Supplementary Information for

Hybrid Effect of Gas Flow and Light Excitation in Carbon/Silicon Schottky Solar Cells

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METHODS

Materials synthesis: Large area, highly pure CNT thin films were directly prepared by a floating catalyst CVD method. Liquid precursor (a mixture of xylene, 0.36 M ferrocene and 0.036 M sulfur) was pumped into the quartz tube at a feeding rate of 3 μL/min and vaporized at 200^{o}C. The vapor was then carried to the reaction zone by a mixture flow of Ar (2500 mL/min) and H_2 (600 mL/min). A nickel mesh was placed near the inlet as a gas flow stabilizer. Temperature for CNT growth was set to 1150^{o}C. As-grown CNT films were collected by a nickel foil placed at the deposition zone (60~600^{o}C) at the rear end of the quartz tube.

Graphene films were grown on copper foils by a self-catalytic CVD. Copper foils were placed in the middle of the quartz tube and heated under the protection of H_2:Ar=2:1 (v/v) with a total gas flow rate of 300 mL/min. Once heating up to 1000^{o}C, ethanol was pumped in at a feeding rate of 10 μL/min with the protection gas switched to H_2: Ar=5:1 (v/v) at a total flow rate of 1200 mL/min. After growth, copper foils were withdrawn and cooled down to room temperature.

Solar cell assembly: n-Si (100) wafers (doping density: 1.5~3×10^{15} cm^{-3}) with a 300 nm SiO_2 layer were patterned by photolithography and wet-etching of oxide (by hydrofluoric acid solution) to make square windows (0.1 cm^2) where n-Si was exposed. The back contact was made using sputtered Ti/Au on the back side of the n-Si. Graphene was then transferred to the top of the patterned wafer and naturally dried to make a conformal coating with the underlying n-Si.

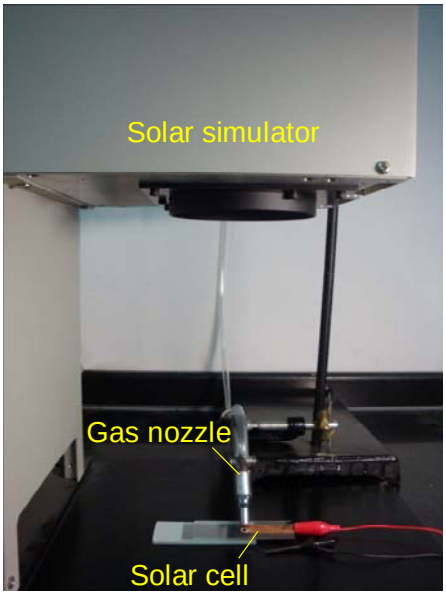

Figure S1. Photograph of the experimental setup for combined photovoltaic and flow test.

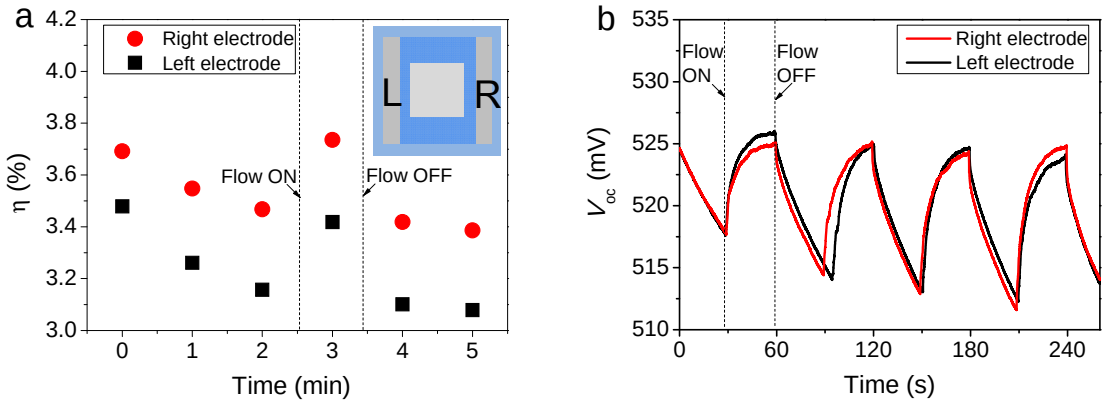

Figure S2. The performance of CNT/n-Si with separated left and right upper electrodes (see the inset). (a) The cell efficiencies measured with left (dark square) and right (red circle) electrodes; (b) V_{oc} of the cell measured with left (dark) and right (red) electrodes with on-off gas flow.

