Óbuda University Doctoral School

of Materials Science and Technology

Curriculum

Updated
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1. AIM OF THE PROGRAM

The Faculty of Light Industry and Environmental Engineering at Óbuda University has decades of tradition in training professionals for the textile and clothing industry, as well as the paper, packaging technology and printing industries. Since 2008, the bachelor's degree in light industry engineering has been supplemented by **a master's degree in light industry engineering(**[1]).

With its **light industry** products, it plays a role *in improving the* increasingly important *quality of life* and *in technological changes that promote sustainable growth*. In order to remain internationally competitive, in addition to manufacturing its traditional products to a high standard, it must also meet the expectations of technological development and various industries and services. Light industry products are used, for example, in the automotive industry, in separation technologies (filter textiles, membranes), in road construction (geotextiles), in composites, in building materials, in healthcare, and in the packaging and printing industries, etc. In addition to traditional applications in the textile industry, technical textiles are now covering an increasingly large area. New raw materials and technologies have emerged in this field. Well-founded research that fits in well with European R&D&I topics contributes to the light industry's presence in demanding markets with products that have *high intellectual added value* and are developed in whole or in part in-house. Representatives of the light industry must participate in the division of labor as competent partners, becoming organically integrated into virtually integrated European product chains.

Materials science aspects of the light industry: The traditional raw materials of the light industry belong to the polymer family. For new applications

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

, there is a growing need for knowledge of other materials science disciplines (metals, ceramics) in the design of various associated systems. Modern processes are increasingly using micro- and nanotechnologies. Sustainability considerations are essential for the further development of the industry.

Expertise: In order to meet the modern requirements of the light industry, we need professionals with in-depth theoretical knowledge who are able to keep pace with rapid developments and even initiate progress.

Based on the above, **the aim of the Doctoral School of Materials Science and Technology (ATDI)** is to train professionals who have comprehensive knowledge of materials, specialize in a field relevant to their research, and are able to use their knowledge to perform creative work based on independent thinking in the field of materials science and its practical applications.

Training and research areas

The doctoral school provides *general knowledge of materials science and materials testing*, and, in line with the needs of the light industry and the master's program in light industry engineering offered by the University, it focuses on raw materials used in the light industry as *macromolecular systems,* paying special attention to environmentally friendly natural raw materials and their application in new areas. In line with the changes in the light industry described above, the doctoral school aims to provide participants with an insight into other areas of materials science, such as *metal and ceramic* sciences, and to enable them to participate in research in these fields.

Another important activity of the doctoral school, which is also based on the traditions of the University*, is* the transfer of knowledge related to *micro- and nanostructured systems,* including the transfer of knowledge related to functional and intelligent micro- and nanostructured metallic, semiconducting, or insulating materials and systems, as well as research into these systems, the examination of their potential areas of application, and their integrability into other systems. It is important to study non-metallic micro- and nanostructured materials in the surface treatment (functionalization) of light industrial products and in complex systems (composites).

The comprehensive study of individual areas of materials science in the doctoral school is in line with the position statement published in 2010 by the six technology platforms of the European Union[2], according to which materials science research and development can be made more effective by integrating different areas.

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

Teachers and supervisors at the doctoral school

The training and research of the doctoral school is mainly carried out by lecturers and researchers from Óbuda University, as well as guest lecturers and supervisors from other universities in the country (University of West Hungary, Budapest University of Technology and Economics, University of Debrecen). The doctoral school cooperates on a contractual basis with the Energy Research Center of the Hungarian Academy of Sciences (MTA EK) and the Wigner Research Center for Physics (MTA Wigner FK). In addition to the staff of these institutes, several researchers from the MTA Natural Sciences Research Center (MTA TTK) are also involved in the work of the doctoral school.

2. KNOWLEDGE UNDERPINNING THE DOCTORAL SCHOOL (master's programs)

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

Typically, suitable prior studies 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 TRAINING

3.1. Structure of the program

In line with its objectives, the doctoral school provides comprehensive knowledge of materials science, general materials science and materials testing, and offers knowledge of specific areas of materials science tailored to the needs of the industry: it gives priority to polymers, which are raw materials for the light industry, and extends the training to other types of materials also used in the light industry, such as ceramics and metals. It also deals specifically with modern materials technology, micro- and nanosystems, and composites, which are used in many areas. Environmental protection, which is important from the point of view of sustainable development, is represented by general issues in the light industry and two important areas of technology.

