SUBJECTS

Last modification by the Doctoral Council (No. 86, December 18, 2023)

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 Károly, 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 Balázsi)
15. The impact of the Industry 4.0 to the manufacturing technology (Balázs Mikó)
16. Modelling of Technical Systems (László Pokorádi)
17. Modelling of Maintenance processes (László Pokorádi)
18. Nuclear Reactor Materials (Zoltán Hózer)
19. Fundamentals of materials science (Mária Berkes Maros)

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 Károly 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. Finite element modelling of heat transfer (Sándor Borza)
9. Fracture mechanics (Tünde Kovács)
10. Impairment of structural materials (Tünde Kovács)
11. Electrochemical methods of the measurement of corrosion and inhibition (Abdul Ibdewi Shaban)
12. Finite element modelling of materials technologies (Viktor Gonda)
13. Measurement of bioelectrical activities (Gergely Márton)
14. Chemical sensors: methods and applications (Abdul Ibdewi Shaban)
15. BioMEMS: miniature bionsensors (Zoltán Fekete)
16. Optical characterization of thin layers (Péter Petrik)
17. Transmission electron microscopy for structural investigations of different materials (Katalin Balázsi)

18. Numerical methods for the evaluation of optical measurements (Péter Petrik)
19. Advanced surface testing techniques (Maria Berkes Maros)
20. Numerical modeling and simulation of heat and mass transfer problems in material science (András Zachár)

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)
18. Investigation of plastics and plastic composites (Andrea Ádám Major)
19. Structure of polymers (Andrea Ádám Major)
20. Fiber chemistry (Tünde Tóth)
21. Protein based sheet systems (Tünde Tóth)
22. Engineering polymers (Maria Berkes Maros)

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)
6. BioMEMS: miniature bionsensors (Zoltán Fekete)
7. Biomaterials for medical applications (Csaba Balázsi)
8. Engineering ceramics (Maria Berkes Maros)

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. Welding technologies 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)
13. Electrodeposition of metals (László Péter)

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 (Zsolt József Horváth)
6. „Band gap engineering" (efficiancy of solar batteries) (Ákos Nemcsics)
7. Self organizing low-dimensional structures (Ákos Nemcsics)
8. Nanotechnology – chemical materials science (Éva Kiss)
9. Medicinal application of colloidal systems (Gergő Gyulai)
10. Surface characterization and modification of polymeric materials (Éva Kiss)
11. Application of microcapsules in the modern industry (Judit Telegdi)
12. Polymers in microtechnology (Andrea Csikós Pap)
13. Adhesive-free Wafer Bonding (Andrea Csikós Pap)
14. Elements and compunds in micro-scale gas sensors (Andrea Csikós Pap)
15. Molecular-beam epitaxy of III-V semiconductor materials (Ákos Nemcsics)
16. Technology and application of polymer based bionic interfaces (Zoltán Fekete)
17. BioMEMS: miniature biosensors (Fekete Zoltán)
18. Chemical sensors: methods and applications (Shaban Ibdewi Abdul)
21. Supramolecular and coordination complexes and polymers (Sándor Pekker, Éva Kováts)
22. Optical characterization of thin layers (Péter Petrik)
23. 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 (Rita Boda Kendrovics)
5. Principles of hydrology (Emőke Bardóczy Székely)
6. Hidrobiology (Rita Boda Kendrovics)

OTHERS

1. Experimental design (Ágota Drégelyi-Kiss)
2. Statistical hypothesis testing (Márta Takács)
3. Engineering education (Péter Tóth)
4. Scientific paper writing (Tünde Kovács) (3 credits)

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

Somorjai, G. A.: Introduction to Surface Chemistry and Catalysis, Wiley1994
Gregg, S. J., Sing K. S. W.: Adsortion, Surface Area and Porosity, Academic 1982
Christmann, K: Introduction to Surface Physical Chemistry, Springer – Steinkopf 1991
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
Schüth F, Sing K, Weitkamp J: Handbook of Porous Solids. Wiley, 2002

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
Prerequisities of the course: -
Content: Introduction to chemical materials science: relation between structure and macroscopic properties. Nanotechnology, preparation and functionalization of nanomaterials, nanoparticles; characteristic properties and application of quantum dots; colloidal drug carrier systems, their function, materials and main types. Formation of self-assembly monolayers, their structure and function, pattern formation by SPM. Preparation of nanolayers, Langmuir-Blodgett films, lithographic techniques for pattern formation. Preparation of nanostructured materials – bottom up and top down approaches. Photonic materials. Magnetic properties, classification of materials, ferro- and ferrimagnetic materials and special properties. Electric conductivity, classification of materials, semiconductors and microelectronic devices, molecular electronics.

Suggested reading

R. W. Cahn: The coming of materials science, Pergamon, Amsterdam,
W. D. Callister: Materials Science and Engineering, An Introduction, Wiley,
W.F. Smith: Principles of Materials Science and Engineering, McGraw-Hill Publ.

4. Principles of radiation chemistry (László Wojnárovits)

Suggested reading

Woods, R.J., Pikaev, A. K., 1994. Applied Radiation Chemistry. Radiation Processing. Wiley and Sons, New York.
Spinks, J.W.T., Woods, R.J., 1990. An Introduction to Radiation Chemistry. Wiley-Interscience, New York.
Haji-Saeid, M., “Radiation Processing: Environmental Applications”, International Atomic Energy Agency, Vienna (2007).

5. Solid-state chemistry (András Stirling)

6. Chemistry of colour (András Víg)

Suggested reading

Heinrich Zollinger: Colour Chemistry; Synthesis, Properties and Applications of Organic Dyes and Pigments, Third revised edition Wiley-VCH, New York, Basel, Cambridge,2011

J. Shore ed.: Cellulosics dyeing. Society of Dyers and Colourists, Manchester, 1995.

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

Suggested reading

Fridman, A.: Plasma Chemistry, Cambridge University Press, New York, 2008

Fridman, A., Kennedy, L.A.: Plasma Physics and Engineering, Taylor & Francis Routledge, New York, 2004

8. Fracture mechanics (Tünde Kovács)

Suggested reading

Bahram Farahmand, Ph.D*:* Fracture Mechanics of Metals, Composites, Welds, and Bolted Joints *Application of LEFM, EPFM, and FMDM Theory,* Kluwer Academic Publishers, 2001.

Kenneth A. Macdonald: Fracture and fatigue of welded joints and structures, Woodhead Publishing Limited, 2011.

P.J.G. Schreurs: Fracture Mechanics, Eindhoven University of Technology Department of Mechanical Engineering Materials Technology September 6, 2012

9. Impairment of structural materials (Tünde Kovács)

Suggested reading

Corrosion: Fundamentals, Testing, and Protection Volume 13A of the ASM Handbook, Vol 13a. 2003.

B. Bhushan: Introduction to Tribology, 2nd Edition March 2013, A John Wiley & Sons, Ltd., Publication

G.E. Totten, Hong Liang: Surface Modification and Mechanisms: Friction, Stress, and Reaction Engineering, CRC Press

G. E Totten: Steel heat treatment Handbook, Marcel Dekker, 2004

Mechanical Testing and Evaluation, ASM Handbook Volume 8, 2000.

10. Manufacturing process planning (Balázs Mikó)

Suggested reading

Serope Kilpakjian; Steven R. Schmid : Manufacturing Engineering and Technology, SI Edition (7e); Pearsons 2013 ISBN 978-981-06-9406-7

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.

Content: The MARC work environment. Solving an elastic problem. Setting up plasticity: yield condition, and material model. Modeling upsetting and extrusion. Solutions for sheet metal forming problems. Thermal model and boundary conditions. Construction of a coupled thermo-mechanical problem. Mesh refinement, and automatic re-mesh. Importing a CAD geometry. Automatic parameter analysis with macros.

Suggested reading MARC documentation; Henry S. Valberg: Applied metal forming, Cambridge University Press, 2010.

