Electronic Supplementary Information

Direct grown carbon nanotube based hybrid electrodes with enhanced thermo-cell performances

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SI-1 The Cup-shaped TEC device

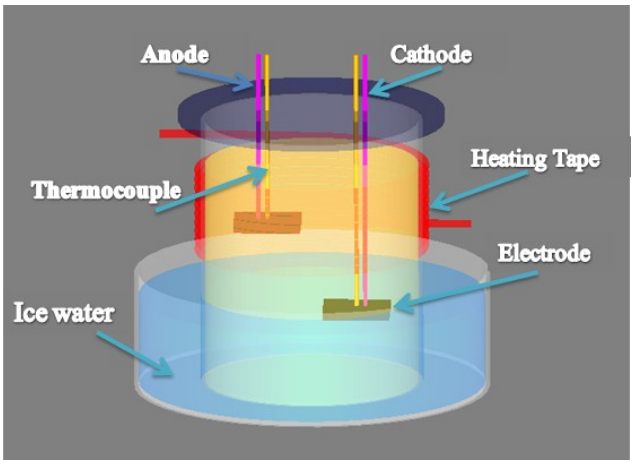


Fig. S1 Schematic picture of the Cup-shaped TEC device

SI-2 XPS data on the elemental contents of the Ag-CNTs hybrid electrodes

Table S1 Comparison of the atomic concentrations of CNTs-based hybrids

Sample	C (%)	O （%）	Fe （%）	Cr （%）	Ag （%）
Ag-CNTs-5	90.22	4.53	1.23	3.21	0.81
Ag-CNTs-10	89.19	3.63	1.15	3.43	2.6
Ag-CNTs-20	87.57	3.49	1.24	3.11	4.59
Ag-CNTs-30	86.15	3.89	1.31	3.02	5.63

SI-3 XPS peak analysises of the Fe2p and Cr2p

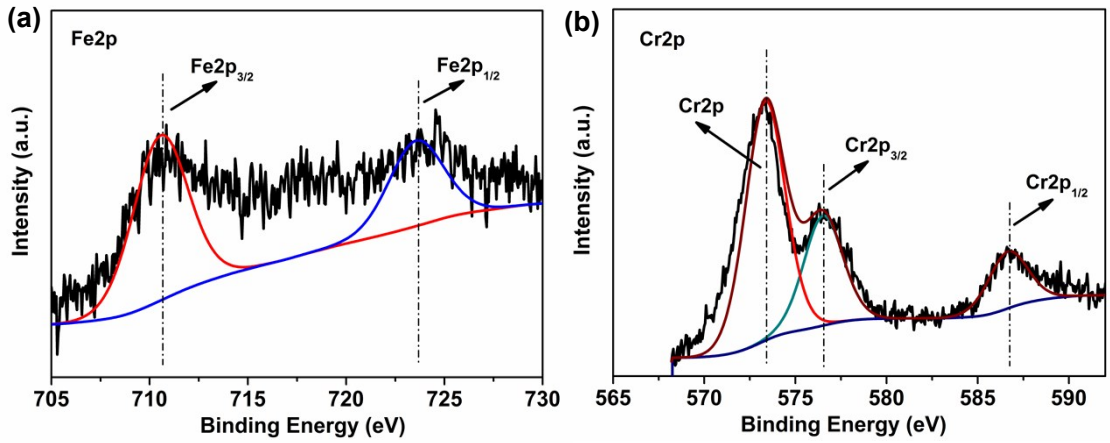


Fig. S2 XPS spectra of Ag-CNTs sample. (a) Fe2p; (b) Cr2p.

As shown in Fig. S2a, XPS spectrum showed two peake at 710.6 eV ($Fe2p_{3/2}$) and 723.5eV ($Fe2p_{1/2}$), corresponding to the Fe-O bonds. [1]As for the Cr2p (Fig. S2b), two peaks from O-Cr bonds appeared at 576.5 eV ($Cr2p_{3/2}$) and 586.7 eV ($Cr2p_{1/2}$).[2]

SI-4 Comparison of conductivity and thermal conductivity of the pristine CNTs and CNTs-based hybrids

Table S2 Comparison of conductivity and thermal conductivity of the pristine CNTs and CNTs-based hybrids

Sample	conductivity (Ω)	Thermal conductivity ($W.m^{-1}.K^{-1}$)
CNTs	11.92	0.1023
Ag-CNTs-5	9.12	0.3368
Ag-CNTs-10	5.65	0.9344
Ag-CNTs-20	4.01	1.0002
Ag-CNTs-30	2.80	1.1096

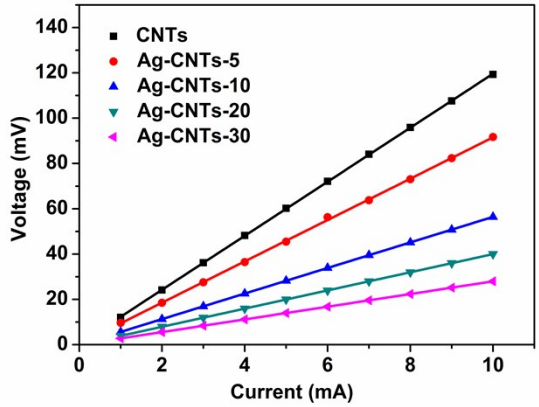


Fig. S3 Four-probe current–voltage measurements of the pristine CNTs and the Ag-CNTs hybrids

