Enantioselective Aza-Henry Reaction with an *N*-Sulfinyl Urea Organocatalyst

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Supporting Information

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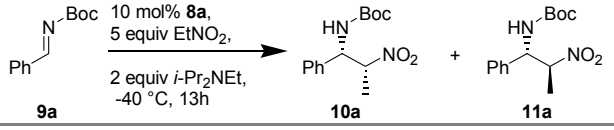
General Methods. All reagents were obtained from commercial suppliers and used without further purification unless otherwise noted. Tetrahydrofuran (THF), toluene, and methylene chloride (CH_2Cl_2) were passed through columns of activated alumina under nitrogen pressure immediately prior to use. Acetonitrile (MeCN) and *N,N*-Diisopropylethylamine (*i*-Pr_2NEt) were distilled over calcium hydride under an atmosphere of nitrogen immediately prior to use. Nitroethane and nitromethane were fractionally distilled and stored under nitrogen. Flash column chromatography was carried out either with Merck 60 230-240 mesh silica gel, or using a Biotage SP Flash Purification System (Biotage No. SP1-B1A) with Flash+ cartridges (Biotage No. FPK0-1107-16046). ^1H and $^{13}C\{^1H\}$ NMR chemical shifts are reported in ppm relative to either the residual solvent peak (^1H, ^{13}C) or TMS (^1H) as an internal standard. IR spectra were recorded as thin films on a Nicolet Avatar 360 FTIR spectrometer equipped with an attenuated total reflectance accessory or as KBr pellets on a Nicolet MAGNA-IR 850 spectrometer, and only partial data are listed. Melting points were determined on a Mel-Temp apparatus and are reported uncorrected. Mass spectrometry (HRMS) was carried out by the University of California at Berkeley Mass Spectrometry Facility.

Di-*tert*-butyl tricarbonate and β-phenylnitroethane were prepared according to literature procedures.[1] Imines **9a-9h** were prepared from α–amido sulfone precursors according to literature procedures.[2] **5a**, **5b**, **8g**, and **8h** are literature compounds.[3]

Optimization of Reaction Conditions

Solvent Optimization:

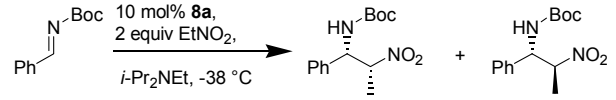


9a **10a** **11a**

Entry	Solvent	Conv.[a]	d.r. (**10**:**11**)[b]	*ee* (%)[b]
1	CH_2Cl_2	82	80:20	90
2	MeCN	100	82:18	92
3	THF	<5	-	28
4	PhMe	5	87:13	79
5	PhCl	23	84:16	84

[a] Conversion to product was determined by ^{1}H NMR analysis of crude product relative to hexamethylbenzene as an internal standard [b] Diastereomeric ratio and enantiomeric excess were determined by chiral HPLC.

Base Stoichiometry:



9a **10a** **11a**

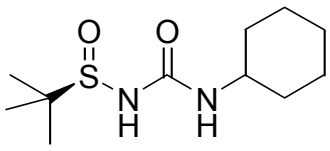
Entry	Equiv *i*-Pr_2NEt	Conv. 3.5 h[a]	Conv. 25 h[a]	d.r. (**10**:**11**)[b]	*ee* (%)[b]
1	1.0	41	92	86:14	94
2	0.5	28	88	88:12	95
3	0.1	4	31	91:9	96

[a] Conversion to product was determined by ^{1}H NMR analysis of crude product relative to hexamethylbenzene as an internal standard [b] Diastereomeric ratio and enantiomeric excess were determined by chiral HPLC.

General Procedures for the Preparation of Sulfinyl Ureas from Sulfinamides and Isocyanates

Procedure A. A stirred solution of (*R*)-*tert*-butanesulfinamide (121 mg, 1.0 mmol) in THF (10 mL) was cooled in a dry ice/acetone bath under a nitrogen atmosphere. Butyllithium in hexanes (1.1 mmol) was added dropwise, and the solution was stirred for 15 min, and then the cold bath was removed and the solution was stirred at rt for 15 min. The appropriate isocyanate (1.1 equiv) was added dropwise, and stirring was continued at rt for 3-5 h. The reaction was quenched by the addition of water (0.5 mL), and the resulting mixture was concentrated.

Procedure B. A stirred solution of (*R*)-*tert*-butanesulfinamide (1.0 equiv) in THF (0.20 M) was cooled in a dry ice/acetone bath under nitrogen atmosphere. Butyllithium in hexanes (1.0 - 2.0 equiv) was added dropwise, and the solution was stirred for 20 min. The appropriate isocyanate (1.2-1.5 equiv) was added dropwise. The solution was stirred for 30 min, after which time the cold bath was removed and stirring was continued at rt for 1 - 18 h.

(*R*)-*N*-(Cyclohexylcarbamoyl)-*tert*-butanesulfinamide 4a. 

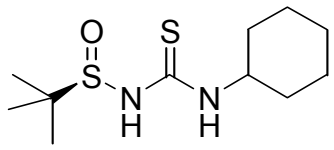
General procedure A was followed, using freshly distilled cyclohexyl isocyanate. The residue was diluted with CH_2Cl_2 (75 mL) and extracted with 0.1 M aqueous NaOH (50 mL, then an additional 25 mL). The combined aqueous layer was acidified to pH < 2 with saturated aqueous $NaHSO_4$ and then extracted with CH_2Cl_2 (3 x 20 mL). The combined extracts were dried over Na_2SO_4, filtered, and concentrated. Crystallization from CH_2Cl_2/EtOAc yielded 145 mg (59%) of white crystalline solid, mp 187-188 °C. IR

(film): 3327, 3202, 2933, 2854, 1695, 1537, 1418, 1031, 1011 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.29 (s, 1H), 5.83 (d, *J* = 7.8 Hz, 1H), 3.66-3.54 (m, 1H), 1.98-1.85 (m, 2H), 1.77-1.65 (m, 2 H), 1.62-1.54 (m, 1H), 1.41-1.29 (m, 2H), 1.28 (s, 9H), 1.27-1.15 (m, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 154.2, 56.8, 49.5, 33.3, 33.3, 25.7, 25.0, 22.5. HRMS (FAB+) calcd for $C_{11}H_{23}N_2O_2S$ $[MH]^+$ 247.1480; found 247.1478.

Cyclohexyl isothiocyanate

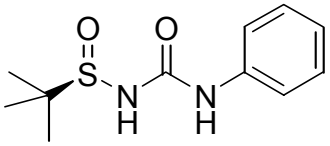
Cyclohexylamine (1.14 mL, 10.0 mmol) was added to a flask containing CH_2Cl_2 (30 mL) and saturated aqueous $NaHCO_3$ (30 mL). The mixture was stirred at 0 °C for 5 min, and then the stirring was stopped and thiophosgene (0.84 mL, 11 mmol) was added directly to the bottom (organic) layer via syringe. The reaction mixture was stirred for 30 min, and then the layers were separated. The organic layer was dried with Na_2SO_4 and concentrated. Silica gel chromatography, eluting with hexanes, afforded 0.408 g (29%) of cyclohexyl isothiocyanate as a pale yellow oil. The ^1H and ^{13}C NMR spectra are consistent with literature values.[4]

(*R*)-*N*-(Cyclohexylcarbamothioyl)-*tert*-butanesulfinamide 4b.



General procedure A was followed. The crude residue was diluted with 0.1 M aqueous NaOH (50 mL) and extracted with CH_2Cl_2 (2 x 25 mL). The aqueous layer was acidified to pH <2 with saturated aqueous $NaHSO_4$, and then extracted with CH_2Cl_2 (2 x 30 mL). The organic layers were dried over Na_2SO_4, filtered, and concentrated. The crude

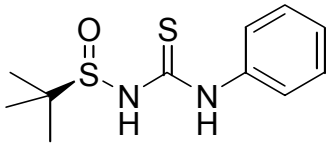
material was recrystallized from EtOAc and collected by vacuum filtration. The mother liquor was reduced in volume and a second crop of crystals was collected, to give a total of 100 mg (38%) of thiourea **4b** as colorless prisms, m.p. 115-118 °C. IR (KBr): 3297, 3158, 2930, 1547, 1497, 1038 cm^{-1}. ^1H NMR (400 MHz, DMSO-d6): δ 8.86 (s, 1H), 8.27 (d, *J* = 7.7 Hz, 1H), 4.05-3.95 (m, 1H), 1.95-1.82 (m, 2H), 1.70-1.60 (m, 2H), 1.58-1.50 (m, 1H), 1.38-1.15 (m, 5 H), 1.18 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, DMSO-d6): δ 181.8, 56.0, 53.1, 31.9, 25.5, 24.6, 22.8. HRMS (FAB+) calcd for $C_{11}H_{23}N_2OS_2$ $[MH]^+$ 263.1252; found 263.1248.

(*R*)-*N*-(Phenylcarbamoyl)-*tert*-butanesulfinamide 6a. 

General procedure B was followed with (*R*)-*tert*-butanesulfinamide (303 mg, 2.50 mmol), *n*-butyllithium (3.8 mL, 5.0 mmol), and phenyl isocyanate (0.41 mL, 3.8 mmol). After 16 h, the reaction mixture was diluted with CH_2Cl_2 (40 mL) and extracted with water (60 mL). The aqueous layer was rinsed with CH_2Cl_2 (4 x 15 mL) and then acidified to pH < 2 with saturated aqueous $NaHSO_4$. The aqueous layer was extracted with CH_2Cl_2 (6 x 20 mL), and the combined extracts were dried over Na_2SO_4, filtered, and concentrated. The crude product was crystallized from CH_2Cl_2/EtOAc and isolated by filtration and rinsing on the filter paper with an additional 2 mL of EtOAc to yield 410 mg (68%) of urea **6a** as a white crystalline solid, mp 171-172 °C. IR (film): 3271, 1686, 1443, 1185, 1032, 891, 759, 690 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.03 (s, 1H), 7.69 (s, 1 H), 7.36 (d, *J* = 7.6 Hz, 2H), 7.24 (apparent t, *J* = 8 Hz, 2H), 7.03 (t, *J* = 7.4 Hz, 1H), 1.34 (s, 9H).

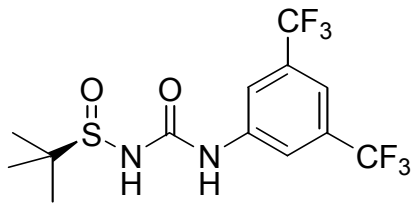
$^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 153.1, 137.7, 129.1, 124.1, 120.0, 56.9, 22.5. HRMS (FAB+) calcd for $C_{11}H_{17}N_2O_2S$ $[MH]^+$ 241.1011; found 241.1004.

(*R*)-*N*-(Phenylcarbamothioyl)-*tert*-butanesulfinamide 6b.

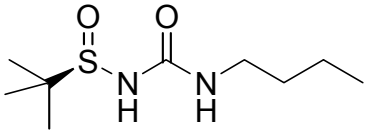


General procedure A was followed, using freshly distilled phenyl isothiocyanate. The crude residue was diluted with 0.1 M aqueous NaOH (50 mL) and washed with CH_2Cl_2 (2 x 25 mL). The aqueous layer was then acidified to pH < 2 with aqueous $NaHSO_4$, and the product was extracted into CH_2Cl_2 (2 x 25 mL). The organic layer was dried over Na_2SO_4 and concentrated. The crude solid was triturated with EtOAc (2 x 2 mL) and isolated by vacuum filtration to yield 133 mg (52%) of thiourea **6b** as a white flaky solid, mp 92.5-93.0 °C. IR (film): 3239, 1483, 1442, 1312, 1169, 1033 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.38 (br s, 1H), 8.50 (br s, 1H), 7.49-7.38 (m, 2H), 7.38-7.28 (m, 2H), 7.26-7.17 (m, 1H), 1.33 (s, 9H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 181.8, 137.6, 129.4, 127.2, 125.0, 57.9, 22.9. HRMS (FAB+) calcd for $C_{11}H_{17}N_2OS_2$ $[MH]^+$ 257.0782; found 257.0775.

(*R*)-*N*-(3,5-Bis(trifluoromethyl)phenylcarbamoyl)-*tert*-butanesulfinamide 6c.

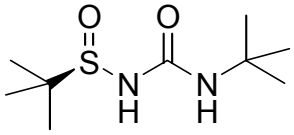


General procedure A was followed. The crude residue was diluted with water (50 mL), acidified to pH < 2 with aqueous $NaHSO_4$, and product was extracted into CH_2Cl_2 (50 mL). The organic layer was dried over Na_2SO_4 and concentrated. Flash column chromatography on a Biotage Flash+ cartridge with a gradient of 1% to 10% of MeOH in CH_2Cl_2 afforded 191 mg (50%) of a urea **6c** as a white solid, mp 74-83 °C. IR (film): 3281, 1716, 1575, 1474, 1382, 1276, 1170, 1127, 1039 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.45 (s, 1H), 8.15 (s, 1H), 7.83 (s, 2H), 7.49 (s, 1H), 1.39 (s, 9H). $^{13}C\{^1H\}$ NMR (126 MHz, CD_3OD): δ 154.8, 141.79, 133.3 (q, J_{CF} = 33 Hz), 124.6 (q, J_{CF} = 272 Hz), 119.9, 117.2, 57.2, 22.6. HRMS (FAB+) calcd for $C_{13}H_{15}F_6N_2O_2S$ $[MH]^+$ 377.0758; found 377.0761.

(*R*)-*N*-(Butylcarbamoyl)-*tert*-butanesulfinamide 6d. 

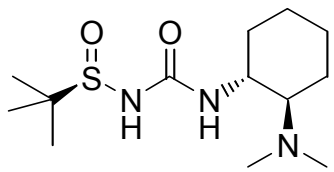
General procedure B was followed with (*R*)-*tert*-butanesulfinamide (121 mg, 1.00 mmol), THF (6 mL), butyllithium (0.50 mL, 1.2 mmol), and butyl isocyanate (0.13 mL, 1.2 mmol). After 6 h, the reaction mixture was diluted with CH_2Cl_2 (20 mL) and extracted with 0.2 M NaOH (25 mL). The aqueous layer was rinsed with CH_2Cl_2 (3 x 10 mL) and then acidified to pH < 2 with saturated aqueous $NaHSO_4$. The aqueous layer was extracted with CH_2Cl_2 (25 mL), and the extract was dried over Na_2SO_4, filtered, and concentrated. Flash column chromatography on a Biotage Flash+ cartridge with a gradient of 12% to 100% of EtOAc in hexanes afforded 76 mg (34%) of a urea **6d** as a clear oil. IR (film): 3340, 2959, 2872, 1655, 1542, 1042 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 6.88 (br s, 1H), 5.65 (br s, 1H), 3.27-3.20 (m, 2H), 1.56-1.47 (m, 2H), 1.41-

1.30 (m, 2H), 1.28 (s, 9H), 0.93 (t, J = 7.3 Hz, 3H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 155.2, 56.8, 40.5, 32.0, 22.5, 20.2, 14.0. HRMS (FAB+) calcd for $C_9H_{21}N_2O_2S$ $[MH]^+$ 221.1324; found 221.1321.

(*R*)-*N*-(*tert*-Butylcarbamoyl)-*tert*-butanesulfinamide 6e. 

General procedure B was followed with (*R*)-*tert*-butanesulfinamide (121 mg, 1.00 mmol), THF (6 mL), butyllithium (0.50 mL, 1.3 mmol), and *tert*-butyl isocyanate (0.14 mL, 1.3 mmol). After 3 h, the reaction mixture was diluted with CH_2Cl_2 (15 mL) and extracted with 0.2 M NaOH (3 x 20 mL). The aqueous layer was acidified to pH < 2 with saturated aqueous $NaHSO_4$ and then extracted with CH_2Cl_2 (2 x 20 mL), and the combined extracts were dried over Na_2SO_4, filtered, and concentrated. The crude solid was triturated with EtOAc (3 mL) and isolated by filtration and rinsing on the filter with EtOAc (2 x 2 mL) to yield 129 mg (59%) of urea **6d** as a white powdery solid, mp 195-196 °C. IR (film): 3335, 3231, 2963, 1708, 1552, 1412, 1364, 1259, 1030, 1011 cm^{-1}. ^{1}H NMR (300 MHz, $CDCl_3$): δ 6.80 (br s, 1H), 5.70 (br s, 1H), 1.36 (s, 9H), 1.27 (s, 9H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 153.8, 56.6, 51.3, 29.1, 22.5. HRMS (FAB+) calcd for $C_9H_{21}N_2O_2S$ $[MH]^+$ 221.1324; found 221.1327.

