Label-Free, Electrical Detection of the SARS Virus N-Protein With Nanowire Biosensors Utilizing Antibody Mimics as Capture Probes

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Supporting Information

Supporting Information Available: Engineered Fibronectin, surface functionalization, experimental setup, measurement of leakage current, absolute response, and a control experiment.

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Engineered Fibronectin

The design, evolution, and characterization of our Fibronectin (Fn) probe is described in details elsewhere.[1] It is worthy to note that our Fn was engineered in such a way to possess a single cystine in the protein, placed at the N' terminus of the polypeptide chain, as shown in Figure S1. This unique cystine was used as anchoring site for the attachment of Fn to the NW surface. Using this strategy, Fn immobilization on the nanowires occurs away from the binding region so the probe maintains an active configuration. Our Fn can also be configured with other functional groups useful in bioconjugation such as an azide or a cyclopentadiene.[2]

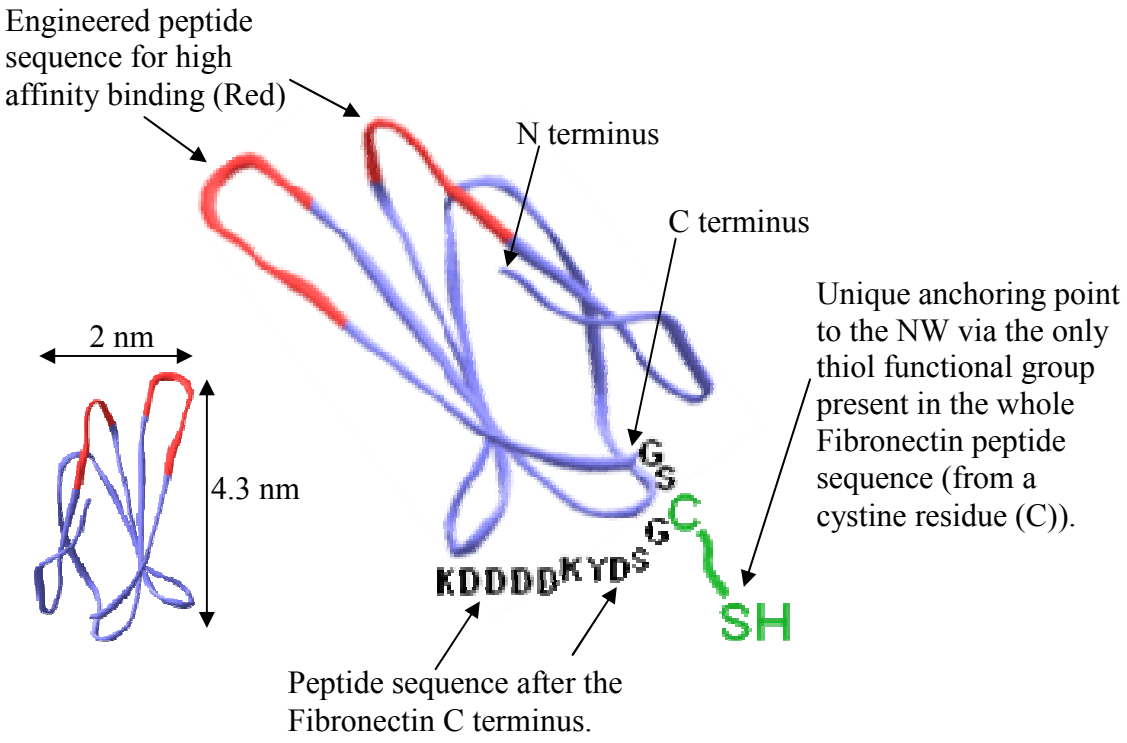

Figure S1. Ribbon structure of our engineered Fibronectin (Fn). The peptide sequence after the Fn C terminus is "spelled out" to show the position of our selective attachment point to the NW surface.

