Electronic Supplementary Material (ESI) for ChemComm.

In Situ Generation of Redox Active Peptides Driven by Selenoester Mediated Native Chemical Ligation

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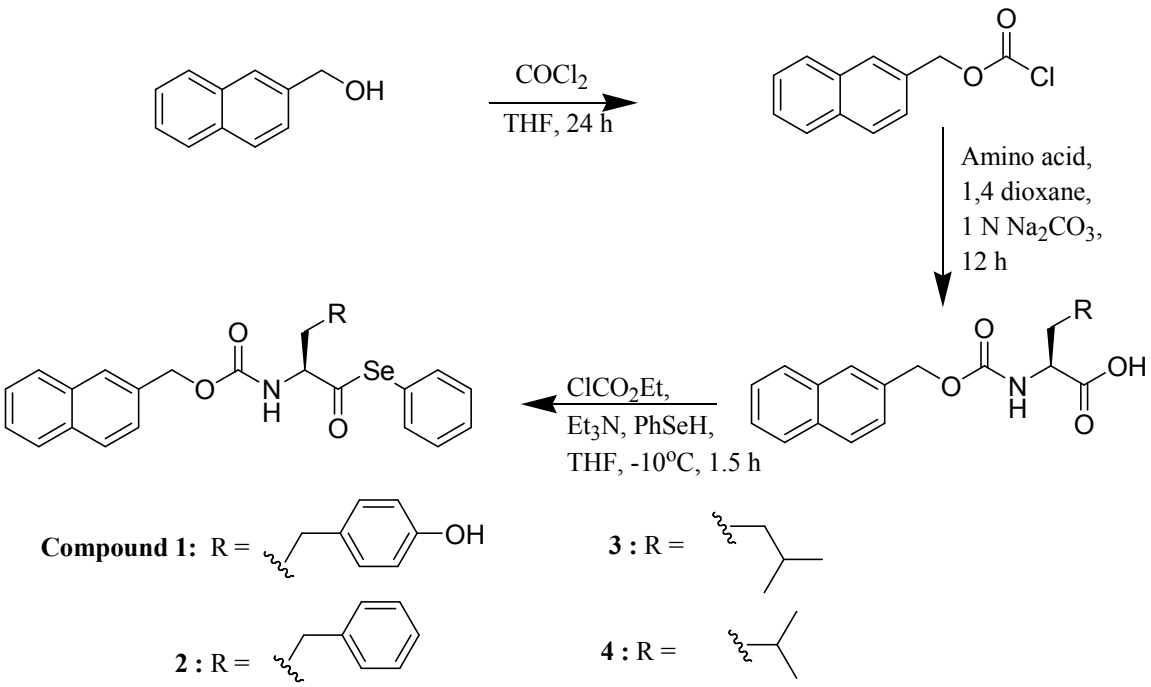
Morphology study
Experimental procedure
^{1}H and ^{13}C NMR spectra of compounds

General Methods.

All the chemicals and reagents were obtained commercially. All NMR spectra were recorded with 400 MHz Bruker AV400 NMR. Compounds concentrations were in the range of 1-10 mmol L^{-1} in $(CD_3)_2SO$ and $CDCl_3$. Mass spectra were recorded on Bruker micrOTOF-Q II by positive and negative mode electrospray ionisations. All the reported FT-IR spectra were taken using Bruker (Tensor 27) FT-IR spectrophotometer. Specific rotations of the synthesized compounds were measured on an Autopol^{R} V automatic polarimeter (Rudolph research analytical). The cell (length = 100 mm, capacity = 2 mL) was used for this study at 25 °C.

Synthetic Scheme

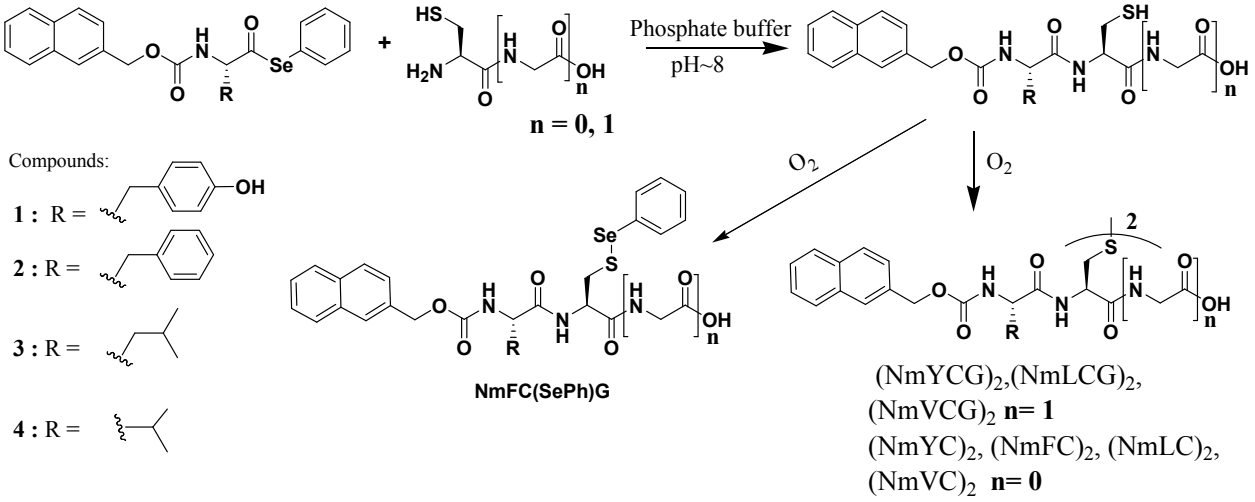
Scheme 1:



Ligation Reactions with selenoesters

Compounds **1-4** (20 mmol L^{-1}) were dissolved in 100 µL of ethanol and Cys or Cys-Gly (20 mmol L^{-1}) was dissolved in 900 µL of phosphate buffer (pH = 8, 100 mmol L^{-1}). 900 µL of Cys or Cys-Gly was added to the reaction vial containing compounds **1** to **4**. The reaction vial was allowed to leave undisturbed. Self-assembly was observed for ligated product NmYCG, NmFC(SePh)G and (NmFC) within 1h upon ligation. All the reaction products of selenoesters were analyzed by HPLC. The reactions are very fast at room temperature and give more than 99 % conversion.

Scheme 2:



Gel melting temperature

Gel melting temperatures of resulting gels were determined by test tube inversion method. The experiment was performed with 5 mL of glass vial (diameter 10 mm). The temperature was increased at 1°C min^{-1}. Gel-sol transition of gels was observed at different concentration of gelators. The gel melting temperature (T_{gel}) increases as the concentration of gelator molecules increases. Thus, it reveals that nanofibrillar network in gel phase is stronger at higher concentration. Gelation temperature was observed at 70 °C, 71 °C and 65 °C at 20 mmol L^{-1} for NmYCG, NmFC(SePh)G and $(NmFC)_2$ gels respectively.

Table S1. Concentration dependence gelation temperature (T_{gel} / °C) of gels

Sr. No.	**Concentration (mmol L^{-1})**	**NmYCG gel**	**NmFC(SePh)G gel**	**$(NmFC)_2$ gel**
1	5 mmol L^{-1}	46 °C	48 °C	48 °C
2	8 mmol L^{-1}	55 °C	56 °C	54 °C
3	10 mmol L^{-1}	59 °C	60 °C	57 °C
4	15 mmol L^{-1}	64 °C	66 °C	62 °C
5	20 mmol L^{-1}	70 °C	71 °C	65 °C

Ligation reactions with thioesters

Compounds **5-8** (20 mmol L^{-1}) were dissolved in 100 µL of ethanol and Cys or Cys-Gly (20 mmol L^{-1}) was dissolved in 900 µL of phosphate buffer (pH = 8, 100 mmol L^{-1}). 900 µL of Cys or Cys-Gly was added to the reaction vial containing compounds **5** to **8**. The reaction vial was allowed to leave undisturbed. Self-assembly was not observed for any ligated products due to poor conversion of desired peptides. The ligated product **NmYCG** could not form gel rather than a viscous solution, which was obtained from reaction of Cys-Gly with NmY-SPh thioester. The HPLC conversion is higher for **NmYCG** compare to other thioesters.

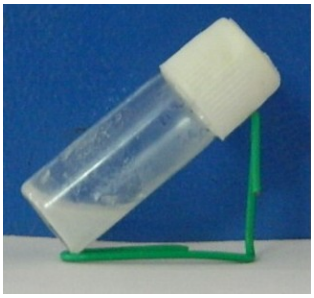


Fig. S1. Optical image of ligated product **NmYCG** upon reaction of NmY-SPh thioester with Cys-Gly. **NmYCG** was unable to form gel due to lower conversion.

Table S2. Native chemical ligation reactions with different thioesters

Entry	Substrate	Cys-Gly[a] and Cys[b]	Product conversion in inert atm. [%]	Product conversion in air [%]	Gel/ Sol[c]
1.	NmY-SPh **5**	Cys-Gly	62.33 NmYCG	28.53 $(NmYCG)_2$	S
2.	NmF-SPh **6**	Cys-Gly	0 NmFCG	0 $(NmFCG)_2$	S
3.	NmL-SPh **7**	Cys-Gly	7.47 NmLCG	7.16 $(NmLCG)_2$	S
4.	NmV-SPh **8**	Cys-Gly	0 NmVCG	0 $(NmVCG)_2$	S
5.	NmY-SPh **5**	Cysteine	92.86 NmYC	90.5 $(NmYC)_2$	S
6.	NmF-SPh **6**	Cysteine	16.14 NmFC	8.13 $(NmFC)_2$	S
7.	NmL-SPh **7**	Cysteine	80.79 NmLC	78.03 $(NmLC)_2$	S
8.	NmV-SPh **8**	Cysteine	27.74 NmVC	26.03 $(NmVC)_2$	S

[a]Cys-Gly dipeptide, [b]Cysteine, [c]G = gel, S = solution

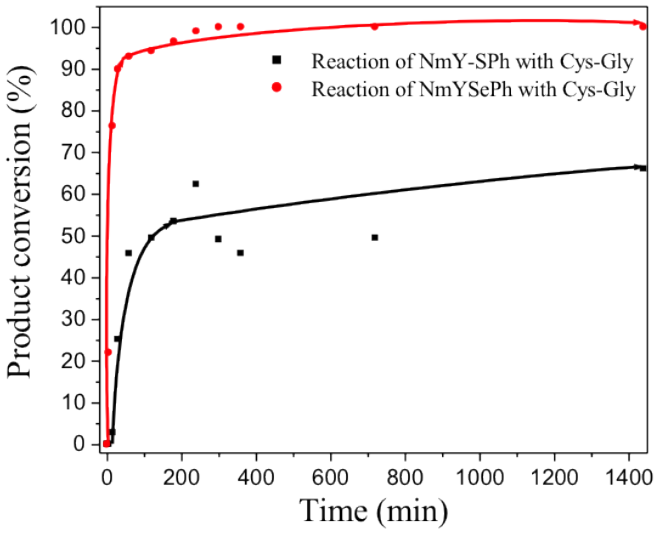


Fig. S2. HPLC analysis for **NmYCG** formation as function of time upon reaction of **NmY-SePh** and **NmY-SPh** with **Cys-Gly**. Selenoester gives 90% **NmYCG** conversion at 30 min while only 25% **NmYCG** conversion was observed from thioester at 30 min.

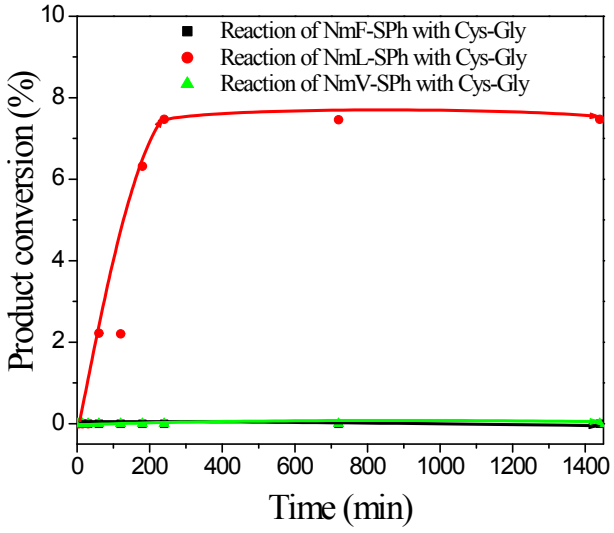
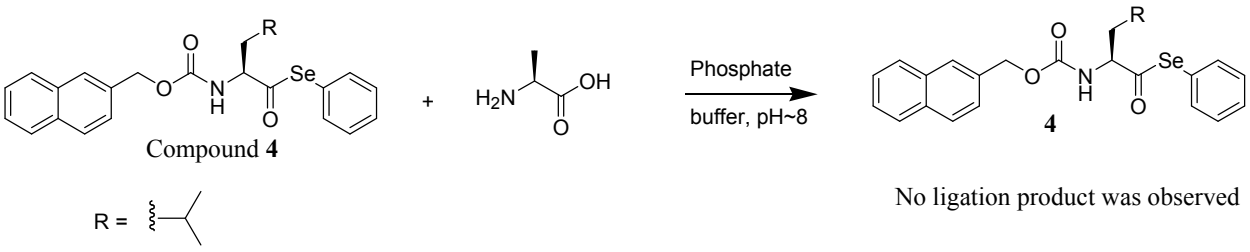


Fig. S3. HPLC analysis for product **NmFCG**, **NmLCG** and **NmVCG** formation as function of time upon reaction of **NmF-SPh**, **NmL-SPh** and **NmV-SPh** with cysteine.

Control experiment

Compound **4** NmVSePh (20 mmol L^{-1}, 8.8 mg) was dissolved in 100 μL of ethanol. A solution of alanine (20 mmol L^{-1}, 3.5 mg) in phosphate buffer (900 μL, pH~8) was mixed together and left undisturbed at room temperature for 1 h. HPLC analysis showed no product conversion with alanine at 1 h, 12 h and even after keeping the solution for long time, which confirms the reaction path and requirement of N-terminal cysteine residue.



Compound **4**

R =

No ligation product was observed

HPLC Analysis

A Dionex HPLC-Ultimate 3000 (High Performance Liquid Chromatography) pump was used to analyze native chemical ligated products. 20 μL of sample was injected onto a Dionex Acclaim ® 120 C 18 column of 250 mm length with an internal diameter 4.6 mm and 5 μm fused silica particles at a flow rate of 1 mL min^{-1} (linear gradient of 40% v/v) acetonitrile in water for 35 min, gradually rising to 100% (v/v) acetonitrile in water at 35 min). This concentration was kept constant until 40 min when the gradient was decreased to 40% (v/v) acetonitrile in water at 42 min. The sample preparation was involved mixing of 100 μL of gel/solution with acetonitrile-water (900 μL, 50: 50 mixture) containing 0.1% trifluoroacetic acid. The samples were then filtered through a 0.45 μm syringe filter (Whatman, 150 units, 13 mm diameter, 2.7 mm pore size) prior to injection. The native chemical ligated products were identified by using Ultimate 3000 RS Variable Wavelength Detector at 280 nm.

Quantitative analysis was done using 2-naphthalene methanol (retention time 10.4 min) as an internal standard. A linear relationship at detection wavelength λ = 280 nm was obtained with different milimolar ratios of starting material (NmYSePh) and 2-naphthalene methanol keeping a constant concentration of 2-naphthalene methanol. The approximate yields of Nmoc based ligated products were calculated from HPLC based on starting materials (Nmoc based selenoesters/thioesters) consumption by integrating the peak areas of starting materials ($area_{sm}$) and Nmoc based product peaks ($area_{pdt}$) and calculating the ratio $area_{pdt}$ / ($area_{pdt}$ + $area_{sm}$) at detection wavelength λ = 280 nm.

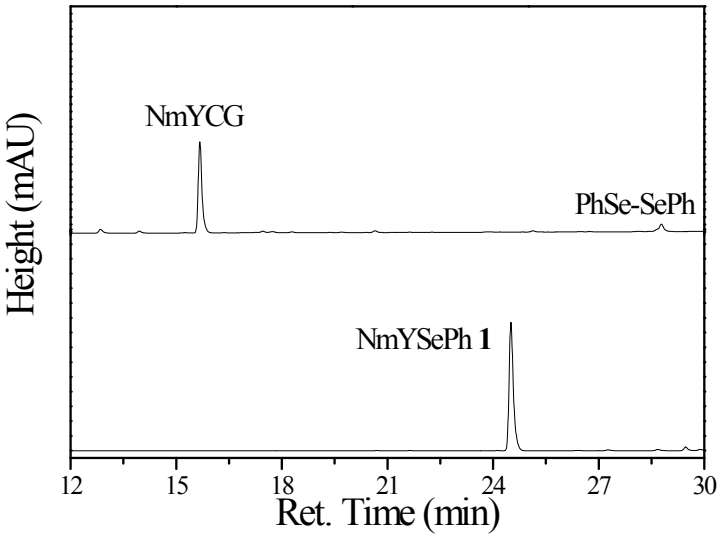


Fig. S4: Overlaid HPLC chromatograms for compound **1** showing peak **NmYCG** after native chemical ligation in air as well as in inert atmosphere.

