Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

Supporting Information

Significant effect of phase composition on oxygen reduction reaction activity on a layered oxide cathode

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Figures

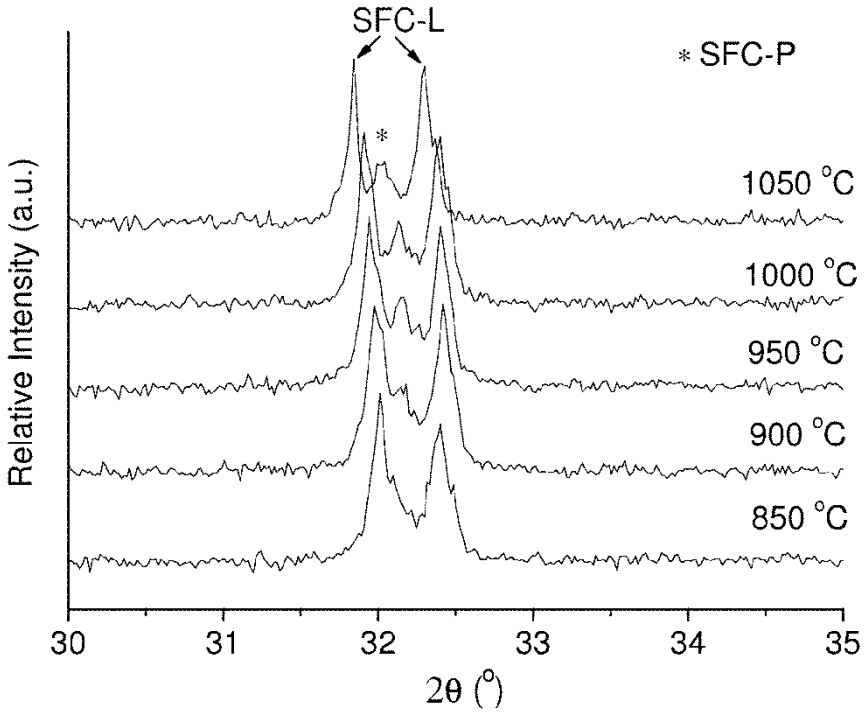


Figure S1. A representative snapshot of high temperature x-ray diffraction patterns of the synthesized SFC2 powder heated at 850 to 1050 ^{o}C between 2θ = 31.5-33^{o}.

