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Application of reductive melting process of CRT glass for recovering valuable metals from PCB waste

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Outline

- Background
- Objective
- Experiment
- Conclusion

BACKGROUND

Cathode Ray Tube (CRT)

used as main component of TV/monitor

Direct disposal

Pb Contamination

GOAL

Pb must be removed before disposal

Printed circuit board (PCB)

PCB in electronics appliance

Valuable materials

- Au, Ag, Cu, Ni, etc…

Direct disposal

Lost of Metals

GOAL

Recovering valuable metals from PCB

OBJECTIVES

Objectives

Lead removal from CRT before disposal

Recovering valuable metals from PCB

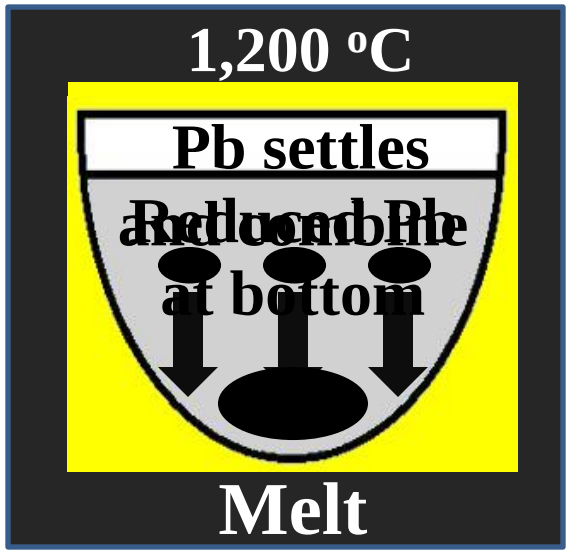
Expensive

Economical

One economical process to achieve two goal can be developed.

