Óbuda University Doctoral School

of Materials Science and Technology

Curriculum

Updated
Based on Resolution No. 58 (January 20, 2021) of the Doctoral School Council

CONTENTS

1. THE OBJECTIVE OF THE PROGRAM

The Sándor Rejtő Faculty of Light Industry and Environmental Engineering at Óbuda University has a decades-long tradition of training professionals for the textile and apparel industry, as well as the paper, packaging, and printing industries. The bachelor's program in light industry engineering has been supplemented by **a master's program in light industry engineering**[1]since 2008.

Light Industry and Materials Science: The collective term "light industry," as used in the domestic tradition, refers to industrial activities that *primarily* involve the processing of *polymer-based materials* for various purposes. It is through the continuous development of traditional products that the needs of the population and the related industries can be adequately met. Light industry products are used, for example, in the automotive industry, in separation technologies (filter fabrics, membranes), in road construction (geotextiles), in composites, in building materials, in healthcare, as well as in the packaging and printing industries, etc. When designing various associated systems developed for new applications, there is an increasing need for knowledge of other areas of materials science (metals, ceramics). State-of-the-art processes are increasingly utilizing micro- and nanotechnologies. Taking sustainability considerations into account is essential for the industry's further development. Accordingly, light industry engineers collaborate with engineers, chemists, and physicists from other fields of materials science, carrying out *complex activities that encompass other areas of materials science.*

The **goal of the Doctoral School of Materials Science and Technology (ATDI) is** to train professionals who possess comprehensive, coherent knowledge across a broad range of materials science, specialize in a field corresponding to their research, and, by applying their knowledge, are capable of performing creative, independent work in the field of materials science and its practical applications. The Doctoral School strives to ensure that graduates are capable of leading research and projects, and developing new research proposals

[1] MAB decision number: KIP MSc 2008/5/VIII/2/3

, to conduct their work on a solid foundation of research ethics, and thus to be capable of succeeding in both higher education/research and other areas of the labor market.

Training and Research Areas

The doctoral school's range of courses and topics—*reflecting the complex nature of materials science*—spans multiple subfields. This enables *students* to *acquire coherent knowledge across the diverse fields of materials science* during their training and research.

The doctoral school's courses include foundational courses providing *general knowledge of materials science and materials testing*, as well as courses covering specific relevant subfields such as *polymers, ceramics, metals, composites, micro- and nanostructured materials, and environmental protection*. Students must select and complete a total of eight courses from the foundational and specialized courses during the first four semesters, under the guidance of their advisor, in accordance with their research topic. Research topics can also be categorized according to the above grouping. Due to the complexity of materials science, both the courses and the topics span more than one of the above subfields.

The comprehensive coverage of individual fields of materials science within the doctoral school aligns with the position statement published in 2010 by the European Union's six technology platforms[2] , *which states that materials science research and development can be made more effective by integrating different fields*.

Faculty and advisors of the doctoral school

The doctoral school's education and research are conducted by faculty members and researchers from Óbuda University, as well as by guest lecturers and thesis advisors invited from other universities in the country (Budapest University of Technology and Economics, University of Debrecen, Eötvös Loránd University, University of Sopron, János Neumann University). The doctoral school cooperates on a contractual basis with the Hungarian Academy of Sciences' Research Center for Energy Sciences (MTA EK), the Wigner Research Center for Physics (MTA Wigner FK), and the Research Center for Natural Sciences (MTA TTK).

2. FOUNDATIONAL KNOWLEDGE FOR THE DOCTORAL SCHOOL (Master's Programs)

Due to the complex nature of materials science, the doctoral school is open to all holders of a master's degree who have acquired in-depth, master's-level knowledge of materials in a technical or natural science field during their previous studies.

[2] (http://ec.europa.eu/research/industrial_technologies/pdf/etps-letter_en.pdf).

Typical qualifying prior studies for the program include a master's degree in light industry engineering, as well as master's degrees in materials engineering, wood engineering, chemical engineering, plastics and fiber technology engineering, bioengineering, electrical engineering, environmental engineering, materials science, chemistry, and physics.

