Course Syllabus

1. Course Title:

Advanced Nanotechnologies

2. Academic Level:

Master

3. ECTS Credits:

25 ECTS

4. Semester:

1, 2, 3 – autumn, spring, autumn semesters

5. School/Department:

Institute of Nanotechnologies, Electronics and Equipment Engineering / Department of Nanotechnology and Microsystems Technology

6. Location:

Taganrog Campus, 2 Shevchenko St., Taganrog

7. Instructor:

Prof. Alexey Kolomiytsev, PhD, email: askolomiytsev@sfedu.ru, Prof. Oleg Ilin, PhD, email: oiilin@sfedu.ru Prof. Maxim Solodovnik, PhD, email: solodovnikms@sfedu.ru Prof. Sergey Balakirev, PhD, email: svbalakirev@sfedu.ru Prof. Vadim Avilov, PhD, email: avilovvi@sfedu.ru

8. Language of Instruction:

English

9. Course Description:

The course is designed to study physical foundations of the plasma state of matter, modern plasma technologies and devices.

10. Course Aims:

- to study theoretical foundations of ionic, ion-plasma processing of micro- and nanostructures; plasma physics; material processing in the production of micro- and nano-devices in plasma;
- to study main plasma processing equipment for processing materials in the production of micro- and nanoelectronic devices;
- to acquire the ability to draw up technological routes for the manufacture of micro- and nanoelectronic products using new progressive methods of processing materials and structures.

11. Specific entry requirements (if any):

English B1. Basic knowledge in the field of physics and mathematics.

12. Course Content:

Modern trends in the development of technology of micro- and nanostructures. Physical and chemical properties of plasma. Plasma: basic concepts and properties. Plasma processes in the technology of manufacturing micro- and nanostructures. Main types of electric discharge in gas and their application in the technology of manufacturing micro- and nanostructures. Non-self-sustaining gas discharge. Direct current glow discharge. Arc discharge. Spark discharge. Corona discharge. Physicochemical foundations of the processes of interaction of active plasma particles with the surface. Classification of processes of interaction of active plasma particles with a surface. Physics of the processes of sputtering of materials during ion bombardment. Processes and technologies for plasma treatment of micro- and nanostructures. Place and role of plasma-chemical and ion-plasma processes in the technology of manufacturing micro- and nanostructures. Magnetron sputtering. Ion plasma sputtering. Plasma-chemical deposition. Ion beam sputtering. Methods for controlling the parameters of ion-plasma technologies. Langmuir probe method. Mass spectrometry. Auger electron spectroscopy. Atomic force microscopy. Methods for processing the results and their application for the analysis of properties, parameters of micro- and nanostructures.

13. Intended Learning Outcomes:

Knowledge: theoretical foundations of ionic, ion-plasma processing of micro- and nanostructures; plasma physics; material processing in the production of micro- and nano-devices in plasma; main plasma processing equipment for processing materials in the production of micro- and nanoelectronic devices.
Abilities: to draw up technological routes for the manufacture of micro- and nanoelectronic products using new progressive methods of processing materials and structures; to use basic methods and techniques of communication in English to solve different problems of professional activities.
Skills: to think abstractly, to analyze, to synthesize the information received in English.

14. Learning and Teaching Methods:

Passive: lecture-visualization using presentation material, oral questioning.
Active: independent work with literature, scientific, educational and reference digital resources, performance of analytical tasks, creation of reproductive individual works.
Interactive: lab sessions and project work. The course can be carried out partly or as a whole using electronic and distant educational system of University.

15. Methods of Assessment/Final assessment information:

Assignments: Semester 1 practical and lab work (100 %), Semester 2 practical and lab work (100 %), Semester 3 practical and lab work (60 %), exam (40%).

16. Reading List:

1. Nanotechnologies in electronics-3. 1 - Moscow: Technosphere, 2016. - 480 p. http://biblioclub.ru/index.php?page=book&id=444856
2. Technological complexes of integrated processes for the production of electronics products - Minsk: Belarusskaya Navuka, 2016. - 253 p. http://biblioclub.ru/index.php?page=book&id=443947
3. Engineering of surfaces of structural materials using plasma and beam technologies: monograph / A.V. Bely, A.S. Kalinichenko, O.G. Devoino, V.A. Ku careko; National Academy of Sciences to Belarus; Physicotechnical Institute; United Institute of Mechanical Engineering; Belarusian National Technical University - Minsk: Belarusian science, 2017. - 459 p. http://biblioclub.ru/index.php?page=book&id=483994
4. Bialik A. D. Materials of electronic technology: Semiconductors. Conductive materials. Magnetic materials: textbook / A.D. Byalik, R.P. Dikareva, T.S. Romanov; Novosibirsk State Technical University - Novosibirsk: Novosibirsk State Technical University, 2017. - 99 p. http://biblioclub.ru/index.php?page=book&id=573767
5. Ilyichev E.V. Micro- and nanotechnologies: teaching aid / E.V. Ilyichev, B.I. Ivanov; Novosibirsk State Technical University - Novosibirsk: Novosibirsk State Technical University, 2018. - 64 p. http://biblioclub.ru/index.php?page=book&id=574748
6. Ivanov N. B. Nanotechnologies of materials and coatings: textbook / N. B. Ivanov, N. A. Pokalyuhin; Kazan National Research Technological University - Kazan: Kazan Scientific Research Technological University (KNITU), 2019. - 236 p. https://biblioclub.ru/index.php?page=book&id=612342