We offer complex, general (foundational) and specialized knowledge of materials science in the following subjects:

Materials Science Seminar

Fundamental subjects in materials science

a) General materials science
b) Materials testing methods

Subject-specific courses (specific areas of materials science)

c) Polymer materials, technologies
d) Ceramics, technologies
e) Metallic materials, technologies
f) Micro- and nanostructured systems
g) Composites
h) Certain environmental aspects of materials science technologies

Other subjects

3. 2. Courses (detailed description in a separate document)

Materials Science Seminar (3 credits, signature)

Lectures by renowned guest speakers on various topics in the diverse field of materials science are designed to give students researching a particular topic and taking courses related to that topic a broad overview of materials science and to acquire *coherent knowledge of materials science* to the extent possible.

Fundamentals of Materials Science (6 credits, exam)

a) General materials science

1. Physical chemistry of surfaces *(Krisztina László)*
2. Porous Materials *(Krisztina László)*
3. Fundamentals of colloid chemistry in nanotechnology *(Zoltán Hórvölgyi)*
4. Fundamentals of Radiochemistry *(László Wojnárovits)*
5. Solid state chemistry *(András Stirling)*
6. Color chemistry *(András Víg)*
7. Introduction to plasma chemistry *(Zoltán Károly, Szilvia Klébert)*

b) Materials testing methods

1. Selected chapters from material testing methods I. *(Erzsébet Takács, Judit Telegdi)*
2. Selected chapters from material 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. Examination of surface microgeometry and microtopography *(Béla Palásti-Kovács)*
8. Methods for examining microelectronic materials and structures *(Balázs Kovács)*
9. Finite element modeling of heat transfer *(Ferenc Divós)*

Subject-specific topics (6 credits, exam)
(specific areas of materials science)

c) Polymer materials and technologies

1. Chemistry and physics of polymers *(Sándor Pekker)*
2. Physics of macromolecules *(Károly Belina)*
3. Characterization and modification of polymer surfaces *(Éva Kiss)*
4. *N a t u r a l* and natural-based polymers *(Cecília Tamásné Nyitrai)*
5. Cellulose chemistry *(Judit Borsa)*
6. Paper industry fiber materials and their surface characteristics *(László Koltai)*
7. Cellulose and paper production (László Koltai)
8. Mechanical and physical properties of paper and corrugated products *(László Koltai)*
9. Printing substrates and printing inks interaction 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 clothing products *(Lívia Kokasné Palicska)*
13. Characteristics of antimicrobial raw materials in the light industry *(Bayoumi Hamuda Hosam)*
14. The use of polymers in microtechnology *(Andrea Csikósné Pap)*

d) Ceramics, technologies

1. Technology of technical ceramics *(János Dusza)*
2. Material structure and fracture mechanism of technical ceramics *(János Dusza)*
3. Mechanical properties of technical ceramics *(János Dusza)*
4. Modern technical ceramics *(Szilvia Klébert)*

e) Metallic materials, technologies

1. Phenomena related to continuous steel casting *(Mihály Réger)*
2. Modeling of thermally activated transformation processes in alloys *(Tamás Réti)*
3. Concentrated energy input material technologies *(Gyula Bagyinszki)*
4. Knowledge of powder technology *(Csaba Balázsi)*
5. Fundamentals of plasticity theory *(Endre Ruszinkó)*
6. Non-classical tasks of plasticity and creep *(Endre Ruszinkó)*
7. Electrochemical methods for measuring corrosion and inhibition

