Decreasing Microbial Fuel Cell startup time using Multi-walled Carbon Nanotubes

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Microbial fuel cells (MFC)

Microbial fuel cells (MFC) facilitate production of electrical energy from organic waste using exoelectrogenic bacteria as biocatalyst.

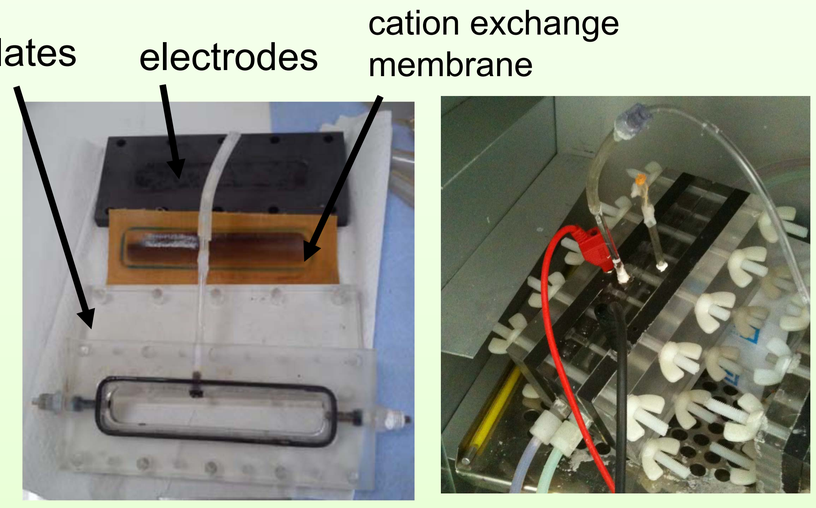
Multiwall carbon nanotube (MWCNT) is a promising electrode material which might be used as an anode modifier in microbial fuel cells (MFCs). Addition of MWCNT powder into the anode surface of a MFC is expected to give various desirable properties on the anode surface. Improvement of cell adhesion and growth is expected, and due to MWCNT unique electrical and structural properties catalyst support is expected as well.

The present study aims to compare the use of MWCNT with plain graphite anode and MWCNT plus electron mediators against plain graphite anode.

Experimental procedure

Three MFC with three different anode surface composition were used. A first one with plain graphite anode surface. On a second one, MWCNT powder (Sigma Aldrich) was applied on the anode surface. The third MFC anode surface was applied with MWCNT powder and meditors. The mediator consists in 10 mg de Meldola's Blue (MB de Alfa-Asier) and 20 ml of Dimetilformamida (DMF de Sigma Aldrich; C3 H7 N O).

To study anode performance, $Fe(III)[CN]_6^{3-}$ was used as electron acceptor in the cathode. Acetate was fed as single substrate to the anode.



Results

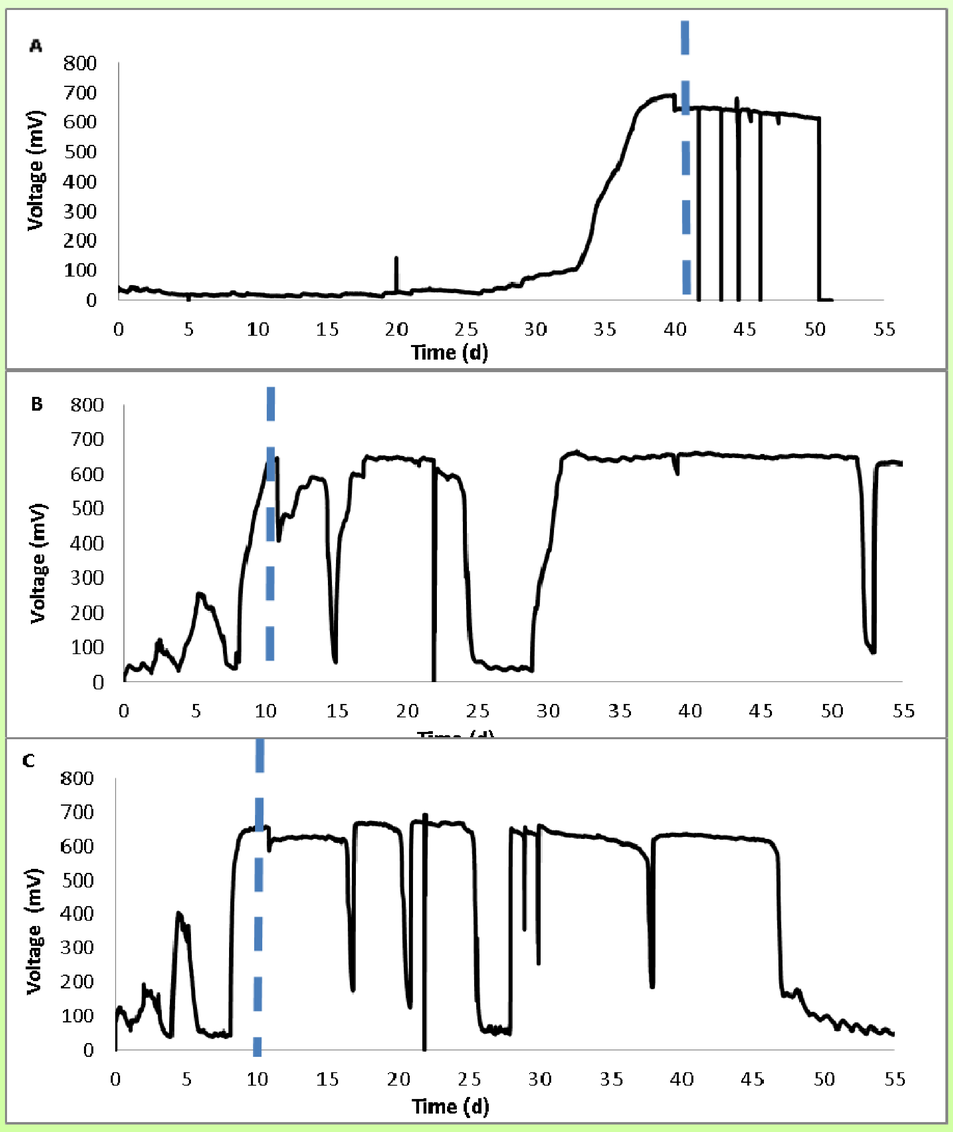
Plain graphite anode

Modified anode with multiwall nanotube

[MWCNT]

Modified anode with multiwall nanotube and Meldola's Blue-Dimetilformamida

[MWCNT-mediator]



Voltage profile that occurred in the three MFC are shown in the Figures.

Start-up time to reach stable maximum voltage was dramatically reduced when used MWCNT compared to the plain graphite electrode.

Around 40 days was needed to reach stable voltage production in plain graphite anode, while only around 10 days were needed to reach stable voltage production in both, MWCNT and MWCNT-mediator.

It was noticed that startup time in the MWCNT-mediator surface was even slightly shorter than the MWCNT surface, but it is not a significant difference.

Voltage profile is showing some dramatically decreasing production from time to time in the three studied cases. This behavior is due to substrate depletion. It is worth to notice how fast the current production is recovered after substrate addition.

Conclusions

Although start-up time of MFC required to approach stable voltage was substantially reduced. Maximum stable voltage has not shown a significant difference between the studied surfaces, and similar to similar studies (Song et al. 2015).

Although current production was similar in the three studied cases, i.e about 650 mV. Further research is need to study if nanotubes application would be beneficial for long term operation, especially in cases of recovery after unstable operation

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