QUALIFICATION PROFILE

Doctoral Program: "ELECTRICAL, MAGNETIC AND OPTICAL PROPERTIES OF CONDENSED MATTER"

Field of higher education: 4. NATURAL SCIENCES, MATHEMATICS AND INFORMATICS

Professional field: 4.1. PHYSICAL SCIENCES

Program Objective

The doctoral program “Electrical, Magnetic, and Optical Properties of Condensed Matter”, within the professional field 4.1. Physical Sciences, aims to prepare highly qualified specialists in the field of condensed matter physics and its interaction with electric, magnetic, and optical fields. The program combines in-depth theoretical training with experimental research, carried out under the guidance of experienced academic staff and utilizing state-of-the-art scientific equipment available in the laboratories of the Institute of Optical Materials and Technologies – Bulgarian Academy of Sciences (IOMT-BAS).

Form and Duration of Study

- Full-time learning: up to 3 years
- Distance learning: up to 4 years
- Independent learning: up to 5 years

Main Research Areas

The doctoral program focuses on both fundamental and applied research into the properties of condensed matter arising from its interaction with electric, magnetic, and electromagnetic fields. Emphasis is placed on the relationship between structure, composition, and physical characteristics of materials, including novel and promising functional materials. The program includes advanced study of optical materials with a wide range of applications in materials science, sensing, photonics, chemistry, biology, and medicine due to their unique structural, electronic, and optical properties.

Research tasks within the program cover both theoretical and practical topics, including:

- Study of photoinduced processes and optical data recording in organic and inorganic media;
- Enhancement of optical quality of polymers through structural and chemical modifications;
- Synthesis and structuring of photonic crystals based on metal oxides and nanosized zeolites for applications in optics and sensing;
- Deposition of thin films and multilayer structures using various techniques;
- Synthesis of two-dimensional (2D) nanomaterials (such as graphene, graphene derivatives, etc.) and nanostructures;

- Development of hybrid and heterostructures for devices in optics, photonics, and optoelectronics;
- Design of biosensors and gas sensors based on surface plasmon resonance and other coherent optical phenomena;
- Characterization of materials using spectroscopic, microscopic, and interferometric methods.

Learning Objectives

The primary educational goals include:

- Developing deep and systematic knowledge in the field of electric, magnetic, and optical phenomena in various classes of condensed matter—metals, dielectrics, semiconductors, nanostructured and hybrid materials—through mastering modern theoretical models, experimental methods, and numerical techniques;
- Cultivating research skills, including hypothesis formulation, experimental planning and execution, data processing and interpretation, and preparation of scientific publications;
- Acquiring interdisciplinary competencies connecting physics with materials science, engineering, chemistry, and biomedical sciences;
- Building capacity for independent scientific work and future participation in national and international research projects;
- Preparing for academic and teaching careers by developing communication and presentation skills, as well as competence in scientific writing;
- Encouraging innovative thinking and application of fundamental knowledge in real-world technologies and industrial development.

Acquired Knowledge and Skills

Graduates of the doctoral program “Electrical, Magnetic, and Optical Properties of Condensed Matter” are expected to possess the following knowledge, skills, and competencies:

- Profound and versatile knowledge of the electrical, magnetic, and optical properties of materials;
- Understanding of the operating principles, capabilities, and applications of modern scientific instruments and experimental techniques used in the field;
- Ability to critically read, interpret, and utilize original scientific publications, including in foreign languages;
- High-level foreign language proficiency enabling active scientific communication and participation in international projects and forums;
- Proficiency with modern computer systems, programming environments, and software tools for modeling, simulation, and scientific data analysis;
- Mastery of fundamental and current theoretical and applied developments in the field of electrical, magnetic, and optical properties of condensed matter, as well as their interdisciplinary applications in materials science, chemistry, engineering, and biomedical sciences;
- Experimental experience, including skills in planning, conducting, and analyzing practically-oriented experiments;

- Capability to effectively apply theoretical knowledge using interdisciplinary approaches, logical and analytical thinking for solving complex scientific and applied problems;
- Demonstrated effective scientific communication and critical thinking in presenting, discussing, and defending scientific results.

Career Opportunities

Graduates holding a PhD in "Electrical, Magnetic, and Optical Properties of Condensed Matter" are equipped to pursue a wide range of career paths and professional activities, including:

- Scientific Research – in institutes and university laboratories focused on fundamental and applied research in condensed matter physics, photonics, nanoscience, and materials science;
- Academic Teaching – as lecturers or researchers in higher education institutions in physics, engineering, chemistry, or interdisciplinary programs;
- Industrial R&D – in applied science laboratories, R&D departments, high-tech companies, and manufacturing enterprises developing new materials, sensors, optical and electronic devices;
- Consulting and Expert Work – in organizations involved in sales, implementation, and maintenance of scientific instrumentation, optical systems, and laboratory equipment;
- Participation in International Research Programs – such as Horizon Europe, Marie Skłodowska-Curie, COST, as well as postdoctoral specializations and academic exchanges
- Innovation and Technology Transfer – including launching independent scientific and applied activities or participating in start-ups focused on new materials and technologies.
