Electronic Supporting Information

Palladium(II)-catalyzed coupling reactions with a chelating vinyl ether and arylboronic acids: A new Heck/Suzuki domino diarylation reaction

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Experimental

General comments

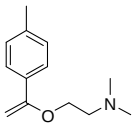
NMR spectra were recorded on a Varian Mercury plus spectrometer ($CDCl_3$ solution, 1H at 399.8 MHz and ^{13}C at 100.5 MHz). Chemical shifts for ^{1}H and ^{13}C are referenced to TMS via the solvent signals (^{1}H, $CHCl_3$ at 7.26 ppm; ^{13}C, $CDCl_3$ at 77.0 ppm). ^{13}C NMR signals are presented in 0.1 ppm accuracy except when the shifts are too close to avoid ambiguous interpretation; in such cases the ^{13}C NMR signals will be presented in 0.01 ppm accuracy. Low resolution EI mass spectra were recorded on a GC-MS instrument equipped with a Varian Chrompack Capillary column CP-SIL 8 CB Low Bleed/MS (30 m x 0.22 mm, 0.25 μm) and utilizing an ion generation potential of 70 eV. The oven temperature was 40-300 °C (gradient 30 °C/min), unless stated otherwise. Analytical LC-MS (ESI+) was performed on a Gilson HPLC system with Finnigan AQA quadrople mass spectrometer using a Chromolith SpeedROOD RP-18e 50 x 4.6 mm column, with gradient of MeOH/H_2O in 0.05% aqueous HCOOH as mobile phase at a flow rate of 4 mL/min. Analytical thin layer chromatography was performed using aluminium sheets precoated with silica 0.2 mm silica gel 60 F254. Visualization was performed by ultraviolet light and/or by staining with an ethanolic solution of phosphomolybdic acid (12 g

phosphomolybdic acid in 250 mL ethanol). Column chromatography was performed using commercially available silica (Merck grade 9385, 230-400 mesh, 60 Å) or aluminum oxide (Aldrich, activated, neutral, STD grade, 150 mesh, 58 Å). Heated reactions were performed in SUN-SRi vials (17 x 60 CLR S/N, 8 mL) or Microwave/safe vials (2-5 mL). The vials were heated in preheated metal blocks and magnetically stirred with Teflon-coated magnetic stirring bars. Balloons filled with molecular oxygen were mounted onto a syringe attached to a needle, providing oxygen to the reaction via penetration of the needle through a septum.

Materials

Palladium(II)acetate, palladium(II)trifluoroacetate, $Pd_2(dba)_3$, $Pd(acac)_2$ and dppp were obtained from Strem Chemicals. All boronic acids and *p*-benzoquinone were purchased from Sigma-Aldrich and used as received. All other reagents and solvents obtained from commercial sources were used as received.

Method A: Procedure for oxidative Heck α-arylation of *N,N*-dimethyl-2-(vinyloxy)ethanamine (1) with *p*-tolylboronic acid yielding *N,N*-dimethyl-2-(1-*p*-tolylvinyloxy)ethanamine (3a), Table 1



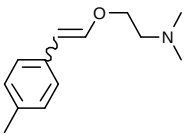
To a thick wall glas vial equipped with a teflon-coated stirring bar, *p*-tolylboronic acid (118 mg, 0.87 mmol), **1** (49.5 mg, 0.43 mmol, 1 equiv) and 1,4-dioxane (3 mL) were added. The mixture was stirred until all material had dissolved whereafter $Pd(O_2CCF_3)_2$ (5 mol%) and dppp (18 mol%) were added. The vial was sealed with a septum, flushed with nitrogen followed by connection of oxygen ballon and stirred at room temperature for 6 hours. The reaction was stopped when GC-MS showed full consumption of the starting olefin (**1**). The mixture was diluted with EtOAc (20 mL) and washed three times with NaOH (20 mL, aq, 0.1M). The organic phase was dried with K_2CO_3 (s), concentrated under reduced pressure and purified by column chromatography (aluminium oxide, iso-hexane:EtOAc:Et_3N, 90:6:4) affording **3a** (66.4 mg, 75%) as a colorless oil; The acquired spectroscopic data were in accordance with previous published results.[1] ^{1}H NMR δ 7.51 (d, *J* = 8.3 Hz, 2H), 7.13 (d, *J* = 8.3 Hz, 2H), 4.62 (d, *J* = 2.7 Hz, 1H), 4.17 (d, *J* = 2.7 Hz, 1H), 3.98 (dd, *J* =5.8, 11.5 Hz, 2H), 2.76 (dd, *J* = 5.8, 11.5 Hz, 2H), 2.36 (s, 6H), 2.34 (s, 3H); ^{13}C NMR δ 160.0, 138.4, 133.8, 128.9, 125.4, 81.9, 66.3, 58.2, 46.1, 21.3; MS (70 eV) m/z (relative intensity) 205 (M^+, 1), 115 (11), 91 (10), 72 (12), 71 (40), 58 (100).

Method B: Procedure for oxidative Heck β-arylation of *N,N*-dimethyl-2-(vinyloxy)ethanamine (1), Table 1

To a thick wall glas vial equipped with a teflon-coated stirring bar, the proper arylboronic acid (0.33 mmol), **1** (20 mg, 0.17 mmol, 1 equiv) and *N,N*-dimethylformamide (1.0 mL) were added. The mixture was stirred until

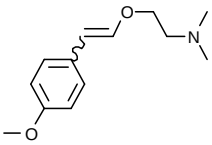
all material had dissolved whereafter $Pd(OAc)_2$ (1.9 mg, 5 mol%) was added. The vial was sealed with a septum, flushed with nitrogen followed by connection of an oxygen ballon and stirred at 60 °C. The reaction was stopped when GC-MS showed full consumption of the starting material dimethyl-(2-vinyloxy-ethyl)-amine (**1**). The mixture was diluted with EtOAc (10 mL) and washed three times with NaOH (10 mL, aq, 1M). The organic phase was dried with K_2CO_3 (s), concentrated under reduced pressure and purified by column chromatography (aluminium oxide).

N,N-dimethyl-2-(4-methylstyryloxy)ethanamine (4a)



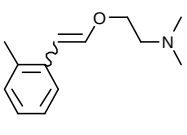
Using method **B**, the reaction mixture was stirred for 24 h and **4a** was obtained as a mixture of isomers in 51% yield (19 mg, *E:Z* = 37:63) after column chromatography (aluminium oxide, iso-hexane:EtOAc:Et_3N gradient, 92:4:4 to 70:26:4) as a colorless oil. The acquired spectroscopic data was in accordance with previous published results.[1] ^{1}H NMR δ 7.47 (d, *J* = 8.15 Hz, 2H, *Z*), 7.13-7.04 (m, *E:Z* mixture, 2H *Z*, 4H *E*), 6.98 (d, *J* = 13.0 Hz, 1H, *E*), 6.15 (d, *J* = 7.0 Hz, 1H, *Z*), 5.83 (d, *J* = 13.0 Hz, 1H, *E*), 5.21 (d, *J* = 7.0Hz, 1H, *Z*), 4.03 (t, *J* = 6.01 Hz, 2H, *Z*), 3.93 (t, *J* = 5.4 Hz, 2H, *E*), 2.73-2.65 (m, *E:Z* mixture, 2H each), 2.35 (s, 6H, *Z*), 2.34 (s, 6H, *E*), 2.31 (s, 3H, *Z*), 2.30 (s, 3H, *E*); ^{13}C NMR δ 147.2, 145.7, 135.3, 135.2, 133.3, 132.9, 129.3, 128.8, 128.1, 125.0, 105.91, 105.89, 71.7, 67.2, 58.6, 58.2, 45.9, 45.6, 21.2, 21.0; MS (70 eV) m/z (relative intensity) 205 (M^+, 15), 115 (7), 105 (9), 72 (93), 58 (100).

2-(4-methoxystyryloxy)-N,N-dimethylethanamine (4b)



Using method **B**, the reaction mixture was stirred for 24 h and **4b** was obtained as a mixture of isomers in 53% yield (23 mg, *E:Z* = 14:86) after column chromatography (aluminium oxide, iso-hexane:EtOAc:Et_3N gradient, 92:4:4 to 70:26:4). The acquired spectroscopic data was in accordance with previous published results.[1] ^{1}H NMR δ 7.51 (d, *J* = 8.9 Hz, 2H, *Z*), 7.14 (d, *J* = 8.7 Hz, 2H, *E*), 6.88 (d, *J* = 12.9 Hz, 1H, *E*), 6.84-6.81 (m, *E:Z* mixture, 2H each), 6.10 (d, *J* = 7.1 Hz, 1H, *Z*), 5.81 (d, *J* = 12.9 Hz, 1H, *E*), 5.19 (d, *J* = 7.1 Hz, 1H, *Z*), 4.04 (t, *J* = 5.9 Hz, 2H, *Z*), 3.93 (t, *J* = 5.5 Hz, 2H, *E*), 3.80 (s, 3H, *Z*), 3.79 (s, 3H, *E*), 2.73 (t, *J* = 5.9 Hz, *Z*), 2.69 (t, *J* = 5.5 Hz, *E*), 2.37 (s, 3H, *Z*), 2.35 (s, 3H, *E*); ^{13}C NMR δ 157.8, 144.6, 129.4, 128.6, 113.6, 105.7, 71.2, 58.4, 55.2, 45.7 (signals from *Z*-isomer); MS (70 eV) m/z (relative intensity) 221 (M^+, 10), 121 (12), 72 (100), 58 (63).

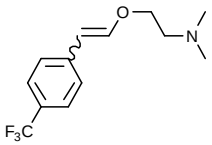
N,N-dimethyl-2-(2-methylstyryloxy)ethanamine (4c)



Using method **B**, the reaction mixture was stirred for 24 h and **4c** was obtained as a mixture of isomers in 56% yield (20 mg, *E:Z* = 38:62) after column chromatography (aluminium

oxide, iso-hexane:EtOAc:Et_3N gradient, 92:4:4 to 70:26:4) as a colorless oil; ^{1}H NMR δ 7.91 (dd, *J* = 1.7, 7.8 Hz, 1H, *Z*), 7.27-7.24 (m, 1H, *E*), 7.17-7.03 (m, *E:Z* mixture, 3H each), 6.86 (d, *J* = 12.8 Hz, 1H, *E*), 6.25 (d, *J* = 7.2 Hz, 1H, *Z*), 5.97 (d, *J* = 12.8 Hz, 1H, *E*), 5.34 (d, *J* = 7.2 Hz, 1H, *Z*), 4.03 (t, *J* = 6.0 Hz, 2H, *Z*), 3.95 (t, *J* = 5.6 Hz, 2H, *E*), 2.71-2.65 (m, *E:Z* mixture, 2H each), 2.34 (s, 6H, *E*), 2.33 (s, 6H, *Z*), 2.30 (s, 3H, *Z*), 2.29 (s, 3H, *E*); ^{13}C NMR δ 148.2, 146.3, 135.1, 134.8, 134.7, 134.1, 130.1, 129.8, 128.9, 126.0, 125.9, 125.8, 125.6, 124.8, 104.2, 102.8, 71.7, 67.4, 58.6, 58.2, 45.9, 45.7, 20.2, 20.0; MS (70 eV) m/z (relative intensity) 205 (M^+, 7), 115 (9), 72 (76), 58 (100); Anal. Calcd for $C_{13}H_{19}NO$ (%): C, 76.06; H, 9.33; N, 6.82. Found: C, 75.95; H, 9.09; N, 6.93.

N,N-dimethyl-2-(4-(trifluoromethyl)styryloxy)ethanamine (4d)



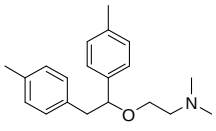
Using method **B**, the reaction mixture was stirred for 24 h and **4d** was obtained as a mixture of isomers in 47% yield (23 mg, *E:Z* = 60:40) after column chromatography (aluminium oxide, iso-hexane:EtOAc:Et_3N gradient, 92:4:4 to 70:26:4) as a colorless oil; ^{1}H NMR δ 7.65 (d, *J* = 8.3 Hz, 2H, *Z*), 7.53-7.47 (m, *E:Z* mixture, 2H each), 7.29 (d, *J* = 8.3 Hz, 2H, *E*), 7.11 (d, *J* = 13.0 Hz, 1H, *E*), 6.31 (d, *J* = 7.0 Hz, 1H, *Z*), 5.86 (d, *J* = 13.0 Hz, 1 H, *E*), 5.26 (d, *J* = 7.0 Hz, 1H, *Z*), 4.08 (t, *J* = 5.9 Hz, 2H, *Z*), 3.98 (t, *J* = 5.5 Hz, 2H, *E*), 2.72-2.67 (m, *E:Z* mixture), 2.35 (s, 6H, *E*), 2.34 (s, 6H, *Z*); ^{13}C NMR δ 149.6, 148.4, 139.9 (q, *J* = 1.5 Hz), 139.3 (q, *J* = 1.5 Hz), 128.1, 127,7 (q, *J* = 32 Hz, *Z*), 127.6 (q, *J* = 32 Hz, *E*) 125.5 (q, *J* = 3.8 Hz), 125.0 (q, *J* = 4.0), 124.9, 124.1 (q, *J* = 272 Hz, Two close signals, *E:Z* carbons), 104.9, 104.7, 72.2, 67.5, 58.6, 58.1, 45.9, 45.6; MS (70 eV) m/z (relative intensity) 259 (M^+, 15), 72 (37), 58 (100); Anal. Calcd for $C_{13}H_{16}F_3NO$ (%): C, 60.22; H, 6.22; N, 5.40. Found: C, 60.48; H, 6.53; N, 5.34.

Method C: General procedure for diarylation of *N,N*-dimethyl-2-(vinyloxy)ethanamine (1), table 2

To a 8 mL glas vial equipped with a teflon-coated stirring bar, corresponding boronic acid (1.04 mmol), *p*-benzoquinone (37.8 mg, 0.35 mmol), **1** (40 mg, 0.35 mmol), and 1,4-dioxane (2.4 mL) were added. The vial was stirred until all material had dissolved whereafter $Pd(O_2CCF_3)_2$ (5 mol%) was added. The vial was rapidly put in a preheated metalblock at 40 °C and the content was magnetically stirred for 8-24 h under open air. The reaction mixture was diluted on EtOAc (10 mL), thereafter put on an separation funnel and extracted with HCl (3-5 x 10 mL, aq, 2M). The acidic aqueous phases were combined and thereafter basified with NaOH (aq, 6M). The alkaline aqueous phase was then extracted with EtOAc (3 x 15 mL). The combined organic phases were thereafter washed with NaOH (3 x 15 mL, aq, 1M), dried with K_2CO_3 (s), concentrated under reduced pressure

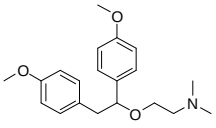
and purified by column chromatography affording pure products **5a**-**5m**. It is worthful to note that the majority of the products could be obtained in >95% purity after merely using the extraction procedure described above.

2-(1,2-di-p-tolylethoxy)-N,N-dimethylethanamine (5a)



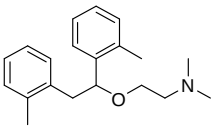
Using method **C**, the reaction mixture was stirred for 8 h and **5a** was obtained in 82% yield (85 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 80:16:4) as a colorless oil; ^{1}H NMR δ 7.16-7.10 (m, 4H), 7.05-6.99 (m, 4H), 4.35 (dd, *J* = 5.9, 7.6 Hz, 1H), 3.42 (ddd, *J* = 5.4, 6.3, 10.1 Hz, 1H), 3.29 (ddd, *J* = 5.4, 6.2, 10.1 Hz, 1H), 3.10 (dd, *J* = 7.7, 13.7 Hz, 1H), 2.83 (dd, *J* = 5.9, 13.7 Hz, 1H), 2.49 (ddd, *J* = 5.4, 6.3, 12.8 Hz, 1H), 2.34 (s, 3H), 2.30 (s, 3H), 2.20 (s, 6H); ^{13}C NMR δ 139.0, 137.1, 135.6, 135.4, 129.4, 128.9, 128.6, 126.7, 83.9, 66.9, 58.8, 45.7, 44.4, 21.1, 21.0; MS (70 eV) m/z (relative intensity) 298 (M^+, 2), 224 (19), 105 (15), 72 (30), 58 (100); Anal. Calcd for $C_{20}H_{27}NO$ (%): C, 80.76; H, 9.15; N, 4.71. Found: C, 80.37; H, 9.05; N, 4.83.

2-(1,2-bis(4-methoxyphenyl)ethoxy)-N,N-dimethylethanamine (5b)



Using method **C**, the reaction mixture was stirred for 18 h and **5b** was obtained in 66% yield (76 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.14 (dd, *J* = 2.2, 6.7 Hz, 2H), 6.99 (dd, *J* = 2.2, 6.6 Hz, 2H), 6.83 (dd, *J* =2.2, 6.7 Hz, 2H), 6.75 (dd, *J* =2.2, 6.6 Hz, 2H), 4.30 (dd, *J* = 6.3, 7.2 Hz, 1H), 3.79 (s, 3H), 3.76 (s, 3H), 3.40 (ddd, *J* = 5.4, 6.3, 10.1 Hz, 1H), 3.29 (ddd, *J* = 5.4, 6.3, 10.1 Hz, 1H), 3.08 (dd, *J* = 7.3, 13.7 Hz, 1H), 2.81 (dd, *J* = 6.3, 13.7 Hz, 1H), 2.53-2.40 (m, 2H), 2.20 (s, 6H); ^{13}C NMR δ 159.0, 157.9, 134.0, 130.7, 130.4, 128.0, 113.6, 113.3, 83.7, 66.7, 58.8, 55.2, 55.1, 45.7, 43.8; MS (70 eV) m/z (relative intensity) 330 (M^+, 11), 256 (25), 240 (19), 208 (10), 135 (10), 121 (14), 72 (71), 58 (100); Anal. Calcd for $C_{20}H_{27}NO_3$ (%): C, 72.92; H, 8.26; N, 4.25. Found: C, 72.97; H, 8.41; N, 4.25.

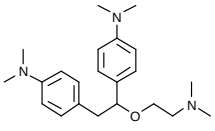
2-(1,2-di-o-tolylethoxy)-N,N-dimethylethanamine (5c)



Using method **C**, the reaction mixture was stirred for 24 h and **5c** was obtained in 66% yield (68 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 80:16:4) as a colorless oil; ^{1}H NMR δ 7.48 (dd, *J* = 1.6, 7.7 Hz, 1H), 7.23 (ddt, *J* = 0.5, 1.5, 7.4 Hz, 1H), 7.15 (dt, *J* = 1.5, 7.4 Hz, 1H), 7.10-7.01 (m, 5H), 4.73 (dd, *J* = 6.1, 7.4 Hz, 1H), 3.41 (ddd, *J* = 5.5, 6.2, 10.0 Hz, 1H), 3.27 (ddd, *J* = 5.4, 6.2, 10.0 Hz, 1H), 3.15 (dd, *J* = 7.4, 13.8 Hz, 1H), 2.86 (dd, *J* = 6.1, 13.8 Hz, 1H), 2.52-2.14 (m, 2H), 2.23 (s, 3H), 2.19 (s, 6H), 2.08 (s, 3H); ^{13}C NMR δ 140.3, 136.70, 136.68, 135.5, 130.3, 130.1, 129.9, 127.1, 126.24, 126.21, 126.18, 125.5, 79.2, 67.0, 58.9, 45.7, 41.2, 19.5, 18.8; MS (70 eV) m/z

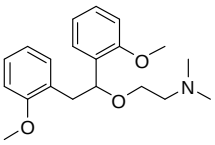
(relative intensity) 298 (M^+, 20), 105 (9), 72 (26), 58 (100); Calcd for $C_{20}H_{27}NO$ (%): C, 80.76; H, 9.15; N, 4.71. Found: C, 80.65; H, 9.02; N, 4.83.

4,4'-(1-(2-(dimethylamino)ethoxy)ethane-1,2-diyl)bis(N,N-dimethylaniline) (5e)



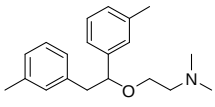
Using method **C**, the reaction mixture was stirred for 12 h and **5e** was obtained in 49% yield (60 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 80:16:4) as a yellow oil; ^{1}H NMR δ 7.13 (dd, *J* = 2.1, 6.7 Hz, 2H), 7.00 (dd, *J* = 2.2, 6.6 Hz, 2H), 6.69 (dd, *J* = 2.1, 6.7 Hz, 2H), 6.63 (dd, *J* = 2.2, 6.6 Hz, 2H), 4.27 (dd, *J* = 5.7, 7.9 Hz, 1H), 3.49-4.42 (m, 1H), 3.37-3.29 (m, 1H), 3.02 (dd, *J* = 7.6, 14 Hz, 1H), 2.94 (s, 6H), 2.89 (s, 6H), 2.80 (dd, *J* = 5.5, 14.0 Hz, 1H), 2.67-2.51 (m, 2H), 2.27 (s, 6H); ^{13}C NMR δ 150.1, 149.1, 130.1, 129.5, 127.8, 127.2, 112,7, 112.3, 84.2, 65.5, 58.2, 45.0, 43.6, 40.9, 40.6; ESI$^+$-MS m/z (relative intensity) 356.3 ($[M+H]^+$, 32), 178.7 ($[M+2H]^{2+}$, 100); Anal. Calcd for $C_{22}H_{33}N_3O$ (%): C, 74.32; H, 9.36; N, 11.82. Found: C, 74.05; H, 9.57; N, 11.98.

2-(1,2-bis(2-methoxyphenyl)ethoxy)-N,N-dimethylethanamine (5f)



Using method **C**, the reaction mixture was stirred for 24 h and **5f** was obtained in 48% yield (55 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.44 (dd, *J* = 1.9, 7.5 Hz, 1H), 7.20 (ddd, *J* = 1.8, 7.3, 8.2 Hz, 1H), 7.16-7.11 (m, 1H), 7.05 (dd, *J* = 1.9, 7.8 Hz, 1H), 6.96 (ddd, *J* = 0.4, 1.1, 7.4 Hz, 1H), 6.81-6.76 (m, 3H), 5.04 (dd, *J* = 5.5, 7.8 Hz, 1H), 3.76 (s, 3H), 3.64 (s, 3H), 3.47 (ddd, *J* = 5.7, 6.2, 11.8 Hz, 1H), 3.34 (ddd, *J* = 5.6, 6.2, 11.8 Hz, 1H), 3.08 (dd, *J* = 7.8, 13.6 Hz, 1H), 2.92 (dd, *J* = 5.4, 13.6 Hz, 1H), 2.51-2.39 (m, 2H), 2.19 (6H); ^{13}C NMR δ 157.8, 157.1, 131.1, 131.0, 127.9, 127.5, 127.0, 126.8, 120.6, 119.9, 110.2, 110.0, 75.4, 67.2, 58.8, 55.3, 55.2, 45.7, 37.6; MS (70 eV) m/z (relative intensity) 330 (M^+, 3), 256 (45), 240 (15), 135 (32), 91 (24), 72 (48), 58 (100); Anal. Calcd for $C_{20}H_{27}NO_3$ (%): C, 72.92; H, 8.26; N, 4.25. Found: C, 72.97; H, 8.19; N, 4.36.

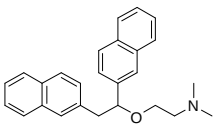
2-(1,2-di-m-tolylethoxy)-N,N-dimethylethanamine (5g)



Using method **C**, the reaction mixture was stirred for 8 h and **5g** was obtained in 92% yield (95 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 80:16:4) as a colorless oil; ^{1}H NMR δ 7.21 (dd, *J* = 0.8, 7.4 Hz, 1H), 7.13 (dd, *J* = 0.5, 7.4 Hz, 1H), 7.10-7.05 (m, 3H), 7.02-6.93 (m, 3H), 4.37 (dd, *J* = 5.2, 8.1 Hz, 1H), 3.45 (ddd, *J* = 5.4, 6.2, 10.0 Hz, 1H), 3.29 (ddd, *J* = 5.4, 6.3, 10.0 Hz, 1H), 3.09 (dd, *J* = 8.1, 13.7 Hz, 1H), 2.83 (dd, *J* = 5.3, 13.7 Hz, 1H), 5.51-2.39 (m, 2H), 2.35 (s, 3H), 2.31 (s, 3H), 2.19 (s, 6H); ^{13}C NMR δ 142.2, 138.8, 137.8, 137.4, 130.4, 128.2, 128.1, 127.8,

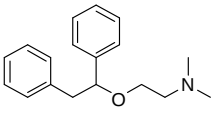
127.3, 126.7, 126.5, 123.8, 84.0, 67.1, 58.9, 45.7, 44.8, 21.4, 21.3; MS (70 eV) m/z (relative intensity) 298 (M^+, 10), 105 (12), 72 (21), 58 (100); Anal. Calcd for $C_{20}H_{27}NO$ (%): C, 80.76; H, 9.15; N, 4.71. Found: C, 80.72; H, 8.99; N, 4.84.

2-(1,2-di(naphthalen-2-yl)ethoxy)-N,N-dimethylethanamine (5h)



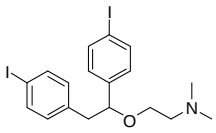
Using method **C**, the reaction mixture was stirred for 24 h and **5h** was obtained in 50% yield (64 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.86-7.82 (m, 2H), 7.80-7.76 (m, 2H), 7.75-7.69 (m, 3H), 7.64 (s, 1H), 7.51-7.46 (m, 3H), 7.47-7.41 (m, 2H), 7.29 (dd, *J* = 1.7, 8.3 Hz, 1H), 4.69 (dd, *J* = 5.6, 7.7 Hz, 1H), 3.49 (ddd, *J* = 5.1, 6.3, 10.2 Hz, 1H), 3.43-3.35 (m, 2H), 3.16 (dd, *J* = 5.7, 13.8 Hz, 1H), 2.58-2.46 (m, 2H), 2.20 (s, 6H); ^{13}C NMR δ 139.3, 136.1, 133.4, 133.2, 133.1, 132.0, 128.3, 128.1, 128.0, 127.9, 127.7, 127.5, 127.5 (2 overlapping signals), 126.1, 125.9, 125.8, 125.7, 125.2, 124.5, 84.2, 66.8, 58.7, 45.5, 44.8; MS (70 eV) m/z (relative intensity) 370 (M^+, 15), 296 (16), 155 (11), 115 (10), 72(32), 58 (100); Anal. Calcd for $C_{26}H_{27}NO$ (%): C, 84.51; H, 7.37; N, 3.79. Found: C, 84.32; H, 7.66; N, 3.54.

