Supporting Information

Target-Induced Conjunction of Split Aptamer as New Chiral Selector for Oligopeptide on Graphene-Mesoporous Silica-Gold NP Hybrids Modified Sensing Platform

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Chemicals and Materials. The D-VP binding aptamer fragments: SH-P1 (5'-HS-$(CH_2)_6$-AAAAA**TCACGTGCATGATAGACGGCG**-3'), P2 (5'-**AAGCCGTCGAGTTGCTGTGTGCCGATGCACGTGA**-3') and the cocaine aptamer fragments: SH-C1 (5'-HS-$(CH_2)_6$-TTTTT**GGGAGTCAAGAACGAA**-3') and C2 (5'-**TTCGTTCTTCAATGAAGTGGGACGACA**-3') were synthesized by Shanghai Sangon Biotechnology Co. Ltd. (Shanghai, China). The concentrations of oligonucleotides were determined using the 260 nm UV absorbance and the corresponding extinction coefficient. Tris(2-carboxyethyl)phosphine hydrochloride (TCEP) was bought from Bio Basic Inc. (Markham Ontario, Canada). L-vasopressin and D-vasopressin were bought from Ai-gene.Inc (Shanghai, China). Cocaine hydrochloride, pethidine hydrochloride and methadone hydrochloride were

purchased from National Institute for the Control of Pharmaceutical and Biological Products (Changchun, China). The other chemicals were of analytical grade. 6-mercaptol-hexanol (MCH) was dissolved in the Tris-HAc buffer (10mM Tris-HAc, pH=7.4). SH-DNA samples were dissolved in the Tris-HCl buffer (25 mM Tris-HCl, 300mM NaCl, 120 μM TCEP, pH=8.2). Other samples were prepared in the Tris-HCl buffer (T-Buffer, 20 mM Tris-HCl, 140 mM NaCl, 5 mM KCl, 5 mM $MgCl_2$, pH=7.4). All the stock and buffer solutions were prepared by using distilled water and stored at 4 °C before use.

Instruments. The morphology of GSGHs was determined by using a XL30 ESEM scanning electron microscope. Transmission electronic microscopy (TEM) images were obtained with a JEM-2100F high-resolution transmission electron microscope operating at 200 kV. Differential pulse voltammetry (DPV) measurements were carried out on an Autolab PGSTAT30 (the Netherlands, controlled by GPES4 and FRA software) in 100 mM PBS buffer (pH=6.5). The parameters applied were as follows: modulation time 50 ms, interval time 0.5 s, modulation amplitude 25 mV, step potential 5 mV and voltage range from 0.7 to 0.1 V. Cyclic voltammetry (CV) measurements were performed with a model CH Instrument 832B electrochemical workstation (Shanghai Chenhua Company, China). A three-electrode system was consisted of the ITO working electrode (5-mm in diameter), an Ag/AgCl reference electrode, and a platinum wire counter electrode. The cell was housed in a homemade Faraday cage to reduce stray electrical noise. All the electrochemical measurements were performed at room temperature of about 13-15 ºC.

Prepareation of ITO Electrode. The desired ITO electrodes were fabricated as follows. Briefly, the indium tin oxide (ITO) electrode (1 cm × 5 cm) was treated with ethanol and distilled water to get a clean surface. Positive photoresist (RZJ-390) was spin-coated on ITO surface with spinning at 3000

rpm for 30 seconds. After preheated 100 s at 100 °C, the photoresist layer coated ITO slides was covered by a photoresist mask (the photoresist mask with desired electrode pattern) and exposed under UV light by Lithography System (JKG-2A Model). The exposed photoresist part was easily removed by 0.1 M NaOH and the revealed ITO layer could be developed by wet chemical etching using the mixed solution (HCl: $FeCl_3$: H_2O = 1:2:1). The desired ITO electrode protected by remained photoresist was left only. After removing the remaining photoresist, the as-prepared ITO electrode was cleaned and stored for use in next step.

