SUBJECTS

Last modification by the Doctoral Council (56, October 08, 2020)

SEMINAR IN MATERIALS SCIENCES

BASIC SUBJECTS IN MATERIALS SCIENCES

a) General studies on materials
   1. Physical chemistry of surfaces (Krisztina László)
   2. Porous materials (Krisztina László)
   3. Nanotechnology – chemical materials science (Éva Kiss)
   4. Principles of radiation chemistry (László Wojnárovits)
   5. Solid-state chemistry (András Stirling)
   6. Chemistry of colour (András Víg)
   7. Introduction into the plasma chemistry (Zoltán Káróly, Szilvia Klébert)
   8. Fracture mechanics (Tünde Kovács)
   9. Impairment of structural materials (Tünde Kovács)
  10. Manufacturing process planning (Balázs Mikó)
  11. Finite element modelling of materials technologies (Viktor Gonda)
  12. Principles of advanced ceramic materials (Szilvia Klébert)
  13. Contemporary concepts in catalysis (József Sándor Pap)
  14. Biomaterials for medical applications (Csaba Balázs)
  15. The impact of the Industry 4.0 to the manufacturing technology (Balázs Mikó)
  17. Modelling of Maintenance processes (László Pokorádi)
  18. Nuclear Reactor Materials (Zoltán Hózer)

b) Methods of material testing
   1. Selected chapters of material testing methods I.: FTIR, HPLC/MS (Erzsébet Takács), SEM, STM, AFM (Judit Telegdi)
   2. Selected chapters of material testing methods II.: XPS, XRF, adsorption of gases/special surface, distribution of pores (Zoltán Káróly Zoltán, Szilvia Klébert)
   3. Advanced separation methods in materials research (Zoltán Juvancz)
   4. Fluorescence spectroscopy and microscopy (Gusztáv Schay)
   5. Advanced mass spectrometry (Sándor Kéki)
   6. Colorimetry (Borbély Ákos)
   7. Characterisation of surface microgeometry and microtopography (Béla Palásti-Kovács, Gabriella Farkas)
   8. Characterization methods of microelectronic materials and devices (Balázs Kovács)
   9. Finite element modelling of heat transfer (Sándor Borza)
  10. Fracture mechanics (Tünde Kovács)
  11. Impairment of structural materials (Tünde Kovács)
  12. Electrochemical methods of the measurement of corrosion and inhibition (Abdul Ibdewi Shaban)
  13. Finite element modelling of materials technologies (Viktor Gonda)
  14. Measurement of bioelectrical activities (Gergely Márton)
SUBJECTS IN SPECIFIC AREAS OF MATERIALS SCIENCES

c) Polymers
1. Polymer chemistry and physics (Sándor Pekker)
2. Physics of macromolecules (Károly Belina)
3. Surface characterization and modification of polymeric materials (Éva Kiss)
4. Natural and natural based polymers (Cecília E. Tamás-Nyitrai)
5. Cellulose chemistry (Judit Borsa)
6. Paper fibres and their surface characteristics (László Koltai)
7. Cellulose and paper technology (László Koltai)
8. Physical properties of papers and corrugated boards (László Koltai)
9. Interaction of printing materials and printing inks (Rozália Szentgyörgyvölgyi)
10. Synthetic fibres and technical textiles (Judit Borsa)
11. Modification of natural polymers and plastics by high energy irradiation (Erzsébet Takács)
12. Characterization of functional textile and clothing products (Lívia Kokas-Palicska)
13. Characteristics of antimicrobial textiles (Hosam Hamuda Bayoumi)
14. Polymers in microtechnology (Andrea Csikós-Pap)
15. Technology and application of polymer based bionic interfaces (Zoltán Fekete)
16. Supramolecular and coordination complexes and polymers (Sándor Pekker, Éva Kováts)
17. Biomaterials for medical applications (Csaba Balázsi)

d) Ceramics
1. Principles of advanced ceramic materials (Szilvia Klébert)
2. Technology of advanced ceramics (János Dusza)
3. Microstructure and fracture mechanisms of advanced ceramics (János Dusza)
4. Mechanical properties of advanced ceramics (János Dusza)
5. Powder technology (Csaba Balázsi)
7. Biomaterials for medical applications (Csaba Balázsi)

e) Metals
1. Continuous casting of steel (Mihály Réger)
2. Modelling of thermally activated transformations in alloys (Tamás Réti)
3. Materials technologies of high energy impact (Gyula Bagyinszki)
4. Welding technologies I: Molten state welding (Gyula Bagyinszki)
5. Hegesztéstechnológiák II: Solid state welding (Gyula Bagyinszki)
6. Powder technology (Csaba Balázsi)
7. Principles of plasticity theory (Endre Ruszinkó)
8. Non-classical problems of plasticity and creep (Endre Ruszinkó)
9. Electrochemical methods of the measurement of corrosion and inhibition (Abdul Ibdewi Shaban)
10. Metal cutting theory (Richárd Horváth)
11. Titanium and Titanium Alloys (Péter Pinke)
12. Nuclear Reactor Materials (Zoltán Hózer)