2-(1,2-diphenylethoxy)-N,N-dimethylethanamine (5i)



Using method **C**, the reaction mixture was stirred for 12 h and **5i** was obtained in 81% yield (76 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.34-7.39 (m, 2H), 7.28-7.22 (m, 4H), 7.21-7.14 (m, 2H), 7.13-7.09 (m, 2H), 4.42 (dd, *J* = 5.8, 7.7 Hz, 1H), 3.44 (ddd, *J* = 5.3, 6.2, 10.2 Hz, 1H), 3.32 (dddd, *J* = 0.5, 5.3, 6.3, 10.2 Hz, 1H), 3.15 (ddd, *J* = 0.5, 7.7, 13.7 Hz, 1H), 2.89 (dd, *J* = 5.8, 13.7 Hz, 1H), 2.56-2.42 (m, 2H), 2.20 (s, 6H); ^{13}C NMR δ 141.8, 138.5, 129.5, 128.2, 128.0, 127.6, 126.7, 126.0, 84.0, 66.9, 58.7, 45.6, 44.8; MS (70 eV) m/z (relative intensity) 270 (M^+, 40), 178 (4), 72 (17), 58 (100); Anal. Calcd for $C_{18}H_{23}NO$ (%): C, 80.26; H, 8.61; N, 5.20. Found: C, 80.13; H, 8.68; N, 5.33.

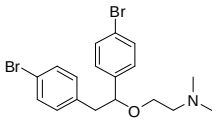
2-(1,2-bis(4-iodophenyl)ethoxy)-N,N-dimethylethanamine (5j)



Using method **C**, the reaction mixture was stirred for 24 h and **5j** was obtained in 11% yield (19 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 60:36:4) as a colorless oil; ^{1}H NMR δ 7.43 (dd, *J* = 2.0, 6.6 Hz, 2H), 7.33 (dd, *J* = 1.8, 6.3 Hz, 2H), 7.07 (dd, *J* = 2.0, 6.6 Hz, 2H), 6.94 (dd, *J* = 1.8, 6.3 Hz, 2H), 4.33 (dd, *J* = 6.0, 7.4 Hz, 1H), 3.40 (ddd, *J* = 5.2, 6.3, 10.2 Hz, 1H), 3.31 (ddd, *J* = 5.1, 6.3, 10.2 Hz, 1H), 3.04 (dd, *J* = 7.4, 13.8 Hz, 1H), 2.79 (dd, *J* = 6.0, 13.8 Hz, 1H), 2.51 (ddd, *J* = 5.1, 6.3, 12.9 Hz, 1H), 2.46 (ddd, *J* = 5.1, 6.3, 12.9 Hz, 1H), 2.22 (s, 3H); ^{13}C NMR δ

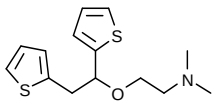
140.5, 136.9, 131.5, 131.3, 131.1, 128.4, 121.5, 120.2, 83.0, 66.9, 58.7, 45.6, 44.0; MS (70 eV) m/z (relative intensity) 522 (M^+, 3), 433 (3), 306 (5), 178 (7), 72 (24), 58 (100); Anal. Calcd for $C_{18}H_{21}I_2NO$ (%): C, 41.48; H, 4.06; N, 2.69. Found: C, 41.58; H, 4.05; N, 2.62.

2-(1,2-bis(4-bromophenyl)ethoxy)-N,N-dimethylethanamine (5k)



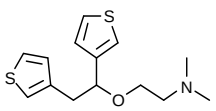
Using method **C**, the reaction mixture was stirred for 8 h and **5k** was obtained in 66% yield (98 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.43 (dd, *J* = 2.0, 6.6 Hz, 2H), 7.33 (dd, *J* = 1.8, 6.3 Hz, 2H), 7.07 (dd, *J* = 2.0, 6.6 Hz, 2H), 6.94 (dd, *J* = 1.8, 6.3 Hz, 2H), 4.33 (dd, *J* = 6.0, 7.4 Hz, 1H), 3.40 (ddd, *J* = 5.2, 6.3, 10.2 Hz, 1H), 3.31 (ddd, *J* = 5.1, 6.3, 10.2 Hz, 1H), 3.04 (dd, *J* = 7.4, 13.8 Hz, 1H), 2.79 (dd, *J* = 6.0, 13.8 Hz, 1H), 2.51 (ddd, *J* = 5.1, 6.3, 12.9 Hz, 1H), 2.46 (ddd, *J* = 5.1, 6.3, 12.9 Hz, 1H), 2.22 (s, 3H); ^{13}C NMR δ 140.5, 136.9, 131.5, 131.3, 131.1, 128.4, 121.5, 120.2, 83.0, 66.9, 58.7, 45.6, 44.0; MS (70 eV) m/z (relative intensity) 428 (M^+, 6), 258 (3), 178 (3), 72 (18), 58 (100); Anal. Calcd for $C_{18}H_{21}Br_2NO$ (%): C, 50.61; H, 4.96; N, 3.28. Found: C, 50.29; H, 5.12; N, 3.48.

2-(1,2-di(thiophen-2-yl)ethoxy)-N,N-dimethylethanamine (5l)



Using method **C**, the reaction mixture was stirred for 24 h and **5l** was obtained in 28% yield (27 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.27 (ddd, *J* = 0.6, 1.4, 4.8 Hz, 1H), 7.13 (dd, *J* = 1.2, 5.1 Hz, 1H), 6.95 (dd, *J* = 3.4, 4.8 Hz, 1H), 6.92 (ddd, *J* = 0.6, 1.4, 3.4 Hz, 1H), 6.89 (dd, *J* = 3.4, 5.1 Hz, 1H), 6.78 (ddd, *J* = 0.8, 2.1, 3.5 Hz, 1H), 4.70 (dd, *J* = 5.6, 7.8 Hz, 1H), 3.63-6.55 (m, 1H), 3.50-3.46 (m, 1H), 3.42 (dd, *J* = 1.1, 7.8, 14.8 Hz, 1H), 3.24 (dd, *J* = 0.9, 5.6, 14.8 Hz, 1H), 2.65-2.52 (m, 2H), 2.28 (s, 6H); ^{13}C NMR δ 145.1, 140.1, 126.4, 126.0 (2 overlapping signals), 125.7, 125.2, 124.1, 79.1, 66.8, 58.6, 45.4, 39.1; MS (70 eV) m/z (relative intensity) 282 (M^+, 2), 97 (15), 72 (19), 58 (100); Anal. Calcd for $C_{14}H_{19}NOS_2$ (%): C, 59.75; H, 6.80; N, 4.98. Found: C, 59.74; H, 6,87; N, 5,12.

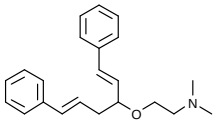
2-(1,2-di(thiophen-3-yl)ethoxy)-N,N-dimethylethanamine (5m)



Using method C, the reaction mixture was stirred for 24 h and **5m** was obtained in 47% yield (46 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 70:26:4) as a colorless oil; ^{1}H NMR δ 7.28 (ddd, *J* = 0.5, 3.0, 5.0 Hz, 1H), 7.18 (dd, *J* = 3.0, 4.9 Hz, 1H), 7.06 (ddd, *J* = 0.5, 1.3, 3.0 Hz, 1H), 7.03 (dd, *J* = 1.3, 5.0 Hz, 1H), 6.93-6.89 (m, 1H), 6.85 (dd, *J* = 1.3, 4.9 Hz, 1H), 4.52 (dd, *J* = 6.1, 7.4 Hz, 1H), 3.48 (ddd, *J* = 5.2, 6.3, 10.2 Hz, 1H), 3.42-3.35 (m, 1H), 3.18 (ddd, *J* =

0.9, 7.4, 14.3 Hz, 1H), 2.97 (ddd, *J* = 0.7, 6.1, 14.3 Hz, 1H), 2.58-2.45 (m, 2H), 2.24 (s, 6H); ^{13}C NMR δ 143.2, 138.6, 128.9, 126.0, 125.9, 124.7, 122.1, 121.9, 79.0, 66.6, 58.7, 45.5, 38.1; MS (70 eV) m/z (relative intensity) 282 (M^+, 47), 72 (10), 58 (100); Anal. Calcd for $C_{14}H_{19}NOS_2$ (%): C, 59.75; H, 6.80; N, 4.98. Found: C, 59.53; H, 6.86; N, 5.07.

2-((1E,5E)-1,6-diphenylhexa-1,5-dien-3-yloxy)-N,N-dimethylethanamine (5n)

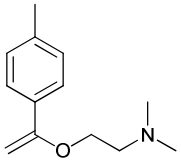


Using method **C**, the reaction mixture was stirred for 12 h and **5n** was obtained in 65% yield (76 mg) after column chromatography (silica gel, iso-hexane:EtOAc:Et_3N, 80:16:4) as a colorless oil; ^{1}H NMR δ 7.42 (ddd, *J* = 0.5, 1.5, 3.6 Hz, 1H), 7.40-7.38 (m, 1H), 7.37-7.25 (m, 6H), 7.24-7.18 (m, 2H), 6.58 (d, *J* = 16.0 Hz, 1H), 6.47 (dt, *J* = 1.5, 15.8 Hz, 1H), 6.27 (dt, *J* = 7.1, 15.8 Hz, 1H), 6.16 (dd, *J* = 7.9, 16.0 Hz, 1H), 3.98-3.92 (m, 1H), 3.70 (ddd, *J* = 5.5, 6.3, 10.0 Hz, 1H), 3.48 (ddd, *J* = 5.5, 6.3, 10.0 Hz, 1H), 2.69-2.48 (m, 4H), 2.29 (s, 6H); ^{13}C NMR δ 137.6, 136.5, 132.3, 132.1, 130.0, 128.5, 128.4, 127.7, 127.0, 126.5, 126.4, 126.0, 81.2, 66.7, 59.0, 45.9, 39.5; MS (70 eV) m/z (relative intensity) 322 (M^+, 7), 232 (8), 204 (5), 147 (5), 115 (12), 72 (52), 58 (100); Anal. Calcd for $C_{22}H_{27}NO$ (%): C, 82.20; H, 8.47; N, 4.36. Found: C, 82,03; H, 8,36; N, 4,39.

Referenses

1. C. M. Andersson, J. Larsson and A. Hallberg, *J. Org. Chem.*, 1990, **55**, 5757-5761.

N,*N*-dimethyl-2-(1-*p*-tolylvinyloxy)ethanamine 3a



Chemical Formula: $C_{13}H_{19}NO$
Molecular Weight: 205,30

Chromatogram Plot

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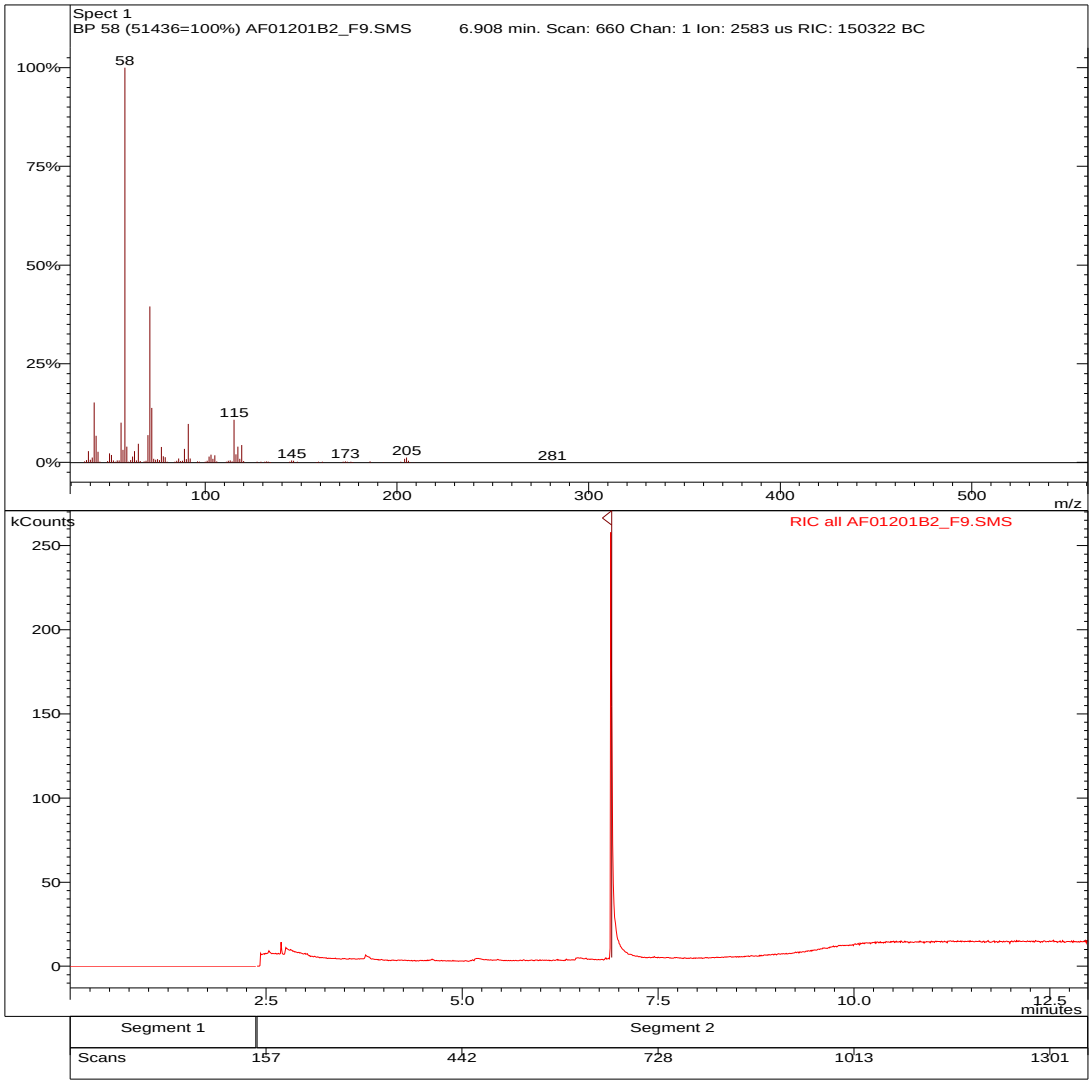

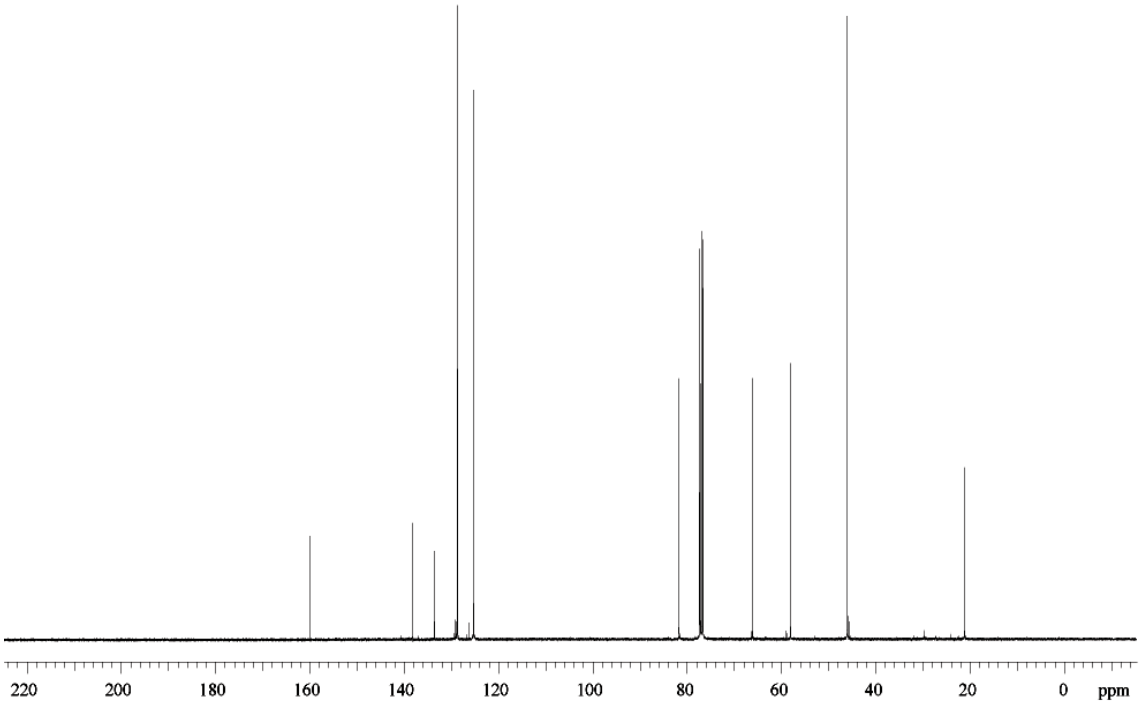
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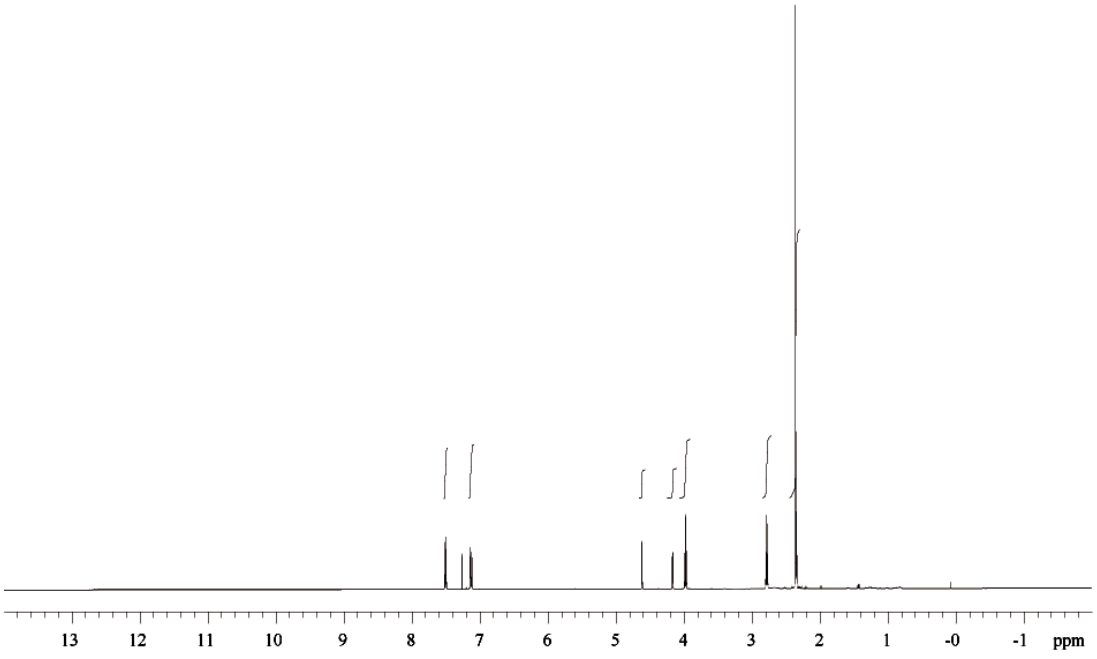
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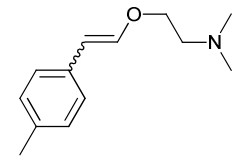
N,N-dimethyl-2-(4-methylstyryloxy)ethanamine 4a



Chemical Formula: $C_{13}H_{19}NO$
Molecular Weight: 205,30

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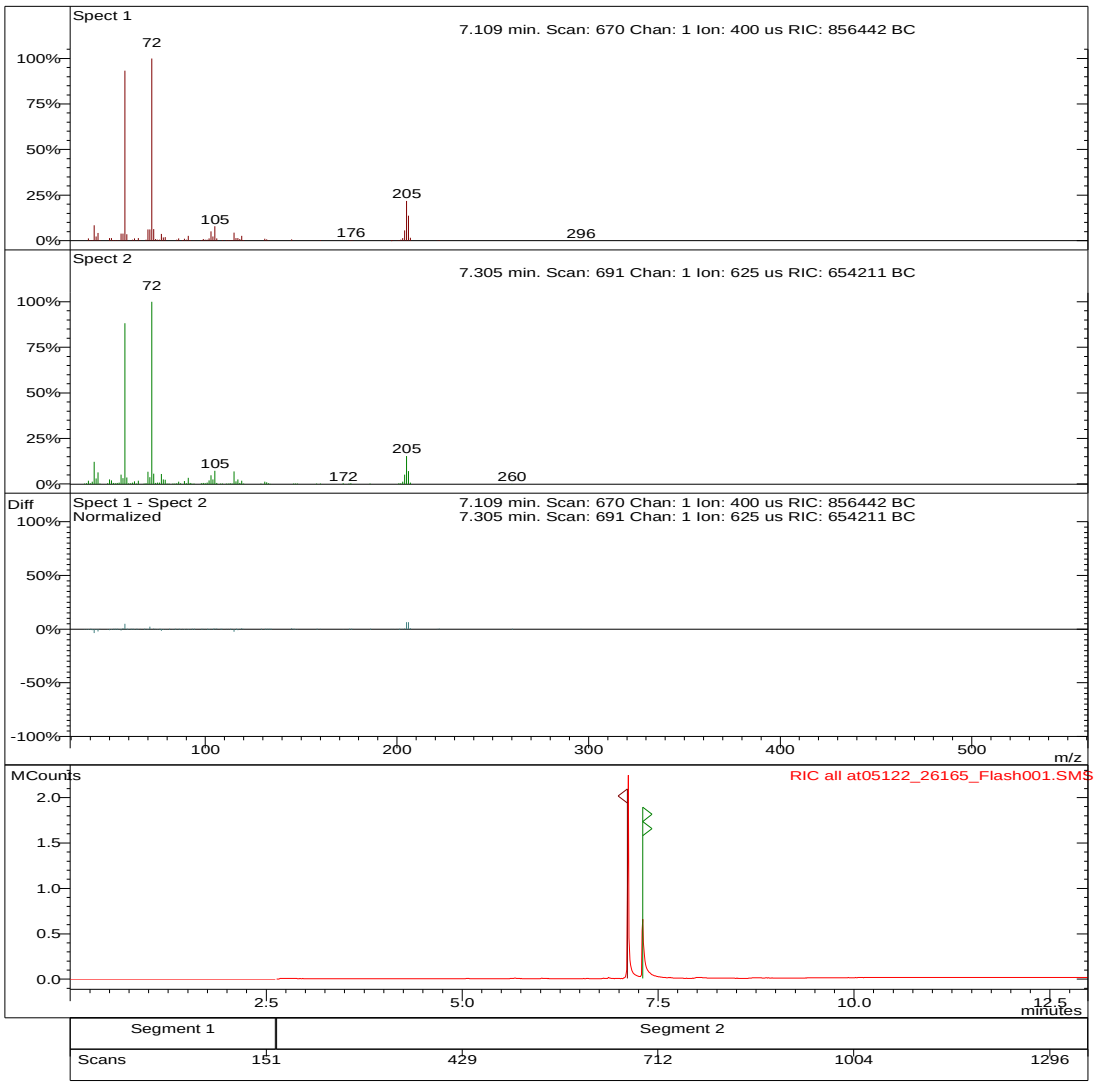

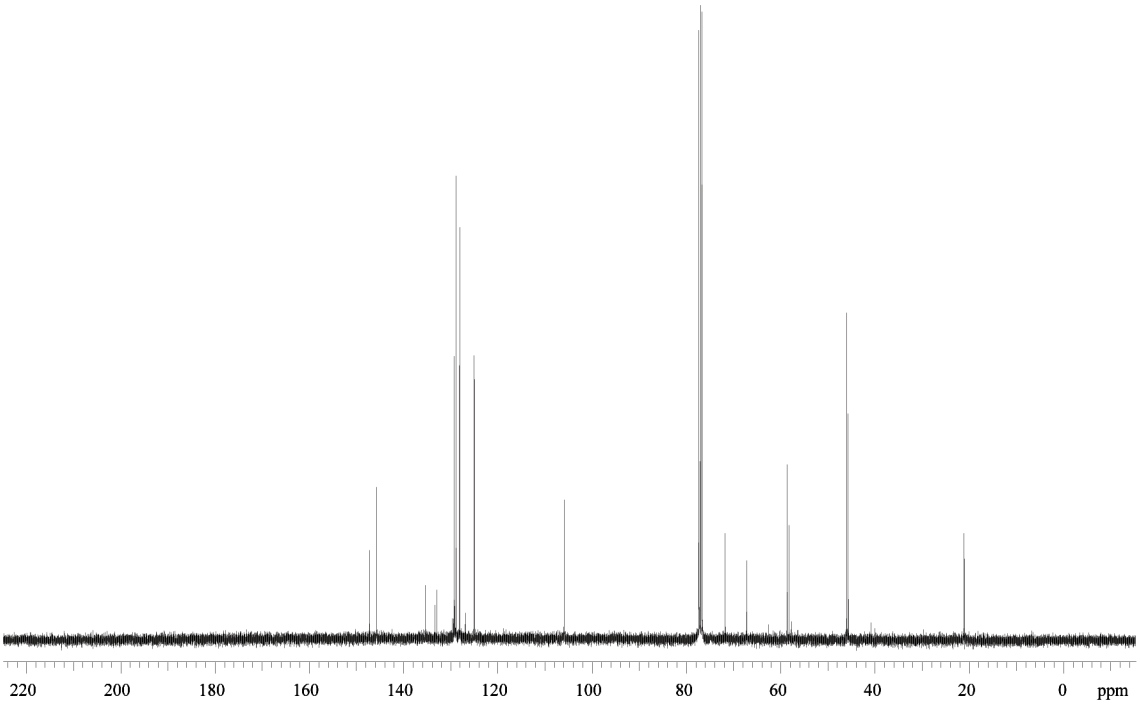
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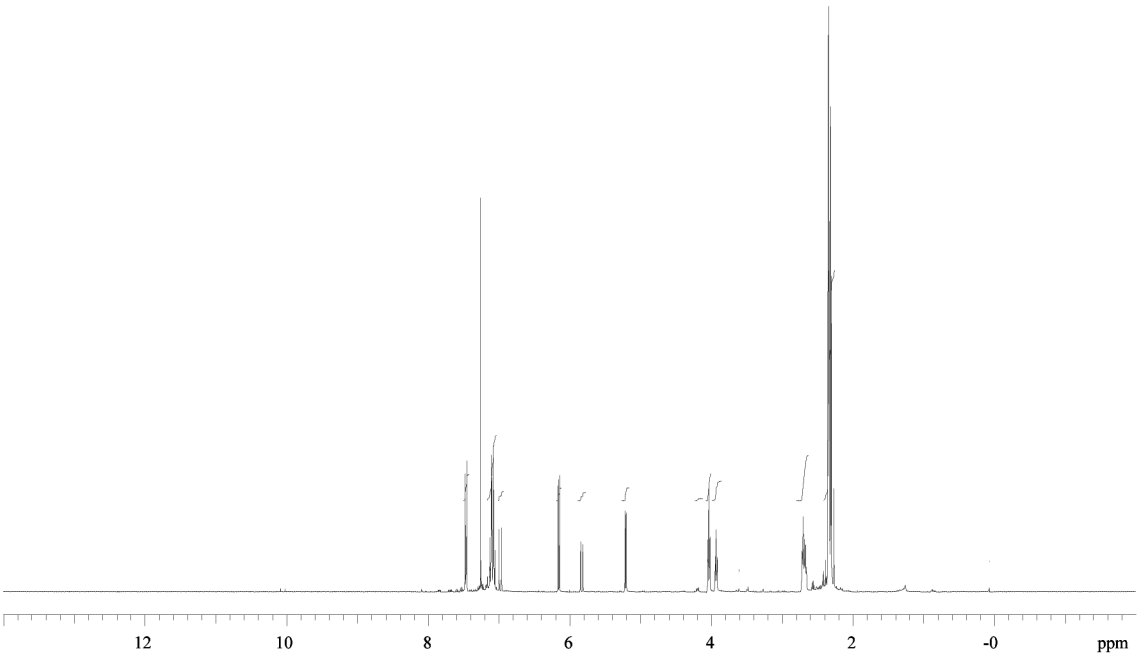
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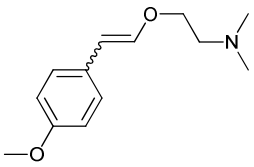
2-(4-methoxystyryloxy)-*N*,*N*-dimethylethanamine 4b



