Extraction of Cu, Zn, and Ni from waste silica-rich integrated circuits by sulfation roasting and water leaching

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Abstract

High-tech electrical and electronic equipment contain large numbers of silica-rich integrated circuits (SRICs) which after its end of life generate huge amount of waste; however, its valuable metal contents can be properly recycled. Extraction of Cu, Ni, and Zn from pulverized SRIC obtained from discarded waste electrical and electronic equipments (WEEE) by sulfation roasting followed by water leaching was studied. Co-extraction of other metals such as Fe, Al, and Pb present in the sample was also explored. Effects of H_2SO_4/SRIC ratio, roasting temperature, time, and varying water leaching conditions on the extraction efficiencies were evaluated. The optimum conditions for Cu, Zn, and Ni extractions were determined as H_2SO_4/SRIC ratio 0.5, roasting temperature 300 °C, roasting time 60 min, leaching temperature 50 °C, leaching time 60 min, and liquid–solid ratio = 10:1 (i.e., 100 mL/10 g) with extraction efficiencies of 61.9, 84.9, and 93.6% for Cu, Ni, Zn, and co-extractions of Fe and Al were 71.1 and 55.6, respectively. Under the optimum conditions, approximate 20% Fe^{3+} was naturally precipitated which is advantageous for the subsequent step. Comparatively, higher extraction efficiencies of Cu, Zn, and Ni were observed in water leaching of H_2SO_4-roasted sample than direct H_2SO_4 leaching of raw sample keeping other leaching conditions constant. Lead retained in the roasted–leached residue was extracted with dilute HCl leaving silica and Al in the final leached residue. Process flow sheet for the extraction of Cu, Ni, Zn, and Pb and reuse of silicon from waste SRICs was proposed.

Keywords: Silica-rich integrated circuits, Heavy metals, Extraction, Sulfation roasting, Water extraction

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