

Porous hydrogel microspheres with excellent temperature-sensitive, magnetic and fluorescent properties for drug delivery

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Preparation of OA/NaUA-Fe₃O₄ nanoparticles:

Firstly, certain amount of FeCl₃·6H₂O (11.55 g) and FeCl₂·4H₂O (5.79 g) were dissolved in deionized water (40 mL) before introduced into a three-necked round-bottomed flask under nitrogen atmosphere. Then, NH₃·H₂O (35 mL) was added to the above solution under vigorous stirring to obtain a black precipitate, which was heated at 70 °C for 1 h. After that, the black precipitate was separated by a magnetite and washed with deionized water several times to remove excess NH₃·H₂O to obtain Fe₃O₄ nanoparticles. Secondly, the purified Fe₃O₄ nanoparticles were redispersed in a mixture of anhydrous ethanol (25 mL) and deionized water (25 mL) and introduced to a three-necked round-bottomed flask under nitrogen under vigorous stirring. Then, oleic acid (OA, 2 g) was added into the above mixture after the temperature reached up to 80 °C, the reaction proceeded for 1 h to prepare OA-Fe₃O₄ nanoparticles, which were collected by a magnetite and purified with anhydrous ethanol when the mixture was cooled to room temperature. Thirdly, the purified hydrophobic OA-Fe₃O₄ nanoparticles were redispersed in CHCl₃ (25 mL) and added into a three-necked flask, then an aqueous solution (40 mL) containing 3 g of NaUA was added to the solution. The mixture was stirred at 45 °C for 1 h and sonicated for 10 min to remove chloroform until the weight of the final solution became constant. Finally, water-soluble OA/NaUA-Fe₃O₄ nanoparticles with a solid content of 7 wt% were obtained.

Preparation of Eu(AA)₃Phen:

Firstly, certain amount of Eu₂O₃ (2 mmol) was dissolved in excess concentrated HCl and evaporated to near dryness to generate EuCl₃, which was then dissolved with anhydrous ethanol (40 mL) to obtain a solution of EuCl₃ in anhydrous ethanol. Secondly, AA (12 mmol) and Phen (4 mmol) were dissolved in 40 mL anhydrous ethanol and added into a single-neck round-bottom flask. Then 40 mL of the above EuCl₃ solution was slowly dropped into the flask under constant stirring. The pH value of the mixture solution was adjusted to 8 with 28 wt% NH₃·H₂O solution, and the mixture was stirred at 60 °C for 8 h. Finally, the mixture was filtered, then washed with anhydrous ethanol and dried in vacuum at 50 °C for 6 h to obtain a powder of Eu(AA)₃Phen.

