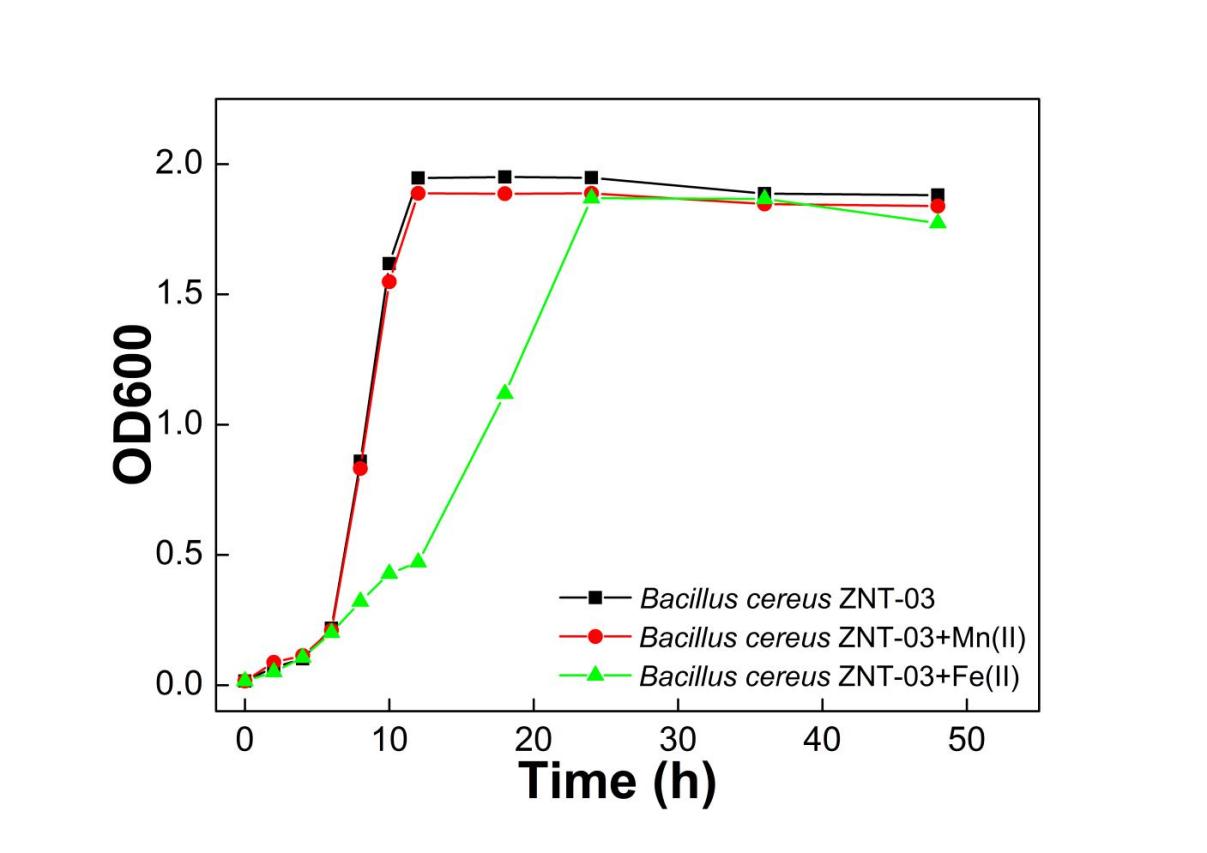
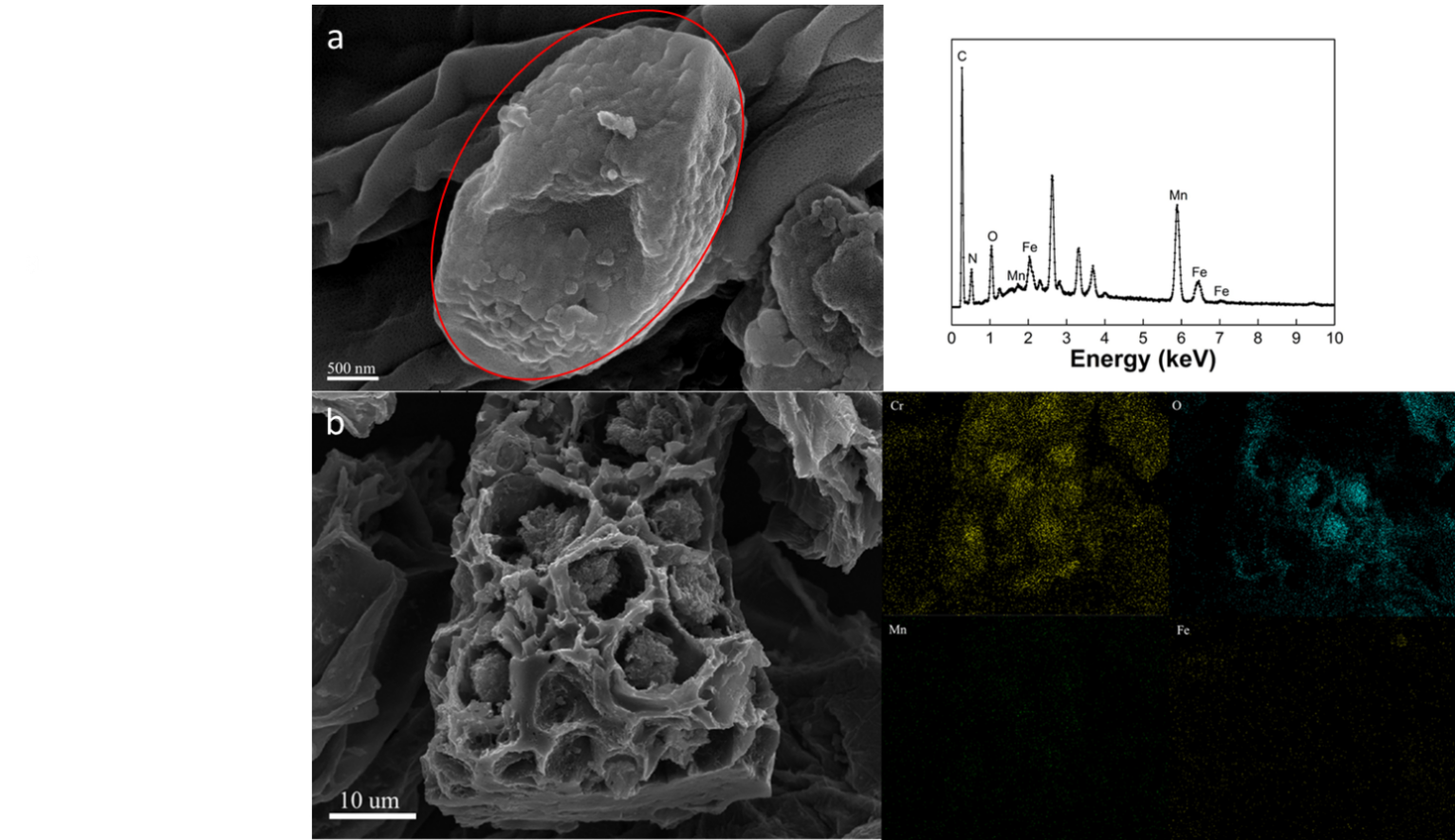
