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

The supporting information for

Self-floating nanostructural Ni-NiO$_x$/Ni foam for solar thermal water evaporation

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Content

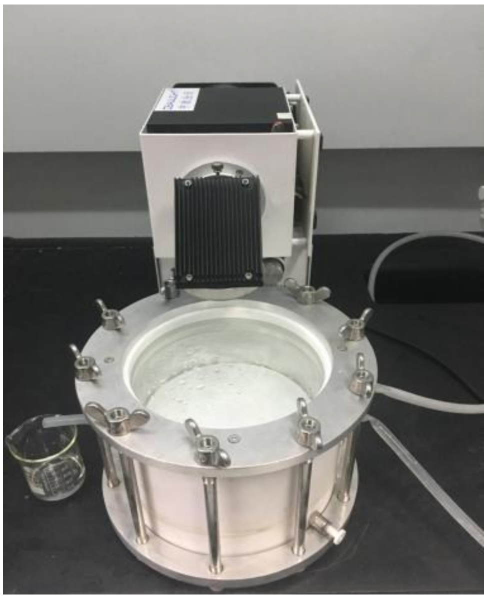

Figure S1. A home-made solar seawater desalination system to simulate solar seawater desalination.

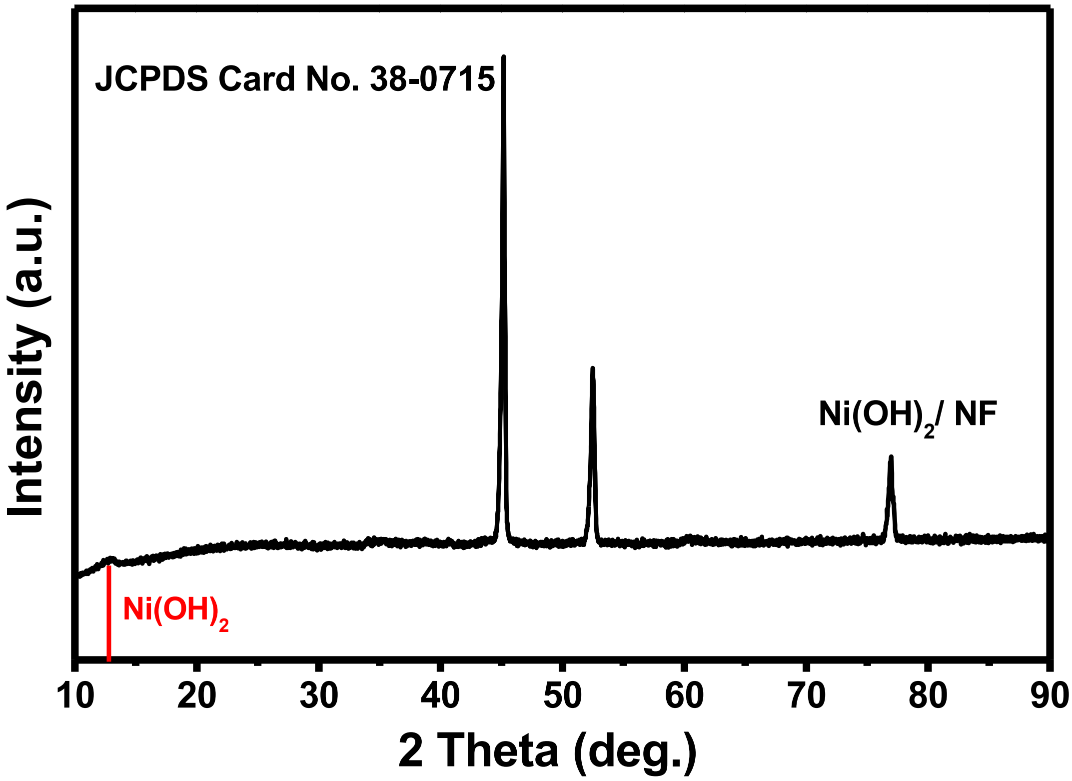

Figure S2. The X-ray diffraction (XRD) pattern of the $Ni(OH)_2$/NF, JCPDS Card No.38-0715.

