Supplementary Information

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Table S1 Chemical composition of cathode material LMO

Elements	Li	Mn	Al	Na	Ca	K	Fe
Wt. %	3.78	64.75	0.9	0.005	0.0009	0.0007	0.0002

Table S2 Lattice parameters of LMO600-800 sample

Sample	a(Å)	b(Å)	c(Å)	V(Å^3)
LMO600	8.1845	8.1845	8.1845	548.25
LMO700	8.2026	8.2026	8.2026	551.9
LMO800	8.2302	8.2302	8.2302	557.75

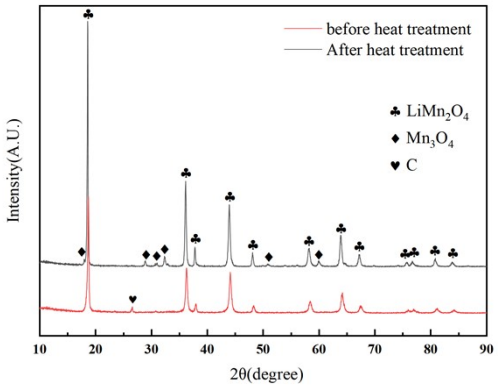

Fig. S1. XRD patterns of before and after heating cathode active materials.

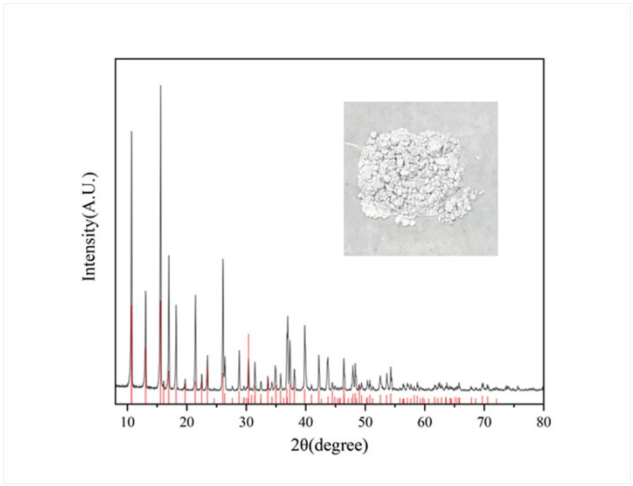

Fig. S2. XRD pattern of the white precipitate during leaching processes.

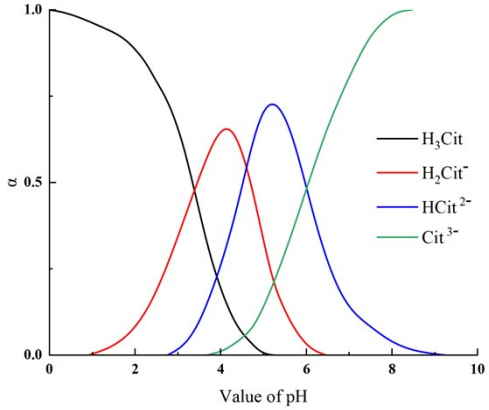

Fig. S3. The ionization of $C_6H_8O_7$ at different pH values.

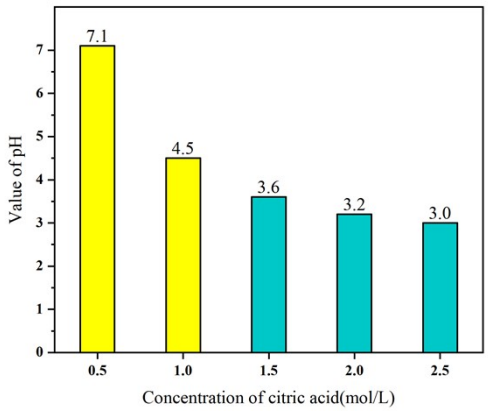

Fig. S4 The pH values of leachate under different citric acid concentration. (leaching time of 60 min，pulp density = 60 g/L，temperature 50 ℃)