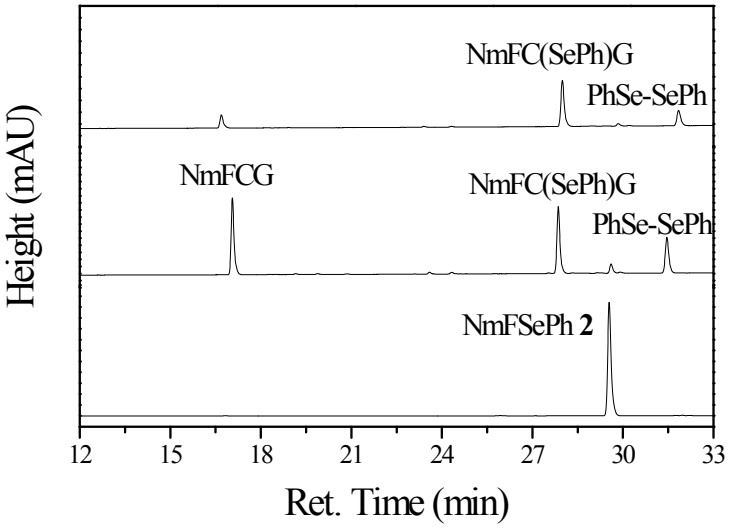


Fig. S5: Overlaid HPLC chromatograms for compound **2** showing peaks **NmFCG** in inert condition after native chemical ligation and sulfur selenide bond of ligated product **NmFC(SePh)G** in air.

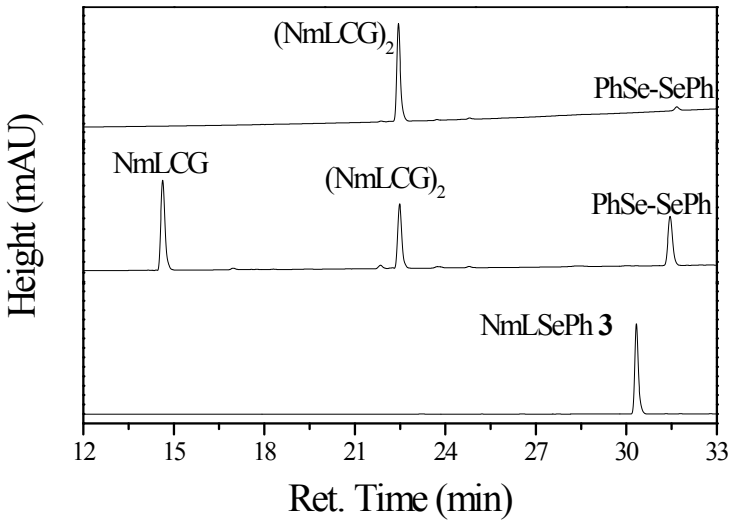


Fig. S6: Overlaid HPLC chromatograms for compound **3** showing peaks **NmLCG** in inert condition after native chemical ligation and **$(NmLCG)_2$** disulfide of ligated product in air.

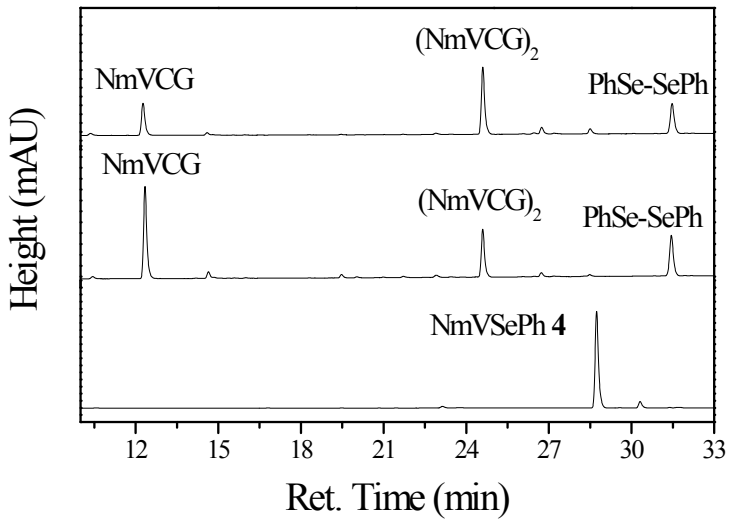


Fig. S7: Overlaid HPLC chromatograms for compound **4** showing peak **NmVCG** in inert condition after native chemical ligation and **$(NmVCG)_2$** disulfide of ligated product in air.

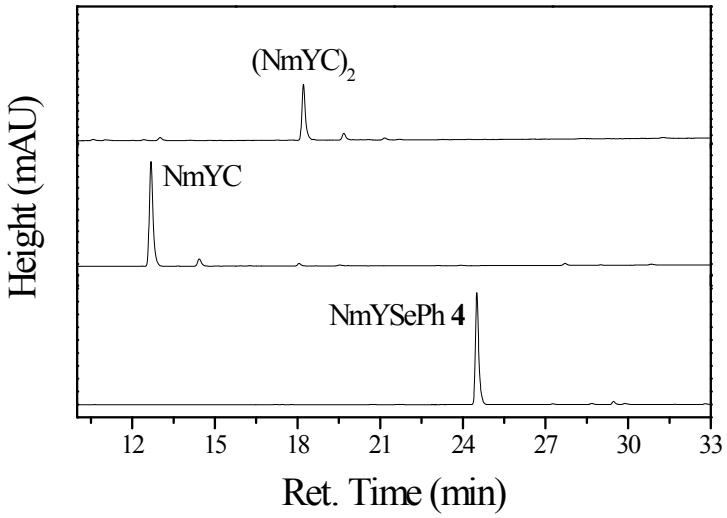


Fig. S8: Overlaid HPLC chromatograms for compound **1** showing peaks **NmYC** in inert condition after native chemical ligation and peak **$(NmYC)_2$** for its corresponding disulfide in air.

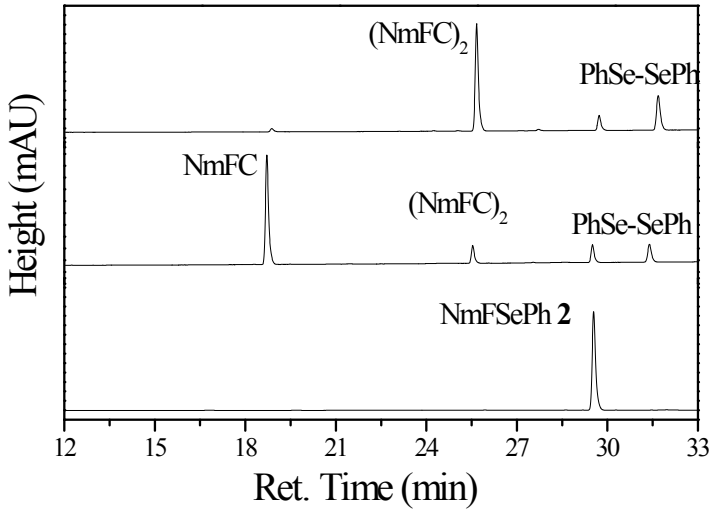


Fig. S9: Overlaid HPLC chromatograms for compound **2** showing peak **NmFC** in inert condition after native chemical ligation and peak **$(NmFC)_2$** for its corresponding disulfide in air.

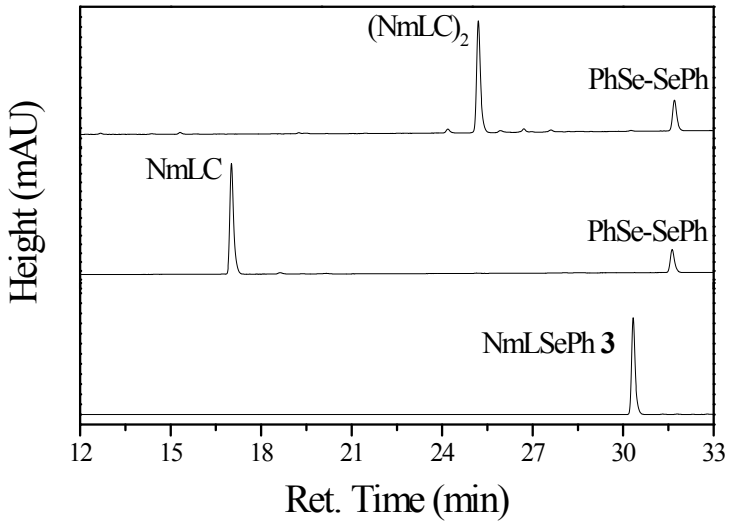


Fig. S10: Overlaid HPLC chromatograms for compound **3** showing peak **NmLC** in inert condition after native chemical ligation and peak **$(NmLC)_2$** for its corresponding disulfide in air.

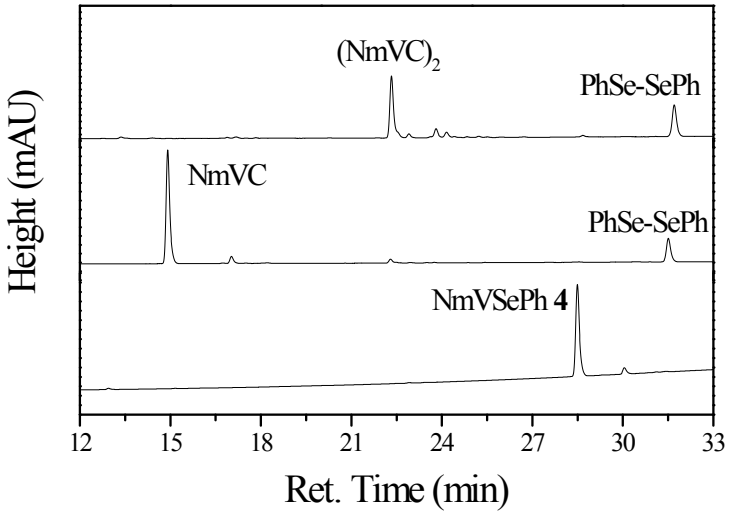


Fig. S11: Overlaid HPLC chromatograms for compound **4** showing peak **NmVC** in inert condition after native chemical ligation and peak **$(NmVC)_2$** for its corresponding disulfide in air.

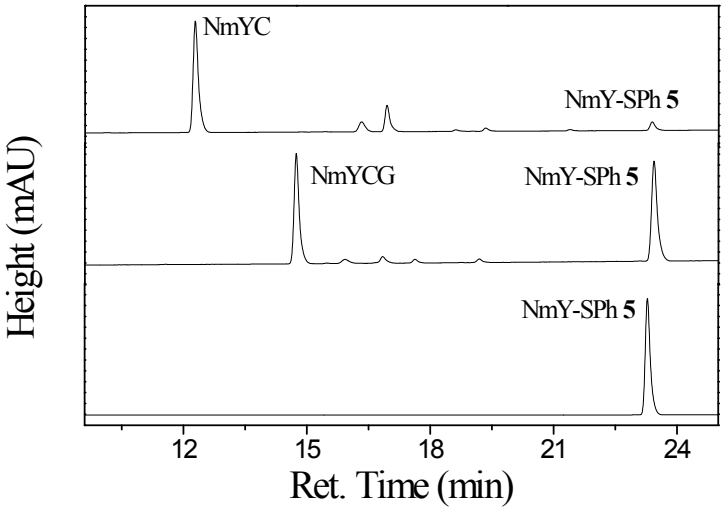


Fig. S12: Overlaid HPLC chromatograms for compound **5** showing peak NmYCG after native chemical ligation with Cys-Gly and peak **NmYC** for ligation reaction of **5** with cysteine.

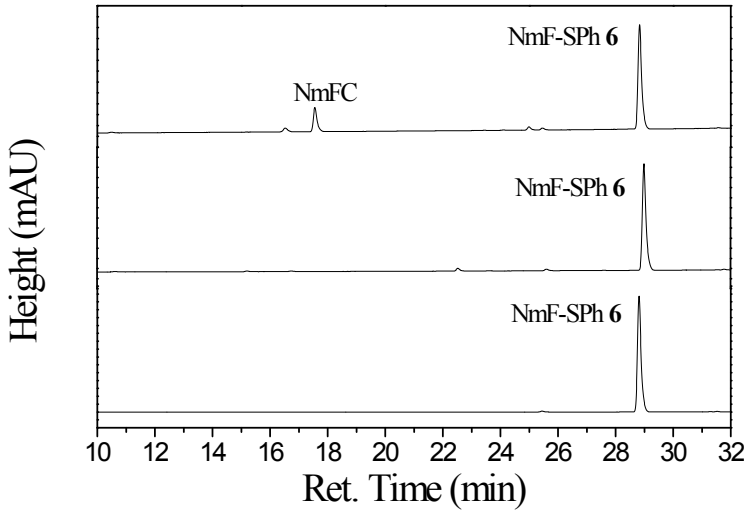


Fig. S13: Overlaid HPLC chromatograms for compound **6** showing **NmFC** ligation product with Cys-Gly. The 16.14 % **NmFC** product was observed upon ligation of **6** with Cysteine.

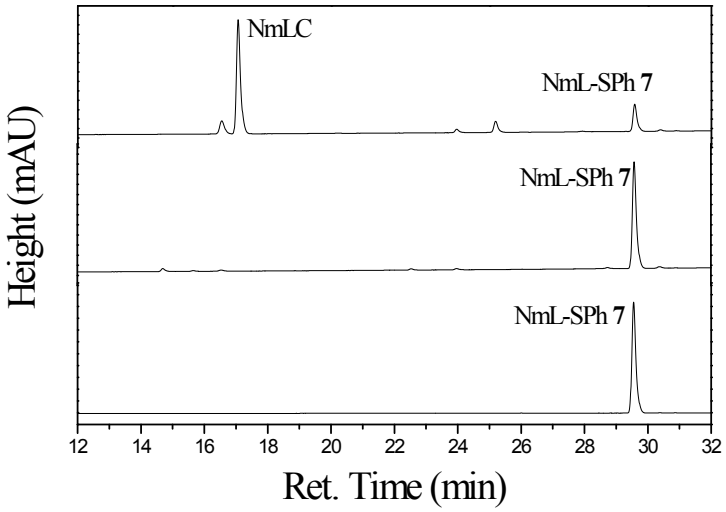


Fig. S14: Overlaid HPLC chromatograms for compound **7** showing ligation product **NmLC** with Cys-Gly. The 80.79 % **NmLC** product was observed upon ligation of **7** with Cysteine.

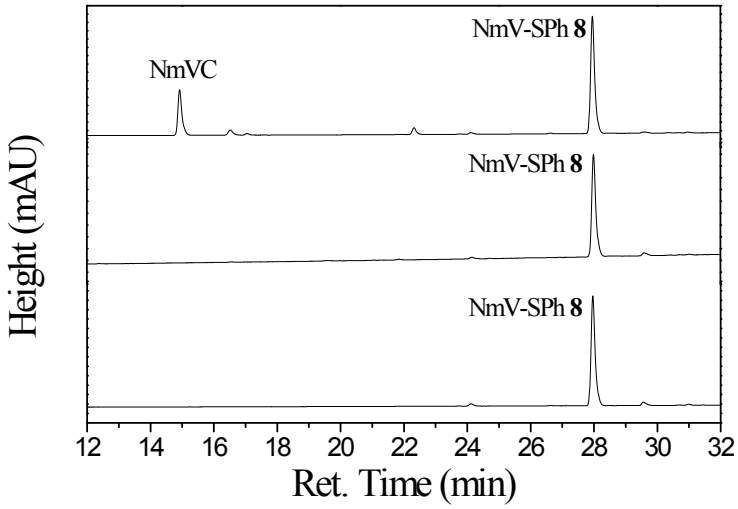


Fig. S15: Overlaid HPLC chromatograms for compound **8** showing ligation product NmVC with Cys-Gly. The 27.74 % **NmVC** product was observed upon ligation of **8** with Cysteine.

ESI-MS analysis of ligated products

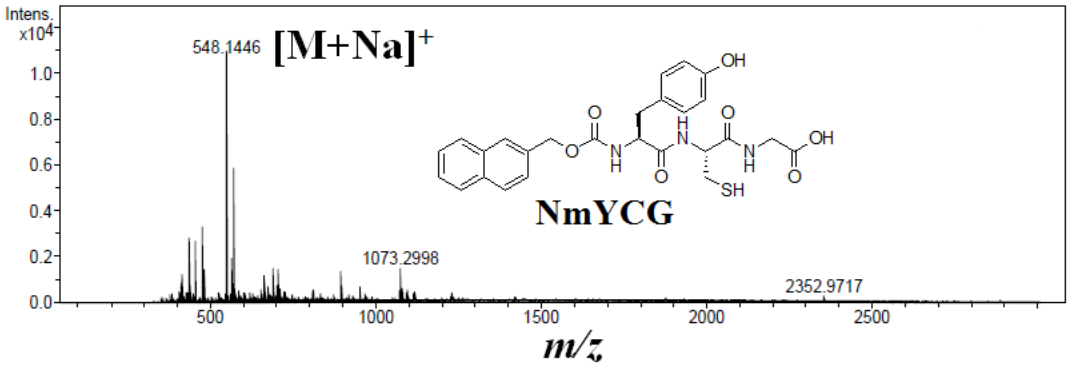


Fig. S16: ESI-MS spectrum of ligated product **NmYCG**.

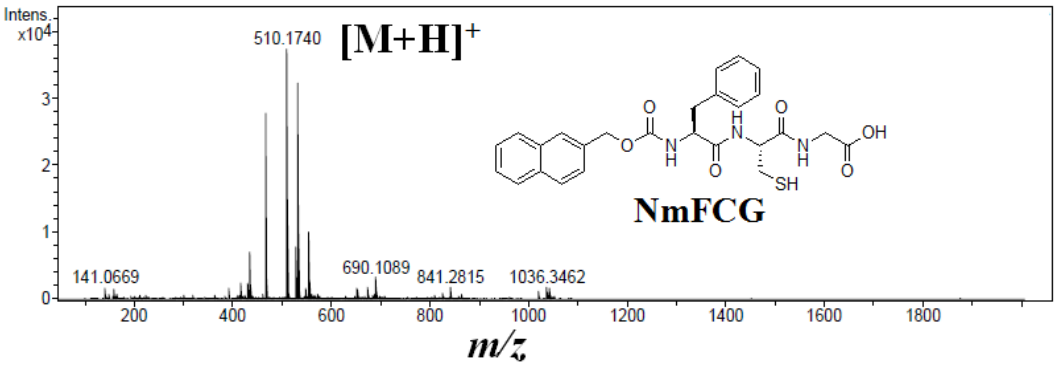


Fig. S17: ESI-MS spectrum of ligated product **NmFCG**.

