The Supporting Information for

High sensitivity silicon nanowire array sensor for joint detecting the tumor markers CEA and AFP

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S1 Surface hydrophilicity

The contact angle tests using a PZ-200SD Drop Shape Analysis (SINDIN, China) were performed to demonstrate the surface hydrophilicity improvement after the SiNWs-FET surface pretreatment by oxygen (O_2) plasma (70 W, 5 minutes). As you can see, the contact angle of the SiNWs-FET sensor surface changed from 113° and 102° to 65° and 53° after oxygen (O_2) plasma treatment (Fig. S1(a ~ d)). The decreased contact angle demonstrated that the surface hydrophilicity increased.

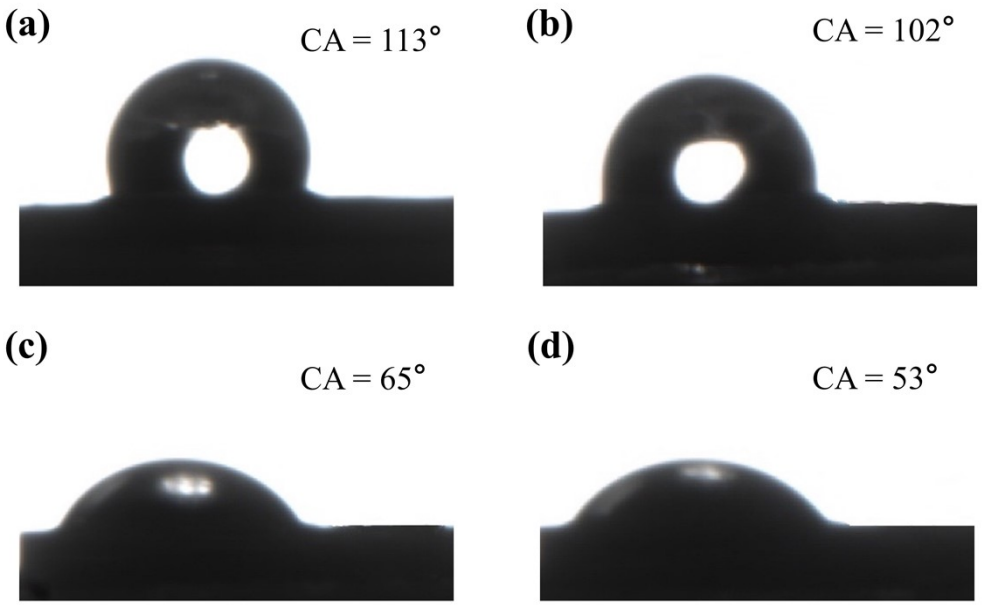

Figure S1. Contact angle of the SiNWs-FET sensor surface before (a, b) and after (c, d) treated with oxygen (O2) plasma.

S2 Repetitive Linear Range Sensing Measure

To demonstrate the detection performance of the SiNWs array sensor to CEA with different concentrations and AFP with different concentrations, we conducted repetitive related experiments (Fig. S2(a, b)). The results showed that the relative current changes had two highly dependent linear relationships with logarithm of CEA concentration (from 1 fg/ml to 10 pg/ml) and logarithm of AFP concentration (from 0.1 fg/ml to 100 pg/ml).