Chemical Formula: $C_{13}H_{19}NO_2$
Molecular Weight: 221,30

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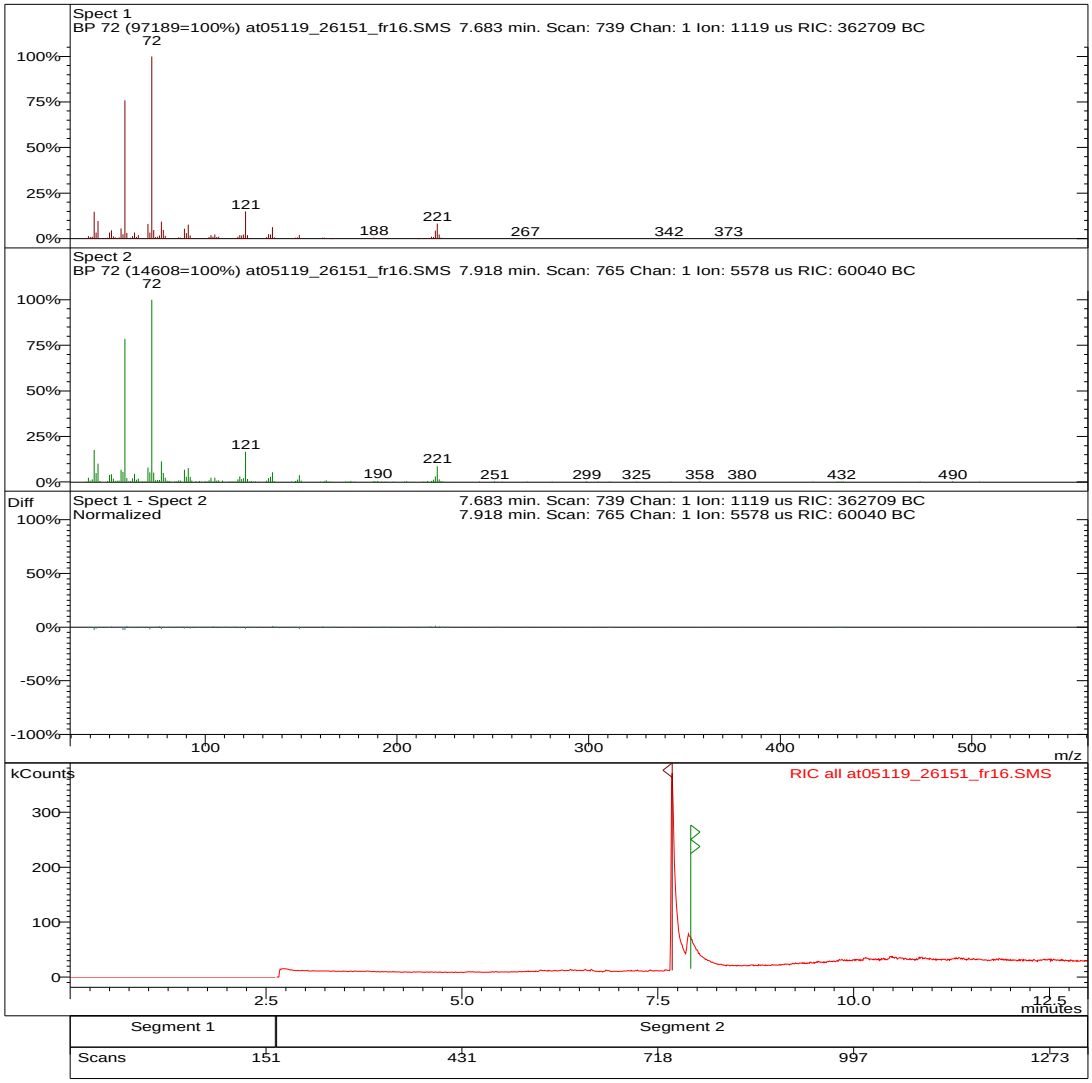

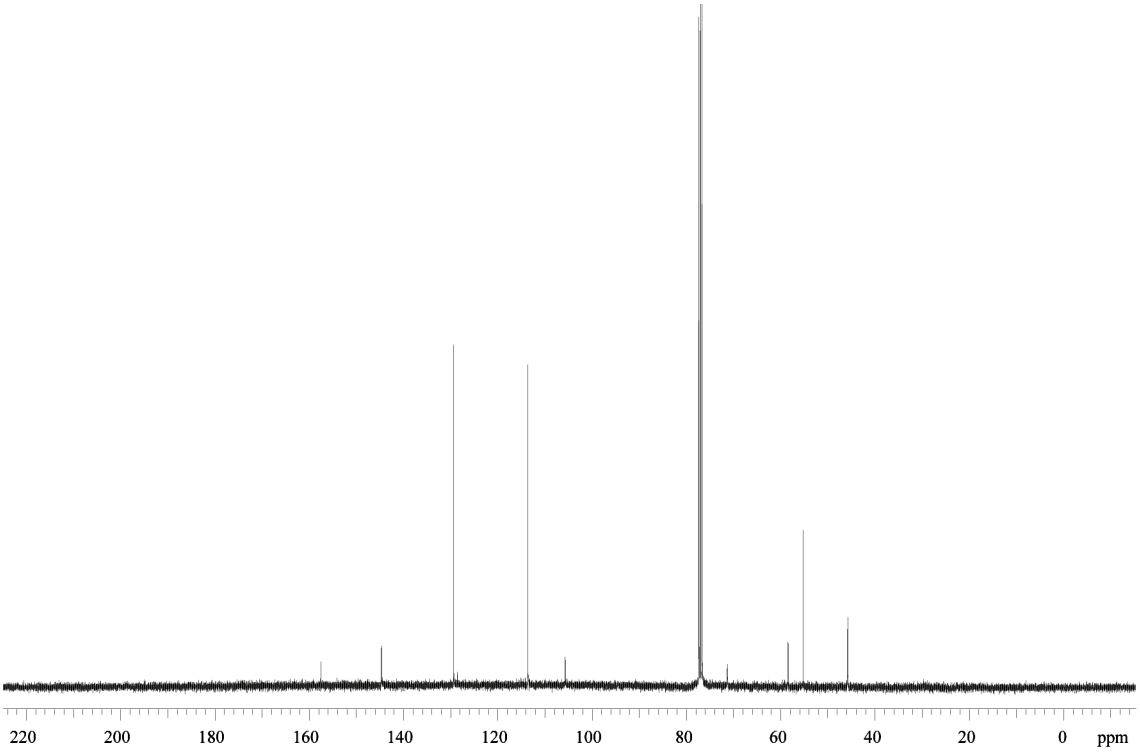
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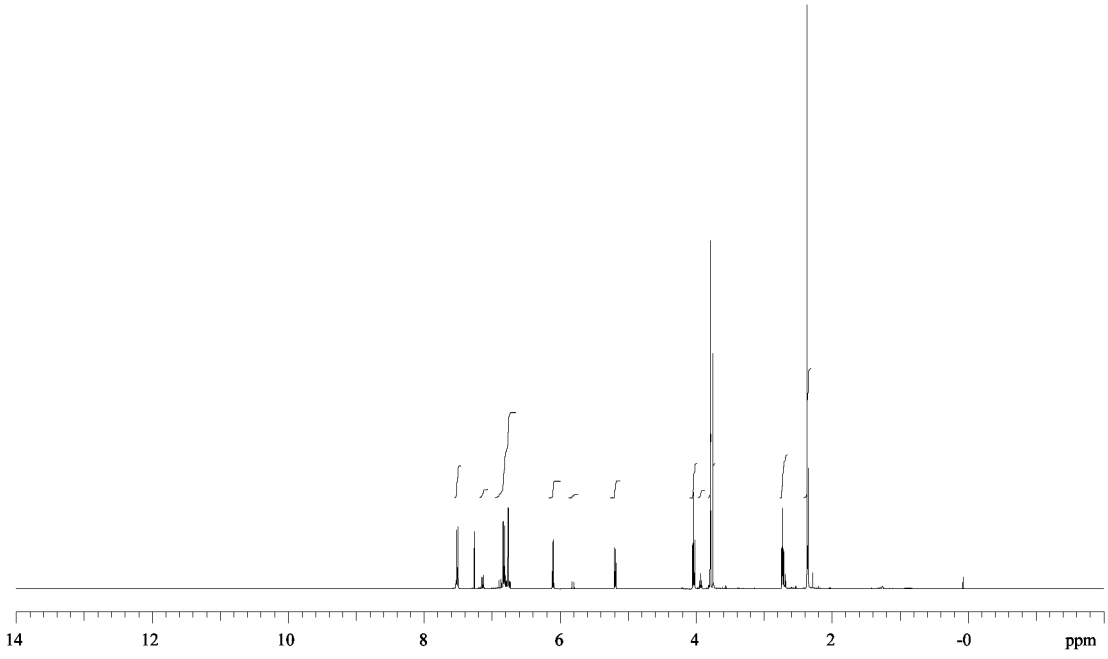
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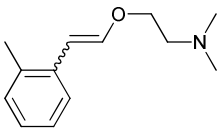
N,N-dimethyl-2-(2-methylstyryloxy)ethanamine 4c



Chemical Formula: $C_{13}H_{19}NO$
Molecular Weight: 205,30

Chromatogram Plot

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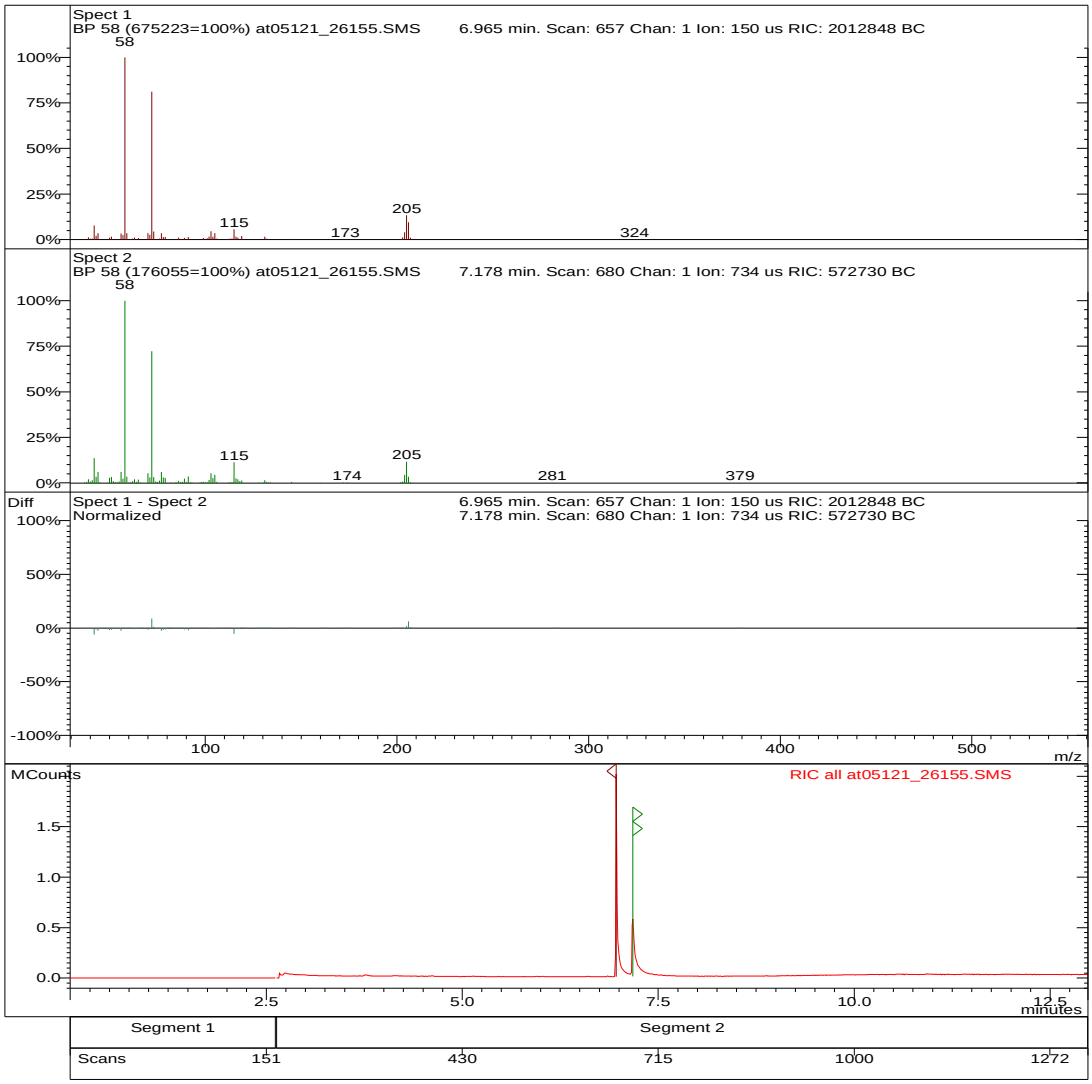

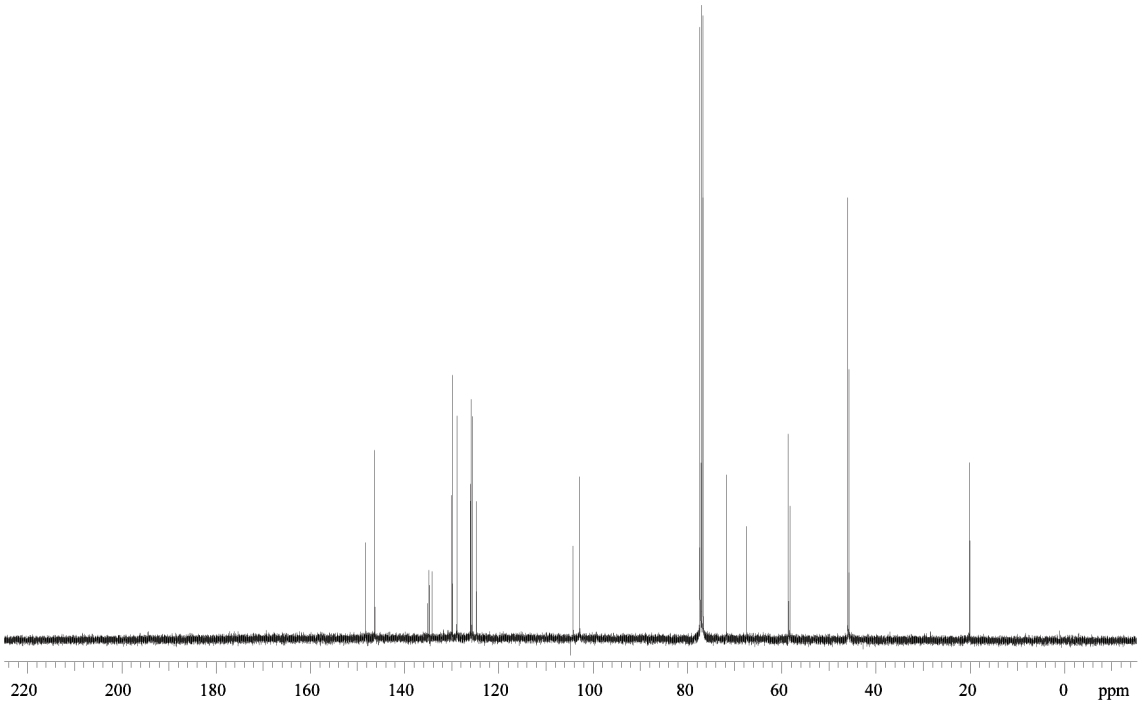
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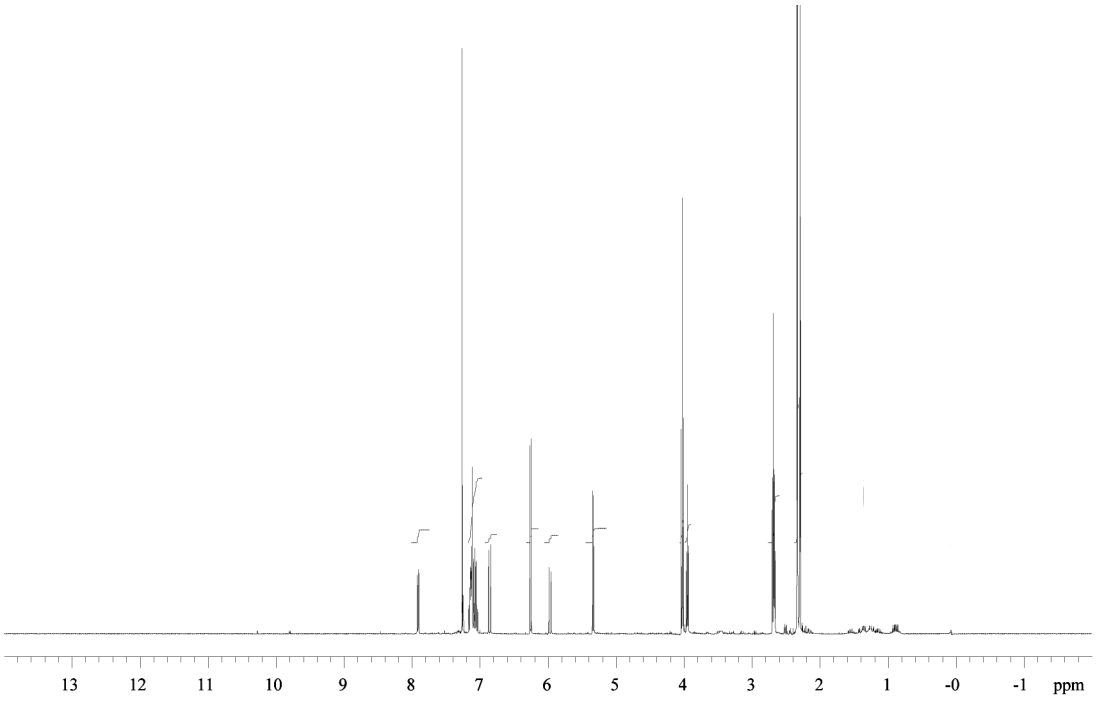
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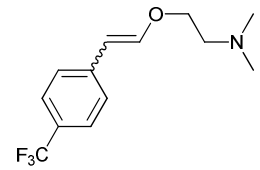
N,N-dimethyl-2-(4-(trifluoromethyl)styryloxy)ethanamine 4d



Chemical Formula: $C_{13}H_{16}F_3NO$
Molecular Weight: 259,27

Chromatogram Plot

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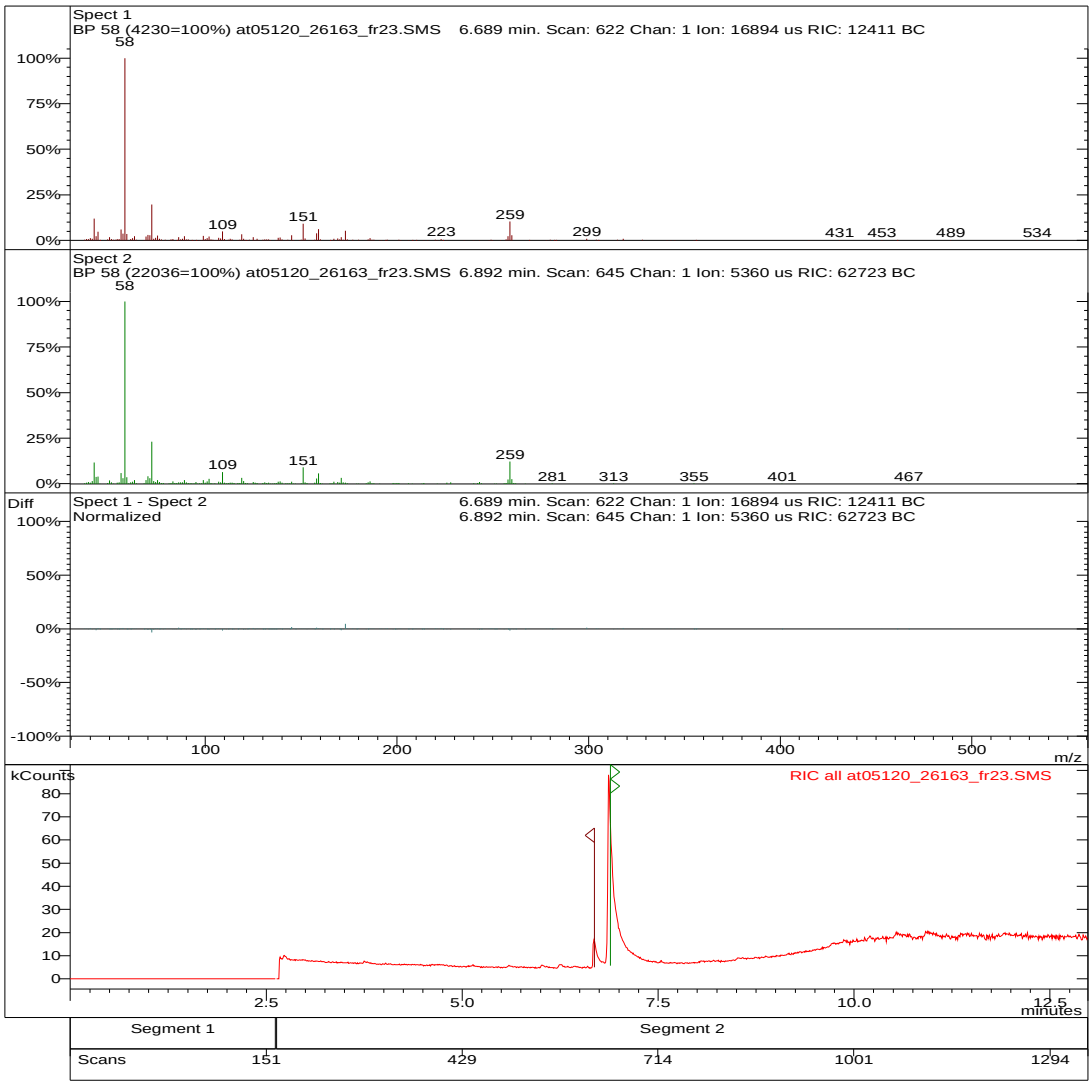
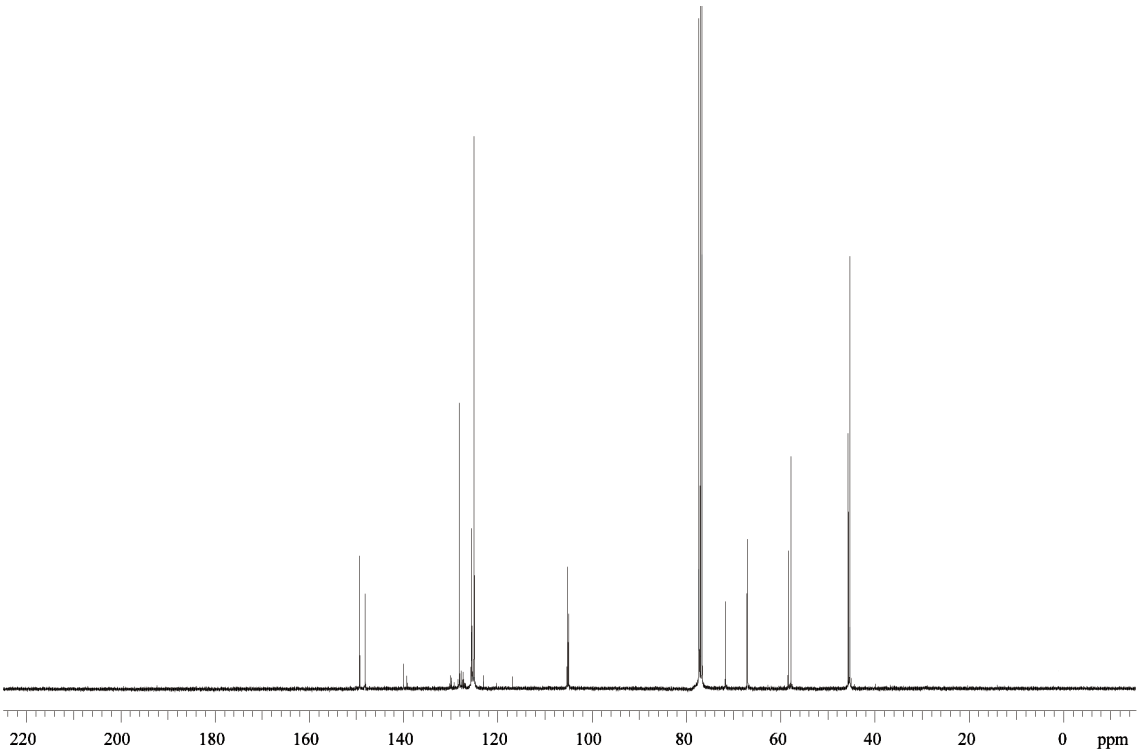
Sample: at05120_26163_fr23
Scan Range: 1 - 1351 Time Range: 0.00 - 12.98 min.
Sample Notes: ROUTINE

