Supporting Information

Chiral sulfur derivatives in the allylation of acyl hydrazones: C_2-symmetric bis-sulfinamides as enhanced chiral organic promoters

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General Methods.

All reactions were run under an atmosphere of dry argon using oven-dried glassware and freshly distilled and dried solvents over activated molecula sieves. TLC was performed on Silica Gel GF_{254} (Merck) with detection by charring with phosphomolybdic acid/EtOH. For flash chromatography, silica Gel (Merck 230-400 mesh) was used. Columns were eluted with positive air pressure. Chromatographic eluents are given as volume to volume ratios (v/v). NMR spectra were recorded with a Bruker AMX_{500} (^{1}H, 500 MHz) and Bruker Avance DRX_{500} (^{1}H, 500 MHz) spectrometers. Chemical shifts are reported in ppm, and coupling constants are reported in Hz. Routine spectra were referenced to the residual proton or carbon signals of the solvent. High-resolution mass spectra were recorded on a Kratos MS-80RFA 241-MC apparatus. Optical rotations were determined with a Perkin-Elmer 341 polarimeter. The organic extracts were dried over anhydrous sodium sulfate and concentrated in vacuo. Sulfinyl chlorides were obtained by the method reported by Hermann.[1] Opticaly pure alkanesulfinates were prepared as previously described following DAG methodology.[2]

Menthyl *p*-toluenesulfinate was prepared as described by Solladiè[3] and used as starting material for the synthesis of *N*-Alkyl-*p*-toluenesulfinamides **11** and **12** as previously described.[4]

General procedure for the synthesis of sulfinamides, 6-9.

To a solution of sulfinate ester, **2-5** (12.6 mmol) in THF (50 mL), at -78º C was added a 1M solution of LiHMDS (15 mL, 15 mmol). The reaction was stirred for 1 hour, then MeOH (20 mL) was added, followed by silica gel and the mixture was stirred for 15 min. After evaporation of the solvent, the residue was purified by flash chromatography (AcOEt to AcOEt:MeOH, 9:1).

(*S*)-Ethanesulfinamide, 6.

Prepared from (*S*)-DAG ethanesulfinate, **2**, and purified by column chromatography (AcOEt). Obtained in quantitative yield as a colourless oil. $[\alpha]_D^{20}$: -18 (c 0.7, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.86 (brs, 2H), 2,75 (c, 2H), 1,31 (t, *J*= 5,5 Hz, 3H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 54.9, 14.5. The enantiomeric excess was determined by HPLC analysis using chiralpak AD column (flow rate 1 mL/min, iPrOH:Hexane 2:98, t_R= 49.8 min (**6*R***) and t_R= 57.7 min (**6*S***)).

(*S*)-*p*-Toluenesulfinamide, 7.[5]

Prepared from (*S*)-Menthyl *p*-toluenesulfinate, **5**, and purified by column chromatography (AcOEt:Hexane, from 1:2 to 1:1). Obtained in quantitative yield as a white solid. m.p.: 113º C, [Lit: m.p.:115º C]. $[\alpha]_D^{20}$:+86 (*c* 0.2, $CHCl_3$), [Lit $[\alpha]_D^{20}$: (*S*) +85 (*c* 1.0, $CHCl_3$)]. ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 7.62 - 7.31 (m, 4H), 4.27 (brs, 2H), 2.41 (s, 3H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ:143.4, 141.5, 129.6, 125.3, 29.7. The enantiomeric excess was determined by HPLC analysis using Daicel Chiracel OD column (flow rate 1 mL/min, iPrOH:Hexane 5:95, t_R=29.1 min (**7*R***) and t_R= 34.3 min (**7*S***)).

(*S*)-Isopropylsulfinamide, 8.[2c]

Prepared from (*S*)-DCG isopropylsulfinate, **3**, and purified by column chromatography, from AcOEt to AcOEt: MeOH, 9:1). Obtained as a white solid with a low melting point, in quantitative yield. $[\alpha]_D^{20}$: -16 (*c* 1.1, $CHCl_3$), Lit[2c] $[\alpha]_D^{20}$ = -18 (*c*

0.7 $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.96 (brs, 2H), 2.72 (m, *J*= 6.9 Hz, 1H), 1.27 (d, *J*= 6.9 Hz, 3H), 1.20 (d, *J*= 6.9 Hz, 3H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 54.6, 15.7, 15.6. HRMS Calc. for C_3H_9NOS [M^+]: 107.0405, Found: 107.0406. The enantiomeric excess was determined by HPLC analysis using Daicel Chiracel AD column (flow rate 1 mL/min, iPrOH:Hexane 5:95, t_R=13.3 min (**8*R***) and t_R= 16.8 min (**8*S***)).

(*R*)-*tert*-Butylsulfinamide, 9.[6]

Prepared from (*R*)-DCG *tert*-butylsulfinate, **4**. In this case, 5 equiv of LiHMDS and a longer time of reaction, 48 hours, was need. Purified by flash chromatography: AcOEt:Hexano 1:4 to AcOEt. Obtained as a white solid in 80% yield. $[\alpha]_D^{20}$: +4.0 (*c* 1.0, $CHCl_3$). [Lit[6] $[\alpha]_D^{20}$: +4.9 (*c* 1.0, $CHCl_3$)]. ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.82 (brs, 2H), 1.18 (s, 9H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 55.3, 22.1.

General procedure for the Synthesis of *N*-Alkyl Alkanesulfinamides, 10, 13-16.

To a solution of the corresponding amine (2.2 eq.) in THF at -78ºC, *n*-BuLi (in hexane, 2.0 eq.) was added. The solution was stirred at -78ºC for 30 min. and then it was added on a solution of the corresponding alkanesulfinate **2-4** (1 eq.) in THF, and it was stirred until all the starting material is consumed (observed by TLC, AcOEt:CH_2Cl_2, 1:4), from 0.5 to 1 h. Then it was quenched with saturated NH_4Cl aqueous solution, extracted with AcOEt, washed with saturated $NaHCO_3$ aqueous solution and brine. The organic layer was dried over Na_2SO_4 and the solvent evaporated. The residue was purified by flash chromatography.

(*S*)-*N*-*tert*-Butyl Ethanesulfinamide, 10.

Prepared from *tert*-butylamine and (*S*)-DAG ethanesulfinate **2**. Time of reaction: 45 min. Purified by cc: AcOEt:Hexano, 1:1, to AcOEt. 67 % yield, white solid. M.p.: 72-75° C. $[\alpha]_D^{20}$: +107.2 (*c* 0.5, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.45 (brs, 1H), 2.73-2.68 (m, 2H), 1.58 (s, 9H), 1.25 (t, *J*=7,5 Hz, 3H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 53.6, 50.8, 31.0, 7.4. HRMS Calc.for $C_6H_{16}NOS$ $(M+H)^+$: 150.1031, Found: 150.0952. The enantiomeric excess was determined by HPLC analysis using Daicel Chiracel AD column (flow rate 1 mL/min, iPrOH:Hexane 4:96, t_R=10.7 min (**10*R***) and t_R= 11.9 min (**10*S***)).

(*S*)-*N*-Benzyl Isopropylsulfinamide, 13.

Prepared from benzylamine and (*S*)-DCG isopropanesulfinate **3**. Time of reaction: 45 min. Purified by cc: AcOEt:Hexano, 1:2, to AcOEt . 89 % Yield, white solid. M.p.: 57-59°.$[\alpha]_D^{20}$: + 65.5 (*c* 0.2, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 7.34-7.26 (m, 5H), 4.27 (m, 2H), 3.81 (s, 1H), 2.84-2.79 (m, *J*= 6.9 Hz, 1H), 1.29 (d, *J*= 6.9 Hz, 3H), 1.26 (d, *J*= 6.9 Hz, 3H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 138.2, 128.6, 128.1, 127.7, 53.6, 47.3, 15.6. HRMS Calc. for $C_{10}H_{15}NOS$ $(M)^+$: 197.0873, Found:197.0874. The enantiomeric excess was determined by HPLC analysis using Daicel Chiracel OJ column (flow rate 1 mL/min, iPrOH:Hexane 2:98, t_R=19.2 min (**13*S***) and t_R= 22.6 min (**13*R***)).

(*S*)-*N*-*tert*-Butyl Isopropylsulfinamide, 14.

Prepared from *tert*-butylamine and (*S*)-DCG isopropanesulfinate **3**. Time of reaction: 60 min. Purified by cc: Ether:Hexano, 1:1, to ether. 50% Yield, yellow oil. $[\alpha]_D^{20}$: + 109.2 (*c* 0.2, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.26 (brs, 1H), 2.68-2.60 (m, 1H) 1.29 (s, 9H), 1.22 (d, *J*= 6.8 Hz, 3H), 1.21 (d, *J*= 6.8 Hz, 3H).. ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 54.5, 53.3, 31.0, 15.5, 14.9. HRMS Calc. for $C_7H_{18}NOS$ $(M+H)^+$: 164.1111, Found: 164.1113.

(*R*)-*N*-Benzyl *tert*-butylsulfinamide, 15.[7]

Prepared from benzylamine and (*R*)-DAG *tert*-butylsulfinate **4**. Time of reaction: 45 min. Purified by cc: AcOEt:Hexano, 1:1, to AcOEt. 62% yield. White solid, m.p. 64-65ºC. $[\alpha]_D^{20}$: -31(*c* 1.0, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 7.38-7.30 (m, 5H), 4.39 (dd, *J*= 13.7 Hz, *J*= 4.7 Hz, 1H), 4.29 (dd, *J*= 13.7 Hz, *J*= 4.7 Hz, 1H), 3.49 (s, 1H), 1.29 (s, 9H). HRMS Calc. for $C_{11}H_{17}NOS$ $(M+H)^+$: 212.1110, Found: 212.1109. The enantiomeric excess was determined by HPLC analysis using Daicel Chiracel AD column (flow rate 1 mL/min, iPrOH:Hexane 2:98, t_R=19.8 min (**15*R***) and t_R= 24.1 min (**15*S***)).

(*R*)-*N*-*tert*-Butyl *tert*-butylsulfinamide, 16.

Prepared from *tert*-butylamine and (*R*)-DAG *tert*-butylsulfinate **4**. Time of reaction: 45 min. Purified by cc: AcOEt:Hexano, 1:1, to AcOEt. 50% Yield, white solid. M.p. 79-81ºC. $[\alpha]_D^{20}$: -38 (*c* 2.0, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.01 (brs, 1H), 1.31 (s, 9H), 1.20 (s, 9H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 55.1, 53.1, 31.0, 22.4. HRMS Calc. for $C_8H_{20}NOS$ $(M+H)^+$: 178.1266, Found 178.1265.

General procedure for the synthesis of C_2-Symmetric Bis-(sulfinyl)isophthaldimines, 19-21.

To a solution of the corresponding sulfinamide, **6-9**, (2 eq.) and isophtaldehyde in THF was added $Ti(OiPr)_4$ (4 eq.). When the starting material is consumed, the reaction is poured into water, and after stirring, filtered through a plug of celite, and the filter cake was washed with CH_2Cl_2. The solvent is removed at vacuo and the residue purified by flash chromatography (AcOEt:Hexane, 1:1, to AcOEt).

(*S,S*)-*N,N'*-Bis-(*p*-toluenesulfinyl)isophthaldimine,19.[8]

77% Yield, white solid. M.p.: 129-131ºC. $[\alpha]_D^{20}$:+ 82.2 (c 0.4, $CHCl_3$). [Lit $[\alpha]_D^{20}$:+ 82.6 (c 0.6, $CHCl_3$)]. ^{1}H-NMR (300 MHz, $CDCl_3$) δ: 8.77 (s, 2H), 8.30 (s, 1H), 7.96 (dd, *J*= 7.6 Hz, *J*= 1.4 Hz, 2H), 7.62 (m, 4H), 7.54 (t, *J*= 7.8 Hz, 1H), 7.32 (m, 4H), 2,20 (s, 6H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ:159.6, 141.9, 141.4, 134.6, 133.0, 130.3, 129.9, 129.5, 124.7, 21.4. HRMS Calc. for $C_{22}H_{21}N_2O_2S_2$ $(M+H)^+$: 409.1046, Found: 409.1057.

(*S,S*)-*N,N'*-Bis-(isopropylsulfinyl)isophthaldimine, 20.

60% Yield, white solid. M.p.: 43-45ºC. $[\alpha]_D^{20}$:+14.6 (*c* 1.1, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 8,61 (s,2H), 8.31 (d, *J*= 1.6 Hz, 1H), 7.97 (dd, *J*= 7.7 Hz, *J*= 1.6 Hz, 2H), 7.58 (t, *J*= 7.7 Hz, 1H), 2.98 (m, *J*= 6.9 Hz, 2H), 1.30 (d, *J*= 6.9 Hz, 6H), 1.21 (d , *J*= 6.8 Hz, 6H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 161.6, 134.6, 132.8, 129.8, 53.9, 14.7, 13.5. HRMS Calc. for $C_{14}H_{21}N_2O_2S_2$ $(M+H)^+$: 313.1045, Found: 313.1044.

(*R,R*)-*N,N'*-Bis-(*tert*-butylsulfinyl)-isophthaldimine, 21.[9]

72% Yield, foam. $[\alpha]_D^{20}$: -34 (*c* 0.3, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 8.65 (s, 2H), 8.32 (s,1H), 8.03 (dd, *J*= 1.5 Hz, *J*= 7.6 Hz, 2H), 7.61 (t, *J*= 7.7 Hz, 1H), 1.27 (s, 18H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ:161.7, 134.8, 132.6, 130.1, 129.6, 58.0, 22.6. HRMS Calc. for $C_{16}H_{25}N_2O_2S_2$ $(M+H)^+$: 341.1358. Found: 341.1357.

Synthesis of hexanedialdehyde.[10]

A solution of cyclohexene (3.0 g, 36.5 mmol) in CH_2Cl_2 (100mL) at -78ºC was purged with oxygen for 5 min. Then, ozone was bubbled through the reaction for 4 h. Triphenylphosphine (9.6 g, 36.5 mmol) was then added, and the reaction was allowed to warm to room temperature overnight. The solvent was removed at the rotary evaporator, cooling at 0ºC, and a mixture of ether:pentane, 3:2, was added to the residue and filtered

through a pad of celite. The solvent was removed at vacuo and the residue purified by flash chromatography (ether:pentane, 3:2) to give the corresponding dialdehyde.

General procedure for the synthesis of C_2-symmetric Bis-(sulfinyl)hexanediimines, 22,23.

To a solution of the corresponding sulfinamide, **4-7**, (2 eq.) in THF was added Ti(O*i*Pr)$_4$ (4 eq.), and then 1,6-hexanedialdehyde (1 eq.). When the starting material is consumed (24 h.), the reaction is poured into water, and after stirring, filtered through a plug of celite, and the filter cake was washed with AcOEt. The solvent is removed at vacuo and the residue purified by flash chromatography (AcOEt:Hexane, 1:1, to AcOEt).

(*S,S*)-*N,N'*-Bis-(isopropylsulfinyl)-1,6-hexanediimine, 22.

64 % Yield, colourless oil. $[\alpha]_D^{20}$: + 228 (*c* 1.0, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 8.10 (t, *J*= 4.5 Hz, 2H), 2.82 (m, 2H), 2.60-2.56 (m, 4H), 1.76-1.73 (m, 4H), 1.28 (d, *J*= 6.9 Hz, 6H), 1.17 (d, *J*= 6.9 Hz, 6H). ^{13}C-NMR (125 MHz, $CDCl_3$)δ:168.5, 53.2, 35.6, 24.8, 14.6, 13.2. HRMS calc. for $C_{12}H_{25}N_2O_2S_2$ $(M+H)^+$: 293.1358, Found: 293.1357.

(*R,R*)-*N,N'*-Bis-(*tert*-butylsulfinyl)-1,6-hexanediimine, 23.[9]

60% Yield, colourless oil. $[\alpha]_D^{20}$: - 262 (*c* 0.3, $CHCl_3$). ^{1}H-NMR (500 MHz $CDCl_3$) δ: 8.10 (t, *J*= 4.5 Hz, 2H), 2.61-2.58 (m, 4H), 1.77-1.74 (m, 4H), 1.22(s, 18H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 168.8, 56.5, 35.7, 24.9, 22.3.

General procedure for the synthesis of C_2-symmetric Bis-sulfinamides, 24-28.

To a solution of the corresponding C_2-symmetric Bis-sulfinylimine, **19-23**, in MeOH is added at 0ºC, sodium borohydride (2 eq.). After stirring for 30 min, acetone is added and the reaction is stirred another 5 min. The solvent is removed at vacuo and the residue is purified by flash chromatography.

(*S,S*)-1,3-Bis-(*p*-tolylsulfinamidemethyl)benzene, 24.

91% Yield, white solid. M.p.: 199-201ºC. $[\alpha]_D^{20}$: +45 (*c* 0.9, $CHCl_3$). ^{1}H-NMR (300 MHz, $CDCl_3$) δ: 7.65-7.55 (m, 4H), 7.44-7.08 (m, 8H), 4.55 (m, 2H), 4.20-3.78 (m, 4H), 2.41 (s, 6H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 141.5, 140.9, 138.4, 129.7, 129.0, 128.2, 127.7, 126.0, 44.4, 21.2. HRMS Calc for $C_{22}H_{25}N_2O_2S_2(M+H)^+$: 413.1358, Found: 413.1357.

(*S*,*S*)-1,3-Bis-(isopropylsulfinamidemethyl)benzene, 25.

85 % Yield, colourless oil. $[\alpha]_D^{20}$: + 43(*c* 1.5, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 7.35-7.26 (m, 4H), 4.28 (d, *J*= 5.5 Hz, 2H), 4.27 (d, *J*= 6.7 Hz, 2H), 3.70 (bs, 2H), 2.85-2.79 (m, *J*= 6.9 Hz, 2H), 1.30 (d, *J*= 6.9 Hz, 6H), 1.27 (d, *J*= 6.9 Hz, 6H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ; 133.5, 123.9, 122.7, 122.4, 48.5, 42.1, 10.4. HRMS Calc. for $C_{14}H_{25}N_2O_2S_2$ $(M+H)^+$: 317.1358. Found: 317.13574.

(*R*,*R*)-1,3-Bis-(*tert*-butylsulfinamidemethyl)benzene, 26.

85% Yield, colourless oil. $[\alpha]_D^{20}$: -33 (*c* 1.0, $CHCl_3$). ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 7.35-7.29 (m, 4H), 4.39 (dd, *J*= 13.8 Hz, *J*= 4.7 Hz, 2H), 4.29 (dd, *J*= 13.8 Hz, *J*= 5.3 Hz, 2H), 3.57 (m, 2H,), 1.27 (s, 18H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 139.0, 128.9, 127.7, 127.4, 49.2, 29.6, 22.6. HRMS Calc. For $C_{16}H_{29}N_2O_2S_2(M+H)^+$:345.1671. Found: 345.1670.

(*S*,*S*)-*N*,*N'*-Bis-(isopropylsulfinyl)-1,6-hexanediamine, 27.

82 % Yield, colourless oil. $[\alpha]_D^{20}$: + 56 (*c* 1.1, $CHCl_3$). ^{1}H-NMR (500 MHz $CDCl_3$) δ: 3.43 (bs, 2H), 3.08-3.00 (m, 4H), 2.68 (m, *J*= 6.9 Hz, 2H), 1.53-1.48 (m, 4H), 1.32-1.30 (m, 4H), 1.19 (d, *J*= 6,9 Hz, 6H), 1.16 (d, *J*= 6.9 Hz, 6H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 55.6, 45.0, 30.9, 26.3, 15.5.

(*R*,*R*)-*N*,*N'*-Bis-(*tert*-butylsulfinyl)-1,6-hexanediamine, 28.

79% Yield, white solid. M.p.: 79-82ºC. ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 3.25-3.06 (m, 6H), 1.59 (m, 4H), 1.35 (m, 4H), 1.20 (s, 18H). ^{13}C-NMR (125 MHz, $CDCl_3$) δ; 55.6, 45.6, 30.9, 26.3, 22.6. HRMS Calc. for $C_{14}H_{33}N_2O_2S_2(M+H)^+$: 325.2064. Found: 325.1985.

Enantioselective allylation of *N*-(benzoyl)isobutylhydrazone. General method: (Kobayashi conditions) To a solution of N-(benzoyl)isobutylhydrazone **17** (20.5 mg, 0.108 mmol), the chiral sulfinamide **6-16** (0.324 mmol) or chiral C_2-symmetric bissulfinamide **24-28** (0.108 mmol), and 2-methyl-2-butene (27 μL, 0.054 mmol) in dichloromethane (0.7 mL) was added allyltrichlorosilane **2** (23 μL, 0.162 mmol) at -78ºC. After stirred at -78ºC for the time indicated in Tables 1 and 2, the reaction was quenched by adding saturated aqueous $NaHCO_3$ (1 mL). After warmed to room temperature, saturated NaCl aqueous solution was added, and the mixture was extracted with dichloromethane (three times). The combined organic layers were dried over Na_2SO_4, filtered and concentrated in vacuo. The residue was purified by column

chromatography (AcOEt: hexanes, 1:4) to afford the corresponding *N*'-(1-isopropylbut-3-enyl)benzohydrazide **18** in high chemical yields as a white solid, mp 73-74ºC.

The enantiomeric ratios of the obtained hydrazides were determined by HPLC analysis using chiralpack AD column, under the following conditions: ***N*'-(1-isopropylbut-3-enyl)benzohydrazide, 18**: flow rate 1 mL/min, iPrOH:Hexane 3:97, 30ºC, t_R= 27.9 min. (**18*R***) and t_R= 33.2 min (**18*S***); ***N*'-(1-cyclohexylbut-3-enyl)benzohydrazide, 33**: flow rate 1 mL/min, iPrOH:Hexane 10:90, 30ºC, t_R= 9.2 min. (**33*R***) and t_R= 23.3 min (**33*S***); ***N*'-(1-phenylbut-3-enyl)benzohydrazide, 34**: flow rate 0.5 mL/min, iPrOH:Hexane 3:97, 30ºC, t_R= 128.2 min. (**34*R***) and t_R= 136.3 min (**34*S***); ***N*'-[1-(*p*-chlorophenyl)but-3-enyl)benzohydrazide, 35**: flow rate 0.7 mL/min, iPrOH:Hexane 3:97, 30ºC, t_R= 59.4 min. (**35*R***) and t_R= 65.6 min (**35*S***).

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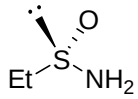
^{1}H NMR (500 MHz, $CDCl_3$)



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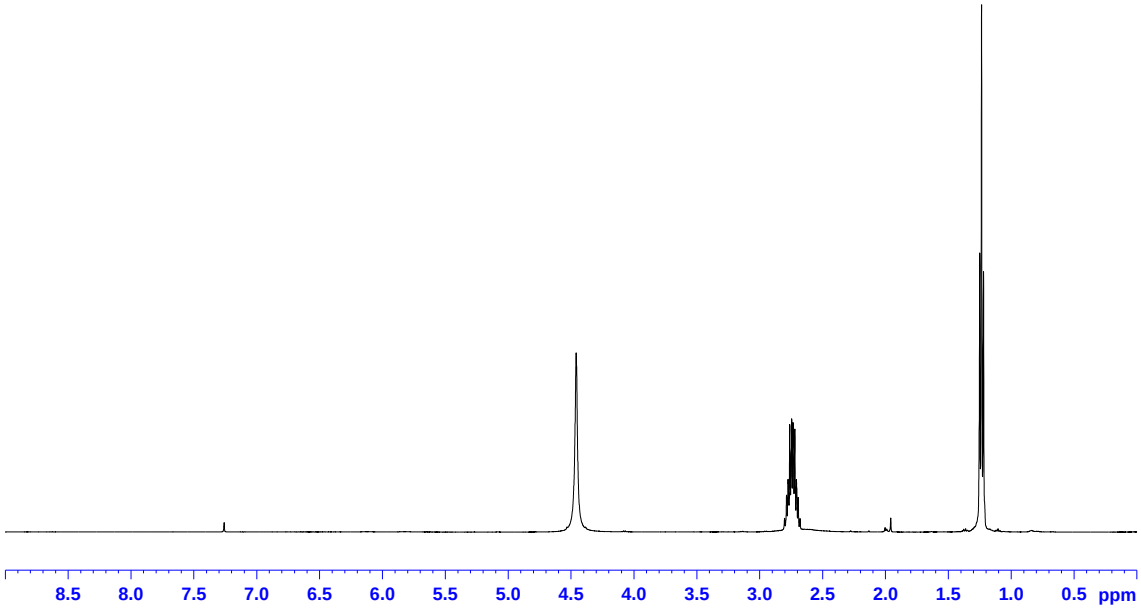
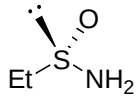
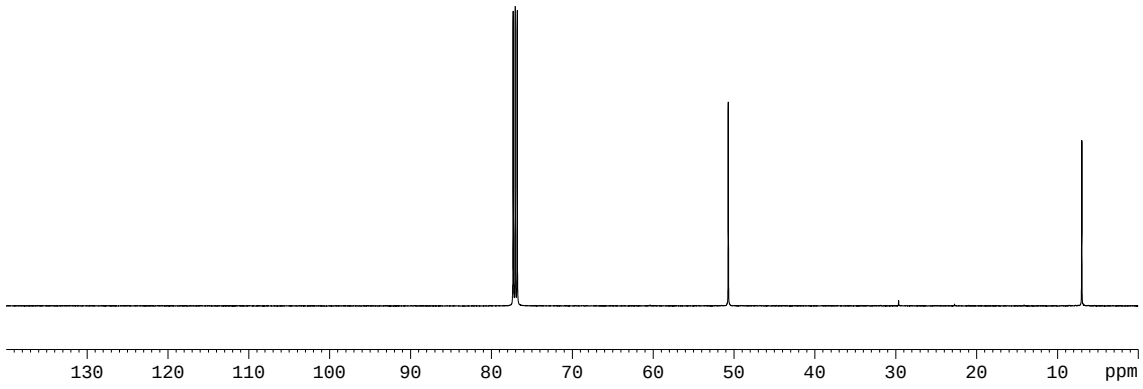
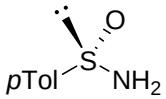




6

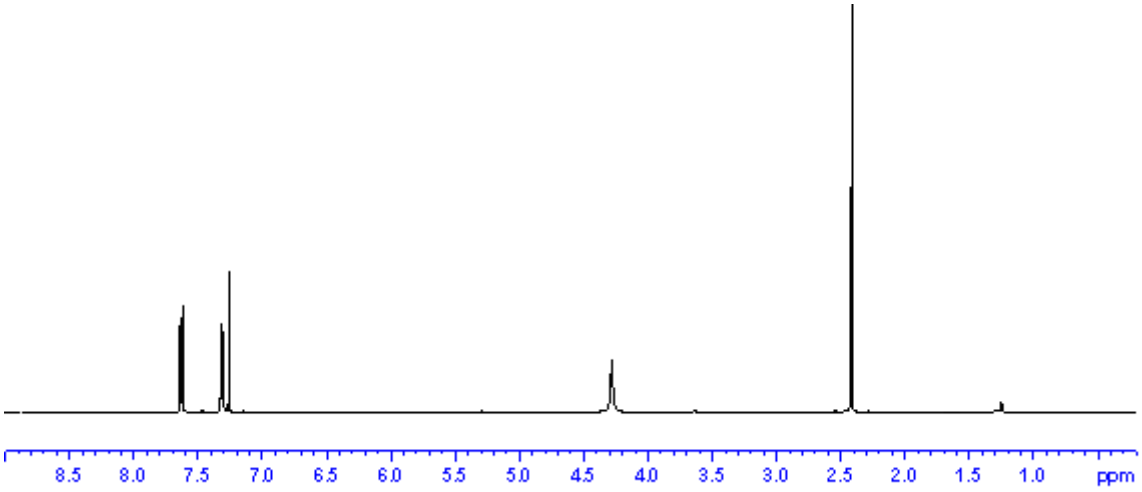
^{13}C NMR (125.5 MHz, $CDCl_3$)



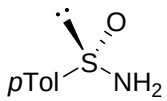


7

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



^{13}C NMR (125.5 MHz, $CDCl_3$)



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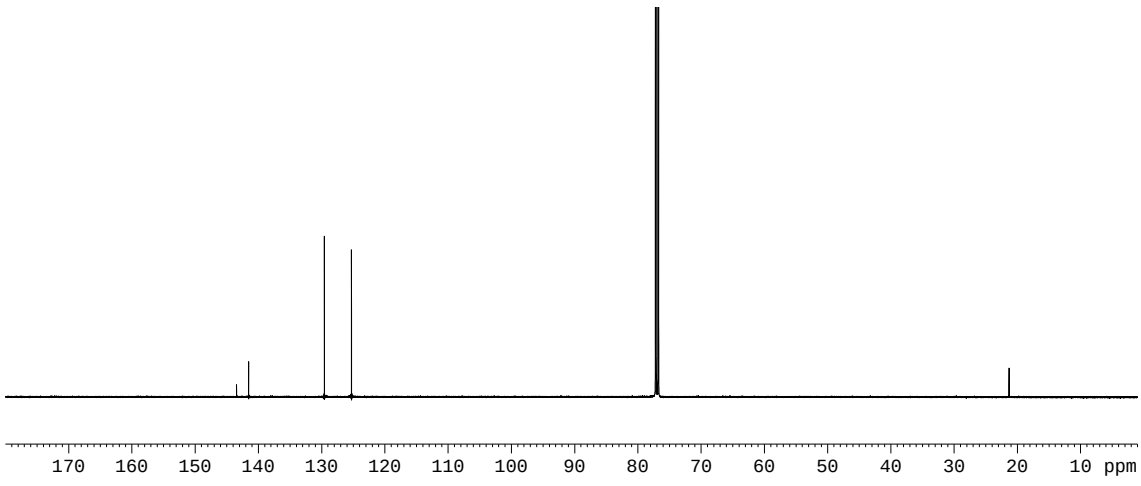
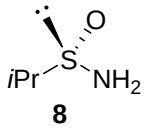


^{1}H NMR (500 MHz, $CDCl_3$)



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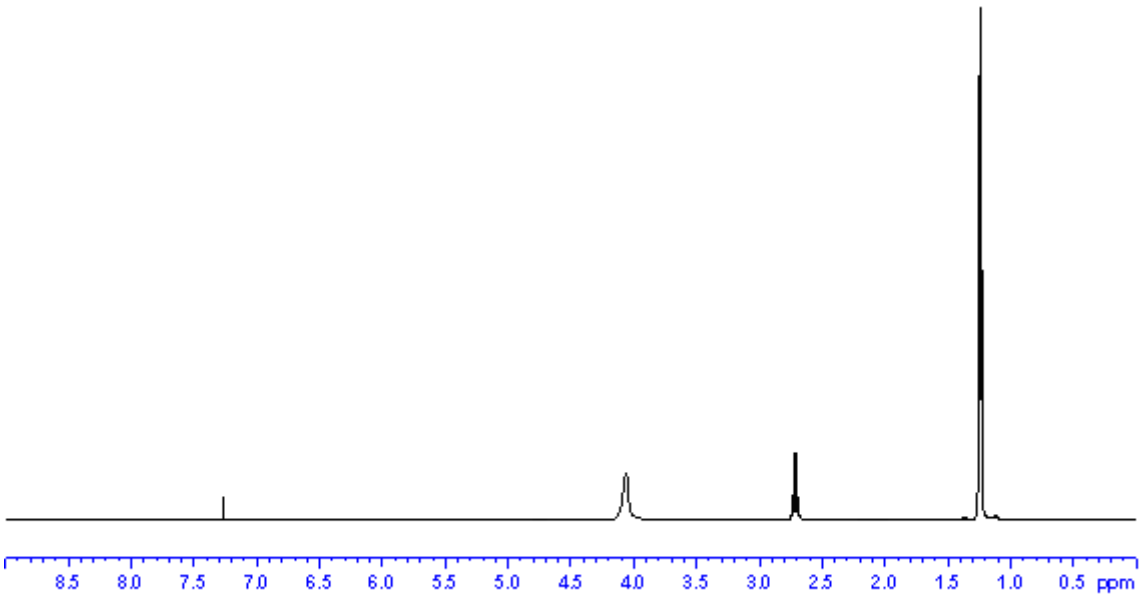
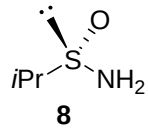


^{13}C NMR (125.5 MHz, $CDCl_3$)



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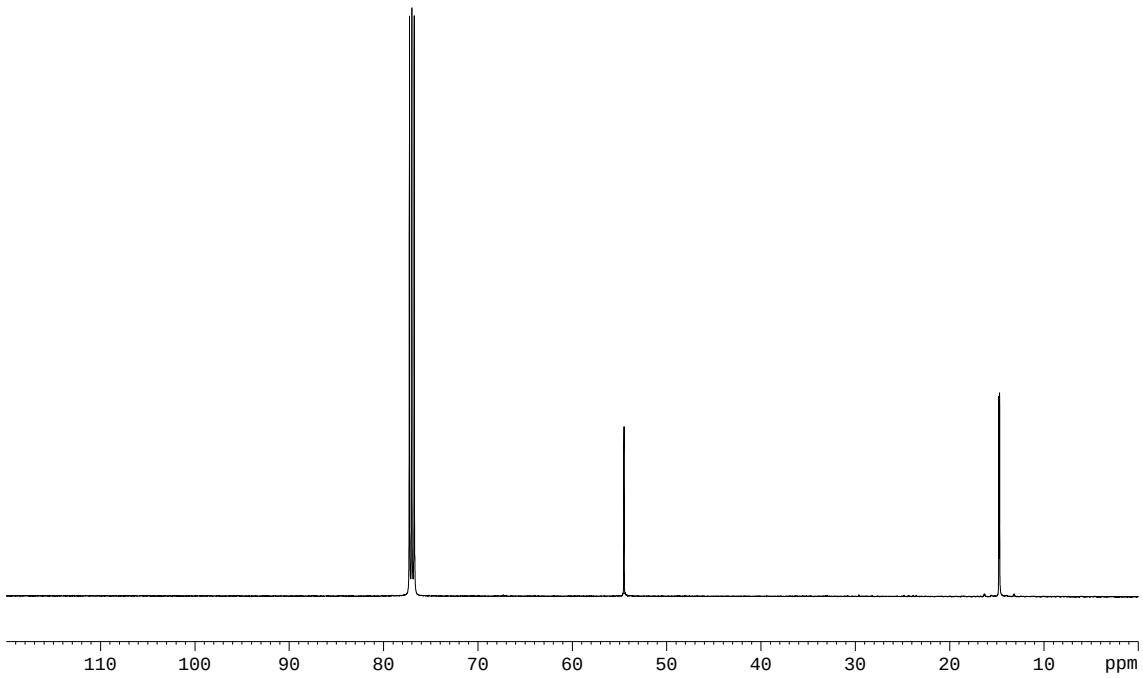
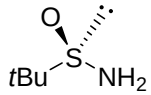
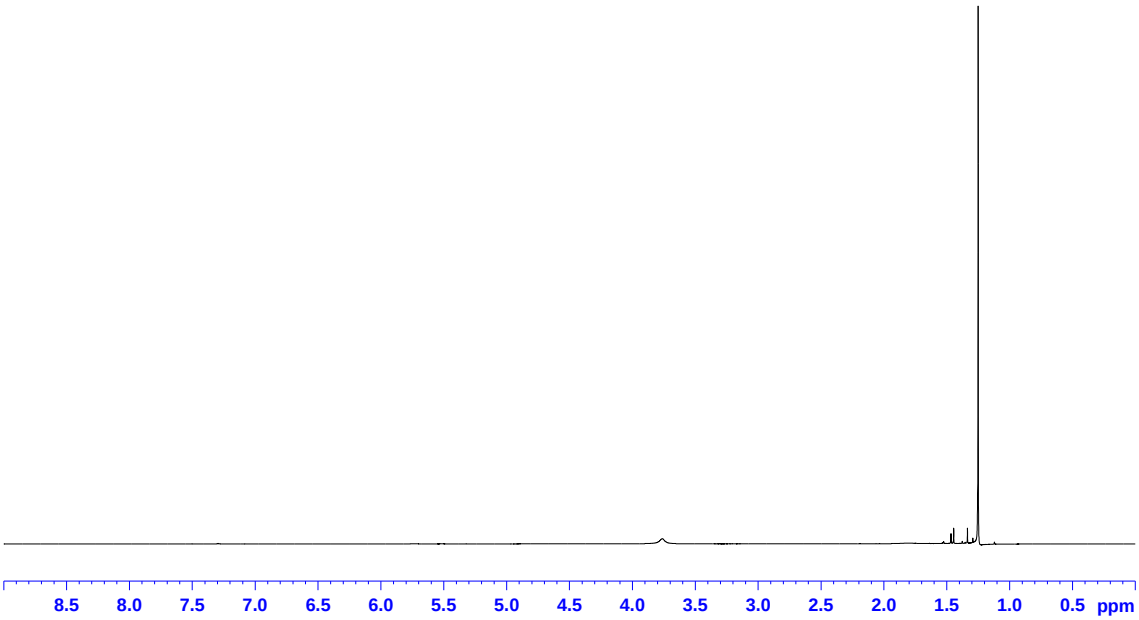
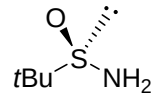




9

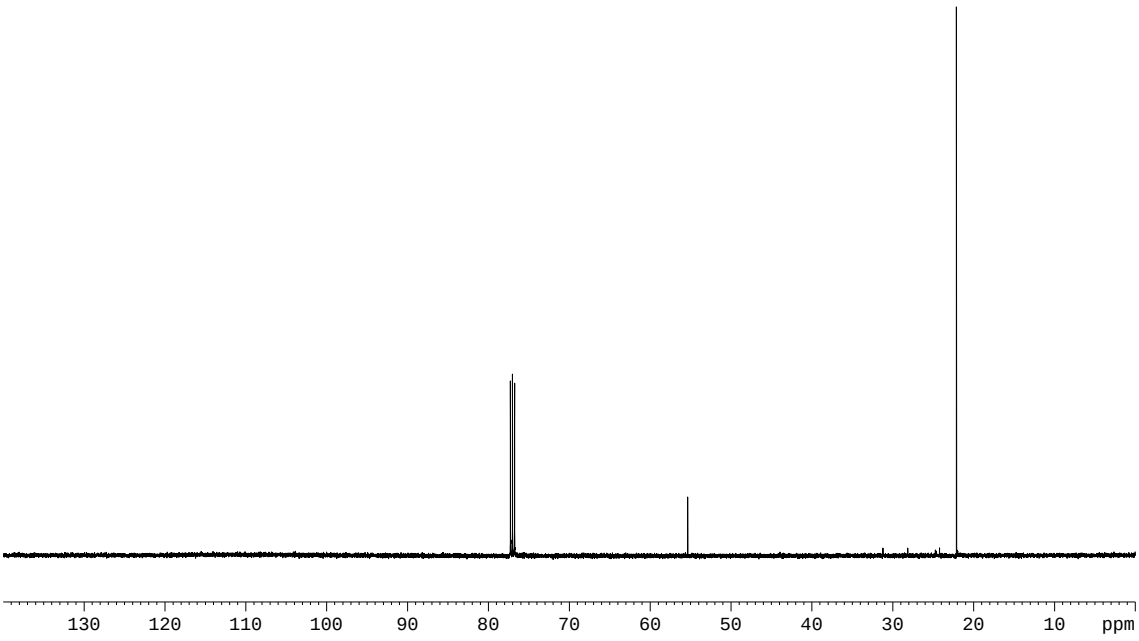
^{1}H NMR (500 MHz, $CDCl_3$)



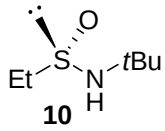


9

^{13}C NMR (125.5 MHz, $CDCl_3$)



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



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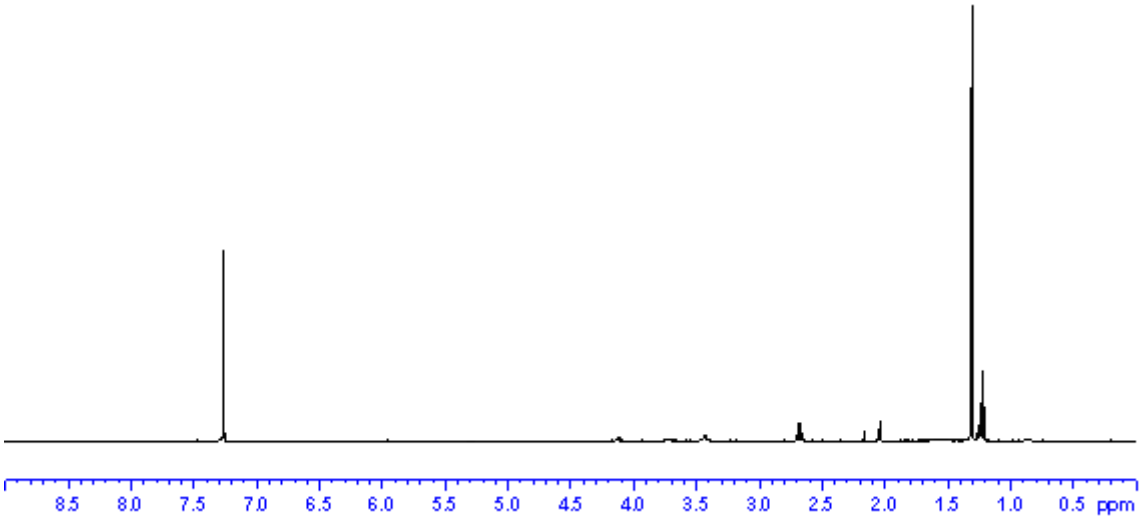

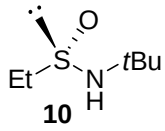

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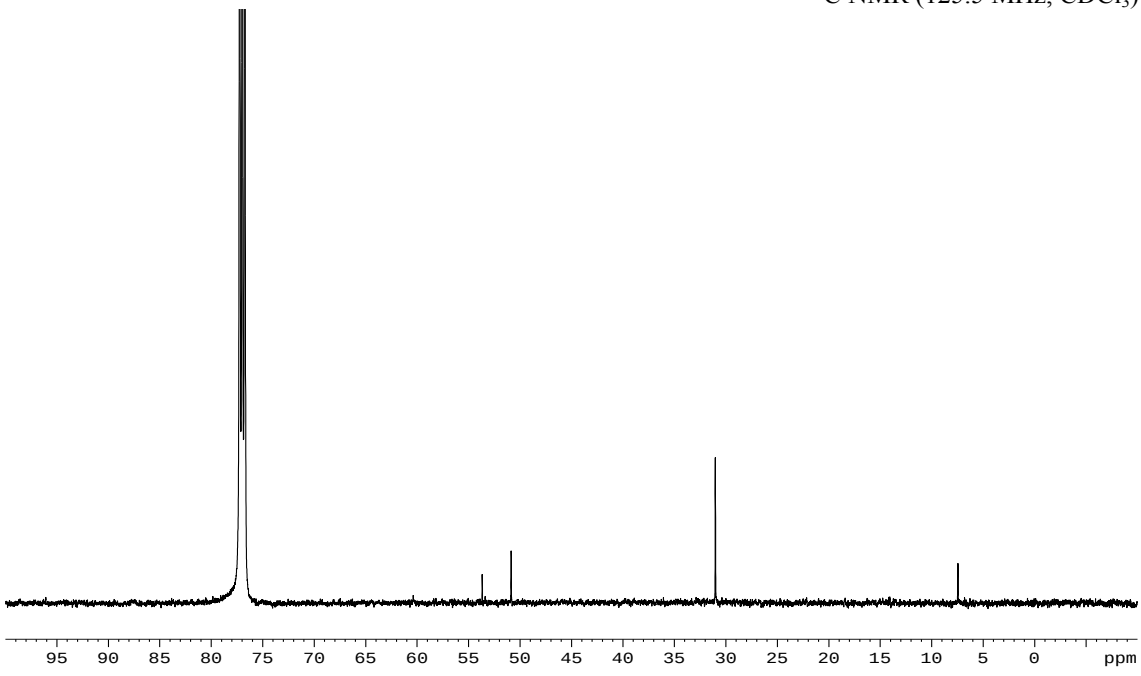
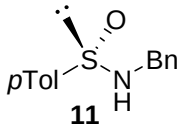
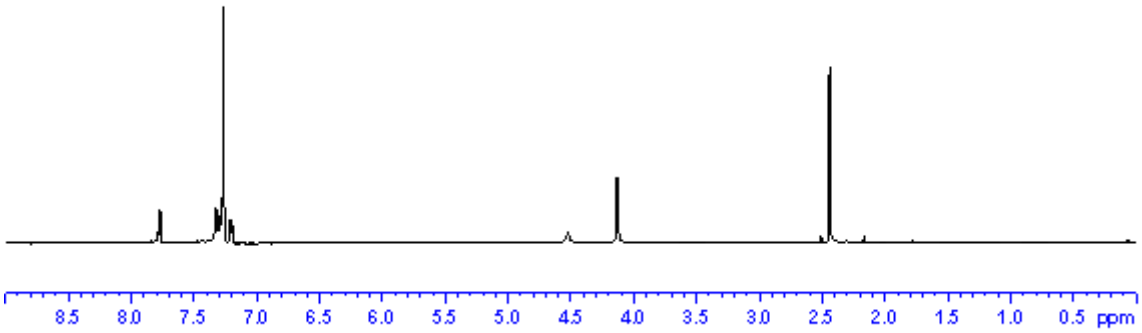
^{13}C NMR (125.5 MHz, $CDCl_3$)



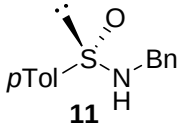


11

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



^{13}C NMR (125.5 MHz, $CDCl_3$)



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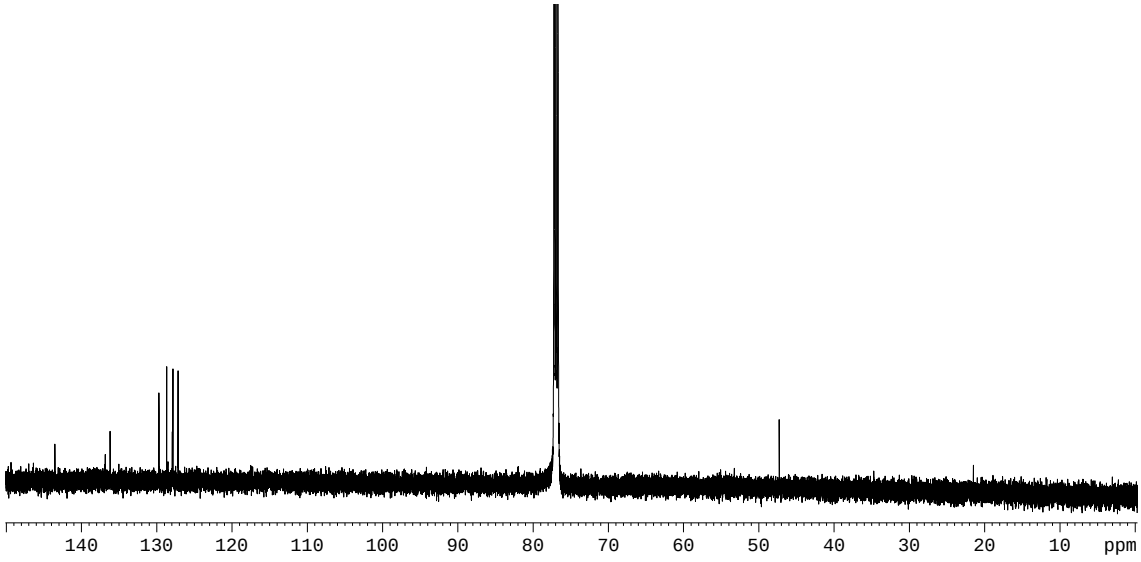
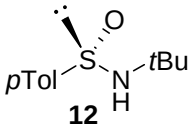
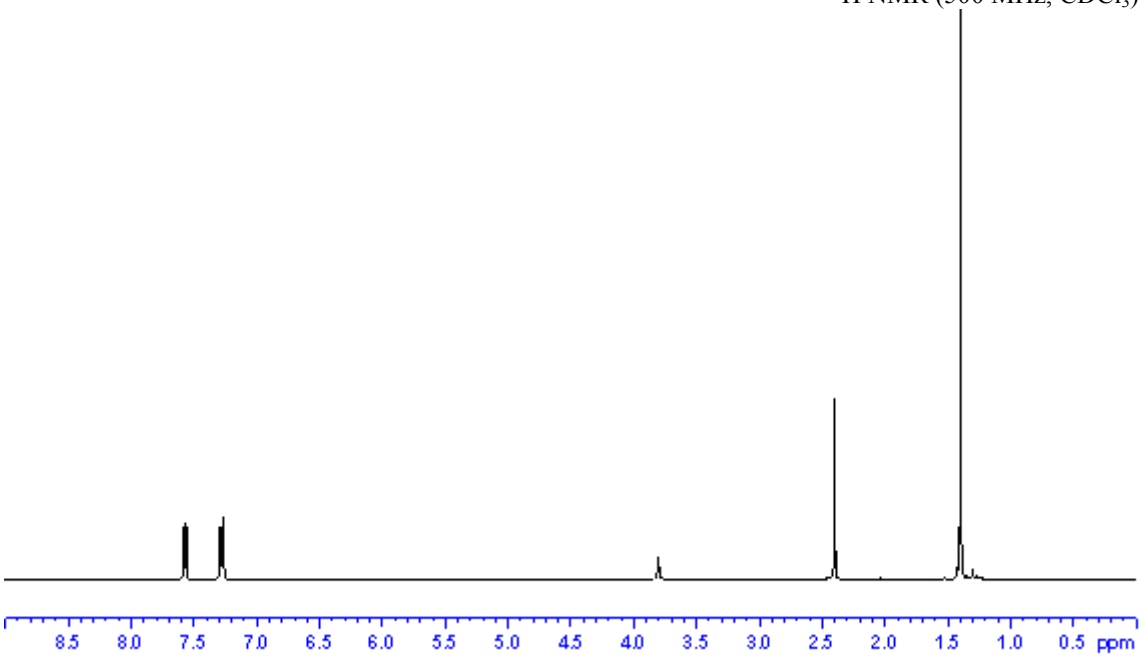
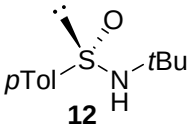




12

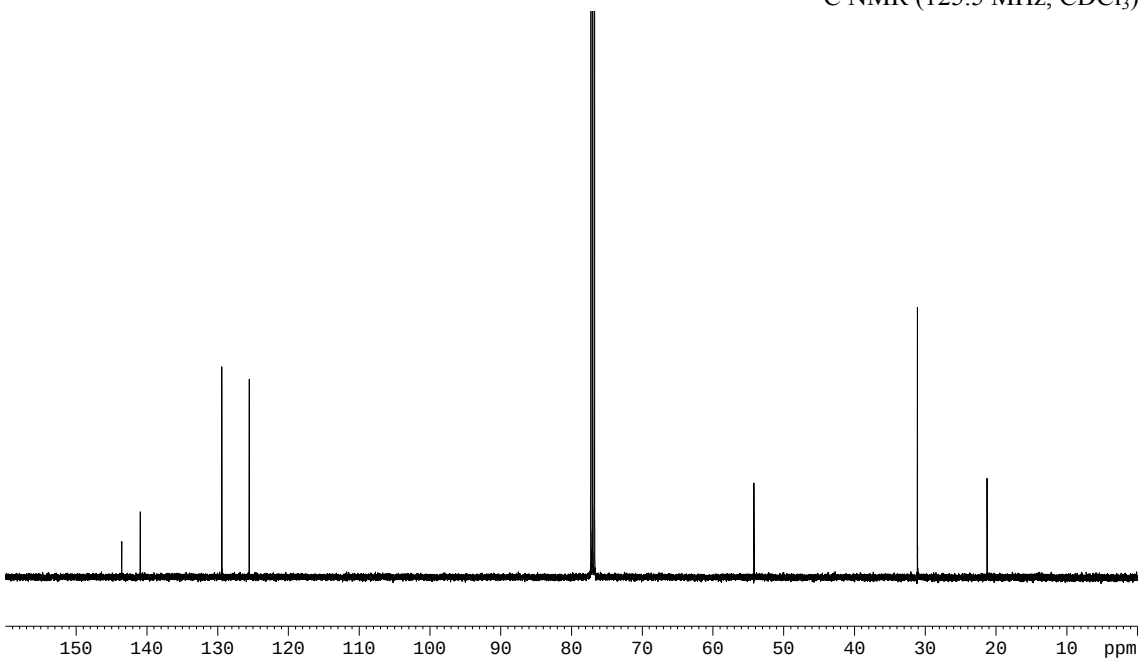
^{1}H NMR (500 MHz, $CDCl_3$)

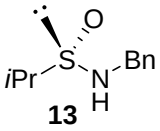




12

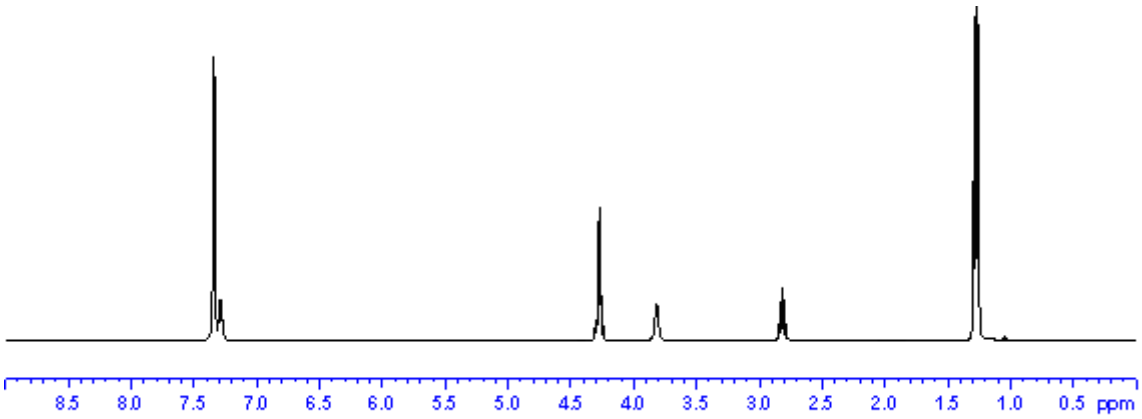
^{13}C NMR (125.5 MHz, $CDCl_3$)

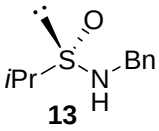




13

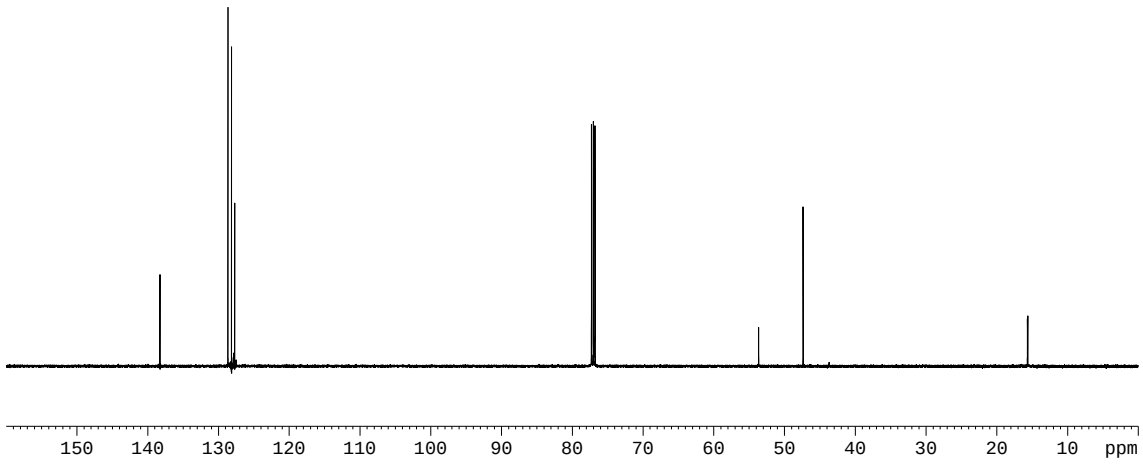
^{1}H NMR (500 MHz, $CDCl_3$)

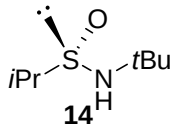




13

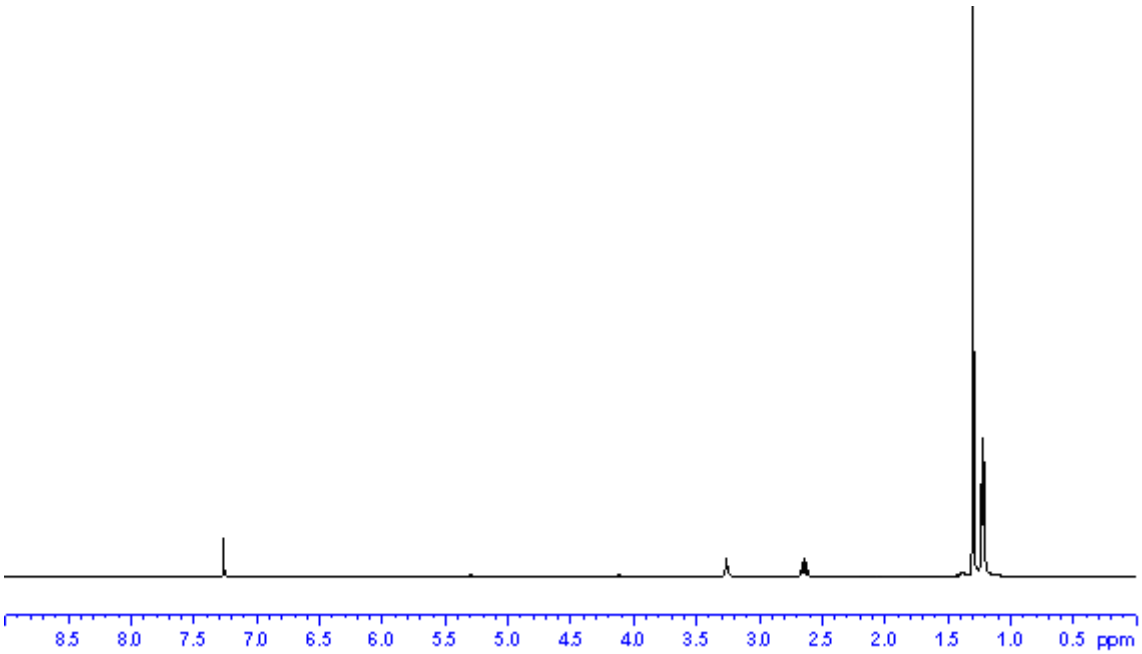
^{13}C NMR (125.5 MHz, $CDCl_3$)

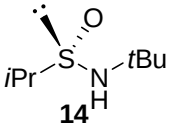




14

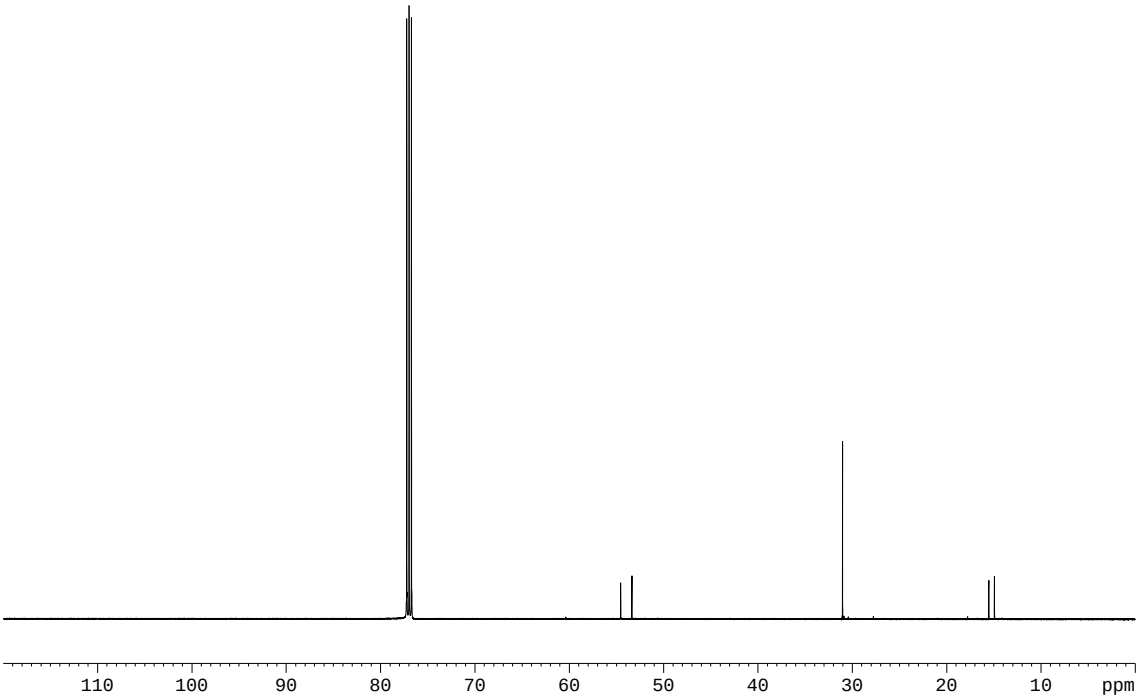
^{1}H NMR (500 MHz, $CDCl_3$)

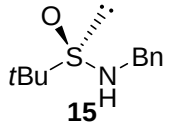




14

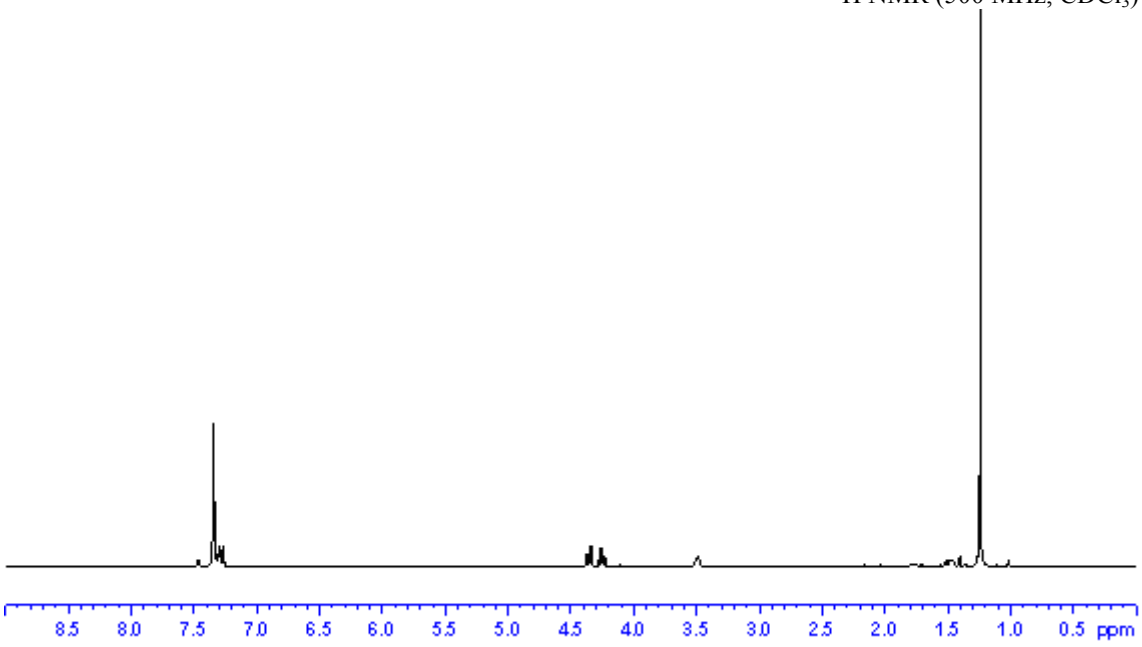
^{13}C NMR (125.5 MHz, $CDCl_3$)

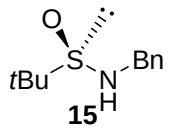




15

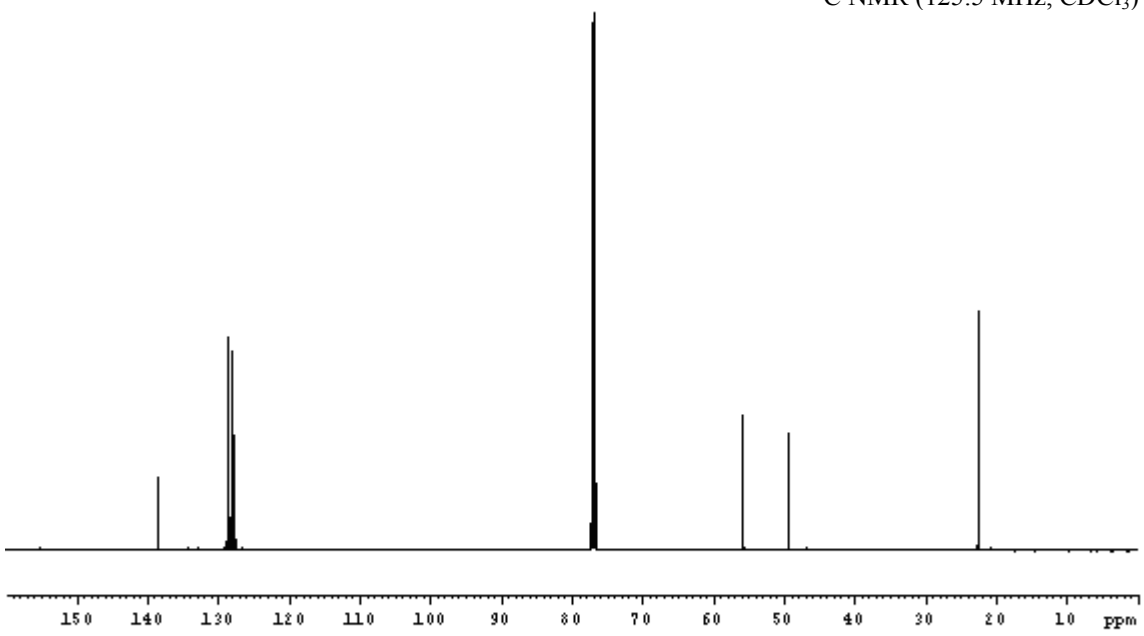
^{1}H NMR (500 MHz, $CDCl_3$)

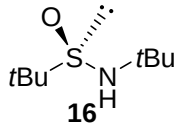




15

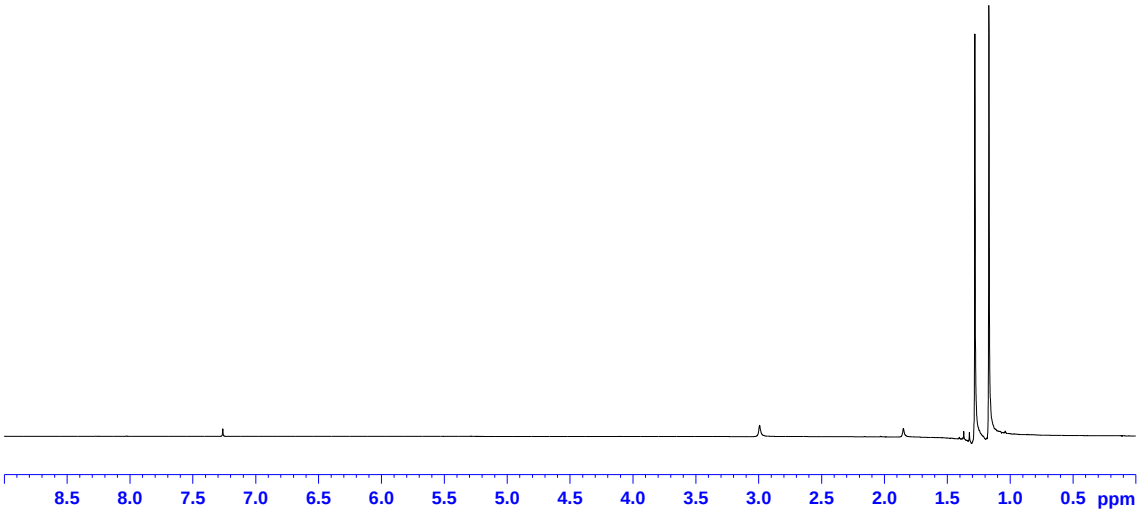
^{13}C NMR (125.5 MHz, $CDCl_3$)

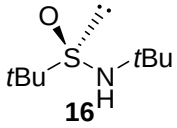




16

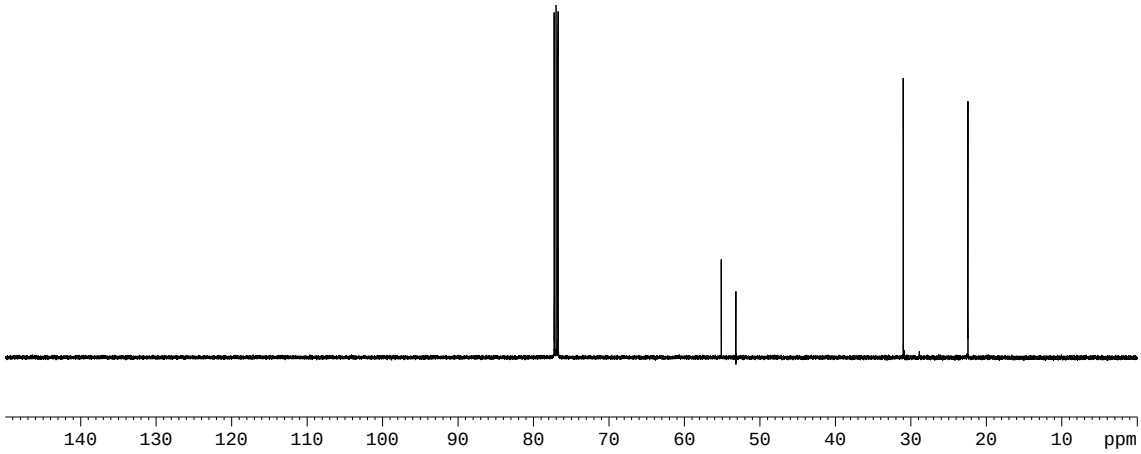
^{1}H NMR (500 MHz, $CDCl_3$)

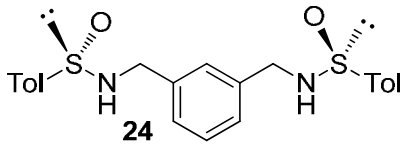




16

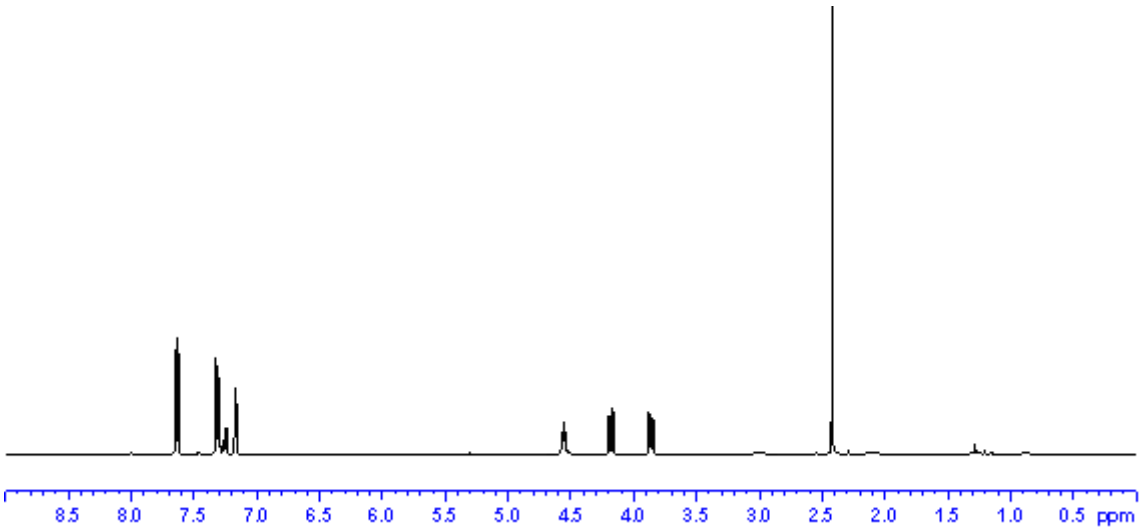
^{13}C NMR (125.5 MHz, $CDCl_3$)

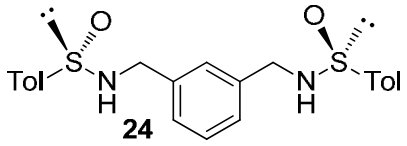




24

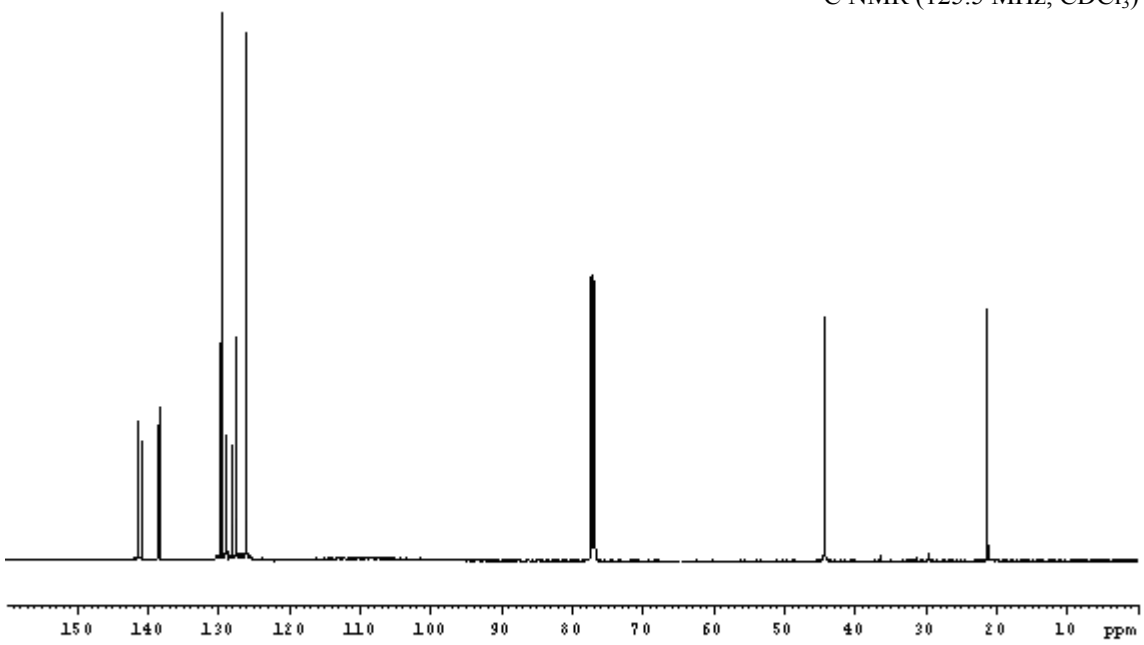
^{1}H NMR (500 MHz, $CDCl_3$)

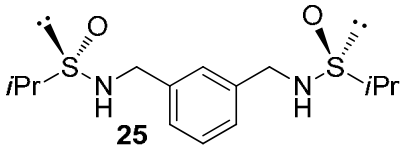




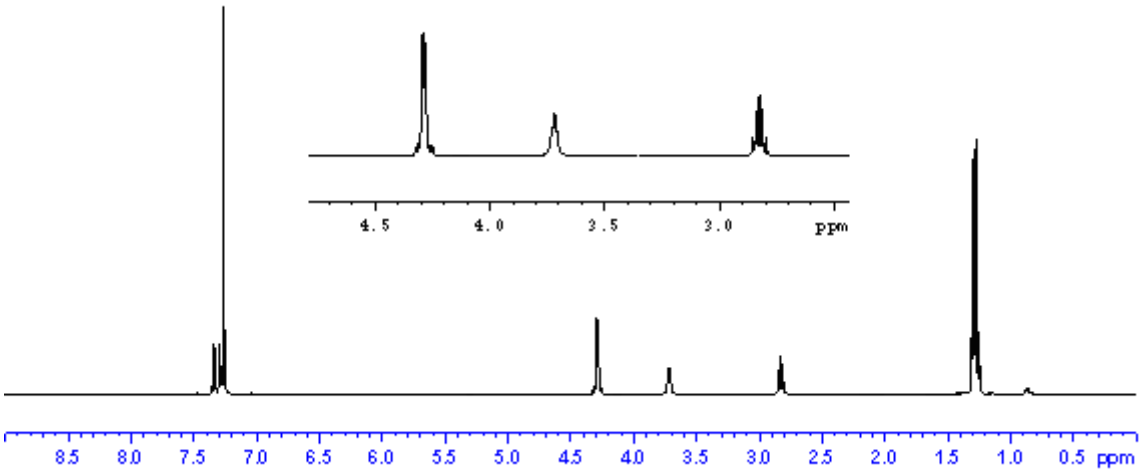
24

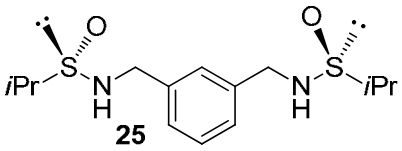
^{13}C NMR (125.5 MHz, $CDCl_3$)



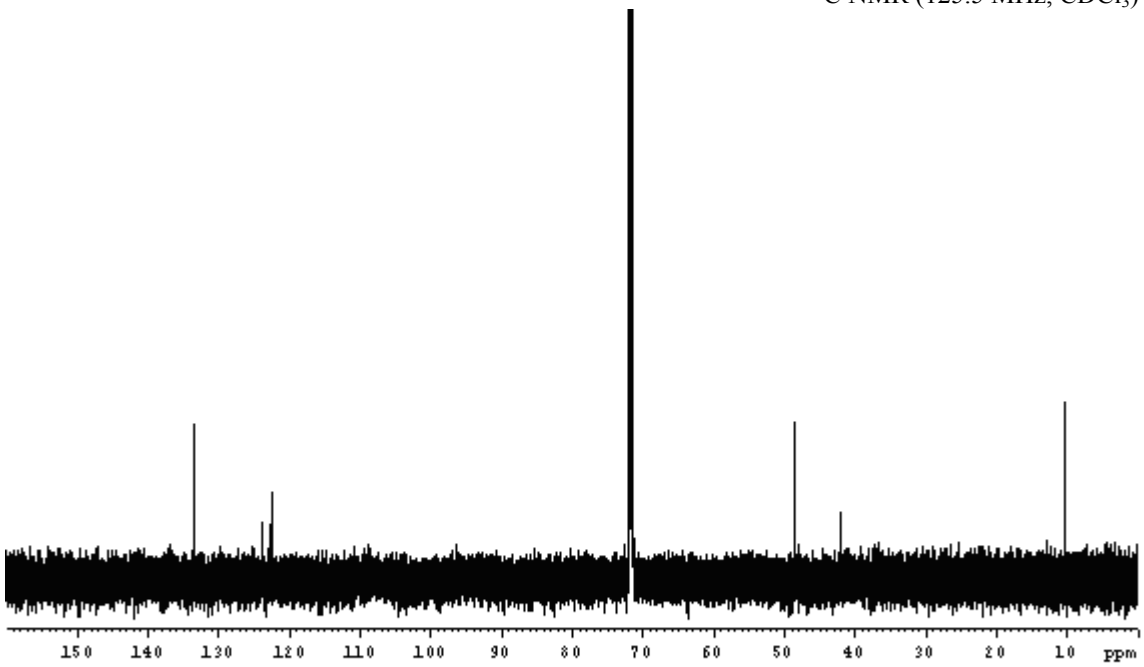


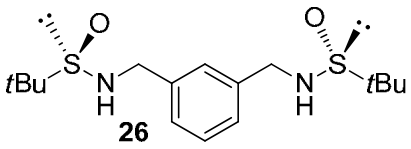
^{1}H NMR (500 MHz, $CDCl_3$)





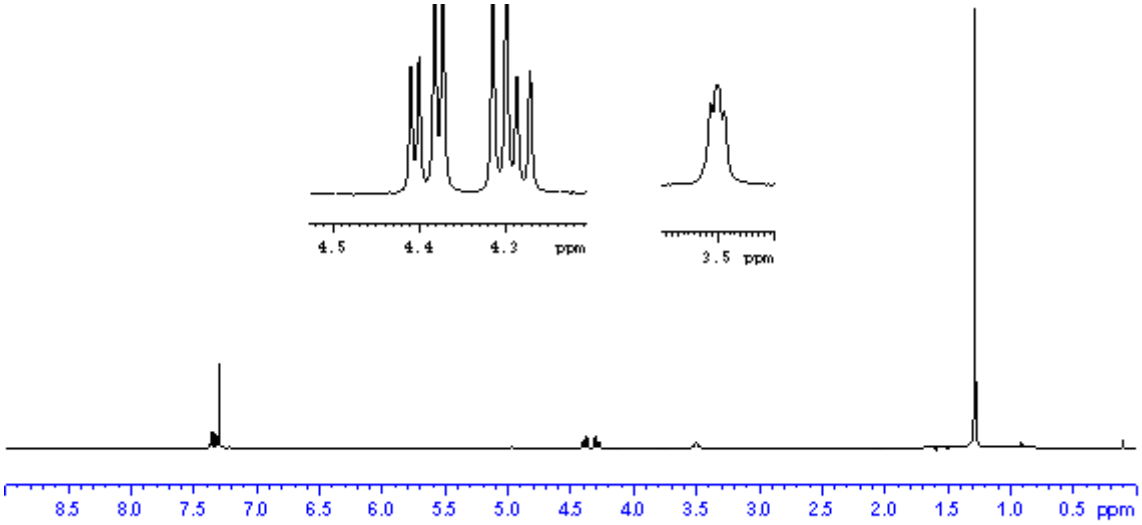
^{13}C NMR (125.5 MHz, $CDCl_3$)

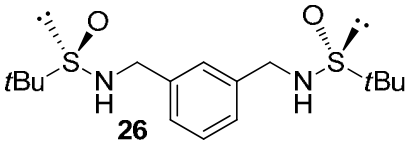




26

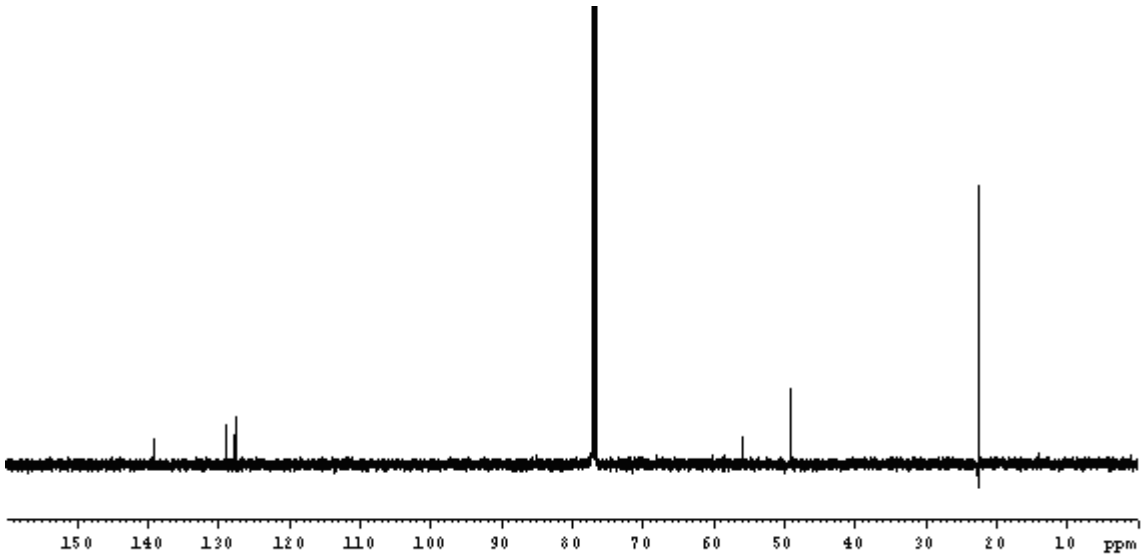
^{1}H NMR (500 MHz, $CDCl_3$)

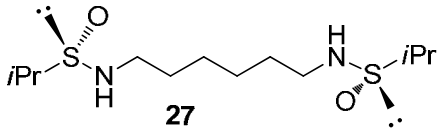




26

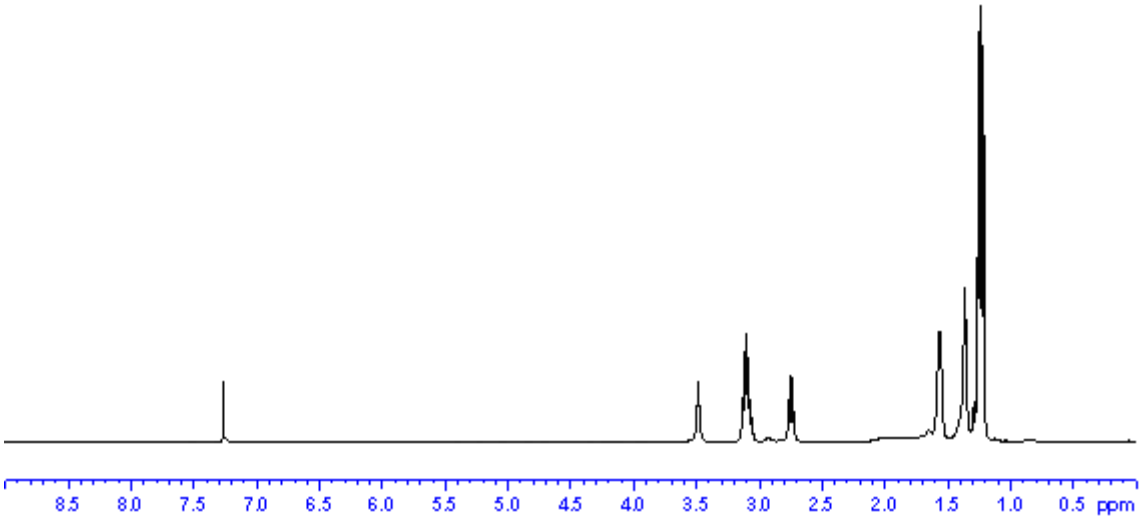
^{13}C NMR (125.5 MHz, $CDCl_3$)

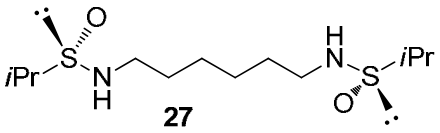




27

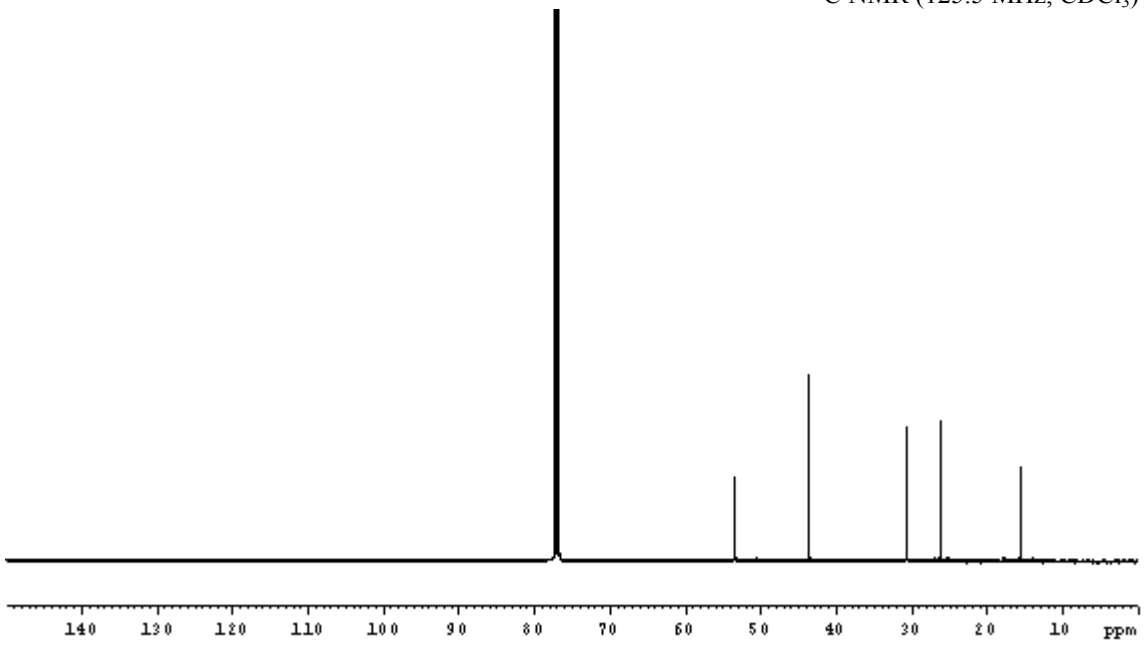
^{1}H NMR (500 MHz, $CDCl_3$)

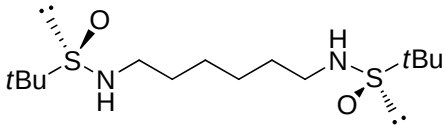




27

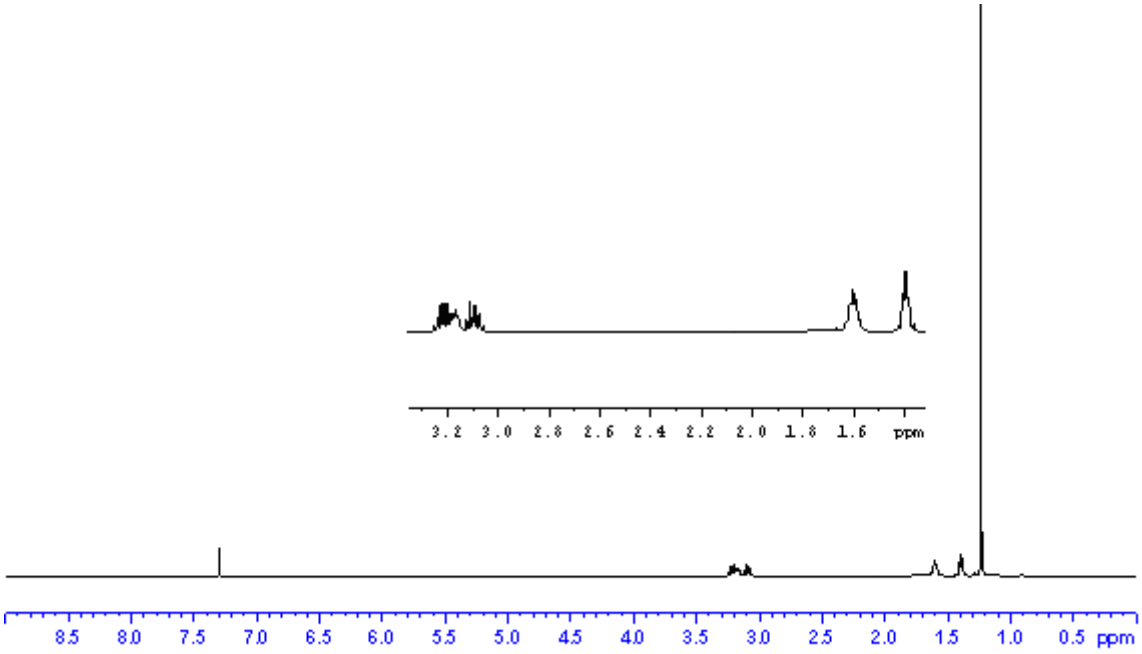
^{13}C NMR (125.5 MHz, $CDCl_3$)

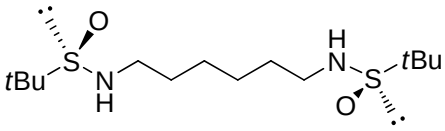




28

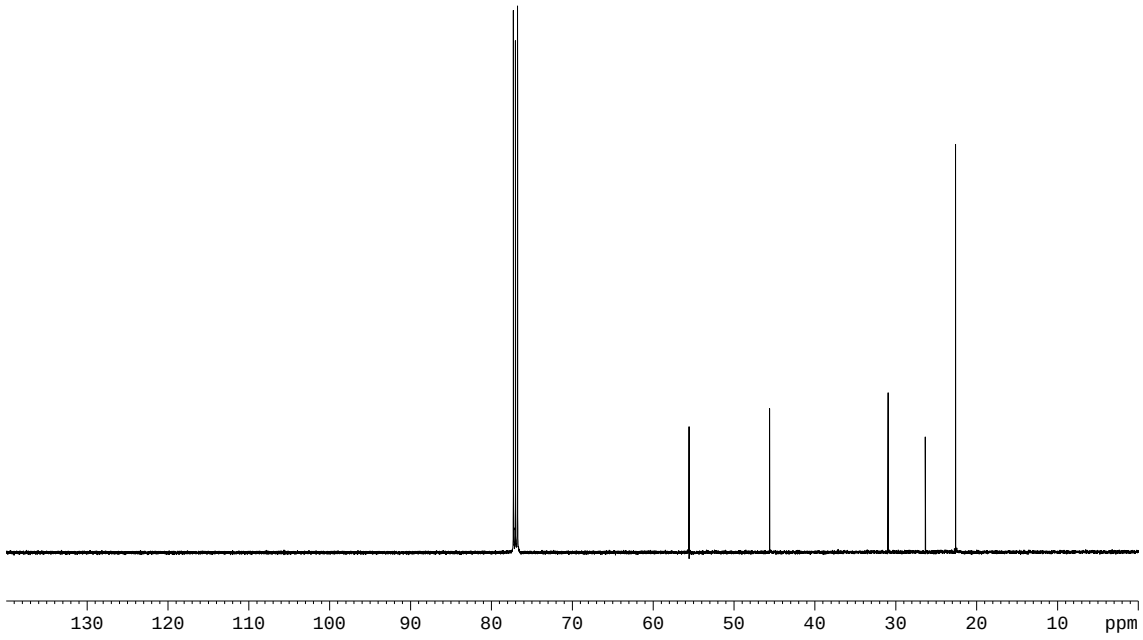
^{1}H NMR (500 MHz, $CDCl_3$)

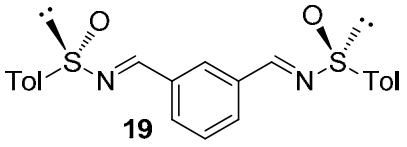




28

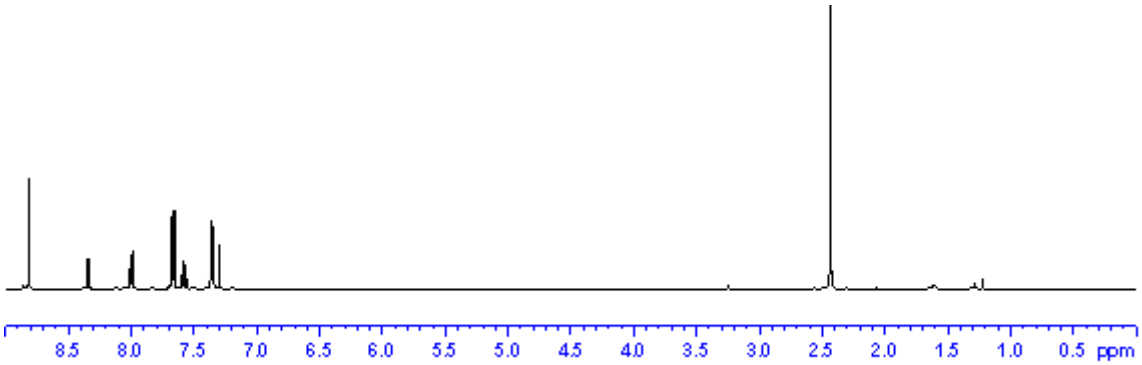
^{13}C NMR (125.5 MHz, $CDCl_3$)

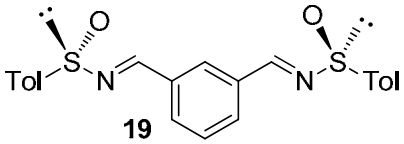




19

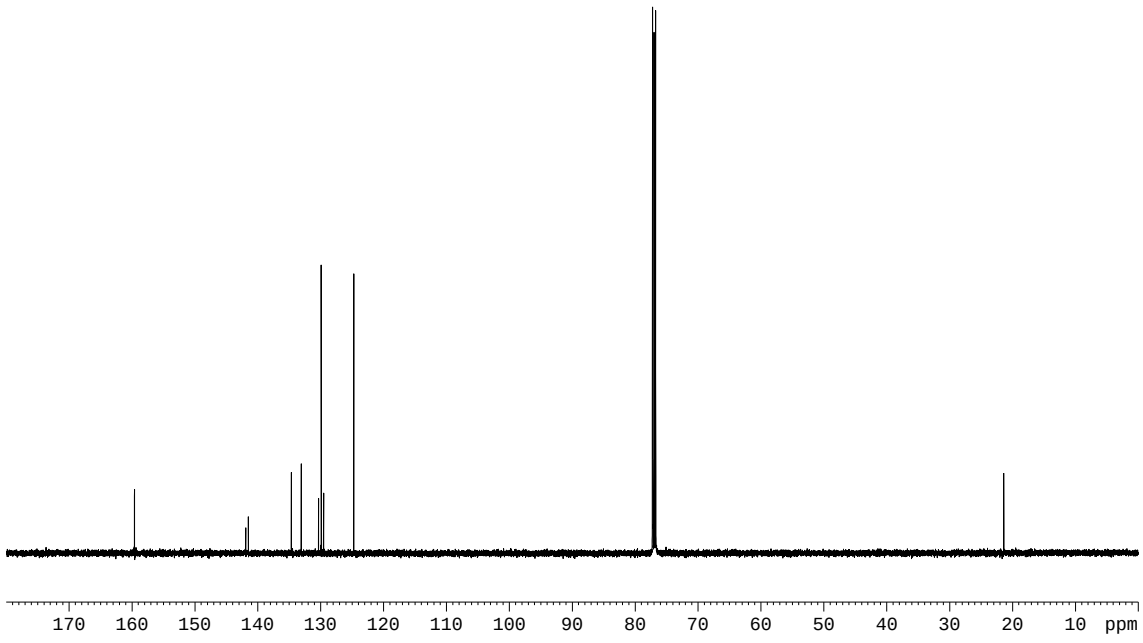
^{1}H NMR (500 MHz, $CDCl_3$)

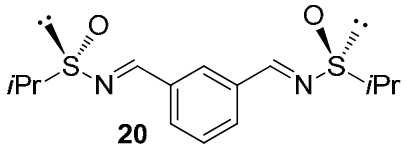




19

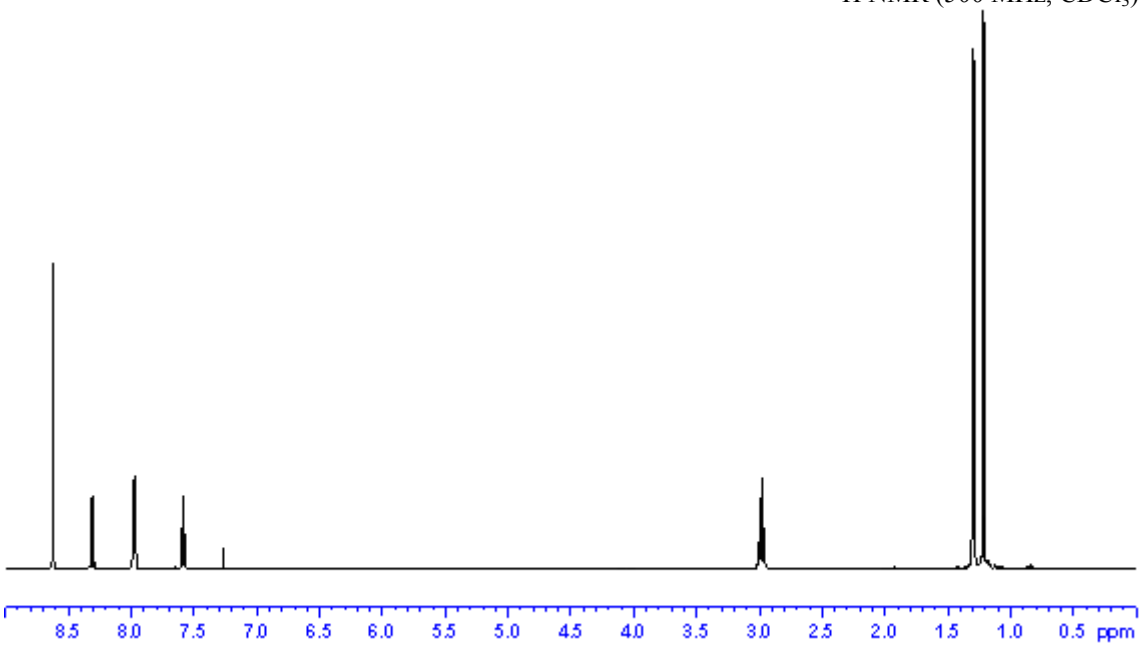
^{13}C NMR (125.5 MHz, $CDCl_3$)

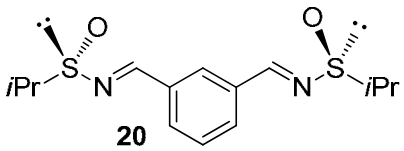




20

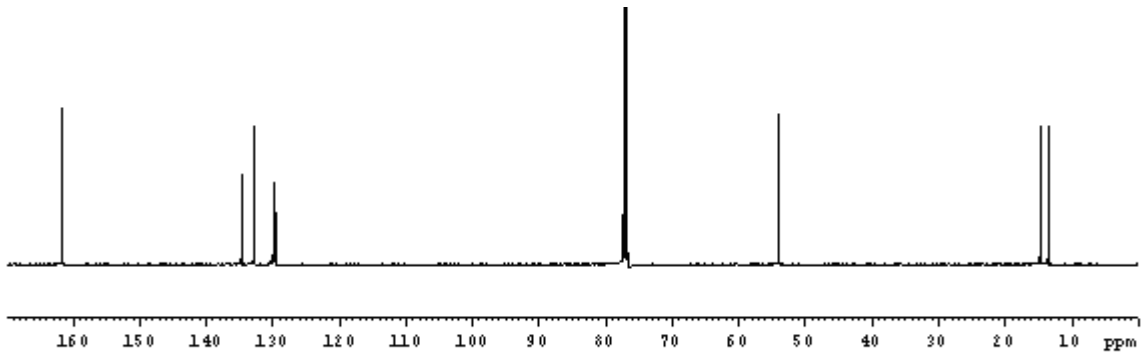
^{1}H NMR (500 MHz, $CDCl_3$)

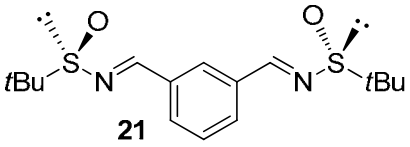




20

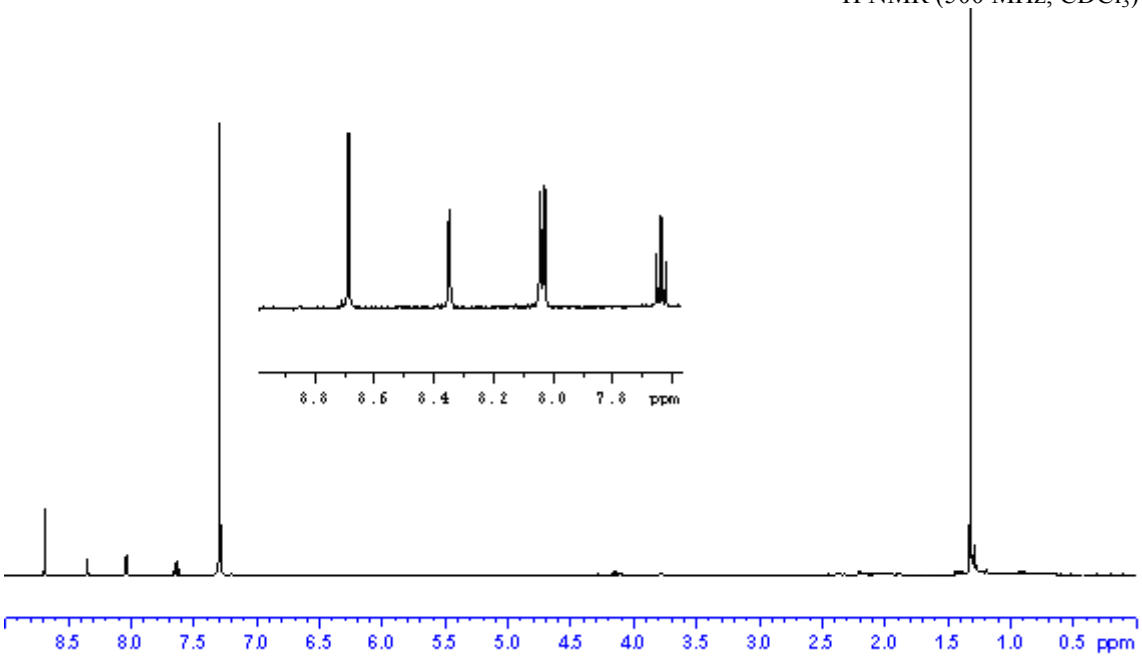
^{13}C NMR (125.5 MHz, $CDCl_3$)

