# Mg<sup>2+</sup>-W<sup>6+</sup> co-doped Li<sub>2</sub>ZnTi<sub>3</sub>O<sub>8</sub> anode with outstanding room, high and low

### temperature electrochemical performance for lithium-ion batteries

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# Table of Contents

1.	
Experimental	S2
II. Supplementary Figs. 1-8 and Tables 1-5	
III. References	

#### I. Experimental

#### Physical characterization and electrochemical measurements

Thermogravimetric (TG) analyses were conducted on a RD496 thermal analyzer at a heating rate of 10 °C min<sup>-1</sup> from room temperature to 800 °C in air. The phases were investigated via an X-ray diffraction technique conducted on a Bruker D8 Advance X-ray diffractometer with Cu K $\alpha$  radiation ( $\lambda = 1.54$  Å) in the 2 $\theta$  ranges of 5-85 ° with the step of 0.02°. The FullProf program is used for crystal structure refinements, employing the Rietveld method. The morphologies of the products were observed by SU8010 scanning electron microscopes (SEM). The high-resolution transmission electron microscope (HR-TEM) (JEM-2100F) was used to observe the nanoscale microstructures. X-ray photoelectron spectroscopy (XPS) measurements (PHI 5600 CI, mono-chromatic Al-Ka radiation) were used to identify the surface species. The electronic conductivity of pristine and doped anodes was obtained from a powder resistivity tester (ST2722-SD).

The electrochemical measurements were performed in CR2025 coin-type cells. The working electrode was composed of 85 wt.% active material, 10 wt.% conductive agent of acetylene black, and 5 wt.% binder of polyvinylidene difluoride (PVDF). The assembly of the cells was carried out in a glove box filled with high purity argon. The loading of active materials is 3-3.5 mg cm<sup>-2</sup>. Charge-discharge and cyclic voltammetry (CV) measurements were in the range of 0.02-3.0 V. Electrochemical impedance spectroscopies (EIS) were recorded with an *ac* voltage of 5 mV from 10

mHz to 100 kHz. The coin-type cells after cycling were transferred to a glove box and then dissembled. The electrodes were rinsed using dimethyl carbonate (DMC) to remove the electrolyte from the electrode surface. Then, electrodes were dried in the glove box antechamber to remove the residual DMC. The morphologies of the electrodes after cycling were observed by S4800 scanning electron microscopes.

### **I**. Supplementary Figs. 1-8 and Tables 1-5



Fig. S1 TG-DTG curves of the precursors of (a) LZTO, (b) LZTW3O, (c) LM6ZTO and (d) LM6ZTW3O.

The thermogravimetric (TG) and differential thermogravimetric (DTG) curves of precursors for LZTO, LZTW3O, LM6ZTO and LM6ZTW3O are shown in Fig. S1 at a heating rate of 10 °C min<sup>-1</sup> in air. Before 550 °C, the weight loss from 300 to 550 °C is related to the decomposition of Li<sub>2</sub>CO<sub>3</sub>, Li<sub>2</sub>CO<sub>3</sub> and H<sub>2</sub>WO<sub>4</sub>, Li<sub>2</sub>CO<sub>3</sub> and

Mg(Ac)<sub>2</sub>·4H<sub>2</sub>O, and Li<sub>2</sub>CO<sub>3</sub>, H<sub>2</sub>WO<sub>4</sub> and Mg(Ac)<sub>2</sub>·4H<sub>2</sub>O for precursors of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O, respectively. It can be seen that there is a platform on the TG curve above 550 °C, indicating the formation of LZTO after this temperature. Based on the above analyses, we design an optimal one-step sintering process at 700 °C for 3 h.



Fig. S2 Cyclic performance of (a) LZTO, LZTW1O, LZTW3O as well as LZTW5O, and (b) LZTO, LM3ZTO, LM6ZTO as well as LM9ZTO at different current densities.



Fig. S3 (a) XPS spectra of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O; (b) Highresolution W 4f XPS spectrum of LZTW3O and LM6ZTW3O; (c) High-resolution Mg 1s XPS spectra of LM6ZTO and LM6ZTW3O; (d) High-resolution Ti 2p XPS spectra of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O.

