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Supporting Information

Combination of Vancomycin and Guanidinium-Functionalized Helical Polymers for Synergistic Antibacterial Activity and Biofilm Ablation

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Measurements

The nuclear magnetic resonance (NMR) spectra were recorded using a Bruker 600 MHz {H} spectrometer operated in the Fourier Transform mode. Chemical shifts are reported in delta (δ) units and expressed in parts per million (ppm) downfield from tetramethylsilane using the residual proton solvent as an internal standard. Size exclusion chromatography (SEC) was performed on Waters 1515 pump and Waters 2414 differential refractive index (RI) detector (set at 40 °C) using a series of two linear TSK gel GMHHR-H columns. The M_n and M_w/M_n values were reported relative to the polystyrene standards. The eluent was tetrahydrofuran (THF) at a flow rate of 0.8 mL/min. FT-IR spectra were recorded on Perkin-Elmer Spectrum BX FT-IR system using KBr pellets at 25 °C. Circular dichroism (CD) spectra were performed on JASCO J1500 using 10.0 or 1.0 mm quartz cells. Absorption spectra were recorded on UNIC 4802 UV/vis double beam spectrophotometer in a 10.0 or 1.0 mm quartz cell. Fluorescence spectra were recorded using a Hitachi F-4600 fluorescence spectrophotometer. The temperature of the water-jacketed cell holder was controlled by a programmable circulation bath. The slit widths were set at 5.0 nm for both excitation and emission. Dynamic light scattering (DLS) measurements were carried on a Nano-ZS90 Zetasizer of Malvern (UK) instrument, all data were averaged over three time measurements. Transmission electron microscopy (TEM) observations were conducted on a JEM-2100F electron microscope operating at an acceleration voltage of 200 kV. The samples for TEM observation were prepared by casting the corresponding solutions of polymers onto copper mesh grids and drying in air at room temperature. Scanning electron microscope (SEM) was used to test SU8020 at 5.0 kV acceleration voltage. Atomic force microscope (AFM) was performed on a Cypher S microscope (Oxford Instruments, Asylum Research). Confocal laser scanning microscopy (CLSM) images were acquired using a Leica TCS SP5 microscope. The absorption spectrum of each photosensitizer was recorded at room temperature with a Microplate Spectrophotometer (Infinite 200 Pro; Shanghai, China).

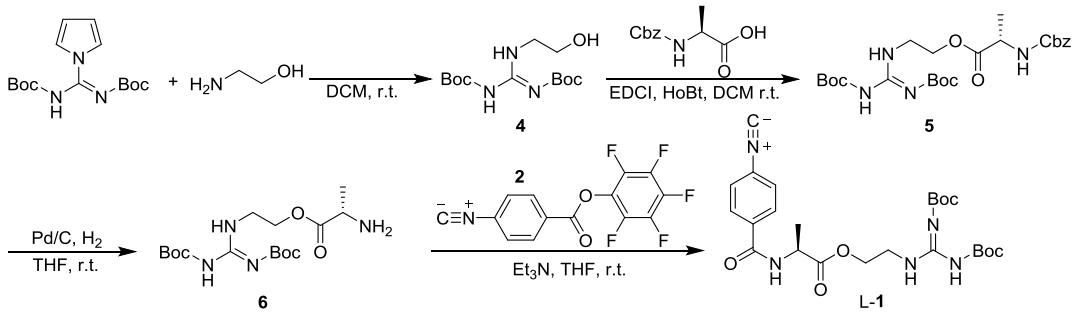
Materials

All solvents were purchased from Sinopharm Co. Ltd., and were purified by the standard procedures before used. THF for polymerizations was further dried over sodium benzophenone ketyl, distilled onto lithium aluminum hydride under nitrogen, and distilled under high vacuum just before use. All chemicals were obtained from Sinopharm and Aladdin Co. Ltd., and were used as received otherwise denoted. Phenyl isocyanide monomer **3**,[1] pentafluorophenyl ester-functionalized phenyl isocyanide monomers **2**,[2] cystamine[3] and alkyne-Pd(II) catalyst[4] were prepared according to procedures we reported previously. *S. aureus* (ATCC25923) and *E. coli* (O157) were purchased from BeNa Culture Collection (Shanghai, China). Exponential bacterial culture was obtained by growing *S. aureus* in fresh medium for approximately 1 h to a density of 10^7-10^8 colony-forming units (CFU) mL^{-1}, with optical density (OD) value at 600 nm reaching 0.5 - 0.6. Approximately

5×10^7 cells were collected at 5000 rpm for 5 min, resuspended in 1 mL of PBS (phosphate-buffered saline) and then subjected to the following photodynamic trials.

Synthetic procedures

Scheme S1. Synthesis of monomer **1**, L-**1**, and D-**1** (Taking L-**1** as an example).



*Synthesis of **4**:* This compound was prepared followed the reported procedure.[5] Under N_2 protection, *tert*-butyl (Z)-(((tert-butoxycarbonyl)amino) (1H-pyrrol-1-yl)methylene)carbamate (10.0 g, 32.3 mmol) was added to a stirred solution of 2-aminoethanol (2.0 g, 32.7 mmol) in dichloromethane (DCM, 100 mL). The resulting solution was stirred at room temperature for 8 h. Then, the reaction mixture was washed by water (3 × 80 mL). The organic phase was concentrated under reduced pressure. The obtained crude product was then purified by column chromatography with CH_2Cl_2/EA (from 8/1 to 4/1, v/v) to obtain **4** as white solid (9.4 g, 96% yield). ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.5–11.4 (s, 1H, N*H*CH_2), 8.8–8.6 (s, 1H, N*H*CO), 5.1–4.0 (s, 1H, OH), 3.78–3.72 (t, J = 6 Hz, 2H, CH_2OH), 3.59–3.52 (m, 2H, CH_2NH), 1.51–1.44 (d, J = 12 Hz, 18H, CH_3). ^{13}C NMR (150 MHz, $CDCl_3$, 25 °C): δ 162.82, 158.31, 153.94, 83.54, 80.09, 63.88, 42.48, 27.53. FT-IR (KBr, 25 °C, cm^{-1}): 3518 ($\nu_{O–H}$), 3323 ($\nu_{N–H}$), 1723 ($\nu_{C=O}$), 1637 ($\nu_{C=N}$). MS m/z calcd for $C_{13}H_{25}N_3O_5$ $[M]^+$: 303.18; Found: 303.18. Anal. Calcd (%) for $C_{13}H_{25}N_3O_5$: C, 51.47; H, 8.31; N, 13.85; Found (%): C, 51.47; H, 8.30; N, 13.84.

*Synthesis of **5**:* This compound was prepared according to the reported literature with slight modification.[6] In a 250 mL round-bottom flask was charged with ((benzyloxy)carbonyl)-L-alanine (6.7 g, 30.0 mmol), 1-ethyl-3(3-dimethylpropylamine) carbodiimide (EDCI, 6.9 g, 35.6 mmol), 1-hydroxybenzotriazole (HOBt, 0.4 g, 3.0 mmol) and dry CH_2Cl_2 (80 mL). After the mixture was stirred at room temperature for 0.5 hour under N_2, compound **4** (9.0 g, 29.7 mmol) in dry CH_2Cl_2 (20 mL) was added via a syringe. The reaction mixture was then allowed to stir at room temperature for 8 hours. The solvent washed with saturated deionized water (50 mL x 3), $NaHCO_3$ (50 mL x 3), and brine (50 mL x 3). The organic layers were combined and dried over Na_2SO_4, filtered and concentrated. The crude product was further purified by silica gel column chromatography using ethyl acetate and petrol ether (v/v = 1/4) as an eluent. After removing all the solvents,

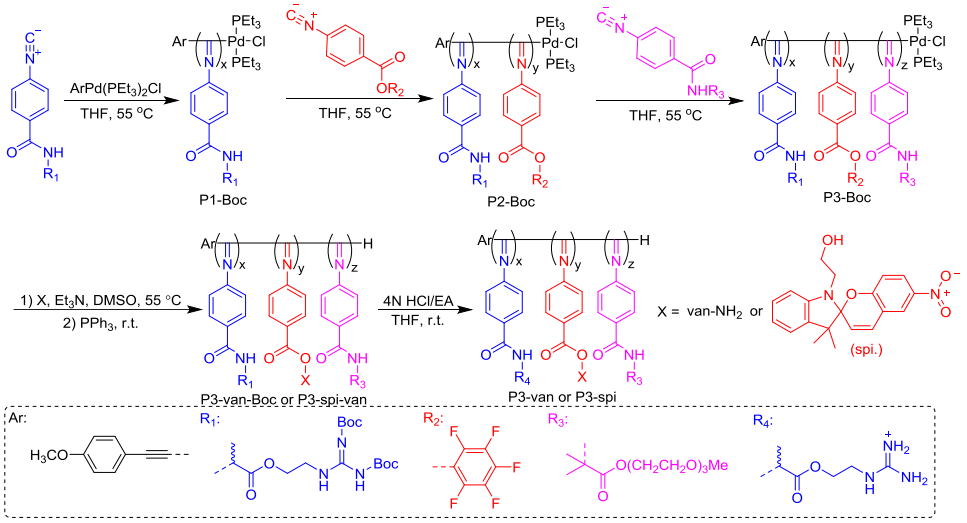
the final white solid product **5** was obtained (15.1 g, 94% yield). ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.66–11.27 (s, 1H, N*H*CH_2), 8.73–8.46 (s, 1H, N*H*CO), 7.50–7.27 (m, 5H, ArH), 5.43–5.32 (d, J = 6 Hz, 1H, N*H*CH), 5.19–5.0 (m, 2H, *CH*$_2$Ar), 4.56–4.35 (m, 1H, CH), 4.34–4.13 (m, 2H, *CH*$_2$OH), 3.84–3.56 (m, 2H, *CH*$_2$NH), 1.51–1.46 (d, J = 6 Hz, 18H, CH_3), 1.45–1.40 (d, J = 6 Hz, 3H, CH_3). ^{13}C NMR (150 MHz, $CDCl_3$, 25 °C): δ 172.46, 163.00, 156.34, 153.70, 136.43, 128.52, 128.18, 128.10, 83.39, 78.72, 66.45, 63.83, 52.86, 40.15, 27.45, 17.70. FT-IR (KBr, 25 °C, cm^{-1}): 3333 ($\nu_{N–H}$), 2986 ($\nu_{C–H}$, aromatic), 2934 ($\nu_{C–H}$, aromatic), 1721 ($\nu_{C=O}$), 1639 ($\nu_{C=N}$). MS m/z calcd for $C_{24}H_{36}N_4O_8$ $[M]^+$: 508.25; Found: 508.23. Anal. Calcd (%) for $C_{24}H_{36}N_4O_8$: C, 56.68; H, 7.14; N, 11.02; Found (%): C, 56.66; H, 7.15; N, 11.01.

