Electronic Supplementary Material (ESI) for Organic and Biomolecular Chemistry

Exploiting reagent evolution in samarium-mediated reaction cascades: application in a tag removal-cyclisation approach to spirooxindole scaffolds

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Supporting Information

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General Experimental

All experiments were performed under an atmosphere of nitrogen using anhydrous solvents, unless stated otherwise. Glassware for inert atmosphere reactions was oven-dried and cooled under a flow of nitrogen. THF was freshly distilled from sodium/benzophenone, CH_2Cl_2 and Et_3N were freshly distilled from CaH_2. Petroleum ether refers to the fraction of petroleum ether boiling in the range 40-60 ºC. All other solvents and reagents were purchased from commercial sources and used as supplied. Except where indicated otherwise, imines were prepared according to literature procedures.

^{1}H NMR and ^{13}C NMR spectra were recorded on a 400 MHz or 500 MHz spectrometer, with chemical shift values being reported in parts per million (ppm) relative to residual $CHCl_3$ (δ_H = 7.27) and $CDCl_3$ (δ_C = 77.0) as internal standards unless otherwise stated. All coupling constants (*J*) are reported in Hertz (Hz). NMR assignments were made with the aid of COSY, HMQC, DEPT135 and DEPT90 experiments.

Low resolution and high resolution mass spectra were obtained using positive or negative electrospray ionisation (ES). Infrared spectra were recorded using an FTIR spectrometer as evaporated films or neat using sodium chloride windows. Melting points are uncorrected. Optical rotations (Sodium D line) are reported as unitless numbers for which the concentration c is in g/l00 mL.

Routine TLC analysis was carried out on aluminium sheets coated with silica gel 60 F254, 0.2 mm thickness. Plates were visualised by UV (254 mm) and/or by staining with aqueous potassium permanganate, ethanolic *p*-anisaldehyde or ethanolic phosphomolybdic acid. Column chromatography was carried out using 35–70μ, 60A silica gel.

Fluorous solid-phase extraction (FSPE) was performed using fluorous silica gel packed in a glass column. Crude products were dry-loaded onto silica gel and transferred onto the fluorous column. Elution with 40% water in MeCN (3 column volumes) provided the non-fluorous components of the mixture, then elution with

MeCN (3 column volumes) provided the fluorous components of the mixture. Fluorous columns were re-used up to 30 times. **FSPE** can be used to purify or part-purify all reactions involving fluorous-tagged starting materials.

General procedure A: Preparation of acetoxyamides using acetoxyacetic acid

EDCI.HCl (1.5 eq), HOBt.H_2O (0.2 eq) and acetoxyacetic acid (1.0 eq) were added to a stirred solution of amine (1.0 eq, 20.8 mmol) in CH_2Cl_2 (40 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 12-48 h, then a 1N aqueous solution of HCl (20 mL) and CH_2Cl_2 (20 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 20 mL). The combined organic layers were washed with a 1N aqueous solution of HCl (20 mL), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

General procedure B: Preparation of acetoxyamides using acetoxyacetyl chloride

Acetoxyacetyl chloride (1.1 eq) was added dropwise to a stirred solution of amine (1.0 eq, 32.6 mmol) and Et_3N (1.1 eq) in CH_2Cl_2 (100 mL) at 0 °C under nitrogen. The resulting solution was allowed to warm to room temperature, then stirred at room temperature for 12 h. A saturated aqueous solution of $NaHCO_3$ (100 mL) was added and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 × 50 mL) and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

General procedure C: Preparation of hydroxyamides

K_2CO_3 (4.0 eq) was added to a stirred solution of acetoxyamide (1.0 eq, 17.1 mmol) in MeOH (30 mL) and water (15 mL) at room temperature. The resulting suspension was stirred at room temperature for 12 h, then was evaporated under reduced pressure. The resulting mixture was adjusted to pH7 using a 1N aqueous solution of HCl, and CH_2Cl_2 (30 mL) was added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 30 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

General procedure D: Preparation of glyoxamides

A solution of DMSO (2.0 eq) in CH_2Cl_2 (2 mL) was added dropwise to a stirred solution of oxalyl chloride (1.1 eq) in CH_2Cl_2 (20 mL) at −78 °C under nitrogen. The resulting solution was stirred at −78 °C for 15 min, then a solution of hydroxyamide (1.0 eq, 8.88 mmol) in CH_2Cl_2 (20 mL) was added dropwise at −78 °C *via* cannula. The resulting solution was stirred at −78 °C for 30 min, then Et_3N (5.0 eq) was added dropwise at −78 °C. The mixture was allowed to warm to room temperature and stirred at room temperature for 3 h. A saturated aqueous solution of $NaHCO_3$ (30 mL) and CH_2Cl_2 (30 mL) were added, and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 × 30 mL), and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude glyoxamide, which was used directly in the next step without further purification.

General procedure E: Tag introduction–Cyclisation: Preparation of fluorous-tagged oxindoles

Fluorous thiol ($C_8F_{17}CH_2CH_2SH$, 0.7 eq) was added to a solution of crude glyoxamide (1.0 eq, 8.88 mmol) in CH_2Cl_2 (50 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 16 h, then trifluoroacetic anhydride (9.0 eq) was added. After stirring at room temperature for 1 h, $BF_3{\cdot}OEt_2$ (5.0 eq) was added, and the resulting solution was stirred at room temperature for 4 h. The mixture was slowly and carefully quenched with a saturated aqueous solution of $NaHCO_3$ (until gas evolution ceased). CH_2Cl_2 (50 mL) was added and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 × 50 mL) and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. **FSPE was used for purification.**

General procedure F: Tag introduction–Cyclisation: Preparation of fluorous-tagged oxindoles for (alternative procedure employing glyoxamides containing electron-rich aromatic rings)

Fluorous thiol ($C_8F_{17}CH_2CH_2SH$, 1.0 eq) was added to a solution of crude glyoxamide (1.0 eq, 4.48 mmol) in CH_2Cl_2 (40 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 1 h, then trifluoroacetic anhydride (2.0 eq) was added, and the resulting solution was stirred at room

temperature for 16 h. The mixture was slowly and carefully quenched with a saturated aqueous solution of $NaHCO_3$ (until gas evolution ceased). CH_2Cl_2 (20 mL) was added and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 × 40 mL) and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. **FSPE was used for purification.**

General procedure G: Preparation of alkylated fluorous-tagged oxindoles

cis-1,4-Dichlorobut-2-ene (1.5 eq) and K_2CO_3 (5.0 eq) were added to a stirred solution of fluorous-tagged oxindole (1.0 eq, 1.55 mmol) in DMF (30 mL) at room temperature under nitrogen. The resulting suspension was stirred for 5-12 h at room temperature, then water (30 mL) and EtOAc (50 mL) were added. The layers were separated, and the organic layer was washed with water (2 × 30 mL), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. **FSPE was used for purification.**

General procedure H: Preparation of samarium diiodide (SmI_2)

Samarium diiodide was prepared by a modification of the procedure of Imamoto and Ono.[1] Samarium powder (2.00 g, 13.8 mmol, 1.2 eq) was added to an oven-dried round-bottomed flask and the flask was sealed and flushed with nitrogen gas for 20 min. THF (110 ml) was added and the resulting suspension bubbled with nitrogen gas for 15 min. Finally, iodine (2.80 g, 10.8 mmol, 1 eq) was added and the flask flushed again with nitrogen gas for 10 min. The flask was covered in aluminium foil and heated at 60 ºC for 18 hours. The approx 0.1 M solution was allowed to cool to room temperature and then used directly.

General procedure I: Preparation of spirooxindoles

In a sealable tube, a solution of alkylated fluorous-tagged oxindole (1.0 eq, 0.12 mmol) in THF (4 mL) was deoxygenated by bubbling through nitrogen gas for 30 min. Then, SmI_2 (2.0 eq. of a 0.1 M solution in THF) was added dropwise over 20 min (using a syringe pump) at room temperature under nitrogen. On completion of the addition, a solution of imine (2.0 eq.) in THF (1 mL) was added, and the tube was sealed. The resulting suspension was heated at 80 °C in an oil bath for 12-18 h, and then allowed to cool to room temperature. A saturated aqueous solution of $Na_2S_2O_3$

(10 mL) and CH_2Cl_2 (10 mL) were added, and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 × 10 mL), and the combined organic layers were washed with a saturated aqueous solution of $NaHCO_3$ (10 mL), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. **Generally, FSPE was used to remove fluorous disulfide by-product and to part-purify spirooxindole products.** In some cases, further purification by recrystallisation or chromatography on silica gel was used to isolate single isomers for characterisation.

General procedure J: Preparation of spirooxindole aldehydes

OsO_4 (0.1 eq. of a 2.5% (w/v) solution in *tert*-butanol) and NMO (3.0 eq.) were added to a stirred suspension of spirooxindole (0.20 mmol) in acetone (12 mL) and water (1.5 mL) at room temperature under nitrogen. The resulting suspension was stirred at room temperature for 60 h, then a saturated aqueous solution of $Na_2S_2O_3$ (10 mL) and CH_2Cl_2 (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 15 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude diol product. The crude product was dissolved in THF (10 mL) and water (2 mL), then $NaIO_4$ (1.5 eq.) was added. The resulting suspension was heated at reflux for 2 h then allowed to cool to room temperature. Et_2O (20 mL) and water (10 mL) were added and the layers were separated. The aqueous layer was extracted with Et_2O (2 × 10 mL) and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

General procedure K: Preparation of spirooxindole methyl esters

Oxidant solution [1.6 mL; freshly prepared from $NaClO_2$ (300 mg) and $NaH_2PO_4.H_2O$ (300 mg) in water (2 mL)] was added in one portion to a stirred solution of aldehyde (0.17 mmol) in *tert*-butanol (4 mL), MeCN (4 mL) and 2-methyl-2-butene (2 mL) at room temperature. The resulting solution was stirred for 2 h at room temperature, then water (10 mL) and CH_2Cl_2 (20 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 20 mL). The combined organic layers were washed with water (20 mL), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude carboxylic acid product. The crude product was dissolved in anhydrous MeOH (8 mL) and trimethylsilyldiazomethane (1.5 mL of a 2.0M

solution in hexanes, 5.0 eq.) was added dropwise at room temperature under nitrogen. The resulting solution was stirred at room temperature for 2 h, then evaporated under reduced pressure to give the crude product.

General procedure L: Preparation of spirooxindole amines

Nitrogen gas was bubbled (15 min) through a solution of *N*-benzyl amine (0.08 mmol) in a 0.05M solution of HCl in MeOH (8 mL; 50 mL stock solution of 0.05 M HCl in MeOH freshly prepared by diluting 208 μL 12M HCl with MeOH). $Pd(OH)_2$ (8 mg, 20% wt.) was added, and the resulting suspension was stirred under an atmosphere of H_2 (1 atm) for 5 min then filtered through a plug of Celite, washing with MeOH. Et_3N (5 drops) was added, and the resulting solution was evaporated under reduced pressure. The residue was dissolved in EtOAc (10 mL), water (5 mL) was added and the layers were separated. The aqueous layer was extracted with EtOAc (2 × 5 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

General procedure M: Preparation of *N*-Troc prolinylspirooxindoles

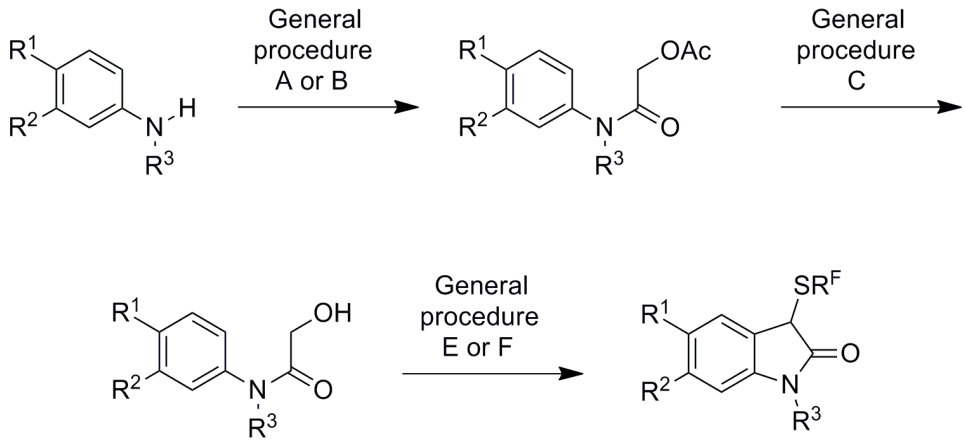
A solution of *N*-Troc (*S*)-prolinyl chloride[2] (1.0 or 3.0 eq.; freshly prepared from *N*-Troc (*S*)-proline)[3] in CH_2Cl_2 (3 mL) was added dropwise at 0 °C to a stirred solution of amine (0.15 mmol) and Et_3N (0.9 mmol) in CH_2Cl_2 (12 mL) under nitrogen. The resulting solution was allowed to warm to room temperature and stirred for 12 h, then CH_2Cl_2 (10 mL) and a saturated aqueous solution of $NaHCO_3$ (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 10 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

General procedure N: Preparation of diketopiperazines

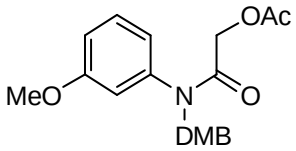
Zn dust (100 eq) was added to a stirred suspension of *N*-Troc amide (0.07 mmol) in THF (4 mL), MeOH (4 mL) and a saturated aqueous solution of NH_4Cl (4 mL) at room temperature. The resulting suspension was stirred at room temperature for 24 h, filtered through Celite, and the filter cake was washed well with EtOAc. Water (10 mL) was added and the layers were separated. The aqueous layer was extracted with

EtOAc (2 × 15 mL) and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product.

Synthesis of fluorous-tagged oxindoles:



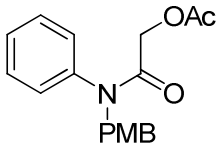
2-Acetoxy-*N*-(2,4-dimethoxybenzyl)-*N*-(3-methoxyphenyl)acetamide S1



NEt_3 (2.21 mL, 15.9 mmol, 1.1 eq) and acetoxyacetyl chloride (2.04 g, 15.9 mmol, 1.0 eq) were added sequentially to a solution of 2,4-dimethoxybenzyl)-(3-methoxyphenyl)-amine[7] (3.69 g, 13.6 mmol, 1.0 eq) in CH_2Cl_2 (24.4 mL) at room temperature under nitrogen. The resulting mixture was stirred at room temperature for 4 h before water (20 mL) and CH_2Cl_2 (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 20 mL). The combined organic layers were dried (Na_2SO_4) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in hexane gave **S1** (5.32 g, 14.2 mmol, 100%) as a light yellow oil, ^{1}H NMR (300 MHz, $CDCl_3$): δ 7.25-7.16 (m, 2H; 2 × Ar-CH), 6.84 (dd, J = 8.4, 2.3 Hz, 1H, Ar-CH), 6.64 (d, J = 7.7 Hz, 1H; Ar-CH), 6.59 (s, 1H; Ar-CH), 6.41 (dd, J = 8.4, 2.3 Hz, 1H; Ar-CH), 6.33 (d, J = 2.3 Hz, 1H; Ar-CH), 4.86 (s, 2H; OCH_2), 4.40 (s, 2H, NCH_2), 3.78 (s, 3H; OCH_3), 3.73 (s, 3H; OCH_3), 3.56 (s, 3H; OCH_3), 2.15 (s, 3H; $C(O)CH_3$); ^{13}C NMR (75 MHz, $CDCl_3$): δ 170.6 (C=O), 166.3 (C=O), 160.4 (Ar-C), 160.3 (Ar-C), 158.6 (Ar-C), 141.5 (Ar-C), 131.3 (Ar-CH), 130.0 (Ar-CH), 120.5 (Ar-

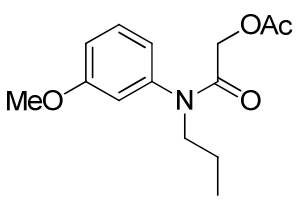
CH), 117.4 (Ar-C), 114.1 (Ar-CH), 113.8 (Ar-CH), 104.1 (Ar-CH), 98.3 (Ar-CH), 61.8 (NCH_2), 55.4 (OCH_3), 55.3 (OCH_3), 55.1 (OCH_3), 47.2 (CH_2O), 20.6 (C(O)CH_3); IR (film): ν_{max} 2932, 2830, 1742 (C=O), 1671 (C=O), 1585, 1506, 1485, 1451, 1437, 1420, 1407, 1369, 1284, 1263, 1217, 1205, 1154, 1126, 1080, 1029, 932, 837, 783, 705; MS (ES+): *m*/*z* (%): 396 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{20}H_{23}NO_6Na$: 396.1418 $[M + Na]^+$; found: 396.1401.

2-Acetoxy-*N*-(4-methoxybenzyl)-*N*-phenylacetamide S2



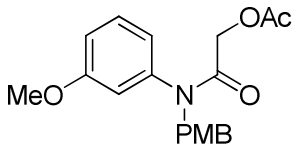
Using general procedure A, EDCI·HCl (5.97 g, 31.2 mmol), HOBt·H_2O (562 mg, 4.16 mmol), acetoxyacetic acid (2.45 g, 20.8 mmol) and (4-methoxybenzyl)phenylamine[4] (4.43 g, 20.8 mmol) in CH_2Cl_2 (40 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave **S2** (5.56 g, 17.7 mmol, 85%,) as a white solid, m.p. (hexanes-Et_2O) 62–65 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.37-7.33 (m, 3H; 3 × Ar-CH), 7.10 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 7.03-7.01 (m, 2H; 2 × Ar-CH), 6.79 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 4.81 (s, 2H; CH_2N), 4.34 (s, 2H; CH_2O), 3.78 (s, 3H; OCH_3), 2.15 (s, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6 (C=O), 166.4 (C=O), 159.0 (Ar-C), 140.0 (Ar-C), 130.3 (Ar-CH), 129.8 (Ar-CH), 128.8 (Ar-C), 128.7 (Ar-CH), 128.4 (Ar-CH), 113.7 (Ar-CH), 61.8 (CH_2O), 55.2 (OCH_3), 52.6 (CH_2N), 20.6 (CH_3); IR (film): ν_{max} 2997, 2947, 2936, 2835, 1748 (C=O), 1681 (C=O), 1613, 1594, 1513, 1494, 1435, 1406, 1371, 1298, 1245, 1225, 1175, 1085, 1022, 1015, 844, 820, 699 cm^{-1}; MS (ES+): *m*/*z* (%): 336 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{18}H_{19}NO_4$: 336.1206 $[M + Na^+]$; found: 336.1216.

2-Acetoxy-*N*-(3-methoxyphenyl)-*N*-propylacetamide S3



Using general procedure B, acetoxyacetyl chloride (3.86 mL, 35.9 mmol), Et_3N (5.00 mL, 35.9 mmol) and *N*-propyl-3-methoxyaniline[5] (5.39 g, 32.6 mmol) in CH_2Cl_2 (100 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave **S3** (8.22 g, 31.0 mmol, 95%) as a colorless oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.32 (t, J = 8.2 Hz, 1H; Ar-CH), 6.91 (dd, J = 8.2, 2.1 Hz, 1H; Ar-CH), 6.81-6.78 (m, 1H; Ar-CH), 6.74 (t, J = 2.1 Hz, 1H; Ar-CH), 4.35 (s, 2H; CH_2O), 3.81 (s, 3H; OCH_3), 3.63 (t, J = 7.6 Hz, 2H; CH_2N), 2.21 (s, 3H; CH_3), 1.52 (sextet, J = 7.6 Hz, 2H; CH_2CH_3), 0.87 (t, J = 7.6 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.5 (C=O), 166.1 (C=O), 160.6 (Ar-C), 141.5 (Ar-C), 130.6 (Ar-CH), 120.2 (Ar-CH), 113.96 (Ar-CH), 113.88 (Ar-CH), 61.6 (CH_2O), 55.4 (OCH_3), 50.9 (CH_2N), 20.7 (CH_2CH_3), 20.5 (CH_3), 11.1 (CH_2CH_3); IR (film): ν_{max} 2964, 2935, 2878, 1747 (C=O), 1680 (C=O), 1601, 1490, 1452, 1432, 1416, 1372, 1227, 1136, 1046, 847, 707 cm^{-1}; MS (ES+): *m*/*z* (%): 288 (50, [M + Na]$^+$), 266 (100, [M + H]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{14}H_{19}NO_4$: 288.1206 [M + Na^+]; found: 288.1214.

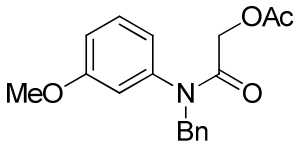
2-Acetoxy-*N*-(4-methoxybenzyl)-*N*-(3-methoxyphenyl)acetamide S4



Using general procedure A, EDCI.HCl (9.40 g, 49.2 mmol), $HOBt.H_2O$ (0.60 g, 4.10 mmol), acetoxyacetic acid (4.80 g, 41.0 mmol) and *N*-(4-methoxybenzyl)-3-methoxy-aniline[6] (5.00 g, 20.5 mmol) in CH_2Cl_2 (31 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in petroleum ether gave **S3** (6.13 g, 17.9 mmol, 87%) as a white powder, m.p. (EtOAc/hexane) 87–89 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (t, J = 8.1 Hz, 1H; Ar-CH), 7.12 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.88 (dd, J = 8.1, 2.5 Hz, 1H; Ar-CH), 6.80 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.61 (dd, J = 8.1, 1.0 Hz, 1H; Ar-CH), 6.54 (d, J = 2.3 Hz, 1H; Ar-CH), 4.80 (s, 2H; CH_2N), 4.39 (s, 2H; CH_2O), 3.79 (s, 3H; OCH_3), 3.73 (s, 3H; OCH_3), 2.16 (s, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.6 (C=O), 166.3 (C=O), 160.4 (Ar-C), 159.0 (Ar-C), 141.1 (Ar-C), 130.5 (2 × Ar-CH), 130.3 (Ar-CH), 128.5 (Ar-C), 113.9 (Ar-CH), 113.7 (Ar-CH), 113.3 (2 × Ar-CH), 61.7 (CH_2O), 55.4

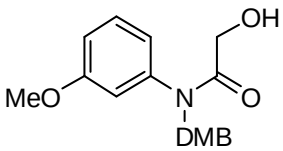
(OCH_3), 55.2 (OCH_3), 52.6 (CH_2N), 20.6 (CH_3); IR (film): ν_{max} 1754 (C=O), 1673 (C=O), 1588, 1513, 1492, 1407, 1244, 1198, 1172, 1025, 820, 703 cm^{-1}; MS (ES+): *m*/*z* (%): 366 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{19}H_{21}NO_5$: 366.1305 $[M + Na^+]$; found: 366.1312.

2-Acetoxy-*N*-benzyl-*N*-(3-methoxyphenyl)acetamide S5



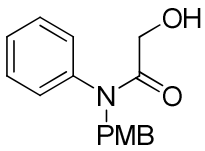
Using general procedure B, acetoxyacetyl chloride (0.79 mL, 7.30 mmol), Et_3N (1.02 mL, 7.30 mmol) and *N*-benzyl-3-methoxyaniline[8] (1.42g, 6.64 mmol) in CH_2Cl_2 (30 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave **S5** (1.71 g, 5.45 mmol, 82%) as a white solid, m.p. (Et_2O) 69–72 °C; ^1H NMR (400 MHz, $CDCl_3$): δ 7.31-7.20 (m, 6H; 6 × Ar-CH), 6.88 (ddd, *J* = 8.0, 2.5, 0.9 Hz, 1H; Ar-CH), 6.64 (dd, *J* = 8.0, 0.9 Hz, 1H; Ar-CH), 6.55-6.54 (m, 1H; Ar-CH), 4.87 (s, 2H; CH_2N), 4.42 (s, 2H; CH_2O), 3.72 (s, 3H; OCH_3), 2.16 (s, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6 (C=O), 166.5 (C=O), 160.5 (Ar-C), 141.7 (Ar-C), 136.8 (Ar-C), 130.5 (Ar-CH), 128.9 (Ar-CH), 128.4 (Ar-CH), 127.5 (Ar-CH), 120.4 (Ar-CH), 114.4 (Ar-CH), 113.8 (Ar-CH), 61.7 (CH_2O), 55.3 (OCH_3), 53.2 (CH_2N), 20.6 (CH_3); IR (film): ν 2966, 2940, 2928, 1743 (C=O), 1672 (C=O), 1426, 1412, 1285, 1241, 1219, 1159, 1076, 1044, 1006 cm^{-1}; MS (ES+): *m*/*z* (%): 336 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{18}H_{19}NO_4$: 336.1206 $[M + Na^+]$; found: 336.1206.

2-Hydroxy-*N*-(2,4-dimethoxybenzyl)-*N*-(3-methoxyphenyl)acetamide S6



Using general procedure C, acetoxyamide **S4** (5.32 g, 14.3 mmol) and K_2CO_3 (7.90 g, 57.2 mmol) in MeOH (44 mL) and water (22 mL) gave hydroxyamide **S6** (4.48 g, 13.5 mmol, 94%) as a colorless oil, ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.21 (t, J = 8.5 Hz, 1H; Ar-CH), 7.14 (d, J = 8.5 Hz, 1H; Ar-CH), 6.85 (dd, J = 8.5, 2.5 Hz, 1H; Ar-CH), 6.57 (d, J = 8.5 Hz, 1H; Ar-CH), 6.50 (t, J = 2.5 Hz, 1H; Ar-CH), 6.41 (dd, J = 8.5, 2.5 Hz, 1H; Ar-CH), 6.35 (d, J = 2.5 Hz, 1H; Ar-CH), 4.90 (s, 2H; NCH_2), 3.82 (d, J = 4.4 Hz, 2H; CH_2OH), 3.78 (s, 3H; OCH_3), 3.73 (s, 3H; OCH_3), 3.57 (s, 3H; OCH_3), 3.45 (t, J = 4.4 Hz, 1H; CH_2OH); ^{13}C NMR (125 MHz, $CDCl_3$): δ 171.6 (C=O), 160.5 (Ar-C), 160.2 (Ar-C), 158.6 (Ar-C), 140.6 (Ar-C), 131.3 (Ar-CH), 130.0 (Ar-CH), 120.5 (Ar-CH), 117.0 (Ar-C), 114.1 (Ar-CH), 113.9 (Ar-CH), 104.0 (Ar-CH), 98.3 (Ar-CH), 60.5 (CH_2OH), 55.3 (2 × OCH_3), 55.1 (OCH_3), 47.6 (CH_2N); IR (film): ν_{max} 3429 (OH), 2993, 2937, 2835, 1650 (C=O), 1599, 1587, 1504, 1485, 1453, 1434, 1376, 1312, 1281, 1261, 1205, 1156, 1126, 1087, 1029, 990, 932, 922, 832, 781, 749, 700; MS (ES+): m/z (%): 354 (100, $[M + Na]^+$); HRMS (ES+): m/z: calcd for $C_{18}H_{21}NO_5Na$: 354.1312 $[M + Na]^+$; found: 354.1318.

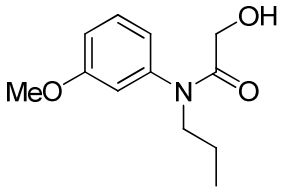
2-Hydroxy-*N*-(4-methoxybenzyl)-*N*-phenylacetamide S7



Using general procedure C, acetoxyamide **S2** (5.37 g, 17.1 mmol) and K_2CO_3 (9.48 g, 68.6 mmol) in MeOH (30 mL) and water (15 mL) gave hydroxyamide **S7** (4.58 g, 16.9 mmol, 98%) as a white solid, m.p. (Et_2O) 74–76 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.37-7.33 (m, 3H; 3 × Ar-CH), 7.11 (d, J = 8.5 Hz, 2H; 2 × Ar-CH), 6.96-6.92 (m, 2H; 2 × Ar-CH), 6.81 (d, J = 8.5 Hz, 2H; 2 × Ar-CH), 4.86 (s, 2H; CH_2N), 3.79 (s, 3H; OCH_3), 3.77 (s, 2H; CH_2O); ^{13}C NMR (125 MHz, $CDCl_3$): δ 171.7 (C=O), 159.1 (Ar-C), 139.2 (Ar-C), 130.3 (Ar-CH), 129.8 (Ar-CH), 128.8 (Ar-CH), 128.7 (Ar-C), 128.4 (Ar-CH), 113.8 (Ar-CH), 60.5 (CH_2O), 55.2 (OCH_3), 53.0 (CH_2N); IR (film): ν_{max} 3434 (OH), 2930, 2835, 1659 (C=O), 1611, 1594, 1513, 1494, 1379, 1298, 1245, 1175, 1097, 1029, 1015, 999, 817, 699 cm^{-1}; MS (ES+): m/z (%):

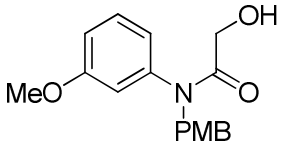
294 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{16}H_{17}N_2O_3$: 294.1101 $[M + H^+]$; found: 294.1091.

2-Hydroxy-*N*-(3-methoxyphenyl)-*N*-propylacetamide S8



Using general procedure C, acetoxyamide **S3** (7.91 g, 29.8 mmol) and K_2CO_3 (16.5 g, 0.1 mol) in MeOH (60 mL) and water (30 mL) gave hydroxyamide **S8** (6.56 g, 29.4 mmol, 98%) as an off-white solid, m.p. (Et_2O) 50–53 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35 (t, *J* = 8.2 Hz, 1H; Ar-CH), 6.94 (dd, *J* = 8.2, 1.9 Hz, 1H; Ar-CH), 6.76-6.74 (m, 1H; Ar-CH), 6.69 (t, *J* = 1.9 Hz, 1H; Ar-CH), 3.83 (s, 3H; OCH_3), 3.81 (s, 2H; CH_2O), 3.72-3.68 (m, 2H; CH_2N), 1.57 (sextet, *J* = 7.5 Hz, 2H; CH_2CH_3), 0.92 (t, *J* = 7.5 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.6 (C=O), 160.6 (Ar-C), 140.6 (Ar-C), 130.6 (Ar-CH), 120.2 (Ar-CH), 113.99 (Ar-CH), 113.98 (Ar-CH), 60.4 (CH_2O), 55.4 (OCH_3), 51.2 (CH_2N), 20.9 (CH_2CH_3), 11.1 (CH_3); IR (film): ν_{max} 3436 (OH), 2965, 2930, 1659 (C=O), 1601, 1490, 1456, 1384, 1313, 1289, 1249, 1211, 1100, 1046, 706 cm^{-1}; MS (ES+): *m*/*z* (%): 246 (35, $[M + Na]^+$), 224 (100, $[M + H]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{12}H_{17}NO_3$: 246.1101 $[M + Na^+]$; found: 246.1101.

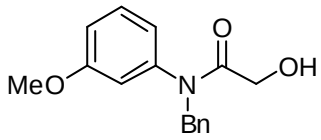
2-Hydroxy-*N*-(4-methoxybenzyl)-*N*-(3-methoxyphenyl)acetamide S9



Using general procedure C, acetoxyamide **S4** (6.00 g, 17.4 mmol) and K_2CO_3 (9.60 g, 69.9 mmol) in MeOH (53 mL) and water (27 mL) gave hydroxyamide **S9** (5.38 g, 100%) as a colorless oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28 (t, *J* = 8.1 Hz, 1H; Ar-CH), 7.15 (d, *J* = 8.8 Hz, 2H; 2 × Ar-CH), 6.92 (dd, *J* = 8.1, 2.5 Hz, 1H; Ar-CH), 6.83 (d, *J* = 8.8 Hz, 2H; 2 × Ar-CH), 6.55 (dd, *J* = 8.1, 0.8 Hz, 1H; Ar-CH), 6.48 (t, *J* = 2.5

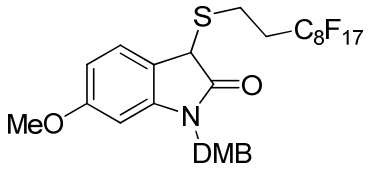
Hz, 1H; Ar-CH), 4.86 (s, 2H; CH_2N), 3.85 (s, 2H; CH_2O), 3.81 (s, 3H; OCH_3), 3.75 (s, 3H; OCH_3), 3.45 (br s, 1H; OH); ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.3 (C=O), 160.4 (Ar-C), 159.1 (Ar-C), 140.3 (Ar-C), 130.4 (Ar-CH), 130.3 (Ar-CH), 128.7 (Ar-CH), 120.4 (Ar-C), 114.3 (Ar-CH), 113.9 (Ar-CH), 113.7 (Ar-CH), 60.4 (CH_2O), 55.3 (OCH_3), 55.2 (OCH_3), 52.8 (CH_2N); IR (film): ν_{max} 3427 (OH), 2926, 2863, 1715 (C=O), 1627, 1513, 1463, 1379, 1348, 1248, 1160, 1039, 921, 883 cm^{-1}; MS (ES+): *m*/*z* (%): 324 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{17}H_{19}NO_4$: 324.1204 $[M + H^+]$; found: 324.1206.

_N_-Benzyl-2-Hydroxy-_N_-(3-methoxyphenyl)acetamide S10



Using general procedure C, acetoxyamide **S5** (3.58 g, 11.4 mmol) and K_2CO_3 (6.31 g, 45.7 mol) in MeOH (40 mL) and water (20 mL) gave hydroxyamide **S10** (3.09 g, 11.4 mmol, 100%) as a colorless oil, ^1H NMR (400 MHz, $CDCl_3$): δ 7.24-7.12 (m, 6H; 6 × Ar-CH), 6.82 (ddd, *J* = 8.3, 2.2, 0.8 Hz, 1H; Ar-CH), 6.48 (ddd, *J* = 7.8, 2.2, 0.8 Hz, 1H; Ar-CH), 6.38 (t, *J* = 2.2 Hz, 1H; Ar-CH), 4.83 (s, 2H; CH_2N), 3.78 (d, *J* = 4.4 Hz, 2H; CH_2O), 3.64 (s, 3H; OCH_3), 3.34 (t, *J* = 4.4 Hz, 1H; OH); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.8 (C=O), 160.4 (Ar-C), 140.3 (Ar-C), 136.6 (Ar-C), 130.4 (Ar-CH), 128.9 (Ar-CH), 128.4 (Ar-CH), 127.7 (Ar-CH), 120.3 (Ar-CH), 114.4 (Ar-CH), 113.8 (Ar-CH), 60.4 (CH_2O), 55.3 (OCH_3), 53.4 (CH_2N); IR (film): ν_{max} 3440 (OH), 2936, 2837, 1653 (C=O), 1598, 1587, 1488, 1377, 1314, 1285, 1238, 1164, 1095, 1077, 1028, 993 cm^{-1}; MS (ES+): *m*/*z* (%): 294 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{16}H_{17}NO_3$: 294.1101 $[M + Na^+]$; found: 294.1098.

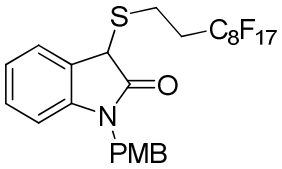
6-Methoxy-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-(2,4-dimethoxybenzyl)-1,3-dihydroindol-2-one 9



Using general procedure D, DMSO (1.00 mL, 13.4 mmol), oxalyl chloride (0.60 mL, 7.30 mmol), a solution of hydroxyamide **S6** (2.20 g, 6.70 mmol) in CH_2Cl_2 (22.3 mL) and Et_3N (3.39 mL, 33.5 mmol) in CH_2Cl_2 (22.3 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure F, fluorous thiol ($C_8F_{17}CH_2CH_2SH$, 2.00 mL, 6.70 mmol), TFAA (1.90 mL, 13.4 mmol) and the crude glyoxamide, in CH_2Cl_2 (44.5 mL) gave the crude product as a 6:1 mixture of regioisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** gave **9** (4.40 g, 5.56 mmol, 82%) as yellow oil. Further purification by flash column chromatography on silica gel eluting with 100% CH_2Cl_2 gave the major regioisomer as a white powder, m.p. (CH_2Cl_2) 93-95 ˚C; ^{1}H NMR (400 MHz, $CDCl_3$, major regioisomer): δ7.24 (d, J = 8.1 Hz, 1H; Ar-CH), 7.15 (d, J = 8.6 Hz, 1H; Ar-CH), 6.55 (dd, J = 8.1, 2.4 Hz, 1H; Ar-CH), 6.52 (d, J = 2.4 Hz, 1H; Ar-CH), 6.46 (d, J = 2.4 Hz, 1H; Ar-C*H*), 6.41 (dd, J = 8.6, 2.4 Hz, 1H; Ar-CH), 4.91 (d, J = 15.6 Hz, 1H; CH_AH$_B$N), 4.79 (d, J = 15.6 Hz, 1H; CH$_A$$H_B$N), 4.34 (s, 1H; C*H*S), 3.88 (s, 3H; OCH_3), 3.76 (s, 6H; 2 × OCH_3), 3.04-2.96 (m, 1H; SCH_AH$_B$), 2.77-2.86 (m, 1H; SCH$_A$$H_B$), 2.49-2.33 (m, 2H; SCH_2CH_2); ^{13}C NMR (100 MHz, $CDCl_3$, major regioisomer): δ 175.8 (C=O), 161.0 (ArC), 160.5 (ArC), 157.9 (ArC), 144.8 (ArC), 129.7 (ArCH), 125.5 (ArCH), 116.5 (ArC), 116.0 (ArC), 107.0 (ArCH), 104.4 (ArCH), 98.5 (ArCH), 97.4 (ArCH), 55.4 (2 × OCH_3), 55.3 (OCH_3), 44.6 (*C*HS), 38.1 (N*C*H$_2$), 31.9 (t, J = 22.2 Hz; *C*H$_2$C$_8$F$_{17}$); 20.9 (t, J = 3.7 Hz; S*C*H$_2$); IR (film): ν_{max} 2932, 2830, 1742, 1715 (C=O), 1613, 1587, 1508, 1462, 1372, 1237, 1203, 1145, 1129, 1110, 1030, 832, 749, 705, 665, 651; MS (ES+): *m*/*z* (%): 814 (100, [M + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{28}H_{22}NO_4F_{17}SNa$: 814.0890 [$M$ + Na] $^+$; found: 814.0926.

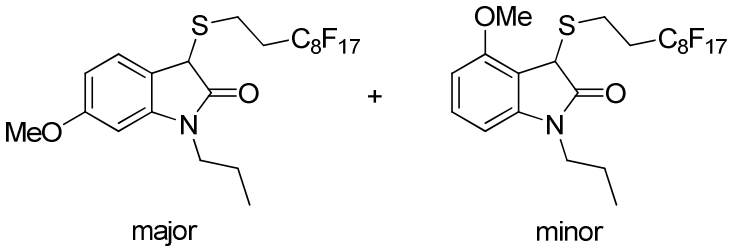
3-(3,3,4,4,5,5,6,6,7,7,8,8,9,910,10,10-Heptadecafluorodecylsulfanyl)-1-(4-methoxybenzyl)-1,3-dihydroindol-2-one S11



Using general procedure D, DMSO (1.3 mL, 17.8 mmol), oxalyl chloride (0.9 mL, 9.76 mmol), a solution of hydroxyamide **S7** (2.41 g, 8.88 mmol) in CH_2Cl_2 (20 mL) and Et_3N (6.2 mL, 44.38 mmol) in CH_2Cl_2 (20 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure E, fluorous thiol ($C_8F_{17}CH_2CH_2SH$, 1.8 mL, 6.21 mmol), the crude glyoxamide, trifluoroacetic anhydride (11.1 mL, 79.9 mmol) and $BF_3{\cdot}OEt_2$ (5.6 mL, 44.4 mmol) in CH_2Cl_2 (50 mL) gave the crude product. Purification by **FSPE** gave **S11** (2.81 g, 3.84 mmol, 62%) as a yellow oil, ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.38 (d, J = 7.6 Hz, 1H; Ar-CH), 7.26 (d, J = 8.7 Hz, 2H; 2 × Ar-CH), 7.23 (t, J = 7.6 Hz, 1H; Ar-CH), 7.07 (t, J = 7.6 Hz, 1H; Ar-CH), 6.85 (d, J = 8.7 Hz, 1H; 2 × Ar-CH), 6.78 (d J = 7.6 Hz, 1H; Ar-CH), 4.91 (d, J = 15.5 Hz, 1H; $NCH_ACH_BC_6H_4OCH_3$), 4.82 (d, J = 15.5 Hz, 1H; $NCH_ACH_BC_6H_4OCH_3$), 4.40 (s, 1H; CHS), 3.77 (s, 3H; OCH_3), 3.04-2.98 (m, 1H; CH_AH_BS), 2.85-2.79 (m, 1H; CH_AH_BS), 2.46-2.35 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.0 (C=O), 159.2 (Ar-C), 143.1 (Ar-C), 129.3 (Ar-CH), 128.7 (Ar-CH), 127.4 (Ar-C), 125.14 (Ar-CH), 125.06 (Ar-C), 123.0 (Ar-CH), 114.2 (Ar-CH), 109.4 (Ar-CH), 55.2 (OCH_3), 44.8 (CHS), 43.5 ($NCH_2C_6H_4OMe$), 31.8 (t, J = 22.0 Hz; $CH_2C_8F_{17}$), 21.0 (t, J = 4.6 Hz, CH_2S); IR (film): ν_{max} 2952, 2930, 2908, 2835, 1712 (C=O), 1614, 1513, 1485, 1466, 1435, 1357, 1345, 1242, 1214, 1150, 1113, 1088, 1029, 954, 898, 755 cm^{-1}; MS (ES+): m/z (%):754 (25, $[M + Na]^+$); HRMS (ES+): m/z: calcd for $C_{26}H_{18}F_{17}NO_2S$: 754.0680 $[M + Na^+]$; found: 754.0672.

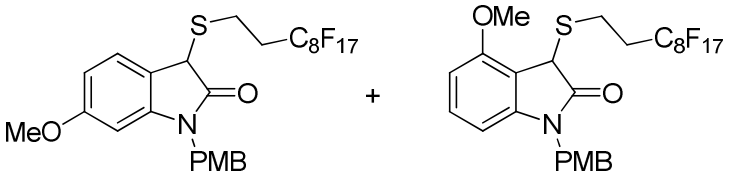
3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecylsulfanyl)-6-methoxy-1-propyl-1,3-dihydroindol-2-one S12



Using general procedure D, DMSO (636 μL, 8.96 mmol), oxalyl chloride (430 μL, 4.93 mmol), a solution of hydroxyamide **S8** (1.00 g, 4.48 mmol) in CH_2Cl_2 (15 mL) and Et_3N (3.12 mL, 22.4 mmol) in CH_2Cl_2 (30 mL) gave the crude glyoxamide product, which was used in the next step without further purification. Using general procedure F, fluorous thiol ($C_8F_{17}CH_2CH_2SH$, 1.28 mL, 4.48 mmol), TFAA (1.25 mL, 8.96 mmol) and the crude glyoxamide, in CH_2Cl_2 (40 mL) gave the crude product (as a 5:1 mixture of regioisomers (by ^{1}H NMR spectroscopy)). Purification by **FSPE** gave **S12** (2.50 g, 3.66 mmol, 82%) as a 5:1 mixture of regioisomers (by ^{1}H NMR spectroscopy) as a brown oil. Further purification by flash column chromatography on silica gel eluting with CH_2Cl_2 gave the major regioisomer as a white solid, m.p. (Et_2O) 59–60 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.27 (d, J = 8.2 Hz, 1H; Ar-CH), 6.59 (dd, J = 8.2, 2.3 Hz, 1H; Ar-CH), 6.43 (d, J = 2.3 Hz, 1H; Ar-CH), 4.29 (s, 1H; CHS), 3.84 (s, 3H; OCH_3), 3.69 (dt, J = 13.9, 7.3 Hz, 1H; CH_AH$_B$N), 3.62 (dt, J = 13.9, 7.3, 1H; CH$_A$$H_B$N), 3.00-2.92 (m, 1H; C$H_AH_B$S), 2.84-2.76 (m, 1H; CH$_A$$H_B$S), 2.47-2.33 (m, 2H; $CH_2C_8F_{17}$), 1.71 (sextet, J = 7.3 Hz, 2H; CH_2CH$_3$), 0.98 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.6 (C=O), 161.0 (Ar-C), 144.8 (Ar-C), 125.9 (Ar-CH), 116.8 (Ar-C), 106.4 (Ar-CH), 96.9 (Ar-CH), 55.6 (OCH_3), 44.5 (CHS), 41.9 (CH_2N), 31.9 (t, J = 21.1 Hz; $CH_2C_8F_{17}$), 20.8 (t, J = 4.6 Hz, CH_2S), 20.7 (CH_2CH_3), 11.3 (CH_3); IR (film): ν_{max} 2972, 2941, 1715 (C=O), 1626, 1600, 1504, 1463, 1367, 1243, 1207, 1150, 1104 cm^{-1}; MS (ES+): m/z (%): 706 (100, [M + Na]$^+$); HRMS (ES+): m/z: calcd for $C_{22}H_{18}F_{17}NO_2S$: 706.0679 [M + Na$^+$]; found: 706.0678 and the minor regioisomer as a white solid, m.p. (Et_2O) 65–67 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.32-7.27 (m, 1H; Ar-CH), 6.64 (d, J = 8.6 Hz, 1H; Ar-CH), 6.52 (d, J = 7.8 Hz, 1H; Ar-CH), 4.36 (s, 1H; CHS), 3.90 (s, 3H; OCH_3), 3.71 (dt, J = 14.1, 7.3 Hz, 1H; CH_AH$_B$N), 3.61 (dt, J = 14.1, 7.3 Hz, 1H; CH$_A$$H_B$N), 3.02 (ddd, J = 13.4, 10.1, 6.3 Hz, 1H; CH_AH$_B$S), 2.88 (ddd, J = 13.4, 10.6, 6.0 Hz, 1H; CH$_A$$H_B$S), 2.48-2.34 (m, 2H; $CH_2C_8F_{17}$), 1.71 (sextet, J = 7.3 Hz, 2H; CH_2CH$_3$), 0.97 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz,

$CDCl_3$): δ 174.9 (C=O), 156.2 (Ar-C), 144.8 (Ar-C), 130.8 (Ar-CH), 111.2 (Ar-C), 105.9 (Ar-CH), 102.0 (Ar-CH), 55.6 (OCH_3), 43.3 (CHS), 42.0 (CH_2N), 31.9 (t, J = 22.0 Hz; $CH_2C_8F_{17}$), 20.9 (t, J = 3.3 Hz, CH_2S), 20.9 (CH_2CH_3), 11.3 (CH_3); IR (film): ν_{max} 2970, 2941, 1713 (C=O), 1608, 1600, 1472, 1354, 1334, 1261, 1243, 1207, 1150, 1111, 1096, 1062, 769, 664 cm^{-1}; MS (ES+): *m*/*z* (%): 706 (100, [M + $Na]^+$), 151 (20); HRMS (ES+): *m*/*z*: calcd for $C_{22}H_{18}F_{17}NO_2S$: 706.0679 [M + Na^+]; found: 706.0668.

6-Methoxy-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-*p*-methoxybenzyl-1,3-dihydroindol-2-one S13[9]

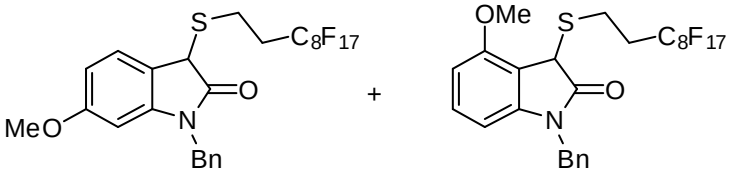


Using general procedure D, DMSO (1.41 mL, 19.9 mmol), oxalyl chloride (0.96 mL, 11.0 mmol), a solution of hydroxyamide **S9** (3.00 g, 9.96 mmol) in CH_2Cl_2 (9.5 mL) and Et_3N (6.93 mL, 49.8 mmol) in CH_2Cl_2 (77.9 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure F, fluorous thiol ($C_8F_{17}CH_2CH_2SH$, 2.62 mL, 9.96 mmol), TFAA (2.81 mL, 19.9 mmol) and the crude glyoxamide, in CH_2Cl_2 (77.9 mL) gave the crude product as a 5:1 mixture of regioisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** gave **S13** (6.08 g, 7.98 mmol, 89%) as yellow oil. Further recrystallisation gave the major regioisomer as a white powder, m.p. (MeOH) 100-103 °C; ^{1}H NMR (400 MHz, $CDCl_3$, major regioisomer): δ 7.19-7.16 (m, 3H; 3 × Ar-CH), 6.76 (d, J = 8.6 Hz, 2H; Ar-CH), 6.48 (dd, J = 8.1, 2.3 Hz, 1H; Ar-CH), 6.28 (d, J = 2.3 Hz, 1H; Ar-CH), 4.80 (d, J = 15.4 Hz, 1H; $NCH_AH_BC_6H_4OCH_3$), 4.69 (d, J = 15.4 Hz, 1H; $NCH_AH_BC_6H_4OCH_3$), 4.27 (s, 1H; CHS), 3.69 (s, 3H; OCH_3), 3.67 (s, 3H; OCH_3), 2.96-2.89 (m, 1H; CH_AH_BS), 2.77-2.70 (m, 1H; CH_AH_BS), 2.38-2.29 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, $CDCl_3$, major regioisomer): δ 175.7 (C=O), 160.9 (Ar-C), 159.2 (Ar-C), 144.4 (Ar-C), 128.7 (Ar-CH), 127.4 (Ar-C), 125.8 (Ar-CH), 116.7 (Ar-C), 114.2 (Ar-CH), 106.7 (Ar-CH), 97.6 (Ar-CH), 55.4 (OCH_3), 55.2

(OCH_3), 44.5 (CHS), 43.5 (CH_2N), 31.8 (t, J = 22.2 Hz, $CH_2C_8F_{17}$), 20.9 (t, J = 4.6 Hz; CH_2S); IR (film): ν_{max} 2926, 2850, 1715 (C=O), 1622, 1500, 1243, 1201, 1145, 1112, 1031, 648 cm^{-1}; MS (ES+): m/z (%): 784 (100, $[M + Na]^+$); HRMS (ES+): m/z: calcd for $C_{27}H_{20}NO_3SF_{17}$: 784.0769 $[M + Na^+]$; found: 784.0785.

6-Methoxy-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-benzyl-1,3-dihydroindol-2-one S14



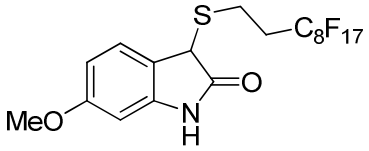
major minor

Using general procedure D, DMSO (514 μL, 7.25 mmol), oxalyl chloride (348 μL, 3.99 mmol), a solution of hydroxyamide **S10** (983 mg, 3.62 mmol) in CH_2Cl_2 (15 mL) and Et_3N (2.50 mL, 18.1 mmol) in CH_2Cl_2 (15 mL) gave the crude glyoxamide product, which was used in the next step without further purification.

Using general procedure F, $C_8F_{17}CH_2CH_2SH$ (1.00 mL, 3.62 mmol), TFAA (1.01 mL, 7.25 mmol) and the crude glyoxamide, in CH_2Cl_2 (40 mL) gave the crude product as a 5:1 mixture of regioisomers (by ^1H NMR spectroscopy). Purification by **FSPE** gave oxindole **S14** (2.07 g, 2.83 mmol, 78%) as a 5:1 mixture of regioisomers (by ^1H NMR spectroscopy) as a brown oil. Further purification by flash column chromatography on silica gel eluting with CH_2Cl_2 gave the major regioisomer as a white solid, m.p. (Et_2O) 80–82 °C; ^1H NMR (400 MHz, $CDCl_3$): δ 7.35-7.26 (m, 6H; 6 × Ar-CH), 6.57 (dd, J = 8.0, 2.0 Hz, 1H; Ar-CH), 6.33 (d, J = 2.0 Hz, 1H; Ar-CH), 4.94 (d, J = 15.5 Hz, 1H; NCH_AH_BPh), 4.85 (d, J = 15.5 Hz, 1H; NCH_AH_BPh), 4.38 (s, 1H; CHS), 3.75 (s, 3H; OCH_3), 3.04 (ddd, J = 13.1, 9.6, 6.8 Hz, 1H; CH_AH_BS), 2.85 (ddd, J = 13.1, 9.8, 6.3 Hz, 1H; CH_AH_BS), 2.50-2.37 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.8 (C=O), 161.0 (Ar-C), 144.4 (Ar-C), 135.4 (Ar-C), 128.9 (Ar-CH), 127.8 (Ar-CH), 127.3 (Ar-CH), 125.9 (Ar-CH), 116.7 (Ar-C), 106.8 (Ar-CH), 97.5 (Ar-CH), 55.4 (OCH_3), 44.5 (NCH_2Ph), 44.0 (CHS), 31.9 (t, J = 21.7 Hz; $CH_2C_8F_{17}$),

21.0 (CH_2S); IR (film): ν 2944, 1715 (C=O), 1621, 1498, 1375, 1337, 1274, 1242, 1200, 1145, 1112, 1084, 1028 cm^{-1}; MS (ES+): *m*/*z* (%): 754 (100, $[M + Na]^+$), 294 (15); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{18}F_{17}NO_2S$: 754.0690 [M + Na^+]; found: 754.0701 and the minor regioisomer as a white solid, m.p. (Et_2O) 76–79 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.34-7.24 (m, 5H; 5 × Ar-CH), 7.20 (t, J = 8.2 Hz, 1H; Ar-CH), 6.62 (d, J = 8.2 Hz, 1H; Ar-CH), 6.42 (d, J = 8.2 Hz, 1H; Ar-CH), 4.97 (d, J = 15.6 Hz, 1H; NCH_AH_BPh), 4.84 (d, J = 15.6 Hz, 1H; NCH_AH_BPh), 4.46 (s, 1H; CHS), 3.90 (s, 3H; OCH_3), 3.09 (ddd, J = 13.2, 9.6, 7.1 Hz, 1H; CH_AH_BS), 2.94 (ddd, J = 13.2, 10.4, 6.3 Hz, 1H; CH_AH_BS), 2.52-2.37 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.1 (C=O), 156.2 (Ar-C), 144.4 (Ar-C), 135.6 (Ar-C), 130.8 (Ar-CH), 128.8 (Ar-CH), 127.7 (Ar-CH), 127.2 (Ar-CH), 111.2 (Ar-C), 106.2 (Ar-CH), 102.8 (Ar-CH), 55.7 (OCH_3), 44.1 (NCH_2Ph), 43.3 (CHS), 31.9 (t, J = 21.1 Hz; $CH_2C_8F_{17}$), 21.3 (t, J = 4.6 Hz, CH_2S); IR (film): ν 2949, 1715 (C=O), 1603, 1471, 1349, 1267, 1240, 1197, 1145, 1132, 1114, 1081 cm^{-1}; MS (ES+): *m*/*z* (%): 754 (25, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{18}F_{17}NO_2S$: 754.0680 [M + Na^+]; found: 754.0672.

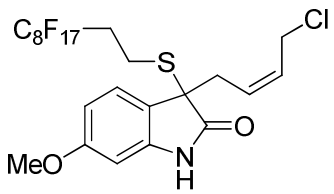
6-Methoxy-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1,3-dihydroindol-2-one S15



A solution of oxindole **9** (3.59 g, 4.49 mmol) and anisole (19.5 mL, 180 mmol, 40 eq) in CH_2Cl_2 (66.2 mL) and TFA (66.2 mL) was heated at 50 ˚C for 48 h, then allowed to cool to room temperature. The mixture was then slowly and carefully quenched with a saturated aqueous solution of $NaHCO_3$ (until gas evolution ceased). CH_2Cl_2 (50 mL) was added and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 × 50 mL) and the combined organic layers were dried (Na_2SO_4) and evaporated under reduced pressure to give the crude product. Purification by **FSPE** gave **S15** (2.31 g, 3.60 mmol, 82%) as a white powder, m.p. (Hexane/EtOAc) 91-94 ˚C, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80 (s, 1H; NH), 7.27 (d, J = 8.3 Hz, 1H; Ar-CH), 6.61 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.47 (d, J = 2.3 Hz, 1H; Ar-CH), 4.31 (s,

1H; C*H*S), 3.81 (s, 3H; OCH_3), 3.01-2.93 (m, 1H; SCH_AH_B), 2.85-2.77 (m, 1H; SCH_AH_B), 2.49-2.34 (m, 2H; SCH_2CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.0 (C=O), 161.0 (Ar-C), 142.3 (Ar-C), 126.1 (Ar-CH), 117.1 (Ar-C), 108.1 (Ar-CH), 97.3 (Ar-CH), 55.5 (OCH_3), 45.3 (*C*HS), 31.8 (t, *J* = 22.2 Hz; $CH_2C_8F_{17}$), 20.8 (SCH_2); IR (film): ν_{max} 3206 (NH), 2920, 1706 (C=O), 1623, 1506, 1457, 1335, 1235, 1198, 1145, 1113, 1030, 955, 827, 703, 649; MS (ES+): *m*/*z* (%): 664 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{19}H_{12}NO_2F_{17}SNa$: 664.0209 $[M + Na]^+$; found: 664.0220.

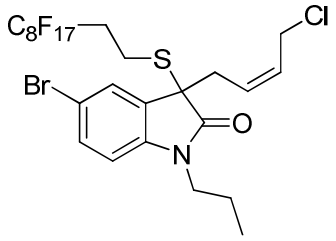
3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-6-methoxy-1,3-dihydroindol-2-one 10



cis-1,4-Dichlorobut-2-ene (825 μL of a 1.0 M solution in DMF, 0.83 mmol) and K_2CO_3 (434 mg, 3.14 mmol) were added sequentially to a stirred solution of **S15** (504 mg, 0.79 mmol) in DMF (10 mL) at room temperature under nitrogen. The resulting suspension was stirred for 45 min at room temperature, then water (30 mL) and EtOAc (50 mL) were added. The layers were separated, and the organic layer was washed with water (2 × 30 mL), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. Purification by **FSPE** gave alkylated oxindole **10** (418 mg, 0.57 mmol, 73%) as a yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.44 (s, 1H; NH), 7.22 (d, *J* = 8.3 Hz, 1H; Ar-CH), 6.63 (dd, *J* = 8.3, 2.3 Hz, 1H; Ar-CH), 6.55 (d, *J* = 2.3 Hz, 1H; Ar-CH), 5.72-5.60 (m, 1H; =C*H*CH_2Cl), 5.39-5.32 (m, 1H; =C*H*CH_2C), 4.03 (d, *J* = 7.8 Hz, 2H; CH_2Cl), 3.80 (s, 3H; OCH_3), 2.95 (ddd, *J* = 14.2, 8.5, 1.3 Hz, 1H; CH_AH_BC), 2.78 (ddd, *J* = 14.2, 6.9, 0.8 Hz, 1H; CH_AH_BC), 2.65 (t, *J* = 8.2 Hz, 2H; SCH_2), 2.32-2.07 (m, 2H; SCH_2CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 179.7 (C=O), 161.1 (Ar-C), 141.6 (Ar-C), 129.7 ($ClCH_2$*C*H=), 126.2 (CCH_2*C*H=), 125.1 (Ar-CH), 120.0 (Ar-C), 108.6 (Ar-CH), 97.4 (Ar-CH), 55.5 (OCH_3), 54.6 (*C*-C=O)), 38.9 (CH_2Cl), 33.3 (CH_2C), 31.4 (t, *J* = 22.2 Hz; $CH_2C_8F_{17}$), 19.9 (t, *J* = 2.8

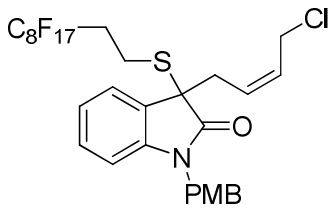
Hz; S*C*H$_2$); IR (film): ν_{max} 3220 (NH), 1710 (C=O), 1606 (C=C), 1501, 1462, 1319, 1235, 1200, 1145, 1105, 779, 732, 705, 651; MS (ES-): *m*/*z* (%): 728 (100, [*M* − H] $^+$); HRMS (ES-): *m*/*z*: calcd for $C_{23}H_{16}NO_2F_{17}Cl$: 728.0329 [*M* − H] $^+$; found: 728.0324.

5-Bromo-3-(4-chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-propyl-1,3-dihydroindol-2-one 11



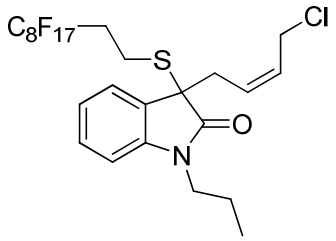
Using general procedure G, 5-bromo-3-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)thio)-1-propylindolin-2-one[9] (1.26 g, 1.72 mmol), *cis*-1,4-dichlorobut-2-ene (0.22 mL, 2.06 mmol) and K_2CO_3 (1.19 g, 8.61 mmol) in DMF (23.3 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **11** (0.90 g, 1.10 mmol, 87%) as a pale brown oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48-7.44 (m, 2H; 2 × Ar-CH), 6.76 (d, *J* = 8.3 Hz, 1H; Ar-CH), 5.69-5.62 (m, 1H; =CH), 5.29-5.22 (m, 1H; =CH), 4.07 (ddd, *J* = 11.8, 8.3, 1.0 Hz, 1H; =CHC*H*$_A$CH$_B$Cl), 3.97 (ddd, *J* = 11.8, 7.3, 0.8 Hz, 1H; =CHCH$_A$C*H*$_B$Cl), 3.72-3.59 (m, 2H; NC*H*$_2$CH$_2$), 2.97 (ddd, *J* = 14.1, 8.6, 1.2 Hz, 1H; =CHC*H*$_A$H$_B$C), 2.79-2.59 (m, 3H; =CHCH$_A$*H*$_B$C and CH$_2$S), 2.28-2.15 (m, 2H; CH$_2$C$_8$F$_{17}$), 1.67 (sextet, *J* = 7.3 Hz, 2H; C*H*$_2$CH$_3$), 0.95 (t, *J* = 7.3 Hz, 3H; CH$_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 175.3 (C=O), 141.6 (Ar-C), 132.4 (Ar-CH), 130.5 (Ar-C), 130.1 (=CH), 127.4 (Ar-CH), 125.7 (=CH), 115.7 (Ar-C), 110.2 (Ar-CH), 53.6 (*C*-C=O), 42.0 (NCH$_2$CH$_2$), 38.8 (CH$_2$Cl), 33.3 (=CHCH$_2$C), 31.5 (t, *J* = 22.0 Hz; CH$_2$C$_8$F$_{17}$), 20.7 (CH$_2$CH$_3$), 19.7 (t, *J* = 4.6 Hz; CH$_2$S), 11.3 (CH$_3$); IR (film): ν_{max} 2971, 2922, 1731 (C=O), 1482, 1197, 1138 cm^{-1}; MS (ES+): *m*/*z* (%): 844 (100, [^{81}Br*M* + Na]$^+$), 842 (80, [^{79}Br*M* + Na]$^+$); HRMS (EI+): *m*/*z*: calcd for $C_{21}H_{15}N_2O_3BrF_{17}S$: 841.9769 [*M* + Na$^+$]; found: 841.9764.

