

Supporting Information

Highly active and durable nitrogen doped-reduced graphene oxide/double perovskite bifunctional hybrid catalysts

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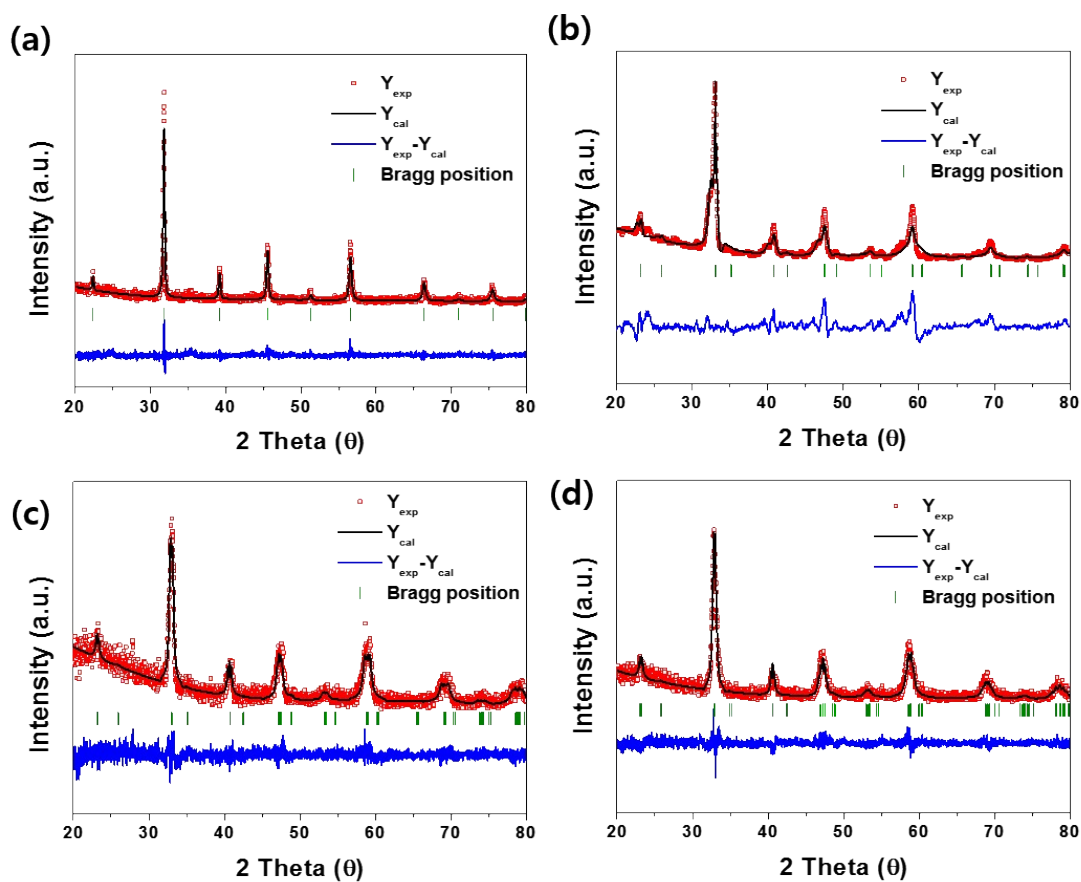


Fig. S1. Rietveld refinement profiles; (a) BSCF, (b) NBSCF, (c) SBSCF, and (d) GBSCF.