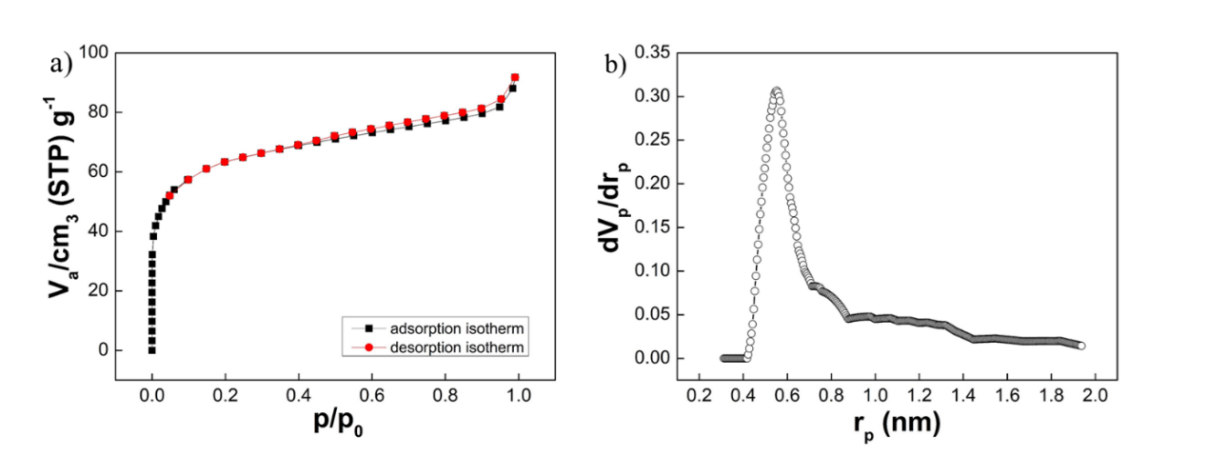
Supplementary materials



