

Carbamoyl Anion Addition to *N*-Sulfinylimines: Highly Diastereoselective Synthesis of α -Amino Amides

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General. All starting materials and reagents were purchased from commercial sources and used as received unless otherwise noted. (*R*)- and (*S*)-tert-butanefulfinamide (>99% ee) and (*R*)-2,4,6-triisopropylphenylsulfinamide (>99% ee) were purchased from AstaTech, Inc. Melting points are uncorrected. Optical rotations were measured on a Perkin-Elmer polarimeter. NMR spectra were recorded on Bruker 400 or 500 MHz instruments. All ^1H and ^{13}C NMR data were referenced to the internal deuterated solvent relative to TMS at 0 ppm. High resolution mass spectroscopy (HRMS) was performed on a TOF instrument with ESI in positive ionization mode. Flash chromatography was performed on a Combi-Flash automated system with silica columns. HPLC analysis for reaction monitoring and diastereoselectivity determination was performed on an Agilent

1100 LC system with one of the following three methods (the method used is listed in the experimental part for each addition product): **Method A:** TSK-gel SuperODS column (ID 4.6mm, length 5.0cm), detection at 220 nm, run time 5 min, mobile phase A = water with 0.2% TFA, mobile phase B = MeCN with 0.2% TFA, ramp from 10% B to 90% B in 3.5 min, hold at 90% B until 5 min, column temperature 25 °C; **Method B:** SB Phenyl column (ID 4.6mm, length 10.0cm), detection at 220 nm, run time 30 min, mobile phase A = water with 0.2% H₃PO₄, mobile phase B = MeOH, ramp from 65 to 75% B in 14 min, ramp from 75% B to 85% B from 14 to 25 min, ramp from 85% B to 90% B from 25 to 30 min, column temperature 25 °C; **Method C:** Chiralpak AD-3 column (ID 4.6mm, length 15.0cm), detection at 220 nm, run time 6.0 min, isocratic 65/35 heptane/isopropanol, column temperature 35 °C. Chiral HPLC analysis of **3** was performed using the following method: Chiralpak AD-3 column (ID 4.6mm, length 15.0cm), detection at 230 nm, run time 8.5 min, isocratic 94/6 heptane/isopropanol, column temperature 25 °C.

4,4-Dimethyl-1-phenylpent-1-yn-3-one, the ketone used to prepare TBS ketimine **32**, was prepared by the procedure of Kim and co-workers (ZnBr₂ mediated coupling of trimethylacetyl chloride with phenylacetylene).¹

Sulfinyl aldimines were prepared by the Ti(OEt)₄ procedure of Ellman and co-workers, with some modifications in the workup.² Instead of adding the reaction mixtures to brine, the reaction mixtures were diluted with EtOAc and treated with a small amount of water to effect controlled formation of TiO₂. This procedure allowed the subsequent filtration of TiO₂ to proceed more quickly. Sulfinyl ketimines were prepared by a modified procedure, using neat Ti(OEt)₄ (no co-solvent). This resulted in much faster reactions than when a co-solvent was used.

Stereochemistry Assignments. The stereochemistry of aldimine addition product **2b** was assigned from X-ray crystal structure determination. The stereochemistry of aldimine addition product **2a** was determined by comparison of the chiral HPLC of **3** obtained by deprotection of its *tert*-butanesulfinyl group with **3** obtained by deprotection of the 2,4,6-triisopropylphenylsulfinyl group of **2b**. Both **2a** and **2b** gave the same (*S*)-enantiomer of **3** after sulfinyl deprotection. All the other aldimine addition products in Table 1 were inferred to have the same relative stereochemistry based on the assignments of **2a** and **2b**. The stereochemistry of ketimine addition product **21** was assigned from X-ray crystal structure determination. All the other ketimine addition products in Table 2 were inferred to have the same relative stereochemistry based on the assignment of **21**. The stereochemistry of dipeptide **42** was assigned by X-ray crystal structure determination.

Diastereoselectivity Determination. The reaction diastereoselectivity was determined from the crude reaction mixture by HPLC analysis. Authentic mixtures of diastereomers were prepared from the purified product by the procedure of Ellman and co-workers.³ In the case of ketimine derived substrates **21**, **23**, **25**, **27**, **29**, **31**, and **33**, this procedure was not effective for generating the diastereomeric mixture (sulfinyl deprotection occurred, but re-sulfinylation did not occur on addition of Et₃N, likely due to the sterically hindered nature of these amines). For these substrates, after sulfinyl

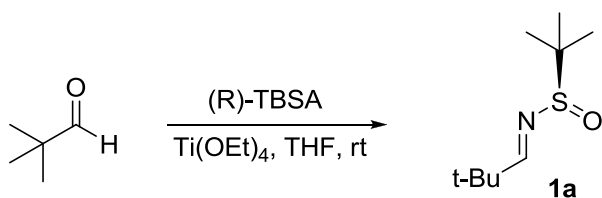
¹ Lee, K. Y.; Lee, M. J.; Kim, J. N. *Tetrahedron* **2005**, *61*, 8705.

² Liu, G.; Cogan, D. A.; Owens, T. D.; Tang, T. P.; Ellman, J. A. *J. Org. Chem.* **1999**, *64*, 1278.

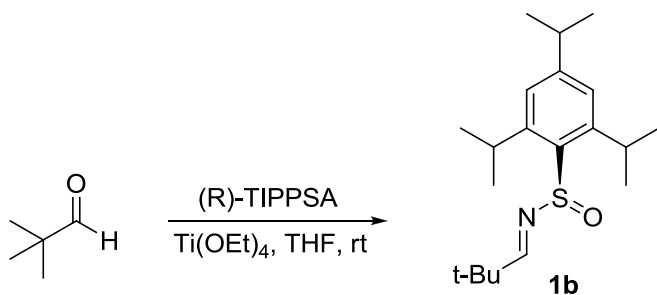
³ Brak, K.; Barrett, K. T.; Ellman, J. A. *J. Org. Chem.* **1999**, *74*, 3606.

deprotection was complete, excess commercially available racemic *tert*-butanesulfinyl chloride (10-20 equiv) was added followed by Et₃N (20-40 equiv). For TIPPS ketimine addition product **35**, authentic diastereomer preparation was not possible, and the reaction diastereoselectivity was estimated as >97:3 by ¹H NMR analysis of the crude reaction mixture (the minor diastereomer was not detected). Likewise, in the formation of dipeptide **42**, the diastereoselectivity of the addition reaction was estimated as >97:3 by ¹H NMR analysis of the crude reaction mixture (the minor diastereomer was not detected).

Procedures and data for *N*-sulfinylimines.

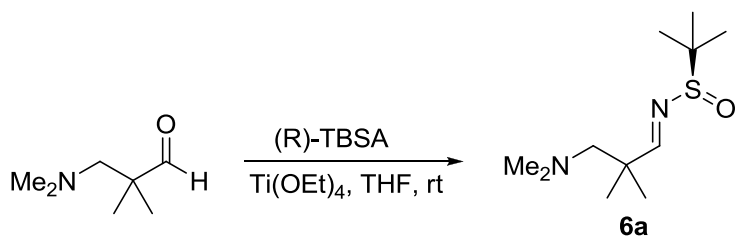


(*R*)-*N*-(2,2-Dimethylpropylidene)-2-methylpropane-2-sulfinamide (1a). To a flask containing (*R*)-*tert*-butanesulfinamide (5.00 g, 41.3 mmol, 1.0 equiv) and THF (17 mL) was added trimethylacetaldehyde (5.38 mL, 49.5 mmol, 1.2 equiv) followed by Ti(OEt)₄ (17.3 mL, 82.5 mmol, 2.0 equiv). The reaction mixture was stirred at rt for 5 h, and then diluted with MTBE (150 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with MTBE (50 mL), and the filtrate was washed with water (3 x 100 mL), dried (Na₂SO₄), filtered, and concentrated to an oil. The oil was further dried under vacuum to give the product (5.70 g, 73% yield) as an oil which crystallized on standing to a white solid. mp 37-39 °C; [α]_D²⁰ -267.0 (*c* 3.23, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 7.93 (s, 1 H), 1.19 (s, 9 H), 1.16 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 175.6, 56.5, 37.9, 26.7, 22.3; HRMS: calcd for C₉H₂₀NOS [M + H]: 190.1260. Found: 190.1261.

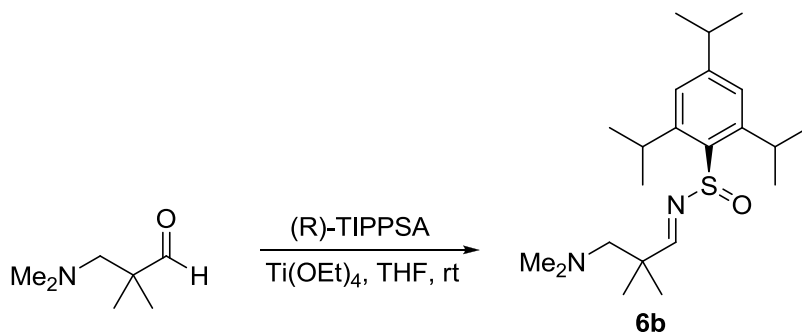


(*R*)-*N*-(2,2-Dimethylpropylidene)-2,4,6-triisopropylbenzenesulfinamide (1b). To a flask containing (*R*)-2,4,6-triisopropylbenzenesulfinamide (10.00 g, 37.4 mmol, 1.0 equiv) and THF (31 mL) was added trimethylacetaldehyde (10.0 mL, 92.1 mmol, 2.5 equiv) followed by Ti(OEt)₄ (31.0 mL, 149.6 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 16 h, and then diluted with EtOAc (300 mL). Water (10.0 mL) was added

dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated to an oil. The oil was chased with MeOH, and subsequent crystallization from MeOH at 0 °C gave the pure product (10.65 g, 85% yield) as an off-white solid. mp 89-90 °C; $[\alpha]_{\text{D}}^{20}$ -208.0 (*c* 3.64, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.17 (s, 1 H), 7.07 (s, 2 H), 3.78-3.68 (m, 2 H), 2.93-2.83 (m, 1 H), 1.27-1.21 (m, 18 H), 1.16 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.0, 152.5, 149.6, 134.7, 122.9, 37.9, 34.4, 27.8, 26.4, 24.5, 24.1, 23.8, 23.7; HRMS: calcd for $\text{C}_{20}\text{H}_{34}\text{NOS}$ [$\text{M} + \text{H}$]: 336.2356. Found: 336.2354.

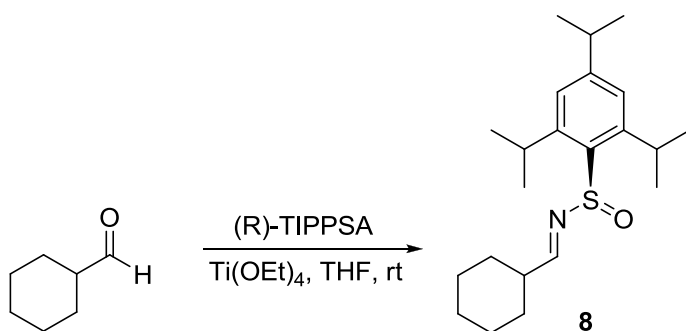


(R)-N-(3-(Dimethylamino)-2,2-dimethylpropylidene)-2-methylpropane-2-sulfinamide (6a). To a flask containing (R)-tert-butanesulfinamide (4.69 g, 38.7 mmol, 1.0 equiv) and THF (16 mL) was added 3-(dimethylamino)-2,2-dimethylpropanal (5.00 g, 38.7 mmol, 1.0 equiv) followed by $\text{Ti}(\text{OEt})_4$ (16.2 mL, 77.4 mmol, 2.0 equiv). The reaction mixture was stirred at rt for 16 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (3 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (10 to 70% EtOAc/hexanes) to give the pure product (4.34 g, 48% yield) as a yellow oil. $[\alpha]_{\text{D}}^{20}$ -213.6 (*c* 6.27, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.98 (s, 1 H), 2.48 (d, *J* = 13.4 Hz, 1 H), 2.40 (d, *J* = 13.4 Hz, 1 H), 2.25 (s, 6 H), 1.20 (s, 9 H), 1.15 (s, 6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 175.4, 68.8, 56.6, 48.0, 43.1, 23.6, 23.3, 22.3; HRMS: calcd for $\text{C}_{11}\text{H}_{25}\text{N}_2\text{OS}$ [$\text{M} + \text{H}$]: 233.1682. Found: 233.1677.

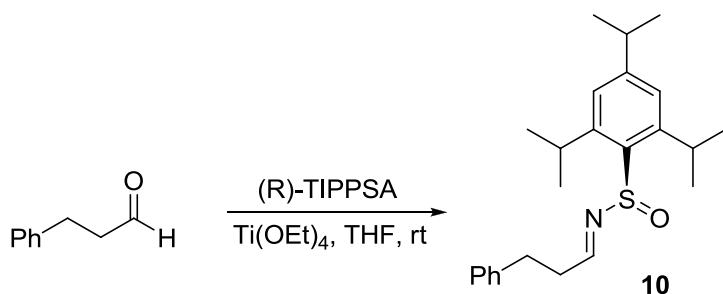


(R)-N-(3-(Dimethylamino)-2,2-dimethylpropylidene)-2,4,6-triisopropylbenzenesulfinamide (6b). To a flask containing (R)-2,4,6-triisopropylbenzenesulfinamide (5.00 g, 18.7 mmol, 1.0 equiv) and THF (15 mL) was added 3-(dimethylamino)-2,2-dimethylpropanal (3.62 g, 28.0 mmol, 1.5 equiv) followed by $\text{Ti}(\text{OEt})_4$ (15.5 mL, 74.8

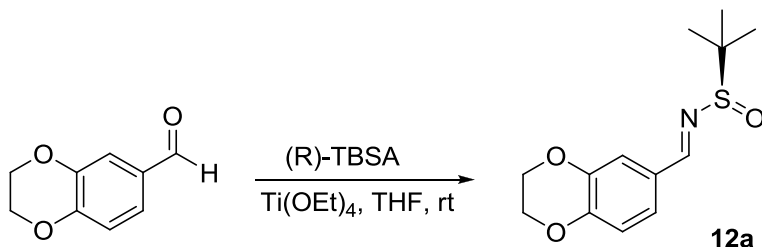
mmol, 4.0 equiv). The reaction mixture was stirred at rt for 16 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (20 to 40% MTBE/hexanes) to give the pure product (4.75 g, 67% yield) as a yellow oil. $[\alpha]_{\text{D}}^{20} -71.5$ (c 4.49, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.25 (s, 1 H), 7.07 (s, 2 H), 3.78-3.68 (m, 2 H), 2.93-2.83 (m, 1 H), 2.44 (d, $J = 1.8$ Hz, 2 H), 2.25 (s, 6 H), 1.27-1.22 (m, 18 H), 1.16 (s, 3 H), 1.13 (s, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.1, 152.5, 149.6, 134.8, 122.8, 68.8, 48.2, 43.0, 34.4, 27.9, 24.6, 24.0, 23.8, 23.7, 23.6, 22.7; HRMS: calcd for $\text{C}_{22}\text{H}_{39}\text{N}_2\text{OS}$ [$\text{M} + \text{H}$]: 379.2778. Found: 379.2779.



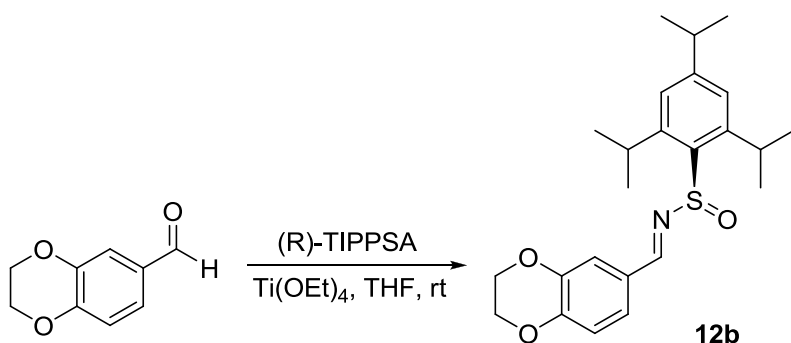
(R)-N-(Cyclohexylmethylene)-2,4,6-triisopropylbenzenesulfinamide (8). To a flask containing (R)-2,4,6-triisopropylbenzenesulfinamide (5.00 g, 18.7 mmol, 1.0 equiv) and THF (15 mL) was added cyclohexanecarbaldehyde (4.53 mL, 37.4 mmol, 2.0 equiv) followed by $\text{Ti}(\text{OEt})_4$ (15.5 mL, 74.8 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 16 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (5% MTBE/hexanes) to give the pure product (5.02 g, 74% yield) as a white solid. mp 80-83 $^\circ\text{C}$; $[\alpha]_{\text{D}}^{20} -156.4$ (c 4.32, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.19 (d, $J = 5.0$ Hz, 1 H), 7.06 (s, 2 H), 3.79-3.69 (m, 2 H), 2.92-2.82 (m, 1 H), 2.51-2.39 (m, 1 H), 1.94-1.65 (m, 5 H), 1.40-1.28 (m, 4 H), 1.27-1.21 (m, 18 H); ^{13}C NMR (100 MHz, CDCl_3) δ 171.1, 152.6, 149.7, 134.6, 122.9, 44.2, 34.4, 29.2, 29.0, 27.8, 25.8, 25.35, 25.33, 24.5, 24.0, 23.8, 23.7; HRMS: calcd for $\text{C}_{22}\text{H}_{36}\text{NOS}$ [$\text{M} + \text{H}$]: 362.2512. Found: 362.2512.



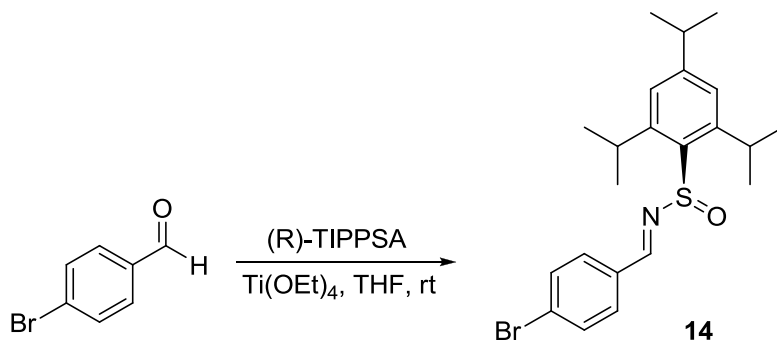
(R)-2,4,6-Triisopropyl-N-(3-phenylpropylidene)benzenesulfinamide (10). To a flask containing (R)-2,4,6-triisopropylbenzenesulfinamide (5.48 g, 20.5 mmol, 1.0 equiv) and THF (17 mL) was added hydrocinnamaldehyde (3.00 mL, 20.5 mmol, 90.0 wt.%, 1.0 equiv) followed by Ti(OEt)_4 (17.0 mL, 82.0 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 1 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (5 to 20% MTBE/hexanes) to give the pure product (5.44 g, 69% yield) as a thick yellow oil. $[\alpha]_{\text{D}}^{20}$ -140.6 (c 5.45, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.38 (t, $J = 4.6$ Hz, 1 H), 7.28-7.24 (m, 2 H), 7.20-7.16 (m, 3 H), 7.07 (s, 2 H), 3.81-3.71 (m, 2 H), 2.97-2.80 (m, 5 H), 1.27-1.20 (m, 18 H); ^{13}C NMR (100 MHz, CDCl_3) δ 166.9, 152.9, 149.7, 140.5, 134.5, 128.6, 128.4, 126.4, 123.0, 38.0, 34.5, 31.5, 27.9, 24.5, 23.9, 23.82, 23.79; HRMS: calcd for $\text{C}_{24}\text{H}_{34}\text{NOS}$ [$\text{M} + \text{H}$]: 384.2356. Found: 384.2346.



(R)-N-((2,3-Dihydrobenzo[b][1,4]dioxin-6-yl)methylene)-2-methylpropane-2-sulfinamide (12a). To a flask containing (R)-tert-butanethioamide (3.18 g, 26.25 mmol, 1.05 equiv) and 2,3-dihydrobenzo[b][1,4]dioxine-6-carbaldehyde (4.19 g, 25.0 mmol, 1.0 equiv) was added THF (80 mL) followed by Ti(OEt)_4 (15.6 mL, 75.0 mmol, 3.0 equiv). The reaction mixture was stirred at rt for 16 h, and then poured into ice-cold brine. The resultant slurry was filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water, dried (MgSO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (10 to 60% EtOAc/hexanes) to give the pure product (3.85 g, 58% yield) as an off-white solid. mp 73-74.5 $^{\circ}\text{C}$; $[\alpha]_{\text{D}}^{20}$ -22.2 (c 3.15, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.44 (s, 1 H), 7.40 (br, 1 H), 7.35-7.33 (m, 1 H), 6.93 (d, $J = 8.3$ Hz, 1 H), 4.33-4.27 (m, 4 H), 1.24 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 161.7, 147.5, 143.8, 128.1, 123.7, 117.8, 117.7, 64.7, 64.1, 57.6, 22.6; HRMS: calcd for $\text{C}_{13}\text{H}_{18}\text{NO}_3\text{S}$ [$\text{M} + \text{H}$]: 268.1002. Found: 268.0998.

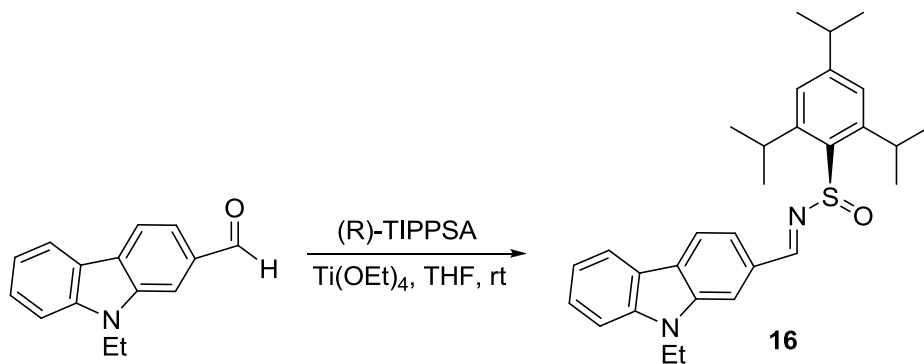


(*R*)-*N*-((2,3-Dihydrobenzo[*b*][1,4]dioxin-6-yl)methylene)-2,4,6-triisopropylbenzenesulfinamide (12b). To a flask containing (*R*)-2,4,6-triisopropylbenzenesulfinamide (3.26 g, 12.2 mmol, 1.0 equiv) and THF (10 mL) was added 2,3-dihydrobenzo[*b*][1,4]dioxine-6-carbaldehyde (2.00 g, 12.2 mmol, 1.0 equiv) followed by Ti(OEt)₄ (10.1 mL, 48.7 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 2 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by crystallization from MeCN with a few drops of water to give the pure product (4.59 g, 91% yield) as a white solid. mp 135-136 °C; [α]_D²⁰ +7.8 (*c* 2.65, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 8.69 (s, 1 H), 7.39-7.38 (m, 1 H), 7.34 (dd, *J* = 8.4, 1.9 Hz, 1 H), 7.08 (s, 2 H), 6.91 (d, *J* = 8.4 Hz, 1 H), 4.30-4.24 (m, 4 H), 3.91-3.81 (m, 2 H), 2.93-2.83 (m, 1 H), 1.28 (d, *J* = 6.8 Hz, 6 H), 1.24 (d, *J* = 7.0 Hz, 6 H), 1.15 (d, *J* = 6.9 Hz, 6 H); ¹³C NMR (100 MHz, CDCl₃) δ 160.3, 152.7, 149.7, 147.5, 143.9, 135.0, 128.4, 123.5, 122.9, 118.0, 117.7, 64.6, 64.1, 34.4, 27.9, 24.4, 24.1, 23.79, 23.76; HRMS: calcd for C₂₄H₃₂NO₃S [*M* + *H*]: 413.2020. Found: 413.2024.

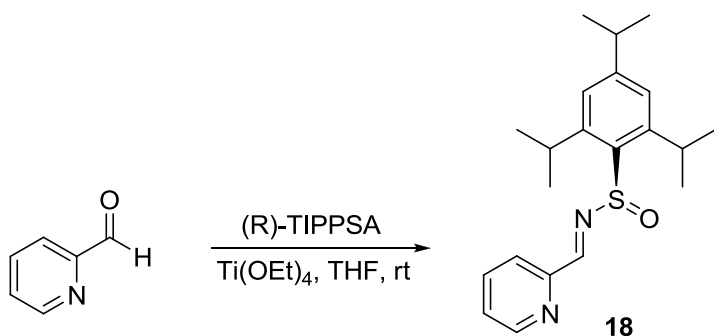


(*R*)-*N*-(4-Bromobenzylidene)-2,4,6-triisopropylbenzenesulfinamide (14). To a flask containing (*R*)-2,4,6-triisopropylbenzenesulfinamide (5.00 g, 18.7 mmol, 1.0 equiv) and THF (15 mL) was added 4-bromobenzaldehyde (3.46 g, 18.7 mmol, 1.0 equiv) followed by Ti(OEt)₄ (15.5 mL, 74.8 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 2 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was

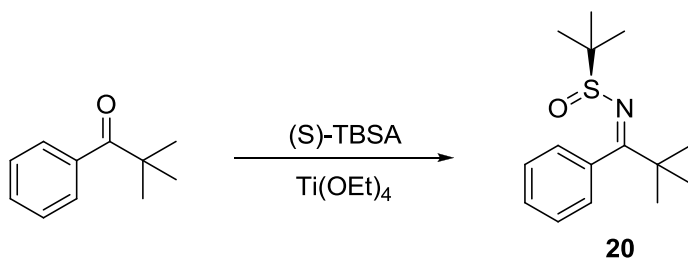
washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by crystallization from MeOH with a few drops of water to give the pure product (5.86 g, 72% yield) as a white solid. mp 140-142 °C; $[\alpha]_{\text{D}}^{20} -2.1$ (*c* 5.99, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.80 (s, 1 H), 7.72-7.70 (m, 2 H), 7.59-7.57 (m, 2 H), 7.09 (s, 2 H), 3.88-3.78 (m, 2 H), 2.94-2.84 (m, 1 H), 1.29 (d, *J* = 6.8 Hz, 6 H), 1.24 (d, *J* = 6.9 Hz, 6 H), 1.14 (d, *J* = 6.8 Hz, 6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 160.1, 152.9, 149.8, 134.4, 133.2, 132.3, 130.7, 127.2, 123.0, 34.4, 28.0, 24.4, 24.0, 23.79, 23.76; HRMS: calcd for $\text{C}_{22}\text{H}_{29}\text{BrNOS}$ [*M* + *H*]: 434.1148. Found: 434.1151.



(R)-N-((9-Ethyl-9H-carbazol-2-yl)methylene)-2,4,6-triisopropylbenzenesulfinamide (16). To a flask containing (R)-2,4,6-triisopropylbenzenesulfinamide (3.59 g, 13.4 mmol, 1.0 equiv) and THF (11 mL) was added 9-ethyl-9H-carbazole-2-carbaldehyde (3.00 g, 13.4 mmol, 1.0 equiv) followed by $\text{Ti}(\text{OEt})_4$ (11.1 mL, 53.7 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 18 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by crystallization from heptane to give the pure product (4.95 g, 78% yield) as a white solid. mp 158-160 °C; $[\alpha]_{\text{D}}^{20} +45.2$ (*c* 2.20, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.99 (s, 1 H), 8.57 (s, 1 H), 8.11 (d, *J* = 7.6 Hz, 1 H), 7.98 (d, *J* = 7.6 Hz, 1 H), 7.51-7.47 (m, 1 H), 7.42-7.39 (m, 2 H), 7.28-7.23 (m, 1 H), 7.10 (s, 2 H), 4.37-4.32 (m, 2 H), 3.99-3.92 (m, 2 H), 2.93-2.85 (m, 1 H), 1.43 (t, *J* = 7.2 Hz, 3 H), 1.33 (d, *J* = 6.5 Hz, 6 H), 1.25 (d, *J* = 6.8 Hz, 6 H), 1.17 (d, *J* = 6.8 Hz, 6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 161.7, 152.6, 149.8, 142.5, 140.6, 135.5, 127.3, 126.5, 126.0, 123.3, 123.0, 122.8, 120.9, 120.0, 109.0, 108.7, 37.9, 34.5, 28.0, 24.4, 24.3, 23.84, 23.81, 13.9; HRMS: calcd for $\text{C}_{30}\text{H}_{37}\text{N}_2\text{OS}$ [*M* + *H*]: 473.2621. Found: 473.2609.

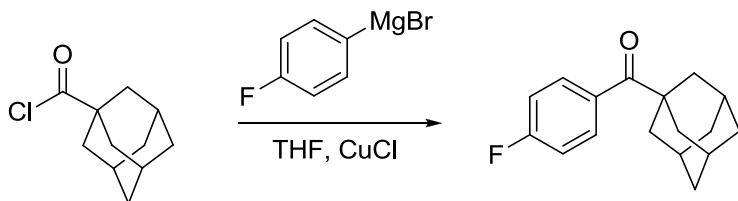


(R)-2,4,6-Triisopropyl-N-(pyridin-2-ylmethylene)benzenesulfinamide (18). To a flask containing (R)-2,4,6-triisopropylbenzenesulfinamide (5.62 g, 21.0 mmol, 1.0 equiv) and THF (17 mL) was added pyridine-2-carbaldehyde (2.00 mL, 21.0 mmol, 1.0 equiv) followed by $\text{Ti}(\text{OEt})_4$ (17.4 mL, 84.1 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 18 h, and then diluted with EtOAc (200 mL). Water (5.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc (50 mL), and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (30 to 50% MTBE/hexanes) to give the pure product (3.92 g, 52% yield) as an off-white solid. mp 133-136 °C; $[\alpha]_{\text{D}}^{20} -59.4$ (c 3.27, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 8.97 (s, 1 H), 8.75-8.73 (m, 1 H), 8.01 (d, $J = 8.0$ Hz, 1 H), 7.79-7.75 (m, 1 H), 7.39-7.36 (m, 1 H), 7.09 (s, 2 H), 3.92-3.82 (m, 2 H), 2.94-2.84 (m, 1 H), 1.29 (d, $J = 6.6$ Hz, 6 H), 1.24 (d, $J = 7.1$ Hz, 6 H), 1.15 (d, $J = 6.9$ Hz, 6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 162.1, 153.0, 152.7, 150.2, 149.9, 136.8, 134.3, 125.8, 123.2, 123.0, 34.4, 28.0, 24.3, 24.0, 23.8, 23.7; HRMS: calcd for $\text{C}_{21}\text{H}_{29}\text{N}_2\text{OS}$ $[\text{M} + \text{H}]$: 357.1995. Found: 357.1997.

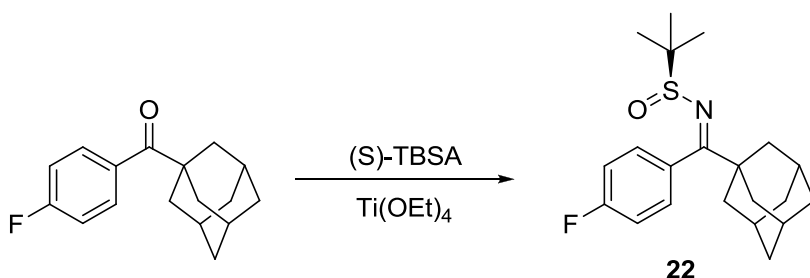


(S)-N-(2,2-Dimethyl-1-phenylpropylidene)-2-methylpropane-2-sulfinamide (20). To a flask containing (S)-tert-butesulfinamide (7.47 g, 61.6 mmol, 2.00 equiv) and 2,2-dimethyl-1-phenylpropan-1-one (5.00 g, 30.8 mmol, 1.0 equiv) was added $\text{Ti}(\text{OEt})_4$ (51.7 mL, 246.6 mmol, 8.0 equiv). The reaction mixture was stirred at 85 °C for 21 h, and then poured into EtOAc (400 mL). Water (25 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 200 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (10 to 50% EtOAc/hexanes) to give the pure product (5.62 g, 69% yield) as an off-white solid. mp 80-81.5 °C; $[\alpha]_{\text{D}}^{20} +129.6$ (c 5.40, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.41-7.36 (m, 3 H), 7.11-7.06 (m, 2 H), 1.23 (s, 9 H), 1.19 (s, 9 H);

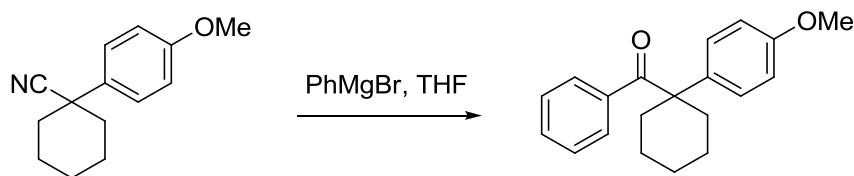
^{13}C NMR (100 MHz, CDCl_3) δ 192.5, 136.9, 128.3, 127.7, 126.5, 55.7, 42.5, 28.0, 22.0; HRMS: calcd for $\text{C}_{15}\text{H}_{24}\text{NOS}$ [$\text{M} + \text{H}$]: 266.1573. Found: 266.1577.



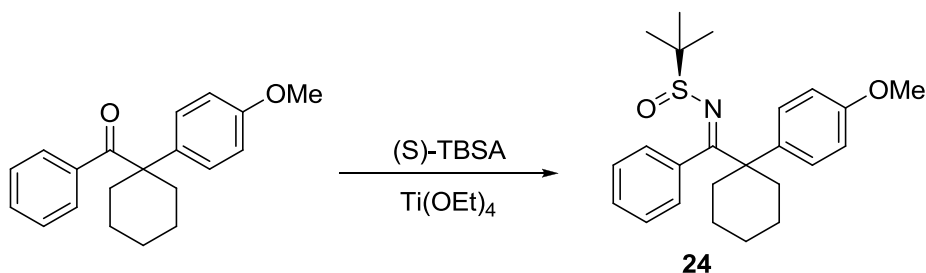
4-Fluorophenyl 1-adamantyl ketone. To a flask containing CuCl (498 mg, 5.03 mmol, 0.10 equiv), 1-adamantanecarbonyl chloride (10.0 g, 50.3 mmol, 1.0 equiv) and THF (100 mL) cooled to $-45\text{ }^{\circ}\text{C}$ was added dropwise 4-fluorophenylmagnesium bromide (50.3 mL, 50.3 mmol, 1.0 M in THF, 1.0 equiv). After the addition was complete, the reaction mixture was stirred for 30 min with warming to $-10\text{ }^{\circ}\text{C}$. The reaction mixture was then quenched with saturated aqueous NH_4Cl solution and extracted with MTBE. The organic phase was dried (MgSO_4), filtered, and concentrated. The crude product was crystallized from MeOH to give the pure product (8.12 g, 63% yield) as a white solid. mp $77\text{--}78\text{ }^{\circ}\text{C}$; ^1H NMR (400 MHz, CDCl_3) δ 7.68–7.62 (m, 2 H), 7.09–7.04 (m, 2 H), 2.11–2.06 (m, 3 H), 2.02–2.00 (m, 6 H), 1.81–1.70 (m, 6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 208.1, 163.9 (d, $J = 250\text{ Hz}$), 135.3 (d, $J = 3.4\text{ Hz}$), 130.0 (d, $J = 8.2\text{ Hz}$), 115.0 (d, $J = 21.2\text{ Hz}$), 46.9, 39.2, 36.5, 28.2; HRMS: calcd for $\text{C}_{17}\text{H}_{20}\text{FO}$ [$\text{M} + \text{H}$]: 259.1493. Found: 259.1487.



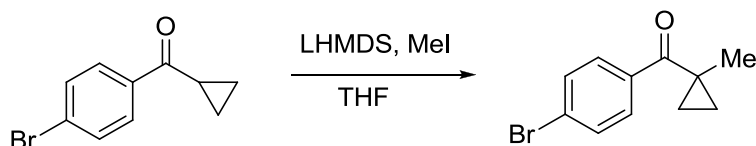
(S)-N-(1-Adamantyl(4-fluorophenyl)methylene)-2-methylpropane-2-sulfonamide (22). To a flask containing (S)-tert-butanesulfonamide (4.93 g, 40.6 mmol, 1.5 equiv) and 4-fluorophenyl 1-adamantyl ketone (7.00 g, 27.1 mmol, 1.0 equiv) was added $\text{Ti}(\text{OEt})_4$ (45.4 mL, 216.8 mmol, 8.0 equiv). The reaction mixture was stirred at $85\text{ }^{\circ}\text{C}$ for 24 h, and then poured into EtOAc (400 mL). Water (25 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 200 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by crystallization from isopropanol (100 mL) and water (50 mL) to give the pure product (8.22 g, 84% yield) as an off-white solid. mp $128\text{--}129\text{ }^{\circ}\text{C}$; $[\alpha]_{\text{D}}^{20} +100.2$ (c 0.42, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.10–6.99 (m, 4 H), 2.07–2.01 (m, 3 H), 1.84–1.81 (m, 6 H), 1.75–1.69 (m, 3 H), 1.66–1.59 (m, 3 H), 1.20 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 191.0, 162.4 (d, $J = 247\text{ Hz}$), 132.3 (d, $J = 3.8\text{ Hz}$), 128.6, 114.8 (d, $J = 21.6\text{ Hz}$), 56.0, 44.5, 39.6, 36.4, 28.2, 22.2; HRMS: calcd for $\text{C}_{21}\text{H}_{29}\text{FNOS}$ [$\text{M} + \text{H}$]: 362.1948. Found: 362.1955.



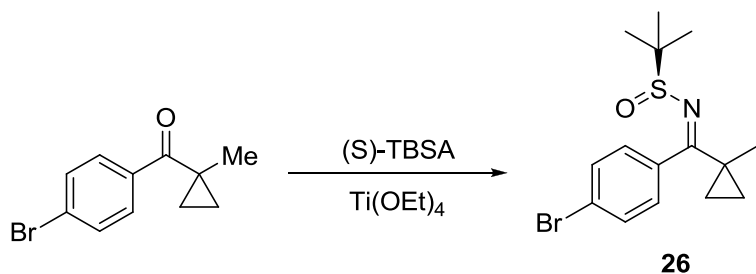
(1-(4-Methoxyphenyl)cyclohexyl)(phenyl)methanone. A flask was charged with 1-(4-methoxyphenyl)cyclohexanecarbonitrile (10.0 g, 46.4 mmol, 1.0 equiv) and THF (30 mL), and the solution was treated at rt with PhMgBr (27.9 mL, 55.7 mmol, 2.0 M, 1.2 equiv). The reaction mixture was heated at 75 °C for 22 h. The reaction mixture was cooled to rt and 6N HCl (100 mL) was added, and the mixture was heated at 75 °C for 18 h. After cooling to rt, the mixture was extracted with hexanes, the organic phase dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO₂ (1% EtOAc/hexanes) to give the pure product (7.11 g, 52% yield) as a thick colorless oil. ¹H NMR (400 MHz, CDCl₃) δ 7.34-7.30 (m, 5 H), 7.21-7.17 (m, 2 H), 6.93-6.89 (m, 2 H), 3.78 (s, 3 H), 2.49-2.46 (m, 2 H), 1.84-1.70 (m, 2 H), 1.66-1.57 (m, 3 H), 1.48-1.36 (m, 2 H), 1.30-1.19 (m, 1 H); ¹³C NMR (100 MHz, CDCl₃) δ 205.3, 158.5, 138.7, 136.1, 131.0, 128.6, 127.8, 127.4, 114.4, 55.2, 37.6, 36.1, 25.9, 23.4; HRMS: calcd for C₂₀H₂₃O₂ [M + H]: 295.1693. Found: 295.1690.



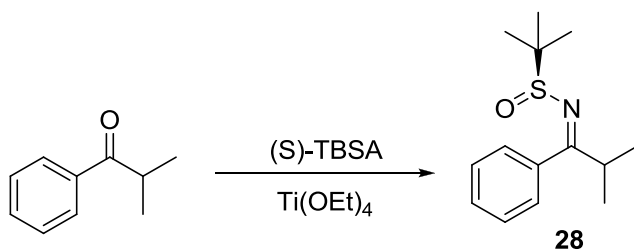
(S)-N-((1-(4-Methoxyphenyl)cyclohexyl)(phenyl)methylene)-2-methylpropane-2-sulfonamide (24). To a flask containing (S)-tert-butanethioamide (7.41 g, 61.1 mmol, 3.0 equiv) and (1-(4-methoxyphenyl)cyclohexyl)(phenyl)methanone (6.00 g, 20.4 mmol, 1.0 equiv) was added Ti(OEt)₄ (25.6 mL, 122.2 mmol, 6.0 equiv). The reaction mixture was stirred at 85 °C for 8 h, and then poured into EtOAc (300 mL). Water (15 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 200 mL), dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by crystallization from heptane (50 mL) to give the pure product (5.33 g, 66% yield) as an off-white solid. mp 114-116 °C; [α]_D²⁰ +61.8 (c 4.42, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 7.27-7.20 (m, 3 H), 7.18-7.13 (m, 2 H), 6.89-6.85 (m, 2 H), 6.57-6.42 (br, 2 H), 3.81 (s, 3 H), 2.24-2.10 (m, 2 H), 2.07-1.99 (m, 1 H), 1.95-1.88 (m, 1 H), 1.72-1.60 (m, 2 H), 1.58-1.45 (m, 3 H), 1.44-1.35 (m, 1 H), 1.24 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 189.8, 158.7, 136.8, 133.7, 129.1, 128.4, 127.3, 127.0, 113.9, 55.9, 55.3, 52.5, 34.5, 34.4, 26.0, 22.9, 22.8, 22.3; HRMS: calcd for C₂₄H₃₂NO₂S [M + H]: 398.2148. Found: 398.2139.



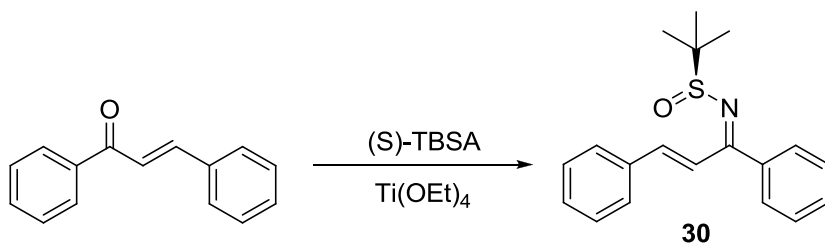
(4-Bromophenyl)(1-methylcyclopropyl)methanone. A flask was charged with (4-bromophenyl)(cyclopropyl)methanone (5.0 g, 22.2 mmol, 1.0 equiv) and THF (50 mL), and the solution was cooled to -78 °C and treated dropwise with LHMDS (26.7 mL, 26.7 mmol, 1.0 M, 1.2 equiv). The reaction mixture was stirred at -78 °C for 10 min, and then MeI (1.94 mL, 31.1 mmol, 1.4 equiv) was added. The reaction was allowed to warm to rt and stirred for 16 h. The reaction mixture was quenched with water, extracted with hexanes, the organic phase dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO₂ (hexanes) to give the pure product (1.46 g, 28% yield) as a yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 7.69-7.66 (m, 2 H), 7.59-7.55 (m, 2 H), 1.42 (s, 3 H), 1.28-1.25 (m, 2 H), 0.80-0.78 (m, 2 H); ¹³C NMR (100 MHz, CDCl₃) δ 203.2, 136.3, 131.5, 129.9, 126.5, 25.4, 21.8, 15.3; HRMS: calcd for C₁₁H₁₂BrO [M + H]: 239.0066. Found: 239.0069.



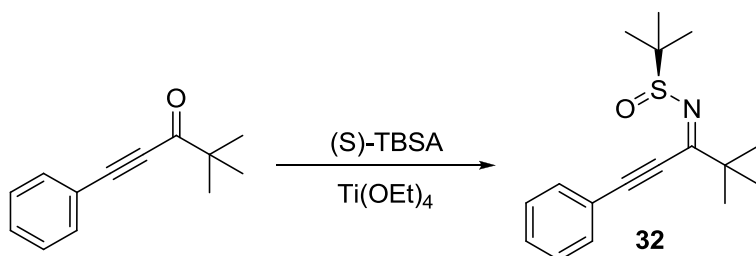
(S)-N-((4-Bromophenyl)(1-methylcyclopropyl)methylene)-2-methylpropane-2-sulfonamide (26). To a flask containing (S)-tert-butanethioamide (2.13 g, 17.6 mmol, 3.0 equiv) and (4-bromophenyl)(1-methylcyclopropyl)methanone (1.40 g, 5.86 mmol, 1.0 equiv) was added Ti(OEt)₄ (7.29 mL, 35.1 mmol, 6.0 equiv). The reaction mixture was stirred at 85 °C for 2 h, and then poured into EtOAc (100 mL). Water (5 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 50 mL), dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO₂ (10% MTBE/hexanes) to give the pure product (1.81 g, 90% yield) as a yellow oil. [α]_D²⁰ +112.0 (c 3.17, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 8.25-7.60 (br, 0.5 H), 7.51-7.49 (m, 2 H), 7.24-6.80 (br, 1.5 H), 1.38-1.08 (m, 12 H), 1.08-1.00 (m, 2 H), 0.92-0.77 (m, 2 H); ¹³C NMR (100 MHz, CDCl₃) δ 188.7, 134.7, 131.4, 128.6, 123.3, 56.1, 25.7, 22.2, 21.4, 17.0, 16.5; HRMS: calcd for C₁₅H₂₁BrNOS [M + H]: 342.0522. Found: 342.0523.



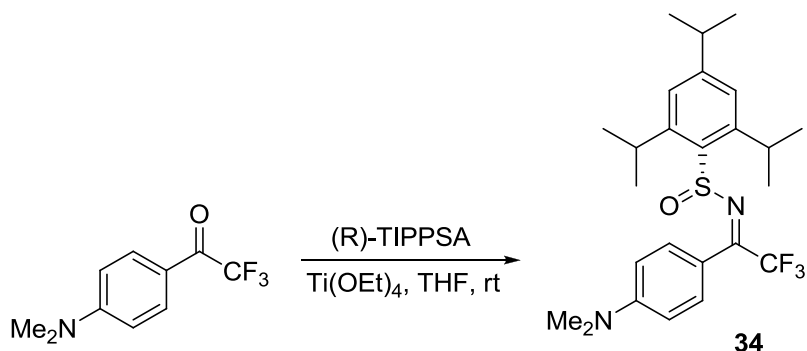
(*S,Z*)-2-Methyl-*N*-(2-methyl-1-phenylpropylidene)propane-2-sulfinamide (28). To a flask containing (*S*)-tert-butanesulfinamide (8.08 g, 66.7 mmol, 2.0 equiv) and isobutyrophenone (5.00 mL, 33.3 mmol, 1.0 equiv) was added Ti(OEt)₄ (28.0 mL, 133.3 mmol, 4.0 equiv). The reaction mixture was stirred at 65 °C for 24 h, and then poured into EtOAc (300 mL). Water (20 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 200 mL), dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by crystallization from heptane at 0 °C to give the pure product (3.80 g, 45% yield) as a light yellow solid. mp 32-33 °C; [α]_D²⁰ +146.9 (*c* 5.08, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 7.42-7.38 (m, 3 H), 7.34-7.25 (br, 2 H), 3.24-2.74 (br, 1 H), 1.24-1.18 (m, 15 H); ¹³C NMR (100 MHz, CDCl₃) δ 190.0, 138.1, 129.3, 128.2, 126.7, 56.2, 40.6, 22.1, 20.1, 19.7; HRMS: calcd for C₁₄H₂₂NOS [M + H]: 252.1422. Found: 252.1420.



(*S,E*)-*N*-((*E*)-1,3-Diphenylallylidene)-2-methylpropane-2-sulfinamide (30). To a flask containing (*S*)-tert-butanesulfinamide (4.66 g, 38.4 mmol, 1.5 equiv) and chalcone (8.00 g, 38.4 mmol, 1.0 equiv) was added THF (16 mL) and Ti(OEt)₄ (16.1 mL, 76.8 mmol, 2.0 equiv). The reaction mixture was stirred at 75 °C for 16 h, and then poured into EtOAc (300 mL). Water (15 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 100 mL), dried (Na₂SO₄), filtered, and concentrated. The crude product was purified by recrystallization from hexanes/MTBE to give the pure product (8.02 g, 67% yield) as a bright yellow solid. mp 71-72.5 °C; [α]_D²⁰ +323.5 (*c* 5.54, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 8.07 (d, *J* = 16.1 Hz, 1 H), 7.69-7.60 (br, 2 H), 7.53-7.43 (m, 6 H), 7.38-7.33 (m, 4 H), 6.90 (d, *J* = 16.1 Hz, 1 H), 1.34 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 175.6, 144.0, 138.8, 135.2, 130.7, 130.1, 129.3, 128.9, 128.4, 128.1, 122.5, 58.6, 22.9; HRMS: calcd for C₁₉H₂₂NOS [M + H]: 312.1417. Found: 312.1424.



(S)-N-(4,4-Dimethyl-1-phenylpent-1-yn-3-ylidene)-2-methylpropane-2-sulfonamide (32). To a flask containing (S)-tert-butananesulfonamide (5.21 g, 43.0 mmol, 2.0 equiv) and 4,4-dimethyl-1-phenylpent-1-yn-3-one¹ (5.00 g, 21.5 mmol, 80 wt.%, 1.0 equiv) was added THF (16 mL) and $\text{Ti}(\text{OEt})_4$ (26.7 mL, 128.9 mmol, 6.0 equiv). The reaction mixture was stirred at 85 °C for 2 h, and then poured into EtOAc (300 mL). Water (15 mL) was added dropwise, and the resultant slurry was stirred for 15 min and then filtered through a pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (3 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by flash column chromatography on SiO_2 (10-15% EtOAc/hexanes) to give the pure product (2.68 g, 43% yield) as a yellow oil. $[\alpha]_{\text{D}}^{20} +271.8$ (c 4.76, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.59-7.56 (m, 2 H), 7.45-7.35 (m, 3 H), 1.32 (s, 9 H), 1.27 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 172.8, 132.7, 130.2, 128.6, 120.9, 103.8, 82.4, 57.3, 42.6, 27.8, 22.3; HRMS: calcd for $\text{C}_{17}\text{H}_{24}\text{NOS}$ [M + H]: 290.1573. Found: 290.1579.

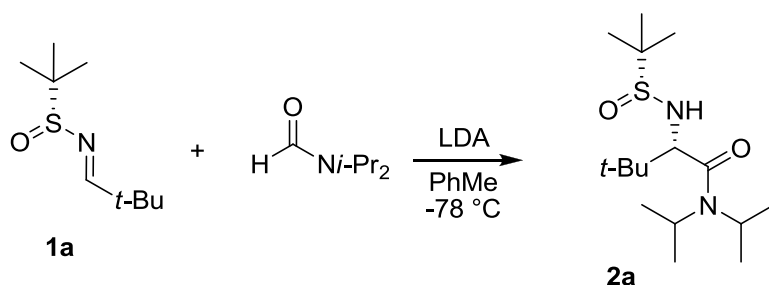


(R)-N-(1-(4-(Dimethylamino)phenyl)-2,2,2-trifluoroethylidene)-2,4,6-triisopropylbenzenesulfonamide (34). To a flask containing (R)-2,4,6-triisopropylbenzenesulfonamide (5.00 g, 18.7 mmol, 1.0 equiv) and THF (15 mL) was added 4-dimethylaminotrifluoroacetophenone (4.06 g, 18.7 mmol, 1.0 equiv) followed by $\text{Ti}(\text{OEt})_4$ (15.5 mL, 74.8 mmol, 4.0 equiv). The reaction mixture was stirred at rt for 24 h, and then diluted with EtOAc (300 mL). Water (10.0 mL) was added dropwise with vigorous stirring. The resultant slurry was stirred at rt for 15 min and filtered through a 1 cm pad of Celite. The Celite cake was washed with EtOAc, and the filtrate was washed with water (2 x 100 mL), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by recrystallization from heptane to give the pure product (5.12 g, 58% yield) as a yellow solid. mp 112-114 °C; $[\alpha]_{\text{D}}^{20} +195.5$ (c 3.80, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.40 (d, $J = 8.0$ Hz, 2 H), 7.07 (s, 2 H), 6.66 (d, $J = 8.8$ Hz, 2 H), 4.01-3.71 (br, 2 H), 3.03 (s, 6 H), 2.92-2.85 (m, 1 H), 1.26-1.23 (m, 12 H), 1.19 (d, $J = 6.5$ Hz,

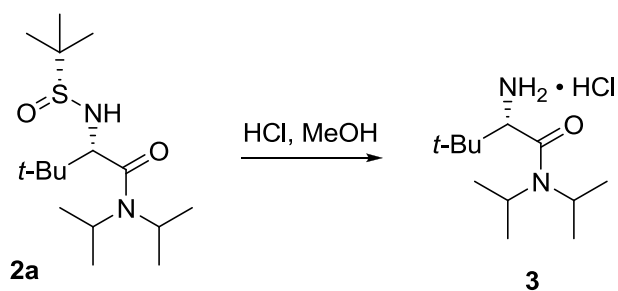
6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 161.9 (q, $J = 33.7$ Hz), 153.1, 152.2, 149.8, 138.2, 130.3, 123.0, 119.4 (q, $J = 282$ Hz), 117.0, 110.9, 39.9, 34.4, 29.0, 24.7, 24.1, 23.74, 23.71; HRMS: calcd for $\text{C}_{25}\text{H}_{34}\text{F}_3\text{N}_2\text{OS}$ [$\text{M} + \text{H}$]: 467.2338. Found: 467.2341.

Procedures and data for α -aminoamides.

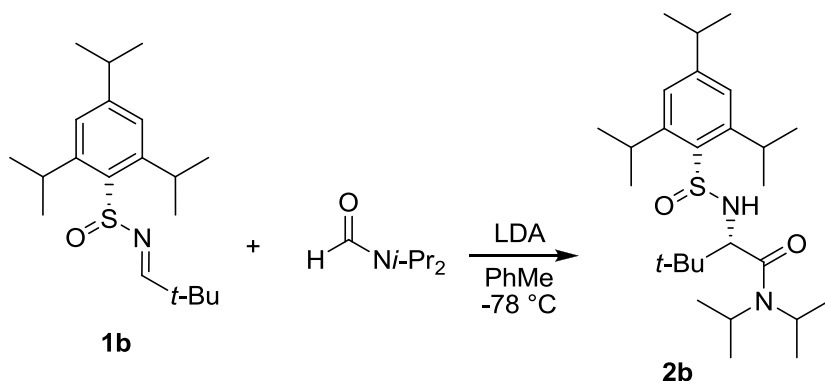
General Procedure for Carbamoyl Anion Addition to *N*-Sulfinylimines. A solution of *N*-sulfinylimine (1.00 equiv), formamide (3.1 equiv) and toluene (10 volumes based on *N*-sulfinylimine) was cooled to -78°C . LDA (3.0 equiv of commercially available 2.0M solution) was added dropwise. The reaction mixture was stirred at -78°C for 10 min, and then quenched by the addition of water. After warming to rt, the reaction mixture was diluted with EtOAc and the layers were separated. The organic phase was washed with water (2-3 times), dried (Na_2SO_4), filtered, and concentrated. The crude product was purified by either flash column chromatography or crystallization as indicated.



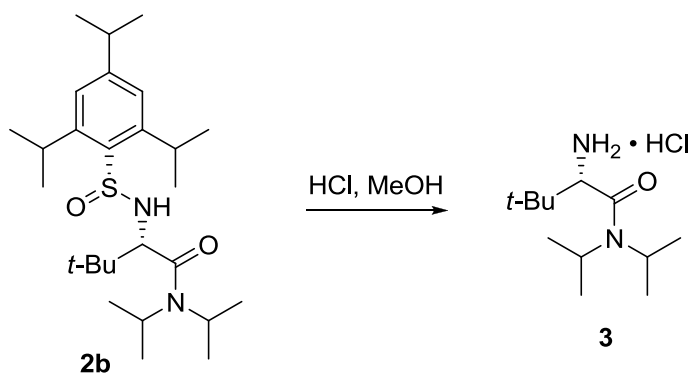
(S)-2-((R)-1,1-Dimethylethylsulfinamido)-*N,N*-diisopropyl-3,3-dimethylbutanamide (2a). According to the general procedure, sulfinimine **1a** (5.00 g, 26.4 mmol), *N,N*-diisopropylformamide (11.89 mL, 81.9 mmol), and toluene (50 mL) were treated with LDA (39.6 mL, 79.2 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 98.1:1.9. Purification by crystallization from hexanes gave **2a** as a white solid (6.49 g, 77% yield). HPLC (Method A): major diastereomer $t_r = 2.618$ min; minor diastereomer $t_r = 2.901$ min. mp $160\text{--}162^\circ\text{C}$; ^1H NMR (400 MHz, CDCl_3) δ 4.38 (d, $J = 10.0$ Hz, 1 H), 4.12–4.02 (m, 1 H), 3.88 (d, $J = 9.6$ Hz, 1 H), 3.42–3.32 (m, 1 H), 1.34–1.32 (m, 6 H), 1.18–1.13 (m, 6 H), 1.12 (s, 9 H), 0.98 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 171.0, 62.7, 56.3, 49.3, 46.3, 35.5, 26.8, 22.4, 21.5, 20.5, 20.3, 20.1; HRMS: calcd for $\text{C}_{16}\text{H}_{35}\text{N}_2\text{O}_2\text{S}$ [$\text{M} + \text{H}$]: 319.2414. Found: 319.2417.



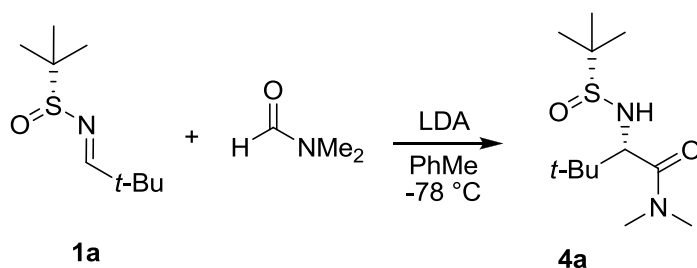
(S)-2-Amino-*N,N*-diisopropyl-3,3-dimethylbutanamide hydrochloride (3) from 2a. A solution of **2a** (5.00 g, 15.7 mmol) in MeOH (80 mL) was treated with HCl in dioxane (11.8 mL, 47.1 mmol). After stirring at rt for 1 h, the reaction mixture was concentrated on a rotovap, and the residue was repeatedly chased with CH₂Cl₂ to give **3** as an off-white solid (3.86 g, 98% yield). Chiral HPLC: (*S*)-enantiomer: 3.45 min, (*R*)-enantiomer: 3.85 min. (*R*)-enantiomer not detected, er >99.5:0.5. mp 194-195 °C; [α]_D²⁰ +54.6 (*c* 1.06, MeOH); ¹H NMR (400 MHz, *d*-6 DMSO) δ 8.26 (br s, 3 H), 4.27-4.17 (m, 1 H), 4.08-4.01 (m, 1 H), 3.55-3.46 (m, 1 H), 1.37 (d, *J* = 6.4 Hz, 3 H), 1.30 (d, *J* = 6.4 Hz, 3 H), 1.20 (d, *J* = 6.4 Hz, 3 H), 1.15 (d, *J* = 6.4 Hz, 3 H), 1.00 (s, 9 H); ¹³C NMR (100 MHz, *d*-6 DMSO) δ 166.8, 55.8, 49.0, 45.6, 33.5, 26.3, 20.9, 20.5, 19.8, 19.5; HRMS: calcd for C₁₂H₂₇N₂O [M – HCl + H]; 215.2118. Found: 215.2115.



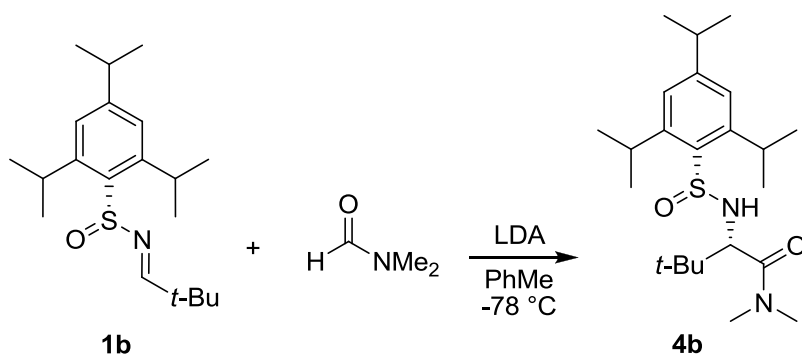
(S)-*N,N*-Diisopropyl-3,3-dimethyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)-butanamide (2b). According to the general procedure, sulfinimine **1b** (1.00 g, 2.98 mmol), *N,N*-diisopropylformamide (1.34 mL, 9.24 mmol), and toluene (10 mL) were treated with LDA (4.47 mL, 8.94 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 99.7:0.3. Purification by chromatography on SiO₂ (10-40% MTBE/hexanes) gave **2b** as a white solid (1.14 g, 82% yield). HPLC (Method A): major diastereomer *t_r* = 4.230 min; minor diastereomer *t_r* = 4.447 min. mp 141-144 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.05 (s, 2 H), 4.69 (d, *J* = 10.6 Hz, 1 H), 4.65-3.55 (br, 2 H), 4.35-4.25 (m, 1 H), 4.02 (d, *J* = 10.5 Hz, 1 H), 3.52-3.42 (m, 1 H), 2.92-2.81 (m, 1 H), 1.41-1.38 (m, 6 H), 1.31-1.26 (m, 12 H), 1.24-1.22 (m, 12 H), 1.04 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 172.1, 152.5, 149.0, 137.8, 123.1, 61.8, 49.5, 46.4, 35.3, 34.4, 28.1, 27.0, 24.5, 24.4, 23.8, 21.8, 20.8, 20.3, 20.1; HRMS: calcd for C₂₇H₄₉N₂O₂S [M + H]; 465.3509. Found: 465.3514.



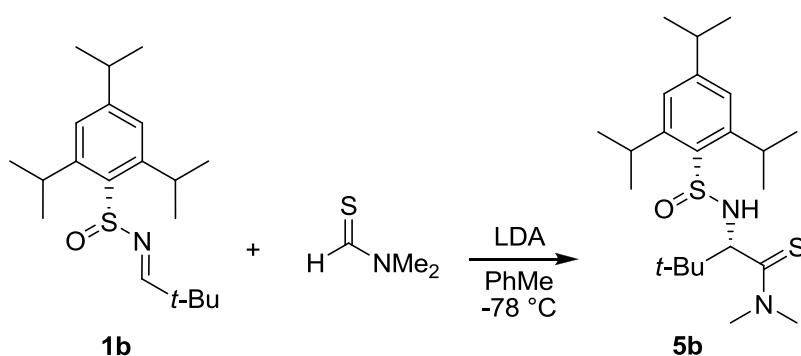
(S)-2-Amino-N,N-diisopropyl-3,3-dimethylbutanamide hydrochloride (3) from 2b. A solution of **2b** (13.85 g, 29.8 mmol) in MeOH (150 mL) was treated with HCl in dioxane (22.4 mL, 89.4 mmol). After stirring at rt for 18 h, the reaction mixture was concentrated on a rotovap. The residue was triturated with Et₂O, and the solid was filtered and washed with Et₂O and hexanes to give **3** as an off-white solid (6.96 g, 93% yield). Chiral HPLC: er >99.5:0.5. Spectral data for **3** obtained from **2b** were identical with **3** obtained from **2a**.