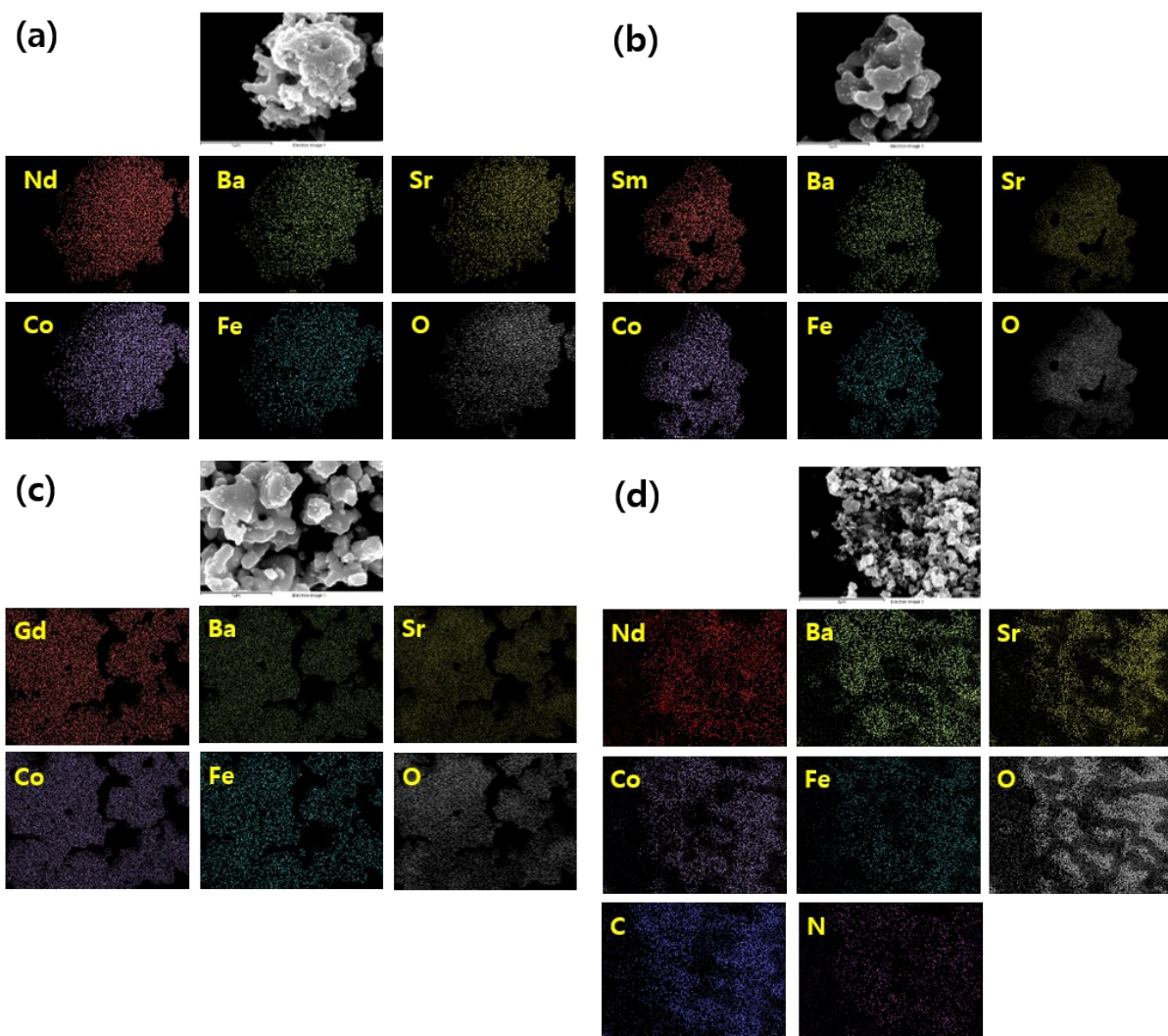


Fig. S2. EDX profiles for area mapping; (a) NBSCF, (b) SBSCF, (c) GBSCF, and (d) NBSCF/N-rGO.

