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ORIGINAL PAPER

Nanostructured polyaniline-coated anode for improving microbial fuel cell power output

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An approach for improving the power generation of a dual-chamber microbial fuel cell by using a nanostructured polyaniline (PANI)-modified glassy carbon anode was investigated. Modification of the glassy carbon anode was achieved by the electrochemical polymerisation of aniline in 1 M H_2SO_4 solution. The MFC reactor showed power densities of 0.082 mW cm^{-2} and 0.031 mW cm^{-2} for the nano- and microstructured PANI anode, respectively. The results from electron microscopy scanning confirmed formation of the nanostructured PANI film on the anode surface and the results from electrochemical experiments confirmed that the electrochemical activity of the anode was significantly enhanced after modification by nanostructured PANI. Electrochemical impedance spectroscopic results proved that the charge transfer would be facilitated after anode modification with nanostructured PANI.

Keywords: dual-chamber microbial fuel cell, nanostructure, polyaniline, glassy carbon, electrochemical impedance spectroscopy

Introduction

Microbial fuel cells (MFCs) have drawn much attention in recent years on account of their capacity to produce direct energy from waste materials. In addition to electricity production, MFC can be used for wastewater treatment (Min et al., 2005), desalination (Cao et al., 2009; Jacobson et al., 2011), denitrification (Clauwaert et al., 2007; Virdis et al., 2011), biochemical oxygen demand (BOD) biosensors (Kim et al., 2003), etc. An MFC is a biochemically-catalysed system using electrochemically active bacteria that can oxidise any biodegradable organic matter and exogenously transfer electrons to an electrode (Rabaey & Verstraete, 2005; Lovley, 2006). MFCs represent an innovative technology to recover electric energy from organic matter. Microorganisms play key roles in anode oxidation by facilitating electron transfer between the electron donor (organic compounds) and the electrode as the sole electron acceptor, and forming biofilm on the electrode. These microorganisms are known as exoelectrogens (Logan, 2007; Schröder, 2007).

A typical MFC consists of an anodic chamber and a cathodic chamber which are separated by a proton exchange membrane (PEM) and an external circuit connecting the two electrodes (Rabaey & Verstraete, 2005; Logan et al., 2006). Electrons, originating from the microbial conversion of organic compounds, are transferred from the anode to the cathode through the external circuit, whereas protons generated at the anode diffuse through the PEM to the cathodic chamber for charge balance (Rabaey & Verstraete, 2005).

The power density of MFCs has increased more than 10000-fold over the last decade (from less than 0.1 mW m^{-2} to over 1000 mW m^{-2}) and still needs to increase by a factor of approximately 3.5 to be comparable to anaerobic digestion (Lovley, 2006; Rabaey & Verstraete, 2005). Much effort has been devoted to improving MFC power generation by optimising system configurations and materials (Sun et al., 2008), with

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