Supporting Information

For

Dehydration in Water: Frustrated Lewis Pairs Catalyzed Directly Allylization of Electron-Rich Arenes and Allyl Alcohols

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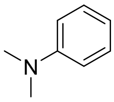
Contents

1. General Information:

All template reaction experiments were carried out under atmospheric conditions. Thin layer chromatography was carried out in the ultraviolet light using a GF-254 silica gel plate. Column chromatography was carried out using 200-300 mesh silica gel. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded at 400 MHz on an Agilent spectrometer. $CDCl_3$ was used as solvent. Chemical shifts were referenced relative to residual solvent. Coupling constants (J) were reported in Hertz (Hz). HRMS were performed on a Thermo Scientific LTQ Orbitrap XL instrument. Melting points were measured with micro melting point apparatus. Tris(pentafluorophenyl)borane (energy chemical, 97%), 2,6-lutidine (kelong, 99%), N,N-dimethylaniline (**1a,** rhawn, 98%), 1,2,3-trimethoxybenzene (**1l**, bidepharm, 98%), 1H-indole (**1m**, bidepharm, 98%), 1-methyl-1H-indole (**1n**, adamas, 98%) , 2-methyl-1H-indole (**1r**, bide, 98%), 2-phenyl-1H-indole (**1s**, adamas, 98%), 5-methoxy-1H-indole (**1t**, bidepharm, 98%), 6-chloro-1H-indole (**1u**, adamas, 98%), 5,6-dichloro-1H-indole (**1v**, bidepharm, 98%) were commercial available, and the N-substituted aromatic amines **1b-1e**, **1h-1k**[1], N-cycloarylamines **1f-1g**[2], **1o** [3], **1p**[4], **1q** [5] and **2a-2r**[6], [7] were prepared according to literature.



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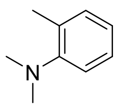

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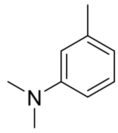

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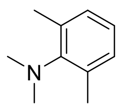

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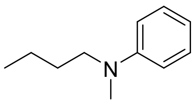

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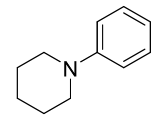

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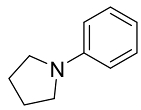

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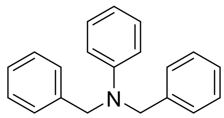

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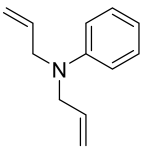

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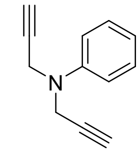

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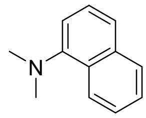

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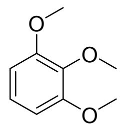

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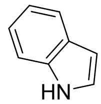

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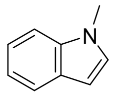

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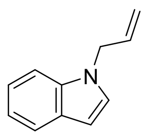

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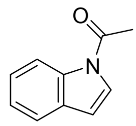

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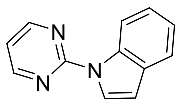

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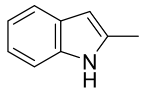

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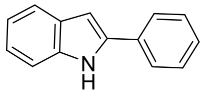

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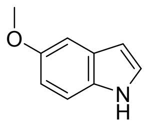

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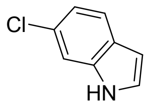

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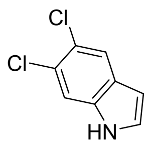

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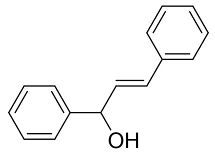

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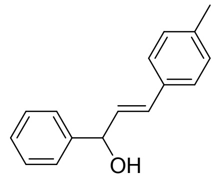

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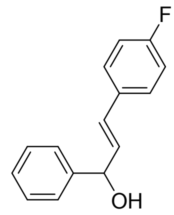

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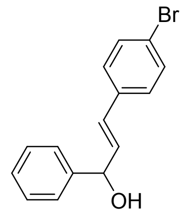

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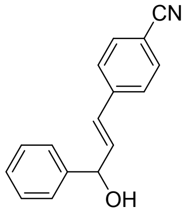

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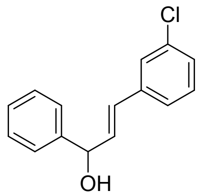

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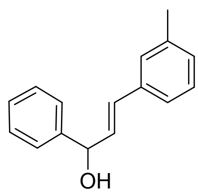

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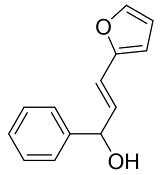

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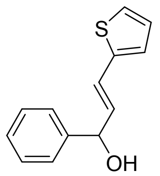

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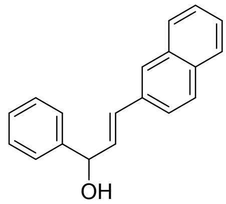

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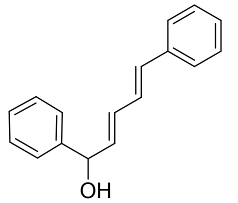

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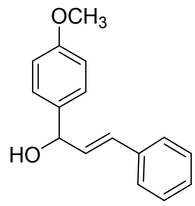

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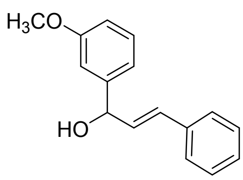

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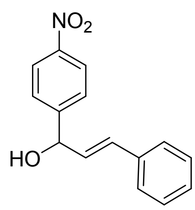

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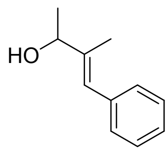

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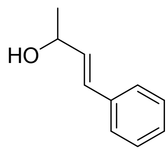

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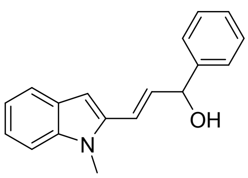

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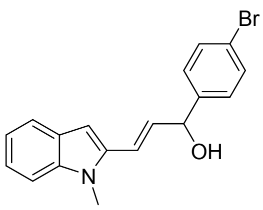
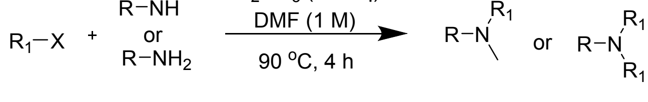


2r

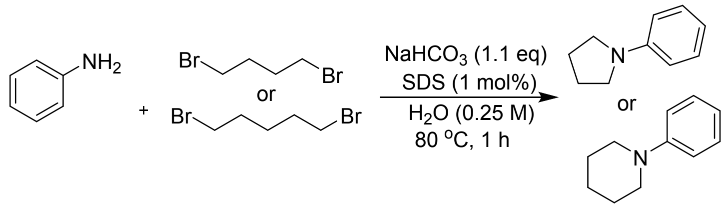
2. Substrate synthesis:

(a) Synthesis of N-substituted aromatic amines 1b-1e, 1h-1k[1]



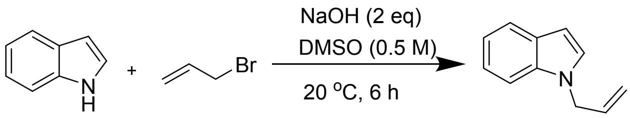
The experimental procedure for the synthesis of N-substituted aromatic amines (1b–1e, 1h-1k), please see: H. Shen, X. Zhang, Q. Liu, J. Pan, W. Hu, Y. Xiong and X. Zhu, Direct oxidative cyanation of tertiary amines promoted by in situ generated hypervalent iodine (III)-CN intermediate, *Tetrahedron Lett.*, 2015, **56**, 5628-5631.

(b) Synthesis of N-cycloarylamines 1f-1g[2]



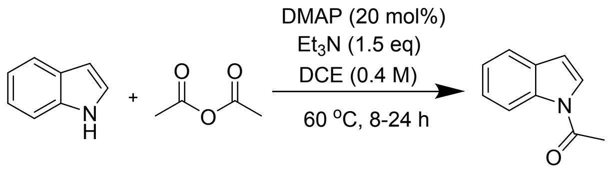
The experimental procedure for the synthesis of N- cycloarylamines (1f–1g), please see: X.-Z. Shu, Y.-F. Yang, Xiao-Feng Xia, K.-G. Ji, X.-Y. Liu and Y.-M. Liang, Platinum-catalyzed cross-dehydrogenative coupling reaction in the absence of oxidant, *Org. Biomol. Chem.,* 2010*,* **8***,* 4077-4079.

(c) Synthesis of compounds 1o [3]



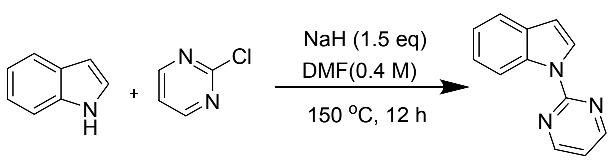
The experimental procedure for the synthesis of N- 1-allyl-1H-indole (1o), please see: S. Olguín-Uribe, M. V. Mijangos, Y. A. Amador-Sánchez, M. A. Sánchez-Carmona and L. D. Miranda, Expedited Synthesis of Matrine Analogues through an Oxidative Cascade Addition/Double-Cyclization Radical Process, *Eur. J. Org. Chem.*, 2017, 2481-2485.

(d) Synthesis of compounds 1p[4]



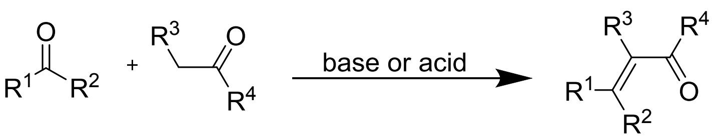
The experimental procedure for the synthesis of 1-(1H-indol-1-yl)ethan-1-one (1p), please see: Z.-L. Yan, W.-L. Chen, Y.-R. Gao, S. Mao, Y.-L. Zhang and Y.-Q. Wang, Palladium - Catalyzed Intermolecular C-2 Alkenylation of Indoles Using Oxygen as the Oxidant, *Adv. Synth. Catal.,* 2014*,* **356***,* 1085-1092.

(e) Synthesis of compounds 1q[5]

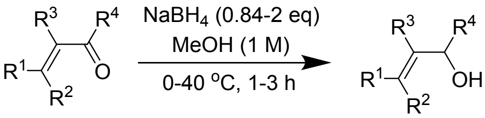


The experimental procedure for the synthesis of 1-(pyrimidin-2-yl)-1H-indole (1q), please see: M. Nishino, K. Hirano, T. Satoh and M. Miura, Copper-Mediated and Copper-Catalyzed Cross-Coupling of Indoles and 1,3-Azoles: Double C-H Activation, *Angew. Chem. Int. Ed.,* 2012, **51**, 6993-6997.

(f) Synthesis of compounds 2a-2r[6], [7]

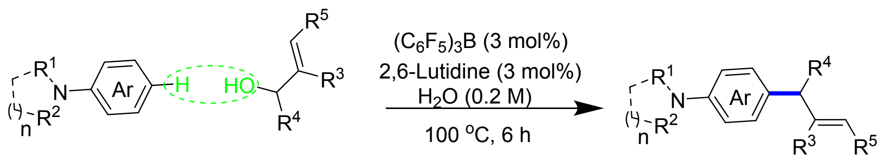


The experimental procedure for the synthesis of conjugated unsaturated ketones, please see: (a) B. Ding, Z. Zhang, Y. Liu, M. Sugiya and T. Imamoto, Chemoselective transfer hydrogenation of α, β-unsaturated ketones catalyzed by pincer-Pd complexes using alcohol as a hydrogen source, *Org. Lett.,* 2013, **15**, **14**, 3690-3693; (b) I. M. Ferreira, E. B. Meira, I. G. Rosset and A. L. M. Porto, Chemoselective biohydrogenation of α, β-and α, β, γ, δ-unsaturated ketones by the marine-derived fungus Penicillium citrinum CBMAI 1186 in a biphasic system, *Journal of Molecular Catalysis B: Enzymatic,* 2015**, 115**, 59-65. (c) A. Sultan, A. R. Raza, M. Abbas, K. M. Khan, M. N. Tahir and N. Saari, Evaluation of silica-H_2SO_4 as an efficient heterogeneous catalyst for the synthesis of chalcones, *Molecules,* 2013, **18**, 10081-10094; (d) Z. Li, X. L. Chen, Y. J. Fu, W. Wang and M. Luo, A facile synthesis of trisubstituted alkenes from β-diketones and aldehydes with $AlCl_3$ as catalyst, *Res Chem Intermed.,* 2012, **38**, 25-35; (e) Y. H. He, Y. Hu and Z. Guan, Natural α-amino acid L-lysine–catalyzed Knoevenagel condensations of α, β-unsaturated aldehydes and 1, 3-dicarbonyl compounds, *Synthetic Communications*, 2011, **41**, 1617-1628; (f) Y. Ma, J. Li, J. Ye, D. Liu and W. Zhang, Synthesis of chiral chromanols via a RuPHOX–Ru catalyzed asymmetric hydrogenation of chromones, *Chem. Commun.,* 2018**, 54**, 13571-13574.



The experimental procedure for the synthesis of conjugated unsaturated ketones, please see: W. Gladkowski, A. Skrobiszewski, M. Mazur, M. Siepka, A. Pawlak, B. Obmi nska-Mrukowicz, A. Bialonska, D. Poradowski, A. Drynda and M, Urbaniak, Synthesis and anticancer activity of novel halolactones with β-aryl substituents from simple aromatic aldehydes, *Tetrahedron*. 2013, **69**, 10414-10423.

3. Typical Procedure for Synthesis of 3:

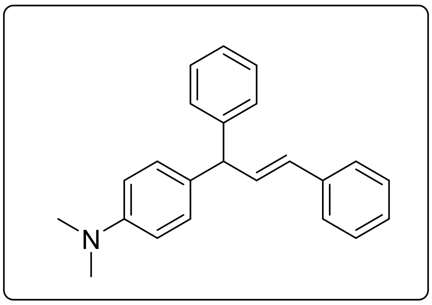


1 n=1,2 **2** **3**

Add $(C_6F_5)_3B$ (4.6 mg, 0.009 mmol), 2,6-lutidine (1μL, 0.009mmol) and allyl alcohol (0.3 mmol) to the reaction tube and disperse immediately with water (1.5 ml). Afterwards, **compound 1** (0.3 mmol) were added. The solution was heated to 100°C. The solution was kept at 100°C for 6 h. Then the solution was diluted with saturated brine. Ethyl acetate extracted and transferred to a round bottom flask. Silica gel was added to the flask and volatiles were evaporated under vacuum. The purification was performed by column chromatography on silica gel using ethyl acetate/petroleum ether as eluent to give **3**.

4. Characterization of 3:

(E)-4-(1,3-diphenylallyl)-N,N-dimethylaniline (3a)[8]



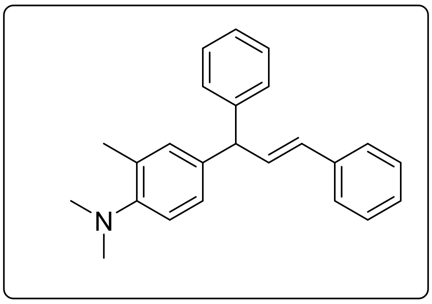
3a

White solid, m.p. 50-53°C, 87 mg, yield: 92%; R_f = 0.30 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45 (d, *J* = 7.6 Hz, 2H), 7.32 (dp, *J* = 29.0, 8.2 Hz, 8H), 7.19 (d, *J* = 7.1 Hz, 2H), 6.83-6.70 (m, 3H), 6.42 (d, *J* = 15.8 Hz, 1H), 4.89 (d, *J* = 7.5 Hz, 1H), 3.00 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 149.29, 144.25, 137.53, 133.38, 131.48, 130.83, 129.32, 128.69, 128.53, 128.44, 127.18, 126.33, 126.26, 112.78, 53.31, 40.79.

(E)-4-(1,3-diphenylallyl)-N,N,2-trimethylaniline (3b)



3b

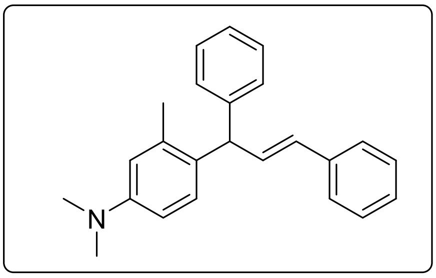
Colorless oil, 69 mg, yield: 68%; R_f = 0.35 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.39 (dd, *J* = 7.1, 1.5 Hz, 2H), 7.37-7.17 (m, 8H), 7.08-6.95 (m, 3H), 6.68 (dd, *J* = 15.8, 7.7 Hz, 1H), 6.37 (d, *J* = 15.8 Hz, 1H), 4.83 (d, *J* = 7.7 Hz, 1H), 2.70 (s, 6H), 2.31 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 143.91, 137.50, 137.44, 133.02, 132.08, 131.36, 131.00, 128.63, 128.48, 128.42, 127.20, 126.45, 126.31, 126.30, 118.34, 53.68, 44.31, 18.48.

HRMS (m/z): calcd for $C_{24}H_{26}N$ $[MH]^+$: 328.2060, found: 328.2056.

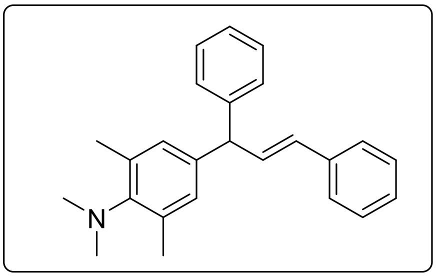
(E)-4-(1,3-diphenylallyl)-N,N,3-trimethylaniline (3c)



3c

Colorless oil, 37 mg, yield: 38%; R_f = 0.45 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.38 (d, *J* = 7.3 Hz, 2H), 7.36-7.26 (m, 4H), 7.26-7.17 (m, 4H), 7.07 (d, *J* = 8.7 Hz, 1H), 6.69 (dd, *J* = 15.9, 6.8 Hz, 1H), 6.61 (d, *J* = 7.3 Hz, 2H), 6.27-6.19 (m, 1H), 5.02 (d, *J* = 6.8 Hz, 1H), 2.95 (s, 6H), 2.28 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$): δ 149.27, 143.64, 137.62, 137.01, 133.33, 130.80, 129.88, 129.30, 128.87, 128.47, 128.29, 127.07, 126.27, 126.09, 114.97, 110.40, 49.71, 40.71, 20.31.
HRMS (m/z): calcd for $C_{24}H_{26}N$ $[MH]^{+}$: 328.2060, found: 328.2063.

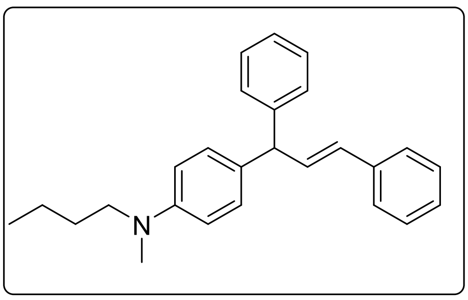
(E)-4-(1,3-diphenylallyl)-N,N,2,6-tetramethylaniline (3d)



3d

Colorless oil, 61 mg, yield: 60%; R_f = 0.32 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40-7.33 (m, 2H), 7.35-7.24 (m, 6H), 7.26-7.15 (m, 5H), 6.83 (s, 2H), 6.64 (dd, *J* = 15.8, 7.8 Hz, 1H), 6.34 (d, *J* = 15.9 Hz, 1H), 4.75 (d, *J* = 7.8 Hz, 1H), 2.78 (s, 6H), 2.23 (s, 6H).
^{13}C NMR (101 MHz, $CDCl_3$): δ 143.84, 139.48, 137.42, 136.92, 132.96, 130.89, 128.76, 128.58, 128.45, 128.37, 127.16, 126.29, 126.25, 53.78, 42.51, 19.21.
HRMS (m/z): calcd for $C_{25}H_{28}N$ $[MH]^{+}$: 342.2216, found: 342.2218.

(E)-N-butyl-4-(1,3-diphenylallyl)-N-methylaniline (3e)



3e

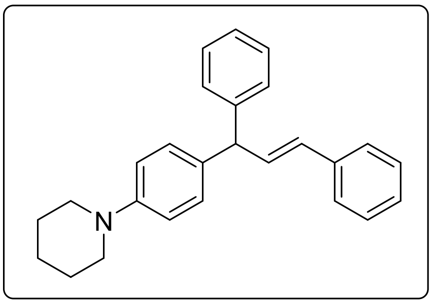
Colorless oil, 70 mg, yield: 66%; R_f = 0.39 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.36 (d, *J* = 7.0 Hz, 2H), 7.33-7.22 (m, 7H), 7.19 (tdd, *J* = 7.2, 4.7, 2.3 Hz, 3H), 7.07 (d, *J* = 8.3 Hz, 2H), 6.71-6.58 (m, 3H), 6.33 (d, *J* = 14.5 Hz, 1H), 4.79 (d, *J* = 7.6 Hz, 1H), 3.30-3.23 (m, 2H), 2.90 (s, 3H), 1.55-1.49 (m, 2H), 1.36-1.28 (m, 2H), 0.93 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 137.54, 133.43, 130.69, 129.29, 128.61, 128.42, 128.32, 127.05, 126.25, 126.14, 112.10, 53.26, 52.64, 38.31, 28.87, 20.33, 13.96.

HRMS (m/z): calcd for $C_{26}H_{30}N$ $[MH]^+$: 356.2373, found: 356.2378.

(E)-1-(4-(1,3-diphenylallyl)phenyl)piperidine (3f)



3f

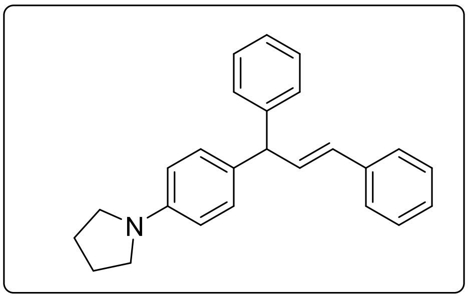
Colorless oil, 100 mg, yield: 94%; R_f = 0.19 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.42 (d, *J* = 7.6 Hz, 2H), 7.40-7.20 (m, 8H), 7.17 (d, *J* = 8.2 Hz, 2H), 6.96 (d, *J* = 8.2 Hz, 2H), 6.72 (dd, *J* = 15.9, 7.5 Hz, 1H), 6.39 (d, *J* = 15.8 Hz, 1H), 4.88 (d, *J* = 7.4 Hz, 1H), 3.18 (t, *J* = 5.4 Hz, 4H), 1.76 (p, *J* = 5.6 Hz, 4H), 1.62 (q, *J* = 5.9 Hz, 2H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 150.74, 144.07, 137.50, 134.13, 133.21, 131.01, 129.27, 128.72, 128.54, 128.45, 127.22, 126.34, 126.32, 116.59, 53.42, 50.80, 25.95, 24.33.

HRMS (m/z): calcd for $C_{26}H_{28}N$ $[MH]^+$: 354.2216, found: 354.2217.

(E)-1-(4-(1,3-diphenylallyl)phenyl)pyrrolidine (3g)



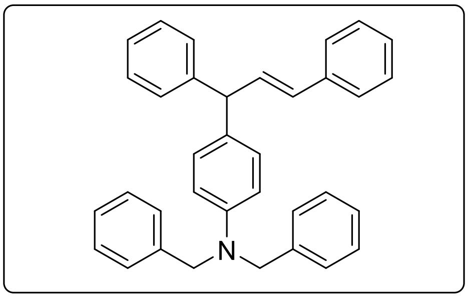
3g

Colorless oil, 85 mg, yield: 83%; R_f = 0.35 (EtOAc/Petroleum ether 1:30)

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.44-7.35 (m, 2H), 7.37-7.23 (m, 7H), 7.26-7.17 (m, 2H), 7.11 (d, *J* = 6.5 Hz, 2H), 6.70 (dd, *J* = 15.8, 7.5 Hz, 1H), 6.56 (d, *J* = 6.6 Hz, 2H), 6.36 (d, *J* = 15.8 Hz, 1H), 4.83 (d, *J* = 7.5 Hz, 1H), 3.36-3.22 (m, 4H), 2.05-1.95 (m, 4H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 146.59, 144.43, 137.61, 133.58, 130.70, 129.39, 128.65, 128.46, 128.34, 127.07, 126.29, 126.13, 111.70, 53.34, 47.70, 25.47.
HRMS (m/z): calcd for $C_{25}H_{26}N$ $[MH]^+$: 340.2060, found: 340.2057.

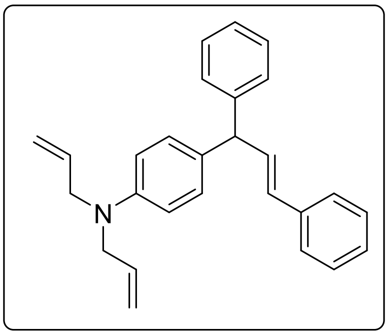
(E)-N,N-dibenzyl-4-(1,3-diphenylallyl)aniline (3h)



3h

Colorless oil, 129 mg, yield: 93%; R_f = 0.32 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.52-7.08 (m, 20H), 7.03 (d, *J* = 8.4 Hz, 2H), 6.75-6.59 (m, 3H), 6.33 (d, *J* = 15.8 Hz, 1H), 4.77 (d, *J* = 7.7 Hz, 1H), 4.63 (s, 4H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 144.10, 137.48, 133.28, 130.73, 129.27, 129.20, 128.60, 128.44, 128.36, 127.10, 126.90, 126.26, 126.20, 54.47, 53.34.
HRMS (m/z): calcd for $C_{35}H_{32}N$ $[MH]^+$: 466.2529, found: 466.2533.

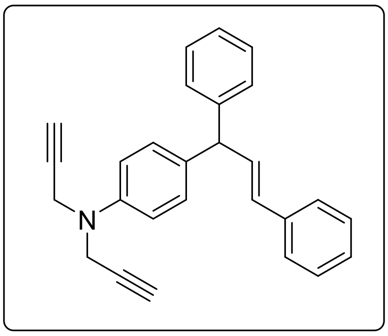
(E)-N,N-diallyl-4-(1,3-diphenylallyl)aniline (3i)



3i

Colorless oil, 91 mg, yield: 83%; R_f = 0.51 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.34 (d, *J* = 8.9 Hz, 2H), 7.32-7.20 (m, 6H), 7.16 (q, *J* = 7.1 Hz, 2H), 7.07-7.00 (m, 2H), 6.63 (q, *J* = 7.5 Hz, 3H), 6.32 (d, *J* = 14.6 Hz, 1H), 5.82 (ddd, *J* = 22.1, 10.1, 4.9 Hz, 2H), 5.20-5.08 (m, 4H), 4.76 (d, *J* = 7.6 Hz, 1H), 3.90-3.83 (m, 4H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 147.36, 144.28, 137.60, 134.23, 133.46, 131.18, 130.77, 129.27, 128.70, 128.51, 128.42, 127.15, 126.34, 126.24, 116.09, 112.44, 53.38, 52.89.
HRMS (m/z): calcd for $C_{27}H_{28}N$ $[MH]^+$:366.2216, found: 366.2217.

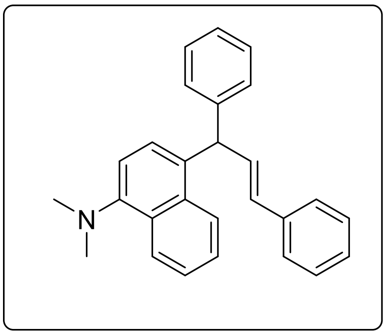
(E)-4-(1,3-diphenylallyl)-N,N-di(prop-2-yn-1-yl)aniline (3j)



3j

Colorless oil, 92 mg, yield: 85%; R_f = 0.35 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.42 (d, *J* = 7.2 Hz, 2H), 7.41-7.18 (m, 10H), 6.97 (d, *J* = 8.6 Hz, 2H), 6.72 (dd, *J* = 15.8, 7.5 Hz, 1H), 6.40 (d, *J* = 15.8 Hz, 1H), 4.89 (d, *J* = 7.5 Hz, 1H), 4.15 (d, *J* = 2.4 Hz, 4H), 2.29 (t, *J* = 2.3 Hz, 2H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 146.33, 143.89, 137.44, 134.80, 133.04, 131.13, 129.42, 128.72, 128.57, 128.50, 127.29, 126.41, 126.36, 115.86, 79.37, 72.79, 53.42, 40.55.
HRMS (m/z): calcd for $C_{27}H_{24}N$ $[MH]^+$: 362.1903, found: 362.1901.

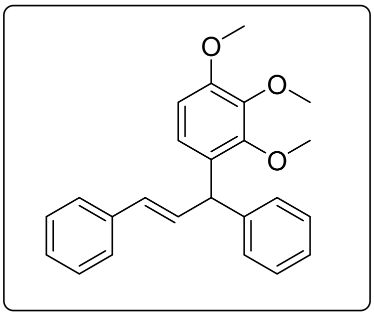
(E)-4-(1,3-diphenylallyl)-N,N-dimethylnaphthalen-1-amine (3k)



3k

Colorless oil, 96 mg, yield: 88%; R_f = 0.19 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, CDCl$_3$): δ 8.30 (d, *J* = 8.3 Hz, 1H), 8.00 (d, *J* = 6.9 Hz, 1H), 7.45-7.36 (m, 2H), 7.32 (d, *J* = 7.2 Hz, 2H), 7.30-7.20 (m, 7H), 7.18 (dd, *J* = 10.1, 6.7 Hz, 2H), 7.01 (d, *J* = 7.8 Hz, 1H), 6.78 (dd, *J* = 15.9, 6.8 Hz, 1H), 6.25 (d, *J* = 16.0 Hz, 1H), 5.57 (d, *J* = 6.2 Hz, 1H), 2.86 (s, 6H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 143.45, 137.46, 133.84, 133.09, 132.95, 131.64, 129.36, 128.98, 128.55, 128.51, 127.29, 126.49, 126.45, 126.37, 125.95, 124.88, 124.82, 124.66, 113.62, 49.98, 45.41.
HRMS (m/z): calcd for $C_{27}H_{26}N$ $[MH]^+$: 364.2060, Found: 364.2065.

(E)-(3-(2,3,4-trimethoxyphenyl)prop-1-ene-1,3-diyl)dibenzene (3l)



3l

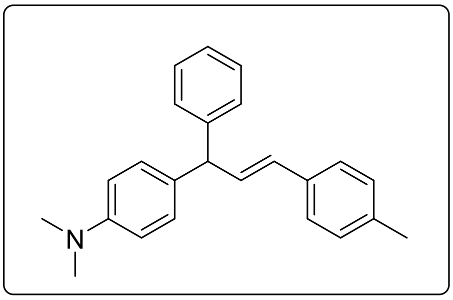
Colorless oil, 36 mg, yield: 33%; R_f = 0.26 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.36 (d, *J* = 7.0 Hz, 2H), 7.32-7.15 (m, 8H), 6.87 (d, *J* = 8.6 Hz, 1H), 6.71-6.61 (m, 2H), 6.28 (d, *J* = 14.4 Hz, 1H), 5.21 (d, *J* = 8.9 Hz, 1H), 3.87 (s, 3H), 3.84 (s, 3H), 3.64 (s, 3H).

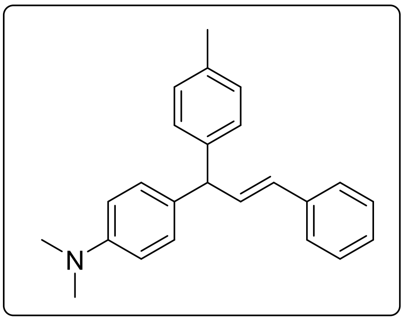
^{13}C NMR (101 MHz, CDCl$_3$): δ 152.46, 151.66, 143.84, 142.46, 137.45, 132.76, 131.15, 129.83, 128.57, 128.46, 128.25, 127.15, 126.25, 126.15, 123.49, 107.07, 60.77, 60.67, 55.95, 47.27.

HRMS (m/z): calcd for $C_{24}H_{25}O_3$ $[MH]^+$: 361.1798, found: 361.1792.

(E)-N,N-dimethyl-4-(1-phenyl-3-(p-tolyl)allyl)aniline(3m1) and (E)-N,N-dimethyl-4-(3-phenyl-1-(p-tolyl)allyl)aniline (3m2)



3m1



3m2

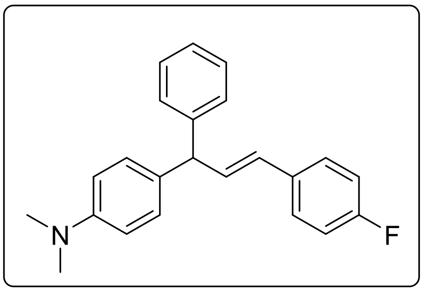
Colorless oil, 90 mg, yield: 92%; 3m1:3m2=1:1, R_f=0.21 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.44 (d, *J* = 8.5 Hz, 1H), 7.41-7.12 (m, 10H), 6.81-6.65 (m, 3H), 6.39 (dd, *J* = 15.9, 10.6 Hz, 1H), 4.86 (t, *J* = 7.9 Hz, 1H), 2.98 (d, *J* = 1.6 Hz, 6H), 2.39 (d, *J* = 4.1 Hz, 3H).

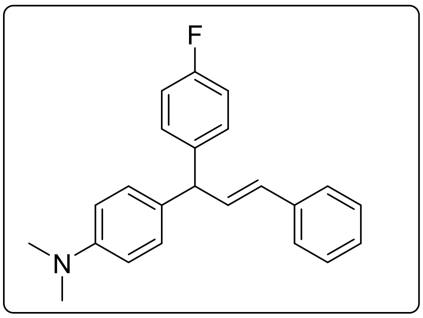
^{13}C NMR (101 MHz, CDCl$_3$): δ 149.17, 133.59, 132.38, 130.74, 130.70, 129.36, 129.31, 129.24, 129.16, 128.71, 128.57, 128.52, 128.42, 127.14, 126.34, 126.25, 126.23, 112.97, 112.94, 53.35, 52.97, 40.89, 40.88, 21.24, 21.11.

HRMS (m/z): calcd for $C_{24}H_{26}N$ $[MH]^+$: 328.2060, found: 328.2063.

(E)-4-(3-(4-fluorophenyl)-1-phenylallyl)-N,N-dimethylaniline (3n1) and (E)-4-(1-(4-fluorophenyl)-3-phenylallyl)-N,N-dimethylaniline(3n2)



3n1



3n2

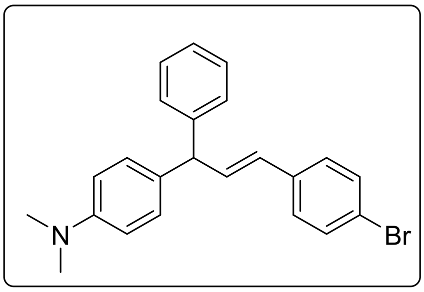
Colorless oil, 85 mg, yield: 86%; 3n1:3n2=1:1, R_f=0.39 (EtOAc/Petroleum ether 1:20).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.36-7.11 (m, 7H), 7.09-7.01 (m, 2H), 6.99-6.87 (m, 2H), 6.67 (d, *J* = 6.7 Hz, 2H), 6.63-6.50 (m, 1H), 6.26 (dd, *J* = 15.8, 8.4 Hz, 1H), 4.75 (d, *J* = 8.6 Hz, 1H), 2.87 (d, *J* = 1.9 Hz, 6H).

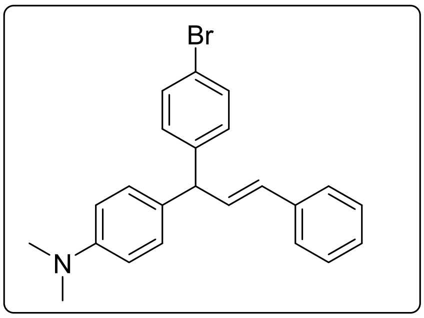
^{13}C NMR (101 MHz, CDCl$_3$): δ 149.30, 133.19, 133.17, 131.46, 130.99, 130.10, 130.02, 129.66, 129.28, 129.23, 128.63, 128.54, 128.44, 127.79, 127.71, 127.27, 126.32, 126.29, 115.45, 115.24, 115.03, 112.83, 53.28, 52.52, 40.75, 40.72.

HRMS (m/z): calcd for $C_{23}H_{23}FN$ $[MH]^+$: 332.1809, Found: 332.1807.

(E)-4-(3-(4-bromophenyl)-1-phenylallyl)-N,N-dimethylaniline (3o1) and (E)-4-(1-(4-bromophenyl)-3-phenylallyl)-N,N-dimethylaniline(3o2)



3o1



3o2

Colorless oil, 99 mg, yield: 85%; 3o1:3o2=1:1, R_f=0.29 (EtOAc/Petroleum ether 1:30).

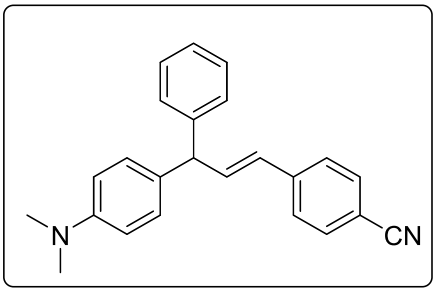
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.39 (dd, *J* = 13.7, 8.1 Hz, 3H), 7.31 (q, *J* = 7.4 Hz, 3H), 7.24 (dd, *J* = 8.4, 6.3 Hz, 3H), 7.16-7.02 (m, 3H), 6.74 (dd, *J* = 8.8, 3.2 Hz, 2H), 6.65 (ddd, *J* = 20.1, 15.8, 7.4 Hz, 1H), 6.31 (dd, *J* = 21.0, 15.8 Hz, 1H), 4.80 (dd, *J* = 13.3, 7.4 Hz, 1H), 2.94 (d, *J* = 1.2 Hz, 6H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 134.22, 132.64, 131.54, 131.43, 131.23, 130.41, 129.70, 129.27, 129.22, 128.59, 128.53, 128.44, 127.84, 127.31, 126.33, 126.31, 53.28, 52.69, 40.82, 40.77.

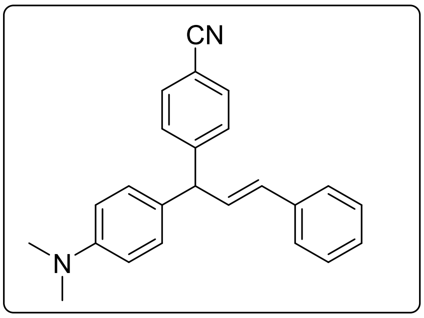
HRMS (m/z): calcd for $C_{23}H_{23}BrN$ $[MH]^+$: 392.1008, Found:392.1011.

(E)-4-(3-(4-(dimethylamino)phenyl)-3-phenylprop-1-en-1-

yl)benzonitrile (3p1) and (E)-4-(1-(4-(dimethylamino)phenyl)-3-phenylallyl)benzonitrile (3p2)



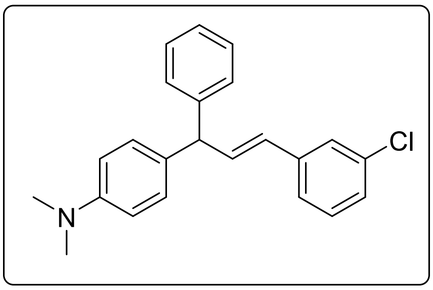
3p1

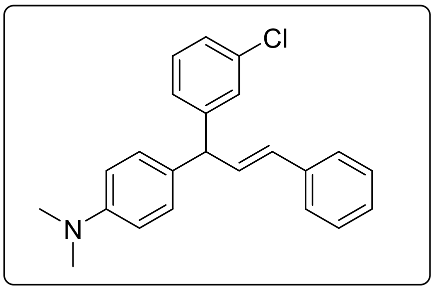


3p2

Colorless oil, 77 mg, yield: 76%; 3p1:3p2=5:2, R_f=0.1 (EtOAc/Petroleum ether 1:20).
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.60-7.54 (m, 2H), 7.44-7.20 (m, 7H), 7.07 (t, *J* = 9.0 Hz, 2H), 6.84-6.78 (m, 1H), 6.71 (d, *J* = 8.8 Hz, 2H), 6.33 (dt, *J* = 15.9, 1.8 Hz, 1H), 4.84 (dd, *J* = 7.6, 4.1 Hz, 1H), 2.94 (d, *J* = 2.7 Hz, 6H).
^{13}C NMR (101 MHz, $CDCl_3$): δ 149.95, 149.40, 143.40, 142.02, 137.57, 136.98, 132.32, 132.21, 132.07, 131.86, 131.67, 130.50, 129.75, 129.39, 129.34, 129.22, 129.19, 128.63, 128.57, 128.55, 128.52, 128.13, 127.52, 126.74, 126.49, 126.44, 126.32, 119.06, 112.77, 110.29, 110.05, 53.33, 53.28, 40.64, 40.58.
HRMS (m/z): calcd for $C_{24}H_{23}N_2$ $[MH]^+$: 339.1856, Found:339.1860.

(E)-4-(3-(3-chlorophenyl)-1-phenylallyl)-N,N-dimethylaniline (3q1) and (E)-4-(1-(3-chlorophenyl)-3-phenylallyl)-N,N-dimethylaniline(3q2)



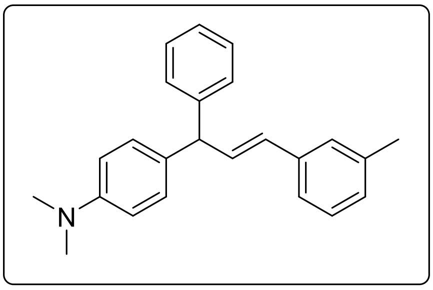


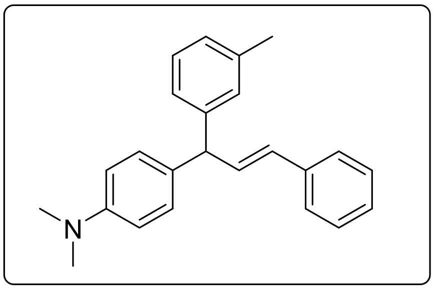
3q1 **3q2**

Colorless oil, 79 mg, yield: 76%; 3q1:3q2=1:1, R_f=0.39 (EtOAc/Petroleum ether 1:20).
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.34-6.99 (m, 11H), 6.65 (d, *J* = 8.6 Hz, 2H), 6.63-6.51 (m, 1H), 6.24 (dd, *J* = 27.4, 15.8 Hz, 1H), 4.73 (dd, *J* = 12.5, 7.5 Hz, 1H), 2.86 (d, *J* = 2.2 Hz, 6H).
^{13}C NMR (101 MHz, $CDCl_3$): δ 134.99, 132.48, 131.34, 129.69, 129.62, 129.56, 129.26, 129.23, 128.70, 128.61, 128.53, 128.46, 127.33, 127.05, 126.87, 126.43,

126.35, 126.20, 124.53, 112.85, 53.25, 53.02, 40.75, 40.70.
HRMS (m/z): calcd for $C_{23}H_{23}ClN$ $[MH]^+$: 348.1514, Found: 348.1511.

(E)-N,N-dimethyl-4-(1-phenyl-3-(m-tolyl)allyl)aniline (3r1) and (E)-N,N-dimethyl-4-(3-phenyl-1-(m-tolyl)allyl)aniline (3r2)

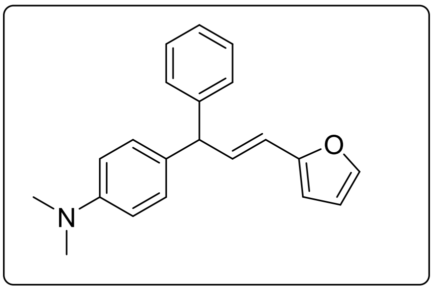


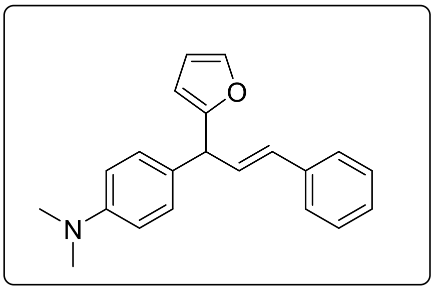


3r1 **3r2**

Colorless oil, 77 mg, yield: 78%; 3ab1:3ab2=3:2, R_f=0.22 (EtOAc/Petroleum ether 1:30).
[1]H NMR (400 MHz, CDCl3): δ 7.39 (d, *J* = 7.4 Hz, 1H), 7.36-7.00 (m, 10H), 6.73 (d, *J* = 8.4 Hz, 2H), 6.67 (ddd, *J* = 12.2, 7.5, 3.8 Hz, 1H), 6.34 (dd, *J* = 15.6, 12.7 Hz, 1H), 4.81 (dd, *J* = 13.8, 7.5 Hz, 1H), 2.94 (s, 6H), 2.34 (s, 3H).
[13]C NMR (101 MHz, CDCl3): δ 133.47, 133.16, 130.89, 130.69, 129.34, 129.28, 129.25, 128.65, 128.45, 128.37, 128.36, 128.26, 127.91, 127.08, 126.99, 126.30, 126.17, 125.68, 123.46, 112.85, 53.30, 40.78, 21.51, 21.38.
HRMS (m/z): calcd for $C_{24}H_{26}N$ $[MH]^+$: 328.2060, found: 328.2065.

(E)-4-(3-(furan-2-yl)-1-phenylallyl)-N,N-dimethylaniline (3s1) and (E)-4-(1-(furan-2-yl)-3-phenylallyl)-N,N-dimethylaniline (3s2)



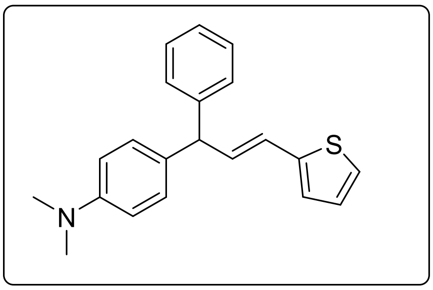


3s1 **3s2**

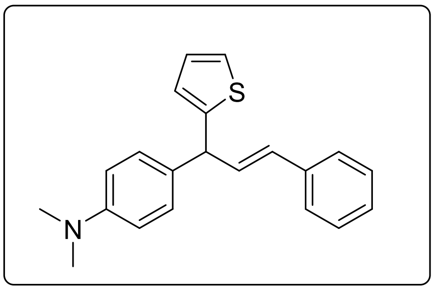
Colorless oil, 64 mg, yield: 70%; 3s1:3s2=1:1, R_f=0.47 (EtOAc/Petroleum ether 1:20).
[1]H NMR (400 MHz, CDCl3): δ 7.40-7.10 (m, 8H), 6.85 (s, 2H), 6.60 (ddd, *J* = 26.9, 15.8, 6.8 Hz, 1H), 6.44-6.06 (m, 3H), 4.82 (dd, *J* = 14.4, 7.3 Hz, 1H), 2.96 (d, *J* = 1.6 Hz, 6H).
[13]C NMR (101 MHz, CDCl3): δ 152.96, 141.71, 141.55, 137.19, 131.15, 130.26, 129.49, 129.04, 128.61, 128.47, 128.43, 128.26, 127.33, 126.37, 126.34, 119.74, 111.19, 110.11, 107.13, 106.51, 53.08, 47.50.

HRMS (m/z): calcd for $C_{21}H_{22}NO$ $[MH]^+$: 304.1696, found: 304.1698.

(E)-N,N-dimethyl-4-(1-phenyl-3-(thiophen-2-yl)allyl)aniline (3t1) and (E)-N,N-dimethyl-4-(3-phenyl-1-(thiophen-2-yl)allyl)aniline (3t2)



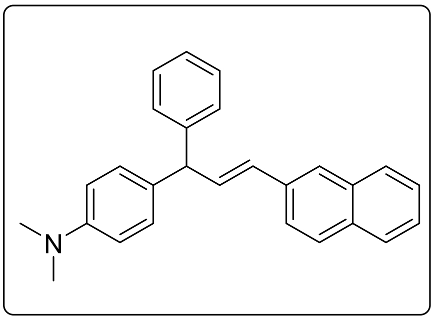
3t1



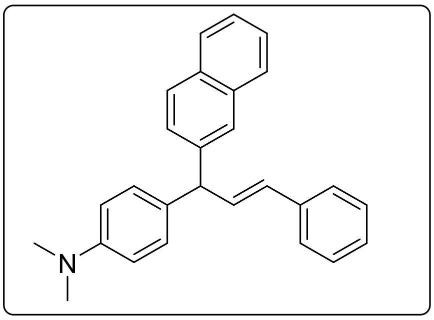
3t2

Colorless oil, 64 mg, yield: 67%; 3t1:3t2=1:1, R_f=0.27 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.42 (d, *J* = 7.7 Hz, 1H), 7.34 (q, *J* = 7.3 Hz, 2H), 7.30 – 7.12 (m, 5H), 7.02 – 6.87 (m, 2H), 6.79 – 6.73 (m, 2H), 6.72-6.54 (dd, *J* = 15.6, 7.0 Hz, 1H), 6.50-6.44 (dd, *J* = 15.8, 10.3 Hz, 1H), 5.04-4.82 (d, *J* = 6.9 Hz, 1H), 2.97 (s, 6H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 149.58, 149.31, 148.74, 143.93, 142.78, 137.29, 133.31, 132.72, 131.17, 130.63, 129.35, 128.91, 128.70, 128.53, 128.45, 127.33, 127.30, 126.74, 126.45, 126.32, 125.04, 124.85, 124.24, 124.16, 123.62, 112.80, 112.76, 53.10, 48.91, 40.76, 40.72.
HRMS (m/z): calcd for $C_{21}H_{22}NS$ $[MH]^+$: 320.1467, Found:320.1470.