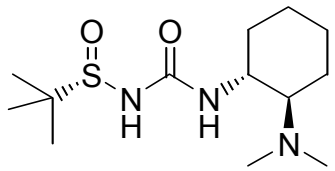
(*R*)-*N*-((1*R*,2*R*)-2-(Dimethylamino)cyclohexylcarbamoyl)-*tert*-butanesulfinamide 7a.



(1*R*,2*R*)-*N*,*N*-Dimethylcyclohexanediamine (0.537 g, 3.78 mmol) was dissolved in CH_2Cl_2 (20 mL) and added dropwise over 5 min to a solution of di-tert-butyltricarbonate (1.05 g, 4.0 mmol) in CH_2Cl_2 with stirring. After stirring at rt for 30 min, 0.10 mL of pyridine was added, and the solution was concentrated to yield the crude isocyanate.

(*R*)-*tert*-Butanesulfinamide (484 mg, 4.00 mmol) was dissolved in 40 mL of THF and cooled to -78 °C. Butyllithium (1.8 mL of a 2.2 M solution in hexanes, 4.0 mmol) was added dropwise, and then the reaction mixture was warmed to rt and stirred for 15 min. The crude isocyanate was dissolved in 3 mL of THF, and the resulting solution was added dropwise, with rinsing with an additional 2 mL of THF. The solution was stirred for an additional 2 h at rt. The reaction was quenched by dropwise addition of water (1.0 mL), and the resulting mixture was then concentrated. The residue was diluted with 10 mL of brine and extracted with ethyl acetate (6 x 25 mL). The organic layers were dried over Na_2SO_4, filtered, and concentrated. Chromatography on silica gel (1%MeOH, 0.1% NH_4OH in CH_2Cl_2 to 10% MeOH, 1% NH_4OH in CH_2Cl_2) gave 357 mg (33%) of urea **7a** as a white solid, mp 53-60 °C. IR (KBr): 3337, 2932, 1701, 1655, 1541, 1049 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 6.41 (br s, 1H), 5.76 (br s, 1H), 3.45-3.30 (m, 1H), 2.48-2.38 (m, 1H), 2.32-2.16 (m, 1H), 2.25 (s, 6H), 1.88-1.72 (m, 2 H), 1.70-1.60 (m, 1H), 1.37-1.02 (m, 4H), 1.27 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 155.3, 66.4, 56.5, 51.8, 39.8, 32.7, 25.1, 24.5, 22.1, 21.4. HRMS (FAB+) calcd for $C_{13}H_{28}N_3O_2S$ $[MH]^+$ 290.1902; found 290.1897.

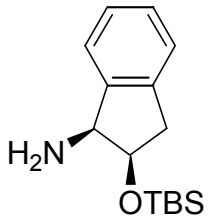
(*S*)-*N*-((1*R*,2*R*)-2-(Dimethylamino)cyclohexylcarbamoyl)-*tert*-butanesulfinamide 7b.



The crude isocyanate was prepared from (1*R*,2*R*)-*N*,*N*-dimethylcyclohexanediamine (0.553 g, 3.89 mmol) as described above. (*R*)-*tert*-Butanesulfinamide (509 mg, 4.20 mmol) was dissolved in 40 mL of THF and cooled to -78 °C. Butyllithium (1.9 mL of a 2.2 M solution in hexanes, 4.2 mmol) was added dropwise, and then the reaction mixture was warmed to rt and stirred for 15 min. The crude isocyanate was dissolved in 6 mL of THF, and the resulting solution was added dropwise, with rinsing with an additional 3 mL of THF. The solution was stirred for an additional 3 h at rt. The reaction was quenched by dropwise addition of acetic acid (3 drops), and the resulting mixture was then concentrated. The residue was diluted with 4 mL of brine and extracted with EtOAc (5 x 5 mL). The organic layers were discarded, and the aqueous layer was made basic by the addition of 0.5 mL of concentrated NH_4OH. This mixture was then extracted with EtOAc (6 x 5 mL). The organic layer was dried over Na_2SO_4 and concentrated to yield a crude oil which crystallized upon standing overnight. The crystals were triturated with EtOAc, collected by vacuum filtration, and rinsed on the filter with EtOAc and hexanes. The filtrate was then concentrated and the procedure was repeated twice, yielding 3 crops of urea **7b** (total 336 mg, 30%) as a white solid, mp 150-153 °C. IR (KBr): 3558, 3312, 3248, 2931, 1647, 1533, 1085 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 6.91 (br s, 1H), 6.17 (br s, 1H), 3.48-3.34 (m, 1H), 2.45-2.16 (m, 2H), 2.24 (s, 6H), 1.88-1.72 (m, 2 H), 1.70-1.60 (m, 1H), 1.37-1.05 (m, 4H), 1.27 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ

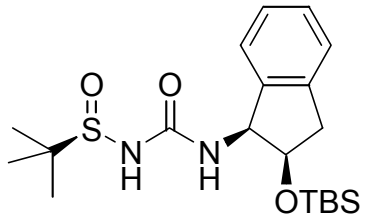
155.3, 66.4, 56.3, 52.0, 40.0, 32.9, 25.0, 24.6, 22.2, 22.0. HRMS (FAB+) calcd for $C_{13}H_{28}N_3O_2S$ $[MH]^+$ 290.1902; found 290.1908.

(1*S*,2*R*)-2-(*tert*-butyldimethylsilyloxy)-2,3-dihydro-1H-inden-1-amine S1



A solution of *tert*-butylchlorodimethylsilane (8.1 g, 54 mmol) in CH_2Cl_2 was added to a stirred solution of (1*S*,2*R*)-cis-1-aminoindan-2-ol (4.00 g, 26.8 mmol), 4-dimethylaminopyridine (0.66 g, 5.4 mmol), and triethylamine (7.4 mL, 53 mmol) in CH_2Cl_2 (40 mL). After stirring 18 h, the reaction mixture was extracted with water (50 mL) followed by brine (50 mL). The organic layer was dried over Na_2SO_4 and concentrated. Flash column chromatography on silica gel eluting with 2% to 50% EtOAc in hexanes afforded 7.1 g (100%) of product **S1** as a light brown oil. IR (film): 2954, 2856, 1472, 1254, 1111, 1068 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.40-36 (m, 1H), 7.25-7.16 (m, 3H), 4.44 (apparent q, 1H), 4.12 (d, *J* = 5.3 Hz, 1H), 3.01 (dd, *J* = 5.9 Hz, 15.8 Hz, 1H), 2.88 (dd, *J* = 4.8 Hz, 15.8 Hz, 1H), 1.48 (br s, 2H), 0.90 (s, 9H), 0.12 (s, 3H), 0.12 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$): δ 144.4, 140.1, 127.6, 126.7, 124.8, 124.6, 75.3, 59.5, 39.2, 25.8, 18.2, -4.6, -4.8. HRMS (FAB+) calcd for $C_{15}H_{26}NOSi$ $[MH]^+$ 264.1784; found 264.1791.

(*R*)-N-((1*S*,2*R*)-2-(tert-butyldimethylsilyloxy)-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfinamide 8d

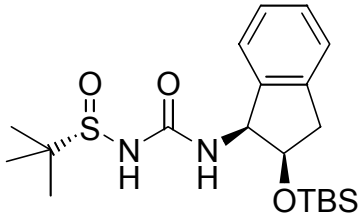


Amine **S1** (2.46 g, 9.35 mmol) was dissolved in CH_2Cl_2 (100 mL). Saturated aqueous $NaHCO_3$ (100 mL) was added and the mixture was stirred for 15 min in an ice bath. The stirring was stopped, and a solution of triphosgene (0.925 g, 3.12 mmol) in CH_2Cl_2 (5 mL) was added directly to the CH_2Cl_2 layer via syringe. Stirring was resumed (1 min at slow speed, followed by 1 min at high speed), and then the layers were separated. The organic layer was dried over Na_2SO_4 and concentrated to yield crude isocyanate as a brown oil.

(*R*)-*tert*-Butanesulfinamide (1.13 g, 9.35 mmol) was dissolved in 75 mL of THF and cooled to -78 °C. Butyllithium (4.25 mL of a 2.2 M solution in hexanes, 9.35 mmol) was added dropwise, and then the reaction mixture was warmed to -40 °C and stirred for 15 min. The crude isocyanate was added dropwise, with rinsing with an additional 5 mL of THF. The cold bath was allowed to melt gradually, and the solution was stirred for an additional 16 h at rt. The reaction was quenched by dropwise addition of water (5 mL), and then the resulting mixture was concentrated. The residue was diluted with EtOAc (250 mL) and water (300 mL), and acidified to pH <2 with saturated aqueous $NaHSO_4$.

The layers were separated, and the organic layer was washed with brine (50 mL) then dried over Na_2SO_4 and concentrated. Flash column chromatography on a Biotage Flash+ cartridge with a gradient of 12% to 60% of EtOAc in hexanes, followed by trituration with 5% EtOAc in hexanes afforded 3.30 g (86%) of urea **8d** as a colorless powder, mp 177-179 °C (phase change at 100°C). IR (KBr): 3356, 2955, 1705, 1653, 1539 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.80 (s, 1H), 7.31 (d, *J* = 7.2 Hz, 1H), 7.22-7.08 (m, 3H), 6.19 (d, *J* = 8.6 Hz, 1H), 5.26 (dd, *J* = 5.2 Hz, 8.4 Hz, 1H), 4.64-4.58 (m, 1H), 3.07 (dd, *J* = 4.9 Hz, 16.2 Hz, 1H), 2.88 (d, *J* = 16.2 Hz, 1H), 1.26 (s, 9H), 0.85 (s, 9H), 0.25 (s, 3H), 0.22 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 155.2, 141.2, 139.7, 127.7, 127.0, 124.7, 124.5, 74.0, 58.1, 56.8, 40.4, 25.8, 22.1, 18.1, -4.8, -4.9. HRMS (FAB+) calcd for $C_{20}H_{35}N_2O_3SSi$ $[MH]^+$ 411.2138; found 411.2137.

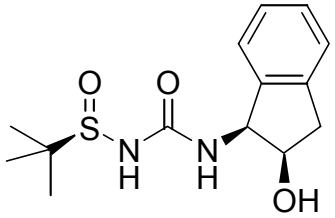
(*S*)-N-((1*S*,2*R*)-2-(tert-butyldimethylsilyloxy)-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfinamide S2



Crude isocyanate was prepared as described above from amine **S1** (1.75 g, 6.65 mmol). (*S*)-*tert*-Butanesulfinamide (812 mg, 6.7 mmol) was dissolved in 30 mL of THF and cooled to -78 °C. Butyllithium (3.05 mL of a 2.2 M solution in hexanes, 6.7 mmol) was added dropwise, and then the reaction mixture was warmed to rt and stirred for 15 min. The crude isocyanate dissolved in 3 mL of THF was added dropwise, and then the solution was stirred for 16 h at rt. The reaction was quenched by dropwise addition of

water (1 mL), and then the resulting mixture was concentrated. The residue was diluted with EtOAc (75 mL) and water (100 mL), and acidified to pH <2 with saturated aqueous $NaHSO_4$. The layers were separated, and the organic layer was washed with brine (100 mL) and then dried over Na_2SO_4 and concentrated. Flash chromatography on silica gel (0% to 5% MeOH in CH_2Cl_2) yielded 2.38 g (87%) of urea **S2** as an off-white foamy solid, mp 74-77 °C. IR (KBr): 3352, 2955, 2928, 2856, 1654, 1526, 1072 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.71 (br s, 1H), 7.33 (d, *J* = 7.2 Hz, 1H), 7.25-7.14 (m, 3H), 6.16 (d, *J* = 8.2 Hz, 1H), 5.22 (dd, *J* = 5.4 Hz, 8.0 Hz, 1H), 4.65-4.58 (m, 1H), 3.07 (dd, *J* = 5.1 Hz, 16.2 Hz, 1H), 2.89 (dd, *J* = 1.9 Hz, 16.2 Hz, 1H), 1.28 (s, 9H), 0.87 (s, 9H), 0.10 (s, 3H), 0.10 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 155.4, 141.1, 139.6, 127.9, 126.9, 124.8, 124.7, 73.9, 58.1, 57.1, 40.3, 25.9, 22.2, 18.1, -4.7, -4.8. HRMS (FAB+) calcd for $C_{20}H_{35}N_2O_3SSi$ $[MH]^+$ 411.2138; found 411.2133.

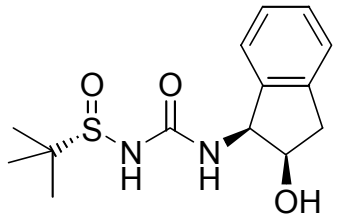
(*R*)-N-((1*S*,2*R*)-2-hydroxy-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfinamide 8a



Urea **8d** (398 mg, 0.969 mmol) was dissolved in 3 mL of THF. To this solution was added 3 mL of a 1.0 M solution of tetrabutylammonium fluoride in THF. After 16 h, the reaction mixture was diluted to 25 mL with EtOAc, and washed with water (15 mL) followed by brine (15 mL). The aqueous layers were combined and extracted with EtOAc (3 x 10 mL). The organic layers were combined, dried over Na_2SO_4, filtered, and

concentrated. Silica gel chromatography (50% EtOAc in hexanes to 100% EtOAc) followed by recrystallization from EtOAc yielded 246 mg (86%) of urea **8a** as a white solid, mp 172-173 °C. IR (KBr): 3512, 3324, 2946, 1635, 1541, 1066 cm^{-1}. ^1H NMR (400 MHz, CD_3CN): δ 7.34 (br s, 1H), 7.28-7.15 (m, 4H), 6.22 (d, *J* = 8.2 Hz, 1H), 5.14 (dd, *J* = 8.4 Hz, 4.9 Hz, 1H), 4.50-4.42 (m, 1H), 3.41 (br s, 1H), 3.10 (dd, *J* = 16.4 Hz, 4.8 Hz, 1H), 2.83 (d, *J* = 16.5 Hz, 1H), 1.22 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, CD_3CN): δ 156.6, 142.9, 141.6, 128.7, 127.8, 126.2, 125.1, 73.8, 59.3, 56.3, 40.5, 22.7. HRMS (FAB+) calcd for $C_{14}H_{21}N_2O_3S$ $[MH]^+$ 297.1273; found 297.1271.

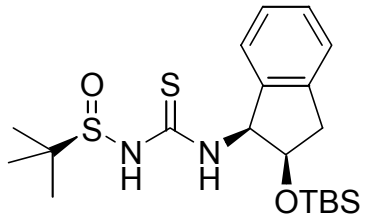
(*S*)-N-((1*S*,2*R*)-2-hydroxy-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfinamide 8c



Urea **S2** (1.64 g, 4.00 mmol) was dissolved in 12 mL of THF. To this solution was added 12 mL of a 1.0 M solution of tetrabutylammonium fluoride in THF. After 16 h, the reaction mixture was concentrated, and then the residue was diluted with 40 mL of water. This mixture was extracted with CH_2Cl_2 (50 mL followed by 2 x 10 mL). The organic layers were combined, dried over Na_2SO_4, filtered, and concentrated. The crude residue was purified by flash chromatography on silica gel (0% to 5% MeOH in CH_2Cl_2) to yield 891 mg (75%) of urea **8c** as a white solid, mp 116-119 °C. IR (KBr): 3336, 2961, 1654, 1541, 1226, 1052 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.41 (br s, 1H), 7.28-7.11 (m, 4H), 6.76 (d, *J* = 8.8 Hz, 1H), 5.32-5.25 (m, 1H), 5.18 (d, *J* = 4.0 Hz, 1H), 4.63-4.57 (m,

1H), 3.12 (dd, J = 5.0 Hz, 16.4 Hz, 1H), 2.98 (d, J = 16.3 Hz, 1H), 1.29 (s, 9H) . $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ.156.4, 140.9, 140.3, 127.8, 126.7, 125.1, 124.2, 72.8, 58.6, 56.4, 39.5, 22.5 .HRMS (FAB+) calcd for $C_{14}H_{21}N_2O_3S$ $[MH]^+$ 297.1273; found 297.1271.