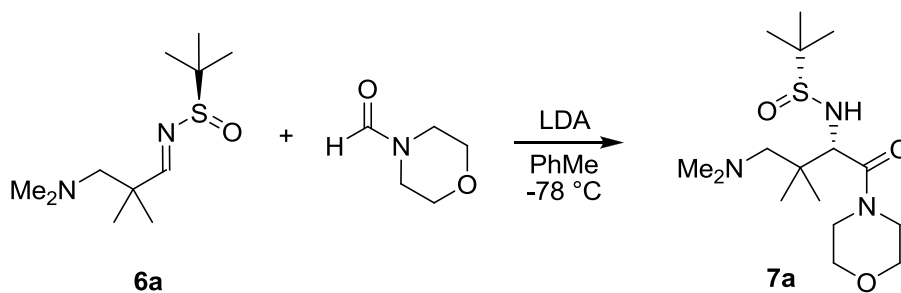
(S)-2-((R)-1,1-Dimethylethylsulfinamido)-N,N,3,3-tetramethylbutanamide (4a). According to the general procedure, sulfinimine **1a** (1.00 g, 5.28 mmol), *N,N*-dimethylformamide (1.27 mL, 16.4 mmol), and toluene (10 mL) were treated with LDA (7.92 mL, 15.8 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 92.8:7.2. Purification by chromatography on SiO₂ (10-70% MTBE/hexanes) gave **4a** as a colorless oil (998 mg, 72% yield). HPLC (Method A): major diastereomer *t_r* = 1.673 min; minor diastereomer *t_r* = 2.070 min. ¹H NMR (400 MHz, CDCl₃) δ 4.37 (d, *J* = 9.7 Hz, 1 H), 4.00 (d, *J* = 10.0 Hz, 1 H), 3.10 (s, 3 H), 2.97 (s, 3 H), 1.18 (s, 9 H), 1.04 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 172.6, 60.5, 56.5, 38.0, 35.7, 35.6, 26.6, 22.2; HRMS: calcd for C₁₂H₂₇N₂O₂S [M + H]: 263.1788. Found: 263.1791.



(S)-N,N,3,3-Tetramethyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)butanamide (4b). According to the general procedure, sulfinimine **1b** (500 mg, 1.49 mmol), *N,N*-dimethylformamide (0.358 mL, 4.62 mmol), and toluene (5 mL) were treated with LDA (2.24 mL, 4.47 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 97.8:2.2. Purification by chromatography on SiO₂ (10-50% MTBE/hexanes) gave **4b** as a colorless oil (507 mg, 83% yield). HPLC (Method A): major diastereomer *t_r* = 3.514 min; minor diastereomer *t_r* = 3.727 min. ¹H NMR (400 MHz, CDCl₃) δ 6.97 (s, 2 H), 4.79 (d, *J* = 10.4 Hz, 1 H), 4.55-3.63 (m, 3 H), 3.06 (s, 3 H), 2.84 (s, 3 H), 2.82-2.72 (m, 1 H), 1.23 (d, *J* = 6.9 Hz, 6 H), 1.17-1.11 (m, 12 H), 0.95 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 172.8, 161.5, 152.1, 148.0, 138.5, 123.0, 62.1, 38.2, 35.5, 35.48, 34.3, 28.3, 26.5, 24.4, 24.1, 23.8; HRMS: calcd for C₂₃H₄₁N₂O₂S [M + H]: 409.2883. Found: 409.2874.

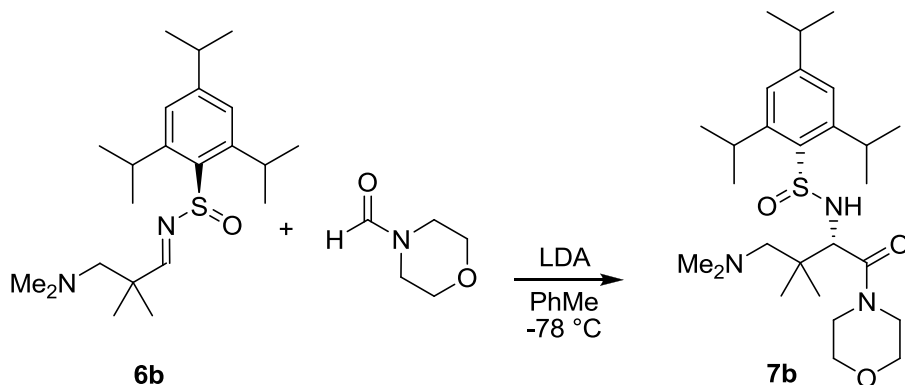


(S)-N,N,3,3-Tetramethyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)butanethioamide (5b). According to the general procedure, sulfinimine **1b** (500 mg, 1.49 mmol), *N,N*-dimethylthioformamide (0.393 mL, 4.62 mmol), and toluene (5 mL) were treated with LDA (2.24 mL, 4.47 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 99.0:1.0. Purification by chromatography on SiO₂ (10-70% MTBE/hexanes) gave **5b** as a yellow solid (533 mg, 84% yield). HPLC (Method A): major diastereomer *t_r* = 3.846 min; minor diastereomer *t_r* = 4.084 min. mp 103-106 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.06 (s, 2 H), 5.26 (d, *J* = 10.8 Hz, 1 H), 4.91-3.21 (br, 2 H), 4.38 (d, *J* = 11.0 Hz, 1 H), 3.48 (s, 3 H), 3.475 (s, 3 H), 2.92-2.82 (m, 1 H), 1.32-1.29 (m, 6 H), 1.25-1.22 (m, 12 H), 1.08 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 205.1, 152.5, 149.0, 138.0, 123.1, 65.8, 44.9, 42.6, 36.7, 34.3, 28.2, 27.0, 24.6, 24.3, 23.8; HRMS: calcd for C₂₃H₄₁N₂OS₂ [M + H]: 425.2655. Found: 425.2661.

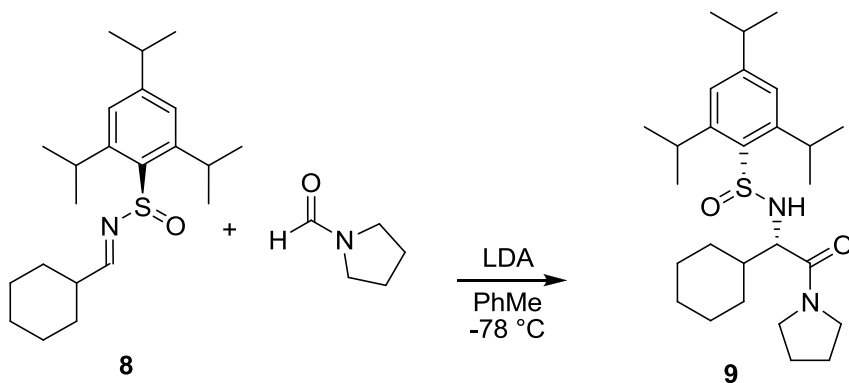


(S)-4-(Dimethylamino)-2-((R)-1,1-dimethylethylsulfinamido)-N,N,3,3-tetramethylbutanamide (7a). According to the general procedure, sulfinimine **6a** (500 mg, 2.15

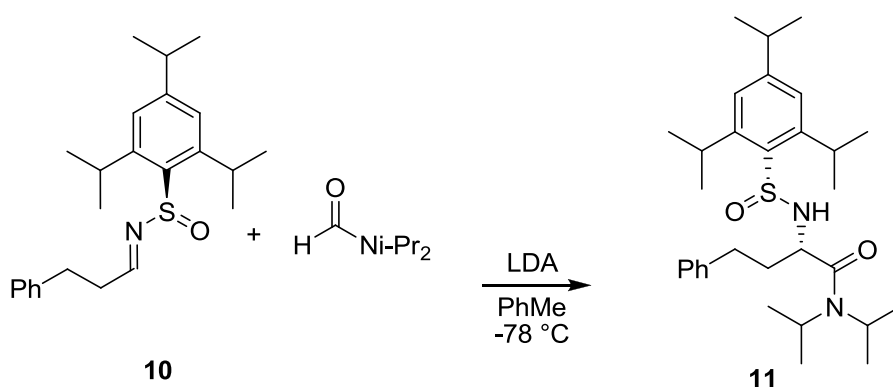
mmol), *N*-formylmorpholine (0.671 mL, 6.67 mmol), and toluene (5 mL) were treated with LDA (3.23 mL, 6.46 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 92.7:7.3. Purification by chromatography on SiO₂ (MTBE) gave **7a** as a colorless oil (571 mg, 76% yield). HPLC (Method A): major diastereomer *t_r* = 0.909 min; minor diastereomer *t_r* = 1.494 min. ¹H NMR (400 MHz, CDCl₃) δ 7.59 (d, *J* = 5.8 Hz, 1 H), 4.24 (d, *J* = 5.8 Hz, 1 H), 3.84-3.46 (m, 8 H), 2.97 (d, *J* = 13.9 Hz, 1 H), 2.36 (s, 6 H), 2.05 (d, *J* = 13.8 Hz, 1 H), 1.20 (s, 9 H), 1.14 (s, 3 H), 0.90 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃) δ 171.0, 68.7, 67.1, 66.8, 60.2, 55.8, 47.9, 47.1, 42.3, 37.7, 26.0, 23.5, 22.6; HRMS: calcd for C₁₆H₃₄N₃O₃S [M + H]: 348.2315. Found: 348.2323.



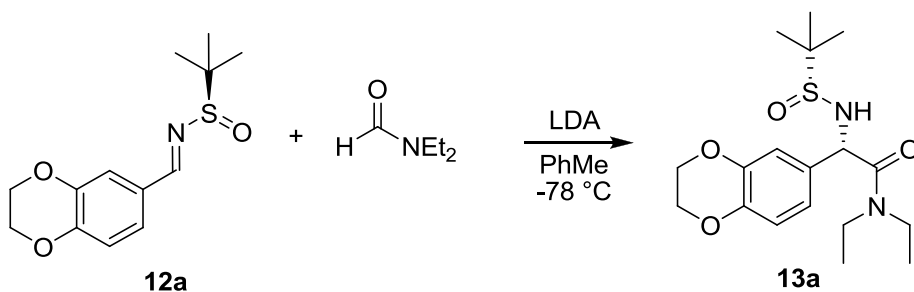
(*R*)-*N*-((*S*)-4-(Dimethylamino)-3,3-dimethyl-1-morpholino-1-oxobutan-2-yl)-2,4,6-triisopropylbenzenesulfonamide (7b**).** According to the general procedure, sulfinimine **6b** (500 mg, 1.32 mmol), *N*-formylmorpholine (0.412 mL, 4.09 mmol), and toluene (5 mL) were treated with LDA (1.98 mL, 3.96 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 97.4:2.6. Purification by chromatography on SiO₂ (MTBE) gave **7b** as a colorless oil (535 mg, 82% yield). HPLC (Method A): major diastereomer *t_r* = 2.568 min; minor diastereomer *t_r* = 2.658 min. ¹H NMR (400 MHz, CDCl₃) δ 7.05 (s, 2 H), 5.89 (d, *J* = 9.1 Hz, 1 H), 4.48 (d, *J* = 9.1 Hz, 1 H), 4.34-3.86 (br, 2 H), 3.80-3.61 (m, 7 H), 3.55-3.47 (m, 1 H), 2.90-2.80 (m, 1 H), 2.78 (d, *J* = 13.6 Hz, 1 H), 2.32 (s, 6 H), 2.00 (d, *J* = 13.9 Hz, 1 H), 1.31 (d, *J* = 6.5 Hz, 6 H), 1.23 (d, *J* = 6.4 Hz, 12 H), 1.07 (s, 3 H), 0.89 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃) δ 171.7, 151.9, 147.9, 138.5, 122.9, 67.6, 67.0, 66.8, 58.8, 48.6, 47.0, 42.2, 39.5, 34.4, 28.4, 24.4, 24.3, 23.8, 22.5; HRMS: calcd for C₂₇H₄₈N₃O₃S [M + H]: 494.3411. Found: 494.3404.



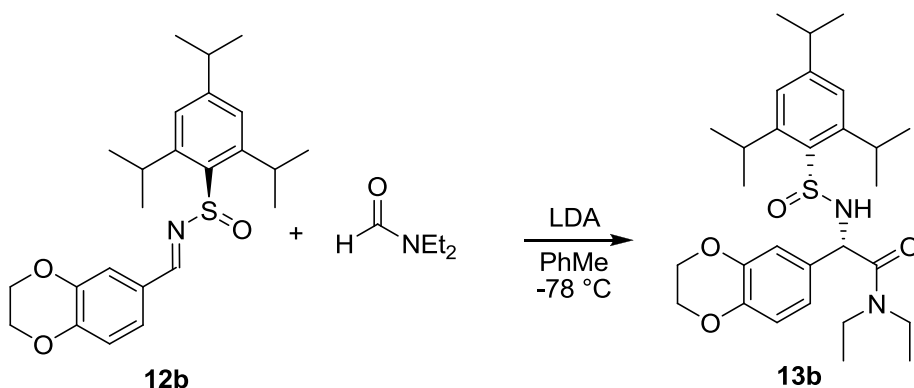
(R)-N-((S)-1-Cyclohexyl-2-oxo-2-(pyrrolidin-1-yl)ethyl)-2,4,6-triisopropylbenzenesulfonamide (9). According to the general procedure, sulfinimine **8** (500 mg, 1.38 mmol), *N*-formylpyrrolidine (0.409 mL, 4.29 mmol), and toluene (5 mL) were treated with LDA (2.07 mL, 4.15 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 96.8:3.2. Purification by chromatography on SiO₂ (10-40% MTBE/hexanes) gave **9** as a colorless oil (505 mg, 79% yield). HPLC (Method A): major diastereomer *t_r* = 3.769 min; minor diastereomer *t_r* = 4.015 min. ¹H NMR (400 MHz, CDCl₃) δ 7.04 (s, 2 H), 4.82 (d, *J* = 9.5 Hz, 1 H), 4.31-3.85 (br, 2 H), 3.89 (dd, *J* = 9.6, 6.0 Hz, 1 H), 3.67-3.61 (m, 1 H), 3.53-3.38 (m, 3 H), 2.91-2.80 (m, 1 H), 2.03-1.96 (m, 2 H), 1.93-1.84 (m, 3 H), 1.81-1.71 (m, 2 H), 1.68-1.60 (m, 3 H), 1.32-1.01 (m, 23 H); ¹³C NMR (100 MHz, CDCl₃) δ 171.2, 152.0, 148.0, 138.5, 123.0, 62.4, 46.7, 45.8, 41.4, 34.4, 30.0, 28.3, 26.2, 26.1, 26.0, 24.4, 24.2, 23.8; HRMS: calcd for C₂₇H₄₅N₂O₂S [M + H]: 461.3196. Found: 461.3199.



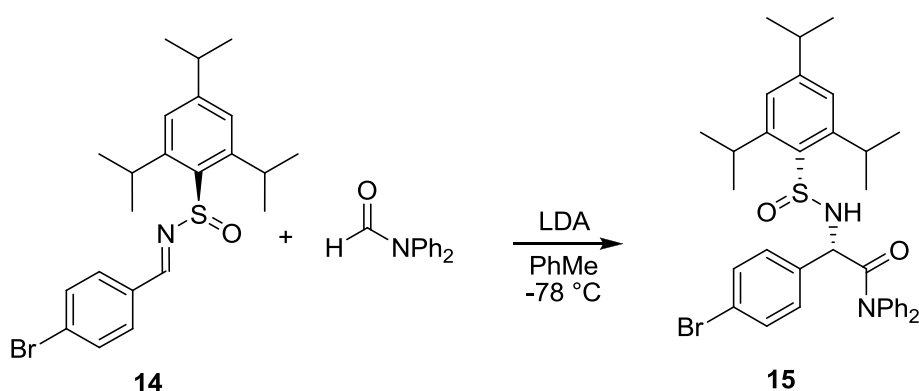
(S)-N,N-Diisopropyl-4-phenyl-2-((R)-2,4,6-triisopropylphenylsulfonamido)butanamide (11). A flask was charged with toluene (20 mL) and LDA (3.91 mL, 7.82 mmol, 2.0 M) and the solution was cooled to -78 °C. *N,N*-Diisopropylformamide (1.17 mL, 8.08 mmol) was added dropwise. After 5 min, a solution of **10** (1.00 g, 2.61 mmol) in toluene (3 mL) was added dropwise. The reaction was quenched after 10 min by the addition of water, and the reaction mixture was allowed to warm to rt. Reaction diastereoselectivity (from HPLC): 98.7:1.3. The reaction mixture was diluted with EtOAc, and the layers separated. The organic phase was washed with water (2 times), dried over Na₂SO₄, filtered, and concentrated. Purification by chromatography on SiO₂ (5-40% MTBE/hexanes) gave **11** as a colorless oil (948 mg, 71% yield). HPLC (Method A): major diastereomer *t_r* = 4.241 min; minor diastereomer *t_r* = 4.344 min. ¹H NMR (400 MHz, CDCl₃) δ 7.32-7.25 (m, 4 H), 7.21-7.17 (m, 1 H), 7.07 (s, 2 H), 5.11 (d, *J* = 9.8 Hz, 1 H), 4.58-3.73 (br, 2 H), 4.16-4.10 (m, 1 H), 3.64-3.54 (m, 1 H), 3.50-3.34 (br, 1 H), 2.92-2.82 (m, 3 H), 1.92-1.87 (m, 2 H), 1.32 (d, *J* = 6.8 Hz, 12 H), 1.24 (d, *J* = 6.8 Hz, 12 H), 1.11 (d, *J* = 6.6 Hz, 3 H), 1.08 (d, *J* = 6.6 Hz, 3 H); ¹³C NMR (100 MHz, CDCl₃) δ 171.4, 152.1, 148.5, 141.4, 138.3, 128.9, 128.5, 126.1, 123.0, 55.8, 48.0, 46.1, 37.3, 34.4, 31.5, 28.3, 24.5, 24.4, 23.83, 23.81, 21.2, 20.6, 20.5, 20.3; HRMS: calcd for C₃₁H₄₉N₂O₂S [M + H]: 513.3509. Found: 513.3501.



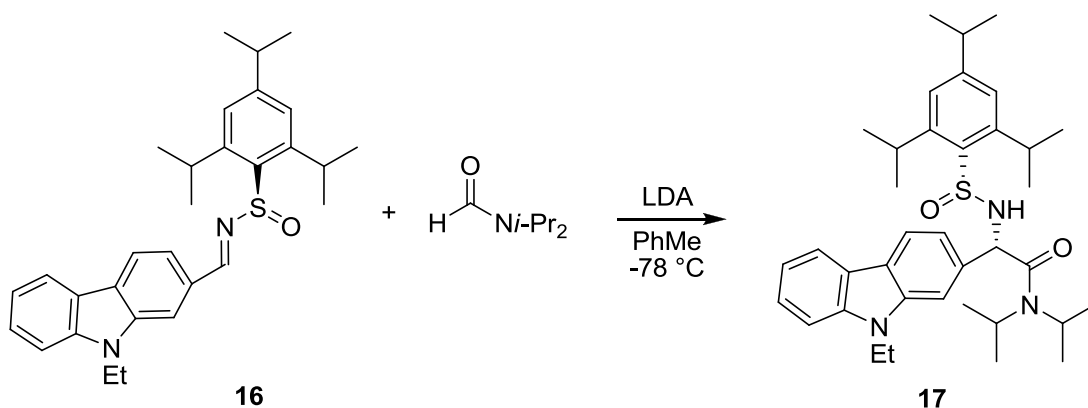
(S)-2-(2,3-Dihydrobenzo[b][1,4]dioxin-6-yl)-2-((R)-1,1-dimethylethylsulfinamido)-N,N-diethylacetamide (13a). According to the general procedure, sulfinimine **12a** (500 mg, 1.87 mmol), *N,N*-diethylformamide (0.644 mL, 5.80 mmol), and toluene (5 mL) were treated with LDA (2.80 mL, 5.61 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 89.9:10.1. Purification by chromatography on SiO₂ (10-80% MTBE/hexanes) gave **13a** as a colorless oil (570 mg, 83% yield). HPLC (Method A): major diastereomer *t_r* = 2.162 min; minor diastereomer *t_r* = 2.226 min. ¹H NMR (400 MHz, CDCl₃) δ 6.90-6.81 (m, 3 H), 5.05 (d, *J* = 8.1 Hz, 1 H), 4.91 (d, *J* = 8.6 Hz, 1 H), 4.23 (br s, 4 H), 3.55-3.46 (m, 1 H), 3.39-3.22 (m, 2 H), 3.20-3.10 (m, 1 H), 1.19 (s, 9 H), 1.10 (t, *J* = 7.1 Hz, 3 H), 1.05 (t, *J* = 7.1 Hz, 3 H); ¹³C NMR (100 MHz, CDCl₃) δ 169.8, 143.7, 143.6, 131.5, 120.9, 117.7, 116.7, 64.3, 64.2, 56.52, 56.49, 41.6, 40.7, 22.5, 14.0, 12.7; HRMS: calcd for C₁₈H₂₉N₂O₄S [M + H]: 362.1843. Found: 362.1832.



(S)-2-(2,3-Dihydrobenzo[b][1,4]dioxin-6-yl)-N,N-diethyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)acetamide (13b). According to the general procedure, sulfinimine **12b** (500 mg, 1.21 mmol), *N,N*-diethylformamide (0.421 mL, 3.75 mmol), and toluene (5 mL) were treated with LDA (1.81 mL, 3.63 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 95.7:4.3. Purification by chromatography on SiO₂ (30-40% EtOAc/hexanes) gave **13b** as a white solid (476 mg, 77% yield). HPLC (Method B): major diastereomer *t_r* = 7.338 min; minor diastereomer *t_r* = 7.545 min. mp 125.5-127 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.05 (s, 2 H), 6.83-6.78 (m, 3 H), 5.46 (d, *J* = 9.2 Hz, 1 H), 5.15 (d, *J* = 9.0 Hz, 1 H), 4.22 (s, 4 H), 4.18-3.90 (m, 2 H), 3.53-3.44 (m, 1 H), 3.40-3.24 (m, 2 H), 3.19-3.10 (m, 1 H), 2.91-2.81 (m, 1 H), 1.28 (d, *J* = 6.8 Hz, 6 H), 1.24-1.21 (m, 12 H), 1.12-1.06 (m, 6 H); ¹³C NMR (100 MHz, CDCl₃) δ 169.8, 151.9, 148.1, 143.7, 143.5, 138.3, 131.7, 123.0, 120.7, 117.8, 116.5, 64.5, 59.3, 41.7, 40.7, 34.4, 28.2, 24.4, 24.3, 23.8, 23.78, 14.2, 12.8; HRMS: calcd for C₂₉H₄₃N₂O₄S [M + H]: 515.2938. Found: 515.2924.

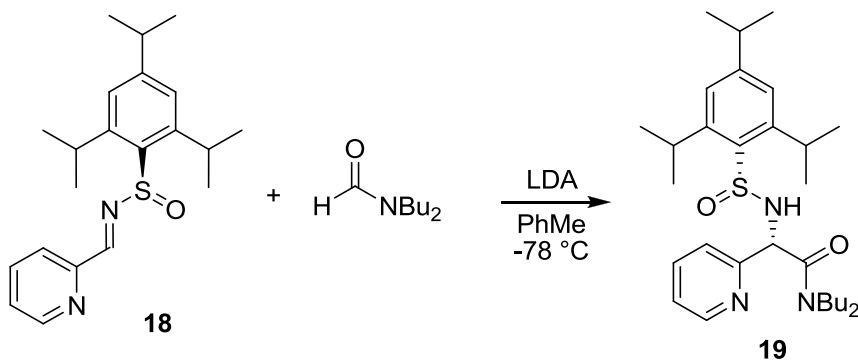


(S)-2-(4-Bromophenyl)-N,N-diphenyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)-acetamide (15). Note: THF was used as solvent due to the insolubility of *N,N*-diphenylformamide in toluene. According to the general procedure, sulfinimine **14** (500 mg, 1.15 mmol), *N,N*-diphenylformamide (0.704 g, 3.57 mmol), and THF (10 mL) were treated with LDA (1.73 mL, 3.45 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 98.1:1.9. Purification by chromatography on SiO₂ (10-40% MTBE/hexanes) gave **15** as a white solid (569 mg, 78% yield). HPLC (Method A): major diastereomer *t_r* = 4.222 min; minor diastereomer *t_r* = 4.404 min. mp 84-87 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.41-7.04 (m, 12 H), 7.04 (s, 2 H), 7.01-6.99 (m, 2 H), 5.40 (d, *J* = 9.0 Hz, 1 H), 5.23 (d, *J* = 9.0 Hz, 1 H), 4.17-3.83 (br, 2 H), 2.91-2.80 (m, 1 H), 1.27 (d, *J* = 6.9 Hz, 6 H), 1.24-1.22 (m, 12 H); ¹³C NMR (100 MHz, CDCl₃) δ 170.6, 152.2, 147.9, 142.1, 141.0, 138.1, 137.2, 132.0, 130.0, 129.4, 129.1, 128.7, 126.7, 126.0, 123.0, 122.6, 60.1, 34.4, 28.3, 24.5, 24.2, 23.8, 23.78; HRMS: calcd for C₃₅H₄₀BrN₂O₂S [*M* + *H*]: 631.1988. Found: 631.1972.

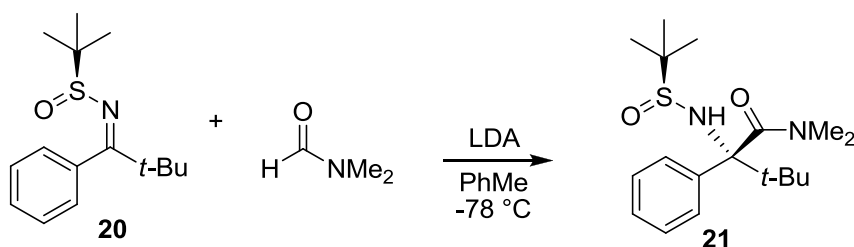


(S)-2-(9-Ethyl-9H-carbazol-2-yl)-N,N-diisopropyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)acetamide (17). According to the general procedure, sulfinimine **16** (331 mg, 0.700 mmol), *N,N*-diisopropylformamide (0.315 mL, 2.17 mmol), and toluene (2.5 mL) were treated with LDA (1.05 mL, 2.10 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 99.1:0.9. Purification by chromatography on SiO₂ (10-40% MTBE/hexanes) gave **17** as a yellow solid (380 mg, 90% yield). HPLC (Method C):

major diastereomer $t_r = 2.063$ min; minor diastereomer $t_r = 2.772$ min. mp 148-150 °C; ^1H NMR (500 MHz, CDCl_3) δ 8.02 (d, $J = 7.7$ Hz, 1 H), 7.99 (s, 1 H), 7.47-7.38 (m, 3 H), 7.35-7.33 (m, 1 H), 7.23-7.20 (m, 1 H), 7.05 (s, 2 H), 5.57 (d, $J = 9.3$ Hz, 1 H), 5.42 (d, $J = 9.5$ Hz, 1 H), 4.34 (q, $J = 7.3$ Hz, 2 H), 4.29-4.00 (m, 3 H), 3.44-3.35 (m, 1 H), 2.90-2.82 (m, 1 H), 1.48-1.41 (m, 9 H), 1.29-1.21 (m, 21 H), 0.59 (d, $J = 6.3$ Hz, 3 H); ^{13}C NMR (125 MHz, CDCl_3) δ 169.8, 151.9, 148.4, 140.3, 139.6, 138.1, 129.3, 125.8, 125.6, 123.1, 123.0, 122.9, 120.5, 119.6, 118.9, 108.9, 108.6, 61.3, 48.6, 46.3, 37.7, 34.4, 28.2, 24.5, 24.3, 23.83, 23.79, 23.5, 21.1, 20.8, 20.2, 19.9, 19.5, 13.8; HRMS: calcd for $\text{C}_{37}\text{H}_{52}\text{N}_3\text{O}_2\text{S}$ [$\text{M} + \text{H}$]: 602.3775. Found: 602.3775.

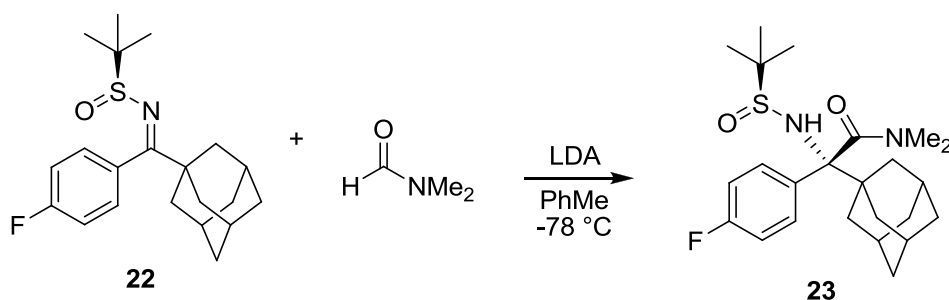


(S)-N,N-Dibutyl-2-(pyridin-2-yl)-2-((R)-2,4,6-triisopropylphenylsulfinamido)acetamide (19). According to the general procedure, sulfinimine **18** (500 mg, 1.40 mmol), *N,N*-dibutylformamide (0.791 mL, 4.35 mmol), and toluene (5 mL) were treated with LDA (2.10 mL, 4.21 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 97.1:2.9. Purification by chromatography on SiO_2 (10-40% MTBE/hexanes) gave **19** as a light yellow oil (583 mg, 81% yield). HPLC (Method B): major diastereomer $t_r = 16.101$ min; minor diastereomer $t_r = 16.713$ min. ^1H NMR (400 MHz, CDCl_3) δ 8.47 (d, $J = 4.8$ Hz, 1 H), 7.67-7.63 (m, 1 H), 7.50 (d, $J = 7.8$ Hz, 1 H), 7.17-7.14 (m, 1 H), 7.05 (s, 2 H), 6.04 (d, $J = 8.5$ Hz, 1 H), 5.55 (d, $J = 8.5$ Hz, 1 H), 4.33-3.80 (br, 2 H), 3.68-3.60 (m, 1 H), 3.45-3.38 (m, 1 H), 3.19-3.12 (m, 1 H), 2.90-2.79 (m, 1 H), 1.55-1.38 (m, 3 H), 1.36-1.16 (m, 23 H), 0.89-0.81 (m, 6 H); ^{13}C NMR (100 MHz, CDCl_3) δ 169.5, 158.3, 151.8, 148.8, 147.7, 138.6, 137.1, 122.9, 121.8, 61.8, 47.5, 46.1, 34.3, 31.2, 29.5, 28.4, 24.4, 24.2, 23.8, 20.0, 19.98, 13.8, 13.78; HRMS: calcd for $\text{C}_{30}\text{H}_{48}\text{N}_3\text{O}_2\text{S}$ [$\text{M} + \text{H}$]: 514.3462. Found: 514.3463.

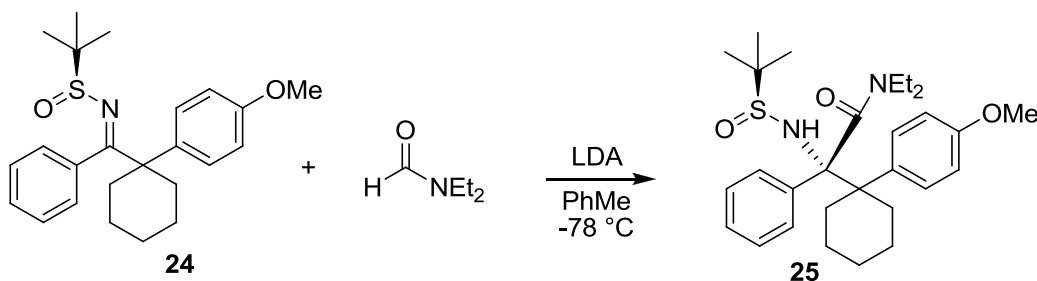


(R)-2-((S)-1,1-Dimethylethylsulfinamido)-N,N,3,3-tetramethyl-2-phenylbutanamide (21). According to the general procedure, sulfinimine **20** (500 mg, 1.88 mmol), *N,N*-dimethylformamide (1.47 mL, 19.0 mmol), and toluene (10 mL) were treated with LDA (9.4 mL, 18.8 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 97.7:2.3.

Purification by chromatography on SiO₂ (10-90% MTBE/hexanes) gave **21** as an off-white solid (497 mg, 78% yield). HPLC (Method A): major diastereomer t_r = 2.650 min; minor diastereomer t_r = 2.803 min. mp 127-130 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.39-7.26 (br, 5 H), 6.00-4.30 (br, 1 H), 3.14-2.73 (br, 3 H), 2.51-2.06 (br, 3 H), 1.32 (s, 9 H), 1.19 (br s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 170.3, 139.4, 128.1, 127.7, 127.4, 73.1, 57.7, 40.5, 40.3, 37.7, 28.0, 23.4; HRMS: calcd for C₁₈H₃₁N₂O₂S [M + H]: 339.2101. Found: 339.2102.

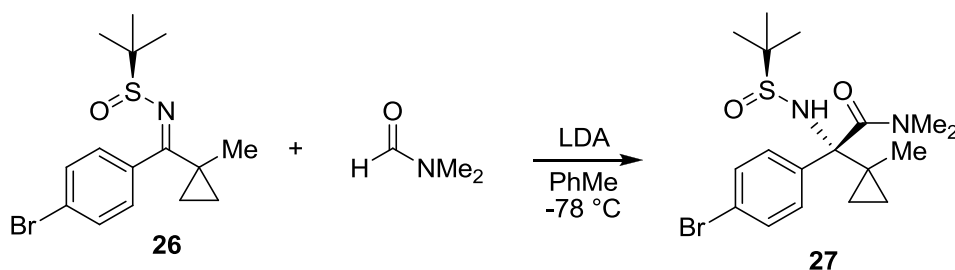


(R)-2-((S)-1,1-Dimethylethylsulfinamido)-N,N-dimethyl-2-(1-(4-fluorophenyl)adamantyl)-2-(4-fluorophenyl)acetamide (23). According to the general procedure, sulfinimine **22** (1.00 g, 2.77 mmol), *N,N*-dimethylformamide (0.664 mL, 8.58 mmol), and toluene (10 mL) were treated with LDA (4.15 mL, 8.30 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 96.9:3.1. Purification by chromatography on SiO₂ (10-70% MTBE/hexanes) gave **23** as a white solid (972 mg, 81% yield). HPLC (Method A): major diastereomer t_r = 3.399 min; minor diastereomer t_r = 3.811 min. mp 184-185 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.36-7.14 (br, 2 H), 7.12-6.93 (br, 2 H), 2.95 (br s, 3 H), 2.28 (br s, 3 H), 2.13-1.69 (br, 6 H), 2.01 (br s, 3 H), 1.68-1.53 (br s, 6 H), 1.34 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 162.9, 160.5, 129.8, 114.9, 114.2, 72.4, 58.0, 53.5, 42.4, 40.2, 37.3, 36.8, 28.9, 23.5; HRMS: calcd for C₂₄H₃₆FN₂O₂S [M + H]: 435.2476. Found: 435.2477.

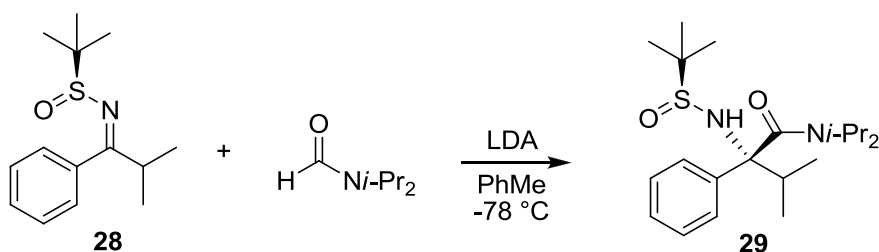


(S)-2-((S)-1,1-Dimethylethylsulfinamido)-N,N-diethyl-2-(1-(4-methoxyphenyl)cyclohexyl)-2-phenylacetamide (25). According to the general procedure, sulfinimine **24** (500 mg, 1.26 mmol), *N,N*-diethylformamide (0.854 mL, 7.67 mmol), and toluene (5 mL) were treated with LDA (3.77 mL, 7.54 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 96.9:3.1. Purification by chromatography on SiO₂ (5-50% MTBE/hexanes) gave **25** as a white solid (472 mg, 75% yield). HPLC (Method A): major diastereomer t_r = 3.757 min; minor diastereomer t_r = 4.071 min. mp 185-187 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.42-7.40 (m, 1 H), 7.31-7.27 (m, 1 H), 7.23-7.18 (m, 2 H), 7.03-6.99 (m, 1 H),

6.89-6.86 (m, 1 H), 6.45-6.41 (m, 1 H), 6.11 (d, $J = 7.7$ Hz, 1 H), 5.69 (d, $J = 8.3$ Hz, 1 H), 4.63 (s, 1 H), 3.78 (s, 3 H), 3.45-3.26 (m, 2 H), 3.14-3.07 (m, 1 H), 3.04-2.95 (m, 1 H), 2.88-2.80 (m, 2 H), 2.57-2.47 (m, 1 H), 1.93 (d, $J = 12.4$ Hz, 1 H), 1.66 (d, $J = 13.2$ Hz, 1 H), 1.47-1.34 (m, 3 H), 1.26 (s, 9 H), 1.20 (t, $J = 6.9$ Hz, 3 H), 1.13-0.98 (m, 1 H), 0.87-0.72 (m, 1 H), 0.20 (t, $J = 7.1$ Hz, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 168.2, 158.0, 140.4, 133.1, 131.7, 130.4, 129.2, 127.0, 126.7, 125.9, 113.0, 112.3, 72.6, 58.5, 55.2, 53.7, 43.8, 40.8, 30.6, 28.1, 25.8, 23.7, 23.1, 12.3, 11.0; HRMS: calcd for $\text{C}_{29}\text{H}_{43}\text{N}_2\text{O}_3\text{S}$ [$\text{M} + \text{H}$]: 499.2989. Found: 499.2994.

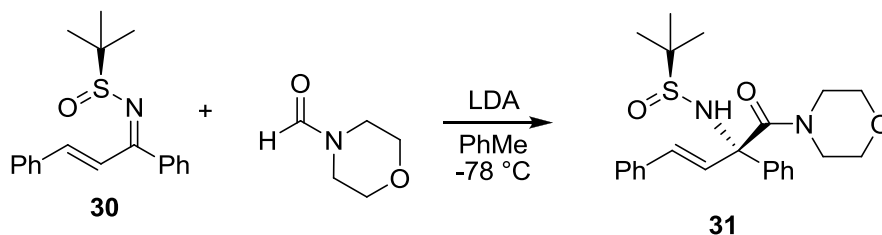


(*R*)-2-(4-Bromophenyl)-2-((*S*)-1,1-dimethylethylsulfinamido)-*N,N*-dimethyl-2-(1-methylcyclopropyl)acetamide (27**).** According to the general procedure, sulfinimine **26** (500 mg, 1.46 mmol), *N,N*-dimethylformamide (0.351 mL, 4.53 mmol), and toluene (5 mL) were treated with LDA (2.19 mL, 4.38 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 95.1:4.9. Purification by chromatography on SiO_2 (10-100% MTBE/hexanes) gave **27** as a white solid (426 mg, 70% yield). HPLC (Method A): major diastereomer $t_r = 2.793$ min; minor diastereomer $t_r = 3.050$ min. mp $125\text{--}127^\circ\text{C}$; ^1H NMR (400 MHz, CDCl_3) δ 7.57-7.50 (m, 4 H), 6.04 (s, 1 H), 2.79 (br s, 6 H), 1.17 (s, 12 H), 0.96-0.90 (m, 1 H), 0.89-0.83 (m, 1 H), 0.58-0.54 (m, 1 H), 0.30-0.26 (m, 1 H); ^{13}C NMR (100 MHz, CDCl_3) δ 172.6, 135.4, 131.7, 131.6, 122.9, 69.0, 57.0, 39.8, 23.4, 23.2, 23.0, 22.1, 12.7, 9.3; HRMS: calcd for $\text{C}_{18}\text{H}_{28}\text{BrN}_2\text{O}_2\text{S}$ [$\text{M} + \text{H}$]: 415.1049. Found: 415.1051.

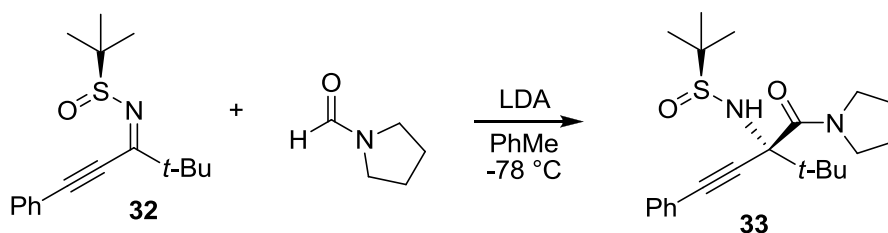


(*R*)-2-((*S*)-1,1-Dimethylethylsulfinamido)-*N,N*-diisopropyl-3-methyl-2-phenylbutanamide (29**).** A flask was charged with toluene (10 mL) and LDA (2.99 mL, 5.97 mmol, 2.0 M) and the solution was cooled to -78°C . *N,N*-Diisopropylformamide (0.90 mL, 6.17 mmol) was added dropwise. After 5 min, a solution of **28** (500 mg, 1.99 mmol) in toluene (2 mL) was added dropwise. The reaction was quenched after 10 min by the addition of water, and the reaction mixture was allowed to warm to rt. Reaction diastereoselectivity (from HPLC): 97.1:2.9. The reaction mixture was diluted with EtOAc, and the layers separated. The organic phase was washed with water (2 times), dried over Na_2SO_4 ,

filtered, and concentrated. Purification by chromatography on SiO₂ (10-40% MTBE/hexanes) gave **29** as a white solid (568 mg, 75% yield). HPLC (Method A): major diastereomer t_r = 3.124 min; minor diastereomer t_r = 3.387 min. mp 186-187.5 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.31-7.29 (m, 2 H), 7.19-7.15 (m, 2 H), 7.11-7.06 (m, 1 H), 6.56 (s, 1 H), 3.73-3.63 (m, 1 H), 3.10-3.00 (m, 1 H), 2.59-2.49 (m, 1 H), 1.23 (d, J = 6.6 Hz, 3 H), 1.18 (d, J = 6.6 Hz, 3 H), 1.11 (d, J = 6.6 Hz, 3 H), 1.08 (s, 9 H), 0.82 (d, J = 6.6 Hz, 3 H), 0.77 (d, J = 6.6 Hz, 3 H), 0.01 (d, J = 6.5 Hz, 3 H); ¹³C NMR (100 MHz, CDCl₃) δ 171.0, 138.3, 127.8, 127.9, 70.4, 58.0, 48.6, 47.4, 31.7, 23.7, 19.9, 19.8, 19.7, 18.9, 18.0; HRMS: calcd for C₂₁H₃₇N₂O₂S [M + H]: 381.2576. Found: 381.2572.

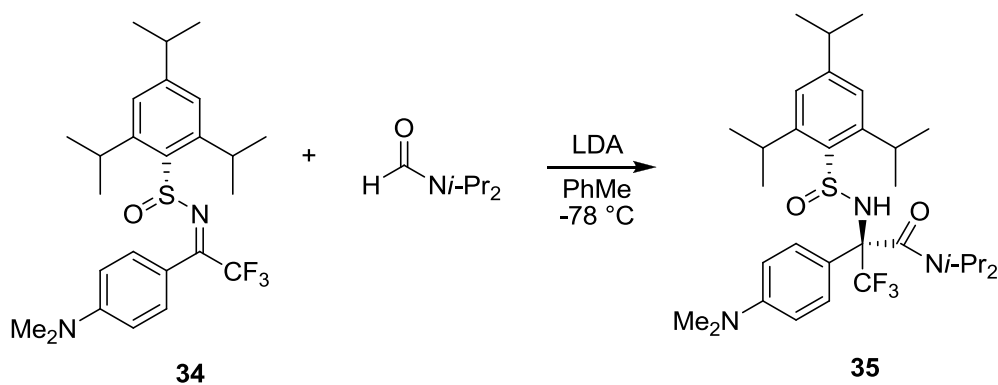


(S)-2-Methyl-N-((S,E)-1-morpholino-1-oxo-2,4-diphenylbut-3-en-2-yl)propane-2-sulfonamide (31). According to the general procedure, sulfonimine **30** (500 mg, 1.61 mmol), *N*-formylmorpholine (0.500 mL, 4.98 mmol), and toluene (5 mL) were treated with LDA (2.41 mL, 4.82 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 91.7:8.3. Purification by chromatography on SiO₂ (10-40% EtOAc/hexanes) gave **31** as a white solid (460 mg, 67% yield). HPLC (Method A): major diastereomer t_r = 2.664 min; minor diastereomer t_r = 2.807 min. mp 181-182 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.51-7.49 (m, 2 H), 7.45-7.28 (m, 8 H), 7.05 (d, J = 16.1 Hz, 1 H), 6.88 (d, J = 16.1 Hz, 1 H), 5.69 (s, 1 H), 3.96-2.81 (br m, 8 H), 1.08 (s, 9 H); ¹³C NMR (100 MHz, CDCl₃) δ 170.0, 140.8, 136.2, 134.1, 128.9, 128.7, 128.5, 128.4, 127.5, 127.3, 127.0, 68.5, 66.5, 65.6, 56.5, 47.4, 43.9, 22.6; HRMS: calcd for C₂₄H₃₁N₂O₃S [M + H]: 427.2050. Found: 427.2054.



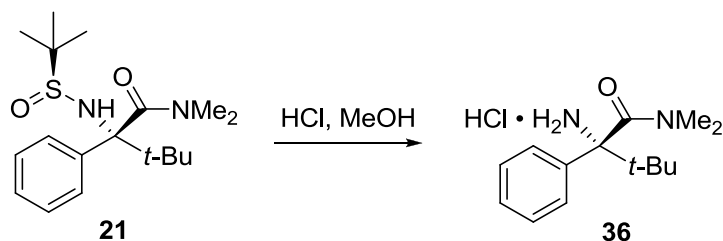
(S)-2-Methyl-N-((S,E)-1-pyrrolidino-1-oxo-2-tert-butyl-2-(2-phenylethynyl))propane-2-sulfonamide (33). According to the general procedure, sulfonimine **32** (500 mg, 1.73 mmol), *N*-formylpyrrolidine (1.00 mL, 10.54 mmol), and toluene (5 mL) were treated with LDA (5.18 mL, 10.37 mmol, 2.0 M). Reaction diastereoselectivity (from HPLC): 94.0:6.0. Purification by chromatography on SiO₂ (10-100% MTBE/hexanes) gave **33** as a light brown oil (491 mg, 73% yield). HPLC (Method A): major diastereomer t_r = 3.130 min; minor diastereomer t_r = 3.272 min. ¹H NMR (400 MHz, CDCl₃) δ 7.56-7.53 (m, 2 H), 7.36-7.33 (m, 3 H), 5.80 (s, 1 H), 4.11-4.05 (m, 1 H), 3.99-3.92 (m, 1 H), 3.77-3.71

(m, 1 H), 3.53-3.46 (m, 1 H), 2.01-1.71 (m, 4 H), 1.31 (s, 9 H), 1.11 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 167.2, 131.6, 128.9, 128.4, 122.2, 93.6, 85.3, 65.8, 55.9, 49.3, 49.0, 42.2, 27.3, 25.8, 23.4, 23.1; HRMS: calcd for $\text{C}_{22}\text{H}_{33}\text{N}_2\text{O}_2\text{S}$ [$\text{M} + \text{H}$]: 389.2257. Found: 389.2250.



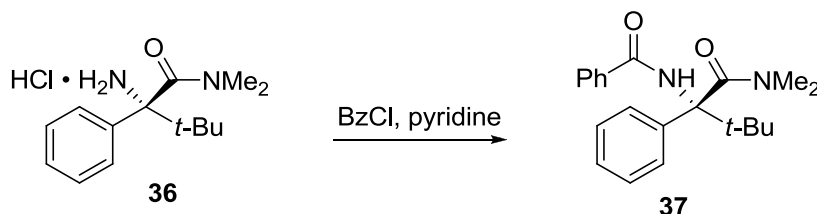
(S)-2-(4-(Dimethylamino)phenyl)-3,3,3-trifluoro-N,N-diisopropyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)propanamide (35). According to the general procedure, sulfonimine **34** (500 mg, 1.07 mmol), *N,N*-Diisopropylformamide (0.482 mL, 3.32 mmol), and toluene (5 mL) were treated with LDA (1.61 mL, 3.21 mmol, 2.0 M). Reaction diastereoselectivity (from ^1H NMR): >97:3 (minor diastereomer not detected). Purification by chromatography on SiO_2 (10-40% MTBE/hexanes) gave **35** as a white solid (486 mg, 76% yield). mp 92-94 °C; ^1H NMR (400 MHz, CDCl_3) δ 7.59 (s, 1 H), 7.35 (d, $J = 8.8$ Hz, 2 H), 7.03 (s, 2 H), 6.77-6.75 (m, 2 H), 4.40-3.70 (m, 3 H), 3.45-3.35 (m, 1 H), 3.00 (s, 6 H), 2.90-2.80 (m, 1 H), 1.49 (d, $J = 7.1$ Hz, 3 H), 1.38 (d, $J = 6.6$ Hz, 3 H), 1.35-1.26 (m, 6 H), 1.26-1.20 (m, 12 H), 0.98 (d, $J = 6.5$ Hz, 3 H), 0.64 (d, $J = 6.4$ Hz, 3 H); ^{13}C NMR (100 MHz, CDCl_3) δ 163.9, 150.6, 150.5, 147.0, 139.9, 129.7, 124.6 (q, $J = 283$ Hz), 122.8, 118.2, 112.0, 71.1 (q, $J = 27$ Hz), 49.5, 48.0, 40.1, 34.2, 28.3, 24.6, 24.2, 23.8, 23.79, 20.3, 20.0, 19.5, 19.3; HRMS: calcd for $\text{C}_{32}\text{H}_{49}\text{F}_3\text{N}_3\text{O}_2\text{S}$ [$\text{M} + \text{H}$]: 596.3492. Found: 596.3485.

Procedures and data for ester synthesis.



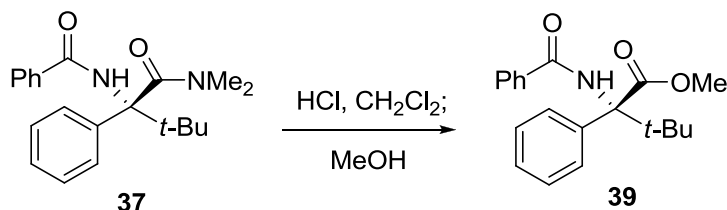
(R)-2-Amino-N,N,3,3-tetramethyl-2-phenylbutanamide hydrochloride (36). A solution of **21** (600 mg, 1.77 mmol) in MeOH (20 mL) was treated with HCl in dioxane (1.33 mL, 5.32 mmol). After stirring at rt for 30 min, the reaction mixture was concentrated on a rotovap, and the residue was repeatedly chased with CH_2Cl_2 to give **36**

as a light yellow solid (446 mg, 93% yield). mp 210-212 °C; $[\alpha]_D^{20}$ -28.4 (*c* 0.44, MeOH); ^1H NMR (400 MHz, *d*-6 DMSO) δ 8.84 (br s, 3 H), 7.49-7.39 (m, 3 H), 7.36-7.31 (m, 2 H), 2.62 (br s, 6 H), 1.18 (s, 9 H); ^{13}C NMR (100 MHz, *d*-6 DMSO) δ 167.3, 135.3, 128.4, 128.38, 127.2, 70.4, 38.7, 38.5, 26.9; HRMS: calcd for $\text{C}_{14}\text{H}_{23}\text{N}_2\text{O}$ [$\text{M} - \text{HCl} + \text{H}$]: 235.1805. Found: 235.1804.

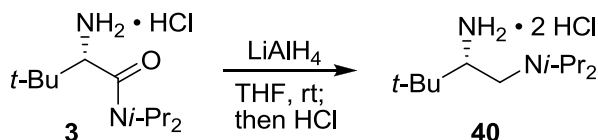


(*R*)-*N*-(1-(Dimethylamino)-3,3-dimethyl-1-oxo-2-phenylbutan-2-yl)benzamide (37).

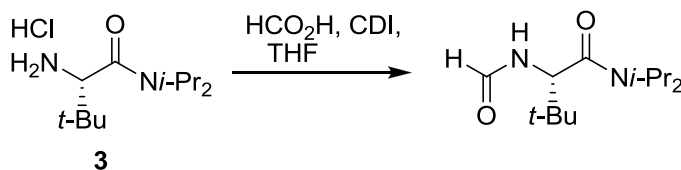
A solution of **36** (1.00 g, 3.69 mmol) in pyridine (20 mL) was treated with benzoyl chloride (1.29 mL, 11.1 mmol). The reaction was heated at 50 °C for 22 h. After cooling to rt, the reaction mixture was diluted with MTBE and washed sequentially with saturated aqueous NH_4Cl solution and water. The organic phase was dried (Na_2SO_4), filtered and concentrated, and the residue was crystallized from heptane to give **37** as an off white solid (1.01 g, 81% yield). mp 176-178 °C; $[\alpha]_D^{20}$ -14.9 (*c* 0.57, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.86-7.84 (m, 2 H), 7.57-7.48 (m, 3 H), 7.42-7.30 (m, 5 H), 7.07 (s, 2 H), 2.96 (s, 3 H), 2.37 (s, 3 H), 1.15 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 169.8, 165.5, 138.0, 135.2, 131.7, 128.9, 127.9, 127.5, 126.8, 126.6, 69.1, 42.7, 37.6, 37.4, 27.5; HRMS: calcd for $\text{C}_{21}\text{H}_{26}\text{N}_2\text{O}_2$ [$\text{M} + \text{H}$]: 339.2067. Found: 339.2068.



(*R*)-Methyl 2-benzamido-3,3-dimethyl-2-phenylbutanoate (39). A solution of **37** (100 mg, 0.295 mmol) in CH_2Cl_2 (3 mL) was treated with 4M HCl in dioxane (0.30 mL, 1.20 mmol). The reaction was stirred at rt for 1 h. MeOH (3 mL) was then added, and the reaction mixture was stirred at rt for 18 h. The reaction mixture was then concentrated to dryness, and the residual solid was chased with Et_2O twice. The solid was then triturated with Et_2O and filtered to remove the solid $\text{Me}_2\text{NH}\cdot\text{HCl}$. The filtrate was concentrated to give **39** as a white solid (87 mg, 91% yield). mp 149.5-151 °C; $[\alpha]_D^{20}$ -57.8 (*c* 1.12, CHCl_3); ^1H NMR (400 MHz, CDCl_3) δ 7.84-7.82 (m, 4 H), 7.56-7.52 (m, 1 H), 7.49-7.45 (m, 2 H), 7.31-7.22 (m, 3 H), 6.83 (s, 1 H), 3.72 (s, 3 H), 1.06 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 171.1, 166.9, 136.9, 134.8, 131.8, 128.8, 128.4, 127.2, 127.1, 127.0, 70.0, 52.2, 38.6, 26.6; HRMS: calcd for $\text{C}_{20}\text{H}_{24}\text{NO}_3$ [$\text{M} + \text{H}$]: 326.1751. Found: 326.1746.

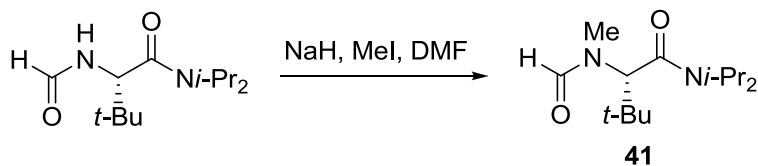
Procedure and data for diamine synthesis.

(*S*)-*N*¹,*N*¹-Diisopropyl-3,3-dimethylbutane-1,2-diamine (40**).** A flask was charged with LiAlH₄ (303 mg, 7.97 mmol) and THF (35 mL). To the resultant slurry was added in portions at rt **3** (1.00 g, 3.99 mmol). After stirring at rt for 1 h, the reaction was quenched by the slow dropwise addition of aqueous 2N NaOH (4 mL). The resultant mixture was treated with Na₂SO₄ (5 g) and was filtered. The filtrate was treated with 4N HCl in dioxane (4.0 mL, 16.0 mmol), and was concentrated to dryness. The resultant solid was triturated with EtOAc, filtered, and the solid washed with EtOAc and dried under vacuum to afford **40** as a white solid (842 mg, 77% yield). mp 256-260 °C; [α]_D²⁰ +21.8 (*c* 1.03, MeOH); ¹H NMR (400 MHz, D₂O) δ 4.01-3.91 (m, 1 H), 3.84-3.74 (m, 1 H), 3.55-3.48 (m, 2 H), 3.34-3.28 (m, 1 H), 1.42 (d, *J* = 6.6 Hz, 3 H), 1.36-1.33 (m, 6 H), 1.28 (d, *J* = 6.6 Hz, 3 H), 1.05 (s, 9 H); ¹³C NMR (100 MHz, D₂O) δ 56.3, 56.2, 54.6, 46.5, 33.8, 24.9, 18.9, 18.0, 16.5, 16.1; HRMS: calcd for C₁₂H₂₉N₂ [*M* - 2HCl + H]: 201.2325. Found: 201.2332.

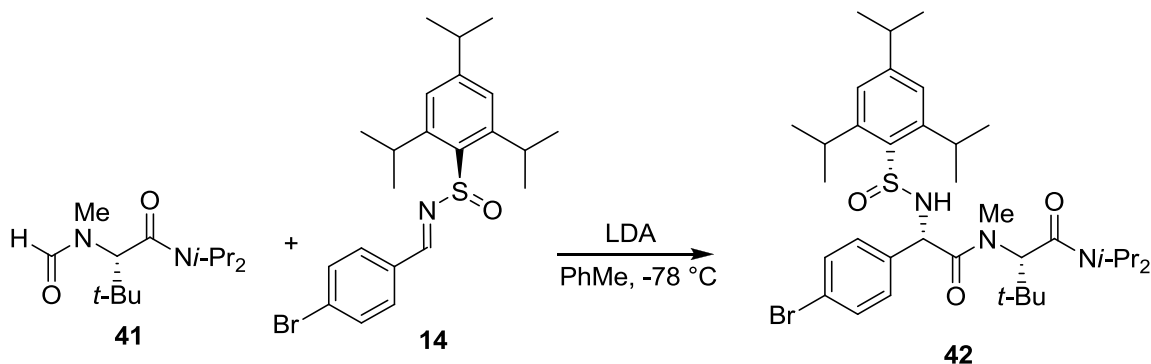
Procedures and data for dipeptide synthesis.

(*S*)-2-Formamido-*N*,*N*-diisopropyl-3,3-dimethylbutanamide. A flask was charged with CDI (1.29 g, 7.97 mmol) and THF (20 mL). To the resultant slurry was added dropwise at rt formic acid (0.30 mL, 7.97 mmol). After stirring at rt for 30 min, the reaction mixture was treated with **3** (1.00 g, 3.99 mmol) followed by Et₃N (1.67 mL, 11.96 mmol). The reaction was stirred at rt for 15 min, and then diluted with water and EtOAc. The layers were separated, and the organic phase was washed with 0.5 N aqueous HCl and water (2 x), dried (Na₂SO₄), filtered, and concentrated to give *(S)*-2-formamido-*N*,*N*-diisopropyl-3,3-dimethylbutanamide as a white solid (833 mg, 86% yield). mp 96-99 °C; [α]_D²⁰ -63.9 (*c* 0.74, CHCl₃); ¹H NMR (400 MHz, CDCl₃) δ 8.22 (d, *J* = 1.4 Hz, 1 H), 6.63 (d, *J* = 9.6 Hz, 1 H), 4.98 (d, *J* = 9.6 Hz, 1 H), 4.35-4.25 (m, 1 H), 3.52-3.42 (m, 1 H), 1.39 (d, *J* = 6.6 Hz, 6 H), 1.25 (d, *J* = 6.6 Hz, 3 H), 1.20 (d, *J* =

6.6 Hz, 3 H), 1.02 (s, 9 H); ^{13}C NMR (100 MHz, CDCl_3) δ 170.0, 160.9, 53.3, 49.6, 46.3, 35.5, 26.7, 21.6, 20.7, 20.2, 20.1; HRMS: calcd for $\text{C}_{13}\text{H}_{27}\text{N}_2\text{O}_2$ [$\text{M} + \text{H}$]: 243.2067. Found: 243.2070.



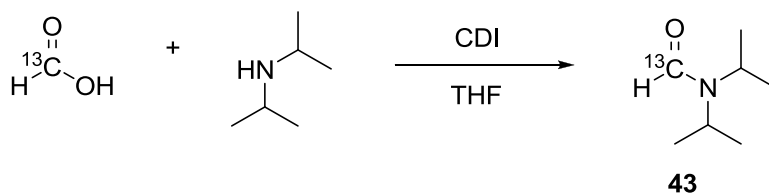
(S)-N,N-Diisopropyl-3,3-dimethyl-2-(N-methylformamido)butanamide (41). A flask was charged with (S)-2-formamido-N,N-diisopropyl-3,3-dimethylbutanamide (2.00 g, 8.25 mmol) and DMF (10 mL) and the solution was cooled to 0 °C. NaH (363 mg, 9.08 mmol, 60 wt.% in mineral oil) was added in portions. After 5 min, MeI (0.62 mL, 9.90 mmol) was added. After 30 min, the reaction mixture was quenched with water (150 mL), resulting in the precipitation of the product. The solid was filtered and washed with water, and then dried under vacuum to provide **41** as a white solid (1.95 g, 92% yield). mp 113-115 °C; $[\alpha]_{\text{D}}^{20}$ -74.9 (*c* 2.03, CHCl_3); Note: product is a ~1:1 mixture of amide rotomers. ^1H NMR (400 MHz, CDCl_3) δ 8.16 (s, 1 H), 8.15 (s, 1 H), 4.99 (s, 1 H), 4.17-4.07 (m, 1 H), 3.92-3.82 (m, 1 H), 3.90 (s, 1 H), 3.49-3.34 (m, 1 H), 3.07 (s, 3 H), 2.99 (s, 3 H), 1.44-1.40 (m, 6 H), 1.24-1.07 (m, 15 H); ^{13}C NMR (100 MHz, CDCl_3) δ 167.7, 166.6, 164.1, 163.4, 65.0, 57.2, 49.0, 48.4, 46.5, 46.2, 36.7, 36.4, 33.5, 30.3, 29.6, 27.8, 27.3, 21.1, 20.9, 20.7, 20.5, 20.47, 20.4, 20.3; HRMS: calcd for $\text{C}_{14}\text{H}_{29}\text{N}_2\text{O}_2$ [$\text{M} + \text{H}$]: 257.2224. Found: 257.2221.



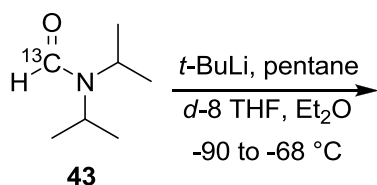
(S)-2-((S)-2-(4-Bromophenyl)-N-methyl-2-((R)-2,4,6-triisopropylphenylsulfinamido)acetamido)-N,N-diisopropyl-3,3-dimethylbutanamide (42). A flask was charged with sulfinimine **14** (1.69 g, 3.89 mmol, 1.00 equiv), **41** (1.50 g, 5.84 mmol, 1.50 equiv) and toluene (15 mL) and the resultant solution was cooled to -78 °C. The solution was treated with LDA (2.92 mL, 5.84 mmol, 2.0 M, 1.50 equiv). After 10 min at -78 °C, the reaction was quenched with water and allowed to warm to rt. The mixture was diluted with EtOAc and the layers were separated. The organic phase was dried (Na_2SO_4), filtered, and concentrated. Reaction diastereoselectivity (from ^1H NMR in CDCl_3): >97:3 (minor diastereomer not detected). Purification by crystallization from heptane gave **42** as a white solid (2.12 g, 79% yield). mp 130-131.5 °C; $[\alpha]_{\text{D}}^{20}$ -115.9 (*c* 1.46, CHCl_3); ^1H

NMR (500 MHz, CDCl₃) δ 7.43 (d, J = 8.3 Hz, 2 H), 7.22 (d, J = 8.3 Hz, 2 H), 7.06 (s, 2 H), 5.33 (d, J = 9.2 Hz, 1 H), 5.24 (s, 1 H), 5.17 (d, J = 9.2 Hz, 1 H), 4.28-3.77 (m, 3 H), 3.36-3.23 (m, 1 H), 3.14 (s, 3 H), 2.90-2.82 (m, 1 H), 1.37 (d, J = 6.7 Hz, 3 H), 1.28-1.21 (m, 21 H), 1.13 (d, J = 6.7 Hz, 3 H), 1.09 (s, 9 H), 0.81 (d, J = 6.4 Hz, 3 H); ¹³C NMR (125 MHz, CDCl₃) δ 171.5, 168.1, 152.5, 148.8, 137.2, 136.5, 132.1, 129.5, 123.0, 122.6, 59.0, 58.9, 48.5, 46.1, 37.3, 34.4, 32.9, 31.9, 29.0, 28.1, 27.8, 24.4, 24.3, 23.8, 23.76, 22.7, 21.05, 21.0, 20.6, 20.3, 14.1; HRMS: calcd for C₃₆H₅₇BrN₃O₃S [M + H]: 690.3299. Found: 690.3295.

Synthesis of ¹³C-labeled DIPF and low temperature ¹³C NMR experiment.