Surface functionalization

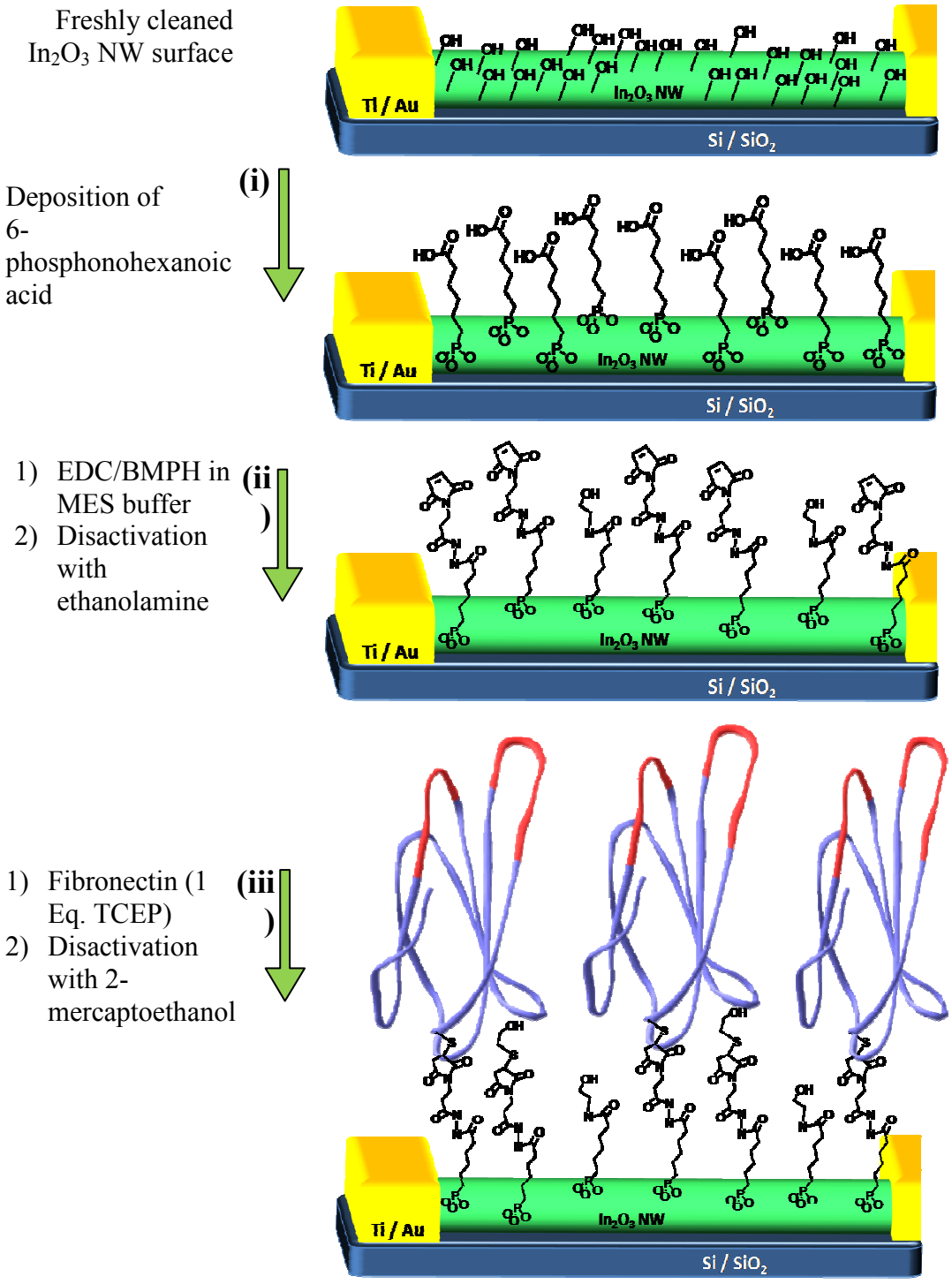

Figure S2. Surface modification of our In_2O_3 nanowire devices resulting in the covalent immobilization of the Fibronectin probe on the nanowires.

