Experimental Section

Figure S1. XRD patterns of (a) the pure colloidal nanoparticles.

Figure S2. Raman spectrum of the pure colloidal nanoparticles.

Figure S3. The hysteresis loops measured at room temperature for the pure colloidal nanoparticles.

Figure S4. (a) and (b) SEM image and size distribution of the pure colloidal nanoparticles.

Figure S5. (a) HRTEM image of single colloidal nanoparticles; (b) and (c) lattice fringe and electron diffraction (ED) pattern of the as-obtained colloidal nanoparticles.

Figure S6. EDS of single separated colloidal nanoparticle.

Experimental Section

Materials: Ferrocene ($Fe(C_5H_5)_2$, ≥98%), hydrogen peroxide (H_2O_2, 30%), acetone (C_3H_6O) (≥99%), lead nitrate, nitric acid mercury and nitric acid cadmium were of analytic grade from the Shanghai Chemical Factory, China. All chemicals were used as received without further purification.

Synthesis of Magnetic Colloidal Nanoparticles:

In a typical synthesis, ferrocene (0.30 g) were dissolved in an acetone (30 mL). After intense sonication for 30 min, 1.0 mL of hydrogen peroxide was slowly added into the above mixture solution, which then was vigorously stirred for 30 min with a magnetic stirring apparatus. After that, the precursor solution was transferred to the Teflon-lined stainless autoclave with the total volume of 50.0 mL, and then heated to and maintained at 240 °C. After 72 h, the autoclave was cooled naturally to room temperature. After intense sonication for 15 min, the products from the Teflon-lined stainless autoclave were magnetized for 10 min by a magnet with 0.20 T, and the supernatant was discarded under a magnetic field. The precipitates were then washed with acetone three times to remove excess ferrocene. Finally, the black products were dried at room temperature in a vacuum oven.

The Removal of Pb^{2+} under different uptake time.

Typically, the nanoparticles suspension (1 g/L, 4 mL) dissolved in distilled water and aqueous solution (1 mg/L, 1 mL) of Pb^{2+} were transferred to the centrifugal tube (10 mL). After uniform oscillated with different uptake time using a shaker ensure sufficient interaction between magnetic nanoparticles and Pb^{2+}, the above mixture solution was magnetized for 5 min by a 0.20 T magnet, and the supernatant was transferred under an external magnetic field. The uptake time performed is 10 min, 30 min, 60 min, 120 min, and 180 min, respectively. Meanwhile, the pH performed is selected for 6. The indictive coupled plasma-atomic emission spectroscopy was used to examine the removal efficiency of Pb^{2+}.

Investigation of the Relationship between pH Value and Adsorption Capacity.

All performances in this section are similar to the above one under different uptake time. The uptake time performed is selected for 120 min. The pH of Pb^{2+} solution was adjusted with 1 M HNO_3 and controlled from 1 to 6.

Investigation of the Relationship between Concentration and Adsorption Capacity.

All performances in this section are similar to the above one under different uptake time. The uptake time and pH performed is selected for 120 min and 6, respectively. The concentration of Pb^{2+} solution performed is 0.1 mg/L, 1 mg/L, 10 mg/L, and 100 mg/L, respectively. Meanwhile, the removal efficiency of Hg^{2+} and Cd^{2+} was determined similarly.

Desorption Study.

Desorption studies was examined by dispersing separated precipitates into 5mL of acidic water with different pH under the assistance of ultrasonication. The pH of Pb^{2+} solution was adjusted with 1 M HNO_3 and controlled from 6 to 1.

Sample Characterization

Surface charge was measured using Particles Analyzer (Delsa Nano C) from Beckman Coulter. The powder X-ray diffraction (XRD) patterns were collected on a Japan Rigaku D/MAX-γA X-ray diffractometer equipped with Cu Kα radiation (λ = 1.54178 Å) over the 2θ range of 10–70 º. Transmission electron microscopy (TEM) images were obtained on Hitachi H-800 transmission electron microscope, using an accelerating voltage of 200kV. High-resolution transmission electron microscopy (HRTEM) images were taken on a JEOL-2010 transmission electron microscope, which was operated at 200 kV. Energy-dispersive X-ray (EDX) analysis was obtained with an EDAX detector installed on the same HRTEM. The Raman spectrum was taken on a LABRAM-HR Confocal Laser Micro-Raman spectrometer using an Ar^+ laser with 514.5 nm at room temperature. The FT-IR spectrum was obtained using a Magna-IR 750 spectrometer in the range of 400-4000 cm^{-1} with a resolution of 4 cm^{-1}. A superconducting quantum interference device (SQUID) magnetometer (Quantum Design MPMS XL-7) was used to measure the magnetic properties of as-prepared samples. The concentration of heavy metal ions was measured using indictive coupled plasma-atomic emission spectroscopy (Atomscan Advantage). The surface area and pore volume was collected by accelerated surface area and porosimetry (ASAP 2020 M+C).