¹³C-N,N-Diisopropylformamide (43). A flask was charged with CDI (17.25 g, 106.4 mmol) and THF (100 mL). To the resultant slurry was added dropwise at rt >99% ¹³C-labeled formic acid (5.00 g, 106.4 mmol). After stirring at rt for 30 min, the reaction mixture was treated with diisopropylamine (16.4 mL, 117.0 mmol). The reaction was stirred at rt for 30 min, and then diluted with water and MTBE. The layers were separated, and the organic phase was washed with water, dried (MgSO₄), filtered, and concentrated. The crude product was purified by vacuum distillation (bp 82 °C, 12 mm Hg) using a short path distillation head to give **43** as a colorless liquid (4.98 g, 36% yield). bp 82 °C, 12 mm Hg; ¹H NMR (400 MHz, CDCl₃) δ 8.21 (d, J = 188.3 Hz, 1 H), 4.24-4.13 (m, 1 H), 3.68-3.56 (m, 1 H), 1.29 (d, J = 6.9 Hz, 6 H), 1.26 (d, J = 6.9 Hz, 6 H); ¹³C NMR (100 MHz, CDCl₃) δ 161.5, 46.5 (d, J = 16.3 Hz), 43.8, 23.3 (d, J = 4.7 Hz), 20.1; HRMS: calcd for C₆¹³CH₁₆NO [M + H]: 131.1260. Found: 131.1259.



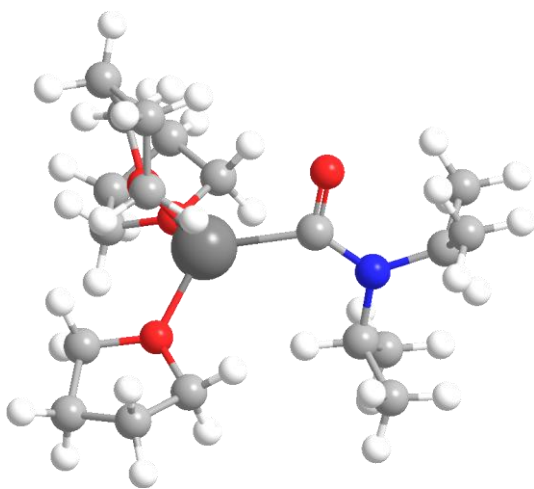
Deprotonation of **43 and low temperature ¹³C NMR analysis of the anion.** To a flask containing **43** (400 mg, 3.10 mmol), *d*-8 THF (5 mL), Et₂O (5 mL), and pentane (1.25 mL) cooled to -100 °C was added dropwise *t*-BuLi (2.00 mL, 3.41 mmol, 1.7 M/pentane, 1.1 equiv). After stirring for 5 min at -100 °C, approximately 1.0 mL of the anion solution was transferred via cannula to an inerted NMR tube immersed in an EtOH/liquid nitrogen dewar (temperature -90 °C). The NMR tube was transferred quickly to a 500 MHz NMR spectrometer, the probe of which had previously been cooled to -68 °C. After shimming, the ¹³C NMR spectrum was recorded using a broad sweep width. The spectrum was referenced to the α -C of *d*-8 THF at 67.57 ppm. Due to ⁶Li and ⁷Li coupling with ¹³C, the signals were broad. See page S104 for copies of the spectrum

taken at -68 °C, from 370 to 130 ppm, and from 220 to -30 ppm. ^{13}C NMR (125 MHz, *d*-8 THF, -68 °C) δ 259.6 (broad).

Computational Modeling Studies.

All calculations were conducted with the Gaussian 09⁴ Unix version on a HPC system at the DFT B3LYP level of theory with the 6-311G+(d,2p) basis set with the CPCM (THF) solvation model. All optimized conformers were subjected to a frequency check to verify the optimized structure is a stable structure (zero imaginary frequencies). To complete the tetrahedral structure of the Li species, the lithium atom was saturated with THF molecules. All structures were subjected to a Conformation search employing the Moe2011.10 program with the LowModeMd method. The lowest energy conformer was then subjected to the DFT optimization with the Gaussian 09 program.⁴ The optimized structures were then subjected to a NMR calculation (B3LYP/6-311G+(d,2p)) with the CPCM (THF) solvation model employing the IGAIM method within Gaussian 09. The final carbon shift was determined by referencing to a separately calculated reference carbon NMR with the optimized TMS structure (B3LYP/6-311G+(d,2p)) with the CPCM (THF) solvation model employing the IGAIM method within Gaussian 09.

Anion Structure 44:



⁴ Gaussian 09, Revision C.01, M. J. Frisch, G. W. Trucks, H. B. Schlegel, G. E. Scuseria, M. A. Robb, J. R. Cheeseman, G. Scalmani, V. Barone, B. Mennucci, G. A. Petersson, H. Nakatsuji, M. Caricato, X. Li, H. P. Hratchian, A. F. Izmaylov, J. Bloino, G. Zheng, J. L. Sonnenberg, M. Hada, M. Ehara, K. Toyota, R. Fukuda, J. Hasegawa, M. Ishida, T. Nakajima, Y. Honda, O. Kitao, H. Nakai, T. Vreven, J. A. Montgomery, Jr., J. E. Peralta, F. Ogliaro, M. Bearpark, J. J. Heyd, E. Brothers, K. N. Kudin, V. N. Staroverov, T. Keith, R. Kobayashi, J. Normand, K. Raghavachari, A. Rendell, J. C. Burant, S. S. Iyengar, J. Tomasi, M. Cossi, N. Rega, J. M. Millam, M. Klene, J. E. Knox, J. B. Cross, V. Bakken, C. Adamo, J. Jaramillo, R. Gomperts, R. E. Stratmann, O. Yazyev, A. J. Austin, R. Cammi, C. Pomelli, J. W. Ochterski, R. L. Martin, K. Morokuma, V. G. Zakrzewski, G. A. Voth, P. Salvador, J. J. Dannenberg, S. Dapprich, A. D. Daniels, O. Farkas, J. B. Foresman, J. V. Ortiz, J. Cioslowski, and D. J. Fox, Gaussian, Inc., Wallingford CT, 2010.

The Cartesian coordinates for the optimized structure are as follows:

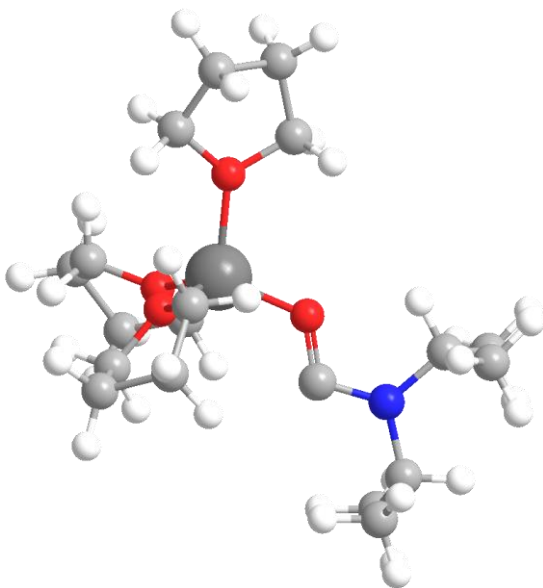
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C	-2.79035621	0.84912506	-1.04522108	
H	-1.74312813	1.00673008	-1.30713010	
C	-3.43940326	0.04791200	-2.18700817	
H	-4.49397134	-0.15991101	-1.99160415	
H	-3.38498026	0.60837005	-3.12333824	
H	-2.92741923	-0.90498707	-2.32949118	
C	-3.44889526	2.23081517	-0.89602907	
H	-4.50534634	2.15293216	-0.62880705	
H	-2.94801123	2.81565921	-0.12322501	
H	-3.38998026	2.78406121	-1.83618514	
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H	-4.09671431	1.45578711	2.17807317	
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H	-5.23659840	-2.01512415	1.27617410	
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H	-3.50549627	-2.27061417	1.56148012	
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O	1.02713008	-1.54898712	-1.29975110	
O	1.23203810	1.73219213	-0.92637007	
C	2.59947520	-1.41749411	1.79036014	
H	3.27618425	-1.79698713	1.02590508	
H	1.77527113	-2.12269916	1.91617414	
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H	2.92137122	1.54850412	2.14161016	
H	1.17886409	1.35816210	2.43007118	
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H	2.85729822	1.38474710	-2.16875517	
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H	-0.05275800	3.12179824	-1.78881714	
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C	1.58045912	4.05993931	-0.69827306	
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H	1.87602514	4.14654632	0.34883603	
C	2.73063921	3.48861226	-1.54173712	
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H	3.70703129	3.87665730	-1.25579310
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Sum of electronic and zero-point Energies=			-1109.892804
Sum of electronic and thermal Energies=			-1109.860034
Sum of electronic and thermal Enthalpies=			-1109.859090
Sum of electronic and thermal Free Energies=			-1109.963880

Carbon NMR shielding (IGAIM, B3LYP/6-311G+(d,2p), CPCM=THF): -81.2366 ppm

Carbon shift (TMS referenced, 185.863 ppm)= 267.1 ppm

Anion Structure 46:

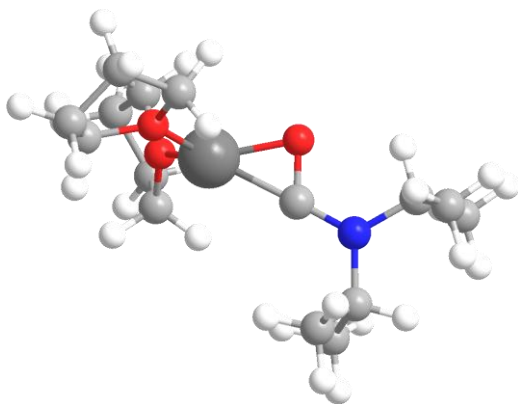


The Cartesian coordinates for the optimized structure are as follows:

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H	-5.24150000	1.13370000	2.07690000
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H	-3.52800000	2.58780000	-0.10290000
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H	-5.29290000	2.42930000	-0.11090000
C	-4.00960000	-1.23500000	-2.30160000
H	-4.08300000	-2.17760000	-2.85020000
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Li	0.96770000	0.02820000	-0.06710000
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C	1.26440000	-0.92670000	2.77130000
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C	0.69680000	2.43350000	-1.86460000
H	0.58340000	1.84800000	-2.78140000
H	-0.27240000	2.51800000	-1.37810000
C	2.90550000	2.30020000	-0.99570000
H	3.10720000	2.74500000	-0.01880000
H	2.19220000	-1.48400000	2.92450000
H	2.37940000	2.01680000	2.29880000
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C	2.82300000	-3.51460000	-1.76250000
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H	4.73320000	-3.51820000	-0.65960000
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C	1.39440000	3.76230000	-2.13530000
C	2.87640000	3.35650000	-2.10340000
C	0.76960000	-0.29240000	4.07010000
C	1.51630000	1.05030000	4.07970000
H	1.17470000	4.47740000	-1.34020000
H	1.09160000	4.20120000	-3.08480000
H	3.54690000	4.18830000	-1.89300000
H	3.16870000	2.91660000	-3.05850000
H	0.98800000	-0.91160000	4.93890000
H	-0.30820000	-0.12820000	4.02620000
H	2.53880000	0.91600000	4.43760000
H	1.03390000	1.80510000	4.69880000
Sum of electronic and zero-point Energies=			-1109.899145
Sum of electronic and thermal Energies=			-1109.866496
Sum of electronic and thermal Enthalpies=			-1109.865552
Sum of electronic and thermal Free Energies=			-1109.970499

Carbon NMR shielding (IGAIM, B3LYP/6-311G+(d,2p), CPCM=THF): -86.0708 ppm
Carbon shift (TMS referenced, 185.863 ppm)= 271.9 ppm

Anion Structure 45:

The Cartesian coordinates for the optimized structure are as follows:

Charge: 0 Spin: 1	Coordinates (Angstroms)		
	X	Y	Z
C	-1.19300500	-0.01263500	-0.11150400
N	-2.55910900	-0.03739300	-0.04181100
C	-3.21857500	0.09486700	1.27562500
H	-4.28999400	0.04905400	1.07684600
C	-3.41322400	-0.19075800	-1.24218000
H	-2.69865100	-0.26850000	-2.05979300
C	-4.23952200	-1.48469900	-1.20862700
H	-4.97614500	-1.48215600	-0.40170000
H	-4.78437800	-1.60698100	-2.14769000
H	-3.59340300	-2.35351000	-1.07543200
C	-4.29392500	1.04107900	-1.49562500
H	-5.03067000	1.19022900	-0.70269600
H	-3.68632700	1.94420500	-1.56830700
H	-4.84249300	0.92439300	-2.43325400
C	-2.94204300	1.45265100	1.93793800
H	-3.52424700	1.55129100	2.85735800
H	-1.88558200	1.55207300	2.18565100
H	-3.21435000	2.27228900	1.27146200
C	-2.88492200	-1.06882600	2.22040300
H	-3.12755900	-2.02671800	1.75796100
H	-1.82401200	-1.06946800	2.46879300
H	-3.45784100	-0.98168600	3.14679300
O	-0.66194000	-0.12159300	-1.27842000
Li	0.86126000	-0.00234200	-0.16112600
O	2.01437100	1.60088800	-0.00470200
O	2.00640700	-1.61042300	-0.04934100
C	2.93522600	2.01895500	-1.04713100
H	3.71557500	1.26410200	-1.13359000
C	1.73606300	2.71045700	0.88990200
H	2.25886900	2.53261000	1.83296500
C	3.14995200	-1.81088400	0.82025400
H	4.00867600	-1.29235200	0.38721200
H	2.92213500	-1.36992400	1.78974200

C	1.67834200	-2.84560400	-0.73858000
H	0.76229100	-3.25120600	-0.30324200
H	1.49736600	-2.60996800	-1.78561100
C	3.37125800	-3.32210300	0.87120300
H	4.41358600	-3.57788700	1.05470100
H	2.76428800	-3.77028200	1.65970800
C	2.87128800	-3.77105800	-0.51090400
H	3.63830400	-3.59937500	-1.26822300
H	2.58744000	-4.82172900	-0.54350600
C	3.45372100	3.39028400	-0.61594500
C	2.26540700	3.95356100	0.17857300
H	2.38620100	2.07273600	-1.99000000
H	0.66386700	2.73045100	1.07617800
H	2.55063400	4.73691200	0.87898500
H	1.50975400	4.35606200	-0.49823500
H	4.32695300	3.28284100	0.02990400
H	3.73274600	4.00857800	-1.46764000

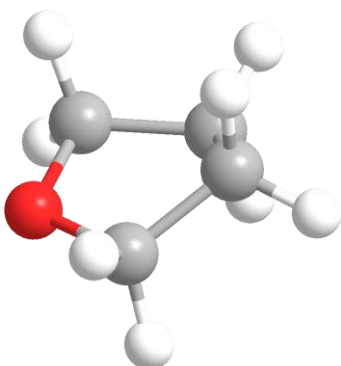
Sum of electronic and zero-point Energies= -877.489283
 Sum of electronic and thermal Energies= -877.463272
 Sum of electronic and thermal Enthalpies= -877.462328
 Sum of electronic and thermal Free Energies= -877.551986

Total of Energy of system (eta-2 Anion with free THF): THF (-232.437992) plus eta-2 Li anion= -1109.989978

Carbon NMR shielding (IGAIM, B3LYP/6-311G+(d,2p), CPCM=THF): -75.4454 ppm

Carbon shift (TMS referenced, 185.863 ppm)= 261.3 ppm

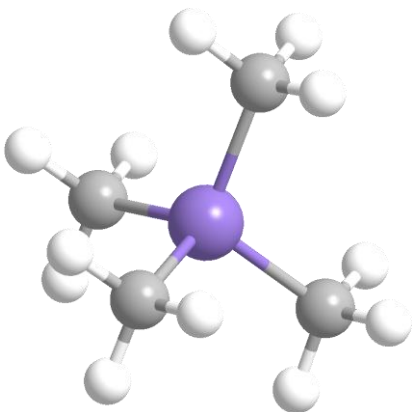
THF



The Cartesian coordinates for the optimized structure are as follows:

Charge: 0 Spin: 1	Coordinates (Angstroms)		
	X	Y	Z
O	0.00000241	-1.25566627	0.00000597
C	1.17445772	-0.42618584	-0.13067911
H	1.94787830	-0.81880701	0.52991905
H	1.53428220	-0.48395688	-1.16269831
C	-1.17445902	-0.42618841	0.13067169
H	-1.94786643	-0.81880991	-0.52994135
H	-1.53429940	-0.48396494	1.16268435

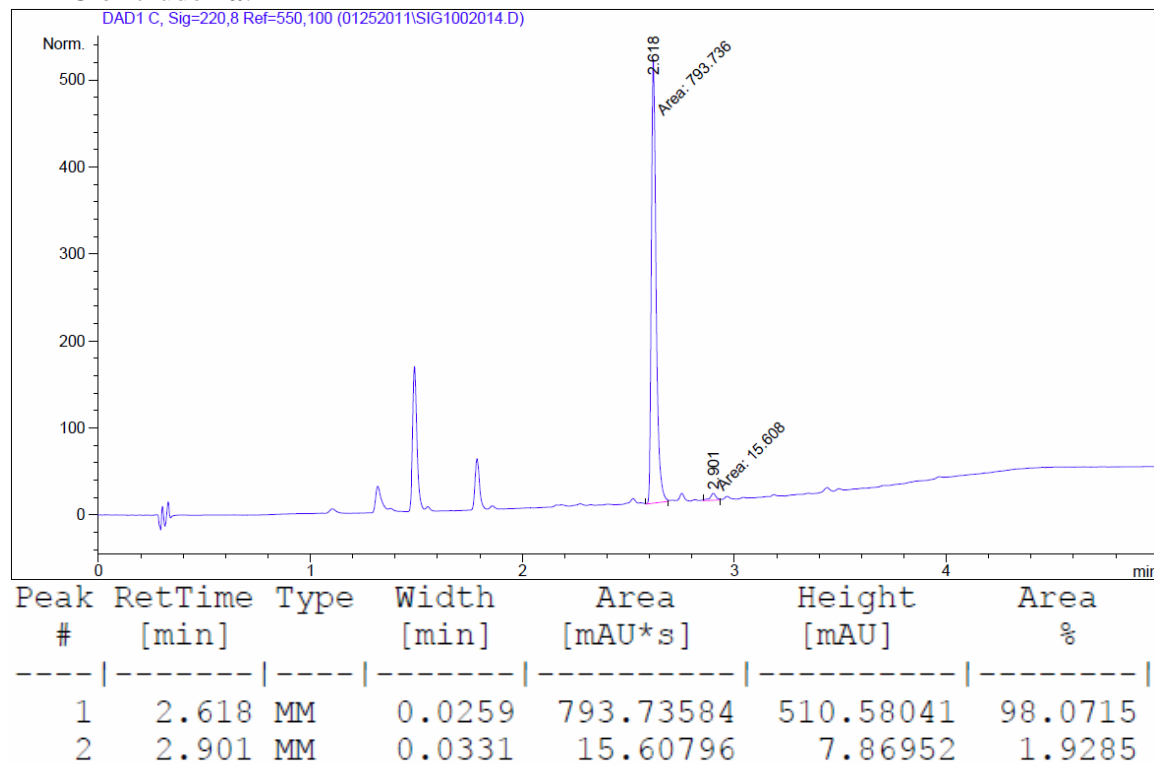
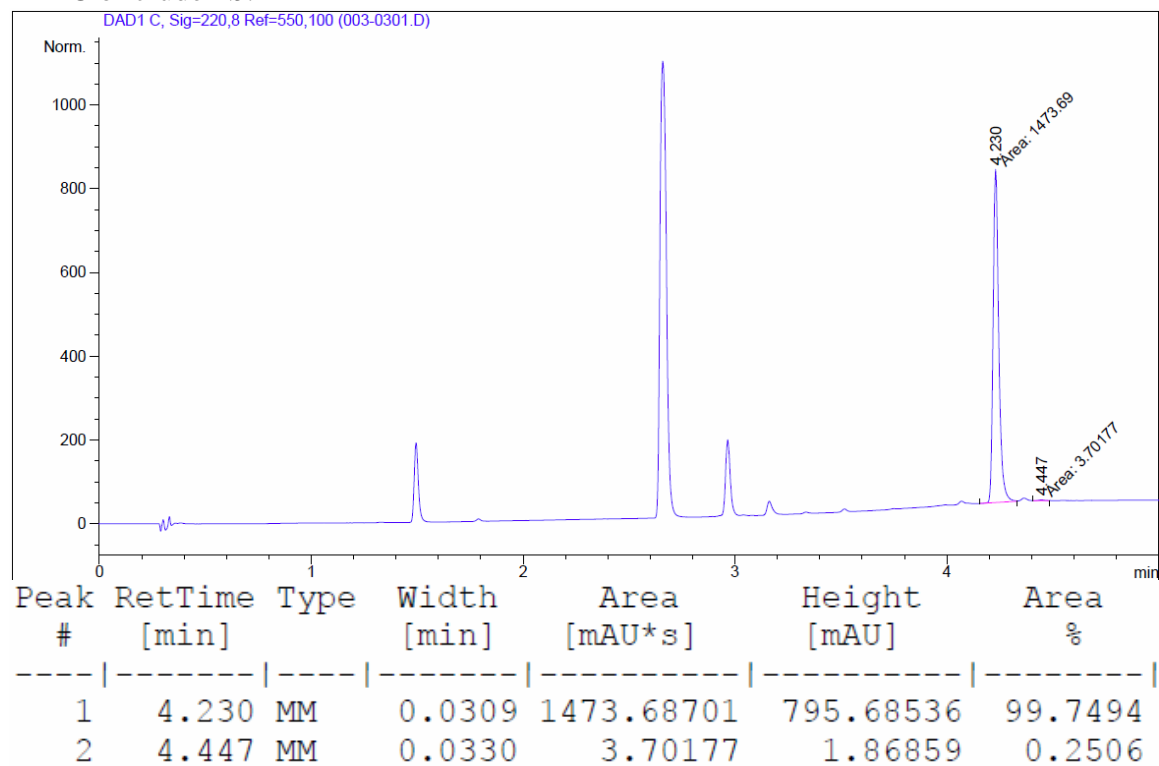
C	0.73424761	0.99538011	0.22533835
C	-0.73424823	0.99538101	-0.22533514
H	0.80156737	1.15715481	1.30285831
H	1.33785450	1.75311631	-0.27247511
H	-1.33785632	1.75311238	0.27248412
H	-0.80156798	1.15716419	-1.30285363
Sum of electronic and zero-point Energies=			-232.409569
Sum of electronic and thermal Energies=			-232.404598
Sum of electronic and thermal Enthalpies=			-232.403654
Sum of electronic and thermal Free Energies=			-232.437992

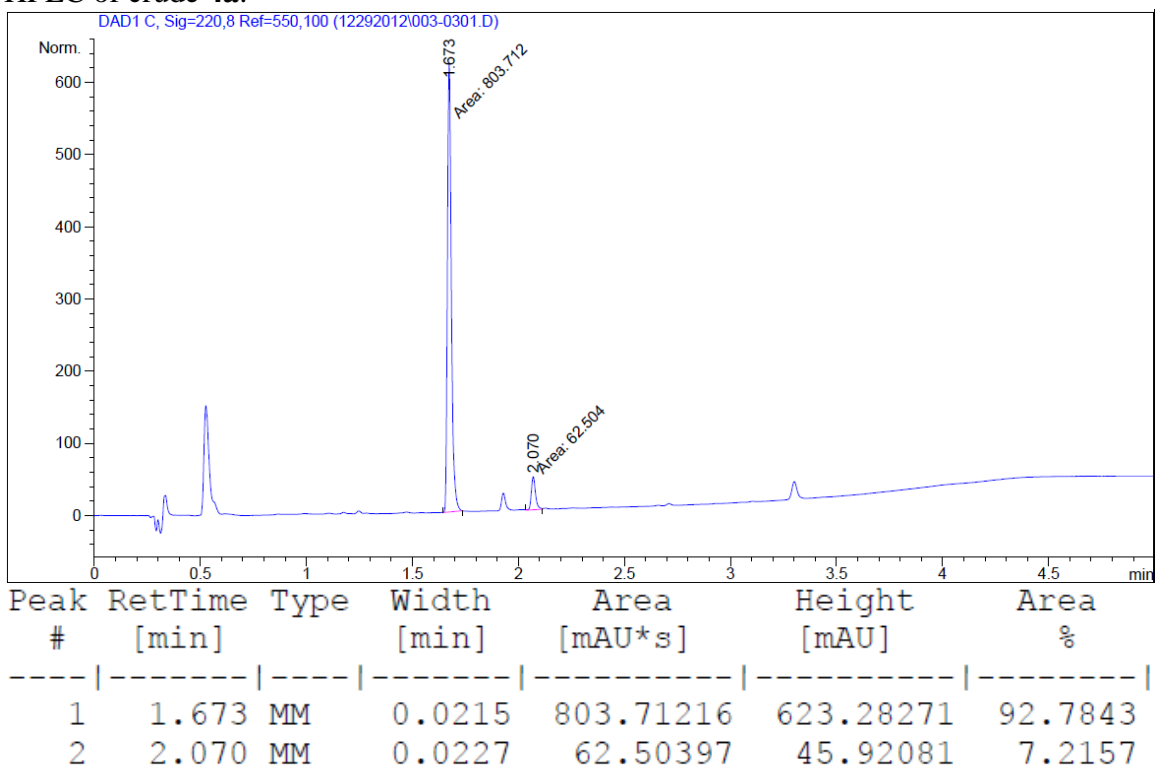
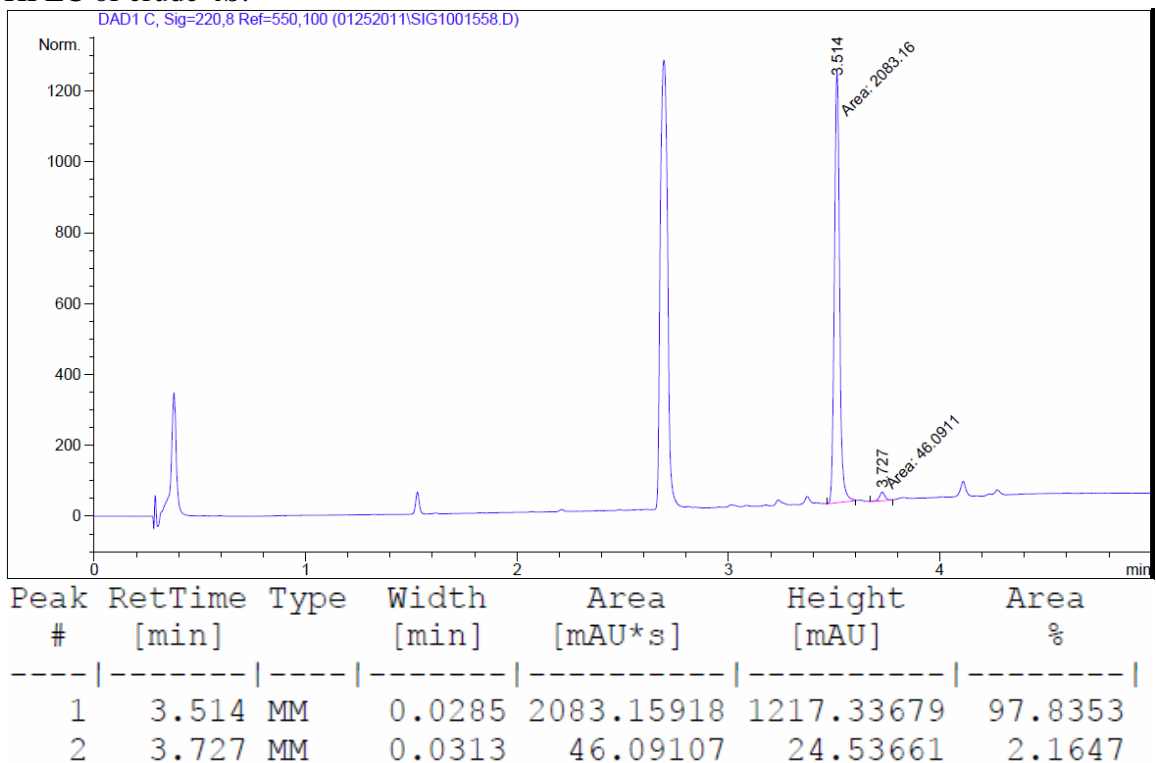
TMS

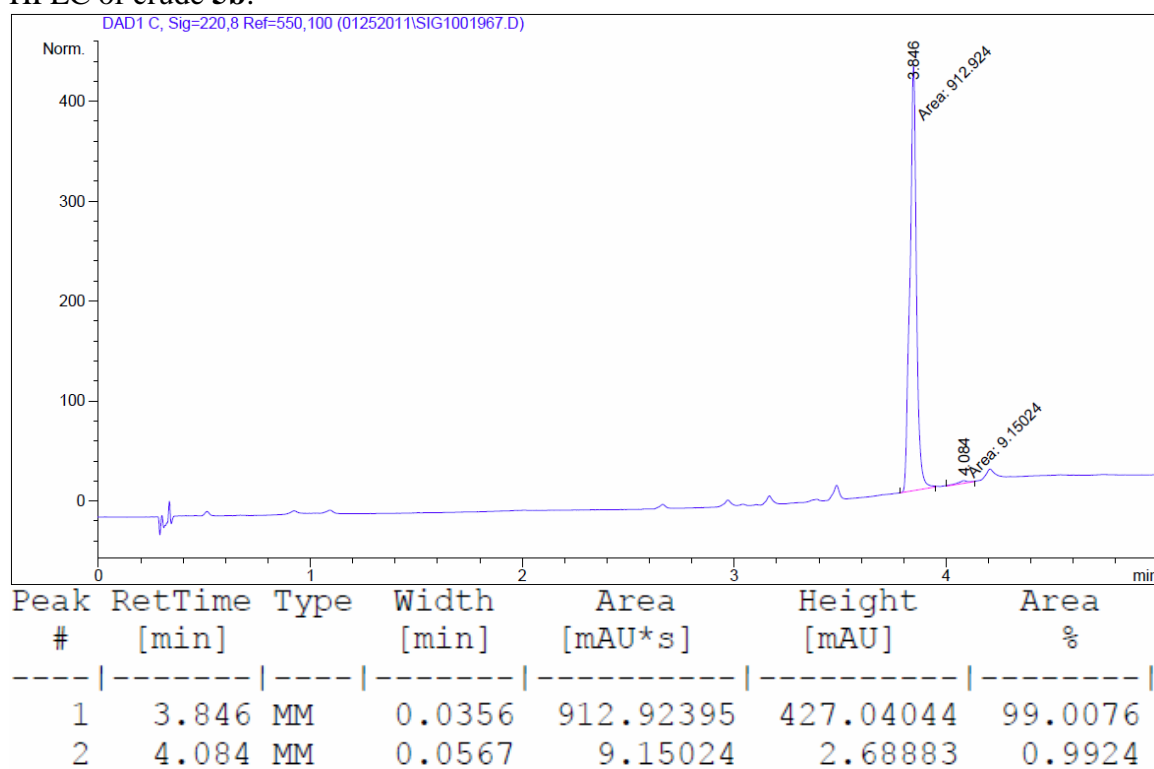
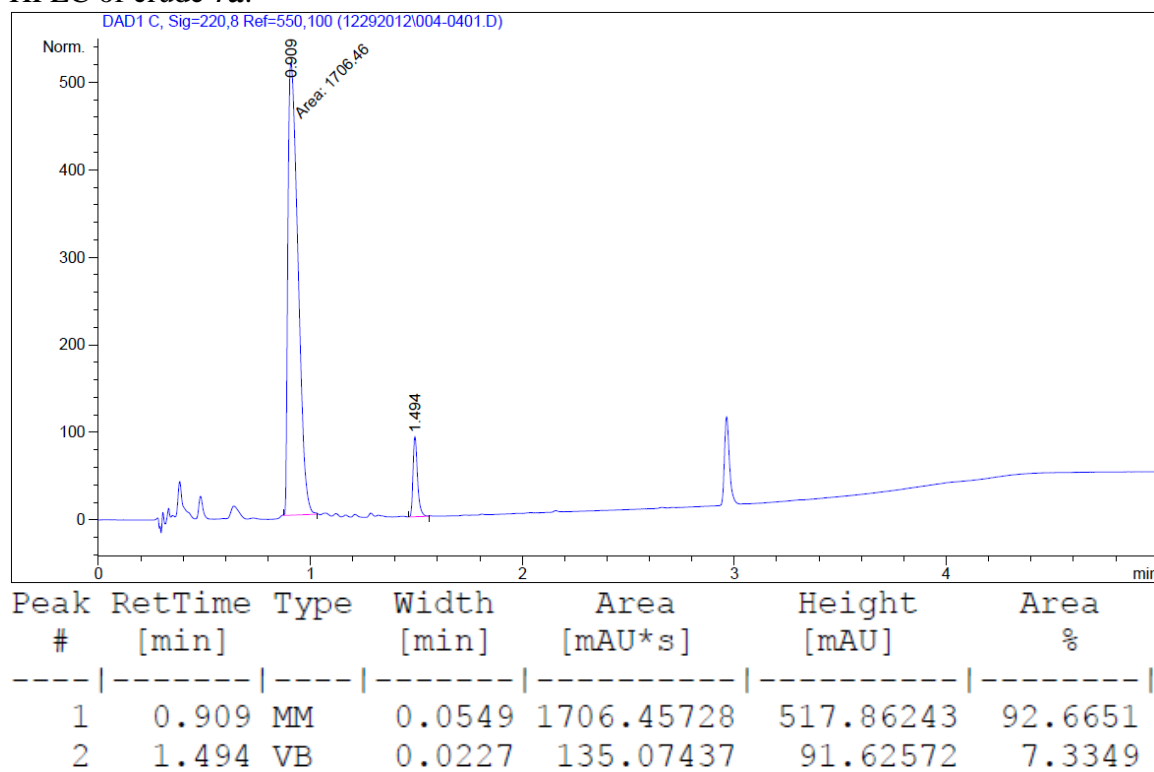
The Cartesian coordinates for the optimized structure are as follows:

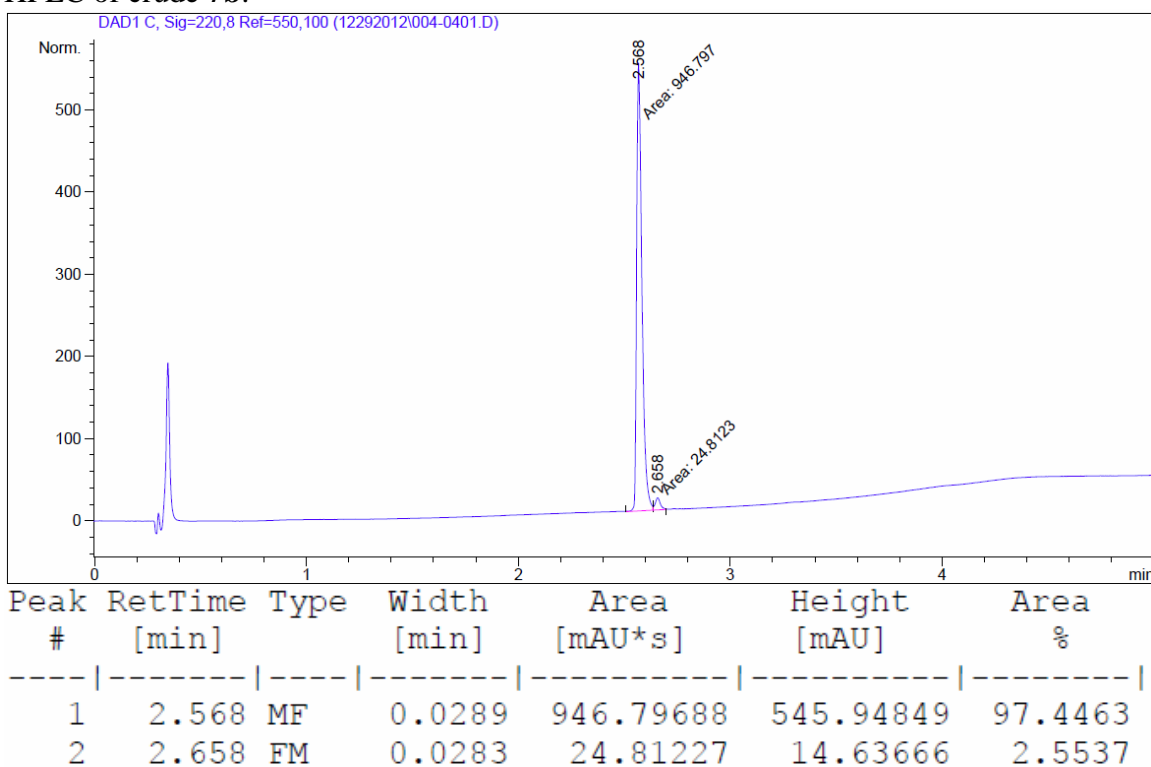
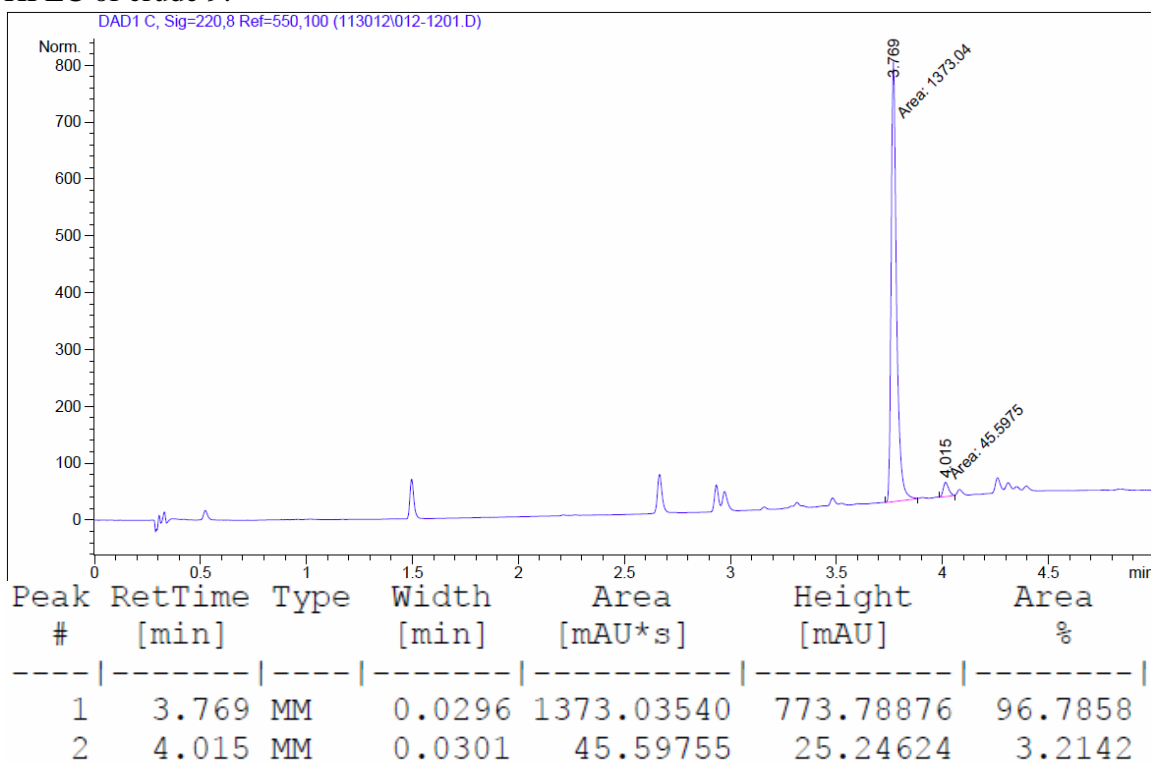
Charge: 0 Spin: 1		Coordinates (Angstroms)		
	X	Y	Z	
Si	0.00000000	0.00000000	0.00000000	
C	1.09190000	1.09190000	1.09190000	
H	1.73490000	0.48650000	1.73490000	
H	1.73490000	1.73490000	0.48650000	
H	0.48650000	1.73490000	1.73490000	
C	-1.09190000	-1.09190000	1.09190000	
H	-1.73490000	-0.48650000	1.73490000	
H	-1.73490000	-1.73490000	0.48650000	
H	-0.48650000	-1.73490000	1.73490000	
C	-1.09190000	1.09190000	-1.09190000	
H	-0.48650000	1.73490000	-1.73490000	
H	-1.73490000	0.48650000	-1.73490000	
H	-1.73490000	1.73490000	-0.48650000	
C	1.09190000	-1.09190000	-1.09190000	
H	0.48650000	-1.73490000	-1.73490000	
H	1.73490000	-0.48650000	-1.73490000	
H	1.73490000	-1.73490000	-0.48650000	
Sum of electronic and zero-point Energies=			-449.131272	
Sum of electronic and thermal Energies=			-449.121924	
Sum of electronic and thermal Enthalpies=			-449.120980	
Sum of electronic and thermal Free Energies=			-449.161441	

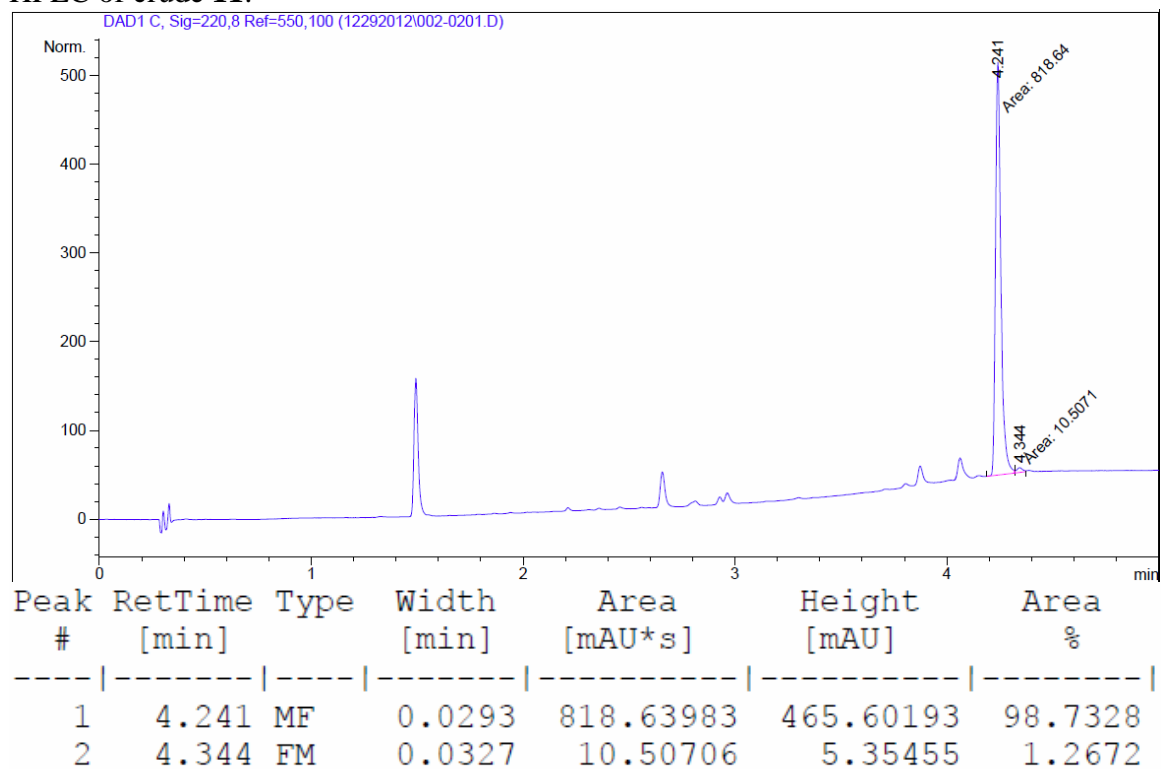
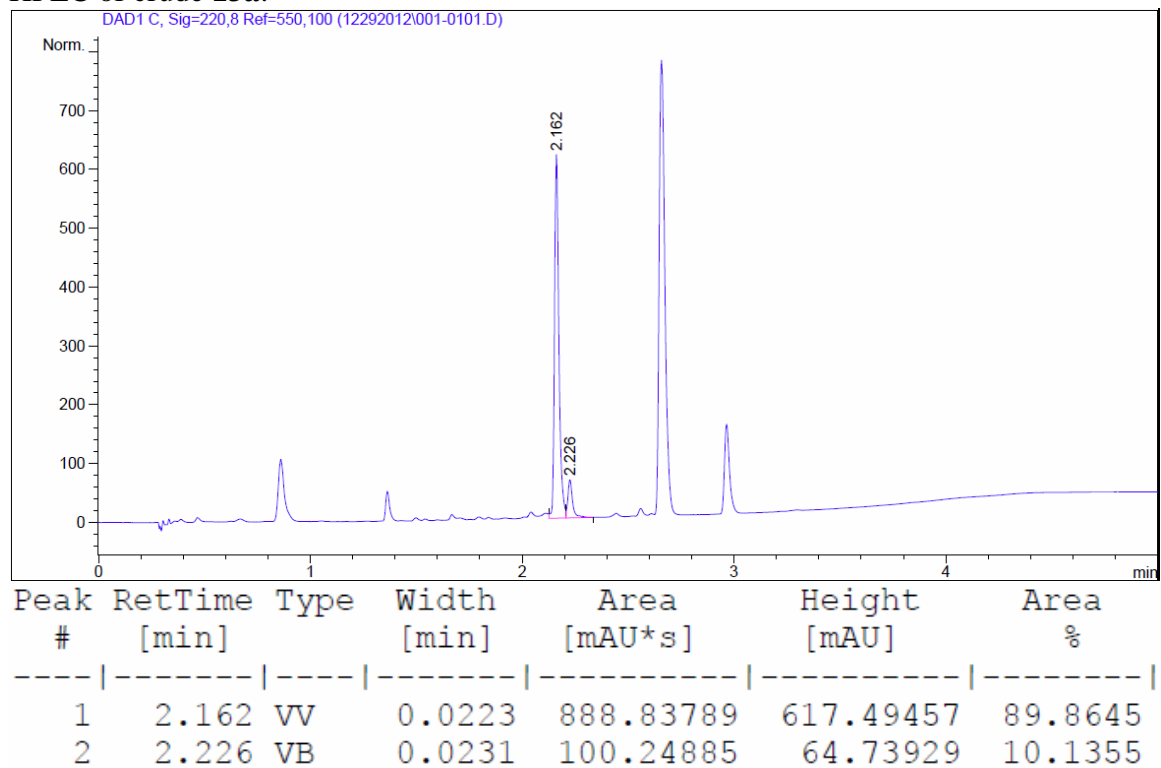
Carbon NMR shielding (IGAIM, B3LYP/6-311G+(d,2p), CPCM=THF): 185.863 ppm

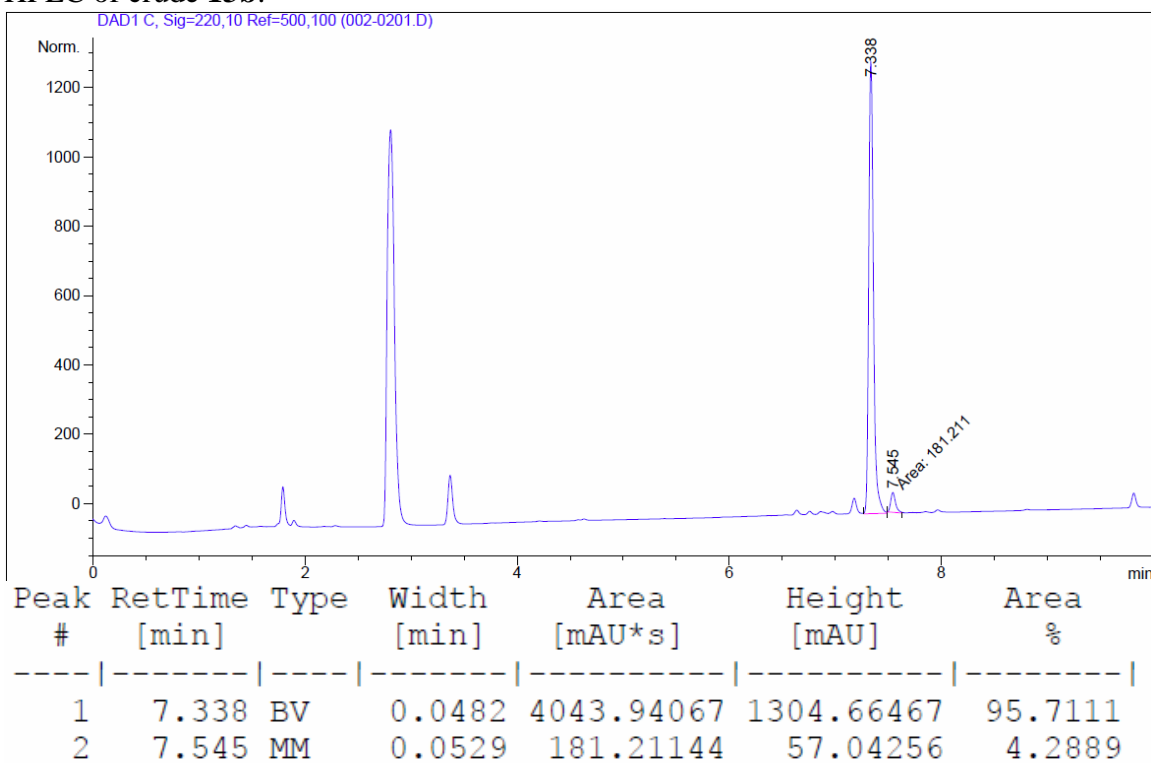
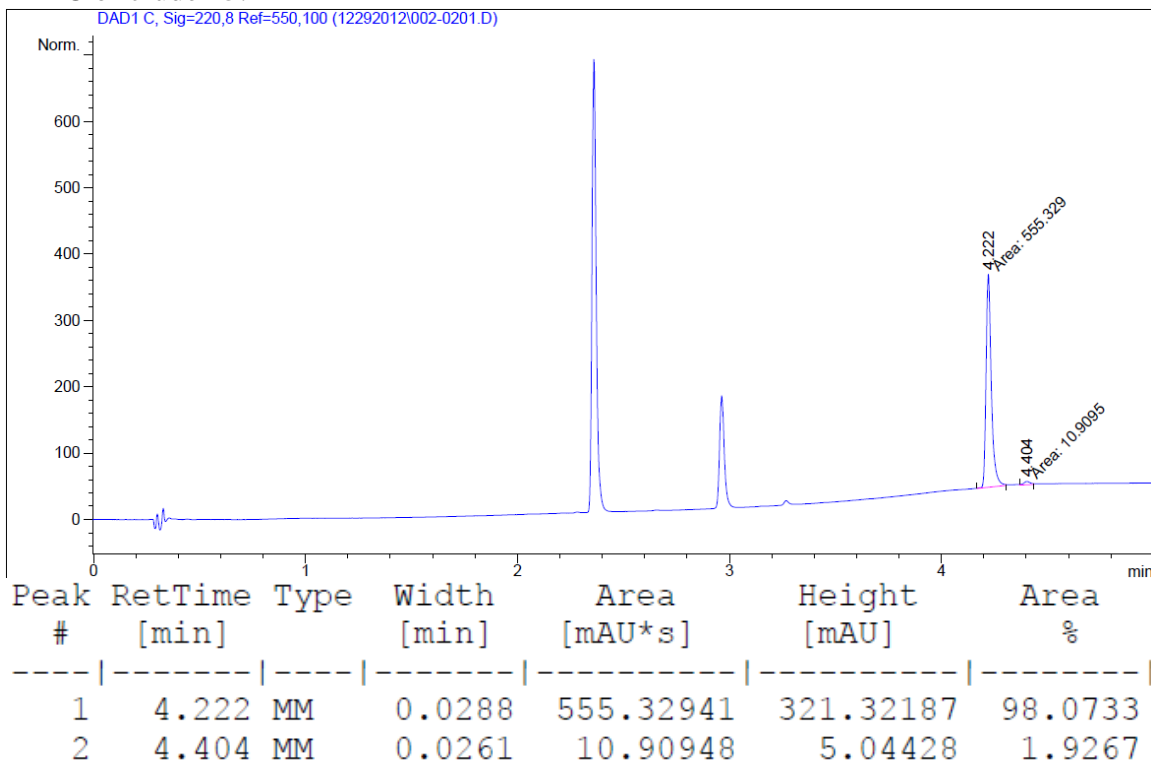
HPLC chromatograms of crude α -amino amides.**HPLC of crude **2a**:****HPLC of crude **2b**:**

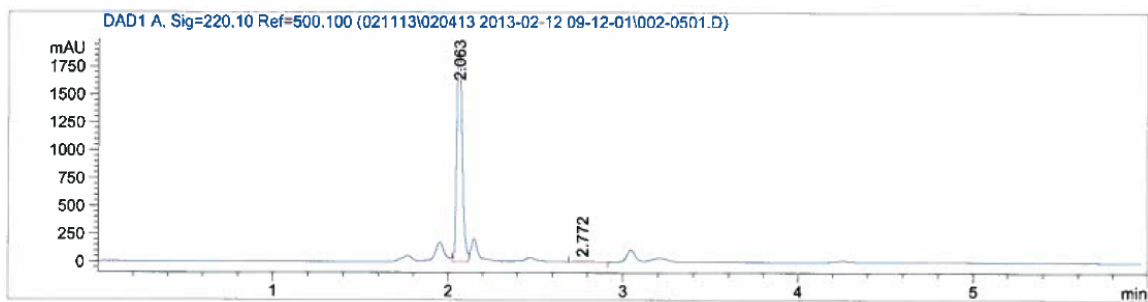
HPLC of crude **4a**:HPLC of crude **4b**:

HPLC of crude **5b**:HPLC of crude **7a**:

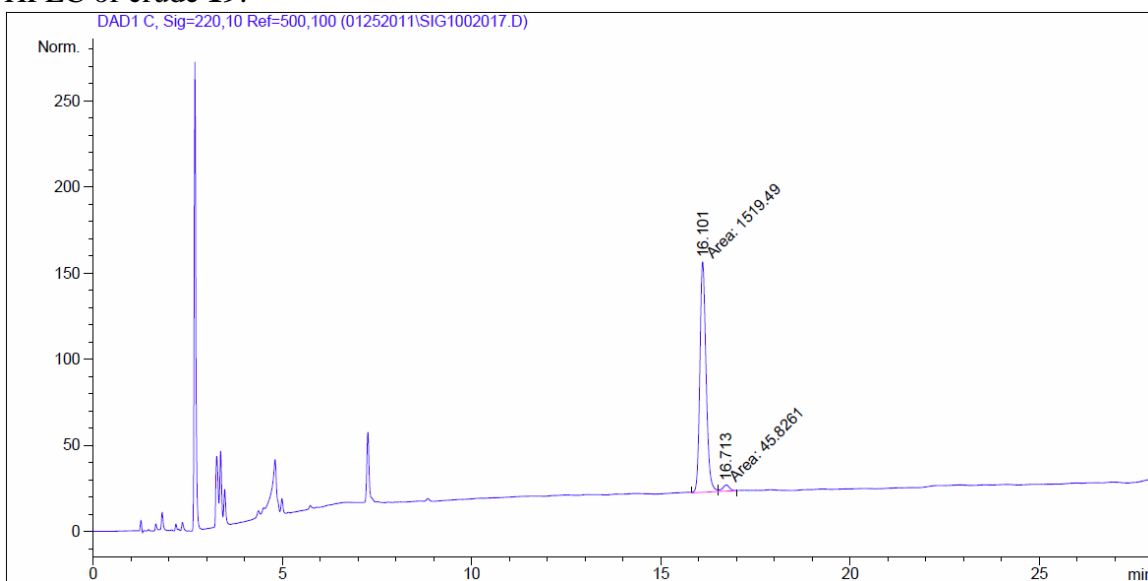
HPLC of crude **7b**:HPLC of crude **9**:

HPLC of crude **11**:HPLC of crude **13a**:

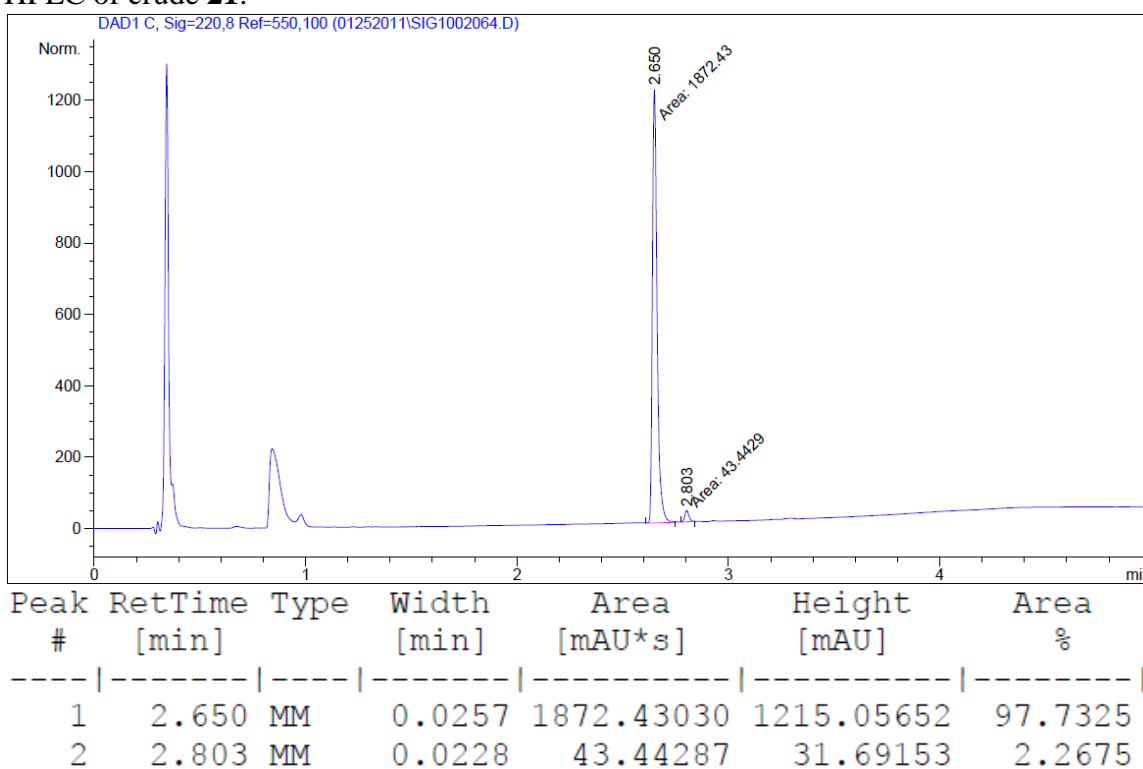
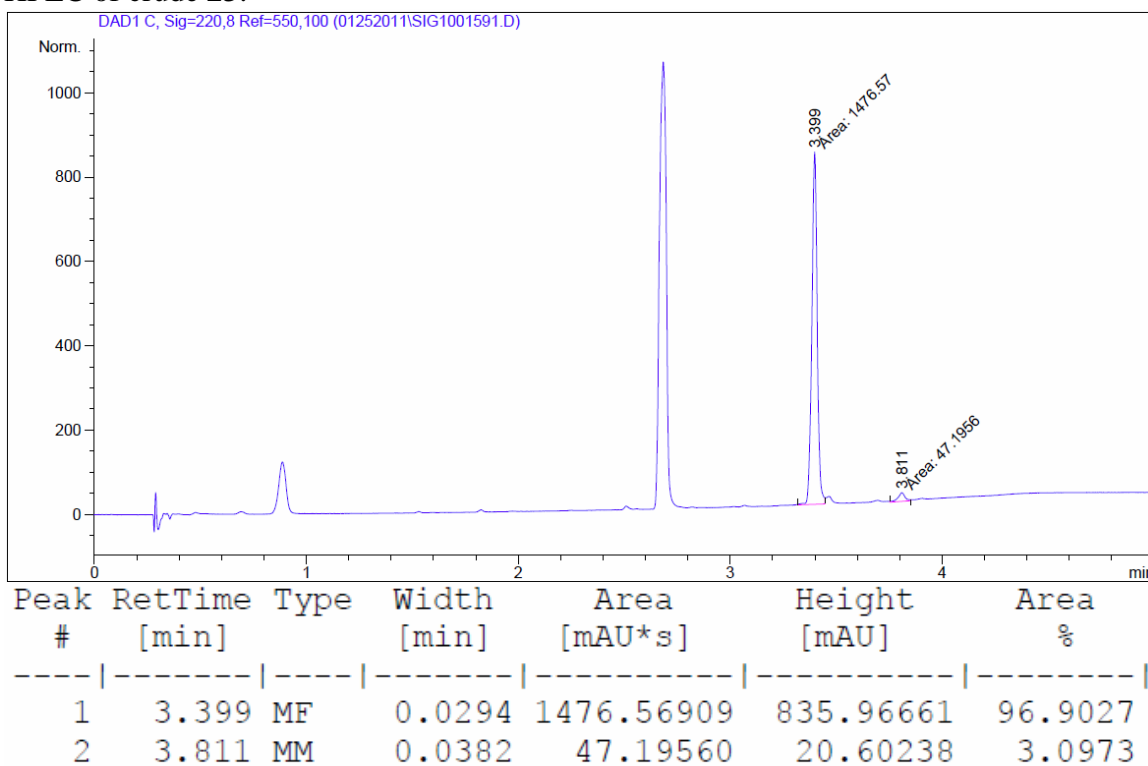
HPLC of crude **13b**:HPLC of crude **15**:

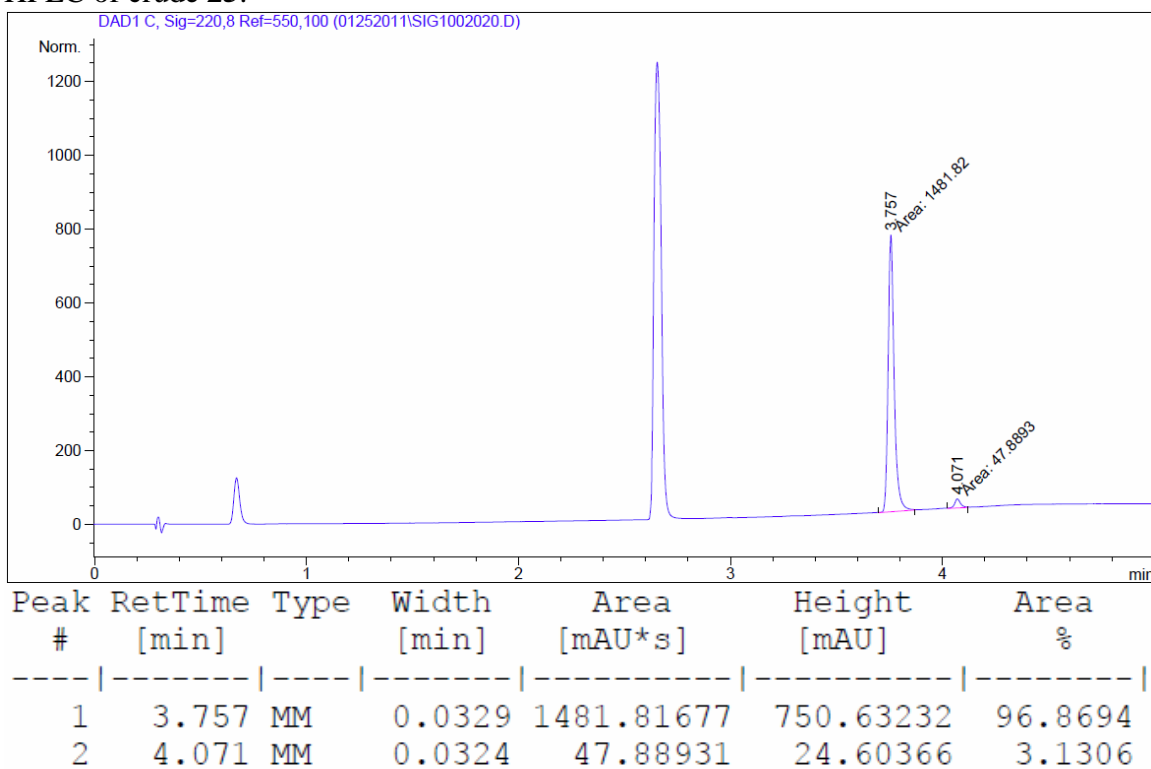
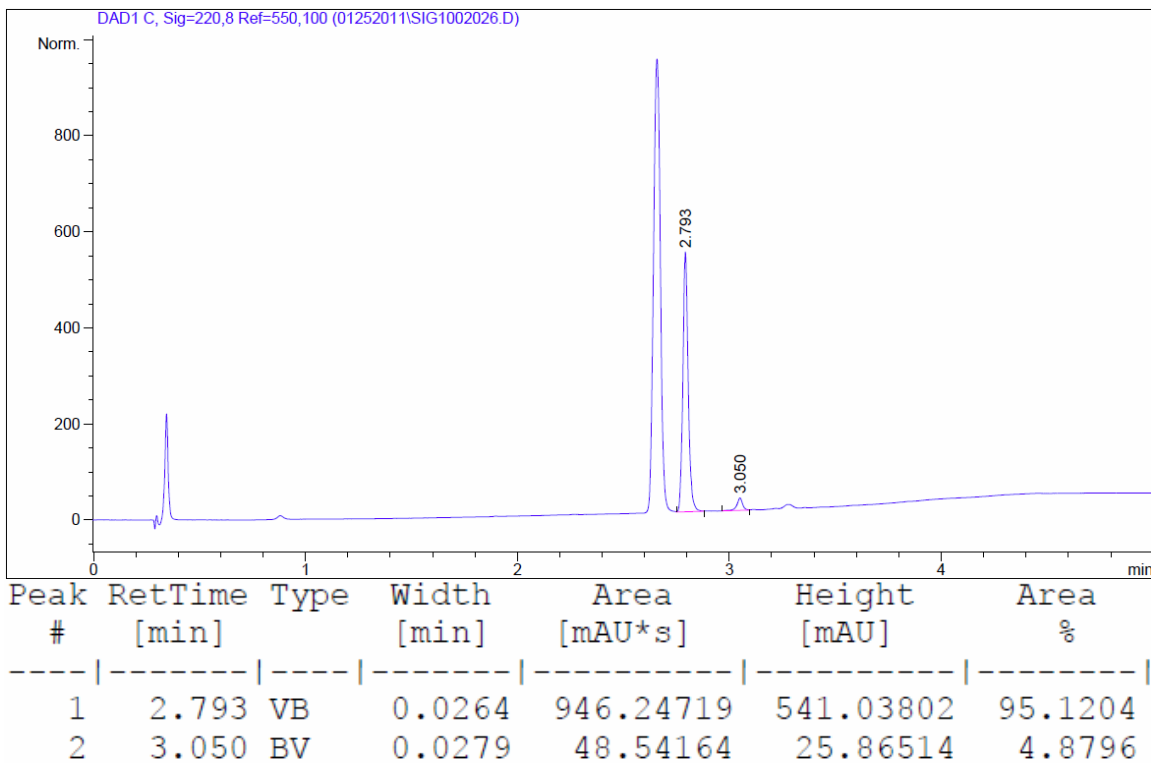
HPLC of crude **17**:

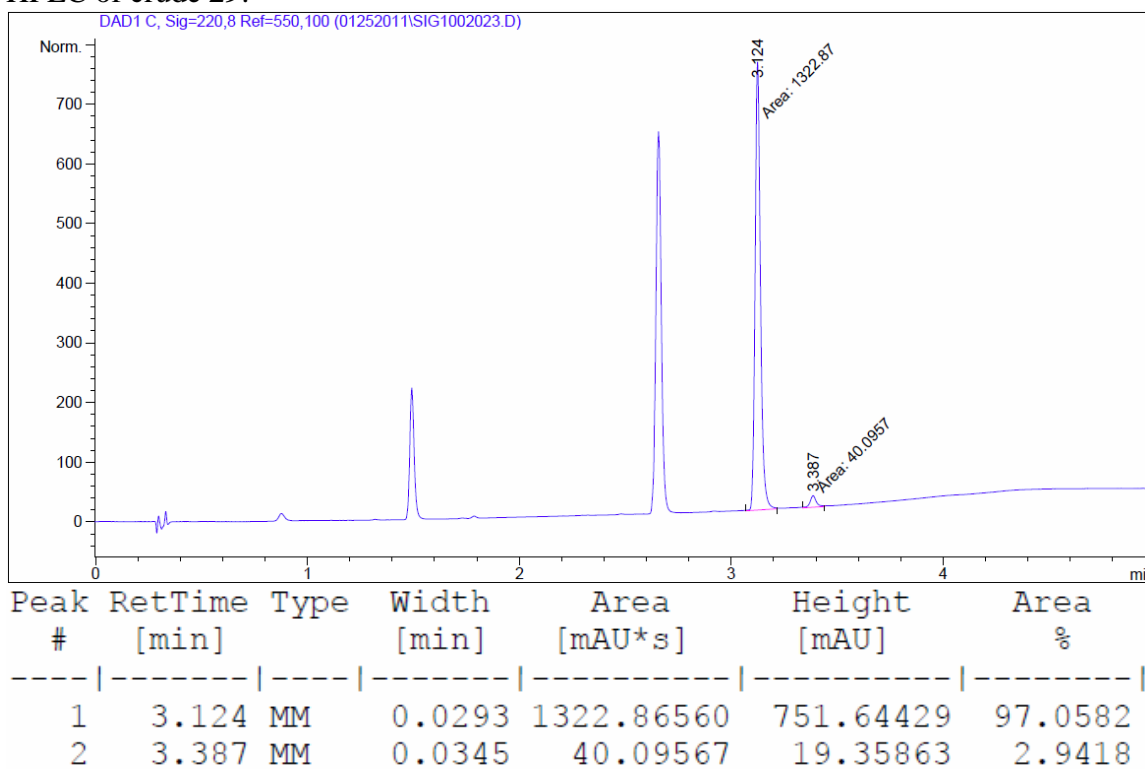
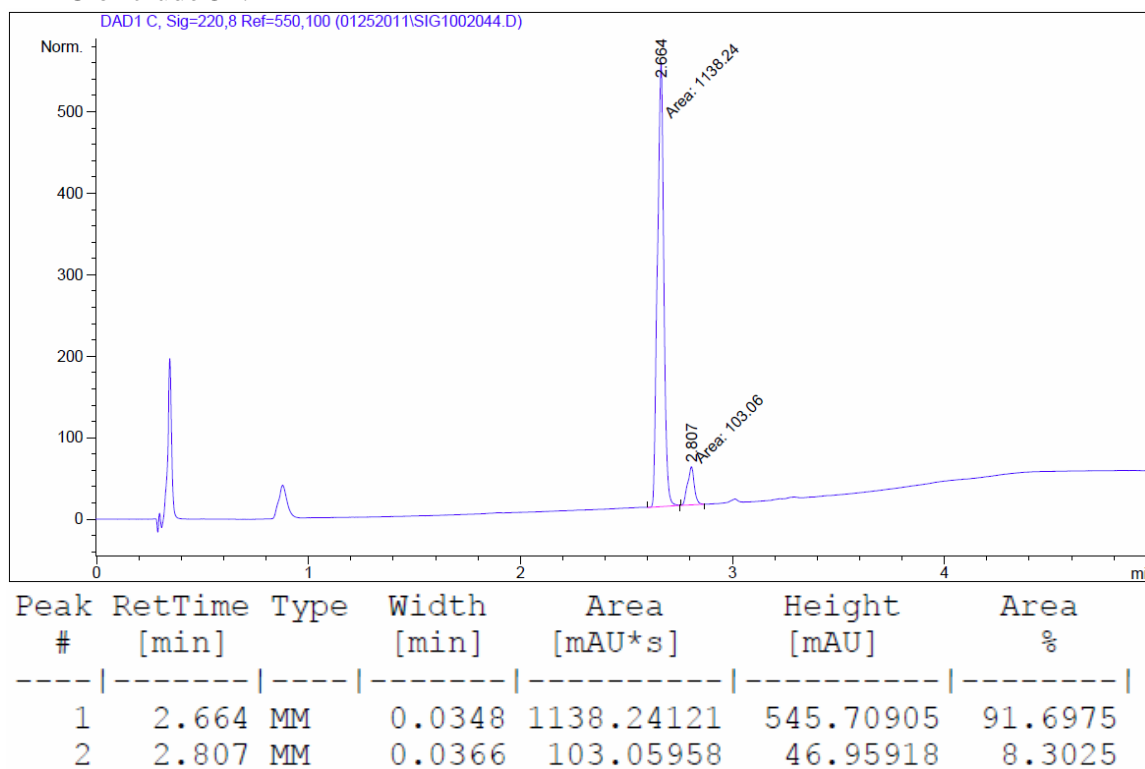
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.063	VV	0.0356	4332.87305	1898.39246	99.1192
2	2.772	VV	0.1085	38.50138	4.96130	0.8808

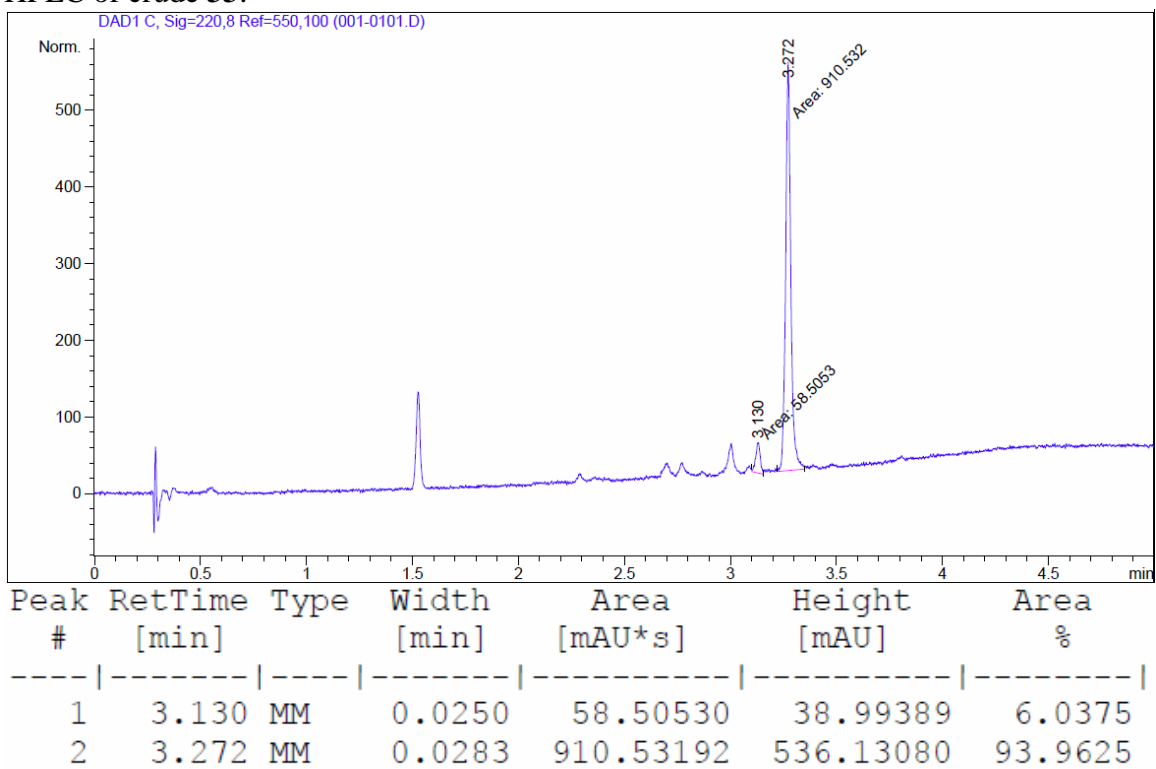
HPLC of crude **19**:

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.101	MF	0.1893	1519.49365	133.79231	97.0724
2	16.713	FM	0.2119	45.82606	3.60420	2.9276

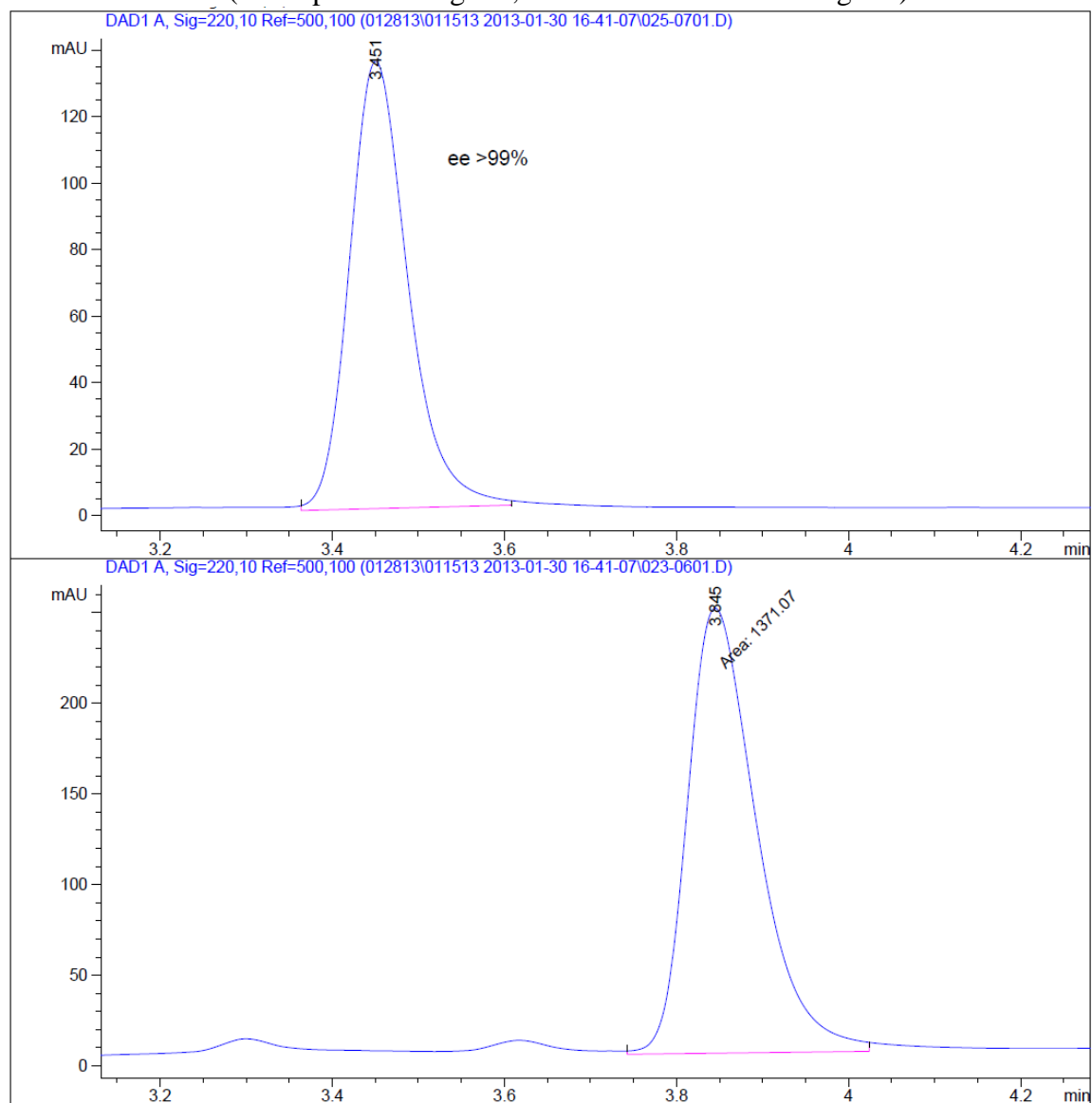
HPLC of crude **21**:HPLC of crude **23**:

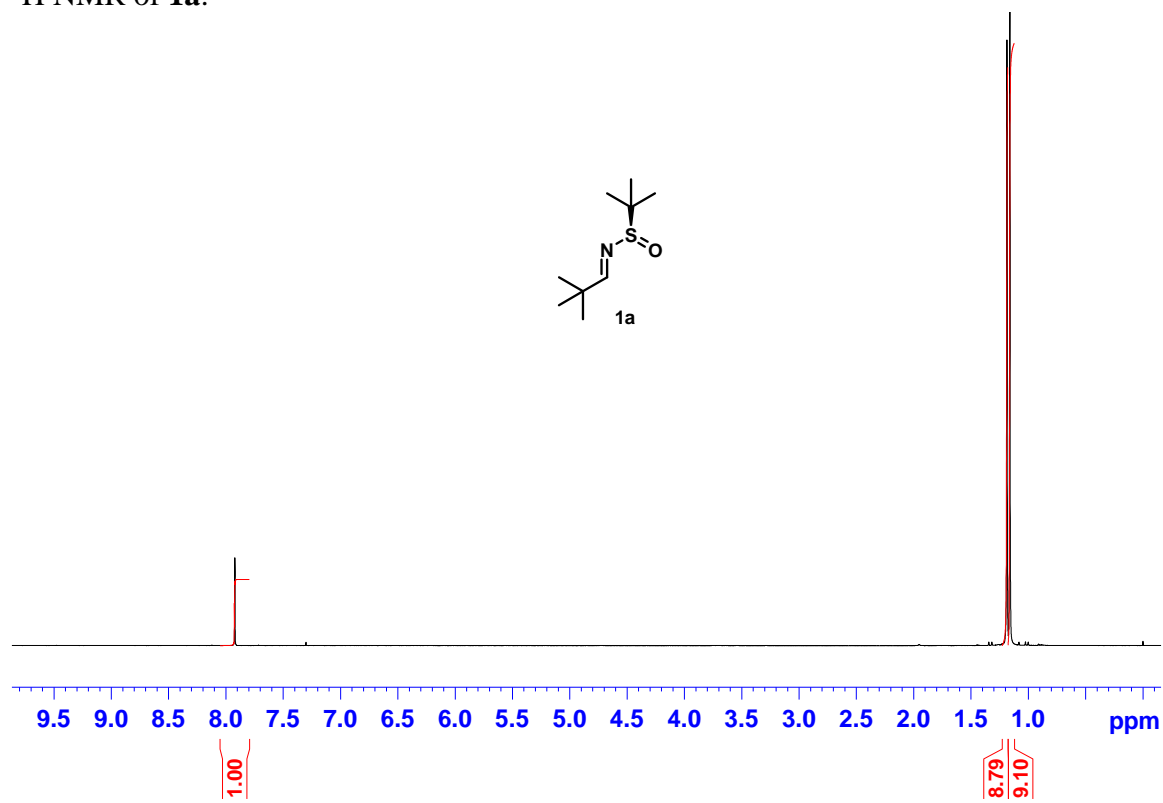
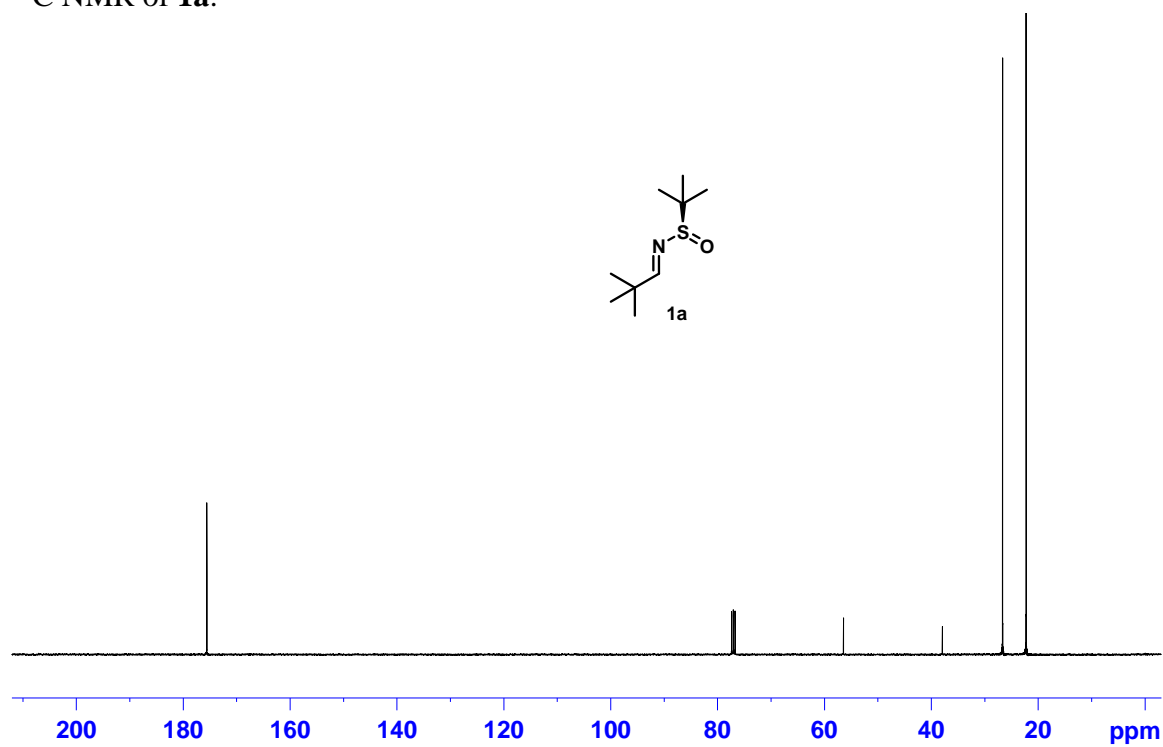
HPLC of crude **25**:HPLC of crude **27**:

HPLC of crude **29**:HPLC of crude **31**:

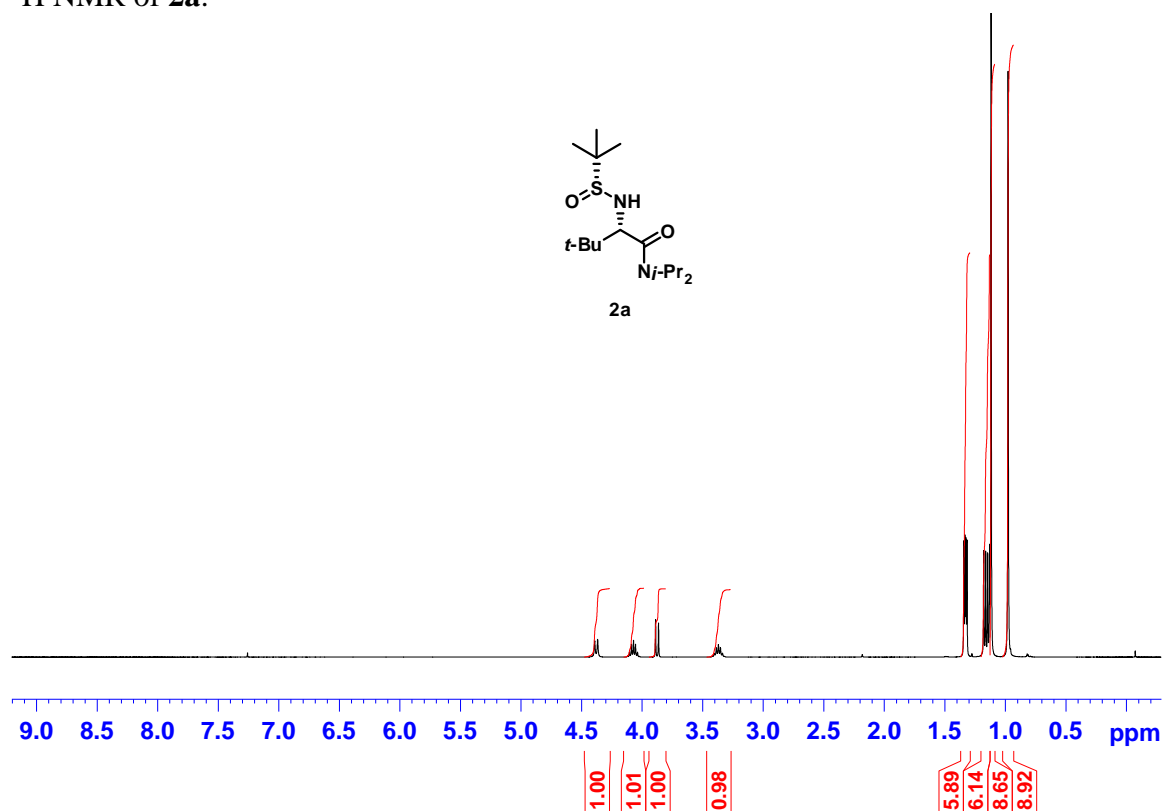
HPLC of crude **33**:

Chiral HPLC of **3** (**3** is top chromatogram, **ent-3** is bottom chromatogram):

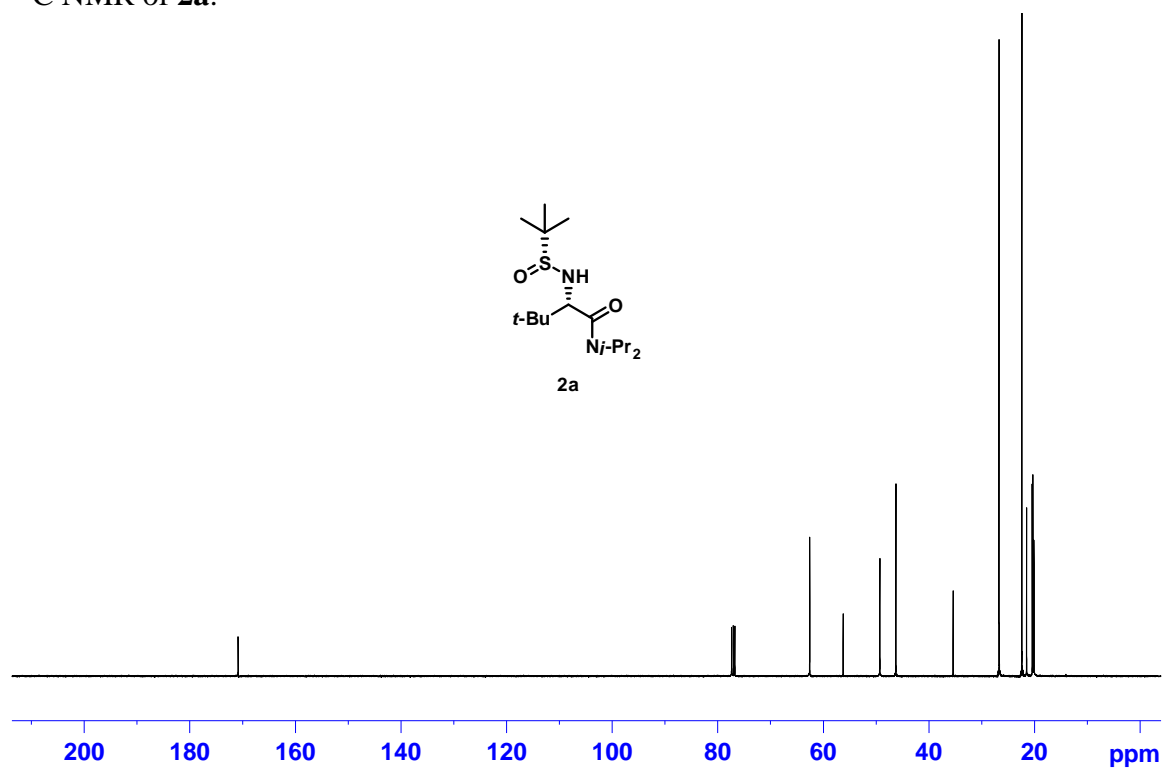


^1H and ^{13}C NMR spectra. ^1H NMR of **1a**: ^{13}C NMR of **1a**:

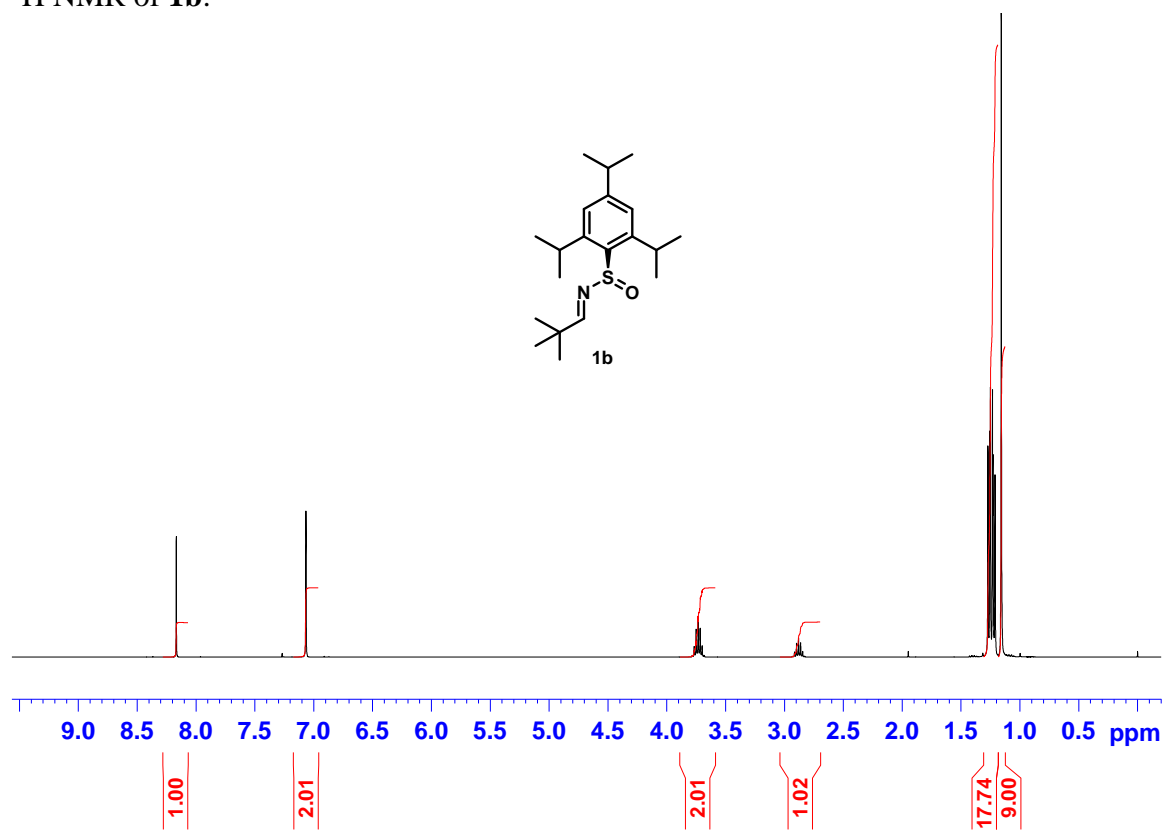
^1H NMR of **2a**:



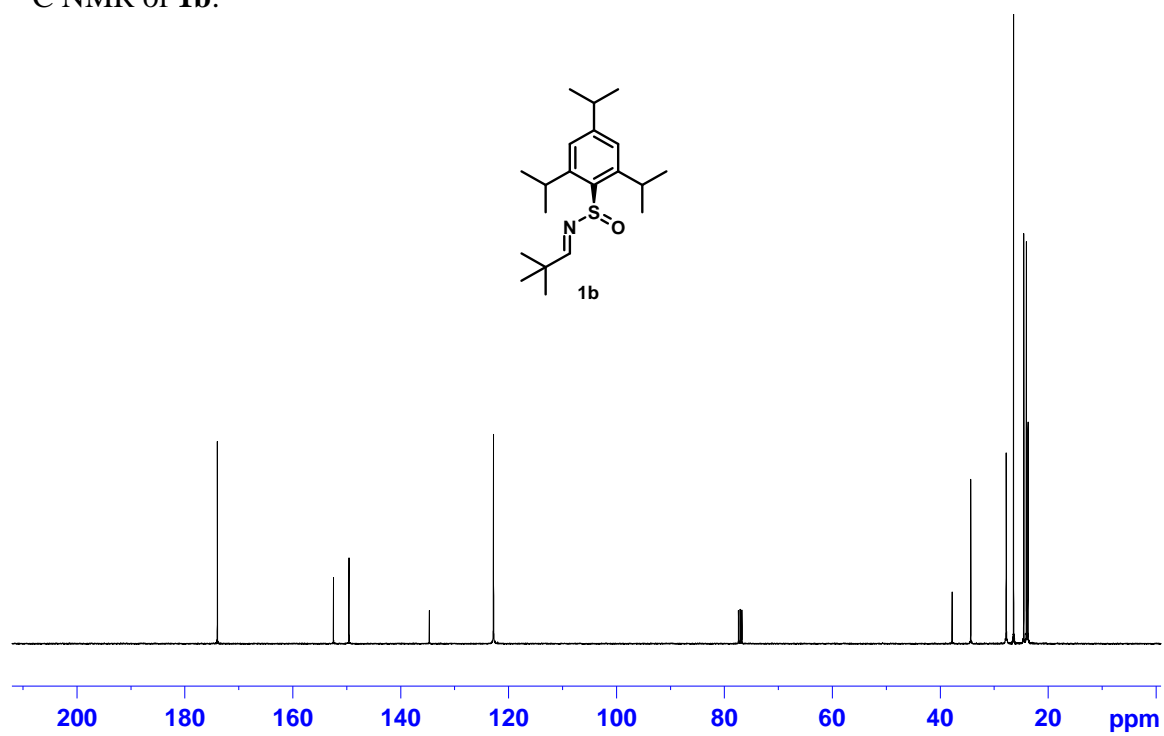
^{13}C NMR of **2a**:



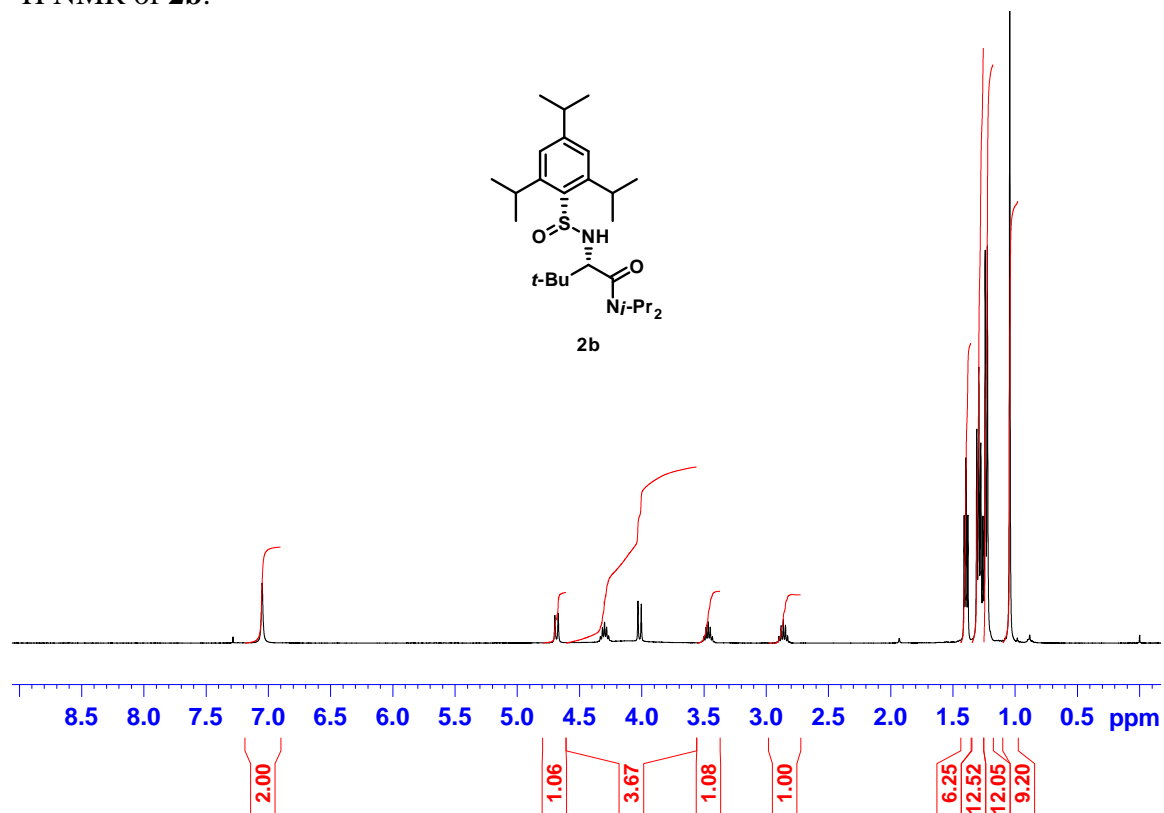
^1H NMR of **1b**:



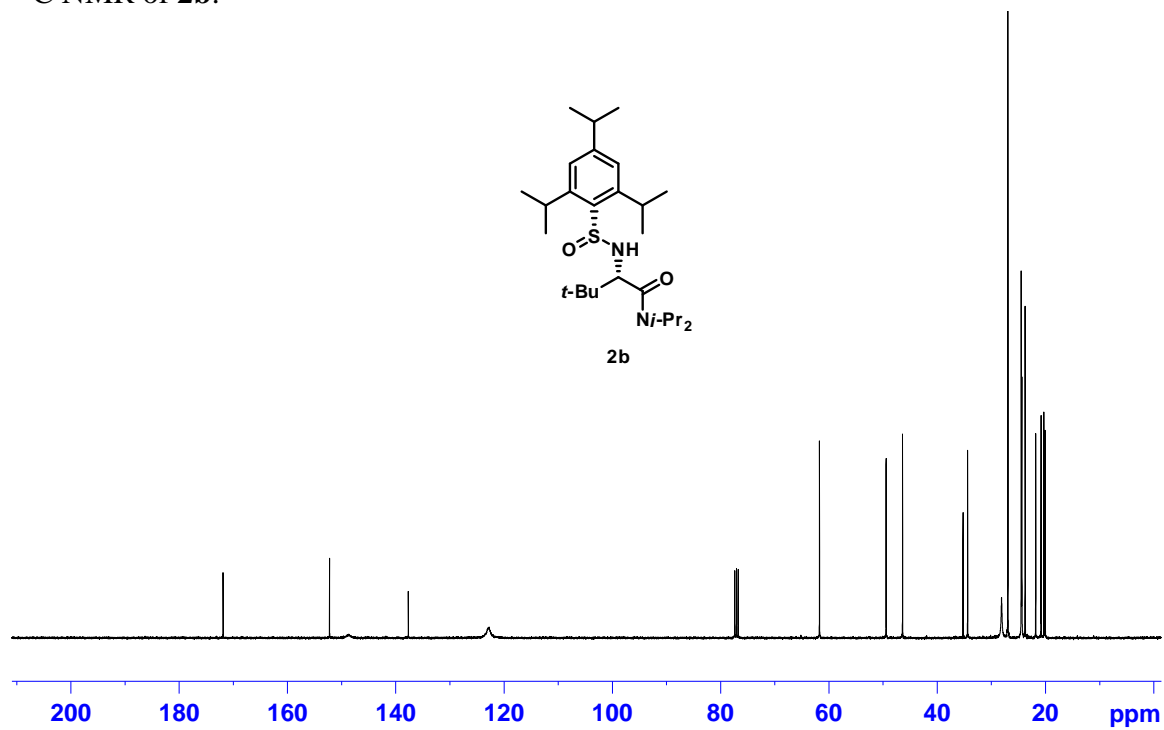
^{13}C NMR of **1b**:

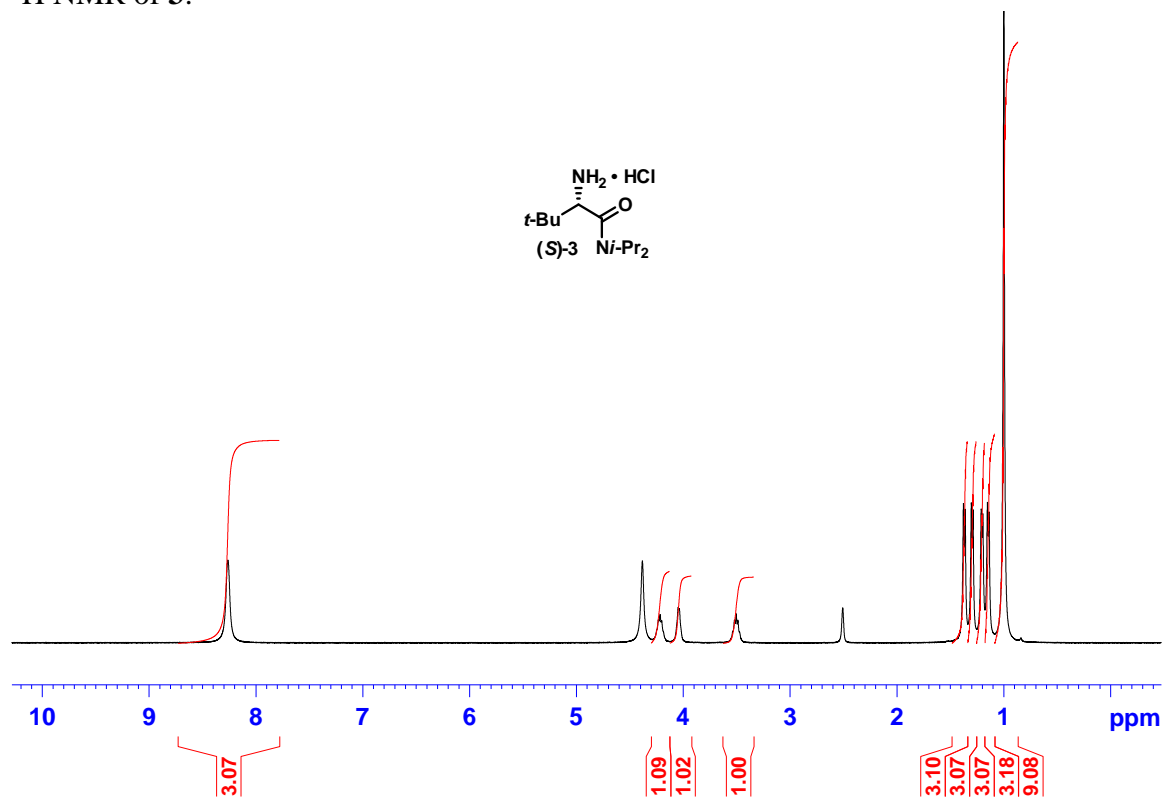
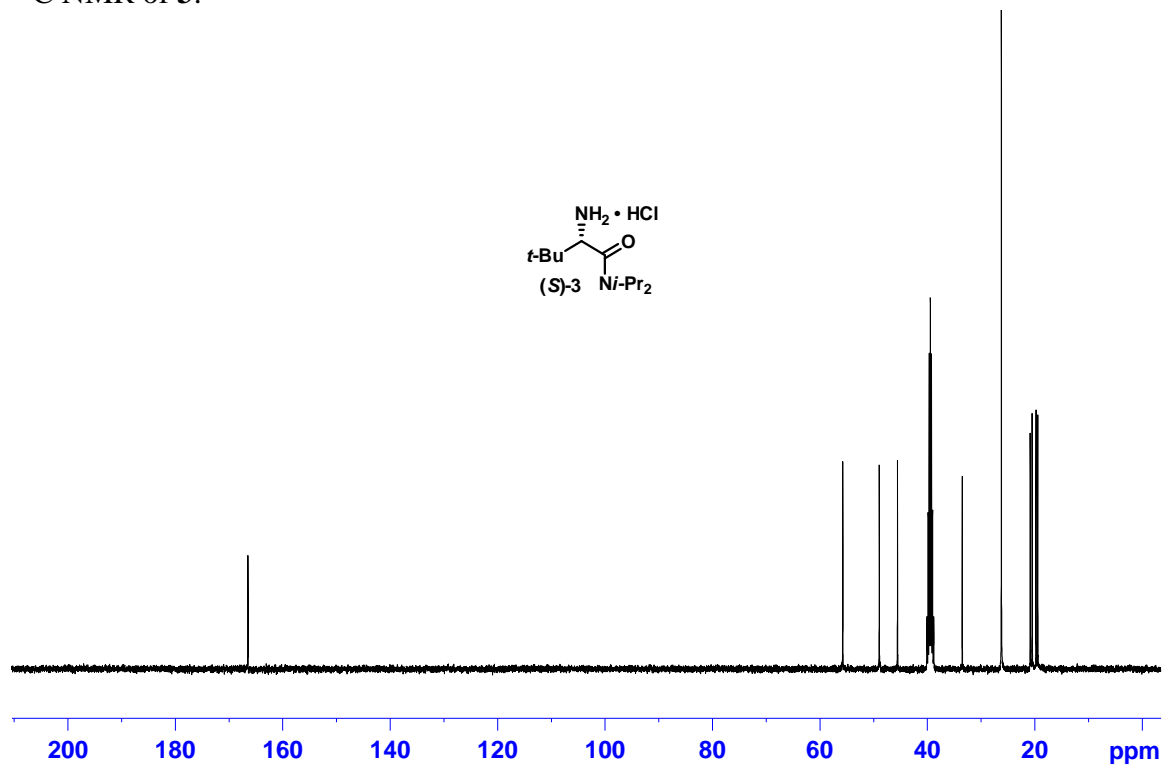


^1H NMR of **2b**:

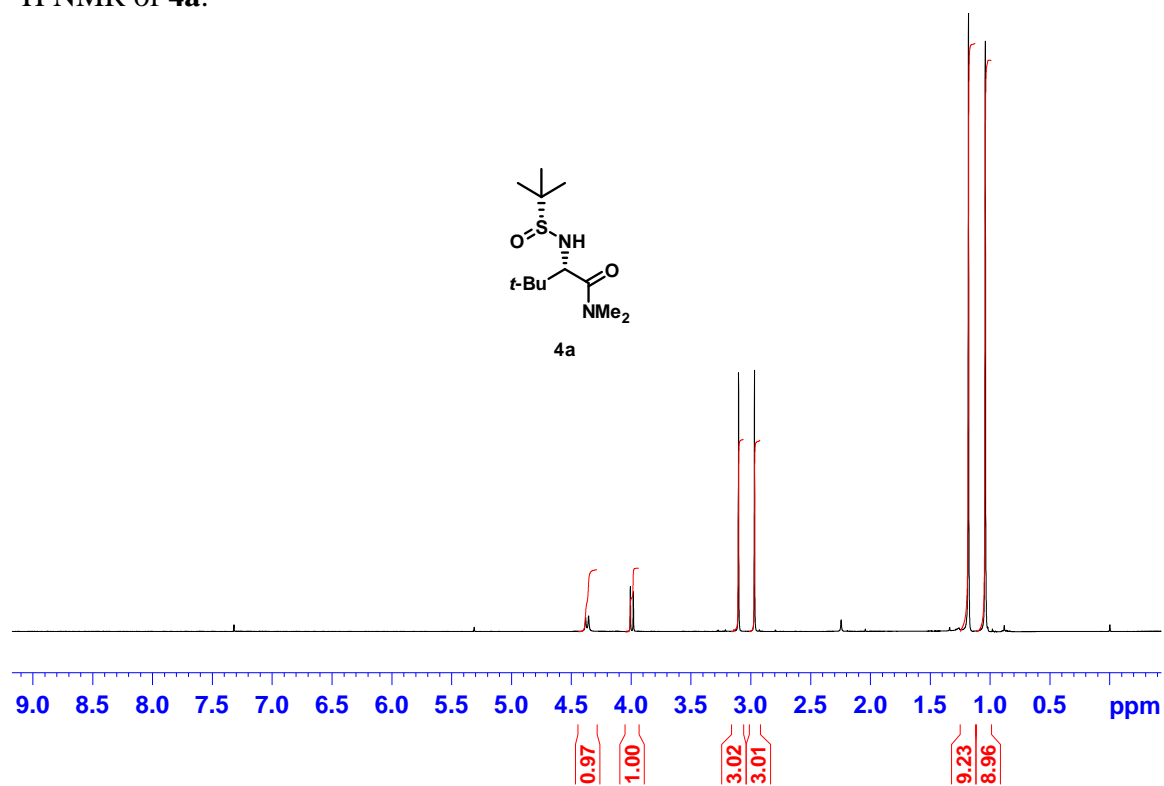


^{13}C NMR of **2b**:

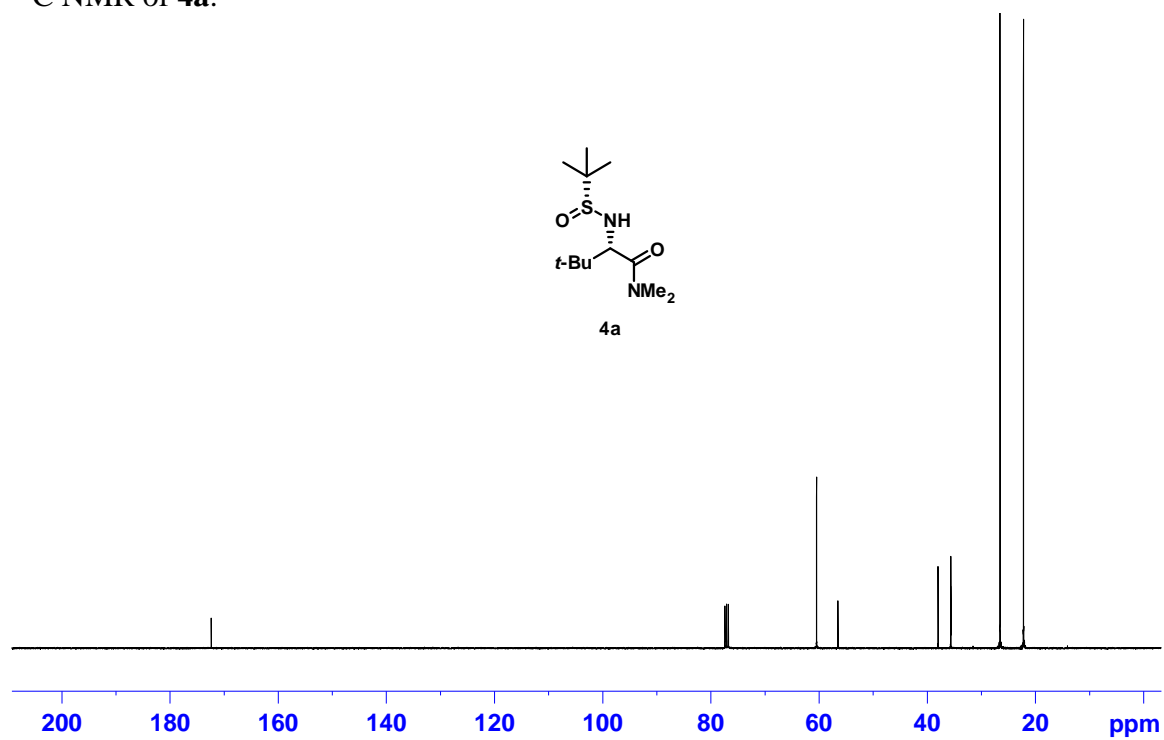


¹H NMR of **3**:¹³C NMR of **3**:

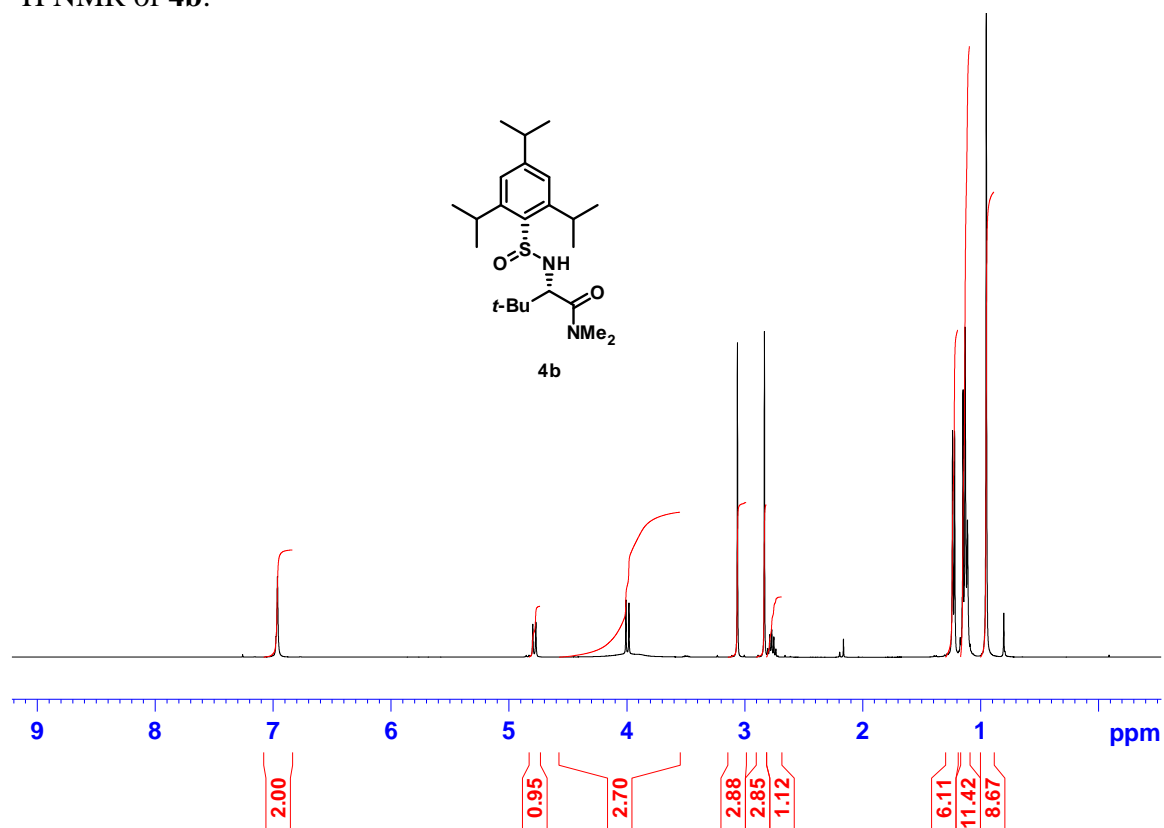
^1H NMR of **4a**:



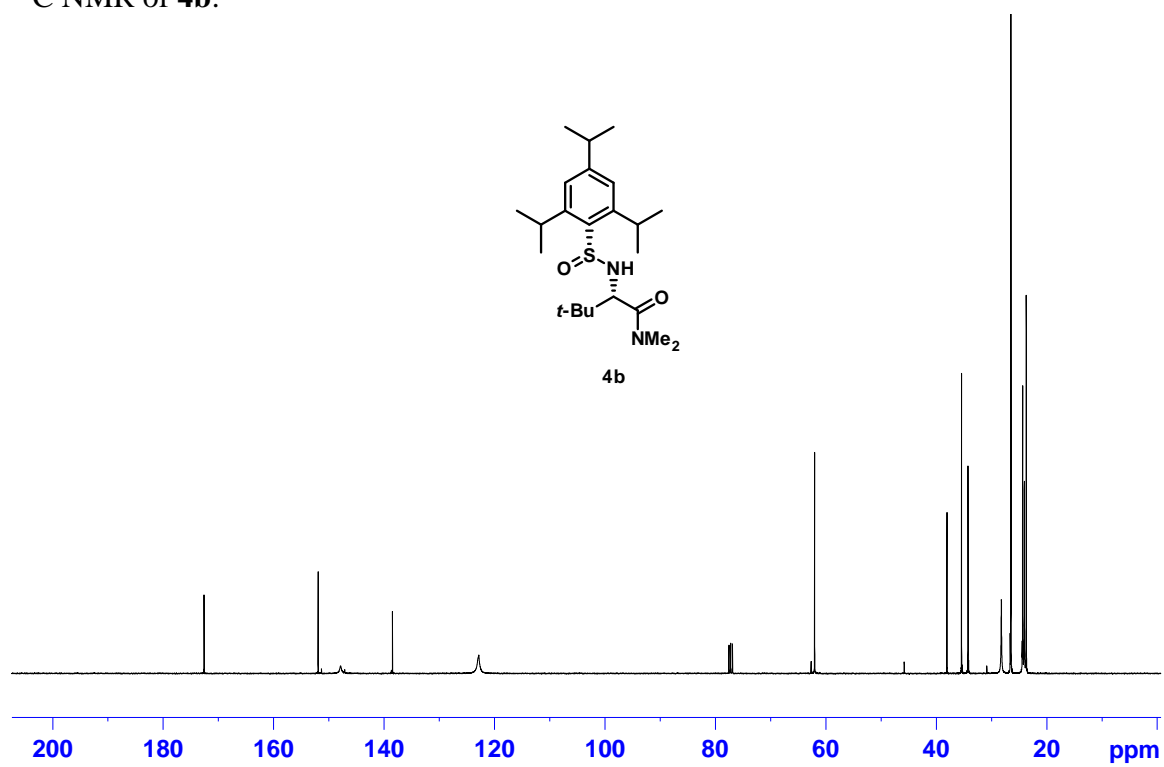
^{13}C NMR of **4a**:



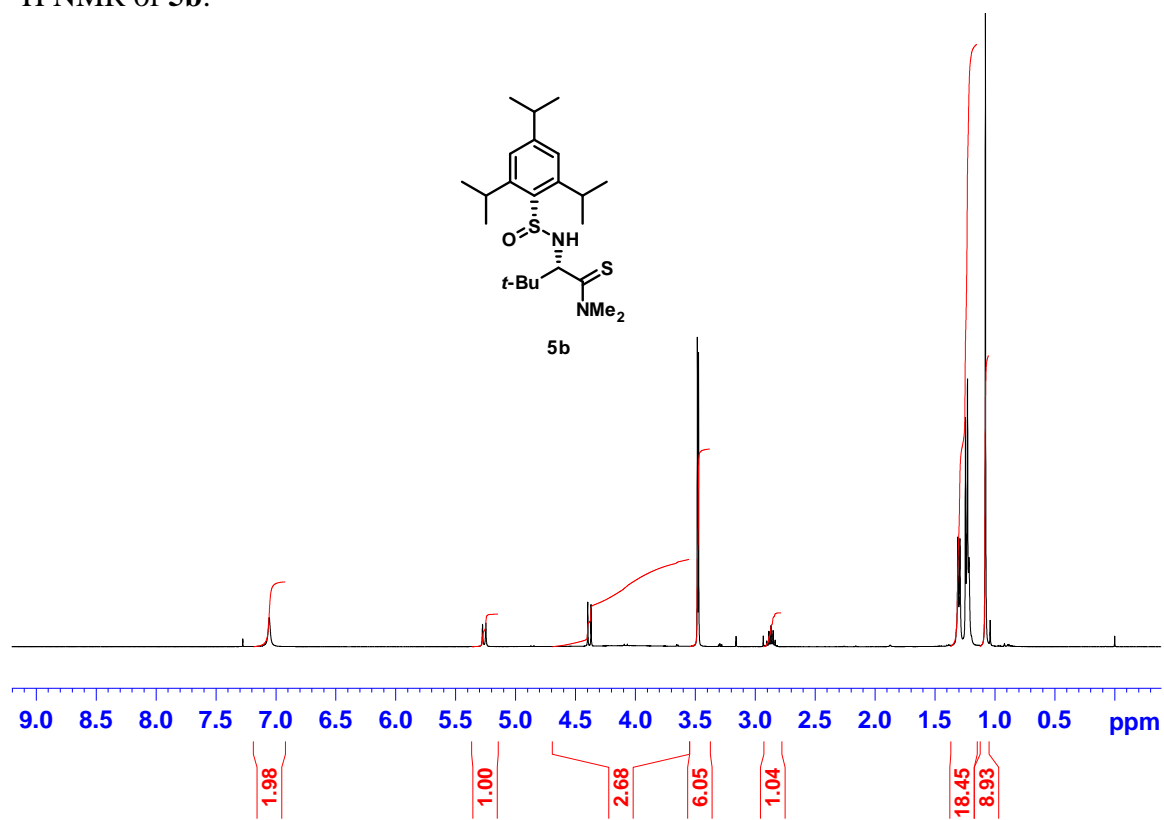
^1H NMR of **4b**:



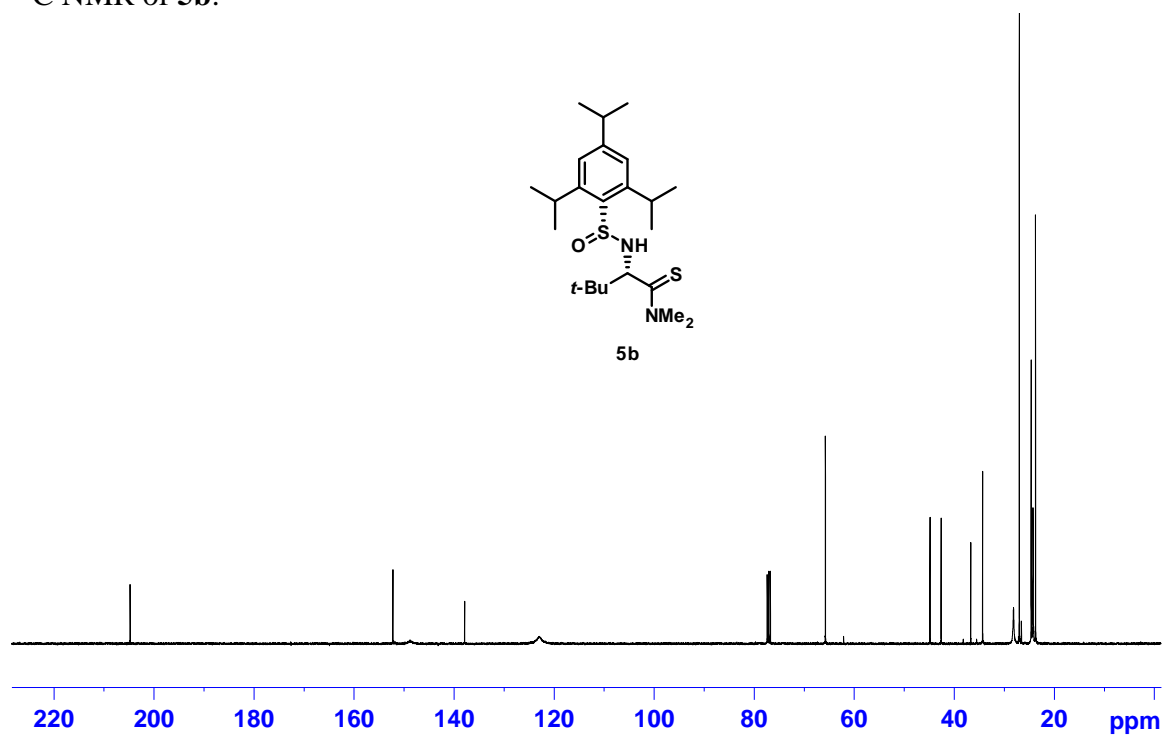
^{13}C NMR of **4b**:



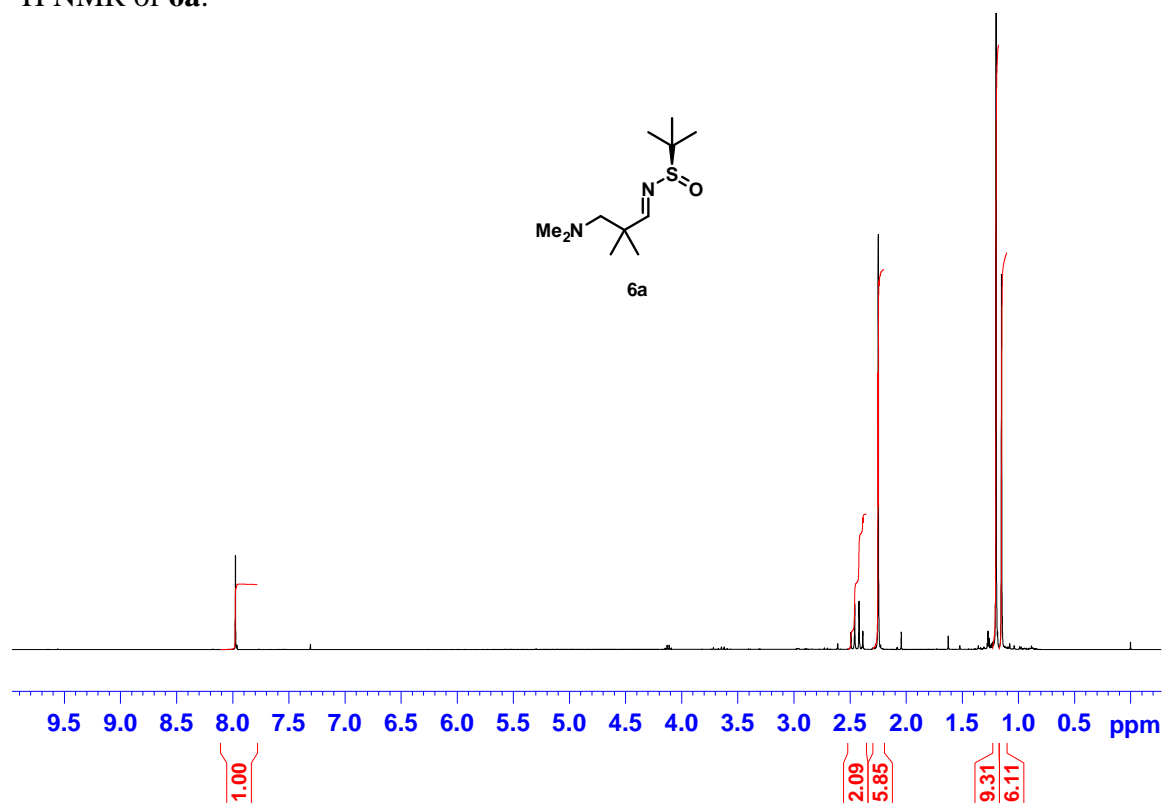
^1H NMR of **5b**:



