**Supporting information**

# Synthesis and application of smart gel material modified silica microspheres for pH adjustable in hydrophilicity liquid chromatography

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**Caption:**

**Fig. S1**. Characterization of (a) FTIR spectra of bare silica and [AVIm]$BF_4$-co-Ita@$SiO_2$, (b) TGA curves of bare silica and [AVIm]$BF_4$-co-Ita@$SiO_2$, (c) Nitrogen physisorption isotherm of [AVIm]$BF_4$-co-Ita@$SiO_2$ measured at 77 K, and (d) XPS spectra of bare silica and [AVIm]$BF_4$-co-Ita@$SiO_2$.

**Fig. S2. T**he pore distribution of (a) desorption and (b) adsorption on the [AVIm]$BF_4$-co-Ita@$SiO_2$ materials and bare silica measured at 77K.

**Fig. S3.** Characterization (a) 3000 magnifications and (b) 10000 magnifications of the SEM images of AVIm$BF_4$-co-Ita@$SiO_2$ materials. The contact angle characterization of our hydrophilicity material (c) under acidic conditions, and (d) neutral conditions.

**Fig. S4.** The contact angle characterization of bare silica material under (a) acidic conditions, and (b) neutral conditions.

**Fig. S5.** Structural formulas of some analytes.

**Fig. S6**. The chromatographic separation of 3 analytes under acidic and neutral separation conditions. Analytes: 1. fluoranthene, 2. colchicine, 3. ferulic acid. Mobile phase: ACN/200 mM ammonium acetate. UV detection at 254 nm. Column temperature: 25°C. Flow rate: 1.0 mL $min^{-1}$.

**Fig. S7.** Separation of 3 nucleosides and nucleobases on [AVIm]$BF_4$-co-Ita@$SiO_2$ column. Analytes: 1. Thymine, 2. Thymidine, 3.6-Chlorouracil. Mobile phase: ACN/200 mM ammonium acetate (90/10, v/v). UV detection at 254 nm. Column temperature: 25°C. Flow rate: 1.0 mL/min.

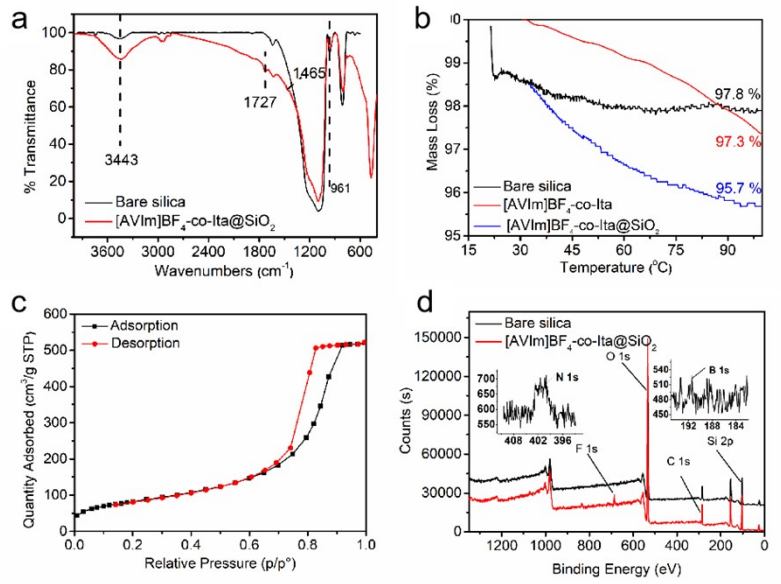
**Fig. S8.** Separation chromatogram of uridine and inosine in Cordyceps Sinensis samples on the [AVIm]$BF_4$-co-Ita@$SiO_2$ column. Mobile phase: ACN/200 mM ammonium acetate. Analytes: Cordyceps Sinensis sample solution with (1) uridine and (2) inosine. UV detection at 254 nm. Column temperature: 25 ºC. Flow rate: 1.0 mL $min^{-1}$.

**Fig. S9.** Stability of the [AVIm]$BF_4$-co-Ita@$SiO_2$ column by total flow volume of the mobile phase. Mobile phase: ACN/200 mM ammonium acetate (85/15, v/v). Analytes: 1. Fluoranthene, 2. colchicine, 3. ferulic acid. UV detection at 254 nm. Column temperature: 25°C. Flow rate: 1.0 mL $min^{-1}$.