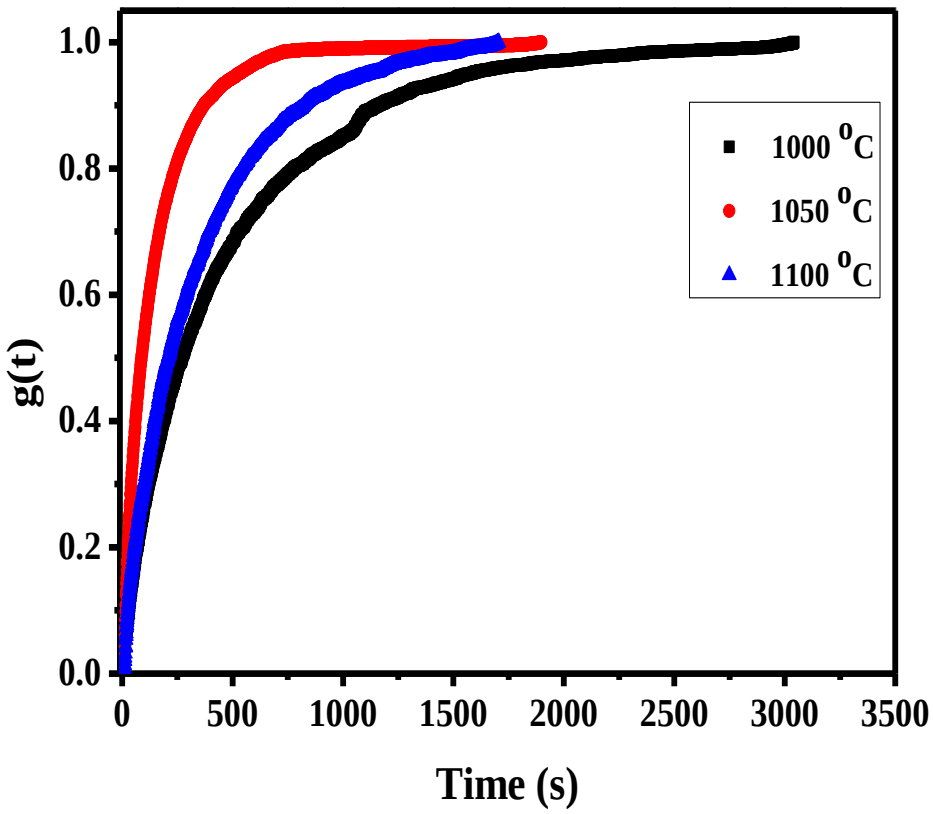


Figure S2. Typical electrical conductivity relaxation (ECR) responses of SFC2-1000, SFC2-1050, and SFC2-1100 at 750 ^{o}C after sudden change of oxygen partial pressure from 0.21 to 0.1 atm.

