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Graphene-Sulfite Oxidase Bioanodes for Enzymatic Biofuel Cells

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Enzymatic biofuel cells (EBFCs) are environmentally friendly electrochemical cells that produce electricity using enzyme catalysts. An EBFC consists of a bioanode in which enzymes catalyze the oxidation of fuels such as sugars, ethanol and sulfite, and/or a biocathode using dioxygen-reducing enzymes. Most EBFCs generate energy from abundant fuels without using noble metals. However, EBFCs are not sufficiently stable and hampered by limited power densities. Graphene possess high conductivity and surface area,^[1] and thus the introduction of graphene offers a strategy to promote the performance of bioelectrode.

We have developed a bioanode based on human sulfite oxidase (HSO) electrostatically immobilized on a graphene-modified carbon paper using polyethyleneimine (PEI), Fig. 1a. HSO catalyzes the oxidation of sulfite to sulfate via direct electron exchange with the electrodes.^[2] Electrocatalytic performance of the bioanode was further enhanced by electroreduction of graphene oxides in the graphene matrix. A stacked EBFC constructed by combining the HSO bioanode and a commercial platinum cathode is found to deliver an open circuit voltage of 0.64 ± 0.01 V, and a maximum power density of $61 \pm 6 \mu\text{W cm}^{-2}$ which is seven times higher than the earlier reported value,^[2] Fig. 1b and c.

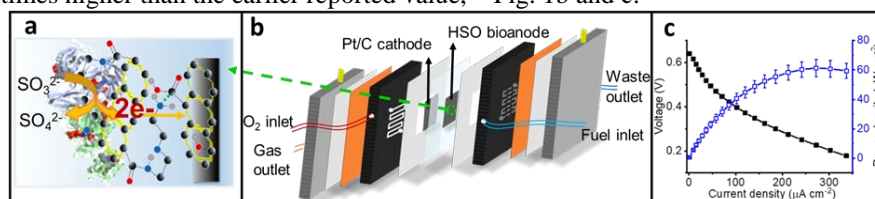


Fig. 1 Illustration of (a) the graphene-HSO bioanode and (b) the EBFC. (c) Polarization and power density curves of the EBFC fueled with Tris-acetate buffer (750 mM, pH 8.4) containing 25 mM Na_2SO_3 (2.0 mL min^{-1}) at the bioanode and O_2 (100 mL min^{-1}) at the cathode at 30°C .

References

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