**Table S1.** Summary report of nitrogen physisorption isotherms of AVImBF$_4$-co-Ita@SiO$_2$ measured at 77K.

**Table S2.** Elemental analysis results of bare silica and AVImBF$_4$-co-Ita@SiO$_2$.

**Table S3.** The fitting result of Eq. (1) by the retention behavior of 8 nucleosides and bases.

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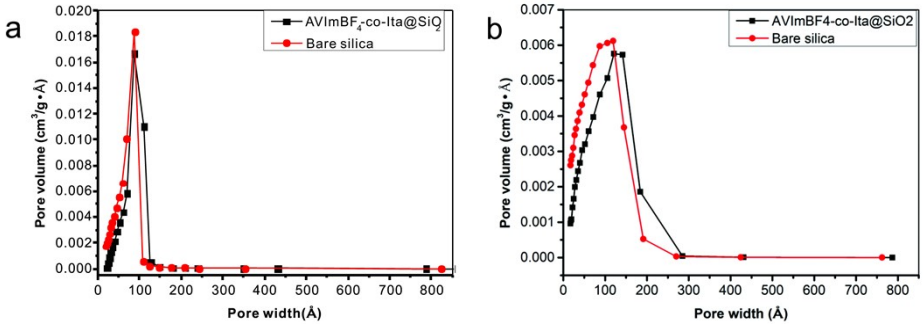


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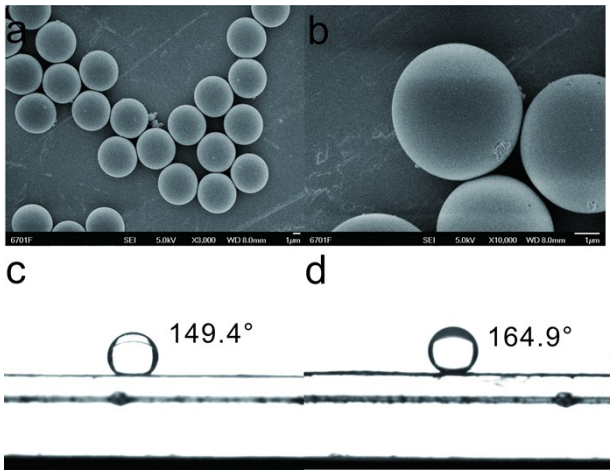


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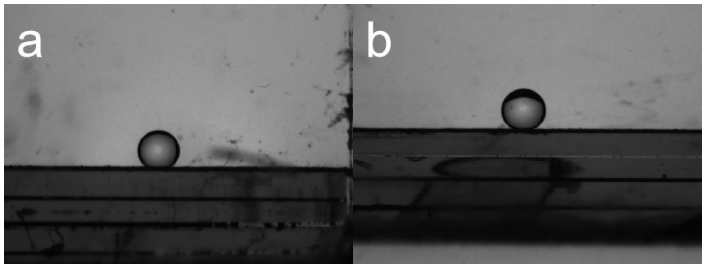
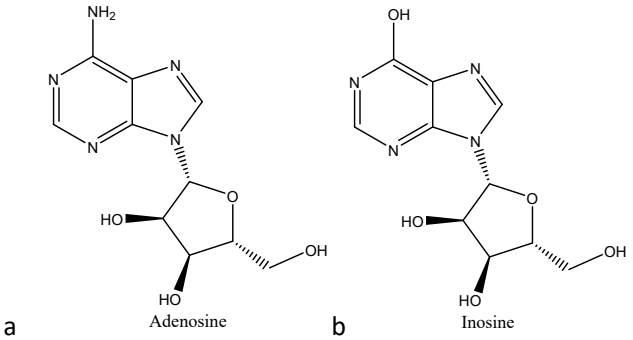
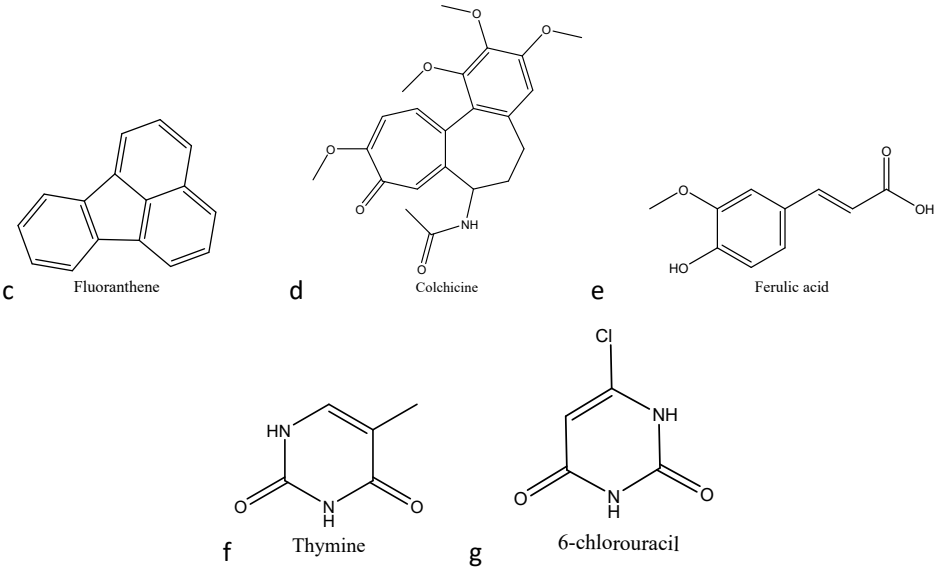



