

**Magnetically recoverable mesoporous melamine–
formaldehyde nanoparticles as an efficient adsorbent for
hexavalent chromium removal**

**Zhongfei Lv,^a Dandan Zhao,^b Changsheng Liang,^a Jiayang Cui,^a Yangben Cai^a
and Shiai Xu^{*a}**

^a Shanghai Key Laboratory of Advanced Polymeric Materials, Key Laboratory for
Ultrafine Materials of Ministry of Education, School of Materials Science and
Engineering, East China University of Science and Technology, Shanghai 200237,
China

^b Chemical Experiment Center, School of Chemistry and Molecular Engineering, East
China University of Science and Technology, Shanghai 2002237, China

Corresponding author. Fax. (+86) 021-6425-3775

Tel.: (+86) 021-64253353

E-mail addresses: saxu@ecust.edu.cn, saxu@163.com

Supplementary tables.

Table S1 Textural parameters of Fe₃O₄, Fe₃O₄@SiO₂, MMMF and MMF.

Sample	BET area (m ² /g)	BJH pore size (nm)	Pore volume (cm ³ /g)	Micropore BET area (m ² /g)
Fe ₃ O ₄	71	19.7	0.25	1
Fe ₃ O ₄ @SiO ₂	465	6.2	0.35	30
MMMF	393	6.9	0.10	22
MMF ^a	317	8.0	0.58	----

^aMMF was synthesized as previously reported³⁶.

Table S2 Adsorption capacity of MMMF at different initial concentrations of Cr (VI) solutions.^a

Conc. (ppm)	45.7	83.3	113.9	175.7
Time (min)				
1	38.1	43.8	62.9	68.0
2	39.9	50.3	64.9	75.1
5	41.4	55.1	73.2	100.4
10	41.4	62.5	91.3	100.5
20	41.7	62.6	93.4	100.9
30	41.7	63.0	98.0	102.5
60	41.7	65.5	101.9	106.8

^a Reaction conditions: 0.05 g of MMMF was added to 50 mL of x ppm Cr (VI) solutions (x = 45.7, 83.3, 113.9, 175.7) and stirred at 150 rpm at 25 °C and pH 6.0 for y min (y = 1, 2, 5, 10, 20, 30, 60).

Table S3 Adsorption capacity of magnetic Fe₃O₄@SiO₂ nanocomposites for Cr (VI).^a

Time (min)	1	2	5	10	20	30	60
q _t (mg/g)	0.2	0.3	0.3	0.3	0.3	0.3	0.3

^a Reaction conditions: 0.05 g of Fe₃O₄@SiO₂ nanocomposites was added to 50 mL of 45 ppm Cr (VI) solutions and stirred at 150 rpm at 25 °C and pH 6.0 for y min (y = 1, 2, 5, 10, 20, 30, 60).

Table S4 Adsorption capacity of MMMF at different temperatures.^a

Temperature (°C)	20	25	30	35	40
q _t (mg/g)	41.6	41.7	41.2	41.2	40.6

^a Reaction conditions: 0.05 g of MMMF was added to 50 mL of 45.7 ppm Cr (VI) solutions and stirred at 150 rpm at x °C (x = 20, 25, 30, 35, 40) and pH 6.0 for 20 min.

Table S5 Adsorption capacity of MMMF for Cr (VI) at different pH values.^a

pH	2	4	6	7	8	10	12
q _t (mg/g)	35.7	36.3	41.7	36.6	33.2	22.9	19.9

^a Reaction conditions: 0.05 g of MMMF was added to 50 mL of 45.7 ppm Cr (VI) solutions and stirred at 150 rpm at 25 °C and pH x (x was adjusted to 2.0, 4.0, 6.0, 7.0, 8.0, 10.0, and 12.0 using 0.1 M HCl or 0.1 M NaOH.) for 20 min.

Table S6 Desorption percentages of MMMF/Cr in 0.1 M NaOH solution at different times.^a

Time (min)	1	2	5	10	20	30	60
Desorption percentage (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0

^a Reaction conditions: 0.05 g of MMMF/Cr was added to 50 mL of 0.1 M NaOH solutions and stirred at 150 rpm at 25 °C for x min (x = 1, 2, 5, 10, 20, 30, 60).

Table S7 Different concentrations of iron ion of the samples Fe_3O_4 , $\text{Fe}_3\text{O}_4@\text{SiO}_2$ and MMMF dissolving under the acid solutions.^a

Samples	Fe_3O_4	$\text{Fe}_3\text{O}_4@\text{SiO}_2$	MMMF
Concentration/ppm	69	0.038	0.018

^aReaction conditions: 0.01 g Fe_3O_4 , $\text{Fe}_3\text{O}_4@\text{SiO}_2$ and MMMF were put into 100 ml HCl aqueous solutions ($\text{pH}<1$) and stirred at room temperature for 2 hours.

