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Supplemental material for

DNA-functionalized Pt nanoparticles as catalyst for chemically powered micromotor: Toward signal-on motion-based DNA biosensor

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Materials and methods. All reagents were obtained from commercial sources and used without further purification unless otherwise stated. 3,4-ethylenedioxythiophene (EDOT), 11-mercaptoundecanoic acid (MUA), 1-Ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC), sodium dodecyl sulfate (SDS), chloroplatinic acid (H_2PtCl_6, 99.95 %), sodium borohydride (NaBH4, 99.0 %), sodium cholate were purchased from Sigma Aldrich. N-hydroxysulfosuccinimide (Sulfo-NHS), Tris (2-carboxyethyl) phosphine hydrochloride (TCEP) were purchased from Pierce Protein Biology.

A cyclopore polycarbonate membrane (Whatman 7060-2511) was purchased from Whatman. This membrane was made conductive to serve as a working electrode by sputtering a thin gold film (80 nm) on one side. The sputter was done using the Denton Discovery 18 instrument at the University of Utah Nanofab lab. A gold plating solution (Orotemp 24) was purchased from Technic Inc (Anaheim, CA). Poly (3,4-ethylenedioxythiophene) (PEDOT) microtubes with an inner gold layer (PEDOT/Au) were prepared by a common electrodeposition method as previously described.1 The microtubes were prepared by EDOT electropolymerization (+0.8 V vs. Ag/AgCl) for a 0.08 C of charge from a solution containing 15 mM EDOT, 7.5 mM KNO3 and 100 mM SDS and subsequent gold electrodeposition (-0.9 V vs. Ag/AgCl) for 1 C of charge from a commercial gold plating solution (Orotemp 24, Technic Inc). After preparation, the microtubes were suspended in 1.5 mL nanopure water and stored at room temperature.

DNA strands were synthesized and purified at the University of Utah Core Facility. Pt nanoparticles (PtNP, 4 nm in size) and PtNP-DNA conjugate were prepared following a literature protocol.2, 3 PtNP-DNA conjugate (500 nM) was stored in PBS buffer pH 7.4 at 4º C until use.

Modification of PEDOT/Au microtubes with DNA 1. The inner gold layer of the PEDOT/Au microtubes was functionalized with a MUA monolayer by incubating the microtubes in an ethanol solution containing 2.5 mM MUA overnight. The microtubes were then rinsed 3 times with ethanol and 3 times with MES buffer (0.1 M, pH 5.5) and collected by centrifugation at 6000×g for 5 minutes. After that, a 200 µL coupling solution containing EDC (0.4 M), sulfo-NHS (0.1 M) and DNA **1** (5 µM) in MES buffer (pH 5.5) was added to the MUA-modified microtubes. The reaction was allowed to proceed at room temperature overnight with gentle shaking. The DNA-functionalized microtubes were then rinsed with SDS 0.05 % and washed with PBS pH 7.4 (5 times). The microtubes were suspended in PBS buffer pH 7.4 and stored at 4º C until use.

Motion-based detection of DNA 3. The PEDOT/Au microtubes modified with DNA **1** was incubated in PBS buffer (pH 7.4) solutions containing different concentrations of DNA **3** for 2 h at room temperature with gentle shaking. The microtubes were then washed extensively with PBS buffer pH 7.4 (5 times) to remove extra DNA **3** in solution. After that, a 10 µL solution of the

microtube suspension was mixed with a 10 µL solution of PtNP conjugated with DNA **2**. The mixture was incubated for 4 h at room temperature to allow the PtNP-DNA conjugate attached to the microtube via DNA hybridization. The microtubes were then washed with PBS buffer pH 7.4 for 10 times to remove extra PtNP-DNA conjugate in solution and resuspended in 20 µL PBS buffer pH 7.4.

For the motion experiment, 2 µL of the microtube suspension was mixed with 2 µL solution containing 10 % hydrogen peroxide and 2 % sodium cholate. After 5 minute of incubation, the mixture was added to a glass slide for movie capturing with an inverted microscope (Olympus IX 71) equipped with DP 71 digital camera. The obtained movies were analysed by Icy software [4] to calculate the speed of micromotors. To obtain an average speed, 20-25 random micromotors were tracked for over 20 frames.

Table S1. DNA sequences studied

Name	Sequences
1	5'-NH_2-$(CH_2)_6$-AAAAACTGACTGACTGA-3'
2	5'- AAAAATGGATGGATGGA-$(CH_2)_6$- HS
3	5'-TCCATCCATCCAAGTGAGTGAGTGTCAGTCAGTCAG-3'
4	5'-AAAACATCAAGTAGCCCAGGATTGATACTGTCCAAATATACCCTGC-3'

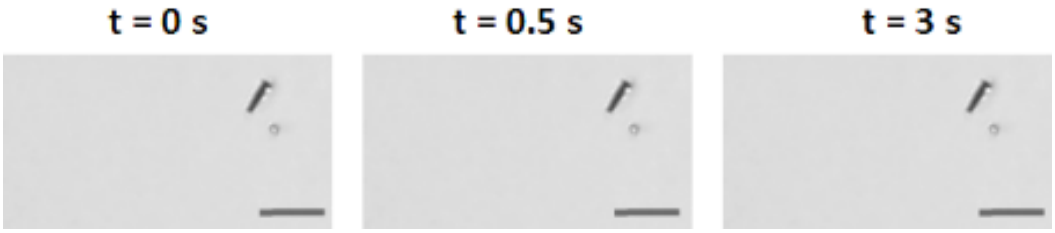

Figure S1. Images for the trajectory of MUA-modified Au/PEDOT microtubes (no DNA) with non-modified PtNP adsorption. No motion was observed indicating that the amount of PtNP adsorbed on microtubes is too low to produce efficient motion under our experimental conditions described above.

References

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