The XPS spectra of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O are shown in Fig. S3a. It can be seen that Zn, Ti and O exist in the four samples. In addition, there is W element in LZTW3O and LM6ZTW3O, corresponding to the two peaks of 35.43 and 37.55 eV (Fig. S3b), attributed to the two spin orbits of W<sup>6+</sup> 4f<sub>7/2</sub> and W<sup>6+</sup> 4f<sub>5/2</sub>, respectively [1]. The high-resolution XPS spectra of Ti 2p display two peaks located at 463.93 eV (Ti  $2p_{1/2}$ ) and 458.25 eV (Ti  $2p_{3/2}$ ) (Fig. S3d), which are the binding energies of Ti<sup>4+</sup> in LZTO [2]. The binding energies of both Ti  $2p_{1/2}$  and Ti  $2p_{3/2}$  in LZTW3O and LM6ZTO are higher than those in LZTO, suggesting the enhancement

in the electron cloud density of Ti due to the effect of ion modification. The extra charge of W or Mg should be compensated by lattice defects, such as Li vacancy [3, 4]. Therefore, an increase in ionic conductivity would be expected compared with LZTO. Compared with the pure LZTO, the peaks of both Ti  $2p_{1/2}$  and Ti  $2p_{3/2}$  in LM6ZTW3O have no obvious shift. Therefore, the additional charge of Mg<sup>2+</sup> and W<sup>6+</sup> may be compensated by the creation of lattice defects for Li vacancy in LM6ZTW3O, benefiting to the diffusion of Li<sup>+</sup> ions.

Table ST Kale capability (				
Material	Current	Specific	Cycle	Reference
	density (A g-	capacity	numbers	
	1)	$(mAh g^{-1})$		
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> @C	2.29	190	35	[5]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	2.29	189	35	[5]
LZTO	2.29	138.2	50	[6]
C-LZTO	2.29	180.9	50	[6]
NC-LZTO	2.29	190.6	50	[6]
LZTO-0	2	75	50	[7]
LZTO-1	2	140	50	[7]
LZTO-2	2	170	50	[7]
LZTO-3	2	168	50	[7]
LZTO	2	78	25	[8]
Li2ZnTi3O8@Li2MoO4	2	112	60	[9]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	2	55	60	[9]
Li2ZnTi3O8/La2O3	3	149.3	40	[10]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	3	116.9	40	[10]
$Li_2ZnAg_{0.15}Ti_{2.85}O_8$	1.6	125	50	[11]
$Li_2ZnTi_3O_8(COS)$	2	161	25	[12]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> (PVDF)	2	135.5	25	[12]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	1.5	175	40	[13]

Table S1 Rate capability of LZTO in recent publications.

Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	1.5	135	40	[13]
$Li_2ZnTi_3O_8$	1.5	100	40	[13]
LZTO-700-3	2.8	141.9	60	[14]
LZTO@C-700-1	2.8	174.5	60	[14]
LZTO@C-700-3	2.8	180.5	60	[14]
LZTO@C-700-5	2.8	173.8	60	[14]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	1.6	150	50	[15]
Li <sub>2</sub> Mg <sub>0.5</sub> Zn <sub>0.5</sub> Ti <sub>3</sub> O <sub>8</sub>	0.8	175	40	[16]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /C	2	145.6	50	[17]
R-100-LZTO	1.6	161.8	50	[18]
R-10-LZTO	1.6	147.1	50	[18]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /TiO <sub>2</sub>	2	173.4	50	[19]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /TiO <sub>2</sub>	3	161.6	60	[19]
$Li_2ZnTi_{2.9}Al_{0.1}O_8$	1.6	131.8	50	[20]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	1.6	118	50	[21]
$Li_2Zn_{0.6}Cu_{0.4}Ti_3O_8$	1	124.8	50	[22]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	0.458	172.7	30	[23]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /C-10	1.8	121.8	50	[24]
LZTO	1.145	47	106	[25]
LZTO@RGO10	1.145	50	106	[25]
LZTO@RGO25	1.145	154	106	[25]
LZTO@RGO50	1.145	113	106	[25]
Table S1 (Contd.)				
Material	Current	Specific	Cycle	Reference
	density (A g-	capacity	numbers	
	1)	$(mAh g^{-1})$		
LM6ZTW3O	1.5	202.4	60	The work
LM6ZTW3O	2	199	80	The work
LM6ZTW3O	2.5	191.7	100	The work
LM6ZTW3O	3	177.9	120	The work



Fig. S4 (a) Impedance spectra of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O

electrodes after cycling at different current densities in Fig. 6 and corresponding equivalent circuit (inset); (b) Relationship between  $Z_{re}$  and  $\omega^{-1/2}$  for Fig. S4a.

