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

Supplementary information

Solid Oxide Fuel Cells for Energy Conversion and Ammonia Synthesis

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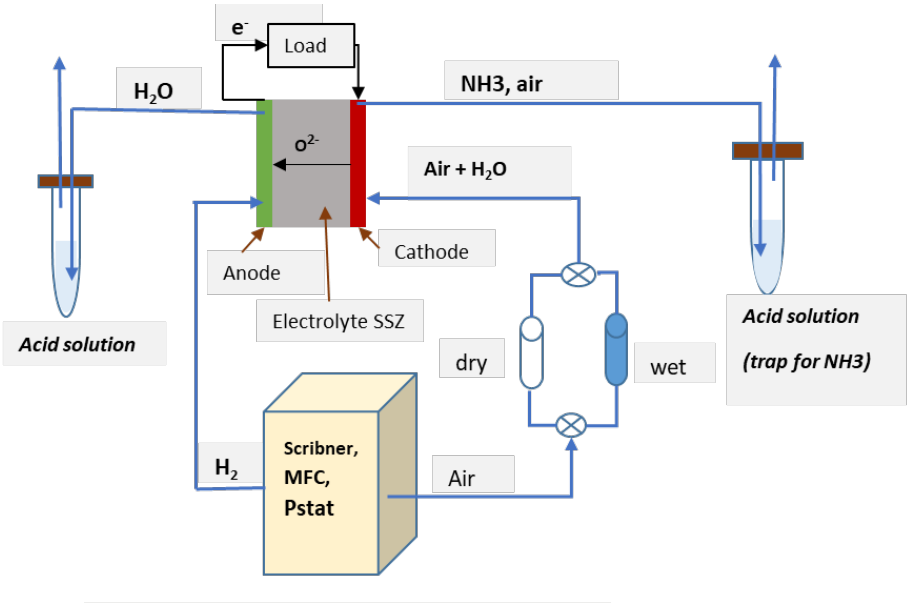
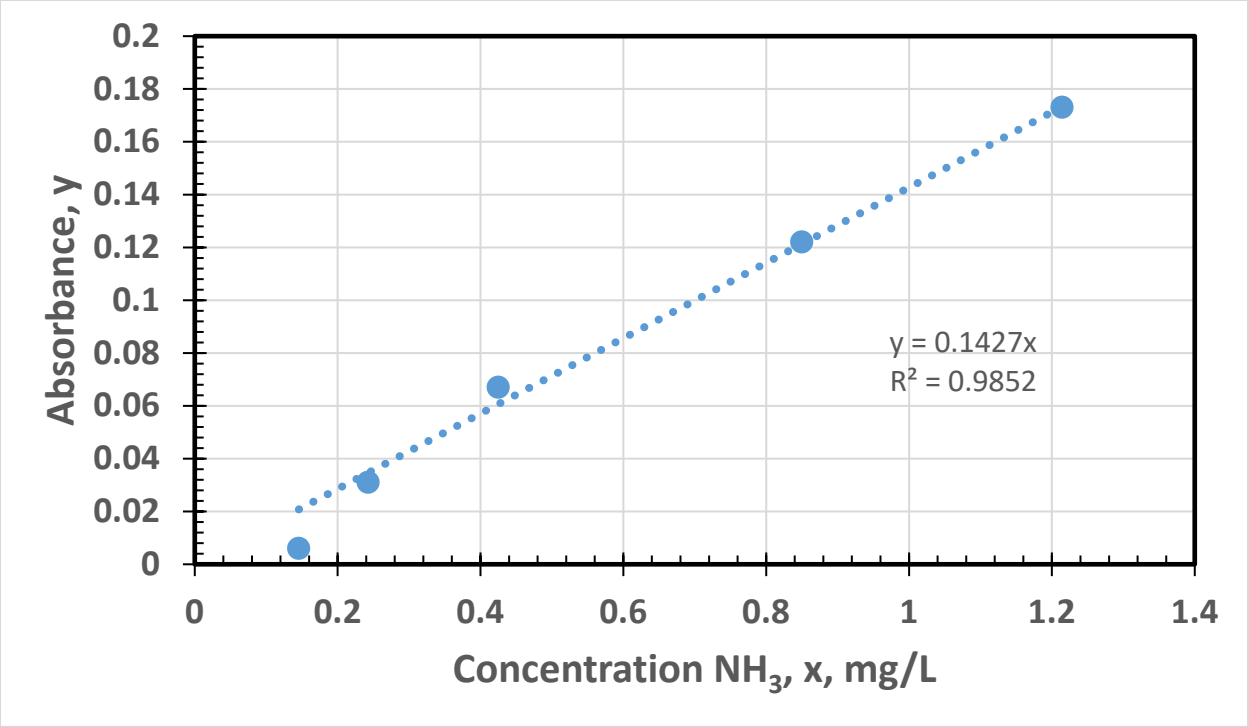
CONTENT

SI-1 Experimental Setup



SI-2. Calibration graph of the spectrophotometer for ammonia

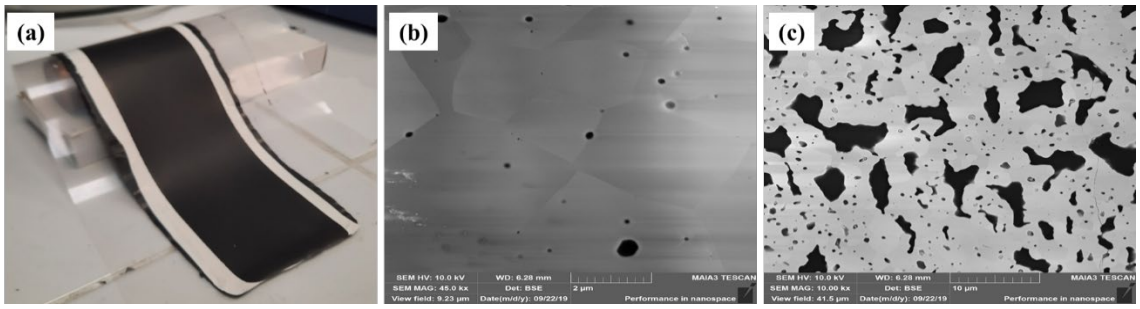


SI-3. Slurry for electrolyte and electrode

The composition of tape casting slurry, wt. %

Compound	Electrolyte	Electrode
SSZ	58.5	30
pore former (Graphite synthetic <20μm)		30
Solvent (water)	5	4
Dispersant (Poly acrylic acid (PAA) with molecular mass of 2000 g/mol)	0.8	0.8
Binder (Polyvinyl alcohol (PVA) with molecular mass of 400 g/mol), 20% solution in water	25	25.7
Plasticizer (Poly ethylene glycol (PEG) with molecular mass of 200 g/mol)	9	8
Plasticizer (Glycerol)	1	1
Defoamer (Polypropylene glycol, grade P-1200)	0.6	0.4
Surfactant (2,4,7,9-tetramethyl-5-decyne-4,7-diol ethoxylate)	0.1	0.1

