

## Supplementary Information

Performance evaluation lithium metal rechargeable batteries with lithium excess cation-disordered rocksalt based positive electrode under high mass loading and lean electrolyte condition

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	thickness	porosity	density
	mm	%	mg/cm <sup>2</sup>
Aluminum foil	0.01	0	2.67
Copper foil	0.002	0	1.80
Glass fiber separator	0.26	91	5.12
Polypropylene separator	0.02	45	1.08

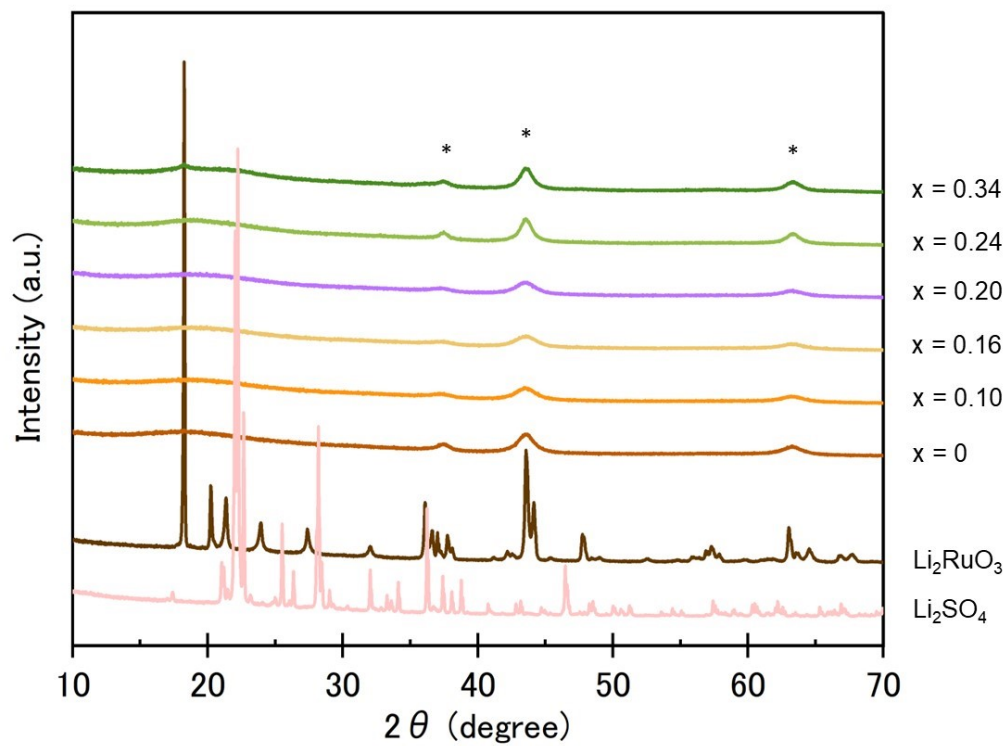
**Table S1.** Parameters of the employed LMBs.

**Table S2.** Energy density simulation of LMB equipped with positive electrode material with capacity of 300 mAh/g and average discharge voltage of 3.1 V.

