Supporting Materials

Recovery of High-purity Silver from Spent Silver Oxide Battery by Sulfuric Acid Leaching and Electrowinning

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Optimization of leaching conditions

The optimization of temperature, H_2SO_4 concentration and solid/liquid ratio was studied prior the measurements. The effect of temperature on metal recovery (Figure S1a) was conducted first in the absence of H_2O_2 with a total leaching time of 240 min and it showed that high temperaure conditions enhanced the extraction of Ag and Mn. The leaching efficiency of silver increased from 70% to 85% and Mn extraction increased slightly from 37 % to 40% when temperature increased from 25 °C to 70 °C, whereas the leacing efficiency of zinc remained at a high level of over 99%. At temperature above 70 °C, the effect of temperature on metal extraction was negligible. As a result, a temperature of 70 °C was considered to be optimal for the leaching of silver oxide battery wastes. Figure S1b shows the leaching efficiency of metal elements as a function of H_2SO_4 concentration. A marked increase of silver leaching efficiency was observed when acid concentration increased from 0.5 M to 1 M while the effect of acid concentration beyound 1 M on metal extration was marginal. The dissolution of Mn increased only slightly with acid concentration and no appreciable change of Zn extraction was

observed. Figure S1c presents the metal extration at different solid/liquid ratio. The extraction of metal elements (Zn, Ag and Mn) was increased with decreaseing S/L ratio. Especially, the dissolution rose from 2.3% to 85% when S/L ration decreased from 150 g/L to 50 g/L. No appreciable increase in the metal extraction was observed when S/L ratio was further decreased to 25 g/L. Overall, the optimal leaching conditions are as follows: a temperature of 70 °C, a H_2SO_4 concentration of 1 M and a S/L of 50 g/L.

