Supporting Information

Lewis Acid Mediated Cyclization: Synthesis of 2-Spirocyclohexylindolines

Xiang-Kai Kong, Zhi-Min Xiong, Xiang Zhi, Xue-Ling Meng, Jing-Feng Zhao, Wen Chen* and Hongbin Zhang*

Key Laboratory of Medicinal Chemistry for Natural Resource, Ministry of Education, Yunnan Provincial Center for Research and Development of Natural Products, School of Chemical Science and Technology, Yunnan University, Kunming, Yunnan 650091, P. R. China.

Table of Contents

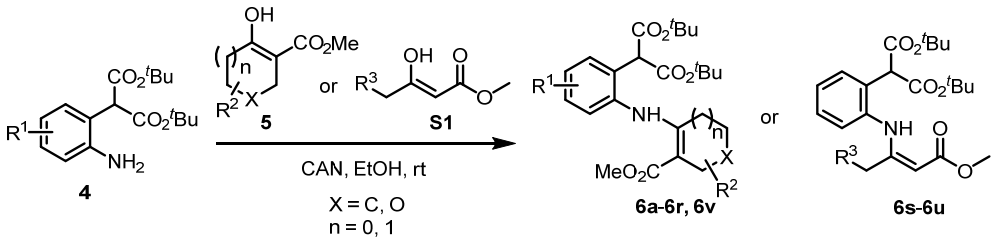
* Corresponding author. E-mail: zhanghb@ynu.edu.cn (H. Zhang); wenchen@ynu.edu.cn (W. Chen)

1. General information

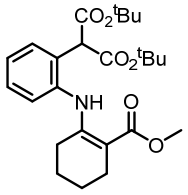
Melting points were measured on a Hanon MP 430 auto melting-point system. The infrared (IR) spectra were recorded on a Nicolet iS10 FTIR spectrometer with 4 cm^{-1} resolution and 32 scans between wavenumber of 4000 cm^{-1} and 400 cm^{-1}. Samples were prepared as KBr disks with 1 mg of samples in 100 mg of KBr. Proton nuclear magnetic resonance (^{1}H-NMR) spectra were obtained on a Bruker Avance 300 or 400 spectrometers at 300 or 400 MHz. Carbon-13 nuclear magnetic resonance (^{13}C-NMR) was obtained on Bruker Avance 300 or 400 spectrometers at 75 or 100 MHz. Chemical shifts are reported as δ values in parts per million (ppm) relative to tetramethylsilane (TMS) for all recorded NMR spectra. High Resolution Mass spectra were taken on AB QSTAR Pulsar mass spectrometer or Aglient LC/MSD TOF mass spectrometer. Optical rotations were recorded on a JASCO P-2000 polarimeter. All new products were characterized by IR, ^{1}H NMR, ^{13}C NMR and HRMS. The substrate compounds were characterized by ^{1}H NMR and ^{13}C NMR. HPLC experiments were determined by a Agilent 1260 Infinity with *n*-hexane and 2-propanol as eluents. Silica gel (200–300 mesh) for column chromatography and silica GF_{254} for TLC were produced by Merck Chemicals Co. Ltd. (Shanghai). THF used in the reactions was dried by distillation over metallic sodium and benzophenone. Starting materials and reagents used in reactions were obtained commercially from Acros, Aldrich and Adamas-beta®, and were used without purification, unless otherwise indicated. All reactions were conducted in dried glassware under a positive pressure of dry nitrogen or argon. Reagents and starting materials were accordingly transferred via syringe or cannula. Reaction temperatures refer to the external oil bath temperature.

2. Experimental section

2.1 General procedure for the synthesis of substrates 6a-6v

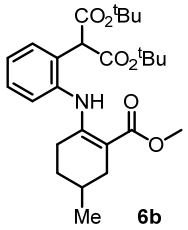


To a solution of **4** (0.50 mmol) and **5** (0.50 mmol) or **S1** (0.50 mmol) in dry EtOH (2 mL) was added cerium (IV) ammonium nitrate (CAN, 27.4 mg, 0.05 mmol). The resulting mixture was stirred at room temperature for 10 h – 48 h. After TLC analysis, the mixture was concentrated then diluted with EtOAc (30 mL), washed with brine (20 mL), and dried over anhydrous sodium sulfate. The combined organic phases were concentrated under reduced pressure, and the residue was purified by flash column chromatography on Et_3N-pretreated silica gel eluting with petroleum ether/EtOAc to give the pure β-enamino-esters **6a-6v**.



6a

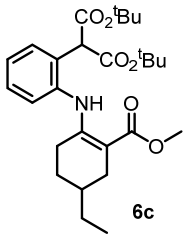
6a: 84% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.18 (s, 1H), 7.36 (dd, *J* = 7.4, 2.0 Hz, 1H), 7.20 - 7.12 (m, 2H), 7.01 (d, *J* = 7.2 Hz, 1H), 4.74 (s, 1H), 3.63 (s, 3H), 2.24 (t, *J* = 6.2 Hz, 2H), 2.00 (t, *J* = 6.4 Hz, 2H), 1.53 - 1.42 (m, 4H), 1.37 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 171.0, 167.6, 157.5, 138.8, 131.8, 129.7, 128.8, 128.3, 126.4, 93.5, 82.2, 55.3, 50.7, 41.6, 28.0, 27.9, 24.0, 22.9, 22.3. **HRMS** (ESI): Calcd for $C_{25}H_{36}NO_6$ $[M+H]^+$: 446.2537, found: 446.2537.



6b

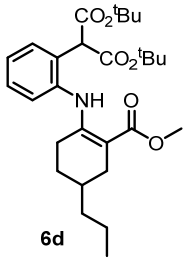
6b: 79% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 10.19 (s, 1H), 7.37 (d, *J* = 7.9 Hz, 1H), 7.22 - 7.12

(m, 2H), 7.02 (d, *J* = 7.2 Hz, 1H), 4.74 (s, 1H), 3.64 (s, 3H), 2.45 (dd, *J* = 15.6, 4.8 Hz, 1H), 2.07 - 1.95 (m, 2H), 1.76 (dd, *J* = 15.3, 10.2 Hz, 1H), 1.60 - 1.45 (m, 2H), 1.39 (s, 9H), 1.37 (s, 9H), 1.10 - 0.96 (m, 1H), 0.90 (d, *J* = 6.2 Hz, 3H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 170.8, 167.5, 157.2, 138.8, 131.7, 129.6, 128.8, 128.2, 126.4, 93.0, 82.2, 82.0, 55.3, 50.6, 32.6, 30.3, 28.8, 27.9, 21.8. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_6$ $[M+H]^+$: 460.2694, found: 460.2694.



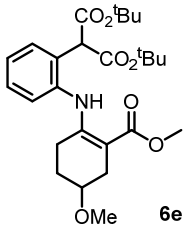
6c

6c: 73% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.11 (s, 1H), 7.32 (dd, *J* = 6.9, 1.8 Hz, 1H), 7.15 - 7.10 (m, 2H), 6.97 (dd, *J* = 7.5, 2.1 Hz, 1H), 4.70 (s, 1H), 3.60 (s, 3H), 2.43 (dd, *J* = 15.0, 3.0 Hz, 1H), 2.00 - 1.95 (m, 2H), 1.74 - 1.69 (, 1H), 1.56-1.52 (m, 1H), 1.34(s, 9H) 1.32 (s, 9H), 1.16 - 1.22 (m, 3H), 0.99 - 0.93 (m, 1H), 0.82 - 0.73 (m, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 171.0, 167.6, 167.6, 157.5, 138.9, 131.8, 129.7, 128.8, 128.3, 126.4, 93.2, 82.3, 82.1, 55.3, 50.7, 35.7, 30.6, 29.1, 28.1, 28.0, 11.7. **HRMS** (ESI): Calcd for $C_{27}H_{40}NO_6$ $[M+H]^+$: 474.2850, found: 474.2848.



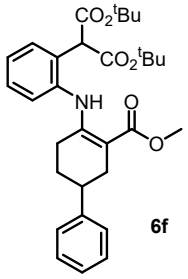
6d

6d: 72% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.13 (s, 1H), 7.32 (dd, *J* = 7.2, 1.6 Hz, 1H), 7.16 - 7.08 (m, 2H), 6.97 (d, *J* = 6.8 Hz, 1H), 4.70 (s, 1H), 3.60 (s, 3H), 2.42(dd, *J* = 15.6, 4.8 Hz, 1H), 2.05 - 1.90 (m, 2H), 1.71 (dd, *J* = 15.2, 10.4 Hz, 1H), 1.54 - 1.48 (m, 1H), 1.34 (s, 9H), 1.32 (s, 9H), 1.28 - 1.07 (m, 5H), 1.01 - 0.91 (m, 1H), 0.77 (t, *J* = 8.0 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.9, 167.6, 167.5, 157.4, 138.8, 131.8, 129.6, 128.8, 128.3, 126.4, 93.1, 82.2, 82.1, 55.3, 50.7, 38.7, 33.6, 30.8, 28.5, 28.0, 20.1, 14.4. **HRMS** (ESI): Calcd for $C_{28}H_{42}NO_6$ $[M+H]^+$: 488.3007, found: 488.3006.



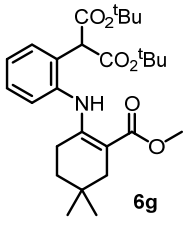
6e

6e: 87% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 10.21 (s, 1H), 7.36 (dd, *J* = 6.9, 1.5 Hz, 1H), 7.22 - 7.10 (m, 2H), 7.04 (d, *J* = 7.6 Hz, 1H), 4.73 (s, 1H), 3.64 (s, 3H), 3.40 - 3.38 (m, 1H), 3.28 (s, 3H), 2.62 (dd, *J* = 15.9, 4.8 Hz, 1H), 2.29 - 2.11 (m, 2H), 2.05 - 1.95 (m, 1H), 1.65 - 1.48 (m, 2H), 1.38 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 170.5, 170.0, 167.4, 156.6, 145.5, 138.5, 131.6, 129.6, 128.7, 128.3, 126.4, 90..4, 82.1, 74.8, 55.8, 55.4, 50.7, 29.6, 27.9, 26.5, 25.0. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_7$ $[M+H]^+$: 476.2643, found: 476.2644.



6f

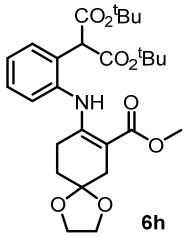
6f: 69% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 10.24 (s, 1H), 7.39 (dd, *J* = 6.9, 1.8 Hz, 1H), 7.23 - 7.12 (m, 7H), 7.06 (dd, *J* = 7.6, 1.8 Hz, 1H), 4.77 (s, 1H), 3.63 (s, 3H), 2.74 - 2.65 (m, 2H), 2.31 - 2.13 (m, 3H), 1.84 - 1.79 (m, 1H), 1.66 - 1.56 (m, 1H), 1.41 (s, 9H), 1.39 (s, 9H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 170.8, 167.6, 157.1, 146.5, 138.8, 131.9, 129.8, 128.9, 128.5, 128.4, 126.9, 126.6, 126.3, 93.3, 82.4, 82.2, 55.4, 50.8, 40.4, 32.6, 28.9, 28.4, 28.0. **HRMS** (ESI): Calcd for $C_{31}H_{40}NO_6$ $[M+H]^+$: 522.2850, found: 522.2847.



6g

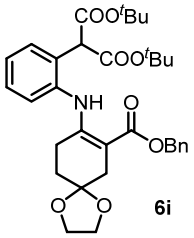
6g: 70% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.08 (s, 1H), 7.35 (dd, *J* = 7.0, 1.6 Hz, 1H), 7.17 - 7.10 (m, 2H), 6.98 (d, *J* = 8.0 Hz, 1H), 4.71 (s, 1H), 3.60 (s, 3H), 2.00 (s, 2H), 1.91 (t, *J* = 6.4 Hz,

2H), 1.33 (s, 18H), 1.16 (t, *J* = 6.4 Hz, 2H), 0.82 (s, 6H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 171.1, 167.6, 156.6, 138.9, 132.0, 129.7, 129.0, 128.4, 126.6, 92.5, 82.2, 55.2, 50.7, 37.9, 34.8, 28.7, 28.2, 28.0, 25.3. **HRMS** (ESI): Calcd for $C_{27}H_{40}NO_6$ $[M+H]^+$: 474.2850, found: 474.2849.



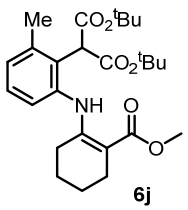
6h

6h: 79% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.31 (s, 1H), 7.47 (dd, *J* = 7.2, 1.6 Hz, 1H), 7.30 - 7.26 (m, 2H), 7.15 (d, *J* = 7.6 Hz, 1H), 4.84 (s, 1H), 4.06 - 3.96 m, 4H), 3.73 (s, 3H), 2.59 (s, 2H), 2.31 (t, *J* = 6.6 Hz, 2H), 1.70 (t, *J* = 6.6 Hz, 2H), 1.48 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.3, 167.6, 156.4, 138.6, 131.7, 129.8, 128.8, 128.4, 126.6, 107.7, 91.0, 82.3, 64.6, 55.5, 50.8, 34.3, 30.7, 28.0, 26.6. **HRMS** (ESI): Calcd for $C_{27}H_{38}NO_8$ $[M+H]^+$: 504.2592, found: 504.2593.



6i

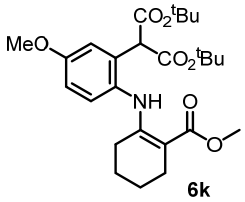
6i: 63% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.36 (s, 1H), 7.45 (d, *J* = 7.2 Hz, 1H), 7.40 - 7.33 (m, 4H), 7.31 - 7.24 (m, 3H), 7.14 (d, *J* = 7.3 Hz, 1H), 5.18 (s, 2H), 4.83 (s, 1H), 4.02 - 3.91 (m, 4H), 2.64 (s, 2H), 2.31 (t, *J* = 6.4 Hz, 2H), 1.69 (t, *J* = 6.4 Hz, 2H), 1.45 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 169.6, 167.5, 156.9, 138.6, 137.2, 131.7, 129.7, 128.8, 128.5, 128.4, 127.9, 127.8, 126.7, 107.7, 90.8, 82.2, 65.0, 64.5, 55.5, 34.3, 30.6, 28.0, 28.0, 26.6. **HRMS** (ESI): Calcd for $C_{33}H_{42}NO_8$ $[M+H]^+$: 580.2905, found: 580.2907.



6j

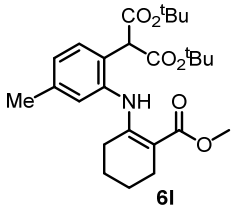
6j: 59% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 10.13 (s, 1H), 7.04 (t, *J* = 7.8 Hz, 1H), 6.90 (d, *J* =

7.2 Hz, 1H), 6.84 (d, *J* = 7.8 Hz, 1H), 4.80 (s, 1H), 3.64 (s, 3H), 2.28 (s, 3H), 2.25 (d, *J* = 6.3 Hz, 2H), 2.04 (t, *J* = 5.7 Hz, 2H), 1.53 - 1.42 (m, 4H), 1.38 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): 170.1, 167.6, 156.3, 139.7, 138.3, 130.8, 127.9, 127.5, 126.5, 94.9, 82.1, 54.6, 50.6, 28.2, 28.0, 24.3, 22.9, 22.3, 20.8. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_6$ $[M+H]^+$: 460.2694, found: 460.2692.



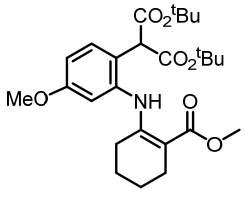
6k

6k: 66% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 9.96 (s, 1H), 6.90 - 6.89 (m, 2H), 6.69 (d, *J* = 8.4 Hz, 2H), 4.66 (s, 1H), 3.66 (s, 3H), 3.58 (s, 3H), 2.19 (t, *J* = 6.0 Hz, 2H), 2.38 (t, *J* = 6.0 Hz, 2H), 1.45 - 1.38 (m, 4H), 1.34 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.9, 167.3, 158.3, 158.0, 133.2, 131,5, 130.0, 114.3, 114.1, 92.5, 82.1, 55.4, 55.2, 50.5, 27.9, 27.7, 23.9, 22.8, 22.3. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_7$ $[M+H]^+$: 476.2643, found: 476.2639.



6l

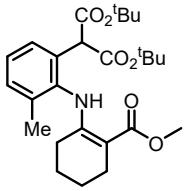
6l: 61% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.12 (s, 1H), 7.26 (d, *J* = 8.0 Hz, 1H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.84 (s, 1H), 4.70 (s, 1H), 3.64 (s, 3H), 2.25 - 2.23 (m, 2H), 2.23 (s, 3H), 1.98 (t, *J* = 5.2 Hz, 2H), 1.51 - 1.44 (m, 4H), 1.38 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.9, 167.7, 157.6, 138.5, 138.2, 129.4, 129.3, 128.8, 127.3, 93.0, 82.0, 54.8, 50.6, 27.9, 27.8, 24.0, 22.9, 22.3, 21.1. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_6$ $[M+H]^+$: 460.2694, found: 460.2693.



6m

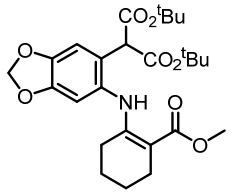
6m: 53% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.10 (s, 1H), 7.24 (d, *J* = 8.8 Hz, 1H), 6.67 (dd,

J = 8.7, 2.5 Hz, 1H), 6.52 (s, 1H), 4.60 (s, 1H), 3.65 (s, 3H), 3.59 (s, 3H), 2.20 (t, *J* = 5.6 Hz, 2H), 1.96 (t, *J* = 5.6 Hz, 2H), 1.48 - 1.40 (m, 4H), 1.32 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 171.0, 167.9, 159.4, 157.4, 139.8, 130.5, 124.1, 114.4, 112.1, 93.6, 82.1, 55.5, 54.6, 50.7, 28.0, 27.9, 24.0, 22.9, 22.3. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_7$ $[M+H]^+$: 476.2643, found: 476.2644.



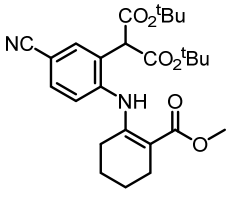
6n

6n: 47% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 9.89 (s, 1H), 7.30 (dd, *J* = 7.3, 2.1 Hz, 1H), 7.16 - 7.08 (m, 2H), 4.82 (s, 1H), 3.64 (s, 3H), 2.26 (t, *J* = 5.7 Hz, 2H), 2.11 (s, 3H), 1.90 - 1.79 (m, 1H), 1.71 - 1.63 (m, 1H), 1.50 - 1.42 (m, 4H), 1.37 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 171.1, 167.9, 167.5, 158.7, 137.6, 137.5, 133.4, 130.1, 127.2, 92.3, 82.1, 81.9, 54.7, 50.5, 27.9, 27.1, 23.9, 22.9, 22.3, 18.6. **HRMS** (ESI): Calcd for $C_{26}H_{38}NO_6$ $[M+H]^+$: 460.2694, found: 460.2692.



6o

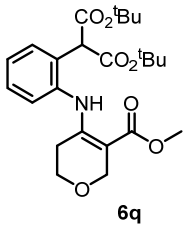
6o: 74% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 9.96 (s, 1H), 6.90 (s, 1H), 6.51 (s, 1H), 5.88 (s, 2H), 4.68 (s, 1H), 3.63 (s, 3H), 2.24 (t, *J* = 5.4 Hz, 2H), 1.94 (t, *J* = 5.2 Hz, 2H), 1.51 - 1.46 (m, 4H), 1.38 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 171.0, 167.6, 158.1, 147.4, 146.3, 132.5, 125.5, 109.4, 108.9, 101.7, 93.1, 82.1, 54.6, 50.6, 28.0, 27.7, 23.9, 22.8, 22.3. **HRMS** (ESI): Calcd for $C_{26}H_{36}NO_8$ $[M+H]^+$: 490.2435, found: 490.2431.



6p

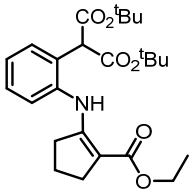
6p: 8% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 10.54 (s, 1H), 7.71 (s, 1H), 7.54 (dd, *J* = 8.2, 1.7 Hz,

1H), 7.13 (d, *J* = 8.3 Hz, 1H), 4.76 (s, 1H), 3.73 (s, 3H), 2.35 (t, *J* = 6.1 Hz, 2H), 2.16 (t, *J* = 6.0 Hz, 2H), 1.63 - 1.56 (m, 4H), 1.48 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 170.7, 166.7, 154.5, 143.7, 134.1, 131.9, 131.2, 127.5, 118.8, 108.3, 97.9, 83.1, 55.7, 51.1, 28.2, 28.0, 24.1, 22.7, 22.3. **HRMS** (ESI): Calcd for $C_{26}H_{35}N_2O_6$ $[M+H]^+$: 471.2490, found: 471.2416.



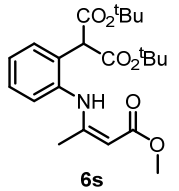
6q

6q: 75% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 9.96 (s, 1H), 7.31 (dd, *J* = 7.2, 1.8 Hz, 1H), 7.20 - 7.09 (m, 2H), 6.99 (dd, *J* = 7.2, 1.5 Hz, 1H), 4.65 (s, 1H), 4.25 (s, 2H), 3.60 (s, 3H), 3.55 (t, *J* = 5.6 Hz, 2H), 2.06 (t, *J* = 5.5 Hz, 2H), 1.34 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 168.3, 167.3, 154.4, 137.7, 131.7, 129.9, 128.6, 128.4, 126.7, 92.1, 82.3, 64.4, 63.6, 55.8, 50.5, 27.9, 27.2. **HRMS** (ESI): Calcd for $C_{24}H_{34}NO_7$ $[M+H]^+$: 448.2330, found: 448.2331.



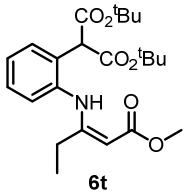
6r

6r: 72% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 9.07 (s, 1H), 7.30 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.22 - 7.18 (td, *J* = 7.6, 1.2 Hz, 1H), 7.12 (td, *J* = 7.6, 1.2 Hz, 1H), 7.04 (dd, *J* = 7.8, 1.2 Hz, 1H), 4.66 (s, 1H), 4.15 (q, *J* = 7.2 Hz, 2H), 2.49 (t, *J* = 7.2 Hz, 2H), 2.38 (t, *J* = 7.6 Hz, 2H), 1.74 - 1.67 (m, 2H), 1.39 (s, 18H), 1.24 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 168.0, 167.6, 161.2, 139.6, 130.2, 129.9, 128.5, 126.8, 125.7, 97.8, 82.4, 58.9, 56.3, 33.2, 29.6, 28.0, 21.5, 14.9. **HRMS** (ESI): Calcd for $C_{25}H_{36}NO_6$ $[M+H]^+$: 446.2537, found: 446.2536.



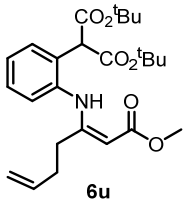
6s

6s: 73% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ 9.94 (s, 1H), 7.40 (dd, *J* = 7.2, 2.0 Hz, 1H), 7.24 - 7.19 (m, 2H), 7.05 (dd, *J* = 7.2, 1.6 Hz, 1H), 4.72 (s, 1H), 4.67 (s, 1H), 3.63 (s, 1H), 1.70 (s, 3H), 1.41 (s, 18H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.5, 167.4, 160.1, 138.3, 131.7, 130.0, 128.6, 128.5, 127.0, 86.0, 82.4, 55.5, 50.3, 28.0, 20.2. **HRMS** (ESI): Calcd for $C_{22}H_{32}NO_6$ $[M+H]^+$: 406.2224, found: 406.2222.



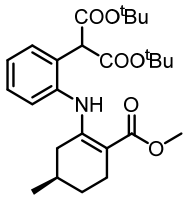
6t

6t: 71% yield. **^{1}H NMR** (400 MHz, $CDCl_3$): δ (ppm): 9.97 (s, 1H), 7.52 - 7.49 (m, 1H), 7.30 - 7.27 (m, 2H), 7.13 -7.11 (m, 1H), 4.80 (s, 1H), 4.77 (s, 1H), 3.69 (s, 3H), 2.10 (q, *J* = 7.5 Hz, 2H), 1.46 (s,18H), 0.95 (t, *J* = 7.4 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.9, 167.4, 165.6, 138.1, 131.7, 129.9, 128.5, 128.5, 127.0, 84.1, 82.4, 55.0, 50.4, 28.0, 25.5, 12.0. **HRMS** (ESI): Calcd for $C_{23}H_{34}NO_6$ $[M+H]^+$: 420.2381, found: 420.2382.



6u

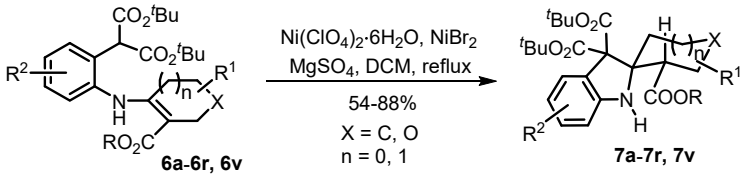
6u: 80% yield. **^{1}H NMR** (300 MHz, $CDCl_3$): δ 9.92 (s, 1H), 7.47 (dd, *J* = 7.2, 2.1 Hz, 1H), 7.25 - 7.18 (m, 2H), 7.05 (dd, *J* = 8.4, 3.3 Hz, 1H), 5.62 - 5.49 (m, 1H), 4.85 - 4.74 (m, 2H), 4.74 (s, 1H), 4.71 (s, 1H), 3.61 (s, 3H), 2.16 - 2.10 (m, 2H), 2.02 (t, *J* = 7.8 Hz, 2H), 1.39 (s, 18H); **^{13}C NMR** (75 MHz, $CDCl_3$): δ 170.7, 167.3, 163.1, 137.9, 136.8, 131.4, 129.8, 128.4, 128.3, 126.9, 115.6, 85.4, 82.3, 57.4, 50.4, 31.7, 31.6, 27.9. **HRMS** (ESI): Calcd for $C_{25}H_{36}NO_6$ $[M+H]^+$: 446.2537, found: 446.2535.



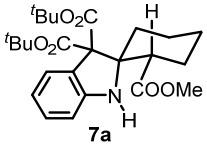
6v

6v: 65% yield. $[\alpha]_D^{20}$ = -16.52 (*c* 1.79, $CHCl_3$). **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.25 (s, 1H), 7.46 (d, *J* = 7.2 Hz, 1H), 7.30 - 7.22 (m, 2H), 7.09 (d, *J* = 7.6 Hz, 1H), 4.82 (s, 1H), 3.72 (s, 3H), 2.51 - 2.48 (m, 1H), 2.29 - 2.21 (m, 1H), 2.06 (dd, *J* = 17.2, 4.2 Hz, 1H), 1.74 - 1.69 (m, 2H), 1.61 - 1.56 (m, 1H), 1.47 (s, 9H), 1.45 (s, 9H), 1.25 (d, *J* = 6.9 Hz, 1H), 0.87 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): 171.0, 167.6, 167.6, 157.1, 138.8, 131.7, 129.7, 128.8, 128.3, 126.4, 93.2, 82.3, 82.1, 55.4, 50.7, 36.1, 31.2, 28.6, 28.1, 28.0, 24.1, 21.7. **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_6$ $[M+H]^+$: 460.2694, found: 460.2662.

2.2 General procedure for the synthesis of products 7a-7v

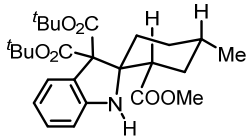


To a solution of β-enamino esters **6a**-**6s** or **6v** (0.15 mmol) in dry DCM (5 mL) were added $Ni(ClO_4)_2·6H_2O$ (55.0 mg, 0.15 mmol), $NiBr_2$ (33.0 mg, 0.15 mmol), and $MgSO_4$ (181.0 mg, 1.50 mmol). The resulting mixture was then heated at reflux under argon for 8-48 h. After TLC analysis, the mixture was diluted with water (10 mL) and extracted with EtOAc (3 × 10 mL). The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1 to 10:1) to give the products **7a**-**7s** or **7v**.



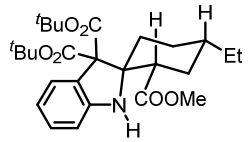
7a

7a: White solid, 88% yield, dr > 50 : 1, m.p.: 139 - 141 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3376, 2982, 2938, 1737, 1716, 1598, 1453, 1391, 1369, 1320, 1280, 1250, 1214, 1189, 1135, 1095, 1055, 970, 856, 844, 755, 745; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.6 Hz, 1H), 7.07 (t, *J* = 7.6 Hz, 1H), 6.73 - 6.68 (m, 2H), 3.50 (dd, *J* = 11.6, 4.8 Hz, 1H), 2.93(s, 3H), 2.15 (td, *J* = 13.2, 3.2 Hz, 1H), 1.99 - 1.95 (m, 1H), 1.77 - 1.74 (m, 4H), 1.62 (s, 9H), 1.47 - 1.44 (m, 1H), 1.41 (s, 9H), 1.34 - 1.27 (m, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 167.9, 167.1, 150.1, 129.0, 126.9, 125.7, 119.4, 111.0, 83.1, 82.0, 71.6, 70.8, 50.8, 45.5, 34.3, 28.1, 27.9, 26.1, 24.1, 23.0; **HRMS** (ESI): Calcd for $C_{25}H_{35}NO_6Na$ $[M+Na]^+$: 468.2357, found: 468.2359.