f) 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 *(József Horváth)*
9. Micro- and nano-electromechanical structures *(József Horváth)*
10. The colloid chemistry fundamentals of nanotechnology (Zoltán Hórvölgyi)
11. Characterization and modification of polymer surfaces (Éva Kiss)
12. The use of microcapsules in modern industry *(Judit Telegdi)*
13. Application of polymers in microtechnology *(Andrea Csikósné Pap)*
14. Adhesive-free slice bonding *(Andrea Csikósné Pap)*
15. Elements and compounds in micro-scale gas sensors *(Andrea Csikósné Pap)*
16. Testing methods for microelectronic materials and structures *(Balázs Kovács)*

g) Composites

1. Composites *(Szilvia Klébert)*

h) Certain environmental aspects of materials science technologies

1. Environmental protection in light industry *(István Patkó)*
2. Recycling plastic waste through pyrolysis *(Zsuzsanna Czégény)*
3. Going Green… environmentally friendly printing *(Csaba Horváth)*

Other subjects

1. Statistical hypothesis testing *(Márta Takács)*
2. Decision-making methods – operations research *(Kornélia Ambrusné Somogyi)*
3. Engineering education *(Péter Tóth)*

4. RESEARCH AND INTERNATIONAL RELATIONS OF THE DOCTORAL SCHOOL

4.1. Research topics (detailed description in a separate document)

The topics are grouped by subject area. (Each topic is listed only once, even though it may belong to two areas.)

a) Polymers
b) Ceramics
c) Metals
d) Micro- and nanosystems
e) Environmental protection

a) Polymers

Research in polymer chemistry and technology primarily covers traditional raw materials used in light industry, their identification, transformation, and new applications. The processing of various sources of cellulose (cotton, hemp, wood, etc.), the largest renewable raw material found in nature, plays a significant role in the development of new functions for various purposes and the recovery of cellulose-based raw materials (1-14). Cellulose and other polymer-based gels also belong to this field of research (15-17). Technical and innovative plastics represent topics in which generally applicable testing methods can be learned (18-19) and polymers with intelligent behavior and environmentally beneficial properties can be developed (20-22).

1. Investigation of the properties of eco-fibers *(János Dusza)*
2. The effect of quaternary ammonium hydroxides on cellulose-based fibers *(Tünde Tóth)*
3. Modification of hemp fiber using alkaline swelling and ultrasound *(Judit Borsa)*
4. The role of incidental wood materials in the formation of colored wood defects *(Levente Albert)*
5. Degradation of wood caused by UV lasers *(György Papp)*
6. The use of transverse sound waves in the examination of wood and wood materials *(Ferenc Divós)*
7. Parametric and electron microscopic analysis of the surface microgeometry and microtopography of paper printing substrates *(Rozália Szentgyörgyvölgyi, Béla Palásti Kovács)*
8. Characterization of original and modified paper industry fibers using scanning electron microscopy *(Lászlóné Telegdi)*
9. -based packaging materials solvent retention capacity *(Rozália Szentgyörgyvölgyi, Szilvia Klébert)*
10. Introduction of new cellulose-based chiral stationary phases *(Zoltán Juvancz)*

11. Study of the non-paper industry applications of cellulose fibers *(Tamásné Nyitrai Cecília)*
12. Modification of cellulose by ionizing radiation-initiated etching *(Erzsébet Takács)*
13. Surface modification and functionalization of textiles with non-equilibrium plasmas (Zoltán Károly, Szilvia Klébert)
14. The role of component characteristics and manufacturing process parameters in the recyclability of various paper products (András Víg)
15. Application of ionizing radiation for the production of cellulose-based hydrogels *(Erzsébet Takács)*
16. Functional gels containing biologically active molecules *(Krisztina Nagyné László)*
17. Carbon nanoparticles gel composites gel composites *(Krisztina Nagyné Krisztina Apoláros)*
18. Apoláros polymers atmospheric pressure mass spectrometry *(Sándor Kéki)*
19. Relaxation processes in engineering plastics *(Károly Belina)*
20. From branched topology macromolecules to intelligent polymers *(Béla Iván)*
21. Environmentally beneficial chemical conversion and degradation of polymers and plastics *(Béla Iván)*
22. Development of biodegradable drug carriers *(Éva Kiss)*

b) Ceramics

Engineering ceramics and various composites reinforced with glass, metal, plastic, carbon fiber, etc. are increasingly being used in the light industry. The study of the macro- and microstructure of these materials contributes to the optimization of their properties in accordance with the requirements of the field of application.

