Electronic Supporting Information

Integrated Molecular Functions in Photo-Generated Hydrogels for Wound Healing

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1. Materials and Synthesis

Materials. 1,8-Naphthalic anhydride, 1,6-Hexamethylenediamine, 1,10-Diaminodecane were procured from Shanghai Macklin Biochemical Technology Co., Ltd., 1,8-Diaminooctane, Iodomethane (CH_3I) were procured from Shanghai Aladdin Biochemical Technology Co., Ltd., CH_2Cl_2, CH_3OH were procured from Sinopharm Chemical Reagent Co., Ltd. All the reagents and solvents were used as received.

Methods. ^1H NMR spectra and ^{13}C NMR spectra were recorded on a Bruker AV400 NMR spectrometer operated in the Fourier transform mode at 400MHZ. Electrospray ionization (ESI) mass spectra were recorded on a LTQ ORBITRAP XL mass spectrometer (Thermo Scientific). UV/Vis spectra were recorded on a UV-1800 Shimadzu spectrometer.

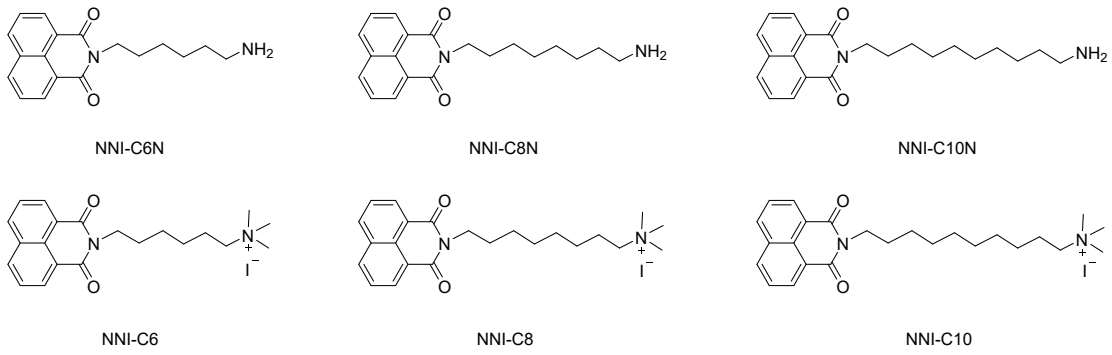

Figure S1. The structure of NNI-C6N, NNI-C8N, NNI-C10N, NNI-C6, NNI-C8 and NNI-C10

1.1 The synthesis of NNI-C6N

1,8-Naphthalic anhydride 1.0 g (5.05 mmol, 1.0 eq), 1,6-Hexamethylenediamine 1.17 g (10.07 mmol, 2.0 eq) and 10 mL DMF were added in a round-bottomed flask. The reaction mixture was stirred at 150 °C for 5 hours under N_2. The reaction mixture was concentrated in vacuo to remove DMF, and the crude product was purified by column chromatography (1:10 CH_3OH/DCM) to provide the desired product as yellow solid (0.85g, 57%). ^1H NMR (400 MHz, $CDCl_3$) 8.61 (dd, J = 7.3, 1.0 Hz, 2H), 8.20 (dd, J = 8.3, 0.9 Hz, 2H), 7.76 (dd, J = 8.1, 7.4 Hz, 2H), 4.18 (m, 2H), 2.68 (t, J = 6.7 Hz, 2H), 1.75 (dt, J = 15.0, 7.7 Hz, 2H), 1.48-1.40 (m, 8H).

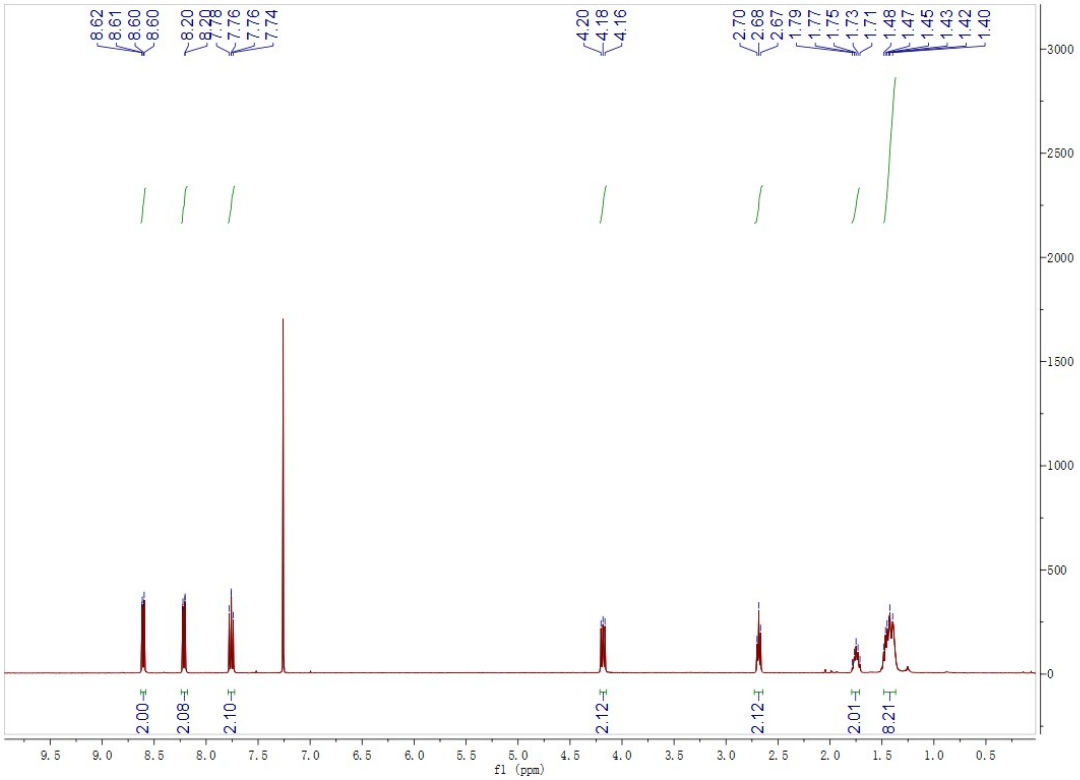

Figure S2. The ^1H NMR spectrum of NNI-C6N

1.2 The synthesis of NNI-C8N

1,8-Naphthalic anhydride 1.0g (5.05 mmol, 1.0 eq), 1,8-Diaminooctane1.17 g (10.07 mmol, 2.0 eq) and 10 mL DMF were added in a round-bottomed flask. The reaction mixture was stirred at 150 ^{o}C for 5 hours under N_2. The reaction mixture was concentrated in vacuo to remove DMF, and the crude product was purified by column chromatography (1:10 CH_3OH/DCM) to provide the desired product as yellow solid (0.78g, 48%).^{1}H NMR (400 MHz, CDCl3) 8.59 (dd, 2H), 8.20 (dd, 2H), 7.74 (dd, J = 14.6, 6.6 Hz, 2H), 4.16 (dd, J = 14.2, 6.6 Hz, 2H), 2.70 (t, J = 7.1 Hz, 1H), 1.72 – 1.69 (m, 2H), 1.48 – 1.25 (m, 12H).

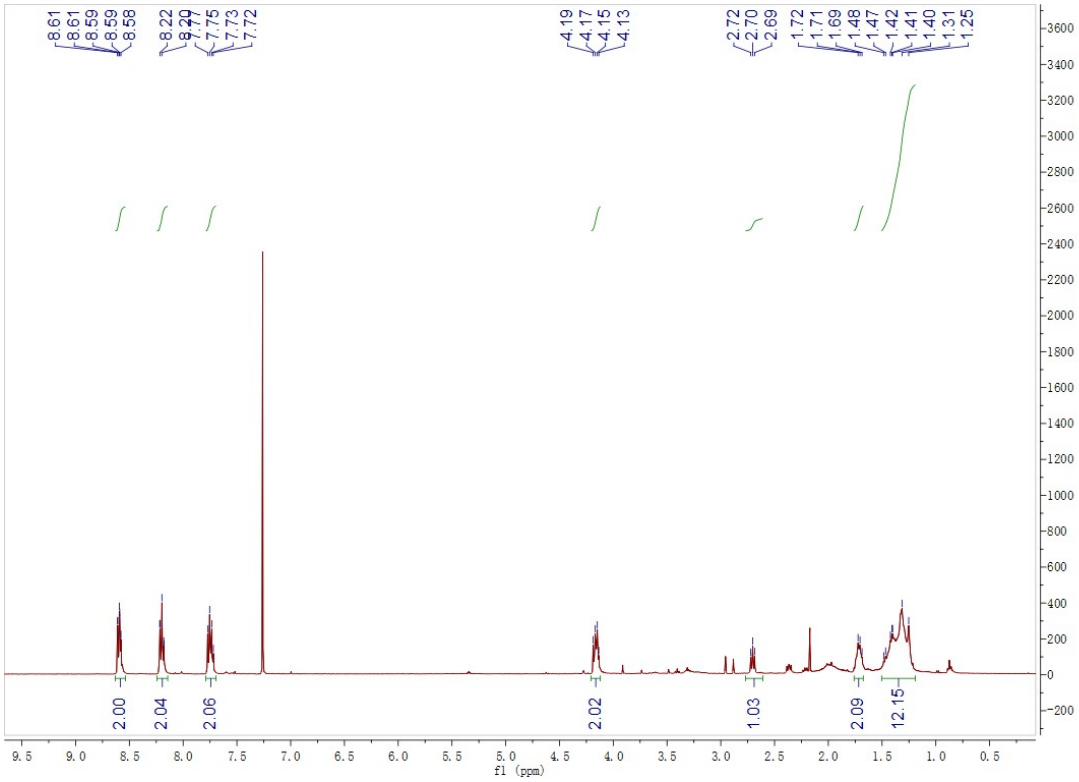

Figure S3. The ^{1}H NMR spectrum of NNI-C8N

1.3 The synthesis of NNI-C10N

1,8-Naphthalic anhydride 1.0g (5.05 mmol, 1.0 eq), 1,10-Diaminodecane1.89 g (10.96 mmol, 2.0 eq) and 10 mL DMF were added in a round-bottomed flask. The reaction mixture was stirred at 150 ^{o}C for 5 hours under N_2. The reaction mixture was concentrated in vacuo to remove DMF, and the crude product was purified by column chromatography (1:10 CH_3OH/DCM) to provide the desired product as yellow solid (0.97g, 55%).

^{1}H NMR (400 MHz, CDCl3) 8.60 (dd, 2H), 8.20 (dd, 2H), 7.76 (dd, 2H), 4.17 (m, 2H), 2.72 (t, J = 7.1 Hz, 1H), 1.72 (m, J = 14.0, 6.7 Hz, 2H), 1.48 – 1.26 (m, 16H).

