

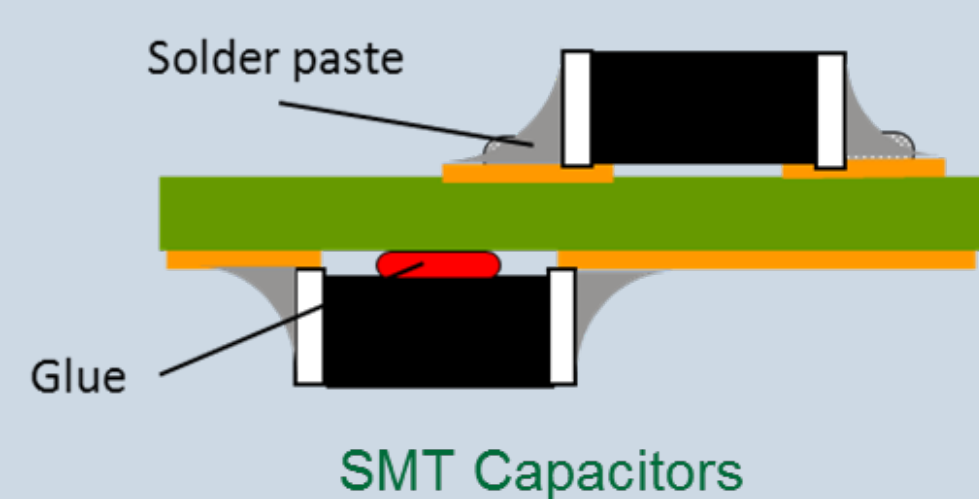
Electrochemistry Enabled Recovery of Critical and Value Metals from Electronic Scrap

What is Valuable in Electronics:

- Cu used for circuit traces
- Sn-Ag alloy for solder
- Au surface coatings
- Pd and Ag in capacitor electrodes
- Nd, Pr, Gd, and Dy in neo magnets
- Co in Li ion batteries
- Steel from enclosure



