Supplementary Information

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Experimental Section

Materials

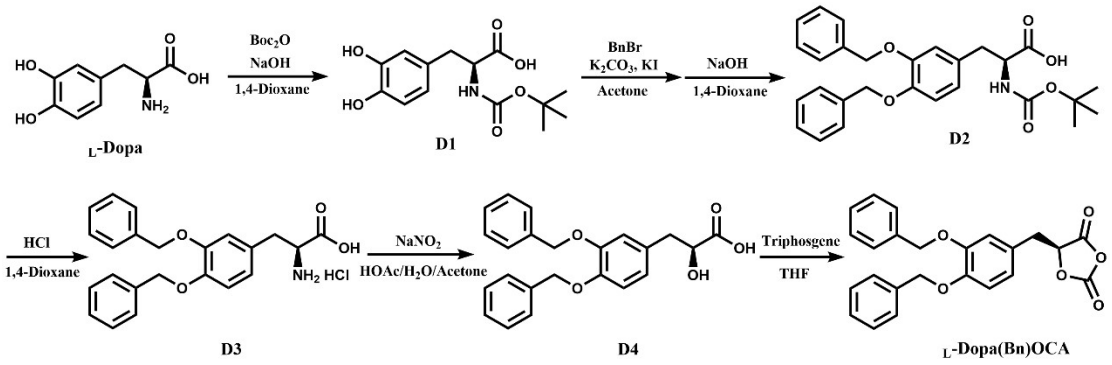
Polyethylene glycol monomethyl ether (mPEG, M_n = 5000) was treated by azeotropic distillation with toluene. Toluene was purchased from Sinopharm Chemical Reagent Co., Ltd. and was distilled with sodium for 6 h to remove the moisture followed by distillation. All other chemicals and solvents were purchased from Adamas, Sigma-Aldrich or Aladdin, and used as received unless otherwise specified.

Measurements

Nuclear Magnetic Resonance (NMR) was used to confirm the chemical structure. ^{1}H NMR and ^{13}C NMR spectra were recorded at room temperature on Bruker Avance 400 spectrometer (400 MHz), using deuterated chloroform ($CDCl_3$) or dimethyl sulfoxide (DMSO-d_6) as solvent. Fourier Transform infrared spectroscopy (FTIR) was recorded on a Nicolet 5700 FT-IR spectrometer ranging from 400 to 4000 cm^{-1} at room temperature, and the samples were prepared by the KBr sample holder method. Mass spectrometry (MS) was performed using a Waters LCT Premier XE spectrometer. Gel permeation chromatography (GPC) was conducted on a system composed of a Waters 2414 Refractive Index Detector equipped with a guard column and two mixed HT columns using THF as the eluent at a flow rate of 1.0 mL min^{-1} against polystyrene standards. Dynamic light scattering (DLS) measurements were performed on a Malvern Nano-ZS ZEN3600 equipped with a He–Ne (λ = 633 nm) laser at 25 °C. Fluorescence spectroscopy was measured on a Perkin Elmer LS55 luminescence spectrometer. UV-Vis spectroscopy was performed on a Shanghai Spectrum SP-1900 spectrophotometer using 1 cm path length quartz cells. Transmission electron microscopy (TEM) experiments were performed on a JEOL 1400 Cryo TEM using carbon-coated grids stained with phosphotungstic acid. Thermogravimetric analysis (TGA) was performed using a TA Q500 analyzer. The test was carried out at a rate of 10 °C min^{-1} from room

temperature to 600 °C under a nitrogen atmosphere. Ultra-high performance liquid chromatography (UPLC) was conducted on Agilent 1260SL equipped with a DAD detector, and the detection wavelength was set to be 230 nm.

Synthesis of OCA monomers



Scheme S1 The synthetic route of $_{L}$-Dopa(Bn)OCA.

Synthesis of D1

Under inert atmosphere, $_{L}$-Dopa (10.00 g, 50.7 mmol, 1 equiv.) was suspended in 1,4-dioxane/H_2O (3/2, v/v, 125 mL). A homogeneous solution was obtained by adding 1 M NaOH (56 mL). Boc_2O (12.18 g, 55.8 mmol, 1.1 equiv.) dissolved in 1,4-dioxane (16 mL) was added. The resulting solution was stirred at room temperature for 0.5 h and deflated during this time. The pH was adjusted to 10 with 1 M NaOH and repeat after 1 hour and 7 hours. After the last pH adjustment, the solution was stirred overnight. After removal of volatile components under reduced pressure, the resulting aqueous phase was adjusted to pH 2 with 1 M HCl and extracted with ethyl acetate (3 × 200 mL). The combined organic phases were washed with 1 M HCl (150 mL) and brine (150 mL), dried over anhydrous $MgSO_4$, filtered, and concentrated under vacuum. The resulting brown solid (14.54 g, 96 % yield) was used in the next step without further purification.

^{1}H NMR (400 MHz, DMSO-d_6): δ 12.49 (br, 1H, -COO*H*), δ 8.71 (d, J = 16.68 Hz, 2H, Ar-O*H*), δ 6.96 (d, J = 8.32 Hz, 1H, -CH-N*H*-COOC), δ 6.47-6.61 (m, 3H, -CH_2-Ar*H*), δ 4.03 (q, J = 7.08 Hz, 1H, -C*H*CH_2-Ar), δ 2.78-2.83 (dd, J = 13.68 Hz, 1H, -CHC*H*$_2$-Ar), δ 2.60-2.66 (dd, J = 13.96 Hz, 1H, -CHC*H*$_2$-Ar), δ 1.34 (s, 9H, -C(C*H*$_3$)$_3$).