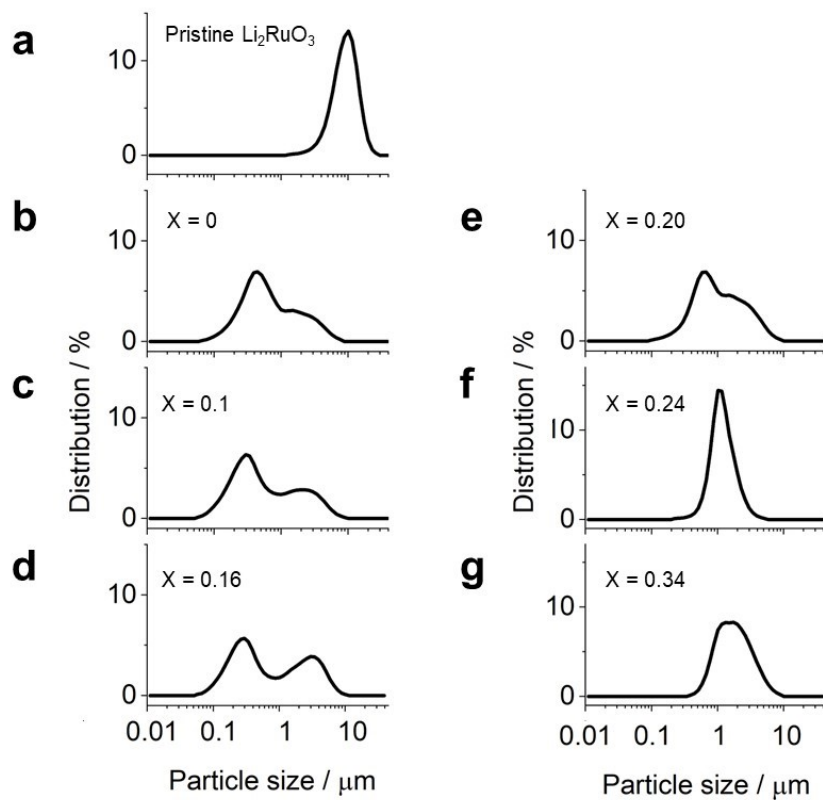
Active material	10	10	30	mg/cm <sup>2</sup>
Active material ratio	0.7	0.7	0.95	
Al foil	2.67	2.67	2.67	mg/cm <sup>2</sup>
Conductive additives and binder	3	3	1.5	mg/cm <sup>2</sup>
Separator	5.12	1.08	1.08	mg/cm <sup>2</sup>
Electrolyte in positive electrode	1.67	1.67	5	mg/cm <sup>2</sup>
Electrolyte in separator	24	0.9	0.9	mg/cm <sup>2</sup>
Lithium	2.67	2.67	2.67	mg/cm <sup>2</sup>
Cu foil	1.8	1.8	1.8	mg/cm <sup>2</sup>
Total mass	50.93	23.79	45.62	mg/cm <sup>2</sup>
Areal capacity	2.1	2.1	8.55	mAh/cm <sup>2</sup>
Average discharge voltage	3.1	3.1	3.1	V
Energy density	127.8	273.6	580.9	Wh/kg
E/C	12.2	1.2	0.7	g/Ah

**Table S2.** Energy density simulation of LMB equipped with positive electrode material with capacity of 200 mAh/g and average discharge voltage of 3.7 V.

