Supporting Information

Efficient and Cost-effective Graphene on Silicon Solar Cells

Prepared by Spray Coating

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Figure S1. XPS spectrum of graphene. The XPS survey spectrum is recorded in the range of $0\sim1200$ eV. The N 1S comes solely from DMF and Na 1S comes from the Na₂SO₄ solution.



Figure S2. The deconvoluted O1S peak of graphene. The peaks at 535.8 and 533 eV are assigned to the Na-O bond and C=O in DMF, respectively. The contribution to the total oxygen content from DMF and Na_2SO_4 is 23.4 atom% (1.9 atom% for Na_2SO_4 and 21.5 atom% for DMF).



Figure S3. SEM image of graphene deposited on silicon substrate. Most graphene flake sizes are in the range of several micrometers.



Figure S4. Statistical results of FF. It is found that there are little changes in FF.



Figure S5. XPS spectra of graphene deposited at different T_{sub} . Clearly the N content decreased as T_{sub} increased, indicating the inefficient removal of DMF in graphene film at lower temperature, which may be responsible for the low J_{sc} at 160°C.



Figure S6. Morphologies of graphene films at different T_{sub} . The scale bar is 1 μ m.



Figure S7. Raman Spectra of graphene deposited at different T_{sub} . The I_D/I_G show little change upon annealing , which is due to the fact that annealing does not lead to an expansion of the sp² clusters.



Figure S8. C 1S spectra of pristione/modified silicon. The new peak C_{Hyq} at ~286.7

eV is an indicative of C-O bonding.

Sub. Temp.	J _{sc}	V _{oc} (V)	FF	PCE(%)
(°C)	(mA/cm ²)			
	4.7	0.35	0.23	0.47
160	4.5	0.35	0.24	0.47
	3.7	0.35	0.27	0.43
Average	4.3	0.35	0.25	0.45
	12.6	0.31	0.3	1.16
180	10.7	0.31	0.26	0.92
	11.1	0.31	0.20	0.92
Average	11.5	0.31	0.28	0.97
	8.6	0.2	0.21	0.46
200	6.4	0.2	0.24	0.32
	7.3	0.2	0.25	0.37
Average	7.4	0.2	0.23	0.37

Table S1. Photovoltaic parameters of three parallel solar cells

fabricated at different T_{sub}.

	1	2	3	Average (nm)
Pink Line	2.48	2.43	2.48	2.46
Cyan Line	9.94	9.63	10.08	9.88
Blue Line	15.35	16.11	16.20	15.89
Red Line	24.73	26.30	28.00	26.30
Black Line	38.53	36.52	35.3	36.78

Table S2. The graphene film thickness measured by ellispometer.

Table S3. Photovoltaic parameters of solar cells with different $\boldsymbol{\delta}$

δ (nm)	J _{sc} (mA/cm ²)	V _{oc} (V)	FF	PCE (%)
2.46 (Pink Line)	0.048	0.26	0.17	0.002
9.88 (Cyan Line)	0.41	0.26	0.24	0.025
15.89 (Blue Line)	5.71	0.3	0.26	0.44
26.30 (Red Line)	12.6	0.31	0.3	1.16
36.78 (BlackLine)	7.6	0.37	0.2	0.56