(*R*)-N-((1*S*,2*R*)-2-(tert-butyldimethylsilyloxy)-2,3-dihydro-1H-inden-1-ylcarbamothioyl)-*tert*-butanesulfinamide S3

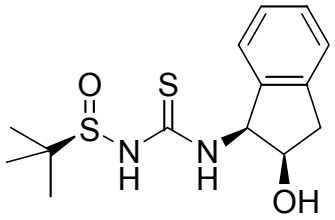


Amine **S1** (3.50 g, 13.3 mmol) was dissolved in CH_2Cl_2 (150 mL). Aqueous K_2CO_3 (0.5 M, 150 mL) was added and the mixture was stirred for 15 min at rt. The stirring was stopped, and thiophosgene (2.04 mL, 26.6 mmol) was added directly to the CH_2Cl_2 layer via syringe. The biphasic mixture was stirred for 1.5 h, and then the layers were separated. The organic layer was dried over Na_2SO_4 and concentrated to yield crude isothiocyanate as a brown oil.

(*R*)-*tert*-Butanesulfinamide (812 mg, 6.7 mmol) was dissolved in 30 mL of THF and cooled to -78 °C. Butyllithium (3.05 mL of a 2.2 M solution in hexanes, 6.7 mmol) was added dropwise, and then the reaction mixture was warmed to rt and stirred for 15 min. Half of the crude isothiocyanate (6.65 mmol) dissolved in 3 mL of THF was added dropwise, and then the solution was stirred for 45 h at rt. The reaction was quenched by dropwise addition of water (1 mL), and then the resulting mixture was concentrated. The

residue was diluted with EtOAc (125 mL) and water (150 mL), and acidified to pH <2 with saturated aqueous $NaHSO_4$. The layers were separated, and the organic layer was washed with water (100 mL) followed by brine (100 mL) and then dried over Na_2SO_4 and concentrated. The crude residue was purified by flash chromatography on silica gel (0% to 5% MeOH in CH_2Cl_2), followed by trituration with EtOAc/hexanes. The mixed fractions were collected separately and subjected to a second purification under the same conditions to yield a total of 1.41 g (50%) of thiourea **S3** as a pale brown solid, mp 122-124 °C. IR (KBr):3273, 2955, 2928, 1491, 1254, 1041 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 8.22 (br s, 1H), 7.76 (d, *J* = 8.7 Hz, 1H), 7.46 (d, *J* = 6.3 Hz, 1H), 7.29-7.19 (m, 3H), 6.03 (dd, *J* = 5.0, 8.5 Hz, 1H) 4.74 (apparent t, 1H), 3.14 (dd, *J* = 4.7 Hz, 16.4 Hz, 1H), 2.92 (d, *J* = 16.4 Hz, 1H), 1.29 (s, 9H), 0.86 (s, 9H), 0.12 (s, 3H), 0.10 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 182.4, 140.2, 139.7, 128.0, 127.3, 124.9, 124.5, 73.8, 63.1, 58.1, 40.7, 25.8, 22.2, 18.1, -4.8, -4.8. HRMS (FAB+) calcd for $C_{20}H_{35}N_2O_3S_2Si$ $[MH]^+$ 427.1909; found 427.1916.

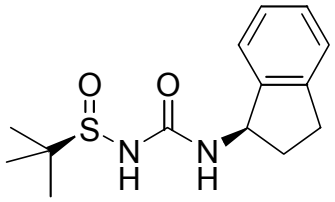
(*R*)-N-((1*S*,2*R*)-2-hydroxy-2,3-dihydro-1H-inden-1-ylcarbamothioyl)-*tert*-butanesulfinamide 8b



Thiourea **S3** (300 mg, 0.71 mmol) was dissolved in 10 mL of THF. To this solution was added 2.13 mL of a 1.0 M solution of tetrabutylammonium fluoride in THF. The solution was stirred for 16 h at rt, and then diluted with saturated aqueous ammonium chloride.

The resulting mixture was extracted twice with CH_2Cl_2. The organic layer was dried over Na_2SO_4 and concentrated. The crude material was purified by reverse phase chromatography on a Biotage C18 column using a gradient of 5% to 95% MeCN in H_2O (with 0.1% TFA) to yield thiourea **8b** (209 mg, 94%) as a white solid, mp 65-67 °C. IR (KBr): 3403, 3284, 2937, 1502, 1048 cm^{-1}. ^1H NMR (400 MHz, DMSO-d6): δ 9.49 (br s, 1H), 8.75 (d, J = 8.3 Hz, 1H), 7.32-7.14 (m, 4H), 5.73 (dd, *J* = 8.1 Hz, 5.0 Hz, 1H), 5.49 (d, *J* = 4.2, 1H), 4.56-4.48 (m, 1H), 3.12 (dd, *J* = 16.4 Hz, 4.6 Hz, 1H), 2.83 (d, *J* = 16.3 Hz, 1H), 1.22 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, CD_3CN): δ 185.0, 141.8, 141.7, 129.0, 127.7, 126.3, 125.4, 73.6, 63.8, 57.4, 40.7, 22.9. HRMS (FAB+) calcd for $C_{14}H_{21}N_2O_2S_2$ $[MH]^+$ 313.1044; found 313.1044.

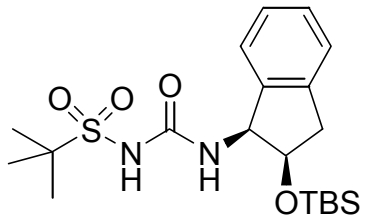
(*R*)-N-((*R*)-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfinamide 8e



CH_2Cl_2 (12 mL) and saturated aqueous $NaHCO_3$ (12 mL) were added to a flask containing (*R*)-1-aminoindane hydrochloride salt (209 mg, 1.23 mmol), and the mixture was stirred for 15 min in an ice bath. The stirring was stopped, and a solution of triphosgene (0.122 g, 0.411 mmol) in CH_2Cl_2 (1.2 mL) was added directly to the CH_2Cl_2 layer via syringe. Stirring was resumed (3 min at slow speed, followed by 2 min at high speed), and then the layers were separated. The organic layer was dried over Na_2SO_4 and concentrated to yield crude isocyanate as a brown oil.

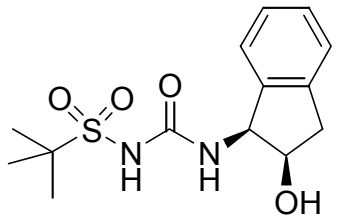
(*R*)-*tert*-Butanesulfinamide (149 mg, 1.23 mmol) was dissolved in 12 mL of THF, and the resulting solution was cooled to -78 °C. Butyllithium (0.60 mL of a 2.2M solution in hexanes, 1.3 mmol) was added dropwise, and then the reaction mixture was warmed to rt and stirred for 15 min. The crude isocyanate dissolved in 1 mL of THF was added dropwise, with rinsing with an additional 1 mL of THF. The solution was stirred for an additional 5 h at rt. The reaction was quenched by dropwise addition of water (0.5 mL), and then the resulting mixture was concentrated. The residue was diluted with 0.01 M aqueous NaOH (50 mL), and the resulting solution washed with CH_2Cl_2 (3 x 25 mL). The aqueous layer was then acidified to pH <2 with saturated aqueous $NaHSO_4$ and then extracted with CH_2Cl_2 (3 x 20 mL). The organic layer was dried over Na_2SO_4 and concentrated. The residue was redissolved in EtOAc and then concentrated to give a brown oil which crystallized upon standing. The crystals were collected by vacuum filtration and rinsed with EtOAc (2x3 mL) on the filter to yield 83 mg (28%) of product as colorless needles, mp 178-180 °C (dec). IR (KBr): 3326, 3221, 2965, 1702, 1536, 1035 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.52 (br s, 1H), 7.38-7.32 (m, 1H), 7.24-7.16 (m, 3H), 6.04 (d, J = 7.8 Hz, 1H), 5.31 (apparent q, 1H), 3.00-2.90 (m, 1H), 2.88-2.77 (m, 1H), 2.60-2.50 (m, 1H), 1.88-1.73 (m, 1H), 1.24 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ154.8, 143.2, 142.8, 128.0, 127.0, 124.7, 124.1, 56.9, 55.9, 34.2, 30.1, 22.2. HRMS (FAB+) calcd for $C_{14}H_{20}LiN_2O_2S$ $[MLi]^+$ 287.1406; found 287.1408.

N-((1*S*,2*R*)-2-(tert-butyldimethylsilyloxy)-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfonamide S4



$RuCl_3$ (1 mg) and $NaIO_4$ (321 mg, 1.5 mmol) were added in one portion to a stirred solution of urea **8d** (411 mg, 1.00 mmol) in MeCN (3 mL), CH_2Cl_2 (3 mL), and water (4.5 mL) at 0 °C. After 5 min, the ice bath was removed and stirring was continued for 20 min at rt. The reaction mixture was then diluted with EtOAc (25 mL) and washed with water (10 mL) followed by brine (10 mL). The organic layer was dried over Na_2SO_4 and concentrated. The residue was redissolved in EtOAc, filtered through a plug of silica, and concentrated to give 405 mg (95%) of product **S4** as a colorless powder, mp 216-219 °C. IR (KBr): 3350, 2933, 1680, 1523, 1332, 1127 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 9.02 (br s, 1H), 7.53 (d, *J* = 7.5 Hz, 1H), 7.30 (d, , *J* = 7.2 Hz, 1H), 7.25-7.15 (m, 3H), 5.25-5.20 (m, 1H), 4.66-4.61 (m, 1H), 3.07 (dd, *J* = 5.3 Hz, 16.1 Hz, 1H), 2.91 (dd, *J* = 3.1 Hz, 16.1 Hz, 1H), 1.46 (s, 9H), 0.88 (s, 9H), 0.13 (s, 3H), 0.12 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 153.4, 140.8, 139.9, 128.0, 126.8, 124.9, 73.7, 61.9, 58.0, 40.3, 25.8, 24.1, 18.1, -4.7, -5.0. HRMS (FAB+) calcd for $C_{20}H_{35}N_2O_4SSi$ $[MH]^+$ 427.2087; found 427.2091.

N-((1*S*,2*R*)-2-hydroxy-2,3-dihydro-1H-inden-1-ylcarbamoyl)-*tert*-butanesulfonamide 8f.



Tetrabutylammonium fluoride (0.75 mL of a 1.0 M solution in THF) was added to a flask containing compound **S4** (107 mg, 0.250 mmol) and the solution was stirred for 20 h. An additional 1 mL of THF was added and the solution was stirred for 2 days. The mixture was diluted with EtOAc (30 mL) and washed with water (15 mL) followed by brine (15 mL). The organic layer was dried over Na_2SO_4, filtered, and concentrated. Crystallization from EtOAc yielded 38.3 mg (49%) of product **8f** as a white solid, mp 170-173 °C. IR (KBr): 3347, 2989, 2823, 1683, 1529, 1328, 1125 cm^{-1}. ^1H NMR (400 MHz, DMSO-d6): δ 10.20 (br s, 1H), 7.25-7.13 (m, 5 H), 5.37 (d, *J* = 4.6 Hz, 1H), 5.04 (dd, J = 8.1 Hz, 5.1 Hz, 1H), 4.42 (apparent q, 1H), 3.06 (dd, J = 16.3 Hz, 4.8 Hz, 1H), 2.77 (d, J = 16.2, 1H), 1.37 (s, 9H). $^{13}C\{^1H\}$ NMR (100 MHz, CD_3CN): δ 153.6, 143.0, 141.0, 129.2, 128.1, 126.6, 125.5, 73.9, 63.1, 59.4, 41.0, 24.8. HRMS (FAB+) calcd for $C_{14}H_{20}LiN_2O_4S$ $[MLi]^+$ 319.1304; found 319.1300.

Representative procedure for the enantioselective aza-Henry reaction (catalyst screening conditions)

tert-Butyl (1*R*,2*S*)-2-nitro-1-phenylpropylcarbamate 10a.

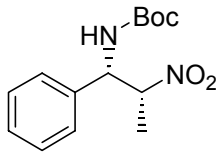
A dry vial containing 0.025 mmol of a potential catalyst under nitrogen was charged with 1.0 mL of a freshly prepared stock solution of imine (0.25 M) and hexamethylbenzene (0.013 M) in CH_2Cl_2. After stirring for 10 min, the vial was cooled to -40 °C, and *i*-Pr_2NEt (87 μL, 0.50 mmol) and $EtNO_2$ (90 μL, 1.25 mmol) were added sequentially. The solution was stirred at -40 °C for 13 h. The vial was removed from the cold bath, the reaction was quenched with 1 M aqueous HCl (3 mL), and the resulting mixture was extracted with CH_2Cl_2 (2 x 4 mL). The extract was dried over Na_2SO_4 and decanted. A 4 mL aliquot of the extract was concentrated for ^1H NMR analysis, while a 0.2 mL aliquot of the extract was filtered through a plug of silica gel, eluting with CH_2Cl_2 followed by concentration for HPLC analysis. The conversion to product was determined by integration relative to the hexamethylbenzene internal standard. The dr and ee were determined by chiral HPLC analysis (Chiralpak AD-H, hexanes/iPrOH 90/10, 1 mL min^{-1}): t_R (1*R*,2*S*) = 9.9 min, t_R (1*S*,2*R*) = 11.2 min, t_R (*anti*) = 12.5 min, 14.9 min. Stereochemical assignments are based on literature determinations. [5a]

General Procedures for the Enantioselective Aza-Henry Reaction.

To obtain reproducible results, the catalyst was dried under vacuum over P_2O_5 overnight prior to use.

Procedure C. An oven dried vial containing 0.05 mmol of catalyst and 0.50 mmol of imine **9** under nitrogen was charged with MeCN (2.0 mL). The mixture was stirred at rt for 15 min, then cooled in a -78 °C bath. Nitroalkane (2.5 mmol) and *i*-Pr_2NEt (44 μL, 0.25 mmol) were added, and then the vial was transferred to a bath at -40 °C and the solution was stirred for 28 h. The reaction vial was removed from the cold bath and the reaction was quenched with 1 M aqueous HCl (4 mL). The resulting mixture was extracted with EtOAc (12 mL, then 2 x 4 mL). The organic layers were dried over Na_2SO_4 and concentrated. The crude residue was purified by chromatography.

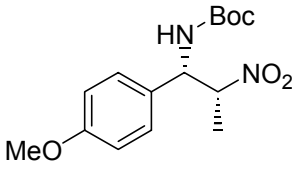
Procedure D. An oven dried flask containing 0.05 mmol of catalyst and 0.50 mmol of imine **9** under nitrogen was charged with MeCN (2.0 mL) followed by *i*-Pr_2NEt (44 μL, 0.25 mmol). The solution was stirred at -40 °C for 10 min, and then $EtNO_2$ (180 μL, 2.5 mmol) was added. After stirring for 27 h, the reaction was quenched with 1 M aqueous HCl (4 mL), and the resulting mixture was extracted with CH_2Cl_2 (12 mL, then 2 x 4 mL). The organic layers were dried over Na_2SO_4 and concentrated. The crude residue was purified by silica gel chromatography, eluting with EtOAc/hexanes.



10a

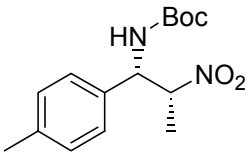
General procedure D was followed, affording 117 mg (84%) of an 85:15 mixture of diastereomers **10a** to **11a** as a white solid after chromatography. The ^1H NMR spectrum

is consistent with values previously reported in the literature.[5a,b] The ee of major diastereomer **10a** was determined to be 95% by chiral HPLC analysis (Chiralpak AD-H, hexanes/*i*PrOH 90/10, 1 mL min^{-1}): t_R (major) = 10.4 min, t_R (minor) = 11.8 min. The ee of minor diastereomer **11a** was determined to be 53% ee under the same analysis conditions: t_R (minor) = 13.6 min, t_R (major) = 16.4 min.