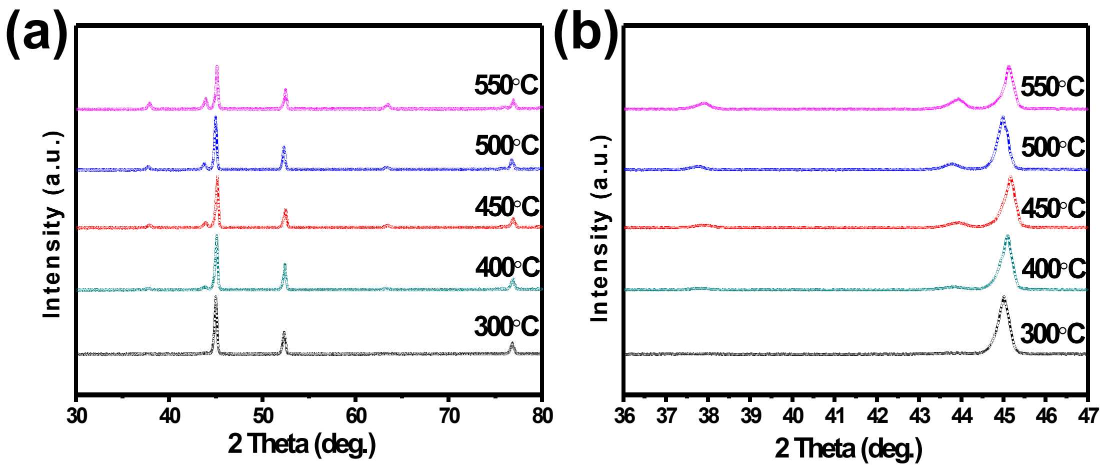

Figure S3. (a) The X-ray diffraction (XRD) pattern of the $Ni(OH)_2$ at different calcining temperatures from 300 to 500 °C for 1h. (b) Intensity variation diagram of characteristic peaks(43.3°) of NiO/NF.

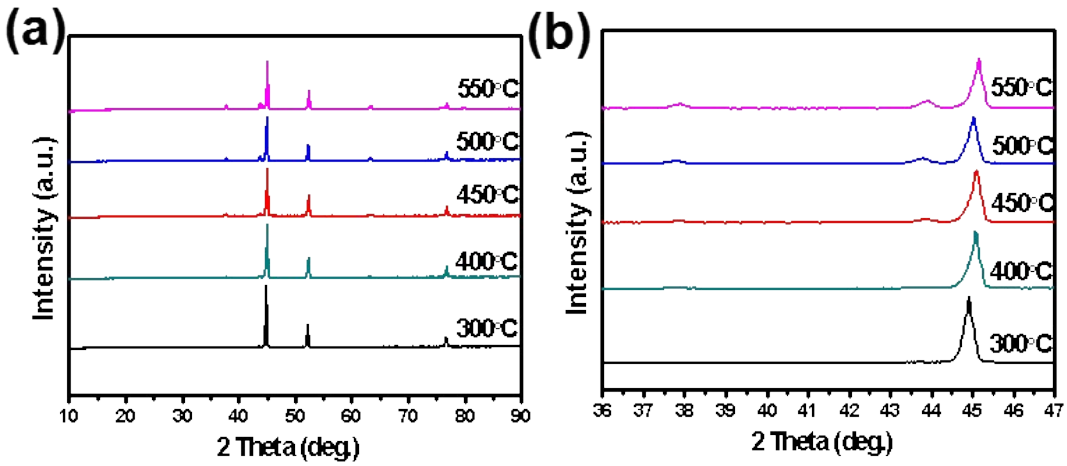

Figure S4. (a) The X-ray diffraction (XRD) pattern of NiO/NF at different temperature being reduced. (b) Intensity variation diagram of characteristic peak(43.3°) of NiO/NF.

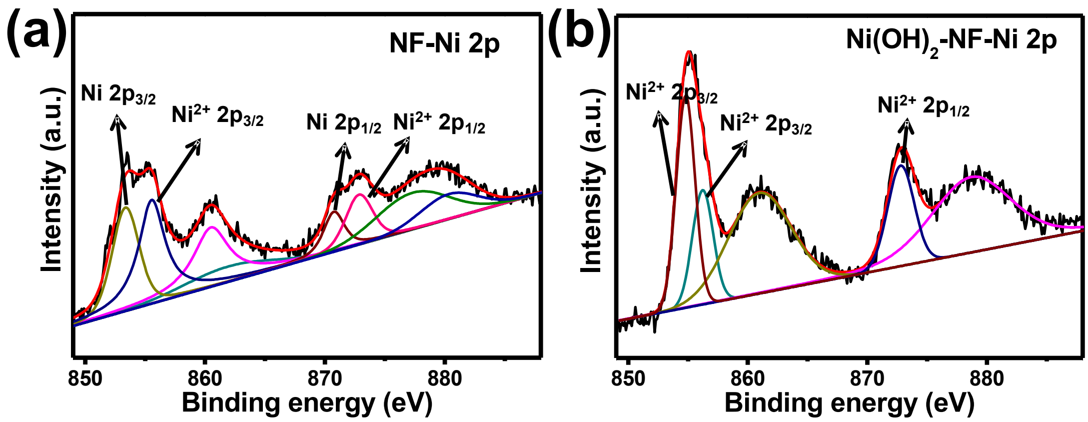

Figure S5. (a-b) The X-ray photoelectron spectroscopy (XPS) spectra of Ni foam, $Ni(OH)_2$.