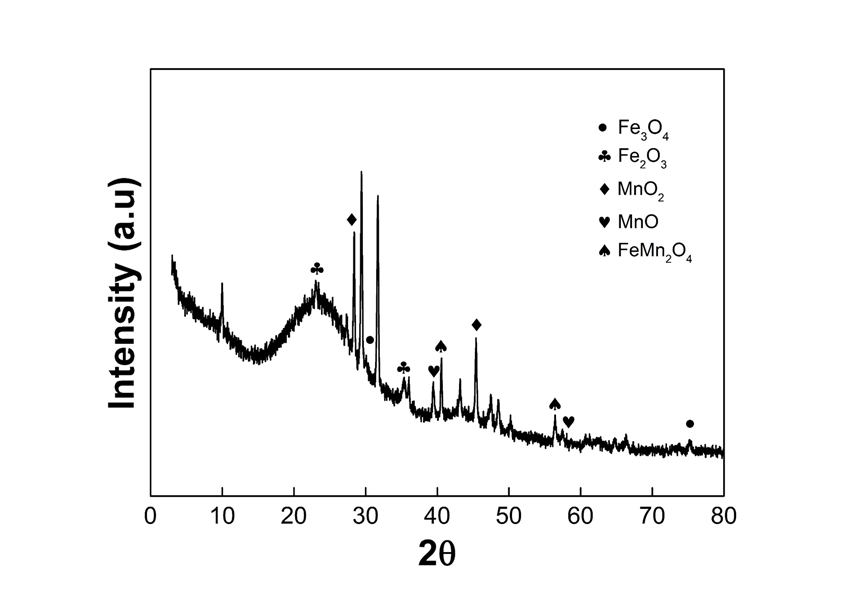
**Fig. S1** Growth curves of *Bacillus cereus* ZNT-03



