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Supporting Information

The fabrication of Fe_3O_4@C anode material through carbonization of biomembrane coated magnetosome chains in magnetotactic bacteria

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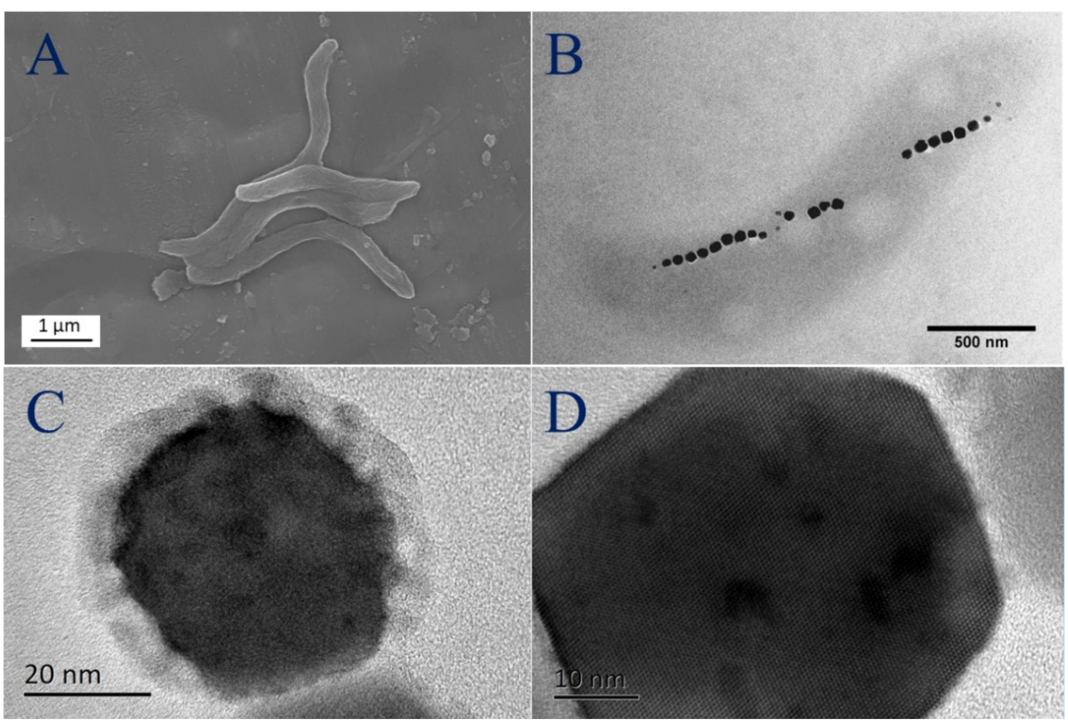

Fig. S1 (A) SEM image of magnetotactic bacteria; (B) TEM image of magnetotactic bacteria and magnetosome chains; (C) bacterial magnetic nanoparticles (NMPs); (D) Fe_3O_4@ultrathin N-doped carbon.

The ethanol solution of magnetotactic bacteria was prepared and dropped onto an aluminum foil before drying for SEM characterization, as is shown in Fig. S1(A). The average size of magnetotactic bacteria is around 3-6 μm. There exists around 20 NMPs in each magnetotactic bacteria from Fig. S1(B). Considering the average diameter of NMPs is around 50 nm and the density of Fe_3O_4 is 5.17g cm^{-1}, if we assume the shape of Fe_3O_4 is ideal cubic and ignore the weight of the ultrathin carbon layer, each magnetotactic bacteria can produce around 1.25×10^{-14} g of active materials. From Fig. S1(C, D), we can observe an obvious change of the lipid bilayer, while the Fe_3O_4 particles still maintains monocrystal, which is consistent with the SAED results.

