Supporting Information

Efficient Solar-Driven Steam Generation for Clean Water Production using a Low-cost and Scalable Natural Rubber Composite Sponge

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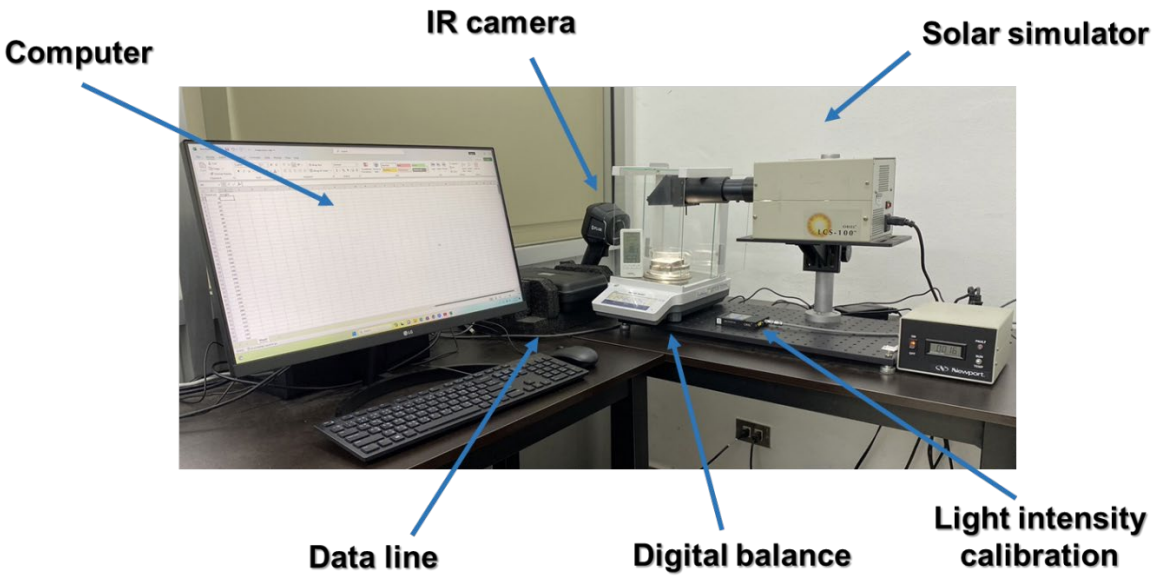

