Protecting-Group-Free Synthesis of 3-*tert*-Prenylated Oxindoles: Contiguous All Carbon Quaternary Centers *via* Tertiary Neopentyl Substitution

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Supporting Information

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(Crystallographic data for compound **4e** is provided separately as a CIF file)

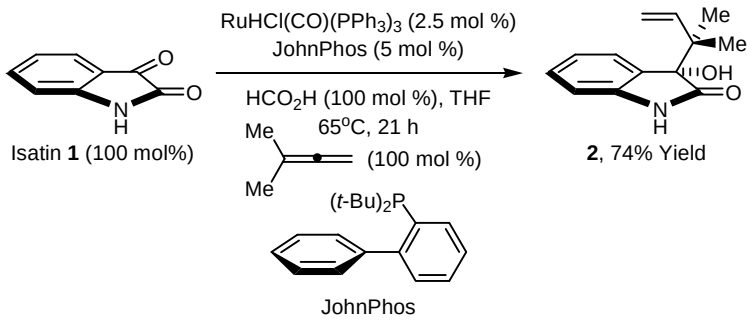
I. General Experimental Details

All reactions were run under an atmosphere of argon unless otherwise indicated. Anhydrous solvents were transferred via oven-dried syringe. All flasks were flame-dried and cooled under a stream of argon unless stated otherwise. *tert*-Prenylation of isatin was carried out in a 350 mL pressure vessel (# 15 joint) purchased from Chemglass (cat number: cg-1880-32). The bushing was lined with size 210 perfluoro O-ring (cat number: cg-309-210). Aza-xylylene additions were carried out in sealed tubes purchased from Fischer Scientific (catalog number 14-959-35C). Anhydrous dichloromethane, THF and toluene were obtained from a solvent delivery system (Innovative Technology Inc. Ps-MD-5). Isatin, (2-Biphenyl)di-*tert*-butylphosphine (JohnPhos) and formic acid (≥95% purity) were used as received from Sigma-Aldrich. 3-Methyl-1,2-butadiene (1,1-dimethylallene) was purchased from ChemSampCo. All other chemicals were used as received from various suppliers in ≥95% purity. Analytical thin-layer chromatography (TLC) was carried out using 0.2-mm commercial silica gel plates (DC-Fertigplatten Kieselgel 60 F254). All reactions that were monitored by TLC were visualized using anisaldehyde stain. Preparative column chromatography employing silica gel was performed according to the method of Still.[1] Infrared spectra were recorded on a Thermo Scientific Nicolet 380 spectrometer using attenuated total reflection (ATR). High-resolution mass spectra (HRMS) were obtained on a Karatos MS9 and are reported as m/z (relative intensity). Accurate masses are reported for the molecular ion $[M+H]^+$ or a suitable fragment ion. Melting points were obtained on a Thomas-Hoover Unimelt apparatus and are uncorrected. Proton nuclear magnetic resonance (^{1}H NMR) spectra were recorded with a Varian Gemini (400 MHz) spectrometer. Chemical shifts are reported in delta (δ) units, parts per million (ppm) downfield from trimethylsilane. Coupling constants are reported in Hertz (Hz). Carbon-13 nuclear magnetic resonance (^{13}C NMR) spectra were recorded with a Varian Gemini 300 (75 MHz) or 400 (100 MHz) spectrometer. Chemical shifts are reported in delta (δ) units, ppm relative to the center of the triplet at 77.0 ppm for deuteriochloroform. ^{13}C NMR spectra were routinely run with broadband decoupling.

[1] Still, W.C.; Kahn, M.; Mitra, A. *J. Org. Chem.* **1978**, *43*, 2923.

II. Preparation of *tert*-prenyl alcohol and chloride

3-(1,1-Dimethyl-allyl)-3-hydroxy-1,3-dihydro-indol-2-one (2)



Isatin **1** (10.3 g, 70 mmol, 100 mol %), $RuHCl(CO)(PPh_3)_3$[2] (1.7 g, 1.75 mmol, 2.5 mol%), JohnPhos [(2-biphenyl)di-*tert*-butylphosphine] (1.04 g, 3.5 mmol, 5 mol %) were added to an oven dried 350 mL pressure vessel[3]equipped with a magnetic stir bar. The reaction vessel was sealed with a rubber septum. The vessel was purged with argon (3 cycles) and 3-methyl-1,2-butadiene (7 mL, 70 mmol, 100 mol %), formic acid (2.68 mL, 70 mmol, 100 mol %) and THF (70 mL) were added sequentially *via* syringe. The septum was removed and the bushing was screwed on quickly. The sealed reaction vessel was placed in a 65 °C oil bath. The reaction vessel was removed from the oil bath after 21 h and was allowed to cool to room temperature, at which point the reaction vessel was opened carefully due to the effervescence of CO_2. The reaction was filtered and the filtrand was washed with EtOAc (*ca*. 50 mL). The filtrate was decanted into a 500 mL round bottom flask and concentrated to dryness. The residue was dissolved in hot EtOAc (*ca*. 250 mL) and the resulting solution was filtered to remove any residual solid. The product was crystallized by concentrating the filtrate to saturation. A layer of hexanes was carefully placed on the top of the solution, which was allowed to reach room temperature then placed in a freezer (-10 °C) for 15 h. Crystals were collected and dried to furnish the title compound (11.3 g, 2 crops) as light brown fluffy crystals in 74 % yield.

mp = 174-175 °C (crystals from EtOAc-hexanes)

^{1}H NMR (400 MHz, DMSO): δ 10.18 (broad, s, 1H), 7.25-7.19 (m, 2H), 6.93 (m, 1H), 6.77 (d, J = 8 Hz, 1H), 6.05 (dd, J = 18 and 10.8 Hz 1H), 5.86 (s, 1H), 4.98 (d, J = 10.8 Hz, 1H), 4.87 (d, J = 18 Hz, 1H), 1.17 (s, 3H), 1.00 (s, 3H).

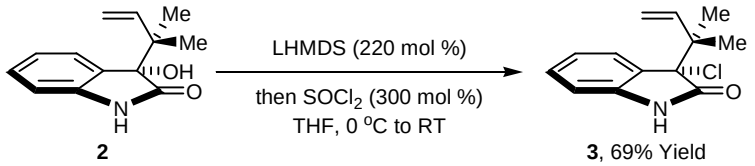
^{13}C NMR (100 MHz, DMSO): δ 179.8, 144, 143.1, 132, 129.6, 126.6, 121.6, 113.6, 109.9, 80, 43.7, 22.4, 21.

HRMS (CI): Calcd. for $C_{13}H_{15}NO_2$ (M+H) 218.1181, Found: 218.1181.

[2] Joseph, T., *et al.*, *J. Mol. Catal. A*, **2003**, *206*, 13.
[3] See General Experimental Details for specifications.

FTIR (neat): 3366, 1706, 1621, 1472, 1185, 1115, 916, 771, 755, 732, 672 cm^{-1}.

3-Chloro-3-(1,1-dimethyl-allyl)-1,3-dihydro-indol-2-one (3)



2 **3**, 69% Yield

Alcohol **2** (2.17 g, 10 mmol, 100 mol %) was added to a flame dried 250 mL round bottom flask equipped with a magnetic stir bar under an atmosphere of argon. THF (30 mL) was added *via* syringe to the stirred mixture and the vessel was cooled to 0 °C using an ice bath. LHMDS in THF (1 M, 22 mL, 22 mmol, 220 mol %) was added over 5 minutes and the orange reaction mixture was warmed to room temperature and allowed to stir for 2 h. The reaction mixture was cooled to 0 °C using an ice bath and thionyl chloride[4] (2.18 mL, 30 mmol, 300 mol %) was added dropwise over 5 minutes, at which point the reaction mixture became a deep red. The reaction mixture was allowed to room temperature and was allowed to stir for 5 h. The reaction mixture was carefully poured into a 500 mL Erlenmeyer flask containing ice. Once the ice had melted, the mixture was extracted with ether (3x, 20 mL) and the combined organic extracts were washed with brine (2x, 20 mL) and dried ($MgSO_4$). The solution was filtered and concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, neat DCM) furnished the title compound (1.62 g) as a yellow-orange residue in 69% yield. Crystallization *via* slow evaporation of DCM provided yellowish prisms.

M.P. = 95-97 °C (crystals from DCM)

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.74 (broad, s, 1H), 7.40 (d, J = 7.6 Hz, 1H), 7.26 (ddd, J = 7.6 and 4.4 Hz, 1H), 7.03 (dd, J = 7.6 Hz, 1H), 6.88 (d, J = 8 Hz, 1H), 6.11 (dd, J = 17.6 and 10.8 Hz, 1H), 5.15 (d, J = 10.8 Hz, 1H), 5.05 (d, J = 17.6 Hz, 1H), 1.38 (s, 3H), 1.23 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 176.7, 141.1, 140.3, 130.1, 129.7, 126.8, 122.7, 115.4, 110.3, 71.3, 44.2, 22.7, 21.2.

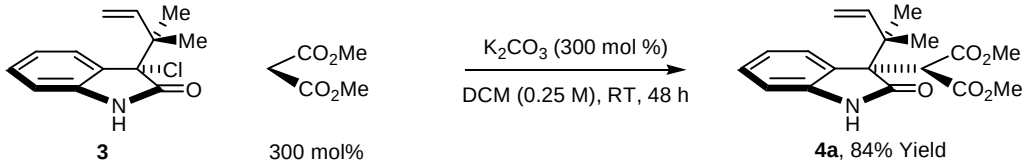
HRMS (CI): Calcd. for $C_{13}H_{14}ClNO$ (M+H) 236.0842, Found: 236.0849.

FTIR ($CDCl_3$): 3242, 1721, 1619, 1473, 1383, 1345, 1186, 1105, 905, 729 cm^{-1}.

[4] Freshly distilled from quinoline.

III. Tertiary Neopentyl Substitution

2-[3-(1,1-Dimethyl-allyl)-2-oxo-2,3-dihydro-1H-indol-3-yl]-malonic acid dimethyl ester (4a)



3 300 mol% **4a**, 84% Yield

To a flame dried sealed tube (13 x 100 mm) capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) and dimethyl malonate (25.4 μL, 0.3 mmol, 300 mol %) were added in quick succession. The septum was replaced with a screw cap and the reaction mixture was allows to stir vigorously (1000-1200 rpm) for 48 h, at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, neat DCM to EtOAc:hexanes, 1:1) provided the title compound (27.8 mg) as a light yellow oil that solidified upon standing in 84% yield. Crystallization *via* slow evaporation of ether-hexanes provided yellowish clusters.

M.P. = 97-100 °C (crystals from ether-hexanes)

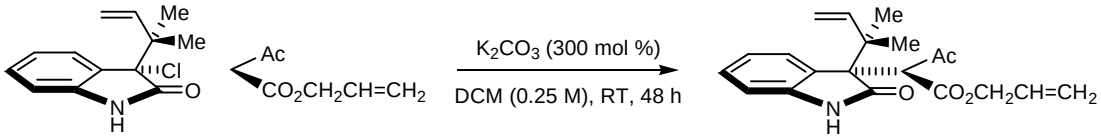
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 (broad, s, 1H), 7.68 (d, *J* = 7.6 Hz, 1H), 7.23 (ddd, *J* = 7.6 and 0.8 Hz, 1H), 7.01 (dd, *J* = 7.6 Hz, 1H), 6.86 (d, *J* = 7.6 Hz, 1H), 5.94 (dd, *J* = 17.6 and 11.2 Hz, 1H), 5.05 (dd, *J* = 11.2 and 1.2 Hz, 1H), 4.97 (d, *J* = 17.6 Hz, 1H), 4.41 (s, 1H), 3.76 (s, 3H), 3.50 (s, 3H), 1.29 (s, 3H), 0.93 (s, 3H)

^{13}C NMR (100 MHz, $CDCl_3$): δ 179.3, 168.6, 167.6, 142.6, 142.5, 128.3, 128.2, 127.9, 121.3, 113.6, 109, 57.6, 54.3, 52.6, 52.2, 41.9, 23.5, 22.6.

HRMS (CI): Calcd. for $C_{18}H_{21}NO_5$ (M+H) 332.1498, Found: 332.1499.

FTIR ($CDCl_3$): 3247, 2953, 2159, 1976, 1705, 1619, 1593, 1471, 1434, 1416, 1383, 1367, 1315, 1216, 1151, 1115, 1071, 1031, 1014, 913, 880, 757, 730, 680 cm^{-1}.

2-[3-(1,1-Dimethyl-allyl)-2-oxo-2,3-dihydro-1H-indol-3-yl]-3-oxo-butyric acid allyl ester (4b)



3 300 mol% **4b**, 74% Yield

To a flame dried sealed tube (13 x 100 mm) capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) and allyl acetoacetate (41 μL, 0.3 mmol, 300%) were added in quick succession and the septum was replaced with a screw cap and stirred vigorously (1000-1200 rpm) for 48 h. The reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, neat DCM to EtOAc:hexanes, 1:1) provided the title compound (25.2 mg) as a viscous yellowish oil in 74% yield.

<< a complex mixture of diastereomers and tautomers >>

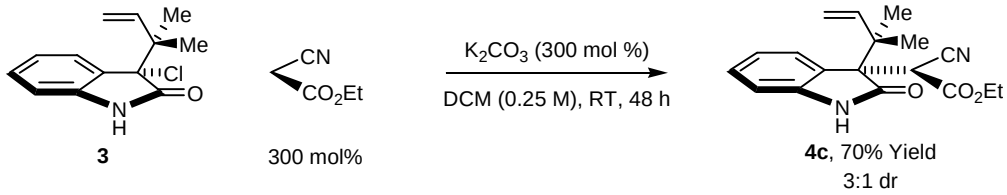
^{1}H NMR (400 MHz, CD_3OD): δ 7.62 (d, *J* = 8 Hz, 0.3H) 7.57 (d, *J* = 7.6 Hz, 1H), 7.21 (m, 1.4H), 6.94 (m, 1.5H), 6.86 (d, J = 7.6, 1.3H), 6.27 (m, 0.4H), 6.02 (m, 2.5H), 5.71 (m, 0.5H), 5.43 (m, 1H), 5.32 (m, 1H), 5.31-4.95 (m, 5.3H), 4.87 (s, 3.1H), 4.8-4.60 (m, 3.2H), 4.39 (m, 1.7H), 2.31 (s, 1H), 2.16 (s, 0.5H), 2.00 (s, 3H), 2.26 (s, 3.3H), 1.18-1.03 (m, 3H), 0.91 (s, 3H).

^{13}C NMR (100 MHz, CD_3OD): δ 225.6, 200.2, 180.3, 178.6, 168.9, 167.3, 145.5, 143.8, 143.2, 142.8, 131.4, 128.6, 128.3, 128, 127.9, 120.9, 120.6, 119.1, 113.4, 113.1, 109.2, 109.1, 66.3, 65.8, 62.7, 60.5, 59, 57.8, 42, 41.8, 32.1, 27.4, 22.5, 22.1, 20.6.

HRMS (CI): Calcd. For $C_{20}H_{24}NO_4$ (M+H) 342.1705, Found: 342.1710

FTIR (DCM): 3248, 3086, 2872, 1705, 1618, 1471, 1415, 1382, 1358, 1309, 1274, 1234, 1200, 1182, 1157, 1114, 1069, 1009, 991, 920, 864, 805, 753, 736, 675 cm^{-1}.

Cyano-[3-(1,1-dimethyl-allyl)-2-oxo-2,3-dihydro-1H-indol-3-yl]-acetic acid ethyl ester (4c)



To a flame dried sealed tube (13 x 100 mm) capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) and ethyl cyanoacetate (32 µL, 0.3 mmol, 300 mol %) were added in quick succession and the septum was replaced with a screw cap. The reaction mixture was allowed stir vigorously (1000-1200 rpm) for 48 h, at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, neat DCM to EtOAc:hexanes, 1:1) provided the title compound (21.8 mg) as an orange residue in 70% yield.

