

# SHIBAYAMA LAB.

## [Mineral Processing and Recycling]

International Research Centre for Sustainable Materials

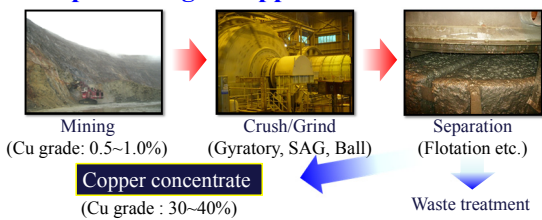
Akita University  
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<http://susmat.iis.u-tokyo.ac.jp/>

### Mineral Processing and Recycling

#### Theme 1: Development of impurities removal method from Cu-ore by mineral processing technology

##### Mineral processing in copper mine



##### Impurities in Cu mineral

- Increasing of As/Sb grade in Cu-ore
- Environmental treatment is required in copper smelting / refining process.

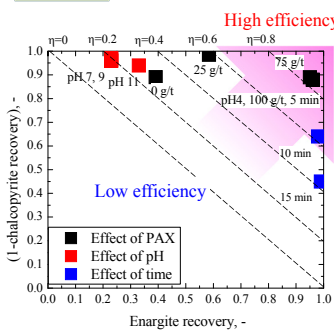


**Enargite ( $\text{Cu}_3\text{AsS}_4$ )**  
(As bearing mineral)  
**Chalcopyrite ( $\text{CuFeS}_2$ )**  
(Typical Cu mineral)

Development of impurities removal technology by using combination of flotation and hydrometallurgical process.

##### Results

##### Effect of flotation parameter

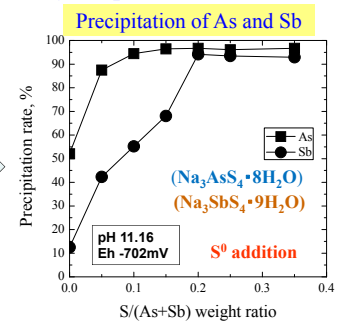
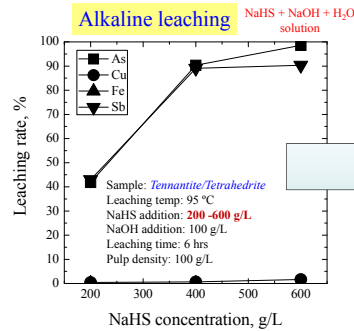


**Separation efficiency**  
 $\eta_N = \eta_{En} - \eta_{Cp}$   
 $(1 - \eta_{Cp}) = -\eta_{En} + (1 + \eta_N)$

The value of separation efficiency

- pH :**  
High enargite recovery was obtained at pH4  
**PAX:**  
Enargite recovery increased by PAX addition  
**Flotation time :**  
Short time flotation is better to obtain high separation efficiency

##### Removal of As/Sb by hydrometallurgical process



It's possible to separate As and Sb from high contents ores by leaching and precipitation process

#### Theme 2: Recovery of valuable metals by chlorination-volatilization and high pressure leaching



PCB: Printed circuit board

##### Elements in e-wastes

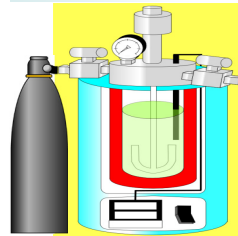
Na, Mg, Al, Si, S, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Sr, Zr, Nb, Mo, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, Ba, Ta, W, Ir, Pt, Au, Pb, Bi

Low recovery metals (minor element) and technological challenges.

Investigation of recovery of valuable metals by pyro-hydrometallurgical process

##### Leaching of metals by high pressure leaching process

##### Autoclave reactor

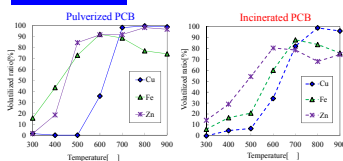


##### Advantages

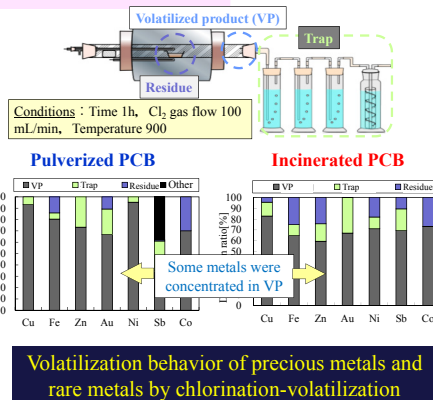
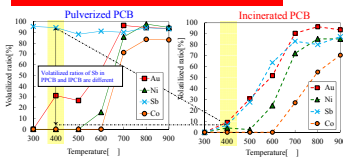
- ◆ This reactor temperature over 200
- ◆ Leaching high pressure with  $\text{O}_2$  gas
- ◆ Improvement of oxidation reaction rate by  $\text{O}_2$  gas supply.
- ◆ Reagent dosage, reaction time etc. can be decreased.

##### Recovery of metals by chlorination-volatilization

##### Base metals

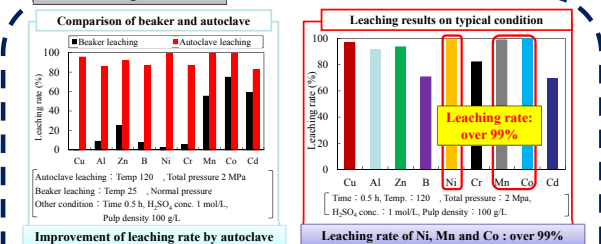


##### Precious metals & rare metals



Volatilization behavior of precious metals and rare metals by chlorination-volatilization

##### Leaching results



Leaching rate of rare metals increased by high pressure and high temperature condition in autoclave reactor