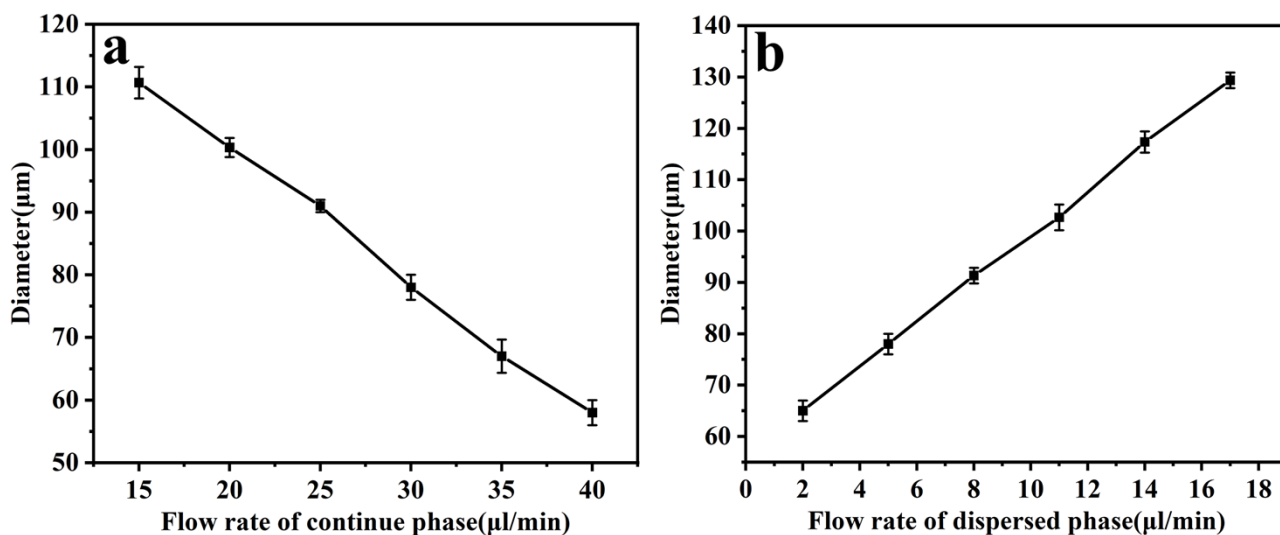


Fig. S1 (a) Effect of continuous phase flow rates on the microdroplet size when the dispersed phase flow rate is 5 $\mu\text{L}/\text{min}$; (b) Effect of dispersed phase flow rates on the microdroplet size when the continuous phase flow rate is 30 $\mu\text{L}/\text{min}$.