10b

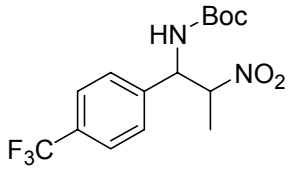
General procedure C was followed, affording 99 mg (64%) of a 90:10 mixture of diastereomers **10b** to **11b** as a white solid after chromatography. The ^{1}H NMR spectrum is consistent with values previously reported in the literature.[5c] The ee of major diastereomer **10b** was determined to be 95% by chiral HPLC analysis (Chiralpak AD-H, hexanes/*i*PrOH 90/10, 1 mL min^{-1}): t_R (major) = 15.5 min, t_R (minor) = 16.3 min. The ee of minor diastereomer **11b** was determined to be 23% ee under the same analysis conditions: t_R (minor) = 18.4 min, t_R (major) = 23.0 min.



10c

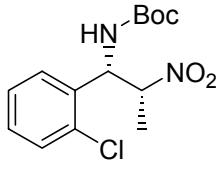
General procedure D was followed, affording 102 mg (68%) of an 79:21 mixture of diastereomers **10c** to **11c** as a white solid after chromatography. The ^{1}H NMR spectrum is consistent with values previously reported in the literature.[5c] The ee of major

diastereomer **10c** was determined to be 95% by chiral HPLC analysis (Chiralpak AD-H, hexanes/*i*PrOH 90/10, 1 mL min^{-1}): t_R (major) = 9.6 min, t_R (minor) = 10.7 min. The ee of minor diastereomer **11c** was determined to be 60% ee under the same analysis conditions: t_R (minor) = 11.4 min, t_R (major) = 13.1 min.



10d

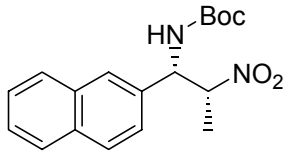
General procedure C was followed, affording 161 mg (92%) of a 77:23 mixture of diastereomers **10d** to **11d** as a white solid after chromatography. The ^1H NMR spectrum is consistent with values previously reported in the literature. [5b] The ee of major diastereomer **10d** was determined to be 92% by chiral HPLC analysis (Chiralpak AD-H, hexanes/EtOH 95/05, 1 mL min^{-1}): t_R (major) = 11.4 min, t_R (minor) = 14.2 min. The ee of minor diastereomer **11d** was determined to be 23% ee under the same analysis conditions: t_R (minor) = 16.4 min, t_R (major) = 27.6 min.



10e

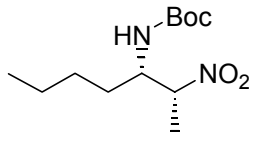
General procedure C was followed, affording 139 mg (88%) of an 80:20 mixture of diastereomers **10e** to **11e** as a white solid after chromatography. The ^1H NMR spectrum is consistent with values previously reported in the literature. [5c] The ee of major

diastereomer **10e** was determined to be 94% by chiral HPLC analysis (Chiralpak AD-H, hexanes/*i*PrOH 90/10, 1 mL min^{-1}): t_R (minor) = 11.0 min, t_R (major) = 13.0 min. The ee of minor diastereomer **11e** was determined to be 87% ee under the same analysis conditions: t_R (minor) = 9.6 min, t_R (major) = 17.3 min.



10f

General procedure D was followed, affording 132 mg (80%) of an 84:16 mixture of diastereomers **10f** to **11f** as a white solid after chromatography. The ^1H NMR spectrum is consistent with values previously reported in the literature. [5c] The ee of major diastereomer **10f** was determined to be 93% by chiral HPLC analysis (Chiralpak AD-H, hexanes/*i*PrOH 90/10, 1 mL min^{-1}): t_R (major) = 13.8 min, t_R (minor) = 15.4 min. The ee of minor diastereomer **11f** was determined to be 22% ee under the same analysis conditions: t_R (minor) = 17.7 min, t_R (major) = 20.2 min.



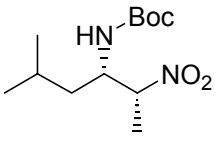
10g

General procedure C was followed on 0.25 mmol scale, affording 52 mg (80%) of a 92:8 mixture of diastereomers **10g** to **11g** as a white solid after chromatography. The ee of major diastereomer **10g** was determined to be 96% and the ee of **11g** was determined to

be 70% by chiral HPLC analysis (Chiralpak AS, hexanes/EtOH 99/1, 1 mL min^{-1}): t_R (**10g** minor) = 9.7 min, t_R (**10g** major) = 11.1 min, t_R (**11g** major) = 6.7 min, t_R (**11g** minor) = 7.4 min.

The diastereomers were separated by silica gel chromatography for NMR analysis. **10g**: ^{1}H NMR (400 MHz, $CDCl_3$, 80:20 mixture of rotamers): 4.75-4.60 (m, 1.6H), 4.55-4.38 (m, 0.4H), 4.11-4.00 (m, 0.2H), 4.00-3.90 (m, 0.8H), 1.53 (d, *J* = 6.9 Hz, 3H), 1.45 (s, 9H), 1.61-1.20 (m, 6H), 0.95-0.83 (m, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 155.4, 85.6, 80.1, 53.5, 29.2, 28.3, 28.1, 22.2, 15.1, 13.9.

11g: ^{1}H NMR (400 MHz, $CDCl_3$, 90:10 mixture of rotamers): δ 4.98-4.85 (m, 0.9H), 4.78-4.70 (m, 0.9H), 4.68-4.53 (m, 0.2H), 3.96-3.78 (m, 1H), 1.57 (d, *J* = 6.8 Hz, 3H), 1.42 (s, 9H), 1.61-1.20 (m, 6H), 0.95-0.82 (m, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 155.8, 85.6, 79.9, 52.7, 31.9, 28.3, 28.1, 22.3, 16.4, 13.9. HRMS (FAB+) calcd for $C_{12}H_{25}N_2O_4$ $[MH]^+$ 261.1814; found 261.1809.

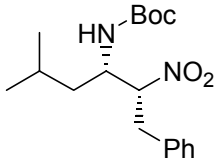


10h

General procedure C was followed on 0.25 mmol scale, affording 49 mg (75%) of a 93:7 mixture of diastereomers **10h** to **11h** as a white solid after chromatography. The ee of major diastereomer **10h** was determined to be 96% by chiral HPLC analysis (Chiralpak AS, hexanes/EtOH 99/1, 1 mL min^{-1}): t_R (**10h** minor) = 7.7 min, t_R (**10h** major) = 9.6 min, t_R(**11h**) = 5.8 min. The ee of **11h** was not determined. The diastereomers were separated for NMR analysis by silica gel chromatography.

10h: ^{1}H NMR (400 MHz, $CDCl_3$, 82:18 mixture of rotamers): δ 4.85-4.75 (m, 0.18 H), 4.75-4.62 (m, 1.64H), 4.50-4.40 (m, 0.18H), 4.22-4.12 (m, 0.18H), 4.08-3.96 (m, 0.82H), 1.78-1.60 (m, 1H), 1.52 (d, *J* = 6.8 Hz, 3H), 1.45 (s, 9H), 1.27 (apparent t, 2H), 0.98-0.88 (m, 6H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 155.2, 85.8, 80.0, 51.8, 38.4, 28.2, 24.7, 23.4, 21.3, 15.1. HRMS (FAB+) calcd for $C_{12}H_{25}N_2O_4$ $[MH]^+$ 261.1814; found 261.1821.

11h ^{1}H NMR (400 MHz, $CDCl_3$, 85:15 mixture of rotamers): δ 4.97-4.82 (m, 0.85 H), 4.76-4.65 (m, 1H), 4.65-4.55 (m, 0.15H), 4.08-3.88 (m, 1H), 1.78-1.62 (m, 1H), 1.57 (d, *J* = 6.3 Hz, 3H), 1.45 (s, 9H), 1.42-1.16 (m, 2H), 1.02-0.85 (m, 6H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 155.6, 86.0, 79.8, 50.8, 41.0, 28.2, 24.7, 23.0, 21.8, 16.3.



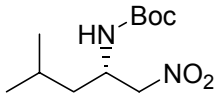
10i

General procedure C was followed, affording 104 mg (62%) of an 88:12 mixture of diastereomers **10i** to **11i** as a white solid after reverse phase chromatography (Biotage C18 25+M cartridge, 30% to 100% MeCN in H_2O with 0.1% TFA). The ee of major diastereomer **10i** was determined to be 96% by chiral HPLC analysis (Chiralpak AD-H, hexanes/EtOH 97/3, 1 mL min^{-1}): t_R (**10i** major) = 8.6 min, t_R (**10i** minor) = 16.2 min, t_R(**11i**) = 7.0 min. The ee of **11i** was not determined. The diastereomers were separated for analysis by silica gel chromatography.

10i: ^{1}H NMR (400 MHz, $CDCl_3$, 77:23 mixture of rotamers): δ 7.31-7.18 (m, 3H), 7.18-7.11 (d, *J* = 7.1 Hz, 2H), 5.40 (d, *J* = 8.9 Hz, 0.23H), 4.92-4.83 (m, 0.77H), 4.73-4.60 (m, 1H), 4.19-4.08 (m, 1H), 3.33 (dd, *J* = 10.7 Hz, 14.6 Hz, 1H), 3.15-3.00 (m, 1H), 1.80-

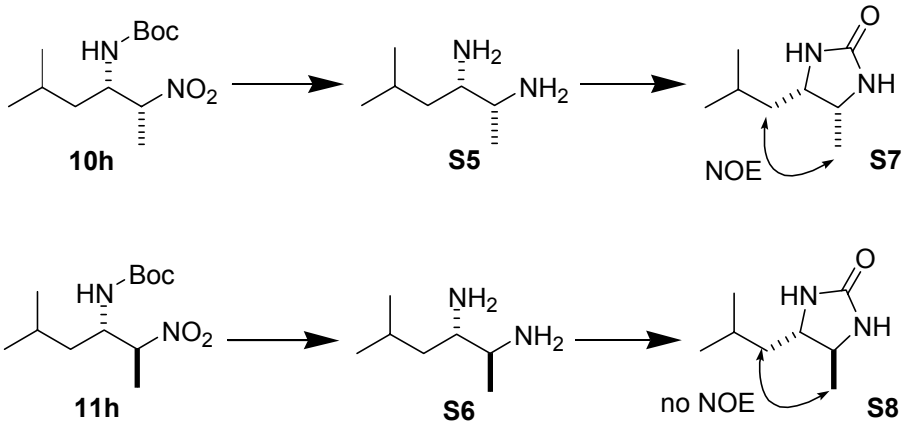
1.60 (m, 1H), 1.45 (s, 9H), 1.42-1.20 (m, 2H), 0.98-0.87 (m, 6H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$, mixture of rotamers, major rotamer peaks reported): δ 155.2,135.5, 128.7, 128.7, 127.3, 92.6, 80.1, 51.3, 38.7, 36.0, 28.2, 24.6, 23.4, 21.1. mp 132-133 °C. HRMS (FAB+) calcd for $C_{18}H_{28}N_2O_4Na$ $[MNa]^+$ 359.1947; found 359.1956. IR (NaCl): 3355, 2960, 2929, 1680, 1545, 1160 cm^{-1}.

11i ^{1}H NMR (400 MHz, $CDCl_3$, 9:1 mixture of rotamers): δ δ 7.33-7.22 (m, 3H), 7.18-7.11 (m, 2 H), 5.00 (d, *J* = 10.2 Hz, 0.9H), 4.82-4.72 (m, 1.1H), 4.20-4.10 (m, 0.9 H) 4.00-3.90 (m, 0.1 H), 3.31 (dd, *J* = 9.9 Hz, 14.5 Hz, 1H), 3.15 (dd, J = 4.5 Hz, 14.5 Hz, 1H), 1.75-1.62 (m, 1H), 1.48 (s, 9H), 1.40-1.24 (m, 2H), 0.95-0.87 (m, 6H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 155.6,135.3, 128.9, 128.8, 127.5, 92.9, 80.0, 49.9, 41.5, 37.0, 28.3, 24.7, 22.8, 21.9.



10j

General procedure C was followed on 0.25 mmol scale, affording 39.5 mg (64%) of **10j** as a white solid, mp 67-69 °C, after silica gel chromatography (10% EtOAc in Hexanes). The ee was determined to be 95% by chiral HPLC analysis (Chiralpak AS, hexanes/*i*PrOH 98/2, 1 mL min^{-1}): t_R (**10j** major) = 10.1 min, t_R (**10j** minor) = 12.2 min. ^{1}H NMR (400 MHz, $CDCl_3$, 85:15 mixture of rotamers): δ 4.95-4.70 (m, 1H), 4.58-4.46 (m, 1.7H), 4.45-4.35 (m, 0.3H), 4.25-4.14 (m, 1H), 1.80-1.60 (m, 1H), 1.44 (s, 9H), 1.45-1.22 (m, 2H), 0.98-0.92 (m, 6H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 155.0, 80.0, 78.7, 47.4, 40.5, 28.2, 24.7, 22.7, 21.8. HRMS (FAB+) calcd for $C_{11}H_{23}N_2O_4$ $[MH]^+$ 247.1658; found 247.1655. IR (NaCl): 3340, 2963, 1684, 1557, 1167 cm^{-1}.



Reduction of nitro group and removal of Boc group:

Racemic **10h** (260 mg, 1.00 mmol) was dissolved in MeOH (7.5 mL) and cooled to 0 °C. $NiCl_2$ (135 mg, 1.04 mmol) was added to the solution with stirring, followed by addition of $NaBH_4$ (188 mg, 5.1 mmol). After stirring for 15 min, the reaction was quenched with sat. aqueous NH_4Cl (20 mL). The mixture was extracted with CH_2Cl_2 (4 x 30 mL). The combined organic layers were washed with brine (75 mL), dried over Na_2SO_4, and concentrated. The crude residue was filtered through a short plug of silica, eluting with 90:10:1 CH_2Cl_2:MeOH:NH_4OH, and then was concentrated. The white solid obtained was redissolved in a mixture of MeOH (3.5 mL) and conc. HCl (1.5 mL) and was stirred at rt for 16 h. The mixture was diluted with 1N aqueous NaOH (40 mL), and extracted with CH_2Cl_2 (5 x 40 mL). The combined organic layers were dried over Na_2SO_4, filtered, and concentrated to yield 101 mg (77% over two steps) of diamine **S5** in approximately 95% purity by ^{1}H NMR.^{1}H NMR (400 MHz, $CDCl_3$): δ 2.86-2.78 (m, 1H), 2.72-2.64 (m, 1H), 1.78-1.64 (m, 1H), 1.38 (br s, 4H), 1.20-1.12 (m, 2H), 0.99 (d, J = 6.5 Hz, 3H), 0.94 (d, J = 6.6 Hz, 3H), 0.89 (d, J = 6.6 Hz, 3H) ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 53.9, 51.0, 42.5, 24.5, 23.6, 21.4, 17.4.

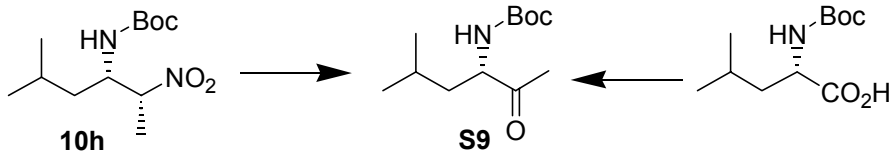
Racemic **11h** (260 mg, 1.00 mmol) was dissolved in MeOH (7.5 mL) and cooled to 0 °C. $NiCl_2$ (135 mg, 1.04 mmol) was added to the solution with stirring, followed by addition of $NaBH_4$ (188 mg, 5.1 mmol). After stirring for 15 min, the reaction was quenched with sat. aqueous NH_4Cl (20 mL). The mixture was extracted with CH_2Cl_2 (4 x 30 mL). The combined organic layers were washed with brine (75 mL), dried over Na_2SO_4, and concentrated. The crude residue was filtered through a short plug of silica, eluting with 90:10:1 CH_2Cl_2:MeOH:NH_4OH, and then was concentrated. The clear oil obtained was redissolved in a mixture of MeOH (3.5 mL) and conc. HCl (1.5 mL) and was stirred at rt for 4 h. The mixture was diluted with 1N aqueous NaOH (40 mL), and extracted with CH_2Cl_2 (5 x 40 mL). The combined organic layers were dried over Na_2SO_4, filtered, and concentrated to yield 120 mg (91% over two steps) of diamine **S6** in approximately 95% purity by ^{1}H NMR.^{1}H NMR (400 MHz, $CDCl_3$): δ 2.72-2.64 (m, 1H), 2.55-2.47 (m, 1H), 1.80-1.68 (m, 1H), 1.34 (br s, 4H), 1.30-1.12 (m, 2H), 1.07 (d, J = 6.4 Hz, 3H), 0.94 (d, J = 6.6 Hz, 3H), 0.89 (d, J = 6.6 Hz, 3H) ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 54.4, 51.2, 43.6, 24.5, 23.6, 21.3, 20.6.

