

RECOVERY OF RARE EARTHS FROM E-WASTE RESIDUES FOR PRODUCTION OF HIGH- PERFORMANCE REE-Mg ALLOYS

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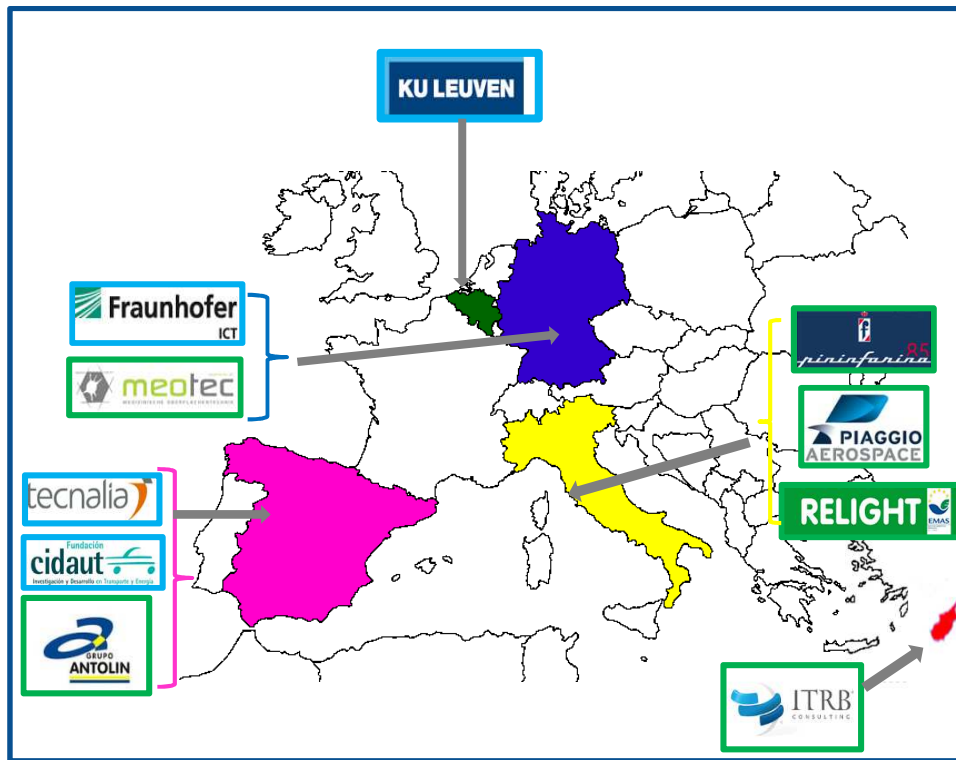
CONTENT

- Introduction
- Waste streams
- Technologies
- REE recovery processes
- Conclusions

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Research under **REMAGHIC Project** (program H2020 Spire 2015)

