Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

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

Cuie Zhao,[a] Panpan Gai,[a] Changhong Liu,[b] Xin Wang,[c] Hao Xu,[a] Jianrong Zhang*[a] and Jun-Jie Zhu*[a]

[a] *State Key Laboratory of Analytical Chemistry for Life Science, School of Chemistry and Chemical Engineering, Nanjing University; Nanjing 210093, P. R. China. E-mail: jrzhang@nju.edu.cn; jjzhu@nju.edu.cn;.*
[b] *State Key Laboratory of Pharmaceutical Biotechnology, School of Life Science, Nanjing University, Nanjing 210093, P. R. China.*
[c] *MOE Key Laboratory of Pollution Processes and Environmental Criteria, Tianjin Key Laboratory of Environmental Remediation and Pollution Control, College of Environmental Science and Engineering, Nankai University, No. 94 Weijin Road, Nankai District, Tianjin 300071, China.*

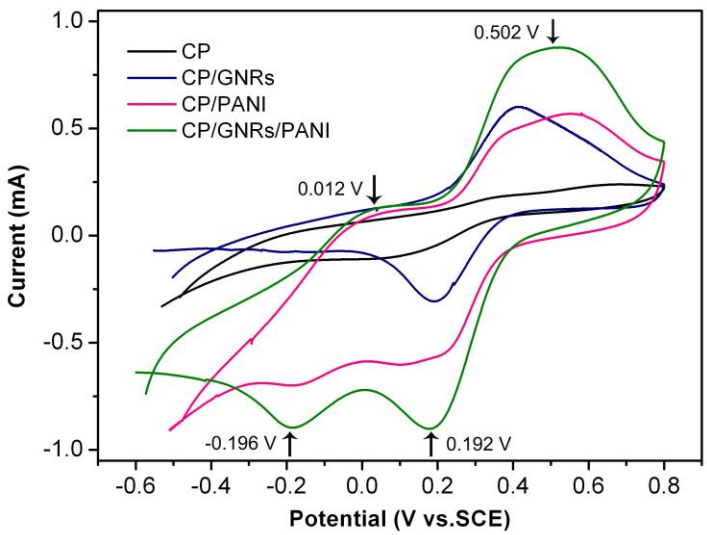

Fig. S1. CV plots of the CP, CP/GNRs, CP/PANI and the CP/GNRs/PANI electrodes in 5.0 mM $Fe(CN)_6^{3-/4-}$ and 0.1 M Na_2SO4, scan rate: 10 mV s^{-1}.

CV plots were carried out to investigate the electrochemical active surface area using $Fe(CN)_6^{3-/4}$ 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 $Fe(CN)_6^{3-/4-}$. 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 $Fe(CN)_6^{3-/4-}$ 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.

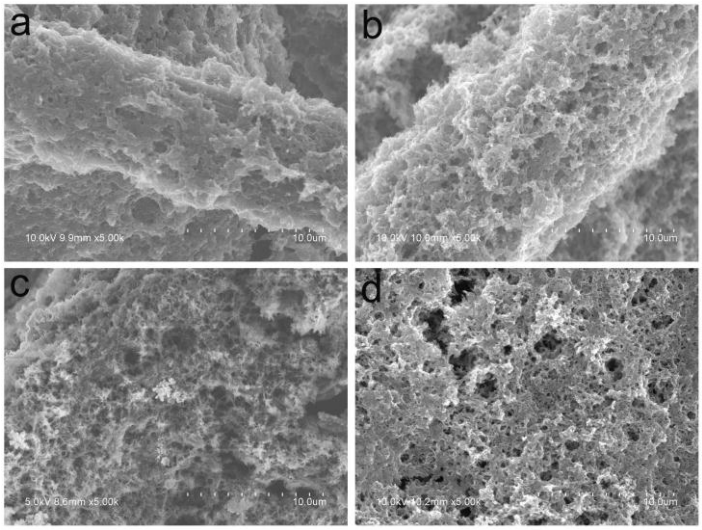

Fig. S2. SEM images of the CP/GNRs/PANI electrodes with the GNRs/PANI mass ratios of: (a) 1:4, (b) 1:8, (c) 1:12, and (d) 1:16, respectively.

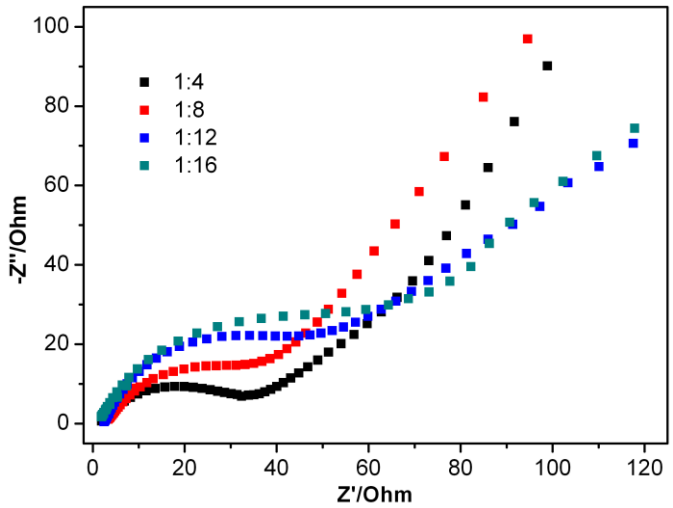

Fig. S3. Nyquist plots of the CP/GNRs/PANI electrodes with different GNRs/PANI mass ratios: (a) 1:4, (b) 1:8, (c) 1:12, and (d) 1:16, respectively, the frequency range is between 10^{-2} and 10^{5} Hz.

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 Ω, respectively.

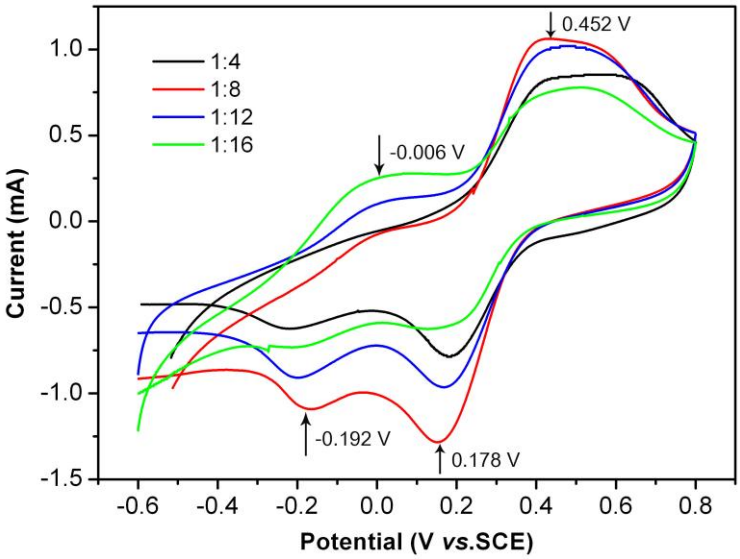

Fig. S4. CV plots of the the CP/GNRs/PANI electrode in 5.0 mM $Fe(CN)_6^{3-/4-}$ and 0.1 M Na_2SO_4 with different GNRs/PANI mass ratios: (a) 1:4, (b) 1:8, (c) 1:12, and (d) 1:16, respectively. Scan rate: 10 mV s^{-1}.

As shown in Fig S4, the CP/GNRs/PANI electrodes displayed two obvious redox peaks, one couple at the potentials of 0.178 and 0.452V, 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.