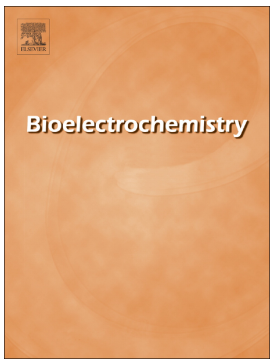

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Effect of surface nano/micro-structuring on the early formation of microbial anodes with *Geobacter sulfurreducens:* experimental and theoretical approaches

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Abstract

Smooth and nano-rough flat gold electrodes were manufactured with controlled Ra of 0.8 and 4.5 nm, respectively. Further nano-rough surfaces (Ra 4.5 nm) were patterned with arrays of micro-pillars 500 µm high. All these electrodes were implemented in pure cultures of *Geobacter sulfurreducens*, under a constant potential of 0.1 V/SCE and with a single addition of acetate 10 mM to check the early formation of microbial anodes. The flat smooth electrodes produced an average current density of 0.9 $A.m^{-2}$. The flat nano-rough electrodes reached 2.5 $A.m^{-2}$ on average, but with a large experimental deviation of ±2.0 $A.m^{-2}$. This large deviation was due to the erratic colonization of the surface but, when settled on the surface, the cells displayed current density that was directly correlated to the biofilm coverage ratio.

The micro-pillars considerably improved the experimental reproducibility by offering the cells a quieter environment, facilitating biofilm development. Current densities of up to 8.5 $A.m^{-2}$ (per projected surface area) were thus reached, in spite of rate limitation due to the mass transport of the buffering species, as demonstrated by numerical modelling. Nano-roughness combined with micro-structuring increased current density by a factor close to 10 with respect to the smooth flat surface.

Keywords

Bioanode; surface roughness; microbial adhesion; microbial fuel cell; modelling.