Eco-recycling of Precious Metal from E-waste

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Agenda

1. Introduction of Urban Mining

2. Global Consumer Electronics Sales Situation

3. Eco-friendly Tin Stripping Method

4. Innovative Eco-friendly Gold Stripping Methods
IMAGEING
What happened to them?
We hope They are......
Actually They are...

Untreated e-wastes cause a serious polluted environment

• Thousands of Asia workers have been dismantling electronic trash with chisels and cutting torches since the 1980s, many cities in Asia have turned into favorite dumping grounds for e-waste from the West.

• Acid baths and open burning are commonly used to separate precious metals from circuit boards causing the serious air pollution and wasted water problems.
1. Introduction of Urban Mining

“Urban Mining” --- urban mining is a concept of recycling metals by extracting them from electronic waste. These include Gold, Silver, Palladium, Tin and others valuable metals.

Gold(Au)  Palladium(Pd)  Tin(Sn)  Platinum(Pt)
2004 ~ 2014 Gold Price Graph

**10 Year Gold**

High 1900.30 Low 383.10

USD/Oz

Based on New York Close

300% growth

<table>
<thead>
<tr>
<th>Precious metal</th>
<th>date</th>
<th>Price (USD/Oz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au</td>
<td>2014/10/2</td>
<td>1211.75</td>
</tr>
<tr>
<td>Ag</td>
<td>2014/10/2</td>
<td>17.09</td>
</tr>
<tr>
<td>Pt</td>
<td>2014/10/2</td>
<td>1273</td>
</tr>
<tr>
<td>Pd</td>
<td>2014/10/2</td>
<td>782</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic metal</th>
<th>date</th>
<th>Price (USD/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>2014/10/2</td>
<td>1.86</td>
</tr>
<tr>
<td>Cu</td>
<td>2014/10/2</td>
<td>6.69</td>
</tr>
<tr>
<td>Ni</td>
<td>2014/10/2</td>
<td>16.56</td>
</tr>
<tr>
<td>Sn</td>
<td>2014/10/2</td>
<td>27.27</td>
</tr>
<tr>
<td>In</td>
<td>2014/10/2</td>
<td>717.5</td>
</tr>
</tbody>
</table>
## 2. Global Consumer Electronics Sales Situation

<table>
<thead>
<tr>
<th>Types</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC (Desktop and NB)</td>
<td>296.1</td>
<td>276.7</td>
<td>263.0</td>
</tr>
<tr>
<td>Ultramobile</td>
<td>195.4</td>
<td>270.7</td>
<td>350.0</td>
</tr>
<tr>
<td>Cell phone</td>
<td>1807.0</td>
<td>1895.1</td>
<td>2000.9</td>
</tr>
<tr>
<td>Wearable electronics and others</td>
<td>21.1</td>
<td>37.2</td>
<td>62.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2319.6</strong></td>
<td><strong>2479.8</strong></td>
<td><strong>2675.9</strong></td>
</tr>
</tbody>
</table>

Unit: million units
E-waste Recycling

Precious metals
Basic metals
Rare earth metals

Electronic wastes
Traditionally, people used two basic methods to recycle e-waste: burning and acid dissolution.

- **Burning** --- burning produced a lot of particulates and toxic chemicals includes dioxin, causing serious air pollution.
- **Acid Dissolution** --- using nitric acid or aqua regia to dissolve the precious metals, and dumping waste water without treatment, causing serious water pollution.
Innovative Eco-friendly Metal Stripping Methods

Silver
Gold
Indium
3. Eco-friendly Tin Stripping Method

“Tin recycling technology of waste PCB” was honored with Taiwan EPA’s innovative project. (2013)

“Tin Stripping Additive and Application Thereof” has submitted the invention patents in Taiwan, USA, and China. (2014)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Range</th>
<th>Optimal condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>68% HNO3</td>
<td>200-400 ml/L</td>
<td>250 ml/L</td>
</tr>
<tr>
<td><strong>SnST-550A</strong>&lt;br&gt;Tin stripping additive</td>
<td>200-400 ml/L</td>
<td>250 ml/L</td>
</tr>
<tr>
<td>Reaction Temp.</td>
<td>15-60°C</td>
<td>30°C</td>
</tr>
<tr>
<td>Tin saturation</td>
<td>160~200 g/L</td>
<td></td>
</tr>
</tbody>
</table>

**SnST-550A Tin stripping additive**

<table>
<thead>
<tr>
<th>Composition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10% Surfactant</td>
<td></td>
</tr>
<tr>
<td>&lt; 20% Metal inhibitor</td>
<td></td>
</tr>
<tr>
<td>&gt; 80% Water</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.0~8.0</td>
</tr>
<tr>
<td>Density</td>
<td>1.0~1.1</td>
</tr>
</tbody>
</table>
<Exp. I——Tin plating on the Cu substrate>

Before Tin stripping

68% HNO3
(250 ml/L)

+ SnST-550A Tin stripper
(250 ml/L)

+ H2O
(500 ml/L)

After Tin stripping

25°C, 2 min
<Exp.II---Waste PCB desoldering>

Before Tin stripping

68% HNO₃
(250 ml/L)
+ SnST-550A Tin stripper
(250 ml/L)
+ H₂O
(500 ml/L)