3. DOCTORAL SCHOOL PROGRAM

3.1. Program Structure

We offer general and specialized knowledge of materials science grouped by subject area. Some courses appear in multiple sections because, due to the interdisciplinary nature of materials science, they cover several subfields.

Materials Science Seminar Foundational

Materials Science Courses

a) General Materials Science
b) Materials Testing Methods

Sub-field courses in materials science

c) Polymer Materials and Technologies
d) Ceramics, Technologies
e) Metallic materials, technologies
f) Composites
g) Micro- and nanostructured systems
h) Selected Environmental Aspects of Materials Science Technologies

Other subjects

3. 2. Courses

Detailed description on the Doctoral School website: http://atdi.uni-obuda.hu/hu/tantargyak

Materials Science Seminar (3 credits, signature)

Lectures on various fields of the diverse discipline of materials science, delivered by renowned guest speakers, are designed to help students conducting research in a specific subject area and taking courses related to that topic gain insight into the broadest possible range of materials science, and to acquire *a coherent understanding of materials science* to the extent possible.

Introductory Courses in Materials Science (6 credits, exam)

a) General Materials Science

1. Physical Chemistry of Surfaces *(Krisztina László)*
2. Porous Materials *(Krisztina László)*
3. Nanotechnology – Chemical Materials Science *(Éva Kiss)*
4. Fundamentals of Radiation Chemistry *(László Wojnárovits)*
5. Solid-State Chemistry *(András Stirling)*
6. Dye Chemistry *(András Víg)*
7. Introduction to plasma chemistry *(Zoltán Károly, Szilvia Klébert)*
8. Fracture Mechanics *(Tünde Kovács)*
9. Analysis of Damage Processes in Structural Materials *(Tünde Kovács)*
10. Process Design *(Balázs Mikó)*
11. Finite Element Modeling of Materials Technologies *(Viktor Gonda)*
12. Fundamentals of engineering ceramics *(Szilvia Klébert)*
13. Contemporary Concepts in Catalysis *(József Pap)*
14. Biomaterials for medical applications *(Csaba Balázsi)*
15. The Impact of Industry 4.0 on Manufacturing Technology *(Balázs Mikó)*
16. Model analysis of technical systems *(László Pokorádi)*
17. Model testing of operational processes *(László Pokorádi)*
18. Materials for nuclear power plants *(Zoltán Hózer)*

b) Material testing methods

1. Selected Chapters on Materials Testing Methods I. *(Erzsébet Takács, Judit Telegdi)*
2. Selected chapters on materials testing methods II. *(Zoltán Károly, Szilvia Klébert)*
3. Modern separation methods in materials research *(Zoltán Juvancz)*
4. Fluorescence Spectroscopy and Microscopy *(Gusztáv Schay)*
5. Modern Mass Spectrometry *(Sándor Kéki)*
6. Color Theory and Color Measurement (*Ákos Borbély)*
7. Investigation of surface microgeometry and microtopography *(Béla Palásti-Kovács, Gabriella Farkas)*
8. Testing methods for microelectronic materials and structures *(Balázs Kovács)*
9. Finite element modeling of heat transfer *(Sándor Borza)*
10. Fracture mechanics *(Tünde Kovács)*
11. Analysis of damage processes in structural materials *(Tünde Kovács)*
12. Electrochemical Methods for Measuring Corrosion and Inhibition *(Abdul Shaban Ibdewi)*
13. Finite element modeling of materials technologies *(Viktor Gonda)*
14. Measurement of bioelectric activities (Gergely Márton)
15. Chemical sensors: methods and applications (Abdul Shaban Ibdewi)
16. 16. BioMEMS: Miniaturized Biosensors (Zoltán Fekete)
17. Optical characterization of thin films (Péter Petrik)
18. Structural analysis of various materials using transmission electron microscopy (Katalin Balázsi)

Courses in the field of materials science (6 credits, exam)

c) Polymers

1. Chemistry and physics of polymers *(Sándor Pekker)*
2. Physics of macromolecules *(Károly Belina)*
3. Characterization and modification of polymer surfaces *(Éva Kiss)*
4. Natural and Nature-Based Polymers *(Cecília E. Tamásné Nyitrai)*
5. Cellulose Chemistry *(Judit Borsa)*