Fig. S1 The solar-driven vaporization setup

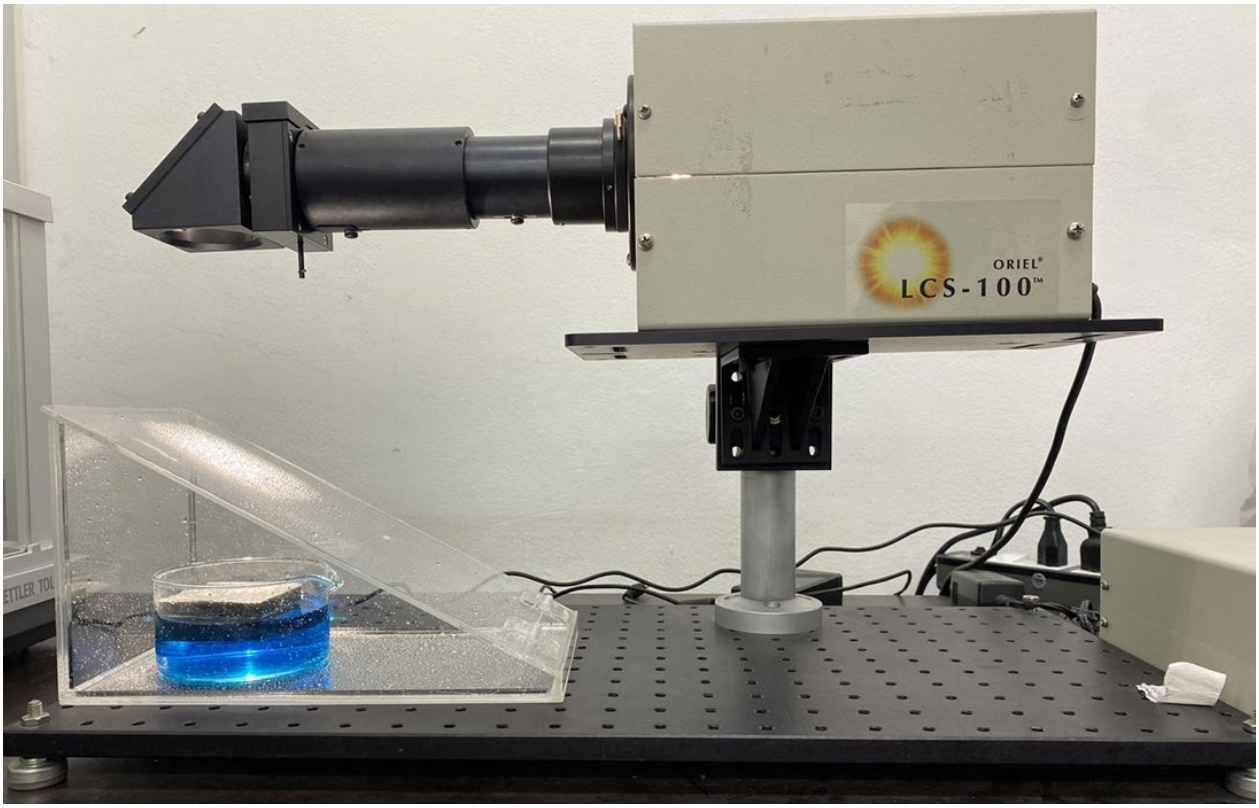

Fig. S2 Desalination and clean water production setup

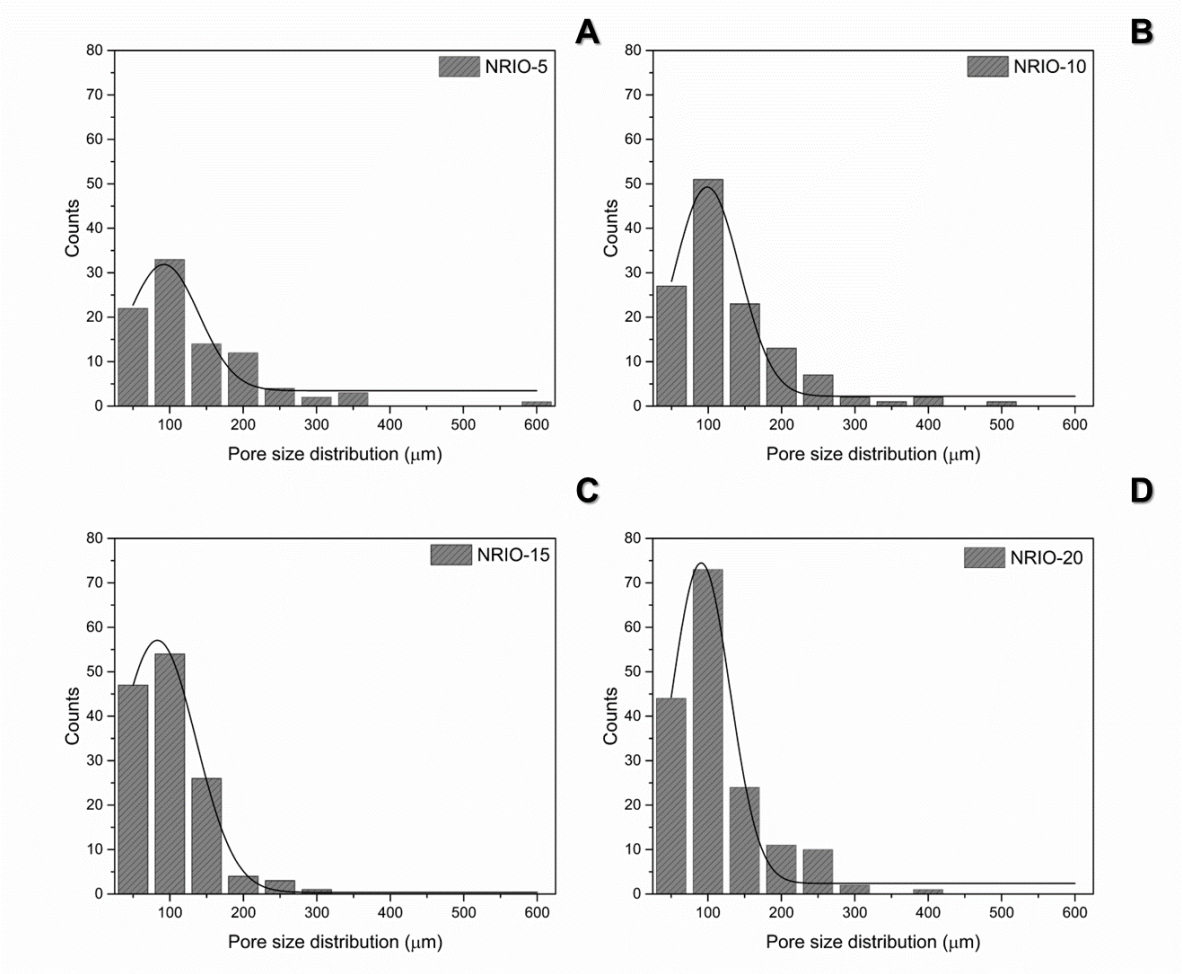

Fig. S3 Pore size distributions of all prepared samples measured from SEM images in Fig. 2A using Image J software and analyzed by Gaussian fitting

