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Electrochemical Behavior of Several Metals from Waste Printed Circuit Boards in Acidic Brominated Lixiviants

PN-III-P1-1.2-PCCDI-2017-0652,TRADE –IT

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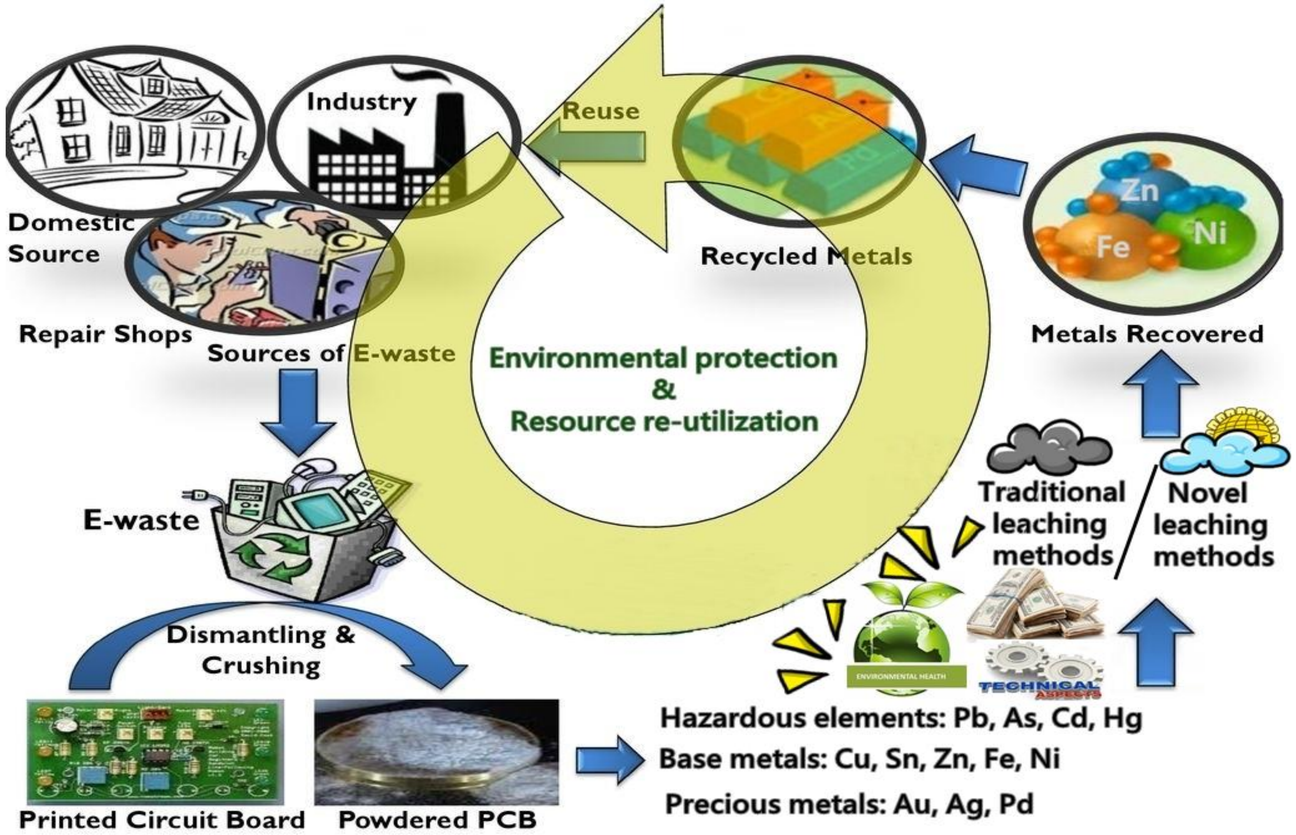
INTRODUCTION



In an attempt to develop an innovative and eco-friendly technology for metals recovery from WPCBs, the dissolution and deposition behaviour of base (Zn, Fe, Ni) and metals precious (Au, Ag) was investigated in acidic bromine-containing electrolytes that could be used as lixiviant in hydrometallurgical route of metals recovery, using electrochemical techniques.

Fast leaching rate, low-toxicity and applicability over a wide range of pH values (from acidic to neutral) are important characteristics of the bromide leaching system.