Reductive melting method

Effective to remove lead from CRT funnel glass



Electric furnace

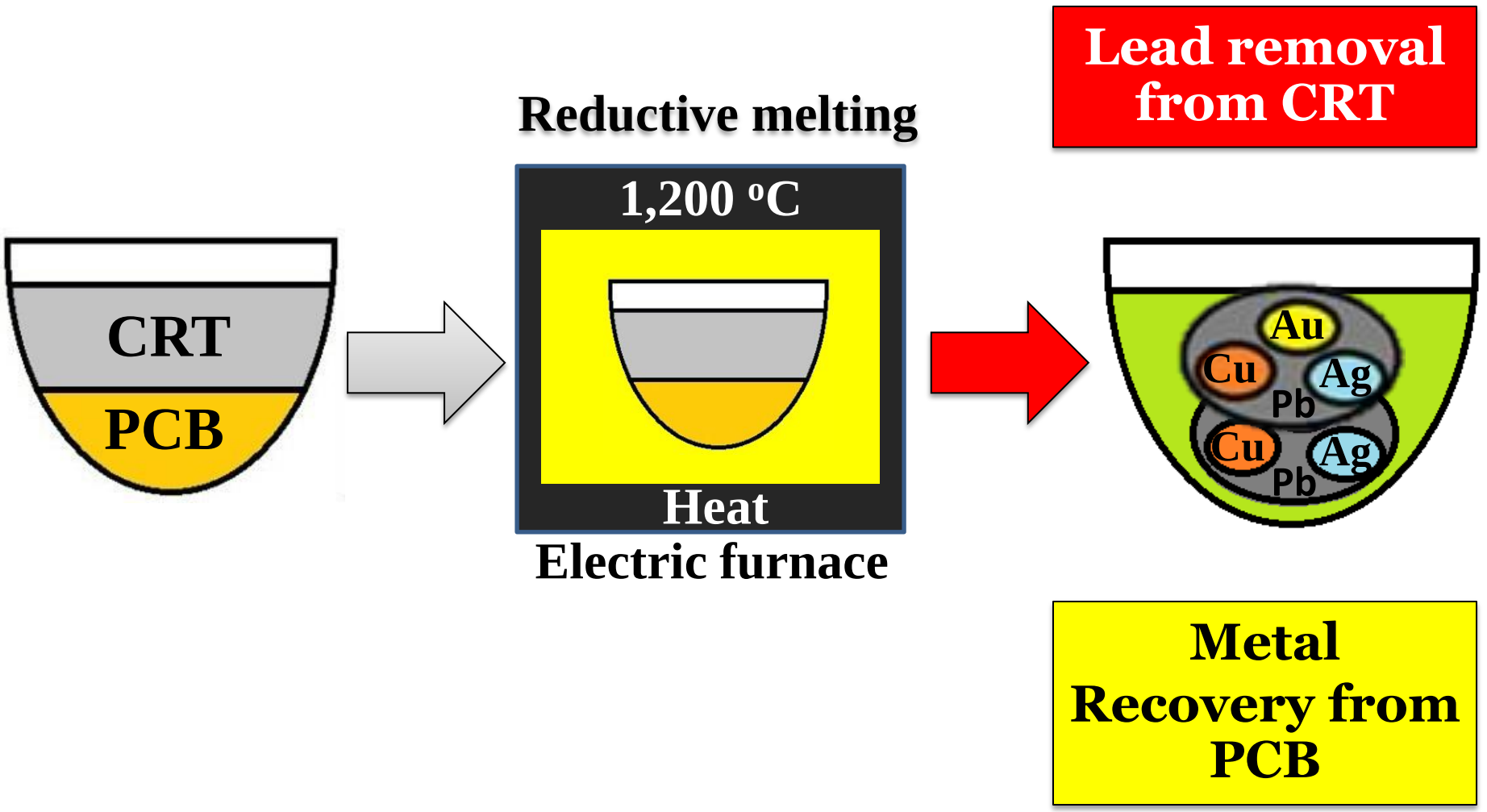
Elemental lead

$2C + O_2 \rightarrow 2CO$

$PbO + CO \rightarrow Pb + CO_2$

Lead can be separated and removed

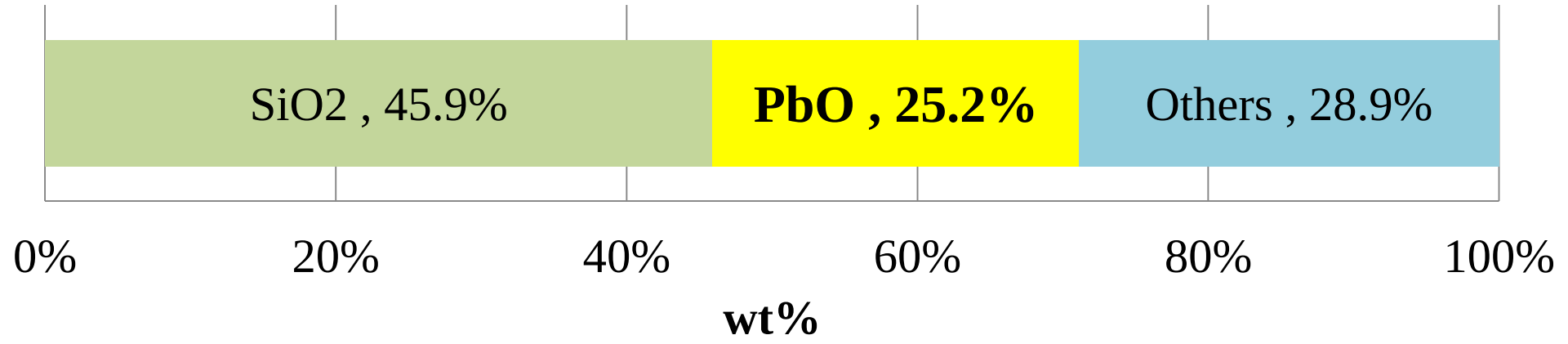
Two problems can be solved in the same time



EXPERIMENTS

CRT funnel glass

Elemental composition (XRF)



Particle Size : - 1000 µm

Metal source

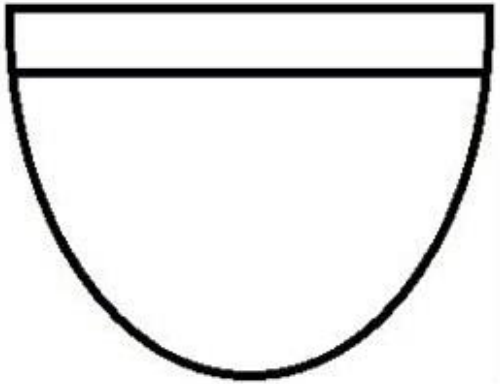
- **Au, Ag, Cu, Ni powder**

  used instead of real PCB

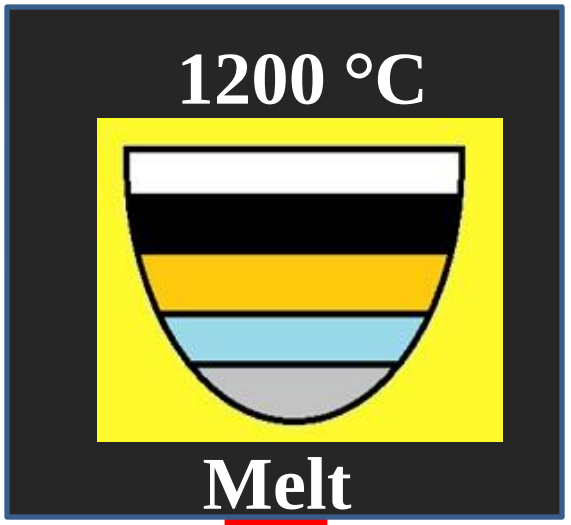
Experiments

1. Pb Glass 20 g without additive metal } ***None***
2. Pb Glass 20 g + Au 0.2 g
3. Pb Glass 20 g + Ag 0.2 g
4. Pb Glass 20 g + Cu 0.2 g
5. Pb Glass 20 g + Ni 0.2 g } ***Single***
6. Pb Glass 20 g + Au + Ag + Cu + Ni (total 0.8 g) } ***Mixed***

