

## Supporting information

### The condition for electrogeneration experiments

The diagram of the MFCs used for our experiments is shown in Fig. 1. The anode chamber contained a high concentration of an electron donor. Because supply rate of the electron donor to the anode is directly proportional to the anodic current under a low concentration of chemical oxygen demand (COD) conditions. The media for the MFCs (pH 7.5) contains as follows; sodium acetate 4.0 g, yeast extract 0.5 g, peptone 0.25 g,  $\text{NH}_4\text{Cl}$  0.25 g,  $\text{NaHCO}_3$  2.5 g,  $\text{KH}_2\text{PO}_4$  4.0 g,  $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$  0.1 g and  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$  0.4 g per liter. The concentrations of chemical oxygen demand were measured twice in a week by a COD test kit (Hach, COD systems) and, if the concentration of COD was lower than 2g/l, sodium acetate (1.0g of sodium acetate almost contains 0.78g of COD.) was added to be 4g/l of COD to keep high concentration of electron donor (mainly acetate) in the anode chamber. The anode potential was kept at 0.04V vs NHE and the anodic current values were measured by a potentiostat (Hokuto Co.,LTD. HA 151). Both current and potential values were recorded by PC via data logger (M-System.Co., Ltd, R1M-GH).

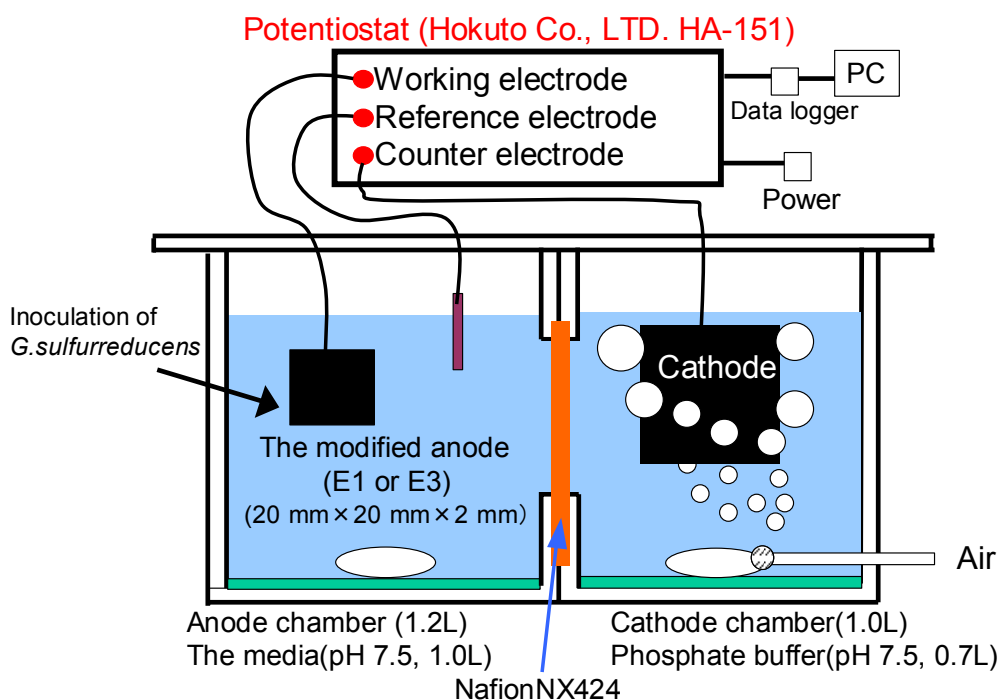


Fig. 1. Schematic diagram of the MFCs

### Discussion about the anode in MFCs

In the communications, the high anodic current density of  $1.2 \text{ mA cm}^{-2}$  was observed under the condition that anode potential was controlled at  $0.04 \text{ V vs. NHE}$ . The high anodic current density indicated that respiration of the *G. sulfurreducens* on the anode is very active. The cyclic voltamogram (See figure 3a in the communications) showed that the anode potential should be kept over  $0.0 \text{ V vs. NHE}$  to generate a high anodic current density. For use of the anode in MFCs, it is important to use the anode on condition that the anode potential is suited for the growth of *G. sulfurreducens* like this electrogeneration experiment. Figure 2 shows a relationship between a) a current-potential curve of an anode, b) a current-potential curve of cathode, and c) a cell voltage. The cell voltage is proportional to the sum of the internal resistance and the external resistance (electrical power output). The anode potential will be estimated by a), b) and c). Thus, it is essential that the anode and the cathode are measured separately. The respiration of *G. sulfurreducens* and decomposition rate of organic matter should be maintained high. Therefore, the condition (i) that a current is prioritized over a cell voltage (power output) is suitable for our purpose rather than the condition (ii) that a power output is prioritized.

