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A conventional symmetric biosupercapacitor based on rusticyanin modified gold electrodes

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Abstract: Here we report on an entirely new kind of bioelectronic device – a conventional biosupercapacitor, which is built from copper containing redox proteins. Prior to biodevice fabrication, detailed spectroelectrochemical studies of the protein, *viz. Acidithiobacillus ferrooxidans* rusticyanin, in solution and in adsorbed state, were performed, including estimation of the redox potential of the T1 site (0.62 V *vs.* NHE), protein midpoint potential when adsorbed on a self-assembled monolayer (0.34 V *vs.* NHE), as well as biocapacitance of rusticyanin modified gold electrodes (115 μF cm^{-2}). The symmetrical biosupercapacitor based on two identical gold electrodes modified with rusticyanin is able to capacitively store electricity and deliver electric power accumulated mostly in the form of biopseudocapacitance, when charged and discharged externally. When charged during just 5 sec, the biosupercapacitor with a total capacitance of about 73 μF cm^{-2} provided a maximum of 4 μA cm^{-2} peak current at 0.40 V. The biodevice, which can be charged and discharged at least 50 times without a significant loss of ability to store electric energy, had a low leakage current below 50 nA cm^{-2}.

Keywords: biosupercapacitor; biopseudocapacitance; direct electron transfer; double-layer capacitance; rusticyanin