Method



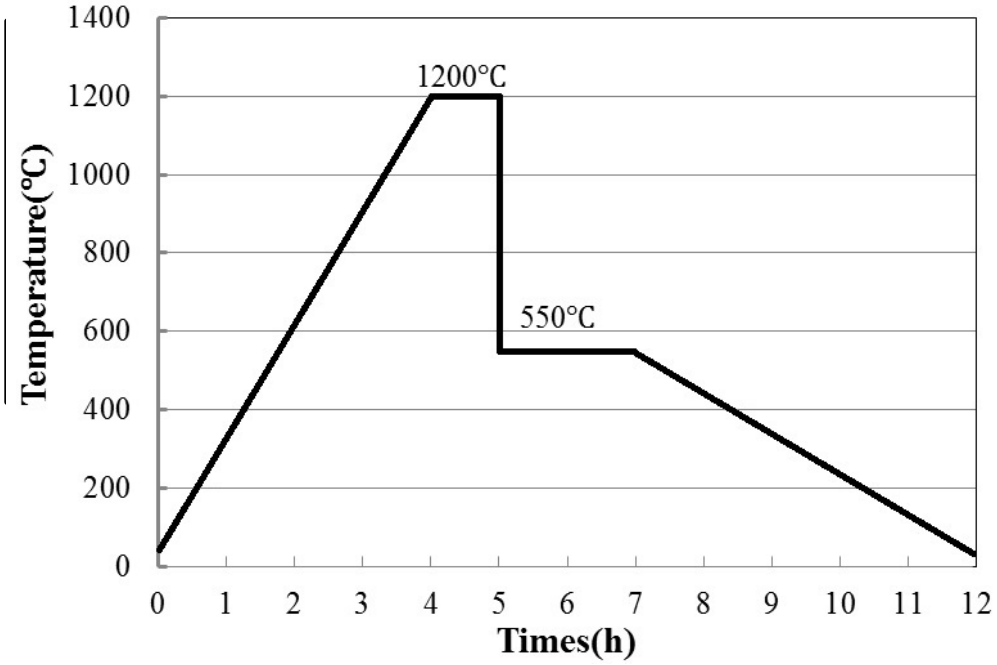
Reductive melting



Separate glass and metals

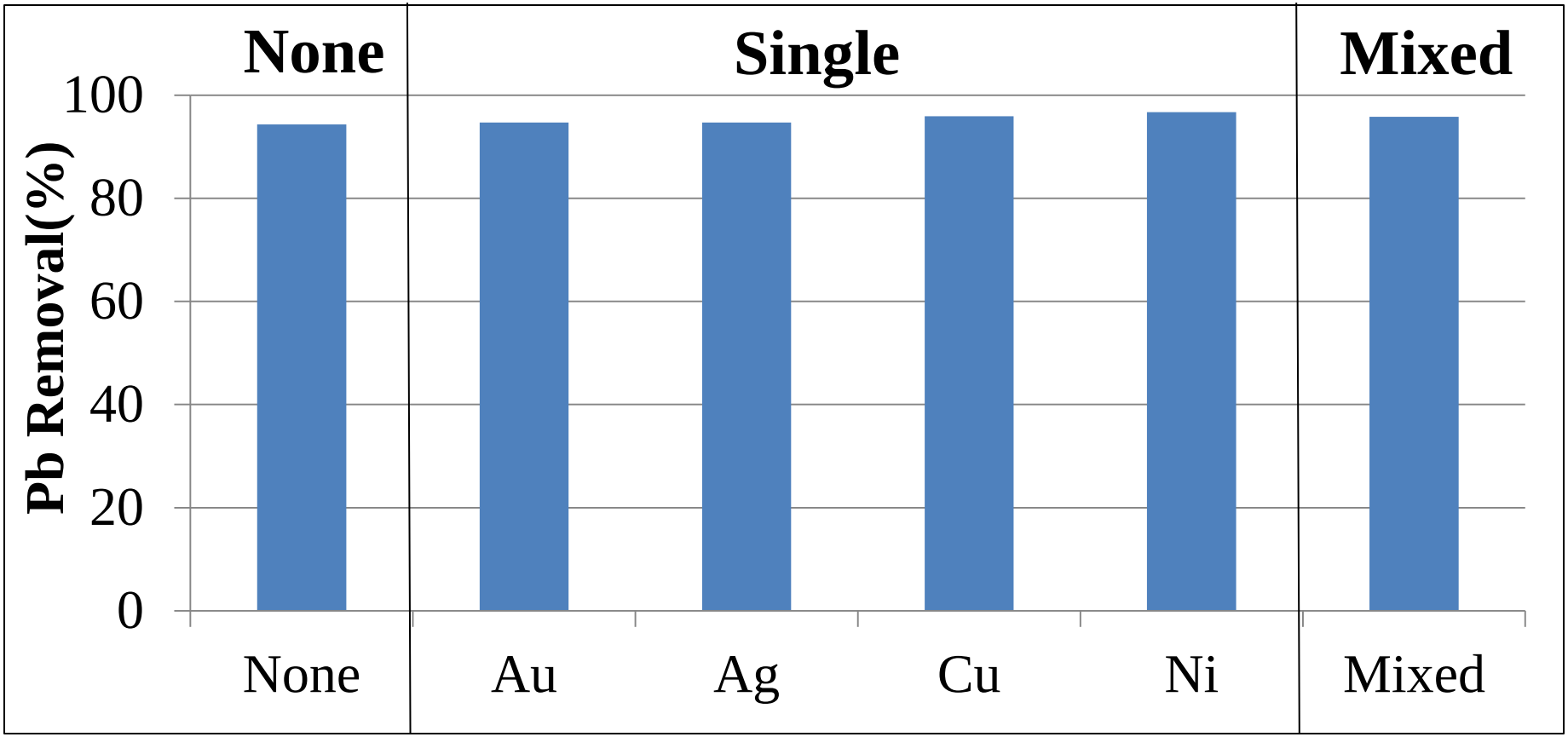
Electric furnace

XRF analysis



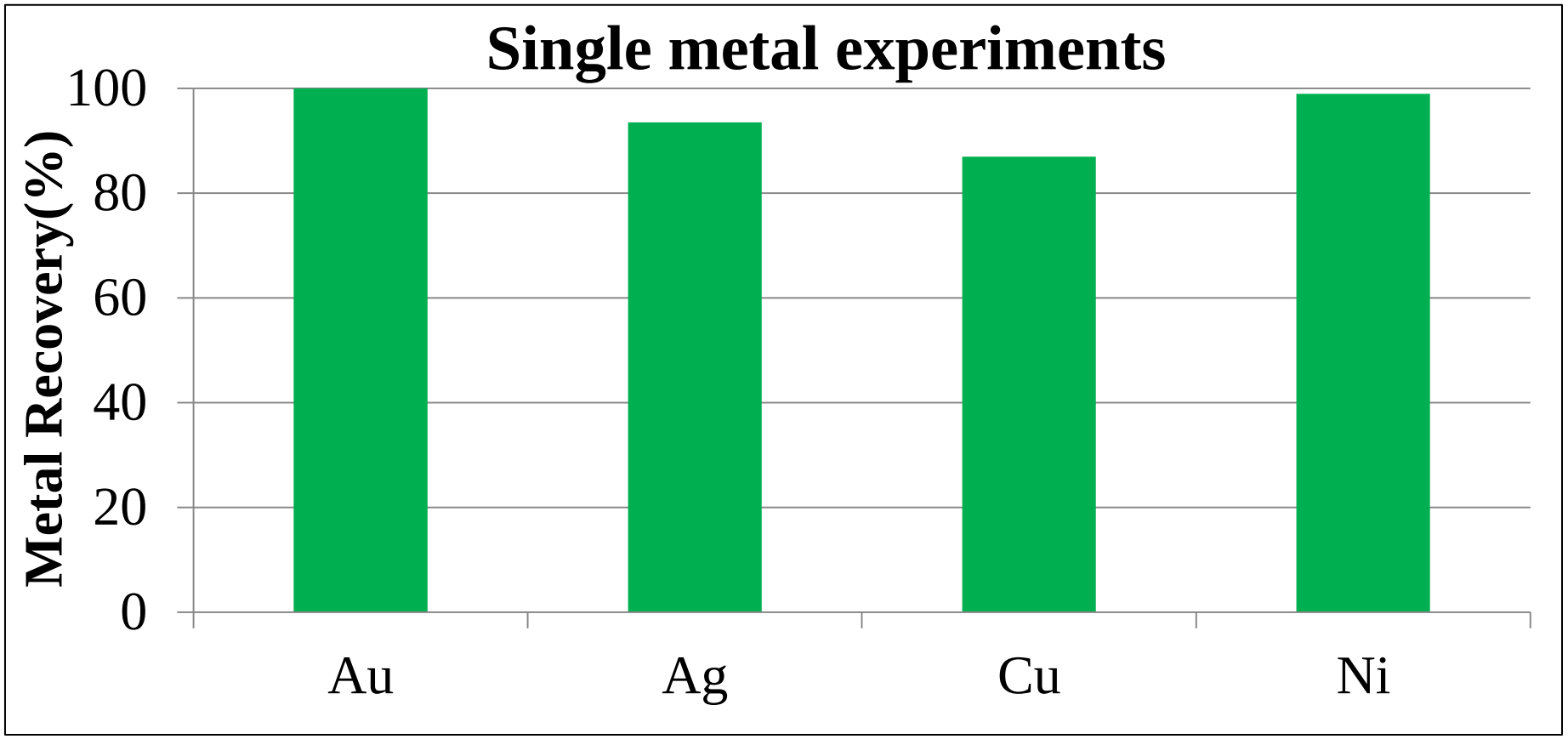
RESULTS AND DISCUSSION

Effects of metal addition on the Pb removal in reductive melting