The electrochemical impedance data were collected on as assembled cells after cycling at different current densities in Fig. 6 and are presented in Fig. S4a. The curves are similar for the four electrodes, composed of a small intercept, two semicircles and a straight line for every electrode. The equivalent circuit model is shown in Fig. S4a (inset).  $R_{\rm b}$  is the combined impedance of the electrolyte and cell components;  $C_{\rm sei}$  and  $R_{\rm sei}$  represent the capacitance and the resistance of the SEI (solid electrolyte interface) layer for the first semicircle;  $C_{\rm dl}$  and  $R_{\rm ct}$ , are the double layer capacitance and charge transfer resistance corresponding to the second semicircle, respectively; W represents Warburg impedance. The charge transfer resistance is 27.13, 18.11, 22.48 and 10.47 for LZTO, LZTW3O, LM6ZTO and LM6ZTW3O (Table S2), respectively. It can be seen that the charge transfer resistance decreases after doping. Small charge transfer resistance is advantageous to the electrochemical performance.

To further investigate the electrode kinetics, the diffusion coefficients of Li<sup>+</sup> ions in the four samples are estimated based on the Warburg diffusion in low frequency using the following equation [26]

$$D_{\mu^+} = R^2 T^2 / (2A^2 n^4 F^4 C^2 \sigma^2)$$
<sup>(1)</sup>

where R is the gas constant (8.314 J mol<sup>-1</sup> K<sup>-1</sup>); T is the room absolute temperature (298.5 K); A is the surface area of the electrode (1.13 cm<sup>2</sup> in this work); n is the number of electrons transferred in the half reaction for the redox couple; F is Faraday

constant (96,485 C mol<sup>-1</sup>); C ( $8.5 \times 10^{-3}$  mol cm<sup>-3</sup>) is the concentration of Li<sup>+</sup> ion in the compound, and  $\sigma$  is the Warburg factor which obeys the following relationship:

$$Z_{re} = \mathbf{R}_{e} + R_{ct} + \sigma \omega^{-1/2}$$
<sup>(2)</sup>

Fig. S4b shows the relationship between  $Z_{re}$  and  $\omega^{-1/2}$ . Based on the Eq. 1-2, the lithium diffusion coefficients ( $D_{Li}^+$ ) of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O can be calculated and the specific values are  $5.39 \times 10^{-11}$ ,  $2.94 \times 10^{-10}$ ,  $1.37 \times 10^{-10}$  and  $3.73 \times 10^{-10}$  cm<sup>2</sup> s<sup>-1</sup>, respectively. Compared with LZTO electrode, Mg<sup>2+</sup>/W<sup>6+</sup> and Mg<sup>2+</sup>-W<sup>6+</sup> doped LZTO materials have high  $D_{Li}^+$ , which indicates the fast diffusion of Li<sup>+</sup> ions and thus guarantees good rate capability.

Table S2 Impedance parameters calculated from equivalent circuit model, lithium diffusion coefficients ( $D_{Li^+}$ ) and electronic conductivity of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O.

Samples	$R_{\rm b}(\Omega)$	$R_{\rm sei}(\Omega)$	$R_{\rm ct}(\Omega)$	$D_{\mathrm{Li^+}}(\mathrm{cm^2\ s^-}$	$\sigma$ (S cm <sup>-1</sup> )
				<sup>1</sup> )	
LZTO	6.55	12.52	27.13	5.39×10 <sup>-11</sup>	3.63×10 <sup>-6</sup>
LZTW3O	4.964	8.237	18.11	2.94×10 <sup>-10</sup>	2.83×10 <sup>-6</sup>
LM6ZTO	3.857	8.052	22.48	1.37×10 <sup>-10</sup>	3.89×10 <sup>-6</sup>
LM6ZTW3O	7.524	5.433	10.47	3.73×10 <sup>-10</sup>	3.76×10 <sup>-6</sup>



Fig. S5 Cyclic voltammograms of (a) LZTO, (b) LZTW3O, (c) LM6ZTO, and (d) LM6ZTW3O electrodes from the 1st to the 5th cycle and (e) comparison of cyclic voltammograms for the four electrodes for the 1st cycle at a rate of 0.5 mV s<sup>-1</sup> in the range of 0.02-3.0 V (vs. Li/Li<sup>+</sup>).

The CV curves of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O were recorded at 0.5 mV s<sup>-1</sup> in the potential range of 0.02-3.0 V and are shown in Fig. S5. There is an anodic peak and two cathodic peaks on the curves for each sample, corresponding to the Ti<sup>4+</sup>/Ti<sup>3+</sup> redox couple. In addition, the reduction process differs between the initial cathodic sweep and subsequent cycles for each electrode, which can be attributed to the activation and/or polarization of the electrodes [15, 27]. The difference between anodic and cathodic peak potentials ( $\varphi_p$ ) is 0.551, 0.489, 0.517 and 0.483 V for LZTO, LZTW3O, LM6ZTO and LM6ZTW3O at the 1st cycle, respectively (Table S3). Among the four electrodes, the LM6ZTW3O shows the smallest potential difference, indicating that the sample has the smallest polarization and Li<sup>+</sup> intercalation/de-intercalation is highly reversible.