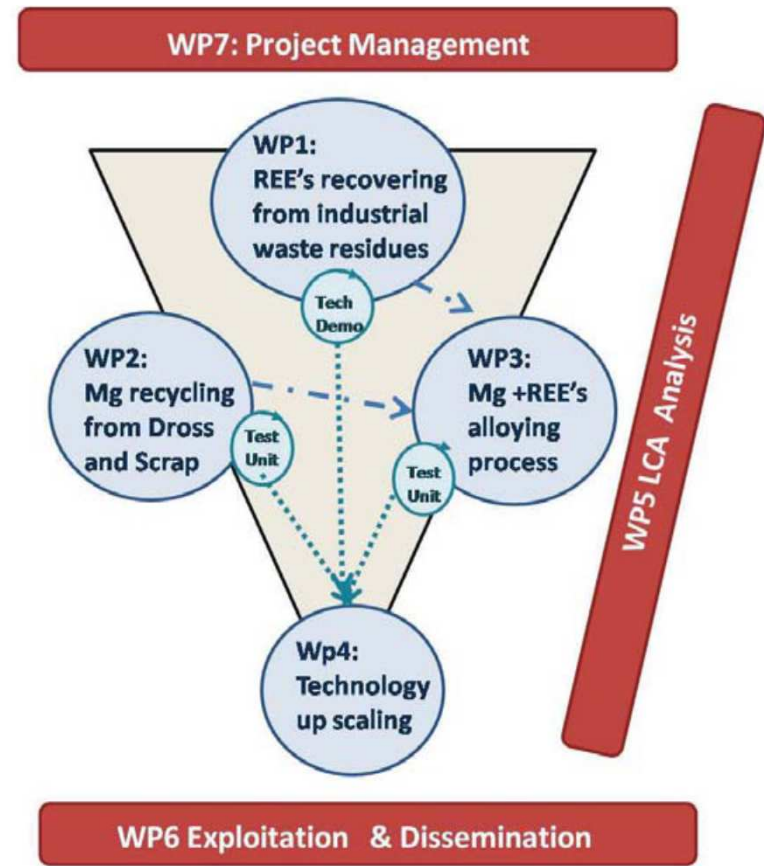
Partners



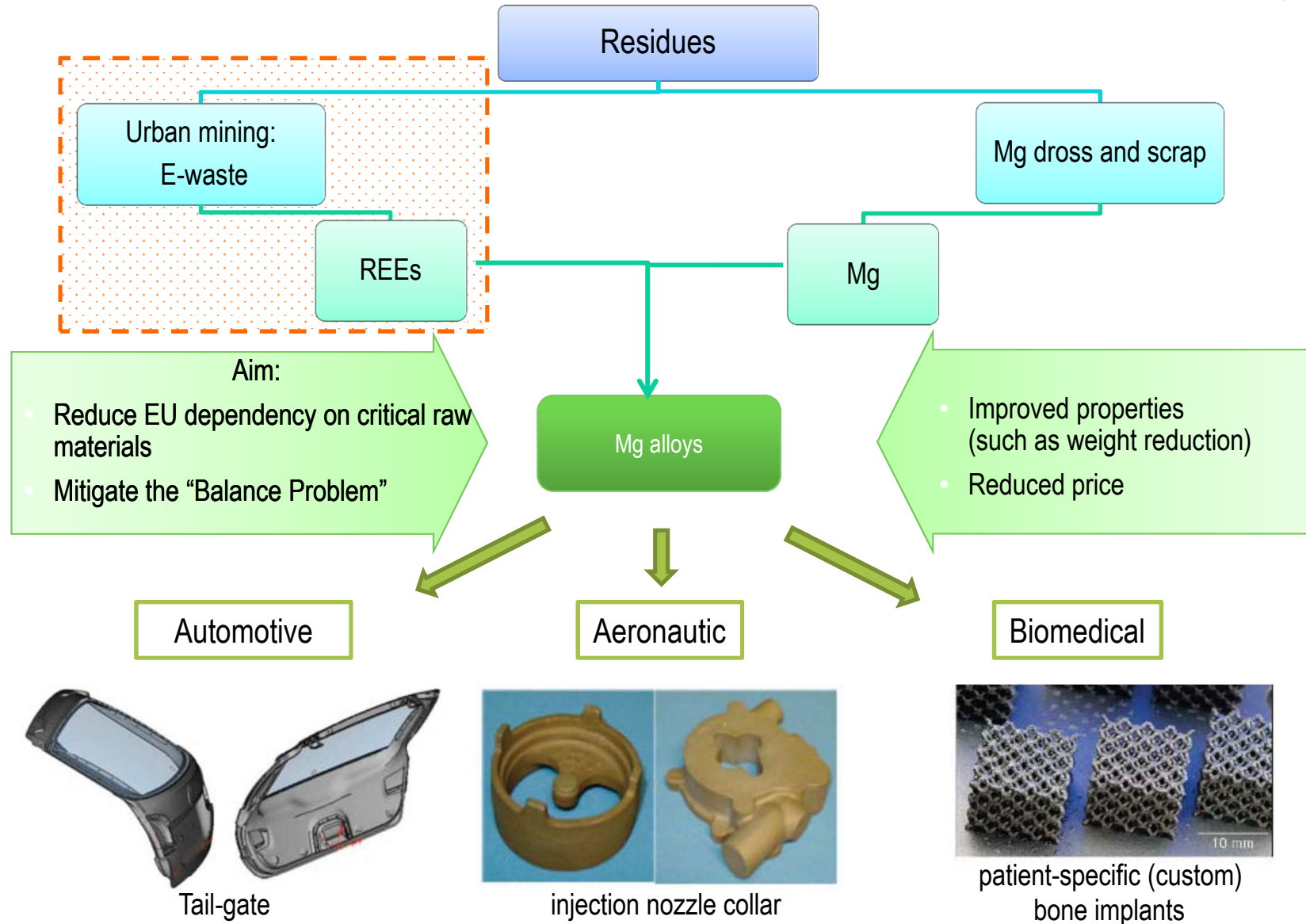
Industrial company

Research center / University

Structure



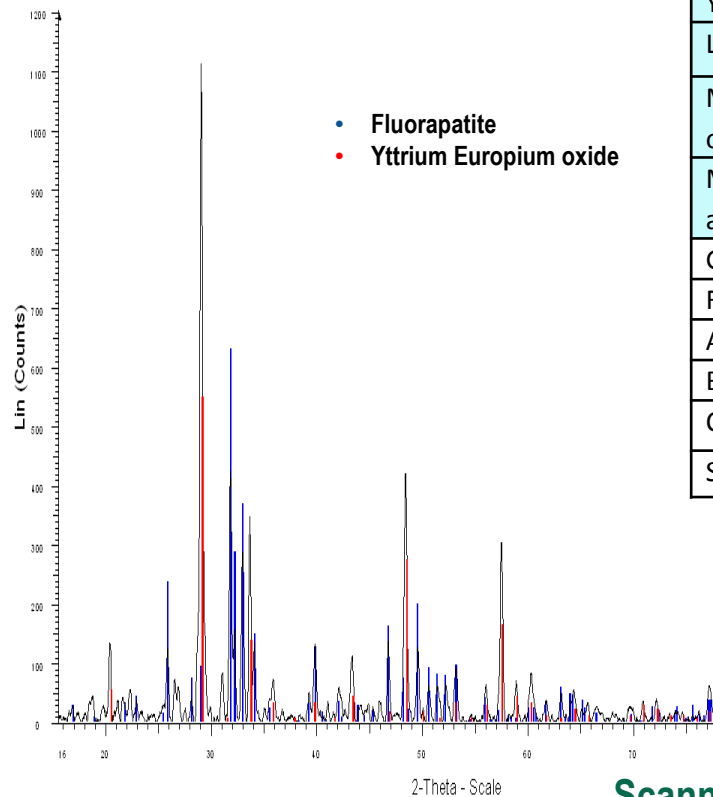
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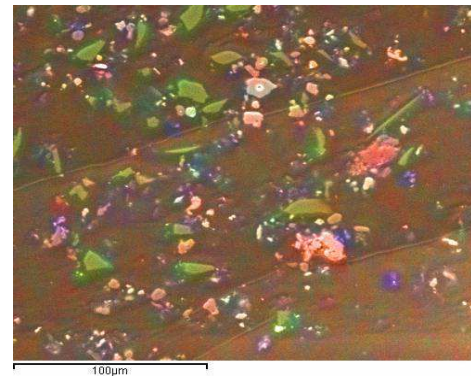
Spent lamp phosphors

X-Ray Diffraction (XRD)



| Compound | Concentration (%) |
|--|-------------------|
| Yttrium europium oxide | 9 |
| Lanthanum cerium terbium phosphate | 3 |
| Magnesium cerium terbium aluminum oxide | 1.5 |
| Magnesium cerium gadolinium aluminum oxide | 0.3 |
| Glass | 60 |
| Fluoroapatite | 13 |
| Alumina | 6 |
| Barium silicate | 3 |
| Calcite | 3 |
| Strontium magnesium phosphate | 0.6 |

REEs
 Y:6%
 La:0.9%
 Ce:0.7%
 Eu:0.4%
 Tb:0.3%
 Gd: 0.1%



Scanning Electron Microscopy (SEM)

