

Fig. S1 The EDS spectra of Sm and Ca co-doping ceria with different Sm contents.

Table S1 the fitting results of impedance spectra

Temperature (°C)	Rb ($\Omega \text{ cm}^2$)	Rgb ($\Omega \text{ cm}^2$)	Rt ($\Omega \text{ cm}^2$)
400	0.152	175.1	175.252
450	0.152	70.0	70.152
500	0.150	31.7	31.850
550	0.150	12.6	12.750
600	0.152	4.9	5.052

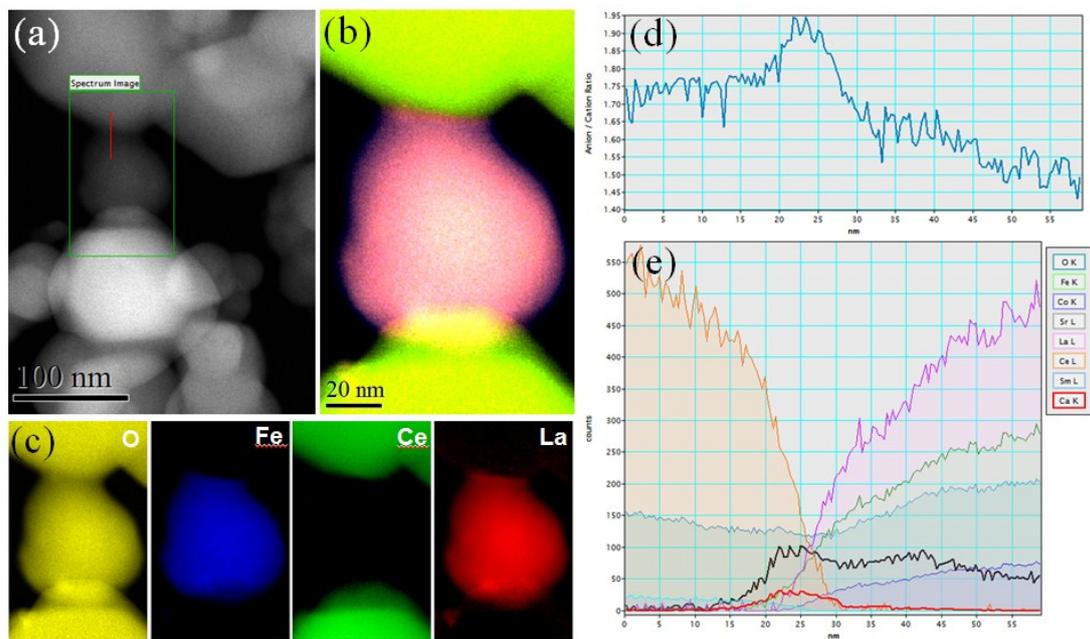


Fig. S2 STEM-EELS elemental mapping of the LSCF-SCDC2. (a) The survey image for EELS mapping and positions for line scan analysis are marked by the rectangle and red lines. (b) The combined color map of O (yellow), Fe (blue), Ce (green), and La (red); (c) EELS mapping of the main elements extracted using O-K, Fe-L3,2, Ce-M5,4, and La-M5,4 edges. (d) The anion to cation ratio across the interface. (e) The elemental distribution analysis across the interface of LSCF-SCDC2 by EDS which shows the segregation of Sr and Ca at the interface.

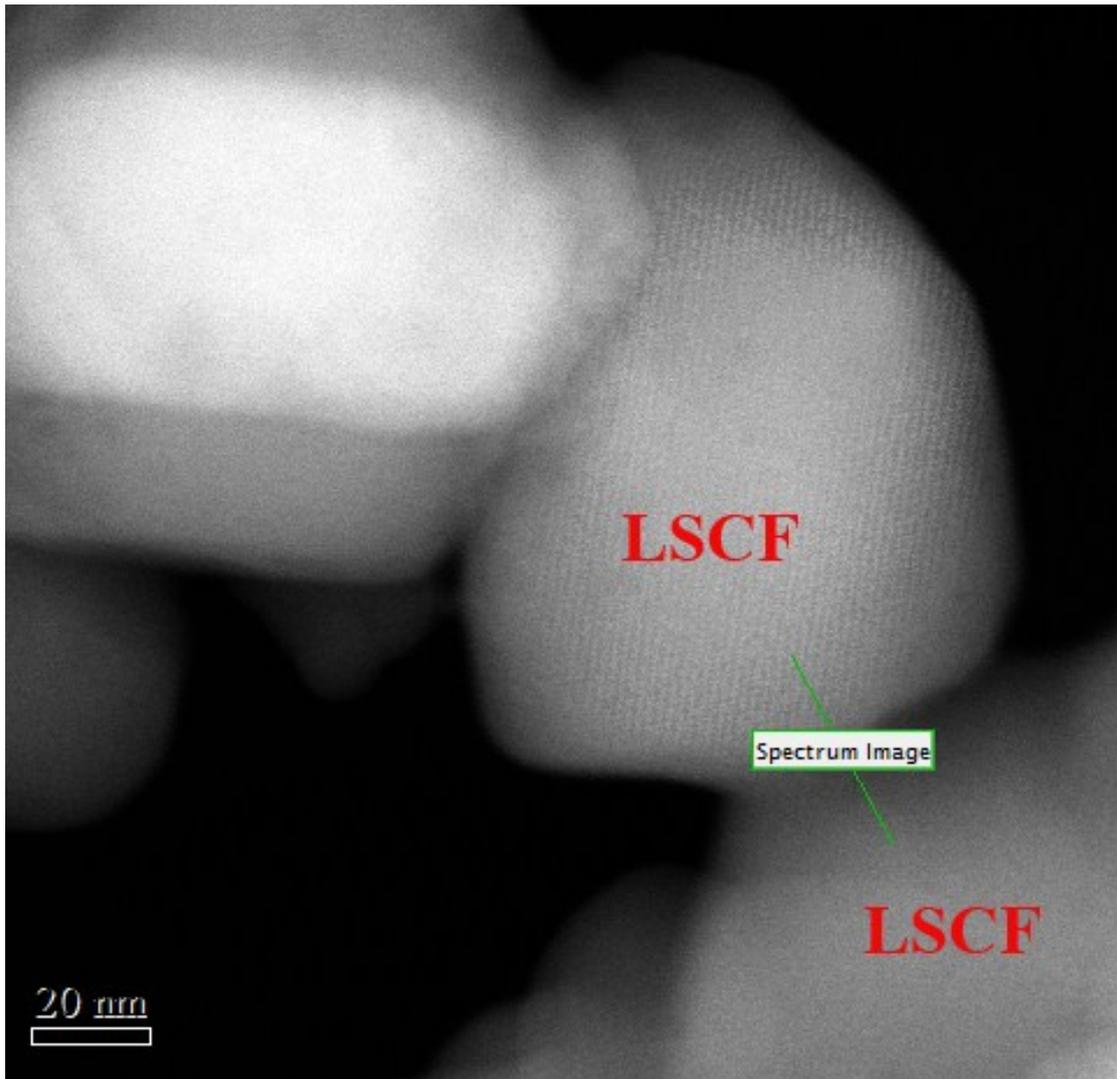


Fig. S3 the survey image including the EELS line scans across the LSCF-
LSCF grain boundaries