f) Composites
1. Composites (Szilvia Klébert)
2. Polymeric nanocomposites (Andrea Ádám-Major)
3. Biomaterials for medical applications (Csaba Balázsi)
g) Micro- and nano-structured materials
1. Semiconductor technologies (Zsolt József Horváth)
2. Semiconductor devices (Zsolt József Horváth)
3. Semiconductors produced from liquid phase (Vilmos Rakovics)
4. Compound semiconductors and their optoelectronic application (Vilmos Rakovics)
5. Solid-state light sources and their application (Horváth Zsolt József)
6. „Band gap engineering“ (efficiency of solar batteries) (Ákos Nemcsics)
7. Self organizing low-dimensional structures (Ákos Nemcsics)
8. Information storage devices and materials structures (Zsolt József Horváth)
9. Micro and nano electromechanical structures (Zsolt József Horváth)
10. Nanotechnology – chemical materials science (Éva Kiss)
11. Medicinal application of colloidal systems (Gergő Gyulai)
12. Surface characterization and modification of polymeric materials (Éva Kiss)
13. Application of microcapsules in the modern industry (Judit Telegdi)
14. Polymers in microtechnology (Andrea Csikós-Pap)
15. Adhesive-free Wafer Bonding (Andrea Csikós-Pap)
16. Elements and compounds in micro-scale gas sensors (Andrea Csikós-Pap)
17. Characterization methods of microelectronic materials and devices (Balázs Kovács)
18. Molecular-beam epitaxy of III-V semiconductor materials (Ákos Nemcsics)
19. Technology and application of polymer based bionic interfaces (Zoltán Fekete)
20. BioMEMS: miniaturizált bioszenzorok (Fekete Zoltán)
21. Chemical sensors: methods and applications (Shaban Ibdewi Abdul)
22. Supramolecular and coordination complexes and polymers (Sándor Pekker, Éva Kováts)
23. Optical characterization of thin layers (Péter Petrik)
24. Measurement of bioelectrical activities (Gergely Márton)

h) Environmental issues of materials sciences technologies
1. Environmental chemistry (Shaban Ibdewi Abdul)
2. Utilization of plastic waste by pyrolysis (Zsuzsanna Czégény)
3. Going Green… environmentally sound printing (Csaba Horváth)
4. Waste water purification technologies (Bodáné Kendrovics Rita)
5. Principles of hydrology (Emőke Bardóczy-Székely)

OTHERS
1. Experimental design (Ágota Drégelyi-Kiss)
2. Statistical hypothesis testing (Márta Takács)
3. Engineering education (Péter Tóth)
PROGRAMS OF SUBJECTS

SEMINAR IN MATERIALS SCIENCES
Invited speakers, mostly foreign guests of the university, give lectures from various areas of materials sciences.

BASIC SUBJECTS IN MATERIALS SCIENCES

a) General studies on materials
1. Physical chemistry of surfaces (Krisztina László)
   Suggested reading
   Gregg, S. J., Sing K. S. W.: Adsorption, Surface Area and Porosity, Academic 1982
   D. Avnir (ed.): The fractal approach to heterogeneous chemistry. Wiley & Sons, Chichester, 1989

2. Porous materials (Krisztina László)
   Suggested reading
   Gregg, S. J., Sing K. S. W.: Adsorption, Surface Area and Porosity, Academic 1982

3. Nanotechnology – chemical materials science (Éva Kiss)
   Aim of the course: Introduction to the chemical aspects of materials science, especially nanotechnology
   Total number of contact hours in the course: 30 hours
   Prerequisites of the course: -
   Suggested reading
   R. W. Cahn: The coming of materials science, Pergamon, Amsterdam,
   W. D. Callister: Materials Science and Engineering, An Introduction, Wiley,

4. Principles of radiation chemistry (László Wojnárovits)
   Suggested reading

5. Solid-state chemistry (András Stirling)
6. Chemistry of colour (András Víg)  
Suggested reading  

7. Introduction into the plasma chemistry (Zoltán Károly, Szilvia Klébert)  
Suggested reading  

8. Fracture mechanics (Tünde Kovács)  
Suggested reading  

9. Impairment of structural materials (Tünde Kovács)  
Suggested reading  
G. E Totten: Steel heat treatment Handbook, Marcel Dekker, 2004  

10. Manufacturing process planning (Balázs Mikó)  
Suggested reading  
Andrew Y. C. Nee: Handbook of Manufacturing Engineering and Technology; Springer 2015 DOI 10.1007/978-1-4471-4670-4

11. Finite element modelling of materials technologies (Viktor Gonda)  
Aim of the course: In the analysis of materials technologies, finite element modeling is beneficial for the determination of stress, strain and temperature distributions, and other technological parameters for complex geometries. By using the MARC finite element software, mechanical, thermal, coupled thermo-mechanical sample problems will be solved. After finishing the course, the student will be able to define a simplified mechanical and/or thermal model for forming or heat treatment, implement it in finite element, run the model, and post process the results, serving as an initial step for further optimizing a solution for more complex problems.  
Number of contact hours: 30.  
Prerequisites: -  
Suggested reading  
MARC documentation;  
12. Principles of advanced ceramic materials (Szilvia Klébert)

**Suggested reading**

13. Contemporary concepts in catalysis (József Sándor Pap)

**Aim of the course:** introduce the modern aspects in catalysis research and the evaluation of catalytic systems to the grad students.