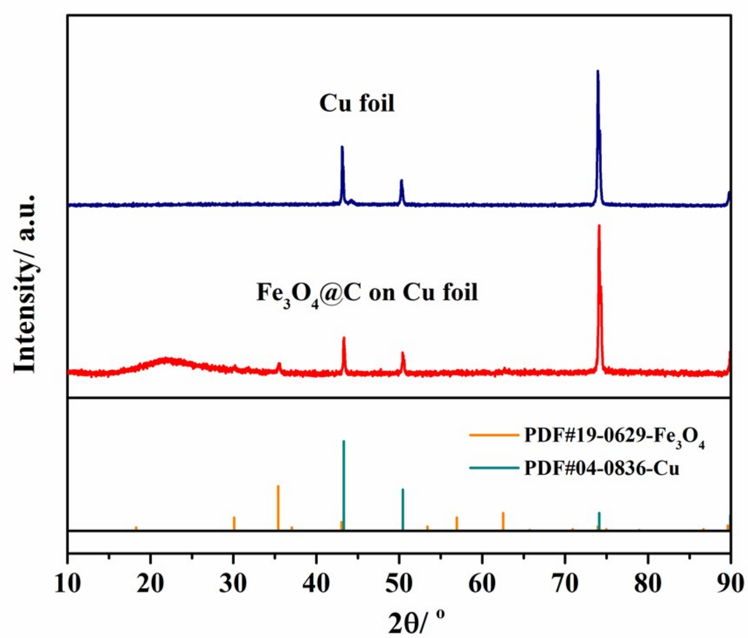

Fig. S2 XRD of Cu substrate and Fe_3O_4@C on copper foil.

This experiment is to confirm that there is no peaks corresponding to Cu foil from 10 ° to 40 °.

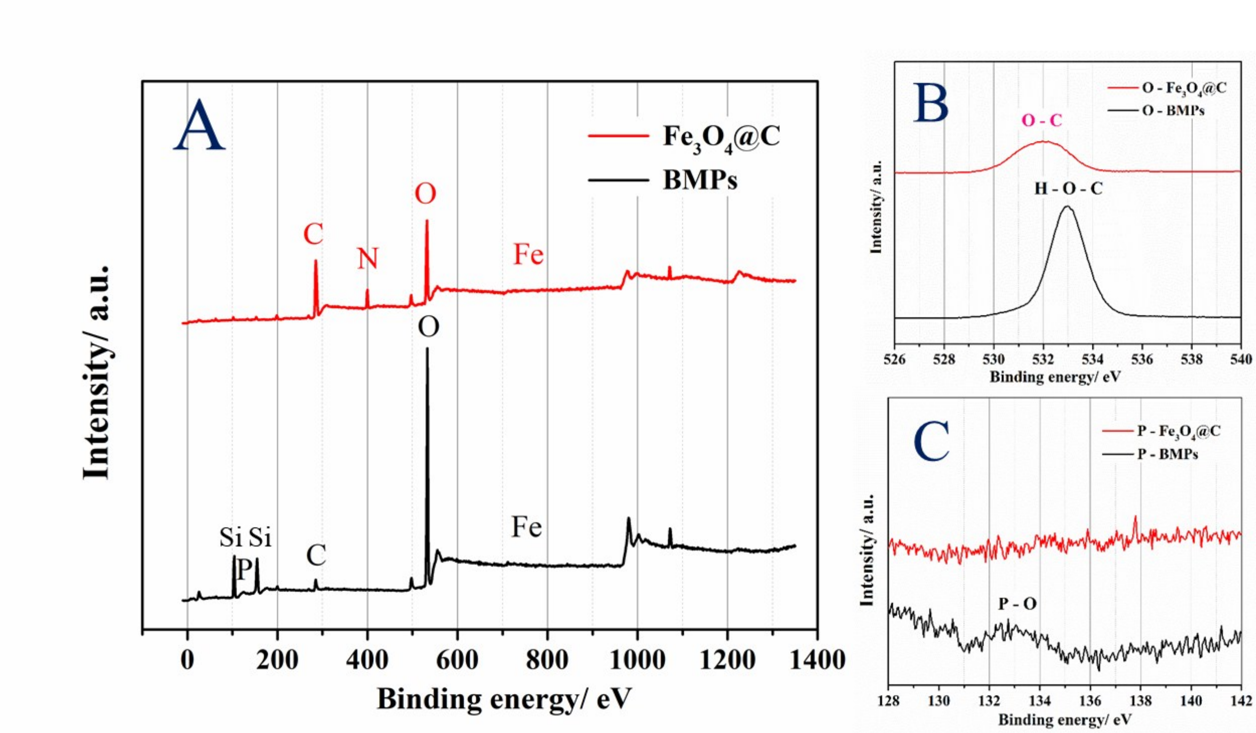

Fig. S3 (A) The XPS spectrum of Fe3O4@C for the whole, O and P.