12. Principles of advanced ceramic materials (Szilvia Klébert)

Suggested reading

Chavarria J.: Kerámia. Novella, Budapest, 1996.
Brook R.J.: Concise encyclopedia of advanced ceramic materials. Pergamon, Oxford, 1991.
Alper A.M.: Phase diagrams in advanced ceramics. Academic Press, London, 1994.
Terpstra R. A., Pex P.A.C., DeVries. A.H.: Ceramic processing. Chapman and Hall, London, 1995.
Segal D.: Chemical synthesis of advanced ceramic materials. Cambridge University Press, Cambridge, 1989.
Bouell D.A., Tien T.Y.: Preparation and properties of silicon nitride based materials. Trans Tech Publications, Zürich, 1989.
Cranner , D.C. , Richerson D.W.: Mechanical testing methodology for ceramic design and reliability. Marcel Dekker, New York, 1998.
Chawla K.K.: Ceramic matrix composites. Chapman and Hall, London, 1993.
Mileiko S.T.: Metal and ceramic based composites. Elsevier, Amsterdam, 1997.

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

G. Rothenberg: *Catalysis, Concepts and Green Applications*, WILEY-VCH Verlag Gmbh & Co. KGaA, Weinheim, 2008.

L. Lloyd: *Handbook of Industrial Catalysts*, Springer, 2011.

A.J. Bard & L. Faulkner: *Electrochemical Methods: Fundamentals and Applications*, Wiley, 2000.

D. Eremin, V. P. Ananikov: Understanding active species in catalytic transformations: From molecular catalysis to nanoparticles, leaching, ‘‘Cocktails” of catalysts and dynamic systems, *Coord. Chem. Rev.* 346 (2017) 2-19.

14. Biomaterials for medical applications (Csaba Balázsi)

Aim of the course: Presentation of ceramic, glass and polymer techology 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

Prerequisities: ---

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

Prerequisities: ---

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:

Andrew Kusiak (2018) Smart manufacturing, International Journal of Production Research, 56:1-2, 508-517, DOI: 10.1080/00207543.2017.1351644

Industry 4.0 Study for the ITRE Commettee; European Parlament (2016) IP/A/ITRE/2015-02 PE 570.007

Deloitte Consulting Group (2015) Induetry 4.0 - Challenges and solutions for the digital transformation and use of exponential technologies.

Jim Davis et al. (2015) CMTC's Guide To Smart Manufacturing. California Manufacturing Technology Consulting

Michael Rüßmann et al. (2015) Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries. Boston Consulting Group www.bcg.com

J. Enke et al. (2018) Industrie 4.0 - Competencies for a modern production system. Procedia Manufacturing 23 267-272

Chao Liu et al.(2018) A systematic development method for cyber-physical machine tools. Manufacturing Systems 48(C) 13-24

C.O. Klingenberg; J.A.d Vale Antunes (2017) Industry 4.0: what makes it a revolution? EurOMA 2017

Marina Crnjac; Ivica Veža; Nikola Banduka (2017) From Concept to the Introduction of Industry 4.0. International Journal of Industrial Engineering and Management (IJIEM) 8(1)21-30

16. Modelling of technical systems (László Pokorádi)

Theoretical background of system emgineering, modelling of technical systems. Clasiffication 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:

Heinz, Mathematical Modeling, Springer Heidelberg Dordrecht London New York, 2011.

17. Modelling of maintenance processes (László Pokorádi)

Theoretical background of maintemance management. Strategies of maintenance. Clafisications of failures. Aging theory. Application of theory of Markov-processes ti 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; Creep; Fracture mechanics

19. Fundamentals of materials science (Maria Berkes Maros)

Aim of the course:

Providing doctoral students with different material science backgrounds with a solid and unified theoretical basis on the structure/property/performance relationships of metallic and nonmetallic materials used in engineering practice, their material-specific mechanical behaviour, and the most important directions of material development, with particular focus on meeting the ever-increasing functional and technological requirements.

Total number of contact hours: 30

Prerequisites: ---

Content: General characterisation of groups of materials, the influence of nano-, micro- and macrostructure of materials and state factors. Structural characterisation of ideal and real crystalline materials. The theoretical background of elastic and plastic deformation, the role of dislocations in deformation. Transport phenomena, diffusion. Type of interfaces and their role in phase transformation. Equilibrium and non-equilibrium crystallisation of Fe-C alloys, characteristic microstructures. Mechanical behaviour and strengthening methods of single and multiphase metallic materials. Advanced high-strength steels and aluminium alloys. Properties of engineering ceramics, methods of toughening. Visco-elasticity of polymers and consequences for mechanical behaviour. The most important mechanical tests of brittle, ductile and viscoelastic materials.

Suggested reading:

Tisza, M.: Physical Metallurgy, ASM International Publisher, Ohio Park, USA, 2001.

Callister*, W. D.: Materials Science and Engineering, an introduction, 7th Ed. John Wiley, New York, 1994, pp1-975. ISBN:13-978-0-471-73696-7*

Porter, D. A., Easterling, K. E., Sherif, M. Y.: Phase Transformation in Metals and Alloys, 4th edition, CRC Press 2022, ISBN-13 978-0367430344, p556.

Ashby, M.F, Jones, D.R.H.: Engineering Materials 1 – An introduction to Microstructures, Processing and Design, 3rd ed., Elsevier Butterwoth-Heinemann, Oxford, 2006. ISBN 0 7506 63804

Ashby, M.F, Jones, D.R.H.: Engineering Materials 2 – An introduction to properties, Applications and Design, 3rd ed., Elsevier Butterwoth-Heinemann, Oxford, 2006. ISBN-13 978-0-7506-6381-6

Tisza, M.: Development of Lightweight Steels for Automotive Applications, doi: 10.5772/intechopen.91024

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

Daniel C. Harris: Quantitative Chemical Analysis, W.H. Freeman and Company, New York, 2007

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

Suggested reading

Brümmer, O., Heydenreich, J., Krebs, K. H., Schneider, H. G. (szerk.): Szilárdtestek vizsgálata elektronokkal, ionokkal és röntgensugárzással, Műszaki Könyvkiadó, Budapest, 1984.

Gregg, S.J., Sing, K.S.W.: Adsorption, Surface Area and Porosity. Academic Press, 1982.

Rouquerol, F., Rouquerol, J., Sing K.: Adsorption by Powders and Porous Solids. Academic Press, 1999.

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

Lakowitz: Principles of fluorescence spectroscopy, Springer, 2006

5. Advanced mass spectrometry (Sándor Kéki)

ESI, APCI, APPI. 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

Stout, Sullivan, Dong, Mainsah, Luo, Mathia, Zahouni: The development of methods for characterisation of roughness in three dimensions, Printing Section, University of Birmingham Edgbuston, Birmingham (1993)

D.J Whitehouse: Handbook of surface metrology, Inside of Phisics Publ., Bristol (1994)

Tom R. Thomas: Rough Surface, Imperial Collage Press, London (1998)

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

Suggested reading

Adrian Benjan, Heat Transfer, John Wiley and Sones, -1993, ISBN 0-471-50290-1, ANSYS

9. Fracture mechanics (Tünde Kovács)

Suggested reading

Bahram Farahmand, Ph.D*:* Fracture Mechanics of Metals, Composites, Welds, and Bolted Joints *Application of LEFM, EPFM, and FMDM Theory,* Kluwer Academic Publishers, 2001.

Kenneth A. Macdonald: Fracture and fatigue of welded joints and structures, Woodhead Publishing Limited, 2011.

P.J.G. Schreurs: Fracture Mechanics, Eindhoven University of Technology Department of Mechanical Engineering Materials Technology September 6, 2012

10. Impairment of structural materials (Tünde Kovács)

Suggested reading

Corrosion: Fundamentals, Testing, and Protection Volume 13A of the ASM Handbook, Vol 13a. 2003.

B. Bhushan: Introduction to Tribology, 2nd Edition March 2013, A John Wiley & Sons, Ltd., Publication

G.E. Totten, Hong Liang: Surface Modification and Mechanisms: Friction, Stress, and Reaction Engineering, CRC Press

G. E Totten: Steel heat treatment Handbook, Marcel Dekker, 2004

Mechanical Testing and Evaluation, ASM Handbook Volume 8, 2000.

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

Aim of the cours: 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

ASM Handbook, Volume 13A - Corrosion: Fundamentals, Testing, and Protection, ISBN 978-0-87170-705-5DC Electrochemical Test Methods, N.G. Thompson and J.H. Payer, NACE, ISBN: 1-877914-63-0. Principles and Prevention of Corrosion, Denny A. Jones, Prentice-Hall, Upper Saddle River, NJ, ISBN 0-13-359993-0.

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

Corrosion and Corrosion Control, 3rd. Ed., Herbert H. Uhlig, John Wiley and Sons, New York, 1985.

