

Controlling Kink Geometry in Nanowires Fabricated by Alternating Metal-Assisted Chemical Etching

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(a) Detailed measurements of segment length

Several nanowires were selected to be measured for each case, and the average value was used to represent the length, the details are shown in Figure S1-S4 and listed in Table S1. The standard deviation of each case was very small, it means the segments in each case are all most the same length. The average lengths were 1.97, 2.64, 3.53 and 4.42 μm for cases (a)-(d), respectively.

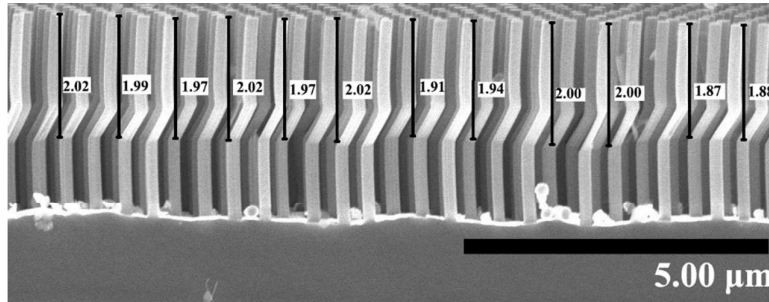


Figure S1. Detailed measurements of case (a)

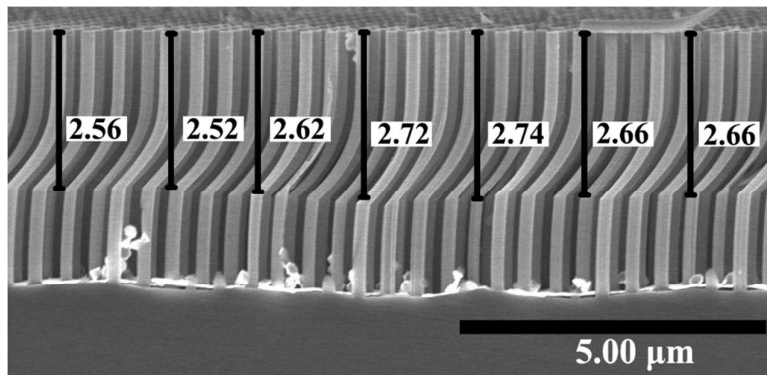


Figure S2. Detailed measurements of case (b)

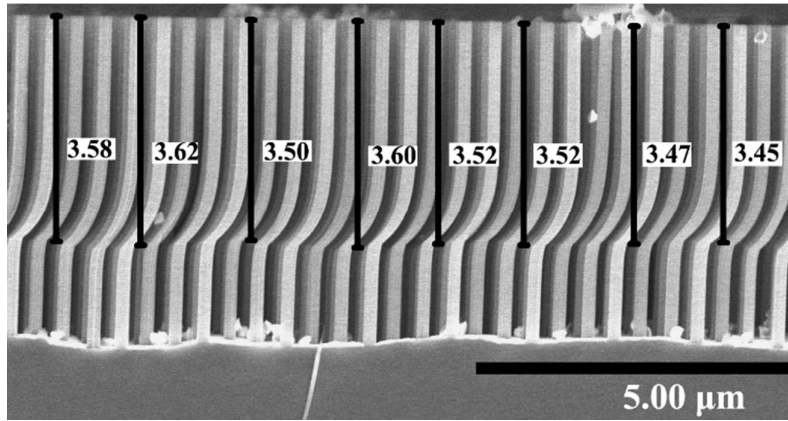


Figure S3. Detailed measurements of case (c)