*Synthesis of **6***: A 250 mL round-bottom flask was charged with compound **5** (12.0 g, 23.6 mmol), 10% palladium-activated carbon (1.2 g) and dry THF (80 mL). The mixture was allowed to stir at room temperature under H2 for 8 h, after filtration, the solvent was removed to give the color-free viscous liquid. (8.5 g, 96% yield). ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.51–11.42 (s, 1H, *NH*CH_2), 8.66–8.55 (s, 1H, *NH*CO), 4.39–4.04 (t, J = 6 Hz, 2H, *CH*$_2$OH), 3.78–3.66 (m, 2H, *CH*$_2$NH), 3.62–3.54 (m, 1H, CH), 1.55–1.41 (d, J = 6 Hz, 18H, CH_3), 1.40–1.31 (d, J = 6 Hz, 3H, CH_3). ^{13}C NMR (150 MHz, $CDCl_3$, 25 °C): δ 175.93, 163.42, 156.35, 153.92, 83.36, 78.49, 63.23, 50.08, 39.42, 28.24, 28.02, 20.95. FT-IR (KBr, 25 °C, cm^{-1}): 3329 ($\nu_{N–H}$), 1737 ($\nu_{C=O}$), 1625 ($\nu_{C=N}$). MS m/z calcd for $C_{16}H_{30}N_4O_6$ $[M]^+$: 374.22; Found: 374.23. Anal. Calcd (%) for $C_{16}H_{30}N_4O_6$: C, 51.32; H, 8.08; N, 14.96; Found (%): C, 51.30; H, 8.09; N, 14.96.

*Synthesis of monomer L-**1***: First, phenyl isocyanide bearing pentafluorophenol ester according to our reported procedure.[2] A 100 mL round-bottom flask was charged with compound **6** (3.0 g, 8.0 mmol), **2** (2.8 g, 8.9 mmol), Et_3N (5.6 mL, 40.0 mmol), and dry THF (30.0 mL). After the resulting mixture was stirred at room temperature for 2 h, the solvent was removed by evaporation under reduced pressure. The residue was dissolved in CH_2Cl_2 (50 mL) and washed successively with H_2O (20 mL × 1), saturated aqueous $NaHCO_3$ (20 mL × 1), brine (20 mL × 1), and dried over anhydrous Na_2SO_4. After filtration, the solvent was removed by evaporation under reduced pressure. The crude product was purified by column chromatography using petroleum ether/ethyl acetate (v/v = 4/1) as eluent to afford monomer L-**1** as a white solid (3.6 g, 90% yield). ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.59–11.34 (s, 1H, *NH*CH_2), 8.58–8.52 (s, 1H, *NH*CO), 7.93-7.77 (b, J = 6 Hz, 2H, ArH), 7.53-7.38 (b, J = 12Hz, 2H, ArH), 6.90-6.61 (s, 1H, *NH*CH), 4.94–4.73 (m, 1H, CH), 4.44–4.21 (s, 2H, *CH*$_2$OH), 3.97–3.58 (m, 2H, *CH*$_2$NH), 1.50–1.46 (d, J = 6 Hz, 18H, CH_3), 1.44–1.21 (m, 3H, CH_3). ^{13}C NMR (150 MHz, $CDCl_3$, 25 °C): δ 172.79, 167.51, 163.37, 160.04, 156.34, 153.16, 135.23, 128.52, 128.18, 128.10, 83.39, 79.52, 63.82, 49.63, 39.35, 28.01, 18.63. FT-IR (KBr, 25 °C, cm^{-1}): 3363 ($\nu_{N–H}$), 2125 ($\nu_{C\equiv N}$), 1730 ($\nu_{C=O}$), 1643 ($\nu_{C=N}$). MS m/z calcd for $C_{24}H_{33}N_5O_7$ $[M]^+$: 503.24; Found: 503.23. Anal. Calcd (%) for $C_{24}H_{33}N_5O_7$: C, 57.25; H, 6.61; N, 13.91; Found (%): C, 57.23; H, 6.60; N, 13.92.

Other macromonomers with similar structures were prepared followed the same procedure described above.

Scheme S2. Synthesis of DL-P3-van，L-P3-van, D-P3-van or DL-P3-spi，L-P3-spi, D-P3-spi



Synthesis of DL-P1-Boc, L-P1-Boc and D-P1-Boc: Taking DL-P1-Boc as an example: The polymerization was performed according to our previously reported procedure.[4] A 10 mL oven dried and nitrogen-filled flask was charged with monomer **1** (150.0 mg, 0.30 mmol), alkyne-Pd(II) catalyst (5.0 mg 0.01 mmol), dry THF (2.0 mL) and a stir bar. The concentrations of monomer **1** and the Pd(II) catalyst were 0.15 and 0.005 M, respectively ($[\mathbf{1}]_0/[Pd]_0 = 30$). The reaction flask was then immersed into an oil bath at 55 °C and stirred for 18 h. After cooled to room temperature, the polymerization solution was precipitated into a large amount of methanol, collected by centrifugation, and dried in vacuum at room temperature overnight, afford DL-P1-Boc as a yellow solid (147 mg, 98% yield). SEC: M_n = 12.0 × 10^3, M_w/M_n = 1.10. ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.70–11.17 (br, 30H, *NH*CH_2), 9.17–8.37 (br, 30H, *NH*CO), 7.90-6.37 (br, 150H, ArH and *NH*CH), 5.00–4.00 (br, 90H, CH and *CH*$_2$OH), 3.97–3.31 (br, 60H, *CH*$_2$NH), 1.77–1.02 (br, 630H, CH_3). FT-IR (KBr, 25 °C, cm^{-1}): 3324 (ν_{N-H}, aromatic), 2963 (ν_{C-H}, aromatic), 2932 (ν_{C-H}, aromatic), 1737 ($\nu_{C=O}$), 1630 ($\nu_{C=N}$).

Following the same procedure, L-P1-Boc and D-P1-Boc were also prepared.

Synthesis of DL-P2-Boc，L-P2-Boc and D-P2-Boc. Taking DL-P2-Boc as an example: A 10 mL oven dried and nitrogen-filled flask was charged with DL-P1-Boc (140 mg, M_n = 12.0 x 10^3, M_w/M_n = 1.10), monomer **2** (15.7 mg, 0.05 mmol), dry THF (2.0 mL), and a stir bar. The reaction flask was then immersed into an oil bath at 55 °C and stirred for 8 h. After cooled to room temperature, the polymerization solution was precipitated into a large

amount of methanol, collected by centrifugation, and dried in vacuum at room temperature overnight, afford DL-P2-Boc as a yellow solid (158.7 mg, 99% yield). SEC: M_n = 12.9 × 10^3, M_w/M_n = 1.11. ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.72–11.16 (br, 30H, *NH*CH_2), 9.16–8.37 (br, 30H, *NH*CO), 7.91-6.38 (br, 170H, ArH and *NH*CH), 5.02–3.99 (br, 90H, CH and *CH*$_2$OH), 3.95–3.30 (br, 60H, *CH*$_2$NH), 1.76–1.03 (br, 630H, CH_3). FT-IR (KBr, 25 °C, cm^{-1}): 3333 ($\nu_{N–H}$, aromatic), 2972 ($\nu_{C–H}$, aromatic), 2885 ($\nu_{C–H}$, aromatic), 1737 ($\nu_{C=O}$), 1630 ($\nu_{C=N}$).

Following the same procedure, L-P2-Boc and D-P2-Boc were also prepared.

Synthesis of DL-P3-Boc，L-P3-Boc and D-P3-Boc. Taking DL-P3-Boc as an example: A 10 mL oven dried and nitrogen-filled flask was charged with DL-P2-Boc (150 mg, M_n = 12.9 × 10^3, M_w/M_n = 1.11), monomer **3** (131.9 mg, 0.35 mmol), dry THF (2.0 mL), and a stir bar. The reaction flask was then immersed into an oil bath at 55 °C and stirred for 20 h. After cooled to room temperature, the polymerization solution was precipitated into a large amount of cold diethyl ether, collected by centrifugation, and dried in vacuum at room temperature overnight, afford DL-P3-Boc as a yellow solid (262 mg, 93% yield). SEC: M_n = 33.4 × 10^3, M_w/M_n = 1.24. ^{1}H NMR (600 MHz, $CDCl_3$, 25 °C): δ 11.70–11.17 (br, 30H, *NH*CH_2), 9.17–8.37 (br, 30H, *NH*CO), 8.04-6.27 (br, 310H, ArH and *NH*CH), 4.94–3.95 (br, 90H, CH and *CH*$_2$OH), 3.97–3.04 (br, 480H, *CH*$_2$NH and *CH*$_2$*CH*$_2$O of hydrophilic segment), 1.81–1.04 (br, 945H, CH_3). FT-IR (KBr, 25 °C, cm^{-1}): 3324 ($\nu_{N–H}$, aromatic), 2972 ($\nu_{C–H}$, aromatic), 2877 ($\nu_{C–H}$, aromatic), 1737 ($\nu_{C=O}$), 1630 ($\nu_{C=N}$).

Following the same procedure, L-P3-Boc and D-P3-Boc were also prepared.

Synthesis of DL-P3-spi-Boc, L-P3-spi-Boc and D-P3-spi-Boc. Taking L-P3-spi-Boc as an example: A 10 mL oven dried and nitrogen-filled flask was charged with L-P3-Boc (50.0 mg, M_n = 34.8 × 10^3, M_w/M_n = 1.21), and spiropyran (spi) (0.12 μmol), dry THF (2.0 mL), and a stir bar. The reaction flask was then immersed into an oil bath at 55 °C and stirred for 10 h. After cooled to room temperature, PPh_3 (4.0 mg, 15 mmol) was added. The solution was stirred for further 4 h, then it was precipitated into a large amount of cold diethyl ether, collected by centrifugation, and dried in vacuum at room temperature overnight, afford L-P3-spi-Boc as a yellow solid (48.0 mg, 95% yield).

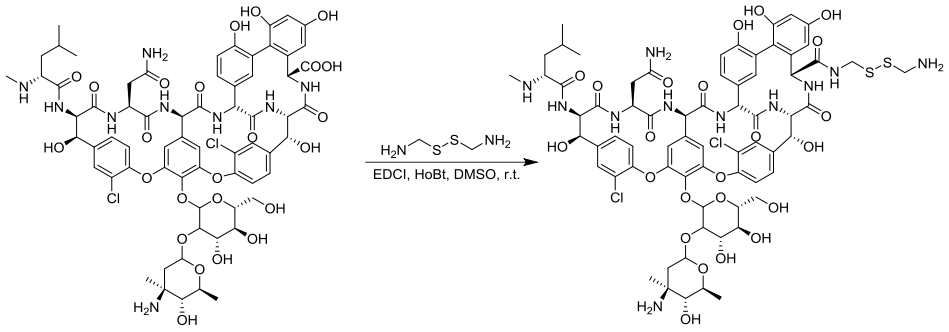
Following the same procedure, DL-P3-spi-Boc and D-P3-spi-Boc were also prepared.

Synthesis of DL-P3-spi, L-P3-spi and D-P3- spi. Taking L-P3-spi as an example: A 10 mL oven dried and nitrogen-filled flask was charged with L-P3-spi-Boc and 4N HCl/EA (4.0 mL), and a stir bar. The reaction flask was stirred for 10 h at room temperature. Then it was precipitated into a large amount of cold diethyl ether, collected by centrifugation, and dried in vacuum at room temperature overnight, afford L-P3-spi as a brown solid.