(E)-N,N-dimethyl-4-(3-(naphthalen-2-yl)-1-phenylallyl)aniline (3u1) and (E)-N,N-dimethyl-4-(1-(naphthalen-2-yl)-3-phenylallyl)aniline (3u2)



3u1



3u2

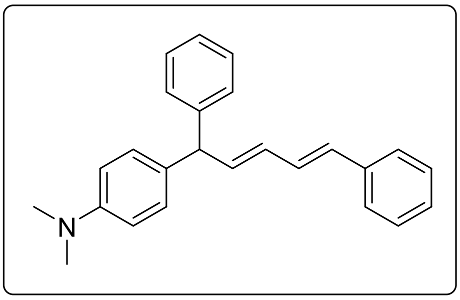
Colorless oil, 95 mg, yield: 87%; 3u1:3u2=1:1, R_f=0.18 (EtOAc/Petroleum ether 1:30).
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.84 (q, *J* = 10.2, 7.8 Hz, 3H), 7.76-7.68 (m, 1H), 7.55-7.19 (m, 10H), 6.93-6.76 (m, 3H), 6.57-6.46 (d, *J* = 15.8 Hz, 1H), 5.06 (d, *J* =

7.4 Hz, 1H), 2.99 (d, *J* = 1.8 Hz, 6H).

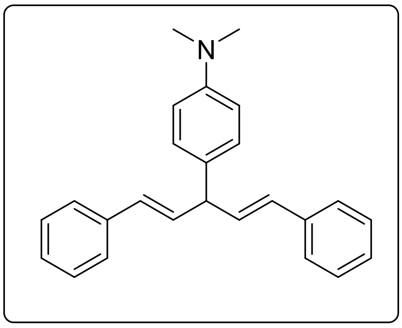
^{13}C NMR (101 MHz, CDCl$_3$): δ 149.27, 144.26, 141.79, 137.56, 135.05, 133.90, 133.73, 133.69, 133.64, 133.22, 132.88, 132.30, 131.73, 131.54, 131.19, 131.04, 129.51, 129.42, 128.76, 128.59, 128.51, 128.35, 128.14, 128.05, 127.96, 127.90, 127.71, 127.67, 127.60, 127.27, 126.78, 126.41, 126.35, 126.23, 126.03, 126.01, 125.68, 125.54, 123.81, 112.98, 112.96, 53.49, 53.44, 40.87, 40.85.

HRMS (m/z): calcd for $C_{27}H_{26}N$ $[MH]^+$: 364.2060, Found: 364.2062.

4-((2E,4E)-1,5-diphenylpenta-2,4-dien-1-yl)-N,N-dimethylaniline (3v1) and 4-((1E,4E)-1,5-diphenylpenta-1,4-dien-3-yl)-N,N-dimethylaniline (3v2)



3v1



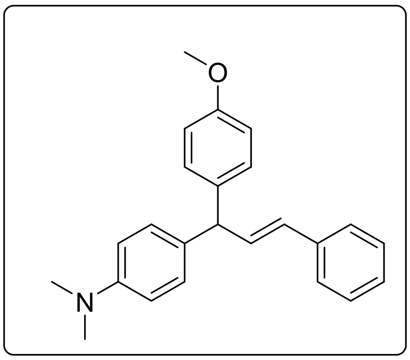
3v2

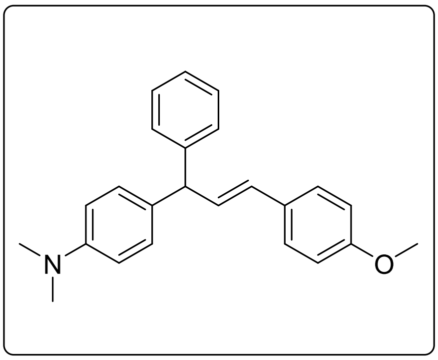
Colorless oil, 83 mg, yield: 81%; 3v1:3v2=3:1, R_f=0.25 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.47-7.23 (m, 10H), 7.23-7.09 (m, 2H), 6.95-6.72 (m, 3H), 6.53-6.15 (m, 3H), 4.80-4.36 (d, *J* = 7.4 Hz, 1H), 2.97 (d, *J* = 5.1 Hz, 6H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 144.14, 137.80, 137.55, 137.53, 132.57, 131.53, 131.33, 130.27, 129.30, 129.07, 128.85, 128.62, 128.60, 128.54, 128.42, 128.32, 127.89, 127.30, 127.19, 126.31, 126.25, 113.07, 53.25, 50.74, 40.94.

(E)-4-(1-(4-methoxyphenyl)-3-phenylallyl)-N,N-dimethylaniline (3w1) and (E)-4-(3-(4-methoxyphenyl)-1-phenylallyl)-N,N-dimethylaniline (3w2)





3w1 **3w2**

Colorless oil, 82 mg, yield: 80%; 3w1:3w2=1:1, R_f=0.09 (EtOAc/Petroleum ether 1:30).

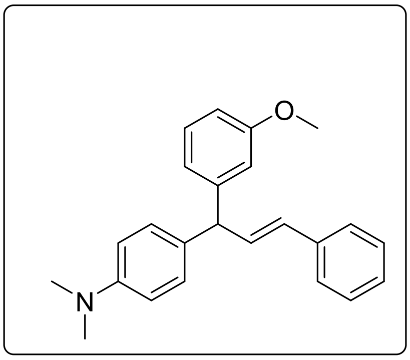
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.47-7.28 (m, 5H), 7.29-7.18 (m, 2H), 7.16 (d, *J* = 8.2 Hz, 2H), 6.89 (t, *J* = 8.8 Hz, 2H), 6.77 (d, *J* = 8.3 Hz, 2H), 6.72-6.55 (m, 1H), 6.36 (t, *J* = 15.4 Hz, 1H), 4.84 (t, *J* = 8.1 Hz, 1H), 3.83 (s, 3H), 2.97 (s, 6H).

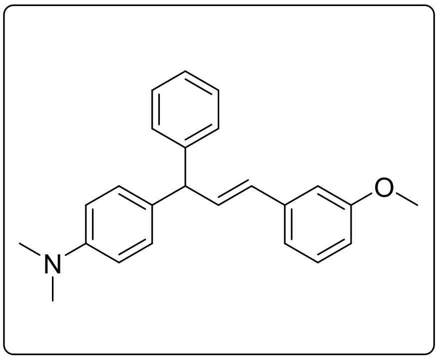
^{13}C NMR (101 MHz, $CDCl_3$): δ 149.16, 133.70, 131.26, 130.62, 130.25, 129.61, 129.33, 129.27, 128.68, 128.52, 128.40, 127.45, 127.14, 126.32, 126.20, 113.94, 113.82, 112.94, 55.32, 55.30, 53.33, 52.49, 40.87.

HRMS (m/z): calcd for $C_{24}H_{26}NO$ $[MH]^+$: 344.2009, Found: 344.2012.

(E)-4-(1-(3-methoxyphenyl)-3-phenylallyl)-N,N-dimethylaniline (3x1)

(E)-4-(3-(3-methoxyphenyl)-1-phenylallyl)-N,N-dimethylaniline (3x2)





3x1 **3x2**

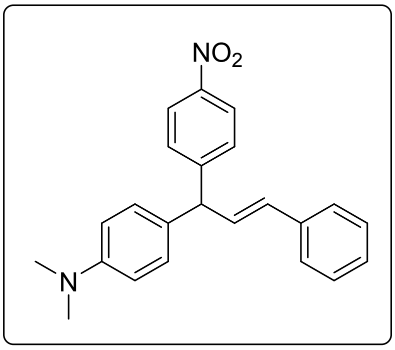
Colorless oil, 77 mg, yield: 75%; 3x1:3x2=1:1, R_f=0.27 (EtOAc/Petroleum ether 1:30).

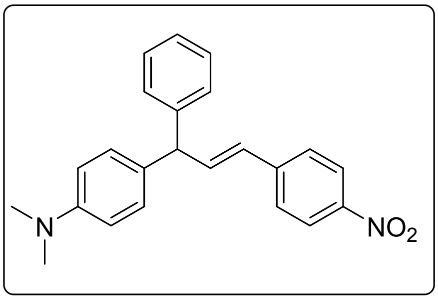
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.38 (d, *J* = 7.1 Hz, 1H), 7.36-7.17 (m, 5H), 7.12 (dd, *J* = 8.9, 2.7 Hz, 2H), 7.01-6.90 (m, 1H), 6.90-6.80 (m, 1H), 6.80-6.61 (m, 4H), 6.34 (t, *J* = 15.4 Hz, 1H), 4.81 (dd, *J* = 12.5, 7.5 Hz, 1H), 3.80-3.78 (s, 3H), 2.94 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 159.79, 159.67, 149.22, 145.89, 144.14, 139.00, 137.52, 133.68, 133.14, 130.85, 130.74, 129.42, 129.30, 129.29, 129.23, 128.64, 128.45, 128.38, 127.12, 126.30, 126.22, 121.12, 118.98, 114.63, 112.95, 111.48, 111.32, 55.21, 55.16, 53.32, 53.25, 40.77.

HRMS (m/z): calcd for $C_{24}H_{26}NO$ $[MH]^+$: 344.2009, found: 344.2013.

(E)-N,N-dimethyl-4-(1-(4-nitrophenyl)-3-phenylallyl)aniline (3y1) and (E)-N,N-dimethyl-4-(3-(4-nitrophenyl)-1-phenylallyl)aniline (3y2)





3y1 **3y2**

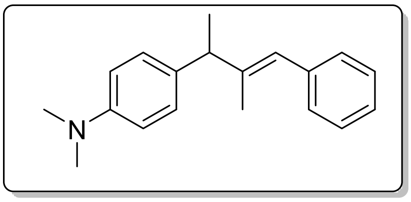
Colorless oil, 78 mg, yield: 72%; 3y1:3y2=2:3, R_f=0.28 (EtOAc/Petroleum ether 1:15).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.15 (dd, *J* = 8.6, 4.5 Hz, 2H), 7.48 (d, *J* = 8.4 Hz, 1H), 7.42-7.29 (m, 4H), 7.24 (d, *J* = 7.3 Hz, 2H), 7.09 (t, *J* = 8.3 Hz, 2H), 6.72 (d, *J* = 8.2 Hz, 2H), 6.62 (dd, *J* = 15.9, 7.4 Hz, 1H), 6.37 (t, *J* = 16.7 Hz, 1H), 4.91 (d, *J* = 7.4 Hz, 1H), 2.94 (d, *J* = 1.9 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 152.08, 149.57, 149.43, 146.61, 146.46, 144.04, 143.27, 138.56, 136.91, 131.97, 131.53, 130.33, 129.62, 129.42, 129.24, 129.19, 128.98, 128.59, 128.56, 127.58, 126.74, 126.55, 126.34, 123.94, 123.66, 112.78, 112.77, 53.41, 53.10, 40.65, 40.59.

HRMS (m/z): calcd for $C_{23}H_{23}N_2O_2$ $[MH]^+$: 359.1754, Found: 359.1758.

(E)-N,N-dimethyl-4-(3-methyl-4-phenylbut-3-en-2-yl)aniline (3z)



3z

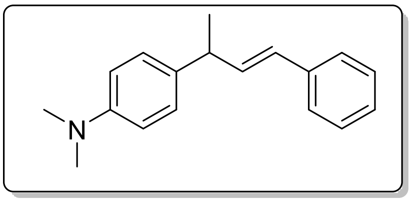
Yellow oil, 40 mg, yield: 51%; R_f=0.34 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.36-7.23 (m, 4H), 7.22-7.09 (m, 3H), 6.72 (d, *J* = 8.7 Hz, 2H), 6.46 (s, 1H), 3.50 (q, *J* = 7.1 Hz, 1H), 2.93 (s, 6H), 1.72 (d, *J* = 1.3 Hz, 3H), 1.45 (d, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 143.06, 138.74, 129.93, 129.29, 128.98, 128.13, 127.97, 127.96, 125.81, 124.09, 112.81, 47.51, 40.84, 19.64, 16.40.

HRMS (m/z): calcd for $C_{19}H_{24}N$ $[MH]^+$: 266.1903, found: 266.1905.

(E)-N,N-dimethyl-4-(4-phenylbut-3-en-2-yl)aniline (3aa)[9]



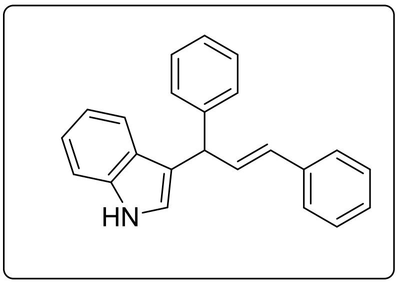
3aa

Yellow oil, 43 mg, yield: 57%; R_f=0.31 (EtOAc/Petroleum ether 1:30).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.35 (dd, J = 8.3, 1.3 Hz, 2H), 7.32-7.23 (m, 2H), 7.22-7.12 (m, 3H), 6.74 (d, J = 8.7 Hz, 2H), 6.41-6.35 (m, 2H), 3.57 (dt, J = 7.2, 3.8 Hz, 1H), 2.93 (s, 6H), 1.44 (d, J = 7.0 Hz, 3H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 137.81, 136.05, 129.05, 128.44, 128.42, 128.20, 127.88, 126.83, 126.10, 113.04, 41.54, 40.88, 21.23.

(E)-3-(1,3-diphenylallyl)-1H-indole (3ab)[10]



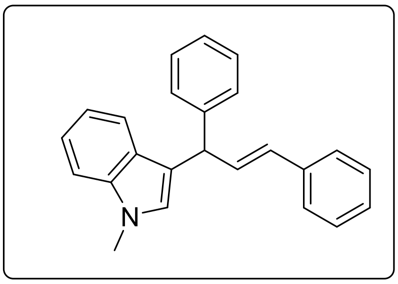
3ab

Yellow solid, m.p. 109-111°C, 79 mg, yield: 86%; R_f = 0.13 (EtOAc/Petroleum ether 1:20).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.85 (s, 1H), 7.54 (d, *J* = 8.0 Hz, 1H), 7.49-7.22 (m, 12H), 7.13 (t, *J* = 7.5 Hz, 1H), 6.89 (d, *J* = 2.4 Hz, 1H), 6.82 (dd, *J* = 15.8, 7.4 Hz, 1H), 6.54 (d, *J* = 15.8 Hz, 1H), 5.21 (d, *J* = 7.4 Hz, 1H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 143.50, 137.59, 136.72, 132.67, 130.64, 128.62, 128.61, 128.55, 127.29, 126.88, 126.51, 126.44, 122.76, 122.18, 119.97, 119.53, 118.66, 111.27, 46.30.

(E)-3-(1,3-diphenylallyl)-1-methyl-1H-indole (3ac) [10]

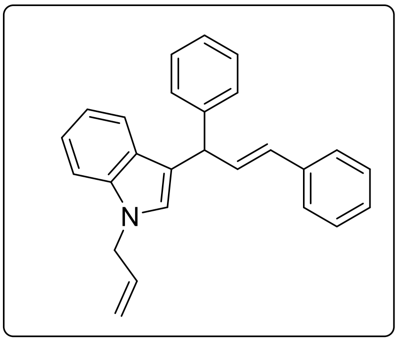


3ac

White solid, m.p. 116-117°C, 90 mg, yield: 93%; R_f = 0.31 (EtOAc/Petroleum ether 1:20).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.57 (d, *J* = 8.0 Hz, 1H), 7.52-7.29 (m, 12H), 7.16 (t, *J* = 7.5 Hz, 1H), 6.87 (q, *J* = 9.2, 7.9 Hz, 2H), 6.58 (d, *J* = 15.8 Hz, 1H), 5.25 (d, *J* = 7.4 Hz, 1H), 3.79 (s, 3H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 143.69, 137.64, 137.53, 132.85, 130.56, 128.63, 128.56, 127.51, 127.35, 127.28, 126.50, 126.45, 121.78, 120.09, 119.03, 117.17, 109.34, 46.31, 32.77.

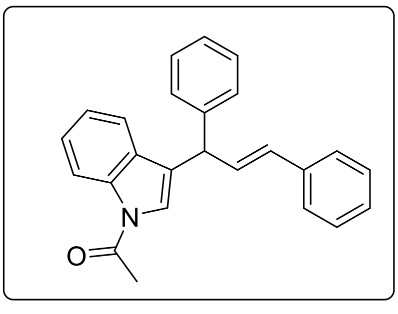
(E)-1-allyl-3-(1,3-diphenylallyl)-1H-indole (3ad)



3ad

Yellow solid, m.p. 49-50^{o}C, 90 mg, yield: 87%; R_f = 0.56 (EtOAc/Petroleum ether 1:15).
^{1}H NMR (400 MHz, CDCl$_3$): δ 7.49 -7.07 (m, 13H), 7.00 (t, J = 7.5 Hz, 1H), 6.80 (s, 1H), 6.71 (dd, J = 15.8, 7.4 Hz, 1H), 6.43 (d, J = 15.8 Hz, 1H), 5.96 (ddd, J = 22.4, 10.5, 5.4 Hz, 1H), 5.20-5.02 (m, 3H), 4.66 (dt, J = 5.4, 1.7 Hz, 2H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 143.49, 137.54, 136.86, 133.58, 132.71, 130.46, 128.49, 128.48, 128.41, 127.45, 127.14, 126.34, 126.33, 121.67, 120.06, 119.04, 117.46, 117.17, 109.59, 48.80, 46.25.
HRMS (m/z): calcd for $C_{26}H_{24}N$ [MH]$^+$: 350.1903, found: 350.1901.

(E)-1-(3-(1,3-diphenylallyl)-1H-indol-1-yl)ethan-1-one (3ae)



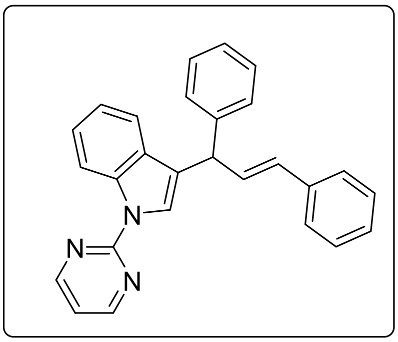
3ae

Yellow solid, m.p. 126-127^{o}C, 60 mg, yield: 57%; R_f = 0.33 (EtOAc/Petroleum ether 1:20).
^{1}H NMR (400 MHz, CDCl$_3$): δ 8.45 (d, J = 8.2 Hz, 1H), 7.44-7.13 (m, 13H), 7.12 (s, 1H), 6.68 (dd, J = 15.8, 7.3 Hz, 1H), 6.45 (d, J = 15.2 Hz, 1H), 5.05 (d, J = 7.3 Hz, 1H), 2.55 (s, 3H).
^{13}C NMR (101 MHz, CDCl$_3$): δ 168.53, 141.75, 137.06, 136.38, 131.66, 130.83,

129.87, 128.73, 128.61, 128.45, 127.56, 126.93, 126.43, 125.33, 125.03, 123.52, 123.22, 120.08, 45.95, 24.08.

HRMS (m/z): calcd for $C_{25}H_{22}NO$ $[MH]^+$: 352.1696, found: 352.1699.

(E)-3-(1,3-diphenylallyl)-1-(pyrimidin-2-yl)-1H-indole (3af)



3af

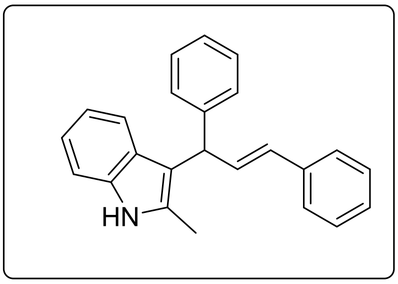
Yellow solid, m.p. 142-143^{o}C, 85 mg, yield: 73%; R_f = 0.41 (EtOAc/Petroleum ether 1:20).

^{1}H NMR (400 MHz, CDCl$_3$): δ 8.81 (d, *J* = 8.4 Hz, 1H), 8.62 (d, *J* = 4.8 Hz, 2H), 8.05 (d, *J* = 1.2 Hz, 1H), 7.40 (d, *J* = 11.8 Hz, 5H), 7.37-7.11 (m, 8H), 6.94 (t, *J* = 4.8 Hz, 1H), 6.78 (dd, *J* = 15.8, 7.4 Hz, 1H), 6.48 (d, *J* = 14.6 Hz, 1H), 5.13 (d, *J* = 7.4 Hz, 1H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 158.07, 157.69, 142.53, 137.39, 136.13, 131.74, 131.11, 130.48, 128.60, 128.56, 128.53, 127.30, 126.63, 126.44, 123.88, 122.71, 121.97, 119.91, 116.39, 115.88, 46.20.

HRMS (m/z): calcd for $C_{27}H_{22}NO_3$ $[MH]^+$: 388.1808, found: 388.1805.

(E)-3-(1,3-diphenylallyl)-2-methyl-1H-indole (3ag)[10]



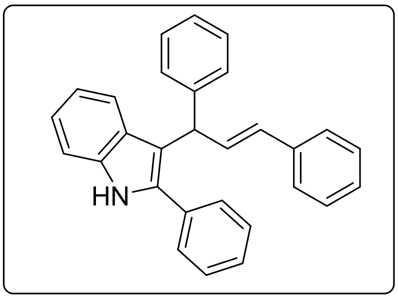
3ag

Yellow solid, m.p. 59-60^{o}C, 81 mg, yield: 84%; R_f = 0.26 (EtOAc/Petroleum ether 1:10).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.77 (s, 1H), 7.44-7.34 (m, 5H), 7.35-7.25 (m, 5H), 7.27-7.18 (m, 2H), 7.16-7.08 (m, 1H), 7.05-6.97 (m, 1H), 6.87 (dd, *J* = 15.8, 7.2 Hz, 1H), 6.45 (dd, *J* = 15.9, 1.5 Hz, 1H), 5.18 (d, *J* = 5.9 Hz, 1H), 2.37 (s, 3H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 143.49, 137.58, 135.37, 132.21, 131.66, 130.61, 129.04, 128.52, 128.31, 128.28, 127.99, 127.12, 126.31, 126.13, 120.92, 119.43, 119.28, 112.86, 110.30, 45.10, 12.41.

(E)-3-(1,3-diphenylallyl)-2-phenyl-1H-indole (3ah) [10]



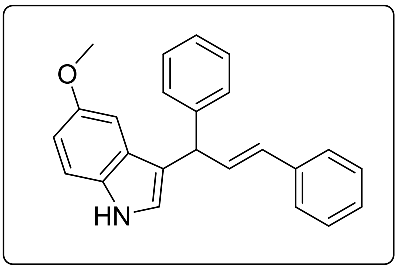
3ah

Yellow solid, m.p. 65-66°C, 106 mg, yield: 92%; R_f = 0.25 (EtOAc/Petroleum ether 1:10).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.06 (s, 1H), 7.57 (dd, *J* = 7.5, 2.3 Hz, 2H), 7.54-7.32 (m, 10H), 7.36-7.25 (m, 5H), 7.28-7.16 (m, 3H), 7.10-7.01 (m, 1H), 6.94 (dd, *J* = 15.8, 7.3 Hz, 1H), 6.46 (dd, *J* = 15.8, 1.4 Hz, 1H), 5.33 (d, *J* = 7.2 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 143.53, 137.55, 136.29, 135.64, 133.01, 132.32, 131.12, 128.86, 128.66, 128.50, 128.35, 128.32, 128.09, 127.96, 127.16, 126.37, 126.17, 122.16, 121.26, 119.75, 113.89, 110.99, 45.19.

(E)-3-(1,3-diphenylallyl)-5-methoxy-1H-indole (3ai) [10]



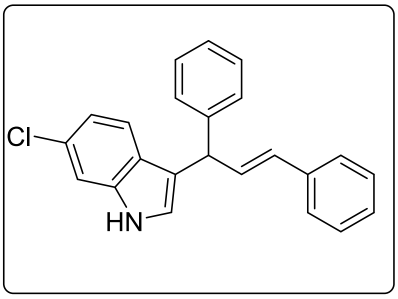
3ai

Yellow solid, m.p. 62-63°C, 81 mg, yield: 80%; R_f = 0.25 (EtOAc/Petroleum ether 1:10).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.90 (s, 1H), 7.42-7.18 (m, 12H), 6.91-6.81 (m, 3H), 6.74 (dd, *J* = 15.8, 7.3 Hz, 1H), 6.47 (d, *J* = 15.9 Hz, 1H), 5.10 (d, *J* = 8.7 Hz, 1H), 3.73 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.79, 143.33, 137.52, 132.52, 131.83, 130.57, 128.53, 128.51, 128.45, 127.25, 127.18, 126.41, 126.33, 125.95, 123.48, 118.32, 112.15, 111.81, 101.83, 55.81, 46.24.

(E)-6-chloro-3-(1,3-diphenylallyl)-1H-indole (3aj)[11]



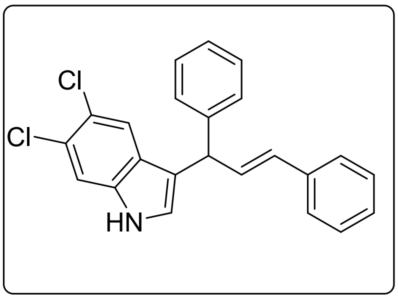
3aj

Yellow solid, m.p. 131-132°C, 80 mg, yield: 78%; R_f = 0.58 (EtOAc/Petroleum ether 1:7).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.94 (s, 1H), 7.40-7.17 (m, 12H), 6.99 (dd, *J* = 8.5, 1.8 Hz, 1H), 6.88 (dd, *J* = 2.4, 1.0 Hz, 1H), 6.70 (dd, *J* = 15.8, 7.4 Hz, 1H), 6.43 (d, *J* = 15.8 Hz, 1H), 5.08 (d, *J* = 7.3 Hz, 1H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 143.02, 137.32, 137.01, 132.11, 130.79, 128.53, 128.51, 128.42, 128.07, 127.29, 126.55, 126.32, 125.40, 123.24, 120.78, 120.21, 118.92, 111.04, 46.08.

(E)-5,6-dichloro-3-(1,3-diphenylallyl)-1H-indole (3ak)



3ak

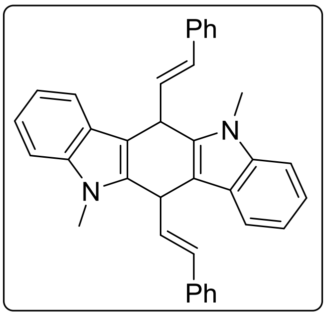
Yellow solid, m.p. 125-126°C, 105 mg, yield: 93%; R_f = 0.31 (EtOAc/Petroleum ether 1:10).

^{1}H NMR (400 MHz, CDCl$_3$): δ 8.00 (s, 1H), 7.46 (s, 1H), 7.42 (s, 1H), 7.39 – 7.34 (m, 3H), 7.33 – 7.31 (m, 3H), 7.30 – 7.28 (m, 2H), 7.26 – 7.20 (m, 2H), 6.91 (dd, *J* = 2.4, 1.0 Hz, 1H), 6.67 (dd, *J* = 15.8, 7.3 Hz, 1H), 6.42 (dd, *J* = 15.8, 1.3 Hz, 1H), 5.04 (d, *J* = 8.5 Hz, 1H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 142.65, 137.20, 135.40, 131.78, 131.00, 128.62, 128.57, 128.45, 128.44, 128.37, 127.40, 126.73, 126.58, 126.36, 126.00, 125.96, 125.91, 124.58, 123.52, 120.76, 118.56, 112.62, 45.87.

HRMS (m/z): calcd for $C_{23}H_{18}Cl_2N$ $[MH]^+$: 378.0811, found: 378.0804.

5,11-dimethyl-6,12-di((E)-styryl)-5,6,11,12-tetrahydroindolo[3,2-b]carbazole (3al)



3al

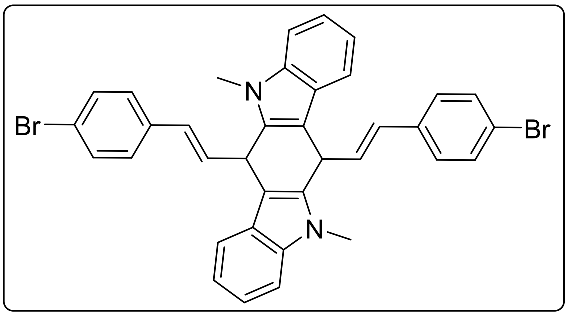
Yellow solid, m.p. 148-150°C, 27 mg, yield: 37%; R_f = 0.54 (EtOAc/Petroleum ether 1:20).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.74 (d, *J* = 7.8 Hz, 1H), 7.35 (m, 3H), 7.30-7.22 (m, 3H), 7.17 (m, 2H), 6.81 (d, *J* = 15.7 Hz, 1H), 6.27 (dd, *J* = 15.7, 8.0 Hz, 1H), 5.20 (d, *J* = 7.8 Hz, 1H), 3.83 (s, 3H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 137.95, 136.94, 135.83, 131.75, 130.20, 128.47, 127.37, 126.36, 125.91, 121.32, 119.24, 118.60, 109.09, 108.94, 37.26, 30.07.

HRMS (m/z): calcd for $C_{36}H_{30}NNa^+$ $[M+Na]^+$: 513.2301, found: 513.2306.

6,12-bis((E)-4-bromostyryl)-5,11-dimethyl-5,6,11,12-tetrahydroindolo[3,2-b]carbazole (3am)



3am

Yellow solid, m.p. 158-159°C, 29 mg, yield: 30%; R_f = 0.51 (EtOAc/Petroleum ether 1:20).

^{1}H NMR (400 MHz, CDCl$_3$): δ 7.70 (d, *J* = 7.9 Hz, 1H), 7.36 (dd, *J* = 8.1, 6.1 Hz, 3H), 7.28-7.20 (m, 1H), 7.21-7.10 (m, 3H), 6.70 (d, *J* = 15.7 Hz, 1H), 6.26 (dd, *J* = 15.7, 7.8 Hz, 1H), 5.18 (d, *J* = 7.7 Hz, 1H), 3.82 (s, 3H).

^{13}C NMR (101 MHz, CDCl$_3$): δ 137.93, 135.77, 135.61, 132.41, 131.61, 131.57, 128.98, 127.84, 125.79, 121.48, 121.15, 119.37, 118.46, 109.18, 108.82, 37.09, 30.07.

HRMS (m/z): calcd for $C_{36}H_{28}N_2Br_2Na^+$$[M+Na]^+$: 669.0511, found: 669.0518.

5. X-Ray Analysis

The X-ray quality crystals of **3af** were grown from ethyl acetate.

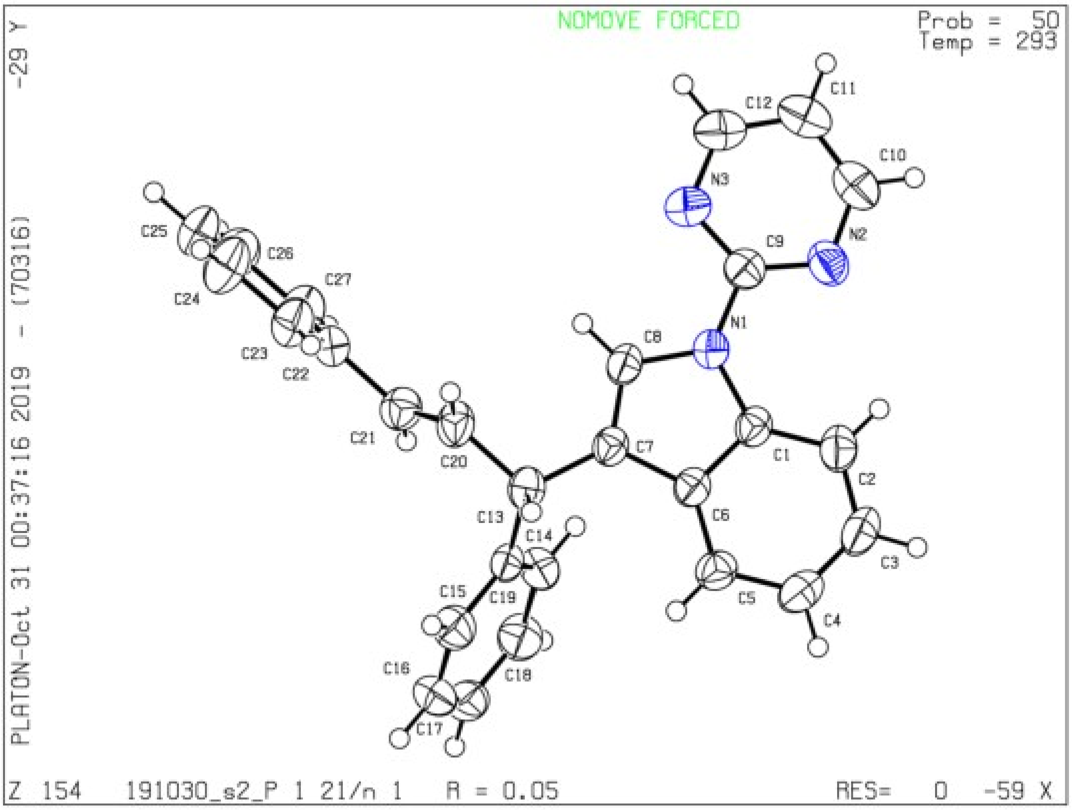


Figure S1. ORTEP Drawing of **3af** (CCDC)

The X-ray quality crystals of **3al** were grown from ethyl acetate and dichloromethane.

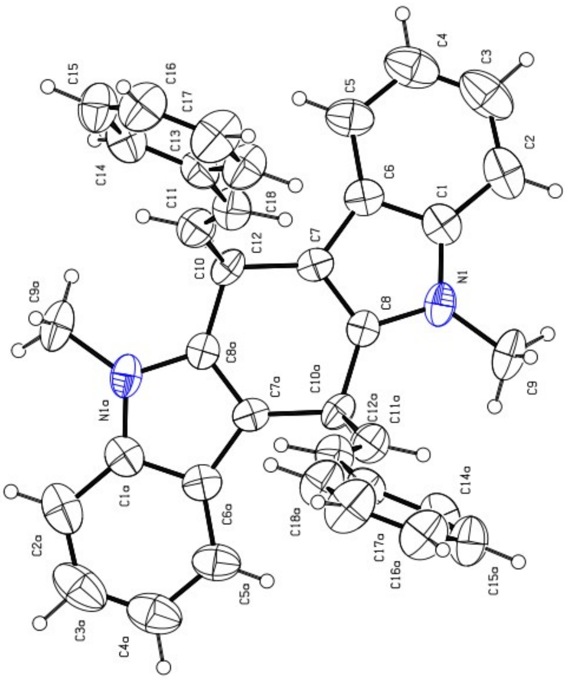


Figure S2. ORTEP Drawing of **3al** (CCDC)

6. References

1. H. Shen, X. Zhang, Q. Liu, J. Pan, W. Hu, Y. Xiong and X. Zhu, Direct oxidative cyanation of tertiary amines promoted by in situ generated hypervalent iodine (III)-CN intermediate, *Tetrahedron Lett*., 2015, **56**, 5628-5631.

2. X.-Z. Shu, Y.-F. Yang, Xiao-Feng Xia, K.-G. Ji, X.-Y. Liu and Y.-M. Liang, Platinum-catalyzed cross-dehydrogenative coupling reaction in the absence of oxidant, *Org. Biomol. Chem.,* 2010*,* **8***,* 4077-4079.

3. S. Olguín-Uribe, M. V. Mijangos, Y. A. Amador-Sánchez, M. A. Sánchez-Carmona and L. D. Miranda, Expedited Synthesis of Matrine Analogues through an Oxidative Cascade Addition/Double-Cyclization Radical Process, *Eur. J. Org. Chem*., 2017, 2481-2485.

4. Z.-L. Yan, W.-L. Chen, Y.-R. Gao, S. Mao, Y.-L. Zhang and Y.-Q. Wang, Palladium - Catalyzed Intermolecular C-2 Alkenylation of Indoles Using Oxygen as the Oxidant, *Adv. Synth. Catal.,* 2014*,* **356***,* 1085-1092.

5. M. Nishino, K. Hirano, T. Satoh and M. Miura, Copper-Mediated and Copper-Catalyzed Cross-Coupling of Indoles and 1,3-Azoles: Double C-H Activation, *Angew. Chem. Int. Ed.,* 2012, **51**, 6993-6997.

6. (a) B. Ding, Z. Zhang, Y. Liu, M. Sugiya and T. Imamoto, Chemoselective transfer hydrogenation of α, β-unsaturated ketones catalyzed by pincer-Pd complexes using alcohol as a hydrogen source, *Org. Lett.,* 2013, **15**, **14**, 3690-3693; (b) I. M. Ferreira, E. B. Meira, I. G. Rosset and A. L. M. Porto, Chemoselective biohydrogenation of α, β-and α, β, γ, δ-unsaturated ketones by the marine-derived fungus Penicillium citrinum CBMAI 1186 in a biphasic system, *Journal of Molecular Catalysis B: Enzymatic,* 2015**, 115**, 59-65. (c) A. Sultan, A. R. Raza, M. Abbas, K. M. Khan, M. N. Tahir and N. Saari, Evaluation of silica-H_2SO_4 as an efficient heterogeneous catalyst for the synthesis of chalcones, *Molecules,* 2013, **18**, 10081-10094; (d) Z. Li, X. L. Chen, Y. J. Fu, W. Wang and M. Luo, A facile synthesis of trisubstituted alkenes from β-diketones and aldehydes with $AlCl_3$ as catalyst, *Res Chem Intermed.,* 2012, **38**, 25-35; (e) Y. H. He, Y. Hu and Z. Guan, Natural α-amino acid L-lysine–catalyzed Knoevenagel condensations of α, β-unsaturated aldehydes and 1, 3-dicarbonyl compounds, *Synthetic Communications*, 2011, **41**, 1617-1628; (f) Y.

Ma, J. Li, J. Ye, D. Liu and W. Zhang, Synthesis of chiral chromanols via a RuPHOX–Ru catalyzed asymmetric hydrogenation of chromones, *Chem. Commun.,* 2018**, 54**, 13571-13574.

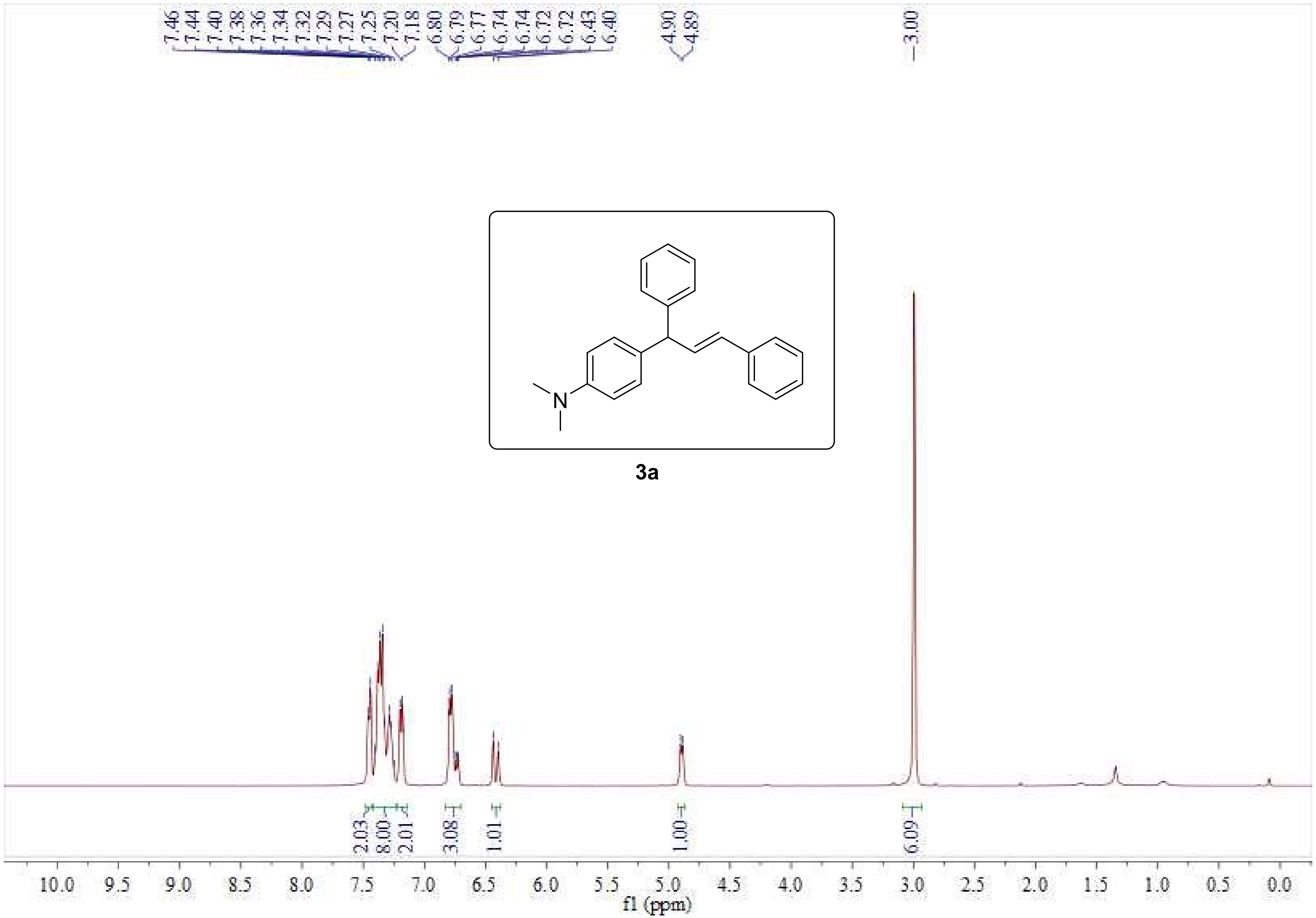
7. W. Gladkowski, A. Skrobiszewski, M. Mazur, M. Siepka, A. Pawlak, B. Obmi nska-Mrukowicz, A. Bialonska, D. Poradowski, A. Drynda and M, Urbaniak, Synthesis and anticancer activity of novel halolactones with β-aryl substituents from simple aromatic aldehydes, *Tetrahedron*. 2013, **69**, 10414-10423.

8. M. Gómez-Martínez, A. Baeza and D. A. Alonso, Pinacol Rearrangement and Direct Nucleophilic Substitution of Allylic Alcohols Promoted by Graphene Oxide and Graphene Oxide CO_2H, *ChemCatChem*., 2017, **9**, 1032-1039.

9. B. Yang and Z.-X. Wang, Nickel-Catalyzed Cross-Coupling of Allyl Alcohols with Aryl-or Alkenylzinc Reagents, *J. Org. Chem*. 2017, **82**, 4542-4549.

10. G.-P. Fan, Z. Liu and G.-W. Wang, Efficient $ZnBr_2$-catalyzed reactions of allylic alcohols with indoles, sulfamides and anilines under high-speed vibration milling conditions, *Green Chem*., 2013, **15**, 1659-1664.

11. T. Mino, M. Ishikawa, K. Nishikawa, K. Wakui and M. Sakamoto, Palladium-catalyzed asymmetric allylic alkylation of indoles by C-N bond axially chiral phosphine ligands, *Tetrahedron: Asymmetry,* 2013, **24**, 499-504.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2.01
3.08
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1.00
6.09
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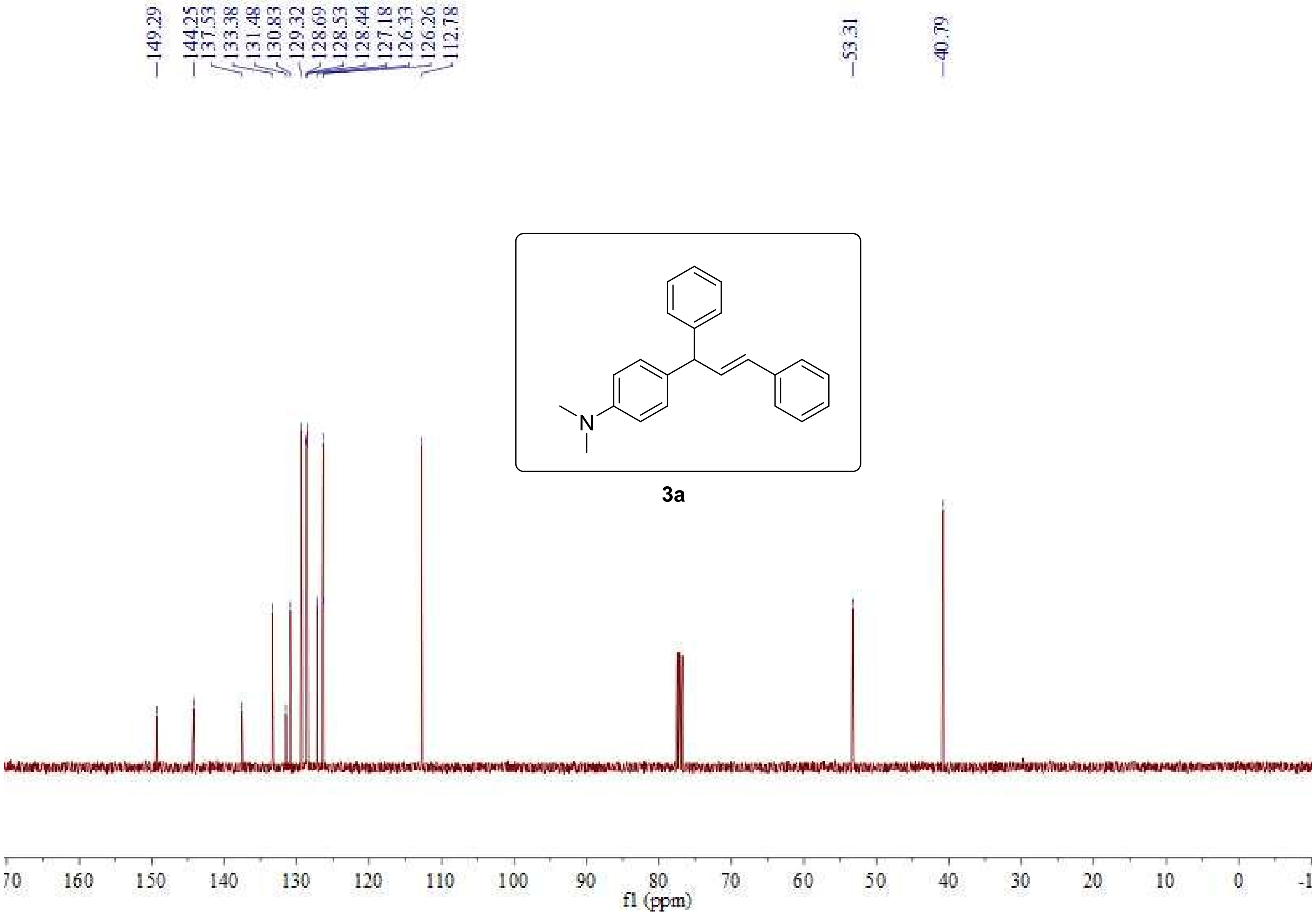
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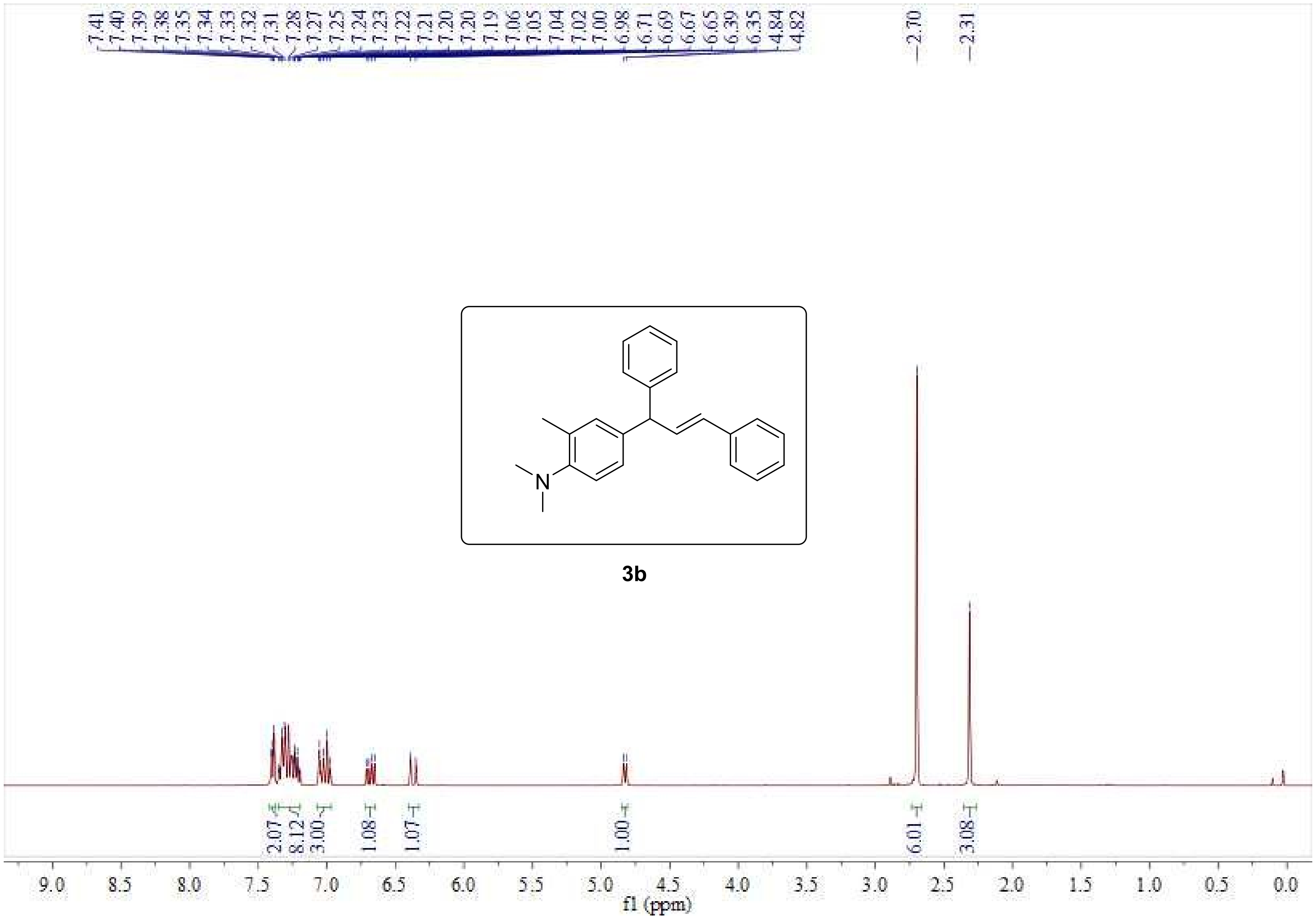
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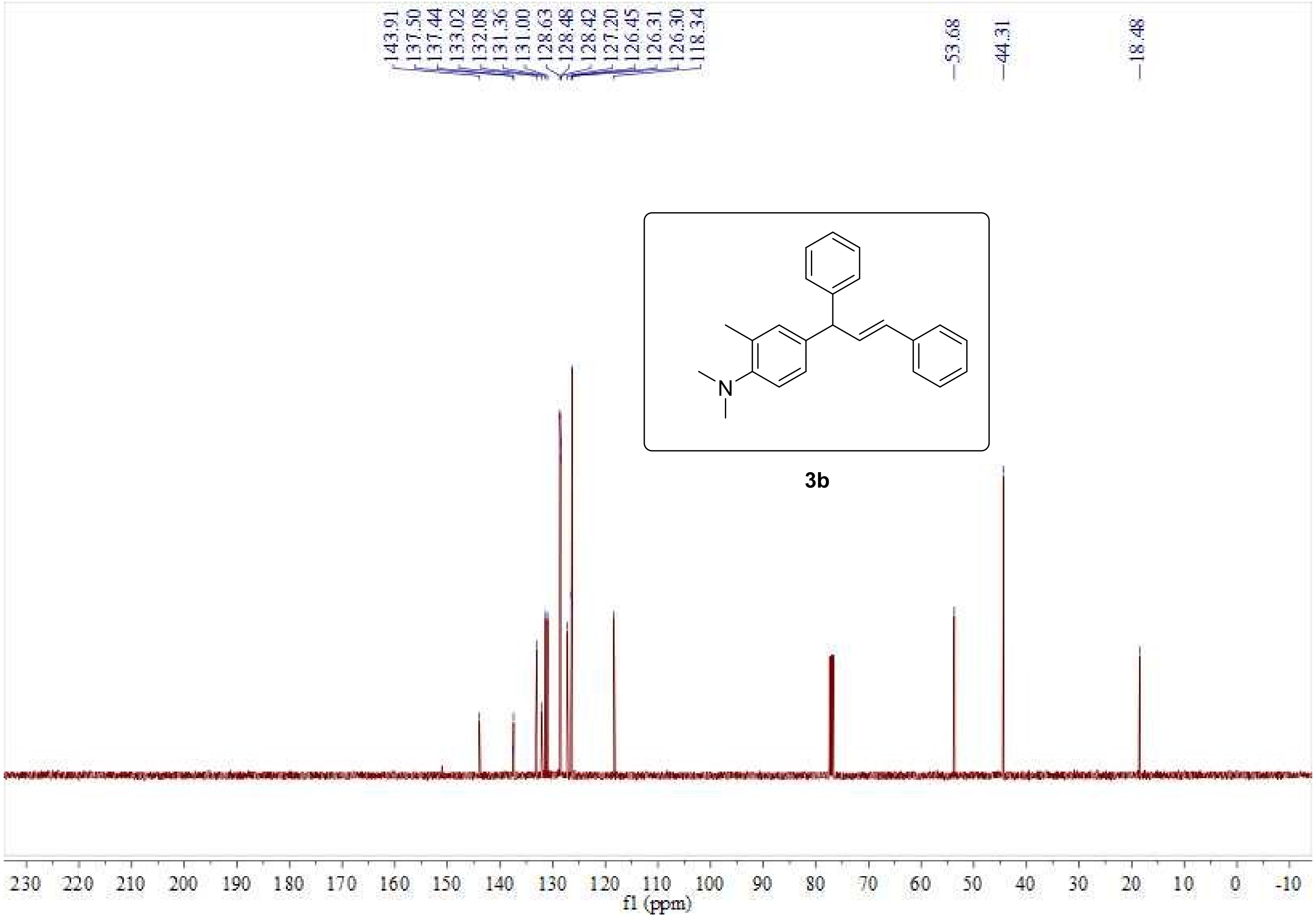
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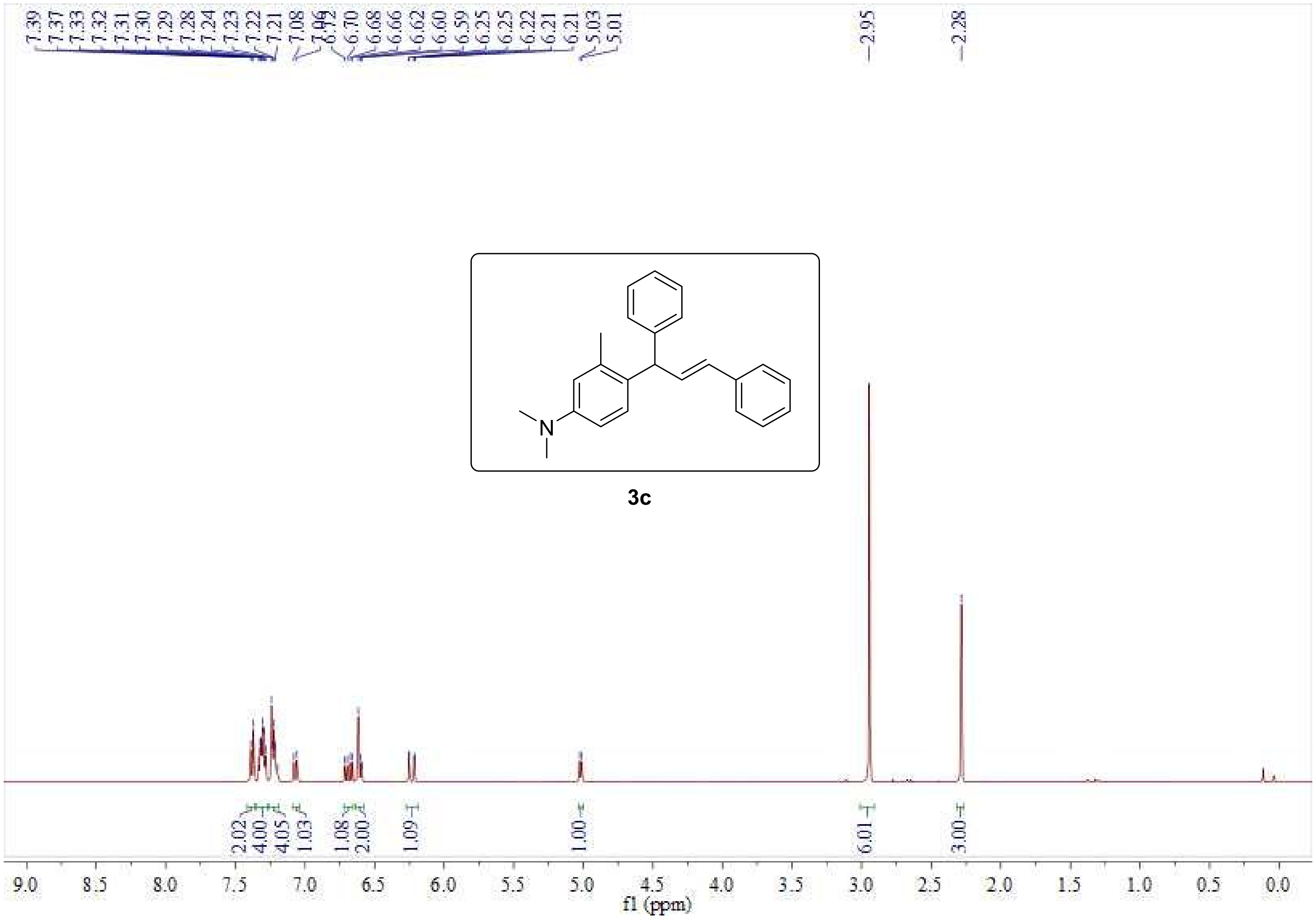
3b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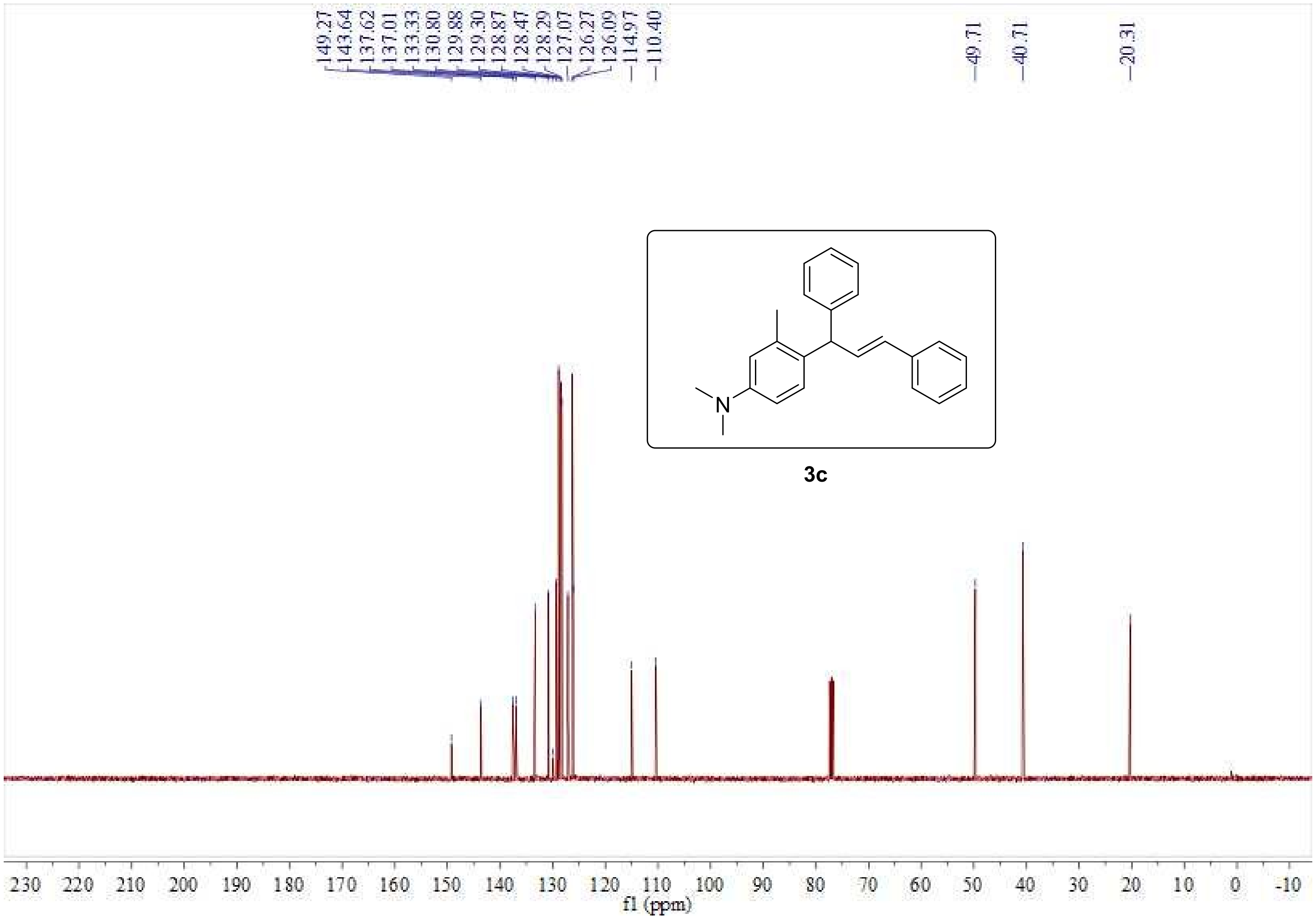
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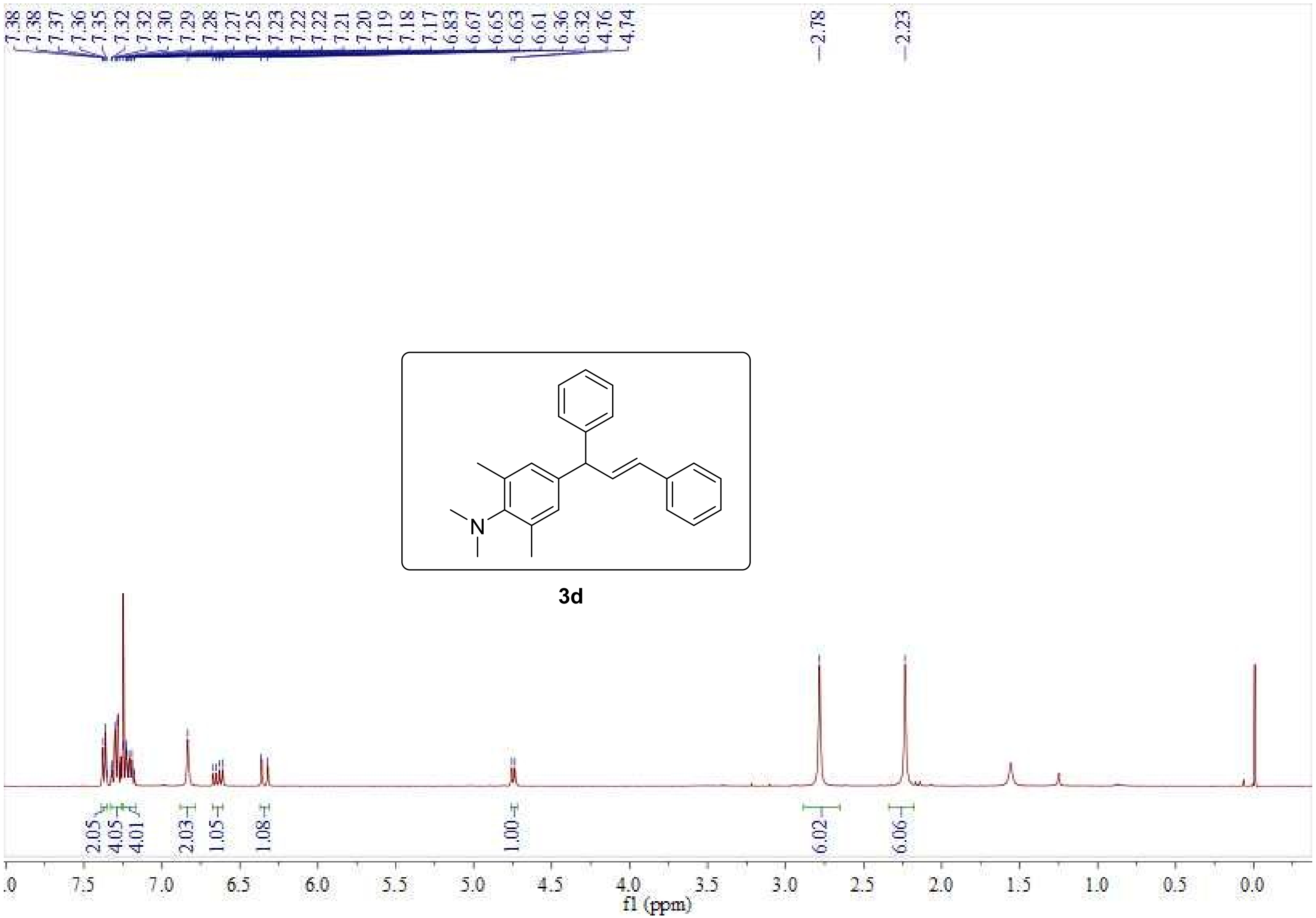
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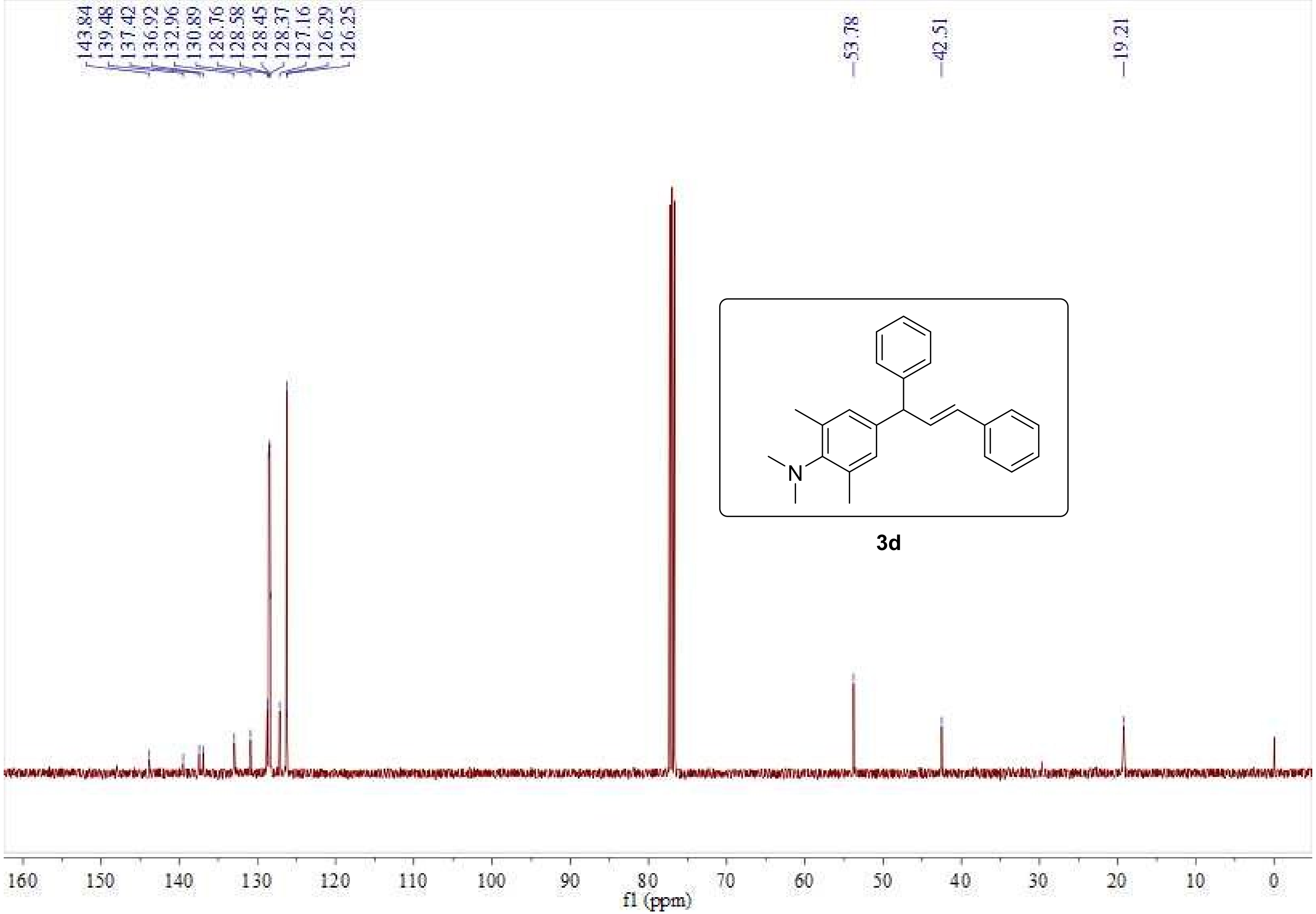
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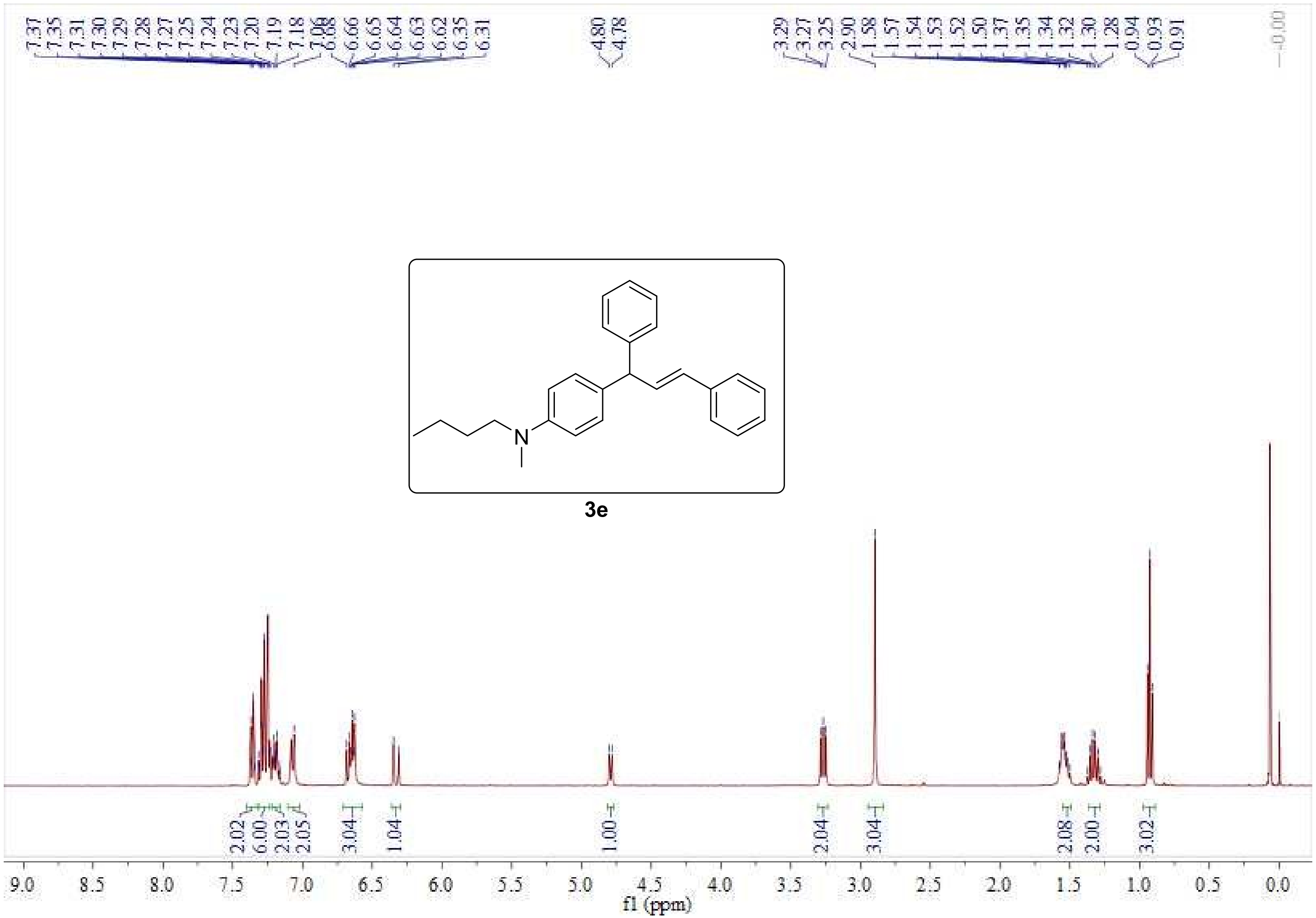
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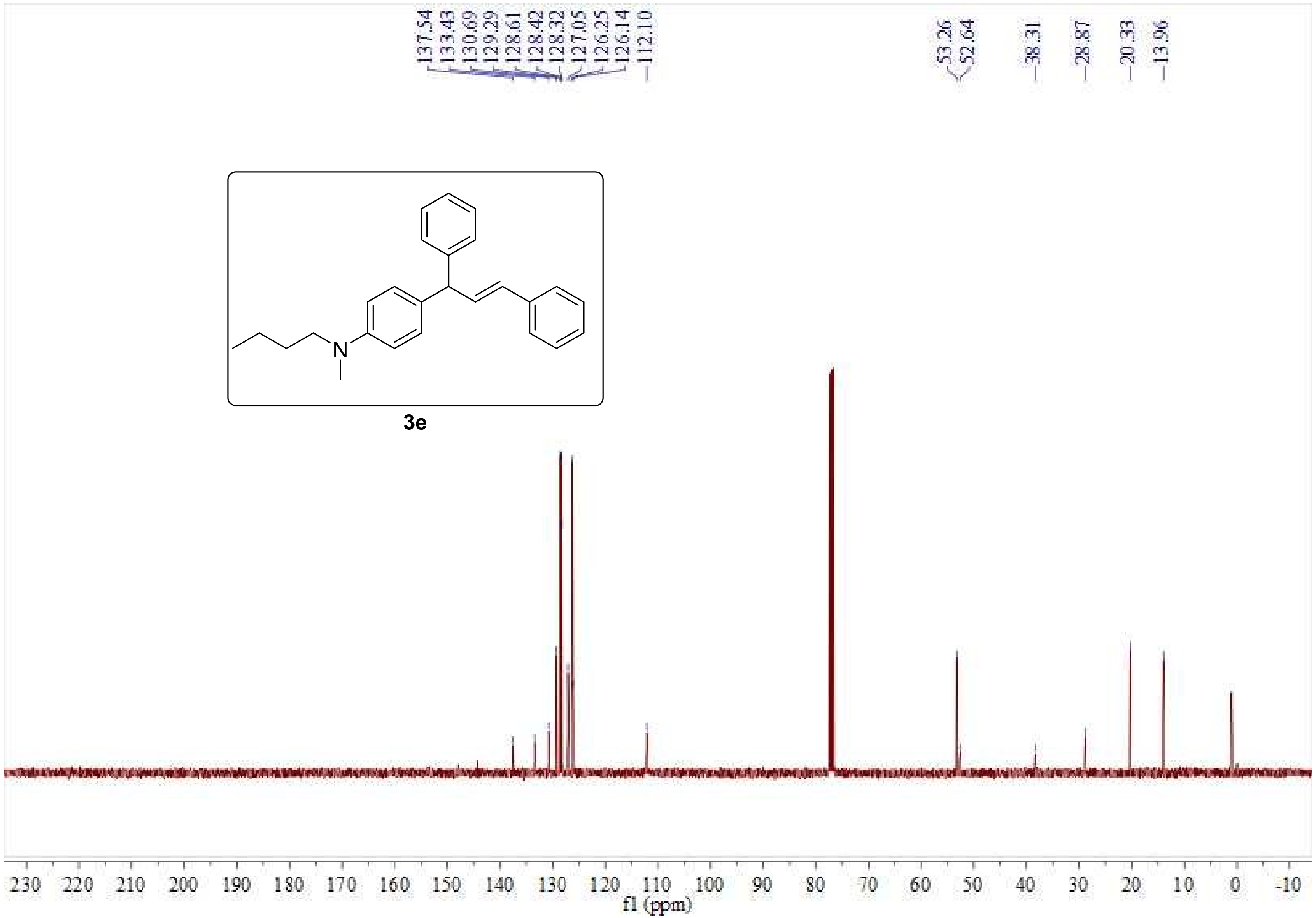
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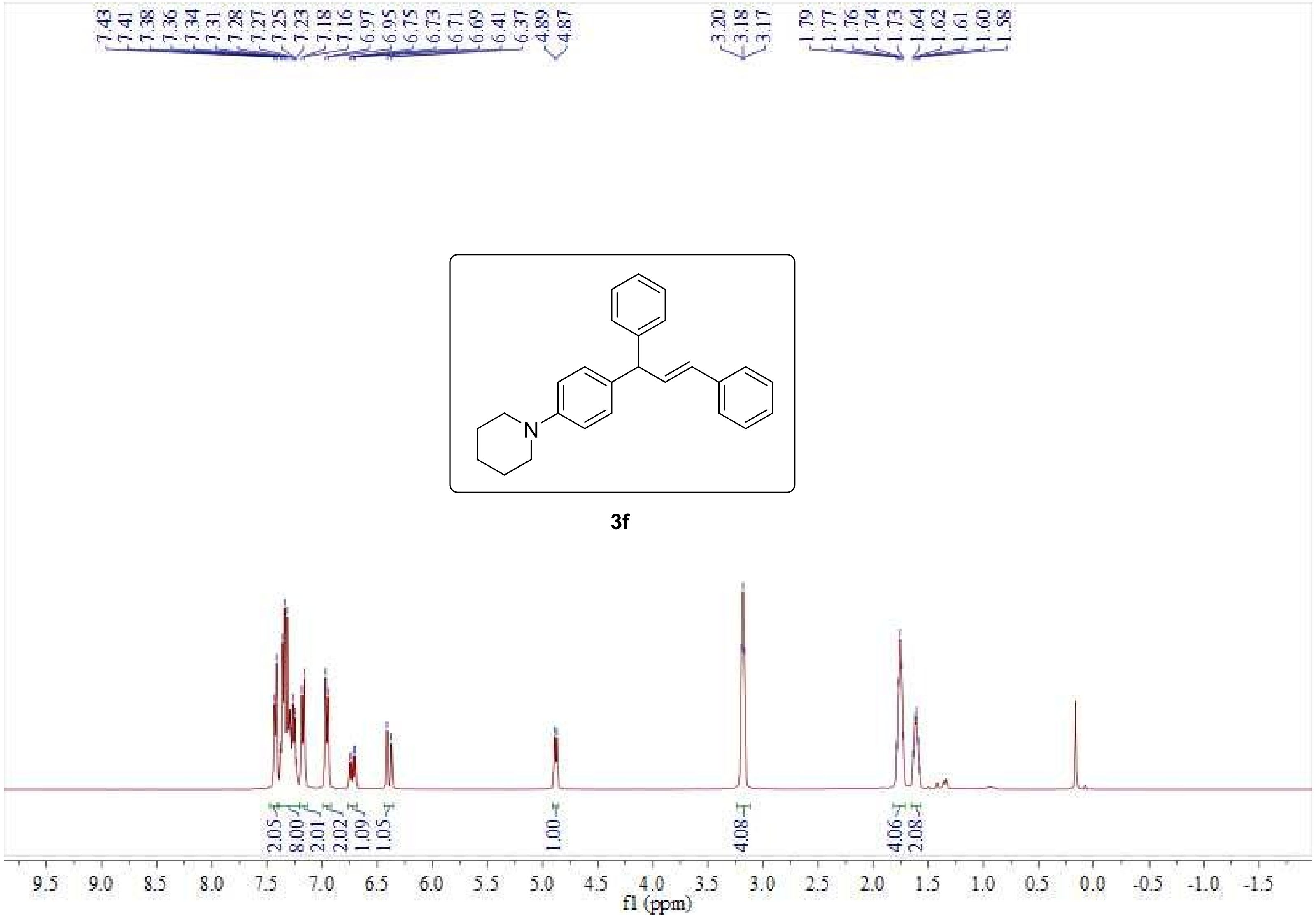
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3.20 3.18 3.17
1.79 1.77 1.76 1.74 1.73 1.64 1.62 1.61 1.60 1.58
N
3f
2.05 8.00 2.01 2.02 1.09 1.05
1.00
4.08
4.06 2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
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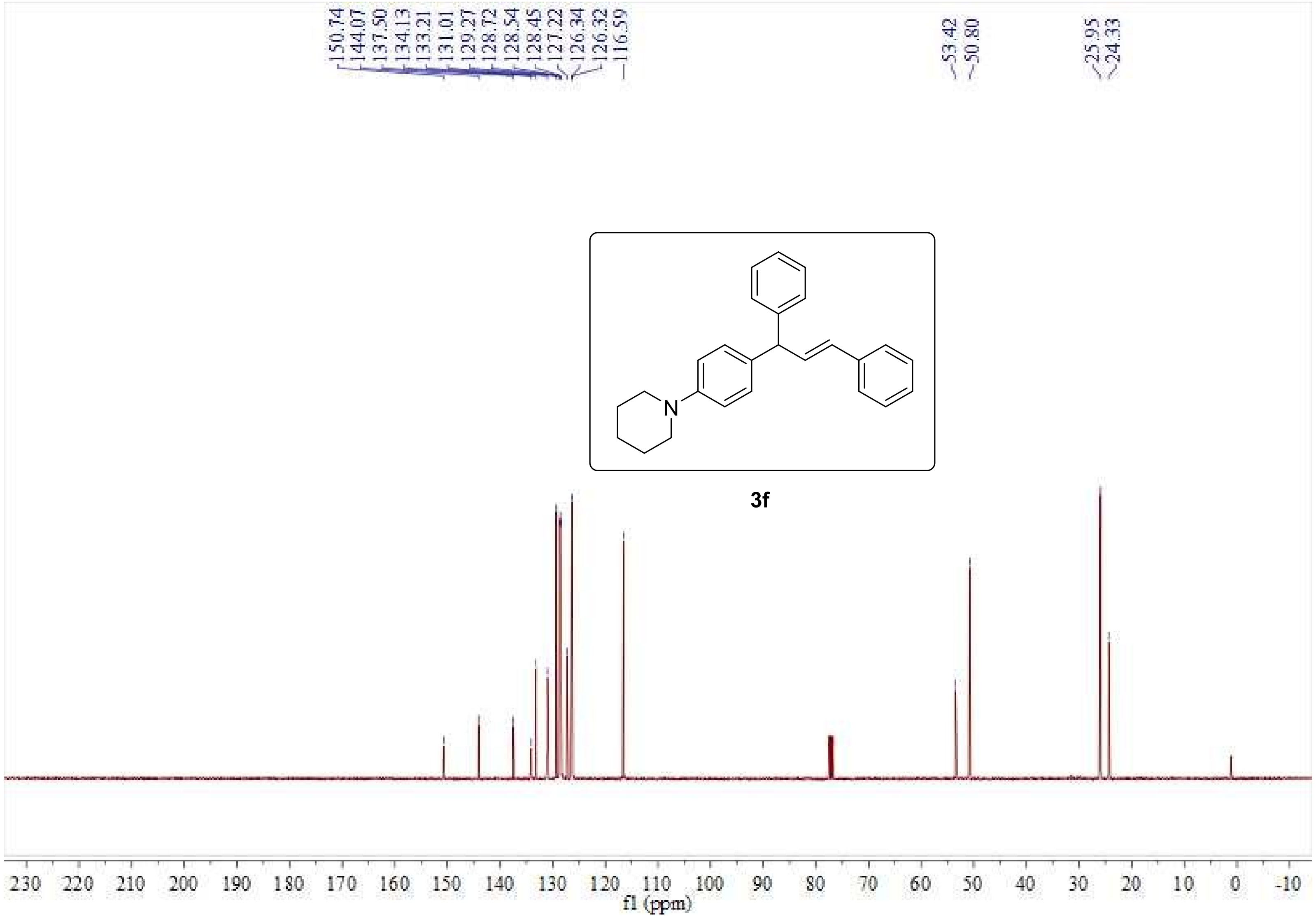
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126.32
116.59
53.42
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25.95
24.33
N
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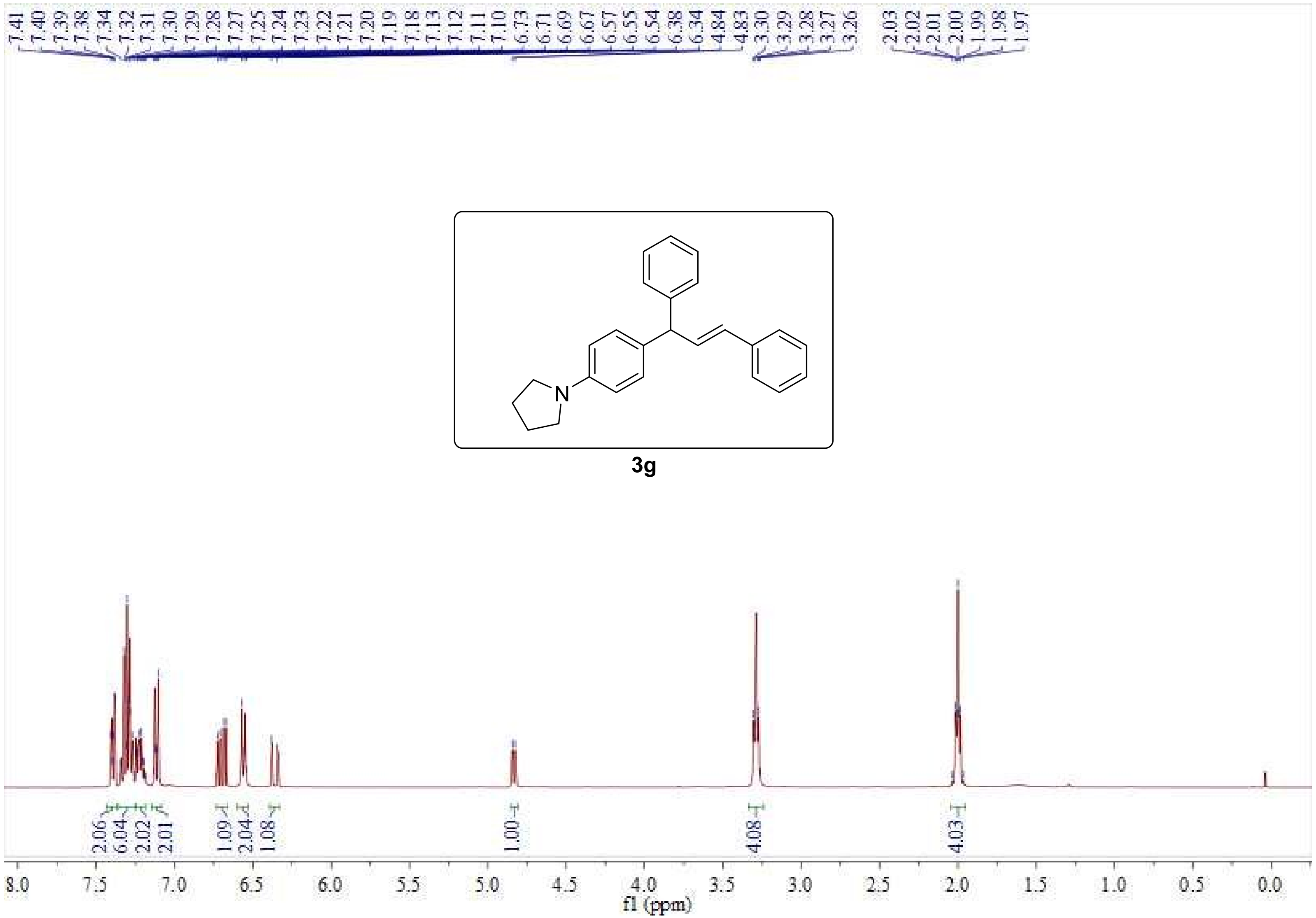
f1 (ppm)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7.21
7.20
7.19
7.18
7.13
7.12
7.11
7.10
6.73
6.71
6.69
6.67
6.57
6.55
6.54
6.38
6.34
4.84
4.83
3.30
3.29
3.28
3.27
3.26
2.03
2.02
2.01
2.00
1.99
1.98
1.97
N
2.06
6.04
2.02
2.01
1.09
2.04
1.08
1.00
4.08
4.03
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
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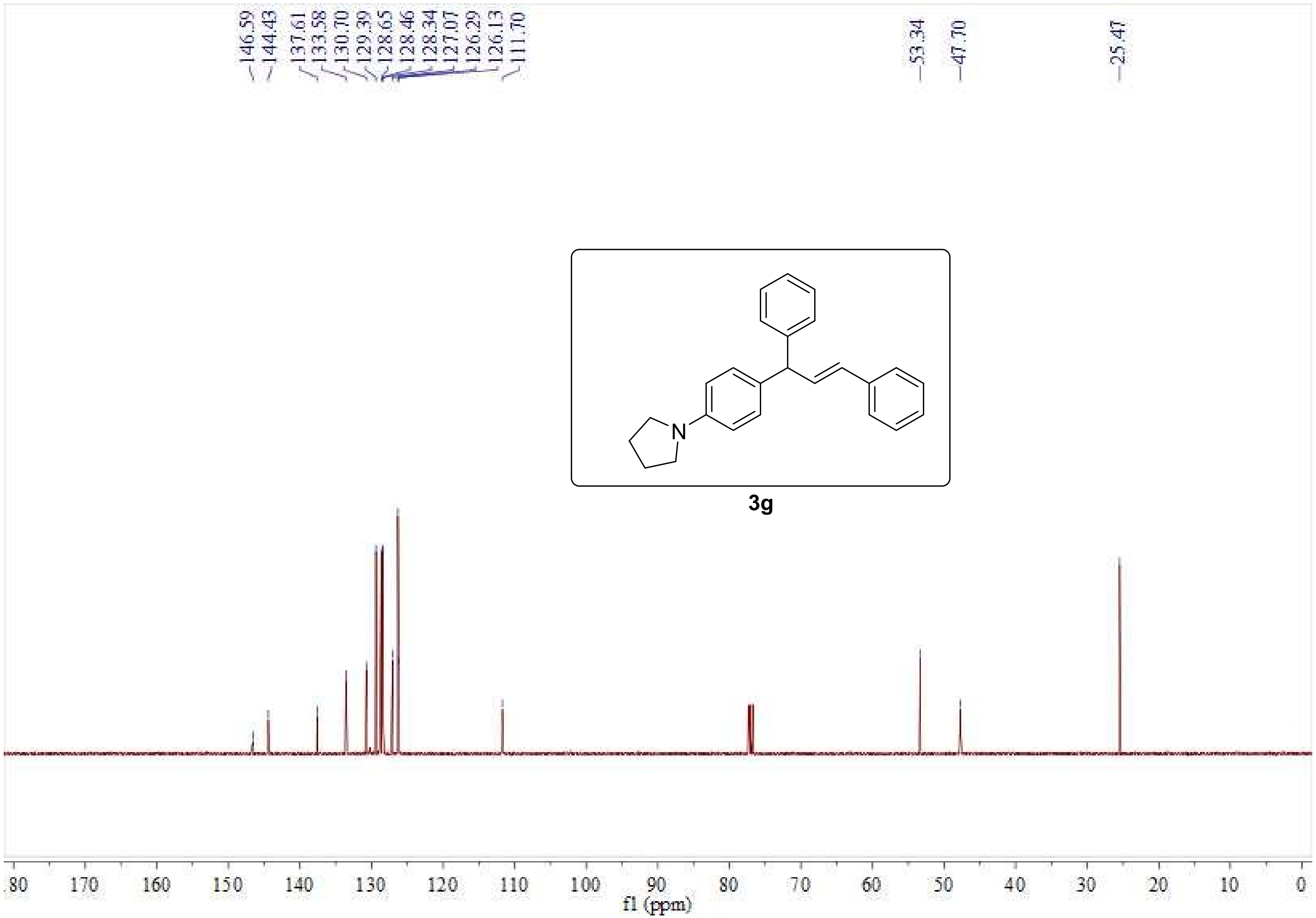
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

3g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53.34
47.70
25.47
N
3g
180
170
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150
140
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120
110
100
90
80
70
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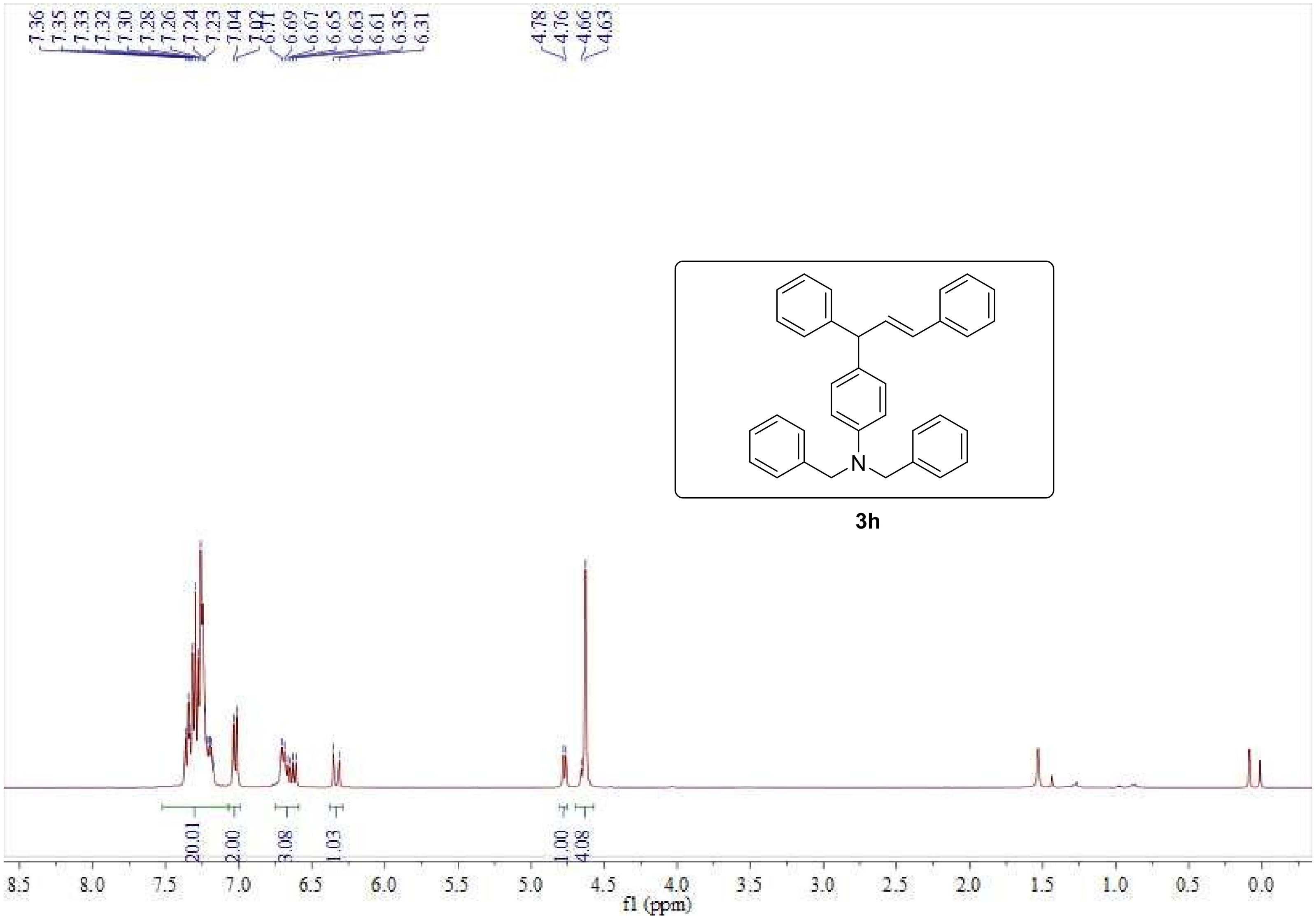
50
40
30
20
10
0
f1 (ppm)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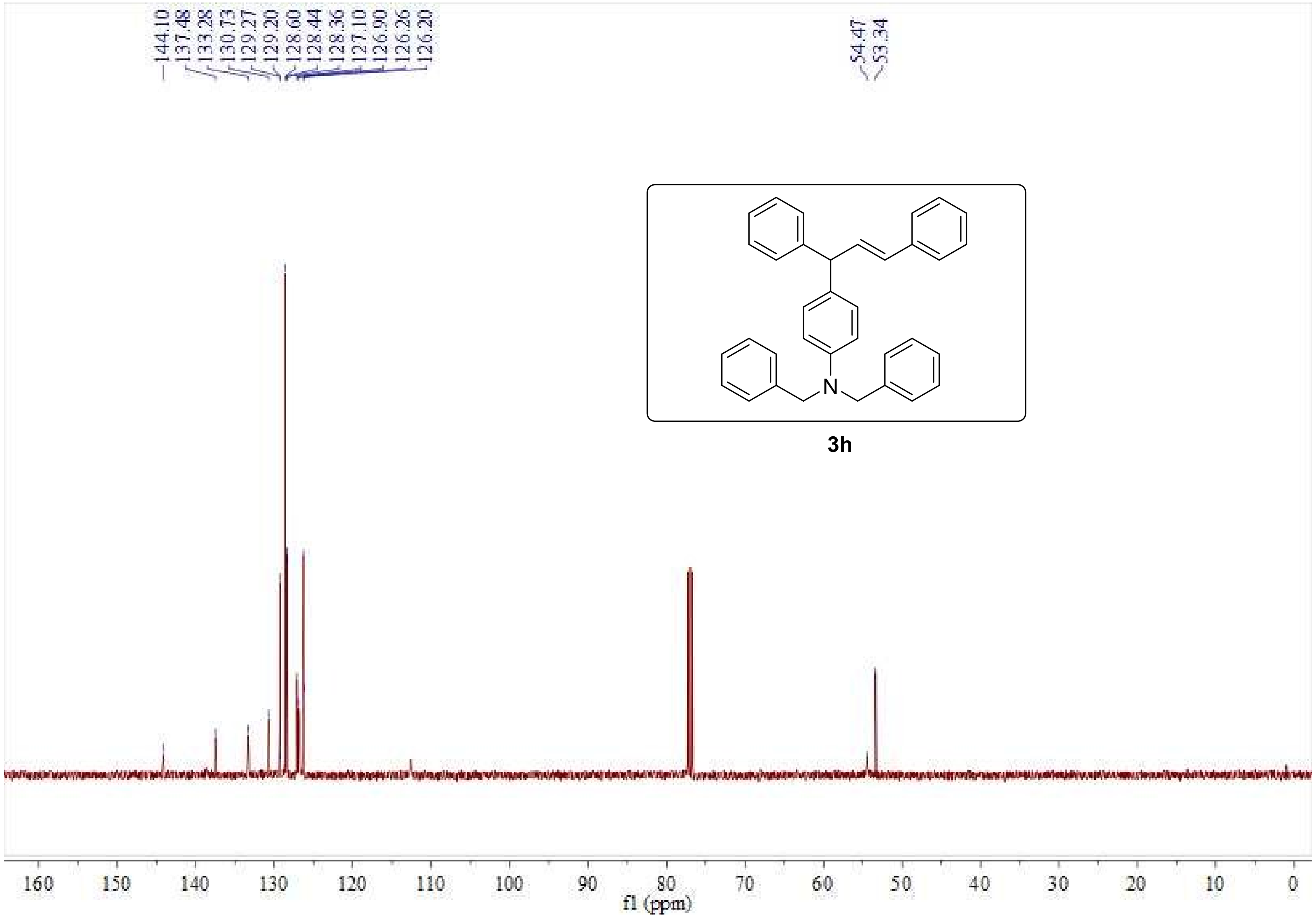
4.78 4.76 4.66 4.63
3h
20.01 2.00 3.08 1.03 1.00 4.08
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



