Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

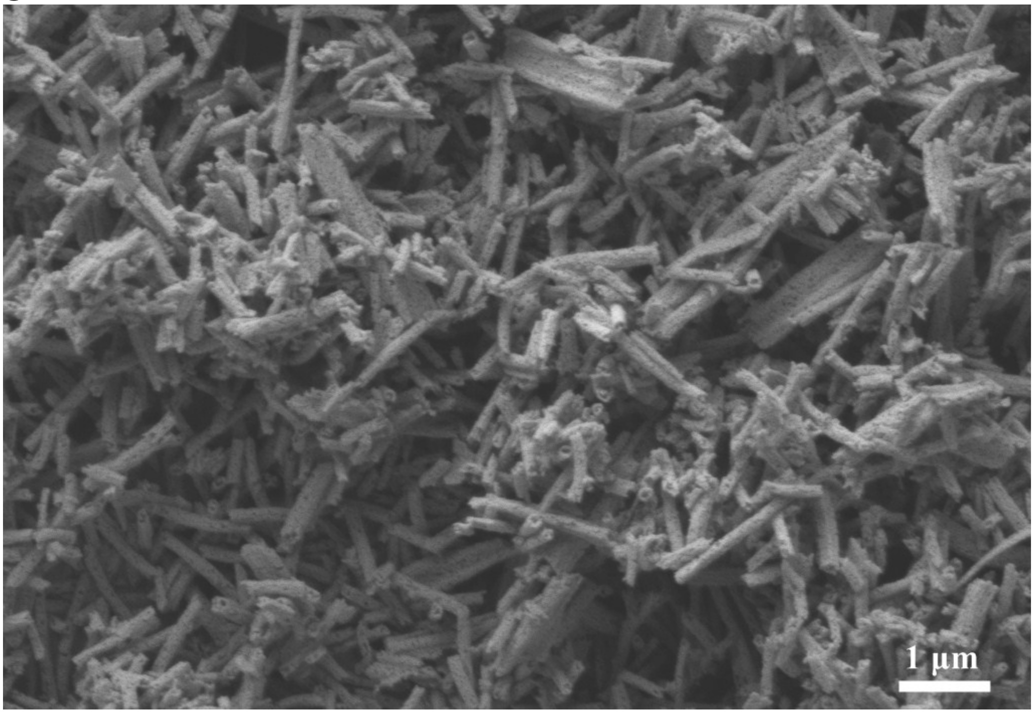

Figure S1. The SEM image of the crushed LMCO-800 sample.

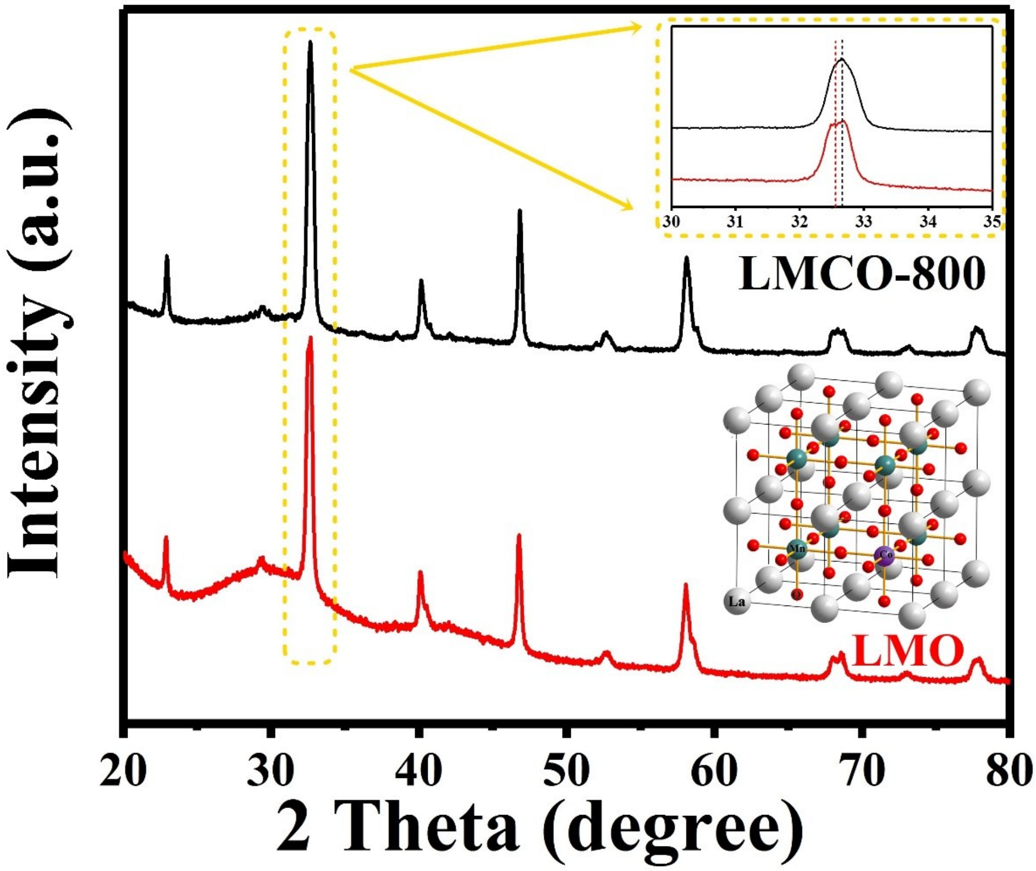

Figure S2. XRD curves of LMCO-800 and LMO at slow scan speed

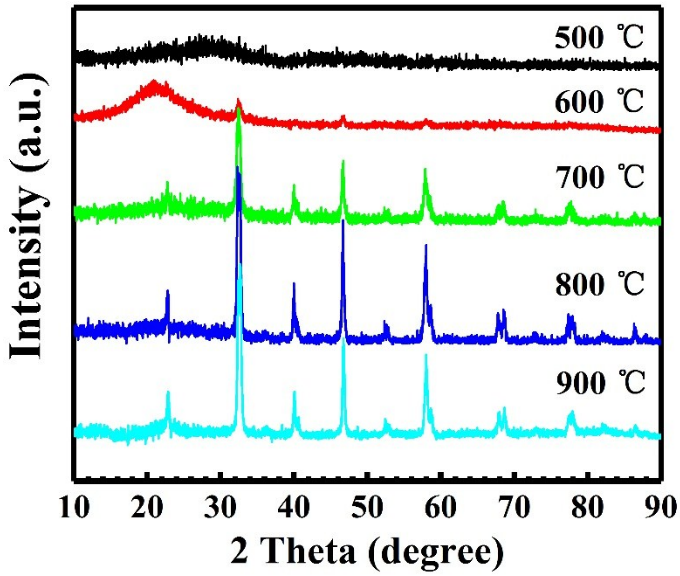

Figure S3. The XRD curves of the LMCO calcined at different temperature.

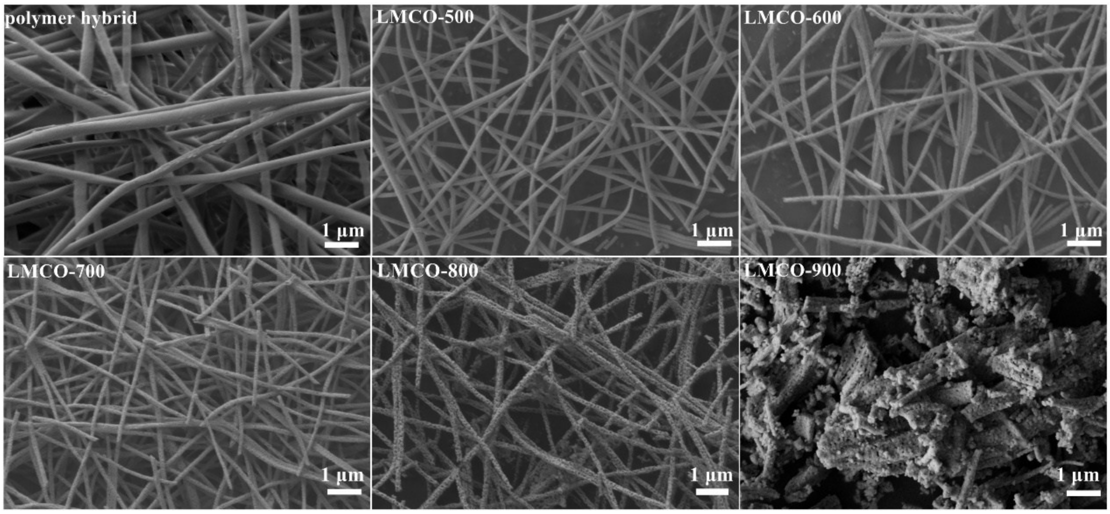

Figure S4. The SEM image of the LMCO calcined at different temperature.

