Optimizing Bioelectric Energy From Algae Using Electrode Design and Series-Parallel Connections Architecture

Alqallaf, Mariam (School: Al Nibras International Bilingual School)

Distributed sensors and low power-systems need sustainable power sources at micro-scale. Still bio-electrochemical systems are limited by low power density and unstable output of electricity. Although spirulina (A photosynthetic microorganism) can generate electric potential through its biological activity, internal resistance and voltage below usable thresholds limit the practical implementation. These energy conversion limitations are addressed in this research through structural, electrical and system optimization. A bio-electrochemical dual chamber was designed to separate the cathode chamber from biological anodic compartment. It not only improves electrochemical stability but also helps in reducing the parasitic interactions. For increasing effective current density and reducing resistive losses, a systematic evaluation was performed for selection of electrode materials, surface area enhancement and spacing optimization. Cells were configured in series, parallel and hybrid connections in the cells to balance the voltage and current output. This configuration also addressed the requirement of minimum input of a DC boost converter. Improved energy accumulation and conversion efficiency was demonstrated with this optimized system as compared to non-optimized system. Voltage elevation to practical levels and stable energy storage in supercapacitor result from optimized system integrated with a boost converter. These results demonstrate the use of bio-based micropower for distributed applications.

Awards Won: