

Course Description

Title: Ceramics vs. Polymers: Dawn of materials

Fields of activity: Chemical Engineering, Chemistry/Chemical Technology, Civil Engineering, Environmental Engineering, Food Engineering, Materials Engineering

Examination type: Written exam

Number of ECTS credits issued: 1

Learning Goals and Objective: The aim of the course is to enable students to gain knowledge in types, properties and uses of products from biodegradable materials. At the same time the students will have been able to explain the mechanism of polymer degradation and describe the benefits of using biodegradable polymeric materials.

Also they will learn the traditional and modern methods for synthesis and processing of ceramics, the photocatalysis of TiO_2 for the protection of the cultural heritage.

Name of activity	Introduction to Biodegradable Polymers
Number of working hours	2 hours
Type of activity	Lecture
Lecturer	Prof. Aleksandra Buzarovska
Short summary of content	- Fundamentals of Biodegradable Polymers; - Categories of biopolymers, production and properties.
Bibliography	Ewa Rudnik, Compostable Polymer Materials , Elsevier 2008
Expected effect	Deeper understanding of the fundamental types of biodegradable polymers, their production and properties.

Name of activity	Application of Biodegradable Polymers; From wall panels to tissue engineering
Number of working hours	2 hours
Type of activity	Lecture
Lecturer	Prof. Aleksandra Buzarovska
Short summary of content	Review of Biodegradable Polymers' applications in Composite Materials.
Bibliography	<ol style="list-style-type: none"> 1. M.Avella, A. Buzarovska et al. Eco-challenges of Bio-based Polymer Composites, <i>Materials</i>, 2, 911-925 (2009) 2. M.Avella, A.Buzarovska et.al. Green Composites based on biodegradable polymer matrices, Chapter 13 in Cornelia Vasile Book Environmentally degradable Materials based on Multicomponent Polymeric Systems (2009) 3. A.Buzarovska, C. Gualandi et al. Effect of TiO₂ nanoparticles loading on PLA porous Scaffolds fabricated by TIPS, <i>Composites Part B</i> 81, 189-195 (2015)
Expected effect	To gain knowledge on various aspects of Biodegradable Polymer materials' application and properties.

Name of activity	MIKROSAM: Manufacturing processes
Number of working hours	3 hours
Type of activity	Company visit
Lecturer	Milena Koneska – company representative
Short summary of content	<ul style="list-style-type: none"> - Company production process - from idea to realization; - Presentation for the main technologies that are included in the manufacturing of composite materials; - Demonstration of the available machines in the period of the visit.
Bibliography	-
Expected effect	<ul style="list-style-type: none"> - Awareness of the different technologies and factors in the field of composite materials manufacturing process; - Connection between mechanical engineers, electrical engineers and developers that operate in the same environment and develop common product.

Name of activity	Introduction to ceramics, their properties and applications
Number of working hours	0.75 hours
Type of activity	Lecture
Lecturer	Prof. Emilija Fidanchevska
Short summary of content	Presenting the basics of ceramics.
Bibliography	C.Barry Carter, M.Grant Norton, Ceramic Materials Science and Engineering, Springer, pages: 3-13; 345-357
Expected effect	Students will gain knowledge for the types of ceramics (traditional and advanced), the raw materials, their properties and applications.

Name of activity	Bottom up and Top down
Number of working hours	0.75 hours
Type of activity	Lecture
Lecturer	Prof. Emilija Fidanchevska
Short summary of content	Processing of fine particles (Sol-gel method and mechanical activation).
Bibliography	<ol style="list-style-type: none"> 1. C.Barry Carter, M.Grant Norton, Ceramic Materials Science and Engineering, Springer, pages: 359-362; 400-411; 2. Mechanical activation of fly ash http://www.sciencedirect.com/science/article/pii/S1877705813015233
Expected effect	Sol-gel and milling of the powders will be presented as an example for bottom up and top down approaches for obtaining fine particles.

Name of activity	The types of shaping and forming of ceramics
Number of working hours	0.75 hours
Type of activity	Lecture
Lecturer	Prof. Emilija Fidanchevska
Short summary of content	Shaping and forming of the powders (pressing, casting and plastic forming-extrusion).
Bibliography	Barry Carter, M.Grant Norton, Ceramic Materials Science and Engineering, Springer, pages: 412-425
Expected effect	The basic procedures for forming the powdered ceramics systems will be discussed.