Table S3 Values of the CV peaks for LZTO, LZTW3O, LM6ZTO and LM6ZTW3O electrodes at the 1st cycle.

Samples	$\varphi_{\mathrm{pa}}\left(\mathrm{V} ight)$	$\varphi_{\rm pc}\left({ m V} ight)$	$\varphi_{\rm p}({\rm V}) = \varphi_{\rm pa} - \varphi_{\rm pc}$
LZTO	1.605	1.054	0.551
LZTW3O	1.619	1.13	0.489
LM6ZTO	1.605	1.088	0.517
LM6ZTW3O	1.612	1.129	0.483



Fig. S6 IR-drop data of LZTO, LZTW3O and LM6ZTW3O electrodes at 1 A g<sup>-1</sup>

when charging is switched to discharging for the (a) 150th cycle and (b) 250th cycle.

The magnitude of internal resistance can be characterized by the voltage drop, or IR drop, when charging or discharging is switched to discharging or charging (Fig. S6). The IR drop of LM6ZTW3O is largely smaller than that of LZTO and LZTW3O.

Material	Current	Cycle	Capacity	Reference
	density (A g <sup>-1</sup> )	numbers	retention	
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> @C	0.229	100	99.2%	[5]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> @C	0.458	100	86.8%	[5]
C-LZTO	0.458	200	91.3%	[6]
NC-LZTO	0.458	200	99%	[6]
C-LZTO	1.145	200	80.6%	[6]
NC-LZTO	1.145	200	93.3%	[6]
LZTO-0	1	100	93.8%	[7]
LZTO-1	1	100	95.9%	[7]
LZTO-2	1	100	99.5%	[7]
LZTO-3	1	100	95.8%	[7]
LZTO-0	1	100	91.7%	[28]
LZTO-1	1	100	93.3%	[28]
LZTO-2	1	100	95.5%	[28]
LZTO-3	1	100	93.2%	[28]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	0.1	50	59.6%	[29]
$Li_2Zn_{0.5}Cu_{0.5}Ti_3O_8$	0.1	50	67.5%	[29]
LZTO	1	250	64%	[8]
$Li_2Zn_{0.9}Cu_{0.1}Ti_3O_8$	0.1	80	93%	[30]
$Li_2Zn_{0.85}Cu_{0.15}Ti_3O_8$	0.1	80	98.5%	[30]
Li2ZnTi3O8@Li2MoO4	0.5/2	300	59.5%	[9]
Li2ZnTi3O8@Li2MoO4	0.5/3	300	68.4%	[9]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /La <sub>2</sub> O <sub>3</sub>	2	300	72.2%	[10]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	2	300	34.4%	[10]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /C@Cu	1	400	71.6%	[31]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /C	1	400	56.8%	[31]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /C@Cu	2	300	63%	[31]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /C	2	300	50.5%	[31]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	1	100	83.1%	[11]
$Li_2ZnTi_3O_8$	2	100	99.2%	[11]
$Li_2ZnAg_{0.15}Ti_{2.85}O_8$	1	100	91.4%	[11]
$Li_2ZnAg_{0.15}Ti_{2.85}O_8$	2	100	82%	[11]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> /LiCoO <sub>2</sub>	2	300	51.4%	[32]
$Li_2ZnTi_3O_8$	2	300	33.3%	[32]
$Li_2ZnTi_3O_8(COS)$	1	400	76.9%	[12]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> (PVDF)	1	400	28.1%	[12]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> (COS)	2	100	67.6%	[12]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub> (PVDF	2	100	50.4%	[12]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	1	400	90%	[13]
Li <sub>2</sub> ZnTi <sub>3</sub> O <sub>8</sub>	2	300	80%	[13]

Table S4 Cyclic performance of LZTO corresponding to the 2nd cycle in recent publications.

Table S4 (Contd.)