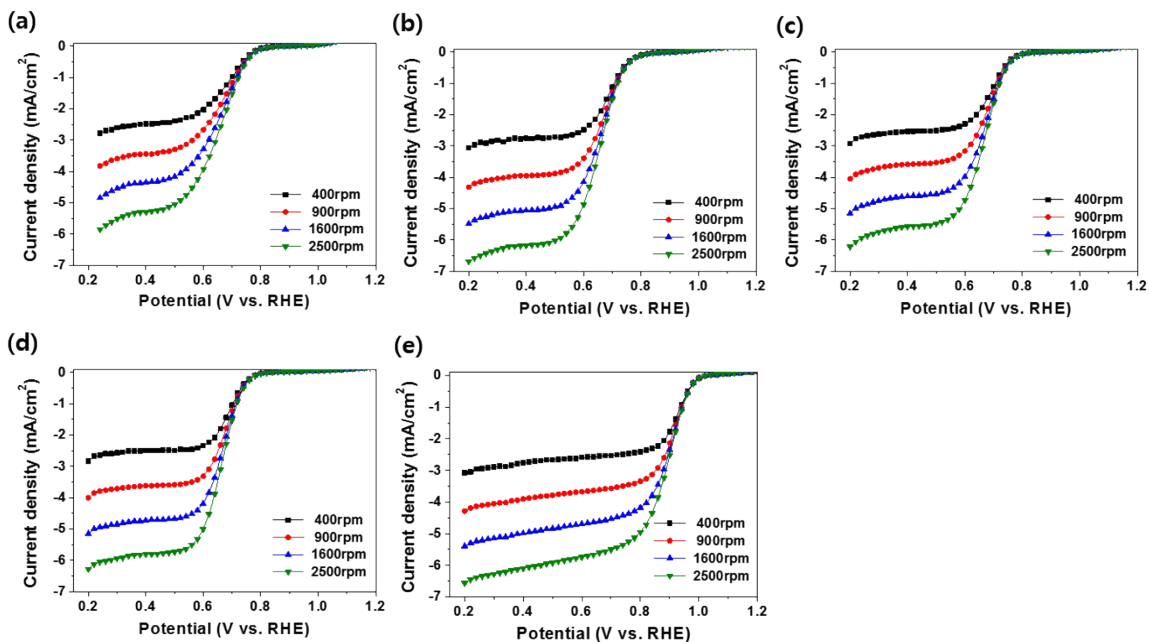


Fig. S3. Plots of oxygen reduction activities at 400 - 2500 rpm; (a) BSCF, (b) NBSCF, (c) SBSCF, (d) GBSCF, and (e) NBSCF/N-rGO.

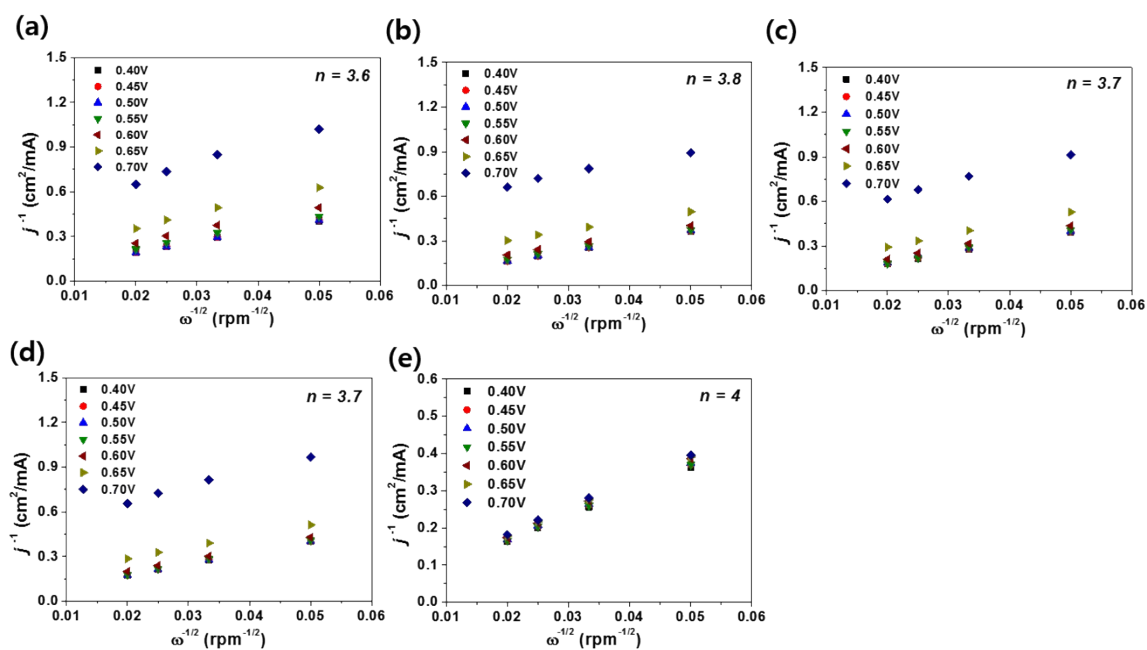


Fig. S4. Koutecky-Levich plots and electron transfer numbers from ORR curves; (a) BSCF, (b) NBSCF, (c) SBSCF, (d) GBSCF, and (e) NBSCF/N-rGO.