Synthesis of D2

To a solution of D1 (6.01 g, 20.2 mmol, 1 equiv.) in acetone (250 mL), potassium carbonate (17.52 g, 126.8 mmol, 6.28 equiv.) and potassium iodide (0.44 g, 2.63 mmol, 0.13 equiv.) were added. After stirring at room temperature for 0.5 h under inert atmosphere, the mixture was cooled to 0 °C, and benzyl bromide (12.05 mL, 101.4

mmol, 5.02 equiv.) was added dropwise. The reaction mixture was heated to reflux for 96 h and the solvent evaporated. Then 1,4-dioxane (120 mL) and 2 M NaOH (120 mL) were added and heated for reflux for 45 min. After cooling to room temperature, the solution was acidified with 2 M HCl to a pH of about 2 and kept at -18 ℃ overnight. The precipitates were filtered, recrystallized three times from ethanol and dried under vacuum to afford a white solid (6.77 g, 70 % yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28-7.44 (m, 10H, -OCH_2-Ar*H*), δ 6.67-6.86 (m, 3H, -CH_2-Ar*H*-OCH_2), δ 5.12 (d, J = 4.88 Hz, 2H, Ar-O*C*H_2-Ar), δ 4.50 (d, J = 5.64 Hz, 1H, -C*H*CH_2-Ar), δ 3.03-3.08 (dd, J = 13.68 Hz, 1H, -CHCH_2-Ar), δ 2.94-2.99 (dd, J = 13.92 Hz, 1H, -CHCH_2-Ar), δ 1.42 (s, 9H, -C(CH_3)$_3$).

Synthesis of D3

Hydrogen chloride in 1,4-dioxane (4 N, 30 mL, 120.0 mmol, 10 equiv.) was dripped into D2 (5.73 g, 12.0 mmol, 1 equiv.) and stirred for 6 h at 0 ℃. After removal of solvent under reduced pressure, the residue was precipitated with diethyl ether and dried under vacuum to afford a white amino acid hydrochloride (4.78 g, 96 % yield).

^{1}H NMR (400 MHz, DMSO-d_6): δ 13.78 (br, 1H, -COO*H*), δ 8.40 (br, 4H, -NH_4Cl), δ 7.29-7.48 (m, 10H, -OCH_2-Ar*H*), δ 6.77-7.12 (m, 3H, -CH_2-Ar*H*-OCH_2), δ 5.10 (d, J = 3.38 Hz, 2H, Ar-O*C*H_2-Ar), δ 4.13 (t, J = 6.36 Hz, 1H, -C*H*CH_2-Ar), δ 3.07-3.12 (dd, J = 13.92 Hz, 1H, -CHCH_2-Ar), δ 3.02-3.07 (dd, J = 14.24 Hz, 1H, -CHCH_2-Ar).

Synthesis of D4

D3 (4.97 g, 12.0 mmol, 1 equiv.) was dissolved in a mixture of H_2O, acetic acid and acetone (1/1/1, v/v/v, 90 mL), to which sodium nitrite (2.07 g, 30.0 mol, 2.5 equiv.) in water was added slowly (about 3 h) at 0 ~ 5 ℃. After the addition was complete, the reaction temperature was kept at 0 ~ 5 ℃ for 3 h and then allowed to warm up to 25 ℃ while stirring for 18 h. After removal of volatile components under reduced pressure, the solution was acidified and extracted with ethyl acetate (3 × 100 mL). The combined organic phases were washed with 1 M HCl (50 mL) and brine (50 mL), dried over anhydrous $MgSO_4$, filtered, and concentrated under vacuum. The resulting residue was precipitated with *n*-hexane, recrystallized three times from toluene and dried under vacuum to afford a white solid (2.17 g, 36 % yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28-7.44 (m, 10H, -OCH_2-Ar*H*), δ 6.73-6.87 (m, 3H, -CH_2-Ar*H*-OCH_2), δ 5.13 (d, J = 7.52 Hz, 2H, Ar-O*C*H_2-Ar), δ 4.40 (s, 1H, -C*H*CH_2-Ar), δ 3.05-3.09 (dd, J = 13.48 Hz, 1H, -CHCH_2-Ar), δ 2.84-2.89 (dd, J = 13.76 Hz, 1H, -CHCH_2-Ar).

Synthesis of $_{L}$-Dopa(Bn)OCA

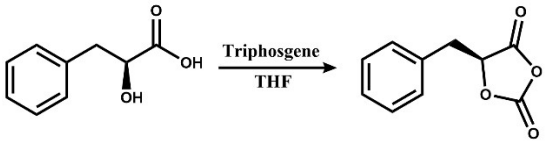
To a mixture of D4 (1.44 g, 4.0 mmol, 1 equiv.) and activated charcoal (~70 mg) in anhydrous THF (4 mL), a solution of triphosgene (1.42 g, 4.8 mmol, 1.2 equiv.) in THF (4 mL) was added at 0 °C. The mixture was allowed to warm up to room temperature while stirring for 24 h. The mixture was filtered through celite, and the filtrate was concentrated under reduced pressure. The resulting residue was precipitated with n-hexane, recrystallized three times from CH_2Cl_2/isopropyl ether and dried under vacuum to afford a white solid (1.00 g, 62 % yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.29-7.45 (m, 10H, -OCH_2-Ar*H*), δ 6.72-6.90 (m, 3H, -CH_2-Ar*H*-OCH_2), δ 5.23 (t, J = 4.52 Hz, 1H, -C*H*CH_2-Ar), δ 5.13 (d, J = 5.60 Hz, 2H, Ar-OCH_2-Ar), δ 3.24-3.29 (dd, J = 15.04 Hz, 1H, -CHCH_2-Ar), δ 3.12-3.17 (dd, J = 15.04 Hz, 1H, -CHCH_2-Ar).

^{13}C NMR (400 MHz, $CDCl_3$): δ 166.48, 149.31, 149.17, 147.97, 137.07, 137.03, 128.66-127.43, 122.00, 116.43, 115.31, 80.10, 71.56, 71.30, 36.06.

HR-MS (EI) m/z: calcd. for $C_{24}H_{20}O_6$ $[M]^+$: 404.1260, found: 404.1265.

Synthesis of $_{L}$-PheOCA

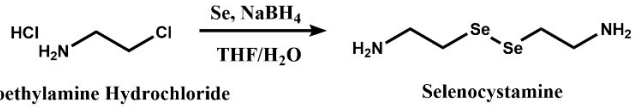


Scheme S2 The synthetic route of $_{L}$-PheOCA.

$_{L}$-PheOCA was synthesized as reported[1] and recrystallized from CH_2Cl_2/n-hexane.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.21-7.39 (m, 5H, -Ar*H*), δ 5.31 (t, J = 4.84 Hz, 1H, -C*H*CH_2-Ar), δ 3.37-3.42 (dd, 1H, J = 14.92 Hz, -CHCH_2-Ar), δ 3.28-3.23 (dd, 1H, J = 14.88 Hz, -CHCH_2-Ar).

Synthesis of crosslinker selenocystamine



Scheme S3 The synthetic route of selenocystamine.