**Number of contact hours:** 30.

**Prerequisites:** -

**Contents:** The basics of catalysis, production, testing and operation. Kinetics. Homogeneous and heterogeneous systems and beyond. Basic tools in electrocatalysis research. Outlook to green chemistry and life-cycle assessment (LCA).

**Suggested reading**

14. Biomaterials for medical applications (Csaba Balázsi)

**Aim of the course:** Presentation of ceramic, glass and polymer technology processes (manufacture of powders, compression, additive manufacturing, spraying, sintering), discussion of the physical, chemical and technological properties of the produced materials with focus on medical applications.

**Number of contact hours:** 30

**Prerequisites:** ---

**Content:** Presentation and medical application-oriented discussion on the composition-structure-properties of materials (ceramics, glasses and polymers) produced by different methods; Bioactive ceramics currently used as coatings for metallic devices, promoting the formation of natural bone tissue, their integration into hard tissues; Ceramic particles, microspheres, and nanostructures in the cancer treatment; scaffolds for tissue engineering, as carriers for drug release as dental implants; new bioceramics with improved mechanical and biological performances, zirconia-based, hydroxiapatite composites or more recently non-oxide ceramics.

**Suggested reading:**
An introduction to bioceramics, Ed. L. L. Hench and J. Wilson, World Scientific Publ., 1993
A manual for biomaterials/scaffold fabrication technology, World Scientific Publ., 2007

15. The impact of the Industry 4.0 to the manufacturing technology (Balázs Mikó)

**Aim of the subject:** The aim of the subject is to present the technical and economic impacts of the nine key technologies of I4.0 to the product design, to the manufacturing technologies, methods and environment.

**Number of contact hours:** 30

**Prerequisites:** ---

**Content:** The Industry 4.0 transforms the principles and the structure of the industry, changes the manufacturing processes and equipment. The integration of nine key technologies (simulation, system integration, IoT, cyber security, cloud computing, additive manufacturing, augmented reality, big data, autonomous robots) ensures the
increasing of productivity during the whole life cycle of a product. The aim of the subject is to present the evolution of these technologies, the possibilities of the application, the technical and economic impact to the product design, to the manufacturing technologies, methods and environment.

**Suggested reading:**
Industry 4.0 Study for the ITRE Committee; European Parliament (2016) IP/A/ITRE/2015-02 PE 570.007
Marina Crnjac; Ivica Veža; Nikola Banduka (2017) From Concept to the Introduction of Industry 4.0. International Journal of Industrial Engineering and Management (IJIEIM) 8(1)21-30

16. Modelling of technical systems (László Pokorádi)
Theoretical background of system engineering, modelling of technical systems. Clasification of models. Methodology of mathematical modeling. One- and Multi-parametrical Sensitivity Analysis. The dimensional Analysis. The stateestimation methods. Modell uncertainties. **Educational goal of subject - Competencies:** To give a general overview about the role of mathematical modelling of technical systems, as well as make a basis of the mathemaztical model-based investigation of military equipment.

**Suggested reading:**

17. Modelling of maintenance processes (László Pokorádi)
Theoretical background of maintenance management. Strategies of maintenance. Clasifications of failures. Aging theory. Application of theory of Markov-processes to investigate maintenance processes. The modern maintenance philosophies, Total Productive Management, Realibility Centered Management. **Educational goal of subject - Competencies:** To give a general overview about the role of maintenance and maintenance management in the military operations, as well as make a basis of modern, mathematical modell-based maintenance management of military equipment.

18. Nuclear reactor materials (Zoltán Hózer)
The objective of the subject is to improve the knowledge of PhD students on the characteristics of nuclear reactor materials and considerations for their selection, on the basic principles of nuclear plant operation, thermal phenomena in the nuclear reactors, mechanical behaviour of reactor materials and the related examination methods.
The subject covers the following topics:

- **Nuclear fuel materials**
  - Fuel assemblies and control rods
  - Coolant
  - Pressurized water reactor and boiling water reactors
  - Reactor pressure vessel materials and structure

- **Heat production and removal in a nuclear reactor**
  - Thermal conductivity of nuclear fuel
  - Operating limits in normal operation
  - Limits for accident conditions (LOCA and RIA)

- **Mechanical behaviour of reactor materials**
  - Mechanical testing methods
b) Methods of material testing

1. Selected chapters of material testing methods I.: FTIR, HPLC/MS (Erzsébet Takács), SEM, STM, AFM (Judit Telegdi)
   Suggested reading

2. Selected chapters of material testing methods II.: XPS, XRF, adsorption of gases/special surface, póruseloszlás (Zoltán Károly Zoltán, Szilvia Klébert)
   Suggested reading

3. Advanced separation methods in materials research (Zoltán Juvancz)
   Suggested reading
   M. L. Lee, Analytical Supercritical Fluid Chromatography
   K.J. Hyver, P. Sandra: High Resolution Gas Chromatography

4. Fluorescence spectroscopy and microscopy (Gusztáv Schay)
   Suggested reading

5. Advanced mass spectrometry (Sándor Kéki)
   ESI, APCI, APCI. Online (LC, GPC)-ESI MS. MALDI MS/MS és ESI-MS/MS (CID, ECD) methods.