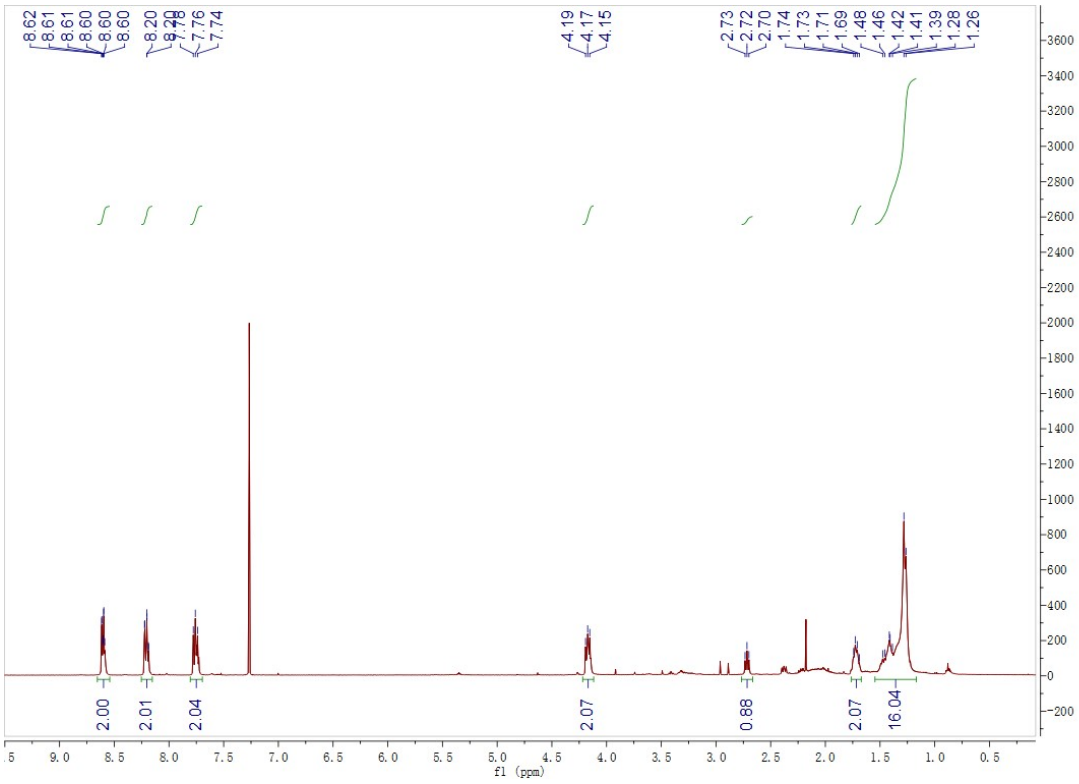

Figure S4. The ^{1}H NMR spectrum of NNI-C10N

1.4 The synthesis of NNI-C6

NNI-C6N 0.5 g (1.69 mmol, 1.0 eq), CH_3I 1.44 g (10.12 mmol) and K_2CO_3 1.40 g (10.12 mmol, 6.0 eq) and 10 mL CH_3OH were added in a round-bottomed flask. The reaction mixture was stirred at 50 °C for 8 hours under N_2. The reaction mixture was concentrated in vacuo to remove CH_3OH, and the crude product was washed by pure water to get white solid (0.69 g, 87.7%). ^{1}H NMR(400 MHz, DMSO) 8.48 (t, 4H), 7.88 (t, J = 7.8 Hz, 2H), 4.06 (t, 2H), 3.29 (m, 2H), 3.05 (s, 9H), 1.68 (m, J = 6.8 Hz, 4H), 1.38 (m, 4H); ^{13}C NMR (101 MHz, DMSO) 163.90, 134.84, 131.78, 131.22, 127.74, 122.50, 65.76, 52.63, 27.82, 26.51, 26.07, 22.47; HRMS (ESI+): calculated: 339.2067; found: 339.2071.

