

Upcycling of low value end-of-life cathode material into next generation cathode materials

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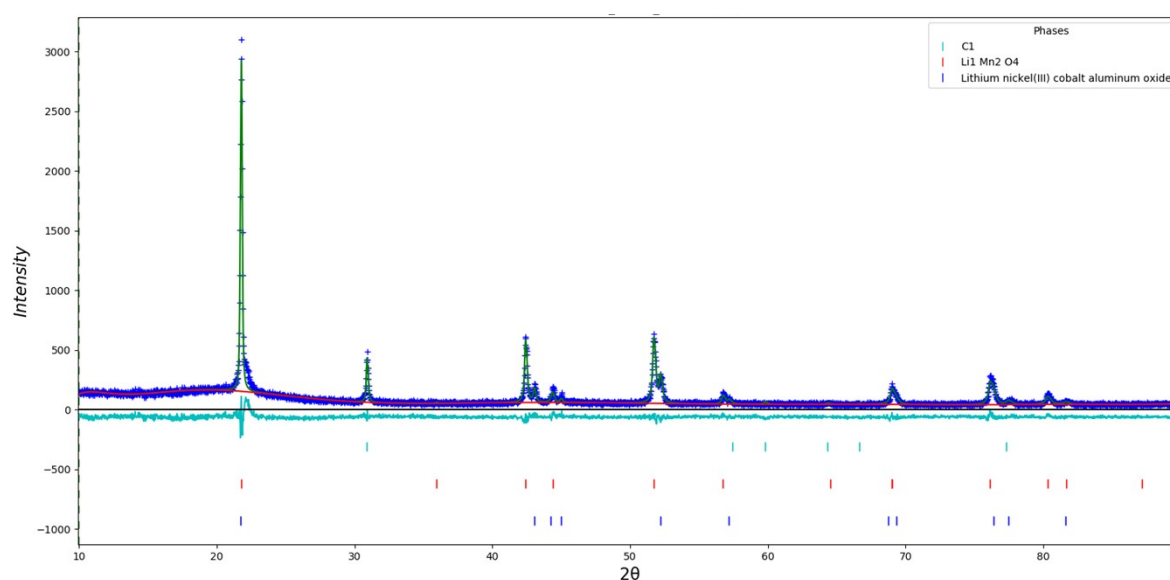


Figure S1: Rietveld refinement plot of end-of-life cathode.

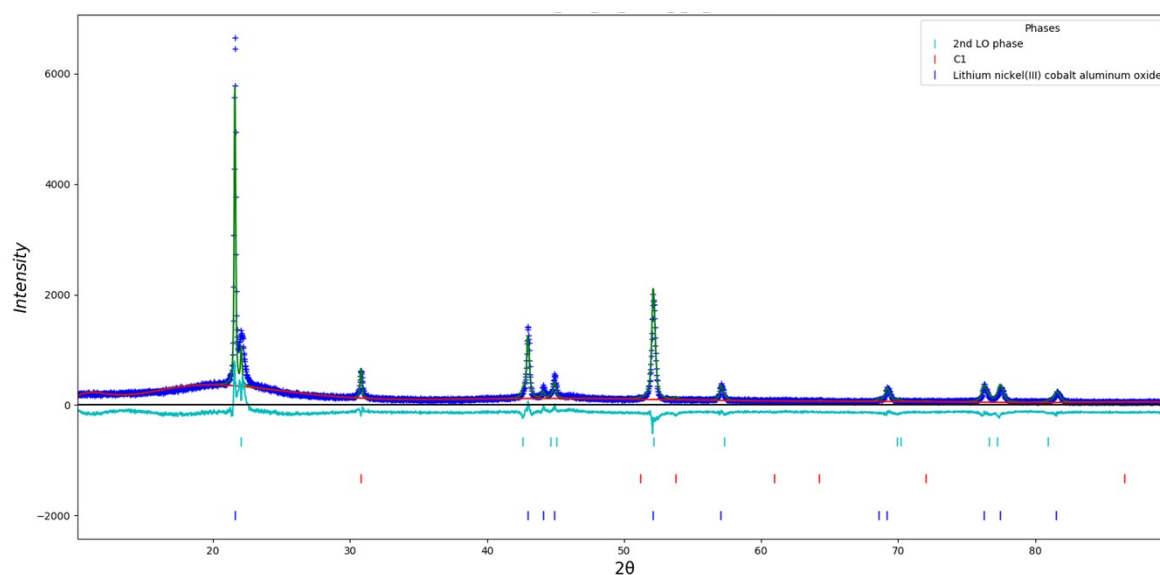


Figure S2: Rietveld refinement plot of end-of-life cathode after 20 mins of leaching.