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EXPERIMENTAL

- **Synthetic electrolytes: Brominated electrolytes of different pH values and metal concentrations**

Mono-element:

$ZnBr_2$ (**10 g/L Zn**) + 2 M KBr + 0.5 M HBr, **pH = 0.3 – 8.5**

$FeBr_2$ (**6 g/L Fe**) + 2 M KBr + 0.5 M HBr, **pH = 0.3 - 3**

$NiBr_2$ (**1 g/L Ni**) + 2 M KBr + 0.5 M HBr, **pH = 0.3 – 7.5**

$AuBr_x$ (**10 – 500 mg/L Au**) + 2 M KBr + 0.5 M HBr

$AgBr_x$ (**10 – 100 mg/L Ag**) + 2 M KBr + 0.5 M HBr

Electrodes:

GC-glassy carbon(ϕ = 3 mm) as working electrode

Pt wire (ϕ = 0.5 mm, L 10 cm) as counter electrode

Ag/AgCl/KCl_{sat} as reference electrode

Three-element (pH from 0.3 to 3):

$ZnBr_2$ (**10 g/L Zn**) + $FeBr_2$ (**6 g/L Fe**) + $NiBr_2$ (**1 g/L Ni**) + 2 M KBr + 0.5 M HBr

- **Real solutions resulted from WPCBs leaching.**

Investigation method: Cyclic voltammetry (v = 20 mV/s, 3 cycles)

PARSTAT 2273 Potentiostat

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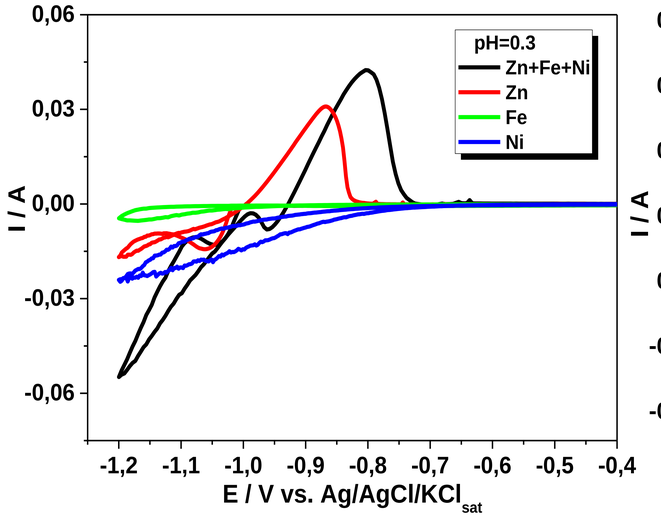
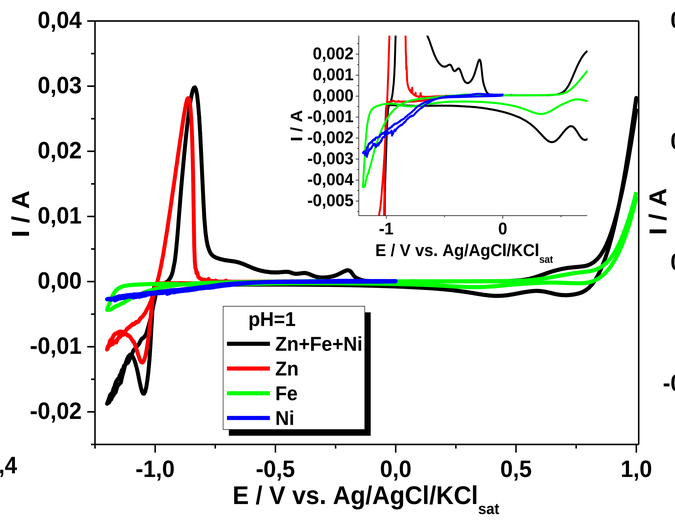
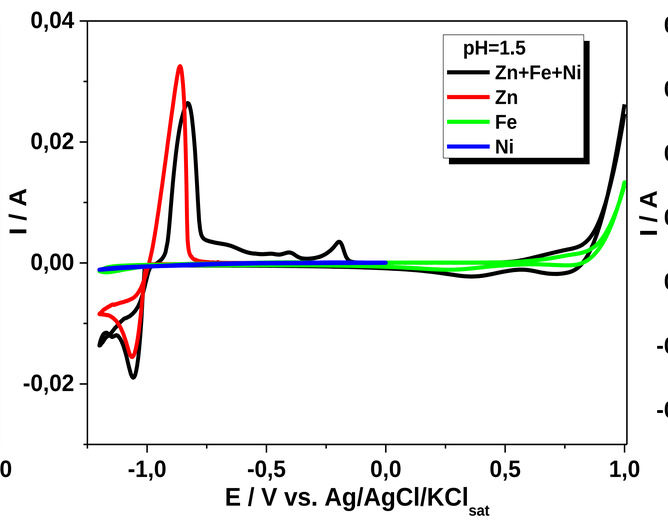
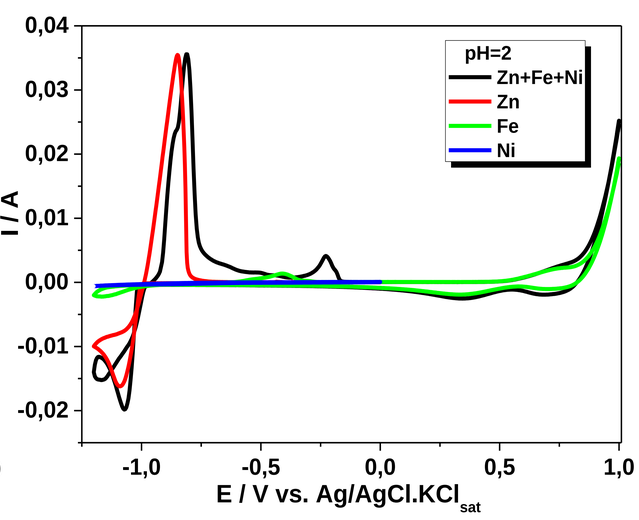
RESULTS AND DISCUSSION

