

Supporting Information for
**“An Evaluation of Immobilized Poly-(S)-N-(1-phenylethyl)acrylamide Chiral
Stationary Phases”**

Guangying Lu ¹, Yiyuan Miao ¹, Jianchao Zhao ¹, Xin Chen ¹ and Yanxiong Ke ^{1,*}

1 Engineering Research Center of Pharmaceutical Process Chemistry, Ministry of Education, School of Pharmacy, East China University of Science and Technology, 130 Meilong Road, Shanghai 200237, China.

* Correspondence: key@ecust.edu.cn

Table of Content

1. Chemicals and equipment	s2
2. Preparation of CSP1 ~ CSP4	s3
3. ¹ HNMR spectra	s7
4. Determination of the ratio of two monomers in polymeric selector	s9
5. Gel permeation chromatography (GPC) result	s9
6. The TGA and DSC results	s10
7. References	s12

1. Chemicals and equipment

Potassium carbonate, toluene, acetone, tetrahydrofuran (THF), nitrobenzene, methyl benzoate, hydrogen fluoride (HF) and pyridine were purchased from Shanghai Lingfeng Chemicals Co., Ltd. (China). Azodiisobutyronitrileacetone was purchased from Shanghai No.4 reagent & H.V. Chemical Co., Ltd. (China). 3-(trimethoxysilyl)propyl methacrylate (TMSPM) was purchased from Shanghai Yaohua Chemical Plant Co., Ltd. (China). Acryloyl chloride and (3-Mercaptopropyl)trimethoxysilane were purchased from Aladdin Reagent (Shanghai) Co., Ltd. (China). (*S*)-1-phenylethanamine was purchased from Shanghai Hanhong Chemicals Co., Ltd. (China). Chloroform was purchased from Shanghai Chemical Reagent Co., Ltd. (China). Trimethyl chlorosilane was purchased from Shanghai Sinopharm Chemical Reagent Co., Ltd. (China). Chloroform D was purchased from J&K Scientific., Ltd. (China).

Anhydrous ethanol, ethyl acetate, methanol, and dichloromethane were purchased from Shanghai Heqi Chemicals Co., Ltd. (China). HPLC-grade spherical silica gel (5 μm particle size; 10 nm pore size; 340 m^2/g surface area) was purchased from Acchrom Technologies Co., Ltd (China). HPLC grade ethanol, *n*-Hexane, and 2-propanol were purchased from J&K Scientific., Ltd. (China). Trifluoroacetic acid (TFA) and triethylamine (TEA) were purchased from Acros (USA).

Analytes were obtained from commercial suppliers.

All HPLC chromatographic separations were performed on a Waters HPLC system consisting of a 515 HPLC pump, 7725i manual injector, model 1500 column heater, and 2489 UV/Vis detector (Waters, USA). All SFC chromatographic separations were performed on the Waters Acquity UPC2™ system (which stands for Acquity Ultra Performance Convergence Chromatography) equipped with a binary manager, an autosampler manager-FL, a column manager, a PDA detector, and a convergence with an automatic backpressure regulator (ABPR). Polymeric CSP columns were used (5 μm , 150 mm $\times$ 4.6 mm, laboratory-made). ^1H NMR identifications were carried out on a Bruker AVANCE 400 (Germany) at a

temperature of 25 °C. Elemental analysis (EA) was measured on an elemental vario EL III (Germany). The number average molecular weight (M_n), the weight average molecular weight (M_w), and the polydispersity index (PDI, M_w/M_n) of the diblock copolymer selector of CSP3 and of the polymer obtained from treating CSP2 with hydrogen fluoride were respectively determined by gel permeation chromatography (GPC) on a Waters 1515 (America) and on a PL-GPC50 (China), using THF as an eluent at 35 °C for the former and DMF as an eluent at 50 °C for the latter. N_2 adsorption-desorption isotherm was obtained on a TriStar II (Micromeritics, America). Thermogravimetric analyses (TGA) were carried out utilizing a TGA 8000 Thermogravimetric Analyzer (PerkinElmer, America) at a heating rate of $10^\circ\text{C min}^{-1}$ under nitrogen atmosphere. Differential scanning calorimetry (DSC) was tested on a DSC Q2000 (TA, America) at a heating rate of $10^\circ\text{C min}^{-1}$ from 25°C to 300°C under nitrogen atmosphere.

