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Potential for recovery of metal value from WEEE using crab shell waste

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Background

Waste electrical and electronic equipment (WEEE) is a complex and rapidly growing waste stream containing valuable materials that are often disposed of or cannot easily be recovered. This research project investigates the potential of crab shell use as a biosorbent to recover metals from solutions containing metal ions. Hence the potential for crab shells to recover value from WEEE is concurrently investigated.

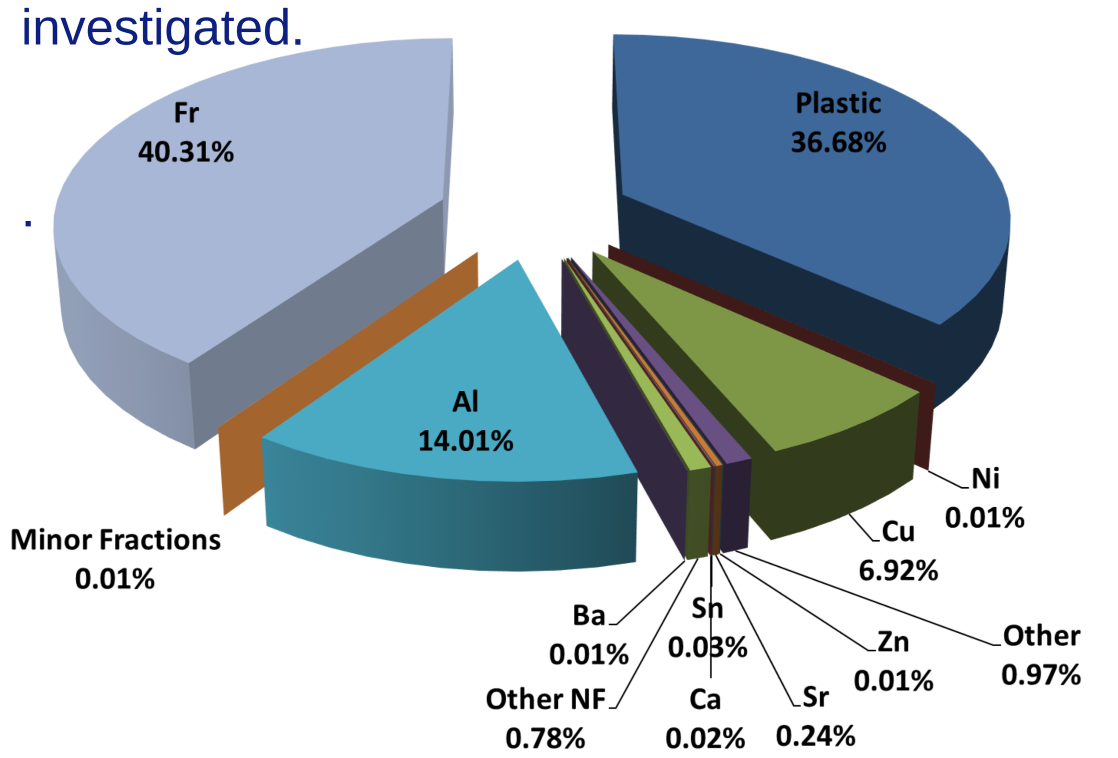

Figure 1:Composition of IT and telecom waste category [1]

WEEE

- Contains a range of valuable materials in different proportions depending on the type of item
- Contains various critical and precious metals that have a high economic importance and supply associated risk
- Waste from the IT and telecommunications category are estimated to be worth £1500 per tonne [1]
- Critical metals within WEEE include cobalt, gallium, germanium, indium, platinum group metals, rare earths and tantalum [2]
- Only 40% of WEEE is taken back through official channels in the EU [3]

Crab shells

- Approximately 490,000 tonnes of crab shell waste are generated globally as a result of crab consumption, of which approximately 3,500-7,000 tonnes are discarded in the UK [4] [5]
- This type of waste is currently not utilized in the UK and disposal costs equate to £40-160 per tonne [5]
- The composition of crab shell consists of 58%, 17%, 10%, 13% and 2% calcium carbonate, chitin, protein, moisture and other substances respectively [6]
- Chitin and its deacetylated form, chitosan, have known adsorptive properties and have many practical applications with an annual production of 150,000 tonnes [6]
- Treatment costs make chitosan production from crab shells unfeasible in the UK

Uptake of metals

Throughout this research it was found that crab shells have the ability to remove various different metal ions from solution effectively and that these values compared well against that of other biosorbents reported in the literature. The crab shell uptake capacity values for the different metals are given in table 1.