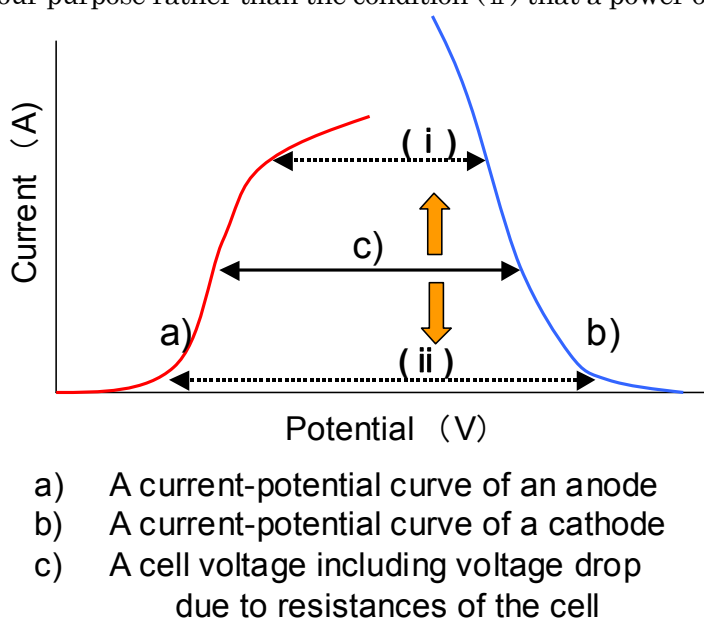


Fig. 2. Relationship between current-potential curves and a cell voltage

### Electrochemical measurements (cyclic voltammetry and chronocoulometry) of the electrodes

The characteristics of the modified electrodes were electrochemically investigated under potentiostatic control using a three-electrode system consisting of a working electrode, a standard calomel reference electrode and a GF counter-electrode. The counter-electrode was inserted into a glass tube with a glass filter to avoid reactions on the working electrode of products from the counter electrode.  $\text{N}_2$  gas ( $0.2 \text{ L min}^{-1}$ ) was injected into an electrochemical cell of working volume  $500 \text{ mL}$  (Hokuto Co., Ltd.). Cyclic voltammograms were recorded on an HSV-100 instrument (Hokuto Co., Ltd.).

### Bacterial incubation

*G. sulfurreducens* (DSMZ Germany, DSM No. 12127<sup>T</sup>) was grown under anaerobic conditions for 5 days at 37 ° C in a medium (pH 7.0) containing 2.5 g sodium acetate, 1.5 g NH<sub>4</sub>Cl, 0.6 g NaH<sub>2</sub>PO<sub>4</sub>, 0.1g KCl, 14 g Fe(III) citrate, 0.25 mg Na<sub>2</sub>WO<sub>4</sub>·H<sub>2</sub>O, 1 mL vitamin solution (biotin 150 mg, folic acid 300 mg, pyridoxine-HCl 50 mg, thiamine-HCl 100 mg, riboflavin 10 mg, nicotinic acid 18 mg, d-Ca-pantothenate 10 mg, vitamin B<sub>12</sub> 18 mg, p-aminobenzoic acid 1 mg, and lipoic acid 2 mg per liter) and 10 mL of a trace element solution.

The composition of the trace element solution contains as follows; nitrilotriacetic acid 1.5 g, MgSO<sub>4</sub>·7H<sub>2</sub>O 3.0 g, MnSO<sub>4</sub>·2H<sub>2</sub>O 0.5 g, NaCl 1.0 g, FeSO<sub>4</sub>·7H<sub>2</sub>O 0.1 g, CoSO<sub>4</sub>·7H<sub>2</sub>O 0.2 g, CaCl<sub>2</sub>·2H<sub>2</sub>O 0.1 g, ZnSO<sub>4</sub>·7H<sub>2</sub>O 0.2 g, CuSO<sub>4</sub>·5H<sub>2</sub>O 10 mg, KAl(SO<sub>4</sub>)<sub>2</sub>·12H<sub>2</sub>O 20 mg, H<sub>3</sub>BO<sub>3</sub> 10 mg, Na<sub>2</sub>MoO<sub>4</sub>·2H<sub>2</sub>O 10 mg, NiCl<sub>2</sub>·6H<sub>2</sub>O 25 mg, Na<sub>2</sub>SeO<sub>3</sub>·5H<sub>2</sub>O 0.3 g, L-cysteine-HCl 2.5 g per liter.

### Analysis of E1 surface

A scanning electron microscopy (SEM) image of the AQDS-PEI-modified GF (E1) is shown in Fig. 3a. The GF filaments can be clearly seen, with homogeneous dispersion of the AQDS-PEI layer. Figure 3b shows the distribution of sulfur in the same view, as detected by energy dispersive X-ray spectroscopy (EDX). These results also prove the existence of dispersed AQDS molecules immobilized on PEI.

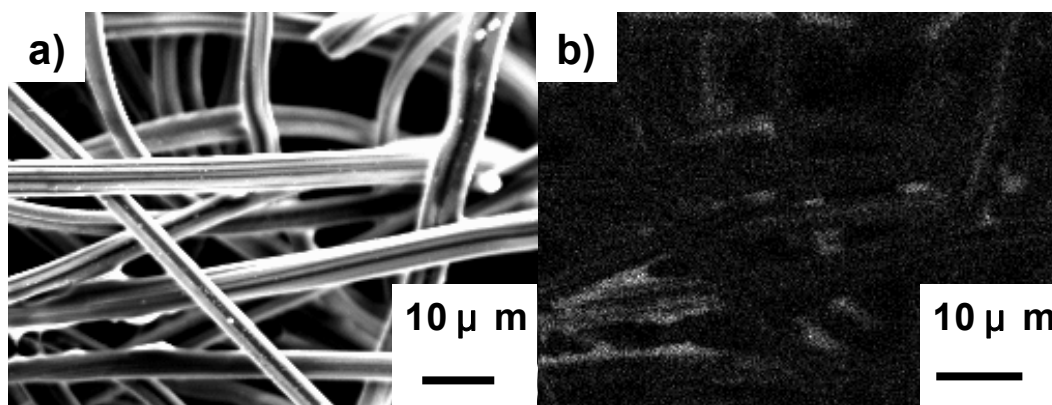


Fig. 3. a) SEM image and b) EDX sulfur molecule distribution image of AQDS-PEI-modified GF (E1).