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16TH IWA World Conference on Anaerobic Digestion
Accelerating natural cycles with anaerobic digestion

Dark photosynthesis: explorations on bioelectrochemical growth of photosynthetic food grade microorganisms on wastewater

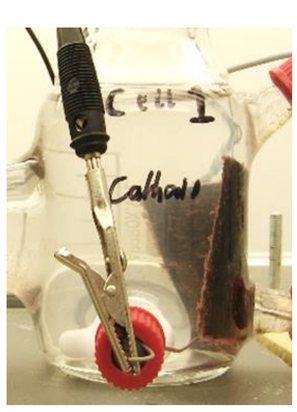
D.P.B.T.B. Strik, M. van der Zwart, L. Jourdin, Y.J. Chu, C.J.N. Buisman

Abstract

Closing the carbon, water and nutrient cycle via microbial electrosynthesis processes can warrant a resource efficient alternative to conventional agriculture. We explore dark photosynthesis to grow ultimately high-value photosynthetic food grade microorganisms in the dark on electron equivalents via microbial electrosynthesis. Here it is shown that microbial electrosynthesis under dark (8 hours) and light (16 hours) conditions is feasible leading to biomass formation and various intermediates suited for further conversion. **The developed open culture microbiome is attractive to reveal new-kinds of electrotrophic microorganisms which could potentially be used in electro-food-culture systems.**

Purple biomass was formed in suspension as well as on the cathode

Hydrogen the dominant identified product and consequent formation of acetate and methane in both dark and light conditions. These products are typically formed in open-culture MES. Also low concentrations of oxygen were determined which supports on photosynthetic activity. Purple colored microbial biomass was by eye visibly formed and attached on the cathode (see Figure 2). Also suspended biomass was present and flushed out the reactor with the effluent. Based on the supplied conditions, the microbial community could both contain electrotrophic and photosynthetic microorganisms



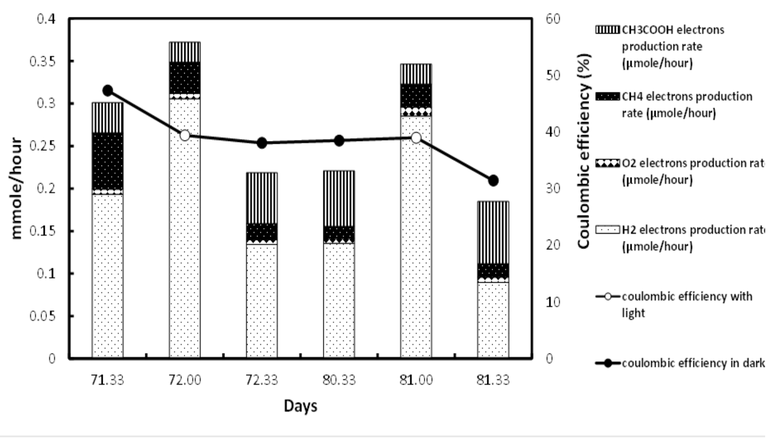


Figure 2. (left) MES (H-cell) reactor operated under dark/light conditions; on the cathode a purple colored by eye visible biofilm was formed. (right) Products formed and consumed in dark-light cycles

Alternating dark-light supply creates diurnal current cycle at constant cathode potential

The MES bioreactors were operated for several months at constant cathode potential. Within the first days the current was increasing during both the light and dark time. During several weeks of operation diurnal current cycles occurred (see Figure 1).

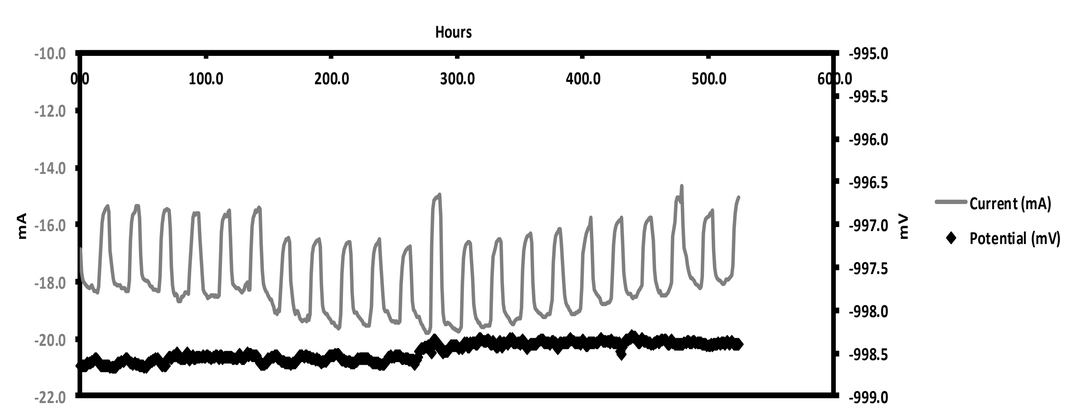


Figure 1. Current and cathode potential under dark-light conditions; current starts to increase in the light while it is decreasing in the dark; all 3 H-cells showed a similar diurnal pattern.

A hypothetical model explains that anaerobic microbial electrosynthesis, photosynthesis, aerobic microbial growth and photo-electrotrophic reactions occurred

The developed microbiome represents a promising start to unravel whether 'dark photosynthesis' processes exist (Figure 3).

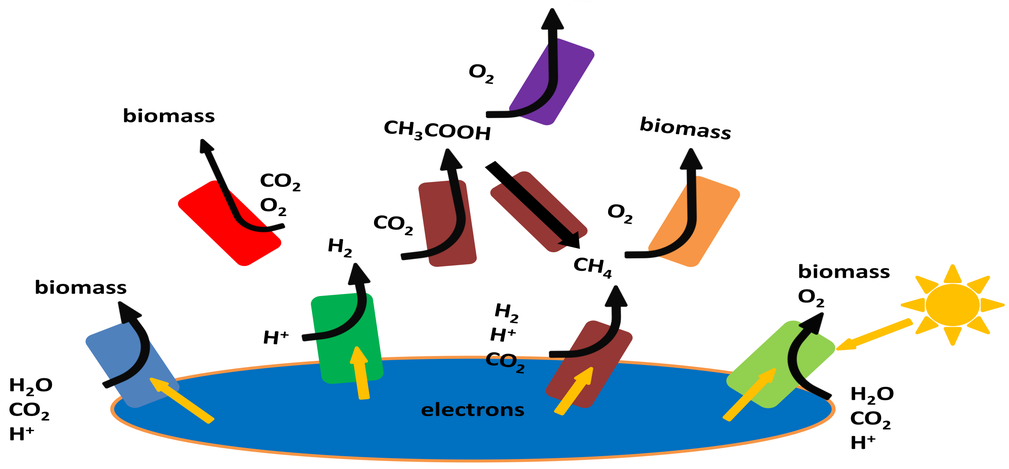


Figure 3. A selection of the hypothetical framework of bioprocesses occurring in the dark-light MES bioreactor.

Wageningen University & Research - Environmental Technology
P.O. Box 123, 6700 AB Wageningen
Contact: david.strik@wur.nl
M +31 (0)6 14 222 759
www.wur.nl/ete

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