KAUNAS UNIVERSITY OF TECHNOLOGY

STUDY MODULE PROGRAMME (SMP)

Module Code	T	150	M	222	Accredited until	2025	09	01	Renewal date		
	Branch of Science		Progr.	Registr. №.							

Entitlement

Clean Room Technologies

Prerequisites

Basic Courses of Physics, Mathematics and Information technology

Main aim

To teach the basic knowledge about modern clean room technologies acquiring the practical skills to carry out operations of micro- and nanotechnology including the ability to create and control very small objects.

Course (module) Learning Outcomes

№.	Outcomes	Teaching / Learning Methods	Assessment Methods
1	Students acquire clean room operation instructions and they are able to use the corresponding equipment	Lecture	Individual work
2	Students are able to perform processes of thin film deposition and dry etching in vacuum as well as to evaluate the parameters of thin films by laser ellipsometer	Laboratory classes	Laboratory examination
3	Students are able to perform and evaluate the processes of optical microlithography	Laboratory classes	Laboratory examination
4	Students acquire principles of electron beam nanolithography and they are able to use a scanning electron microscope	Laboratory classes	Laboratory examination
5	Students acquire principles of nanoimprint lithography and they are able to use the atomic force microscope	Laboratory classes	Laboratory examination
6	Students are able to use clean room technologies to create and control very small objects	Individual project, Laboratory classes, Tutorial	Laboratory examination, Laboratory notes and report, Oral examination

Summary

Theoretical knowledge on modern clean room technologies acquiring the practical skills to carry out operations of micro- and nanotechnology in strictly controlled environment will be assimilated. After completion of course students will be able to perform operations of micro- and nanotechnology (thin film vacuum deposition, optical, electron beam, nanoimprint lithography, plasma chemical etching, ion beam sputtering, etc.) to create very small objects. The students will be taught to work independently with the selected equipment (the certificate will be issued). The students will gain experience in preparation of research paper.

Level of module

Level of programme		Subject group	Subject level
Cycle	Degree		
Second	Master	Special Subjects	Applied

Syllabus

№.	Sections and themes
1.	Clean room technologies
1.1	Introduction to the clean room technologies.
1.2	Thin film deposition in clean room environment.
1.3	Plasma-chemical etching of thin films.
1.4	Ion beam etching of thin films and multilayers.
1.5	Modern technologies of micro- and nanolithography. Optical lithography.
1.6	Electron beam nanolithography.

№.	Sections and themes
1.7	UV-nanoimprint lithography.
1.8	Thermal nanoimprint lithography and micro-contact printing.

Evaluation procedure of knowledge and abilities:

The ten-grade scale and the cumulative evaluation system are applied. The module's final evaluation consists of the sum of multiplications of the grades of the intermediate assessments and the final assessment multiplied by weighting coefficients (percentage components).

References

№.	Title	Edition in KTU library		In KTU bookstore	Number of ex. in the methodical cabinet of the depart.
		Pressmark	Number of exemplars		
1.	Jonas Vilys, Sigitas Tamulevičius, Viktoras Grigaliūnas, Šarūnas Meškinis, Asta Guobienė. Paviršiaus inžinerija ir nanotechnologijos. Mokomoji knyga. Kaunas: Vitae Litera, 2007. 225 psl.	D198358		Yes	16
2.	Asta Guobienė ir kt. Medžiagų mokslas: laboratoriniai darbai. Mokomoji knyga. Kaunas: Dakra, 2013. 130 p.	KTU02-000050466		Yes	20
3.	Saulius Raila, Viktoras Grigaliūnas, Vitoldas Kopustinskas, Juozas Margelevičius, Igoris Prosyčevas. Neardančioji gaminių kontrolė: mokomoji knyga. Kaunas: Technologija, 1998. 74 p.	KTU02-000010626		Yes	5

Additional literature

№.	Title
1.	P. Rai-Choudhury. Handbook of Microlithography, Micromachining, and Microfabrication, SPIE Optical Engineering Press, Bellingham, Washington, 1997.
2.	http://www.afmworkshop.com/atomic-force-microscope-animated-tutorials/
3.	Entering Clean Room Training Video: https://www.youtube.com/watch?v=Fb-qxEVHGgk
4.	Basic Introduction to a Clean Room: https://www.youtube.com/watch?v=ggG_smKxEBI
5.	What is a Cleanroom (or Clean Room)?: https://www.youtube.com/watch?v=tVAZo2uhOB0
6.	E-beam Evaporator (1 of 2) - training video (Georgia Tech - Microelectronics Research Center): https://www.youtube.com/watch?v=hAht2ME2TPI
7.	E-Beam Lithography, University of Washington, Part 1-3: https://www.youtube.com/watch?v=bvgITKqYpuY, https://www.youtube.com/watch?v=fZmC5xeHHaw, https://www.youtube.com/watch?v=ktkDqofYfMY
8.	Photolithography: https://www.youtube.com/watch?v=9x3Lh1ZfggM
9.	Nanoimprint lithography (NIL) at DTU: https://www.youtube.com/watch?v=i-2vHoYh9T0
10.	Nanoimprint Lithography, part 1-2, Lecture: https://www.youtube.com/watch?v=2O8JVB5i1R4, https://www.youtube.com/watch?v=HnYQVxOhkLc

Lecturer

	Position	Name, surname
Coordinating	General Research Assistant	Viktoras GRIGALIŪNAS

Subdivision

	Entitlement	Code	Contribution, %
Atsakingas padalinys	Institute of Materials Science	70	100

Languages of instruction

Spring semester:	Lithuanian, English

Teaching form

№.		Semester	Structure		Credits

	Mode of studies			Lectures	Practical (supervised)	Laboratory (supervised)	Tutorial	Independent Learning	Total hours	
1	Standard	A	S	11	11	21	21	96	160	6

Teaching form Standard

Schedule of individual work tasks and their influence on final grade

Assessment form	Final Assessment	№. of syllabus	Total hours	Influence on grade, %	Week of presentment of task (*) and reporting (o)															
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17-20
Laboratory notes and report		2-8	18	10		*						o								
Laboratory examination		2-8	18	20		*						o								
Individual work		9-12	28	20									*							o	
Oral examination	√	13-16	32	50													*				o
Total:	-	-	96	100																	

Assessment criteria and connection to the study module's study results

Assessment form	Assessment week	Assessment criteria	Course (module) Learning Outcomes
Laboratory examination	8	• The laboratory work was presented properly, all questions were answered.	• Students acquire principles of electron beam nanolithography and they are able to use a scanning electron microscope • Students acquire principles of nanoimprint lithography and they are able to use the atomic force microscope • Students are able to perform and evaluate the processes of optical microlithography • Students are able to perform processes of thin film deposition and dry etching in vacuum as well as to evaluate the parameters of thin films by laser ellipsometer • Students are able to use clean room technologies to create and control very small objects
Laboratory notes and report	8	• The layout and description of laboratory work is correct.	• Students are able to use clean room technologies to

Assessment form	Assessment week	Assessment criteria	Course (module) Learning Outcomes
			create and control very small objects
Individual work	16	• The goal and tasks of the individual work are formulated properly. The relevant issues are analyzed using a novel literature. The appropriate research methods are chosen. The work is done systematically, in detail, in the original manner, without essential errors. Conclusions and recommendations are well formulated. The work is written in the correct language, in a scientific style. The structure and layout of the work is correct.	• Students acquire clean room operation instructions and they are able to use the corresponding equipment
Oral examination	17	• During the exam all questions are properly answered, the student is able to have a reasonable discussion.	• Students are able to use clean room technologies to create and control very small objects