Name of activity	Sintering of ceramics
Number of working hours	0.75 hours
Type of activity	Lecture
Lecturer	Prof. Emilija Fidanchevska
Short summary of content	Sintering is the process of making a powdered material to coalesce into a solid or porous mass by heating it without liquefaction.
Bibliography	Barry Carter, M.Grant Norton, Ceramic Materials Science and Engineering, Springer, pages: 427-443
Expected effect	The students will learn the process of sintering, grain growth, types of sintering.

Name of activity	TiO ₂ and it's properties
Number of working hours	1 hour
Type of activity	Lecture
Lecturer	Prof. Emilija Fidanchevska
Short summary of content	Titanium dioxide coated glass was found to have a specific property known as the superhydrophilicity phenomenon. Thanks to this property, today we have developed self-cleaning glass and anti-fogging coatings.
Bibliography	<ol style="list-style-type: none"> 1. Application of Titanium Dioxide Photocatalysis to create self-cleaning building materials. 2. V.Jovanov, O.Rudic, J.Ranogajec, E.Fidanchevska, Synthesis of nanocomposite coating based on TiO₂/ZnAl layer double hydroxides, <i>Materiales de Construcción</i> 67(325):112, 2017
Expected effect	The students will get familiar with the self-cleaning property of TiO ₂ .

Name of activity	Industrial waste ceramics
Number of working hours	2 hours
Type of activity	Lecture
Lecturer	Prof. Biljana Angjusheva
Short summary of content	Ceramics from waste
Bibliography	<ol style="list-style-type: none"> 1. A.Zimmer, Ceramics products from waste, http://cdn.intechweb.org/pdfs/11638.pdf
Expected effect	The students will learn about industrials wastes (fly ash and bottom ash) as potential raw materials for fabrication ceramics products.

Name of activity	Sieving
Number of working hours	1 hours
Type of activity	Laboratory work
Lecturer	Asst. Vojo Jovanov, Prof. Biljana Angjusheva, Prof. Emilija Fidanchevska
Short summary of content	They will be shown the methods of separating wanted elements from unwanted material.
Bibliography	-
Expected effect	Students will have the possibilities to work in labs to understand the practical points of the lecture and learn the methods of separating elements.

Name of activity	Mechanical activation
Number of working hours	1 hours
Type of activity	Laboratory work
Lecturer	Asst. Vojo Jovanov, Prof. Biljana Angjusheva, Prof. Emilija Fidanchevska
Short summary of content	In this laboratory it will be shown the sorting or grinding of fly ash
Bibliography	-
Expected effect	To know the ways of sorting or grinding fly ash, and when it is better to use sorting, when grinding.

Name of activity	Sol-gel method
Number of working hours	1 hours
Type of activity	Laboratory work
Lecturer	Asst. Vojo Jovanov, Prof. Biljana Angjusheva, Prof. Emilija Fidanchevska
Short summary of content	An example for bottom up and top down approaches will be shown for obtaining fine particles.
Bibliography	-
Expected effect	Students will have the possibilities to work in labs to understand the practical points of the lecture.

Name of activity	Pressing
Number of working hours	1 hours
Type of activity	Laboratory work
Lecturer	Asst. Vojo Jovanov, Prof. Biljana Angjusheva, Prof. Emilija Fidanchevska
Short summary of content	The basic procedures for forming the powdered ceramics systems will be shown
Bibliography	-
Expected effect	Students will have the possibilities to work in labs to understand the practical points of the lecture.

Name of activity	Slip-casting
Number of working hours	1 hours
Type of activity	Laboratory work
Lecturer	Asst. Vojo Jovanov, Prof. Biljana Angjusheva, Prof. Emilija Fidanchevska
Short summary of content	The students will be shown the manufacture of ceramics by allowing slip to solidify in a mold
Bibliography	-
Expected effect	Students to gain knowledge on the manufacture processes that can be used.