Operator: Operator
Date: 06/08/2009 16:17

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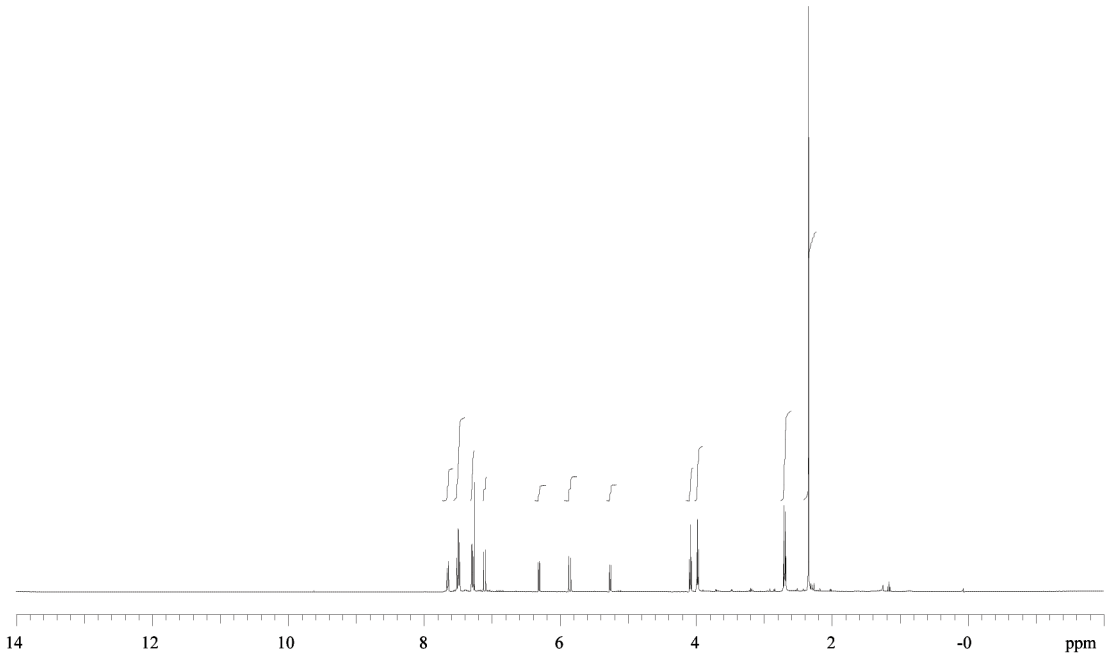
ppm


14
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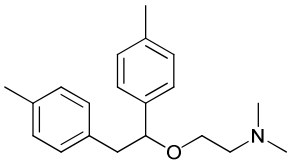
8
6
4
2
-0
ppm

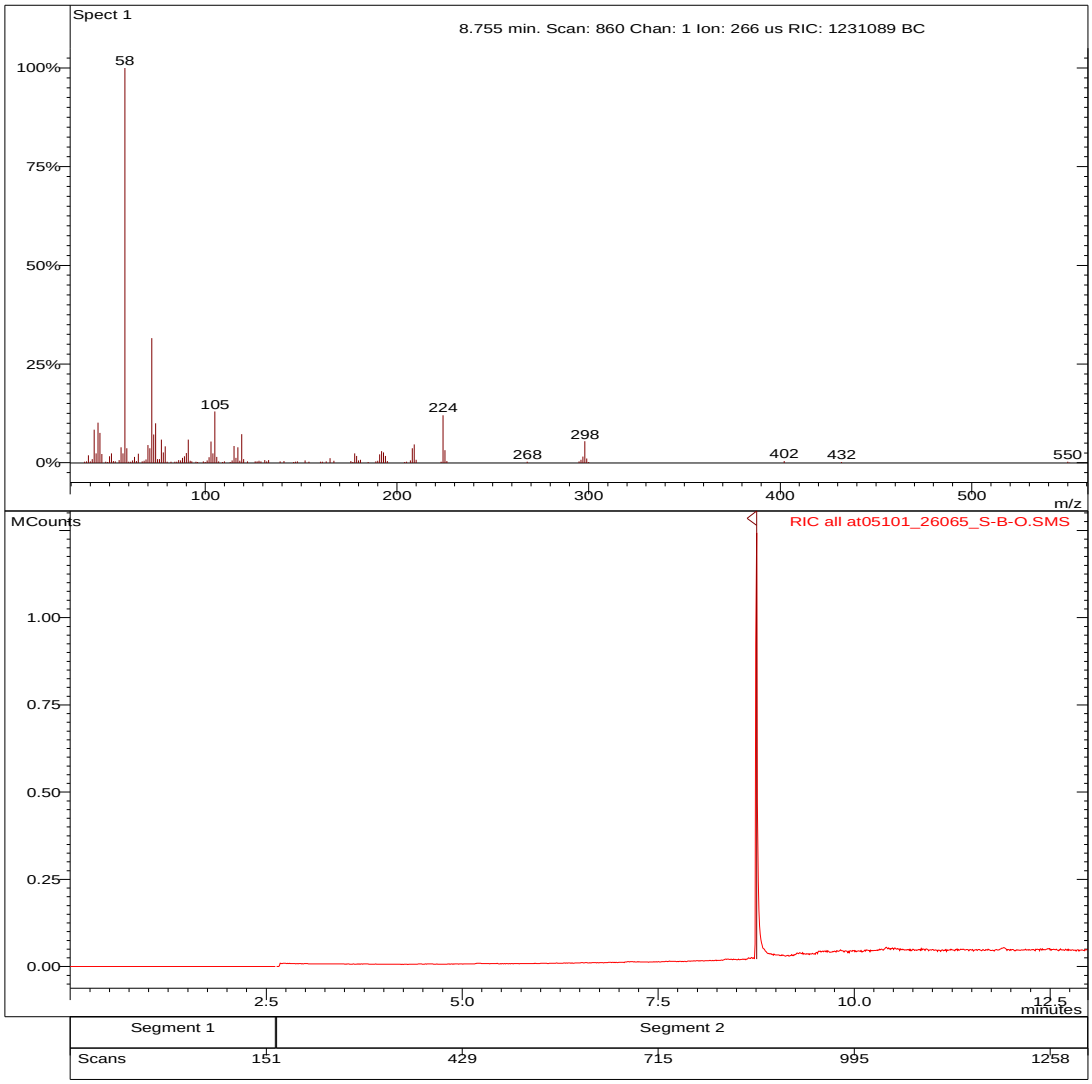
2-(1,2-di-*p*-tolylethoxy)-*N*,*N*-dimethylethanamine 5a

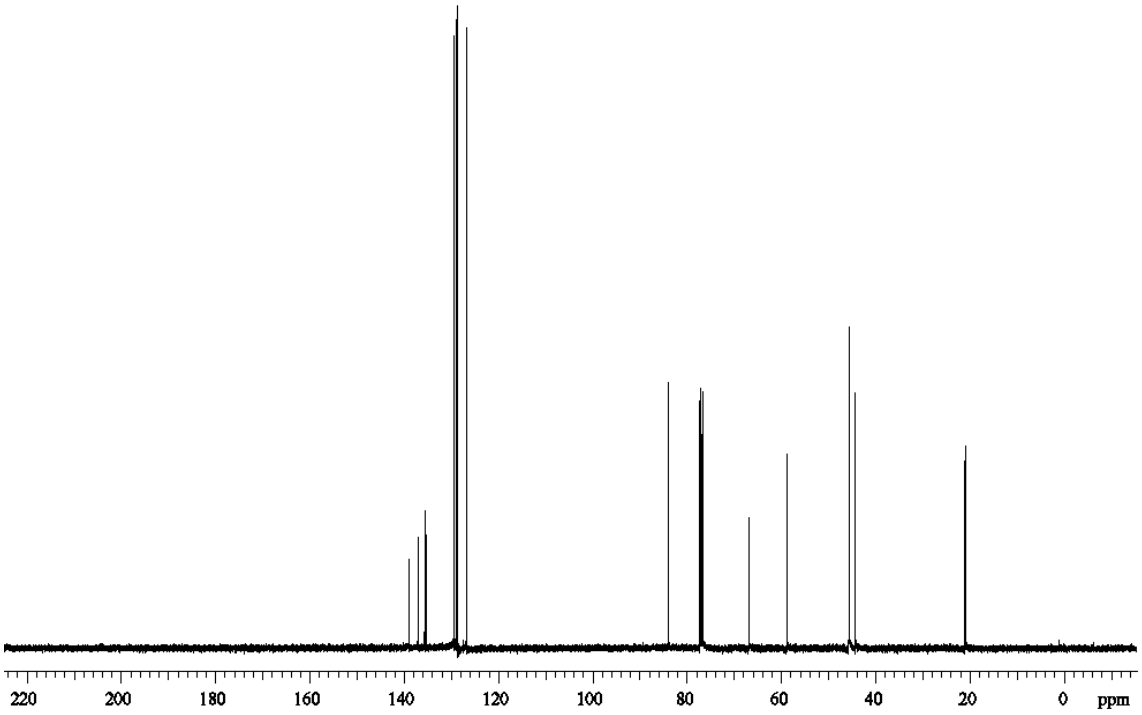


Chemical Formula: $C_{20}H_{27}NO$
Molecular Weight: 297,43

Chromatogram Plot

File: m:\... \at05 oxidativ heck\synthesis\at051\gc\at05101_26065_s-b-o.sms
Sample: at05101_26065_S-B-O
Operator: Operator
Scan Range: 1 - 1309 Time Range: 0.00 - 12.98 min.
Date: 03/06/2009 09:15
Sample Notes: ROUTINE

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200
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60
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20
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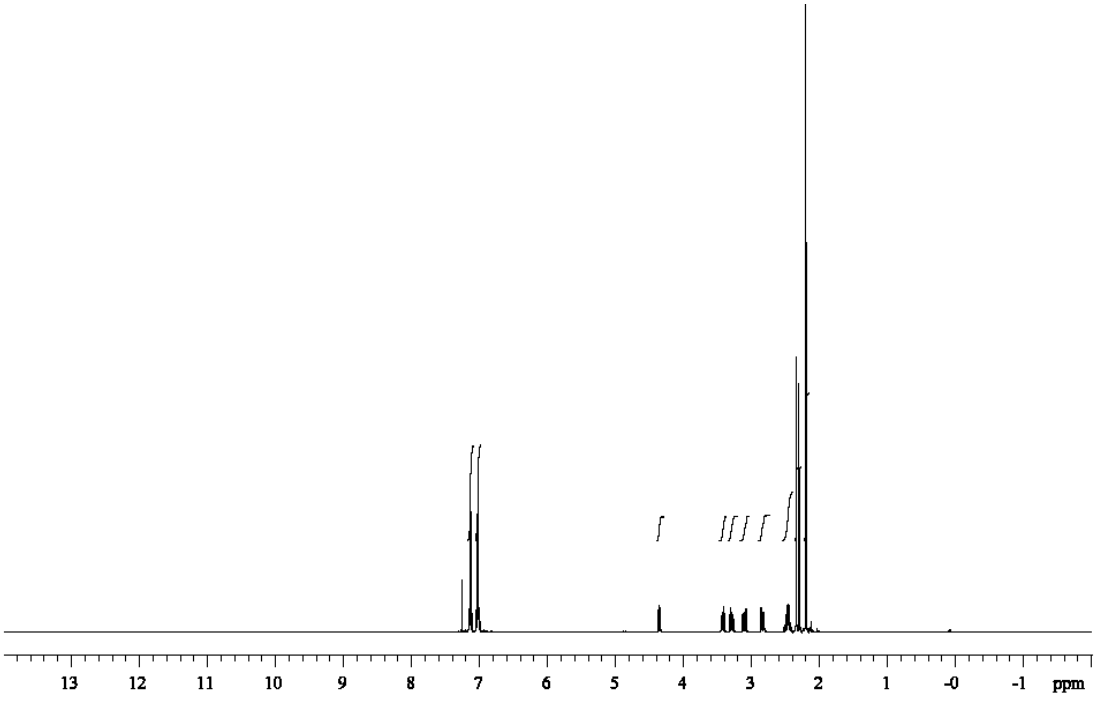
ppm


13
12
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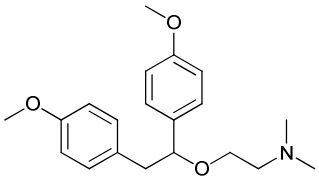
9
8
7
6
5
4
3
2
1
-0
-1
ppm

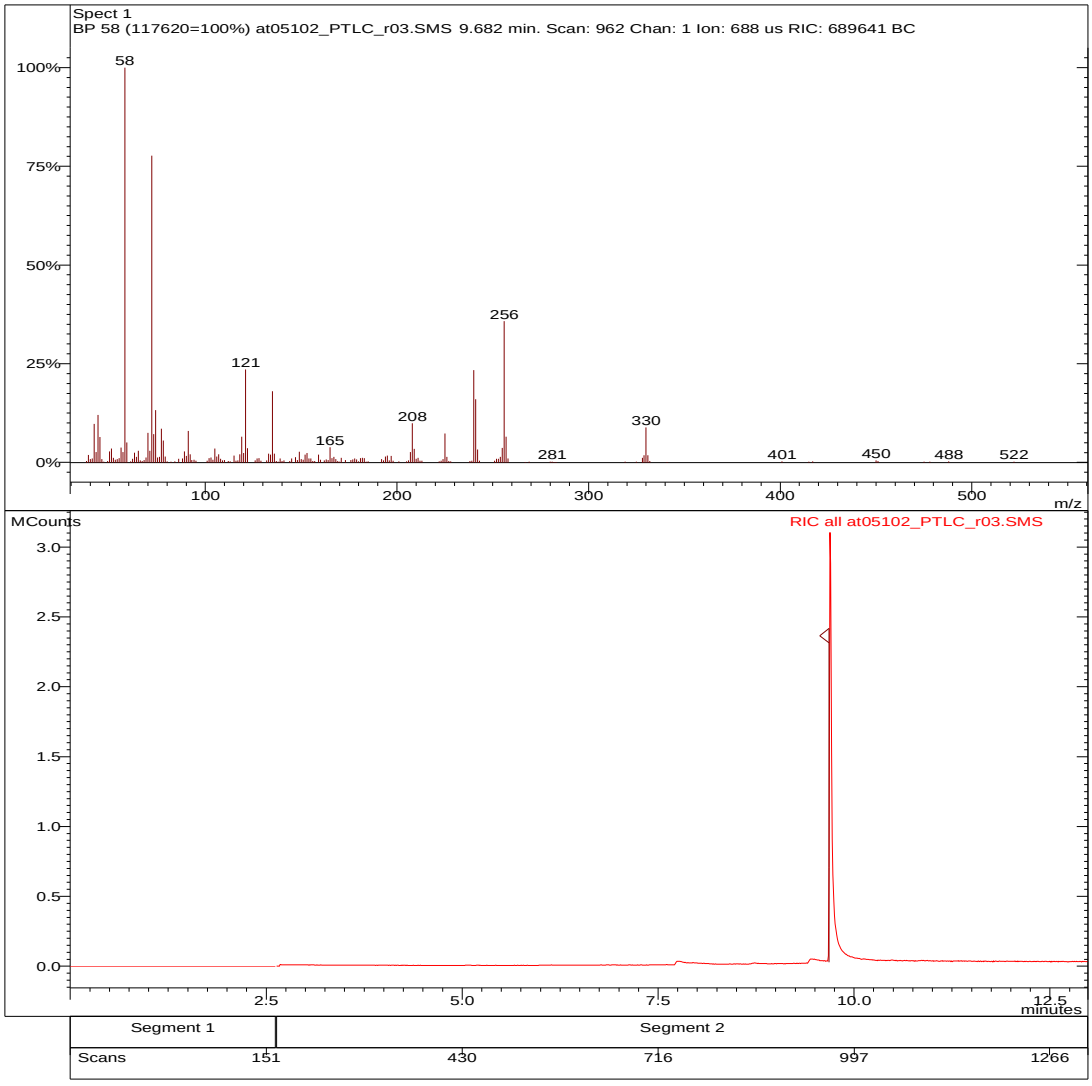
2-(1,2-*bis*(4-methoxyphenyl)ethoxy)-*N*,*N*-dimethylethanamine 5b

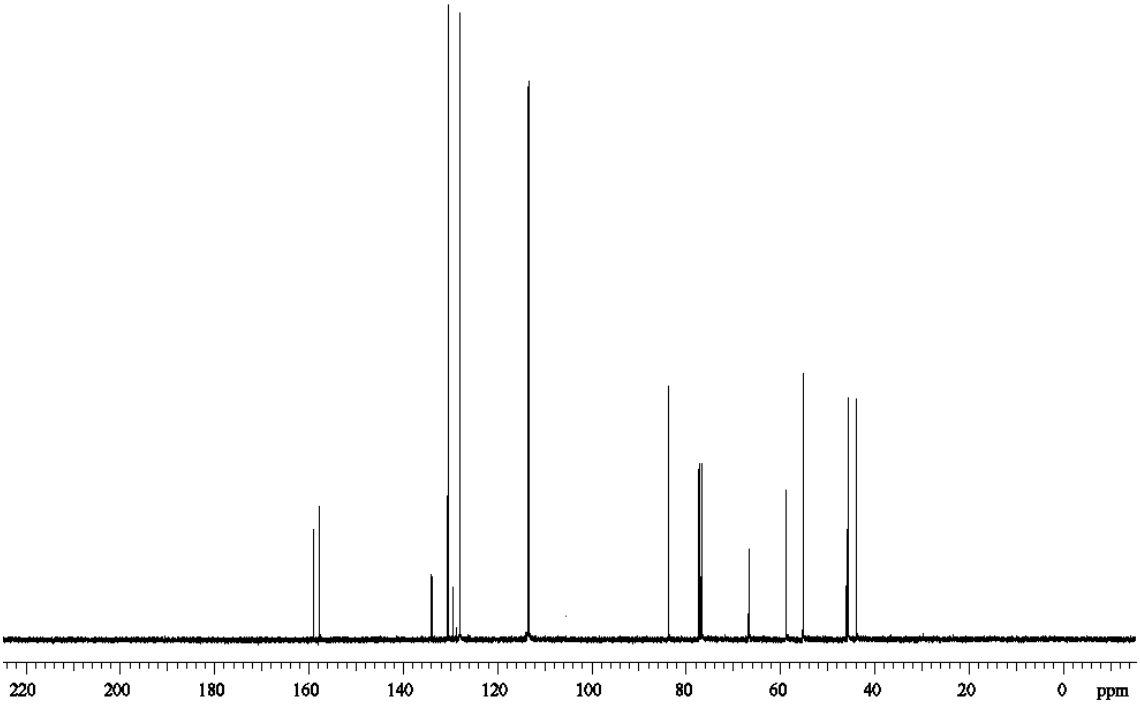


Chemical Formula: $C_{20}H_{27}NO_3$
Molecular Weight: 329,43

Chromatogram Plot

File: \:\... \at05 oxidativ heck\synthesis\at051\gc_02\at05102_ptlc_r03.sms
Sample: at05102_PTLC_r03 Operator: Operator
Scan Range: 1 - 1320 Time Range: 0.00 - 12.98 min. Date: 03/19/2009 12:03
Sample Notes: ROUTINE

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200
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140
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100
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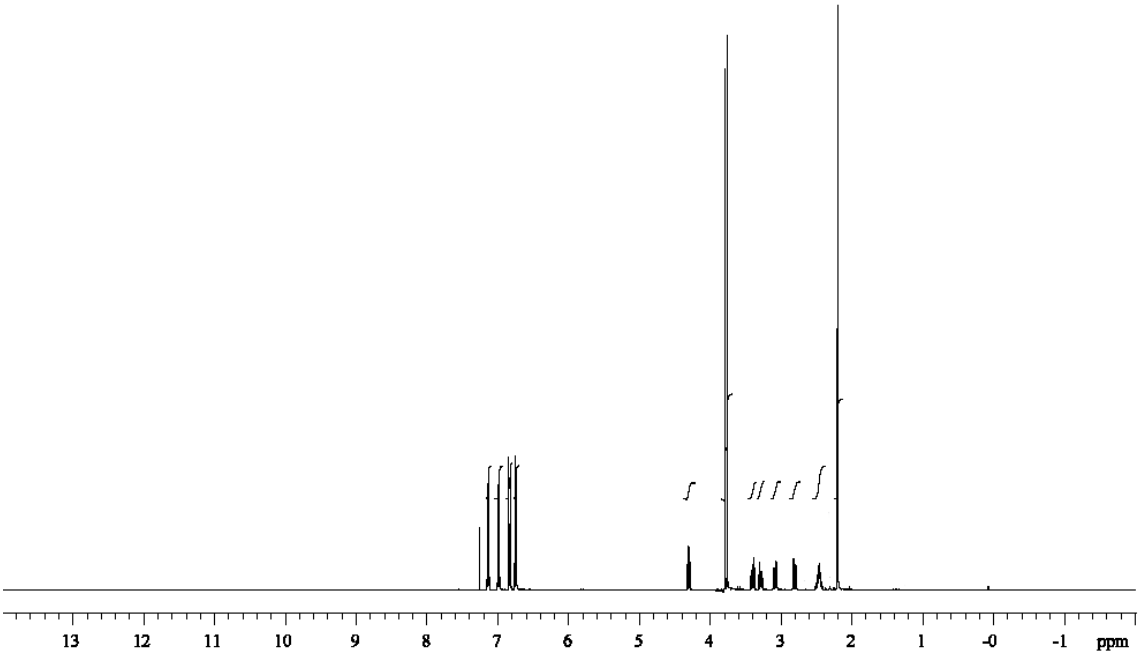
60
40
20
0
ppm


13
12
11
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8
7
6
5
4
3
2
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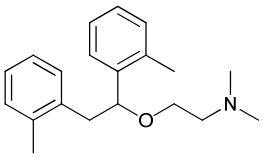
-0
-1
ppm

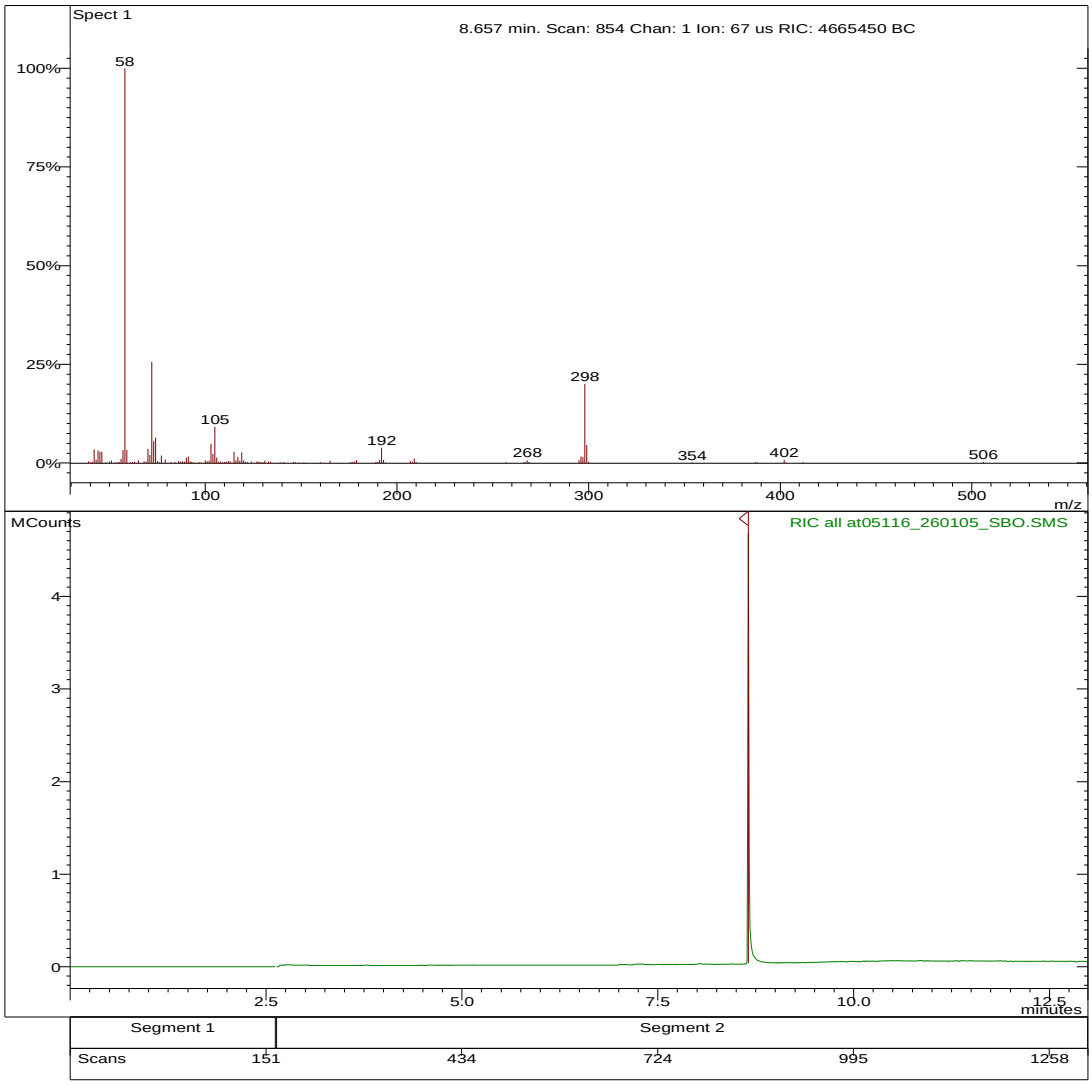
2-(1,2-di-*o*-tolylethoxy)-*N*,*N*-dimethylethanamine 5c