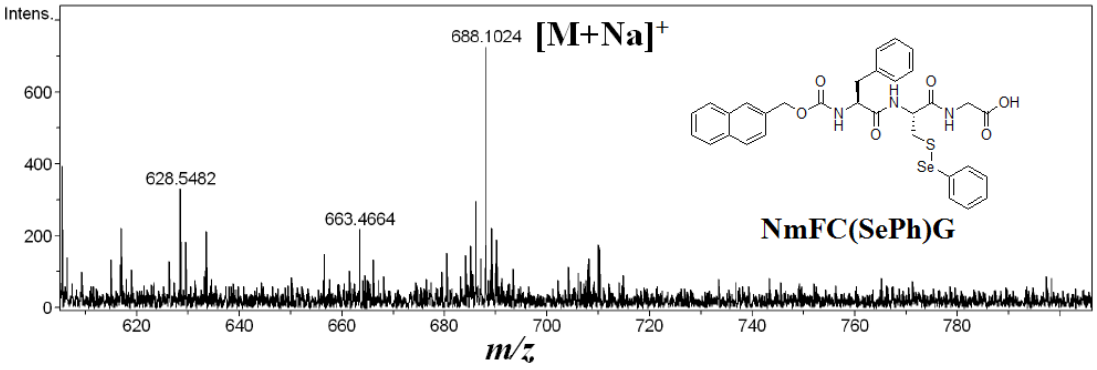


Fig. S18: ESI-MS spectrum of ligated product **NmFC(SePh)G** (sulfur linked with selenophenol).

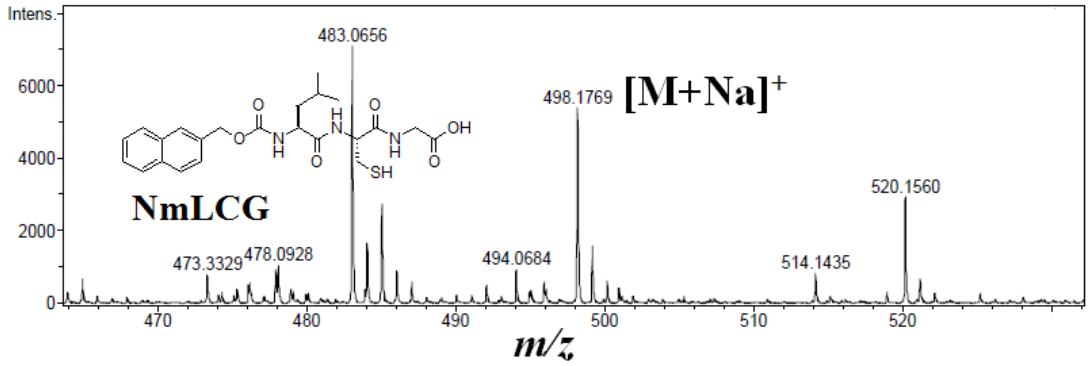


Fig. S19: ESI-MS spectrum of ligated product **NmLCG**.

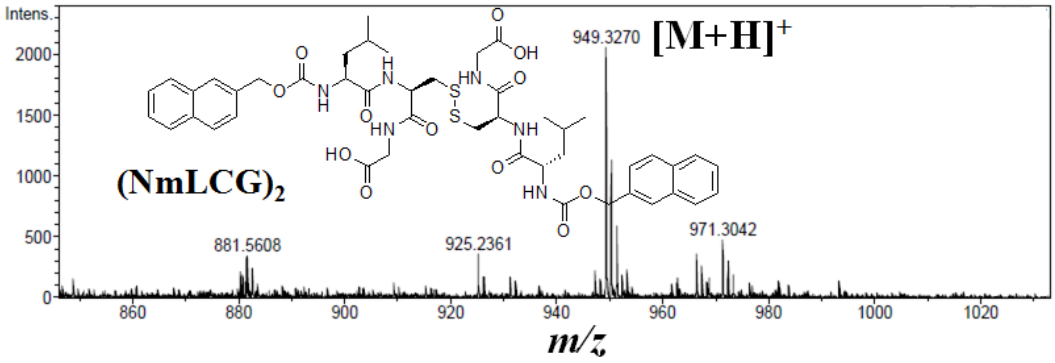


Fig. S20: ESI-MS spectrum of disulfide of ligated product **(NmLCG)$_2$**.

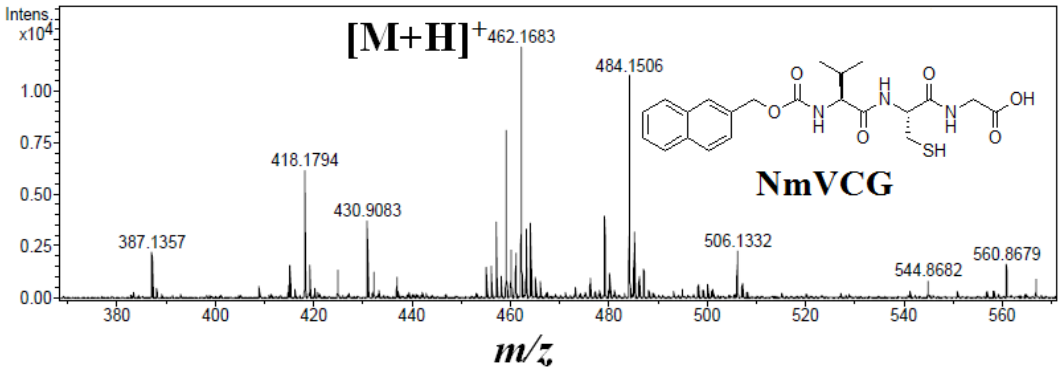


Fig. S21: ESI-MS spectrum of ligated product **NmVCG**.

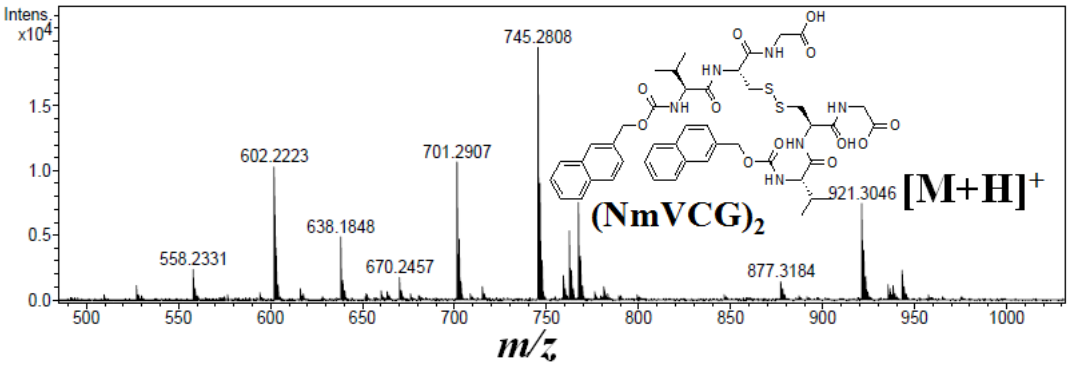


Fig. S22: ESI-MS spectrum of disulfide based ligated product **$(NmVCG)_2$**.

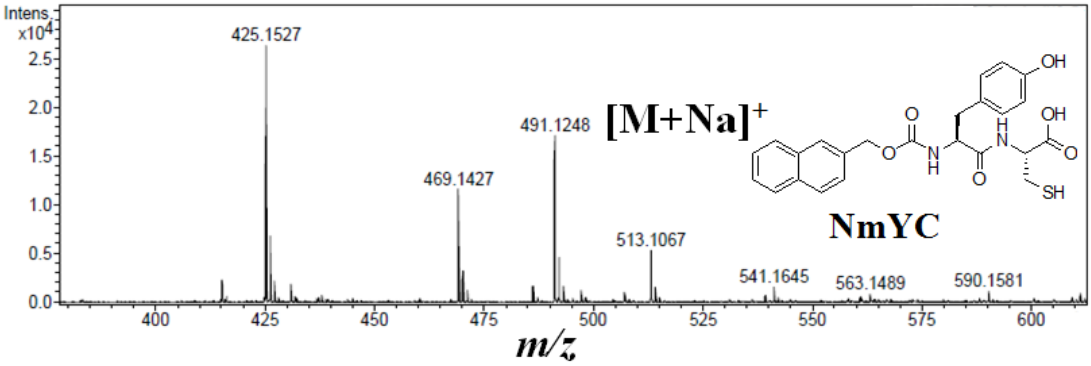


Fig. S23: ESI-MS spectrum of ligated product **NmYC**.

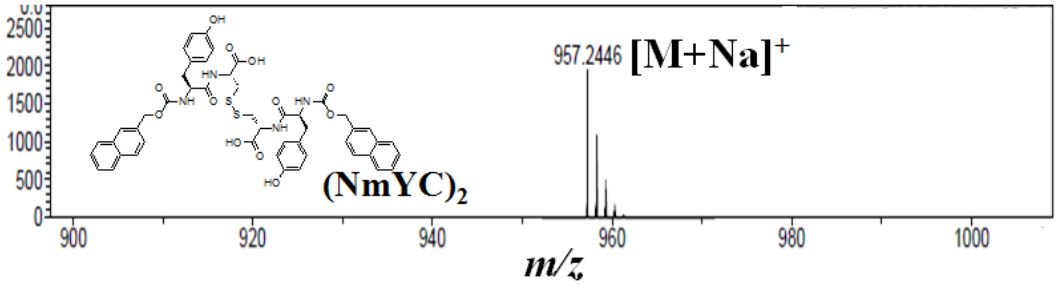


Fig. S24: ESI-MS spectrum of disulfide based ligated product **(NmYC)$_2$**.

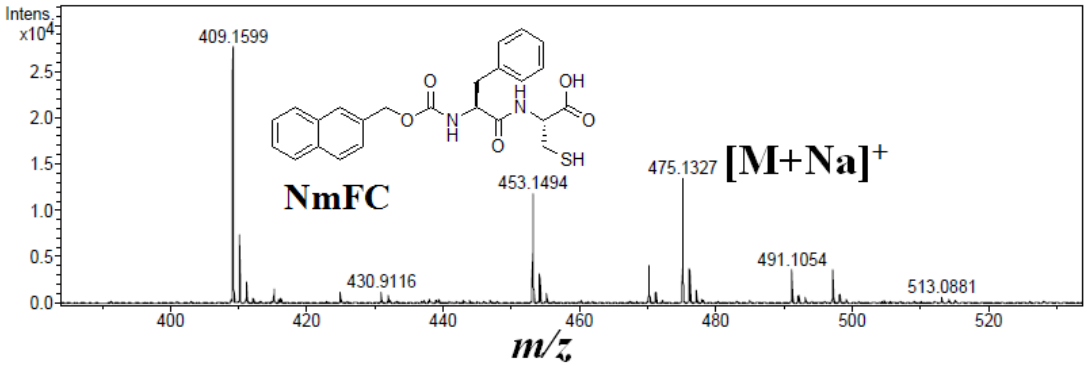


Fig. S25: ESI-MS spectrum of ligated product **NmFC**.

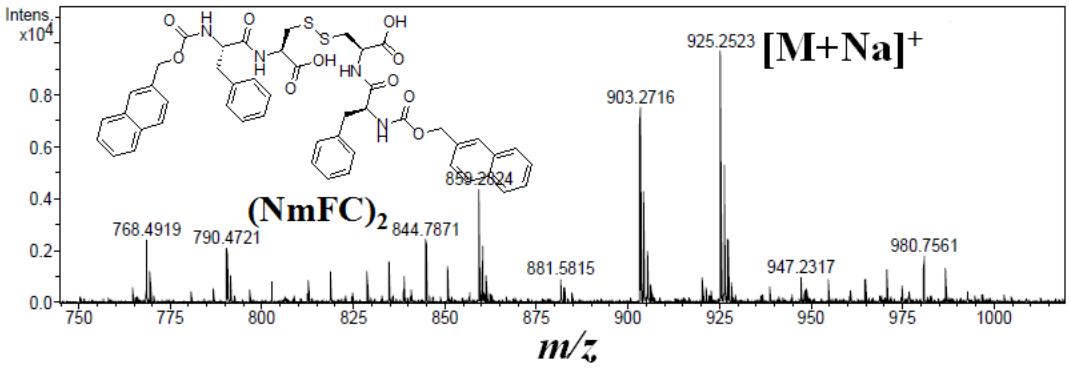


Fig. S26: ESI-MS spectrum of disulfide based ligated product **(NmFC)$_2$**.

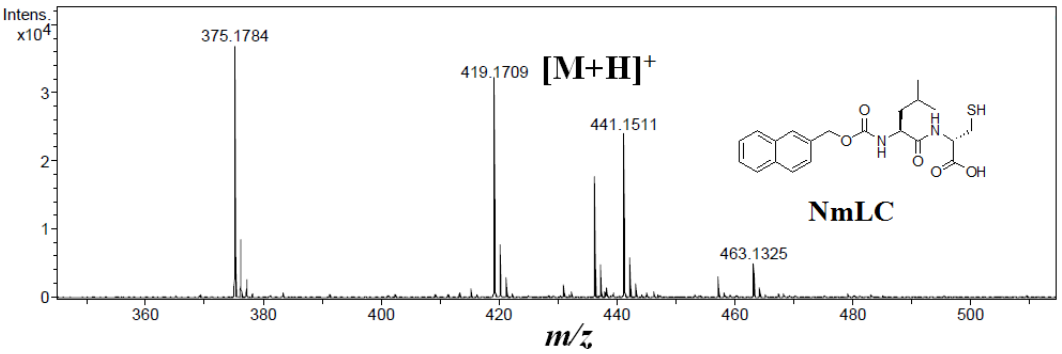


Fig. S27: ESI-MS spectrum of ligated product **NmLC**.

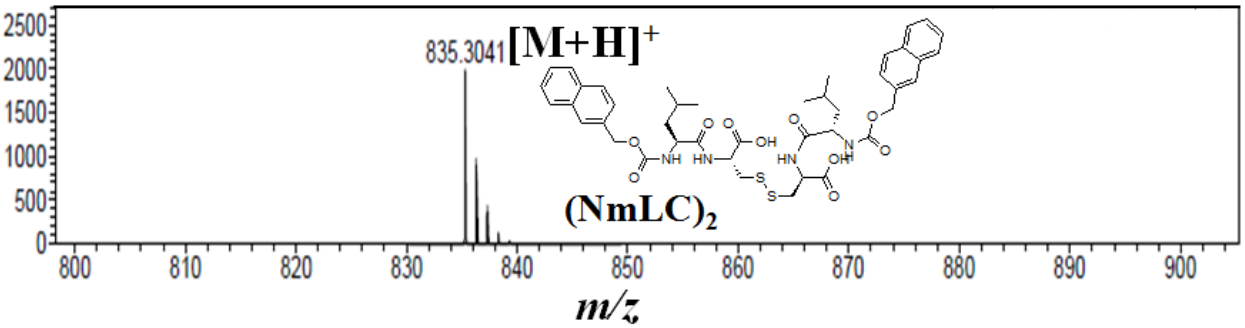


Fig. S28: ESI-MS spectrum of disulfide based ligated product **(NmLC)$_2$**.

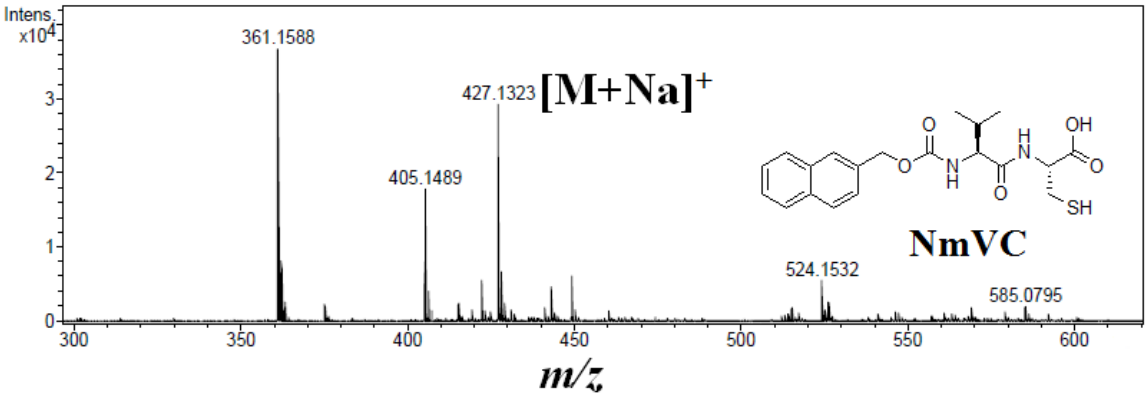


Fig. S29: ESI-MS spectrum of ligated product **NmVC**.