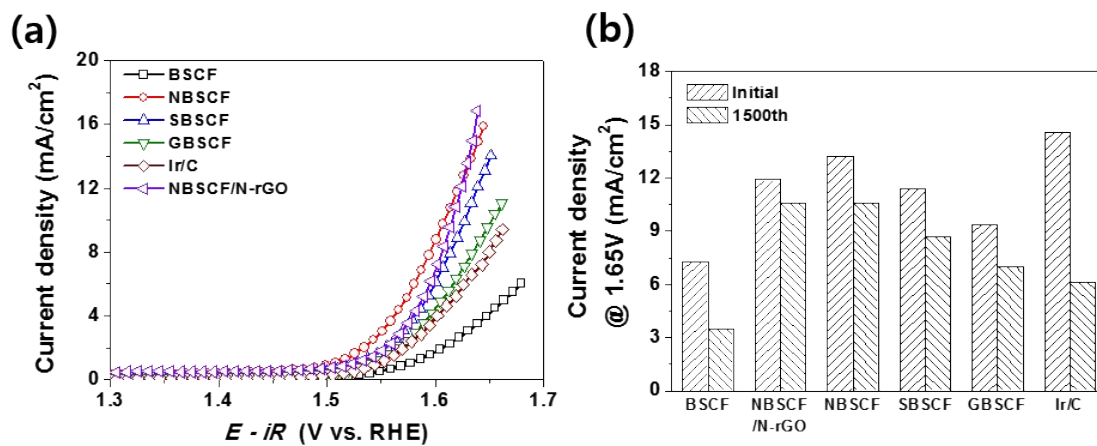


Fig. S5. (a) OER polarization curves after potential cycling and (b) current density values of initial and 1500th cycle at 1.65 V in OER curves.