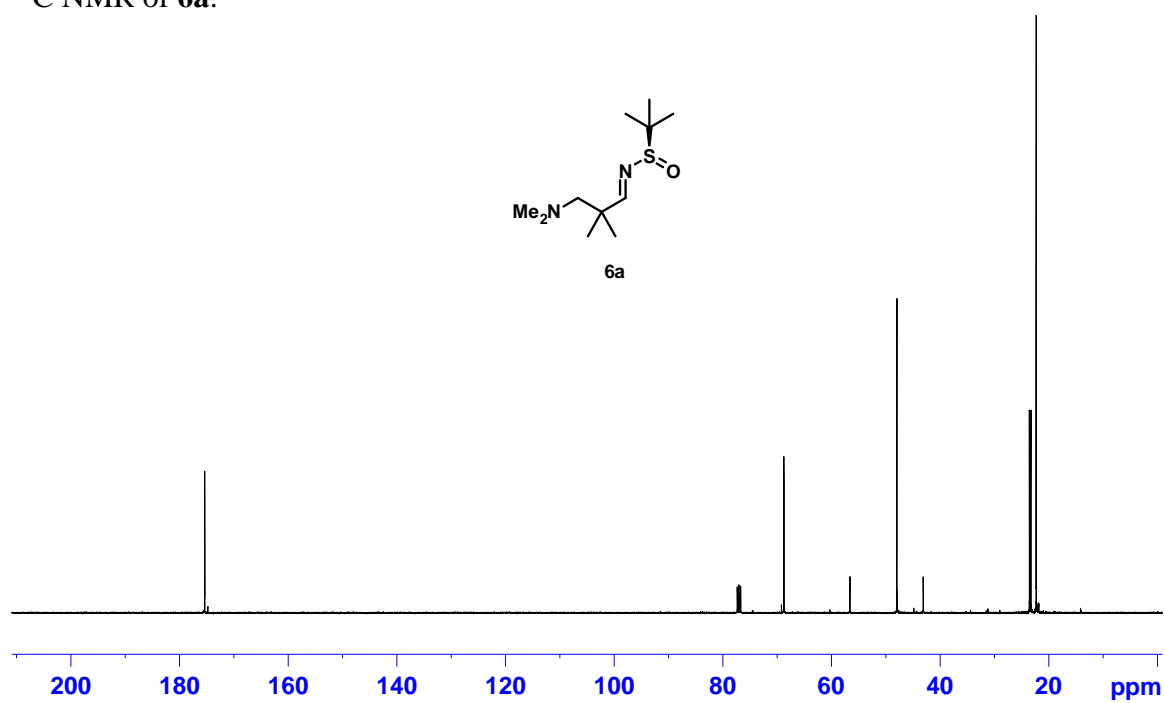
^{13}C NMR of **5b**:



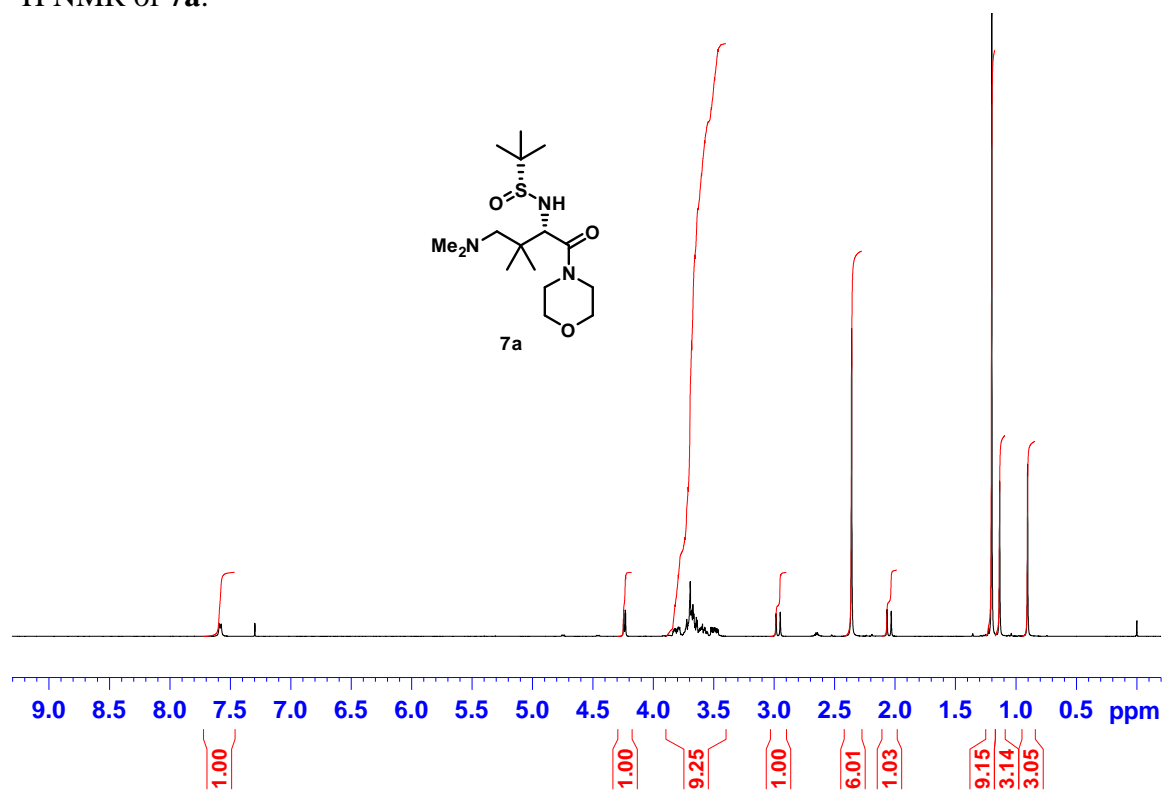
^1H NMR of **6a**:



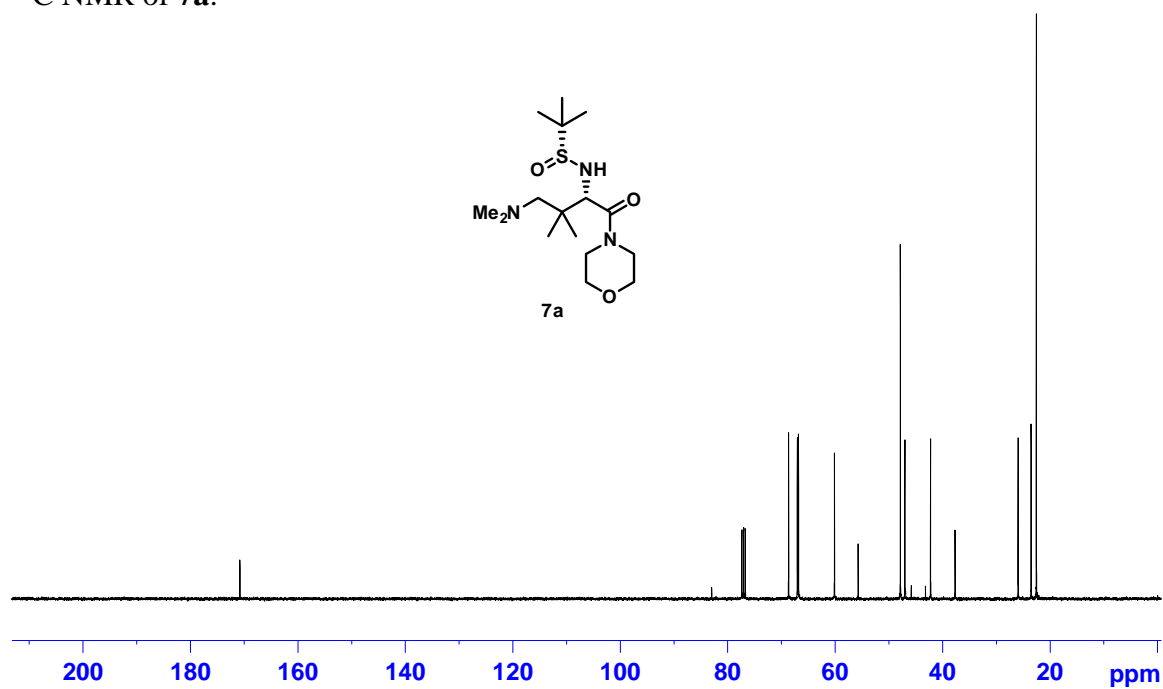
^{13}C NMR of **6a**:



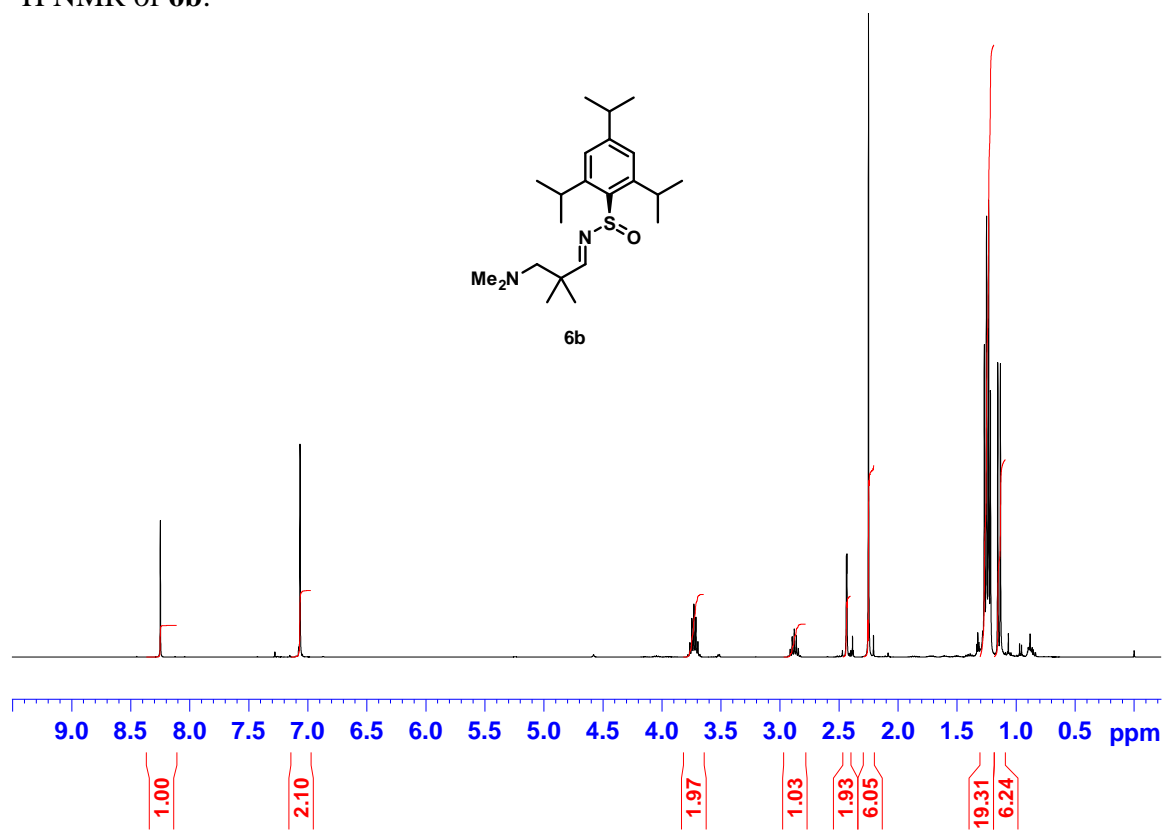
^1H NMR of **7a**:



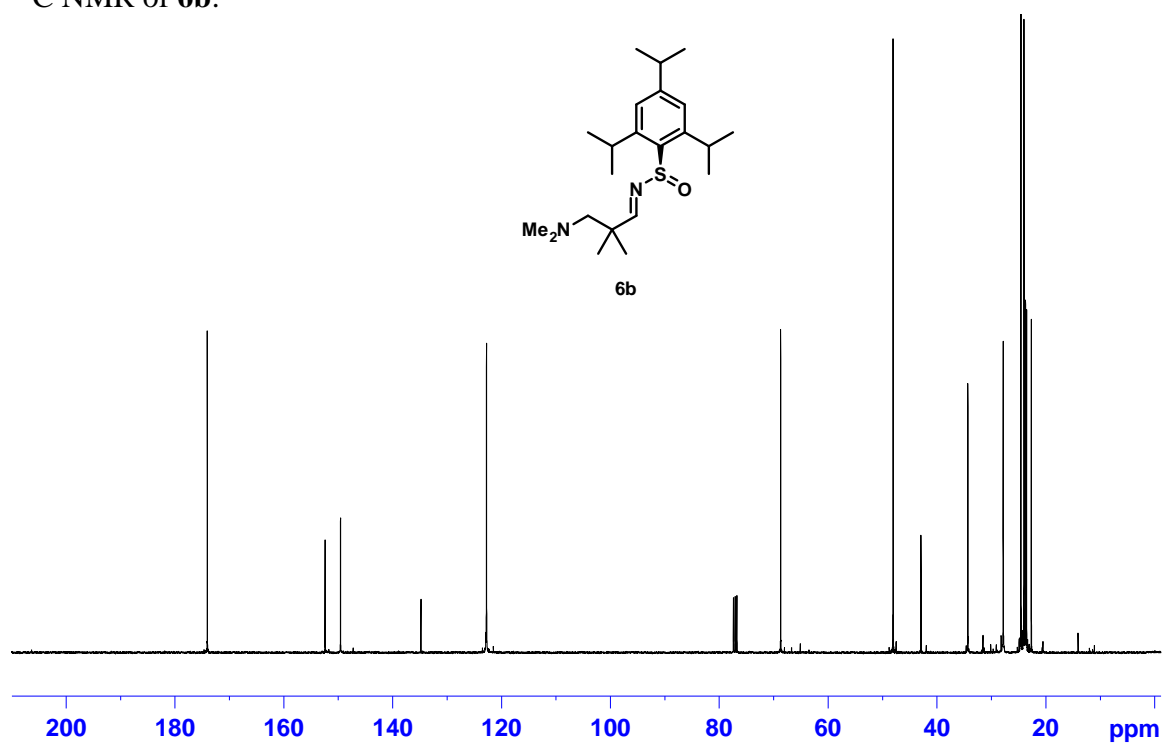
^{13}C NMR of **7a**:



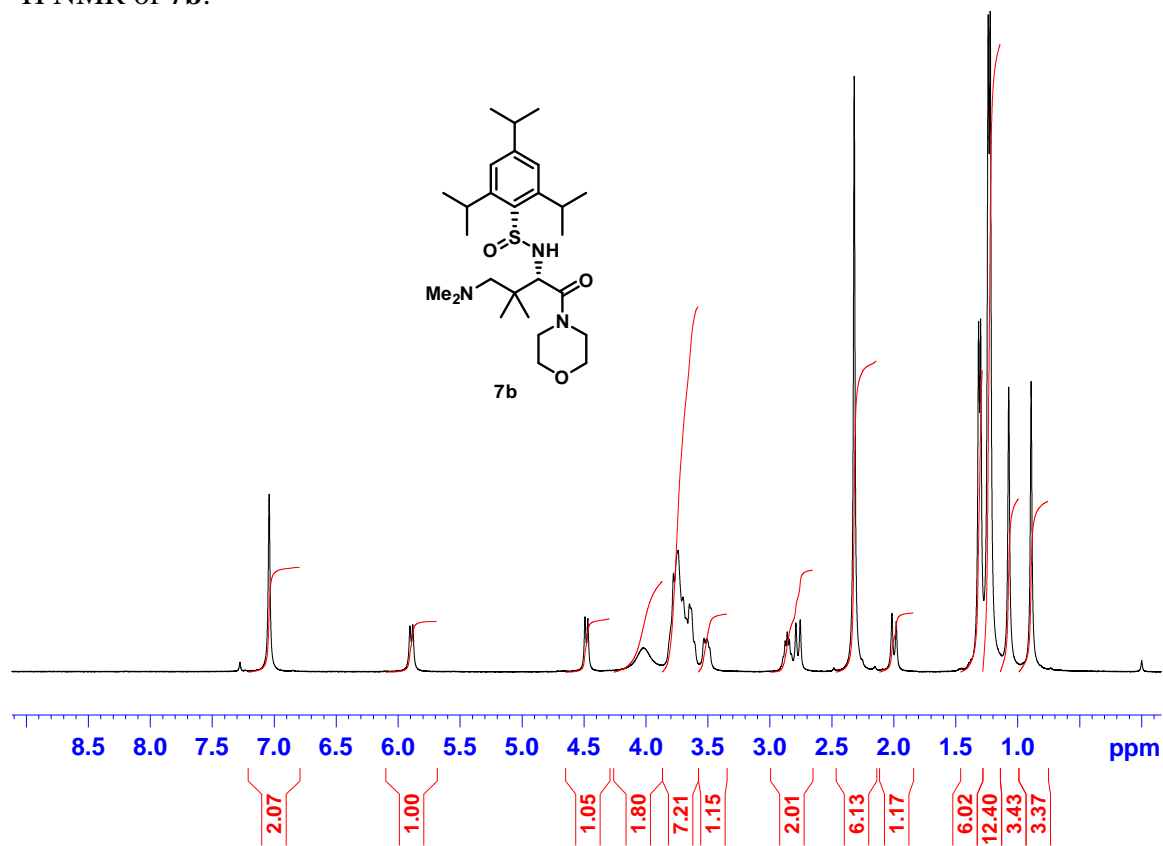
^1H NMR of **6b**:



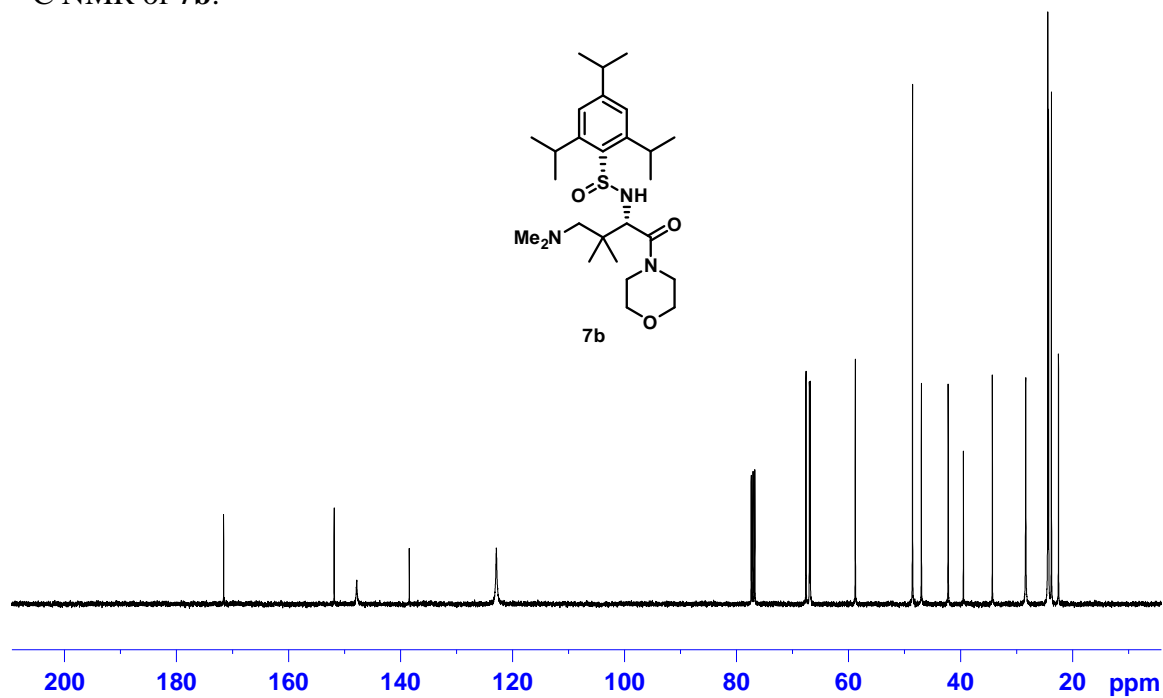
^{13}C NMR of **6b**:



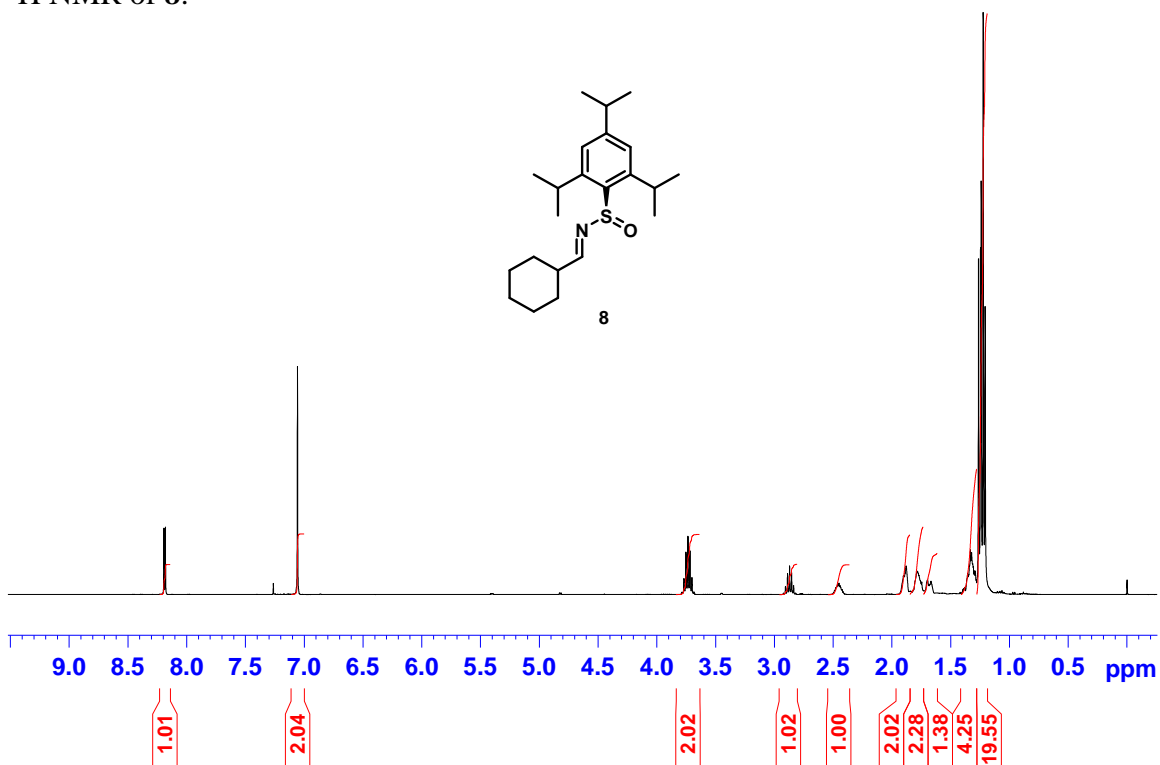
^1H NMR of **7b**:



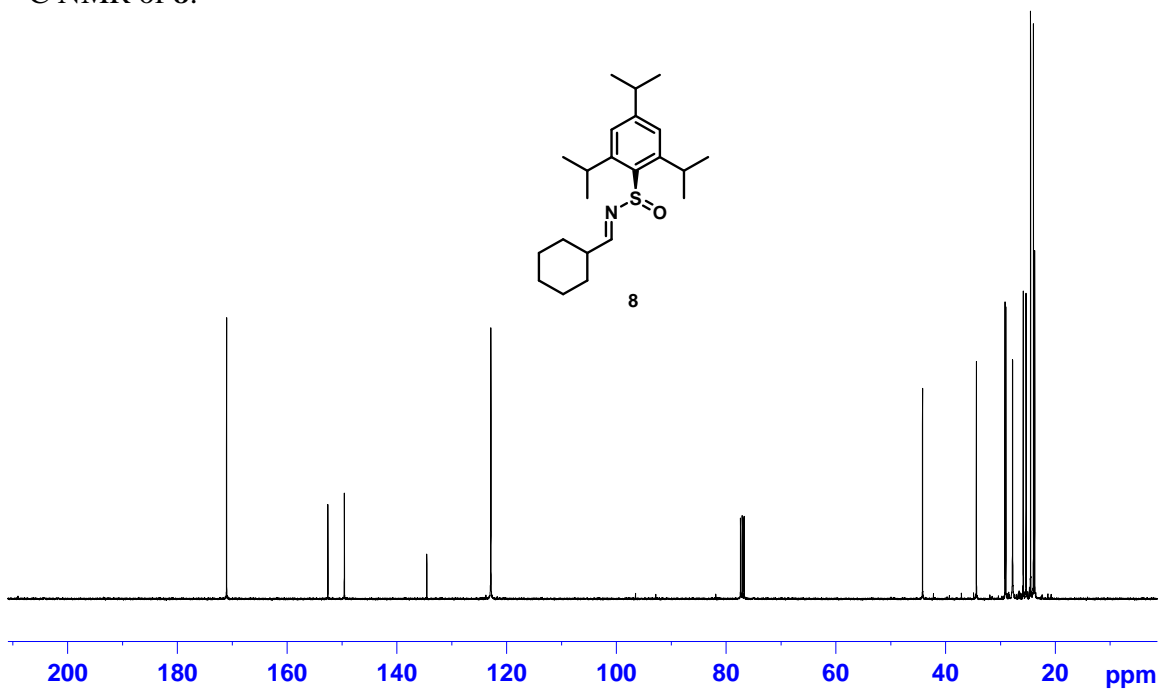
^{13}C NMR of **7b**:

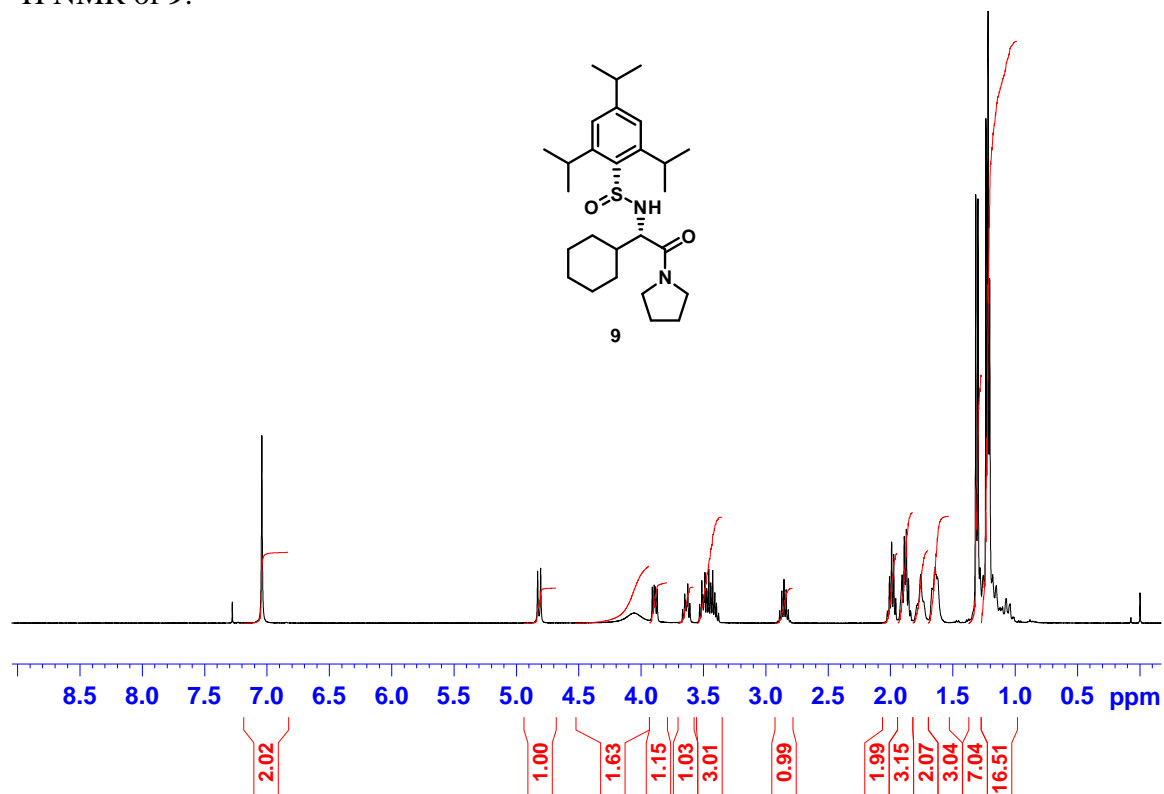
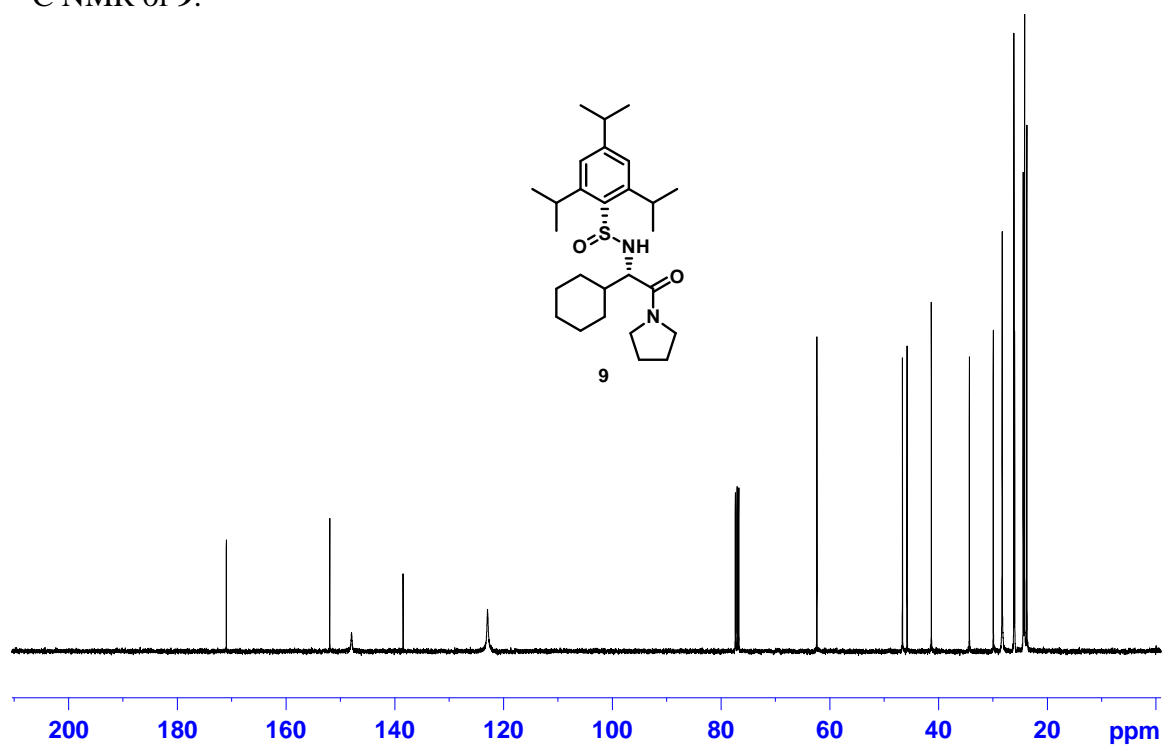


^1H NMR of **8**:

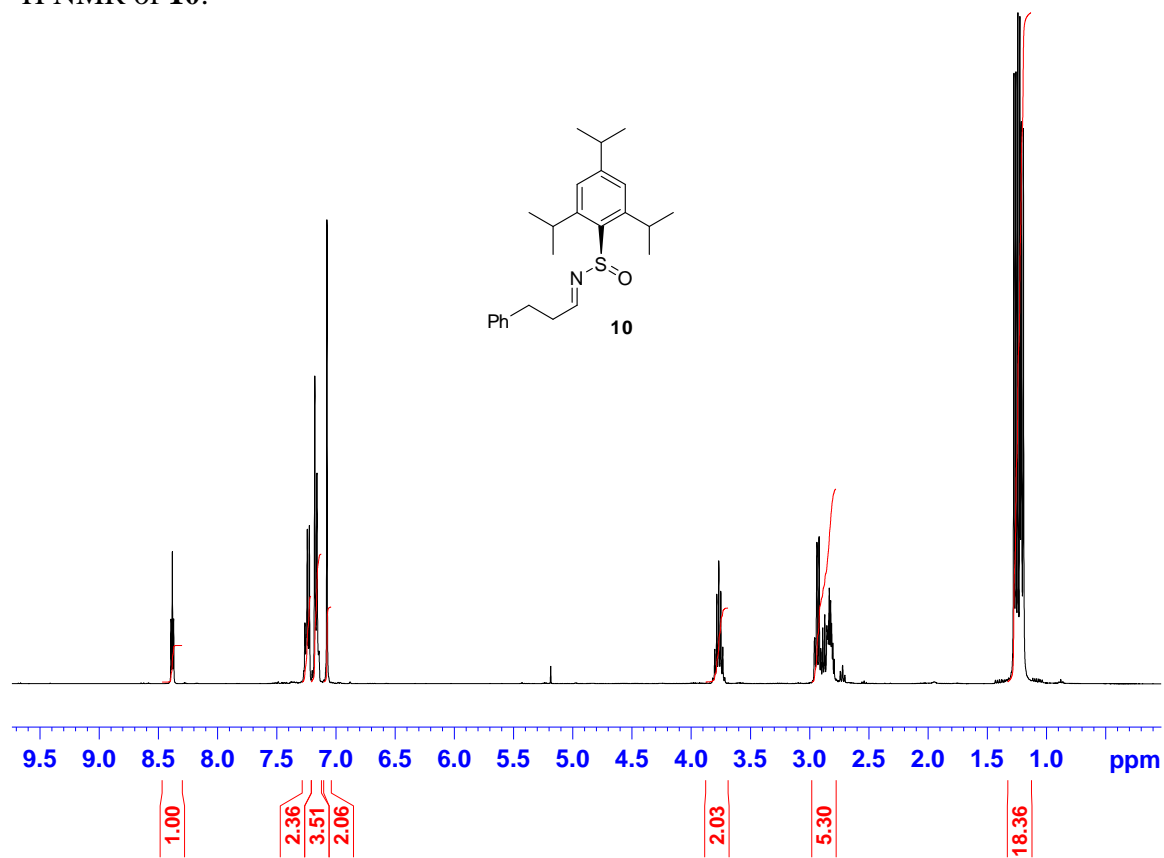


^{13}C NMR of **8**:

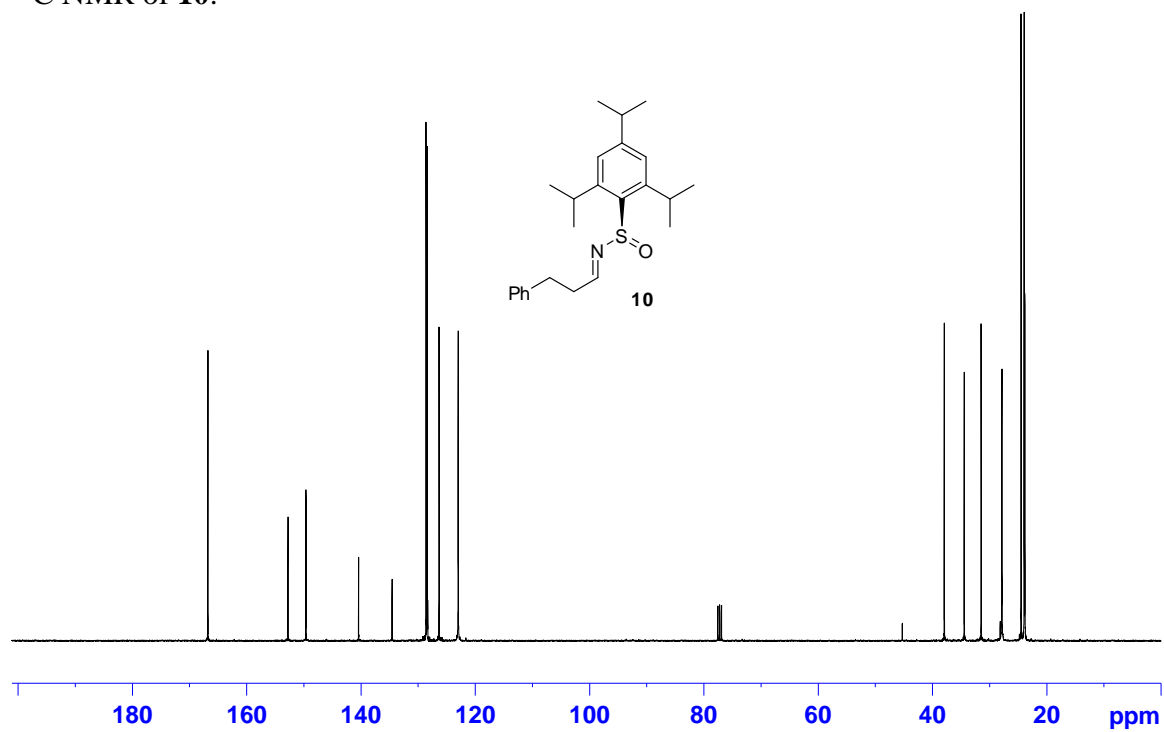


¹H NMR of **9**:¹³C NMR of **9**:

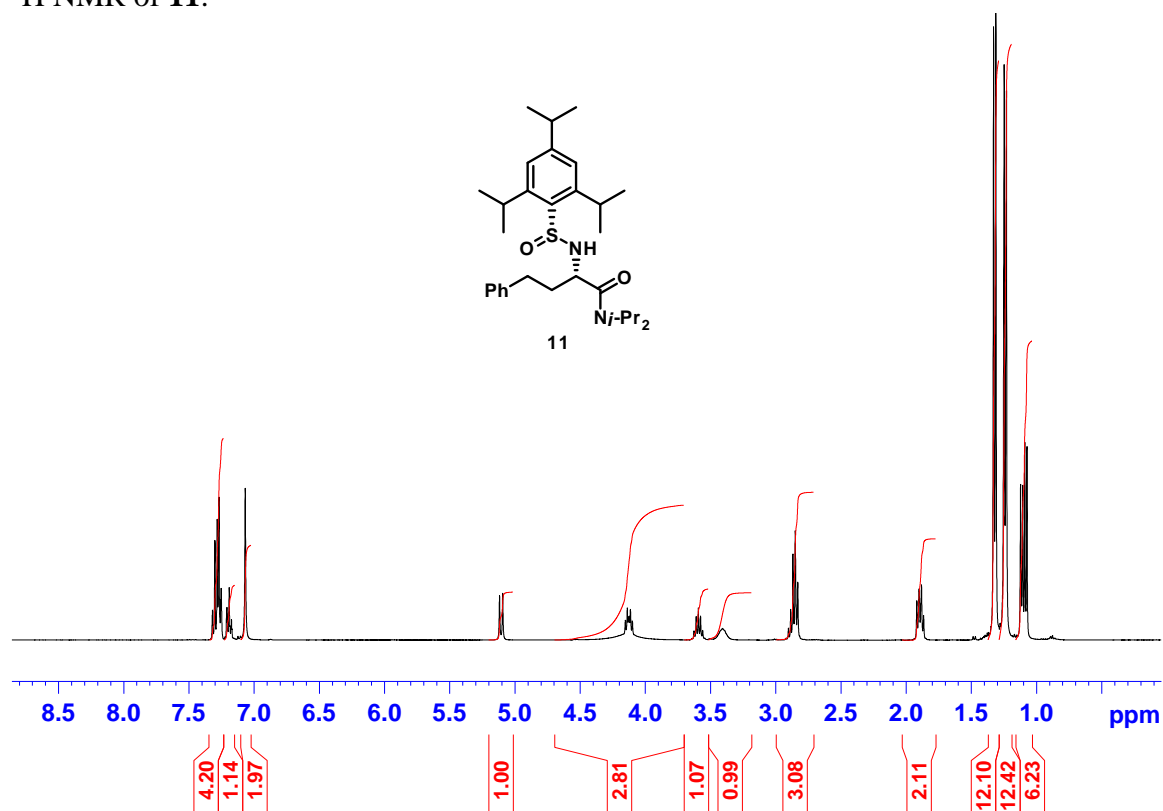
^1H NMR of **10**:



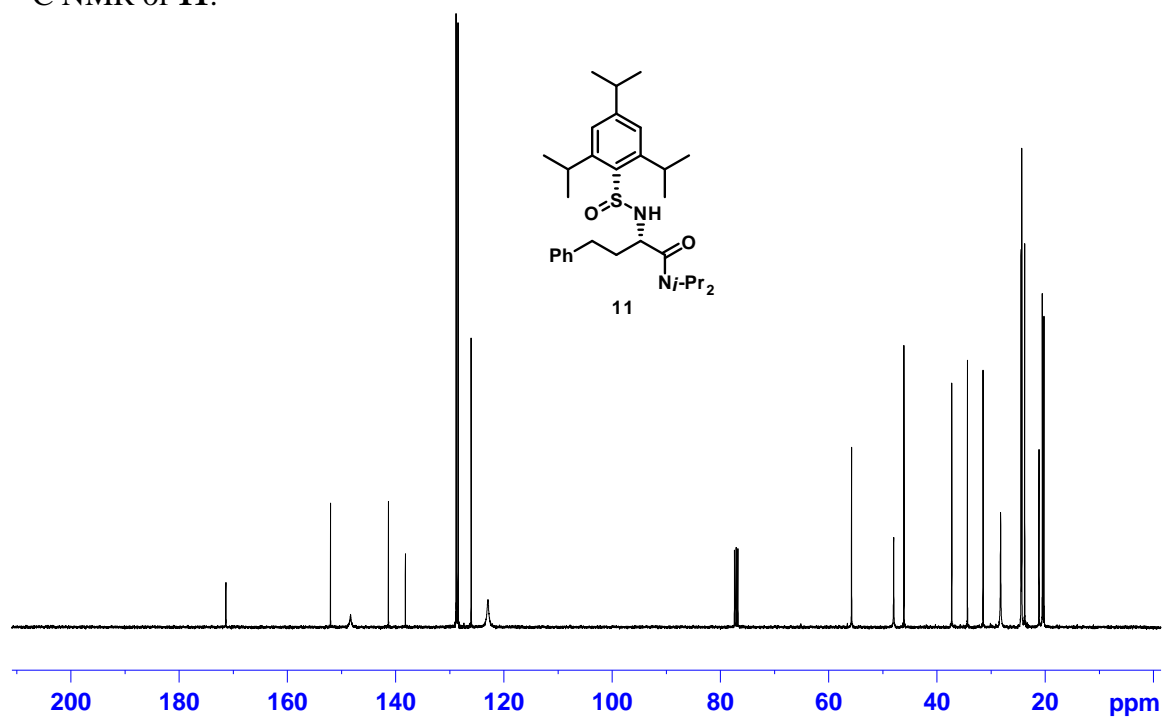
^{13}C NMR of **10**:



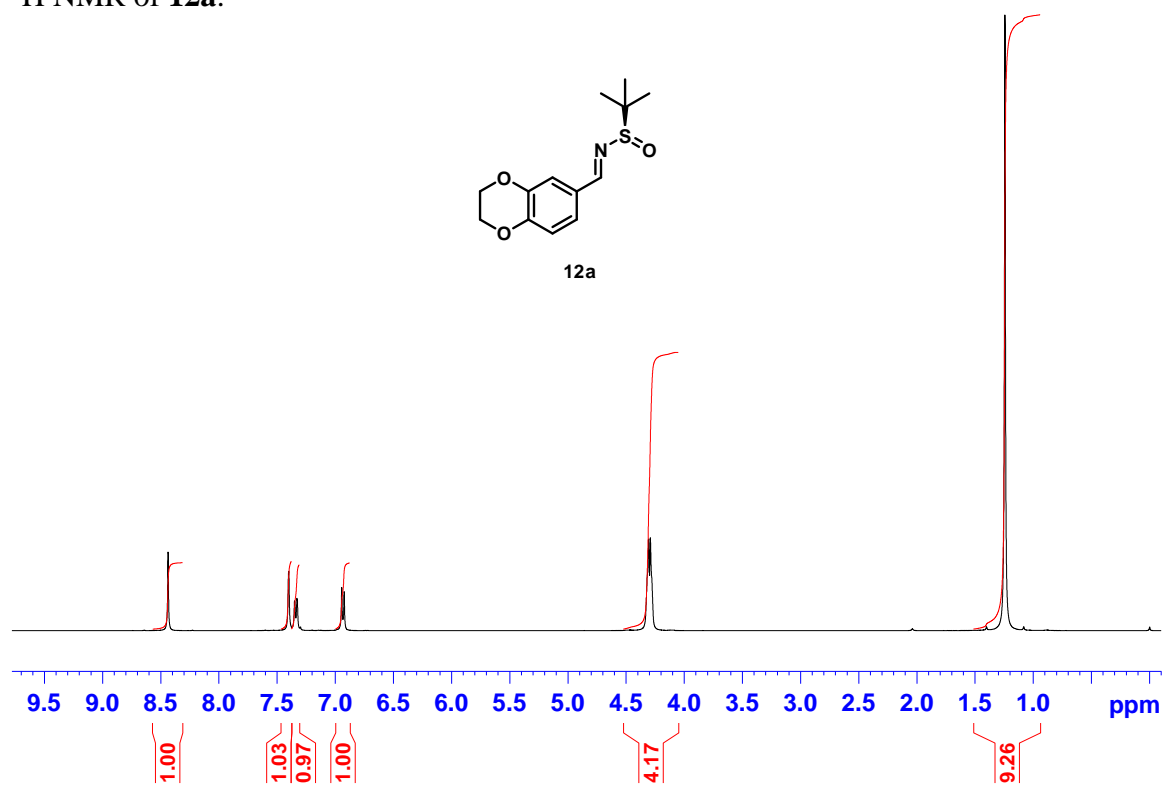
^1H NMR of **11**:



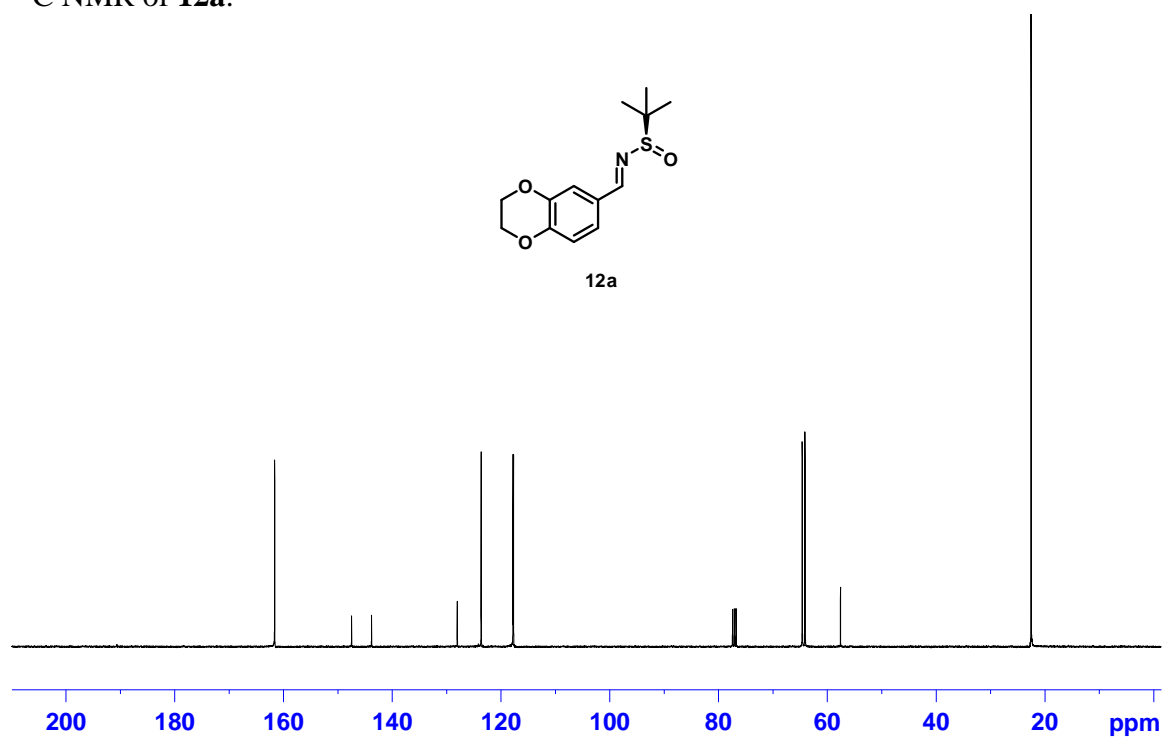
^{13}C NMR of **11**:



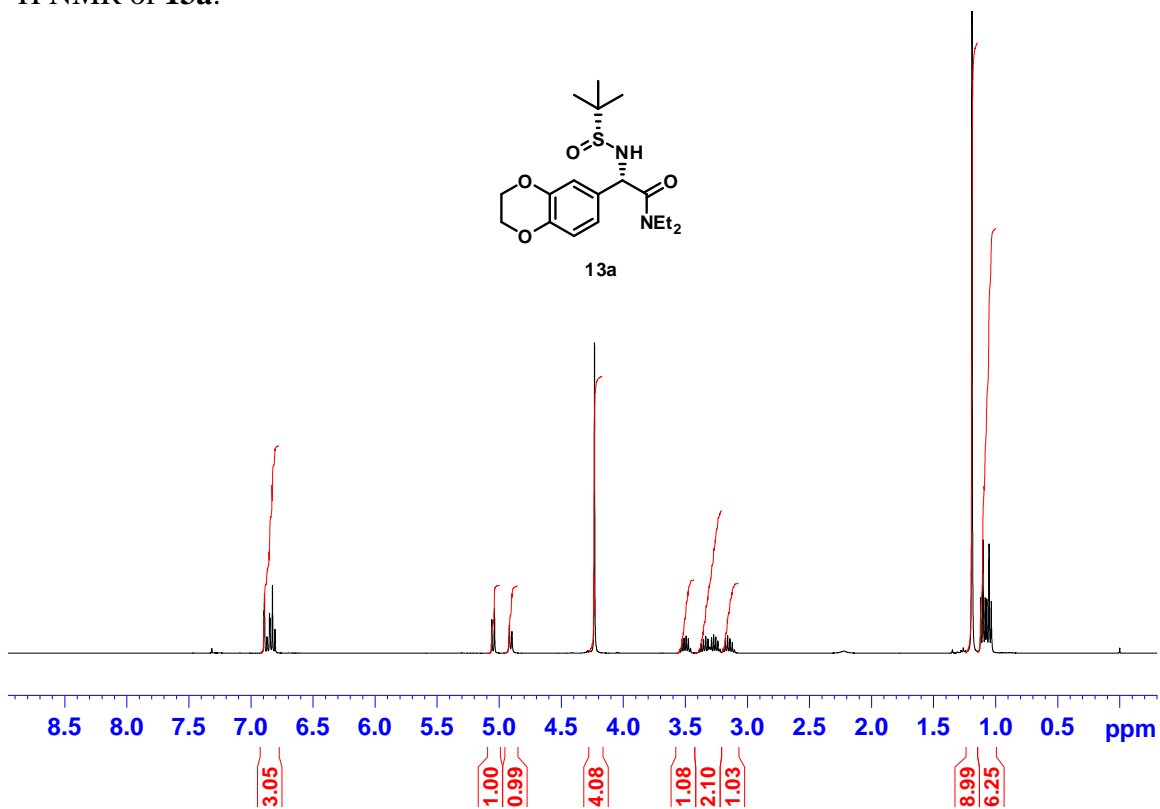
^1H NMR of **12a**:



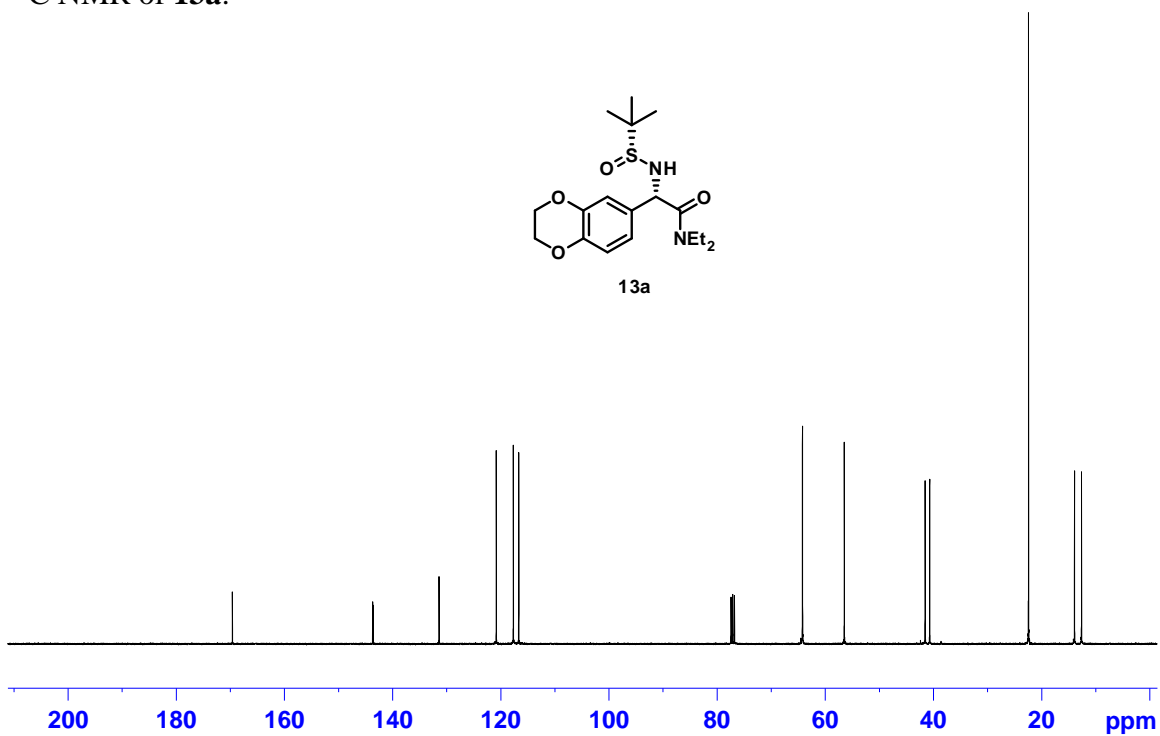
^{13}C NMR of **12a**:



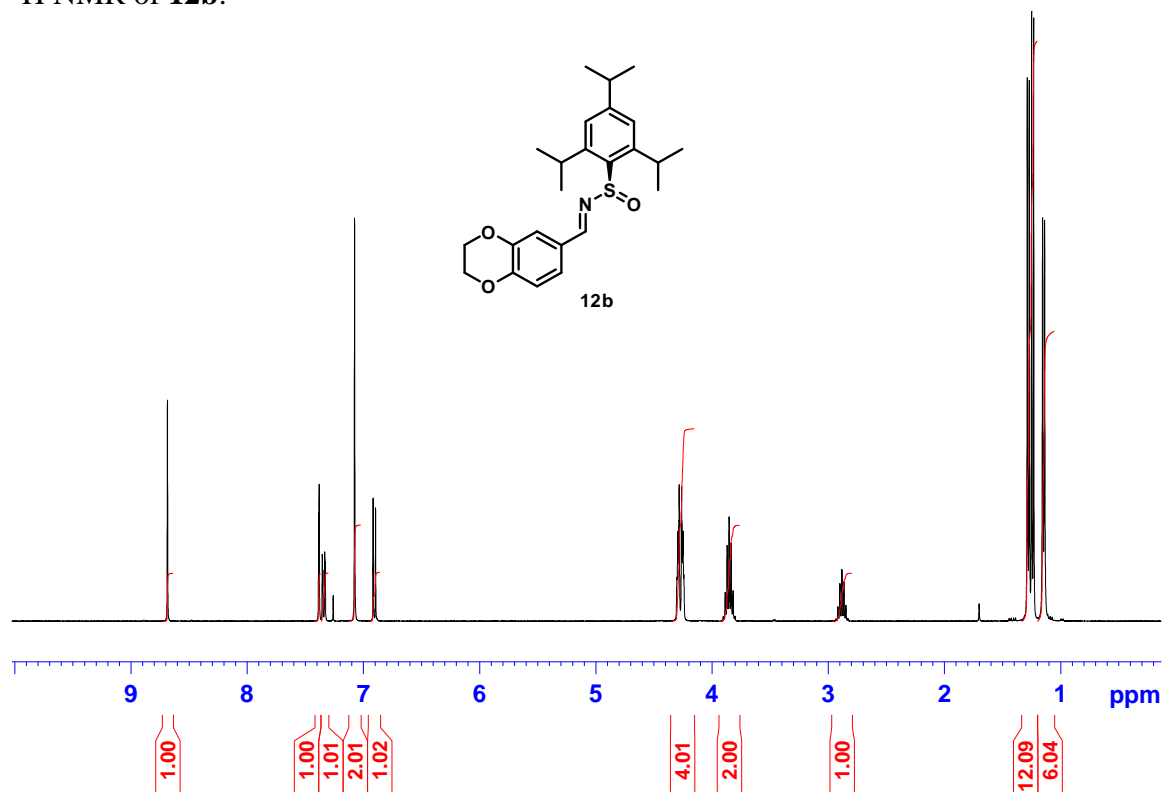
^1H NMR of **13a**:



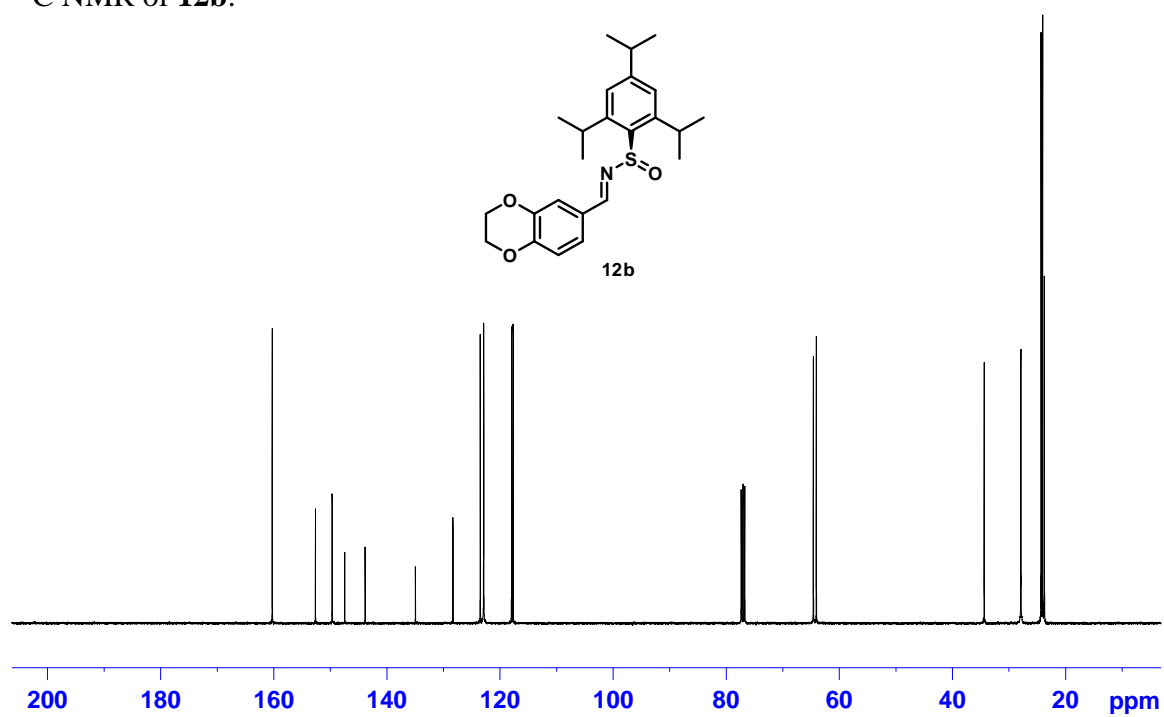
^{13}C NMR of **13a**:



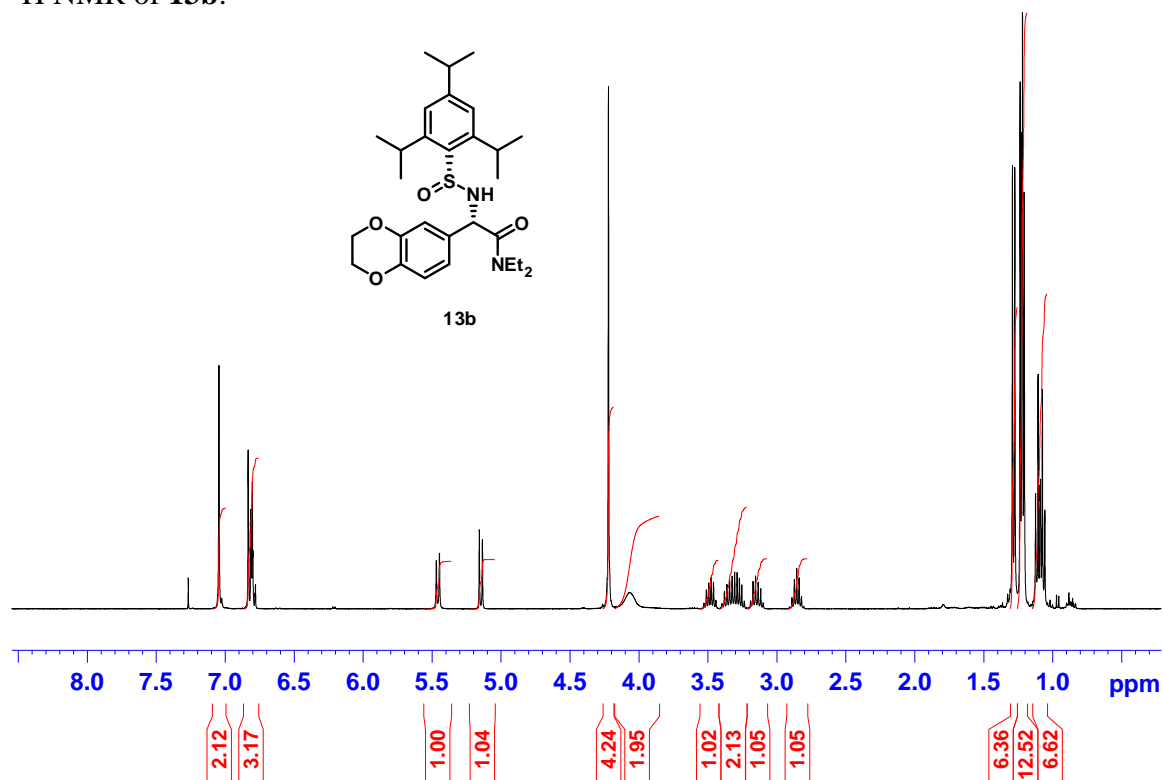
^1H NMR of **12b**:



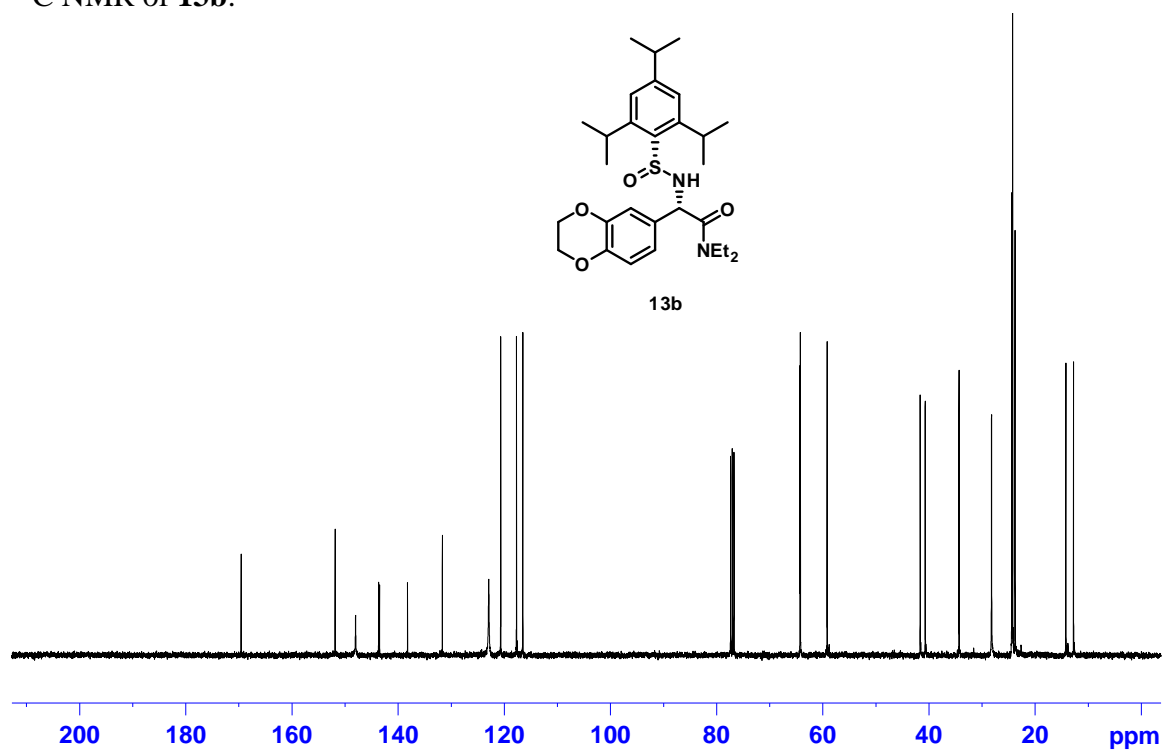
^{13}C NMR of **12b**:



