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DEVELOPMENT OF OPEN EDUCATIONAL RESOURCES ON PERMANENT MAGNETS AND RARE EARTH ELEMENTS

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University of Zagreb
**FACULTY OF MINING
GEOLOGY AND
PETROLEUM
ENGINEERING**



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RECO2MAG PROJECT

Title: Novel grain boundaries engineered NdFeB permanent magnets

Duration of the project: 2022 – 2023

Financed by: EIT KIC RawMaterials



Consortium:

Jozef Stefan Institut (JSI), Ljubljana, Slovenia (project leader)

Geological Survey of Slovenia, GeoZS, Slovenia

IVL Svenska Miljoeinstitutet AB (IVL Swedish Environmental Research Institute), Sweden

Magneti Ljubljana d.d., Slovenia

University of Belgrade - Faculty of Mining & Geology (UNIBG-RGF), Serbia

University of Zagreb – Faculty of Mining, Geology and Petroleum Engineering (UNIZG-RG), Croatia

Valeo Powertrain Systems, France



RECO2MAG OBJECTIVE

- to use the latest technological innovations for heightened raw material efficiency in the production of permanent magnets (PMs), coupled with the latest information on critical raw materials resources in RIS countries, to create product chain organisations for a more independent and efficient EU PM industry ecosystem.

WP 5 EDUCATION AND LEARNING (UNIZG-RGNF)

GOAL:

to share the knowledge gained during implementation of the project with the wider stakeholder community (PhD students and researchers, as well policy makers and RM exploration and production experts - emphasis on RIS (Regional Innovation Scheme) countries, i.e. countries and regions in Europe where the pace of innovation is modest or moderate!)

OBJECTIVES:

- To develop online courses syllabi on (1) permanent magnets and (2) REE value chain
- To certify each developed course by ECTS (European Credit Transfer and Accumulation System) credits
- To organise implementation of e-learning courses
- To adapt learning materials and recorded lectures to be used as OER (Open Educational Resources)

TASK 5.1: DEVELOPMENT OF COURSE SYLLABI

- titles
- descriptions
- objectives
- learning outcomes
- outlines (topics)
- required learning materials
- grading policy
- learning activities

TASK 5.2: ORGANISATION AND IMPLEMENTATION OF ONLINE COURSES

- online meetings with lecturers and panelists
- Agenda
- platform for online course GoTo Meeting
- e-learning platform MoD
- advertisement of courses
- communication with applicants
- conducting examinations and evaluations
- awarding of certificates

TASK 5.3. PREPARATION OF OER



- to adapt recorded lectures and learning materials (text, video, quizzes, and links to other open-source materials on the internet) to be used as OER (Open Educational Resources)
- to store in Dabar (Digital academic archives and repositories)

<https://repozitorij.rgn.unizg.hr/>

- to grant creative commons license CC0 (enables creators and owners to waive interests in their works and thereby place them as completely as possible in the public domain, so that others may freely build upon, enhance and reuse the works for any purposes without restriction under copyright or database law)



COURSE SYLLABI

short version:

- 8 hours of: introductory panel discussions, lectures, final discussion
- online test
- successful participant – certificate of attendance

long version:

- additional 22 hours of teamwork
- scientific essay and presentation
- successful participant awarded with one ECTS credit.

Estimated number of participants	30
Number of teaching hours	8
Estimated number of hours of individual/team work per participant	22
Total workload	30
Proposed number of ECTS credits	1

LEARNING OUTCOMES

1. to explain the basic relationships between the magnetic properties and microstructural specifics;
2. to summarize the most important applications for rare-earth-based permanent magnets;
3. to propose appropriate magnetic materials for various applications, taking into account hysteresis properties, thermo- and magnetic stability, the cost of production;
4. to illustrate key challenges and needs of European producers of permanent magnets;
5. to discuss challenges and solutions related to permanent magnets for electric-vehicle drive applications;
6. to explain how life-cycle assessment (LCA) can be used to compare the environmental performance of products that utilise magnets;
7. to demonstrate the ability to lead and productively participate in a team work;
8. to evaluate and synthesize materials from diverse sources and integrate multiple perspectives into oral presentations.

