Supporting Information

Thread as a Matrix for Biomedical Assays

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Experimental

Source of Materials

Steel pins, Delrin block, and Paraffin wax were purchased from McMaster-Carr (NJ, USA). Scotch®MultiTask Tape #25, and 3M™ Vinyl Tape #471 were purchased from 3M (MN, USA). Petroleum jelly, unwaxed dental floss, and bandages were purchased from CVS Pharmacy, Inc. (RI, USA). A 100% cotton thread with a diameter of 0.3 mm Cebelia Crochet Cotton Art G167, and Rayon floss were purchased from DMC (NJ, USA). Hemp cord and 100% polyester thread were purchased from Derice, Inc. (OH, USA). A thread made of 50% cotton and 50% acrylic was purchased from Lion Brand Yarn company (NY, USA), and Yarn from Coats & Clark (SC, USA). All chemicals used for the colorimetric assays were purchased from Sigma Aldrich. Pro-Etch laminator was purchased from Micro-Mark (NJ, USA).

Device Preparation

For the woven array design, we wound the thread through a loom to arrange and orient the thread. We made the loom by installing steel pins into a 1.5 cm thick Delrin block (two parallel rows of pins, 6 cm apart, with the pins in each row spaced by 0.5 cm).

We sealed the woven array devices using either Scotch tape (Scotch®MultiTask Tape #25) or Vinyl tape (3M™ Vinyl Tape #471).

To make the surface of the cotton thread hydrophobic (for a small subset of experiments, as indicated) we applied: i) a small amount of Paraffin wax (McMaster-Carr, NJ, USA) on the thread by rubbing the wax across a taught thread, ii) a small amount of petroleum jelly (CVS Pharmacy, Inc., RI, USA) by spreading it on the outside of the thread.

For the sewn array design, we sewed the thread with a needle into all-purpose latex free plastic bandages (CVS Pharmacy, Inc., RI). To isolate the assays on two adjacent stitches physically, we blocked every other hole (formed by the needle) in the bandage with 3 μL droplets of clear nail polish. The bandages have small holes in them that we used as guidelines for sewing the threads.

Assays

To detect protein, we immersed the thread in a solution of 250 mM citric acid (pH 1.8) and 0.5 μL 3.3 mM tetrabromophenol blue (TBPB) in 95% ethanol, at the desired detection zone. TBPB is a protein error indicator. Protein error indicators are pH indicators which contain an ionizable group that is displaced in the presence of protein to provide a detectable color change (When ionizes, TBPB changes from yellow to blue). This is the same color change that the indicator would undergo under the influence of a pH change. The citric acid buffer prevents the change in pH (1).

To detect nitrites, we immersed the thread in a solution of 2 mg/mL sulfanilamide, 1.7 mg/ml 3-hydroxy-1,2,3,4-tetrahydrobenzo(h)quinoline and 25 mg/mL tartaric acid in methanol. To detect ketones, we spotted the thread with 0.5 μL solution of 20 mg/mL sodium phosphate, 20 mg/mL sodium borate, 10 mg/mL glycine, 0.5 μL solution of 20 mg/mL nitroprusside, 30 mg/mL polyethylenglycol (PEG, Mw = 2000), and 2 mg/ml polyacrylic acid (PAA, Mw = 2000).

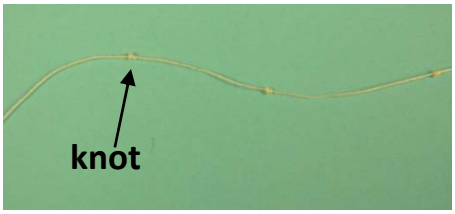
We laminated the thread between two pieces of tape using a laminator (Pro-Etch laminator, Micro-Mark, NJ, USA).

Reference

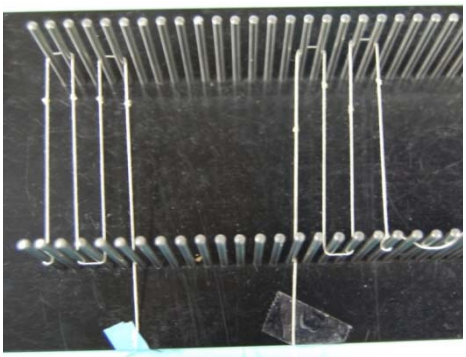
(1) Free, H. M.; Collins, G. F.; Free, A. H. *Clin. Chem.* **1960,** 6, 352-361.

Figure S1. A sequence of images showing the assembly of the “woven array” device. **(A)** We first made knots on a thread. **(B)** We used a loom to arrange several threads in parallel to each other. **(C)** We inserted a piece of tape (with holes) underneath the threads, pressed the threads against the tape to make intimate contact between the tape and the thread. **(D)** We pressed a second piece of tape on top of the threads to encapsulate them between the two pieces of tape. **(E)** We disconnected the thread form the loom by cutting the thread where it contacts the pins of the loom.

