ASIIN Accreditation Report

Master's Degree Programme
Quantum Physics for Advanced Materials Engineering
Multicomponent nanostructured coatings. Nanofilms

Provided by
National University of Science and Technology "MISIS", Moscow

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Table of Content

A About the Accreditation Process

Title of the degree Programme	Labels applied for [1]	Previous accreditation	Involved Technical Committees (TC)[2]
Quantum Physics for Advanced Materials Engineering	ASIIN	N/A	05, 13
Multicomponent nanostructured coatings. Nanofilms	ASIIN, EUR-ACE®	N/A	05, 13
Date of the contract: 19.11.2013 **Submission of the final version of the self-assessment report:** 26.03.2014 **Date of the onsite visit:** 14./15.10.2014 **at:** Hall of Nanotechnologies			
Peer panel: Prof. Dr.-Ing. Werner Jüptner, Bremen University; Prof. Dr. Stefan Sotier, University of Applied Science Munich; Prof. Dr. Michael Müller-Preußker, Humboldt University Berlin; Dr. Frank Prissok, BASF Polyurethanes GmbH Igor Nikishin, M.V. Lomonosov Moscow State University (Student)			
Representative of the ASIIN headquarter: Johanna Zaklika			
Responsible decision-making committee: Accreditation Commission			
Criteria used: European Standards and Guidelines as of 10.05.2005 ASIIN General Criteria as of 28.06.2012			

[1] ASIIN Seal for degree programmes; EUR-ACE® Label: European Label for Engineering Programmes

[2] TC: Technical Committee for the following subject areas: TC 05 – Physical Technologies, Materials and Processes); TC 13 – Physics.

Subject-Specific Criteria of Technical Committee 05 - Physical Technologies, Materials and Processes

Subject-Specific Criteria of Technical Committee 13 - Physics

In order to facilitate the legibility of this document, only masculine noun forms will be used hereinafter. Any gender-specific terms used in this document apply to both women and men.

B Characteristics of the Degree Programmes

a) Name & Final Degree	b) Areas of Specialization	c) Mode of Study	d) Duration & Credit Points	e) First time of offer & Intake rhythm	f) Number of students per intake	g) Fees
Quantum Physics for Advanced Materials Engineering/ Master of Physics		Full time	4 Semester 120 CP	01.09.2009 fall semester	N° 5-15	10. 000 US$ per year
Multicompo-nent nanostruc-tured coat-ings. Nanofilms/ Master of Metallurgy		Full time	4 Semester 120 CP	01.09.2012 fall semester	N° 5-15	10. 000 US$ per year

For the *Master's degree programme Quantum Physics for Advanced Materials Engineering*, the self-assessment report states the following **intended learning outcomes**:

This master's program enables students to orient themselves in the modern scientific and applied research and development of quantum-sized materials and devices through the acquisition of skills in both theoretical calculations in the field of quantum physics of nanosystems as well as experimental measurements using modern equipment in the field of electron and scanning probe microscopy and spectroscopy.

Students are able to:

- use persistently basic knowledge in the field of mathematical, natural, humanitarian and economic sciences in the professional activities.
- use methods and means of energy- and resources-saving technologies which ensure rational natural resource use and environmental protection while implementing production processes.
- have excellent skills in fundamental physics sections required to accomplish scientific research tasks, use the knowledge of modern problems of physics, and advanced achievements of physics in his/her research activity (in accordance with the Master's program "Physics of Nanosystems").

- set at his/her own discretion specific tasks of scientific research in physics (in accordance with the area of expertise of the Master's program) and solve them with modern equipment, information technologies with use of the most recent domestic and foreign experience.
- apply in practice general occupational knowledge and theory, have excellent skills in physics required to meet scientific innovative challenges.
- apply in practice the skills of drawing up and execution of scientific and technical documentation, research reports, reviews, reports and articles in accordance with the area of expertise of the Master's programs "Physics of Nanosystems".
- possess profound professionally and graded knowledge in the field of information technologies, modern computer networks, software products and Internet resources for performing the occupational tasks including those outside of the relevant training for professional activity.
- plan physical researches, organize team's work for performing specific tasks of scientific research, manage the research activities of the team and junior students and schoolchildren in the field of physics
- have professional knowledge for the analysis of parameters of electron, phonon and magnon spectra, voltage-current characteristics of the tunneling and Josephson junctions, electronic transport and magnetic responses to external electric and magnetic fields of metals crystals and dielectrics, and also apply the methods of their theoretical analysis using Green's functions and continual integrals in the quantum field theory of statistical physics.

The following **curriculum** is presented:

Semester	Title of the module	Hours of lectures and discussions	Hours of independent study	Total, hours	Credits (ECTS)
1	1.1 Advanced methods of coatings and nanofilms deposition	18	57	75	3
	1.2 Disperse-strengthened by nanoparticles tribological coatings	16	59	75	3
	1.3 SHS process as a basis of synthesis of inorganic materials	24	76	100	4
	1.4 Russian language (basics)	34	41	75	3
	1.5 Project Management (basics)	17	58	75	3

	1.6 Technological Innovation Management (basics)	12	38	50	2
	Scientific research			250	10
	Term project №1			50	2
Total for Semester 1				**750**	**30**
2	2.1 Nanofilms: fundamental principles, characterization, testing, and application	34	41	75	3
	2.2 Methods of contact and non-contact characterization of surface topography	8	17	25	1
	2.3 Quality Management (basics)	12	38	50	2
	2.4 Management accounts (basics)	12	38	50	2
	2.5 Russian language (basics)	18	57	75	3
	Scientific research			350	14
	Term project №2			125	5
Total for Semester 2				**750**	**30**

Semester	**Title of the module**	**Hours of lectures and discussions**	**Hours of independent study**	**Total, hours**	**Credits (ECTS)**
3	3.1 New methods for studying mechanical properties and standards	24	76	100	4
	3.2 Business valuation and risk management (basics)	12	38	50	2
	3.3 Protection of intellectual property rights (basics)	17	58	75	3
	Scientific research			400	16
	Term project №3			125	5
Total for Semester 3				**750**	**30**

