An optimal and membrane-less glucose/oxygen enzymatic fuel cell based on a bioanode with a high coulombic efficiency and current density

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An optimal and membrane-less glucose/oxygen enzymatic biofuel cell possessing a high coulombic efficiency and power output was fabricated and characterized. A mixture of two sugar oxidizing enzymes, viz. pyranose dehydrogenase from *Agaricus meleagris* (*Am*PDH) and the free dehydrogenase domain of cellobiose dehydrogenase expressed in *E. coli* from *Corynascus thermophiles* (*rec*DH_{Ct}CDH) were entrapped in a low potential Os redox polymer hydrogel and used as the anode in combination with a cathode based on bilirubin oxidase from *Myritgecium verrucaria* entrapped in a high potential Os redox polymer hydrogel. Optimization showed that the current density for the mixed enzyme electrode could be further improved by using an engineered variant of *rec*DH_{Ct}CDH with a high glucose turnover rate in combination with an Os redox polymer with a high concentration of Os-complexes as well as a low density graphite electrode. The optimal enzymatic biofuel cell with the *Am*PDH/*rec*DH_{Ct}CDH anode showed not only a similar maximum voltage as with the enzyme biofuel cell based on the *rec*DH_{Ct}CDH only anode (0.55 V) but also a clear higher maximum power output (20 μW cm^{-2}) at 300 mV of the cell voltage in air-saturated physiological buffer. Most importantly, the estimated half-life of the mixed enzyme biofuel cell can reach up to 12 h, which was apparently longer than that of a biofuel cell where the bioanaode was based on only one single enzyme.