The synthesis of selenocystamine was carried out by following the similar route as previously reported.[2] Briefly, sodium borohydride (3.33 g, 88 mmol, 1.1 equiv.) was dissolved in 150 mL DI water. Se powder (6.32 g, 80 mmol, 1 equiv.) was added in two parts and the resulting mixture was stirred at 50 ℃ for 1 h. Afterwards, 2-

chloroethylamine hydrochloride (11.14 g, 96 mmol, 1.2 equiv.) was added under Ar flow. The reaction was carried out at 50 ℃ for 6 h. The reaction solution was alkalized with sodium hydroxide at 0 ℃ and then was extracted with dichloromethane (3×100 mL). The organic layers were combined and dried with anhydrous $MgSO_4$. The solvent was removed under vacuum to yield a light-yellow oil.

^{1}H NMR (400 MHz, DMSO-d_6): δ 3.17 (s, 4H, -N*H*$_2$), δ 2.95 (t, J = 6.84 Hz, 4H, -SeCH$_2$C*H*$_2$-), δ 2.83 (t, J = 6.84 Hz, 4H, -SeC*H*$_2$CH$_2$-).

LR-MS (EI) m/z: calcd. for $C_4H_{12}N_2Se_2$ $[M]^+$: 246.1, found: 245.9.

Optical purity determination of $_L$-Dopa(Bn)OCA

According to the literature,[3] (+)–α–methylbenzylamine (70 μL, 0.54 mmol) was added to a solution of $_L$-Dopa(Bn)OCA (145 mg, 0.36 mmol) in CH_2Cl_2 (2 mL) at room temperature. The reaction mixture was then stirred until CO_2 no longer evolved. The reaction mixture was diluted with CH_2Cl_2 (5 mL), washed with cold 2N HCl (2 × 5 mL), brine (5 mL) and dried over Na_2SO_4. The solvent was removed by evaporation to give the amide adduct as a white solid. UPLC eluent H_2O/acetonitrile (gradient 90/10 to 20/80 over 13 min.): diastereomer mixture 98/2.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.16-7.46 (m, 14H, -OCH$_2$-Ar*H* and -CH(CH$_3$)-Ar*H*), δ 6.55-6.86 (m, 4H, -CH$_2$-Ar*H*-OCH$_2$ and -CH(CH$_3$)-Ar*H*), δ 5.05-5.14 (m, 4H, Ar-OC*H*$_2$-Ar), δ 5.03-5.11 (m overlapped, 1H, -C*H*(CH$_3$)-Ar), δ 4.22 (dt, J = 7.64, 4.88 Hz, 1H, -C*H*CH$_2$-Ar), δ 3.03-3.08 (dd, J = 13.88 Hz, 1H, -CHC*H*$_2$-Ar), δ 2.82-2.88 (dd, J = 13.88 Hz, 1H, -CHC*H*$_2$-Ar), 2.33 (d, J = 5.00 Hz, 1H, -O*H*), 1.43 (d, J = 6.88 Hz, 3H, -CH(C*H*$_3$)-Ar).

General procedure for the polymerization of OCA monomers

In a 10 mL Schlenk, $_L$-Dopa(Bn)OCA (64 mg, 0.16 mmol, 20 equiv.) was dissolved in anhydrous toluene (0.8 mL) followed by the addition of *neo*-pentanol (80 μL of 0.1 M in toluene, 0.008 mmol, 1 equiv.) and 4-MOP (80 μL of 0.1 M in toluene, 0.008 mmol, 1 equiv.). The monomer conversion was monitored by FT-IR. When the polymerization was complete, the reaction solution was precipitated in the mixture of diethyl ether/hexane (4/1, v/v), and the precipitate was dried under vacuum to afford a white solid (45 mg, 77 % yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.21-7.37 (m, 200H, -OCH$_2$-Ar*H*), δ 6.56-6.83 (m, 60H, -CH$_2$-Ar*H*-OCH$_2$), δ 5.15 (s, 20H, -C*H*CH$_2$-Ar), δ 4.90 (d, 40H, Ar-OC*H*$_2$-Ar), δ 4.11 (s, 2H, -C*H*$_2$C(CH$_3$)$_3$), δ 3.05 (dd, 19H, -CHC*H*$_2$-Ar), δ 2.95 (dd, 21H, -CHC*H*$_2$-

Ar), δ 1.26 (s, 9H, -C(CH_3)$_3$).

^{13}C NMR (400 MHz, $CDCl_3$): δ 168.43, 149.05, 148.28, 137.37, 128.65-127.38, 122.39, 116.26, 115.10, 73.39, 71.30, 71.24, 36.46.

Removal of the benzyl group from poly(Dopa(Bn)OCA)

In a 25 mL Schlenk, poly($_L$-Dopa(Bn)OCA) (90 mg, 0.007 mmol) was dissolved in THF/methanol (2/1, v/v, 9 mL) followed by the addition of 10 % Pd/C (0.3 g, 30 wt%), which was purged with nitrogen for 5 min, sealed and filled with hydrogen via a balloon. The mixture was stirred for 24 h under hydrogen and then filtered through celite. The filter cake was washed with THF and methanol. The filtrate and wash solutions were combined, and the solvent was removed under vacuum. The resulting polymer was dissolved in THF/methanol (1/1, v/v) and then precipitated with ether. An blue power was obtained (47 mg, 90% yield).

^{1}H NMR (400 MHz, DMSO-d_6): δ 8.81 (br, 36H, Ar-O*H*), δ 6.36-6.65 (m, 60H, -Ar-*H*), δ 5.10 (s, 20H, -C*H*CH_2-Ar), δ 4.02 (s, 2H, -CH_2C(CH_3)$_3$), δ 2.96 (d, 19H, -CHCH_2-Ar), δ 2.80 (d, 21H, -CHCH_2-Ar), δ 1.24 (s, 9H, -C(CH_3)$_3$).

Preparation of uncross-linked micelles

The uncross-linked micelles were prepared using a common solvent-displacement method. mPEG$_{5k}$-*b*-poly(Phe)OCA$_{20}$ or mPEG$_{5k}$-*b*-poly(Dopa)OCA$_{20}$ (25 mg) was dissolved in DMSO (1.5 mL) into which DI water (15 mL) was slowly added under vigorous stirring. After vigorous stirring for another 2 h at room temperature, the uncross-linked micelles were obtained and further dialyzed against DI water for 48 h to remove DMSO (MWCO of 3500 Da).