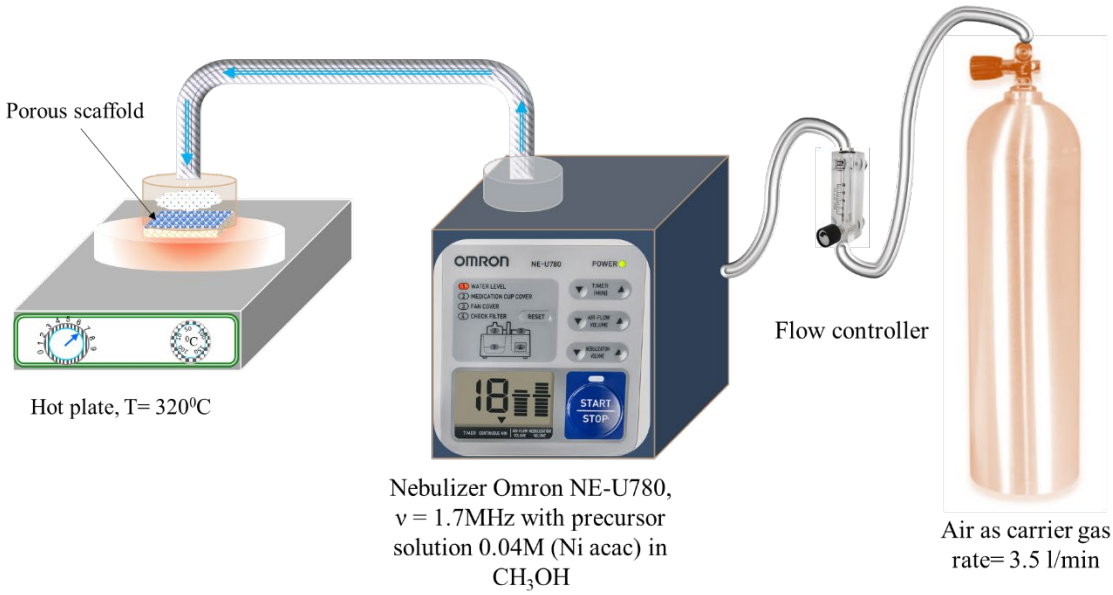
SI -4. (a) photographic image of the green tape (porous, black/Dense, white/porous, black), (b) SEM image of the ScSZ electrolyte, and (c) SEM image of the porous scaffold layers after sintering at 1500 ^{0}C



SI-5. Experimental setup of AACVD for the deposition of NiO into porous ScSZ layer

Deposition of NiO on porous layer SSZ was done AACVD techniques.

The experimental setup is shown in Fig.SI-5, Omron NE-U780 Model Ultrasonic Nebulizer of frequency 1.7MHz was used for grown thin film. A stock solution of 0.04M nickel (II) acetylacetonate (Ni (acac)) in methanol is used as the precursor. The substrate temperature was maintained at 320°C, and the air was used as carrier gas with a flow rate of 3.5 l/min. The flow rate was controlled by a general purpose flow meter, Dwyer 1-10 l/min Air. Time deposition 1.5 hours.



LSCF deposition

An infiltration solution of LSCF precursor was prepared by dissolving stoichiometric amounts of

a) $La(NO_3)_3 \cdot 6H2O$, $Sr(NO_3)_2$, $Co(NO_3)_2 \cdot 6H_2O$ and $Fe(NO)_3 \cdot 9H_2O$ in ethanol

b) 0.03M solution in 100 ml(10ml H2O+methanol) Fe(ac), Co(ac), La(ac), Sr(ac)

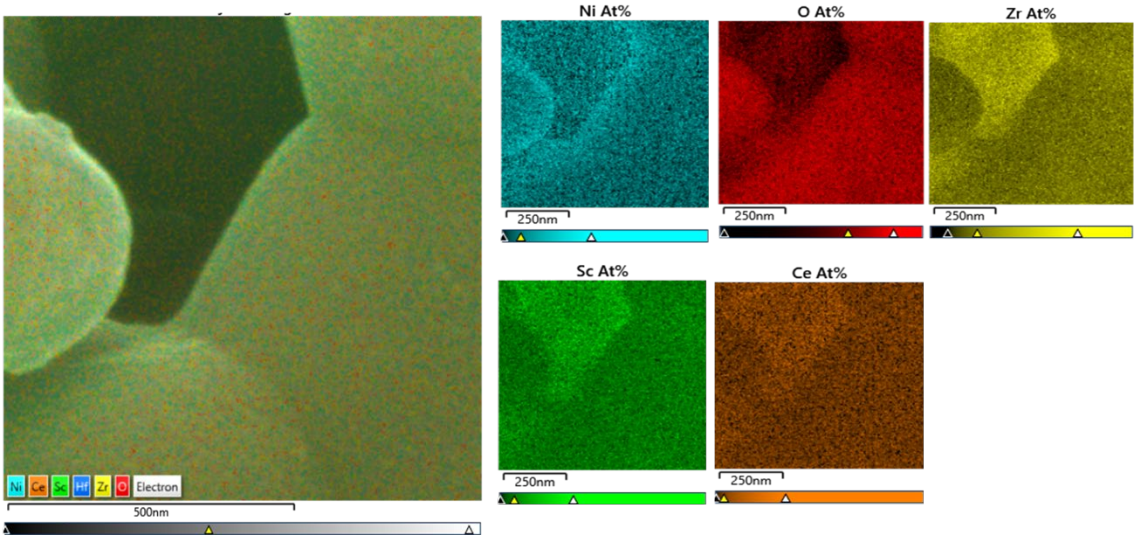
Infiltration was carried out by inserting precursor solution into porous SSZ layer. The infiltrated samples dried at room temperature and then fired at 450°C for 1 h to decompose the organic compounds.