6. Fibrous Materials in the Paper Industry and Their Surface Properties *(László Koltai)*
7. Cellulose and Paper Manufacturing (László Koltai)
8. Mechanical and physical properties of papers and corrugated products *(László Koltai)*
9. Interaction between printing substrates and printing inks during printing *(Rozália Szentgyörgyvölgyi)*
10. Synthetic fibers and technical textiles *(Judit Borsa)*
11. Applications of high-energy radiation for modifying the properties of natural polymers and plastics *(Erzsébet Takács)*
12. Characterization of functional textile and apparel products *(Lívia Kokasné Palicska)*
13. Characteristics of antimicrobial raw materials in the light industry *(Hosam Bayoumi Hamuda)*
14. Applications of polymers in microtechnology *(Andrea Csikósné Pap)*
15. Technology and applications of polymer-based bionic interfaces *(Zoltán Fekete)*
16. Supramolecular and coordination complexes and polymers *(Sándor Pekker, Éva Kováts)*
17. Biomaterials for medical applications *(Csaba Balázsi)*

d) Ceramics

1. Fundamentals of technical ceramics (Szilvia Klébert)
2. Technology of technical ceramics *(János Dusza)*
3. Material structure and fracture mechanisms of engineering ceramics *(János Dusza)*
4. Mechanical Properties of Technical Ceramics *(János Dusza)*
5. Knowledge of Porous Materials *(Csaba Balázsi)*
6. BioMEMS: Miniaturized Biosensors *(Zoltán Fekete)*
7. Biomaterials for medical applications *(Csaba Balázsi)*

e) Metals

1. Phenomena related to continuous steel casting *(Mihály Réger)*
2. Modeling of thermally activated transformation processes in alloys *(Tamás Réti)*
3. High-energy-input materials technologies *(Gyula Bagyinszki)*
4. Welding Technologies I: Bulk Welding *(Gyula Bagyinszki)*
5. Welding Technologies II: Pressure Welding *(Gyula Bagyinszki)*
6. Knowledge of Process Technology *(Csaba Balázsi)*
7. Fundamentals of Plasticity *(Endre Ruszinkó)*
8. Non-classical Problems in Plasticity and Creep *(Endre Ruszinkó)*
9. Electrochemical Methods for Measuring Corrosion and Inhibition *(Abdul Shaban Ibdewi)*
10. Machining Theory *(Richárd Horváth)*
11. Titanium and titanium alloys *(Péter Pinke)*
12. Materials for Nuclear Power Plants *(Zoltán Hózer)*

f) Composites

1. Composites *(Szilvia Klébert)*
2. Polymer-based nanocomposites *(Andrea Ádámné Major)*
3. Biomaterials for medical applications *(Csaba Balázsi)*

g) Micro- and nanostructured systems

1. Semiconductor technologies *(Zsolt József Horváth)*
2. Semiconductor devices *(Zsolt József Horváth)*
3. Semiconductors produced from the liquid phase *(Vilmos Rakovics)*
4. Compound semiconductors and their optoelectronic applications *(Vilmos Rakovics)*
5. Solid-state light sources and their applications *(Zsolt József Horváth)*
6. Band Gap Engineering (or the Efficiency of Solar Cells) *(Ákos Nemcsics)*
7. Self-organizing low-dimensional systems *(Ákos Nemcsics)*
8. Information storage devices and material structures *(Zsolt József Horváth)*

9. Micro- and nano-electromechanical structures *(Zsolt József Horváth)*
10. Nanotechnology – Chemical Materials Science *(Éva Kiss)*
11. Medical applications of colloidal systems *(Gergő Gyulai)*
12. Characterization and modification of polymer surfaces *(Éva Kiss)*
13. Applications of Microcapsules in Modern Industry *(Judit Telegdi)*
14. Applications of polymers in microtechnology *(Andrea Csikósné Pap)*
15. Adhesive-free lamination *(Andrea Csikósné Pap)*
16. Elements and Compounds in Micro-Scale Gas Sensors *(Andrea Csikósné Pap)*
17. Testing methods for microelectronic materials and structures *(Balázs Kovács)*
18. Molecular beam epitaxy of III-V semiconductors *(Ákos Nemcsics)*
19. Technology and applications of polymer-based bionic interfaces *(Zoltán Fekete)*
20. BioMEMS: Miniaturized Biosensors *(Zoltán Fekete)*
21. Chemical sensors: methods and applications *(Abdul Shaban)*
22. Supramolecular and coordination complexes and polymers *(Sándor Pekker, Éva Kováts)*
23. Optical characterization of thin films *(Péter Petrik)*
24. Measurement of bioelectrical activities *(Gergely Márton)*