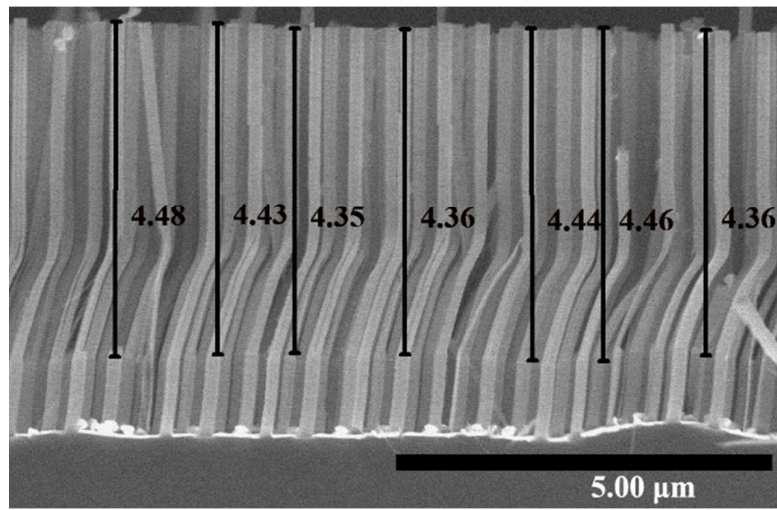


Figure S4. Detailed measurements of case (d)

Table S1. Details of segment length (μm)

<i>Measurement</i>	<i>Cases(a)</i>	<i>Cases(b)</i>	<i>Cases(c)</i>	<i>Cases(d)</i>
<i>1</i>	2.02	2.56	3.58	4.48
<i>2</i>	1.99	2.52	3.62	4.43
<i>3</i>	1.97	2.62	3.50	4.35
<i>4</i>	2.02	2.72	3.60	4.36
<i>5</i>	1.97	2.74	3.52	4.44
<i>6</i>	2.02	2.66	3.52	4.46
<i>7</i>	1.91	2.66	3.47	4.36
<i>8</i>	1.94	--	3.45	--
<i>9</i>	2.00	--	--	--
<i>10</i>	2.00	--	--	--
<i>11</i>	1.87	--	--	--
<i>12</i>	1.88	--	--	--
<i>Average</i>	1.97	2.64	3.53	4.42
<i>Standard deviation</i>	0.054	0.08	0.0663	0.0533

(b) Detailed measurements of kinking angle

Several nanowires were selected to be measured for each case, and the average value was used to represent the kinking angle, the details are shown in Figure S5-S7 and listed in Table S2. The standard deviation of each case was very small, it means the kinks in each case are almost the same. The average kinking angles were 177° , 163° and 132° for cases (a)-(c), respectively.

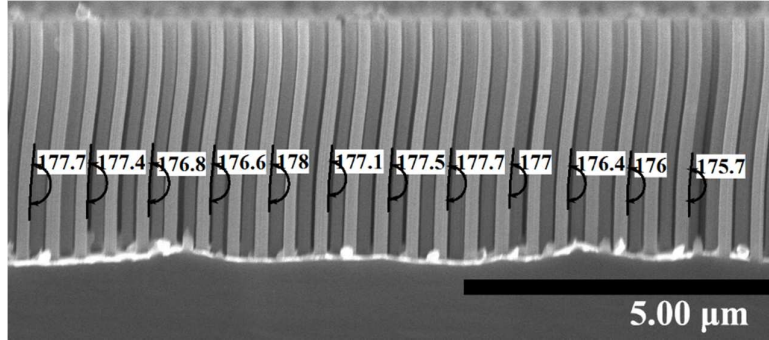


Figure S5. Detailed measurements of case (a)

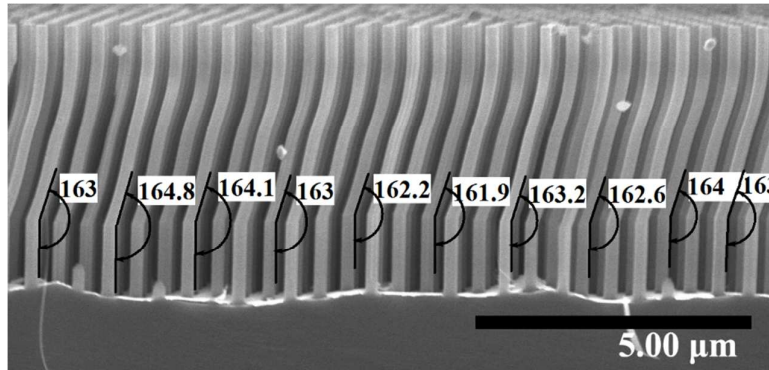


Figure S6. Detailed measurements of case (b)

