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Editorial

Sustainable Utilization of Metals-Processing, Recovery and Recycling

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1. Introduction and Scope

Our modern everyday life and thus our technical progress is based on a variety of metals. For example, computer chips and smartphones contain up to 60 different metals in various compounds and concentrations. The secure supply of our industry with these raw materials has become a strategic element of global politics and always leads to conflicts of interest between economics and ecology, as well as social needs.

Georesources, i.e., metal-containing primary raw materials, will continue to provide the bulk of supply for a long time, but deposits will become poorer and more complex. In the wake of Europe's demand for a "circular economy", the reuse of metal-containing materials or their elements themselves is becoming increasingly important. However, recycling in a growing demand environment, especially in the Asian region, can never close the gap even with theoretically complete recirculation. In this respect, the sustainable use of our metals is very important. However, that does not mean recycling at any price, as there is always an optimum balance between resource use (energy, materials, personnel, land, water, etc.) and the resource proceeds of every metal extraction process.

The high demand on advanced metallic materials raises the need for an extensive recycling of metals and a more sustainable use of raw materials. Advanced materials are crucial for technological applications, coexisting with an increasing scarcity of natural resources. This Special Issue, "Sustainable Utilization of Metals - Processing, Recovery and Recycling", is dedicated to the latest scientific achievements in efficient production of metals, purposing a sustainable resource use. Research centers from three continents present in 25 research papers and two review papers the results of their work in recent years on this topic.

These also include primary raw materials directly, waste from past mining and processing operations, metallurgical slags and end-of-life products such as Waste Electric and Electronic Equipment (WEEE) or batteries. Depending on the country situation, the implementation of new processes or the use of new substances in existing plants requires adapted technologies, in particular to create or maintain jobs in less industrialized regions, thus ensuring social peace.

2. Contributions

The idea of circular economy is the point of origin for contributions, aiming on the recirculation of metal-rich waste streams—such as WEEE, multi-metal alloys and composite materials—back into metal production. This topic goes along with pursuing the holistic use of input materials, resulting in the avoidance of waste by-products. In order to minimize material losses and energy consumption, this issue explores concepts for the optimization concerning the interface between mechanical and thermal pre-treatment and metallurgical processes. Furthermore, the direct re-use of complex alloys and composite materials without splitting them up into their single constituents is taken into account.

Papers in this issue are also engaged with the question of how the properties of indispensable advanced materials and alloys can be preserved by a more responsible input or even avoidance of

particular constituents. In this regard, new approaches in material design, structural engineering and substitution are provided.

Considering both principal aspects—circular economy and material design—the recovery and the use of minor metals play an essential role, since their importance for technological applications often goes along with a lack of supply on the world market. Additionally, their ignoble character, as well as their low concentration in recycling materials cause a low recycling rate of these metals, awarding them the status of "critical metals". The research of this increasingly important material group will be discussed in this Special Issue in seven research papers [1–7].

Also classified as critical metals but included in a separate category is the group of Rare Earth Elements (REE). Recovery of these elements and thus securing of supply of raw materials independently of non-European market is still the focus of research today. Four papers deal with the recovery of REE [8–11].

Base and precious metals will be more and more in the focus of future research, as primary deposits will become poorer and more complex and thus winning is not that easy. Consumer and production wastes show excellent recovery opportunities for this group of metals. That is why eleven papers deal with the recovery of base metals [12–22] and one of precious metals [23].

Also, the recycling from complex systems like WEEE or batteries is in focus in this Special Issue. In these systems selective extraction of several metals in one step is not feasible or even goal of research. Numerous groups of metals are extracted simultaneously and treated in further steps to be separated optimally from multicomponent systems. For this reason, four papers show an overlap over multiple metal groups, base, precious and critical metals [24–27].

Conflicts of Interest: The author declare no conflict of interest.

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