h) Selected environmental aspects of materials science technologies

1. Environmental chemistry *(Abdul Shaban)*
2. Recycling plastic waste via pyrolysis *(Zsuzsanna Czégény)*
3. Going Green… Environmentally Friendly Printing *(Csaba Horváth)*
4. Wastewater treatment technologies *(Rita Bodáné Kendrovics)*
5. Fundamentals of hydrology *(Emőke Bardóczyné Székely)*

Other subjects (6 credits, exam)

1. Experiment Design *(Ágota Drégelyi-Kiss)*
2. Statistical Hypothesis Testing *(Márta Takács)*
3. Engineering Education *(Péter Tóth)*

4. RESEARCH AND INTERNATIONAL RELATIONS OF THE DOCTORAL SCHOOL

4.1. Research topics

Detailed description on the Doctoral School's website:
http://atdi.uni-obuda.hu/hu/temakiirasok

The topics are grouped by subject area. Some topics appear in multiple sections because, due to the interdisciplinary nature of materials science research, they span several subfields.

a) Polymers
b) Ceramics
c) Metals
d) Micro- and Nanosystems
e) Environmental Protection

a) Polymers

A significant portion of research in polymer chemistry and technology focuses on processing various sources of cellulose—the most abundant renewable raw material in nature—developing new functions, and recovering cellulose-based raw materials. Engineering and innovative plastics are represented by topics where research allows for the acquisition of generally applicable testing methods and the development of polymers with designed smart behavior and environmentally beneficial properties.

1. Investigation of the Properties of Eco-Fibers *(János Dusza)*
2. The role of by-products in the formation of colored wood defects *(Levente Albert)*
3. UV laser-induced degradation of wood *(György Papp)*
4. Application of transverse sound waves for the examination of wood and wood materials *(Ferenc Divós)*
5. Introduction of new cellulose-based chiral stationary phases *(Zoltán Juvancz)*
6. The role of component characteristics and manufacturing parameters in the recyclability of various paper products *(László Koltai)*
7. Production and potential applications of natural-based hydrogels *(Tünde Tóth)*
8. The effect of cellulose fibers of different origins and types on the properties of papers treated with PVOH/PVAc copolymers and their modifications *(László Koltai)*
9. Thermal identification of base papers for corrugated products as a function of the mechanical load-bearing capacity of the corrugated product *(László Koltai, Péter Böröcz)*
10. Activation and functionalization of polymer surfaces with non-equilibrium plasmas *(Szilvia Klébert)*
11. Atmospheric pressure photoionization mass spectrometry of nonpolar polymers *(Sándor Kéki)*
12. Relaxation processes in engineering plastics *(Károly Belina)*
13. Preparation and investigation of nanocomposites with polymer matrix *(Andrea Ádámné Major)*
14. Study of polymer-ceramic-metal composite systems *(Károly Belina)*
15. From macromolecules with branched topologies to smart polymers *(Béla Iván)*
16. Environmentally beneficial chemical transformations and degradation of polymers and plastics *(Béla Iván)*
17. Development of biodegradable drug carriers *(Éva Kiss)*
18. Strain-optical investigation of polymer-containing hybrid composite structures processed using laser beam technologies *(Lajos Borbás)*
19. Research on polymer-based biosensors *(Gergely Márton)*
20. Decision-preparation procedures based on mathematical models in operations management *(László Pokorádi)*

b) Ceramics

Engineering ceramics and various composites reinforced with glass, metal, plastic, carbon fiber, etc., are being used to an ever-increasing extent. The investigation of the macro- and microstructures of these materials contributes to the optimization of their properties according to the requirements of the application area.