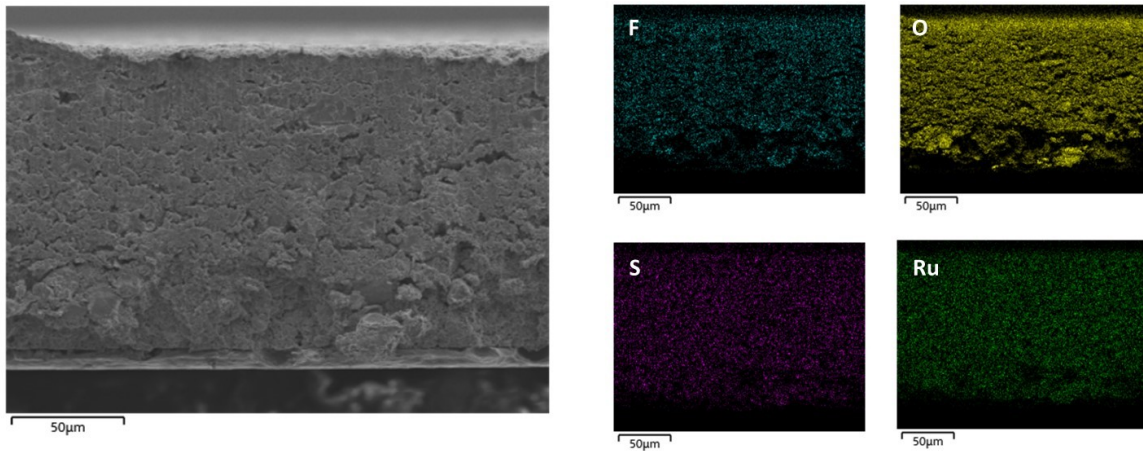
Active material	10	10	30	mg/cm <sup>2</sup>
Active material ratio	0.7	0.7	0.95	
Al foil	2.67	2.67	2.67	mg/cm <sup>2</sup>
Conductive additives and binder	3	3	1.5	mg/cm <sup>2</sup>
Separator	5.12	1.08	1.08	mg/cm <sup>2</sup>
Electrolyte in positive electrode	1.67	1.67	5	mg/cm <sup>2</sup>
Electrolyte in separator	24	0.9	0.9	mg/cm <sup>2</sup>
Lithium	2.67	2.67	2.67	mg/cm <sup>2</sup>
Cu foil	1.8	1.8	1.8	mg/cm <sup>2</sup>
Total mass	50.93	23.79	45.62	mg/cm <sup>2</sup>
Areal capacity	1.4	1.4	5.7	mAh/cm <sup>2</sup>
Average discharge voltage	3.7	3.7	3.7	V
Energy density	101.7	217.7	462.3	Wh/kg
E/C	18.3	1.83	1.03	g/Ah



**Figure S4.** XRD profiles of  $\text{Li}_2\text{RuO}_3/\text{Li}_2\text{SO}_4$  samples.



**Figure S5.** Particle size distribution of (a) pristine  $\text{Li}_2\text{RuO}_3$  and (b-g)  $\text{Li}_2\text{RuO}_3/\text{Li}_2\text{SO}_4$  samples.

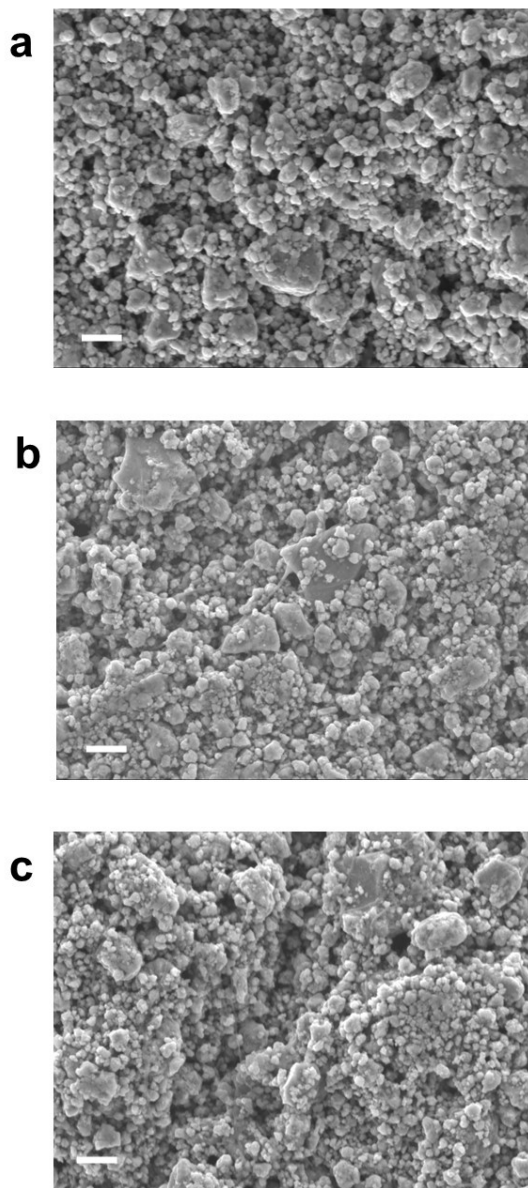


**Figure S6.** Cross sectional SEM images of  $\text{Li}_2\text{RuO}_3/\text{Li}_2\text{SO}_4$  electrodes with  $x = 0.2$ .