2. Preparation and Characterization of CSP1 ~ CSP4

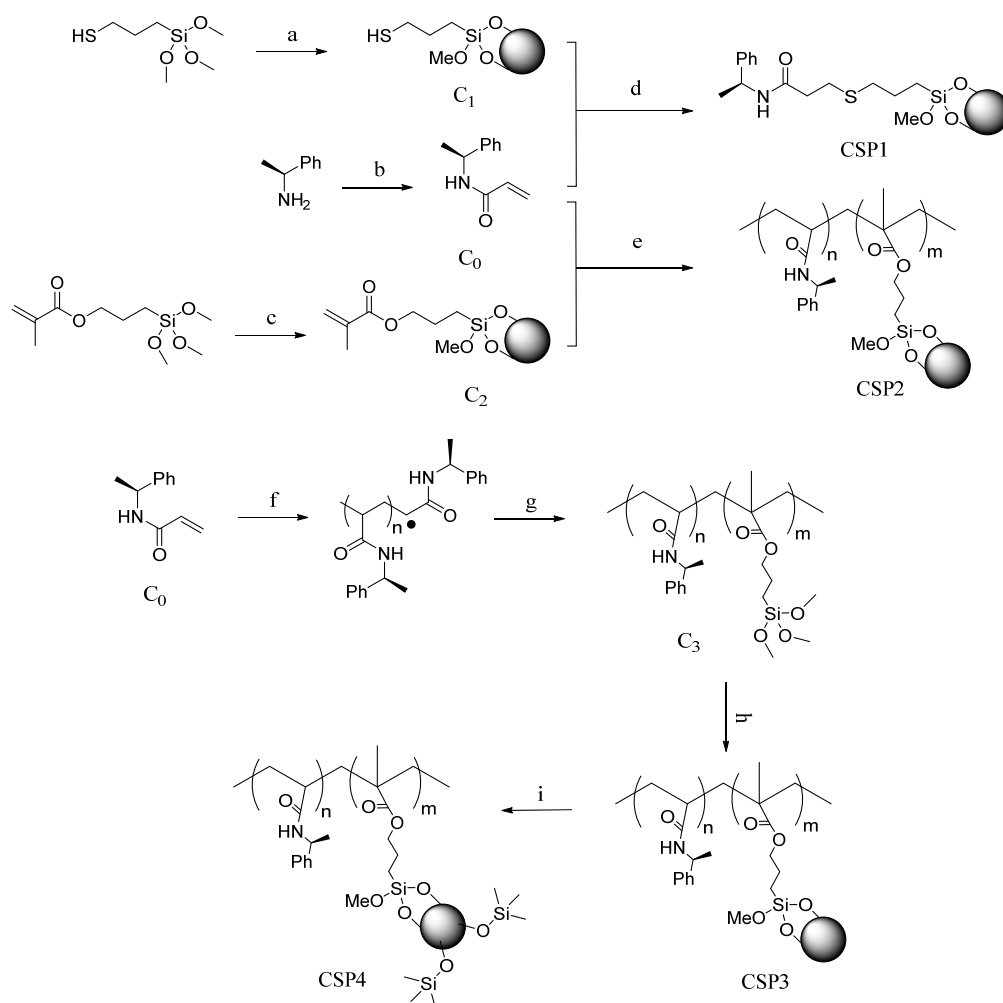


Figure S1. Synthetic scheme for the preparation of CSP1 ~ CSP4. (a) Anhydrous pyridine, Silica gel, Anhydrous toluene, N₂, reflux for 48 h. (b) Acryloyl chloride, K₂CO₃, THF/H₂O, 0 °C, 4 h. (c) Silica gel, Anhydrous toluene, N₂, 80 °C, 48 h. (d) methanol, AIBN, N₂, reflux for 12 h. (e) Anhydrous toluene, AIBN, N₂, 80 °C, 24 h. (f) Anhydrous ethanol, AIBN, N₂, 70 °C for 2 h and (g) 3-(trimethoxysilyl)propyl methacrylate, 70 °C for another 22 h. (h) Dried at 100 °C for 12 h after coating with chloroform, Then anhydrous toluene, N₂, reflux for 24 h. (i) Anhydrous pyridine, Trimethyl chlorosilane, Anhydrous toluene, N₂, reflux for 24 h.