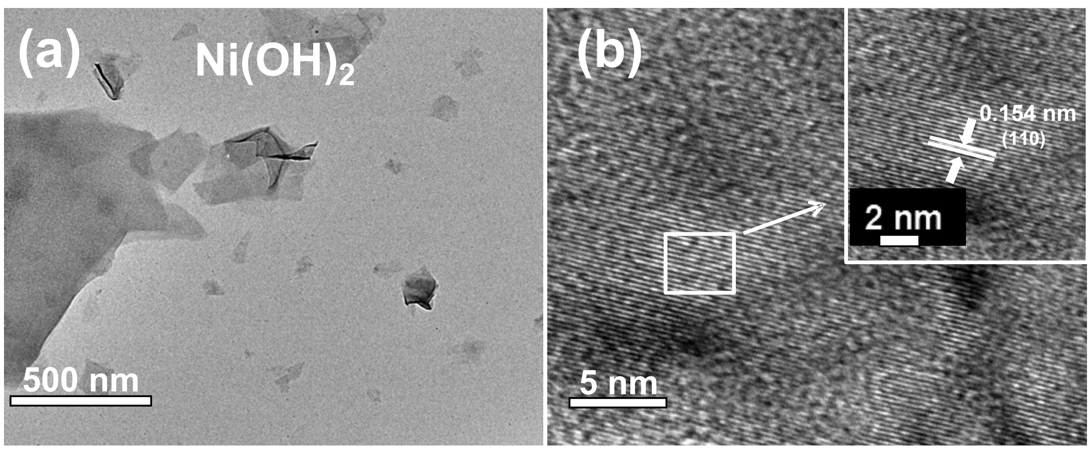

Figure S6. (a-b) The TEM and HRTEM of the $Ni(OH)_2$, the high resolution (HR) TEM image illustrates the lattice fringe space of 0.154 nm relating to the $Ni(OH)_2$ (110).

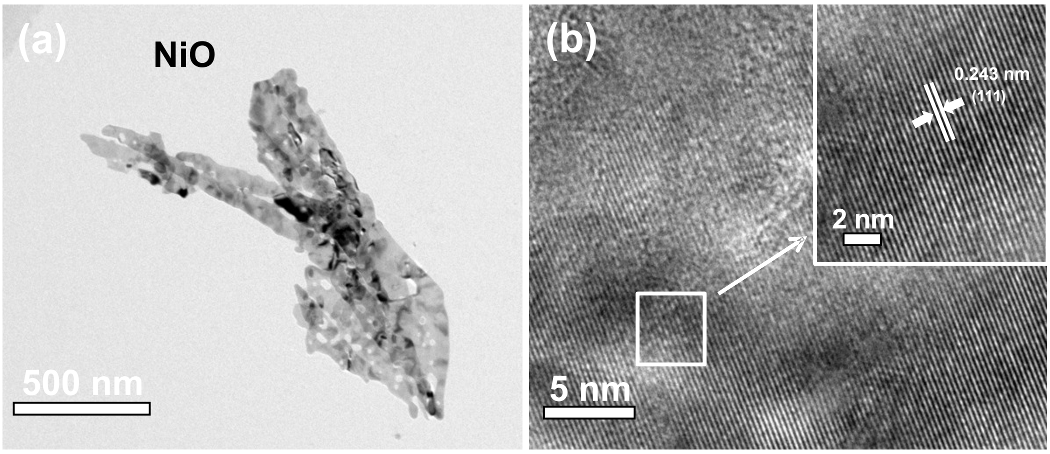

Figure S7. (a-b) The TEM and HRTEM of the $Ni(OH)_2$,the high resolution (HR) TEM image illustrates the lattice fringe space of 0.243 nm relating to the NiO(111).