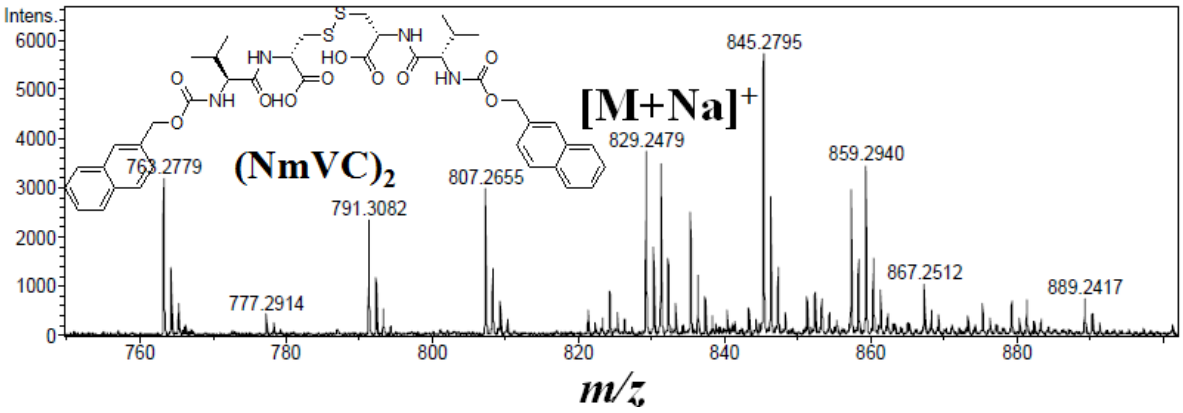


Fig. S30: ESI-MS spectrum of disulfide based ligated product **$(NmVC)_2$**.

Proposed self-assembly mechanism

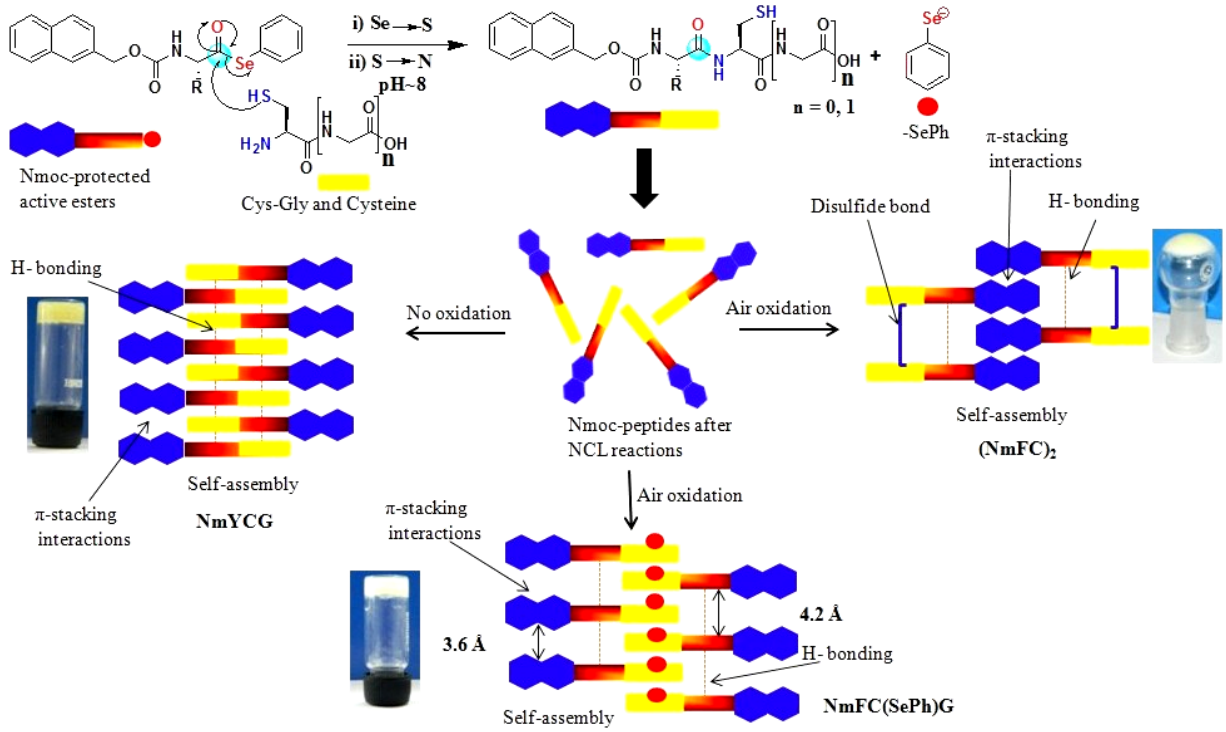


Fig. S31: Proposed mechanism for gel formation.

Characterization of the properties of self-assembly

Rheological measurement was carried out using an Anton Paar Physica MCR 301 rheometer with parallel plate of geometry (25 mm in diameter, 0.200 μm gap). 200 μL of **NmYCG**, **NmFC(SePh)G** and **$(NmFC)_2$** gels were prepared in glass vials and transferred onto the plate of the instrument using microspatulla. The temperature was kept at 25°C by using an integrated temperature controller. Then dynamic frequency sweep of the gel **NmYCG, NmFC(SePh)G** and **$(NmFC)_2$** were measured as function of frequency in the range of 0.05-100 rad s^{-1} with constant strain value 0.05%. The time sweep was measured at constant strain of 0.05%. To determine the exact strain for frequency sweep and time sweep experiments the linear viscoelastic (LVE) regime were performed at constant frequency of 10 rad s^{-1}. The stiffness of gel determined when the value storage modulus G' exceed over the loss modulus G''. The Kinetics of gel formation of **$(NmFC)_2$** was carried out by rheology. A solution of **$(NmFC)_2$** (immediately after NCL reaction) was poured onto the instrument plate and time sweep measurement was done at constant strain of 0.05%. It started to gain gelation properties at 12 min where the G' (storage modulus) and G'' (loss moduls) prominentaly got separated and G' rises above the G''. Dis-assembly behavior of gel was performed by adding Tris(2-carboxyethyl)phosphine (TCEP) (40 mmol L^{-1}, 10.6 μL) to a gel formed by **$(NmFC)_2$** (20 mmol L^{-1}). The gels were transferred onto the plate of rheometer by using micro-spatula immediately after addition of TCEP. The time sweep measurement was done at constant strain of 0.05%. As time sweep experiment shows that the gel **$(NmFC)_2$** started to break at 60 min, where the G' (storage modulus) and G'' (loss modulus) started to intermix with each other.

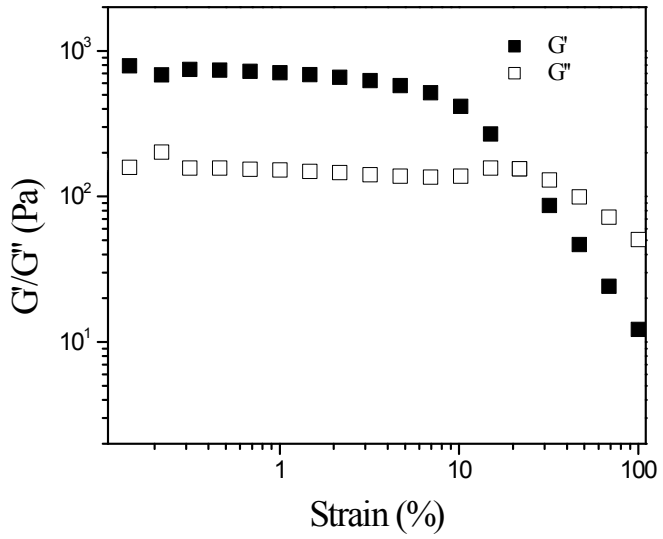


Fig. S32: Rheological measurement of LVE at constant frequency 10 rad s^{-1} for gel **NmYCG**.

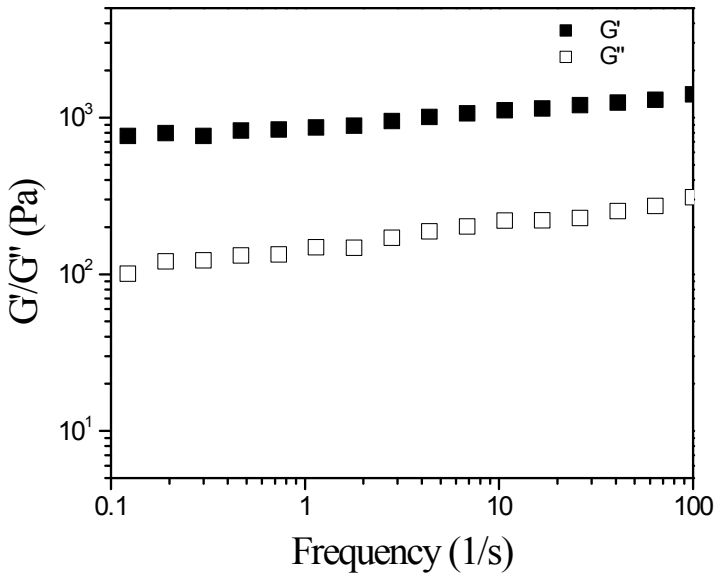


Fig. S33: Dynamic frequency sweep of self-assembled peptide **NmYCG** at constant strain 0.05%.

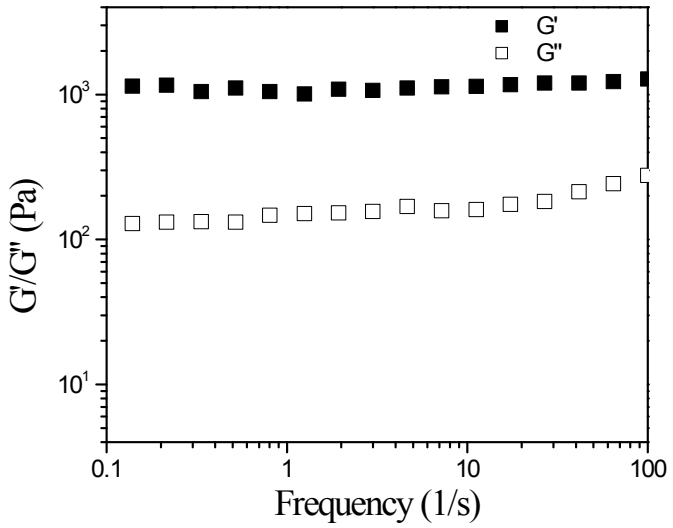


Fig. S34: Dynamic frequency sweep of self-assembled peptide **NmFC(SePh)G** at constant strain 0.05%.

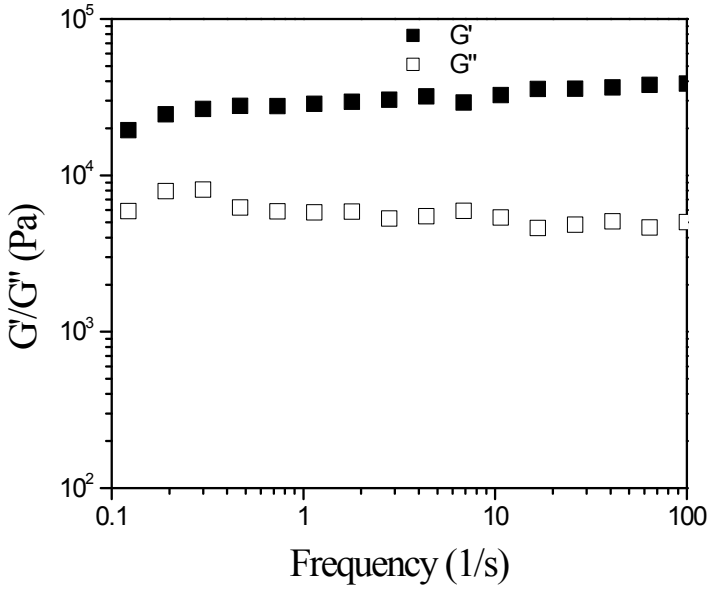


Fig. S35: Dynamic frequency sweep of self-assembled peptide **$(NmFC)_2$** at constant strain 0.05%.

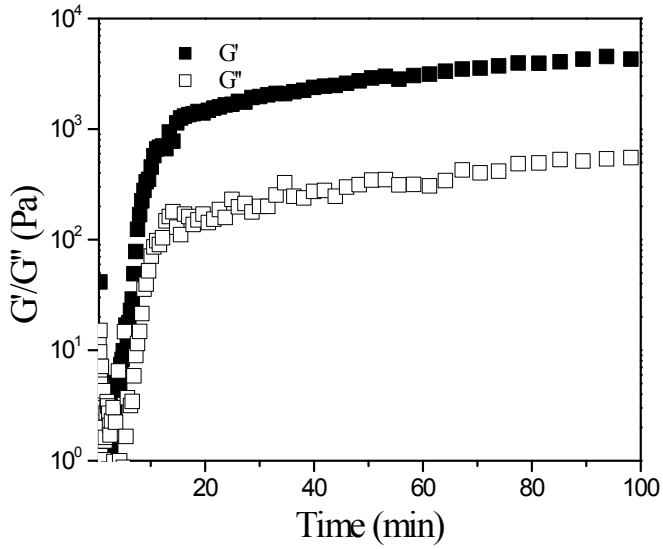


Fig. S36: Oscillatory rheology of a solution containing 20 mmol L^{-1} of **$(NmFC)_2$** at 25 °C shows that **$(NmFC)_2$** started gaining gelation property at 12 min.

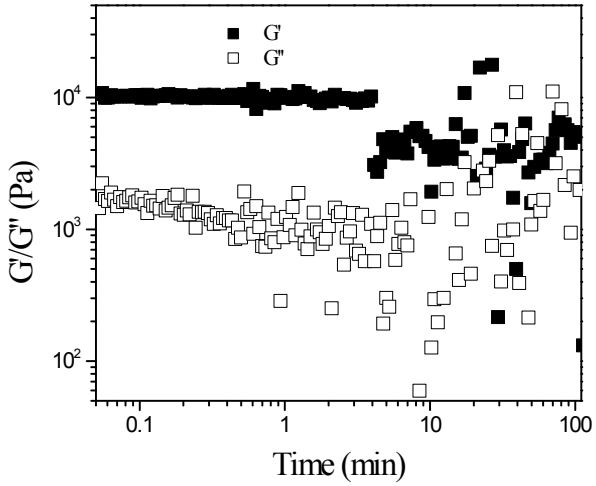


Fig. S37: Oscillatory rheology of a gel containing 20 mmol L^{-1} of **$(NmFC)_2$** and solution of TCEP 40 mmol L^{-1} at 25 °C indicates that the gel started breaking at 60 min.

Circular dichroism

Circular dichroism (CD) spectra were measured at 25 °C on a Jasco J-815 spectropolarimeter. Spectra were measured between 300 and 190 nm with a data pitch of 0.1 nm. The bandwidth was set to 1 nm with a scanning speed of 20 nm min^{-1} and a response time of 1 s. The path length was 1 mm quartz cell (Starna Scientific Ltd. Hainault, UK). Samples were prepared at concentration of 2 mmol L^{-1}. Experimental data were acquired in thrice and the average data is shown.

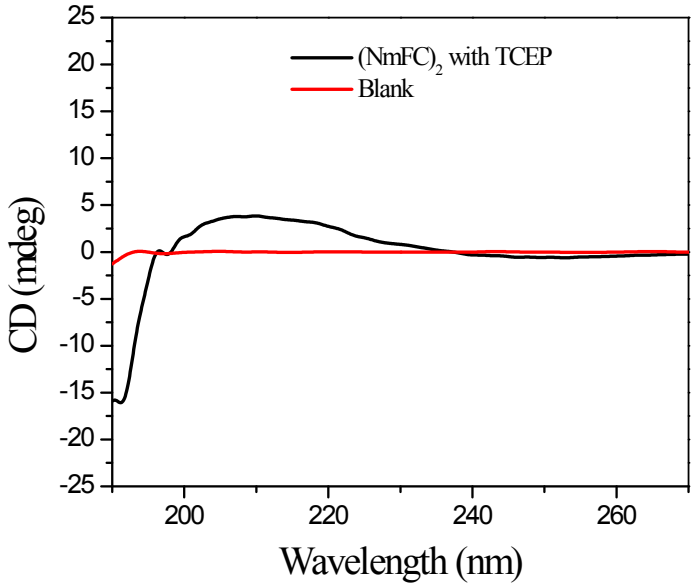


Fig. S38: CD spectra of **$(NmFC)_2$** gel upon treatment with TCEP which results into gel-sol transition.

FT-IR Study

Fourier transform infrared (FTIR) spectra were recorded on Bruker (Tensor 27) FTIR spectrophotometer for wet gels by using ZnSe windows. The gel samples were placed between crystal Zn-Se windows and scanned between 900 and 4000 cm^{-1} over 64 scans at a resolution of 4 cm^{-1} and an interval of 1 cm^{-1}.

Table S3. FTIR analysis of peptide gels obtained via NCL

Sr. No.	Peptide gel	Amide-I (C=O stretching)	Amide-II (C-N stretching, N-H bending)
1	**NmYCG**	1640/1688 cm^{-1}	1580/1534 cm^{-1}
2	**NmFC(SePh)G**	1610/1680 cm^{-1}	1551/1504 cm^{-1}
3	**$(NmFC)_2$**	1685 cm^{-1}	1589/1526 cm^{-1}

UV-Vis spectroscopy

UV-Vis absorption spectra of gels were recorded using a Varian Cary100 Bio UV-Vis spectrophotometer.

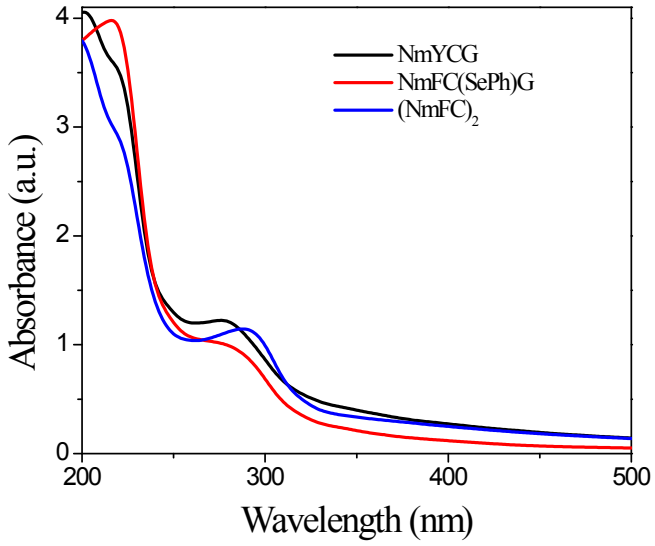


Fig. S39: UV-Vis spectra of **NmYCG**, **NmFC(SePh)G** and **$(NmFC)_2$** gels after NCL reaction.