12. 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: -

Content: The MARC work environment. Solving an elastic problem. Setting up plasticity: yield condition, and material model. Modeling upsetting and extrusion. Solutions for sheet metal forming problems. Thermal model and boundary conditions. Construction of a coupled thermo-mechanical problem. Mesh refinement, and automatic re-mesh. Importing a CAD geometry. Automatic parameter analysis with macros.

Suggested reading

MARC documentation;

Henry S. Valberg: Applied metal forming, Cambridge University Press, 2010.

13. Measurement of bioelectrical activities (Gergely Márton)

Suggested reading

Ramesh Srinivasan: Anatomical constraints on source models for high-resolution EEG and MEG derived from MRI (Technol Cancer Res Treat. 2006 Aug; 5(4): 389–399.)

Pouria Fattahi, Guang Yang, Gloria Kim, Mohammad Reza Abidian: A Review of Organic and Inorganic Biomaterials for Neural Interfaces (Adv Mater. 2014 Mar 26; 26(12): 1846–1885.)

Pour Aryan, Naser, Kaim, Hans, Rothermel, Albrecht: Stimulation and Recording Electrodes for Neural Prostheses (2015, book).

Amelia A. Schendel, Kevin W. Eliceiri, Justin C. Williams: Advanced Materials for Neural Surface Electrodes. Curr Opin Solid State Mater Sci. 2014 Dec 1; 18(6): 301–307.

Gergely Márton: Development and Characterization of novel microelectrode arrays for neurophysiology (Ph.D. dissertation, 2015)

14. 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

W. Gopel, J. Hesse, J. N. Zemel , Chemical and Biochemical Sensors, in: Trends in Sensor Markets (Vol. Eds: W. Gopel, T. A. Jones t, M. Kleitz, I. Lundstrom, T. Seiyama), Part 1/11, Vol. 2/3, Weinheim New York (1995).

Dorothee Grieshaber, Robert MacKenzie, Janos Vőrös, Electrochemical Biosensors - Sensor Principles and Architectures, and Erik Reimhult, Sensors 2008, 8, 1400-1458

Danielle W. Kimmel, Gabriel LeBlanc, Mika E. Meschievitz, and David E. Cliffel, Electrochemical
Sensors and Biosensors, Anal. Chem., 84 (2012) 685-707, dx.doi.org/10.1021/ac202878q | Anal. Chem. 2012, 84, 685–707.

15. BioMEMS: miniature bionsensors (Zoltán Fekete)

Suggested reading

Lab-on-a-Chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis, szerk.: R. Edwin Oosterbroek és Albert van den Berg, ISBN: 978-0-444-51100-3.

16. Optical characterization of thin layers (Péter Petrik)

Aim of the course: Learning the mathematical description of polarized light, the measurement methods based mainly on the measurement of the polarization of light and interpretation of the measured quantities, and the light-matter interaction as well as the material properties based on this.

Suggested reading

Azzam Bashara: Ellipsometry and polarized light

E. Irene, H. Tompkins: Handbook of ellipsometry

M. Losurdo, K. Hingerl: Ellipsometry at the nanoscale

17. Transmission electron microscopy for structural investigations of different materials (Katalin Balázsi)

Aim of the course: The understanding of modern-day electron-beam instruments for the analyses of solid materials, mainly the transmission electron microscope (TEM)

Total number of hours: 30 hours

Prerequisities of the course: ---

Content: The using of TEM will be discussed in detail though practical applications in study of different materials, for example, thin films, powders, ceramics or metals; all possibilities of TEM study (bright field or dark field imaging, scanning mode of TEM) using the transmission electron microscopy CM-20 with accelerating voltage 200kV, high resolution TEM Jeol 3010 with EELS elemental mapping and novel Cs corrected TEM/STEM Themis with 4 EDS detectors. Two different preparation techniques of TEM samples and lamellas will be
showed by SEM/FIB and ion milling techniques.

Suggested reading

M. Rühle and M. Wilkens Transmission Electron Microscopy, , Ed. Cahn and Haasen, Elsevier Pbl, 1983

18. Numerical methods for the evaluation of optical measurements

Aim of the course:

Total number of hours: 30 hours

Prerequisities of the course: Physics

Content: Description of polarization and propagation of light; Reflection and transmission of light at interfaces and thin films; Software tools for the analysis of optical measurements; Programming languages for optical analysis; Models for homogeneous materials and interfaces; Optical measurement methods for surfaces and thin films; Methods of thin film preparation; Parameterization of the optical dispersion; Minimization of multi-parameter models; Benchmarking of different numerical approaches

Suggested reading

H.G. Tompkins, J.N. Hilfiker, Spectroscopic ellipsometry: practical application to thin film characterization, Momentum Press, New York, NY, 2016.

P. Petrik, Parameterization of the dielectric function of semiconductor nanocrystals, Physica B: Condensed Matter. 453 (2014) 2–7. https://doi.org/10.1016/j.physb.2014.03.065.

Poole Jr, C. P., & Owens, F. J. (2003). Introduction to nanotechnology. John Wiley & Sons.

Fried, T. Lohner, P. Petrik; Chapter 6 "Ellipsometric Characterization of Thin Films" in vol. 4 of Handbook of Surfaces and Interfaces of Materials: "Solid Thin Films and Layers", ed. H. S. Nalwa, 2001, Academic Press, San Diego, pp. 335-367

19. Advanced Surface Testing Techniques (Maria Berkes Maros)

Aim of the course: This course aims to familiarise students with the state-of-the-art methods of materials testing used for characterizing the physical, mechanical, tribological, structural, and topographical features of surfaces and surface layers or thin films of engineering structures, with particular emphasis on the performance of engineering surfaces subjected to tribological loadings.

Total number of contact hours: 30

Prerequisites: ---

Content: The purpose, methods, and applications of surface testing. Theoretical and experimental investigation of damage to gradient and heterogeneous surfaces, complex tribological characterization of surface layers and coatings. Surface physics aspects of tribological damage (atomistic approach to surface tension, adhesion, friction, and wear). Methods and tools for investigations of surface micro-geometry and topography (2D and 3D profilometry). Testing of the surface mechanical properties at the micro- and nano-level (scratch test, hardness testing, micro- and nanotribological testing, Calotest). Microstructural characterization of surface layers and coatings at different levels of length scale (e.g. optical, SEM, TEM, AFM, XRD, EDX, Raman spectroscopy). Engineering applications: testing of thin films, diffusion and coating layers, micro- and nanocomposites, MEMS/NEMS devices, magnetic storage systems, etc.

Suggested reading:

B. BHUSHAN: Modern Tribology Handbook, Volume One, CRC Press, ISBN0-8493-8403-6, 2001. p1760
O'CONNOR, D. J., SEXTON, B. A.: Surface Analysis Methods in Materials Science, Springer, 2003. pp 1-585
D. DOWSON: Experimental methods in tribology, Tribology series 44. Elsevier 2004. ISBN: 0 444 51589 5
VICKERMAN, J.C., GILMORE, I.: Surface Analysis: The Principal Techniques, 2nd Ed. Wiley, 2009.p 686
WATTS, J. F., WOLSTENHOLME, J.: An Introduction to Surface Analysis by XPS and AES, John Wiley & Sons, 2003, pp 1-212.
PAKSERESHT, A., SHARIFAHMADIAN, O.: Handbook of Research on Tribology in Coatings and Surface Treatment, IGI Publishing, (2022) p.470. ISBN13: 9781799896838, DOI: 10.4018/978-1-7998-9683-8

20. Numerical modeling and simulation of heat and mass transfer problems in material science (András Zachár)

Aim of the course: Presenting such basic knowledge that the students efficiently apply the tools of computational fluid dynamics to such problems that arising in the area of material science and engineering and somehow connected to heat and mass transfer processes and thermo-hydraulics.