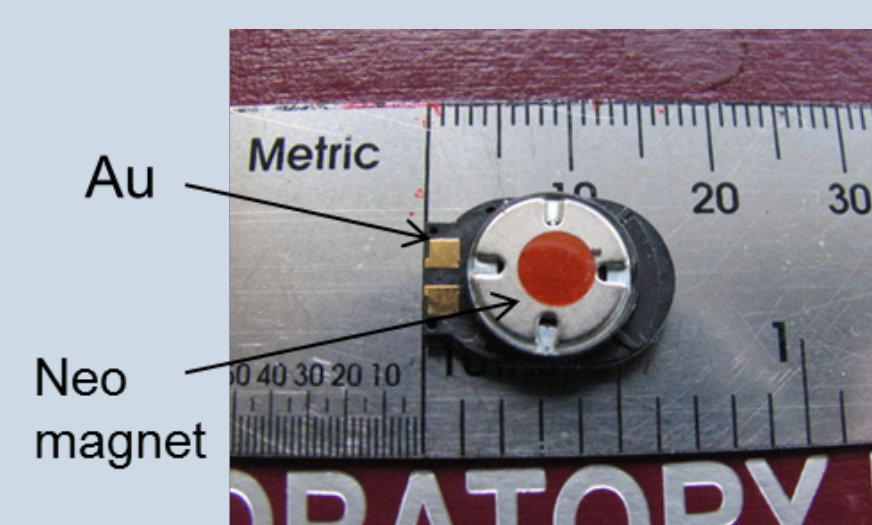
Vibrator



SMT Capacitors



Nd-Fe-B magnet from hard disk drive



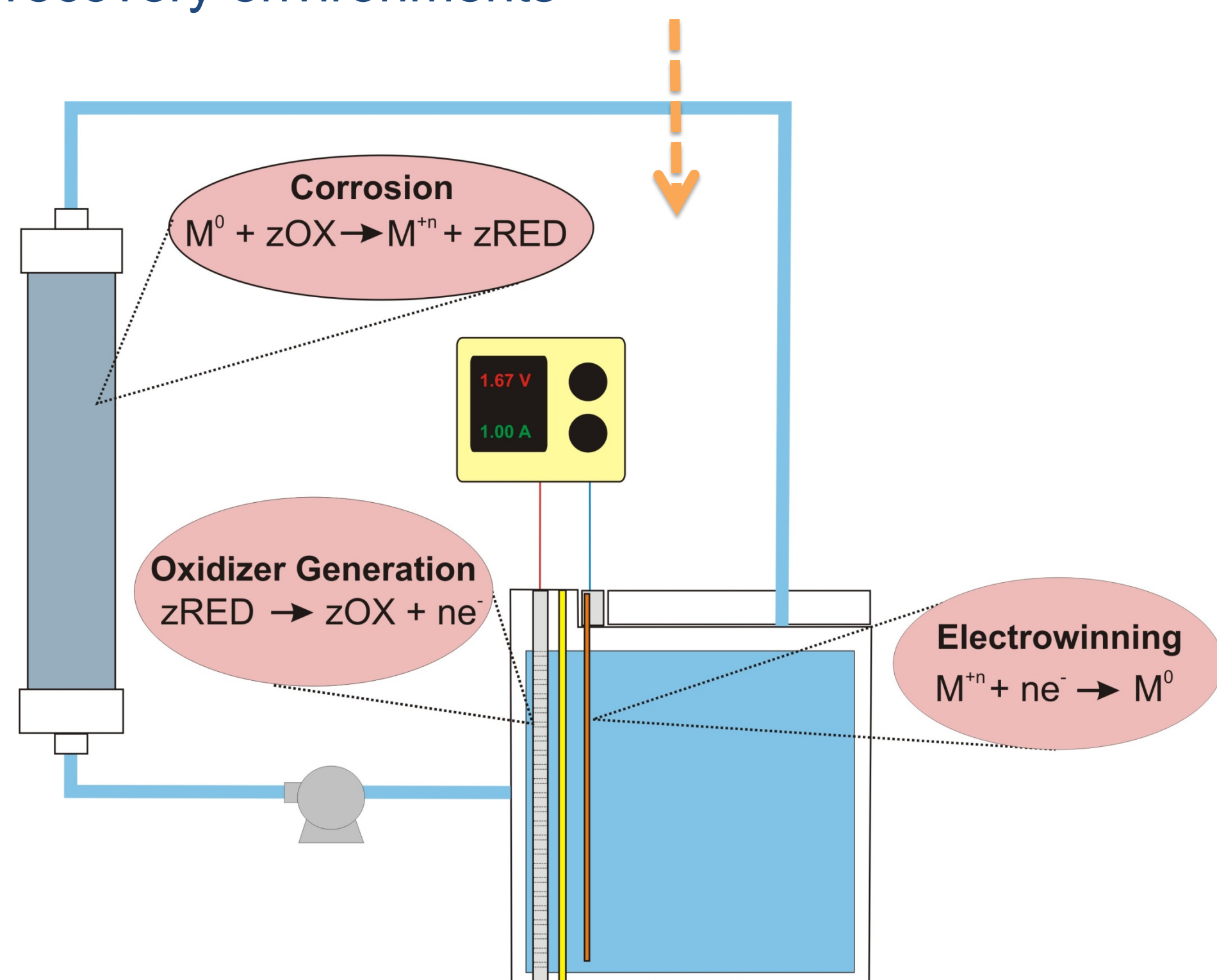
Smartphone speaker



Milled non-ferrous cell phone material

Approach to Recycling Metals from Electronics:

1. Develop recovery process for all value metals (base and precious)
2. Use electrochemistry to generate dissolution and recovery environments

