Supporting information

Ultrafast Carbon Dioxide Sorption Kinetics Using Morphology-Controllable Lithium Zirconate

Fa-Qian Liu,[a] Guo-Hua Li,[b] Shu-Wen Luo,[a] Wei-Hua Li,*[a] Zhao-Ge Huang,[b] Wei Li,[b] Feng Su,[b] Chao-Qin Li,[b] Zhen-Bo Ding,[b] and Qinglong Jiang*[c]*

[a] School of Chemical Engineering and Technology, Sun Yat-sen University, Zhuhai 519082, China. E-mail: liufq7@mail.sysu.edu.cn; liweihua3@mail.sysu.edu.cn

[b] Engineering Research Center of High Performance Polymer and Molding Technology, Ministry of Education, Qingdao University of Science and Technology, Qingdao 266042, China.

[c] Department of Chemistry and Physics, University of Arkansas, Pine Bluff, AR 71601, USA. E-mail: jiangq@uapb.edu

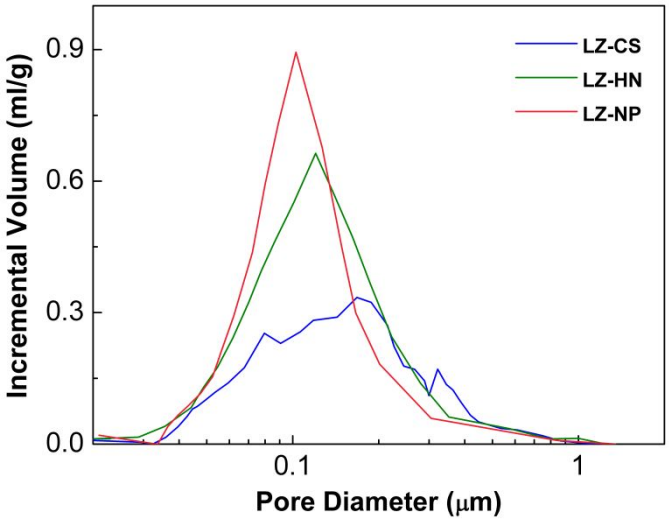

Figure S1. Hg intrusion pore size distributions versus pore diameter data of all LZ-supported adsorbents. The volume of the big pores was measured as the volume belonging to the pore size of the pore entrance.

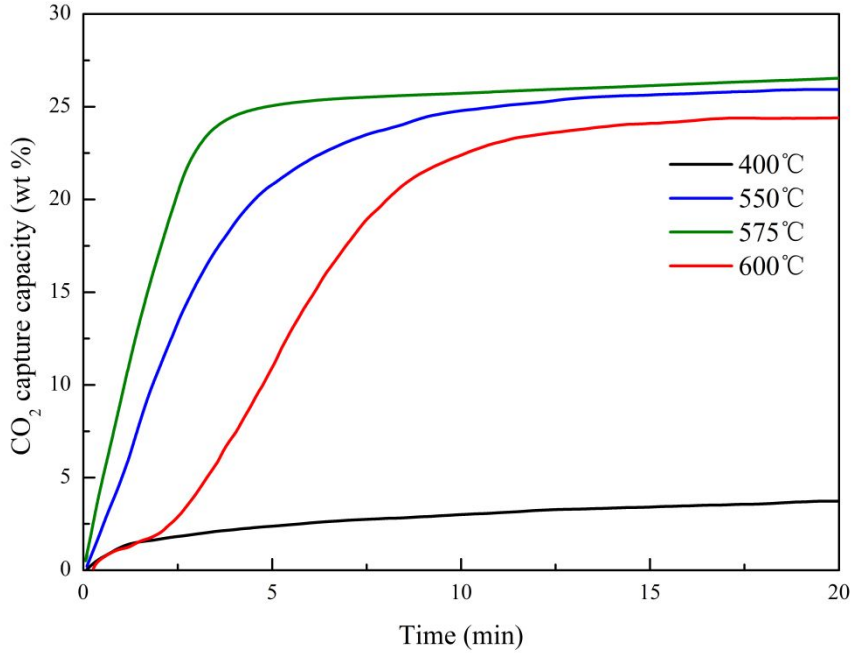

Figure S2. The absorption profiles of CO_2 in the nanoporous lithium zirconate at 400, 550, 575, and 600 °C When P_{CO2}= 1 bar.