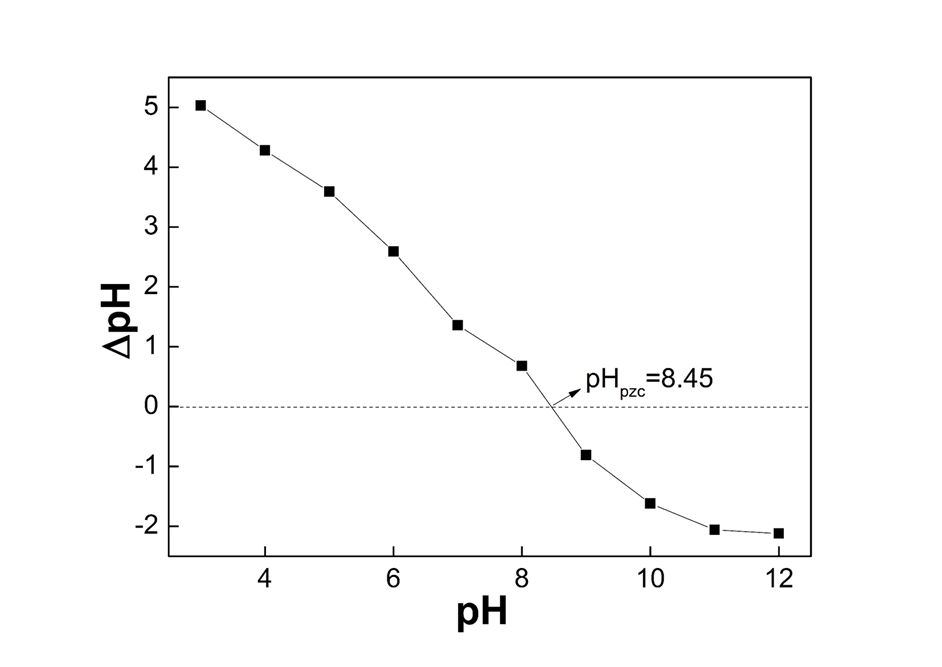
**Fig. S2** SEM of FMBC before and after Cr(VI) adsorption (a) SEM-EDS of FMBC before Cr(VI) adsorption, and (b) SEM mapping of FMBC after Cr(VI) adsorption