Synthesis of monomer **C₀** [1]

To a solution of (*S*)-1-phenylethanamine (25.00 g, 206.30 mmol), K₂CO₃ (21.40 g, 154.70 mmol) in 160 ml THF/H₂O (v/v 1:1) at 0 °C, 1.5 equivalent acryloyl chloride (28.00g, 309.50 mmol) was added dropwise. And then the mixture was stirred for 4 h at room temperature. The solvent THF was removed under reduced pressure and more

water was added. The aqueous phase was extracted with dichloromethane (100 ml) three times. And the combined organic extract was washed with aqueous NaHCO₃, dried with sodium sulfate, filtered, and concentrated under reduced pressure, and then purified by recrystallizing with the mixture of ethyl acetate and ether to obtain the product as a white solid (26.20 g, 73% yield). ¹HNMR (CDCl₃): δ 1.47 (d, 3H), δ 5.10-5.24 (m, 1H), δ 5.57 (d, 1H), δ 6.13 (q, 1H), δ 6.23 (d, 1H), δ 6.40 (s, 1H), δ 7.00-7.50 (m, 5H).

Synthesis of 3-mercaptopropyl silica C₁ [2]

To a suspension of 5 μm spherisorb silica gel (12.00 g) in 250 mL anhydrous toluene, 3-mercaptopropyltriethoxysilane (15 mL) and anhydrous pyridine (15 mL) were added. The mixture refluxed under N₂ for 48 h and then was filtrated. The silica gel was washed with methanol (130 ml), dichloromethane (130 ml), chloroform (130 ml) and acetone (130 ml) respectively, and then dried under vacuum at 50 °C. About 13.00 g modified silica gel was obtained. Anal. Found: C 3.58%, H 1.05%.

Synthesis of 3-(trimethoxysilyl)propylmethacrylate modified silica gel C₂ [3]

To a suspended solution of 5μm spherisorb silica gel (5.00 g) in toluene (80 ml), the γ-MAPS (5.00 g, 20.00 mmol) was added under N₂ at room temperature. After the mixture was stirred at 80 °C for 48 h, the silica gel was collected by filtration, washed with methanol (130 ml) and dichloromethane (130 ml), and dried under vacuum at 50 °C. Anal. Found: C 6.59%, H 1.60%.

Synthesis of diblock copolymer C₃ [4]

The solution of monomer C₀ (5.00 g, 28.60 mmol), AIBN (0.20 g, 1.20 mmol) in 50 ml anhydrous ethanol was stirred at 70 °C for 2 h, then the mixture (2 ml) of γ-MAPS (0.37 g, 1.50 mmol) and anhydrous ethanol (2 ml) was added. The reaction was held at 70 °C for another 22 h. Then the mixture was poured into a large amount of hexane, the separated precipitate was filtered off and dried under vacuum at 40 °C. ¹HNMR spectra of the diblock copolymer show broad peaks at 6.50-7.50 ppm, and at 3.48 ppm which are assigned to aromatic protons and -Si-O-CH₃ repeated units in the diblock copolymer.

Preparation of CSP1

To a suspension of thiol-modified silica gel C₁ (4.00 g) in methanol (40 ml), the monomer C₀ (0.60 g, 3.43 mmol) and AIBN (80 mg, 0.49 mmol) were added, respectively. The mixture was stirred under N₂ reflux for 12 h. After cooling and filtration, the silica gel was washed with methanol (130 ml), dichloromethane (130 ml), chloroform (130 ml), acetone (130 ml) and dried in vacuo at 50 °C to yield CSP1. The reaction efficiency was 70.14%.

