Nano-bio-catalysis based on enzyme entrapment using different hosts
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What is a Biofuel cell?
A fuel cell that uses biological organisms such as enzymes or microbes to catalyze reactions.

Advantages & applications:
- Can be operated at room temperature and at various pH.
- Oxidize organic fuels with high activation energy.
- Cost advantage over some traditional fuel cells.
- Small scale in vivo power generation.

Anode Reaction
Glucose → Gluconic acid + 2H⁺ + 2e⁻

Cathode Reaction
½ O₂ + 2H⁺ + 2e⁻ → H₂O

Limitations of Current BFC
- Current density depends on Enzyme loading.
- Uses BQ as mediator which isn’t found in nature.

My Research/Objectives
1. Make samples using different types of carbon host (some samples were received from PNNL).
2. Test these different carbon hosts for enzyme loading, i.e Carbon nanotube, mesoporous carbon, activated carbon.
3. Try to eliminate BQ from the equation.

Synthesis of Nanobio catalyses
On Carbon Nanotube

Simple schematic of GOx in MSU-F-C (mesoporous carbon)

Previous Research
Fischback, Michael Bryant. “Introduction and characterization of an innovative Biofuel cell platform with improved stability through novel enzyme immobilization techniques.”

Methods
- Half-cell method
  - Platinum MEA was replaced with Ag/AgCl reference electrode.
  - Only the performance of the Anode was tested (against reference electrode).

Biofuel cell construction & testing
- A 2x2 BFC was constructed and performance of the anodes were tested in a BFC.

Experiment Conditions
- Glucose Oxidase enzyme used for catalysis.
- Fuel solution:
  - 200 mM glucose
  - 20 mM Benzoquinone (BQ)

Results & Discussions

Concentration of GOx in different BFC in various Benzinoquinone concentrations at 0.1 V

When the BQ conc. was doubled, Current density increased 45 times. This was used as baseline for other experiments.

CNT performs way better than mesoporous carbon in BFC due to its very high surface area. Enzymes are on the surface rather than inside the pores.

Without BQ, Mesoporous carbon performed slightly better. 0.1 M KCl was used instead. 200 mM glucose was in 100 mM PBs buffer (pH-7.4)

Conclusion
- CEC performs better than MSU-F-C/GOx with BQ. Without BQ, however, MSU-F-C/GOx performs slightly better.
- Enzyme loading is higher for CNT than MSU-F-C.
- BQ in fuel solution could actually be ‘harmful’ for MSU-F-C.

Future Plan
- Make activated carbon sample using almost same procedure as MSU-F-C/GOx and compare against baseline.
- Find an effective replacement for BQ in BFC.

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