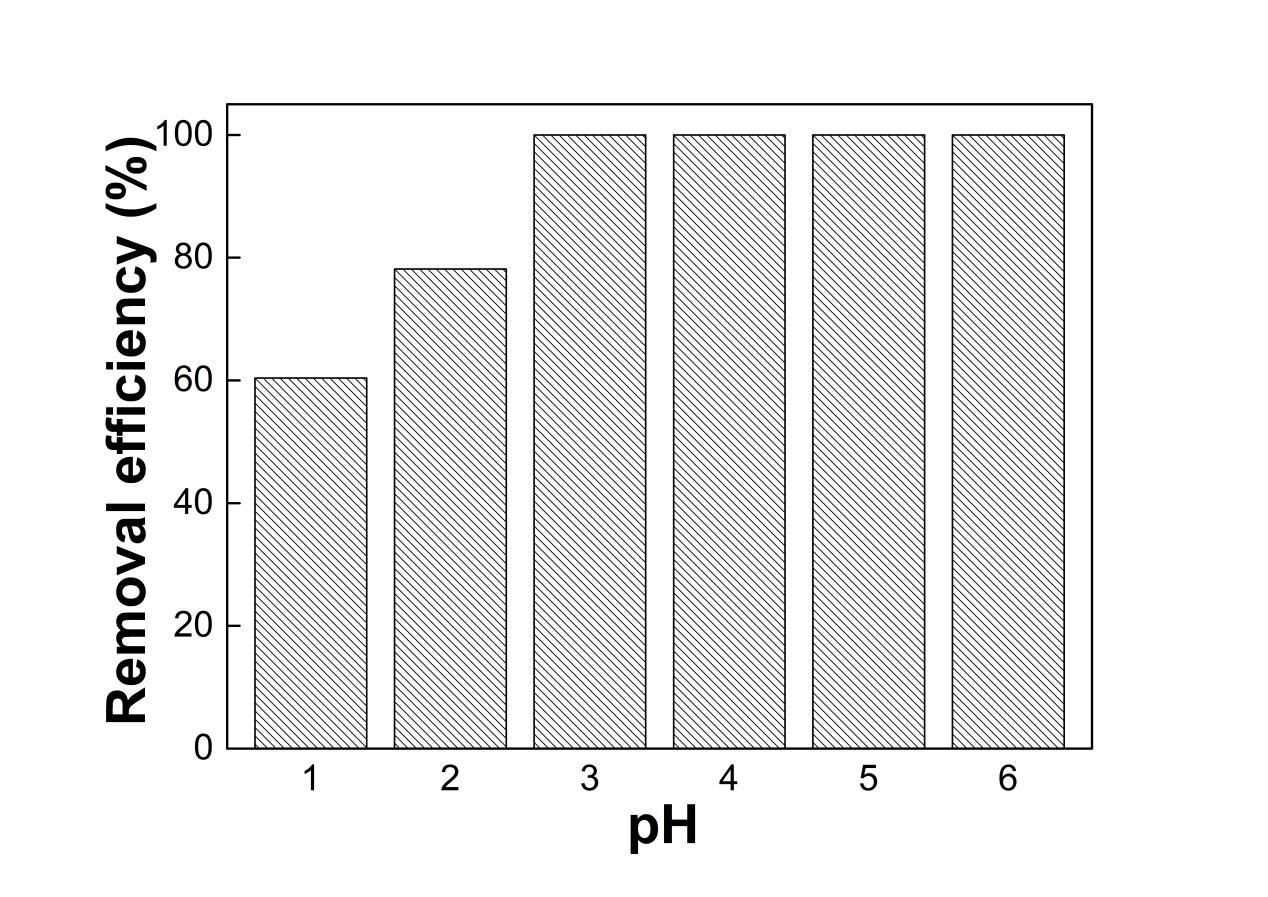
**Fig. S3** (a) N2 adsorption-desorption isotherm of FMBC; (b) pore size distribution of FMBC