1. Development of silicon nitride ceramics containing carbon nanotubes and graphene *(János Dusza)*
2. Development of superhard ceramic coatings *(János Dusza)*

3. Application of SiC as a cladding for nuclear reactor fuel elements *(Zoltán Hózer)*
4. Preparation of calcium phosphate-based layers and fibers and investigation of their structural properties *(Katalin Balázsi)*
5. Preparation and investigation of aluminum CNT and graphene nanocomposites *(Katalin Balázsi, Csaba Balázsi)*
6. Preparation, structural investigation, and microscopy of advanced zirconia-based ceramics and composites *(Katalin Balázsi, Csaba Balázsi)*
7. Synthesis, structural and tribological characterization, and microscopy of advanced silicon nitride-based ceramics and composites *(Katalin Balázsi, Csaba Balázsi)*
8. Study of polymer-ceramic-metal composite systems *(Károly Belina)*
9. Development of a ceramic coating via atomization and characterization of its structure *(Csaba Balázsi, Katalin Balázsi)*
10. Development of calcium phosphate-based bioceramics using various separation technologies *(Csaba Balázsi, Katalin Balázsi)*
11. Decision-preparation procedures based on mathematical models in operational management *(László Pokorádi)*

c) Metals

Mechanical engineers encounter metals frequently during their MSc studies. We also recommend research topics tailored to their interests, as well as to materials engineers, light industry engineers, chemists, and physicists with relevant expertise in the field.

1. Measurement and estimation of segregation characteristics formed during continuous casting of steels *(Mihály Réger)*
2. Stability of centerline segregation *(Mihály Réger)*
3. Investigation of the physicochemical and electrical properties and equations of batteries *(István Vajda)*
4. Development of a model applicable to the multi-objective optimization of electrical machines *(István Vajda)*
5. Further development and application of a theoretical model of bulk MHS material for the optimization of superconducting magnetic bearings and bulk superconducting rotating electrical machines *(István Vajda)*
6. Materials science aspects of parameter optimization for resistance welding *(Gyula Bagyinszki)*
7. Production and characterization of steels reinforced with nanostructured oxide dispersion *(Csaba Balázsi, Katalin Balázsi)*
8. Experimental and numerical investigation of creep and thermal expansion in zirconium tubes *(Zoltán Hózer)*
9. The effect of hydrogen on the properties of nuclear reactor fuel cladding *(Zoltán Hózer)*
10. Perdynamic modeling of nonlinear deformation of solids *(Viktor Gonda)*
11. Modeling of creep deformation in the presence of direct current *(Endre Ruszinkó)*
12. Study of polymer-ceramic-metal composite systems *(Károly Belina)*
13. Binding technologies applicability segments segments for *(Gyula Bagyinszki)*
14. Investigation of semi-solid state formation *(Viktor Gonda, Mihály Réger)*
15. Development of a biocompatible material for 3D printing *(Tünde Kovács)*
16. Creep in soldering materials: finite element analysis *(Viktor Gonda)*
17. Modeling of additive manufacturing technology *(Viktor Gonda)*
18. Investigation of micro- and macro-accuracy of free-form milled surfaces *(Balázs Mikó)*
19. Analysis of dimensional measurements using computed tomography *(Ágota Drégelyi-Kiss)*
20. Investigations on measurement uncertainty of feature measurements of CMMs *(Ágota Drégelyi-Kiss)*
21. Toolpath optimization for machining free-form surfaces with a ball-end mill *(Balázs Mikó)*

22. Optimization of the dimensional chain considering design and manufacturing aspects *(Balázs Mikó)*
23. Optimization of measurement points in coordinate measurement technology *(Balázs Mikó)*
24. Ultrasound and Irreversible Deformation of Metals *(Endre Ruszinkó)*
25. The effect of ultrasonic welding on microstructure and mechanical properties *(Tünde Kovács)*
26. Deformation mechanisms and performance of ECAP-processed Al alloys and composites *(Viktor Gonda)*
27. Decision-preparation procedures based on mathematical models in operations management *(László Pokorádi)*
28. Surface treatment technology development 3D printing manufactured titanium alloys for improving implant-tissue integration *(Tünde Kovács, Hajnalka Hargitai)*
29. Consumable-electrode inert gas MIG/MAG robotic welding dynamic arc stabilization options *(Károly Széll)*

d) Micro- and nanosystems, functional materials

Micro- and nanotechnologies are the result of the latest technological advancements; their application has brought about breakthroughs in numerous fields and enabled the development of new functions. Within this topic, the faculty of the doctoral school focus on the study of complex nanostructures, as well as the fabrication and characterization of metal- and semiconductor-based systems, while also addressing specific nanotechnology-based properties of metals. Basic research on organometallic frameworks, fullerenes, and carbon nanotubes contributes to the development of composite technology. The analysis of microcontaminants in water has environmental significance.