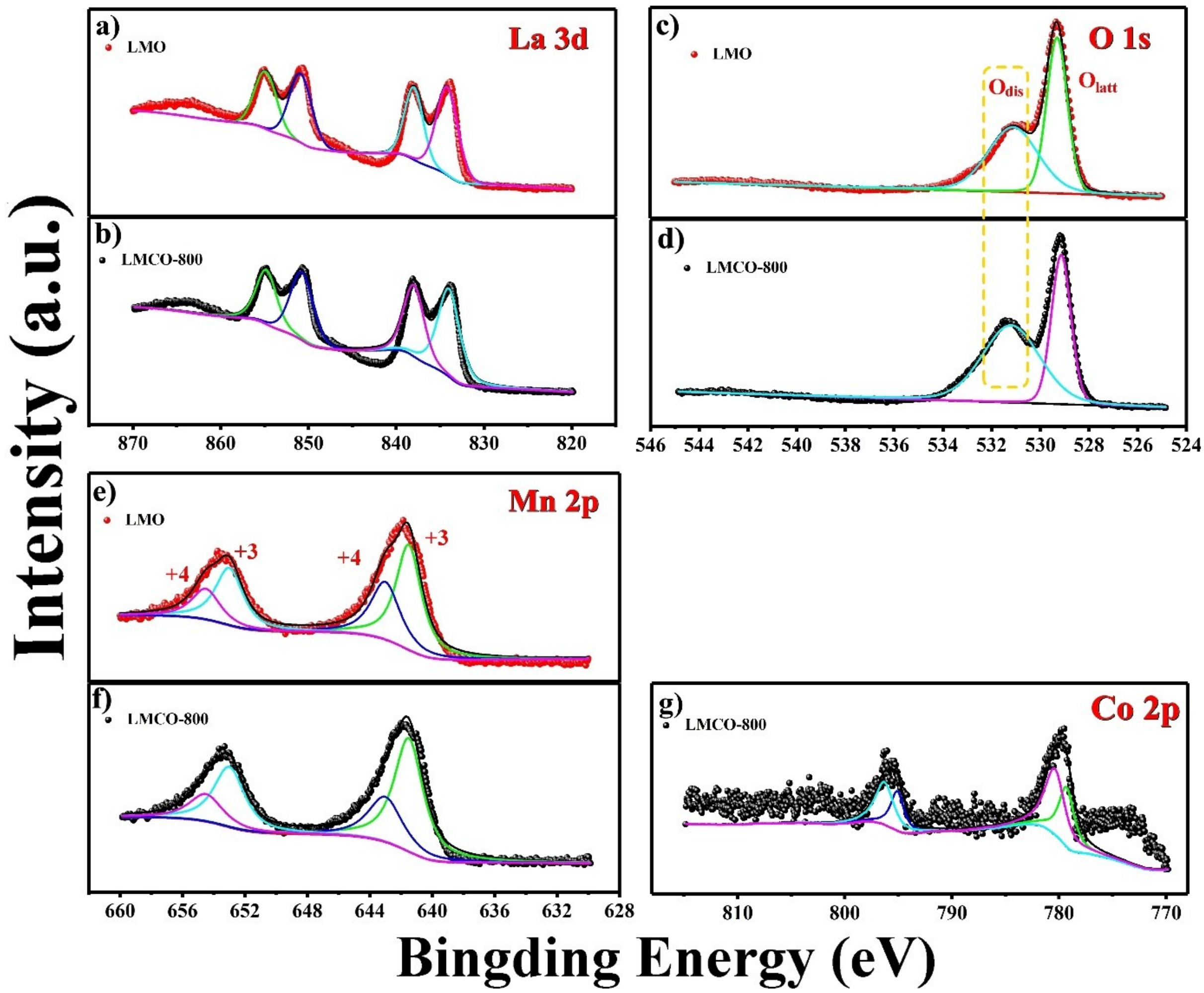

Figure S5. The XPS spectra of survey spectrum for LMCO-800 and LMO (a, d) La 3d, (b, e) Co 2p, (c, f) Mn 2p, and (g) O 1s