Following the same procedure, DL-P3-spi and D-P3-spi were also prepared.

Synthesis of cystamine. Into a 100 mL dried beaker, a well-weighed cystamine dihydrochloride (1.00 g, 4.40 mmol), sodium hydroxide (0.36 g, 9.00 mmol), and ultra-pure water (20 mL) were charged. The mixture was allowed to stir until the raw materials were completely dissolved. After stirring for a while, the aqueous solution was extracted with CH_2Cl_2. The organic phase was collected and concentrated and dried in vacuum. Then, the product (cystamine) was obtained with a pale yellow solid in 90% yield.

Scheme S3. Synthesis of van-NH_2.



In a 25 mL round-bottom flask was charged with Van (38.0 mg, 26.2 μmol), 1-ethyl-3(3-dimethylpropylamine) carbodiimide (EDCI, 6.0 mg, 31.3 μmol), 1-hydroxybenzotriazole (DMAP, 2.5 mg, 20.5 μmol) and dry DMSO (10 mL). After the mixture was stirred at room temperature for 0.5 hour under N_2, cystamine (20.0 mg, 131.3 μmol) was added via a syringe. The reaction mixture was then allowed to stir at room temperature for 10 hours. The crude products were precipitated with DCM, washed repeatedly with DCM, and dried to produce a white solid.

Antibacterial activity. A concentration of *E. coli* (O157) and *S. aureus* (ATCC25923) bacterial suspension used in the antibacterial test were 10^5 CFU/mL in phosphate buffered saline (PBS), respectively (CFU represents for colony forming units). First, 100 μL of corresponding sample solution (0.05 – 50 μM) was placed into a standard 24-well culture plate. And then 400 μL of corresponding bacterial suspension in PBS was added into each well. After that, the cultures and the samples were incubated in an incubator (B6060, Heraeus, Germany) at 37 °C for 24 h and the absorbance of the sample is measured at intervals during this period. Then, 100 μL of planktonic bacterial suspensions were serially diluted and added onto the nutrition agar plates, respectively. The bacterial colonies were recorded after incubation at 37 °C for 24 h. Each experiment was repeated three times. The MIC is defined as the lowest concentration of testing chemical that inhibits visible growth of bacteria as observed with the unaided eye.

Hemolytic activity. The hemolysis assay was conducted according to a method reported previously.[7] Fresh blood containing sodium citrate (3.8 wt. %) in the ratio of 9:1 from healthy Balb/c mouse was diluted with normal saline and centrifuged at 1500 rpm for 10

min. The erythrocyte pellets were collected at the bottom of centrifuge tube and washed for four times with normal saline. Subsequently, erythrocyte pellets were diluted with normal saline to 2% (v/v) concentration. 1.5 mL of antimicrobial materials solutions at different concentrations were respectively placed in a 2 mL tube containing 50 μL of 2% erythrocyte pellets solution. Normal saline solution was used as the negative control (NC) and distilled water was used as the positive control (PC). All the tubes were gently mixed and the mixtures were incubated for 1 h at 37 °C. After that, all the tubes were centrifuged at 3000 rpm for 5 min and the supernatant was transferred to 96-well plates for the estimation of free hemoglobin. Spectroscopic analysis at 545 nm was conducted. The hemolysis rate was calculated using the mean OD value for each group as follows:

$$\text{Hemolysis rate (\%)} = (OD_{sample} - OD_{negative\ control}) / (OD_{positive\ control} - OD_{negative\ control}) \times 100\%$$

where OD_{sample} corresponds to the OD value obtained in the presence of antimicrobial materials solutions, $OD_{negative\ control}$ and $OD_{positive\ control}$ were obtained from the positive and negative control tests as mentioned above, respectively.

CLSM study. Strain of *S. aureus* (ATCC25923) was used in this test. An overnight culture was diluted in PBS to obtain the bacterial concentration of 10^5 CFU/mL, and added into 8-well plate with 240 μL bacterial suspension and 60 μL dye-labeled DL-P3-spi, L-P3-spi and D-P3-spi solution, respectively. The 8-well plate was incubated at 37 °C for 0.5, 1, 3, 5 and 7 h, respectively. Then, most of the PBS solution was carefully removed and observed at different incubation time by CLSM. The images were taken using a confocal laser scanning platform (Leica TCS SP5 microscope).

Analysis of biofilm inhibition. Strain of *E. coli* (O157) was used in this test. Briefly, all tested bacterial strains were grown from the frozen stock in BHI broth for 24 h at 37 °C. Next, 100 μL of antimicrobial material solutions with different concentrations were prepared in a flat-bottomed 96-well microplates. Control wells with no compounds were also prepared. An equal volume (100 μL) of bacterial suspensions diluted 1:10 (OD_{600} = 0.1) was added to each well. After incubation for 48 h at 37 °C, spent media and free-floating bacteria were removed by turning over the plates. The wells were vigorously rinsed at least four times with doubly distilled water (DDW). Next, 0.4% crystal violet (200 μL) was added to each well. After 45 min, wells were vigorously rinsed three times with DDW to remove unbound dye. After adding 200 μL of 30% acetic acid to each well, the plate was shaken for 15 min to release the dye. Biofilm formation was quantified by measuring the difference between absorbance of untreated and treated bacterial samples for each tested concentration of the compounds and the absorbance of appropriate blank well at 600 nm using Microplate Spectrophotometer. The 50% minimum biofilm inhibitory concentration ($MBIC_{50}$) value was defined as the lowest concentration at which at least 50% reduction in biofilm formation was measured compared to untreated cells. Each

concentration of compound was tested in five replicates, and three independent experiments were performed.

Analysis of biofilm eradication. Strain of *E. coli* (O157) was used in this test. To each well of a flat-bottomed 96-well plate, 8 µL of overnight bacterial culture was brought to a volume of 200 µL with fresh media. Plates were incubated for 48 h at 37 °C to establish biofilm. After 24 h, the wells were carefully emptied by inverting the plate and gently shaking. A pre-mixed solution of media and antimicrobial materials solution were added to each well. The plates were incubated at 37 °C. 16 h after preestablished biofilms were treated with antimicrobial materials, the media from each well was removed, biofilm were washed three times with 200 µL PBS to remove planktonic cells, and biofilms were regrown overnight at 37 °C in 200 µL fresh media. 100 µL of supernatant from each well were transferred to a fresh 96-well flat-bottomed plate and the OD at 600 nm was measured using Microplate Spectrophotometer. Concentrations of compound yielding a regrown OD of less than 0.1 corresponded to the minimum biofilm eradication concentration (MBEC). Five replicates were completed for each concentration of compound as well as positive and negative controls.

Table S1. The Characterization Data for polymers[a]

Samples[a]	M_n[b] (kDa)	M_w/M_n[b]	Yield[c] (%)	Size[d] (nm)	ε_{364}[e] ($M^{-1}cm^{-1}$)
Van	N.D.	N.D.[f]	N.D.	N.D.	N.D.
DL-P1-Boc	12.0	1.10	98	N.D.	-
DL-P1	N.D.	N.D.	N.D.	N.D.	-
DL-P2-Boc	12.9	1.11	99	N.D.	-
DL-P3-Boc	33.4	1.24	93	N.D.	-
DL-P3	N.D.	N.D.	N.D.	N.D.	-
DL-P3-van-Boc	36.3	1.31	98	N.D.	-
DL-P3-van	N.D.	N.D.	99	137	-
L-P1-Boc	11.7	1.08	93	N.D.	-11.60
L-P1	N.D.	N.D.	N.D.	N.D.	-11.59
L-P2-Boc	12.1	1.10	99	N.D.	-10.80
L-P3-Boc	34.8	1.21	90	N.D.	-8.33
L-P3	N.D.	N.D.	N.D.	N.D.	-8.34
L-P3-van-Boc	37.6	1.32	97	N.D.	-8.10
L-P3-van	N.D.	N.D.	98	142	-8.10
D-P1-Boc	12.4	1.14	95	N.D.	+11.21
D-P1	N.D.	N.D.	N.D.	N.D.	+11.21
D-P2-Boc	12.9	1.12	97	N.D.	+10.33
D-P3-Boc	34.1	1.20	91	N.D.	+8.11
D-P3	N.D.	N.D.	N.D.	N.D.	+8.12
D-P3-van-Boc	37.1	1.30	98	N.D.	+7.80
D-P3-van	N.D.	N.D.	94	136	+7.80

[a]The polymers were synthesized according to Scheme S2. [b]M_n and M_w/M_n were determined by SEC with equivalent to polystyrene standards. [c]Isolated yields. [d]Determined by dynamic light scattering. [e]Measured in THF at 25 °C (c = 0.2 mg/mL).

Table S2. The Antibacterial data of polymers

Samples[a]	MIC (μM)		MBEC (μM)		HC_{50} (μM)	Selectivity HC_{50}/MIC_{90}	
	E. coli[b]	*S. aureus*[c]	*E. coli*	*S. aureus*	RBC[d]	*E. coli*	*S. aureus*
Van	50	0.69	N.D.[e]	N.D.	N.D.	N.D.	N.D.
DL-P1-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
DL-P1	40	40	N.D.	N.D.	1.5	N.D.	N.D.
DL-P2-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
DL-P3-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
DL-P3	25	25	N.D.	N.D.	135	5.4	5
DL-P3-van-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
DL-P3-van	1.5	0.8	45	4	150	10	187.5
L-P1-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
L-P1	35	35	N.D.	N.D.	1.5	N.D.	N.D.
L-P2-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
L-P3-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
L-P3	20	20	N.D.	N.D.	135	6.8	6.8
L-P3-van-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
L-P3-van	0.5	0.2	15	1	150	30	750
D-P1-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D-P1	45	45	N.D.	N.D.	1.5	N.D.	N.D.
D-P2-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D-P3-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D-P3	30	30	N.D.	N.D.	135	4.5	4.5
D-P3-van-Boc	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D-P3-van	2	1	70	5	150	7.5	150

[a]The polymers were synthesized according to Scheme S2. [b]*E. coli* (O157). [c]*S. aureus* (ATCC25923). [d]Rat red blood cells. [e]N.D.: not determined.