A



B



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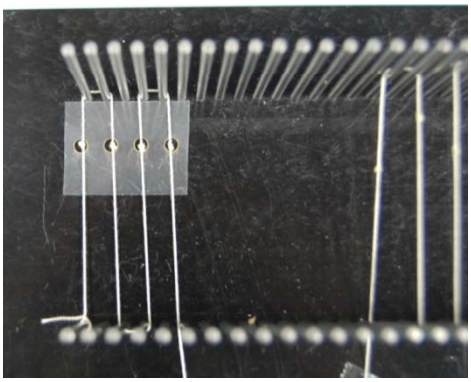

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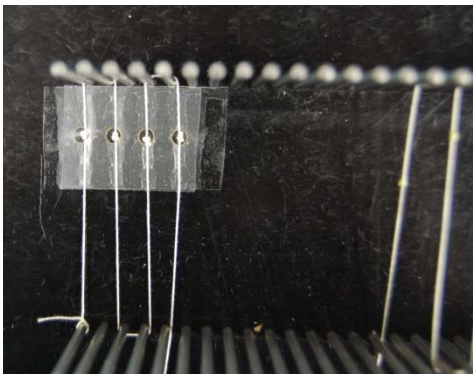

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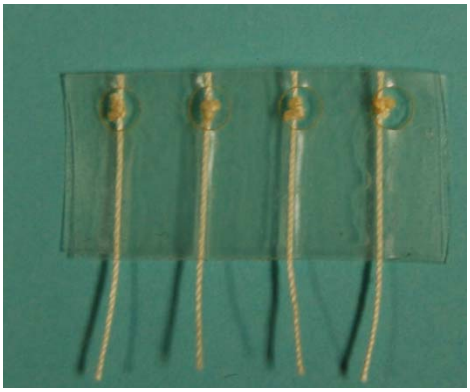
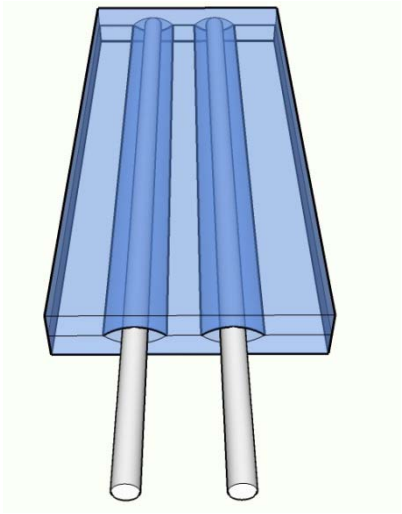


Figure S1

Figure S2. Schematic illustrations demonstrating the effect of the width of a gap between two threads encapsulated between two pieces of Scotch tape. **(A)** When the gap is wide, the contact that the Scotch tape makes with the thread is enough to separate the two threads from each other. **(B)** When the gap is narrow, it acts as an open channel between the two threads.

A



B

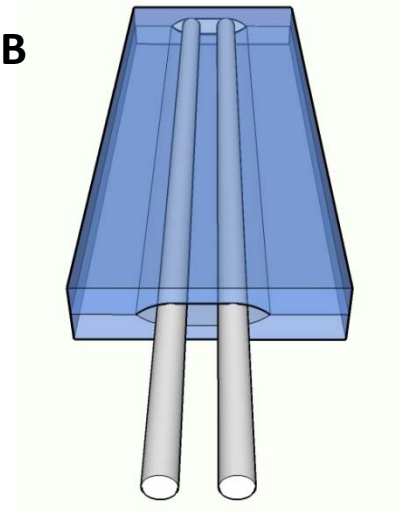


Figure S2

Figure S3. Images of the woven-array device fabricated with different types of tapes after the bottom of the tape dipped into a solution of red ink. **(A)** Threads between two pieces of vinyl tape. **(B)** Thread between two pieces of Scotch tape. The Scotch tape does not seal conformally to the string, and therefore leaves small gaps that serve as capillaries around the thread. **(C)** Threads sandwiched between one piece of Scotch tape and one piece of vinyl tape. **(D)** Thread with petroleum jelly on their outer side encapsulated between two pieces of Scotch tape.

