Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supplementary Information for Zirconia Incorporated Calcium Looping Absorbents with Superior Sintering Resistance for Carbon Dioxide Capture from *In-situ* or *Ex-situ* Processes

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Table S1. Crystallite sizes of CaO and $CaZrO_3$ of some samples.

Sample	CaO (nm)		$CaZrO_3$
	(200)	(220)	(202)
SD-CaO	>100	>100	-
SD-Zr10	57.3	54.1	25.5
SD-Zr20	54.6	52.2	26.1
SD-Zr30	46.9	45.7	26.7
FD-Zr20	53.6	53.7	22.0
HD-Zr20	51.5	52.0	24.7

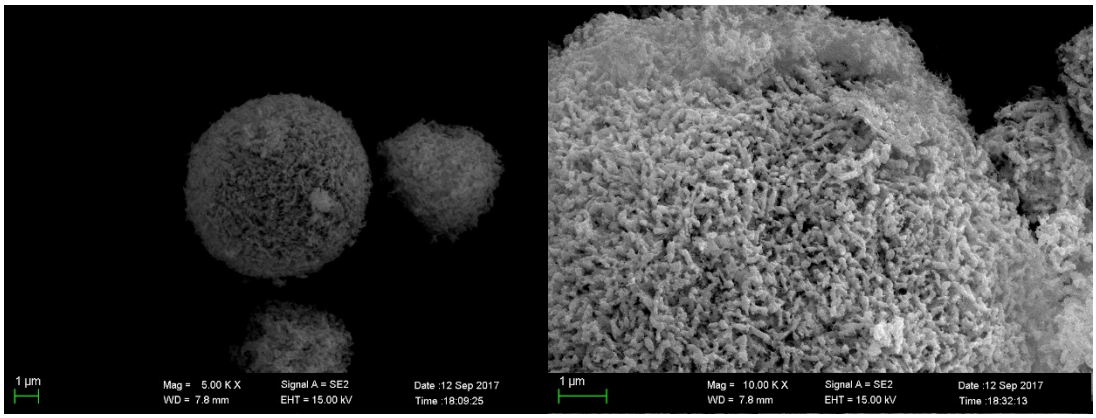

Fig. S1. Sphere structure of SD-Zr20.

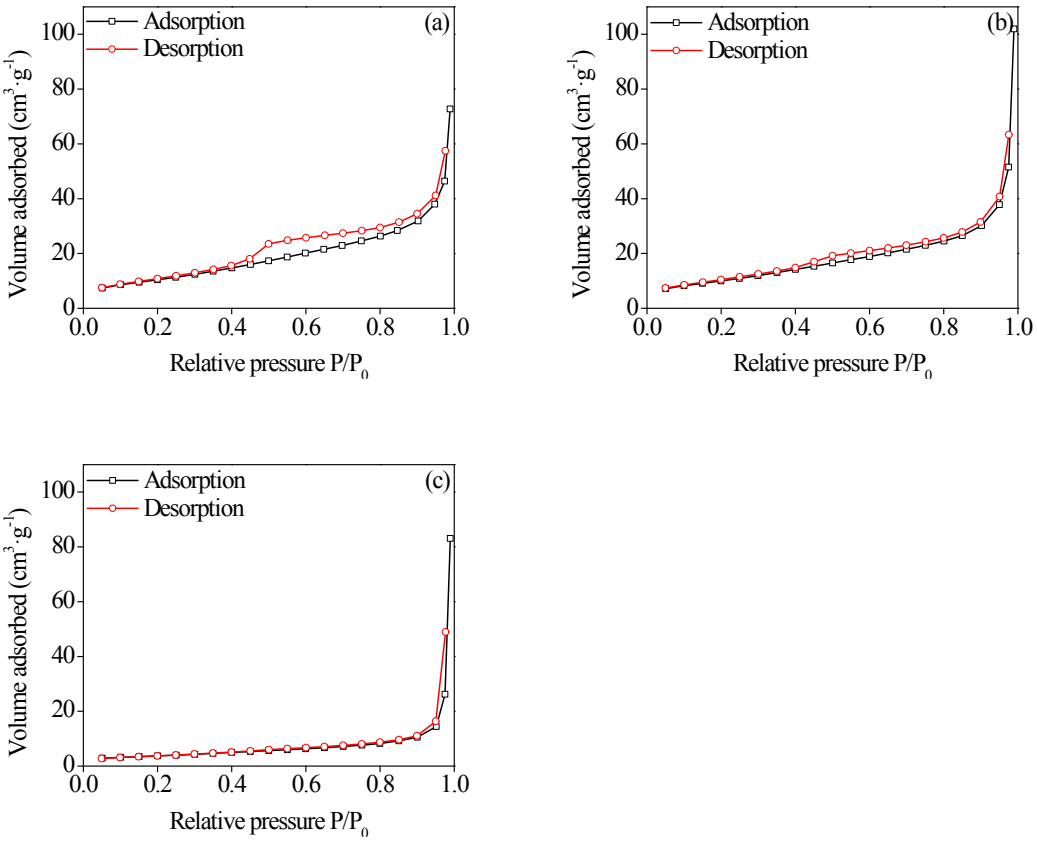

Fig. S2. The N_2 physi-sorption isotherms of **(a)** FD-Zr20, **(b)** SD-Zr20 and **(c)** HD-Zr20.