7b

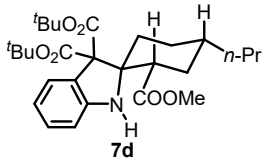
7b: White solid, 60% yield, dr > 50 : 1, m.p.: 136 - 139 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3377, 2977, 2926, 2873, 1745, 1720, 1607, 1470, 1367, 1278, 1223, 1134, 1004, 839, 816, 745; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.6 Hz, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.72 - 6.66 (m, 2H), 3.55 (dd, *J* = 12.4, 3.6 Hz, 1H), 2.93 (s, 3H), 2.20 (td, *J* = 13.6, 4.0 Hz, 1H), 1.99 - 1.95 (m, 1H), 1.75 - 1.68 (m, 2H), 1.61 (s, 9H), 1.50 - 1.45 (m, 2H), 1.41 (s, 9H), 1.18 - 1.15 (m, 1H), 0.96 (d, *J* = 5.6 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 168.1, 167.2, 150.3, 129.1, 127.1, 125.8, 119.4, 111.1, 83.1, 82.1, 71.2, 70.7, 50.9, 45.5, 34.6, 34.4, 31.7, 30.7, 28.2, 28.0, 22.2; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_6Na$ $[M+Na]^+$: 482.2513, found: 482.2516.



7c

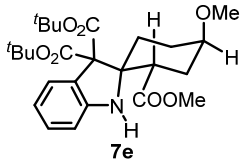
7c: White solid, 73% yield, dr > 50 : 1, m.p.: 82 - 85 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3385, 2974, 1742, 1722, 1607, 1473, 1366, 1286, 1245, 1135, 1026, 841, 739; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.49 (d, *J* = 7.6 Hz, 1H), 7.03 - 6.99 (td, *J* = 7.6, 0.8 Hz, 1H), 6.68 - 6.64 (m, 2H), 3.48 (dd, *J* = 13.2, 4.0 Hz, 1H), 2.88 (s, 3H), 2.12 (td, *J* = 13.6, 4.0 Hz, 1H), 1.98 - 1.91 (m, 1H), 1.76 - 1.68 (m, 2H), 1.55 (s, 9H), 1.35 (s, 9H), 1.25 - 1.17 (m, 4H), 1.13 - 1.06 (m, 1H), 0.83 (t, *J* = 7.2

Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 168.1, 167.2, 150.3, 129.1, 127.0, 125.8, 119.4, 111.1, 83.1, 82.1, 71.6, 70.6, 50.9, 45.5, 37.4, 34.3, 32.3, 29.5, 29.3, 28.2, 28.0, 11.5; **HRMS** (ESI): Calcd for $C_{27}H_{39}NO_6Na$ $[M+Na]^+$: 496.2670, found: 496.2670.



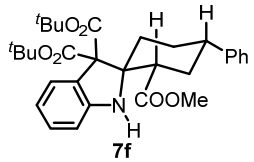
7d

7d: White solid, 76% yield, dr > 50 : 1, m.p.: 89 - 91 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3386, 2931, 2870, 1733, 1471, 1392, 1368, 1282, 1254, 1170, 1135, 1027, 840, 746, 640, 468; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.54 (d, *J* = 7.6 Hz, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.70 (t, *J* = 7.6 Hz, 1H), 6.66 (d, *J* = 7.6 Hz, 1H), 4.97(brs, 1H), 3.54 (dd, *J* = 12.0, 3.2 Hz, 1H), 2.93 (s, 3H), 2.19 (td, *J* = 13.2, 3.6 Hz, 1H), 1.99 - 1.96 (m, 1H), 1.80 - 1.72 (m, 2H), 1.61 (s, 9H), 1.48 - 1.45 (m, 1H), 1.40 (s, 9H), 1.36 - 1.30 (m, 3H), 1.26 - 1.22 (m, 2H), 1.17 - 1.05 (m, 1H), 0.88 (t, *J* = 6.8 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 168.0, 167.2, 150.3, 129.1, 127.0, 125.7, 119.4, 111.0, 83.1, 82.1, 71.6, 70.6, 50.9, 45.5, 39.0, 35.2, 34.4, 32.6, 29.7, 28.2, 28.0, 19.9, 14.3; **HRMS** (ESI): Calcd for $C_{28}H_{41}NO_6Na$ $[M+Na]^+$: 510.2826, found: 510.2825.



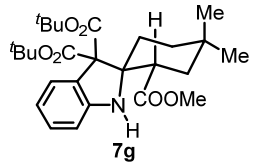
7e

7e: Colorless oil, 79% yield, dr > 50 : 1. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3378, 3047, 2978, 2933, 1717, 1607, 1472, 1367, 1138, 854, 744; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.59 (d, *J* = 7.6 Hz, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.72 (t, *J* = 7.6 Hz, 1H), 6.68 (d, *J* = 7.6 Hz, 1H), 4.51 (brs, 1H), 3.78 (dd, *J* = 10.4, 5.6 Hz, 1H), 3.54 (s, 1H), 3.31 (s, 3H), 2.97 (s, 3H), 2.45 (td, *J* = 14.0, 3.6 Hz, 1H), 1.99 - 1.92 (m, 3H), 1.79 - 1.76 (m, 1H), 1.75 - 1.66 (m, 1H), 1.59 (s, 9H), 1.41 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 168.0, 166.8, 150.2, 129.0, 127.8, 125.9, 119.7, 111.6, 83.0, 82.0, 72.9, 71.1, 71.0, 55.8, 50.9, 40.2, 29.5, 28.2, 28.1, 28.0, 26.1; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_7Na$ $[M+Na]^+$: 498.2462, found: 498.2467.



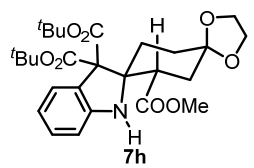
7f

7f: Colorless oil, 76% yield, dr > 50 : 1. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3387, 2977, 2868, 1732, 1606, 1471, 1368, 1256, 1169, 1028, 838, 747, 641, 468; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.44 (d, *J* = 7.6 Hz, 1H), 7.21 - 7.17 (m, 2H), 7.14 - 7.09 (m, 3H), 6.97 (t, *J* = 7.6 Hz, 1H), 6.63 - 6.60 (m, 2H), 3.62 (dd, *J* = 12.4, 4.0 Hz, 1H), 2.83 (s, 3H), 2.58 - 2.52 (m, 1H), 2.26 (td, *J* = 13.6, 3.6 Hz, 1H), 2.02 - 1.99 (m, 1H), 1.91 - 1.79 (m, 3H), 1.66 - 1.58(m, 1H), 1.52 (s, 9H), 1.30 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.8, 168.0, 167.3, 150.2, 145.6, 129.2, 128.6, 126.9, 126.5, 125.8, 119.7, 111.4, 83.3, 82.3, 71.0, 51.1, 45.9, 42.1, 34.8, 33.5, 30.7, 28.2, 28.0, 25.9; **HRMS** (ESI): Calcd for $C_{31}H_{39}NO_6Na$ $[M+Na]^+$: 544.2670, found: 544.2668.



7g

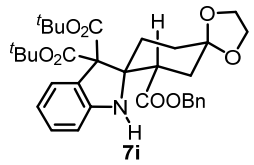
7g: Colorless oil, 64% yield, dr > 50 : 1. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3388, 2976, 2866, 1732, 1607, 1471, 1368, 1253, 1151, 778, 744, 639, 467; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.56 (d, *J* = 7.6 Hz, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.72 - 6.66 (m, 2H), 4.53 (s, 1H), 3.64 (dd, *J* = 13.6, 4.0 Hz, 1H), 2.94 (s, 3H), 2.38 - 2.30 (m, 1H), 1.82 (dd, *J* =13.6 Hz, 1H),1.73 (t, *J* =14.0 Hz, 2H), 1.62 (s, 9H), 1.46 - 1.42 (m, 3H), 1.40 (s, 9H), 1.02 (s, 3H), 1.00 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 168.1, 167.2, 150.3, 129.1, 127.2, 125.8, 119.4, 111.2, 83.0, 82.1, 71.3, 70.8, 50.9, 42.0, 38.9, 35.8, 32.6, 30.4, 29.5, 28.2, 28.0, 24.2; **HRMS** (ESI): Calcd for $C_{27}H_{39}NO_6Na$ $[M+Na]^+$: 496.2670, found: 496.2673.



7h

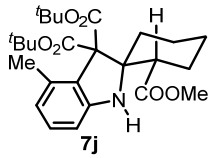
7h: White solid, 80% yield, dr > 50 : 1, m.p.: 134 - 136 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3375, 2977, 2949, 1732, 1607, 1471, 1393, 1369, 1306, 1256, 1169, 1136, 1098, 1048, 852, 839,

747, 600, 473; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.57 (d, *J* = 7.6 Hz, 1H), 7.07 (t, *J* = 7.6 Hz, 1H), 6.73 (t, *J* = 7.6 Hz, 1H), 6.69 (d, *J* = 7.6 Hz, 1H), 3.95 (d, *J* = 1.6 Hz, 4H), 3.85 (dd, *J* = 13.2, 3.6 Hz, 1H), 2.96 (s, 3H), 2.51 (td, *J* = 13.2, 5.6 Hz,1H), 2.13 - 2.03 (m, 1H), 2.01 - 1.96 (dd, *J* = 13.6, 3.6 Hz, 1H), 1.87 - 1.72 (m, 3H), 1.61 (s, 9H), 1.41 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.3, 168.0, 166.8, 150.0, 129.2, 127.4, 125.7, 119.8, 111.5, 107.3, 83.3, 82.2, 70.7, 70.4, 64.6, 51.1, 43.7, 34.3, 31.9, 31.8, 28.1, 28.0; **HRMS** (ESI): Calcd for $C_{27}H_{37}NO_8Na$ $[M+Na]^+$: 526.2411, found: 526.2409.



7i

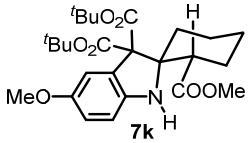
7i: White solid, 66% yield, dr > 50 : 1, m.p.: 121 - 123 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3224, 2976, 2933, 1727, 1657, 1591, 1496, 1455, 1369, 1232, 1214, 1135, 1053, 851, 752, 698; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.66 (d, *J* = 8.4 Hz, 1H), 7.29 - 7.26 (m, 3H), 7.18 (d, *J* = 8.4 Hz, 2H), 7.12 (t, *J* = 7.6 Hz, 1H), 6.81 (t, *J* = 7.5 Hz 1H), 6.69 (d, *J* = 7.8 Hz, 1H), 4.35 (d, *J* = 12.3 Hz, 1H), 4.19 (d, *J* = 12.3 Hz, 1H), 3.95 (s, 4H), 3.85 (dd, *J* = 13.4, 3.5 Hz, 1H), 2,50 (td, *J* = 13.2, 4.6 Hz, 1H), 2.16 - 2.03 (m, 2H), 1.85 - 1.76 (m, 3H), 1.50 (s, 9H), 1.42 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 172.7, 168.0, 168.7, 150.2, 135.8, 129.2, 128.8, 128.4, 128.1, 127.7, 126.1, 120.0, 111.7, 107.4, 83.2, 82.4, 70.6, 70.5, 66.3, 64.7, 64.6, 44.2, 34.7, 31.8, 31.8, 28.5, 28.1, 28.0; **HRMS** (ESI): Calcd for $C_{33}H_{42}NO_8Na$ $[M+H]^+$: 580.2905, found: 580.2908.



7j

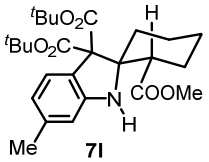
7j: Colorless oil, 63% yield, dr > 50 : 1. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3313, 2933, 1728, 1589, 1456, 1393, 1368, 1252, 1159, 1052, 841, 736; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 6.97 (t, *J* = 7.6 Hz, 1H), 6.58 (d, *J* = 7.6 Hz, 1H), 6.56 (d, *J* = 7.6 Hz, 1H), 4.77 (brs, 1H), 3.34 (s, 3H), 3.14 (dd, *J* = 9.2, 7.2 Hz, 1H), 2.33 (s, 3H), 2.16 - 2.12 (m, 1H), 1.88 - 1.82 (m, 2H), 1.76 - 1.72 (m, 1H),1.67 – 1.60(m, 4H), 1.49 (s, 9H), 1.47 (s, 9H), 1.29 -1.21 (m, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.8, 167.7, 167.1, 151.3, 137.0, 129.0, 127.2, 123.4, 110.6, 82.3, 82.2, 73.7, 69.8,

51.3, 46.3, 33.4, 28.6, 28.2, 28.1, 24.6, 22.3, 20.9; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_6Na$ $[M+Na]^+$: 482.2513, found: 482.2510.



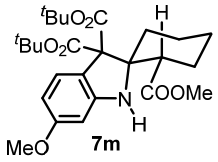
7k

7k: Colorless oil, 73% yield, dr > 50 : 1. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3364, 2968, 2948, 1729, 1479, 1368, 1278, 1254, 1132, 1099, 971, 840, 732, 662; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.19 (d, *J* = 2.0 Hz, 1H), 6.66 (dd, *J* = 8.4, 2.0 Hz, 1H), 6.61 (d, *J* = 8.4 Hz, 1H), 4.21 (brs, 1H), 3.71 (s, 3H), 3.48 (dd, *J* = 12.8, 4.4 Hz, 1H), 2.98 (s, 3H), 2.12 (td, *J* = 13.2, 3.6 Hz, 1H), 1.95 - 1.91 (m, 1H), 1.77 - 1.73 (m, 4H), 1.61 (s, 9H), 1.49 - 1.45 (m, 1H), 1.41 (s, 9H), 1.30 - 1.24 (m, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 167.9, 167.1, 153.6, 144.3, 128.7, 115.0, 112.1, 111.8, 83.2, 82.1, 72.1, 71.3, 55.8, 50.9, 45.6, 34.5, 28.2, 28.0, 26.2, 24.2, 23.0; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_7Na$ $[M+Na]^+$: 498.2462, found: 498.2461.



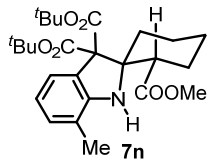
7l

7l: White solid, 54% yield, dr > 50 : 1, m.p.: 137 - 141 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3379, 2976, 1732, 1718, 1619, 1456, 1367, 1168, 1133, 1053, 794, 572; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.40 (d, *J* = 7.6 Hz, 1H), 6.52 (d, *J* = 7.6 Hz, 1H), 6.51 (s, 1H), 3.50 (dd, *J* = 10.8, 5.2 Hz, 1H), 2.96 (s, 3H), 2.23 (s, 3H), 2.13 (td, *J* = 13.2, 3.2 Hz, 1H), 1.97 - 1.93 (m, 1H), 1.75 - 1.73 (m, 4H), 1.61 (s, 9H), 1.49 - 1.45 (m, 1H), 1.42 (s, 9H), 1.33 - 1.28 (m, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 168.2, 167.4, 150.4, 139.0, 125.5, 124.3, 120.5, 111.9, 83.0, 82.0, 71.7, 70.7, 51.0, 45.6, 34.5, 28.2, 28.0, 26.2, 24.2, 23.1, 21.7; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_6Na$ $[M+Na]^+$: 482.2513, found: 482.2514.



