Outstanding Recovery of Critical Minerals from Raw Black Mass

Highlights

- **Iondrive has achieved breakthrough results in a new study of its Li-ion battery recycling process using Raw Black Mass (grounded spent batteries, containing a mixture of different Li-ion battery types).**
- **This is an important extension of the previous studies which demonstrated the scalability of Iondrive's recycling process using pure pCAM (precursor Cathode Active Material), excluding Lithium (ASX Announcement 30 July 2024).**
- **Results from this latest study demonstrate high selective recovery rates for all four valuable critical minerals of interest, even using the lower quality Raw Black Mass.**
- **Further, a simple three-stage pretreatment process was found to be effective in removing impurities, including PVDF binder, graphite, and ferrous iron, with significant improvement in the recovery rates of:**
    - **Nickel (100%)**
    - **Cobalt (98.6%)**
    - **Manganese (98.4%)**
    - **Lithium (89.1%) – *with follow-on selective testing showing the potential for 100% Lithium recovery with adjustments to solvent concentrations.***
- **These results are a substantial leap forward in the commercialisation of Iondrive's unique and environmentally sustainable Li-ion battery recycling technology.**
- **Iondrive's Pre-Feasibility Study (PFS) remains on track for completion by the end of October 2024.**
- **A successful PFS is anticipated to provide a gateway to the development of a pilot plant, together with opportunities for industry collaboration and non-dilutive funding in Europe and Australia.**

Iondrive Limited (ASX: ION) ("Iondrive" or the "Company") is pleased to announce exceptional results from its latest trials aimed at enhancing the recovery of critical minerals from black mass. These results demonstrate significant progress in the Company's ability to recover valuable minerals, even from mixed and low-grade black mass feedstock and the effectiveness of a simple pre-treatment process to further improve recovery rates.

Iondrive Limited Dr CEO Ebbe Dommisse commented:

Our latest results are a major breakthrough for Iondrive. Achieving such high recovery rates from mixed Black Mass is a significant step forward. Compared to our previous trials, which used pristine material, these new results demonstrate the robustness of our process, even with lower-quality, mixed material. Looking ahead, we expect to work with more consistent, higher-grade material through partnerships, which will further improve the efficiency and reliability of our recycling technology.

Iondrive uses Deep Eutectic Solvents and biodegradable organic solvents in a non-toxic, closed-loop process. This eco-friendly method avoids the widely used toxic mineral acid leaching, minimising the environmental impact. Most battery recycling processes shred and pre-treat waste batteries to produce Black Mass, a powdered mixture of critical minerals like lithium, cobalt, nickel, and manganese. Black Mass is typically exported to Asia for further processing, where energy-intensive pyrometallurgical and acid-leaching hydrometallurgical methods are used to extract and refine the minerals.

Previously reported test results validated the scalability of the high critical mineral recoveries at a 1,000x scale-up from earlier small-scale trials at the University of Adelaide, and the results were independently verified by IMO at 1,700x scale-up (refer ASX announcement 30 July 2024). Those tests were performed using pure pCAM material, excluding Lithium.

The current study used Raw Black Mass as the feedstock (lower-grade, mixed Li-ion battery types, which is often considered a worst-case scenario for commercial feedstock). The current study focused on the assessment of:

- Mineral recoveries with the inclusion of Lithium in the Black Mass.
- The impact of impurities in mixed Black Mass on mineral recoveries. The PVDF binder material that binds anode and cathode materials was hypothesised to inhibit leaching of critical minerals by binding them to the graphite and limiting exposure to solvents for leaching.
- The effectiveness of pretreatment in removing binders and graphite.
- Assessing the overall improvement of mineral recovery by first eliminating these impurities from the Black Mass.

The results of the current study are detailed in Table 1. These results demonstrate a major leap forward in Iondrive's ability to demonstrate the recovery of valuable minerals, including Lithium, even from the lower quality Raw Black Mass. More importantly, the simple three-stage pretreatment process was found to be effective in removing impurities, including PVDF binder, graphite, and ferrous iron, with a significant improvement in the recoveries of the critical minerals.

Table 1: Metal Recoveries from large-scale bench trials

Battery Minerals	Total Recovery			
	Pretreated Black Mass Oct 24	Raw Black Mass Oct 24	IMO pCAM material July 24 *	UoA pCAM material May 24 *
Lithium	89.1%	82.9%	NA	NA
Nickel	100.0%	88.5%	98.3%	97.6%
Cobalt	98.6%	96.5%	98.6%	97.6%
Manganese	98.4%	94.4%	84.6%	87.7%

* Refer ASX announcement 30 July 2024.

Further, the selectivity of the extraction of the four critical minerals was maintained using both the Raw Black Mass and the Pretreated Black Mass. This selectivity improves both the efficiency and economic viability of the process.

Selective additional tests demonstrated the potential for 100% lithium recovery with adjustments to the solvent concentrations, with some minor loss of selectivity of the other metals. Further work will be planned to explore the economic trade-off between the metals and lithium.

Iondrive extends its gratitude to CSIRO's Dr. Warren Bruckard and Professor Bill Skinner from University of South Australia for their invaluable contributions. A special thanks also to Iondrive's technical team, including Jandre Nel and Mike Jureidini, with support from Dr. Jingxiu Wang, Yanqiu Lyu, and Dr. Philip van Eyk from the University of Adelaide.

Pre-Feasibility Study Completion

Iondrive's Pre-Feasibility Study (PFS) remains on track for completion by the end of October 2024. The consultant reports are being finalised which provide the Capex/Opex cost estimates for a commercial-scale recycling plant, along with the benchmarking assessment of these cost estimates against hydrometallurgical recycling plants utilising incumbent technology.

A successful PFS outcome opens the pathway to the development of a pilot plant, opportunities for collaboration with potential industry partners, as well as access to non-dilutive financial support in Europe and Australia.

Authorised for release by the Board of Iondrive Limited.

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