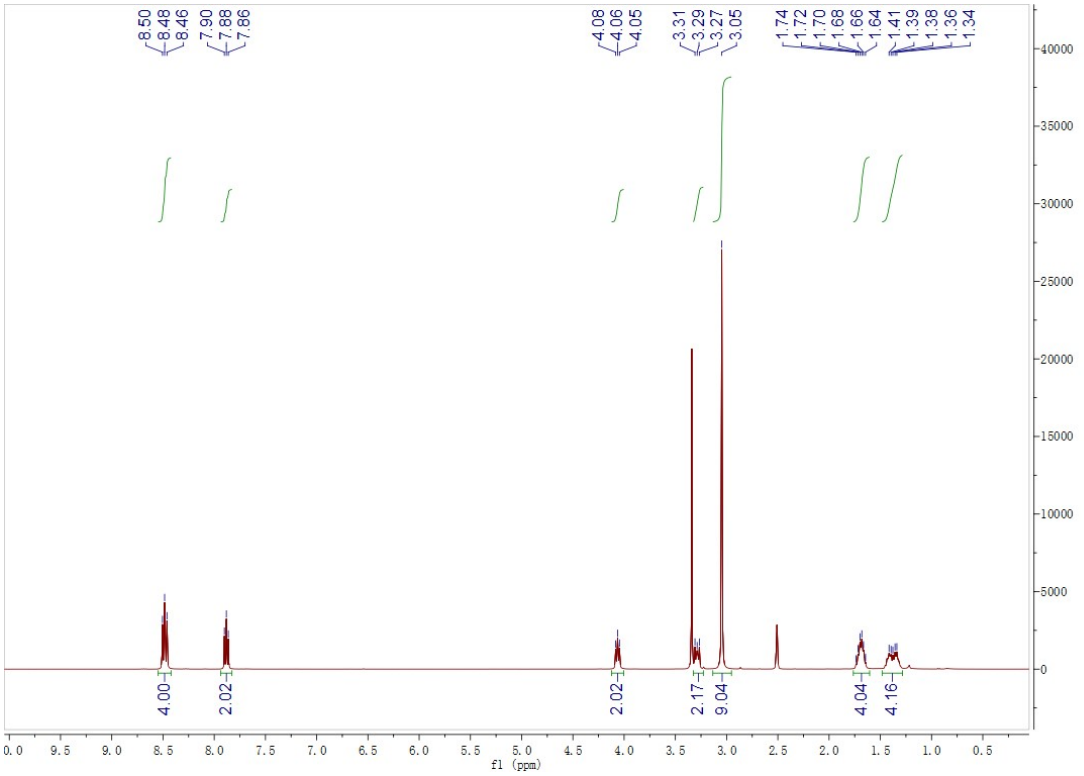

Figure S5. The ^{1}H NMR spectrum of NNI-C6

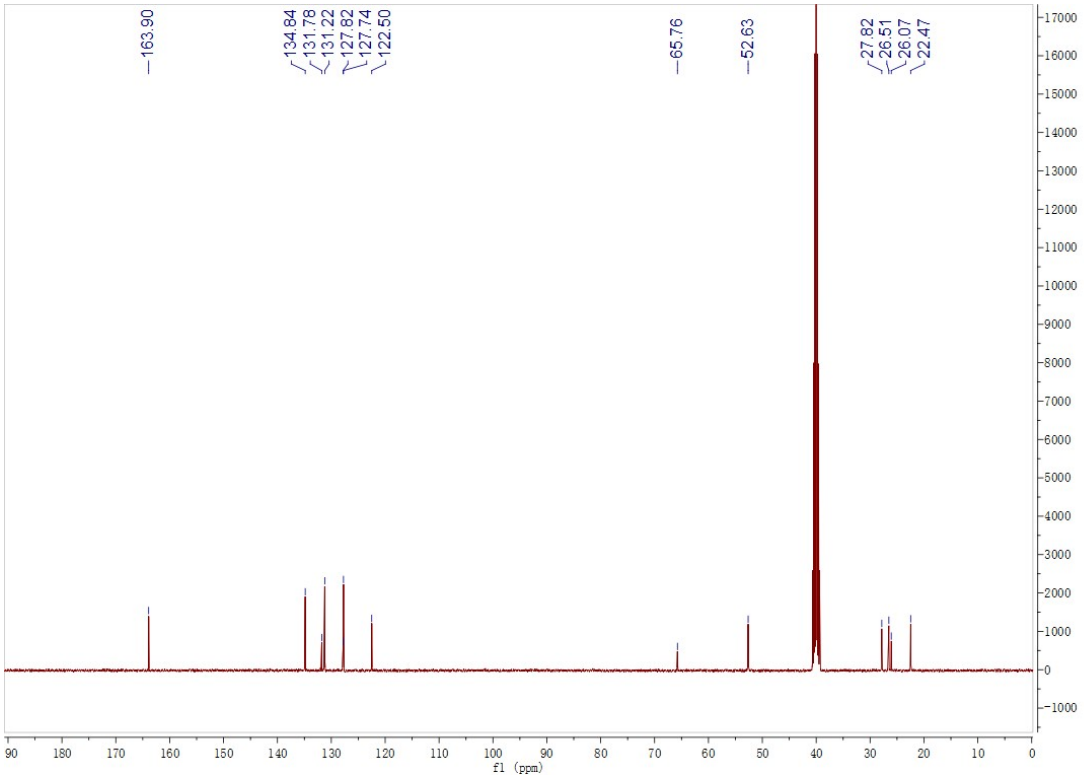

Figure S6. The ^{13}C NMR spectrum of NNI-C6

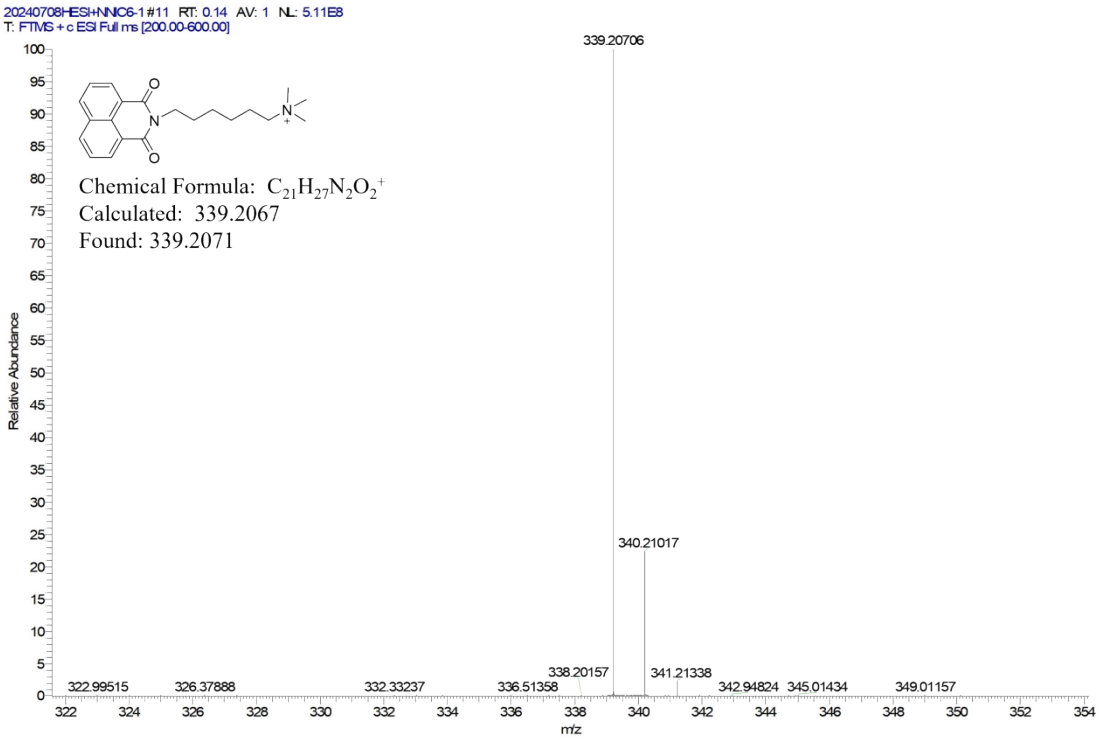

Figure S7. The ESI mass spectrum of NNI-C6

1.5 The synthesis of NNI-C8

NNI-C8N 0.5 g (1.54 mmol, 1.0 eq), CH_3I 1.31 g (9.24 mmol, 6.0 eq) and K_2CO_3 1.28 g (9.24 mmol, 6.0 eq) and 10 mL CH_3OH were added in a round-bottomed flask. The reaction mixture was stirred at 50 ^oC for 8 hours under N_2. The reaction mixture was concentrated in vacuo to remove CH_3OH, and the crude product was washed by pure water to get white solid (0.68 g, 89.5%). ^1H NMR(400 MHz, DMSO) 8.47 (t, 4H), 7.87 (t, J = 7.8 Hz, 2H), 4.04 (t, 2H), 3.28 (m, 2H), 3.04 (s, 9H), 1.66 (m, J = 6.8 Hz, 4H), 1.35 (m, 8H); ^{13}C NMR (101 MHz, DMSO) 163.87, 134.81, 131.77, 131.20, 127.80, 127.73,122.49, 65.74 , 52.63, 28.92, 27.90, 26.90, 26.12, 22.44; HRMS (ESI+): calculated: 367.2380; found: 367.2382.