Preparation of core cross-linked micelles

mPEG$_{5k}$-*b*-poly(Dopa)OCA$_{20}$ (25 mg) was dissolved in DMSO (1.5 mL) into which DI water (15 mL) was slowly added under vigorous stirring. The pH was raised to pH 9 by the addition of 0.1 M NaOH (aq). After the mixture was stirred and bubbled with air steadily for 10 minutes, the solution of crosslinker (equivalent to half the molar weight of catechols) was added slowly and continue stirring for 1 hour at room temperature. The core cross-linked micelles were obtained and further dialyzed against DI water for 48 h to remove solvent and unreacted crosslinker (MWCO of 3500 Da).

Characterizations of micelles

The size and size distribution of the micelles were measured by DLS. Before measurement, all samples were filtered through a 0.45 μm filter (Millipore) and the micelle concentrations were kept at 1.0 mg mL^{-1}. The morphology of micelles was observed on TEM. Samples were prepared by drop-casting micellar solutions onto 200

mesh carbon film supported copper grid stained with phosphotungstic acid and then air-drying at room temperature before measurement. The critical micelle concentrations (CMCs) of the mPEG-*b*-poly(DopaOCA) micelles before and after cross-linking were measured through fluorescence spectra by using pyrene as a hydrophobic fluorescent probe. Emission spectra were recorded ranging from 350 to 500 nm with a fixed excitation at 334 nm. The ratios of the intensities at 392 to 372 nm from the excitation spectra of pyrene were plotted against the concentration of the micelles.

Stability of micelles

Upon dilution with 10-fold DMF, the size and size distribution of the micelles were measured at 25 ℃ by DLS. In addition, the stability study of micelles was performed through characterization of the structure of micelles with ^{1}H NMR spectrum in DMSO-d_6.

Antioxidant activity of micelles

Antioxidant activity of micelles was assessed on the basis of the capacity of the compounds to scavenge the stable α,α-diphenyl-β-picrylhydrazyl (DPPH) free radical. A micellar solution was added to DPPH in methanol, and left to incubation for 30 min at room temperature. The absorbance of the reaction mixture was then measured at 517 nm using a UV-Vis spectrophotometer. The experiments were repeated at different concentrations to determine the inhibition ratio of the DPPH radicals.

Thermal decomposition test

The TGA thermogram of the copolymer mPEG$_{5k}$-*b*-poly(DopaOCA)$_{20}$ was tested at a rate of 10 °C min^{-1} under nitrogen flow.

***In vitro* degradation test**

According to the literature,[4] 10 mg of the polymer poly(DopaOCA)$_{10}$ was incubated in 1 mL of phosphate buffer solution of pH 7.4 at 37 °C for studying the behavior of degradation *in vitro*. After a predetermined time, the solution was taken, tested for pH and lyophilized. The obtained mixture was dissolved in DMSO-d_6 for ^{1}H NMR analysis.

Supplementary References

[1] Y. Sun, Z. Jia, C. Chen, Y. Cong, X. Mao and J. Wu, *J. Am. Chem. Soc.*, 2017, **139**, 10723−10732.

[2] C. Wei, Y. Zhang,* B. Yan, Z. Du, and M. Lang*, *Chem.-Eur. J.*, 2018, **24**, 789−792.

[3] O. Thillaye du Boullay, C. Bonduelle, B. Martin-Vaca* and D. Bourissou*, *Chem. Commun.*, 2008, 1786-1788.

[4] J. Hu, C. Sun, S. Li, Y. Yuan and Y. Zhang,* *Polym. Chem.*, 2021, **12**, 4467-4471.

Supplementary Figures

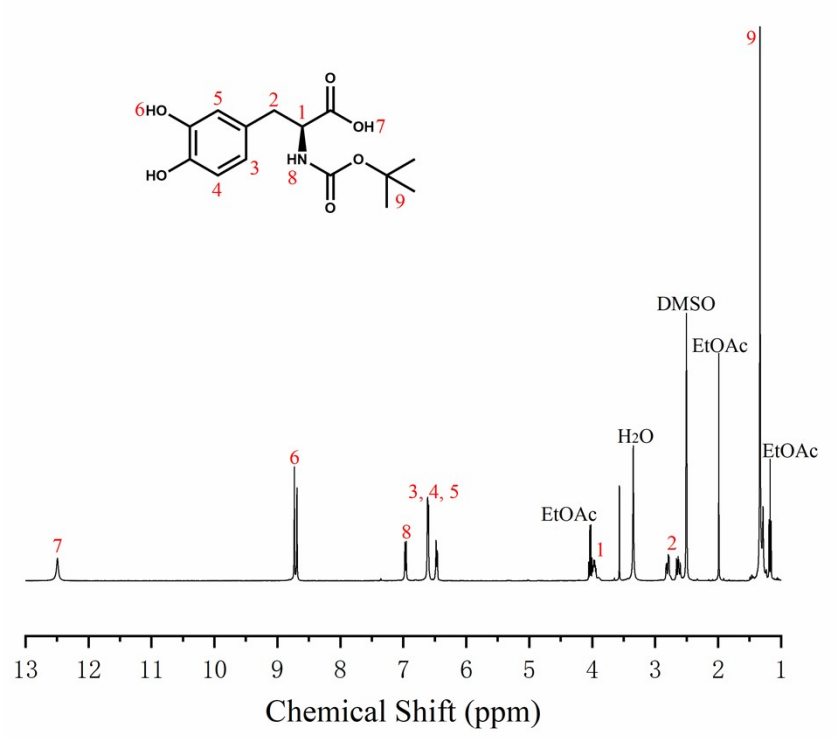


Fig. S1 ^{1}H NMR spectrum of D1 in DMSO-d_6.