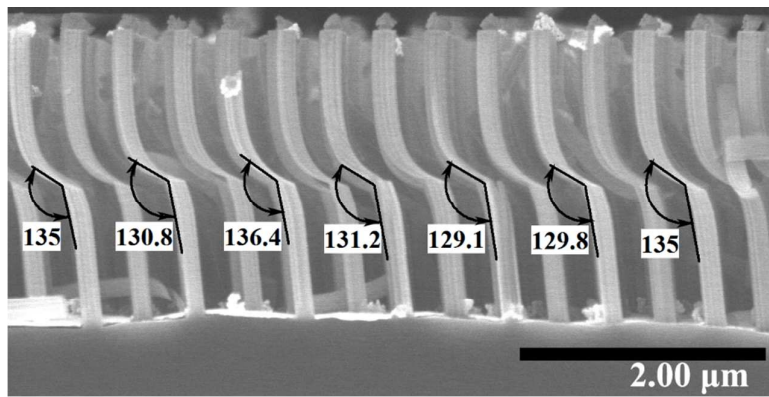


Figure S7. Detailed measurements of case (c)

Table S2. Details of kinking angle

<i>Measurement</i>	<i>Cases(a)</i>	<i>Cases(b)</i>	<i>Cases(c)</i>
<i>1</i>	177.7°	163°	135°
<i>2</i>	177.4°	164.8°	130.8°
<i>3</i>	176.8°	163°	136.4°
<i>4</i>	176.6°	162.2°	131.2°
<i>5</i>	178°	161.9°	129.1°
<i>6</i>	177.1°	163.2°	129.8°
<i>7</i>	177.5°	162.6°	135°
<i>8</i>	177.7°	164°	--
<i>9</i>	177°	163°	--
<i>10</i>	176.4°	--	--
<i>11</i>	176°	--	--
<i>12</i>	175.7°	--	--
<i>Average</i>	177°	163°	132°
<i>Standard deviation</i>	0.72	0.89	2.9

(c) Detailed measurements of periodically nanowires

In order to minimize the error, several nanowires were selected to be measured, and the average value was used to represent the length and kinking angle (Figure S8-S9), and listed in Table S3 and S4, respectively. The standard deviation of each case was very small, it means the kinks or segments in each case are almost the same. The first and third segments were etched in the same etchant for the same time, and the lengths are 0.98 and 1.06 μm , respectively; the deviation is only about 5.6%. Similarly second and fourth segments were fabricated in the same way. Their lengths are 2.99 and 2.95 μm , respectively, which means the deviation is only about 1%. The kinking angles are 135.2°, 134.6°, and 137.7°, the deviation of kinking angles is only 1.2%.