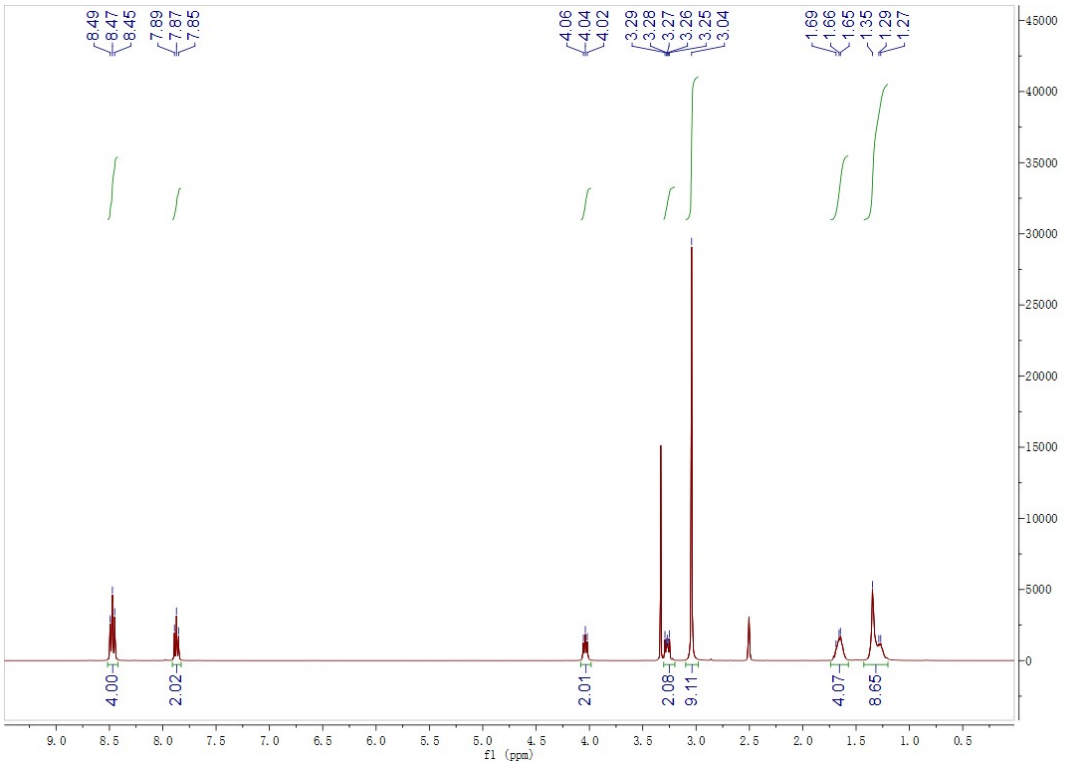

Figure S8. The ^{1}H NMR spectrum of NNI-C8

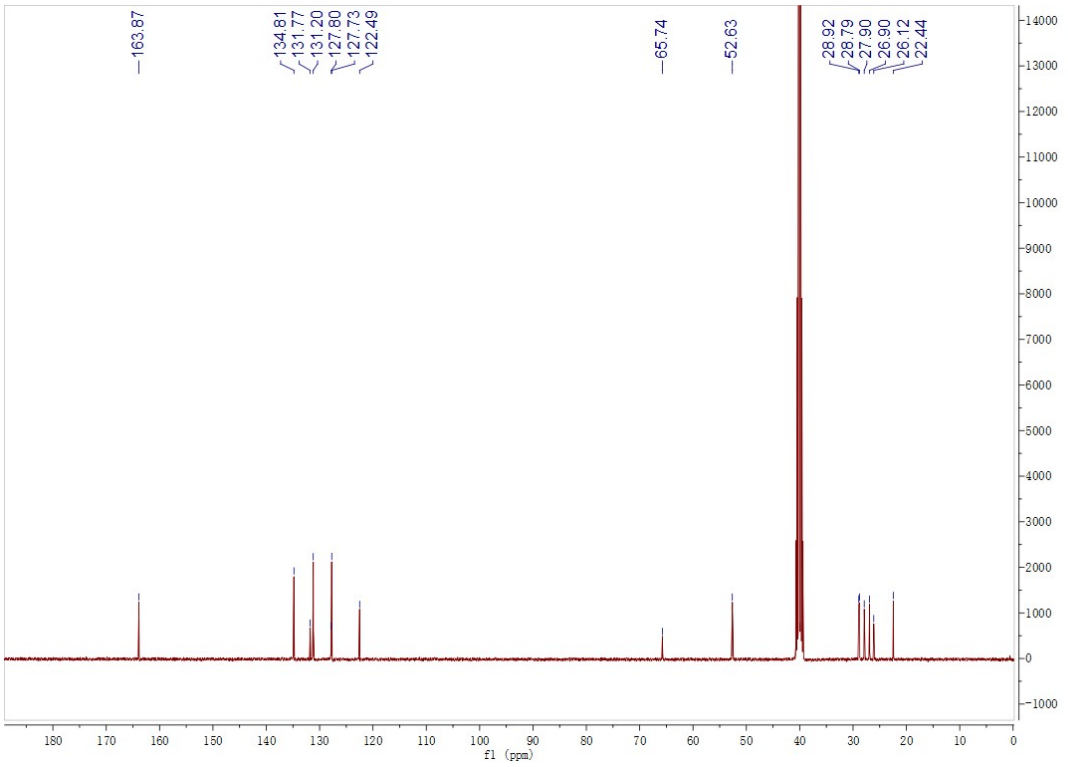

Figure S9. The ^{13}C NMR spectrum of NNI-C8

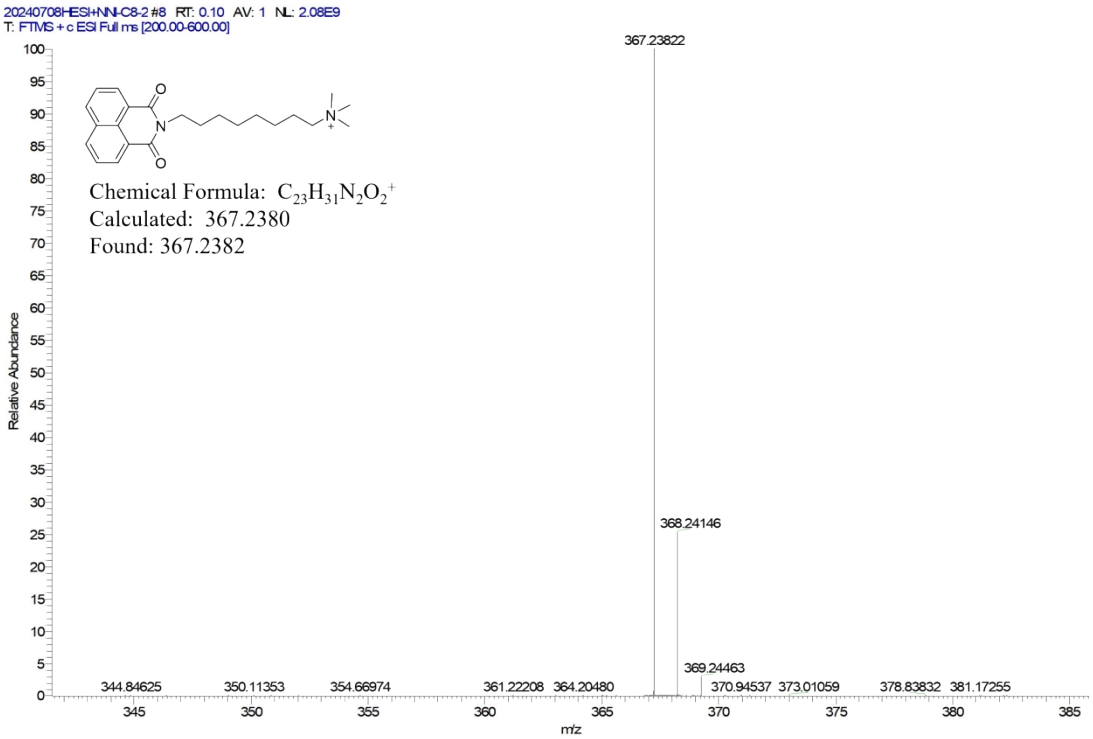

Figure S10. The ESI mass spectrum of NNI-C8

1.6 The synthesis of NNI-C10

NNI-C10N 0.5 g (1.42 mmol, 1.0 eq), CH_3I 1.21 g (8.52 mmol, 6.0 eq) and K_2CO_3 1.28 g (9.24 mmol, 6.0 eq) and 10 mL CH_3OH were added in a round-bottomed flask. The reaction mixture was stirred at 50 °C for 8 hours under N_2. The reaction mixture was concentrated in vacuo to remove CH_3OH, and the crude product was washed by pure water to get white solid (0.68 g, 89.5%). ^1H NMR(400 MHz, DMSO) 8.46 (t, J = 8.0 Hz, 4H), 7.86 (t, J = 8.1, 7.4 Hz, 2H), 4.02 (t, 2H), 3.26 (m, 2H), 3.04 (s, 9H), 1.63 (m, 4H), 1.27 (d, J = 16.2 Hz, 12H); ^{13}C NMR (101 MHz, DMSO) 163.85, 134.79, 131.76, 131.18, 127.80, 127.71, 122.49, 65.77, 52.63, 29.23-28.90 (m), 27.91, 26.98, 26.17, 22.48; HRMS (ESI+): calculated: 395.2693; found: 395.2695.