Total number of contact hours: 30 = 15 hours lecture (theoretical material) + 15 hours labor practice (Ansys-CFX laboratory)

Prerequisites: Basic knowledge of mathematical, physical and heat and fluid flow sciences taught in university courses of engineering.
Content:
Lecture (theoretical): The course topic gives the students an introductory knowledge in the area of heat and fluid flow and transport what can be used to solve such problems connected to the material science and engineering. Students learn different modeling techniques what makes possible to work out such mathematical and numerical models can be solved by advanced numerical simulation software. With these techniques students can investigate such manufacturing and technology processes connected to material science.
Laboratory courses (Ansys-CFX)
The students learn in the laboratory courses an introductory knowledge of Ansys-CFX CFD software what can be used to solve complex heat and mass transport problems all of the area of engineering science. The course topic gives the student the basic knowledge of geometry drawing or import from 3D modeling software and geometry post processing, numerical grid generation techniques, specifying the physics of the investigated problem via the specification of the initial and boundary conditions and post processing the results. Case study problems will be presented from the first step (geometry and problem definition) to the result evaluation (post processing).
Suggested reading:
H. K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics, The Finite Volume Method, Pearson Prentice Hall, London, New York, 2007.
Suhas Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis, 1980.
Ansys_CFX-Pre_Users_Guide

SUBJECTS IN SPECIFIC AREAS OF MATERIALS SCIENCES

c) Polymers

1. Polymer chemistry and physics (Sándor Pekker)

2. Physics of macromolecules (Károly Belina)

Suggested reading
F. W. Billmeyer Jr.: Textbook of Polymer Science, 3rd ed., Interscience, New York, 1984.
J. A. Manson, L.H. Sperling: Polymer Blends and Composites, Plenum, New York, 1976
L. R. G. Treloar: The Physics of Rubber Elasticity, 3rd. ed., Clarendon Press, Oxford, 1975
B. Wunderlich: Macromolecular Physics, Vol I-III. Academic Press, Orlando, 1973

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
Prerequisities of the course: -
Content: Physico-chemical interactions between solid and liquid phases. Interfacial phenomena in polymer-containing systems. Basic principles of wettability and adsorption, models describing the phenomena and kinetics of the processes. Instrumental methods for the determination of surface chemical composition: modern surface sensitive techniques (ESCA, SIMS, FT-IR), high-performance imaging techniques (AFM, STM). Indirect methods for the investigation of interfacial interactions: wettability, direct force measurement, particle adhesion, colloid stability, adsorption of macromolecules, formation of self-assembly monolayer or Langmuir-Blodgett film. Surface modification of polymers by “wet” and plasma techniques.
Suggested reading:
D.J.Shaw: Bevezetés a kolloid- és felületi kémiába, Műszaki Könyvkiadó, Budapest, 1986. J. Andrade: Surface and Interfacial Aspects of Biomedical Materials, Plenum Press, N.Y. 1985. F. McRitchie: ChemistryatInterfaces, Acad. Press, London, 1990.

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

Suggested reading

Peter Ulvkov (ed): Plant Polysaccharides, Biosynthesis and Bioengineering. Blackwell Publishing Ltd, UK, 2011

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

Prerequisities 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 mostimportant 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

Lewin, M., Pearce, E. M. (Eds.): Handbook of Fiber Chemistry, Third Edition, Marcel Dekker, New York, 2007.
Klemm, D, Philipp, B., Heinze, T., Heinze, U., Wagenknecht, W.: Comprehensive cellulose chemistry, Wiley-VCH, Weinheim, 1998.
Franck, R. R. (Ed.): Plast and other plant fibres, Woodhead Publishing Ltd, Cambridge, 2005.
Woodings, C. (Ed.): Regenerated Cellulose Fibres, Woodhead Publishing Ltd, Cambridge, 2001.
Morton, W. E., Hearle, J. W. S.: Physical Properties of Textile Fibres, Third Edition, The Textile Institute, Menchester, 1997.
Pastore, Ch. M., Kiekens, P. (Eds): Surface characteristics of fibres and textiles, Marcel Dekker, New York, 2001.
Raheel, M. (Ed.): Modern Textile Characterization Methods, Marcell Dekker, 1996.

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

Suggested readings

Carrasco, F.; Mutje, P.; Pelach, M. A..;(1996): Refining of bleached cellulosic pulps: characterizationapplication of the colloidal titration technique, Wood Science and Technology, 1996/30, pp. 227-236
Kaewprasit, C.; Hequet, E.; Abidi, N.; and Gourlot J.P.(1998): Application of Methylene Blue Adsorption to Cotton Fiber Specific Surface Area Measurement Part I. Methodology, Journal of Cotton Science, 1998/2, pp.164-173
Kagan, B.;Kliger,G.A. (1965): The cellulose for paper making to a moisture content 1965/34. p. 853.
Karlson, O.; Westermark, U. (1996): Evidence for Chemical Between Lignin and Cellulose in Kraft Pulps, Pulp and Paper , 22/10. pp. 397-400.
Thode, E. F.: (1950): Influence of surface properties of fibers on papermaking, in Paper Mill News; 73/5. p. 12-14.

7. Cellulose and paper technology (László Koltai)

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

Suggested reading

Markström, H.(2005): Testing Methods and Instruments for Corrugated Board, Lorentzen and Wettre, Kista, Sweden,
Twede D. and Selke S.E.M. (2005): Cartons,Crates and Corrugated Board – Handbook of Paper and Wood Packaging Technology, DEStech Publication Inc.
How much new paper can the market absorb?, International Paperworld, 2003(4):pp.18-22

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

Suggested reading

H. Kipphan: Handbook of Print Media, Springer, Berlin, 2000
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

Prerequisities 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

McIntyre, J. E. (Ed.): Synthetic fibres: nylon, polyester, acrylic, polyolefin, Woodhead Publishing Ltd, Cambridge, 2005.

Lewin, M. (Ed): Handbook of Fiber Chemistry, CRC London, 2007

Hearle, J. W. S. (Ed.): High-performance fibres, Woodhead Publishing Ltd, Cambridge, 2005.

Horrocks, A. R., Anand, S. C. (Eds): Handbook of technical textiles, Woodhead Publishing Ltd, Cambridge, 2000.

Mallick, P. K.: Fiber-reinforced composites, CRC Press, 2008.

Morton, W.E., Hearle, J. W. S.: Physical Properties of Textile Fibres, Third Edition, The Textile Institute, Menchester, 1997.

Pastore, Ch. M., Kiekens, P. (Eds): Surface characteristics of fibres and textiles, Marcel Dekker, New York, 2001.

Raheel, M. (Ed.): Modern Textile Characterization Methods, Marcell Dekker, 1996.

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

Suggested reading

Woods, R.J., Pikaev, A.K., 1994. Applied Radiation Chemistry. Radiation Processing. Wiley and Sons, New York.

Spinks, J.W.T., Woods, R.J., 1990. An Introduction to Radiation Chemistry. Wiley-Interscience, New York.

Haji-Saeid, M., “Radiation Processing: Environmental Applications”, International Atomic Energy Agency, Vienna (2007).

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

Suggested reading

Petra Knecht: Funktionstextilien, Deutscher Fachverlag, ISBN: 3-87150-833-0,

R.-D. Reumann(Hrsg): Prüfverfahren in der textil-und Bekleidungstechnik

Fabric testing, Edited by J Hu, Hong Kong Polytechnic University, Hong Kong, Woodhead Publishing Series in Textiles No. 76

Karl Mahall: Quality Assesment of Textiles, Springer, ISBN 3-540-44072-0

13. Characteristics of antimicrobial textiles (Hosam Hamuda Bayoumi)

Suggested reading

Chen Enzan, Su Haijia, Zhang Wanying, Tan Tianwei (2011): A novel shape-controlled synthesis of dispersed silver nanoparticles by combined bioaffinity adsorption and TiO2 photocatalysis. Powder Technology, 212: 166-172.

Dang Viet Quang, Pradip B. Sarawade, Askwar Hilonga, Jong-Kil Kim, Young Gyu Chai, Sang Hoon Kim, Jae-Yong Ryu, Hee Taik Kim (2011): Preparation of amino functionalized silica micro beads by dry method for supporting silver nanoparticles with antibacterial properties. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 389: 118-126.

Fu-Chu Yang, Kuo-Hui Wu, Ming-Jie Liu, Wen-Po Lin, Ming-Kuan Hu (2009): Evaluation of the antibacterial efficacy of bamboo charcoal/silver biological protective material. Materials Chemistry and Physics, 113: 474-479.