4	4.1 Nanofilms for mechanical engineering and medicine	12	13	25	1
	4.2 Friction and wear of coatings	18	32	50	2
	Scientific research			50	2
	Term project №4			125	5
	Preparation of qualification work (master thesis)			500	20
Total for Semester 4				**750**	**30**
Total				**3000**	**120**

For the *Master's degree programme Multicomponent nanostructured coatings. Nanofilms*, the self-assessment report states the following **intended learning outcomes**:

The graduate who has completed the educational program successfully is supposed to demonstrate as learning outcomes the following competences:

- have skills in the fundamental areas of chemistry, physical chemistry, materials science to solve research and development problems; Use the knowledge of contemporary advantages of materials science in their research activities.
- use skills of drawing up and execution of scientific and technical documents, research reports, reviews, reports and articles on the master's program profile.
- possess profound professionally and graded knowledge in the field of information technologies, modern computer networks, software products and Internet resources for performing the occupational tasks including those outside of the relevant training for professional activity.
- plan physical researches, organize team's work for performing specific tasks of scientific research, manage the research activities of the team and junior students and schoolchildren in the field of physics.
- have professional knowledge for analysis and process control in coating. Be able to work out ways of purposeful changes in the properties of functional materials and coatings. Work on modern research and manufacturing equipment, justify his/her choice, assess the risks and identify measures to ensure the safety of technological processes.

The following **curriculum** is presented:

Semester	**Title of the module**	**Hours of lecture**	**Hours of inde-**	**Hours**	**Credits**

		and discussion	pendent study	total	ECTS
1	Philosophical issues of natural science	58	86	144	4
	Foreign language	36	0	36	1
	Electron Theory of Metals	68	112	180	5
	Quantum Physics of Solids	34	110	144	4
	Term project in area of training	36	72	108	3
	Technology and Materials of Quantum Electronics	34	74	108	3
	Electronic Properties of Quantum-Sized Semiconductor Structures and Heterostructures	34	110	144	4
	Scientific research in semester	0	180	180	5
2	Foreign language	17	19	36	1
	Quantum Physics of Solids	34	110	144	4
	A1*. Laboratory workshop on the study of nanosystems	68	112	180	5
	A2*. Probe microscopy	68	112	180	5
	Term project in area of training	36	36	72	2
	Spectroscopic Methods for Materials Characterization	68	112	180	5
	Scientific research in semester	0	144	144	4
	Scientific research practice	0	360	360	10

3	Foreign language	17	55	72	2
	Term project in area of training	36	0	36	1
	Superconducting circuits and qubits	51	93	144	4
	Quantum mechanics and statistics of nanoparticles	68	76	144	4
	V1*. Physics of Liquid-crystal Membranes	51	93	144	4
	V1*. Experimental Methods in Physics of Low-dimensional Systems	51	93	144	4
	S1*. Introduction to Path Integral Methods in Condensed Matter Physics	68	76	144	4
	S2*. Physical Properties of Quasicrystals	68	76	144	4
	Scientific Research in semester	0	108	108	3
	Scientific Research Practice	0	108	108	3
4	Scientific Research Practice	0	540	540	15
	Master Thesis	0	720	720	20
			TOTAL	**4320**	**120**

C Peer Report for the ASIIN Seal[3]

1. Formal Specifications

Criterion 1 Formal Specifications

Evidence:

- Self-Evaluation-Report
- Website of the programmes[4]

Preliminary assessment and analysis of the peers:

The self-assessment report stated all the relevant formal specifications, such as degree programme title, programme duration, credit points awarded etc. All the relevant programme specifications were available on the website of the University. The relevant documents presented on the webpage were approved by the rector, up-to-date and accessible to all students and teachers.
The peers learned that both master programmes are taught in English and mainly are addressed to foreign students. In addition to the national programmes the University offers international master programmes. One of the general objectives of the University is to strengthen the international alignment. The auditors strongly supported this development and saw the necessity of global competiveness prospectively. The peers recommended to advertise both programmes as international ones.

The auditors noted that tuition is charged but that, in fact, most of the students either receive state grants for their studies or are exempted from the tuition fees due to the cooperation with foreign partner universities. Enrolment on a fee base is possible but only students pay the fees themselves.

Further details are presented in the chapters below (learning outcomes, curriculum credit points).

[3] This part of the report applies also for the assessment for the European subject-specific labels. After the conclusion of the procedure, the stated requirements and/or recommendations and the deadlines are equally valid for the ASIIN seal as well as for the sought subject-specific label.
[4] http://en.misis.ru/academics/programs/quantum-physics/ and
http://en.misis.ru/academics/programs/Nanofilms/ (as consulted online on 22.10.2014)

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 1:

The panel considered the criterion to be fulfilled.

2. Degree programme: Concept & Implementation

Criterion 2.1 Objectives of the degree programme

Evidence:

- Defined programme objectives and learning outcomes in the Self-Evaluation-Report
- Website of the programmes[5]

Preliminary assessment and analysis of the peers:

The objectives of the *Master's programmes Quantum Physics for Advanced Materials Engineering* and *Multicomponent nanostructured coatings. Nanofilms* reflected the level-specific requirements of the European Qualifications Frameworks and can be clearly allocated to level 7.

