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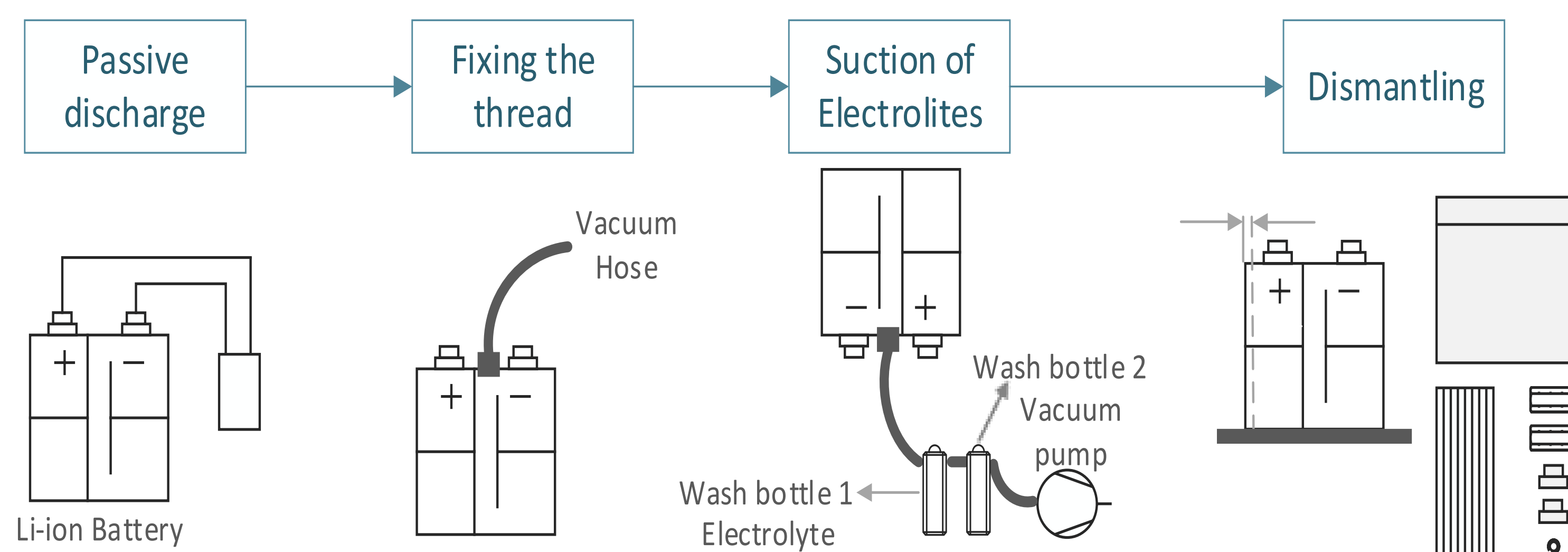
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Goal

To establish a small scale in-house recycling process for Li-ion batteries LiFePO₄ type, which is material efficient and environmentally friendly in compliance with legal and safety requirements