Fluorescence spectroscopy

Fluorescence emission spectra of gels (20 mmol L^{-1}) were recorded on a Horiba Scientific Fluoromax-4 spectrophotometer with a 1 cm path length quartz cell at room temperature. The slit width for the excitation and emission was set at 2 nm and 1 nm data pitch. Excitations of samples were performed at 280 nm and the data range was in between 290 to 550 nm.

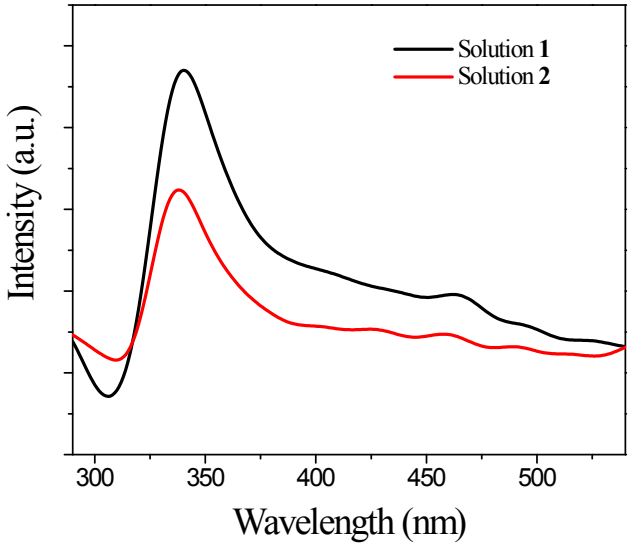


Fig. S40: Fluorescence emission spectra of NmYSePh **1** and NmFSePh **2** solutions prior to NCL reactions (λ_{ex}= 280 nm).

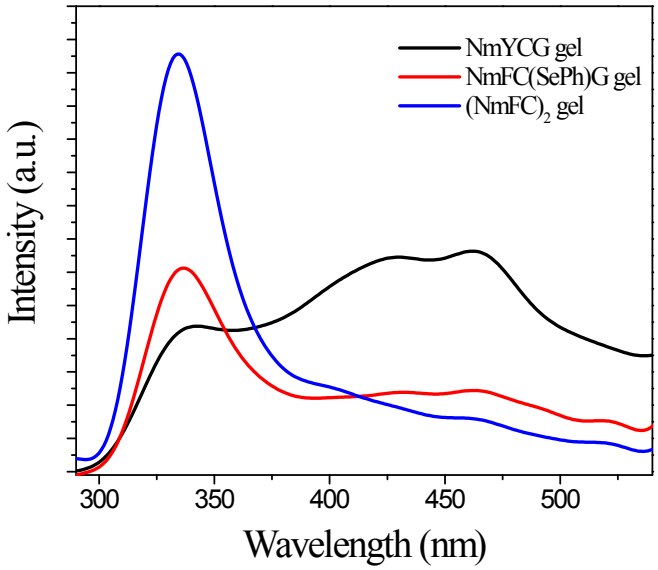


Fig. S41: Fluorescence emission spectra of **NmYCG**, **NmFC(SePh)G** and **$(NmFC)_2$** gels after NCL reaction (λ_{ex} = 280 nm).

Wide angle X-ray diffraction study

The XRD measurements were performed using Rigaku SmartLab, Automated Multipurpose X-ray diffractometer. The X-rays were produced using a sealed tube and the wavelength of the X-ray was 0.154 nm (Cu K-alpha).

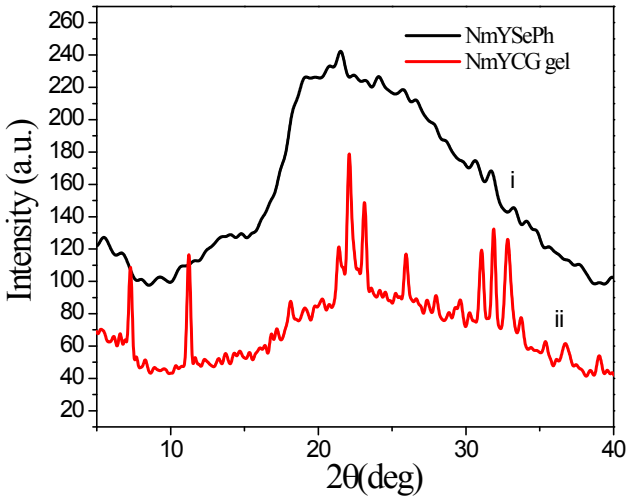


Fig. S42: Wide angle powder XRD of i) dried gel of **NmYCG** and ii) powder of **NmYSePh**.

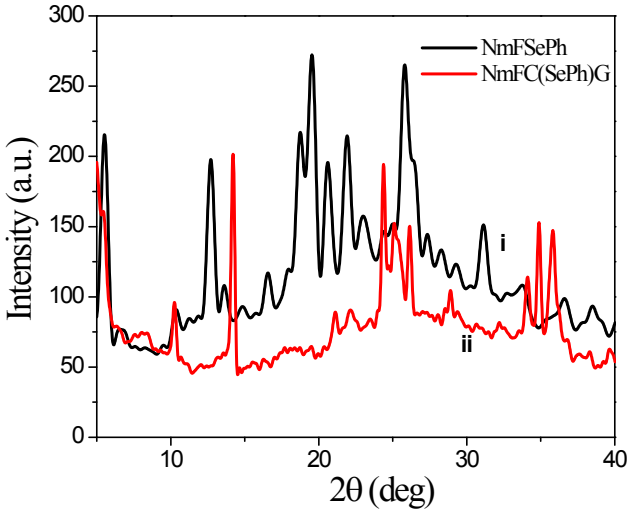


Fig. S43: Wide angle powder XRD of i) dried gel of **NmFC(SePh)G** and ii) powder of **NmFSePh**.

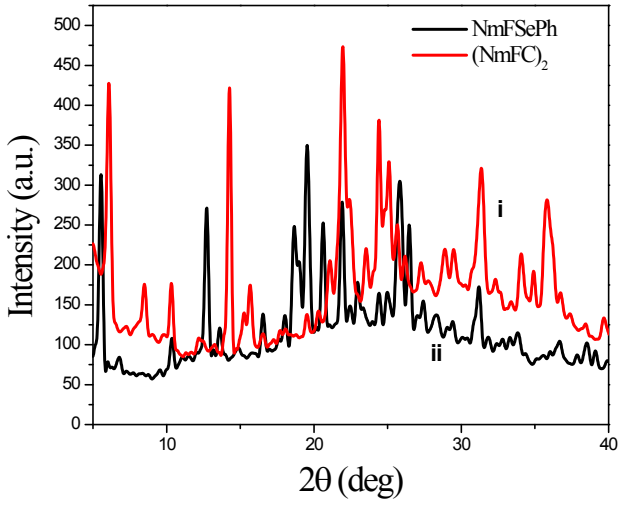


Fig. S44: Wide angle powder XRD of (i) dried gel of **$(NmFC)_2$** and (ii) powder of **NmFSePh**.

Time resolved study

2 mL gel sample was prepared in a 1 cm^2 quartz cuvette and Time resolved studies were done by a time correlated single photon counting (TCSPC) system from Horiba Yovin (Model: Fluorocube-01-NL). Samples were excited at 376 nm using a picosecond diode laser (Model: Pico Brite-375L). The signals were collected at magic angle (54.70) polarization using a photomultiplier tube (TBX-07C) as detector, which has a dark counts less than 20 cps. The instrument response function was typically 140 ps. The data analysis was performed using IBH DAS (version 6, HORIBA Scientific, Edison, NJ) decay analysis software.

The amplitude-weighted lifetime was estimated by

$$\langle \tau \rangle = \sum_{i=1}^{n} a_i \tau_i$$

where τ_i is the fluorescence lifetime of various fluorescent species and are the normalized pre-exponential factors. To gain the best fitting in all cases the χ^2 was kept near to unity.

Table S4. Decay parameters for **NmYCG**, **NmFC(SePh)G** and **$(NmFC)_2$** gel.

Entry	α_1	α_2	τ_1(ns)	τ_2(ns)	τ^a(ns)	χ^2
NmYCG (gel)	0.91	0.09	0.70	5.59	1.14	1.67
NmFCG (gel)	0.71	0.29	1.31	7.04	3.39	1.10
$(NmFC)_2$ (gel)	0.94	0.06	0.84	4.78	1.06	1.26

τ^a The amplitude weighted average lifetime, Normalized amplitude of each component is given by α

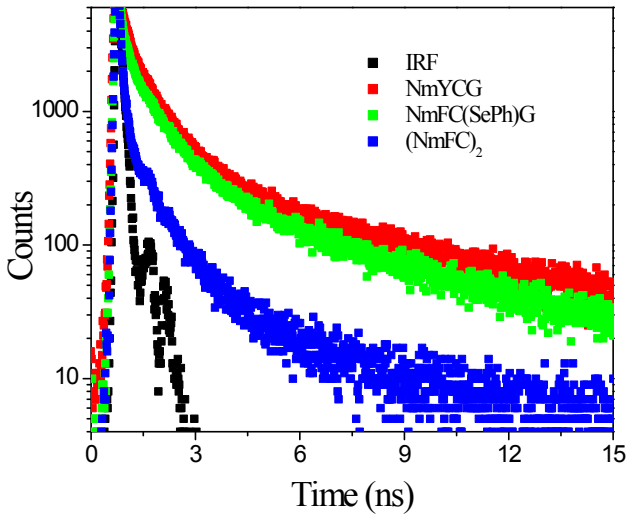


Fig. S45: Emission decay curves for self-supporting gels of **NmYCG**, **NmFC(SePh)G** and **$(NmFC)_2$** monitored at 470 nm (IRF: instrument response function).

Morphological study

Transmission electron microscopic images were taken using a PHILIPS electron microscope (model: CM 200), operated at an accelerating voltage of 200 kV. 2 mmol L^{-1} of dilute gel solution was dried on carbon-coated copper grids (300 mesh) by slow evaporation in air, then allowed to dry separately under vacuum at room temperature.

AFM study was done by placing very dilute solution of gel (200 µL of gel was dissolved in 800 µL of milii-Q water) on mica and allowed it to dry in air for 2 days at room temperature. Images were recorded by using scanning probe microscope AIST-NT instrument (model no. smart SPM-1000).

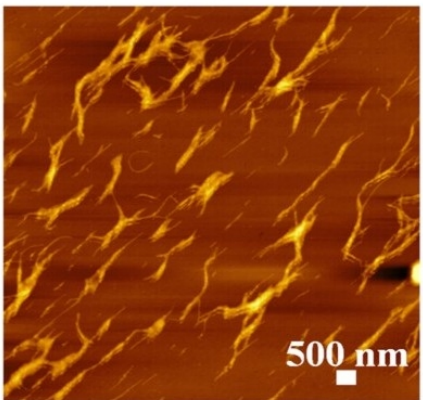


Fig. S46: AFM image of dis-assembled peptide gel **$(NmFC)_2$** (20 mmol L^{-1}) upon addition of TCEP (40 mmol L^{-1}) which converts to **NmFC** indicating disruption of nanofibrillar structures.

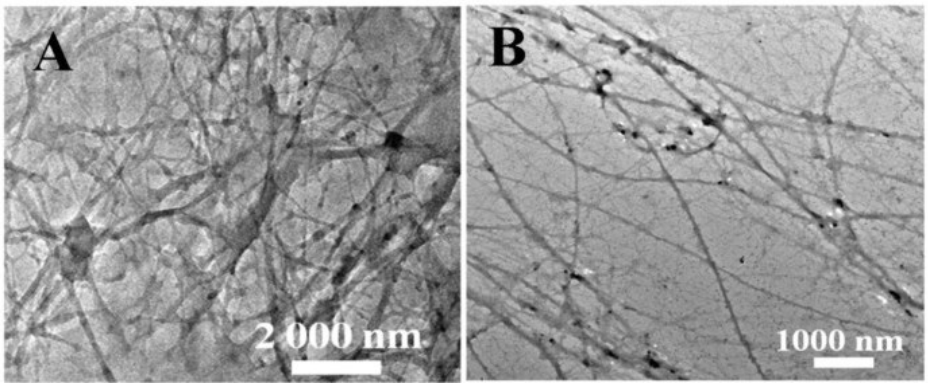
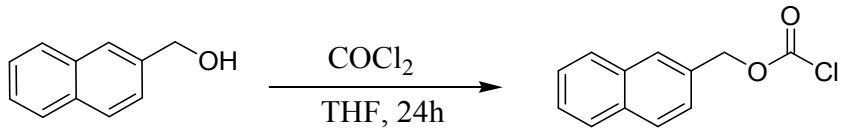


Fig. S47. TEM images indicating nanofibrillar structures of self-assembled gels of A) **NmFC(SePh)G** and B) **$(NmFC)_2$**.

Experimental Procedures

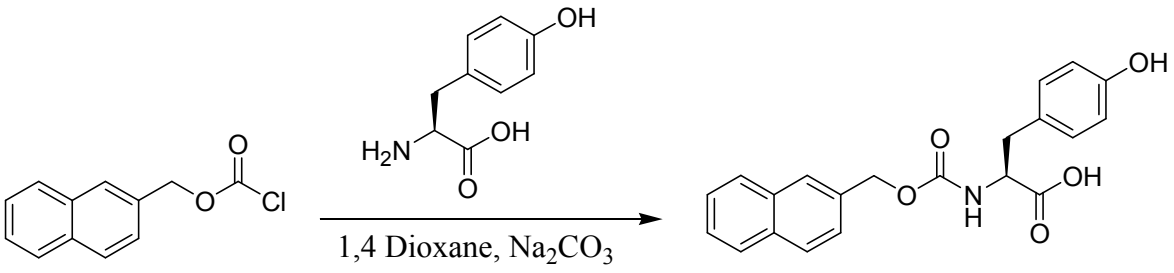
Synthesis of Naphthalene-2-methyloxy chloroformate 9



To a stirred solution of naphthalene methanol (5 g, 31.6 mmol) in dry THF (140 mL), phosgene (39.2 mL, 75.5 mmol) was added at 0 °C. The stirring was continued at ambient temperature for 24 h. The reaction was monitored by thin layer chromatography (TLC). After completion of reaction, excess phosgene was removed under low vacuum and trapped with aqueous NaOH. Reaction mixture was concentrated and oily product was obtained. Then it was dissolved in hot hexane to get crystalline product **9.**

Yield = 6.8 g (30 mmol, 94.93%); mp: 62 °C; FT-IR (KBr): ῡ 3066 (m), 1777 (s), 1601 (ms), 1168 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.90 (d, 4H), 7.56 (m, 2H), 7.29 (s, 1H), 5.48 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 71.82, 125.7, 126.6, 127.8, 128.1, 128.6, 130.6, 133.5, 140.9, 147.9, 150.7 ppm.

Synthesis of Nmoc-Tyr-OH 10

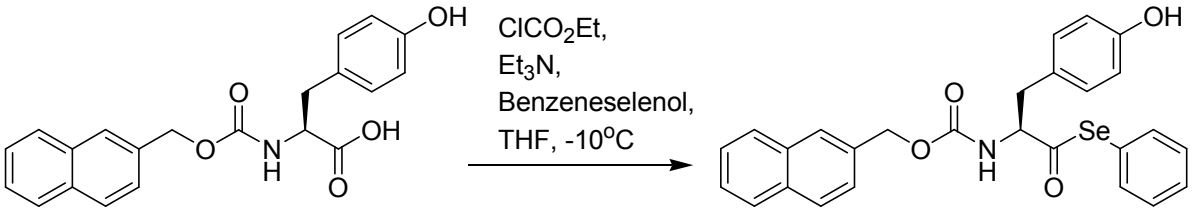


A solution of tyrosine (0.724 g, 4 mmol) in a mixture of 1,4 dioxane (10 mL) and 2M sodium carbonate (13 mL) was stirred and cooled in an ice-water bath. Naphthalene-2-methoxychloroformate (0.882 g, 4 mmol) was added and stirring was continued at room

temperature for 12 h. Reaction mixture was diluted with 200 mL of water and dioxane was evaporated under vacuum. Aqueous layer was washed with diethyl ether and the pH of aqueous layer was adjusted to 2 with 2N hydrochloric acid. The aqueous phase was extracted with ethyl acetate (3 x 50 mL) and dried over Na_2SO_4. It was concentrated in vacuo to give **10** as colorless solid.

Yield= 1.124 g (3 mmol, 75%). mp: 111 °C. $[\alpha]_D^{25}$ = -7 (c = 1, MeOH); FT-IR (KBr): ϑ 3331 (br), 3055 (br), 2928 (ms), 1709 (s), 1612 (ms), 1513 (s), 1445 (s), 1367 (ms), 1336 (ms), 1225 (s) cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 9.21 (s, 1H, OH of Tyr), 7.89 (d, 4H, Nph), 7.52 (t, 3H, Nph), 7.42 (s, 1H, *J*= 7.52 Hz, NH), 7.05 (d, 2H, *J*= 8.28 Hz, Tyr), 6.66 (d, 2H, *J*= 8 Hz, Tyr), 5.17 (q, 2H, CH_2 of Nph), 4.25 (m, 1H, $C^{\alpha}H$ of Tyr), 2.95 (dd, 1H, *J*= 4.52 and 4 Hz, $C^{\beta}H$ of Tyr), 2.87 (dd, 1H, *J*= 5 and 5 Hz, $C^{\beta}H$ of Tyr) ppm; MS (ESI) m/z for $C_{21}H_{19}NO_5$ $(M+H)^+$ calcd.: 366.1341 found: 366.4131.