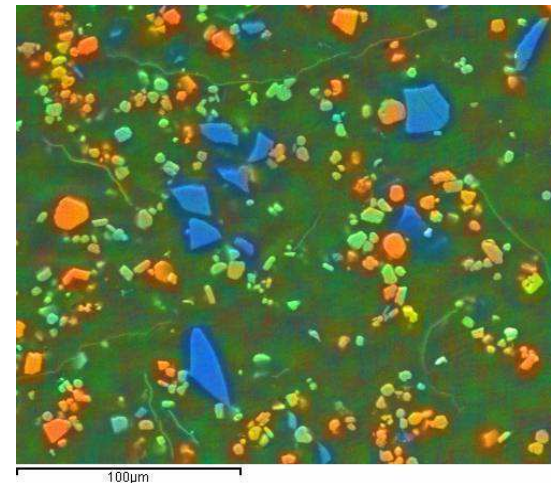
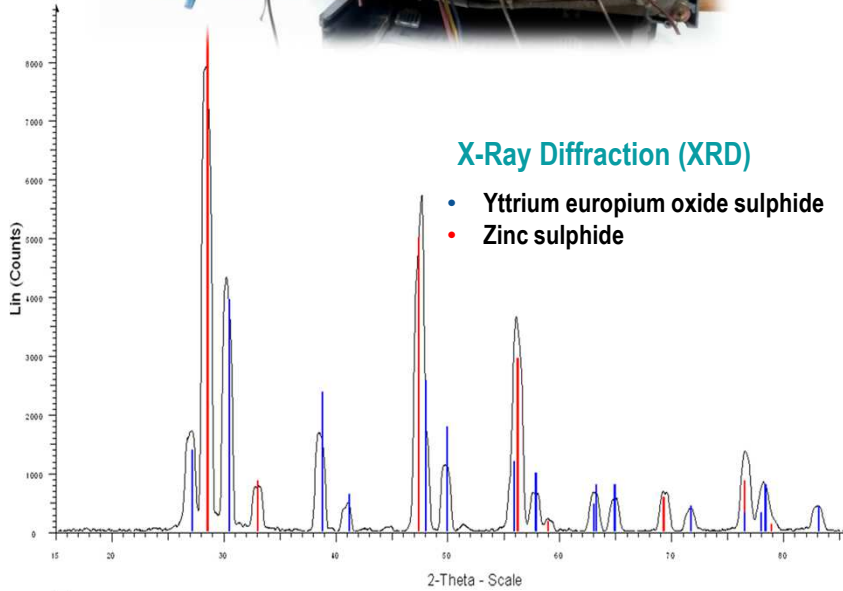
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Cathode ray tube phosphors



| Compound | Concentration (%) |
|---------------------------------|-------------------|
| Yttrium europium oxide sulphide | 23 |
| Zinc sulphide | 46 |
| Glass | 25 |
| Aluminum | 1.5 |

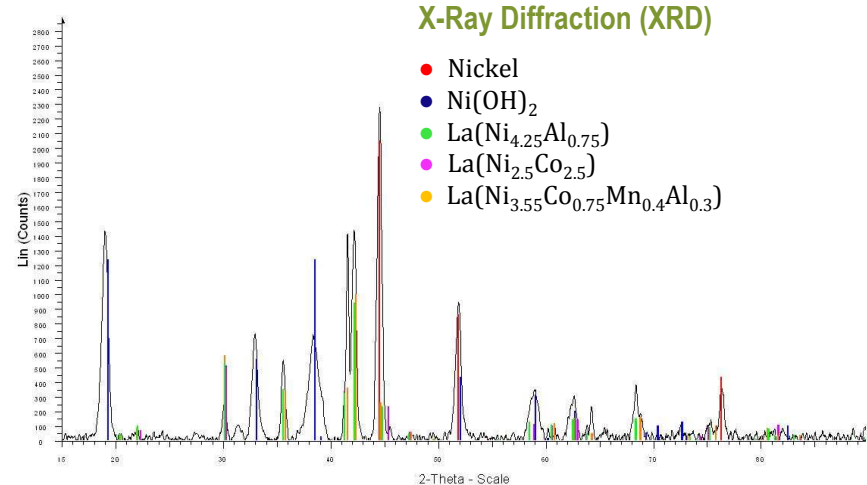
REEs
Y: 15%
Eu:1%



Scanning Electron Microscopy (SEM)

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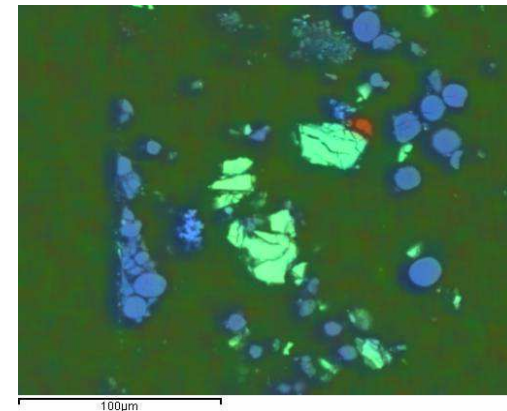
NiMH batteries black powder



| Compounds | Concentration (%) |
|---|-------------------|
| LaNi₅ (hydrogen storage alloy based on mischmetal -mainly lanthanum, cerium and nickel including cobalt, aluminium and manganese) | 45 |
| Metallic Nickel | 15 |
| Nickel hydroxide | 35 |
| Others (electrolyte, Co, Zn, graphite, etc.) | 5 |

REEs
La: 13%
Ce:2%

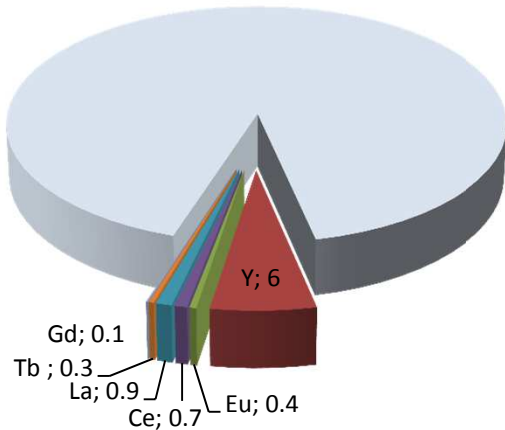
Scanning Electron Microscopy (SEM) Mapping with the EDX analysis on the micrograph



