



## ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАИ

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### **Basic Information:**

Course Title: SOLUTIONS FOR CRITICAL RAW MATERIALS SUBSTITUTION IN CATALYSTS AND DIFFERENT ADVANCED INDUSTRIAL MATERIALS

Lecturer: Prof. Z. Cherkezova- Zheleva, PhD

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Total Teaching Hours: 30 hours + 15 practicum

### **Annotation** (up to 150 words)

The lecture course is addressed to PhD students with interests in the field of solid state chemistry and catalysis. Background in matter structure and characterization methods will be appreciated.

The challenge of critical raw materials (CRMs): advanced multidisciplinary view. The lecture focus is on the specific issues of the CRMs. Motivation: Difficulties in their access have a negative impact and depress industrial sectors vital to Europe. This is an advanced and priority area in material science, which integrates fundamental and applied research addressing the substitution of CRMs in catalysts, high value alloys and metal-matrix composites. Special issues will be material production, microstructure evolution characterization, (in-situ) property characterization, optimization of the full material life-cycle, such as usage, life-time, and recycling. An overview of appropriate characterization methods as a way of solving scientific and technical problems in understanding the CRM role in different type industrial materials. Characterization methods for study of materials properties at different levels (macro-, micro-, nanometer and atomic scale) with use of X-ray analysis (diffraction and spectroscopy), Electron microscopy, Mossbauer analysis, etc. will be discussed.

A practical course will also be held. It aims to familiarize the participants with the specific scientific and technical challenges in the study, design and preparation of improved and nanomaterials with reduced or without CRM content. Skills related to preparation of nano-dimensional multifunctional composite materials based on transition metal or transition metal-precious metal compounds by mechanochemical synthesis and activation, thermal and sol-gel synthesis.

### **Course content** (brief description by topics or modules)

Topic / Module 1: Critical Raw Materials - Importance and Applications in High-Tech Materials

Topic / Module 2: Synthesis and Characterization of Materials Containing Critical Raw Materials (CRM), Substitution of CRM

Topic / Module 3: Sustainable Use, Peysce and Recycling of Critical Raw Materials

### **Teaching and assessment methods**

Lecture course - group or individual

Practical exercises for material synthesis and investigation

Theoretical and practical examination

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



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- In-depth knowledge of critical raw materials and their role in high-tech materials and catalysts.
  - Acquisition of practical skills for the synthesis, processing, and investigation of functional and nanostructured materials.
  - Understanding of sustainable approaches for the use, substitution, and recycling of critical raw materials.
  - Skills for analyzing the relationship between material structure and properties.
  - Knowledge of up-to-date trends and challenges in materials science and circular economy strategies.

### Literature:

1. Critical Raw Materials Resilience: Charting a Path towards Greater Security and Sustainability; European Commission and Social Committee: Brussels, Belgium, 2020.
2. Lemonnier, V. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, a Green Deal Industrial Plan for the Net-Zero Age; European Commission: Brussels, Belgium, 2023.
3. RMIS—Critical, Strategic and Advanced Materials. Available online: <https://rmis.jrc.ec.europa.eu/eu-critical-raw-materials> (accessed on 21 March 2024).
4. Critical Raw Materials for Strategic Technologies and Sectors in the EU—A Foresight Study, Bobba, S.; Carrara, S.; Huisman, J.; Mathieux, F.; Pavel, C. ; European Commission: Brussels, Belgium, 2020; ISBN 9789-2761-53375.
5. Tercero Espinoza, L., Massa, I., Tzimas, E., & Pavel, C. (2022). Rare Earths and Energy Transition: A Review of Global Supply Chains and European Vulnerability. JRC Science for Policy Report, European Commission.