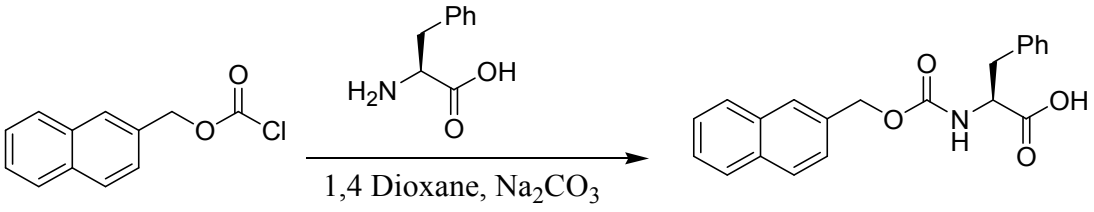
Synthesis of Nmoc-Tyr-SePh (NmYSePh) 1



Nmoc-Tyr-OH (0.500 gm, 1.36 mmol) in 50 mL THF was added with 1.36 mmol, 0.189 mL) Et_3N. 1.36 mmol (0.129 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 °C and stirred it for 10 min. Benzeneselenol (1.36 mmol, 0.144 mL) was added to the reaction mixture, which was easily prepared from C_6H_5MgBr and Se. The solution was kept for 30 min at 10 °C with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over sodium sulphate. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **1** was obtained as white solid.

Yield= 0.520 g (1 mmol, 73.52%). mp: 161^{o}C; $[\alpha]_D^{25}$ = -36 (c = 1, MeOH); FT-IR (KBr): ῡ 3316 (br), 3053 (ms), 2922 (s), 2852 (ms), 1696 (s), 1606 (ms), 1517 (s), 1471 (ms), 1369 (ms) 1260 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (d, 4H, *J*= 8 Hz, Nph), 7.48 (t 3H, Nph), 7.38 (m, 5H, Ph), 7.25 (s, 1H, NH), 6.97 (d, 2H, *J* = 7.28 Hz, Tyr), 6.68 (d, 2H, *J* = 7.56 Hz, Tyr), 5.28 (q, 2H, CH_2 oh Nph), 4.72 (m, 1H, C$^{\alpha}$ H of Tyr), 3.09 (dd, 1H, *J*= 4.24 and 4.24 Hz, C$^{\beta}$ H of Tyr), 3.00 (dd, 1H, C$^{\beta}$ of Tyr) ppm ; ^{13}C NMR (100 MHz, $CDCl_3$): δ 203.5, 155.9, 154.9, 135.9, 133.1, 132.0, 130.5, 130.3, 129.4, 129.0, 128.6, 128.4, 128.0, 127.7, 127.3, 126.9,126.5, 126.4, 126.3, 125.7, 121.3, 115.7, 70.6, 67.6, 64.2, 36.9 ppm; MS (ESI) m/z for $C_{27}H_{23}NO_4Se$ $(M+Na)^+$ calcd.: 528.0690, found: 528.0686.

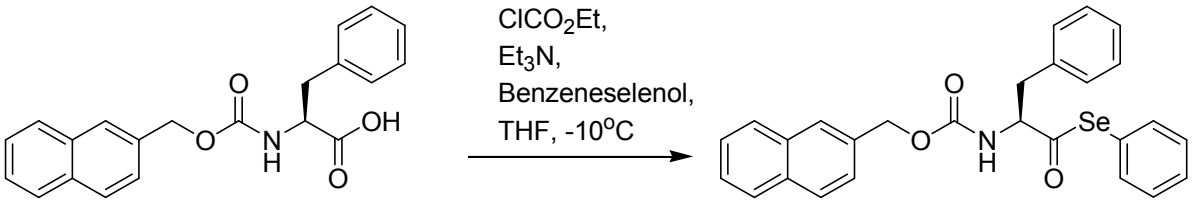
Synthesis of Nmoc-Phe-OH (11)



A solution of phenylalanine (0.660 g, 4 mmol) in a mixture of 1,4 dioxane (10 mL) and 2M sodium carbonate (13 mL) was stirred and cooled in an ice-water bath. Naphthalene-2-methoxychloroformate (0.882 g, 4 mmol) was added and stirring was continued at room temperature for 12 h. Reaction mixture was diluted with 200 mL of water and dioxane was evaporated under vacuum. Aqueous layer was washed with diethyl ether and the pH of aqueous layer was adjusted to 2 with 2N hydrochloric acid. The aqueous phase was extracted with ethyl acetate (3 x 50 mL) and dried over Na_2SO_4, concentrated in vacuum to give **11** as white solid

Yield = 1.12 g (3.2 mmol, 80%). mp: 102 ^{o}C; $[\alpha]_D^{25}$ = -7 (*c* = 1, MeOH); FT-IR (KBr): ῡ 3340 (s), 3030 (br), 2930 (br), 2884 (br), 1692 (s), 1529 (s), 1450 (m), 1338 (m), 1258 (s) cm^{-1}; 12.75 (s, 1H, COOH), 7.88 (d, 4H, Nph), 7.73 (d, 1H, *J*=8.04 Hz, Nph), 7.53 (t, 2H, Nph), 7.41 (d, 1H, *J*= 8.28, NH), 7.21 (m, 5H, Phe), 5.16 (s, 2H, CH_2 of Nph), 4.21 (q, 1H, C$^{\alpha}$ H of Phe), 3.11 (d, 1H, C$^{\beta}$H of Phe), 2.86 (m, 1H, C$^{\beta}$H of Phe) ppm; MS (ESI) m/z for $C_{21}H_{19}NO_4$ $(M+Na)^+$ calcd.: 372.1212, found: 372.1206.

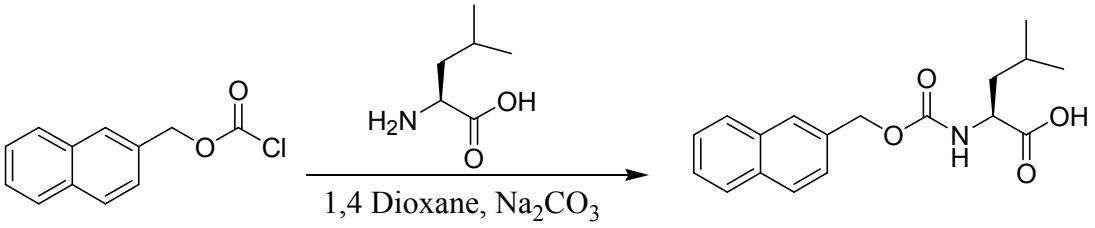
Synthesis of Nmoc-Phe-SePh (NmFSePh) 2



Nmoc-Phe-OH (0.526 gm, 1.5 mmol) in 50 mL THF was added with 1.5 mmol, 0.208 mL) Et_3N. 1.5 mmol (0.142 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 °C and stirred it for 10 min. Benzeneselenol (1.36 mmol, 0.158 mL) was added to the reaction mixture, which was easily prepared from C_6H_5MgBr and Se. The solution was kept for 30 min at 10 °C with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuum and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuum and covered with a layer of petroleum ether. The compound **2** was obtained as white solid.

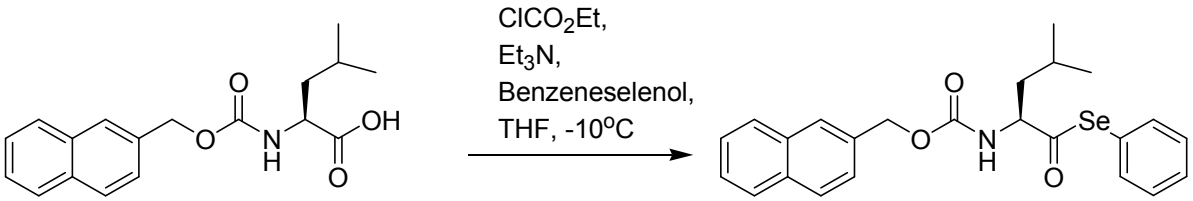
Yield=0.45g (0.92 mmol, 61.33 %). mp: 123°C; $[\alpha]_D^{25}$ = -38 (c = 1, MeOH); FT-IR (KBr): ῡ 3299 (s), 3058 (ms), 3029 (ms), 2963 (ms), 1693 (s), 1578 (s), 1530 (ms), 1444 (ms), 1368 (ms), 1315 (ms), 1257 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.84 (t, 4H, Nph), 7.48 (m, 3H, Nph), 7.41 (m, 5H, Ph), 7.24 (m, 5H, Phe), 7.15 (d, 1H, *J*= 7.52 Hz, NH), 5.30 (q, 2H, CH_2 of Nph), 4.75 (m, 1H, C^{α} H of Phe), 3.15 (d, 1H, C^{β} H of Phe), 3.12 (d, 1H, C^{β} H of Phe) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 203.5, 155.8, 135.9, 135.0, 133.3, 133.1, 130.5, 129.5, 129.3, 129.0, 128.8, 128.7, 128.4, 128.2,128.0, 127.7, 127.3, 127.2, 126.3, 125.8, 125.7, 67.6, 66.6, 65.0, 64.0, 62.0, 37.7; MS (ESI) m/z for $C_{27}H_{23}NO_3Se$ $(M+Na)^+$ calcd.: 512.0741, found: 512.0728.

Synthesis of Nmoc-Leu-OH (12)



A solution of leucine (0.524 g, 4 mmol) in a mixture of 1,4 dioxane (10 mL) and 2M sodium carbonate (13 mL) was stirred and cooled in an ice-water bath. Naphthalene-2-methoxychloroformate (0.882 g, 4 mmol) was added and stirring was continued at room temperature for 12 h. Reaction mixture was diluted with 200 ml of water and dioxane was evaporated under vacuum. Aqueous layer was washed with diethyl ether and the pH of aqueous layer was adjusted to 2 with 2N hydrochloric acid. The aqueous phase was extracted with ethyl acetate (3 x 50 mL) and dried over Na_2SO_4 concentrated in vacuo to give **12** as white solid.
Yield =0.954 g (3 mmol, 75%). mp: 79 °C; $[\alpha]_D^{25}$ = -12 (*c* = 1, MeOH); FT-IR (KBr): ϑ 3418 (br), 3380 (br), 3053 (ms), 2960 (s), 2874 (ms), 1700 (s), 1604 (ms), 1517 (s), 1462 (ms), 1363 (ms), 1321 (ms), 1239 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.91 (t, 4H, Nph), 7.63 (d, 1H, J= 7.84 Hz, NH), 7.53 (t, 3H, Nph), 5.20 (s, 2H, CH_2 of Nph), 4.00 (m, 1H, C^{α} H of Leu), 1.66 (m, 1H, C^{γ}H of Leu), 1.53 (m, 1H, C^{β}H of Leu), 1.49 (m, 1H, C^{β}H of Leu), 0.88 (d, 6H, C^{δ}Hs of Leu) ppm; MS (ESI) m/z for $C_{18}H_{21}NO_4$ $(M+Na)^+$ calcd.: 338.1368, found: 338.1378.

Synthesis of Nmoc-Leu-SePh (NmLSePh) 3

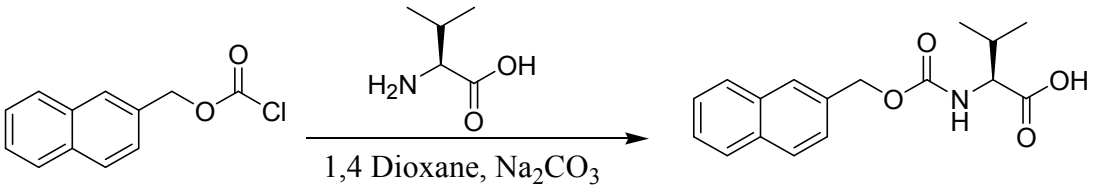


Nmoc-Leu-OH (0.392gm, 1.24 mmol) in 50 mL THF was added with 1.24 mmol, 0.172 mL) Et_3N. 1.24 mmol (0.117 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 °C and stirred it for 10 min. Benzeneselenol (1.24 mmol, 0.131 mL) was added to the reaction mixture, which

was easily prepared from C_6H_5MgBr and Se. The solution was kept for 30 min at 10 ^oC with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **3** was obtained as white solid.

Yield =0.321g (0.7 mmol, 56.45%). mp: 91^oC; $[\alpha]_D^{25}$ = -30 (*c* = 1, MeOH); FT-IR (KBr): ϑ 3382 (s), 3059 (ms), 2955 (s), 2872 (ms), 1718 (s), 1701 (s), 1600 (ms), 1576 (s), 1465 (ms), 1386 (ms), 1336 (ms), 1250 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, 4H, *J*= 7.76 Hz, Nph), 7.48 (m, 5H, Ph), 7.37 (d, 3H, Nph), 7.27 (s, 1H, NH), 5.35 (m, 2H, CH_2 of Nph), 4.51 (m, 1H, C^{α} H of Leu), 1.73 (d, 2H, C^{β}Hs of Leu), 1.52 (m, 1H, C^{γ}H of Leu), 0.93 (d, 6H, *J* = 6.04 Hz, C^{δ}Hs of Leu) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 203.9, 155.9, 136.01, 133.4, 133.2, 133.1, 131.5, 129.3, 129.1, 128.9, 128.4, 128.01, 127.7, 127.5, 127.2, 126.3, 125.7, 67.6, 62.4, 41.0, 24.7, 23.0, 22.6, 21.4 ppm; MS (ESI) m/z for $C_{24}H_{25}NO_3Se$ $(M+Na)^+$ calcd.: 478.0897, found: 478.0890.

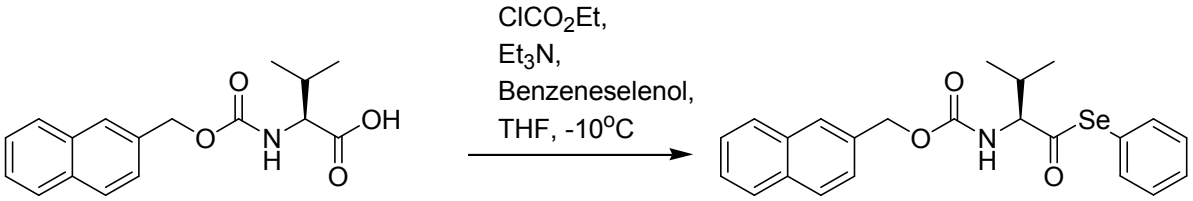
Synthesis of Nmoc-Val-OH (13)



A solution of valine (0.468 g, 4 mmol) in a mixture of 1,4 dioxane (10 mL) and 2M sodium carbonate (13 mL) was stirred and cooled in an ice-water bath. Naphthalene-2-methoxychloroformate (0.882 g, 4 mmol) was added and stirring was continued at room temperature for 12 h. Reaction mixture was diluted with 200 mL of water and dioxane was evaporated under vacuum. Aqueous layer was washed with diethyl ether and the pH of aqueous layer was adjusted to 2 with 2N hydrochloric acid. The aqueous phase was extracted with ethyl acetate (3 x 50 mL) and dried over Na_2SO_4, concentrated in vacuo to give **13** as white solid.

Yield=1.012 g (3.3 mmol, 82.5%). mp: 99 °C; $[\alpha]_D^{25}$ = -5 (*c* = 1, MeOH); FT-IR (KBr): ῡ 3419 (s), 3055 (br), 2960 (br), 1739 (s), 1679 (m), 1545 (s), 1463 (m), 1399 (m), 1258 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 12.56 (s,1H, COOH), 7.90 (t, 4H, Nph), 7.53 (d, 3H, Nph), 7.37 (s, 1H, NH), 5.22 (s, 2H, CH_2 of Nph), 4.02 (m, 1H, $C^{\alpha}H$ of Val), 2.08 (m, 1H, $C^{\beta}H$ of Val), 0.92 (d, 6H, $C^{\gamma}Hs$ of Val). ppm; MS (ESI) m/z for $C_{17}H_{19}NO_4$ $(M+Na)^+$ calcd.: 324.1206, found: 324.1228.

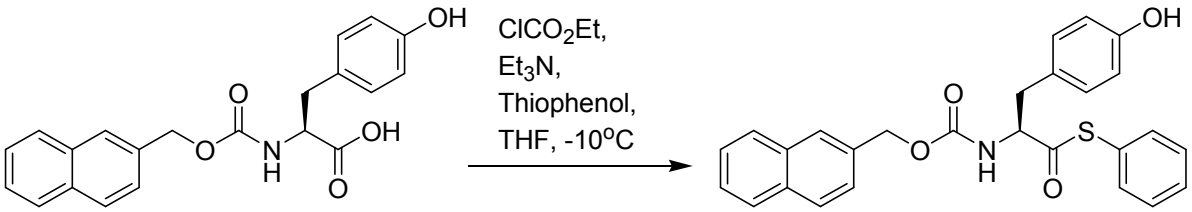
Synthesis of Nmoc-Val-SePh (NmVSePh) 4



Nmoc-Val-OH (0.540 gm, 1.79 mmol) in 50 mL THF was added with 1.79 mmol, 0.248 mL) of Et_3N. 1.79 mmol (0.169 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 °C and stirred it for 10 min. Benzeneselenol (1.79 mmol, 0.189 mL) was added to the reaction mixture, which was easily prepared from C_6H_5MgBr and Se. The solution was kept for 30 min at 10 °C with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **4** was obtained as white solid.