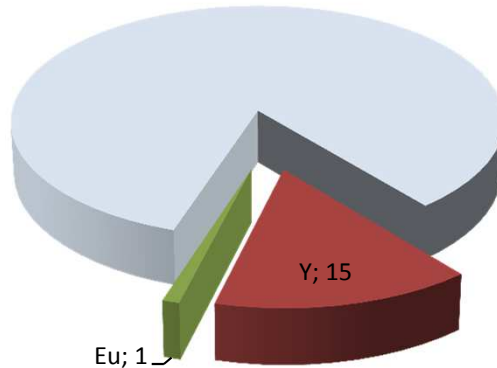
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E-Waste

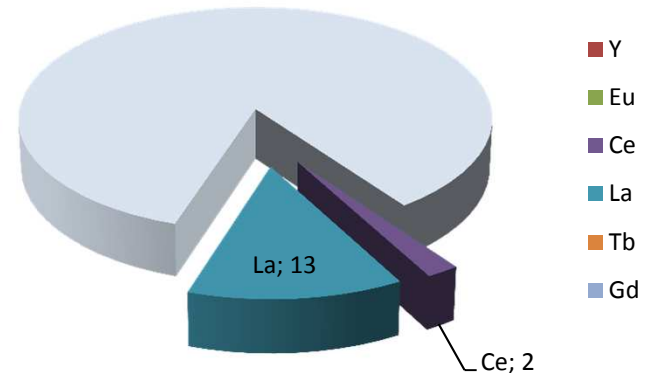
Spent lamp phosphors



Cathode Ray Tube phosphors



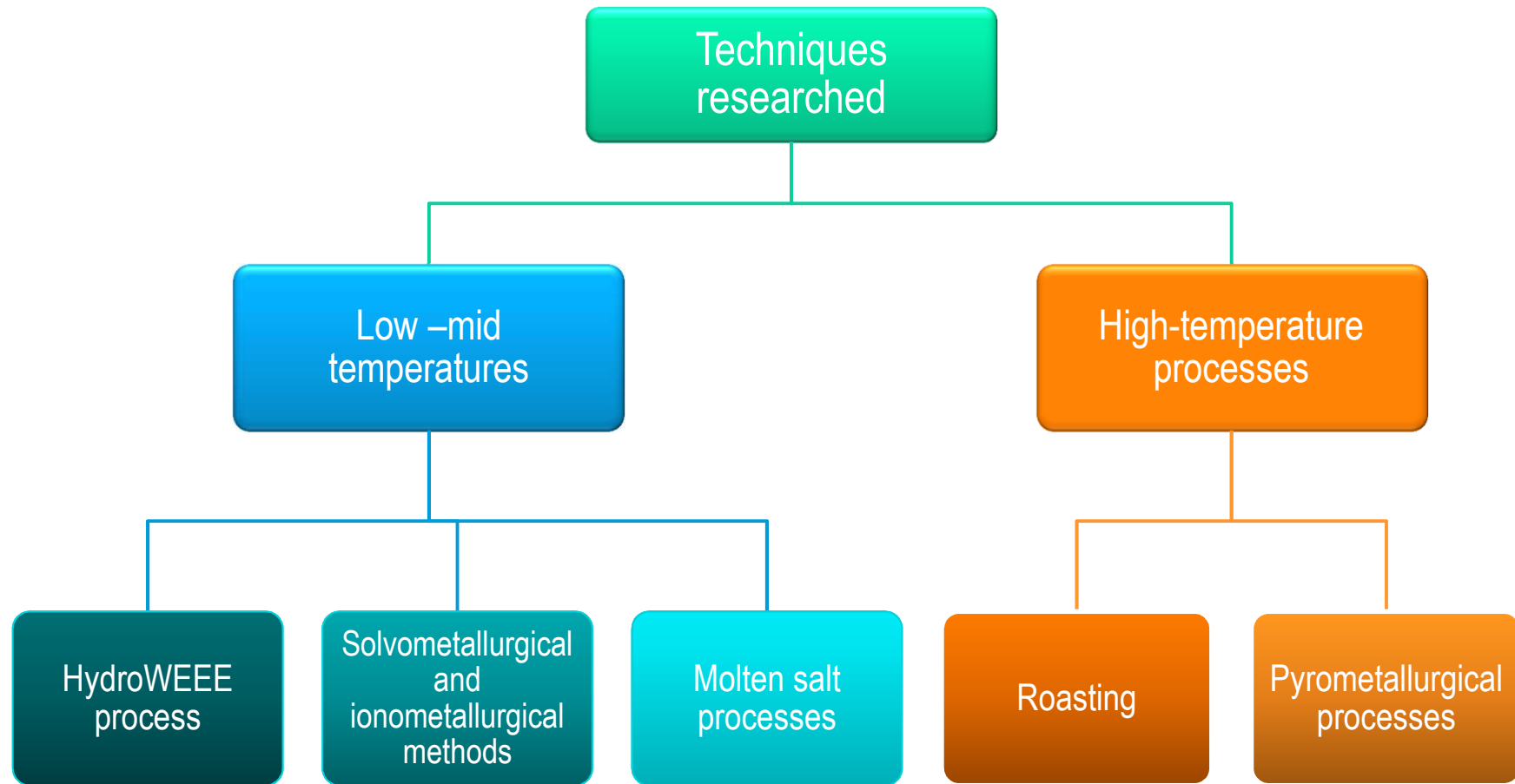
NiMH batteries black powder



- Y
- Eu
- Ce
- La
- Tb
- Gd

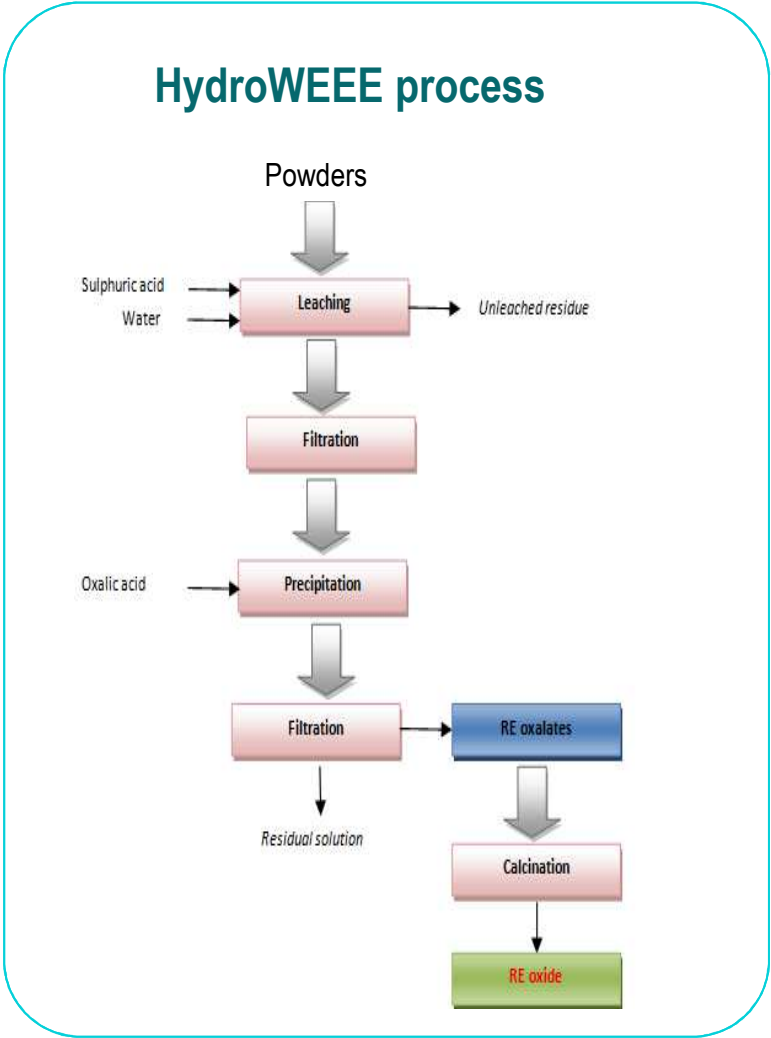
La, Eu, Tb, Y, Ce, Gd

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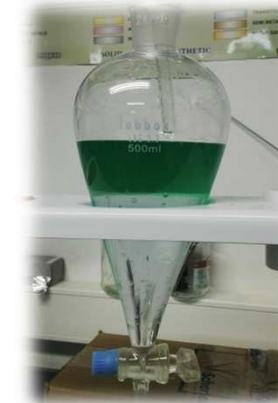
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Techniques researched



Solvometallurgical and ionometallurgical methods

- Extraction with organic solvents (acetic acid, methanesulfonic acid, D2EHPA in xylene, etc)