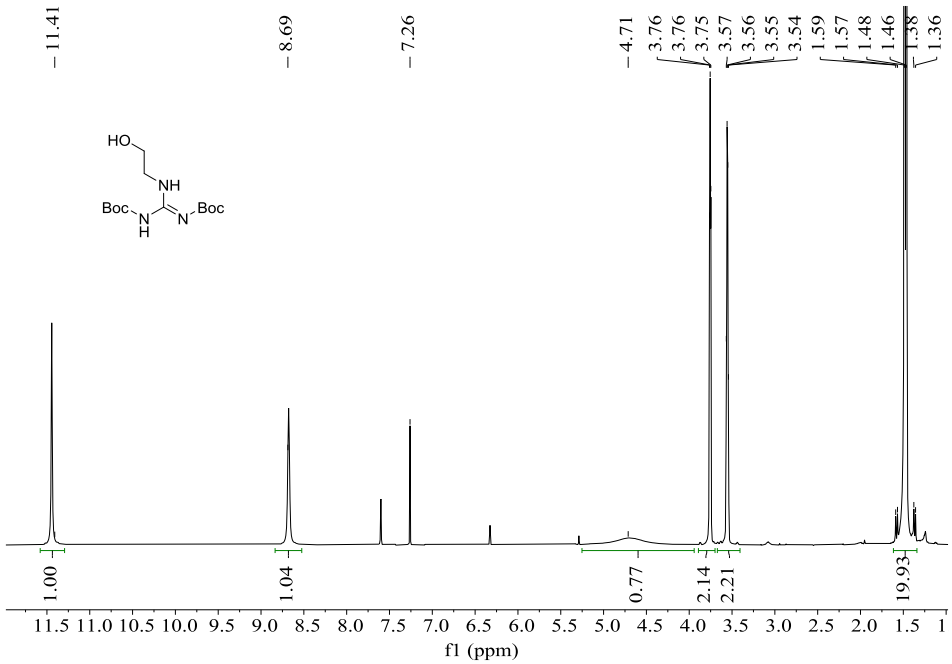


Figure S1. ^{1}H NMR (600 MHz) spectrum of compound **4** measured in $CDCl_3$ at 25 °C.

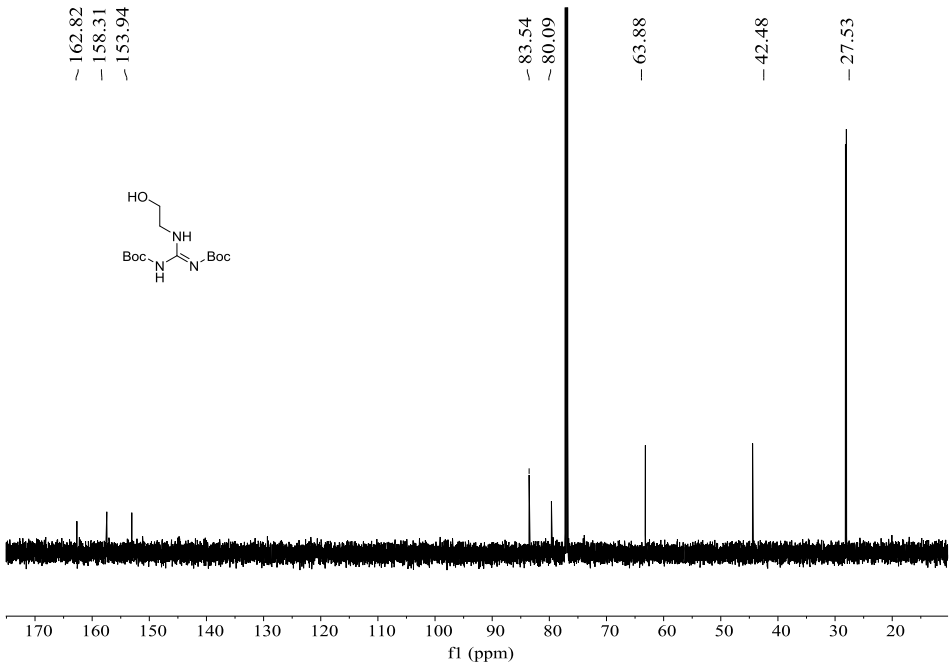


Figure S2. ^{13}C NMR (150 MHz) spectrum of compound **4** measured in $CDCl_3$ at 25 °C.

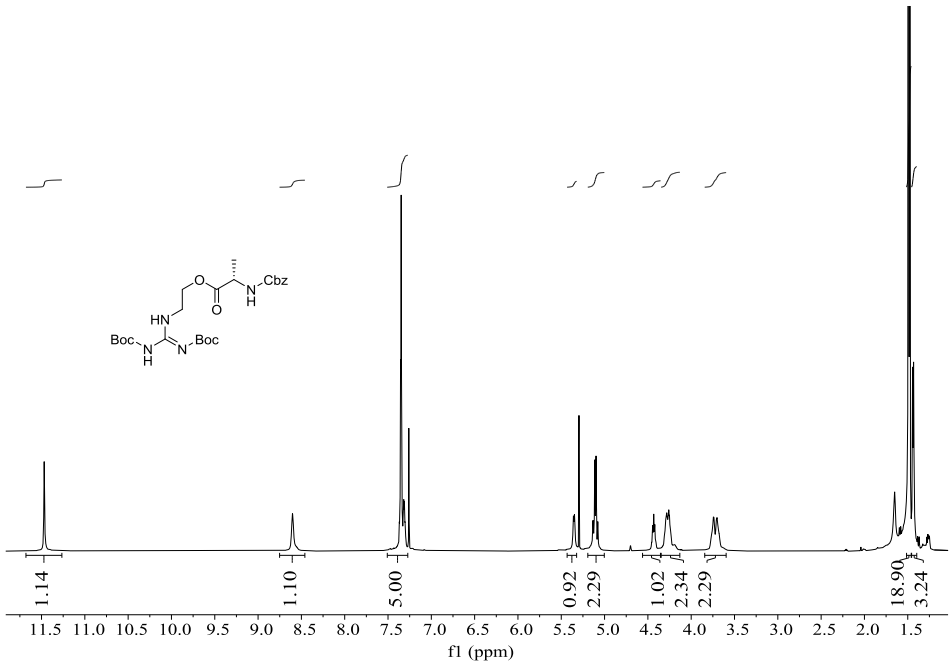


Figure S3. ^{1}H NMR (600 MHz) spectrum of compound **5** measured in $CDCl_3$ at 25 °C.

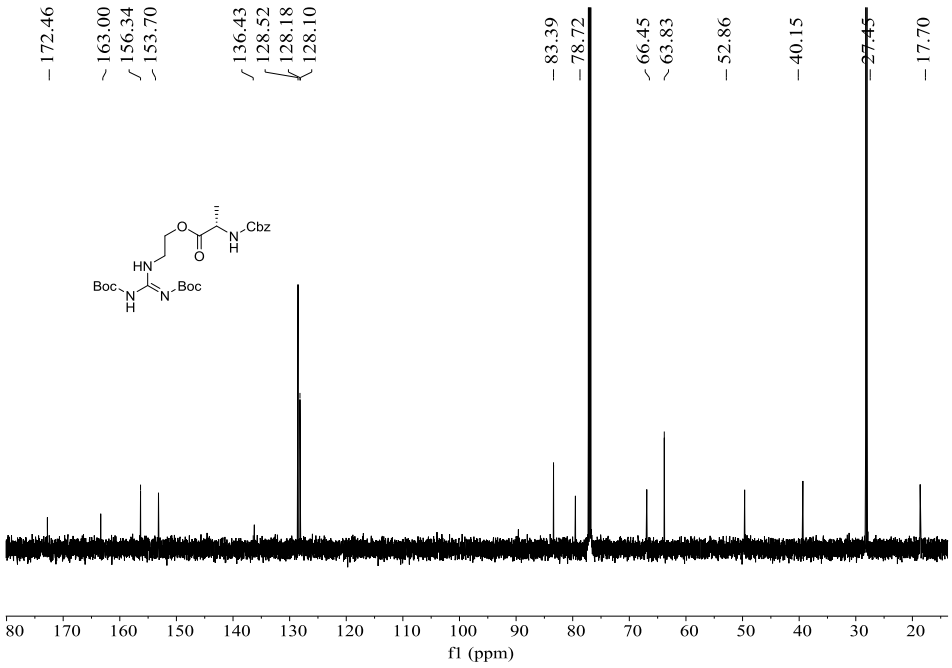


Figure S4. ^{13}C NMR (150 MHz) spectrum of compound **5** measured in $CDCl_3$ at 25 °C.

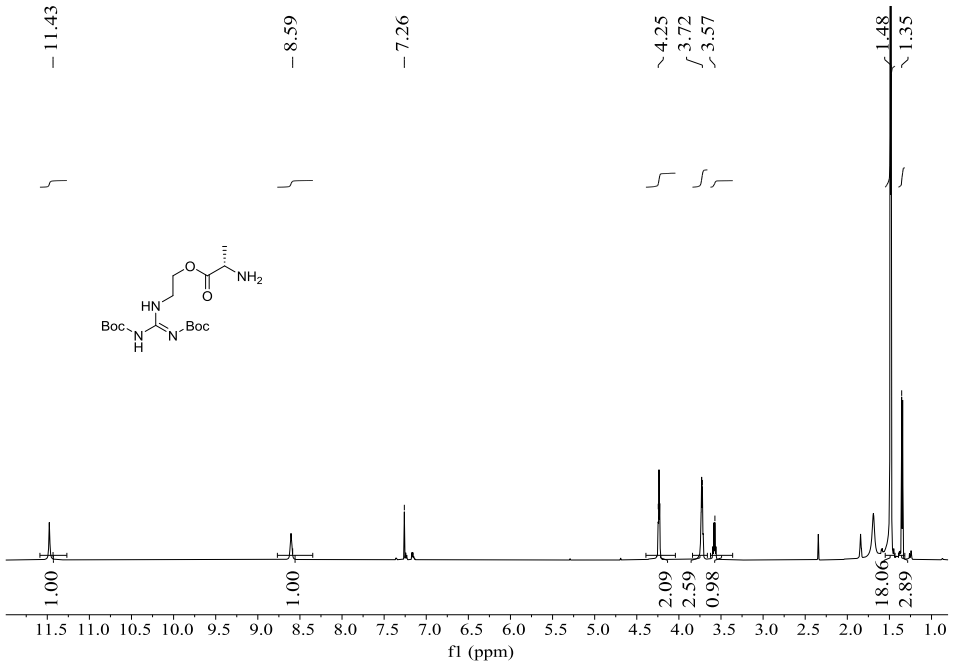


Figure S5. ^{1}H NMR (600 MHz) spectrum of compound **6** measured in $CDCl_3$ at 25 °C.

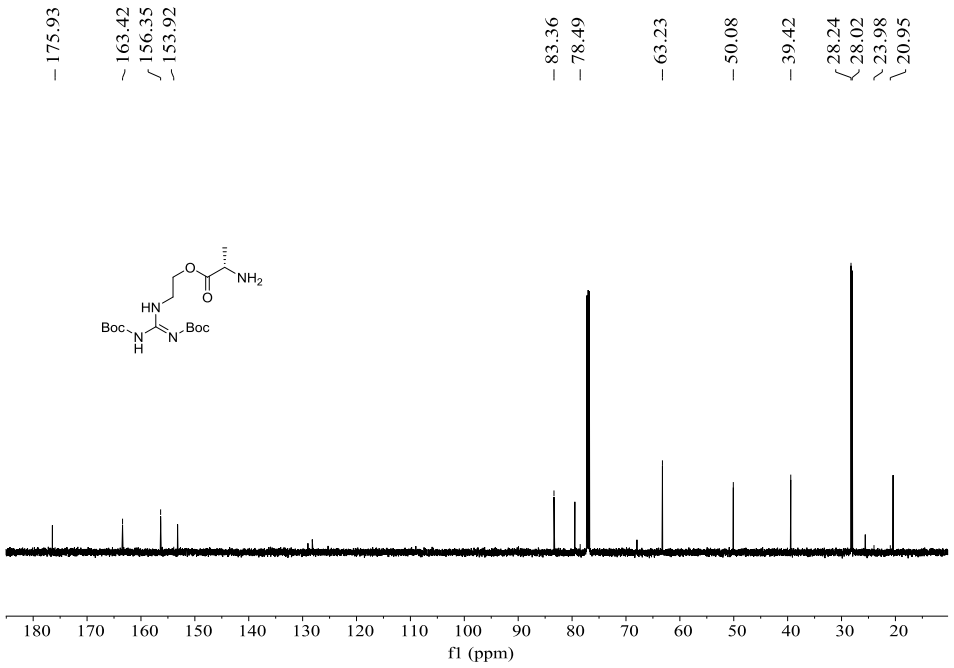


Figure S6. ^{13}C NMR (150 MHz) spectrum of compound **6** measured in $CDCl_3$ at 25 °C.