Yield = 0.387 g (0.87 mmol, 48.99%). mp: 99 °C; $[\alpha]_D^{25}$ = -42 (*c* = 1, MeOH); FT-IR (KBr): ῡ 3420 (s), 3054 (br), 2968 (br), 2868 (ms), 1723 (s), 1693 (s), 1602 (m), 1519 (s), 1466 (m), 1391 (ms), 1314 (ms), 1259 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.88 (t, 4H, Nph), 7.53 (m, 5H, Ph), 7.41 (d, 3H, Nph), 7.34 (s, 1H, NH), 5.38 (q, 2H, CH_2 of Nph), 4.49 (q, 1H, $C^{\alpha}H$ of Val), 2.40 (m, 1H, $C^{\beta}H$ of Val), 0.97 (d, 6H, *J* = 6.76 Hz, $C^{\gamma}Hs$ of Val) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 203.2, 156.3, 135.9, 133.4, 133.2, 133.1, 131.5, 129.3, 129.2, 129.0, 128.4, 128.0, 127.7, 127.3, 126.3, 125.9, 125.7, 68.5, 67.7, 30.6, 19.5, 16.7 ppm; MS (ESI) *m/z* for $C_{23}H_{23}NO_3Se$ $(M + Na)^+$ calcd.: 464.0741, found: 464.0740.

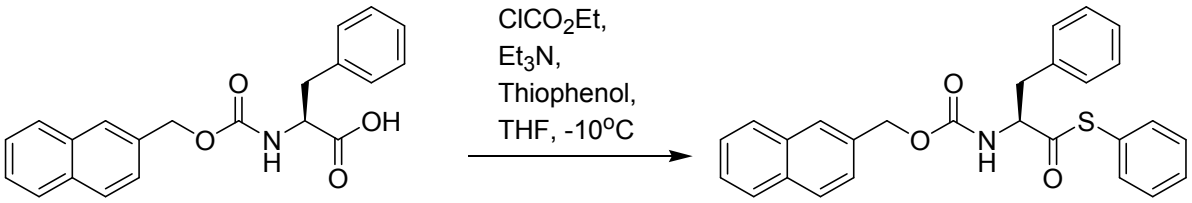
Synthesis of Nmoc-Tyr-SPh (NmY-SPh) 5



Nmoc-Tyr-OH (0.358 gm, 0.98 mmol) in 25 mL THF was added with 0.98 mmol (0.137 mL) Et_3N. 0.98 mmol (0.093 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 ^oC and stirred it for 10 min. Thiophenol (0.98 mmol, 0.1 mL) was added to the reaction mixture. The solution was kept for 30 min at 10 ^oC with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **5** was obtained as white solid.

Yield= 0.324 g (0.71 mmol, 72.34 %). $[\alpha]_D^{25}$ = -30 (c = 1, MeOH); FT-IR (KBr): ῡ 3320 (br), 3050 (ms), 2955 (ms), 1689 (s), 1604 (ms), 1521 (s), 1440 (ms), 1340 (ms), 1310 (ms), 1264 (s); ^1H NMR (400 MHz, $CDCl_3$): δ 7.81 (t, 4H, Nph), 7.48 (m, 2H), 7.43 (s, 1H, Nph), 7.40 (m, 5H, Ph), 7.33 (d, 1H, NH), 7.01 (d, 2H, *J*= 8.8 Hz, Tyr), 6.71 (d, 2H, *J*= 8.8 Hz, Tyr), 5.28 (s, 2H of Nph), 4.77 (m, 1H, $C^{\alpha}H$ of Tyr), 3.08 (m, 2H, $C^{\beta}Hs$ of Tyr) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.90, 155.7, 154.8, 134.6, 133.4, 133.1, 130.6, 129.6, 129.3, 128.4, 128.0, 127.7, 127.2, 127.1, 126.9, 126.3, 125.8, 115.6, 67.49, 61.51, 37.63 ppm; MS (ESI) m/z for $C_{27}H_{23}NO_4S$ $(M+Na)^+$ calcd.: 480.1240 found: 480.1305.

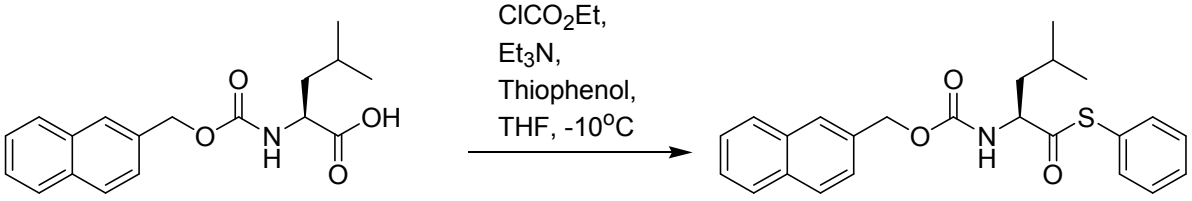
Synthesis of Nmoc-Phe-SPh (NmF-SPh) 6



Nmoc-Phe-OH (0.522 gm, 1.5 mmol) in 50 mL THF was added with 1.5 mmol, 0.208 mL) Et_3N. 1.5mmol (0.142 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 ^oC and stirred it for 10 min. Thiophenol (1.5 mmol, 0.152 mL) was added to the reaction mixture. The solution was kept for 30 min at 10 ^oC with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **6** was obtained as white solid.

Yield= 0.580 g (1.31 mmol, 87%). $[\alpha]_D^{25}$ = -16 (c = 1, MeOH); FT-IR (KBr): ῡ 3305 (s), 3058 (ms), 2965 (ms), 1690 (s), 1533 (ms), 1446 (s), 1369 (ms), 1318 (ms), 1259 (s); ^1H NMR (400 MHz, $CDCl_3$): δ 7.76 (m, 4H, Nph), 7.41 (m, 2H, Nph), 7.31 (s, 1H, Nph), 7.21 (d, 1H, *J*= 7.28 Hz, NH), 7.18 (m, 5H, Ph), 7.10 (m, 5H, Phe), 5.22 (s, 2H, CH_2 of Nph), 4.78 (m, 1H, C^{α} H of Phe), 3.10 (m, 2H, C^{β}Hs of Phe) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 198.7, 193.1, 135.2, 134.6, 133.4, 133.1, 131.7, 129.6, 129.4, 129.2, 128.7, 128.3, 127.7, 127.2, 126.2, 125.7, 67.45, 61.37, 38.43 ppm; MS (ESI) m/z for $C_{27}H_{23}NO_3S$ $(M+Na)^+$ calcd.: 464.1291 found: 464.1368.

Synthesis of Nmoc-Leu-SPh (NmL-SPh) 7

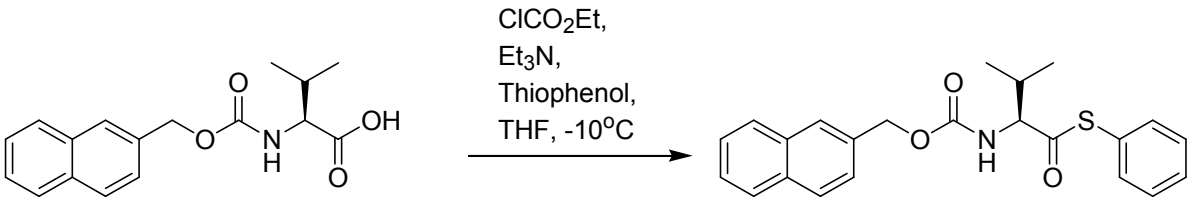


Nmoc-Leu-OH (0.321 gm, 1 mmol) in 25 mL THF was added with 1 mmol (0.139 mL) Et_3N. 1 mmol (0.095 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 °C and stirred it for 10

min. Thiophenol (1 mmol, 0.1 mL) was added to the reaction mixture. The solution was kept for 30 min at 10 °C with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **7** was obtained as white solid.

Yield= 0.262 g (0.64 mmol, 64%). $[\alpha]_D^{25}$ = -11 (c = 1, MeOH); FT-IR (KBr): ῡ 3380 (s), 3058 (ms), 2958 (ms), 2875 (ms), 1700 (s), 1506 (s), 1469 (ms), 1336 (ms), 1262 (s); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (m, 4H, Nph), 7.49 (d, 2H, Nph), 7.46 (s, 1H, Nph), 7.39 (m, 5H, Ph), 5.32 (s, 2H, CH_2 of Nph), 4.62 (m, 1H, C^{α}H of Leu), 1.76 (m, 2H, C^{β}Hs of Leu), 1.58 (m, 1H, C^{γ}H of Leu), 0.96 (d, 6H, J= 5.28 Hz, C^{δ}Hs of Leu) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): 199.5, 155.8, 134.6, 133.5, 133.2, 133.1, 129.5, 129.2, 128.4, 128.0, 127.7, 127.2, 127.0, 126.3, 126.2, 125.7, 67.45, 59.54, 41.79, 24.82, 23.06, 21.58 ppm; MS (ESI) m/z for $C_{24}H_{25}NO_3S$ $(M+Na)^+$ calcd.: 430.1447 found: 480.1446.

Synthesis of Nmoc-Val-SPh (NmV-SPh) 8



Nmoc-Val-OH (0.311 gm, 1 mmol) in 25 mL THF was added with 1 mmol (0.139 mL) Et_3N. 1 mmol (0.1 mL) of $ClCO_2Et$ was added to the reaction mixture at -15 °C and stirred it for 10 min. Thiophenol (1 mmol, 0.1 mL) was added to the reaction mixture. The solution was kept for 30 min at 10 °C with stirring. The reaction mixture was stirred for 1h at room temperature. 20 mL water was added. THF was evaporated in vacuo and the residue was dissolved in ethyl acetate. The solution was washed with saturated $NaHCO_3$ solution and water. The ethyl acetate layer was extracted and dried over Na_2SO_4. It was concentrated in vacuo and covered with a layer of petroleum ether. The compound **8** was obtained as white solid.

Yield= 0.289 g (0.735 mmol, 73.66%). $[\alpha]_D^{25}$ = -9 (c = 1, MeOH); FT-IR (KBr): ῡ 3347 (s), 3051 (ms), 2960 (ms), 1723 (s), 1682 (s), 1529 (s), 1446 (ms), 1392 (ms), 1343 (ms), 1295 (s);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (m, 4H, Nph), 7.49 (m, 3H, Nph), 7.39 (m, 5H, Ph), 5.32 (s, 2H, CH_2 of Nph), 4.51 (m, 1H, $C^{\alpha}H$ of Val), 2.36 (m, 1H, $C^{\beta}H$ of Val), 1.04 (d, 3H, *J*= 7.28 Hz, $C^{\gamma}Hs$ of Val), 0.93 (d, 3H, *J*= 7.28 Hz, $C^{\gamma}Hs$ of Val) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): 198.7, 156.2, 134.6, 133.5, 133.2, 133.1, 131.7, 130.1, 129.5, 129.2, 128.4, 128.0, 127.7, 127.2, 127.0, 126.3, 126.2, 125.7, 67.52, 65.74, 31.23, 19.48, 16.87 ppm; MS (ESI) m/z for $C_{23}H_{23}NO_3S$ $(M+Na)^+$ calcd.: 416.2191 found: 416.1297.

^{1}H and ^{13}C NMR spectra

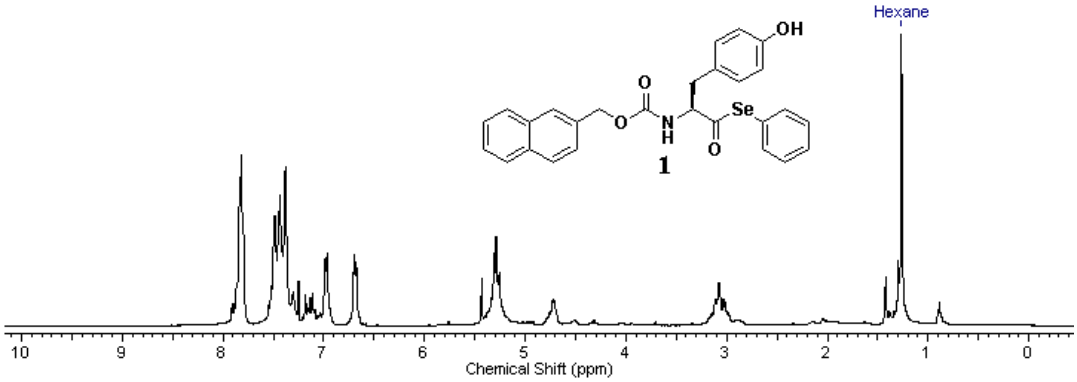


Fig. S48: ^{1}H NMR spectrum of NmYSePh **1**.

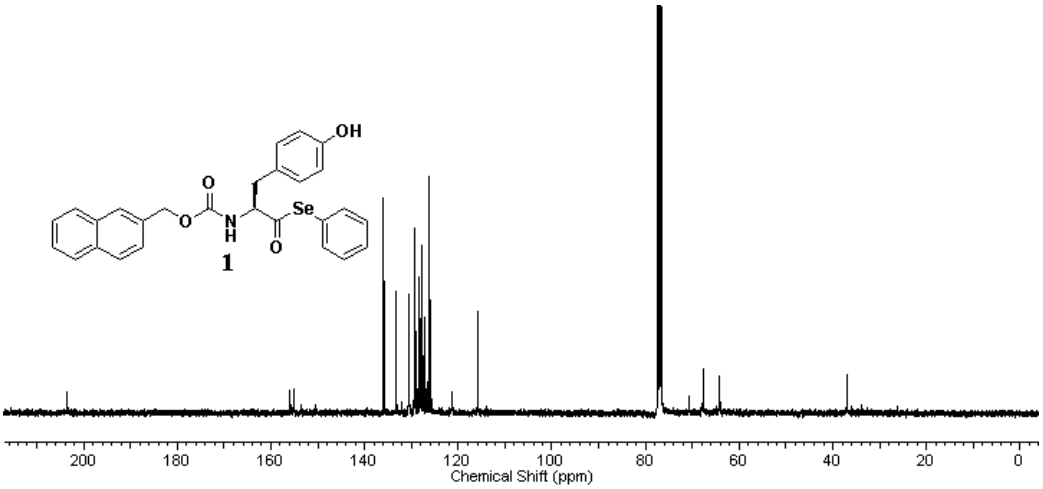


Fig. S49: ^{13}C NMR spectrum of NmYSePh **1**.

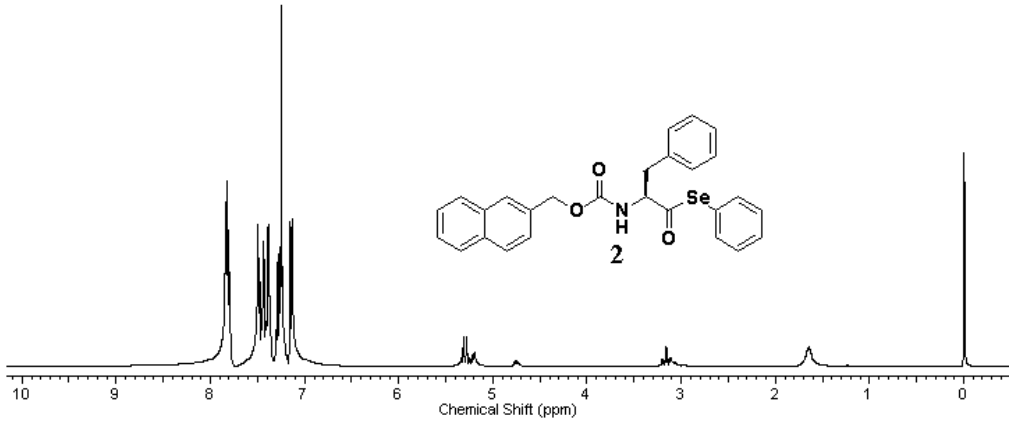


Fig. S50: ^{1}H NMR spectrum of NmFSePh **2**.

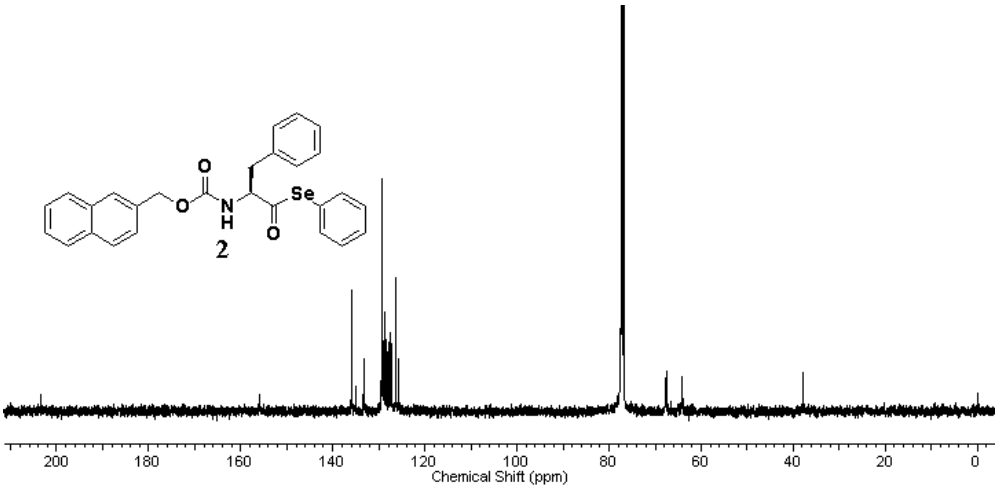


Fig. S51: ^{13}C NMR spectrum of NmFSePh **2**.

