Supporting Information

Template-free synthesis of mesoporous $SrTiO_3$ single crystals

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Experimental Section

Characterization: XRD patterns were recorded with a Rigaku D/MAX 2550VB diffractometer using Cu Kα radiation at 40 kV and 100 mA at a scanning rate of 8 °/min. Scanning electron microscopy (SEM), and transmission electron microscopy (TEM) characterizations were conducted using a HITACHI S4800 and a Thermo Fisher Scientific Talos F200X, respectively. The Brunauer-Emmett-Teller (BET) method was utilized to calculate the specific surface area. The pore volumes and pore size distributions were derived from the desorption branches of isotherms using the Barrett-Joyner-Halenda (BJH) model. XPS was recorded on an AXIS ULTRA DLD XPS SYSTEM with MONO Al source (Shimadzu Crop), and the binding energy of the C 1s peak at 284.8 eV was taken as an internal reference. UV-vis spectra were recorded with a Shimadzu UV-2550.

Film preparation and EIS analysis: 10 mg catalyst was well dispersed in 100 μL dimethyl formamide (DMF) and 50 μL Nafion solution by ultrasonicating for 30 minutes. Then 20 μL slurry was dropped onto the prepared 1 cm × 1 cm FTO glass and dried naturally. Electrochemical impedance spectroscopy (EIS) measurements were carried out with a CHI760E workstation in a standard three-electrode system. The Pt mesh and Ag/AgCl (3.5 M KCl) electrode were used as the counter electrode and the reference electrode respectively, and 0.5 M Na_2SO_4 aqueous solution was used as the electrolyte.

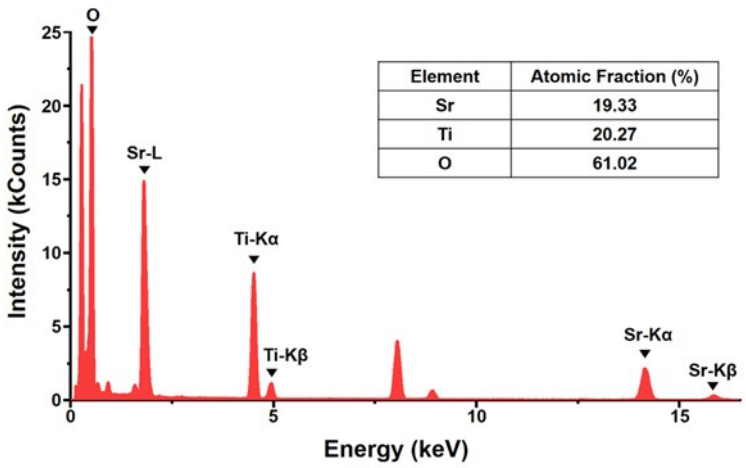

Fig. S1 The EDS spectrum of MSC $SrTiO_3$-48h and corresponding element ratio, indicating that the atomic ratio of Sr, Ti, O is nearly 1:1:3. The unindexed signals are corresponding to C and Cu originated from TEM grid (0.28 keV for C, 8.03 keV for Cu Kα and 8.91 keV for Cu Kβ).

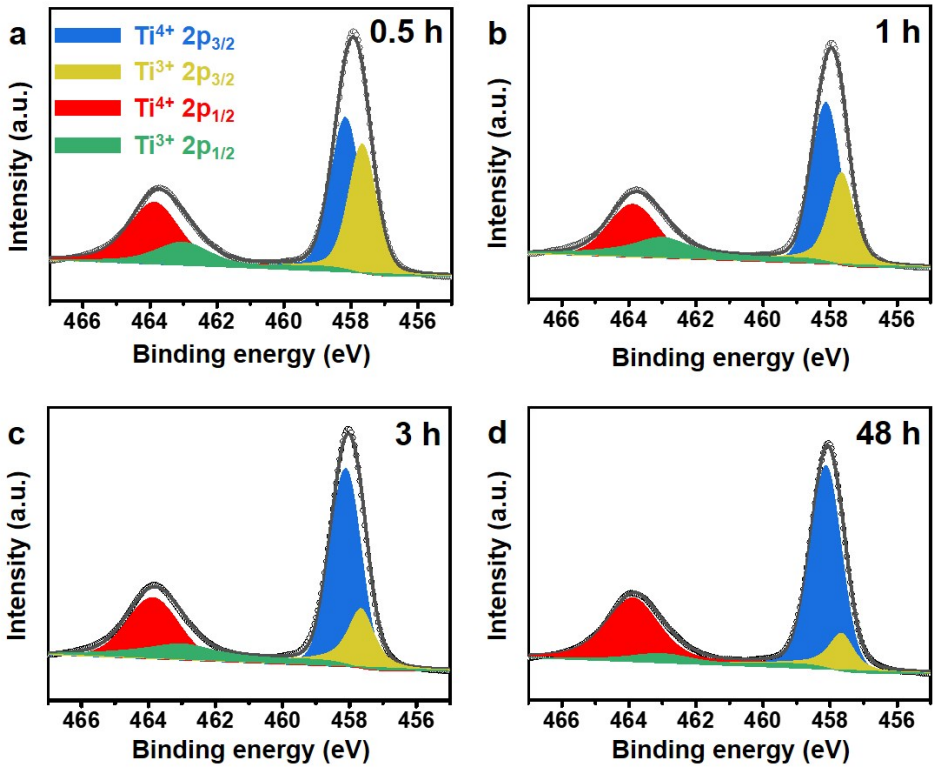

Fig. S2 (a-d) Time-dependent XPS spectra of MSC $SrTiO_3$ in the Ti 2p region collected at different synthesis stages of (a) 0.5 h, (b) 1 h, (c) 3h, and (d) 48 h, respectively, showing that the decreased content of Ti^{3+} during the synthesis.

