Basic Information:

Course Title: **APPLIED ELECTROCHEMISTRY**

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Total Teaching Hours: 30 lecture hours

Annotation (up to 150 words)

The aim of the proposed course is to support PhD students during their training and to familiarize them with some of the main practical applications of electrochemical systems. These include electroplated and electroless deposited coatings (including alloy coatings) with specific purposes, such as improved decorative appearance, corrosion protection, hydrogen generation and storage, electrocatalytic materials for fuel cells, purification of contaminated water and air, etc. The course also covers the methods for obtaining such materials, the main techniques for investigating their properties and phase structure, as well as the preliminary preparation of the samples themselves and the electrochemical/chemical compositions and baths used.

The course will be of interest to PhD students and postgraduate trainees working in the fields of electrochemistry, electro- and photoelectrocatalysis, and materials science.

Course content (brief description by topics or modules)

Module 1. Electrochemical and Chemical Methods for Preparation and Characterization of Functional Coatings

Topic 1: Introduction to Electrochemistry. Types of chemically deposited metallic and alloy coatings and their practical applications.

Topic 2: Preparation of composite coatings. Types of electrolytes and materials suitable for electroless metallization.

Topic 3: Electroplating technologies. Preparation of coatings with special functional, decorative, and protective properties. Influence of electrolysis conditions on their structure and properties.

Module 2. Electrocatalysis, Hydrogen Technologies, and Environmental Applications

Topic 1: Electrochemical preparation and characterization of multicomponent non-noble alloys and their application as catalytic materials for hydrogen generation and storage.

Topic 2: Hydrogen production by water electrolysis. Advanced catalysts, catalyst supports, and electrodes.

Topic 3: Preparation and characterization of electrocatalytic materials applicable in fuel cells and electrolyzers.

Topic 4: Electrochemical preparation and characterization of semiconductor oxides for photoelectrocatalytic oxidation of organic pollutants in water and air.

Module 3. Corrosion and Protective Coatings

Topic 1: Corrosion – types and characteristic features. Basic principles of corrosion protection.

Topic 2: Experimental methods for determination of corrosion resistance and protective ability of electroplated coatings.

Topic 3: Electrochemical preparation and corrosion characterization of zinc and composite/hybrid coatings.

Teaching and assessment methods

- Classroom-based lecture course.
- Assessment is carried out through a test. The final evaluation is "pass" or "fail". In case of a "fail" evaluation, a resit opportunity is provided.

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

- Knowledge of the main electrochemical processes and methods for preparation of functional coatings and electrocatalytic materials.
- Practical skills for sample preparation and characterization of electrochemical materials.
- Skills for analysis and interpretation of experimental results.

Literature:

1. A. Brenner, "Electrodeposition of Alloys, Principles and Practice", Academic Press, New York, 1963.

2. Электрохимия, Б.Б. Дамскин, О.А. Петрий, Г.А. Цирлина, Химия, Москва, 2006.

3. J. O'M Bockris, A. Reddy, M. Gamboa-Aldeco, "Modern Electrochemistry, Vol. 2A Fundamentals of EIectrodics", Kluwer Acad. Publ. New York, 2002.

4. V. Bagotsky, "Fundamentals of Electrochemistry", Wiley-Interscience, Sponsored by ISE, 2006.

5. Handbook of electrochemistry, ed. C. G. Zoski, Elsevier, 2007.

6. A. Bard, L. Faulkner, "Electrochemical methods. Fundamentals and applications". Wiley-VCH Verlag GmbH & Co., KGaA, 2001.

7. Al. Milchev, "Electrocrystallization: Fundamentals of nucleation and growth", Kluwer Academic Publishers, 2002.

8. R. Holze, "Experimental Electrochemistry. A Students's Lab Course", Wiley-VCH Verlag GmbH & Co., KGaA, 2007.

9. N. Sato, "Electrochemistry at Metal and Semiconductor Electrodes"; Elsevier: Amsterdam, 1998.

10. "Catalysis in Electrochemistry: From Fundamental Aspects to Strategies for Fuel Cell Development", Edited by E. Santos and W. Schmickler, Wiley, 2011.

11. "Corrosion: Fundamentals, testing and protection", ASM Handbook, 2003, Editors: St.D. Cramer and B.S. Covino.

12. R.W. Revie, H.H. Uhlig, "Corrosion and corrosion control", Forth Edition, Wiley Interscience, 2007.

13. Su-Il Pyun, Jong Won Lee, "Progress in Corrosion Science and Engineering II", Springer, 2012.

14. 3. Гаврилов Г., Ц. Николов, "Химическо никелиране и дисперсни покрития", Техника, С., 1985

15. Г. Гаврилов, М. Ангелова, "Химическо отлагане на метални покрития", Техника, С., 1976.

16. Хр. Петров, "Галванизиране на пластмаси", 1982

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

It is recommended that participants in the course have basic knowledge of theoretical electrochemistry.