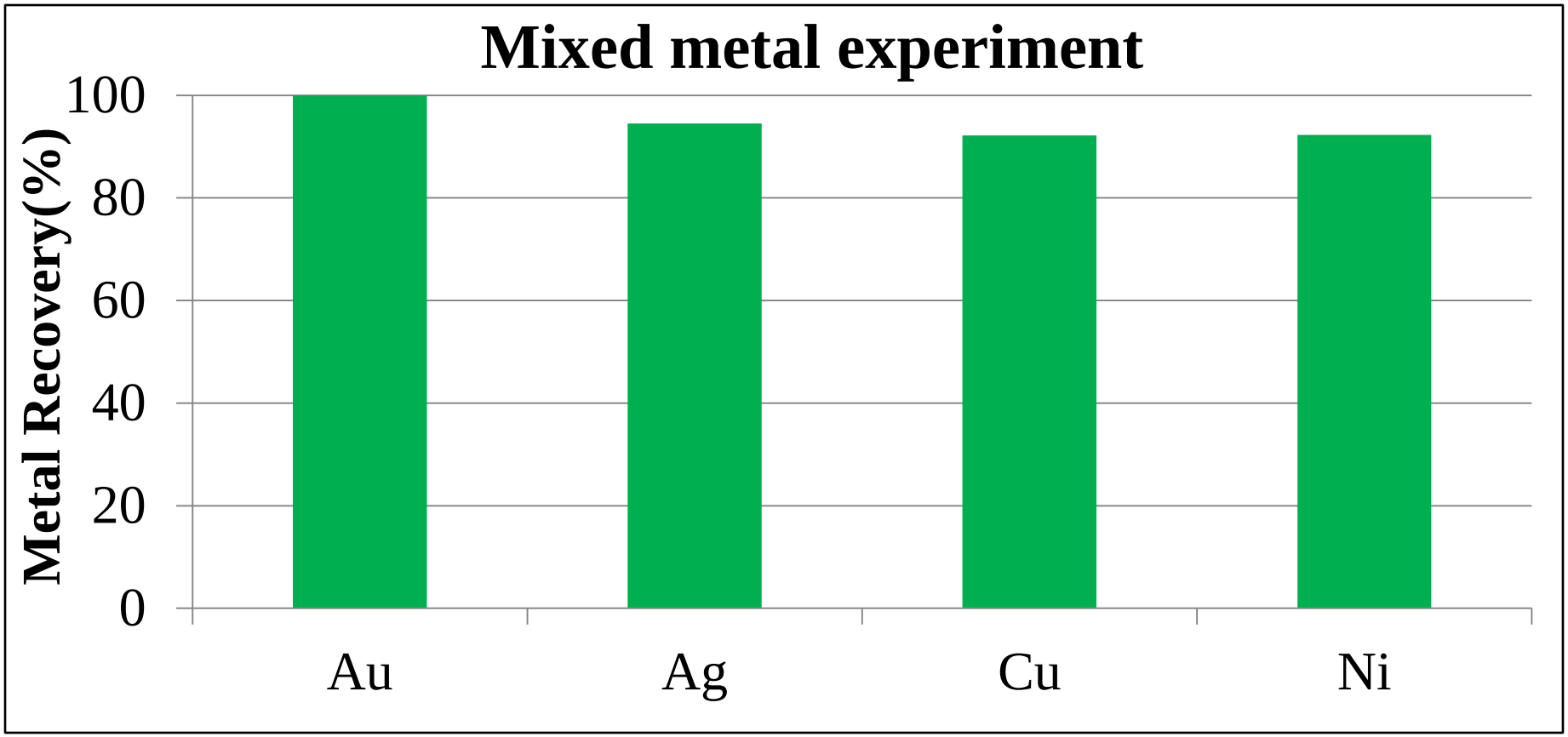


Reductive melting removed Pb from CRT effectively

XRF results of Metal recovery by reductive melting



XRF results of Metal recovery by reductive melting



Reductive melting recovered metals effectively

Summary

Sample	Pb removal	Metal recovery
Pb glass without additive metal	**94**	**-**
Pb glass with single metal	**~95%**	**+90%**
Pb glass with mixed metal	**96**	**+92%**

Reductive Melting is effective to remove Pb and recover metals from CRT and PCB

Effect of In_2O_3 contamination experiment

Effect of In_2O_3 contamination

Liquid-crystal displays(LCD)