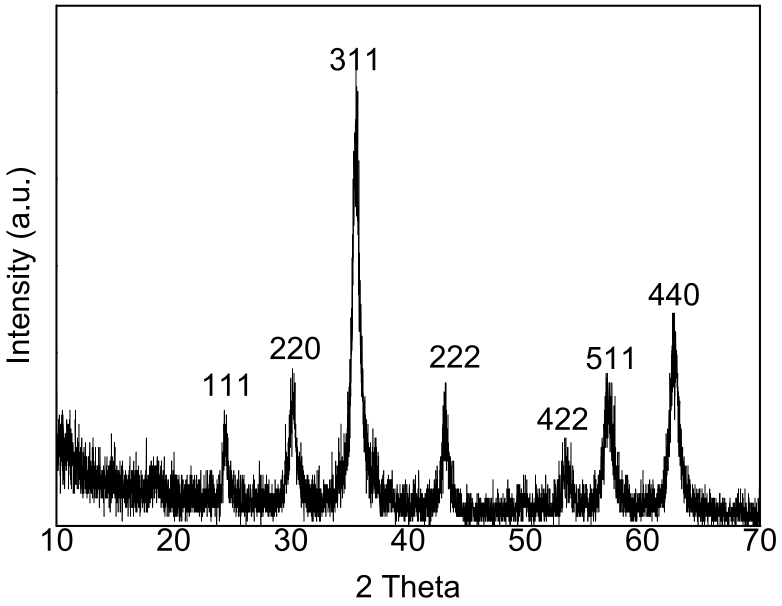
311
220
111
222
422
511
440
Intensity (a.u.)
10
20
30
40
50
60
70
2 Theta

Figure S1.

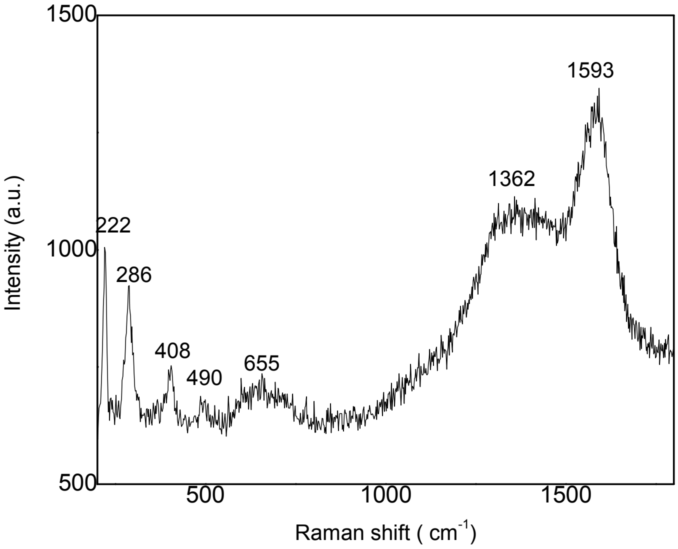
1500
1000
500
Intensity (a.u.)
222
286
408
490
655
1362
1593
500
1000
1500
Raman shift (cm-1)

Figure S2.

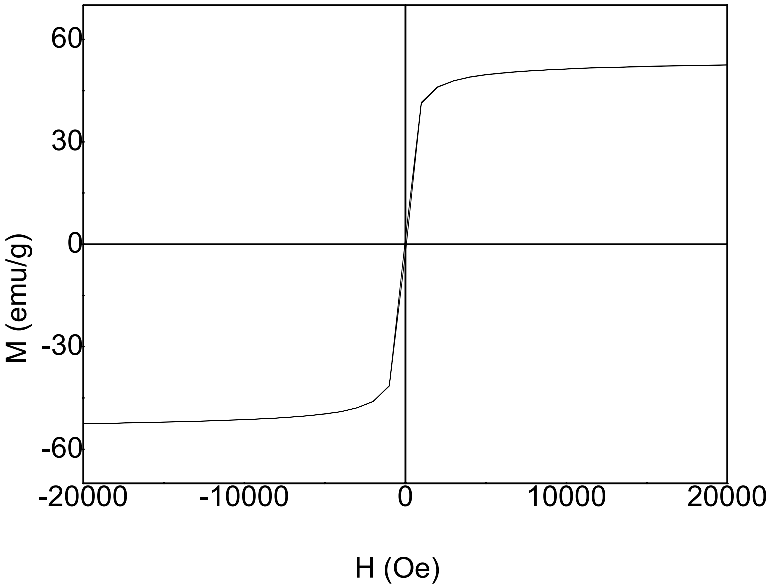

Figure S3.

