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Progress on the Recovery of Critical Raw Materials

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To aim for a sustainable, low-carbon, resource-efficient, and competitive economy, many countries have published their Critical Raw Materials (CRM) lists, with CRM defined as those which are of particularly great importance to the country's economy and, at the same time, have a high risk of supply disruptions.[1] Extensive research and developmental activities have led to the emergence of new methods and engineering processes for the recovery of critical, precious, and other materials from mineral ores or tailings, extractive waste, and metallurgy slags.[2] These highlight the technological innovation and contributions that have been made to a more comprehensive knowledge on raw materials.

In 2021, *JOM* Advisors of the Hydrometallurgy and Electrometallurgy Committee of the Extraction and Processing Division of The Minerals, Metals & Materials Society organised a special topic on the emergence of new methods, processes, and engineering flowsheets in hydro(bio)-, pyro- and electrometallurgy: "Advances in Process Metallurgy"[3]. In 2022, the special topic is focused on Progress on Recovery of Critical Raw Materials. Based on their main aims, these papers can be grouped into two categories: resource recovery by hydrometallurgy routines, and utilization research of metallurgical slags or by pyrometallurgy. Due to a wealth of high-quality submissions, this topic has been allocated into two parts. Eleven papers will be published in May 2022 as Part I, and the remaining accepted papers will be published in July 2022 as Part II. Here, we provide the summary report on the Part I issue:

Hong Peng and Kerstin Forsberg are Guest Editors for the Hydrometallurgy and Electrometallurgy Committee of the TMS Extraction and Processing Division, and organized the topic Progress on Recovery of Critical Raw Materials in the May 2022 issue of JOM.

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The first five papers in this topic focus on resource recovery by hydrometallurgy routines. In the first paper, "Efficient Oxidation Approach for Selective Recovery of Lithium from Cathode materials of Spent $LiFePO_4$ Batteries", Liu et al. have developed a green and efficient approach for recovering Li from spent $LiFePO_4$ batteries by utilising the oxidant of NaClO in the leaching process. Gharabaghi et al. conducted the leaching tests on cadmium recycling from zinc plant residues by varying different parameters through a fractional factorial design in, "Clean practical method for cadmium recycling from toxic material and optimization of recycling process".

The third paper, by Luo and He, proposes a two-step leaching indirect carbonation process using NH_4Cl and CH_3COOH in order to combine the advantages of the two leaching agents to obtain a better experimental outcome in, "Indirect carbonation by a two-step leaching process using ammonium chloride and acetic acid".

In the fourth paper, "Efficient extraction of manganese from low-grade pyrolusite by sawdust pyrolysis reduction roasting-acid leaching process", Ju et al. combined sawdust pyrolysis reduction roasting and an acid leaching process to extract manganese from low-grade pyrolusite.

Finally, Fang et al. discuss the performance of digenite ($Cu_{1.8}S$) and covellite (CuS) crystallite in the leaching process of chalcocite in, "How Ferric Salt Enhances the First-Stage Acidic Leaching of Chalcocite: Performance of Intermediate Crystallite".

The next six manuscripts focus on utilization research of metallurgical slags or by pyrometallurgy. In, "Direct extraction of nickel and copper from low-grade nickel sulfide ore by chlorination roasting with mixed $MgCl_2{\cdot}6H_2O$ and NaCl", Xu et al. have developed a new extraction technology of chlorination roasting with a mixture of two chloride salts to co-extract nickel and copper from low-grade nickel ores. For the utilization of zinc smelting a high sulfur residue, Gong et al. have investigated

the changes in the wetting angle between the sulfur and the other main minerals to evaluate the mineral association under various conditions through criterion equations in their paper, "Association Law of Sulfur and Different Components in Zinc Smelting High-Sulfur Residue".

The next two papers are about research on magnesium pellets. Bai et al. have developed a method of continuous image analysis to account for the volume change of pellets during a reduction process for this first paper, "Reduction swelling mechanism for different types of pellets based on continuous imaging analysis". The second paper reports on the investigation of the effect of MgO/SiO_2 and FeO contents softening–melting behaviors of a magnesium pellets slag system in, "Softening–melting behaviors of a MgO-SiO_2-FeO slag system on a coke bed".

The last two papers are about the utilization of aluminum dross. Xu et al. report on the utilization of secondary aluminum dross as a carbon-free reductant to recycle valuable metals from copper slag by smelting reduction in, "Iron recovery from waste copper slag by using coal and secondary aluminum dross as co-reductants". Zuo et al., in their paper, "Basic physical properties of aluminum alloys and their electrolyte systems prepared by molten salt electrolysis using black aluminum dross as raw material," have measured the density and surface tension of the proposed molten salt system of different components when using black aluminum dross as raw material.

All titles and authors of the articles published under the topic "Progress on Recovery of Critical Raw Materials" in the May 2022 issue (vol. 74, no. 5) of JOM can be accessed via the journal's page at: http://link.springer.com/journal/11837/74/5/page/1.

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CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there are no conflicts of interest.

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