Lischer S., Körner E., Balazs D.J., Shen D., Wick P., Grieder K., Haas D., Heuberger M., Dirk H. (2011): Antibacterial burst-release from minimal Ag-containing plasma polymer coatings. J. R. Soc. Interface, 8:1019-1030

Mohan Murali Y., Vimala K., Thomas Varsha, Varaprasad K., Sreedhar B., Bajpai K.S., Raju K. Mohana (2010): Controlling of silver nanoparticles structure by hydrogel networks. Journal of Colloid and Interface Science, 342: 73-82.
Sangphil Park, P.S. Keshava Murthy, Saemi Park, Y. Murali Mohan, Won-Gun Koh (2011): Preparation of silver nanoparticle-containing semi-interpenetrating network hydrogels composed of pluronic and poly(acrylamide) with antibacterial property. Journal of Industrial and Engineering Chemistry, 17: 293-297.
Sharma K. Virender, Yngard A. Ria, Lin Yekaterina (2009): Silver nanoparticles: Green synthesis and their antimicrobial activities. Review Article, Advances in Colloid and Interface Science, 145: 83-96.
Sheikh N., Akhavan A., Kassaee Z.M. (2009): Synthesis of antibacterial silver nanoparticles by γ-irradiation. Physica E: Low-dimensional Systems and Nanostructures, 42: 132-135.

14. Polymers in microtechnology (Andrea Csikós Pap)

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

Suggested reading

Hassler, C., Boretius, T. and Stieglitz, T. (2011), Polymers for neural implants. J. Polym. Sci. B Polym. Phys., 49: 18–33. doi:10.1002/polb.22169

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

Suggested reading

Jonathan W. Steed – David R. Turner – Karl J. Wallace: Core Concepts in Supramolecular Chemistry and Nanochemistry, John Wiley and Sons Ltd., Sussex, England, 2007.
Makoto Fujita, Ed.: Molecular Self-Assembly Organic Versus Inorganic Approaches, Springer Verlag, Berlin, 2000.
Helena Dodziuk: Introduction to Supramolecular Chemistry, Kluwer Academic Publishers, New York, 2002.

17. Biomaterials for medical applications (Csaba Balázsi)

Aim of the course: Presentation of ceramic, glass and polymer techology 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
Prerequisities: ---
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

18. Investigation of plastics and plastic composites (Andrea Ádám Major)

Aim of the course: Students will be introduced to the test methods of plastics and plastic-based composites.
Number of contact hours: 30
Prerequisities: ---
Content: Types of test methods of plastics. Reasons for testing. Preparatory operations. Source and condition of test pieces. Test conditions. Limitations of results. Sampling. Standards. Test piece preparation. Conditioning. Mass, density and dimensions. Mechanical testing methods of plastics. Hardness. Tensile Stress-Strain. Compression Stress-Strain. Shear Properties. Charpy Impact Strength. Fracture Toughness. Structural testing of plastics. Scanning Electron microscopy Method (SEM). Flow properties of plastics. Melt Flow Rate, Melt Flow Index (MFR, MFI, MVR). Thermal properties of plastics. Differential Scanning Calorimetry (DSC), crystallization and melting properties of plastics.

Suggested reading:
Roger Brown: Handbook of Polymer Testing Handbook of Polymer Testing,
https://www.academia.edu/33220313/Handbook_of_Polymer_Testing_Handbook_of_Polymer_Testing

19. Structure of polymers (Andrea Ádám Major)

Aim of the course: Students will be introduced to the structure of polymers, the relationship between structure and properties of polymers.
Number of contact hours: 30
Prerequisities: ---
Content: Size, spatial structure, polymolecularity of macromolecules. Configuration and conformation. Physical state, concept of physical state. Overview of physical states of polymers using thermomechanical curves. Polymer - based multicomponent systems. Characteristics determining the supermolecular structure and macroscopic behaviour of polymers. Molecular weight, molecular weight distribution, chain flexibility, segment motion. Intermolecular interactions of macromolecules, cross linked polymers, cross linked types. Characteristics of relaxation. Mechanical relaxation on polymers. Amorphous polymers are glassy and viscous liquids. Crystalline state of polymers, supermolecular structure. Morphology of crystalline polymers. Mechanism and kinetics of crystallization. Rheology of plastics. Rheological responses: ideal cases and deviations from it, realistic cases. Interpretation of viscosity and temperature dependence. Viscoelastic behaviour of polymers.
Suggested reading:
David I. Bower: An Introduction to Polymer Physics, Cambridge University Press, 2002.
M. Rubinstein, R.H. Colby: Polymer Physics, Oxford Univ. Press, 2003. ISBN: 9780198520597
M. Doi: Introduction to Polymer Physics, Calendron Press, Oxford, 1996

20. Fiber chemistry (Tünde Tóth)

Aim of the course: Presentation of natural and man made fibers, their manufacture and properties.
Number of contact hours: 30
Prerequisities: ---
Content: Types of fiber-forming polymers, characterization, structure. Functional groups, bonds. Chemical and physical properties of macromolecules. Manufacture and modification of fiber properties regarding the application.
Suggested reading:
Lewin, M., Pearce, E. M. (Eds.): Handbook of Fiber Chemistry, Third Edition, Marcel Dekker, New York, 2007.

21. Protein based sheet systems (Tünde Tóth)

Aim of the course: Presentation of manufacture and properties of protein based sheet systems.
Number of contact hours: 30
Prerequisities: ---
Content: Chemical composition and structure of proteins. Protein based fibers (silk, wool): production, morphology, structure models. Manufacture of sheets (fabrics), their properties and chemical modification.. Material science based methods for investigation of protein based textile materials.
Suggested reading:
Advances in Silk Science and Technology, Woodhead Publishing Series in Textiles, Ed: Arindam Basu, 2015
Scientific literature

22. Engineering polymers (Maria Berkes Maros)

Aim of the course:
The course aims to familiarise PhD students with the material-specific characteristics of engineering polymers, the advantages and limitations of their technical application, the characteristics of their mechanical behaviour compared to metals, and the most important mechanical characteristics. The course also aims to enable students to judge the specific user demands arising under different operating conditions, which can be met primarily by using polymer materials and selecting the appropriate engineering polymer.
Total number of contact hours: 30
Prerequisites: ---
Content: Micro-macro-scale structural characterization
of polymers. Structure/property/mechanical behaviour relationships for thermoplastic, thermosetting polymers, elastomers and liquid crystalline polymers. Concepts and types of homogeneous and heterogeneous polymer

structures. Material science background and peculiarities of the mechanical behaviour of polymers. Main mechanical models of viscoelastic materials. Rheology: visco-elasticity and time dependence. Short and long-term mechanical tests of polymers. Deformation, fracture and typical failure modes of polymers. Information content and determination of mechanical properties. Processing technologies. Typical applications of engineering polymers (PA, PE, PP, PP, PC, POM, ABS, polyimide, polysulphone, PVC, epoxies, phenols, amines, silicones, etc.), with particular reference to automotive applications. Polymer matrix composites, polymer fibre materials. Environmental protection, recycling.

Suggested reading:

FAKIROV, S.: Fundamentals of Polymer Science for Engineers, Wiley-VCH Verlag GmbH & Co. KGaA, ISBN: 978- 3-527341313 (Hardback) (2017) p.386, https://doi.org/10.1002/9783527802180.fmatter

MYER KUTZ: Applied Plastics Engineering Handbook, Processing and Materials, Elsevier, 2011, ISBN 978-1-4377-3514-7, p574, doi.org/10.1016/C2010-0-67336-6

MITTAL, V.: High Performance Polymers and Engineering Plastics, Wiley, ISBN: 978-1-118-01669-5 (2011) p.452.

GERDEEN, J. C., RORRER, R. A. L.: Engineering Design with Polymers and Composites, 2nd Ed., CRC Press, Taylor & Francis Group, ISBN 978-1-4398-6052-6 (Hardback) (2012) p. 306

ROSATO, D. V., DIMATTIA, D.P., ROSATO, D.V.: Designing with Plastics and Composites: A Handbook, Springer-Verlag New York Inc. ISBN 1461597250 (2013) P981.

YOUNG, R. J., LOVELL, P. A.: *Introduction to Polymers*, Second Edition, Chapman & Hall,1991, ISBN 0-412-30640-9, p.443

d) Ceramics

1. Principles of advanced ceramic materials (Szilvia Klébert)

Suggested reading

Chavarria J.: Kerámia. Novella, Budapest, 1996.

Brook R.J.: Concise encyclopedia of advanced ceramic materials. Pergamon, Oxford, 1991.

Alper A.M.: Phase diagrams in advanced ceramics. Academic Press, London, 1994.

Terpstra R. A., Pex P.A.C., DeVries. A.H.: Ceramic processing. Chapman and Hall, London, 1995.

Segal D.: Chemical synthesis of advanced ceramic materials. Cambridge University Press, Cambridge, 1989.

Bouell D.A., Tien T.Y.: Preparation and properties of silicon nitride based materials. Trans Tech Publications, Zürich, 1989.