<< an inseparable 75:25 mixture of diastereomers >>

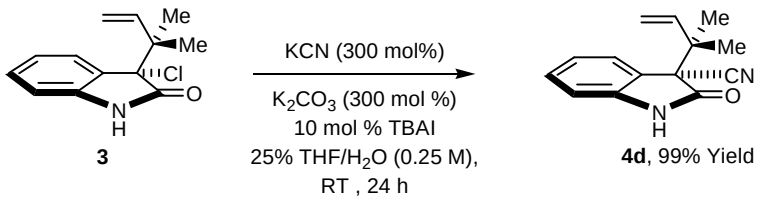
^{1}H NMR (400 MHz, $CDCl_3$ for major diastereomer): δ = 8.32 (broad, s, 1H), 7.62 (d, *J* = 7.4 Hz, 1H), 7.28 (dd, *J* = 7.4 Hz, 1H), 7.06 (dd, *J* = 7.4 Hz, 1H), 6.88 (d, *J* = 7.4 Hz, 1H), 6.26 (dd, *J* = 17.2 and 6.4 Hz, 1H), 5.25 (m, 2H), 4.34 (s, 1H), 3.97 (q, *J* = 7.2 Hz, 2H), 1.35 (s, 3H), 1.03 (s, 3H), 1.01 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 179, 164.4, 142.9, 141.7, 129.9, 127.3, 127.1, 122.7, 116.6, 116.5, 110.5, 110.4, 63.7, 57, 42.8, 41.7, 24.6, 22.7.

HRMS (CI) Calcd. for $C_{18}H_{20}N_2O_3$ (M+H) 313.1552, Found: 313.1548.

FTIR ($CDCl_3$): 3262, 2980, 1712, 1619, 1596, 1472, 1417, 1385, 1368, 1329, 1235, 1156, 1112, 1011, 923, 856, 756, 733, 678 cm^{-1}.

3-(1,1-Dimethyl-allyl)-2-oxo-2,3-dihydro-1H-indole-3-carbonitrile (4d)



To a flame dried sealed tube (13 x 100 mm) charged with chloride **3** (23.5 mg, 0.1 mmol, 100 mol%), capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %), KCN (19.5 mg, 0.3 mmol, 300 mol %) and tetrabutylammonium iodide (3.7 mg, 0.01 mmol, 10 mol %). THF (0.1 mL) and H_2O (0.3 mL) were added and the septum was quickly replaced with a screw cap. The mixture was stirred vigorously (1000-1200 rpm) for 24 h, at which point the reaction mixture was diluted with EtOAc (0.3 mL) and the organic layer was separated. The aqueous layer was extracted twice with EtOAc (0.3 mL) and the combined organic extracts were diluted with DCM (*ca* 0.10 mL), dried ($MgSO_4$) and filtered. The residue was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4) provided the title compound (22.6 mg) as light yellow residue in > 99% yield.

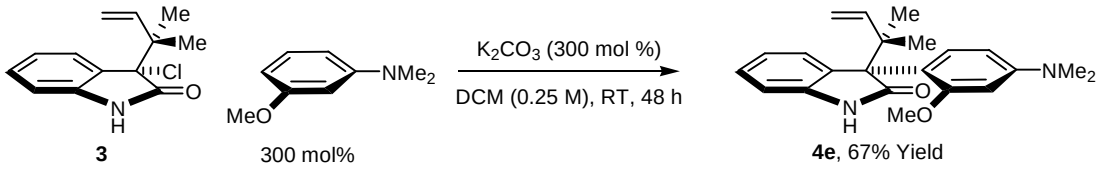
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.75 (broad, s, 1H), 7.39 (d, *J* = 7.8 Hz, 1H), 7.33 (dd, *J* = 7.8 Hz, 1H), 7.08 (dd, *J* = 7.8 Hz, 1H), 6.93 (d, *J* = 7.8 Hz, 1H), 5.97 (dd, *J* = 17.2 and 10.4 Hz, 1H), 5.20 (d, *J* = 10.4 Hz, 1H), 5.08 (d, *J* = 17.2, 1H), 1.43 (s, 3H), 1.22 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 172.2, 141.6, 140.4, 130.5, 126.3, 124.8, 122.8, 116.9, 116.3, 111, 54.8, 44.2, 24.2, 22.9.

HRMS (CI): Calcd. for $C_{14}H_{14}N_2O$ (M+H) 227.1183, Found: 227.1179.

FTIR ($CDCl_3$): 3266, 2973, 2243, 1722, 1619, 1599, 1473, 1416, 1386, 1369, 1322, 1237, 1191, 1153, 1111, 1002, 730, 687 cm^{-1}.

3-(1,1-Dimethyl-allyl)-3-(4-dimethylamino-2-methoxy-phenyl)-1,3-dihydro-indol-2-one (4e)



To a flame dried sealed tube (13 x 100 mm) capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) and *N*,*N*-dimethyl-*m*-anisidine (48.5 μL, 0.3 mmol, 300 mol %) was added in quick succession and the septum was replaced with a screw cap. The reaction mixture was allowed to stir vigorously (1000-1200 rpm) for 48 h, at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4 to 1:1) provided the title compound (23.6 mg) as a yellow solid in 67% yield. Crystallization from ether-pentane (chamber method) provided light yellow crystals.

<<Note: Compound **4e** was isolated as mixture of rotomers>>

M.P. = 167-169 °C (crystals from ether-pentane)

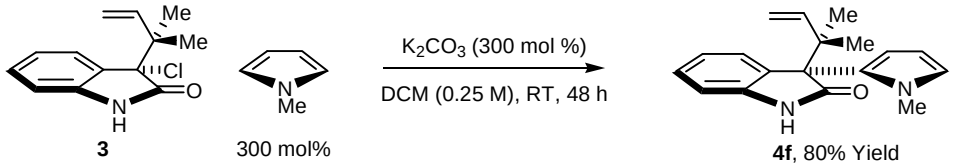
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.50 (broad, s, 1H), 7.86 (d, *J* = 8.2 Hz, 1H), 7.11 (ddd, *J* = 8.2, 1.2 Hz, 1H), 6.90-6.82 (m, 3H), 6.72 (m, 1H), 6.30-6.27 (dd, *J* = 8.8 Hz and 2.6 Hz, 1H), 6.12 (d, *J* = 2.6 Hz, 1H), 5.27 (d, *J* = 17.6 Hz, 1H), 5.15 (d, *J* = 10.8 Hz, 1H), 3.59 (s, 3H), 2.89 (s, 6H), 1.26 (broad, s, 6H).

^{13}C NMR (100 MHz, $CDCl_3$/ DMSO): δ 183.3, 158.9, 150.9, 142.8, 133.6, 127.3, 126.3, 121.3, 117.8, 111.8, 108.6, 104.5, 98.6, 66.1, 59.2, 55.8, 41.9, 40.7, 31.8, 22.9, 22.7.

HRMS (CI): Calcd. $C_{22}H_{27}N_2O_2$ (M+H) 351.2073, Found: 351.2068

FTIR ($CDCl_3$): 3209, 3080, 2978, 2935, 1702, 1613, 1561, 1513, 11469, 1441, 1415, 1380, 1360, 1324, 1287, 1243, 1213, 1162, 1121, 1098, 1061, 1033, 983, 955, 908, 868, 814, 791, 759, 729, 683 cm^{-1}.

3-(1,1-Dimethyl-allyl)-3-(1-methyl-1H-pyrrol-2-yl)-1,3-dihydro-indol-2-one (4f)



To a flame dried sealed tube (13 x 100 mm) capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) and *N*-methylpyrrole (26.6 µL, 0.3 mmol, 300 mol %) was added in quick succession and the septum was replaced with a screw cap. The reaction mixture was allowed to stir vigorously for 48 h., at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4 to 1:1) provided the title compound (22.4 mg) as an orange residue in 80% yield.

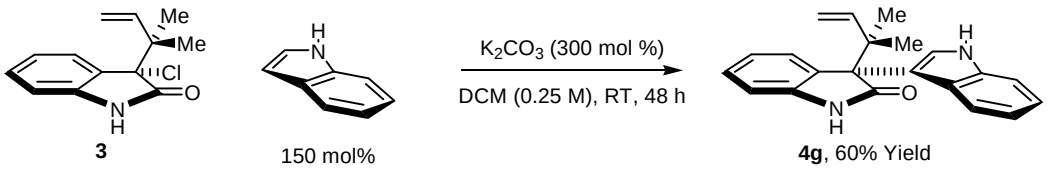
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.65 (broad, s, 1H), 7.22 (m, 2H), 6.89 (d, *J* = 7.6 Hz, 1H), 6.65 (m, 2H), 6.40 (m, 1H), 6.03 (m, 1H), 5.18 (d, *J* = 17.6 Hz, 1H), 5.12 (d, *J* = 11.2 Hz, 1H), 2.90 (s, 3H), 1.33 (s, 3H), 1.24 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 181.7, 145.4, 142.3, 132.2, 129.3, 128.9, 127.8, 124.6, 123.1, 113.8, 113.3, 110.5, 106.8, 60.4, 44.1, 35.1, 23.9, 21.7.

HRMS (CI): Calcd. For $C_{18}H_{20}N_2O$ (M+H) 281.1654, Found: 281.1651.

FTIR ($CDCl_3$): 3246, 2976, 1703, 1616, 1469, 1413, 1382, 1365, 1323, 1301, 1222, 1185, 1160, 1097, 1021, 911, 750, 731, 672 cm^{-1}.

3-(1,1-Dimethyl-allyl)-1,3-dihydro-1'H-[3,3']biindolyl-2-one (4g)



To a flame dried sealed tube (13 x 100 mm) charged with indole (17.6 mg, 0.15 mmol, 150 mol %), capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) was added and the septum was quickly replaced with a screw cap. The reaction mixture was allowed to stir vigorously for 48 h, at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4 to 1:1) provided the title compound (19 mg) as a reddish solid in 60% yield. Crystallization from DCM-hexane (layer method) delivered pink crystals.

M.P. = 119-121 °C (crystals from DCM-hexanes)

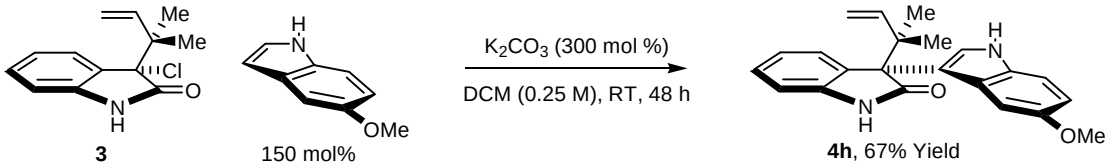
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.36 (broad, s, 1H), 8.14 (broad, s, 1H), 7.53 (d, *J* = 2.8 Hz, 1H), 7.32-7.18 (m, 4H), 7.06 (t, *J* = 7.2 Hz, 1H), 6.94 (t, *J* = 7.6 Hz, 1H), 6.88 (m, 2H), 6.59 (dd, *J* = 17.8 and 11.2 Hz, 1H), 5.25 (d, *J* = 17.8 Hz, 1H), 5.14 (d, *J* = 11.2 Hz, 1H), 1.32 (s, 3H), 1.30 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 180.9, 145.4, 141.2, 136.4, 133, 128.1, 127.4, 126.9, 126, 122.1, 121.9, 121.6, 120, 112.7, 112.2, 111.2, 110, 59.3, 43.6, 24.8, 22.7.

HRMS (CI): Calcd. for $C_{21}H_{20}N_2O$ (M+H) 317.1654, Found: 317.1649.

FTIR ($CDCl_3$): 3293, 2971, 2927, 2160, 2031, 1976, 1701, 1654, 1618, 1559, 1541, 1522, 1508, 1486, 1471, 1458, 1375, 1326, 1214, 1102, 1016, 911, 747, 669 cm^{-1}.

3-(1,1-Dimethyl-allyl)-5'-methoxy-1,3-dihydro-1'H-[3,3']biindolyl-2-one (4h)



To a flame dried sealed tube (13 x 100 mm) charged with 5-methoxyindole (22.1 mg, 0.15 mmol, 150 mol %), capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) was added and the septum was replaced with a screw cap. The reaction mixture was allowed to stir vigorously for 48 h, at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4 to 1:1) provided the title compound (23.2 mg) as a purple solid in 67% yield. Crystallization from DCM-hexanes (layer method) delivered lavender needles.

M.P. = 118-119 °C (crystals from DCM-hexanes)

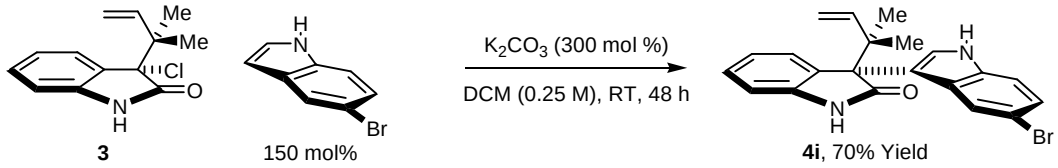
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.67 (broad, s, 1H), 8.08 (broad, s, 1H), 7.49 (d, *J* = 2.4 Hz, 1H), 7.29 (d, *J* = 7.2 Hz, 1H), 7.19 (ddd, *J* = 7.8 and 1.2 Hz, 1H), 7.10 (d, *J* = 8.8 Hz, 1H), 6.54 (ddd, *J* = 7.8 Hz and 1.2 Hz, 1H), 6.86 (d, *J* = 7.8 Hz, 1H), 6.72 (m, 2H), 6.62 (dd, *J* = 17.6 and 10.2 Hz, 1H), 5.16 (dd, *J* = 17.6 and 0.8 Hz, 1H), 5.12 (dd, *J* = 10.2 and 0.8 Hz, 1H) 3.56 (s, 3H), 1.30 (s, 3H), 1.29 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 180.9, 153.4, 145.1, 141.2, 132.8, 131.2, 127.9, 127.1, 127, 126.5, 121.6, 112.4, 111.9, 111.6, 111.2, 109.3, 103.1, 59.2, 55.3, 43.3, 24.6, 22.3.

HRMS (CI): Calcd. for $C_{22}H_{22}N_2O_2$ (M+H) 347.1760, Found: 347.1754.

FTIR ($CDCl_3$): 3298, 2934, 2160, 2031, 1977, 1701, 1654, 1618, 1559, 1541, 1507, 1485, 1471, 1375, 1327, 1289, 1216, 1178, 1099, 1031, 012, 798, 752, 731, 669 cm^{-1}.

5'-Bromo-3-(1,1-dimethyl-allyl)-1,3-dihydro-1'H-[3,3']biindolyl-2-one (4i)



To a flame dried sealed tube (13 x 100 mm) charged with 5-bromoindole (29.4 mg, 0.15 mmol, 150 mol %), capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added K_2CO_3 (41.5 mg, 0.3 mmol, 300 mol %). A freshly prepared solution of chloride **3** in DCM (0.25 M, 0.4 mL, 0.1 mmol, 100 mol %) was added and the septum was replaced with a screw cap. The reaction mixture was allowed to stir vigorously for 48 h, at which point the reaction mixture was concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4 to 1:1) provided the title compound (27.7 mg) as and orange solid in 70% yield. Crystallization from DCM-hexanes (layer method) delivered orange crystals.

M.P. = 218-220 °C (crystal from DCM-hexanes)

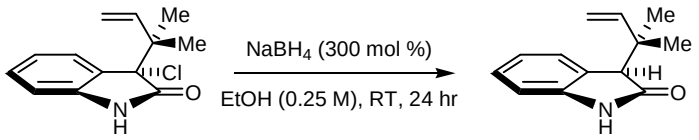
^{1}H NMR (400 MHz, DMSO): δ 11.25 (broad, s, 1H), 10.69 (broad, s, 1H), 7.54 (m, 2H), 7.28 (m, 3H), 7.14 (m, 1H), 6.95 (m, 2H), 6.41 (m, 1H), 5.11 (m, 2H), 1.23 (s, 3H), 1.21 (s, 3H).

