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Bacterial Electrocatalysis of $K_4[Fe(CN)_6]$ Oxidation

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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 $K_4[Fe(CN)_6]$ oxidation by MR-1.

$K_4[Fe(CN)_6]$ 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 $K_4[Fe(CN)_6]$ 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 $K_3[Fe(CN)_6]$. 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 $Ru[(NH_3)_6]Cl_3$ 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 Δ EPS) 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.

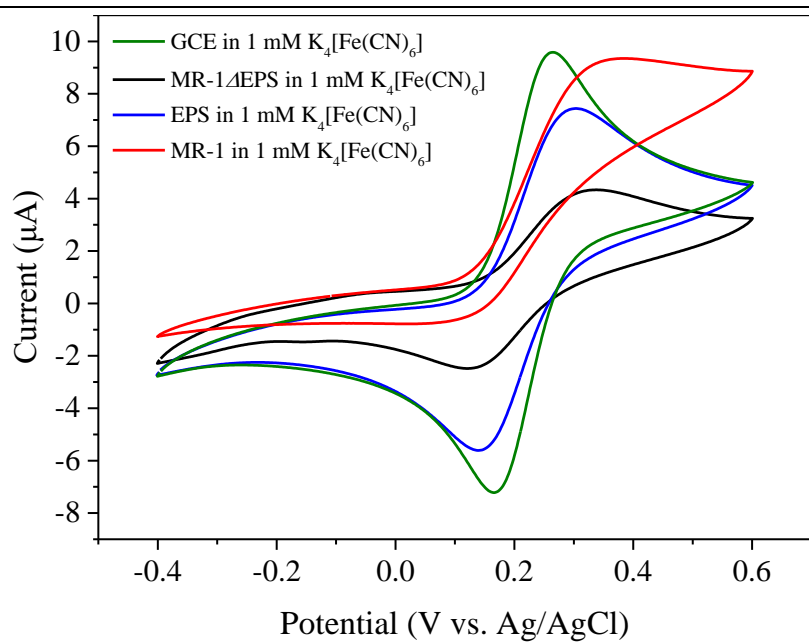


Fig.1 The effect of EPS on cyclic voltammograms of 1 mM K₄[Fe(CN)₆] in 50 mM PBS (pH 7.0), scan rate: 10 mV/s

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