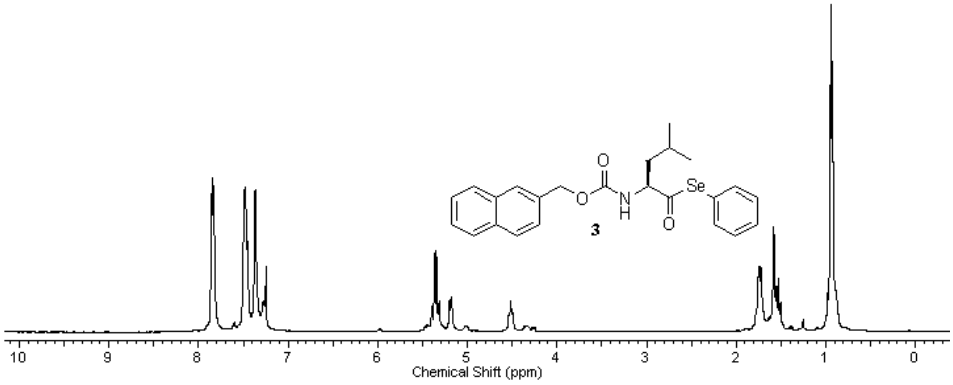


Fig. S52: ^{1}H NMR spectrum of NmLSePh **3**.

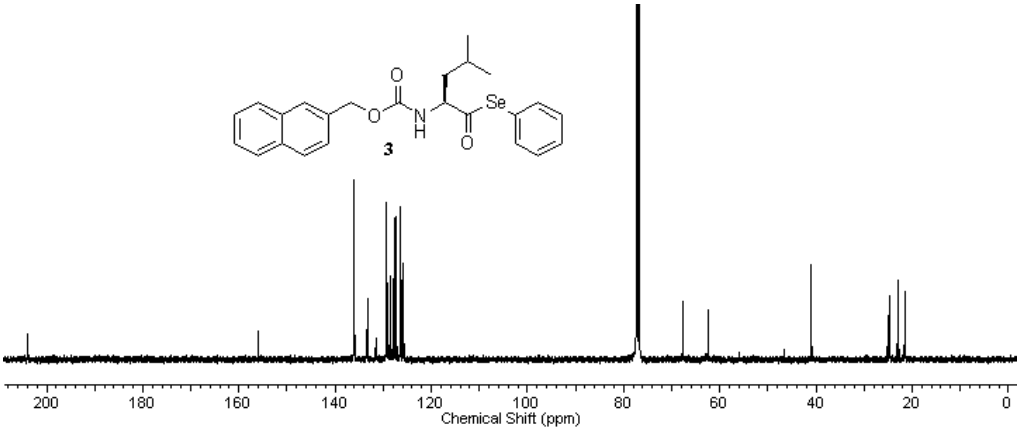


Fig. S53: ^{13}C NMR spectrum of NmLSePh **3**.

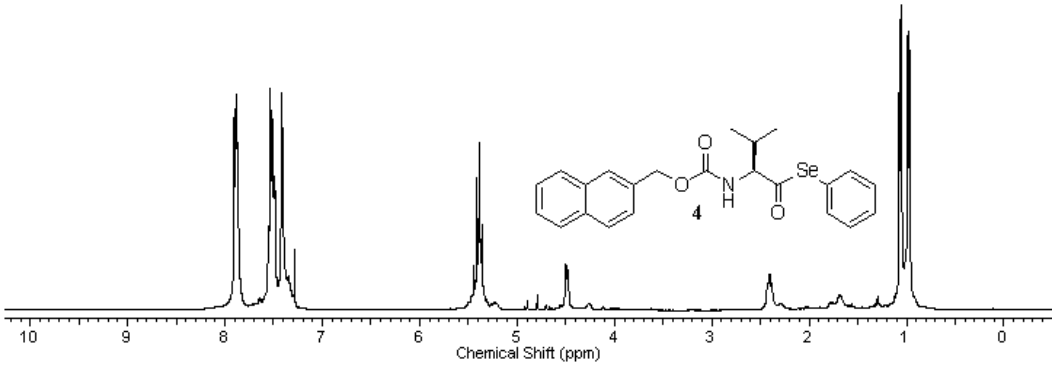


Fig. S54: ^{1}H NMR spectrum of NmVSePh **4**.

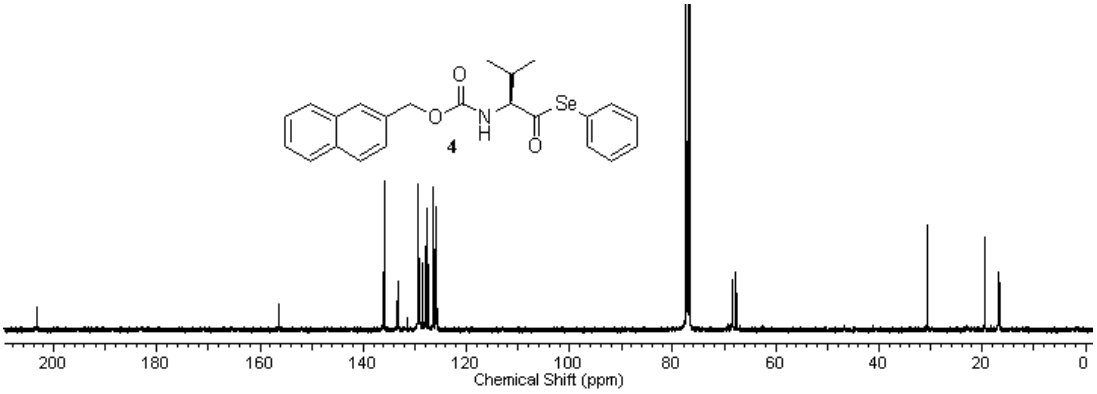


Fig. S55: ^{13}C NMR spectrum of NmVSePh **4**.

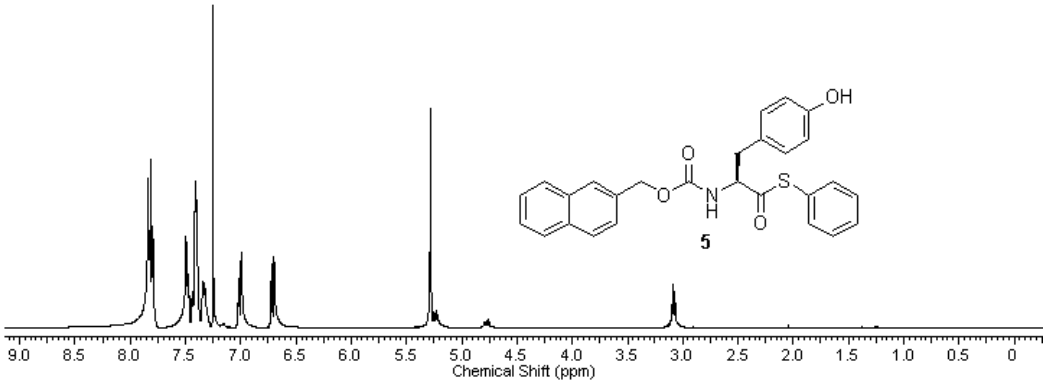


Fig. S56: ^{1}H NMR spectrum of NmY-SPh **5**.

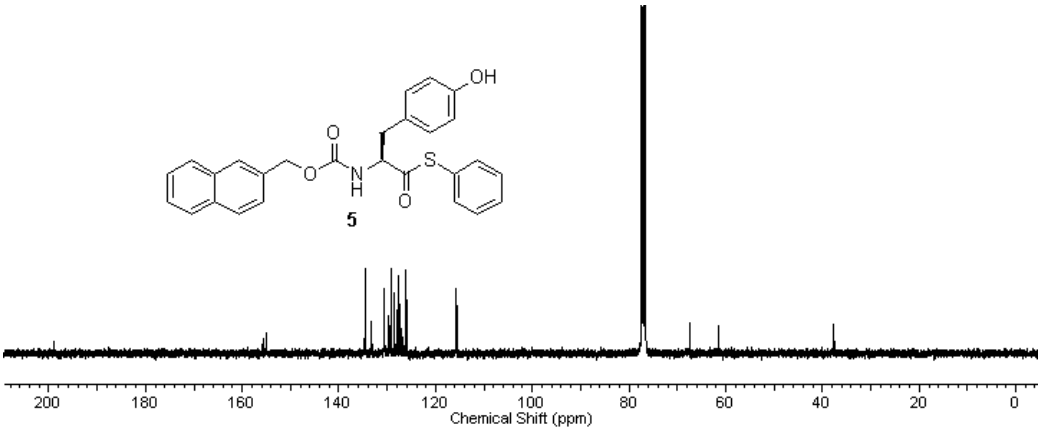


Fig. S57: ^{13}C NMR spectrum of NmY-SPh **5**.

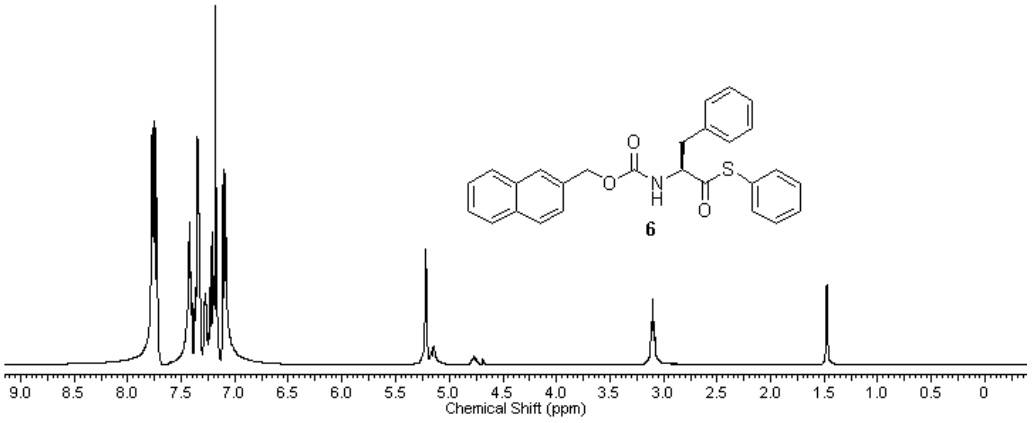


Fig. S58: ^{1}H NMR spectrum of NmF-SPh **6**.

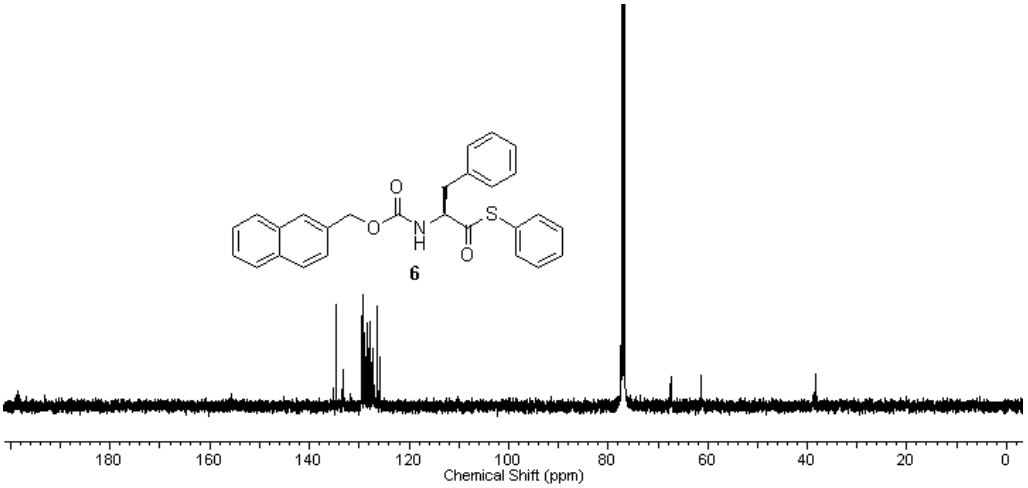


Fig. S59: ^{13}C NMR spectrum of NmF-SPh **6**.

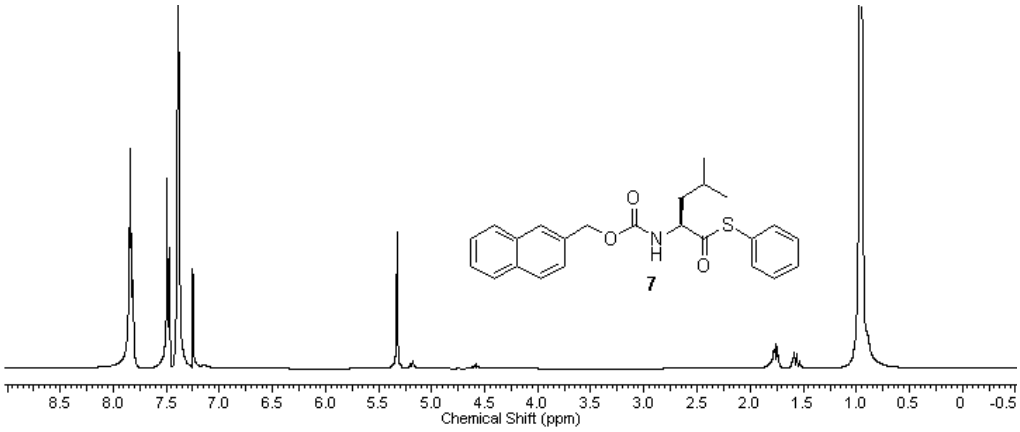


Fig. S60: [1]H NMR spectrum of NmL-SPh **7**.

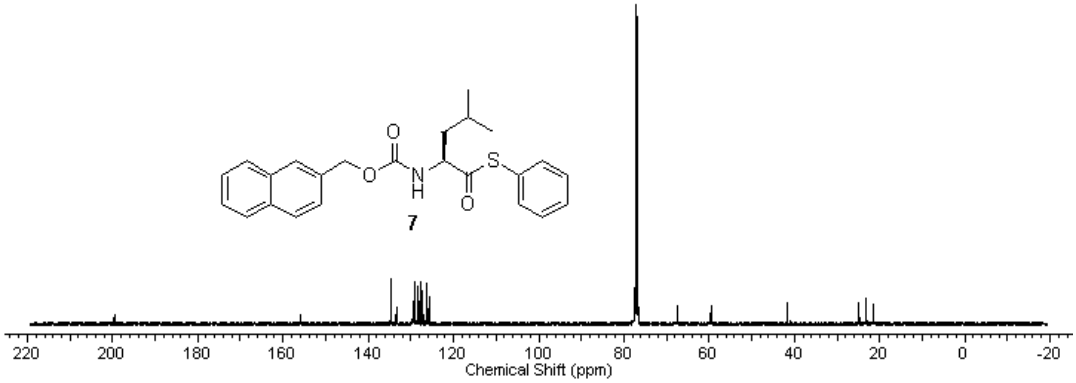


Fig. S61: [13]C NMR spectrum of NmL-SPh **7**.

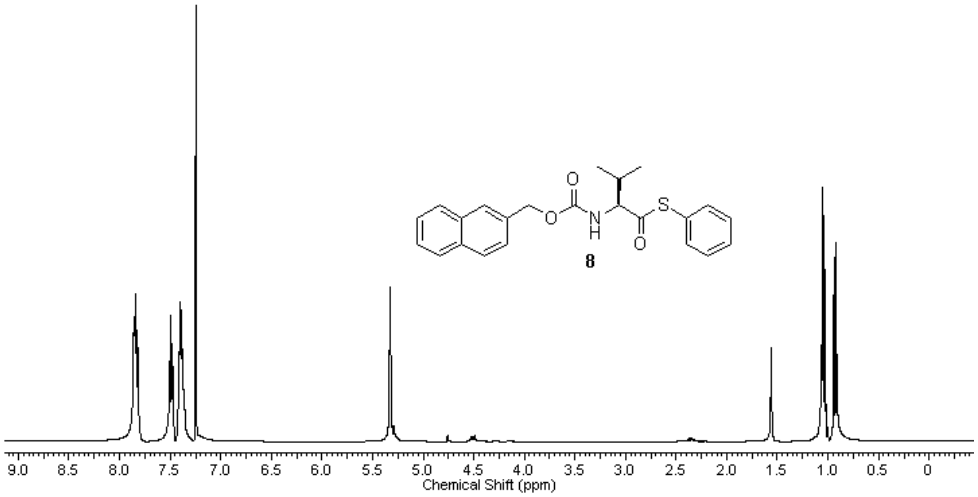


Fig. S62: [1]H NMR spectrum of NmV-SPh **8.**

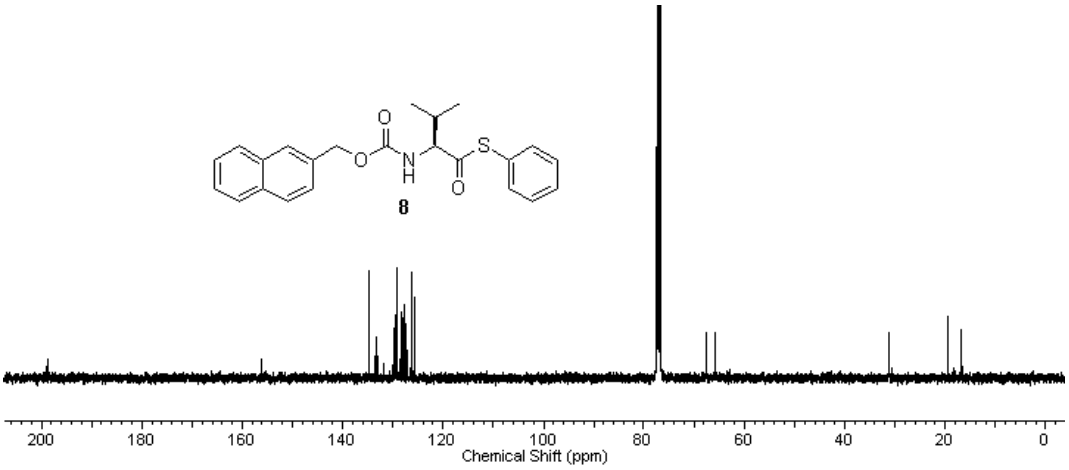


Fig. S63: ^{13}C NMR spectrum of NmV-SPh **8**.