25°C, 10 min

After Tin stripping
Exp.III --- Waste PC motherboard desoldering

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68% HNO3
(250 ml/L)
+
SnST-550A Tin stripper
(250 ml/L)
+
H2O
(500 ml/L)

25°C, 40 min

Before Tin stripping

After Tin stripping
<Exp. IV—Waste appliance board desoldering>

Before Tin stripping

![Before Tin stripping image]

After Tin stripping

![After Tin stripping image]

68% HNO₃
(250 ml/L)

+ SnST-550A Tin stripper
(250 ml/L)

+ H₂O
(500 ml/L)

25°C, 40 min

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Tin stripping and purifying process

68% HNO3 : SnST-550A : H2O (1 : 1 : 2)

Filter

25℃, 30 min

pH > 12

Added 20wt% NaOH liquid

Take out the components

Water rinse

Dry

Tin oxide

Furnace

20% H2 + 80% N2

99.96% Tin

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## 4. Innovative Eco-friendly Gold Stripping Methods

<table>
<thead>
<tr>
<th>Classification</th>
<th>Composition</th>
<th>Corrosiveness</th>
<th>Effect</th>
<th>Method</th>
<th>Rate of stripping</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqua Regia</td>
<td>HCl + HNO3</td>
<td>High</td>
<td>Substrate destroyed totally</td>
<td>Chemical method</td>
<td>Slow</td>
<td>Dangerous</td>
</tr>
<tr>
<td>Cyanide</td>
<td>NaCN + Lead acetate</td>
<td>Low</td>
<td>High toxic</td>
<td>Chemical method</td>
<td>Moderate</td>
<td>Dangerous</td>
</tr>
<tr>
<td>UW-700 Electrolyte Gold stripper</td>
<td>Sulfide mixture</td>
<td>Neutral</td>
<td>Non-effect on substrate</td>
<td>Electrolysis method</td>
<td>Fast</td>
<td>Very safe</td>
</tr>
<tr>
<td>UW-860 Gold stripper</td>
<td>Citrate mixture</td>
<td>Low</td>
<td>Slight effect on substrate</td>
<td>Chemical method</td>
<td>Moderate</td>
<td>Much safer than Aqua Regia and Cyanide</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Classification</th>
<th>Au conc.</th>
<th>Purification rate</th>
<th>Cost</th>
<th>Waste Water Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqua Regia</td>
<td>&lt; 0.5 g/L</td>
<td>Slow</td>
<td>Low</td>
<td>Alkali neutralization treatment</td>
</tr>
<tr>
<td>Cyanide</td>
<td>0.6~0.8 g/L</td>
<td>Moderate</td>
<td>Low</td>
<td>Need to break the cyanide, and need to consider lead contamination</td>
</tr>
<tr>
<td>UW-700 Electrolyte Gold stripper</td>
<td>5~7 g/L</td>
<td>Fast</td>
<td>Very low</td>
<td>Without any treatment</td>
</tr>
<tr>
<td>UW-860 Gold stripper</td>
<td>1~3 g/L</td>
<td>Moderate</td>
<td>Low</td>
<td>Alkali neutralization treatment</td>
</tr>
</tbody>
</table>
UW-700 Electrolyte Gold stripping

“Eco-friendly of Gold stripping technology” was honored with Taiwan EPA’s innovative project. (2014)

(Taiwan Invention Patent: I 426157 USA and China are submitted)

2014 USA Pittsburgh International Invention Exhibition (Gold Medal)
Before Gold Stripping

After Gold stripping

(1)

(2)

(3)

(4)

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National Taiwan University
UW-700 Electrolyte Gold stripping Method

Before Gold stripping

After Gold stripping

Before Gold stripping

After Gold stripping
UW-860 Chemical Gold stripping

(Taiwan, USA, Germany, China, Japan Invention Patents are submitted)
Fortune One

Automatic Continuous Gold Stripping Machine

Before Gold stripping

After Gold stripping
LDS (or MID) with gold plating layer

Gold layer was stripped completely
No damage on the plastic substrate

Semiconductor with gold plating layer

Gold layer was stripped completely
No damage on the silicone wafer

Soaked into UW-860 (30°C • 90 sec)

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National Taiwan University
1 ton of waste cell phone board can extract about 400g of Au, 2.3 Kg of Ag, 150 Kg of Cu, and 80 kg of Sn.

Purchase price is about 4,000~5,000 USD  Recovery value is about 20,000 USD

1 ton of waste PC board can extract about 300g of Au, 1 Kg of Ag, 172 Kg of Cu, and 120 kg of Sn.

Purchase price is about 3,000~3,700 USD  Recovery value is about 15,000 USD

UWin got the precious metals from e-waste.
Automatic Eco Stripping Machines

<Fortune one>: Automatic Gold stripping line

<Iron one>: Automatic electrolyte stripping line
Portable stripping machines

<Catcher one>: Portable stripping machine

Before Gold stripping  After Gold stripping

<Portable Rolling one>: Portable stripping machine

Before  After
UWin is the world’s most complete supplier of eco-friendly metal stripping agent. Its project includes: Au, Ag, Pd, Pt, Ni, Sn, Al, Ti, Cu, ITO stripper.

[Locations]
The End

Thanks!