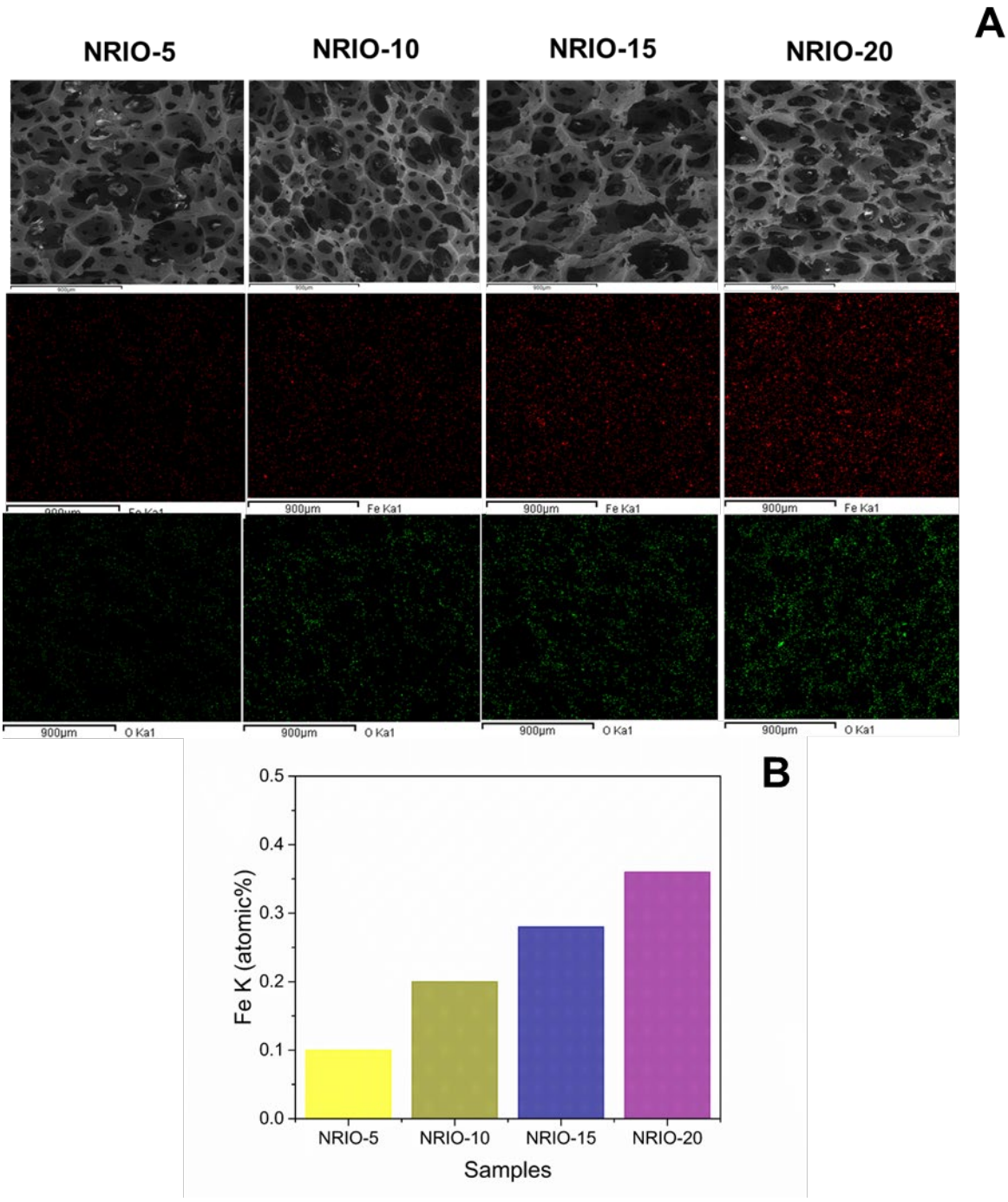

Fig. S4 A) SEM/EDS analysis of Fe and O elements and B) Fe atomic% of the composite sponges

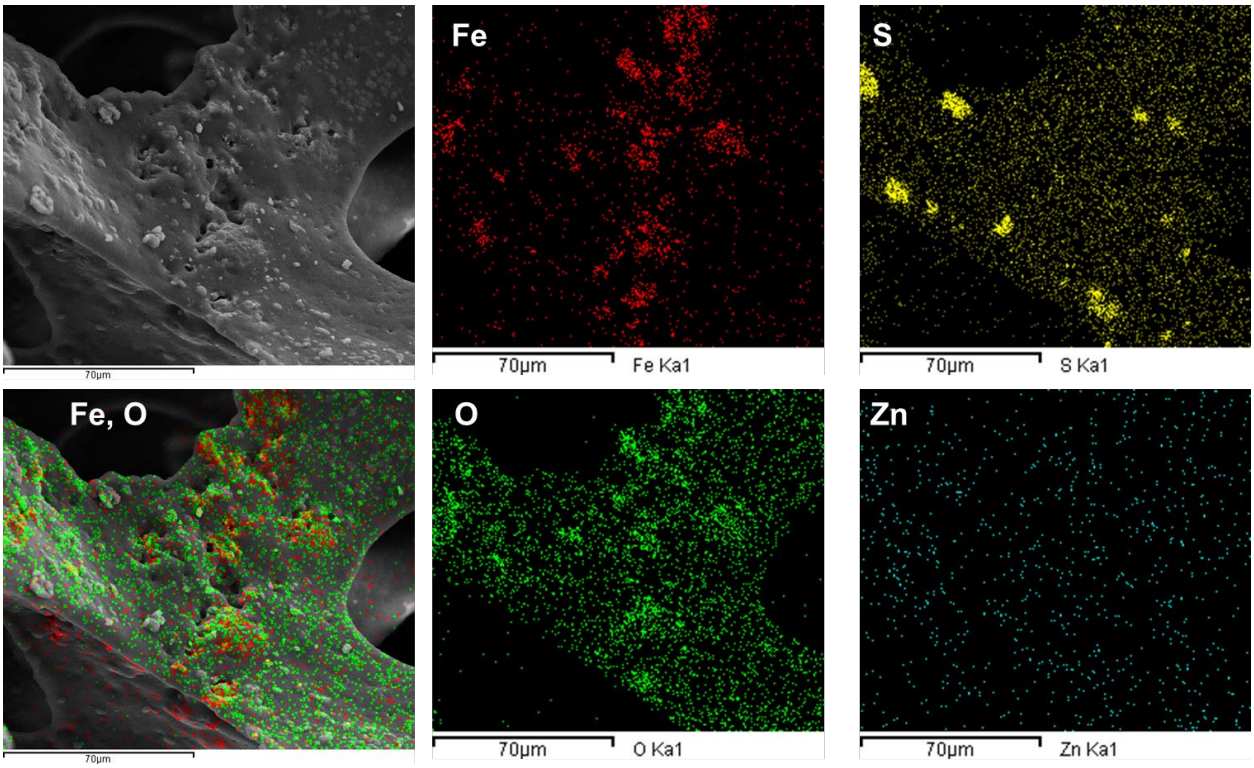

Fig. S5 SEM/EDS elemental mapping on the cross-section of NRIO-20 at ×1000 magnification

