Boosting MFC Biocatalyst Performance: A Novel Gene Identification and Consortia Engineering Approach

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Microbial fuel cells (MFCs) are devices that use bacteria to catalyze the conversion of waste into electricity. Although MFCs are a promising technology for sustainable energy production, further advances to reduce costs and improve performance are needed for MFCs to become practical. In this study, a high-performance microbial consortia was engineered from genes identified using a rapid screening approach. An E. coli fosmid library was screened in MFCs and the gene inserts from clones demonstrating enhanced power generation were sequenced, revealing both novel and previously identified genes involved in improved biocatalyst performance. A 103-clone microbial consortia was engineered by matching the sequenced genes to other fosmid-harboring E. coli clones. Gene regulation and electron transfer mechanisms of the consortia were analyzed using qPCR and cyclic voltammetry respectively. A novel artificial biofilm was developed involving a layer-by-layer (LbL) synthesis method with bacteria and nanoparticle embedded conductive polymers. The engineered biofilm demonstrated significantly improved power densities over comparable MFCs developed thus far. The novel MFC also exhibited enhanced ability to remove total petroleum hydrocarbons, providing a potential new platform for remediation of hydrocarbon-contaminated sites. This study is the first to demonstrate enhanced MFC performance using an engineered consortia and LbL assembly of electrogenic artificial biofilms. Compared to other methods to improve MFC performance, consortia and biofilm engineering have the potential to be significantly more cost-effective, and prove to be promising steps towards the widespread and accessible implementation of MFC technology.

Awards Won:

Intel ISEF Best of Category Award of $5,000

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