Supplementary Material

Aptamer-conjugated MoS_2 for enrichment and direct detection of small molecules in laser desorption/ionization mass spectrometry

Yaju Zhao,* [a] Qiaobo Liao[b] and Kai Xi[b]

[a] *Zhejiang Engineering Research Institute of Food & Drug Quality and Safety, School of Management and E-Business, Zhejiang Gongshang University, Hangzhou 310018, P.R. China. E-mail*: zyj@zjgsu.edu.cn

[b] *School of Chemistry and Chemical Engineering, Nanjing University, Nanjing 210023, P.R. China*

1. Experimental section

1.1 Chemicals and reagents

MoS_2 powder was purchased from Alfa Aesar (Shanghai, China). Hexane was purchased from Nanjing Chemical Reagent Co., Ltd. (Nanjing, China). Sulfadimethoxine (SDM), sulfathiazole (STZ), sulfisoxazole (SIX), sulfaquinoxaline (SQX), and n-butyllithium in hexane (1.6 M) were purchased from Sigma-Aldrich (St. Louis, MO). The 5'-thiol-modified SDM aptamer with the sequence of 5'-SH-$(CH_2)_6$-GAGGGCAACGAGTGTTTATAGA-3' was synthesized by Sangon Biotech Co., Ltd. (Shanghai, China) and purified using HPLC. Commercial milk samples were purchased from local supermarkets in Nanjing, China. 10 mM phosphate buffer (PBS) containing 1 mM $MgCl_2$ at pH 8.0 was used for preparation of aptamer solution. All other reagents were of analytical grade and used without further purification. All aqueous solutions were prepared with Millipore ultrapure water (resistivity of 18.2 MΩ·cm) throughout our experiments.

1.2 Apparatus

UV-vis spectrum was performed on a Synergy Hybrid Reader (BioTek, USA). CT15RT versatile refrigerated centrifuge (Shanghai Tianmei Scientific Instrument Co., Shanghai, China) was used for centrifugation. Fourier transform infrared (FTIR) spectra were obtained on a Nicolet™ iS10 FTIR spectrometer (Thermofisher Scientific, USA). X-ray diffraction (XRD) analyses were performed by D8 ADVANCE (Bruker, Germany). The morphology of MoS_2 and aptamer-conjugated MoS_2 were characterized by transmission electron microscope (TEM) using a JEOL JEM-1011 microscope (JEOL, Tokyo, Japan). Photographs of MoS_2 and aptamer-conjugated MoS_2 matrix spots were captured by the camera equipped on the MS instrument.

1.3 Synthesis of MoS_2 nanosheets

The MoS_2 nanosheets were synthesized by chemical exfoliation according to the previously reported procedure with some modifications[1]. Briefly, pristine bulk MoS_2 was intercalated with lithium by reacting MoS_2 powder (3 g) with n-butyllithium in hexane (1.6 M, 30 mL) at 100 °C in a poly (tetrafluoroethylene) (Teflon)-lined autoclave for 4 h. Then the solution was transferred to a flask and stirred under N_2 atmosphere at 25 °C for 48 h. The suspension was filtered over a filter paper and washed with 200 mL of hexane, giving a black powder of intercalated MoS_2 compound. Exfoliation was then immediately suspended in 200 mL of ultrapure water and sonicated for 4 h. The solution was centrifuged with 3000 rpm for several times to remove the unexfoliated materials. The concentration of the obtained MoS_2 solution was calculated as 0.5 mg mL^{-1} by the drying and weighting method.

1.4 Preparation of analyte solutions

Standard stock solution of SDM, STZ, SIX, and SQX (5 mM) was prepared in methanol. Then standard solutions were prepared by diluting standard stock solutions with ultrapure water. The milk sample preparation was performed according to previous reports with some modifications[2]. Briefly, the milk samples were defatted by centrifugation at 5000 rpm for 10 min at 4 °C. Then, 1 mL of the defatted milk sample was mixed with 1 mL of trichloroacetic acid. After that, the mixture was ultrasonically treated for 15 min at room temperature, followed by centrifugation at 15,000 rpm for 10 min. The supernatant was collected and neutralized by NaOH for analysis. The SDM-spiked milk sample was prepared by adding known amounts of SDM into the treated milk sample. All analyte solutions were stored at 4 ℃ prior to use.