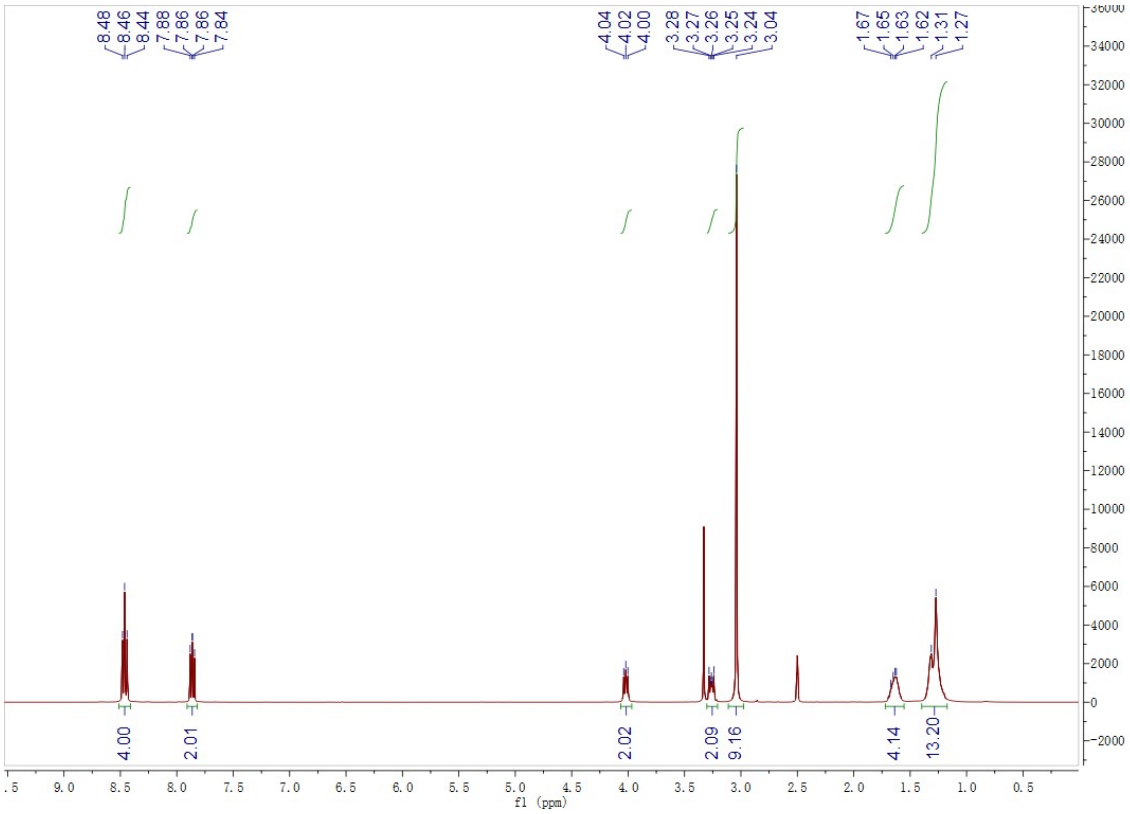

Figure S11. The ^{1}H NMR spectrum of NNI-C10

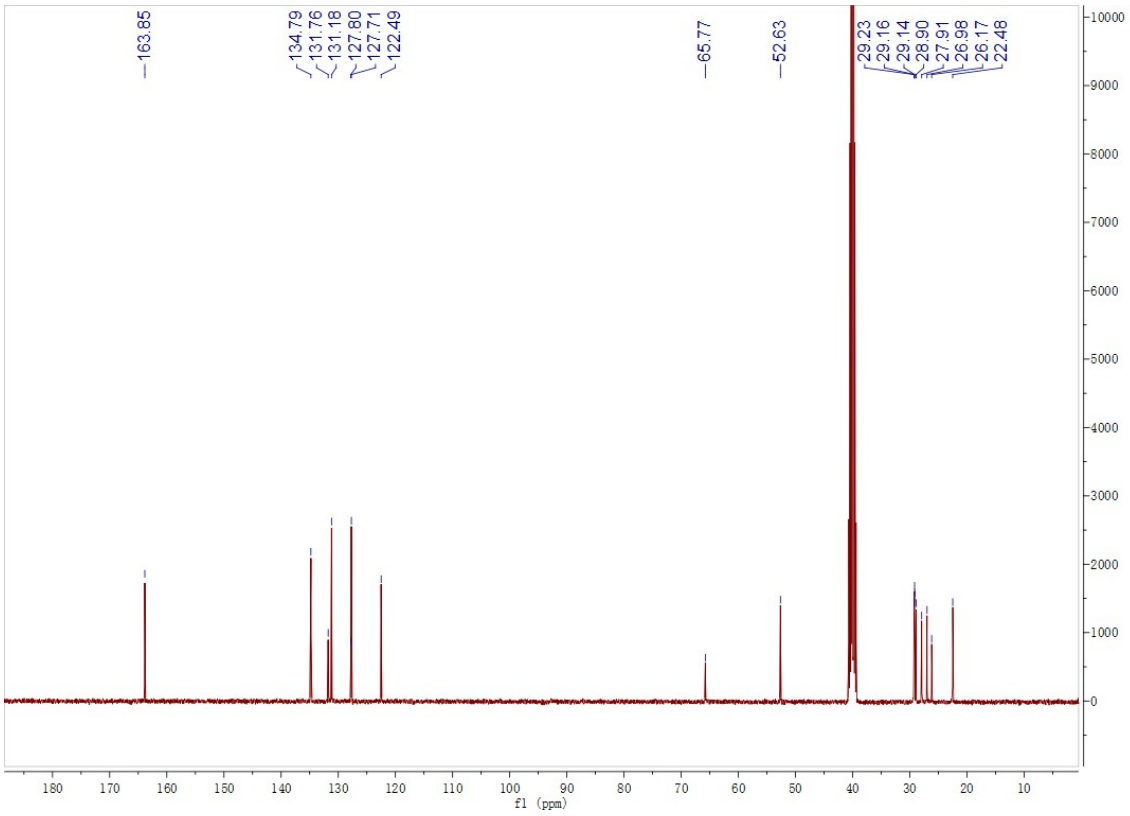

Figure S12. The ^{13}C NMR spectrum of NNI-C10

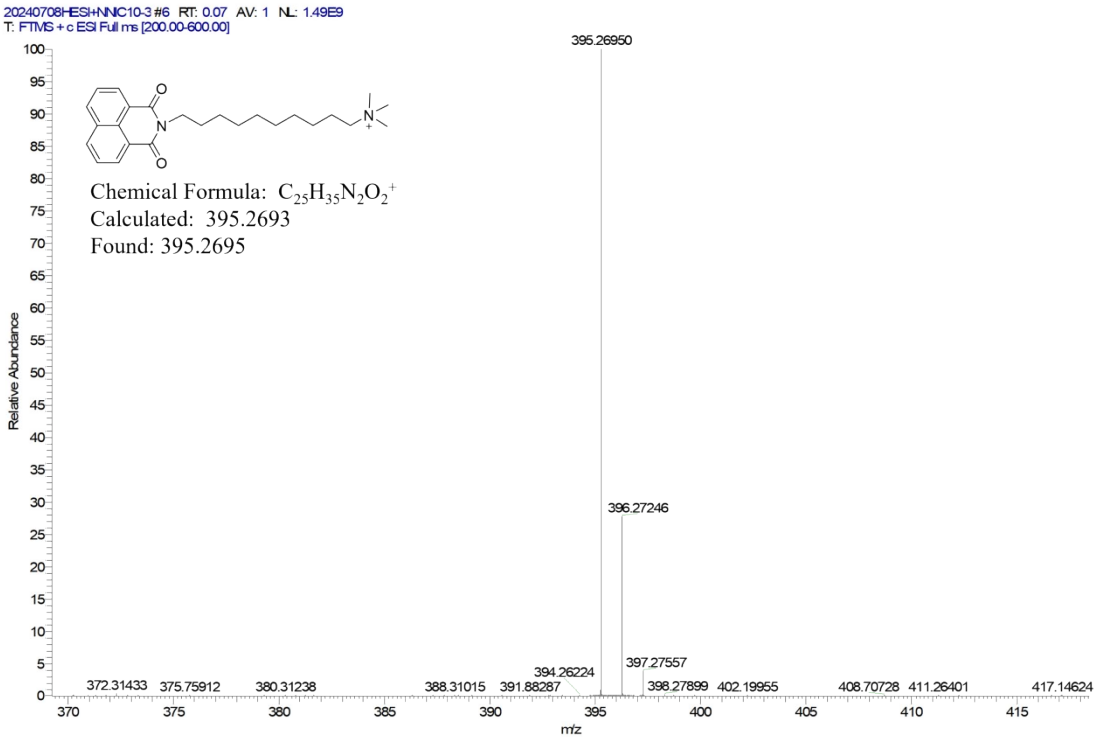

Figure S13. The ESI mass spectrum of NNI-C10

Table S1. The absorption of NNIs solutions (saline) with various concentration

Samples	Concentration (mg mL^{-1})	Absorbance (365 nm)
NNI-C6	0.074	1.011
	0.052	0.702
	0.037	0.544
	0.019	0.287
	0.011	0.143
NNI-C8	0.076	1.022
	0.051	0.709
	0.038	0.548
	0.019	0.284
	0.009	0.14
NNI-C10	0.077	0.938
	0.049	0.645
	0.039	0.506

	0.020	0.277
	0.012	0.135

Table S2. Antibacterial performance of NNI solutions (in physiological saline) against *S. Aureus*

Samples		Control (CFU mL^{-1})	(CFU mL^{-1})	Log_{10} reduction	Reduction rate (%)
NNI-C6	1	3.6×10^7	4.5×10^6	0.90	87.500
	2	2.5×10^7	3.2×10^6	0.89	87.200
	3	4.7×10^7	5.3×10^6	0.95	88.723
NNI-C8	1	3.6×10^7	<10	>5	>99.999
	2	2.5×10^7	<10	>5	>99.999
	3	4.7×10^7	<10	>5	>99.999
NNI-C10	1	3.6×10^7	1.8×10^5	2.30	99.500
	2	2.5×10^7	1.7×10^5	2.17	99.320
