Facile synthesis of hybrid silicon quantum dots and fluorescent detection of bovine hemoglobin

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Synthesis of silicon quantum dots using a silicon precursor

The silicon quantum dots (SiQDs) were synthesized by APTES (or TSIM) and the hydrothermal method. The synthesis procedure and treatment were the same with the hybrid SiQDs. Briefly, 2 mL of APTES (or TSIM) was added in a 50 mL of flask, and then 6 mL of 0.1 M L-AA (fresh prepared) was added into the flask and stirred for 5 min. The mixture was transferred into a Teflon-lined autoclave chamber of 50 mL volume, and heat to 160 $^{\circ}$ C for 6 h. The reactors were cooled to room, and the mixture was filtrated by 0.22 µm membrane, and the resultant transparent solution was dialyzed with 1 kDa interception of the dialysis bag for 24 h. They were further characterized by XPS and shown in Fig. S2 and Fig. S3.



Fig. S1 XRD spectrum of the hybrid SiQDs.



Fig. S2 XPS spectra of (a) full range, (b) C 1s, (c) N 1s, (d) O 1s, (e) Si 2p peak of the SiQDs using APTES as the silicon precursor. (f) The content of elements detected by XPS.



Fig. S3 XPS spectra of (a) full range, (b) C 1s, (c) N 1s, (d) O 1s, (e) Si 2p peak of the SiQDs using TSIM as the silicon precursor. (f) The content of elements detected by XPS.



Fig. S4 The fluorescence lifetime spectra of the hybrid SiQDs (APTES/TSIM=1:1) and the SiQDs synthesized from APTES or TSIM, respectively.

Table S1. Fluorescence lifetime value and relative content of SiQDs synthesized from

 different silicon sources

Silicon source	Parameter	Value /ns	Relative %	τ/ns
APTES	$ au_1$	0.7320	6.81	
	$ au_2$	4.3115	32.40	8.76
	$ au_3$	12.0277	60.79	
TSIM	τ_1	0.8959	13.02	
	$ au_2$	3.6824	55.03	5.26
	τ_3	9.7429	31.95	
APTES/TSIM= 1:1	τ	10.8743	100	10.87



Fig. S5 The stability of hybrid SiQDs in different pHs of phosphate buffer at room temperature (a); under physiological condition (pH 7.4) at 37° C (b), 25° C (c), and the comparison of fluorescence intensity at 25° C and 37° C (d).



Fig. S6 The storage stability of the hybrid SiQDs (physiological condition, pH 7.4) at room temperature



Fig. S7 The UV-Vis spectrum of BHb (10 μ M) (black line), the fluorescence excitation spectrum, and fluorescence emission spectra (blue line) of the hybrid SiQDs.