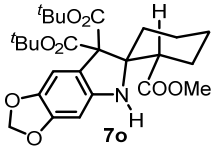
7m

7m: White solid, 73% yield, dr > 50 : 1, m.p.: 140 - 142°C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3366, 2974, 2934, 1720, 1617, 1458, 1368, 1132, 821, 790, 657, 589; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.40 (d, *J* = 8.0 Hz, 1H), 6.26 - 6.24 (m, 2H), 4.50 (s, 1H), 3.71 (s, 3H), 3.50 - 3.46 (m, 1H), 3.00 (s, 3H), 2.11 (td, *J* = 13.2, 3.6 Hz, 1H), 1.95 (d, *J* = 7.6 Hz, 1H), 1.76 - 1.72 (m, 4H), 1.60 (s, 9H), 1.47 - 1.43 (m, 1H), 1.40 (s, 9H), 1.35 - 1.24 (m, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 168.3, 167.3, 160.9, 151.7, 126.4, 119.3, 105.5, 96.6, 83.0, 81.9, 71.9, 70.3, 55.2, 51.0, 45.6, 34.3, 28.2, 28.0, 26.2, 24.1, 23.1; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_7Na$ $[M+Na]^+$: 498.2462, found: 498.2462.



7n

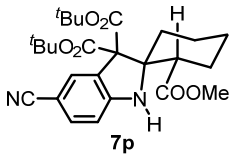
7n: White solid, 64% yield, dr > 50 : 1, m.p.: 137 - 139 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3375, 2938, 1737, 1716, 1597, 1368, 1279, 1249, 1135, 843, 744; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.40 (d, *J* = 7.6 Hz, 1H), 6.89 (d, *J* = 7.6 Hz, 1H), 6.64 (t, *J* = 7.6 Hz, 1H), 4.26 (brs, 1H), 3.49 (dd, *J* = 11.6, 4.8 Hz, 1H), 2.88 (s, 3H), 2.20 - 2.13 (m, 4H), 2.01(d, *J* =7.6 Hz, 1H), 1.80 - 1.75 (m, 4H), 1.62 (s, 9H) 1.54 - 1.51 (m, 1H), 1.41 (s, 9H), 1.34 - 1.29 (m, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 168.1, 167.4, 149.1, 129.7, 126.3, 123.3, 120.1, 119.6, 83.0, 82.0, 71.8, 71.2, 50.9, 45.7, 34.3, 28.2, 28.0, 26.4, 24.2, 23.1, 16.9; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_6Na$ $[M+Na]^+$: 482.2513, found: 482.2510.



7o

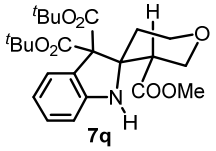
7o: White solid, 73% yield, dr > 50 : 1, m.p.: 152 - 156 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3371, 2971, 2928, 1748, 1719, 1617, 1478, 1366, 1137, 1078, 940, 877, 847, 607; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.06 (s, 1H), 6.27 (s, 1H), 5.84 (d, *J* = 8.4 Hz, 2H), 4.14 (brs, 1H), 3.47 (dd, *J* = 11.2, 4.4 Hz, 1H), 3.10 (s, 3H), 2.13 - 2.06 (m, 1H), 1.93 (brd, *J* = 13.2 Hz, 1H), 1.75 - 1.73 (m, 4H), 1.60 (s, 9H) 1.42 (s, 9H), 1.33 - 1.25 (m, 2H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 168.1, 167.4, 149.1, 129.7, 126.3, 123.3, 120.1, 119.6, 83.0, 82.0, 71.8, 71.2, 50.9, 45.7, 34.3, 28.2, 28.0,

26.4, 24.2, 23.1, 16.9; **HRMS** (ESI): Calcd for $C_{26}H_{35}NO_8Na$ $[M+Na]^+$: 512.2255, found: 512.2258.



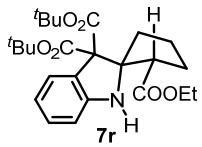
7p

7p: White solid, 64% yield, dr > 50 : 1, m.p: 208 - 211 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3727, 3368, 2932, 2860, 2212, 1730, 1608, 1488, 1393, 1368, 1317, 1152, 1133, 1024, 920, 851, 838, 821, 772, 729, 589, 468;**^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.81 （d, *J* = 1.6 Hz, 1H）, 7.38 （dd，*J* = 8.4, 1.6 Hz, 1H）, 6.65 (dd, *J* = 1.6 Hz, 1H), 4.92 (brs, 1H), 3.50 (dd，*J* = 12.0, 3.6 Hz, 1H), 2.99 (s, 3H), 2.17 (td, *J* = 13.6, 9.6 Hz, 1H), 1.95 (dd，*J* = 13.2, 2.8 Hz, 1H), 1.80 -1.72 (m, 3H), 1.63 (s, 9H), 1,48 (d, *J* = 6.4 Hz, 1H), 1.40 (s, 9H), 1.33 – 1.30 (m, 1H), 1.24 (s, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.7, 167.1, 166.1, 154.0, 134.2, 129.0, 127.4, 120.6, 110.1, 100.9, 84.1, 83.1, 72.1, 70.1, 51.1, 45.8, 33.9, 28.2, 27.9, 26.0, 23.9, 23.1. **HRMS** (ESI): Calcd for $C_{26}H_{35}N_2O_6$ $[M+H]^+$: 471.2490, found: 471.2487.



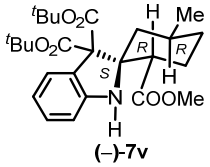
7q

7q: White solid, 81% yield, dr > 50 : 1, m.p.: 73 - 75 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3431, 3380, 2978, 2931, 1731, 1715, 1608, 1477, 1369, 1249, 1154, 1138, 1025, 749, 549; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.6 Hz, 1H), 7.09 (t, *J* = 7.6 Hz, 1H), 6.77 (t, *J* = 7.6 Hz, 1H), 6.74(d, *J* = 7.6 Hz, 1H), 4.74 (brs, 1H), 3.99 - 3.89 (m, 2H), 3.82 - 3.63 (m, 3H), 3.02 (s, 3H), 2.40 (td, *J* = 13.2, 5.2 Hz, 1H), 1.90 (d, *J* = 13.2 Hz, 1H), 1.59 (s, 9H), 1.42 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 171.9, 167.4, 166.8, 149.6, 129.3, 127.5, 126.1, 120.2, 112.2, 83.3, 82.4, 70.8, 69.1, 65.9, 65.1, 51.1, 45.3, 33.6, 28.1, 28.0; **HRMS** (ESI): Calcd for $C_{24}H_{33}NO_7Na$ $[M+Na]^+$: 470.2149, found: 470.2156.



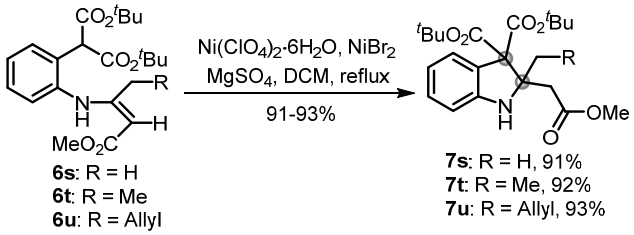
7r

7r: White solid, 75% yield, dr > 50 : 1, m.p.: 89 - 91 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3363, 2977, 1732, 1606, 1469, 1393, 1369, 1257, 1151, 1022, 851, 745, 469; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.45 (d, *J* = 7.6 Hz, 1H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.73 (t, *J* = 7.6 Hz, 1H), 6.63 (d, *J* = 7.6 Hz, 1H), 4.67 (brs, 1H), 3.75 - 3.67 (m, 1H), 3.43 - 3.35 (m, 1H), 3.27 (t, *J* = 9.2 Hz, 1H), 2.35 - 2.23 (m, 2H), 2.08 - 1.85 (m, 3H), 1.78 - 1.69 (m, 1H), 1.53 (s, 9H), 1.40 (s, 9H), 0.89 (s, *J* = 7.2 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 167.6, 167.0, 149.7, 129.1, 127.1, 126.5, 119.6, 111.6, 82.4, 82.1, 79.1, 69.8, 60.4, 49.7, 37.0, 28.8, 28.1, 27.9, 22.6, 13.8; **HRMS** (ESI): Calcd for $C_{25}H_{35}NO_6Na$ $[M+Na]^+$: 468.2357, found: 468.2359.



(–)-7v

7v: White solid, 65% yield, dr > 50 : 1, m.p.: 101 - 104 °C. $[\alpha]_D^{20}$ = -85.3 (*c* 1.27, $CHCl_3$). **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3385, 2978, 2950, 2929, 2872, 1732, 1607, 1471, 1393, 1254, 1168, 1135, 1048, 843, 748, 665, 469; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.7 Hz, 1H), 7.07 (t, *J* = 7.6 Hz, 1H), 6.71(t, *J* = 7.6 Hz, 1H), 6.67 (d, *J* = 7.6 Hz, 1H), 4.48 (brs, 1H), 3.47 (dd, *J* = 12.5, 4.2 Hz, 1H), 2.93 (s, 3H), 2.95 - 2.90 (m, 2H), 1.87 - 1.79 (m, 2H), 1.76 - 1.72 (m, 2H), 1.62 (s, 9H), 1.42 (s, 9H), 1.02 - 0.98 (m, 1H), 0.94 (d, *J* = 6.4 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.4, 168.0, 167.3, 150.4, 129.1, 126.8, 125.8, 119.4, 111.1, 83.2, 82.1, 72.2, 70.8, 51.0, 45.2, 43.2, 32.6, 29.5, 28.2, 28.0, 26.0, 22.5; **HRMS** (ESI): Calcd for $C_{26}H_{37}NO_6$ $[M+H]^+$: 460.2694, found: 460.2691.

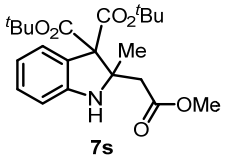


6s: R = H
6t: R = Me
6u: R = Allyl

7s: R = H, 91%
7t: R = Me, 92%
7u: R = Allyl, 93%

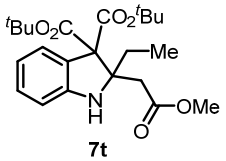
To a solution of β-enamino esters **6s-6u** (0.15 mmol) in dry DCM (5 mL) were added

$Ni(ClO_4)_2·6H_2O$ (55.0 mg, 0.15 mmol), $NiBr_2$ (33.0 mg, 0.15 mmol), and $MgSO_4$ (181.0 mg, 1.50 mmol). The resulting mixture was then stirred at reflux under argon for 8-48 h. After TLC analysis, the mixture was diluted with water (10 mL) and extracted with EtOAc (3 × 10 mL). The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1 to 10:1) to give the products **7s**-**7u**.



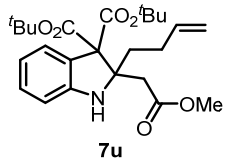
7s

7s: Colorless oil, 91% yield. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3379, 2977, 1732, 1607, 1482, 1392, 1369, 1270, 1229, 1149, 1024, 850, 836, 747, 636, 590, 540, 470; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.43 (d, *J* = 7.6 Hz, 1H), 7.09 (t, *J* = 7.6 Hz, 1H), 6.76 (t, *J* = 7.6 Hz, 1H), 6.65 (d, *J* = 7.6 Hz, 1H), 4.77 (brs, 1H), 3.70 (s, 3H), 3.56 (d, *J* = 16.0 Hz, 1H), 2.79 (d, *J* = 16.4 Hz, 1H), 1.49 (s, 9H), 1.45 (s, 3H), 1.42 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.1, 166.8, 166.7, 149.6, 129.5, 127.6, 125.1, 119.0, 110.7, 82.3, 82.2, 70.2, 66.6, 51.7, 39.3, 28.0, 27.9, 21.5; **HRMS** (ESI): Calcd for $C_{22}H_{31}NO_6Na$ $[M+Na]^+$: 428.2044, found: 428.2039.



7t

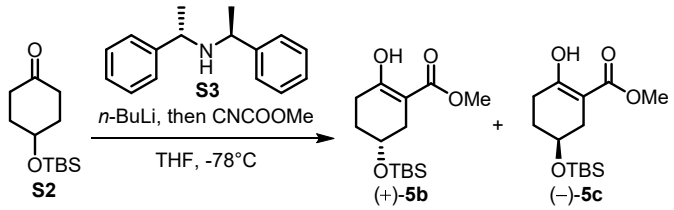
7t: Colorless oil, 92% yield. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 2798, 1732, 1606, 1470, 1394, 1369, 1258, 1150, 1024, 851, 746; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.42 (d, *J* = 7.6 Hz, 1H), 7.11 (t, *J* = 7.2 Hz, 1H), 6.76 (t, *J* = 7.6 Hz, 1H), 6.71 (d, *J* = 8.0 Hz, 1H), 3.66 (s, 3H), 3.28 (d, *J* = 15.6 Hz, 1H), 2.87 (d, *J* = 15.2 Hz, 1H), 2.10 - 1.96 (m, 2H), 1.48 (s, 9H), 1.46 (s, 9H), 0.88 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.1, 167.1, 166.9, 129.6, 126.9, 126.4, 119.2, 110.5, 82.6, 82.5, 70.6, 70.4, 51.8, 38.1, 29.6, 28.0, 9.7; **HRMS** (ESI): Calcd for $C_{23}H_{33}NO_6Na$ $[M+Na]^+$: 442.2200, found: 442.2202.



7u

7u: White solid, 93% yield, m.p.: 89 - 90 °C. **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3377, 2982, 1723, 1606, 1481, 1396, 1371, 1329, 1238, 1144, 1018, 904, 835, 743, 661, 553; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.41 (d, *J* = 7.6 Hz, 1H), 7.10 (t, *J* = 8.0 Hz, 1H), 6.75 (t, *J* = 7.6 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 5.74 - 5.64 (m, 1H), 4.95 - 4.87 (m, 2H), 3.66 (s, 3H), 3.33 (d, *J* = 15.6 Hz, 1H), 2.90 (d, *J* = 15.6 Hz, 1H), 2.10 - 1.96 (m, 4H) 1.48 (s, 9H), 1.45 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 172.9, 167.0, 166.7, 149.5, 138.2, 129.5, 126.6, 125.9, 118.8, 114.5, 110.0, 82.5, 82.4, 70.5, 69.6, 51.6, 38.5, 36.3, 29.1, 27.8; **HRMS** (ESI): Calcd for $C_{25}H_{35}NO_6Na$ $[M+Na]^+$: 468.2357, found: 468.2359.

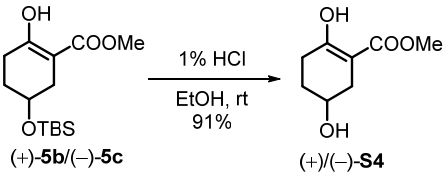
2.3 Asymmetric synthesis of products 7w-7z



Procedure leading to enantio-enriched mixture of (+)-**5b** and (–)-**5c**[1]: To a solution of chiral amine **S3** (10.81g, 48.0 mmol) in THF (80 mL) was added a 2.5 M *n*-butyllithium solution in hexane (19.2 mL, 48.0 mmol) at -78 °C. The reaction mixture was stirred at -78 °C for 30 min then ketone **S2** (9.12 g, 40 mmol) in THF (15 mL) was added. The resulting solution was then stirred at -78 °C for 1h before addition of methyl cyanoformate (3.8 mL, 48.0 mmol). After stirring at -78 °C for another 30 min, H_2O (2 mL) was introduced. The pH of the mixture was then adjusted to 7.0 with a 1 M aqueous solution of hydrogen chloride. The organic layer was separated and the aqueous layer was extracted with EtOAc (3 × 100 mL). The combined organic phases were dried over anhydrous Na_2SO_4. After being concentrated, the residue was purified by flash column chromatography on silica gel (petroleum ether/EtOAc = 20:1) to give an inseparable mixture of (+)-**5b** and (–)-**5c** (10.50 g, 92%) as a yellow oil[2].