Fabrication of GSGHs-based Sensing Platform. The Fc-PEI was synthesized according to a previous literature.[1] To provide a negatively charged clean surface, the as-prepared ITO electrodes were cleaned by ultrasonication in ethanol aqueous solution saturated with NaOH, acetone, ethanol and distilled water, respectively. The negatively charged ITO substrate was first immersed in PEI aqueous solution (0.5 mg/mL, containing 0.5M NaCl) for 15min. After carefully washed and dried, the electrodes were immersed in poly(sodium 4-styrenesulfonate) (PSS) aqueous solution (0.5 mg/mL, containing 0.5M NaCl). The PSS-terminated film was alternately immersed in Fc-PEI and PSS solution and incubated for 15 min. This process was repeated twice to obtain the $(Fc\text{-}PEI/PSS)_2$ and with another layer of PEI as the outermost layer to fix the GSGHs. After drying the multilayer for 30 min, 15 μL of 12.5 mg/mL GSGHs was casted on the multilayer over night and then final sensing platform PEI/PSS/$(Fc\text{-}PEI/PSS)_2$/PEI/GSGHs was obtained. For the stability detection, the final sensing platform was dried and stored in air at room temperature.

Fabrication of the Sensing Interface. The as-prepared GSGHs-based sensing platform was covered with 50 μL of 2.1 μM SH-P1 and kept for 3 h. Then the modified electrode was covered with 20 μL

of 1 mM MCH and kept at room temperature for 30 min to reduce the nonspecific adsorption. The final sensing interface was obtained after rinsing with distilled water and being dried by nitrogen.

Electrochemical Detection of D-VP. The as-prepared sensing interfaces were measured by using DPV to collect the electrochemical signals of Fc to get an original of peak current (i_0). And then 50 μL of samples containing 5 μM P2 and different concentrations of D-VP were placed on the sensing interface and incubated for 20 minutes at 30 ºC. After that, the decreased peak current (i) of DPV was measured. For a control experiment, 100 μg/ml L-VP containing 5 μM P2 was placed on the interface and incubated for 40 min, respectively.

The Generality of the GSGHs-based Sensing Platform. The general applicability of the novel sensing platform was demonstrated by replacing SH-P1 with SH-C1 (one of the fragments of cocaine binding aptamer). After the sensing interfaces were completely obtained, the cocaine solutions with 5 μM C2 were placed onto the sensing interface and incubated for 40 min at 30 ºC, followed by being measured using DPV. For the control experiments, the sensing interfaces were treated with 2.5 mM ecgonine, 2.5 mM pethidine and 2.5 mM methadone containing 5 μM C1 were added into incubation chamber and incubated for 40 min, respectively.

Figures

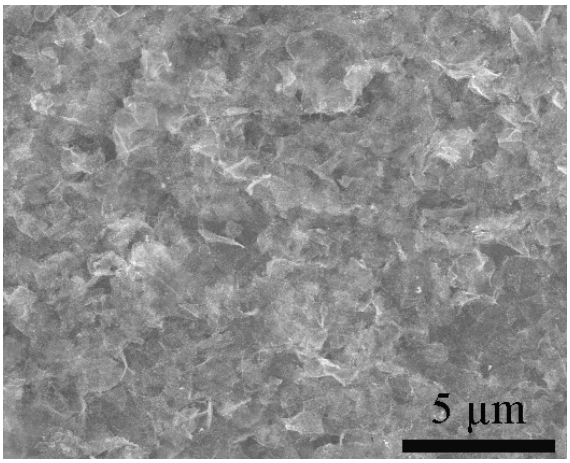

Figure S1 SEM images of GSGHs.

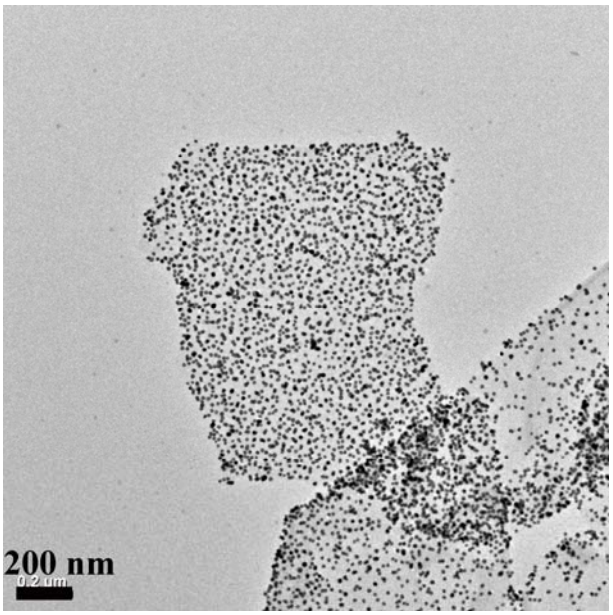

Figure S2 TEM images of GSGHs.