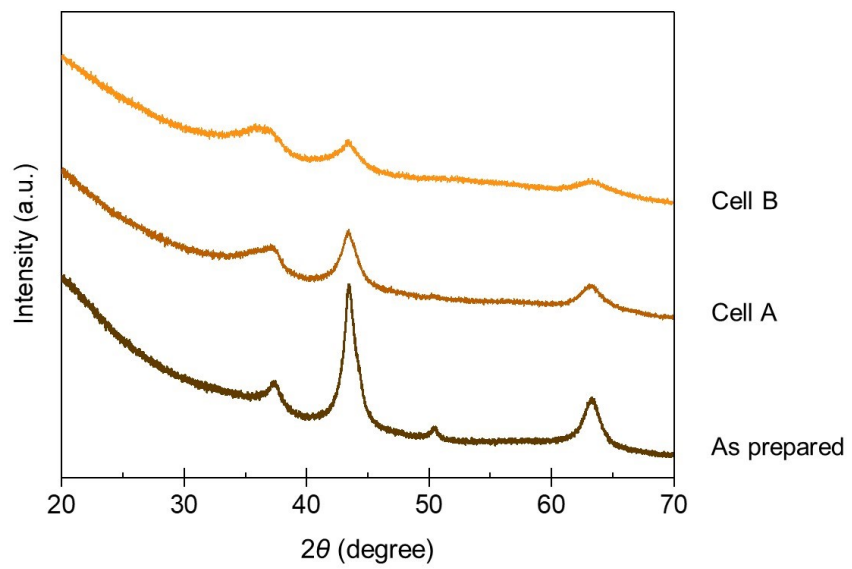
**Table S7.** Technological parameters for cell A and B.

		Cell A	Cell B	
Aluminum foil	Mass loading	2.7	2.7	mg/cm <sup>2</sup>
	Thickness	10	10	μm
Positive Electrode	Mass loading	20	30	mg/cm <sup>2</sup>
Electrolyte	Composition	1M LiFSI in sulfolane	4M LiFSI In DME	
	Mass loading	15	10	mg/cm <sup>2</sup>
PO separator	Mass loading	1.08	1.08	mg/cm <sup>2</sup>
	Thickness	20	20	μm
Ceramic separator	Mass loading	29.3		mg/cm <sup>2</sup>
	Thickness	90		μm
PO separator	Mass loading	1.08		mg/cm <sup>2</sup>
	Thickness	20		μm
Electrolyte	Composition	4M LiFSI In DME		
	Mass loading	2.5		mg/cm <sup>2</sup>
Lithium foil	Mass loading	2.67	2.67	mg/cm <sup>2</sup>
	Thickness	100	20	μm
Copper foil	Mass loading	10.8	1.8	mg/cm <sup>2</sup>
	Thickness	12	2	μm
Total Weight		85.1	48.2	mg/cm <sup>2</sup>
Average Discharge Voltage		3.15	3.12	V
Areal Capacity		5.92	7.77	mAh/cm <sup>2</sup>
E/C		2.95	1.28	g/Ah
Energy density		219.0	502.3	Wh/kg





**Figure S8.** SEM images of  $\text{Li}_2\text{RuO}_3/\text{Li}_2\text{SO}_4$  electrodes with  $x = 0.2$  (a) before and after 40th cycle taken out from (b) cell A and (c) cell B. Scale bar is 1  $\mu\text{m}$ .



**Figure S9.** XRD profiles of  $\text{Li}_2\text{RuO}_3/\text{Li}_2\text{SO}_4$  electrodes before and after 40th cycle