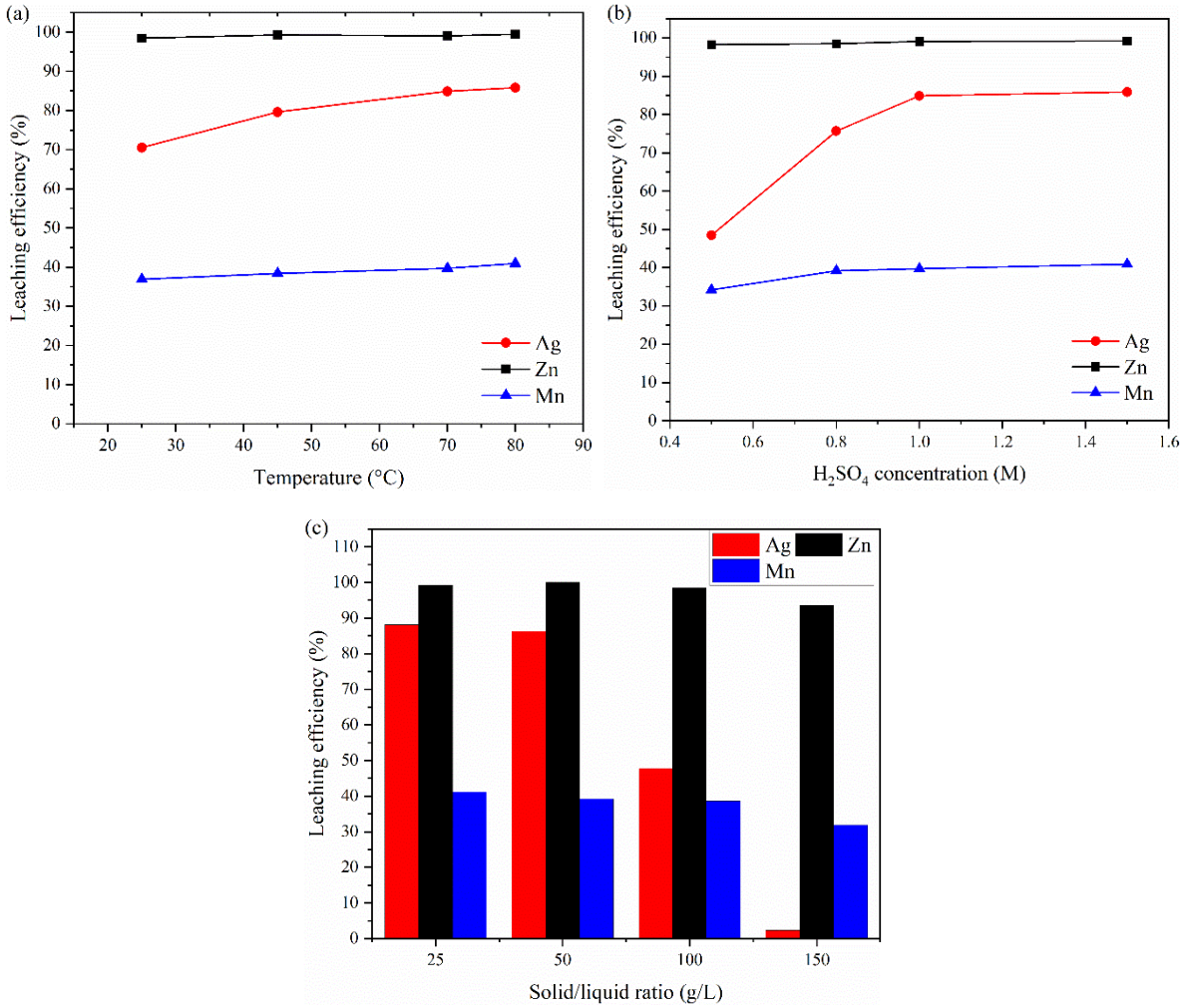

Fig S1. (a) leaching behavior of Zn, Ag, Mn as a function of temperature (S/L = 50 g/L, H_2SO_4 = 1.0 mol/L, leaching time = 240 min); (b) leaching behavior of Zn, Ag, Mn as a function of H_2SO_4 concentration (S/L = 50 g/L, T = 70 °C, leaching time = 240 min); (c) leaching efficiency of metal elements at different S/L ratio (H_2SO_4 = 1.0 mol/L, T = 70 °C, leaching time = 240 min).

Particle size distribution of raw materials

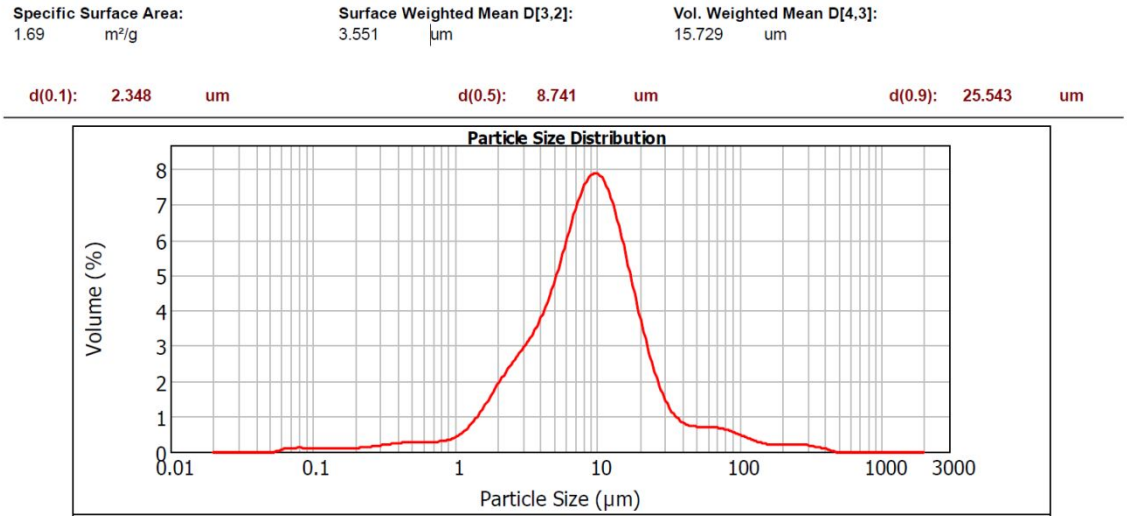

Fig S2. Particle size distribution of spent silver oxide battery materials.