Rare Metal Extraction & Processing: Recycling, Co, REE

Sponsored by: TMS Extraction and Processing Division, TMS: Hydrometallurgy and Electrometallurgy Committee

Program Organizers: Gisele Azimi, University of Toronto; Takanari Ouchi, The University of Tokyo; Kerstin Forsberg, KTH Royal Institute of Technology; Hojong Kim, Pennsylvania State University; Shafiq Alam, University of Saskatchewan; Alafara Baba, University of Ilorin; Neale Neelameggham, IND LLC

Wednesday 8:30 AM
March 17, 2021
Room: RM 44
Location: TMS2021 Virtual

8:30 AM

Recycling of Rare Earths from Neodymium Magnets Using Focused Infrared and Solid Phase Extraction: *Mélodie Bonin*[1]; Dominic Larivière[1]; [1]Université Laval

Neodymium magnets (NdFeB magnets) are used in many technologies such as electric cars, windmills, or hard disk drives (HDD). Recycling the rare earth elements (REE) from waste magnets is interesting considering that their concentration is sometimes higher than in the ores from which they originate. In this study, we investigated the recovery of praseodymium, neodymium, dysprosium, and terbium from NdFeB magnets of HDD using focused infrared digestion (FID) and solid phase extraction (SPE). Because of its ease of use and low consumable cost, FID was investigated as a new strategy for the rapid dissolution of REE. When unmagnetized and powdered to <250 μm, REE are totally dissolved after 5 minutes with 3N H_2SO_4 or HCl. In magnetised and crushed form, pieces of 6x3 mm can be dissolved in less than 30 min. REE can then be isolated by SPE. Results on the dissolution and extraction will be provided.

8:50 AM Invited

The Italian National Research Council Operations within the EIT Raw Materials Framework: *Paolo Dambruoso*[1]; Salvatore Siano[2]; Armida Torreggiani[1]; Ornella Russo[3]; Vladimiro Dal Santo[4]; Stefania Marzocchi[5]; [1]ISOF-CNR; [2]IFAC-CNR; [3]Library of the Bologna CNR Research Area ; [4]SCITEC-CNR; [5]Library of the Bologna CNR Research Area

The strategy adopted and the results achieved by the Italian National Research Council within the Knowledge and Innovation Community “Raw Materials” of the European Institute of Innovation and Technology (KIC EIT-RM) will be presented in some details. We will focus on activities dedicated to education as well as validation and acceleration actions of the EIT-RM. Regarding the former, will be presented activities tackling the awareness of the citizens on the impact of RMs in our life, guiding pupils toward an informed engagement into RMs university carriers, and lifelong learning of professionals dedicated to methodologies to access, organize and share scientific literature and data. Regarding the validation and acceleration actions, two main activities will be discussed: 1) development of Platinum–Group Metals free catalysts and the corresponding know-how transfer initiative toward ESEE countries; 2) development of novel analytical logging tools and portable devices for real-time compositional analyses based on laser technologies.

9:10 AM

Experimental Determination of Liquidus Temperature and Phase Equilibria of the CaO-Al_2O_3-SiO_2-Na_2O Slag System Relevant to E-waste Smelting: *Md Khairul Islam*[1]; Michael Somerville[2]; Mark Pownceby[2]; James Tardio[1]; Nawshad Haque[2]; Suresh Bhargava[1]; [1]RMIT University; [2]CSIRO

The recovery of valuable and critical metals from electronic wastes (e-waste) via the pyrometallurgical route has some challenges including high processing temperatures. Designing appropriate slag systems based on the major elemental components in e-waste could bring operational advantages by lowering the liquidus temperature. In this study, the quaternary slag system CaO-Al_2O_3-SiO_2-Na_2O was investigated to determine the liquidus temperature and phase equilibria of slags relevant to e-waste smelting. The slags were thermally equilibrated at different temperatures inside a vertical tube furnace followed by rapid quenching. The quenched slags were examined by SEM to observe the phase formed and the equilibrium compositions were determined using energy dispersive (ED) spectrometry. The liquidus temperature of the slags in the anorthite ($CaO.Al_2O_3.2SiO_2$) phase field was significantly decreased with increasing levels of Na_2O, while a similar but less pronounced trend followed in the gehlenite ($2CaO.Al_2O_3.SiO_2$) phase field. The slag composition moved towards the pseudo-wollastonite ($CaO.SiO_2$) region upon the addition of Na_2O.

9:30 AM Invited
How to Prepare Future Generations for the Challenges in the Raw Materials Sector: *Armida Torreggiani*[1]; Alberto Zanelli[2]; Alessandra Degli Esposti[2]; Eleonora Polo[2]; Paolo Dambruoso[2]; Renata Lapiska-Viola[2]; Kerstin Forsberg[3]; Emilia Benvenuti[4]; [1]National Research Council of Italy-CNR; [2]ISOF-CNR; [3]KTH - Royal Institute of Technology; [4]National Research Council of Italy (CNR)

Accessible raw materials (RMs), such as rare-earth-elements, indium, neodymium, etc., are essential in technologies and allow the transition towards a low-carbon economy. But how can the RMs uses and importance be successfully introduced in secondary schools, where they are rarely part of education? Some learning paths for pupils from 10 to 18 years old were developed by an European project, Raw Matters Ambassadors @Schools (RM@Schools-http://rmschools.isof.cnr.it/) involving 18EU countries and funded by the European Institute for Innovation and Technology. Different educational approaches (such as learning by doing, peer-to-peer, gamification, etc.) are used to foster students' interest in circular economy and RM-related topics. The pathways are oriented toward a common goal: students are guided to become Young RM Ambassadors (science communicators) and create a "product" to be communicated outside of the class. By doing this, students develop 21st century learning skills such as creativity, critical thinking, awareness of responsibility and teamwork.

9:50 AM Invited
Circular Economy for Rare Earths: What are the Different Strategies, Challenges, and Opportunities?: *Komal Habib*[1]; [1]University of Waterloo

A stable and secure supply of raw materials is necessary for proper functioning of our modern society. These supply related concerns have lately been addressed by the concept of raw materials criticality, where rare earth elements have been classified as critical materials due to their key role in most of today's hi-tech applications (ranging from information technology & telecommunication to renewable energy technologies), and their potential high supply risk. In order to reduce raw materials criticality, a number of solutions have been considered in the past, such as stockpiling, diversifying supply and increasing recycling. More recently, circular economy is seen as a system to reduce criticality by keeping the materials in economy for longer time period, through using strategies such as reusing, refurbishing, remanufacturing and recycling. This talk is aimed at exploring challenges and opportunities related to these strategies for rare earths based permanent magnets, i.e., neodymium-iron-boron (NdFeB) magnets.