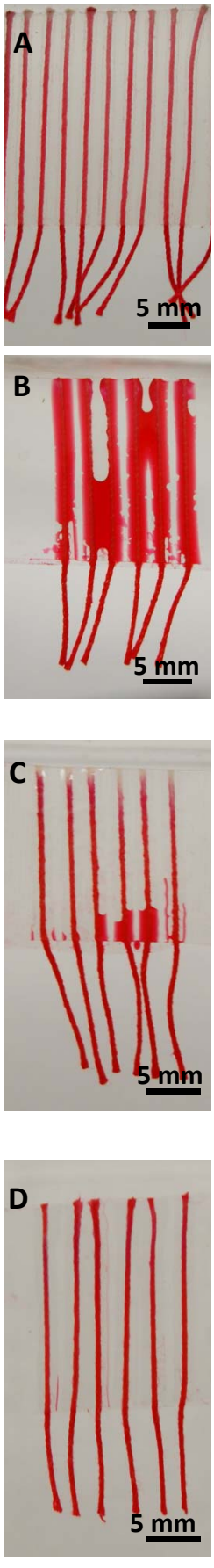


Figure S3

Figure S4. An image of two threads coated with petroleum jelly on their outer side and encapsulated with two pieces of Scotch tape after the bottom of the tape was dipped into a solution of red ink. The ink wicked only within the thread and the petroleum jelly allowed us to pull out the treads from the encapsulating tape.

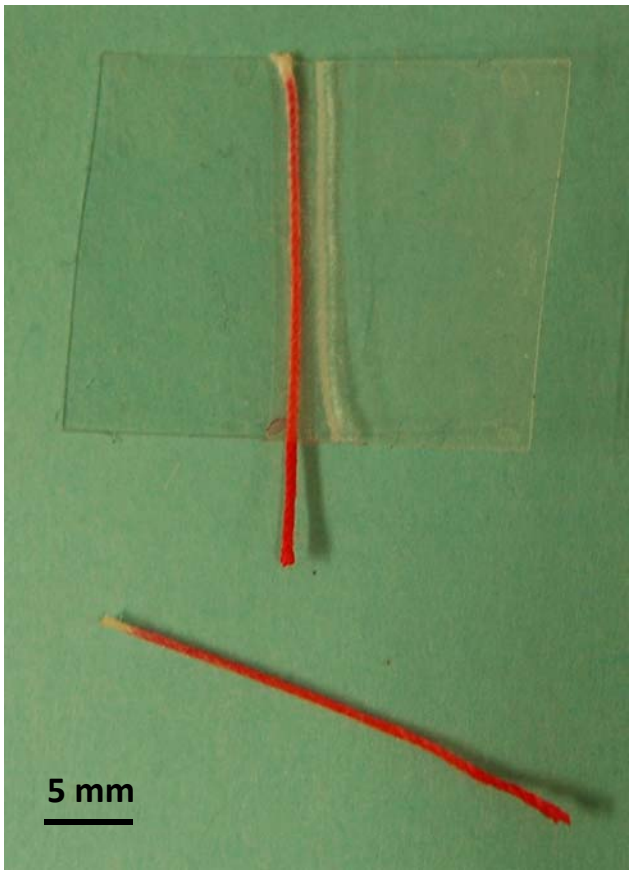


Figure S4

Figure S5. Protein detection assays by using varying concentrations of BSA.

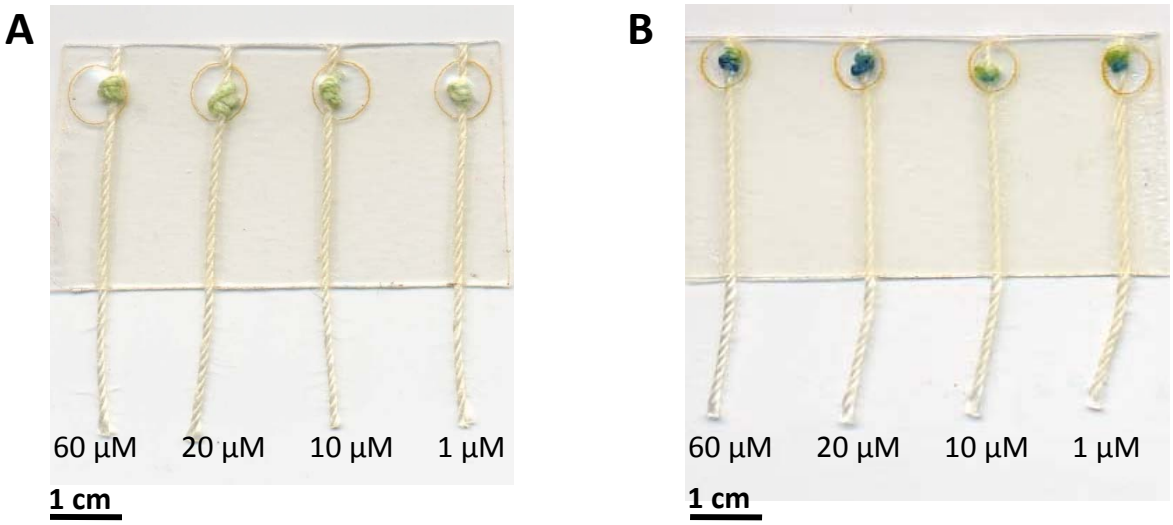


Figure S5