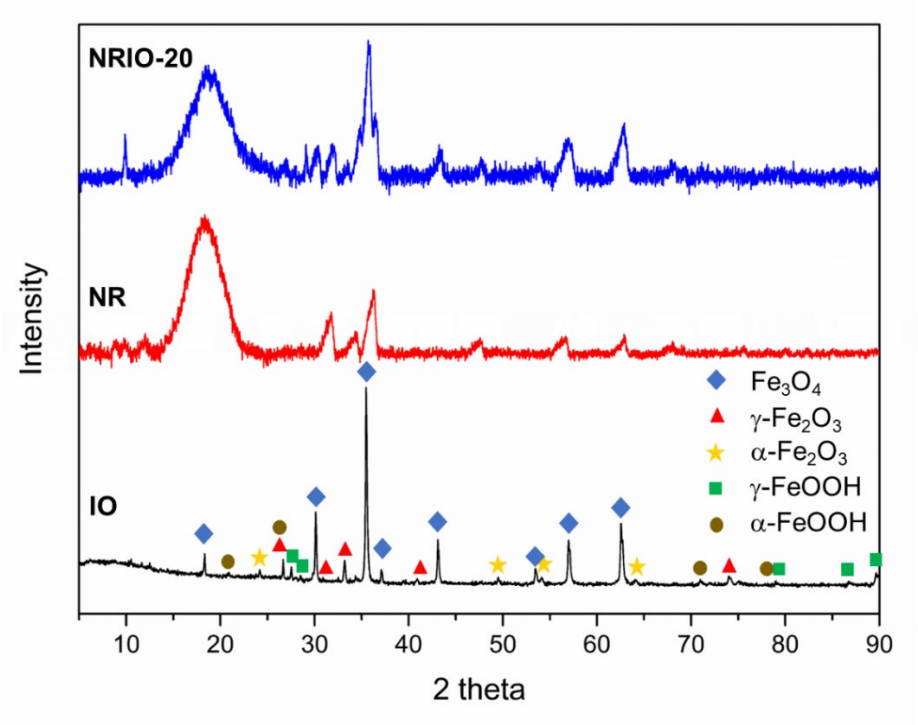

Fig. S6 XRD patterns of NRIO-20, NR, and IO

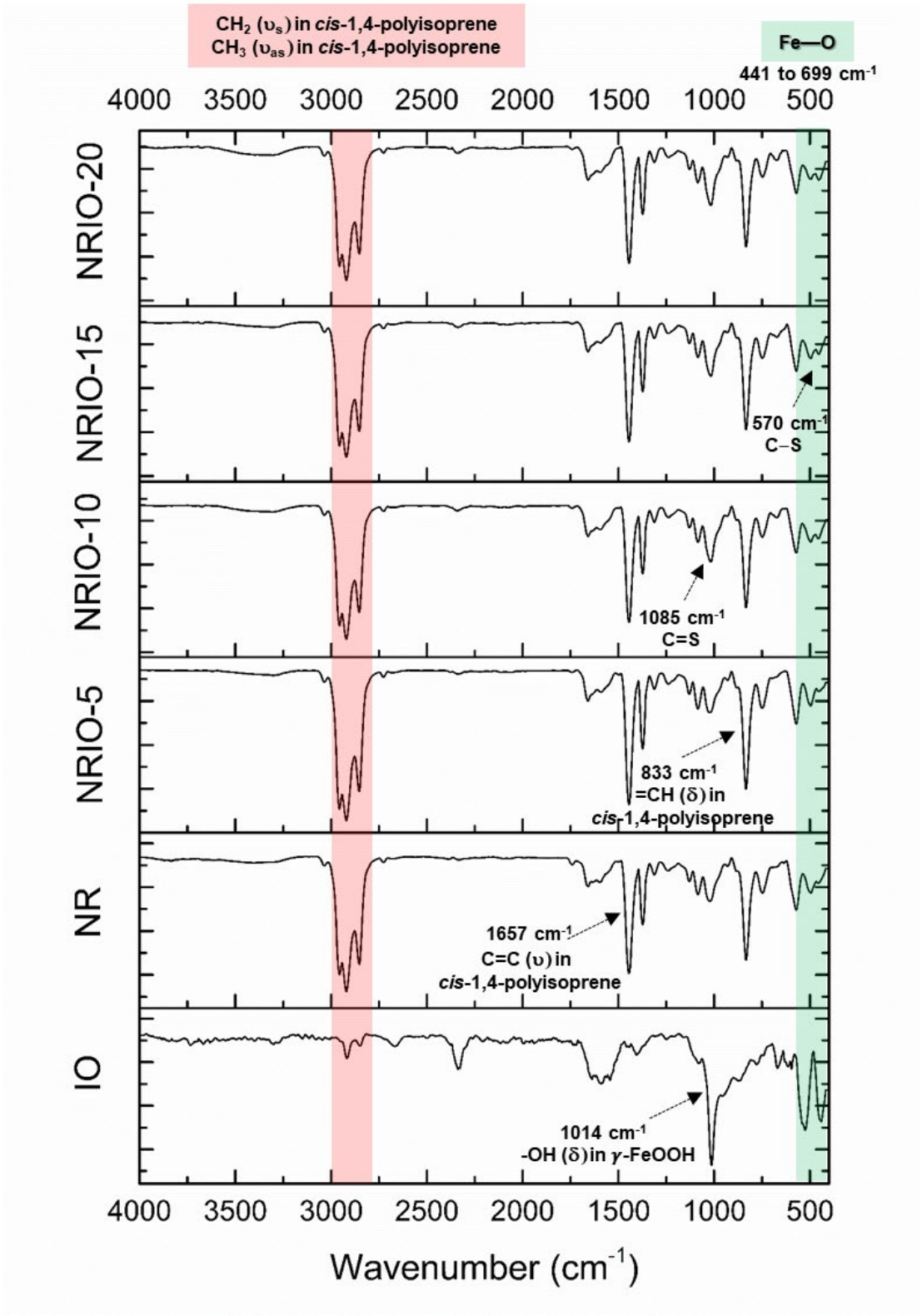

Fig. S7 ATR-FTIR spectra of all samples

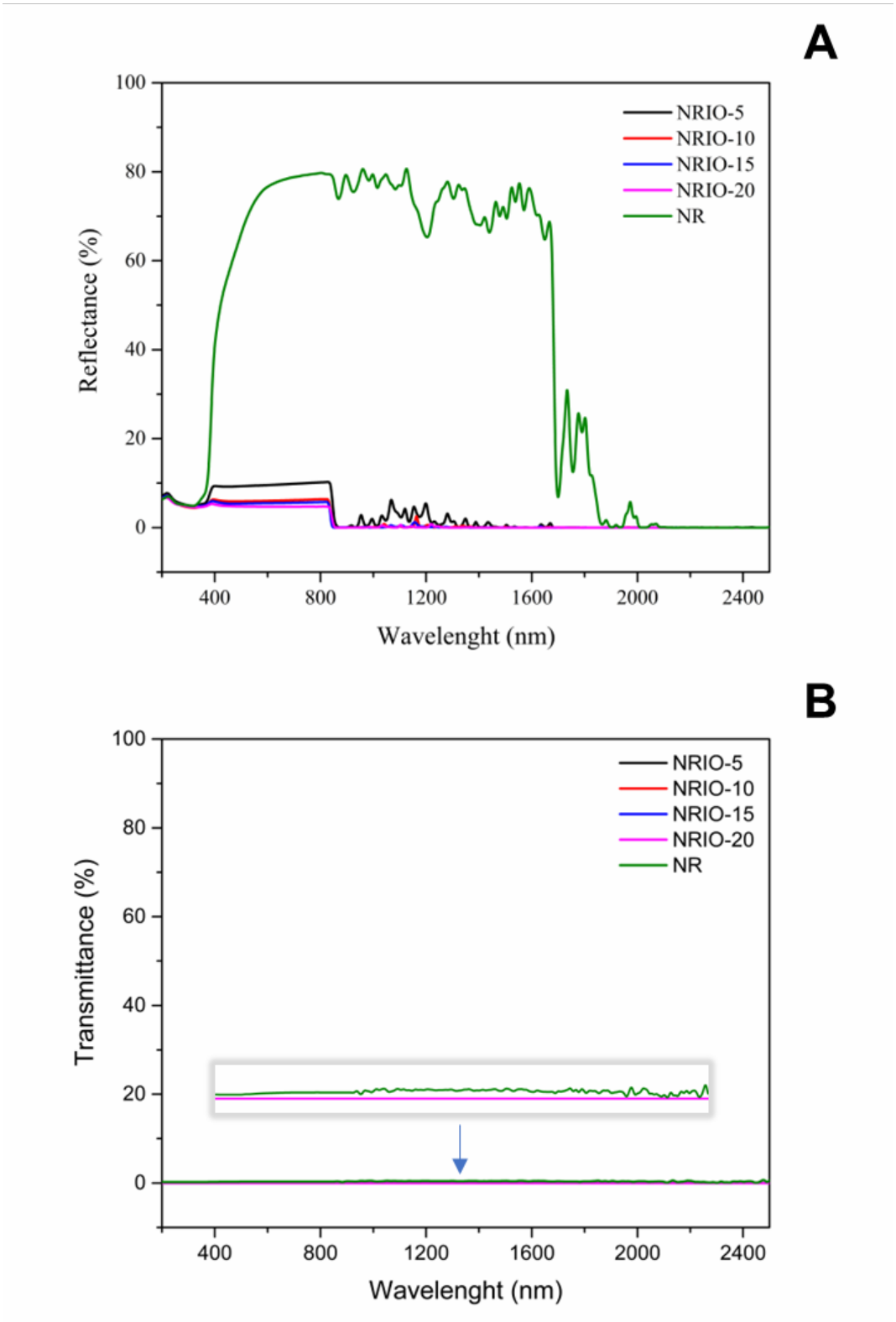