^{13}C NMR (100 MHz, DMSO): δ 179.2, 145.8, 142.8, 136.1, 133.2, 129.4, 128.7, 128.6, 127.7, 125.2, 124.4, 121.6, 113.6, 112.7, 112.5, 111.9, 109.9, 59.2, 43.9, 23.1, 22.7.

HRMS (CI): Calcd. for $C_{21}H_{19}BrN_2O$ (M+H) 395.0759, Found:395.0759.

FTIR ($CDCl_3$): 3293, 2972, 2160, 2031, 1976, 1701, 1618, 1470, 1413, 1381, 1364, 1330, 1235, 1155, 1106, 1055, 1005, 910, 883, 864, 796, 777, 750, 735, 681 cm^{-1}.

3-(1,1-Dimethyl-allyl)-1,3-dihydro-indol-2-one (4j)



3 **4j**, 68% Yield

To a flame dried sealed tube (13 x 100 mm) charged with chloride **3** (23.5 mg, 0.1 mmol, 100 mol%), capped with a rubber septum and equipped with a magnetic stir bar under an atmosphere of argon was added $NaBH_4$ (19.5 mg, 0.3 mmol, 100 mol %) and absolute ethanol (0.4 mL). The septum was replaced with a screw cap and the reaction mixture was allowed to stir vigorously for 24 h, at which point brine (1 mL) and EtOAc (1 mL) were added to the reaction mixture. The organic layer was separated and the aqueous layer was extracted twice with EtOAc (1 mL). The combined organic extracts were diluted with DCM (10 mL), dried ($MgSO_4$), filtered and concentrated *in vacuo* onto silica gel. Purification by flash column chromatography (SiO_2, EtOAc:hexanes, 1:4) provided the title compound (13.6 mg) in 68% yield. Slow evaporation from chloroform delivered yellowish needles.

M.P. = 136-137 °C (crystals from chloroform)

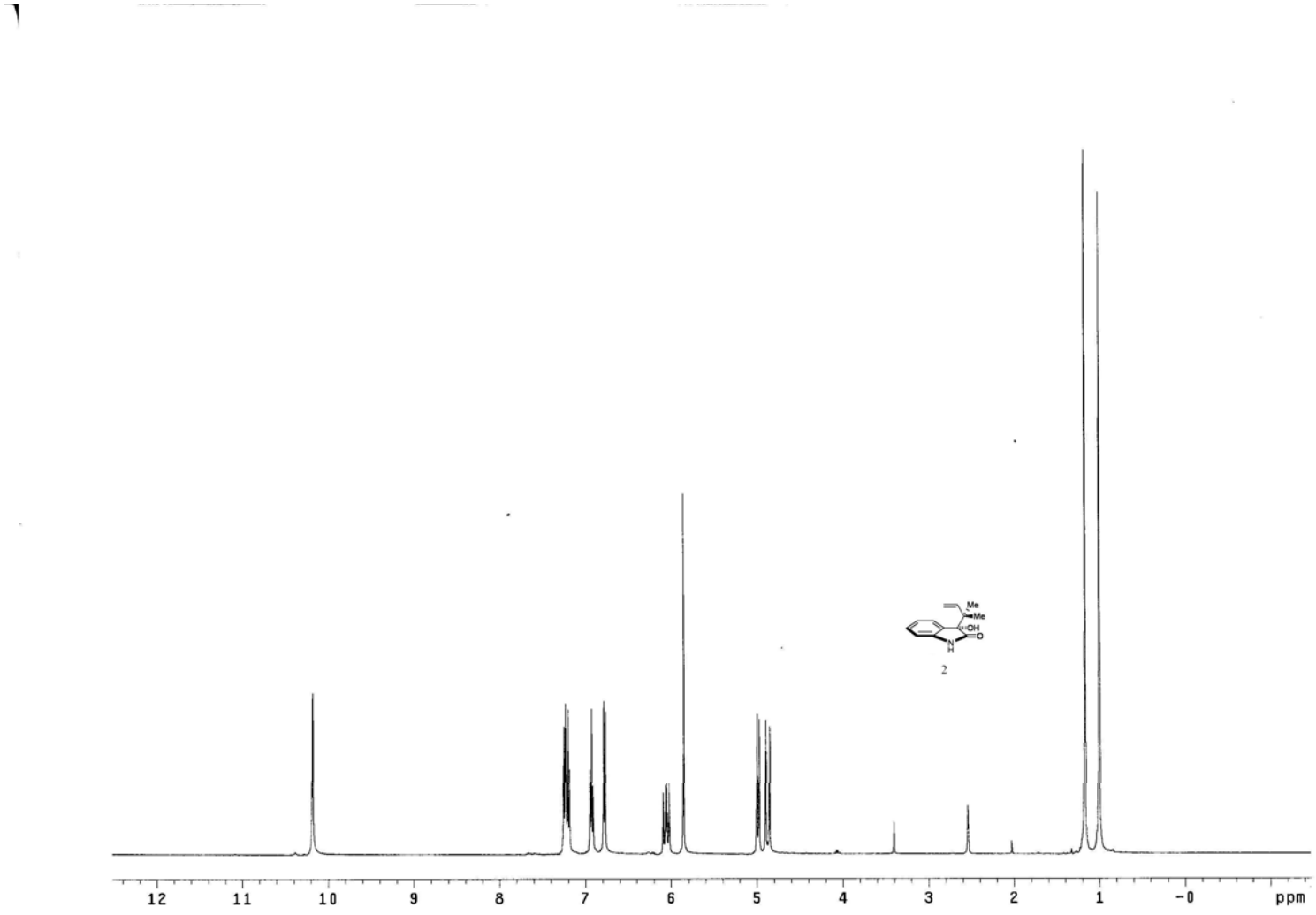
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.31 (broad, s, 1H), 7.30 (d, *J* = 7.6 Hz, 1H), 7.20 (t, *J* = 7.6 Hz, 1H), 6.95 (t, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 7.6 Hz, 1H), 5.99 (dd, *J* = 17.6, and 10.6 Hz, 1H), 5.06 (d, *J* = 10.6 Hz, 1H), 4.98 (d, *J* = 17.6 Hz, 1H), 3.25 (s, 1H), 1.35 (s, 3H), 1.12 (s, 3H).

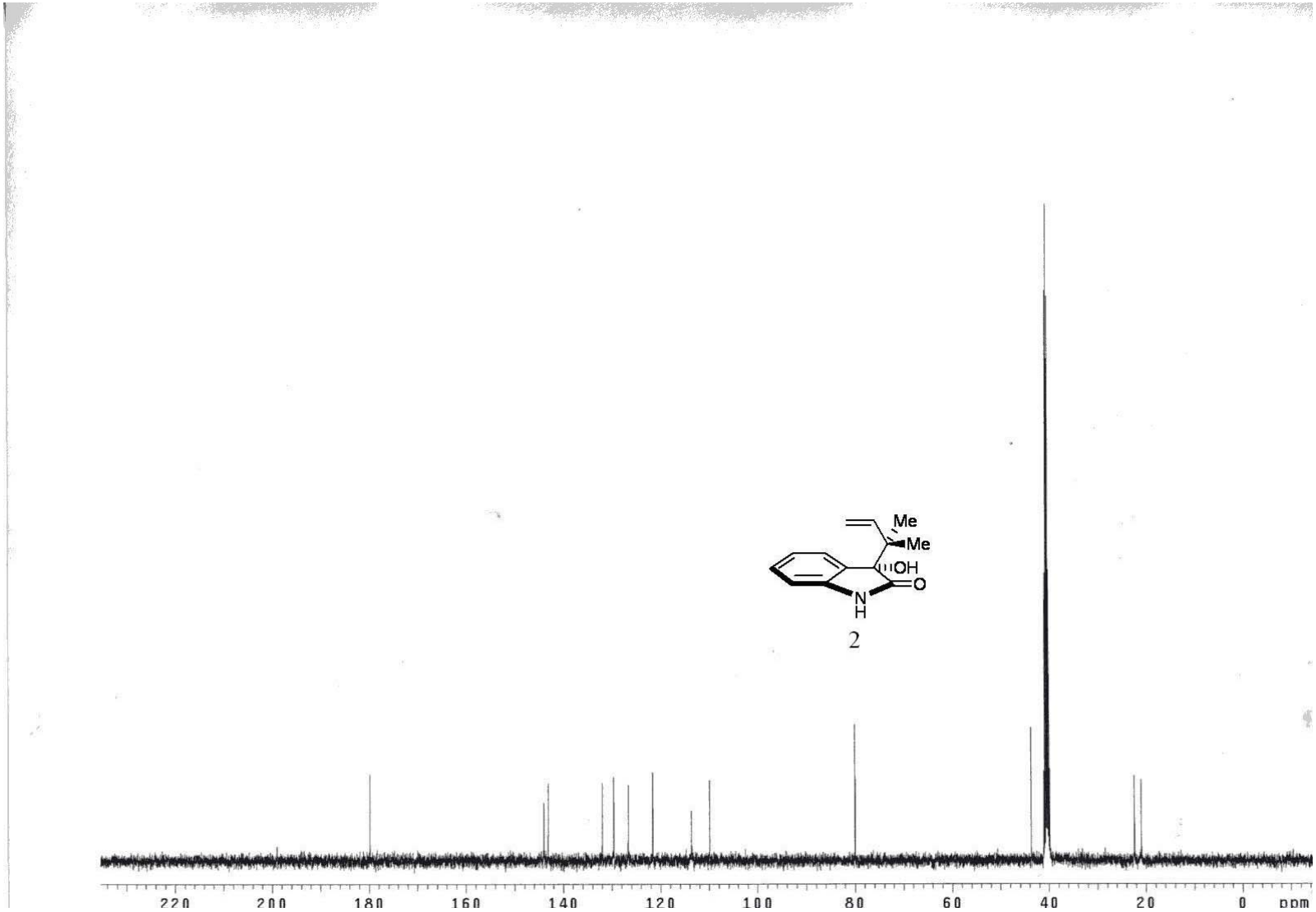
^{13}C NMR (100 MHz, $CDCl_3$): δ 178.8, 145.5, 142.2, 128.2, 127.9, 126.6, 121.7, 112.8, 109.5, 55, 40.8, 25.9, 22.6.

HRMS (CI): Calcd. For $C_{13}H_{15}NO$ (M+H) 202.1232, Found: 202.1231.

FTIR ($CDCl_3$): 3214, 3084, 2964, 2160, 1701, 1619, 1596, 1486, 1471, 1414, 1381, 1364, 1332, 1299, 1233, 1167, 1101, 1002, 916, 750, 731, 679 cm^{-1}.