SI-5 Internal resistance of the TEC with a variation of the temperature difference

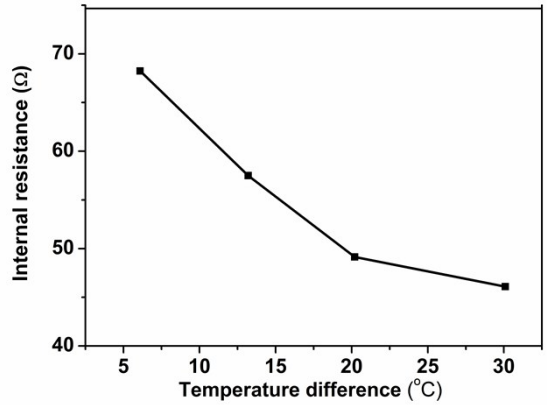


Fig. S4 The relation between the internal resistance and the temperature difference

With the increasing temperature difference, the internal resistance of the cell decrease from 68.2 Ω for ΔT =6.1°C to 46.1 Ω for ΔT =30.1°C, which might be due to an increase of the ion conductivity of the electrolyte, similar case could be found in the porous nanocarbon electrodes.[3]

SI-6 Effect of temperature difference on maximum specific output power

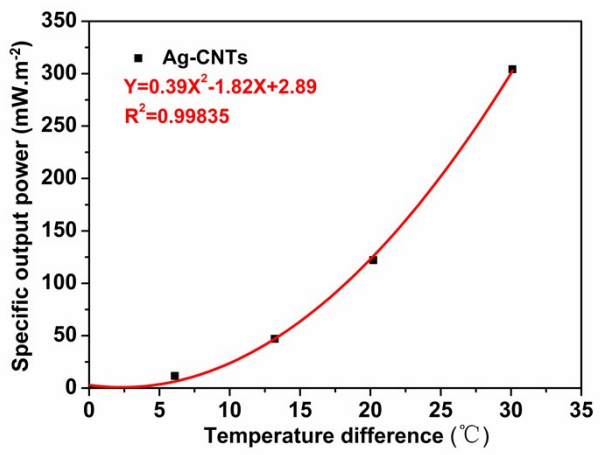


Fig. S5 Specific output power vs temperature difference for the Ag-CNT electrode.

With the increasing temperature difference, the maximum specific output power **(**P_{MAX}**)** increase from11.5 to 304.2 $mW.m^{-2}$. By fitting data, the P_{MAX} increase quadratically with the temperature difference.

SI-7 Internal resistance of the TEC with a variation of the operation temperature

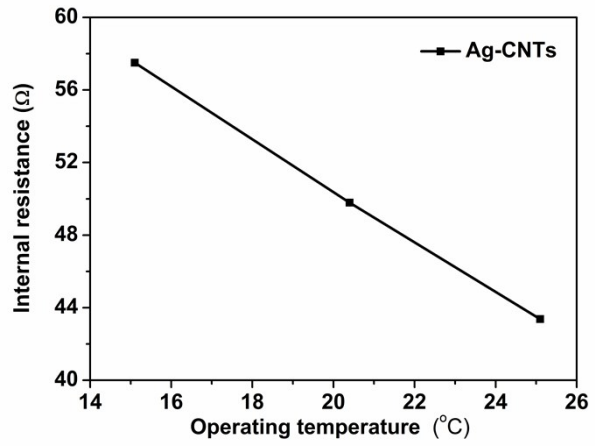
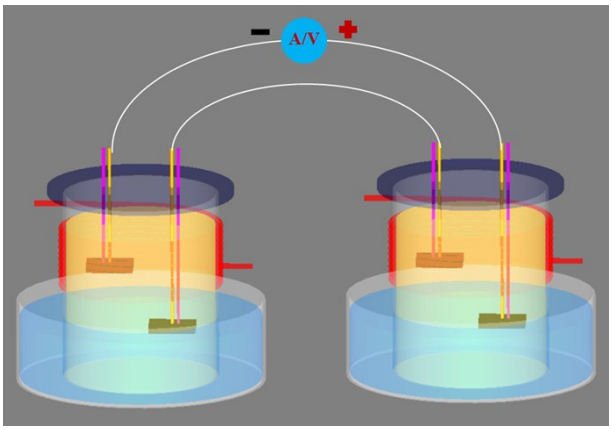


Fig. S6 Internal resistance vs operaing temperature for the Ag-CNTs electrode.

Under the same temperature difference (13.2°C), the internal resistance of the cell decrease by 24.5 % (from 57.5 to 43.4Ω) with the increasing operating temperature.

SI-8 Two identical cells connected in series



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