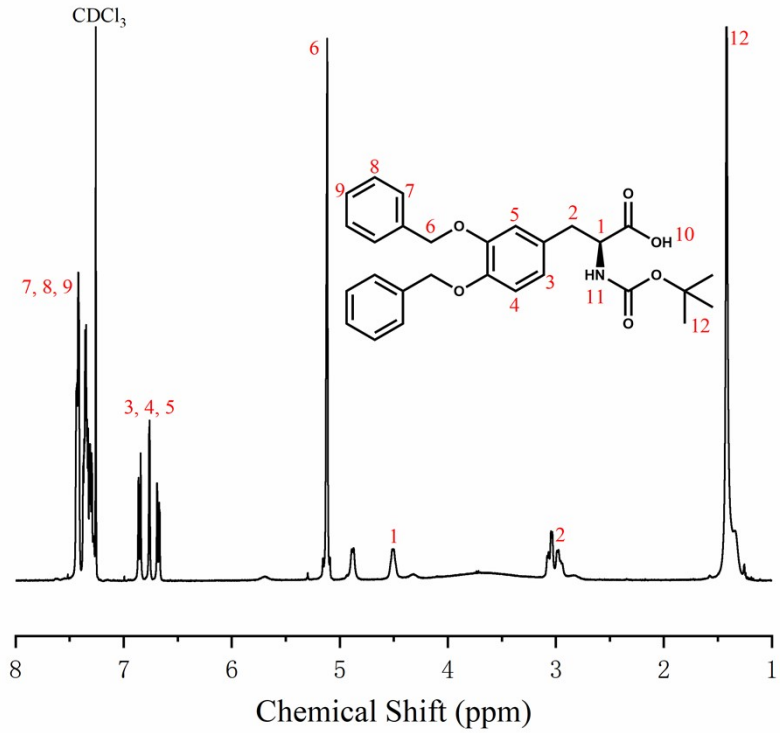


Fig. S2 ^{1}H NMR spectrum of D2 in $CDCl_3$.

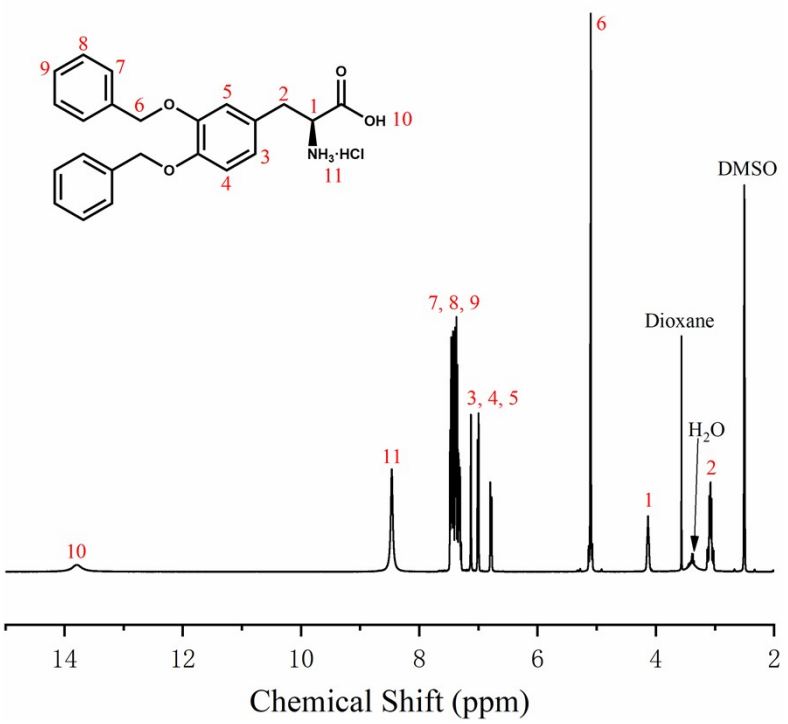


Fig. S3 ^{1}H NMR spectrum of D3 in DMSO-d_6.

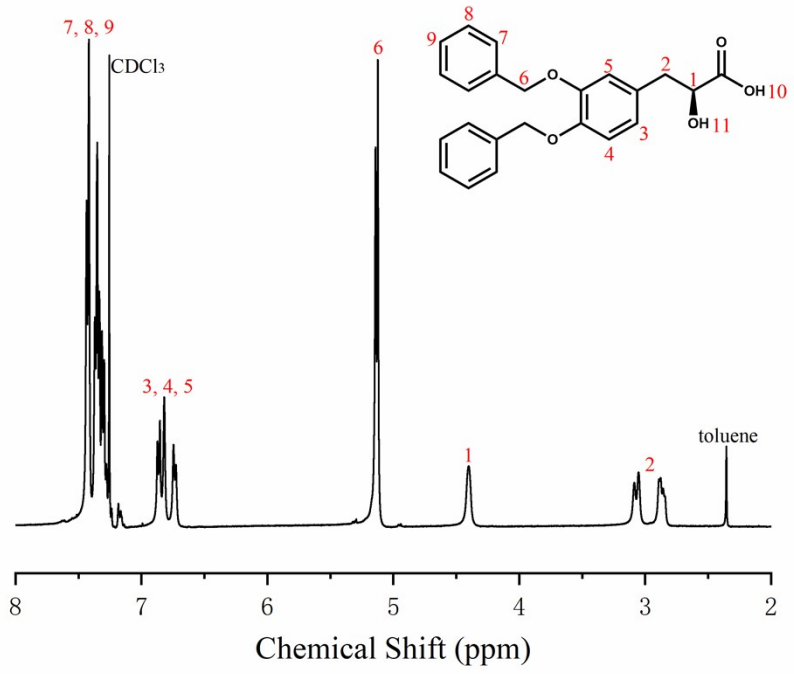


Fig. S4 ^{1}H NMR spectrum of D4 in $CDCl_3$.

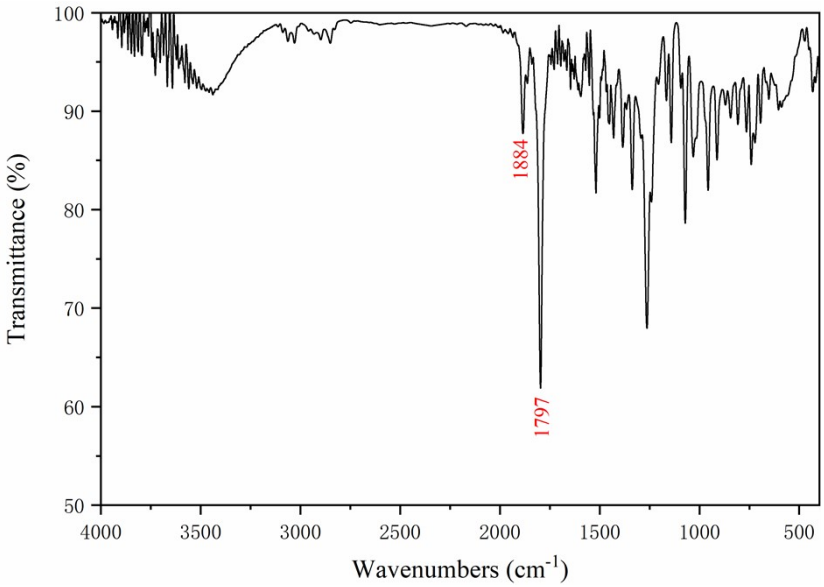


Fig. S5 FT-IR spectrum of $_{L}$-Dopa(Bn)OCA.