IV. NMR Spectra of Novel Compounds





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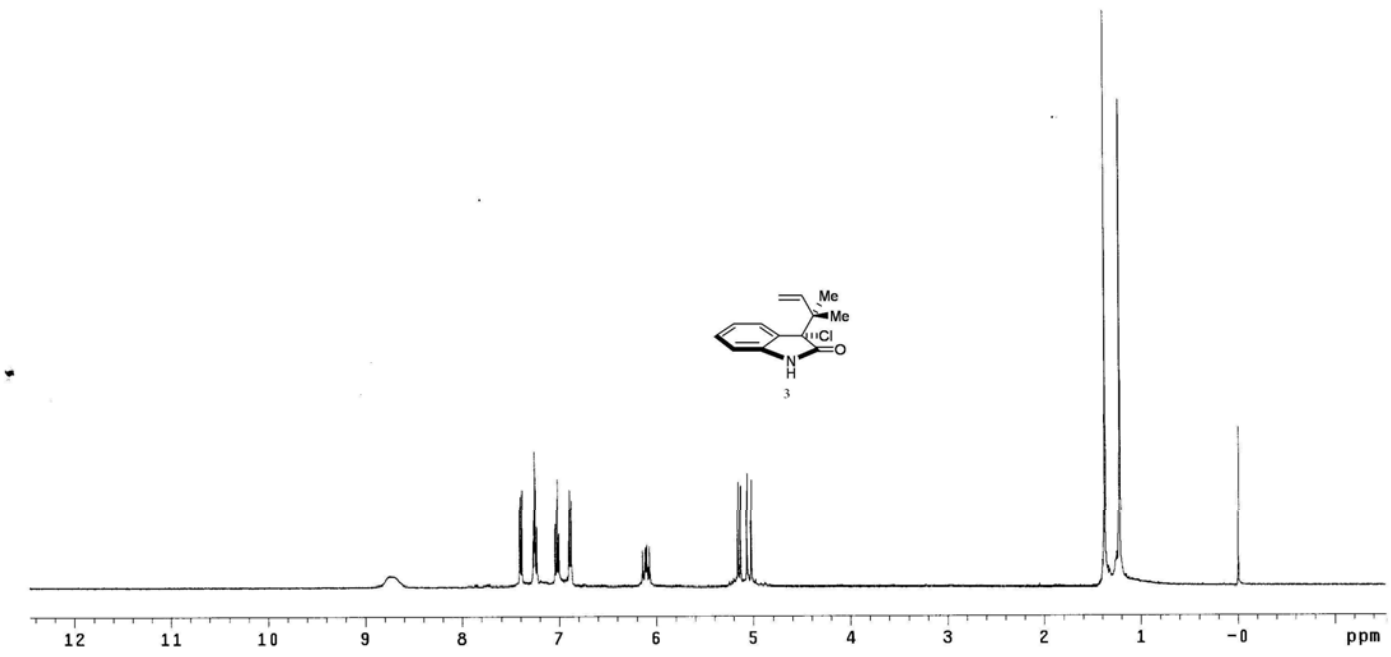
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-0
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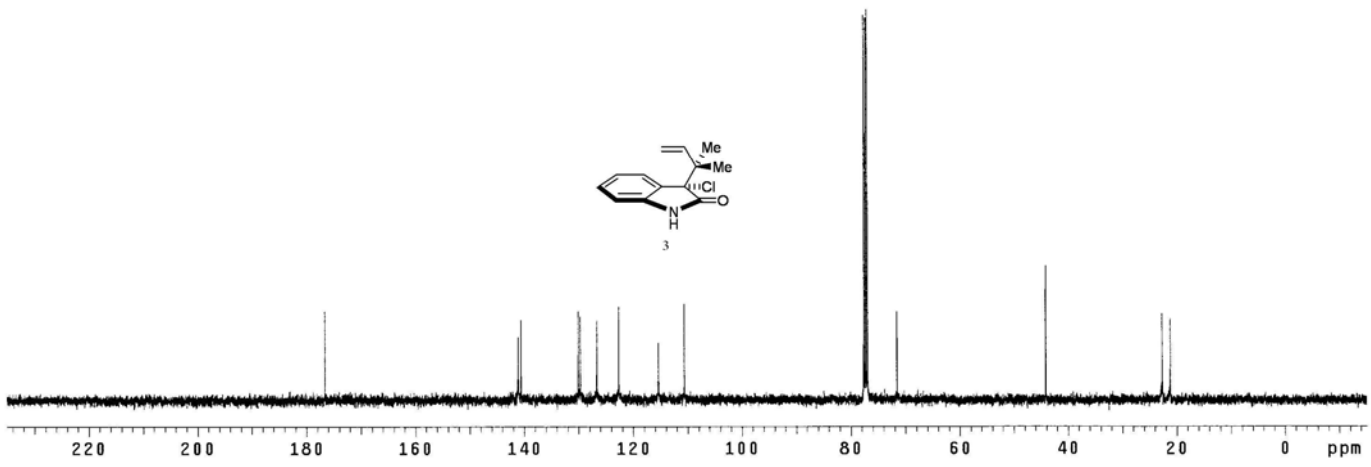
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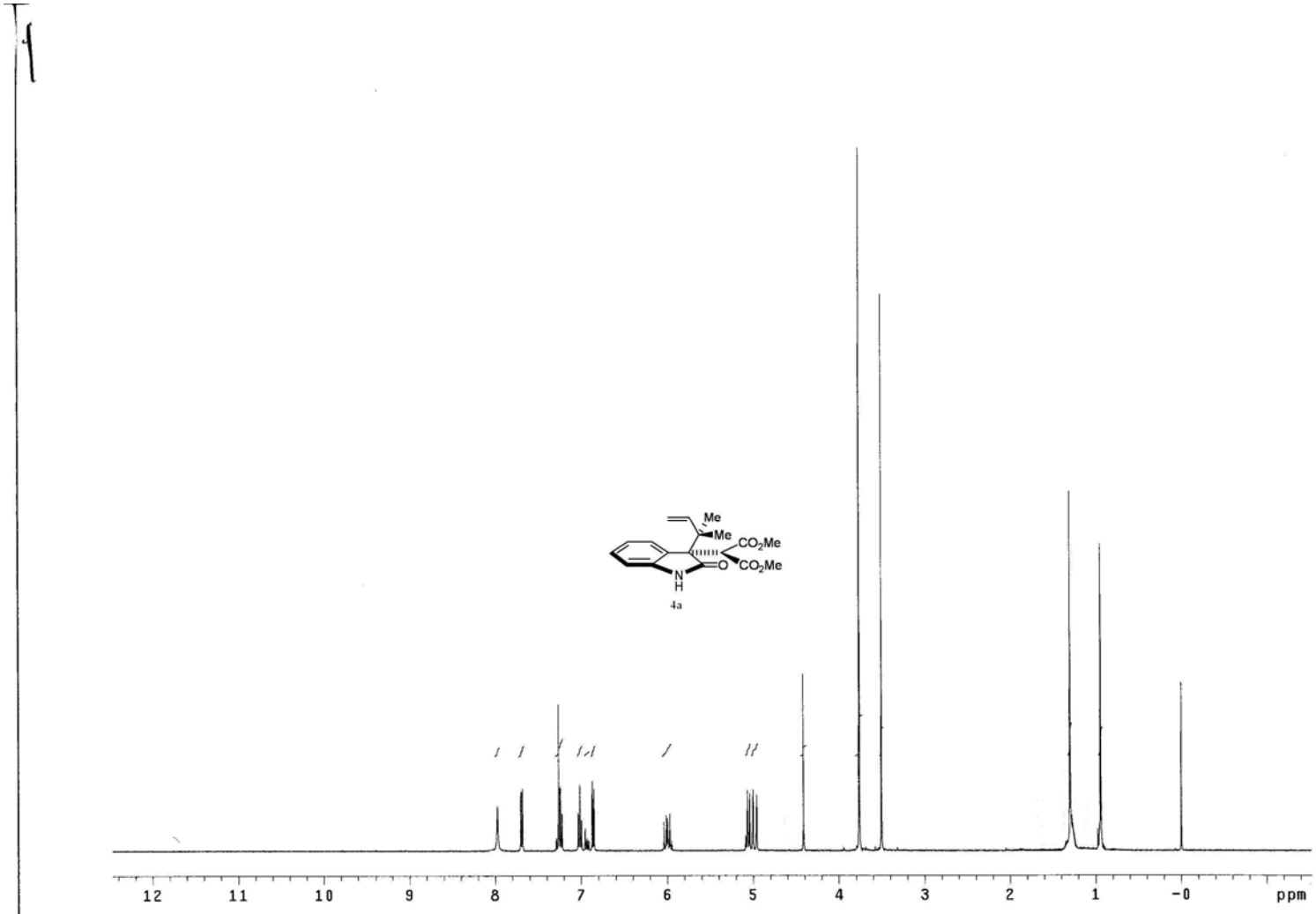
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CO2Me
O
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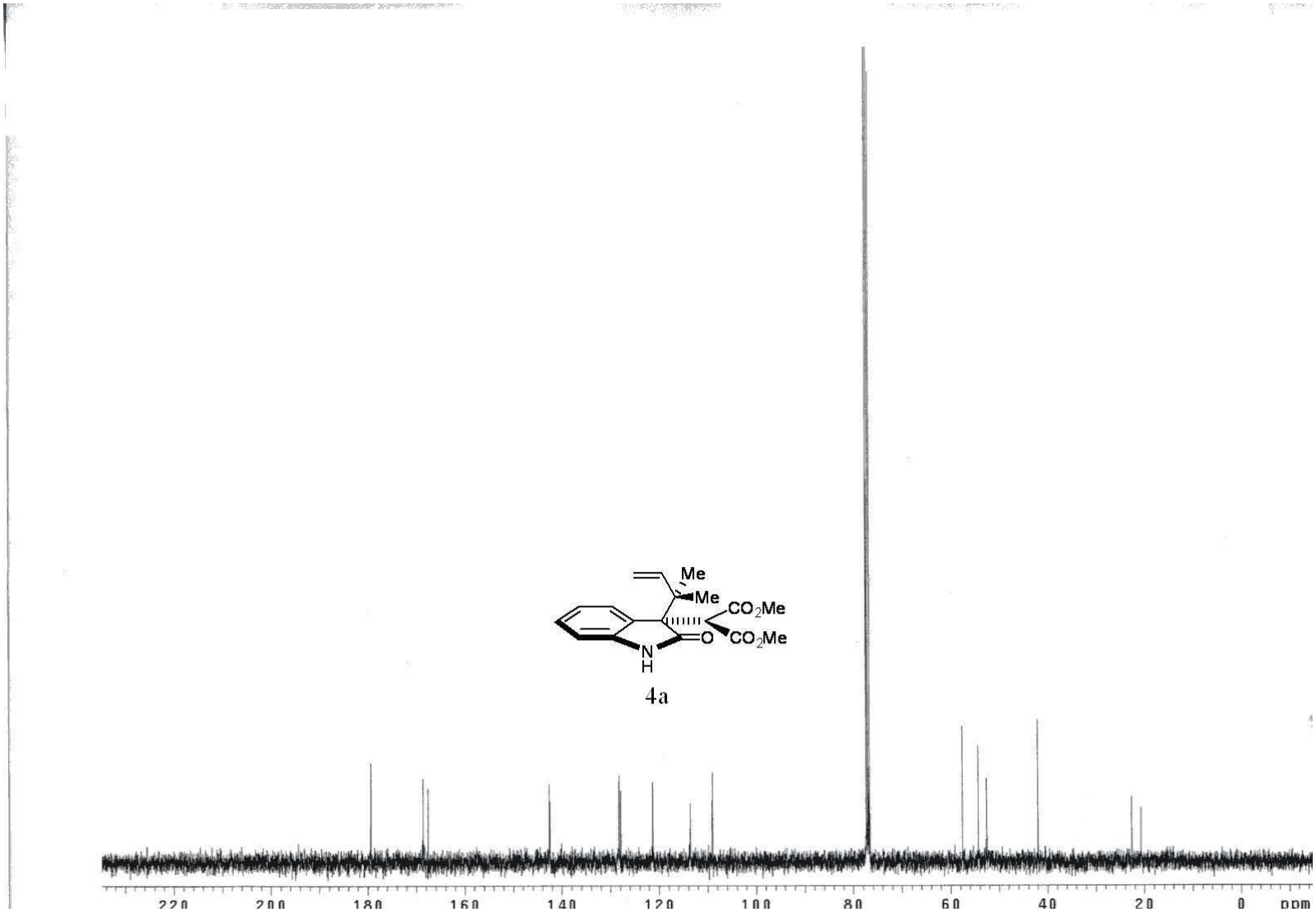
-0
ppm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O
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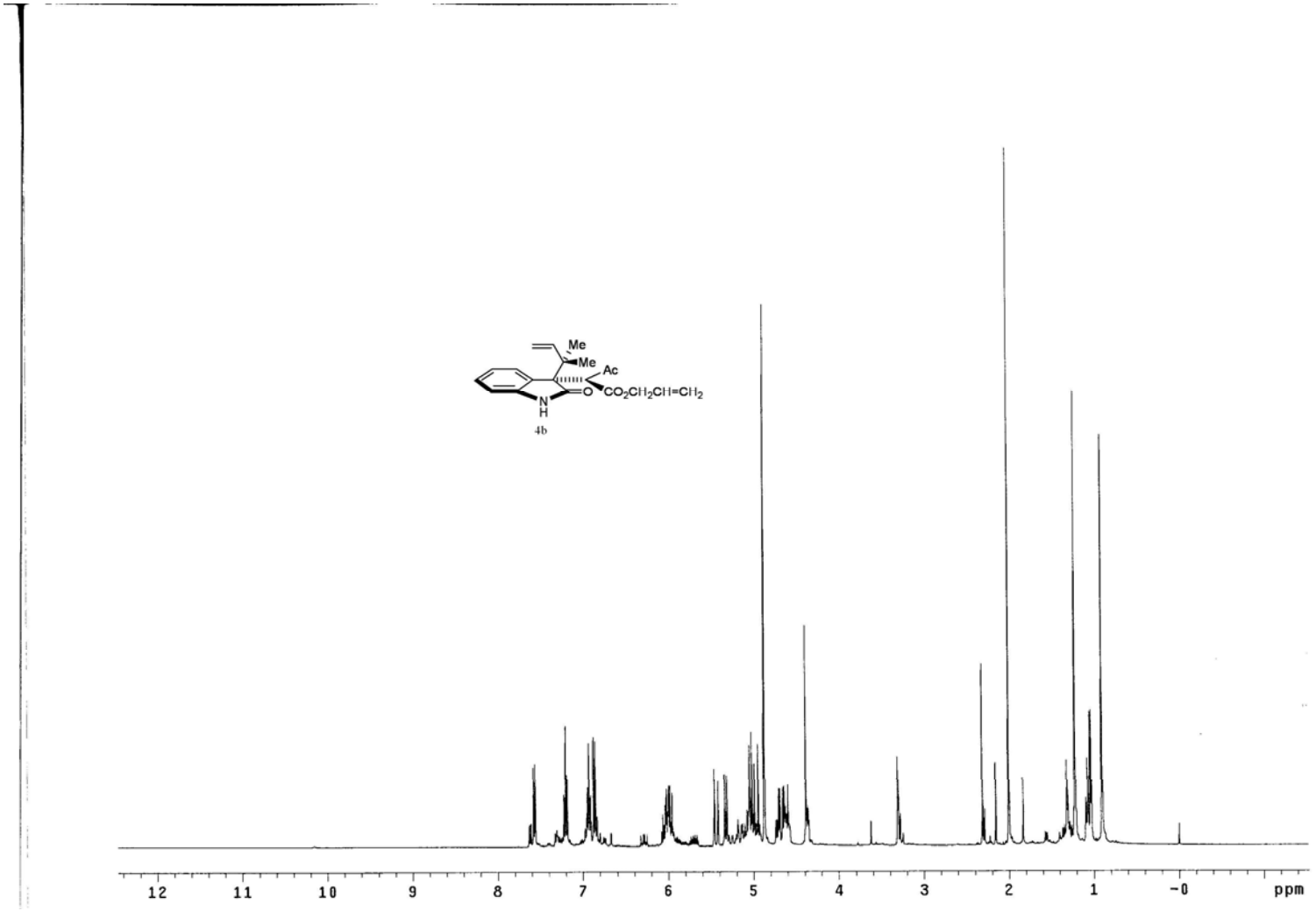
ppm

4a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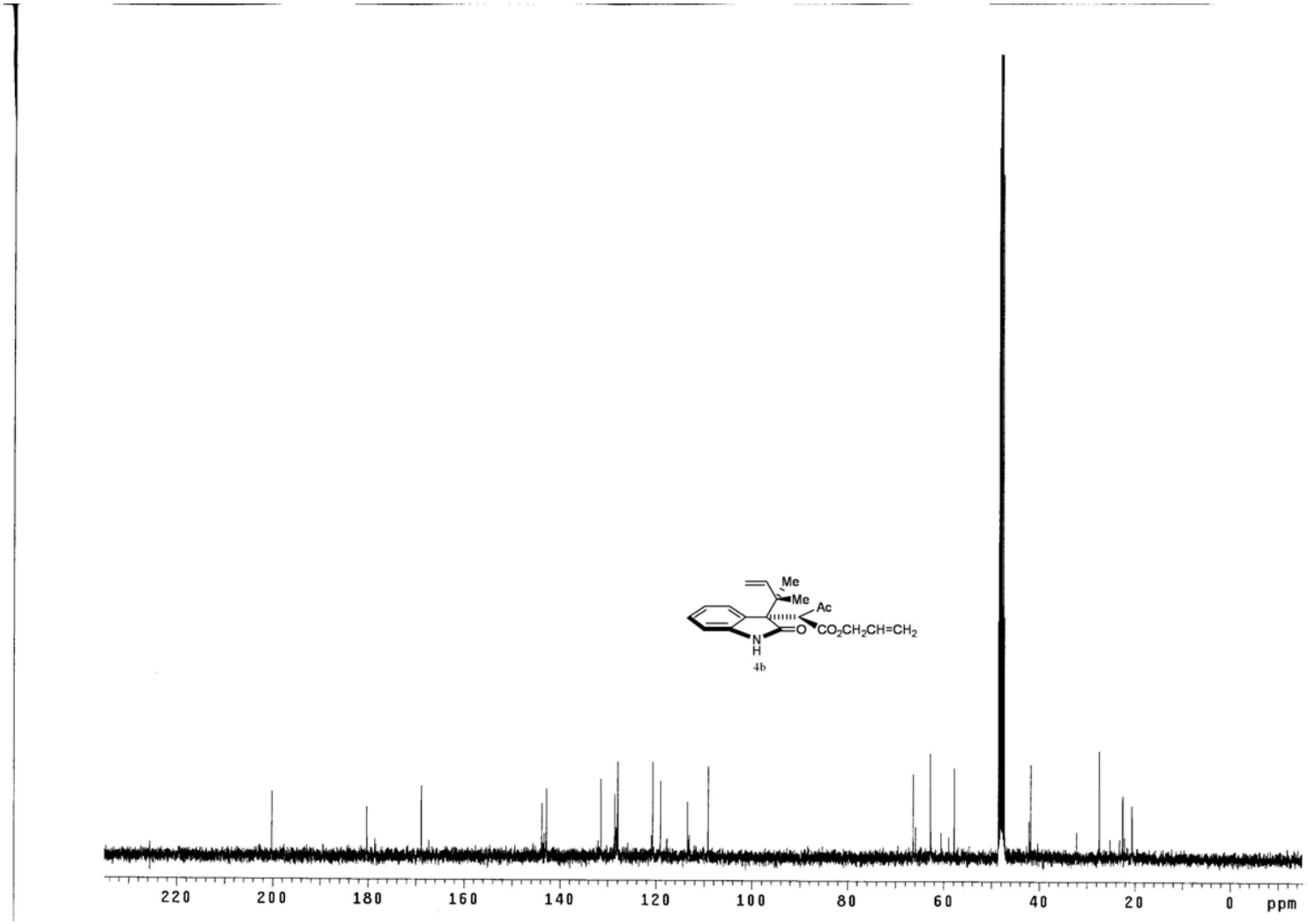
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CO2CH2CH=CH2
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H
4b
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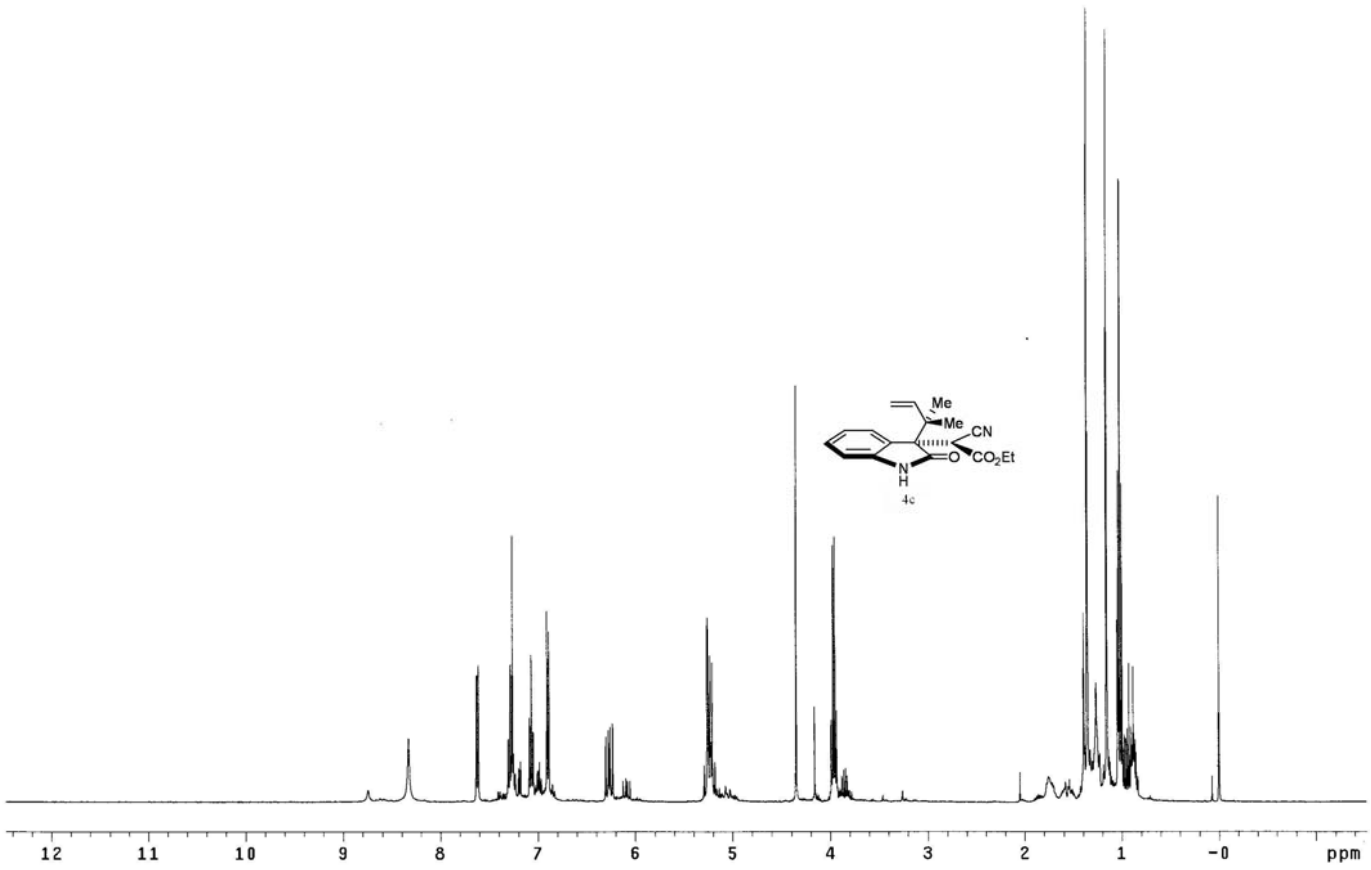
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CO2Et
O
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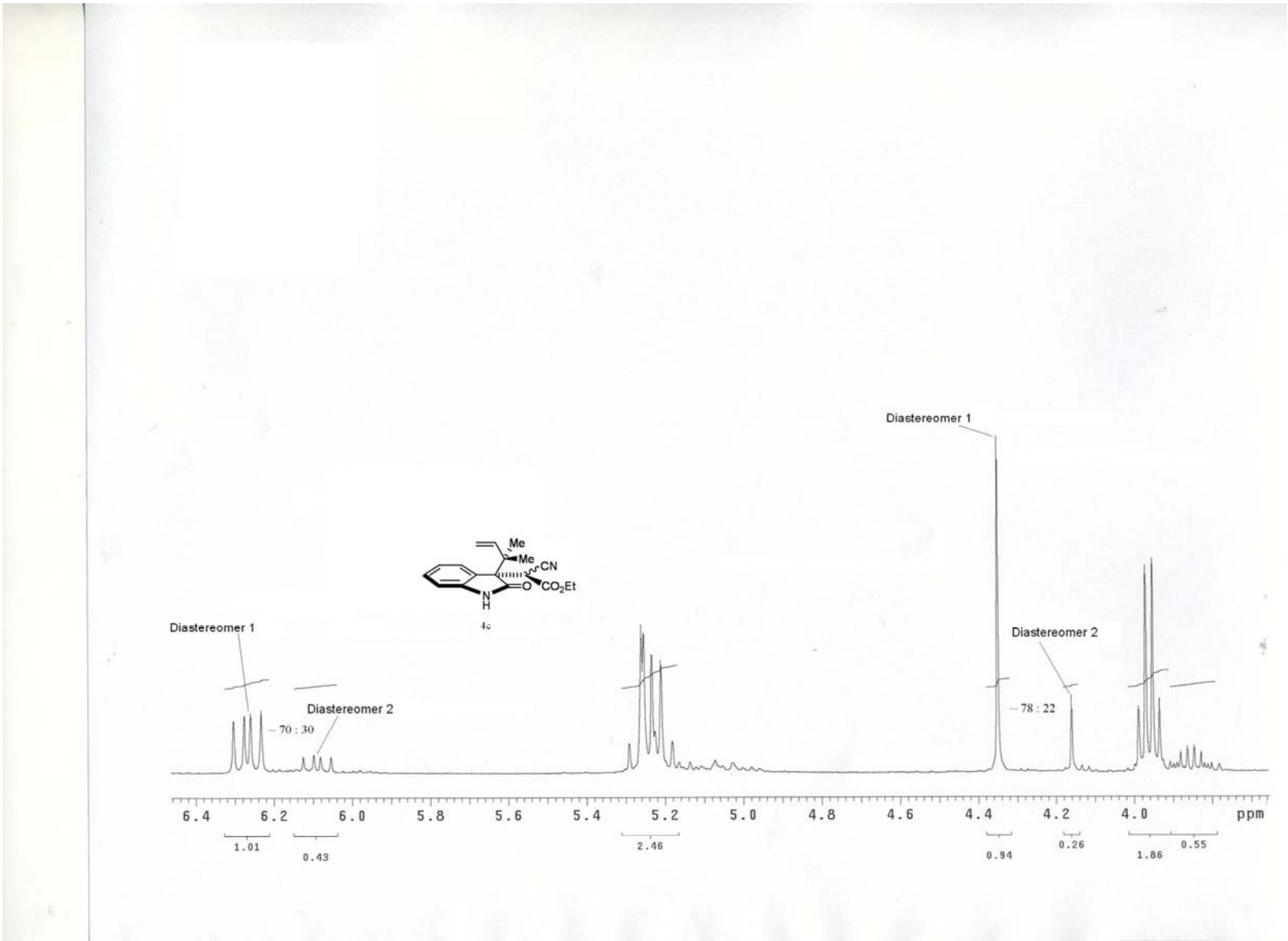
ppm