Fig. S8 A) Reflectance and B) transmittance of all prepared samples

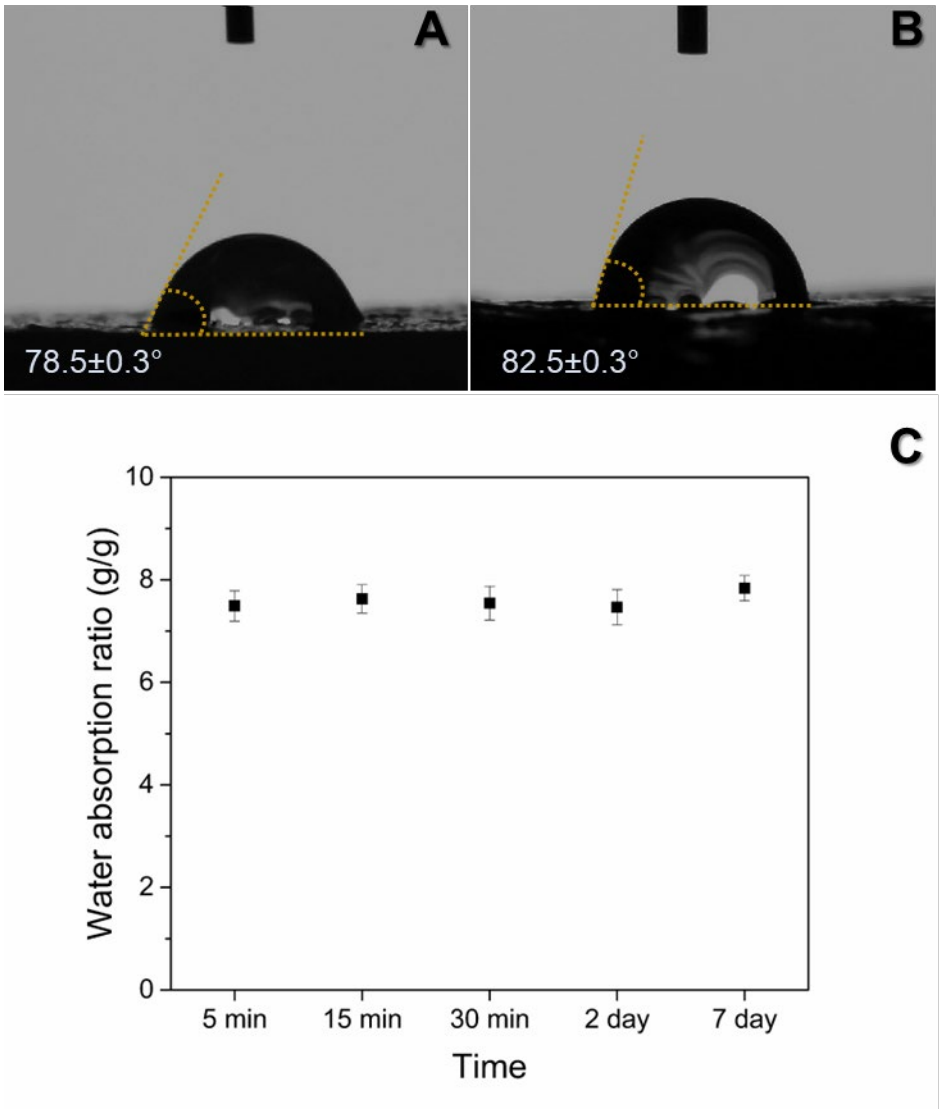

Fig. S9 Water contact angle of A) NR and B) NRIO-20 and C) water absorption ratio of NRIO-20