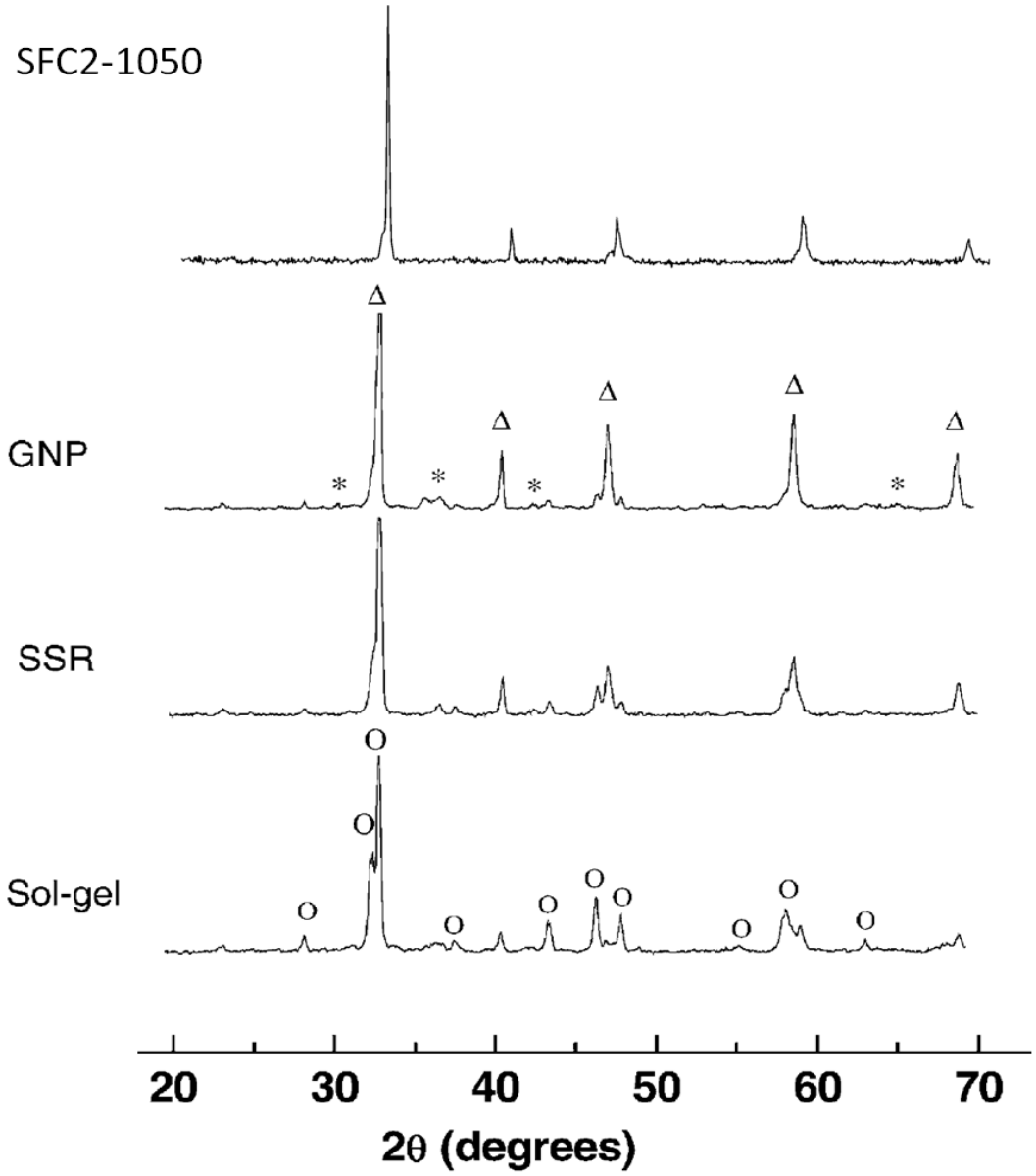
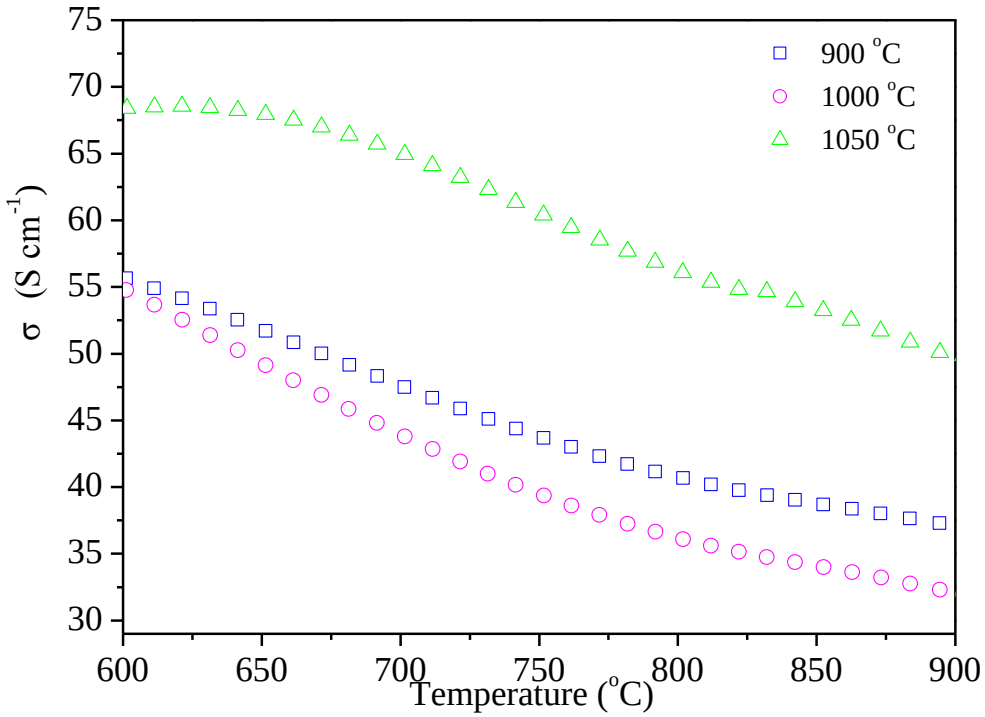


Figure S3. A comparison of XRD patterns between SFC2-1050 and those reported in Ref [1]. Symbols (*, Δ, O) in the figure refer to spinel, perovskite, and layered oxide, respectively. The relative intensities of perovskite and layered oxide for SFC2-1050 are similar to that prepared by glycine nitrate process (GNP). Deng et al reported that the SFC2-GNP shows the highest oxygen permeability [1].

[1] Z. Q. Deng, W. Liu, D. K. Peng, C. S. Chen, W. S. Yang, *Materials Research Bulletin* **2004**, *39*, 963–969.