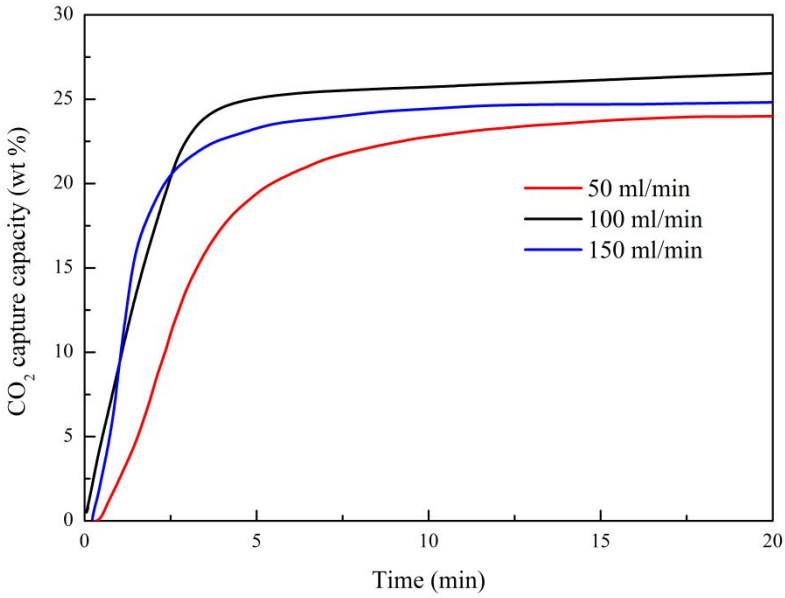

Figure S3. CO_2 capture capacity over nanoporous lithium zirconate under different flow rates at 575 °C

Table S1 A direct comparison of the experimental data obtained in this work with data previously reported.

Material	Maximum absorption rate (wt% min^{-1})	CO_2 uptake (wt%)	Capture Time (min)	BET surface area (m^2 g^{-1})	Temperature	references
LZ-NP	10.28	27.1	30	62	575°C	This work
		25	4			
LZ-HN	6.08	23.6	30	39	575°C	This work
		16.2	4			
LZ-CS	1.45	16.3	30	4	575°C	This work
		3.3	4			
nanocrystalline Li_2ZrO_3 prepared via an sol-gel process	/	21	60	/	550°C	1
Li_2CO_3/K_2CO_3-doped Li_2ZrO_3	/	8.3	90	/	525°C	2
Li_2ZrO_3 prepared from surfactant-template/ultrasound-assisted Method	1.4	22	/	/	575°C	3
K-Doped Li_2ZrO_3 prepared from starch-assisted sol–gel method	/	22	20	/	550°C	4
K-doped Li_2ZrO_3 prepared from citrate route	/	23	15	6.61	550°C	5
Li_2ZrO_3 nanotubes	/	26	60	57.9	550°C	6
K-doped Li_2ZrO_3 prepared from solid-state reaction	/	4.0	183	<1	420 to 460 °C	7
Li_2ZrO_3 prepared by soft-chemistry route	0.83	29.87	~300	10.87	485 ◦C	8
nanocrystalline Li_2ZrO_3	9.18	19	30	2	575°C	9
TOS-900	0.31	26.28	~400	/	450°C	10
TOS-U700	0.58	20.04	~200	/	450°C	10
K-doped Li_2ZrO_3		23	~35	/	575°C	11

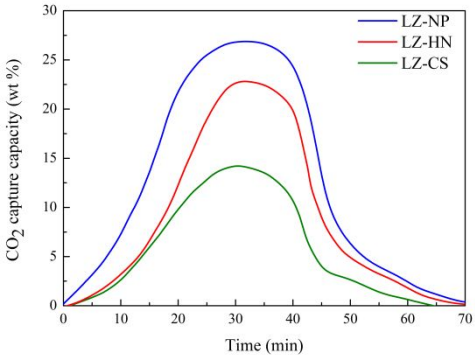

Figure S4. CO_2 capture and regeneration experimental results at 0.75 bar. Absorption conditions: 575 °C, 100 mL/min CO_2. Regeneration conditions: 690 °C, 100 mL/min Ar.

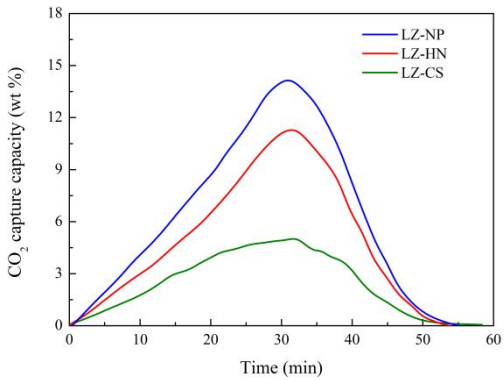

Figure S5. CO_2 capture and regeneration experimental results at 0.5 bar. Absorption conditions: 575 °C, 100 mL/min CO_2. Regeneration conditions: 690 °C, 100 mL/min Ar.