Cranner , D.C. , Richerson D.W.: Mechanical testing methodology for ceramic design and reliability. Marcel Dekker, New York, 1998.

Chawla K.K.: Ceramic matrix composites. Chapman and Hall, London, 1993.

Mileiko S.T.: Metal and ceramic based composites. Elsevier, Amsterdam, 1997.

2. Technology of advanced ceramics (János Dusza)

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

Total number of hours: 30 hours

Prerequisities: --

Content: Description of the technological routes applied for the production/preparation of advanced ceramics as: powder syntesis/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:

D.W. Richerson, Modern Ceramic Engineering, Marcel Dekker Inc., 1982.

F. Riley, Structural Ceramics, Cambridge Univ. Press, 2006.

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

Prerequisities: --

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 electyron microscopy, focused ion beam milling, etc.

Suggested reading:

D.W. Richerson, Modern Ceramic Engineering, Marcel Dekker Inc., 1982.

F. Riley, Structural Ceramics, Cambridge Univ. Press, 2006.

Concise Encyclopedia of Advaned Ceramic Materials (Ed.R.J.Brook), Pergamon Press, Oxford, 1991.

J. Dusza, M. Steen. Fractography and Fracture Mechanics Property Assessment of Advanced Structural Ceramics. International Materials Reviews, 44, 1999, pp.165-216

J. Dusza, P. Šajgalik, Silicon nitride and alumina-based nanocomposites. In: Handbook of Nanoceramics and their Based Nanodevices. Ed. T.-Y. Tseng, H.S.Nalwa. Stevenson Ranch: American Sci.Publ. 2009, pp.253-283

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

Prerequisities: --

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

D.W. Richerson, Modern Ceramic Engineering, Marcel Dekker Inc., 1982.

F. Riley, Structural Ceramics, Cambridge Univ. Press, 2006.

Concise Encyclopedia of Advaned Ceramic Materials (Ed.R.J.Brook), Pergamon Press, Oxford, 1991.

J. Dusza, M. Steen. Fractography and Fracture Mechanics Property Assessment of Advanced Structural Ceramics. International Materials Reviews, 44, 1999, pp.165-216

J. Dusza, P. Šajgalik, Silicon nitride and alumina-based nanocomposites. In: Handbook of Nanoceramics and their Based Nanodevices. Ed. T.-Y. Tseng, H.S.Nalwa. Stevenson Ranch: American Sci.Publ. 2009, pp. 253-283

5. Powder technology (Csaba Balázsi)

Aim of the course: Presentation of powder techology 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

Prerequisities 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

Gopal Shankar Upadhyaya, Powder Metallurgy Technology, Cambridge International Science and Publishing, 2002

Anish Upadhyaya, Gopal Shankar Upadhyaya, Powder Metallurgy: Science, Technology, and Materials, CRC Press, Taylor & Francis Group, 2011

Ceramic Matrix Composites, Microstructure/Properties Relationship, Ed. Prof. I. M. Low, Woodhead Publishing Ltd., Abington Hall, Abington, 2006

Engineering Ceramics, Current Status and Future Prospects, Ed. Tatsuki Ohji and Mrityunjay Singh, The American Ceramic Society and John Wiley & Sons, Inc. 2016

Powder Metallurgy Progress, http://www.imr.saske.sk/pmp/is.html

6. BioMEMS: miniature bionsensors (Zoltán Fekete)

Suggested reading

Lab-on-a-Chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis, szerk.: R. Edwin Oosterbroek és Albert van den Berg, ISBN: 978-0-444-51100-3.

7. Biomaterials for medical applications (Csaba Balázsi)

Aim of the course: Presentation of ceramic, glass and polymer techology 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

Prerequisities: ---

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

8. Engineering ceramics (Maria Berkes Maros)

Aim of the course: The course aims to familiarise doctoral students with the material-specific characteristics of engineering ceramics, their advantages, limitations, typical deterioration processes, and material testing methods, and to enable them to assess the applicability of different engineering ceramics under specific operating conditions to enhance the performance and reliability of engineering structures.

Total number of contact hours: 30

Prerequisites: ---

Content: Micro- and macro-scale material structures of crystalline and non-crystalline ceramics. Phase transformations, crystalline defects in ceramics. Mechanical behavior and structural background of single crystals, polycrystalline and amorphous ceramics. Deformation and failure behavior of ceramics at different temperatures. Main mechanical properties of brittle materials, standard test methods. Information content and reliability of metrics. Typical engineering applications (Al_2O_3, AlN, Si_3N_4, SiC, ZrO_2, B_4C, BN, TiN, ZrO_2, diamond, SiAlONs, WC, SiO_2, C, Si, Ge). Typical loadings in different applications, damage modes, and material properties relevant in different service conditions. Advanced manufacturing techniques for engineering ceramics. Common methods of increasing strength and toughness in monolithic and multiphase structures. Ceramic matrix composites and ceramic reinforcing phases (fibers, whiskers, coatings).

Suggested reading:

KINGERY, W. D., BOWEN, H. K., UHLMANN, D. R.: Introduction to Ceramics, 2nd Edition, John Wiley&Sons, New York Chichester Brisbane Toronto Singapore, ISBN 0-471-47860-1, 1975.

RICHERSON, W. D, LEE, W.E.: Modern Ceramic Engineering, Properties, Processing, and Use in Design; CRC Press, Taylor & Francis Group, LLC, 4th ed., ISBN 13: 978-1-4987-1691-8 (Hardback); ISBN 13: 978-1-4987-1693-2 (ePub);(2018) p812

RILEY, F.: Structural Ceramics, Fundamentals and Case Studies, Cambridge University Press; 1st ed. ISBN-13: 978-052184586 (2009) p418.

SOMIYA, S.: Handbook of Advanced Ceramics, Materials, Applications, Processing, and Properties, Academic Press, ISBN 978-0-12-385469-8 (2013) p1258.

CHIANG, Y-M., BIRNIE, D. P., KINGERY, W. D.: Physical Ceramics, (Principles for Ceramic Science and Engineering) John Wiley & Sons Inc., New York, 1996, ISBN 0-471-59873-9

SHELDON, B. W. DANFORTH, S. C.: Silicon-Based Structural Ceramics, 1994. The American Ceramic Society; ISBN 0-944904-76-9

LINSMEIER, K-D.: The Manual: “Technical Ceramics – The Material of Choice for extremely demanding Applications”, Verlag Moderne Industrie – CeramTec, Süddeutcher Verlag onpact GmbH, letölthető kézikönyv (2011) https://www.ceramtec.com/manual/technical-ceramics/

BENGISUM, M.: Engineering Ceramics (Series: Engineering materials), 1st ed. Springer Berlin, Heidelberg, XXI, p 620, https://doi.org/10.1007/978-3-662-04350-9

Greil, P. (2002). Advanced Engineering Ceramics. Advanced Engineering Materials, 4(5), 247–254. doi:10.1002/1527-2648(20020503)4:5<247::aid-adem247>3.0.co;2-n

e) Metals

1. Continuous casting of steel (Mihály Réger)

Suggested reading

B.G. Thomas, "Continuous Casting: Modeling," The Encyclopedia of Advanced Materials, (J. Dantzig, A. Greenwell, J. Michalczyk, eds.) Pergamon Elsevier Science Ltd., Oxford, UK, Vol. 2, 2001, 8p., (Revision 3, Oct. 12, 1999).