- Y/Eu separation by ionic liquids



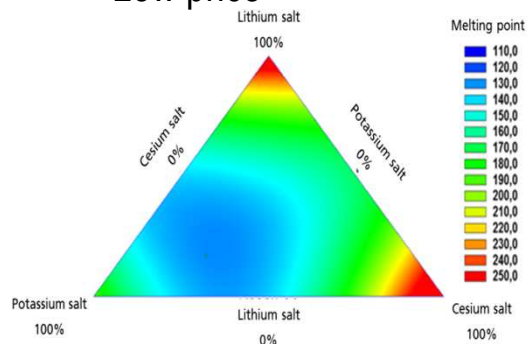
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Techniques researched

Molten salt processes

Focus on mixtures with:

- Low melting point: lowered energy consumption
- High thermal and chemical stability
- Low toxicity
- Low price



Roasting

(lamp & CRT powders)

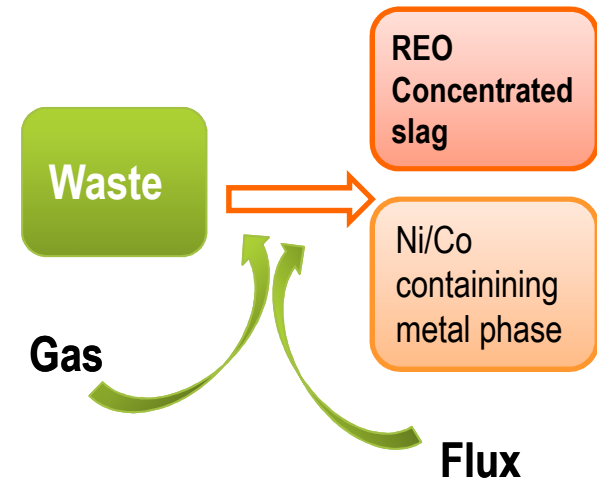
Gas-solid reaction to transform chemical composition (with or without addition of reactants)

Types:

- Oxidising
- Chlorinating
- Sulphating
- ...

Pyrometallurgical processes

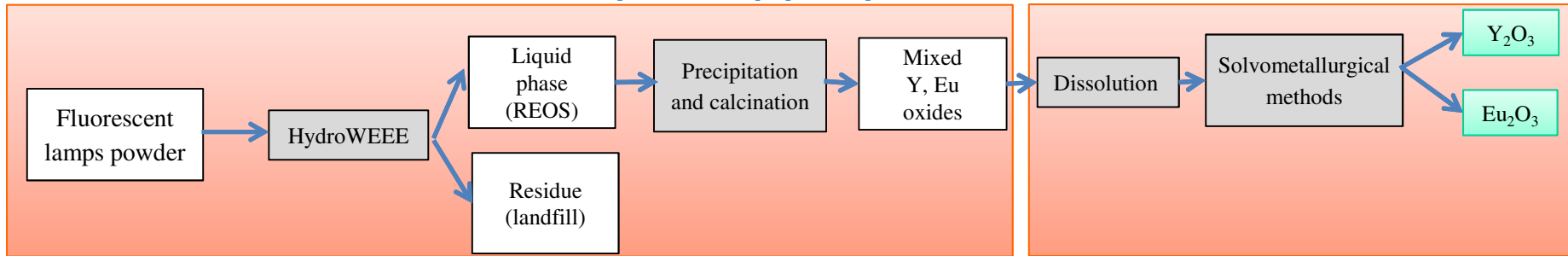
(NiMH batteries powder)



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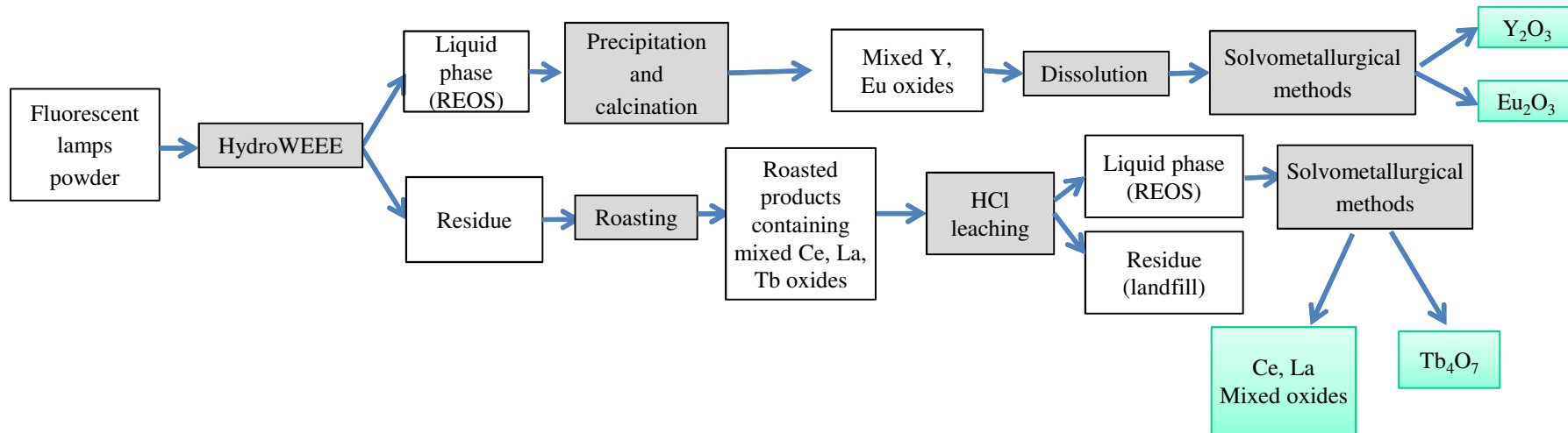
Combination of different techniques for each waste stream treatment

Spent lamp phosphors



ROASTING to transform REE phosphates (Lanthanum cerium terbium phosphate 3 %) into REE oxides, more easily leachable

T^a 900°C



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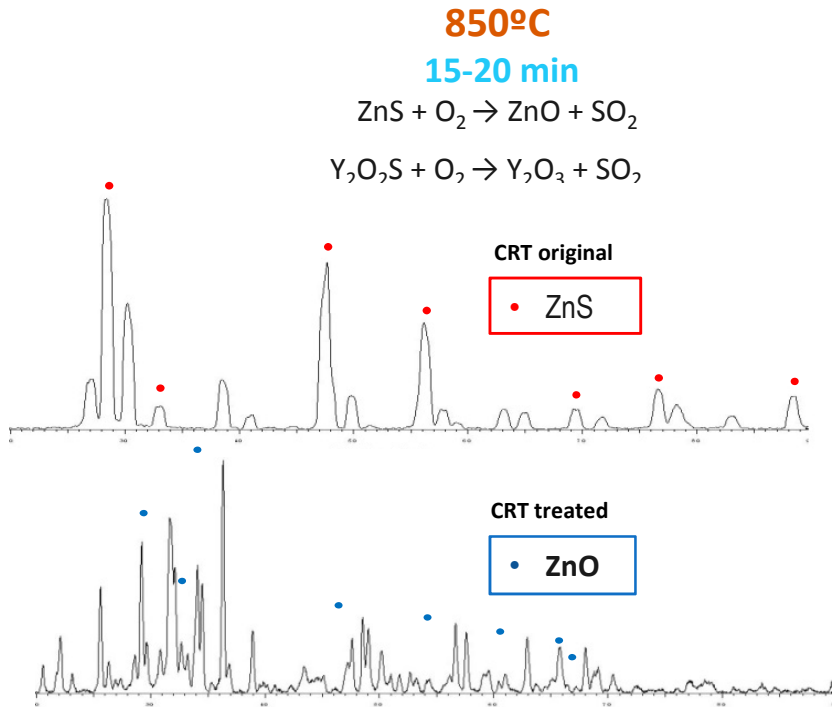
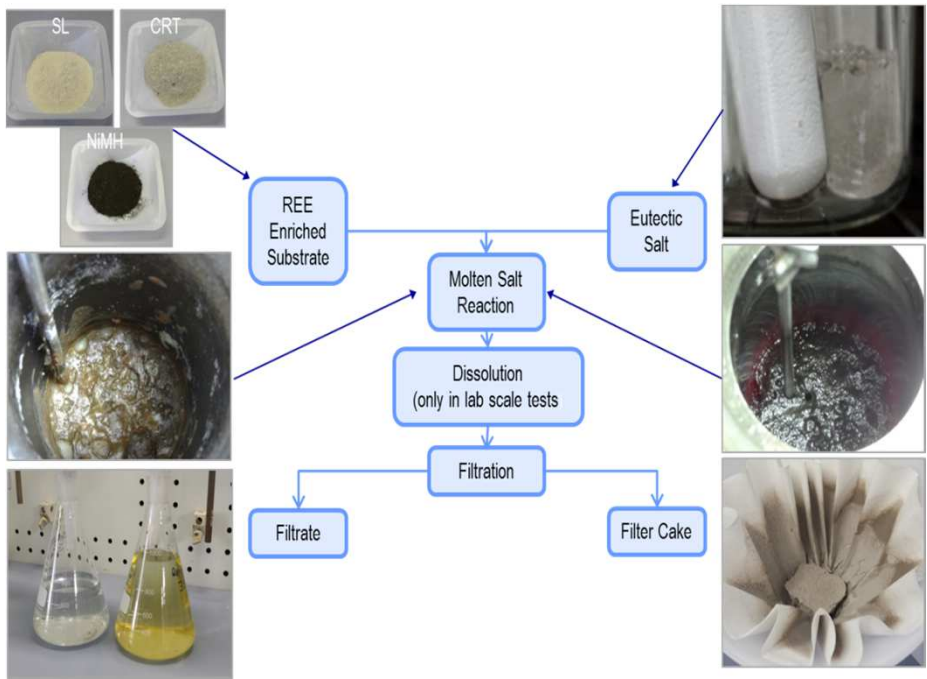
Combination of different techniques for each waste stream treatment