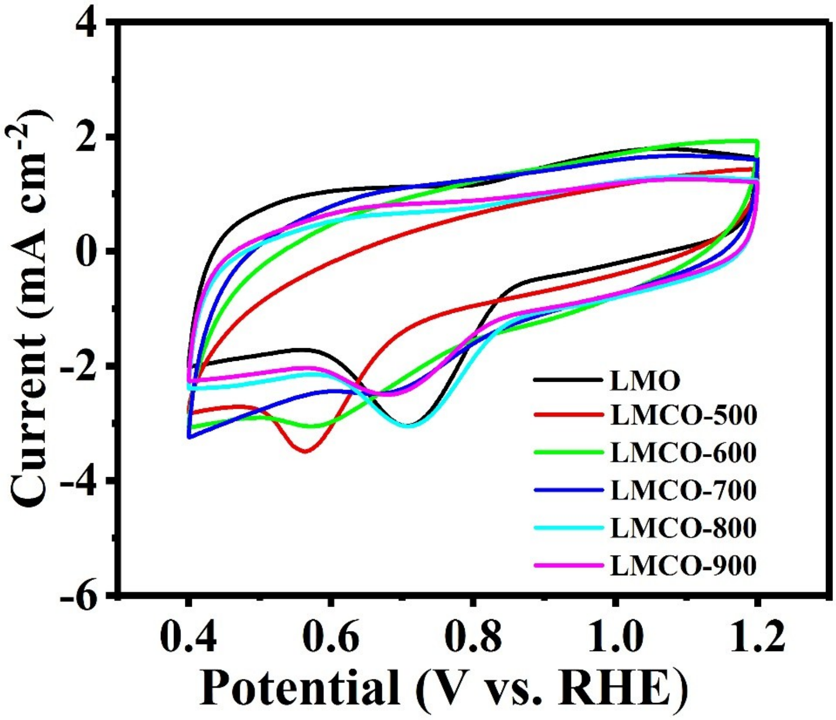

Figure S6. Cyclic voltammograms curves of different samples obtained in O_2-saturated 0.1 mol L-1 KOH solutions

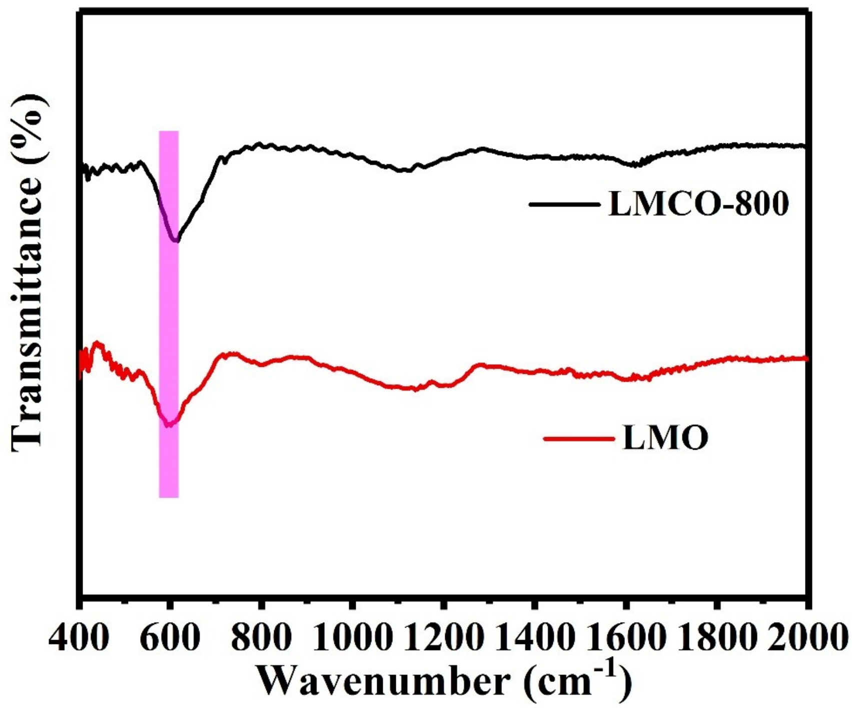

Figure S7. FTIR spectra of LMO and LMCO-800.