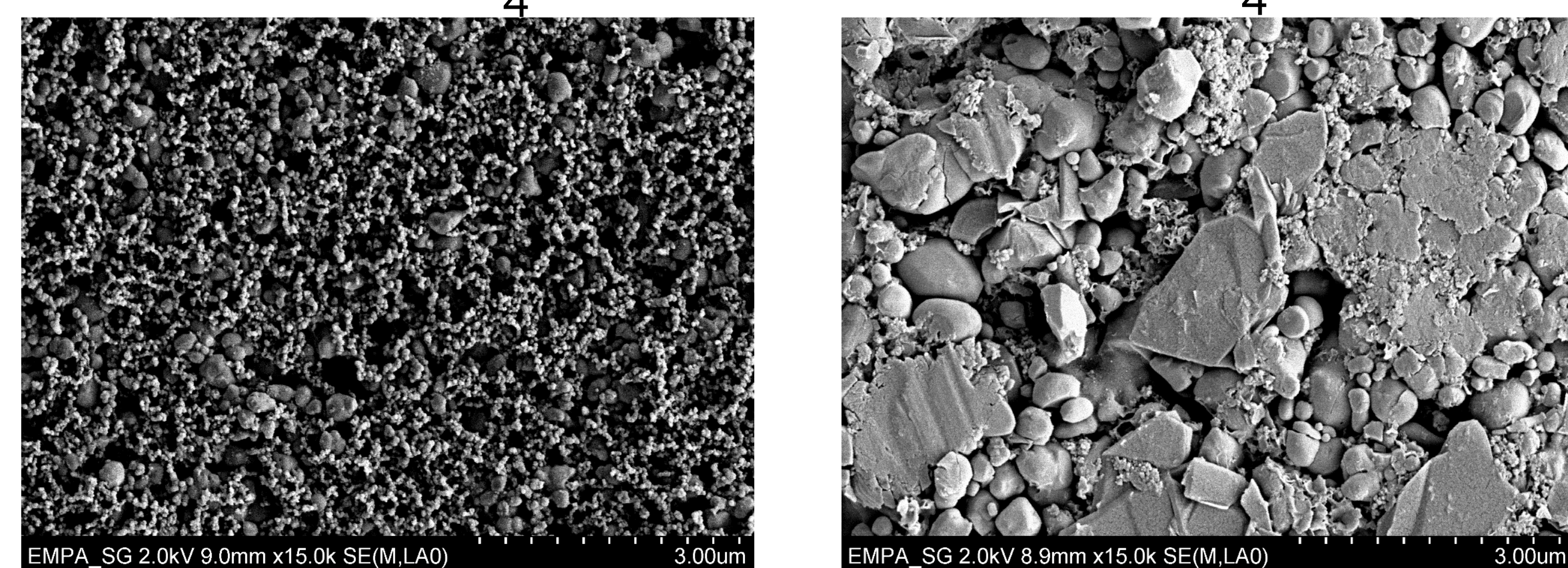
1. Pre-treatment

Cells are discharged to 2.5V before manual dismantling to separate the materials in a sealed box