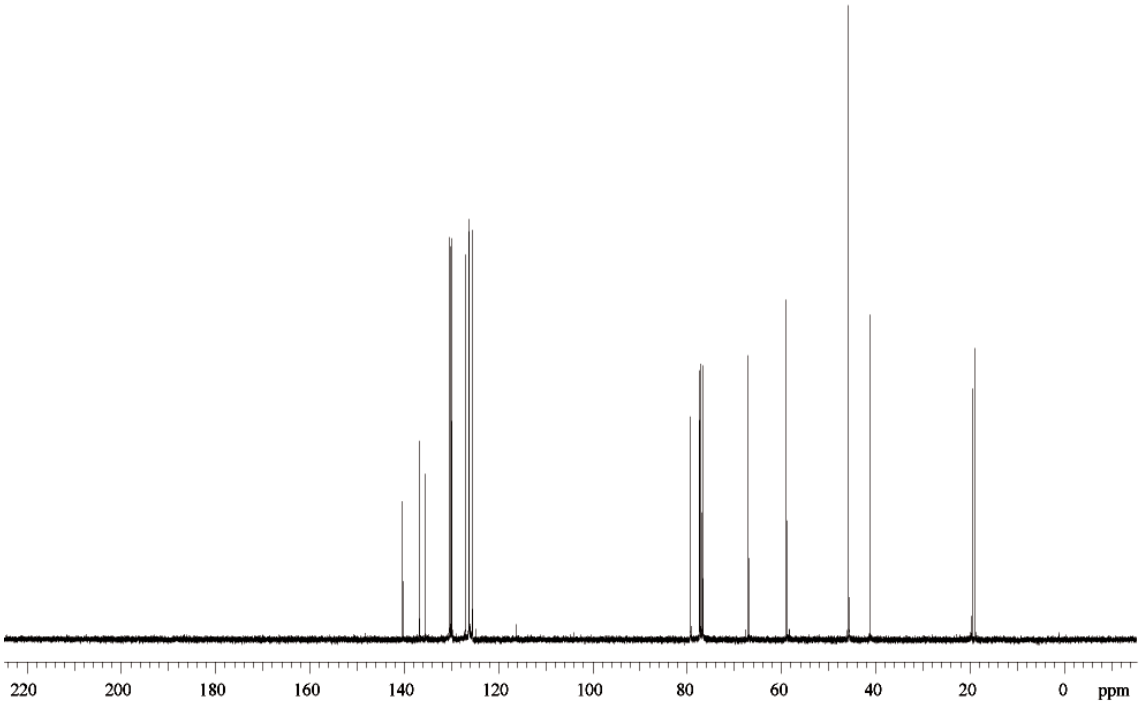


Chemical Formula: $C_{20}H_{27}NO$
Molecular Weight: 297,43

Chromatogram Plot

File: \:\... \at051\gc_02\at05106 och framåt\at05116_260105_sbo.sms
Sample: at05116_260105_SBO
Operator: Operator
Scan Range: 1 - 1309 Time Range: 0.00 - 12.99 min.
Date: 04/27/2009 10:30
Sample Notes: ROUTINE

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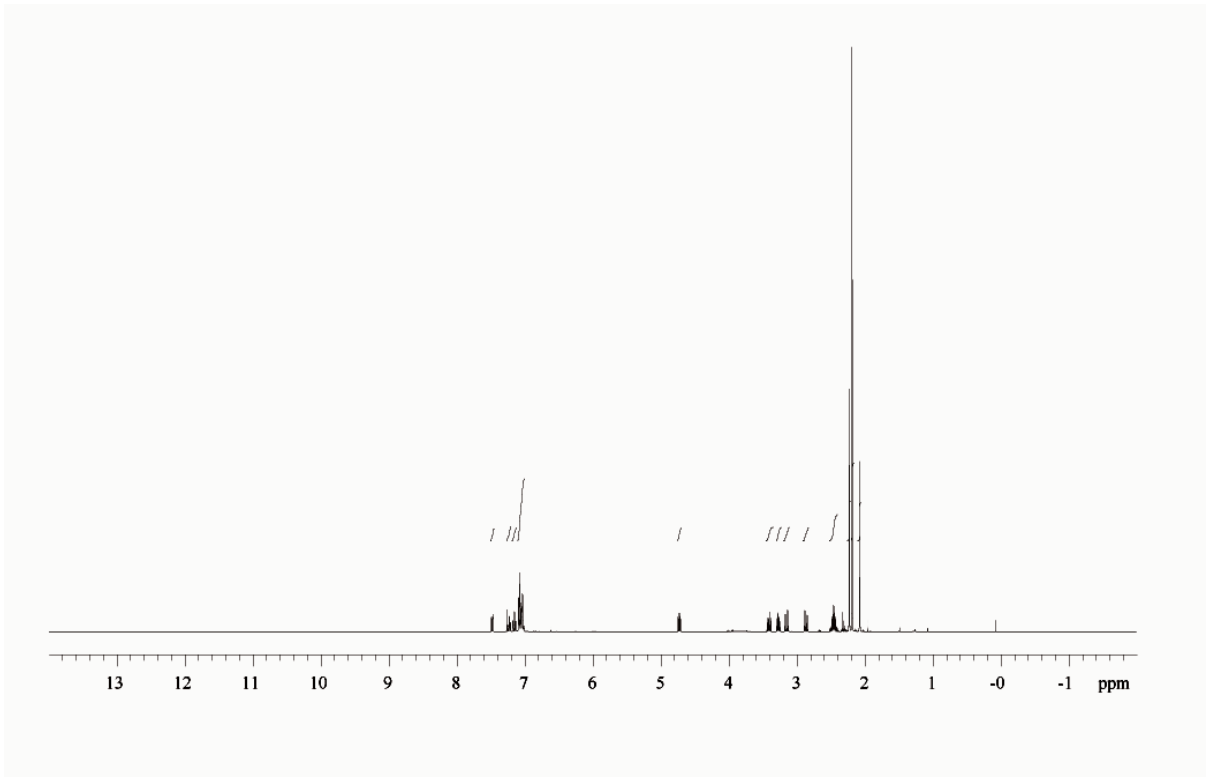
20
0
ppm


13
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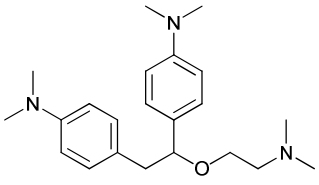
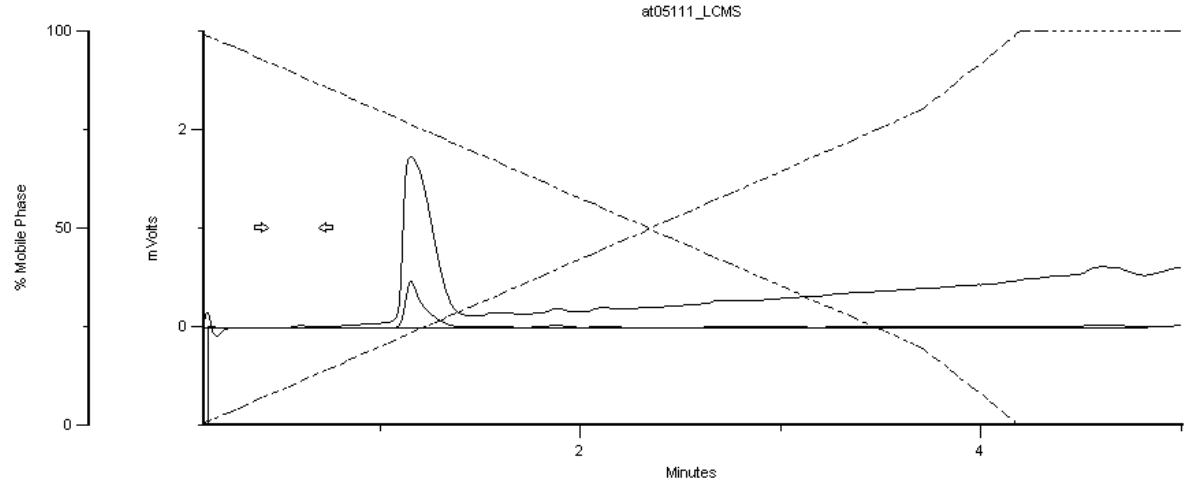
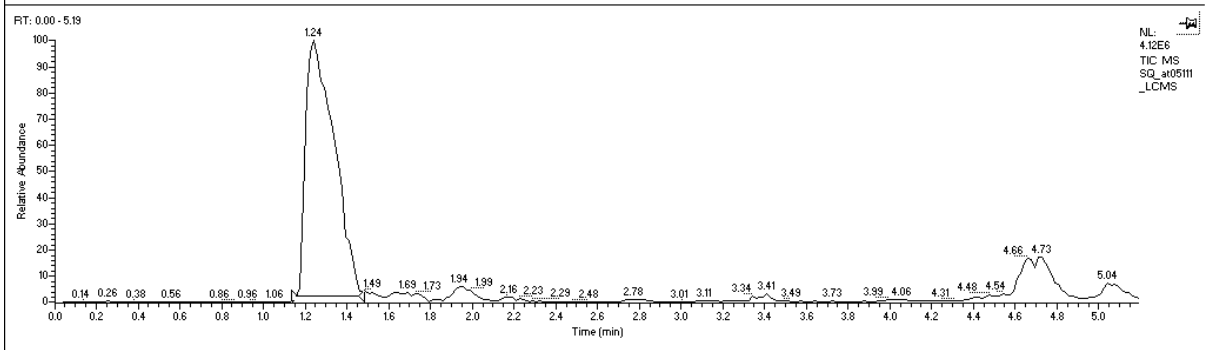
-1
ppm

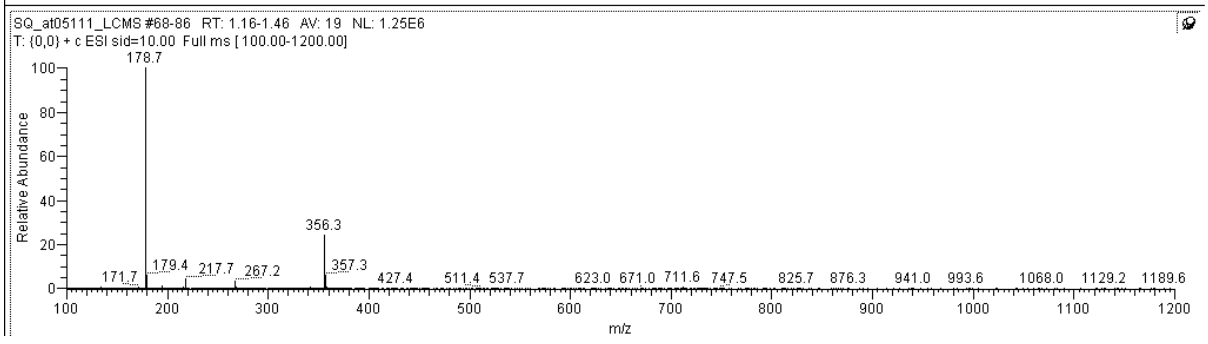
4,4'-(1-(2-(dimethylamino)ethoxy)ethane-1,2-diyl)*bis*(*N*,*N*-dimethylaniline) 5e

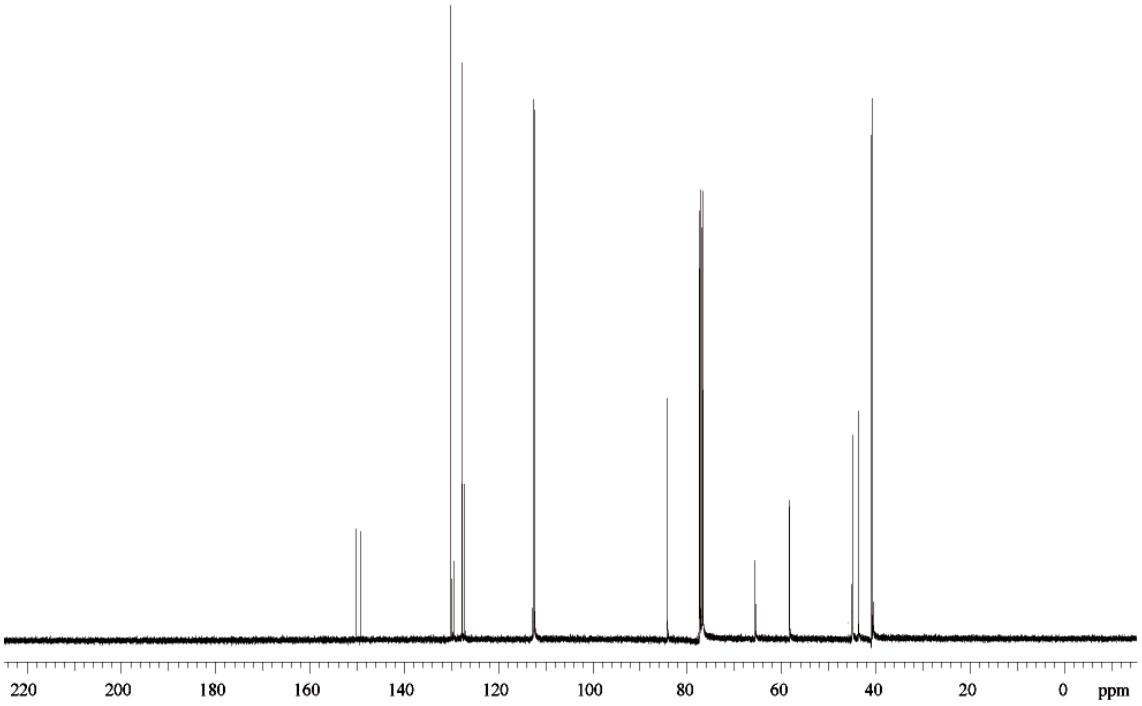


Chemical Formula: $C_{22}H_{33}N_3O$
Molecular Weight: 355,52





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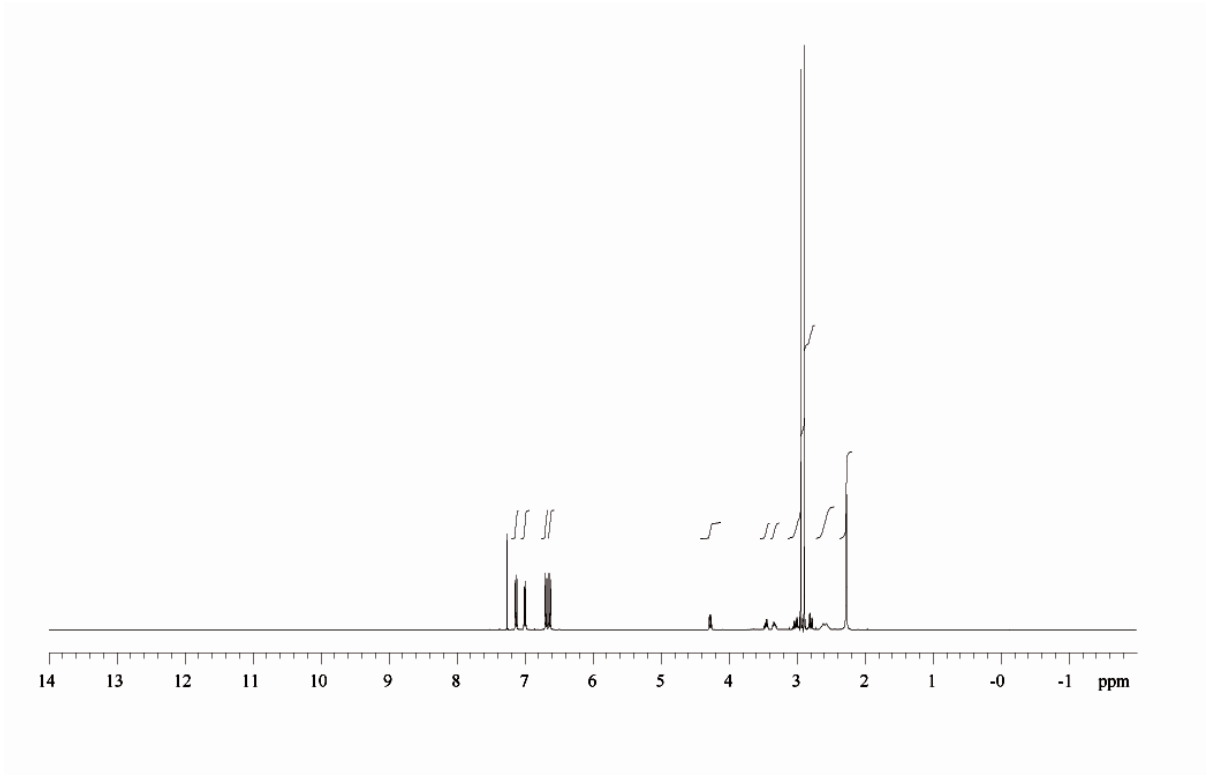
14
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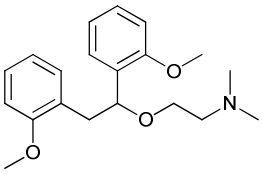
-0
-1
ppm

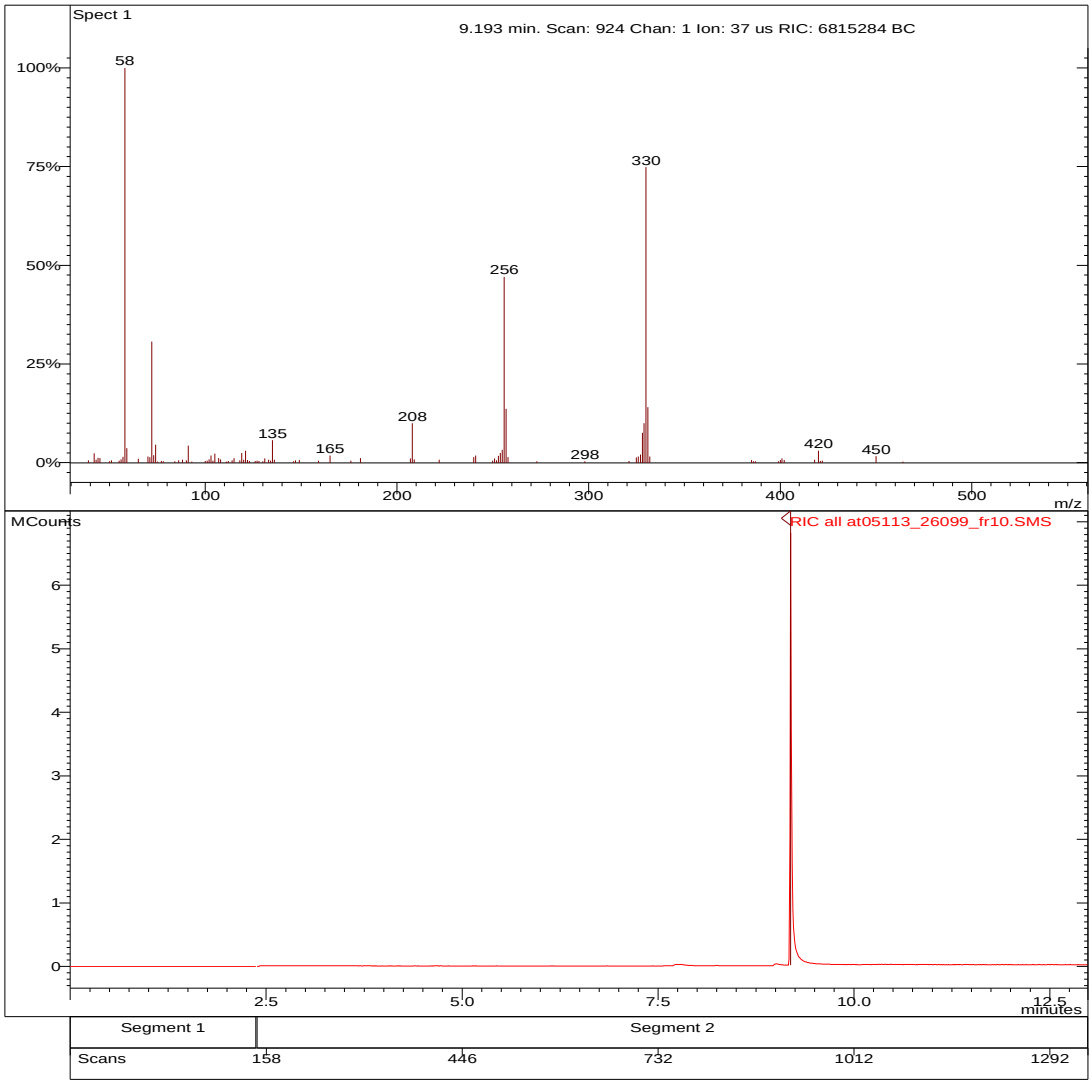
2-(1,2-*bis*(2-methoxyphenyl)ethoxy)-*N*,*N*-dimethylethanamine 5f

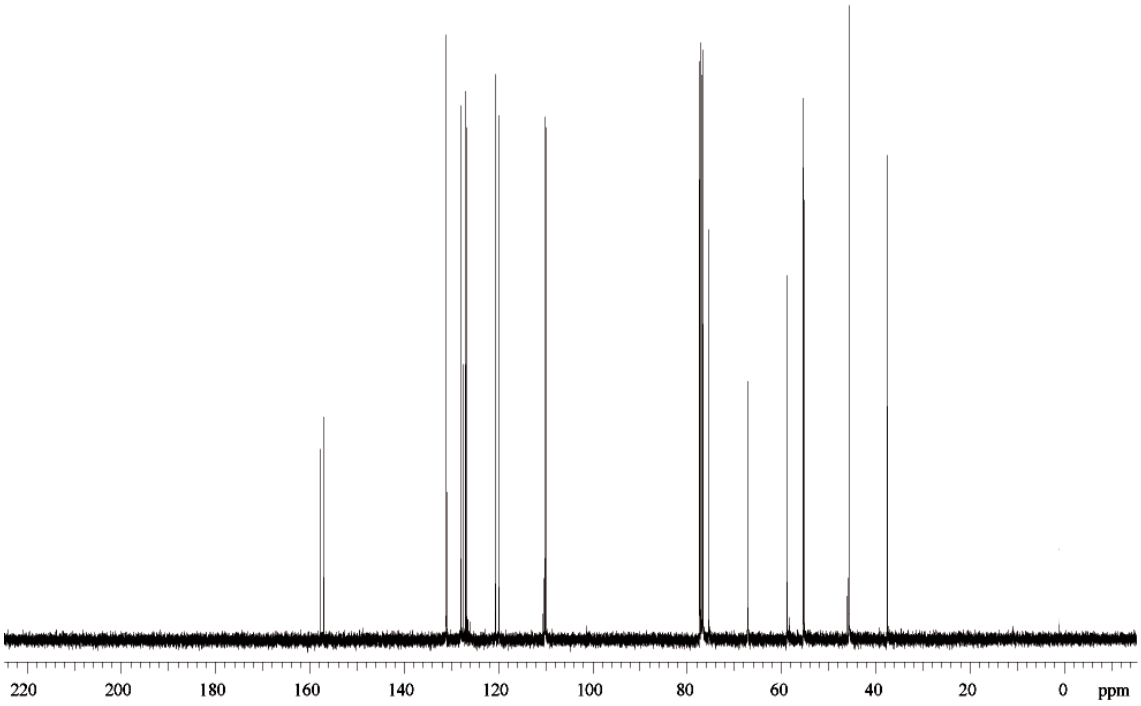


Chemical Formula: $C_{20}H_{27}NO_3$
Molecular Weight: 329,43

Chromatogram Plot

File: \:\... \at051\gc_02\at05106 och framåt\at05113_26099_fr10.sms
Sample: at05116_260105_fr10 Operator: Operator
Scan Range: 1 - 1347 Time Range: 0.00 - 12.98 min. Date: 04/29/2009 11:41
Sample Notes: ROUTINE

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140
120
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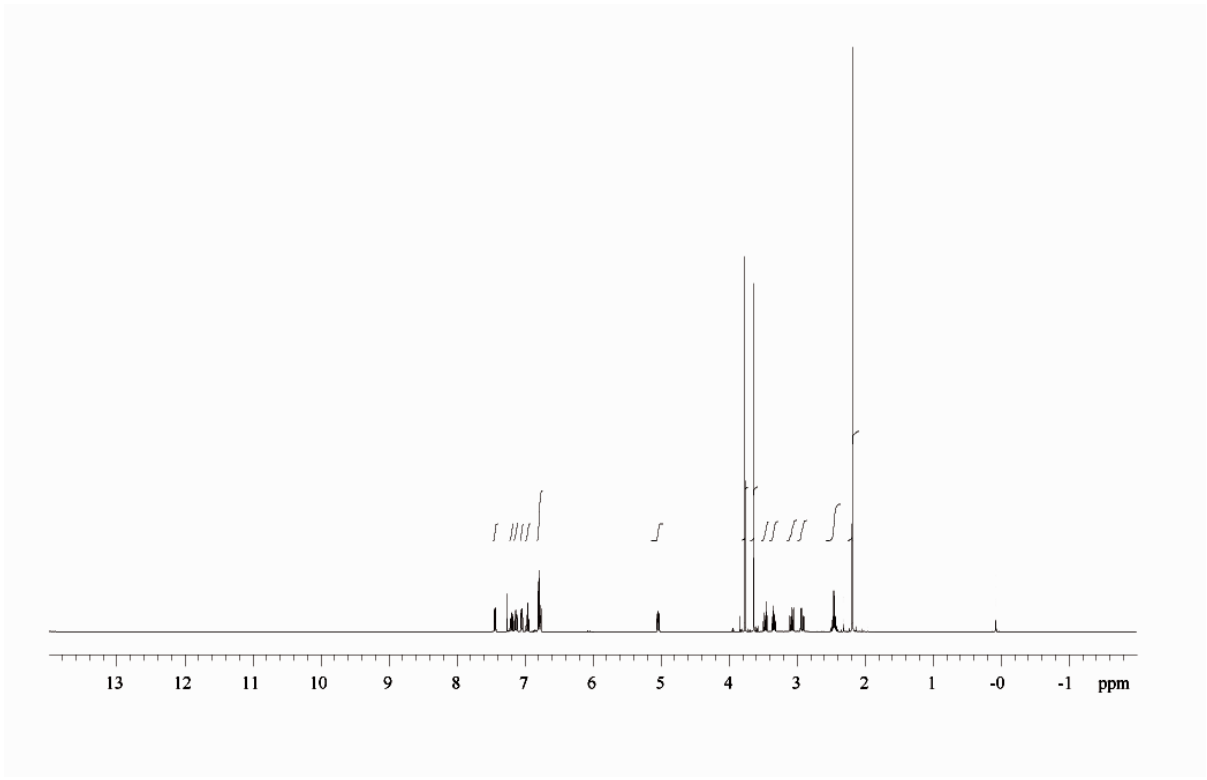
80
60
40
20
0
ppm


13
12
11
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9
8
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6
5
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3
2
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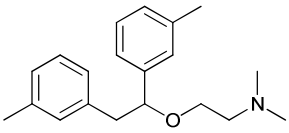
-0
-1
ppm