This procedure was repeated some times, and the cell was sintering at 900°C for 1 h.

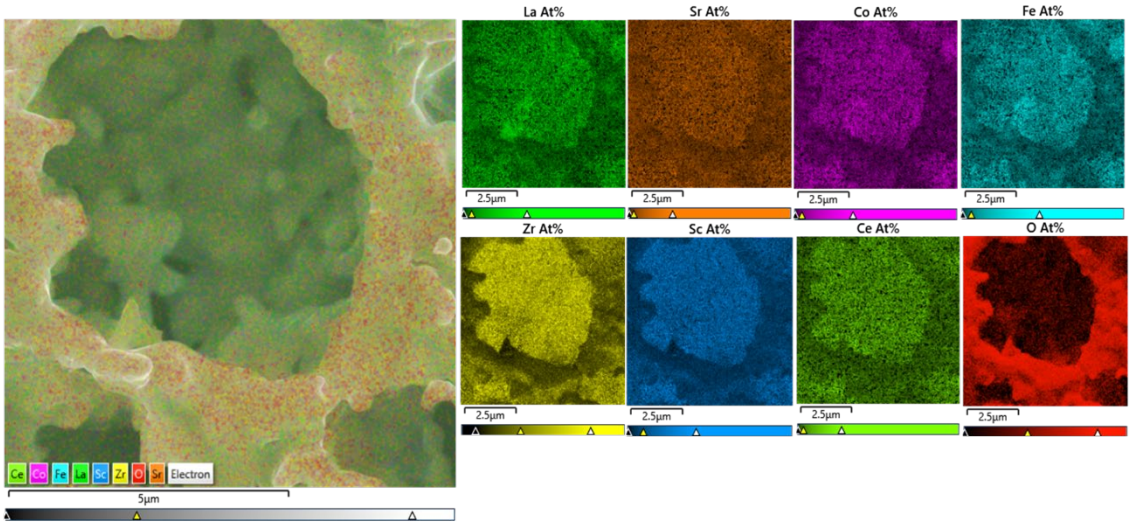
SI-6. The elementary analysis of the deposited anode and cathode

Electrodes	Atomic %								
	O	Ni	Zr	Sc	Fe	La	Co	Sr	Ce
NiO-ScSZ	54.1	37.1	7.8	0.9	-	-	-	-	-
LSCF-ScSZ	61.6	-	26.9	6.6	1.8	1.3	0.8	0.6	0.3

SI-7. EDS mapping of the AACVD deposited NiO onto the porous ScSZ scaffold



SI-8. EDS mapping of the infiltrated LSCF (acetate precursor) onto ScSZ by infiltration



SI-9 XRD analysis

X-ray diffraction pattern of (a) NiO infiltrated in porous ScSZ layer, (b) LSCF (acetate precursor) in porous ScSZ, (c) LSCF (nitrate precursor) in porous ScSZ, (d) LNF powder calcined at 900 °C and (e) MDC powder calcined at 900 °C.