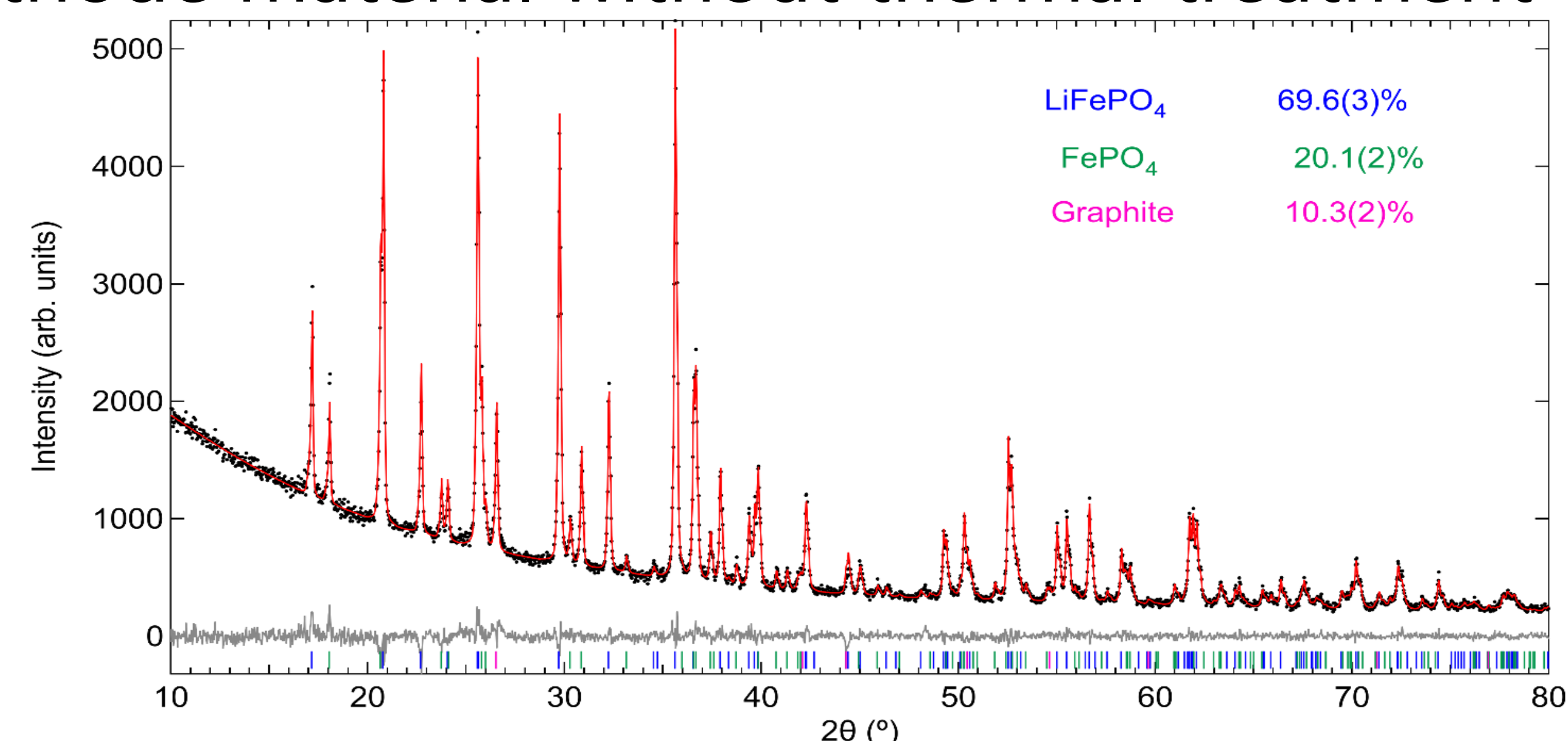
3. Material Characterization

Scanning electron microscopy (SEM) images: Unused LiFePO₄ Used LiFePO₄