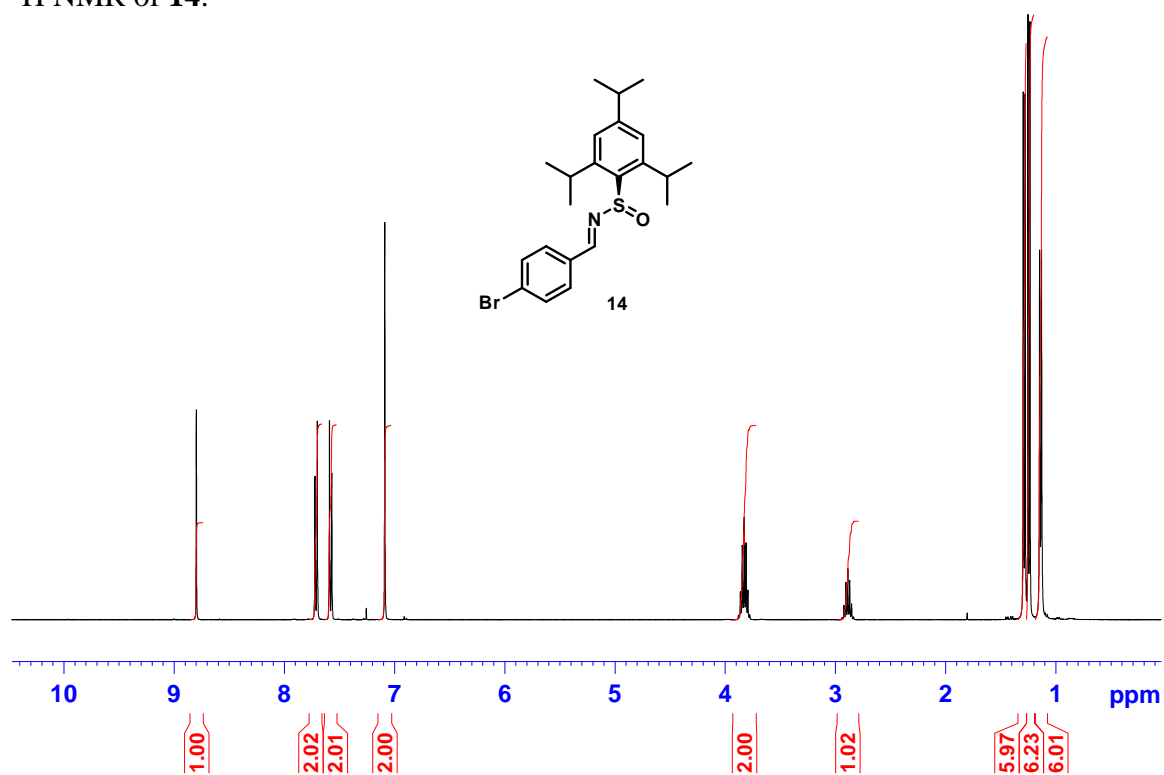
^1H NMR of **13b**:



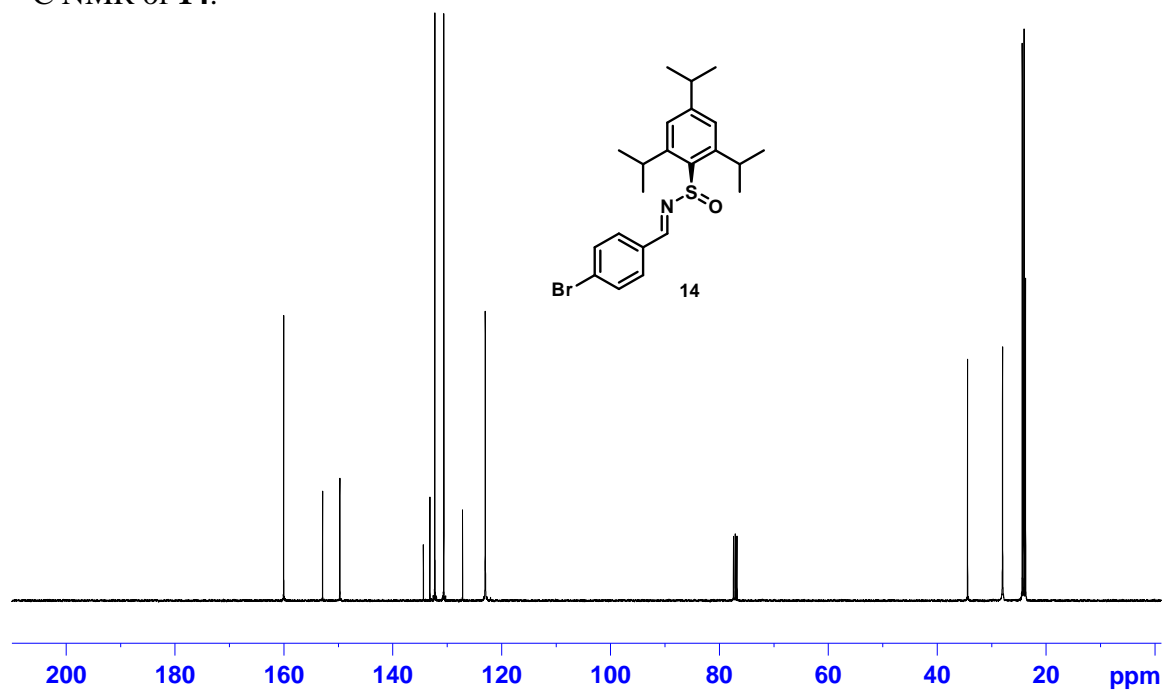
^{13}C NMR of **13b**:



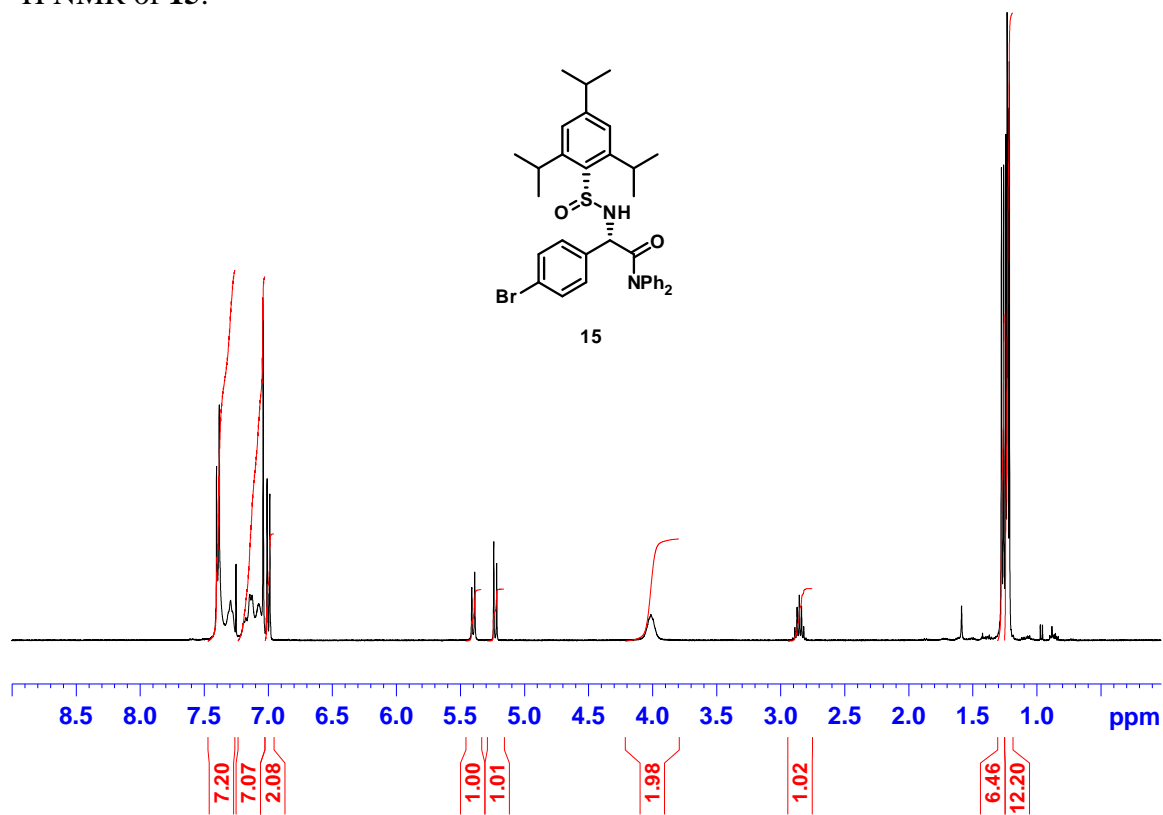
^1H NMR of **14**:



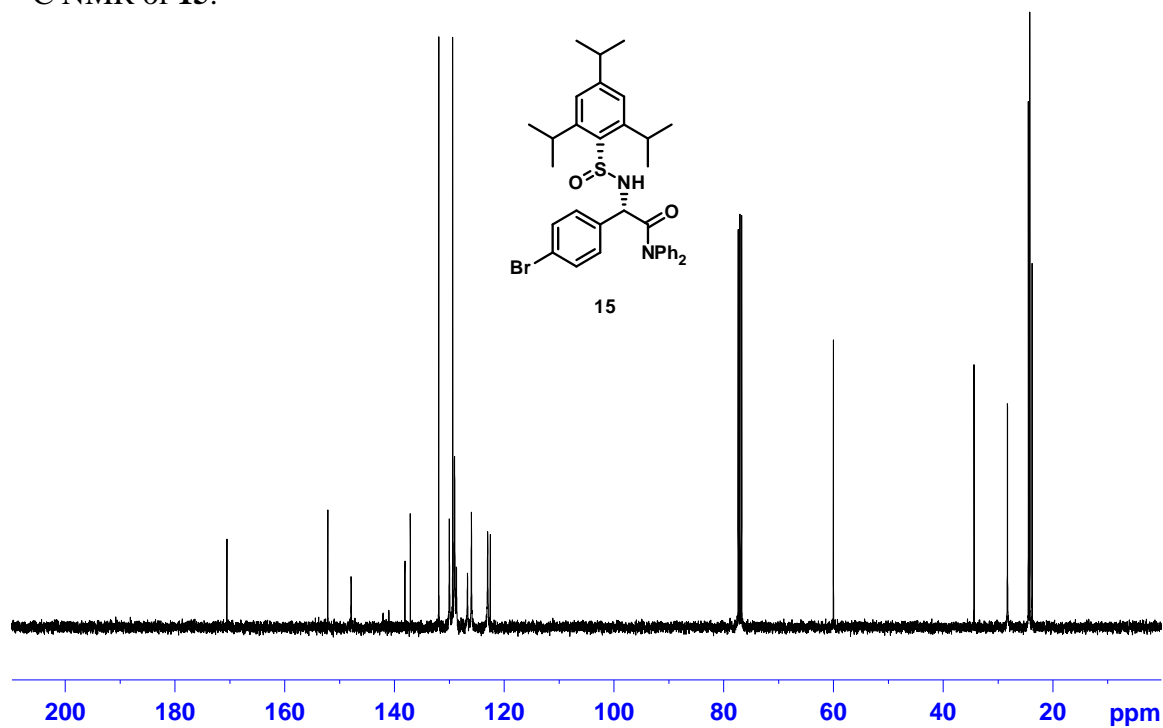
^{13}C NMR of **14**:



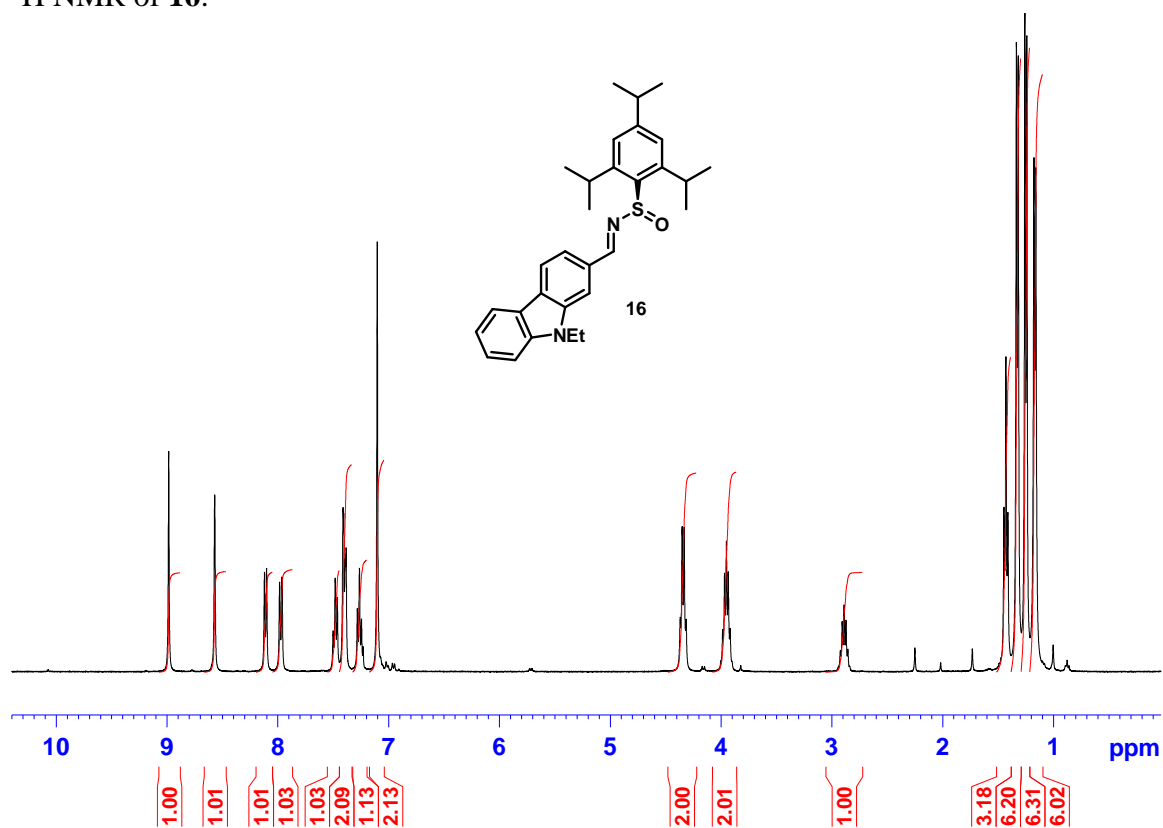
^1H NMR of **15**:



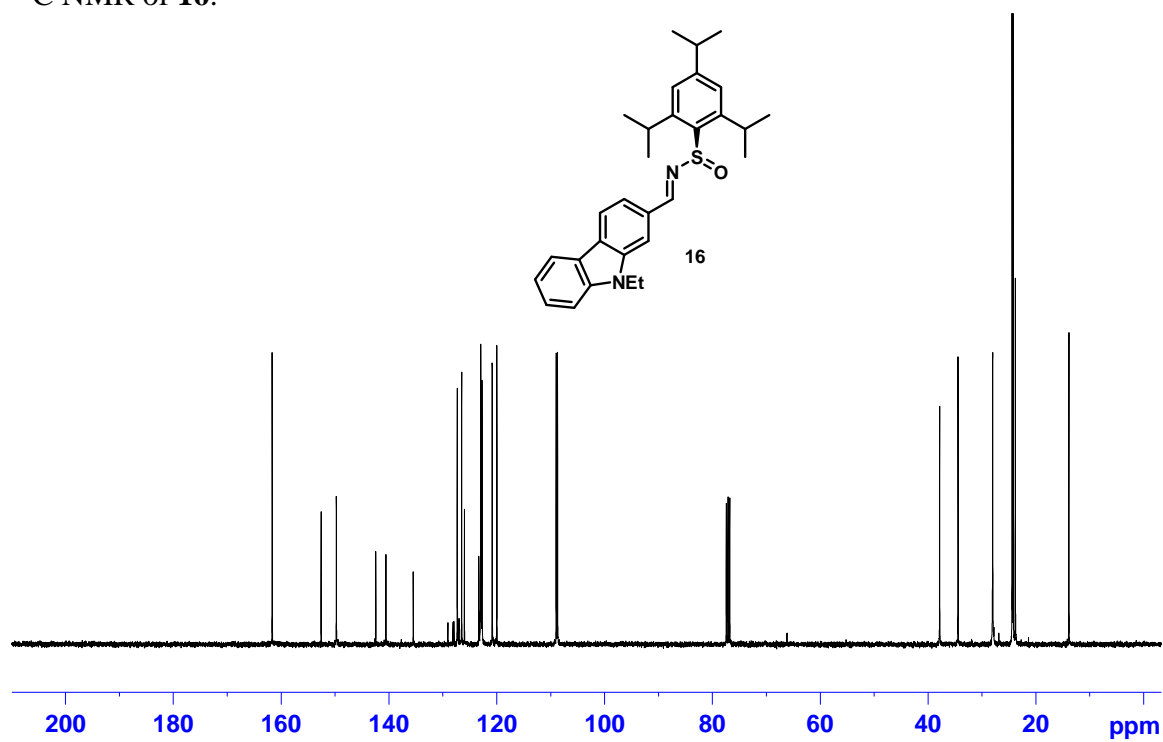
^{13}C NMR of **15**:



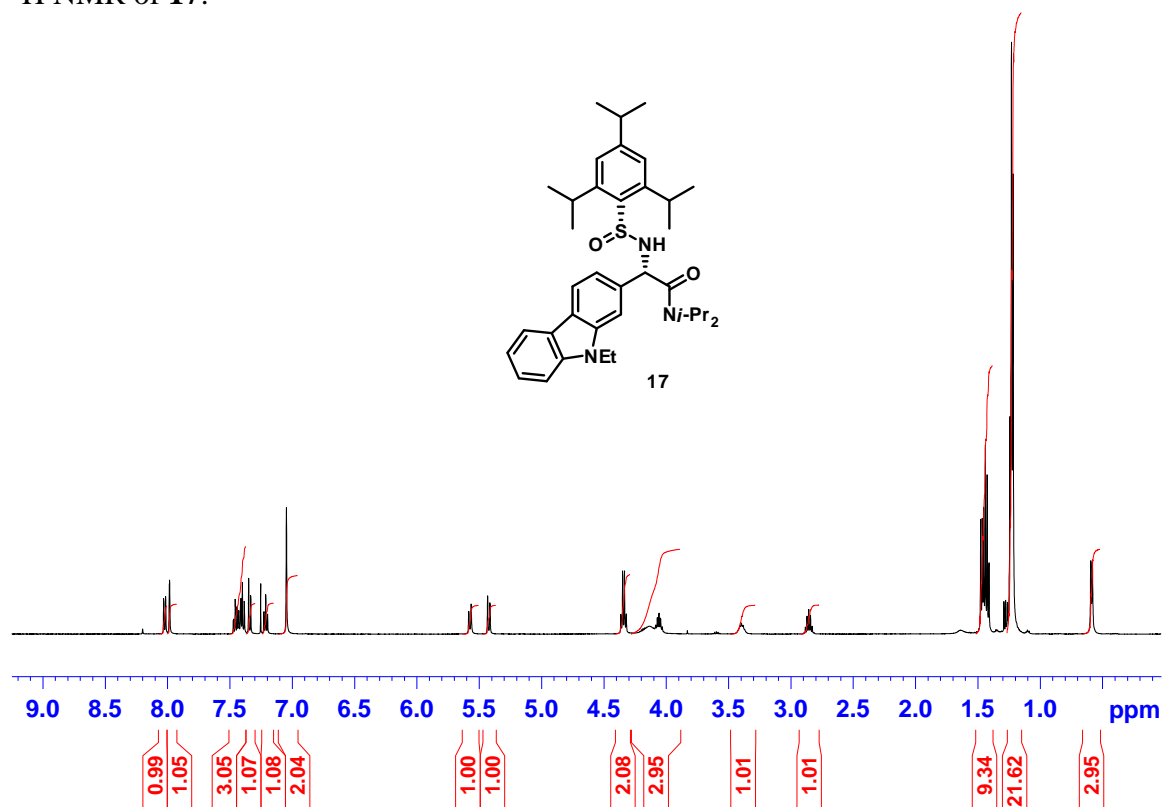
^1H NMR of **16**:



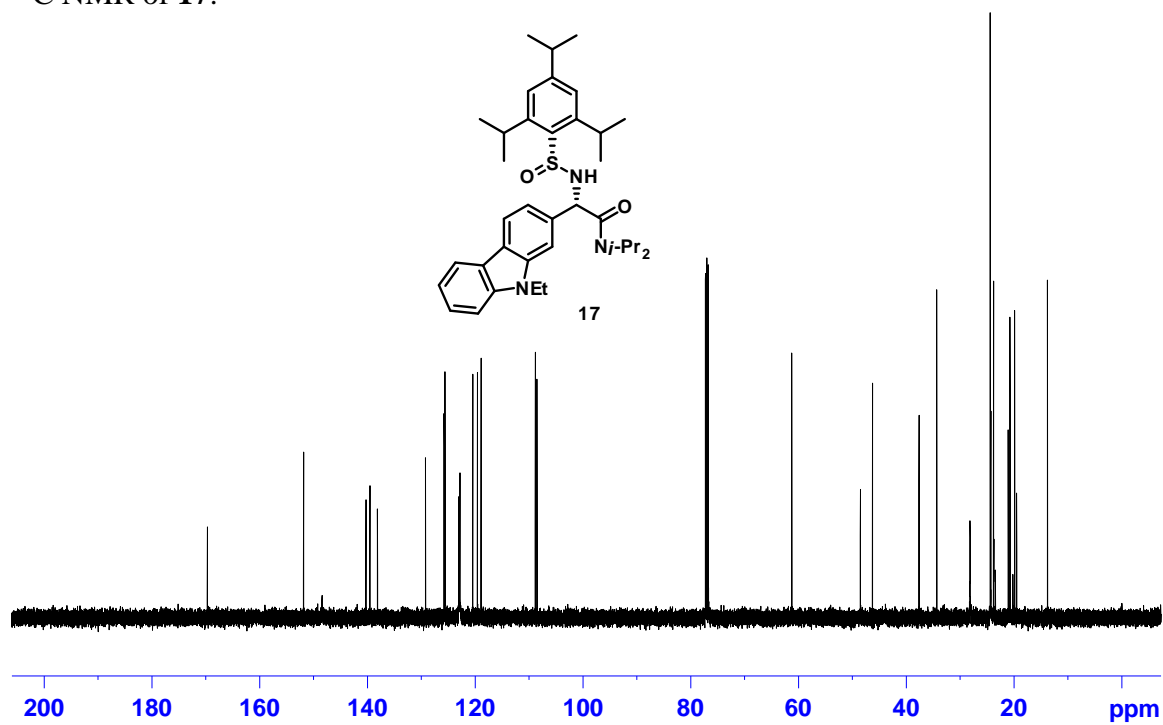
^{13}C NMR of **16**:



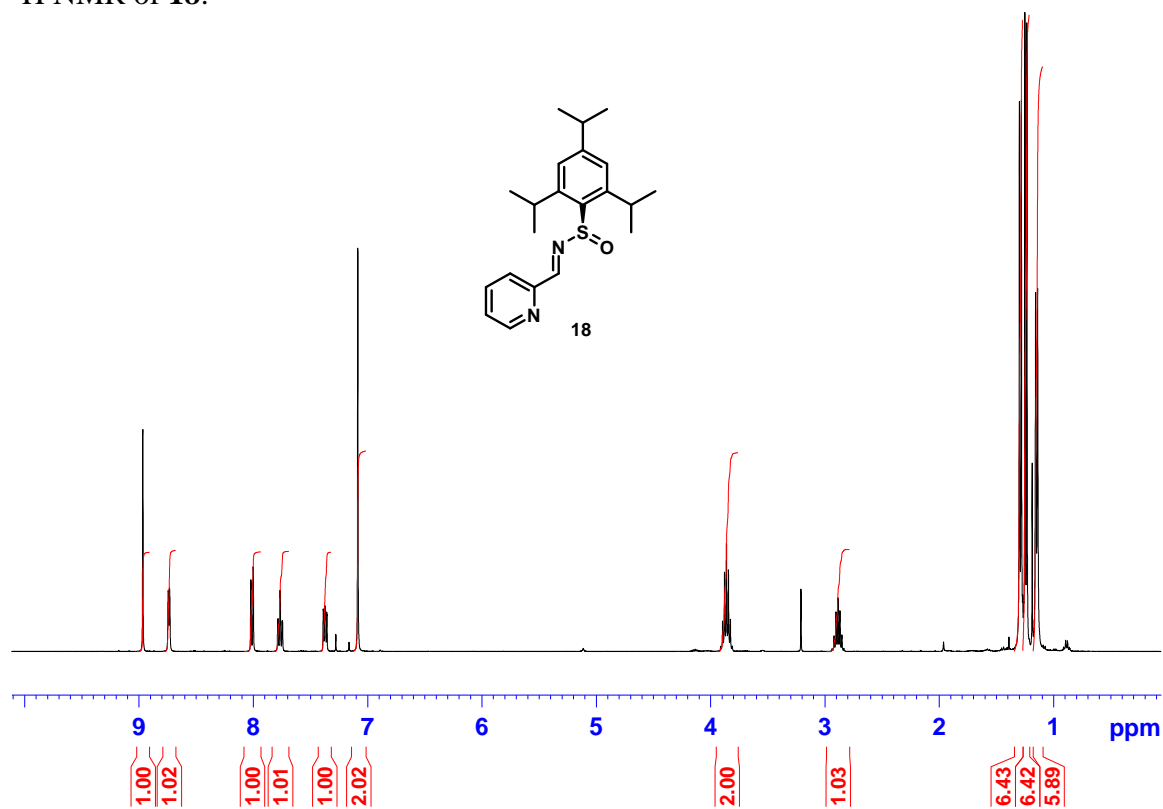
^1H NMR of **17**:



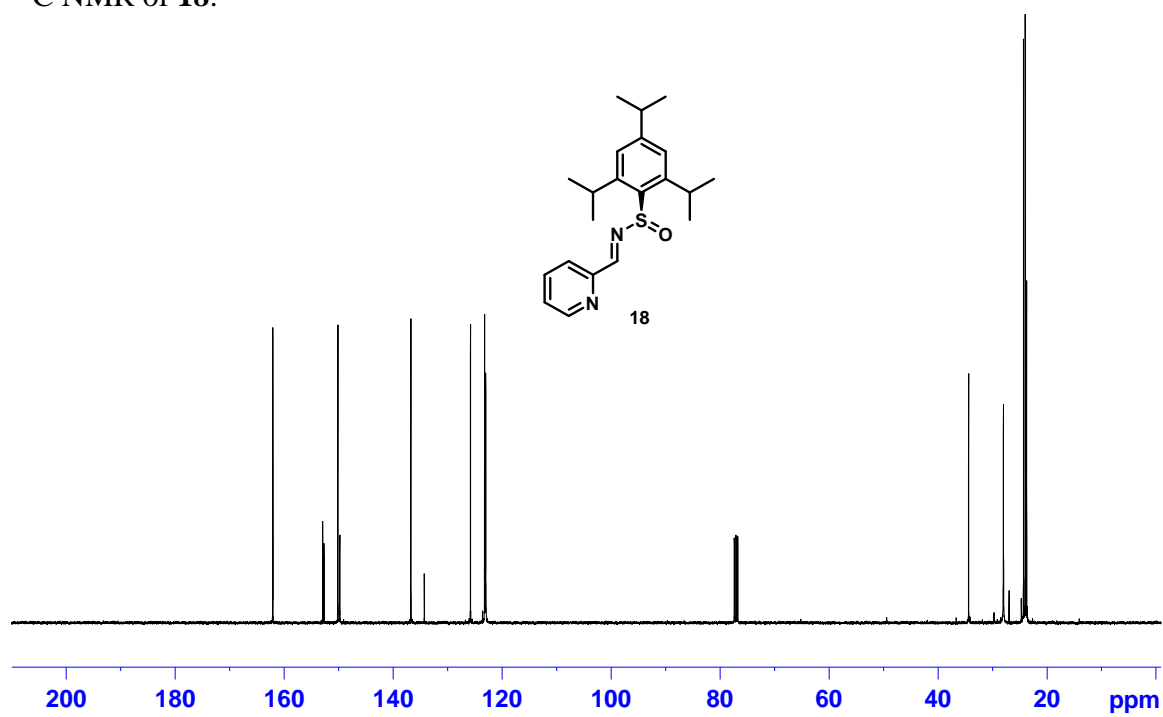
^{13}C NMR of **17**:



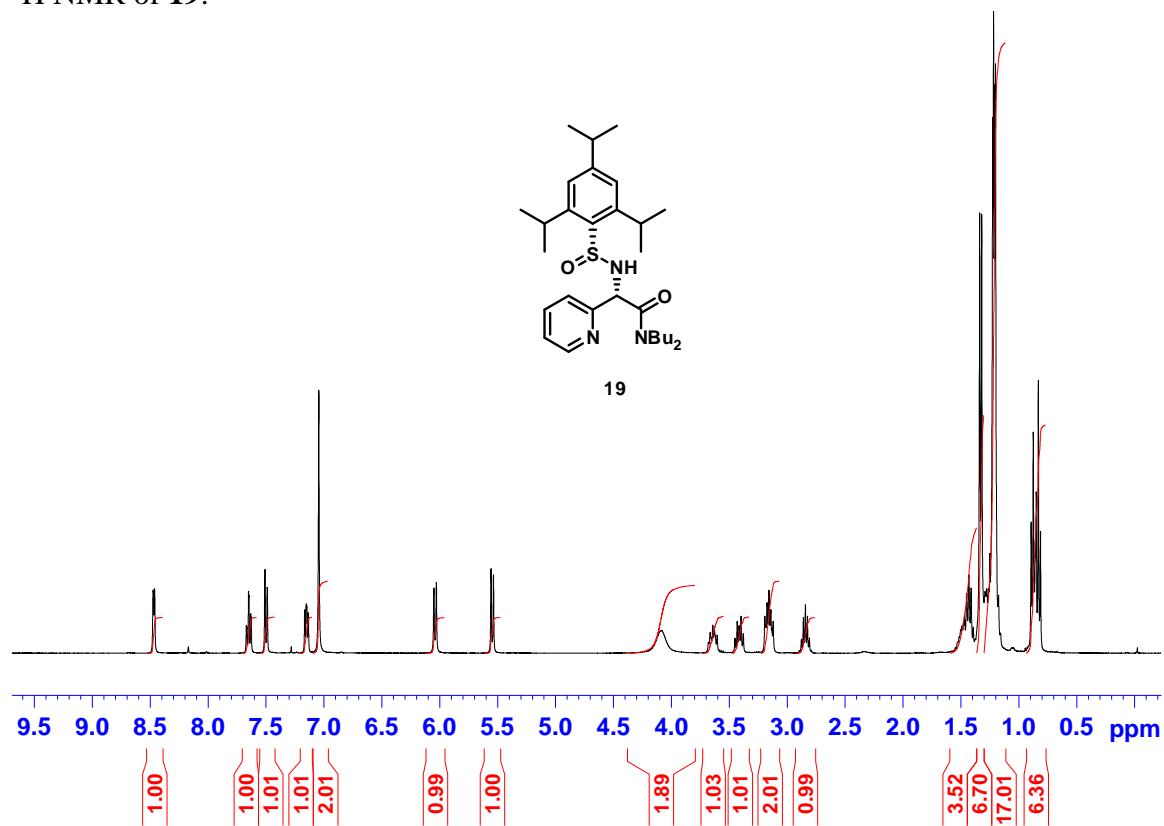
^1H NMR of **18**:



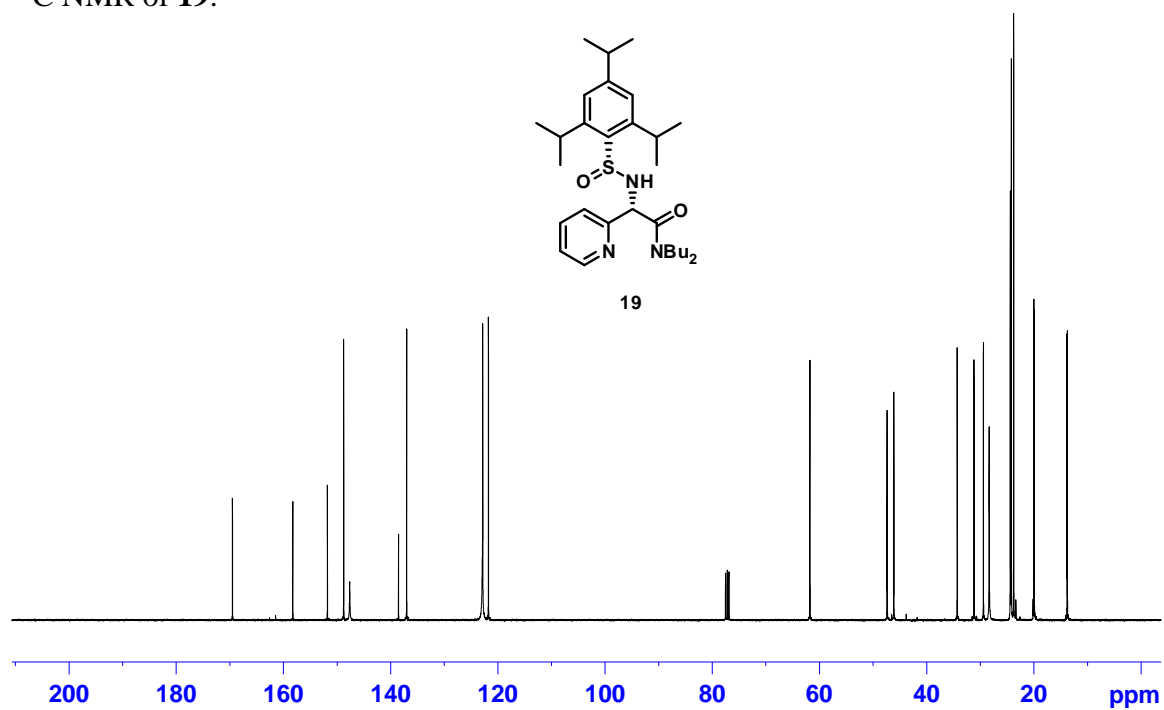
^{13}C NMR of **18**:

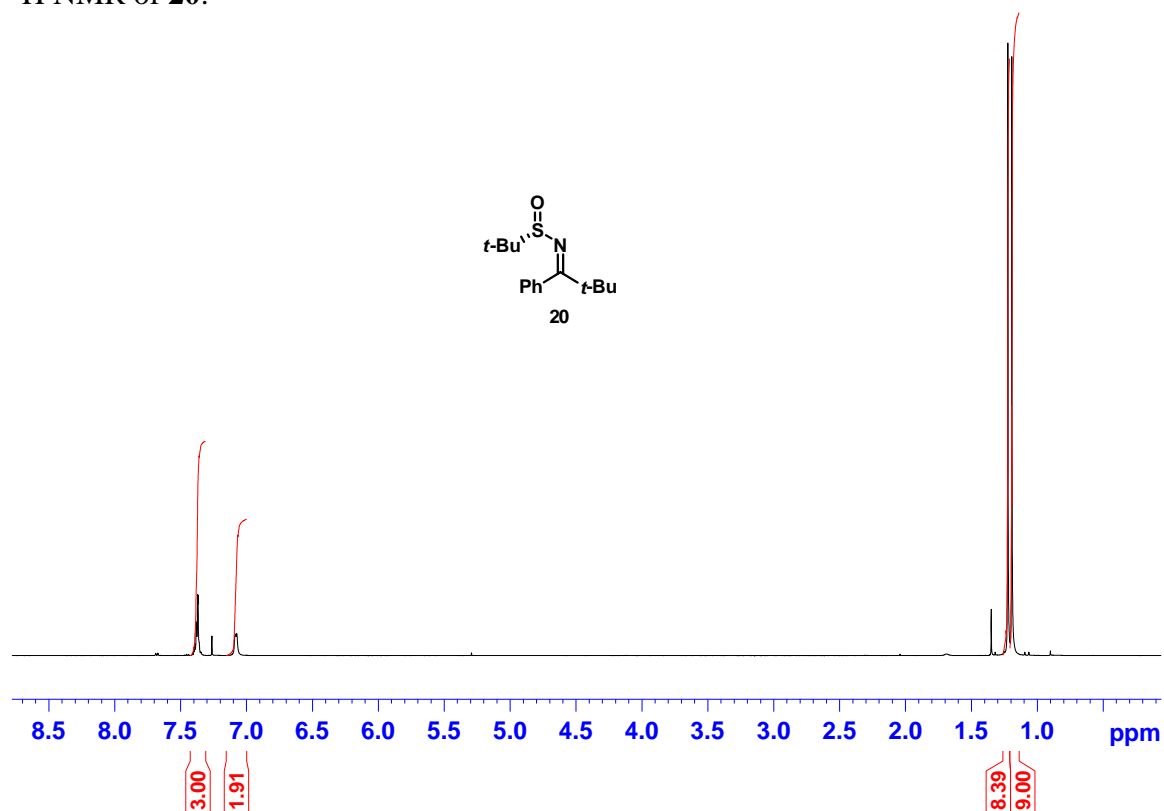
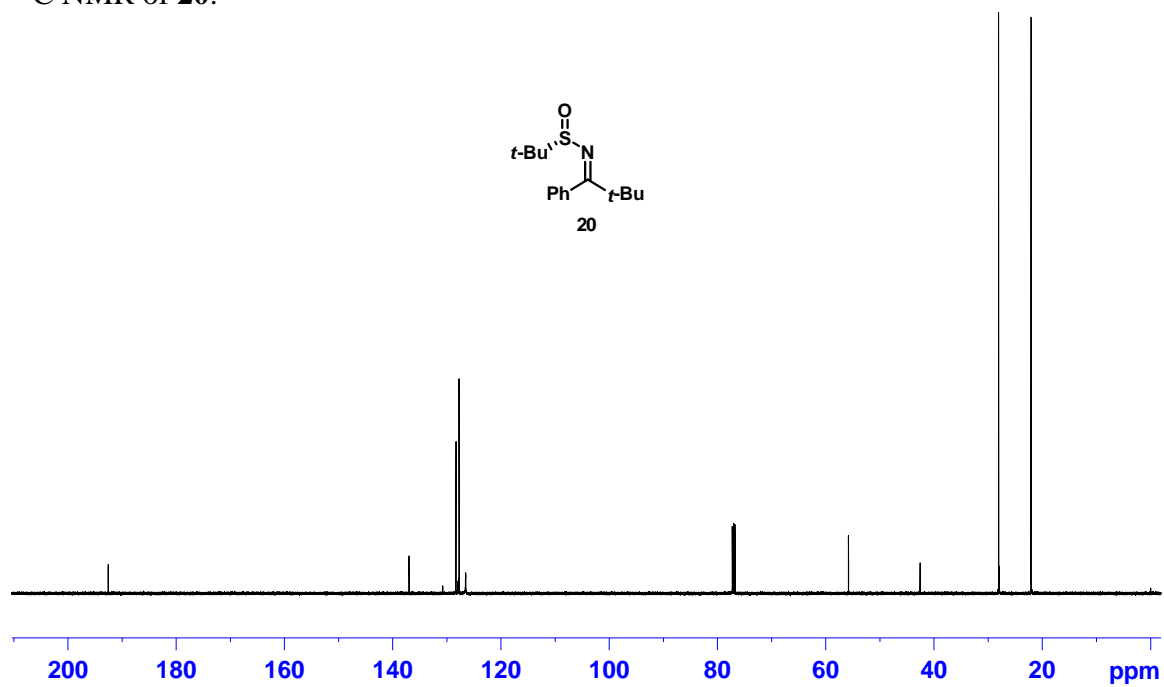


^1H NMR of **19**:

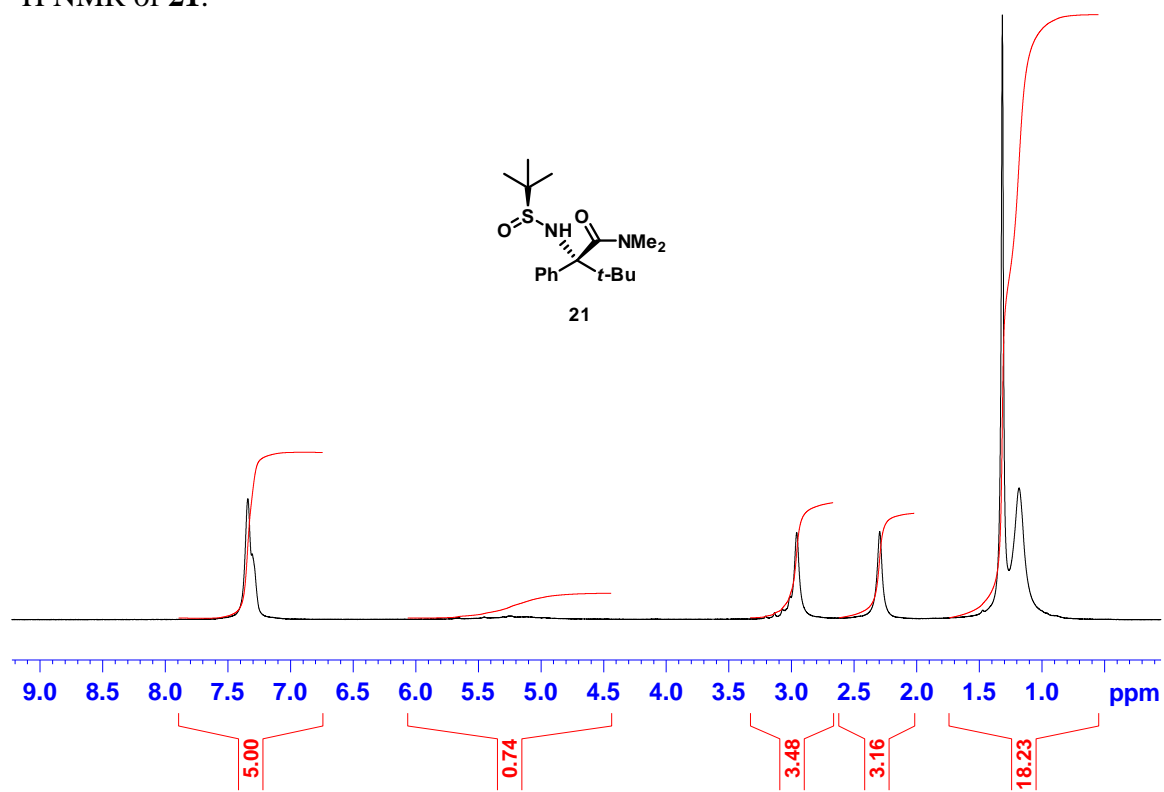


^{13}C NMR of **19**:

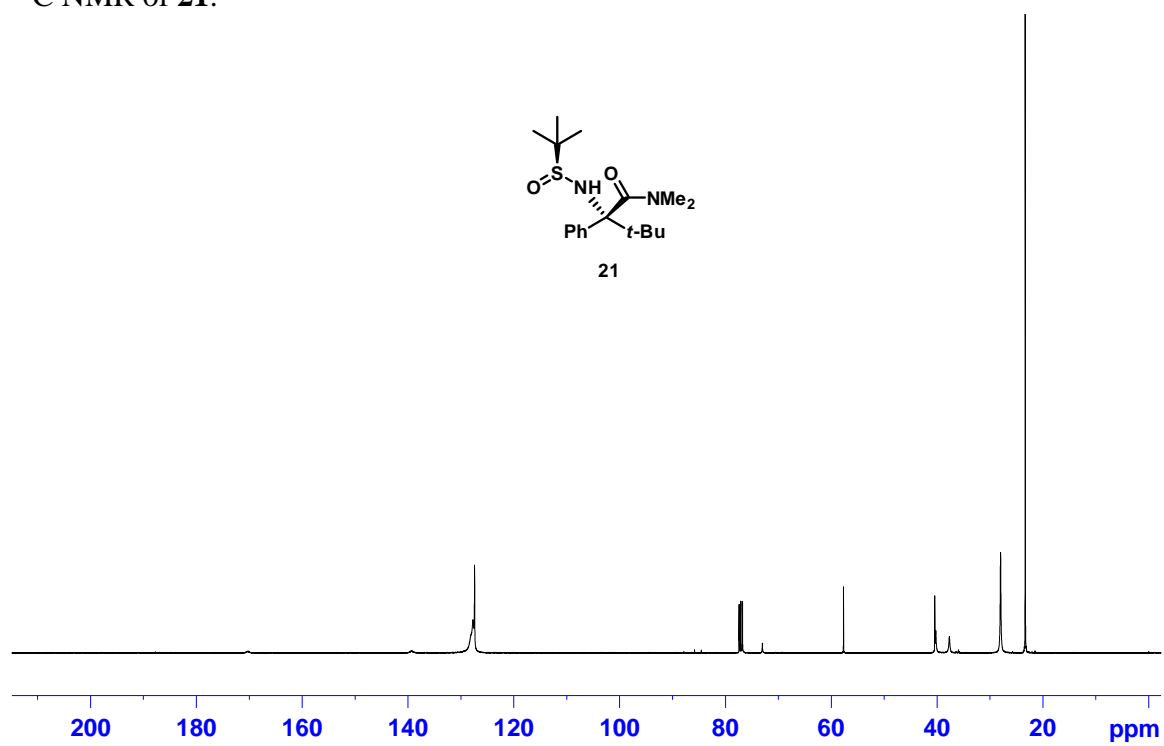


¹H NMR of **20**:¹³C NMR of **20**:

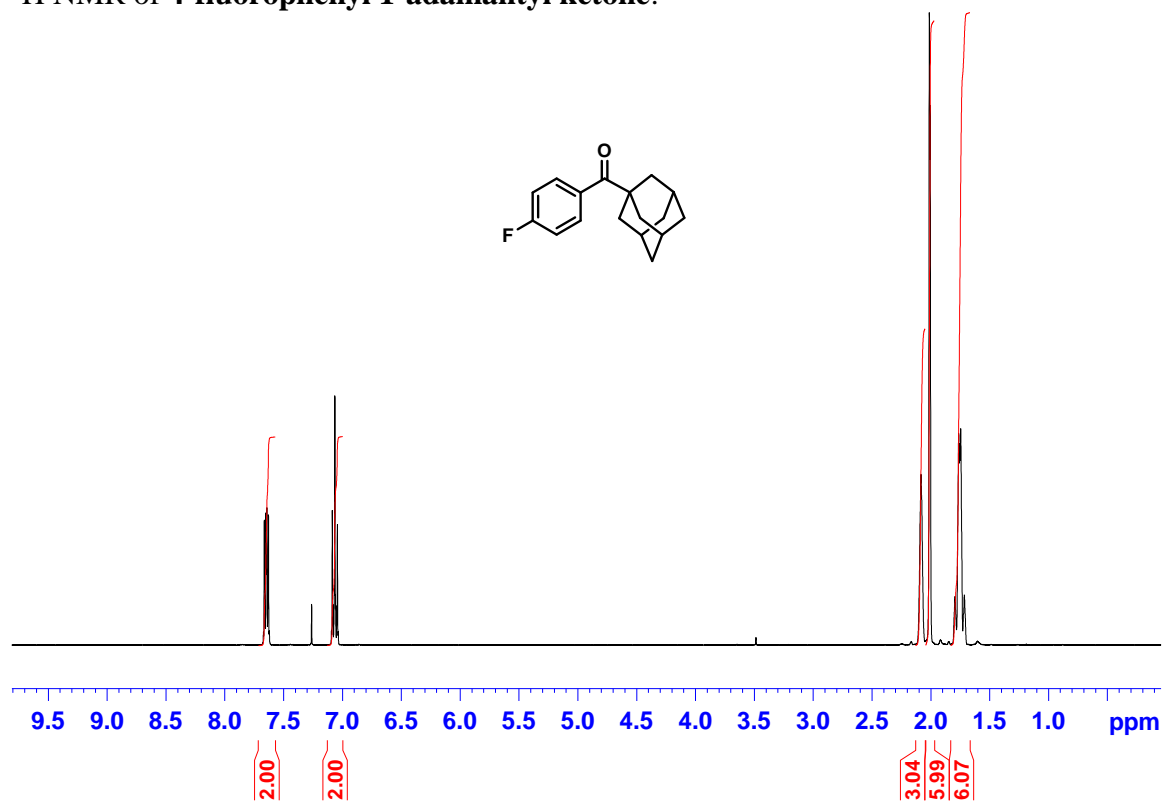
^1H NMR of **21**:



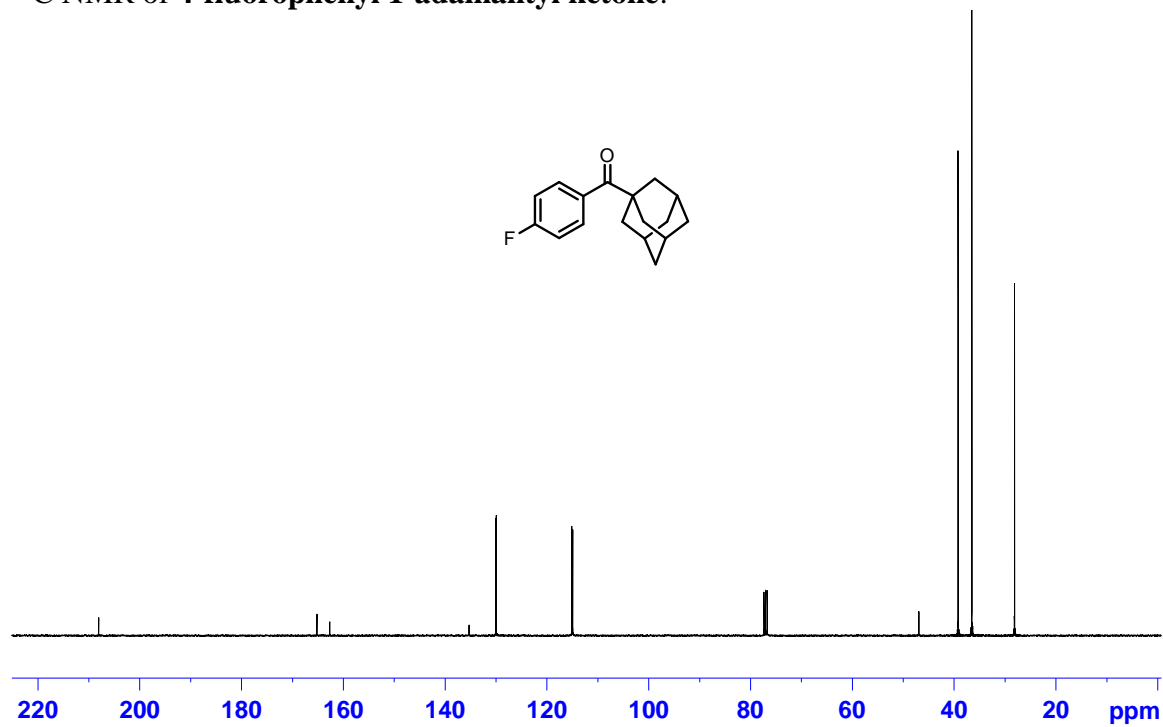
^{13}C NMR of **21**:



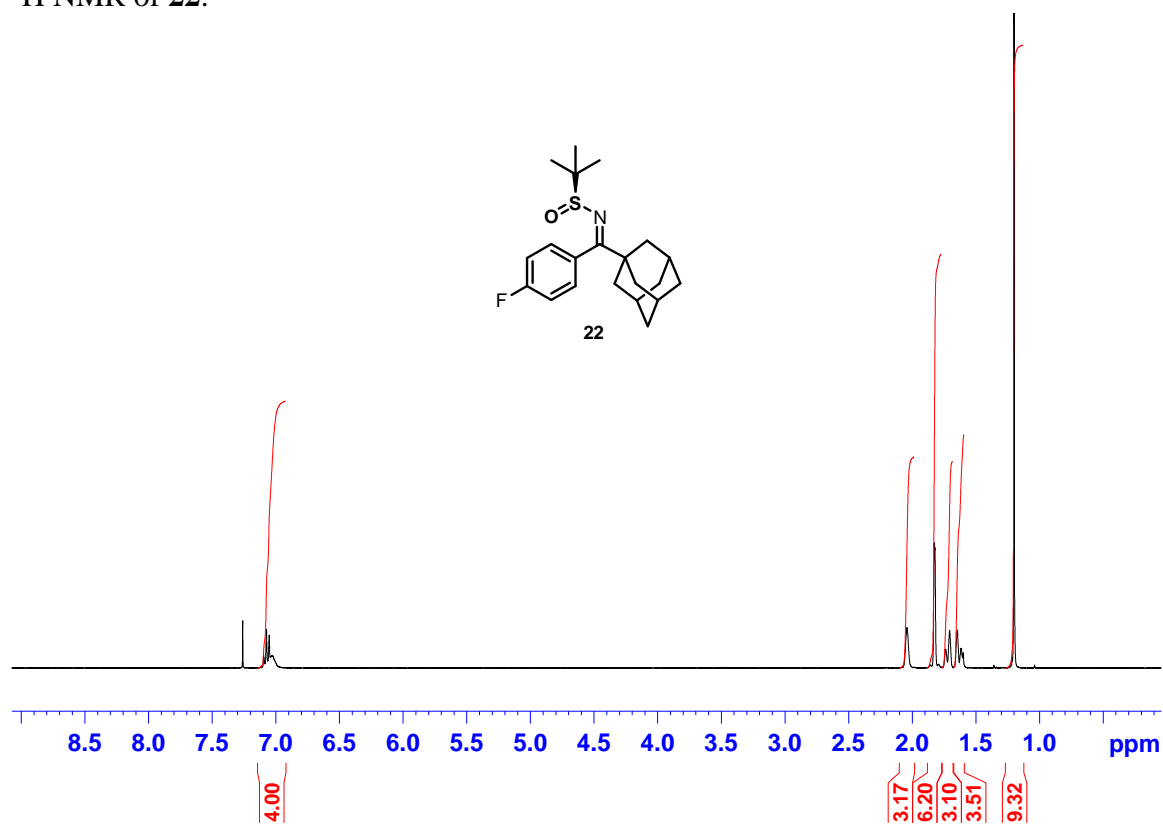
^1H NMR of **4-fluorophenyl 1-adamantyl ketone**:



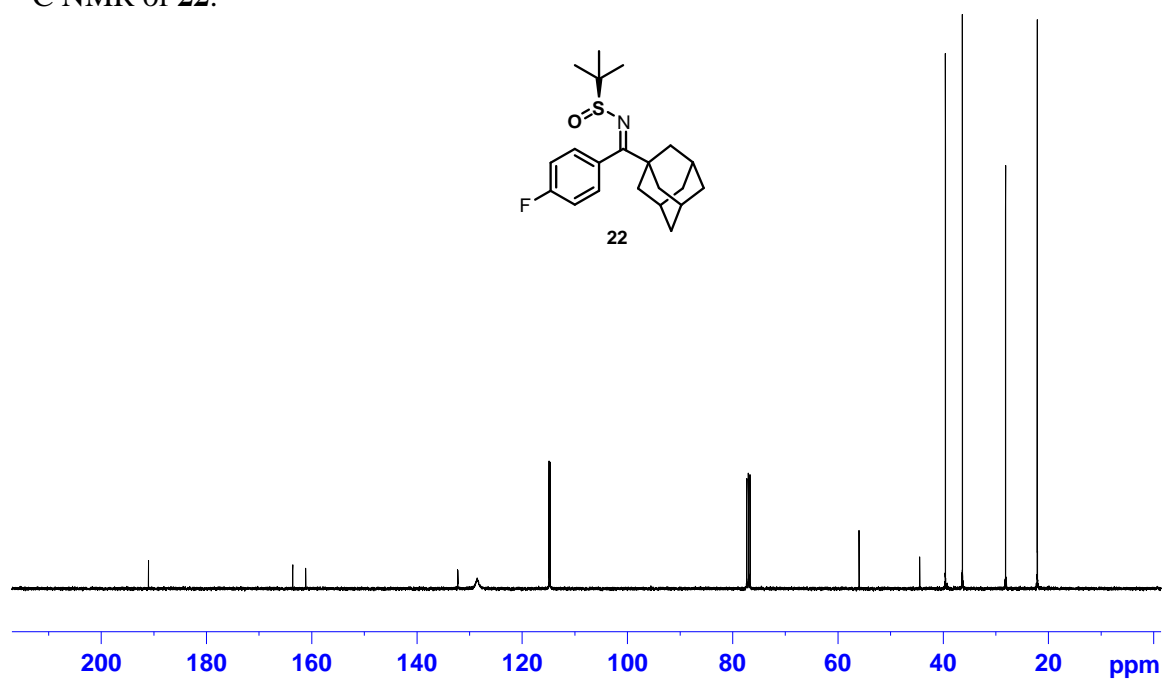
^{13}C NMR of **4-fluorophenyl 1-adamantyl ketone**:



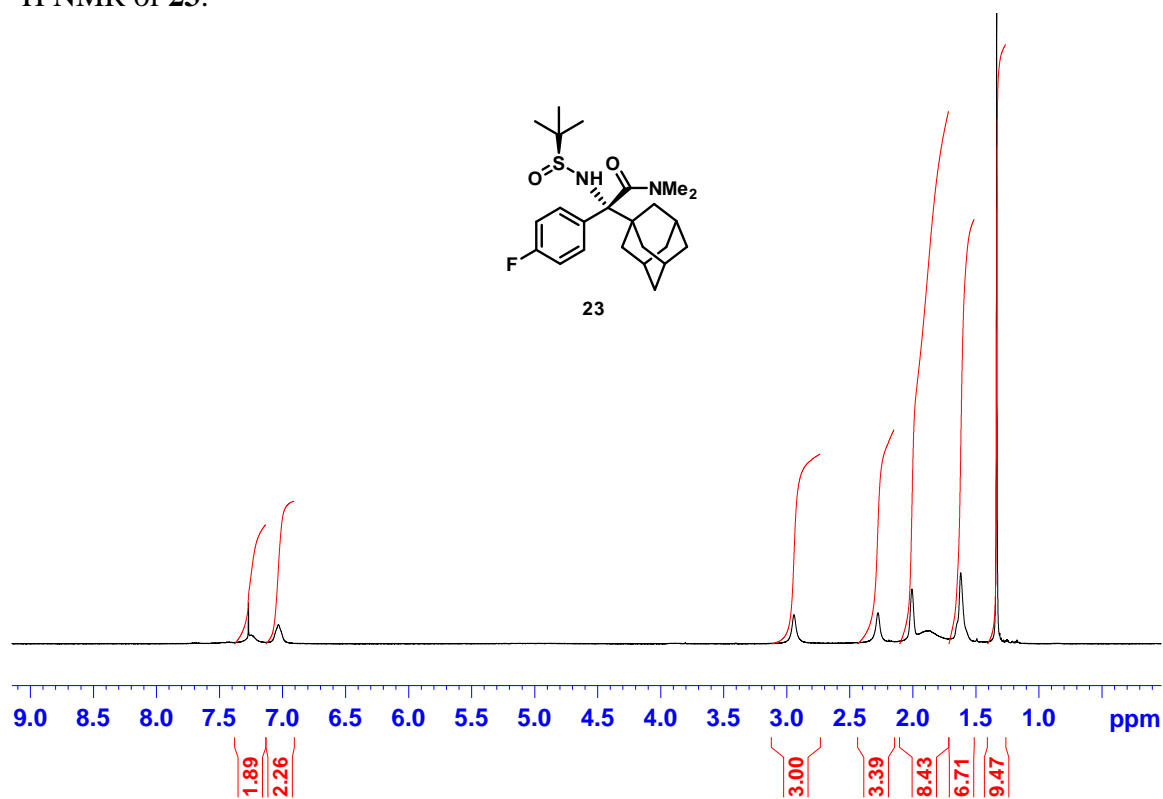
^1H NMR of **22**:



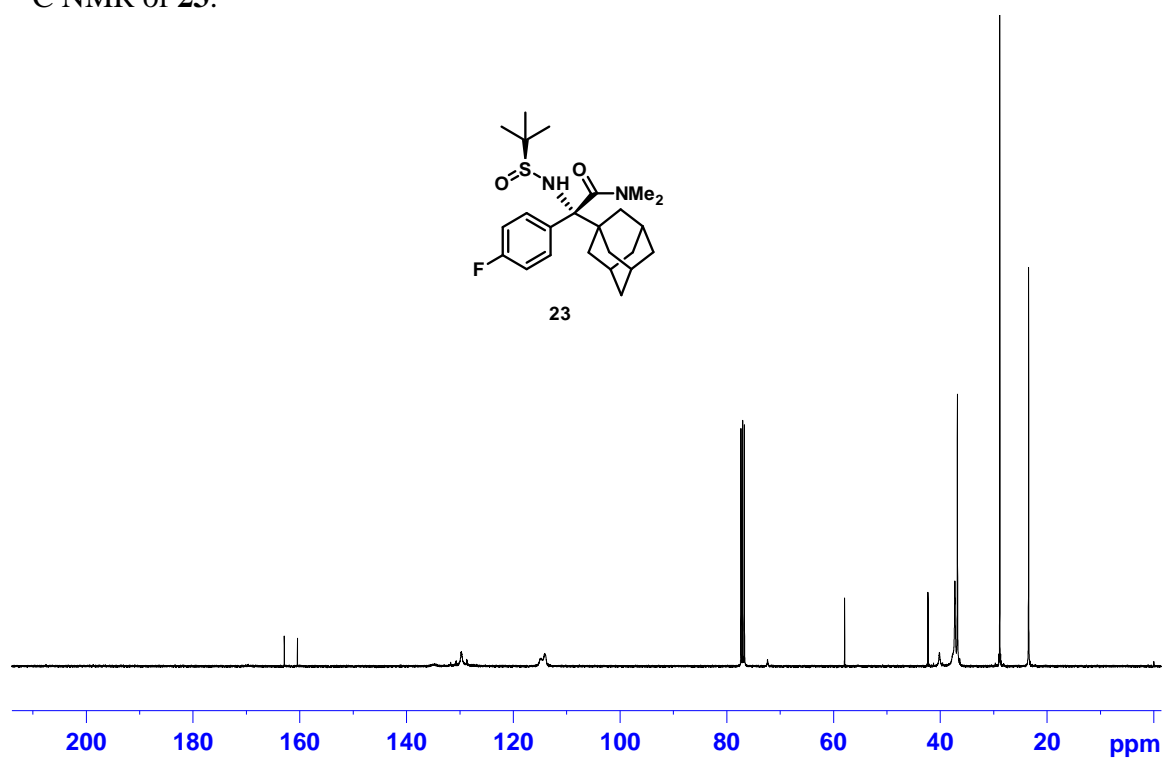
^{13}C NMR of **22**:



