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SYMPOSIUM

Harnessing a Nanostructured Fluorescence Energy Transfer Sensor for Quick Detection of Extremely Small Amounts of Glucose

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Abstract

Fluorescence technique is one of the major solutions for achieving the continuous and noninvasive glucose sensor for diabetes. In this article, a highly sensitive nanostructured sensor is developed to detect extremely small amounts of aqueous glucose by applying fluorescence energy transfer (FRET). A one-pot method is applied to produce the dextran-fluorescein isothiocyanate (FITC)-conjugating mesoporous silica nanoparticles (MSNs), which afterward interact with the tetramethylrhodamine isothiocyanate (TRITC)-labeled concanavalin A (Con A) to form the FRET nanoparticles (FITC-dextran-Con A-TRITC@MSNs). The nanostructured glucose sensor is then formed via the self-assembly of the FRET nanoparticles on a transparent, flexible, and biocompatible substrate, e.g., poly(dimethylsiloxane). Our results indicate the diameter of the MSNs is 60 ± 5 nm. The difference in the images before and after adding 20 μl of glucose (0.10 mmol/liter) on the FRET sensor can be detected in less than 2 min by the laser confocal laser scanning microscope. The correlation between the ratio of fluorescence intensity, I(donor)/I(acceptor), of the FRET sensor and the concentration of aqueous glucose in the range of 0.04–4 mmol/liter has been investigated; a linear relationship is found. Furthermore, the durability of the nanostructured FRET sensor is evaluated for 5 days. In addition, the recorded images can be converted to digital images by obtaining the pixels from the resulting matrix using Matlab image processing functions. We have also studied the *in vitro* cytotoxicity of the device. The nanostructured FRET sensor may provide an alternative method to help patients manage the disease continuously.

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Abbreviations: (APTS) 8-aminopyrene-1,3,6-trisulfonate, (Con A) concanavalin A, (FITC) fluorescein isothiocyanate, (FRET) fluorescence energy transfer, (HUVEC) human umbilical vein endothelial cells, (LCSM) laser confocal scanning microscopy, (MSN) mesoporous silica nanoparticle, (MW) molecular weight, (PDAC) poly(diallyldimethyl ammonium chloride), (PDMS) poly(dimethylsiloxane), (p(HEMA)) poly(2-hydroxyethyl methacrylate), (RGB) red, green, blue, (SEM) scanning electron microscopy, (SPS) sulfonated polystyrene, (TEM) transmission electron microscopy, (TRITC) tetramethylrhodamine isothiocyanate

Keywords: fluorescence energy transfer sensor, glucose monitoring, image process, nanostructured materials

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