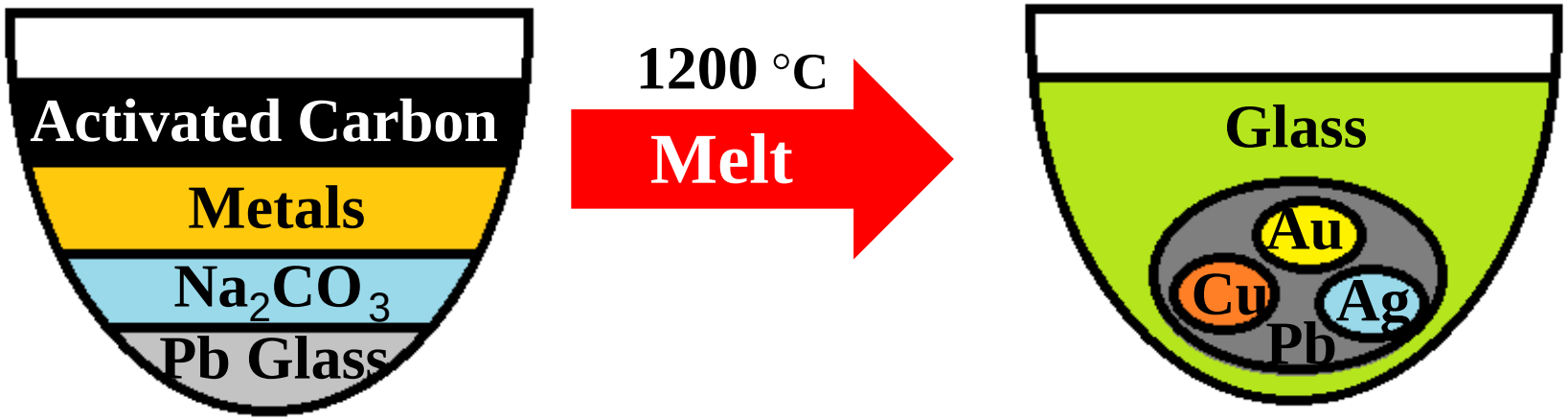
Contains In_2O_3

Monitor Collecting

In_2O_3 contaminate to reductive melting process

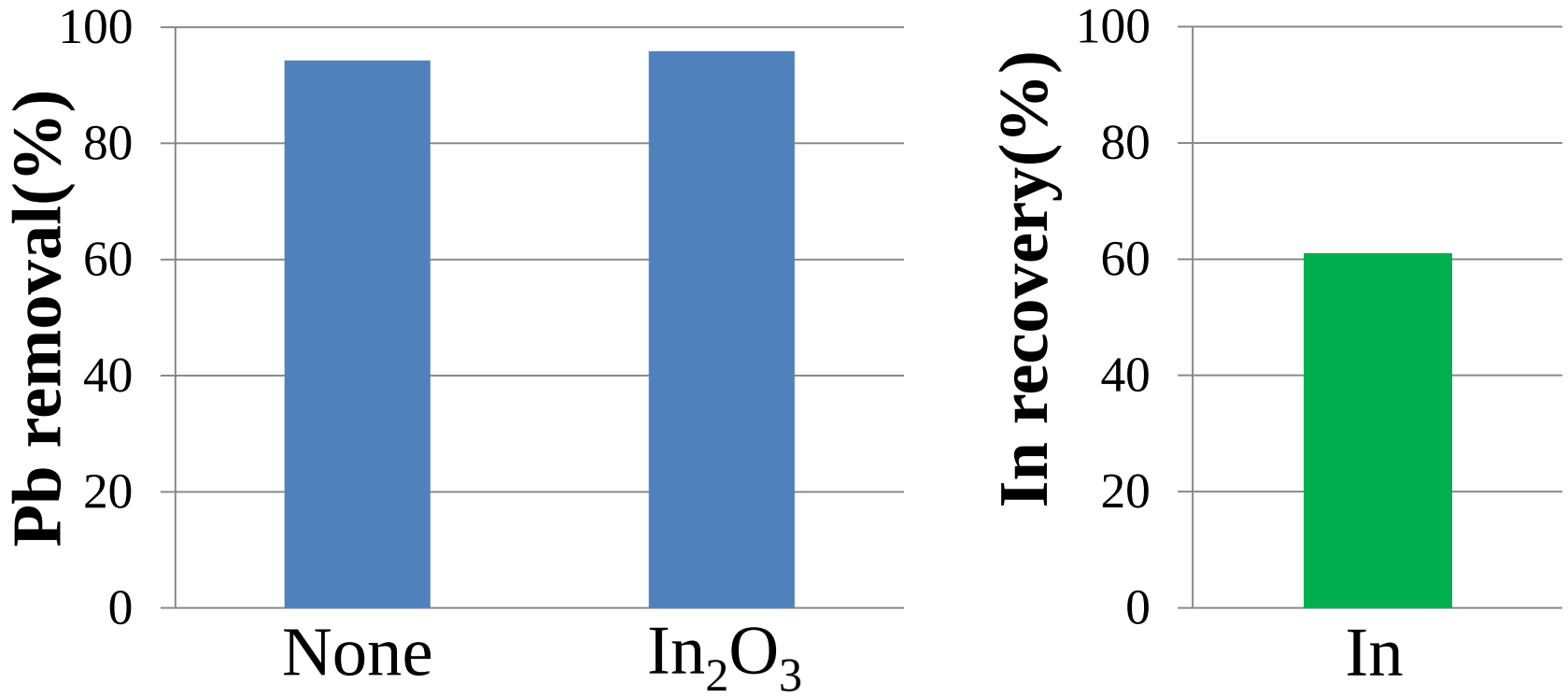
Experiments

- **Effect of In_2O_3 contamination on Pb removal**