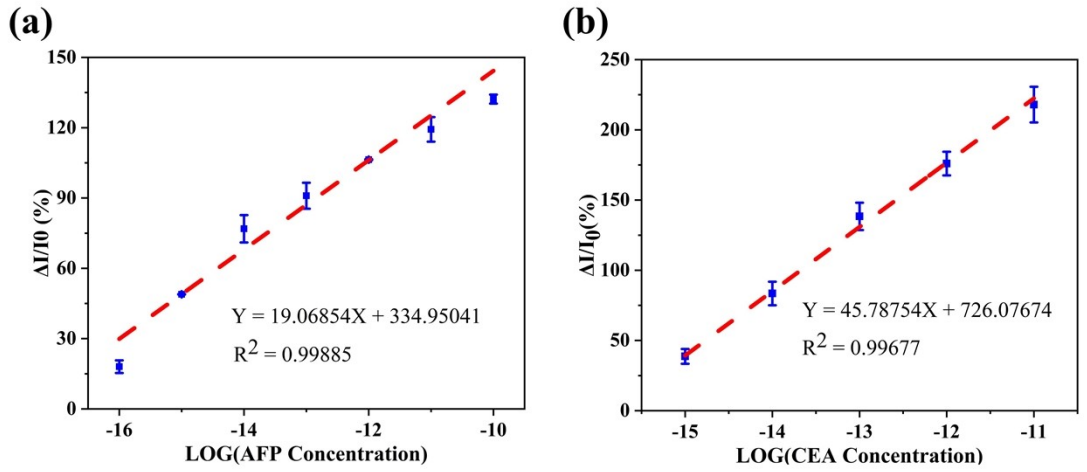

Figure S2. Relative current changes of SiNW-array FET sensor as functions of the logarithm of AFP concentration (a) and the logarithm of CEA concentration (b).

S3 Repetitive Specificity Sensing Measure

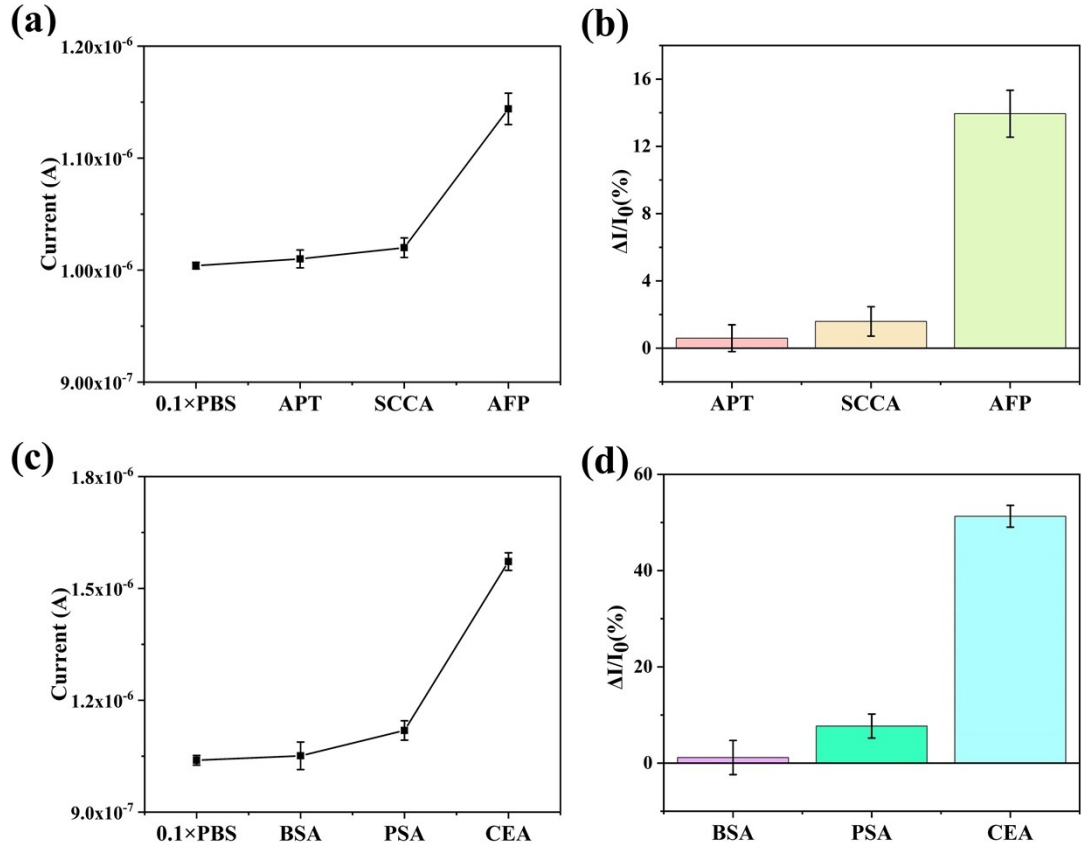

Figure S3. The repetitive specificity sensing measurements of SiNWs-FET sensor. (a) Anti-AFP-Modified SiNWs array detect 0.1 fg/ml AFP, 1 μg/ml APT and SCCA. (b) The normalized currents of 0.1 fg/ml AFP, 1 μg/ml APT and SCCA. (c) Anti-CEA-Modified SiNWs array detect 1 fg/ml CEA, 10 mg/ml BSA and 100 μg/ml PSA. (d) The normalized currents of 1 fg/ml CEA, 10 mg/ml BSA and 100 μg/ml PSA.