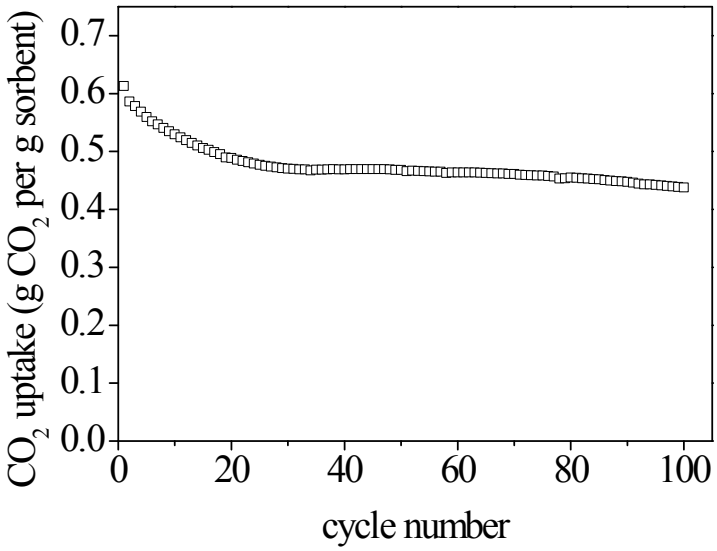

Fig. S3. The CO_2 uptake of SD-Zr20 over the 100 cycles under severe conditions (carbonation in 90 vol.% CO_2 at 650 °C for 10 min and calcination in 90 vol.% CO_2 at 950 °C with no dwell time).

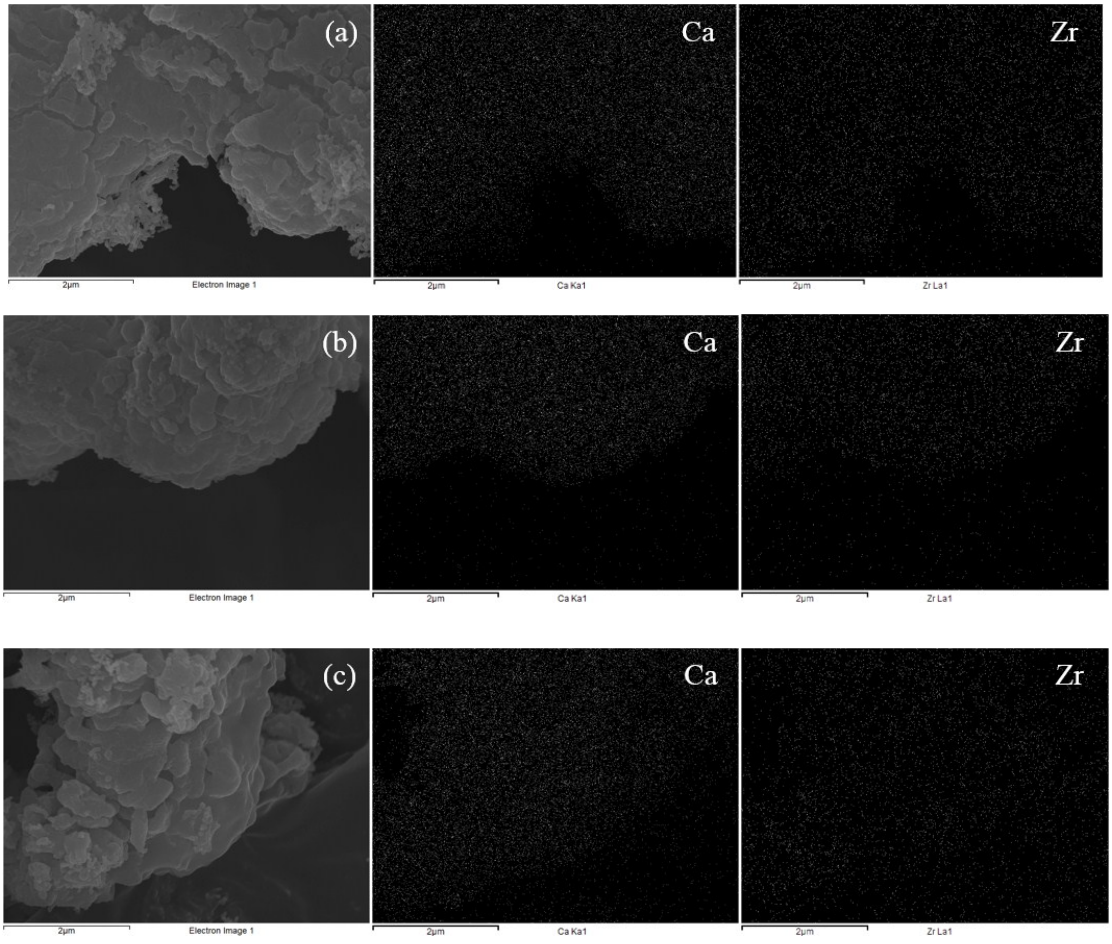

Fig. S4. EDS figures of FD-Zr20 (a), SD-Zr20 (b) and HD-Zr20 (c) after cycles under severe conditions.