

Supporting Information

A Functionalized Aluminum-Catalyzed Silicon Nanowire Formation and Radial Junction Photovoltaic Device

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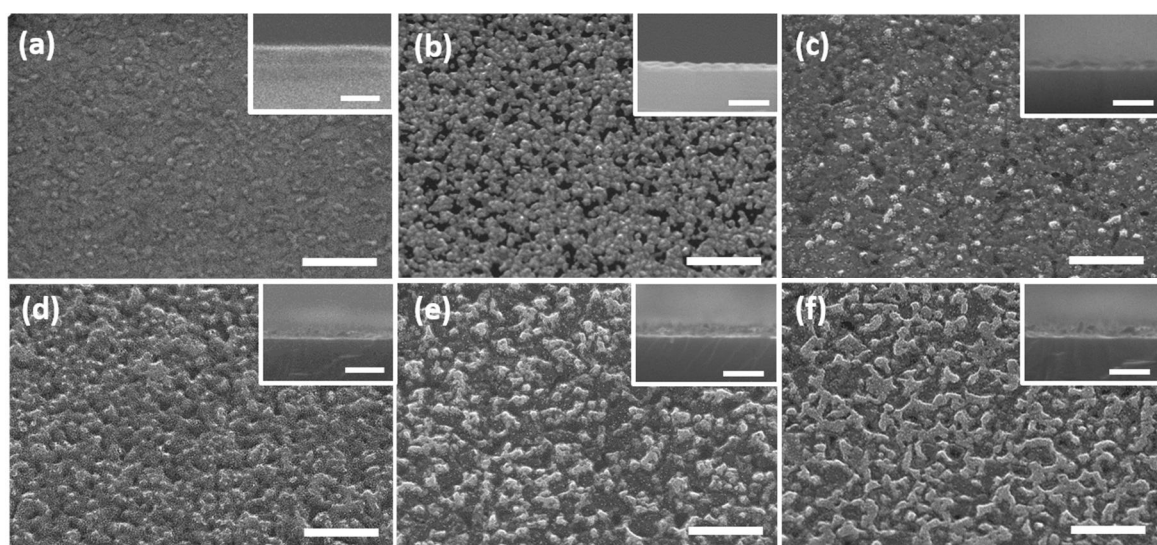


Fig. S1 30°-tilted SEM images of Al-catalyst on n-Si(111) substrates. (a) As-sputtered Al film of 50-nm thickness followed by (b) 1% HF etching for 10 sec and heating inside a CVD chamber to different growth temperatures of (c) 600 °C, (d) 650 °C, (e) 700 °C, and (f) 750 °C before VLS growth process. Scale bar is 500 nm. The cross-sectional images corresponding to each Al catalyst condition are shown in the inset. Scale bar is 100 nm.

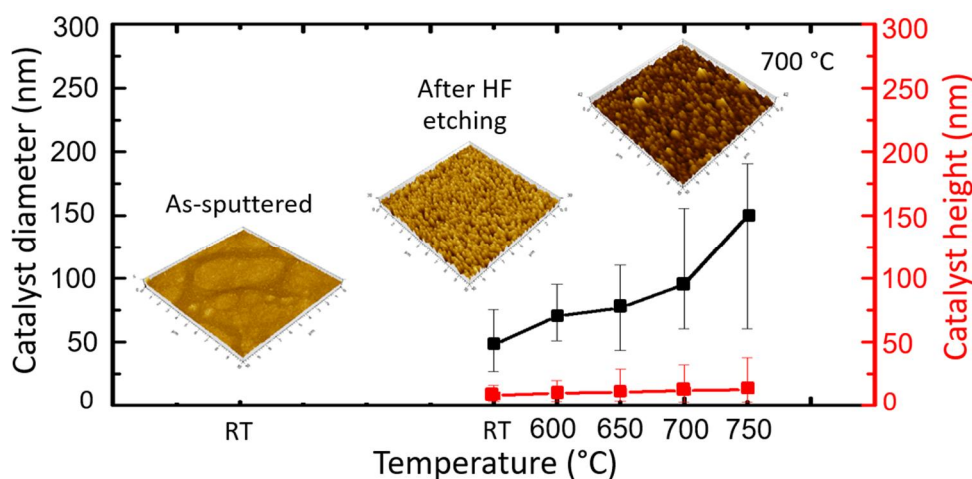


Fig. S2 Al-catalyst diameter and height as a function of the heating temperature from 600 - 750 °C inside the CVD chamber after 1% HF etching for 10 sec. AFM images of Al-catalyst surfaces after sputtering, HF etching, and heating to 700 °C are represented.

Table S1 Summarized mean values and standard deviations of NW length, tip and base diameters, VS (or radial) and VLS (or axial) growth rates of SiNWs grown at various temperatures of 600 °C, 650 °C, 700 °C, and 750 °C for 30 min. The data and statistics are based on 20-30 NWs of each condition.

Growth Temperature (°C)	NW length (μm)	Tip diameter (μm)	Base diameter (μm)	VLS growth rate (nm/min)	VS growth rate (nm/min)
600	1.24 ± 1.03	0.08 ± 0.06	0.13 ± 0.05	41.3 ± 34.5	1.1 ± 0.8
650	3.88 ± 1.98	0.06 ± 0.08	0.18 ± 0.06	122.5 ± 65.8	4.3 ± 0.9
700	6.14 ± 1.83	0.08 ± 0.03	0.42 ± 0.05	201.3 ± 61.1	11.2 ± 1.1
750	9.03 ± 1.93	0.14 ± 0.01	0.71 ± 0.04	300.6 ± 64.2	19.1 ± 1.8

Table S2 Summarized mean values and standard deviations of NW length, tip and base diameters of SiNWs grown at 700 °C with various growth times of 5 min, 10 min, 20 min, and 30 min followed by post-annealing at 850 °C for 20 min. The data and statistics are based on around 20 NWs for each condition.

Growth time (min)	NW length (μm)	Tip diameter (μm)	Base diameter (μm)	VLS growth rate (nm/min)	VS growth rate (nm/min)
5	1.34 ± 0.15	0.04 ± 0.02	0.10 ± 0.03	268.0 ± 27.9	6.1 ± 0.9
10	2.48 ± 0.31	0.05 ± 0.02	0.18 ± 0.06	248.0 ± 32.5	6.5 ± 0.9
20	4.43 ± 0.85	0.08 ± 0.03	0.36 ± 0.07	221.5 ± 46.5	7.1 ± 1.0
30	6.14 ± 1.83	0.08 ± 0.03	0.42 ± 0.05	201.3 ± 61.1	11.2 ± 1.1

