Rational selection of carbon fiber properties for high-performance textile electrodes in bioelectrochemical systems.

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Details

Abstract

Novel applications of bioelectrochemical systems (BES) are emerging constantly, but the majority still lacks economic viability. Especially the use of electrochemical system components without adaptation to BES requirements causes poor exploitation of the potential system performance. The electrode material is one central component that determines BES performance. While commercial carbon fiber (CF) fabrics are commonly used, their customizability as two- or three-dimensional electrode material for BES is rarely investigated. Using pure cultures of S. oneidensis MR-1, we identified CF properties impacting bacterial current generation: 1. The removal of the sizing (protective coating) is of great importance for all the fibers studied, as it acts as an electrical insulator. By desizing, the maximum current density (jmax) is increased by up to 40-fold. 2. Alteration of the filament surface chemistry results in an accelerated initial development of current generation, but the maximum current density (jmax) is hardly affected. 3. A specific yarn structure, the stretch-broken yarn, supports exceptionally high current densities. The good electrode

performance is correlated to the presence of free filament ends (responsible for 41 % current increase), which are characteristic for this yarn. 4. Moreover, a combination of these free filament ends with a high degree of graphitization enhances electrode performance of a commercial fabric by 100 %.
The results demonstrate that the CF selection can greatly influence the achievable electrode performance of CF fabrics, and thereby contributes to rational engineering of CF based electrodes that can be tailored for the many BES applications envisaged.

Involved units

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