Criterion 2.2 Learning Outcomes of the Programme

Evidence:

- Defined programme objectives and learning outcomes in the Self-Evaluation-Report
- Module handbook

Preliminary assessment and analysis of the peers:

The panel deemed the definition of the learning outcomes of the *Master's programme Quantum Physics for Advanced Materials Engineering* to be clear and adequate for the qualification of the second academic cycle. The learning outcomes are achievable, accessible, developed together with all relevant stakeholders, and reflect currently foreseeable developments in the field of quantum physics. The definition of the learning outcomes complied with the Subject-Specific Criteria of the ASIIN Technical Committee 13 - Physics and in some parts also with the Subject-Specific Criteria of the ASIIN Technical Committee 05 - Physical Technologies, Materials and Processes. The students are qualified to use their knowledge in the field of mathematical, natural, humanitarian and economic scienc-

[5] http://en.misis.ru/academics/programs/nanosystems/ and http://en.misis.ru/academics/programs/Nanofilms/ (as consulted online on 19.09.2014)

es. The students are prepared for scientific and applied research and development of quantum-sized materials and devices through the acquisition of skills in both theoretical calculations in the field of quantum physics of nanosystems as well as experimental measurements using modern equipment in the field of electron and scanning probe microscopy and spectroscopy. They were capable to make use of their competences in order to analyse parameters of electron, phonon and magnon spectra, voltage-current characteristics of the tunneling and Josephson junctions, electronic transport and magnetic responses to external electric and magnetic fields of metals crystals and dielectrics. Furthermore, they could also apply the methods of their theoretical analysis using (Green's) functions and path integrals in the quantum field theory or statistical physics.

For the study programme *Multicomponent nanostructured coatings. Nanofilms* the peers gained the impression that the learning outcomes are conceived in too general terms and thus do not adequately relate to the specific qualification profile of this masters' degree programme. Up to now the university presented only subject-specific competences in the engineering field while the curriculum is also focused on management and social skills, which are not part of the learning outcomes currently. The university pursued the approach that the students gained knowledge for analysis and process control in coating and have excellent skills in the fundamental areas of chemistry, physical chemistry, materials science to solve research and development problems. Furthermore, the students possessed profound professionally and graded knowledge in the field of information technologies, modern computer networks, software products and internet resources for performing the occupational tasks. Along with specialized expertise the students also are made familiar with business management questions (project management, innovation management), legal frameworks and quality assurance in this special field. Due to its capacity to combine technical knowledge and business administration knowledge the students are prepared for management tasks. In the view of the audit team the learning objectives have to be adapted in this way that skills and competences graduates should acquire in the management field are indicated more precisely.

The generic learning objectives for the master's *Multicomponent nanostructured coatings. Nanofilms programme* and the mapping of related learning outcomes at the module level need to be improved in order to illustrate how the engineering-specific knowledge, skills and competences of the Subject Specific Criteria of the relevant Technical Committees of ASIIN are affected. The peers found it difficult to grasp from the documentation whether the knowledge, skills and competences establish a sound basis. The peers considered it recommendable to work out a more distinctive engineering and at the same time the management profile for the programme, thereby clarifying the acquired competences of graduates. As programme coordinators and staff conclusively and distinctively

described the study aims and learning outcomes to be achieved in the study programme, the peers believed the aforementioned aspect to be largely a problem of description, not of structure. This in turn is a precondition with respect to the question whether the programmes under review qualify for the award of the EUR-ACE® label. In particular, the modules which contribute to the acquisition of the engineering-specific learning outcomes in the areas of "Engineering Analysis", "Engineering Design" and "Engineering Practice" had to be addressed more clearly. Considering that, it can be stated that the learning outcomes had to be revised. Until the finale completion the peers suggested to postpone awarding the EUR-ACE label.

Criterion 2.3 Learning outcomes of the modules/module objectives

Evidence:

- Module Handbook
- Objectives Matrix (Appendix D)

Preliminary assessment and analysis of the peers:

The module objectives, as defined in the submitted handbook, represented a more concrete and hands-on application of the programme learning outcomes and translated them to the practical requirements of the physics and engineering practice and research. The handbook encompassed almost all module relevant information, starting from the title, semester, contents, intended module learning outcomes, credits, prerequisites and literature. However, the peers deemed it necessary to make the following revisions and amendments: specification of the examination form, duration of the examination and determination of grades. In addition to this the prerequisites are described in a very general way and could be specified. Especially for foreign students the information basis should be meaningful. Moreover, no detailed module description and therefore no clear definition of the learning outcomes foreseen are in place for the term project, scientific research modules and final thesis. In this context the peers enquired about the factual content of the term project and the scientific research modules, which made up an considerable part of the curricula. The students were introduced to different research approaches within the module. As a result the students were able to accomplish scientific research task, use the knowledge of modern problems of physics and nanotechnologies in order to perform complex experiments, draw conclusions to achieve results. By the same token the students became qualified drawing up and executing scientific and technical documentation, research reports, reviews, articles in accordance with the area of expertise of the two master programmes. The scientific research work of the students included the explanation of topics, discussions, and intermediary research results within the framework of the scientific research seminar. The university established a public forum

on the research results, including the involvement of employers and leading researchers, to assess the knowledge level, skills, and competences acquired by the students. The audit team recognized for the *master programme Multicomponent nanostructured coatings. Nanofilms* that the students were qualified to realize engineering designs in accordance with the level of their knowledge and understanding. They were able to apply their knowledge and understanding to the development of solutions for unusual problems and could use their ability as engineers. For this master programme they noted that the students were qualified to plan, construct, and conduct experiments and interpret the results (focus on experimental physics) in order to solve complex physical problems or use simulation and modeling on the basis of physical fundamental principles. The module description needed to be adapted that the competences in the fields of engineering design and engineering practice became visible.

Criterion 2.4 Job market perspectives and practical relevance

Evidence:

- Overview of companies and institutes in the Self-Evaluation-Report
- Discussion with responsible staff for the study programs

Preliminary assessment and analysis of the peers:

The peers deemed the programme under review to have a clear practical relevance and to prepare the graduates adequately to the requirements of the labour market or research institutes. During the audit session with the students the peers got the possibility to consult graduates from the *master programme Multicomponent nanostructured coatings. Nanofilms*. It became clear that the graduates, who came from abroad, were well equipped to start in the industry or research institutes. Typical placements in the industry encompass such job profiles in fields of mechanical engineering, aviation, aerospace and automotive industry, whereas not only practical implementations skills are required, but also scientific/optimizing approach is necessary, as several students stated. Some of these placements are paid internships, which are often followed full-time contract. This fact shows that the education of the graduates corresponds to the requirements of the labour market, and a generally high demand and very good employability of the MISIS graduates.

In principle, the panel concluded that training offered is appropriately linked to experimental practice. Based on the dialogue with the programme coordinators they noted that especially in the basic introductory modules the experimental practice has a visibly smaller importance and should be additionally fostered.

Criterion 2.5 Admissions and entry requirements

Evidence:

- Procedure for admission of citizens to educational institutions of higher professional education, approved by the order No.2895 of the Ministry of Education and Science of the Russian Federation
- List of entrance examinations to educational institutions of higher professional education with state accreditation approved by the order No.505 of the Ministry of Education and Science of the Russian Federation
- Website[6]

Preliminary assessment and analysis of the peers:

The university's admission rules had been discussed and, in principle, been considered adequate to serve their function in the framework of quality assurance. For the *master programme Quantum Physics for Advanced Materials Engineering* students had to take a subject-specific admission test, which included questions on such topics like mechanics, elasticity theory and quantum mechanics. Due to the fact the *master programme Multi-component nanostructured coatings. Nanofilms* is mainly addressed to foreign students the admission prescribed an entrance examination in form of an interview where the students are examined in the fields of physics, chemistry and material science. The admission rules for both master programmes require, that foreign and Russian students achieve a minimum TOEFL score of 525 (paper based) or 200 (computer based). The whole range of questions of the admission examination, including recommended literature for preparation, as well as the general admission rules, can be found at the university's website, which ensures transparence for the study applicants and allows for good preparation.

The peers discussed with the university's representatives the recognition of qualifications gained at other HEI, in particular abroad. In the statute of the university they affirmed that, so far, no particular rules referring to the recognition of competences achieved in other HEI are in place. In principle, such regulation is meant to encourage and support the mobility of students as a pivotal point of the Lisbon Convention (see in particular: Section III "Convention on the Recognition of Qualifications concerning Higher Education in the European Union"). The peers detect the recognition to be still input-oriented and the achieved competences not to be sufficiently taken into consideration.

[6] http://en.misis.ru/Admissions/Rules/

Criterion 2.6 Curriculum/Content

Evidence:

- Curriculum / content overview (Appendix F)
- Objectives matrix in the Self-Evaluation-Report

Preliminary assessment and analysis of the peers:

All in all, the curricula of the degree programmes under consideration correspond to the (generic) course learning outcomes. The curricula presented to the panel are mostly clear and transparent. However, the curriculua for both programmes presented for the audit contained inconsistencies with respect to the hours of lectures, tutorials and laboratory work compared to the module descriptions. This should be corrected.

With regard to the *programme Quantum Physics for Advanced Materials Engineering*, the modules encompass a broad spectrum of topics of physical principles of correlated electron systems and devices of quantum electronics, as well as some important manufacturing techniques and measurements of physical and chemical characteristics of quantum-sized structures and materials. Moreover the study focused on macroscopic quantum phenomena discovered in nano-structured materials and quantum devices. Students advanced their knowledge in natural sciences and mathematics, extended their overview of inner-physical correlations as well as those with related disciplines, and have specialised themselves on the field of quantum physics in such a way that the students find access to current international research. All in all, the module objectives correspond to the subject-specific requirements of international educational standards.

Looking at the *master programme Multicomponent nanostructured coatings. Nanofilms*, the key objectives enabled students to find a scientific approach for problem solution as well as to find the right tools, plan research and get familiar with project management topics. According to the curriculum the students are required to complete four term projects and to write four term papers as a part of their scientific research activities. The close link between the educational process and production operations consists of completing laboratory research projects and writing the term research paper based on the activities performed at the premises of the training scientific centre “Teply stan” as well as accomplishing scientific research assignments. The modules focused on fundamentals and most recent developments in the fields of plasma physics and surface engineering. The master described the advanced methods of surface modification and deposition of nanofilms and multicomponent nanostructured coatings, the investigation methods of their structure (elemental and phase composition, grain size, texture, morphology, surface topography, structure of the grain boundaries, dislocation structure, etc.) and properties (hardness, Young's modulus, elastic recovery, friction and wear, impact resistance,

electrochemical characteristics) as well as novel characterization technique and standards. Indeed the management competences are part of the curriculum, but as mentioned above the peers criticized that the learning outcomes currently did not consider this expertise. As indicated above (see chapter C-2.2) the engineering-specific learning outcomes are conveyed via the curriculum but should be also reflected in the learning outcomes (on programme and module level). Furthermore, the relation between the physics and the engineering management components of the programme should be clarified

In a nutshell, the subject-specific parts of the curricula of the programmes were deemed to be all in all content-wise coherent, clear, and in accordance with the newest tendencies of the related disciplines. Nonetheless, the audit team saw in the following aspects room for improvement: whereas it was part of the aim to qualify the students in the field of information technologies, modern computer networks, software products and internet resources, the code of practice seemed to be different. During the session with the students the peers received the feedback that the guidance concerning scientific computing and information technology could be enhanced. Moreover, the audit team saw room for providing more elective components in both curricula (cf. 3.3 education methods).

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 2:

The revised objectives matrix of the programme *Multicomponent nanostructured coatings. Nanofilms programme* allowed the panel to complete their picture of the qualification profile. By specification the intended learning outcomes the peers were able to complete the assessment concerning the EUR-ACE Label. In the view of the audit team the learning objectives were adapted in this way that skills and competences graduates should acquire in the management field are indicated more precisely. The modules which contribute to the acquisition of the engineering-specific learning outcomes in the areas of “Engineering Analysis”, “Engineering Design” and “Engineering Practice” were now addressed more clearly.

The revisions and amendments concerning the module descriptions have not taken place yet. Nevertheless, they still considered that all module descriptions need to be updated with regard to issues described in different sections of this report: specification of the examination form, duration of the examination and determination of grades. In addition to this the prerequisites are described in a very general way and could be specified (A 1.).

The peers saw the requirement concerning the rule of recognition remain justified (A. 3).

The same applies to the recommendation E. 1 and E. 5. They made no modifications regarding their proposed decision.

