



Topic of dissertation thesis

Academic year **2026/2027**

Title	Magnetic micromaterials in optical and photonic applications		
Institute	Faculty of Electrical Engineering and Information Technology University of Žilina		
Place	Žilina, Slovakia		
PhD. programme	electrotechnologies and materials		
Supervisor	Norbert Tarjányi, doc. Ing. PhD. Department of physics		
Co-supervisor	Kliknite alebo ťuknite sem a zadajte text. Kliknite alebo ťuknite sem a zadajte text.		
Study form	Internal		
Study duration	3 years (internal form)		
Study language	english		
Start date	1.9.2026		
Research domain	Materials, Integrated photonics, Optoelectronics, Applied Optics		
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Dissertation topic abstract

The topic of the dissertation is the study of the optical properties of magnetic micromaterials, which currently occur, for example, in the form of microwires and microtapes, and the search for possible applications in optics and photonics using their physical properties. The basic area of research is the physics of materials, with application overlap in the areas of integrated and applied optics. The focus of the work lies in experimental investigation, the results of which are suitably supplemented by theoretical description and supported by numerical analysis. The contribution of the work will be the characterization of the optical properties of selected types of materials and the design of specific functional optical applications using the studied forms of materials.

Extended information, research responsibilities and tasks of PhD. candidate

1. Scientific and professional context of the topic: When optical radiation interacts with magnetic materials, some of the magneto-optical phenomena is often observed. These phenomena are also used to study the physical properties of micromaterials such as microwires and microtapes. It is somewhat surprising that, despite their measurable magneto-optical response, any information available to the professional public about their optical properties is practically missing. This is largely because these materials are not primarily developed for optical applications, and the interaction with an optical wave serves only to characterize the magnetic structure, anisotropy, and behavior of the investigated system in the presence of an external magnetic field. However, their dimensions and shapes, which can be achieved during production, as well as their magnetic properties, in combination with suitable optical elements, offer the possibility to uniquely modify the properties of these optical elements, which opens up a door in the field of applied research. However, it is also desirable to know the basic optical properties of these materials to be able to know the limits of their use and to optimize their properties when designing a specific application.

2. Objectives and expected benefits of the work: The partial objectives of the research include the construction of a modifiable apparatus for obtaining data necessary for determining the optical properties of the investigated materials (especially the complex refractive index as a function of wavelength) and for observing magneto-optical phenomena. The main objectives will

be to obtain the dispersion dependence of the refractive index and information about the magnetic properties of the samples from the measured data, which will be used in the design of specific applications, and the realization of these applications, as well. By fulfilling the objectives of the work, it can be expected to contribute to filling the gap in the availability of data describing the optical properties of the investigated materials and pave the way to innovation and development in the field of optical application of micromagnetic materials. 3. Methodology and research approach: To achieve the objectives of the work, it will be necessary to design, prepare, and perform experiments, analyze and process data, and create theoretical models. The utilization of software tools such as Matlab, Mathcad, Ansys Lumerical, Comsol, etc. is expected. The technologies include methods for preparing thin layers by sputtering or spin coating, preparation of bulk samples from polymer materials (especially PDMS), preparation of microstructures by DLW methods, and/or 3D printing using photopolymers. During the first year of the study, intensive work is expected on assembling modifiable measuring equipment, its testing, and obtaining the first results of measurements of optical properties of micromaterials. The following approximately six-month period would be devoted to systematic measurement and evaluation of optical properties with simultaneous identification of application-usable parameters. The last year to year and a half of the study would be devoted to the design and realization of a specific type of optical element using the investigated micromaterials. 4. Tasks and responsibilities of a doctoral student: The doctoral student is expected to independently solve defined research tasks under the professional guidance of a supervisor, prepare and conduct experiments, process and interpret data, prepare scientific publications and conference papers, and collaborate with members of the research team and external partners. 5. Supporting materials: The topic of the thesis follows on from research that began thanks to the developing cooperation of the supervisor and a research group at the Department of Physics FEI TUKE in 2024-2025, with to date results published in the proceedings of 2 international scientific conferences (SPIE Photonics Prague 2025, APCOM 2025 (proceedings will be published in 2026)). Another output intended for submission in a scientific journal (Sensors and Actuators A: Physical) is currently being prepared, and some results of the current research are planned for presentation at the APCOM 2026 conference. A proposal for a joint VEGA project is being prepared with the DP FEI TUKE, with the start of the solution in 2027, in which we would like to devote more intensively to the issue of studying the optical properties of magnetic materials and their use in optical applications. The doctoral student would be part of the research team.

Candidate profile

Required qualifications:

(The supervisor defines the required qualification, skills and knowledge for the proposed dissertation topic.)

The candidate should be a graduate of a technical and/or physical discipline focused on material research, with basic knowledge of general optics, and have basic experience with experimental and laboratory work. He/she should be familiar with the basics of programming, numerical methods, and/or data processing. He/she should be able to read and understand technical/scientific literature in English and communicate in English both orally and in writing. Successful completion of doctoral studies requires a high degree of independence, responsibility, and an active approach to solving tasks. The candidate should demonstrate sufficient patience and systematicity, which are required for long-term work on a complex research problem. Interest in interdisciplinary research and cooperation with the commercial (non-academic) sphere, experience in publishing and presenting work results, communication skills, and openness to teamwork are great advantages.

Funding: project info, for which dissertation topic is proposed (only funded, not submitted) Kliknite alebo ťuknite sem a zadajte text.