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133.28
130.73
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129.20
128.60
128.44
128.36
127.10
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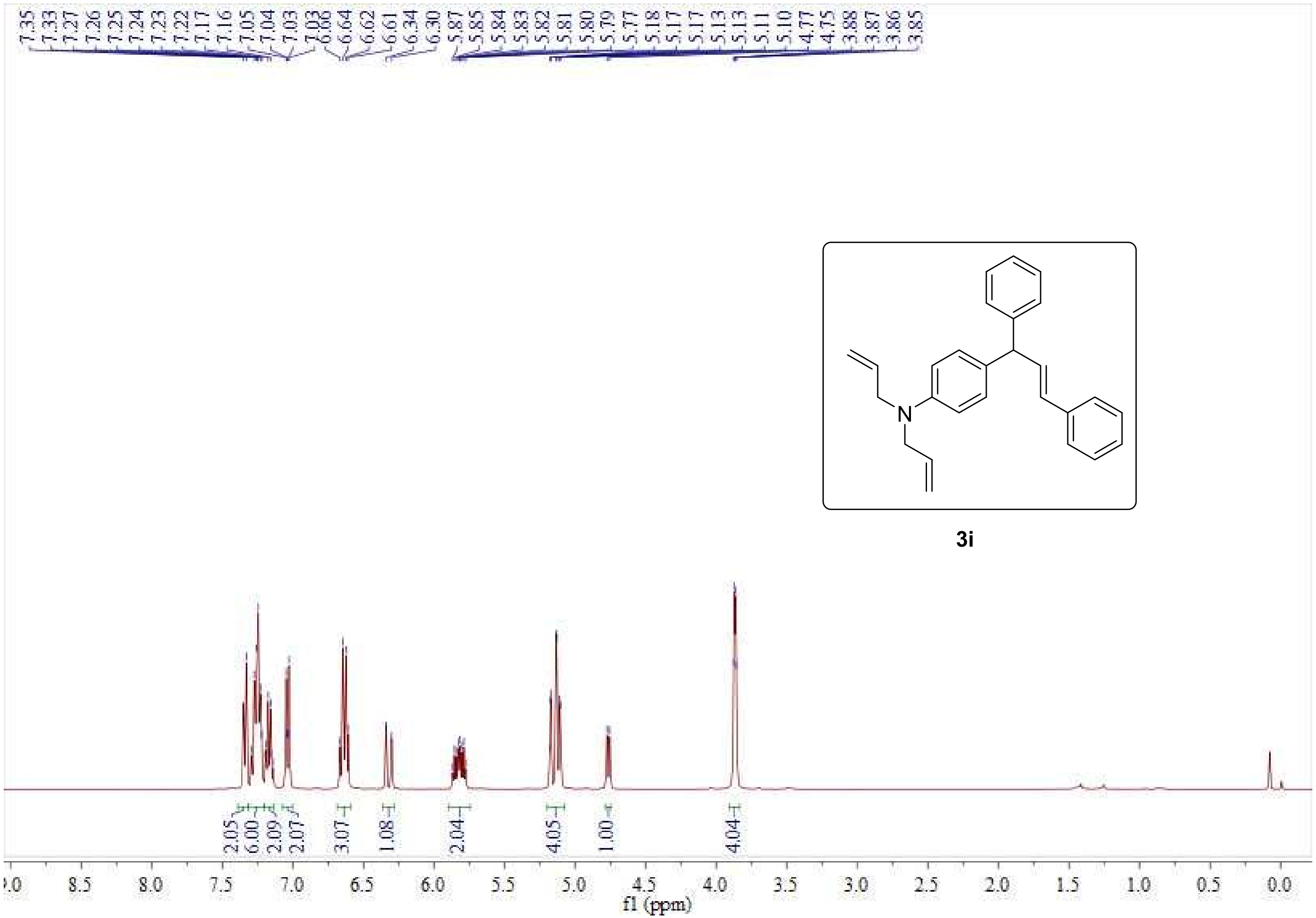
126.26
126.20
54.47
53.34
N
3h
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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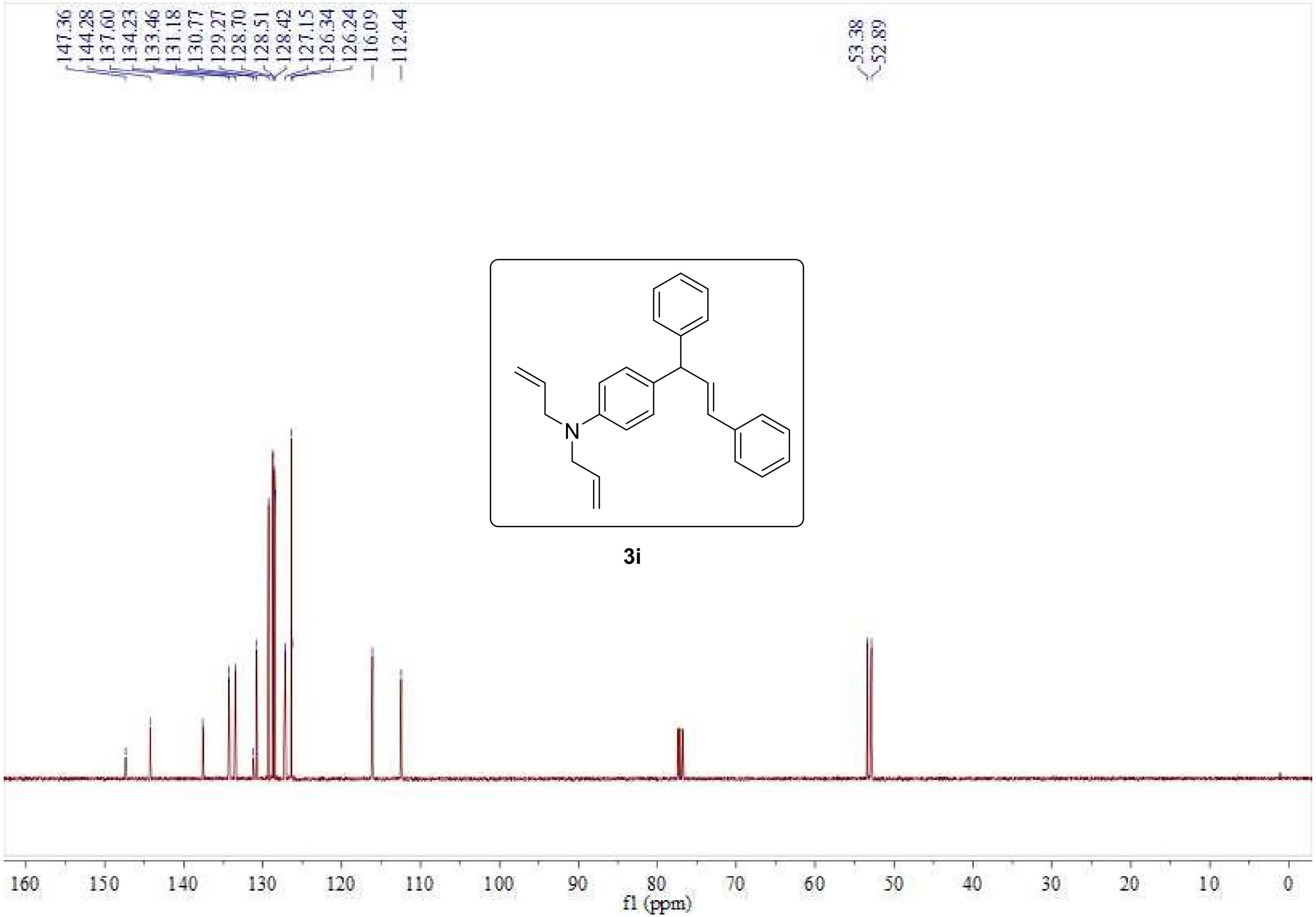
N
3i
2.05 6.00 2.09 2.07 3.07 1.08 2.04 4.05 1.00 4.04
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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127.15
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112.44
53.38
52.89
N
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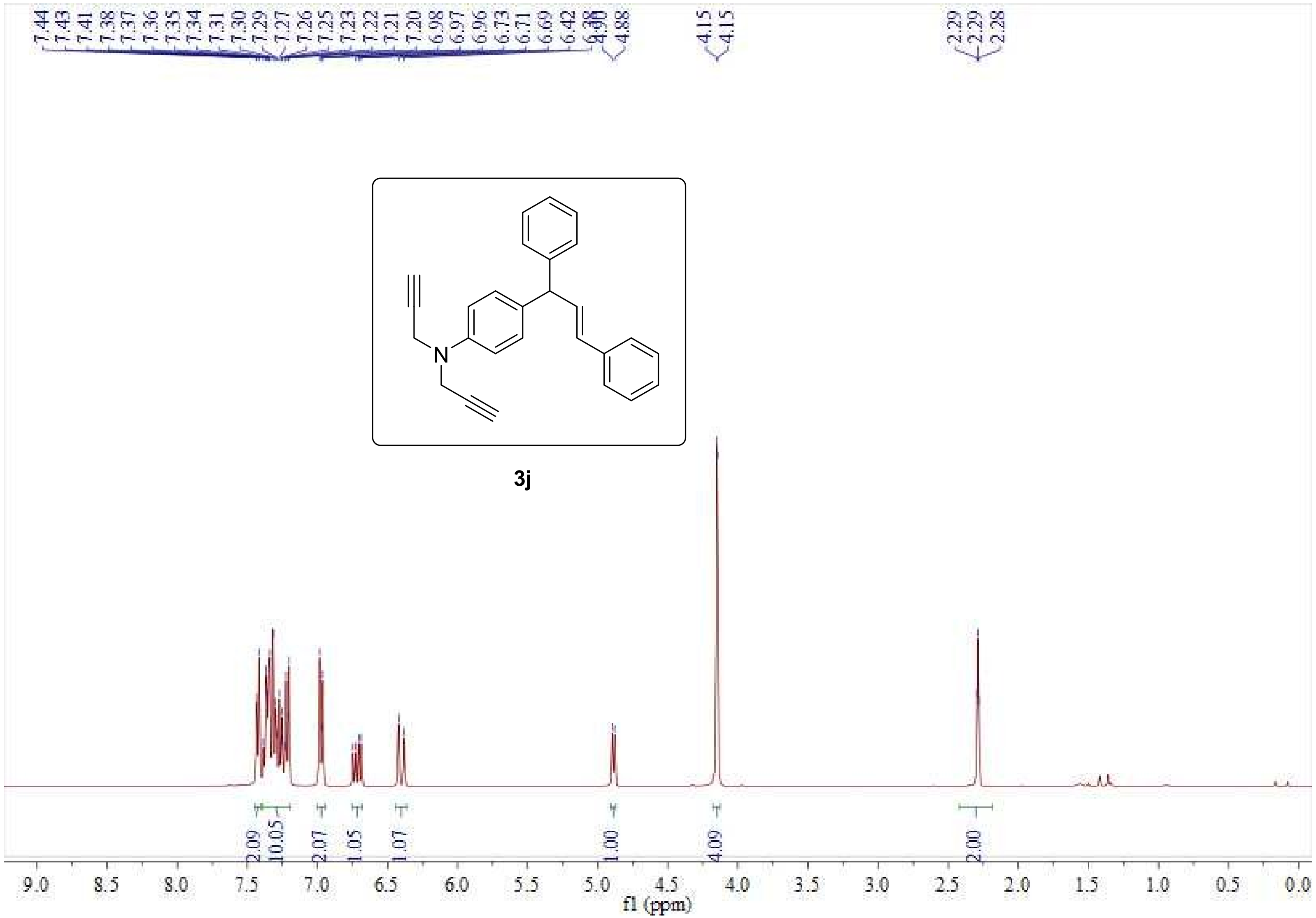
f1 (ppm)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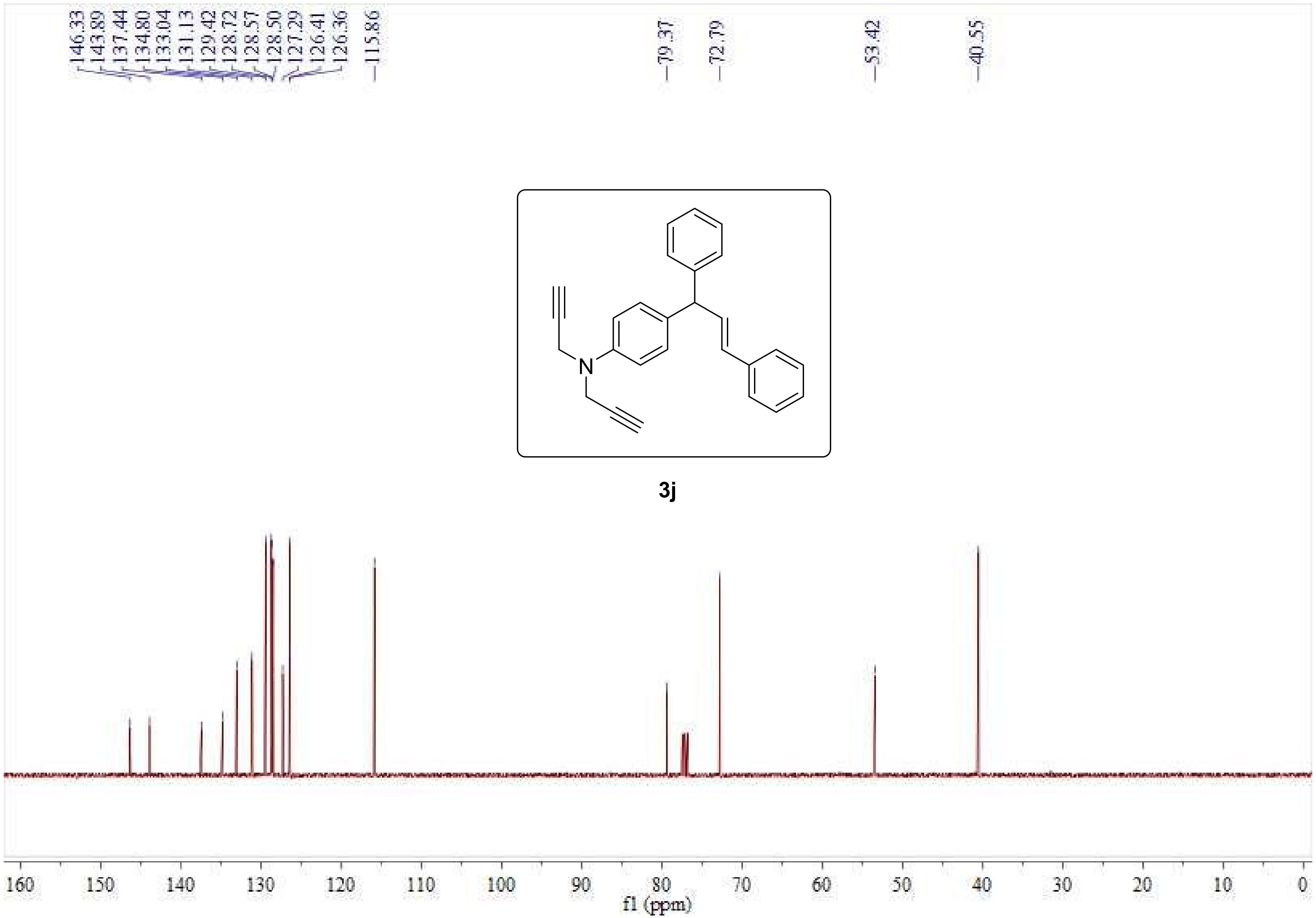
4.15 4.15
2.29 2.29 2.28
N
3j
2.09 10.05 2.07 1.05 1.07 1.00 4.09 2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.50
127.29
126.41
126.36
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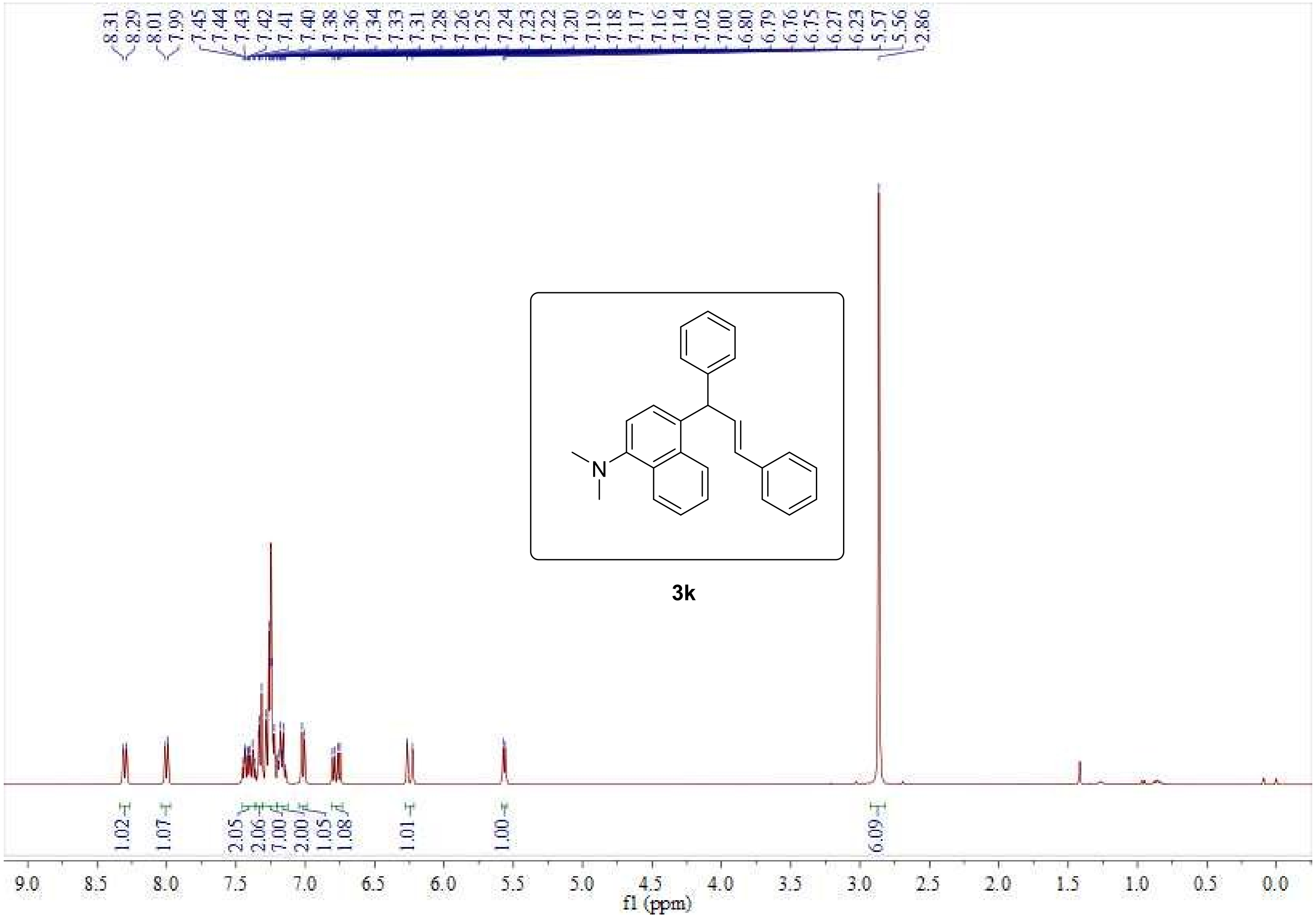
79.37
72.79
53.42
40.55
N
3j
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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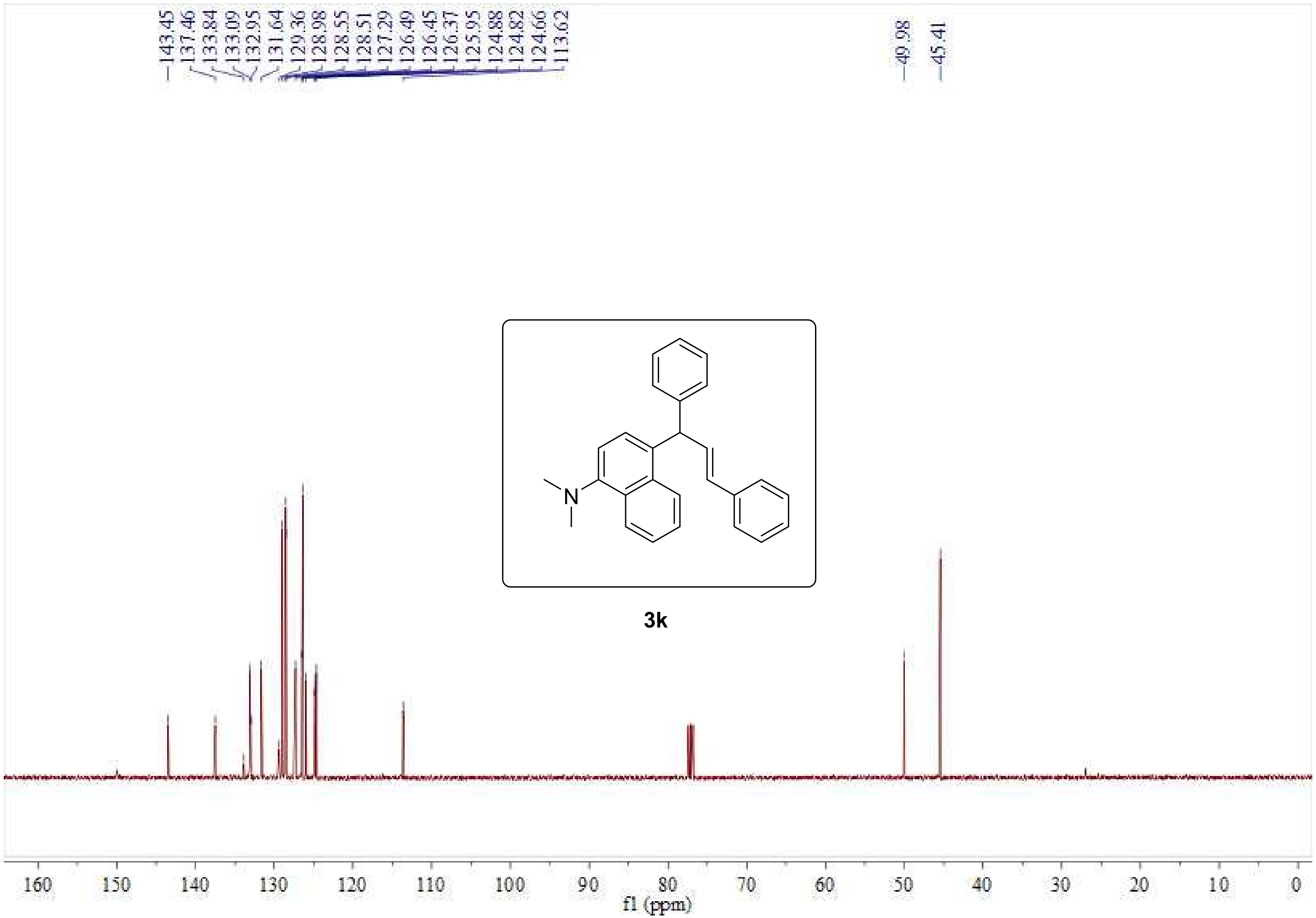
7.34
7.33
7.31
7.28
7.26
7.25
7.24
7.23
7.22
7.20
7.19
7.18
7.17
7.16
7.14
7.02
7.00
6.80
6.79
6.76
6.75
6.27
6.23
5.57
5.56
2.86
N
1.02
1.07
2.05
2.06
7.00
2.00
1.05
1.08
1.01
1.00
6.09
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

3k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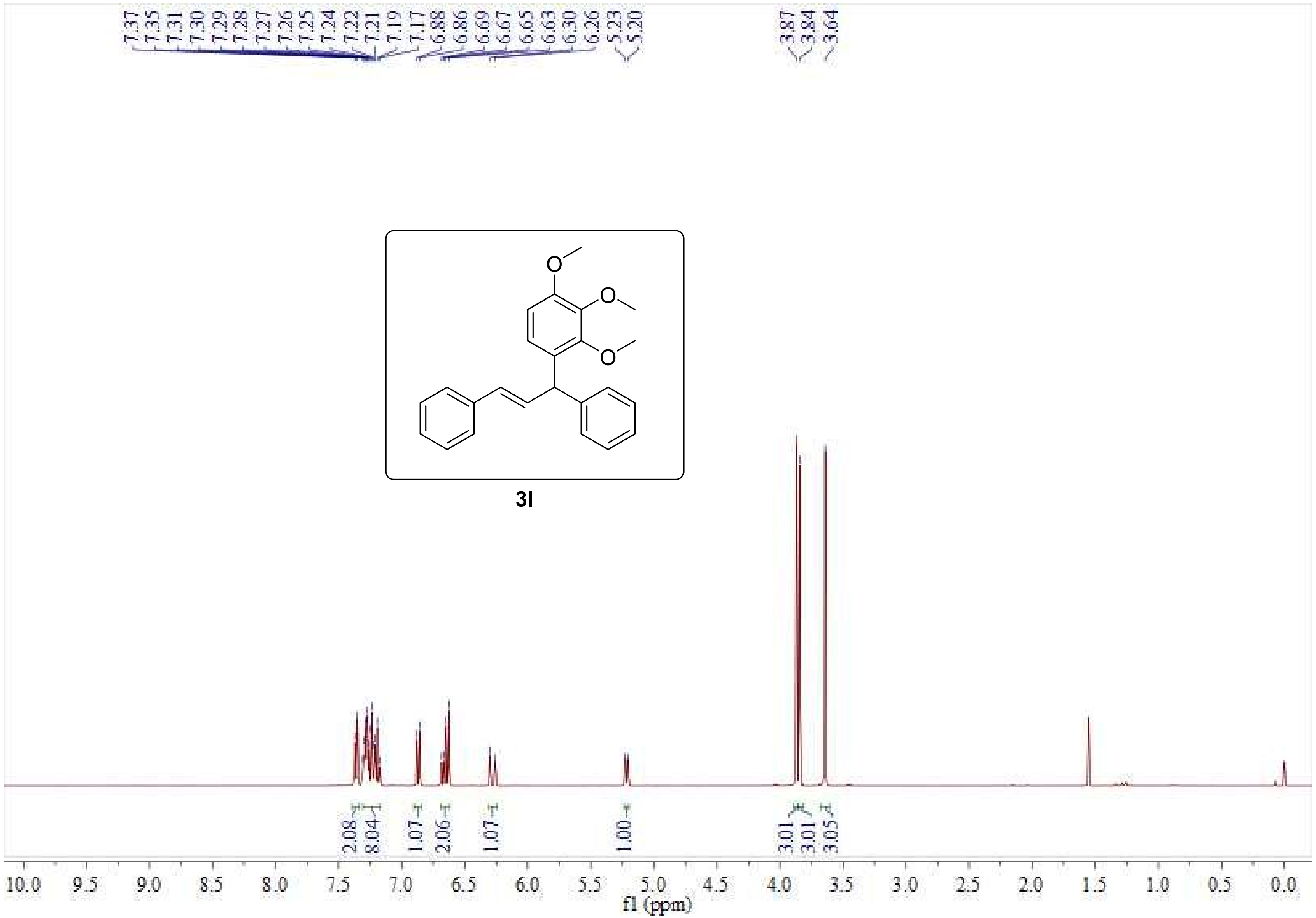
128.51
127.29
126.49
126.45
126.37
125.95
124.88
124.82
124.66
113.62
49.98
45.41
N
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

3k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7.27
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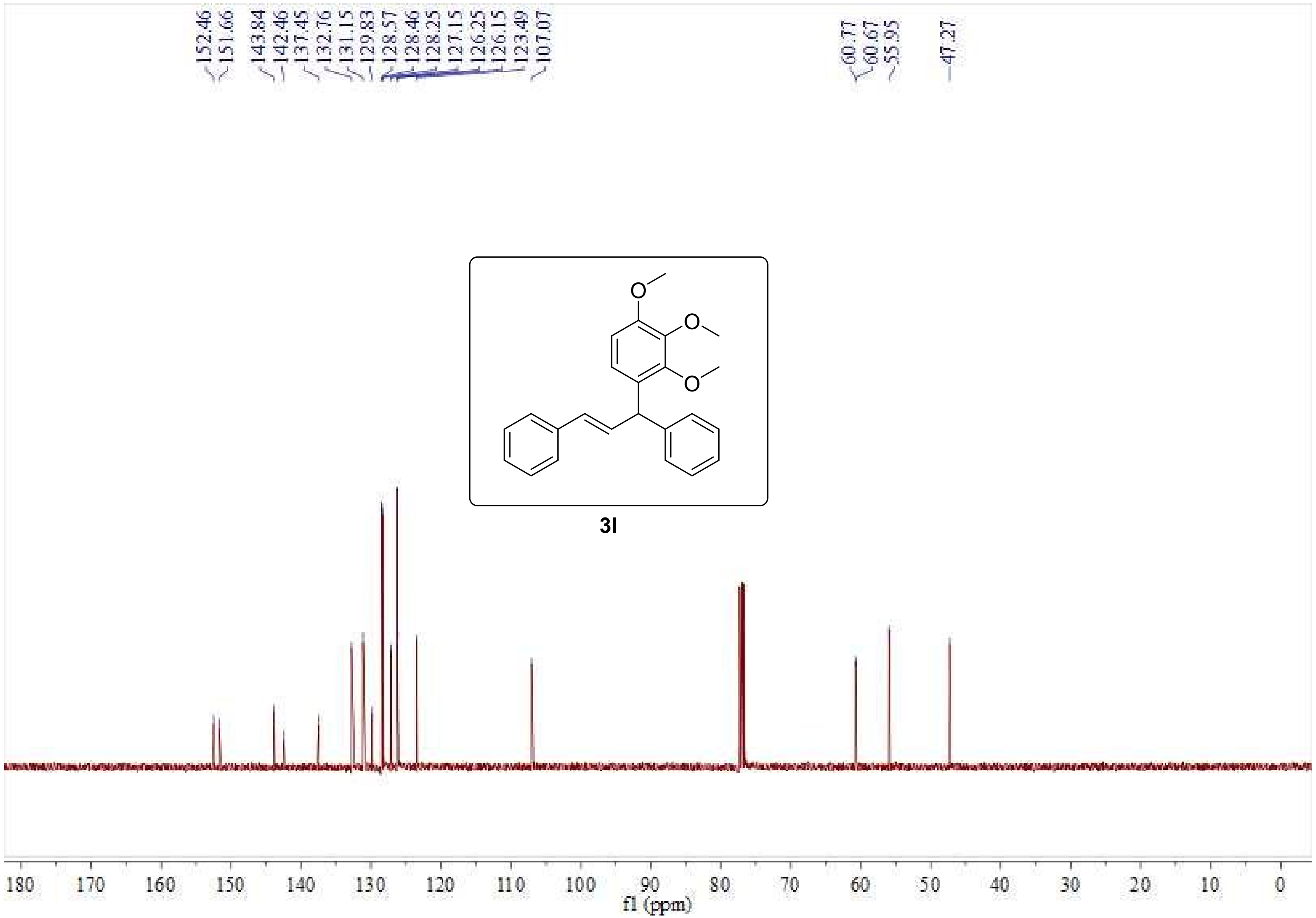
7.24
7.22
7.21
7.19
7.17
6.88
6.86
6.69
6.67
6.65
6.63
6.30
6.26
5.23
5.20
3.87
3.84
3.64
2.08
8.04
1.07
2.06
1.07
1.00
3.01
3.01
3.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
3l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128.46
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126.25
126.15
123.49
107.07
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47.27
O
O
O
3l
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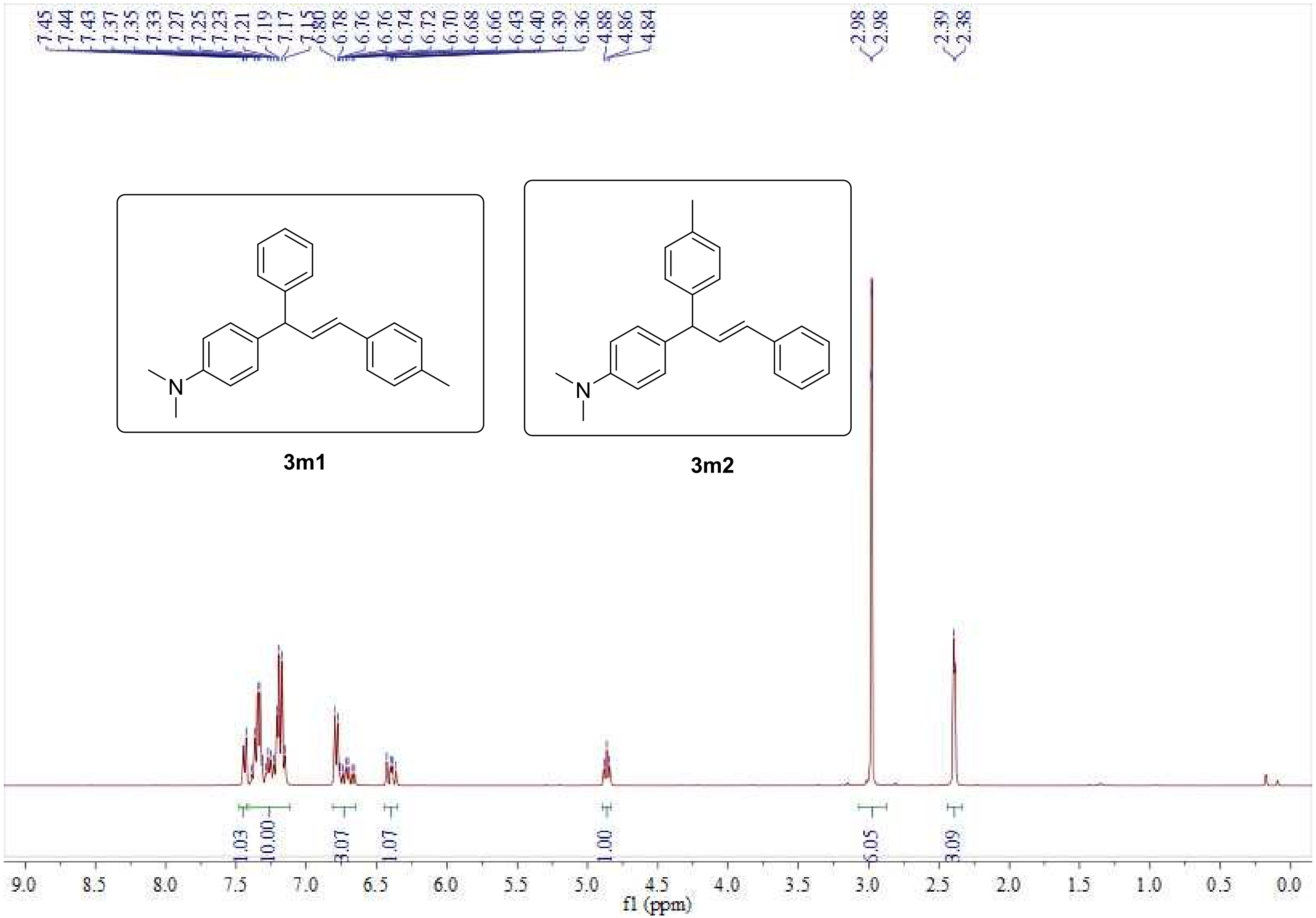
f1 (ppm)