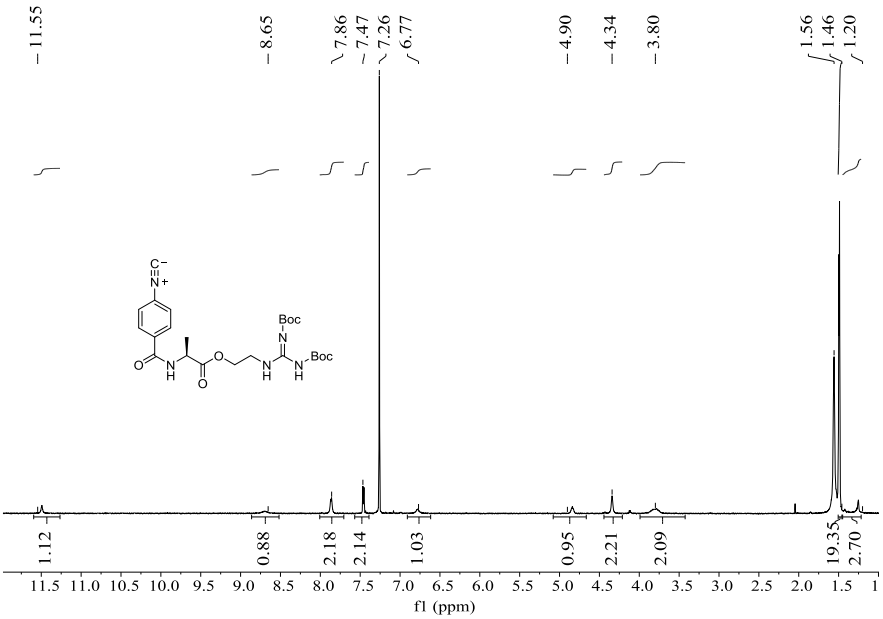


Figure S7. ^{1}H NMR (600 MHz) spectrum of monomer L-**1** measured in $CDCl_3$ at 25 °C.

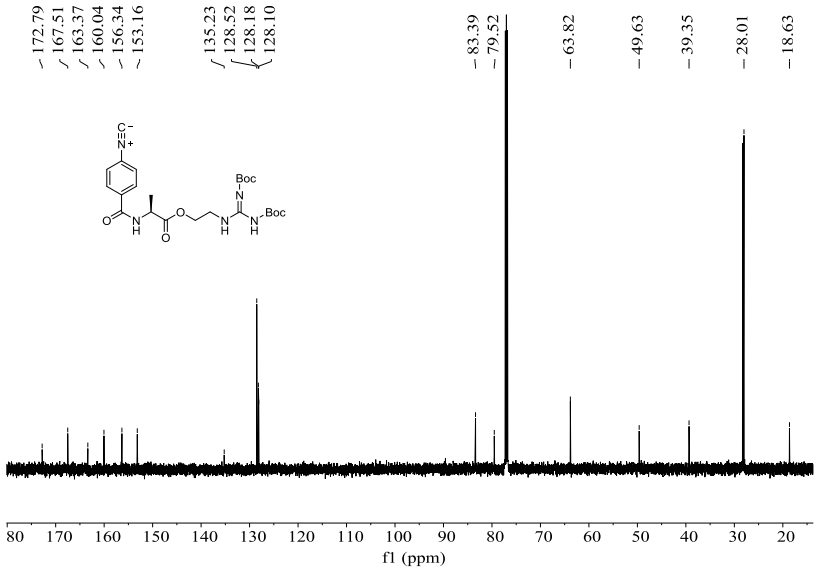


Figure S8. ^{13}C NMR (150 MHz) spectrum of monomer L-**1** measured in $CDCl_3$ at 25 °C.

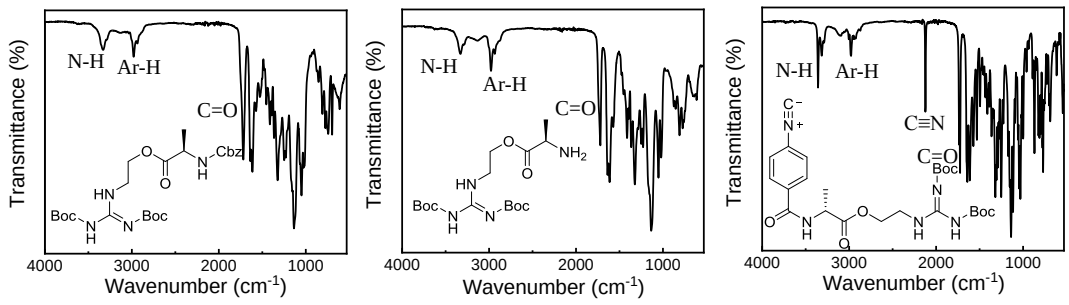


Figure S9. FT-IR spectra of monomer **5**, **6** and L-**1** measured at 25 °C using KBr pellets.

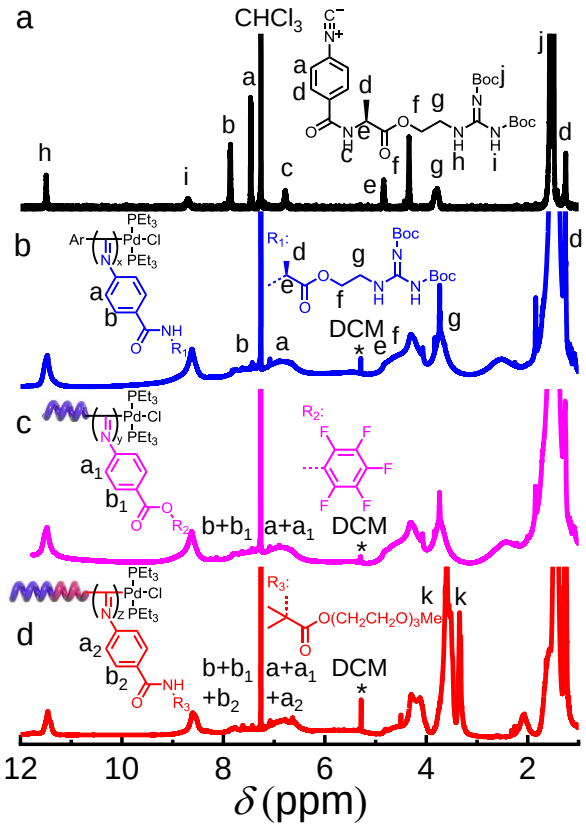


Figure S10. ^{1}H NMR (600 MHz) spectra of monomer L-1 (a), L-P1-Boc (b), L-P2-Boc (c), and L-P3-Boc (d) measured in $CDCl_3$ at 25 °C.

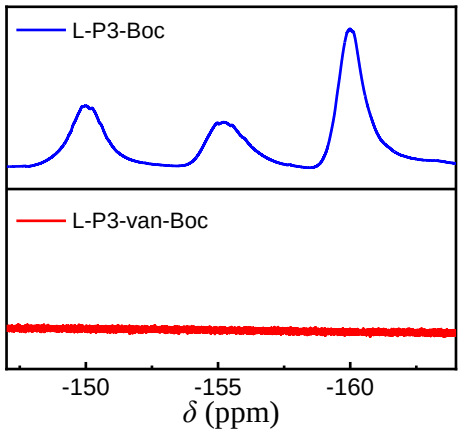


Figure S11. ^{19}F NMR (564 MHz) spectra of L-P3-Boc and L-P3-van-Boc measured in $CDCl_3$ at 25 °C.

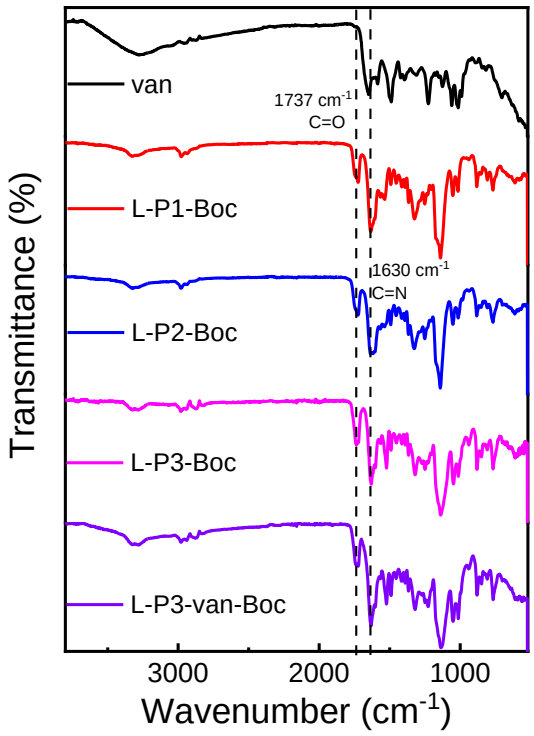


Figure S12. FT-IR spectra of van, L-P1-Boc, L-P2-Boc, L-P3-Boc, and L-P3-van-Boc measured at 25 °C using KBr pellets.

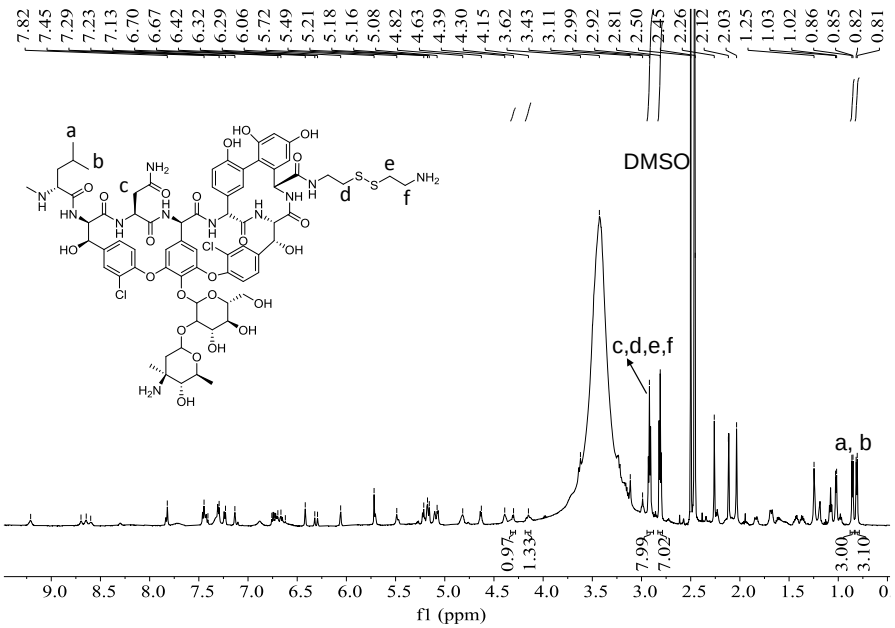


Figure S13. ^{1}H NMR (600 MHz) spectra of Van-NH_2 measured in DMSO at 25 °C.

