Journal of the Taiwan Institute of Chemical Engineers 78 (2017) 329–336

Contents lists available at ScienceDirect

Journal of the Taiwan Institute of Chemical Engineers

journal homepage: www.elsevier.com/locate/jtice

Mesoporous Co_3O_4 nanoflakes as an efficient and non-precious cathode catalyst for oxygen reduction reaction in air-cathode microbial fuel cells

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A R T I C L E   I N F O

Article history:
Received 6 February 2017
Revised 13 June 2017
Accepted 14 June 2017
Available online 6 July 2017

Keywords:
Microbial fuel cell
Oxygen reduction reaction
Co_3O_4 nanoflakes

A B S T R A C T

Cobalt oxide is well known for its excellent oxygen reduction reaction (ORR) activity, however, its ORR activity can be further improved by synthesizing its porous architecture. Therefore, mesoporous Co_3O_4 nanoflakes were prepared by a two-step hydrothermal method and were employed as the cathode catalyst in a double-chamber microbial fuel cell (MFC) to explore its ORR activity for electricity generation. The electrochemical tests suggested that addition of Co_3O_4 nanoflakes enhanced the electrocatalytic activity of the cathode significantly. Besides, the cathode with a higher concentration of Co_3O_4 nanoflakes (COF-2) showed faster ORR kinetics as compared to the bare cathode. Evidently, COF-2 achieved an exchange current density of 4.18 mA/cm^2, which was 3.2 times higher as compared to the bare cathode. Consequently, this improved ORR activity increased the power output in MFC. COF-2 obtained a maximum power density of 347 ± 7 mW/m^2, which was approximately 8 times higher than the bare cathode. The enhanced ORR activity and improved electric output in the MFC can be attributed to the mesoporous nature of Co_3O_4 nanoflakes that exposed a higher number of ORR active sites at the cathode surface. Overall, mesoporous Co_3O_4 nanoflakes proved to be highly efficient and *ca.* 30 times cheaper than platinum, therefore, can be preferred in large-scale MFC applications over other expensive cathode catalysts.