M. El-Bealy: Fluctuated Cooling conditions and Solid Shell Resistance in Continuously Cast Steel Slabs, Canadian Metallurgical Quaterly, Vol. 36, No. 3, 203-222, 1997

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

Suggested reading

J. W. Christian: The Theory of Transformations in Metals and Alloys, Pergamon Press, Oxford, (1975).

J.S. Kirkaldy and D.J. Young: Diffusion in the Condensed State, The Institute of Metals, The University Press, London (1987)

D. Raabe: Computational Materials Science, Wiley-VCH, New York (1998)

W. C. Lesli: The Physical Metallurgy of Steels, McGraw-Hill Company, New York, (1981)

3. Materials technologies of high energy impact (Gyula Bagyinszki)

4. Welding technologies I: Molten state welding (Gyula Bagyinszki)

5. Welding technologies II: Solid state welding (Gyula Bagyinszki)

6. Powder technology (Csaba Balázsi)

Aim of the course: Presentation of powder techology 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

Prerequisities 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

Gopal Shankar Upadhyaya, Powder Metallurgy Technology, Cambridge International Science and Publishing, 2002

Anish Upadhyaya, Gopal Shankar Upadhyaya, Powder Metallurgy: Science, Technology, and Materials, CRC Press, Taylor & Francis Group, 2011

Ceramic Matrix Composites, Microstructure/Properties Relationship, Ed. Prof. I. M. Low, Woodhead Publishing Ltd., Abington Hall, Abington, 2006

Engineering Ceramics, Current Status and Future Prospects, Ed. Tatsuki Ohji and Mrityunjay Singh, The American Ceramic Society and John Wiley & Sons, Inc. 2016

Powder Metallurgy Progress, http://www.imr.saske.sk/pmp/is.html

7. Principles of plasticity theory (Endre Ruszinkó)

Suggested reading Rusinko, A. and Rusinko, K. Plasticity and Creep of Metals, Springer, Berlin, 2011
Chen, W. and Han, D.: Plasticity for structural engineers, Springer, Heidelberg, 1988.
Honeycomb, R.: Plastic Deformation of Metals, Edward Arnold, London, 1984.

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

Suggested reading
Rusinko, A. and Rusinko, K.: Plasticity and Creep of Metals, Springer, Berlin, 2011
Rusinko, A.: Ultrasound and Irrecoverable Deformation in Metals, LAP LAMBERT Academic Publishing, 2012.
Betten, J.: Creep mechanics, Springer, Heidelberg, 2005
Chen, W. and Han, D.: Plasticity for structural engineers, Springer, Heidelberg, 1988.

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

Aim of the cours: 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
ASM Handbook, Volume 13A - Corrosion: Fundamentals, Testing, and Protection, ISBN 978-0-87170-705-5DC Electrochemical Test Methods, N.G. Thompson and J.H. Payer, NACE, ISBN: 1-877914-63-0. Principles and Prevention of Corrosion, Denny A. Jones, Prentice-Hall, Upper Saddle River, NJ, ISBN 0-13-359993-0.
Electrochemical Techniques in Corrosion Engineering, 1986, National Association of Corrosion Engineers(NACE).
Corrosion and Corrosion Control, 3rd. Ed., Herbert H. Uhlig, John Wiley and Sons, New York, 1985.

10. Metal cutting theory (Richárd Horváth)

Suggested reading
David A. Stephenson, John S. Agapiou: Metal Cutting Theory and Practice (second edition, 2005) Viktor P. Astakhov: Geometry of Single-point Turning Tools and Drills (2010)

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

Prerequisities: ---

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, $\alpha+\beta$ 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: Leyens Ch., Peters M. (eds.): Titanium and Titanium Alloys, Fundamentals and Applications, Wiley-Vch, Weinheim, 2003.

Lütjering G., Williams, J. C.: Titanium, Springer-Verlag, Berlin, 2007.
Joshi V. A.: TITANIUM ALLOYS An Atlas of Structures and Fracture Features, Taylor & Francis Group, 2006.
Cotton J. D. et al: State of the Art in Beta Titanium Alloys for Airframe Applications, JOM, Vol. 67, No. 6, 2015, pp. 1281-1303. Wang L., Zhang L. C. (eds.): Development and Application of Biomedical Titanium Alloys, Bentham Science Publishers, 2018.

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

13. Electrodeposition of metals

Aim of the course: Presentation of the basis of the electrodeposition of metals and that of galvanotechnology based on elemental understanding of electrochemistry and metallurgy
Total number of hours: 30 hours
Prerequisites of the course: basic knowledge of physical chemistry and materials science
Content: Basic concepts of electrochemistry, electrode classification. Static and dynamic methods in electrochemistry. Electrochemical instrumentation. Electrochemical stability diagrams. Fundamental cases of metal deposition and dissolution kinetics. Transport processes in electrochemistry. Investigation of electrodeposited materials: X-ray diffraction, scanning electron microscopy, analysis of the surface roughness. Microscopic aspects of metal deposition and dissolution. Nucelation phenomena, deposition in kinetic and transport-limited regimes, pulse plating. Crystallography, dendrite formation, texture. Role of the bath components in metal deposition. Alloy formation in electroplating, codeposition modes. nanostructure synthesis by electrochemical methods. Fundamentals of galvanotechnology.
Suggested readings:
A. Brenner: Electrodeposition of Alloys. Academic Press, New York, 1963.
E. Budevski, G Staikov, W. L. Lorenz: Electrochemical Phase Formation and Growth. VCH, Weinheim, 1996.
N. Kanani: Electroplating – Basic Principles, Processes and Practice. Elsevier, 2004.
Y. D. Gamburg, G. Zangari: Theory and Practice of Metal Electrodeposition. Springer, 2011.
László Péter: Electrochemical Methods of Nanostructure Preparation. Springer, 2021.

f) Composites

1. Composites (Szilvia Klébert)

Suggested reading
Deborah D.L. Chung, Carbon Fiber Composites, 1994, Butterworth-Heinemann
K. K. Chawla, Ceramic Matrix Composites 1993, Springer-Science+Business Media, BV.
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
Sanjay Mazumdar, Composites Manufacturing Materials, Product, and Process Engineering 2001, CRC Press

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

Content: Types of polymer matrix materials and nanoparticles. Carbon nanotubes, motmorillonite clay and other types of nanoparticles. Preparation and production of nanocomposites. Properties of nanocomposites: structure, electrical conductivity, mechanical, thermal, crystallization, burning, optical properties. Application of polymer nanocomposites.

Suggested reading

Sati N. Bhattacharya, Rahul K. Gupta, Musa R. Kamal: Polymeric Nanocomposites Theory and Practice, Carl Hanser Publishers, Munich, 2008.

Joseph H. Koo: Polymer Nanocomposites: Processing, Characterization, and Applications, McGraw-Hill, New York, 2006.

3. Biomaterials for medical applications (Csaba Balázsi)

Aim of the course: Presentation of ceramic, glass and polymer techology 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

Prerequisities: ---

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

g) Micro- and nano-structured materials

1. Semiconductor technologies (Zsolt József Horváth)

Prerequisites: basic knowledges in physics and chemistry

Suggested reading

D. V. Morgan and K. Board: An introduction to semiconductor microtechnology, John Wiley and Sons, New York, 1983.

S. M. Sze: Semiconductor Devices: Physics and Technology, John Wiley and Sons, New York, 1985.

2. Semiconductor devices (Zsolt József Horváth)

Prerequisites: basic knowledges in physics and electric engineering

Suggested reading

S. M. Sze, K. K. Ng: Physics of Semiconductor Devices, 3rd Edition, Wiley, New York, 2006.

D. L. Pulfrey: Understanding Modern Transistors and Diodes, Cambridge University Press, Cambridge, 2010.

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

S. M. Sze, M.K Lee: Semiconductor Devices, Physics and Technology. 3rd Edition, Wiley, New York, 2012.

5. Solid-state light sources and their application (Horváth Zsolt József)

Prerequisites: basic knowledges in physics and electric engineering

Suggested reading

Bahaa E.A. Saleh, Malvin Carl Teich: Fundamentals of Photonics, Second Edition, John Wiley & Sons Inc., Hoboken, N.J., 2007.

Optoelectronics and Photonics, Pearson Education, 2013.

Safa Kasap, Harry Ruda, Yann Boucher: Handbook of Optoelectronics and Photonics,Cambridge University Press, 2009.

S. M. Sze, K. K. Ng: Physics of Semiconductor Devices, 3rd Edition, Wiley, New York, 2006.

6. „Band gap engineering” (efficiancy 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

Prerequisities of the course: -

Content: Introduction to chemical materials science: relation between structure and macroscopic properties. Nanotechnology, preparation and functionalization of nanomaterials, nanoparticles; characteristic properties and application of quantum dots; colloidal drug carrier systems, their function, materials and main types. Formation of self-assembly monolayers, their structure and function, pattern formation by SPM. Preparation of nanolayers, Langmuir-Blodgett films, lithographic techniques for pattern formation. Preparation of nanostructured materials – bottom up and top down approaches. Photonic materials. Magnetic properties, classification of materials, ferro- and ferrimagnetic materials and special properties. Electric conductivity, classification of materials, semiconductors and microelectronic devices, molecular electronics.

Suggested reading

R. W. Cahn: The coming of materials science, Pergamon, Amsterdam,

W. D. Callister: Materials Science and Engineering, An Introduction, Wiley,

W.F. Smith: Principles of Materials Science and Engineering, McGraw-Hill Publ.

