Polyaniline networks grown on graphene nanoribbons-coated carbon paper with synergistic effect for high-performance microbial fuel cells

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Fig. S1. CV plots of the CP, CP/GNRs, CP/PANI and the CP/GNRs/PANI electrodes in 5.0 mM Fe(CN)₆³⁻/⁴⁻ and 0.1 M Na₂SO₄, scan rate: 10 mV s⁻¹.

CV plots were carried out to investigate the electrochemical active surface area using Fe(CN)₆³⁻/⁴⁻ as probe. As shown in Fig S1, no obvious redox peaks were observed in the CP electrode, while the CP/GNRs electrode exhibited a couple of well-defined redox peaks at the potentials of 0.192V and 0.502V, attributing to the redox reaction of Fe(CN)₆³⁻/⁴⁻. After the PANI networks fabricated on the CP or CP/GNRs electrode surface at the same conditions, both the CP/PANI and CP/GNRs/PANI electrode exhibited another one pair of redox peaks at the potentials of about -0.196 and 0.012 V, ascribing to the characteristic redox peaks from PANI. However, the peak currents of Fe(CN)₆³⁻/⁴⁻ in the CP/GNRs/PANI electrode were much higher than that of the CP/GNRs or CP/PANI electrode. Based on the Cottrell equation, with the same projected surface area, the active surface area of the CP/GNRs/PANI was much larger than that of the other three electrodes.
Fig. S2. SEM images of the CP/GNRs/PANI electrodes with the GNRs/PANI mass ratios of: (a) 1:4, (b) 1:8, (c) 1:12, and (d) 1:16, respectively.

Fig. S3. Nyquist plots of the CP/GNRs/PANI electrodes with different GNRs/PANI mass ratios: (a) 1:4, (b) 1:8, (c) 1:12, and (d) 1:16, respectively, the frequency range is between $10^{-2}$ and $10^{5}$ Hz.

The charge-transfer resistance of the CP/GNRs/PANI electrodes with the GNRs/PANI mass ratios of 1:4, 1:8, 1:12, and 1:16 was 38, 40, 52 and 60 $\Omega$, respectively.
**Fig. S4.** CV plots of the CP/GNRs/PANI electrode in 5.0 mM Fe(CN)$_6^{3-/4-}$ and 0.1 M Na$_2$SO$_4$ with different GNRs/PANI mass ratios: (a) 1:4, (b) 1:8, (c) 1:12, and (d) 1:16, respectively. Scan rate: 10 mV s$^{-1}$.

As shown in Fig S4, the CP/GNRs/PANI electrodes displayed two obvious redox peaks, one couple at the potentials of 0.178 and 0.452 V, attributing to the redox reaction of Fe(CN)$_6^{3-/4-}$, while the other one at the potentials of -0.192 and -0.006 V, ascribing to the characteristic redox peaks from PANI. The CP/GNRs/PANI electrode with the GNRs/PANI mass ratio of 1:8 exhibited much higher peak current of Fe(CN)$_6^{3-/4-}$ than that of the other three CP/GNRs/PANI electrodes. Based on the Cottrell equation, with the same projected surface area, the active surface area of the CP/GNRs/PANI electrode with the GNRs/PANI mass ratio of 1:8 was relatively larger than that of the other three CP/GNRs/PANI electrodes.