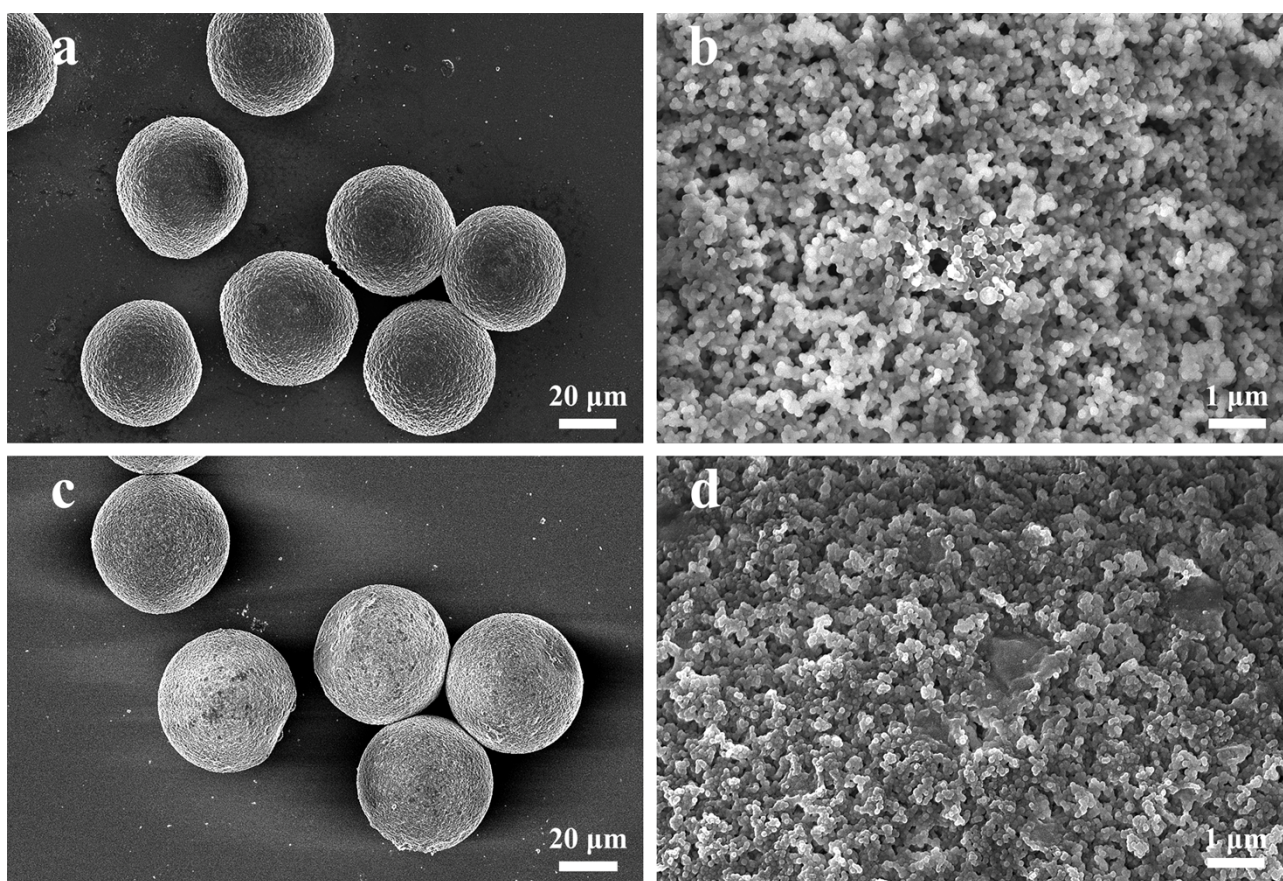


Fig. S2 SEM images of two different porous hydrogel microspheres: (a-b) A_{15}C_2 ; (c-d) A_{15}C_8 . (The two samples were prepared at the same flow rate of continuous/disperse phase of $20\mu\text{L}\cdot\text{min}^{-1}/5\mu\text{L}\cdot\text{min}^{-1}$)

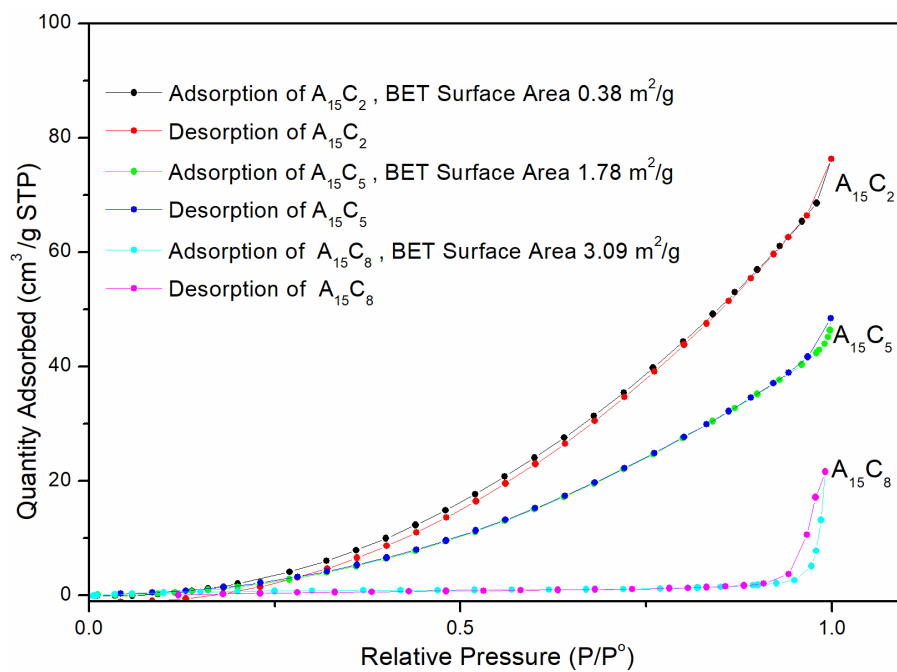


Fig. S3 Nitrogen adsorption-desorption isotherms of porous hydrogel microspheres $A_{15}C_2$, $A_{15}C_5$ and $A_{15}C_8$.