Name of activity	Pottery making
Number of working hours	1 hours
Type of activity	Laboratory work
Lecturer	Asst. Vojo Jovanov, Prof. Biljana Angjusheva, Prof. Emilija Fidanchevska
Short summary of content	The students will be shown how pottery is made and will have the chance on making their own pottery.
Bibliography	-
Expected effect	Learning how to make pottery and the learning the properties of ceramics

Name of activity	Titan: Manufacturing processes and safety techniques
Number of working hours	3 hours
Type of activity	Company visit
Lecturer	Magdalena Slavejkova – company representative
Short summary of content	<ul style="list-style-type: none"> - Presentation for the company and its work and current projects; - Presentation for the main safety techniques that are included in their factory; - Tour around the factory and demonstration of the available machines in the period of the visit.
Bibliography	-
Expected effect	<ul style="list-style-type: none"> - Awareness of the different technologies, factors and ways of implementing the techniques concerning the safety that has to be top priority. - Connection between mechanical engineers, electrical engineers and developers that operate in the same environment and develop common product. -The machinery and processes used in the production of cement.

Name of activity	From raw material to final product
Number of working hours	4 hours
Type of activity	Case study
Lecturer	Professor from the Faculty of Mechanical Engineering
Short summary of content	- The students will be given one theoretical problem about a specific product. They will have to use all the knowledge gathered from the previous classes to explain theoretically how would they make the product from a scratch.
Bibliography	-
Expected effect	<ul style="list-style-type: none"> - To learn the processes used for making different types of products; - To know when one material is used and when another and why; - Combine different properties to make something new and with better quality;

Name of activity	Laser ablation of polymer composites
Number of working hours	0.75 hours
Type of activity	Lecture
Lecturer	Prof. Jadranka Blazhevaska Gilev
Short summary of content	The fundamentals of polymer composites, different methods of extraction of thin films.
Bibliography	The material science of thin films - Milton Ohring
Expected effect	To achieve basic and advanced knowledge in the field of polymer composites, laser ablation, obtaining thin films by laser deposition, application of the obtained composite systems.

Name of activity	TEA CO2 laser ablation
Number of working hours	0.75 hours
Type of activity	Laboratory exercise
Lecturer	Prof. Jadranka Blazhevaska Gilev, Asst. Stefan Serafimoski
Short summary of content	Practical work related with the theoretical lecture Laser ablation of polymer composites. TEA CO2 Pulsed Laser ablation from substrate (rGO, MWCNT) of a polymer.
Bibliography	The material science of thin films - Milton Ohring
Expected effect	To achieve basic and advanced knowledge in the field of polymer composites, laser ablation, obtaining thin films by laser deposition, application of the obtained composite systems.

Name of activity	Laser ablation of polymer based composite
Number of working hours	0.75 hours
Type of activity	Laboratory exercise
Lecturer	Prof. Jadranka Blazhevaska Gilev, Asst. Stefan Serafimoski
Short summary of content	TEA CO2 Pulsed Laser ablation from substrate (polymer composite) on a quartz glass sample.
Bibliography	The material science of thin films - Milton Ohring
Expected effect	To achieve basic and advanced knowledge in the field of polymer composites, laser ablation on a quartz glass, obtaining thin films by laser deposition, application of the obtained composite systems.

Name of activity	Contact angle, Hardness (Shore D), FTIR and UV/VIS characterization.
Number of working hours	0.75 hours
Type of activity	Laboratory exercise
Lecturer	Prof. Jadranka Blazhevaska Gilev, Asst. Stefan Serafimoski
Short summary of content	Measuring the contact angle and the hardness (Shore D method) of ablated samples from activity 2. Obtaining the FTIR spectrum of the sample obtained by laser ablation in activity 2 and the UV/VIS spectrum of the sample obtained by laser ablation in activity 3.
Bibliography	Write all the needed bibliography for this activity.
Expected effect	To achieve basic and advanced knowledge in the field of polymer composites, testing of their physical and mechanical properties, as well as different methods of characterization of materials.

Name of activity	Final exam
Number of working hours	2 hours
Type of activity	Revision + Written exam
Lecturer	The test will have several questions from every lecturer
Short summary of content	- The participants will summarize what they learned in the past week and solve a test made up of questions on the topic of lectures, laboratory and discussions.
Bibliography	-
Expected effect	- The students will work on the key points of the topic of the course that will be included in the test, thus hopefully taking some solid knowledge back with them.