1. Pb Glass 20 g without additive metal } ***None***
2. Pb Glass 20 g + In_2O_3 0.2 g } ***Single***

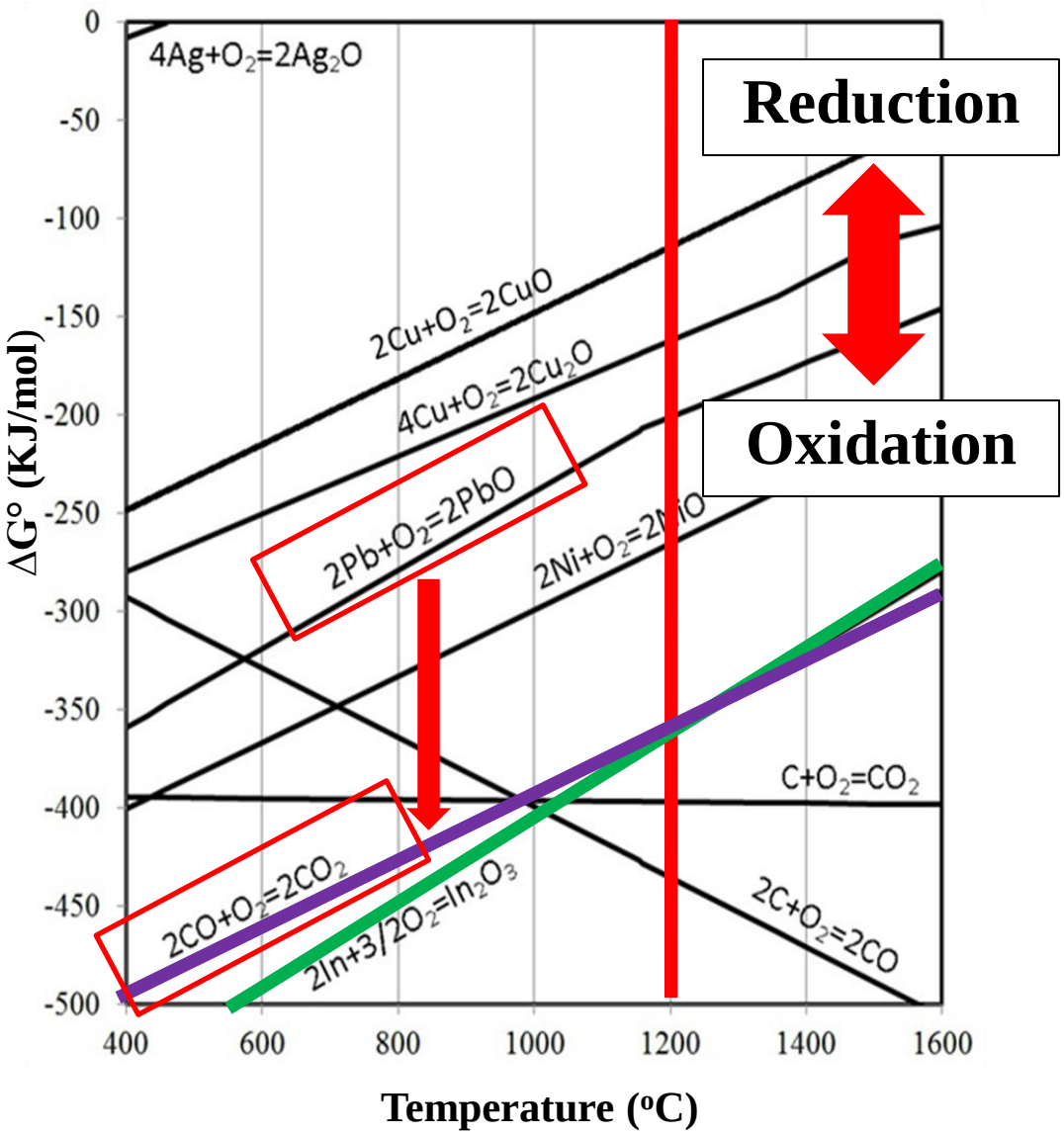
Effect of In_2O_3 contamination on Pb removal in reductive melting