Experimental setup diagram

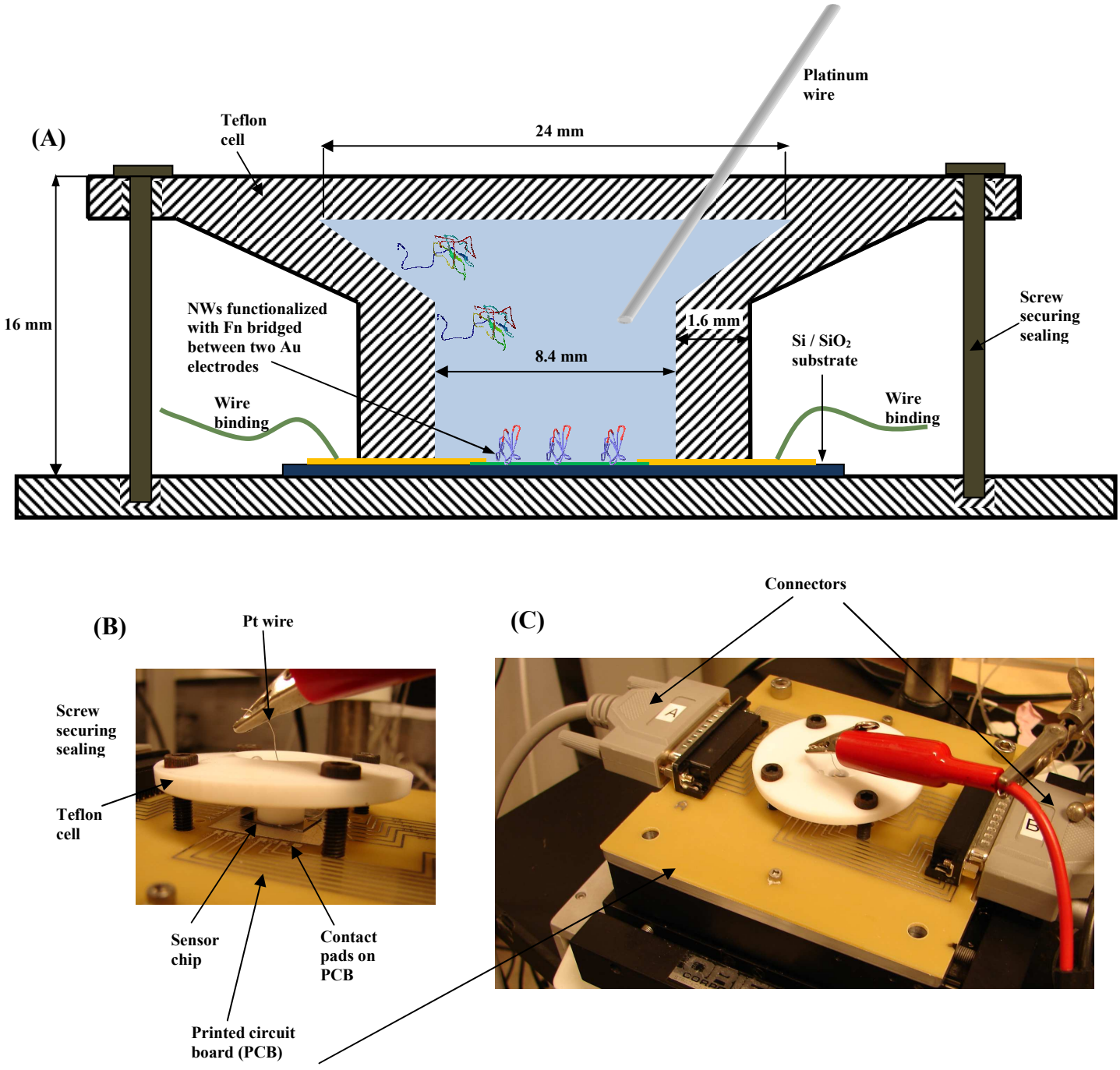

Fig. S3. Details and components are indicated in the figures. (A) Cross-section schematic diagram of the setup used for real time N protein sensing. This diagram is not on scale; the nanosensor device is shown enlarged for clarity with respect to the rest of the set up. (B) A side view of such setup. (C) A top-view photograph of the setup showing the Teflon cell atop a circuit board.

Leakage current between the source and drain electrode through the buffer

To determine the leakage through the aqueous solution, we measured the current from control devices without nanowires between the source and drain electrodes. Figure S4 plots the sensing response of a device with nanowires and a control device without nanowires, and one can clearly see that the leakage is negligible compared to the sensing signal. We note that the leakage current for the device without nanowires is typically around 1 pA, while the current for the device with nanowires is around 1.5 nA.