1. Functional gels containing biologically active molecules *(Krisztina Nagyné László)*
2. Gel composites containing carbon nanoparticles *(Krisztina Nagyné László)*
3. Study of complex nanostructures using infrared spectroscopy *(Katalin Kamarás)*
4. Memory properties of silicon nitride-based non-volatile memory devices *(Zsolt József Horváth)*
5. Preparation and characterization of steels reinforced with oxide dispersion in a nanostructured matrix *(Csaba Balázsi, Katalin Balázsi)*
6. Electrical properties of metal-compound semiconductor contacts *(Zsolt József Horváth)*
7. Investigation of molecular beam epitaxial nanostructures and technical conditions for their production (*Ákos Nemcsics)*
8. Modeling the Particulate Behavior of RHEED Oscillations Using the MC Method (*Ákos Nemcsics)*
9. Investigation of semiconductor-electrolyte interfaces for solar cell applications *(Ákos Nemcsics)*
10. Investigation of modern, unconventional solar cells *(Ervin Rácz)*
11. Research on GaInAsP/InP LEDs *(Vilmos Rakovics)*
12. Investigation of selective reactions in organometallic frameworks *(Éva Kováts)*
13. Supramolecular and coordination solids *(Sándor Pekker, Éva Kováts)*
14. Fabrication and application of micro-scale force-measuring devices based on piezoresistive and piezoelectric principles *(Andrea Csikósné Pap)*
15. Characterization of light absorption and scattering by suspended matter in natural waters based on the measurement of effective refractive index *(Miklós Serényi)*
16. Fabrication of calcium phosphate-based layers and fibers and investigation of their structural properties *(Katalin Balázsi)*
17. Preparation and investigation of aluminum CNT and graphene nanocomposites *(Katalin Balázsi, Csaba Balázsi)*
18. Investigation of multimodal microsystems implantable into nervous tissue *(Zoltán Fekete)*
19. Novel computing technology using phase-change materials *(Krisztián Koháry)*

20. Novel flexible and high-resolution display technology *(Krisztián Koháry)*
21. Research on polymer-based biosensors *(Gergely Márton)*
22. Optical investigation of nanostructured thin films (Miklós Fried)
23. Design and application of a sensor for detecting heavy metal ions in our environment *(Abdul Shaban)*
24. Organic-inorganic nanocomposites and and application in artificial photosynthesis *(Dávid Srankó, József Sándor Pap)*
25. From macromolecules with branched topologies to smart polymers *(Béla Iván)*
26. Synthesis and characterization of aluminum CNT and graphene nanocomposites *(Katalin Balázsi, Csaba Balázsi)*
27. Synthesis of calcium phosphate-based layers and fibers and investigation of their structural properties *(Katalin Balázsi)*
28. Integrated microfluidic / Lab-on-a-Chip systems for point-of-care medical diagnostic applications *(Péter Fürjes)*
29. Creating “twistronic” devices with layered materials *(Péter Nemes-Incze)*
30. Low-dimensional nanostructures for the optical detection of biomolecules and gases *(Péter Petrik)*
31. Zero-dimensional nanostructures for improving the efficiency of GaAs-based solar cells *(Ákos Nemcsics)*
32. Combinatorial Preparation and Characterization Methods for High-Throughput Study of Advanced Functional Materials *(Miklós Fried)*
33. Non-destructive optical mapping tool made from inexpensive components *(Miklós Fried)*

e) Environmental Protection

Materials science also plays an important role in solving environmental problems. In addition to environmentally conscious development, the identification, transformation, and recycling of waste and pollutants, as well as the degradation of larger, non-biodegradable molecules to make them biodegradable, and the production of corrosion-inhibiting nano- and micro-coating layers are also tasks of materials science.