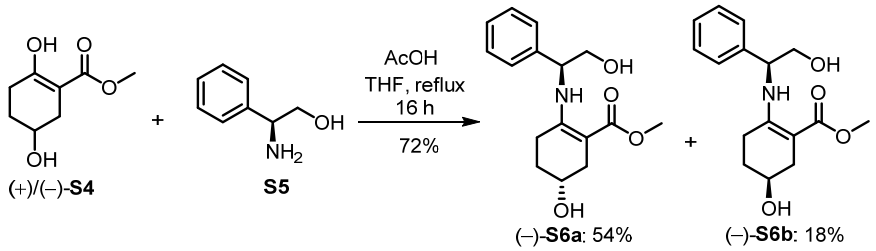
FTIR (KBr, thin film) ν_{max} (cm^{-1}): 2953, 2859, 1661, 1443, 1300, 1057, 1033, 1016, 836, 775; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 12.08 (s, 1H), 3.91- 3.85 (m, 1H), 3.69 (s, 3H), 2.38 (dd, *J* = 16.8, 4.8

Hz ,1H), 2.25 - 2.17 (m, 1H), 2.11 (dd, *J* = 15.6, 6.8 Hz, 1H), 1.70 - 1.65 (m, 2H), 0.82 (s, 9H), 0.06 (s, 3H), 0.00(s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.1, 171.6, 95.1, 66.6, 51.6, 31.9, 30.45, 26.00, 25.97, 25.90, 18.3, -4.5, -4.6.



(+)-**5b**/(–)-**5c** (+)/(–)-**S4**

A mixture of (+)-**5b** and (–)-**5c** (3:1, 5.73g, 20.0 mmol) was dissolved in 70 mL of 1% HCl in EtOH. The resulting mixture was stirred at ambient temperature for 3 h. The solvent was removed under reduced pressure, and the residue was purified by flash chromatography (petroleum ether/EtOAc = 5:1→2:1) to yield a mixture of (+)-**S4** and (–)-**S4** (colorless oil, 3.13 g, 91%)[2].



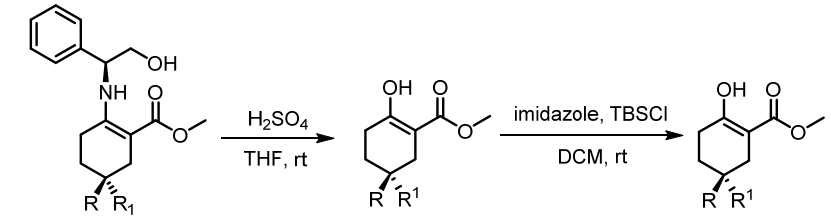
(+)/(–)-**S4** **S5** (–)-**S6a**: 54% (–)-**S6b**: 18%

To a mixture of β-ketoesters (+)-**S4** and (–)-**S4** (1.72 g, 10.0 mmol) in THF (20 mL) were added (*S*)-(+)-2-Phenylglycinol **S5** (2.74 g, 20.0 mmol) and AcOH (865 μL, 15.0 mmol). The resulting solution was stirred at reflux for 16 h. After being cooled to room temperature, the mixture was diluted with ethyl acetate (50 mL), washed with brine (15 mL), and dried over anhydrous Na_2SO_4. After concentrated under reduced pressure, the residue was purified by flash column chromatography on silica gel (MeOH/ DCM = 1:50 → 1:20) to give enamine (–)-**S6b** (561.1 mg, 18%). Further elution provided (–)-**S6a** (1.55 g, 54%).

(–)-**S6a**: White solid, 141 - 143 °C. $[\alpha]_D^{20}$ = –25.9 (*c* 1.01, $CHCl_3$). **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3386, 2947, 1720, 1637, 1453, 1247, 1091, 750, 701, 451; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 9.59 (d, *J* = 8.4 Hz, 1H), 7.37 - 7.34 (m, 2H), 7.30 - 7.25 (m, 3H), 4.70 - 4.65 (m, 1H), 3.90 - 3.81 (m, 2H), 3.72 (s, 3H), 2.64 - 2.54 (m, 2H), 2.27 (dd, *J* = 15.6, 6.4 Hz, 1H), 2.06 - 1.99 (m, 1H), 1.69 - 1.66 (m, 2H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 171.3, 158.6, 140.4, 129.1, 127.9, 126.6, 88.3, 67.7, 66.0, 58.9, 50.8, 33.0, 29.5, 24.0; **HRMS** (ESI): Calcd for $C_{16}H_{21}NO_4Na$ $[M+H]^+$:

292.1504, found: 292.1543.

(–)-**S6b**: White solid, 142 - 143 °C. $[\alpha]_D^{20}$ = –26.8 (*c* 0.97, $CHCl_3$). ^1H NMR (400 MHz, $CDCl_3$): δ 9.61 (d, *J* = 8.4 Hz, 1H), 7.37 - 7.34 (m, 2H), 7.30 - 7.25 (m, 3H), 4.69 - 4.64 (m, 1H), 3.95 - 3.89 (m, 1H), 3.85 - 3.81 (dd, *J* = 11.3, 4.4 Hz, 1H), 3.77 - 3.74 (m, 1H), 3.72 (s, 3H), 2.66 (dd, *J* = 15.4, 4.6 Hz, 1H), 2.46 - 2.38 (m, 1H), 2.27 - 2.20 (m, 2H), 1.80 - 1.77 (m, 1H), 1.57 - 1.50 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.3, 158.5, 140.3, 129.1, 127.9, 126.5, 88.3, 67.7, 66.3, 58.9, 50.8, 33.1, 29.7, 24.3; **HRMS** (ESI): Calcd for $C_{16}H_{21}NO_4Na$ $[M+H]^+$: 292.1504, found: 292.1543.



(–)-**S6a**: R = H, R_1 = OH
(–)-**S6b**: R_1 = H, R = OH

(+)-**S4a**: R = H, R_1 = OH, 94%
(–)-**S4b**: R_1 = H, R = OH, 91%

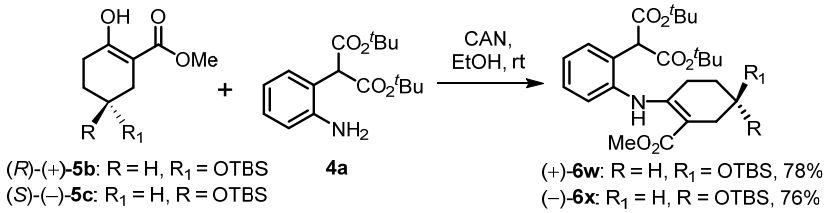
(+)-**5b**: R = H, R_1 = OTBS, 95%
(–)-**5c**: R_1 = H, R = OTBS, 92%

To a solution of enamine **S6** [either (–)-**S6a** or (–)-**S6b**, 1.46 g, 5.01 mmol] in THF (10 mL) was added 1.0 M aqueous solution of sulfuric acid (1.0 mL). The resulting mixture was stirred for 2 h at room temperature then quenched with saturated aqueous solution of $NaHCO_3$ (30 mL). The mixture was extracted with EtOAc (3 × 25 mL). The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by flash chromatography (hexane/EtOAc = 50:1→10:1) to afford β-ketoester **S4**[2]. (+)-**S4a**: 808.0 mg, 94% from (–)-**S6a**; or (–)-**S4b**: 782.0 mg, 91% from (–)-**S6b**.

To a solution of β-ketoester **S4** [either (+)-**S4a** or (–)-**S4b**, 344.0 mg, 2.0 mmol] in DCM were added imidazole (408.0 mg, 6.0 mmol) and TBSCl (603.0 mg, 4.0 mmol). The resulting mixture was stirred at room temperature for 5 h before addition of water (50 mL). The mixture was then extracted with ethyl acetate (3 × 15 mL). The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by flash chromatography (hexane/EtOAc = 50:1) to afford β-ketoester (+)-**5b** or (–)-**5c** as colorless oil[2].

(+)-**5b**: 543.0 mg, 95% yield, $[\alpha]_D^{20}$ = 16.9 (*c* 1.31, $CHCl_3$); (–)-**5c**: 526.0 mg, 92% yield, $[\alpha]_D^{20}$ = –17.2 (*c* 1.88, $CHCl_3$). **^1H NMR** (400 MHz, $CDCl_3$): δ 12.08 (s, 1H), 3.91- 3.85 (m, 1H), 3.69 (s,

3H), 2.38 (dd, *J* = 16.8, 4.8 Hz ,1H), 2.25 - 2.17 (m, 1H), 2.11 (dd, *J* = 15.6, 6.8 Hz, 1H), 1.70 - 1.65 (m, 2H), 0.82 (s, 9H), 0.06 (s, 3H), 0.00(s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.1, 171.6, 95.1, 66.6, 51.6, 31.9, 30.45, 26.00, 25.97, 25.90, 18.3, -4.5, -4.6.



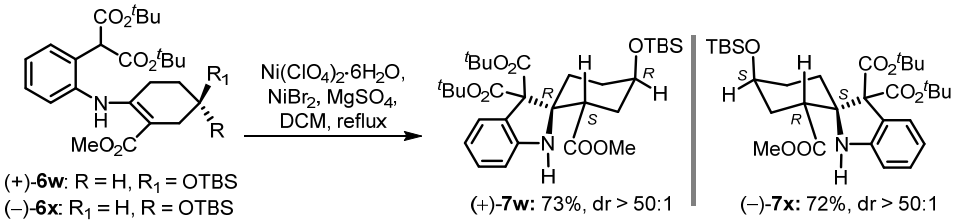
(*R*)-(+)-**5b**: R = H, R_1 = OTBS
(*S*)-(–)-**5c**: R_1 = H, R = OTBS

4a

(+)-**6w**: R = H, R_1 = OTBS, 78%
(–)-**6x**: R_1 = H, R = OTBS, 76%

To a solution of (+)-**5b** or (–)-**5c** (143.2 mg 0.50 mmol) and **4a** (154.0 mg, 0.50 mmol) in dry EtOH (2 mL) was added CAN (27.4 mg, 0.05 mmol). The resulting mixture was then stirred at room temperature for 24 h. After TLC analysis, the mixture was concentrated, and diluted with EtOAc (35 mL). The resulting solution washed with brine (15 mL), dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. The residue was purified by flash column chromatography on Et_3N-pretreated silica gel (petroleum ether/EtOAc = 50:1→10:1) to give the β-enamino ester (+)-**6w** or (–)-**6x**.

(+)-**6w**: 224.6 mg, 78% yield. $[\alpha]_D^{20}$ = 5.84 (*c* 1.37, $CHCl_3$). (–)-**6x**: 218.8 mg, 76% yield. $[\alpha]_D^{20}$ = -5.99 (*c* 0.94, $CHCl_3$). **^{1}H NMR** (400 MHz, $CDCl_3$): δ 10.17 (s, 1H), 7.36 (dd, *J* = 7.4, 1.6 Hz, 1H), 7.22 - 7.14 (m, 2H), 7.02 (d, *J* = 7.2 Hz, 1H), 4.74 (s, 1H), 3.88 - 3.78 (m, 1H), 3.65 (s, 3H), 2.54 (dd, *J* = 14.4, 5.0, Hz 1H), 2.19 - 2.13 (m, 2H), 2.06 - 1.97 (m, 1H), 1.60 - 1.57 (m, 1H), 1.42 - 1.59 (m, 1H), 1.39 (s, 18H), 0.82 (s, 9H), 0.00 (s, 3H), -0.01 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 170.7, 167.6, 167.6, 156.6, 138.8, 131.8, 129.7, 128.8, 128.4, 126.5, 91.2, 82.3, 67.4, 55.5, 50.8, 33.6, 30.9, 28.0, 26.1, 25.8, 18.3, -4.5, -4.6. **HRMS** (ESI): Calcd for $C_{31}H_{50}NO_7Si$ $[M+H]^+$: 576.3351, found: 576.3357.



(+)-**6w**: R = H, R_1 = OTBS
(–)-**6x**: R_1 = H, R = OTBS

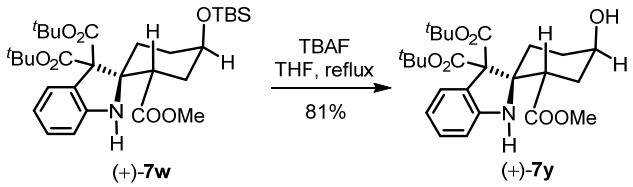
(+)-**7w:** 73%, dr > 50:1

(–)-**7x:** 72%, dr > 50:1

To a solution of β-enamino esters (+)-**6w** or (–)-**6x** (86.0 mg, 0.15 mmol) in dry DCM (5 mL) were added $Ni(ClO_4)_2·6H_2O$ (55.0 mg, 0.15 mmol), $NiBr_2$ (33.0 mg, 0.15 mmol), and $MgSO_4$

(181.0 mg, 1.50 mmol). The resulting mixture was then stirred at reflux under argon for 8-48 h. After TLC analysis, the mixture was quenched with water (5 mL). The organic layer was separated and the aqueous layer was extracted with EtOAc (3 × 10 mL). The combined organic phases were washed with brine (15 mL), dried over anhydrous Na_2SO_4, and concentrated. The residue was purified by flash column chromatography on silica gel (petroleum ether/EtOAc = 20:1→10:1) to give the product (+)-**7w** or (–)-**7x**.

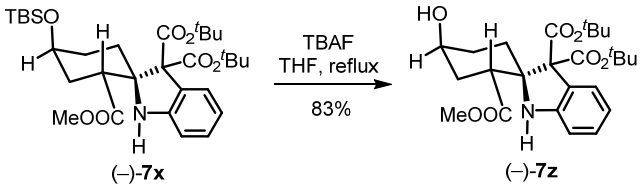
(+)-**7w**: 62.8 mg, 73% yield, dr > 50 : 1. $[\alpha]_D^{20}$ = 20.3 (*c* 1.7, $CHCl_3$). (–)-**7x**: 61.9 mg, 72% yield, dr > 50 : 1. $[\alpha]_D^{20}$ = -20.6 (*c* 1.6, $CHCl_3$). **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 2978, 2932, 2857, 1730, 1659, 1593, 1531, 1369, 1347, 1249, 1137, 963, 887, 836, 777, 751; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.60 (d, *J* = 8.0 Hz, 1H), 7.07 (td, *J* = 7.6, 1.2Hz, 1H), 6.74 (t, *J* = 7.6Hz, 1H), 4.09 (s, 1H), 3.81 (dd, *J* = 13.2, 3.6Hz, 1H), 3.03 (s, 3H), 2.55 - 2.46 (m, 1H), 2.06 - 1.98 (m, 1H), 1.84 - 1.79 (m, 1H), 1.74 - 1.71 (m, 3H), 1.58 (s, 9H), 1.41 (s, 9H), 0.91 (s, 9H), 0.06 (s, 6H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.5. 168.0, 166.6, 150.0, 129.0, 127.9, 126.1, 119.7, 111.6, 82.7, 81.8, 71.1, 65.0, 50.9, 40.1, 33.7, 30.1, 28.1, 27.9, 27.6, 25.9, 18.3, -4.8; **HRMS** (ESI): Calcd for $C_{31}H_{49}NO_7SiNa$ $[M+Na]^+$: 598.3171, found: 598.3174.



