Rare earth reduction in high performance
permanent magnet electric machines

LowREEMotors Newsletter - Nr. 1 / 2022

We are glad to present the next LowREEMotors newsletter. Many things had occurred since the beginning of our project. Due to the CoVid-19 all our meetings and communication was done via teleconferences, but the project goes on and we held in 2021 two online workshops about "Efficient use of Rare Earth Elements in permanent magnets for electrical vehicles" and "Production of NdFeb Magnets" and about 100 participants were registered.
The project progresses and the feedstock production will be upscaled, so that as soon as the new designed injection mould is available first trial can be done.

Meet the Consortium

Zienab Elghoul

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Sustainability assessments of materials and circular economy

Role in the Project: *Project partner*
Area of Expertise*: Life Cycle Assessment, Sustainability and Circular Economy*

Why is assessing the impact of permanent magnets important?
Permanent magnets are a crucial component in electric vehicles motors; As the market for EVs expands, the demand for permanent magnets increases. The most common type of magnet is Neodymium-Iron-Boron. Depending on the usage, the permanent magnets contain other Rare Earth Elements such as Dysprosium. Neodymium and Dysprosium are crucial to the exceptional performance of these magnets -although they are associated with clean technologies- their mining and extraction is an intense process that could lead to environmental damage. Accordingly, understanding the impact of permanent magnets is crucial to a transparent and sustainable value chain.

How can Life Cycle Assessment methodology enable the design of lower impact permanent magnets?
Understanding the environmental impact is not the whole picture. It is critical to assess the product life cycle and highlight the hotspots and bottlenecks in the product value chain that contribute the most to the environmental impact of these magnets. It's crucial to understand the environmental impact of alternative materials; which will allow design choices to be guided by a life cycle thinking while finding a trade-off between their ecological impact and the magnet performance. Life cycle assessment methodology is the backbone for a life cycle-driven design as it helps quantify the environmental impact on a system, product, and process levels.

What challenges arise when preforming a Life Cycle Assessment on rare earth permanent magnets?
The main challenge is the commercial sensitivity of the production processes of Rare Earth Oxides, leading to several uncertainties. More transparency in the supply chain is needed to achieve a higher accuracy of the life cycle assessment. Another challenge is allocating the impacts to individual rare earth elements. Rare earth elements are mined together and concentrated together. Then, several steps take place to separate each rare earth element; This means a distribution of the environmental impact among the extracted Rare earth elements is necessary. Additionally, the main driving force for rare earth elements mining and production is the market for the elements with the highest economic importance (i.e., Neodymium and Dysprosium), which poses whether the environmental impact should be allocated based on the mass or market value of the different rare earth elements.

How does the substitution of Cerium instead of Neodymium influence the ecological impact?
The environmental impact of Cerium substituted magnets in the context of the project has approximately the same ecological impact as Neodymium magnets. That is when compared to NdFeB magnets with an energy product of ~340 kJ/m³.

Did you find any influence between the classical production route via pressing compared to Metal Injection Moulding?
In our analysis, the Metal injection moulding route scored better in most environmental impact categories when compared to the classical production route. The results are mainly due to the higher efficiency of the metal injection moulding process. Of course, these results are on pilot scale processes; Nonetheless, they are promising.

Project Update

Webinar April 2022

The next webinar “LCA of permanent magnets” will be held online on 25th of April. The registration will open soon.

Webinar October 2022

The other webinar “Advanced Electrical Machine Design” will be held October.

Magnets with less neodymium

The composition and the manufacturing route of Cerium substituted sintered magnets have been defined, tested and validated by CEA Grenoble. The process parameters have been shared with the industrial partner Magneti, who is currently in charge of providing more than 20 kg of sintered magnets for prototyping four electrical machines. The Ce content of these magnets allows a replacement of about 30 % of the Nd (which dominates the bill of materials for magnets) with a cheaper material, the Ce price being ten times lower than other light rare earth (Nd, Pr).

Powder injection moulding of new magnetic alloys

The Powder Injection Moulding technique leads to considerable reduction of waste and lost of critical material since netshape magnets can be produced without machining operation. Montanuniversitaet Leoben in Austria and CEA in France have worked together in order to define a process route for an efficient feedstock production, suited for handling highly reactive Ce based powders. In the same time, CEA and Magneti partners have designed an injection mould liable to shape crescent-like parts, taking into account the anisotropic shrinkage and geometrical distortion during sintering. The combination of a magnetic field during injection allows manufacturing anisotropic magnets with a geometry that would optimize the performance of new electrical machines.

High-performance electric motors testing

Two high-performance electric motors are under analysis. One is a low voltage motor (left figure), and the other is a high voltage motor. The high voltage electric motor consists of the typical block-typed magnets where Cerium substitution is analysed. The right figure shows the high voltage prototype assambly with Cerium substitution. The low voltage motor prototype consists of complex-shaped magnets developed through powder injection moulding and Cerium substitution. The development of complex-shaped magnets could expand the motor design alternatives.

Upcoming Related Events

Global Rare Earths Summit 2022

31 March 2022, online

City & Financial Global and REIA are proud to co-present the Global Rare Earths Summit 2022 on Thursday, 31st March. This leading virtual summit will provide a forum where senior policy members, mining, financial and supply chain executives can discuss how to manage the supply/demand squeeze for rare earths and meet the global need for a swift and responsible transition to green energy.

https://www.cityandfinancialconferences.com

4th RawMaterials Summit

23 - 25 May 2022, Berlin, Germany

As Europe's premier raw materials event, the RawMaterials Summit provides a holistic view of the raw materials ecosystem in the EU and beyond. Bringing together representatives from industry, policymakers, academia, investors and civil society from across Europe and further afield.

https://www.eitrmsummit.com/

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Connecting matters

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

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