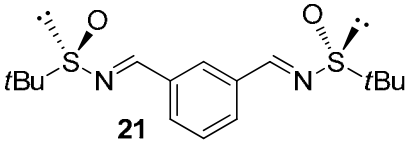




21

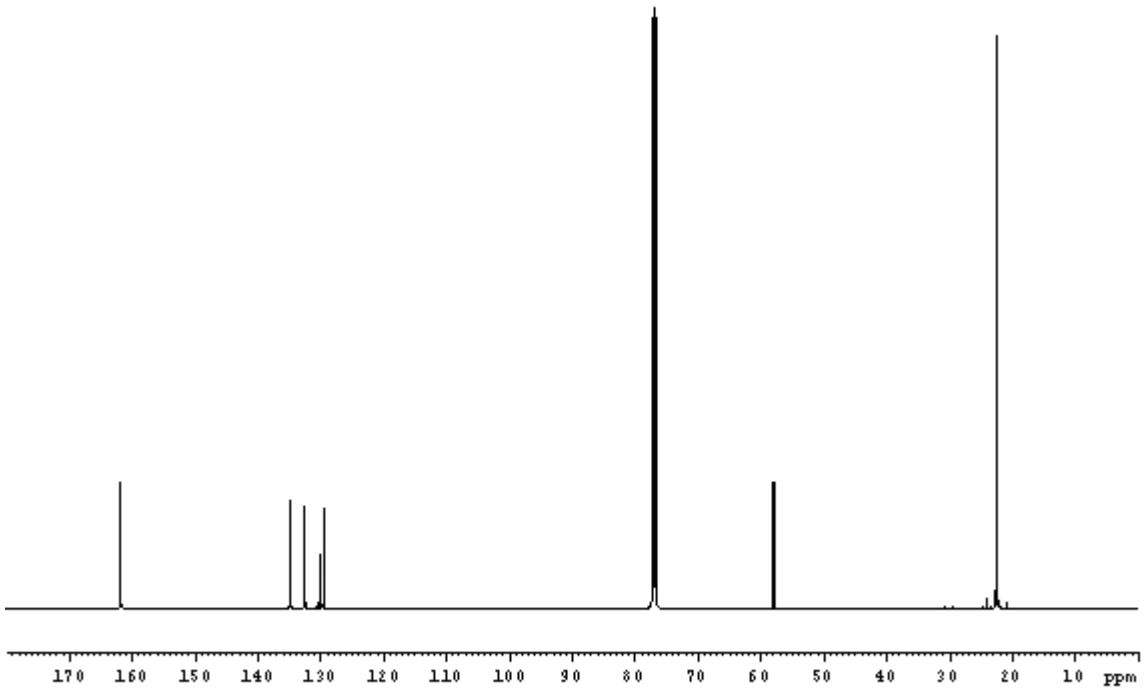
^{1}H NMR (500 MHz, $CDCl_3$)

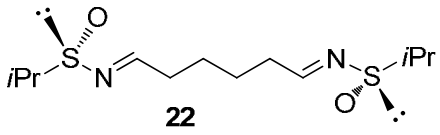




21

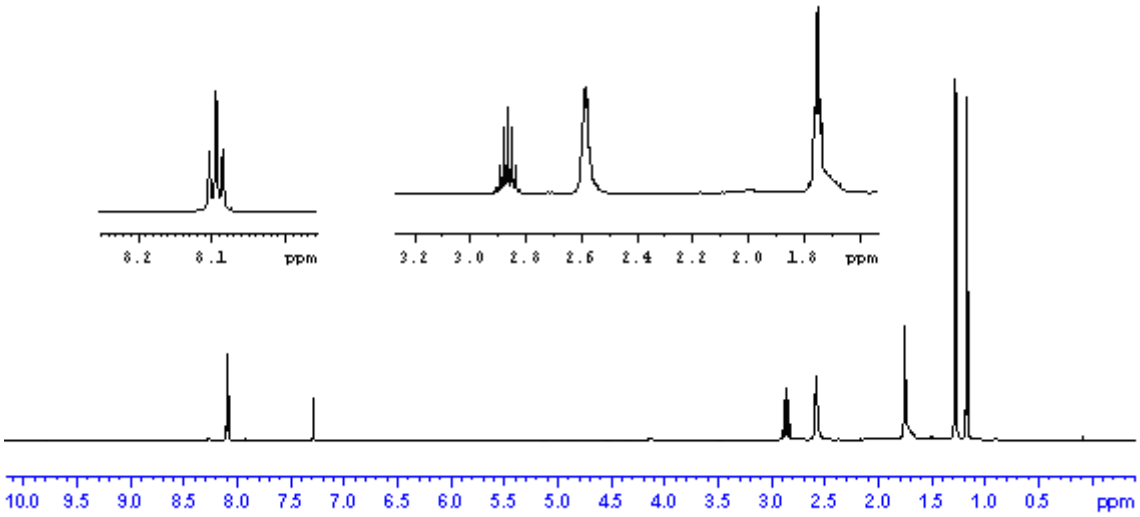
^{13}C NMR (125.5 MHz, $CDCl_3$)

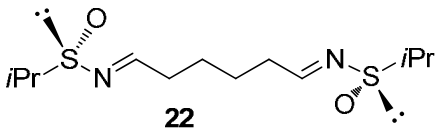




22

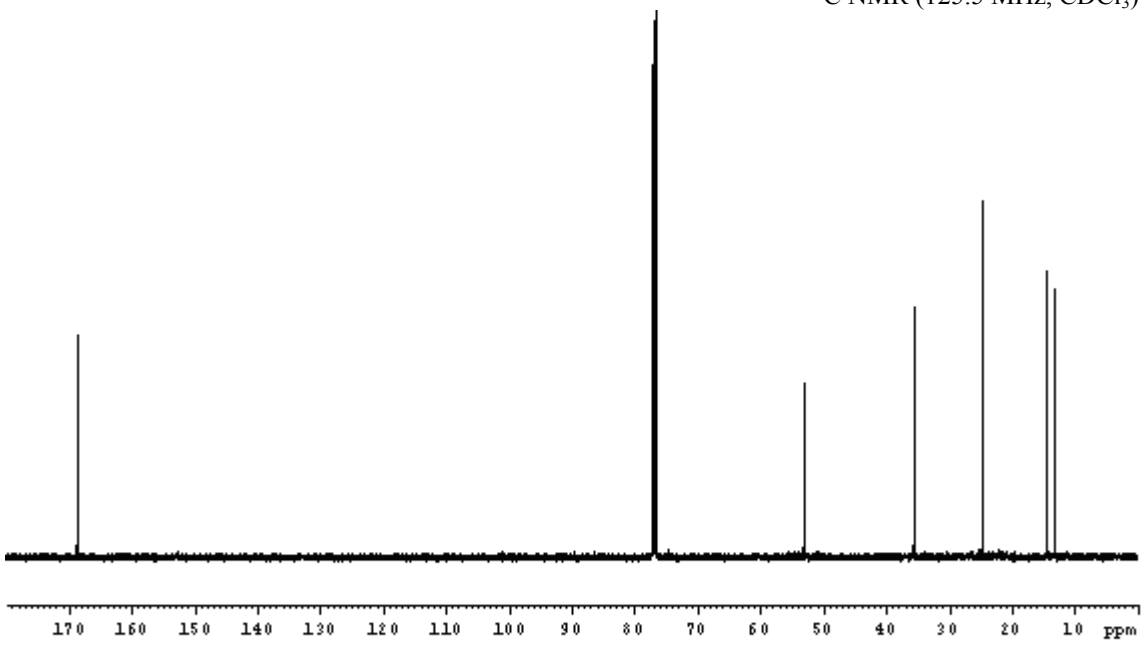
^{1}H NMR (500 MHz, $CDCl_3$)

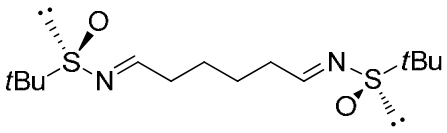




22

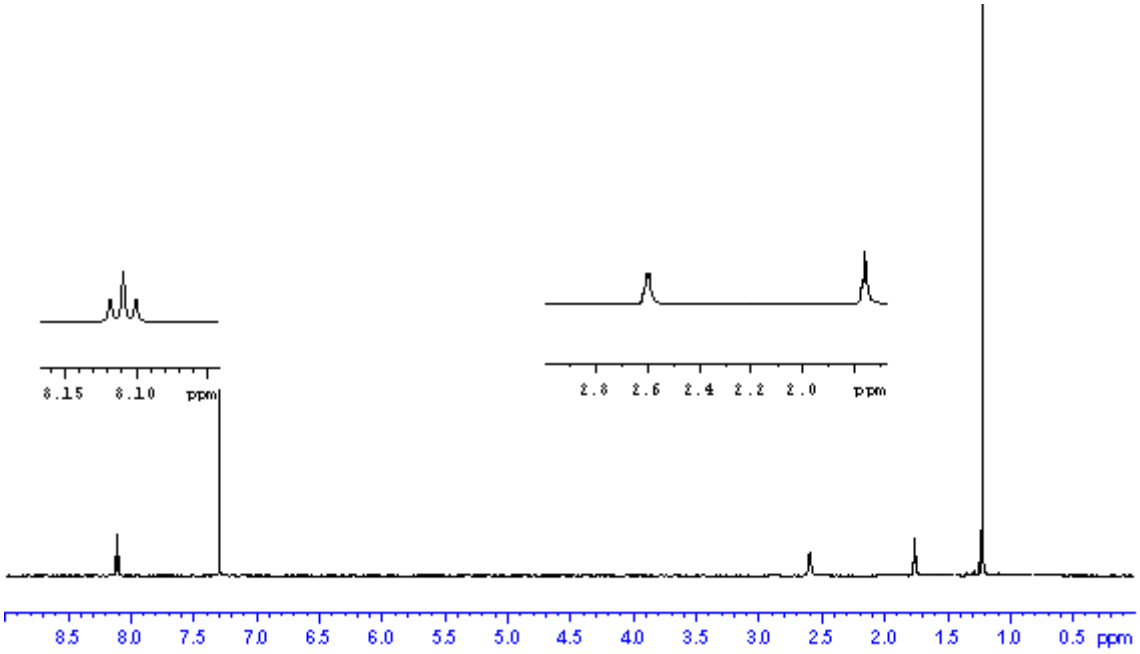
^{13}C NMR (125.5 MHz, $CDCl_3$)

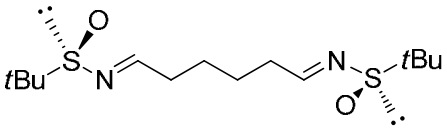




23

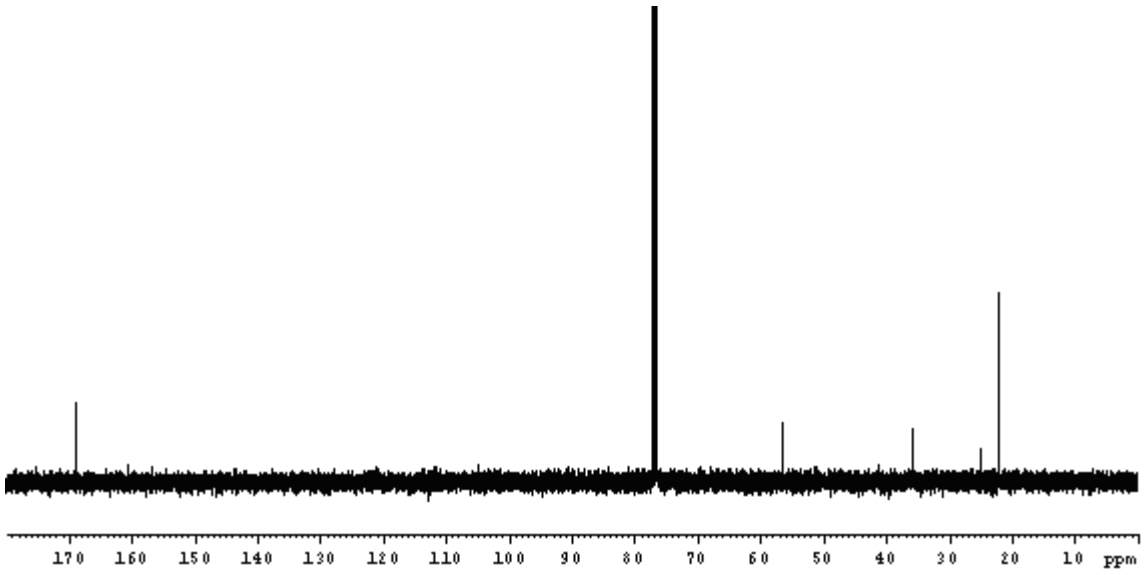
^{1}H NMR (500 MHz, $CDCl_3$)



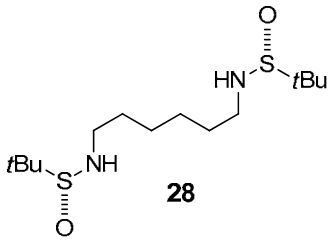


23

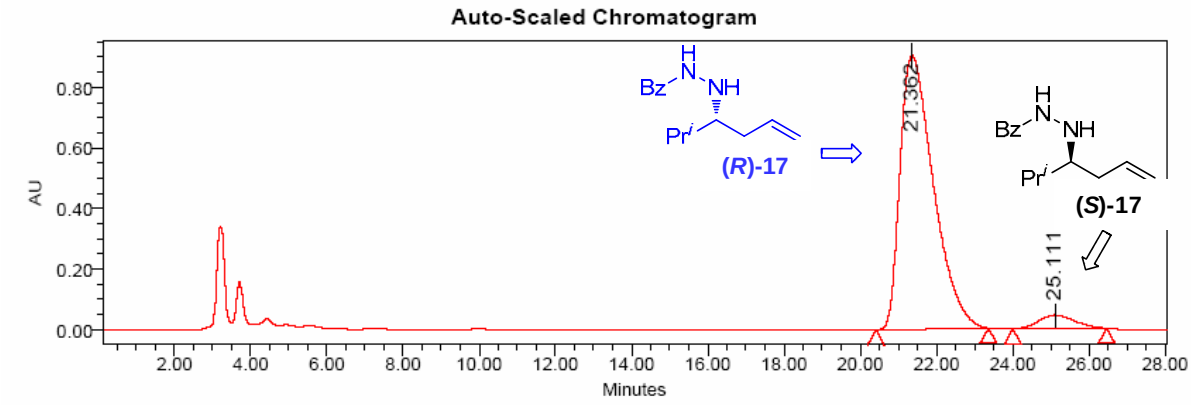
^{13}C NMR (125.5 MHz, $CDCl_3$)



HPLC data for the allylation of hydrazone 17 with ligand 28.



28



Processed Channel: PDA 210.0 nm

	Processed Channel	Retention Time (min)	Area	% Area	Height
1	PDA 210.0 nm	21.362	54991322	94.97	902661
2	PDA 210.0 nm	25.111	2914810	5.03	44499

Spectrum Index Plot