Naziv Projekta

Oznaka in naziv projekta

N1-0451 – RENEWAL – Pridobivanje neodima iz odpadnih trajnih magnetov Nd-Fe-B z elektrokemijo

N1-0451 – RENEWAL – Recovery of Neodymium from wasted Nd-Fe-B permanent magnets by electrochemistry

Logotipi ARIS in drugih sofinancerjev

Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije

Projektna skupina

Vodja projekta:

Dr. Laura, Marie ADAM - 61375

Sodelujoče raziskovalne organizacije:

Sestava projektne skupine:

Prof. Dr. Kristina Žužek - 18824

Dr. Gašper Tavčar - 21556

Vsebinski opis projekta

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Permanentni magneti na osnovi redkih zemelj se uporabljajo vse pogosteje, saj so med drugim prisotni v električnih vozilih in vetrnih turbinah.

Med te magnete spadajo tudi magneti NdFeB, pri čemer neodim (Nd) zaradi svoje omejene razpoložljivosti in dobavne verige, ki jo večinoma nadzoruje Kitajska, velja za kritično surovino (**CRM**). V okviru projekta RENEWAL nameravamo to problematiko obravnavati z neposrednim pridobivanjem Nd iz izrabljenih (**EoL**) permanentnih magnetov NdFeB. Trenutno stanje tehnike (SOTA) kaže, da je elektroliza v staljenih soleh (**MSE**) učinkovitejša v primerjavi s postopki, ki uporabljajo ionske tekočine ali globoko evtektična topila. Vendar je bila MSE za pridobivanje Nd doslej večinoma izvedena v staljenih soleh na osnovi fluoridov. Pri takšni izvedbi nastajajo ogljikov dioksid in perfluoroogljikovodiki, proces pa poteka pri temperaturi okoli 1100 °C. Poleg tega se anoda med procesom porablja, zato jo je treba zamenjevati.

V zadnjem času so bili razviti postopki MSE v staljenih soleh na osnovi kloridov, ki preprečujejo nastajanje toplogrednih plinov, omogočajo uporabo dimenzijsko stabilne anode ter delovanje pri zmernejših temperaturah, okoli 600 °C. Žal pa v tem primeru na anodi

nastaja klor. V kombinaciji z visoko temperaturo to povzroča močno korozijo elektrokemijske celice.

Projekt RENEWAL se osredotoča na razvoj procesa v eni sami elektrokemijski celici, ki omogoča pridobivanje Nd z oksidacijo permanentnih magnetov na anodi in redukcijo Nd na katodi. Izvedene bodo elektrokemijske raziskave, s katerimi bomo podrobneje preučili in razumeli posamezne korake procesa. V drugem delu projekta se bomo osredotočili na sestavo elektrolita. Trenutni elektroliti na osnovi kloridov namreč vsebujejo litij, ki prav tako velja za kritično surovino (**CRM**). Zato nameravamo razviti in preučiti novo zmes staljenih soli, ki bo omogočala izogib uporabi litija.

Osnovni podatki sofinanciranja so dostopni na spletni strani *SICRIS*.

Faze projekta in opis njihove realizacije

1. Understanding of the electroleaching mechanism of raw neodymium, NdFeB and end-of-life permanent magnets
2. Understanding of the electrodeposition mechanism of Nd in chloride electrolyte
3. Coupling electroleaching and electrodeposition of end-of-life permanent magnets via molten salt electrolysis
4. Improvement of the electrolyte by avoiding Li
5. Characterization of the deposits
6. Project management and training
7. Dissemination, exploitation and communication

Bibliografske reference

Project Title

Project Number and Title

N1-0451 – RENEWAL – Pridobivanje neodima iz odpadnih trajnih magnetov Nd-Fe-B z elektrokemijo

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ARIS and Other Co-funders' Logos

Project Team

Project Leader:

Dr. Laura, Marie ADAM - 61375

Participating Research Organisations:

Project Team Members:

Prof. Dr. Kristina Žužek - 18824

Dr. Gašper Tavčar - 21556

Project Description (few sentences):

Permanent magnets based on rare earth elements are more and more used as they are presents in electric vehicles and wind turbines.

Among these magnets are the NdFeB magnets and Nd is considered as a critical raw material (**CRM**) due to its low availability and supply chain controlled mainly by China. In the project RENEWAL, we plan to address this issue by recovering Nd directly from end-of-life (**EoL**) NdFeB permanent magnets. The SOTA highlights a good efficiency of molten salt electrolysis (**MSE**) compared to ionic liquid or deep eutectic solvent. However, MSE of Nd has been mainly performed in fluoride based molten salts. In this configuration, there is production of carbon dioxide and perfluorocarbon and the temperature is around 1100°C. In addition, the anode is consumed during the process, so it needs to be changed. More recently, MSE in chloride based molten salts have been performed, avoiding the production of greenhouses gaz and enable the use of a dimensionnally stable anode as well as working at moderate temperature (around 600°C). Unfortunately, in this case, there is production of chlorine at the anode. Combined to the high temperature, it induces a high corrosion of the electrochemical cell.

RENEWAL is focusing on the development of a one-cell process to recover Nd by oxidizing the permanent magnets at the anode and reducing Nd at the cathode. Electrochemical studies will be performed to understand every step of the process. In a second part, we will focus on the composition of the electrolyte. Indeed, current chloride-based electrolyte are using lithium which is also considered as CRM. We plan to work in a new molten salt to avoid the use of Li.

Project Phases and Description of Their Implementation

8. Understanding of the electroleaching mechanism of raw neodymium, NdFeB and end-of-life permanent magnets
9. Understanding of the electrodeposition mechanism of Nd in chloride electrolyte
10. Coupling electroleaching and electrodeposition of end-of-life permanent magnets via molten salt electrolysis

11. Improvement of the electrolyte by avoiding Li
12. Characterization of the deposits
13. Project management and training
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Bibliographic References