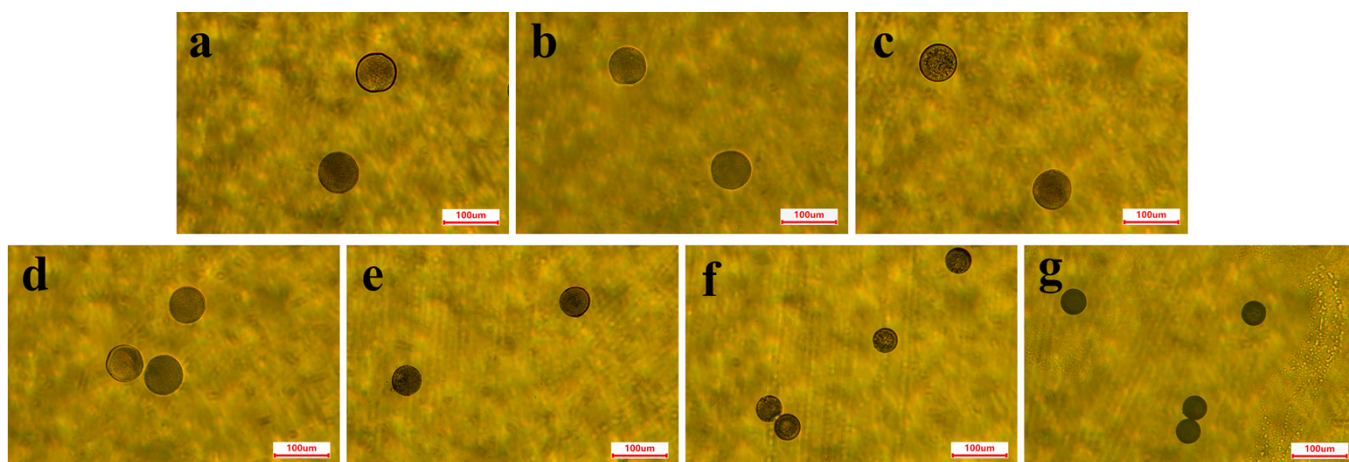


Fig. S4 Optical microscope images of porous hydrogel microspheres $A_{15}C_5$ at different temperatures showing different diameters: (a) 25 °C, 78 μ m, (b)30 °C, 77 μ m , (c)35°C, 76 μ m , (d)40°C, 74 μ m , (e)45°C, 61 μ m, (f) 50°C, 52 μ m, (g) 55 °C, 50 μ m.