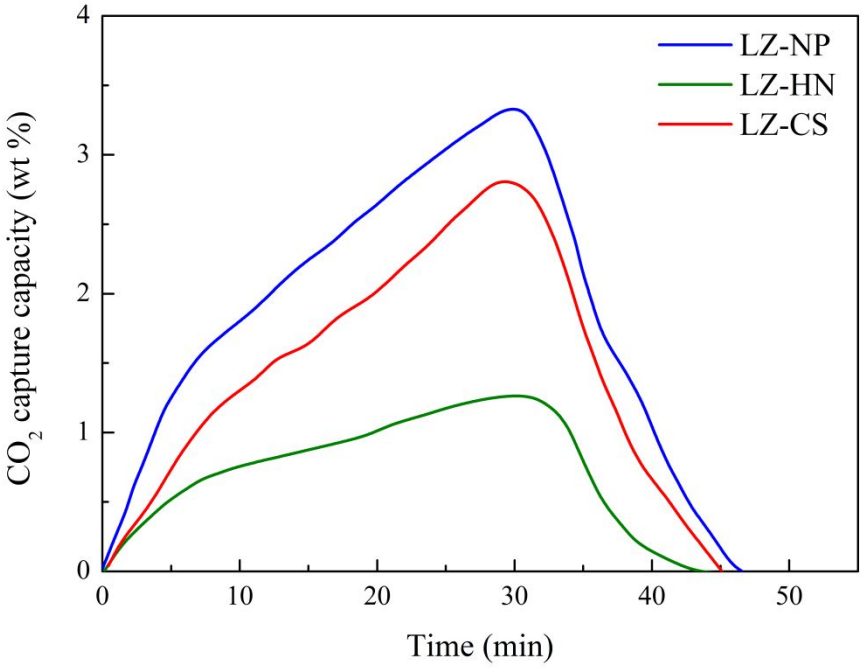

Figure S6. CO_2 capture and regeneration experimental results at 0.25 bar. Absorption conditions: 575 °C, 100 mL/min CO_2. Regeneration conditions: 690 °C, 100 mL/min Ar.

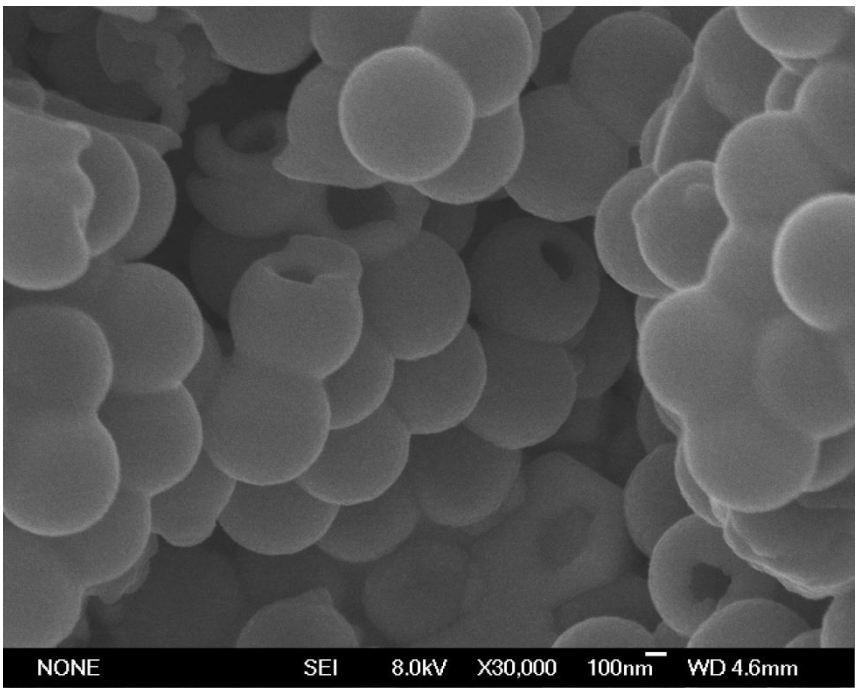

Figure S7. SEM images of LZ-HN absorbents after 60 absorption/desorption cycles.