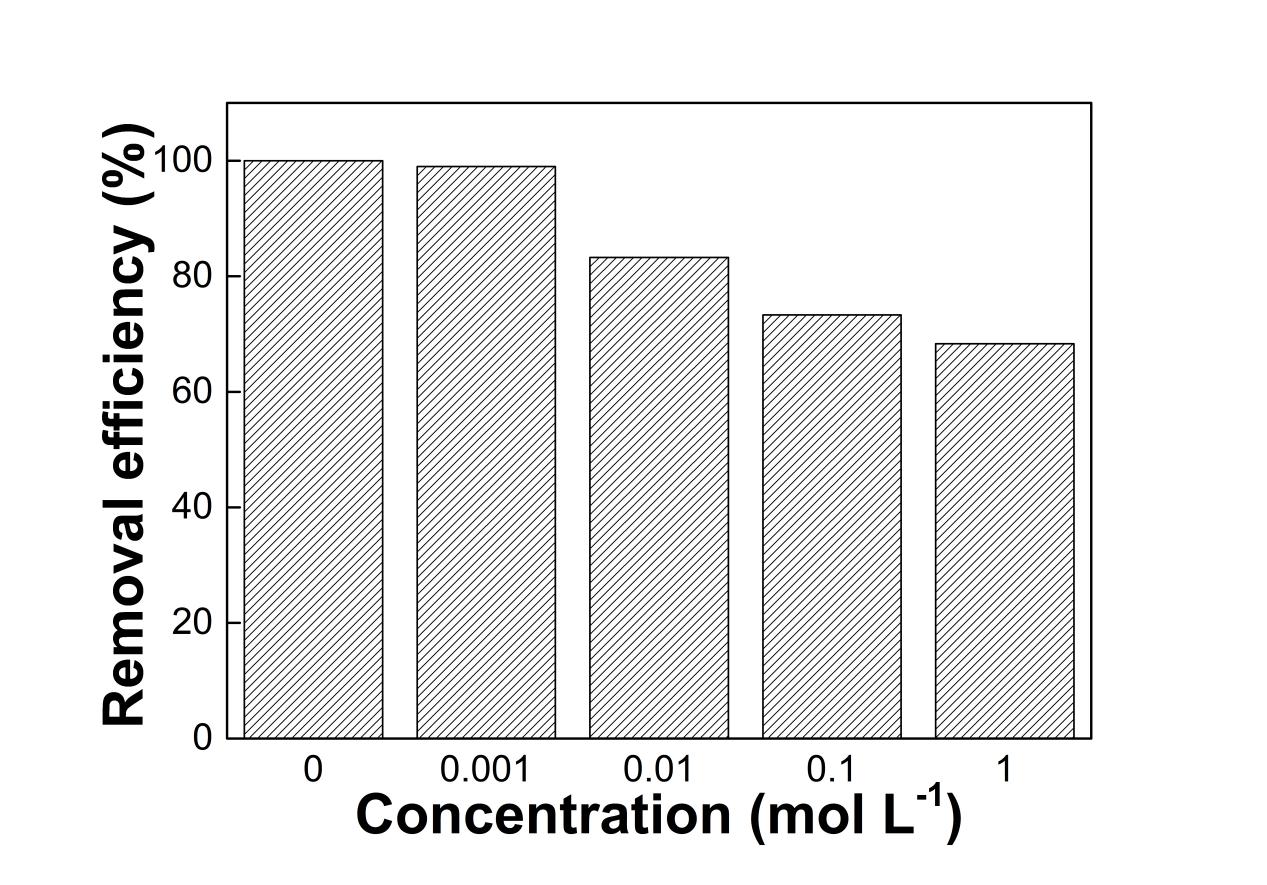
**Fig. S4** XRD patterns of FMBC



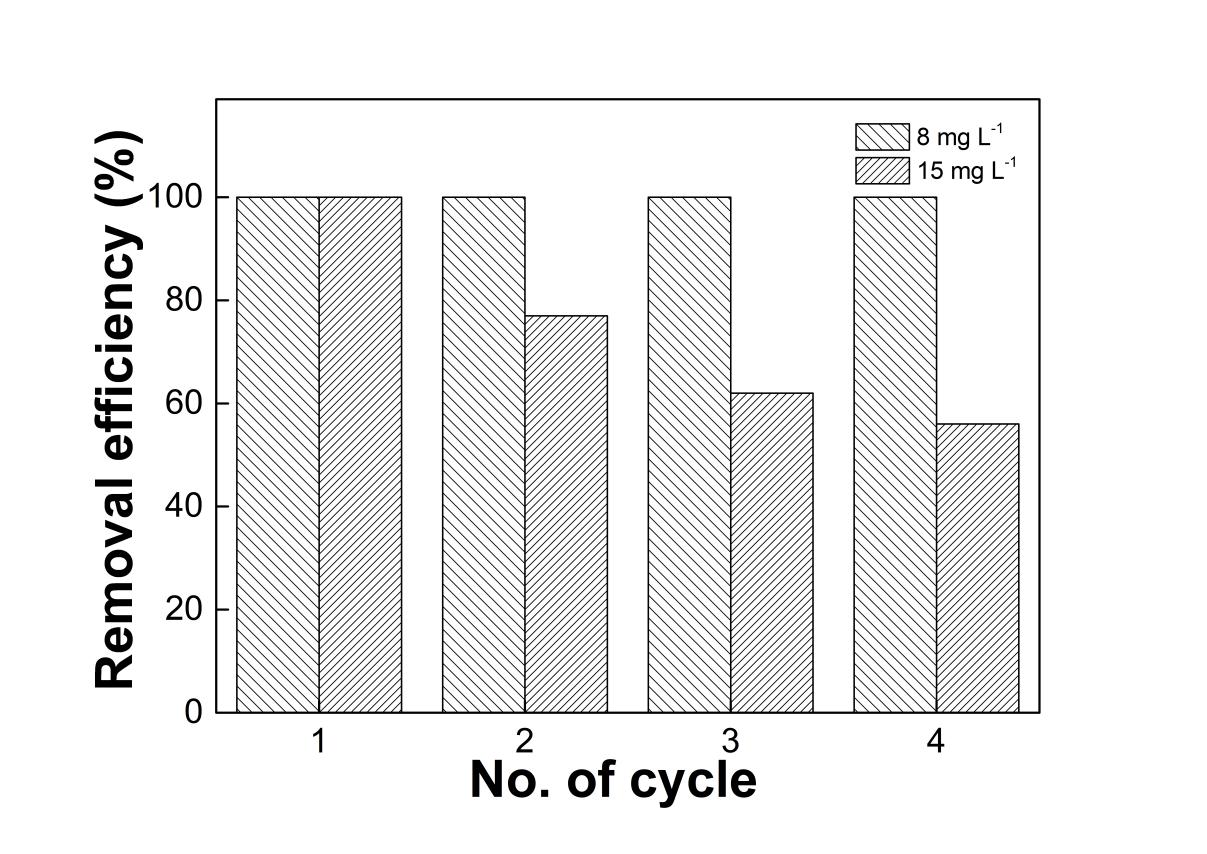
**Fig. S5** pHzpc of FMBC



**Fig. S6** The removal efficiency of Cr(III) using FMBC under different pH conditions (C0 =27 mg L-1; dosage = 1 g L-1; T = 298 K)



**Fig. S7** Effects of coexisting ions (NaCl) on Cr(VI) removal by FMBC ( C0 =17 mg L-1; dosage = 1 g L-1; T = 298 K; pH = 1.5)



**Fig. S8** Regeneration of FMBC ( dosage = 1 g L-1; T = 298 K; pH = 1.5)



**Fig. S9** Magnetism of FMBC after acidic soaking for 180 days

**Table S1** The physical and chemical properties of FMBC

|  |  |
| --- | --- |
| Properties | Average value |
| N (%) | 3.04 |
| C (%) | 66.22 |
| H (%) | 2.38 |
| Fe (mg g-1)) | 3.07 |
| Mn (mg g-1) | 2.56 |
| BET surface area (m2 g-1) | 165.204 |
| Total pore volume (cm3 g-1) | 0.142 |

**Table S2** Parameters for kinetic models of Cr(VI) adsorption using FMBC

|  |  |  |
| --- | --- | --- |
| Models | Parameters | |