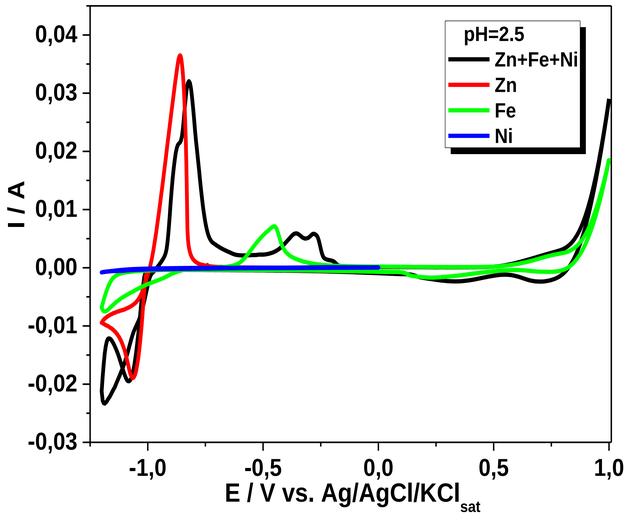
Cyclic voltammograms recorded on a glassy carbon electrode from 2 M KBr+0.5 M HBr solutions containing different metal bromides (MBr_2); scan rate 20 mV/s

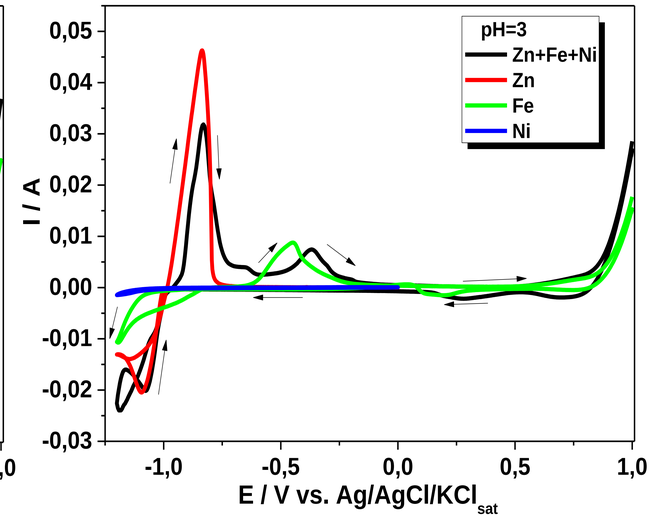












Values of anodic oxidation potentials of Zn, Ni and Fe in different mono-element electrolytes

pH	$E_{p,a}$ [V vs. Ag/AgCl]		
	Zn	Ni	Fe
0.3	-0.868	-	-
1	-0.863	-0.213	-
1.5	-0.861	-0.216	-0.381
2	-0.849	-0.216	-0.407
2.5	-0.861	-0.228	-0.451
3	-0.835	-0.235	-0.447

