Optical Approaches for Glucose Biosensing

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Abstract

Diabetes mellitus is one of the leading incurable diseases which may lead to severe health complications. The key for diabetes management is regular monitoring and maintenance of blood glucose levels in the body. We present herein three optical glucose biosensors for glucose monitoring-two enzymatic based hydrogel system and one non-enzymatic system. Firstly, a fluorescent enzymatic hydrogel consisting of fluorescein, polyethylene glycol and glucose oxidase (GOx) is employed. GOx catalyzes oxidation of glucose to gluconic acid that interacts with pH-sensitive fluorescein motif in hydrogel and thus significantly quenches its fluorescence, which was optically measured and correlated with glucose concentration. Then, a fluorescence “turn-on” glucose biosensor was investigated by using coumarin as a fluorophore instead of fluorescein. To increase the biocompatibility, both GOx and coumarin were covalent bonded on the matrix of muti-arm polyethylene glycol. The highly porous 3-D structure of the hydrogel allows quick response to glucose within 5 min. However, the behaviors of enzymatic based systems are highly limited by the activity of catalytic enzymes. To elongate the lifespan of the biosensor, non-enzymatic glucose detection system was also developed, in which surface enhanced Raman scattering (SERS) was utilized for glucose sensing using monolayer of 4-mercaptophenylboronic acid (MPBA) self-assembled on Ag nanorods surfaces as the recognition element. Through the specific binding of glucose with the boronic acid motif in MPBA, quantitative detection of glucose in a clinically relevant (0-20 mM) concentration range was successfully demonstrated.

Biography

Jun Chen is a Ph.D. student in the Department of Biomedical Engineering, University of Connecticut, USA. She earned her Bachelor degree in 2011 from Central South University, China. Her research concentrates on biocompatible and injectable biosensors.

Yu Lei is a Castleman associate professor of Chemical and Biomolecular Engineering and Biomedical Engineering at the University of Connecticut, USA. Dr. Lei obtained his Ph.D. degree in 2004 at the University of California-Riverside in Chemical and Environmental Engineering. His current research combines biotechnology, nanotechnology, and sensing technology, especially as applied to the development of gas sensors, electrochemical sensors, and biosensors.