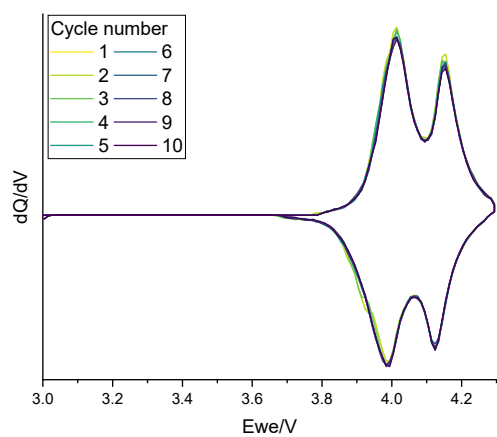


Figure S3: dQ/dV for recovered LMO when cycled at 10 mA g^{-1} between 3-4.3 V

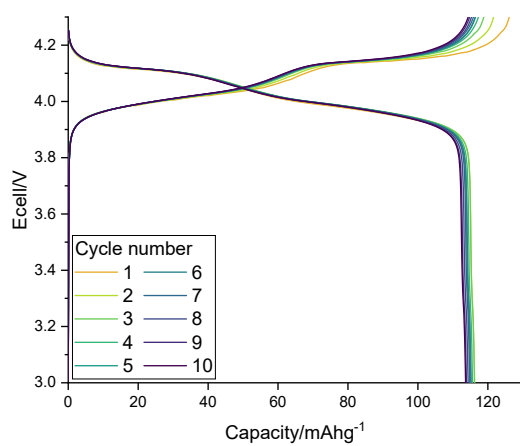


Figure S4: Galvanostatic charge-discharge profiles for LMO made from pristine starting materials. Cells were cycled at 10 mA g^{-1} between 3-4.3 V.

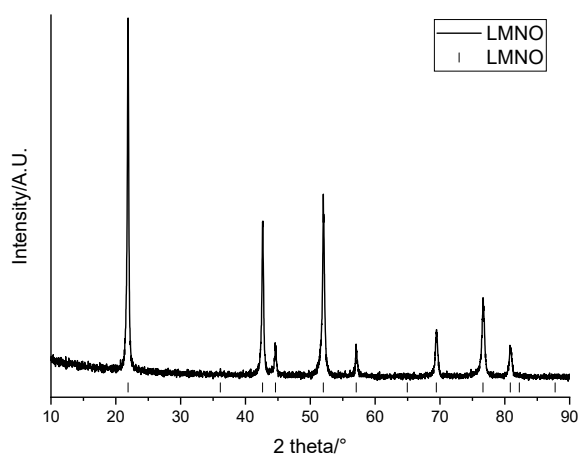


Figure S5: XRD pattern of $\text{LiMn}_{1.5}\text{Ni}_{0.5}\text{O}_4$ made from LMO recovered from a Quality Control Rejected cell (Co $K\alpha$). Tick marks correspond to LMNO (black).

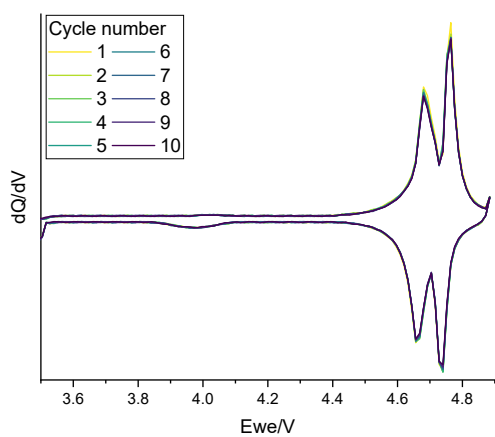


Figure S6: dQ/dV for LMNO when cycled at 10 mA g^{-1} between 3-4.3 V

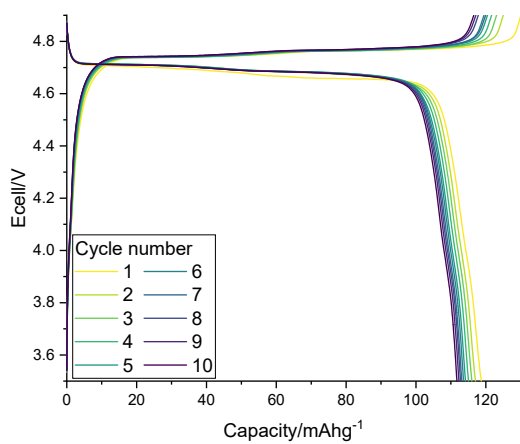


Figure S7: Galvanostatic charge-discharge profile for LMNO made from pristine starting materials. Cells were cycled at 10 mA g^{-1} between 3.5-4.9 V.

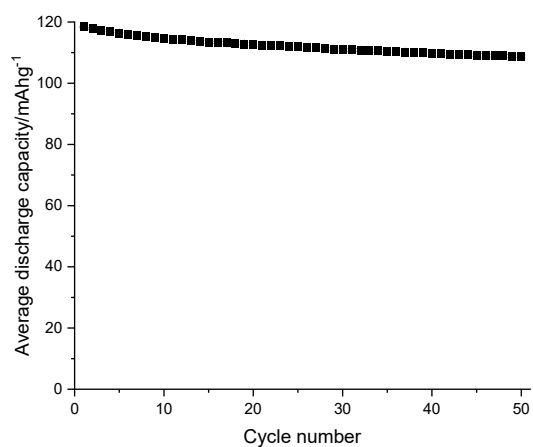


Figure S8: Average gravimetric discharge capacity against cycle number for upcycled LMNO made from recovered LMO. Cells were cycled at 10 mA g^{-1} between 3.5-4.9 V.

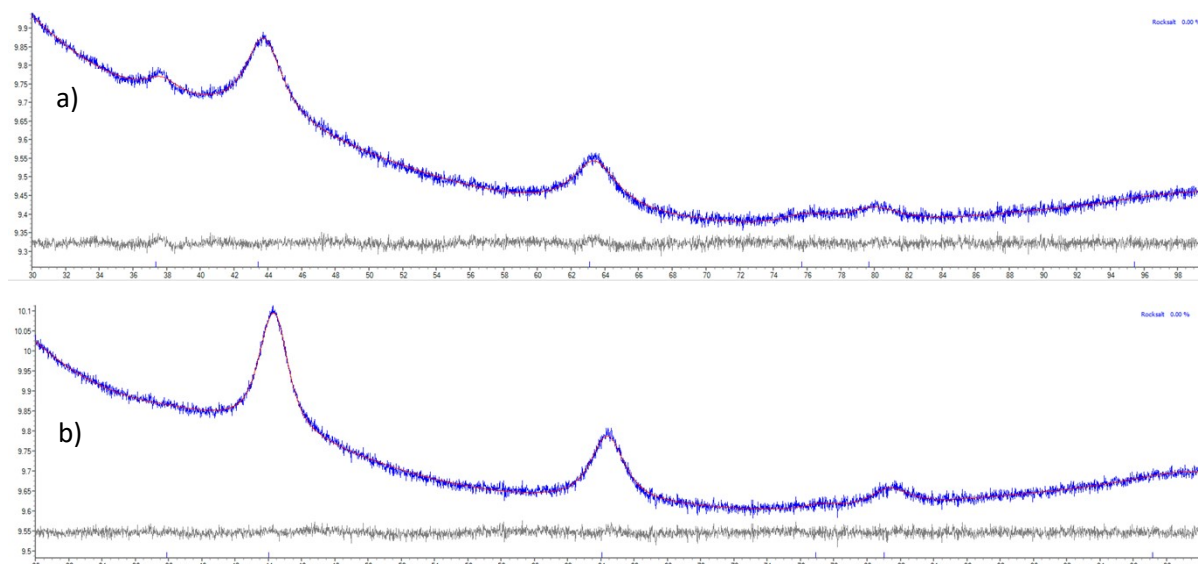


Figure S9: Pawley refinement plots of recovered a) $\text{Li}_4\text{Mn}_2\text{O}_5$ and b) $\text{Li}_2\text{MnO}_{2.25}\text{F}$.

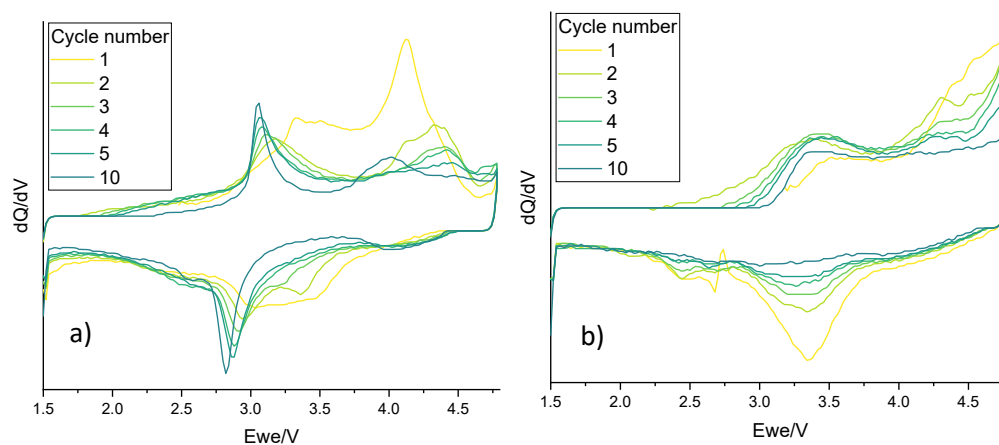


Figure S10: dQ/dV for a) $\text{Li}_4\text{Mn}_2\text{O}_5$ and b) $\text{Li}_2\text{MnO}_{2.25}\text{F}$ when cycled at 10 mA g^{-1} between 3-4.3 V