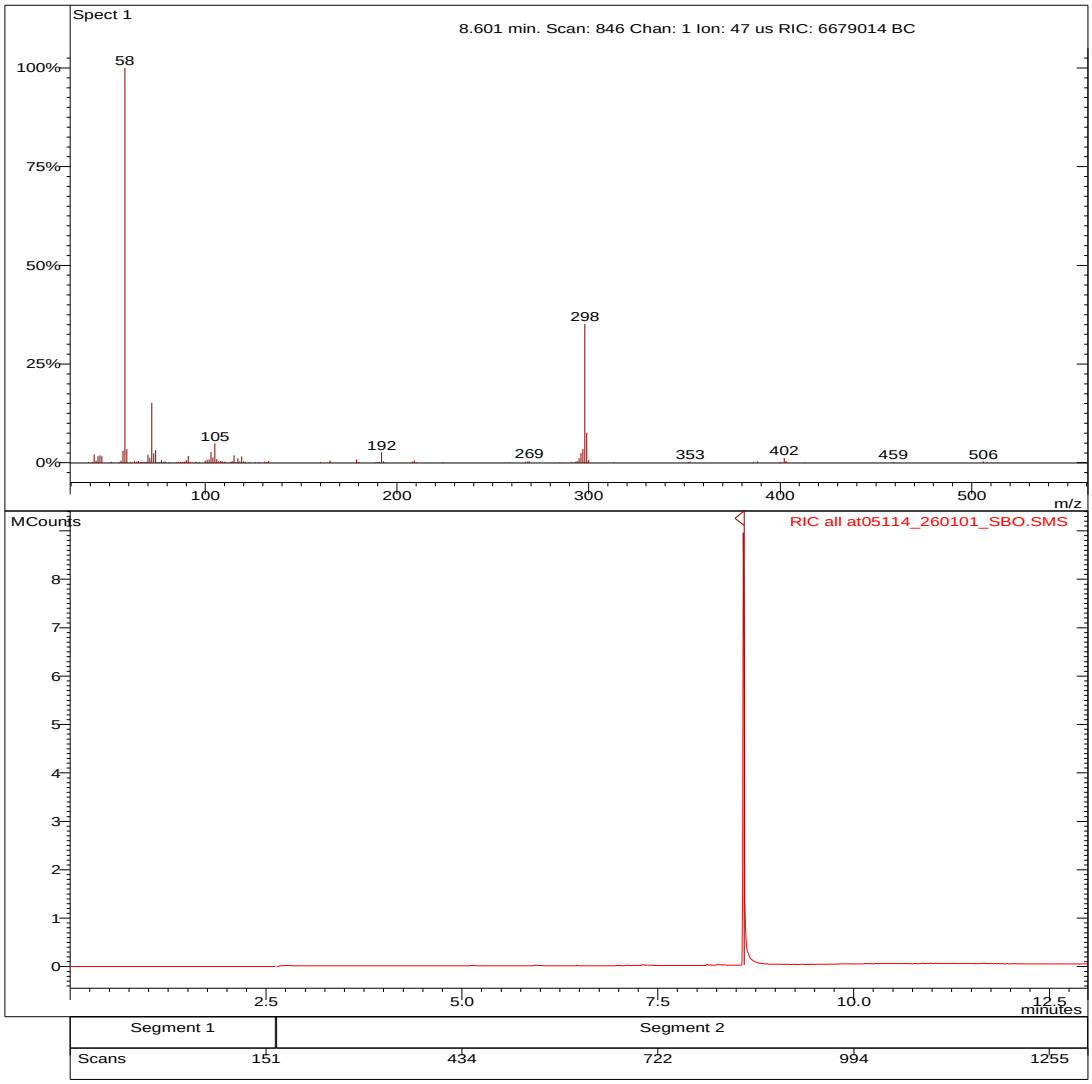
2-(1,2-di-*m*-tolylethoxy)-*N*,*N*-dimethylethanamine 5g

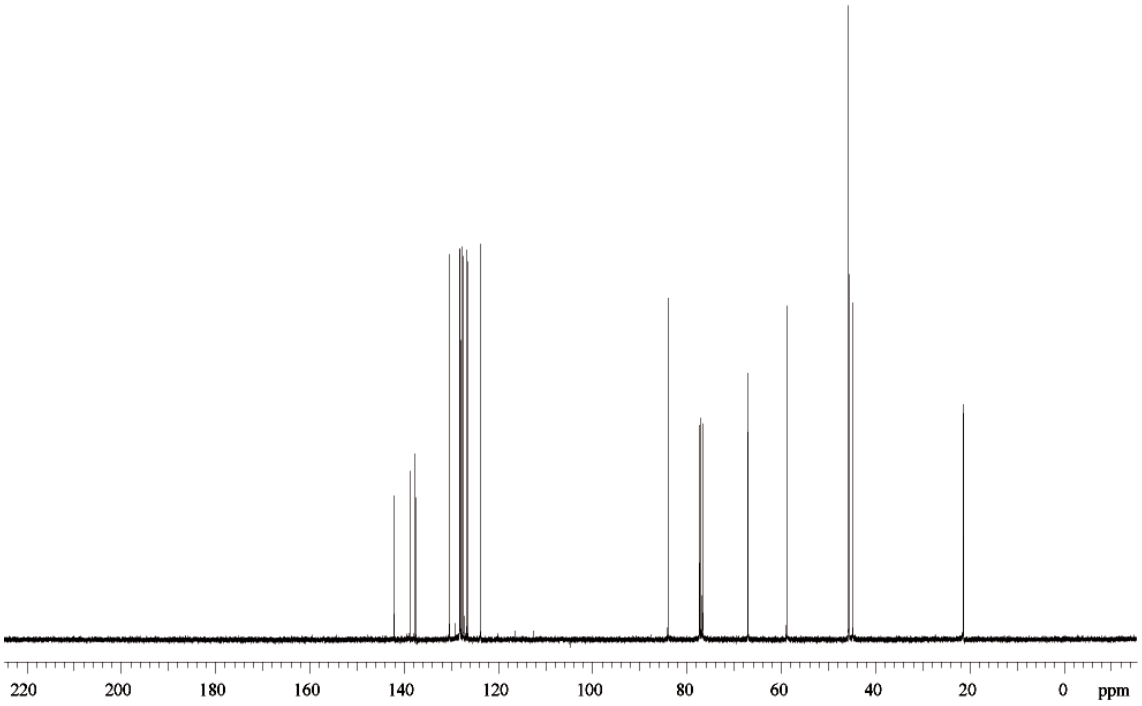


Chemical Formula: $C_{20}H_{27}NO$
Molecular Weight: 297,43

Chromatogram Plot

File: \:\... \at051\gc_02\at05106 och framåt\at05114_260101_sbo.sms
Sample: at05114_260101_SBO
Operator: Operator
Scan Range: 1 - 1306 Time Range: 0.00 - 12.99 min.
Date: 04/27/2009 12:41
Sample Notes: ROUTINE

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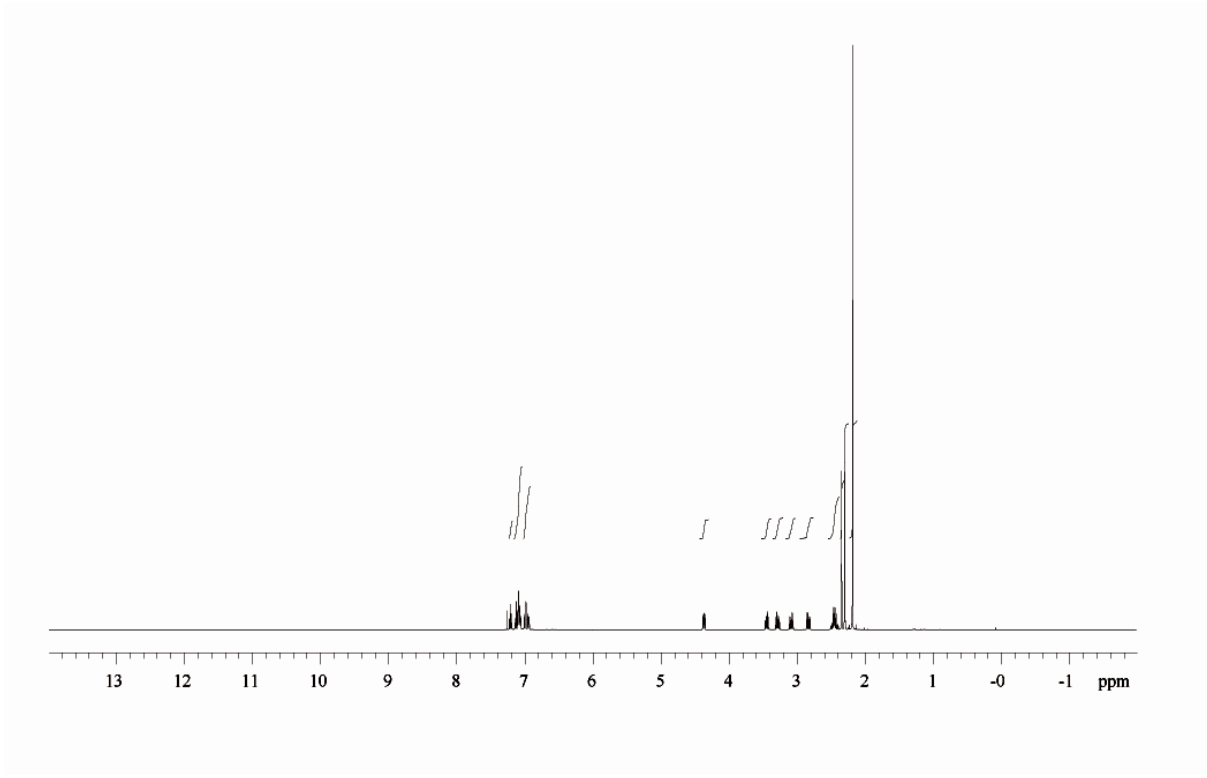
200
180
160
140
120
100
80
60
40
20
0
ppm


13
12
11
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8
7
6
5
4
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2
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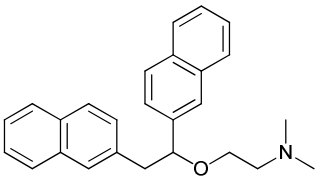
-0
-1
ppm

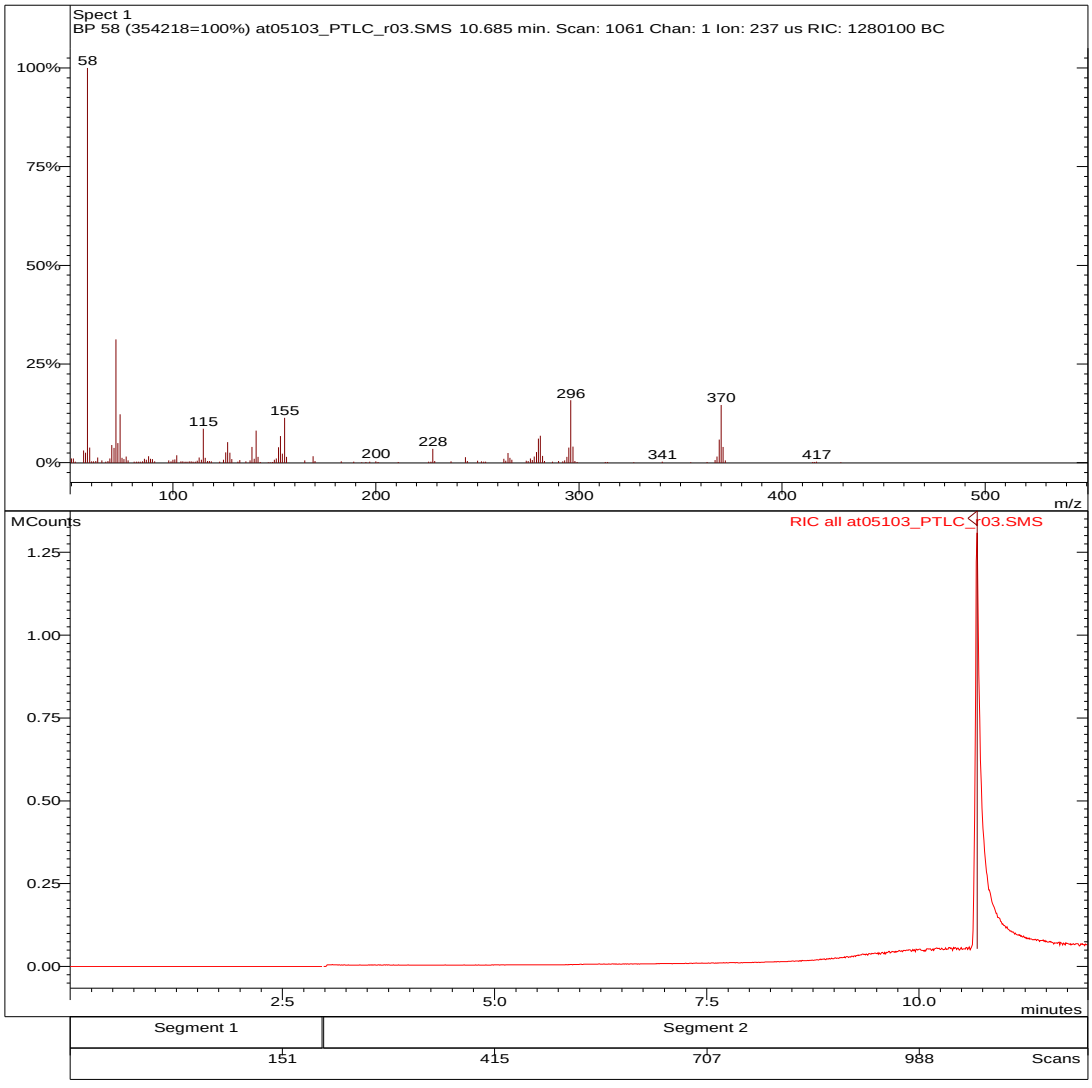
2-(1,2-di(naphthalen-2-yl)ethoxy)-*N*,*N*-dimethylethanamine 5h

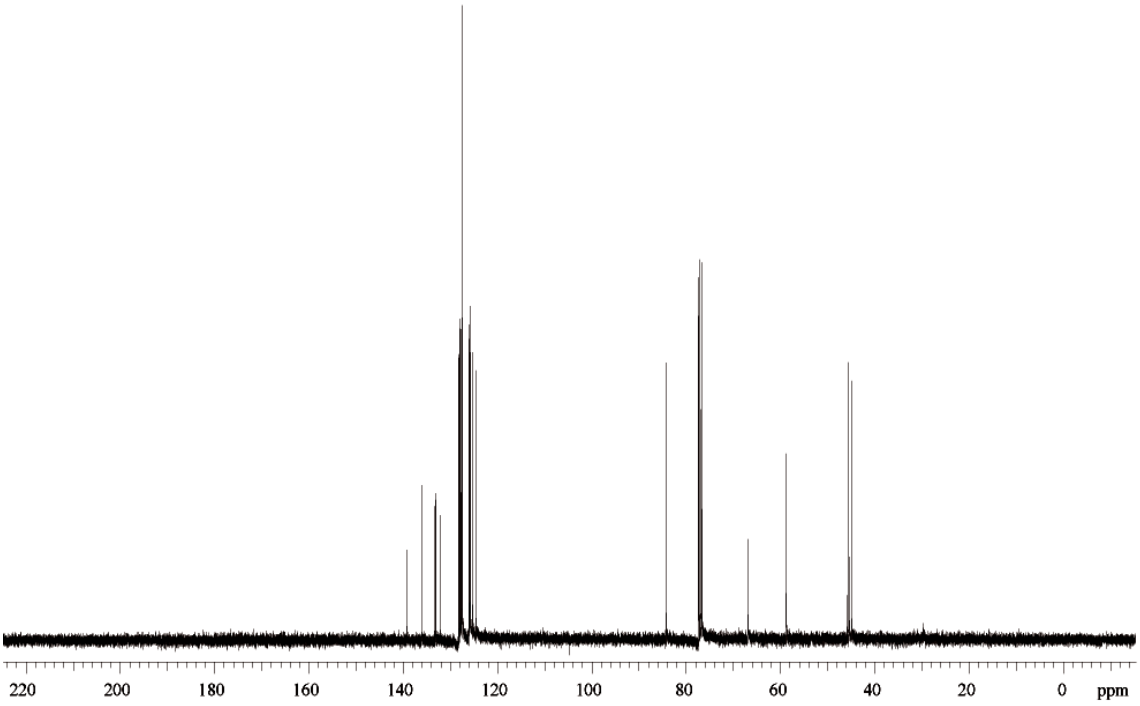


Chemical Formula: $C_{26}H_{27}NO$
Molecular Weight: 369,50

Chromatogram Plot

File: \:\... \at05 oxidativ heck\synthesis\at051\gc_02\at05103_ptlc_r03.sms
Sample: at05105_PTLC_r03 Operator: Operator
Scan Range: 1 - 1205 Time Range: 0.00 - 11.99 min. Date: 03/20/2009 14:18
Sample Notes: ROUTINE

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200
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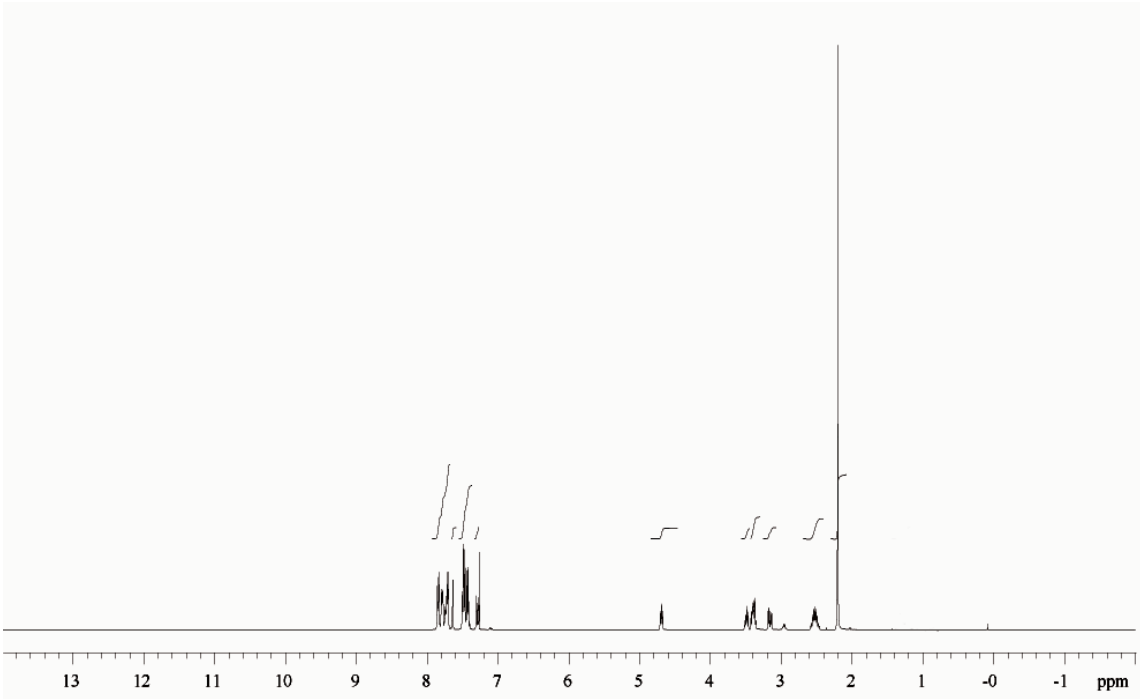
160
140
120
100
80
60
40
20
0
ppm


13
12
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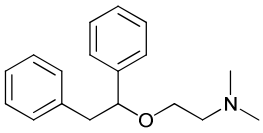
-0
-1
ppm

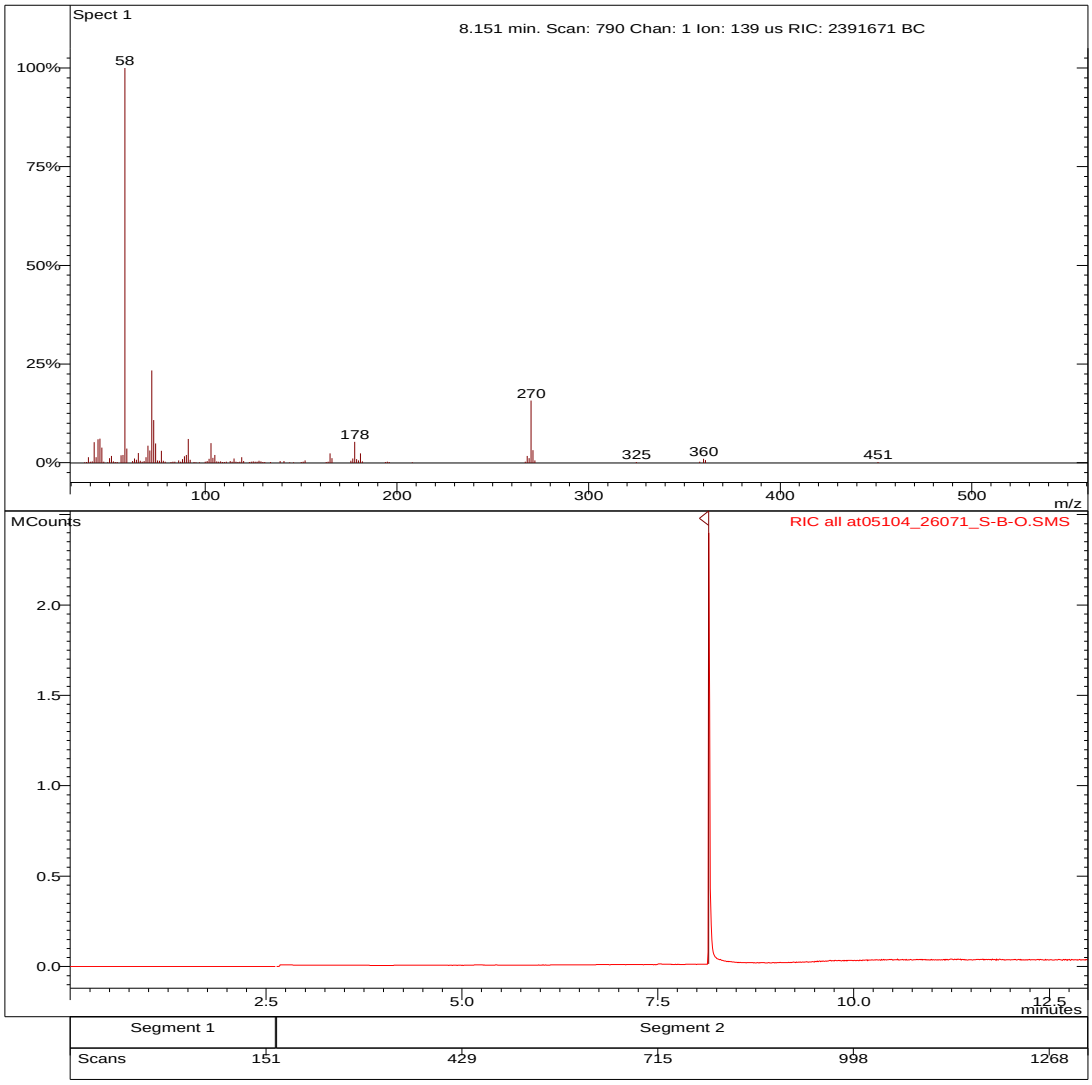
2-(1,2-diphenylethoxy)-*N*,*N*-dimethylethanamine 5i

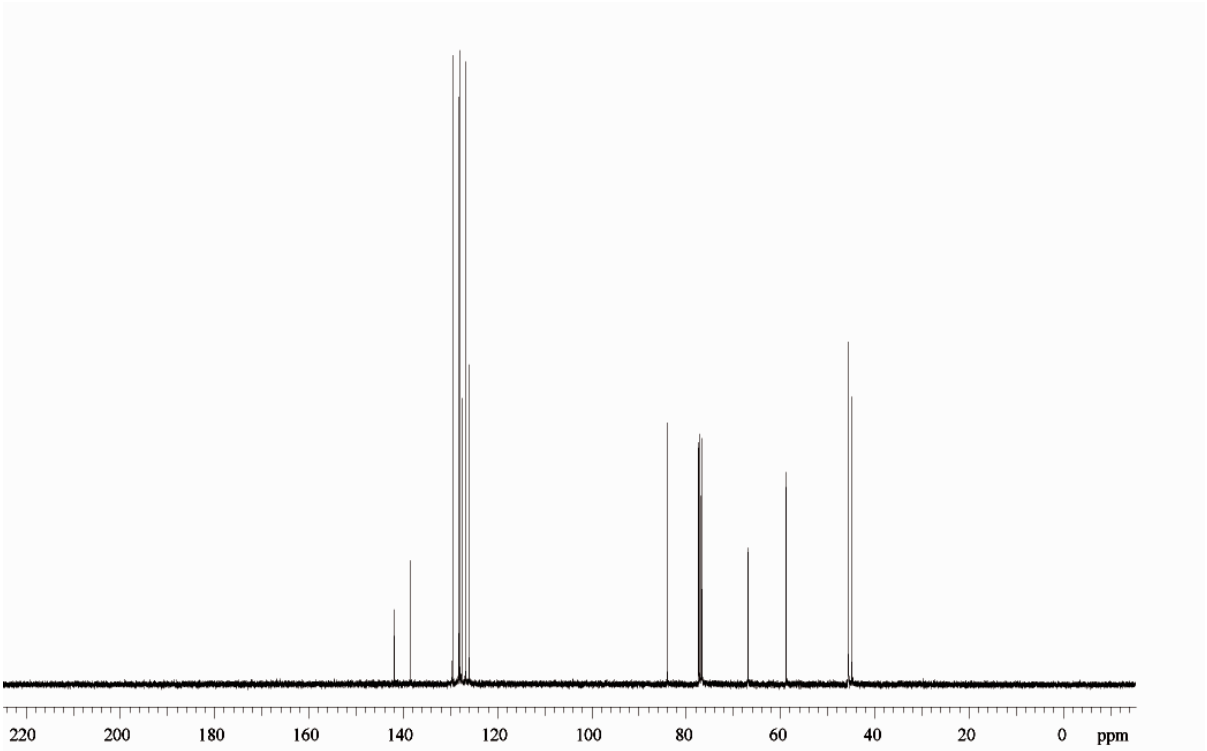


Chemical Formula: $C_{18}H_{23}NO$
Molecular Weight: 269,38

Chromatogram Plot

File: \:\... \at05 oxidativ heck\synthesis\at051\gc\at05104_26071_s-b-o.sms
Sample: at05104_26071_S-B-O
Operator: Operator
Scan Range: 1 - 1321 Time Range: 0.00 - 12.99 min.
Date: 03/06/2009 11:30
Sample Notes: ROUTINE