6. Colorimetry (Borbély Ákos)

7. Characterisation of surface microgeometry and microtopography (Béla Palásti-Kovács, Gabriella Farkas)
   Aim of the course: Knowledge and application of methods, techniques, quantifiable parameters, measuring instruments used for the microgeometric characterization of surfaces of structural materials.
   Number of contact hours: 30
   Prerequisite: -
   Content: Students will review the types of surface irregularities, their parameters and function characteristics, the most important elements of their influence on the functional behaviour (e.g. print quality, etc.). They learn about traditional and modern evaluation methods, related international standards, practical and research equipment, computer programs, screening techniques (amplitude density, spectrum analysis, autocorrelation and fractal testing, etc.) and the limitations of their usability. Measuring and laboratory exercises and analyses will be carried out.
   Suggested reading
8. Characterization methods of microelectronic materials and devices (Balázs Kovács)

**Suggested reading**

9. Finite element modelling of heat transfer (Sándor Borza)

**Suggested reading**

10. Fracture mechanics (Tünde Kovács)

**Suggested reading**

11. Impairment of structural materials (Tünde Kovács)

**Suggested reading**
- G. E Totten: Steel heat treatment Handbook, Marcel Dekker, 2004

12. Electrochemical methods of the measurement of corrosion and inhibition (Abdul Ibdewi Shaban)

**Aim of the course:** Provide fundamental knowledge of electrochemistry, understanding of controlling factors for metal corrosion, experimental approaches for measuring corrosion rate, interpretation of EC results. provide awareness and understanding of forms of corrosion and corrosion phenomenology such as passivity and localized corrosion, galvanic corrosion, dealloying, approaches for corrosion prevention and control such as coatings, inhibitors.

**Number of hours:** 30 hours

**Prerequisite:** basic knowledge of electrochemistry.

**Content:** Thermodynamics of corrosion, Kinetics of corrosion, Polarization, Corrosion rate measurement techniques, Corrosion measurements, Cell design, Sample preparation, Experimental techniques, Corrosion potential measurements, Polarization resistance, Potentiostatic and potentiodynamic polarization, Galvanic corrosion, Pitting (including scratch techniques), Electrochemical impedance spectroscopy (EIS), Passivity/localized corrosion, Statistical analysis of corrosion data, Corrosion inhibitors.

**Suggested reading**
- Electrochemical Techniques in Corrosion Engineering, 1986, National Association of Corrosion Engineers (NACE).
13. Finite element modelling of materials technologies (Viktor Gonda)

**Aim of the course:** In the analysis of materials technologies, finite element modeling is beneficial for the determination of stress, strain and temperature distributions, and other technological parameters for complex geometries. By using the MARC finite element software, mechanical, thermal, coupled thermo-mechanical sample problems will be solved. After finishing the course, the student will be able to define a simplified mechanical and/or thermal model for forming or heat treatment, implement it in finite element, run the model, and post process the results, serving as an initial step for further optimizing a solution for more complex problems.

**Number of contact hours:** 30.

**Prerequisites:**


**Suggested reading**

MARC documentation;


14. Measurement of bioelectrical activities (Gergely Márton)

**Suggested reading**


15. Chemical sensors: methods and applications (Abdul Ibdewi Shaban)

**Aim of the course:** The aim of the course is to give students deep insight into chemical sensors and their practical applications. The course deals with basic principles of different types of chemical sensors based on electrochemical, gravimetrical and thermal transduction. Electrochemical sensors and their applications in environmental analysis are emphasized. The use of polymers (conductive and nonconductive) in chemical sensors is described with special emphasis on ion-selective electrodes. Modelling of the response of ion-selective membranes is briefly introduced.

**Prerequisite:**

**Content:** describe the operation principles for chemical sensors based on electrochemical, and gravimetrical transduction; explain the operation principle of potentiometric, amperometric, and gravimetric sensors and give examples of their applications; derive the Nernst equation based on the concept of electrochemical potential; give examples of chemical sensors based on applications of different polymers; explain the construction and operation principle of ion-selective electrodes; evaluate the analytical performance of gravimetrical methods: as an example- QCM based calibration plots and selectivity measurements.