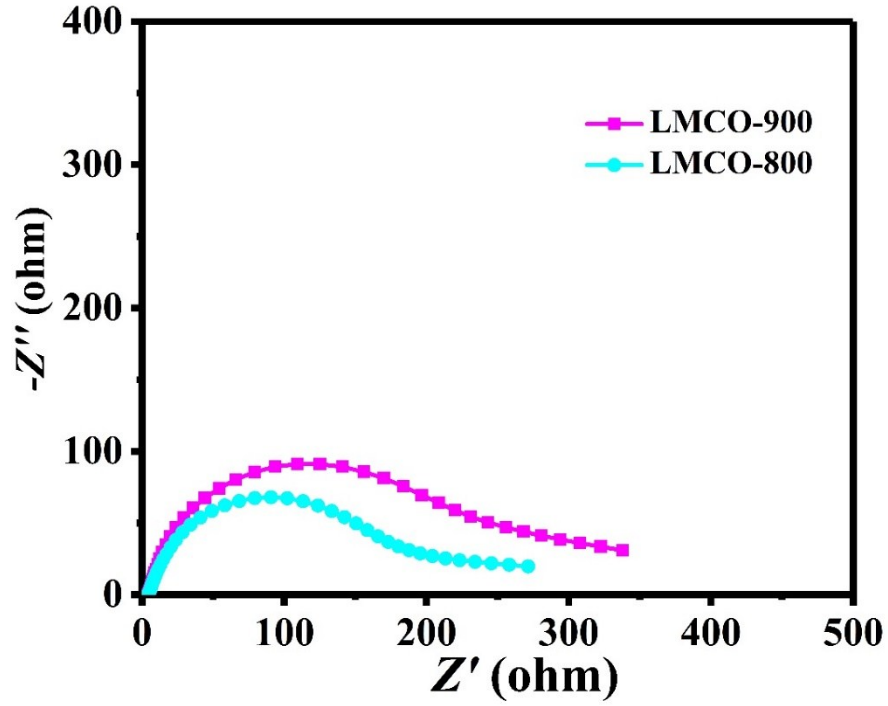

Figure S8. Electrochemical impedance spectra of the LMCO-800 and LMCO-900 recorded at 1.63 V (vs. RHE).

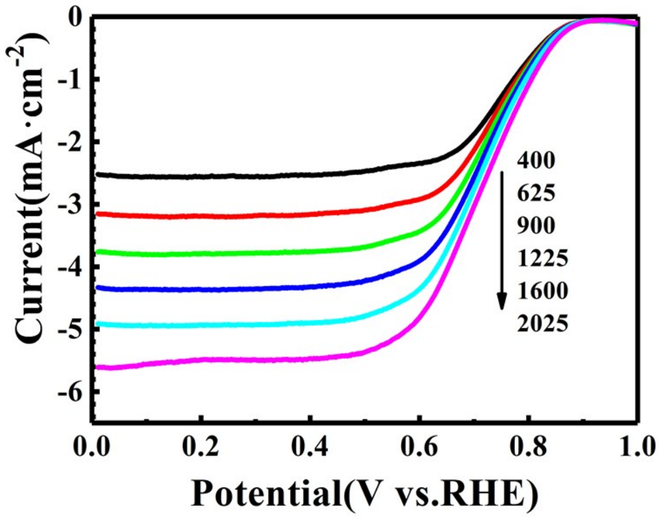

Figure S9. The LSV curves of LMCO-800 nanotubes at different rotating speeds.