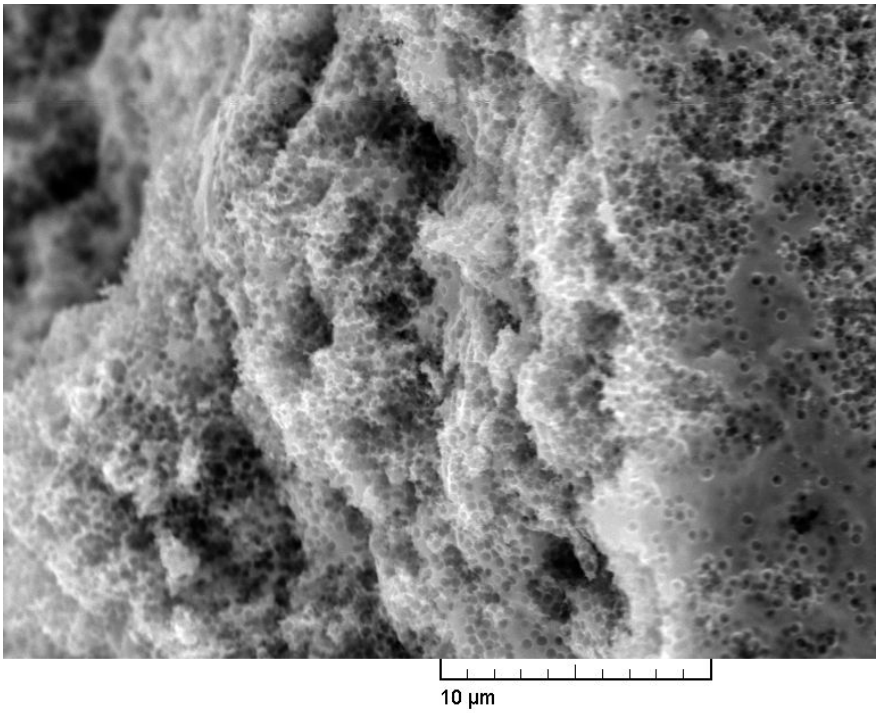

Figure S8. SEM images of LZ-NP absorbents after 60 absorption/desorption cycles.

References

(1) Guo, X. Z.; Ding, L.; Ren, J.; Yang, H. Preparation and CO_2 Capture Properties of Nanocrystalline Li_2ZrO_3 Via an Epoxide-Mediated Sol-Gel Process. *J. Sol-Gel Sci. Technol.* **2017,** *81*, 844-849.

(2) Wang, C.; Dou, B.; Song, Y.; Chen, H.; Xu, Y.; Xie, B. High Temperature CO_2 Sorption on Li_2ZrO_3 Based Sorbents. *Ind. Eng. Chem. Res.* **2014,** *53*, 12744-12752.

(3) Radfarnia, H. R.; Iliuta, M. C. Surfactant-Template/Ultrasound-Assisted Method for the Preparation of Porous Nanoparticle Lithium Zirconate. *Ind. Eng. Chem. Res.* **2011,** *50*, 9295-9305.

(4) Xiao, Q.; Tang, X.; Zhong, Y.; Zhu, W. A Facile Starch-Assisted Sol–Gel Method to Synthesize K-Doped Li2zro3 Sorbents with Excellent CO_2 Capture Properties. *J. Am. Ceram. Soc.* **2012,** *95*, 1544-1548.

(5) Xiao, Q.; Liu, Y.; Zhong, Y.; Zhu, W. A Citrate Sol-Gel Method to Synthesize Li_2ZrO_3 Nanocrystals with Improved CO_2 Capture Properties. *J. Mater. Chem.* **2011,** *21*, 3838-3842.

(6) Guo, L.; Wang, X.; Zhong, C.; Li, L. Synthesis and CO_2 Capture Property of High Aspect-Ratio Li2zro3 Nanotubes Arrays. *Appl. Surf. Sci.* **2011,** *257*, 8106-8109.

(7) Martínez-dlCruz, L.; Pfeiffer, H. Effect of Oxygen Addition on the Thermokinetic Properties of Co2 Chemisorption on Li_2ZrO_3. *Ind. Eng. Chem. Res.* **2010,** *49*, 9038-9042.

(8) Iwan, A.; Stephenson, H.; Ketchie, W. C.; Lapkin, A. A. High Temperature Sequestration of CO_2 Using Lithium Zirconates. *Chem. Eng. J.* **2009,** *146*, 249-258.

(9) Ochoa-Fernández, E.; Rønning, M.; Yu, X.; Grande, T.; Chen, D. Compositional Effects of Nanocrystalline Lithium Zirconate on Its CO_2 Capture Properties. *Ind. Eng. Chem. Res.* **2008,** *47*, 434-442.

(10) N., N. B.; Takeo, Y.; Hiroto, K.; Shin‐Ichi, N.; Kazuaki, N. Processing of Lithium Zirconate for Applications in Carbon Dioxide Separation: Structure and Properties of the Powders. *J. Am. Ceram. Soc.* **2004,** *87*, 68-74.

(11) Peltzer, D.; Munera, J.; Cornaglia, L.; Strumendo, M. Characterization of Potassium Doped Li_2ZrO_3 Based CO_2 Sorbents: Stability Properties and CO_2 Desorption Kinetics. *Chem. Eng. J.* **2018,** *336*, 1-11.