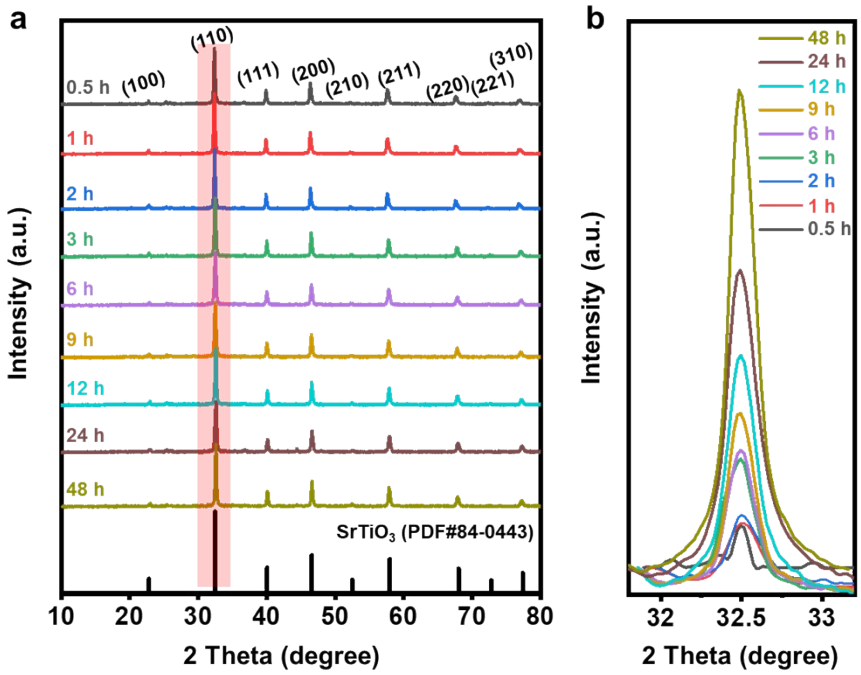

Fig. S3 Powder XRD analysis of the as synthesized $SrTiO_3$ at different reaction stages from 0.5 to 48 h of (a) the normalized patterns and (b) the practical intensity of characteristic (110) peak, showing the enhanced crystallinity with prolonging the reaction time, which is consistent with the SEM and TEM images.