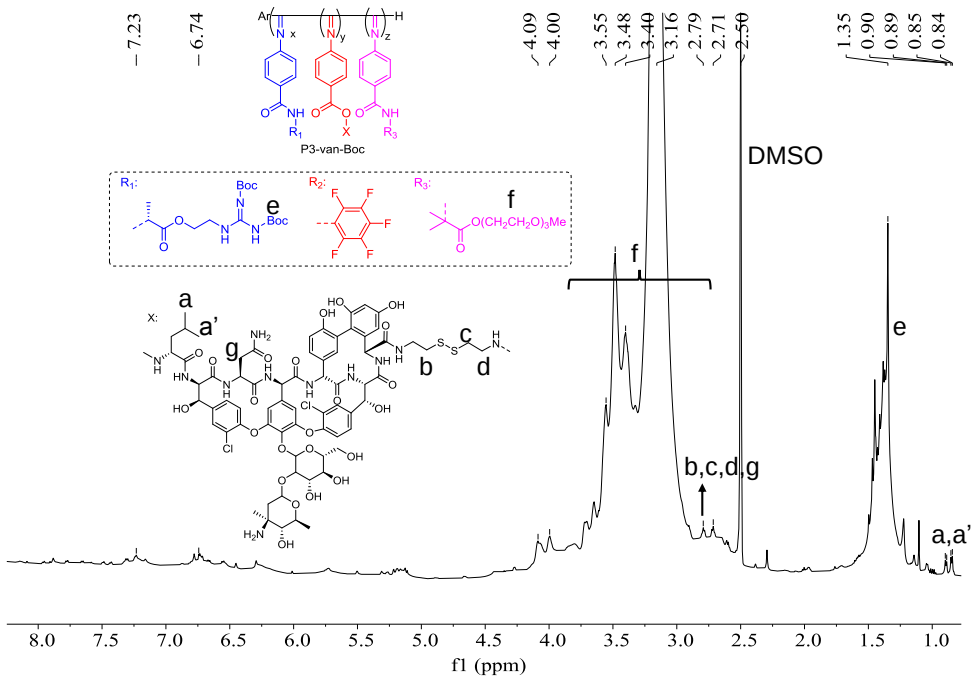


Figure S14. ^{1}H NMR (600 MHz) spectra of L-P3-van-Boc measured in DMSO at 25 °C.

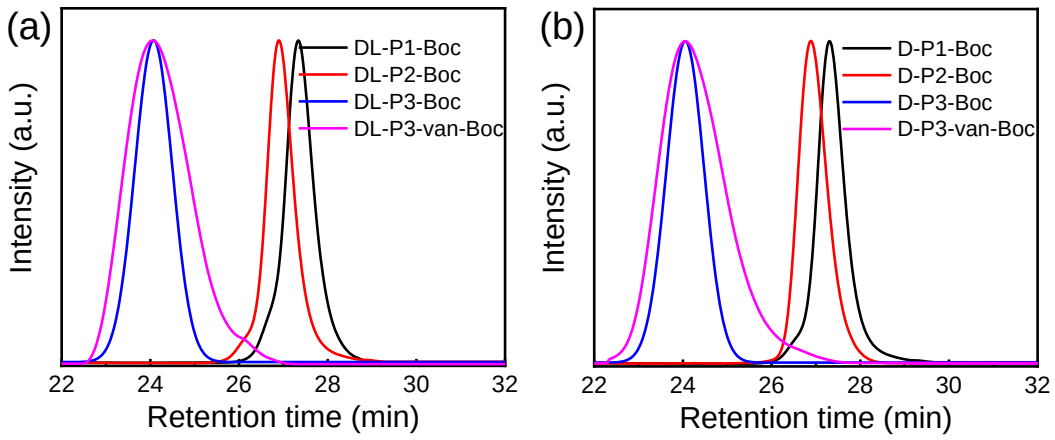


Figure S15. SEC curves of (a) homopolymer DL-P1-Boc, DL-P2-Boc, DL-P3-Boc and DL-P3-van-Boc and (b) homopolymer D-P1-Boc, D-P2-Boc, D-P3-Boc and D-P3-van-Boc.

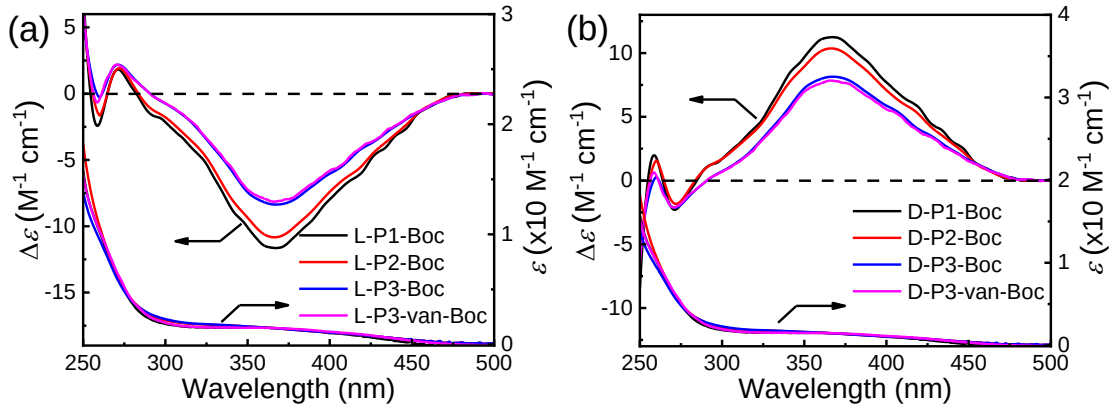


Figure S16. CD and UV-vis spectra (a) of homopolymer L-P1-Boc, L-P2-Boc, L-P3-Boc and L-P3-van-Boc and (b) homopolymer D-P1-Boc, D-P2-Boc, D-P3-Boc and D-P3-van-Boc.

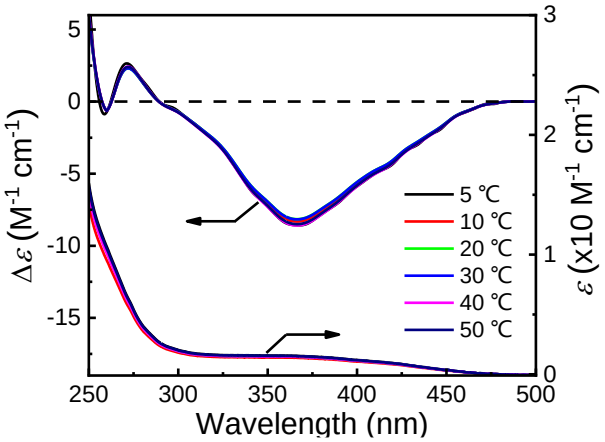


Figure S17. CD and UV-vis spectra of L-P3-van recorded in water at different temperatures.

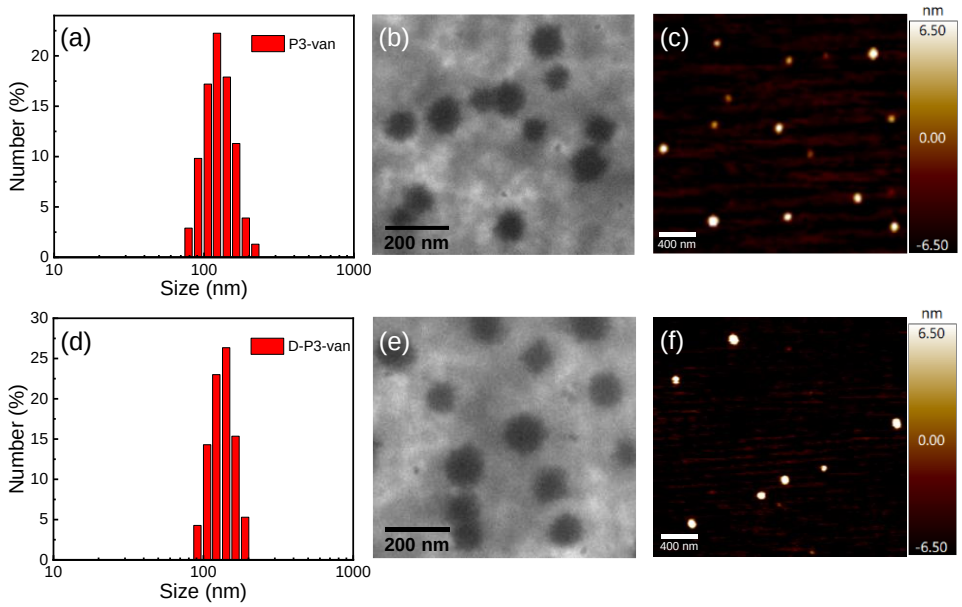


Figure S18. Hydrodynamic diameter (D_h), the TEM and AFM image of DL-P3-van (a), (b), (c) and D-P3-van (d), (e), (f).

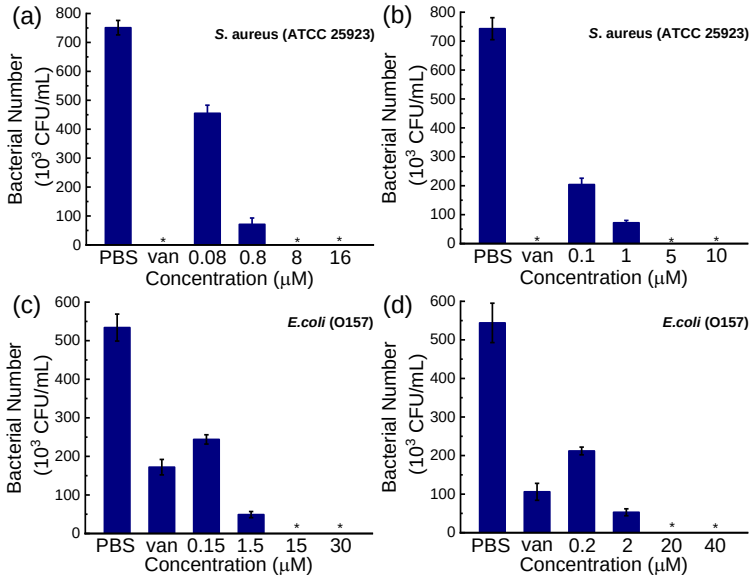


Figure S19. Antibacterial ability of DL-P3-van and D-P3-van against (a, b) *S. aureus*, *E. coli.* (c, d) and Van as the positive controls, respectively. PBS as the negative control. * Indicates no detection of bacteria in the plate counting experiments. The error bars indicate the standard deviations of triplicate experiments.

