A cost-effective and field-ready potentiostat that poises subsurface electrodes to monitor bacterial respiration.

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Abstract

Here, we present the proof-of-concept for a subsurface bioelectrochemical system (BES)-based biosensor capable of monitoring microbial respiration that occurs through exocellular electron transfer. This system includes our open-source design of a three-channel microcontroller-unit (MCU)-based potentiostat that is capable of chronoamperometry, which laboratory tests showed to be accurate within 0.95 ± 0.58% (95% Confidence Limit) of a commercial potentiostat. The potentiostat design is freely available online: http://angenent.bee.cornell.edu/potentiostat.html. This robust and field-ready potentiostat, which can withstand temperatures of -30 °C, can be manufactured at relatively low cost ($600), thus, allowing for en-masse deployment at field sites. The MCU-based potentiostat was integrated with electrodes and a solar panel-based power system, and deployed as a biosensor to monitor microbial respiration in drained thaw lake basins outside Barrow, AK. At three different depths, the working electrode of a microbial three-electrode system (M3C) was maintained at potentials corresponding to the microbial reduction of iron(III) compounds and humic acids. Thereby, the working electrode mimics these compounds and is

used by certain microbes as an electron acceptor. The sensors revealed daily cycles in microbial respiration. In the medium- and deep-depth electrodes the onset of these cycles followed a considerable increase in overall activity that corresponded to those soils reaching temperatures conducive to microbial activity as the summer thaw progressed. The BES biosensor is a valuable tool for studying microbial activity in situ in remote environments, and the cost-efficient design of the potentiostat allows for wide-scale use in remote areas.

Involved units

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