Anodic oxidation potentials of metals from three-element electrolyte

pH	$E_{p,a}$ [V vs. Ag/AgCl]		
0.3	-0.803	-	-
1	-0.834	-0.201	-0.385
1.5	-0.830	-0.192	-0.407
2	-0.812	-0.227	-
2.5	-0.821	-0.280	-0.355
3	-0.830	-	-0.368

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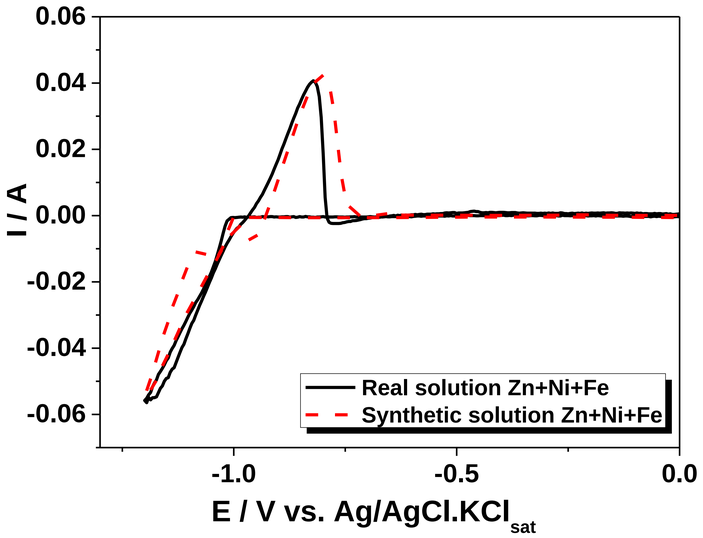

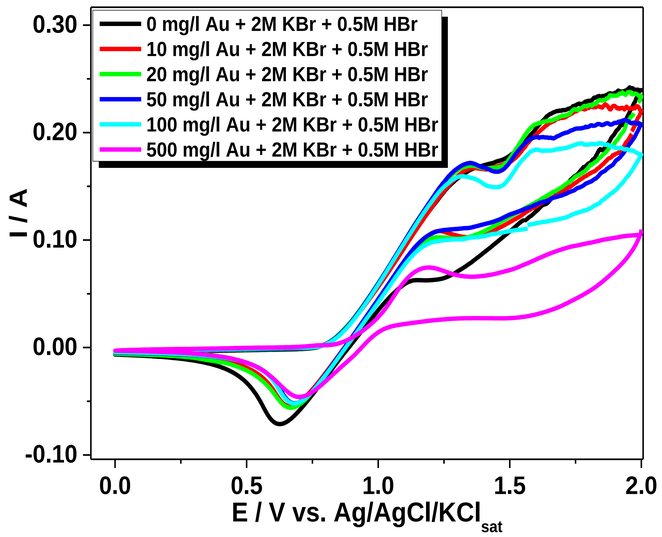

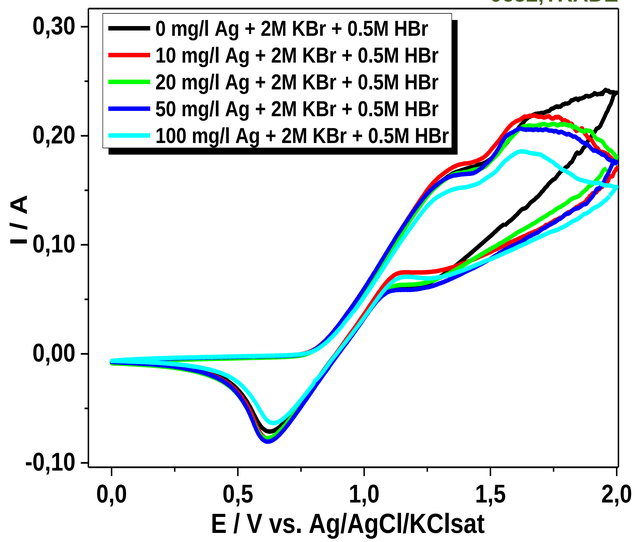

Cyclic voltammograms recorded on a glassy carbon electrode from real solutions resulted from WPCBs leaching and electrolytes with various metal bromides concentrations (MBr_2); scan rate 20 mV/s

CONCLUSIONS

The results revealed the possibility of Zn, Ni and Fe co-deposition from synthetic electrolytes that simulate the brominated leaching solutions used for metal extraction from WPCBs and their regeneration.

In the case of Au and Ag, the leaching process is rather complicated due to the formation of complex species with bromine and further research is needed to optimeze the operating conditions.

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