The equation S1

$$\alpha_{sol} = \frac{\int_{0.28\,\mu m}^{2.5\,\mu m} I_{sol} \cdot \alpha(\lambda) \cdot d\lambda}{\int_{0.28\,\mu m}^{2.5\,\mu m} I_{sol}(\lambda) \cdot d\lambda} = \frac{\int_{0.28\,\mu m}^{2.5\,\mu m} I_{sol}(\lambda) \cdot [1 - R(\lambda)] \cdot d\lambda}{\int_{0.28\,\mu m}^{2.5\,\mu m} I_{sol}(\lambda) \cdot d\lambda}$$

The equation S2

$$\alpha(\lambda) = 1 - R(\lambda) - T(\lambda) = 1 - R(\lambda)$$

Where, a_{sol} is overall solar absorptance. I_{sol}(l) is the radiation intensity at wavelength l in AM 1.5 solar spectrum . R(l)and T(l) are reflectance and transmittance at wavelength l, respectively.

Table S1. Calculation data of absorbance of different samples.

Sample	Total(A,%)
Ni foam	68.09
$Ni(OH)_2$/Ni foam	70.50
NiO/Ni foam	88.16
Ni-NiO_x/Ni foam	90.31

Table S2. Calculation data of the thermal conductivity of different samples.

Thermal conductivity = thermal diffusion coefficient * density * specific heat.

Sample	Temp. ℃	Dia. mm	THK mm	Volume mm^3	Mass mg	Density g/cm^3	Thermal diffusion cm^2/s	Specific heat J/g*C	Thermal conductivity (W/MK)
Ni foam	30	12.7	0.293	37.10	206.02	5.55	0.0044	0.43	1.04
$Ni(OH)_2$/NF	31	12.7	0.157	19.88	92.99	4.68	0.0033	0.45	0.69
NiO/NF	29	12.7	0.281	35.58	172.75	4.86	0.0047	0.43	0.99
Ni-NiO_x/NF	30	12.7	0.266	33.68	158.98	4.72	0.0012	0.43	0.24

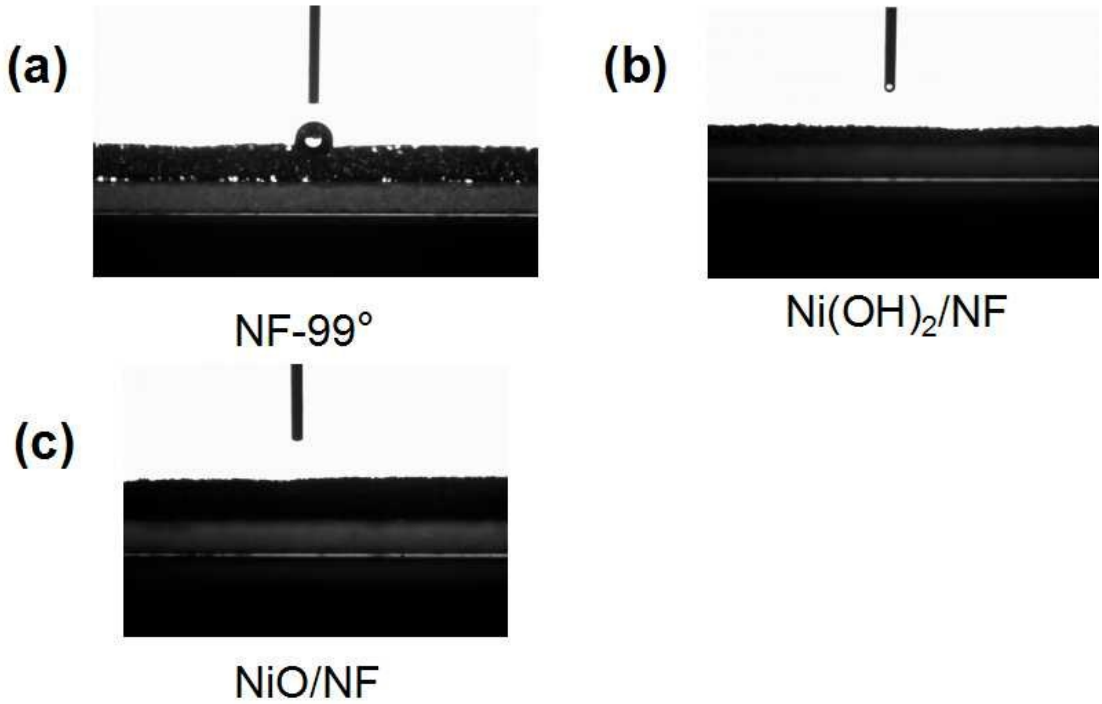

Figure S8. (a-c) The contact angles of the original Ni foam, $Ni(OH)_2$ nanosheets, NiO nanosheets samples display super hydrophilic behavior.