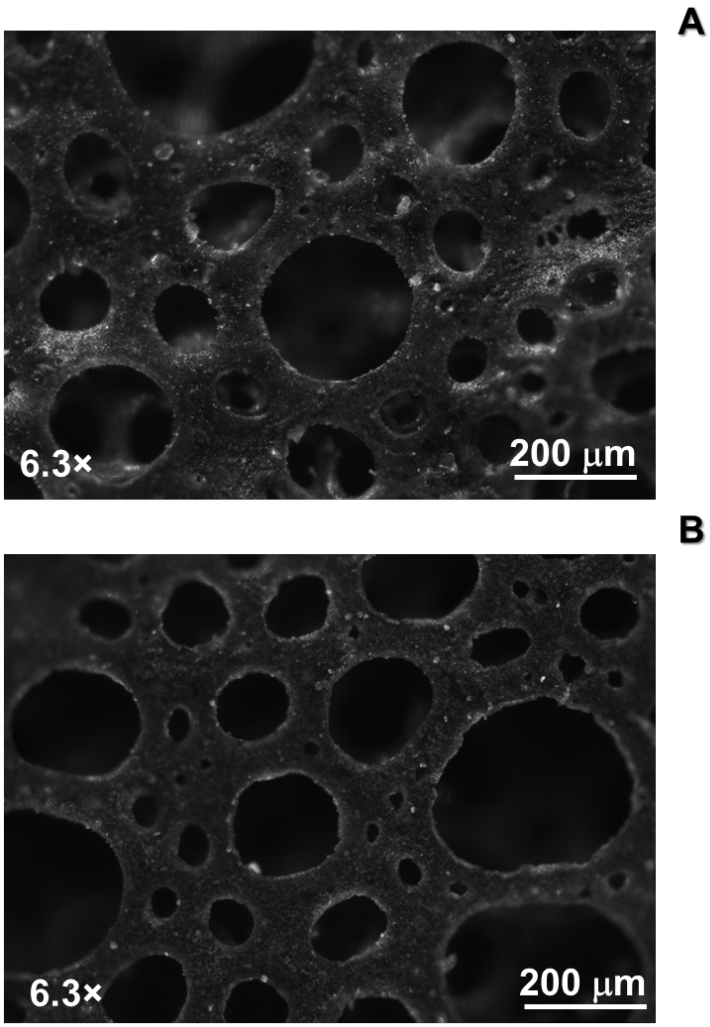

Fig. S10 Optical microscope images (BX43F, Olympus) of NRIO-20 A) before and B) after ozone treatment for 72 h with an ozone concentration of 50 pphm and a temperature of 40°C

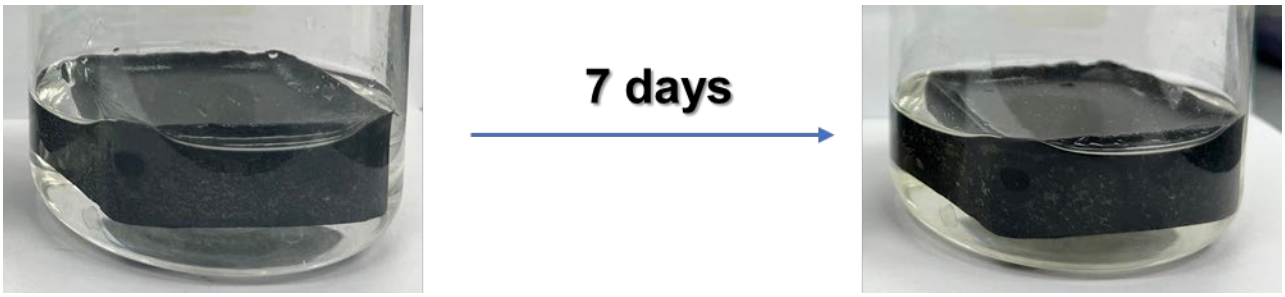

Fig. S11 The process of chemical corrosion resistance test. The specimen was submerged in an acid solution (pH 1) for 7 days.

