Improving the Direct Electron Transfer Efficiency in Laccase Electrodes for Biofuel Cell Cathodic Reactions

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Abstract

Fungal laccases are one of the best candidates for enzymatic biofuel cell cathodes due to its ability to reduce O_2 directly to H_2O at high potentials; laccases are also suitable for direct electron transfer when appropriately wired toward different electroactive surfaces such as gold or graphite. However, laccase faces several hindering conditions when taking to many *in vivo*-like environments, being the most relevant chloride inhibition and the functional pH. Chloride anions are a reversible inhibitor of laccase and are present in most biological fluids. Additionally, the typically acidic pH-optima for laccase performance take any laccase-modified electrode out of range for many natural fluids.

This presentation will show strategies to improve laccase performance under these non-favoured environments. It has been shown that specific orientation of laccase for DET can reduce this inhibition source when immobilized on a low-density graphite (LDG) electrode[1] and how to extend this immobilization method to gold planar electrodes[2]. We will show the improvement brought to current density and chloride resistance by combining a LDG electrode with gold nanoparticles. The limitations brought by the use of neutral pH can be addressed by generation of a local acidic pH environment. This has been achieved by inserting the laccase electrode in a magnetic ring that allows the deposition of magnetic nanoparticles carrying another enzyme able to acidify the environment.[3] For conceptual purposes we have used glucose oxidase (GOx) to produce a gluconic-acid environment, managing to lower pH 2 units while keeping the bulk pH neutral and therefore allowing laccase to work. Catalase was present for oxygen-regeneration purposes.

