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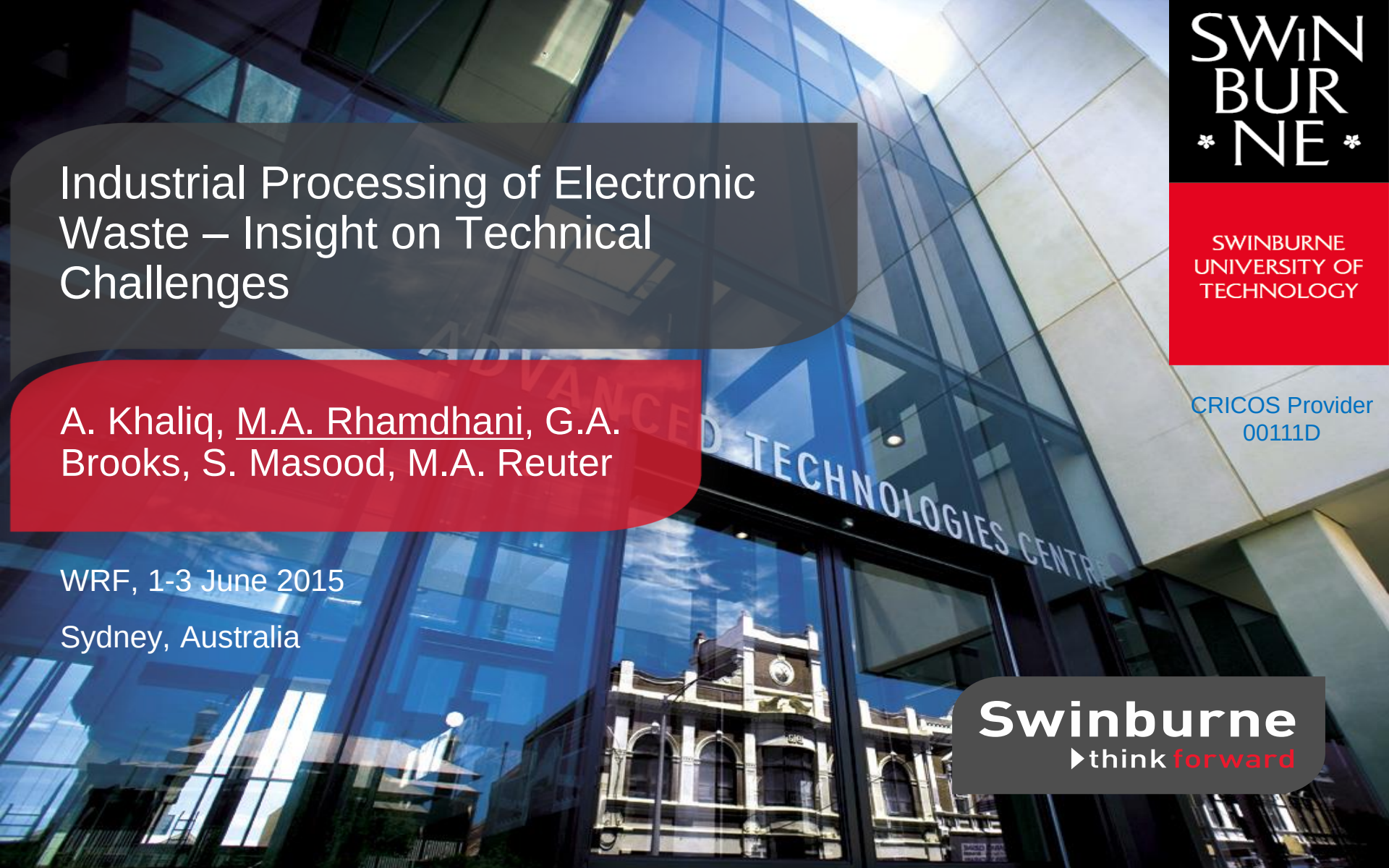

Industrial Processing of Electronic Waste – Insight on Technical Challenges

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Sydney, Australia

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Swinburne think forward

Lowering of the grade of ores around the world

Availability of alternative resources for metals

- Low grade/weathered ores
- Urban ores, including **Electronic wastes**

Electronic wastes

- 20-25 million tonnes are generated annually (global)
- Great challenges but also opportunities
- Contain: Precious, Platinum Group, Base, Hazardous, and Rare Metals