Figurre S4 Electrical conductivity of SFC2-900, SFC2-1000 and SFC2-1050.

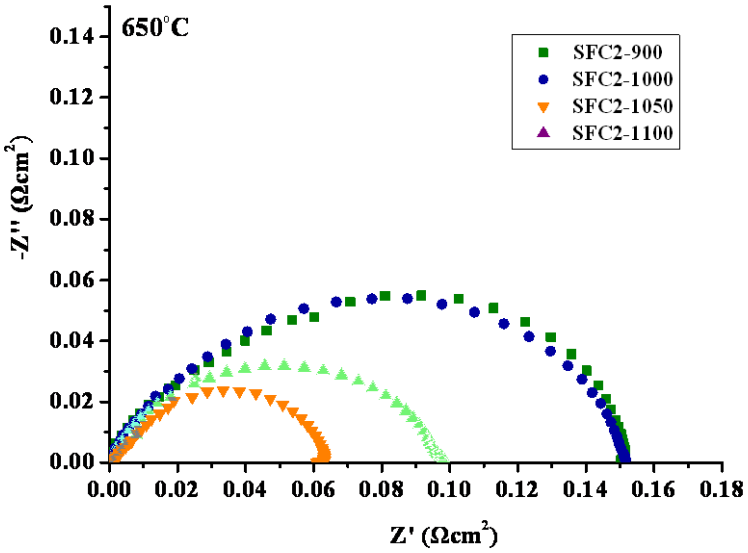


Figure S5 Typical EIS of SFC2-900, SFC2-1000, SFC2-1050 and SFC2-1100 cathodes measured at 650 ^{o}C. The difference between real axes intercepts of the impedance plot is the electrode polarization resistance (R_p).

Table S1 Structure parameters of SFC-L and SFC-P phases in SFC2-900, SFC2-1000 and SFC2-1050 obtained by Rietveld refinement. Space groups of SFC-L and SFC-P phases are Iba2 and Pm-3m respectively.

SFC2-900

SFC-L Phase

Site	Np	x	y	z	Occ	Beq
Sr	8	0.3855	0.3376	0.971	1	2.8(16)
Sr	8	0.3716	0.156	0	1	5.5(22)
Fe	8	0.1257	0.2489	0.983	1	1.3(10)
Fe/Co	8	0.1124	0.038	0.05	0.574	0.0(41)
Fe/Co	8	0.1427	0.4564	0.012	0.643	0.0(30)
O	8	0.1283	0.1381	0.961	1	4.8(85)
O	8	0.1443	0.3581	0.973	1	11(12)
O	8	0.0039	0.2525	0.241	1	0(13)
O	8	0.2502	0.2428	0.234	1	0(13)
O	8	0.202	0.0304	0.36	1	20(21)
O	8	0.3847	0.0406	0.85	1	20(16)
O	4	0.5	0.5	0.796	0.964	20(22)

Lattice parameters

a (Å) 11.0478(20)

b (Å) 19.0498(49)

c (Å) 5.4978(12)

SFC-P Phase

Site	Np	x	y	z	Occ	Beq
Sr	1	0	0	0	1	5.2(13)
Fe/Co	1	0.5	0.5	0.5	1	0.8(12)
O	3	0.5	0.5	0	0.68(18)	3.7(42)

Lattice parameters

a (Å) 3.85975(72)

R_{exp} =3.20 R_{wp}=3.97 R_p=3.13 χ^2=1.24

SFC2-1000

SFC-L Phase

Site	Np	x	y	z	Occ	Beq
Sr	8	0.3855	0.3376	0.971	1	1.7(23)
Sr	8	0.3716	0.156	0	1	2.4(25)
Fe	8	0.1257	0.2489	0.983	1	0.3(12)
Fe/Co	8	0.1124	0.038	0.05	0.574	0.0(59)
Fe/Co	8	0.1427	0.4564	0.012	0.643	3.6(53)
O	8	0.1283	0.1381	0.961	1	1.0(98)
O	8	0.1443	0.3581	0.973	1	4(13)
O	8	0.0039	0.2525	0.241	1	0(18)
O	8	0.2502	0.2428	0.234	1	2(23)
O	8	0.202	0.0304	0.36	1	20(33)
O	8	0.3847	0.0406	0.85	1	20(23)
O	4	0.5	0.5	0.796	0.964	20(31)