Cyclization:

Diamine **S5** (52 mg, 0.49 mmol) was dissolved in CH_2Cl_2 (5 mL). A solution of di-*tert* butyl tricarbonate (155 mg, 0.59 mmol) in CH_2Cl_2 (5 mL) was added dropwise over 10 min to the diamine solution with stirring. The mixture was stirred an additional 10 min, and then was concentrated. The crude residue was purified by silica gel chromatography (100% CH_2Cl_2 to 5% MeOH in CH_2Cl_2) to yield 45 mg (59%) of the cyclized product **S7** as a white solid. NMR (400 MHz, $CDCl_3$): δ 5.73 (br s, 1H), 5.62 (br s, 1H), 3.85-3.75

(m, 2H), 1.67-1.55 (m, 1H), 1.55-1.45 (m, 1H), 1.26-1.18 (m, 1H), 1.11 (d, J = 5.8 Hz, 3H), 0.95 (d, J = 6.6 Hz, 3H), 0.91 (d, J = 6.6 Hz, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 164.1, 53.7, 51.4, 38.3, 25.0, 23.5, 21.6, 15.7. HRMS (FAB+) calcd for $C_8H_{17}N_2O$ $[MH]^+$ 157.1341; found 157.1340.

Diamine **S6** (52 mg, 0.40 mmol) was dissolved in CH_2Cl_2 (4 mL). A solution of di-*tert* butyl tricarbonate (125 mg, 0.48 mmol) in CH_2Cl_2 (4 mL) was added dropwise over 10 min to the diamine solution with stirring. The mixture was stirred an additional 10 min, and then was concentrated. The crude residue was purified by silica gel chromatography (100% CH_2Cl_2 to 5% MeOH in CH_2Cl_2) to yield 43 mg (69%) of the cyclized product **S8** as a white solid. NMR (400 MHz, $CDCl_3$): δ 5.78 (br s, 1H), 5.72 (br s, 1H), 3.45-3.35 (m, 1H), 3.35-3.27 (m, 1H), 1.75-1.60 (m, 1H), 1.52-1.43 (m, 1H), 1.36-1.27 (m, 1H), 1.22 (d, J = 6.1 Hz, 3H), 0.93 (d, J = 6.7 Hz, 3H), 0.91 (d, J = 6.6 Hz, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 163.5, 58.5, 54.6, 44.4, 24.8, 23.2, 21.9, 20.8. HRMS (FAB+) calcd for $C_8H_{17}N_2O$ $[MH]^+$ 157.1341; found 157.1338.



Synthesis of Ketone:

Compound **10h** (130 mg, 0.50 mmol) was dissolved in 1 mL of MeOH. A solution of NaOMe in MeOH (1.0 mmol in 1.0 mL, freshly prepared from Na and MeOH) was added, followed by an additional 3 mL of MeOH. The mixture was cooled in a -78 °C

bath, and ozone was bubbled through until a pale blue color persisted. The solution was stirred for 1 h, and then purged with dry N_2. Dimethylsulfide (0.5 mL) was added, and then the cold bath was removed and the mixture was stirred for 16 h at rt. The solution was concentrated, then diluted with 5 mL of water and extracted with 5 mL of CH_2Cl_2. The organic layer was washed with brine (2 x 5 mL), dried over Na_2SO_4, and concentrated. Flash column chromatography on a Biotage Flash+ cartridge with a gradient of 3% to 24% EtOAc in hexanes provided 61.3 mg (53%) of ketone **S9** as a thick oil which solidified upon standing. The ^{1}H NMR spectrum is consistent with literature data.[6] The product was determined to be 91% ee by chiral HPLC analysis (Chiralpak AS, hexanes/EtOH 99/1, 1 mL min^{-1}): t_R (major) = 7.0 min, t_R (minor) = 9.5 min. $[\alpha]^{26}_D$ = + 34.7° (*c* = 1, $CHCl_3$).

Ketone **S9** was also prepared from Boc-Leucine according to the literature procedure[6] in >99% ee. $[\alpha]^{26}_D$ = + 38.9° (*c* = 1, $CHCl_3$)

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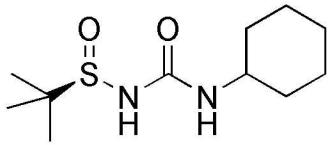
4a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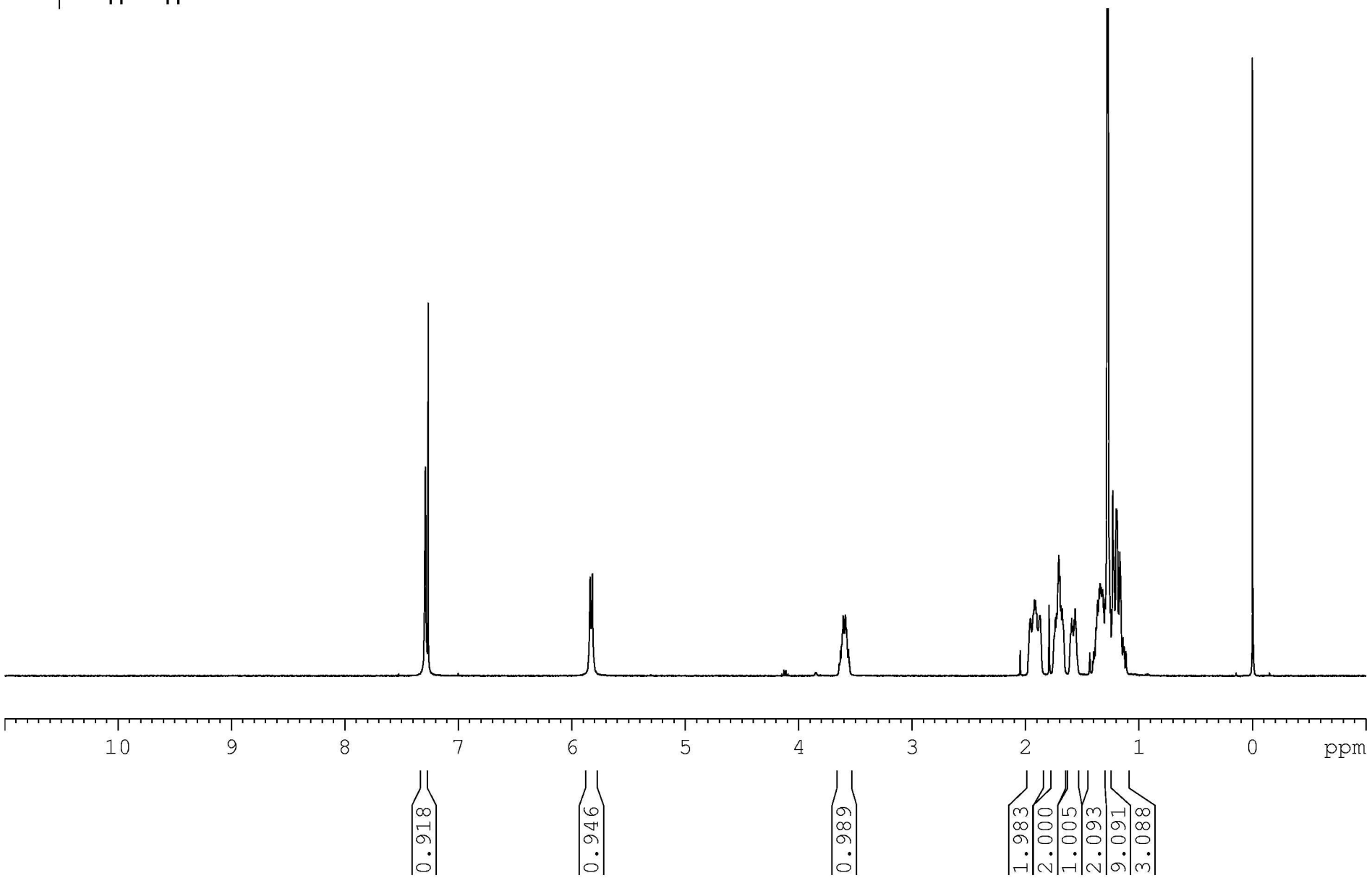
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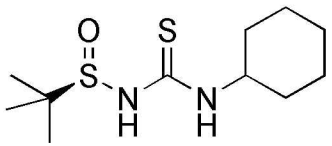
4b


O
S
S
N
H
N
H

10
9
8
7
6
5
4
3
2
1
0
ppm
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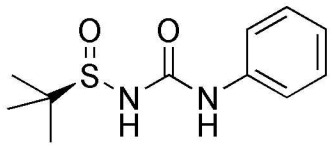
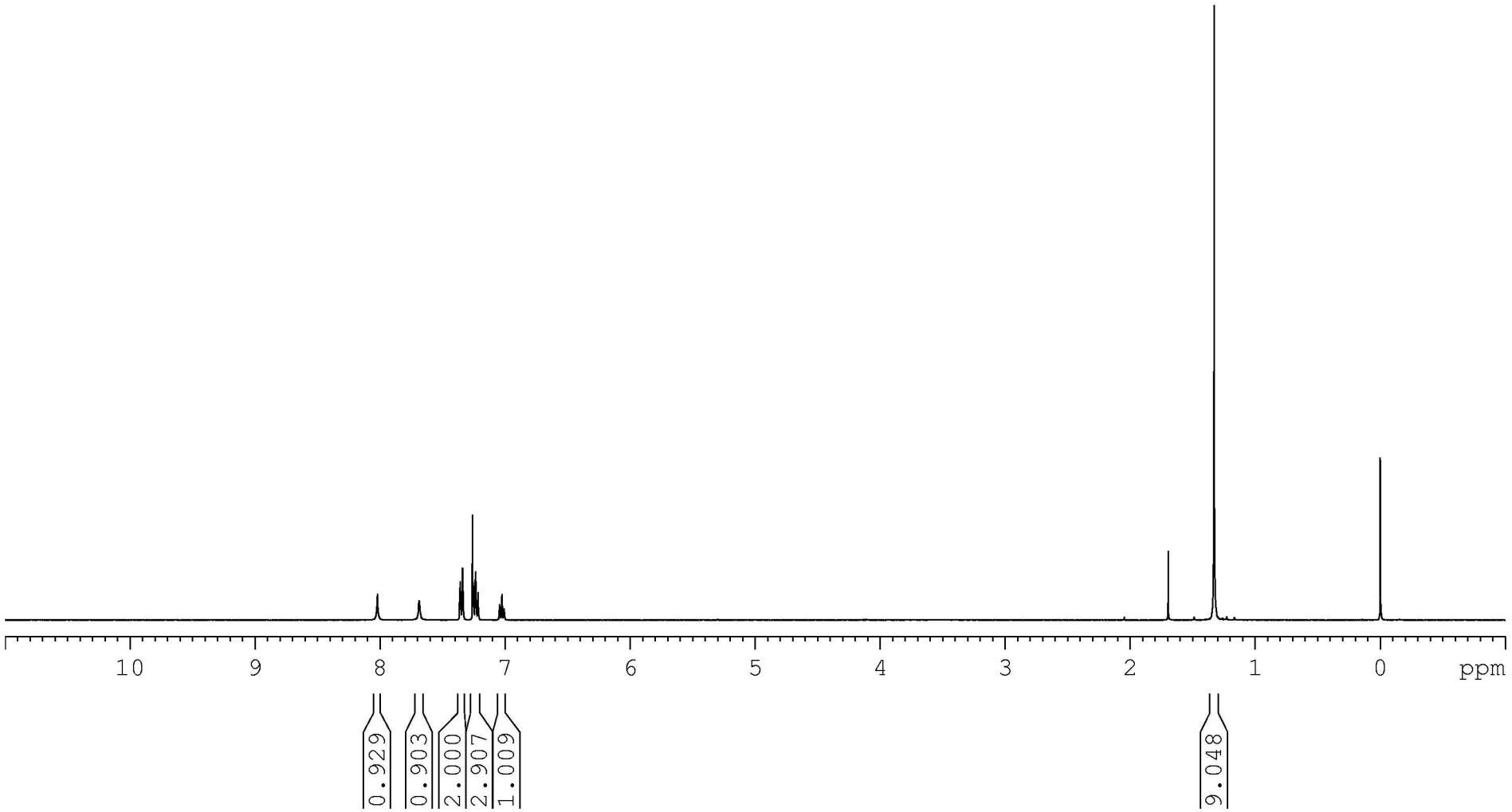
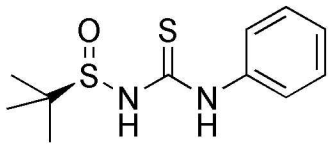
1.001
1.040
2.057
2.079
1.074
4.691