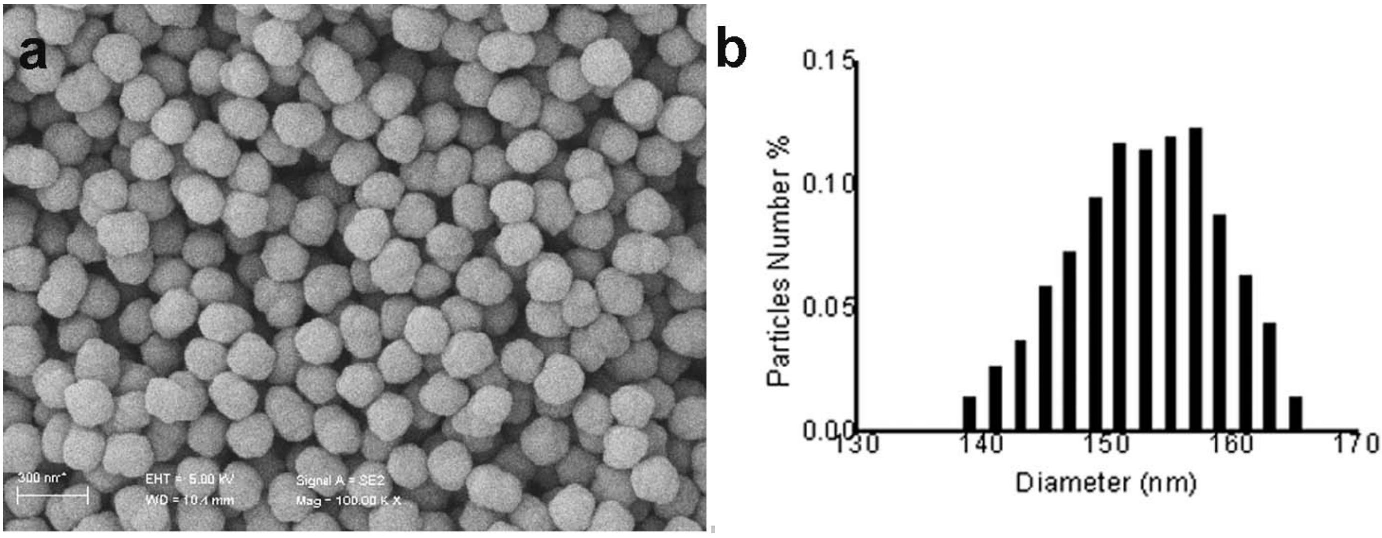
a
300 nm
EHT = 5.00 kV
WD = 10.1 mm
Signal A = SE2
Mag = 100.00 K X
b
0.15
0.10
0.05
0.00
Particles Number %
130
140
150
160
170
Diameter (nm)

Figure S4.

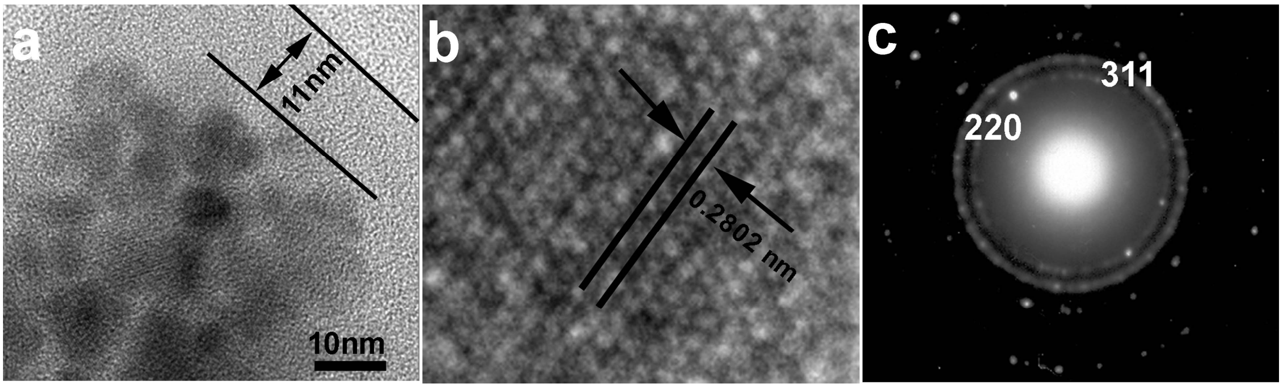

Figure S5.