Fig. S3 shows the rest of XPS data. After carbonization, the intensity of C and N increase obviously, implying that N doped carbon layer is formed, according to Fig. S3(A). The intensity of O decreases significantly and the peak position shift leftwards, as shown in Fig. S3(B). It should be result of H_2O loss. As for P in Fig. S3(C), there is no peak of it after carbonization, demonstrating that there is no P in the N-doped carbon film.

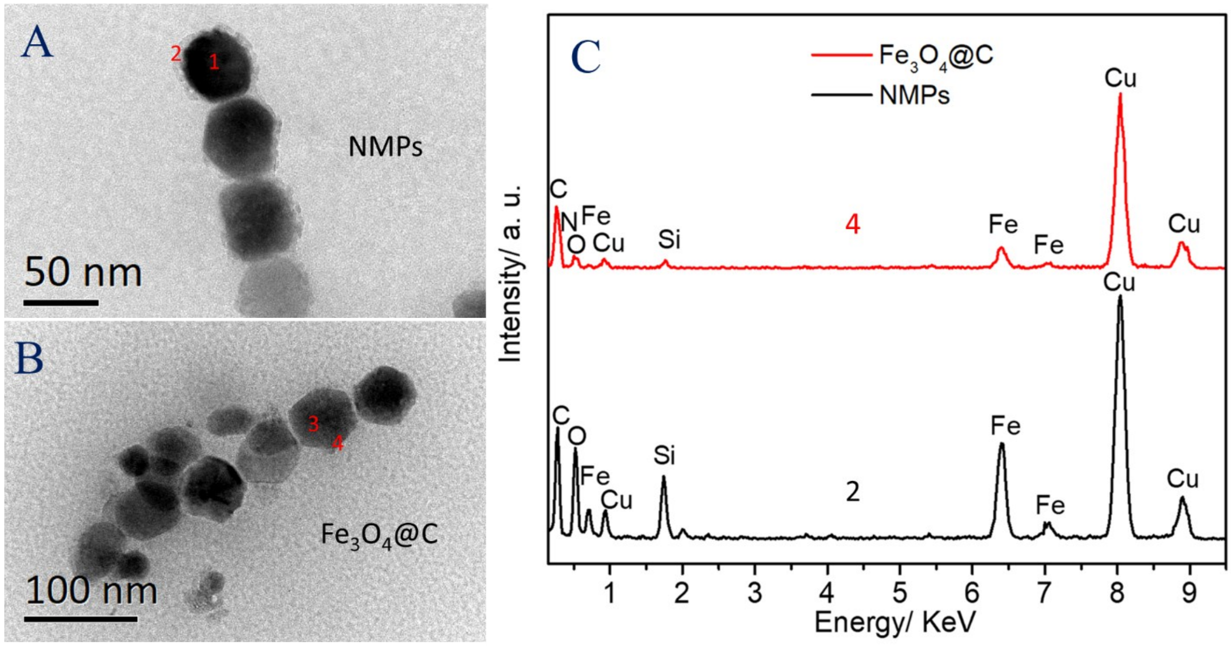

Fig S4. EDS test for difference region of NMPs and Fe_3O_4@C.

EDS test has been done to further examine the element change after carbonization, which is shown in Fig. S4(C). The relative intensity of C to O is much higher after carbonization. If look carefully, there is a tiny peak on the red line between C and O. It should be corresponding to doped N. The intensity of Si is dramatically decreased, indicating that there exists only little Si in some kind of form in N-doped carbon film.

As a matter of fact, this work suffers from low productivity problem as a result of the restriction of magnetotactic bacteria concentration in culture solution. However, it has been proved recent years that the productivity of BMPs can be greatly increased in many ways, such as optimized fermentation,[1] selection of overproducers,[2] genomic amplification,[3] transfer of gene cluster to foreign organism and so on.[4] Owing to limitations of experimental conditions, the productivity of BMPs in this experiment is only about 20 mg per 100 L culture solution, but we still believe this material could be useful in the future when the study and fabrication of magnetotactic bacteria is mature and the productivity of BMPs have been improved to an acceptable level.

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