**Suggested reading**


16. BioMEMS: miniature bionsensors (Zoltán Fekete)

Suggested reading

17. Optical characterization of thin layers (Péter Petrik)

Suggested reading
Azzam Bashara: Ellipsometry and polarized light
E. Irene, H. Tompkins: Handbook of ellipsometry
M. Losurdo, K. Hingerl: Ellipsometry at the nanoscale

SUBJECTS IN SPECIFIC AREAS OF MATERIALS SCIENCES

c) Polymers

1. Polymer chemistry and physics (Sándor Pekker)

2. Physics of macromolecules (Károly Belina)

Suggested reading
J. A. Manson, L.H. Sperling: Polymer Blends and Composites, Plenum, New York, 1976

3. Surface characterization and modification of polymeric materials (Éva Kiss)

Aim of the course: Characteristic surface and interfacial interactions of polymers, surface modification techniques
Total number of hours: 30 hours
Prerequisites of the course: -

Suggested reading

4. Natural and natural based polymers (Cecília E. Tamás-Nyitrai)

Suggested reading

5. Cellulose chemistry (Judit Borsa)

Aim of the course: Presentation of natural and natural based man-made fibres as raw materials and substrates of materials research.
Total number of hours: 30 hours
Prerequisites of the course: -
Content: Chemical and physical structures of cellulose, main characteristics of cellulose based natural and man-made fibres (cotton, linen, hemp, viscose, Lyocell), cellulose as raw material, the most important methods of physical
and chemical modification: swelling in various activating agents, manufacturing derivatives in polymer analogous reactions, graft copolymers, modification of the surface by plasma, natural fiber reinforced polymers.

**Suggested reading**


6. **Paper fibres and their surface characteristics (László Koltai)**

**Suggested readings**


7. **Cellulose and paper technology (László Koltai)**

8. **Physical properties of papers and corrugated boards (László Koltai)**

**Suggested reading**


9. **Interaction of printing materials and printing inks (Rozália Szentgyörgyvölgyi)**

**Suggested reading**

- S. Sean: Introduction to Digital Printing, Pira, 2003

10. **Synthetic fibres and technical textiles (Judit Borsa)**

**Aim of the course:** Presentation of new, non-traditional fibres

**Total number of hours:** 30 hours

**Prerequisites of the course:** -

**Content:** Main characteristics of fibre-forming polymers, models of fibre structure (fringed micella, fringed fibrilla, para-crystal), crystallinity and orientation, various states of polymers (phase, physical), fibre classes, most important fibre properties, fibre manufacturing methods (modification of synthetic fibres: molecular level, fibre manufacturing), non-conventional fibres (hollow, bicomponent, micro, nano, carbon fibres)

**Suggested reading**

11. Modification of natural polymers and plastics by high energy irradiation (Erzsébet Takács)

Suggested reading

12. Characterization of functional textile and clothing products (Lívia Kokas-Paliscka)

Suggested reading
Petra Knecht: Funktionstextilien, Deutscher Fachverlag, ISBN: 3-87150-833-0,
R.-D. Reumann(Hrsg): Prüverfahren in der textil-und Bekleidungstechnik
Fabric testing. Edited by J Hu, Hong Kong Polytechnic University, Hong Kong, Woodhead Publishing Series in Textiles No. 76

13. Characteristics of antimicrobial textiles (Hosam Hamuda Bayoumi)

Suggested reading

14. Polymers in microtechnology (Andrea Csikós-Pap)
15. Technology and application of polymer based bionic interfaces (Zoltán Fekete)

Suggested reading

16. Supramolecular and coordination complexes and polymers (Sándor Pekker, Éva Kováts)

Suggested reading

17. Biomaterials for medical applications (Csaba Balázs)

Aim of the course: Presentation of ceramic, glass and polymer technology processes (manufacture of powders, compression, additive manufacturing, spraying, sintering), discussion of the physical, chemical and technological properties of the produced materials with focus on medical applications.

Number of contact hours: 30

Prerequisites: --

Content: Presentation and medical application-oriented discussion on the composition-structure-properties of materials (ceramics, glasses and polymers) produced by different methods; Bioactive ceramics currently used as coatings for metallic devices, promoting the formation of natural bone tissue, their integration into hard tissues; Ceramic particles, microspheres, and nanostructures in the cancer treatment; scaffolds for tissue engineering, as carriers for drug release as dental implants; new bioceramics with improved mechanical and biological performances, zirconia-based, hydroxiapatite composites or more recently non-oxide ceramics.

Suggested reading:
An introduction to bioceramics, Ed. L. L. Hench and J. Wilson, World Scientific Publ., 1993
A manual for biomaterials/scaffold fabrication technology, World Scientific Publ., 2007

d) Ceramics

1. Principles of advanced ceramic materials (Szilvia Klébert)

Suggested reading

2. Technology of advanced ceramics (János Dusza)

Aim of the course: To introduce the technology of advanced ceramics

Total number of hours: 30 hours

Prerequisites: --

Content: Description of the technological routes applied for the production/preparation of advanced ceramics as: powder synthesis/preparation, forming – press, cold isostatic press, injection molding, etc., sintering – pressureless sintering, hot pressing, spark plasma sintering, etc., final shaping – diamond cutting, grinding, polishing, etc.
Suggested reading:

3. Microstructure and fracture mechanisms of advanced ceramics (János Dusza)

Aim of the course: To introduce the microstructure and fracture mechanisms of advanced ceramics
Total number of hours: 30 hours
Prerequisites: --

Content: The microstructure parameters of structural ceramics will be introduced as volume fraction of individual phases, grain size, grain aspect ratio, grain boundary, etc together with the basic fracture mechanisms as clevage, intergranular fracture, pull – out, etc. The main observation techniques/methods will be introduced as light microscopy, scanning electron microscopy, transmission electron microscopy, high resolution transmission electron microscopy, focused ion beam milling, etc.