(+)-**7w** (+)-**7y**

To a solution of (+)-**7w** (38.0 mg, 0.066 mmol) in THF (1 mL) was added 1.0 M TBAF in THF (3 mL). The reaction mixture was stirred at reflux for 4 h. After being cooled to room temperature, the mixture was diluted with water (10 mL) and extracted with ethyl acetate (3 × 5 mL). The combined organic phases were washed with brine (10 mL), dried over anhydrous Na_2SO_4, and concentrated. The residue was purified by flash chromatography (hexane/EtOAc = 2:1) to afford (+)-**7y** (24.7 mg, 81%).

(+)-**7y**: White solid, m.p.: 178 - 182 °C. $[\alpha]_D^{20}$ = 60.2 (*c* 0.99, $CHCl_3$).



To a solution of (–)-**7x** (74.0 mg, 0.13 mmol) in THF (1 mL) was added 1.0 M TBAF in THF (5 mL). The reaction mixture was stirred at reflux for 4 h. After being cooled to room temperature, the mixture was diluted with water (10 mL) and extracted with ethyl acetate (3 × 10 mL). The combined organic phases were washed with brine (10 mL), dried over anhydrous Na_2SO_4, and concentrated. The residue was purified by flash chromatography (hexane/EtOAc = 2:1) to afford (–)-**7z** (49.2 mg, 83%).

(–)-**7z**: White solid, m.p.: 178 - 182 °C. $[\alpha]_D^{20}$ = –60.5 (*c* 0.92, $CHCl_3$). **FTIR** (KBr, thin film) ν_{max} (cm^{-1}): 3384, 2978, 2932, 1729, 1607, 1472, 1369, 1256, 1170, 1151, 1027, 840, 750; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.59 (d, *J* = 7.6 Hz, 1H), 7.08 (td, *J* = 7.6, 1.2 Hz, 1H), 6.74 (td, *J* = 7.6, 0.8 Hz, 1H), 6.69(d, *J* = 7.6Hz, 1H), 4.18 (s, 1H), 3.96 (dd, *J* = 13.2, 4.0 Hz 1H), 2.98 (s, 3H), 2.66 - 2.58 (m, 1H), 2.10 - 2.03 (m, 1H), 1.83 - 1.79 (m, 4H), 1.61 (s, 9H), 1.43 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 168.0, 167.0, 150.2, 129.1, 127.5, 125.9, 119.8, 111.5, 83.2, 82.2, 71.3, 71.0, 64.4, 51.0, 39.7, 32.7, 29.5, 28.2, 28.0, 27.8; **HRMS** (ESI): Calcd for $C_{25}H_{35}NO_7Na$ $[M+H]^+$: 461.2486, found: 461.2488.

2.4 Powder X-ray diffraction (XRD) of $Ni(ClO_4)_2·6H_2O/NiBr_2$ complex

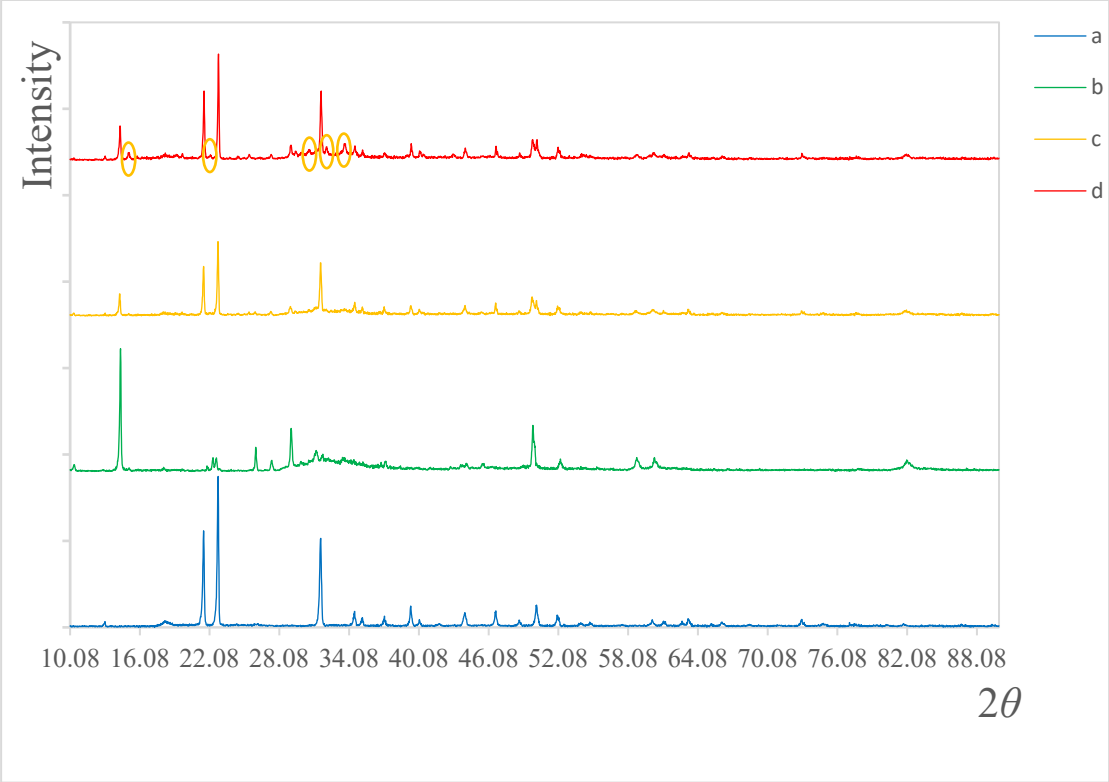


Figure S1 XRD patterns: (a) $Ni(ClO_4)_2·6H_2O$, (b) $NiBr_2$, (c) $Ni(ClO_4)_2·6H_2O$ and $NiBr_2$ physical mixture (1:1 molar ratio), (d) $Ni(ClO_4)_2·6H_2O/NiBr_2$ complex.

Preparation of $Ni(ClO_4)_2·6H_2O/NiBr_2$ complex: A mixture of $Ni(ClO_4)_2·6H_2O$ (110.0 mg, 0.3 mmol), $NiBr_2$ (65.6 mg, 0.3) and DCM (5 mL) was heated at reflux under Ar for 12 h. The resulting mixture was then evaporated under reduced pressure to remove the solvent and dried in a vacuum dryer at room temperature for 6 h to give $Ni(ClO_4)_2·6H_2O/NiBr_2$ complex.

XRD patterns were obtained using a Rigaku TTR diffractometer with Cu Kα radiation (180 kV), at a scanning rate of 9°/min. Powder samples were mounted on a vitreous sample holder and scanned with a step size of 2θ = 0.02° between 2θ = 10°and 90°.

2.5 UV–vis spectral changes of model substrate 6a by addition of Lewis acids

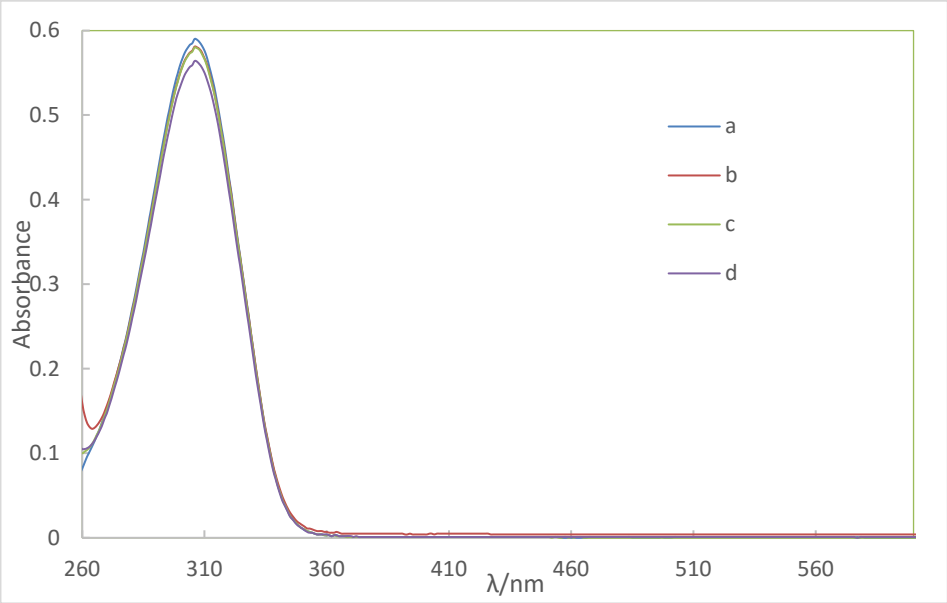


Figure S2 UV–vis spectral changes of model substrate **6a** (0.04 mM) by addition of Lewis acid (a: 0 mM, b: $NiBr_2$ (0.08 mM), c: $Ni(ClO4)_2{\cdot}6H_2O$ (0.08 mM), d: $NiBr_2$ (0.04 mM) and $Ni(ClO4)_2{\cdot}6H_2O$ (0.04 mM)).

Absorption spectra measurements were carried out with a Shimadzu UV 1900 UV-Vis spectrophotometer using a conventional 1 cm path (1cm×1cm×4 cm) quartz cell. Given the poor solubility of Lewis acids ($NiBr_2$ and $Ni(ClO_4)_2{\cdot}6H_2O$) in DCM, a DCM/DMF (V : V = 88 : 12) solution was used in the spectral measurements. The concentration of model substrate **6a** was held constant at 4×10^{-5} $M{\cdot}L^{-1}$ (0.04 mM). Then, an appropriate amount of Lewis acid was added, and the final concentrations was held at 8×10^{-5} $M{\cdot}L^{-1}$ (0.08 mM). The absorption spectra measurements were taken after 30 min. The measurements were done in the 260–600 nm spectral range.

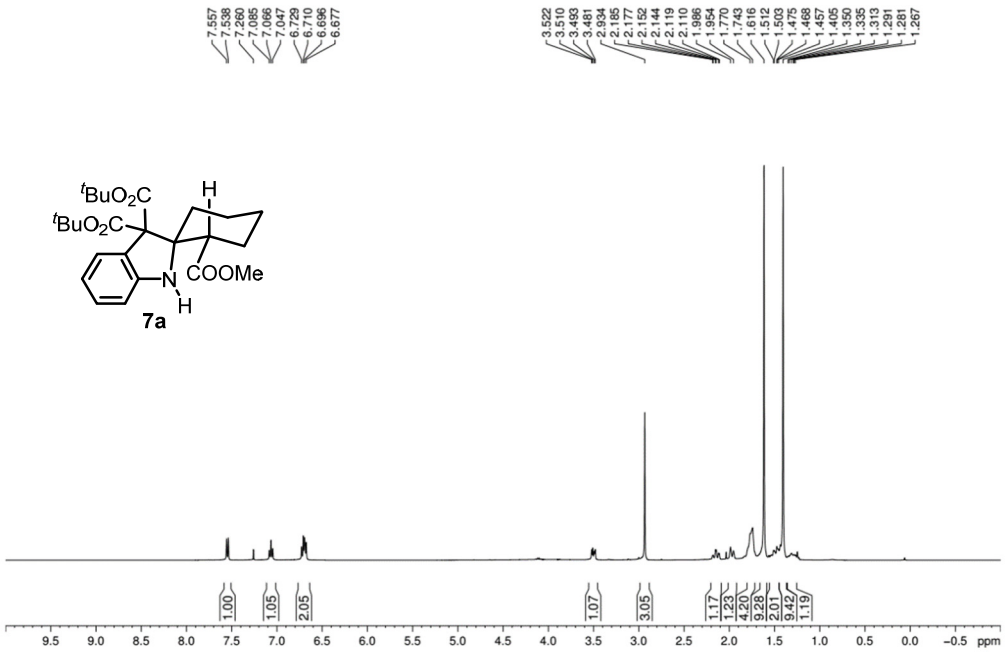
2.5 References

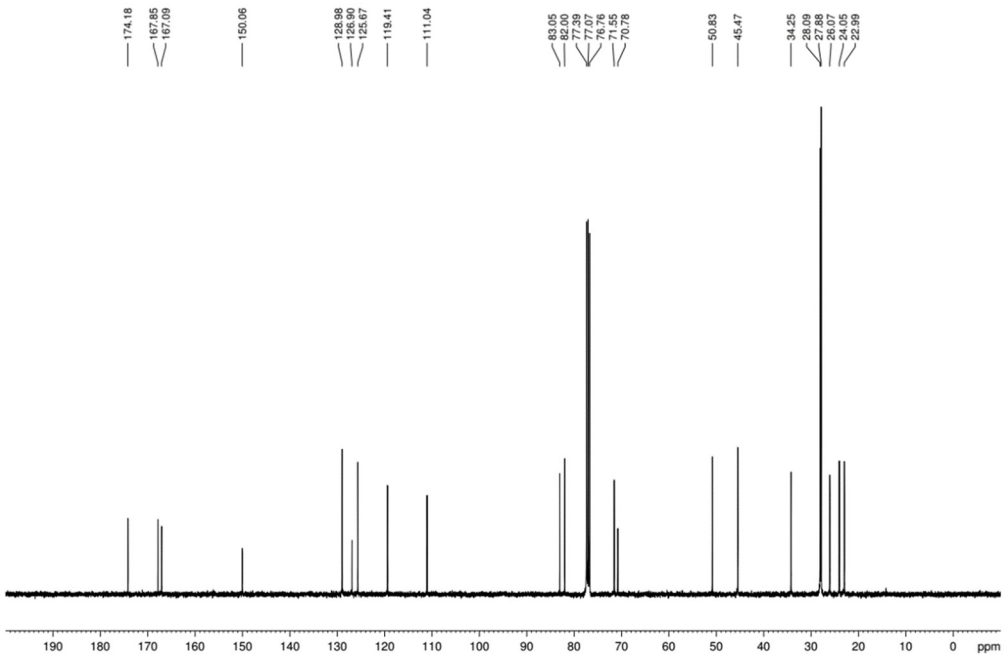
1. Chapdelaine, D.; Belzile, J.; Deslongchamps, P. A Convergent Synthesis of the Cardenolide Skeleton: Intramolecular Aldol Condensation via Reduction of α-Bromoketones. *J. Org. Chem.* **2002**, *67*, 5669-5672.