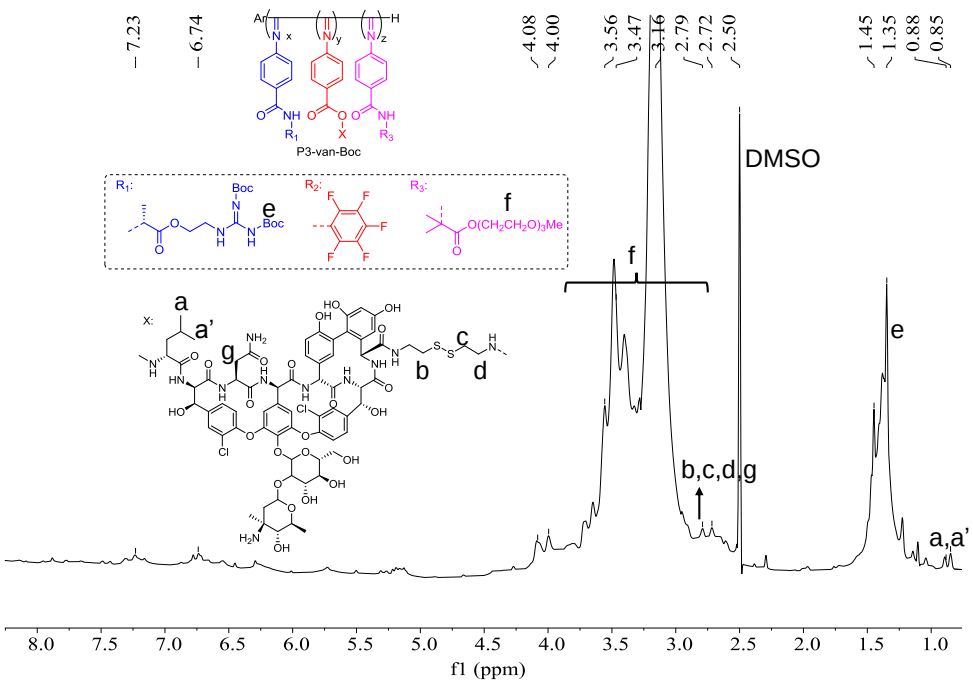


Figure S20. ^{1}H NMR (600 MHz) spectra of L-P3-van-Boc (DP_{GUA} = 40) measured in DMSO at 25 °C.

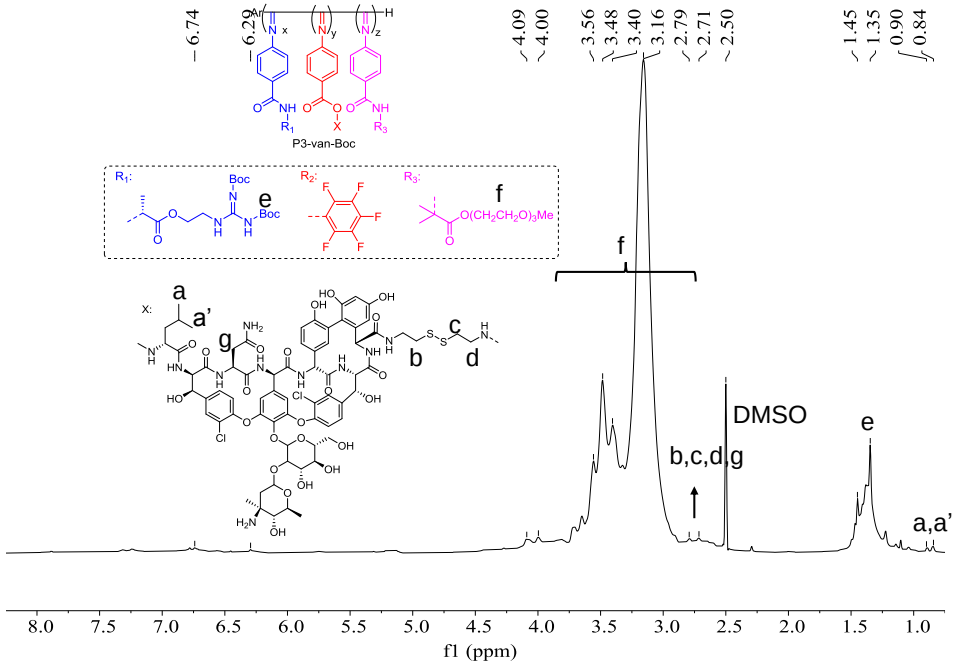


Figure S21. ^{1}H NMR (600 MHz) spectra of L-P3-van-Boc (DP_{OEG} = 50) measured in DMSO at 25 °C.

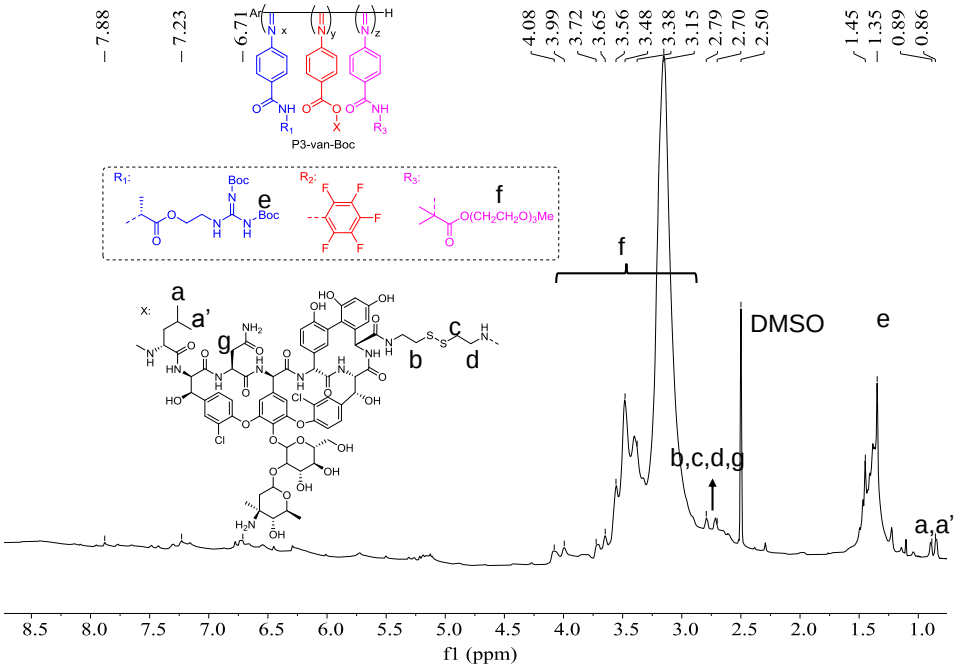


Figure S22 ^{1}H NMR (600 MHz) spectra of L-P3-van-Boc (DP_{Van} = 10) measured in DMSO at 25 °C.

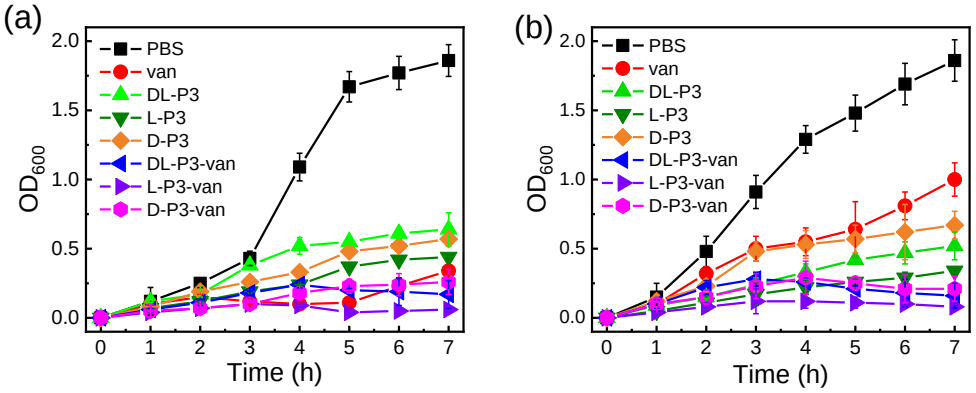


Figure S23. Growth curves of (a) *S. aureus* and (b) *E. coli* after exposure to different antimicrobial materials.

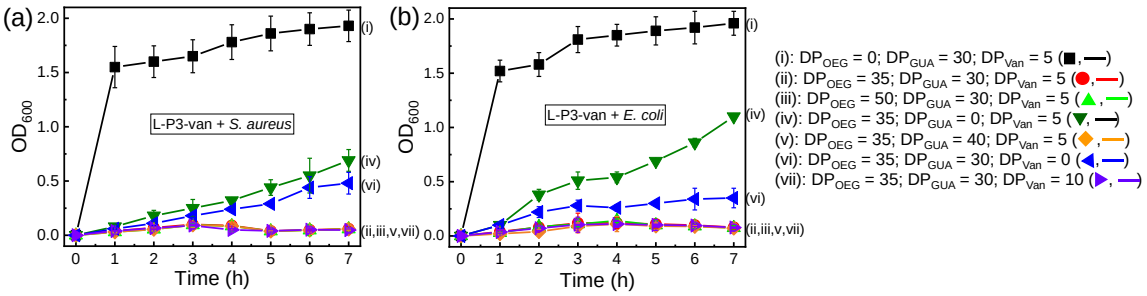


Figure S24. Growth curves of (a) *S. aureus* and (b) *E. coli* after exposure to antimicrobial materials with different feeding ratio.

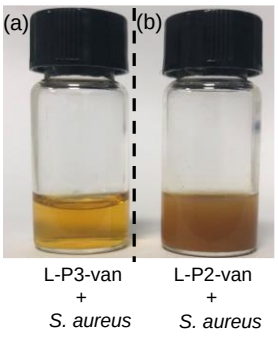


Figure S25. The photograph of the co-incubation of (a) L-P3-van and (b) L-P2-van with *S. aureus* in water at 25 °C.

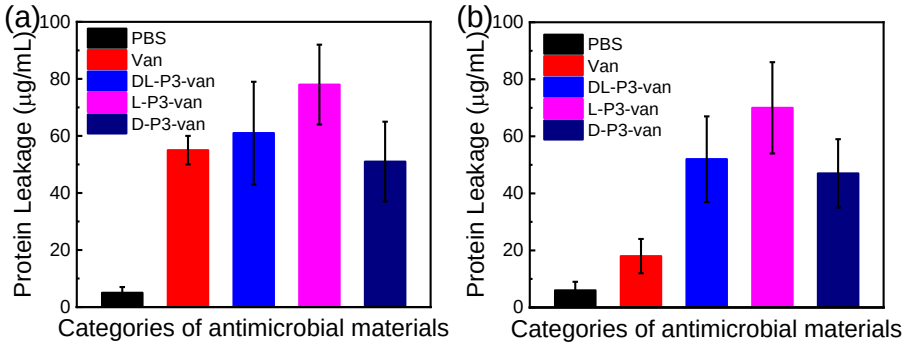


Figure S26. Protein leakage quantification of *S. aureus* (a) and *E. coli* (b) with different treatments.