Diastereomer 1
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Me
CN
CO2Et
O
N
H
4c
Diastereomer 1
Diastereomer 2
~ 70 : 30
Diastereomer 2
~ 78 : 22
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
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4.2
4.0
ppm
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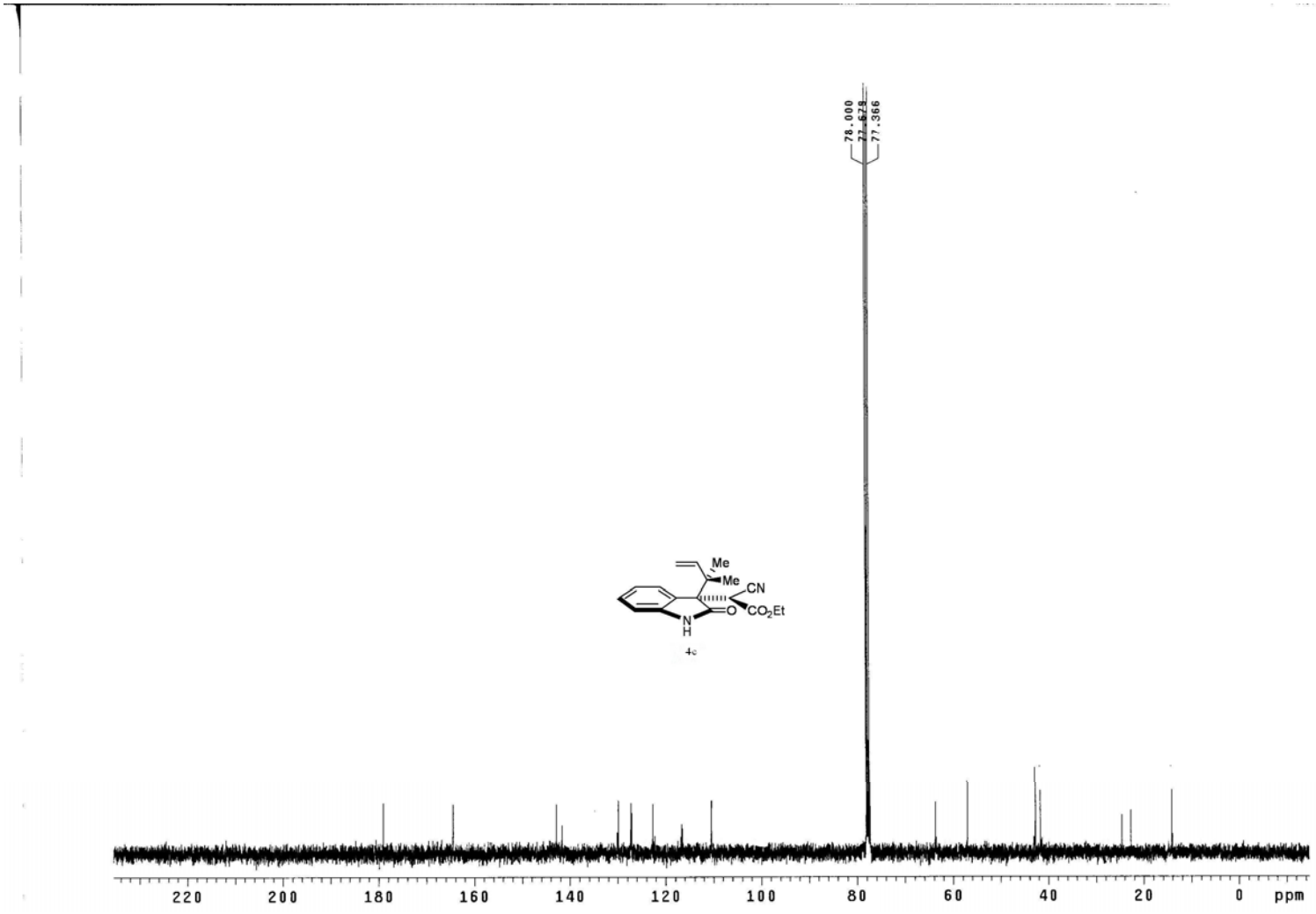
1.86
0.55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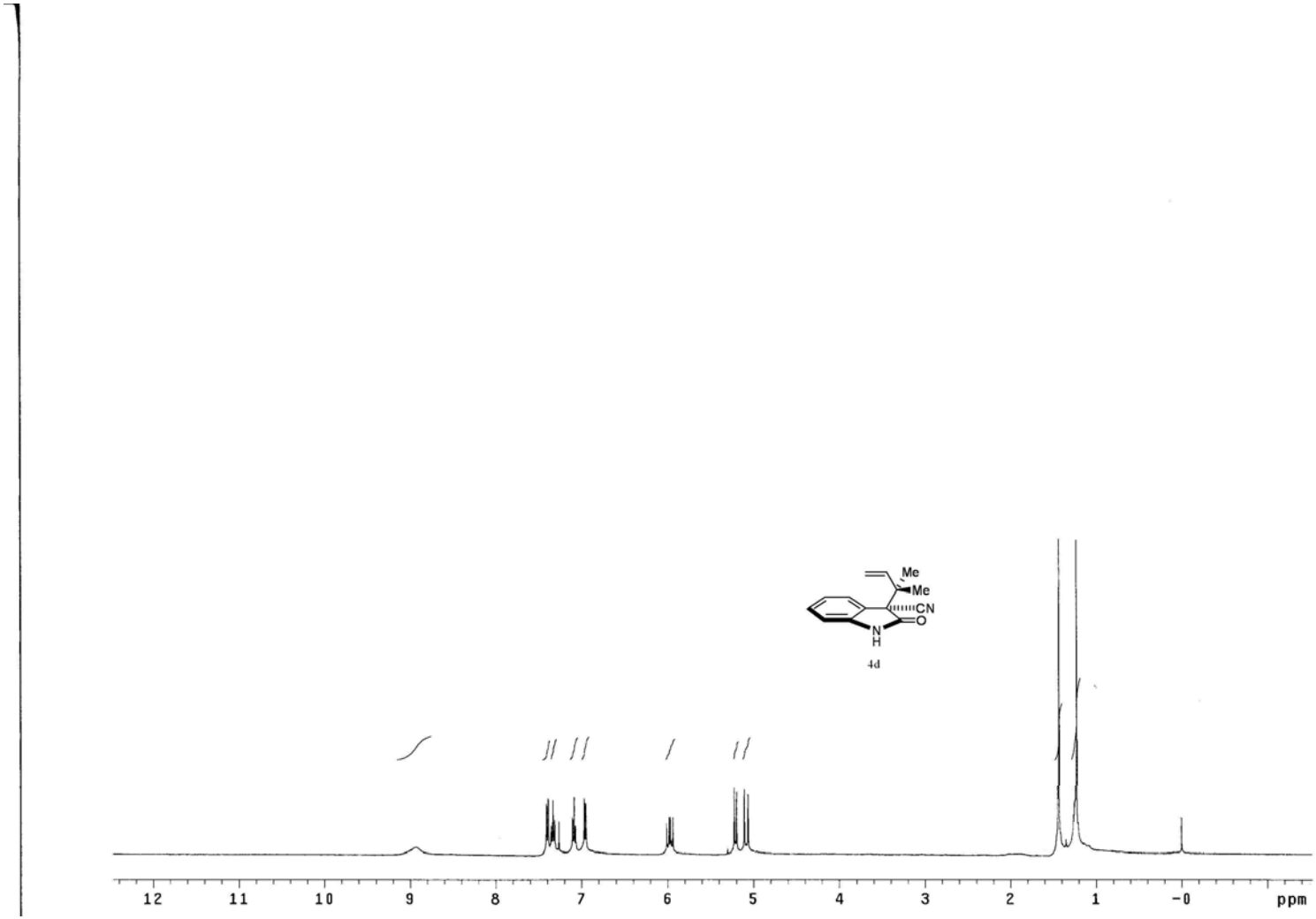
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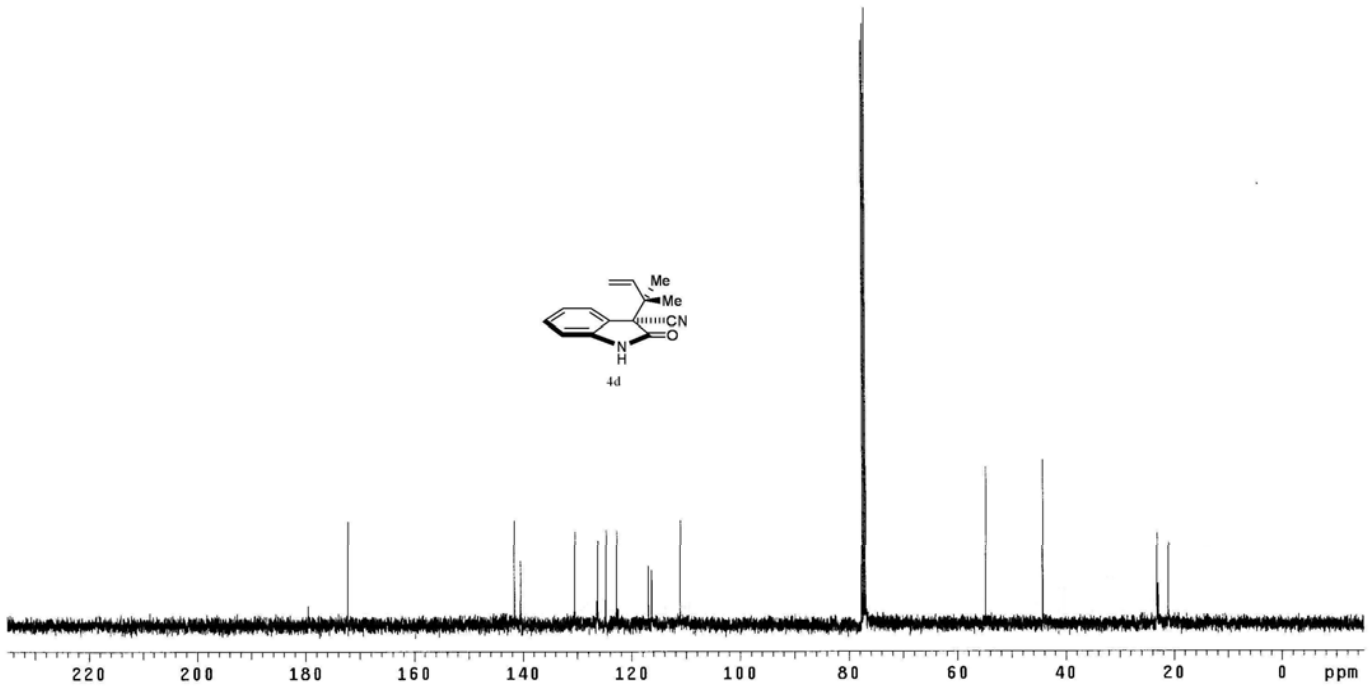
