Power generation from a hybrid biological fuel cell in seawater

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Highlights
- A true hybrid biological fuel cell was tested in laboratory and open environments.
- Robust anodic and cathodic bioelectrocatalysis was maintained in seawater tests.
- The hybrid fuel cell is distinct from marine sediment-based microbial fuel cells.
- The open design allows integration of alternative catalysts and electrode materials.
- System may be scaled and designed for environmental monitor and sensor applications.

Abstract
A hybrid biological fuel cell (HBFC) comprised of a microbial anode for lactate oxidation and an enzymatic cathode for oxygen reduction was constructed and then tested in a marine environment. Shewanella oneidensis DSP-10 was cultivated in laboratory medium and then fixed on a carbon felt electrode via a silica sol–gel process in order to catalyze anodic fuel cell processes. The cathode electrocatalyst was composed of bilirubin oxidase, fixed to a carbon nanotube electrode using a heterobifunctional cross linker, and then stabilized with a silica sol–gel coating. The anode and cathode half-cells provided operating potentials of ~0.44 and 0.48 V, respectively (vs. Ag/AgCl). The HBFC maintained a reproducible open circuit voltage >0.7 V for 9 d in laboratory settings and sustained electrocatalytic activity for >24 h in open environment tests.

1. Introduction
Biological fuel cells use biocatalysts for the conversion of chemical energy into electricity. These catalysts include redox enzymes that oxidize fuels in the anodic half-cell (e.g., hydrogen, alcohols, and sugars) or catalyze reduction reactions in the cathodic half-cell (e.g., oxygen reduction). Alternatively, microbes (typically bacteria) can act as anodic catalysts by breaking down fuel and transferring electrons to the anode. The current flow, in essence, represents an alternative route for cellular respiration, i.e., the cells using the anode rather than oxygen as an electron acceptor. Various applications are envisioned for enzymatic and microbial fuel cells; enzymatic fuel cells (EFCs), for example, may be used for implantable...