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

Prerequisities of the course: -

Content: General introduction to disperse systems in the colloidal size range. Fields of applications of drug delivery particles. Preparation and uses of lipid, surfactant, polymeric gel and solid polymer based nanoparticles. Development of diagnostic and therapeutic (theranostic) nanosystems. Characterization of colloidal systems: drug content, encapsulation efficacy, size (static and dynamic light scattering, atomic force microscopy, electron microscopy), surface composition. Possibilities for controlled drug transport (active and passive transport). Introduction to thin film based diagnostic techniques.

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

Prerequisities of the course: -

Content: Physico-chemical interactions between solid and liquid phases. Interfacial phenomena in polymer-containing systems. Basic principles of wettability and adsorption, models describing the phenomena and kinetics of the processes. Instrumental methods for the determination of surface chemical composition: modern surface sensitive techniques (ESCA, SIMS, FT-IR), high-performance imaging techniques (AFM, STM). Indirect methods for the investigation of interfacial interactions: wettability, direct force measurement, particle adhesion, colloid stability, adsorption of macromolecules, formation of self-assembly monolayer or Langmuir-Blodgett film. Surface modification of polymers by “wet” and plasma techniques.

Suggested reading

D.J.Shaw: Bevezetés a kolloid- és felületi kémiába, Műszaki Könyvkiadó, Budapest, 1986. J. Andrade: Surface and Interfacial Aspects of Biomedical Materials, Plenum Press, N.Y. 1985. F. McRitchie: ChemistryatInterfaces, Acad. Press, London, 1990.

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 compunds in micro-scale gas sensors (Andrea Csikós Pap)

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

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

Suggested reading

Hassler, C., Boretius, T. and Stieglitz, T. (2011), Polymers for neural implants. J. Polym. Sci. B Polym. Phys., 49: 18–33. doi:10.1002/polb.22169

19. BioMEMS: miniatűrizált bioszenzorok (Fekete Zoltán)

Suggested reading

Lab-on-a-Chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis, szerk.: R. Edwin Oosterbroek és Albert van den Berg, ISBN: 978-0-444-51100-3.

20. 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.

Total numbers of hours: 30

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

W. Gopel, J. Hesse, J. N. Zemel , Chemical and Biochemical Sensors, in: Trends in Sensor Markets (Vol. Eds: W. Gopel, T. A. Jones t, M. Kleitz, I. Lundstrom, T. Seiyama), Part 1/11, Vol. 2/3, Weinheim New York (1995).

Dorothee Grieshaber, Robert MacKenzie, Janos Vőrös, Electrochemical Biosensors - Sensor Principles and Architectures, and Erik Reimhult, Sensors 2008, 8, 1400-1458

Danielle W. Kimmel, Gabriel LeBlanc, Mika E. Meschievitz, and David E. Cliffel, Electrochemical
Sensors and Biosensors, Anal. Chem., 84 (2012) 685-707, dx.doi.org/10.1021/ac202878q **|** Anal. Chem. 2012, 84, 685–707.

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

Suggested reading

Jonathan W. Steed – David R. Turner – Karl J. Wallace: Core Concepts in Supramolecular Chemistry and Nanochemistry, John Wiley and Sons Ltd., Sussex, England, 2007.

Makoto Fujita, Ed.: Molecular Self-Assembly Organic Versus Inorganic Approaches, Springer Verlag, Berlin, 2000.

Helena Dodziuk: Introduction to Supramolecular Chemistry, Kluwer Academic Publishers, New York, 2002.

22. Optical characterization of thin layers (Péter Petrik)

Aim of the course: Learning the mathematical description of polarized light, the measurement methods based mainly on the measurement of the polarization of light and interpretation of the measured quantities, and the light-matter interaction as well as the material properties based on this.

Suggested reading

Azzam Bashara: Ellipsometry and polarized light

E. Irene, H. Tompkins: Handbook of ellipsometry

M. Losurdo, K. Hingerl: Ellipsometry at the nanoscale

23. Measurement of bioelectrical activities (Gergely Márton)

Suggested reading

Ramesh Srinivasan: Anatomical constraints on source models for high-resolution EEG and MEG derived from MRI (Technol Cancer Res Treat. 2006 Aug; 5(4): 389–399.)

Pouria Fattahi, Guang Yang, Gloria Kim, Mohammad Reza Abidian: A Review of Organic and Inorganic Biomaterials for Neural Interfaces (Adv Mater. 2014 Mar 26; 26(12): 1846–1885.)

Pour Aryan, Naser, Kaim, Hans, Rothermel, Albrecht: Stimulation and Recording Electrodes for Neural Prostheses (2015, book).

Amelia A. Schendel, Kevin W. Eliceiri, Justin C. Williams: Advanced Materials for Neural Surface Electrodes. Curr Opin Solid State Mater Sci. 2014 Dec 1; 18(6): 301–307.

Gergely Márton: Development and Characterization of novel microelectrode arrays for neurophysiology (Ph.D. dissertation, 2015)

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

Stanley Manahan, 2017, Environmental Chemistry, 10th Edition, CRC Press, ISBN 9781498776936 - CAT# K29755

René P. Schwarzenbach, Philip M. Gschwend, Dieter M. Imboden, 2016, Environmental Organic Chemistry, 3rd Edition, ISBN: 978-1-118-76723-8,

Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L., Strong Chemistry of the Environment, Elsevier Science & Technology Books 2002.

Lecture Handouts in digital format.

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

Suggested reading

S. Kaminsky (Editor): Feedstock recycling and pyrolysis of waste plastics (John Wiley & Sons, Ltd 2006)

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

Suggested reading

Nigel Wells: Sustainability, Energy & Environment; Frequently asked question … and some answers, Printcity GmbH Co.KG, 2008, Paris, 23 p.

Nsenga Thompson: Big impact, Green strategies for smaller printers, American Printer, April, 2010 18-20 p.

Kunio Ishibashi: Green Standard and GP certification system, World Print and Communication Forum, London, March 25, 2010

CMYK goes GREEN, Environmental compatibility in the printing process, Expressis Business,Issue 35, April 2008

Kipphan, H.: Handbuch der Printmedien, Springer-Verlag, Berlin, 2003

4. **Waste water purification technologies (Rita Boda Kendrovics)**

5. **Principles of hydrology (Emőke Bardóczy-Székely)**

6. **Hidrobiology (Rita Boda Kendrovics)**

OTHERS

1. **Experimental design (Ágota Drégelyi-Kiss)**

Suggested reading

Montgomery, Douglas C. Design and analysis of experiments. John Wiley & Sons, 2017.

Myers, Raymond H., Douglas C. Montgomery, and Christine M. Anderson-Cook. Response surface methodology: process and product optimization using designed experiments. John Wiley & Sons, 2016.

Taguchi, Genichi, Subir Chowdhury, and Yuin Wu. Taguchi's quality engineering handbook. Hoboken, NJ: John Wiley & Sons, 2005.

2. **Statistical hypothesis testing (Márta Takács)**

3. **Engineering education (Péter Tóth)**

4. **Writing and publishing scientific works (Kovács Tünde)**

Aim of the course:. This subject is designed to give the students a helping hand in writing a scientific paper.

Total number of hours: 30

Prerequisites: ---

Content: It provides generic advice on ways that a scientific paper can be improved. The focus is on the following ethical and non-technical issues: (1) when to start writing, and in what language; (2) how to choose a good title; (3) what should be included in the various sections (abstract, introduction, experimental, results, discussion, conclusions, and supporting information (supplementary material); (4) who should be considered as a co-author, and who should be acknowledged for help; (5) which journal should be chosen; and (6) how to respond to reviewers' comments. Purely technical issues, such as grammar, artwork, reference styles, etc., are not considered. The student should get to know the types of scientific publications and the requirements for their formal and content structure. Gain skills in preparing a publication to publish your own research findings or publish a literature review.

References:

Chris A. Mack: How to write a good scientific paper SPIE PRESS Bellingham, Washington USA 2018 (ISBN 9781510619135)

Robert A. Day and Barbara Gastel: How to Write and Publish a Scientific Paper: Seventh Edition, Cambridge University Press 978-1-107-67074-7

Scholz, F. Writing and publishing a scientific paper. ChemTexts 8, 8 (2022). https://doi.org/10.1007/s40828-022-00160-7

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http://www.sciencemag.org/careers/2016/11/how-keep-scientific-literature

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