1 Surface display of a redox enzyme and its site-specific wiring to gold electrodes.

Amir L, Carnally SA, Rayo J, Rosenne S, Melamed Yerushalmi S, Schlesinger O, Meijler MM, Alfonta L.
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The attachment of biomolecules and whole organisms to surfaces has been studied for several decades; this paper describes the first example of site-specific attachment of a true living biohybrid to inorganic material.

Bacteria were first engineered to express para-azido-L-phenylalanine (Az-Phe) in the enzyme alcohol dehydrogenase II (ADHII). The mutated bacteria were then covalently linked onto a redox-linker-modified gold surface (or gold nanoparticles) through a Cu(I)-catalyzed alkyne-azide reaction. Attached bacteria were proven to be viable by culturing colonies obtained from electrochemical desorption. A gold electrode was modified in the same method with bacteria, and only with mutated bacteria was a strong response to ethanol observed using cyclic voltammetry. A biofuel cell was assembled with the modified electrode as an anode and ethanol as fuel. The power output performance of the bacteria-modified electrode was better than electrodes modified with purified enzyme, and the performance kept improving a week after the electrode construction, showing the superiority of this system.

Different types of bacteria were tested and different results were observed, showing that both the orientation of the enzyme relative to the electrode and the distance of the redox active linker from the enzyme active site are crucial for effective active site-electrode communication. Thus, this method offers a general method that could be adapted to any redox enzyme or any protein (including antibodies), providing the enzyme with the right orientation relative to the surface and including a single population of enzymes relative to the electrode.

Disclosures
None declared

No comments yet.

Comments:

Abstract:

The generation of a current through interaction between bacteria and electrodes has been explored by various methods. We demonstrate the attachment of living bacteria through a surface displayed redox enzyme, alcohol dehydrogenase II. The unnatural amino acid para-azido-l-phenylalanine was incorporated into a specific site of the displayed enzyme, facilitating electron transfer between the enzyme and an electrode. In order to attach the bacteria carrying the surface displayed enzyme to a surface, a linker containing an alkyne and a thiol moiety on opposite ends was synthesized and attached to the dehydrogenase site specifically through a copper(I)-catalyzed azide-alkyne cycloaddition reaction. Using this approach we were able to covalently link bacteria to gold-coated surfaces and to gold nanoparticles, while maintaining viability and catalytic activity. We show the performance of a biofuel cell using these modified bacteria at the anode, which resulted in site-specific dependent fuel cell performance for at least a week. This is the first example of site-specific attachment of a true living biohybrid to inorganic material.

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