	45	0