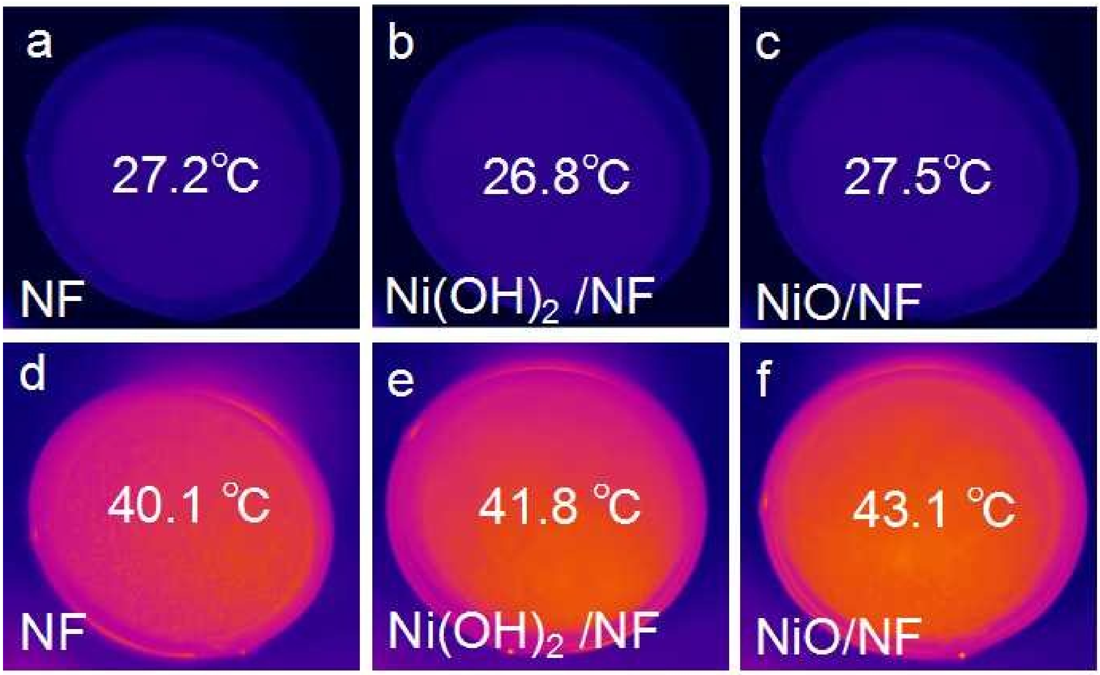

Figure S9. (a-f) The infrared images of water and NF, $Ni(OH)_2$/NF and NiO/NF films floating on the water before and after 2 hours irradiation.

Table S3. Calculation data of the evaporation rate and conversion efficiency of different samples.

Film	Fitting equation	Evaporation rate ofwater(v,kg/m² h)	Power of the evaporation (kJ/m² h)	Conversion efficiency(η,%)
Darkness	Y=0.0566x+8E-05	0.0566	2444.60	3.84
Water without light	Y=0.1545x+0.0123	0.1545	2439.35	10.47
Water under light	Y=0.6941x-0.1019	0.6941	2426.40	46.78
Ni foam	Y=0.9683X-0.0451	0.9683	2412.54	64.89
$Ni(OH)_2$/Ni foam	Y=1.1674x-0.0963	1.1674	2409.39	78.13
NiO/Ni foam	Y=1.302x-0.1257	1.302	2406.99	87.05
Ni-NiO_x/Ni foam	Y=1.4092x-0.1303	1.4092	2398.38	93.88