Weight versus value distribution in E-Waste

Weights %	Fe (wt %)	Al (wt %)	Cu (wt %)	Plastics (wt %)	Ag (ppm)	Au (ppm)	Pd (ppm)
TV-board	28%	10%	10%	28%	280	20	10
PC-board	7%	5%	20%	23%	1000	250	110
Mobile phone	5%	1%	13%	56%	1380	350	210
DVD-player	62%	2%	5%	24%	115	15	4
Value-share	Fe	Al	Cu	Sum Precious Metals	Ag	Au	Pd
TV-board	4%	11%	42%	43%	8%	27%	8%
PC-board	0%	1%	14%	85%	5%	65%	15%
Mobile phone	0%	0%	7%	93%	5%	67%	21%
DVD-player	13%	4%	36%	47%	5%	37%	5%

Characteristics of E-Waste

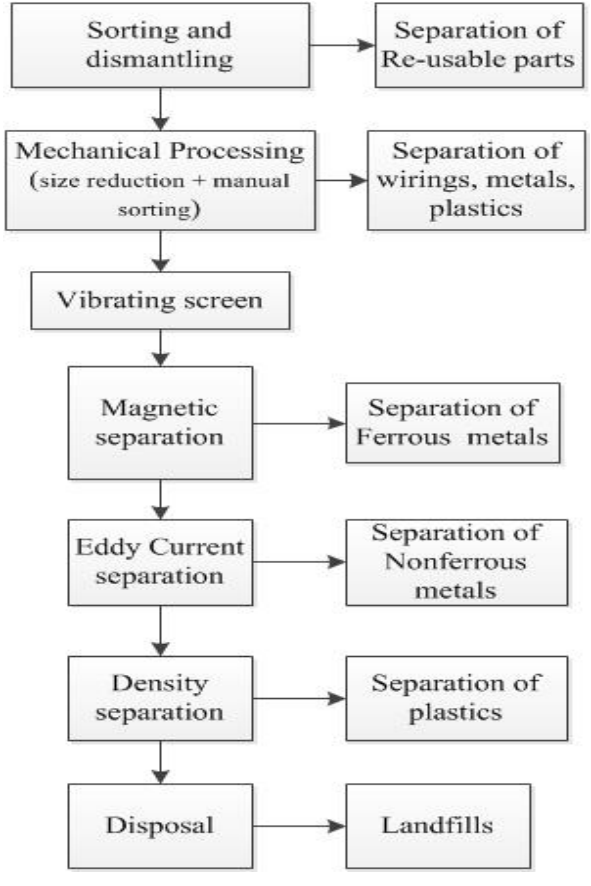
Complex microstructures

- **Contain remarkably different components**, e.g. plastics (hydrocarbons), glass (oxides), metals (ferrous and non-ferrous), and other components

Complex compositions

- The metals of interests are usually in **minor proportion (very low concentration)**
- They contain **large number of elements** (including valuable and hazardous substances), e.g. more than 40 metals on a cell phone
- Varies for different locations, products, and **time**

Current Industrial Practices



The pre-processing of e-waste to separate metal and non-metal fractions

Pre-processing

- Dismantling, sorting and mechanical processing
- Metallic and non-metallic fractions are separated