220
200
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80
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40
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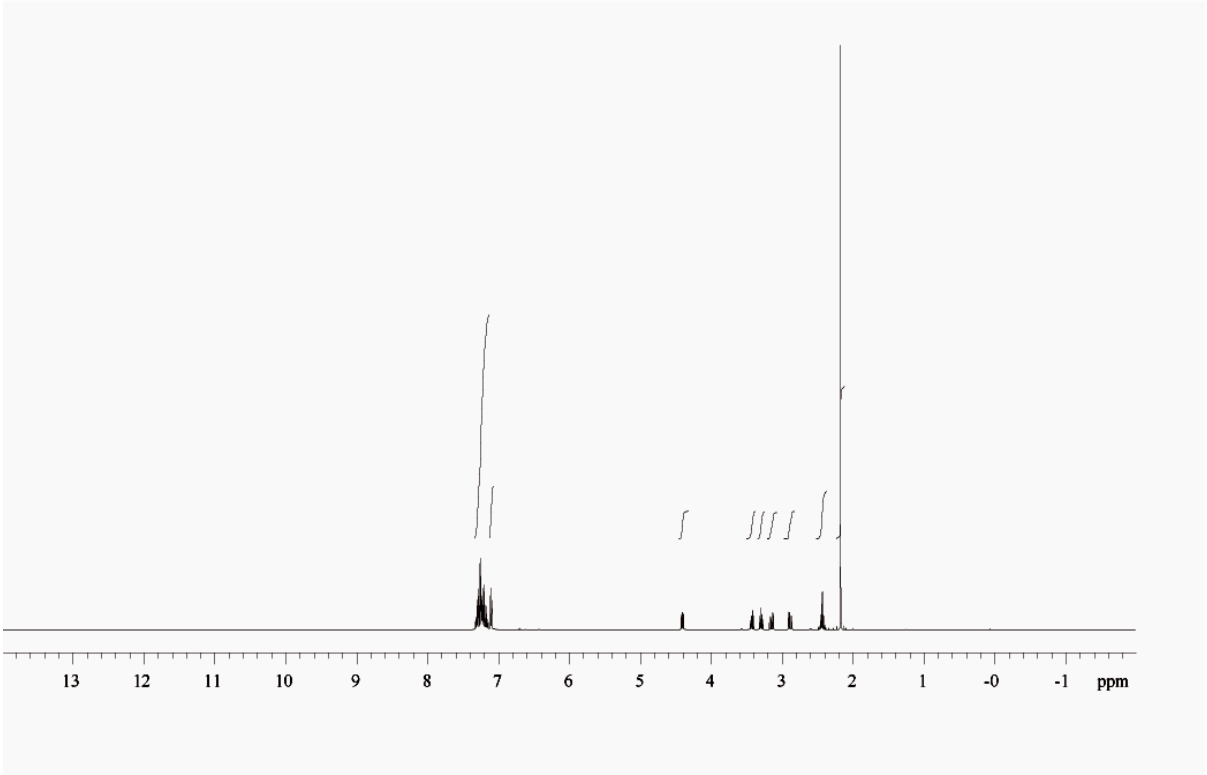
ppm


13
12
11
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9
8
7
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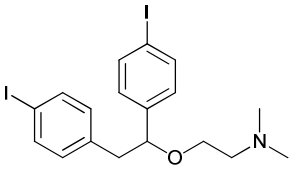
-0
-1
ppm

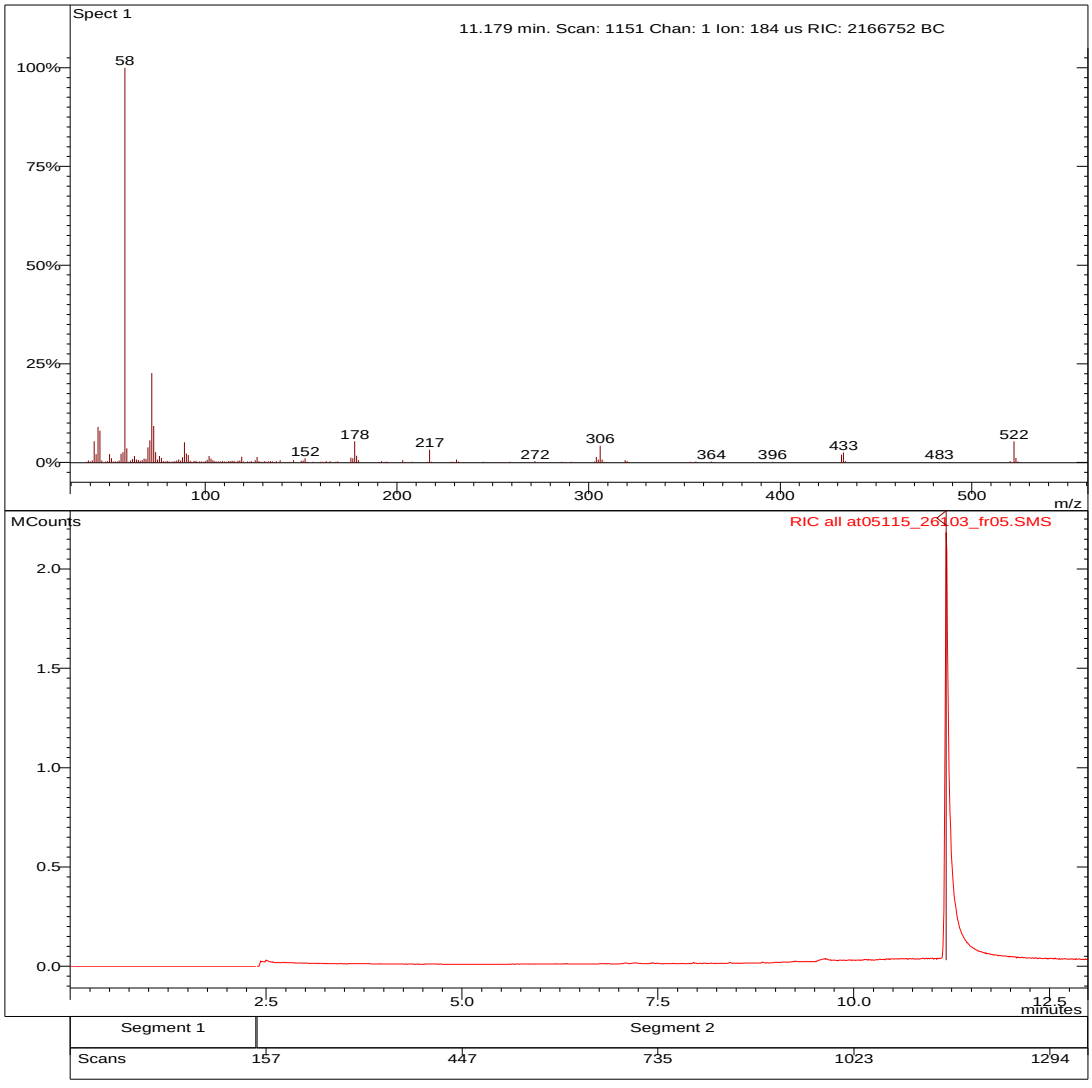
2-(1,2-*bis*(4-iodophenyl)ethoxy)-*N*,*N*-dimethylethanamine 5j

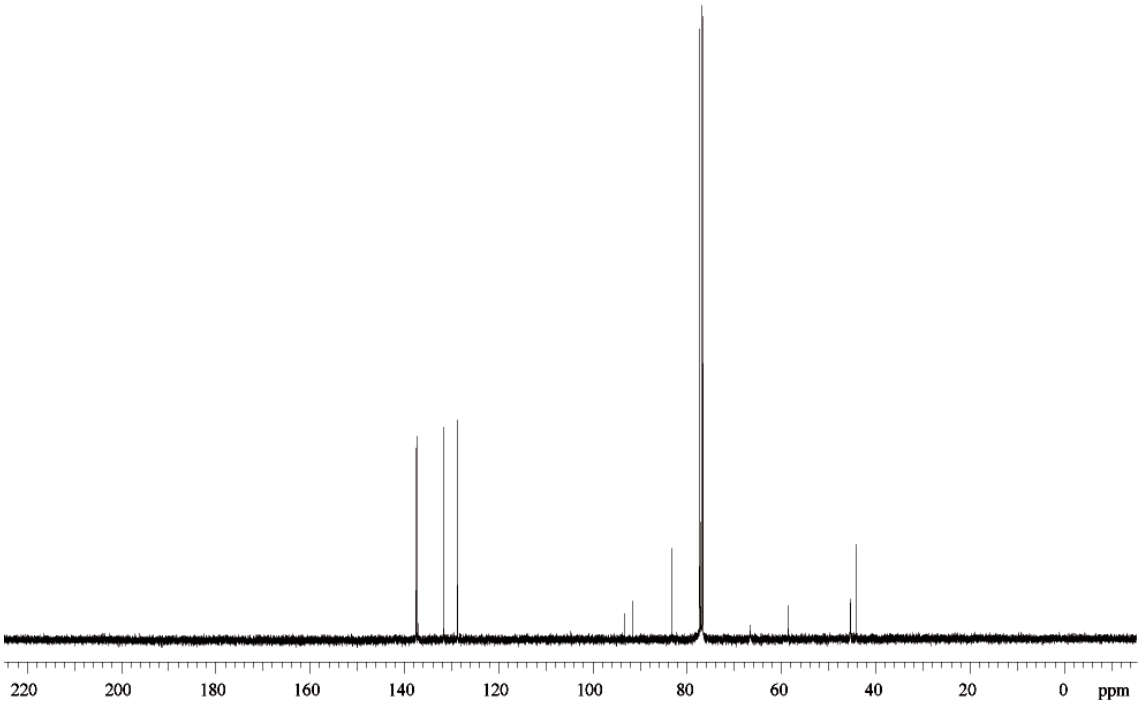


Chemical Formula: $C_{18}H_{21}I_2NO$
Molecular Weight: 521,17

Chromatogram Plot

File: \:\... \at051\gc_02\at05106 och framåt\at05115_26103_fr05.sms
Sample: at05115_260103_fr05 Operator: Operator
Scan Range: 1 - 1347 Time Range: 0.00 - 12.99 min. Date: 04/29/2009 09:24
Sample Notes: ROUTINE




220
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140
120
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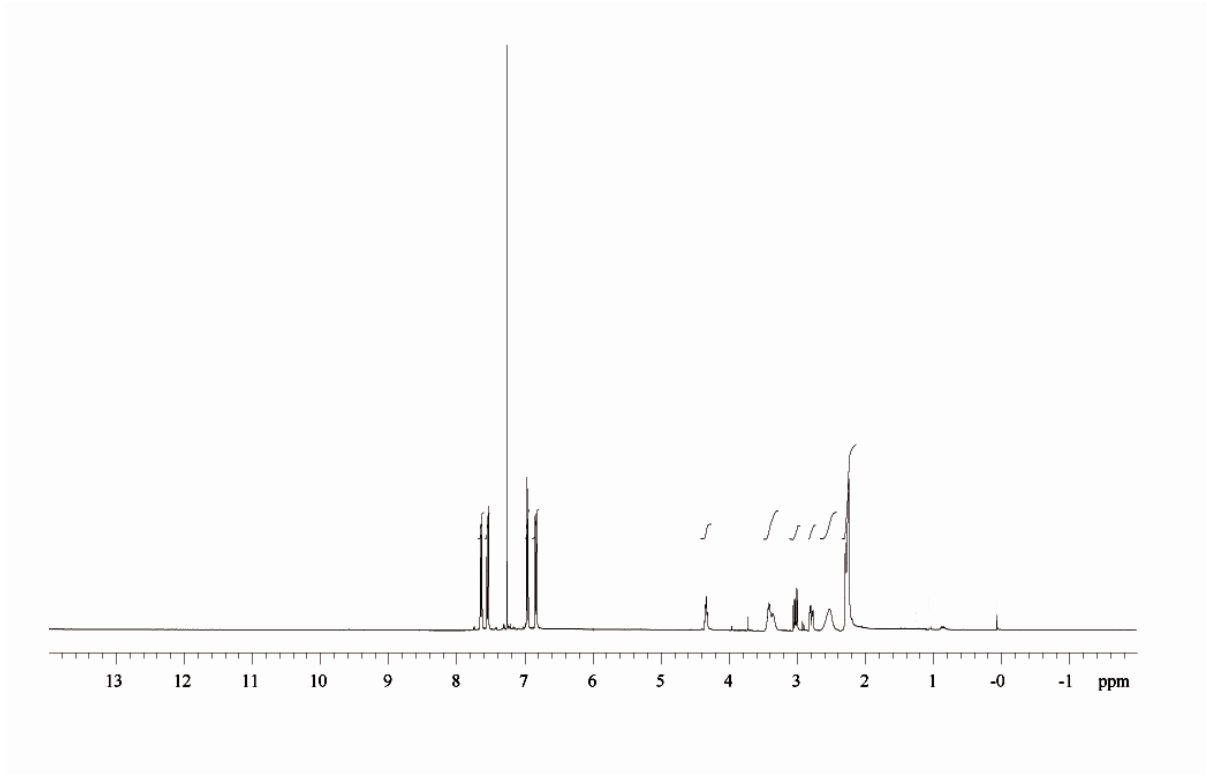
80
60
40
20
0
ppm


13
12
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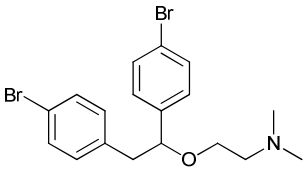
-0
-1
ppm

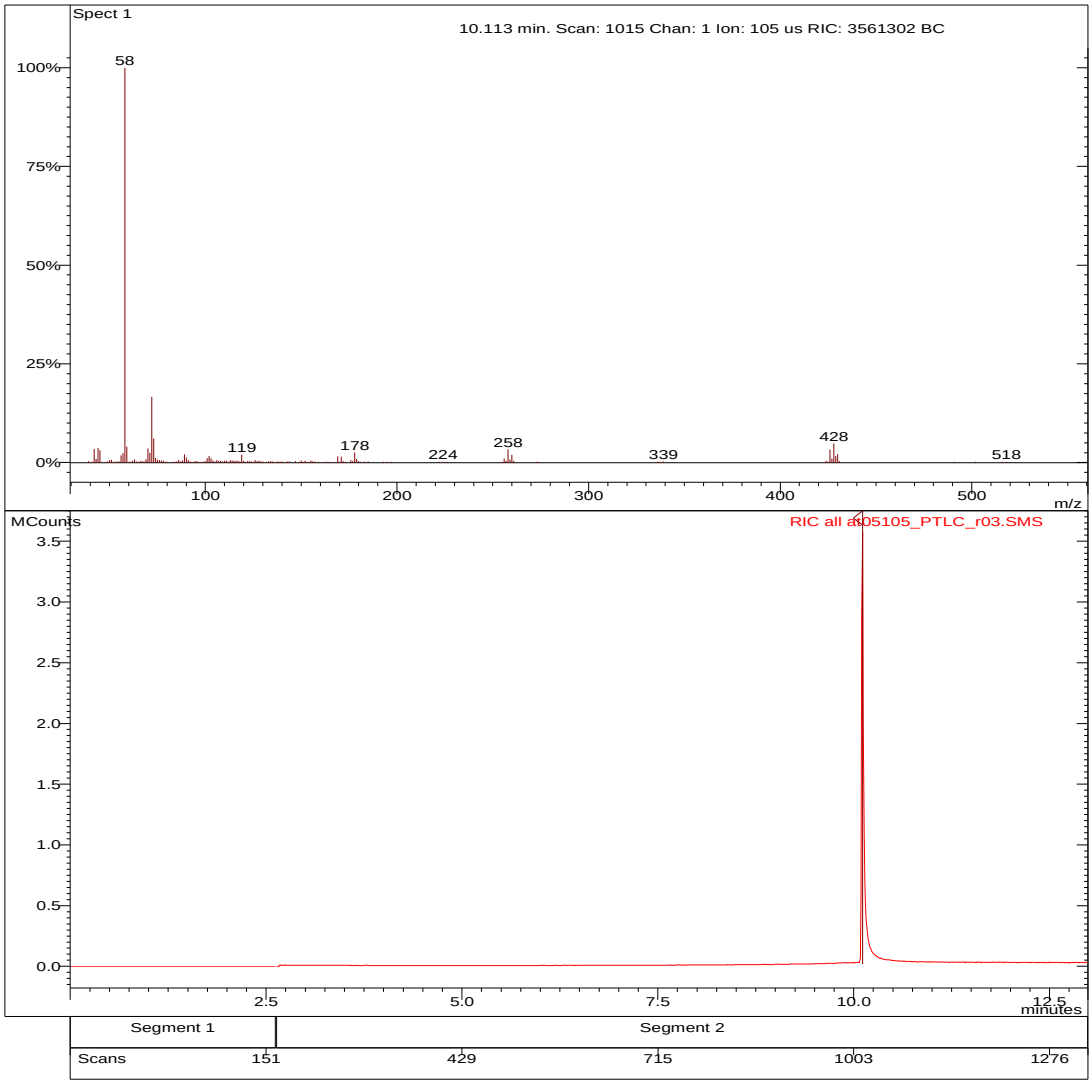
2-(1,2-bis(4-bromophenyl)ethoxy)-*N*,*N*-dimethylethanamine 5k

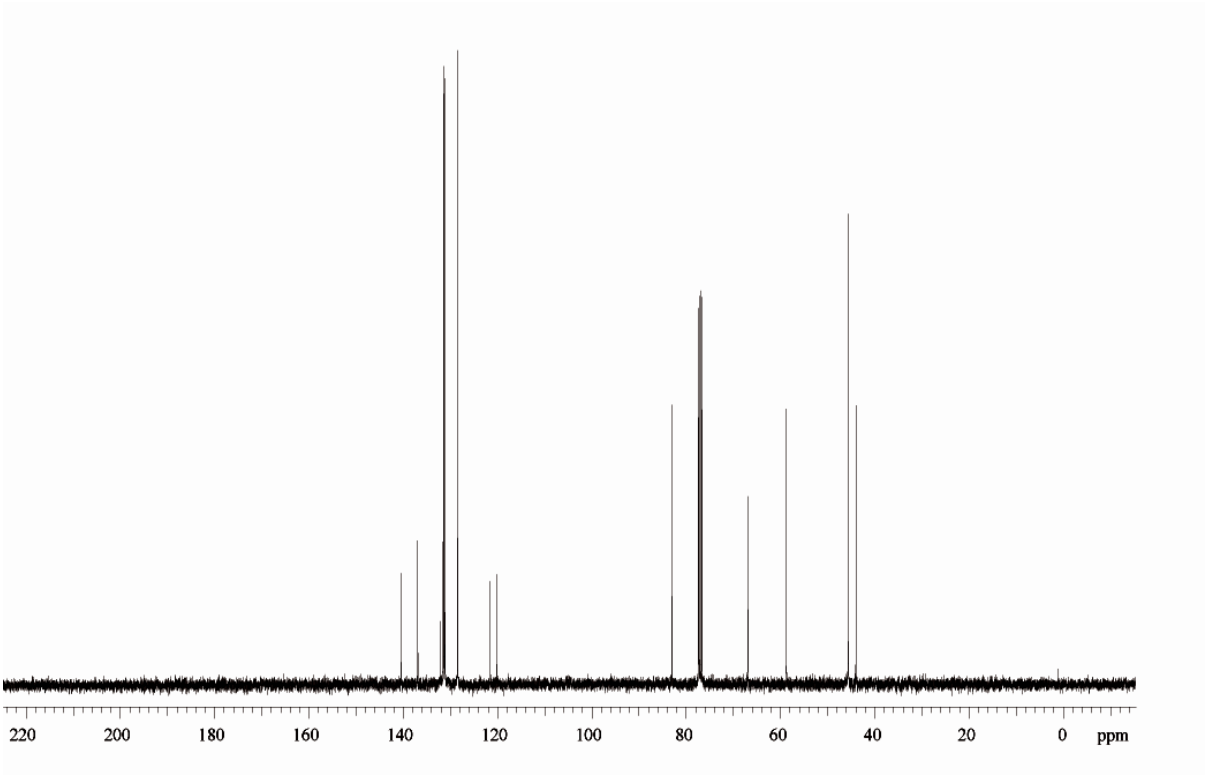


Chemical Formula: $C_{18}H_{21}Br_2NO$
Molecular Weight: 427,17

Chromatogram Plot

File: \:\... \at05 oxidativ heck\synthesis\at051\gc_02\at05105_ptlc_r03.sms
Sample: at05105_PTLC_r03 Operator: Operator
Scan Range: 1 - 1330 Time Range: 0.00 - 12.99 min. Date: 03/20/2009 12:55
Sample Notes: ROUTINE




220
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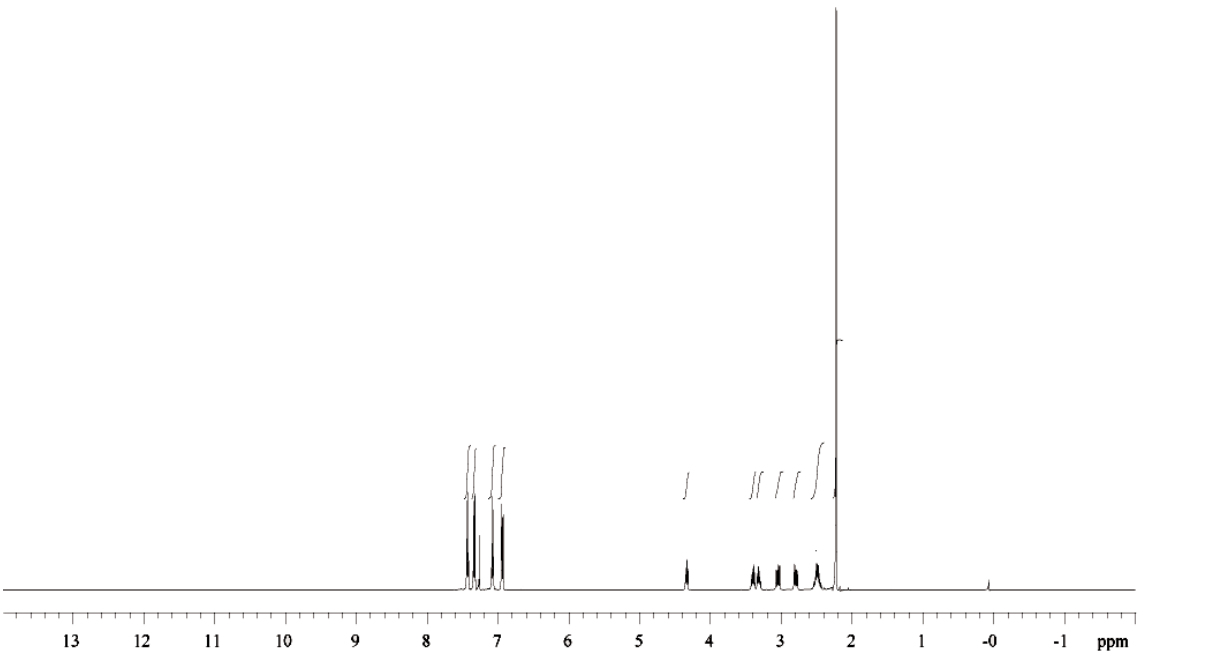
0
ppm


13
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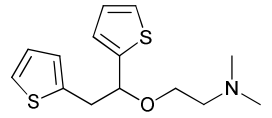
-1
ppm

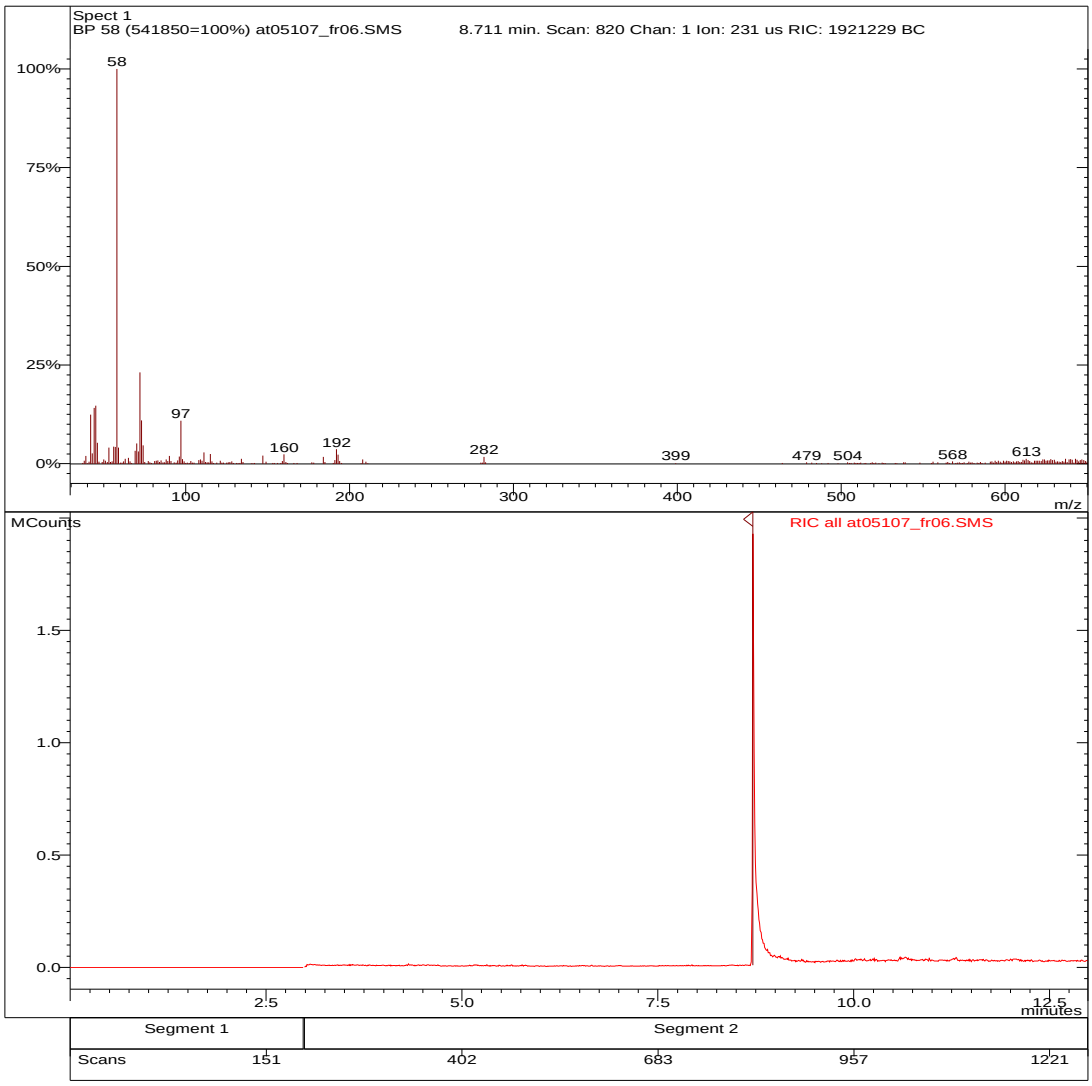
2-(1,2-di(thiophen-2-yl)ethoxy)-*N*,*N*-dimethylethanamine 5l