The sensing measurements are performed by using a Keithley 2450 semiconductor parameter analyzer (Keithley Instruments Inc., Cleveland, OH) to monitor the source-drain current. To demonstrate selectivity of our SiNWs array sensor, high concentrations of interferents and low concentrations of analytes are selected for comparative analysis. Besides, repetitive experiments were also carried out to demonstrate specificity of SiNWs array sensor. When our SiNWs array was modified with AFP / CEA, our sensor had a visible current change to CEA/AFP (Fig. S3(a, c)). Meanwhile, the current changes of interferents were neglectable (Fig. S3(a, c)). The relative current change rate were ~13.944% and ~51.299 respectively (Fig. S3(b, d)), when 0.1 fg/ml AFP and 1 fg/ml CEA were introduced to the SiNWs arrays. Experiment results revealed a superior selectivity of our sensor.

Table S1. Comparison of detection limit and linea range among various sensors

Year	Classification	Target	Linear range	LOD[a]	Ref
2019	Nanoclusters sensor	AFP	10 to 100 nM	2.4 nM	[19]
2022	Two-size enzyme-linked immunosensor	AFP	20 to 600 ng/ml	9.7 ng/ml	[1]
2021	Two-size ELISA sensor	AFP	6 to 100 ng/ml	2 ng/ml	[2]
2020	Electrochemical aptasensor	AFP	1 ng/ml to 10 μg/mL	0.3013 ng/ml	[3]
2015	Photoelectrochemical sensor	AFP	50 pg/mL to 20 ng/mL	20 pg/mL	[4]
2020	SERRS-based lateral flow immunoassay sensor	AFP	10 pg/mL to 500 ng/mL	9.2 pg/mL	[5]
2018	Electrochemical immunosensor	AFP	3.5 pg/mL to 35 ng/mL	0.106 pg/ml	[6]
2022	Electrochemical immunosensor	AFP	100 fg/ml to 200 ng/ml	18.6 fg/ml	[7]
2016	Optical biosensor	AFP	10 fg/ml to 10 ng/ml	14 aM	[8]
2022	This work	AFP	0.1 fg/ml to 100 pg/ml	0.1 fg/ml	
2016	Electrochemical biosensor	AFP	0.001 to 10 fg/ml	0.0003 fg/ml	[9]
2019	Nanoclusters sensor	CEA	10 to 100 nM	5.6 nM	[19]
2019	Chemiluminescence immunoassay sensor	CEA	0.1 to 64 ng/mL	85 pg/ml	[10]
2013	Chemiluminescence immunoassay sensor	CEA	50 pg/ml to 20 ng/mL	34 pg/ml	[11]
2018	Fluorescence aptasensor	CEA	50 pg/ml to 2.0 ng/mL	20 pg/ml	[12]
2019	“Sense-and-treat” ELISA sensor	CEA	10 to 500 pg/ml	10 pg/ml	[13]
2021	Photoelectrochemical aptasensor	CEA	100 fg/ml to 10 ng/mL	47 fg/ml	[14]
2018	Electrochemical immunosensor	CEA	100 fg/ml to 20 ng/mL	30 fg/ml	[15]
2021	Electrochemical immunosensor	CEA	10 fg/ml to 40 ng/mL	3.5 fg/ml	[16]
2022	This work	CEA	1 fg/ml to 10 pg/ml	1 fg/ml	
2020	Electrochemical immunosensor	CEA	1 fg/ml to 100 ng/mL	0.8 fg/ml	[17]
2021	Fluorescent biosensor	CEA	1 fg/ml to 100 ng/mL	6.76 ag/ml	[18]

[a] LOD: limit of detection.

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