As mentioned in the manuscript, the electron transfer number (n) calculated from the above curves by the following Koutecky–Levich (K-L) equation:

$$\frac{1}{J} = \frac{1}{J_K} + \frac{1}{J_L} \qquad (1)$$

$$B = 0.2nFC_0D_0^{2/3}\nu^{-\frac{1}{6}} \qquad (2)$$

J represent the measured disc current density, J_L represent diffusion-limiting current density. Jk is the kinetic current defined by $J_k = B\omega^{1/2}$, where the ω stands for the angular speed of electrode. In the equation 2, n represents the number of transferred electron in the reaction, F is the Faraday constant, C_0 is the saturated concentration and D_0 is the diffusion coefficient of oxygen in 0.1 M KOH solution. Moreover, ν represents the kinematic viscosity of electrolyte. The constants for the case of 0.1 M KOH was given as follows: Co = 1.2 x 10^{-6} mole cm^{-3}, D = 1.9 x 10^{-5} cm^2 s^{-1} and υ = 0.01 cm^2 s^{-1}.

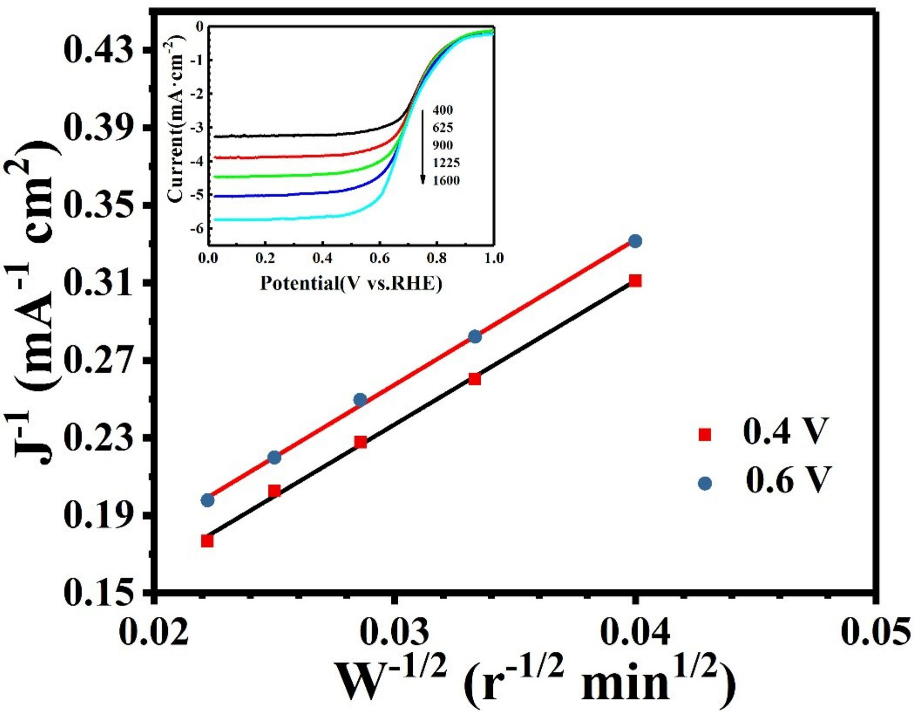

Figure S10. The LSV curves of LMO nanotubes at different rotating speeds and the calculated electron transfer number

