Supplementary materials

Materials and reagents

The DNA sequence was synthesized and purified in Shanghai Biological Engineering Co., Ltd (China). The details are showed in the supplementary information. Mn-ZnS QDs were synthesized from MPA (J&K Chemical Co Ltd., China), Mn(Ac), $Zn(Ac)_2 \cdot 2H_2O$, $Mn(Ac)_2 \cdot 4H_2O$ and $Na_2S \cdot 9H_2O$ (all Tianjin Kemiou Chemical Reagent Co., Ltd.). Ultrapure water (18.2 MΩ cm) was produced by a WaterPro ultrapure water system (Labconco, US). All solutions were prepared in ultrapure water.

Instruments

The morphology of the QDs and QDs-DNA was observed on a JEM-2100 transmission electron microscope (TEM, JEOL Ltd. Japan). RTP was measured by a Cary Eclipse fluorescent spectrophotometer (Varian Co. Ltd, US), and pH was detected by a pH meter (Shanghai Lei-ci, China). The sizes and morphology of QDs were characterized on a Nano-ZS grain-size/Zeta potential analyzer (Malvern). Resonance light scattering (RLS) spectra were detected by the same fluorescence spectrophotometer at the scanning range of 200-700 nm.

Synthesis of Mn-ZnS QDs

Mn-ZnS QDs were prepared by an existing method (Miao et al., 2014, 2015). In each time, $Zn(Ac)_2$ (10 mL, 0.1 $mol \cdot L^{-1}$), $Mn(Ac)_2$ (4 mL, 0.01 $mol \cdot L^{-1}$) and MPA (100 mL, 0.04 $mol \cdot L^{-1}$) solutions were added into a 250 mL three- necked bottle. The mixture was adjusted to pH 11 by adding a 1 $mol \cdot L^{-1}$ NaOH solution and

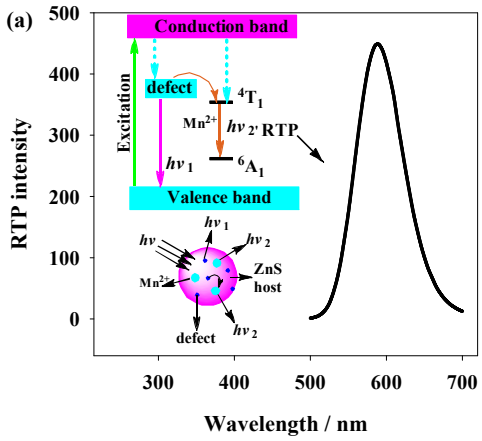
magnetically stirred for 30 min at room temperature and argon ventilation. Then 10 mL 0.1 mol·L^{-1} of Na_2S was injected under air isolation. After argon ventilation under stirring for 20 min and ageing in air for 2 hours, the resulting solution was kept at 50 °C to form MPA-capped Mn-ZnS QDs. Then a same volume of ethanol was added to precipitate the QDs. The resulting solution was centrifuged, washed with ethanol, and dried in a vacuum oven for 24 h, forming powder Mn-ZnS QDs.

Table S1. Sequences of oligonucleotides used in this study.

Name of oligonucleotide	Sequence of oligonucleotide
Capture DNA 1（S1）	5’-SH-$(CH_2)_6$-CTT CAA CGA TG-3’
Capture DNA 2（S2）	5’–CGG CAG AGG CAT - $(CH_2)_3$ -SH- 3’
Target DNA (complementary DNA)	5’-CAT CGT TGA AGA TGC CTC TGC CG-3’
Single-base mismatch DNA	5’-CAT CGT TGA AGA T**C**C CTC TGC CG-3’ (Replace the 14th base "G" of complementary DNA with "C")
Random DNA	5’-TCA TTC CAG CTC GTA ACG CTA TAG ATA-3’

Table S2 Effect of co-existing substance (major biomolecules) on the RTP intensity of 50 nM target DNA.

Co-existing substance	[Co-existing substance] / [Target DNA]	Change of the RTP Intensity (%)
Na^+	500000	+4.3
K^+	100000	+3.7
Ca^{2+}	600	-4.6
Mg^{2+}	500	-2.8
Glucose	10000	-3.8
Glutamic acid	800	-4.2
Alanine	1000	-3.3



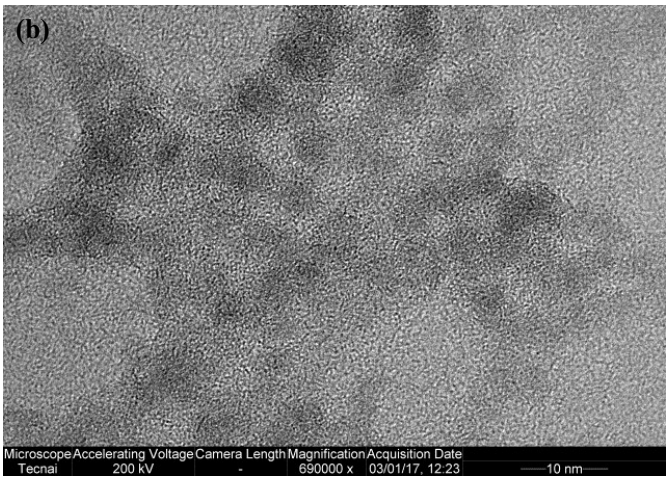


Fig. S1. (a) The RTP emission spectra of Mn-ZnS QDs (10 mg L^{-1}). Inset: schematic illustration of electronic transition involved in the RTP emission from Mn-ZnS QDs. Solutions were prepared in PBS (0.02M, pH 7.4). (b) TEM image of MPA-capped Mn-ZnS QDs.

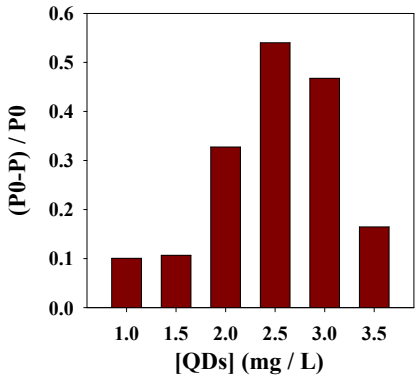


Fig. S2. The effects of different concentrations of QDs-DNA (P1 and P2) on the phosphorescence quenching rate of the exciton energy transfer system were investigated after the target DNA (20 nM) was added.