References

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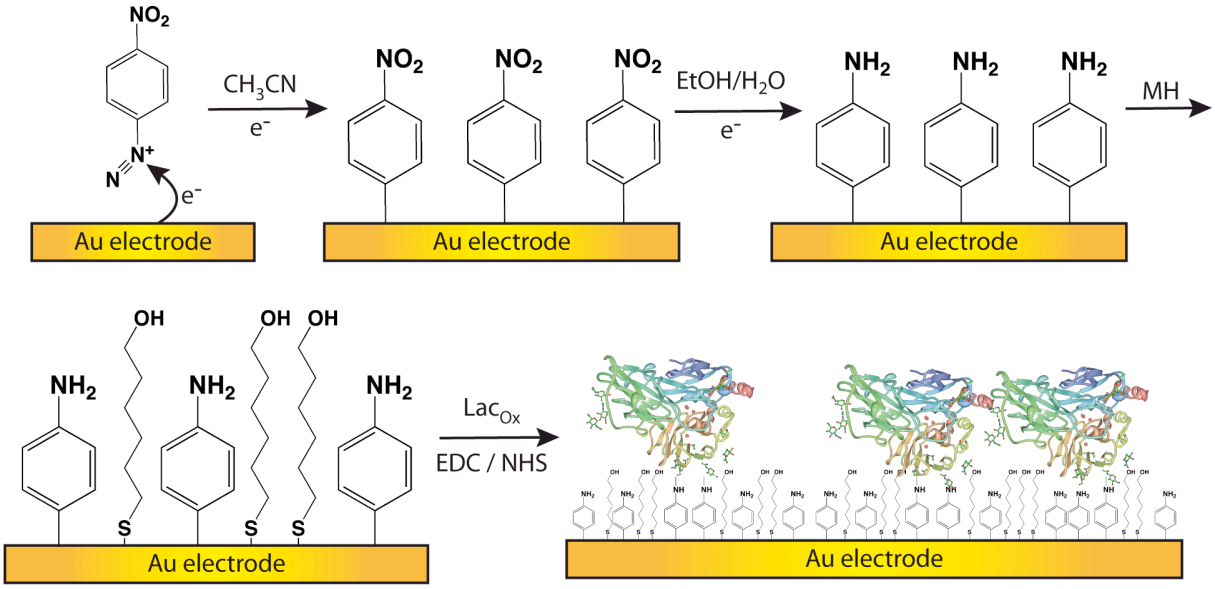
Figures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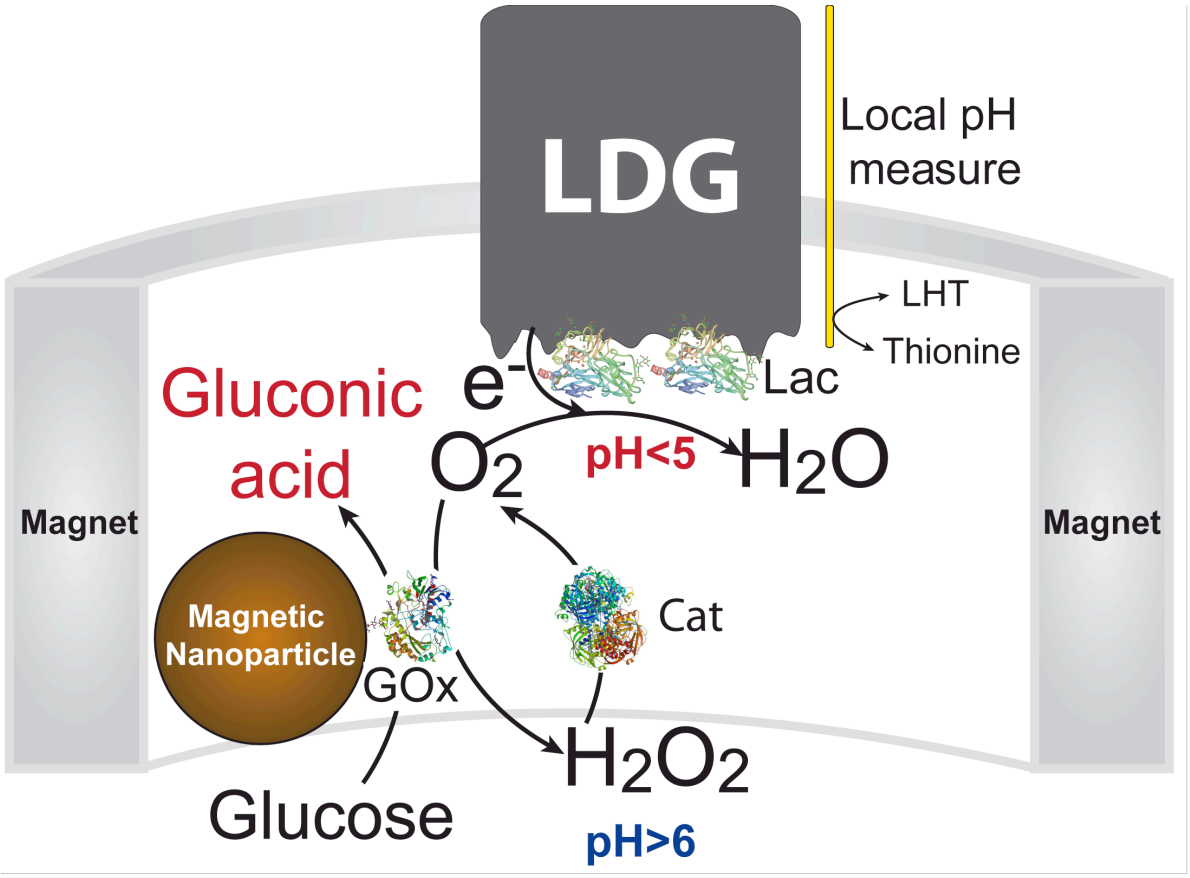
CH3CN
e-
NO2
NO2
NO2
EtOH/H2O
e-
NH2
NH2
NH2
MH
N+
N
e-
Au electrode
Au electrode
Au electrode
OH
OH
OH
NH2
NH2
NH2
S
S
S
Au electrode
Lac Ox
EDC / NHS
Au electrode


LDG
Local pH
measure
LHT
Thionine
Lac
e-
Gluconic
acid
O2
pH<5
H2O
Magnet
Magnet
Magnetic
Nanoparticle
GOx
Cat
H2O2
Glucose
pH>6