2. Supporting figures

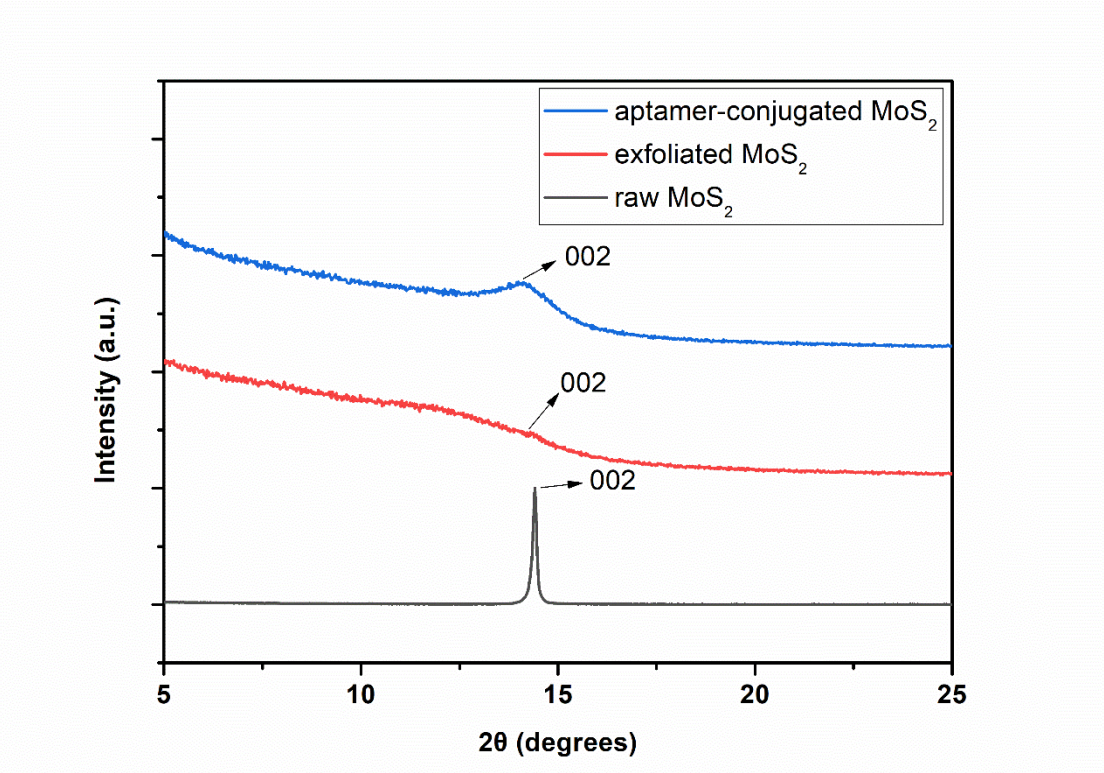

Fig. S1. XRD spectra of raw MoS_2, exfoliated MoS_2, and aptamer-conjugated MoS_2 nanosheets.

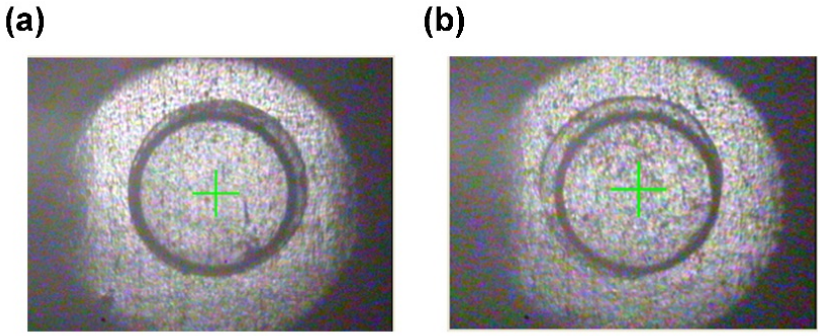

Fig. S2. The optical images of (a) MoS_2 and (b) aptamer-conjugated MoS_2 matrices with the analyte solutions dispersed on the target plate.