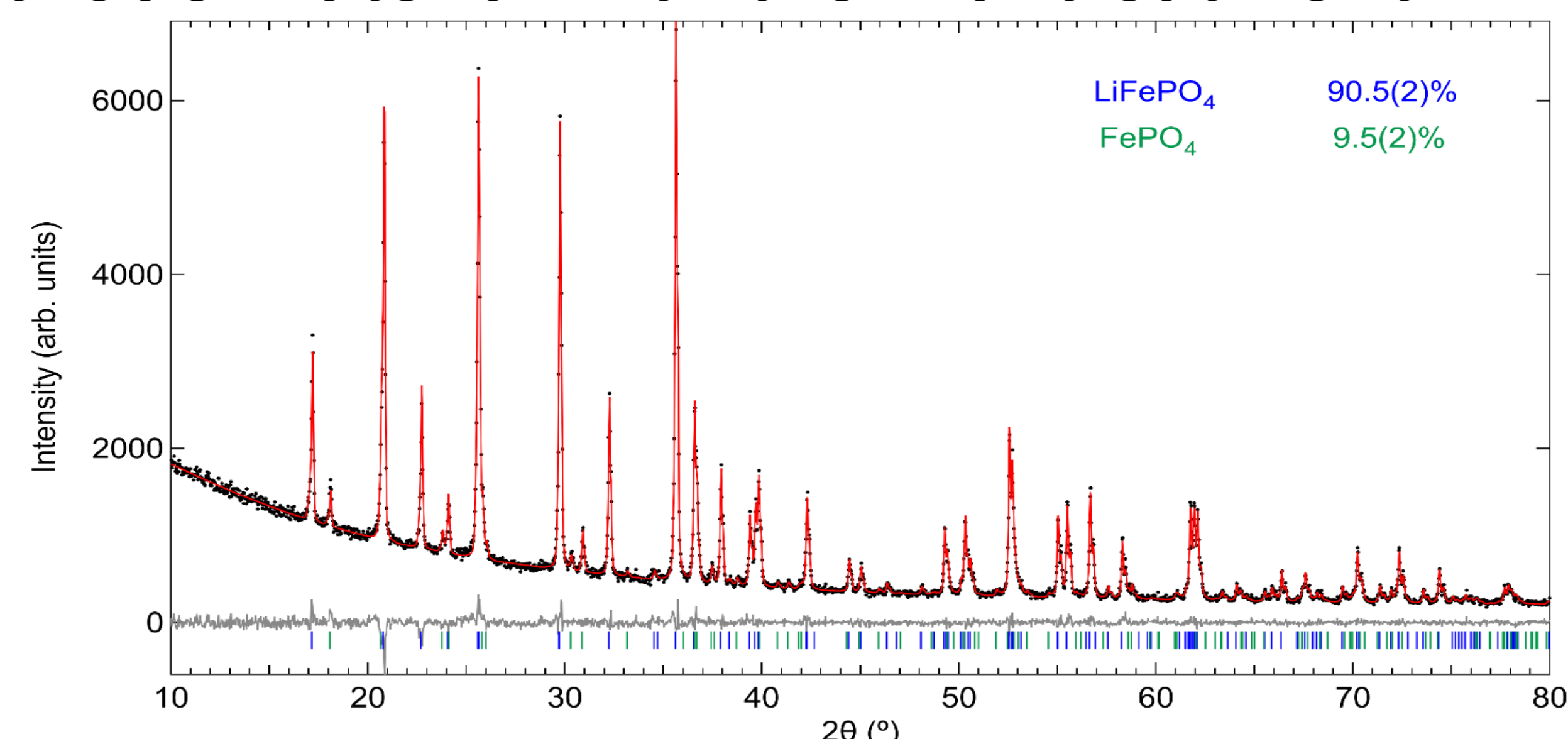


X-Ray diffraction (XRD) patterns:

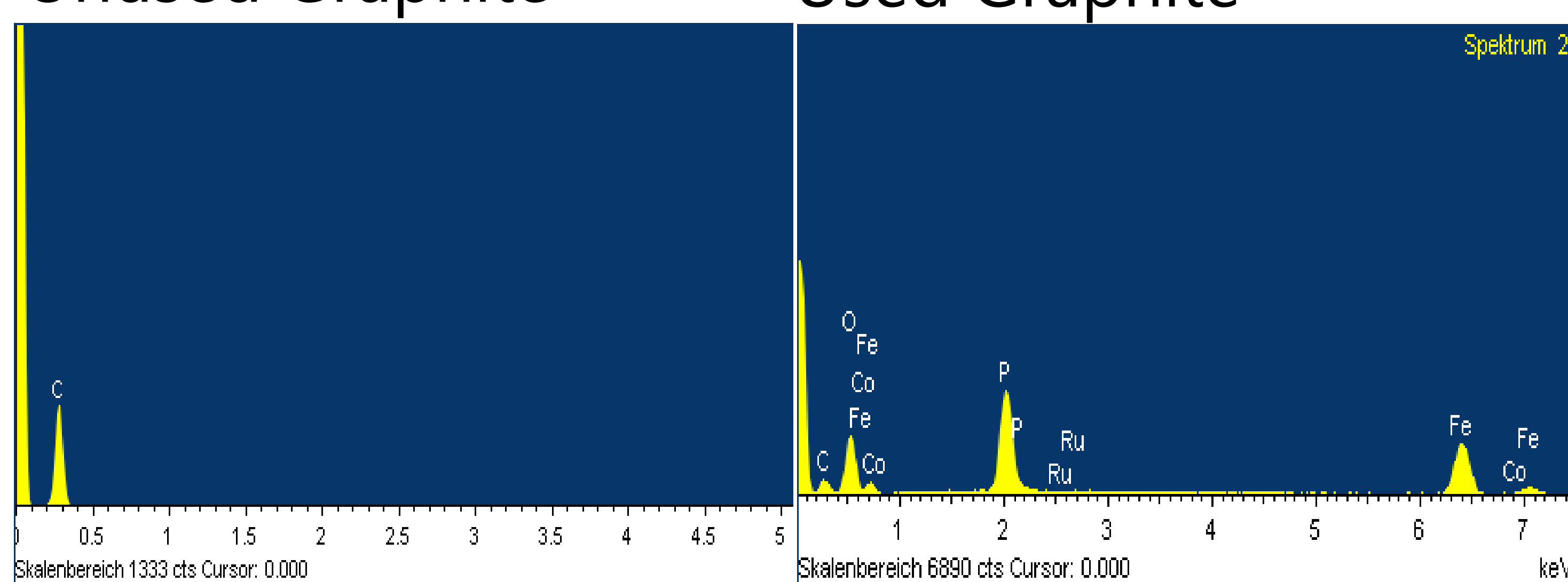
Cathode material without thermal treatment



