Bacterial Electrocatalysis of K₄[Fe(CN)₆] Oxidation

Zheng, Zhiyong; Xiao, Yong; Wu, Ranran; Christensen, Hans Erik Mølager; Zhao, Feng; Zhang, Jingdong

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Bacterial Electrocatalysis of K₄[Fe(CN)₆] Oxidation

Zhivong ZHENG*, Yong XIAOa, Ranran WUb, Hans Erik Mølager CHRISTENSENd, Feng ZHAOd, Jingdong ZHANGe

Department of Chemistry, Technical University of Denmark, Kemitorvet, 2800, Kgs.

Lyngby, Denmark; zhizhe@kemi.dtu.dk

La Department of Chemistry, Technical University of Denmark, Kemitorvet, 2800, Kgs. Lyngby, Denmark; CAS Key Laboratory of Urban Pollutant Conversion, Institute of Urban Environment, Chinese Academy of Sciences (CAS), Xiamen, 361021, China, yongxi@kemi.dtu.dk

b Department of Chemistry, Technical University of Denmark, Kemitorvet, 2800, Kgs. Lyngby, Denmark; CAS Key Laboratory of Urban Pollutant Conversion, Institute of Urban Environment, Chinese Academy of Sciences (CAS), Xiamen, 361021, China, wu_rr@tib.cas.cn

c Department of Chemistry, Technical University of Denmark, Kemitorvet, 2800, Kgs. Lyngby, Denmark, hemc@kemi.dtu.dk

d CAS Key Laboratory of Urban Pollutant Conversion, Institute of Urban Environment, Chinese Academy of Sciences (CAS), Xiamen, 361021, China, fzhao@iue.ac.cn

e Department of Chemistry, Technical University of Denmark, Kemitorvet, 2800, Kgs. Lyngby, Denmark, jz@kemi.dtu.dk

Shewanella oneidensis MR-1 (MR-1), a model strain of electrochemically active bacteria, can transfer electrons from cell to extracellular electron acceptors including Fe(III) (hydro)oxides[1]. It has been reported that several redox species such as cytochromes in membranes and flavins assist in the electron transport (ET) processes[1,2]. However, the oxidization of metal compounds was barely described. Here we report electrocatalysis of K₄[Fe(CN)₆] oxidation by MR-1.

K₄[Fe(CN)₆] is a redox inorganic compound and shows a reversible redox process on bare glassy carbon (GCE). This is reflected by a pair of symmetric peaks on cyclic voltammetry (CV) (Fig. 1). Interestingly, unsymmetric peaks with a strong anodic peak and a very weak cathodic peak are found on CVs of 1.0 mM K₄[Fe(CN)₆] when the GCE was coated with MR-1, distinguished from the reversible CV on bare electrodes (Fig. 1). A similar electrochemical pattern has been observed using K₃[Fe(CN)₆]. These results suggested an electrocatalysis process of [Fe(CN)₆]₄⁻ to [Fe(CN)₆]₃⁻ by MR-1. The ratio of anodic peak current vs cathodic peak current depends on scan rate, suggesting both diffusion of redox molecules and interfacial ET rate are key factors of the electrocatalysis. Moreover, Selectivity of MR-1 is another interesting issue: MR-1 does not catalyze other redox compounds such as Ru[(NH₃)₆]Cl₃ and Resorufin.

In our recent work, extracellular polymeric substances (EPS) showed redox properties and electron hopping through EPS[2]. Here we notice that neither the glassy carbon electrode (GCE) coating EPS extracted from MR-1 nor MR-1 removed EPS (MR-1 ΔEPS) exhibited asymmetric redox feature (Fig.1), but caused the decrease of current and the broadening of the difference of anodic and cathodic peak potential, indicating the hindrance of reaction. More work to disclose the origin of the electrocatalysis phenomenon is in progress, aiming at the identification of related compositions in MR-1.
Acknowledgements

This work is supported by the China Scholarship Council (CSC) (No. [2016]3100), Carlsberg Foundation (no.CF15-0164) and the Otto Mønsted Foundation.

References (see example below)


Fig. 1 The effect of EPS on cyclic voltammograms of 1 mM K₄[Fe(CN)₆] in 50 mM PBS (pH 7.0), scan rate: 10 mV/s