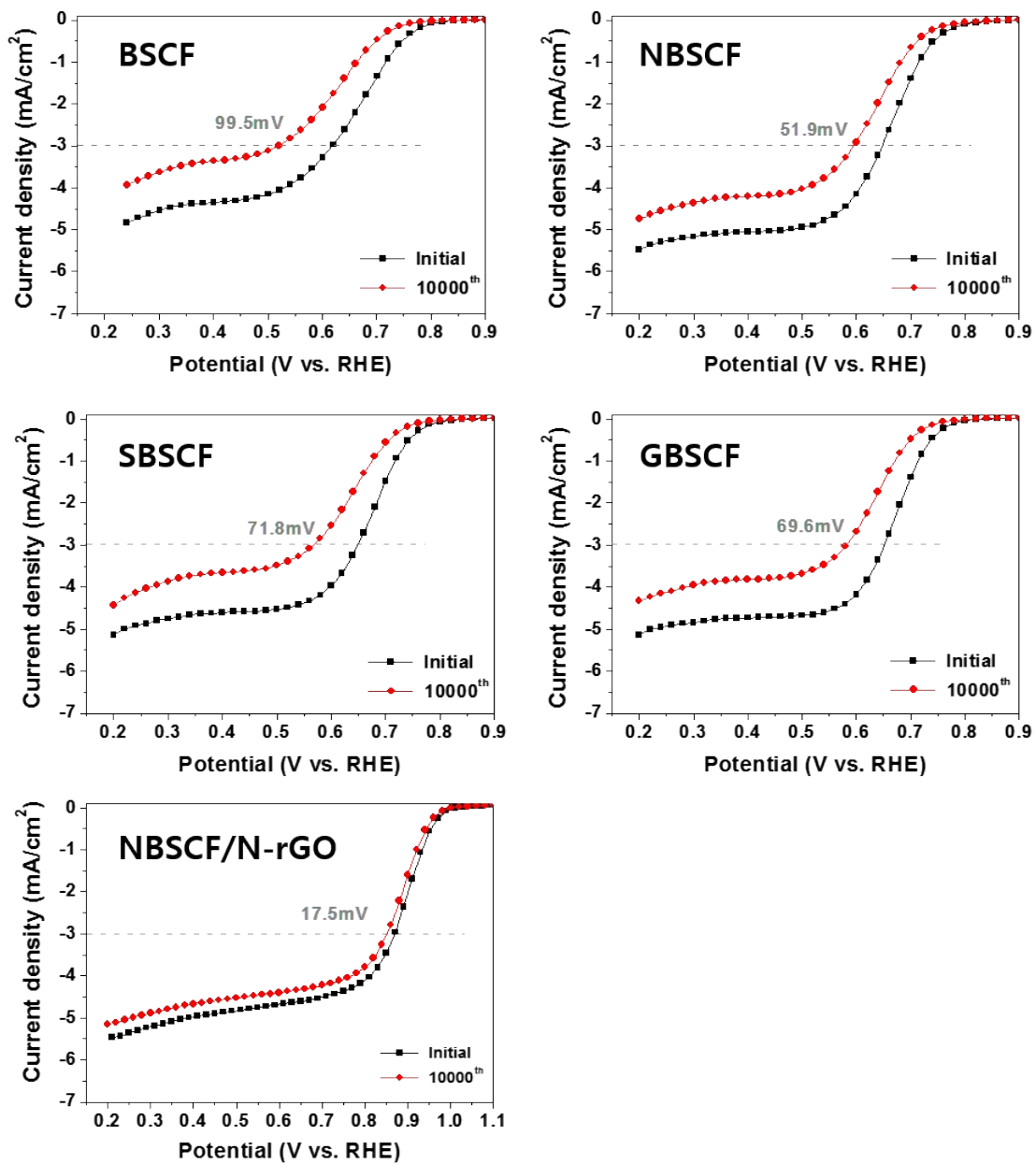


Fig. S6. ORR polarization curves of the catalysts before and after 10,000 cycles of potential sweep (0.6 – 1.2 V).

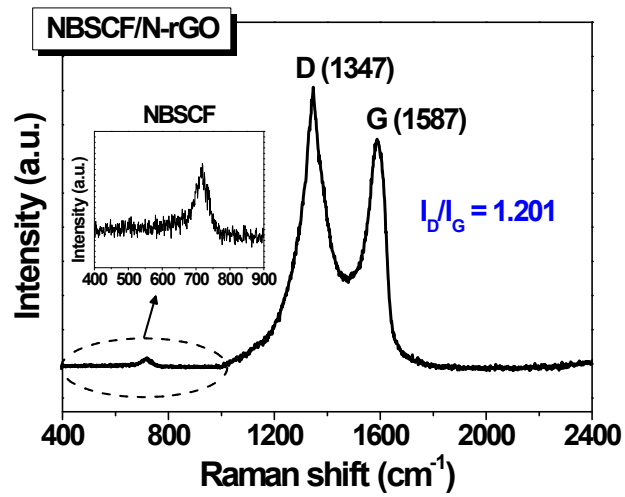


Fig S7. Raman spectra of NBSCF/N-rGO catalyst.