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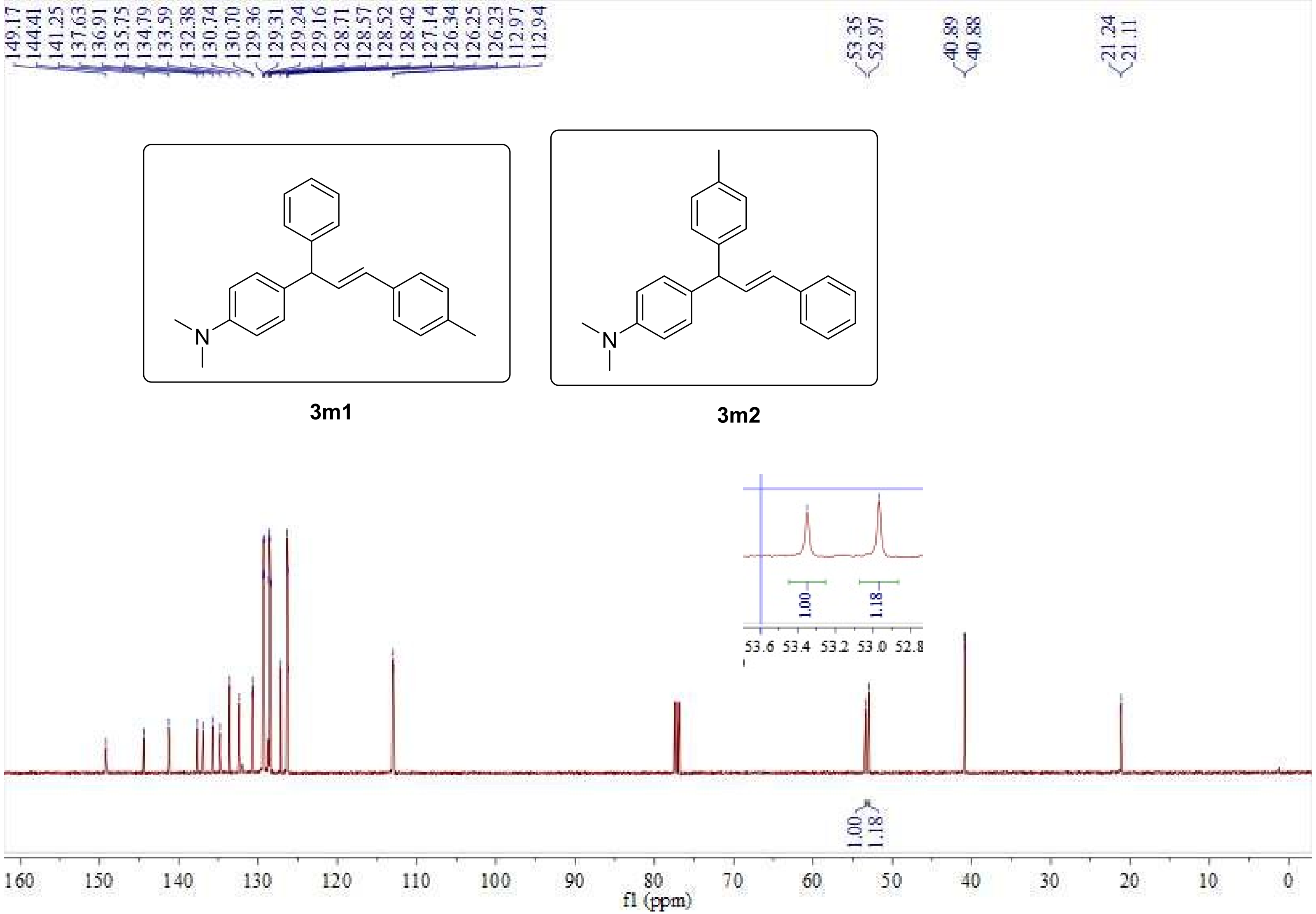
2.98 2.98
2.39 2.38
N
3m1
3m2
1.03 10.00 3.07 1.07 1.00 6.05 3.09
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.57
128.52
128.42
127.14
126.34
126.25
126.23
112.97
112.94
53.35
52.97
40.89
40.88
21.24
21.11
N
3m1
N
3m2
1.00
1.18
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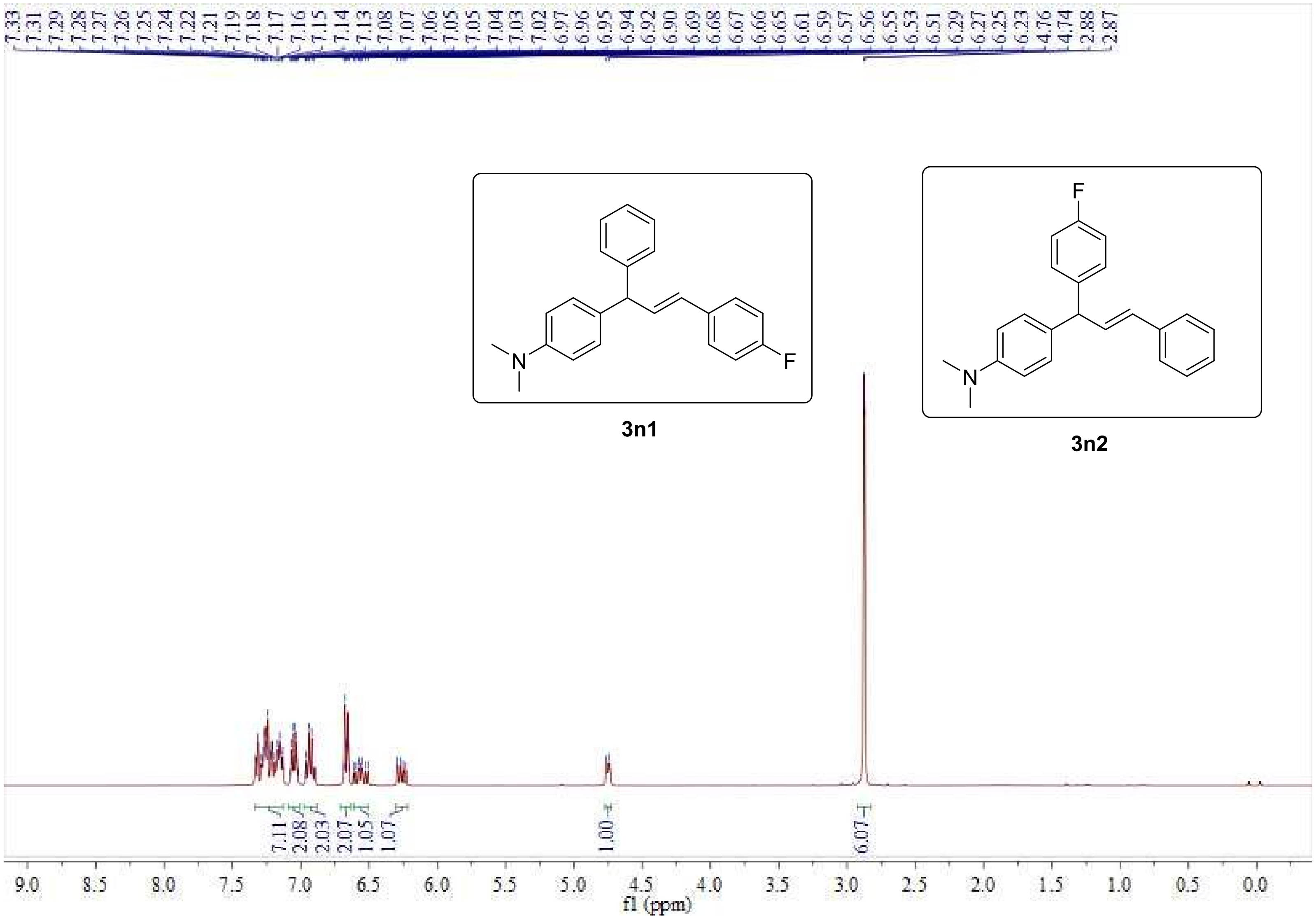
1.00
1.18
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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F
N
3n1
3n2
7.11 2.08 2.03 2.07 1.05 1.07
1.00
6.07
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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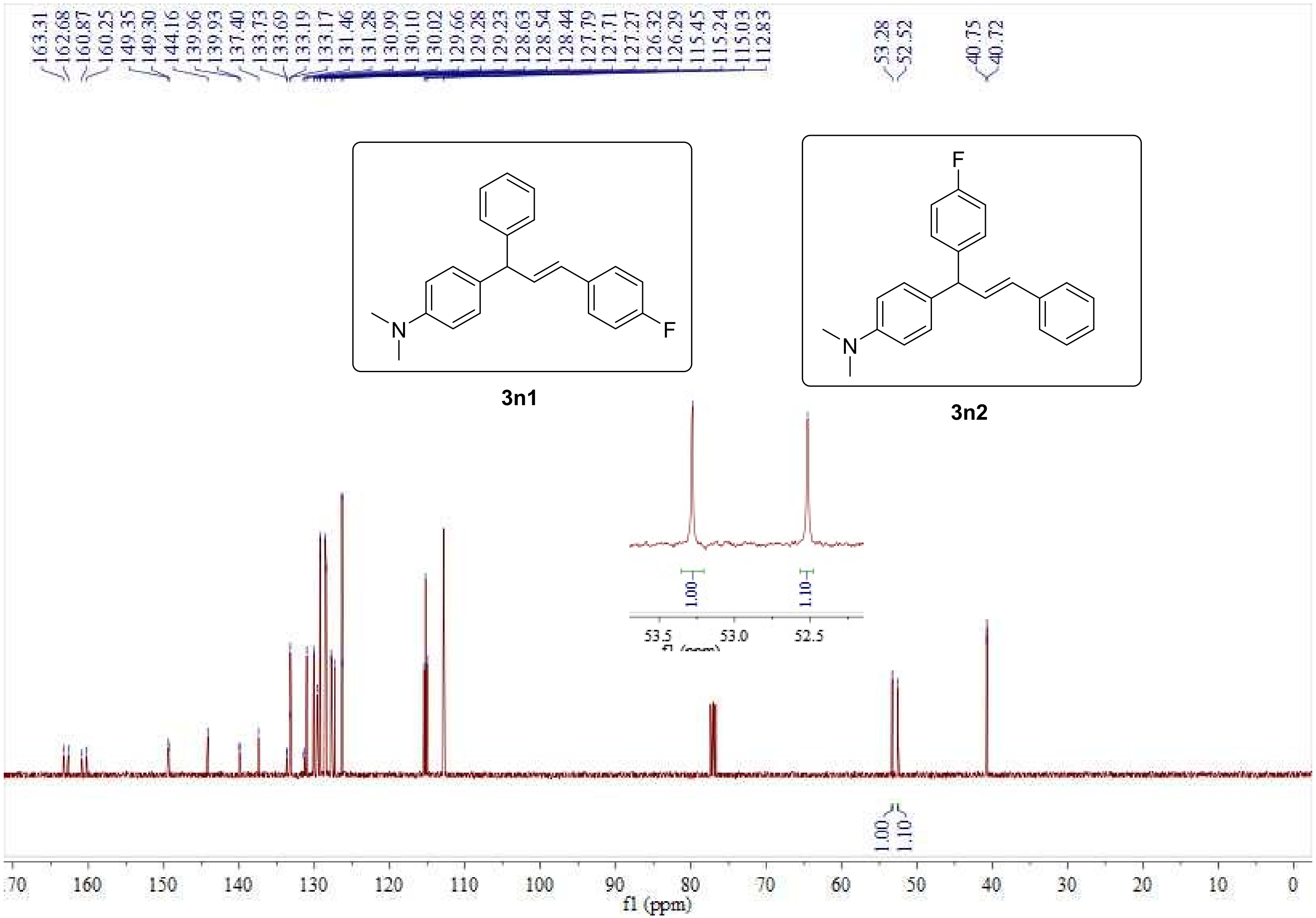
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126.32
126.29
115.45
115.24
115.03
112.83
53.28
52.52
40.75
40.72
F
N
3n1
3n2
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1.10
53.5
53.0
52.5
1.00
1.10
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110
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50
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20
10
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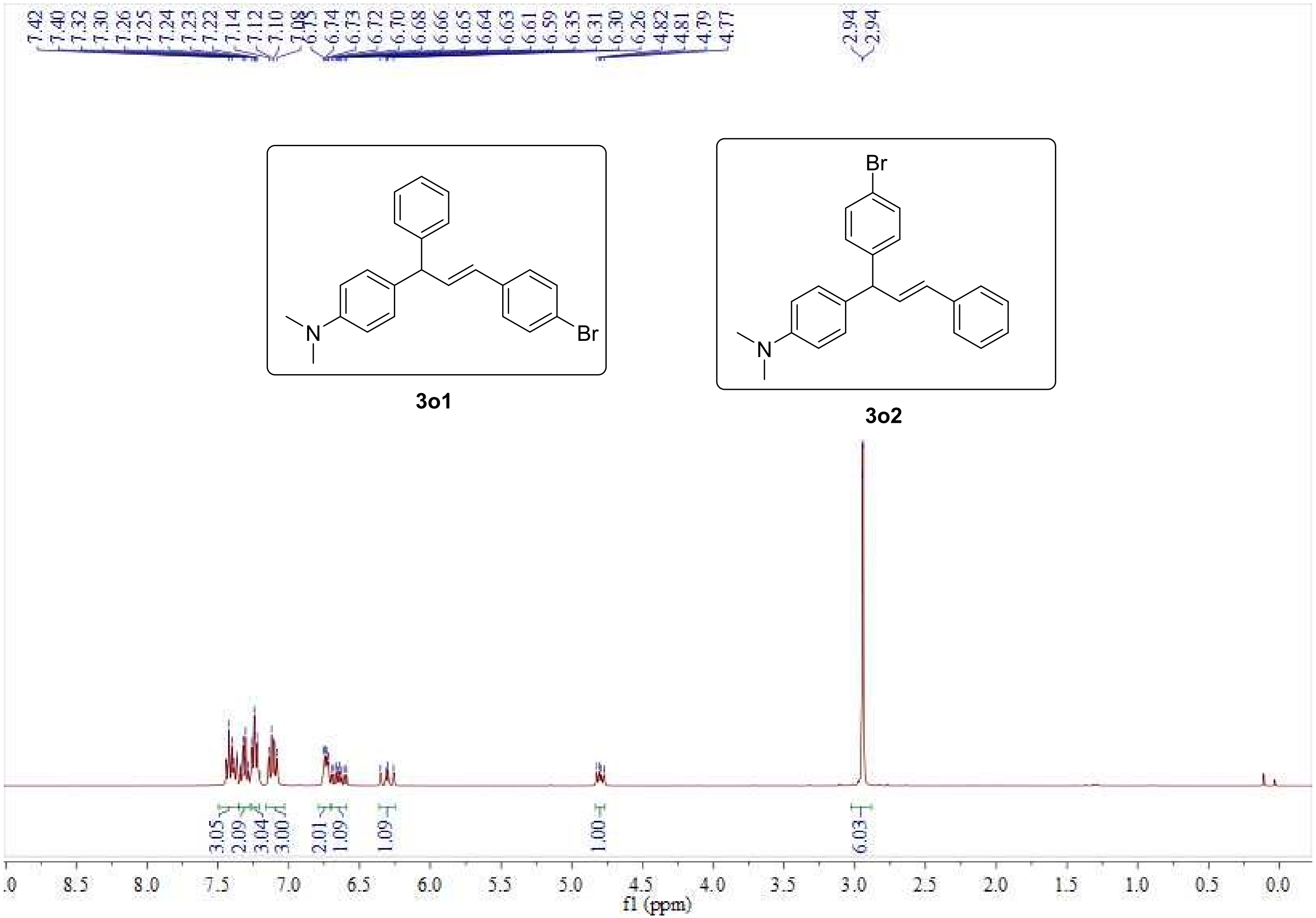
f1 (ppm)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Br
3o1
3o2
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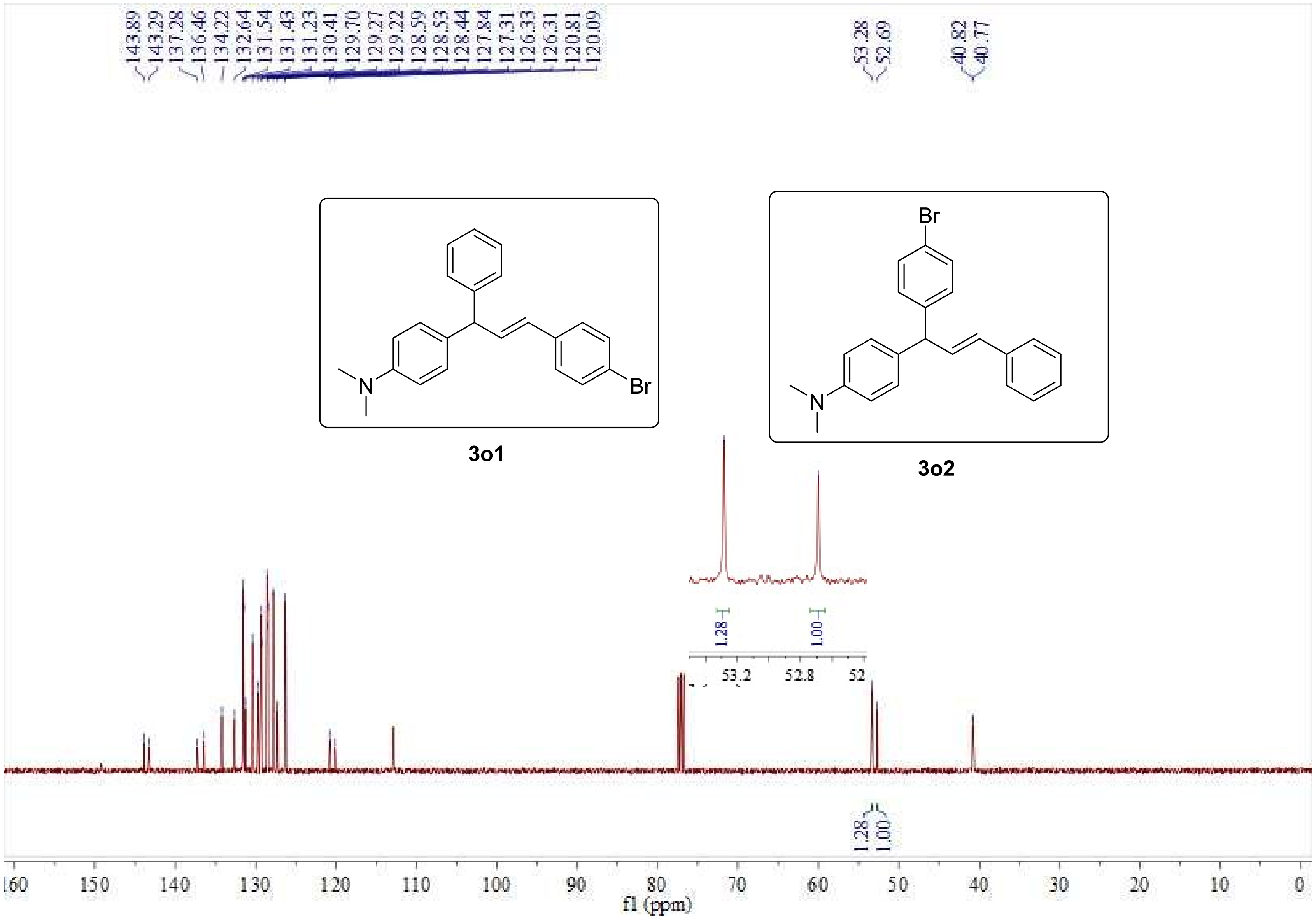
fl (ppm)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128.59
128.53
128.44
127.84
127.31
126.33
126.31
120.81
120.09
53.28
52.69
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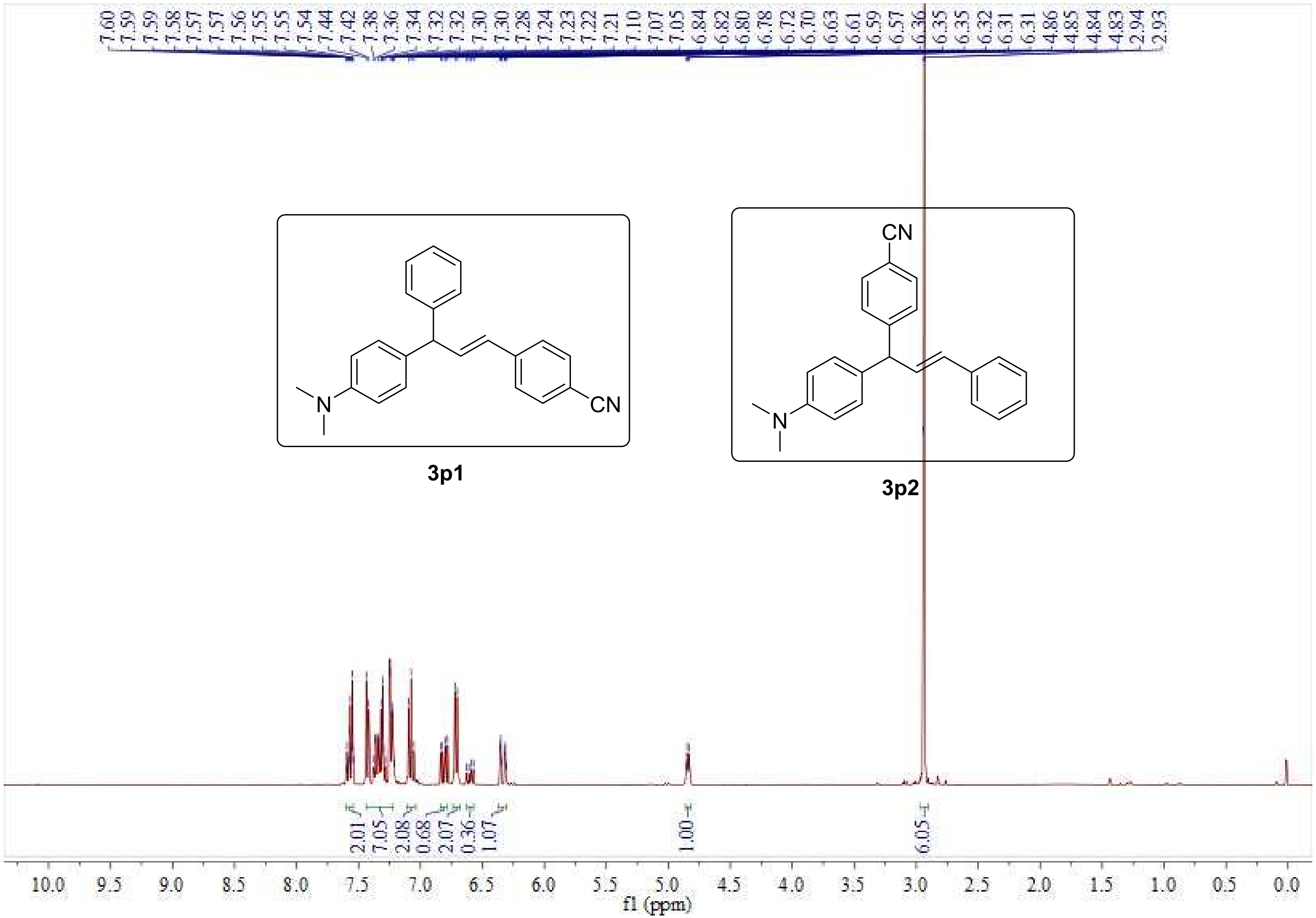
40.77
Br
N
3o1
3o2
1.28
1.00
53.2
52.8
52
f1 (ppm)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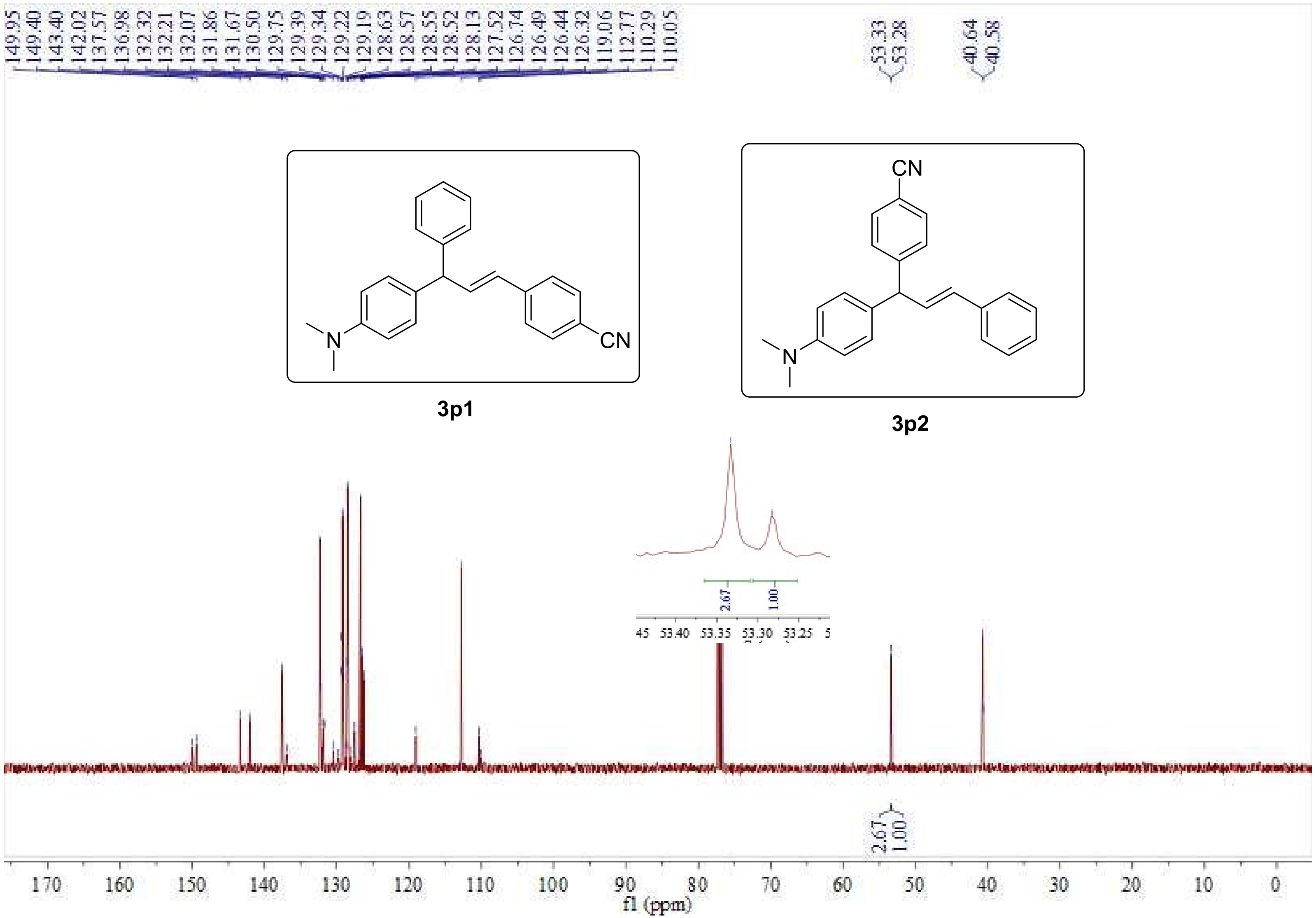
CN
N
3p1
3p2
2.01 7.05 2.08 0.68 2.07 0.36 1.07
1.00
6.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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129.19
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128.57
128.55
128.52
128.13
127.52
126.74
126.49
126.44
126.32
119.06
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110.05
53.33
53.28
40.64
40.58
CN
N
CN
N
3p1
3p2
2.67
1.00
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2.67
1.00
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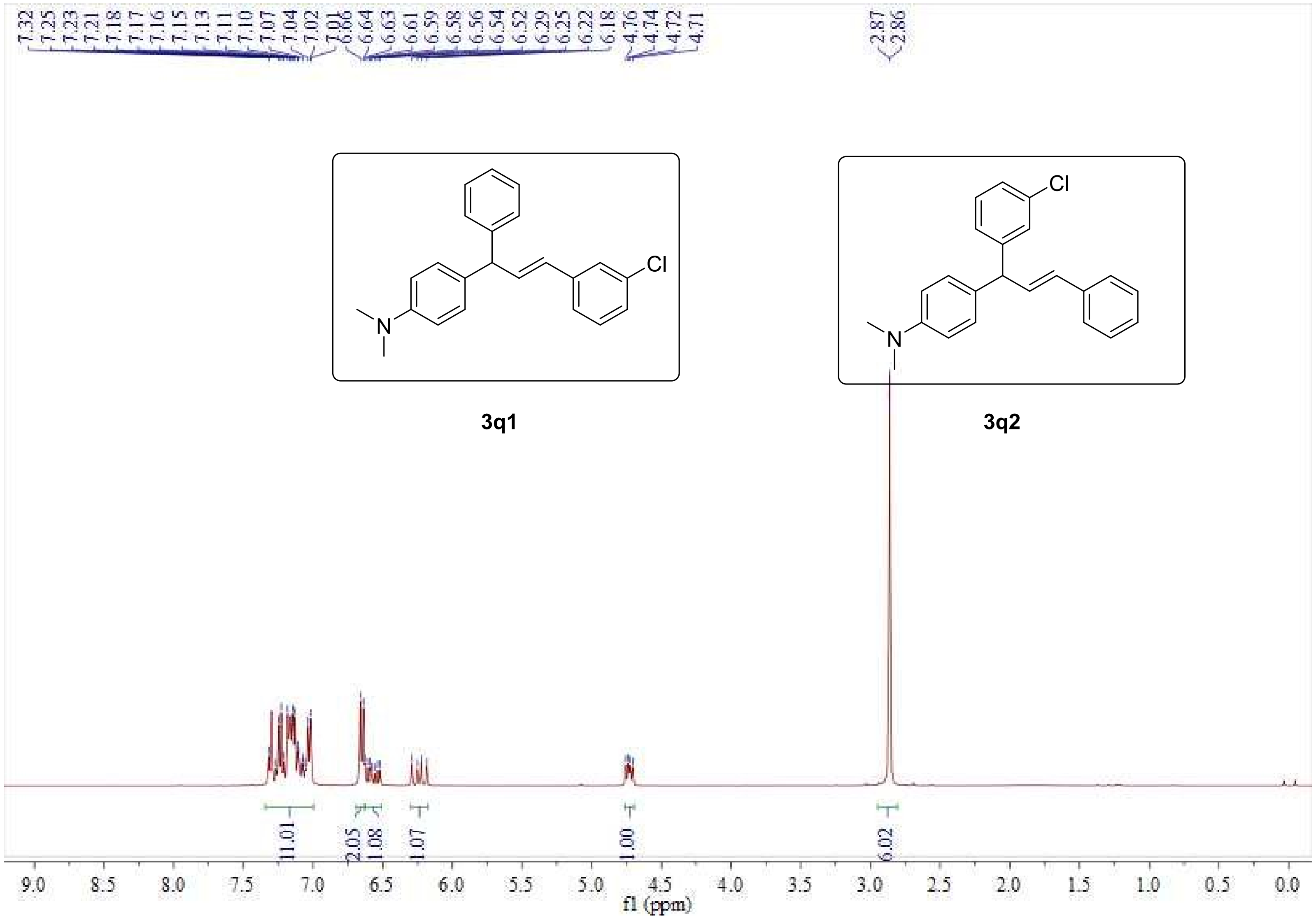
f1 (ppm)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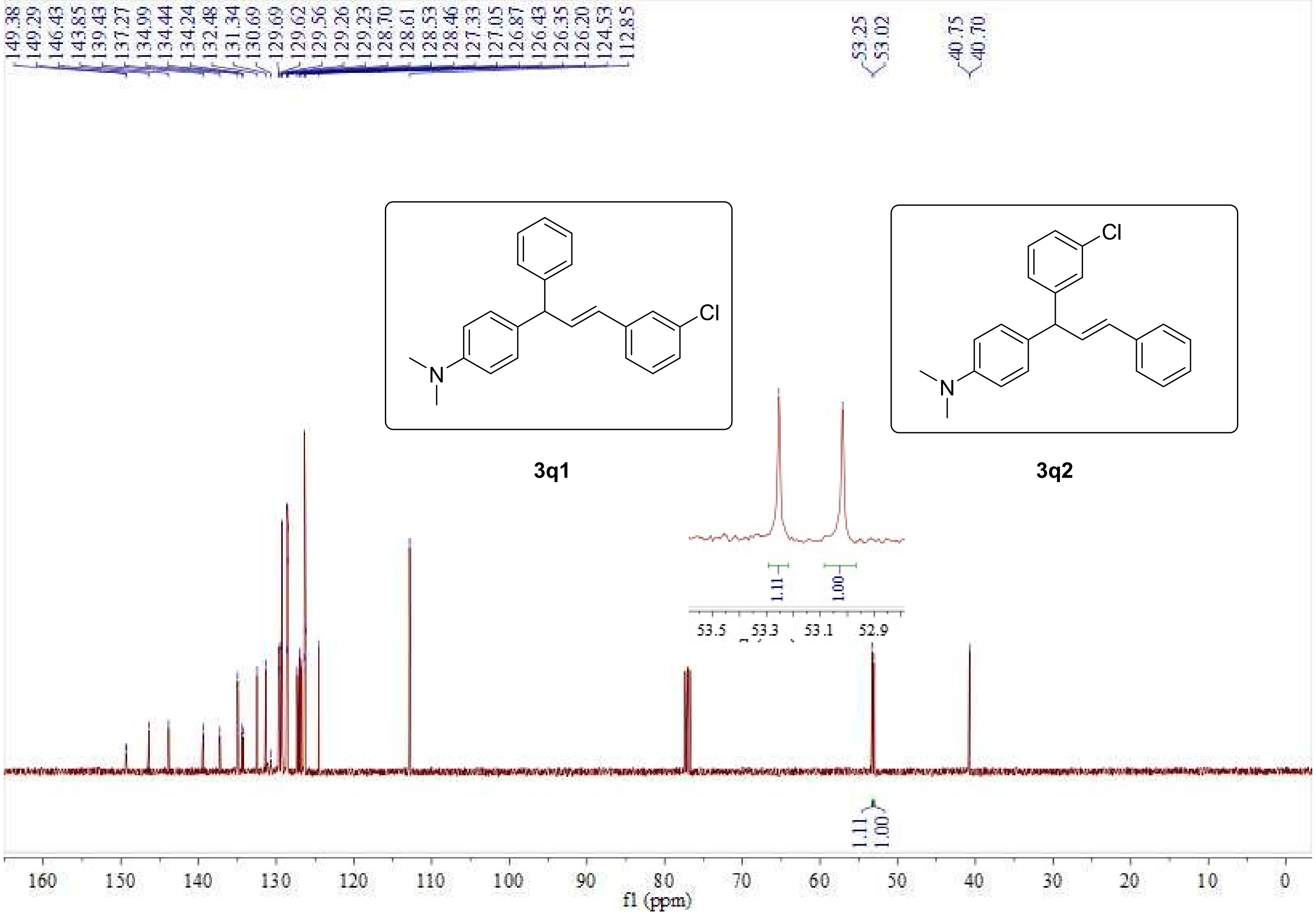
2.87 2.86
Cl
N
Cl
N
3q1
3q2
11.01
2.05
1.08
1.07
1.00
6.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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129.26
129.23
128.70
128.61
128.53
128.46
127.33
127.05
126.87
126.43
126.35
126.20
124.53
112.85
53.25
53.02
40.75
40.70
Cl
N
1.11
1.00
53.5
53.3
53.1
52.9
160
150
140
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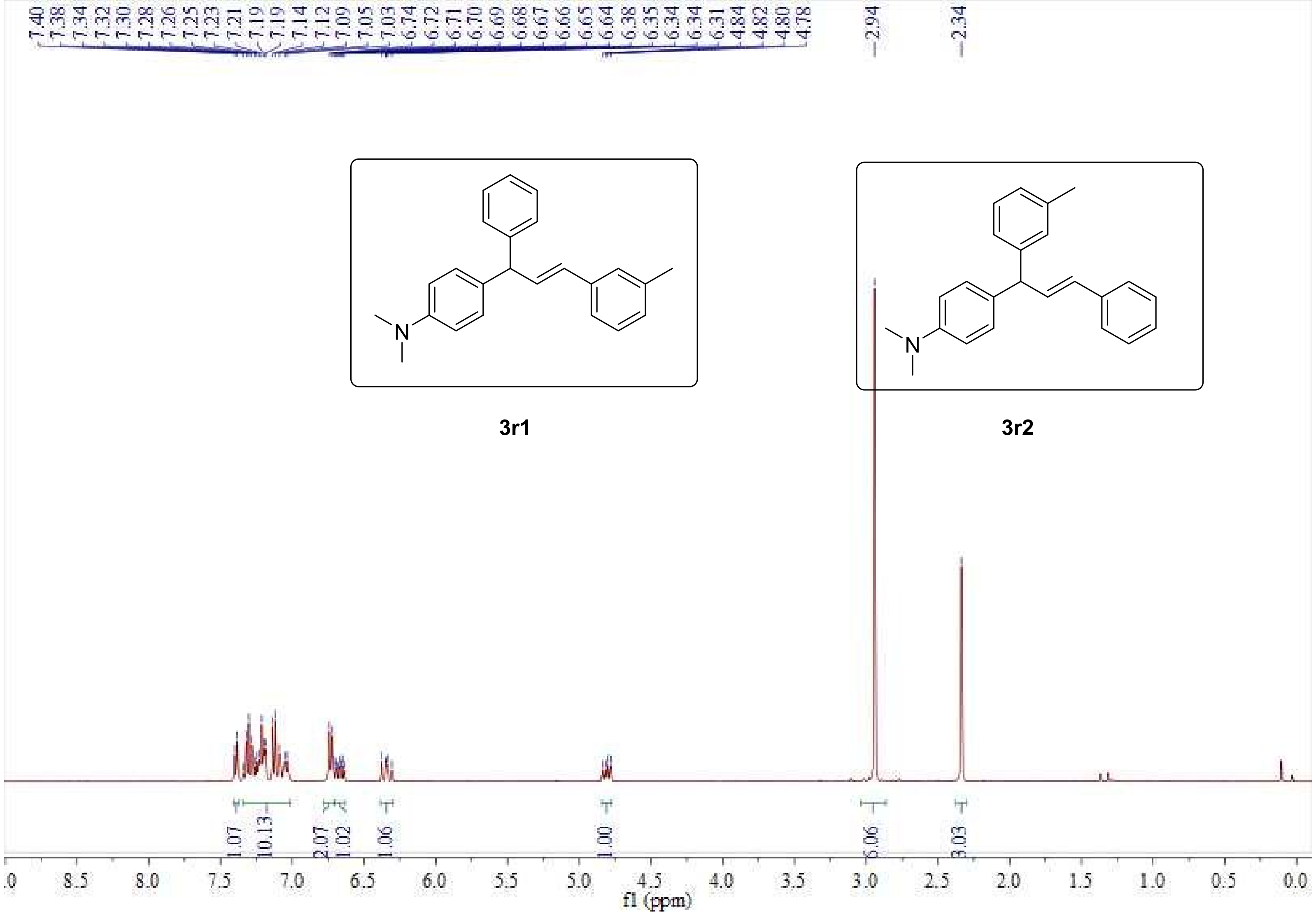
80
70
60
50
40
30
20
10
0
f1 (ppm)

3q1

3q2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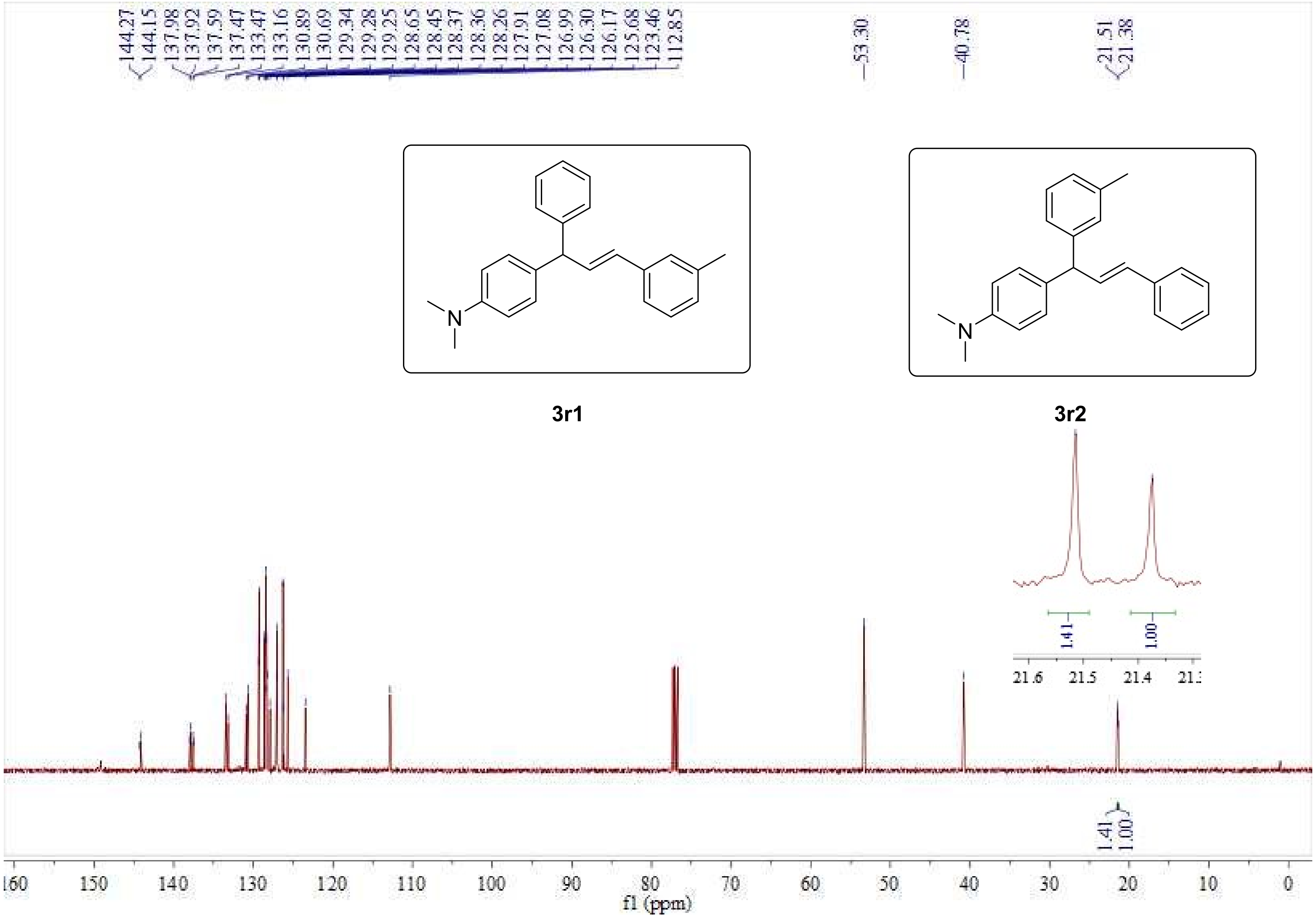
2.94
2.34
N
3r1
N
3r2
1.07
10.13
2.07
1.02
1.06
1.00
6.06
3.03
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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127.08
126.99
126.30
126.17
125.68
123.46
112.85
53.30
40.78
21.51
21.38
N
N
3r1
3r2
1.41
1.00
21.6
21.5
21.4
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110
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50
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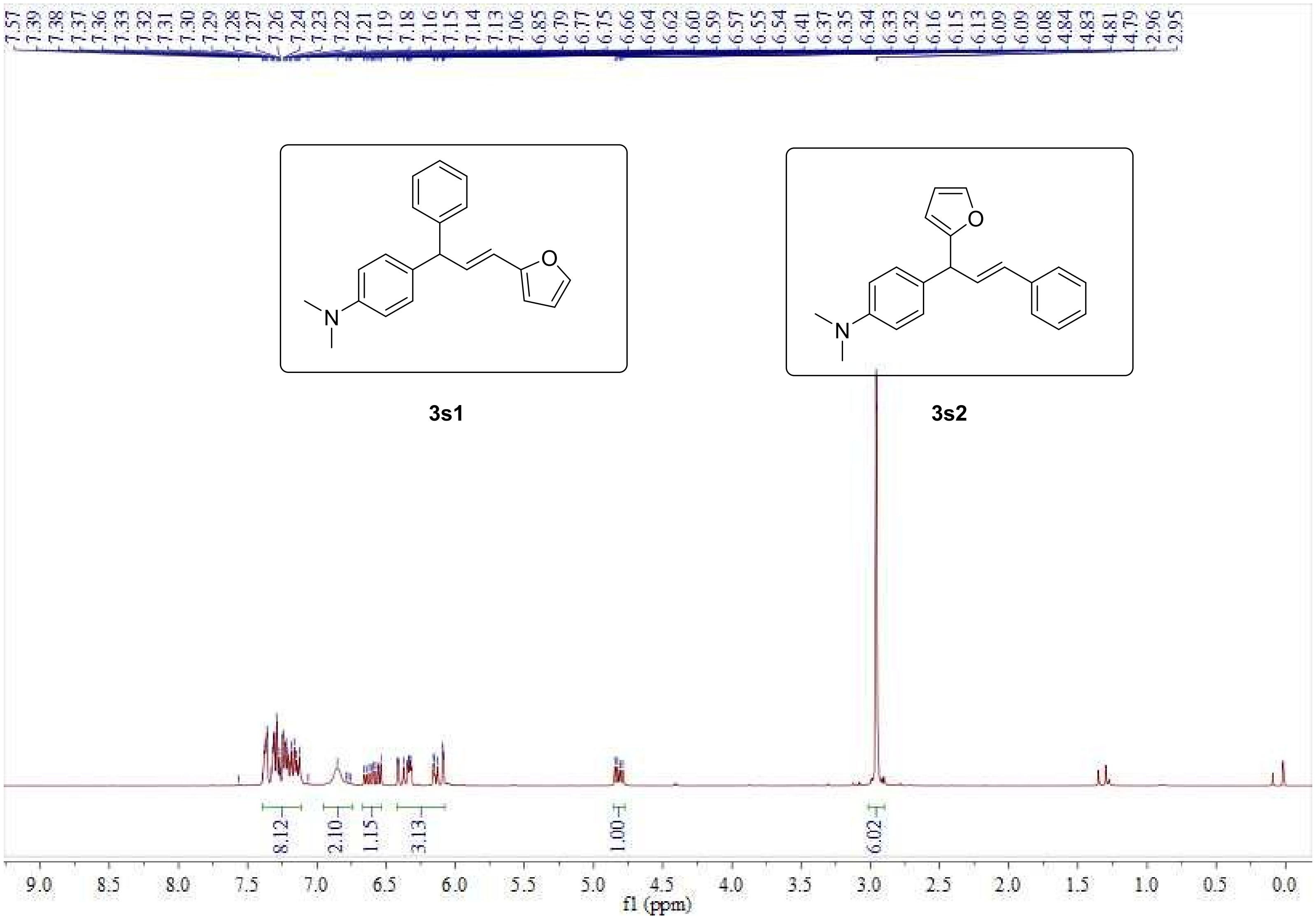
30
20
10
0
f1 (ppm)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N
O
3s1
3s2
8.12
2.10
1.15
3.13
1.00
6.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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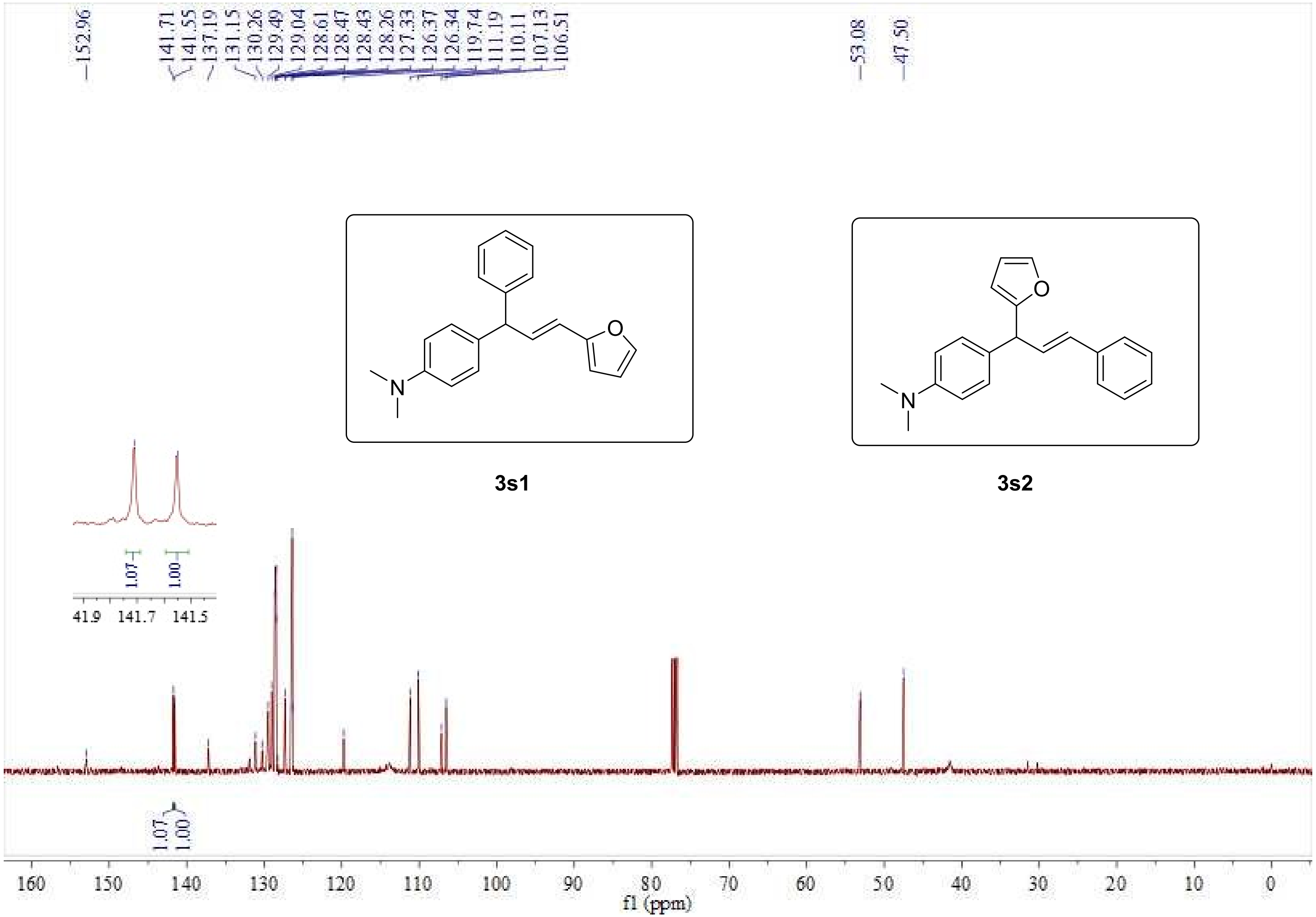

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126.34
119.74
111.19
110.11
107.13
106.51
53.08
47.50
O
N
3s1
3s2
1.07
1.00
41.9
141.7
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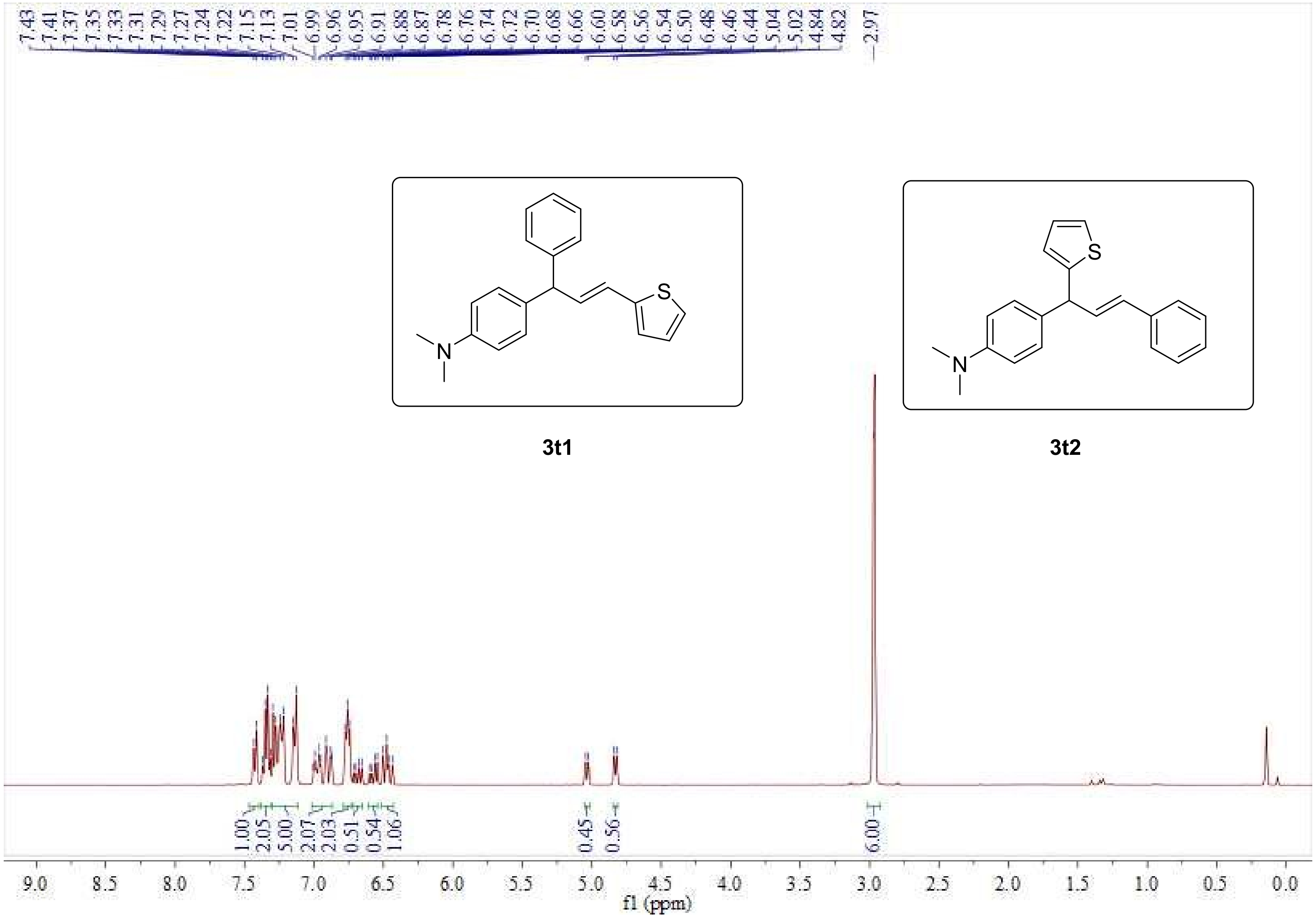
f1 (ppm)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2.97
S
S
N
N
3t1
3t2
1.00 2.05 5.00 2.07 2.03 0.51 0.54 1.06
0.45 0.56
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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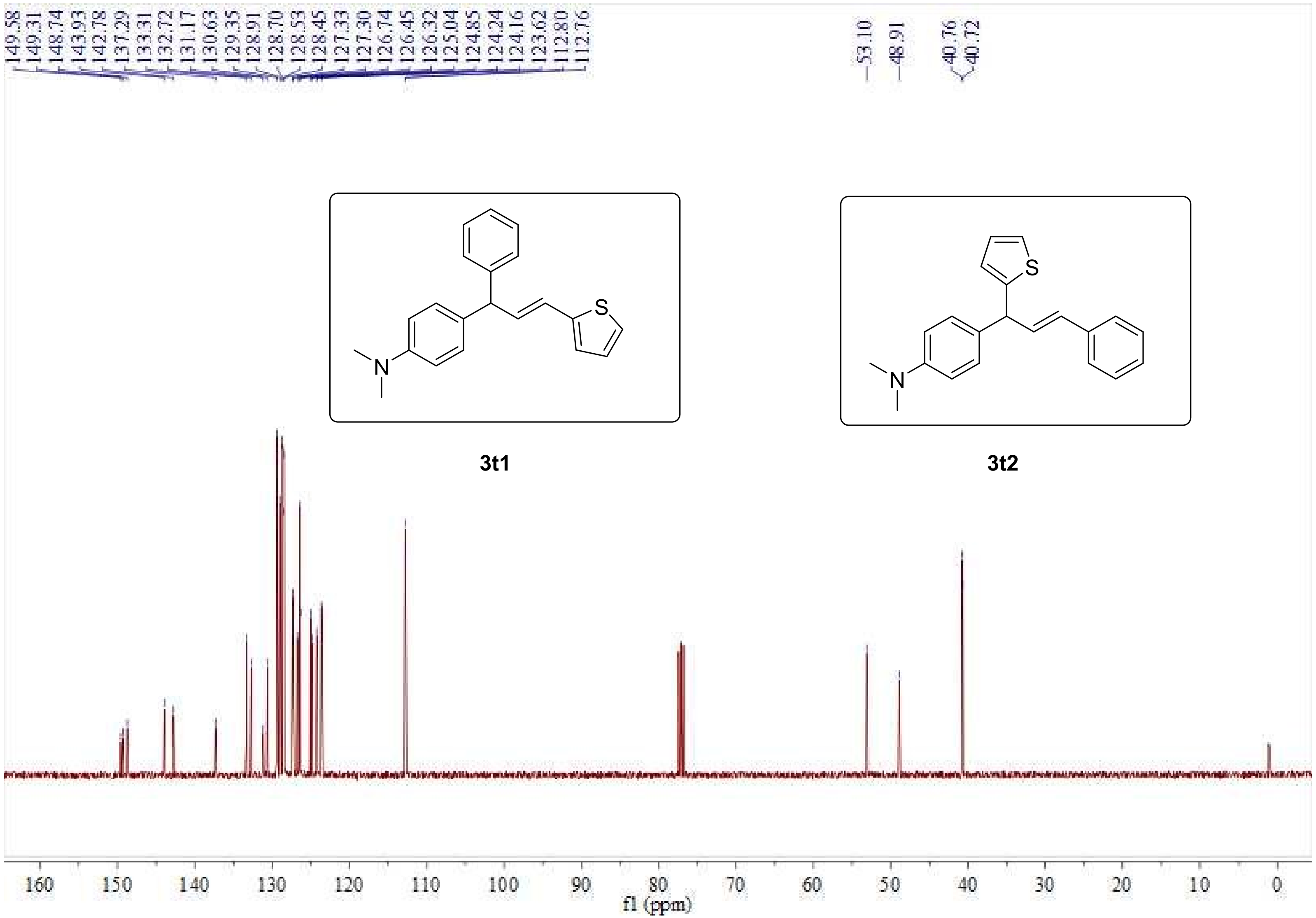
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127.33
127.30
126.74
126.45
126.32
125.04
124.85
124.24
124.16
123.62
112.80
112.76
53.10
48.91
40.76
40.72
S
N
3t1
3t2
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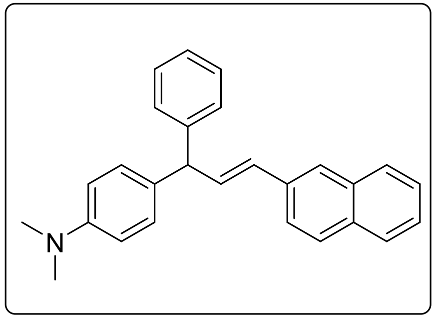
f1 (ppm)