- In_2O_3 has no effect on Pb removal
- Only 61% of In was recovered

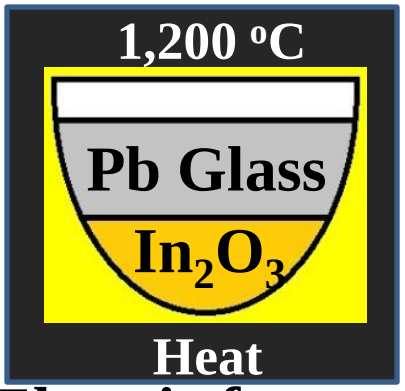
Why only 61% of In was recovered

Ellingham Diagram

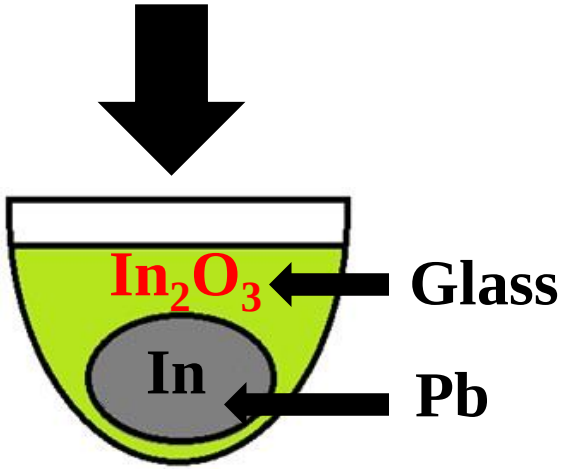


In_2O_3 → In

Reductive melting

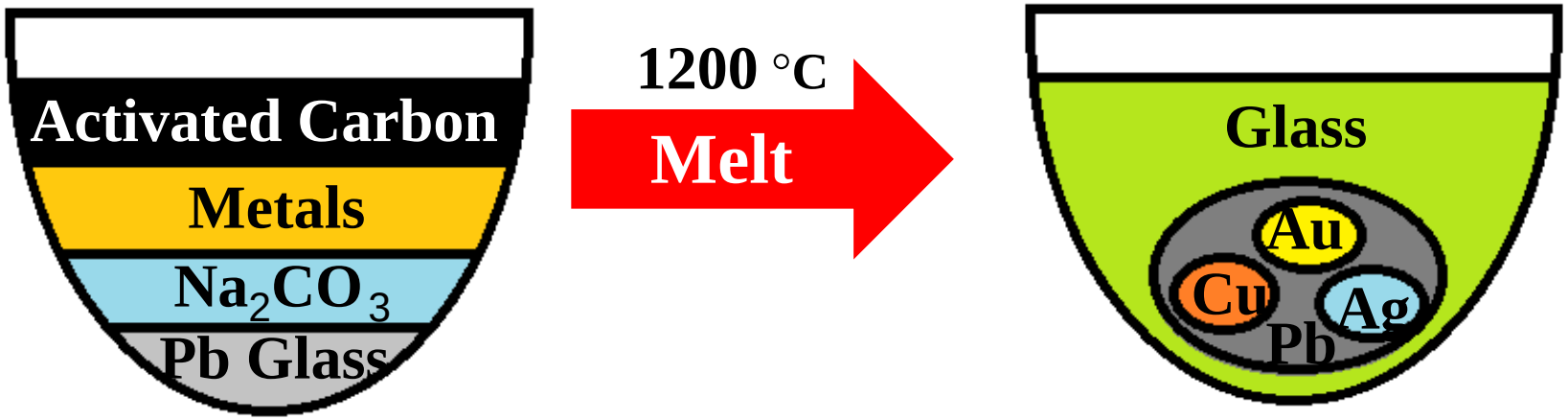


Electric furnace



Experiments

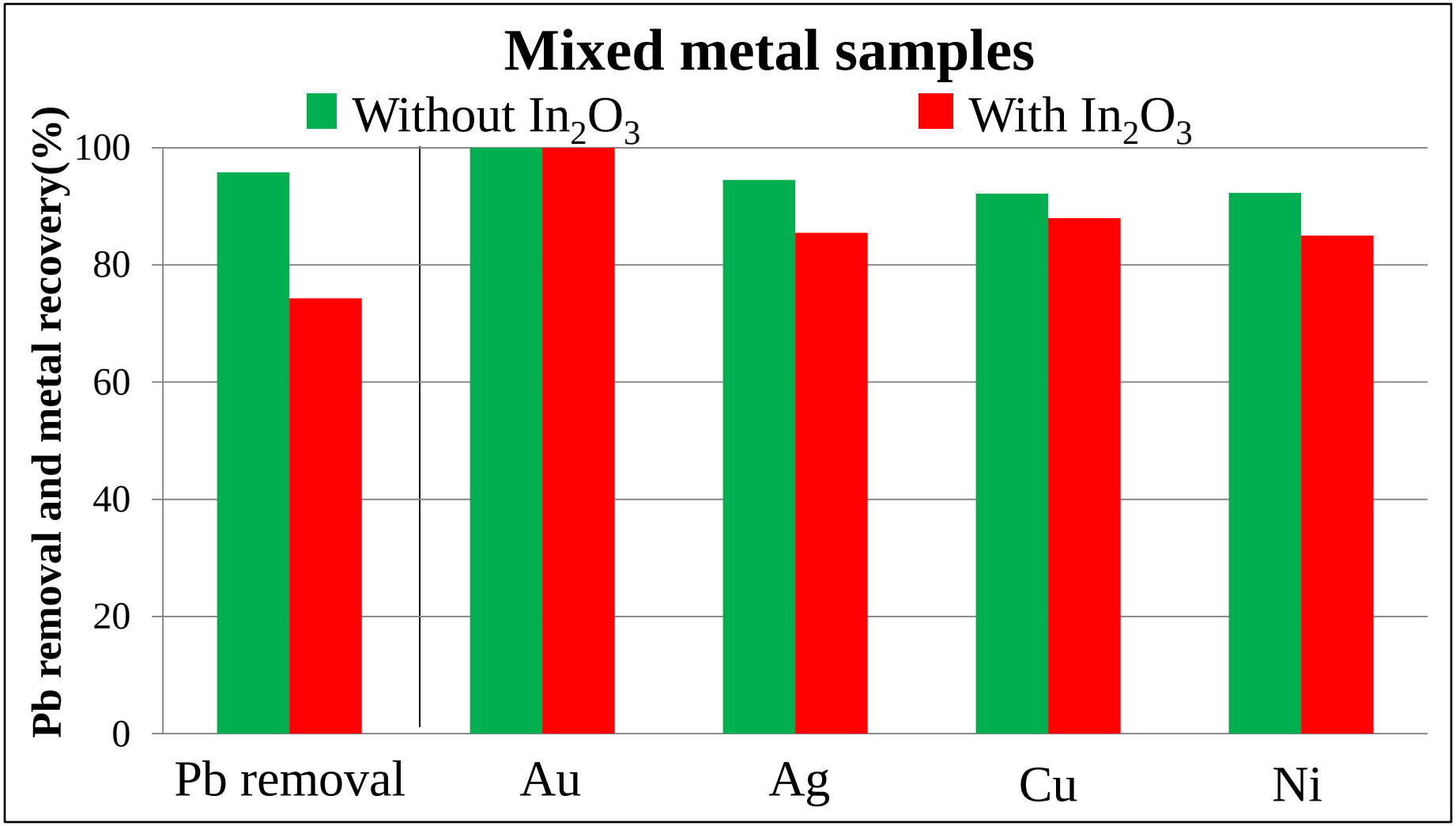
- **Effect of In_2O_3 contamination on metal recovery**



1. Pb Glass 20 g + Au + Ag + Cu + Ni (total 0.8 g)
2. Pb Glass 20 g + Au + Ag + Cu + Ni + In_2O_3 (total 1 g)

} ***Mixed***

Effects of In_2O_3 contamination on Metal recovery by reductive melting



Effect of In_2O_3 contamination on reductive melting

- Pb removal decreased **(- 21%)**
- Ag recovery deceased **(- 9%)**
- Cu recovery deceased **(- 4%)**
- Ni recovery deceased **(- 7%)**

In_2O_3 contamination reduces Pb removal and metal recovery

CONCLUSION

Conclusion

- Reductive melting effectively removes Pb from CRT and Recover metals at the same time
- In_2O_3 contamination reduces the Pb removal and metal recovery.

?????
Questions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Thank you
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SLOW DOWN