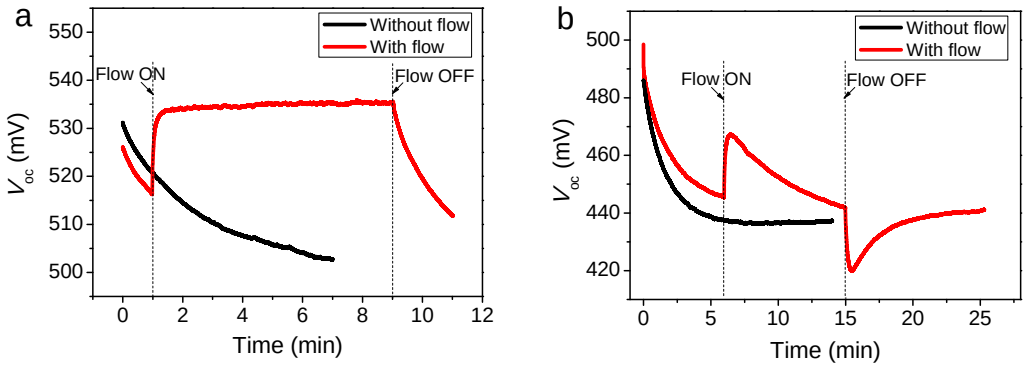

Figure S3. (a) The increase in V_{oc} under long duration gas flow (red curve). (b) Decay of V_{oc} with gas flowing (red curve).

Table S1. Photovoltaic parameters of CNT/n-Si Schottky solar cells.

Test time	η (%)		V_{oc} (mV)		J_{sc} (mA/cm^2)		*FF* (%)	
(min)	Cell 1	Cell 2	Cell 1	Cell 2	Cell 1	Cell 2	Cell 1	Cell 2
1	6.45	6.49	518	518	20.0	19.5	62.2	64.3
2	6.37	6.40	510	510	20.0	19.5	62.4	64.4
3	6.33	6.73	510	525	20.0	19.5	62.0	65.8
4	6.29	6.47	503	510	20.0	19.5	62.5	65.0
5	6.26	6.36	503	510	20.0	19.5	62.3	63.8

* Data in red color are obtained with gas flowing.

Table S2. Photovoltaic parameters of G/n-Si Schottky solar cells.

Test time	η (%)		V_{oc} (mV)		J_{sc} (mA/cm^2)		*FF* (%)	
(min)	Cell 3	Cell 4	Cell 3	Cell 4	Cell 3	Cell 4	Cell 3	Cell 4
0	2.24	2.31	465	472	16.5	17.1	29.2	28.6
1	2.04	2.06	450	450	16.2	16.6	28.0	27.5
2	1.96	1.96	442	442	16.0	16.4	27.7	27.0
3	1.93	1.92	442	442	15.9	16.3	27.4	26.6
4	1.92	1.90	442	435	15.9	16.3	27.3	26.9
5	1.92	1.90	442	435	15.9	16.2	27.3	26.8
6	1.92	2.02	442	465	15.9	16.3	27.3	26.5
7	1.93	1.81	442	427	16.0	16.0	27.3	26.5
8	1.93	1.84	442	435	16.0	16.1	27.3	26.3

* Data in red color are obtained with gas flowing.

Table S3. Photovoltaic parameters of a CNT/n-Si Schottky solar cell measured at left and right electrodes.

Test time	η (%)		V_{oc} (mV)		J_{sc} (mA/cm^2)		*FF* (%)	
(min)	Left	Right	Left	Right	Left	Right	Left	Right
0	3.48	3.69	518	510	19.2	19.5	34.9	37.2
1	3.26	3.55	510	503	19.2	19.5	33.4	36.2
2	3.16	3.47	503	495	19.1	19.5	32.8	36.0
3	3.42	3.74	525	510	19.2	19.5	33.9	37.6
4	3.10	3.42	503	495	19.1	19.5	32.4	35.5
5	3.08	3.39	495	487	19.1	19.5	32.6	35.7

* Data in red color are obtained with gas flowing.