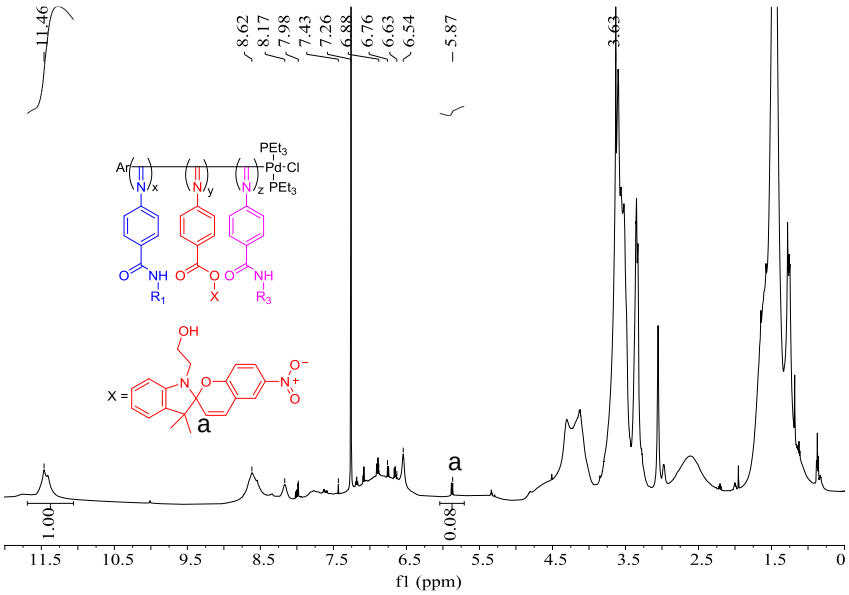


Figure S27. ^{1}H NMR (600 MHz) spectrum of L-P3-spi-Boc measured in $CDCl_3$ at 25 °C.

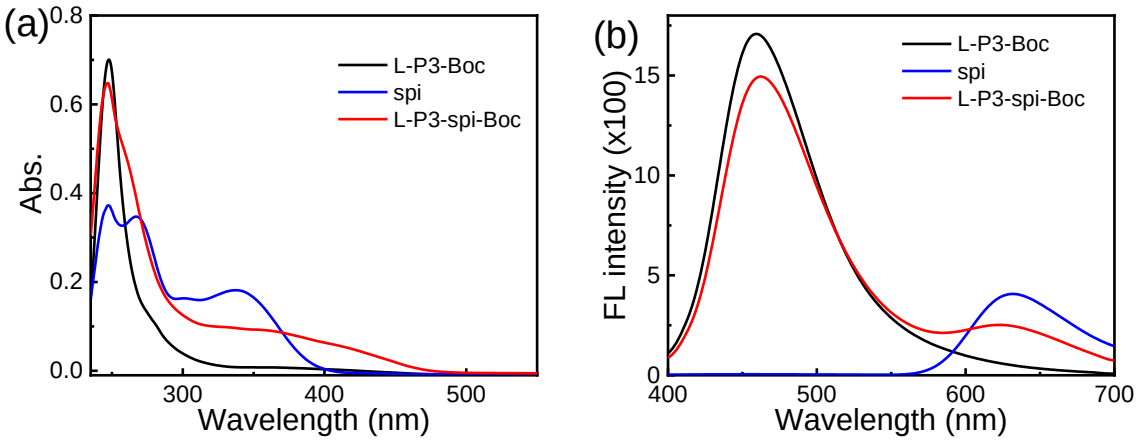


Figure S28. (a) UV spectra and (b) Fluorescent spectra of L-P3-Boc, spi. and L-P3-spi-Boc measured in THF at 25 °C.

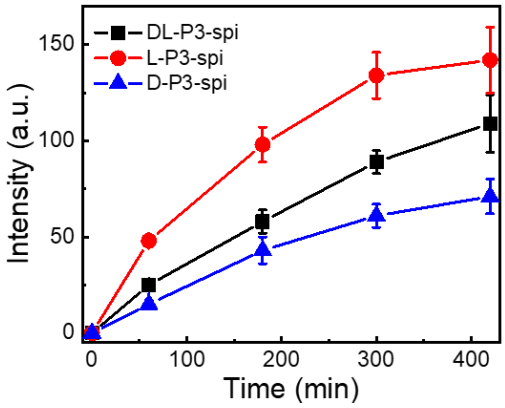


Figure S29. Fluorescence intensities per image for treated *S. aureus* with DL-P3-spi, L-P3-spi and D-P3-spi, as calculated by ImageJ software.

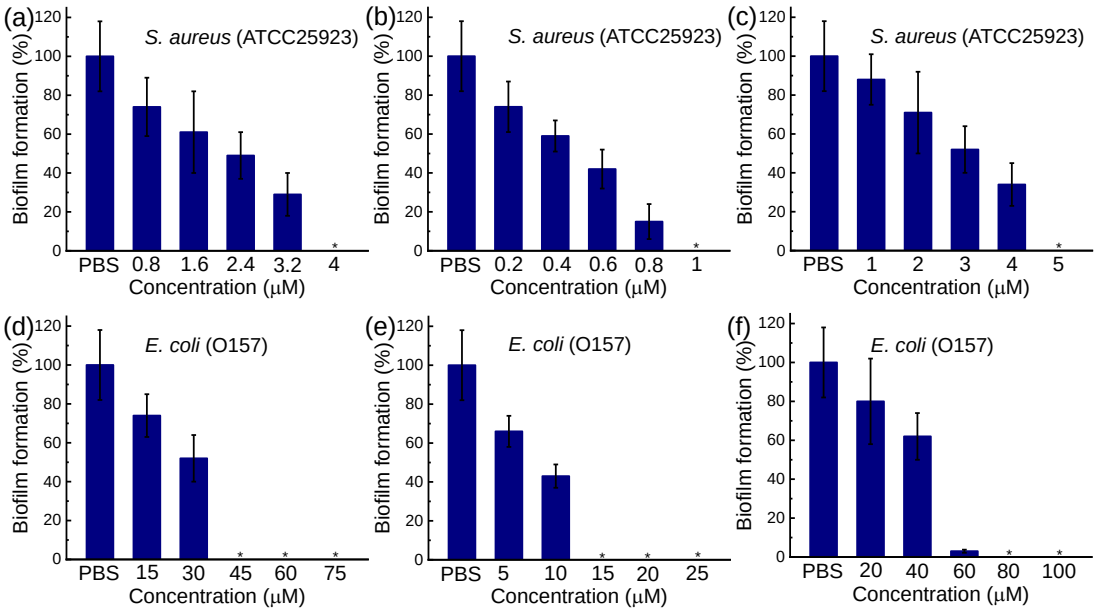


Figure S30. Inhibition of biofilm formation by DL-P3-van (a, d), L-P3-van (b, e) and D-P3-van (c, f) for *S. aureus* and *E. coli*. Data are presented as mean ± SD, n = 5.

The biofilm inhibition property of antibacterial material with different conformations were evaluated by crystal violet staining. The result was summarized in Figure S24. It could be noted that biofilm of *S. aureus* formation rate reached 50% at concentration of 2.4, 0.6 and 3 μM that corresponds to the $MBIC_{50}$ different conformational antimicrobial materials; for the biofilm of *E. coli*, the $MBIC_{50}$ of DL-P3-van, L-P3-van and D-P3-van corresponds to concentration of 30, 10 and 50 μM, respectively.

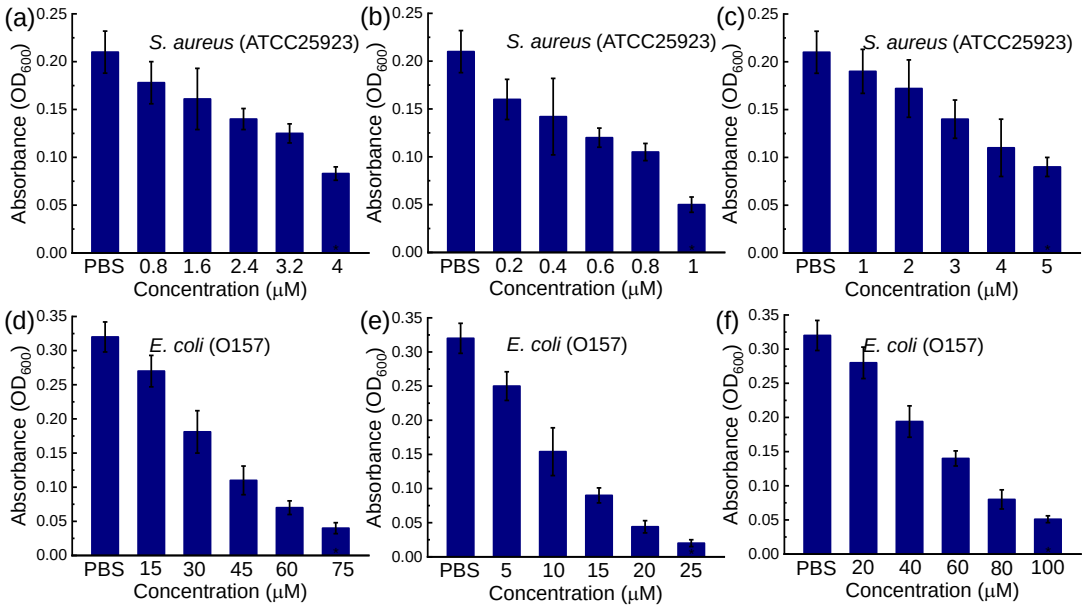


Figure S31. Biofilm eradication activity of DL-P3-van (a, d), L-P3-van (b, e) and D-P3-van (c, f) for *S. aureus* and *E. coli*. Data are presented as mean ± SD, n = 5.

Biofilm eradication activity was also performed in order to further demonstrate the biofilmdisrupting ability of antibacterial material with different conformations.[8] The result was shown in Figure S25, for the biofilm of *S. aureus*, the regrown OD_{600} of concentration 4, 1 and 5 μM for antibacterial materials DL-P3-van, L-P3-van and D-P3-van is less than 0.1, indicating that > 95 % clearance of bacteria, which demonstrated that these antibacterial materials are an active biofilm-eradicating compound at the concentration of 1-5 μM; for the biofilm of *E. coli*, the concentrations of DL-P3-van, L-P3-van, and D-P3-van showed good biofilm removal rates at 45, 15 and 70 μM, respectively.

References

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(2) J. Yin, L. Xu, X. Han, L. Zhou, C.-L. Li, Z.-Q. Wu, *Polym. Chem.* **2017**, *8*, 545–556.

(3) X. Han, J. Zhang, C.-Y. Qiao, W.-M. Zhang, J. Yin, Z.-Q. Wu, *Macromolecules* **2017**, *50*, 4114–4125.

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