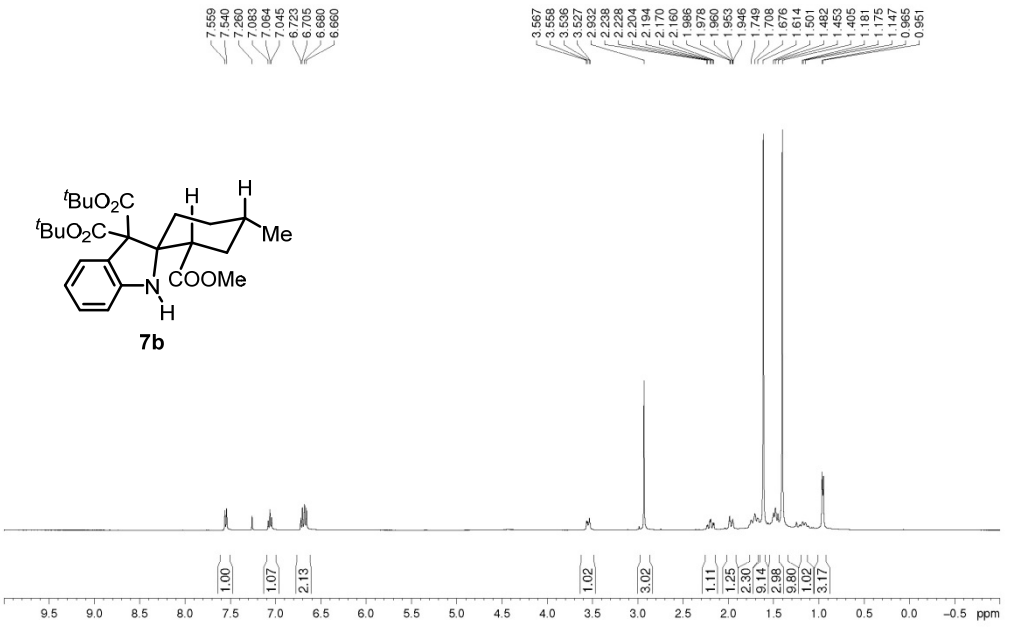
2. Konopelski, J. P.; Lin, J.; Wenzel, P. J.; Deng, H.; Elliott, G. I.; Gerstenberger, B. S. Carbanion

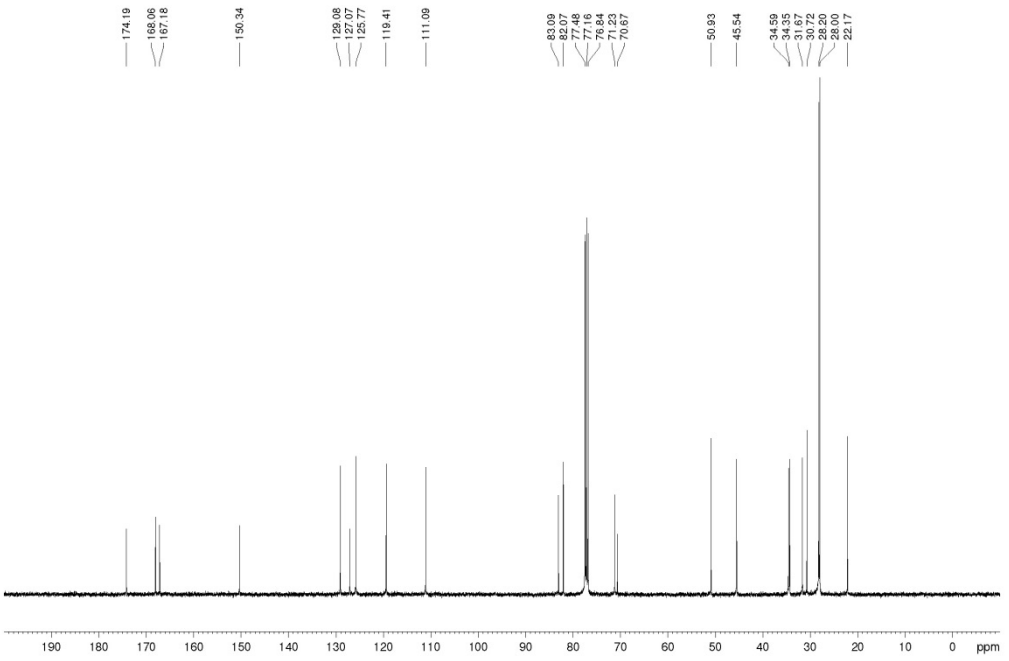
Stabilization by Distal Silyloxy Groups. Origin of the High Diastereoselectivity in the Formation of Quaternary Centers with Aryllead (IV) Triacetate Reagents. *Org. Lett*. **2002**, *4*, 4121-4124.

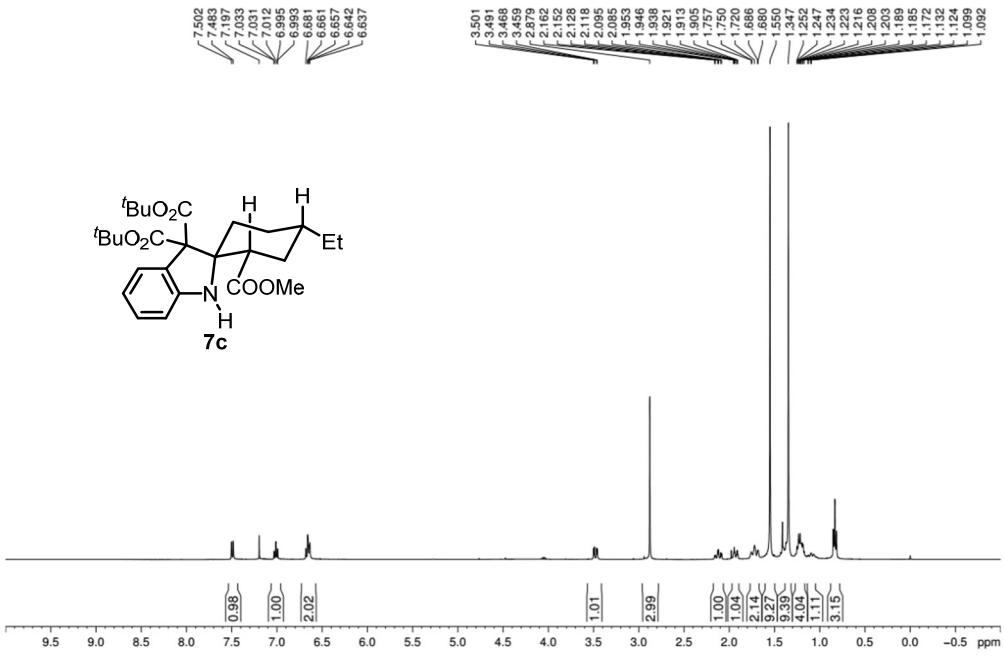
3. Copies of ^{1}H and ^{13}C NMR spectra

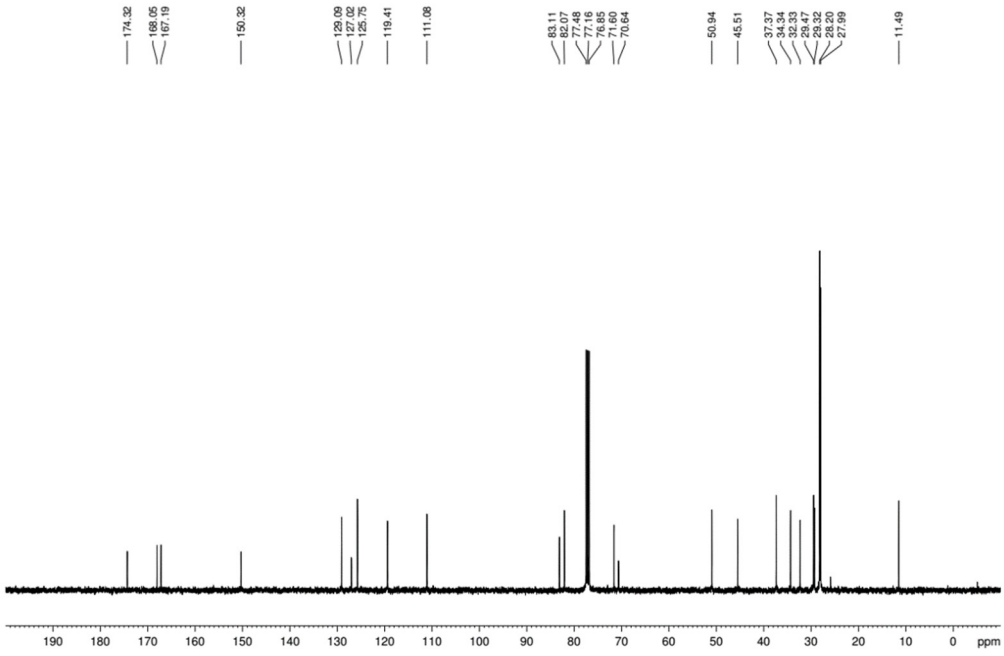


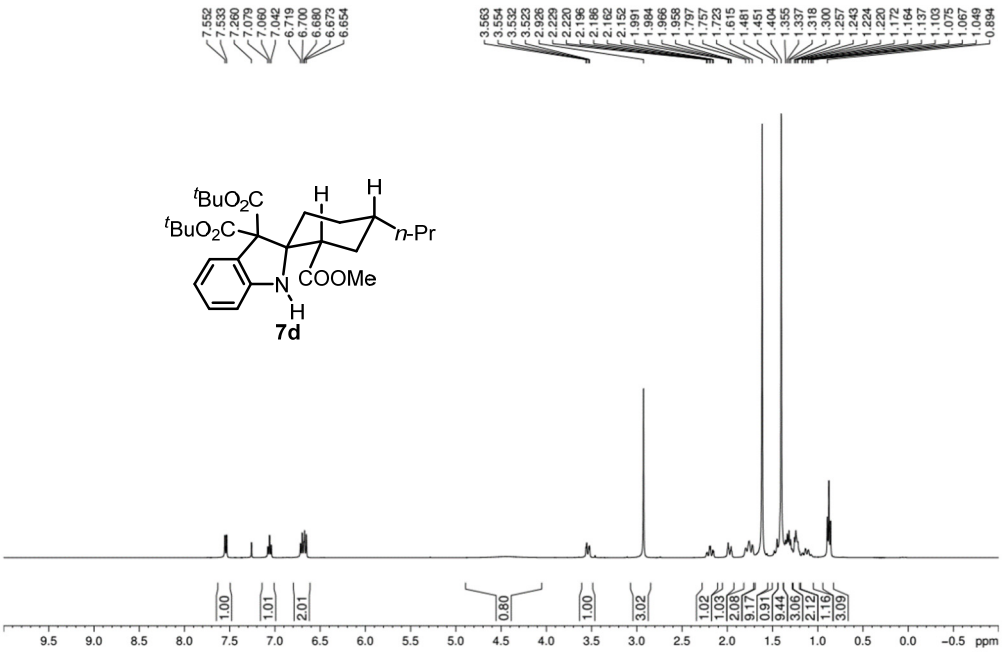


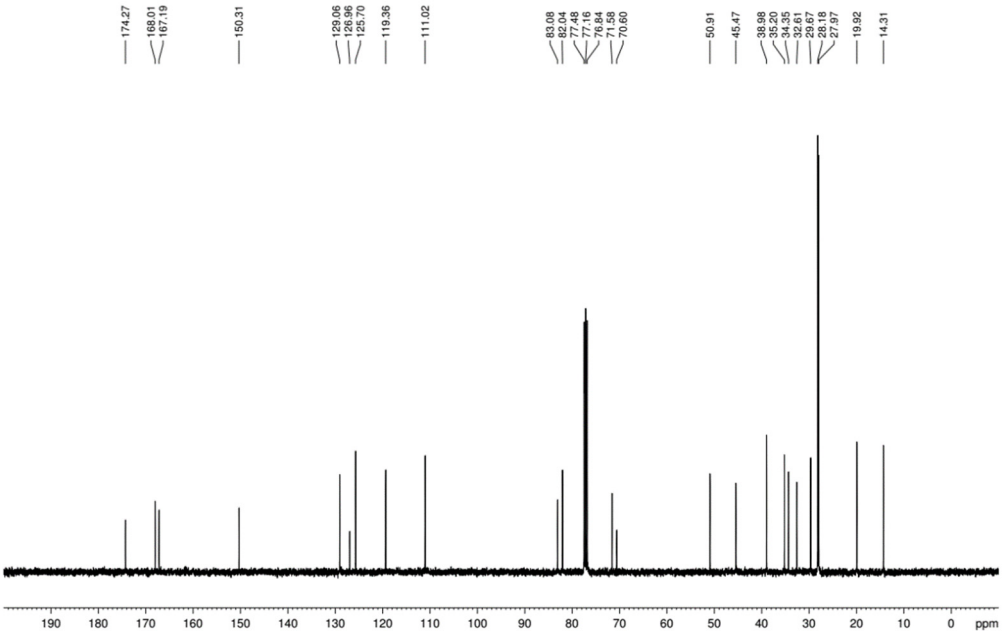

7.559
7.540
7.260
7.083
7.064
7.045
6.723
6.705
6.680
6.660
3.567
3.558
3.536
3.527
2.932
2.238
2.228
2.204
2.194
2.170
2.160
1.986
1.978
1.960
1.953
1.946
1.749
1.708
1.676
1.614
1.501
1.482
1.453
1.405
1.181
1.175
1.147
0.965
0.951
tBuO2C
tBuO2C
H
H
Me
COOMe
N
H
7b
1.00
1.07
2.13
1.02
3.02
1.11
1.25
2.30
9.14
2.98
9.80
1.02
3.17
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 ppm

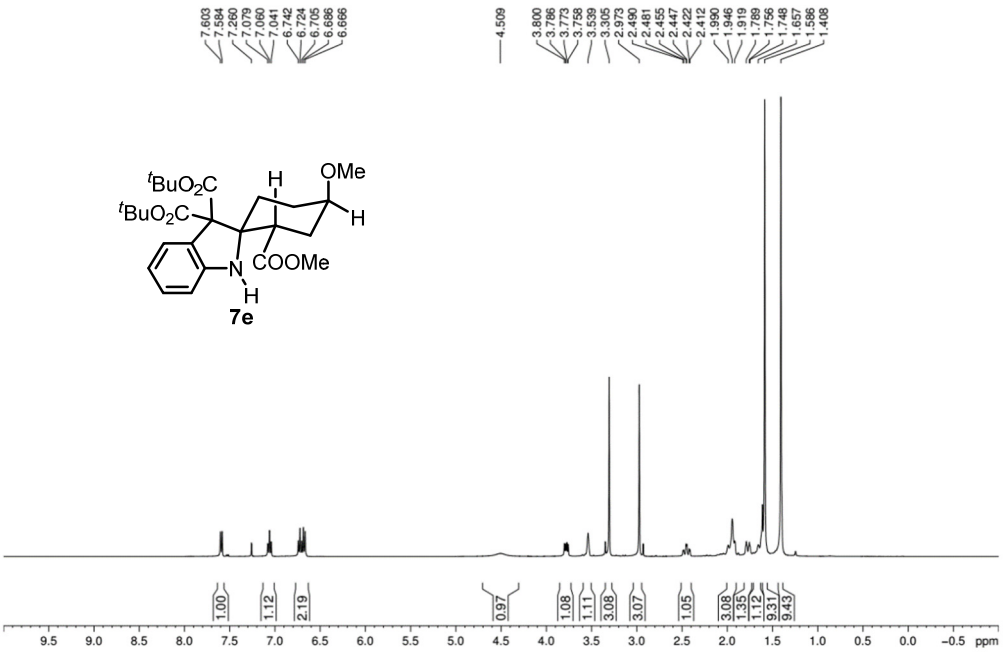

174.19
168.06
167.18
150.34
129.08
127.07
125.77
119.41
111.09
83.09
82.07
77.48
77.16
76.84
71.23
70.67
50.93
45.54
34.59
34.55
31.67
30.72
28.20
28.00
22.17
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

