Supplementary information

Selective removal of IgG from proteinuria using a polymer coated core-shell magnetic nanoparticle

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Experimental section

Synthesis of N-methacryloyl-L-aspartic acid (MAsp) monomer

Preparation of Fe$_3$O$_4$, Fe$_3$O$_4$@SiO$_2$, Fe$_3$O$_4$@SiO$_2$@KH-570

The Fe$_3$O$_4$ nanoparticles were prepared by means of solvothermal synthesis. A typical procedure was: FeCl$_3$·6H$_2$O (2.7 g) was dissolved in EG (80 mL) under
ultrasonication, and subsequently NaAc (7.2 g), PEG (1 g) were added to the solution. After vigorous stirring for 0.5 h, the solution was transferred to a teflon-lined stainless steel autoclave (100 mL capacity), push N\textsubscript{2} for 15 min to remove oxygen, then heated at 200 °C for 12 h, and then cooled to room temperature. The nanoparticles were collected with a magnet, washed with ethanol and H\textsubscript{2}O. For characterization, dry it under vacuum at 30 °C, about 0.7 g Fe\textsubscript{3}O\textsubscript{4} nanoparticles can be obtained.

The obtained Fe\textsubscript{3}O\textsubscript{4} from the first step was put into use for preparation of Fe\textsubscript{3}O\textsubscript{4}@SiO\textsubscript{2} directly without drying. They were dispersed evenly in 700 mL mixture of ethanol-H\textsubscript{2}O (4:1) and 5.25 mL NH\textsubscript{3}·H\textsubscript{2}O with ultrasonication for 30 min, then the mixture was stirred for 30 min at room temperature. 2.8 mL TEOS was added into it and stirred for another 10 h under N\textsubscript{2} protection. The product was washed with ethanol and water successively.

Redisperse the obtained wet Fe\textsubscript{3}O\textsubscript{4}@SiO\textsubscript{2} in 200 mL solvent of ethanol-H\textsubscript{2}O (4:1) and 6 mL NH\textsubscript{3}·H\textsubscript{2}O, then 1.6 mL KH-570 was added and stirred under 40 °C for 24 h. The product Fe\textsubscript{3}O\textsubscript{4}@SiO\textsubscript{2}@KH-570 was collect with a magnet and washed with ethanol, dry under vacuum at 30 °C.

\textit{Preparation of Fe\textsubscript{3}O\textsubscript{4}@SiO\textsubscript{2}@MAsp-HEMA}

Mini-emulsion polymerization method was adopted to prepare Fe\textsubscript{3}O\textsubscript{4}@SiO\textsubscript{2}@MAsp-HEMA. HEMA was monomer, EGDMA was cross-linker, SDS and PVA consist of complex emusifier.

The first aqueous phase was prepared by dissolving PVA (0.2 g), SDS (0.030 g),
and NaHCO$_3$ (0.025 g) in 10 mL water, ultrasonic degassing. The second aqueous phase was prepared by dissolving PVA (0.1 g), SDS (0.1 g) in 200 mL water, ultrasonic degassing. The oil phase was prepared by mixing HEMA (0.7 mL), EGDMA (1.4 mL) and MAsp (0.25 mmol). Then Fe$_3$O$_4$@SiO$_2$@KH-570 (0.70 g, 0.1 mmol) was added into the first aqueous phase under ultrasonic and mechanical stirring, after 30 min, drop the oil phase into the magnetic fluid. The second aqueous phase was lastly added under mechanical stirring. Flow N$_2$ for 30 min, then added (NH$_4$)$_2$S$_2$O$_8$ (0.125 g) and NaHSO$_3$ (0.125 g) into the system and heated to 40 °C, to initiate the reaction. Kept stirring for 24h. The final product of Fe$_3$O$_4$@SiO$_2$@MAsp-HEMA was washed by ethanol/water (v/v, 1:1), then dried it under vacuum at 40 °C for 24 h.

Fig. S3 Thermo gravimetric curve of Fe$_3$O$_4$@SiO$_2$@MAsp-HEMA
Fig. S4 XRD pattern of Fe₃O₄@SiO₂, Fe₃O₄@SiO₂@KH-570, and Fe₃O₄@SiO₂@MAsp-HEMA

Fig. S5 ITC graphs of the MAsp titration with (a) IgG, (b) BSA and (c) no protein in PBS (0.01M, pH 7.2). Solid squares: titration data; line: fitted titration curve

**Optimization of FASS-CE**

Four background electrolyte solutions include 2.3M acetic acid+0.05% Tween20 (pH=2.1), 2.3M acetic acid+0.1% Tween20 (pH=2.1), 1.7M acetic acid+0.1% Tween20 (pH=2.2), and 40 mM chloroacetic acid+0.1% Tween20 (pH=2.2) were evaluated; four separation voltage levels at 10 kV, 15 kV, 20 kV and 25 kV were explored, respectively; the different sample injection pressures (+13 kV; +15 kV; +20 kV; +25 kV), time (10 s, 20 s, 25 s, 30 s, 40 s), and water-plug time (30 mbar×10 s, 30 mbar×20 s, 30 mbar×30 s) were studied. Taken the migration time, Rs and column efficiency into consideration, the optimized conditions were 2.3M acetic acid+0.1% Tween20 (pH=2.1) of background electrolyte, 10 kV separation voltage, electrokinetic injection: 25 kV×30 s, water-plug: 30 mbar×10 s.