Table S8 Cyclic adsorption performance of MMMF for Cr (VI).^a

Times	0	1	2	3	4	5
q _t / mg/g	30.0	30.0	30.0	30.0	29.0	29.0

^a Reaction conditions: 0.2 g of MMMF was added to 50 mL of 145.7 ppm Cr (VI) solution and stirred at 150 rpm at 25 °C and pH 6.0 for 20 min.

Figure captions.

Fig. S1. Photographs of Fe_3O_4 (A), MMF (B) and MMMF (C).

Fig. S2. HR-TEM image of Fe_3O_4 nanospheres.

Fig. S3. IR spectrum of (A) Fe_3O_4 nanospheres, (B) $\text{Fe}_3\text{O}_4@\text{SiO}_2$ nanocomposites, and (C) MMMF nanoparticles.

Fig. S4. Elemental mappings of MMMF nanoparticles: (A1) carbon; (B1) nitrogen; (C1) oxygen; (D1) silicon; and (E1) iron.

Fig. S5. Elemental mappings of MMMF/Cr: (A2) carbon; (B2) nitrogen; (C2) oxygen; (D2) silicon; (E2) iron; and (F2) chromium.

Fig. S6. TGA curves of MMF (A) and MMMF (B).

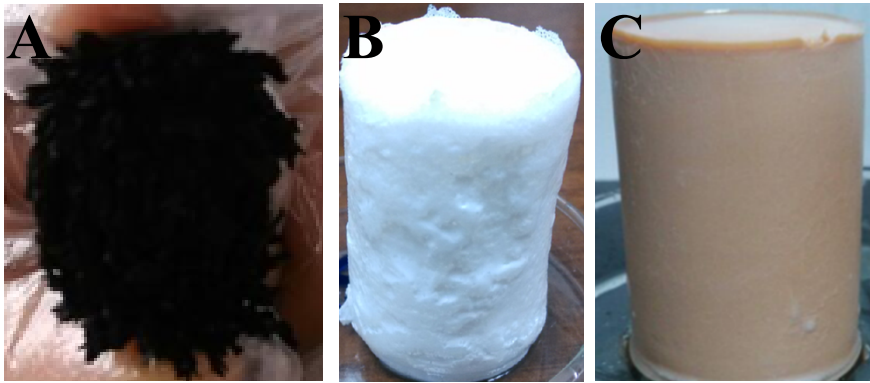


Fig. S1

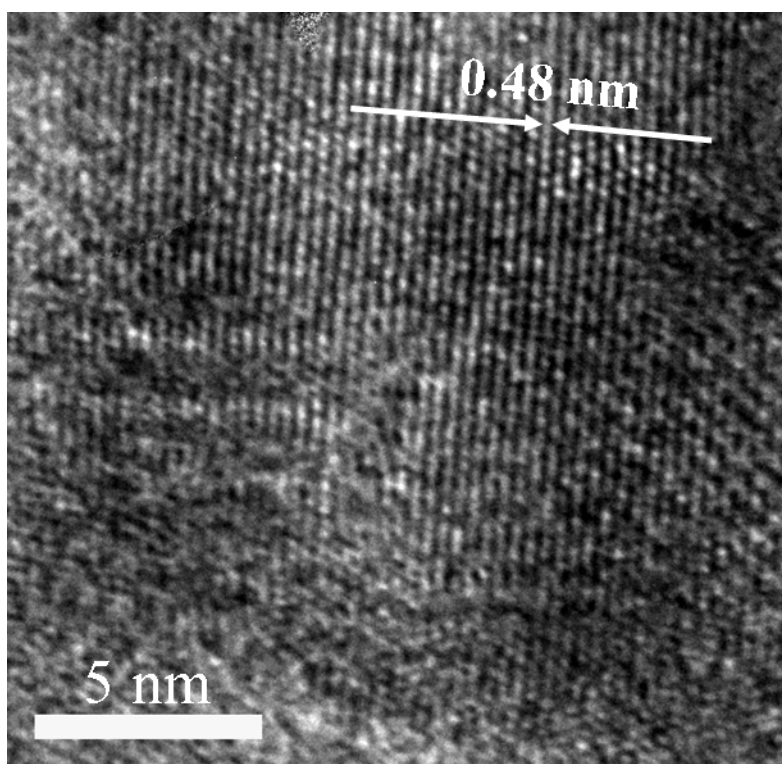


Fig. S2

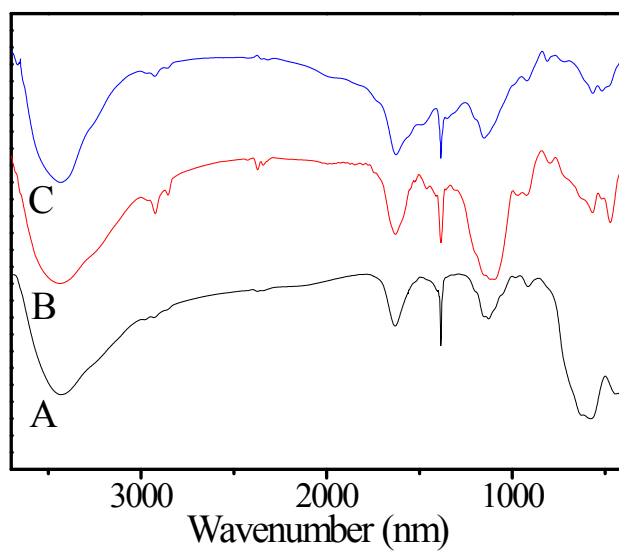


Fig. S3

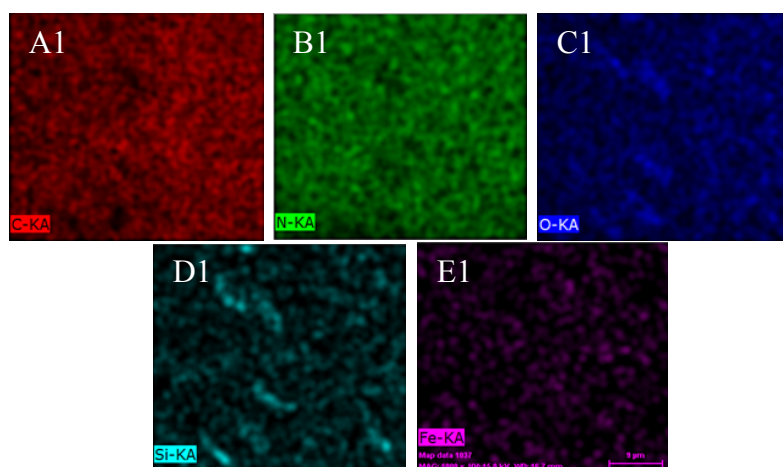


Fig. S4

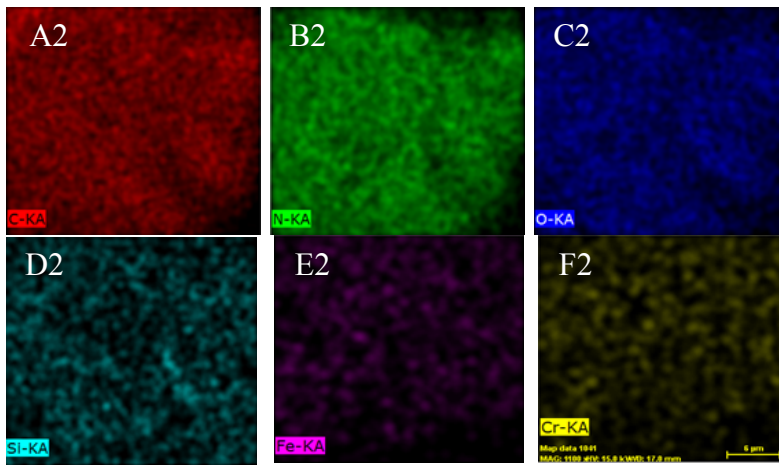


Fig. S5

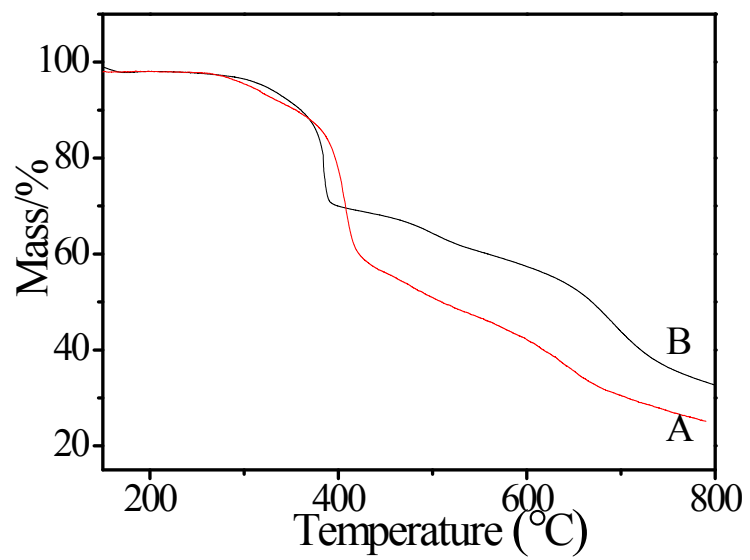


Fig. S6