Single-walled carbon nanotube-based optical hydrogel films for glucose monitoring in cell cultures

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During cell culturing bio-analytes, such as glucose, are monitored to maintain optimal cell culture growth conditions. It is vital for cell health that glucose levels are maintained during cell growth. Therefore, glucose is typically manually monitored in most of the small and medium scale bio-reactors and cell culture flasks. Autonomous glucose monitoring provides continuous control of the analyte during the culturing process, reduces the time of cell culture surveillance by technical personnel, and reduces the risk of contamination.

We develop an optical sensor for continuous glucose monitoring in cell cultures. The sensor is based on a nanocomposite comprising semiconductive single-walled carbon nanotube (SWCNT) and bio-engineered glucose oxidase (GOx). To create a functional sensing layer, the SWCNT/GOx composites are immobilized in a hydrogel matrix. The hydrogel is optically transparent to the fluorescence emission of SWCNTs, permeable to glucose molecules, bio-compatible, and non-degradable.

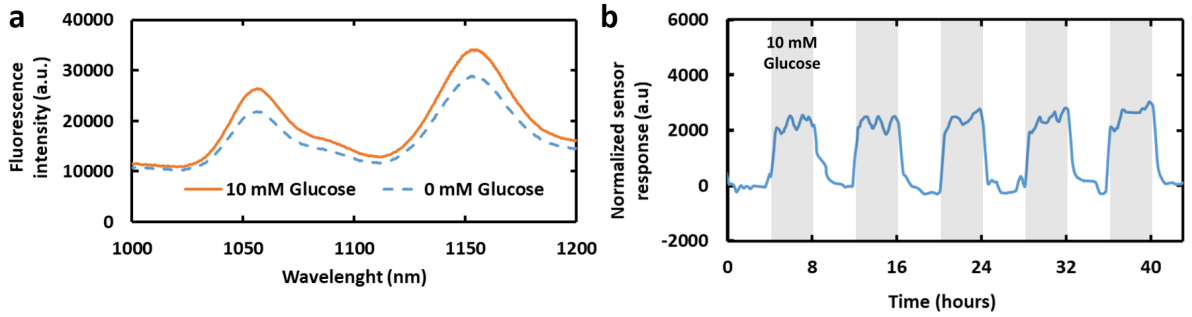

Figure 1 : Glucose monitoring in cell culture using SWCNT/GOx sensors. (a) Fluorescence spectra of SWCNT/GOx sensor exposed to 10 mM glucose in cell culture media. (b) Continuous monitoring of 10 mM glucose in cell culture media (grey areas), administrated in alternating cycles with cell medium without glucose (white areas).

In this study, we immobilized the optical hydrogel/SWCNT/GOx sensor material onto poly(methyl methacrylate) substrates which are inserted into a fluidic device. The sensing layer is illuminated with laser light at 660 nm and the fluorescence signal from SWCNTs is monitored in the near-infrared region between 1000 and 1200 nm. The cell culture media with and without added glucose are circulated through the fluidic device. The fluorescence intensity is recovered to its initial levels once the sensor is in contact with a cell culture medium without supplemented glucose. The hydrogel-based immobilization allows the integration of the sensing material inside cell culture flasks creating glucose-responsive layers, which can be monitored using an external optical reader.