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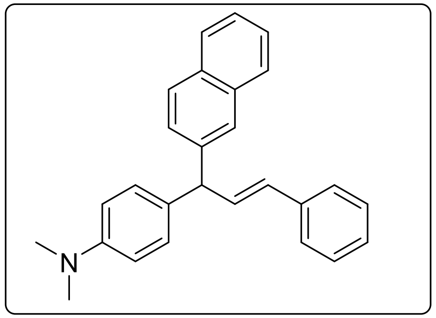

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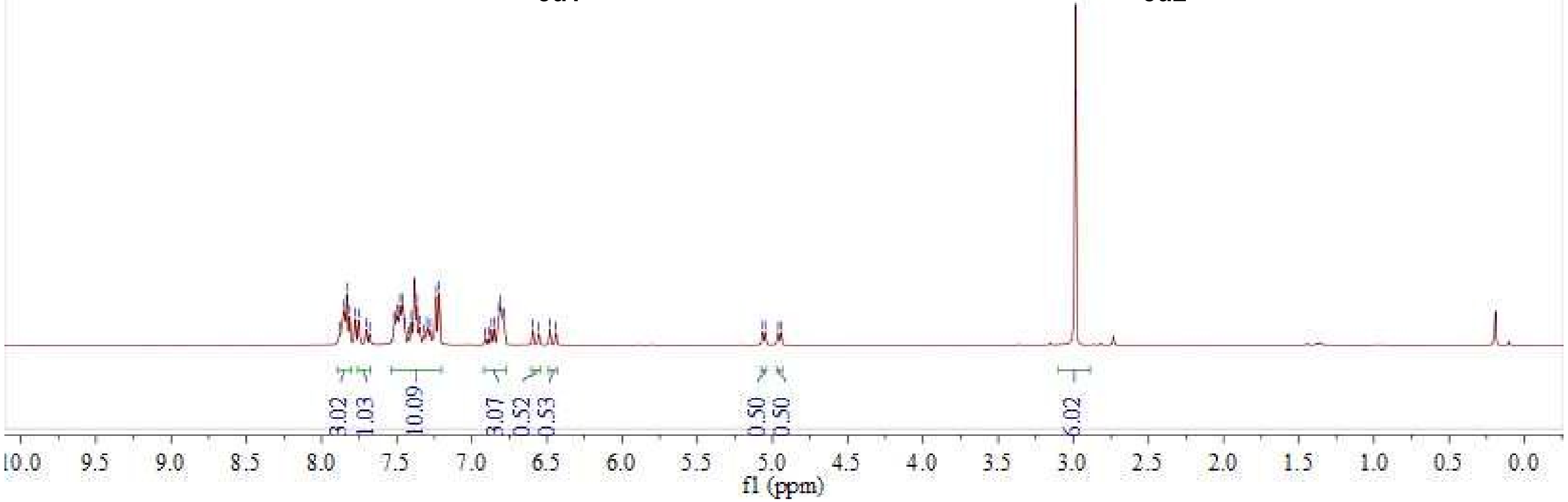
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3.02 1.03 10.09 3.07 0.52 0.53 0.50 0.50 6.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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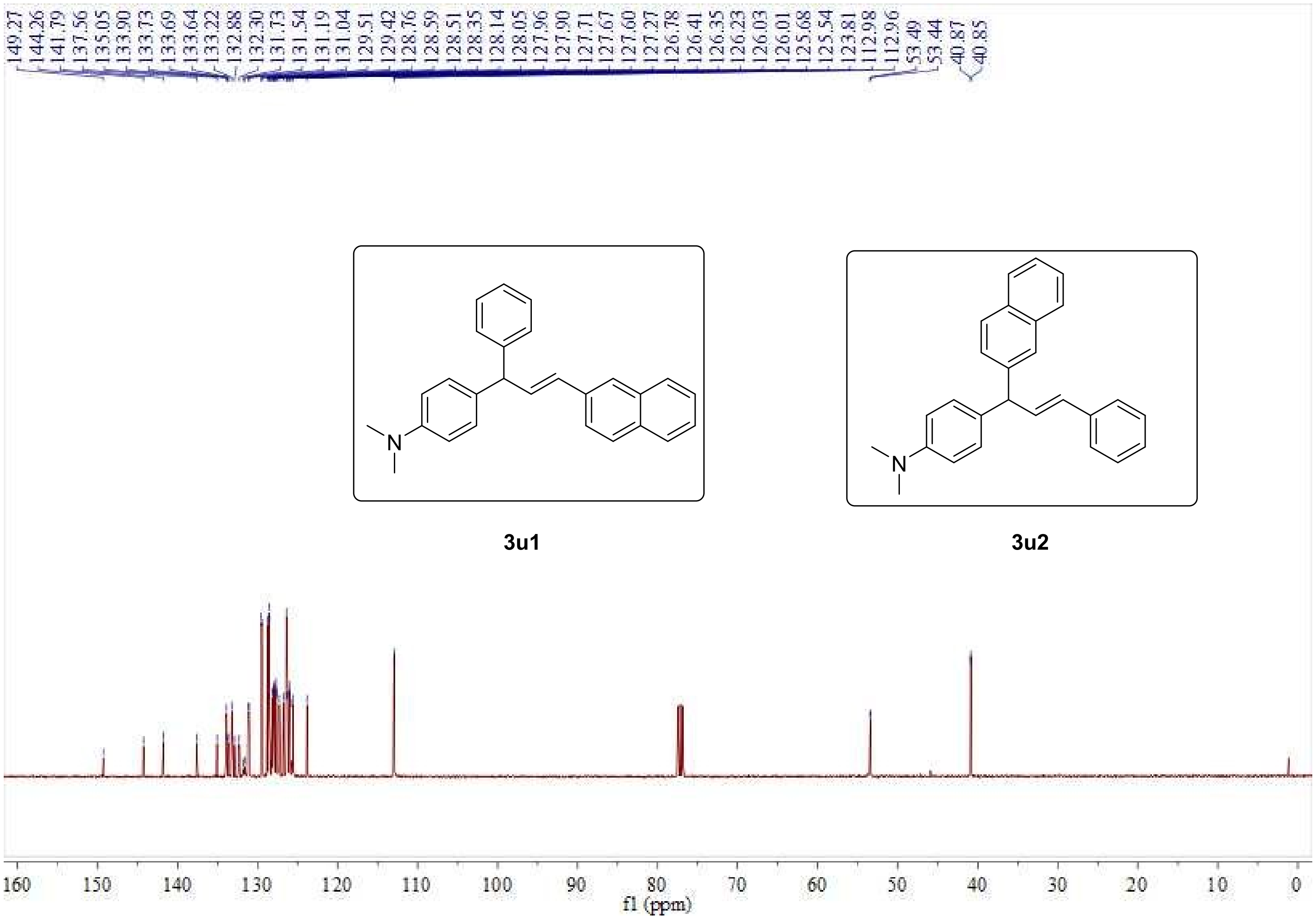
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128.76
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128.05
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127.90
127.71
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127.27
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126.41
126.35
126.23
126.03
126.01
125.68
125.54
123.81
112.98
112.96
53.49
53.44
40.87
40.85
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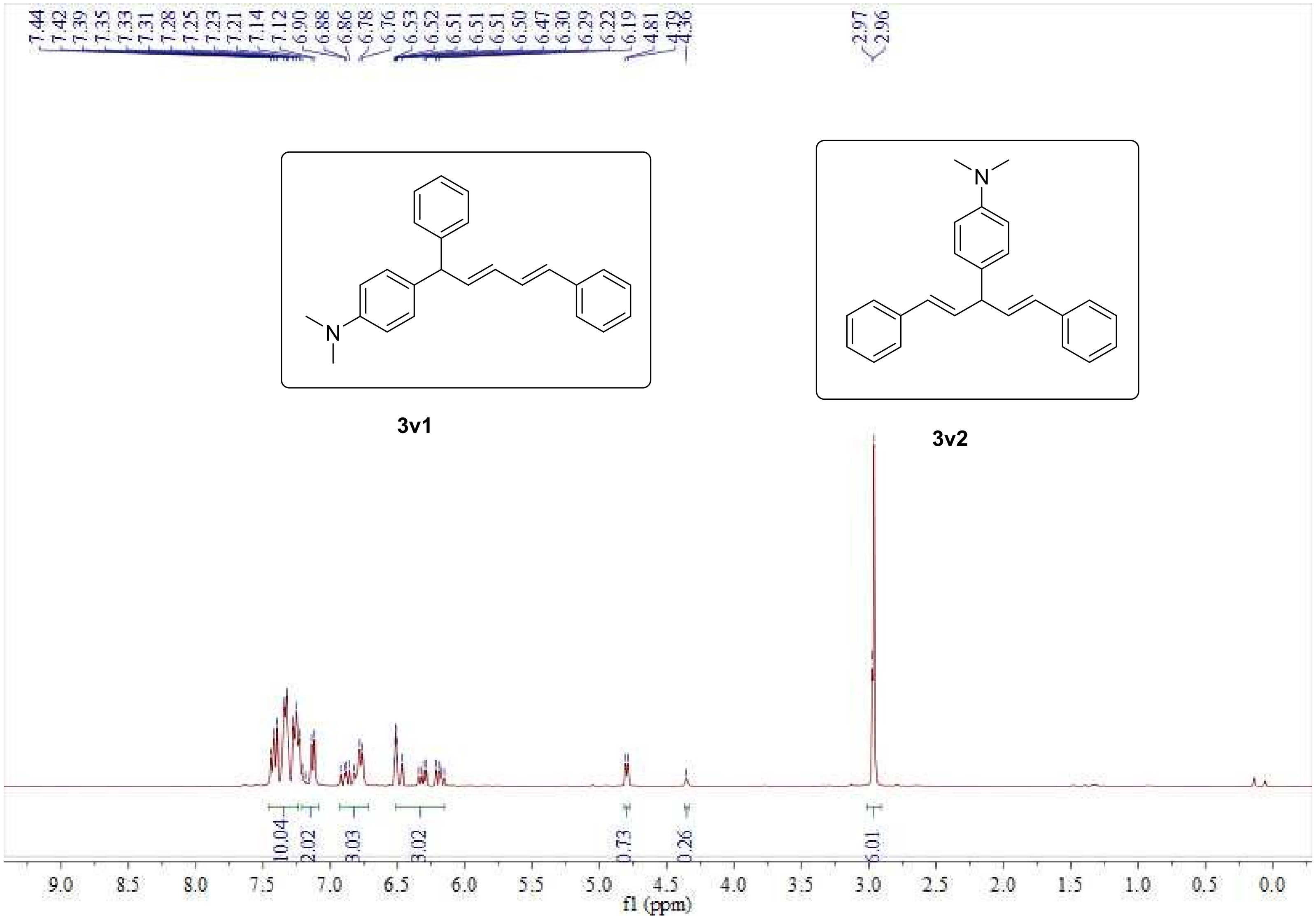
f1 (ppm)

3u1

3u2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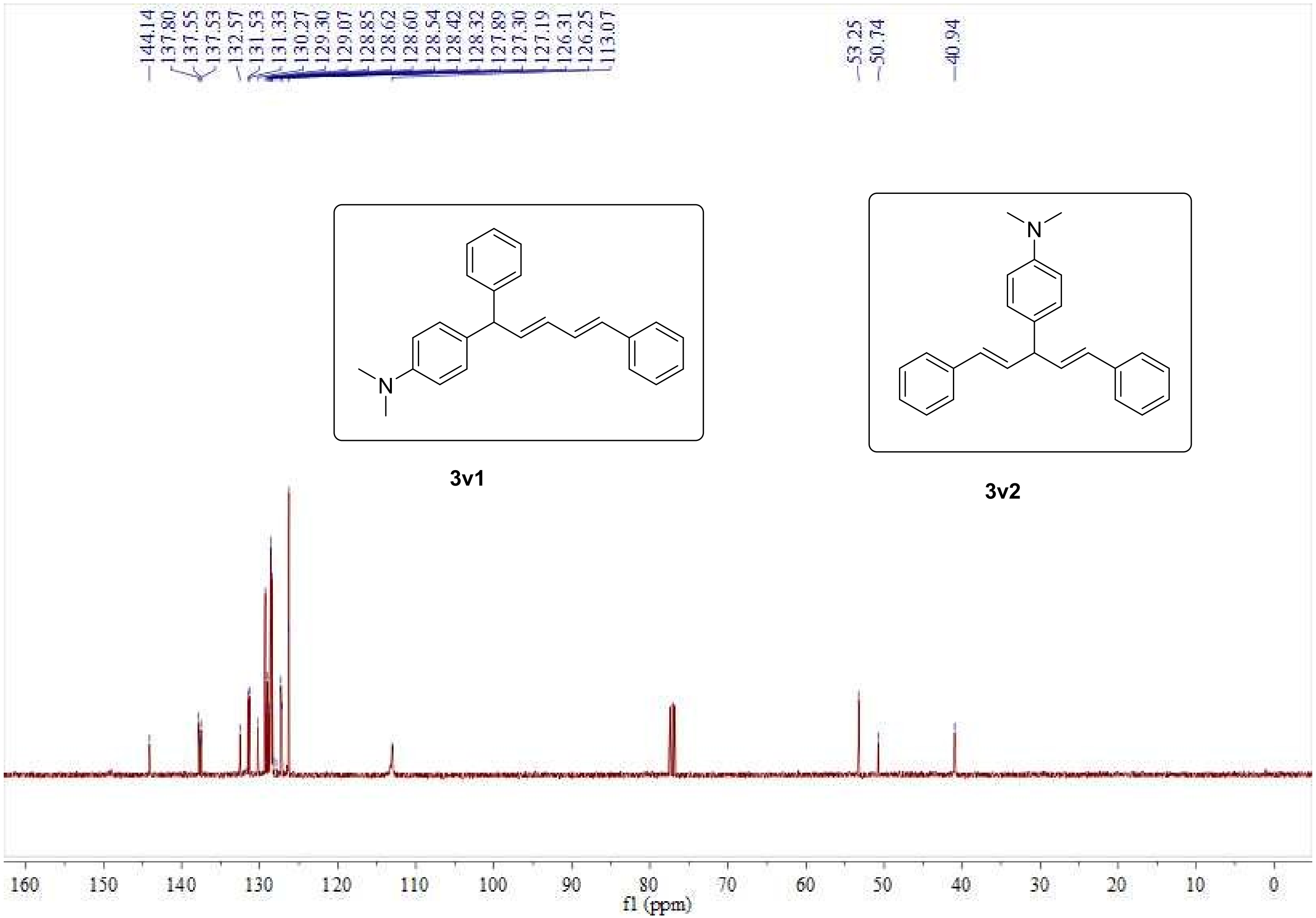
2.97 2.96
N
3v1
3v2
10.04 2.02 3.03 3.02 0.73 0.26 6.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



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126.31
126.25
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3v1
3v2
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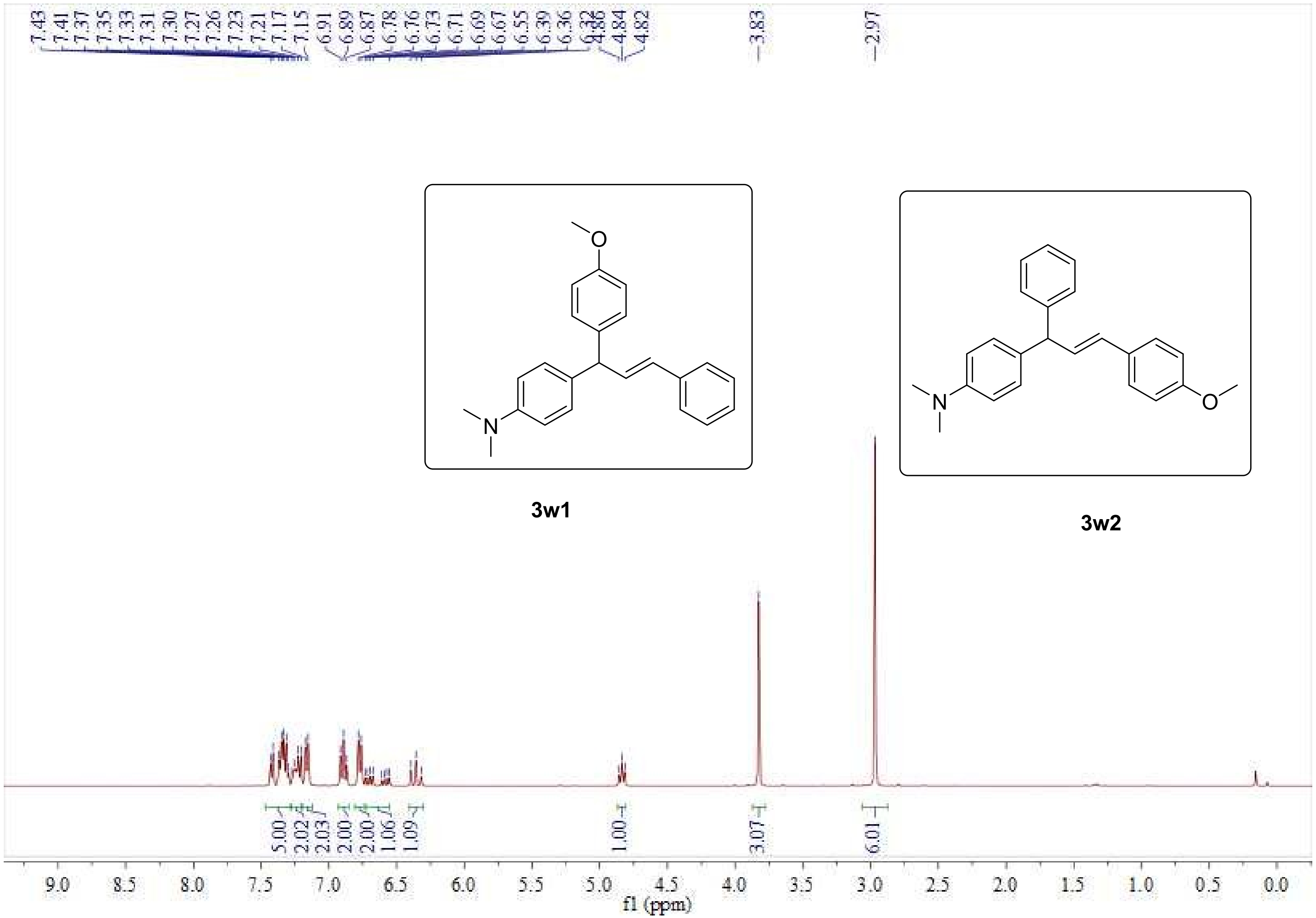
f1 (ppm)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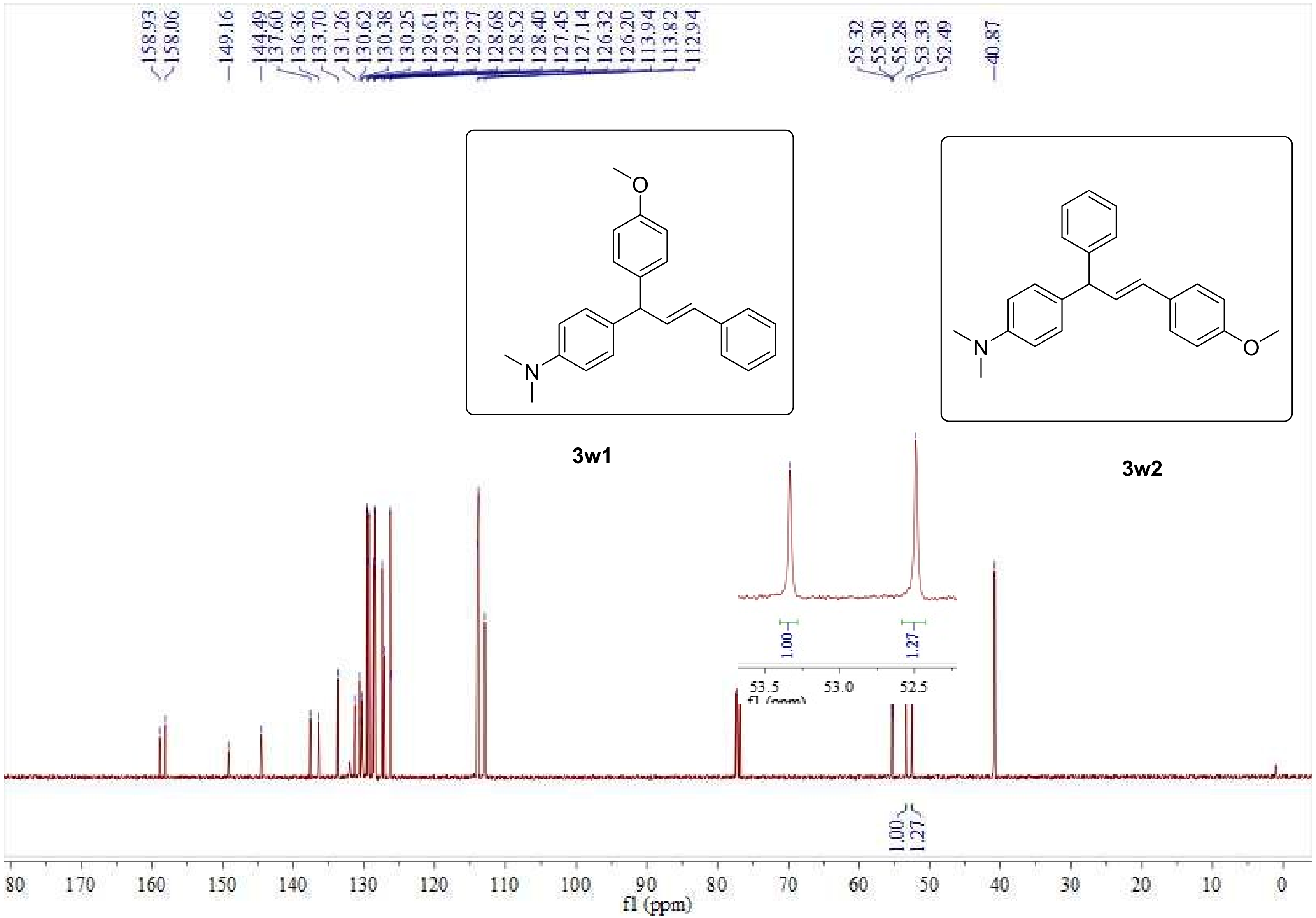
3.83
2.97
3w1
3w2
5.00 2.02 2.03 2.00 2.00 1.06 1.09
1.00
3.07
6.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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126.20
113.94
113.82
112.94
55.32
55.30
55.28
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52.49
40.87
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3w2
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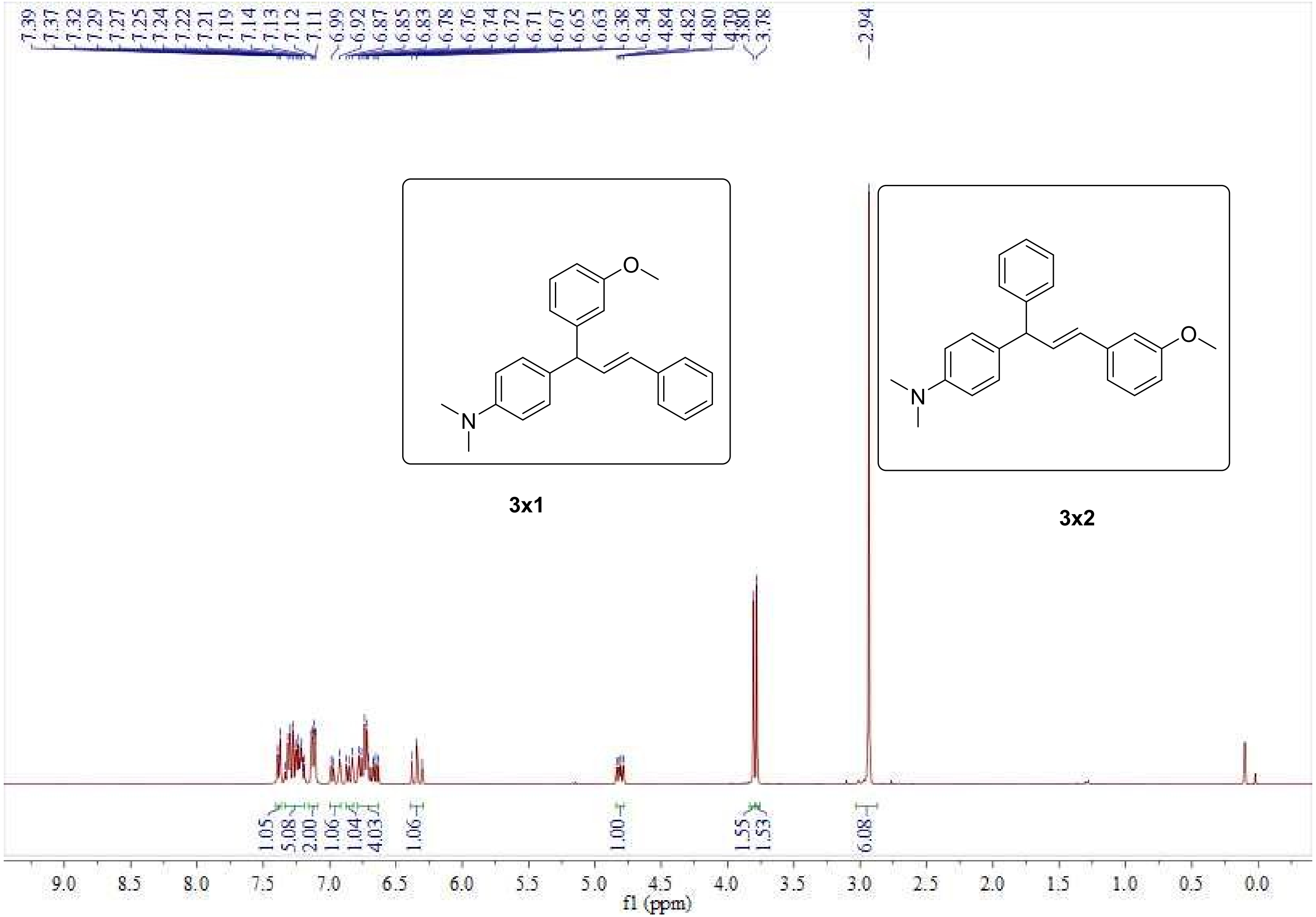
f1 (ppm)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2.94
3x1
3x2
1.05 5.08 2.00 1.06 1.04 4.03 1.06 1.00 1.55 1.53 6.08
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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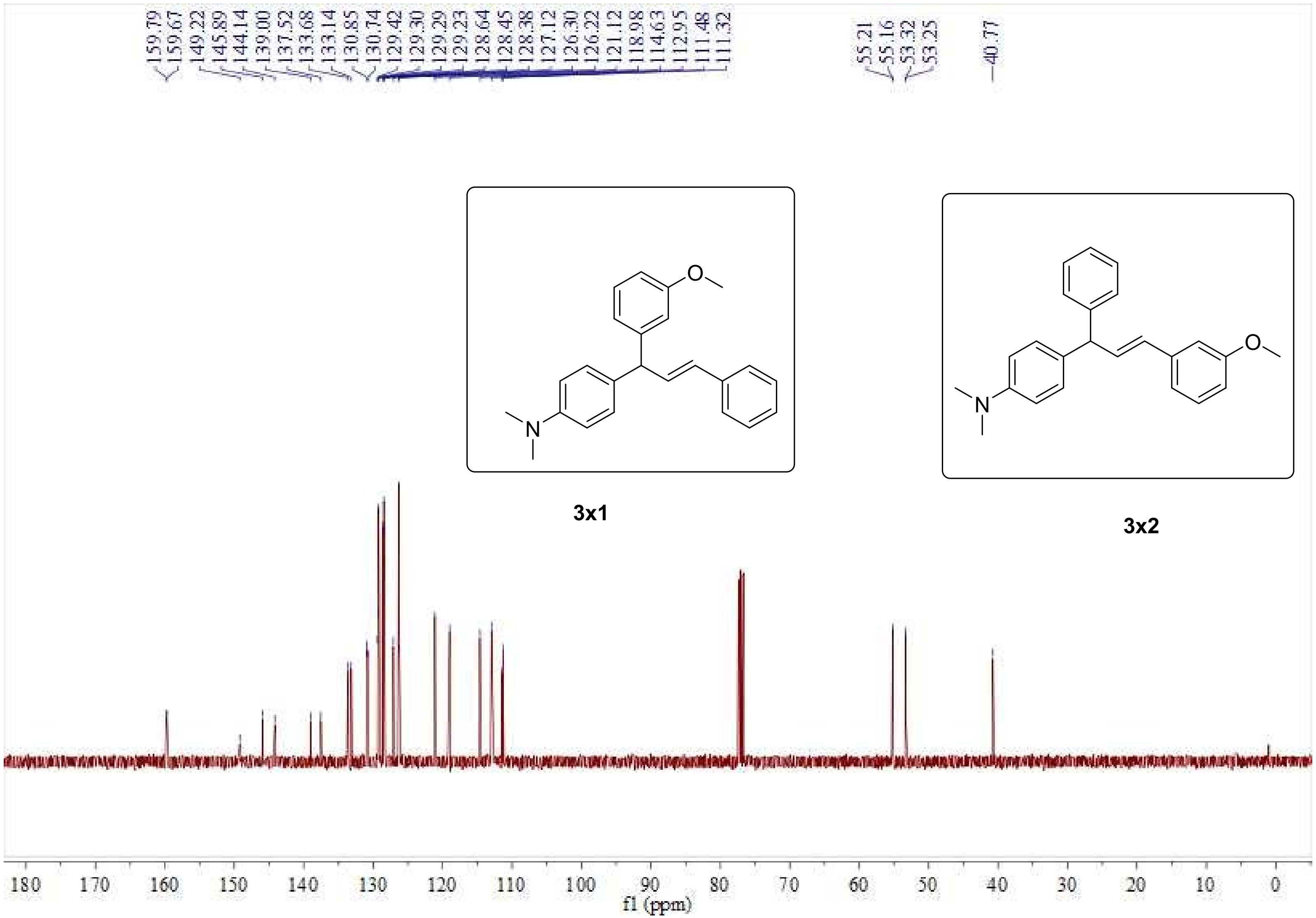

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111.48
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55.16
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O
N
3x2
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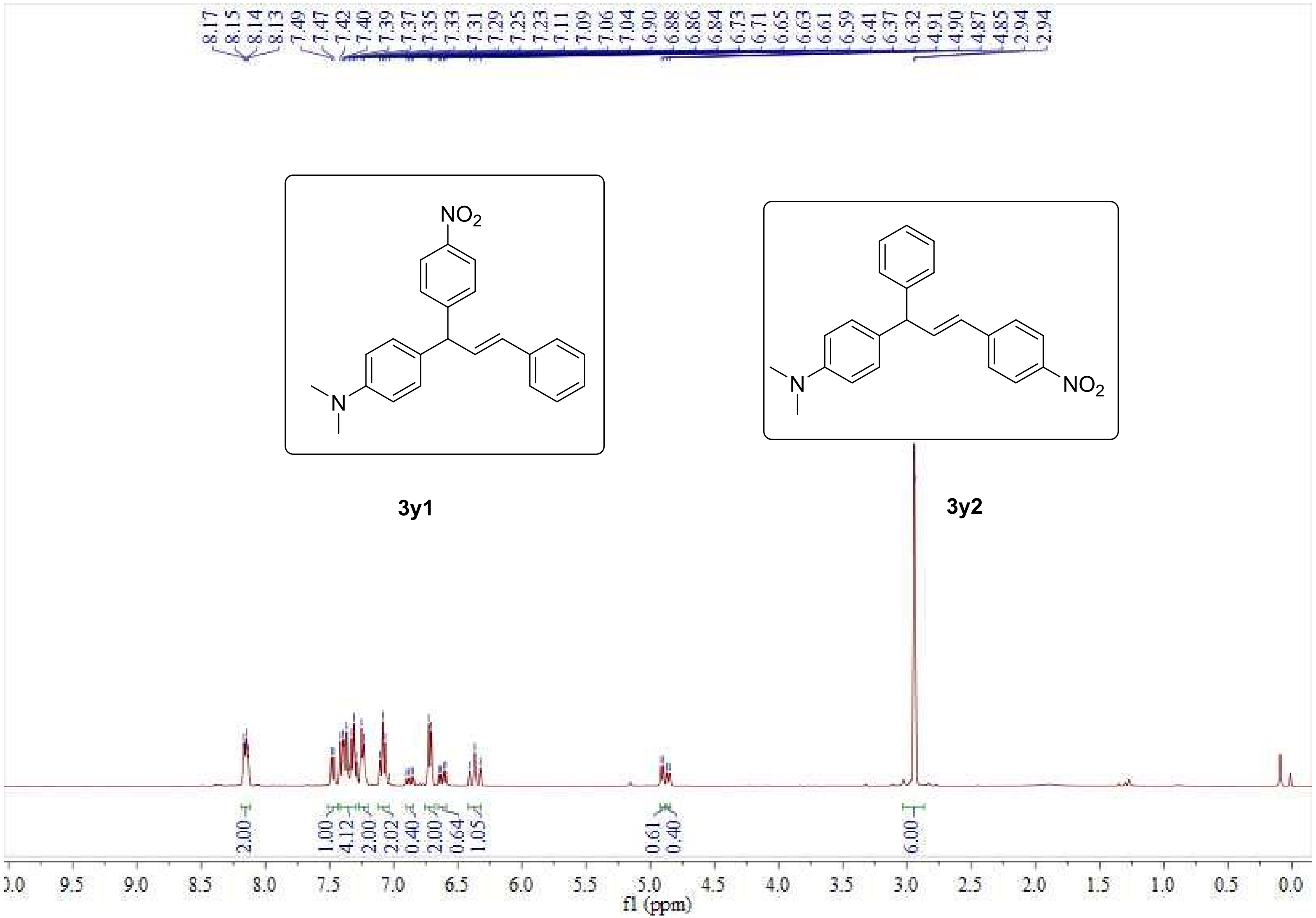

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4.87
4.85
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NO_2
3y2
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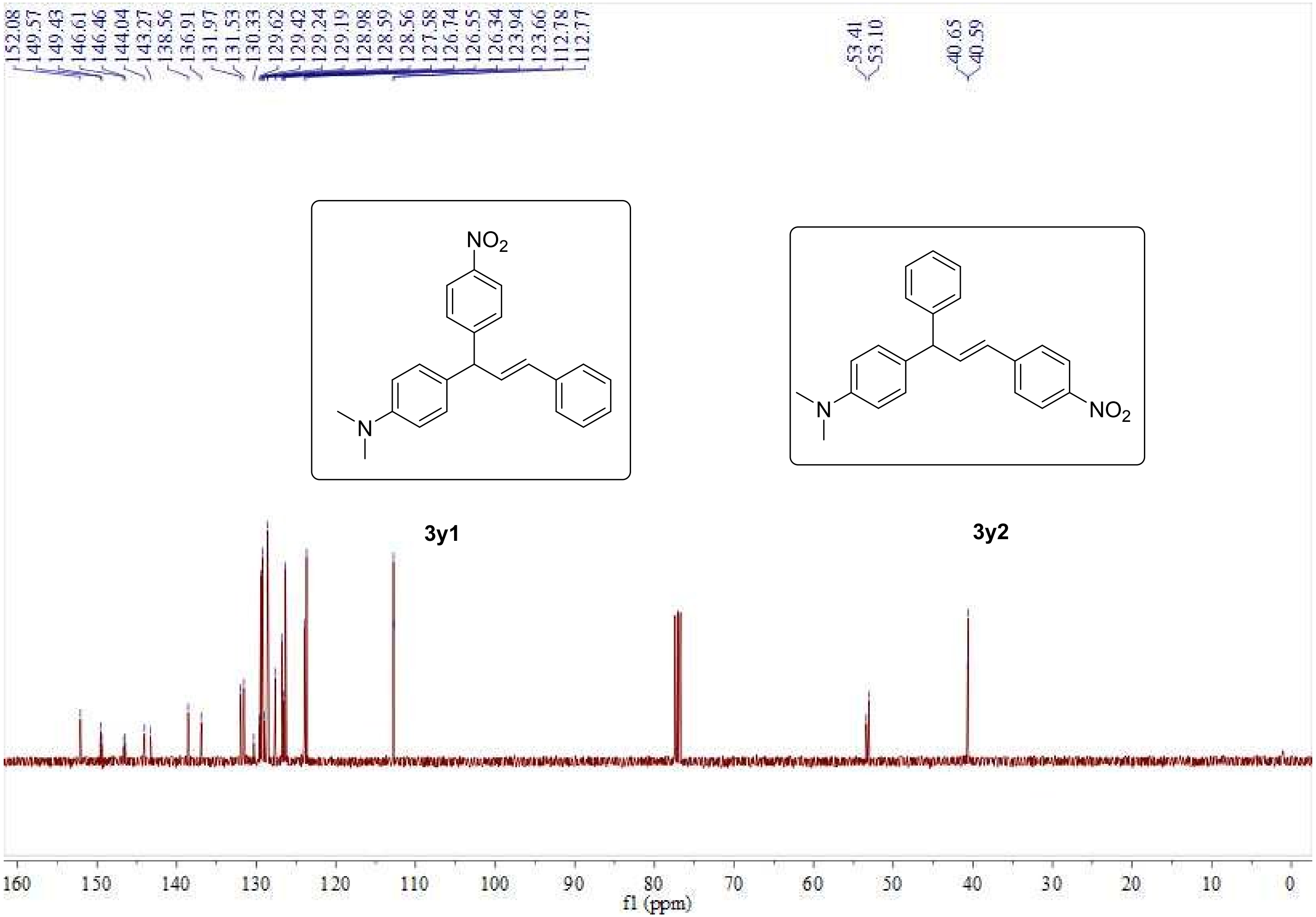
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NO_2
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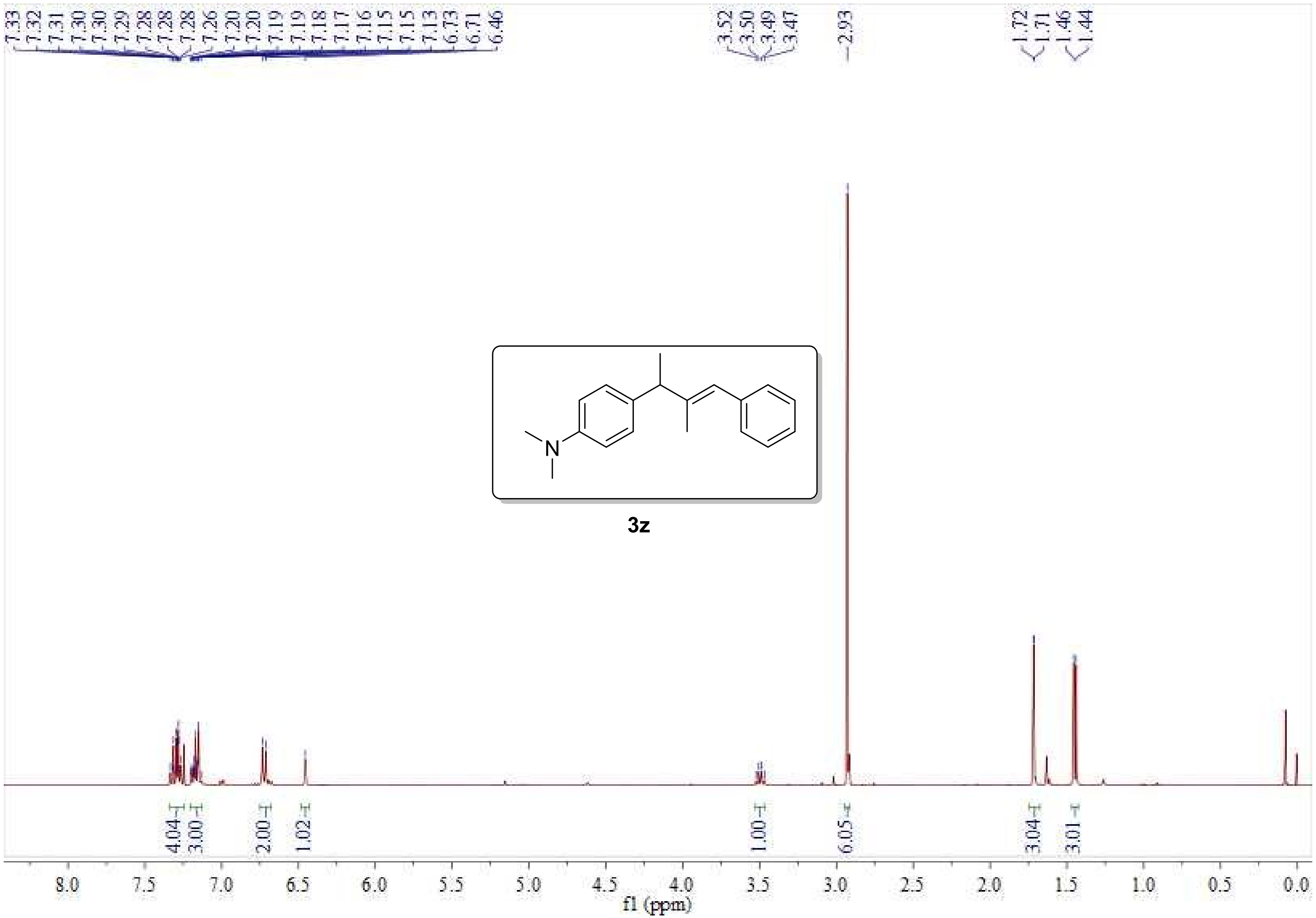
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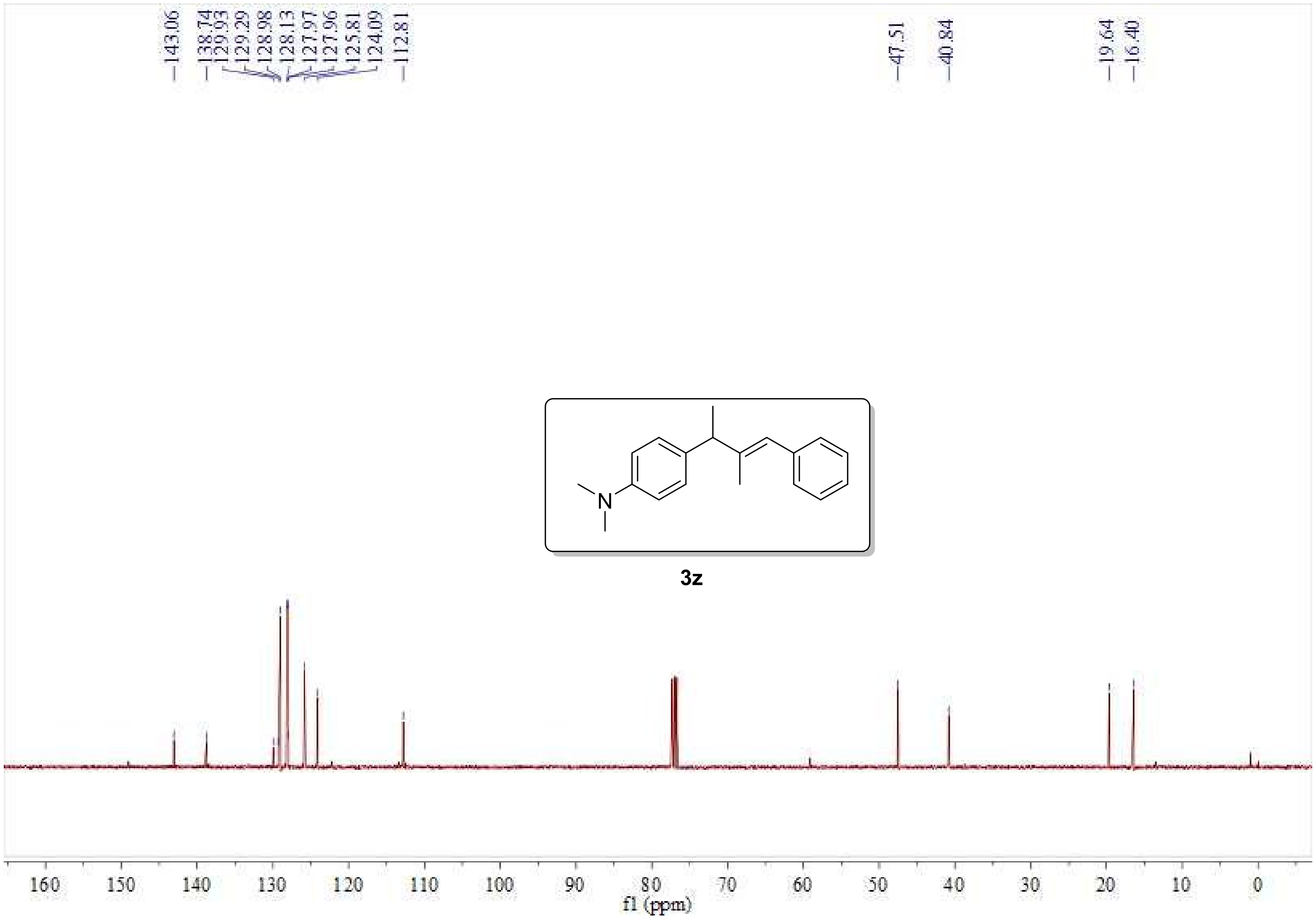