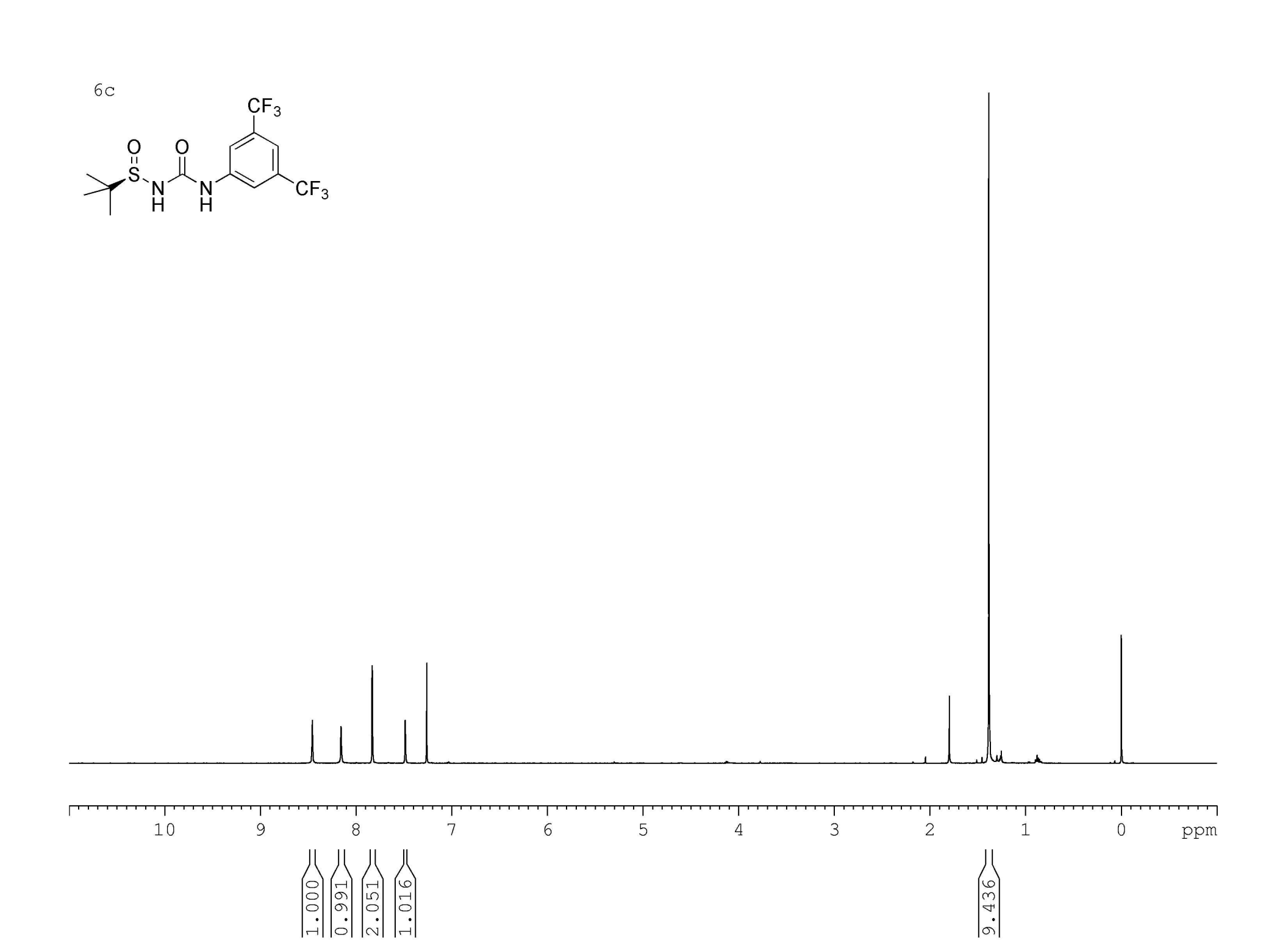
6a





6b




6c
CF3
O
O
S
N
H
N
H
CF3
10
9
8
7
6
5
4
3
2
1
0
ppm
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0.991
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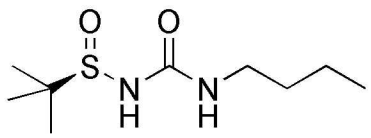
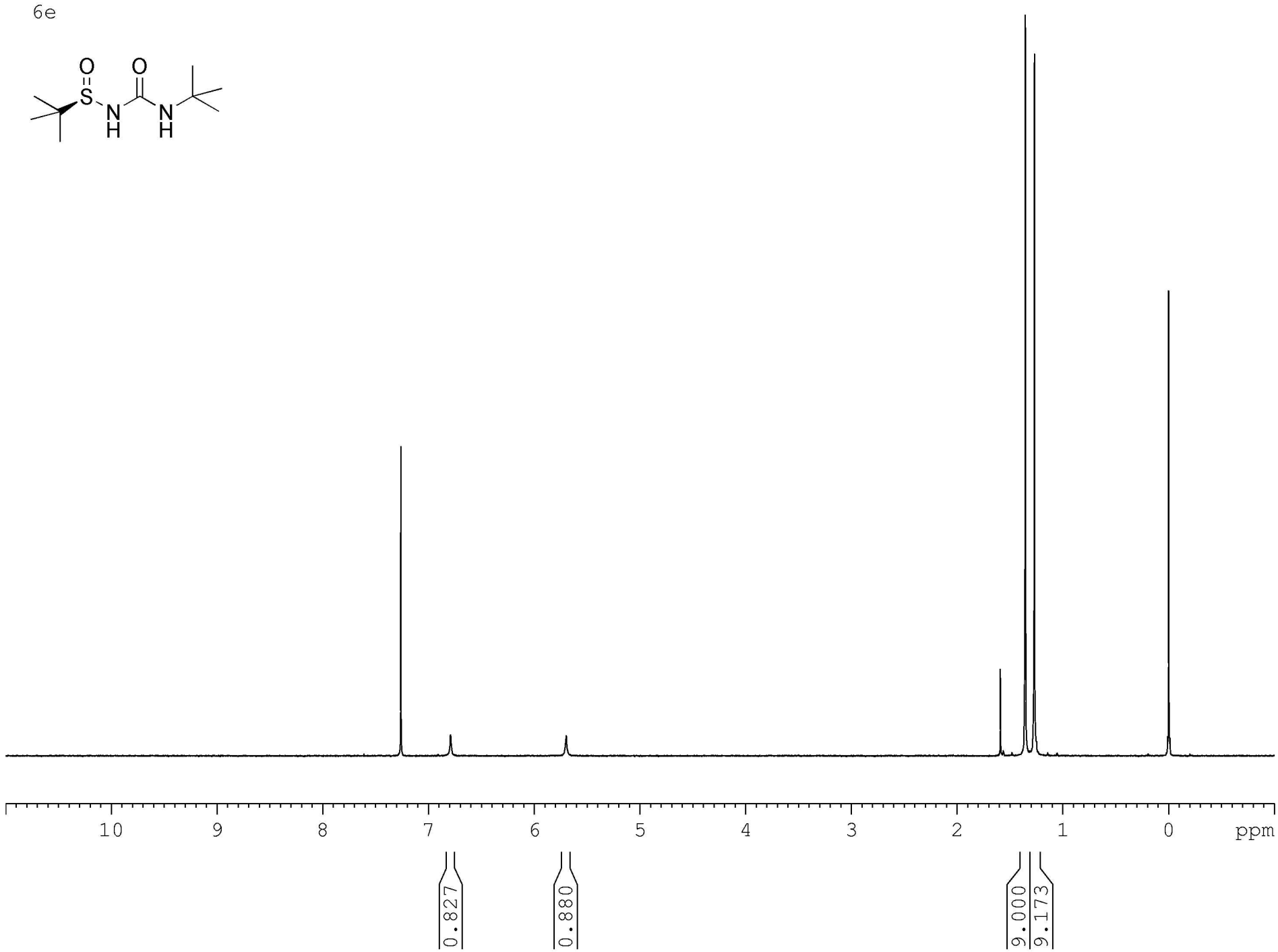
1.016
9.436

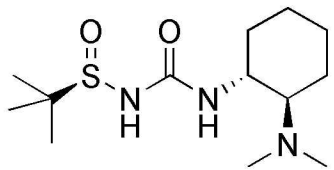
6d


O
O
S
N
H
N
H

10
9
8
7
6
5
4
3
2
1
0
ppm
0.882
0.898
1.965
1.952
2.172
8.653
3.000

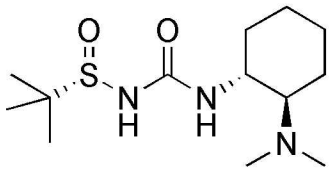

6e
O
O
S
N
H
N
H
10
9
8
7
6
5
4
3
2
1
0
ppm
0.827
0.880
9.000
9.173

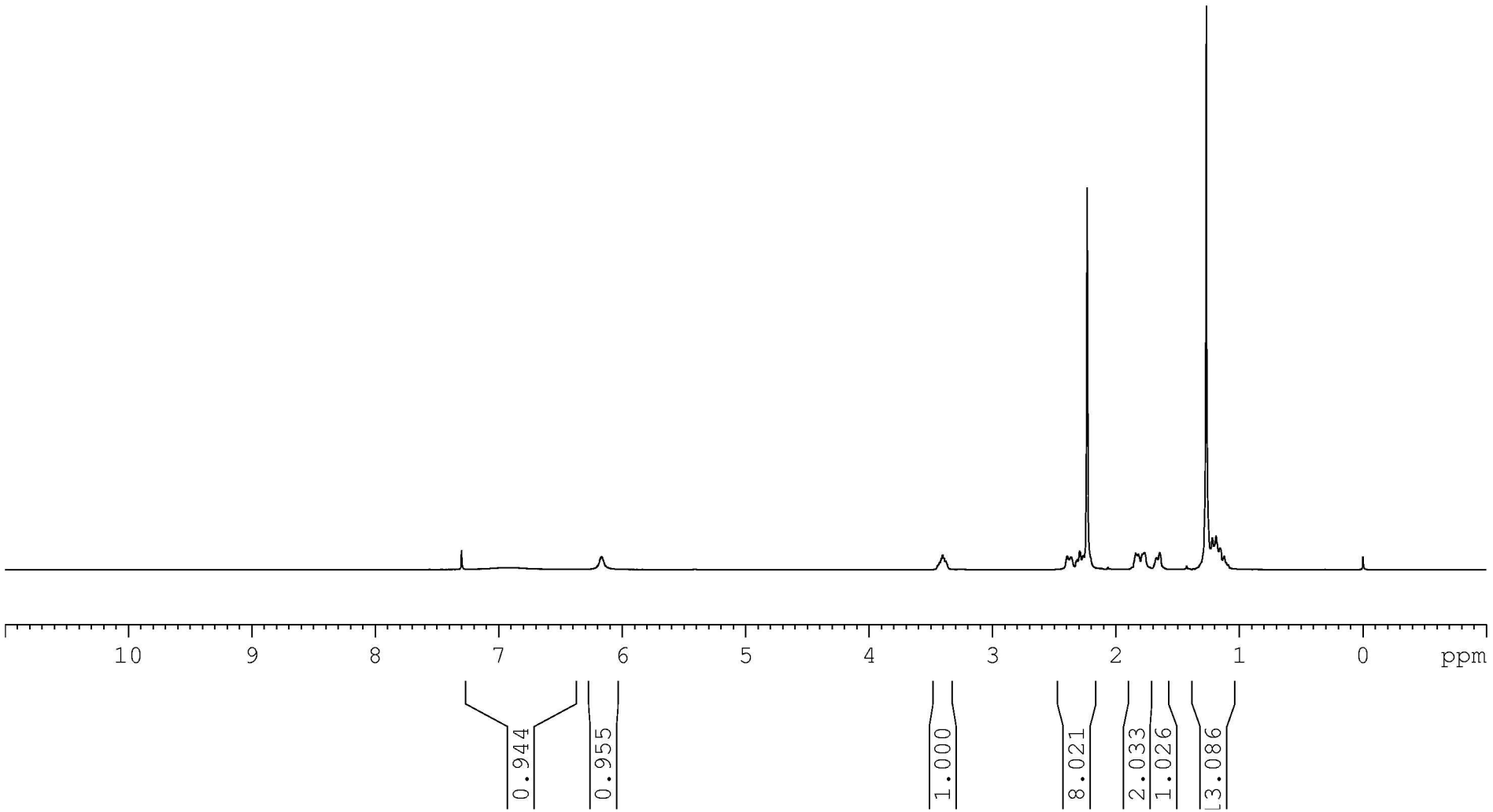
7a


O
O
S
N
H
N
H
N

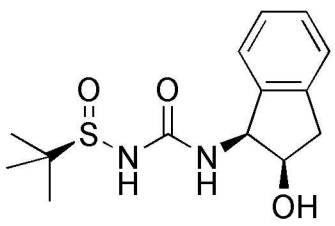
10
9
8
7
6
5
4
3
2
1
0
ppm
0.952
1.479
1.000
1.041
7.285
2.100
1.057
3.528

7b





8a


O
O
S
N
H
N
H
OH

10
9
8
7
6
5
4
3
2
1
0
ppm
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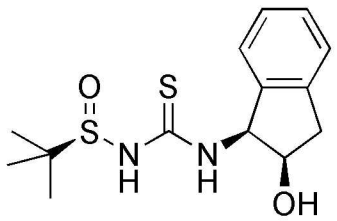
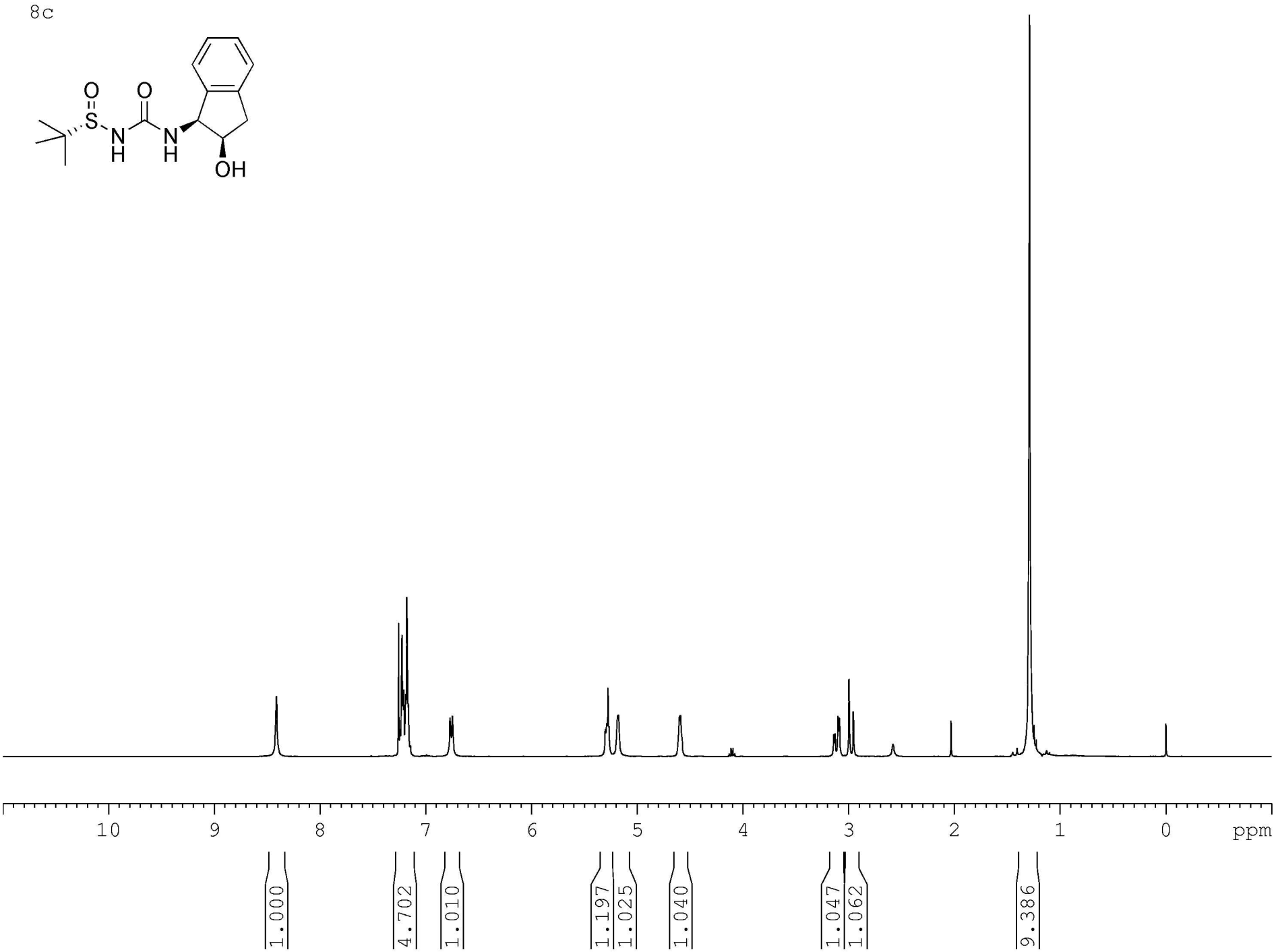
4.060
0.949
0.997
0.995
0.959
1.000
1.000
1.359
9.153