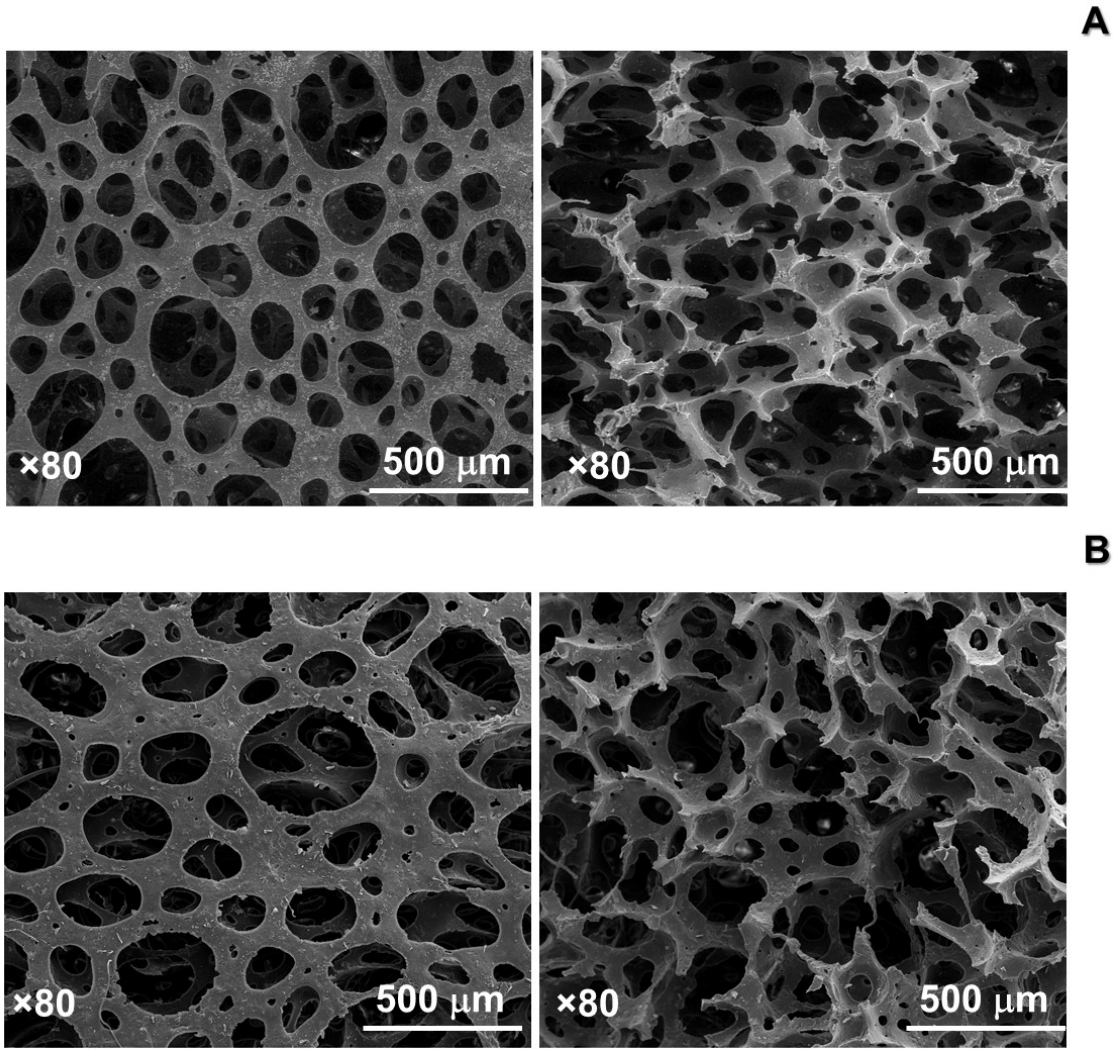

Fig. S12 Surface and cross-sectional SEM images of NRIO-20 A) before and B) after acid treatment for one week

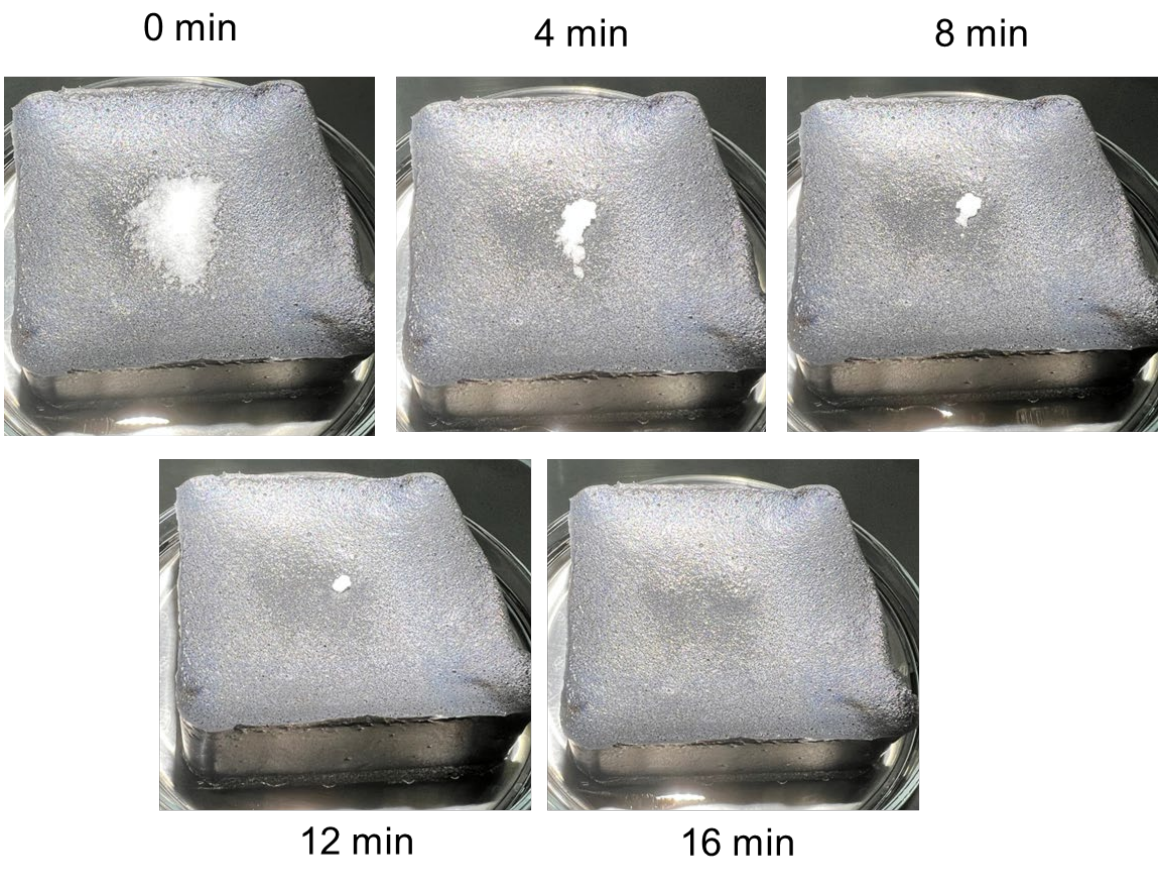

Fig. S13 Salt was rejected by NRIO-20 in 16 mins

Table S1 Comparison of solar absorbers under 1 sun irradiation

Materials	Fabrication procedure	Light absorption (%)	Evaporation rate ($kg/m^2/h$)	Thermal conductivity (W/m/K)	Efficiency (%)	Ref.
Fe_3O_4/polypyrrole-coated superhydrophilic porous foam	1) Prepare hydrophilic porous polymer foam (HPSS) by a hydrothermal method from sodium *p*-styrene sulfonate 2) Soak HPSS foam in a solution of $FeCl_3 \cdot 6H_2O$ and PVP for 48 h, then add $N_2H_4 \cdot H_2O$ into the solution and keep the temperature constant at 70℃ for 6 h in an oil bath 3) Wash the sample with distilled water and freeze-dry to obtain the black-grey foam 4) Prepare HPSS/Fe_3O_4 /PPy by alternately spraying solution A (ammonium persulfate) and solution B (pyrrole, IPA, and phytic acid) on the upper surface of HPSS/Fe_3O_4 several times until the surface of HPSS/Fe_3O_4 becomes completely black 5) Wash the foam with DI water and then dry	92	1.51	Dry=0.039	94.7	[1]
Electrically conductive and magnetic carbon aerogel	*Preparation of magnetic waste paper (MWP) aerogels* 1) Soak shredded waste paper in DI water for 24 h and stir for 3 h 2) Dilute the obtained waste paper pulp with DI water and then add sodium chlorite to the pulp 3) Adjust to pH 4.5 followed by oxidation at 80°C for 2 h under mechanical stirring 4) Wash the treated waste paper pulp with DI water and ethanol and then disperse it in ethanol 5) Prepare iron solution by dissolving $FeCl_3 \cdot 6H_2O$ in ethylene glycol followed by adding the proper amount of sodium acetate and polyethylene glycol 6) Add the paper pulp into the iron solution, stir for 1 h, and then seal the mixture at 200°C for 24 h to grow Fe_3O_4 nanoparticles 7) Wash the Fe_3O_4-modified cellulose with DI water and ethanol and then disperse it in ethanol 8) Pour the suspension into a mold and then dry at 60°C for 6 h *Preparation of magnetic carbon aerogels* 9) Pyrolyze the MWP aerogels at 200-1000°C under N_2 for 4 h 10) Activate the external surface using O_2-plasma for 2 min	~97	1.46	Dry=0.044	~70.3%	[2]
Al-Ti-O PVDF hybrid membrane	1) Ball-mill commercial Al and TiO_2 powder to obtain black Al-Ti-O hybrid 2) Wash the ball-milled sample with 0.1M HCl, centrifuge, rinse	90.23	1.24	-	77.52	[3]