1. Development of biodegradable drug carriers *(Éva Kiss)*
2. Characterization of light absorption and scattering by suspended matter in natural waters based on the measurement of effective refractive index *(Miklós Serényi)*
3. Co-pyrolysis of biomass and plastic waste *(Zsuzsanna Novákné Czégény)*
4. Development of methods for analyzing new types of pollutants *(Zoltán Juvancz)*
5. Environmentally beneficial chemical transformations and degradation of polymers and plastics (Béla Iván)
6. The role of component characteristics and manufacturing parameters in the recyclability of various paper products *(László Koltai)*
7. Radiation-induced degradation of water-soluble antibiotics (fluoroquinolones) (Erzsébet Takács, Erzsébet Illés)
8. Acoustic metamaterials and their application in noise reduction *(Lívia Pintér Cveticanin)*

4.2. International Relations

To help participants gain international experience and build a network of contacts, ATDI leverages the foreign partnerships of the *Erasmus* program at Óbuda University—which has been recognized with the E-Quality European Quality Award and the Award for Excellence in International Cooperation Culture—

as well as *the international collaborations of its doctoral advisors and faculty members.* The ATDI strives to play an active role in the activities of international networks; this is becoming increasingly prominent in several fields.

Under the Erasmus program, doctoral students and their advisors can travel to partner institutions based on bilateral agreements signed with the University's partner institutions. The personal academic connections of advisors and faculty members also provide opportunities for doctoral students to travel.

The ATDI also seeks to establish partnerships with doctoral schools and training programs abroad.

5. ACADEMIC REQUIREMENTS

5.1. Academic requirements

On December 1, 2015, the National Assembly adopted Act CCVI of 2015 on the amendment of certain laws regulating education. Accordingly, the doctoral program consists of 8 semesters, during which the student must earn 240 credit points to obtain the certificate of completion. The general regulations regarding credits that can be earned in doctoral programs are contained in the Óbuda University Doctoral Credit Regulations [Appendix D2) of the University Doctoral and Habilitation Regulations].

The doctoral program consists of two phases: the first four semesters are the "training and research" phase, and the second is the "research and dissertation" phase. At the end of the fourth semester, as the conclusion of the training and research phase and as a prerequisite for beginning the research and dissertation phase, students must pass a comprehensive examination that assesses and evaluates their academic and research progress.

Individuals who have prepared for the degree on their own may also enroll in the doctoral program, provided they have met the admission and doctoral program requirements. In this case, student status is established upon application for the comprehensive exam and its acceptance.

In the theoretical part of the comprehensive exam, the examinee takes exams in at least two and at most three subjects/topics. Recommended subjects/topics for the comprehensive exam:

1. Chemistry and Physics of Polymers (Pekker S.)
2. Cellulose Chemistry (Borsa J.)
3. Technology of Technical Ceramics (Dusza J.)
4. Mechanics of Materials (M. Ruszinkó)
5. Information Storage Devices and Material Structures (Zs. Horváth)
6. Micro- and Nano-Electromechanical Structures (Zs. Horváth)
7. Applications of Polymers in Microtechnology (Csikósné Pap A.)

8. Compound Semiconductors and Their Optoelectronic Applications (Rakovics V.)
9. Materials testing methods (Telegdi, Takács, Klébert, Károly Z.)
10. Modern separation methods in materials testing (Z. Juvancz)

The Doctoral School Council may approve examination topics in addition to those listed above.
In the second part of the comprehensive examination, the candidate presents their knowledge of the literature, reports on their research results, outlines their research plan for the second phase of the doctoral program, and provides a timeline for the completion of the dissertation and the publication of the results.

The doctoral candidate must submit their dissertation within three years of the comprehensive examination.

5.2. Acceptance of studies outside the doctoral school

The Doctoral School Council may grant partial exemption from fulfilling any element of the program requirements (academic, research, teaching) provided that

- the student engaged in activities relevant to the doctoral program prior to the start of the program;
- the student is participating in a partial program outside the institution (at a research institute, company, or abroad).

The Doctoral School Council is authorized to decide on the approval of the work program for off-campus partial training. The credit value of courses completed in this manner is determined by the Doctoral School Council.