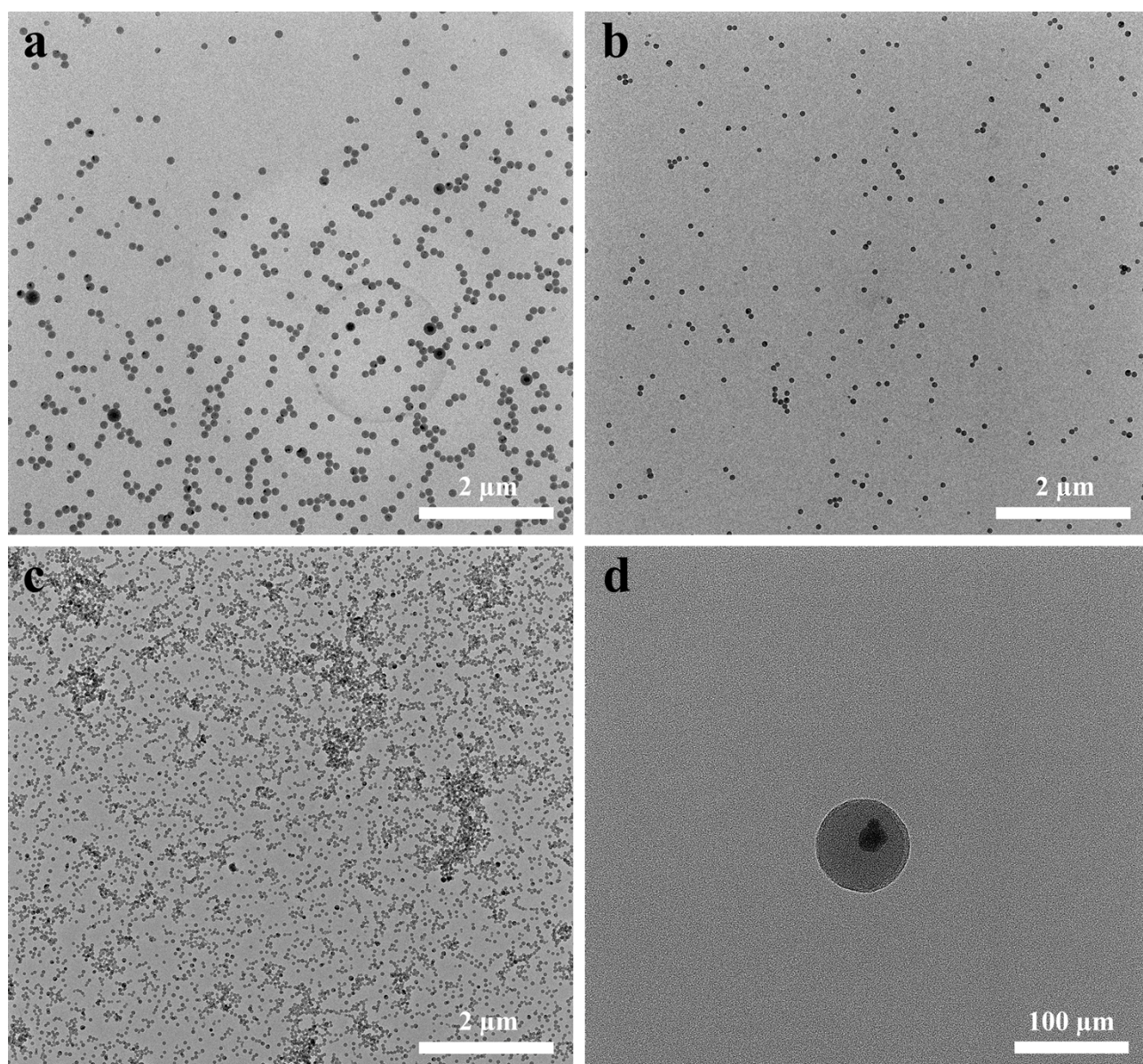


Fig. S5 TEM images of $\text{Fe}_3\text{O}_4/\text{P}(\text{St-co-Eu}(\text{AA})_3\text{Phen})$ nanomicrospheres: (a) A_{10} ; (b) A_{15} ; (c) A_{20} ; (d) A_{15} image at high magnification. (The average diameters of A_{10} , A_{15} , A_{20} analyzed from Fig. S4 a-c are 122 nm, 83 nm and 58 nm, respectively.)

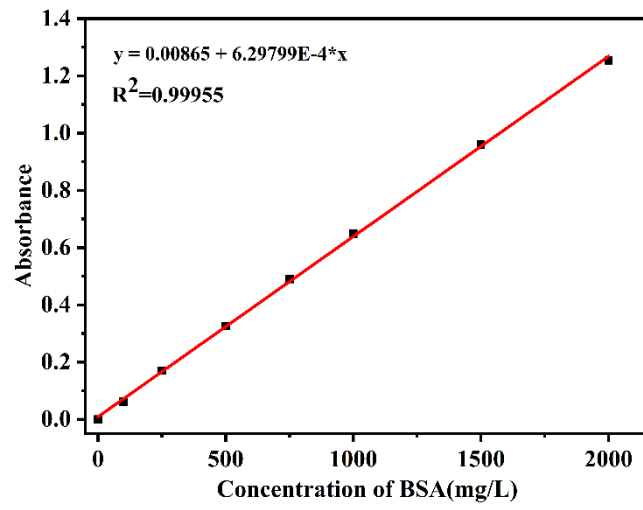


Fig. S6 Standard curve of BSA aqueous solution