Lattice parameters

a (Å) 11.0178(29)

b (Å) 19.0381(44)

c (Å) 5.5340(13)

SFC-P Phase

Site	Np	x	y	z	Occ	Beq
Sr	1	0	0	0	1	4.4(11)
Fe/Co	1	0.5	0.5	0.5	1	1.8(12)
O	3	0.5	0.5	0	0.68(14)	3.0(33)

Lattice parameters

a (Å) 3.86493(91)

R_{exp} =3.16 R_{wp}=4.78 R_p=3.59 χ^2=1.51

SFC2-1050

SFC-L Phase

Site	Np	x	y	z	Occ	Beq
Sr	8	0.3855	0.3376	0.971	1	2.3(51)
Sr	8	0.3716	0.156	0	1	2.5(54)
Fe	8	0.1257	0.2489	0.983	1	0.0(21)
Fe	8	0.1124	0.038	0.05	0.574	0(12)
Fe	8	0.1427	0.4564	0.012	0.643	0.0(79)
O	8	0.1283	0.1381	0.961	1	2(21)
O	8	0.1443	0.3581	0.973	1	2(20)
O	8	0.0039	0.2525	0.241	1	0(43)
O	8	0.2502	0.2428	0.234	1	0(44)
O	8	0.202	0.0304	0.36	1	20(58)
O	8	0.3847	0.0406	0.85	1	14(37)
O	4	0.5	0.5	0.796	0.964	20(54)

Lattice parameters

a (Å) 11.0136(81)

b (Å) 19.074(13)

c (Å) 5.5266(31)

SFC-P Phase

Site	Np	x	y	z	Occ	Beq
Sr	1	0	0	0	1	1.84(67)
Fe	1	0.5	0.5	0.5	1	2.80(80)
O	3	0.5	0.5	0	0.769(99)	2.8(22)

Lattice parameters

a (Å) 3.86255(51)

R_{exp} =3.62 R_{wp}=4.07 R_p=3.18 χ^2=1.12

Table S2 Parameters obtained in oxygen permeability test for SFC2-1000, SFC2-1050 and SFC2-1100 membranes. p_h and p_l are the partial oxygen pressures on the feed and permeate side, respectively.

SFC2-1000

T (^{o}C)	J (mL·cm^{-2}·min^{-1})	Ph	Pl
850	0.079832855	0.21	0.000393
825	0.075480835	0.21	0.000372
800	0.069562449	0.21	0.000342
775	0.063544897	0.21	0.000313
750	0.054651541	0.21	0.000269
725	0.052611884	0.21	0.000259
700	0.050080906	0.21	0.000247
675	0.045672543	0.21	0.000225
650	0.042181461	0.21	0.000208

SFC2-1050

T (^{o}C)	J (mL·cm^{-2}·min^{-1})	Ph	Pl
850	0.534968811	0.21	0.00258
825	0.439374595	0.21	0.002119
800	0.40059091	0.21	0.001932
775	0.312056783	0.21	0.001505
750	0.265250271	0.21	0.001279
725	0.212638352	0.21	0.001026
700	0.167721662	0.21	0.000809
675	0.076468687	0.21	0.000369
650	0.070473852	0.21	0.00034

SFC2-1100

T (^{o}C)	J (mL·cm^{-2}·min^{-1})	Ph	Pl
850	0.137257107	0.21	0.000676
825	0.123274758	0.21	0.000607
800	0.106780688	0.21	0.000526
775	0.103857722	0.21	0.000511
750	0.097243956	0.21	0.000479
725	0.078459405	0.21	0.000386
700	0.066835211	0.21	0.000329
675	0.073339658	0.21	0.000361
650	0.063670182	0.21	0.000313