

Cathodic electrosynthesis using the bacterium *Kyrpidia spormannii*: biotic and abiotic processes enhance the electrocatalytic activity of graphite cathodes

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Abstract

Kyrpidia spormannii, a recently discovered knallgas bacterium, is a natural producer of polyhydroxybutyrate (PHB). It was shown that *K. spormannii* is able to grow on a cathode in a microbial electrolysis cell (MEC) under microoxic conditions using CO₂ as carbon source. As its electron transfer mechanism is not yet elucidated, the goal of this study was to find indications for either direct or indirect electron transfer of *K. spormannii* on graphite cathodes. Initially, graphite cathodes exhibit a large overpotential for hydrogen evolution and thus only little hydrogen production at the chosen operating potential of -744 mV vs. SCE. While this would suggest direct electron transfer, it cannot be ruled out that the electrode's catalytic activity is improved during inoculation with *K. spormannii*, giving yield to hydrogenotrophic growth of the organism. Therefore, we investigated to which extend operation of a graphite cathode together with *K. spormannii* influenced its catalytic activity for hydrogen evolution.

After 16 days of operation at -744 mV vs. SCE under microoxic conditions, linear sweep voltammetry revealed a roughly two-fold increase of current density of the sterile run and an up to three-fold increase in current density of the biotic run at -744 mV vs. SCE compared to unpolarized cathodes (Fig. 1). Though EDX data showed precipitation of trace elements from the electrolyte on the cathode surface, only upon operation of the cathode in the presence of oxygen an increase in catalytic activity could be observed. XPS analysis revealed oxygen-containing functional groups on the cathode surface.

In conclusion, the improvement of the catalytic activity for hydrogen evolution can be attributed to two key aspects: 1) An abiotic effect due to the formation of oxygen-containing functional groups on the graphite surface triggered by the polarization of the cathode under microoxic conditions. 2) A biotic effect in the presence of *Kyrpidia spormannii* which has to be further investigated.

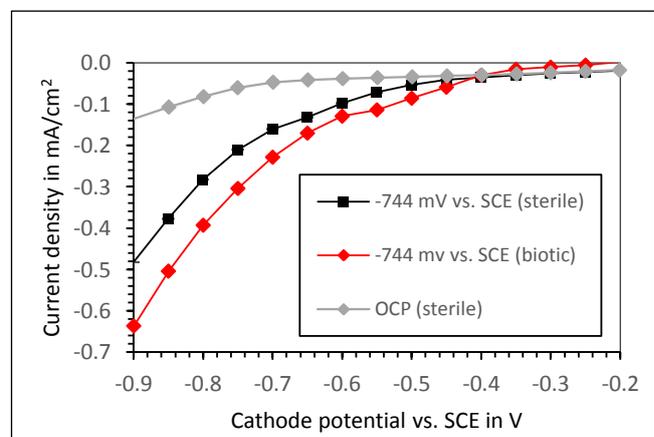


Fig. 1: Linear sweep voltammetry curves of graphite cathodes after 9 days of operation at the indicated potential.