Metal	Max Uptake (mg/g)	pH	Metal	Max Uptake (mg/g)	pH
Copper	243.9	6	Cadmium*	165.3	7.5
Nickel	169.5	4.5	Cobalt*	322.6	6
Silver	5.21	6	Lanthanum*	140.1	5
Manganese	69.9	6	Cerium*	144.9	6
Zinc	123.7	6	Europium*	49.5	6
Chromium	25.5	5	Phosphate* ions	108.9	6

Table 1: Maximum uptake values for various metals obtained using the Langmuir model (* denotes critical metal)

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Overview of metal uptake

- Raw ground crab shell performed significantly better than its pre-treated forms of chitin and chitosan
- The uptake mechanism involves micro-precipitation of metal ions followed by adsorption onto chitin
- Adsorption onto chitin generally increased with solution pH due to increased micro-precipitation
- Co-existence of other metals ions generally inhibited the uptake capacity with heavy metals having the greatest effect
- In some cases, co-existence of ions such as sodium and potassium had a positive effect on uptake
- Studies on the desorption of metal ions from the crab shell reported high elution efficiencies and eluate metal concentrations, with economical eluents such as 0.1 M HCl
- Processes such as electroplating can extract metals from eluate with high metal concentrations

Recovery of value from WEEE

Overall, it is hypothesised that crab shells could be used to extract value from WEEE through a process such as that illustrated in figure 2.:

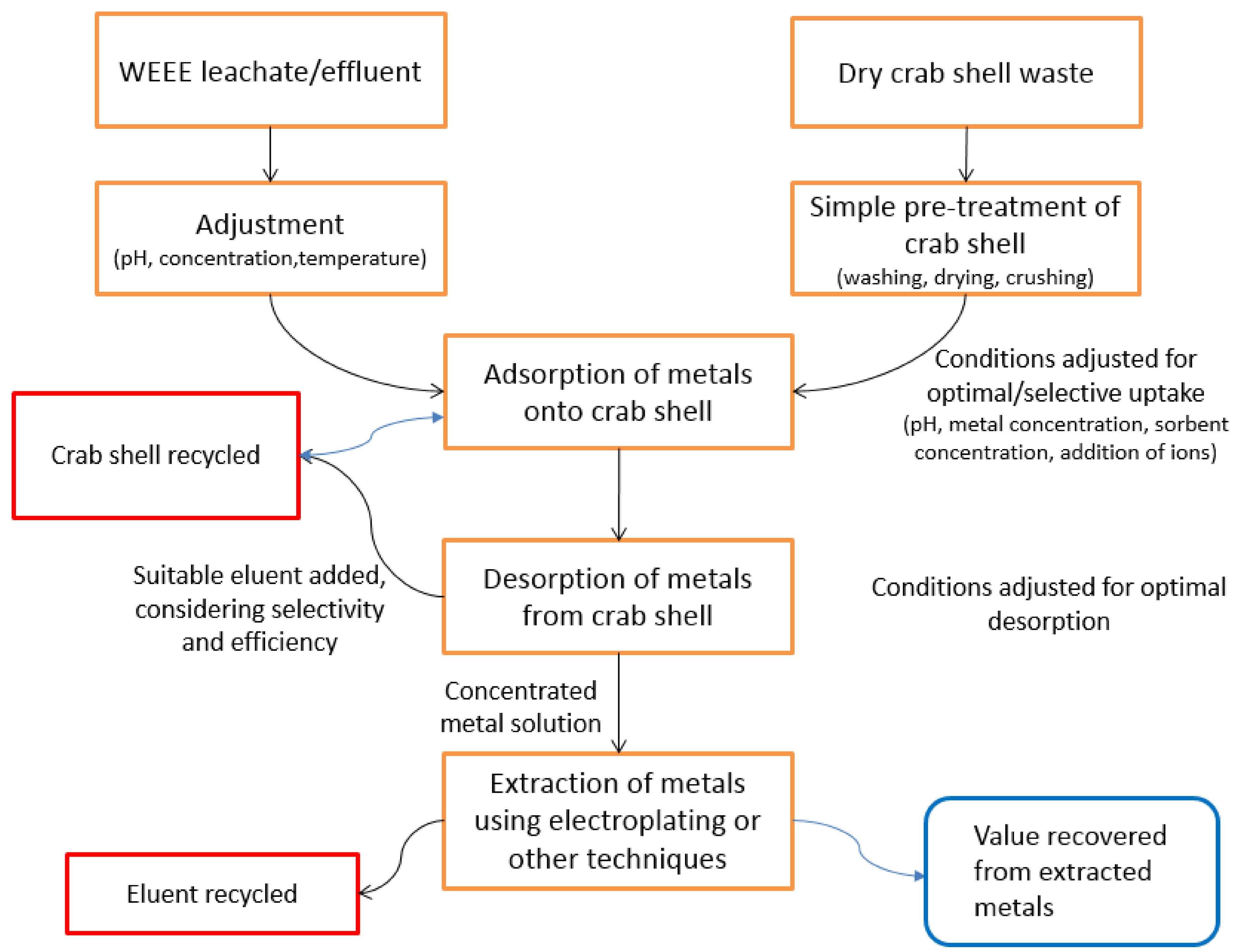

Figure 2: Potential use of crab shells for recovery of value from WEEE

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