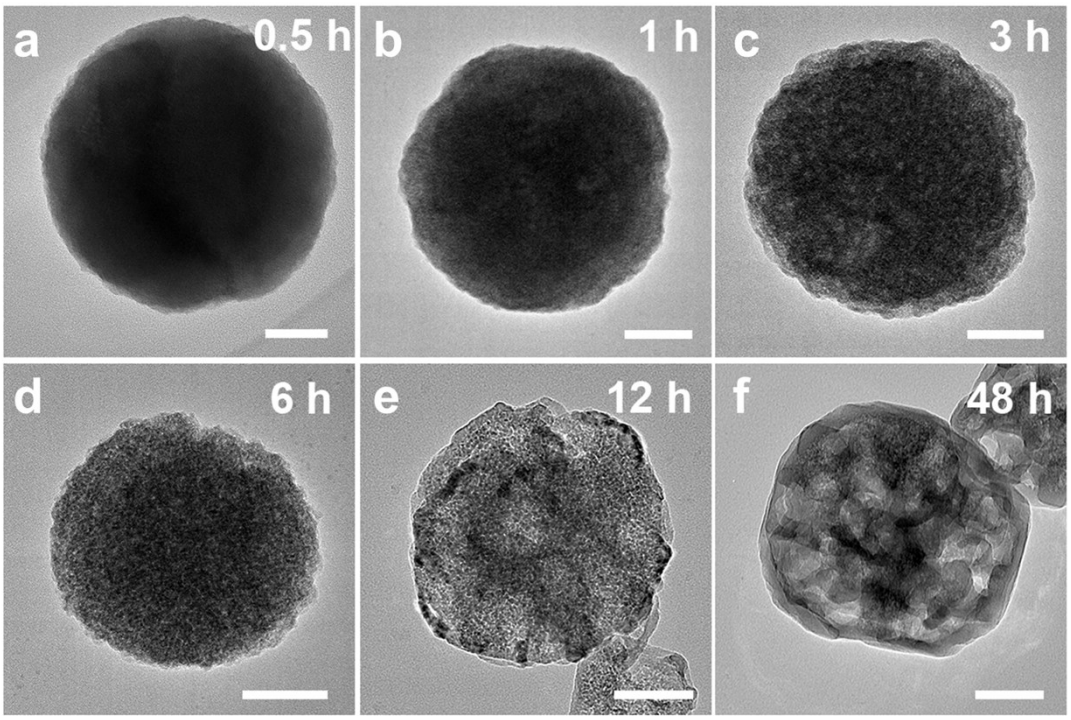

Fig. S4 TEM images of the crystallization process of MSC $SrTiO_3$ at different reaction states of (a) 0.5 h, (b) 1 h, (c) 3 h, (d) 6 h, (e) 12 h, and (f) 48 h, respectively, displaying the visual formation process of MSC $SrTiO_3$. Scale bars in (a-f): 50 nm.

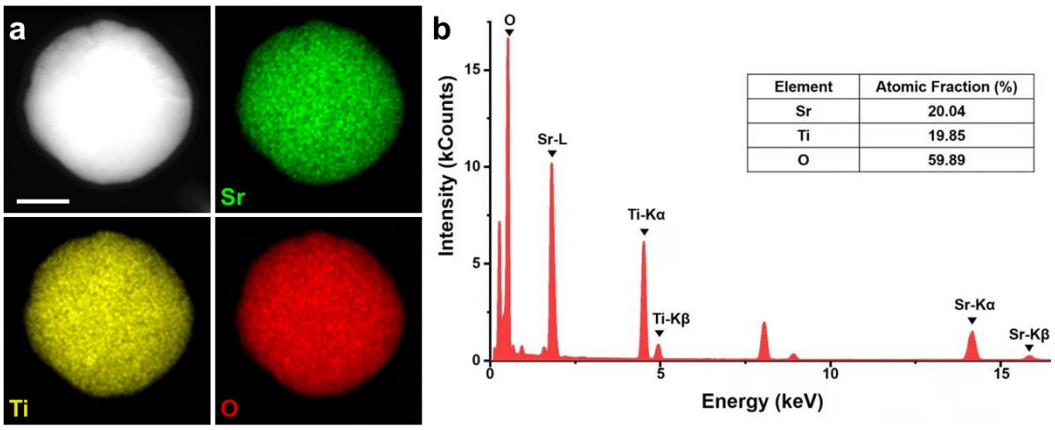

Fig. S5 (a) Typical HAADF-STEM image of $SrTiO_3$ at 0.5 h and corresponding EDS maps of Sr, Ti, and O, showing the homogeneous distribution over the $SrTiO_3$ particle. Scale bar: 50 nm. (b) The EDS spectrum of MSC $SrTiO_3$-0.5h and corresponding element ratio, indicating that the atomic ratio of Sr, Ti, O is nearly 1:1:3. The unindexed signals are corresponding to C and Cu originated from TEM grid (0.28 keV for C, 8.03 keV for Cu Kα and 8.91 keV for Cu Kβ).

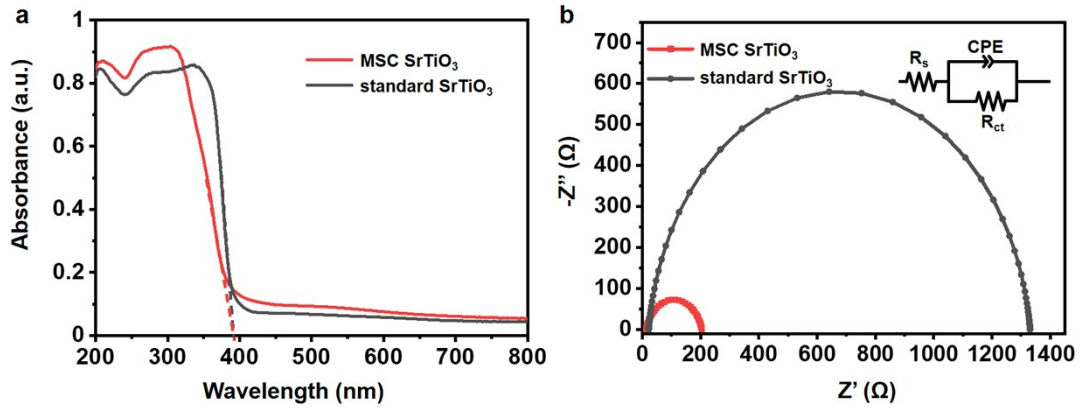

Fig. S6 (a) UV-vis spectra and (b) EIS spectra of MSC and standard $SrTiO_3$, which suggest the mesoporous single crystals would not significantly change the light absorption but accelerate the charge transfer ability.

Table S1 Calculated area ratio of O_v/O_{latt} collected at different reaction time.

Sample (time)	0.5 h	1 h	3 h	48 h
Area ratio of O_v/O_{latt}	2.2	1.76	1.37	0.36

Table S2 The average interplanar spacing of (110) and (020) facets, calculated from SAED.

Time (h)	d_{110} (Å)	d_{020} (Å)
0.5	2.83	1.99
1.0	2.82	1.98
3.0	2.77	1.96
48	2.75	1.95