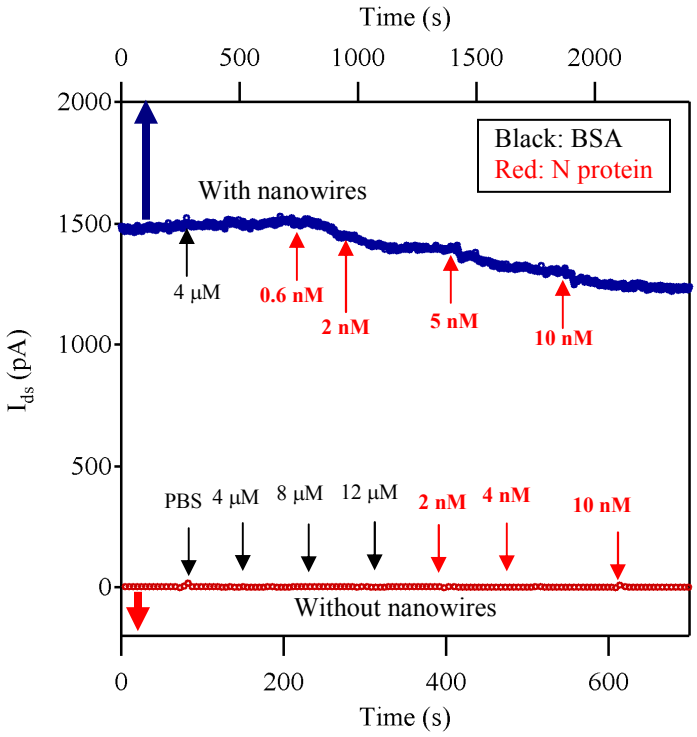

Figure S4. Plots of I_{ds} for a device with nanowires (blue) and a control device without nanowires (red) between the source and drain. The concentration of BSA and N protein is changed at the time indicated by the arrows.

Absolute responses for N protein sensing

Figure S5 shows the absolute response of three devices used in Figure 3 in the main text. It can be seen that, before normalization by the initial conductance, the response shows large device-to-device variation.

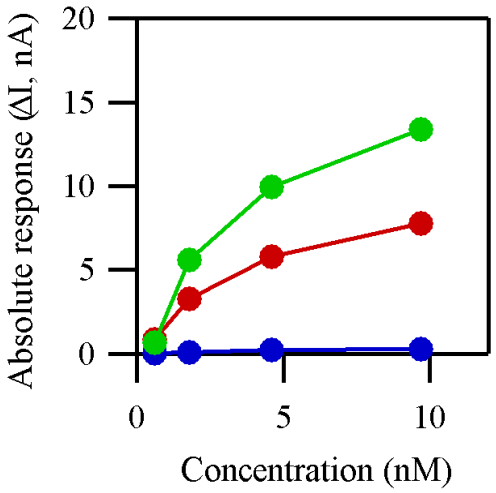

Figure S5. Absolute response of the three nanowire device used to detect the N protein. These are the same devices shown as relative response in Figure 3

Baseline for the control experiment to confirm the role of Fn

A device was functionalized according to steps (i), (ii), and (iii) outlined Fig. S2. The maleimide-surface-rich nanowire device was then treated with 2-mercaptoethanol prior to Fn immobilization (step (iv)). With all the binding sites blocked with 2-mercaptoethanol, the Fn capture probe is not expected to bind to the nanowire surface, and thus this device should not specifically recognize the N protein. A stable baseline was established for this device after saturation of any site for non-specific binding with a 40 μM solution of BSA (Fig. S6).

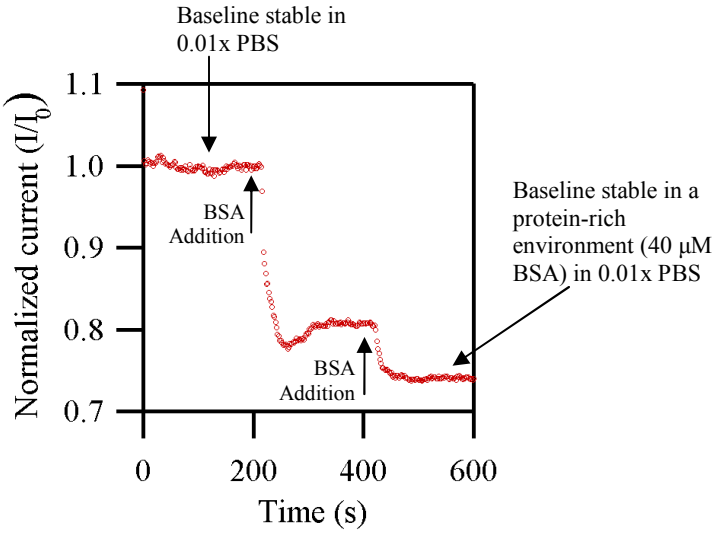

Figure S6. Establishing baseline in a protein-rich environment for the device passivated with 2-mercaptoethanol prior to Fn.

References

1 Liao, H. I.; Olson, C. A.; Ishikawa, F. N.; Curreli, M.; Chang, H.-K.; Thompson, M. E.; Zhou, C.; Roberts, R. W.; Sun, R., *in preparation*.

2 (a) Agnew, H.D.; Yeo, W.S.; Bailey; R.C.; Heath, J.R.; J. Am. Ch. Soc. 2006, 128, 9518-9525. (b) Bunimovich, Y. L.; Ge, G.; Beverly, K. C.; Ries, R. S.; Hood, L.; Heath, J. R. Langmuir 2004, 20, 10630-10638. (c) Yousaf, M.N.; Houseman, B. T.; Mrksich, M. PNAS 2001, 98, 5992-5996.