



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София
ул. „Сердика“ № 4
<http://edu.bas.bg>

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Basic Information:

Course Title: Modern electrochemistry – from macro to nano scale systems

Lecturer: . Prof. Dr.rer.nat Ilia Valov

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Total Teaching Hours: 30

Annotation (up to 150 words)

The purpose of the course is to present a fundamental view on the theory of electrochemical processes in liquids, solid-state electrolytes and nanoscaled electrochemical systems, and relate it to concrete applications. The first part will explain in accessible manner the electrochemical thermodynamics as an origin of the driving forces in physicochemical systems and the kinetics as the way for using these systems for applications such as energy conversion and storage. In the second part of the course, it will be demonstrated how the fundamentals learned can be used to applications: designing properties of batteries, fuel cells, sensors, artificial neurons and synapses, and others. The course is ideally suited for Ph.D. students and as well for experts in the broad field of materials electrochemistry

Course content (brief description by topics or modules)

Topic / Module 1: Electrochemical thermodynamics and kinetics.

Accessible overview of the essential background in theoretical electrochemistry: Driving forces, equilibria, steady-state, phases and interphases, actions and interactions, materials. Reactions and limiting steps, charge and mass transfer. Electrochemical instrumentation.

Topic / Module 2: Solid state electrochemistry

Point defects in solids, how ions move in solids – defect chemistry, types of ionic and mixed ionic-electronic solid electrolytes. Specifics of Solid-state electrochemistry compared to electrochemistry with liquid electrolytes.

Topic / Module 3: Electrochemical functionalities on demand

Designing applications in electrochemical systems by selecting materials, stacks and processes. Tuning electrochemical behaviour and using electrochemical effects for applications in information technologies – next generation brain-inspired hardware, artificial neurons and synapses, space technologies, in energy conversion and storage. Sensors and actuators.

Teaching and assessment methods

The lectures will be held on power point slides and blackboard.

Assessment will be made based on written tests and/or oral examination.

Competencies acquired as a result of training (3–5 points)

1. Essential fundamental knowledge for electrochemical systems and their applications
2. Fundamentals and Applications of physical chemistry of solids / solid state electrochemistry, point defects, defect chemistry



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3. Fundamentals and applications of nanoelectrochemistry. How the nano-size effects change the properties, reactivity and functionality of matter.
 4. Novel trends and applications of gaseous, liquid and solid-state electrochemical systems

Literature:

Ph. Rieger, Electrochemistry (available in English only)

L. Antropov, Theoretical electrochemistry (available in Russian and English)

H. Rickert, Solid state electrochemistry (in German and English)

I. Nenov, Fundamentals of Electrochemistry (available in Bulgarian only)

Additional information (optional) (e.g., special requirements, laboratory equipment, prior knowledge)

For students with background in chemistry, physics, biology and/or engineering