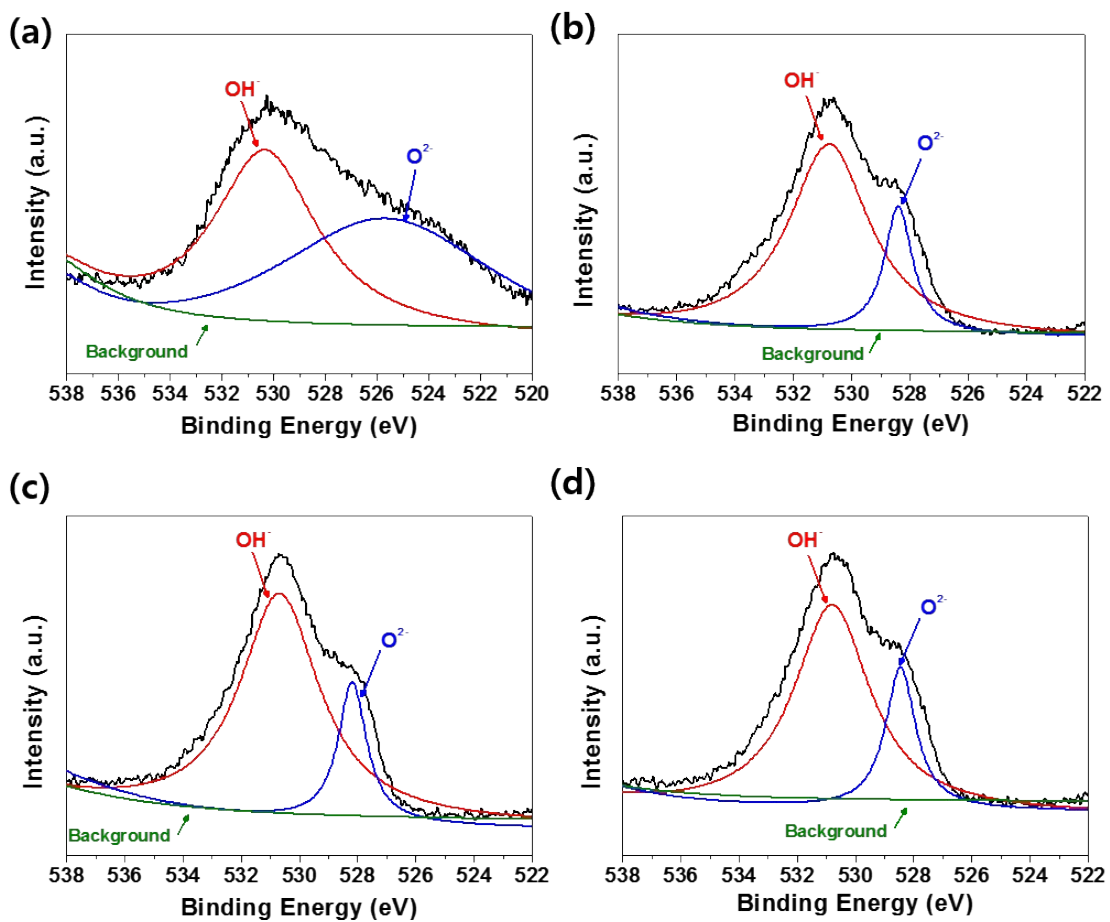


Fig. S8. O 1s XPS spectra of the catalysts; (a) BSCF, (b) NBSCF, (c) SBSCF, and (d) GBSCF.

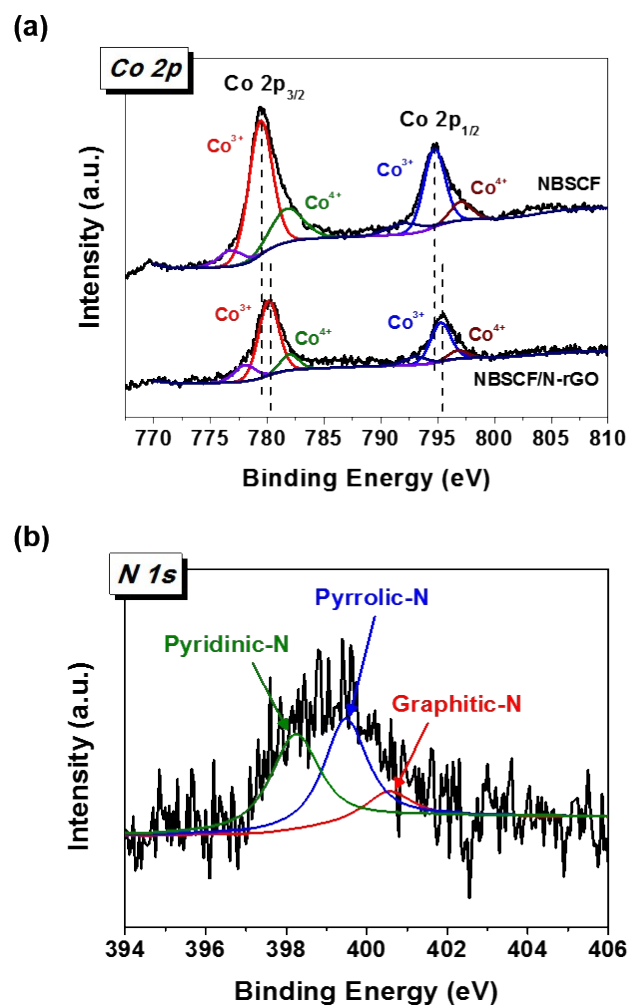


Fig S9. XPS spectra of NBSCF/N-rGO and NBSCF; (a) Co 2p peaks in NBSCF/N-rGO and NBSCF and (b) N 1s peak in NBSCF/N-rGO.