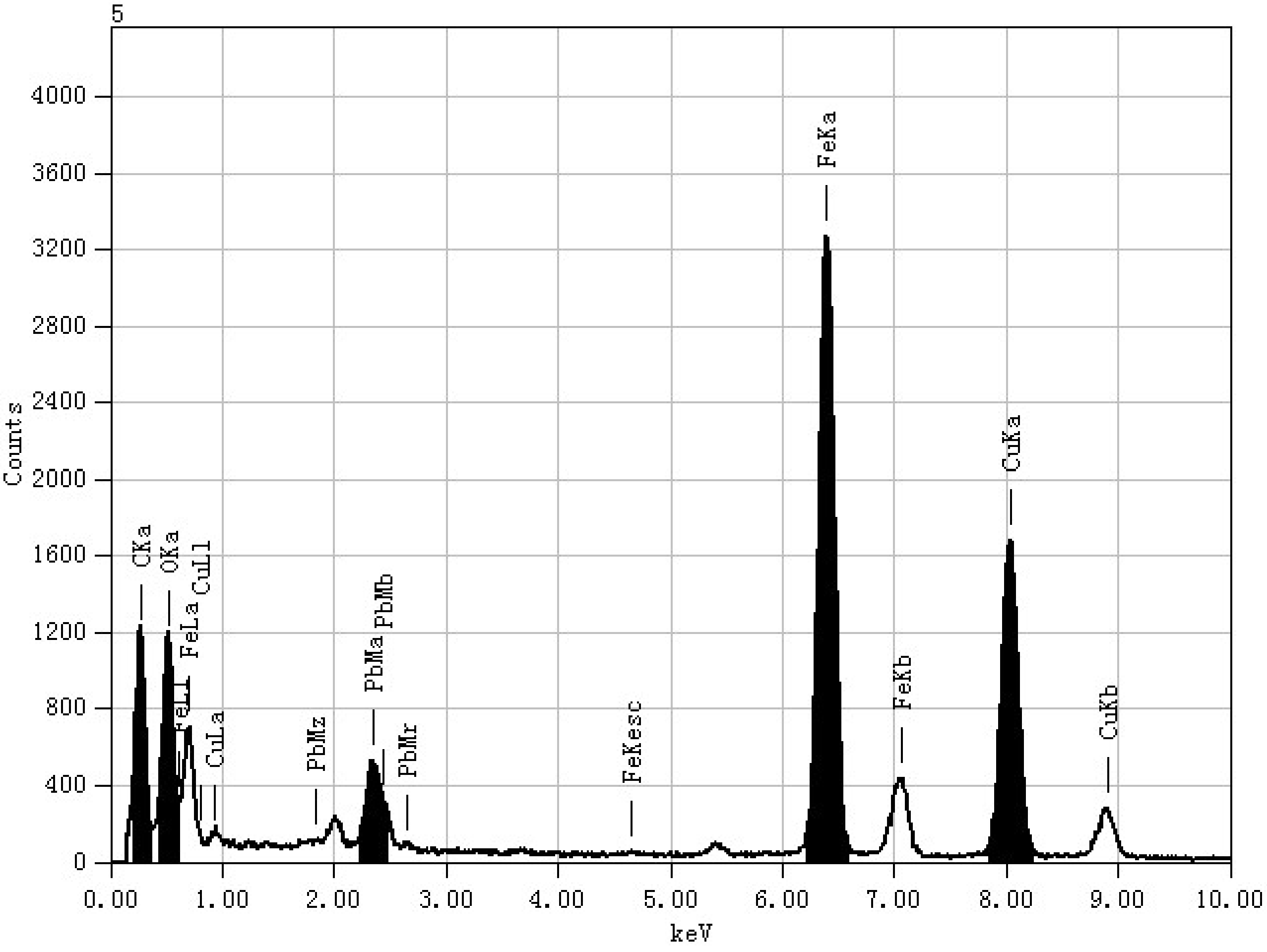
5
Counts
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
CKa
OKa
CuLl
FeLa
FeLl
CuLa
PbMz
PbMa
PbMb
PbMr
FeKesc
FeKa
FeKb
CuKa
CuKb
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
keV

Figure S6.