| Pseudo-first-order | qe (mg g-1)  K1(min)  R2  qe (mg g-1)  K2 (g mg-1 min-1)  R2 | 10.46  5.27  0.97  10.71  1.48  0.98 |
| 10mg L-1 |
|  |
| Pseudo-second-order |
| 10mg L-1 |
| Pseudo-first-order | qe (mg g-1)  K1(min)  R2  qe (mg g-1)  K2 (g mg-1 min-1)  R2 | 14.65  3.80  0.95  15.28  0.51  0.97 |
| 20mg L-1 |
|  |
| Pseudo-second-order |
| 20mg L-1 |
| Pseudo-first-order | qe (mg g-1)  K1(min)  R2  qe (mg g-1)  K2 (g mg-1 min-1)  R2 | 17.23  1.60  0.98  19.00  0.13  0.98 |
| 30mg L-1 |
|  |
| Pseudo-second-order |
| 30mg L-1 |
| Pseudo-first-order | qe (mg g-1)  K1(min)  R2  qe (mg g-1)  K2 (g mg-1 min-1)  R2 | 25.61  1.70  0.94  27.35  0.11  0.97 |
| 40mg L-1 |
|  |
| Pseudo-second-order |
| 40mg L-1 |

The pseudo-first-order model (Eq. (1)) and pseudo-second-order model (Eq. (2)) are as follows (Chen et al., 2018):

Qe and qt (mg g-1) are the adsorption amounts of Cr (VI) by adsorbents at equilibrium and time, respectively; k1 (min-1) and k2 (g (mg·min)-1) are the rate constants, respectively.