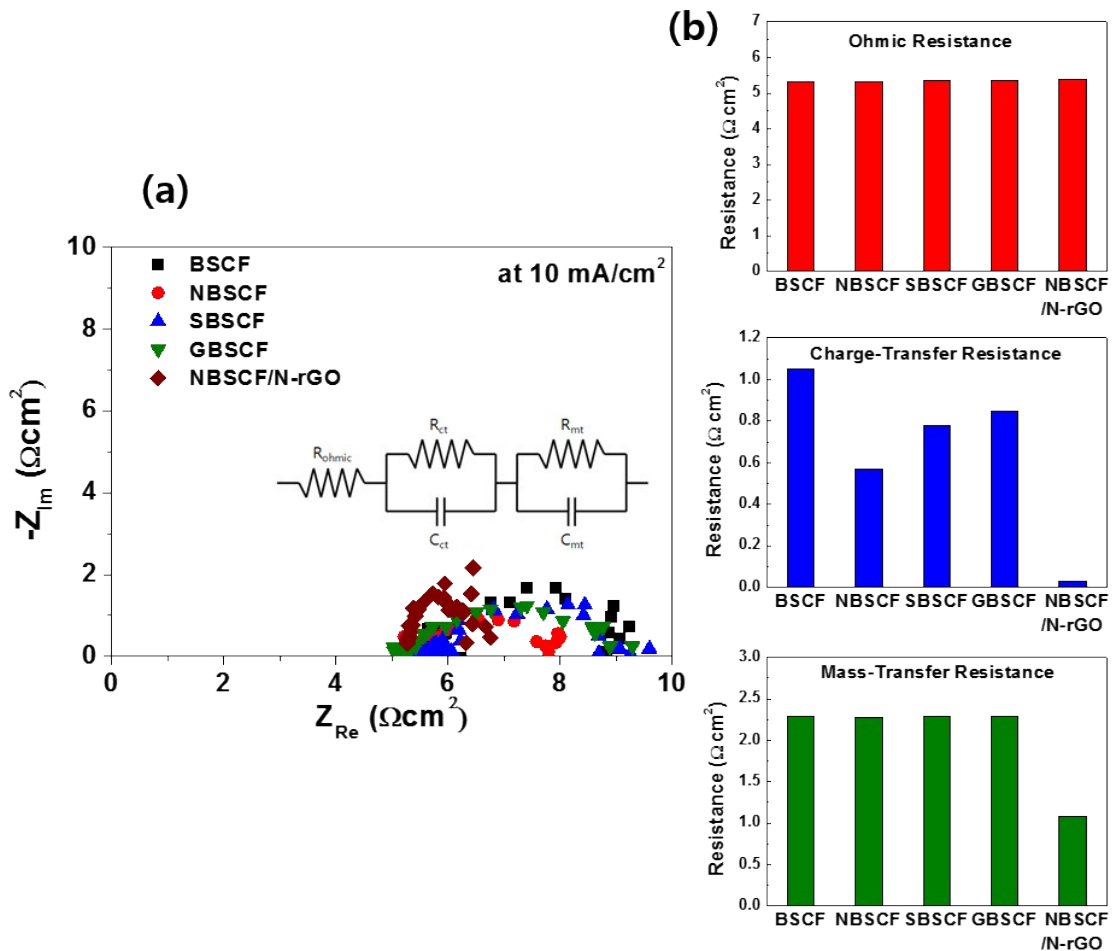


Fig. S10. (a) Nyquist plots of the catalysts at 10 mA cm⁻². (b) Calculated ohmic, charge-transfer, and mass-transfer resistances of the catalysts from Nyquist plots using an appropriate equivalent circuit.

Table S1. Crystal structure parameters of the catalysts from high resolution-synchrotron XRD spectrum (Rietveld refinement profile).

Catalysts	Space group	Phase structure	Lattice parameters (Å)			Unit cell volume (Å ³)
			a-axis	b-axis	c-axis	
BSCF	<i>Pm$\bar{3}$m</i>	Cubic	3.9794	-	-	63.02
NBSCF	<i>Pmmm</i>	Orthorhombic	3.8563	3.8270	7.7365	114.18
SBSCF	<i>Pmmm</i>	Orthorhombic	3.8282	3.8243	7.7386	113.29
GBSCF	<i>Pmmm</i>	Orthorhombic	3.8094	3.8240	7.6228	111.04

Table S2. Elemental compositions of NBSCF, SBSCF, and GBSCF as weight ratios from SEM-EDX results.

Catalysts	Lanthanides (Nd, Sm and Gd)	Ba	Sr	Co	Fe	O
NBSCF	9.28	4.39	4.75	13.54	5.45	62.59
SBSCF	9.92	4.01	5.09	13.19	4.95	62.84
GBSCF	10.66	4.81	5.13	14.71	4.67	60.02