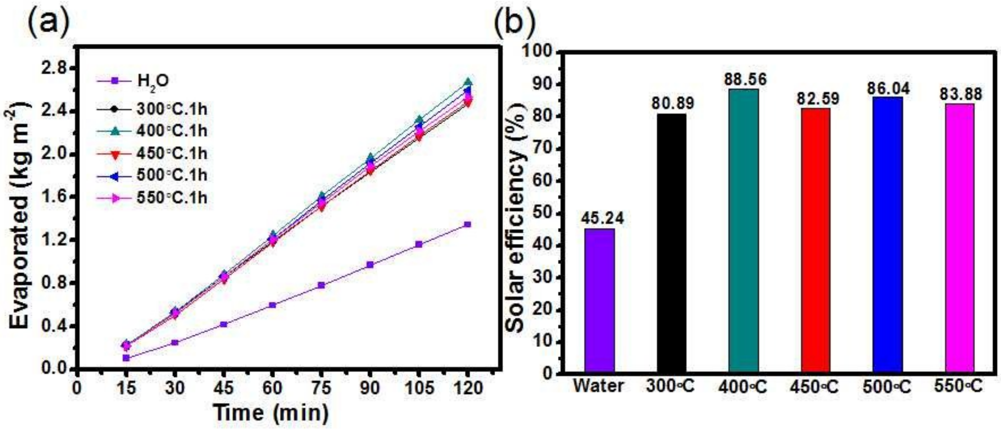

Figure S10. (a) The step 2 of the synthesis process (optimize preparation condition 1) : the dependence of evaporation rate of water on irradiation time for the different calcination temperature of $Ni(OH)_2$/NF samples under 1 sun simulated light (100 mW cm^2). The evaporation of water makes a blank contrast. (b) Corresponding solar efficiency of the above 6 samples.

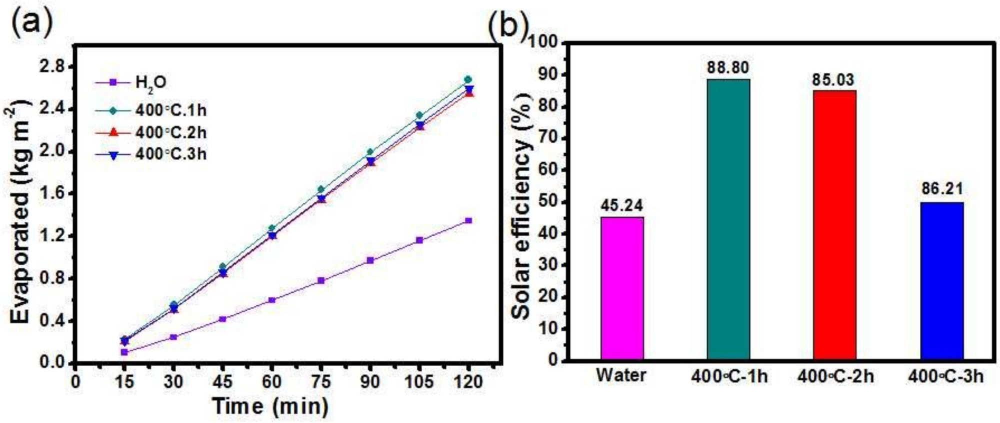

Figure S11. (a) The step 2 of the synthesis process (optimize preparation condition 2) : the dependence of evaporation rate of water on irradiation time for the different calcination time of $Ni(OH)_2$/NF samples under 1 sun simulated light (100 mW cm^2). The evaporation of water makes a blank contrast. (b) Corresponding solar efficiency of the above 4 samples.

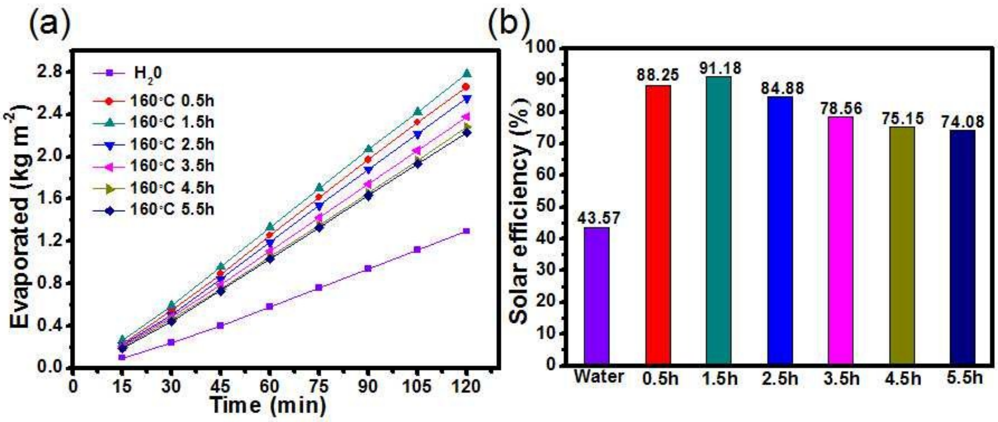

Figure S12. (a) The step 3 of the synthesis process (optimize preparation condition 3) : the dependence of evaporation rate of water on irradiation time for the different reduction time of NiO/NF samples under 1 sun simulated light (100 mW cm^2). The evaporation of water makes a blank contrast. (b) Corresponding solar efficiency of the above 7 samples.