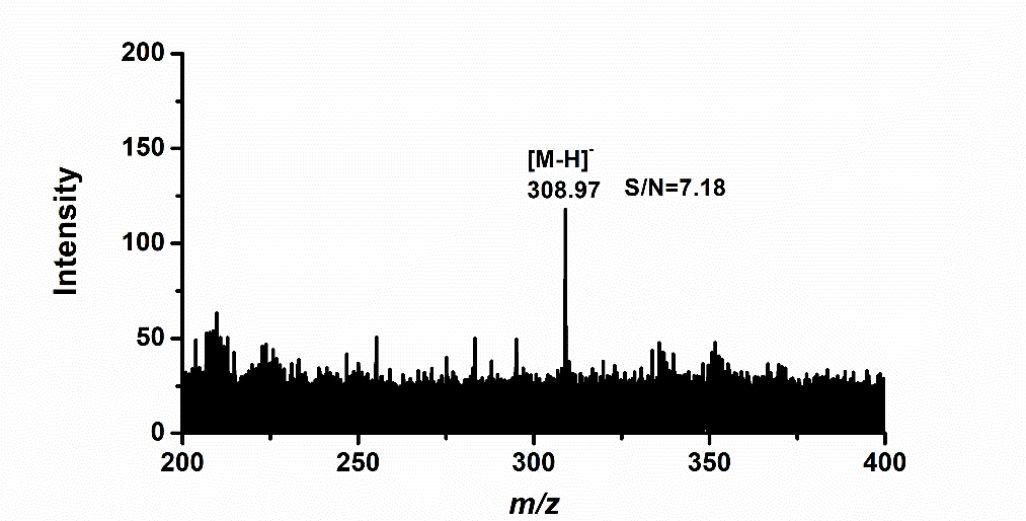

Fig. S3 Mass spectrum of 100 nM SDM in standard test solution after extraction with aptamer-conjugated MoS_2.

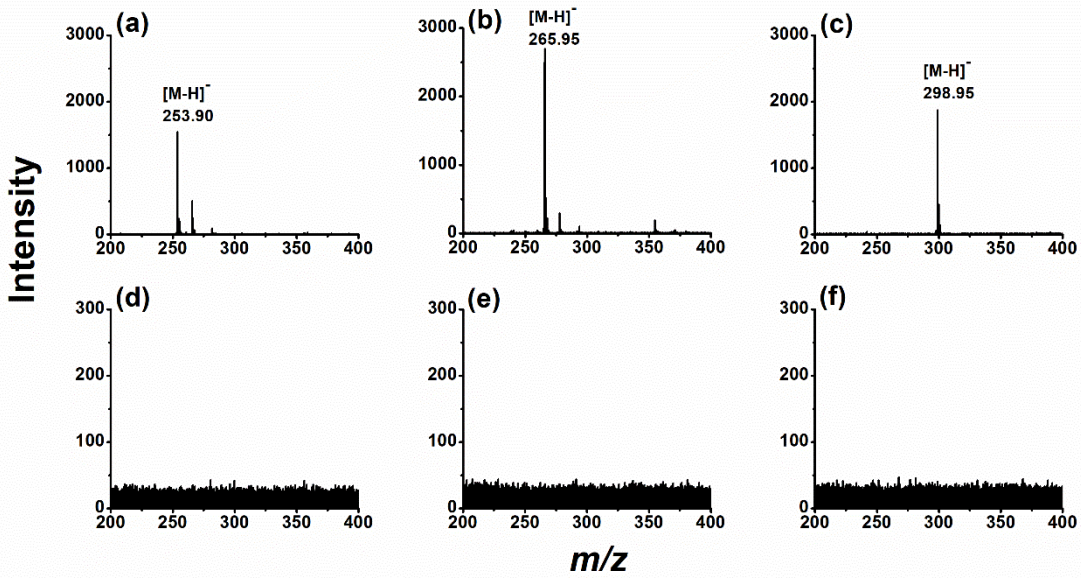

Fig. S4 Mass spectra of 100 μM (a) STZ, (b) SIX, and (c) SQX using aptamer-conjugated MoS_2 matrices in negative mode; Mass spectra of 200 nM (d) STZ, (e) SIX, and (f) SQX in standard test solution after extraction with aptamer-conjugated MoS_2.

3. Reference

1. Y. Zhao, Q. Liao, K. Xi and D. Xu, *J. Am. Soc. Mass Spectr.*, 2021, **32**, 2463–2471.
2. Y. Zhao, M. Tang, F. Liu, H. Li, H. Wang and D. Xu, *Anal. Chem.*, 2019, **91**, 13418-13426.