Embedded in base metals production

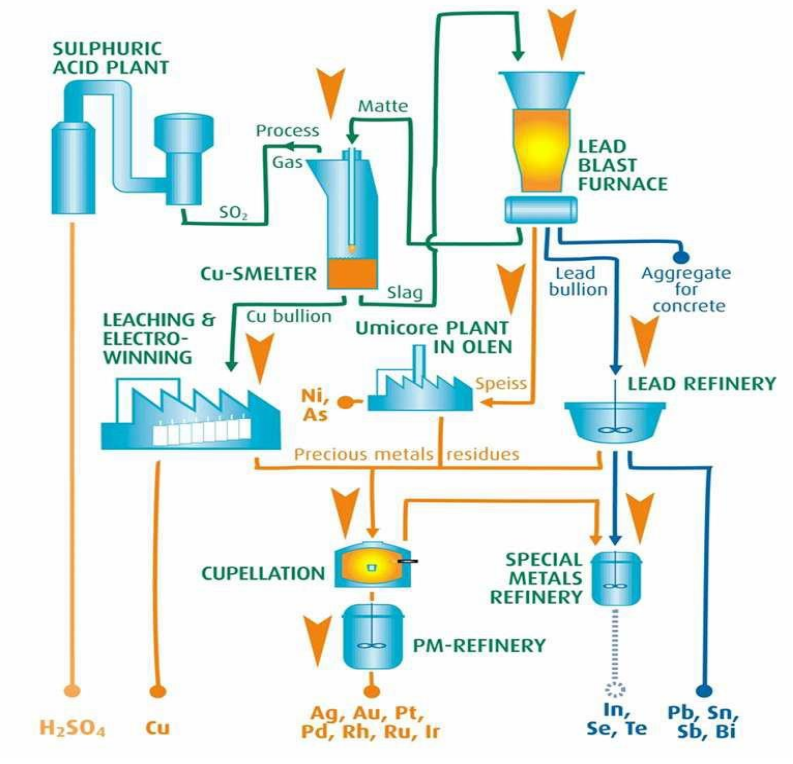
- Cu, Pb, Zn, Ni

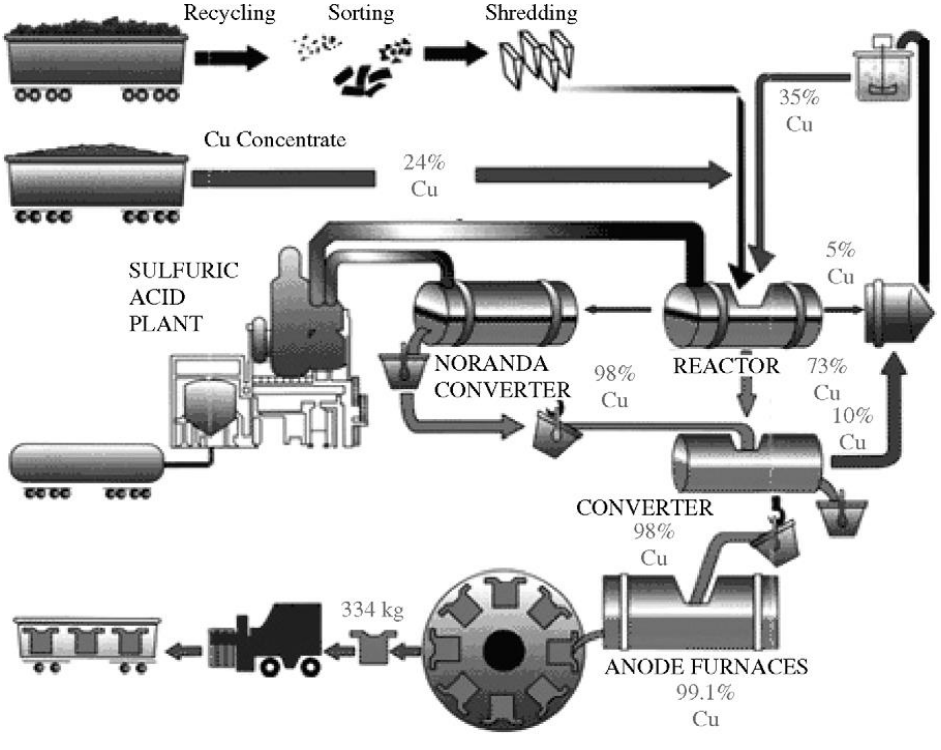
Metallurgical processes

- Hydrometallurgical routes
- Pyrometallurgical routes

Current Industrial Practices

A flowsheet for Umicore's integrated metals smelter and refinery, Hageluken (2006)





Noranda smelting (Cu concentrate and e-waste is fed into furnace at 1250°C), Veldbuizen and Sippel (1994)

Characteristics of Industrial Metallurgical Processes

Rely on stable processes

- Some reactors may not easy to start nor to stop
- Avoid unnecessary changes in operating parameters

Narrow operating conditions

- For example, narrow Temperature and Pressure ranges
- Fine tuning the operating parameters based on experience and knowledge
- Highly sensitive on the type and composition of feed/ores

Variation in composition of feed

- Moving target in terms of optimisation
- Need a robust process and sometime need additional equipment/reactor

Lack of Fundamental Knowledge

- To inform or develop optimum conditions and best practices for this “new“ complex materials
- Examples:
  - **Thermodynamics, Kinetics, Separation, Refining, Extraction, and Materials**