**Table S3** Isotherm models parameters and correlation coefficients of Cr(VI) adsorption using FMBC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Temperature | Langmuir model | | Freundlich model | |
| 278 K | qmax | 16.97 | KF | 3.00 |
| KL | 0.10 | n | 2.35 |
| R2 | 0.97 | R2 | 0.97 |
| 288 K | qmax | 18.54 | KF | 8.50 |
| KL | 0.38 | n | 4.79 |
| R2 | 0.97 | R2 | 0.91 |
| 298 K | qmax | 21.25 | KF | 15.11 |
| KL | 1.94 | n | 9.35 |
| R2 | 0.93 | R2 | 0.92 |
| 308 K | qmax | 17.84 | KF | 14.48 |
| KL | 5.97 | n | 14.33 |
| R2 | 0.90 | R2 | 0.86 |

Langmuir (Eq. (3)) and Freundlich (Eq. (4)) as follows (Xiao et al., 2018):

Ce (mg L-1) is the equilibrium concentration, qe and qm (mg g-1) are the equilibrium adsorption amounts and maximum adsorption capacity, respectively. KL and KF (L mg-1) are the parameters. And n is the adsorption intensity.

**Table S4** The XPS data of FMBC before and after Cr(VI) adsorption

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Before adsorption | Binding Energy | Atomic | After adsorption | Binding Energy | Atomic |
| C 1s | C=C | 283.4 eV | 57.71% | C=C | 283.8 eV | 76.09% |
| C-C | 284.5 eV | 31.68% | C-C | 285.4 eV | 15.50% |
| C=O | 288.2 eV | 10.61% | C=O | 287.7 eV | 8.41% |
| O 1s | O2- | 530.0 eV | 33.18% | O2- | 529.8 eV | 1.63% |
| C=O | 531.2 eV | 3.48% | C=O | 530.7 eV | 16.61% |
| Fe-OH | 531.7 eV | 58.00% | Fe-OH | 530.9 eV | 62.48% |
| -OH | 534.9 eV | 5.34% | -OH | 532.6 eV | 19.28% |
| N 1s | Pyrrolic-N | 399.4 eV | 89. 40% | Pyrrolic-N | 398.9 eV | 100.0% |
|  | Fe-Nx | 397.4 eV | 7.25% |  |  |  |
|  | Pyridinic-N | 396.4 eV | 3.35% |  |  |  |
| Fe 2p | Fe (II) | 729.4 eV | 19.19% | Fe(II) | 731.5 eV | 23.99% |
| Fe (II) | 716.6 eV | 19.00% | Fe(II) | 718.7 eV | 23.75% |
| Fe (III) | 724.2 eV | 31.07% | Fe(III) | 723.8 eV | 26.27% |
| Fe (III) | 710.4 eV | 30.74% | Fe(III) | 710.0 eV | 25.99% |
| Mn 2p | Mn (II) | 644.2 eV | 17.73% | Mn(II) | 643.8 eV | 12.18% |
|  | Mn (II) | 655.9 eV | 17.83% | Mn(II) | 650.2 eV | 11.66% |
|  | Mn (VI) | 640.5 eV | 32.09% | Mn(VI) | 636.5 eV | 37.92% |
|  | Mn (VI) | 651.3 eV | 32.34% | Mn(VI) | 647.4 eV | 38.25% |
| Cr 2p |  |  |  | Cr(III) | 576.3 eV | 37.97% |
|  |  |  | Cr(III) | 586.6 eV | 34.28% |
|  |  |  | Cr(VI) | 577.5 eV | 23.75% |
|  |  |  | Cr(VI) | 589.2 eV | 4.00% |

**Table S5** Comparison of the maximum adsorption capacities of Cr(VI) on FMBC with other adsorbents

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Experimental conditions | | | | |
| Absorbents | Qmax | pH | Treatment | Reference |
|  | (mg g-1) |  | Time (h) |  |
| Wheat straw biochar | 21.34 | 1 | 5 | [Wang et al. (2010)](#_ENREF_6) |
| Citrobacter freundii biochar | 19.43 | 2 | 12 | Simranjeet et al. (2022) |
| Tamarindus indica bark biochar | 21.00 | 2 | - | Goyal et al. (2016) |
| Core Shell adsorbents | 15.60 | 2.5 | 0.5 | Campos et al. (2019) |
| Pineapple peel biochar | 7.44 | 4 | 35 | Wang et al. (2016) |
| Magnetic carbon | 3.74 | 7 | 0.25 | [Zhu et al. (2014)](#_ENREF_8) |

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