



WasteSorted Grants

E-waste 2020–21

Mini Plant Recycling and Metal Recovery from Waste Printed Circuit Boards and Integrated Circuits

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Outline

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3. Main results
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Introduction

“Urban mining” of e-waste

- Proximity to urban area – requiring safe process
- Complicated in material and structure – metal lock in plastics, alloys

Western Australia’s scenario

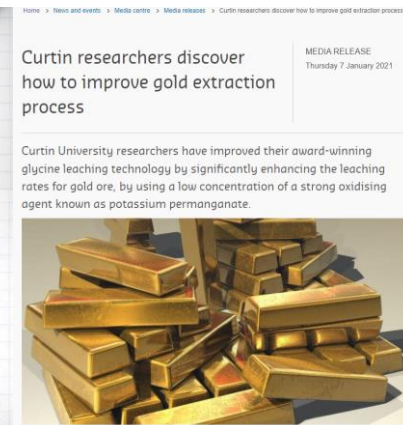
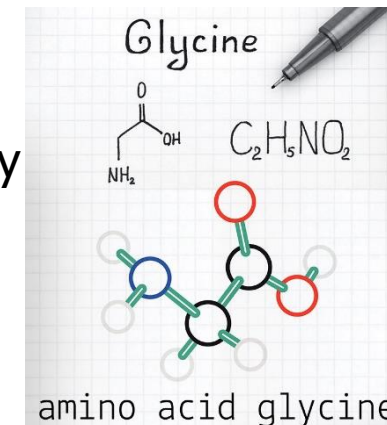
- Low e-waste volume – pyrometallurgical process not highly economic
- Vast geography – expensive road transport to a centralized location

Why hydrometallurgy?

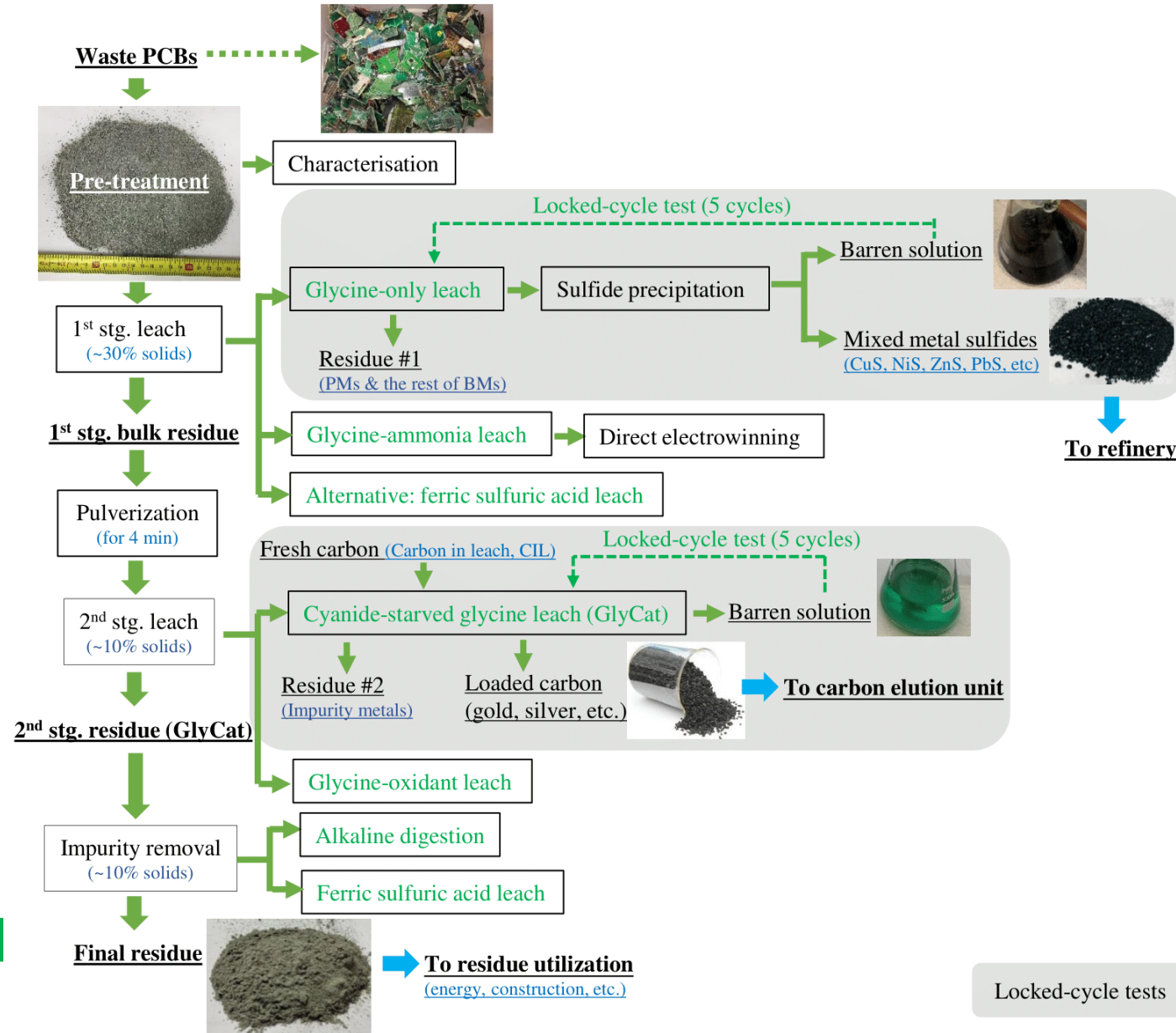
- De-centralized; Flexible in scales and modules; Lower capital investment – friendly to SMEs