Cathode-ray tube (CTR) phosphors

HydroWEEE process can be applied but, to avoid H₂S release from ZnS during leaching, the abundant matrix of the green and blue phosphors:

Treatment with molten salt processes

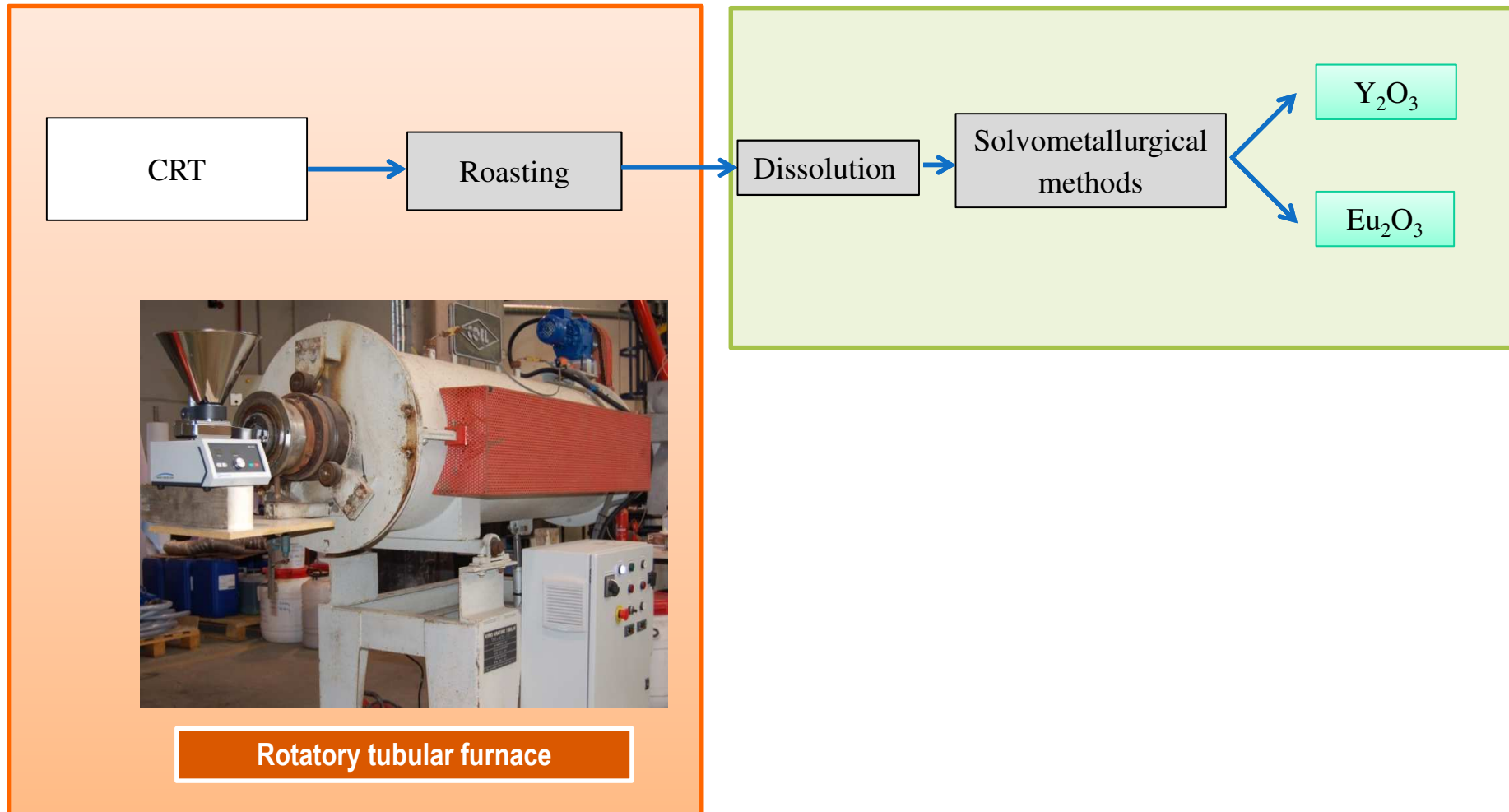
Oxidising roasting



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Combination of different techniques for each waste stream treatment