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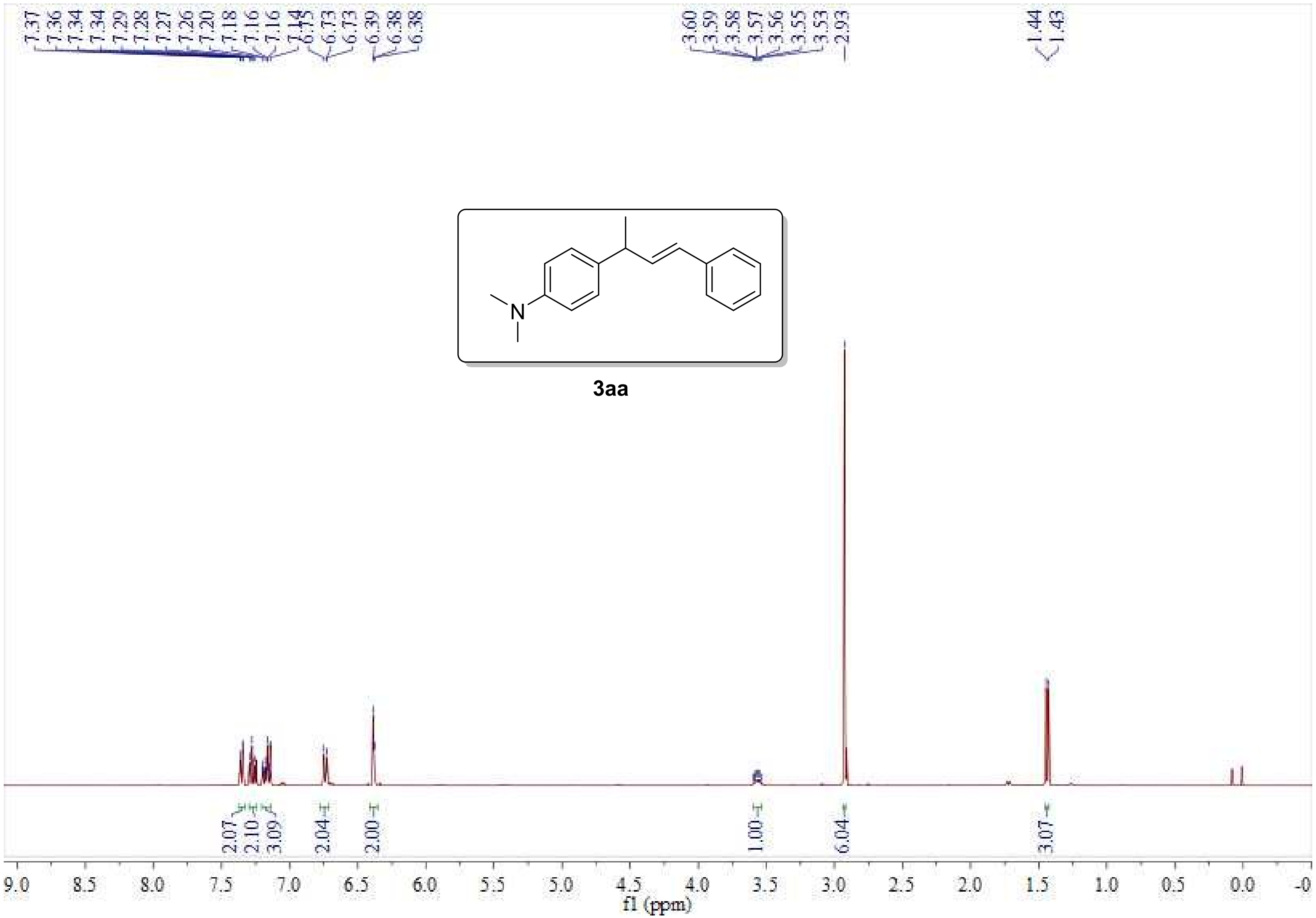
3z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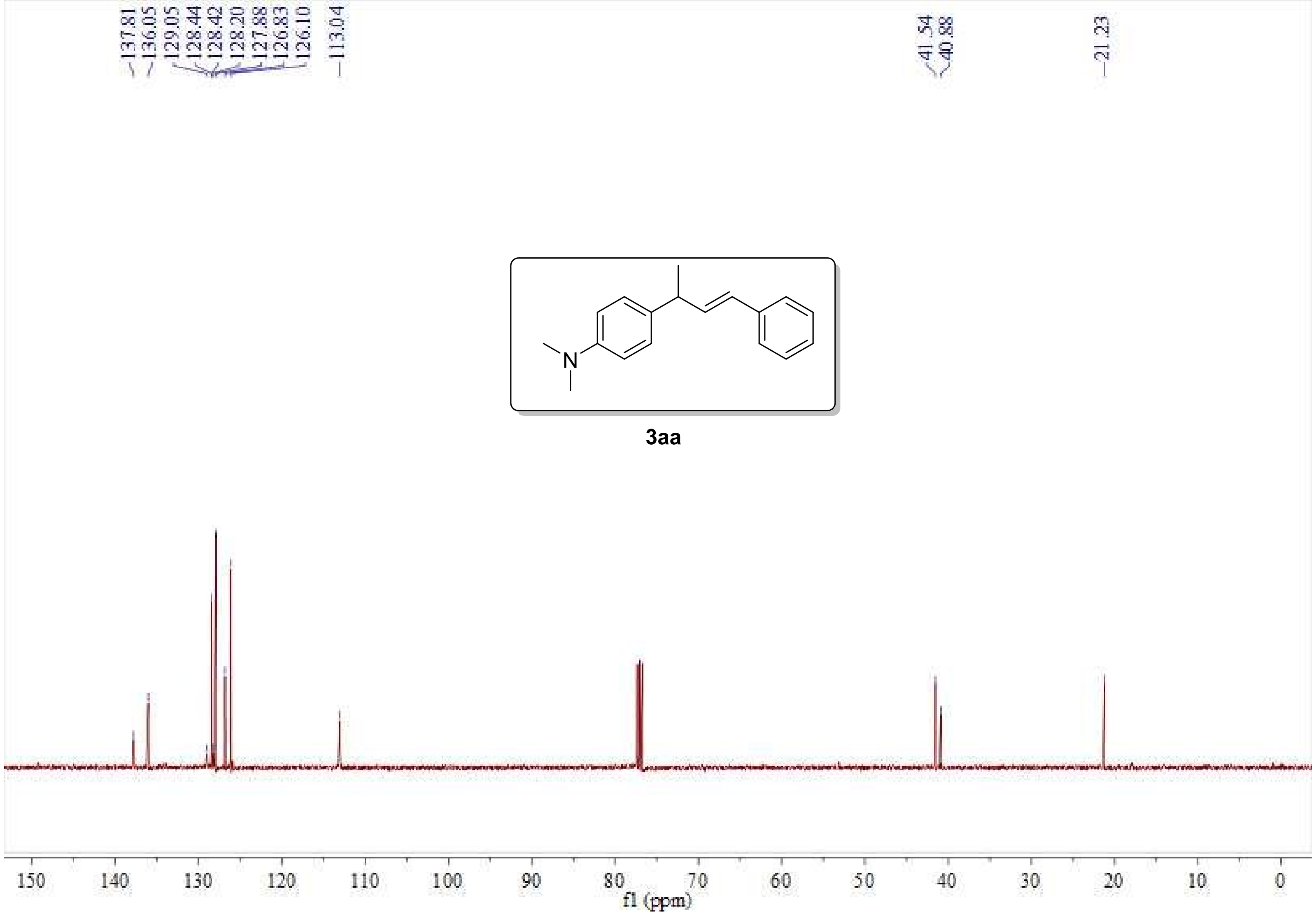
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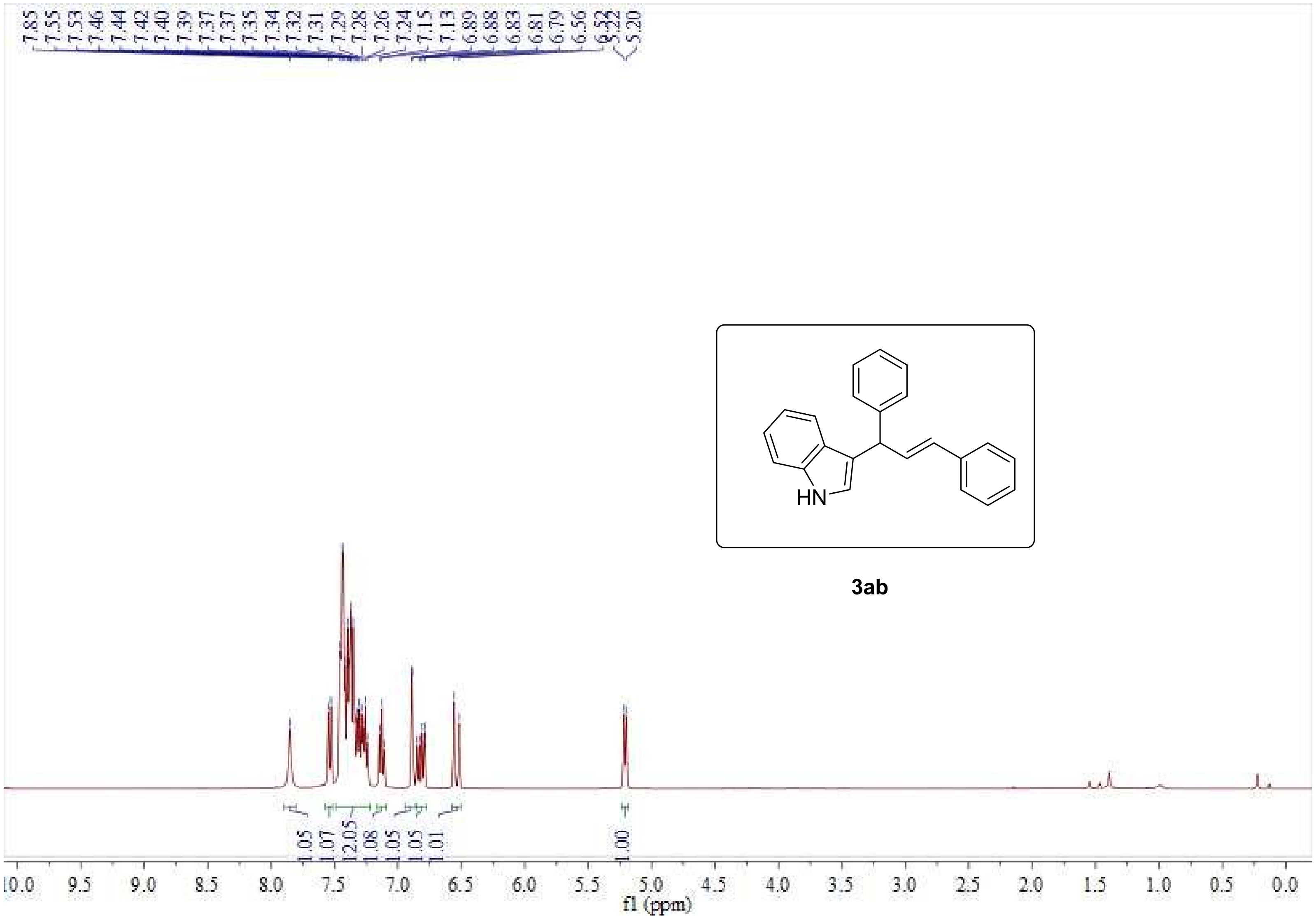
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1.01
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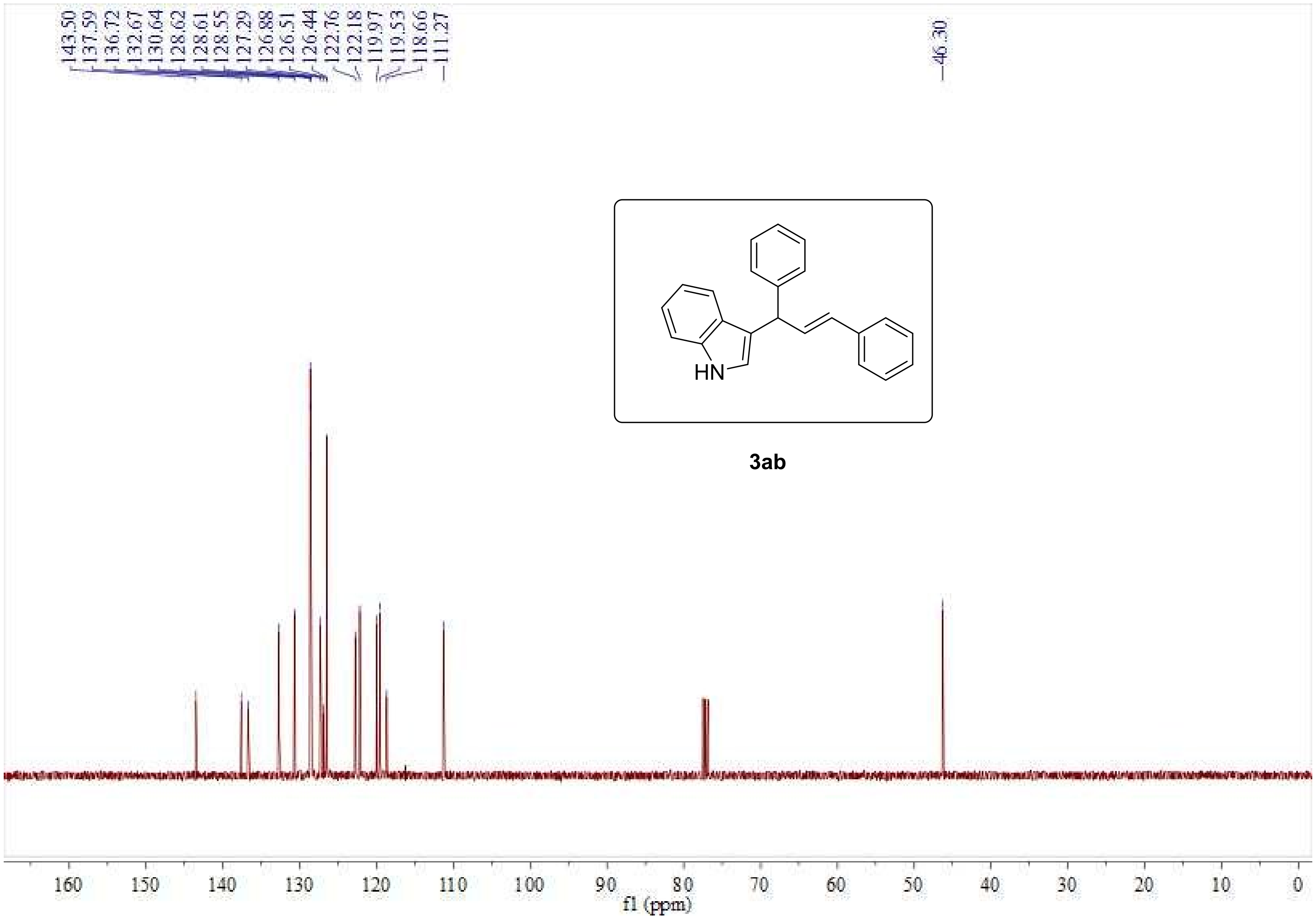
f1 (ppm)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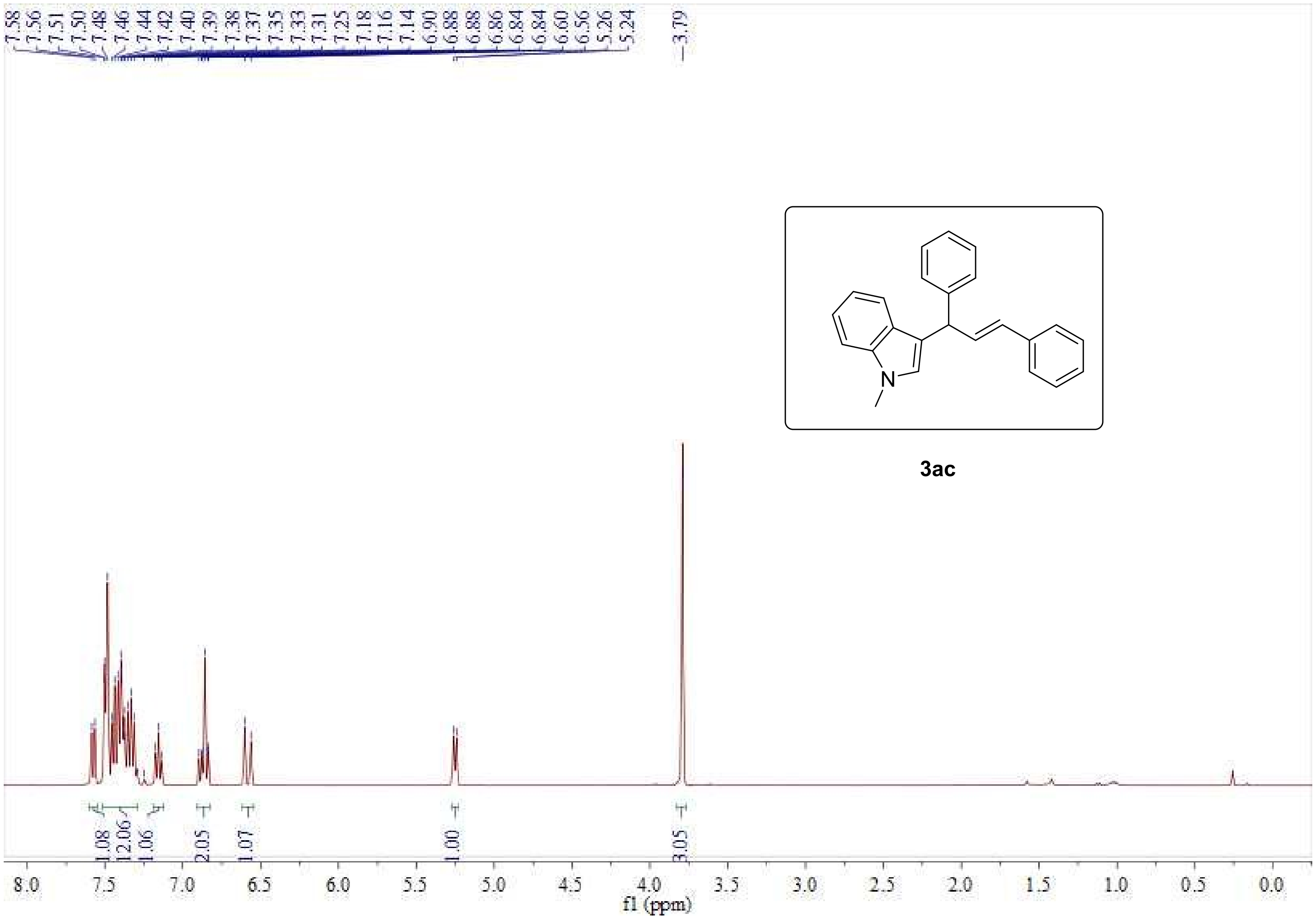
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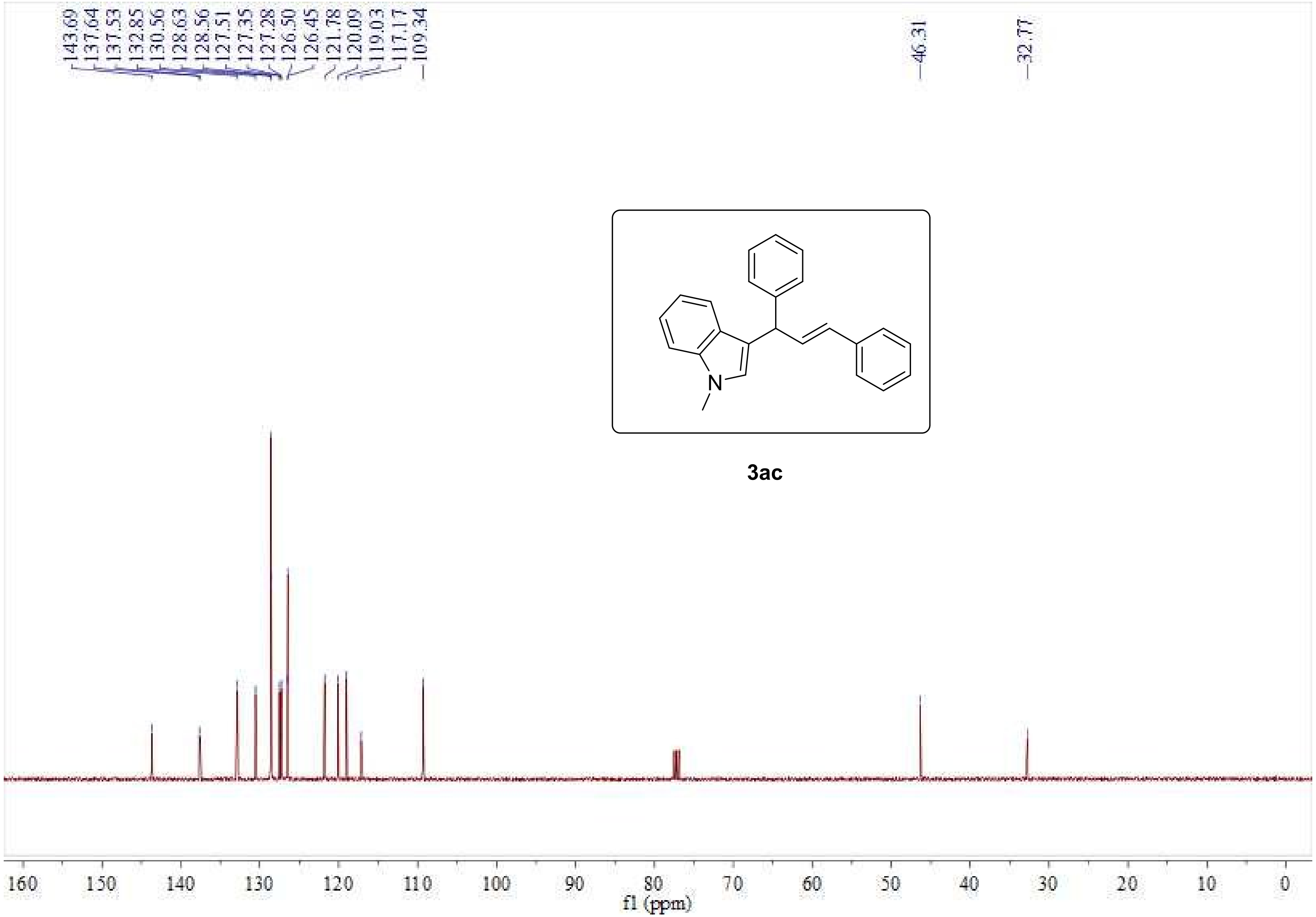
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46.31
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N
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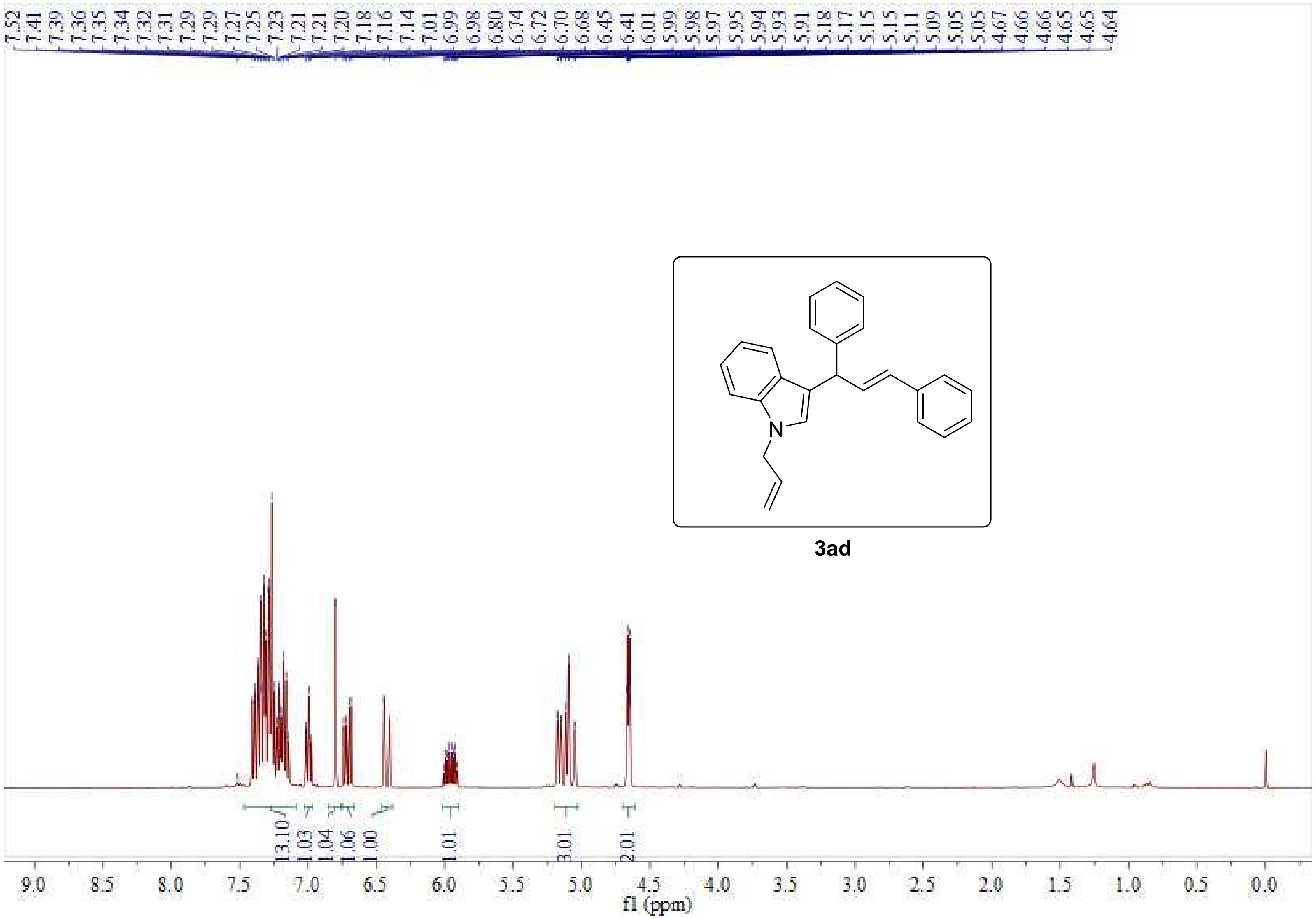
f1 (ppm)

3ac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N
3ad
13.10 1.03 1.04 1.06 1.00 1.01 3.01 2.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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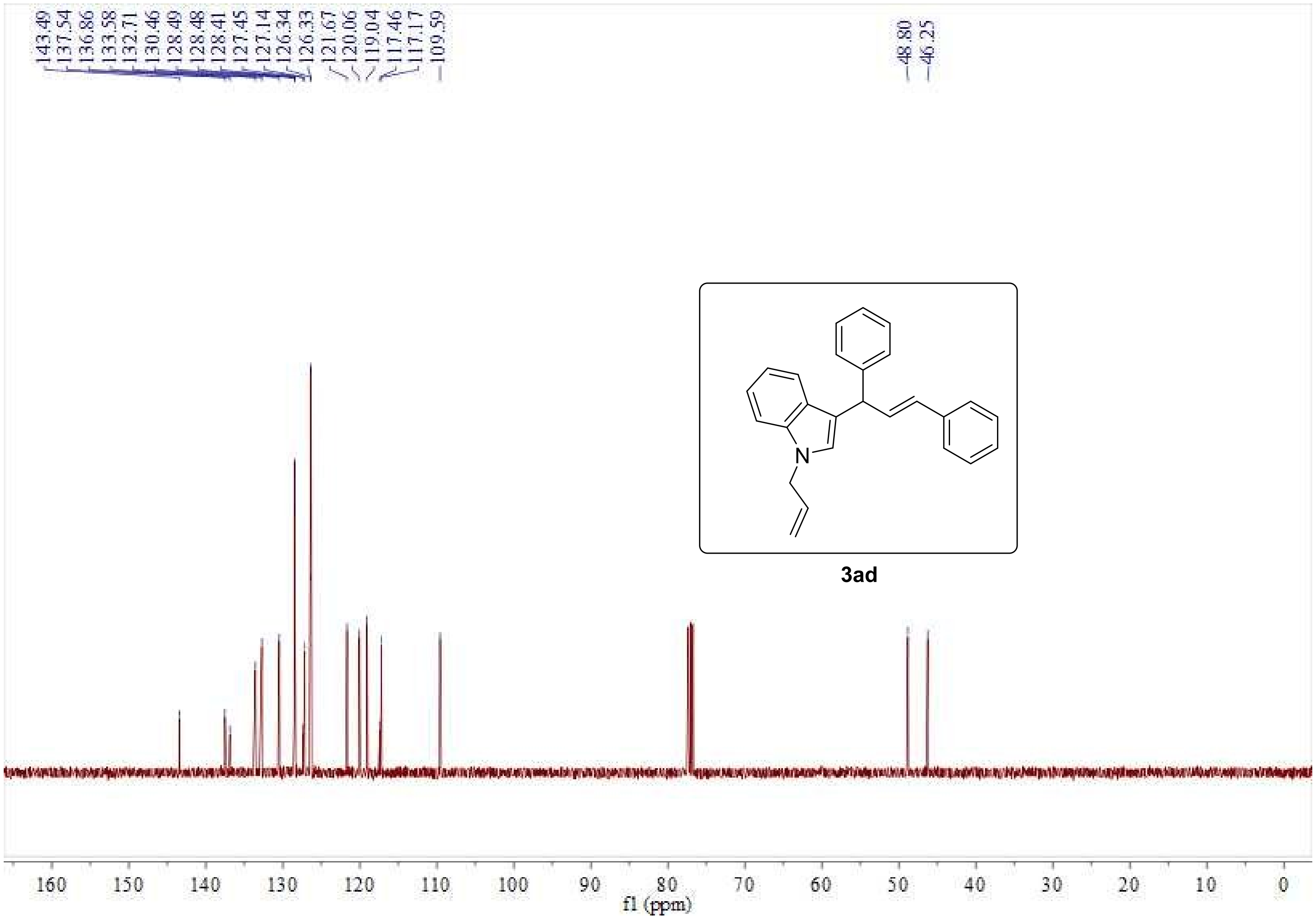
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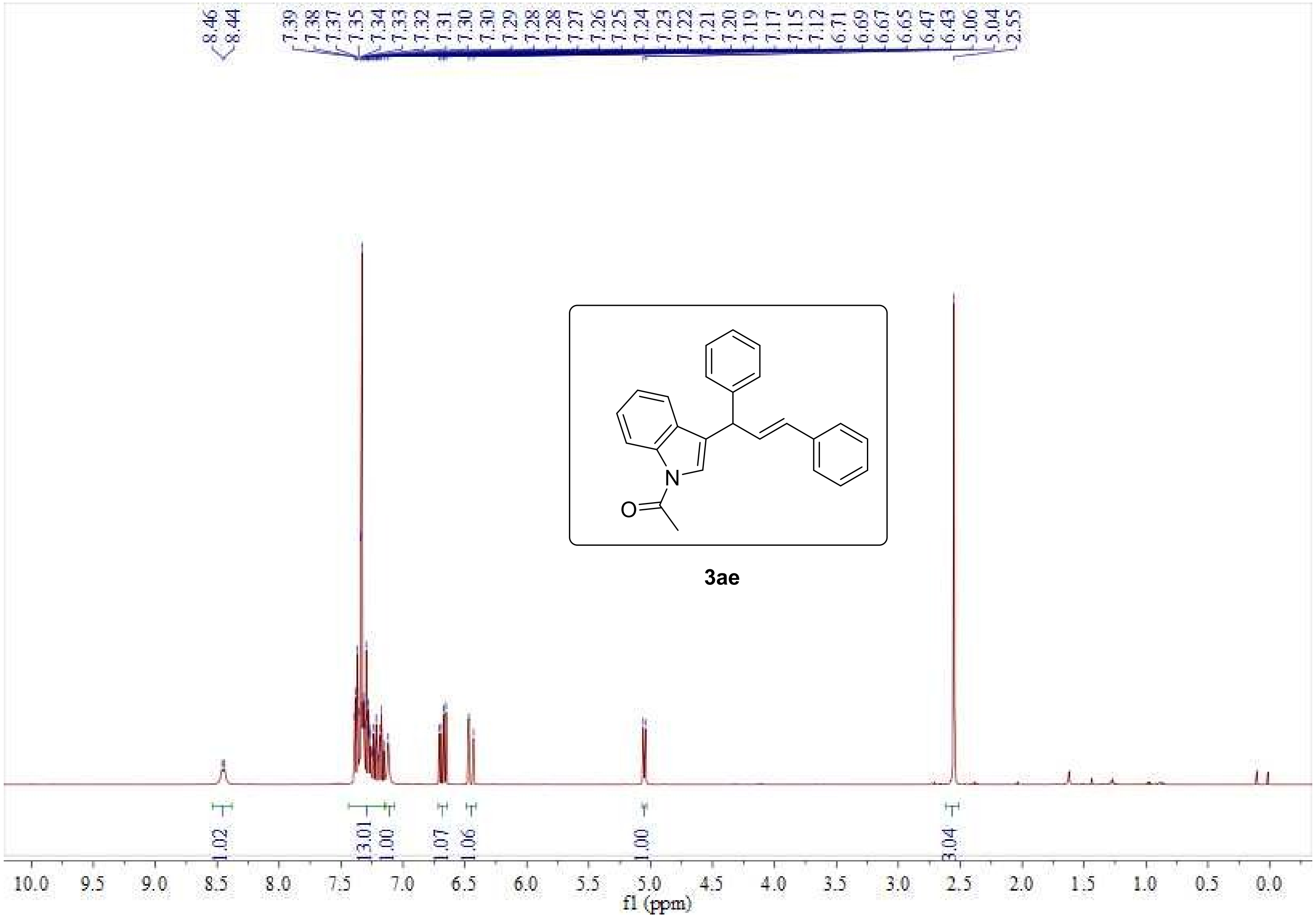
f1 (ppm)

3ad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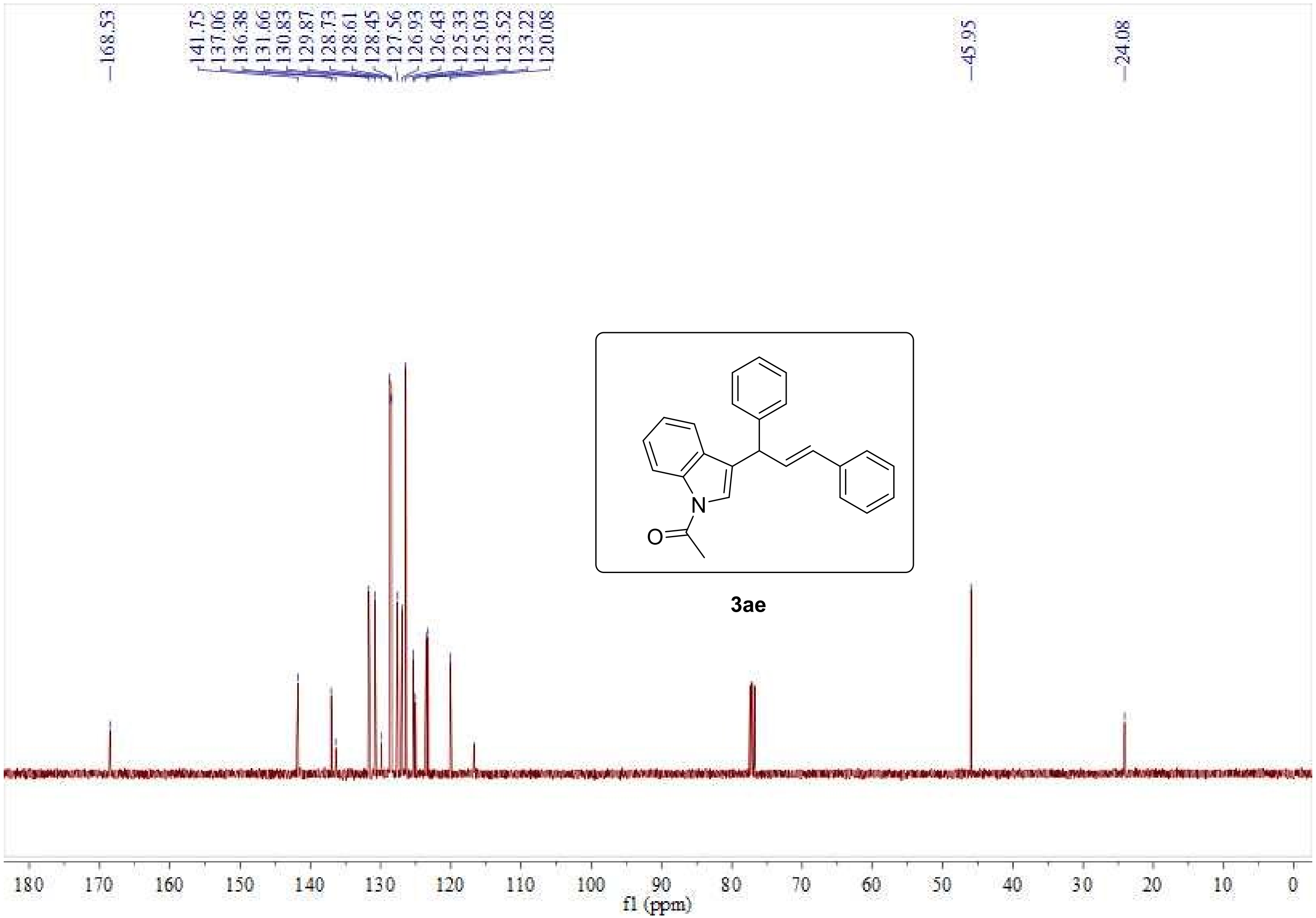
7.19
7.17
7.15
7.12
6.71
6.69
6.67
6.65
6.47
6.43
5.06
5.04
2.55
N
O
3ae
1.02
13.01
1.00
1.07
1.06
1.00
3.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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126.43
125.33
125.03
123.52
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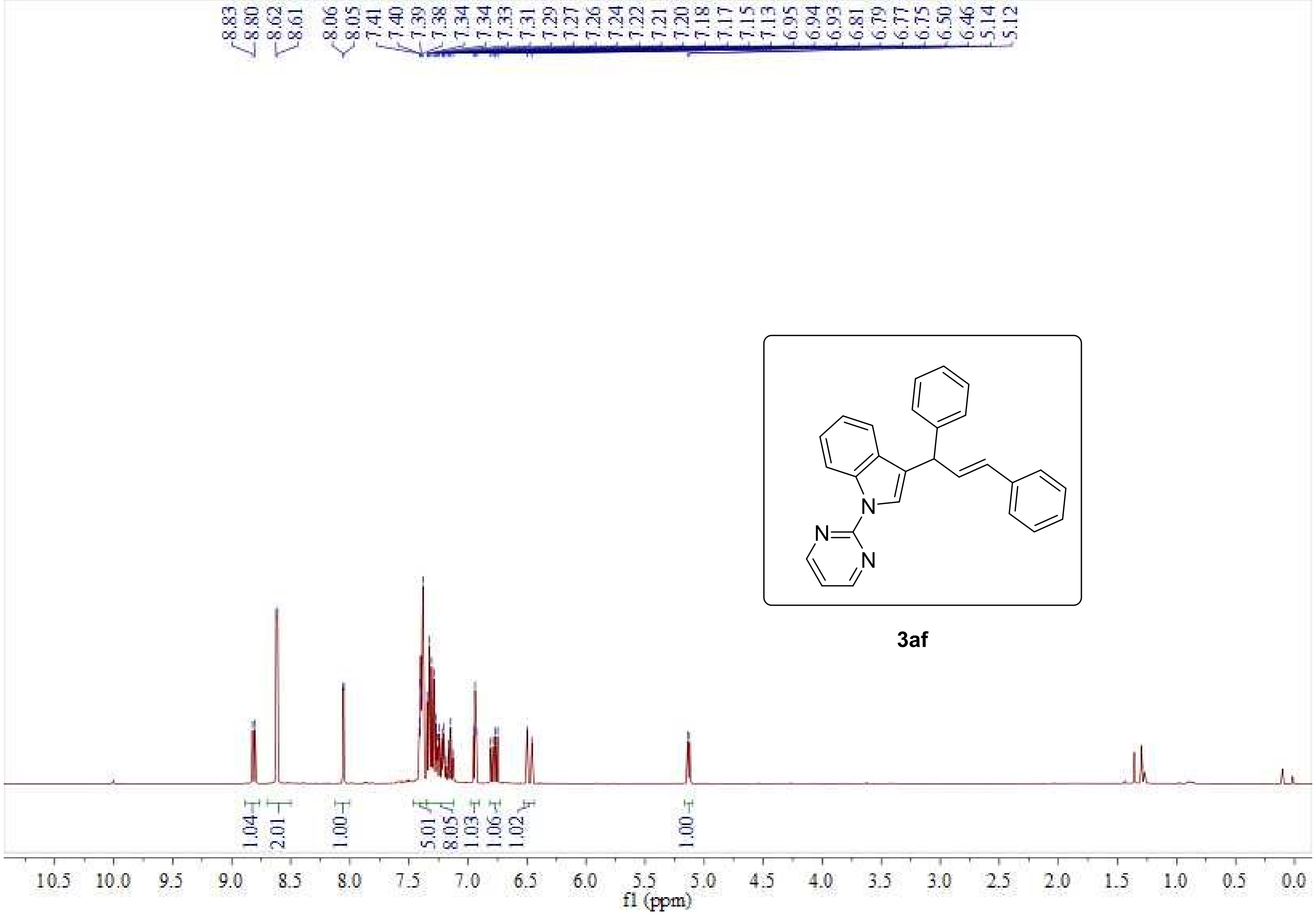
24.08
O
N
3ae
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



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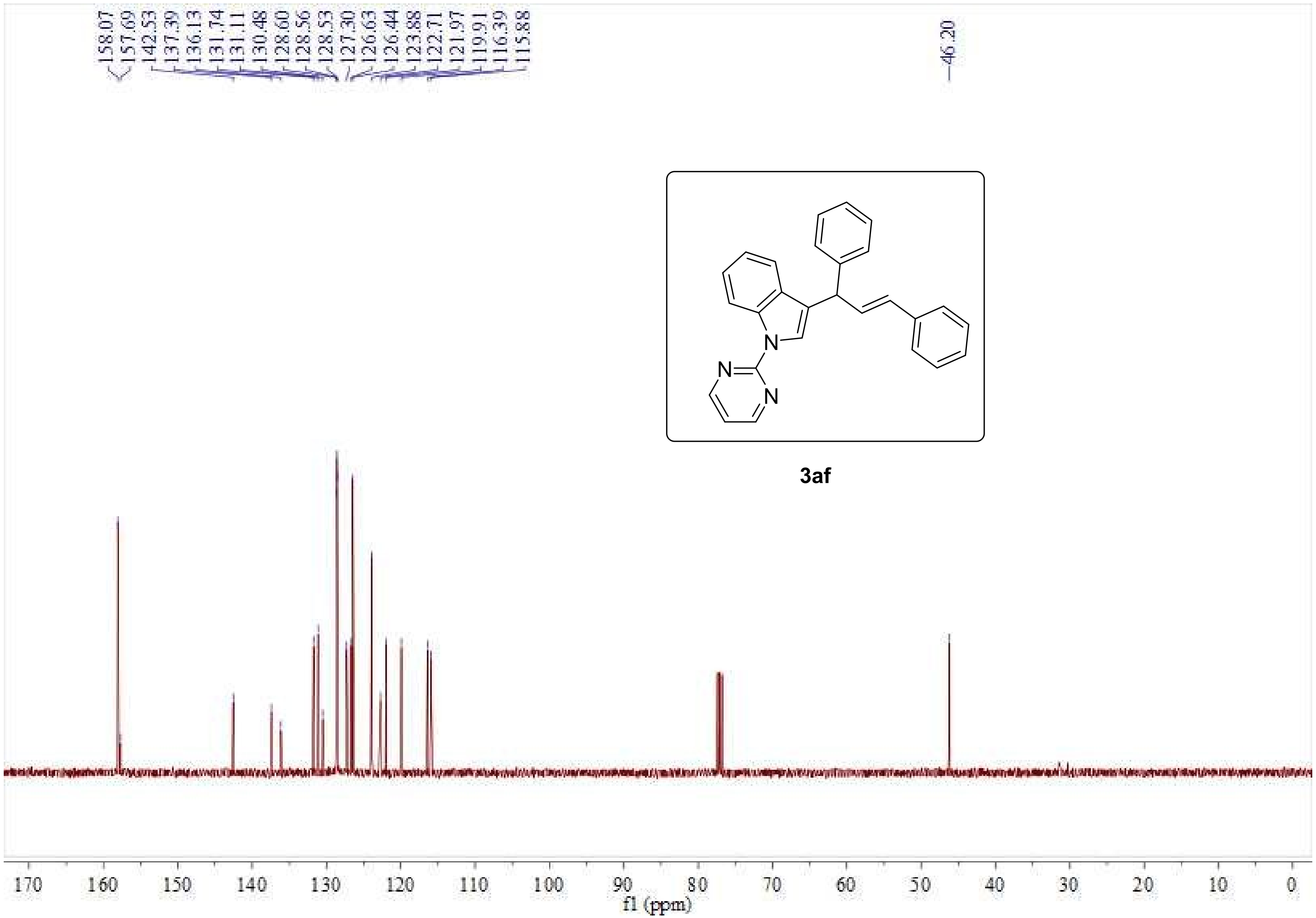
7.33
7.31
7.29
7.27
7.26
7.24
7.22
7.21
7.20
7.18
7.17
7.15
7.13
6.95
6.94
6.93
6.81
6.79
6.77
6.75
6.50
6.46
5.14
5.12
1.04
2.01
1.00
5.01
8.05
1.03
1.06
1.02
1.00
N
N
N
3af
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.56
128.53
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126.63
126.44
123.88
122.71
121.97
119.91
116.39
115.88
46.20
N
N
N
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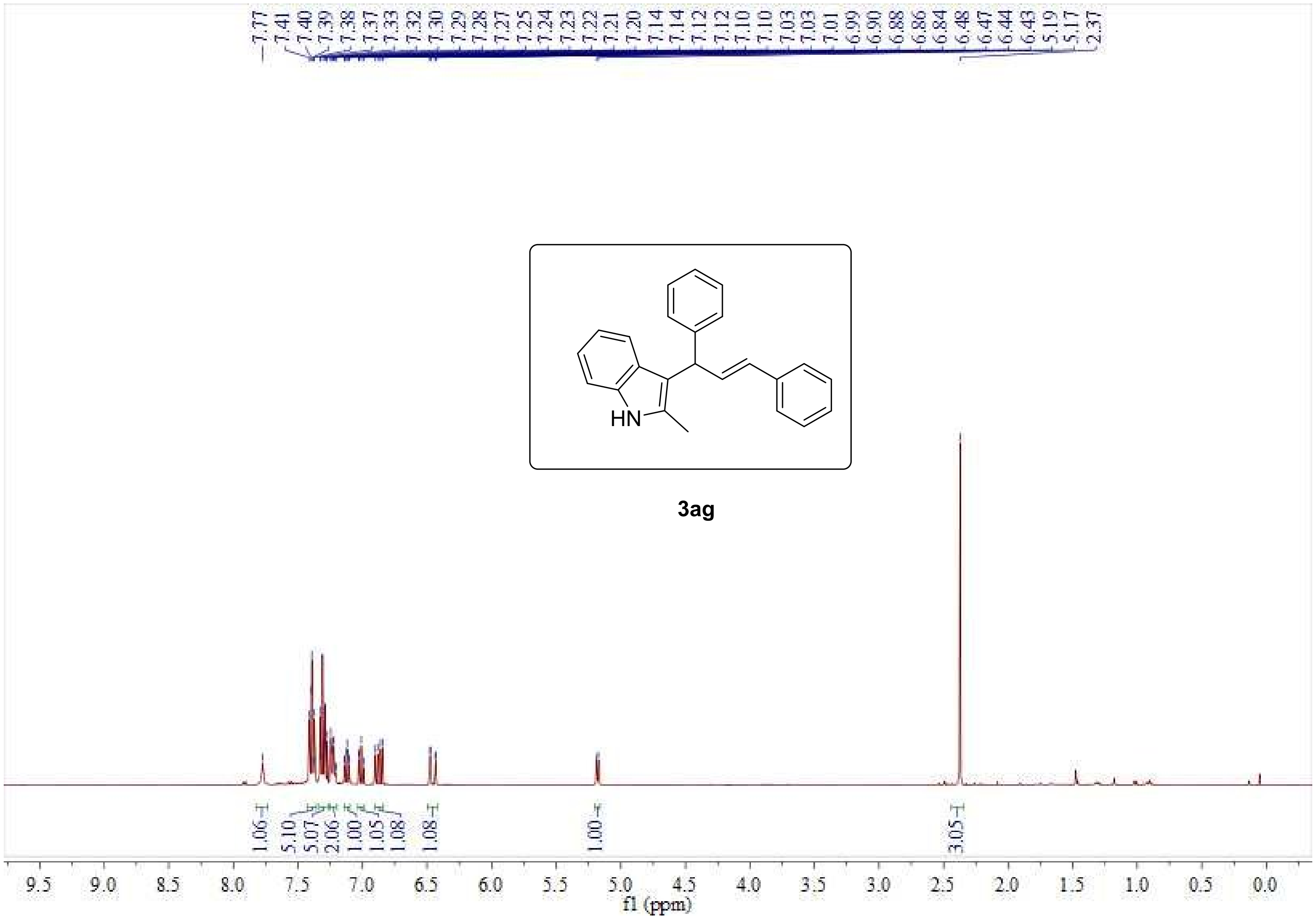
f1 (ppm)