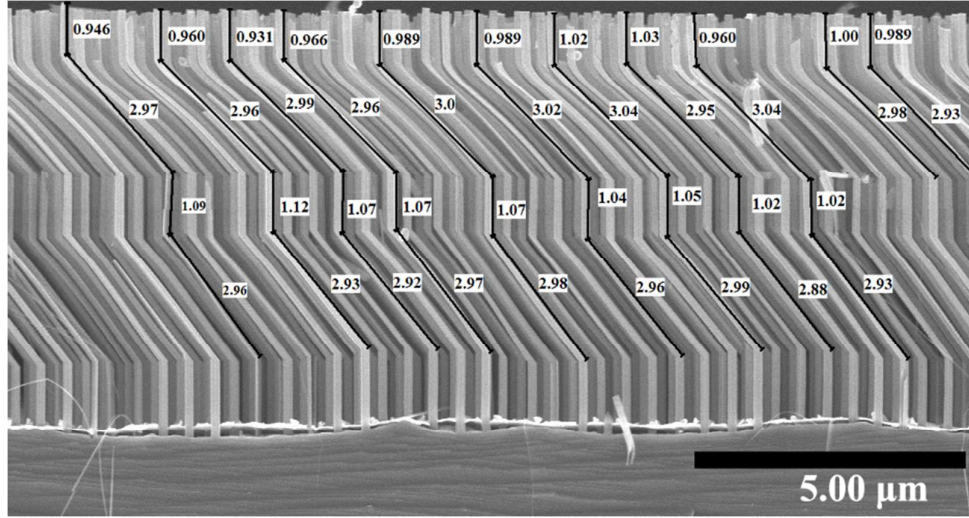


Figure S8. Detailed length measurements of each segment

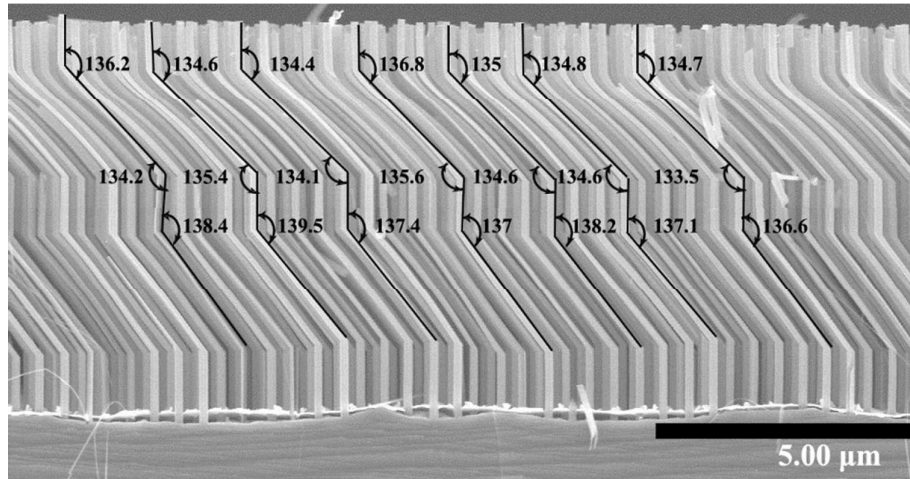


Figure S9. Detailed angle measurements of each kink

Table S3. Details of each segment

<i>Measurement</i>	<i>1st segment</i>	<i>2nd segment</i>	<i>3rd segment</i>	<i>4th segment</i>
1	0.946	2.97	1.09	2.96
2	0.960	2.96	1.12	2.93
3	0.931	2.99	1.07	2.92
4	0.966	2.96	1.07	2.97
5	0.989	3.0	1.07	2.98
6	0.989	3.02	1.04	2.96
7	1.02	3.04	1.05	2.99
8	1.03	2.95	1.02	2.88
9	0.96	3.04	1.02	2.93
10	1.00	2.98	--	--
11	0.989	2.93	--	--

<i>Average(μm)</i>	0.98	2.99	1.06	2.95
<i>Standard deviation</i>	0.0305	0.0364	0.0326	0.0346

Table S4. Details of each kink

<i>Measurement</i>	<i>Kink I</i>	<i>Kink II</i>	<i>Kink III</i>
<i>1</i>	136.2°	134.2°	138.4°
<i>2</i>	134.6°	135.4°	139.5°
<i>3</i>	134.4°	134.1°	137.4°
<i>4</i>	136.8°	135.6°	137°
<i>5</i>	135°	134.6°	138.2°
<i>6</i>	134.8°	134.6°	137.1°
<i>7</i>	134.7°	133.5°	136.6°
<i>Average</i>	135.2°	134.6°	137.7°
<i>Standard deviation</i>	0.91	0.74	1.00

(d) Viscosity and surface tension of etchant

The viscosity and surface tension of each component of etchant can be found from papers previously reported^{S1-S6}, as listed in Table S5. The viscosity of glycerol (945.0 mPa*S) is about 1000 times larger than that of other components (~1 mPa*S). And the surface tension of ethanol (22.39 mN/m) is about 1/3 that of DI water (72 mN/m). According to the liquid mixture theory^{S7, S8}, the viscosity of etchant increases when adding glycerol, while the surface tension of etchant decreases when adding ethanol. These different physical properties greatly affect the diffusion of HF and H₂O₂ from bulk solution to the reaction interface, and, thus, result in a change of the etching direction.

Table S5. Physical properties of etchant components

Component	Surface Tension (20°C, mN/m)	Viscosity (20°C, mPa*S)
DI water	71.99 ^[S1]	1.002 ^[S2]
HF(50 wt.%)	10.2 mN/m at 0°C ^[S3]	0.8 ^[S4]
H₂O₂ (30 wt.%)	75.6 ^[S5]	1.05 ^[S5]
Ethanol	22.39 ^[S6]	1.078 ^[S6]
Ethylene glycol	47 ^[S6]	16.13 ^[S6]
Glycerol	62.5 ^[S6]	945.0 ^[S6]

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