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SYMPOSIUM

Biofouling of Polymer Hydrogel Materials and its Effect on Diffusion and Enzyme-Based Luminescent Glucose Sensor Functional Characteristics

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Abstract

Background:

Continuous glucose monitoring is crucial to developing a successful artificial pancreas. However, biofouling and host response make *in vivo* sensor performance difficult to predict. We investigated changes in glucose diffusivity and sensor response of optical enzymatic glucose sensors due to biological exposure.

Method:

Three hydrogel materials, poly(2-hydroxyethyl methacrylate) (pHEMA), poly(acrylamide) (pAM), and poly(2-hydroxyethyl methacrylate)-co-poly(acrylamide) (p(HEMA-co-AM)), were tested for glucose diffusivity before and after exposure to serum or implantation in rats for 1 month. Luminescent sensors based on these materials were measured to compare the response to glucose before and after serum exposure.

Results:

Glucose diffusivity through the pHEMA [$(8.1 \pm 0.38) \times 10^{-8}$ cm^2/s] slabs was much lower than diffusivity through pAM [$(2.7 \pm 0.15) \times 10^{-6}$ cm^2/s] and p(HEMA-co-AM) [$(2.5 \pm 0.08) \times 10^{-6}$]. As expected from these differences, sensor response was highly dependent on material type. The pHEMA sensors had a maximum sensitivity of 2.5%/(mg/dl) and an analytical range of 4.2–356 mg/dl, while the p(HEMA-co-AM) sensors had a higher sensitivity [14.9%/(mg/dl)] and a narrower analytical range (17.6–70.5 mg/dl). After serum exposure, the pHEMA sensors were unaffected, whereas the p(HEMA-co-AM) sensors exhibited significantly decreased sensitivity and increased analytical range.

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Abbreviations: (HEMA) 2-hydroxyethyl methacrylate, (DMPAP) 2,2-dimethoxy-2-phenylacetophenone, (GOx) glucose oxidase, (pAM) poly(acrylamide), (PBS) phosphate-buffered saline, (PDMS) poly(dimethylsiloxane), (PdP) palladium (II) meso-tetra(4-carboxyphenyl) porphine, (pHEMA) poly(2-hydroxyethyl methacrylate), (p(HEMA-co-AM) or copolymer) 50:50 molar ratio copolymer of pHEMA and pAM, (TEGDA) tetra(ethylene glycol) diacrylate, (TMSPMA) 3-(trimethoxysilyl)propyl methacrylate

Keywords: biofouling, biomaterials, biosensing, enzymes, luminescence, transport

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Abstract cont.

Conclusions:

Decreases in glucose diffusivity in the polymers resulting from *in vitro* serum exposure and residence *in vivo* were shown to be similar, suggesting that serum incubation was a reasonable approximation of *in vivo* fouling. While biofouling is expected to affect the response of flux-based sensors, we have shown that this depended on the type of sensor and matrix used. Therefore, proper design and materials selection may minimize response alterations occurring upon implantation.

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