Glycine technology

- A serial of patents, invented at Curtin University, and commercialized by Mining and Process Solutions (MPS)
- Using non-toxic amino acid glycine as major lixiviant
- Proven high affinity to gold and copper



The mini plant processes



Locked-cycle tests

Main results

Metals in original PCB sample:

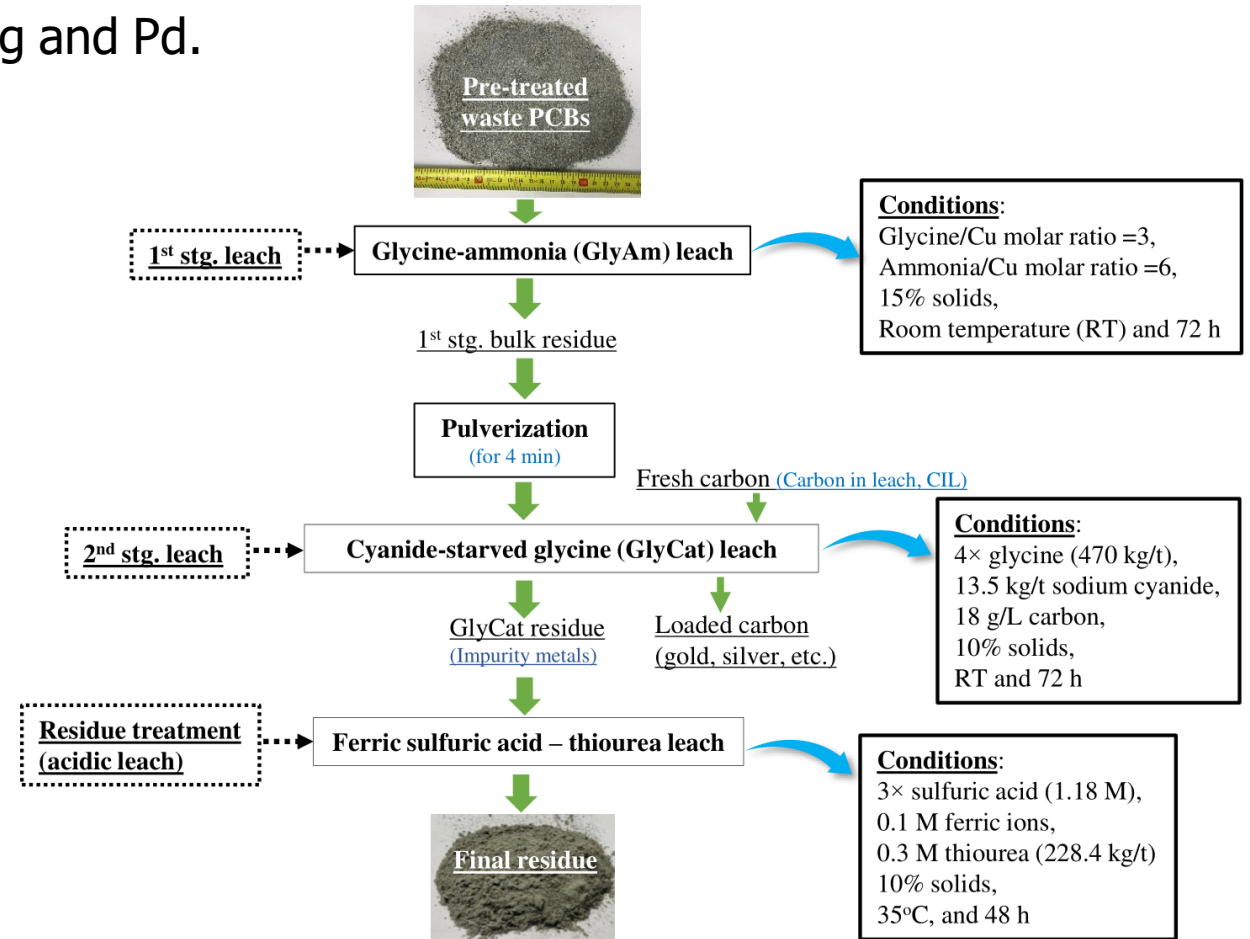
- Around 88% economic values come from Cu, Au, Ag and Pd.

