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Electronic Supplementary information (ESI)

Ultrasensitive detection of microRNA with a bismuthene-enabled fluorescence quenching biosensor

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1. Bismuthene nanosheet preparation

Bismuthene nanosheets were prepared by the probe-sonication liquid-phase exfoliation method as previously reported.[1, 2] A total of 30 mg Bi powder was added into N-methyl-2-pyrrolidone (NMP) solution (300 ml). The Bi powder solution was sonicated for 6 h in an ice bath with a power of 420 W. Then, the solution was treated by probe sonication with a power of 1080 W for 24 h. Subsequently, the solution was centrifuged at 7000 rpm for 30 min. Finally, the required bismuthene nanosheets were carefully collected.

Reference:

1. L. Lu, Z. Liang, L. Wu, Y. Chen, Y. Song, S. C. Dhanabalan, J. S. Ponraj, B. Dong, Y. Xiang, F. Xing, D. Fan, H. Zhang, *Laser Photonics Rev.* 2018, **12,** 1700221;
2. H. Huang, X. Ren, Z. Li, H. Wang, Z. Huang, H. Qiao, P. Tang, J. Zhao, W. Liang, Y. Ge, *Nanotechnology* 2018, **29,** 235201.

2. Transient absorption measurements

Time-resolved and transient absorption spectra of the samples were obtained with an automated femtosecond transient absorption spectrometer (Ultrafast systems, HELIOS FIRE). The system can be used to measure a time window of 8 ns with a time resolution of 14 fs. The pump beam can be selected from the wavelength range of the visible to near-infrared region (800 nm), while the probe beam can be adjusted within the 320 nm to 1600 nm wavelength range with the help of an optical parametric amplifier (Spectra Physics TOPAS prime), a femtosecond Ti:sapphire amplified laser (Spectra Physics, Spitfire Ace, 100 fs, 1 kHz, 4 mJ at 800 nm) and supercontinuum generation nonlinear optical crystals. In the present case, the samples were pumped at the excitation edge of the dye FAM (450 nm), and the probe was selected in the visible region that covers the entire dye emission spectrum. The transient absorption signal (ΔA) was collected as a function of the delay time (τ) between the probe and pump pulses. Here, the differential absorption gives the change in the absorption induced by the pump pulses, $\Delta A = A_0 - A_\tau$, where A_0 and A_τ are the sample absorption without and with pump excitation. Finally, the data were analyzed and plotted using Surface Xplorer and Origin software.

3. Materials and Characterization

Oligonucleotides were purchased from Beijing Genomics Institute (Shenzhen, China). The sequence information of the oligonucleotides is shown in Table 1. Fluorescence measurements were performed with an RF-5301PC from Shimadzu of Japan. AFM images were obtained with an L01F4C8 microscope from Bruker of Germany. HRTEM images were taken under a JEM-3200FS microscope from JEOL of Japan. XRD data were collected using a D8 Advance instrument from Bruker of Germany. Raman spectra were obtained with an iHR 320 spectrometer from Horibai of Japan.

Table 1. Sequence information of oligonucleotides used in the experiments

Name	Sequence (5‘-3‘)
miRNA-21	UAGCUUAUCAGACUGAUGUUGA
FAM-ssDNA	FAM - TCA ACA TCA GTC TGA TAA GCT A
Mismatched miRNA-21	UAGCUUAUCAGGCUGAUGUUGA