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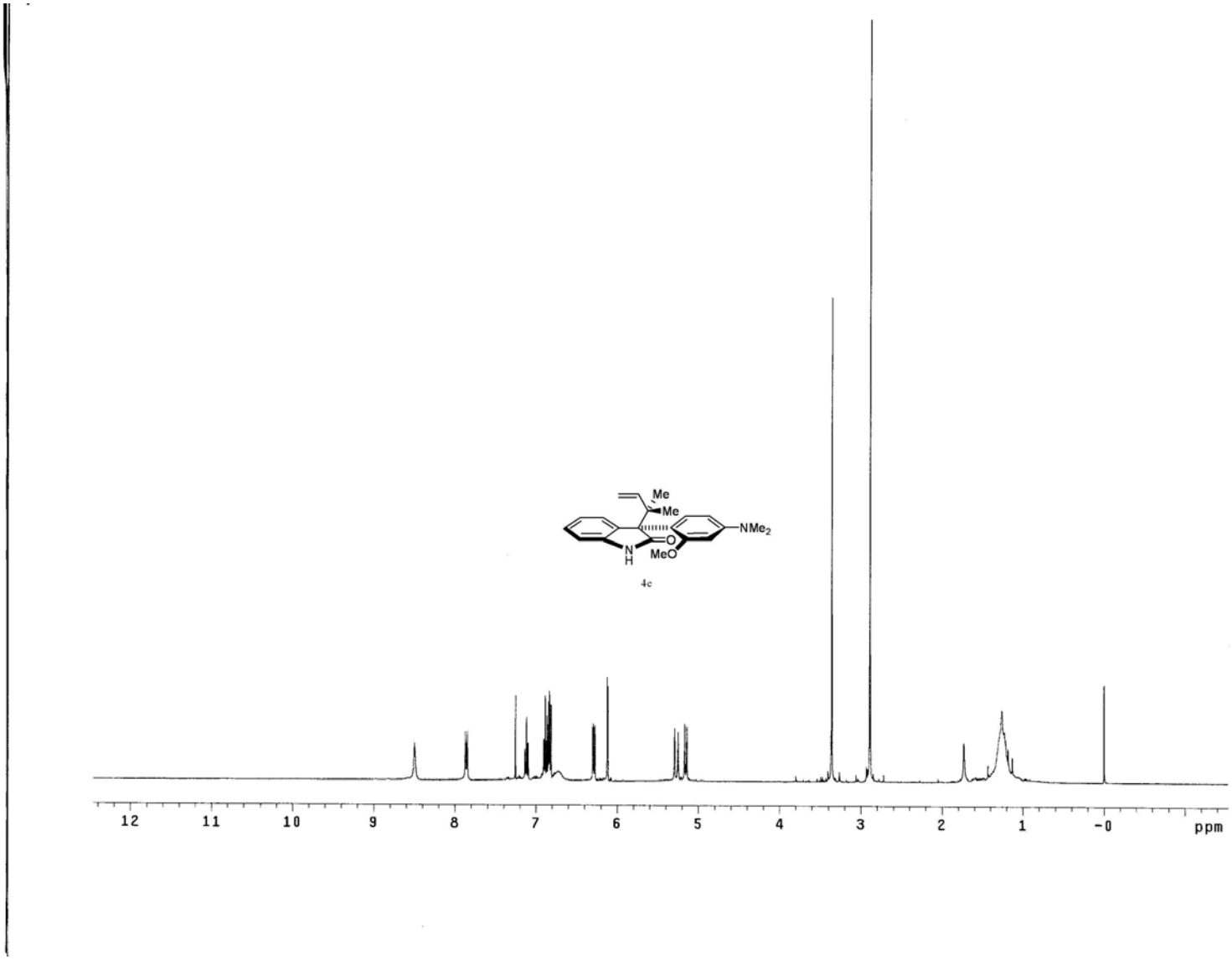
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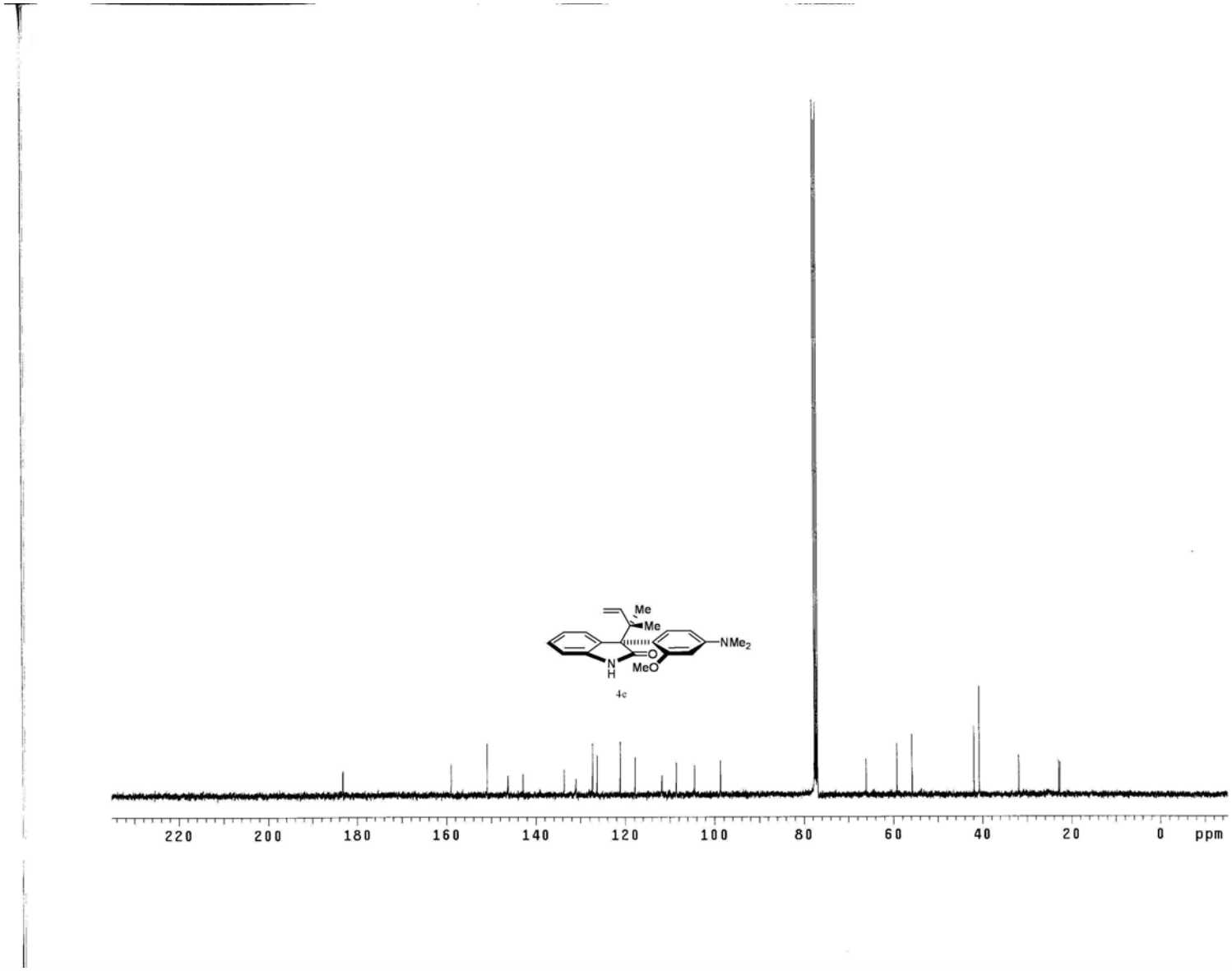
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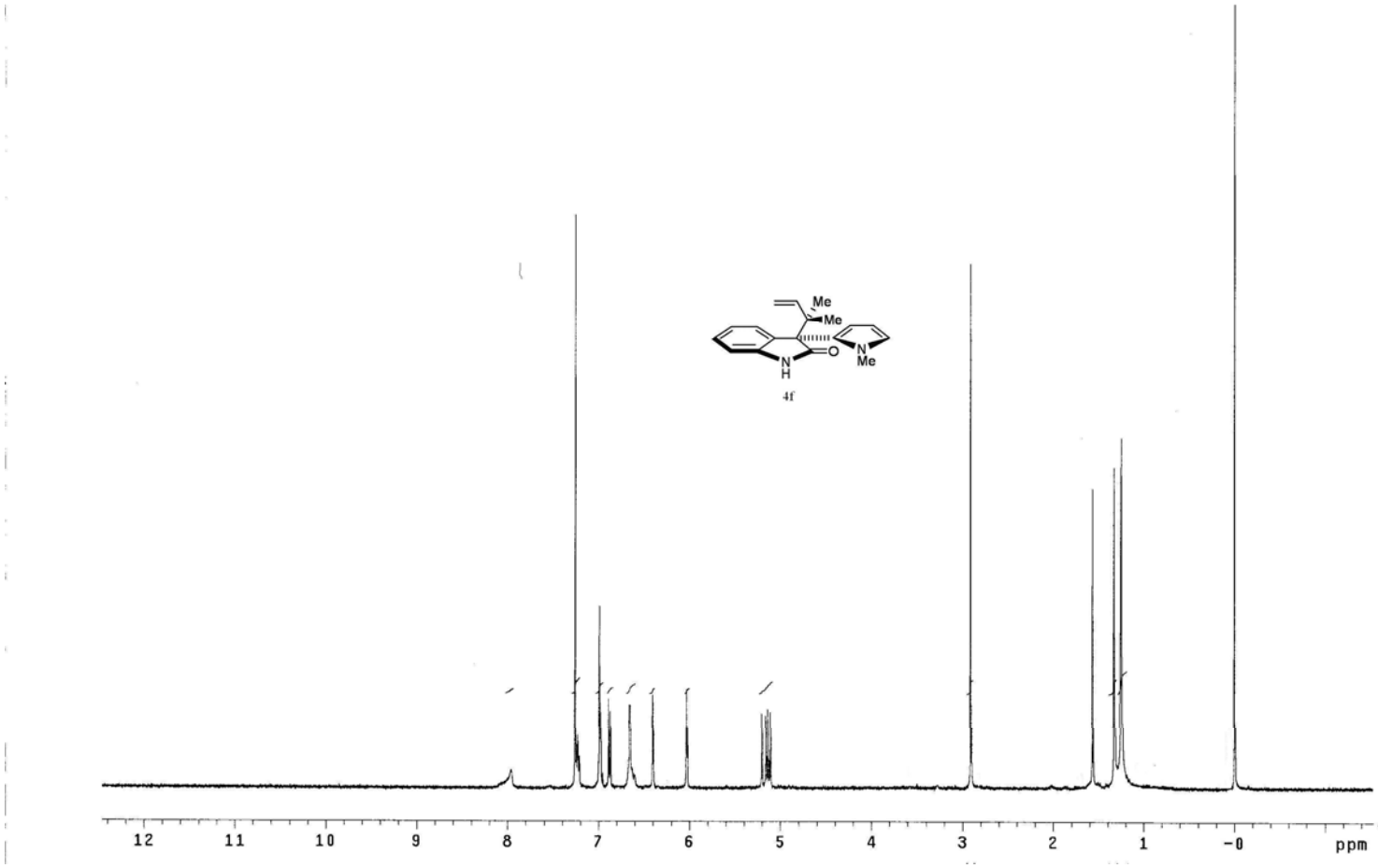
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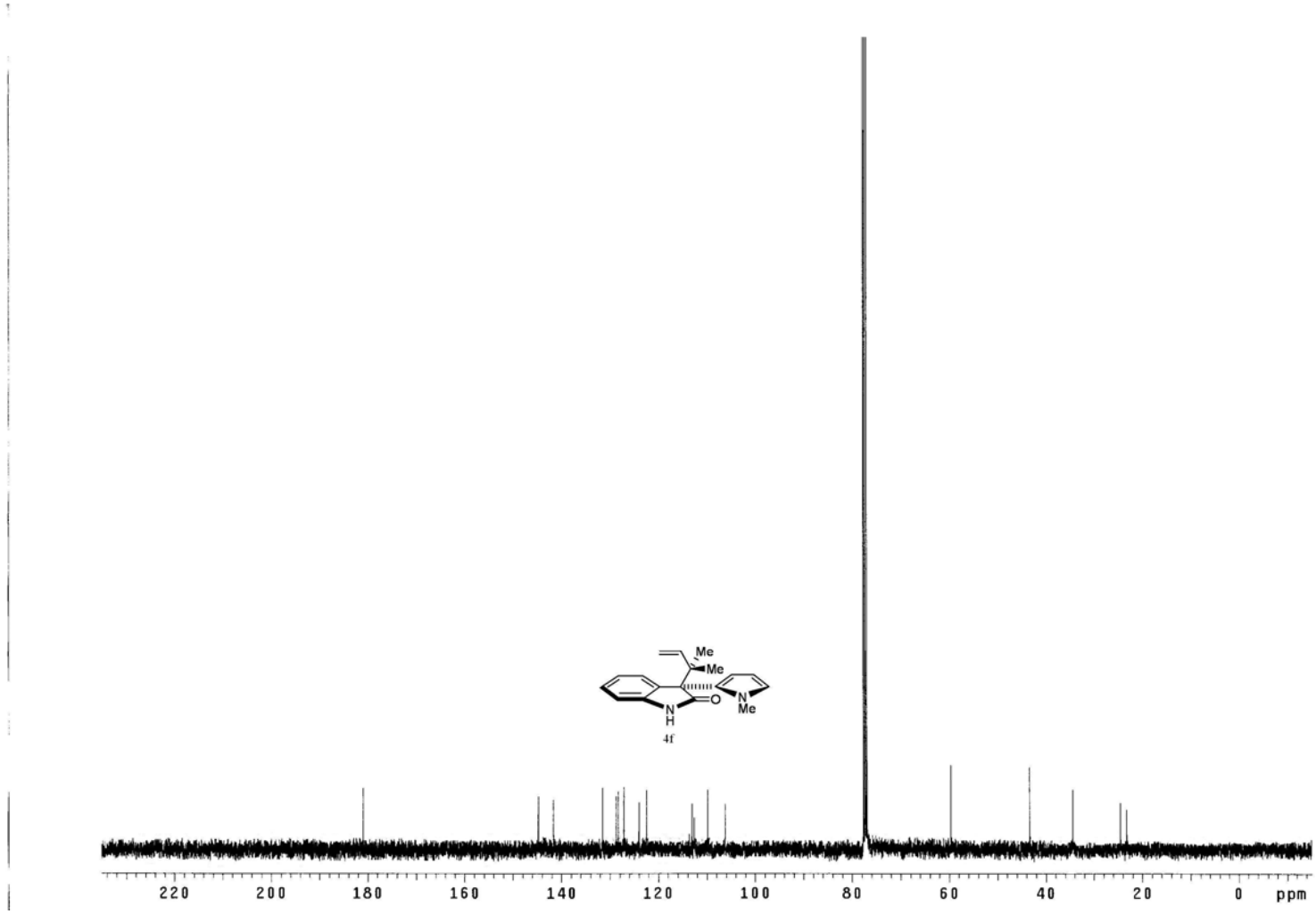
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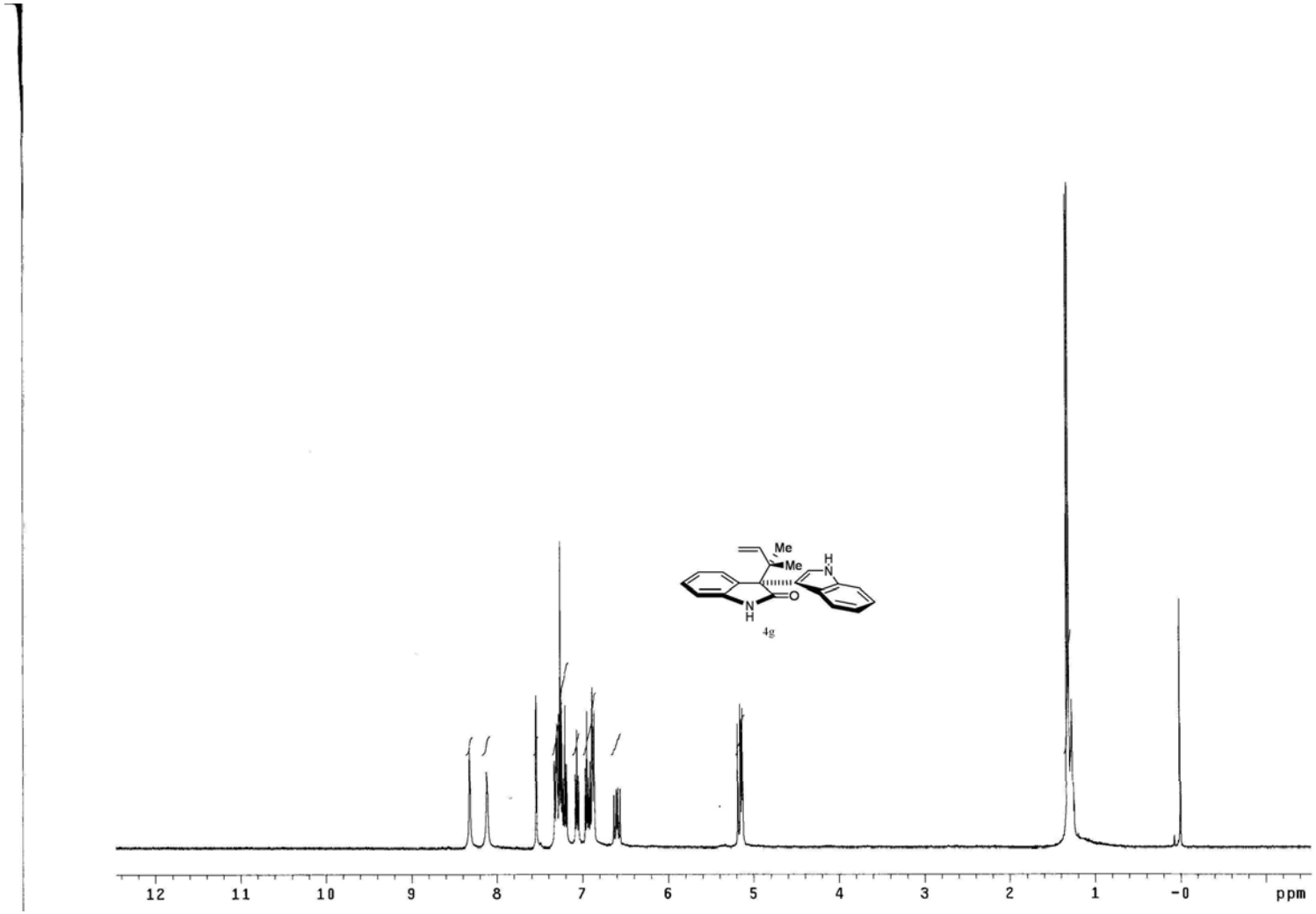
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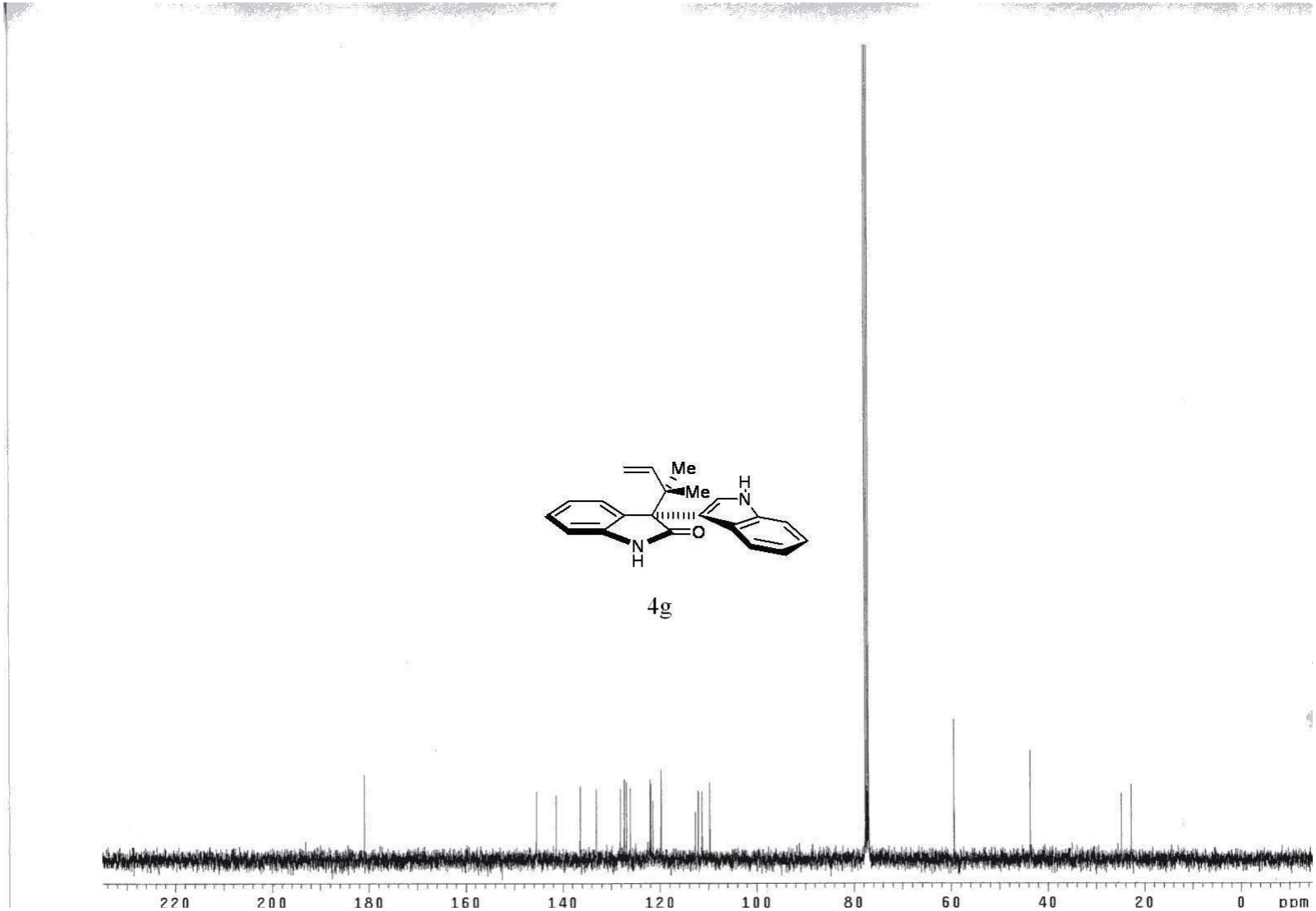

