

**Fabrication of Fe/Fe₃C@porous carbon sheets from biomass and its application
for simultaneous reduction and adsorption of uranium(VI) from solutions**

Xiangxue Wang^a, Shouwei Zhang^{a,b}, Jiaxing Li^{a*}, Jinzhang Xu^b, Xiangke Wang^{a,c*}

^a Institute of Plasma Physics, Chinese Academy of Sciences, P.O. Box 1126, Hefei, 230031, P. R. China. Email: lijx@ipp.ac.cn (J. Li), xkwang@ipp.ac.cn (X. Wang), Tel: +86-551-65592788; Fax: +86-551-65591310.

^b School of Materials Science and Engineering, Hefei University of Technology, 230031, Hefei, P. R. China.

^c Faculty of Engineering, King Abdulaziz University, Jeddah 21589, Saudi Arabia.

FTIR and XPS results analysis

The oxygen element comes from the oxygen containing functional group in gelatin, which is an animal derivative produced by partial hydrolysis of collagen or extracted from various animal by-products. It is unavoidable to contain various proteins that have abundant oxygen-containing functional groups. In our case, the O element was not completely decomposed, resulting in the O element peak in the Fe/Fe₃C@PCS composite.

As for the concern about the presence of Fe-O bond, the FTIR and XPS spectra of Fe/Fe₃C@PCS were measured. In FTIR, two bands at \sim 1250 cm⁻¹ and 1600 cm⁻¹ were observed, ascribing to C-O and C=O bond vibration, respectively.¹ As for the characteristic peak of Fe-O at \sim 500-600 cm⁻¹, no such peak was observed (Figure S1).² In XPS spectra, the high resolution C1s spectrum with the binding energy ranging from 282 to 292 eV can be fitted into four different peaks, as shown in Figure

S2A. The peak located at \sim 284.31 eV corresponds to the sp^2 -hybridized graphite-like carbon atoms (C=C).^{3,4} The peak centered at 285.07 eV is attributed to the sp^3 -hybridized carbon atoms (C-C)/or incomplete or defective graphitic structures.^{3,4} The other two peaks are considered to originate in carbon atoms binded to one and two oxygen atoms, respectively. With respect to the high resolution O 1s spectrum, it has three distinct peaks. In details, the peak located at \sim 532.57 eV is due to C=O; the one at \sim 534.08 eV derives from the contribution of C-OH/C-O-OH/N-O-C;⁴ as for the peak at \sim 535.78 eV, it comes from the physically adsorbed O₂/H₂O (Figure S2B).⁴ The Fe 2p spectrum consists of a doublet structure due to multiplet splitting (i.e., Fe2p_{3/2} and Fe 2p_{1/2}) as shown in main text (Figure 6B). The peaks at 706.7 eV and 709.8 eV are the Fe⁰ and Fe₃C, respectively.⁵ Other peaks may be considered as Fe³⁺ shake-up satellite.

Based on the above results, there are some Fe-O compounds in the as-prepared product, but we believe that the Fe, Fe₃C and C are the mainly compounds in our sample.

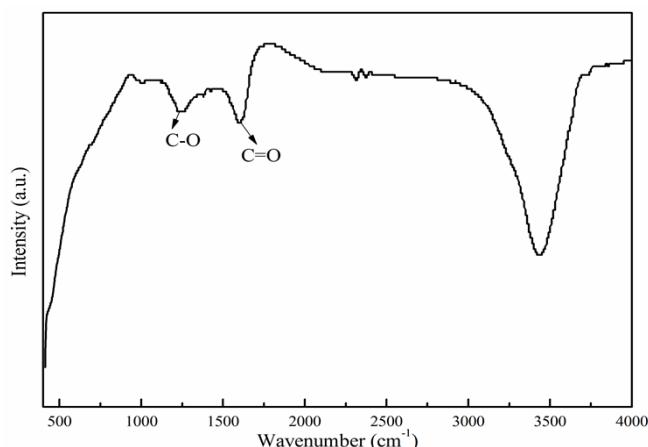


Figure S1: The FTIR spectrum of Fe/Fe₃C@PCS.

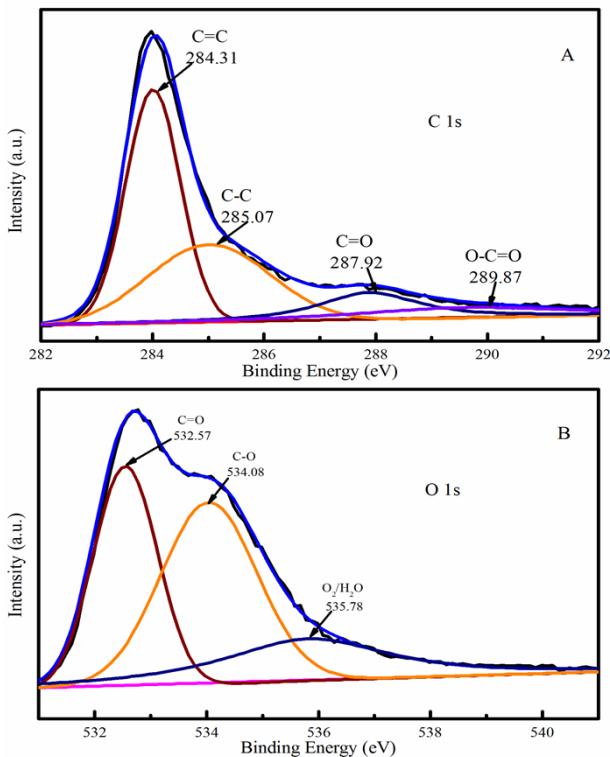


Figure S2. The XPS analysis of Fe/Fe₃C@PCS: (A) C 1s spectrum; (B) O 1s spectrum

To identify the phase and structure of the product, HRTEM was performed. The Fe/Fe₃C particles were surrounded by carbon. The lattice fringe with a distance of 0.21 nm, indicating a highly crystalline structure, corresponded to the (110) plane of the α -Fe crystal. The outer lattice fringe with a calculated *d*-spacing of 0.34 nm corresponded to the (002) plane of graphite.⁶ The lattice fringe with a distance of 0.126 nm is attributed to (322) crystal planes of Fe₃C.⁷ Therefore, we believe the presence of Fe/Fe₃C structure in sample.

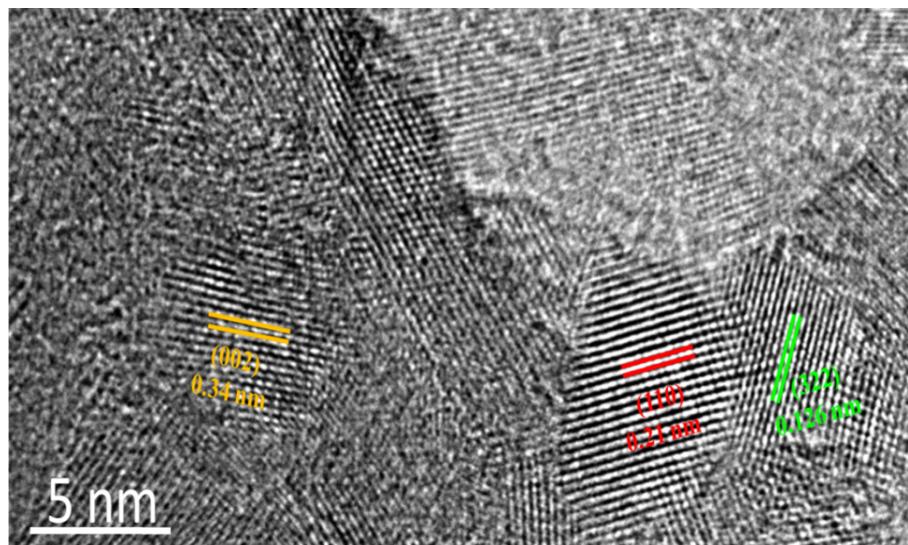


Figure S3. HRTEM image of Fe/Fe₃C@PCS

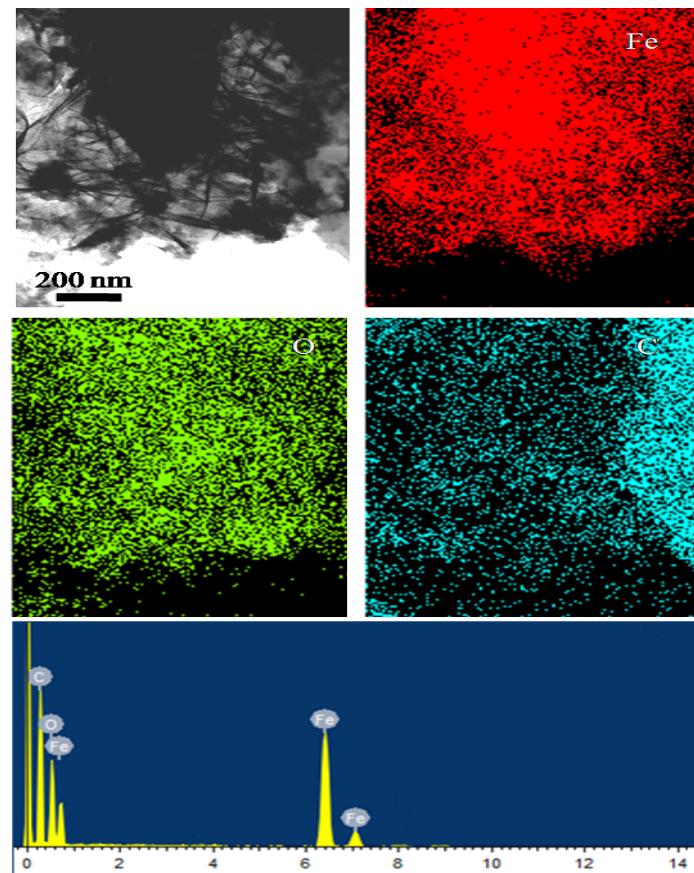


Figure S4. The elemental mapping of the homogenous dispersion and the EDS spectrum of the Fe/Fe₃C@PCS.

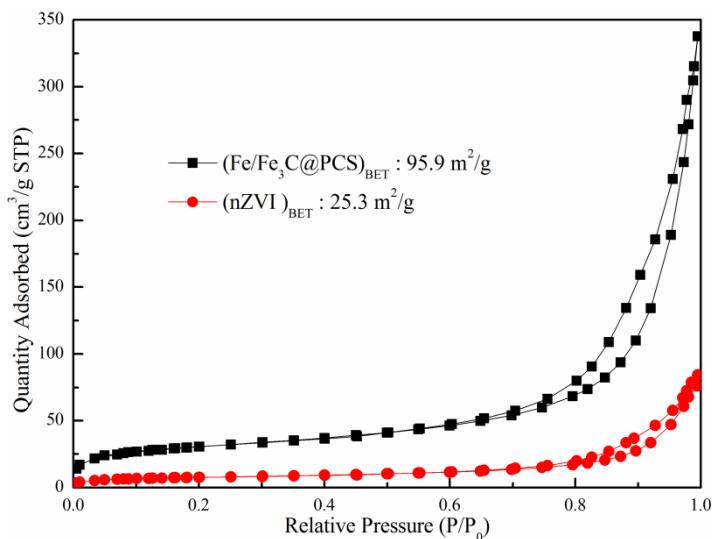


Figure S5. Nitrogen adsorption-desorption isotherms of Fe/Fe₃C@PCS and nZVI.

1. D. H. Liu , Y. Guo , L. H. Zhang , W. C. Li , T. Sun and A. H. Lu, *Small*, 2013, **9**, 3852-3857.
2. G. Q. Xie, P. X. Xi, H. Y. Liu, F. J. Chen, L. Huang, Y. J. Shi, F. P Hou, Z. Z. Zeng, C. W. Shao and J. Wang, *J. Mater. Chem.*, 2012, **22**, 1033-1039.
3. C. L. Chen, B. Liang, A. Ogino, X. K. Wang and M. Nagatsu, *J. Phys. Chem. C*, 2009, **113**, 7659-7665.
4. X. Y. Chen, C. Chen, Z. J. Zhang and D. H. Xie, *J. Mater. Chem. A*, 2013, **1**, 10903-10911.
5. K. Y. Yang, W. Xu, Y. Zhang, W. T. Zheng and X. Wang, *Chem. Res. Chin. Univ.*, 2010, **26**, 348-351.
6. Z. H. Wen, S. Q. Ci, F. Zhang, X. L. Feng, S. M. Cui, S. Mao, S. L. Luo, Z. He and J. H. Chen, *Adv. Mater.*, 2012, **24**, 1399-1404.
7. J. Su, Y. H. Gao, M. Sun, X. Y. Han, X. H. Zhang and Q. Zhang, *Micro. Nano Lett.*, 2012, **7**, 271-274.