Modification of existing processes or adoption of new technologies in the plant

- Extensive pre-processing and main extraction processes → longer overall process chains
- Dealing with “new“ by products, e.g. limit emission of CO_2 , NOx, and other hazardous materials/gases to environment

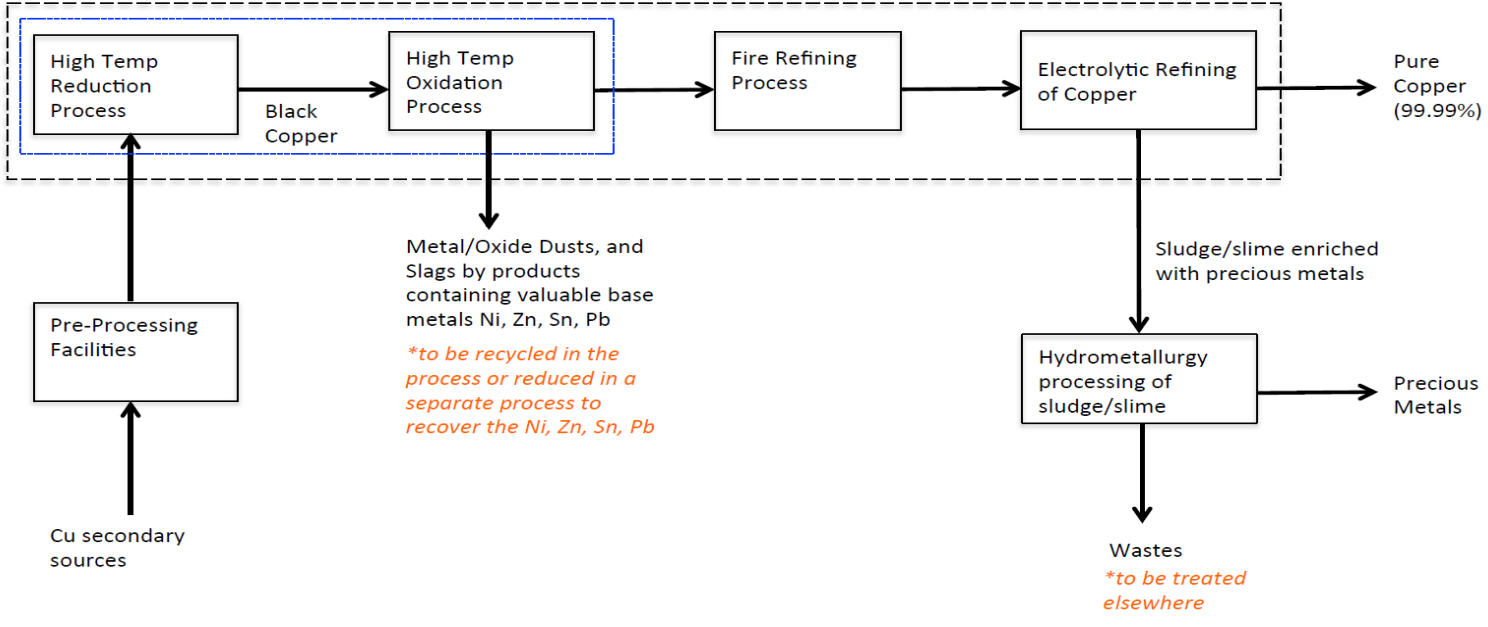
The need to know the “value proposition”

- Systematic analyses of modified or new technologies and process routes, in terms of **techno-economic**, impact to environment (e.g. **life cycle assessment**), scale up from laboratory to full size plant, and feasibility, need to be considered

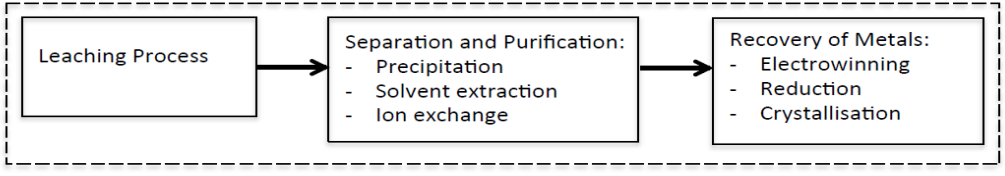
MODEL 3A :

Embedding E-waste Processing in a Base Metal Secondary Pyrometallurgical Processing, and sludge/slime is processed through hydrometallurgy

Base Metal Processing using Secondary Sources, e.g. Black Copper Route



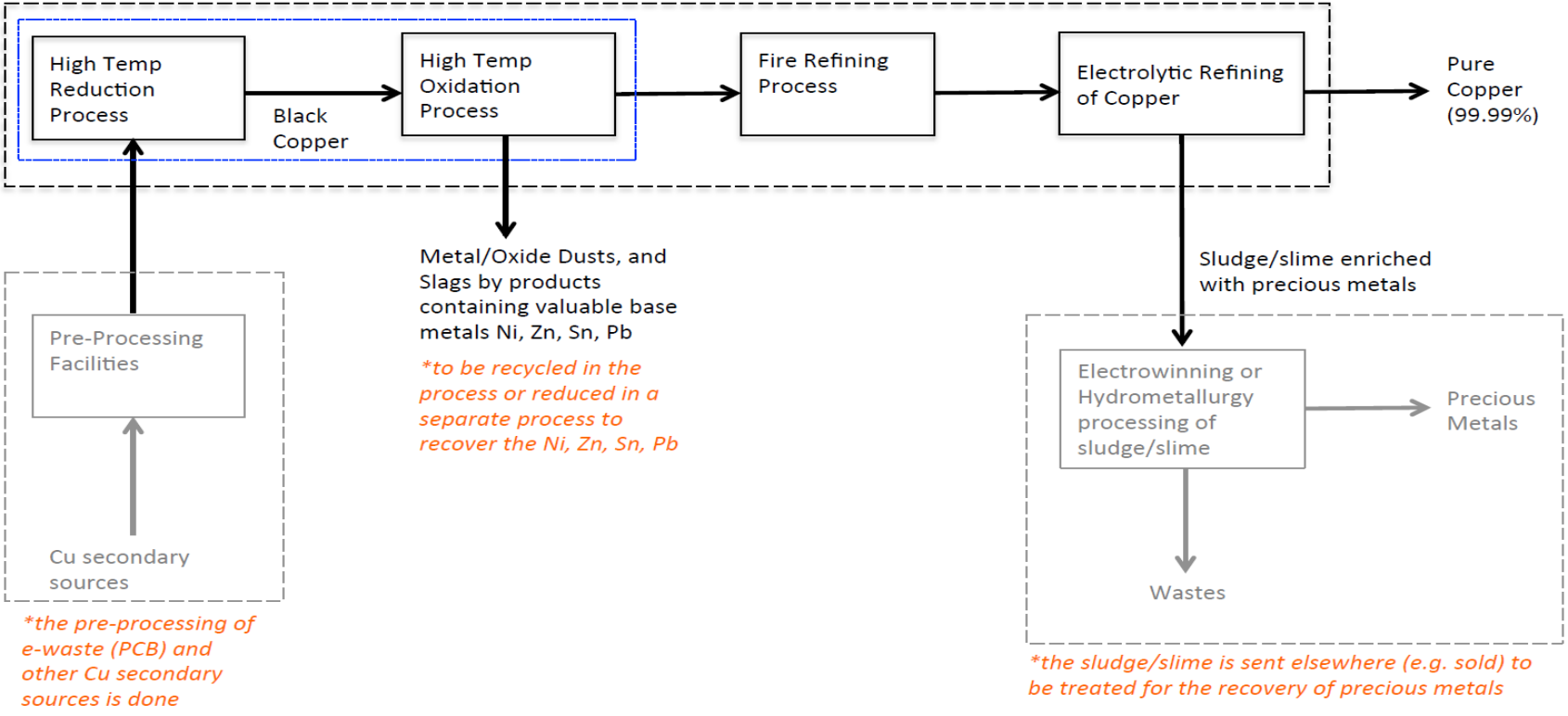
Hydrometallurgy Processing of Sludge/Slime



MODEL 3B :

Modification of Model 3, where both pre-processing of e-waste (and other secondary sources) and extraction of precious metals from sludge/slime are carried out elsewhere

Base Metal Processing using Secondary Sources, e.g. Black Copper Route



Concluding Remarks

- Large potential for processing of **E-waste**, but
- There are technical challenges that slows down the adoption of this alternative resource in industry
- A comprehensive approach is needed to address the challenges
  - Innovations and development in all sectors particularly on **fundamental science** and **technology**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