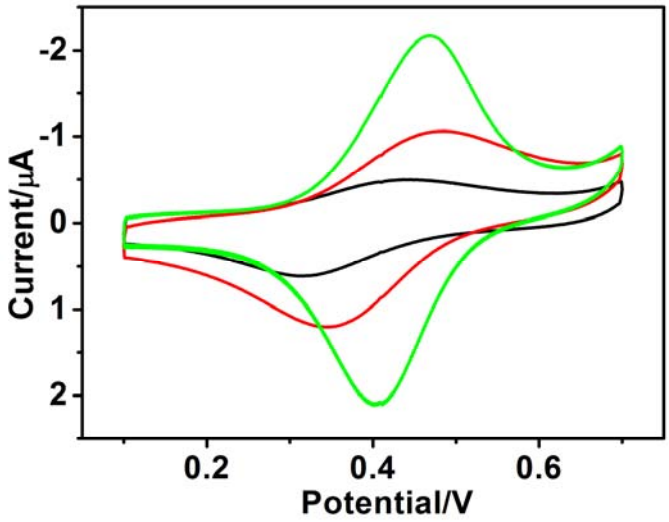

Figure S3 CVs of PEI/PSS/(Fc-PEI/PSS)$_1$ (blank), PEI/PSS/(Fc-PEI/PSS)$_2$ (red), PEI/PSS/(Fc-PEI/PSS)$_2$/PEI/GSGHs (green)-modified ITO electrodes in 100 mM PBS (pH 6.5).

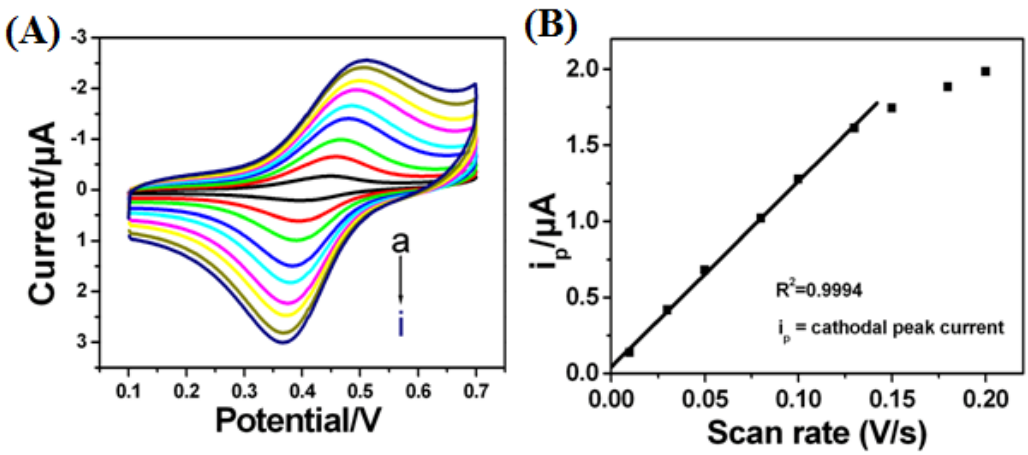

Figure S4 (A) CVs of (PEI/PSS/(Fc-PEI/PSS)$_2$/PEI/GSGHs) in pH 6.5 100 mM PBS buffer at the scan rates of (a) 10, (b) 30, (c) 50, (d) 80, (e) 100, (f) 130, (g) 150, (h) 180, and (i) 200 mV/s. (B) The linear relationship between the cathodal peak currents and their scan rates.

References

1. Hodak, J.; Etchenique, R.; Calvo, E. J.; Singhal, K.; Bartlett, P. N. *Langmuir* **1997**, *13*, 2708-2716.