**Fig. S4.** The contact angle characterization of bare silica under (a) acidic conditions, and (b) neutral conditions.



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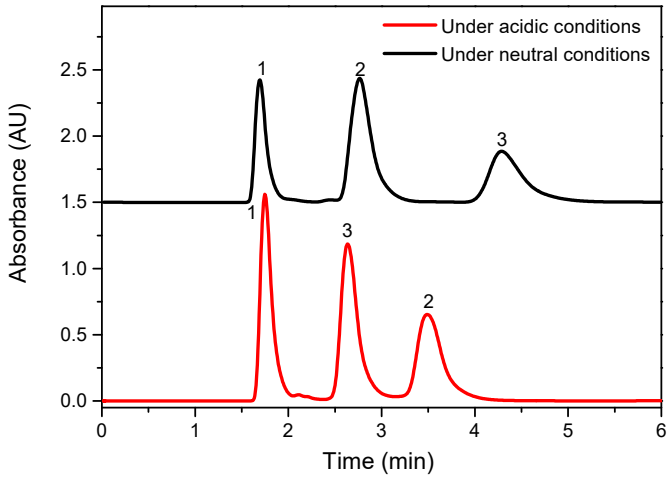


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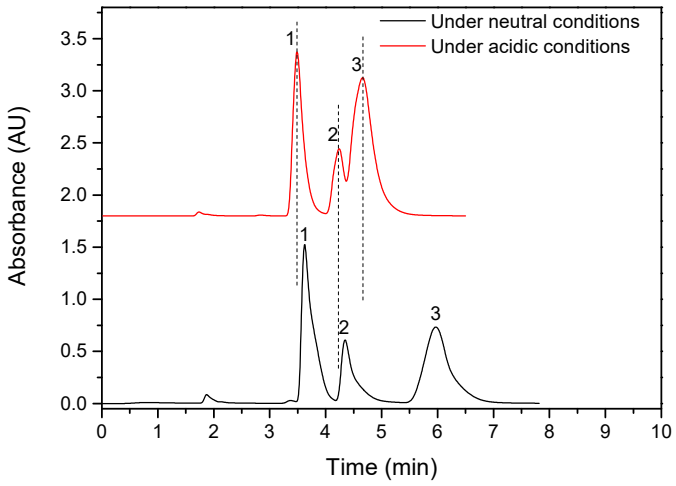