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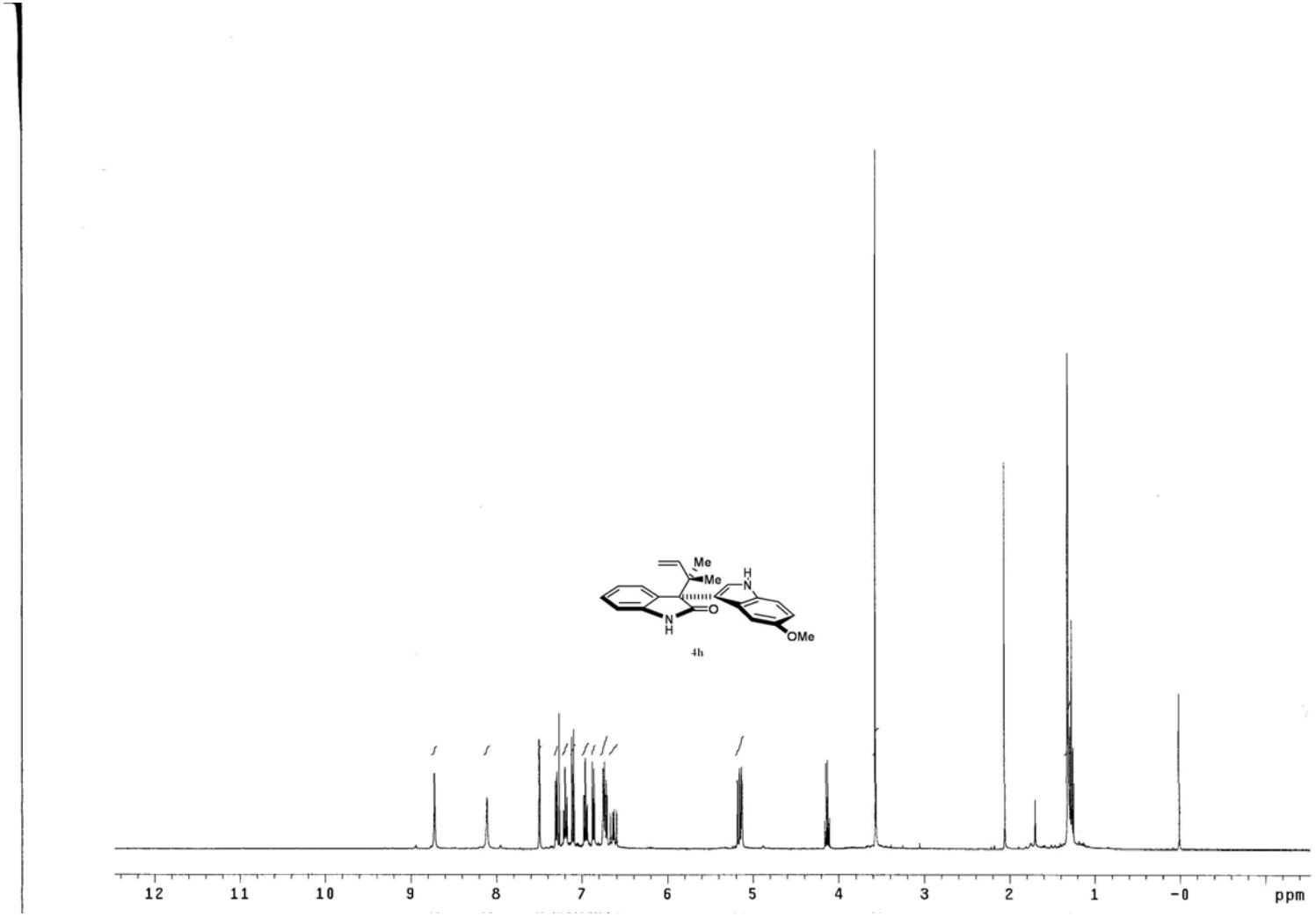
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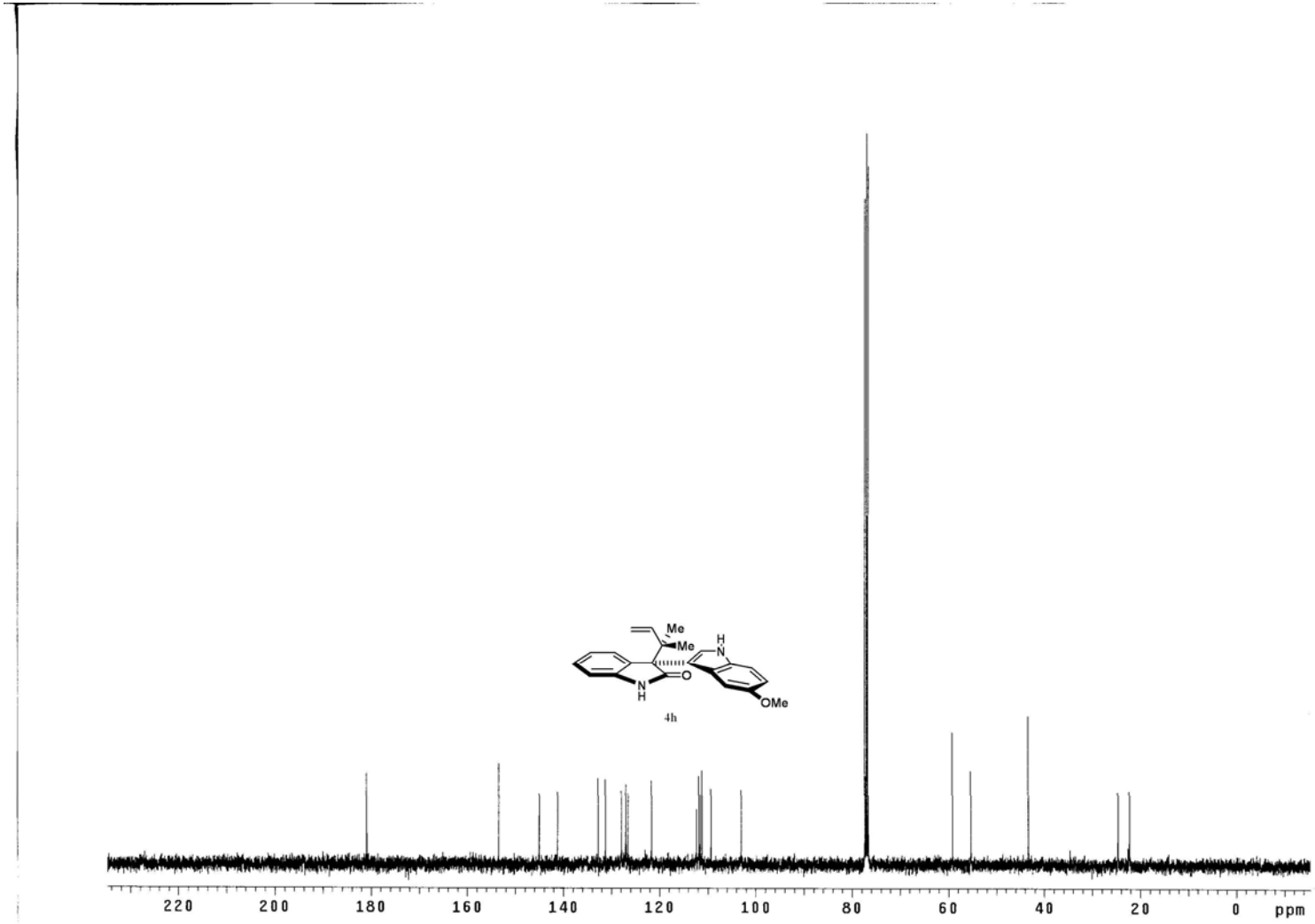
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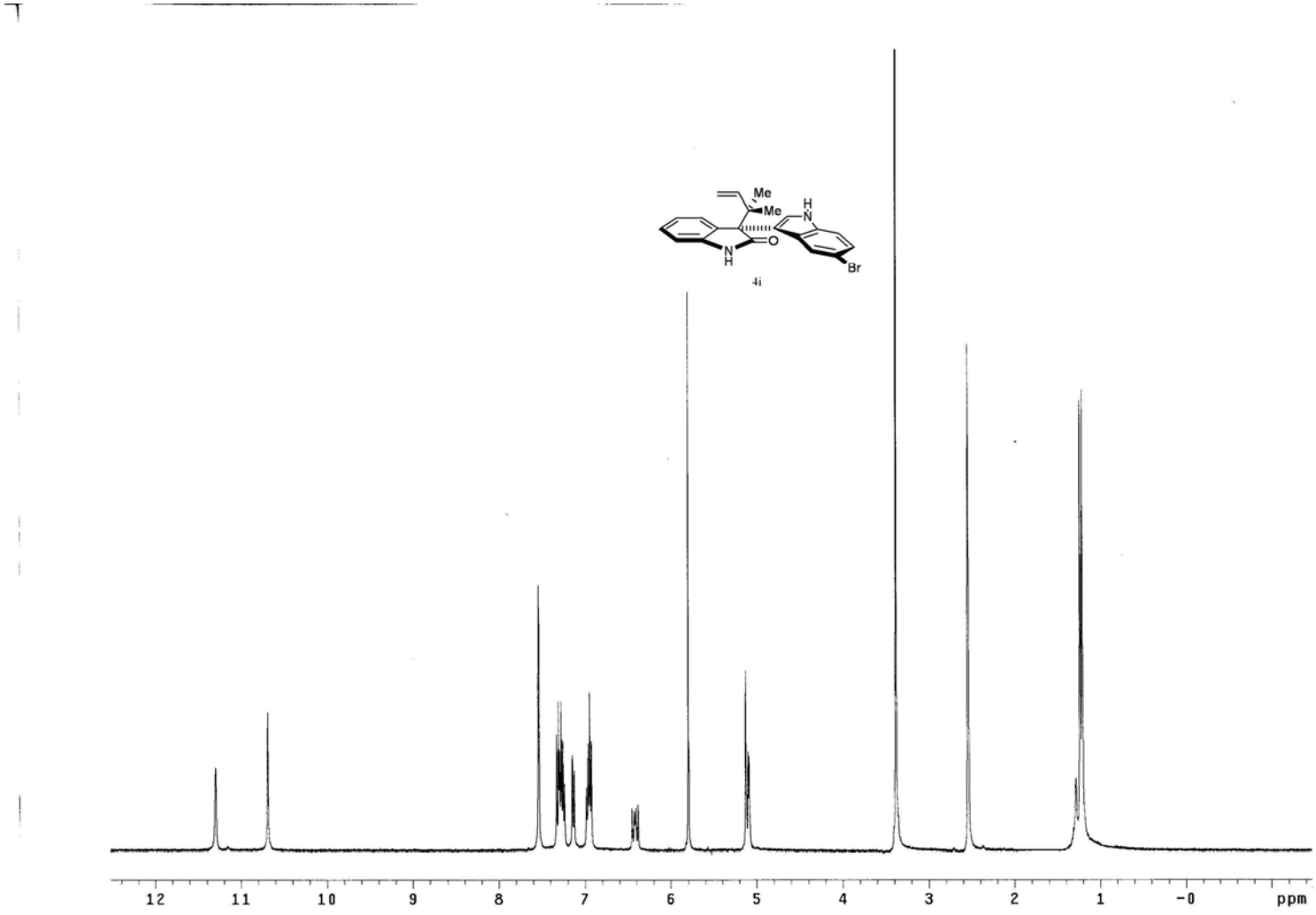
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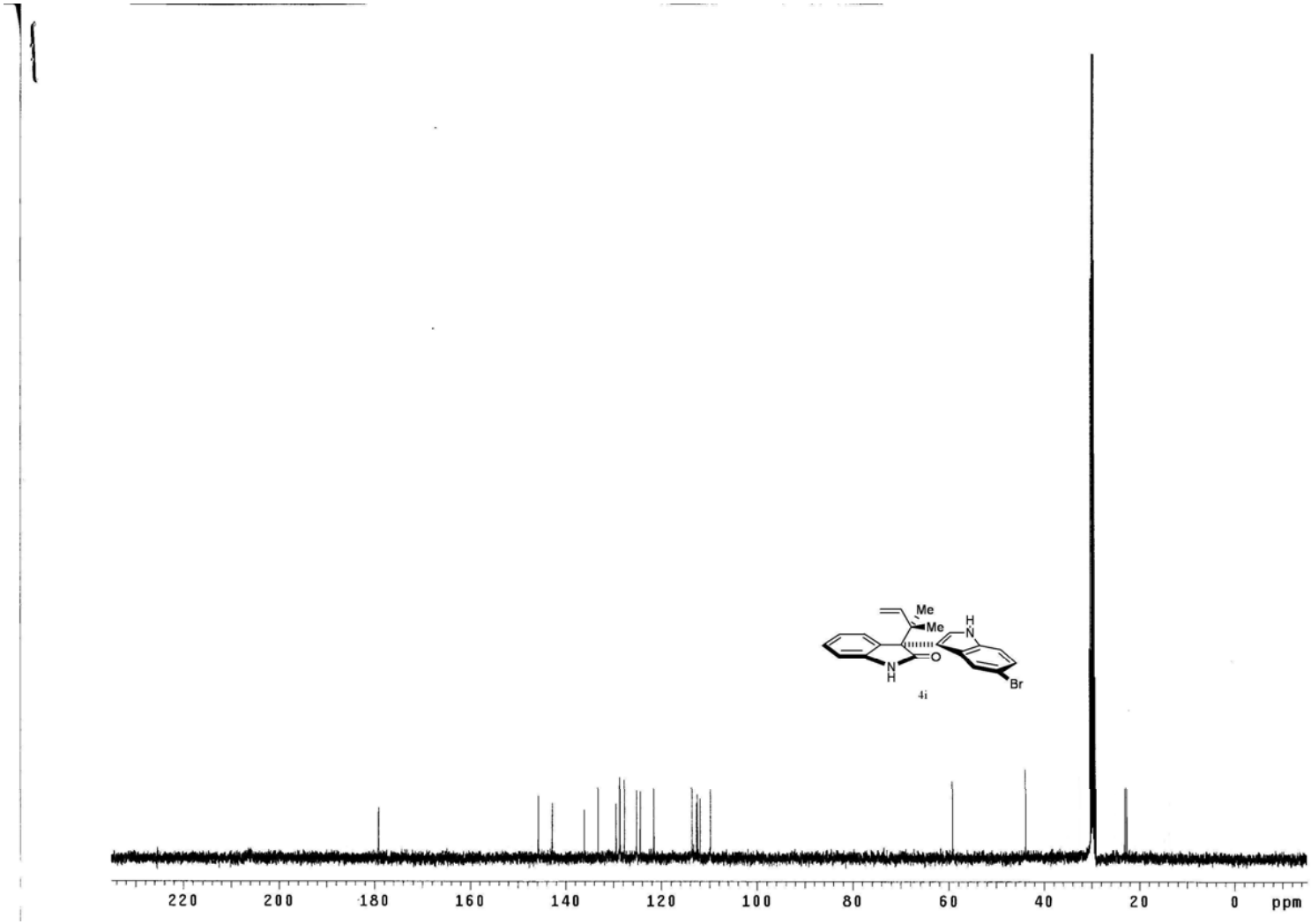
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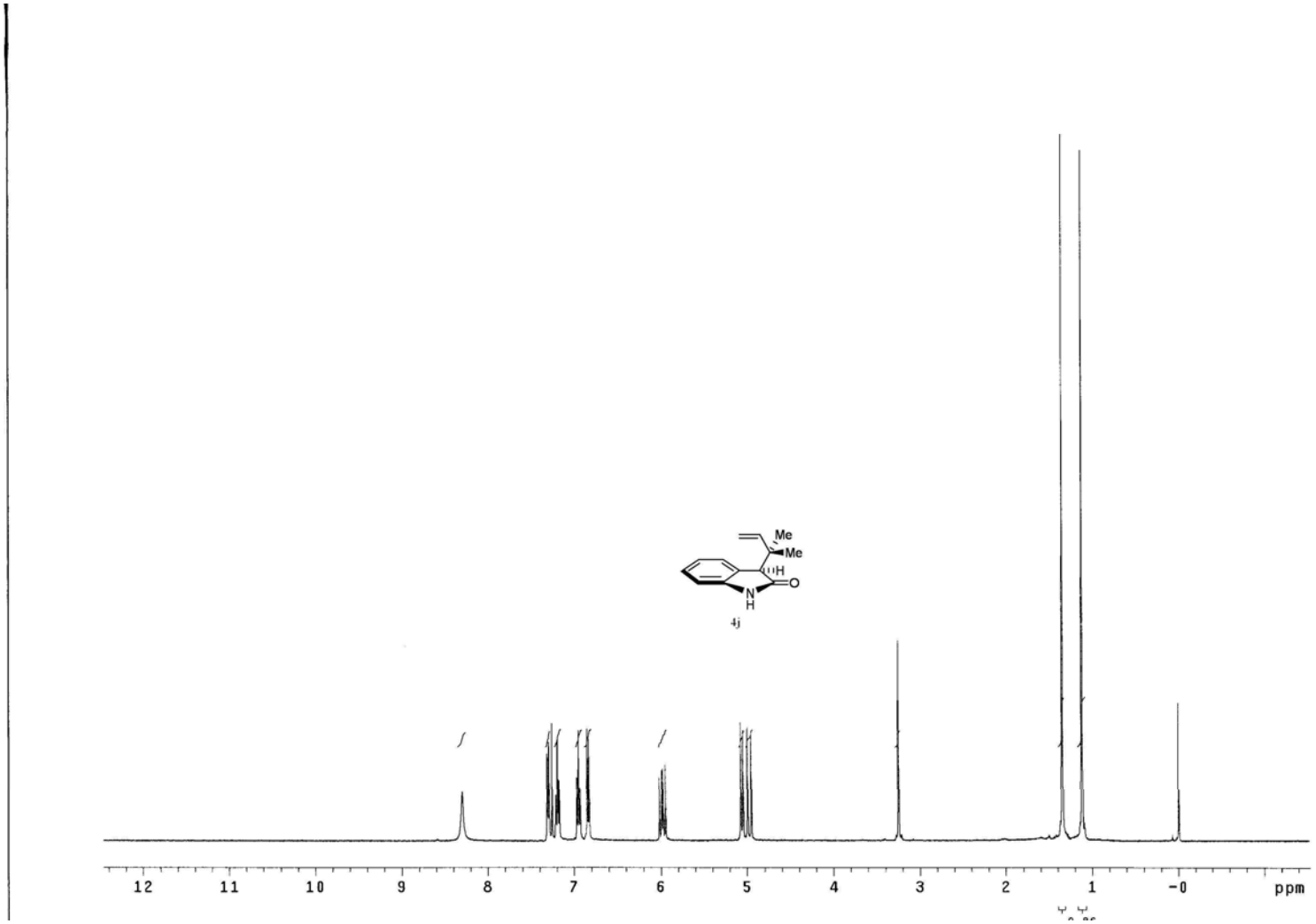
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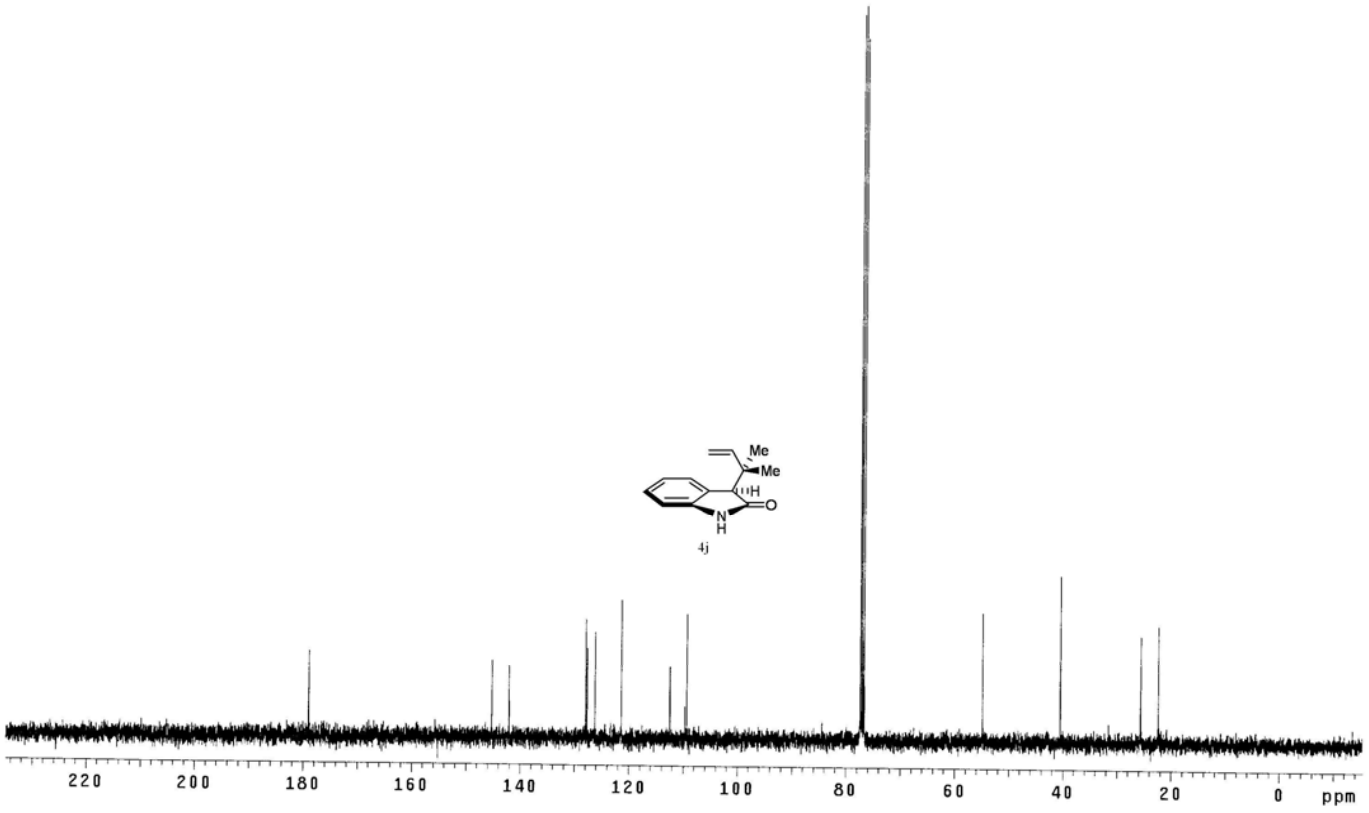
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