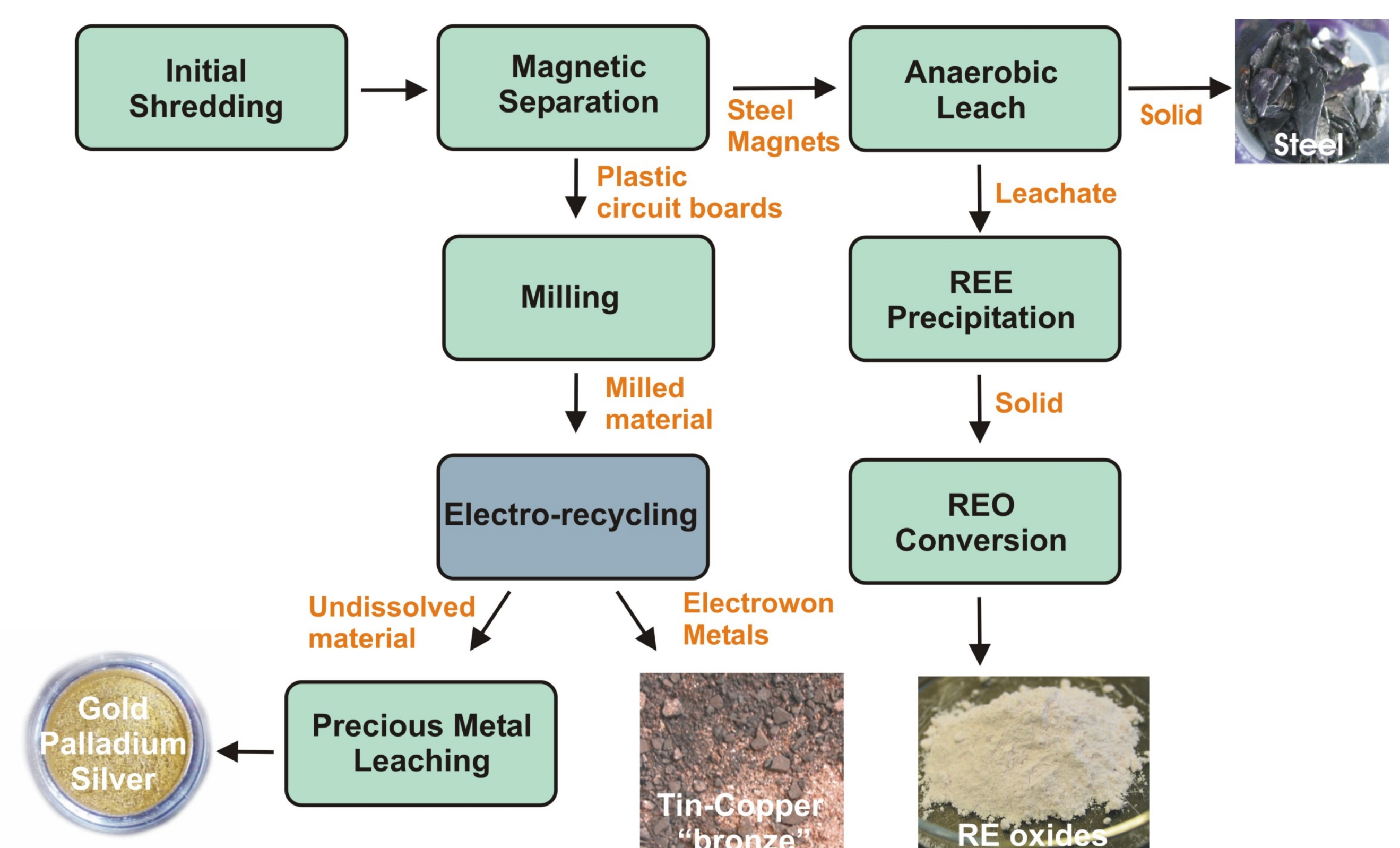


Electrochemical recovery of base metals



Recovery Flowsheet:

1. Shred and separate ferrous and non-ferrous material
2. Dissolve base metals (Sn, Ni and Cu) using ferric-based oxidizer chemistry
3. Recover REEs from ferrous stream as oxides (mixed Nd and Pr)
4. Selectively recover precious metals: Ag, Au and Pd



Conclusion:

- Electronic materials provide significant metals value for recovery, including a modest amount of critical materials
- Using thermodynamic and dissolution measurements a process to recover the bulk of non-ferrous metals using electricity as the primary reagent
- A flow sheet has been developed to take electronic material and produce multiple value streams: precious and base metals, rare earth oxides and steel