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Urban Mining: Characterization and Recycling of Solid Wastes

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As the world moves toward zero waste and low-carbon economy, awareness of urban mining as well as concerns about environmental effects is increasing. Urban mining explores the mineral resource and economic value of the waste streams generated in urban spaces and has been playing a significant role in the planning and designing of sustainable cities. In this special topic *JOM* presents papers that bring out comprehensive information on the promotion of resource conservation through recycling, reuse, and recovery of secondary resources from solid wastes and safeguarding of the environment.

This special topic features a paper titled "Preparation of Pyrolytic Carbon from Waste Tires for Methylene Blue Adsorption" by Yuzhe Zhang et al. Waste tires are a challenging source of solid waste for recycling due to the large volume produced, the durability of the tires, and the components in the tire that are ecologically problematic. The authors proposed a new process of preparing pyrolytic carbon from waste tires to treat methylene blue dye (MB). Treating waste by the application of other wastes is a resource-saving pollution control strategy. Previous methylene blue (MB) treatment methods are either expensive or have high energy demands. In this study, two pollution treatments were combined via carbon pyrolysis. Waste tire pyrolysis by microwave irradiation produced pyrolytic carbon, which was then used to adsorb MB. The results showed that recycled pyrolytic carbon benefits the MB adsorption reaction as a spontaneous endothermic reaction. The reported recycling processes have low cost and low energy requirements compared with previous studies. Successful implementation of these processes will not only enable high-value materials to be reused but also bring both economic and environmental benefits.

Another interesting paper included in this special topic encompasses the decolorization of rapeseed oil using montmorillonite authored by Mengna Yang et al. This paper describes a low-temperature atmospheric calcination technology for solving the current environmental issues associated with activated clay production. In this study, the structural alteration of montmorillonite during the production of activated clay was investigated with this new technology. The results revealed that the increase in temperature aggravates the destruction of the octahedral sheets in montmorillonite laminates because of the continuous dissolution of cations in the sheets, with relatively stable tetrahedral sheets. Activated montmorillonite layers became curled and stacked in disorder, which was different from those in the original. The maximum acidity of 230 mmol/kg was achieved at an optimum temperature of 200°C. Under this condition, the specific surface area and total pore volume increased from 78.4 m^2/g to 226 m^2/g and from 0.107 cm^3/g to 0.318 cm^3/g, respectively. With the improvement in the decolorization ability of the clay, the absorbance of the rapeseed oil decreased to 0.867 from 4.070.

Recycling valuable metals from spent batteries has been attracting increasing attention among researchers because of the rapid increase of electronic product consumption. Recycling of valuable metals from spent lithium-ion batteries (LIBs) appears inevitable for both environmental protection and resource recovery. In the study by Guilan Gao et al., an efficient hydrometallurgical leaching of Co and Li from cathode materials of spent LIBs is explored using a citric acid/sodium thiosulfate ($Na_2S_2O_3$) system. Under optimized leaching conditions, approximately 96% of Co and 99% of Li can be recycled from the spent LIBs by this system. Furthermore, pure sulfur can be obtained as a by-product during the leaching process, and SO_2 produced during the reaction is easily collected as

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a raw material for production of sulfuric acid. The present study represents a promising process for hydrometallurgical recovery of valuable metals from spent LIBs.

With increasing amounts, solid waste containing harmful elements such as arsenic poses a great threat to the environment, and these solid wastes need to be treated prior to disposal. Ailiang Chen et al. report a leaching process of cobalt/nickel residue using alkali at atmospheric pressure. Under optimum leaching conditions, about 99% and 87% leaching ratios of arsenic and zinc were reached, respectively, whereas cobalt, copper, and nickel remained non-dissolved. Based on thermal analysis and kinetics calculation, the activation energy of the leaching process is 42.06 kJ/mol and the reaction order is 2.77. This work effectively recovered arsenic from the hazardous residue, while greatly reducing environmental pollution. It also laid a solid foundation for further comprehensive recovery of valuable metals from the metallurgical process of zinc.

Weifeng Liu et al. report a technical route for preparing sodium pyroantimonate by pressure oxidation in NaOH solution. The *E*-pH diagram of the Sb-H_2O system shows that Sb(III) from antimony trioxide can be oxidized to Sb(V) to prepare sodium pyroantimonate under different alkaline concentrations. In the direct pressure oxidation technique, the product was doped with antimony trioxide because of the diffusion effect. By comparison, the technique of complex leaching-pressure oxidation could prepare an eligible product, which presented regular hexahedral morphology. Nevertheless, sodium pyroantimonate transformed to $NaSbO_3$ at excessive temperatures. The sodium antimonite solution prepared in the leaching process contained 18 g/l Sb. The antimony precipitation ratio in the pressure oxidation process increased with the stirring speed and oxygen partial pressure. Under the optimum conditions of temperature of 150°C, oxygen partial pressure of 2.0 MPa, stirring speed of 1000 rpm, and reaction time of 2 h, the antimony precipitation ratio was 97.70%.

In summary, five papers are being published under the topic of Urban Mining: Characterization and Recycling of Solid Wastes: Part II, which provide excellent research achievements on the subject. To read or download any of the papers, follow the url https://link.springer.com/journal/11837/71/10/page/1 to the table of contents page for the October 2019 issue (vol. 71, no. 10).

- "Preparation of Pyrolytic Carbon from Waste Tires for Methylene Blue Adsorption" by Yuzhe Zhang, Qian Cheng, Dandan Wang, Da Xia, Xudong Zheng, Zhongyu Li, and Jiann-Yang Hwang.
- "Structural Alteration of Montmorillonite by Acid Activation and Its Effect on the Decolorization of Rapeseed Oil" by Mengna Yang, Hongjuan Su, Tongjiang Peng, Bowen Li, and Yanyan Xie.
- "A Citric Acid/$Na_2S_2O_3$ System for the Efficient Leaching of Valuable Metals from Spent Lithium-ion Batteries" by Guilan Gao, Xin He, Xiaoyi Lou, Zheng Jiao, Yaoguang Guo, Shuai Chen, Xingmin Luo, Suyang Sun, Jie Guan, and Hao Yuan.
- "Recovery of Arsenic from Arsenic-Bearing Cobalt/Nickel Residue using Sodium Persulfate" by Ailiang Chen, Jinxi Qiao, Shuang Long, Zhen Qian, Yalin Ma, Yang Qiu, Ruikang Wang, Zhiqiang Liu, Yan Zhang, Yutian Ma, Peng Zhang, and Xiaojian Ou.
- "Preparation of Sodium Pyroantimonate from Antimony Trioxide by Pressure Oxidation in NaOH Solution" by Weifeng Liu, Kunkun Zhang, Duchao Zhang, Lin Chen, Liangqiang Liu, and Tianzu Yang.