Suggested reading:

4. Mechanical properties of advanced ceramics (János Dusza)

Aim of the course: To introduce the mechanical properties of advanced ceramics
Total number of hours: 30 hours
Prerequisites: --

Content of the course:
We are dealing in detail with the mechanical properties of advanced ceramics as hardness, fracture toughness, strength, creep characteristics, etc., together with the methods /characterization technics for measuring these properties. We are discussing the relationships between the technological route – microstructure – final properties.

Suggested reading

5. Powder technology (Csaba Balážsi)

Aim of the course: Presentation of powder technology processes (manufacture of metallic and non-metallic powders, compression, sintering), discussion of the physical, chemical and technological properties of the produced materials.
Total number of hours: 30 hours
Prerequisites of the course: ---

Content: Presentation and application-oriented discussion on the composition-structure-properties of materials produced by different methods of powder technology; metallic and non-metallic materials prepared via powder metallurgy technology; the influence of technological process preparation of powder materials on their microstructure formation and development; special technological processes of powder materials with particular physical-chemical properties; environmental issues of the production and application of powder materials.

Suggested reading

7. Biomaterials for medical applications (Csaba Balázsi)

Aim of the course: Presentation of ceramic, glass and polymer technology processes (manufacture of powders, compression, additive manufacturing, spraying, sintering), discussion of the physical, chemical and technological properties of the produced materials with focus on medical applications.
Number of contact hours: 30

Prerequisites: ---

Content: Presentation and medical application-oriented discussion on the composition-structure-properties of materials (ceramics, glasses and polymers) produced by different methods; Bioactive ceramics currently used as coatings for metallic devices, promoting the formation of natural bone tissue, their integration into hard tissues; Ceramic particles, microspheres, and nanostructures in the cancer treatment; scaffolds for tissue engineering, as carriers for drug release as dental implants; new bioceramics with improved mechanical and biological performances, zirconia-based, hydroxiapatite composites or more recently non-oxide ceramics.

Suggested reading:
An introduction to bioceramics, Ed. L. L. Hench and J. Wilson, World Scientific Publ., 1993
A manual for biomaterials/scaffold fabrication technology, World Scientific Publ., 2007

e) Metals

1. Continuous casting of steel (Mihály Réger)

Suggested reading

2. Modelling of thermally activated transformations in alloys (Tamás Réti)

Suggested reading

3. Materials technologies of high energy impact (Gyula Bagyinszki)
4. Welding technologies I: Molten state welding (Gyula Bagyinszki)

5. Hegesztéstechnológiák II: Solid state welding (Gyula Bagyinszki)

6. Powder technology (Csaba Balázsi)
   **Aim of the course:** Presentation of powder technology processes (manufacture of metallic and non-metallic powders, compression, sintering), discussion of the physical, chemical and technological properties of the produced materials.
   **Total number of hours:** 30 hours
   **Prerequisites of the course:** ---
   **Content:** Presentation and application-oriented discussion on the composition-structure-properties of materials produced by different methods of powder technology; metallic and non-metallic materials prepared via powder metallurgy technology; the influence of technological process preparation of powder materials on their microstructure formation and development; special technological processes of powder materials with particular physical-chemical properties; environmental issues of the production and application of powder materials.
   **Suggested reading**
   Ceramic Matrix Composites, Microstructure/Properties Relationship, Ed. Prof. I. M. Low, Woodhead Publishing Ltd., Abington Hall, Abington, 2006

7. Principles of plasticity theory (Endre Ruszinkó)
   **Suggested reading**

8. Non-classical problems of plasticity and creep (Endre Ruszinkó)
   **Suggested reading**

9. Electrochemical methods of the measurement of corrosion and inhibition (Abdul Ibdewi Shaban)
   **Aim of the course:** Provide fundamental knowledge of electrochemistry, understanding of controlling factors for metal corrosion, experimental approaches for measuring corrosion rate, interpretation of EC results. provide awareness and understanding of forms of corrosion and corrosion phenomenology such as passivity and localized corrosion, galvanic corrosion, dealloying, approaches for corrosion prevention and control such as coatings, inhibitors.
   **Number of hours:** 30 hours
   **Prerequisite:** basic knowledge of electrochemistry.
   **Content:** Thermodynamics of corrosion, Kinetics of corrosion, Polarization, Corrosion rate measurement techniques, Corrosion measurements, Cell design, Sample preparation, Experimental techniques, Corrosion potential measurements, Polarization resistance, Potentiostatic and potentiodynamic polarization, Galvanic
corrosion, Pitting (including scratch techniques), Electrochemical impedance spectroscopy (EIS), Passivity/localized corrosion, Statistical analysis of corrosion data, Corrosion inhibitors.

**Suggested reading**


Electrochemical Techniques in Corrosion Engineering, 1986, National Association of Corrosion Engineers (NACE).