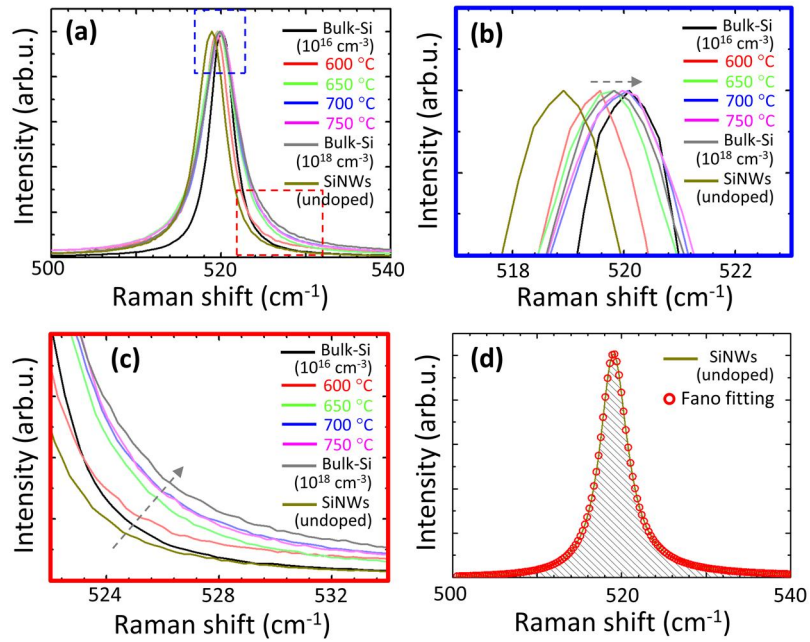


Fig. S3 (a) Raman spectra, (b) Raman shift of Si optical phonon peak, and (c) asymmetrical broadening (part of half-width on the post maximum side) of SiNWs grown at various temperatures from 600 - 750 °C for 30 min and post-annealed at 850 °C for 20 min; comparison with p-type Si wafers with a B-doping concentration of 10^{16} cm^{-3} and 10^{18} cm^{-3} , and undoped Au-catalyzed SiNWs grown at 600 °C for 30 min and post-annealed at 850 °C

for 20 min. (d) The Raman spectrum of undoped Au-catalyzed SiNWs and the fitting data of the Si optical phonon peak using the Fano equation.

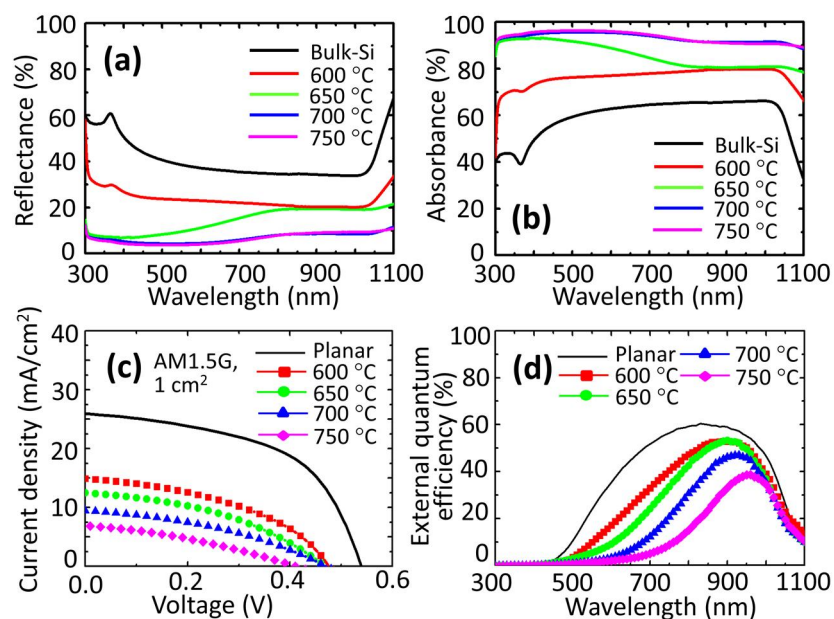


Fig. S4 (a) Reflectance, and (b) absorbance spectra of Al-catalyzed SiNWs grown at various growth temperatures of 600 - 750 °C compared to bulk-Si. (c) J-V characteristics of solar cells measured under AM1.5G, and (d) the EQE.

Table S3 Photovoltaic characteristics of SiNW-based solar cells with various SiNW growth temperatures compared to a planar cell.

Growth Temperature (°C)	PCE (%)	J _{sc} (mA/cm ²)	V _{oc} (V)	FF (%)	R _s (Ω cm ²) @ V = V _{oc}	R _{sh} (Ω cm ²) @ V = 0 V
- (Planar)	7.6	25.90	0.54	54.01	1.17	111.30
600	3.4	14.93	0.50	46.29	1.79	131.82
650	2.5	12.60	0.49	40.17	5.89	140.02
700	1.7	9.49	0.47	38.13	8.71	162.58
750	1.1	7.12	0.43	36.88	9.62	157.61