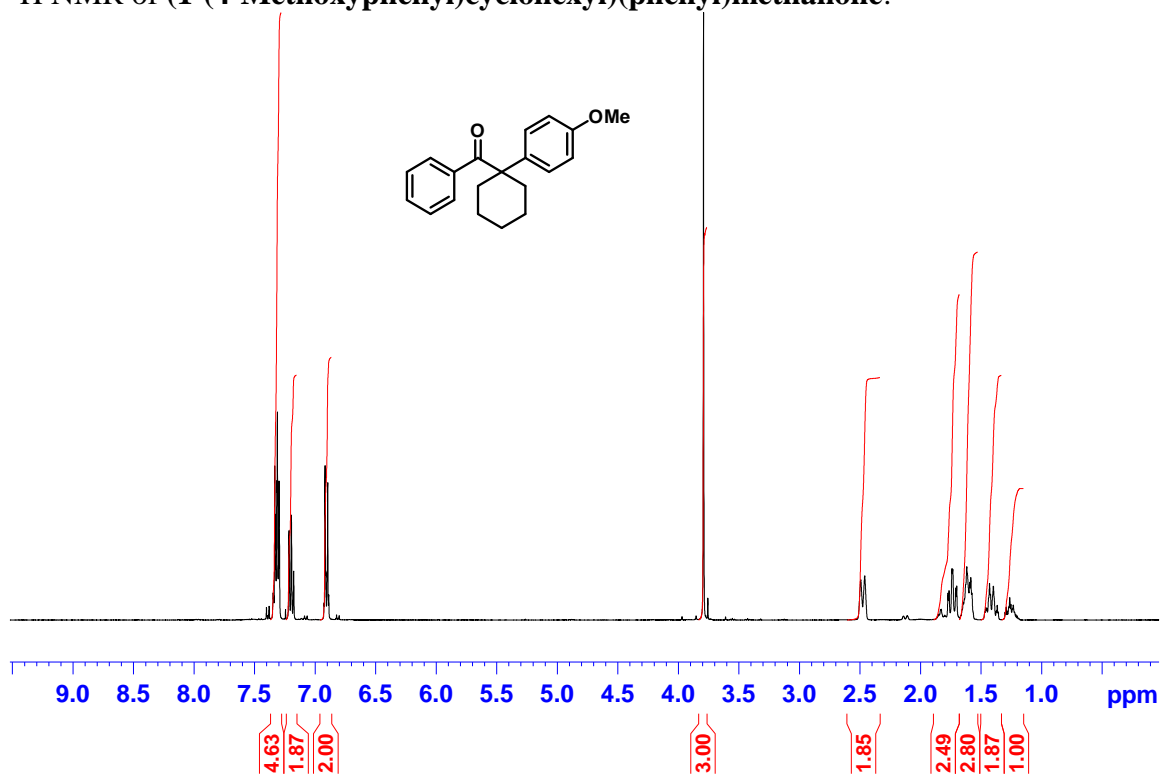
^1H NMR of **23**:



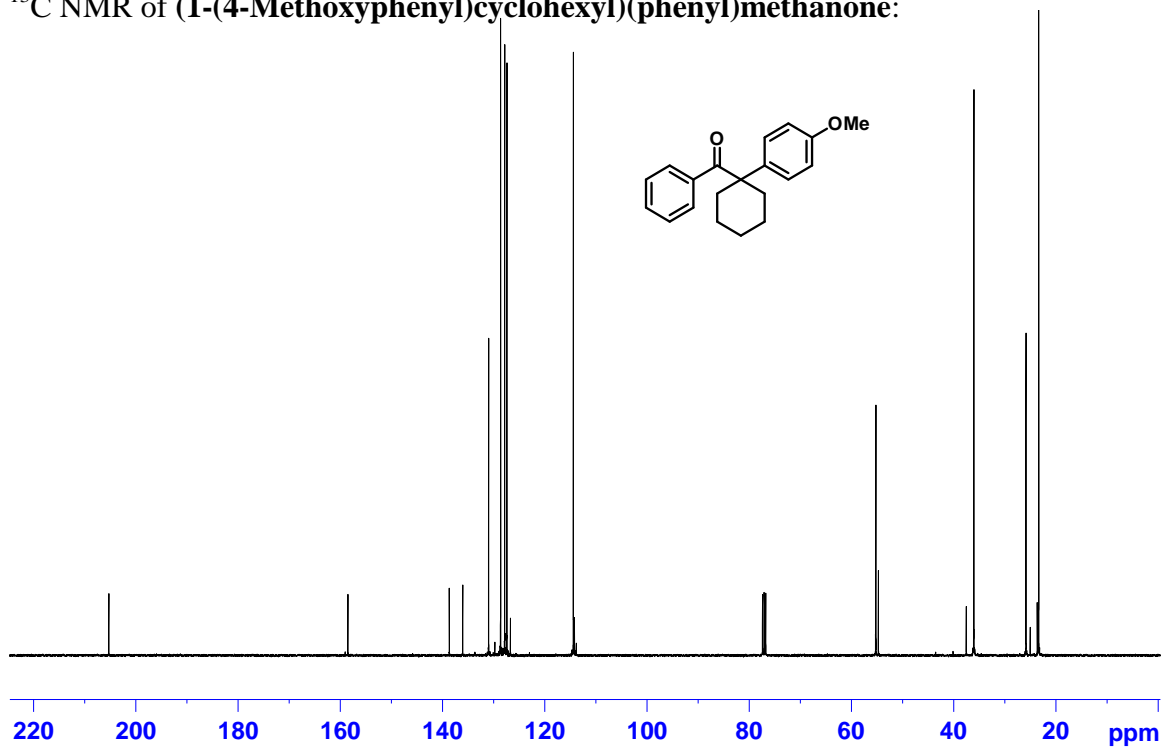
^{13}C NMR of **23**:

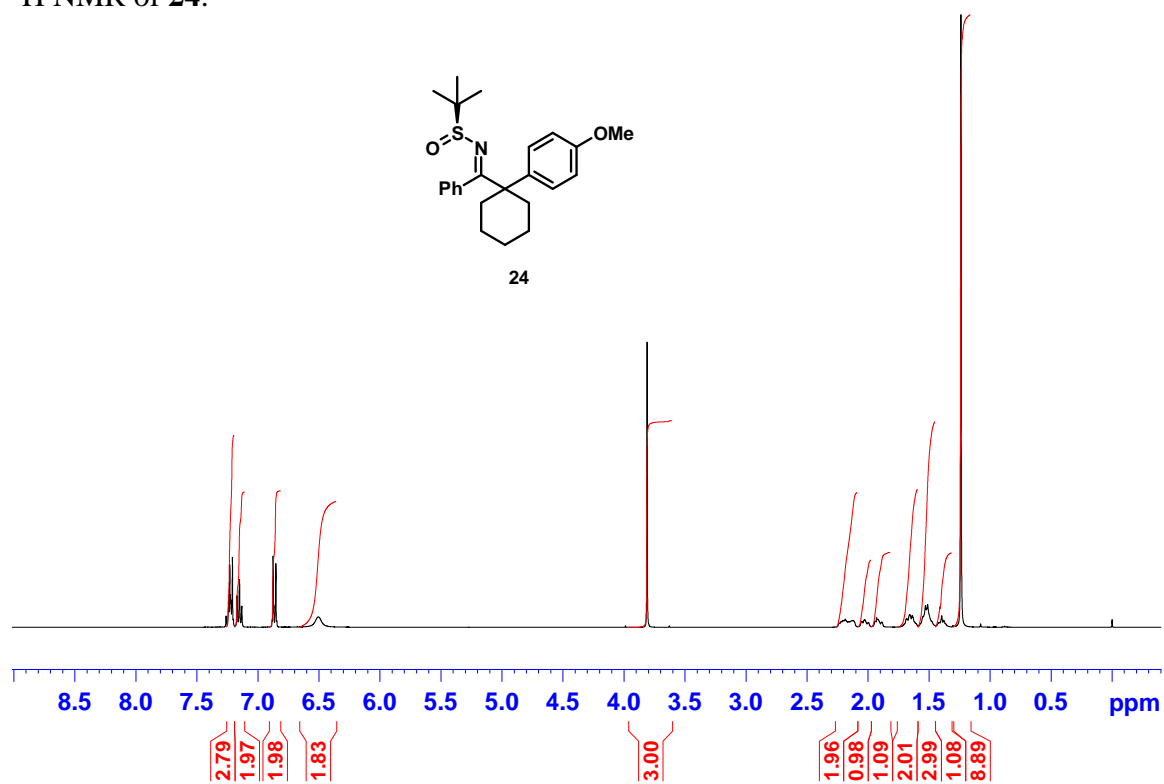
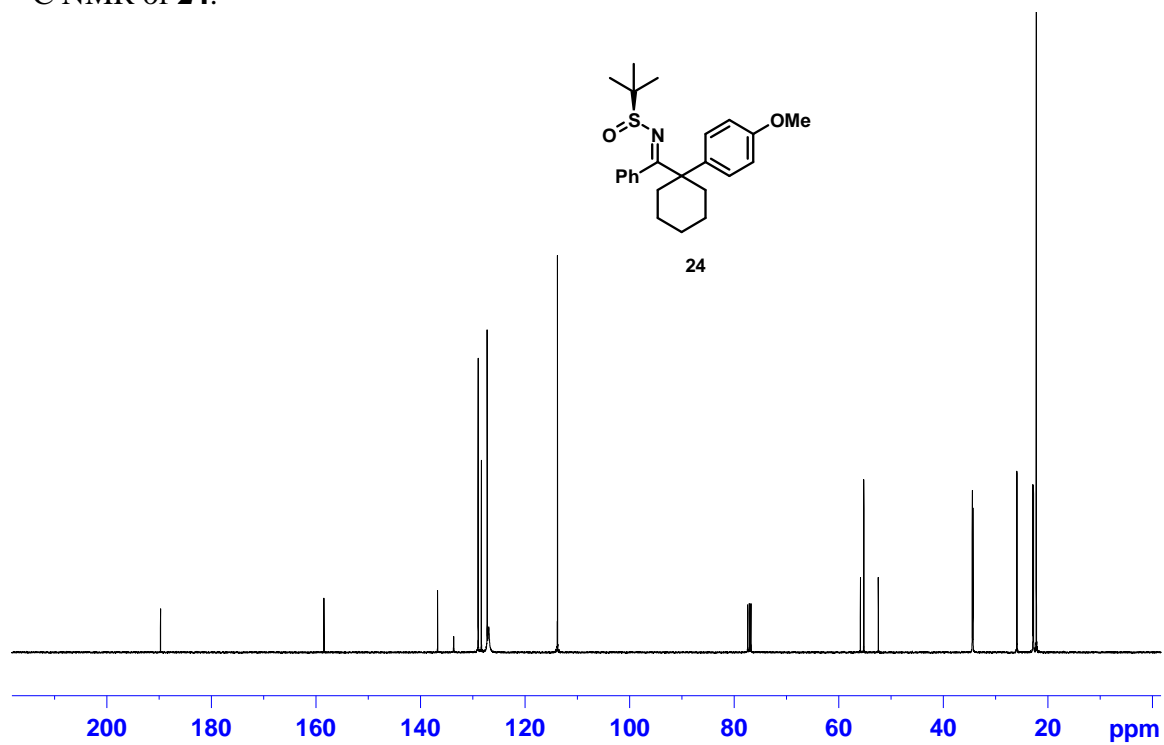


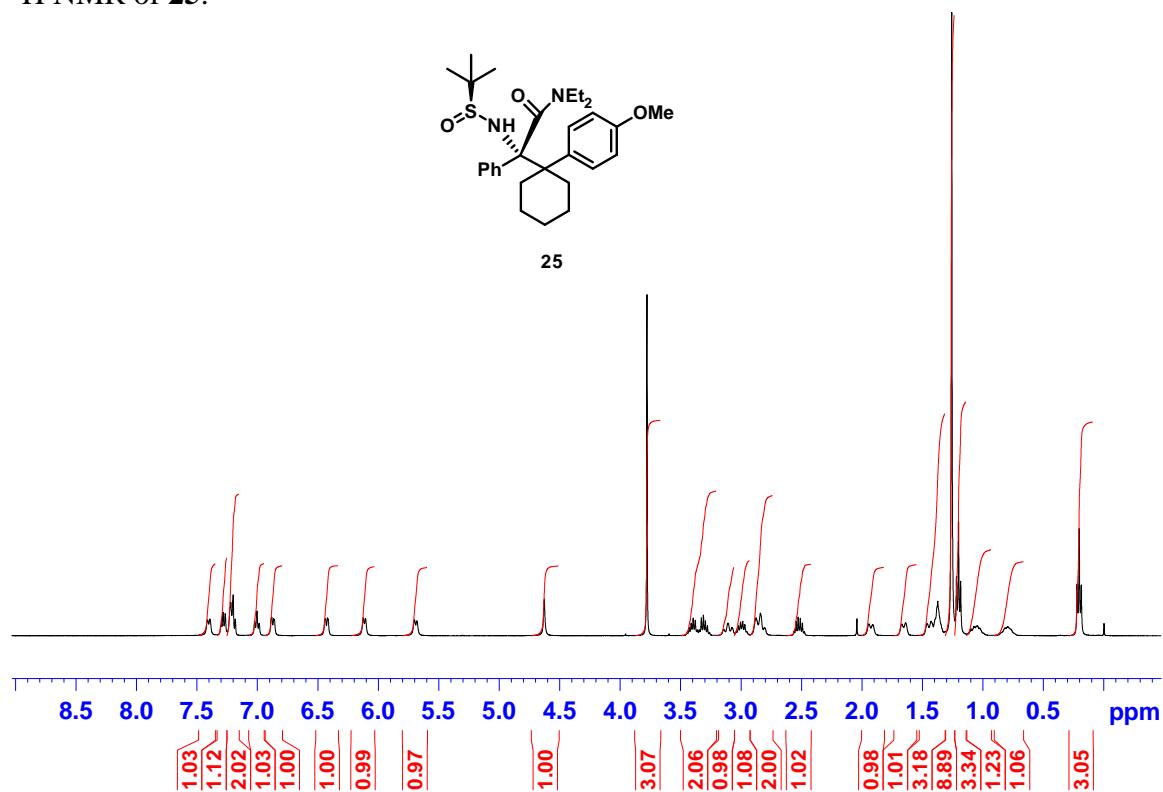
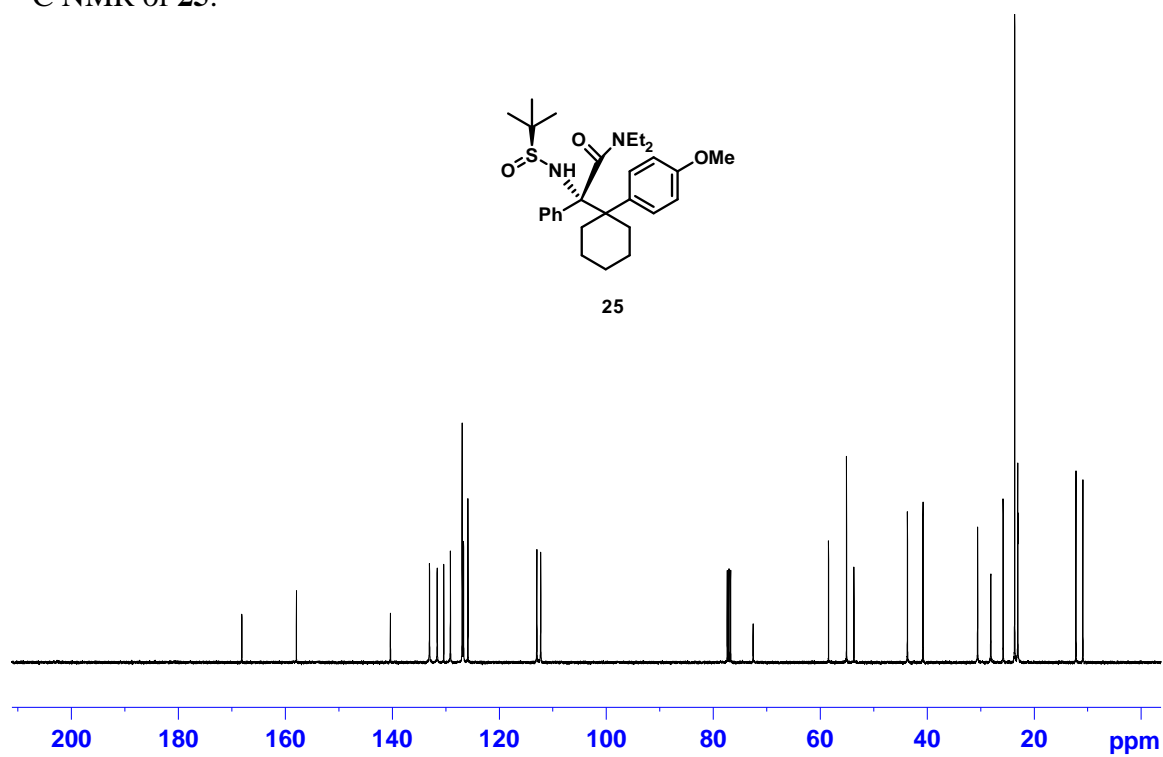
¹H NMR of (1-(4-Methoxyphenyl)cyclohexyl)(phenyl)methanone:



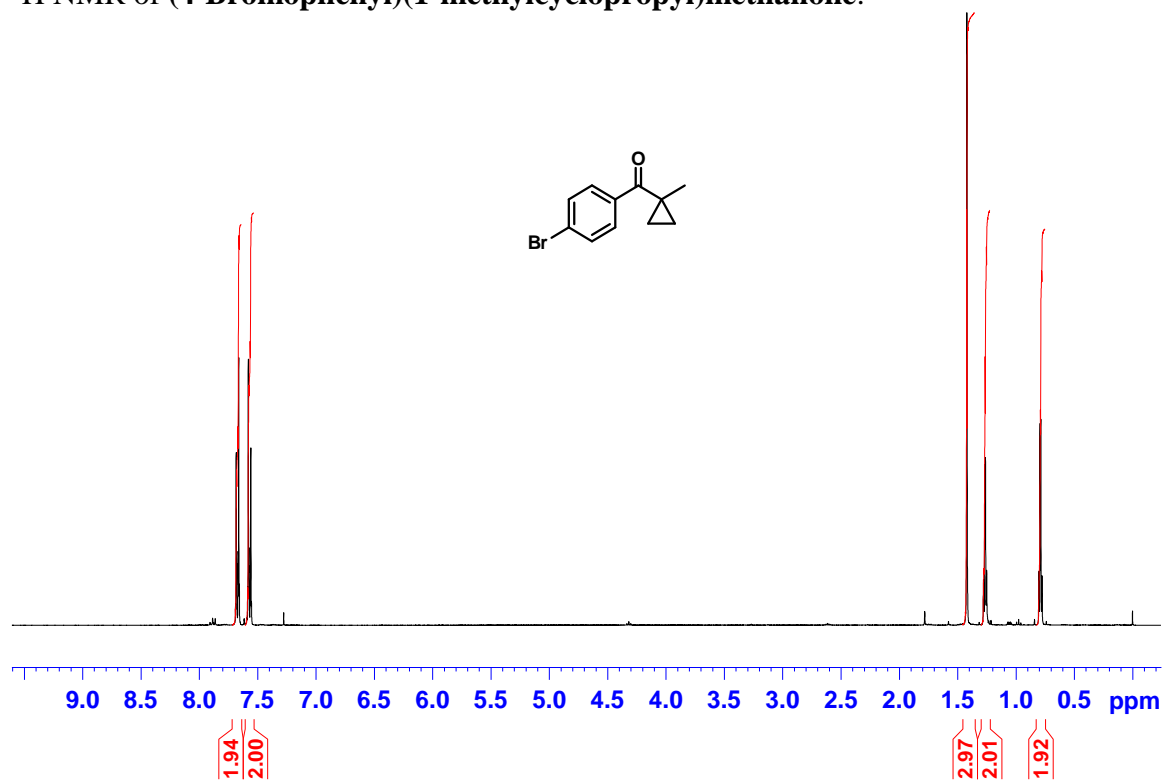
¹³C NMR of (1-(4-Methoxyphenyl)cyclohexyl)(phenyl)methanone:



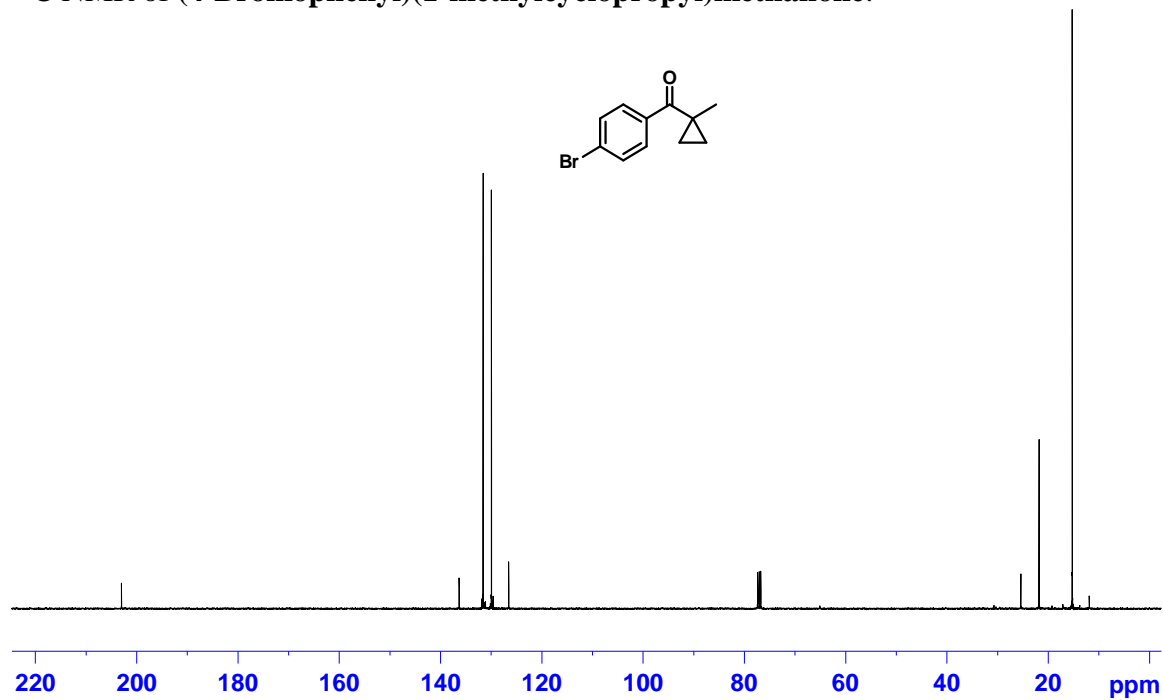
¹H NMR of **24**:¹³C NMR of **24**:

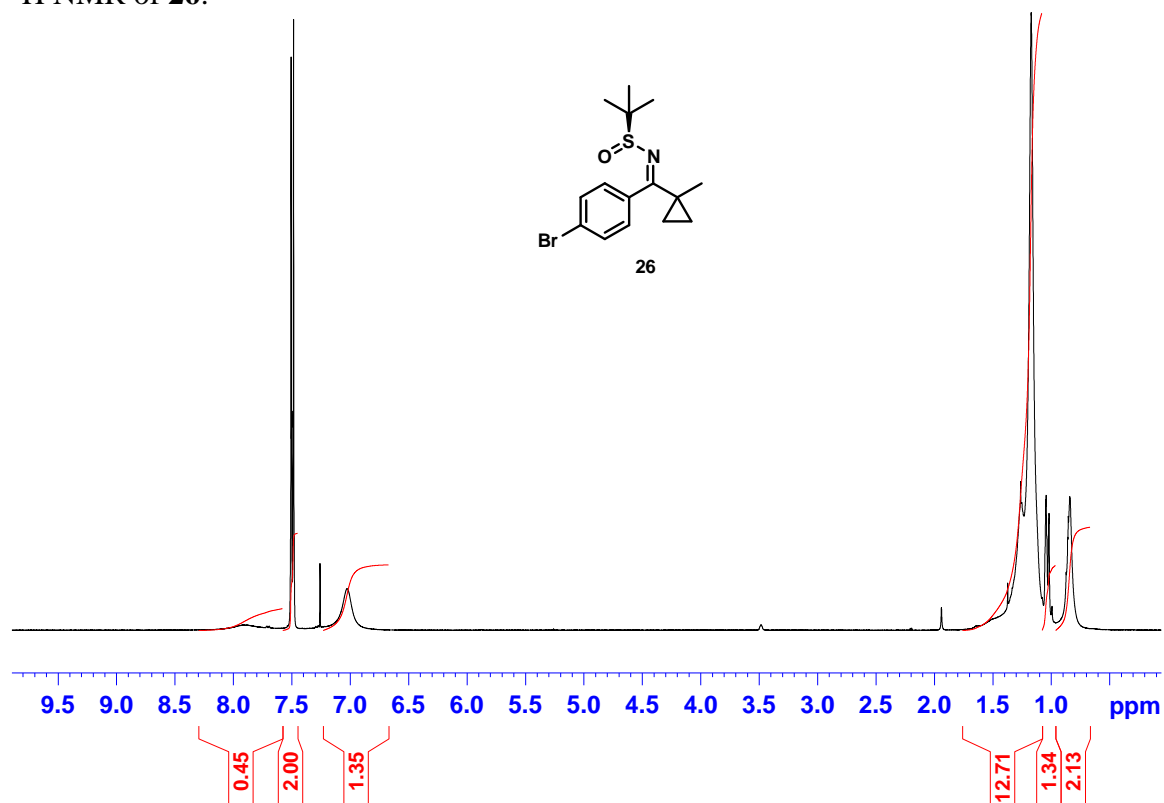
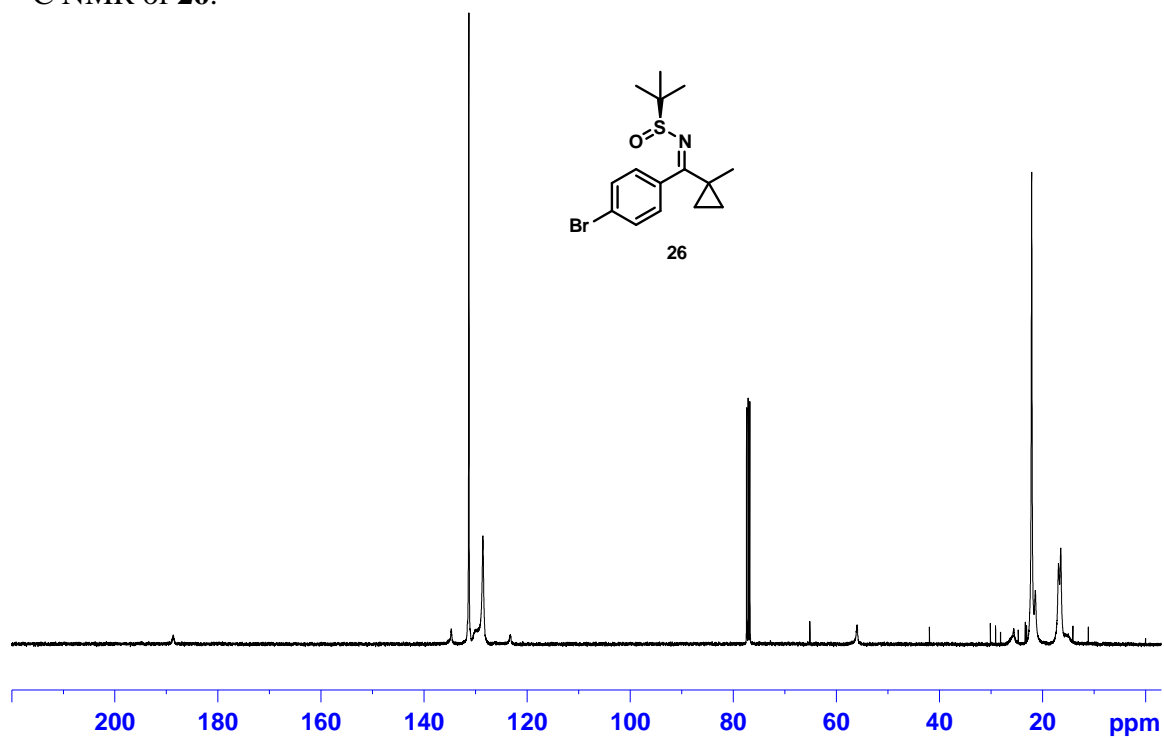
¹H NMR of **25**:¹³C NMR of **25**:

^1H NMR of (4-Bromophenyl)(1-methylcyclopropyl)methanone:

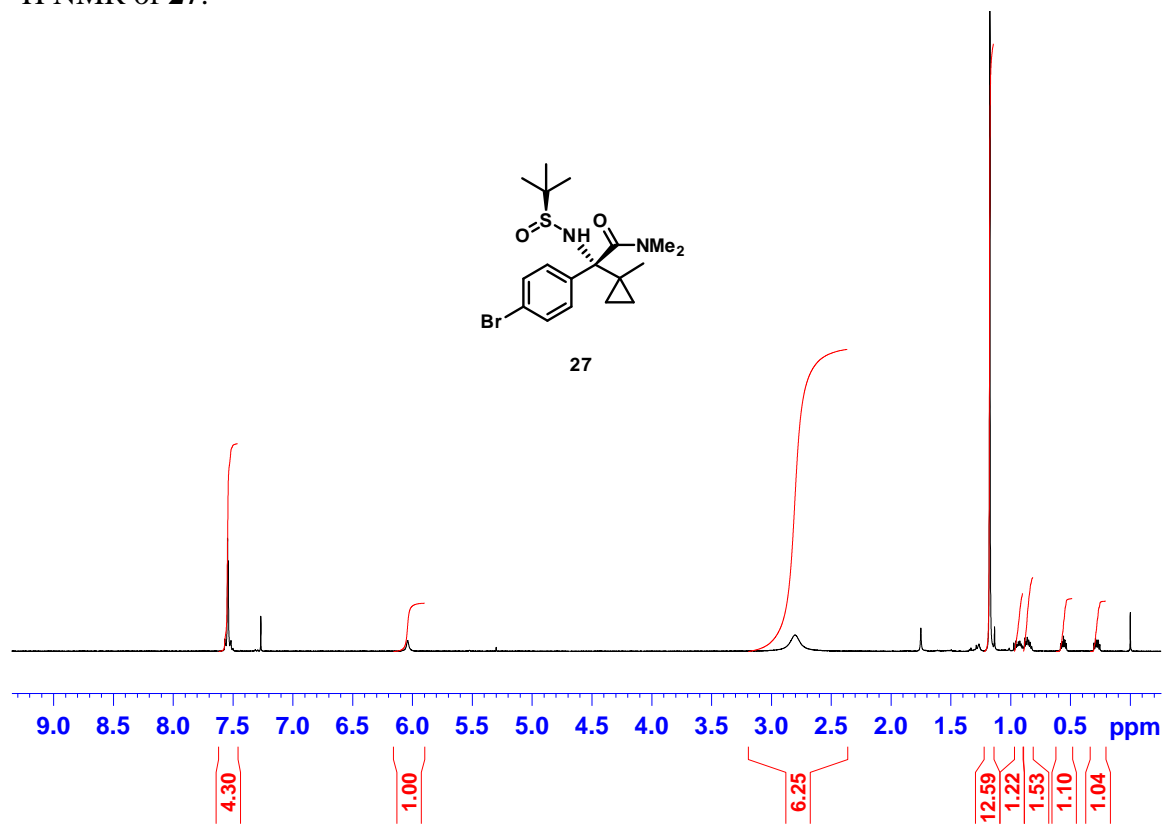


^{13}C NMR of (4-Bromophenyl)(1-methylcyclopropyl)methanone:

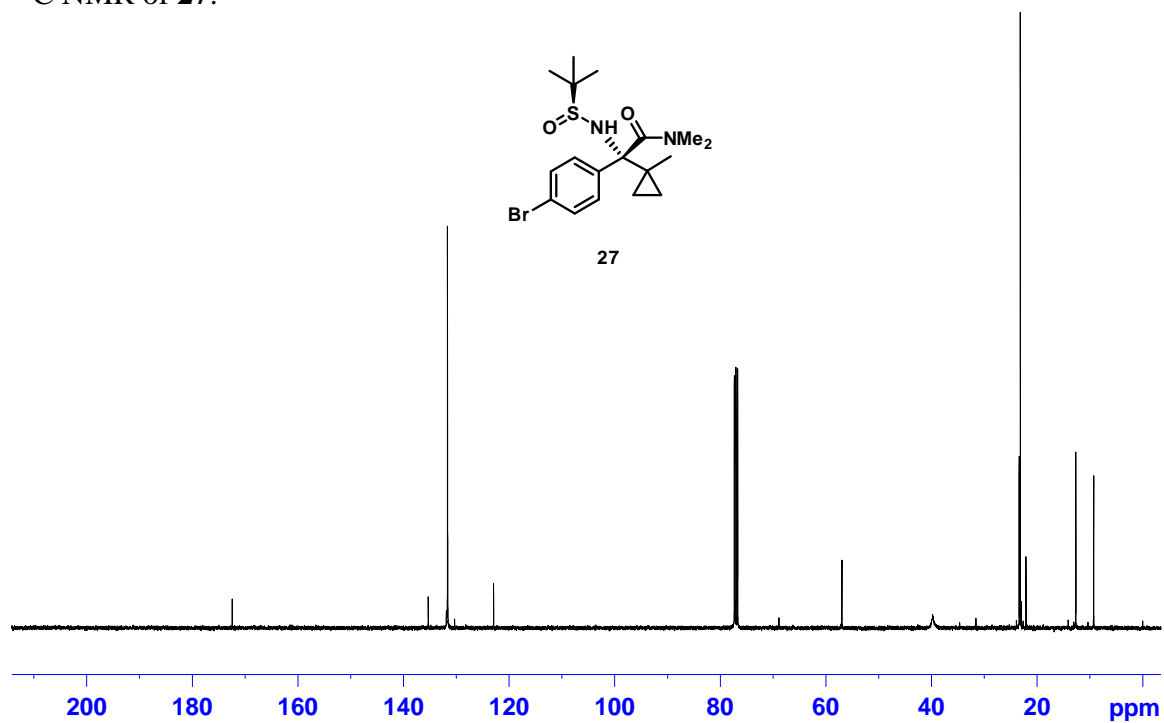


¹H NMR of **26**:¹³C NMR of **26**:

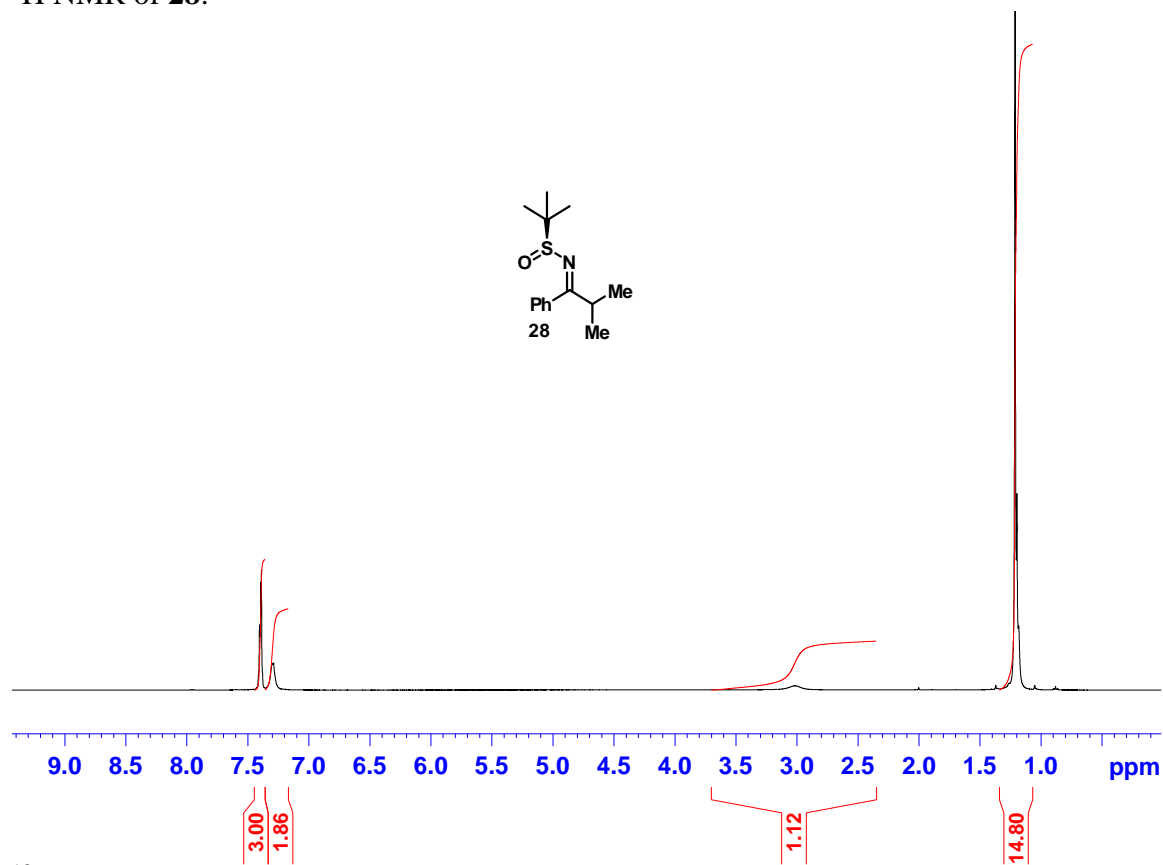
^1H NMR of **27**:



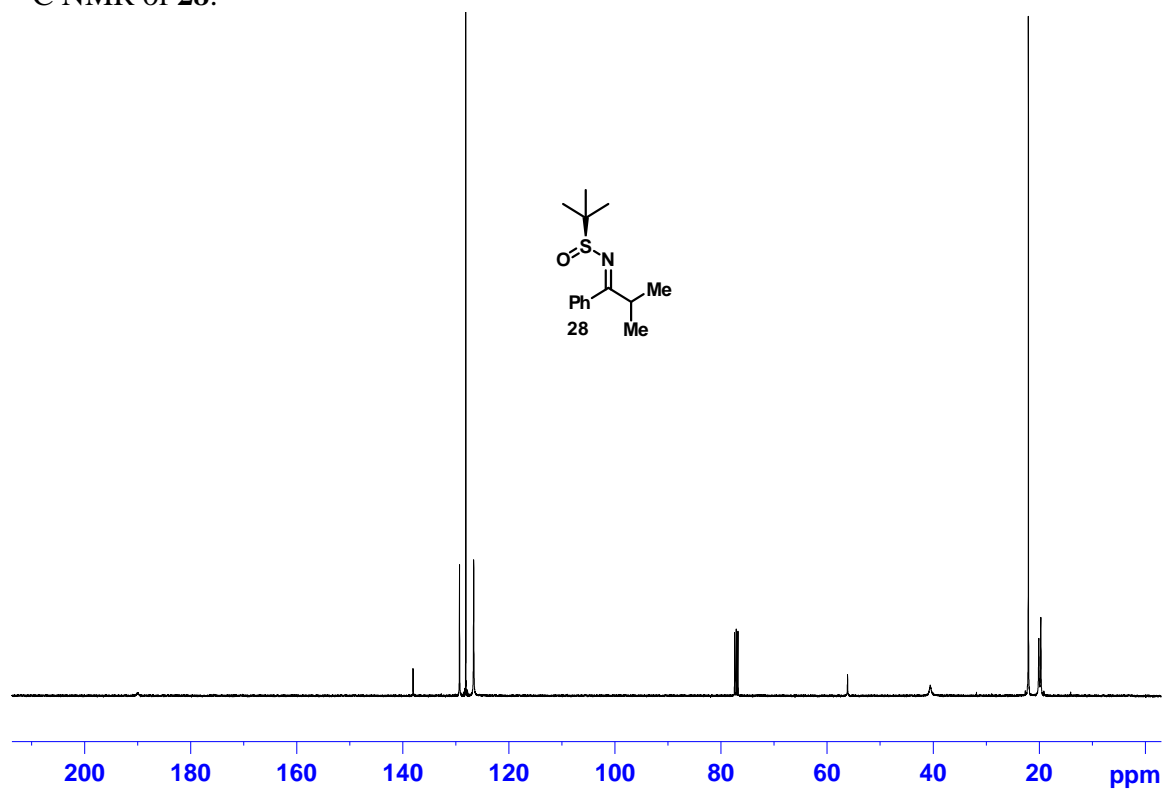
^{13}C NMR of **27**:



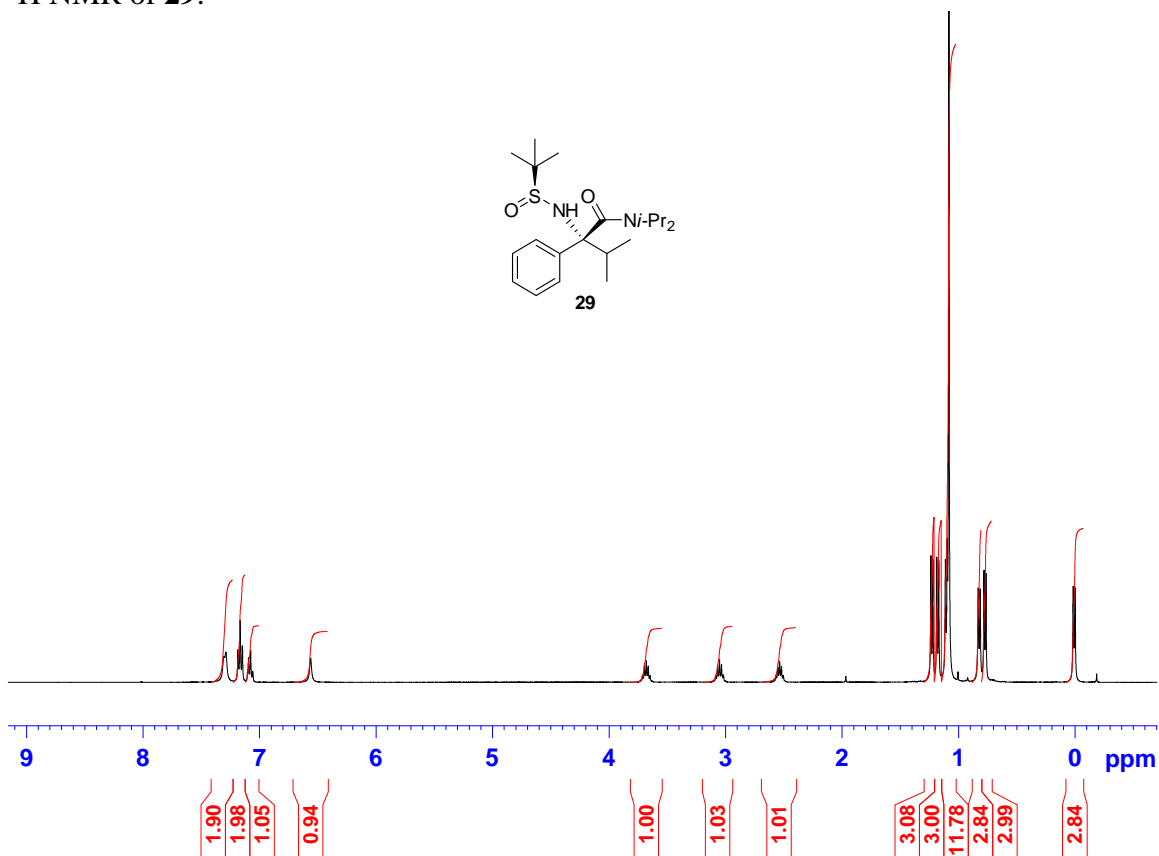
^1H NMR of **28**:



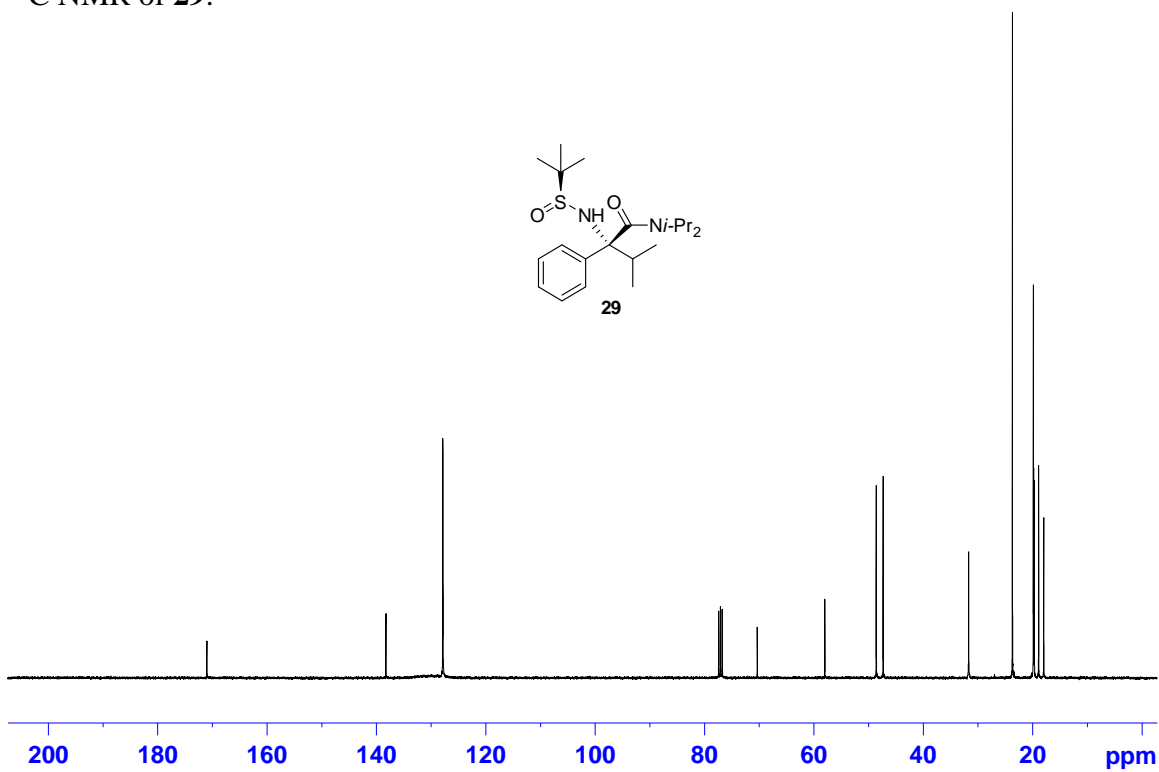
^{13}C NMR of **28**:



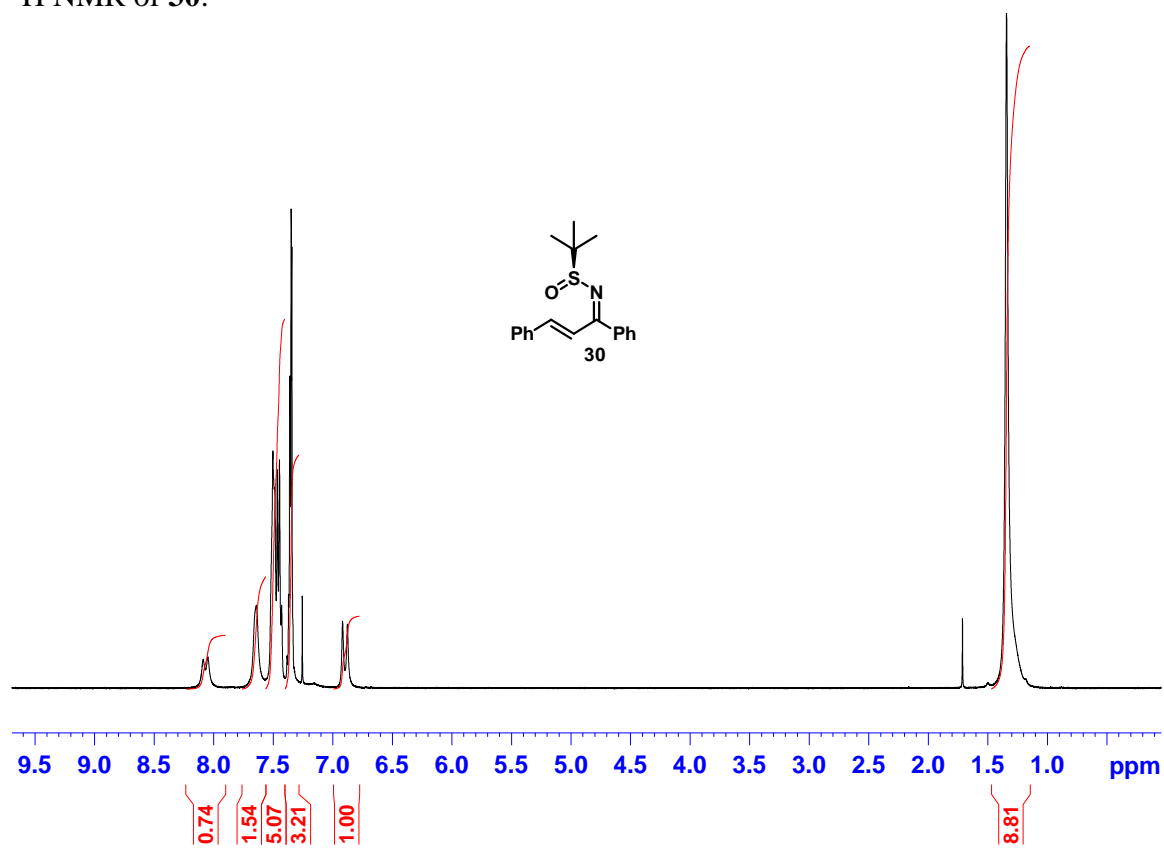
^1H NMR of **29**:



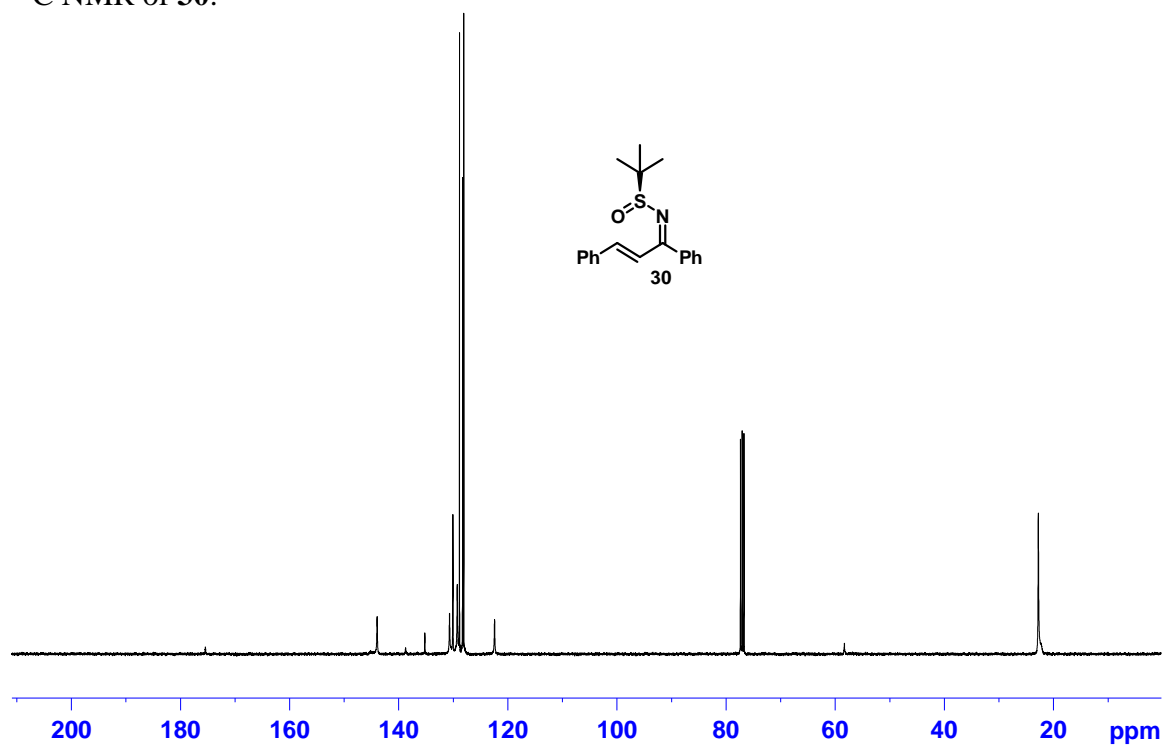
^{13}C NMR of **29**:

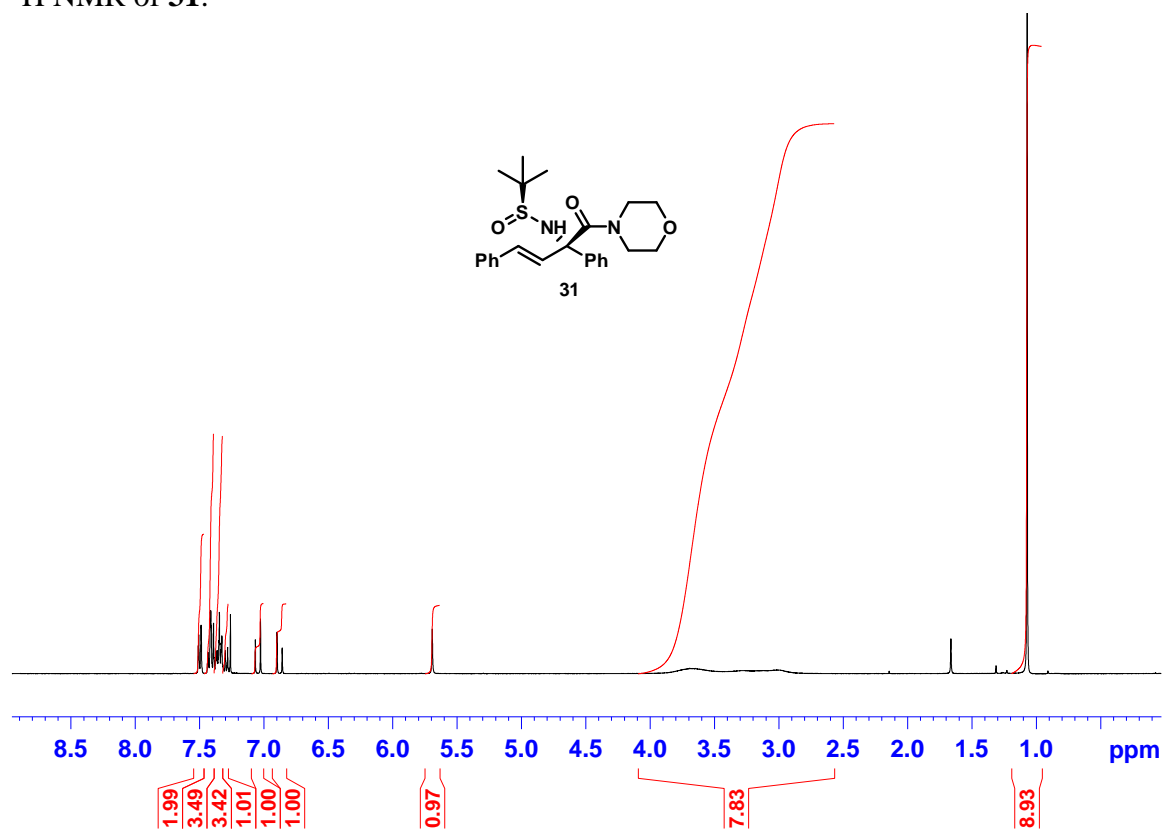
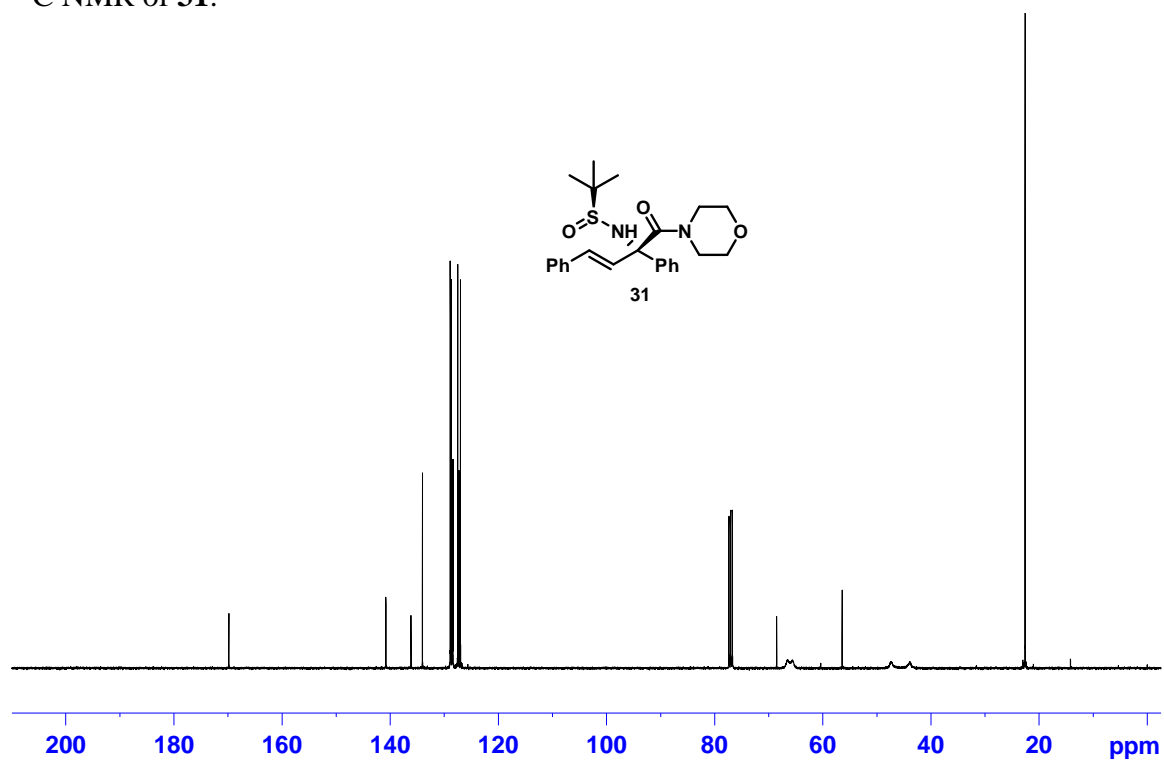


^1H NMR of **30**:

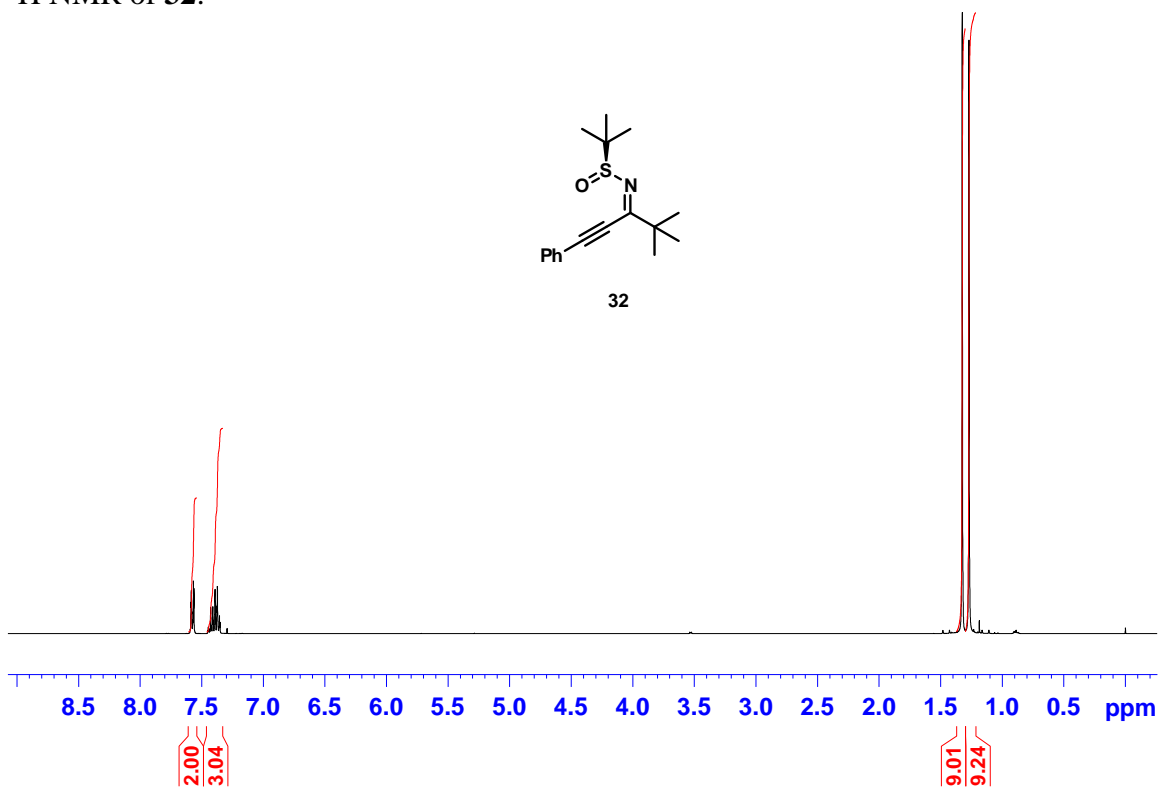


^{13}C NMR of **30**:

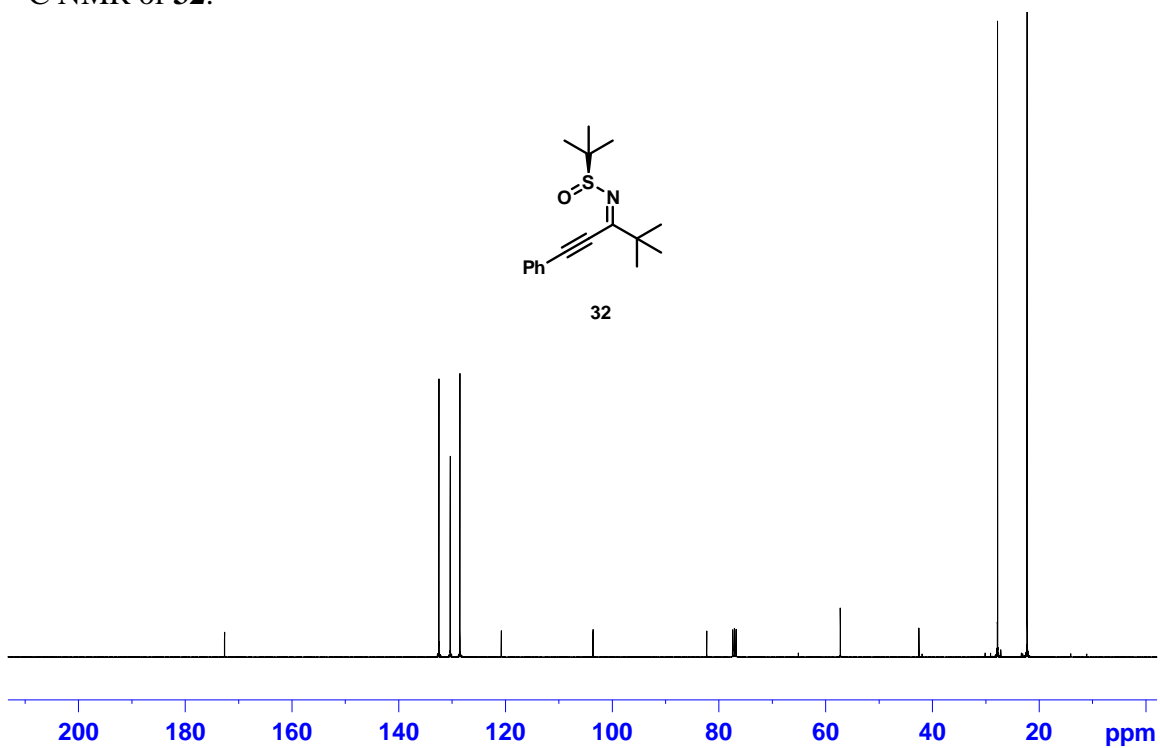


^1H NMR of **31**: ^{13}C NMR of **31**:

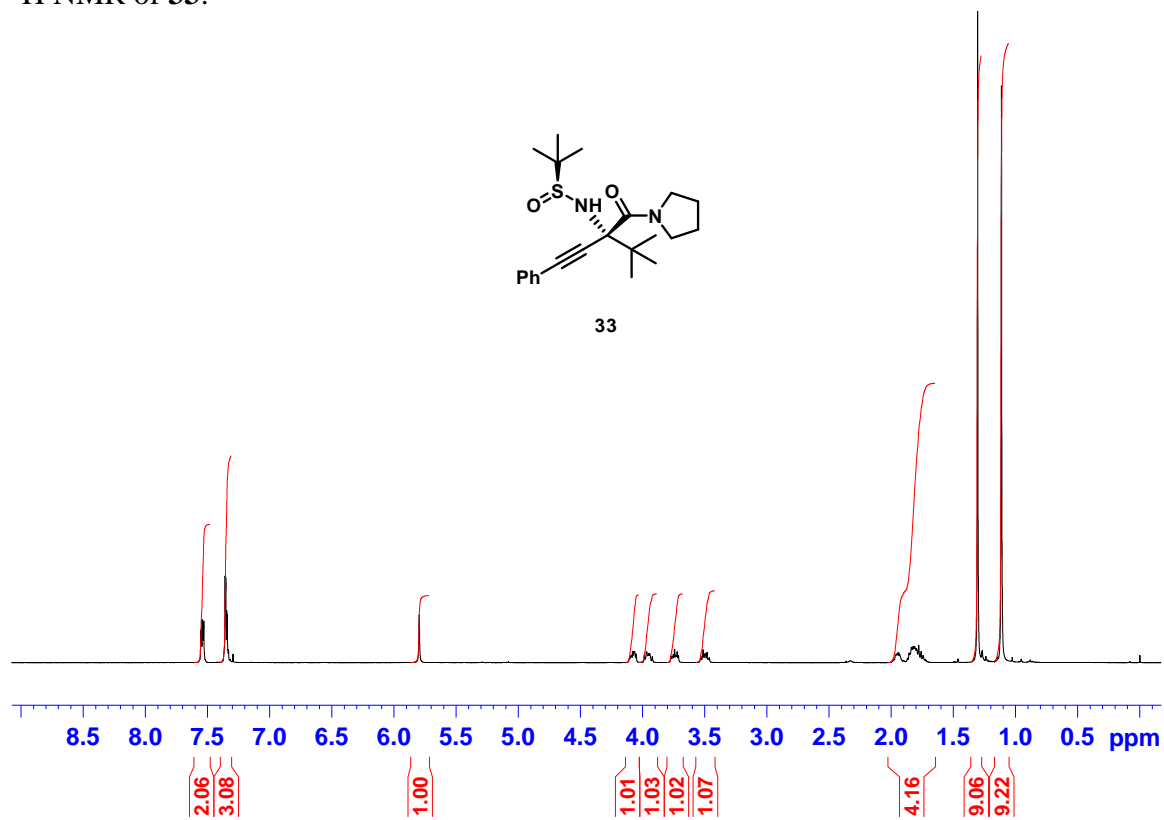
^1H NMR of **32**:



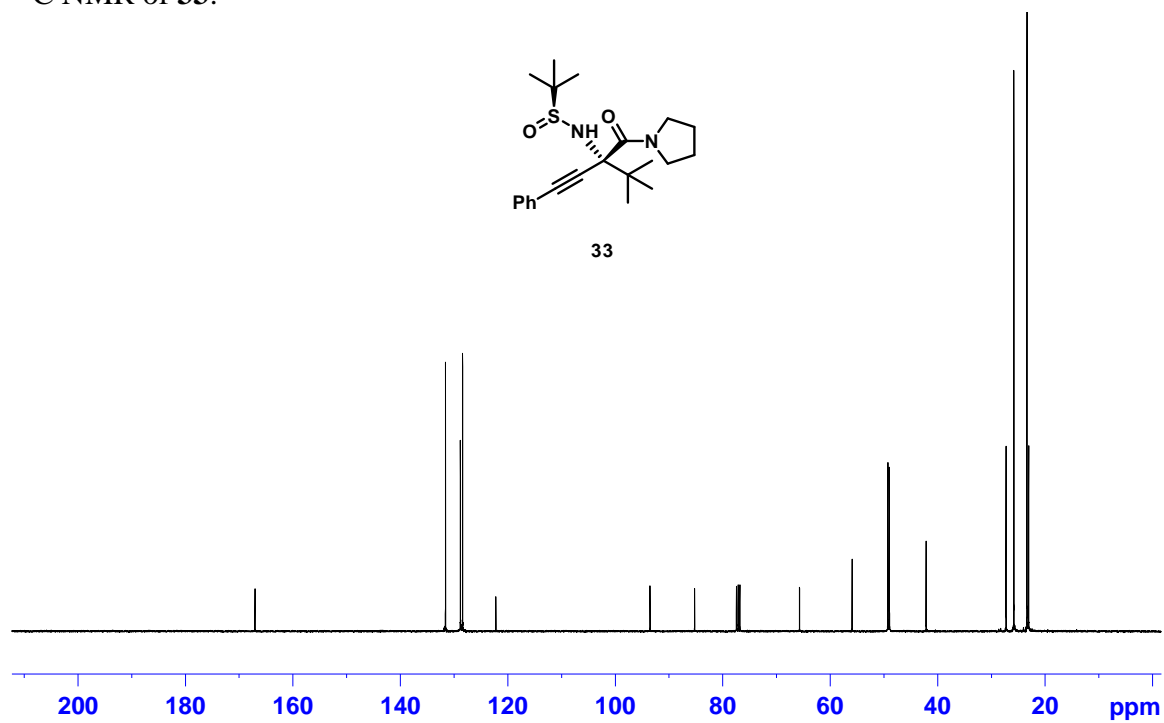
^{13}C NMR of **32**:



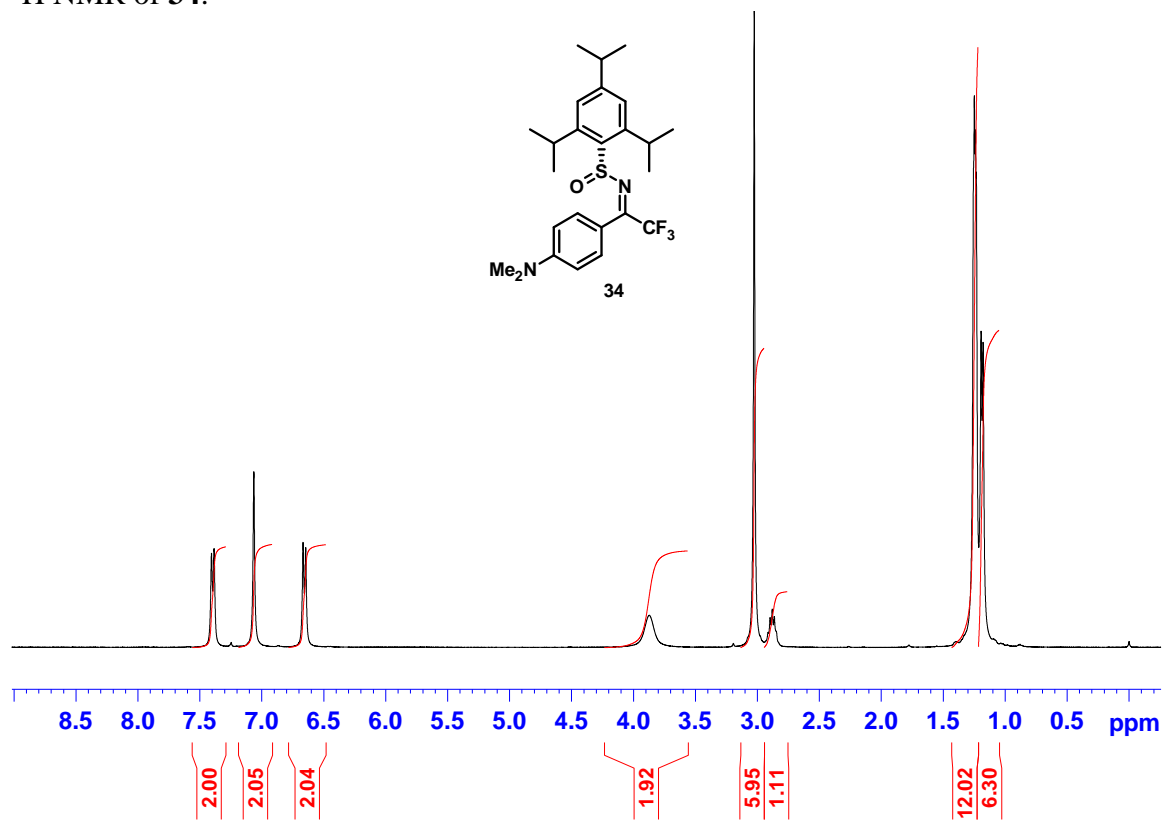
^1H NMR of **33**:



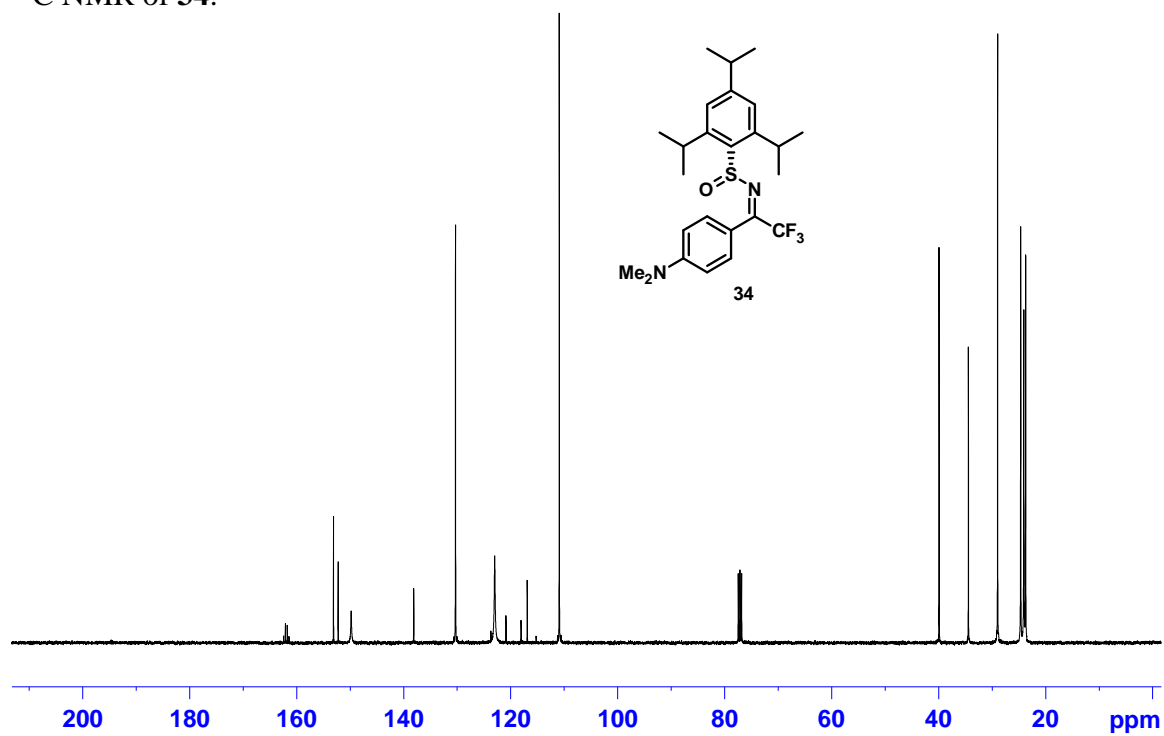
^{13}C NMR of **33**:



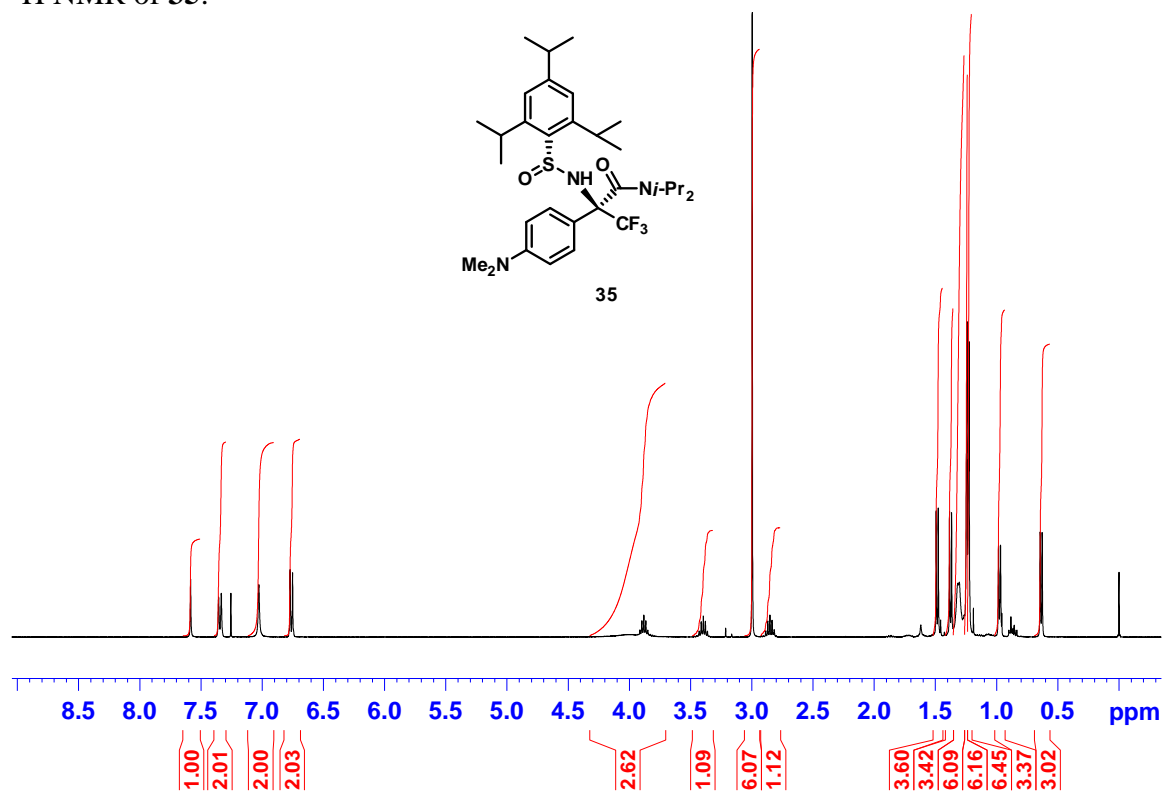
^1H NMR of **34**:



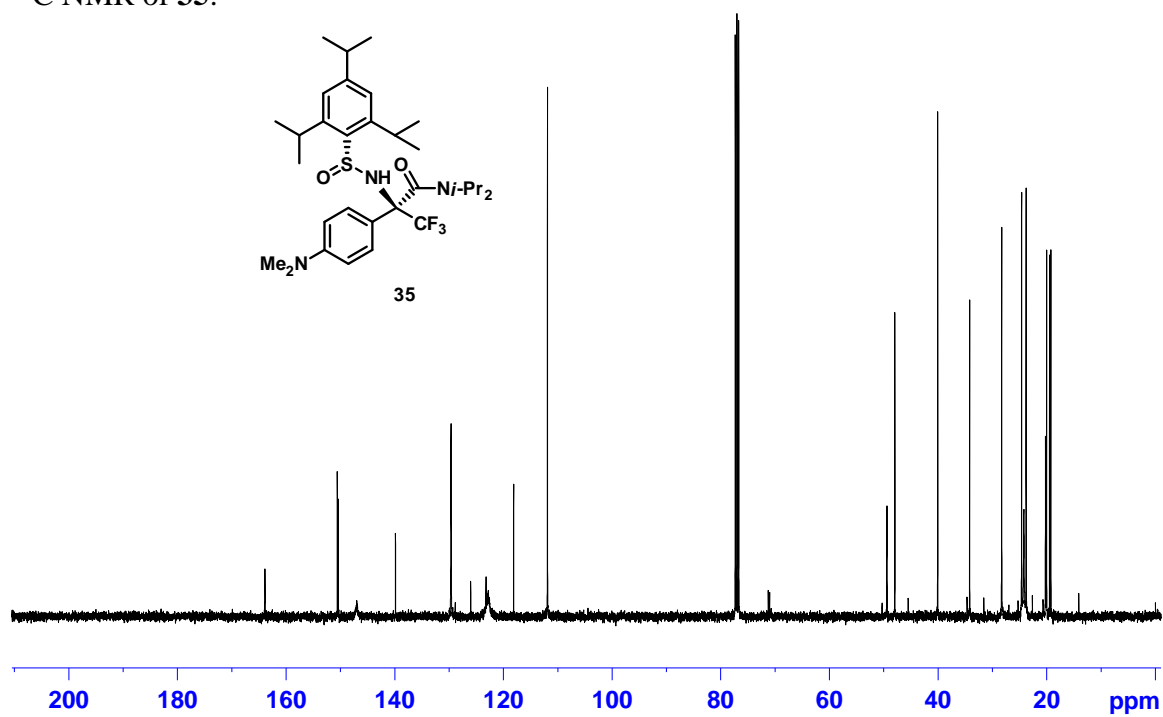
^{13}C NMR of **34**:



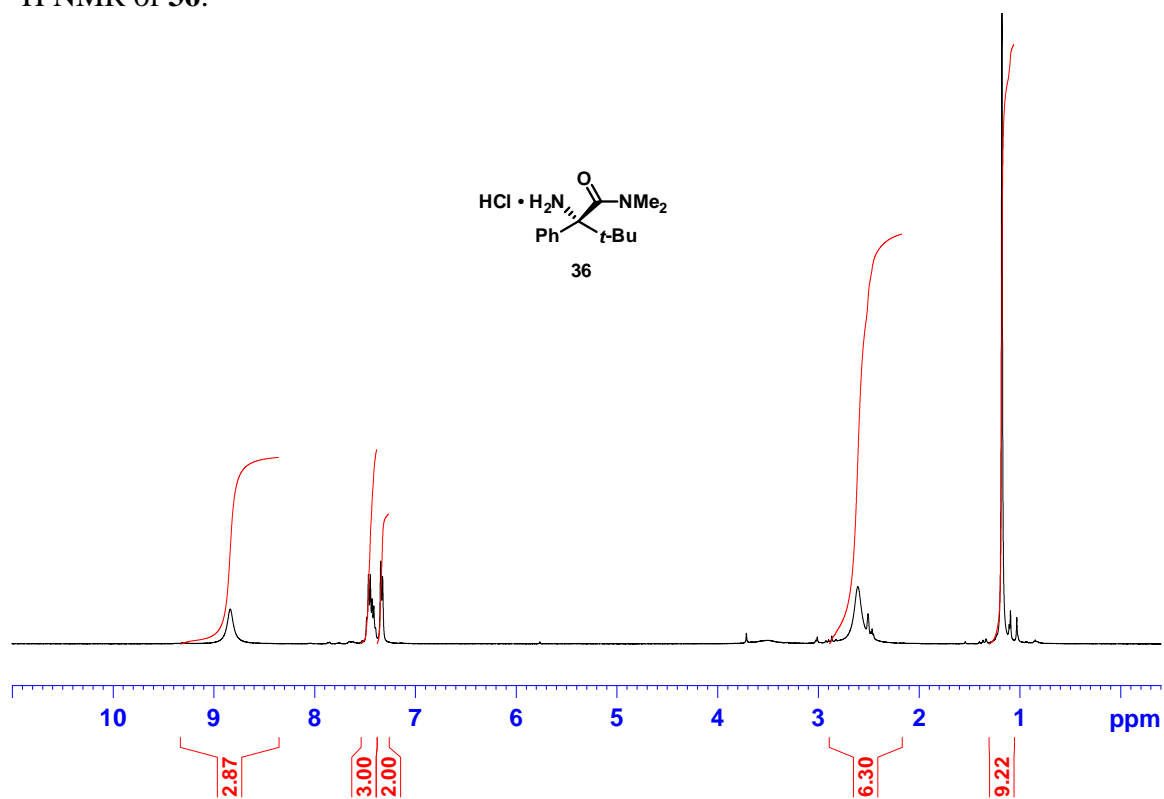
^1H NMR of **35**:



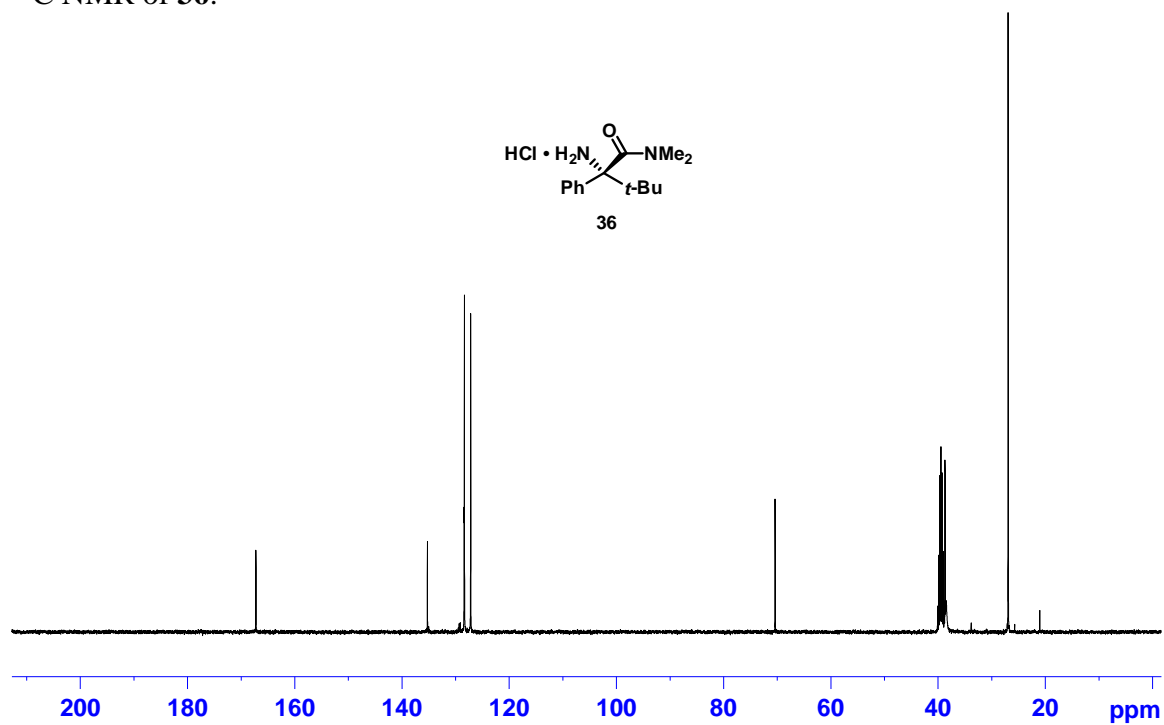
^{13}C NMR of **35**:



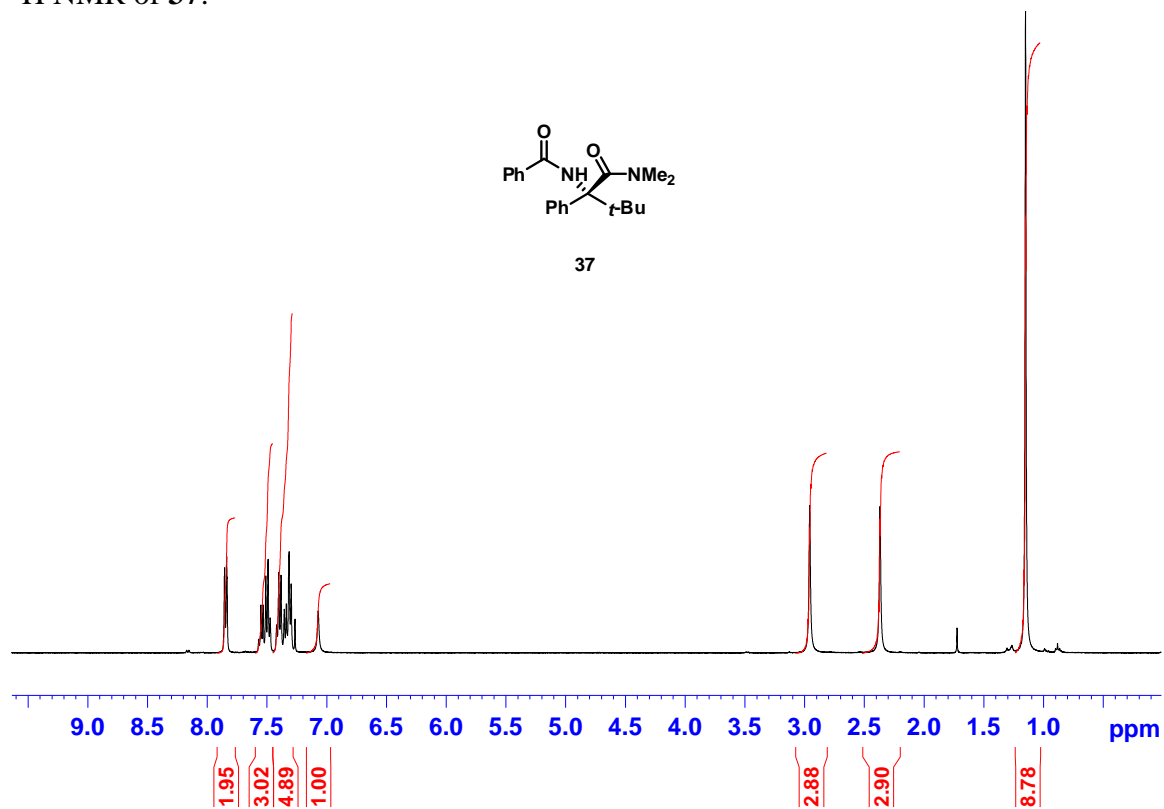
^1H NMR of **36**:



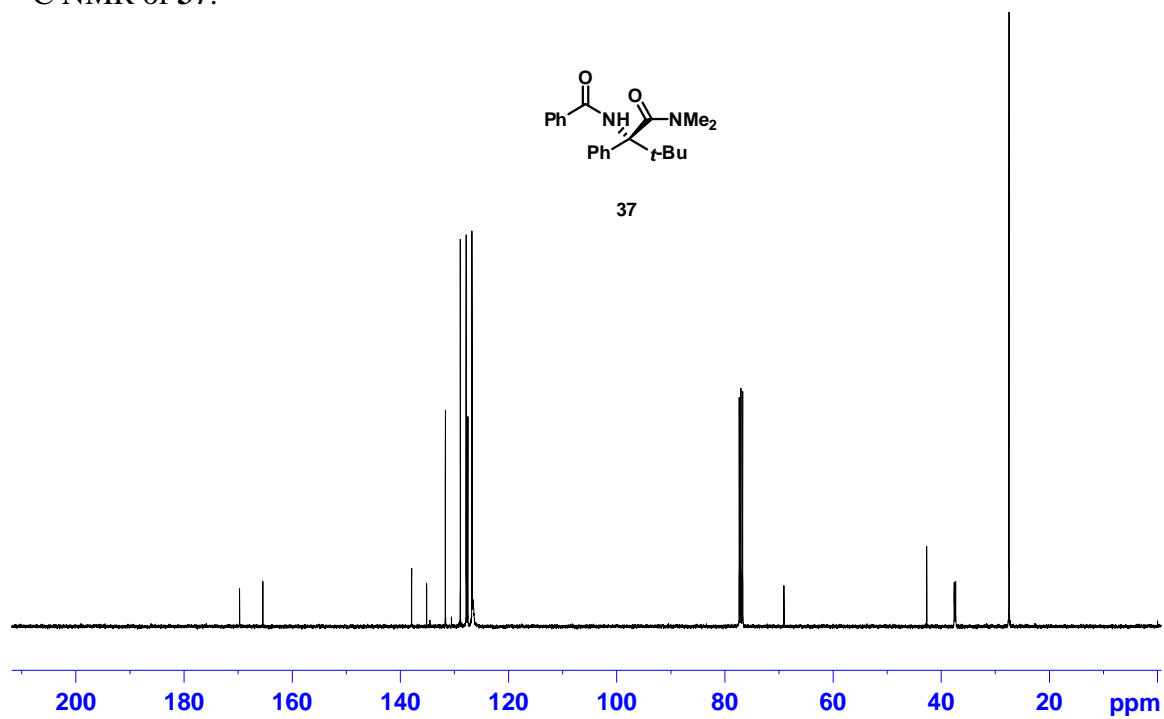
^{13}C NMR of **36**:



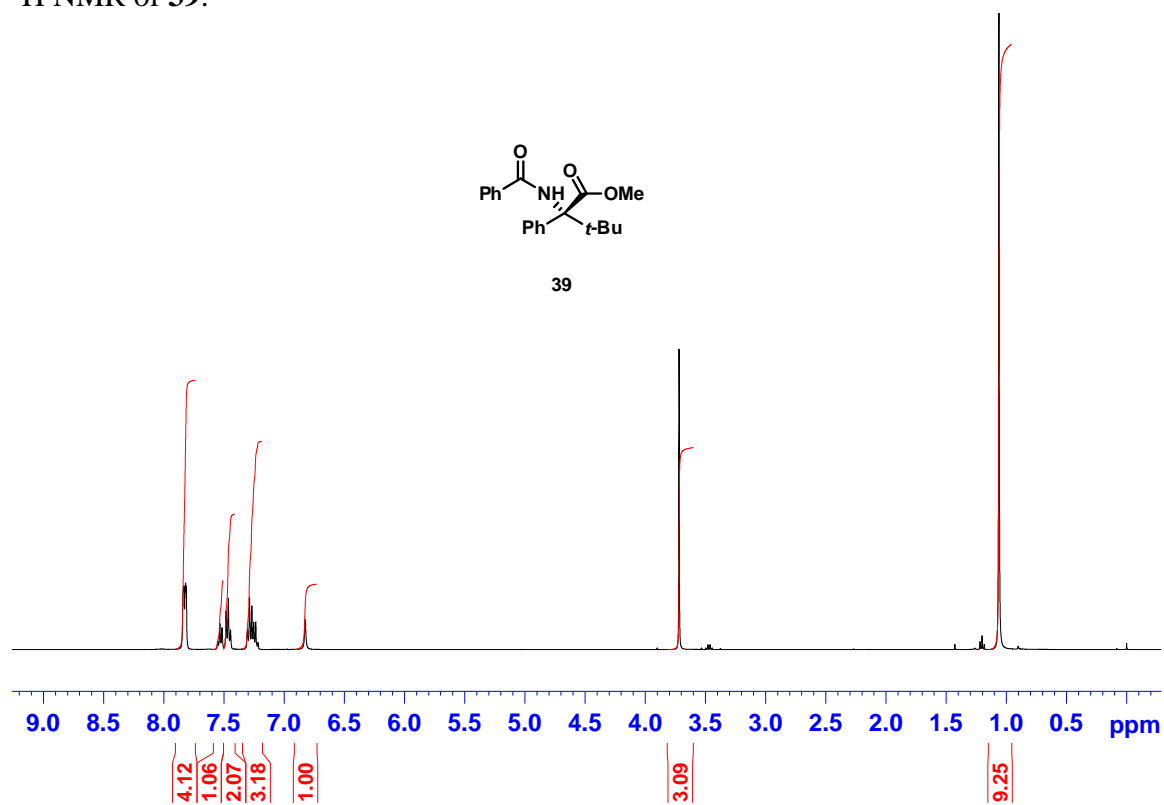
^1H NMR of **37**:



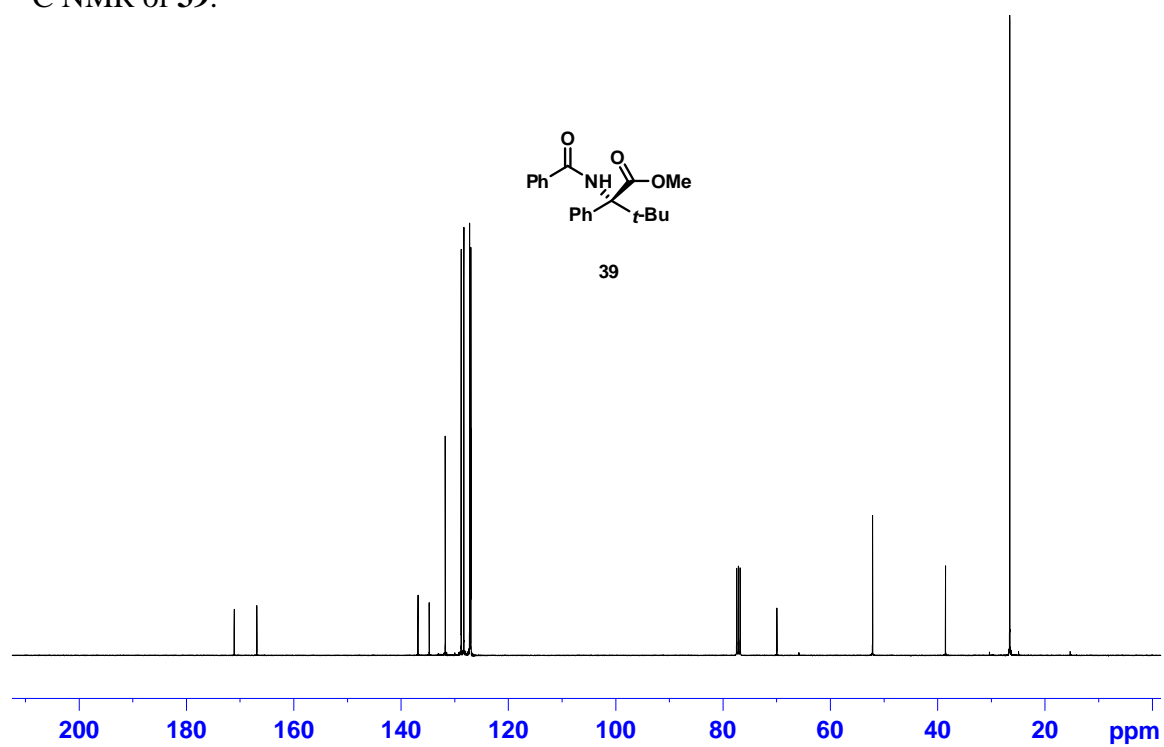
^{13}C NMR of **37**:



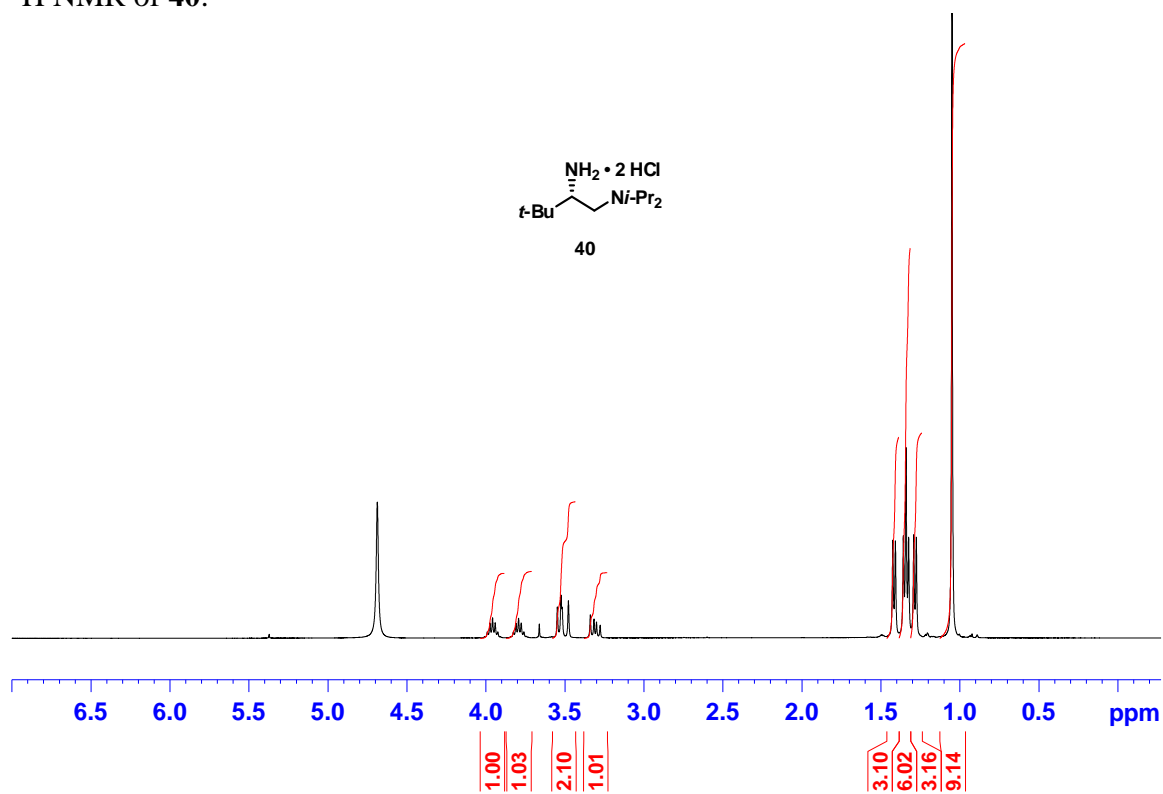
^1H NMR of **39**:



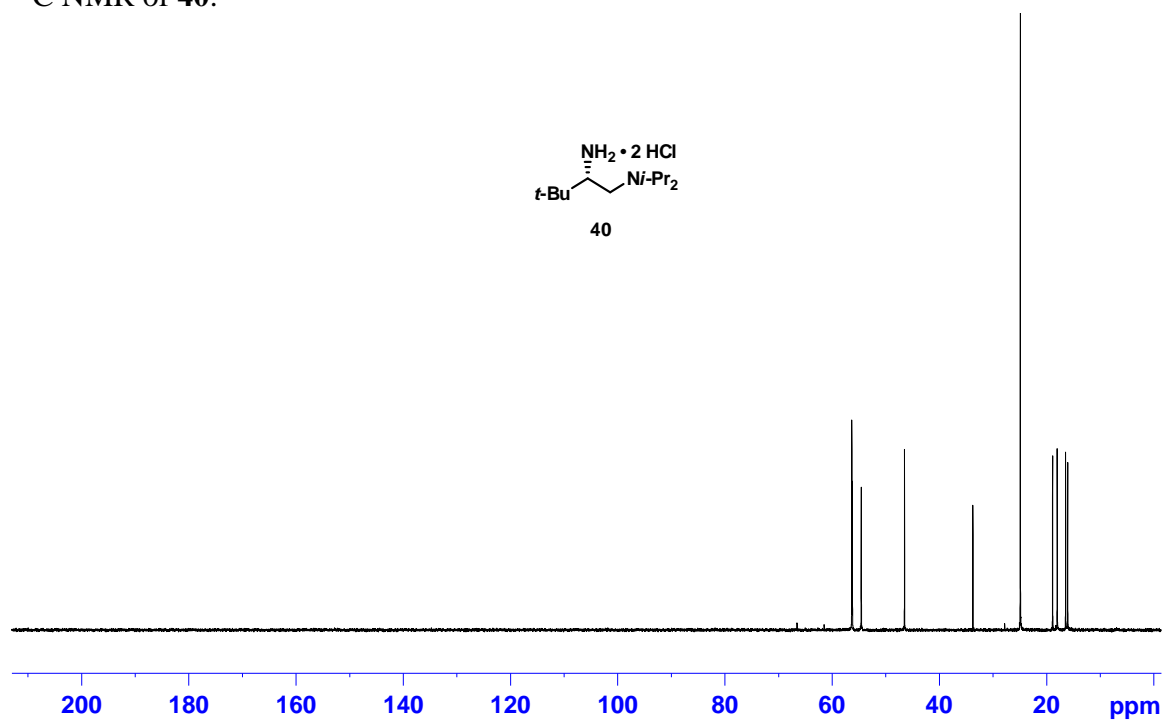
^{13}C NMR of **39**:



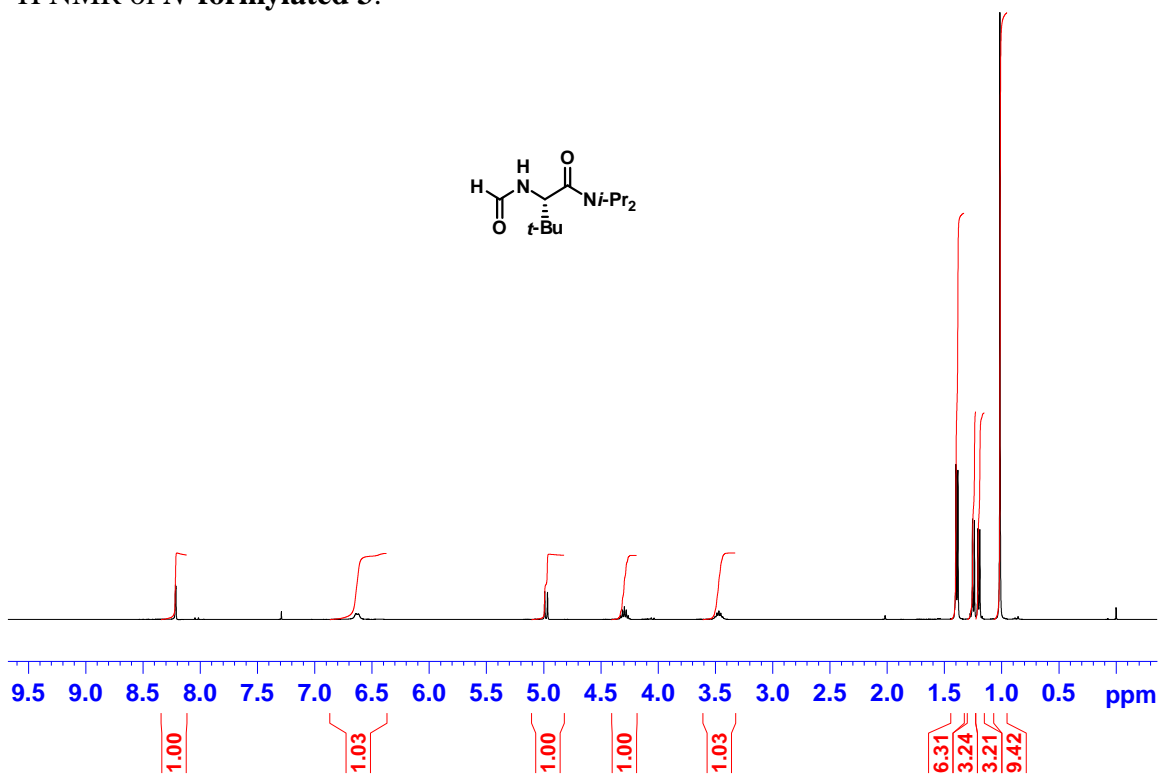
^1H NMR of **40**:



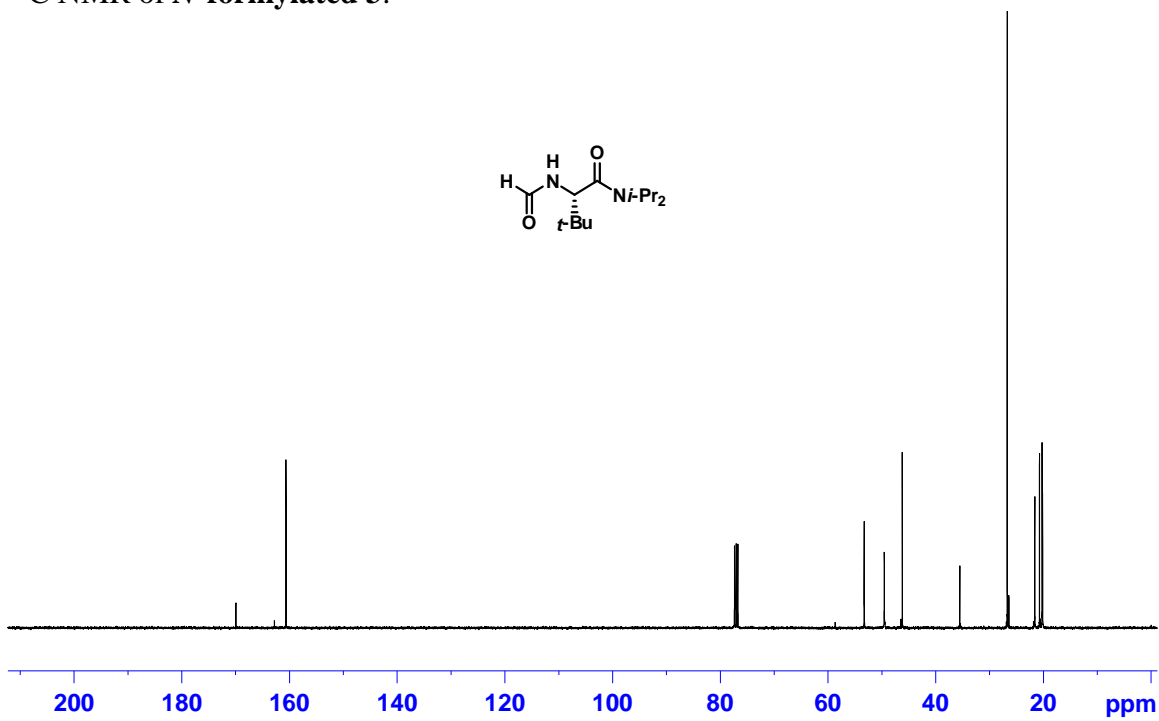
^{13}C NMR of **40**:



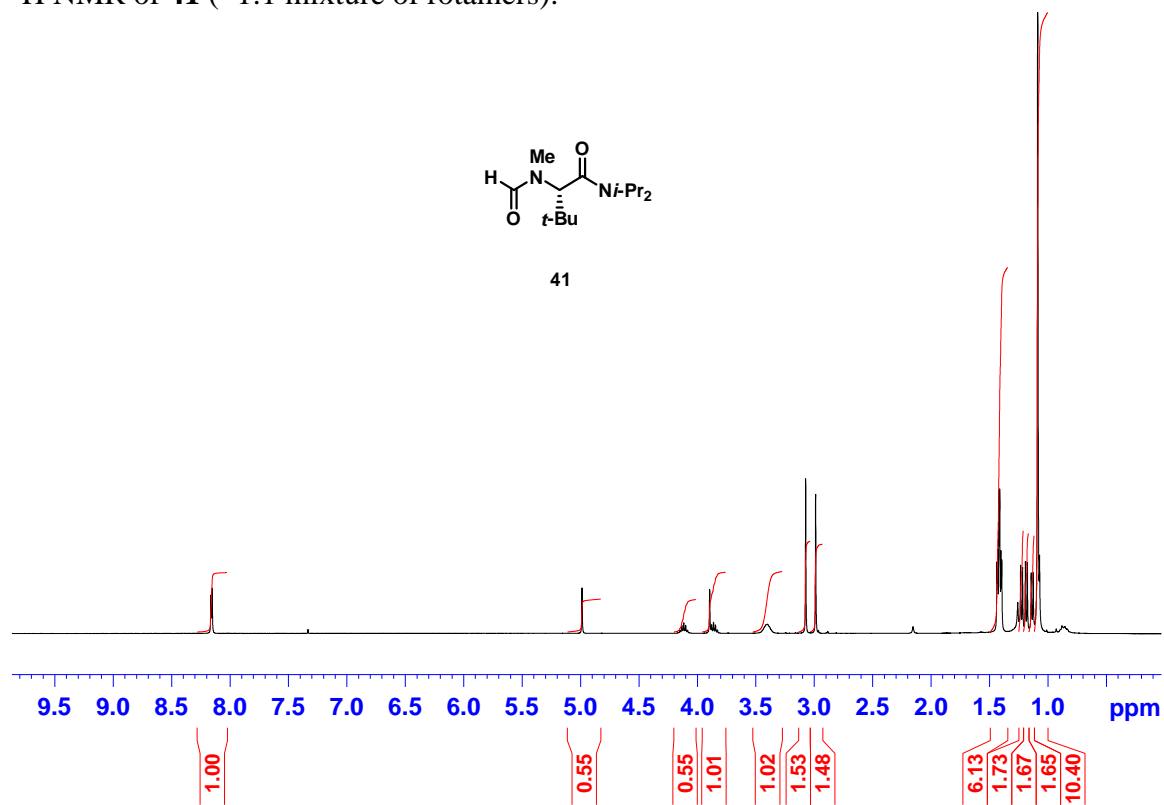
¹H NMR of *N*-formylated 3:



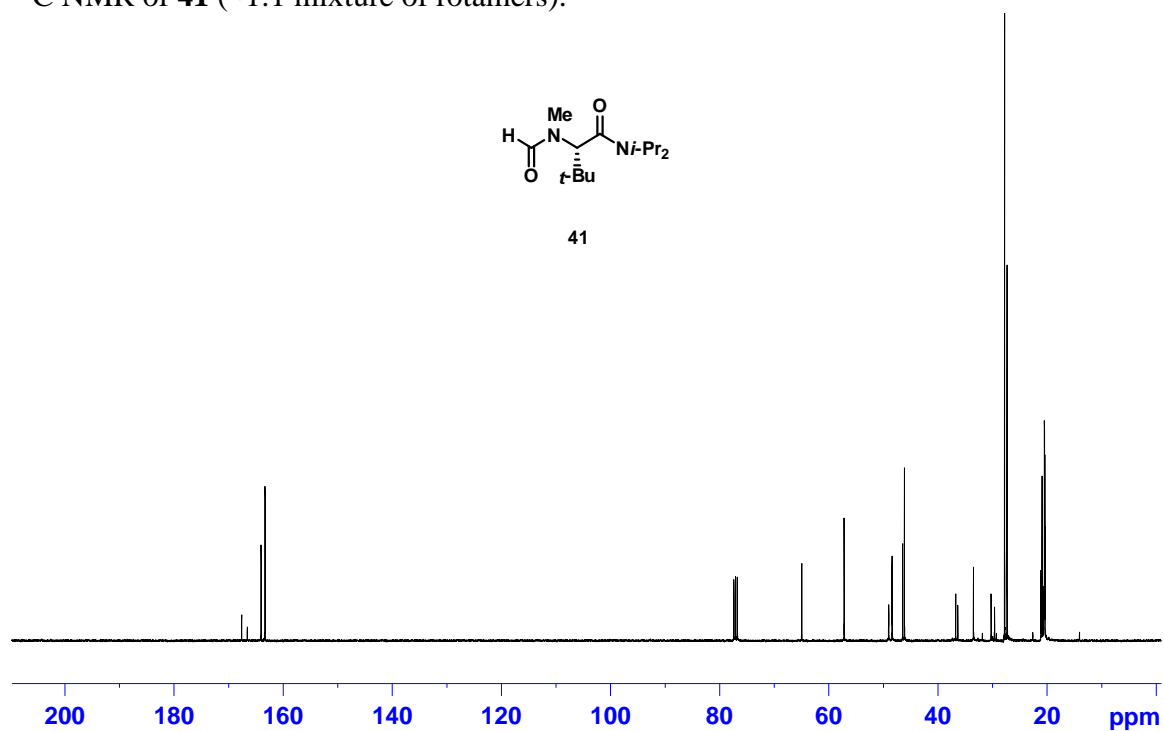
¹³C NMR of *N*-formylated 3:



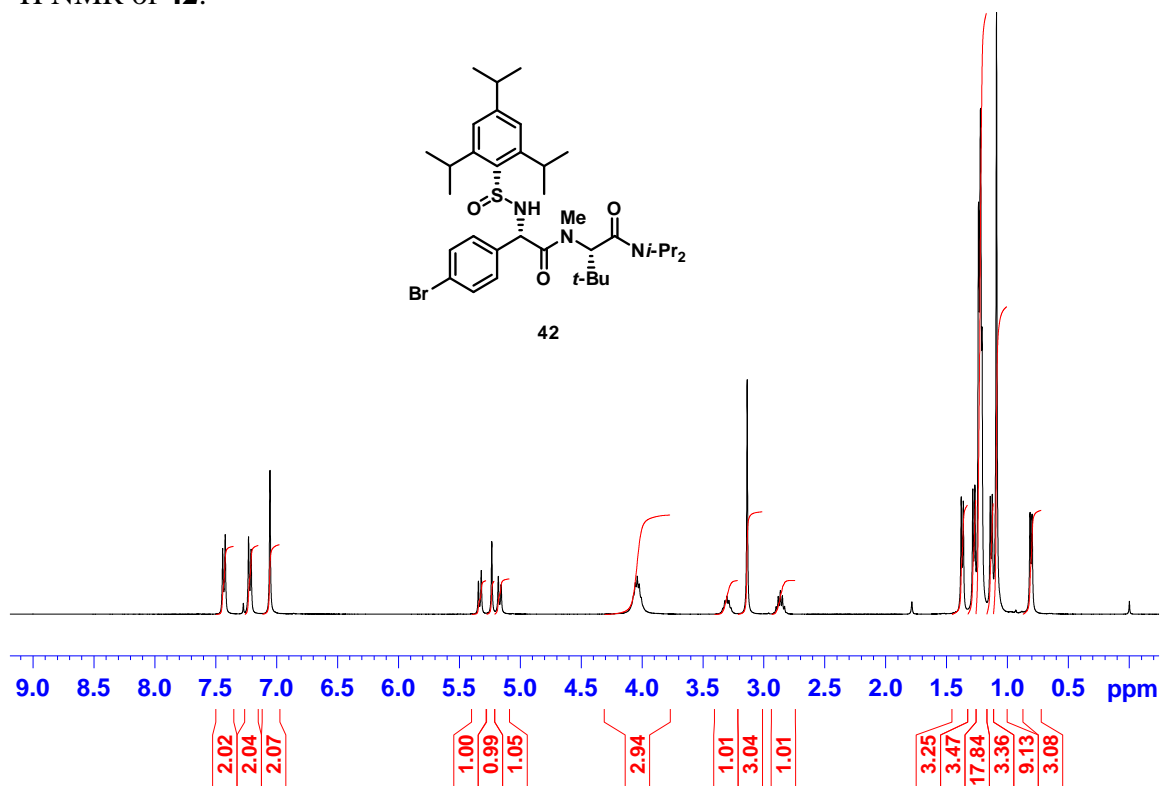
^1H NMR of **41** (~1:1 mixture of rotamers):



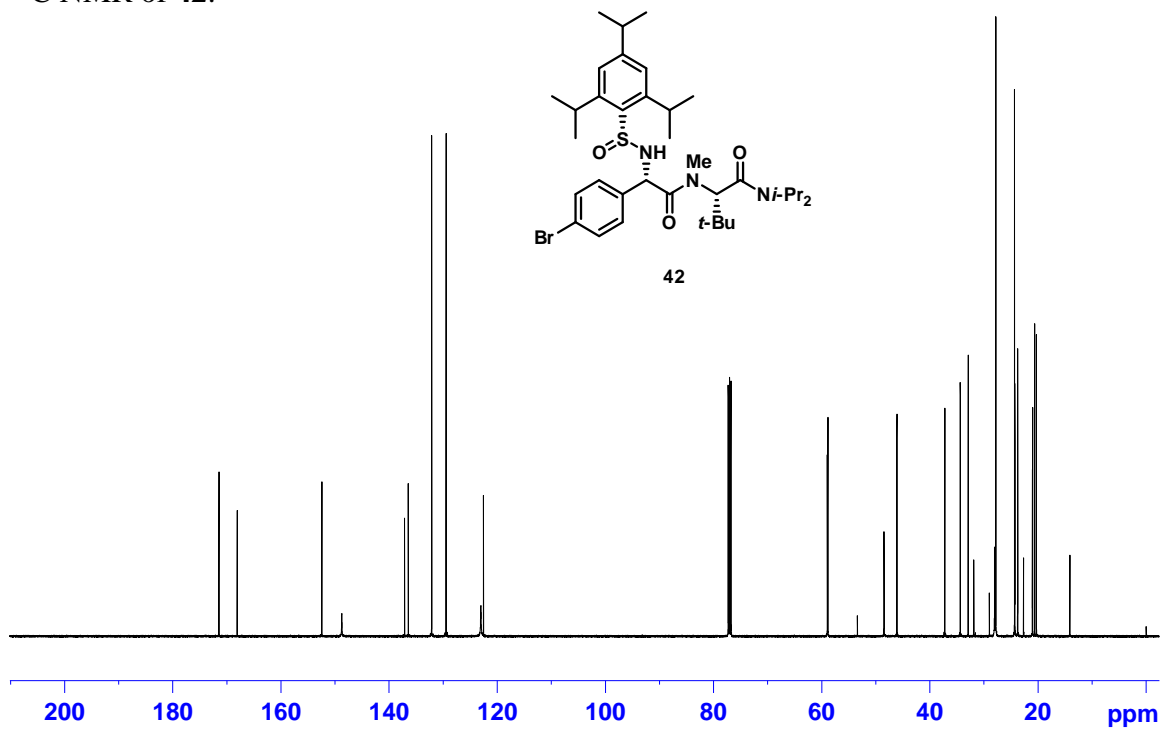
^{13}C NMR of **41** (~1:1 mixture of rotamers):



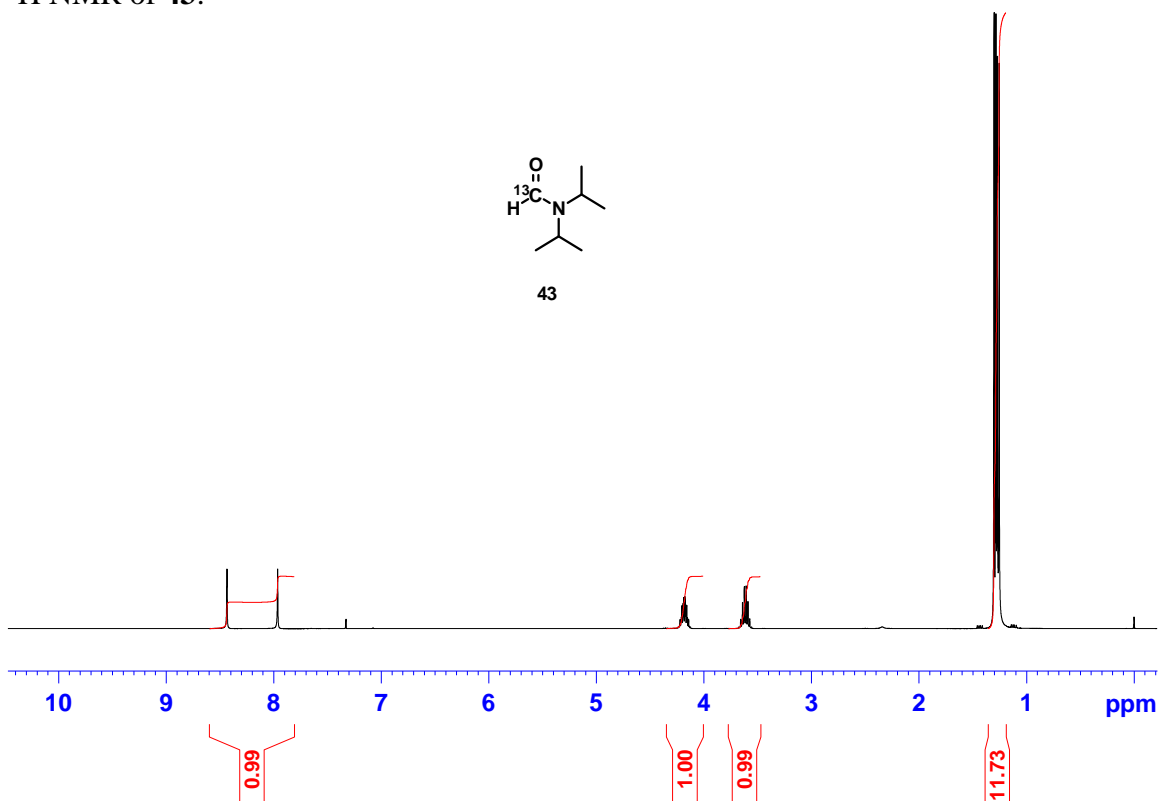
^1H NMR of **42**:



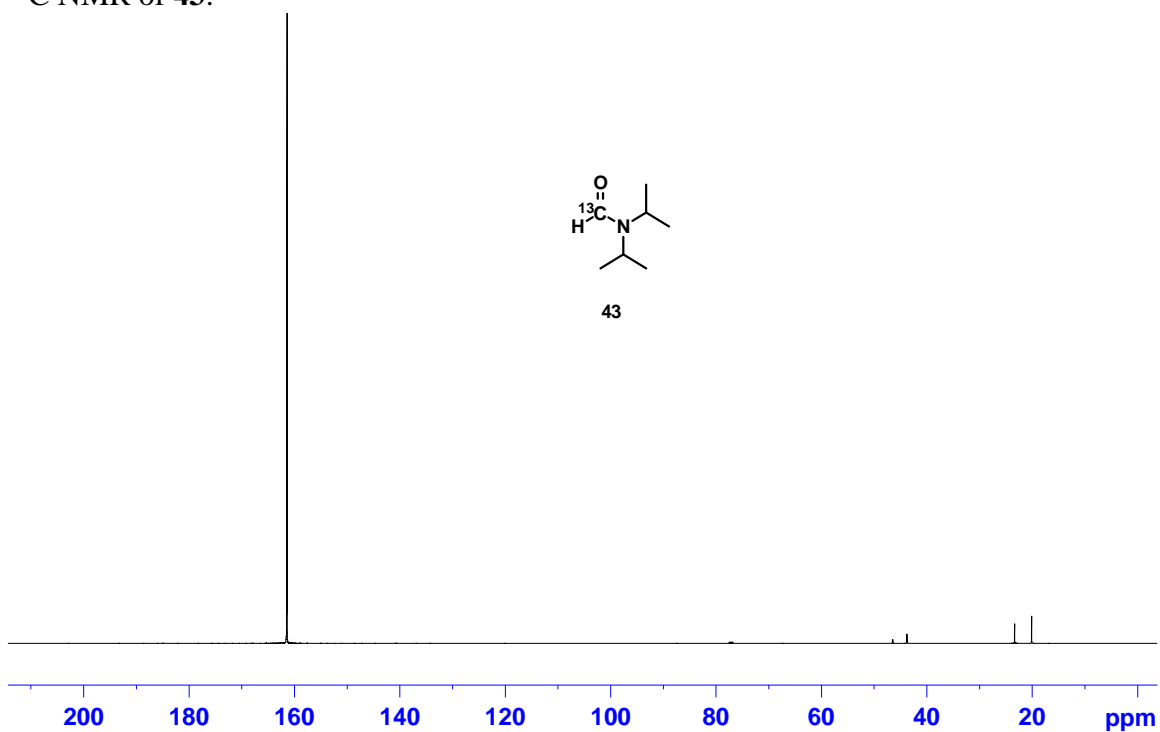
^{13}C NMR of **42**:

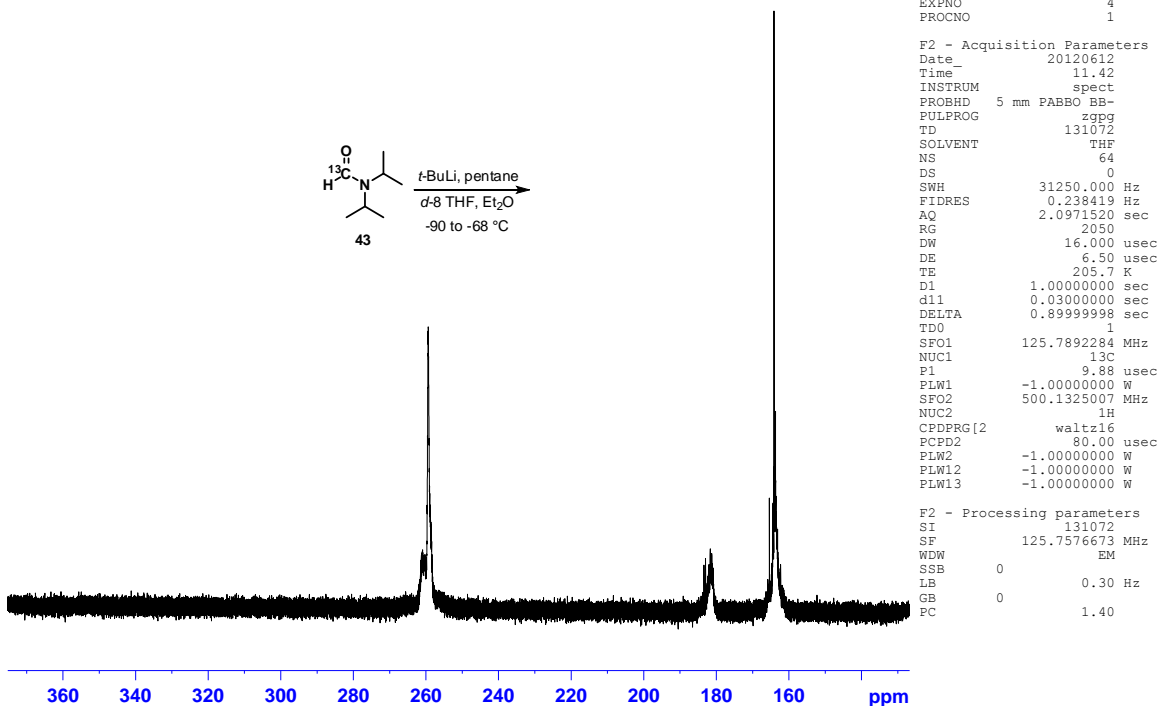


^1H NMR of **43**:



^{13}C NMR of **43**:



¹³C NMR of the anion of **43** at -68 °C (370 to 130 ppm):¹³C labeled diisopropylforamide in THF/Et₂O/pentane/ 1.4:1.4:1/ncg/102658-034¹³C NMR of the anion of **43** at -68 °C (220 to -30 ppm):