3af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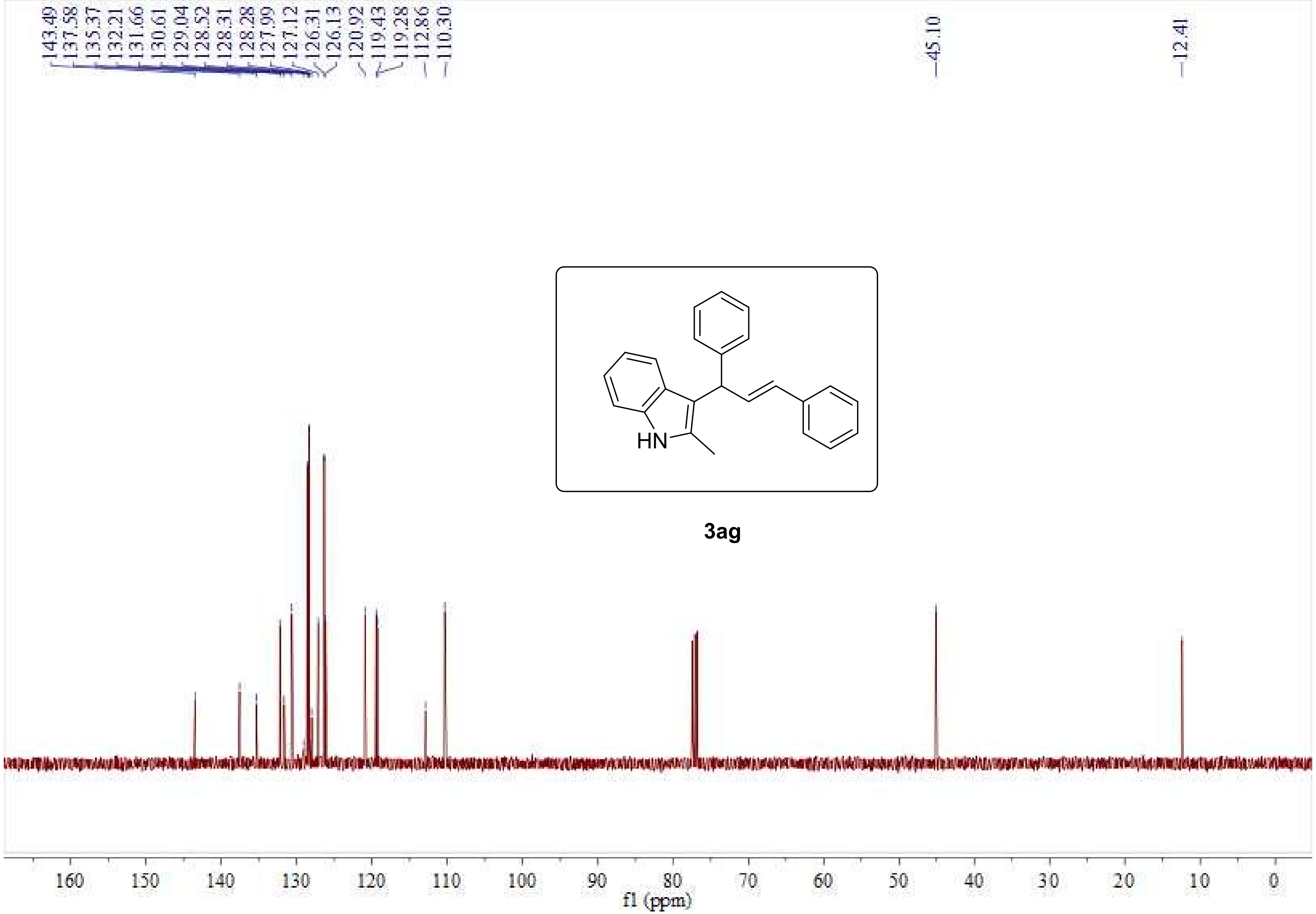
HN
3ag
1.06 5.10 5.07 2.06 1.00 1.05 1.08 1.08 1.00 3.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.52
128.31
128.28
127.99
127.12
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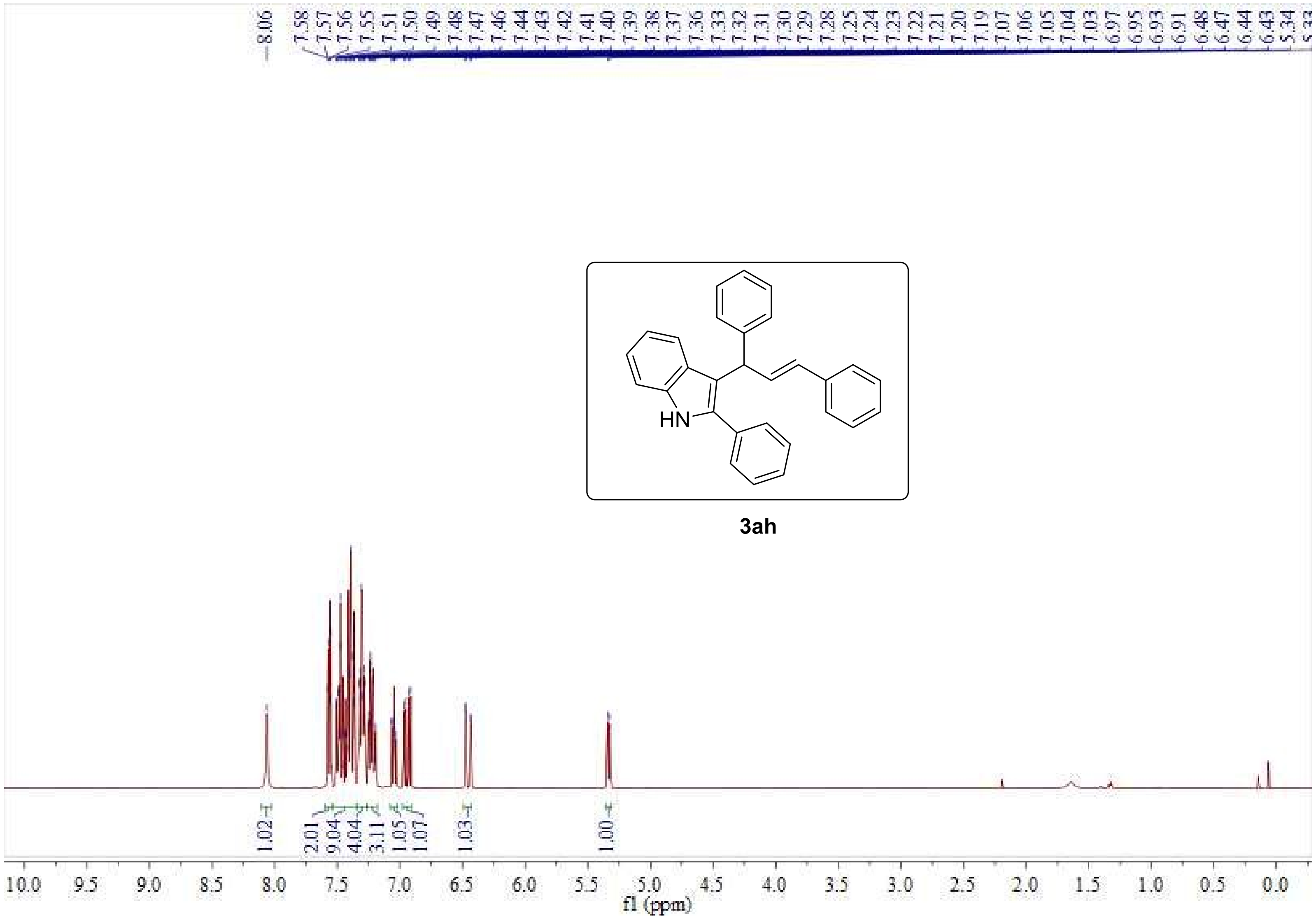
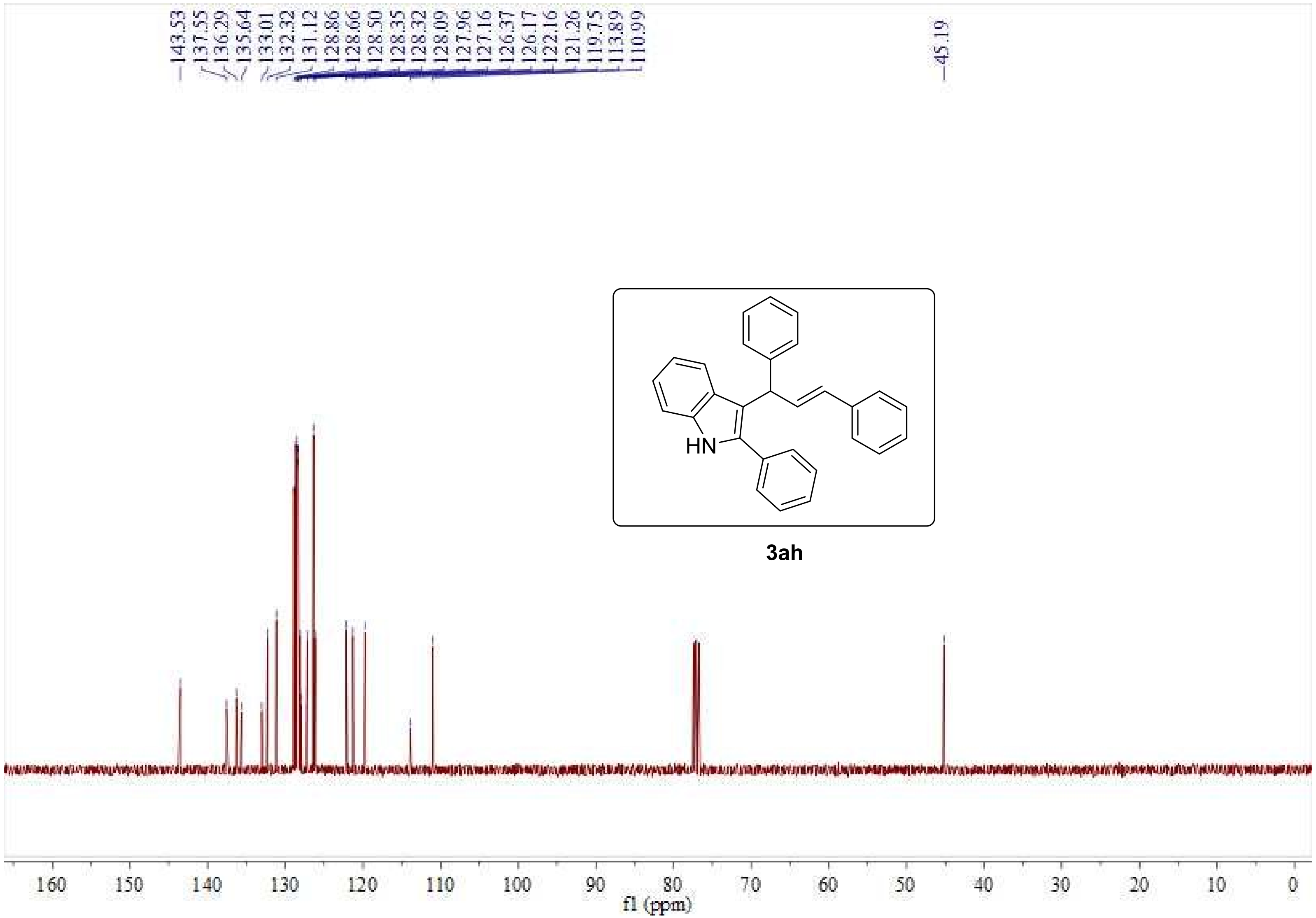
126.13
120.92
119.43
119.28
112.86
110.30
45.10
12.41
HN
3ag
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



8.06
7.58 7.57 7.56 7.55 7.51 7.50 7.49 7.48 7.47 7.46 7.44 7.43 7.42 7.41 7.40 7.39 7.38 7.37 7.36 7.33 7.32 7.31 7.30 7.29 7.28 7.25 7.24 7.23 7.22 7.21 7.20 7.19 7.07 7.06 7.05 7.04 7.03 6.97 6.95 6.93 6.91 6.48 6.47 6.44 6.43 5.34
HN
3ah
1.02
2.01 9.04 4.04 3.11 1.05 1.07
1.03
1.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.32
128.09
127.96
127.16
126.37
126.17
122.16
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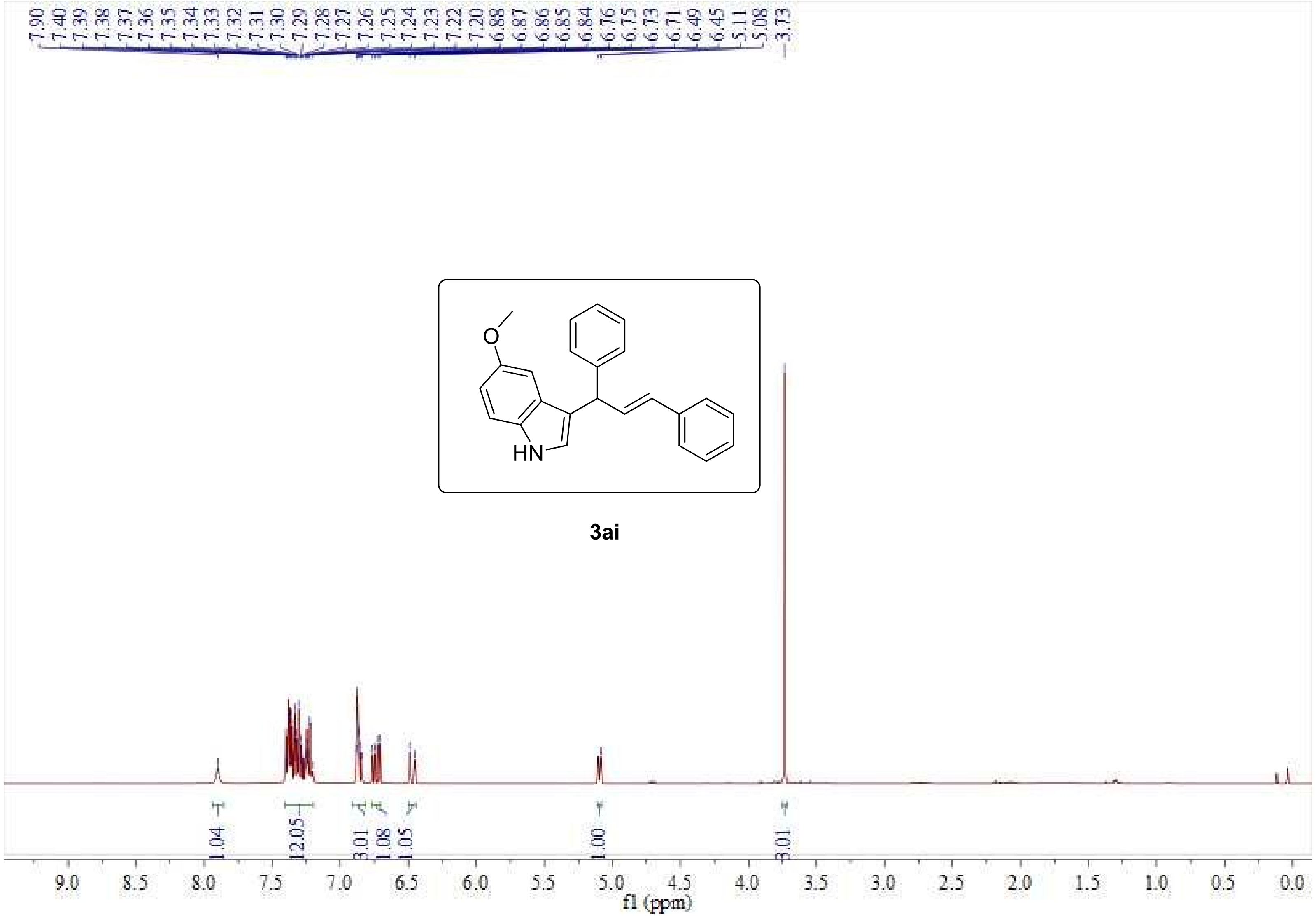
113.89
110.99
45.19
HN
3ah
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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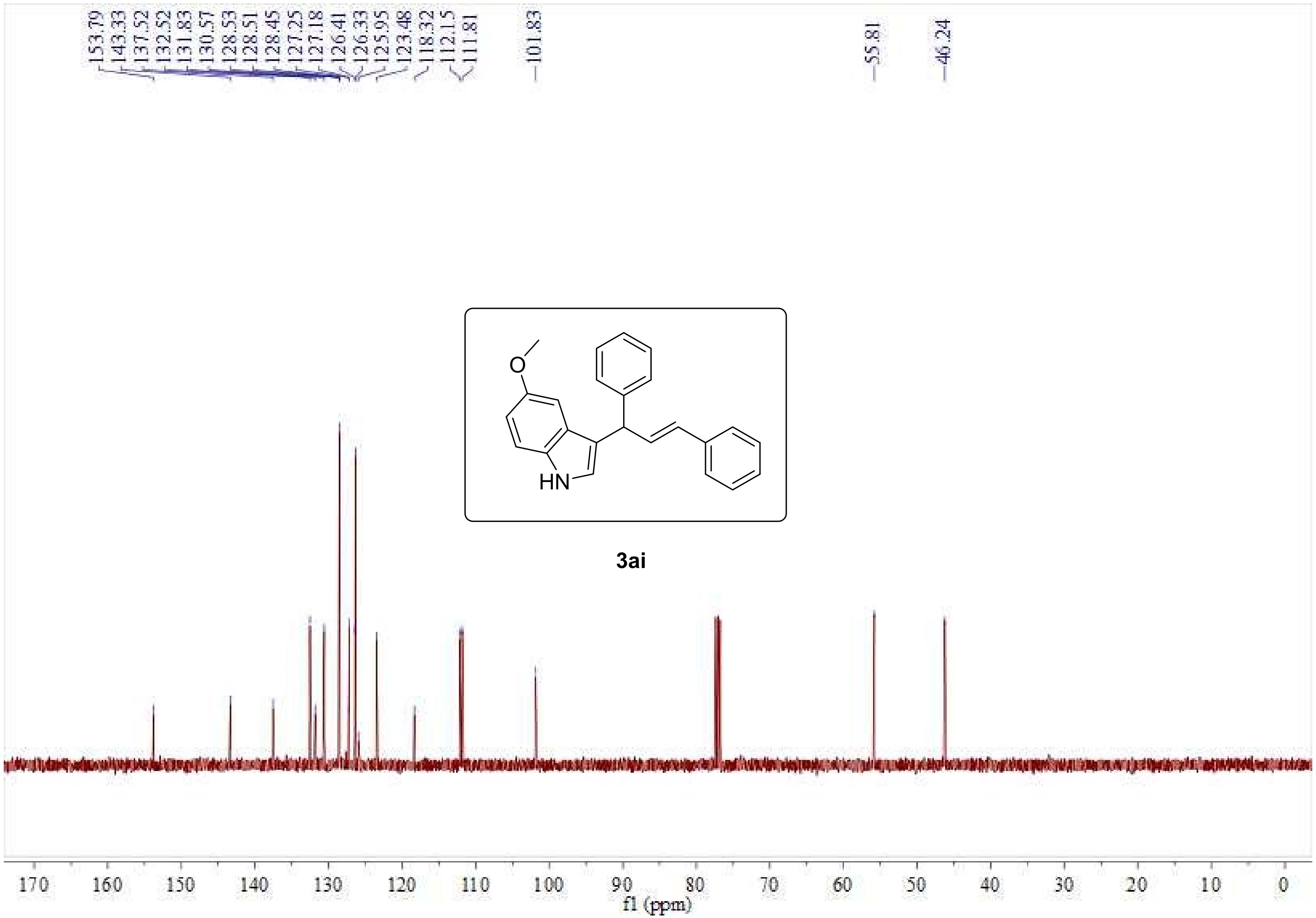
HN
O
3ai
1.04
12.05
3.01
1.08
1.05
1.00
3.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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126.33
125.95
123.48
118.32
112.15
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55.81
46.24
O
HN
3ai
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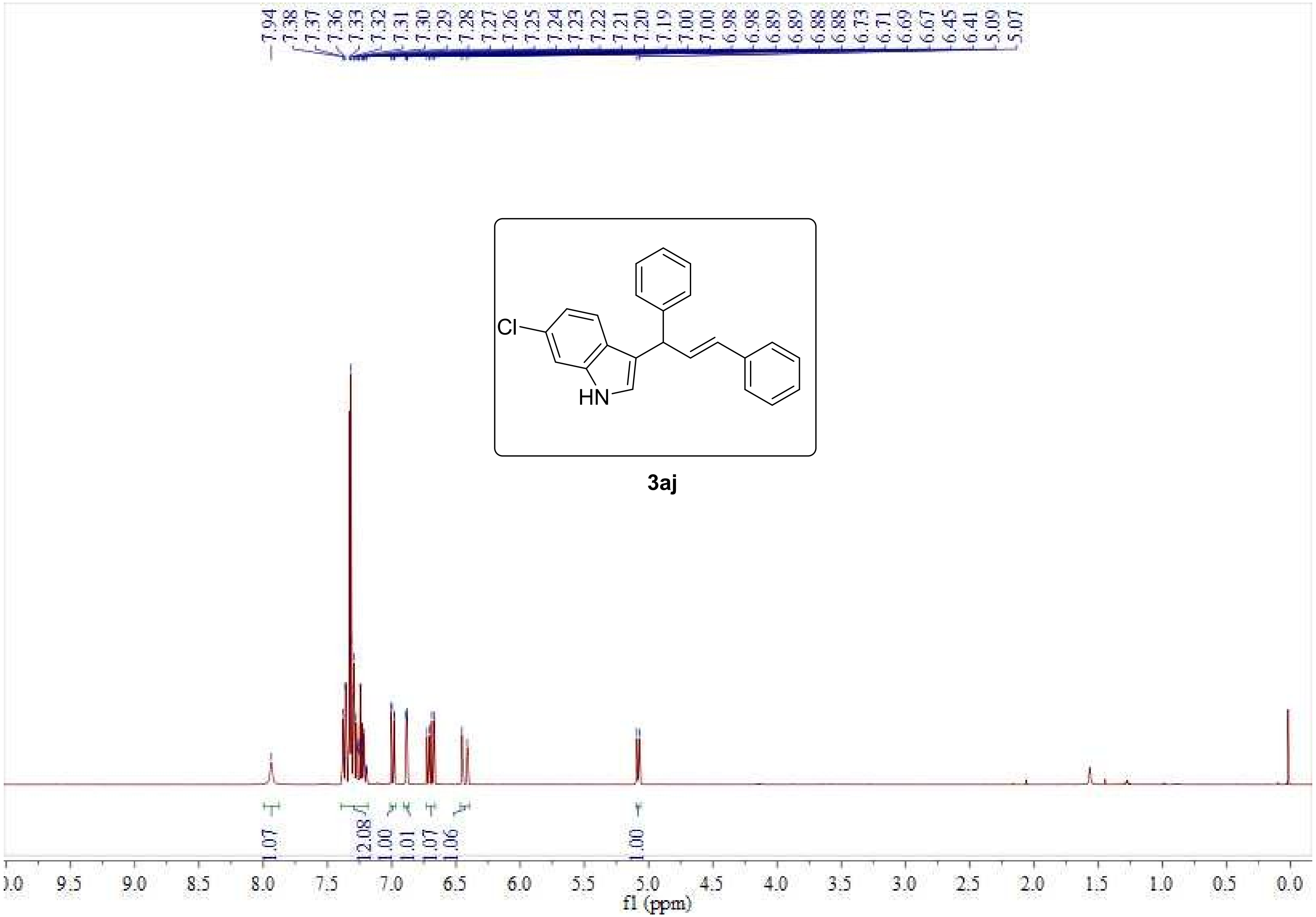
f1 (ppm)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7.25
7.24
7.23
7.22
7.21
7.20
7.19
7.00
7.00
6.98
6.98
6.89
6.89
6.88
6.88
6.73
6.71
6.69
6.67
6.45
6.41
5.09
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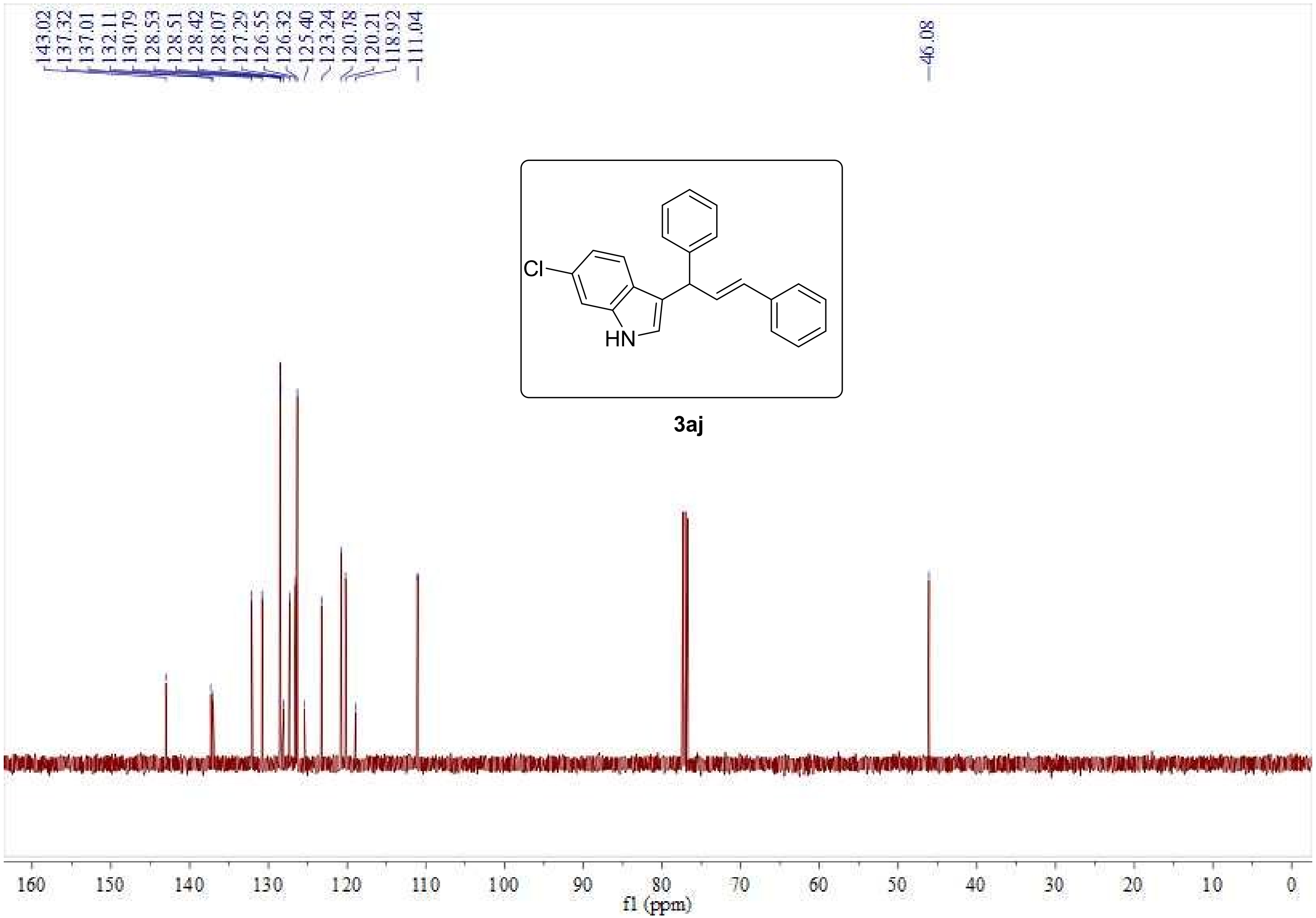
HN
3aj
1.07
12.08
1.00
1.01
1.07
1.06
1.00
f1 (ppm)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137.01
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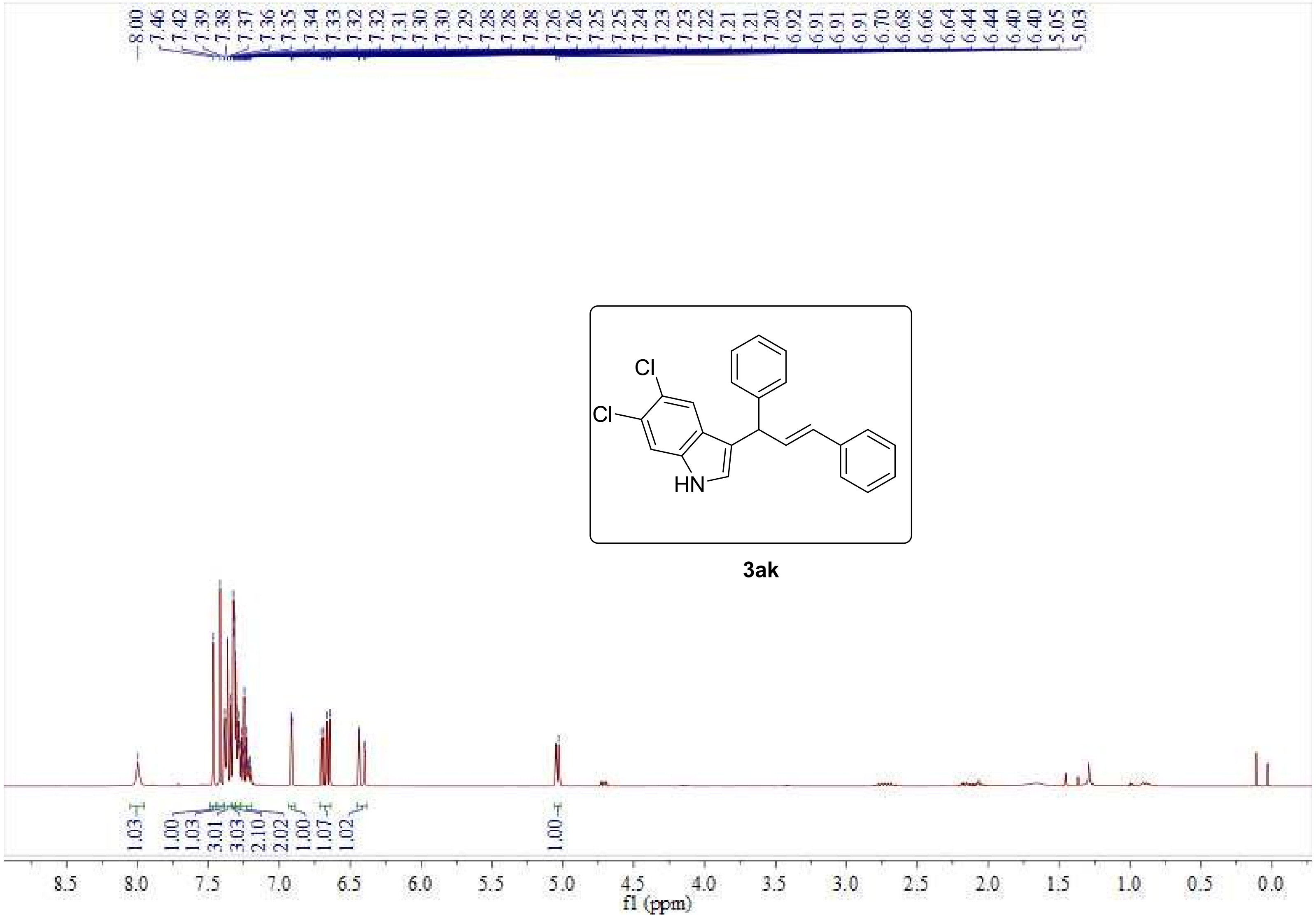
128.51
128.42
128.07
127.29
126.55
126.32
125.40
123.24
120.78
120.21
118.92
111.04
46.08
Cl
HN
3aj
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



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7.33
7.32
7.32
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7.28
7.28
7.26
7.26
7.25
7.25
7.24
7.23
7.23
7.22
7.21
7.21
7.20
6.92
6.91
6.91
6.91
6.70
6.68
6.66
6.64
6.44
6.44
6.40
6.40
5.05
5.03
Cl
Cl
HN
3ak
1.03
1.00
1.03
3.01
3.03
2.10
2.02
1.00
1.07
1.02
1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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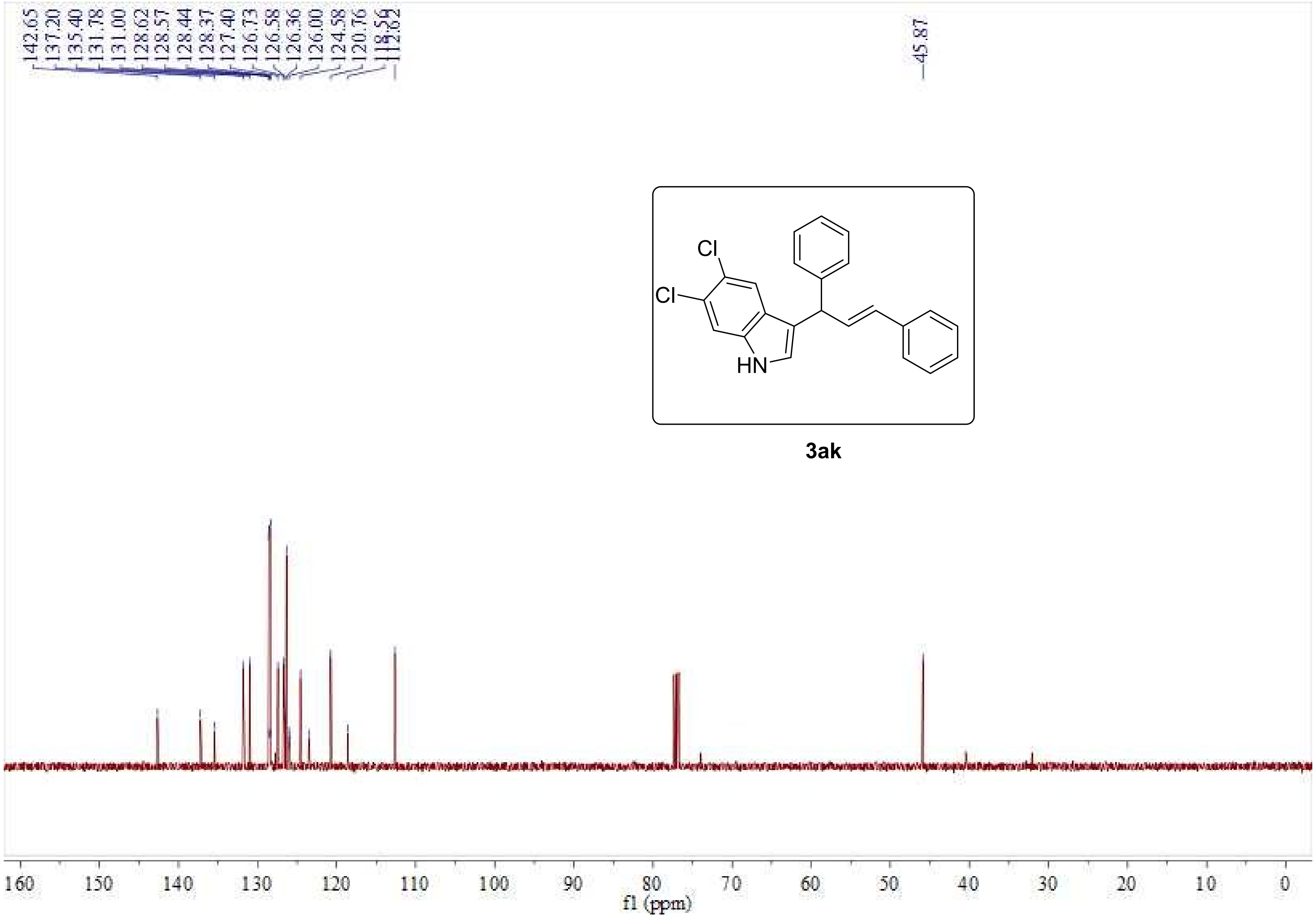
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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126.00
124.58
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45.87
Cl
Cl
HN
3ak
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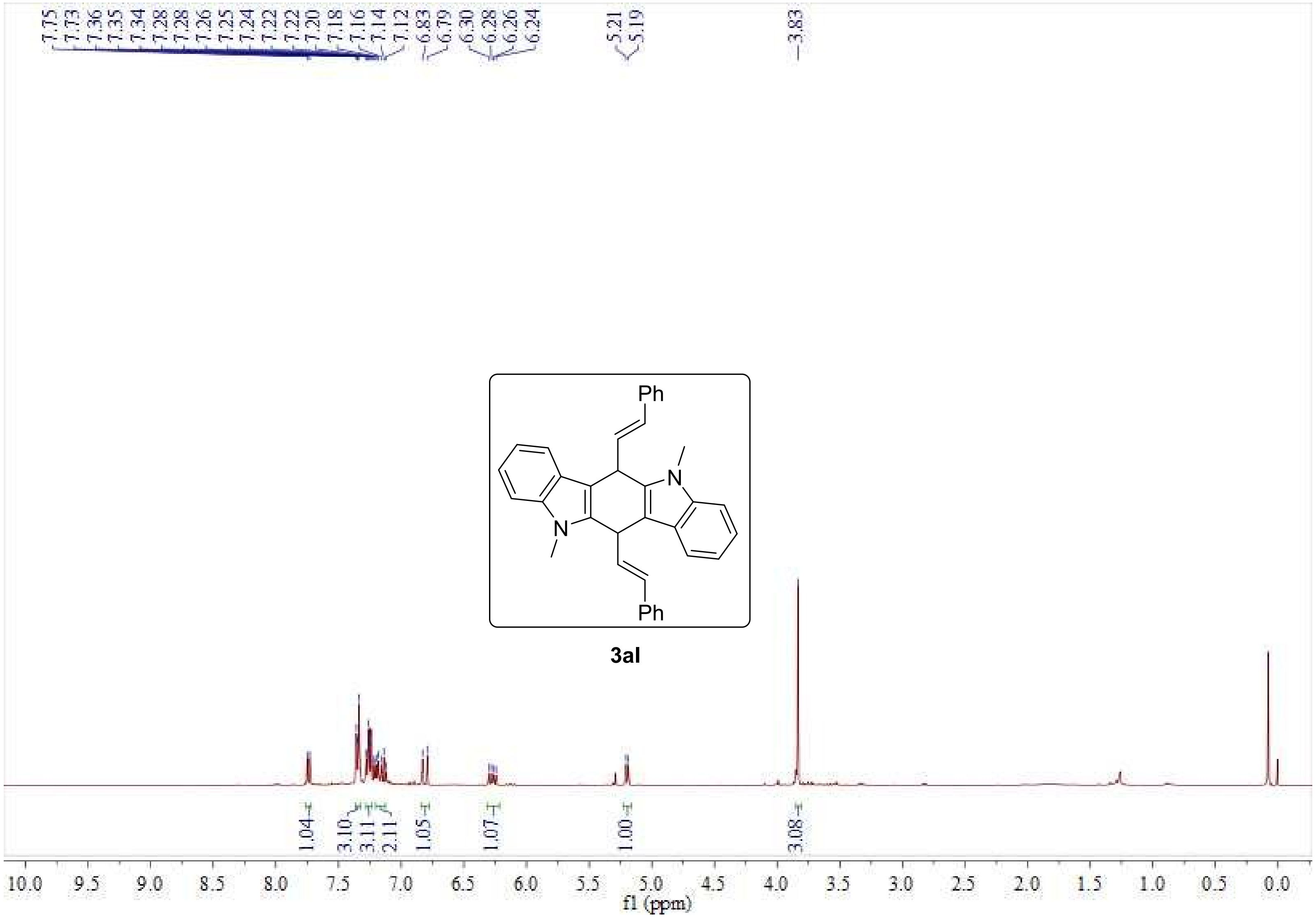
f1 (ppm)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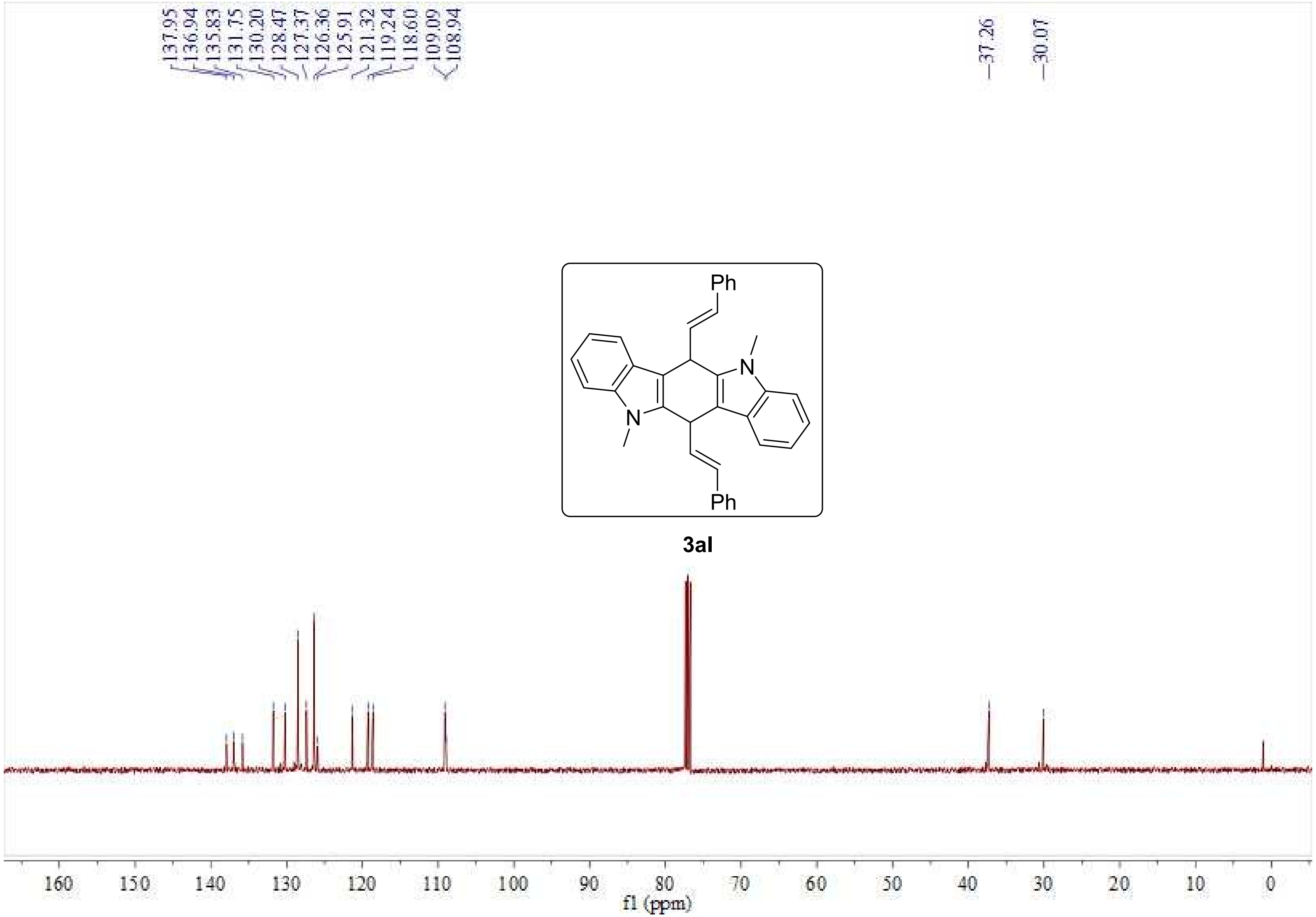
7.18
7.16
7.14
7.12
6.83
6.79
6.30
6.28
6.26
6.24
5.21
5.19
3.83
Ph
N
N
Ph
1.04
3.10
3.11
2.11
1.05
1.07
1.00
3.08
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

3al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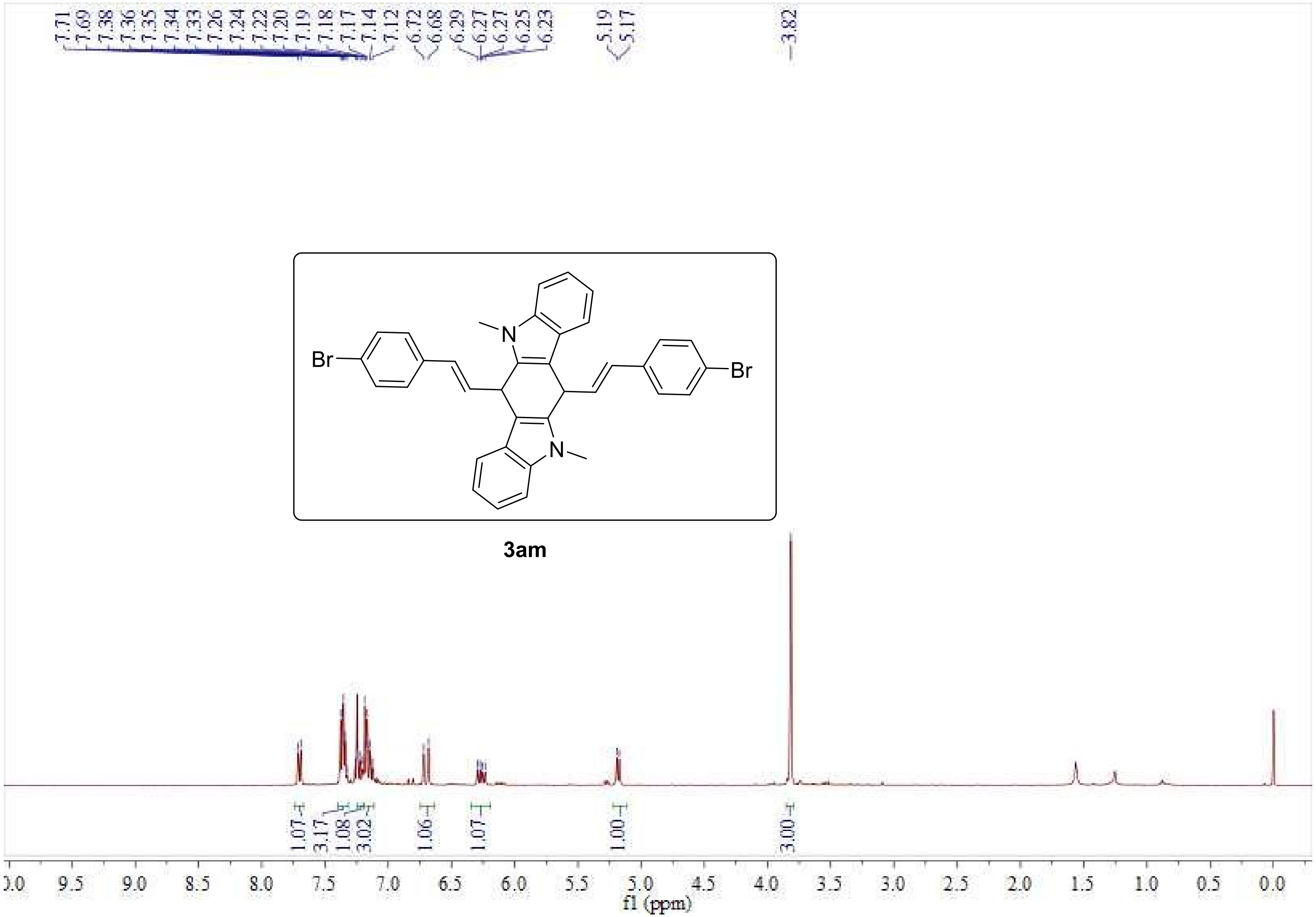
126.36
125.91
121.32
119.24
118.60
109.09
108.94
37.26
30.07
Ph
N
N
Ph
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

3al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7.18
7.17
7.14
7.12
6.72
6.68
6.29
6.27
6.27
6.25
6.23
5.19
5.17
3.82
Br
Br
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N
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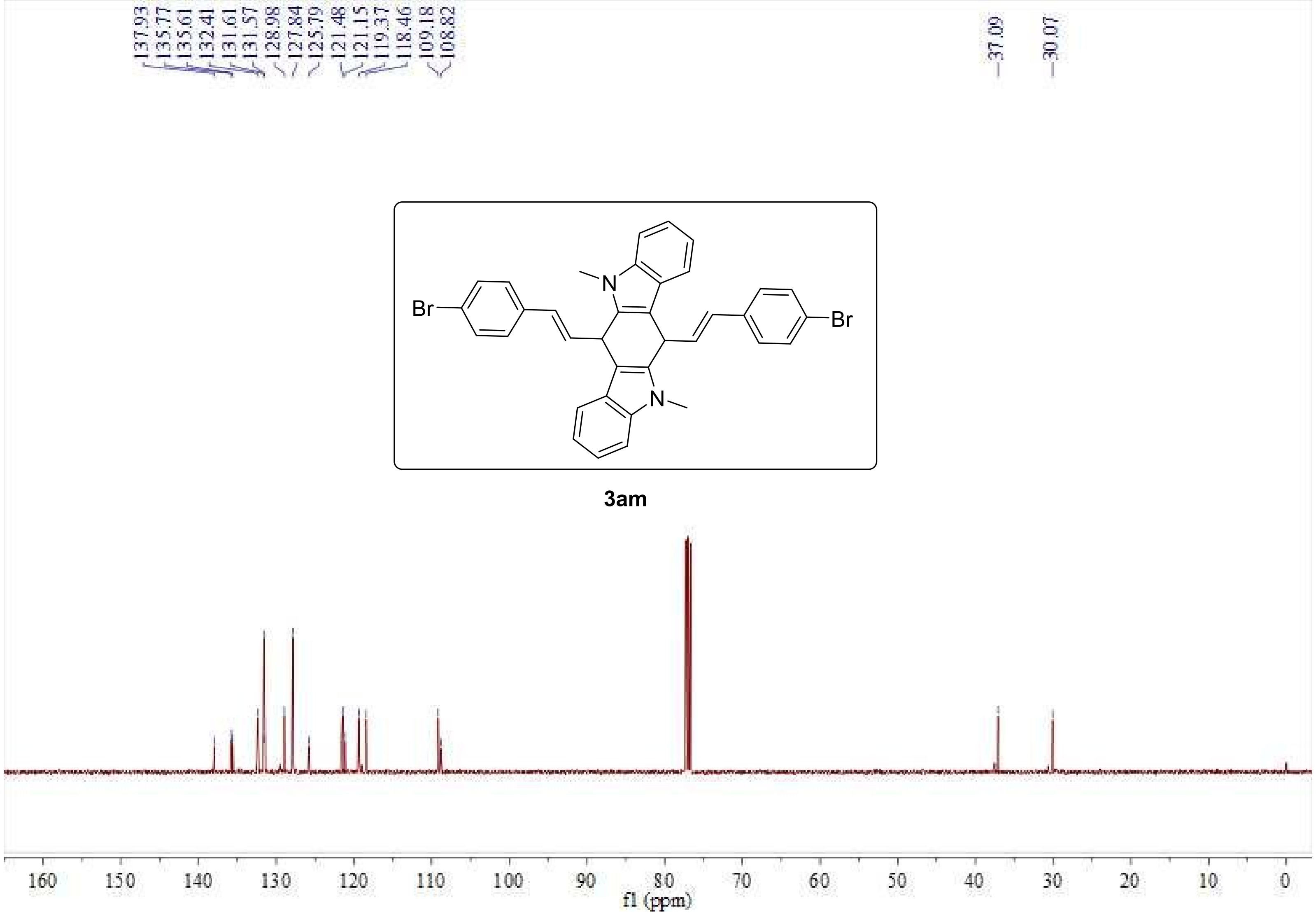
3.17
1.08
3.02
1.06
1.07
1.00
3.00
fl (ppm)

3am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118.46
109.18
108.82
37.09
30.07
Br
N
N
Br
3am
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)