3. Degree Programme: Structures, Methods & Implementation

Criterion 3.1 Structure and modularity

Evidence:

- Curriculum overview in the Self-Evaluation-Report
- Module Handbook

Preliminary assessment and analysis of the peers:

The study programme consisted of clearly structured modules fully complying with the master's level and organized in a way that the programme can be commenced in every academic year. Theoretically the programme concepts allowed for time to be spent at another higher education institution or on a practical placement without loss of time. For the *master Multicomponent nanostructured coatings. Nanofilms* could be noted that the programme addressed primarily international students. For the master Quantum Physics for Advanced Materials Engineering the peers understood that students were encouraged to gain experiences abroad. MISiS maintained close cooperation with a number of educational and industrial partners. Recognizing the vital role of the English language in global communication, the university signed an agreement with Cambridge University Press with the objective of improving English teaching at both graduate and undergraduate levels. Under this agreement, all MISiS undergraduate students are now acquiring English through a specially-conceived blended-learning curriculum. The goal of the program is to raise the linguistic competence of MISiS students.

Criterion 3.2 Workload and credit points

Evidence:

- Module Handbook
- Discussions with students

Preliminary assessment and analysis of the peers:

The panel deduced the analysis of the workload from the self-assessment report, the curriculum and the module descriptions and deemed the workload to be feasible and realistic. The amount of the self-study indicated in the module descriptions is significantly above average, which was deemed for positive at master's level, and which allows for flexibility of work distribution, so that the students confirmed the feasibility of workload and all in all favourable study conditions. Due to the fact that the study programmes underwent the first cycle and the graduates just completed the programmes, the auditors

encouraged the programme coordinators to assess the actual student's workload for each educational component and to adjust the credit point allocation or the time for self-studies. When asked about the uniform allocation of credit points to the heterogeneous course units, the students considered the distribution of credits as overall adequate, although they admitted that deviations with regard to individual modules/units did occur, due to the relatively incomparable content of different units and the varying individual learning behaviour.

Criterion 3.3 Educational methods

Evidence:

- Discussion with teaching staff
- Module handbook

Preliminary assessment and analysis of the peers:
The university presented a very consistent and mature concept of teaching technologies, encompassing student-centred problem-solving, practice oriented teaching technologies, and stated additionally to follow the international good practice in engineering education. Each teaching staff member chooses the methodology for the courses individually, according to performance of the group and the individual teaching style. Training of students for professional activity during the whole period of their education under the program is carried out by different methods and forms. For the master quantum could be stated that students carried out three special physics laboratory practices on spectroscopy, scanning probe microscopy and experimental methods of solid-state physics. They had scientific-research practice in semesters 2, 3, and 4 and also carried out three term projects. The numerous practical works performed in the labs, ensured the high practical relevance of the programme as well as high level of ability to work independently. In order to strengthen the international alignment of the *study programme Multicomponent nanostructured coatings. Nanofilms* the university invited lecturers from leading foreign universities and companies to carry out specific lectures.

The offer of elective courses for the *Multicomponent nanostructured coatings. Nanofilms progamme* should also be ensured. The students confirmed the impression of the audit team that there are no elective elements which allow developing a specific profile.

Criterion 3.4 Support and advice

Evidence:

- Discussion with students
- Discussion with teaching staff

- Self-assessment report

Preliminary assessment and analysis of the peers:
The university provides a very good support and advice infrastructure where students can address different contact persons on different levels (starting from the most direct one, the lecturer of the relevant course during his weekly consultancy hours, curator's institute, tutor's institute, social support, psychological support) in case of questions or difficulties emerging in the course of studies. The institutions support in the field of professional orientation and career planning, by organizing meetings of students of different departments and advising on employability.

There is very good support and advice in terms of international mobility. The students stated that the application procedure is clear, transparent and fair, which is evidence for, all in all, good results of support and advice. Also the consultancy among students works well – there are initiatives involving senior students into consultations of younger students, also the students' parliament started its activities recently and aims at further enhancement of the study situation. Generally, students confirmed that they always know whom to turn to with different kinds of concerns and topics; be it subject-specific, general or even life- and working style questions, so that the peers deemed the initiatives in place to be adequate for the successful management of the programme and achievement of the learning outcomes.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 3:

The peers encouraged the HEI to evaluate regularly the student's workload for each educational component (E. 3).

Furthermore they saw room for improvement in the matter that the offer of elective courses for the study programme *Multicomponent nanostructured coatings. Nanofilms programme* is extendable (E. 4).

4. Examination: System, Concept & Implementation

Criterion 4 Exams: System, concept & implementation

Evidence:

- Module Handbook
- Inspection of final theses

Preliminary assessment and analysis of the peers:

The programme coordinators explained the organisation of examinations to the peers. An examination timetable is prepared and made available to the students, examinations are coordinated so that students have sufficient time to prepare for them. For both programmes the examinations were held once a semester during the examination session on the following dates: summer session is in June; winter session is in January, with the duration of three weeks. The form of examinations is defined in the module handbook as well as in the subject-specific syllabi, so that students are informed about the assessment modalities in due time. Also, the timing of the exams allows for preparation since students know in advance when the exam period ("exam session") will take place. The students had the opportunity to repeat an exam during the subsequent semester, according to the international regulations of the University.

The assessment forms are mostly interactive: presentations during a students' conference or participation in the exhibition or conferences, which the peers found to be very valuable for training of the debating and defence skills of the graduates. This form of work is a very commendable approach to Master's education, since the focus lies on the development of research skills and competences and the time dedicated to the self-study and independent work is very high, which fosters the ability to work autonomously.

The programme is concluded by the thesis which must encompass both theoretical treatment of a certain problem with a practical solution. The defence includes a presentation on results of the research. The peers learned that the students receive guidelines on writing the graduate qualification paper; its layout and defence procedure have been published to maximize control of the graduating departments work, improve the quality of all types of graduate qualification papers as well as to provide methodological assistance to lecturers and students. Final research paper (Master thesis) defence is held at the State Certification Commission meetings. This procedure is very similar to the European ones and fulfils the requirements for due assessment of the achievement of the learning outcomes. All in all, the exam routine allows for a thorough assessment of student's performance and the achievement of the learning outcomes of the modules.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 4:

The panel considered the criterion to be fulfilled.

