A single dual-emissive nanoprobe for quantification of spontaneous glucose in human serum

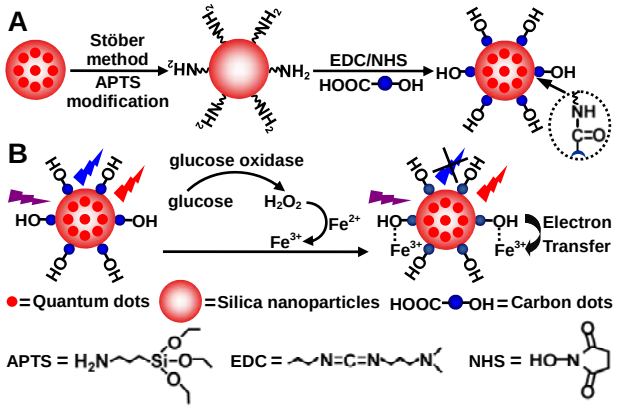
Xiaoyan Huang, Xiaoling Gu, Liying Zhang, Yang Jin, Shuhu Du*

School of Pharmacy, Nanjing Medical University, Nanjing, Jiangsu 211166, China

Abstract (300 word limit)

In this work, we report a strategy of a single dual-emissive ratiometric fluorescent nanoprobe (QDs@SiO_2-CDs) with the controllable ratio of emissive intensities to realize the consecutive color variations from blue to red for the quantification of blood glucose. The red quantum dots (rQDs) were embedded into silica nanoparticles (SiO_2 NPs) as an stable internal standard emission, and blue carbon dots (bCDs) were further covalently linked onto the surface of SiO_2 NPs, in which the ratiometric fluorescence intensity of blue to red is controlled at 5:1. When the oxidation of glucose induced the formation of Fe^{3+} ions, the fluorescent intensity (at 445 nm) of bCDs (from QDs@SiO_2-CDs) was thus quenched by the electron transfer from CDs to Fe^{3+}. Meanwhile, the fluorescent intensity (at 630 nm) of rQDs (from QDs@SiO2-CDs) keeps almost unchanged. It has been demonstrated that the fluorescence intensity ratio I_{445}/I_{630} is linearly related to the glucose concentration in the range of 0−75 μM (R^2 = 0.989). The calculated detection limit is about 3 μM in terms of the 3σ rule. Consecutive color variations from blue to red with the dosage of glucose can be seen under a 365 nm UV lamp. That is to say, the ratiometric fluorescent probe can be used for the detection of glucose in human serum. The test result show that the spontaneous blood glucose determined by the probe was almost in accordance with that measured by a standard glucometer. The method reported here opens a window to the wide applications of the ratiometric fluorescent probe in biological assays.

Image



Scheme 1. Schematic illustration of (A) the synthesis of the dual-emission ratiometric fluorescent probe QDs@SiO_2-CDs nanoparticles and (B) the visual detection of glucose.

Recent Publications (minimum 5)

1. Shaw, J. E.; Sicree, R. A.; Zimmet, P. Z.(2010) Diabetes Res. Clin. Pract. 87, 4-14.
2. Whiting, D. R.; Guariguata, L.; Weil, C.; Shaw, J.(2011) Diabetes Res. Clin. Pract. 94, 311-321.
3. Han, M.; Gao, X.; Su, J. Z.; Nie, S.(2001) Nat. Biotechnol. 19, 631-635.
4. Jiang, W. X.; Dong, X.; Jiang, J.; Yang,Y. H.; Yang, J.; Lu, Y. B.; Fang, S. H.; Wei, E. Q.; Tang, C.; Zhang, W. P.(2016) Sci. Rep. 6, 20568-20576.
5. Grossi, M.; Morgunova, M.; Cheung, S.; Scholz, D.; Conroy, E.; Terrile, M.; Panarella, A.; Simpson, J. C.; Gallagher, W. M.; O'Shea, D. F. (2016) Nat. Commun. 7,10855-10867.
6. Kamiyama, D.; Sekine, S.; Barsi-Rhyne, B.; Hu, J.; Chen, B.; Gilbert, L. A.; Ishikawa, H.; Leonetti, M. D.; Marshall, W. F.; Weissman, J. S.; Huang, B.(2016) Nat. Commun. 7, 11046-11054.
7. Sandanaraj, B. S.; Gremlich, H. U.; Kneuer, R.; Dawson, J.; Wacha, S.(2010) Bioconjugate Chem. 21, 93-101.
8. Zheng, M.; Ruan, S.; Liu, S.; Sun, T.; Qu, D.; Zhao, H.; Xie, Z.; Gao, H.; Jing, X.; Sun, Z.(2015) ACS nano 9, 11455-11461.



Biography (150 word limit)

Shuhu Du

July, 1987–November, 2004 Employer: Anhui Academy of Medical Sciences
Location: 15 Yonghong Road, Hefei, Anhui, China
Position or Title: Research fellow
Duties: Drug development research

November, 2004–January, 2013 Employer: Nanjing Medical University
Location: 818 Tianyuan East Road, Nanjing, Jiangsu, China
Position or Title: Professor
Duties: Teaching and scientific research

Email: shuhudu@njmu.edu.cn

Notes/Comments: