Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Anchoring Nickel Nanoparticles on Three-Dimensionally Macro-/mesoporous Titanium Dioxide with Carbon Layer from Polydopamine Using Polymethylmethacrylate Microspheres as Sacrificial Templates

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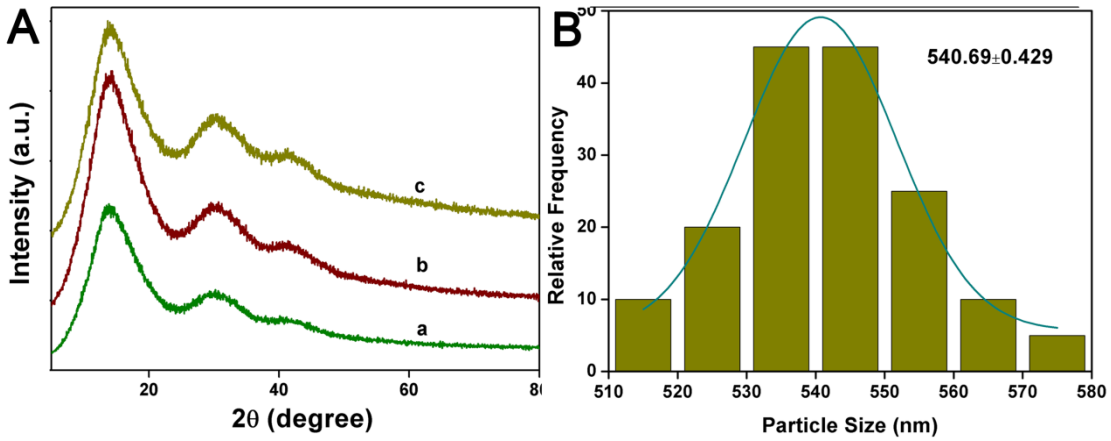

Figure S1. A: X-Ray diffraction patterns of PMMA (a), PMMA@TiO_2 (b), PMMA@TiO_2@PDA-Ni^{2+}(c); B: The particle size distribution of PMMA microspheres

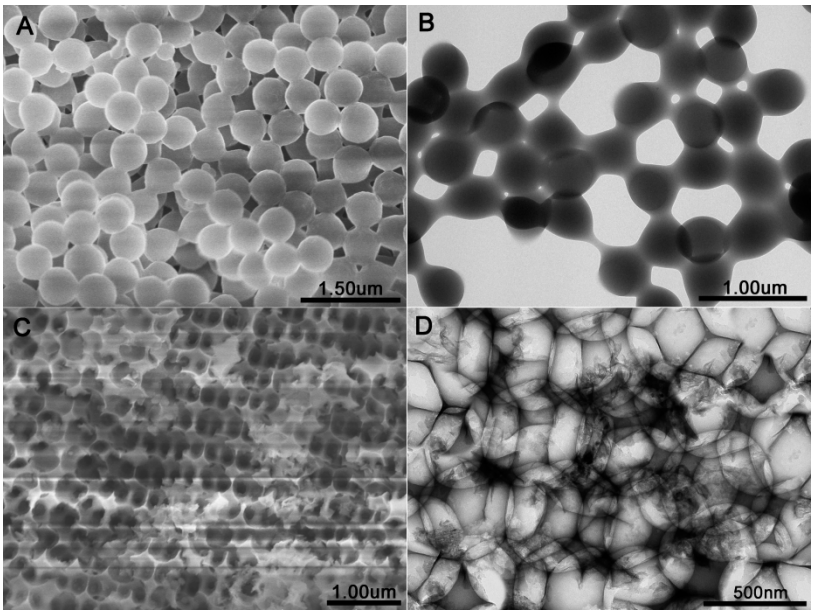

Figure S2. The SEM and TEM images of PMMA@TiO_2 (A, B) and 3D inverse-opal TiO_2 carbonized at 500 ^oC for 3 h (C,D)

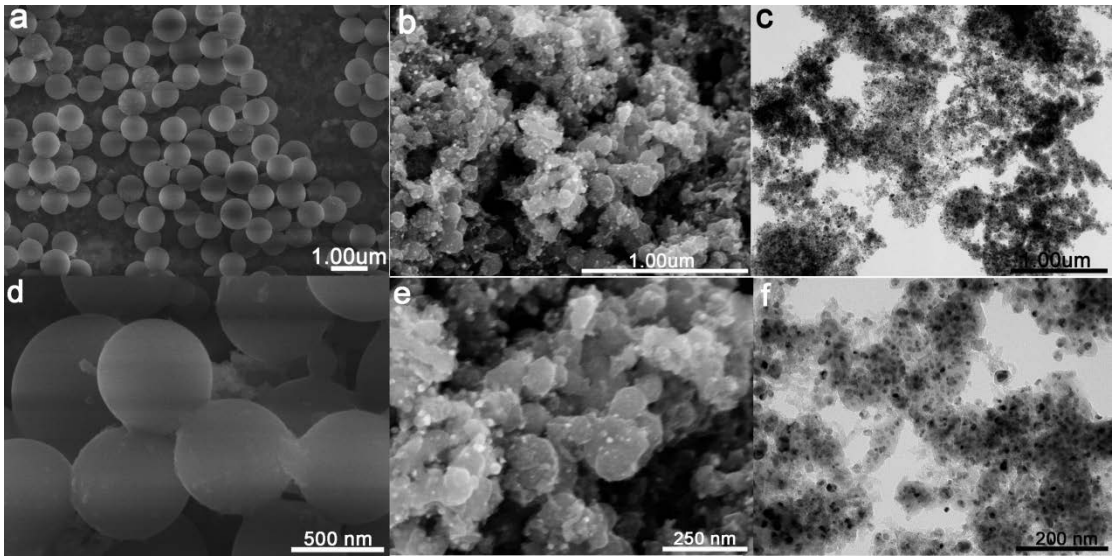

Figure S3. (a,d) SEM image of PMMA@PDA-Ni^{2+}, and (b,e) SEM and (c,f) TEM images of 3D C-Ni annealed at 500 ^oCin N_2 atmosphere.

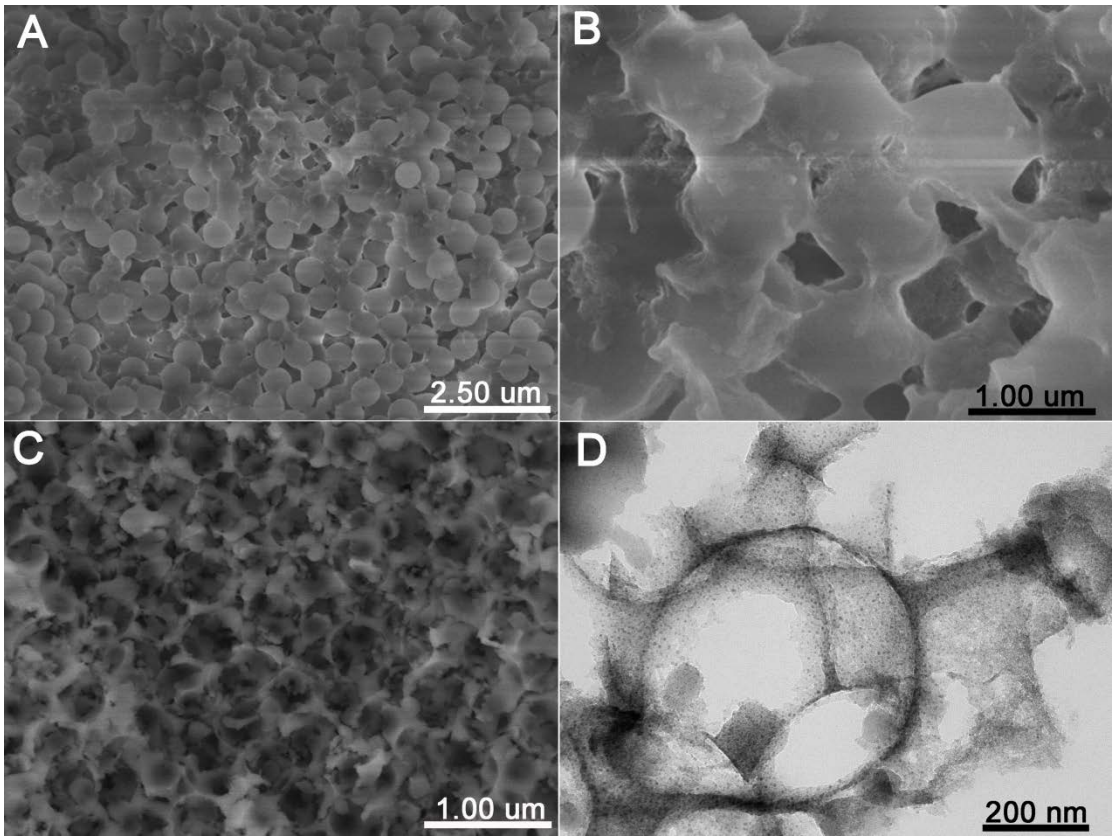

Figure S4. (a, b) SEM image of 3D PMMA@SiO_2@PDA-Ni^{2+} composites; (c) SEM image

and (d) TEM image of 3D SiO_2@C-Ni annealed at 500 °C in N_2 atmosphere.

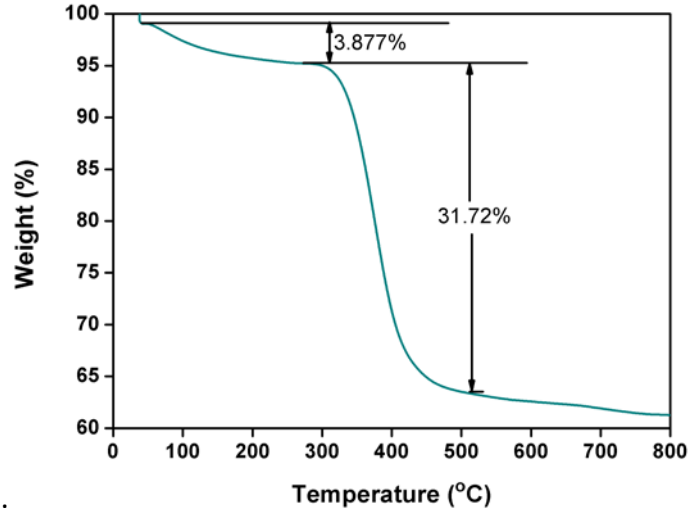

Figure S5. TGA curves of 3D TiO_2@C-Ni-500.

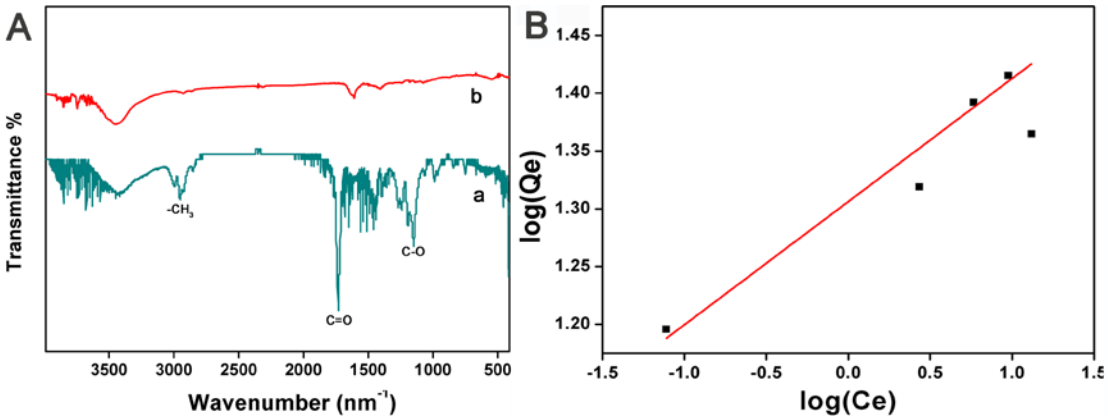

Figure S6. (A) The FT-IR spectra of PMMA@TiO_2@PDA-Ni^{2+}(a) and 3D TiO_2@C-Ni-500(b) composites. (B) The fitting curve of Freundlich model.

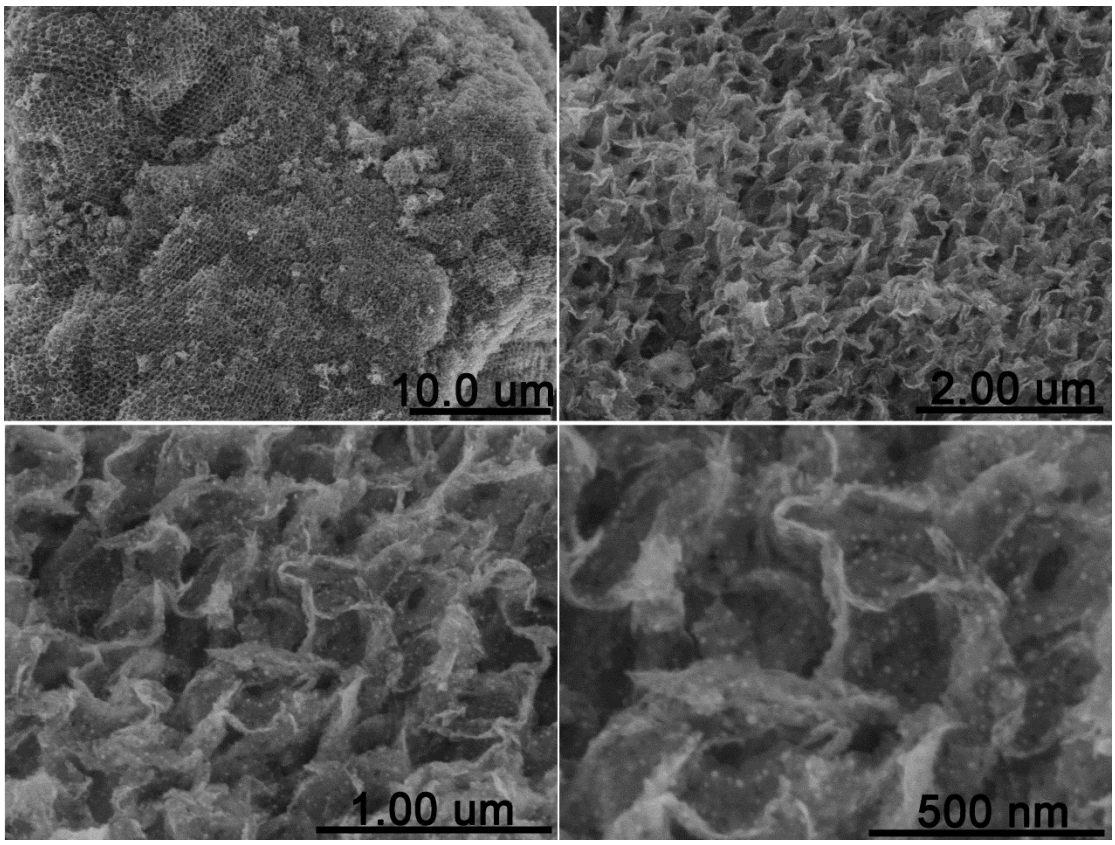

Figure S7. SEM images of 3D TiO_2@C-Ni-500 after seven catalytic reaction.

Table S1. Comparison of the activity parameter κ of metal catalysts for the reduction of 4-NP

Samples	k($\times10^{-3}s^{-1}$)	κ($\times10^{-3}$ $mg^{-1}s^{-1}$)	References
TiO_2@C-Ni-500	17.6	152.0	This work
Fe_3O_4@SiO_2-Au@mSiO$_2$	7	105.0	[1]
P_{PAA}	15.46	38.43	[2]
C@CoNi/500	15.8	100.6	[3]
C-Ni/400	5.9	142.0	[4]
Ag/Cu	6.70	74	[5]
Ni/SNTs(23.0 wt%)	84	91	[6]
TiO_2@C-Ni/700	15.17	173.21	[7]

Table S2. Comparison of the adsorption capacity of different adsorbents for BHb

protein

Materials	Adsorption capacity (mg g^{-1})	References
TiO_2@C-Ni-500	1031.27 mg g^{-1}	This work
Fe_3O_4@C/Ni-500	641.0 mg g^{-1}	[8]
$CuFe_2O_4$ MNCs	4475 mg g^{-1}	[9]
Fe_3O_4@ZIF-8	>6000 mg g^{-1}	[10]
Anionic PILs	983.4 mg g^{-1}	[11]
Polydopamine-coated MIP silica NPs	321.7 mg g^{-1}	[12]
C@CoNi	628.93 mg g^{-1}	[13]
Fe_3O_4@BHb- MIPs	37.58 mg g^{-1}	[14]

References

1. Y. Deng, Y. Cai, Z. Sun, J. Liu, C. Liu, J. Wei, W. Li, C. Liu, Y. Wang and D. Zhao, *Journal of the American Chemical Society*, 2010, **132**, 8466-8473.
2. C. Kästner and A. F. Thünemann, *Langmuir the Acs Journal of Surfaces & Colloids*, 2016, **32**, 7383.
3. Y. Ling, M. Zhang, J. Zheng, J. Xu, T. Hayat and N. S. Alharbi, *Dalton Transactions*, 2018, **47**, 7839.
4. L. Ding, M. Zhang, Y. Zhang, J. Yang, J. Zheng, T. Hayat, N. S. Alharbi and J. Xu, *Nanotechnology*, 2017, **28**, 345601.
5. Y. Sun, F. Zhang, L. Xu, Z. Yin and X. Song, *Journal of Materials Chemistry A*, 2014, **2**, 18583-18592.
6. S. Zhang, S. Gai, F. He, S. Ding, L. Li and P. Yang, *Nanoscale*, 2014, **6**, 11181-11188.
7. Y. Ling, M. Zhang, X. Li, J. Zheng and J. Xu, *Dalton Transactions*, 2018.
8. J. Wang, M. Zhang, J. Xu, J. Zheng, T. Hayat and N. S. Alharbi, *Dalton Trans*, 2018, **47**.
9. J. Zheng, Z. Lin, W. Liu, L. Wang, S. Zhao, H. Yang and L. Zhang, *Journal of Materials Chemistry B*, 2014, **2**, 6207-6214.
10. J. Zheng, Z. Lin, G. Lin, H. Yang and L. Zhang, *Journal of Materials Chemistry B*, 2015, **3**, 2185-2191.
11. M. Dang, Q. Deng, G. Fang, D. Zhang, J. Liu and S. Wang, *Journal of Materials Chemistry B*, 2017, **5**, 6339-6347.
12. Z. Xia, Z. Lin, Y. Xiao, L. Wang, J. Zheng, H. Yang and G. Chen, *Biosensors & Bioelectronics*, 2013, **47**, 120-126.
13. Y. Ling, M. Zhang, J. Zheng, J. Xu, T. Hayat and N. S. Alharbi, *Dalton*

Transactions, 2018, **47**, 7839-7847.
14. R. Gao, X. Mu, Y. Hao, L. Zhang, J. Zhang and Y. Tang, *Journal of Materials Chemistry B*, 2014, **2**, 1733-1741.