"Smart" Biofuel Cells Controlled by Biocomputing Systems

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Biofuel cells with switchable power release controlled by biochemical signals logically processed by biomoleculer computing systems have been designed. The switchable properties of the biofuel cells were based on the polymer-brush-modified electrodes with the activity dependent on the solution pH value. The pH changes generated *in situ* by biocatalytic reactions, allowed the reversible activation – inactivation of the bioelectrocatalytic interfaces, thus affecting the activity of the entire biofuel cells. Boolean logic operations performed by either enzymes- or immune-based systems were functionally integrated with the switchable biocatalytic process allowing logic control over them. Scaling up the complexity of the biocomputing systems to complex multi-component logic networks with built-in “program” resulted in the control of the bioelectronic systems by multi-signal patterns of biochemical inputs.

The studied biofuel cells demonstrated for the first time the possibility to control power release by biochemical signals processed according to the Boolean logic operations “programmed” in the biocomputing systems. This opens opportunities for future implantable bioelectronic devices logically controlled by physiological conditions, including various biomarkers, substrates and immune-signals. The designed systems and performed experiments demonstrated the concepts and illustrated possible approaches. Switchable bioelectronic systems can be controlled by local interfacial pH changes. Implementation of this approach will result in the biofuel cells integrated with the biocomputing systems operating directly on the bioelectrocatalytic interfaces. Further scaling up the complexity of biocomputing system controlling biofuel cell activity will be achieved by networking immune- and enzyme-based logic gates responding to a large variety of biochemical signals.