Study Programme: Master Academic Studies in Physics

Course Unit Title: Memristive materials

Course Unit Code: M24MM

Lecturer: dr Kristina Čajko

Type and Level of Studies: Master Academic Degree

Course Status (compulsory/elective): Elective

Semester (winter/summer): Winter

Language of instruction: English

Mode of course unit delivery (face-to-face/distance learning): Face-to-face

Number of ECTS Allocated: 8

Prerequisites: Condensed Matter Physics

Course Aims:

Acquiring modern theoretical and practical knowledge about memristive materials. To enable students to understand basic phenomena and processes of memristive materials and possibilities of their application in advanced technologies.

Learning Outcomes

After completing and learning the course content, the student should have developed:

General abilities:

- Knowledge of basic concepts in the characterization of memristive properties of materials.
- Ability to independently use academic and expert literature in this field.

Course specific abilities:

Student's ability to interpret experimental results.

Syllabus:

Theory

Definition and physical models of memristors. Types, properties and structure of memristive materials. Unipolar and bipolar resistive switching effect. Experimental investigation of memristive characteristics of functional materials. Current-voltage characteristics of memristive materials. Determination of memory window, resistance in low resistance state and high resistance state. Physical mechanisms of transition of memristive materials from high resistance to low resistance state and vice versa. Conduction mechanisms. RRAM (Resistive Random Access Memory) nano devices. Application of memristive materials in artificial neural networks.

Practice

Familiarization with the operation of basic instruments for experimental measurements related to investigation of memristive characteristics of functional materials. Preparation and presentation of seminar papers.

Literature

1. L. Chua, G. Ch. Sirakoulis, A. Adamatzky editors, *Handbook of Memristor Networks*, Springer, 2019.
2. S. Spiga, A. Sebastian, D. Querlioz, B. Rajendran editors, *Memristive Devices for Brain-Inspired Computing from Materials, Devices, and Circuits to Applications - Computational Memory, Deep Learning, and Spiking Neural Networks*, Woodhead Publishing Series, Elsevier, 2020.
3. J. Rupp, D. Ielmini, I. Valov, editors, *Resistive Switching: Oxide Materials, Mechanisms, Devices and Operations*, Springer Cham, 2022.
4. N. F. Mott and E. A. Davis, *Electronic Processes in Non-Crystalline Materials*, Oxford University Press, Oxford, UK, 1979.
5. D. R. Lamb, *Electrical Conduction Mechanisms in Thin Insulating Films*, Methuen, London, UK, 1967.

Weekly Contact Hours	**Lectures:** 3	**Practical work:** 2

Teaching Methods

Lectures (3 hours per week during the semester), practice (1 hour per week during the semester), presentation of a seminar work (1 hour per week during the semester).

Knowledge Assessment (maximum of 100 points)

Pre-exam obligations	points	**Final exam**	points
Active class participation	5	written exam	
Practical work	10	oral exam	70
Colloquium(s)		....	
Seminar(s)	15		

The methods of knowledge assessment may differ; the table presents only some of the options: written exam, oral exam, project presentation, seminars, etc.