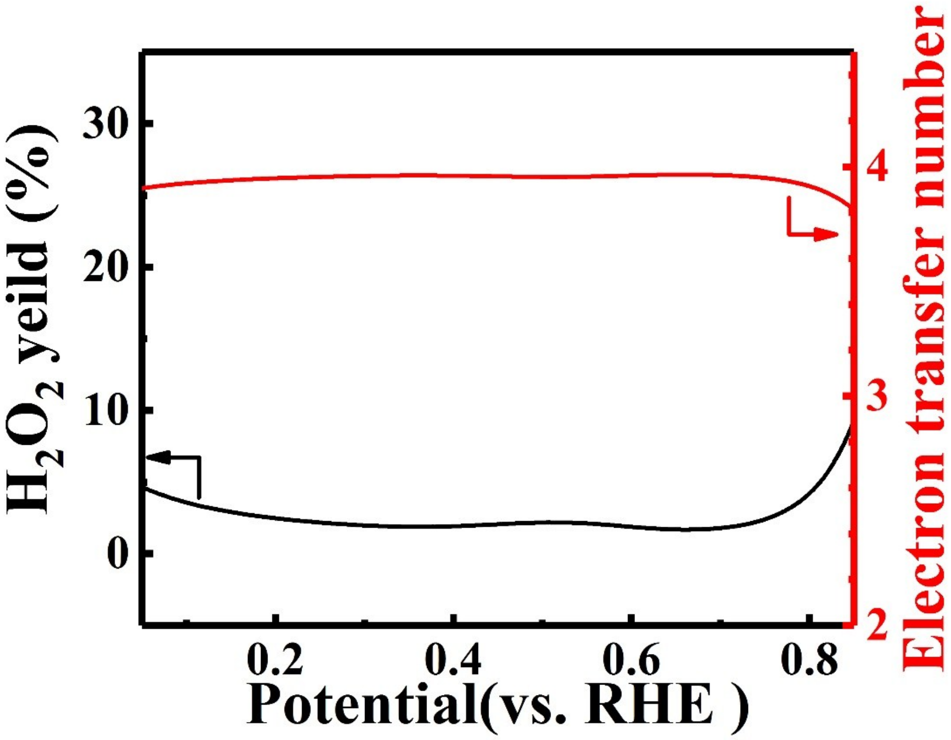

Figure S11. The hydrogen peroxide yield and number of transferred electrons converted from the ring-disc polarization curves.

The number of transferred electron (n) and the percentage of peroxide intermediate (HO_2^-) relative to total results are calculated using following equations:

$$HO_2^-\% = 200 \times \frac{I_R/N}{I_D + (I_R/N)} \quad (3)$$

$$n = \frac{4I_D}{I_D + (I_R/N)} \quad (4)$$

Where I_D and I_R represent the measured current density of disk and ring, respectively. The N represents the current collection efficiency of RRDE and here N = 0.37.

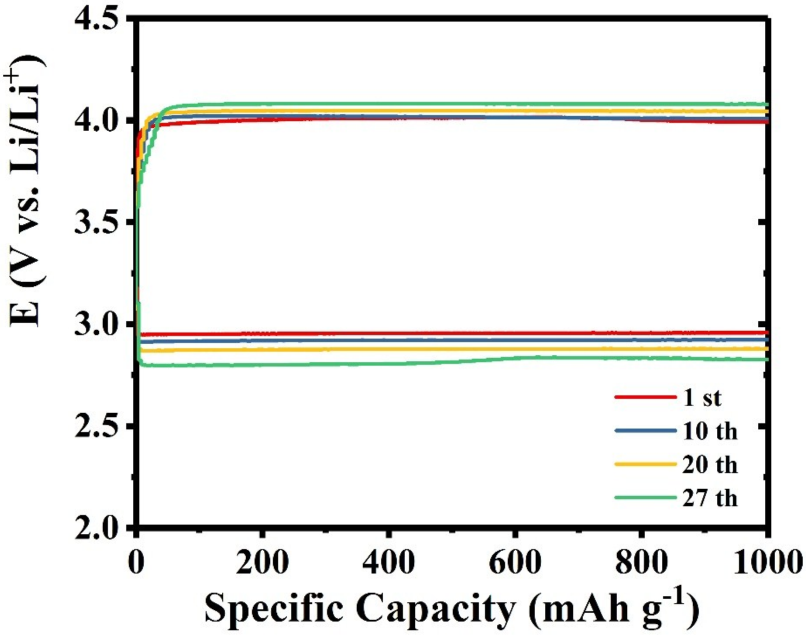

Figure S12. The discharge–charge profiles of the LMO at different cycles.

Table S1. The overpotential to the half-wave potentials in the ORR curves and potentials at 10 mA cm^{-2} in the OER curves

Catalysts in the manuscript	**E for the ORR**	**E for the OER**	ΔE
	Half-wave potential ($E_{1/2}$)	**Potential at 10 mA cm^{-2}**	
LMO	**0.73**	**2.04**	**1.31**
LCMO-500	**0.67**	**2.02**	**1.35**
LCMO-600	**0.73**	**1.86**	**1.13**
LCMO-700	**0.72**	**1.79**	**1.07**
LCMO-800	**0.75**	**1.77**	**1.02**
LCMO-900	**0.74**	**1.85**	**1.11**