1. Examination of composites used in light industry *(János Dusza)*
2. Carbon nanotubes and graphene containing silicon nitride *(János Dusza)*
3. Development of super-hard ceramic coatings *(János Dusza)*
4. Application of SiC as cladding for nuclear power plant fuel elements *(Zoltán Hózer)*
5. Investigation of microwave absorbers *(Zoltán Király, Szilvia Klébert)*

c) Metals

The curriculum for light industry engineers includes materials science, including the main characteristics of metallic materials and alloys. The doctoral school aims to provide further education opportunities for students who have developed a long-term interest in this subject or curriculum. Materials engineers and mechanical engineers who mainly study metals during their MSc studies can also find topics that match their interests.

1. Measurement and estimation of enrichment characteristics during continuous steel casting *(Mihály Réger)*
2. Stability of centerline segregation *(Mihály Réger)*
3. New materials and designs for increasing the power density of electric rotating machines *(István Vajda)*
4. Resistance welding Parameter optimization *(Gyula Bagyinszki)*
5. Combined application of activation analytical methods for the analysis of metal alloys *(Zsolt Révay)*
6. Nanostructured oxides reinforced steels Production and characterization *(Csaba Balázsi)*

d) Micro- and nanosystems, functional materials

Micro- and nanotechnologies are the result of the latest technological developments, and their application has led to breakthroughs in many areas. Within this topic, the doctoral school aims to study complex nanostructures (1) and to produce and characterize metal- and semiconductor-based systems (2-7), also touching upon the corrosion protection of metals based on nanotechnology (8). Functional textiles containing various active ingredients (9), and within these, microencapsulation technology (10), are among the latest developments. Basic research on metal-organic frameworks, fullerenes, and carbon nanotubes contributes to the development of composite technology (11-13). The analysis of micropollutants in water is of environmental importance (14).

1. Study of complex nanostructures using infrared spectroscopy *(Katalin Kamarás)*
2. Silicon nitride based non volatile memory structures *(Zsolt József Horváth)*
3. Production and characterization of nanostructured oxide-dispersed reinforced steels (Csaba Balázsi)
4. Electrical properties of metal-compound semiconductor contacts *(Zsolt József Horváth)*
5. Investigation of molecular beam epitaxy nanostructures and technical conditions for their production (*Ákos Nemcsics)*
6. A RHEED oscillation particular behavior using using the MC method (*Ákos Nemcsics)*
7. Research on GaInAsP/InPLEDs *(Vilmos Rakovics)*
8. Nano- and microlayers in materials deterioration against in aggressive environments *(Lászlóné Telegdi)*
9. Examination of the effectiveness of antibacterial textiles against multi-resistant pathogenic bacteria *(Ákos Tóth)*
10. Production, characterization, and textile industry application of capsules containing antibacterial agents *(Lászlóné Telegdi)*

11. Investigation of selective reactions in metal-organic frameworks *(Éva Kováts)*
12. Supramolecular and coordination solids *(Sándor Pekker, Éva Kováts)*
13. Carbon nanoparticles gel composites gel composites *(Nagyné Krisztina László)*
14. Characterization of light absorption and scattering of suspended matter in natural waters based on effective refractive index measurements *(Miklós Serényi)*

e) Environmental protection

One of the serious tasks of the light industry is to prevent pollution caused by technologies (e.g., chemicals and dyes used in the paper and textile industries) from entering the environment and to render such pollution harmless. Environmental awareness plays an important role in solving pollution problems (1), the identification, conversion, and recycling of waste and pollutants (2-6), and the degradation of larger molecules that are not biodegradable, thereby making them biodegradable (7-9). In addition to the above, the production of corrosion-inhibiting nano- and micro-layers
(10) – in addition to its scientific significance – also has economic importance.