5. Resources

Criterion 5.1 Staff involved

Evidence:

- staff handbook (Appendix A)
- Discussion with members of the university management
- Discussions with teaching staff
- Discussions with students

Preliminary assessment and analysis of the peers:

The peer group studied the staff handbook and concluded that the composition of the teaching body was able to ensure that the intended learning outcomes are achieved by the time the degree is completed. The available contact hours (overall and for individual lecturers) are defined and outlined in the self assessment report. Where feasible, the topics of lectures are linked to research, e.g. progressive methods of processing, progressive methods of treatment, and demonstration projects. The descriptions in the staff handbook which was part of the appendices provided with the self-assessment report depict the various research activities of the staff members and the peers conclude that the research activities of teaching staff are adequate to ensure that the educational level sought is attained.

In the discussion with the students the audit team learned that in some lectures the English speaking level is expandable. In principle the audit team stated that the English speaking level is quite high, but under consideration of the international orientation of the two programmes the panel recommended to enhance the teachers´ skills in English language consistently.

Criterion 5.2 Staff development

Evidence:

- Discussion with members from the university management
- Discussion with members from the faculty management
- Discussion with teaching staff

Preliminary assessment and analysis of the peers:

As for short-term staff development, a range of practice-oriented and adequate initiatives supports the policy of further training. Typical trainings, which are conducted quite frequently, are trainings or short internships in the industry on operating the recently pur-

chased equipment or various online seminars on teaching design, computer-mediated teaching and other skills related to the professional area. This broad offer of operatively needed courses is a very commendable approach to staff development which ensures efficiency of the teaching process. Moreover the teaching staff members are regularly participating in international conferences, symposia and relevant scientific meetings.

All in all, the panel deemed the staffing to be qualitatively as well as quantitatively enough as to ensure an adequate implementation of the programme.

Criterion 5.3 Institutional environment, financial and physical resources

Evidence:

- Visitation of the laboratories
- Information in the Self-Evaluation-Report

Preliminary assessment and analysis of the peers:

The university - at present belonging to the 15 HEI's of Russia being supported as centers of excellence - has all relevant resources which are necessary for the implementation of the programme on a due level in the next years. The library provides all the necessary online resources, including all relevant Russian journals but also overarching engineering and management full text data bases, which ensures good availability of all relevant resources and thus also a good framework for independent research work and study of student. The scientific and technical library constantly acquires new editions of educational and scientific literature. In terms of training and information support, the program has sufficient library stock of up-to-date educational literature on specialized subjects of the curriculum. The students and academic staff have free access to information resources.

The labs presented during the campus guided tour meet the requirements for achieving the intended learning outcomes and reflect the average level and quality of equipment for the implementation of a master's programme. The peers were positively surprised by the new and adequate laboratory equipment (Laboratory of Design, Synthesis and Study of Nanohybrid Materials, Laboratory of Separation and Concentration of Trace Elements and Micro-and Nanoparticles, Laboratory of Physical Methods and Apparatus of Diagnosis and Therapy of Oncological Diseases). The students confirmed in this context the participation in scientific research activities in key fields of research of the department.

As for content-wise cooperation, a range of joint projects with partner research and industrial bodies allows for a solid transfer between theory and practice (Alcoa, Cognitive Technologies, IBS, TMK etc.). The university maintains a range of international coopera-

tion with universities in Germany, USA, Mongolia, Kazakhstan, Vietnam in order to facilitate students' and teachers' mobility.

All these resource provide a very solid basis for successful implementation of the programme.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 5:

It is recommended to enhance teachers' skills in English language.

6. Quality Management: Further Development of Degree Programmes

Criterion 6.1 Quality assurance & further development

Evidence:

- Respective Chapter in the SAR
- Audit discussion

Preliminary assessment and analysis of the peers:

The university implemented a quality assurance system in line with the standards of ISO 9001:2008 since 2000 and several bodies of the university hold a certificate of the procedures regarding Mission, Quality Policies, Quality Guidelines, MISiS Education Standards and further relevant fields. The primary goal of the university is to guarantee the quality of the educational services through meeting the demands of students, lectures and involved stakeholders.

The Quality policies for further development of the teaching design are described in the self-assessment report and involve – apart from the academic staff – both students and employers into the curriculum modernization and enhancement process. The processes in place and methods used are adequate in order to monitor all teaching-relevant processes and to prevent a failure of achieving the goals (cf. also 6.2).

Criterion 6.2 Instruments, methods and data

Evidence:

- Self assessment report

Preliminary assessment and analysis of the peers:
The processes defined in the framework of the QMS system encompass such fields of the teaching process as training, education, research, methodology, international cooperation and human resources, and hereby ensure a holistic view on the programme management and sustainable programme enhancement.

In order to enable continuous improvement and development of the educational services, regular questionnaire surveys are conducted as a part of the program realization process. The parties concerned (academic staff and other staff members, rector's office staff, students, applicants and employers) are questioned about their level of satisfaction and expectations. Questionnaire surveys using a unified questionnaire in regard to the disciplines covered by the curriculum are conducted to evaluate satisfaction of the students with the educational process and monitor the training process for the purposes of quality assurance as well as discovery of opportunities for its improvement and development.

An initial assessment of the achievement of the program goals and fulfilling learning outcomes is made by the hosting departments at the regular mid-semester stuff meetings where the prospective master's degree holders make their reports on the progress of their research work and study, and their training results are discussed by the professors. The final assessment of the achievement of the program goals and fulfilling learning outcomes by each student is made at the pre-examination stuff meeting, where review report of the each student's supervisor is discussed and approved. An independent assessment is made by the faculty office based on the assessment marks of each student at the end of each semester and are discussed at the faculty meetings. The peers recognized that a regular exchange with students and lecturers is in place, both formally and informally.

The instruments, methods and data of the quality management system in place provide a complete picture on all teaching and learning relevant processes.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 6:

The panel considered the criterion to be fulfilled.

