minerals

Editorial

Editorial for the Special Issue on "Recovery of Precious Metals, Rare Earth Elements and Special Metals from Spent Secondary Products"

Zenixole R. Tshentu [1,*] and Durga Parajuli [2,*]

1 School of Biomolecular and Chemical Sciences, Department of Chemistry, Nelson Mandela University, Gqeberha 6031, South Africa
2 Nanomaterials Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Higashi, Tsukuba 305-8565, Japan
* Correspondence: zenixole.tshentu@mandela.ac.za (Z.R.T.); parajuli.durga@aist.go.jp (D.P.)

The global demand for precious metals in chemical, petrochemical, electrical and electronic products, for medical and dentistry applications, as well as jewelry and automobile industries, when set against the dwindling natural deposits, demands the development of more efficient recovery methods as well as a move towards urban mining [1]. The latter is becoming more attractive due to its high yields compared with extraction from primary ores [1]. The current recovery rates for precious metals and rare earth elements (REEs) from spent products are low, and there is a need to move towards a closed-loop recycling system. However, the heterogeneous nature of such secondary sources of precious metals and REEs demands the development of robust methods for the recovery of strategic metals. Nine papers have been contributed to this Special Issue (https://www.mdpi.com/journal/minerals/special_issues/RPMREEs (accessed on 19 March 2022). Four original articles and one review are focused on the recovery of REEs from spent phosphors and coal fly ash, while three original articles and one review discuss the recovery of precious metals and other valuable elements from spent secondary sources, such as printed circuit boards and catalytic converters.

The term 'rare earth elements' describes the industrial importance of Sc, Y, and the lanthanides. Among the five papers focused on the REEs, three discuss methods for recovering high-purity elements from fluorescent lamps ([2–4] Peter Boelens et al.; Bing-Xuan He et al.; Clive H. Yen et al.). Mero-Lee et al. presented South African coal fly ash as an alternative source of REEs [5], and Mukaba et al. contributed an overview of the leaching techniques used to recover REEs from phosphogypsum [6]. The articles present several options to increase the sustainability of REEs. These include experimenting with the separation techniques used for other purposes or obtaining an element-specific leaching system with the optimization of factors such as acid/alkali concentration, type of carrier gas, temperature, etc. These papers suggest the lack of a highly efficient method to date. Therefore, collecting the ideas from all the methods proposed to date and forming a new protocol seems to be an achievable option. In addition, the physical factors also play a major limiting role in the efficient recovery of REEs from the fluorescent lamps. This means that restructuring the fluorescent lamps for phosphors recycling might be one of the easiest ways to resolve this issue, and this is in line with the principles of a circular economy.

Spent secondary sources or city mines are the new global challenges, as well as the new sources of treasures. Although the world has accepted the importance of these 'wastes', the real challenge lies in the costs of effectively recycling rare and precious elements. It is true that the mass percentage of the platinum group metals in the spent electrical/electronic devices is more than that in the natural mine, however, the coexistence of several heavy metals and metalloids in a high concentration demands a more sophisticated separation protocol. Suponic et al. discussed the combination of physical methods of dismantling the

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spent circuit board before hydrometallurgical treatment [7]. Moleko-Boyce et al. proposed the use of functionalized Merrifield resins for the recovery of PGMs from the leachates of the catalytic converters [8]. A different approach was taken by An et al., in which a bacterium was used for the selective leaching of a metal. This is interesting, although the working atmosphere is somewhat challenging for practical implementations [9]. Many of the studied approaches for the sustainable recovery of valuable metals from the spent sources are comprehensively summarized by Xolo et al. [10]. While describing the progress made to date, this review reinforces the need for the development of more concise methods for the selective, effective, and environmentally friendly recovery of strategic metals.

The purpose of this Special Issue is to obtain further insight into the status of recycling valuable metals from spent resources, which is largely achieved. We would like to express our sincere thanks to the contributors and the reviewers for their assistance, expertise and time. We are thankful to the *Minerals* editorial team for their continuous support.

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