1. Development of biodegradable drug carriers (Éva Kiss)
2. Characterization of light absorption and scattering of suspended matter in natural waters based on effective refractive index measurement *(Miklós Serényi)*
3. Combined pyrolysis of biomass and plastic waste (*Zsuzsanna Czégény)*
4. Development of a new type of pollutant analysis *(Zoltán Juvancz)*
5. Environmentally beneficial chemical conversion and degradation of polymers and plastics (Béla Iván)
6. The role of component characteristics and manufacturing process parameters in the recyclability of various paper products *(András Víg)*
7. Degradation of water-soluble organic substances using high-energy radiation *(László Wojnárovits)*
8. Radiation-induced degradation of water-soluble antibiotics (fluoroquinolones) *(Erzsébet Takács, Erzsébet Illés)*
9. Changes in the structure of micellar systems and the persistent organic substances they solvate as a result of high-energy ionizing radiation wastewater treatment *(Erzsébet Takács, Tamás Csay)*
10. Nano- and micro-layers against material deterioration in aggressive environments *(Lászlóné Telegdi)*

4.2. International relations

ATDI intends to make use of the foreign partnerships of the *Erasmus* program, which operates excellently at Óbuda University and has been awarded the E-Quality European Quality Award and the International Cooperation Culture Award, as well as *the international cooperation of its doctoral supervisors and lecturers.*

Under the Erasmus program, doctoral students and their supervisors can also travel to partner institutions on the basis of bilateral agreements concluded with the University's partner institutions. E.g.

Bolton University, Great Britain Ege University Izmir, Turkey Tampere University, Finland Universidade do Minho, Portugal University of Ljubljana, Slovenia University of Maribor, Slovenia University of Zagreb, Croatia

The personal academic relationships of supervisors and lecturers also provide opportunities for doctoral students to travel.

5. STUDY REQUIREMENTS

5.1. Study requirements

The doctoral program lasts six semesters, during which students must earn 180 credit points to obtain their degree. The general regulations governing the credits that can be earned in the doctoral program are contained in the Óbuda University Doctoral Credit Regulations (EDSZ Annex 2).

Credits can be earned in the program based on the following activities:

- Completion of courses;
- Research;
- Teaching.

The credits that can be earned or minimum obtainable number of credits are is as follows:

Total credits to be earned: 180

- **Courses: at least 48 credits,** with a value of 6 credits per course.
  - o Compulsory subjects: Materials Science Seminar, 2 subjects in basic materials science, and 2 subjects serving to establish the research topic. These subjects are approved by the doctoral school council on the recommendation of the supervisor.

- The student may freely choose 4 additional subjects from among all subjects offered by the doctoral school, with the consent of the supervisor.

- **Research (three components)**
  - Semesterly (written and oral) research report (*44 credits):*
    - Semesters 1-4: 6-6 credits (24 credits),
    - Semesters 5-6: 10-10 credits (20 credits).
  - Active participation in a research project*: 6-10 credits/project*.
  - Publications related to the research topic: *at least 50 credits* according to the Credit Regulations of the Doctoral Regulations.

- **Teaching**: **maximum 45 credits,** 2 credits per week for 1 contact hour= .

5.2. Curriculum

The recommended course structure and the order of compulsory reports are shown in the table below:

Type of subject	Semester					
	1	2	3	4	5	6
Fundamentals of Materials Science 1.	X					
Fundamentals of Materials Science 2.	X					
Subject Area 1.		X				
Subject area course 2.		X				
Elective subject 1.			X			
Elective subject 2.			X			
Elective subject 3.				X		
Elective subject 4.				X		
Research report	X	X	X	X	X	X

5.3. Monitoring academic progress

- During the program, students are required to earn an average of 30 (minimum 21) credits per semester.
- Specific milestones during the program (minimum credits required to continue the program):
  - 50 credits at the end of the first academic year;
  - 110 credits at the end of the second academic year;

These study progress requirements are the same for full-time (scholarship) and part-time students; students in individual training programs are free to complete the 180 credits according to their own plans.

5.4. Acceptance of studies outside the doctoral school

The Doctoral School Council may grant partial exemption from any element of the training requirements (academic, research, teaching) if

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

The Doctoral School Council is authorized to decide on the acceptance of the work program for partial training outside the institution. The credit value of courses completed in this manner is determined by the Doctoral School Council.