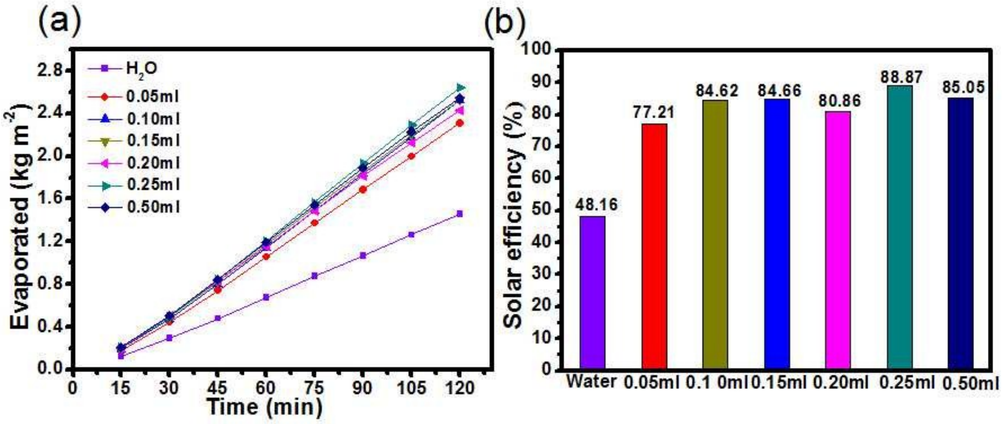

Figure S13. (a) The step 3 (Optimize preparation condition 4): the dependence of evaporation rate of water on irradiation time for the different reduction concentration of NiO/NF samples under 1 sun simulated light (100 mW cm^2).The evaporation of water makes a blank contrast. (b) Corresponding solar efficiency of the above 7 samples.

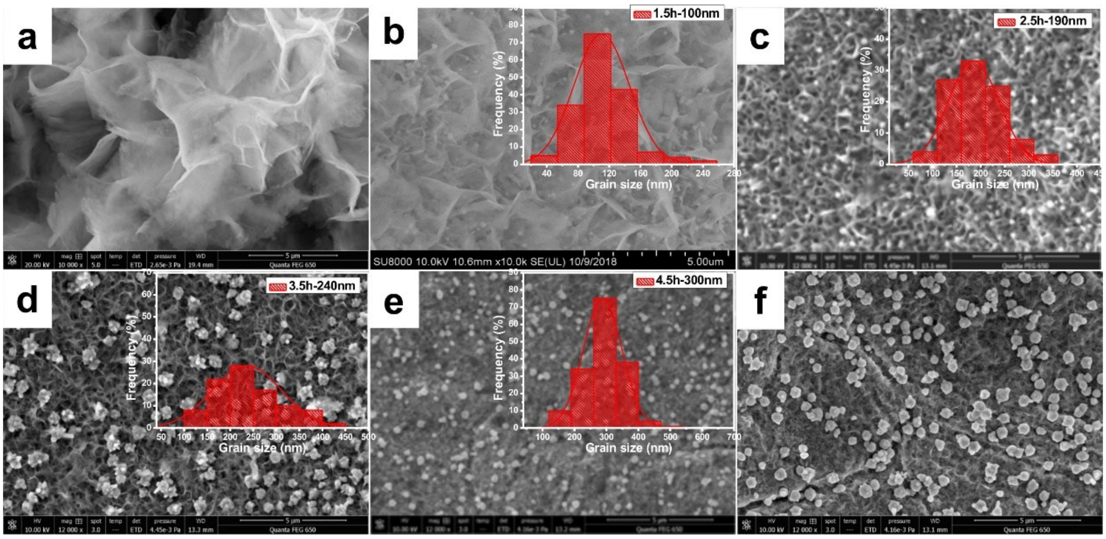

Figure S14. (a-f) SEM images of the different reduction time (0.5 h-5.5 h) of NiO/NF Samples.

