Enzyme Proteins as an Electroactive Component of Supercapacitor

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Enzymes show specific functions depending on their unique 3D structures actually determined by the amino acid sequences. Histidine, one of the 20 main amino acids, can form a complex compound with an electrochemically-active species and further used as an electroactive material for a supercapacitor. Here we introduce an enzyme-linked electric double-layer capacitor simultaneously acting as the pseudocapacitor given by the cyclovoltametric intercalation of histidine-tagged enzymes with ferricyanide. In this case study, indium tin oxide (ITO) was employed as the substrate to immobilize histidine-tagged methyl tryptophan oxidase (HMTO) via amino-glutaraldehyde cross-linking chemistry. The HMTO-ITO was further activated with ferricyanide. The approximate amount of HMTO on a 1.13 cm^2 ITO substrate was 0.49 μg and the specific capacitance measured 6.88 F g^{-1} at a scan rate of 10 mV s^{-1}. The HMTO can be replaced with a variety of different functionalized recombinant proteins having for example heat or chemical resistivity, light sensitivity, substrate selectivity, and even mechanical strength indicating a wide-spread use of the electroactive biomacromolecules.