Preparation of CSP2

To a suspension of 3-(trimethoxysilyl)propylmethacrylate modified silica gel C₂ (5.00 g) in anhydrous toluene (50 ml), the monomer C₀ (2.00 g, 11.42 mmol) and AIBN (80 mg, 0.49 mmol) were added. The mixture was stirred under N₂ at 80 °C for 24 h. After cooling and filtration, the silica gel was washed with toluene (130 ml), dichloromethane (130 ml), chloroform (130 ml) and acetone (130 ml), and dried in vacuo at 50 °C to yield CSP2. The reaction efficiency was 54.81%.

Preparation of CSP3

5 µm spherisorb silica gel (5.00 g) was suspended in the solution of the diblock copolymer C₃ (2.00 g) in chloroform (50 ml), then the solvent chloroform was removed slowly under reduced pressure at 30 °C to obtain the coated silica gel. After drying for 12 h under vacuum, the coated silica gel was suspended in anhydrous toluene (50 ml), then refluxed for 24 h. After cooling and filtration, the modified silica gel with chiral diblock copolymer C₃ was washed with toluene (130 ml), dichloromethane (130 ml), chloroform (130 ml) and acetone (130 ml), and dried in vacuo at 50 °C to yield CSP3. The reaction efficiency was 32.06%.

Preparation of CSP4

To a suspension of the packing material of CSP3 (4.00 g) and anhydrous pyridine (2 ml) in the dried toluene (50 ml), trimethyl chlorosilane (2 ml) was added slowly under N₂ at room temperature and then the mixture was refluxed for 24 h. After cooling and filtration, the packing material was washed with toluene (130 ml), dichloromethane (130 ml), chloroform (130 ml), acetone (130 ml) and dried in vacuo at 50 °C to yield CSP4.

The chiral selectors loading of CSP1 ~ CSP4

The capacity of chiral selectors (μ) is calculated, according to the formula: μ (mmol/g) = $10 \times (C_1 - C_0) / (M \times n)$, where C_1 and C_0 refer to the nitrogen content of prepared CSPs and pure silica, $C_0 \approx 0$; M refers to the atom weight of nitrogen; n refers to the number of nitrogen atom contained in each immobilized chiral selector and linkage.

For CSP1, the selector loading is calculated according to the mentioned above; for CSP2 ~ CSP4, the corresponding selector loading are based on the chiral monomer unit and are also calculated according to the mentioned above.

Anal. Found: C 13.14%, H 1.96%, N 0.77% for CSP1 (0.55 mmol/g); C 19.62%, H 2.83%, N 1.48% for CSP2 (1.06 mmol/g); C 10.13%, H 1.94%, N 0.92% for CSP3 (0.66 mmol/g); C 11.72%, H 2.17%, N 0.75% for CSP4 (0.54 mmol/g).