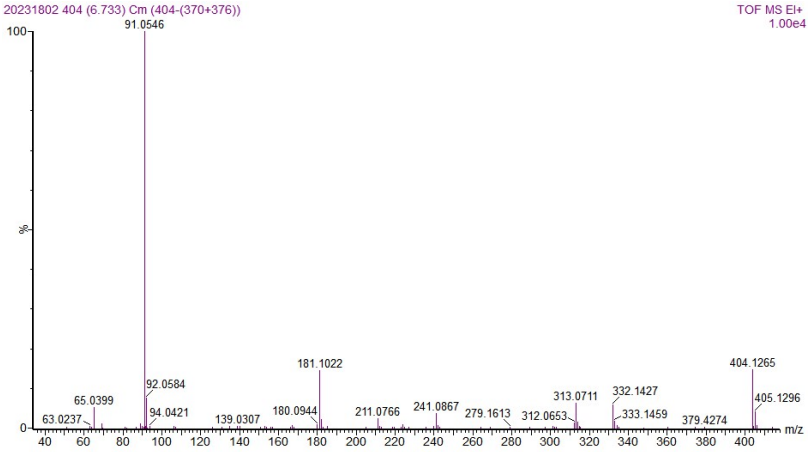


Fig. S6 Electron-impact-ionization mass spectrum of $_{L}$-Dopa(Bn)OCA.

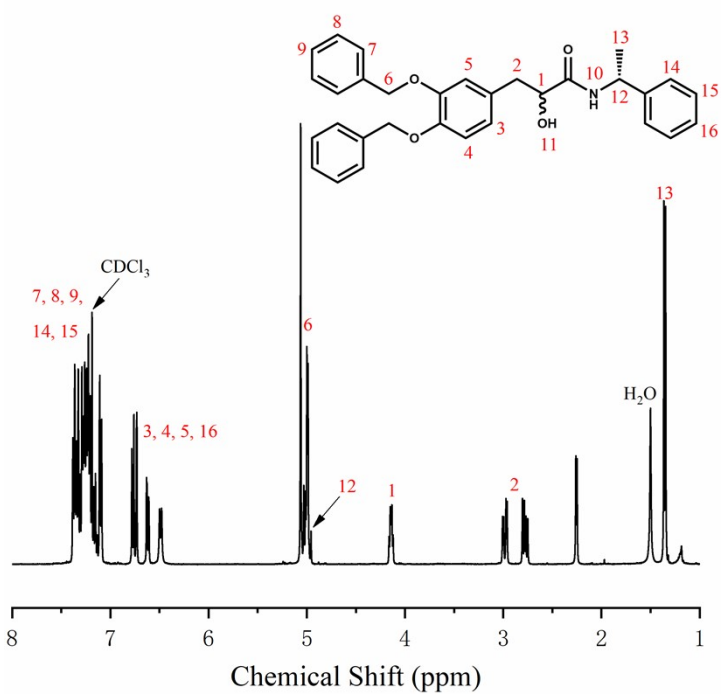


Fig. S7 ^{1}H NMR spectrum of (+)–α–methylbenzylamine adduct of Dopa(Bn)OCA in $CDCl_3$.

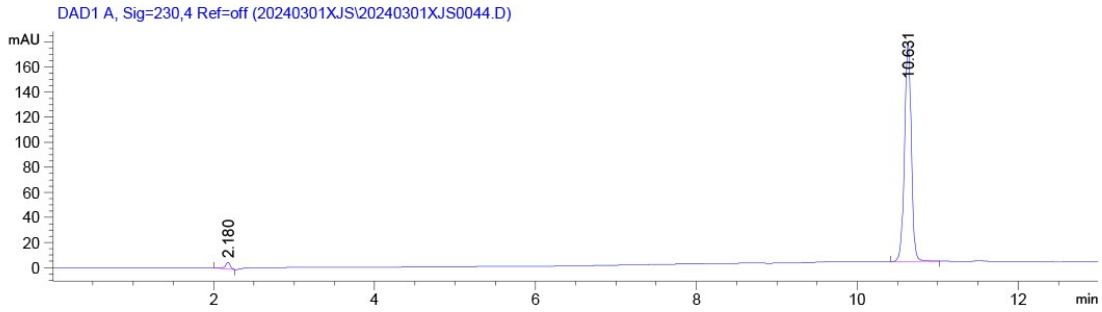


Fig. S8 Ultra-high performance liquid chromatogram of (+)–α–methylbenzylamine adduct of Dopa(Bn)OCA.

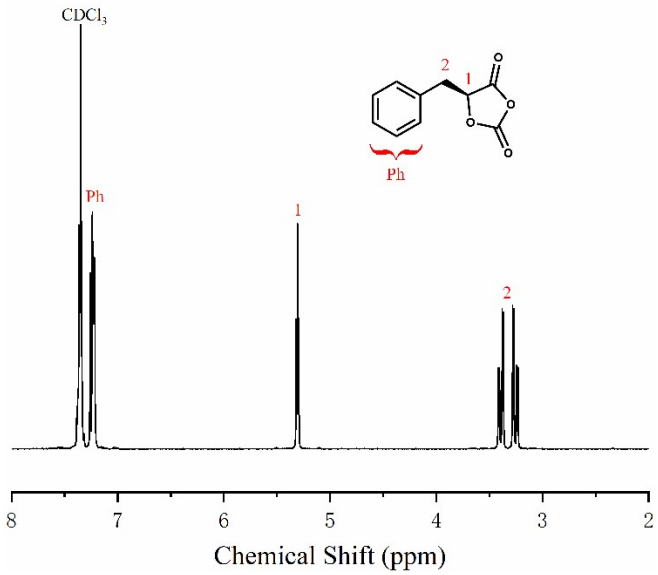


Fig. S9 ^{1}H NMR spectrum of $_{L}$-PheOCA in $CDCl_3$.