Cathode material with thermal treatment

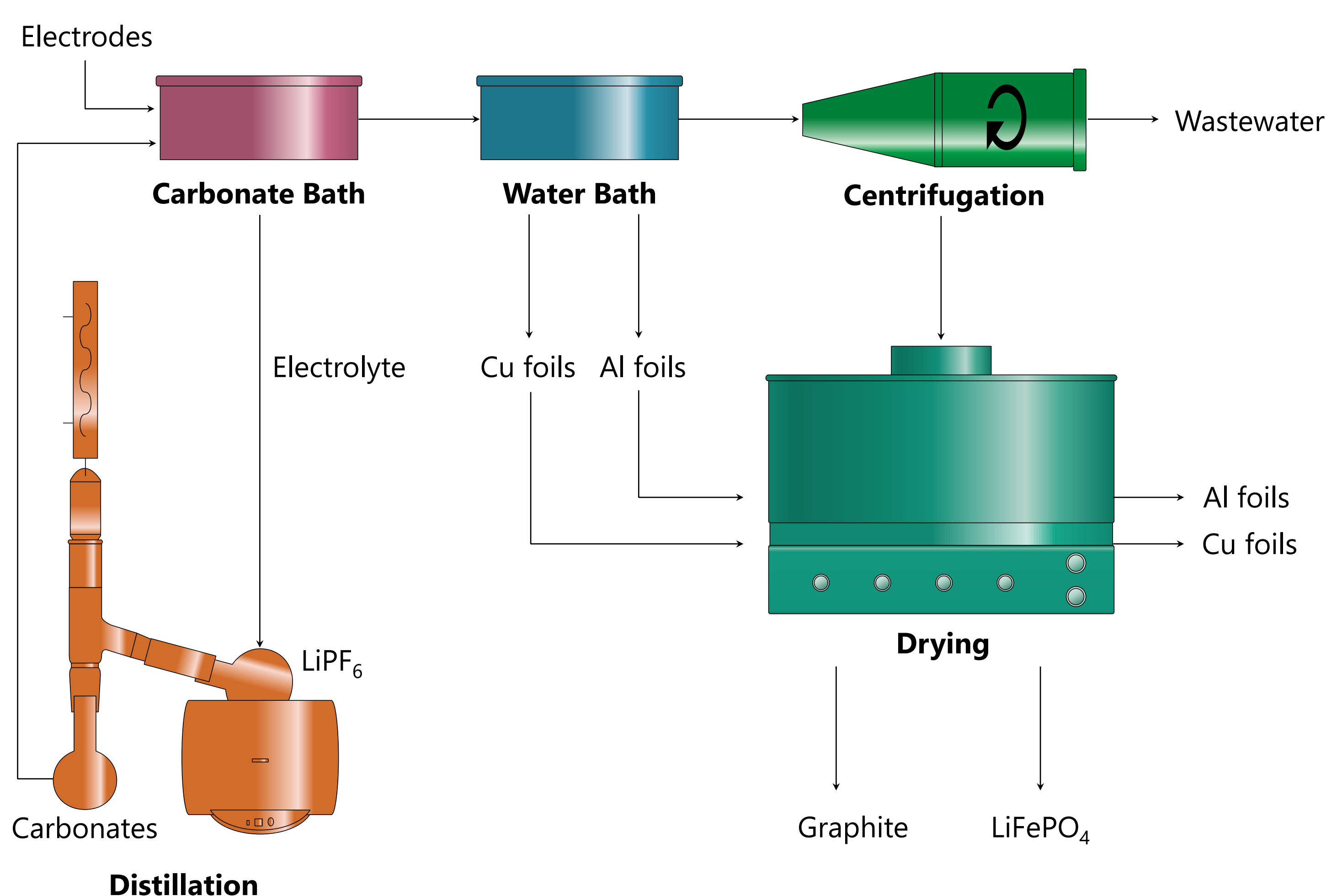


Energy dispersive spectroscopy (EDX): Unused Graphite Used Graphite



2. Material Recovery

A water based recycling process is developed to separate the cathode and anode materials from aluminum and copper foils. The lithium salt from the electrolyte is recovered by distillation and the distilled carbonates are reused in the process. Anode materials are further heat-treated to decompose the binder based on Polyvinylidene fluoride (PVDF)



4. Results

- A low-tech and small scale recycling process is developed for LiFePO₄ batteries
- Mechanical shredding is avoided which implies lower operational costs
- The outputs of the process are: Lithium carbonate, plastic housing and electrode materials that can be re-used in new batteries

5. Future Work

- Acid leaching to recover Lithium from the cathode material
- Structural finger print of electrode materials by Raman Spectrum
- Re-use of cathode and anode powders in a new battery and assessment of its performance