10. **Metal cutting theory (Richárd Horváth)**

**Suggested reading**

David A. Stephenson, John S. Agapiou: Metal Cutting Theory and Practice (second edition, 2005)


11. **Titanium and Titanium Alloys (Péter Pinke)**

**Aim of the course:** Presentation of titanium and titanium alloys, the discussion of production, properties and applications of titanium grades and titanium alloys.

**Total number of contact hours:** 30

**Prerequisites:** ---

**Content:** The preparing of titanium and processing to semi-finished products. Alloying of titanium and presentation the relationship between the composition, structure and properties. Typical titanium alloys (α alloys, α+β alloys, β alloys). Technological processing of titanium alloys: melting, casting, forming, welding, surface treatment, powder metallurgy. Heat treatment of titanium alloys. Major application fields of titanium alloys: aerospace, chemical industry, automotive applications, biomedical applications; application examples.

**Suggested reading:**


12. **Nuclear reactor materials (Zoltán Hózer)**

The objective of the subject is to improve the knowledge of PhD students on the characteristics of nuclear reactor materials and considerations for their selection, on the basic principles of nuclear plant operation, thermal phenomena in the nuclear reactors, mechanical behaviour of reactor materials and the related examination methods.

The subject covers the following topics:

- Nuclear fuel materials
  - Fuel assemblies and control rods
  - Coolant
  - Pressurized water reactor and boiling water reactors
  - Reactor pressure vessel materials and structure
- Heat production and removal in a nuclear reactor
  - Thermal conductivity of nuclear fuel
  - Operating limits in normal operation
  - Limits for accident conditions (LOCA and RIA)
- Mechanical behaviour of reactor materials
  - Mechanical testing methods
  - Creep
  - Fracture mechanics
f) Composites

1. Composites (Szilvia Klébert)
   Suggested reading
   Long Yu, Biodegradable Polymer Blends and Composites from Renewable Resources, 2008, Wiley
   Richard Wool, X. Susan Sun, Bio-Based Polymers and Composites, 2005, Elsevier Science & Technology Books

2. Polymeric nanocomposites (Andrea Ádám-Major)
   Aim of the course: The aim of the lecture is to study the properties of nanocomposites consist of polymer matrix and nanoparticles.
   Total number of hours: 30 hours
   Suggested reading

3. Biomaterials for medical applications (Csaba Balázsi)
   Aim of the course: Presentation of ceramic, glass and polymer technology processes (manufacture of powders, compression, additive manufacturing, spraying, sintering), discussion of the physical, chemical and technological properties of the produced materials with focus on medical applications.
   Number of contact hours: 30
   Prerequisites: ---
   Content: Presentation and medical application-oriented discussion on the composition-structure-properties of materials (ceramics, glasses and polymers) produced by different methods; Bioactive ceramics currently used as coatings for metallic devices, promoting the formation of natural bone tissue, their integration into hard tissues; Ceramic particles, microspheres, and nanostructures in the cancer treatment; scaffolds for tissue engineering, as carriers for drug release as dental implants; new bioceramics with improved mechanical and biological performances, zirconia-based, hydroxiapatite composites or more recently non-oxide ceramics.
   Suggested reading:
   An introduction to bioceramics, Ed. L. L. Hench and J. Wilson, World Scientific Publ., 1993
   A manual for biomaterials/scaffold fabrication technology, World Scientific Publ., 2007

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g) Micro- and nano-structured materials

1. Semiconductor technologies (Zsolt József Horváth)
   Prerequisites: basic knowledges in physics and chemistry
   Suggested reading

2. Semiconductor devices (Zsolt József Horváth)
   Prerequisites: basic knowledges in physics and electric engineering
   Suggested reading
3. **Semiconductors produced from liquid phase (Vilmos Rakovics)**
   **Suggested reading**
   C.D. Lokhande Chemical deposition of metal chalcogenide thin films, Materials Chemistry and Physics, Volume 27, Issue 1, January 1991, Pages 1–43

4. **Compound semiconductors and their optoelectronic application (Vilmos Rakovics)**
   **Suggested readings**

5. **Solid-state light sources and their application (Horváth Zsolt József)**
   **Prerequisites:** basic knowledges in physics and electric engineering
   **Suggested reading**
   Optoelectronics and Photonics, Pearson Education, 2013.

6. **„Band gap engineering” (efficiency of solar batteries) (Ákos Nemcsics)**

7. **Self organizing low-dimensional structures (Ákos Nemcsics)**

8. **Information storage devices and materials structures (Zsolt József Horváth)**

9. **Micro and nano electromechanical structures (Zsolt József Horváth)**
   **Prerequisites:** basic knowledges in physics and chemistry

10. **Nanotechnology – chemical materials science (Éva Kiss)**
    **Aim of the course:** Introduction to the chemical aspects of materials science, especially nanotechnology
    **Total number of contact hours in the course:** 30 hours
    **Prerequisites of the course:**
    **Suggested reading**
    R. W. Cahn: The coming of materials science, Pergamon, Amsterdam,
    W. D. Callister: Materials Science and Engineering, An Introduction, Wiley,
11. Medicinal application of colloidal systems (Gergő Gyulai)

Aim of the course: Introduction of colloidal particlals and thin film systems and their applications in advanced medicinal practices.