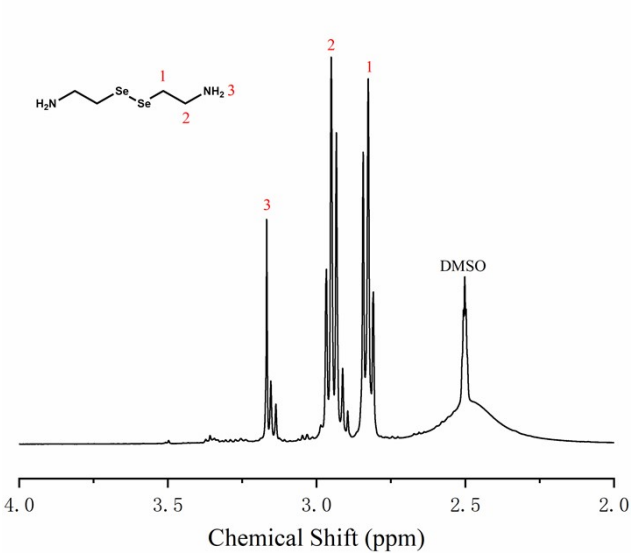


Fig. S10 ^{1}H NMR spectrum of selenocystamine in DMSO-d_6.

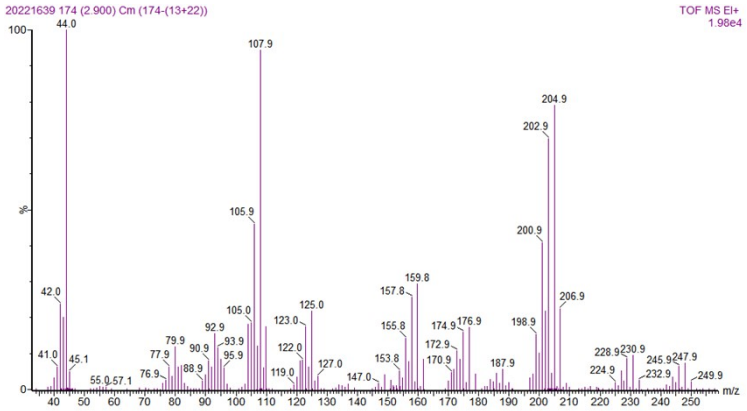


Fig. S11 Electron-impact-ionization mass spectrum of selenocystamine.

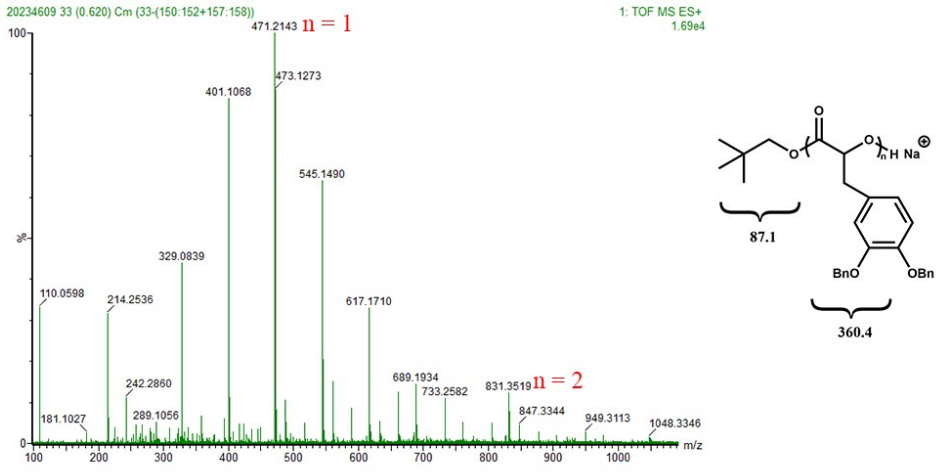


Fig. S12 Electrospray-ionization mass spectrum (Region m/z 100 to 1200) of polyester prepared by polymerization of $_{L}$-Dopa(Bn)OCA with *neo*-pentanol (Toluene, 25°C, $[OCA]_0/[ROH]_0/[MOP]_0$ = 5/1/1).

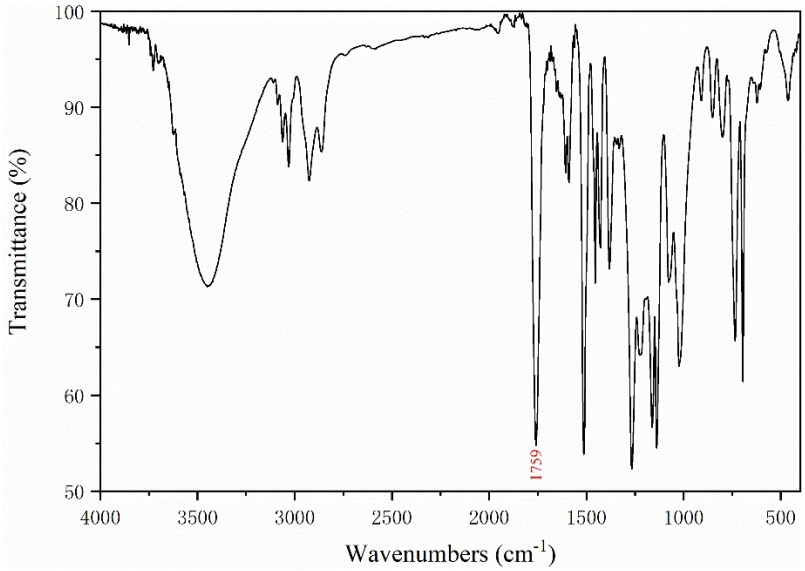


Fig. S13 FT-IR spectrum of poly($_L$-Dopa(Bn)OCA).