3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-(4-methoxybenzyl)-1,3-dihydroindol-2-one 12



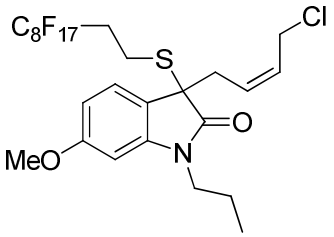
Using general procedure G, oxindole **S11** (1.13 g, 1.55 mmol), *cis*-1,4-dichlorobut-2-ene (0.23 mL, 1.86 mmol) and K_2CO_3 (1.07 g, 7.75 mmol) in DMF (30 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **12** (976 mg, 1.19 mmol, 77%) as a yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35 (dd, J = 7.6, 0.8 Hz, 1H; Ar-CH), 7.26-7.21 (m, 3H; 3 × Ar-CH), 7.10 (td, J = 7.6, 1.0 Hz, 1H; Ar-CH), 6.85-6.79 (m, 3H; 3 × Ar-CH), 5.66-5.58 (m, 1H; =CH), 5.31-5.23 (m, 1H; =CH), 4.91 (d, J = 15.4 Hz, 1H; NCH_ACH$_B$C$_6$H$_4$OMe), 4.78 (d, J = 15.4 Hz, 1H; NCH$_A$CH_BC$_6$H$_4$OMe), 4.07 (ddd, J = 12.1, 8.3, 1.0 Hz, 1H; =CHCH_ACH$_B$Cl), 3.98 (dd, J = 12.1, 7.0 Hz, 1H; =CHCH$_A$CH_BCl), 3.77 (s, 3H; OCH_3), 3.03 (ddd, J = 14.1, 8.8, 1.2 Hz, 1H; =CHCH_AH$_B$C), 2.83 (ddd, J = 14.1, 6.8, 1.2 Hz, 1H; =CHCH$_A$$H_B$C), 2.71-2.62 (m, 2H; CH_2S), 2.23-2.09 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.0 (C=O), 159.2 (Ar-C), 142.3 (Ar-C), 129.8 (=CH), 129.5 (Ar-CH), 128.8 (Ar-CH), 128.2 (Ar-C), 127.4 (Ar-C), 126.3 (=CH), 124.1 (Ar-CH), 123.2 (Ar-CH), 114.1 (Ar-CH), 109.5 (Ar-CH), 55.1 (OCH_3), 53.8 (*C*-C=O), 43.5 (N*C*H$_2$C$_6$H$_4$OCH$_3$), 38.9 (=CH*C*H$_2$Cl), 33.4 (=CH*C*H$_2$C), 31.4 (t, J = 22.0 Hz; *C*H$_2$C$_8$F$_{17}$), 19.7 (t, J = 3.7 Hz, CH_2S); IR (film): ν_{max} 3030, 2946, 2924, 1712 (C=O), 1617, 1516, 1485, 1466, 1441, 1348, 1295, 1244, 1206, 1175, 1144, 1035, 953, 747, 646 cm^{-1}; MS (ES+): *m*/*z* (%): 844 (30, [^{37}ClM + Na]$^+$), 842 (100, [^{35}ClM + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{23}NO_2ClF_{17}S$: 842.0759 [$M$ + Na$^+$]; found: 794.0748.

3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-propyl-1,3-dihydroindol-2-one 13



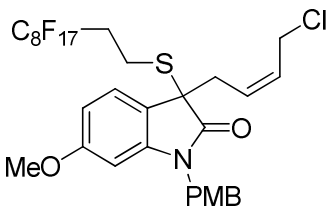
Using general procedure G, 3-((3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)thio)-1-propylindolin-2-one[9] (4.80 g, 7.70 mmol), *cis*-1,4-dichlorobut-2-ene (1.21 mL, 11.5 mmol) and K_2CO_3 (1.43 g, 38.4 mmol) in DMF (80 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **13 (**3.78 g, 5.20 mmol, 68%) as a yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.37-7.30 (m, 2H; 2 × Ar-CH), 7.12 (dt, J = 7.6, 1.0 Hz, 1H; Ar-CH), 6.87 (d, J = 7.8 Hz, 1H; Ar-CH), 5.65-5.59 (m, 1H; =CH), 5.23-5.31 (m, 1H; =CH), 4.05 (ddd, J = 11.8, 8.3, 1.3 Hz, 1H; =CHCH_ACH$_B$Cl), 3.97 (dd, J = 11.8, 7.3 Hz, 1H; =CHCH$_A$CH_BCl), 3.62-3.74 (m, 2H; CH_2N), 2.97 (ddd, J = 14.1, 8.8, 1.3 Hz, 1H; =CHCH_ACH$_B$C), 2.80 (ddd, J = 14.1, 7.1, 1.3 Hz, 1H; =CHCH$_A$CH_BC), 2.71-2.65 (m, 1H; CH_AH$_B$S), 2.64-2.58 (m, 1H; CH$_A$$H_B$S), 2.22-2.11 (m, 2H; C$H_2C_8F_{17}$), 1.68 (sextet, J = 7.4 Hz, 2H; CH_2CH$_3$), 0.96 (t, J = 7.4 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.6 (C=O), 142.7 (Ar-C), 129.7 (=CH), 129.5 (Ar-CH), 128.3 (Ar-C), 126.3 (=CH), 124.2 (Ar-CH), 123.0 (Ar-CH), 108.8 (Ar-CH), 53.8 (*C*-C=O), 41.9 (N*C*H$_2$), 38.9 (=CH*C*H$_2$Cl), 33.4 (=CH*C*H$_2$C), 31.6 (t, J = 22.0 Hz; *C*H$_2$C$_8$F$_{17}$), 20.8 (CH_2CH_3), 19.8 (t, J = 3.7 Hz; *C*H$_2$-S), 11.3 (CH_3); IR (film): ν_{max} 3060, 2971, 2939, 2878, 1712 (C=O), 1612, 1487, 1468, 1444, 1360, 1249, 1114, 1025, 953, 872, 751 cm^{-1}; MS (EI+): *m*/*z* (%): 764 (100, [M + Na]$^+$); HRMS (EI+): *m*/*z*: calcd for $C_{25}H_{21}NOClF_{17}S$: 764.0655 [M + Na$^+$]; found: 764.0659.

3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-6-methoxy-1-propyl-1,3-dihydroindol-2-one 14



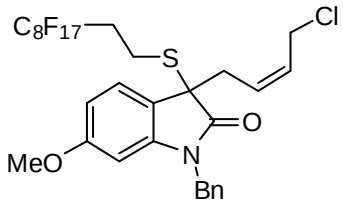
Using general procedure G, oxindole **S12** (606 mg, 0.89 mmol), *cis*-1,4-dichlorobut-2-ene (112 μL, 1.06 mmol) and K_2CO_3 (490 mg, 3.55 mmol) in DMF (10 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **14** (600 mg, 0.78 mmol, 88%) as a yellow oil, ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.24 (d, J = 8.2 Hz, 1H; Ar-CH), 6.61 (dd, J = 8.2, 2.2 Hz, 1H; Ar-CH), 6.43 (d, J = 2.2 Hz, 1H, Ar-CH), 5.65-5.60 (m, 1H; C*H*=CH_2Cl), 5.31-5.25 (m, 1H; CH=CH_2C), 4.06 (dd, J = 12.0, 8.5 Hz, 1H; C$H_A$$CH_B$Cl), 3.97 (dd, J = 12.0, 7.3 Hz, 1H; CH_ACH_BCl), 3.67 (dt, J = 14.2, 7.2 Hz, 1H; NC$H_A$$CH_B$$CH_2$), 3.62 (dt, J = 14.2, 7.2 Hz, 1H; NCH_AC$H_B$$CH_2$), 2.94 (ddd, J = 14.0, 8.5, 0.6 Hz, 1H; =CHC$H_A$$H_B$C), 2.77 (dd, J = 14.0, 7.0, 1H; =CH$CH_A$$H_B$C), 2.69 (dt, J = 13.4, 7.8 Hz, 1H; C$H_A$$H_B$S), 2.62 (dt, J = 13.4, 7.8, 1H; $CH_A$$H_B$S), 2.24-2.13 (m, 2H; $CH_2C_8F_{17}$), 1.68 (sextet, J = 7.2 Hz, 2H; C$H_2$$CH_3$), 0.96 (t, J = 7.2 Hz, 3H; CH_3); ^{13}C NMR (125 MHz, $CDCl_3$): δ 176.5 (C=O), 161.1 (Ar-C), 143.9 (Ar-C), 129.5 (*C*H=CH_2Cl), 126.5 (*C*H=CH_2C), 125.0 (Ar-CH), 119.9 (Ar-C), 106.6 (Ar-CH), 96.8 (Ar-CH), 55.5 (OCH_3), 53.5 (*C*-C=O), 41.8 (CH_2N), 39.0 (CH_2Cl), 33.4 (=CH*C*H_2C), 31.6 (t, J = 21.7 Hz; *C*$H_2C_8F_{17}$), 20.8 (*C*H_2CH_3), 19.7 (t, J = 3.6 Hz; CH_2S), 11.3 (CH_3); IR (film): ν_{max} 2966, 2941, 1716 (C=O), 1624, 1602, 1504, 1463, 1370, 1241, 1209, 1148, 1109, 1034 cm^{-1}; MS (ES+): *m*/*z* (%): 794 (100, [M + Na]$^+$), 533 (20), 151 (20); HRMS (EI+): *m*/*z*: calcd for $C_{26}H_{23}NO_2ClF_{17}S$: 794.0759 [$M$ + Na$^+$]; found: 794.0775.

6-Methoxy-3-(4-chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-*p*-methoxybenzyl-1,3-dihydroindol-2-one 15



Using general procedure G, oxindole **S13** (0.29 g, 0.40 mmol), *cis*-1,4-dichlorobut-2-ene (0.60 mL, 0.60 mmol) and K_2CO_3 (0.26 g, 1.90 mmol) in DMF (5 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **15** (0.24 g, 0.29 mmol, 77%) as a yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.17-7.11 (m, 3H; 3 × Ar-C*H*), 6.83 (d, *J* = 8.8 Hz, 2H; Ar-C*H*), 6.58 (dd, *J* = 8.2, 2.3 Hz, 1H; Ar-C*H*), 6.37 (d, J = 2.3 Hz, 1H; Ar-C*H*), 5.66-5.59 (m, 1H; =CH), 5.24-5.30 (m, 1H; =CH), 4.88 (d, *J* = 15.4 Hz, 1H; $NCH_AH_BC_6H_4OCH_3$), 4.74 (d, *J* = 15.4 Hz, 1H; $NCH_AH_BC_6H_4OCH_3$), 4.07 (ddd, *J* = 11.8, 8.1, 1.3 Hz, 1H; $=CHCH_ACH_BCl$), 3.97 (dd, *J* = 11.8, 7.3 Hz, 1H; $=CHCH_ACH_BCl$), 3.77 (s, 3H; OCH_3), 3.76 (s, 3H; OCH_3), 3.00 (ddd, *J* = 14.1, 8.6, 1.5 Hz, 1H; $=CHCH_ACH_BC$), 2.79 (ddd, *J* = 14.1, 6.8, 1.8 Hz, 1H; $=CHCH_ACH_BC$), 2.73-2.62 (m, 2H; CH_2S), 2.25-2.11 (m, 2H, $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, CDCl): δ 176.6 (C=O), 160.9 (Ar-C), 159.2 (Ar-C), 143.6 (Ar-C), 130.9 (Ar-CH), 129.3 (=CH), 128.8 (Ar-CH), 127.4 (Ar-C), 126.5 (=CH), 124.9 (Ar-CH), 119.7 (Ar-C), 114.2 (2 × Ar-CH), 106.9 (Ar-CH), 97.5 (Ar-CH), 55.4 (OCH_3), 55.2 (OCH_3), 53.5 (*C*-C=O), 43.7 (NCH_2), 39.0 ($=CHCH_2Cl$), 33.5 ($=CHCH_2C$), 31.5 (t, *J*=22.2 Hz; $CH_2C_8F_{17}$), 19.7 (t, *J*=2.9 Hz; CH_2S); IR (film): ν=3006, 2942, 2841, 2364, 1714 (C=O), 1622, 1515, 1470, 1374, 1239, 1152, 1036 cm^{-1}; MS (EI+): *m*/*z* (%): 872 (100, $[M + Na]^+$); HRMS (EI+): *m*/*z*: calcd for $C_{31}H_{25}NO_3ClF_{17}S$: 872.0870 [$M + Na^+$]; found: 872.0870.

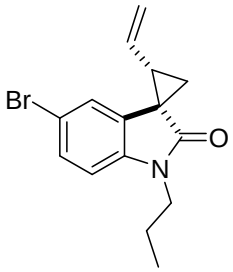
3-(4-Chlorobut-2-enyl)-3-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecylsulfanyl)-1-benzyl-1,3-dihydroindol-2-one 16



Using general procedure G, oxindole **S14** (1.36 g, 1.86 mmol), *cis*-1,4-dichlorobut-2-ene (0.23 mL, 2.23 mmol) and K_2CO_3 (1.03 mg, 7.94 mmol) in DMF (16 mL) gave the crude product. Purification by **FSPE** gave alkylated oxindole **16** (1.23g, 2.78 mmol, 80%) as a yellow oil, ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.33-7.24 (m, 6H; 6 ×

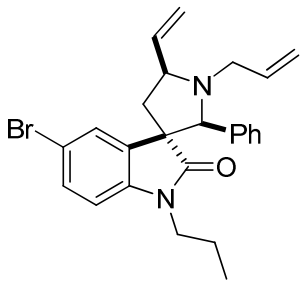
Ar-CH), 6.59 (dd, *J* = 8.2, 2.0 Hz, 1H; Ar-CH), 6.34 (d, *J* = 2.0 Hz, 1H, Ar-CH), 5.66-5.61 (m, 1H; C*H*=CH_2Cl), 5.33-5.27 (m, 1H; C*H*=CH_2C), 4.95 (d, *J* = 15.6 Hz, 1H; NC$H_A$$H_B$Ph), 4.81 (d, *J* = 15.6 Hz, 1H; NC$H_A$$H_B$Ph), 4.07 (dd, *J* = 12.0, 8.9 Hz, 1H; CH_ACH_BCl), 3.97 (dd, *J* = 12.0, 7.3 Hz, 1H; CH_ACH_BCl), 3.75 (s, 3H; OCH_3), 3.02 (dd, *J* = 14.0, 8.8 Hz, 1H; NCH_ACH_BC-C=O), 2.82 (dd, *J* = 14.0, 7.0 Hz, 1H; NCH_ACH_BC-C=O), 2.76-2.65 (m, 2H; CH_2S), 2.25-2.15 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.7 (C=O), 161.0 (Ar-C), 143.6 (Ar-C), 135.3 (Ar-C), 129.7 (*C*H=CH_2Cl), 128.8 (Ar-CH), 127.9 (Ar-CH), 127.3 (Ar-CH), 126.5 (*C*H=CH_2C), 124.9 (Ar-CH), 119.7 (Ar-C), 107.0 (Ar-CH), 97.5 (Ar-CH), 55.4 (OCH_3), 53.5 (*C*-C=O), 44.0 (NCH_2Ph), 39.0 (CH_2Cl), 33.4 (=CH*C*H_2C), 31.5 (t, *J* = 27.5 Hz; *C*$H_2C_8F_{17}$), 19.7 (t, *J* = 4.6 Hz; CH_2S); IR (film): ν 2958, 2945, 1713 (C=O), 1624, 1501, 1456, 1375, 1236, 1200, 1145, 1114, 1081, 1033 cm^{-1}; MS (ES+): *m*/*z* (%): 844 (30, [^{37}Cl*M* + Na]$^+$), 842 (100, [^{35}Cl*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{23}NO_2ClF_{17}S$: 842.0759 [*M* + Na^+]; found: 794.0748.

rac-(1*S*,2*S*)-5'-bromo-1'-propyl-2-vinylspiro[cyclopropane-1,3'-indolin]-2'-one 17



A solution of oxindole **11** (452 mg, 0.55 mmol) in THF (17 mL) was deoxygenated by bubbling through nitrogen gas for 45 min. Then, SmI_2 (11.0 mL of a 0.1M solution in THF, 1.10 mmol) was added dropwise over 1 h (using a syringe pump) at rt under nitrogen. On completion of the addition, a saturated aqueous solution of $NaHCO_3$ (20 mL) and EtOAc (20 mL) were added, and the layers were separated. The aqueous layer was extracted with EtOAc (2 × 10 mL), and the combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave vinylcyclopropane **17** (90 mg, 0.29 mmol, 53%) as a pale yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35 (dd, J = 8.3, 2.0 Hz, 1H; Ar-CH), 6.95 (d, J = 2.0 Hz, 1H; Ar-CH), 6.76 (d, J = 8.3 Hz, 1H; Ar-CH), 6.21 (ddd, J = 17.1, 10.3, 9.4 Hz, 1H; C*H*=CH$_2$), 5.27 (ddd, J = 17.1, 1.5, 0.5 Hz, 1H; CH=C*H*$_A$H$_B$), 5.14 (dd, J = 10.3, 2.0 Hz, 1H; CH=CH$_A$*H*$_B$), 3.73-3.69 (m, 2H; NCH$_2$), 2.53-2.46 (m, 1H; CH$_2$C*H*N), 2.00 (dd, J = 8.1, 4.8 Hz, 1H; C*H*$_A$H$_B$CHN), 1.94 (dd, J = 8.8, 4.8 Hz, 1H; CH$_A$*H*$_B$CHN), 1.75-1.65 (m, 2H; C*H*$_2$CH$_3$), 0.95 (t, J = 7.3 Hz, 3H; CH$_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 174.1 (C=O), 141.8 (Ar-*C*), 133.6 (*C*H=CH$_2$), 132.8 (Ar-*C*), 129.4 (Ar-CH), 121.4 (Ar-CH), 117.2 (=CH$_2$), 114.4 (Ar-*C*), 109.5 (Ar-CH), 42.0 (NCH$_2$), 37.7 (*C*H-CH=CH$_2$), 33.6 (*C*-C=O), 25.0 (*C*H$_2$CH), 21.0 (*C*H$_2$CH$_3$), 11.4 (CH$_3$); IR (film): ν_{max} 3417, 2080, 2965, 2359, 1716 (C=O), 1607, 1485, 1367, 1204, 1141 cm^{-1}; MS (ES+): *m*/*z* (%): 308 (100, [^{81}Br*M* + H]$^+$), 306 (100, [^{79}Br*M* + H]$^+$); HRMS (ES+): *m*/*z*: calcd for C$_{15}$H$_{16}$NO^{79}Br: 306.0488 [*M* + H$^+$]; found: 306.0501.

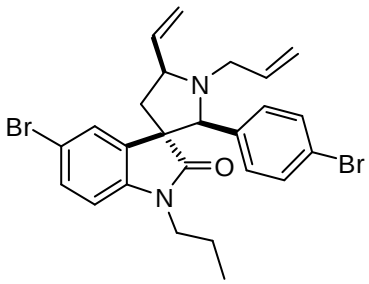
***rac*-(2'*S*,5'*S*,3*S*)-1'Allyl-5-bromo-2'-phenyl-1-propyl-5'-vinyl-1*H*-spiro[indole-3,3'-pyrrolidin]-2-one 19**



Using general procedure I, oxindole **14** (101 mg, 0.12 mmol) and SmI_2 (2.5 mL of a 0.1 M solution in THF, 0.25 mmol) in THF (4 mL), and a solution of imine (36 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 3:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 10% Et_2O in petroleum ether gave **19a** (30 mg, 0.07 mmol, 54%, major diastereoisomer) as an off-white solid, m.p. (Et_2O) 104–107 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.46 (d, J = 2.0 Hz, 1H; Ar-CH), 7.15 (dd, J = 8.3, 2.0 Hz, 1H; Ar-CH), 7.10-6.95 (m, 5H; 5 × Ar-CH), 6.38 (d, J = 8.3 Hz, 1H; Ar-CH), 5.96 (ddd, J = 17.1, 10.1, 8.3 Hz, 1H; CHC*H*=CH_2), 5.88 (ddt, J = 17.2, 10.4, 6.9 Hz, 1H; CH_2C*H*=CH_2), 5.33 (ddd, J = 17.2, 1.6, 0.8 Hz, 1H; CHCH=C$H_A$$H_B$), 5.26 (dd, J = 10.1, 1.6 Hz, 1H; CHCH=$CH_A$$H_B$), 5.13-5.10 (m, 1H; CH_2CH=C$H_A$$H_B$), 4.96 (ddt, J = 17.1, 2.0, 1.3 Hz, 1H; CH_2CH=$CH_A$$H_B$), 4.26 (s, 1H; C*H*Ph), 3.79-3.73 (m, 1H; CH_2C*H*N), 3.66 (ddd, J = 14.1, 8.3, 6.3 Hz, 1H; NC$H_A$$H_B$$CH_2$), 3.42-3.32 (m, 2H; NC$H_A$$H_B$$CH_2$ and C$H_A$$H_B$CH=$CH_2$), 3.22 (dd, J = 14.9, 6.9 Hz, 1H; C$H_A$$H_B$CH=$CH_2$), 2.67 (dd, J = 13.4, 9.1 Hz, 1H; C$H_A$$H_B$CHN), 1.88 (dd, J = 13.4, 7.0 Hz, 1H; C$H_A$$H_B$CHN), 1.56-1.45 (m, 2H; C$H_2$$CH_3$), 0.82 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.2 (C=O), 141.3 (Ar-C), 140.1 (CH_2*C*H=CH_2), 136.1 (Ar-C), 134.7 (Ar-C), 132.2 (CH*C*H=CH_2), 130.0 (Ar-CH), 128.8 (Ar-CH), 128.1 (Ar-CH), 127.47 (Ar-CH), 127.42 (Ar-CH), 118.9 (CH_2CH=*C*H_2), 117.1 (CHCH=*C*H_2), 114.2 (Ar-C), 108.9 (Ar-CH), 74.8 (*C*HPh), 63.8 (CH_2*C*HN), 57.9 (*C*-C=O), 51.2 (*C*H_2CH=CH_2), 41.7 (NC$H_2$$CH_2$), 40.9 (*C*$H_2$CHN), 20.7 (*C*$H_2$$CH_3$), 11.4 ($CH_3$); IR (film): ν_{max} 2966, 2932, 1710 (C=O), 1606, 1480, 1456, 1426, 1349, 1336, 1142, 1114, 923, 806, 747, 703 cm^{-1}; MS (ES+): *m*/*z* (%): 475 (90, [^{81}Br*M* + Na]$^+$), 473 (100, [^{79}Br*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{25}H_{27}N_2O^{81}Br$: 453.1365 [*M* + H^+]; found: 453.1372; and **19b** (13 mg, 0.03 mmol, 23%, minor diastereoisomer) as a yellow oil, which crystallized from aqueous

ethanol as an off-white solid, m.p. 132–134 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48 (d, J = 2.0 Hz, 1H; Ar-CH), 7.34 (dd, J = 8.3, 2.0 Hz, 1H; Ar-CH), 7.19-7.00 (m, 5H; 5 × Ar-CH), 6.49 (d, J = 8.3 Hz, 1H; Ar-CH), 6.08 (ddd, J = 17.2, 9.9, 8.3 Hz, 1H; CHC*H*=CH_2), 5.84 (ddt, J = 17.2, 10.1, 7.0 Hz, 1H; CH_2C*H*=CH_2), 5.31 (ddd, J = 17.2, 1.8, 0.5 Hz, 1H; CHCH=CH_AH$_B$), 5.22 (dd, J = 10.1, 1.8 Hz, 1H; CHCH=C$H_A$$H_B$), 5.12 (br dd, J = 10.1, 1.3 Hz, 1H; CH_2CH=CH_AH$_B$), 4.93 (ddt, J = 17.2, 2.0, 1.3 Hz, 1H; CH_2CH=C$H_A$$H_B$), 4.01 (s, 1H; C*H*Ph), 3.63 (q, J = 8.3 Hz, 1H; CH_2C*H*N), 3.45 (ddd, J = 14.5, 8.6, 6.0 Hz, 1H; NCH_AH$_B$$CH_2$), 3.36 (br dd, J = 14.7, 7.0 Hz, 1H; CH_AH$_B$CH=CH_2), 3.14 (dd, J = 14.7, 7.0 Hz, 1H; C$H_A$$H_B$CH=$CH_2$), 2.95 (ddd, J = 14.5, 8.3, 6.6 Hz, 1H; NC$H_A$$H_B$$CH_2$), 2.32 (dd, J = 13.2, 8.3 Hz, 1H; CH_AH$_B$CHN), 2.24 (dd, J = 13.2, 8.3 Hz, 1H; C$H_A$$H_B$CHN), 1.11-0.82 (m, 2H; C$H_2$$CH_3$), 0.52 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.1 (C=O), 142.5 (Ar-C), 140.2 (*C*H=CH_2), 135.7 (Ar-C), 135.3 (Ar-C), 131.6 (CH*C*H=CH_2), 130.7 (Ar-CH), 128.0 (Ar-CH), 127.8 (Ar-CH), 127.7 (Ar-CH), 126.0 (Ar-CH), 119.1 (CH_2CH=*C*H_2), 117.1 (CHCH=*C*H_2), 114.4 (Ar-C), 109.1 (Ar-CH), 77.4 (*C*HPh), 65.5 (CH_2*C*HN), 57.4 (*C*-C=O), 50.6 (*C*H_2CH=CH_2), 41.3 (N*C*$H_2$$CH_2$), 40.6 (*C*$H_2$CHN), 20.3 (*C*$H_2$$CH_3$), 11.1 ($CH_3$); IR (film): ν_{max} 2967, 2932, 1716 (C=O), 1605, 1486, 1455, 1423, 1348, 1208, 1189, 1137, 1114, 1098, 996, 923, 806, 748, 700 cm^{-1}; MS (ES+): *m*/*z* (%): 475 (100, [^{81}Br*M* + Na]$^+$), 473 (85, [^{79}Br*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd (%) for $C_{25}H_{27}N_2O^{81}Br$: 473.1199 [*M* + Na^+]; found: 473.1206.

rac-(2'*S*,5'*S*,3*S*)-1'-Allyl-5-bromo-2'-(4-bromophenyl)-1-propyl-5'-vinyl-1*H*-spiro[indole-3,3'-pyrrolidin]-2-one 20

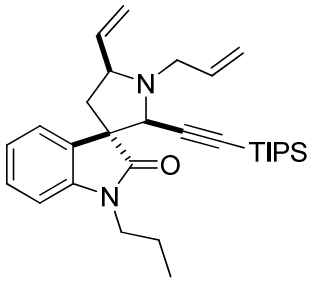


Using general procedure I, oxindole **11** (67 mg, 0.08 mmol) and SmI_2 (1.6 mL of a 0.1 M solution in THF, 0.16 mmol) in THF (2 mL), and a solution of imine (37 mg,

0.16 mmol) in THF (1 mL) gave the crude product as a 3:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave **20** (30 mg, 0.06 mmol, 69%) as a 3:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy), as a yellow oil. Further purification by flash chromatography on silica gel eluting with 20% Et_2O in petroleum ether gave the minor diastereoisomer as a pale yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.47 (d, J = 2.0 Hz, 1H; Ar-CH), 7.35 (dd, J = 8.3, 2.0 Hz, 1H; Ar-CH), 7.31-7.24 (m, 4H; 4 × Ar-CH), 6.52 (d, J = 8.3 Hz, 1H; Ar-CH), 6.05 (ddd, J = 17.2, 10.1, 8.3 Hz, 1H; CHC*H*=CH_2), 5.82 (ddt, J = 17.2, 10.1, 6.8 Hz, 1H; CH_2C*H*=CH_2), 5.31 (dd, J = 17.2, 1.8 Hz, 1H; CHCH=C$H_A$$H_B$), 5.23 (dd, J = 10.1, 1.8 Hz, 1H; CHCH=$CH_A$$H_B$), 5.13 (dd, J = 10.1, 2.0 Hz, 1H; CH_2CH=C$H_A$$H_B$), 4.92 (br dd, J = 17.2, 2.0 Hz, 1H; CHCH=$CH_A$$H_B$), 3.96 (s, 1H; C*H*Ar), 3.63 (q, J = 8.3 Hz, 1H; CH_2C*H*N), 3.48 (ddd, J = 13.8, 8.3, 6.3 Hz, 1H; NC$H_A$$H_B$), 3.34 (dd, J = 14.9, 6.6 Hz, 1H; C$H_A$$H_B$CH=$CH_2$), 3.10 (dd, J = 14.9, 7.3 Hz, 1H; $CH_A$$H_B$CH=$CH_2$), 3.00 (ddd, J = 13.8, 8.1, 6.6 Hz, 1H; NC$H_A$$H_B$), 2.31 (dd, J = 13.2, 8.3 Hz, 1H; C$H_A$$H_B$CHN), 2.25 (dd, J = 13.2, 8.3 Hz, 1H; $CH_A$$H_B$CHN), 1.16-1.00 (m, 2H; C$H_2$$CH_3$), 0.56 (t, J=7.6 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.0 (C=O), 142.5 (Ar-C), 140.0 (*C*H=CH_2), 135.0 (2 × Ar-C), 131.4 (CH*C*H=CH_2), 130.94 (Ar-CH), 130.89 (Ar-CH), 129.81 (Ar-CH), 126.1 (Ar-CH), 121.8 (Ar-C), 119.4 (CH_2CH=*C*H_2), 117.4 (CHCH=*C*H_2), 114.6 (Ar-C), 109.3 (Ar-CH), 76.7 (*C*HAr), 65.6 (CH_2*C*HN), 57.4 (*C*-C=O), 50.7 (*C*H_2CH=CH_2), 41.4 (CH_2N), 40.7 (*C*H_2CHN), 20.5 (*C*$H_2$$CH_3$), 11.1 ($CH_3$); IR (film): ν_{max} 2964, 2930, 1715 (C=O), 1606, 1483, 1348, 1206, 1189, 1110, 1069, 1007, 923, 806 and 736 cm^{-1}; MS (ES+): *m*/*z* (%): 555 (50, [^{81}Br^{81}Br*M* + Na]$^+$), 553 (100, [^{81}Br^{79}Br*M* + Na]$^+$), 551 (50, [^{79}Br^{79}Br*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd (%) for $C_{25}H_{26}N_2O^{79}Br_2$: 551.0304 [*M* + Na^+]; found: 551.0298; and the major diastereoisomer as an off-white solid, m.p. 110–112 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.46 (d, J = 2.2 Hz, 1H; Ar-CH), 7.21-7.18 (m, 3H; 3 × Ar-CH), 6.93 (d, J = 8.1 Hz, 2H; 2 × Ar-CH), 6.42 (d, J = 8.3 Hz, 1H; Ar-CH), 5.95 (ddd, J = 17.1, 10.1, 8.3 Hz, 1H; CHC*H*=CH_2), 5.84 (ddt, J = 17.2, 10.1, 6.8 Hz, 1H; CH_2C*H*=CH_2), 5.32 (br d, J = 17.1 Hz, 1H; CHCH=C$H_A$$H_B$), 5.25 (dd, J = 10.1, 2.0 Hz, 1H; CHCH=$CH_A$$H_B$), 5.12 (dd, J = 10.1, 2.0 Hz, 1H; CH_2CH=C$H_A$$H_B$), 4.94 (dd, J = 17.2, 2.0 Hz, 1H; CH_2CH=$CH_A$$H_B$), 4.21 (s, 1H; C*H*Ar), 3.78-3.72 (m, 1H; CH_2C*H*N), 3.65 (ddd, J = 14.1, 8.1, 6.6 Hz, 1H; NC$H_A$$H_B$),

3.42-3.34 (m, 2H; NCH_AH_B and $CH_AH_BCH{=}CH_2$), 3.16 (dd, *J* = 14.9, 6.8 Hz, 1H; $CH_AH_BCH{=}CH_2$), 2.68 (dd, *J* = 13.4, 9.3 Hz, 1H; CH_AH_BCHN), 1.88 (dd, *J* = 13.4, 6.8 Hz, 1H; CH_AH_BCHN), 1.57-1.45 (m, 2H; CH_2CH_3), 0.83 (t, *J* = 7.6 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 177.9 (C=O), 141.3 (Ar-C), 139.8 ($CHCH{=}CH_2$), 135.2 (Ar-C), 134.4 (Ar-C), 131.8 ($CH_2CH{=}CH_2$), 130.6 (Ar-CH), 130.4 (Ar-CH), 129.7 (Ar-CH), 128.6 (Ar-CH), 121.3 (Ar-C), 119.2 ($CH_2CH{=}CH_2$), 117.3 ($CHCH{=}CH_2$), 114.3 (Ar-C), 109.1 (Ar-CH), 74.1 (*C*HAr), 63.7 (CH_2CHN), 57.8 (*C*-C=O), 51.1 ($CH_2CH{=}CH_2$), 41.7 (CH_2N), 40.8 (CH_2CHN), 20.7 (CH_2CH_3), 11.3 (CH_3); IR (film): ν_{max} 2964, 2930, 1712 (C=O), 1606, 1483, 1427, 1348, 1141, 1069, 1010, 923 and 805 cm^{-1}; MS (ES+): *m*/*z* (%): 555 (50, [^{81}Br^{81}Br*M* + Na]$^+$), 553 (100, [^{81}Br^{79}Br*M* + Na]$^+$), 551 (50, [^{79}Br^{79}Br*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{25}H_{26}N_2O^{79}Br_2$: 529.0490 [*M* + H$^+$]; found: 529.0490.

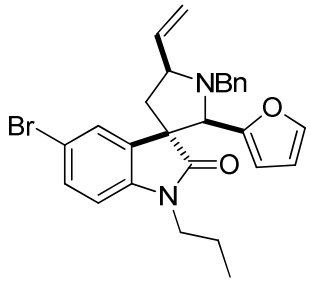
rac-(2'_R_,5'_S_,3_S_)-1'-Allyl-1-propyl-2'-((triisopropylsilyl)ethynyl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 21



Using general procedure I, oxindole **13** (0.23 g, 0.32 mmol) and SmI_2 (6.5 mL of a 0.1 M solution in THF, 0.65 mmol) in THF (2 mL), and a solution of imine (0.16 g, 0.65 mmol) in THF (1 mL) gave the crude product as a 11:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 20% Et_2O in petroleum ether gave **21** (0.11 g, 0.23 mmol 75%) as a 11:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ7.53 (dd, *J* = 7.6, 1.4 Hz, 1H; Ar-CH), 7.20 (td, *J* = 7.6, 1.4 Hz, 1H; Ar-CH), 7.02 (td, *J* = 7.6, 1.0 Hz, 1H; Ar-CH), 6.78 (br d, *J* = 7.6 Hz, 1H; Ar-C*H*), 6.04-5.93 (m, 1H; $CH_2CH{=}CH_2$), 5.80 (ddd, *J* = 17.1, 10.2, 8.3 Hz, 1H; $CH_2CH{=}CH_2$), 5.29-5.15 (m, 4H; $CHCH{=}CH_2$ and $CH_2CH{=}CH_2$), 3.87 (s, 1H; C*H*-

C≡CSi), 3.77-3.68 (m, 1H; NC$H_AH_BCH_2$),), 3.64-3.53 (m, 2H; CH_AH_BCH=CH_2 and NCH_AH_BCH_2), 3.51-3.43 (m, 2H; CH_AH_BCH=CH_2 and CH_2CHN), 2.51 (dd, J = 13.2, 8.7 Hz, 1H; CH_AH_BCHN), 1.84 (dd, J = 13.2, 7.8 Hz, 1H; CH_AH_BCHN), 1.72-1.64 (m, 2 H; C$H_2$$CH_3$), 0.95 (t, J = 7.3 Hz, 3H; CH_2CH_3), 0.87-0.75 (m, 21 H; Si(CH(CH_3)$_2$)$_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.3 (C=O), 142.5 (Ar-C), 139.5 (CHCH=CH_2), 134.0 (Ar-C), 131.6 ($CH_2$$C$H-$CH_2$), 127.6 (Ar-CH), 125.1 (Ar-CH), 122.4 (Ar-CH), 119.6 (CH_2CH=CH$_2$), 117.5 (CHCH=CH$_2$), 107.9 (Ar-CH), 102.9 (CHC≡CSi), 87.3 (CHC≡CSi), 63.6 ($CH_2$$C$HN), 62.6 ($C$H-C≡CSi), 55.4 ($C$-C=O), 50.8 ($CH_2$CH=$CH_2$), 41.9 ($CH_2$CHN)), 41.7 (NC$H_2$$CH_2$), 20.8 ($CH_2$$CH_3$), 11.5 ($CH_2$$CH_3$), 11.1 (3 × CH(CH$_3$)$_2$), 10.9 (3 × CH(CH$_3$)$_2$); IR (film): ν_{max} 2944, 2866, 2167 (C≡C), 1643 (C=O), 1463, 1383, 1337, 1266, 1242, 1203, 1148, 1099, 996, 920, 883 cm^{-1}; MS (ES+): m/z (%): 477 (100, [M + H]$^+$); HRMS (ES+): m/z: calcd for $C_{30}H_{44}N_2OSi$: 477.3281 [M + H$^+$]; found: 477.3296.

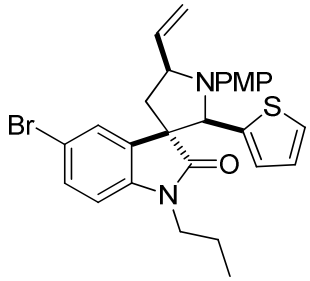
rac-(2'_R_,5'_S_,3_S_)-1'-Benzyl-5-bromo-2'-furan-2-yl-1-propyl-5'-vinyl-1H-spiro[indole-3,3'-pyrrolidin]-2-one 22



Using general procedure I, oxindole **11** (102 mg, 0.12 mmol) and SmI_2 (2.5 mL of a 0.1 M solution in THF, 0.25 mmol) in THF (4 mL), and a solution of imine (46 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 7:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 5% EtOAc in petroleum ether gave **22** (38 mg, 0.08 mmol, 65%) as a 7:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow oil. Further purification by flash column chromatography on silica gel eluting with 3% acetone in pentane gave the minor diastereoisomer as a pale yellow oil, and the major diastereoisomer as a white solid, m.p. (Et_2O) 115–117 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51 (d, J = 1.7 Hz, 1H; Ar-CH), 7.27-7.19 (m, 5H; 5 × Ar-CH), 7.12 (dd, J = 8.2, 1.7 Hz, 1H; Ar-CH), 7.09 (br

d, *J* = 1.8 Hz, 1H; furyl-CH), 6.53 (d, *J* = 8.2 Hz, 1H; Ar-CH), 6.08 (dd, *J* = 3.3, 1.8 Hz, 1H; furyl-CH), 5.96 (d, *J* = 3.3 Hz, 1H; furyl-CH), 5.89 (ddd, *J* = 17.2, 10.1, 8.2 Hz, 1H; C*H*=CH_2), 5.31 (dd, *J* = 17.1, 1.0 Hz, 1H; CH=CH_AH_B), 5.17 (dd, *J* = 10.1, 1.0 Hz, 1H; CH=CH_AH_B), 4.21 (s, 1H; C*H*furyl), 3.92 (d, *J* = 14.2 Hz, 1H; NCH_AH_BPh), 3.82 (d, *J* = 14.2 Hz, 1H; NCH_AH_BPh), 3.69 (dt, *J* = 14.1, 7.3 Hz, 1H; NC$H_AH_BCH_2$), 3.63 (q, *J* = 8.2 Hz, 1H; CH_2CHN), 3.45 (dt, *J* = 14.1, 7.3 Hz, 1H, $NCH_AH_BCH_2$), 2.49 (dd, *J* = 13.4, 8.2 Hz, 1H; CH_AH_BCHN), 1.92 (dd, *J* = 13.4, 8.2 Hz, 1H; CH_AH_BCHN), 1.58 (sextet, *J* = 7.3 Hz, 1H; CH_2CH_3), 0.85 (t, *J* = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.1 (C=O), 151.0 (furyl-C), 141.6 (furyl-CH), 141.5 (Ar-C), 139.8 (*C*H=CH_2), 136.1 (Ar-C), 134.6 (Ar-C), 130.3 (Ar-CH), 129.8 (Ar-CH), 128.4 (Ar-CH), 127.9 (Ar-CH), 126.9 (Ar-CH), 117.3 (CH=*C*H_2), 114.5 (Ar-C), 109.9 (Ar-CH), 109.0 (furyl-CH), 108.8 (furyl-CH), 69.0 (*C*Hfuryl), 64.5 (CH_2*C*HN), 56.4 (*C*-C=O), 53.8 (N*C*H_2Ph), 41.6 (N*C*H_2CH_2), 41.5 (*C*H_2CHN), 20.5 (*C*H_2CH_3), 11.1 (CH_3); IR (film): ν_{max} 2964, 2930, 1712 (C=O), 1606, 1480, 1427, 1351, 1141, 1110, 920, 806, 733 and 702 cm^{-1}; MS (ES+): *m*/*z* (%): 515 (85, [^{81}Br*M* + Na]$^+$), 513 (100, [^{79}Br*M* + Na]$^+$), 465 (25), 463 (25); HRMS (ES+): *m*/*z*: calcd for $C_{27}H_{27}N_2O_2{}^{79}Br$: 491.1329 [*M* + H^+]; found: 491.1344.

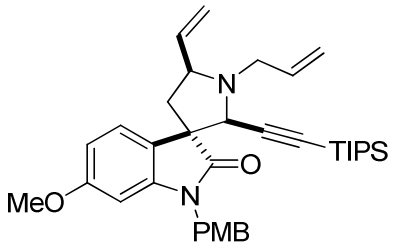
rac-(2'*R*,5'*S*,3*S*)-5-Bromo-1'-(4-methoxyphenyl)-1-propyl-2'-thiophen-2-yl-5'-vinyl-1*H*-spiro[indole-3,3'-pyrrolidin]-2-one 23



Using general procedure I, oxindole **11** (99 mg, 0.12 mmol) and SmI_2 (2.4 mL of a 0.1 M solution in THF, 0.25 mmol) in THF (4 mL), and a solution of imine (52 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 4:1:0.8 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave **23** (47 mg, 0.09 mmol, 74%) as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow oil. Further purification by recrystallisation from

ethanol gave the major diastereoisomer as a white solid, m.p. (EtOH) 115–117 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.31 (dd, *J* = 8.3, 2.0 Hz, 1H; Ar-CH), 7.23 (dd, *J* = 5.0, 1.0 Hz, 1H; thienyl-CH), 6.95 (dd, *J* = 5.0, 3.5 Hz, 1H; thienyl-CH), 6.81 (d, *J* = 9.2 Hz, 2H; 2 × Ar-CH), 6.75 (d, *J* = 9.2 Hz, 2H; 2 × Ar-CH), 6.65 (d, *J* = 8.3 Hz, 1H; Ar-CH), 6.58 (br d, *J* = 3.5 Hz, 1H; thienyl-CH), 6.22 (d, *J* = 2.0 Hz, 1H; Ar-CH), 6.09 (ddd, *J* = 17.2, 10.1, 7.5 Hz, 1H; C*H*=CH_2), 5.47 (d, *J* = 17.2 Hz, 1H; CH=C$H_A$$H_B$), 5.30 (d, *J* = 10.1, 1.0 Hz, 1H; CH=$CH_A$$H_B$), 4.91 (s, 1H; C*H*thienyl), 4.80 (q, *J* = 7.5 Hz, 1H; CH_2C*H*N), 3.72 (s, 3H; OCH_3), 3.65-3.60 (m, 2H; NC$H_2$$CH_2$), 2.44 (d, *J* = 7.5 Hz, 2H; CH_2CHN), 1.68 (sextet, *J* = 7.3 Hz, 2H; C$H_2$$CH_3$), 0.93 (t, *J* = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.4 (C=O), 153.0 (thienyl-C), 146.9 (Ar-C), 141.9 (Ar-C), 141.8 (Ar-C), 140.0 (*C*H=CH_2), 130.9 (Ar-CH), 129.9 (Ar-C), 128.6 (Ar-CH), 127.0 (thienyl-CH), 124.8 (thienyl-CH), 124.7 (thienyl-CH), 116.8 (CH=*C*H_2), 116.6 (Ar-CH), 114.4 (Ar-C), 114.2 (Ar-CH), 109.2 (Ar-CH), 69.4 (*C*Hthienyl), 61.8 (CH_2*C*HN), 57.3 (OCH_3), 55.6 (*C*-C=O), 41.5 (N*C*$H_2$$CH_2$), 41.3 (*C*$H_2$CHN), 20.6 (*C*$H_2$$CH_3$), 11.3 ($CH_3$); IR (film): ν_{max} 2964, 2924, 2874, 1712 (C=O), 1603, 1510, 1480, 1424, 1351, 1337, 1239, 1178, 1110, 1038, 993, 811, 730, 697 cm^{-1}; MS (ES+): *m*/*z* (%): 547 (70, [^{81}Br*M* + Na]$^+$), 545 (70, [^{79}Br*M* + Na]$^+$), 525 (90), 523 (90), 521 (70), 519 (50), 144 (35), 130 (100); HRMS (ES+): *m*/*z*: calcd for $C_{27}H_{27}N_2O_2{}^{79}BrS$: 523.1049 [*M* + H^+]; found: 523.1036.

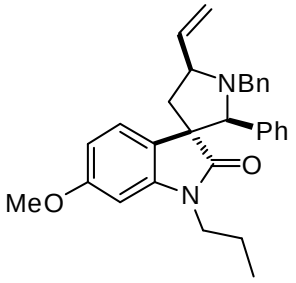
rac-(2'*R*,5'*S*,3*S*)-1'-Allyl-6-methoxy-1-(4-methoxybenzyl)-2'-((triisopropylsilyl)ethynyl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 24



Using general procedure I, oxindole **15** (0.10 g, 0.11 mmol) and SmI_2 (2.3 mL of a 0.1 M solution in THF, 0.23 mmol) in THF (2 mL), and a solution of imine (0.06 g, 0.23 mmol) in THF (1 mL) gave the crude product as a 8:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel

eluting with 10% Et_2O in petroleum ether gave **24** (40 mg, 0.07 mmol, 63%) as a 8:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.41 (d, J = 8.2 Hz, 1H; Ar-CH), 7.22 (d, J = 8.8 Hz, 2H; Ar-CH), 6.82 (d, J = 8.8 Hz, 2H; Ar-CH), 6.50 (dd, J = 8.2, 2.3 Hz, 1H; Ar-CH), 6.29 (d, J = 2.3 Hz, 1H; Ar-CH), 6.05-5.93 (m, 1H; CH_2=C*H*-CH_2), 5.80 (ddd, J = 17.2, 10.1, 8.3 Hz, 1H; CHC*H*=CH_2), 5.30-5.16 (m, 4H; 2H CHCH=CH_2 and CH_2CH=CH_2), 4.83 (d, J = 15.4 Hz, 1H; NCH_AH$_B$C$_6$H$_4$OCH$_3$), 4.77 (1 H, d, J = 15.4 Hz, 1H; NCH$_A$$H_BC_6H_4OCH_3$), 3.90 (s, 1H; C*H*C≡CSi), 3.77 (s, 3H; OCH_3), 3.72 (s, 3H; OCH_3), 3.57 (dd, J = 14.9, 7.3 Hz, 1H; CH_2C*H*N), 3.53-3.44 (m, 2H; NCH_2CH=CH_2), 2.55 (dd, J = 13.1, 8.3 Hz, 1H; CH_AH$_B$CHN), 1.85 (1 H, dd, J = 13.1, 8.1 Hz, 1H; CH$_A$$H_B$CHN), 0.84-0.80 (m, 21 H, Si(C*H*(CH_3)$_2$)$_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 179.2 (C=O), 159.8 (Ar-C), 158.9 (Ar-C), 143.4 (Ar-C), 139.4 (CH*C*H=CH_2), 131.6 (CH_2*C*H=CH_2), 128.6 (Ar-CH), 127.9 (Ar-C), 126.0 (Ar-C), 125.5 (Ar-CH), 119.6 (CH_2CH=*C*H_2), 117.5 (CHCH=*C*H_2), 114.1 (Ar-CH), 106.2 (Ar-CH), 103.0 (CH*C*≡CSi), 96.9 (Ar-CH), 87.4 (CHC≡*C*Si), 63.6 (CH_2*C*HN), 62.6 (*C*HC≡CSi), 55.4 (*C*-C=O), 55.2 (OCH_3), 55.0 (OCH_3), 50.9 (N*C*H$_2$CH=CH_2), 43.4 (N*C*H$_2$CH_2), 42.2 (*C*H_2CHN), 18.3 (3 × CH(*C*H_3)$_2$), 10.9 (3 × *C*H(CH$_3$)$_2$); IR (film): ν_{max} 2941, 2863, 2172 (C≡C), 1716 (C=O), 1626, 1514, 1463, 1379, 1248, 1158, 1037, 995, 922 cm^{-1}; MS (ES+): m/z (%): 585 (100, [M + H]$^+$); HRMS (ES+): m/z: calcd for $C_{36}H_{48}N_2O_3Si$: 585.3489 [M + H$^+$]; found: 585.3507.

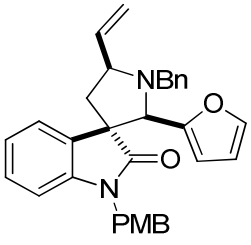
rac-(2'*S*,5'*S*,3*S*)-1'-Benzyl-6-methoxy-2'-phenyl-1-propyl-5'-vinyl-1*H*-spiro[indole-3,3'-pyrrolidin]-2-one 25



Using general procedure I, oxindole **14** (105 mg, 0.14 mmol) and SmI_2 (2.7 mL of a 0.1 M solution in THF, 0.3 mmol) in THF (4 mL), and a solution of imine (53 mg, 0.27 mmol) in THF (1 mL) gave the crude product as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** eluting with

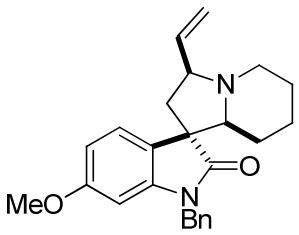
MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide[9] (45 mg, 0.05 mmol, 69%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with 10% EtOAc in hexane gave **25** (43 mg, 0.10 mmol, 70%) as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow oil. Recrystallisation from Et_2O-hexane (1:1) gave the major diastereoisomer as a white solid, m.p. (1:1 Et_2O-hexane) 117–120 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.36 (d, J = 8.3 Hz, 1H; Ar-CH), 7.27-7.19 (m, 3H; 3 × Ar-CH), 7.13-7.04 (m, 7H; 7 × Ar-CH), 6.45 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.09 (d, J = 2.3 Hz, 1H; Ar-CH), 5.94 (ddd, J = 17.1, 10.1, 8.3 Hz, 1H; C*H*=CH_2), 5.25 (br d, J = 17.1 Hz, 1H; CH=CH_AH$_B$), 5.09 (dd, J = 10.1, 1.2 Hz, 1H; CH=C$H_A$$H_B$), 4.11 (s, 1H; C*H*Ph), 3.94 (d, J = 14.2 Hz, 1H; NCH_AH$_B$Ph), 3.74 (s, 3H; OCH_3), 3.70 (d, J = 14.2 Hz, 1H; NC$H_A$$H_B$Ph), 3.66-3.60 (m, 2H; NCH_AH$_B$$CH_2$ and CH_2C*H*N), 3.31 (ddd, J = 14.6, 8.1, 6.8 Hz, 1H; NC$H_A$$H_B$$CH_2$), 2.61 (dd, J = 13.2, 9.6 Hz, 1H; CH_AH$_B$CHN), 1.85 (dd, J = 13.2, 6.8 Hz, 1H; C$H_A$$H_B$CHN), 1.56-1.42 (m, 2H; C$H_2$$CH_3$), 0.80 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 179.1 (C=O), 159.4 (Ar-C), 143.5 (Ar-C), 140.6 (*C*H=CH_2), 136.5 (Ar-C), 136.1 (Ar-C), 130.1 (Ar-CH), 128.4 (Ar-CH), 127.8 (Ar-CH), 127.4 (Ar-CH), 127.1 (Ar-CH), 126.9 (Ar-CH), 126.2 (Ar-CH), 124.9 (Ar-C), 116.2 (CH=*C*H_2), 105.1 (Ar-CH), 95.6 (Ar-CH), 75.3 (*C*HPh), 64.2 (CH_2*C*HN), 57.3 (*C*-C=O), 55.3 (OCH_3), 53.3 (N*C*H_2Ph), 41.6 (N*C*$H_2$$CH_2$), 41.2 (*C*$H_2$CHN), 20.7 (*C*$H_2$$CH_3$), 11.4 ($CH_3$); IR (film): ν_{max} 2966, 2930, 1711 (C=O), 1624, 1597, 1501, 1455, 1379, 1210, 1106 cm^{-1}; MS (ES+): *m*/*z* (%): 475 (100, [*M* + Na]$^+$), 453 (70, [*M* + H]$^+$); HRMS (ES+): *m*/*z*: calcd (%) for $C_{30}H_{32}N_2O_2$: 453.2537 [*M* + H$^+$]; found: 453.2547.

rac-(2'*R*,5'*S*,3*S*)-1'-Benzyl-2'-furan-2-yl-1-(4-methoxybenzyl)-5'-vinyl-1*H*-spiro[indole-3,3'-pyrrolidin]-2-one 26



Using general procedure I, oxindole **12** (138 mg, 0.17 mmol) and SmI_2 (3.4 mL of a 0.1 M solution in THF, 0.34 mmol) in THF (4 mL), and a solution of imine (62 mg, 0.25 mmol) in THF (1 mL) gave the crude product as a 5:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 20% Et_2O in petroleum ether gave **26** (56 mg, 0.11 mmol, 68%) as a 5:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow oil. Further purification by slow crystallisation from ethanol gave the major diastereoisomer as a white solid, m.p. (EtOH) 138–140 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.46 (dd, J = 7.7, 0.8 Hz, 1H; Ar-CH), 7.28-7.25 (m, 2H; 2 × Ar-CH), 7.22-7.20 (m, 1H; Ar-CH), 7.17-7.15 (m, 2H; 2 × Ar-CH), 7.07-7.01 (m, 4H; 3 × Ar-CH and furyl-CH), 6.96 (td, J = 7.7, 0.8 Hz, 1H; Ar-CH), 6.78 (d, J = 8.8 Hz, 2H; 2 × Ar-CH), 6.52 (d, J = 7.7 Hz, 1H; Ar-CH), 6.04 (dd, J = 3.2, 1.9 Hz, 1H; furyl-CH), 5.91 (ddd, J = 17.3, 10.1, 8.2 Hz, 1H; C*H*=CH_2), 5.90 (d, J = 3.2 Hz, 1H; furyl-CH), 5.30 (dd, J = 17.3, 1.0 Hz, 1H; CH=C$H_A$$H_B$), 5.14 (dd, J = 10.1, 1.6 Hz, 1H; CH=C$H_A$$H_B$), 5.01 (d, J = 15.6 Hz, 1H; NC$H_A$$H_B$$C_6H_4OCH_3$), 4.58 (d, J = 15.6 Hz, 1H; NC$H_A$$H_B$$C_6H_4OCH_3$), 4.32 (s, 1H; C*H*furyl), 3.94 (d, J = 14.2 Hz, 1H; NC$H_A$$H_B$Ph), 3.82 (d, J = 14.2 Hz, 1H; NC$H_A$$H_B$Ph), 3.77 (s, 3H; OCH_3), 3.68-3.63 (m, 1H; CH_2C*H*N), 2.59 (dd, J = 13.3, 8.9 Hz, 1H; C$H_A$$H_B$CHN), 1.99 (dd, J = 13.3, 7.6 Hz, 1H; C$H_A$$H_B$CHN); ^{13}C NMR (125 MHz, $CDCl_3$): δ 178.7 (C=O), 158.8 (Ar-C), 151.3 (Ar-C), 142.1 (Ar-C), 141.4 (furyl-CH), 140.1 (*C*H=CH_2), 136.5 (Ar-C), 132.6 (Ar-C), 129.8 (Ar-CH), 128.2 (Ar-CH), 127.8 (Ar-CH), 127.7 (Ar-C), 127.6 (Ar-CH), 126.8 (Ar-CH), 125.2 (Ar-CH), 122.1 (Ar-CH), 117.0 (CH=*C*H_2), 113.9 (Ar-CH), 109.9 (furyl-CH), 108.8 (furyl-CH), 108.5 (Ar-CH), 69.3 (*C*Hfuryl), 64.8 (CH_2*C*HN), 56.3 (*C*-C=O), 55.2 (OCH_3), 54.1 (N*C*H_2Ph), 43.1 (N*C*$H_2$$C_6H_4$OMe), 41.8 (*C*$H_2$CHN); IR (film): ν_{max} 2924, 2835, 1712 (C=O), 1611, 1513, 1485, 1466, 1359, 1245, 1178, 1155, 1029, 1010, 920, 814, 736, 694 cm^{-1}; MS (ES+): *m*/*z* (%): 513 (100, [M + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{32}H_{30}N_2O_3$: 513.2149 [M + Na^+]; found: 513.2164.

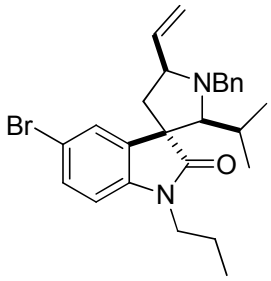
rac-(1'_S_,3'S,8a'S)-1-Benzyl-6-methoxy-3'-vinyl-3',5',6',7',8',8a'-hexahydro-2'_H_-spiro[indoline-3,1'-indolizin]-2-one 27



Using general procedure I, oxindole **16** (134 mg, 0.16 mmol) and SmI_2 (3.3 mL of a 0.1 M solution in THF, 0.33 mmol) in THF (3 mL), and a solution of imine (41 mg, 0.33 mmol) in THF (0.5 mL) gave the crude product as a 5:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** eluting with MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide (52 mg, 0.05 mmol, 66%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave **27** (37 mg, 0.10 mmol, 58%) as a 5:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow oil. Further purification by flash column chromatography on silica gel eluting with 10% EtOAc in petroleum ether gave the major diastereoisomer as a pale yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.35-7.23 (m, 6H; 6 × Ar-CH), 6.53 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.29 (d, J = 2.3 Hz, 1H; Ar-CH), 5.81 (ddd, J = 17.1, 9.9, 8.2 Hz, 1H; CH=CH_2), 5.25 (dd, J = 17.1, 1.8 Hz, 1H; CH=CH_AH$_B$), 5.17 (dd, J = 9.9, 1.8 Hz, 1H; CH=C$H_A$$H_B$), 5.03 (d, J = 15.6 Hz, 1H; NCH_AH$_B$Ph), 4.75 (d, J = 15.6 Hz, 1H; NC$H_A$$H_B$Ph), 3.73 (s, 3H; OCH_3), 3.20-3.14 (m, 1H; NCH_AH$_B$$CH_2$), 3.04 (q, J = 8.2 Hz, 1H; NCHCH=CH_2), 2.63-2.57 (m, 2H; NCHCH_AH$_B$C and NC$H$$CH_2$$CH_2$), 1.92 (td, J = 12.1, 2.5 Hz, 1H; NC$H_A$$H_B$$CH_2$), 1.76 (dd, J = 13.4, 7.8 Hz, 1H; NCHC$H_A$$H_B$C), 1.66-1.57 (m, 2H; 2 × CH), 1.46-1.35 (m, 1H; CH), 1.26-1.10 (m, 2H; 2 × CH), 0.97-0.87 (m, 1H; CH); ^{13}C NMR (100 MHz, $CDCl_3$): δ 180.2 (C=O), 159.5 (Ar-C), 143.4 (Ar-C), 139.7 (_C_H=CH_2), 136.0 (Ar-C), 128.8 (Ar-CH), 127.6 (Ar-CH), 127.2 (Ar-CH), 125.7 (Ar-C), 125.4 (Ar-CH), 117.1 (CH=_C_H_2), 105.9 (Ar-CH), 96.9 (Ar-CH), 72.2 (N_C_H$CH_2$$CH_2$), 68.6 (_C_HCH=$CH_2$), 55.4 (_C_-C=O and OCH_3), 51.9 (N_C_$H_2$$CH_2$), 43.9 (N_C_$H_2$Ph), 42.4 (_C_$H_2$C-C=O), 26.6 ($CH_2$), 25.0 ($CH_2$), 23.7 ($CH_2$); IR (film): ν_{max} 2937, 2852, 2790, 1707 (C=O), 1624, 1598, 1499, 1455, 1378, 1341, 1263, 1210, 1164, 1147, 1119, 1036, 922, 825, 732; MS (ES+): m/z

(%): 411 (60, $[M + Na]^+$), 389 (100, $[M + H]^+$); HRMS (ES+): *m/z*: calcd for $C_{25}H_{28}N_2O_2$: 389.2224 $[M + H]^+$; found: 389.2224.