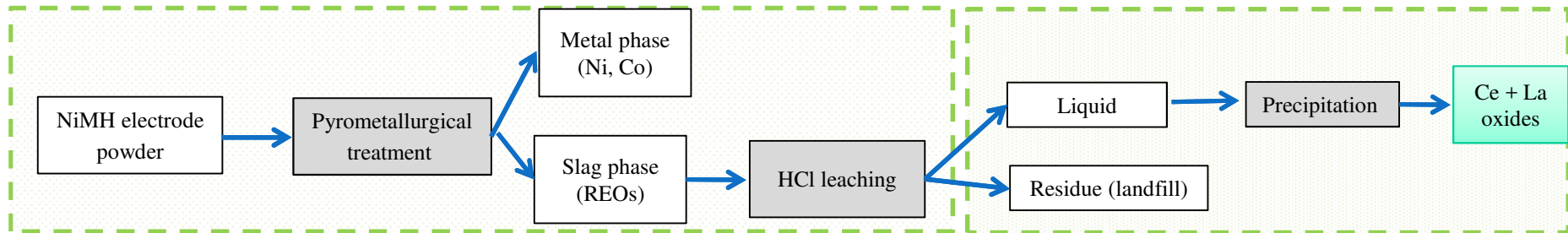
Cathode-ray tube (CTR) phosphors



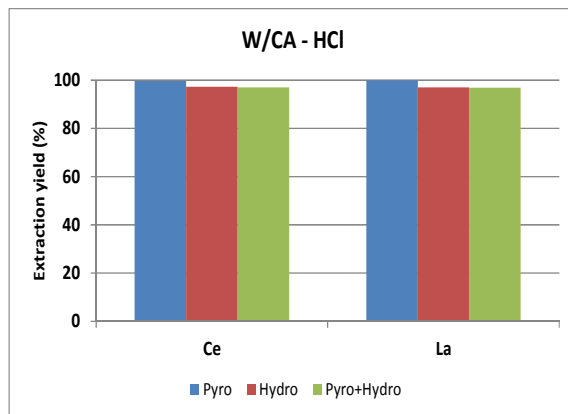
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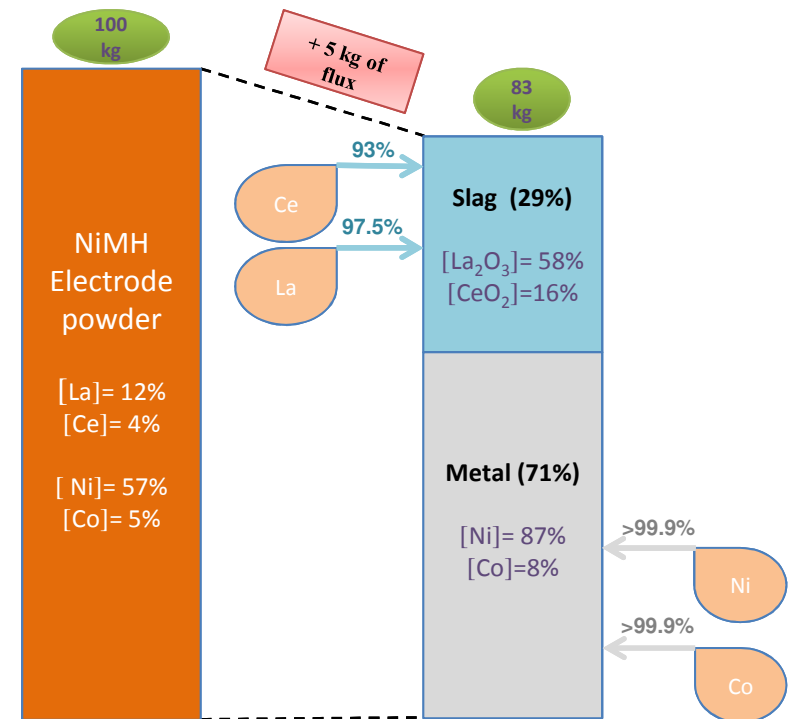
NiMH batteries black powder



Flux: wollastonite/calcium aluminate (1/4)
Waste/flux: 4/1



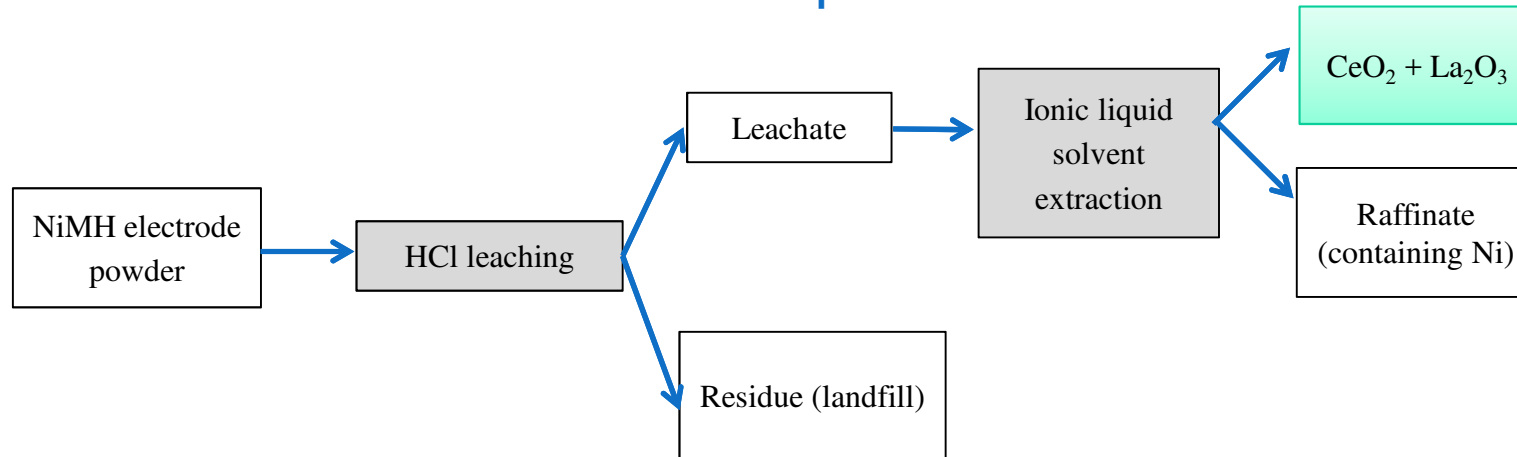
This route allows recovering up to **96.9%** of **Ce+La** contained in the waste



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Combination of different techniques for each waste stream treatment

NiMH batteries black powder



Under research:

- HCl leaching of the powder
- **Ce** and **La** recovery from leachate through solvent extraction with ammonium and phosphonium ionic liquids

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According to the results obtained up to now,

- The production of competitive REE Mg alloys from residues is foreseen, getting both
 - *Reduction of EU dependency on critical raw materials: Mg and some REEs (Nd, Tb,...)*
 - *Mitigation of the “Balance Problem” by the use of those more abundant REE (Ce, La,...)*

- REEs recovery from the studied waste streams needs for the combination of several technologies, hydro-, solvo- pyro-metallurgy, in order to obtain the desired element with the required purity

For more information see poster

**INTEGRATED FLOW SHEET FOR THE RECOVERY OF RARE EARTHS
FROM CRTs AND LAMP PHOSPHOR WASTE**

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**THANKS FOR YOUR
ATTENTION!!**

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