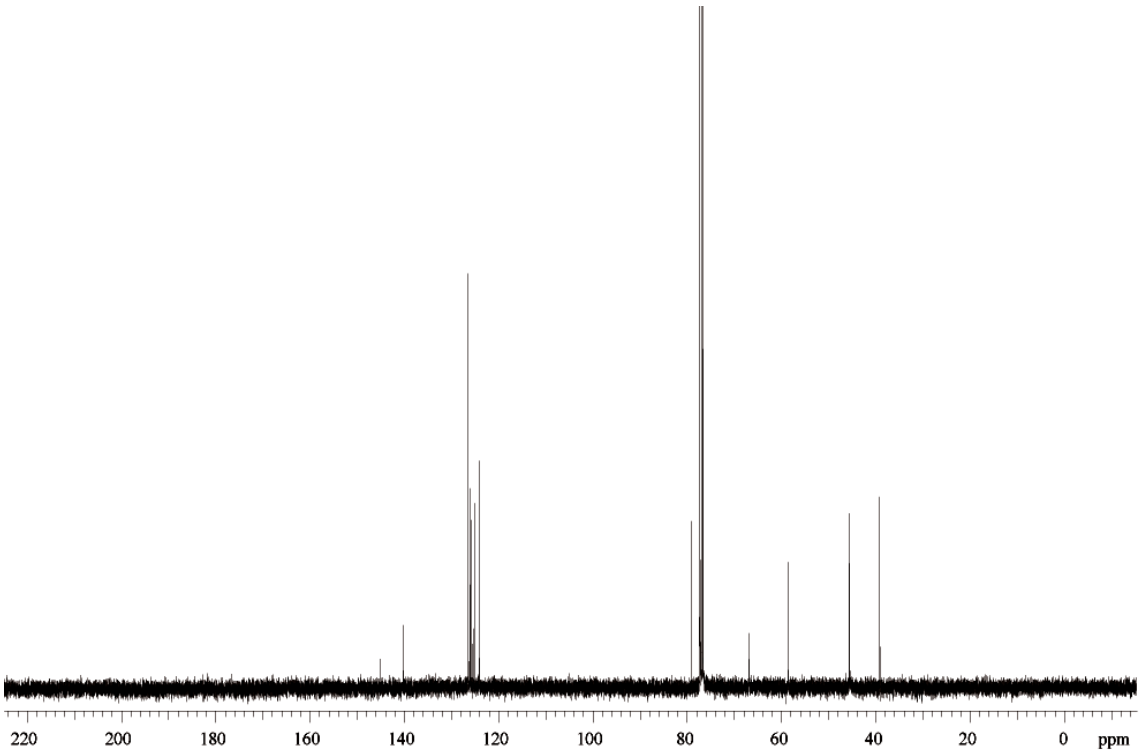


Chemical Formula: $C_{14}H_{19}NOS_2$
Molecular Weight: 281,44

Chromatogram Plot

File: \:\... \synthesis\at051\gc_02\at05106 och framåt\at05107_fr06.sms
Sample: at05107_fr06 — Operator: Org Farm Kemi
Scan Range: 1 - 1273 Time Range: 0.00 - 12.99 min. — Date: 05/05/2009 12:31
Sample Notes: Routine

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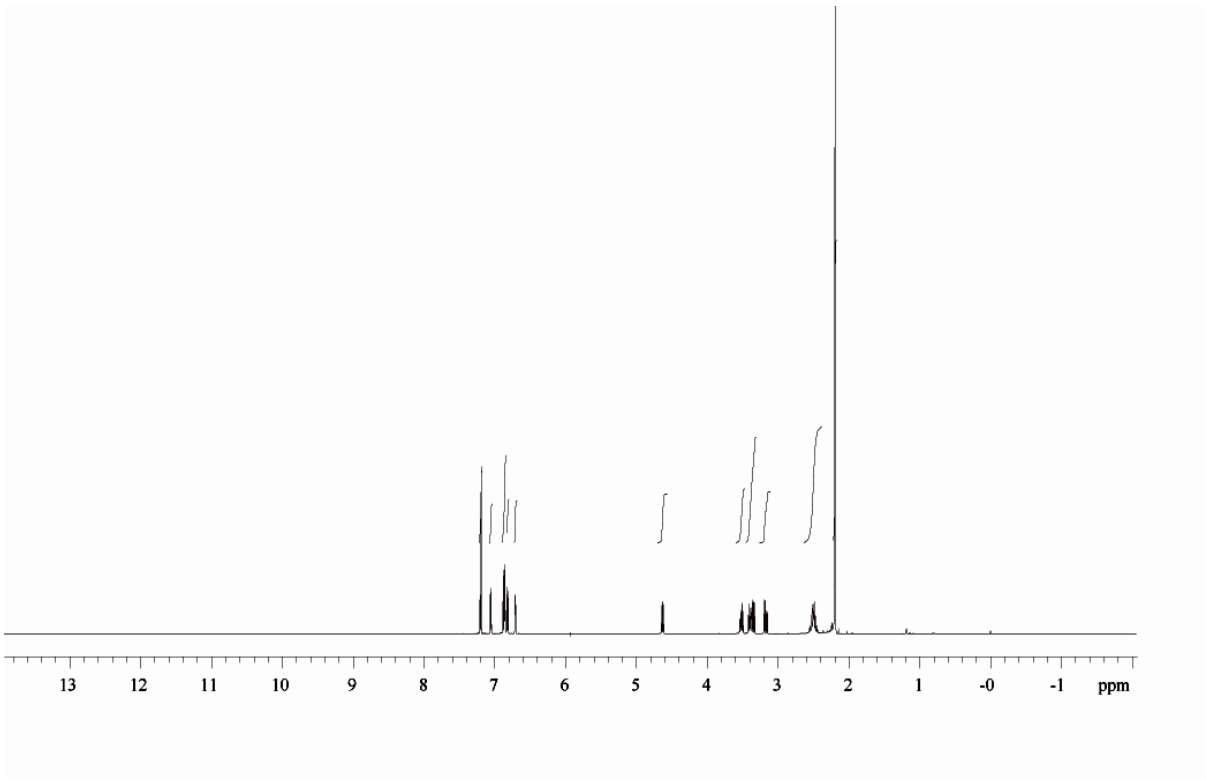
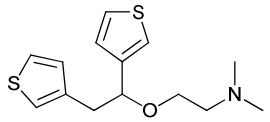
180
160
140
120
100
80
60
40
20
0
ppm


13
12
11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

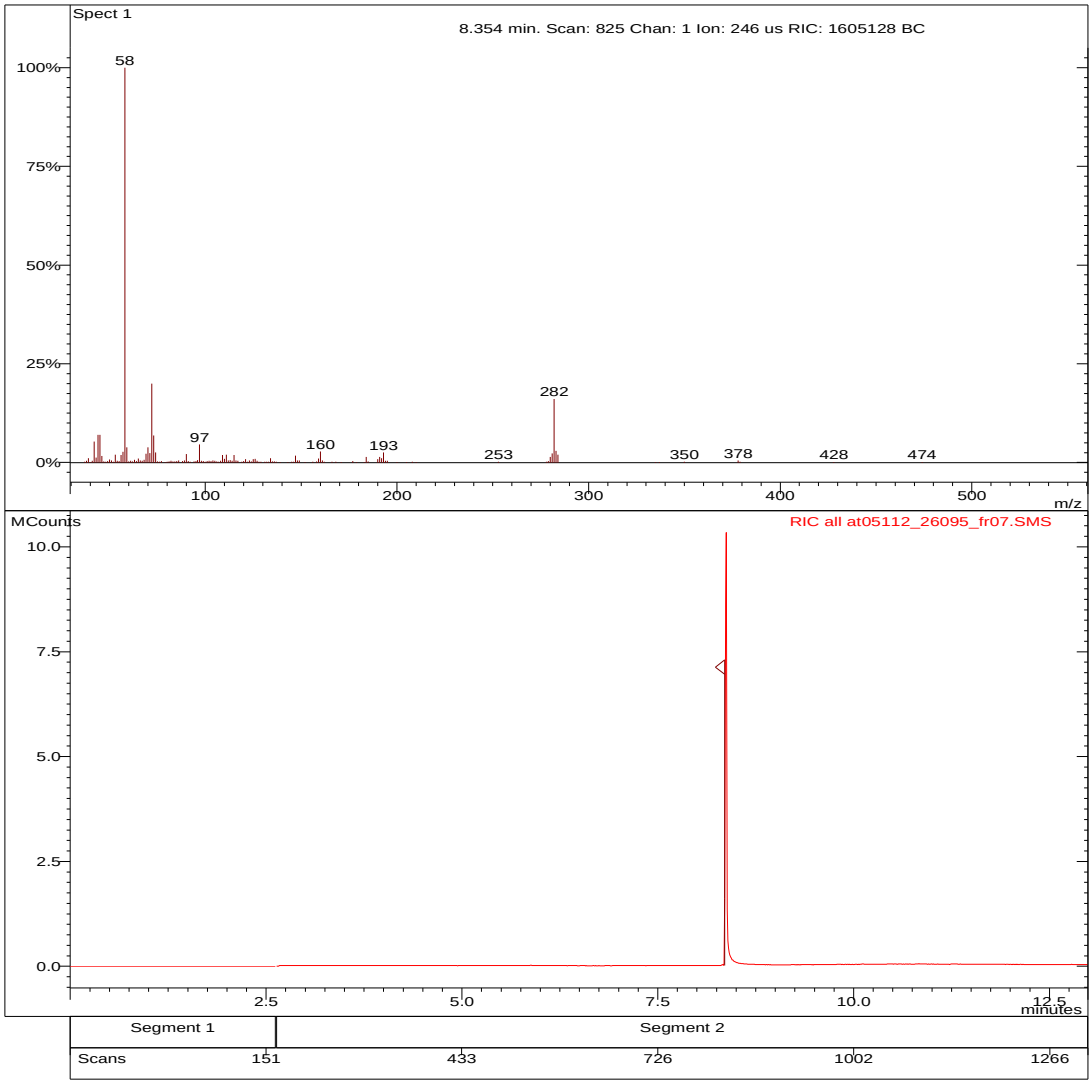
2-(1,2-di(thiophen-3-yl)ethoxy)-*N*,*N*-dimethylethanamine 5m

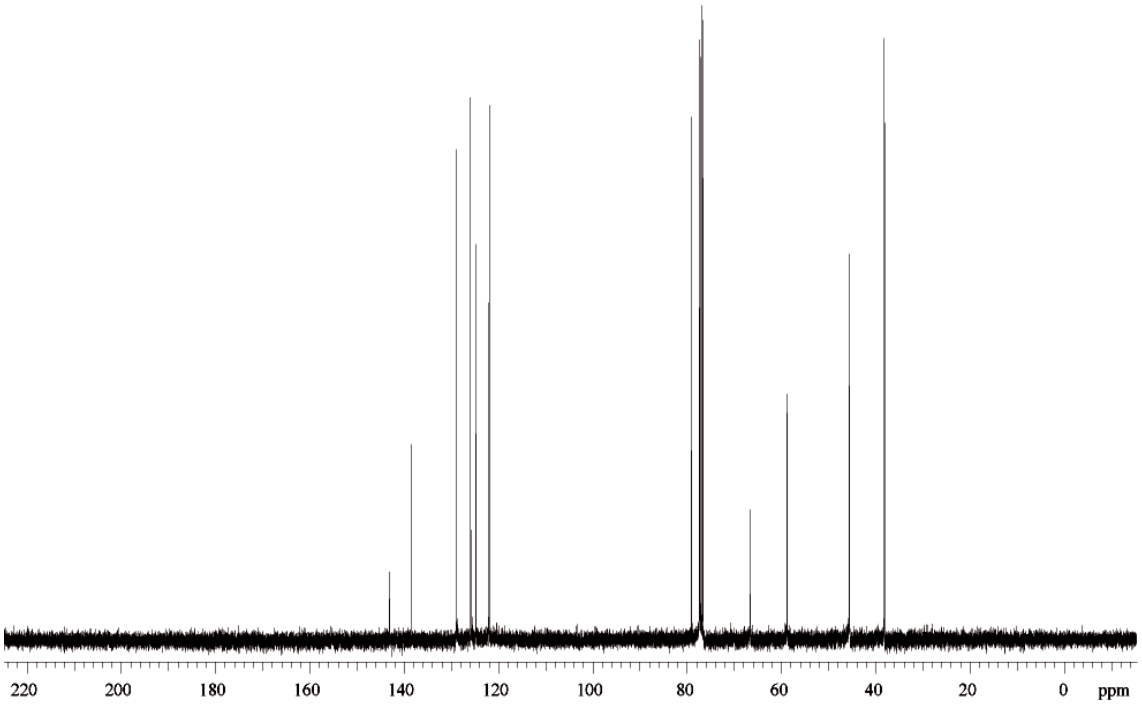


Chemical Formula: $C_{14}H_{19}NOS_2$
Molecular Weight: 281,44

Chromatogram Plot

File: \:\... \at051\gc_02\at05106 och framåt\at05112_26095_fr07.sms
Sample: at05112_26095_fr07 Operator: Operator
Scan Range: 1 - 1318 Time Range: 0.00 - 12.99 min. Date: 04/23/2009 12:35
Sample Notes: ROUTINE

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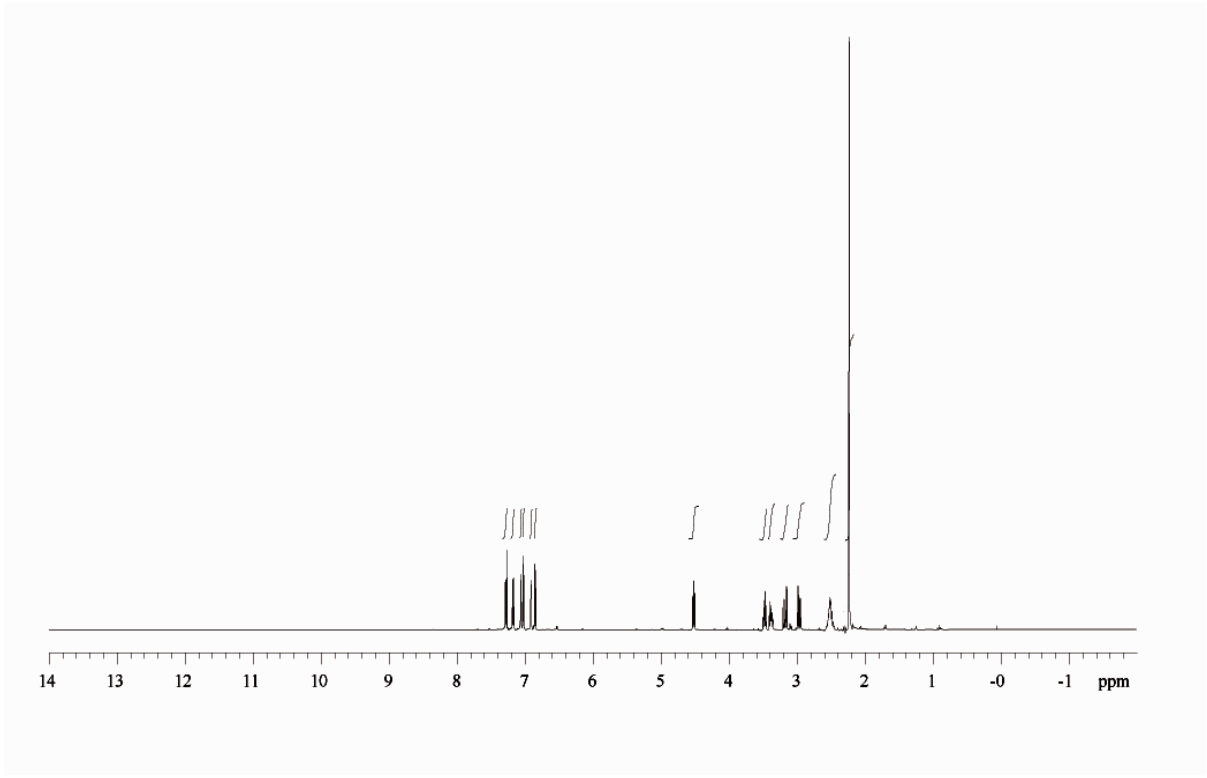
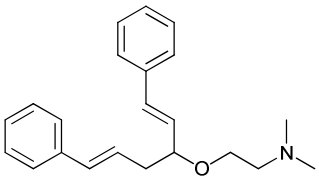
180
160
140
120
100
80
60
40
20
0
ppm


14
13
12
11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm

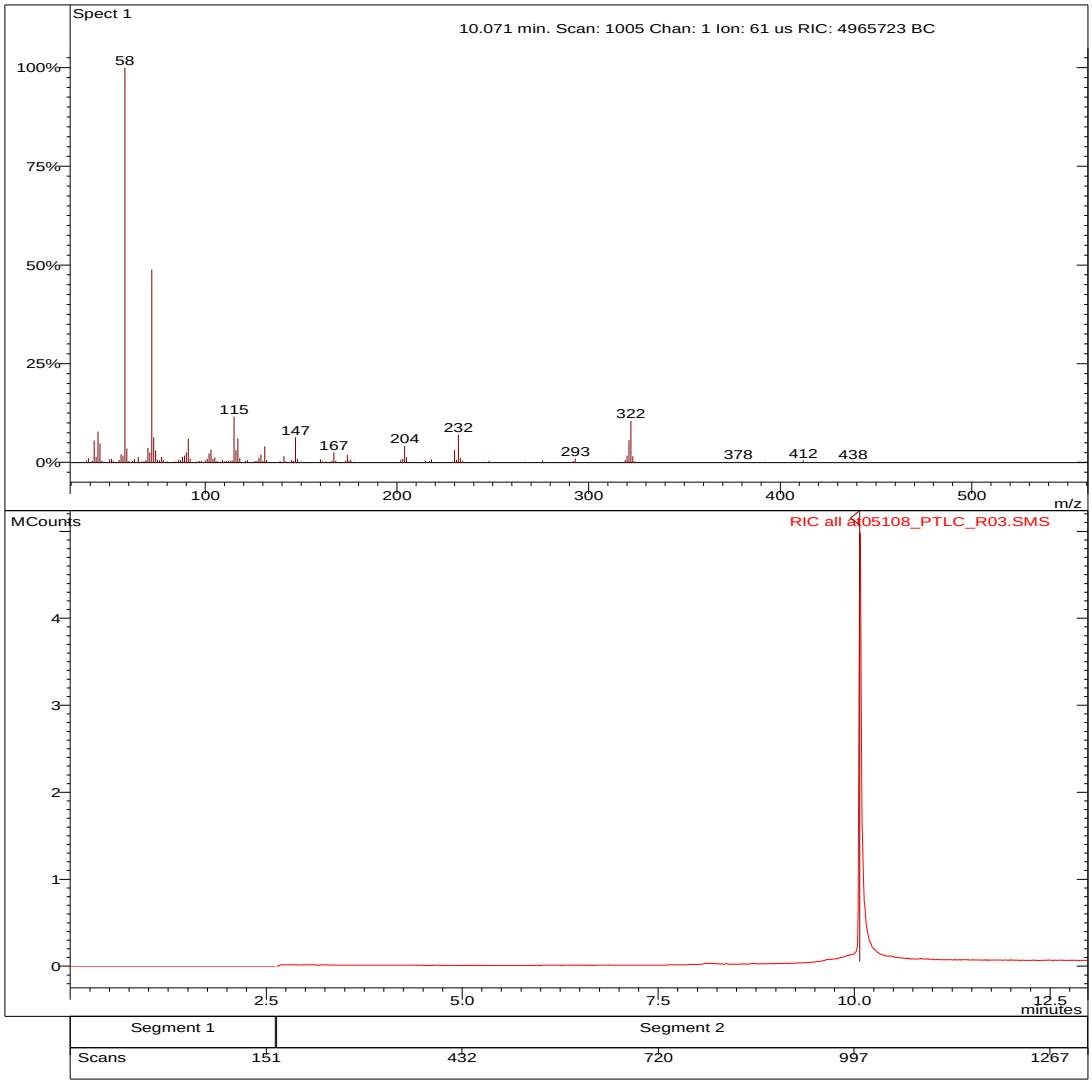
2-((1*E*,5*E*)-1,6-diphenylhexa-1,5-dien-3-yloxy)-*N*,*N*-dimethylethanamine 5n

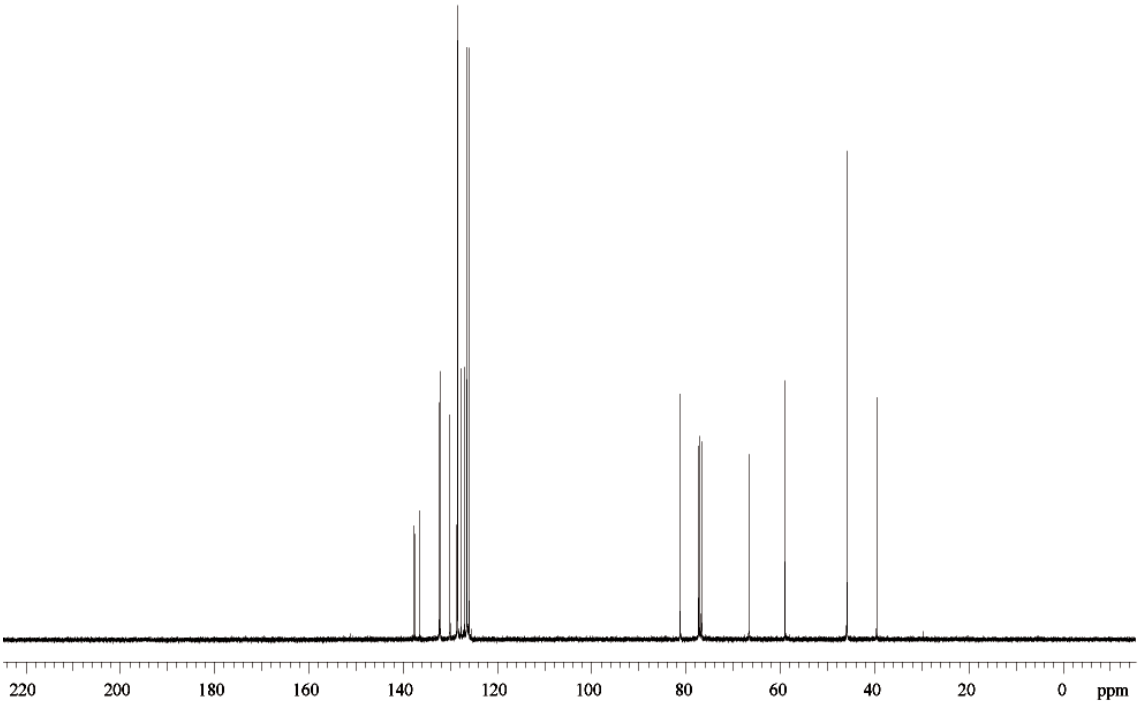


Chemical Formula: $C_{22}H_{27}NO$
Molecular Weight: 321,46

Chromatogram Plot

File: \:\... \synthesis\at051\gc_02\at05106 och framåt\at05108_ptlc_r03.sms
Sample: at05108_PTLC_R03 Operator: Operator
Scan Range: 1 - 1318 Time Range: 0.00 - 12.98 min. Date: 03/25/2009 11:31
Sample Notes: ROUTINE

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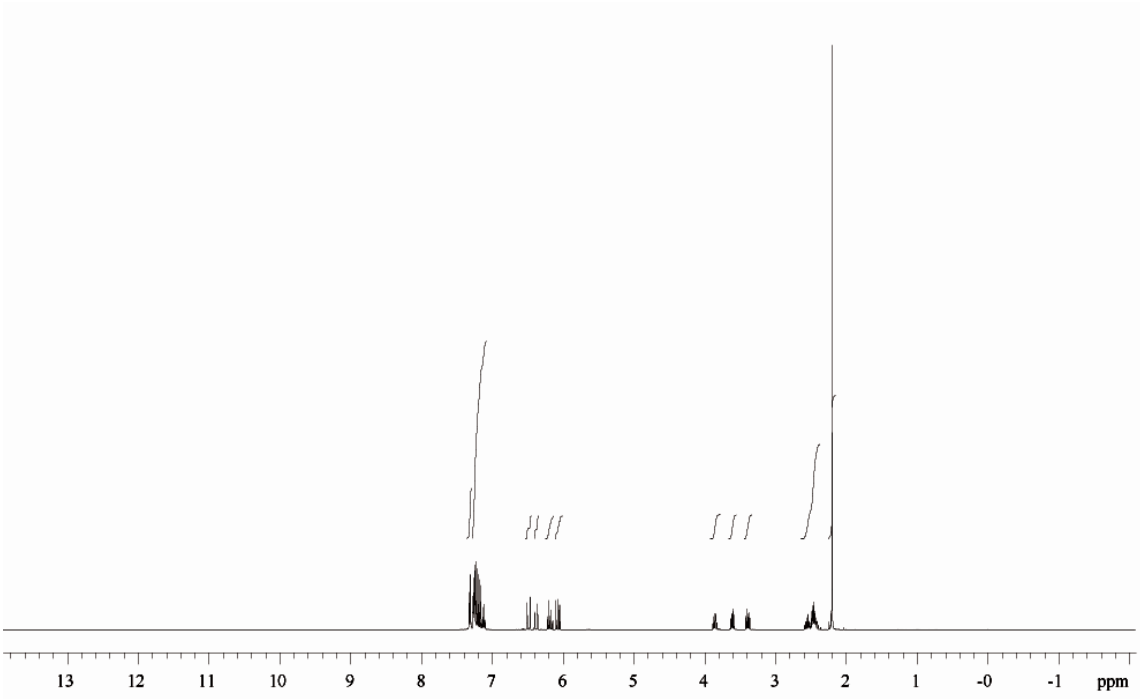
200
180
160
140
120
100
80
60
40
20
0
ppm


13
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11
10
9
8
7
6
5
4
3
2
1
-0
-1
ppm