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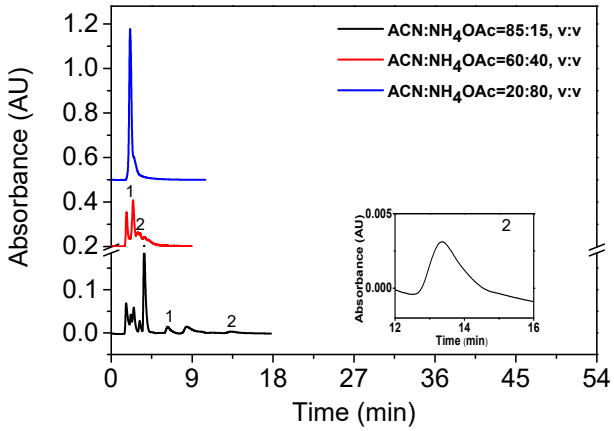


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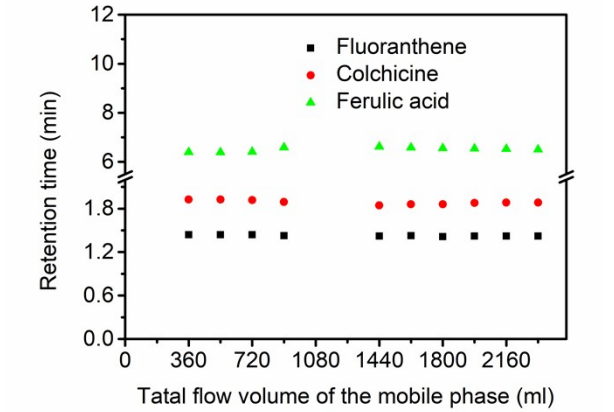


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**Table S1**

Summary report of nitrogen physisorption isotherms of $AVImBF_4$-co-Ita@$SiO_2$ measured at 77K.

| | | $AVImBF_4$-co-Ita@$SiO_2$ | Bare silica |
|---|---|---|---|
| Surface area ($m^2/g$) | BET surface area | 298.8311 | 355.3867 |
| | Adsorption | 342.1520 | 420.4800 |
| | Desorption | 400.6504 | 474.6626 |
| Pore volume ($cm^3/g$) | Adsorption | 0.79851 | 0.7708 |
| | Desorption | 0.8131 | 0.8051 |
| | Total pore volume of pores | 0.8048 | 0.7998 |
| Pore size (nm) | Adsorption average pore width | 10.7733 | 9.0023 |
| | Adsorption | 9.1780 | 7.3326 |
| | Desorption | 8.1177 | 6.7845 |

**Table S2**

Elemental analysis results of bare silica and $AVImBF_4$-co-Ita@$SiO_2$.

| | | N (%) | C (%) | H (%) |
|---|---|---|---|---|
| Bare silica | 1 | 0 | 0.38 | 0.663 |
| | 2 | 0 | 0.42 | 0.650 |
| $AVImBF_4$-co-Ita@$SiO_2$ | 1 | 0.66 | 2.94 | 0.673 |
| | 2 | 0.58 | 2.82 | 0.519 |

**Table S3**

The fitting result of Eq. (1) by the retention behavior of 8 nucleosides/bases.

| | Under neutral conditions | | | | Under acidic conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | c | $r^2$ | a | b | c | $r^2$ |
| 6-Chlorouracil | -2.5702 | -1.7324 | -0.0812 | 0.99984 | -4.1330 | -1.8795 | 3.4389 | 0.99963 |
| Cytosine | -3.0287 | -2.3265 | 2.1098 | 0.99994 | -2.7593 | -1.9938 | 2.2004 | 0.99992 |
| Adenosine | -2.6328 | -1.9373 | 1.3723 | 0.99979 | -2.9554 | -1.9139 | 2.1124 | 0.99969 |
| Thymine | -2.1037 | -1.0691 | 0.7988 | 0.99883 | -2.2706 | -1.0524 | 1.1340 | 0.99997 |
| Uridine | -2.6836 | -1.9545 | 0.8100 | 0.99996 | -2.9950 | -1.8244 | 1.4395 | 0.99992 |
| Thymidine | -1.7547 | -1.1217 | -0.1788 | 0.99980 | -2.2151 | -1.1797 | 0.6446 | 0.99972 |
| Inosine | -4.1030 | -2.9956 | 2.9722 | 0.99998 | -3.9177 | -2.6215 | 2.7718 | 0.99994 |
| Guansine | -5.6495 | -3.8168 | 5.4460 | 0.99992 | -4.9572 | -3.2371 | 4.5002 | 0.99999 |