Materials	Fabrication procedure	Light absorption (%)	Evaporation rate ($kg/m^2/h$)	Thermal conductivity (W/m/K)	Efficiency (%)	Ref.
	with DI water and ethanol multiple times, and dry at 60°C for 12h 3) Produce porous PVDF membrane with black Al-Ti-O hybrid using nonsolvent-induced phase inversion					
Fe_3O_4/polyvinyl alcohol decorated delignified wood evaporator	1) Soak wood sheets in 2 wt% $NaClO_2$ (pH 4.6) for various periods (0−10 h), rinse with a 1:1 mixture of ethanol and DI water, and then freeze-dry to obtain delignified wood 2) Add PVA in DI water and then heat at 80°C for 30 min 3) Add $FeCl_3$ in the PVA solution and remove bubbles using ultrasonic treatment 4) Coat the wooden substrates with the $FeCl_3$/PVA suspension using a flexible writing brush, wipe excess solution off, and then blow with air to remove unattached particles 5) Heat coated samples at 120°C for 12 h	~97	1.3	Dry=0.22 Wet= 0.29	73	[4]
Fe_3O_4/diatomite-decorated cotton evaporator	1) Tear the cotton into cotton wadding and stir it with Fe_3O_4 dispersion for 6 h 2) Add diatomite and PVA to the dispersion, heat it to 80°C, and then stir until the surface water dries off 3) Press the material into the mold, dry it in an oven at 80°C for 12 h	93.42	1.32	-	82.9	[5]
$CuFeSe_2$ NP-decorated wood membrane	1) Dissolve $Cu(acac)_2$ and $Fe(acac)_3$ in oleylamine and diphenyl ether and then stir under nitrogen 2) Dehydrate at 110°C for 1.5 h and then heat to 265°C for 1 h 3) Inject the mixture of diphenyl diselenide and oleylamine into the prepared solution and then stir for 1 h to obtain $CuFeSe_2$ NP 4) Add ethanol into the reaction mixture and then centrifuge 5) Rinse the particles with ethanol-petroleum ether to remove excess oleylamine and disperse the particles in chloroform 6) Submerge a piece of wood into the dispersion of $CuFeSe_2$ NPs and then vacuum until it becomes black	~99	~1.06	Dry=0.12 Wet=0.525	67.7	[6]
Cotton-CuS nanocage agarose aerogel	1) Disperse Cu_2O in Milli-Q water and react it with thiourea at 90°C for 4 h to create CuS yolk-shell nanocages 2) Centrifuge and wash the obtained particles with water and ethanol several times 3) Disperse CuS nanocages, agarose, and urea in water and ethanol solution and stir at 80°C for 30 min 4) Pour the suspension onto a cotton pad, cool down, and then freeze dry	97	1.63	Dry=0.04	94.9	[7]

Materials	Fabrication procedure	Light absorption (%)	Evaporation rate ($kg/m^2/h$)	Thermal conductivity (W/m/K)	Efficiency (%)	Ref.
Polypyrrole coated natural latex foam	1) Dip commercial natural rubber latex foam into 1% pyrrole aqueous solution for 2-3 h with proper back and forth extrusion 2) Add ammonium persulfate solution into the above solution 3) Polymerize in an ice bath for 6 h 4) Clean the sample with DI water	~95	1.76	Dry=0.2257 Wet= 0.5199	98	[8]
Polydopamine coated natural rubber latex sponge	1) Ultrasonically clean the natural rubber sponge with ethanol and DI water 2) Adjust the pH of dopamine solution to 8.5 with ammonia 3) Soak the natural rubber sponge in the dopamine solution at RT for 18 h 4) Rinse the sample with ethanol and vacuum-dry at 60°C	-	1.35	-	84.6	[9]
MXene and protonated-g-C_3N_4 on natural latex foam	1) Prepare MXene powder from Ti_3AlC_2 and LiF in 9 M HCl solution, rinse with DI water, and dry overnight in a vacuum oven 2) Prepare g-C_3N_4 by heating melamine in a furnace at 550°C, mix it into 2 M HNO_3 solution before placing in an oven for 4 h and then washing with DI water 3) Disperse MXene, g-C_3N_4, and PVA in DI water and then brush coat the mixture onto the natural latex foam	93.1	1.85	-	93.5	[10]
Iron oxide black/natural rubber composite sponge	1) Blend the compounding formulation to produce natural rubber/ iron oxide black composite sponge 2) Put the mixture into a silicone mold and vulcanize at 70°C for 2 h 3) Wash the composite sponge and dry it overnight at 90°C	95	1.20	Dry=0.048 Wet=0.108	77.05	This work

Table S2 Comparison of water quality

Sample	TDS (ppm)	EC (μS/cm)	References
Simulated seawater	**>9990**	**43563.33**	**This work**
Condensed water	**23**	**53.16**	**This work**
DI water	**1**	**9.10**	**This work**
Pacific Ocean water (Before SWRO*)	39434	474.5	[11]
Pacific Ocean water (after SWRO)	409	8.1	[11]
WHO recommendation for drinking water	<500	<1400	[12]

* SWRO is the seawater reverse osmosis process

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