3. ¹HNMR Spectra

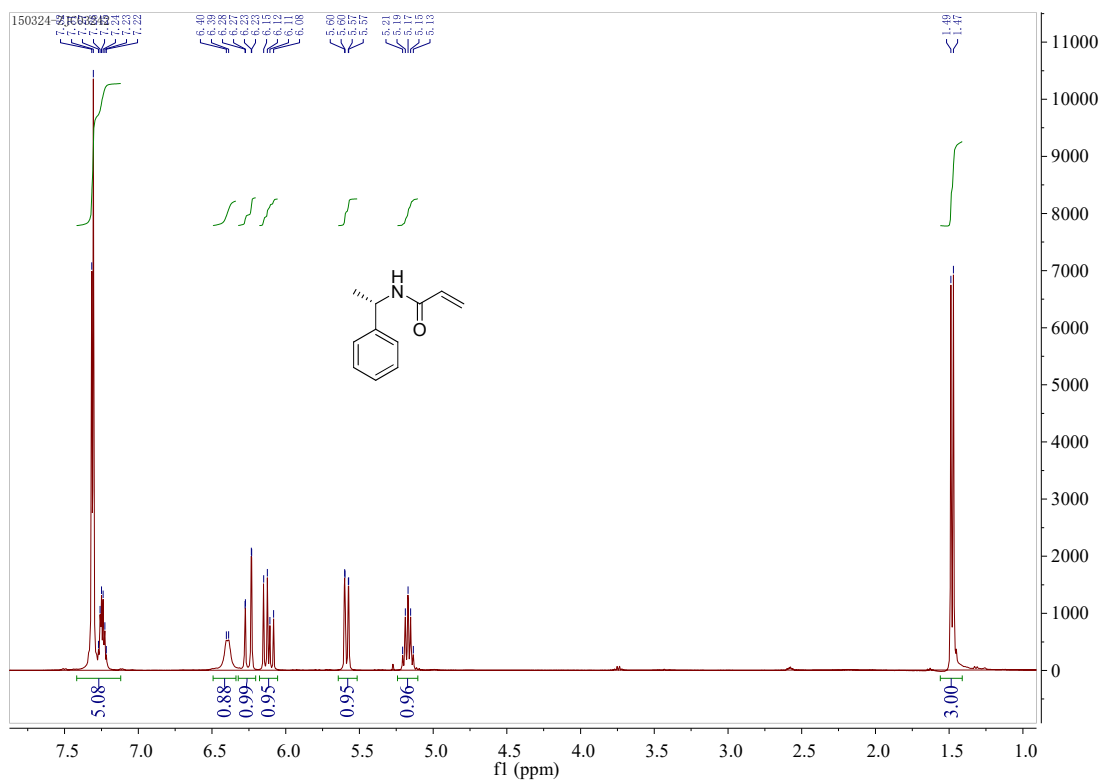


Figure S2. ^1H NMR Spectra of monomer C_0

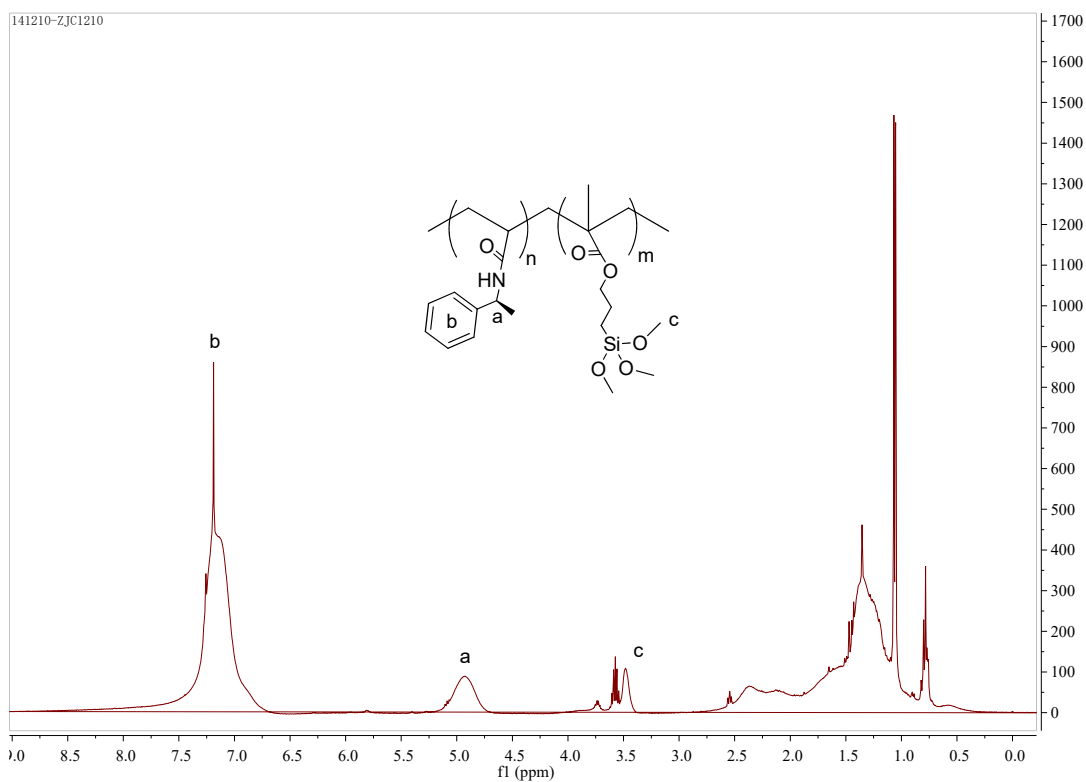


Figure S3. ^1H NMR Spectra of the copolymer C₃

4. Determination of the ratio of two monomers in polymeric selector

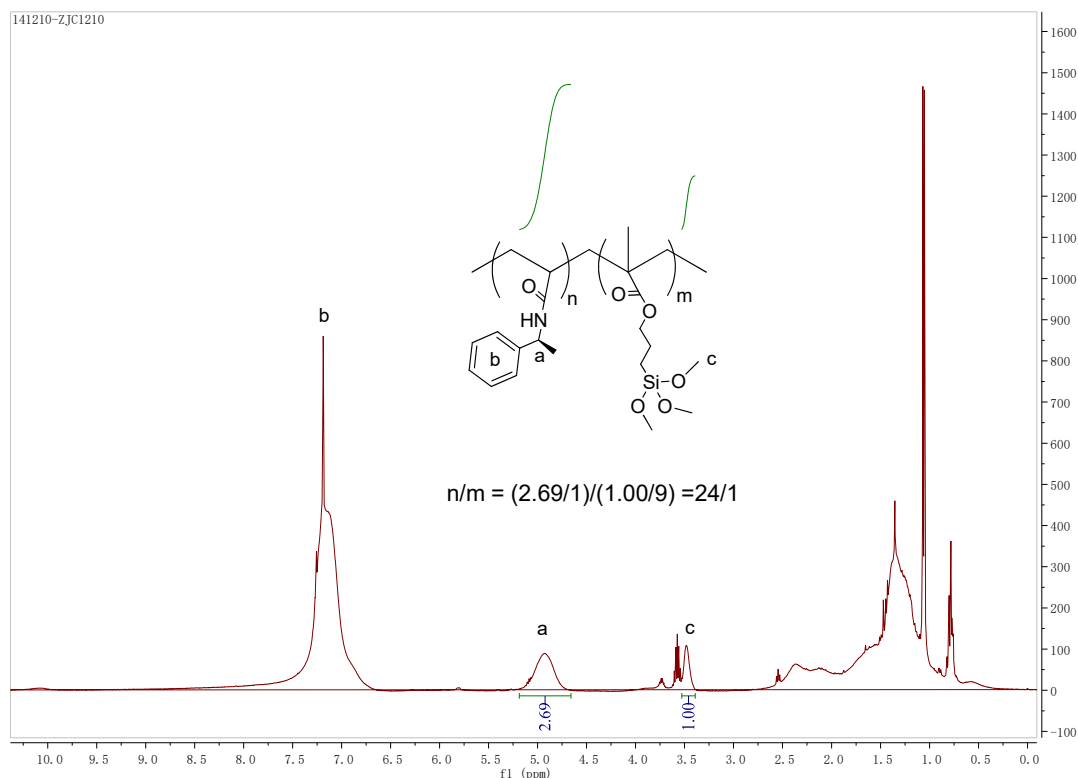


Figure S4. Determination of the ratio of two monomers

5. Gel permeation chromatography (GPC) result

Dissolution of the CSP2 silica matrix by hydrogen fluoride treatment.

A solution of 10 ml H₂O/HF (v/v, 1:1) was cooled to 0 °C in an ice bath with magnetic stirring. CSP2 (1.00 g) was then added in a single portion and stirring was continued at 0 °C for 1 h and at 25 °C for additional 1 h. The mixture was then extracted with Chloroform (30 ml). And the combined organic extract was washed with H₂O, dried with sodium sulfate, filtered, and concentrated under reduced pressure, to give the polymer (118.00 mg).