Total number of hours: 30 hours

Prerequisites of the course: -


12. Surface characterization and modification of polymeric materials (Éva Kiss)

Aim of the course: Characteristic surface and interfacial interactions of polymers, surface modification techniques

Total number of hours: 30 hours

Prerequisites of the course: -


Suggested reading

13. Application of microcapsules in the modern industry (Judit Telegdi)

14. Polymers in microtechnology (Andrea Csikós-Pap)

15. Adhesive-free Wafer Bonding (Andrea Csikós-Pap)

16. Elements and compounds in micro-scale gas sensors (Andrea Csikós-Pap)

17. Characterization methods of microelectronic materials and devices (Balázs Kovács)

Suggested reading

18. Molecular-beam epitaxy of III-V semiconductor materials (Ákos Nemcsics)

19. Technology and application of polymer based bionic interfaces (Zoltán Fekete)

Suggested reading
20. BioMEMS: miniatűrizált bioszenzorok (Fekete Zoltán)
Suggested reading

21. Chemical sensors: methods and applications (Shaban Ibdewi Abdul)
Aim of the course: The aim of the course is to give students deep insight into chemical sensors and their practical applications. The course deals with basic principles of different types of chemical sensors based on electrochemical, gravimetrical and thermal transduction. Electrochemical sensors and their applications in environmental analysis are emphasized. The use of polymers (conductive and nonconductive) in chemical sensors is described with special emphasis on ion-selective electrodes. Modelling of the response of ion-selective membranes is briefly introduced.
A tantárgy összóraszáma: 30 óra
Prerequisite: -
Content: describe the operation principles for chemical sensors based on electrochemical, and gravimetical transduction; explain the operation principle of potentiometric, amperometric, and gravimetric sensors and give examples of their applications; derive the Nernst equation based on the concept of electrochemical potential; give examples of chemical sensors based on applications of different polymers; explain the construction and operation principle of ion-selective electrodes; evaluate the analytical performance of gravimetical methods: as an example- QCM based calibration plots and selectivity measurements.
Suggested reading

22. Supramolecular and coordination complexes and polymers (Sándor Pekker, Éva Kováts)
Suggested reading

23. Optical characterization of thin layers (Péter Petrik)
Suggested reading
Azzam Bashara: Ellipsometry and polarized light
E. Irene, H. Tompkins: Handbook of ellipsometry
M. Losurdo, K. Hingerl: Ellipsometry at the nanoscale

24. Measurement of bioelectrical activities (Gergely Márton)
Suggested reading

h) Environmental issues of materials sciences technologies

1. Environmental chemistry (Shaban Ibdewi Abdul)
   
   Aim of the course: Application of chemical principles to the study of the environment. It includes natural processes and pollution problems related to air, water, and soil.
   
   Total number of hours: 30
   
   Prerequisites: ---
   
   Content:
   
   Part I. Introduction to environmental chemistry: Introduction; Environmental Chemistry: Water; Pollutants of Waters; Unit Operations Water Treatments; Advanced treatments of Waste Water.
   
   Part II. Water Analysis: Water Analysis: ions; Water Analysis: low concentrations of common ions; Water Analysis: trace pollutants part 1,2.
   
   Part III. Atmosphere: The Atmospheric chemistry; Air Pollutants- General; Air Pollutants: Organic Type.
   
   Part IV. Atmospheric Analysis: Atmospheric analysis: Gases 1; Atmospheric analysis: Gases 2; Atmospheric analysis: Particulates.
   
   Part V. Soil: Soil formation; Soil properties.
   
   Part VI. Soil Analysis: Analysis of soils, sediments and biological specimens.
   
   Part VII. Toxicology: Toxicological Chemistry; Toxicology: Organic Compounds; Hazardous wastes: Reactions; Waste reduction and minimization-physical methods of treatment of hazardous-wastes; Chemical treatment of hazardous wastes.
   
   Learning Outcomes: On successful completion of the course the student will be able to:
   
   i. Exhibit acquaintance of chemical principles of different fundamental environmental phenomena and processes in air, water, and sand.
   
   ii. Apply basic concepts of chemical thermodynamics, kinetics, and photochemistry to analyze chemical processes involved in different environmental problems.
   
   iii. Describe the impact of industrial processes, water purification, waste treatment, energy production, and pollution mitigation strategies.

   Suggested reading
   
   
   
   
   Lecture Handouts in digital format.

2. Utilization of plastic waste by pyrolysis (Zsuzsanna Czégény)

   Suggested reading
   

3. Going Green... environmentally sound printing (Csaba Horváth)

   Suggested reading
   
   
   Nsenga Thompson: Big impact, Green strategies for smaller printers, American Printer, April, 2010 18-20 p.
CMYK goes GREEN, Environmental compatibility in the printing process, Expressis Business, Issue 35, April 2008

4. Waste water purification technologies (Bodáné Kendrovics Rita)

5. Principles of hydrology (Emőke Bardóczy-Székely)

OTHERS

1. Experimental design (Ágota Drégelyi-Kiss)
   Suggested reading

2. Statistical hypothesis testing (Márta Takács)

3. Engineering education (Péter Tóth)