Material	Current	Cycle	Capacity	Reference
	density (A g <sup>-1</sup> )	numbers	retention	
LZTO	1	100	91%	[27]
LZTO/C-1	1	100	92.4%	[27]
LZTO/C-2	1	100	94.8%	[27]
LZTO/C-3	1	100	79.8%	[27]
Pristine Cu-LZTO	1	200	86.9%	[33]
Bare Cu-LZTO	1	200	87%	[33]
Cu-G-LZTO	1	200	89.6%	[33]
Cu-G-Au-LZTO	1	200	98.7%	[33]
Pristine Cu-LZTO	2	200	75%	[33]
Bare Cu-LZTO	2	200	85.1%	[33]
Cu-G-LZTO	2	200	93.1%	[33]
Cu-G-Au-LZTO	2	200	93.4%	[33]
LZTO-700-3	1	200	66.9%	[14]
LZTO@C-700-1	1	200	60.8%	[14]
LZTO@C-700-3	1	200	71.7%	[14]
LZTO@C-700-5	1	200	69.7%	[14]
LZTO-700-3	2	200	72.3%	[14]
LZTO@C-700-1	2	200	67.2%	[14]
LZTO@C-700-3	2	200	73.1%	[14]
LZTO@C-700-5	2	200	65.7%	[14]
LZTO@C-N-1	1	200	71.3%	[34]
LZTO@C-N-2	1	200	77.7%	[34]
LZTO@C-N-3	1	200	83.0%	[34]
LZTO@C-N-3	2	200	75.5%	[34]
LZTO	1	200	68.5%	[35]
LZTO@C-N-1	1	200	61.8%	[35]
LZTO@C-N-2	1	200	68.1%	[35]
LZTO@C-N-3	1	200	63.8%	[35]
LZTO@C-N-2	2	200	73.7%	[35]
LZTO	1	400	75.8%	[36]
LZTO/G	1	400	76.4%	[36]
LZTO	2	300	63.1%	[36]
LZTO/G	2	300	72.3%	[36]
LZTO@GNS	1	400	81.6%	[37]
LZTO@GNS-CNT	1	400	93.3%	[37]
LZTO	1	400	86.7%	[38]
LZTMO@G	1	400	87.5%	[38]
LZTO	2	300	57.2%	[38]
LZTMO@G	2	300	89.7%	[38]

Material	Current	Cycle	Capacity	Reference
	density (A g <sup>-1</sup> )	numbers	retention	
LZTO@C	1	200	70.5%	[39]
LZTO@C	2	200	65.7%	[39]
LZTO@C@La2O3	1	200	89.8%	[39]
LZTO@C@La2O3	2	200	77.2%	[39]
LM6ZTW3O	1	100	118.1%	The work
LM6ZTW3O	1	200	116.5%	The work
LM6ZTW3O	1	300	107.2%	The work
LM6ZTW3O	1	400	94.7%	The work
LM6ZTW3O	2	100	114.7%	The work
LM6ZTW3O	2	200	116.1%	The work
LM6ZTW3O	2	300	91.3%	The work
LM6ZTW3O	3/0.5	300	106%	The work
LM6ZTW3O	4/0.5	300	110.9%	The work

Table S4 (Contd.)



Fig. S7 Ex-situ XRD patterns of the LZTO, LZTW3O, LM6ZTO and LM6ZTW3O electrodes cycling for 200 cycles at 1 A g<sup>-1</sup>.

Table S5 Cell volumes of LZTO, LZTW3O, LM6ZTO and LM6ZTW3O electrodes before and after cycling at 1 A g<sup>-1</sup> for 200 cycles.

Samples	Cell volumes (Å <sup>3</sup> )		
	Before cycling	After cycling	
LZTO	586.3(9)	591.7	
LZTW3O	586.1(8)	587.8(7)	
LM6ZTO	586.4(3)	585.5(4)	
LM6ZTW3O	586.2(3)	587.9(1)	



Fig. S8 Surface SEM images of (a-b) LZTO, (c-d) LZTW3O, (e-f) LM6ZTO and (g-h) LM6ZTW3O after cycling for 200 cycles at 1 A g<sup>-1</sup>.

The SEM images of the LZTO, LZTW3O, LM6ZTO and LM6ZTW3O

electrodes cycling for 200 cycles at 1 A g<sup>-1</sup>, are shown in Fig. S8. The surface of the LZTO electrode is severely damaged after repeated Li<sup>+</sup> intercalation/deintercalation, and cracks with different width and depth appear (Fig. S8a-8b). The cracks will prevent the transportation of electrons and diffusion of Li<sup>+</sup> ions, and then lead to the capacity fading. There is small crack on the surface of LM6ZTO (Fig. S8e-8f). However, there is no obvious crack on the surface of LZTW3O and LM6ZTW3O (Fig. S8c-8d and Fig. S8g-8h). The integrated surface can keep good electrical contact between active particles.

#### III. References

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