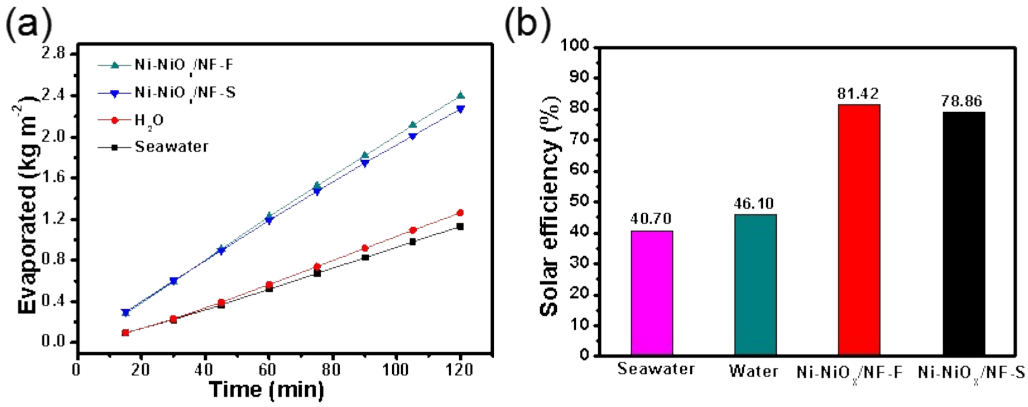

Figure S15. (a) The evaporation rate curve of seawater, H_2O, Ni-NiO$_x$/NF-S(seawater), Ni-NiO$_x$/NF-F(fresh water). (All experiments were conducted in ambient temperature of 15-18℃ with a humidity of 18-20%), (b) the photothermal conversion efficiency of the seawater, H_2O, Ni-NiO$_x$/NF-S(seawater), Ni-NiO$_x$/NF-F(fresh water). Due to the room temperature for this measurement is lower than that for Figure S10-13 (RT=25-27^{o}C). The environmental temperature is a critical factor for the water evaporation. The quantity of heat is same from the solar thermal conversion, the temperature change is the same according to the equation ($Q = mC_p\Delta T$). Suppose that the Q keeps constant for the one sample, then ΔT should not change. That indicates the temperature of water surface will increase from 15 to 25^{o}C in this case. In the case of Figure S10, the temperature will turn to 35 ^{o}C. But the water evaporation rate will slower at 25 ^{o}C than that at 35^{o}C . That's why the water evaporation rate decreases.

Table S4 The comparison of photothermal evaporation performance of Ni-NiO_x/NF and the reported related photothermal materials

Sample	Light intensity ($kw \cdot m^{-2}$)	Water evaporation rate ($v, kg \cdot m^{-2} \cdot h^{-1}$)	Conversion Efficiency (η,%)	Classification of solarthermal materials	Reference
Al NP/AAM	1	0.92	58%	Metallic plasmonic material	*Nat. Photonics* S1[1]
Au film/Airlaid paper	4.5	5.5	77%	Metallic plasmonic material	*Adv. Mater.* S2[2]
Black gold membranes	1	0.68	42.5%	Metallic plasmonic material	*Nat. Commun.* S3[3]
TiO_2/Au NP film/AAO	1	--	--	Metallic plasmonic material	*ACS Appl. Mater. Interfaces* S4[4]
Au/D-NPT/AAO	4	~5.2	90%	Metallic plasmonic material	*Sci. Adv.* S5[5]
Black Al-Ti-O membrane	1	1.23	77.5%	Metallic plasmonic material	*Nano Energy* S6[6]
Ni-NiOx/NF	1	1.41	93.9	Metallic plasmonic material	This work
rGO/MWCNT	1	1.22	80.3%	Carbon-based material	*J. Mater. Chem. A*.S7[7]
Carbon foam/ Exfoliated graphite	1	1.02	64%	Carbon-based material	*Nat. Commun.* S8[8]
Hierarchical graphene foam	1	1.46	>90%	Carbon-based material	*Adv. Mater.* S9[9]
RGO+bacterial nanocellulose aerogel	10	11.8	83%	Carbon-based material	*Adv. Mater.* S10[10]
3D-CG/GN	1	1.25	85.6%	Carbon-based material	*Adv. Mater.S11*[11]
Black TiOx	1	0.8012	50.30%	Semiconductor material	*Adv. Energy Mater.* S12[12]
Black Titania nanocage	1	1.13	70.9%	Semiconductor material	*ACS Appl. Mater. Interfaces* S13[13]
Cu_7S_4 nanocrystal film	1.006 (Infrared lamp)	--	77.10%	Semiconductor material	*Small* S14[14]
Ti_2O_3 NP/Cellulose membrane	1	1.32	83%	Semiconductor material	*Adv. Mater.* S16[15]
PPy/Coated SS	1	0.92	58%	Organic material	*Adv. Mater*. S17[16]
Bubble wrap/commercial spectrally selective coating on copper	1	--	64%	Composite material	*Nat. Energy* S17[17]

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