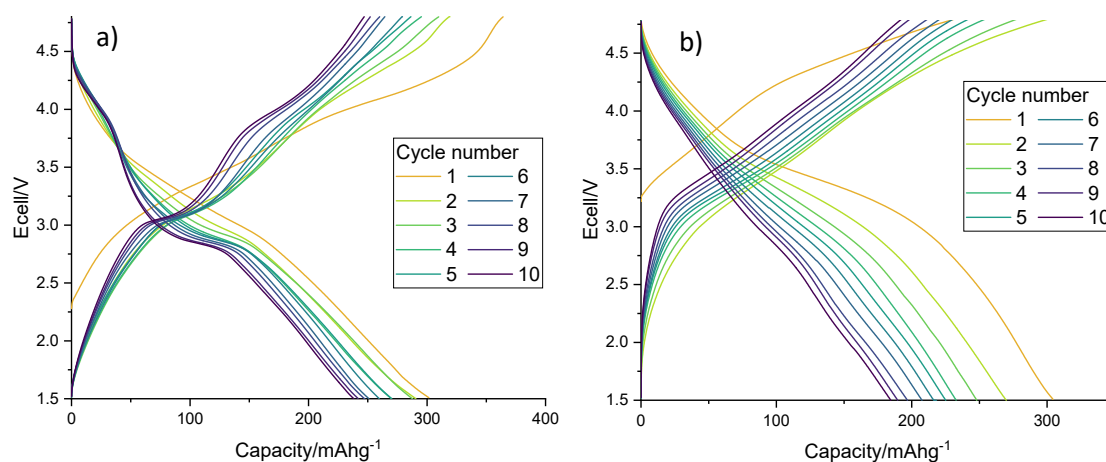


Figure S11: Galvanostatic charge-discharge profiles for a) $\text{Li}_4\text{Mn}_2\text{O}_5$ and b) $\text{Li}_2\text{MnO}_{2.25}\text{F}$ made from pristine starting materials. Cells were cycled at 10 mA g^{-1} between 1.5-4.8 V.

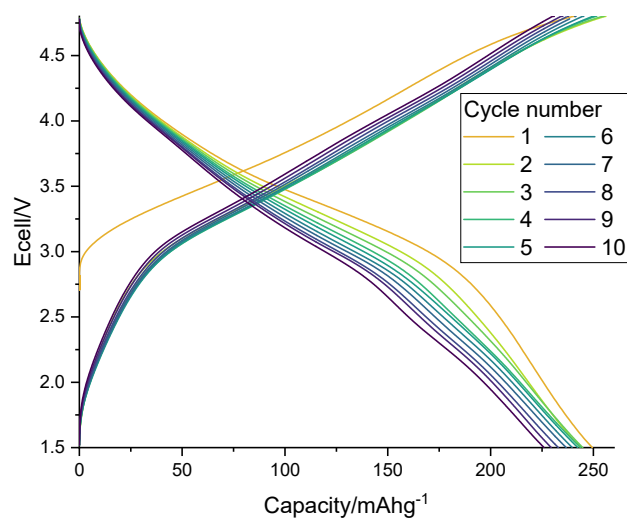


Figure S12: Galvanostatic charge-discharge profile for $\text{Li}_{1.8}\text{Na}_{0.2}\text{MnO}_2\text{F}$ made from pristine starting materials. Cells were cycled at 10 mA g^{-1} between 1.5-4.8 V.

Table S1: Pawley refinement results for the lattice parameters of LiMn_2O_4 and layered oxide phase at different leaching times

Lattice parameters			
Leaching time/mins	LiMn ₂ O ₄ phase	Layered oxide phase	
	<i>a</i> /Å	<i>a</i> /Å	<i>c</i> /Å
0	8.208(4)	2.859(5)	14.263(1)
5	8.177(1)	2.857(6)	14.267(2)
10	8.201(2)	2.856(7)	14.273(4)
15	8.204(2)	2.859(4)	14.286(2)
20	/	2.857(3)	14.272(2)

Table S2: ICP-OES results showing the concentration of each element in solution at different leaching times

Concentration in solution/ppm					
Leaching time/mins	Li	Mn	Ni	Co	Al
5	436.95	4759.12	61.06	97.61	82.02
10	672.50	8804.06	90.41	174.25	128.30
15	852.90	12018.49	156.85	240.55	195.16
20	891.89	12571.27	287.72	273.18	220.88