	3	4.7×10^7	2.5×10^5	2.27	99.468

Table S3. The hemolysis rate of Hydrogel 3 and 0.0001% benzalkonium chloride solution (w/w)

Samples	Absorbance (545 nm)	Hemolysis rate (%)
Saline (Negative control)	0.023	--
Pure water (Positive control)	1.055	--
Hydrogel 3	0.026	0.29

Table S4. Antibacterial performance of Hydrogel 3 against *E. Coli, S. Aureus, P. Aeruginosa, S. Epidermidis, and MRSA*. The log_{10} reduction and reduction rate (%) demonstrate the superior antibacterial efficacy of Hydrogel 3

Bacteria	Sample	Control (CFU mL^{-1})	(CFU mL^{-1})	Log_{10} reduction	Reduction rate (%)
E. Coli 8099	1	1.9×10^7	<10	>5	>99.999
	2	2.1×10^7	<10	>5	>99.999
	3	1.8×10^7	<10	>5	>99.999
S. Aureus ATCC 6538	1	3.6×10^7	<10	>5	>99.999
	2	4.5×10^7	<10	>5	>99.999
	3	2.7×10^7	<10	>5	>99.999
P. Aeruginosa ATCC 15442	1	1.2×10^8	<10	>5	>99.999
	2	1.5×10^8	<10	>5	>99.999
	3	8.9×10^7	<10	>5	>99.999
S. Epidermidis CMCC 26069	1	3.6×10^7	<10	>5	>99.999
	2	2.9×10^7	<10	>5	>99.999
	3	4.7×10^7	<10	>5	>99.999
MRSA 2654	1	1.9×10^7	168	>5	>99.999
	2	2.2×10^7	189	>5	>99.999
	3	2.1×10^7	153	>5	>99.999