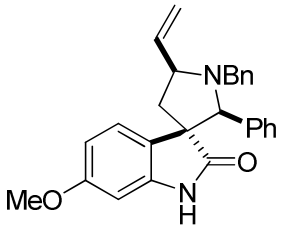
rac-(2'_S_,3S,5'S)-1'-Benzyl-5-bromo-2'-isopropyl-1-propyl-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 28



Using general procedure I, oxindole **11** (109 mg, 0.13 mmol) and SmI_2 (2.7 mL of a 0.1 M solution in THF, 0.27 mmol) in THF (2 mL), and a solution of imine (43 mg, 0.27 mmol) in THF (0.5 mL) gave the crude product as a 3:1:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** eluting with MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide (38 mg, 0.04 mmol, 60%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with 20% Et_2O in petroleum ether gave **28** (37 mg, 0.08 mmol, 60%, 3:1:1 mixture of diastereoisomers) as a yellow solid. Recrystallisation from Et_2O gave the major diastereoisomer, m.p. 128-130 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.72 (d, *J* = 2.0 Hz, 1H; Ar-CH), 7.38-7.30 (m, 5H; 5 × Ar-CH), 7.28-7.21 (m, 1H; Ar-CH), 6.71 (d, *J* = 8.3 Hz, 1H; Ar-CH), 5.76 (ddd, *J* = 17.2, 10.1, 7.8 Hz, 1H; C*H*=CH_2), 5.06 (br dd, *J* = 17.2, 1.5 Hz, 1H; CH=C$H_A$$H_B$), 4.93 (br dd, *J* = 10.1, 1.5 Hz, 1H; CH=C$H_A$$H_B$), 3.94 (d, *J* = 14.4 Hz, 1H; NC$H_A$$H_B$Ph), 3.82 (d, *J* = 14.4 Hz, 1H; NC$H_A$$H_B$Ph), 3.71 (dt, *J* = 14.1, 6.8 Hz, 1H, NC$H_A$$H_B$$CH_2$), 3.57 (dt, *J* = 14.1, 7.1 Hz, 1H, NC$H_A$$H_B$$CH_2$), 3.54-3.48 (m, 1H; CH_2C*H*N), 3.14 (d, *J* = 5.0 Hz, 1H; NC*H*CH$(CH_3)_2$), 2.44 (dd, *J* = 13.1, 9.3 Hz, 1H; C$H_A$$H_B$CHN), 2.05-1.96 (m, 1H; C*H*$(CH_3)_2$), 1.75-1.63 (m, 3H; C$H_A$$H_B$CHN and C$H_2$$CH_3$), 0.96 (t, *J* = 7.3 Hz, 3H; CH_2CH_3), 0.77 (d, *J* = 6.8 Hz, 3H; CH(CH_3)$_A$$(CH_3)_B$, 0.48 (d, *J* = 7.0 Hz, 3H; CH$(CH_3)_A$(CH_3)$_B$; ^{13}C NMR (100 MHz, $CDCl_3$): δ 179.4 (C=O), 141.6 (Ar-C), 140.9 (*C*H=CH_2), 139.1 (Ar-C), 135.9 (Ar-C), 130.2 (Ar-CH), 129.9 (Ar-CH), 129.2 (Ar-

CH), 128.0 (Ar-CH), 126.7 (Ar-CH), 115.8 (CH=*C*H_2), 114.4 (Ar-C), 109.4 (Ar-CH), 76.4 (N*C*HCH(CH_3)$_2$), 66.6 (CH_2*C*HN), 56.4 (*C*H_2Ph), 55.5 (*C*-C=O), 43.9 (*C*H_2CHN), 41.8 (N*C*$H_2CH_2CH_3$), 29.1 (CH*C*H(CH_3)$_2$), 20.5 (*C*H_2CH_3), 19.5 (CH(*C*H_3)$_A$(CH_3)$_B$), 18.8 (CH(CH_3)$_A$(*C*H_3)$_B$), 11.4 (CH_2*C*H_3); IR (film): ν_{max} 2965, 2929, 1698 (C=O), 1601, 1606, 1478, 1424, 1346, 1217, 1199, 1176, 1107, 917, 826, 704 cm^{-1}; MS (ES+): *m*/*z* (%): 491 (80, [^{81}Br*M* + Na]$^+$), 489 (100, [^{79}Br*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{31}N_2O^{79}Br$: 489.1512 [*M* + Na^+]; found: 489.1510.

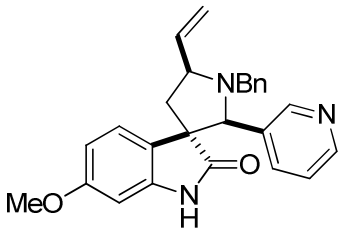
rac-(2'*S*,5'*S*,3*S*)-1'Benzyl-6-methoxy-2'-phenyl-5'-vinyl-1*H*-spiro[indole-3,3'-pyrrolidin]-2-one 29



Using general procedure I, oxindole **10** (252 mg, 0.35 mmol) and SmI_2 (6.9 mL of a 0.1 M solution in THF, 0.69 mmol) in THF (6 mL), and a solution of imine (135 mg, 0.69 mmol) in THF (1 mL) gave the crude product as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica gel eluting with 30% EtOAc in petroleum ether gave **29** (109 mg, 0.27 mmol, 76%) as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow oil. Recrystallisation from EtOAc-hexane (1:1) gave the major diastereoisomer as an off-white solid, m.p. (Et_2O) 137-140 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.31 (d, *J* = 8.3 Hz, 1H; Ar-CH), 7.25-7.20 (m, 3H; Ar-CH), 7.19-7.12 (m, 3H; 3 × Ar-CH), 7.10-7.05 (m, 5H; 4 × Ar-CH and NH), 6.46 (dd, *J* = 8.3, 2.3 Hz, 1H; Ar-CH), 6.13 (d, *J* = 2.3 Hz, 1H; Ar-CH), 5.93 (ddd, *J* = 17.3, 10.2, 8.2 Hz, 1H; C*H*=CH_2), 5.26 (dd, *J* = 17.3, 1.0 Hz, 1H; CH=CH_AH_B), 5.11 (dd, *J* = 10.2, 1.0 Hz, 1H; CH=CH_AH_B), 4.10 (s, 1H; C*H*Ph), 3.94 (d, *J* = 14.3 Hz, 1H; NCH_AH_BPh), 3.705 (s, 3H; OCH_3), 3.702 (d, *J* = 14.3 Hz, 1H; NCH_AH_BPh), 3.66-3.59 (m, 1H; C*H*CH=CH_2), 2.61 (dd, *J* = 13.4, 9.3 Hz, 1H; CH_AH_BCHN), 1.89 (dd, *J* = 13.4, 7.1 Hz, 1H; CH_AH_BCHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 181.4 (C=O), 159.4 (Ar-C), 140.6 (Ar-C), 140.5 (*C*H=CH_2), 136.6 (Ar-C), 136.0 (Ar-C), 130.1 (2 ×

Ar-CH), 128.4 (2 × Ar-CH), 127.8 (2 × Ar-CH), 127.5 (2 × Ar-CH), 127.2 (Ar-CH), 126.9 (Ar-CH), 126.6 (Ar-CH), 125.0 (Ar-C), 116.4 (CH=*C*H_2), 106.7 (Ar-CH), 96.1 (Ar-CH), 75.2 (*C*HPh), 64.2 (*C*HCH=CH_2), 57.8 (*C*-C=O), 55.3 (OCH_3), 53.3 (N*C*H_2Ph), 41.5 (*C*H_2CHN); IR (film): ν_{max} 3220 (NH), 2923, 2835, 1705 (C=O), 1627, 1596, 1501, 1453, 1335, 1305, 1277, 1191, 1152, 1119, 1108, 1024, 920, 823, 749, 698; MS (ES-): *m*/*z* (%): 409 (100, $[M - H]^+$); HRMS (ES-): *m*/*z*: calcd for $C_{27}H_{25}N_2O_2$: 409.1921 $[M - H]^+$; found: 409.1916.

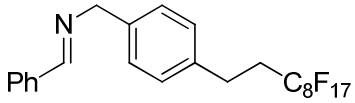
rac-(2'*S*,3S,5'S)-1'-Benzyl-6-methoxy-2'-(pyridin-3-yl)-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 30



Using general procedure I, oxindole **10** (87 mg, 0.12 mmol) and SmI_2 (2.4 mL of a 0.1 M solution in THF, 0.24 mmol) in THF (2 mL), and a solution of imine (47 mg, 0.24 mmol) in THF (0.5 mL) gave the crude product as a 5:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** eluting with MeOH (100 mL) gave the non-fluorous crude product, then eluting with THF (100 mL) gave fluorous disulfide (41 mg, 0.04 mmol, 72%) as a white solid. Further purification of the non-fluorous crude product by flash column chromatography on silica gel eluting with EtOAc gave **30** (34 mg, 0.08 mmol, 69%) as a 5:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a yellow oil. Further purification by flash column chromatography on silica gel eluting with EtOAc gave the major diastereoisomer as a yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$): δ8.36-8.29 (m, 3H; 2 × pyridyl-CH and NH), 7.41 (d, *J* = 5.0 Hz, 1H; pyridyl-CH), 7.24-7.18 (m, 4H; 4 × Ar-CH), 7.03-7.01 (m, 2H; 2 × Ar-CH), 6.97 (dd, *J* = 7.6, 5.0 Hz, 1H; pyridyl-CH), 6.44 (dd, *J* = 8.3, 2.3 Hz, 1H; Ar-CH), 6.15 (d, *J* = 2.3 Hz, 1H; Ar-CH), 5.96 (ddd, *J* = 17.3, 10.1, 8.0 Hz, 1H; C*H*=CH_2), 5.31 (dd, *J* = 17.3, 0.9 Hz, 1H; CH=C$H_A$$H_B$), 5.17 (dd, *J* = 10.1, 0.9 Hz, 1H; CH=C$H_A$$H_B$), 4.12 (s, 1H; C*H*-pyridyl), 3.86 (d, *J* = 14.2 Hz, 1H; NC$H_A$$H_B$Ph), 3.73 (d, *J* = 14.2 Hz, 1H; NC$H_A$$H_B$Ph), 3.69 (s, 3H; OCH_3), 3.71-3.65 (m, 1H; NC*H*CH=CH_2), 2.63 (dd, *J* = 13.4, 9.1 Hz, 1H; C$H_A$$H_B$CHN), 1.93

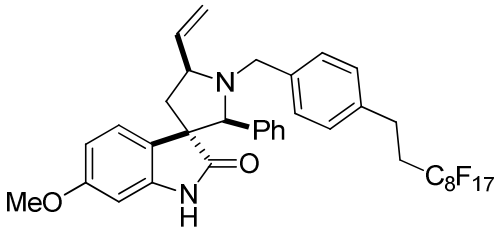
(dd, J = 13.4, 7.0 Hz, 1H; CH_AH_BCHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 181.0 (C=O), 159.6 (Ar-C), 149.5 (pyridyl-CH), 148.5 (pyridyl-CH), 140.9 (Ar-C), 140.0 ($CH=CH_2$), 136.0 (pyridyl-CH), 135.7 (Ar-C), 132.7 (Ar-C), 129.9 (Ar-CH), 128.0 (Ar-CH), 127.1 (Ar-CH), 126.3 (Ar-CH), 124.1 (Ar-C), 122.5 (pyridyl-CH), 117.0 ($CH=CH_2$), 106.7 (Ar-CH), 96.5 (Ar-CH), 73.1 (*C*H-pyridyl), 64.6 ($NCHCH=CH_2$), 57.8 (*C*-C=O), 55.3 (OCH_3), 53.6 (NCH_2Ph), 41.1 (CH_2CHN); IR (film): ν_{max} 3204 (NH), 2924, 2834, 1697 (C=O), 1632, 1594, 1502, 1345, 1315, 1262, 1150, 1122, 1074, 1023, 923; MS (ES+): *m*/*z* (%): 434 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{25}N_3O_2$: 434.1839 $[M + H]^+$; found: 434.1834.

Benzylidene-[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)-benzyl]-amine



Benzaldehyde (0.09 mL, 0.90 mmol, 1.0 eq) and $MgSO_4$ (excess) were added to a solution of 4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)-benzylamine (500 mg, 0.90 mmol, 1.0 eq) in CH_2Cl_2 (5.00 mL). The resulting mixture was stirred for 18 h, then filtered through Celite. Evaporation of the filtrate gave benzylidene-[4-(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl)-benzyl]-amine (296 mg, 0.46 mmol, 51%) as a white powder, m.p. 95-97 °C (MeOH); ^1H NMR (400 MHz, $CDCl_3$): δ 8.41 (s, 1H; CH=N), 7.77-7.82 (m, 2H; 2 × Ar-CH), 7.40-7.47 (m, 3H; 3 × Ar-CH), 7.31 (d, J = 8.1 Hz, 2H; 2 × Ar-CH), 7.21 (d, J = 8.1 Hz, 2H; 2 × Ar-CH), 4.82 (s, 2H; NCH_2), 2.88-2.95 (m, 2H; $CH_2CH_2C_8F_{17}$), 2.28-2.45 (m, 2H; $CH_2C_8F_{17}$); ^{13}C NMR (400 MHz, $CDCl_3$): δ 162.0 (CH=N), 137.8 (2 × Ar-C), 136.1 (Ar-C), 130.8 (Ar-CH), 128.6 (Ar-CH), 128.45 (Ar-CH), 128.43 (Ar-CH), 128.3 (Ar-CH), 64.7 (NCH_2), 33.0 (t, J = 21.2 Hz; $CH_2C_8F_{17}$), 26.1 (t, J = 4.2 Hz; $CH_2CH_2C_8F_{17}$); IR (film): ν 2917, 2848, 1640 (C=N), 1371, 1332, 1198, 1144, 1114, 1085, 955, 825, 703, 655; MS (ES+): *m*/*z* (%): 642 (100, $[M + H]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{22}H_{17}NF_{17}$: 642.1084 $[M + H]^+$; found: 642.1079.

rac-(2'_S_,3S,5'S)-1'-(4-(3,3,4,4,5,5,6,6,7,7,8,8,9,910,10,10-Heptafluorodecyl)benzyl-6-methoxy-2'-phenyl-5'-vinylspiro[indoline-3,3'-pyrrolidin]-2-one 41

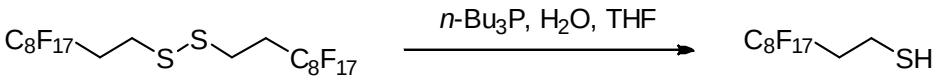


Using general procedure I, oxindole **10** (109 mg, 0.15 mmol) and SmI_2 (3.0 mL of a 0.1 M solution in THF, 0.30 mmol) in THF (4 mL), and imine (115 mg, 0.18 mmol) gave the crude product as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy). Purification by **FSPE** eluting with 60% aqueous MeCN gave the non-fluorous reaction components, then elution with MeOH (100 mL) gave spirooxindole **41** (87 mg, 0.10 mmol, 68%) as a 4:1 mixture of diastereoisomers (by ^{1}H NMR spectroscopy) as a pale yellow solid, then eluting with THF (100 mL) gave fluorous disulfide (60 mg, 0.06 mmol, 84%) as an off-white solid. Further purification of the fluorous fraction by flash column chromatography on silica gel eluting with 3% acetone in $CHCl_3$ allowed separation of the diastereoisomers. **41** (major diastereoisomer): m.p. (Et_2O) 131-134 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81 (s, 1H; NH), 7.30 (d, J = 8.3 Hz, 1H; Ar-CH), 7.40-7.00 (m, 7H; Ar-CH), 6.99 (d, J = 8.0 Hz, 2H; 2 × Ar-CH), 6.46 (dd, J = 8.3, 2.4 Hz, 1H; Ar-CH), 6.16 (d, J = 2.4 Hz, 1H; Ar-CH), 5.95 (ddd, J = 17.2, 10.1, 8.3 Hz, 1H; C*H*=CH_2), 5.29 (dd, J = 17.2, 1.1 Hz, 1H; CH=CH_AH$_B$), 5.15 (dd, J = 10.1, 1.1 Hz, 1H; CH=CH_A*H*$_B$), 4.08 (s, 1H; C*H*Ph), 3.91 (d, J = 14.1 Hz, 1H; NCH_AH$_B$Ar), 3.72 (d, J = 14.1 Hz, 1H; NCH_A*H*$_B$Ar), 3.70 (s, 3H; OCH_3), 3.65-3.59 (m, 1H; C*H*CH=CH_2), 2.90-2.86 (m, 2H; CH_2S), 2.60 (dd, J = 13.4, 9.6 Hz, 1H; CH_AH$_B$CHN), 2.40-2.30 (m, 2H; $CH_2C_8F_{17}$), 1.89 (dd, J = 13.4, 7.0 Hz, 1H; CH$_A$*H*$_B$CHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 181.5 (C=O), 159.4 (Ar-C), 140.6 (*C*H=CH_2), 140.4 (Ar-C), 137.7 (Ar-C), 136.5 (Ar-C), 134.1 (Ar-C), 130.6 (Ar-CH), 128.4 (Ar-CH), 127.8 (Ar-CH), 127.5 (Ar-CH), 127.2 (Ar-CH), 126.6 (Ar-CH), 124.9 (Ar-C), 116.6 (CH=*C*H_2), 106.7 (Ar-CH), 96.2 (Ar-CH), 74.9 (*C*HPh), 63.8 (*C*HCH=CH_2), 57.9 (*C*-C=O), 55.3 (OCH_3), 52.5 (N*C*H_2Ar), 41.3 (*C*H_2CHN), 33.0 (t, J = 22.2 Hz; $CH_2C_8F_{17}$), 26.0 (t, J = 3.7 Hz; CH_2S); IR (film): ν_{max} 3200 (NH), 3016, 2959, 2937, 1714 (C=O), 1624, 1505, 1455, 1237, 1199, 1146, 12113, 984,

835, 802, 701; MS (ES+): *m*/*z* (%): 879 (100, $[M + Na]^+$), 857 (20, $[M + H]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{37}H_{29}N_2O_2$: 857.2031 $[M + Na]^+$; found: 857.2031.

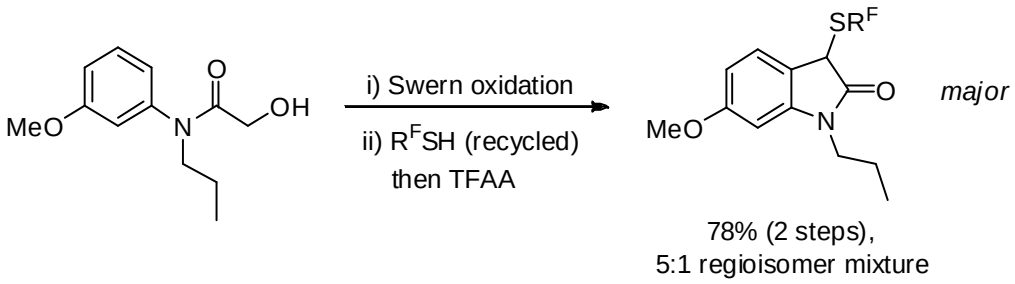
Reduction of fluorous disulfide to fluorous thiol:

In all tag-removal cyclisation reactions to form spirooxindoles, **FSPE** can be used to isolate fluorous disulfide for recycling.



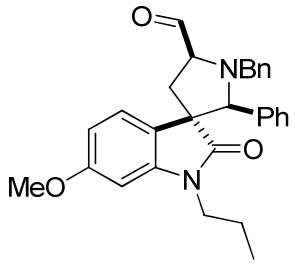
A solution of water (0.57 mL of a 1.0 M solution in THF, 0.57 mmol) and *n*-Bu_3P (141 μL, 0.57 mmol) were added sequentially to a stirred solution of disulfide[9] (500 mg, 0.52 mmol) in THF (15 mL) at room temperature under nitrogen. The resulting solution was stirred at room temperature for 9 h, then evaporated under reduced pressure to give the crude product. Purification by Kugelrohr distillation (bp 60-70 ˚C, 10 mm Hg) gave fluorous thiol[9] (349 mg, 0.73 mmol, 70%) as a colorless oil.

Use of recycled fluorous thiol in a Pummerer reaction:



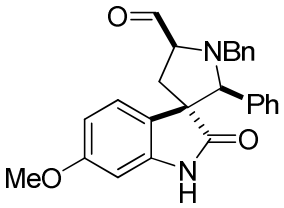
Using general procedure D, hydroxyamide **S7** (289 mg, 1.29 mmol) was oxidized to the corresponding glyoxamide. Using general procedure F, the crude glyoxamide, recycled fluorous thiol (621 mg, 1.29 mmol) and TFAA (360 μL, 2.59 mmol) in CH_2Cl_2 (10 mL) gave the crude product. Purification by **FSPE** eluting with 60% MeCN in water gave the non-fluorous components of the mixture, then elution with MeCN gave oxindoles **17** (688 mg, 1.01 mmol, 78%) as a 5:1 mixture of regioisomers (by ^{1}H NMR spectroscopy) as a pale brown oil.

rac-(2'_S_,5'_S_,3_S_)-1'-Benzyl-6-methoxy-2-oxo-2'-phenyl-1-propyl-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carbaldehyde 31



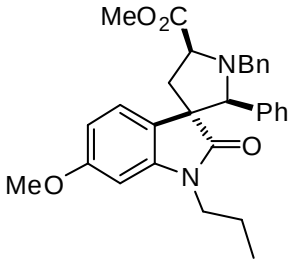
Using general procedure J, OsO_4 (207 μL of a 2.5% w/v solution in *tert*-butanol, 20.3 μmol), NMO (71 mg, 0.6 mmol) and spirooxindole **25** (92 mg, 0.20 mmol) in acetone (12 mL) and water (1.5 mL), then $NaIO_4$ (61 mg, 0.29 mmol) in THF (10 mL) and water (2 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in petroleum ether gave aldehyde **31** (80 mg, 0.18 mmol, 87% over two steps) as a white solid, m.p. (Et_2O) 148-151 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.22 (d, J = 1.8 Hz, 1H; CHO), 7.30-7.17 (m, 7H; 7 × Ar-CH), 7.13 (d, J = 8.3 Hz, 1H; Ar-CH), 7.08-7.03 (m, 3H; 3 × Ar-CH), 6.38 (dd, J = 8.3, 2.2 Hz, 1H; Ar-CH), 6.06 (d, J = 2.2 Hz, 1H; Ar-CH), 4.27 (s, 1H; C*H*Ph), 4.02 (d, J = 12.7 Hz, 1H; NCH_AH$_B$Ph), 3.67 (OCH_3), 3.63-3.56 (m, 2H; CH_2C*H*N and NCH_AH$_B$CH$_2$), 3.31 (d, J = 12.7 Hz, 1H; NCH$_A$$H_B$Ph), 3.32-3.25 (m, 1H; NCH$_A$$H_BCH_2$), 2.71 (dd, J = 13.8, 11.4 Hz, 1H; CH_AH$_B$CHN), 1.97 (dd, J = 13.8, 5.6 Hz, 1H; CH$_A$$H_B$CHN), 1.51-1.38 (m, 2H; CH_2CH$_3$), 0.74 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 201.7 (C=O), 177.8 (C=O), 159.8 (Ar-C), 143.6 (Ar-C), 137.0 (Ar-C), 135.9 (Ar-C), 130.0 (Ar-CH), 128.6 (Ar-CH), 128.0 (Ar-CH), 127.9 (Ar-CH), 127.74 (Ar-CH), 127.71 (Ar-CH), 125.8 (Ar-CH), 123.0 (Ar-C), 105.4 (Ar-CH), 96.1 (Ar-CH), 76.8 (*C*HPh), 70.3 (CH_2*C*HN), 57.8 (N*C*H$_2$Ph), 57.3 (*C*-C=O), 55.4 (OCH_3), 41.7 (N*C*H$_2$CH$_2$), 36.3 (*C*H$_2$CHN), 20.7 (*C*H$_2$CH$_3$), 11.4 (CH_3); IR (film): ν_{max} 2961, 2934, 1726 (C=O), 1713 (C=O), 1624, 1600, 1503, 1455, 1379, 1210, 1107 cm^{-1}; MS (ES+): *m*/*z* (%): 477 (100, [M + Na]$^+$); HRMS (ES+): *m*/*z*: calcd (%) for $C_{29}H_{30}N_2O_3$: 477.2149 [M + Na$^+$]; found: 477.2161.

rac-(2'_S_,5'_S_,3_S_)-1'-Benzyl-6-methoxy-2-oxo-2'-phenyl-1,2-dihydrospiro[indole-3,3'pyrrolidine]-5'-carbaldehyde 32



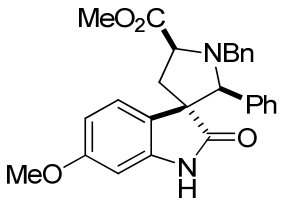
OsO_4 (0.27 mL of a 2.5% w/v solution in *tert*-butanol, 0.03 mmol) and NMO (95 mg, 0.81 mmol) were added to a stirred suspension of spirooxindole **29** (110 mg, 0.27 mmol) in acetone (9 mL) and water (1.5 mL) at room temperature under nitrogen. The resulting suspension was stirred at room temperature for 48 h, then a saturated aqueous solution of $Na_2S_2O_3$ (10 mL) and CH_2Cl_2 (10 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 15 mL). The combined organic layers were dried (Na_2SO_4) and evaporated under reduced pressure to give the crude diol product. The crude product was dissolved in EtOAc (6.8 mL), $Pb(OAc)_4$ (180 mg, 0.41 mmol) was added and the resulting suspension was stirred at room temperature for 15 min. The resulting mixture was filtered through a short silica plug, washing with EtOAc. The filtrate was evaporated under reduced pressure to give aldehyde **32** (100 mg, 0.24 mmol, 94% over two steps) as a white foam; ^{1}H NMR (500 MHz, $CDCl_3$): δ 9.29 (d, J = 3.5 Hz, 1H; CHO), 7.64 (s, 1H; NH), 7.38-7.28 (m, 7H; 7 × ArCH), 7.19-7.11 (m, 4H; 4 × ArCH), 6.46 (dd, J = 8.2, 2.3 Hz, 1H; ArCH), 6.20 (d, J = 2.3 Hz, 1H; ArCH), 4.34 (s, 1H; C*H*Ph), 4.10 (d, J = 12.7 Hz, 1H; CH_AH$_B$Ph), 3.71 (s, 3H; OCH_3), 3.66 (ddd, J = 10.9, 5.4, 3.5 Hz, 1H; C*H*CHO), 3.40 (d, J = 12.7 Hz, 1H; CH$_A$$H_B$Ph), 2.78 (dd, J = 13.7, 10.9 Hz, 1H; CH_AH$_B$CHN), 2.10 (dd, J = 13.7, 5.4 Hz, 1H; CH$_A$$H_B$CHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 201.5 (C=O), 179.9 (C=O), 159.8 (Ar-C), 140.7 (Ar-C), 136.8 (Ar-C), 136.0 (Ar-C), 130.0 (2 × Ar-CH), 128.6 (3 × Ar-CH), 128.1 (Ar-CH), 128.0 (Ar-CH), 127.9 (2 × Ar-CH), 127.8 (Ar-CH), 126.2 (Ar-CH), 123.1 (Ar-C), 106.9 (Ar-CH), 96.7 (Ar-CH), 76.6 (*C*HPh), 70.3 (*C*HCHO), 57.9 (*C*-C=O), 57.8 (Ph*C*H$_2$), 55.3 (OCH_3), 36.4 (*C*H$_2$CHN); IR (film): ν_{max} 3238 (NH), 2928, 2825, 1722 (2 × C=O), 1629, 1596, 1501, 1453, 1342, 1307, 1272, 1191, 1154, 1122, 1027, 825, 753, 698; MS (ES−): *m*/*z* (%): 411 (100, [M − H]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{26}H_{25}N_2O_3$: 413.1860 [M + H$^+$]; found: 413.1877.

rac-(2'_S_,5'_S_,3_S_)-1'-Benzyl-6-methoxy-2-oxo-2'-phenyl-1-propyl-1,2-dihydro-spiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 33



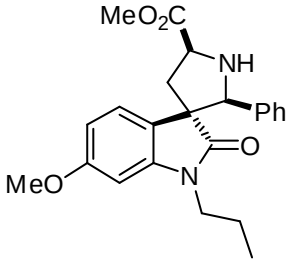
Using general procedure K, oxidant solution (1.60 mL), aldehyde **31** (77 mg, 0.17 mmol) in *tert*-butanol (4 mL), MeCN (4 mL) and 2-methyl-2-butene (2 mL) then trimethylsilyldiazomethane (1.50 mL of a 2.0 M solution in hexanes, 3.00 mmol) in anhydrous MeOH (8 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 20% EtOAc in petroleum ether gave methyl ester **33** (66 mg, 0.14 mmol, 80%) as a white solid, m.p. (Et_2O) 116-118 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.77 (d, J = 8.3 Hz, 1H; Ar-CH), 7.32-7.22 (m, 7H; 7 × Ar-CH), 7.10-7.08 (m, 3H; 3 × Ar-CH), 6.51 (dd, J = 2.5, 8.3 Hz, 1H; Ar-CH), 6.09 (d, J = 2.5 Hz, 1H; Ar-CH), 4.19 (s, 1H; C*H*Ph), 4.04 (d, J = 13.6 Hz, 1H; NCH_AH$_B$Ph), 3.77 (dd, J = 11.1, 5.6 Hz, 1H; NC*H*CO_2CH_3), 3.75 (s, 3H; OCH_3), 3.64 (ddd, J = 14.5, 8.5, 6.3 Hz, 1H; NCH_AH$_B$$CH_2$), 3.51 (d, J = 13.6 Hz, 1H; NCH$_A$$H_B$Ph), 3.45 (s, 3H; OCH_3), 3.31 (ddd, J = 14.5, 8.2, 6.6 Hz, 1H; NCH$_A$$H_B$$CH_2$), 2.80 (dd, J = 13.5, 11.1 Hz, 1H; CH_AH$_B$CHN), 2.13 (dd, J = 13.5, 5.6 Hz, 1H; CH$_A$$H_B$CHN), 1.54-1.44 (m, 2H; C$H_2$$CH_3$), 0.79 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (125 MHz, $CDCl_3$): δ 178.1 (C=O), 174.1 (C=O), 159.7 (Ar-C), 143.4 (Ar-C), 136.1 (Ar-C), 135.8 (Ar-C), 130.0 (Ar-CH), 128.3 (Ar-CH), 128.0 (Ar-CH), 127.5 (Ar-CH), 127.3 (Ar-CH), 127.2 (Ar-CH), 123.5 (Ar-C), 105.4 (Ar-CH), 95.7 (Ar-CH), 76.3 (*C*HPh), 63.3 (N*C*HCO$_2$Me), 57.4 (*C*-C=O), 56.2 (N*C*H$_2$Ph), 55.3 (OCH_3), 51.6 (OCH_3), 41.7 (N*C*H$_2$CH$_2$), 38.2 (*C*H$_2$CHN), 20.7 (*C*H$_2$CH$_3$), 11.4 (CH_3); IR (film): ν_{max} 2951, 2930, 1747 (C=O), 1711 (C=O), 1624, 1504, 1435, 1382, 1367, 1209, 1173, 1106 cm^{-1}; MS (ES+): *m*/*z* (%): 507 (100, [M + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{30}H_{32}N_2O_4$: 507.2254 [M + Na$^+$]; found: 507.2262.

rac-(2'_S_,5'_S_,3_S_)-1′-Benzyl-6-methoxy-2-oxo-2′-phenyl-1,2-dihydrospiro[indole-3,3′-pyrrolidine]-5′-carboxylic acid methyl ester 34



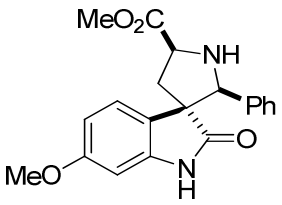
Using general procedure K, oxidant solution (2.4 mL), aldehyde **32** (100 mg, 0.24 mmol) in *tert*-butanol (10.4 mL), MeCN (10.4 mL) and 2-methyl-2-butene (5.2 mL) then trimethylsilyldiazomethane (2.1 mL of a 2.0 M solution in hexanes, 4.20 mmol) in anhydrous MeOH (14.9 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 40% EtOAc in petroleum ether gave methyl ester **34** (85 mg, 0.13 mmol, 80%) as a white solid, m.p. (EtOAc/hexane) 172 -175 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.79 (s, 1H; NH), 7.72 (d, J = 8.5 Hz, 1H; ArCH), 7.33-7.22 (m, 7H; 7 × ArCH), 7.13-7.10 (m, 3H; 3 × ArCH), 6.52 (dd, J = 8.5, 2.4 Hz, 1H; ArCH), 6.16 (d, J = 2.4 Hz, 1H; ArCH), 4.19 (s, 1H; C*H*Ph), 4.04 (d, J = 13.6 Hz, 1H; NCH_AH$_B$Ph), 3.77-3.74 (m, 1H; C*H*CO$_2$CH$_3$), 3.71 (s, 3H; OCH$_3$), 3.51 (d, J = 13.6 Hz, 1H; NCH$_A$$H_B$Ph), 3.46 (s, 3H; OC$H_3$), 2.80 (dd, J = 13.4, 10.9 Hz, 1H; CH_AH$_B$CHN), 2.18 (dd, J = 13.4, 6.2 Hz, 1H; CH$_A$$H_B$CHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 180.3 (C=O), 174.0 (C=O), 159.6 (Ar-C), 140.5 (Ar-C), 136.8 (Ar-C), 135.9 (Ar-C), 130.0 (Ar-CH), 129.5 (Ar-CH), 128.5 (Ar-CH), 128.3 (Ar-CH), 128.2 (Ar-CH), 128.0 (2 × Ar-CH), 127.7 (Ar-CH), 127.65 (Ar-CH), 127.63 (Ar-CH), 127.3 (Ar-CH), 123.6 (Ar-C), 106.9 (Ar-CH), 96.2 (Ar-CH), 76.1 (*C*HPh), 63.2 (*C*HCO$_2$CH$_3$), 57.9 (*C*-C=O), 56.1 (NCH_2Ph), 55.4 (OCH$_3$), 51.7 (OCH$_3$), 38.4 (*C*H$_2$CHN); IR (film): ν 3243 (NH), 3030, 2941, 2830, 1708 (C=O), 1624 (C=O), 1596, 1453, 1342, 1240, 1200, 1149, 1024, 1110, 1027, 827, 751, 700, 668; MS (ES+): *m*/*z* (%): 465 (100, [M + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{27}H_{26}N_2O_4$: 465.1785 [M + Na] $^+$; found: 465.1779.

rac-(2'_S_,5'_S_,3_S_)-6-Methoxy-2-oxo-2'-phenyl-1-propyl-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 35



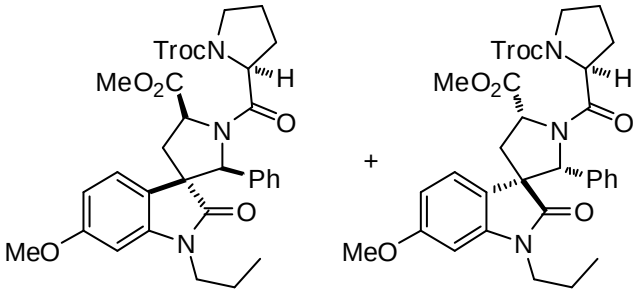
Using general procedure L, *N*-benzyl amine **33** (38 mg, 0.08 mmol) and $Pd(OH)_2$ (8 mg, 20% wt.) in a 0.05 M solution of HCl in MeOH (8 mL) gave amine **35** (30 mg, 0.08 mmol, 97%) as a white solid, m.p. (Et_2O) 66-69 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ7.17 (d, J = 8.3 Hz, 1H; Ar-CH), 7.12-7.06 (m, 5H; 5 × Ar-CH), 6.41 (dd, J = 8.3, 2.3 Hz, 1H; Ar-CH), 6.15 (d, J = 2.3 Hz, 1H; Ar-CH), 4.68 (s, 1H; C*H*Ph), 4.43 (dd, J = 10.6, 5.8 Hz, 1H; NC*H*CO_2CH_3), 3.85 (s, 3H; OCH_3), 3.72 (s, 3H; OCH_3), 3.68 (ddd, J = 14.5, 8.3, 6.3 Hz, 1H; NC$H_A$$H_B$$CH_2$), 3.41 (ddd, J = 14.5, 8.1, 6.8 Hz, 1H; NC$H_A$$H_B$$CH_2$), 3.21 (br s, 1H; NH), 2.95 (dd, J = 13.5, 10.6 Hz, 1H; C$H_A$$H_B$CHN), 2.33 (dd, J = 13.5, 5.8 Hz, 1H; C$H_A$$H_B$CHN), 1.62-1.48 (m, 2H; C$H_2$$CH_3$), 0.85 (t, J = 7.3 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 178.0 (C=O), 173.9 (C=O), 159.7 (Ar-C), 143.5 (Ar-C), 136.1 (Ar-C), 127.6 (Ar-CH), 126.6 (Ar-CH), 125.7 (Ar-CH), 122.8 (Ar-C), 105.5 (Ar-CH), 96.1 (Ar-CH), 71.2 (*C*HPh), 58.0 (*C*-C=O), 57.4 (N*C*HCO_2CH_3), 55.3 (OCH_3), 52.5 (OCH_3), 41.8 (CH_2N), 40.2 (*C*H_2CHN), 20.7 (*C*$H_2$$CH_3$), 11.4 ($CH_3$); IR (neat): ν_{max} 3337 (NH), 2956, 2933, 1739 (C=O), 1701 (C=O), 1625, 1599, 1500, 1380, 1204, 1175, 1097, 1013 cm^{-1}; MS (ES+): *m*/*z* (%): 395 (100, [*M* + H]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{23}H_{26}N_2O_4$: 395.1965 [*M* + Na^+]; found: 395.1978.

rac-(2′*S*,5′*S*,3*S*)-6-Methoxy-2-oxo-2′-phenyl-1,2-dihydro-spiro[indole-3,3′-pyrrolodine]-5′-carboxylic acid methyl ester 36



Using general procedure L, *N*-benzyl amine **34** (70 mg, 0.16 mmol) and $Pd(OH)_2$ (14 mg, 20% wt.) in a 0.05 M solution of HCl in MeOH (4.6 mL) gave amine **36** (41 mg, 0.25 mmol, 74%) as a white foam; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 (s, 1H; NH), 7.18-7.07 (m, 6H; 6 × Ar-CH), 6.41 (dd, *J* = 8.3, 2.4 Hz, 1H; Ar-CH), 6.19 (d, *J* = 2.4 Hz, 1H; Ar-CH), 4.64 (s, 1H; C*H*Ph), 4.35 (dd, *J* = 10.3, 6.1 Hz, 1H; NC*H*CO_2Me), 3.84 (s, 3H; OCH_3), 3.70 (s, 3H; OCH_3), 2.93 (dd, *J* = 13.5, 10.3 Hz, 1H; C$H_A$$H_B$CHN), 2.87 (br s, 1H; N*H*CHCO_2Me), 2.36 (dd, *J* = 13.5, 6.1 Hz, 1H; CH$_A$*H*$_B$CHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 180.5 (C=O), 174.1 (C=O), 159.6 (Ar-C), 140.6 (Ar-C), 136.9 (Ar-C), 127.7 (2 × Ar-CH), 127.5 (Ar-CH), 126.7 (Ar-CH and Ar-C), 126.1 (Ar-CH), 123.4 (Ar-CH), 106.9 (Ar-CH), 96.5 (Ar-CH), 71.3 (*C*HPh), 58.5 (*C*H$CO_2$$CH_3$), 57.6 (*C*-C=O), 55.3 (OCH_3), 52.3 (OCH_3), 40.5 (*C*H_2CHN); IR (film): ν_{max} 3202 (NH), 2951, 2921, 2849, 1718 (broad; C=O), 1628, 1598, 1506, 1457, 1340, 1311, 1276, 1193, 1154, 1125, 1031, 833, 754, 699; MS (ES+): *m*/*z* (%): 353 (100, [*M* + H]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{20}H_{21}N_2O_4$: 353.1496 [*M* + H]$^+$; found: 353.1498.

(2'*S*,5'*S*,3*S*)-6-Methoxy-2-oxo-2'-phenyl-1-propyl-1'-[1-(3,3,3-trichloroethoxycarbonyl)-pyrrolidine-2*S*-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 37b and (2'*R*,5'*R*,3*R*)-6-Methoxy-2-oxo-2'-phenyl-1-propyl-1'-[1-(3,3,3-trichloroethoxycarbonyl)-pyrrolidine-2*S*-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 37a

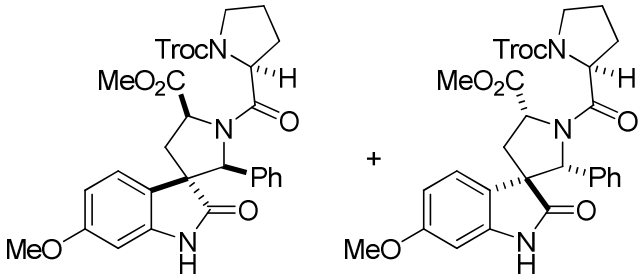


Using general procedure M, a solution of *N*-Troc (*S*)-prolinyl chloride (136 mg, 0.44 mmol) in CH_2Cl_2 (3 mL), amine **35** (58 mg, 0.15 mmol) and Et_3N (123 μL, 0.88

mmol) in CH_2Cl_2 (12 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 50% EtOAc in hexane gave amide **37b** (49 mg, 0.07 mmol, 50%) as a white solid, m.p. (Et_2O) 158-160 °C; $[\alpha]_D^{21}$ = +38.4 (c 0.75, $CHCl_3$); ^{1}H NMR (500 MHz; $CDCl_3$, 3:1 mixture of rotamers; data given for major rotamer only): δ 8.32 (d, *J* = 7.6 Hz, 1H; Ar-CH), 7.53 (t, *J* = 7.6 Hz, 1H; Ar-CH), 7.33 (t, *J* = 7.6 Hz, 1H; Ar-CH), 7.15 (t, *J* = 7.6 Hz, 1H; Ar-CH), 6.48 (d, *J* = 7.6 Hz, 1H; Ar-CH), 6.35 (d, *J* = 2.3 Hz, 1H; Ar-CH), 6.08 (dd, *J* = 8.5, 2.3 Hz, 1H; Ar-CH), 5.46 (d, *J* = 8.5 Hz, 1H; Ar-CH), 5.44 (s, 1H; C*H*Ph), 5.36 (d, *J* = 12.0 Hz, 1H; C$H_A$$H_B$$CCl_3$), 5.18 (dd, *J* = 11.3, 6.8 Hz, 1H; NC*H*CO_2CH_3), 4.59 (d, *J* = 12.0 Hz, 1H; $CH_A$$H_B$$CCl_3$), 4.34 (dd, *J* = 8.5, 3.8 Hz, 1H; NC*H*C(O)N), 3.85 (s, 3H; OCH_3), 3.80-3.72 (m, 1H; CHN), 3.73 (s, 3H; OCH_3), 3.66-3.60 (m, 1H; CHN), 3.50-3.44 (m, 2H; 2 × CHN), 2.43 (dd, *J* = 13.3, 6.8 Hz, 1H; C$H_A$$H_B$$CHCO_2CH_3$), 2.34 (dd, *J* = 13.3, 11.3 Hz, 1H; $CH_A$$H_B$$CHCO_2CH_3$), 2.12-2.04 (m, 1H; CH), 1.77-1.61 (m, 4H; 2 × CH_2), 1.46-1.38 (m, 1H; CH), 0.98 (t, *J* = 7.3 Hz, 3H; CH_3); ^{13}C NMR (125 MHz, $CDCl_3$, 3:1 mixture of rotamers; data given for major rotamer only): δ 178.1 (C=O), 173.3 (C=O), 172.7 (C=O), 160.5 (C=O), 151.7 (Ar-C), 144.2 (Ar-C), 139.6 (Ar-C), 129.0 (Ar-CH), 128.7 (Ar-CH), 128.4 (Ar-CH), 128.1 (Ar-CH), 127.6 (Ar-CH), 126.2 (Ar-CH), 117.2 (Ar-C), 105.5 (Ar-CH), 97.1 (CCl_3), 96.2 (Ar-CH), 73.5 (O*C*H_2CCl_3), 66.1 (*C*HPh), 58.0 (N*C*HCO_2CH_3), 57.3 (*C*-C=O), 56.7 (N*C*HC(O)N), 55.4 (OCH_3), 52.4 (OCH_3), 47.6 (N*C*$H_2CH_2CH_2$), 41.6 (N*C*$H_2CH_2CH_3$), 36.5 (*C*H_2CHN), 30.5 (CH_2), 23.3 (CH_2), 20.7 (*C*H_2CH_3), 11.4 (CH_3); IR (neat): ν_{max} 2951, 2931, 1732 (C=O), 1717 (C=O), 1703 (C=O), 1656 (C=O), 1623, 1408, 1348, 1310, 1211, 1170, 1112, 1173 cm^{-1}; MS (ES+): *m*/*z* (%): 690 (85, [$^{35}Cl_2$^{37}Cl*M* + Na]$^+$); 688 (100, [$^{35}Cl_3$*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{31}H_{34}N_3O_7Cl_3$: 688.1365 [*M* + Na^+]; found: 688.1355; and amide **37a** (47 mg, 0.07 mmol, 48%) as an amorphous white solid, $[\alpha]_D^{21}$ = +43.2 (c 0.84, $CHCl_3$); ^{1}H NMR (500 MHz; D_6-DMSO, complex mixture of rotamers; data given for the two major rotamers only): δ 8.55-8.23 (br m, 2H; Ar-CH, both rotamers), 7.57-7.36 (br m, 2H; Ar-CH, both rotamers), 7.34 (t, *J* = 7.3 Hz, 1H; Ar-CH, one rotamer), 7.30 (t, *J* = 7.3 Hz, 1H; Ar-CH, one rotamer), 7.22-7.08 (br m, 2H; Ar-CH, both rotamers), 6.88-6.72 (br m, 2H; Ar-CH, both rotamers), 6.66 (d, *J* = 2.2 Hz, 1H; Ar-CH, one rotamer), 6.64 (d, *J* = 2.2 Hz, 1H; Ar-CH, one rotamer), 6.14 (dd, *J* = 8.2, 2.2 Hz, 1H; Ar-CH, one rotamer), 6.10 (d, *J* = 8.2, 2.2 Hz, 1H; Ar-CH, one rotamer), 5.32 (d, *J* = 8.2 Hz, 1H; Ar-CH, one rotamer), 5.27 (d, *J* =

8.2 Hz, 1H; Ar-CH, one rotamer), 4.98 (s, 2H; C*H*Ph, both rotamers), 4.83 (d, *J* = 12.3 Hz, 1H; C*H*$_A$H$_B$CCl$_3$, one rotamer), 4.79-4.75 (m, 1H; C(O)NC*H*, one rotamer), 4.76 (d, *J* = 12.3 Hz, 1H; C*H*$_A$H$_B$CCl$_3$, one rotamer), 4.72 (dd, *J* = 11.4, 7.3 Hz, 1H; C(O)NC*H*, one rotamer), 4.64 (d, *J* = 12.3 Hz, 1H; CH$_A$*H*$_B$CCl$_3$, one rotamer), 4.21 (d, *J* = 12.3 Hz, 1H; CH$_A$*H*$_B$CCl$_3$, one rotamer), 4.16 (dd, *J* = 8.8, 2.5 Hz, 1H; C(O)NC*H*, one rotamer), 4.03 (dd, *J* = 9.2, 2.2 Hz, 1H; C(O)NC*H*, one rotamer), 3.74 (s, 3H; OCH$_3$, one rotamer), 3.72 (s, 3H; OCH$_3$, one rotamer), 3.72-3.61 (m, 4H; NC*H*$_2$CH$_2$CH$_3$, both rotamers), 3.69 (s, 3H; OCH$_3$, one rotamer), 3.68 (s, 3H; OCH$_3$, one rotamer), 3.66-3.51-3.34 (m, 4H; NC*H*$_2$CH$_2$CH$_2$, both rotamers), 2.37-2.30 (m, 4H; 2 × CH, both rotamers), 1.94-1.79 (m, 4H; 2 × CH, both rotamers), 1.71-1.57 (m, 4H; C*H*$_2$CH$_3$, both rotamers), 0.898 (t, *J* = 7.3 Hz, 3H; CH$_3$, one rotamer), 0.895 (t, *J* = 7.3 Hz, 3H; CH$_3$, one rotamer); ^{13}C NMR (125 MHz, D$_6$-DMSO, complex mixture of rotamers; data given for the two major rotamers only): δ178.4 (C=O, one rotamer), 178.3 (C=O, one rotamer), 172.0 (C=O, one rotamer), 171.8 (C=O, one rotamer), 171.3 (C=O, one rotamer), 171.2 (C=O, one rotamer), 160.2 (C=O, both rotamers), 152.0 (Ar-C, one rotamer), 151.5 (Ar-C, one rotamer), 144.2 (Ar-C, both rotamers), 138.3 (Ar-C, one rotamer), 138.2 (Ar-C, one rotamer), 128.2-127.5 (3 × Ar-CH, both rotamers), 125.6 (Ar-CH, one rotamer), 125.4 (Ar-CH, one rotamer), 116.8 (Ar-C, one rotamer), 116.7 (Ar-C, one rotamer), 106.0 (Ar-CH, both rotamers), 96.1 (Ar-CH, one rotamer), 95.9 (Ar-CH, one rotamer), 95.4 (CCl$_3$, both rotamers), 74.0 (OC*H*$_2$CCl$_3$, one rotamer), 73.7 (O*C*H$_2$CCl$_3$, one rotamer), 65.0 (*C*HPh, both rotamers), 58.4 (N*C*HC(O), both rotamers), 58.2 (N*C*HC(O), both rotamers), 56.4 (*C*-C=O, both rotamers), 55.4 (OCH$_3$, both rotamers), 52.1 (OCH$_3$, one rotamer), 52.0 (OCH$_3$, one rotamer), 47.6 (N*C*H$_2$CH$_2$CH$_2$, one rotamer), 46.7 (N*C*H$_2$CH$_2$CH$_2$, one rotamer), 40.7 (N*C*H$_2$CH$_2$CH$_3$, both rotamers), 35.5 (CH$_2$, one rotamer), 35.1 (CH$_2$, one rotamer), 29.3 (CH$_2$, one rotamer), 28.5 (CH$_2$, one rotamer), 23.2 (CH$_2$, one rotamer), 22.2 (CH$_2$, one rotamer), 20.3 (*C*H$_2$CH$_3$, both rotamers), 11.1 (CH$_3$, both rotamers); IR (film): *v* 2955, 2930, 1704 (broad; C=O), 1668 (C=O), 1622, 1407, 1356, 1206, 1170, 1124, 1110 cm^{-1}; MS (ES+): *m*/*z* (%): 690 (80, [^{35}Cl$_2$^{37}Cl*M* + Na]$^+$); 688 (100, [^{35}Cl$_3$*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for C$_{31}$H$_{34}$N$_3$O$_7$Cl$_3$: 666.1535 [*M* + H$^+$]; found: 666.1537.

(2'*S*,5'*S*,3*S*)-6-Methoxy-2-oxo-2'-phenyl-1'-[1-(3,3,3-trichloroethoxycarbonyl)-pyrrolidine-2*S*-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 38b and
(2'*R*,5'*R*,3*R*)-6-Methoxy-2-oxo-2'-phenyl-1'-[1-(3,3,3-trichloroethoxycarbonyl)-pyrrolidine-2*S*-carbonyl]-1,2-dihydrospiro[indole-3,3'-pyrrolidine]-5'-carboxylic acid methyl ester 38a

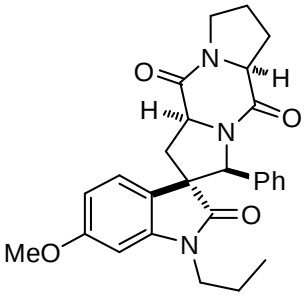


Using general procedure M, a solution of *N*-Troc-(*S*)-prolinyl chloride (14.0 mg, 0.05 mmol) in CH_2Cl_2 (5.60 mL), amine **36** (16 mg, 0.05 mmol) and Et_3N (6.60 μL, 0.05 mmol) gave the crude product. Purification by flash column chromatography on silica gel eluting with 50% EtOAc in hexane gave amide **38b** (14 mg, 0.02 mmol, 50%) as a white solid, m.p. (Et_2O) 110-113 °C; $[\alpha]_D^{26}$ = +1.65 (c 2.5, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$, 1.5:1 mixture of rotamers): δ 8.29-8.37 (m, 2H; 2 × ArCH, both rotamers), 7.91 (s, 1H; NH, one rotamer), 7.61 (s, 1H; NH; one rotamer), 7.57-7.50 (m, 2H; 2 × ArCH, both rotamers), 7.37-7.30 (m, 2H; 2 × ArCH, both rotamers), 7.19-7.12 (m, 2H; 2 × ArCH, both rotamers), 6.63 (d, *J* = 7.1 Hz, 1H; ArCH, one rotamer), 6.53 (d, *J* = 7.8 Hz, 1H; ArCH, one rotamer), 6.43 (d, *J* = 2.3 Hz, 1H; ArCH, one rotamer), 6.41 (d, *J* = 2.3 Hz, 1H; ArCH, one rotamer), 6.12-6.07 (m, 2 H; ArCH, both rotamers), 5.48-5.46 (m, 3 H; ArCH both rotamers and C*H*Ph, one rotamer), 5.45 (s, 1H; C*H*Ph, one rotamer), 5.36 (d, *J* = 12.2 Hz, 1H; C$H_AH_BCCl_3$; one rotamer), 5.15-5.24 (m, 2H; C*H*CO_2CH_3, both rotamers), 4.95 (d, *J* = 12.2 Hz, 1H; C$H_AH_BCCl_3$; one rotamer), 4.52 (d, *J* = 12.2 Hz, 1H; C$H_AH_BCCl_3$; one rotamer), 4.51 (d, *J* = 12.2 Hz, 1H; C$H_AH_BCCl_3$; one rotamer), 4.37 (dd, *J* = 8.4, 4.2 Hz, 1H; NC*H*CH_2CH_2, one rotamer), 4.30 (dd, *J* = 8.4, 4.2 Hz, 1H; NC*H*CH_2CH_2, one rotamer), 3.87 (s, 3H; OCH_3, one rotamer), 3.86 (s, 3H; OCH_3, one rotamer), 3.73-3.71 (m, 6H; OCH_3, both rotamers), 3.69-3.60 (m, 2H; NCH$CH_2CH_2CH_AH_B$, both rotamers), 3.55-3.45 (m, 2H; NCH$CH_2CH_2CH_AH_B$, both rotamers), 2.47-2.40 (m, 4H; 2 × NCHCH_2C, both rotamers), 2.13-2.01 (m, 2H; NCH$CH_2CH_AH_B$, both rotamers),

1.78-1.63 (m, 4H; $NCHCH_2CH_AH_B$ and $NCHCH_AH_BCH_2$, both rotamers), 1.47-1.29 ppm (m, 2H; $NCHCH_AH_BCH_2$); ^{13}C NMR (100 MHz, $CDCl_3$, 1.5:1 mixture of rotamers): δ180.6 (C=O, one rotamer), 180.3 (C=O, one rotamer), 171.1 (C=O, one rotamer), 173.3 (2 × C=O, both rotamers), 172.9 (C=O, one rotamer), 172.8 (C=O, one rotamer), 172.6 (C=O, one rotamer), 160.45 (ArC, one rotamer), 160.47 (ArC, one rotamer), 152.9 (ArC, one rotamer), 151.8 (ArC, one rotamer), 142.1 (ArC, one rotamer), 141.7 (ArC, one rotamer), 139.5 (ArC, one rotamer), 139.3 (ArC, one rotamer), 129.0 (Ar-CH, one rotamer), 128.8 (Ar-CH, one rotamer), 128.6 (2 × Ar-CH, both rotamers), 128.4 (Ar-CH, one rotamer), 128.3 (Ar-CH, one rotamer), 127.73 (Ar-CH, one rotamer), 127.68 (Ar-CH, one rotamer), 126.70 (Ar-CH, one rotamer), 126.66 (Ar-CH, one rotamer), 126.4 (Ar-CH, one rotamer), 126.3 (Ar-CH, one rotamer), 117.7 (CCl_3, one rotamer), 117.6 (CCl_3, one rotamer), 107.0 (Ar-CH, one rotamer), 106.8 (Ar-CH, one rotamer), 96.7 (Ar-CH, one rotamer), 96.2 (Ar-CH, one rotamer), 75.1 (CH_2CCl_3, one rotamer), 73.7 (CH_2CCl_3, one rotamer), 66.5 (CHPh, one rotamer), 66.3 (CHPh, one rotamer), 58.6 (*C*-C=O, one rotamer), 58.5 (*C*-C=O, one rotamer), 58.1 (2 × $CHCO_2CH_3$, both rotamers), 57.6 ($NCHCH_2C$, one rotamer), 57.4 ($NCHCH_2C$, one rotamer), 52.5 (OCH_3, one rotamer), 52.5 (OCH_3, one rotamer), 47.8 ($NCHCH_2CH_2CH_2$, one rotamer), 47.1 ($NCHCH_2CH_2CH_2$, one rotamer), 36.2 (2 × $CHCH_2C$, both rotamers), 29.8 ($NCHCH_2$, one rotamer), 29.7 ($NCHCH_2$, one rotamer), 24.4 ($NCHCH_2CH_2$, one rotamer), 23.1 ($NCHCH_2CH_2$, one rotamer) ; IR (film): *v* 3238 (NH), 2955, 2918, 2844, 1719 (C=O), 1659 (C=O), 1655 (C=O), 1634 (C=O), 1599, 1504, 1453, 1432, 1413, 1339, 1307, 1284, 1256, 1205, 1193, 1159, 1124, 1031, 811, 753, 702 ; MS (ES+): *m/z* (%): 646 (100, $[M + Na]^+$); HRMS (ES+): *m/z*: calcd for $C_{28}H_{28}N_3O_7Cl_3Na$: 646.0885 [$M + Na^+$]; found:646.0894; and amide **38a** (12.5 mg, 0.02 mmol, 45%) as a white solid, m.p. (Et_2O) 155-157 °C; $[\alpha]_D^{26}$ = +29.45 (c 2.2, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$, complex mixture of rotamers; data given for the two major rotamer only): δ 8.64 - 8.42 (m, 2 H; 2 × ArCH, both rotamers), 7.85-7.79 (m, 2 H; NH, both rotamers), 7.67-7.44 (m, 2 H; 2 × ArCH, both rotamers), 7.37-7.09 (m, 2 H; 2 × ArCH, both rotamers), 6.66-6.48 (m, 2 H; 2 × ArCH, both rotamers), 6.43 (d, *J* = 2.4 Hz, 1 H; ArCH, one rotamer), 6.42 (d, *J* = 2.4 Hz, 1 H; ArCH, one rotamer), 6.15 (dd, *J* = 8.5, 2.4 Hz, 1 H; ArCH, one rotamer), 6.11 (dd, *J* = 8.5, 2.4 Hz, 1 H; ArCH, one rotamer), 5.45 (d, *J* = 8.4 Hz, 1 H; ArCH, one rotamer), 5.34 (d, *J* = 8.4 Hz, 1 H; ArCH, one

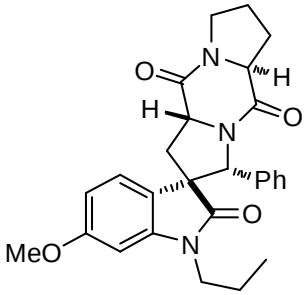
rotamer), 5.05-4.99 (m, 2 H; C*H*CO_2CH_3, both rotamers), 4.98 (s, H; CHPh, one rotamer), 4.97 (s, H; CHPh, one rotamer), 4.86 (d, *J* = 11.9 Hz, 1 H; C$H_AH_BCCl_3$, one rotamer), 4.74 (d, *J* = 11.9 Hz, 1 H; C$H_AH_BCCl_3$, one rotamer), 4.52 (d, *J* = 11.9 Hz, 1 H; $CH_AH_BCCl_3$, one rotamer), 4.33 (t, *J* = 6.1 Hz, 1 H; NC*H*CH_2, one rotamer), 4.22 (t, *J* = 6.1 Hz, 1 H; NC*H*CH_2, one rotamer), 4.21 (d, *J* = 11.9 Hz, 1 H; $CH_AH_BCCl_3$, one rotamer), 3.86 (s, 6 H; OCH_3, both rotamers), 3.75 (s, 3 H; OCH_3, one rotamer), 3.73 (s, 3 H; OCH_3, one rotamer), 3.68 - 3.72 (m, 2 H; NCH$CH_2CH_2CH_2$, both rotamers), 3.41 - 3.52 (m, 2 H; NCH$CH_2CH_2CH_2$, both rotamers), 2.37 - 2.50 (m, 4 H; 2 × CHCH_2C, both rotamers), 2.22 - 2.30 (m, 2 H, NCHCH_2; both rotamers), 2.11 - 2.15 (m, 4 H, NCHCH_2 and NCHCH_2CH_2; both rotamers), 1.94 – 1.85 ppm (m, 2 H, NCHCH_2CH_2; both rotamers); ^{13}C NMR (100 MHz, $CDCl_3$, complex mixture of rotamers, data given only for the major rotamers): δ180.9 (C=O), 180.6 (C=O), 174.1 (C=O), 173.3 (C=O), 172.5 (C=O), 172.2 (C=O), 171.8 (C=O), 171.7 (C=O), 160.53 (Ar-C, one rotamer), 160.51 (Ar-C, one rotamer), 152.6 (Ar-C, one rotamer), 152.3 (Ar-C, one rotamer), 141.6 (2 × Ar-C, both rotamers), 137.8 (Ar-C, one rotamer), 137.3 (Ar-C, one rotamer), 129.68 (Ar-CH, one rotamer), 128.7 (Ar-CH, one rotamer), 128.6 (Ar-CH, one rotamer), 126.9 (2 × Ar-CH, both rotamers), 126.5 (2 × Ar-CH, both rotamers), 117.6 (CCl_3, one rotamer), 117.4 (CCl_3, one rotamer), 106.98 (Ar-CH, one rotamer), 106.93 (Ar-CH, one rotamer), 100 (2 × Ar-CH, both rotamers), 96.91 (Ar-CH, one rotamer), 96.87 (Ar-CH, one rotamer), 96.64 (Ar-CH, one rotamer), 96.62 (Ar-CH, one rotamer), 75.1 (*C*H_2CCl_3, one rotamer), 74.5 (*C*H_2CCl_3, one rotamer), 65.9 (CHPh, one rotamer), 65.8 (CHPh, one rotamer), 58.8 (*C*HCO_2CH_3, one rotamer), 58.6 (*C*HCO_2CH_3, one rotamer), 58.51 (N*C*HCH_2, one rotamer), 58.47 (N*C*HCH_2, one rotamer), 57.63 (*C*-C=O, one rotamer), 57.59 (*C*-C=O, one rotamer), 52.53 (OCH_3), 52.50 (OCH_3), 47.7 (NCHCH_2CH_2*C*H_2, one rotamer), 46.9 (NCHCH_2CH_2*C*H_2, one rotamer), 36.1 (CH*C*H_2C, one rotamer), 35.8 (CH*C*H_2C, one rotamer), 30.0 (NCH*C*H_2, one rotamer), 29.7 (NCH*C*H_2, one rotamer), 23.7 (NCHCH_2*C*H_2, one rotamer), 22.6 (NCHCH_2*C*H_2, one rotamer); IR (film): *v* 3238 (NH), 2955, 2918, 2844, 1719 (C=O), 1659 (C=O), 1655 (C=O), 1634 (C=O), 1599, 1504, 1453, 1432, 1413, 1339, 1307, 1284, 1256, 1205, 1193, 1159, 1124, 1031, 811, 753, 702; MS (ES+): *m*/*z* (%): 646 (100, [*M* + Na]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{28}H_{28}N_3O_7Cl_3Na$: 646.0885 [*M* + Na^+]; found:646.0894.

(2*S*,3*S*,5a*S*,10a*S*)-6'-Methoxy-3-phenyl-1'-propyl-5a,6,7,8-tetrahydro-1*H*-spiro[dipyrrolo[1,2-*a*:1'2'-*d*]pyrazine-2,3'-indoline]-2',5,10(3*H*,10a*H*)-trione 39b



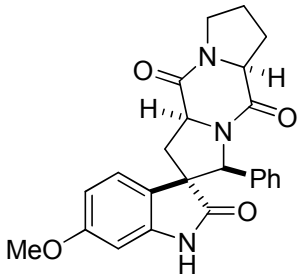
Using general procedure N, Zn dust (480 mg, 7.34 mmol), *N*-Troc amide **37b** (49 mg, 0.07 mmol) in THF (4 mL), MeOH (4 mL) and a saturated solution of NH_4Cl (4 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 3% MeOH in CH_2Cl_2 gave diketopiperazine **39b** (32 mg, 0.07 mmol, 95%) as a white solid, m.p. (Et_2O) 129-132 °C; $[\alpha]_D^{20}$ = +141.0 (c 0.52, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.42-7.30 (br m, 1H; Ar-CH), 7.26 (t, *J* = 7.3 Hz, 1H; Ar-CH), 7.20-7.07 (br m, 1H; Ar-CH), 7.04-6.91 (br m, 1H; Ar-CH), 6.70-6.54 (br m, 1H; Ar-CH), 6.37 (d, *J* = 2.2 Hz, 1H; Ar-CH), 6.09 (dd, *J* = 8.3, 2.2 Hz, 1H; Ar-CH), 5.43 (d, *J* = 8.3 Hz, 1H; Ar-CH), 5.24 (dd, *J* = 10.8, 6.9 Hz, 1H; CCH_2CHN), 5.08 (s, 1H; C*H*Ph), 4.38 (t, *J* = 7.9 Hz, 1H; CH_2CH_2CHN), 3.79-3.69 (m, 2H; $NCH_AH_BCH_2CH_3$ and $NCH_AH_BCH_2CH_2$), 3.73 (s, 3H; OCH_3), 3.65-3.60 (m, 2H; $NCH_AH_BCH_2CH_3$ and $NCH_AH_BCH_2CH_2$), 2.73 (dd, *J* = 13.6, 10.8 Hz, 1H; CCH_AH_BCHN), 2.35-2.29 (m, 1H; $NCHCH_AH_BCH_2CH_2$), 2.32 (dd, *J* = 13.6, 6.9 Hz, 1H; CCH_AH_BCHN), 2.27-2.19 (m, 1H; $NCHCH_AH_BCH_2CH_2$), 2.05-1.94 (m, 2H; $CH_2CH_2CH_2$), 1.75 (sextet, *J* = 7.3 Hz, 2H; CH_2CH_3), 0.99 (t, *J* = 7.3 Hz, 3H; CH_3); ^{13}C NMR (125 MHz, $CDCl_3$): δ 179.3 (C=O), 167.1 (C=O), 166.9 (C=O), 160.5 (Ar-C), 144.2 (Ar-C), 138.0 (Ar-C), 128.1 (3 × Ar-CH), 126.2 (Ar-CH), 117.5 (Ar-C), 105.6 (Ar-CH), 96.3 (Ar-CH), 65.2 (*C*HPh), 61.0 (CH_2CH_2NCH), 58.8 (CCH_2NCH), 55.7 (*C*-C=O), 55.4 (OCH_3), 45.3 and 41.4 (2 × CH_2N), 34.0 (CCH_2CHN), 27.4 (CH_2CH_2N), 23.7 ($CH_2CH_2CH_2$), 20.7 (CH_2CH_3), 11.3 (CH_3); IR (neat): ν_{max} 2964, 2933, 2876, 1716 (C=O), 1662 (C=O), 1624, 1422, 1379, 1277, 1208, 1107 cm^{-1}; MS (ES+): *m*/*z* (%): 482 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{27}H_{29}N_3O_4$: 460.2231 $[M + H^+]$; found: 460.2224.

(2*R*,3*R*,5a*S*,10a*R*)-6'-Methoxy-3-phenyl-1'-propyl-5a,6,7,8-tetrahydro-1*H*-spiro[dipyrrolo[1,2-*a*:1'2'-*d*]pyrazine-2,3'-indoline]-2',5,10(3*H*,10a*H*)-trione 39a



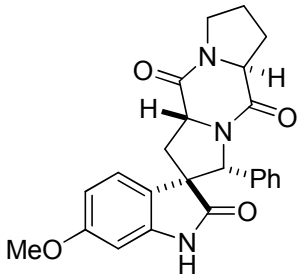
Using general procedure N, Zn dust (461 mg, 7.05 mmol), *N*-Troc amide **37a** (47 mg, 0.07 mmol) in THF (4 mL), MeOH (4 mL) and a saturated solution of NH_4Cl (4 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 3% MeOH in CH_2Cl_2 gave diketopiperazine **39a** (30 mg, 0.07 mmol, 93%) as an amorphous white solid; $[\alpha]_D^{28}$ = +69.3 (c 0.56, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.43-6.55 (br m, 5H; 5 × Ar-CH), 6.35 (d, *J* = 2.2 Hz, 1H; Ar-CH), 6.07 (dd, *J* = 8.6, 2.2 Hz, 1H; Ar-CH), 5.56 (d, *J* = 8.6 Hz, 1H; Ar-CH), 5.38 (ddd, *J* = 11.3, 6.0, 1.5 Hz, 1H; CCH_2CHN), 5.21 (s, 1H; $CHPh$), 4.17 (ddd, *J* = 12.1, 9.3, 6.3 Hz, 1H; $NCH_AH_BCH_2CH_2$), 4.11 (ddd, *J* = 12.1, 5.8, 1.8 Hz, 1H; CH_2CH_2CHN), 3.72 (s, 3H; OCH_3), 3.70-3.66 (m, 2H; $NCH_2CH_2CH_3$), 3.30 (ddd, *J* = 12.1, 9.8, 4.8 Hz, 1H; $NCH_AH_BCH_2CH_2$), 2.54 (dd, *J* = 12.8, 6.0 Hz, 1H; $NCHCH_AH_BC$), 2.48 (dd, *J* = 12.8, 11.3 Hz, 1H; $NCHCH_AH_BC$), 2.40-2.30 (m, 1H; CH), 2.13-1.79 (m, 3H; 3 × CH), 1.78-1.69 (m, 2H; CH_2CH_3), 0.98 (t, *J* = 7.6 Hz, 3H; CH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 179.4 (C=O), 166.4 (C=O), 164.5 (C=O), 160.3 (Ar-C), 144.0 (Ar-C), 137.8 (Ar-C), 128.4 (2 × Ar-CH), 128.0 (Ar-CH), 126.0 (Ar-CH), 118.0 (Ar-C), 105.7 (Ar-CH), 96.3 (Ar-CH), 66.5 ($CHPh$), 63.2 (CH_2CH_2CHN), 57.8 (CCH_2CHN), 55.4 (OCH_3), 54.6 (C-C=O), 44.4 ($NCH_2CH_2CH_2$), 41.4 ($NCH_2CH_2CH_3$), 36.7 (CCH_2CHN), 28.2 (CH_2), 22.4 (CH_2), 20.7 (CH_2CH_3), 11.3 (CH_3); IR (neat): ν_{max} 2964, 2934, 2876, 1702 (C=O), 1661 (C=O), 1622, 1427, 1378, 1305, 1209, 1177, 1106 cm^{-1}; MS (ES+): *m*/*z* (%): 482 (100, $[M + Na]^+$); HRMS (ES+): *m*/*z*: calcd for $C_{27}H_{29}N_3O_4$: 460.2231 $[M + H^+]$; found: 460.2233.

(2*S*,3*S*,5a*S*,10a*S*)-6'-Methoxy-3-phenyl-5a,6,7,8-tetrahydro-1*H*-spiro[dipyrrolo[1,2-*a*:1'2'-*d*]pyrazine-2,3'-indoline]-2',5,10(3*H*,10a*H*)-trione 40b



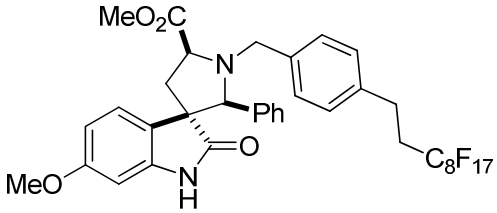
Using general procedure N, Zn dust (187 mg, 2.88 mmol), *N*-Troc amide **38b** (18 mg, 0.03 mmol) in THF (1 mL), MeOH (1 mL) and a saturated solution of NH_4Cl (1 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 10% MeOH in EtOAc gave diketopiperazine **40b** (11.5 mg, 0.03 mmol, 96%) as a white solid, m.p. (EtOAc) 290-292 °C; $[\alpha]_D^{24}$ = –74.7 (c 1.50, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 400 MHz) δ 7.88 (s, 1H; NH), 7.42-7.31 (m, 1H; ArCH), 7.27 (t, *J* = 7.3 Hz, 1H; Ar-CH), 7.19-7.08 (m, 1H; ArCH), 7.04-6.91 (m, 1H; ArCH), 6.71-6.60 (m, 1H; ArCH), 6.40 (d, *J* = 2.4 Hz, 1H; ArCH), 6.09 (dd, *J* = 8.4, 2.4 Hz, 1H; ArCH), 5.40 (d, *J* = 8.3 Hz, 1H; ArCH), 5.20 (dd, *J* = 11.0, 6.8 Hz, 1H; NC*H*CH_2C), 5.16 (s, 1 H; CHPh), 4.41 (t, *J* = 7.8 Hz, 1H; NC*H*CH_2CH_2), 3.81-3.73 (m, 1H; NCH_AH_B), 3.71 (s, 3H; OCH_3), 3.67-3.60 (m, 1H; NCH_AH_B), 2.73 (dd, *J* = 13.6, 11.0 Hz, 1H; NCHCH_AH_BC), 2.40 (dd, *J* = 13.6, 6.8 Hz, 1H; NCHCH_AH_BC), 2.36-2.28 (m, 1H; NCHCH_AH_B), 2.28-2.19 (m, 1H; NCHCH_AH_B), 2.05-1.96 (m, 2H; NCHCH_2CH_2); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 180.9 (C=O), 167.00 (C=O), 166.99 (C=O), 160.3 (ArC), 141.5 (ArC), 137.7 (ArC), 128.2 (ArCH), 126.5 (ArCH), 117.8 (ArC), 106.7 (ArCH), 96.8 (ArCH), 64.9 (*C*HPh), 61.1 (N*C*HCH_2CH_2), 58.7 (N*C*HCH_2C), 56.1 (*C*-C=O), 55.3 (OCH_3), 45.3 (NCH$CH_2CH_2CH_2$), 33.9 (NCH*C*H_2C), 27.4 (NCH*C*H_2), 23.7 (NCHCH_2CH_2); IR (film): ν_{max} 3206 (NH), 2918, 2858, 1712 (C=O), 1661 (C=O), 1631 (C=O), 1594, 1501, 1453, 1425, 1337, 1307, 1281, 1189, 1156, 1124, 1108, 1031, 834, 749, 698; MS (ES+): *m*/*z* (%): 418 (100, [*M* + H]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{24}H_{24}N_4O_3$: 418.1770 [*M* + H] $^+$; found: 418.1761.

(2*R*,3*R*,5a*S*,10a*R*)-6'-Methoxy-3-phenyl-5a,6,7,8-tetrahydro-1*H*-spiro[dipyrrolo[1,2-*a*:1'2'-*d*]pyrazine-2,3'-indoline]-2',5,10(3*H*,10a*H*)-trione 40a



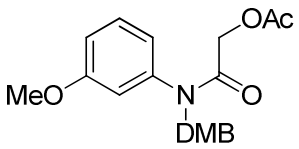
Using general procedure N, Zn dust (156 mg, 2.40 mmol), *N*-Troc amide **38a** (15 mg, 0.02 mmol) in THF (1 mL), MeOH (1 mL) and a saturated solution of NH_4Cl (1 mL) gave the crude product. Purification by flash column chromatography on silica gel eluting with 10% MeOH in EtOAc gave diketopiperazine **40a** (8 mg, 0.02 mmol, 80%) as a white solid, m.p. (Et_2O) 239-241 °C; $[\alpha]_D^{25}$ = +10.8 (c 0.75, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 400 MHz) δ 7.80 (s, 1H; NH), 7.33-7.17 (m, 5H; 5 × ArCH), 6.39 (d, *J* = 2.5 Hz, 1H; ArCH), 6.08 (dd, *J* = 8.5, 2.5 Hz, 1H; ArCH), 5.52 (d, *J* = 8.5 Hz, 1H; ArCH), 5.34 (dd, *J* = 11.5, 6.1 Hz, 1H; NC*H*CH_2C), 5.29 (s, 1H; CHPh), 4.20-4.10 (m, 2H; NC*H*CH_2CH_2 and NCH_AH_B), 3.70 (s, 3H; OCH_3), 3.32 (m, 1H; NCH_AH_B), 2.50-2.00 (m, 2H; NCHCH_2C), 2.41-2.34 (m, 1H; NCHCH_AH_B), 2.14-2.06 (m, 1H; $NCHCH_2CH_AH_B$), 2.03-1.92 (m, 1H; $NCHCH_AH_B$), 1.92-1.82 (m, H; $NCHCH_2CH_AH_B$); ^{13}C NMR ($CDCl_3$, 100 MHz) δ181.1 (C=O), 166.2 (C=O), 164.6 (C=O), 160.2 (Ar-C), 141.4 (Ar-C), 137.6 (Ar-C), 128.5 (Ar-CH), 128.1 (Ar-CH), 126.3 (Ar-CH), 107.0 (Ar-CH), 96.7 (Ar-CH), 66.2 (*C*HPh), 63.2 (N*C*HCH_2CH_2), 57.7 (N*C*HCH_2C), 55.4 (*C*-C=O), 55.0 (OCH_3), 44.5 ($NCHCH_2CH_2CH_2$), 36.7 (NCH*C*H_2C), 28.2 (NCH*C*H_2), 22.4 ($NCHCH_2CH_2$); IR (film): ν_{max} 3206 (NH), 2918, 2858, 1712 (C=O), 1661 (C=O), 1631 (C=O), 1594, 1501, 1453, 1425, 1337, 1307, 1281, 1189, 1156, 1124, 1108, 1031, 834, 749, 698; MS (ES+): *m*/*z* (%): 418 (100, [*M* + H]$^+$); HRMS (ES+): *m*/*z*: calcd for $C_{24}H_{24}N_4O_3$: 418.1770 [*M* + H]$^+$; found: 418.1761.

rac-(2'_S_,3S,5'S)-Methyl 1'-(4-(3,3,4,4,5,5,6,6,7,7,8,8,9,910,10,10-heptafluorodecyl)benzyl-6-methoxy-2-oxo-2'-phenylspiro[indoline-3,3'-pyrrolidine]-5'-carboxylate 42



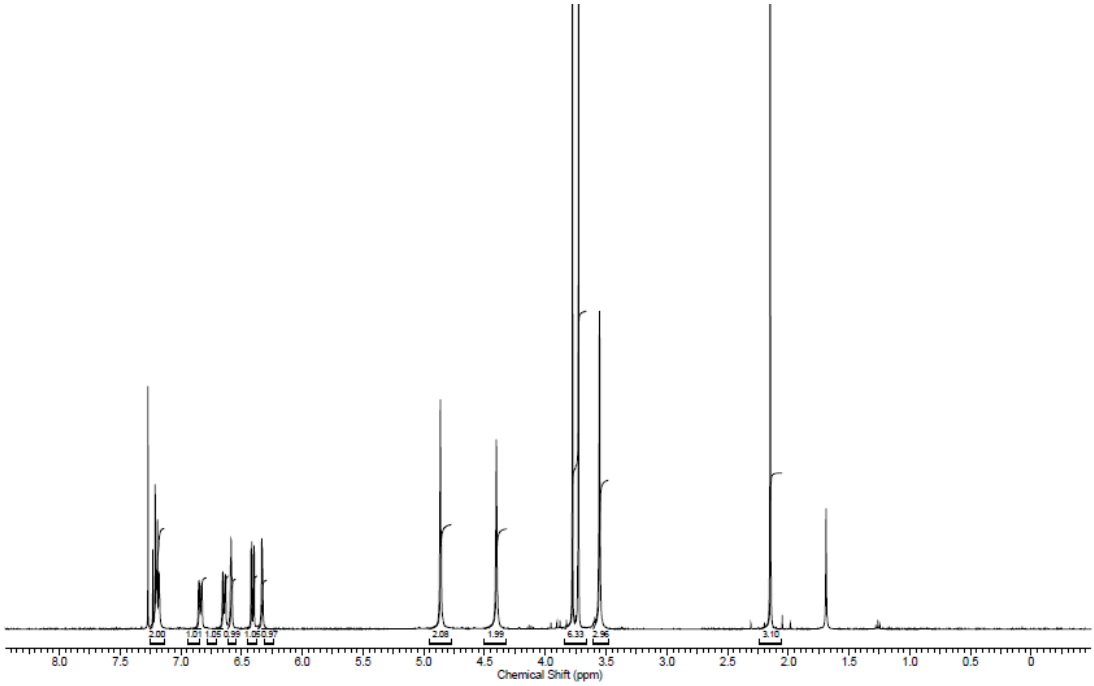
OsO_4 (82 µL of a 2.5% w/v solution in *tert*-butanol, 8.06 µmol) and NMO (28 mg, 0.24 mmol) were added to a stirred suspension of spirooxindole **41** (69 mg, 0.08 mmol) in acetone (5 mL) and water (1 mL) at room temperature under nitrogen. The resulting suspension was stirred at room temperature for 84 h, then a saturated aqueous solution of $Na_2S_2O_3$ (5 mL) and CH_2Cl_2 (5 mL) were added. The layers were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 × 5 mL). The combined organic layers were dried (Na_2SO_4) and evaporated under reduced pressure to give the crude diol product. The crude product was dissolved in EtOAc (5 mL), then $Pb(OAc)_4$ (54 mg, 0.12 mmol) was added and the resulting suspension was stirred at room temperature for 15 min. The resulting mixture was filtered through a short silica plug, washing with EtOAc. The filtrate was evaporated under reduced pressure to give the crude aldehyde product. Using general procedure K, oxidant solution (1.0 mL) and the crude aldehyde in *tert*-butanol (2 mL), MeCN (2 mL) and 2-methyl-2-butene (1 mL), then trimethylsilyldiazomethane (1.0 mL of a 2.0 M solution in hexanes, 2.0 mmol) in anhydrous MeOH (5 mL) gave the crude product. Purification by **FSPE** eluting with 60% aqueous MeCN gave the non-fluorous reaction components, then elution with MeOH (100 mL) gave methyl ester **42** (57 mg, 0.06 mmol, 80%) as a pale yellow solid, m.p. 69-71 °C (Et_2O); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.79 (s, 1H; NH), 7.69 (d, J = 8.3 Hz, 1H; Ar-CH), 7.29-7.11 (m, 9H; 9 × Ar-CH), 6.51 (dd, J = 8.3, 2.2 Hz, 1H; Ar-CH), 6.16 (d, J = 2.2 Hz, 1H; Ar-CH), 4.17 (s, 1H; C*H*Ph), 4.00 (d, J = 13.9 Hz, 1H; NCH_AH$_B$Ar), 3.77 (dd, J = 10.8, 6.0 Hz, 1H; NC*H*CO_2CH_3), 3.71 (s, 3H; OCH_3), 3.55 (d, J = 13.9 Hz, 1H; NCH$_A$$H_B$Ar), 3.52 (s, 3H; OCH_3), 2.92-2.88 (m, 2H; CH_2S), 2.79 (dd, J = 13.4, 10.8 Hz, 1H; CH_AH$_B$CHN), 2.44-2.30 (m, 2H; $CH_2C_8F_{17}$), 2.18 (dd, J = 13.4, 6.0 Hz, 1H; CH$_A$$H_B$CHN); ^{13}C NMR (100 MHz, $CDCl_3$): δ 180.3 (C=O), 174.3 (C=O), 159.6 (Ar-C), 140.5 (Ar-C), 138.1

(Ar-C), 135.6 (Ar-C), 134.1 (Ar-C), 130.5 (Ar-CH), 128.3 (Ar-CH), 127.9 (Ar-CH), 127.7 (Ar-CH), 127.6 (Ar-CH), 127.5 (Ar-CH), 123.6 (Ar-C), 106.8 (Ar-CH), 96.2 (Ar-CH), 75.7 (*C*HPh), 62.7 (N*C*HCO$_2$CH$_3$), 57.9 (*C*-C=O), 55.3 (OCH$_3$), 55.1 (N*C*H$_2$Ar), 51.7 (OCH$_3$), 38.3 (CH2), 32.9 (t, J = 22.1 Hz; CH$_2$C$_8$F$_{17}$), 26.1 (CH$_2$S); IR (film): ν_{max} 3210 (NH), 2948, 2922, 2849, 1714 (2 × C=O), 1631, 1506, 1456, 1341, 1236, 1198, 1145, 1113, 1087, 1026, 806, 702; MS (ES+): *m*/*z* (%): 887 (100, [M - H]$^+$); HRMS (ES-): *m*/*z*: calcd for C$_{37}$H$_{29}$F$_{17}$N$_2$O$_4$: 887.1783 [M − H] $^+$; found: 887.1776.

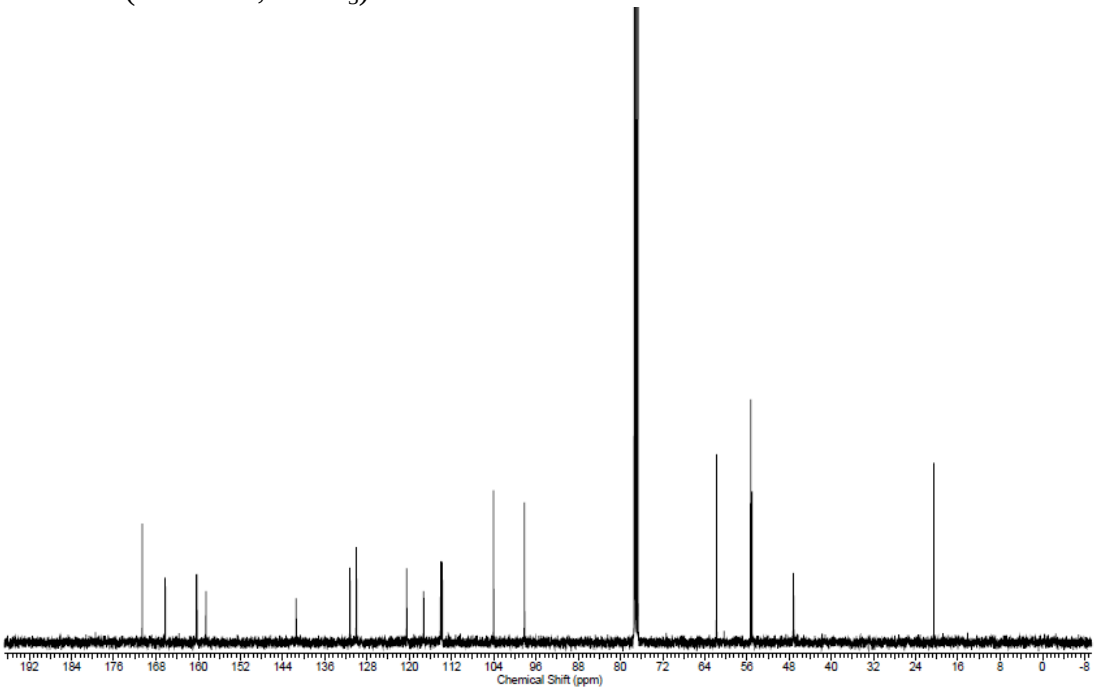


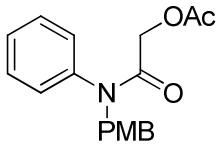
S1

^{1}H NMR (400 MHz, $CDCl_3$)



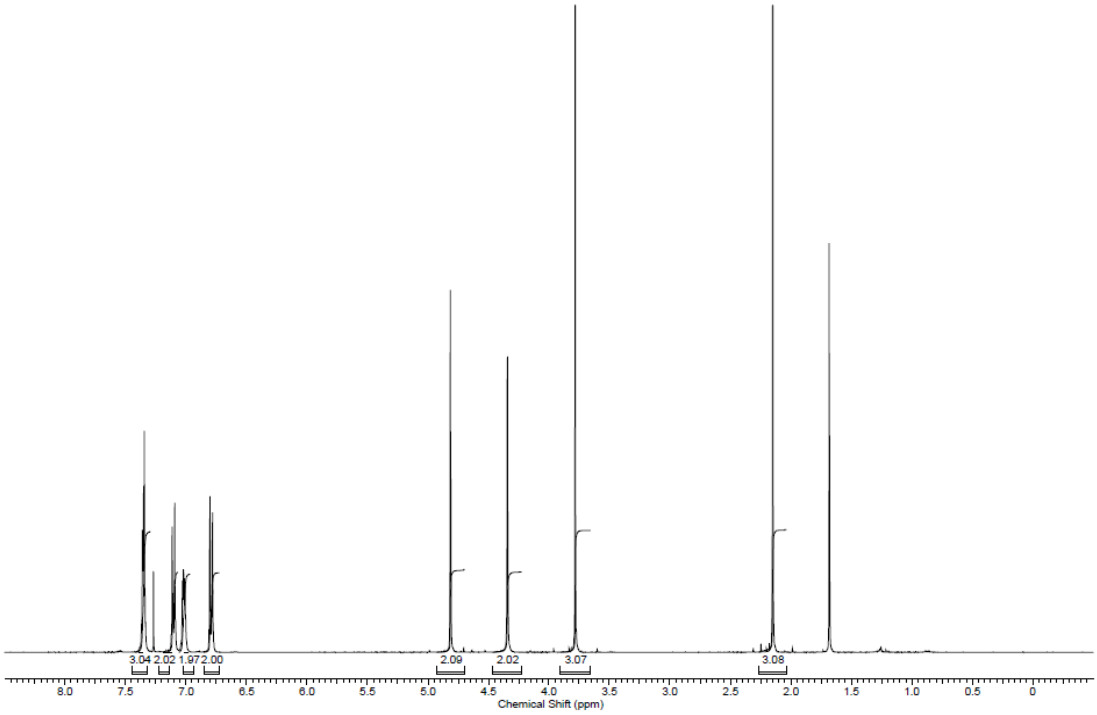
^{13}C NMR (100 MHz, $CDCl_3$)



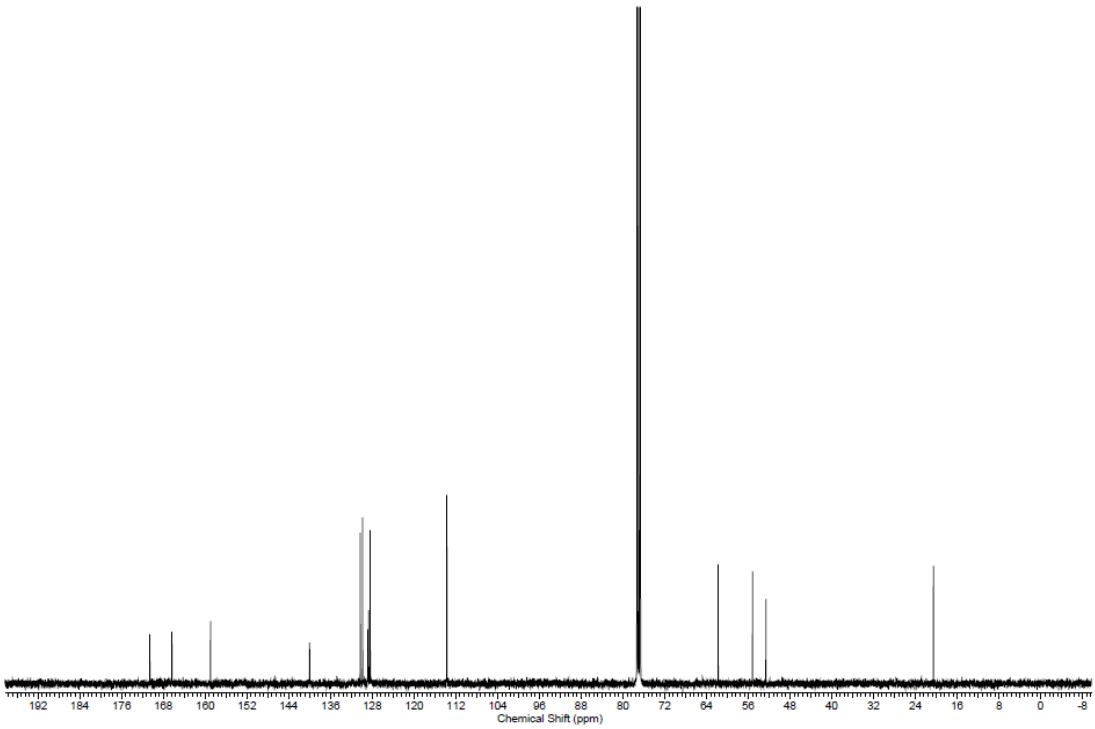


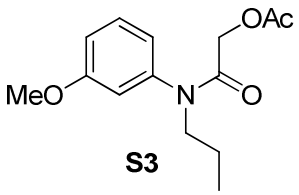
S2

^{1}H NMR (400 MHz, $CDCl_3$)



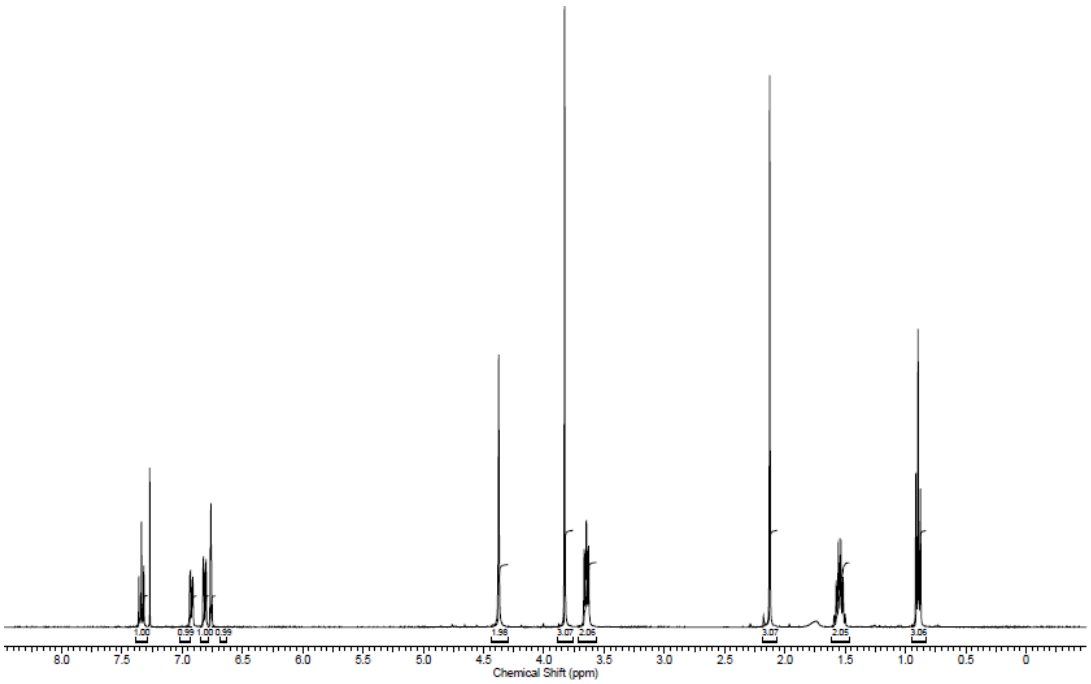
^{13}C NMR (100 MHz, $CDCl_3$)



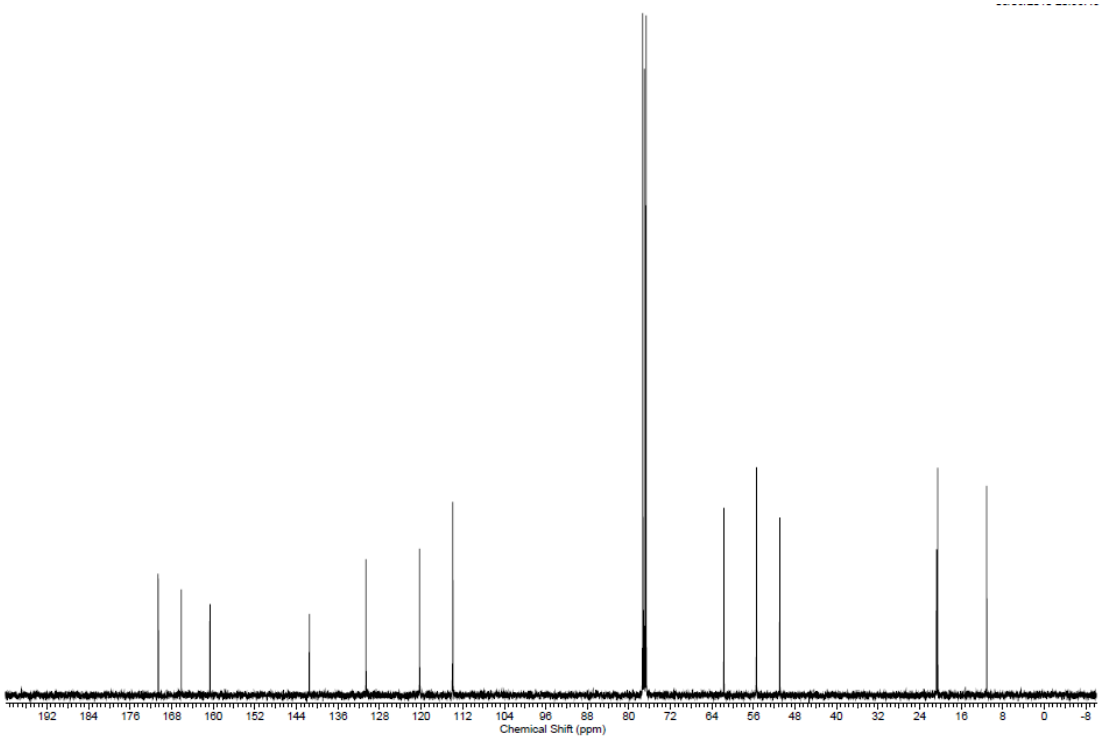


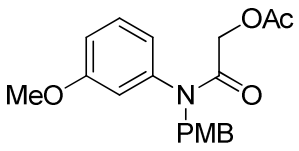
S3

^{1}H NMR (400 MHz, $CDCl_3$)



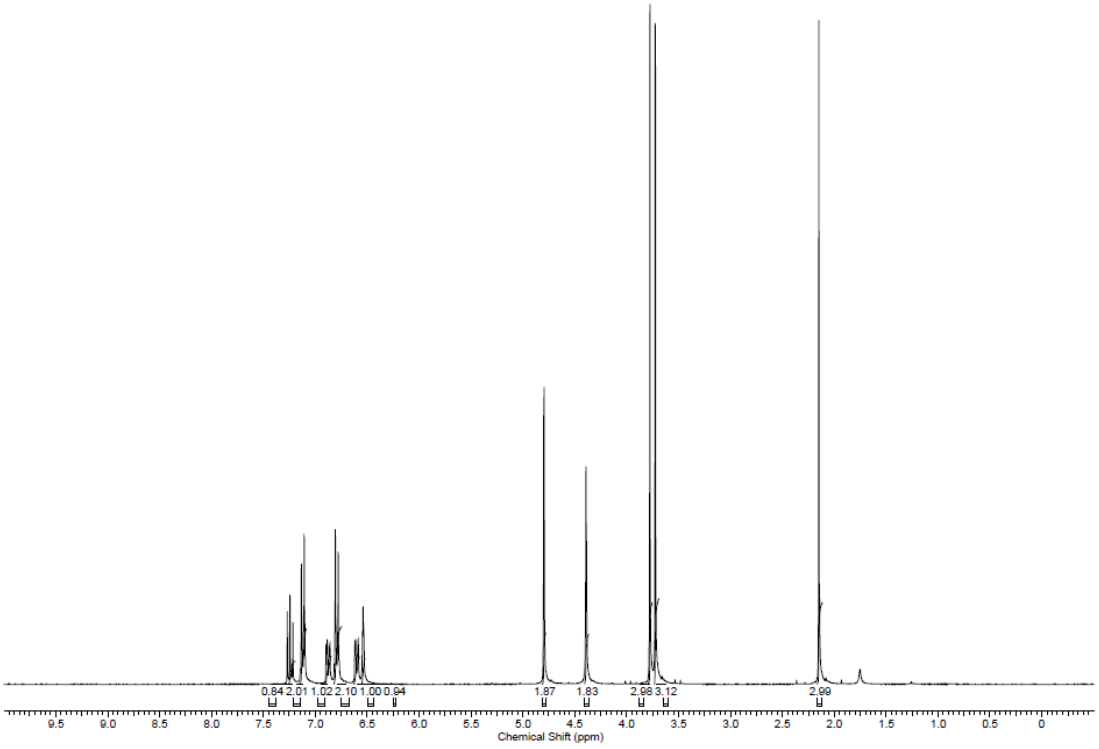
^{13}C NMR (100 MHz, $CDCl_3$)



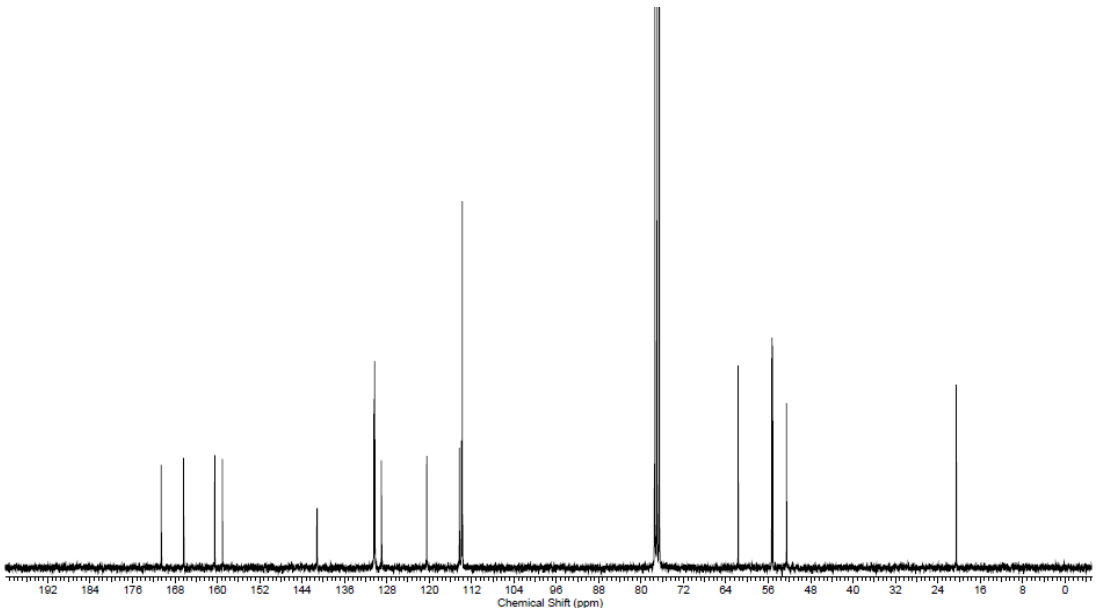


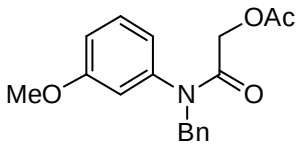
S4

^{1}H NMR (300 MHz, $CDCl_3$)



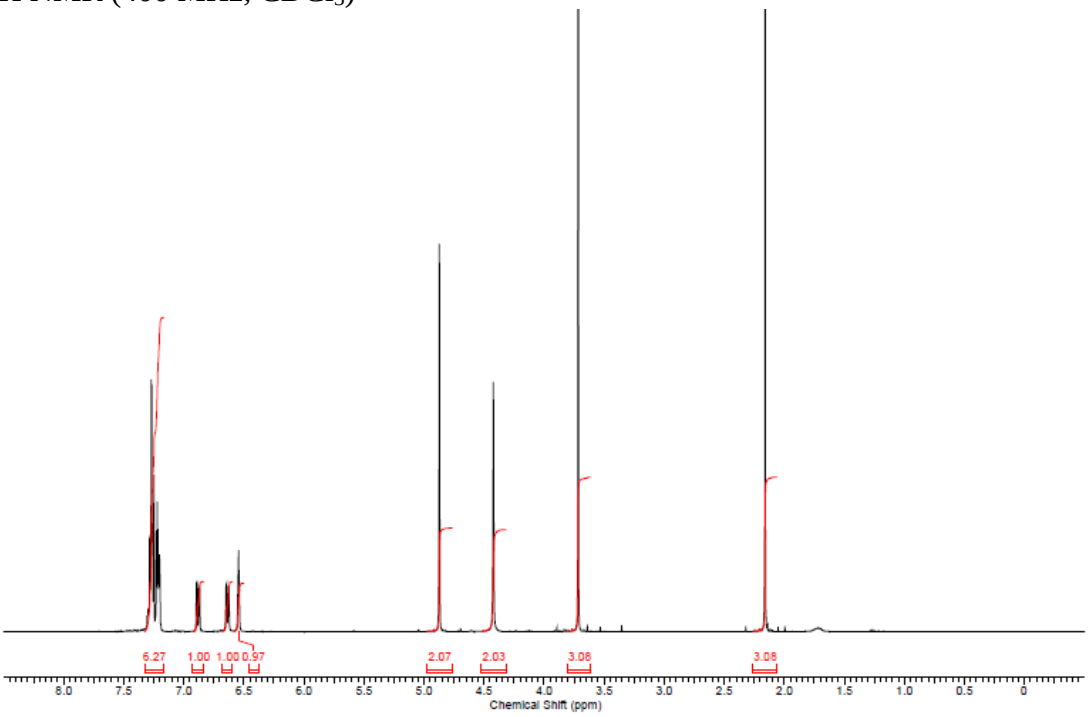
^{13}C NMR (75 MHz, $CDCl_3$)



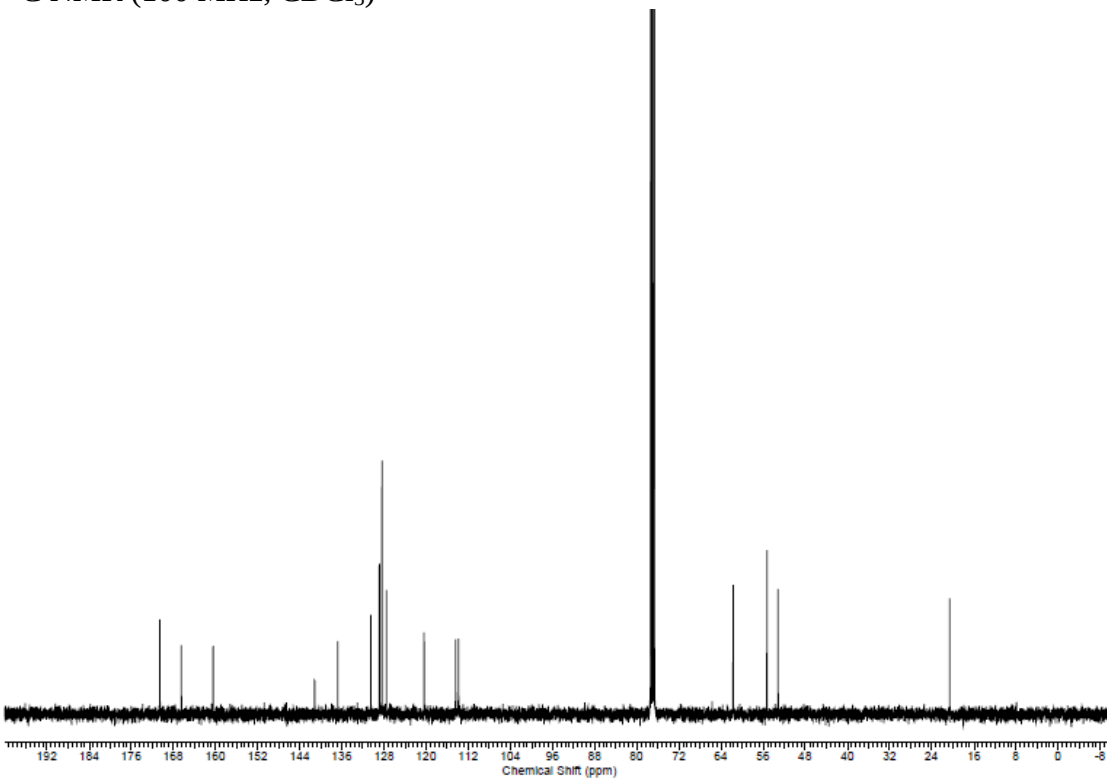


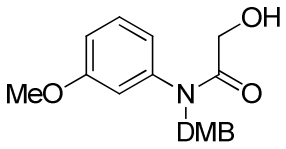
S5

^{1}H NMR (400 MHz, $CDCl_3$)



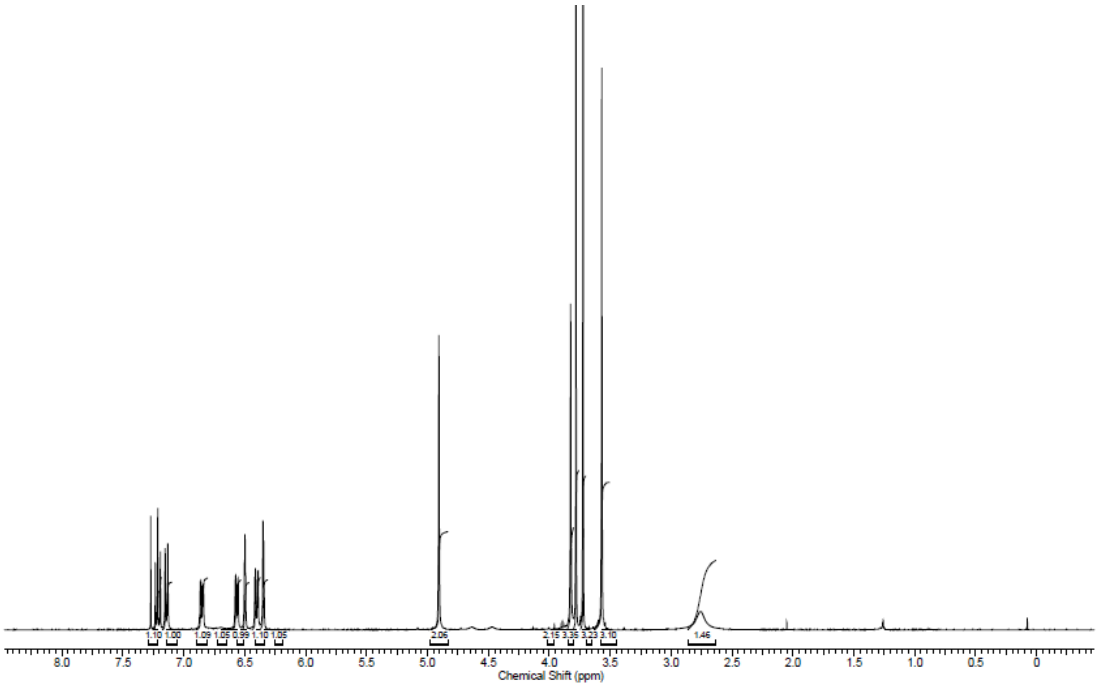
^{13}C NMR (100 MHz, $CDCl_3$)



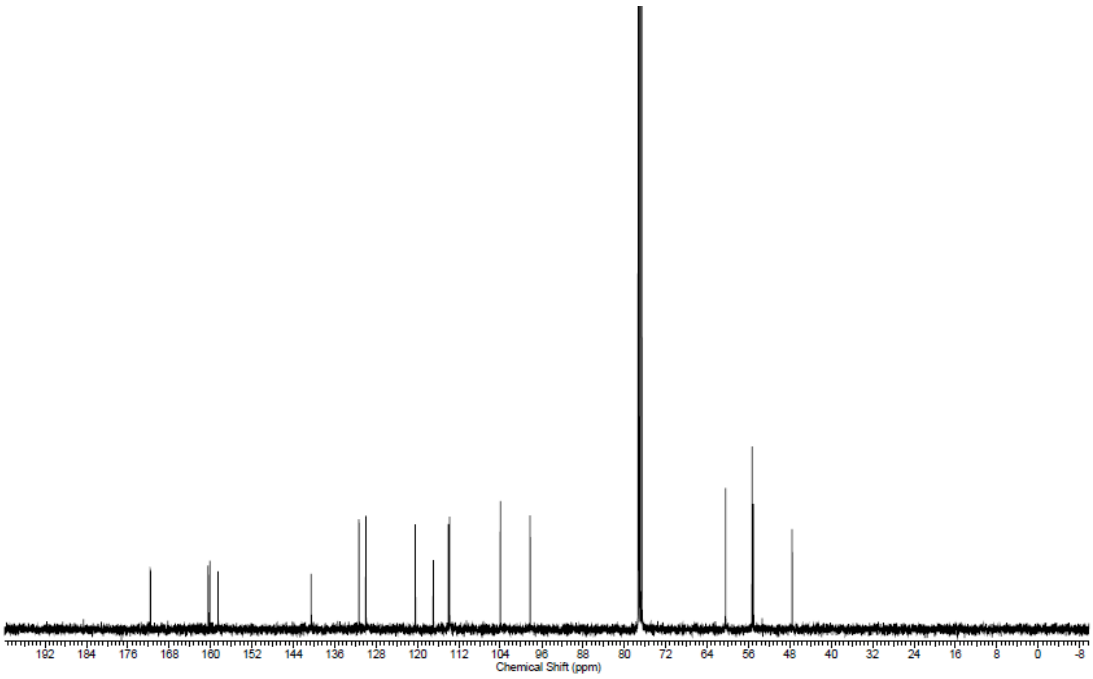


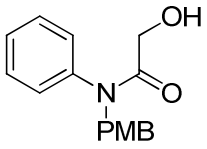
S6

^{1}H NMR (400 MHz, $CDCl_3$)



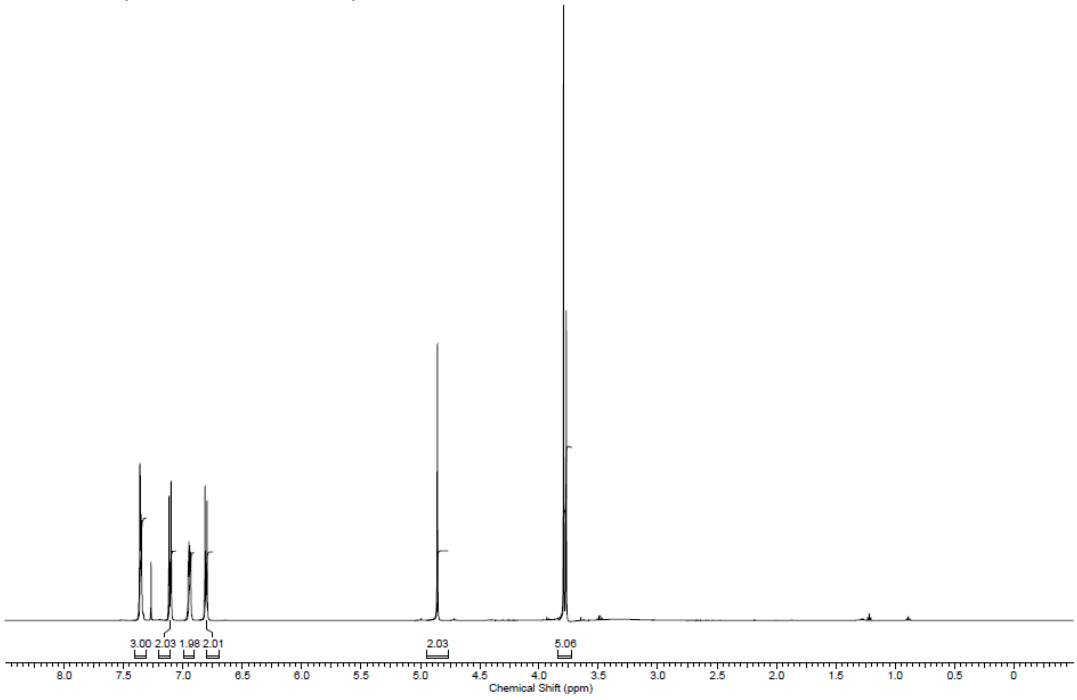
^{13}C NMR (100 MHz, $CDCl_3$)



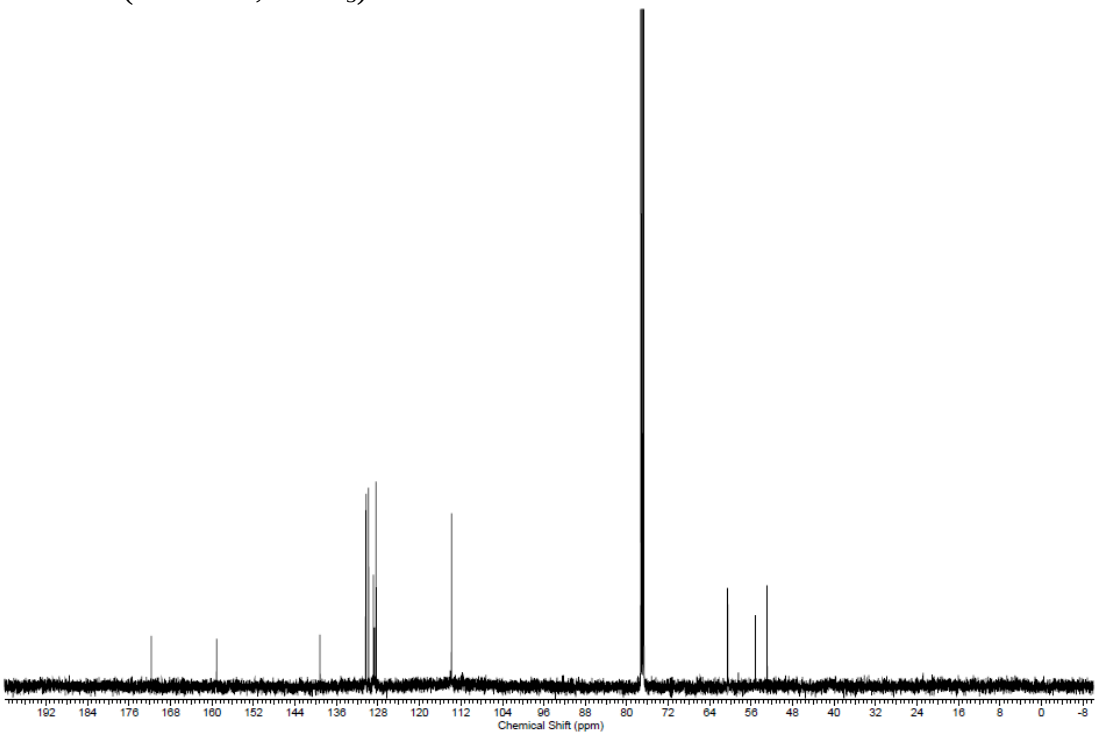


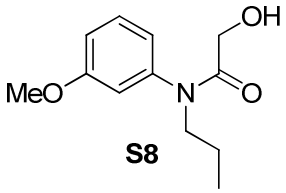
S7

^{1}H NMR (500 MHz, $CDCl_3$)



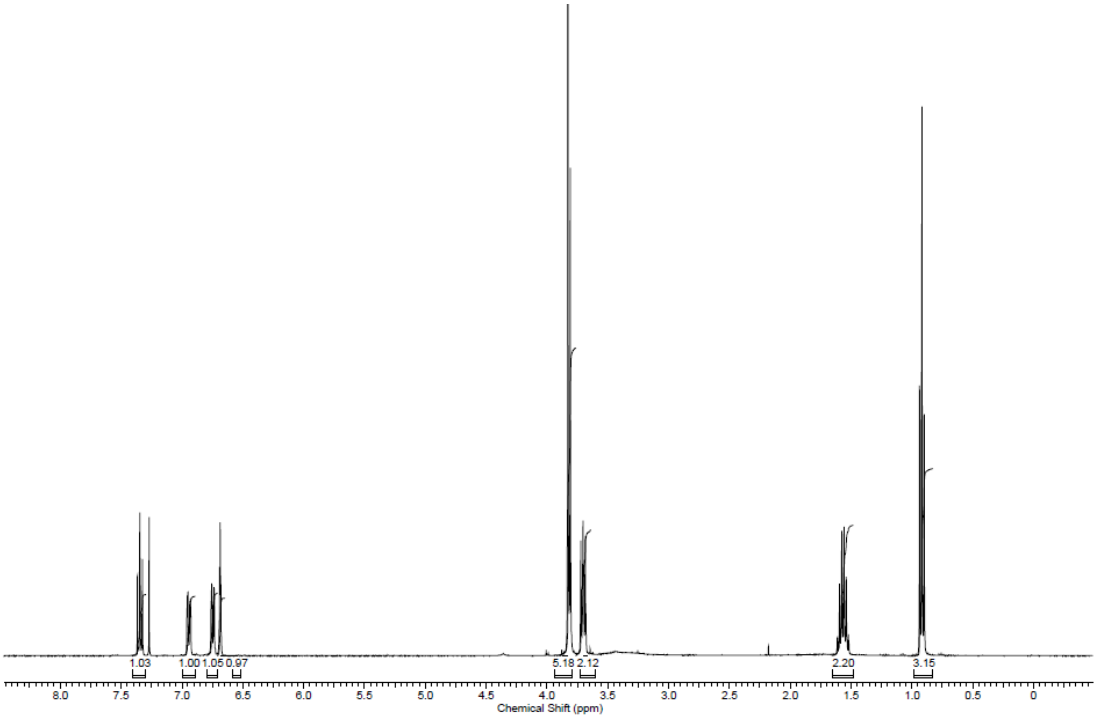
^{13}C NMR (125 MHz, $CDCl_3$)



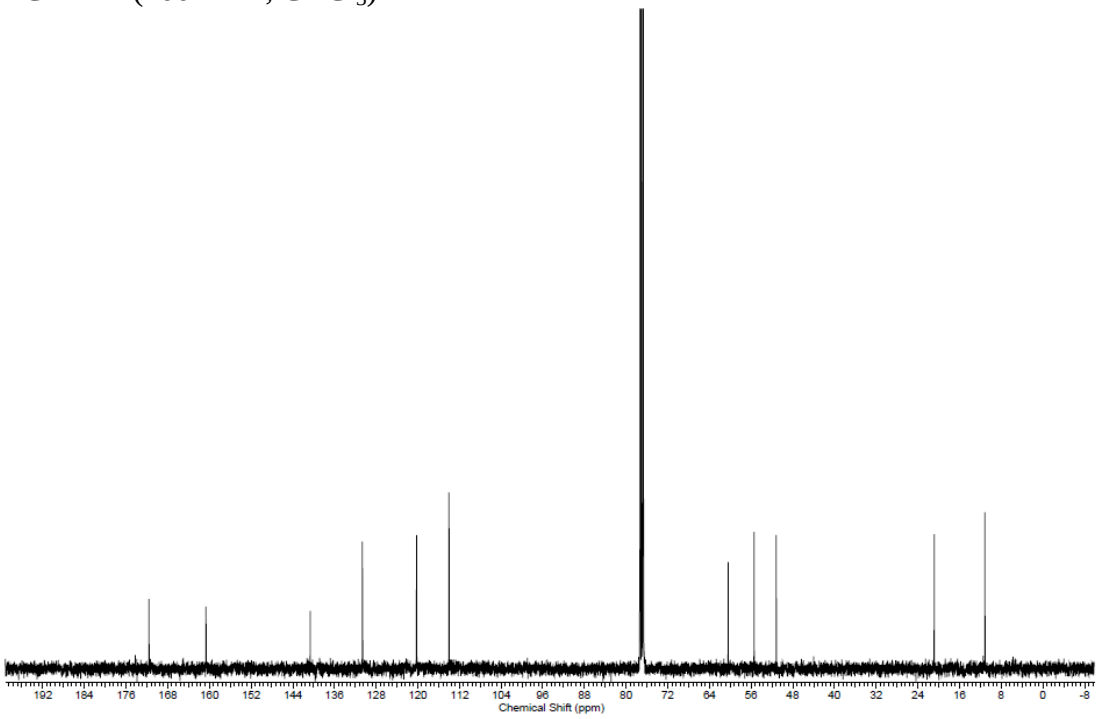


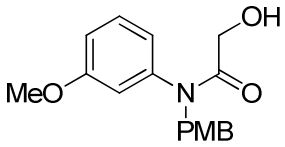
S8

^{1}H NMR (400 MHz, $CDCl_3$)



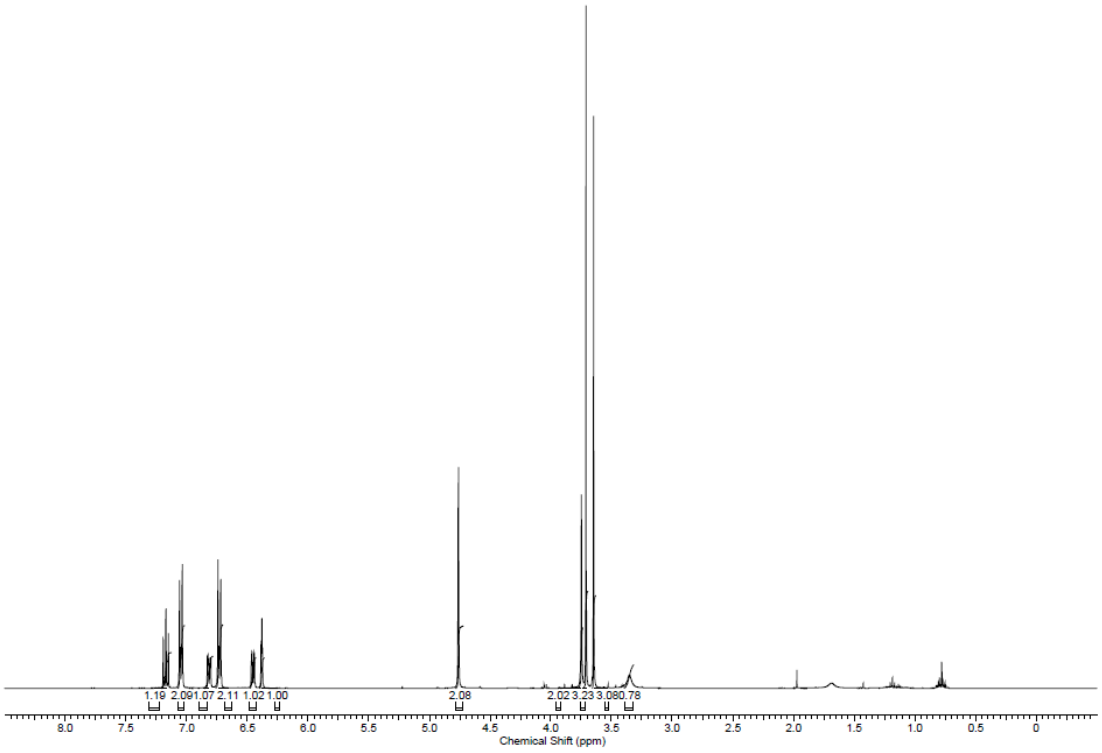
^{13}C NMR (100 MHz, $CDCl_3$)



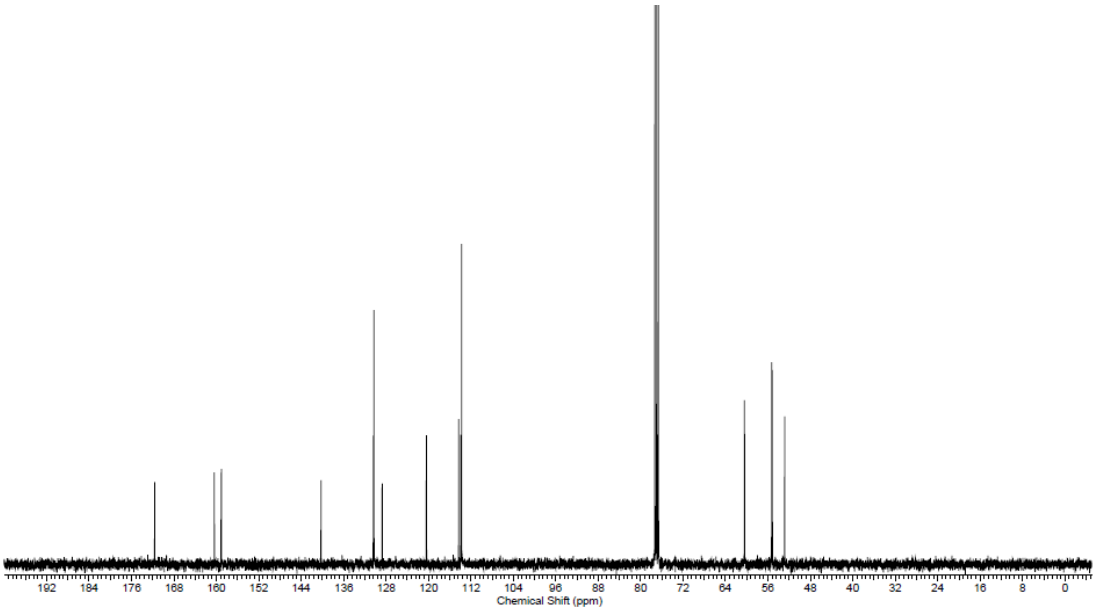


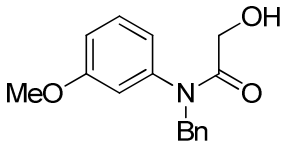
S9

^{1}H NMR (400 MHz, $CDCl_3$)



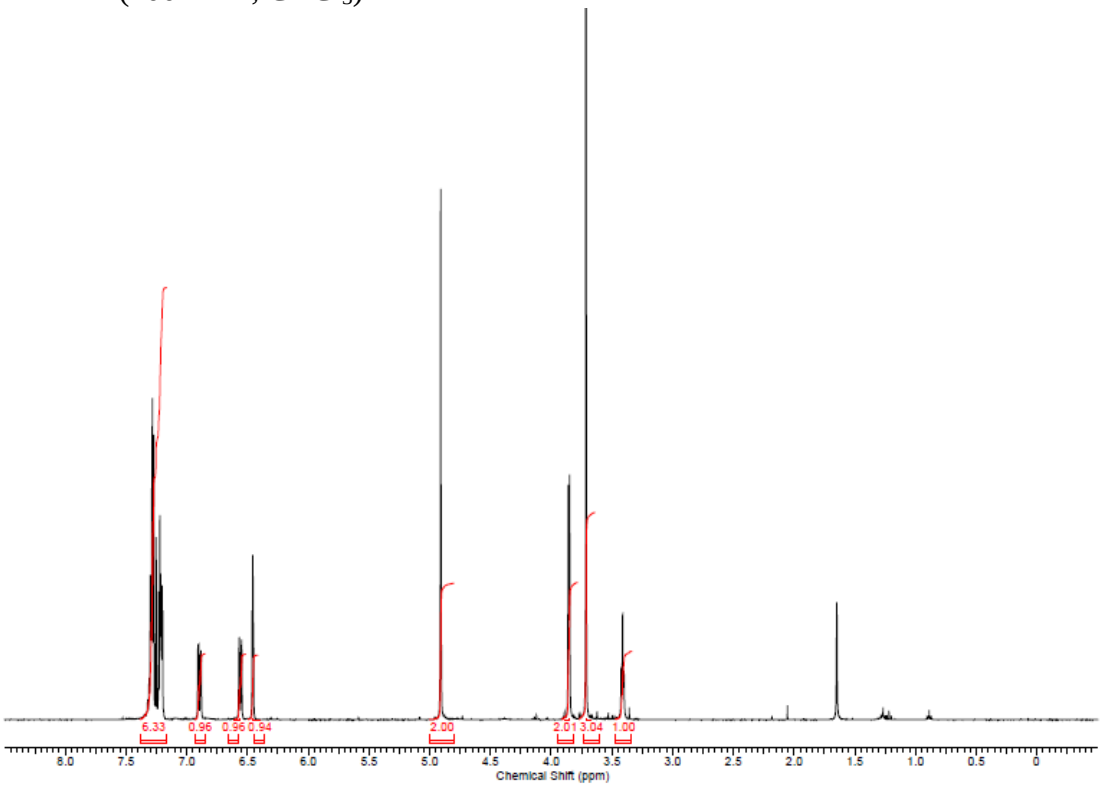
^{13}C NMR (100 MHz, $CDCl_3$)



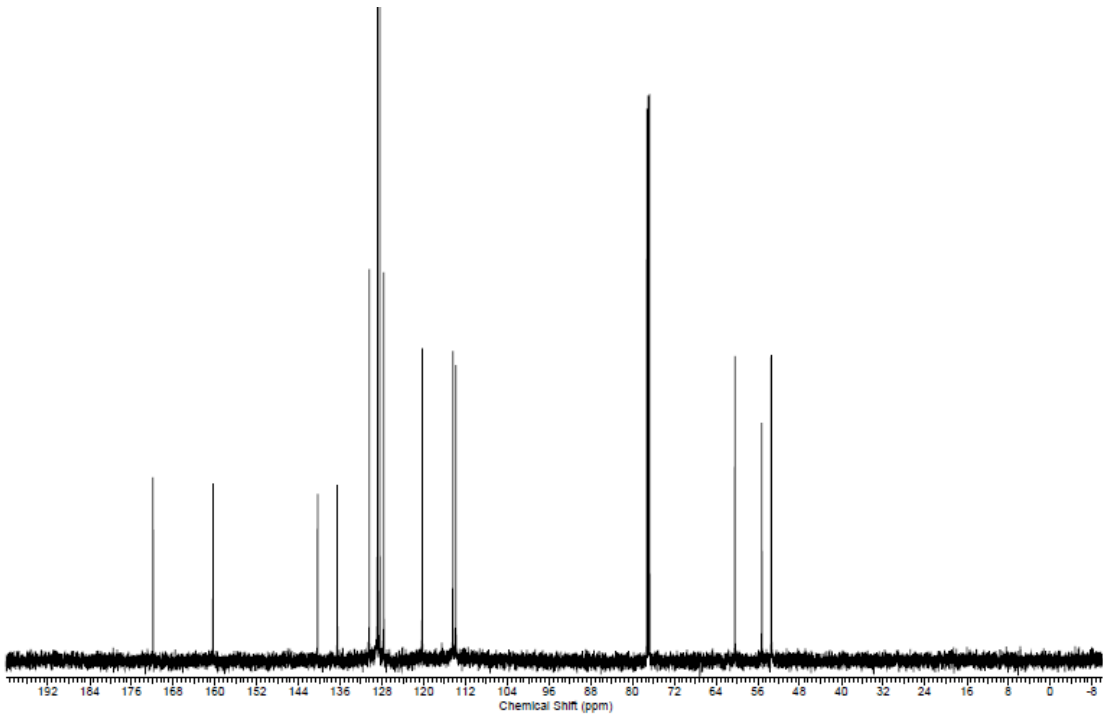


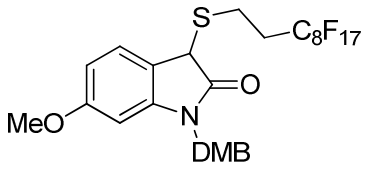
S10

^{1}H NMR (400 MHz, $CDCl_3$)



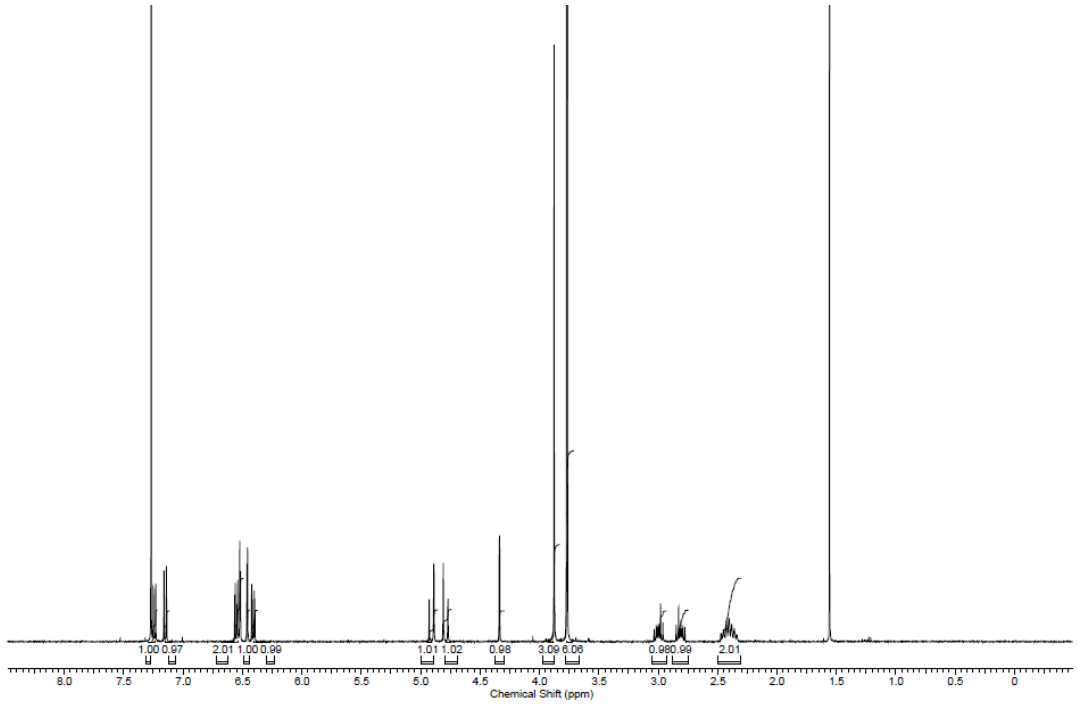
^{13}C NMR (100 MHz, $CDCl_3$)



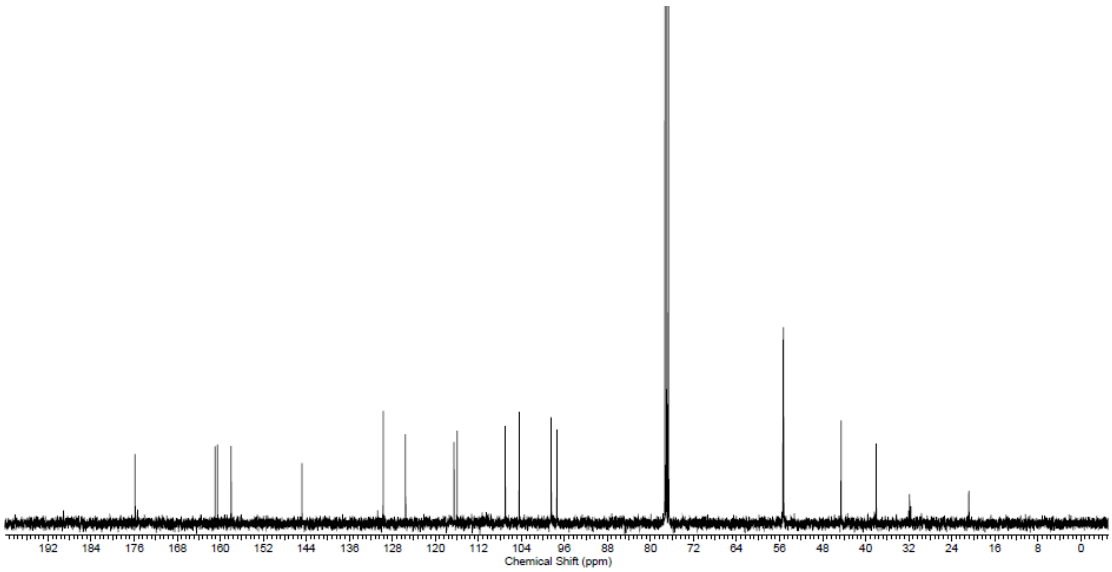


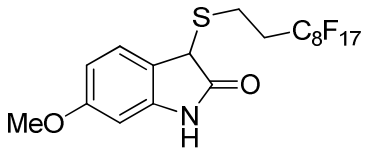
9

^{1}H NMR (400 MHz, $CDCl_3$)



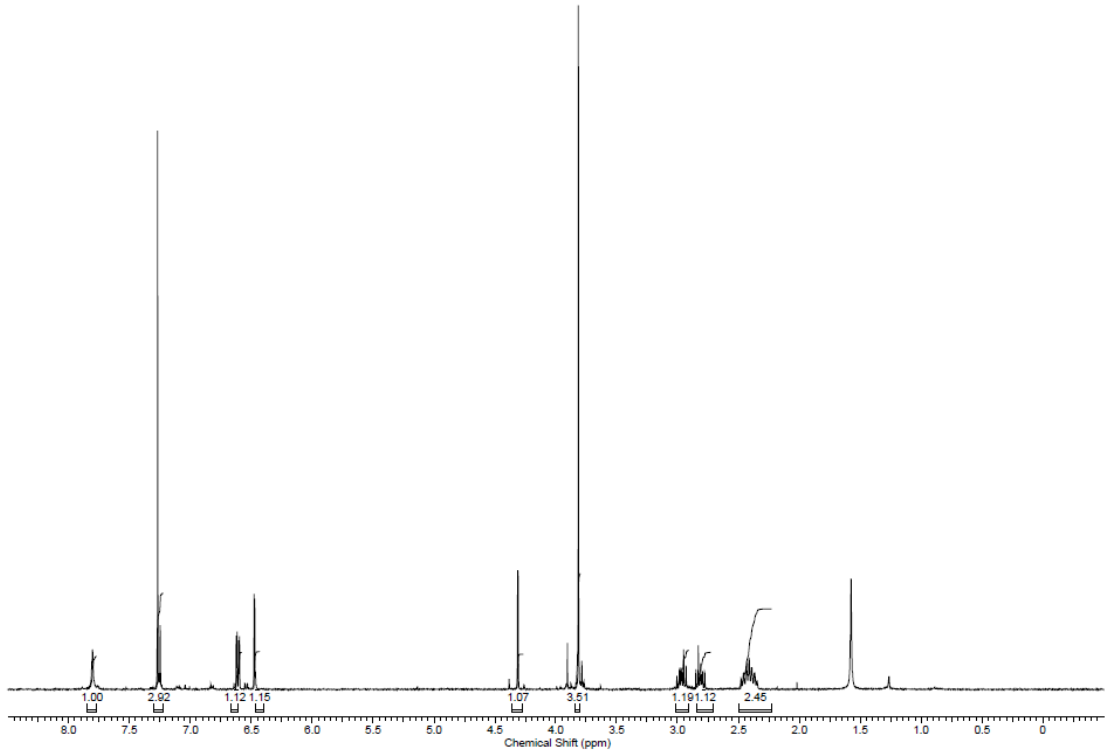
^{13}C NMR (100 MHz, $CDCl_3$)



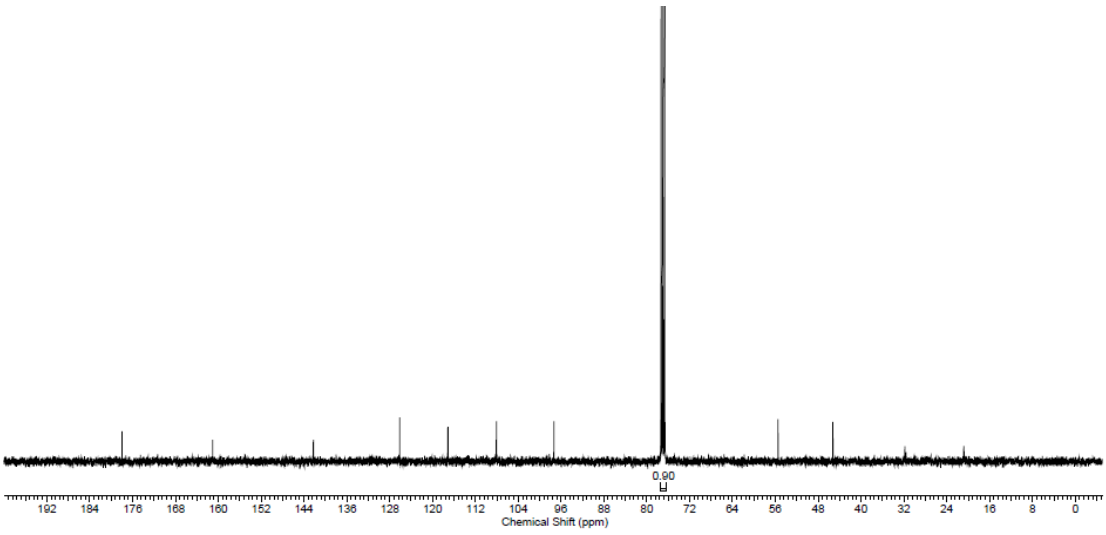


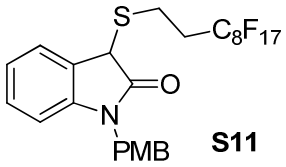
S15

^{1}H NMR (400 MHz, $CDCl_3$)



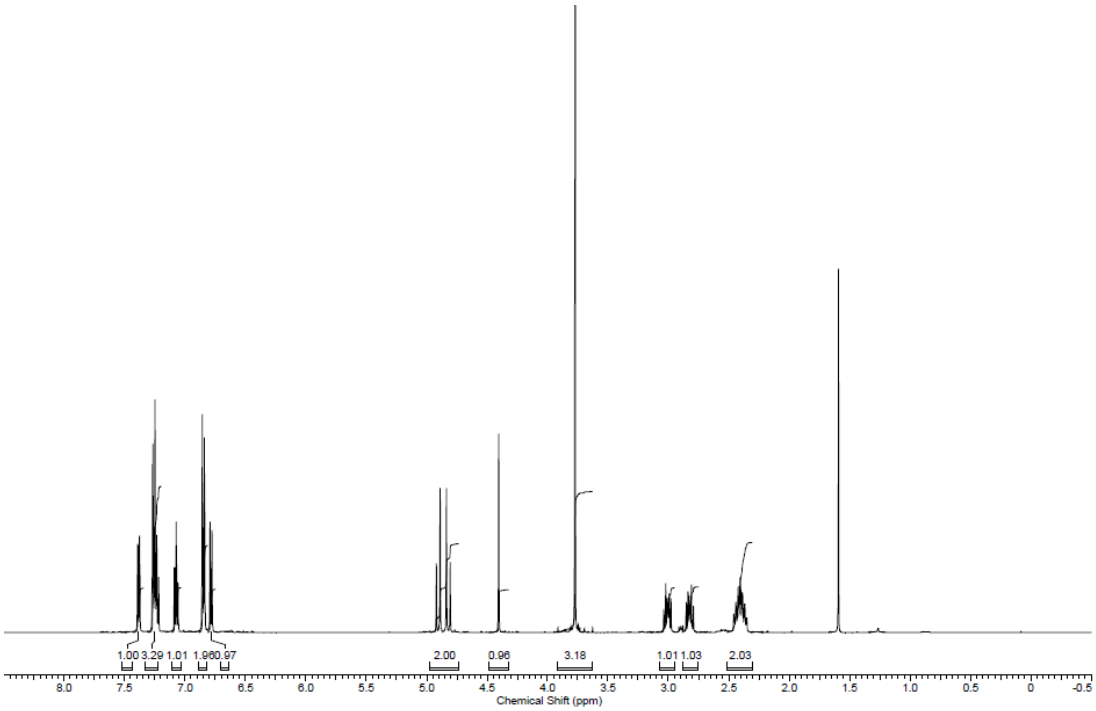
^{13}C NMR (100 MHz, $CDCl_3$)



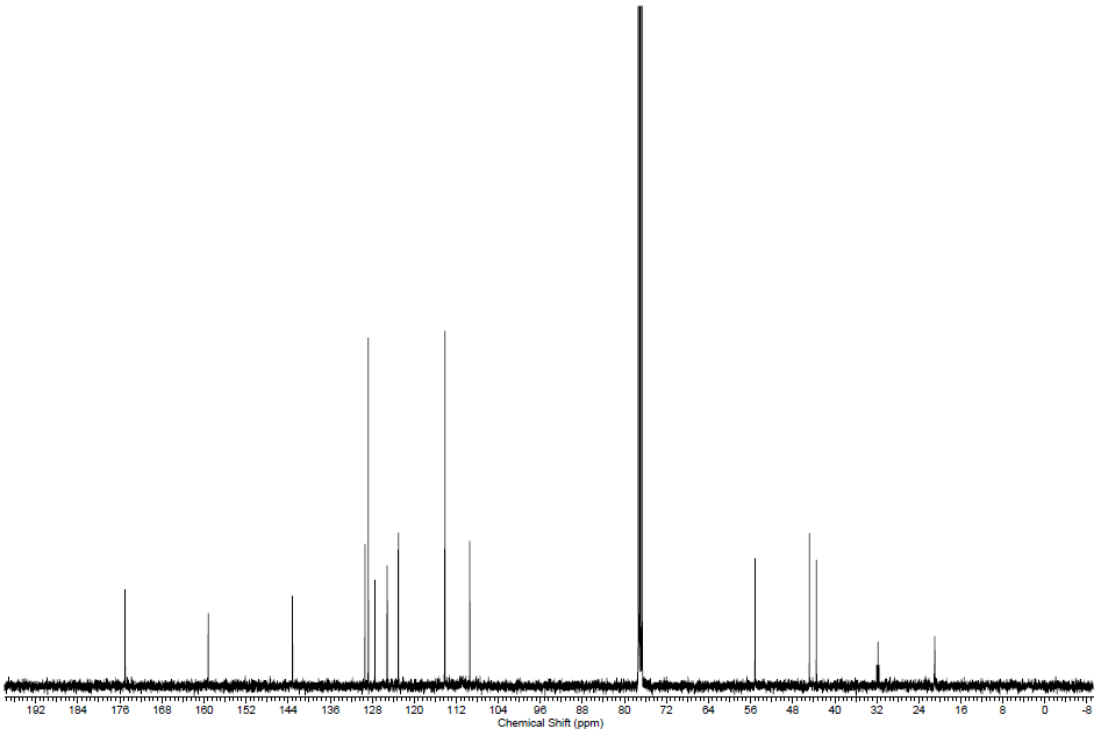


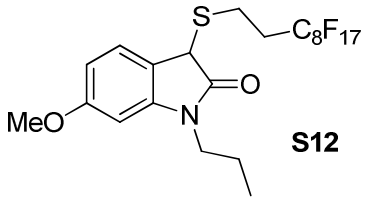
S11

^{1}H NMR (500 MHz, $CDCl_3$)



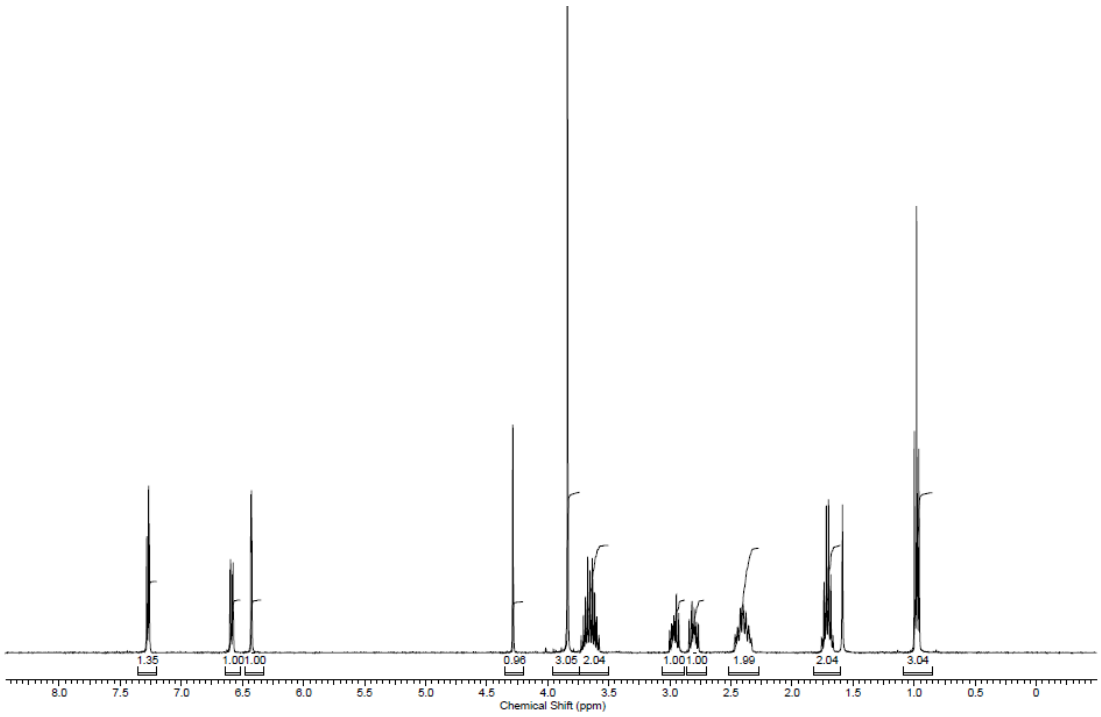
^{13}C NMR (100 MHz, $CDCl_3$)



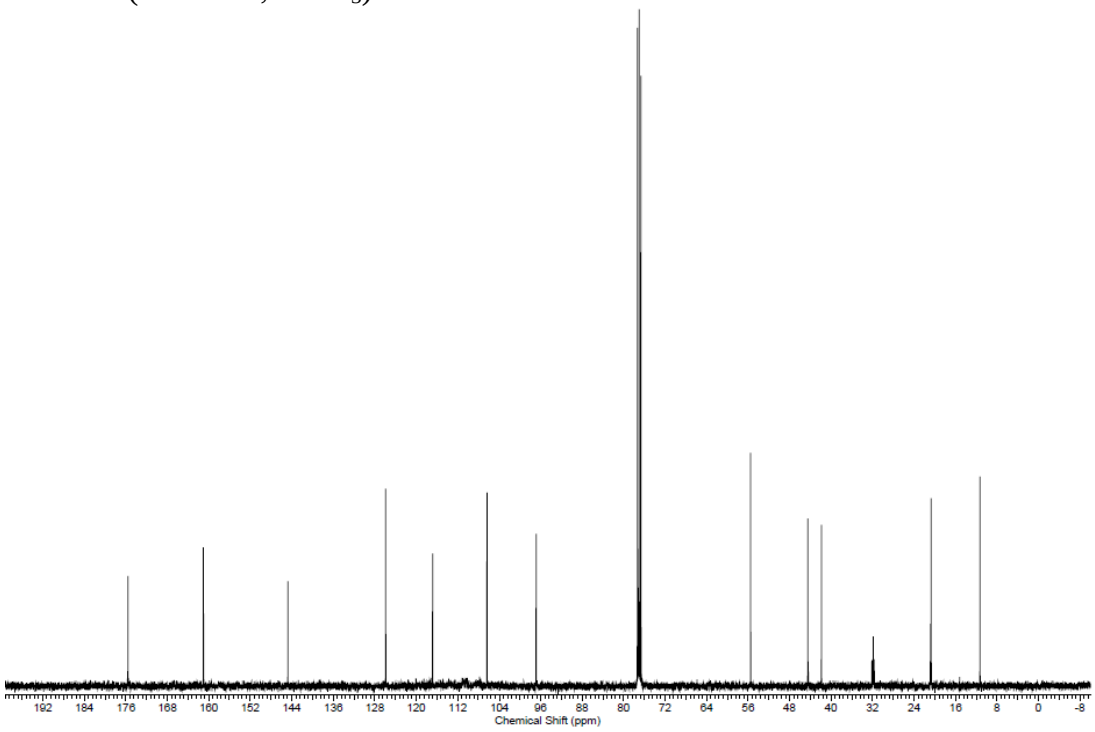


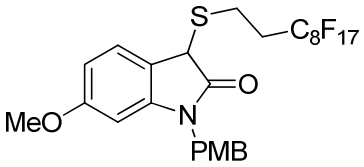
S12

^{1}H NMR (400 MHz, $CDCl_3$)



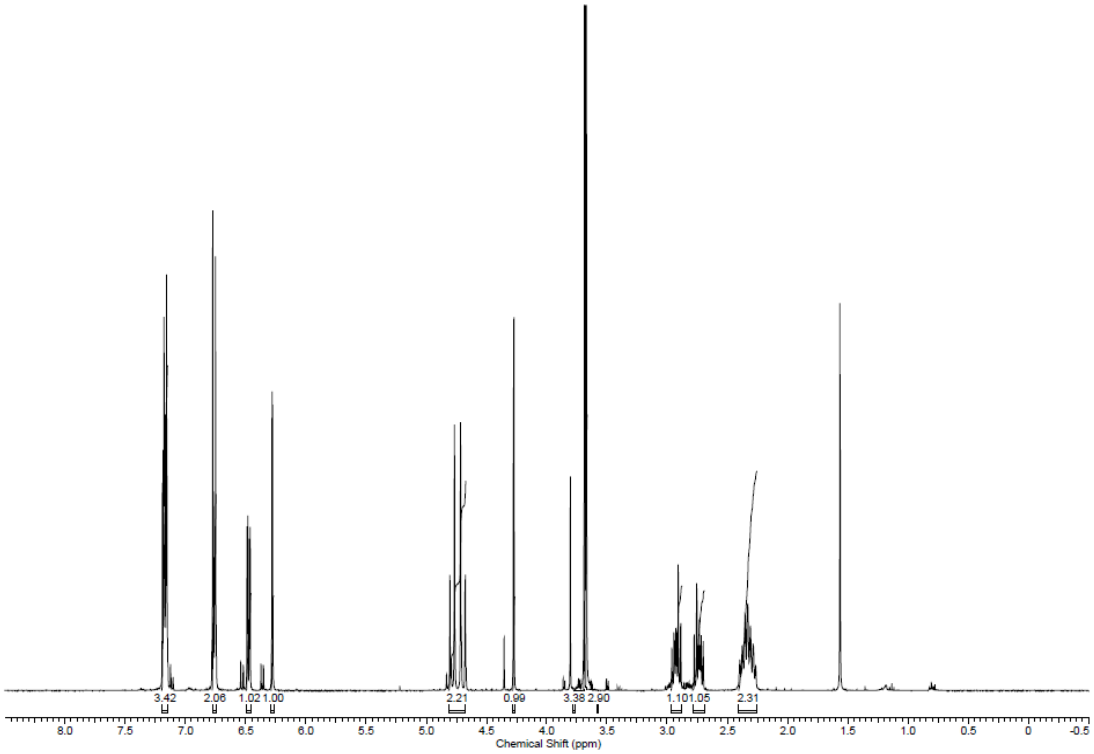
^{13}C NMR (100 MHz, $CDCl_3$)



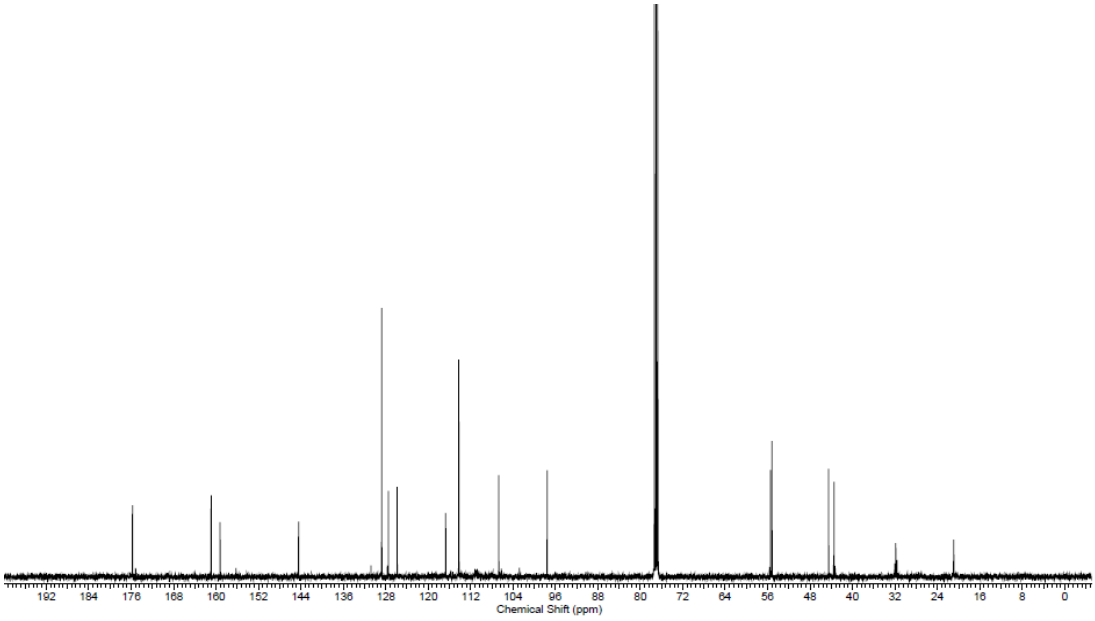


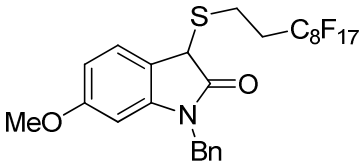
S13

^{1}H NMR (400 MHz, $CDCl_3$)



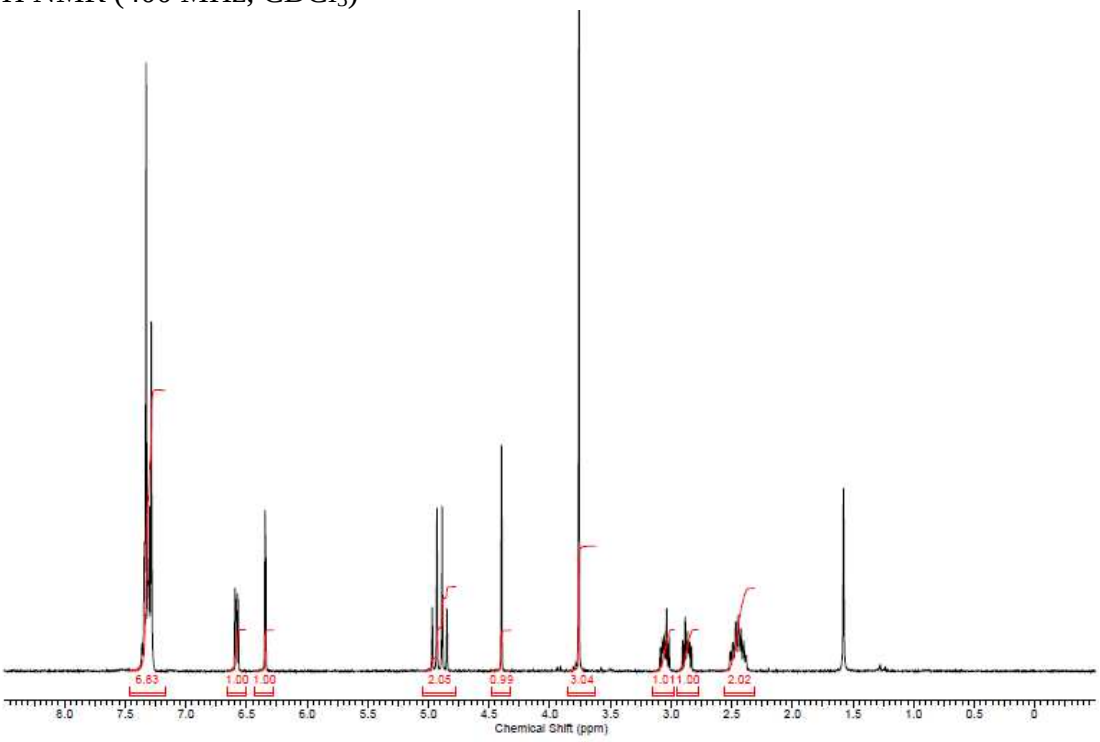
^{13}C NMR (100MHz, $CDCl_3$)



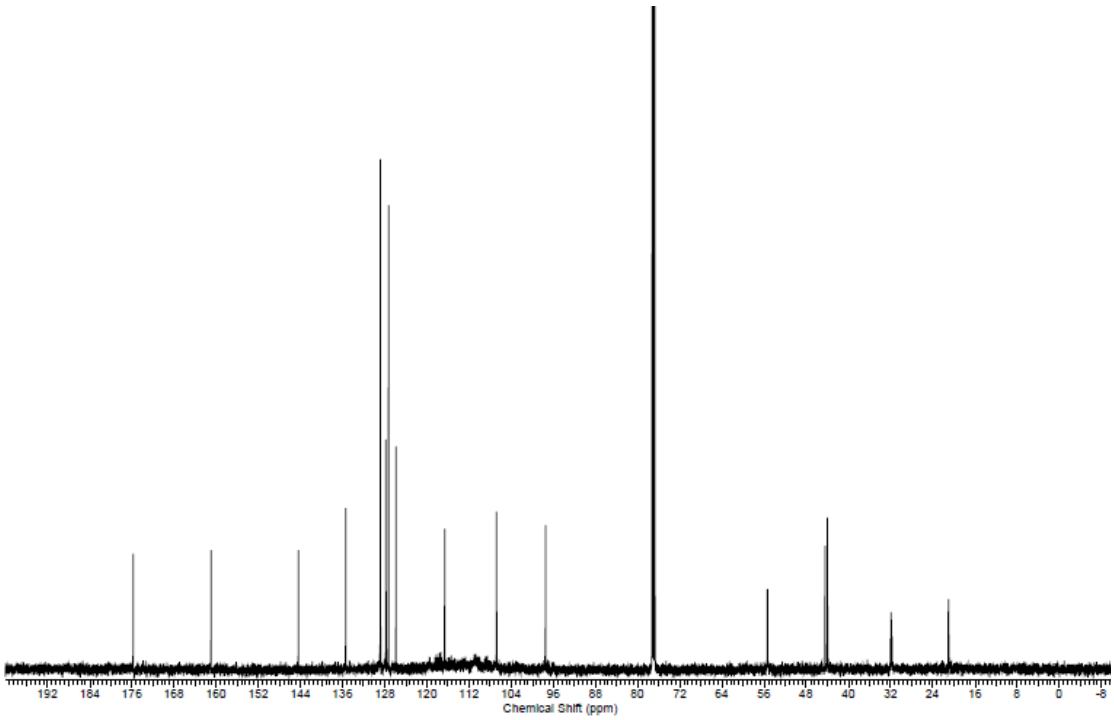


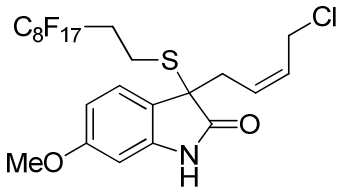
S14

^{1}H NMR (400 MHz, $CDCl_3$)



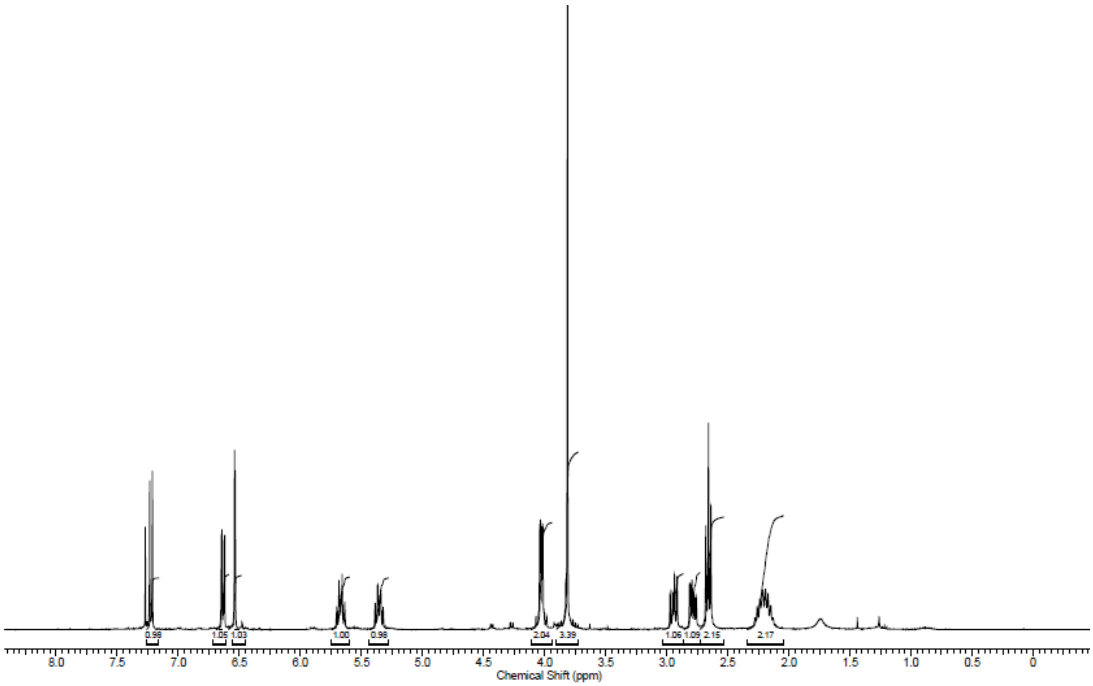
^{13}C NMR (100MHz, $CDCl_3$)



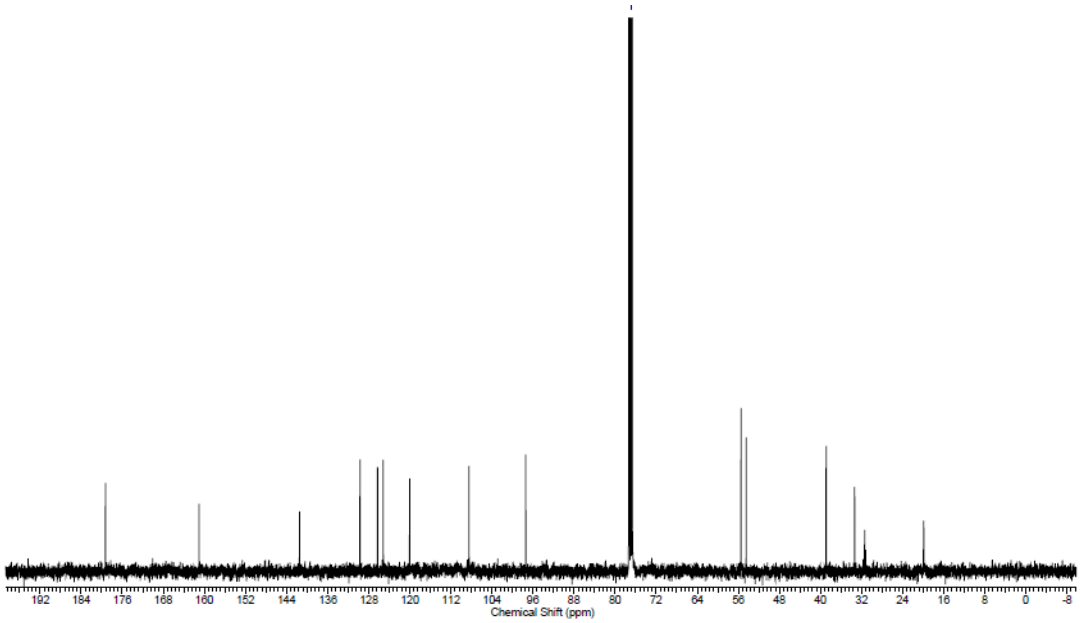


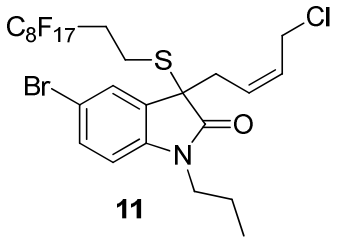
10

^{1}H NMR (400 MHz, $CDCl_3$)



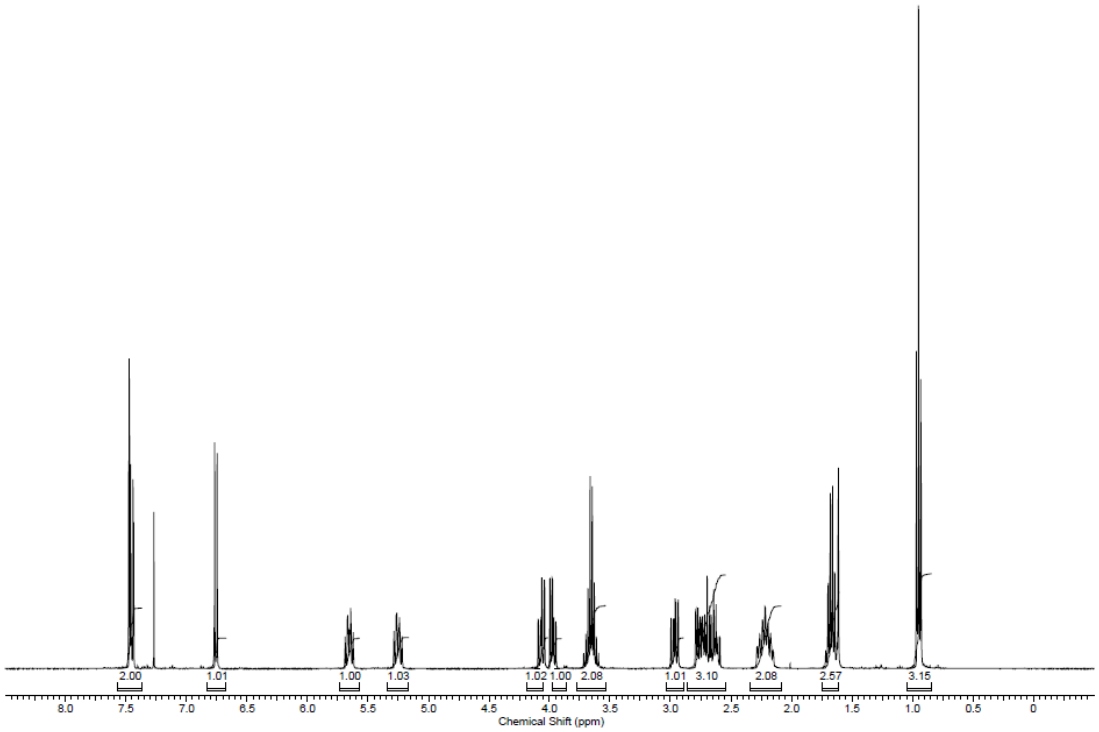
^{13}C NMR (100 MHz, $CDCl_3$)



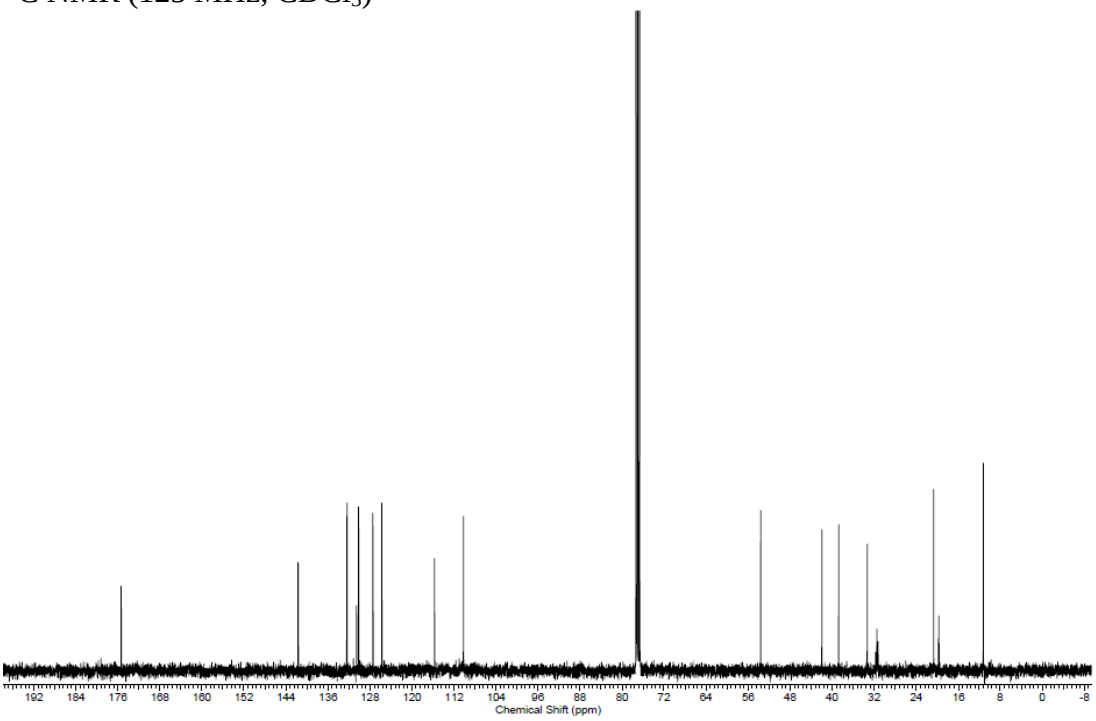


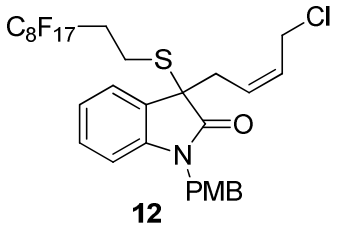
11

^{1}H NMR (400 MHz, $CDCl_3$)



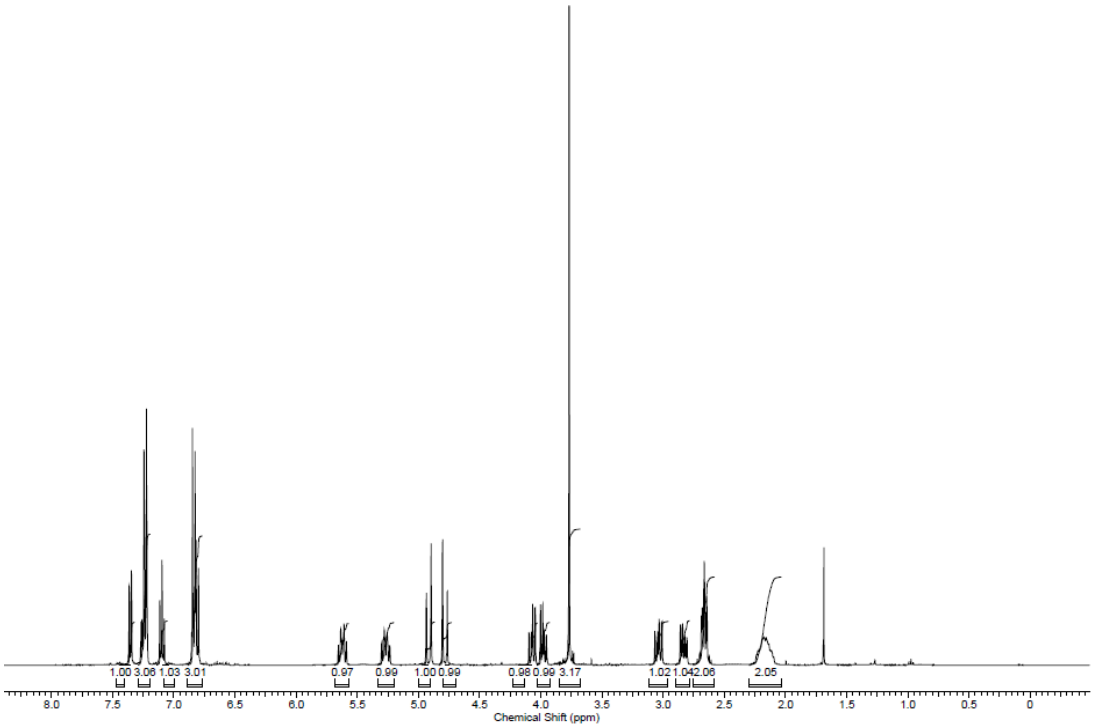
^{13}C NMR (125 MHz, $CDCl_3$)



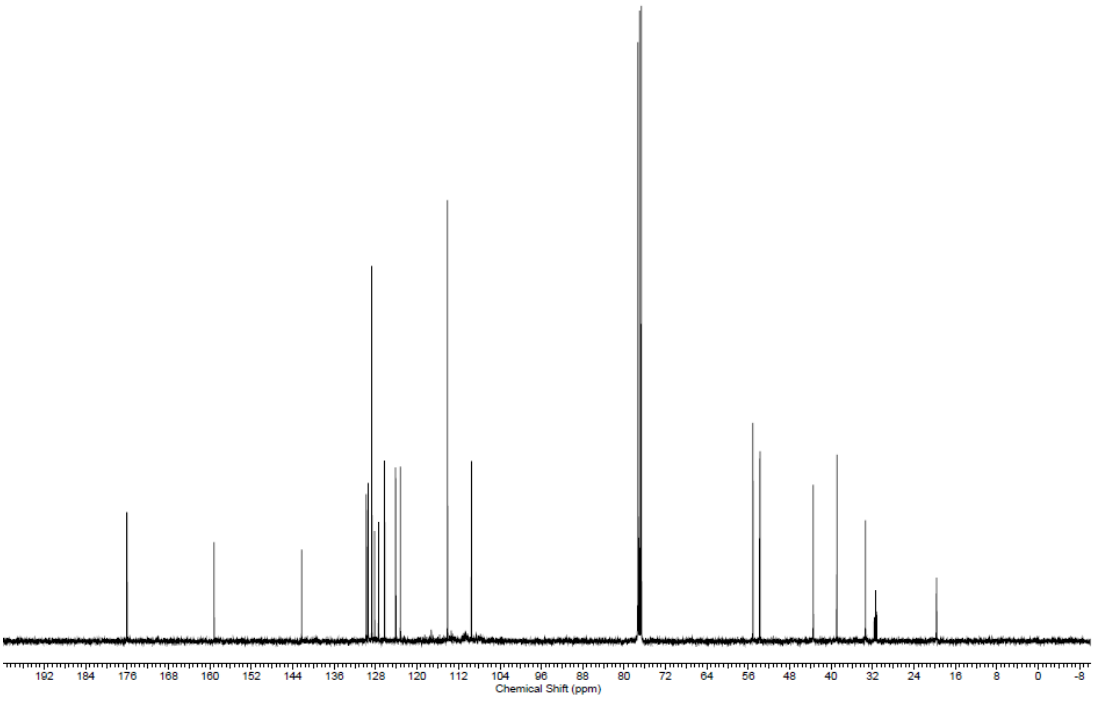


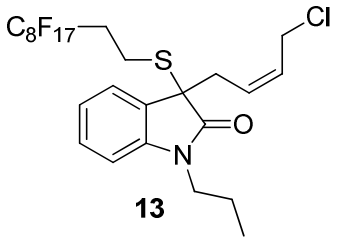
12

^{1}H NMR (400 MHz, $CDCl_3$)



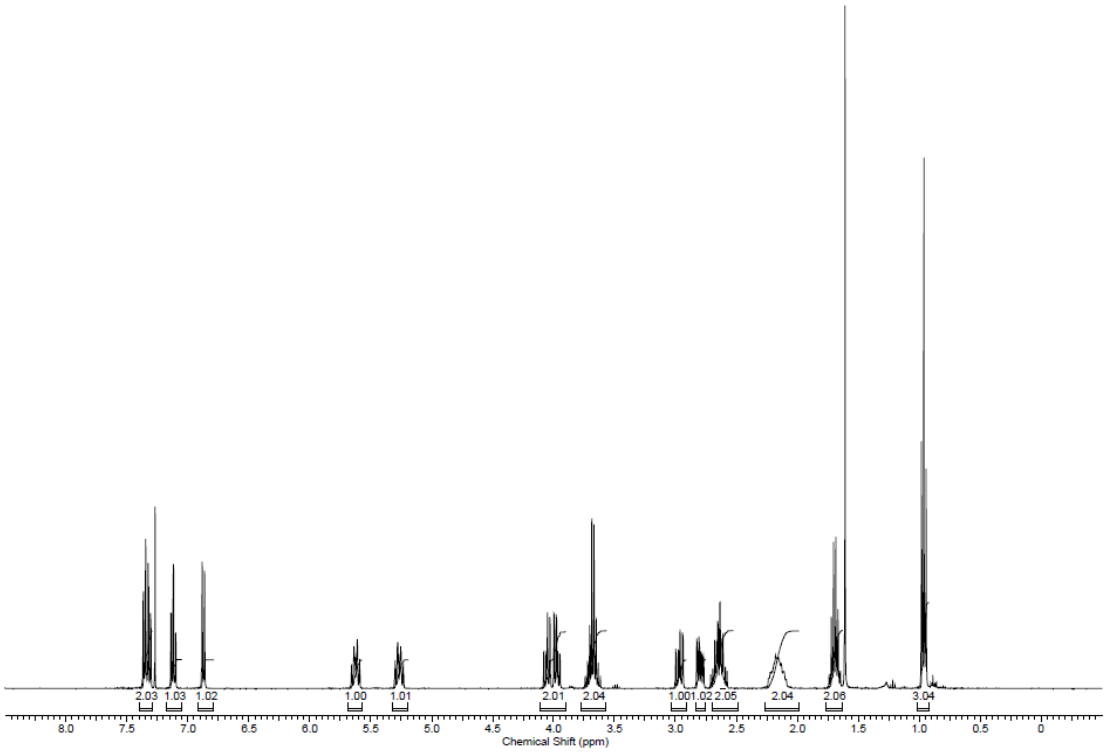
^{13}C NMR (100 MHz, $CDCl_3$)



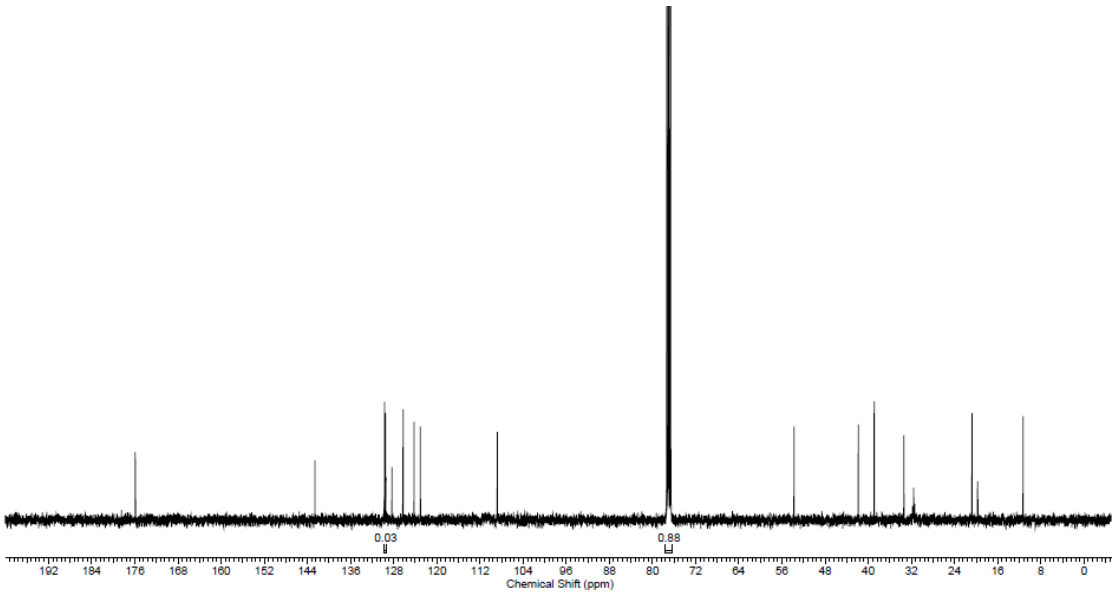


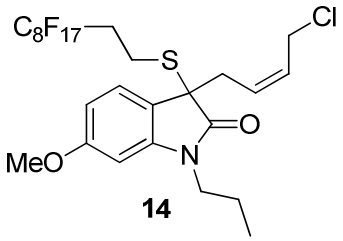
13

^{1}H NMR (400 MHz, $CDCl_3$)



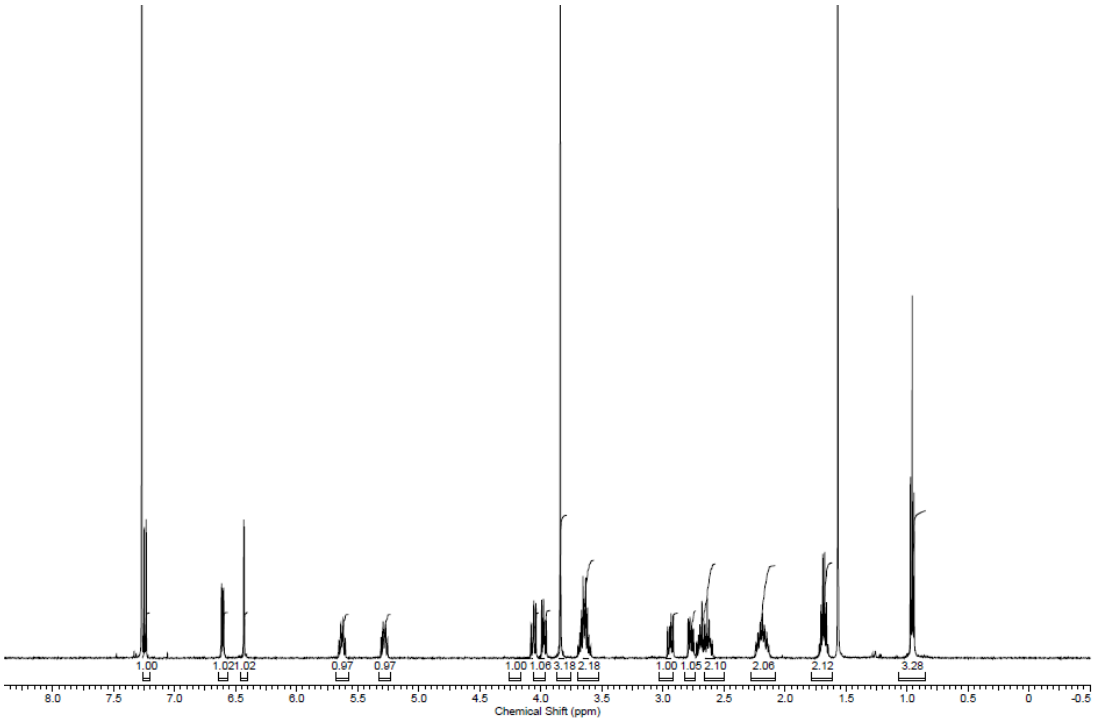
^{13}C NMR (100 MHz, $CDCl_3$)



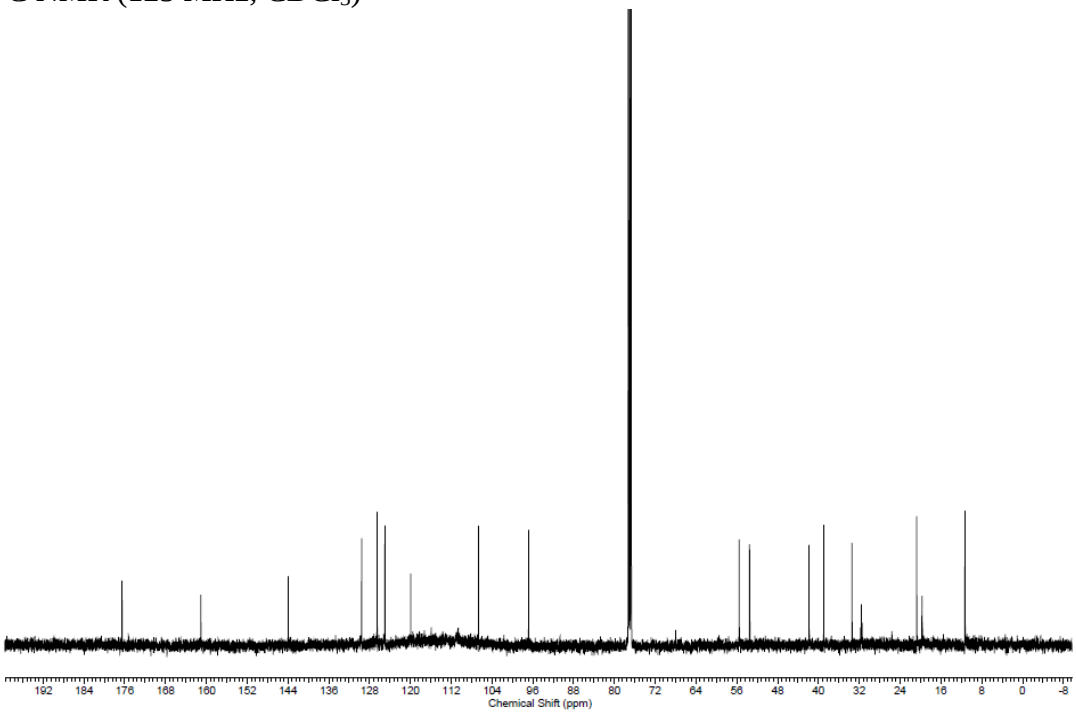


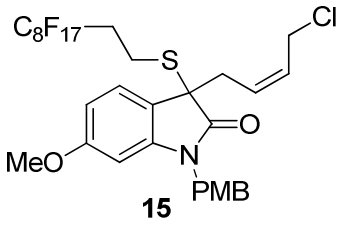
14

^{1}H NMR (500 MHz, $CDCl_3$)



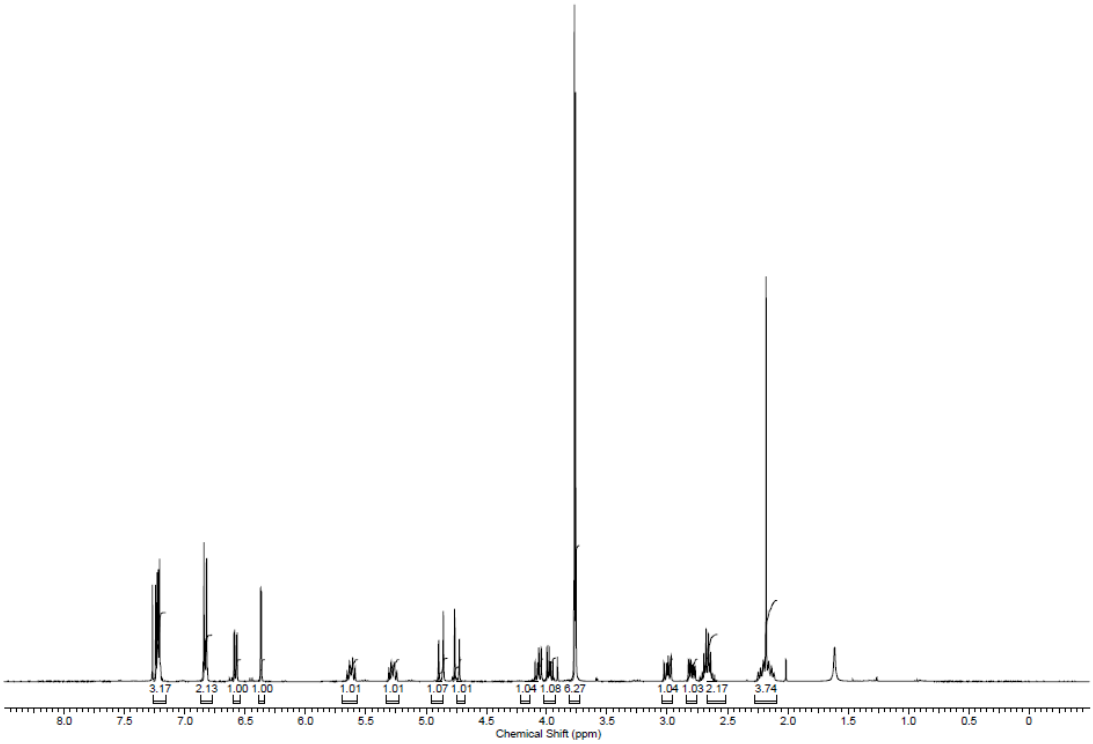
^{13}C NMR (125 MHz, $CDCl_3$)



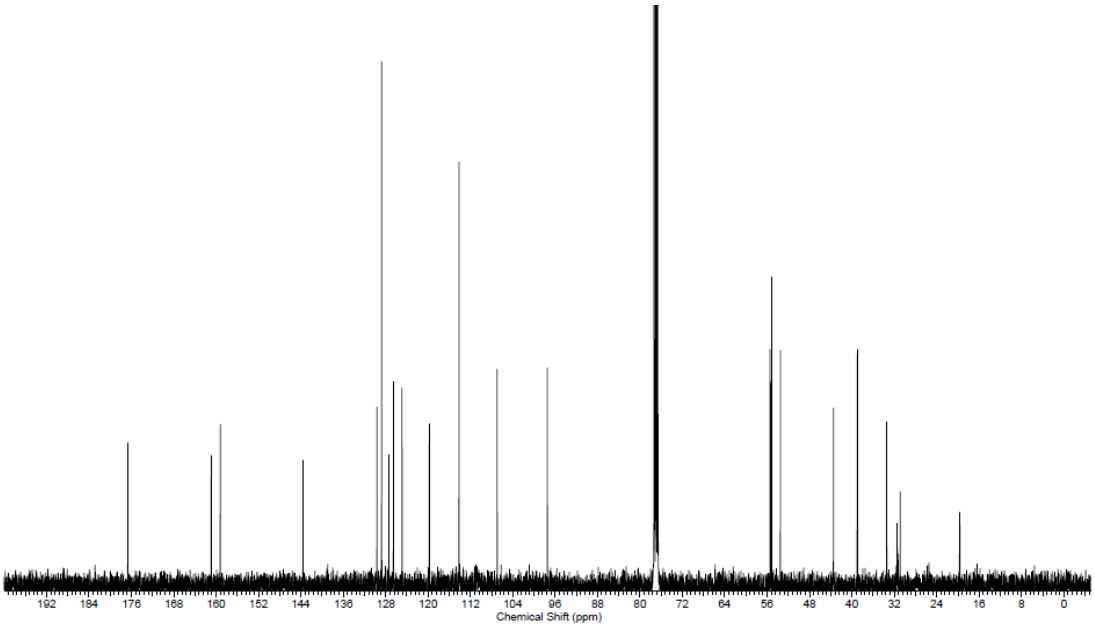


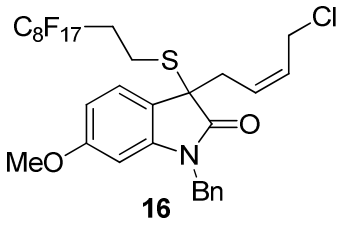
15

^{1}H NMR (400 MHz, $CDCl_3$)



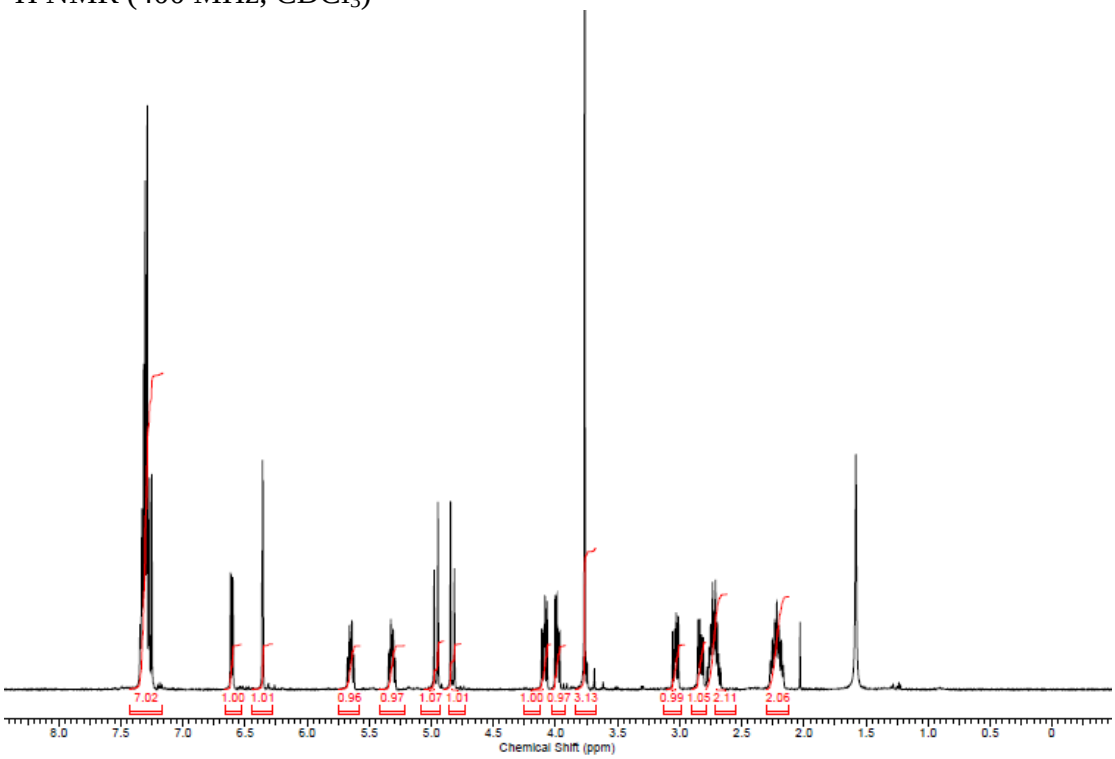
^{13}C NMR (100 MHz, $CDCl_3$)



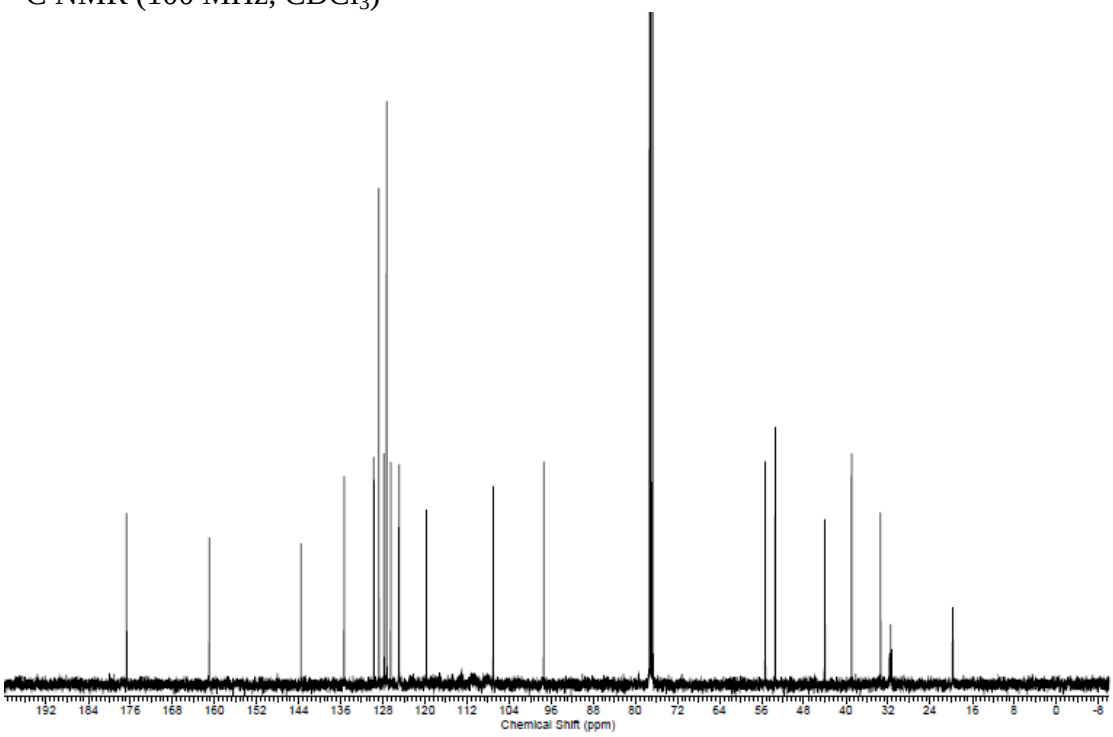


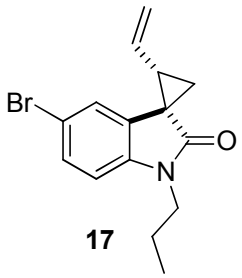
16

^{1}H NMR (400 MHz, $CDCl_3$)



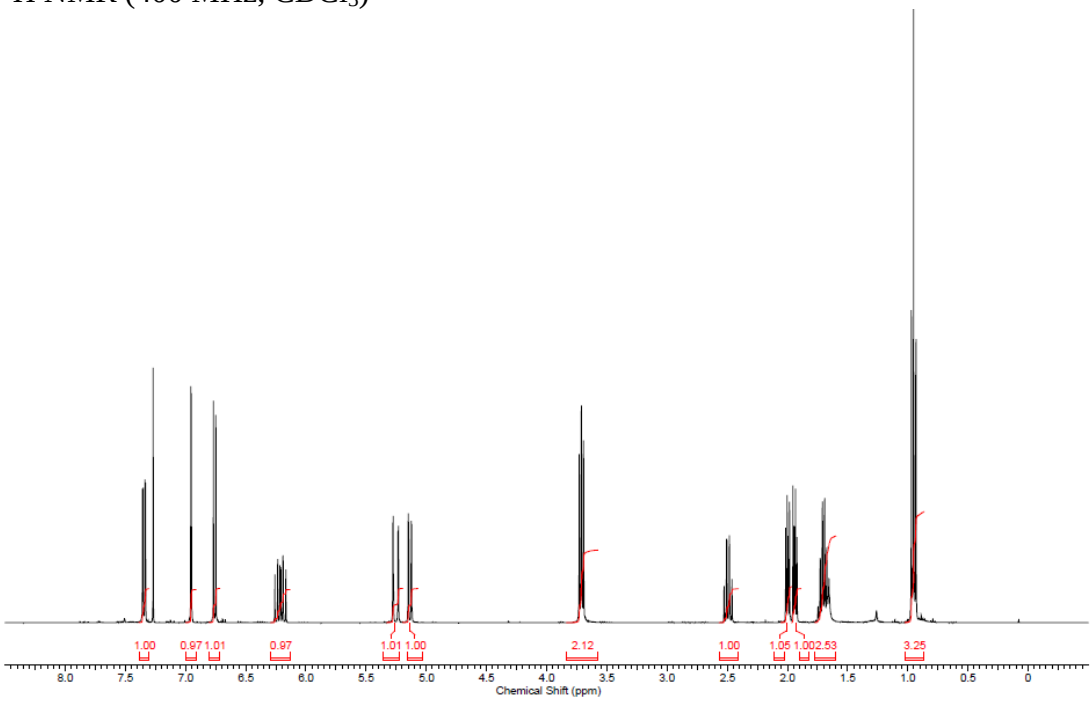
^{13}C NMR (100 MHz, $CDCl_3$)



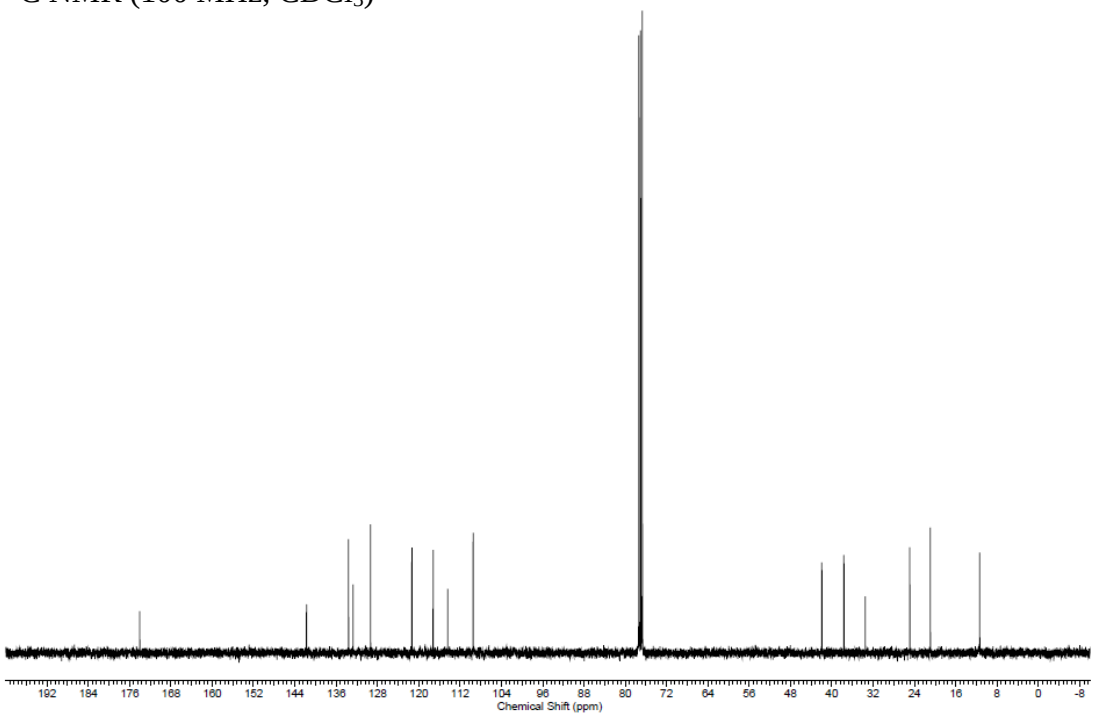


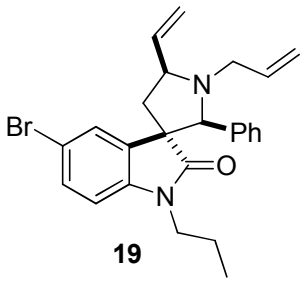
17

^{1}H NMR (400 MHz, $CDCl_3$)



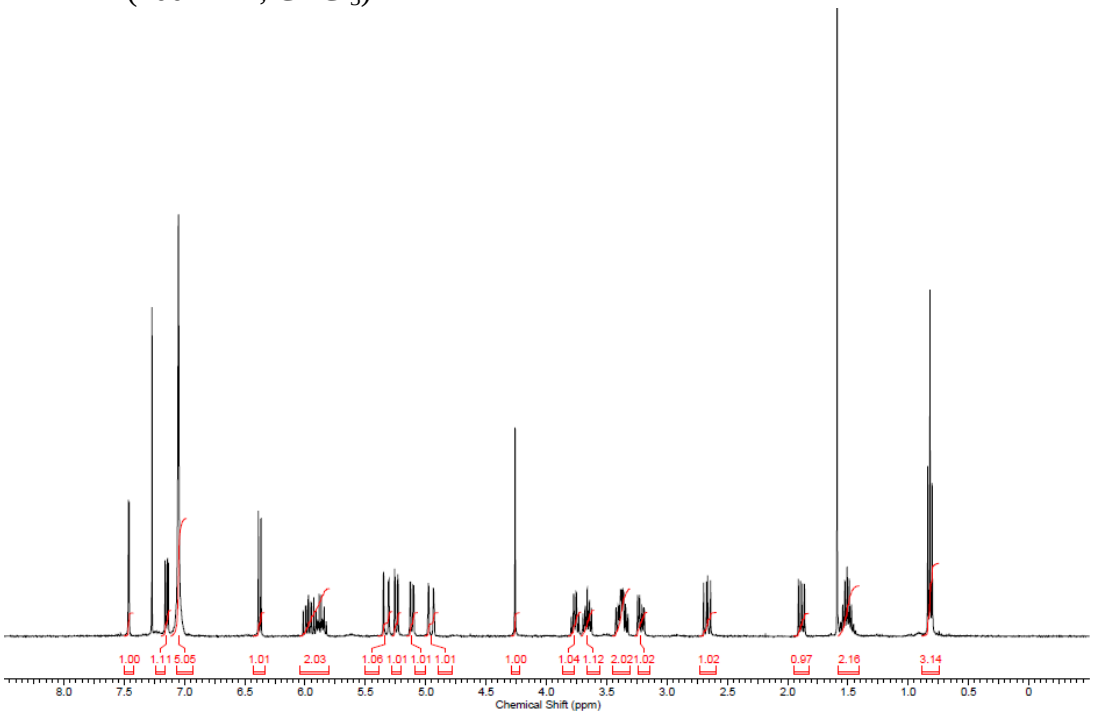
^{13}C NMR (100 MHz, $CDCl_3$)



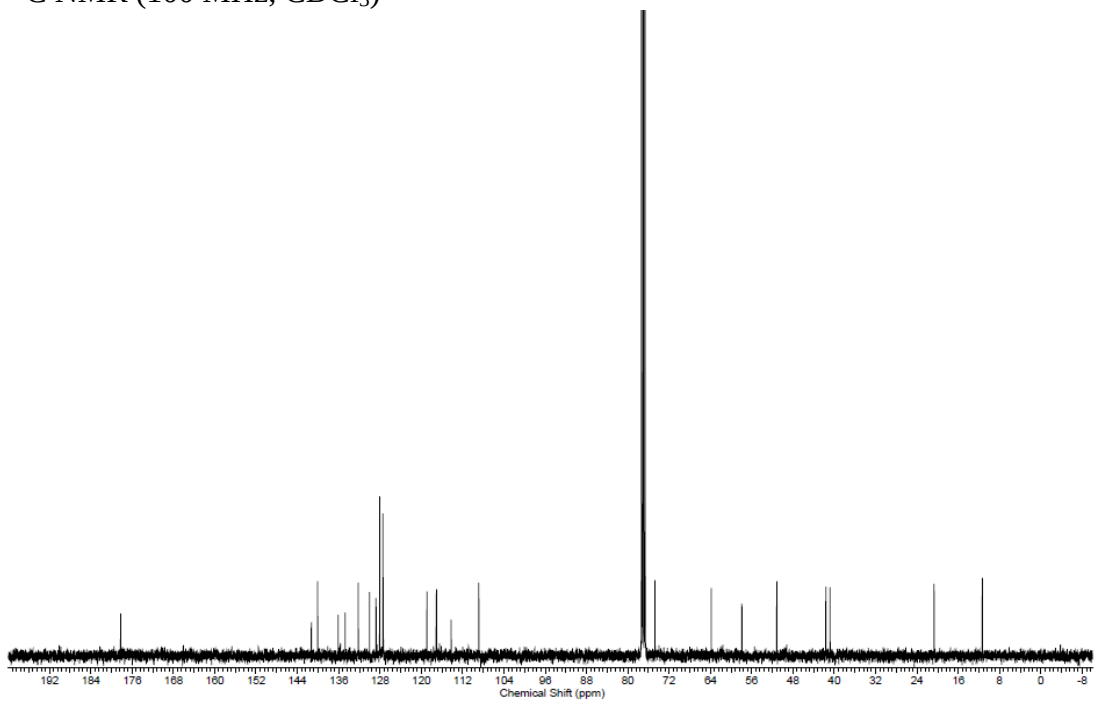


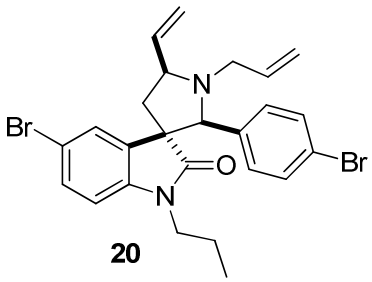
19

^{1}H NMR (400 MHz, $CDCl_3$)



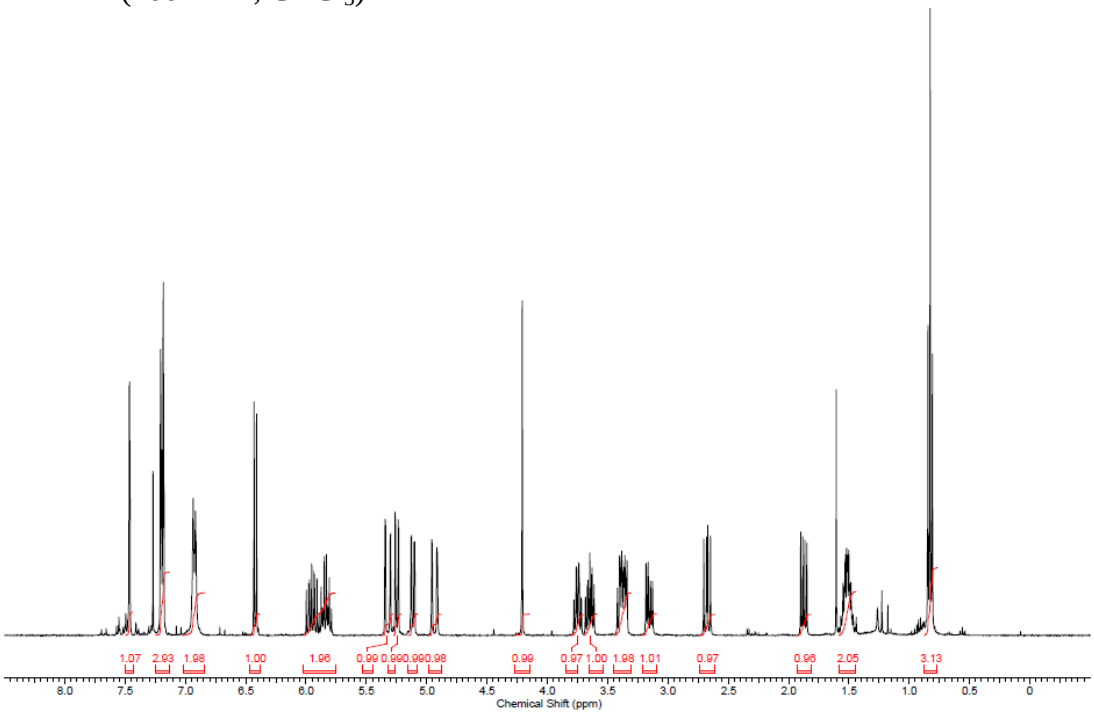
^{13}C NMR (100 MHz, $CDCl_3$)



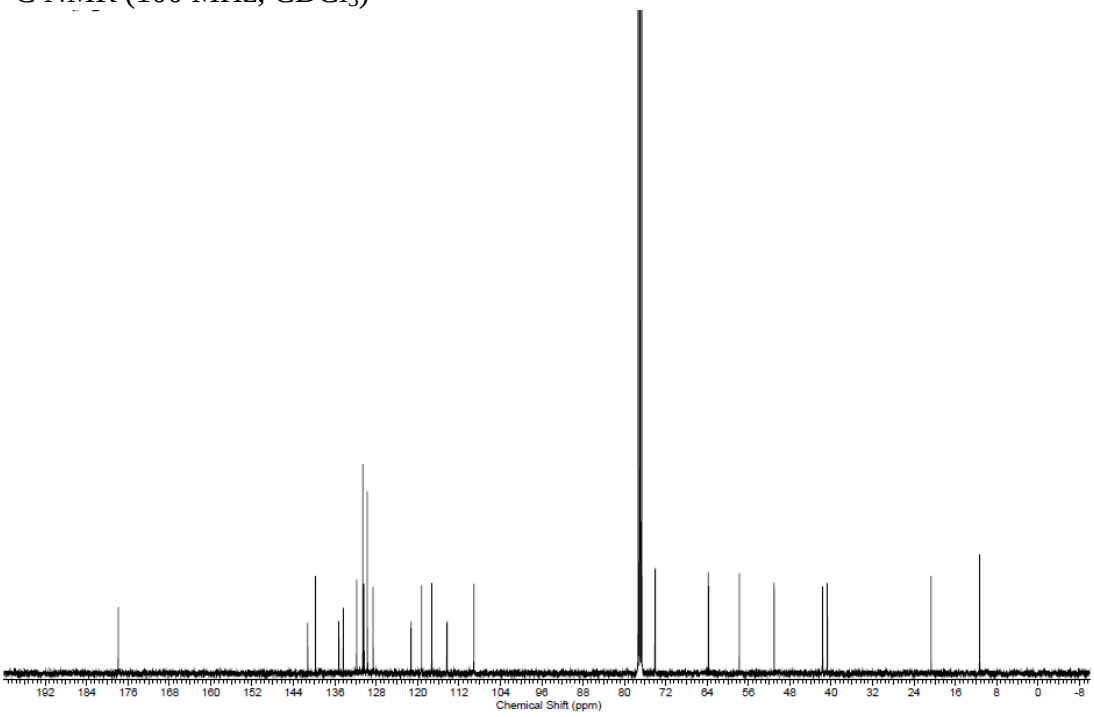


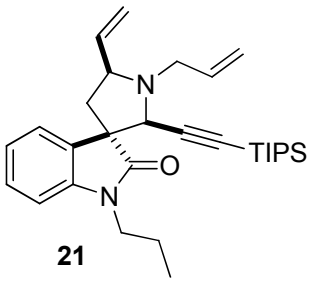
20

^{1}H NMR (400 MHz, $CDCl_3$)



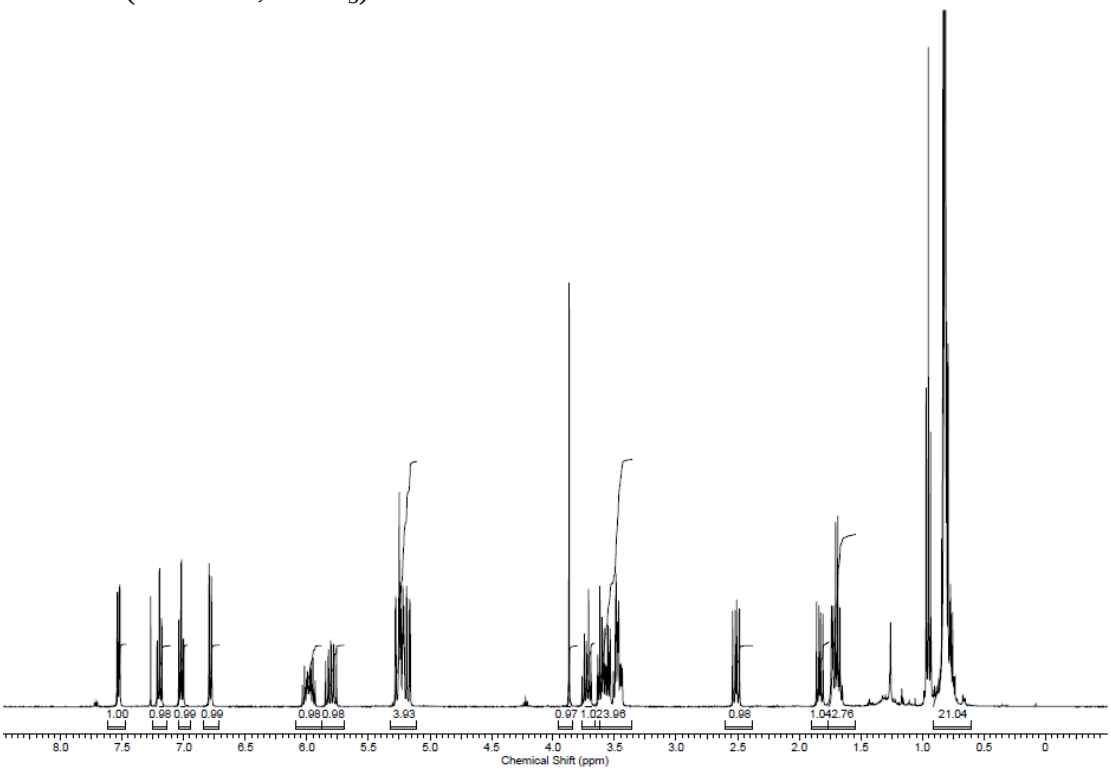
^{13}C NMR (100 MHz, $CDCl_3$)



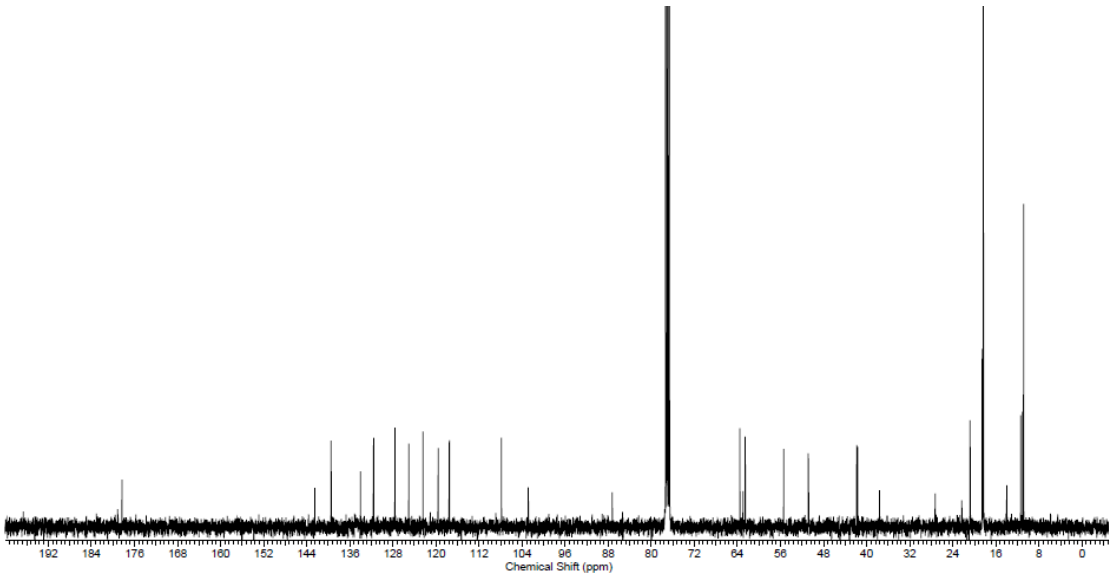


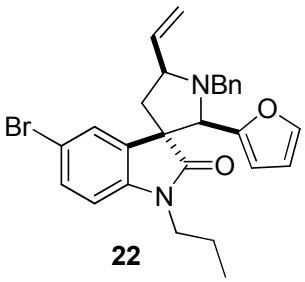
21

^{1}H NMR (400 MHz, $CDCl_3$)



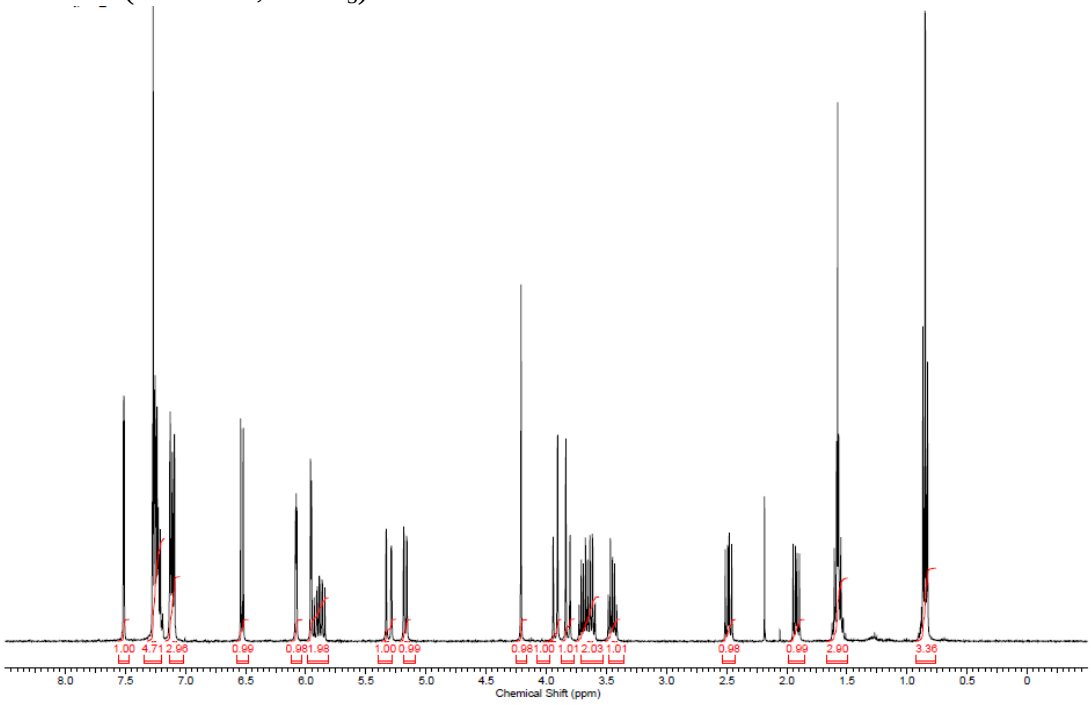
^{13}C NMR (100 MHz, $CDCl_3$)



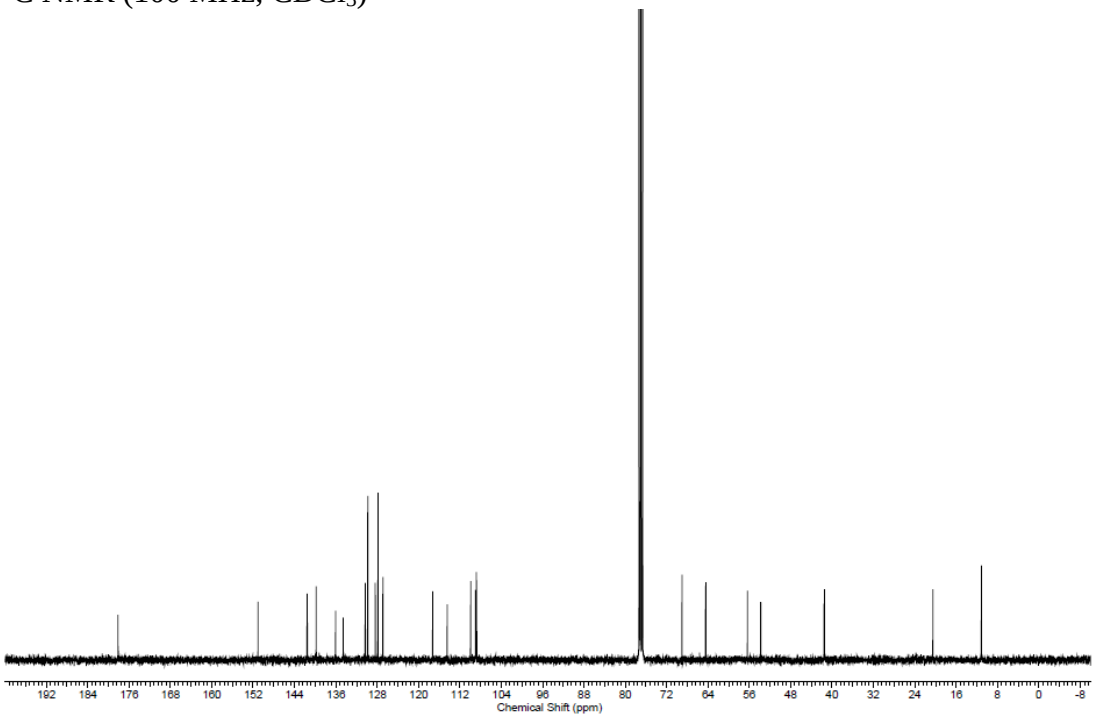


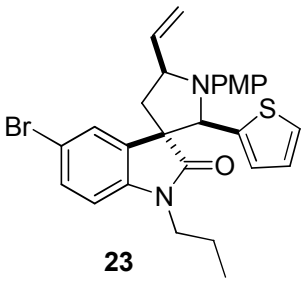
22

^{1}H NMR (400 MHz, $CDCl_3$)



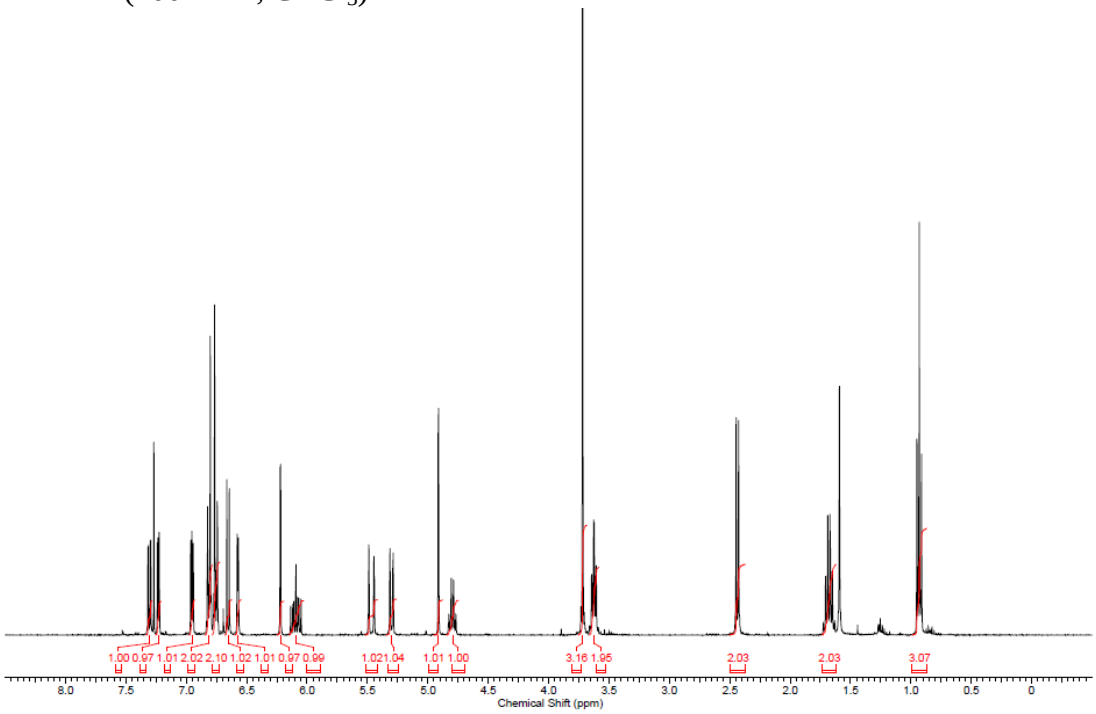
^{13}C NMR (100 MHz, $CDCl_3$)



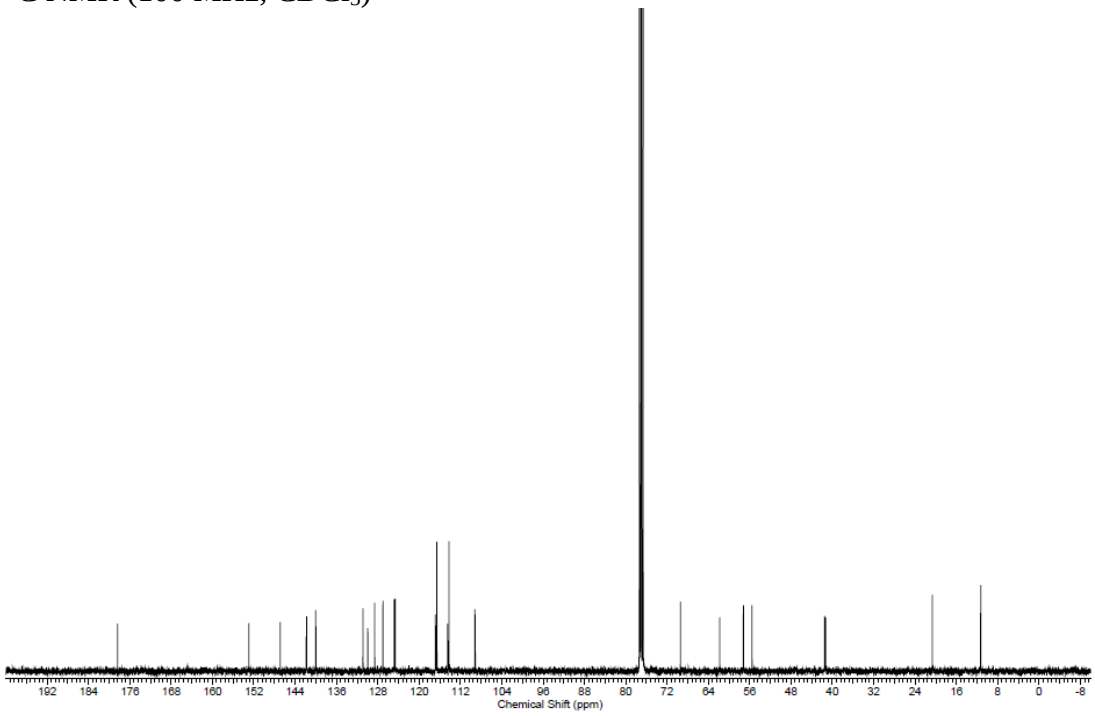


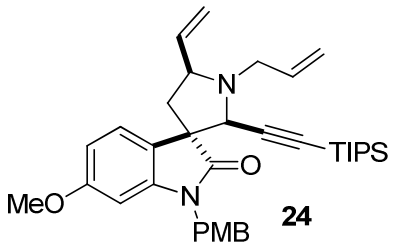
23

^{1}H NMR (400 MHz, $CDCl_3$)



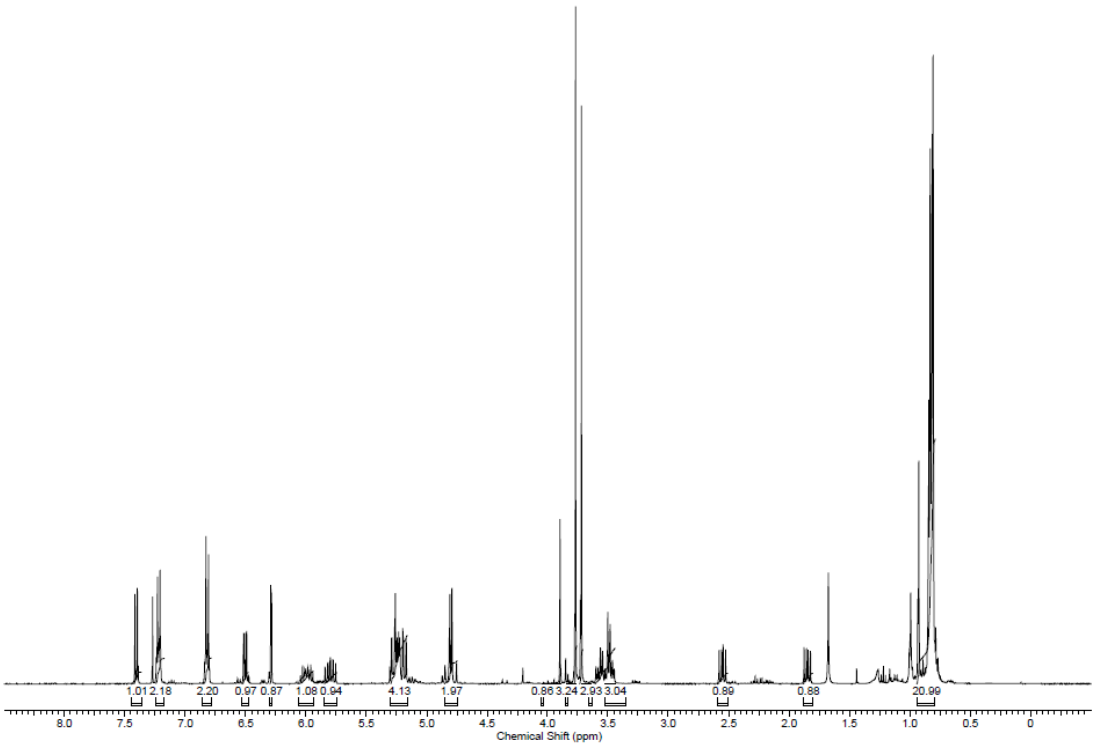
^{13}C NMR (100 MHz, $CDCl_3$)



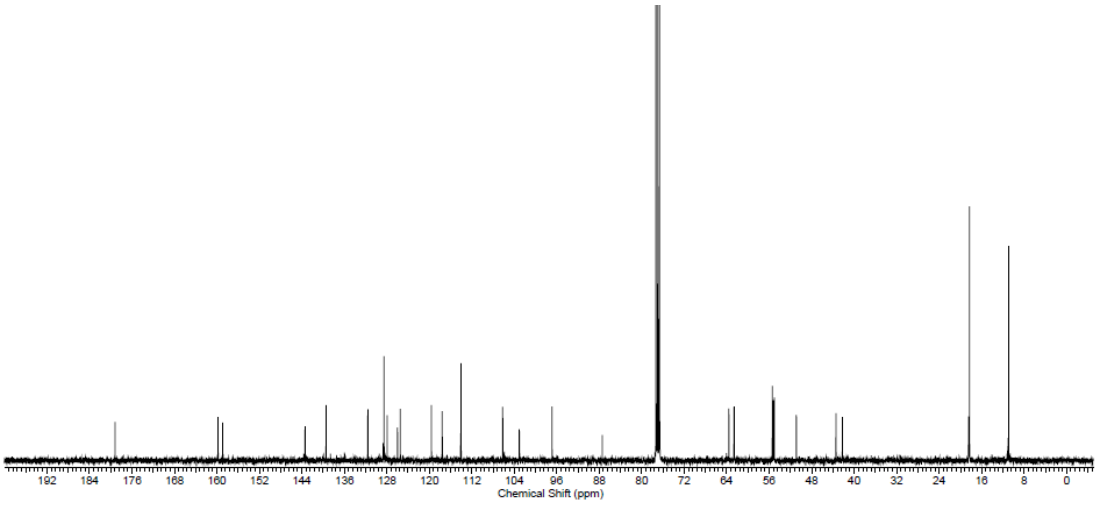


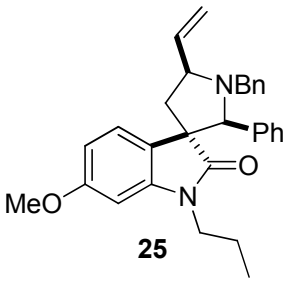
24

^{1}H NMR (400 MHz, $CDCl_3$)



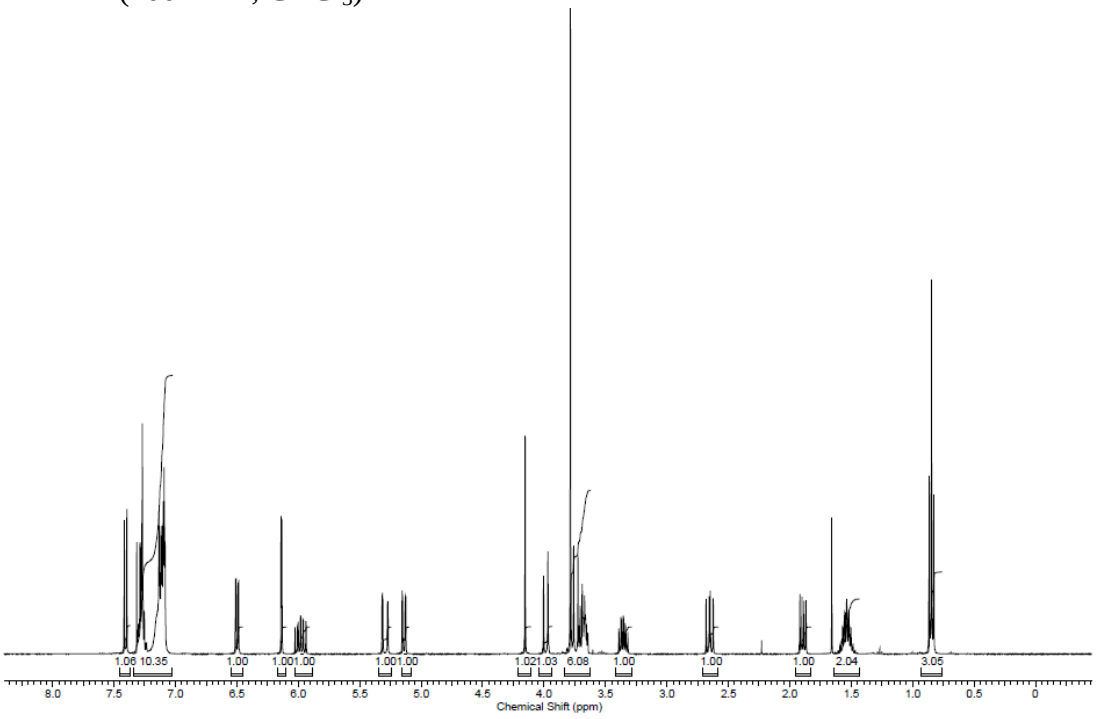
^{13}C NMR (100 MHz, $CDCl_3$)



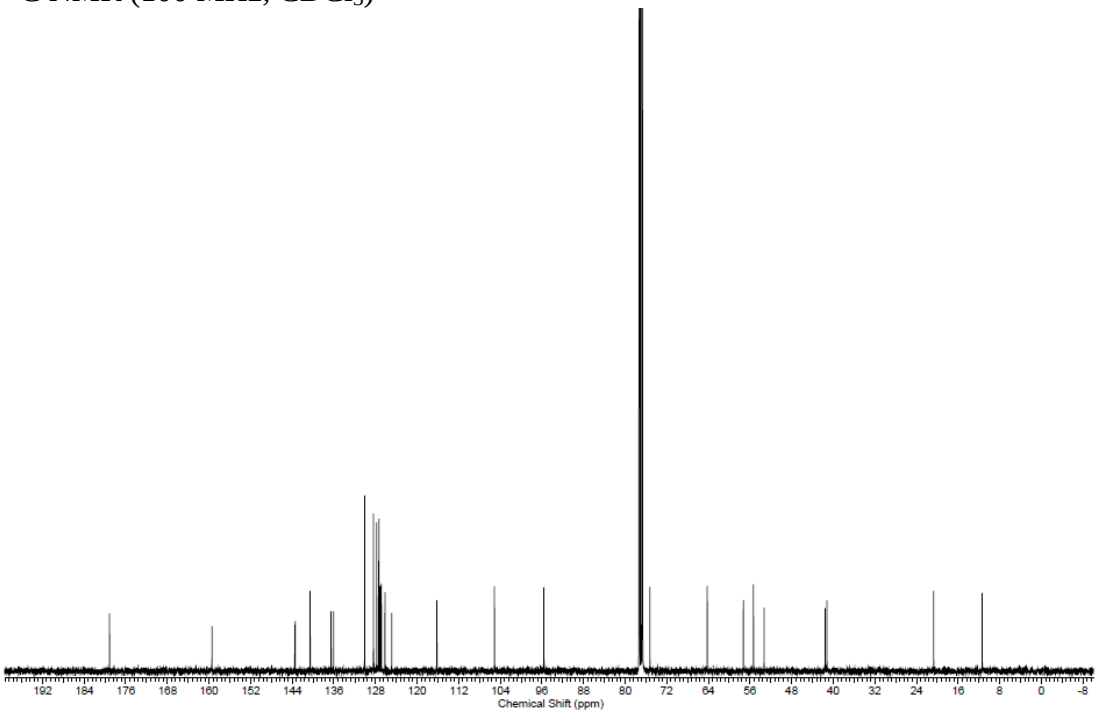


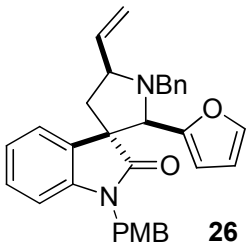
25

^{1}H NMR (400 MHz, $CDCl_3$)



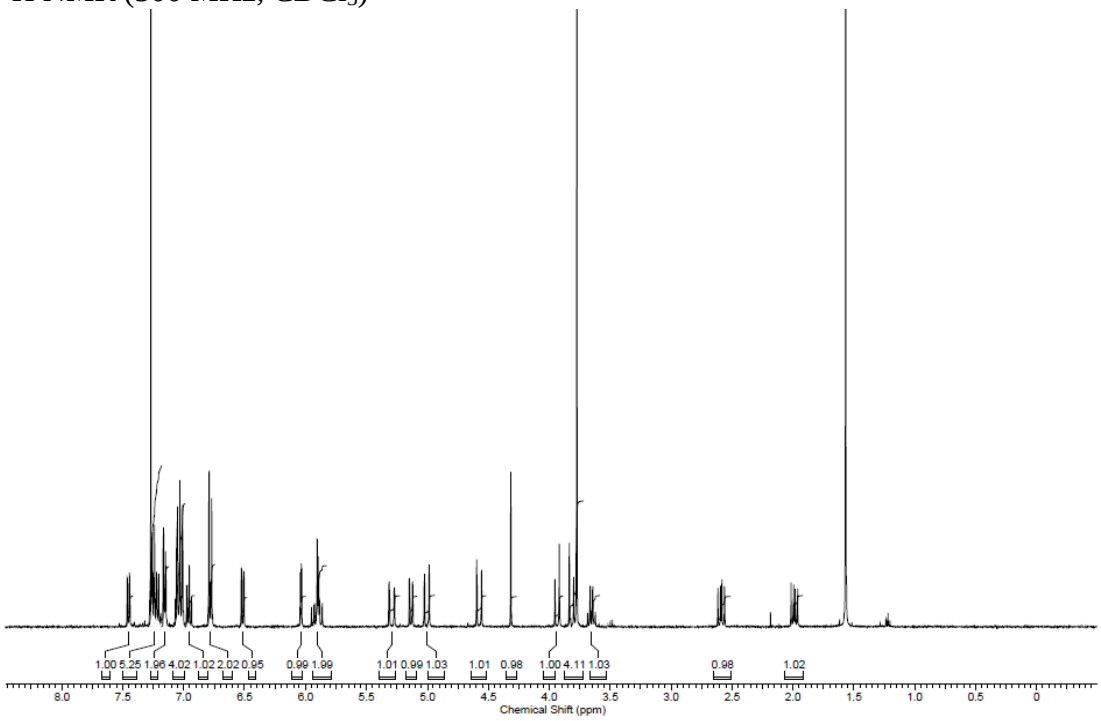
^{13}C NMR (100 MHz, $CDCl_3$)



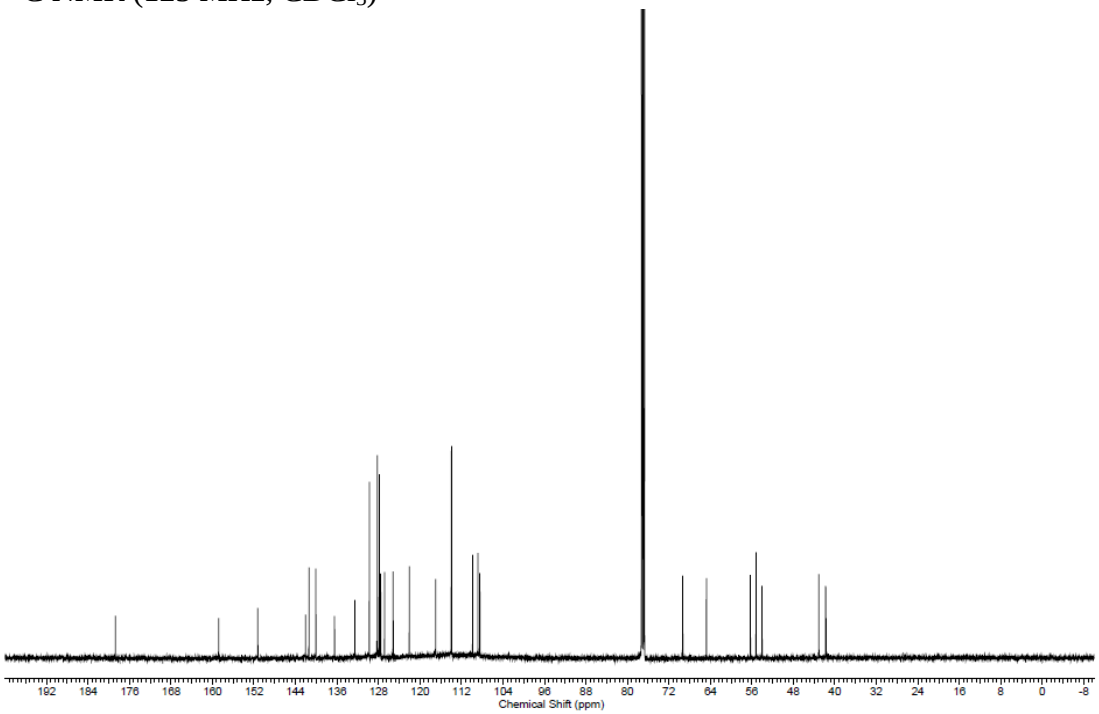


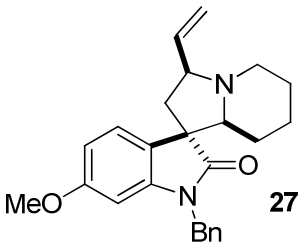
26

^{1}H NMR (500 MHz, $CDCl_3$)



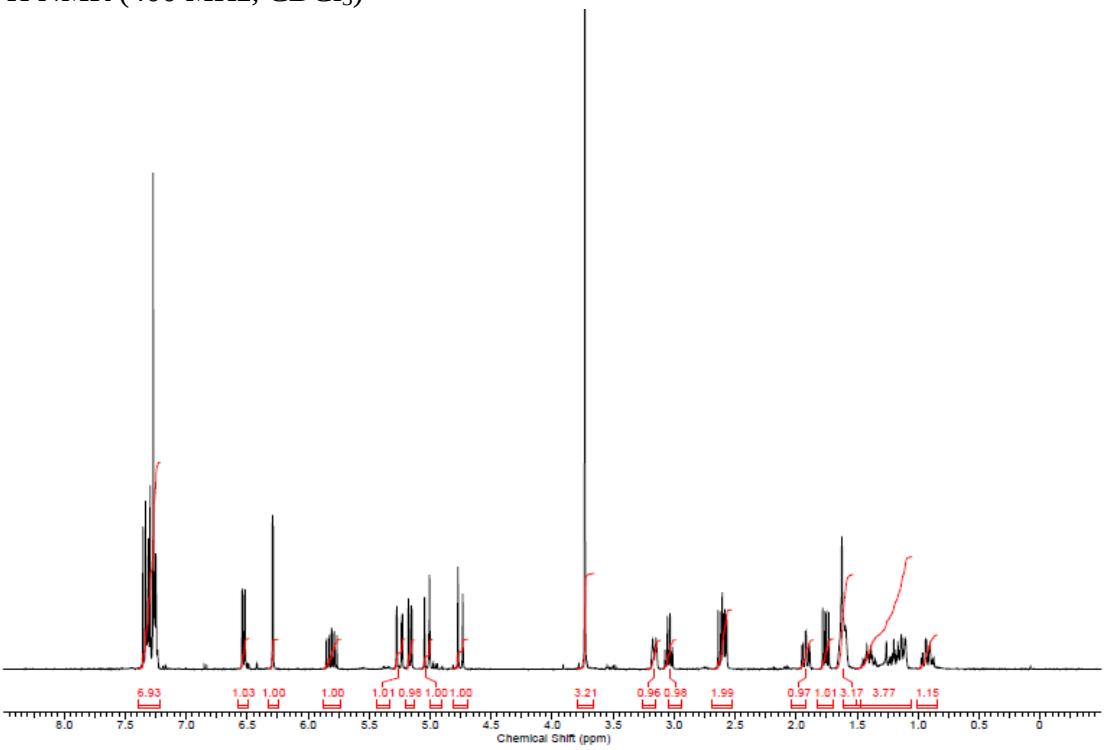
^{13}C NMR (125 MHz, $CDCl_3$)



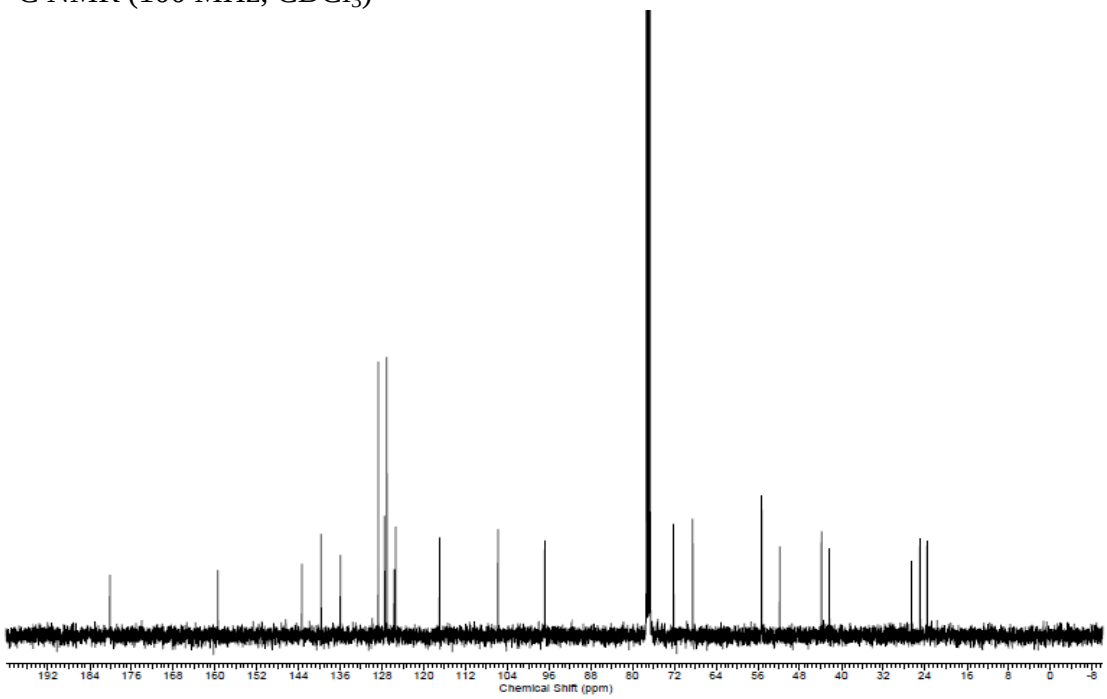


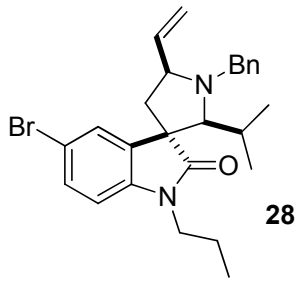
27

^{1}H NMR (400 MHz, $CDCl_3$)



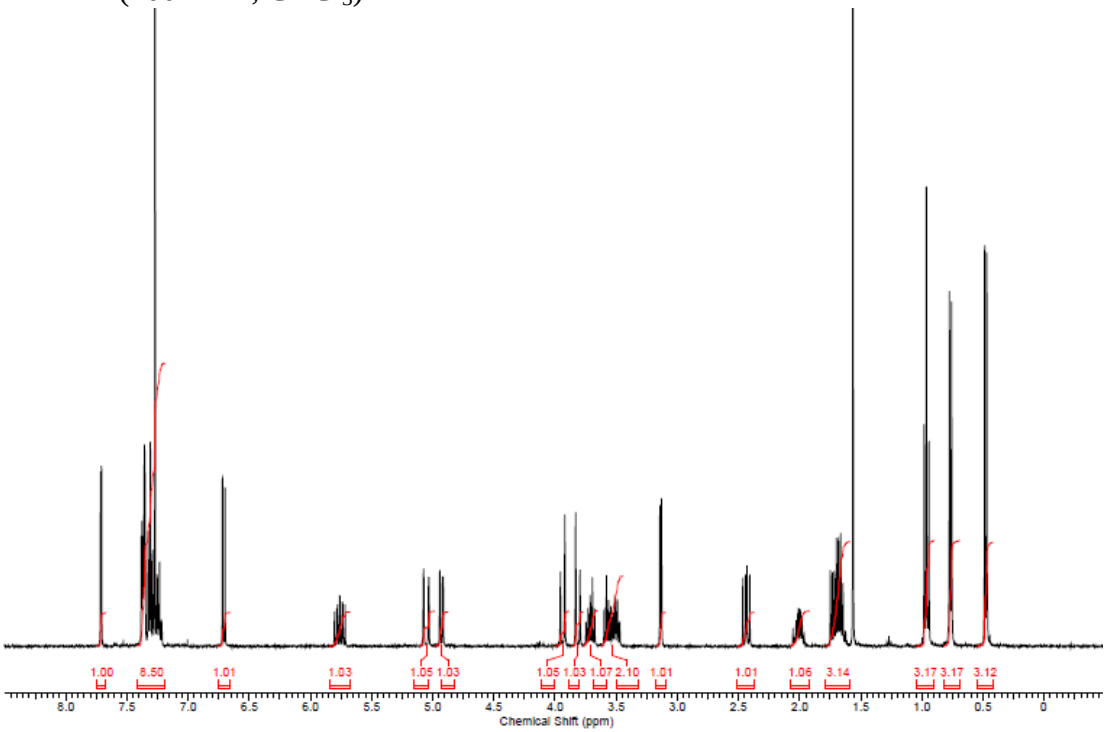
^{13}C NMR (100 MHz, $CDCl_3$)



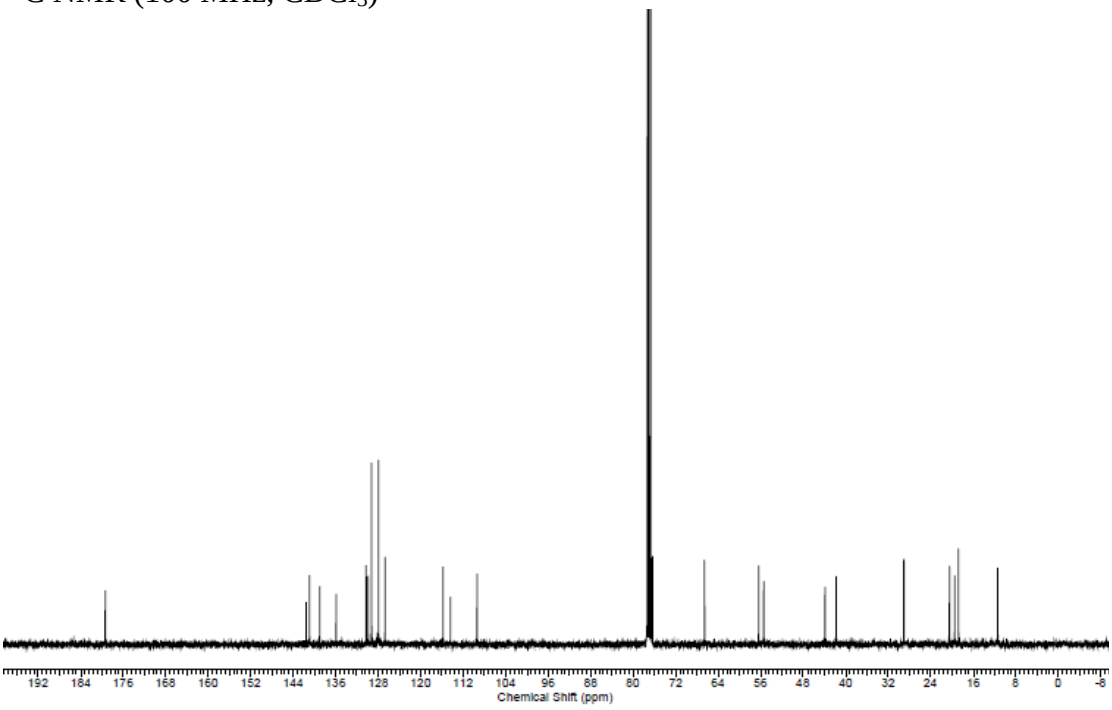


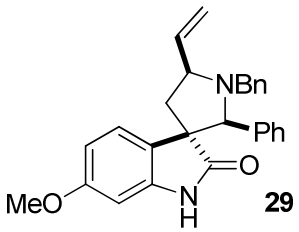
28

^{1}H NMR (400 MHz, $CDCl_3$)



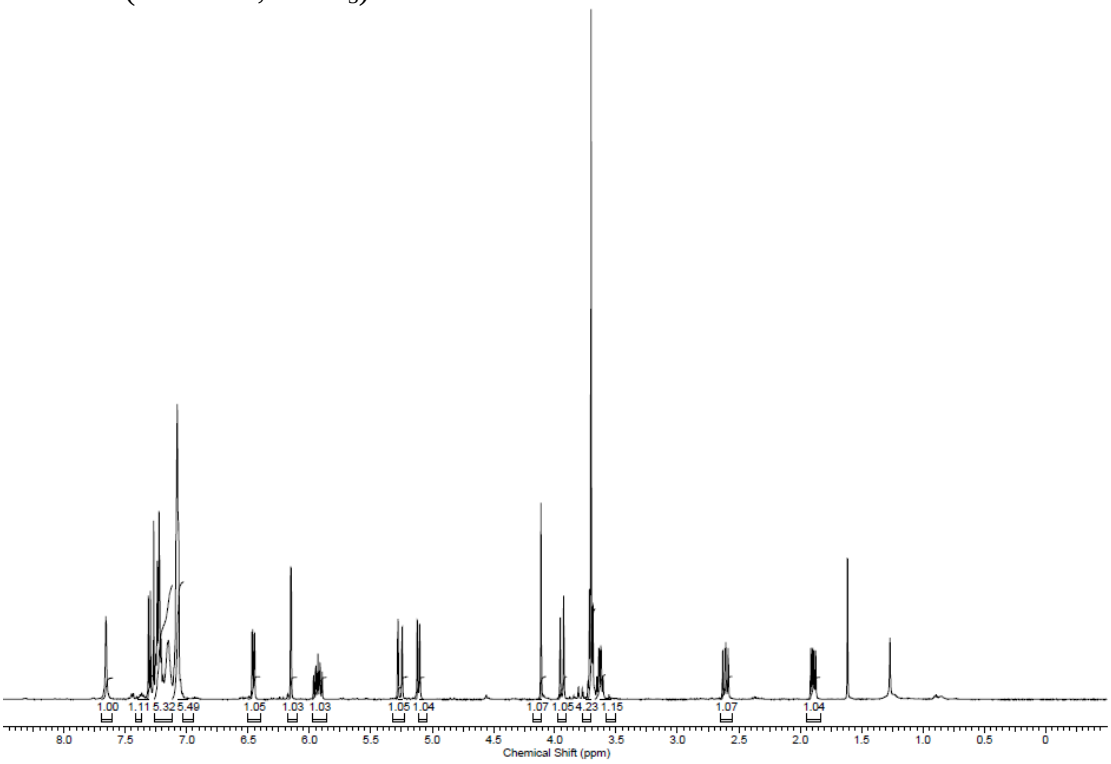
^{13}C NMR (100 MHz, $CDCl_3$)



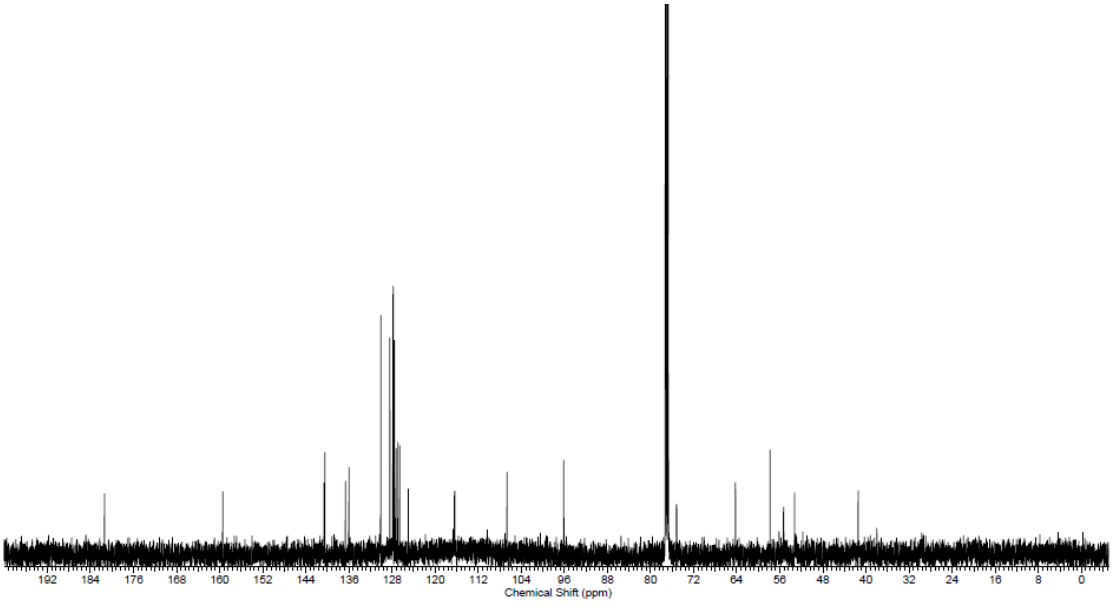


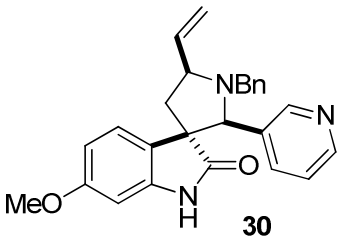
29

^{1}H NMR (500 MHz, $CDCl_3$)



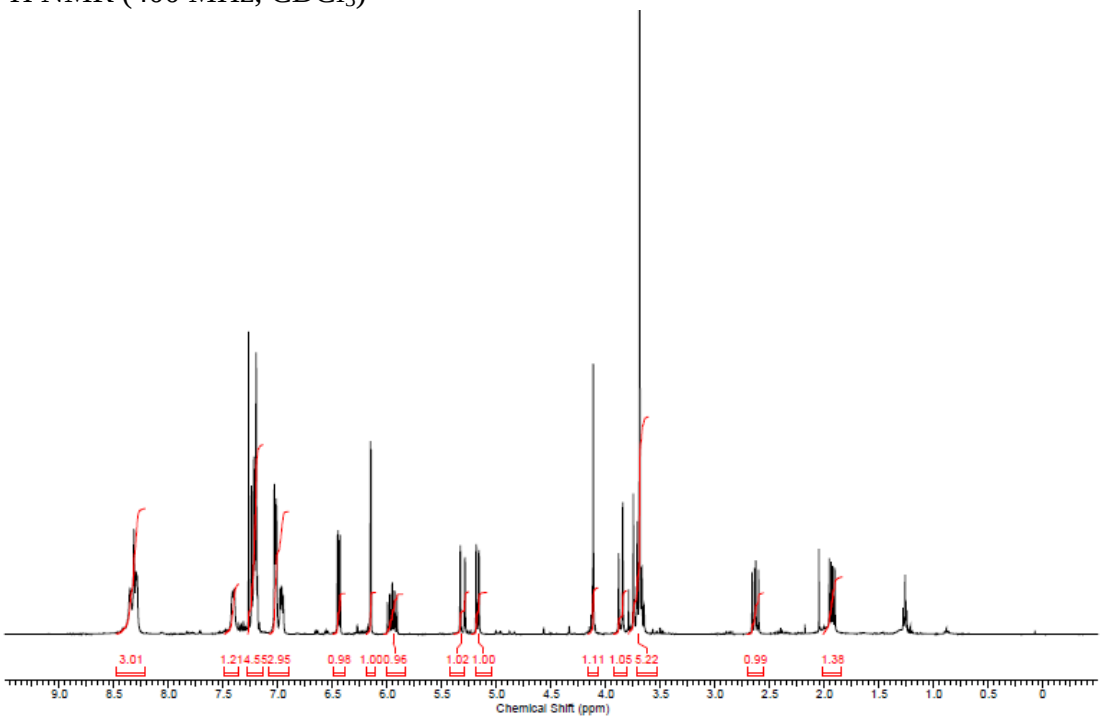
^{13}C NMR (125 MHz, $CDCl_3$)



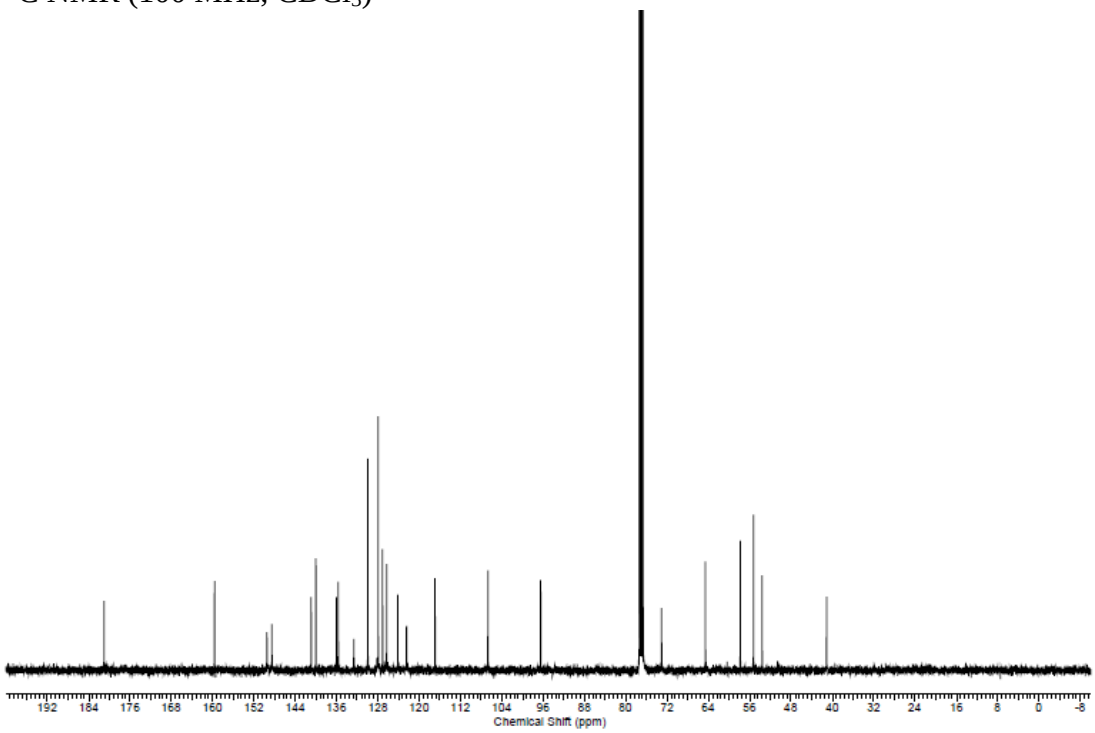


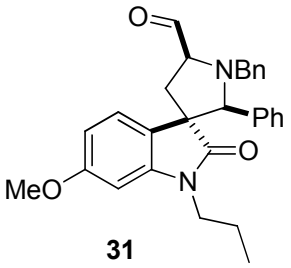
30

^{1}H NMR (400 MHz, $CDCl_3$)



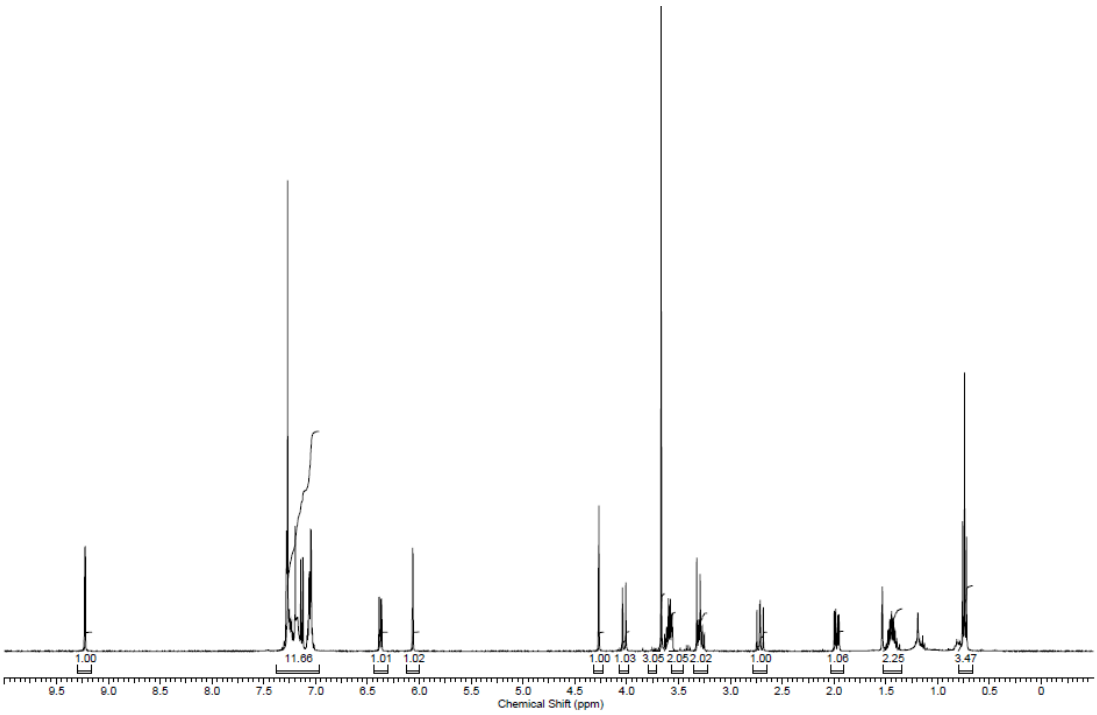
^{13}C NMR (100 MHz, $CDCl_3$)



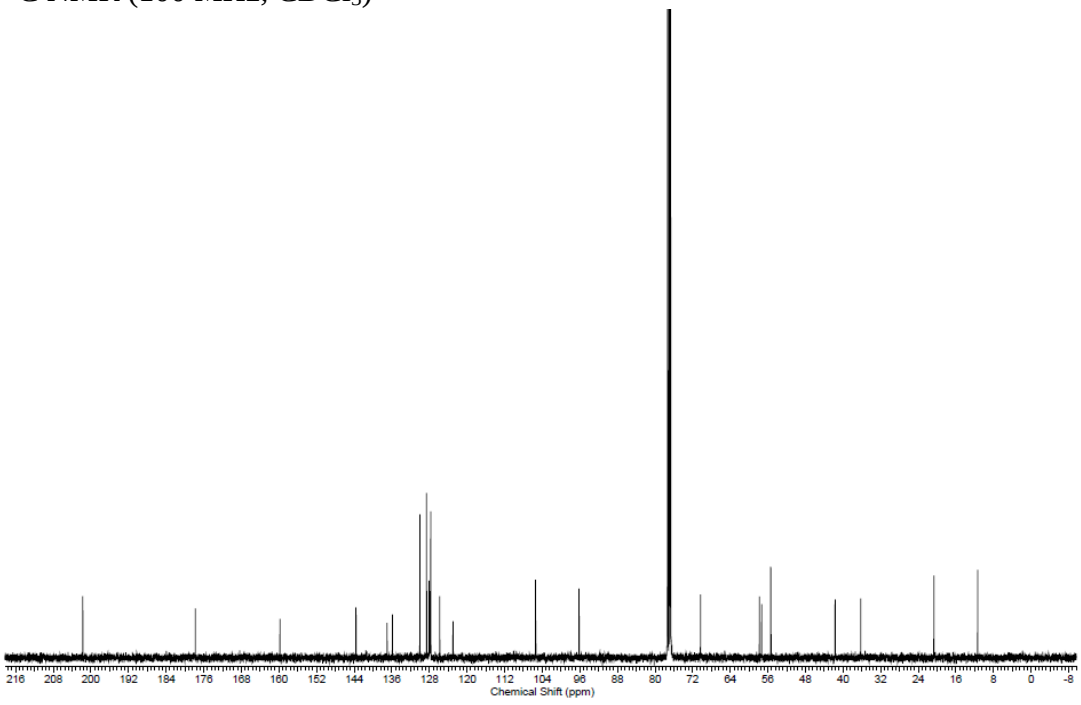


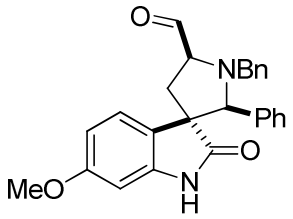
31

^{1}H NMR (400 MHz, $CDCl_3$)



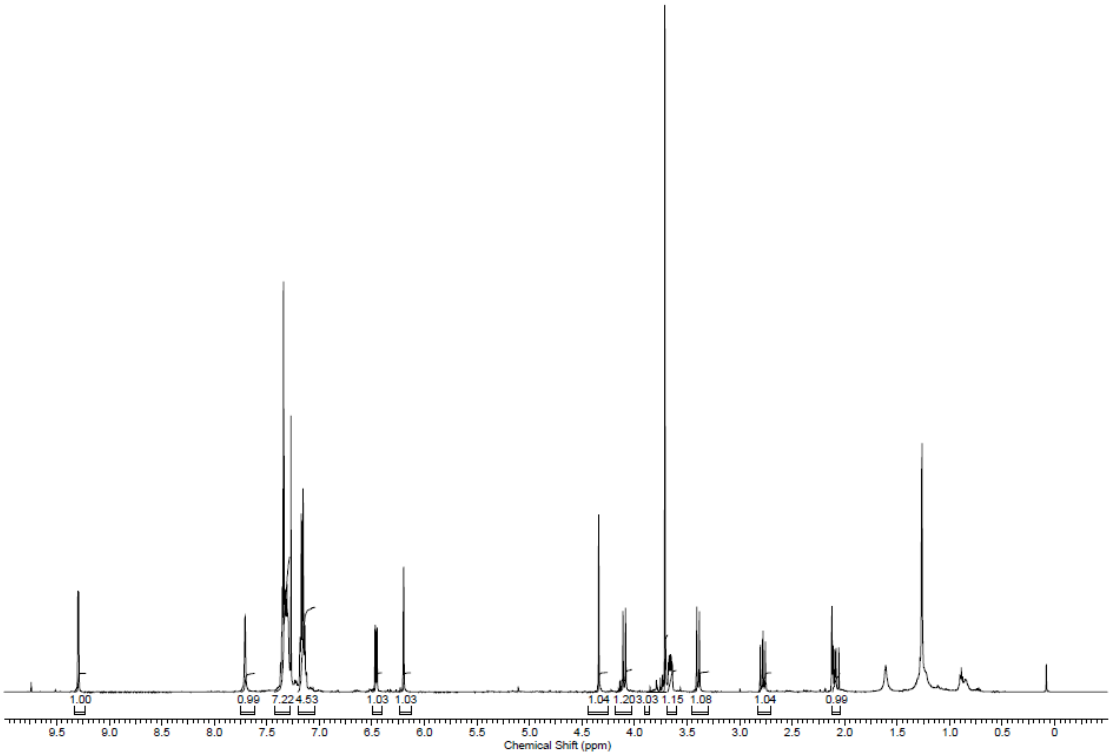
^{13}C NMR (100 MHz, $CDCl_3$)



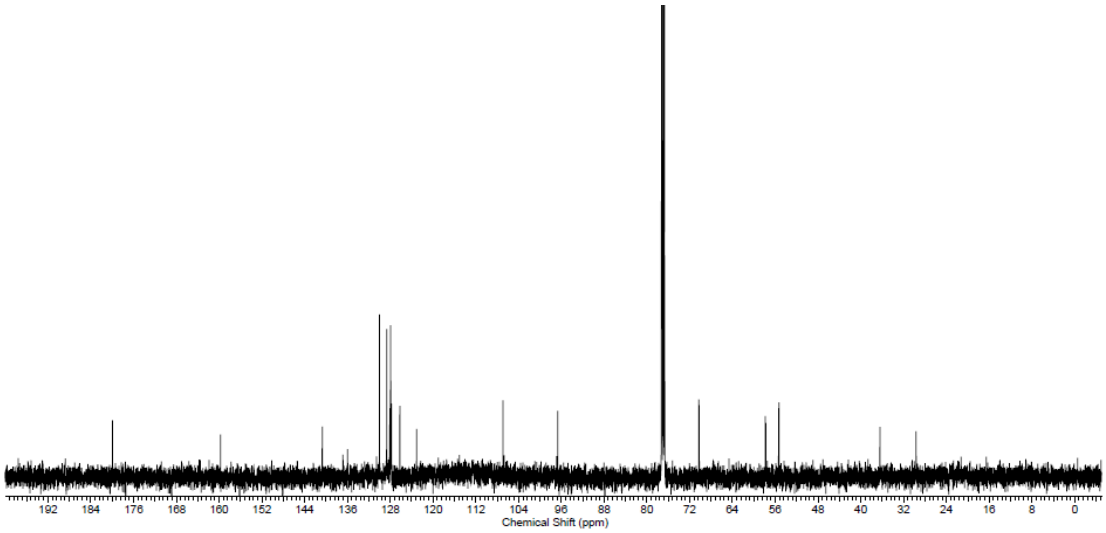


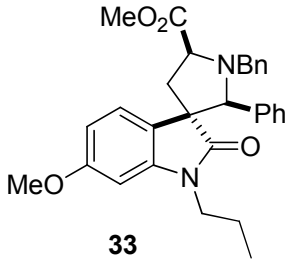
32

^{1}H NMR (500 MHz, $CDCl_3$)



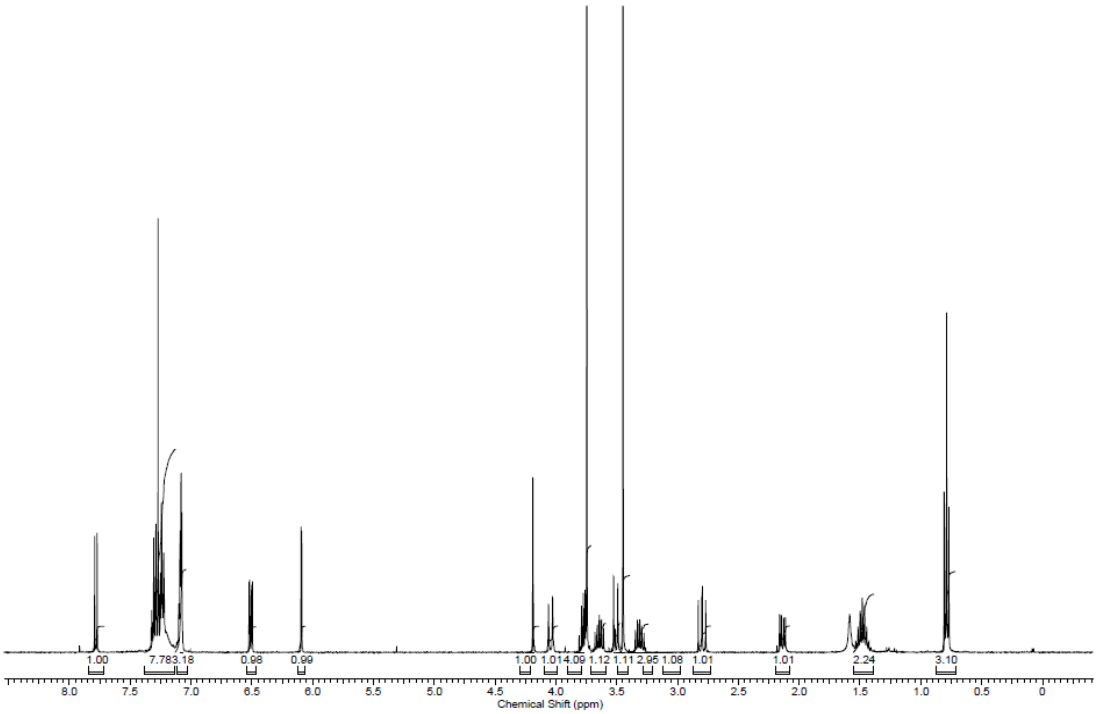
^{13}C NMR (125 MHz, $CDCl_3$)



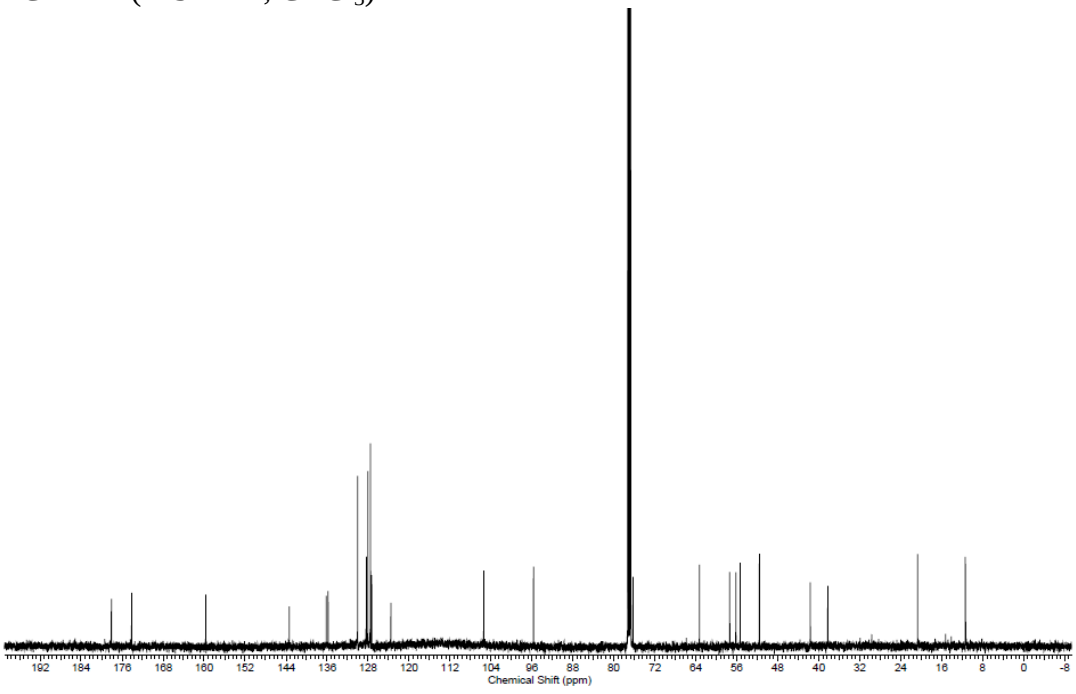


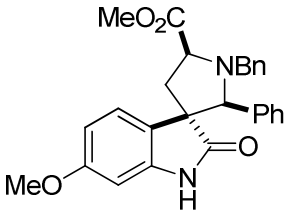
33

^{1}H NMR (400 MHz, $CDCl_3$)



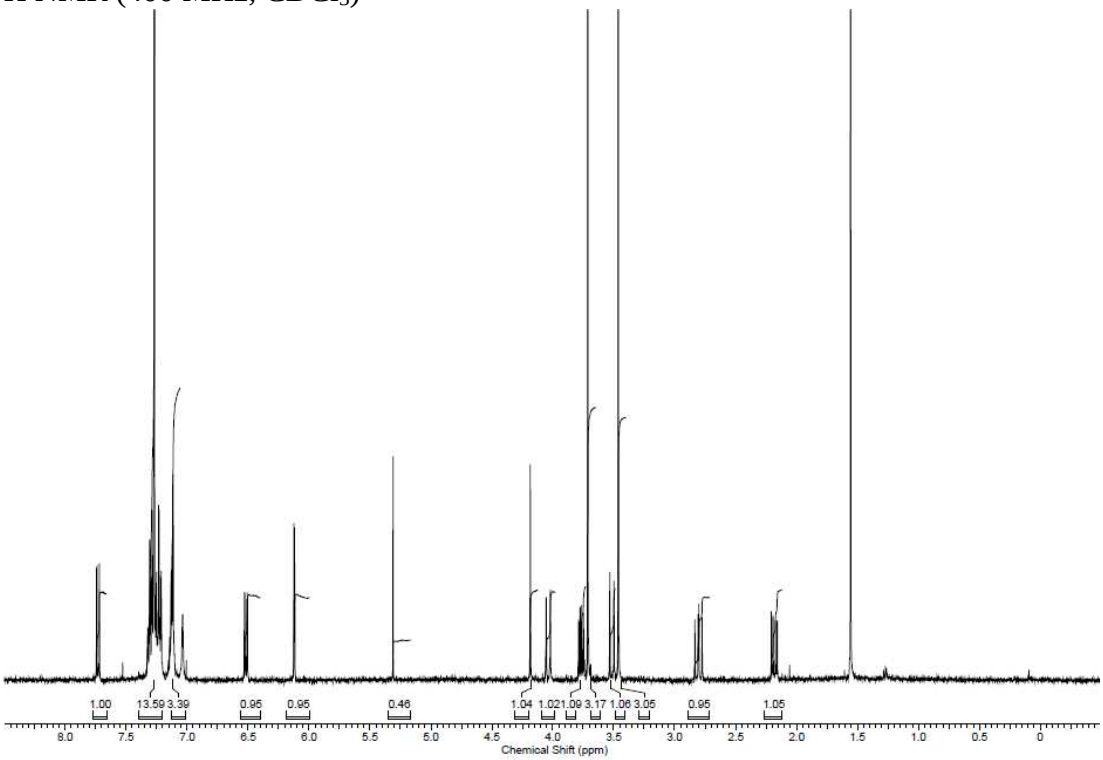
^{13}C NMR (125 MHz, $CDCl_3$)



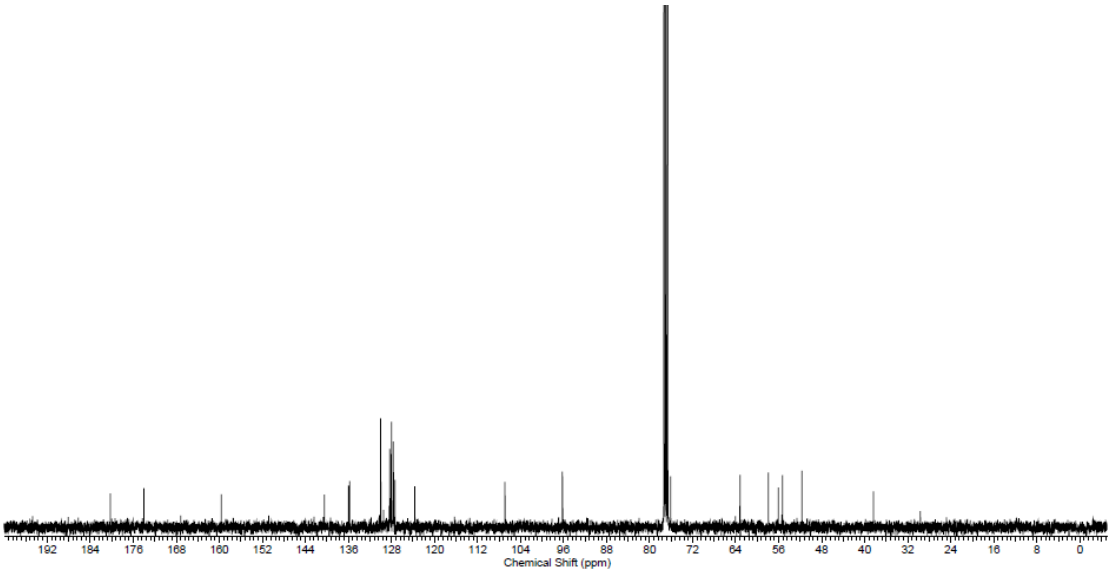


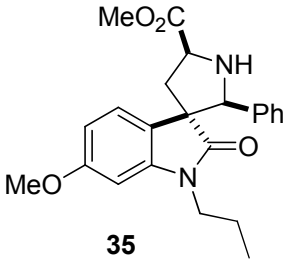
34

^{1}H NMR (400 MHz, $CDCl_3$)



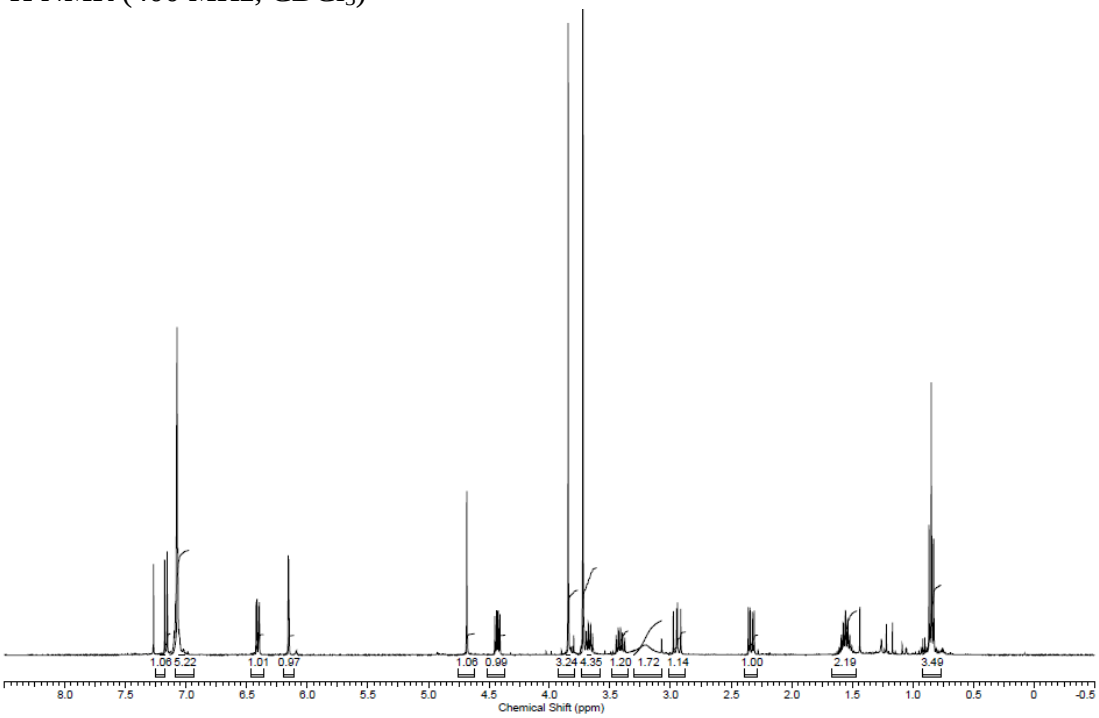
^{13}C NMR (100 MHz, $CDCl_3$)



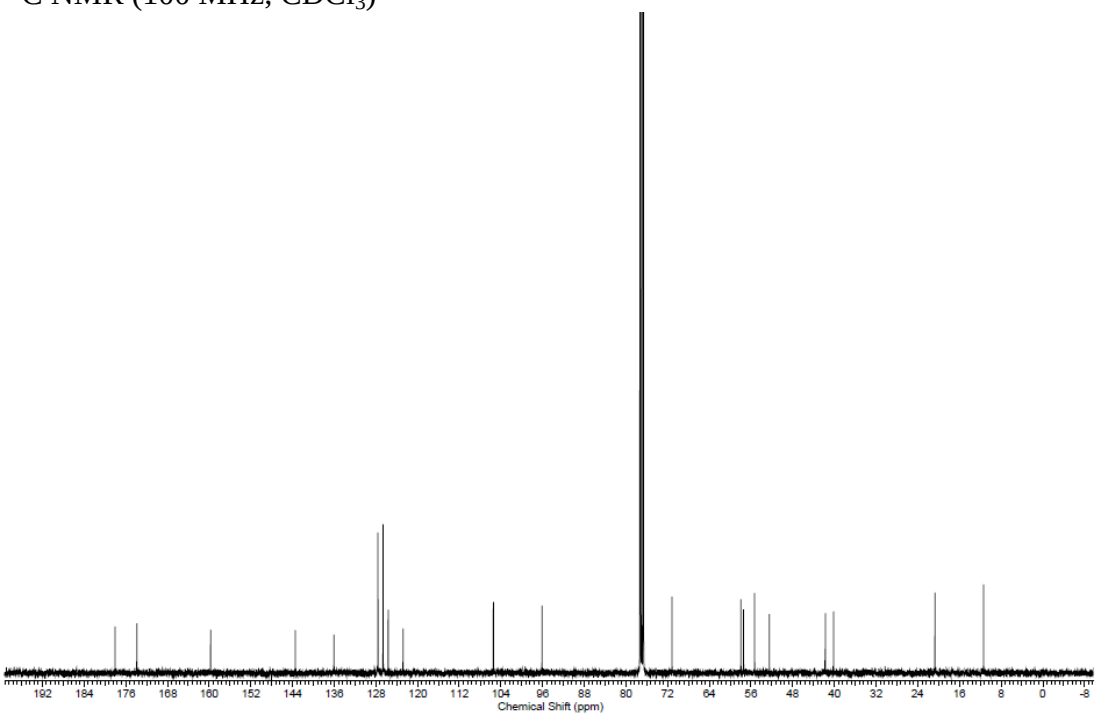


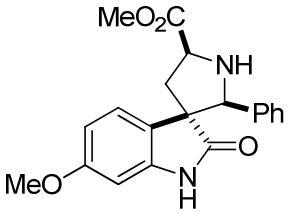
35

^{1}H NMR (400 MHz, $CDCl_3$)



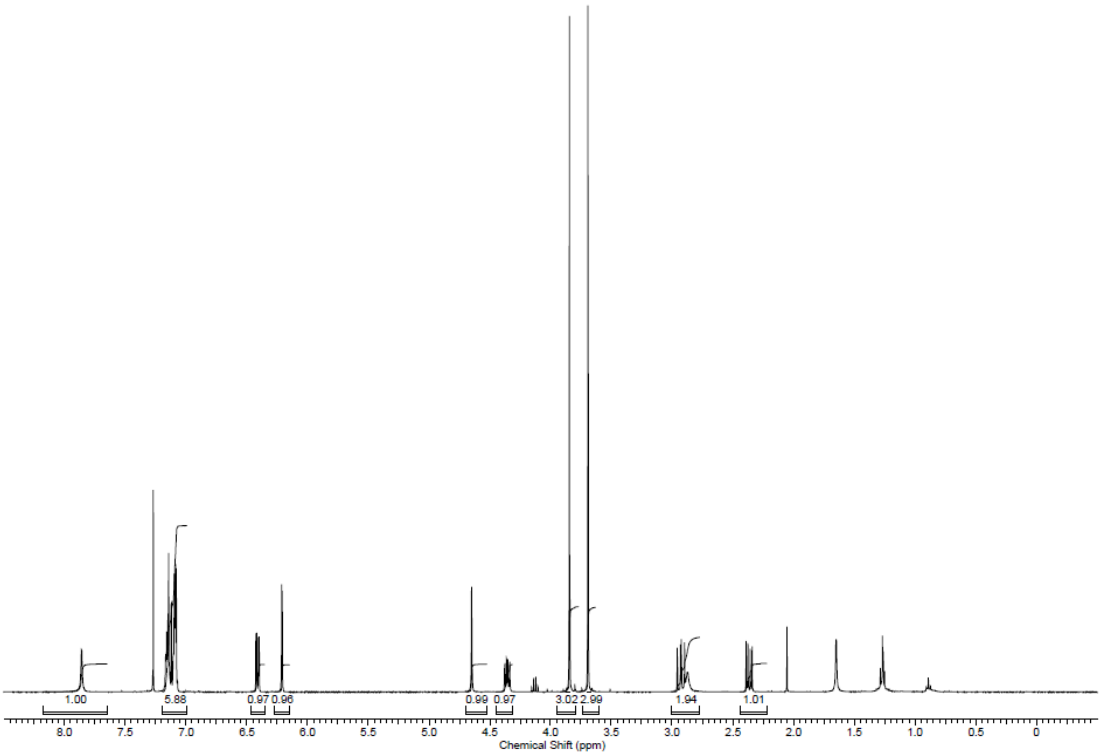
^{13}C NMR (100 MHz, $CDCl_3$)



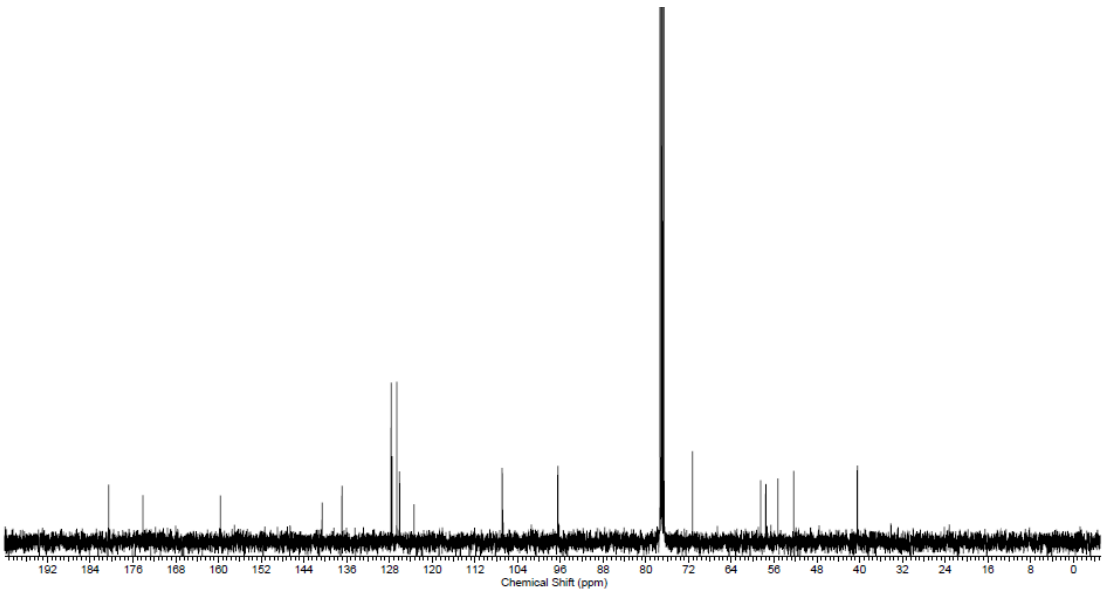


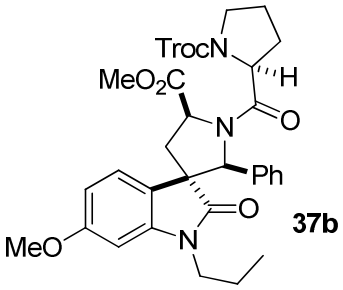
36

^{1}H NMR (400 MHz, $CDCl_3$)



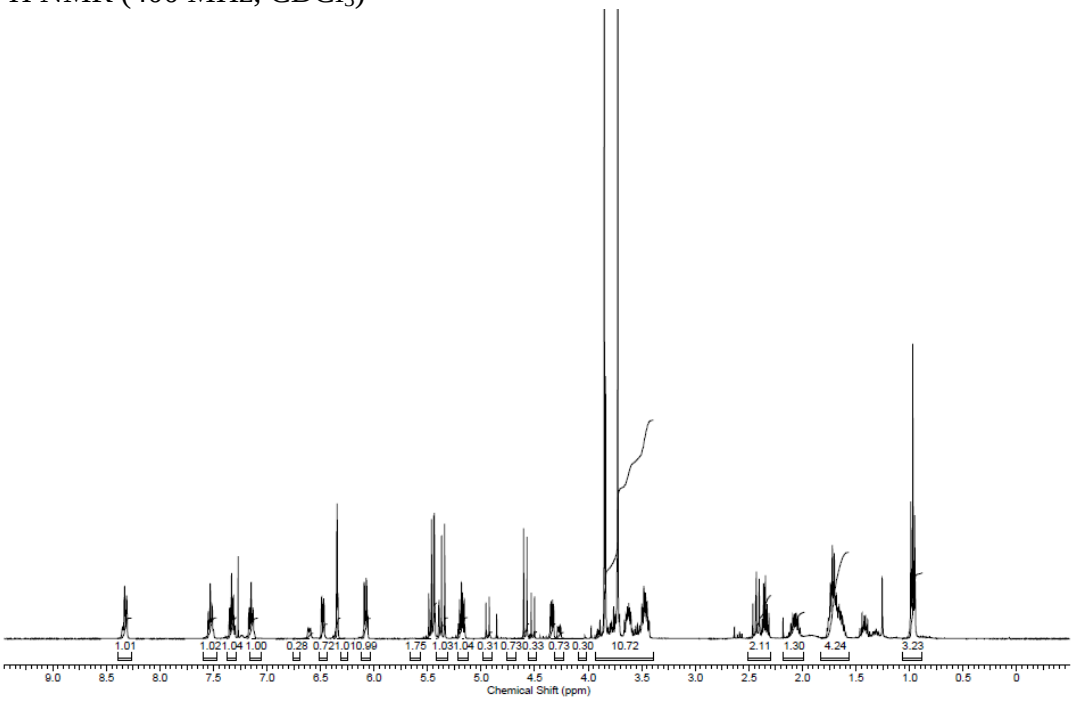
^{13}C NMR (100 MHz, $CDCl_3$)



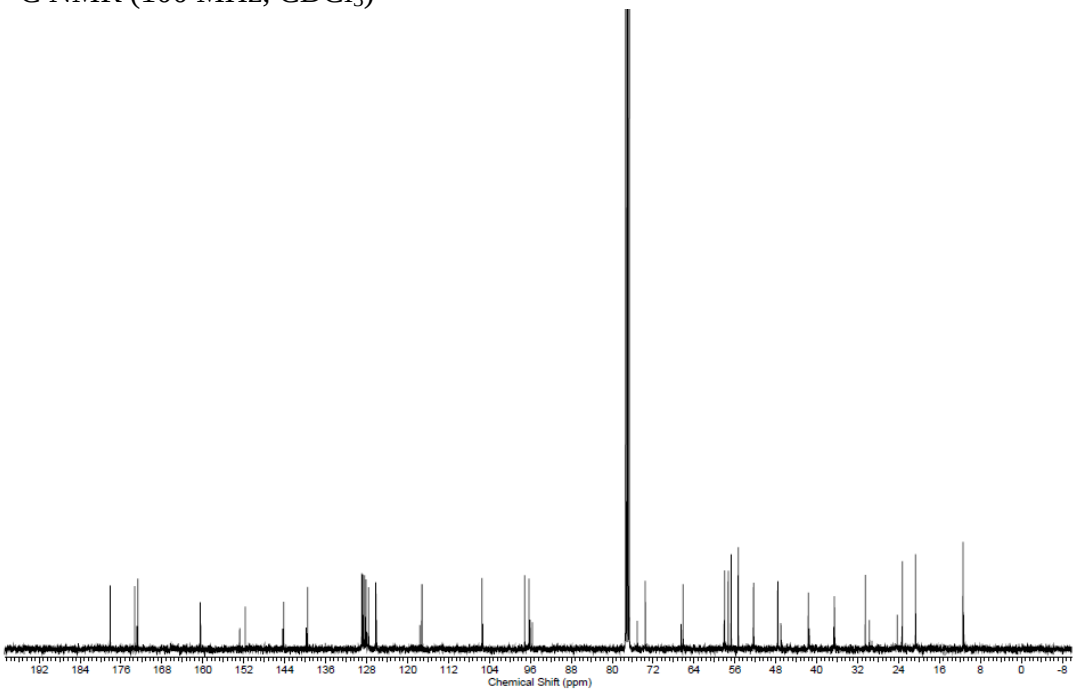


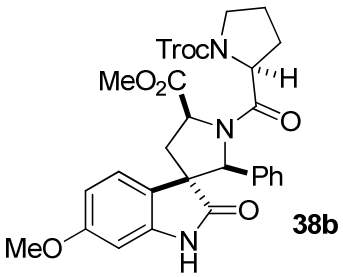
37b

^{1}H NMR (400 MHz, $CDCl_3$)