7. Documentation & Transparency

Criterion 7.1 Relevant Regulations

Evidence:

- Website[7]
- Admission regulations, cf. official documents provided on website
- Examination regulations, cf. official documents provided on website

Preliminary assessment and analysis of the peers:

The regulations quoted in the self-assessment report were partly presented as a part of document package for assessment, partly available at the website and also partly accessible in the study management portal of MISIS. Thus, the relevant documents are accessible to all relevant stakeholders. The regulations encompass all key stipulations for admissions, the operation of the programme and graduation. They are legally valid and in force.

Criterion 7.2 Diploma Supplement and Certificate

Evidence:

- Certificates

Preliminary assessment and analysis of the peers:

The peers noted that a Diploma Supplement or equivalent document did not exist. The Diploma Supplement provides information about the study aims and (generic) learning objectives, nature, level, context, content and status of the studies, the success of the graduate as well as about the composition of the final grade. It also includes a description of the national higher education system in order to allow foreign higher education institutions or employers a judgement about the qualification presented. Templates are provided, for example, by the European Commission Directorate General Education and Culture (http://ec.europa.eu/education/lifelong-learning-policy/) as part of its lifelong-learning policy.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 7:

A programme-specific Diploma Supplement has to be prepared and handed out to students on a regular basis providing information about the objectives, intended learning outcomes, structure and level of the degree, as well as about an individual's performance.

[7] http://en.misis.ru/Admissions/Rules/

The Diploma Supplement has to indicate how the final mark was calculated (including weighting of marks) (A. 2).

D Additional Documents

Before preparing their final assessment, the panel ask that the following missing or unclear information be provided together with the comment of the Higher Education Institution on the previous chapters of this report:

- Curricula for both programmes contain inconsistencies with respect to the hours of lectures, tutorials and laboratory work compared to the module descriptions.

E Comment of the Higher Education Institution (06.02.2015)

The institution provided following additional documents:

- Curricula for both programmes contain inconsistencies with respect to the hours of lectures, tutorials and laboratory work compared to the module descriptions
- Appendix D self assessment report. Objective matrixes
- Modulehandbook for both programmes

F Summary: Peer recommendations (11.02.2015)

Taking into account the additional information and the comments given by the peers summarize their analysis and **final assessment** for the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ma Quantum Physics for Advanced Materials Engineering	With requirements	--	30.09.2020
Ma Multicomponent nanostructured coatings. Nanofilms	With requirements	EUR-ACE	30.09.2020

Requirements

For all programmes

A 1. (ASIIN 2.3) The module descriptions must be updated according to the comments made in the accreditation report (amendment of research modules, specification of

the examination form and determination of grades, revision of prerequisites, correction of the notations/clarification of the learning outcomes).

A 2. (ASIIN 7.2) A programme-specific Diploma Supplement has to be prepared and handed out to students on a regular basis providing information about the objectives, intended learning outcomes, structure and level of the degree, as well as about an individual's performance. The Diploma Supplement indicates how the final mark was calculated (including weighting of marks).

A 3. (ASIIN 2.5) Regulations must be put in place covering the recognition of competences acquired externally.

Recommendations

E 1. (ASIIN 2.2, 2.6) It is recommended to enhance the competence of students in the fields of scientific computing and information technology.

E 2. (ASIIN 5.2) It is recommended to enhance teachers' skills in English language.

For the Master's degree Quantum Physics

E 3. (ASIIN 3.2) It is recommended to evaluate the student's workload for each educational component regularly.

For the Master's degree programme Multicomponent nanostructured coatings. Nanofilms

E 4. (ASIIN 3.3) It is recommended to offer elective courses that allow developing a specific profile that complements the degree programme sensibly.

E 5. (ASIIN 2.4) It is recommended to include more experimental practice within the basic introductory modules.

G Comment of the Technical Committees

Technical Committee 05- Physical Technologies, Materials and Processes (06.03.2015)

Assessment and analysis for the award of the ASIIN seal:

The technical committee discusses the procedure. All in all, it deems the assessment of the peers as well as the proposed requirements and recommendations adequate.

Assessment and analysis for the award of the EUR-ACE Label:

The Technical Committee deems that the intended learning outcomes of the degree programme comply with the engineering specific part of Subject-Specific Criteria of the Technical Committee 05.

The technical committee 05 - Physical Technologies, Materials and Processes, recommends the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ma Quantum Physics for Advanced Materials Engineering	With requirements	--	30.09.2020
Ma Multicomponent nanostructured coatings. Nanofilms	With requirements	EUR-ACE	30.09.2020

Technical Committee 13- Physics (10.03.2015)

Assessment and analysis for the award of the ASIIN seal:

The technical committee discusses the procedure. All in all, it deems the assessment of the peers as well as the proposed requirements and recommendations adequate.

Concerning recommendation four, the technical committee suggests a slight modification: The technical committee determines that the Master „Multicomponment nanostructured coatins. Nanonfilms" is a very specialized study program. In this effect it asks why the offer of elective courses "that allow developing a specific profile" is recommended. To stress this point the technical committee modifies the respective recommendation four as follows:

It is recommended to offer elective courses that complements the degree programme sensibly. In all other points the technical committee follows the proposal for a decision of the peers.

Assessment and analysis for the award of the EUR-ACE Label:

The technical committee 13 states that the technical committee 05 is competent for the decision about the award of the EUR-ACE Label.

The technical committee 13 – Physics, recommends the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ma Quantum Physics for Advanced Materials Engineering	With requirements	--	30.09.2020
Ma Multicomponent nanostructured coatings. Nanofilms	With requirements	EUR-ACE	30.09.2020

H Decision of the Accreditation Commission (27.03.2015)

Assessment and analysis for the award of the ASIIN seal:

The Accreditation Commission for Degree Programmes discussed the procedure. It agreed with all requirements and recommendations.

Assessment and analysis for the award of the EUR-ACE Label:

The Accreditation Commission for Degree Programmes stated that the technical committee 05 is competent for the decision about the award of the EUR-ACE Label.