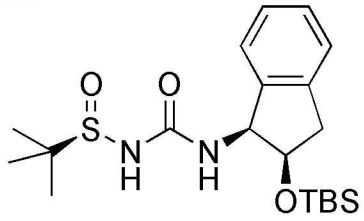
8b


O
S
S
N
H
N
H
OH

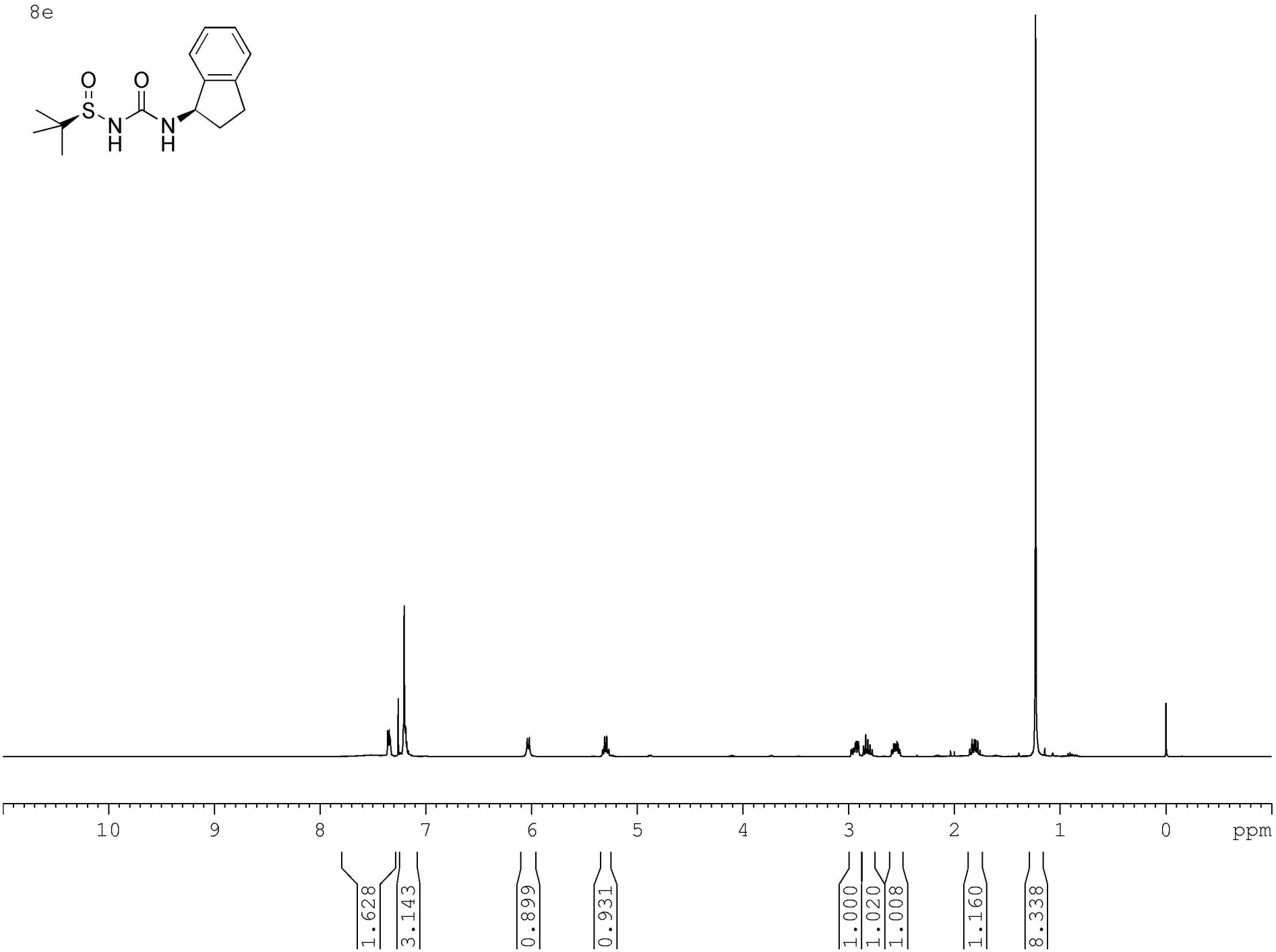
10
9
8
7
6
5
4
3
2
1
0
ppm
0.917
0.936
4.111
1.000
0.961
1.001
1.007
1.000
9.166


8c
O
O
S
N
H
N
H
OH
10
9
8
7
6
5
4
3
2
1
0
ppm
1.000
4.702
1.010
1.197
1.025
1.040
1.047
1.062
9.386

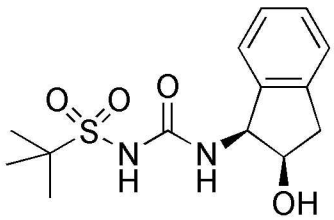
8d


O
O
S
N
H
N
H
OTBS

10
9
8
7
6
5
4
3
2
1
0
ppm
1.000
1.048
3.079
1.008
1.020
1.019
1.034
1.029
9.516
9.232
3.127
2.910

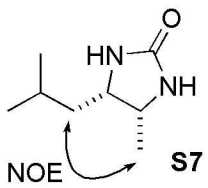

8e
O
O
S
N
H
N
H
10
9
8
7
6
5
4
3
2
1
0
ppm
1.628
3.143
0.899
0.931
1.000
1.020
1.008
1.160
8.338

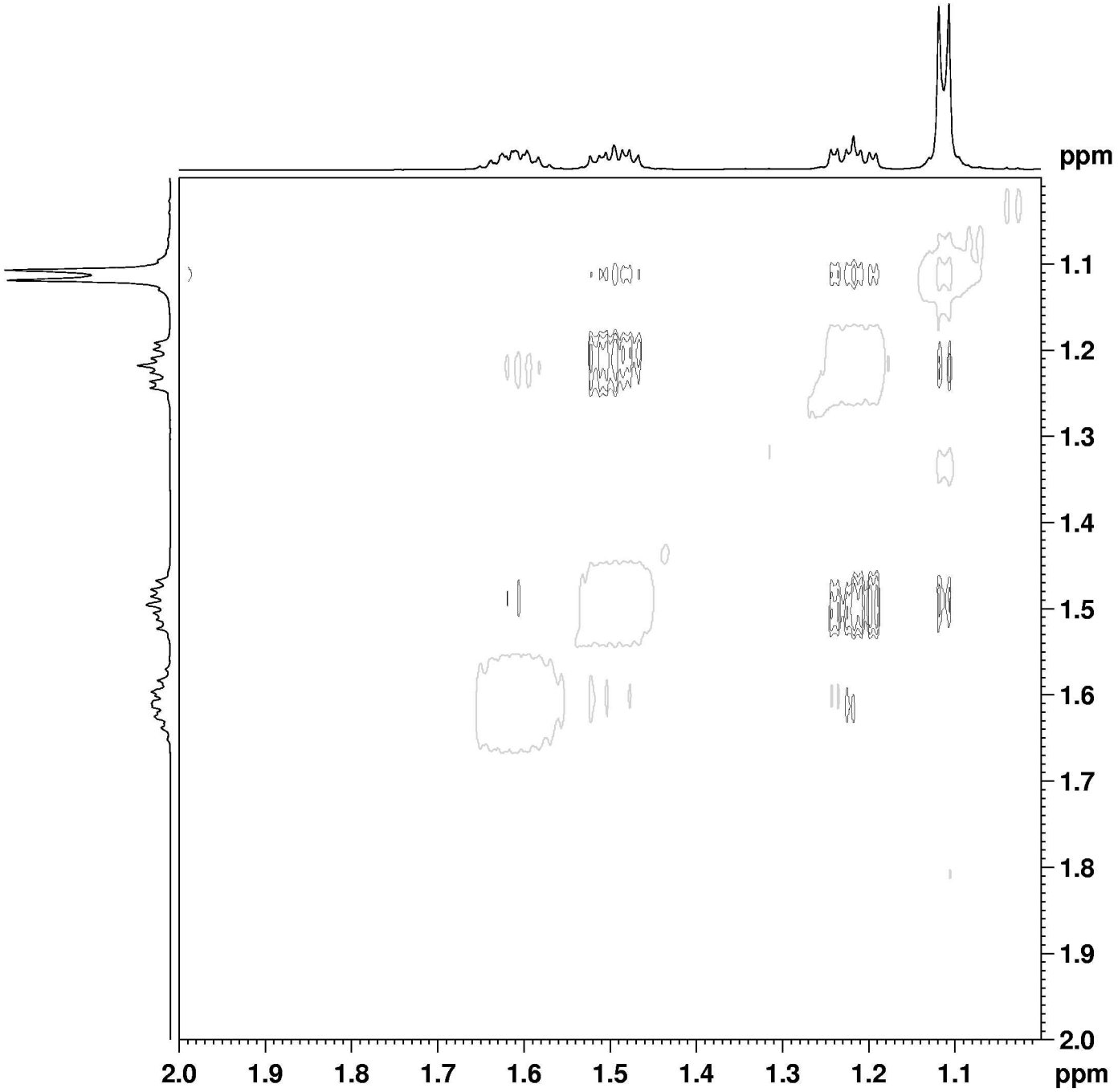
8f


O
O
S
O
N
H
O
N
H
OH

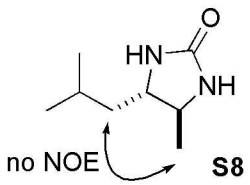
10
9
8
7
6
5
4
3
2
1
0
ppm
0.955
4.997
0.978
0.995
1.000
1.008
0.999
9.098

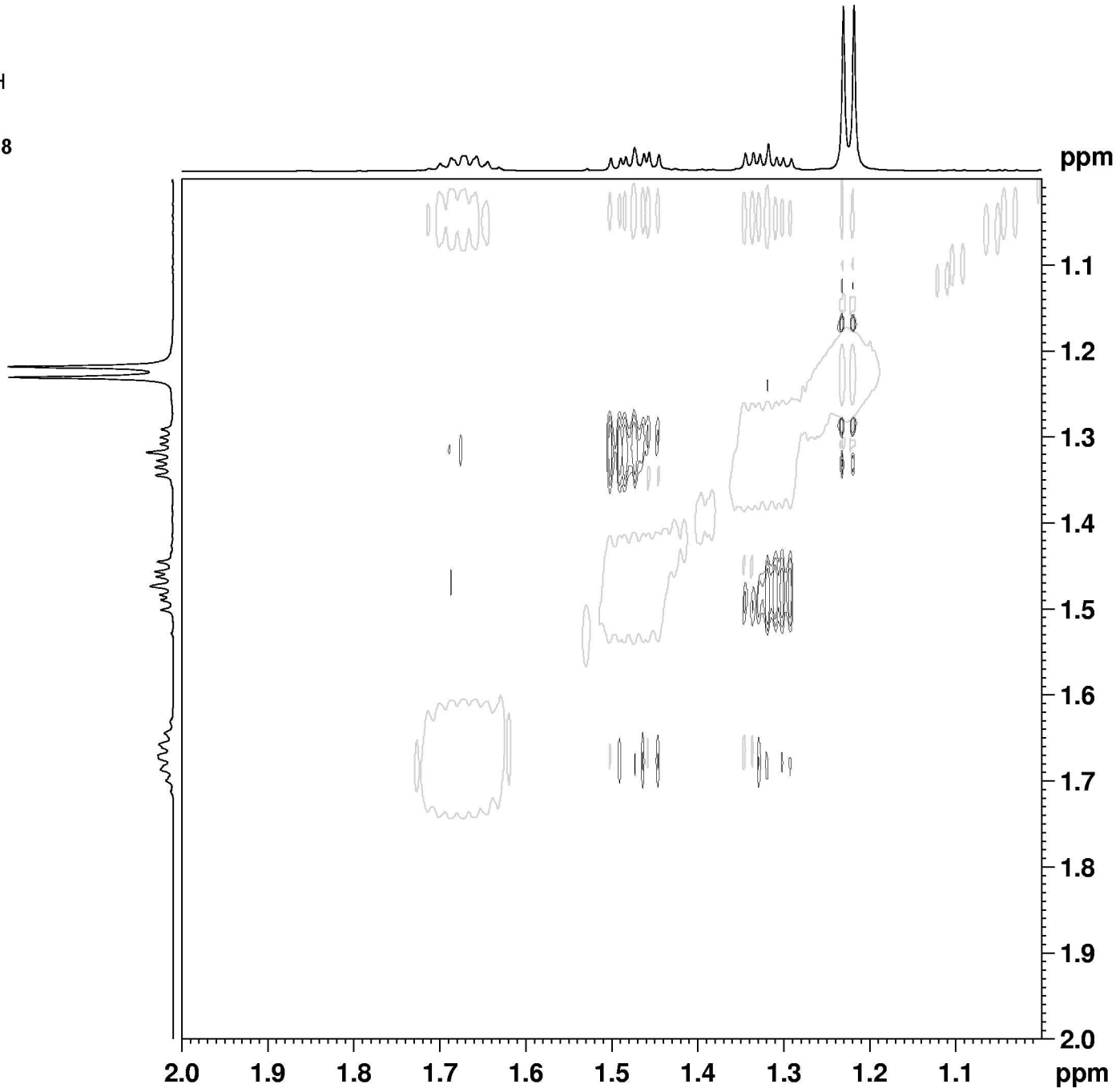
S7
NOESY


O
HN
NH
NOE
S7


ppm
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
ppm

S8
NOESY


HN
O
NH
no NOE
S8


ppm
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
ppm

ata File C:\HPCHEM\2\DATA\MROBAK~1\11060606.D Sample Name: MTR2-48

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Area Percent Report

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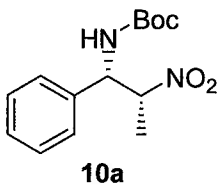
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: MWD1 C, Sig=210,8 Ref=360,100



10a

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.388	MM	0.2884	1262.36047	72.95079	82.6072
2	11.803	MM	0.3033	25.65276	1.40983	1.6787
3	13.609	MM	0.3382	51.47518	2.53673	3.3685
4	16.417	MM	0.4829	188.65916	6.51136	12.3456

Totals : 1528.14758 83.40871

Results obtained with enhanced integrator!

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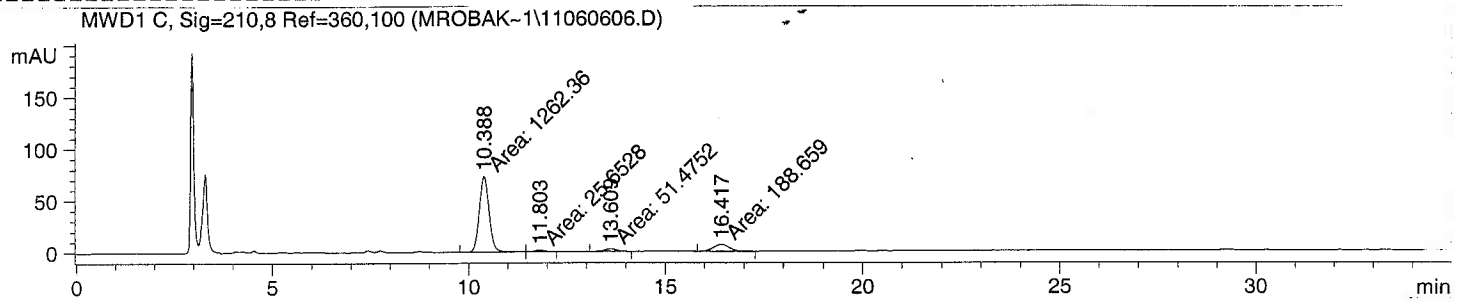
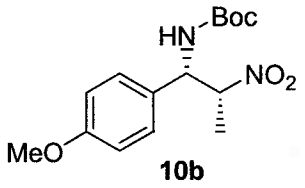


ata File C:\HPCHEM\2\DATA\MROBAK\03140702.D Sample Name: MTR2-136

Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

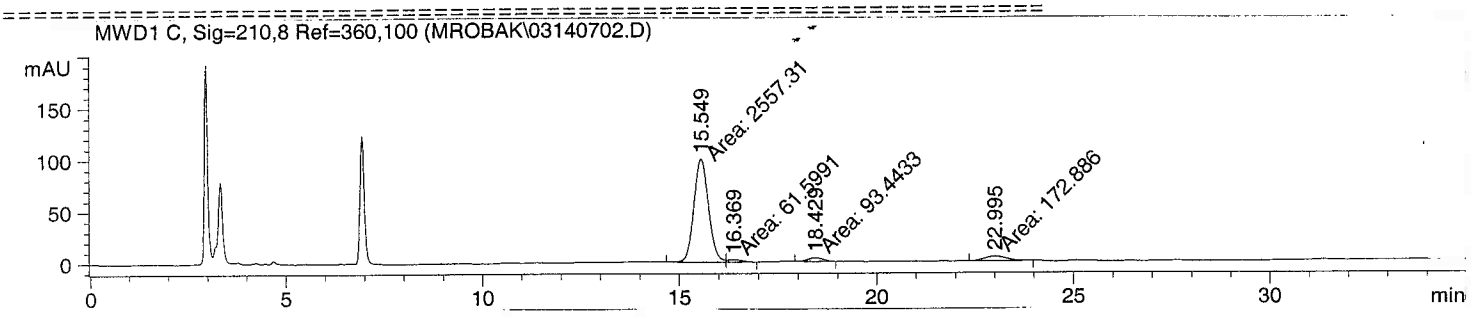


10b

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.549	MF	0.4280	2557.30713	99.57829	88.6343
2	16.369	FM	0.4170	61.59914	2.46214	2.1350
3	18.429	MM	0.4460	93.44327	3.49186	3.2387
4	22.995	MM	0.6529	172.88620	4.41343	5.9921
Totals :				2885.23573	109.94572	

Results obtained with enhanced integrator!