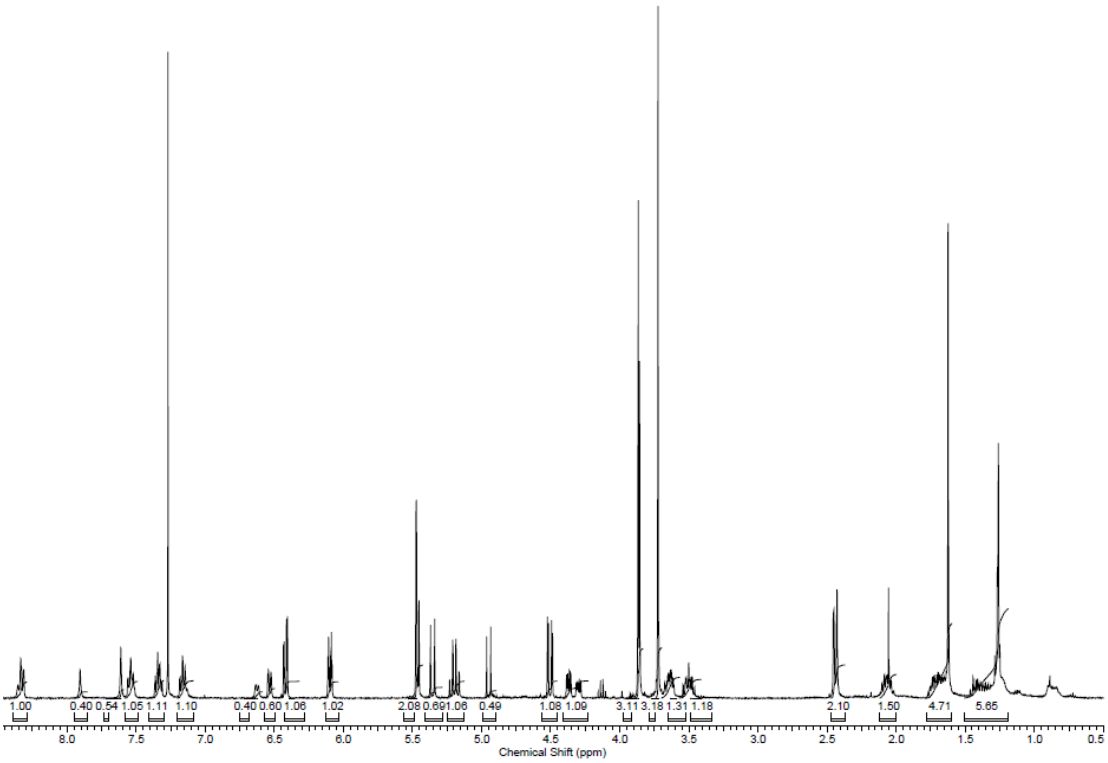
^{13}C NMR (100 MHz, $CDCl_3$)



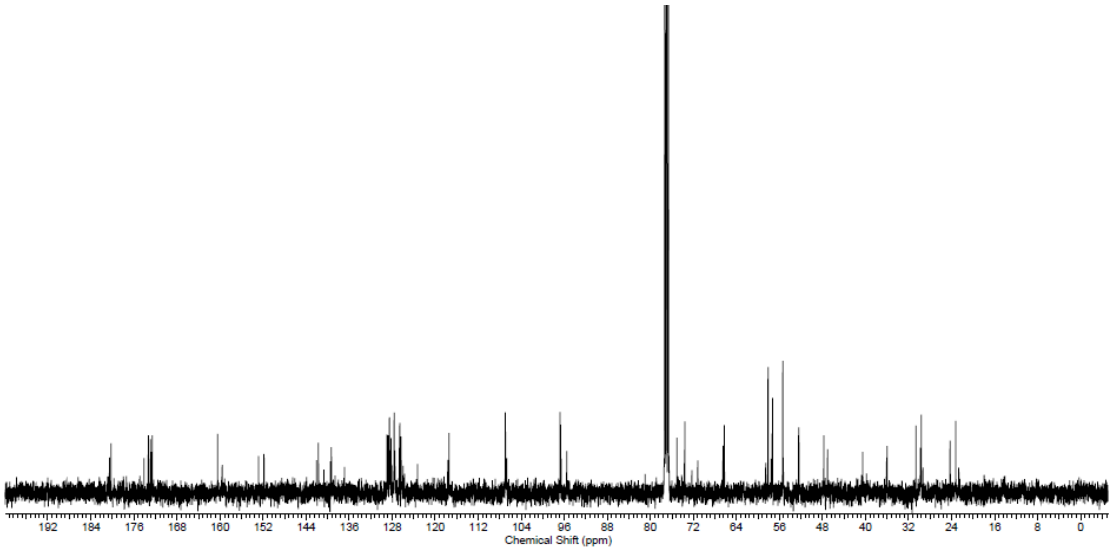


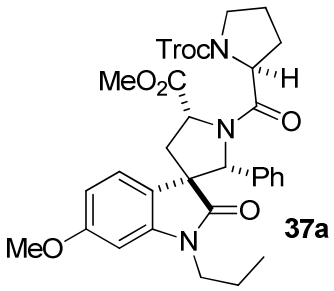
38b

^{1}H NMR (400 MHz, $CDCl_3$)



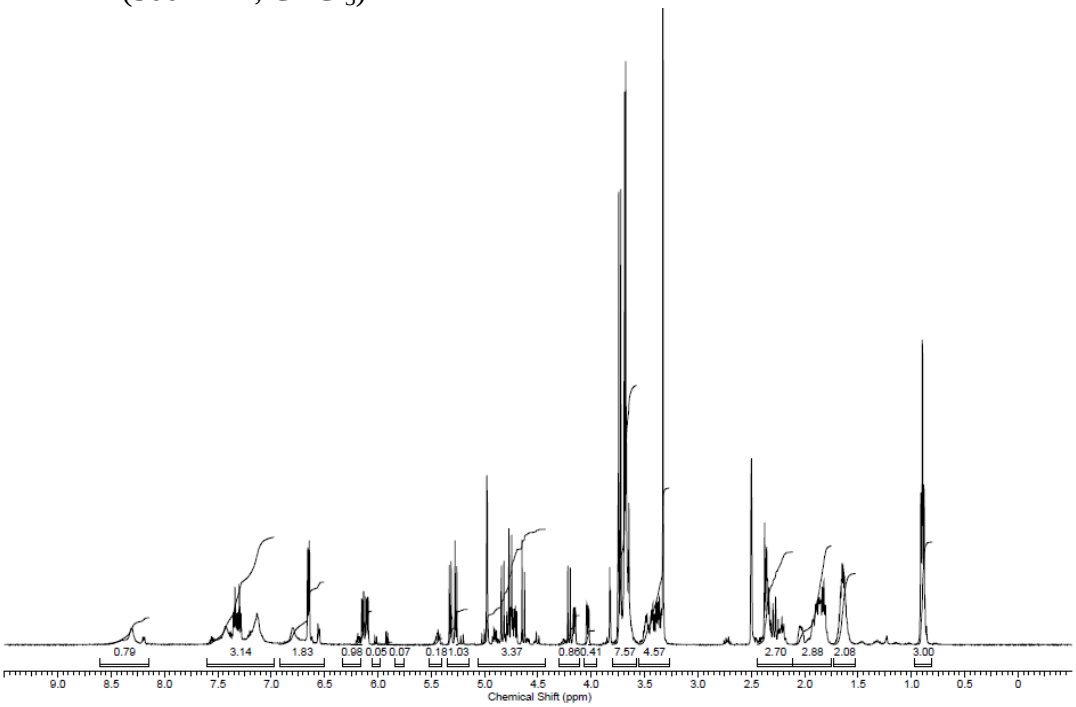
^{13}C NMR (100 MHz, $CDCl_3$)



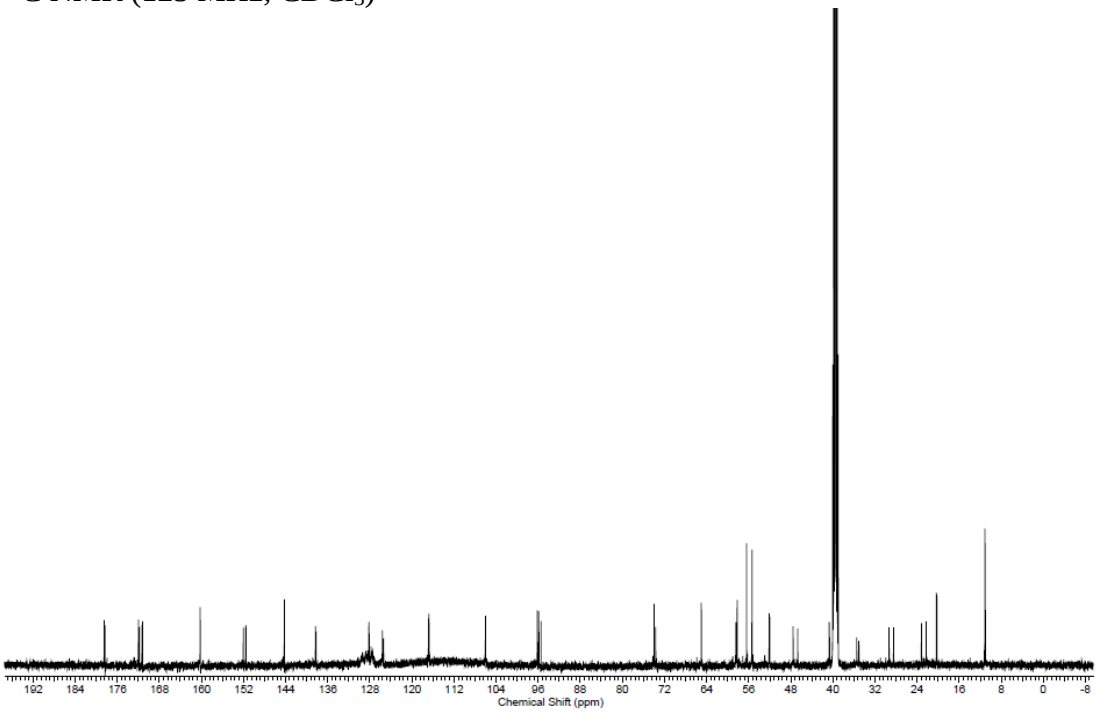


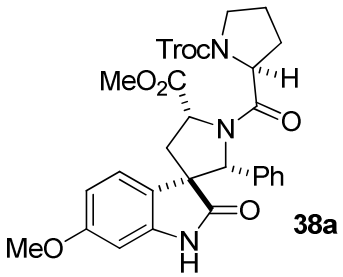
37a

^{1}H NMR (500 MHz, $CDCl_3$)



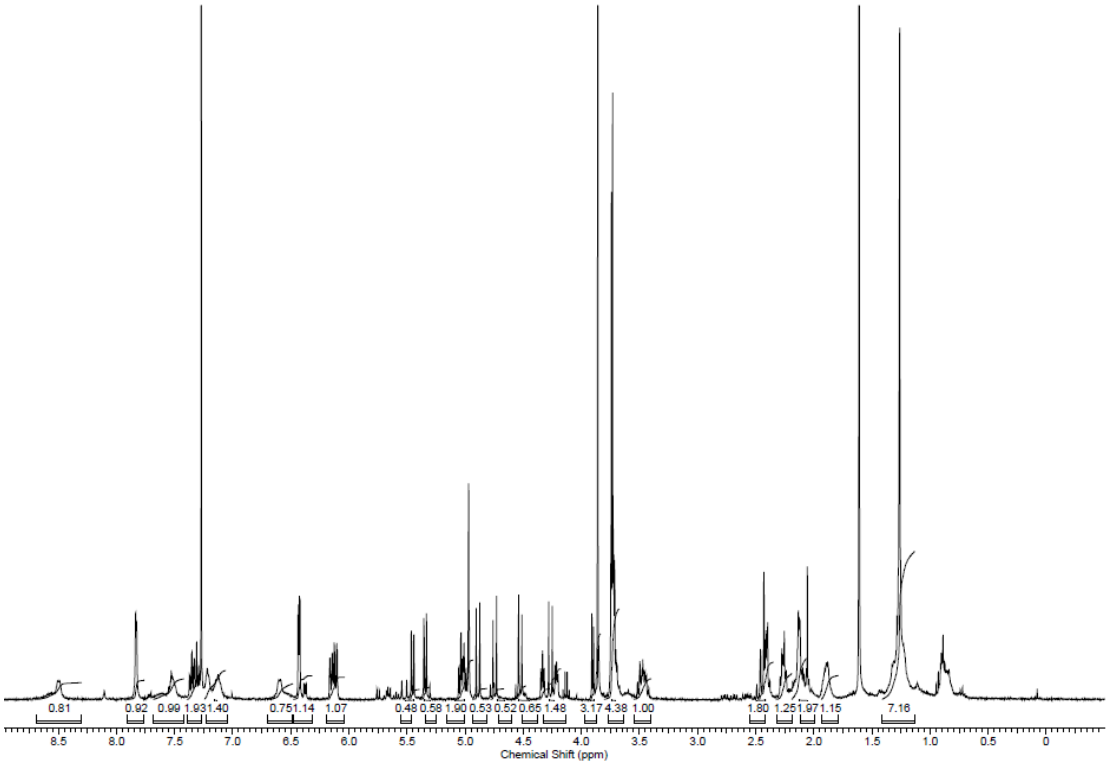
^{13}C NMR (125 MHz, $CDCl_3$)



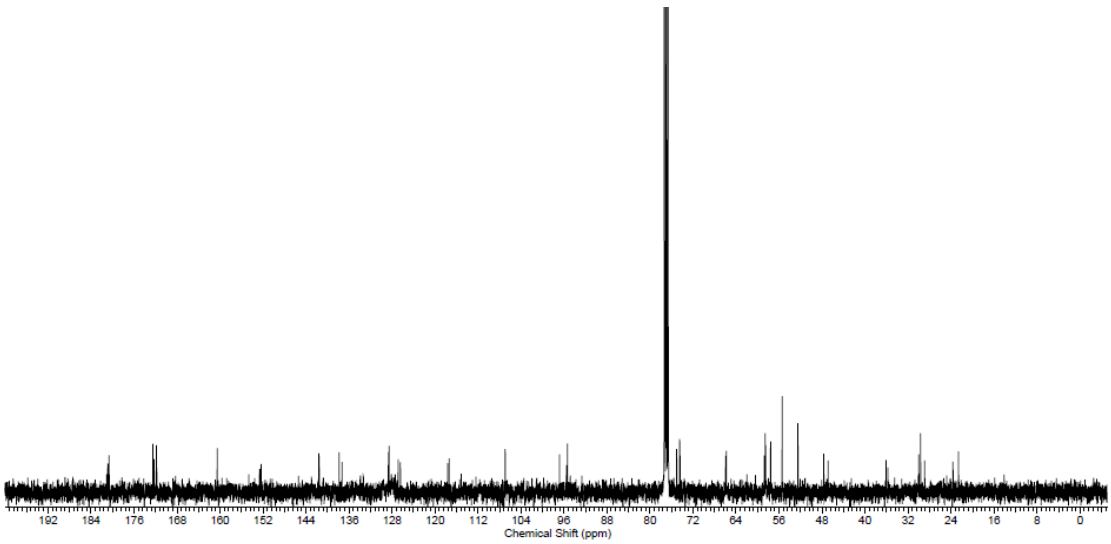


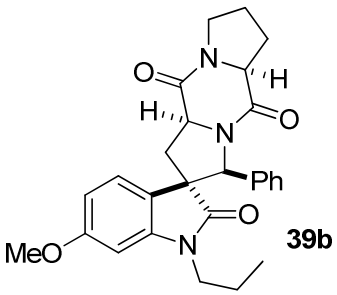
38a

^{1}H NMR (400 MHz, $CDCl_3$)



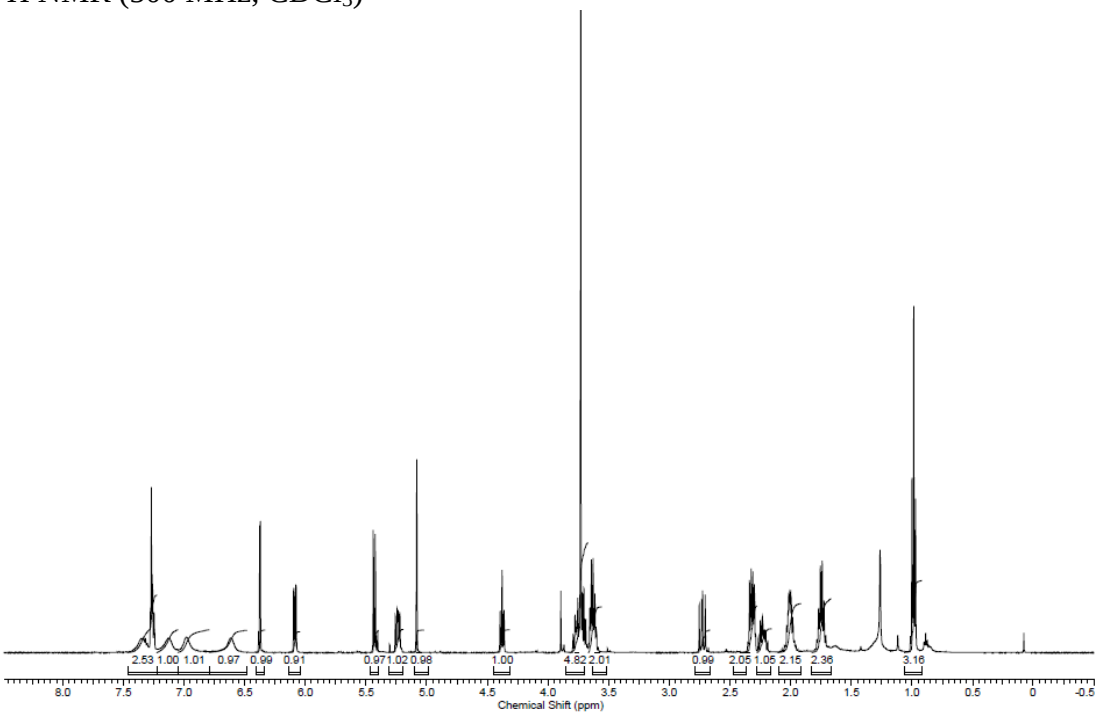
^{13}C NMR (100 MHz, $CDCl_3$)



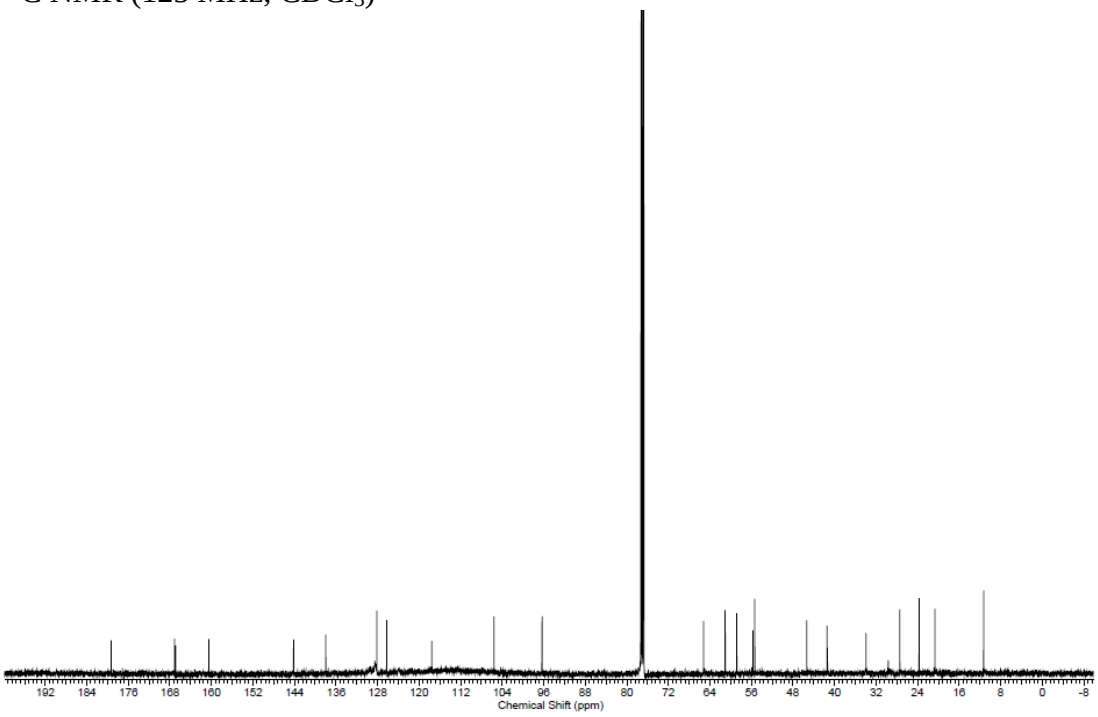


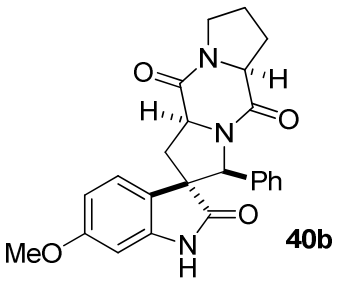
39b

^{1}H NMR (500 MHz, $CDCl_3$)



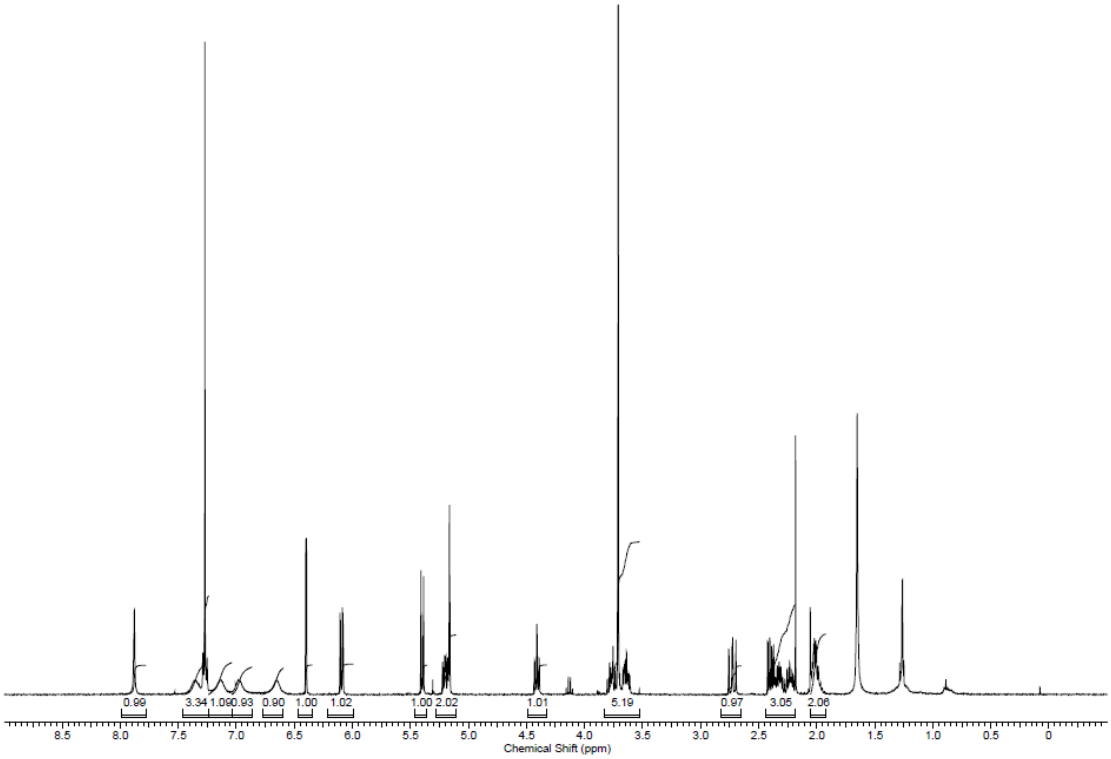
^{13}C NMR (125 MHz, $CDCl_3$)



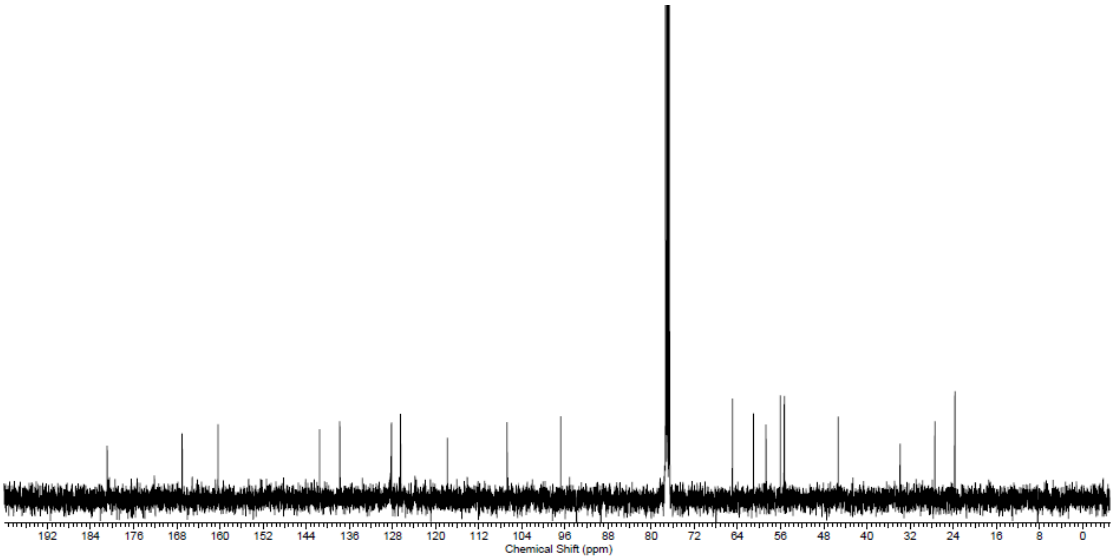


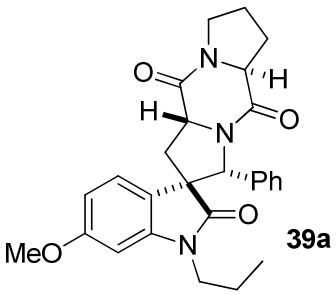
40b

^{1}H NMR (400 MHz, $CDCl_3$)



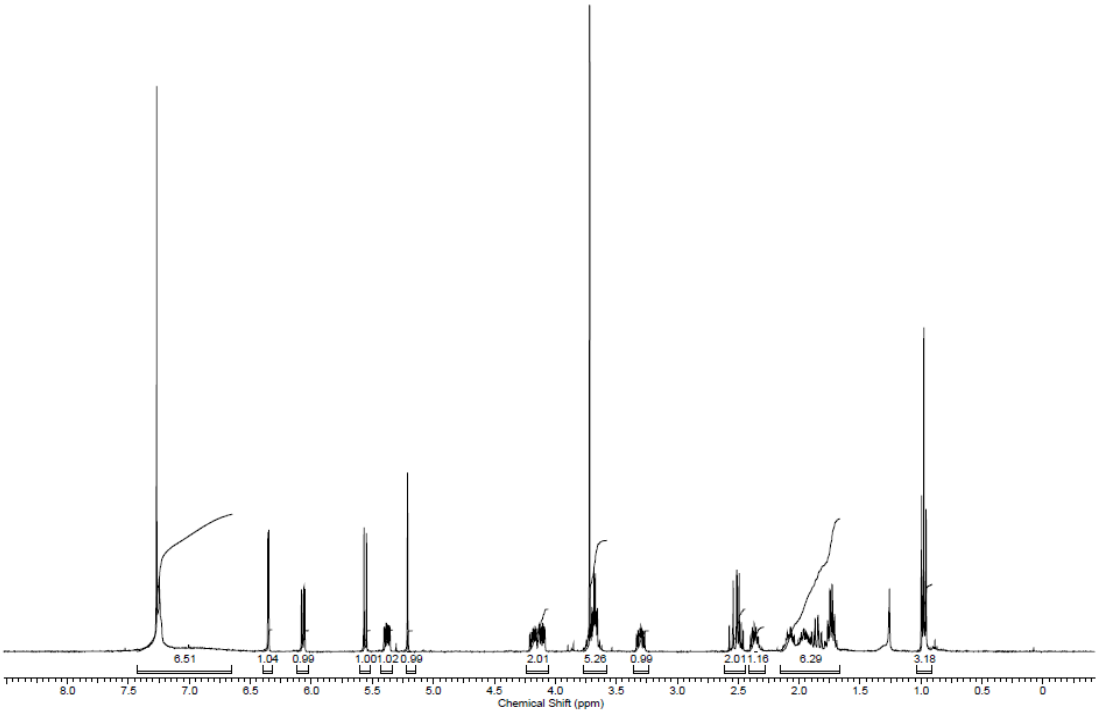
^{13}C NMR (100 MHz, $CDCl_3$)



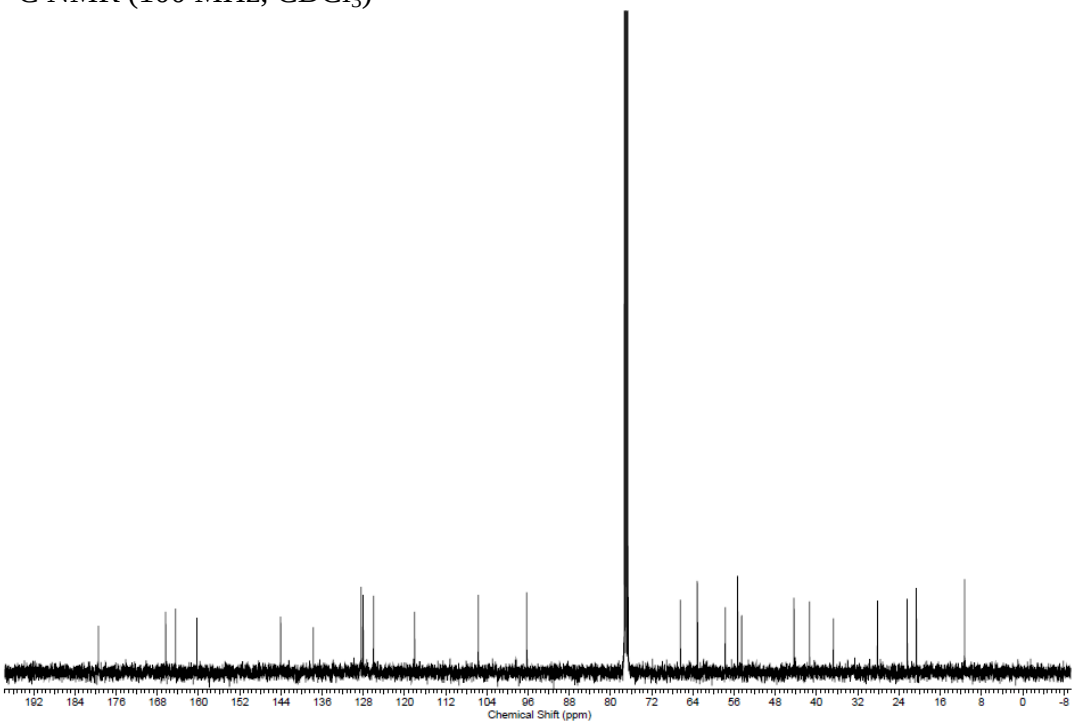


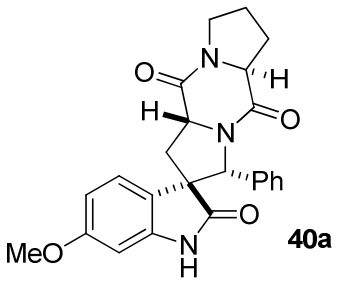
39a

^{1}H NMR (400 MHz, $CDCl_3$)



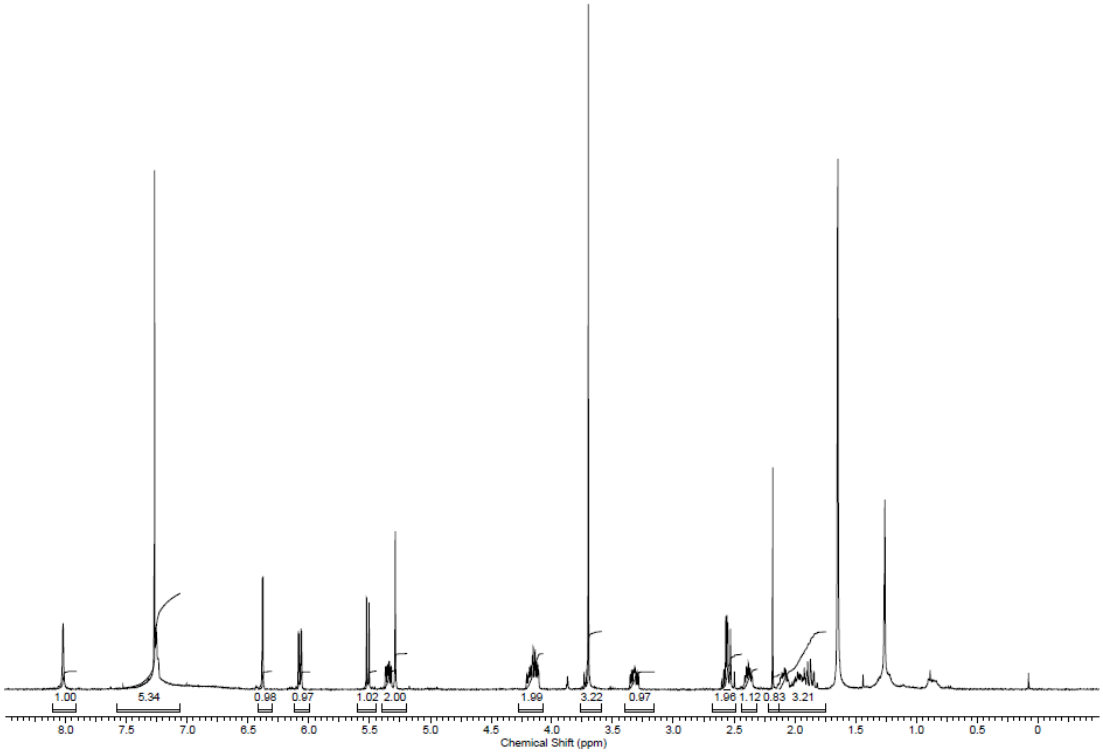
^{13}C NMR (100 MHz, $CDCl_3$)



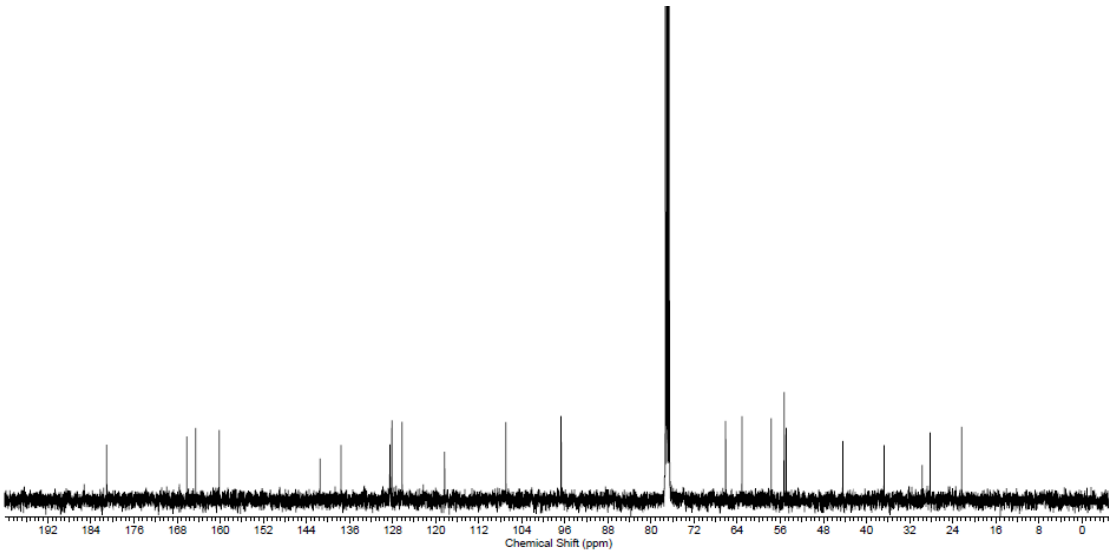


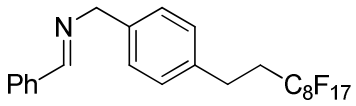
40a

^{1}H NMR (400 MHz, $CDCl_3$)

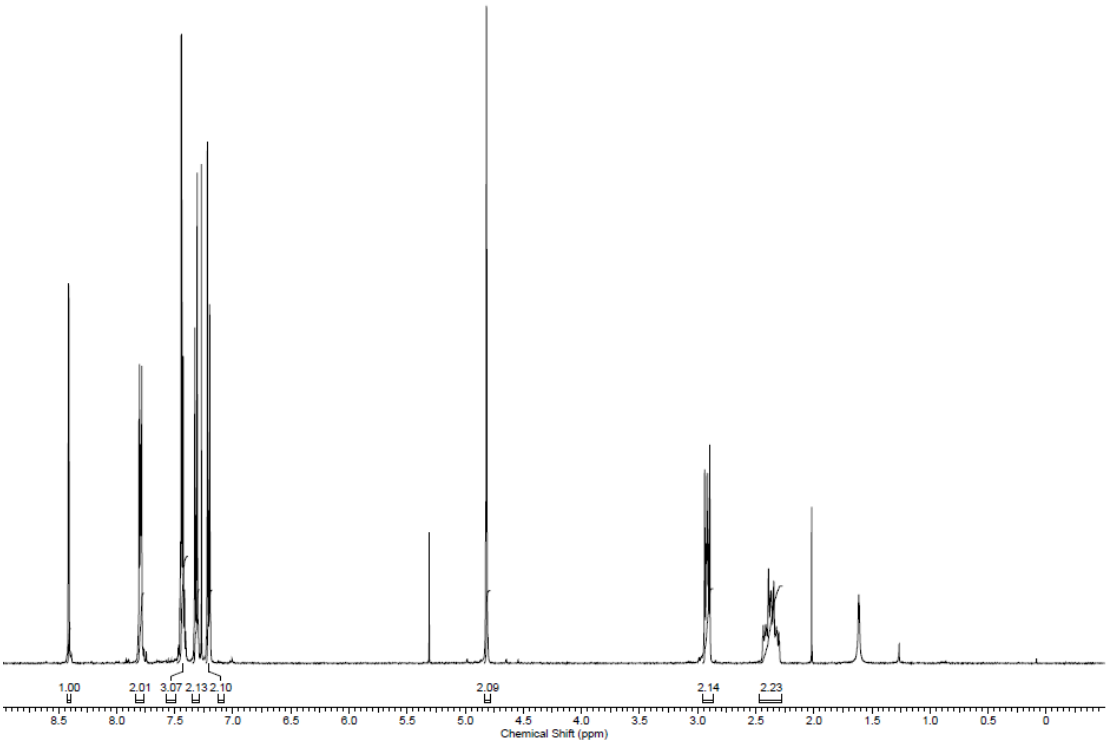


^{13}C NMR (100 MHz, $CDCl_3$)



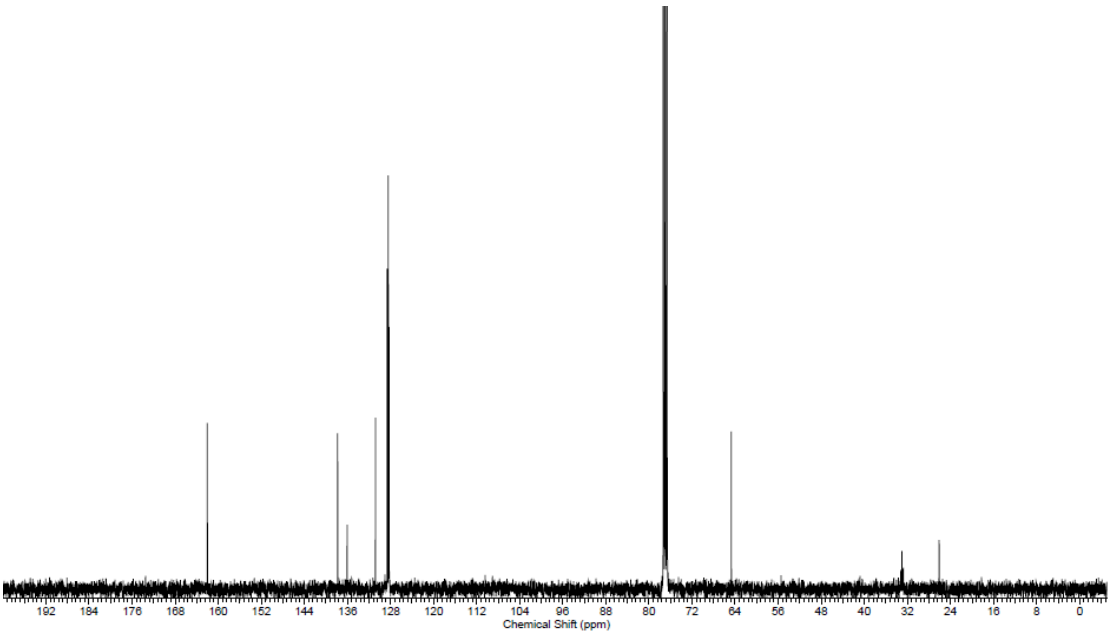


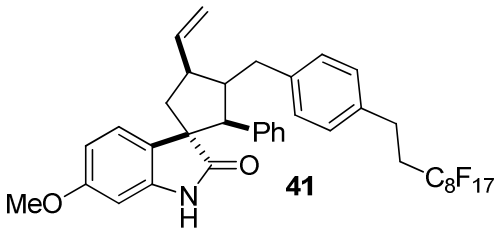
^{1}H NMR (500 MHz, $CDCl_3$)



1

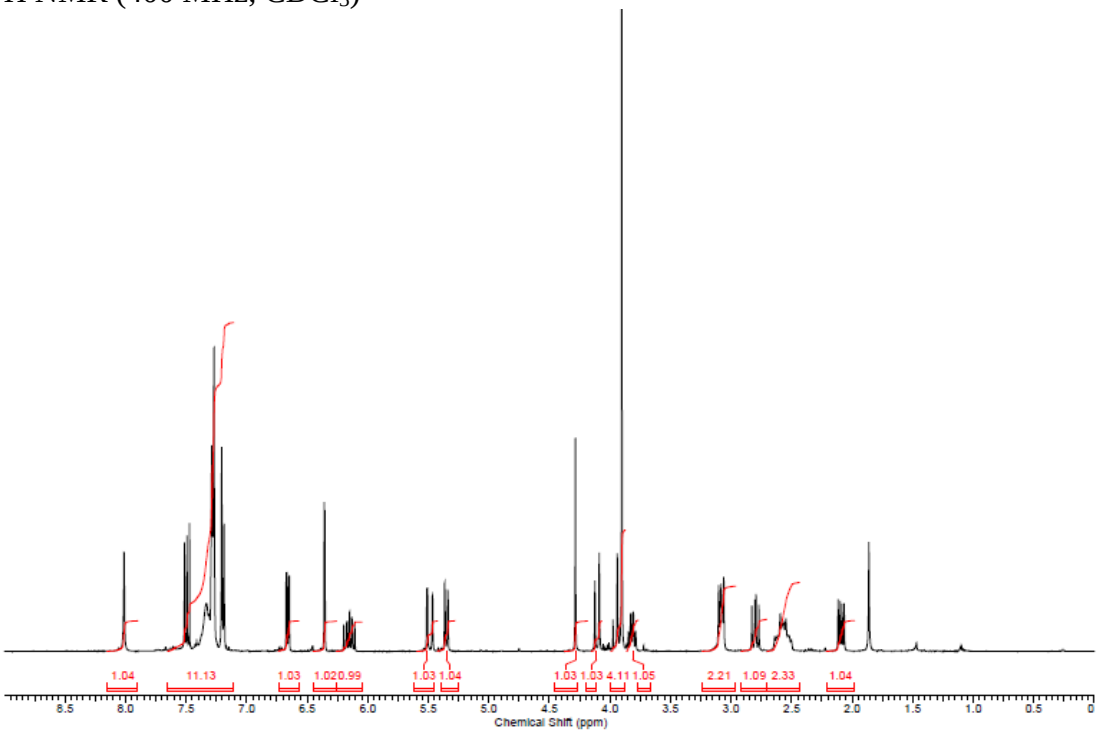
^{13}C NMR (100 MHz, $CDCl_3$)



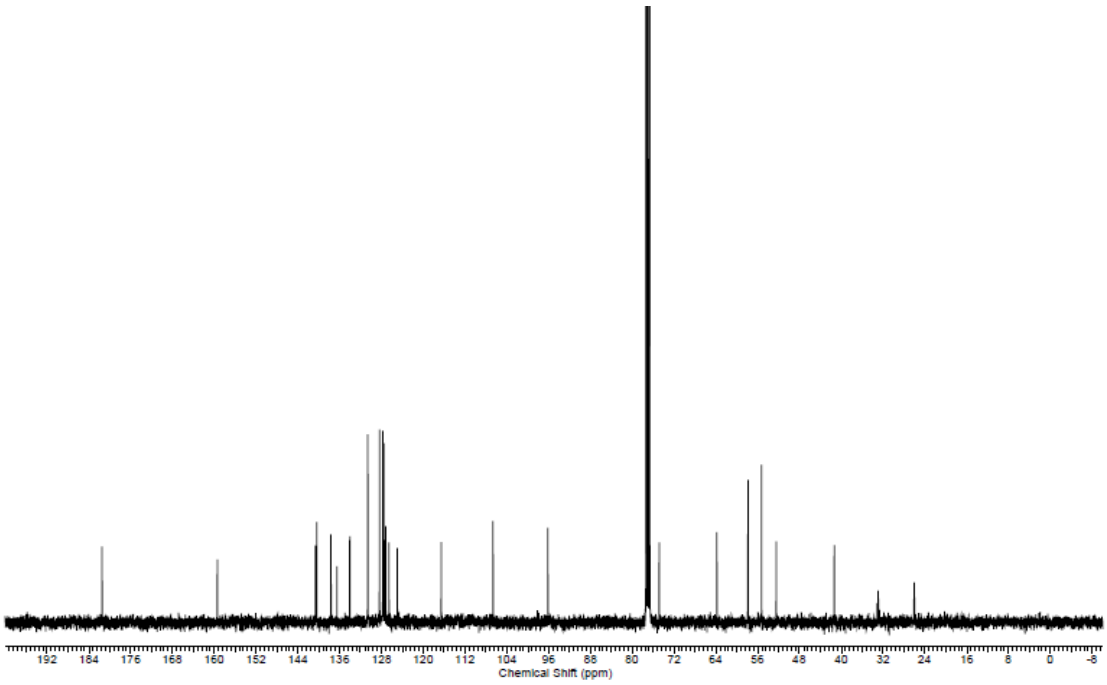


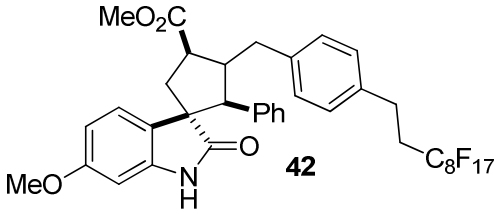
41

^{1}H NMR (400 MHz, $CDCl_3$)



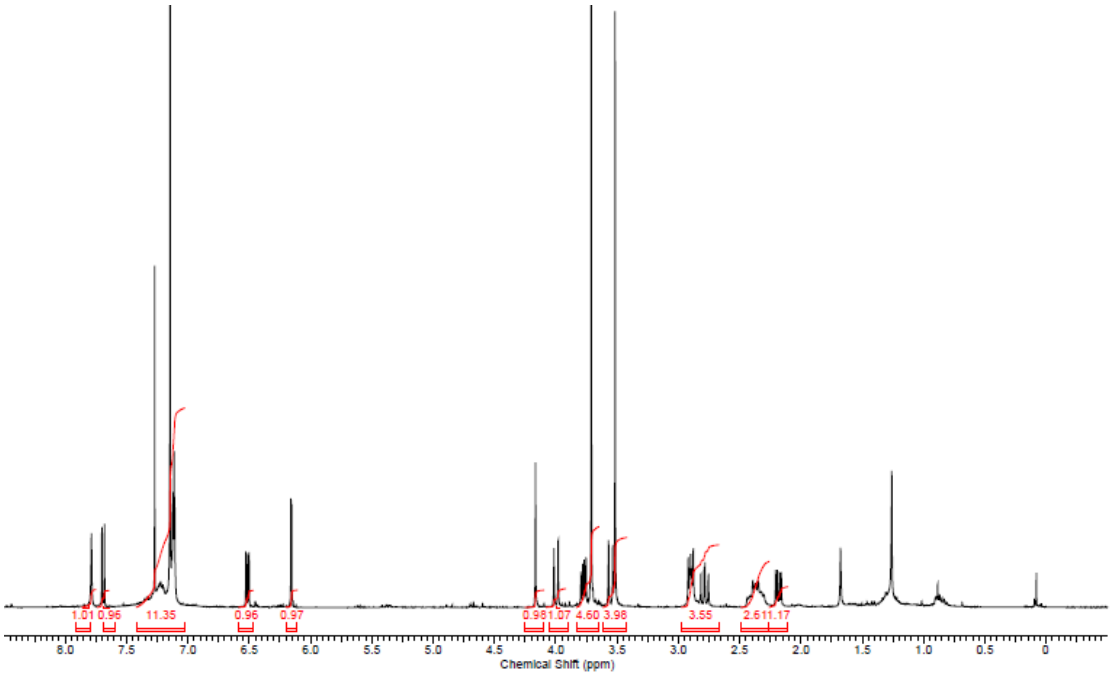
^{13}C NMR (400 MHz, $CDCl_3$)



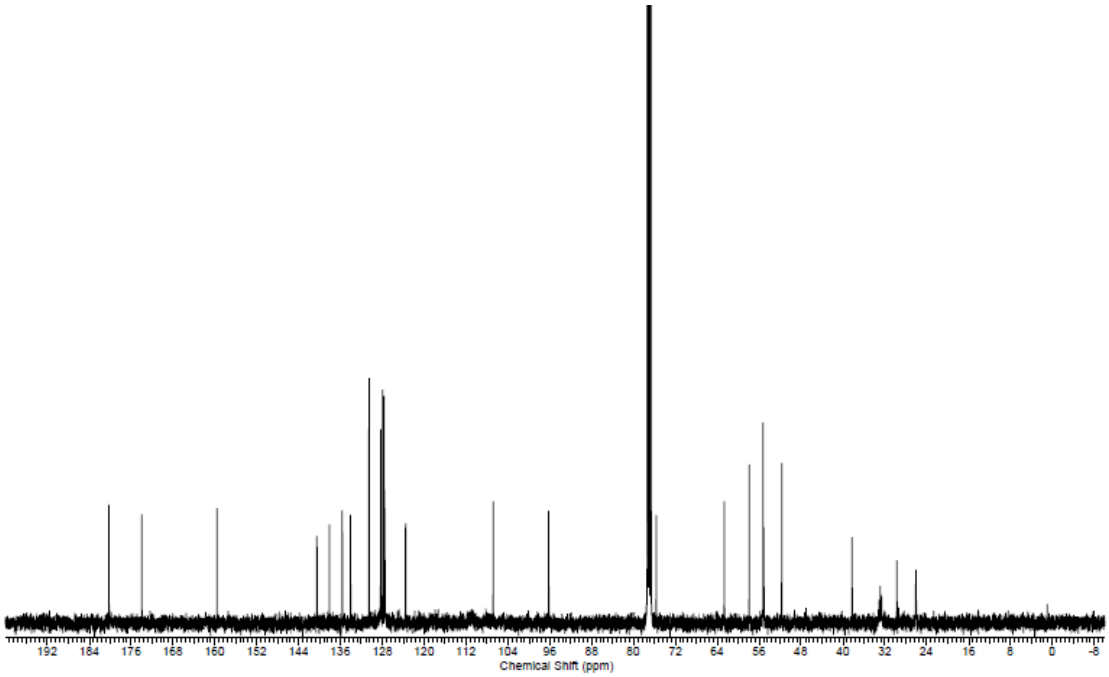


42

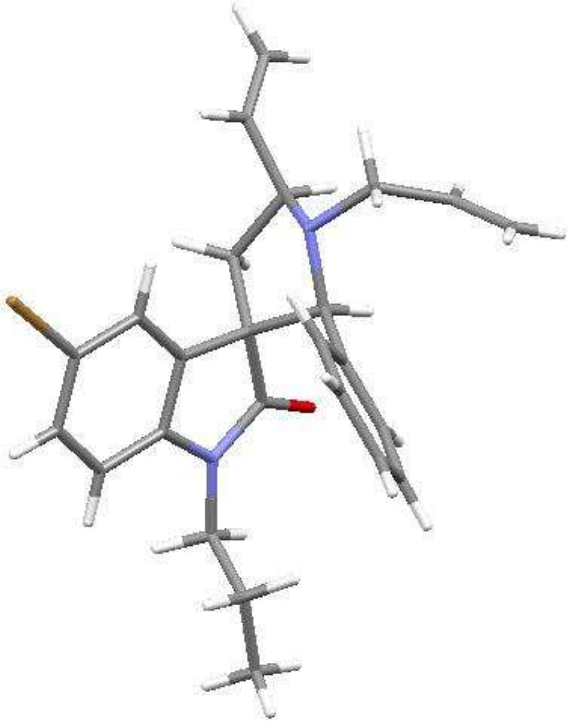
^{1}H NMR (400 MHz, $CDCl_3$)

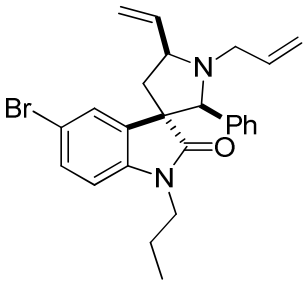


^{13}C NMR (400 MHz, $CDCl_3$)



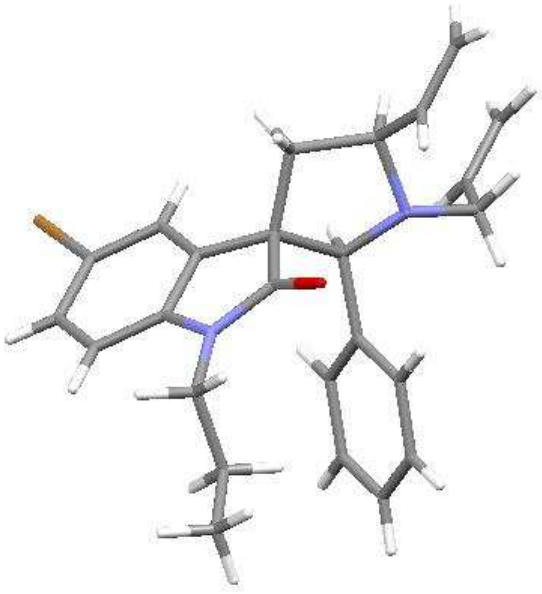
X-ray crystal structure of 19a (CCDC 780379):

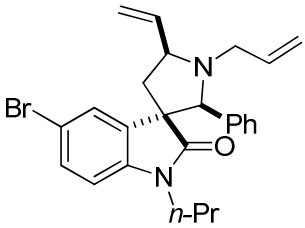




19a

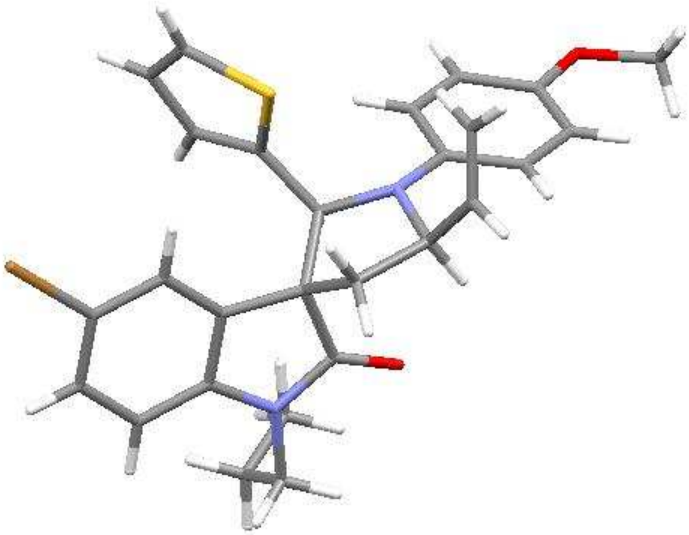
X-ray crystal structure of 19b (CCDC 780380):

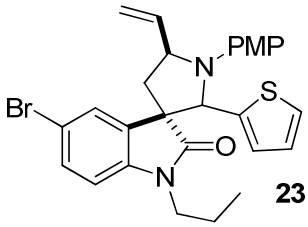




19b

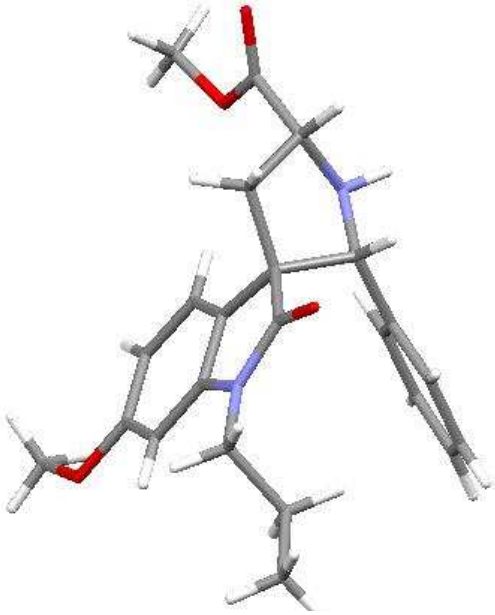
X-ray crystal structure of 23 (CCDC 780381):

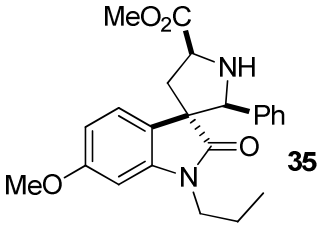




23

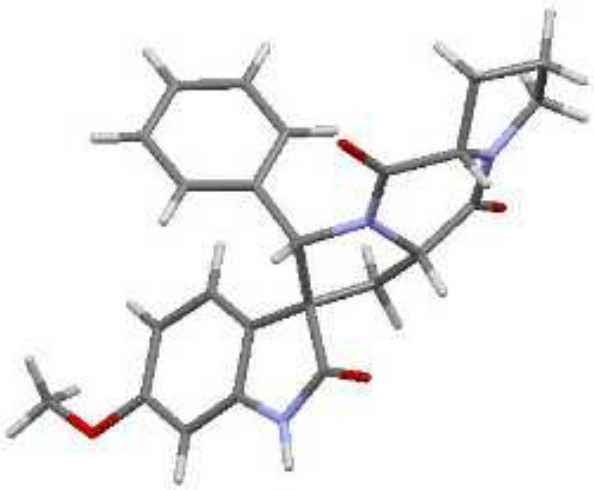
X-ray crystal structure of 35 (CCDC 780382):

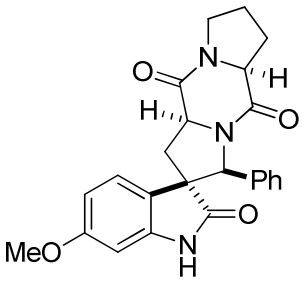




35

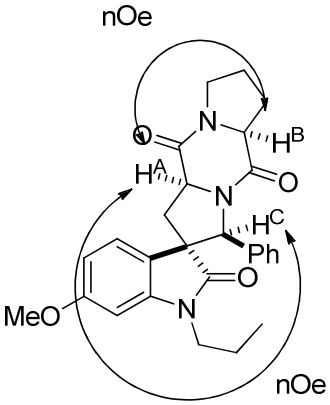
X-ray crystal structure of 40b (CCDC 791298**):**



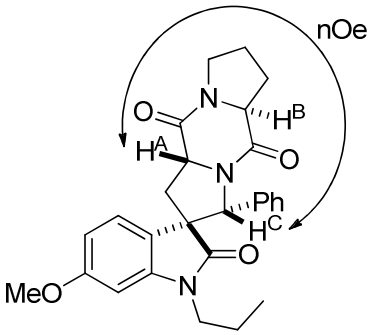


40b

NOE study of diketopiperazines 39a and 39b:



39b



39a

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