Metal Recovery in the Mobile Phone Waste by Chemical and Biological Treatments

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The amount of waste electrical and electronic equipment (WEEE) generation has been growing due to rapid economic growth and technological advances all over the world. Recycling of electronic waste is an important subject not only on the point of waste treatment but also on the recovery aspect of valuable metals. The objectives of this study were to investigate the stepwise separation and recovery of metals including both (non)ferrous metals and precious metals from the mobile phone waste by combining chemical and biological methods.

The metal fractions attached to printed circuit board (PCB) and camera part were separated from the mobile phone waste, and then pulverized less than approx. ~ 2 mm size particles. For chemical treatment, the metal fractions were dissolved in aqua regia, and then the pH of the acidic solution was increased to 10.5 by adding NH_4OH. As the pH increased, metal precipitation occurred and recovered at acidic, neutral and basic conditions, respectively. For a biological method, the neutral filtrate was added to a growth medium containing metal-reducing bacteria as a metal-precipitate precursor, and then reactived for 2 weeks under anoxic conditions.

As resuluts of pH raising method with NH_4OH, the first precipitate was iron oxide (FeOOH) produced in acidic condition (pH 3.9~4.2). Sequentially, copper chloride hydroxide ($Cu_2Cl(OH)_3$) and rare earth-metal complex were produced in slightly acidic to neutral (pH 5.7~7.7) and alkaline condition (pH 8.3~10.5), respectively. In biological treatment using the neutral filtrate (pH 7.7) removed Fe and Cu, rhodochrosite ($MnCO_3$) and calcite ($CaCO_3$) were formed as nano-sized minerals by metal-reducing bacteria. Thus, trace elements such as Mn and Ca remaining in the neutral filtrate were mineralized by the metal-reducing bacteria, and at the same time, the carbonate mineralization would be effective in carbon dioxide fixation.

Therefore, these results indicate that simple and effective metal recovery of the mobile phone waste might be feasible by chemical and biological treatments, and the recovered metals such as Fe, Cu, and rare earth-metal complex can be recycled as raw materials for diverse industries.