

Electronic Supplementary Information

for

Protonated iron-phthalocyaninate complex used for cathode material for a hydrogen peroxide fuel cell operated under acidic conditions

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Experimental Section

Materials. [Fe(TPP)Cl], [Fe(OEP)Cl] and [Fe(Pc)Cl] were purchased from Aldrich Chemicals and used without any other purification. Ni mesh (150 mesh) and glassy carbon electrodes (3 mm ϕ or 1cm x 1cm) were purchased from BAS Ltd. Purification of water (18.2 M Ω cm) was performed with a Milli-Q system (Millipore, Direct-Q 3 UV). Fe complexes of [Fe(OEP)Cl], [Fe(TPP)Cl] and [Fe(Pc)Cl] were purchased from Sigma-Aldrich.

Mounting Fe Complex on a Glassy Carbon Electrode. [Fe(TPP)Cl], [Fe(OEP)Cl] or [Fe(Pc)Cl] was dissolved in benzonitrile. (0.60 mg, 1mL, A trace amount of trifluoroacetic acid was added to a solution of [Fe(Pc)Cl] for increasing solubility.) A small portion of the solution (7.0 μ L) was placed on a glassy carbon electrode (0.071 cm²) and dried in an oven at 70 °C for 40 min. For Nafion coating, a surface of Fe complex-modified electrode was immersed in a 10 μ L Nafion solution (MeOH, 0.05%) and dried in an oven at 70 °C for 40 min. The loaded amount of Fe complex on the glassy carbon electrode was calculated based on the current for the reduction of Fe^{III}/Fe^{II} in the solution without H₂O₂. The charges for the reduction of [Fe(TPP)Cl], [Fe(OEP)Cl] and [Fe(Pc)Cl] were 3.6×10^{-7} , 7.6×10^{-7} and 2.9×10^{-6} C, which correspond to 3.7×10^{-12} , 7.9×10^{-12} and 3.0×10^{-11} mol, respectively.

Electrochemical reduction of Hydrogen Peroxide with [Fe(OEP)Cl], [Fe(TPP)Cl] and [Fe(Pc)Cl]. The electrochemical behaviours of H₂O₂ at electrodes modified with Fe complexes were examined using an ALS 630B electrochemical analyzer. Saturated calomel electrode and platinum electrodes were used as reference and counter electrodes, respectively. Glassy carbon electrodes mounting [Fe(OEP)Cl], [Fe(TPP)Cl] or [Fe(Pc)Cl] were used as working electrodes. The measurements were performed at room temperature in acetate buffer solutions (pH 4) containing 3mM H₂O₂.

Evaluation of the performance of a H₂O₂ fuel cell. A buffer solution of pH 3-5 containing H₂O₂ solution (300 mM) was placed in a one-compartment electrochemical cell. Ni and glassy carbon electrode with [Fe(OEP)Cl], [Fe(TPP)Cl] or [Fe(Pc)Cl] were immersed in the H₂O₂ solution. Cell performance was evaluated by a BAS 100W. Measurements were performed in a deaerated acetate buffer solution at room temperature.

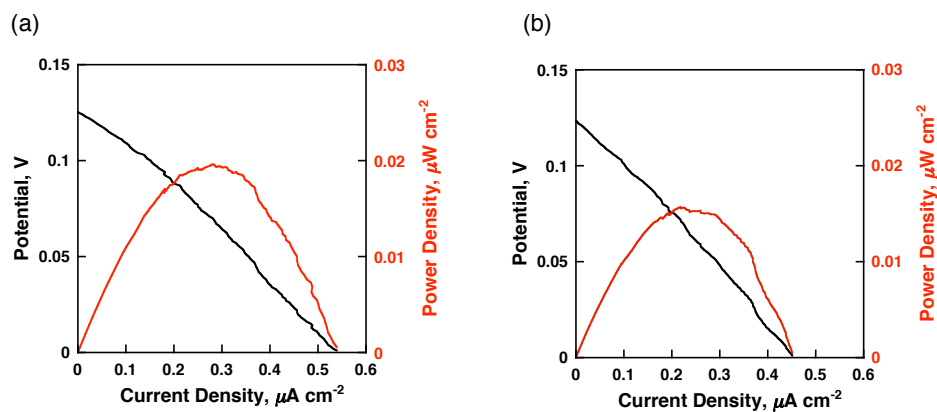


Fig. S1. *I-V* (black) and *I-P* (red) curves of a one-compartment H₂O₂ fuel cell with a Ni anode and cathodes modified with (a) [Fe(TPP)Cl] and (b) [Fe(OEP)Cl]. Performance tests were conducted in an acetate buffer containing 300 mM H₂O₂. The pH of the solutions was fixed to be 4. Current density was normalized by the geometrical area of glassy carbon electrode.