	Metal content in wt. %					
	Cu	Fe	Al	Sn	Pb	Zn
Metal content	22.6	1.8	3.20	2.80	0.30	0.70
Economic value*, %	19.6	-	0.88	10.7	0.07	0.22

	Metal content in g/t			
	Co	Au	Ag	Pd
Metal content	59.7	106.8	170.5	10.4
Economic value*, %	0.04	60.38	1.22	6.91

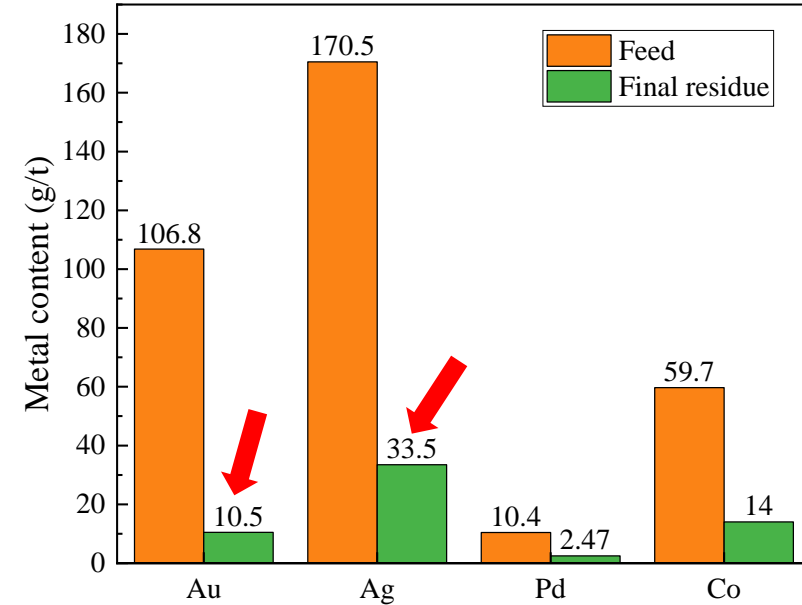
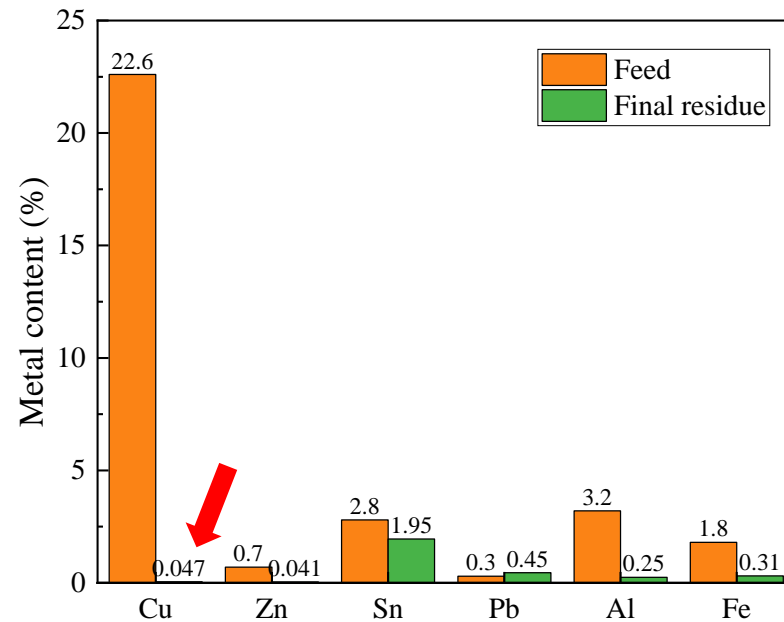
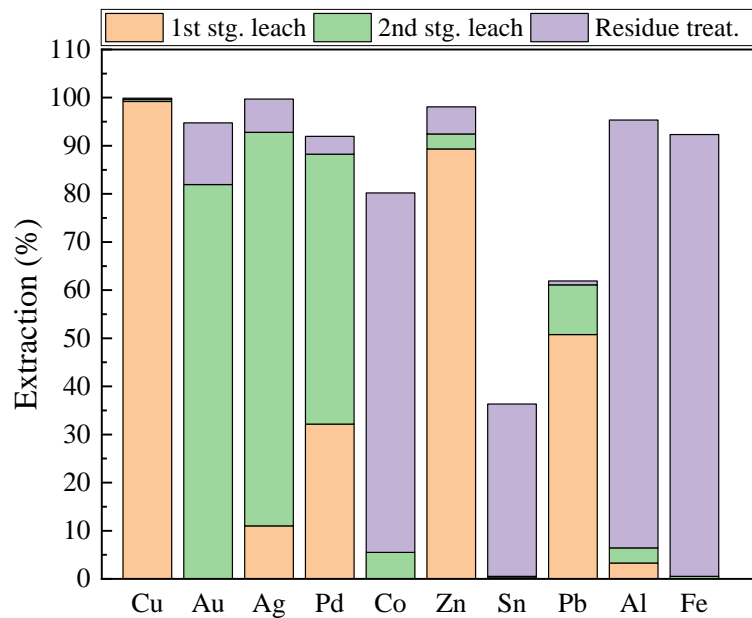
* Based on metal official prices of London Metal Exchange (cash-bid) on 08 Feb 2022.

Selected process conditions:



Main results

Selected process conditions: overall metal extractions and metal in residue



Overall extraction: >99% Cu, >90% Au, >95% Ag and >85% Pd

Metal content reduced by 99.8% for Cu, 90.2% for Au, 80.4% for Ag

Conclusions

1. Two-stage glycine leaching process was developed to extract base (BMs) and precious (PMs) metals, respectively. In the first stage, **glycine-only** and **glycine-ammonia** systems were investigated; in the second stage, **glycine-oxidant** and **cyanide-starved glycine** systems were investigated.
2. Two locked-cycle tests for each stage were done to recover BMs by **glycine-only** leaching followed by **sulphide precipitation**, and to recover PMs **cyanide-starved glycine** leaching coupled with **carbon adsorption** (CIL). Metal recoveries ranged in 70-90% at 10-15% solids, room temperature and 48-72 hours.
3. The non-cyanide **glycine-oxidant** system was shown feasible to extract >85% gold, 70% silver, 89% palladium and 88% copper at 2% solids, room temperature and 96 hours while further optimisation at higher solids is required.
4. Combining the two-stage leaching and residue treatment leaching, overall extraction of **99.9% copper, 93.1% gold, 96.0% silver and 89.9% palladium** were achieved. Meanwhile, >90% nickel, cobalt, zinc and aluminium were co-extracted. The rest of major metals, i.e. lead, tin and iron, remained relatively refractory with much lower extractions. The metals extracted represented >90% economic value of the waste PCBs.

Future Work

1. Full pilot scale continuous test of the developed process
2. Process modelling
3. Full economic assessment of the process
4. Coupling physical processing line to separate bulk of metals before leaching

Publication

1. H. Li, E. Oraby and J. Eksteen, 2022. Extraction of precious metals from waste printed circuit boards using cyanide-free alkaline glycine solution in the presence of an oxidant. *Minerals Engineering*, under review

Acknowledgement



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Curtin University



THANK YOU !

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