Table S1. GPC results of the diblock copolymer selector of CSP3 and of the polymer of CSP2.

Polymer	Mn	Mw	PDI
C ₃	7090	11734	1.66
Polymer of CSP2	51272	175247	3.42

Chromatograms of GPC

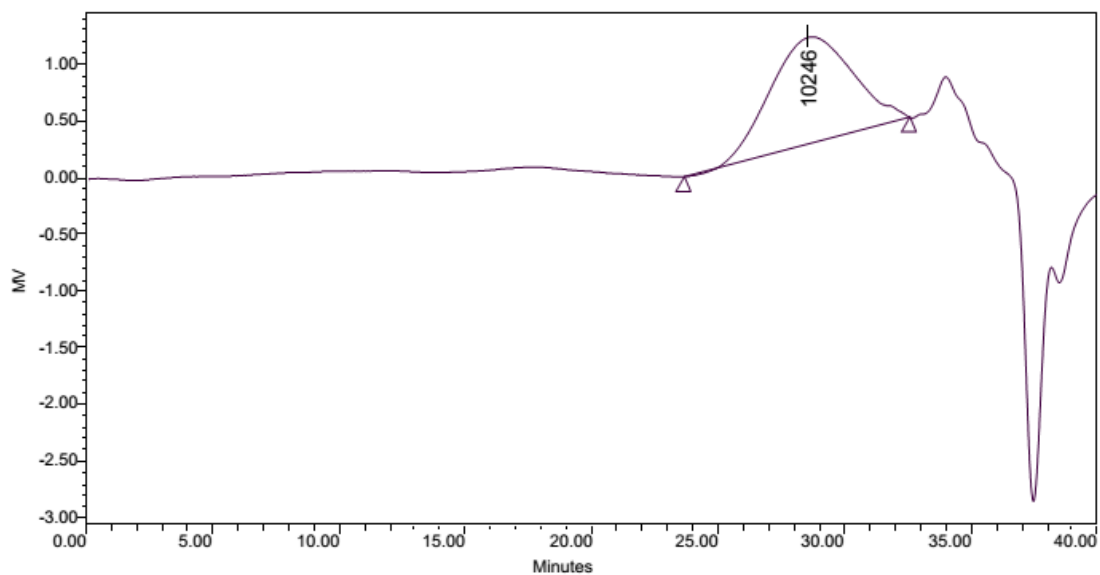


Figure S5. Chromatogram of GPC for diblock copolymer selector of CSP3

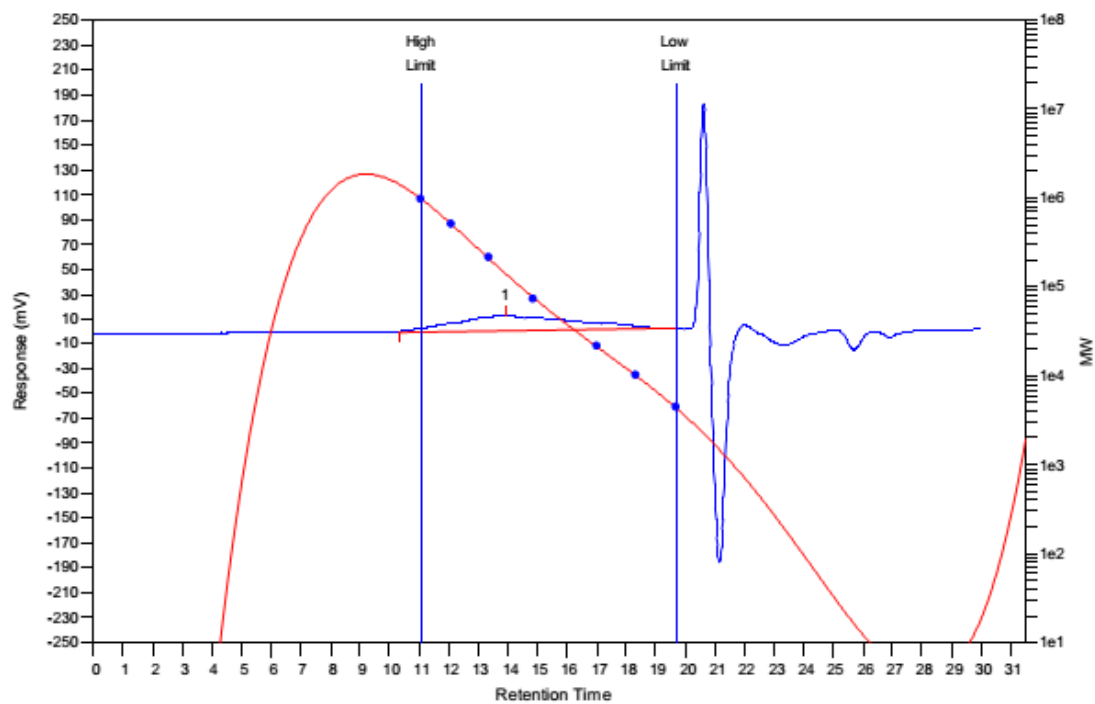


Figure S6. Chromatogram of GPC for polymer selector of CSP2

6. The TGA and DSC results

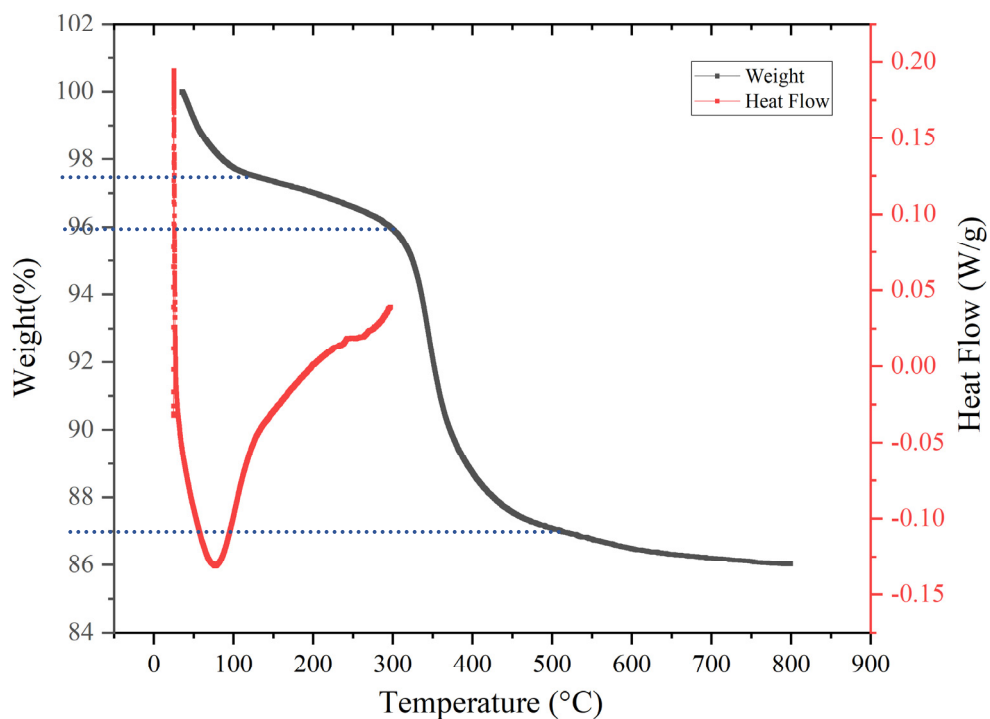


Figure S7. The TGA and DSC results of CSP3

Thermogravimetric measurement reveals a 2.5% thermal weight loss below 100 °C, which can be attributed to water adsorbed in silica gel or a trace quantity of leftover solvent. The heat absorption in DSC curve between 50°C-100°C corresponds to the evaporation of water or solvent. The stationary phase decomposes at about 300 °C, and about 9% weight loss can be seen between 300 °C and 500 °C.

7. References

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