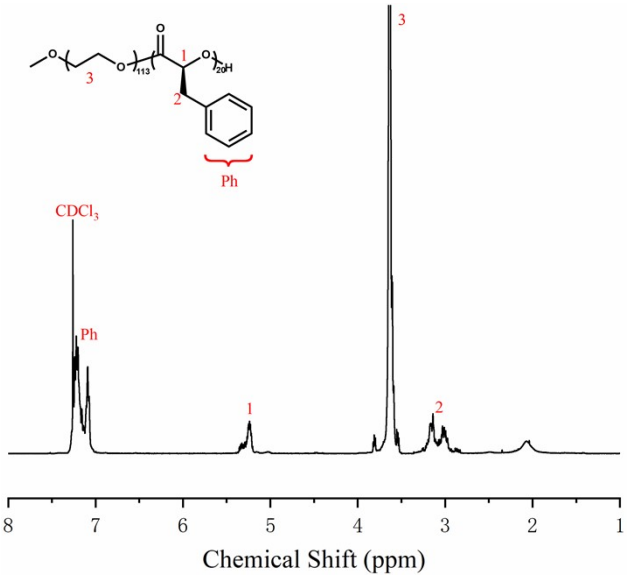


Fig. S14 ^{13}C NMR spectrum of mPEG-*b*-poly(PheOCA) in $CDCl_3$.

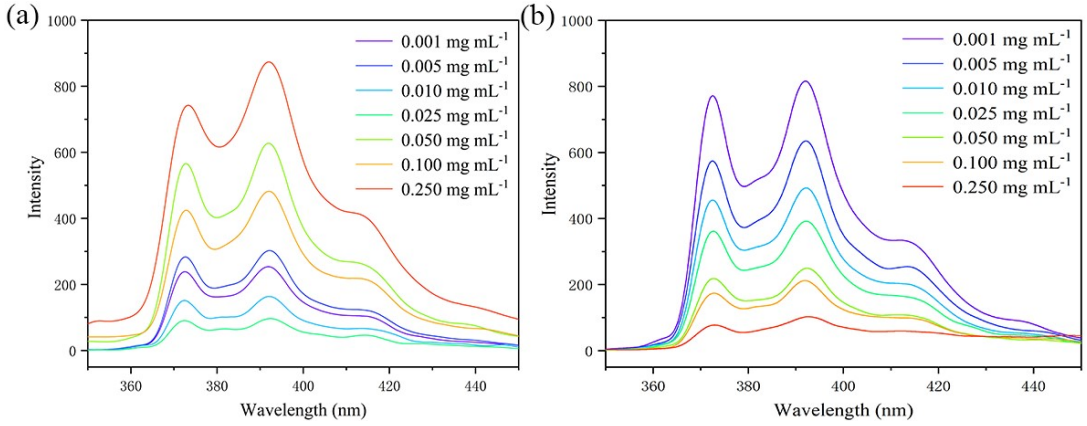


Fig. S15 The emission spectra of pyrene in mPEG$_{5k}$-*b*-poly(DopaOCA)$_{20}$ solution (a) before and (b) after cross-linking at different concentrations (λ_{ex} = 334 nm).

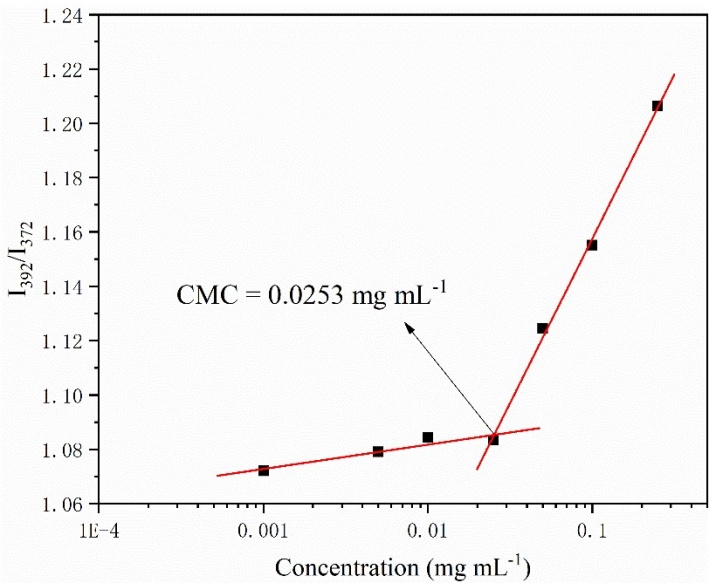


Fig. S16 The intensity ratio (I_{392}/I_{372}) as a function of the concentration of mPEG$_{5k}$-*b*-poly(DopaOCA)$_{20}$ solution.

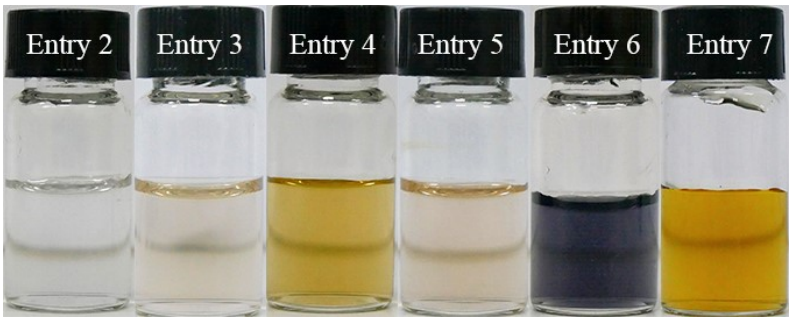


Fig. S17 Colour of polymeric micellar solutions.

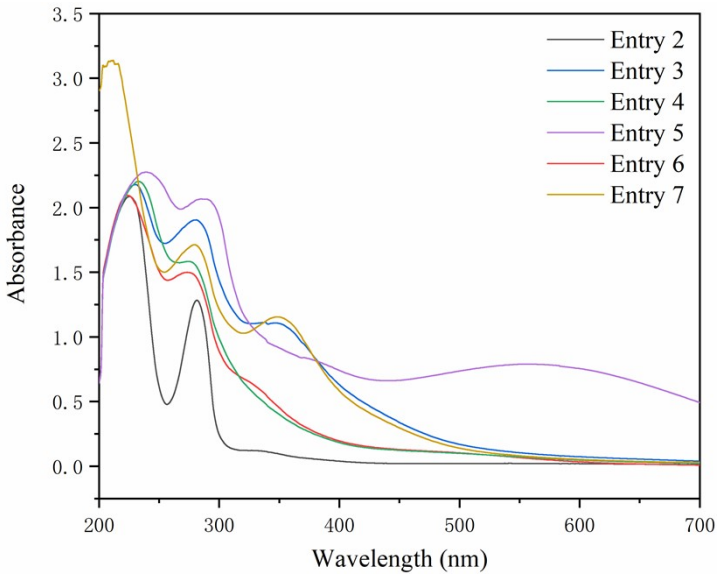


Fig. S18 UV-vis spectrum of polymeric micelles in water.