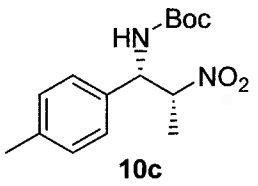


analytical HPLC 7/20/2007 2:39:03 PM

ata File C:\HPCHEM\2\DATA\MROBAK~1\11060608.D Sample Name: MTR2-50

Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

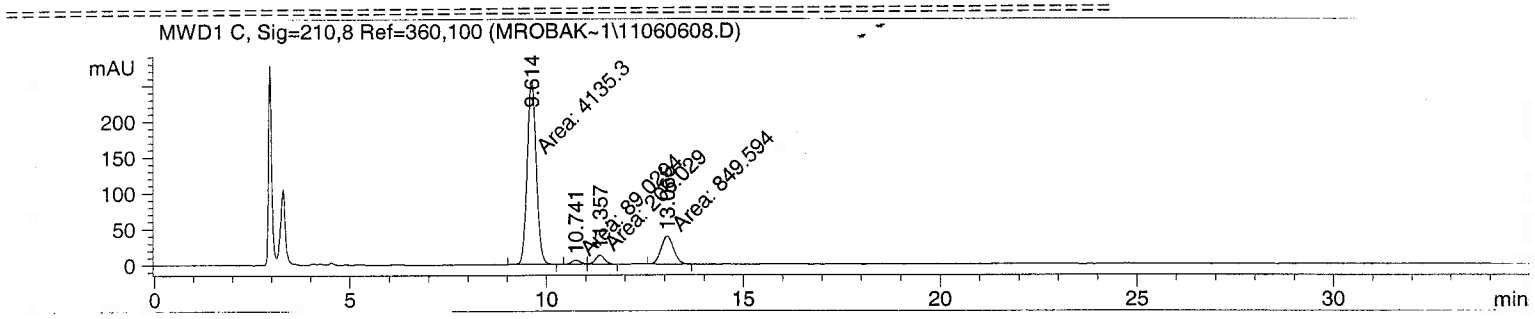


10c

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.614	MM	0.2684	4135.30078	256.77518	78.3208
2	10.741	MF	0.2696	89.02940	5.50397	1.6862
3	11.357	FM	0.2804	206.02855	12.24541	3.9021
4	13.065	MM	0.3667	849.59418	38.61240	16.0909
Totals :				5279.95290	313.13696	

Results obtained with enhanced integrator!



Data File C:\HPCHEM\2\DATA\MROBAK\03230711.D Sample Name: MTR2-138

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Area Percent Report

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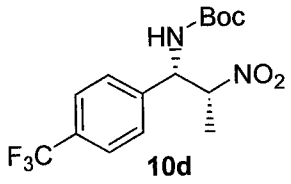
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs



10d

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.446	MM	0.2909	1043.70447	59.80339	76.1635
2	14.167	MM	0.2773	44.41248	2.66914	3.2410
3	16.363	MM	0.4348	94.72878	3.63076	6.9128
4	27.572	MM	1.0105	187.50082	3.09269	13.6827
Totals :				1370.34656	69.19598	

Results obtained with enhanced integrator!

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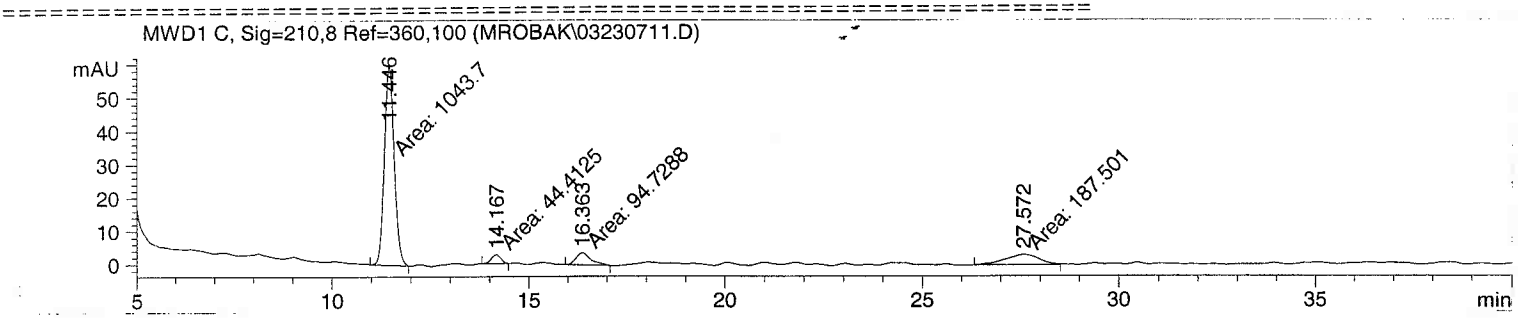

)ata File C:\HPCHEM\2\DATA\MROBAK\03230705.D Sample Name: MTR2-140

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Area Percent Report

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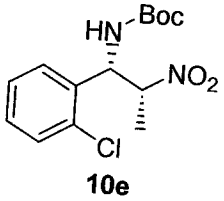
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs



10e

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.609	MM	0.2717	148.93532	9.13453	1.3799
2	10.998	MM	0.3094	265.16974	14.28284	2.4568
3	12.990	MM	0.3778	8356.55859	368.69659	77.4248
4	17.301	MM	0.5572	2022.47070	60.49460	18.7385

Totals : 1.07931e4 452.60856

Results obtained with enhanced integrator!

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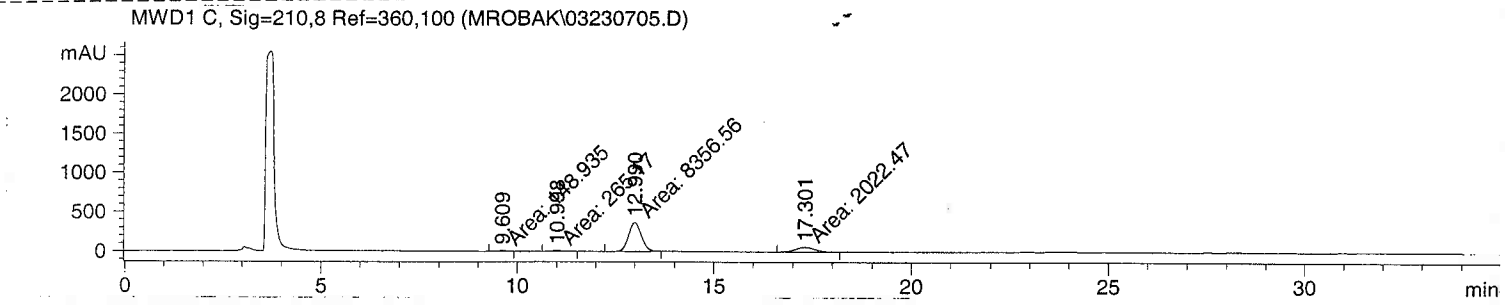

)ata File C:\HPCHEM\2\DATA\MROBAK~1\11060607.D

Sample Name: MTR2-49

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Area Percent Report

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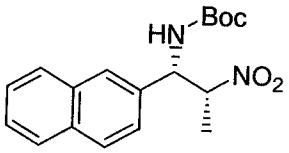
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs



10f

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.786	MM	0.4042	8119.00488	334.75671	81.3067
2	15.434	MM	0.4352	309.37054	11.84688	3.0981
3	17.665	MM	0.5114	619.12488	20.17776	6.2001
4	20.176	MM	0.5984	938.15759	26.12850	9.3951
Totals :				9985.65790	392.90986	

Results obtained with enhanced integrator!

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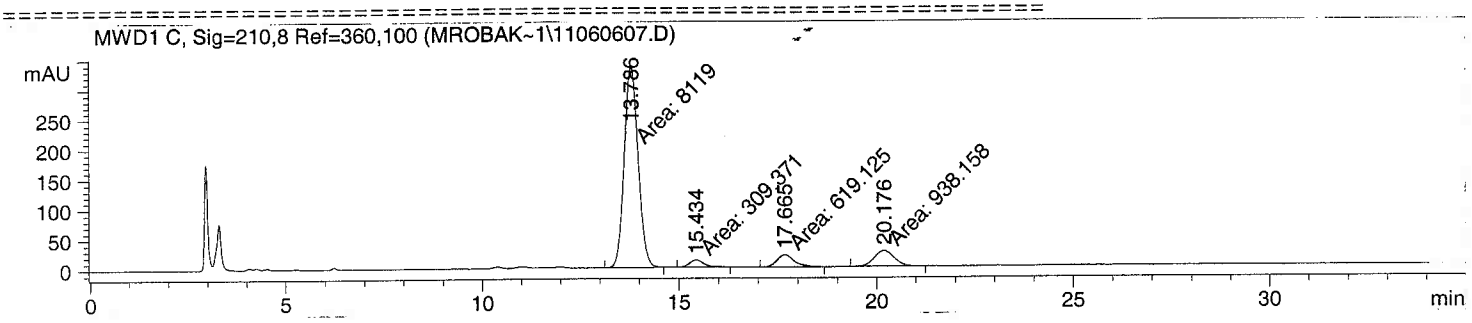

Data File C:\HPCHEM\2\DATA\MROBAK~1\12200602.D Sample Name: MTR2-113A

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Area Percent Report

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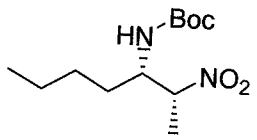
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs



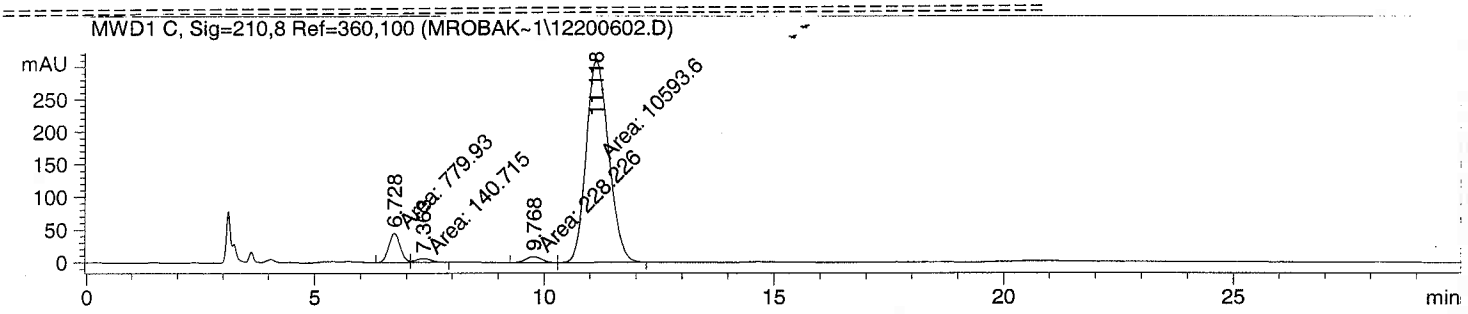
10g

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.728	MF	0.2916	779.93005	44.58244	6.6419
2	7.363	FM	0.4074	140.71454	5.75628	1.1983
3	9.768	MM	0.4126	228.22646	9.21856	1.9436
4	11.118	MM	0.5693	1.05936e4	310.14392	90.2161
Totals :				1.17425e4	369.70120	

Results obtained with enhanced integrator!

==========



Data File C:\HPCHEM\2\DATA\MROBAK~1\12200611.D Sample Name: MTR2-114A

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Area Percent Report

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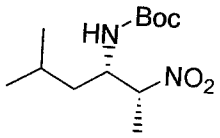
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs



10h

Signal 1: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.775	MM	0.2684	536.80463	33.33732	6.8252
2	7.709	MM	0.3171	144.00175	7.56919	1.8309
3	9.632	MM	0.5384	7184.24463	222.40256	91.3439
Totals :				7865.05101	263.30907	

Results obtained with enhanced integrator!

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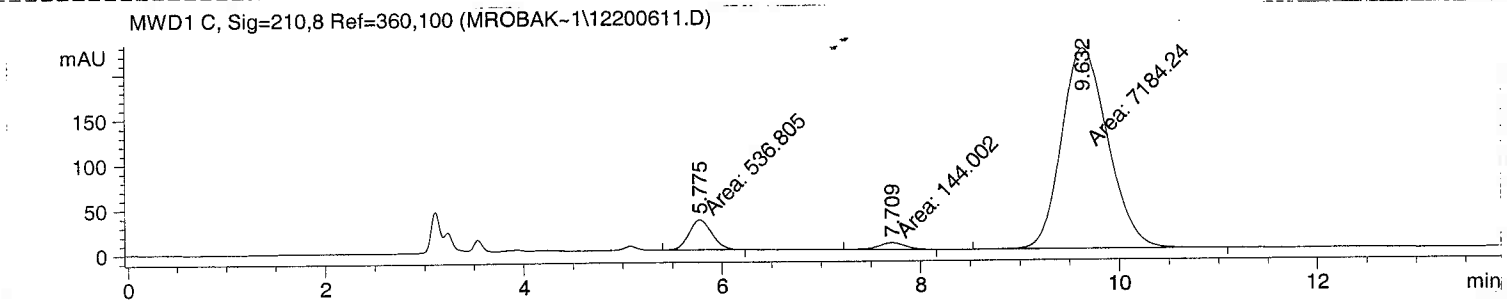

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Area Percent Report

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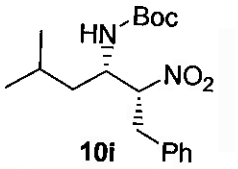
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: MWD1 A, Sig=222,64 Ref=360,100

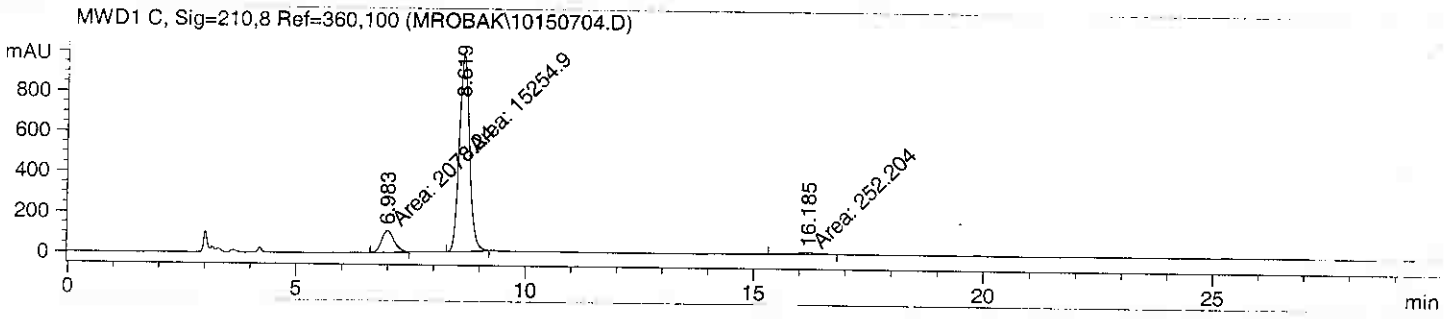
Signal 2: MWD1 B, Sig=254,16 Ref=360,100

Signal 3: MWD1 C, Sig=210,8 Ref=360,100



10i

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.983	MM	0.3181	2078.24146	108.89008	11.8181
2	8.619	MM	0.2587	1.52549e4	982.77380	86.7478
3	16.185	MM	0.6039	252.20430	6.96066	1.4342
Totals :				1.75853e4	1098.62454	



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Area Percent Report

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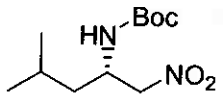
Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Use Multiplier & Dilution Factor with ISTDs



10j

Signal 1: MWD1 A, Sig=250,100 Ref=360,100

Signal 2: MWD1 B, Sig=254,16 Ref=360,100

Signal 3: MWD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.134	MF	0.6855	7.75255e4	1884.85864	97.6684
2	12.173	FM	0.8426	1850.70630	36.60738	2.3316
Totals :				7.93762e4	1921.46603	

Results obtained with enhanced integrator!