The Accreditation Commission for Degree Programmes decides about the award of the ASIIN Seal and the EUR-ACE Label as follows:

Degree Programme	ASIIN-seal	Subject-specific label	Maximum duration of accreditaiton
Ma Quantum Physics for Advanced Materials Engineering	With requirements	--	30.09.2020
Ma Multicomponent nanostructured coatings. Nanofilms	With requirements	EUR-ACE	30.09.2020

Requirements

For all programmes

A 1. (ASIIN 2.3) The module descriptions must be updated according to the comments made in the accreditation report (amendment of research modules, specification of the examination form and determination of grades, revision of prerequisites, correction of the notations/clarification of the learning outcomes).

A 2. (ASIIN 7.2) A programme-specific Diploma Supplement has to be prepared and handed out to students on a regular basis providing information about the objectives, intended learning outcomes, structure and level of the degree, as well as about an individual's performance. The Diploma Supplement indicates how the final mark was calculated (including weighting of marks).

A 3. (ASIIN 2.5) Regulations must be put in place covering the recognition of competences acquired externally.

Recommendations

E 1. (ASIIN 2.2, 2.6) It is recommended to enhance the competence of students in the fields of scientific computing and information technology.

E 2. (ASIIN 5.2) It is recommended to enhance teaching' skills in the English language.

For the Master's degree Quantum Physics

E 3. (ASIIN 3.2) It is recommended to evaluate the student's workload for each educational component regularly.

For the Master's degree programme Multicomponent nanostructured coatings. Nanofilms

E 4. (ASIIN 3.3) It is recommended to offer elective courses that complement the degree programme.

E 5. (ASIIN 2.4) It is recommended to include more experimental practice within the basic introductory modules.

I Fulfilment of Requirements (08.04.2016)

For all programmes

A 1. (ASIIN 2.3) The module descriptions must be updated according to the comments made in the accreditation report (amendment of research modules, specification of the examination form and determination of grades, revision of prerequisites, correction of the notations/clarification of the learning outcomes).

First Treatment	
Peers	Fulfilled Justification: The module descriptions were revised according to the comments made in the accreditation report. Missing data and missing descriptions were added, the learning outcomes were clarified
TC 05	Fulfilled Justification: The module descriptions were revised according to the comments made in the accreditation report. Missing data and missing descriptions were added, the learning outcomes were clarified
TC 13	Fulfilled Justification: The module descriptions were revised according to the comments made in the accreditation report. Missing data and missing descriptions were added, the learning outcomes were clarified
AC	Fulfilled Justification: The module descriptions were revised according to the comments made in the accreditation report. Missing data and missing descriptions were added, the learning outcomes were clarified

A 2. (ASIIN 7.2) A programme-specific Diploma Supplement has to be prepared and handed out to students on a regular basis providing information about the objectives, intended learning outcomes, structure and level of the degree, as well as about an individual's performance. The Diploma Supplement indicates how the final mark was calculated (including weighting of marks).

First Treatment	
Peers	Partly fulfilled Justification: Beside the blank form the HEI submitted a subject specific diploma supplement for the “Nanofilm” Masters. This document meets the European standards.
TC 05	Fulfilled Justification: The technical committee discusses the procedure. According to the assessment of the peers it considers requirements one, three and four to be fulfilled. As the first students of the Quantum Physics-program will graduate in summer 2016, the technical committee understands that a subject specific diploma supplement right now only exists for the Master Nanostructured Coatings. Therefore the technical committee assesses the relevant requirement two in case of the Master Multicomponent Nanostructured Coatings. Nanofilms to be fulfilled. In case of the Master Quantum Physics for Advanced Material Engineering it assesses requirement two under the precondition to be fulfilled, that a subject specific diploma supplement will be submitted not later than eight weeks after the receipt of the final decision of the accreditation commission.
TC 13	Fulfilled Justification: The technical committee discusses the procedure. According to the assessment of the peers it considers requirements one, three and four to be fulfilled. As the first students of the Quantum Physics-program will graduate in summer 2016, the technical committee understands that a subject specific diploma supplement right now only exists for the Master Nanostructured Coatings. Therefore the technical committee assesses the relevant requirement two in case of the Master Multicomponent Nanostructured Coatings. Nanofilms to be fulfilled. In case of the Master Quantum Physics for Advanced Material Engineering it assesses requirement two under the precondition to be fulfilled, that a subject specific diploma supplement will be submitted not later than eight weeks after the receipt of the final decision of the accreditation commission.
AC	Fulfilled (Nanofilms)/Not fulfilled (Quantum Physics) Justification: As a subject specific Diploma Supplement is still missing, the Accreditation Commission assesses requirement two for the Master Quantum Physics for Advanced Materials Engineering

	by now to be not fulfilled. Thereby it takes the anticipatory resolution to prolong the accreditation immediately, without any further treatment, when the HEI presents a revised subject specific diploma supplement for this study program as well *Remark: On July 15th the HEI submitted the missing diploma supplements for the respective degree program. According to the anticipatory resolution of the accreditation commission requirement two is thereby for the master program fulfilled.*

A 3. (ASIIN 2.5) Regulations must be put in place covering the recognition of competences acquired externally.

First Treatment	
Peers	Fulfilled Justification: The HEI issued appropriate regulations covering the recognition of competences acquired externally. ("Academic credit arrangement policy")
TC 05	Fulfilled Justification: The HEI issued appropriate regulations covering the recognition of competences acquired externally. ("Academic credit arrangement policy")
TC 13	Fulfilled Justification: The HEI issued appropriate regulations covering the recognition of competences acquired externally. ("Academic credit arrangement policy")
AC	Fulfilled Justification: The HEI issued appropriate regulations covering the recognition of competences acquired externally. ("Academic credit arrangement policy")

The accreditation commission for degree programs decides the prolongation of the accreditation as follows:

Degree Programme	ASIIN-seal	Subject-specific label	Maximum duration of accreditaiton
Ma Quantum Physics for Advanced Materials Engineering	All requirements fulfilled	--	30.09.2020
Ma Multicomponent nanostructured coatings. Nanofilms	All requirements fulfilled	EUR-ACE	30.09.2020