„Green deal and circular economy challenges of rare earth-based permanent magnets with technical aspects”

OUTLINE

Introductory round table (*Panelists:* Milan Grohol (DG Grow, EC), Roland Gauss (EIT RM), Dr. Carlo Burkhardt HSPF Germany, Badri Veluri (Grundfoss, REIA), Prof. Kristina Žužek (JSI); *Moderator:* Prof. Sibila Borojević Šoštarić (UNIZG RGNF))

Green deal and circular economy challenges of rare earth-based permanent magnets (prof. Dr. Carlo Burkhardt, HSPF Germany)

Magnetic Theory, Electromagnetism, Ferromagnetism, (Prof. Dr. Kristina Žužek IJS, Slovenia)

Rare earth-based permanent magnet properties, their production and recycling routes (Dr. Tomaž Tomše IJS, Slovenia)

Industrial aspects of sustainable production of permanent magnets (Dr. Milana Karajić, Magneti d.d., Slovenia)

Applications (and reuse) of permanent magnets (Jean-Marc Dubus / Louis Charles, Valeo, France)

Life Cycle Assessments of PMs (Steve Harris, IVL Swedish Environmental Research Institute, Sweden)

Final discussion (all lecturers; moderator: Sibila Borojević Šoštarić (UNIZG RGNF))

Panelists:)

Moderator: Sibila Borojević Šoštarić (UNIZG RGNF)

'Rare Earth Elements value chain gaps and opportunities in the ADRIA region" LEARNING OUTCOMES

1. to describe the basic chemistry and properties of REEs, including their atomic structure, electronic configuration, and unique characteristics that make them valuable for various industrial, technological, and energy-related applications.
2. to describe general behaviour and abundance of REE in the Earth crust.
3. to classify the primary and secondary sources of REEs.
4. to interpret REE deposits based on their major geological features and overall genesis.
5. to describe the processes used to extract and refine REEs from various primary and secondary sources.
6. to analyse the current state of the REE value chain in the ADRIA region, including gaps and opportunities for growth and development.
7. to collaborate effectively with others in the team to compose a clear, concise, and well-structured scientific essay that effectively communicates key ideas and arguments and to develop and deliver a cohesive and engaging presentation.

'Rare Earth Elements value chain gaps and opportunities in the ADRIA region' OUTLINE

Introductory round table (*Panelists:* Dr. Slavko Šolar (UNEC for Europe), Tina Benda (EIT Raw Materials); Prof. Nenad Tomašić (UNIZG-PMF), Efthymios Balomenos (Greek alumina plant MYTILINEOS); Prof. Kristina Žužek (JSI); *Moderator:* Prof. Sibila Borojević Šoštarić (UNIZG RGNF))

Rare Earth Elements – introduction and basic properties (Prof. Nenad Tomašić, UNIZG-PMF, Croatia)

Geology and classification of REE deposits (Prof. Borojević Šoštarić, UNIZG-RGNF, Croatia)

REE deposits in ADRIA region (Dr. Radusinović, GEOZMN, Montenegro)

Classification of waste and types of secondary REE sources (Prof. Marta Mileusnić, UNIZG-RGNF, Croatia)

Potential of secondary REE sources in ADRIA region (Dr. Robert Šajn, GEOZS, Slovenia)

Process Metallurgy and Metal Recycling of REE (Prof. Srećko Stopić, RWTH Aachen University, Germany)

Final discussion and closing (all lecturers; moderator: Sibila Borojević Šoštarić (UNIZG RGNF))

ORGANISATION AND IMPLEMENTATION OF ONLINE COURSES

Key performance indicators for 2022 (workshop on permanent magnets held on 12th of December 2022)

Core KPI: EITHE08.2-EITRIS – EIT RIS Participants in non-labelled education and training

48 successful participants (8 long version)

Specific KPI: KICN01-11 – Improve gender balance in the RM sector

56% of workshop participants women

Key performance indicators for 2023 (workshop on REE value chain held on 4th of May 2023)

Core KPI: EITHE08.2-EITRIS – EIT RIS Participants in non-labelled education and training

70 successful participants (country of origin in RIS – 42; country of residence in RIS -60) (8 long version)

Specific KPI: KICN01-11 – Improve gender balance in the RM sector

47% of workshop participants women

Instead of conclusion (list of chalanges)

1. Promotion (use of multiple channels - social media, email, website, etc.)
2. Background knowledge
3. Ensuring attendance
4. Technical issues: Internet Connection; Platforms Compatibility
5. Engagement and interaction (final discussion, problem with brakes, test)
6. Time zone differences
7. Feedback



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