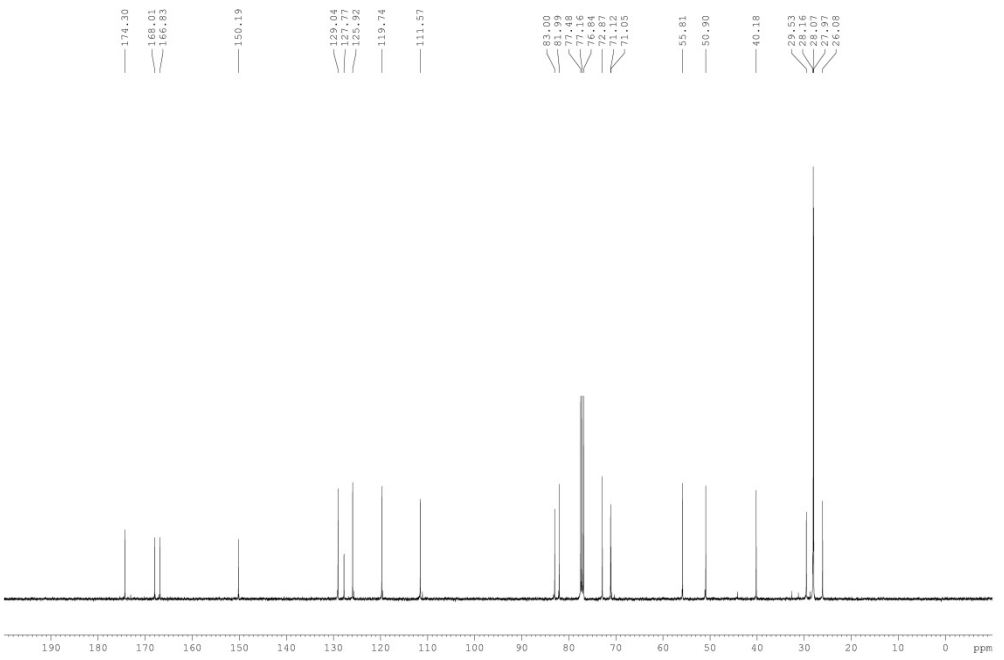

7.502
7.483
7.197
7.033
7.031
7.012
6.995
6.993
6.681
6.661
6.657
6.642
6.637
3.501
3.491
3.468
3.459
2.879
2.162
2.152
2.128
2.118
2.095
2.085
1.953
1.946
1.938
1.921
1.913
1.905
1.757
1.750
1.720
1.686
1.680
1.550
1.347
1.252
1.247
1.234
1.223
1.216
1.208
1.203
1.189
1.185
1.172
1.132
1.124
1.099
1.092
tBuO2C
tBuO2C
H
H
Et
N
H
COOMe
7c
0.98
1.00
2.02
1.01
2.99
1.00
1.04
2.14
9.27
9.39
4.04
1.11
3.15
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 ppm

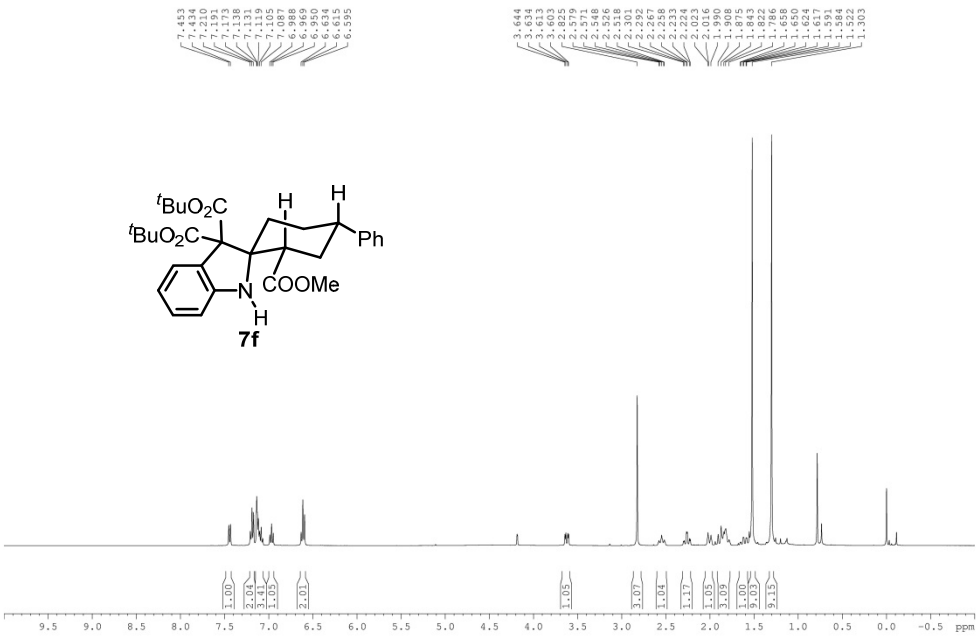

174.32
168.05
167.19
150.32
129.09
127.02
125.75
119.41
111.08
83.11
82.07
77.48
77.16
76.85
71.60
70.64
50.94
45.51
37.37
34.34
32.33
29.47
28.32
28.30
27.99
11.49
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

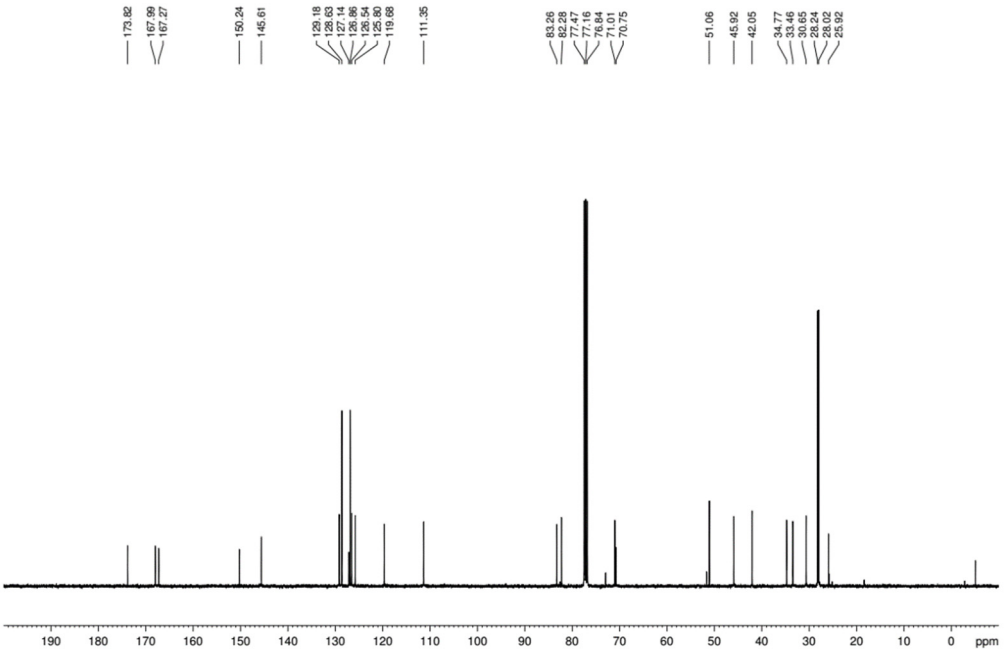

7.552
7.533
7.260
7.079
7.060
7.042
6.719
6.700
6.680
6.673
6.654
3.563
3.554
3.532
3.523
2.926
2.229
2.220
2.196
2.186
2.162
2.152
1.991
1.984
1.966
1.958
1.797
1.757
1.723
1.615
1.461
1.451
1.404
1.365
1.337
1.318
1.300
1.257
1.243
1.224
1.220
1.172
1.164
1.137
1.103
1.075
1.067
1.049
0.894
tBuO2C
tBuO2C
H
H
n-Pr
N
H
COOMe
7d
1.00
1.01
2.01
0.80
1.00
3.02
1.02
1.03
2.08
9.17
0.91
9.44
3.06
2.12
1.16
3.09
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 ppm

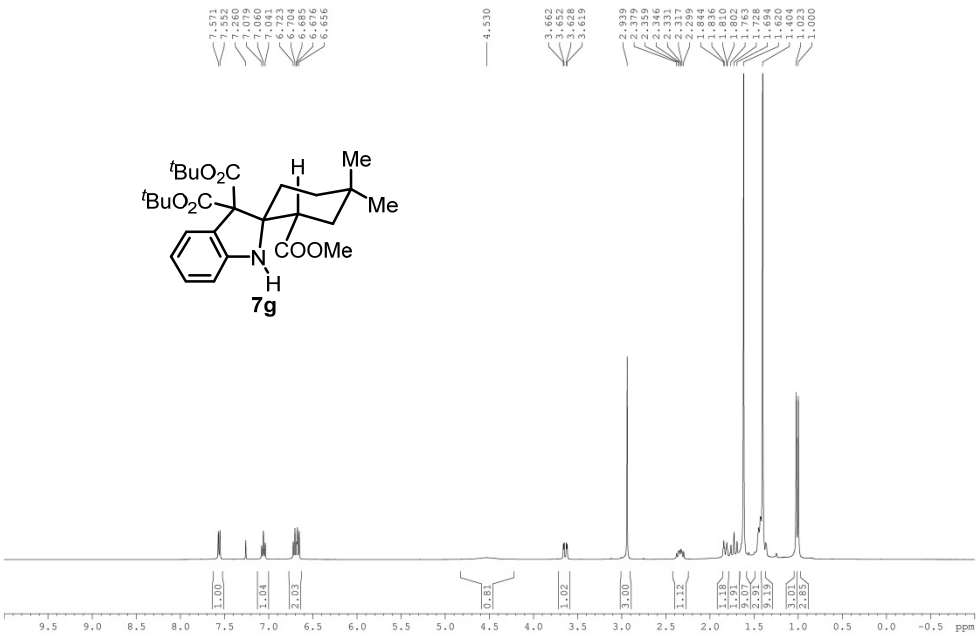

174.27
168.01
167.19
150.31
129.06
126.96
125.70
119.36
111.02
83.08
82.44
77.48
77.16
76.84
71.58
70.60
50.91
45.47
38.98
35.20
34.45
32.61
29.67
28.18
27.97
19.92
14.31
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

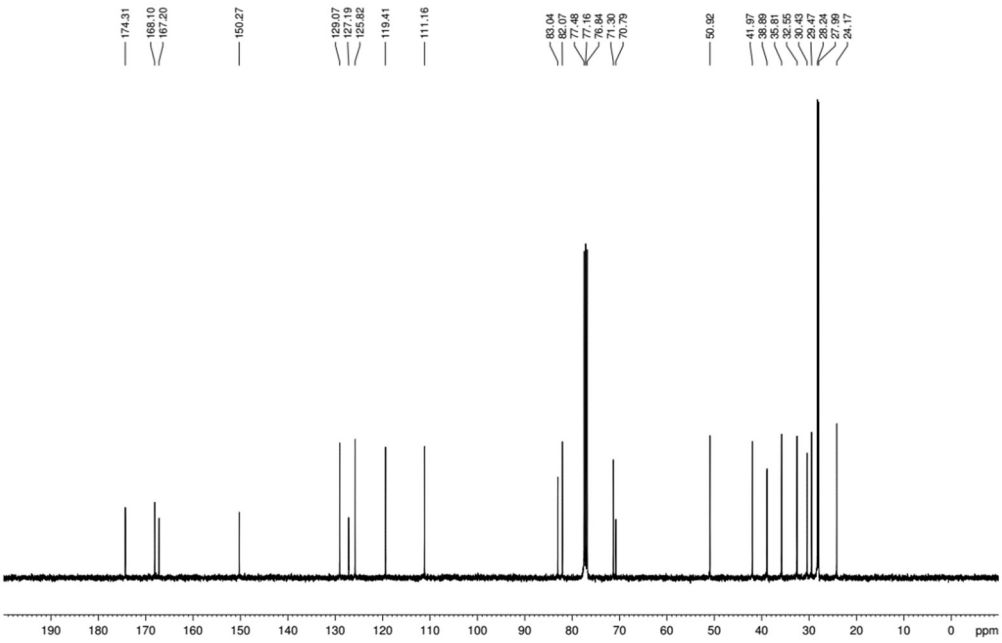

7.603
7.584
7.260
7.079
7.060
7.041
6.742
6.724
6.705
6.686
6.666
4.509
3.800
3.786
3.773
3.758
3.539
3.305
2.973
2.490
2.461
2.455
2.447
2.422
2.412
1.990
1.946
1.919
1.789
1.756
1.748
1.657
1.586
1.408
tBuO2C
tBuO2C
H
OMe
H
N
H
COOMe
7e
1.00
1.12
2.19
0.97
1.08
1.11
3.08
3.07
1.05
3.08
1.35
1.12
9.31
9.43
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 ppm

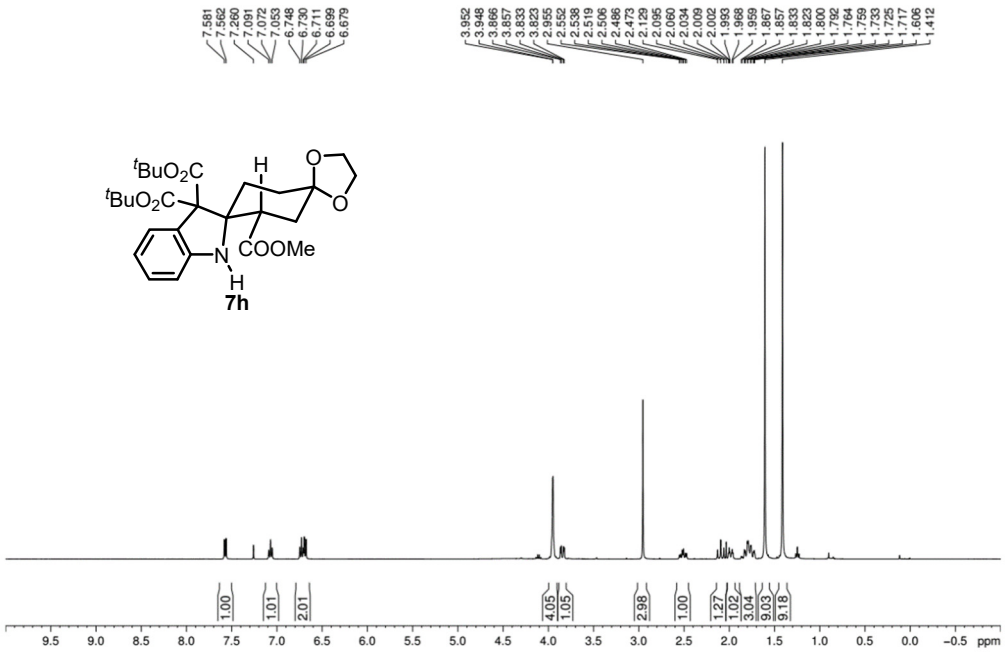

174.30
168.01
166.83
150.19
129.04
127.77
125.92
119.74
111.57
83.00
81.99
77.48
77.16
76.84
72.80
71.12
71.05
55.81
50.90
40.18
29.53
28.16
28.07
27.97
26.08
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

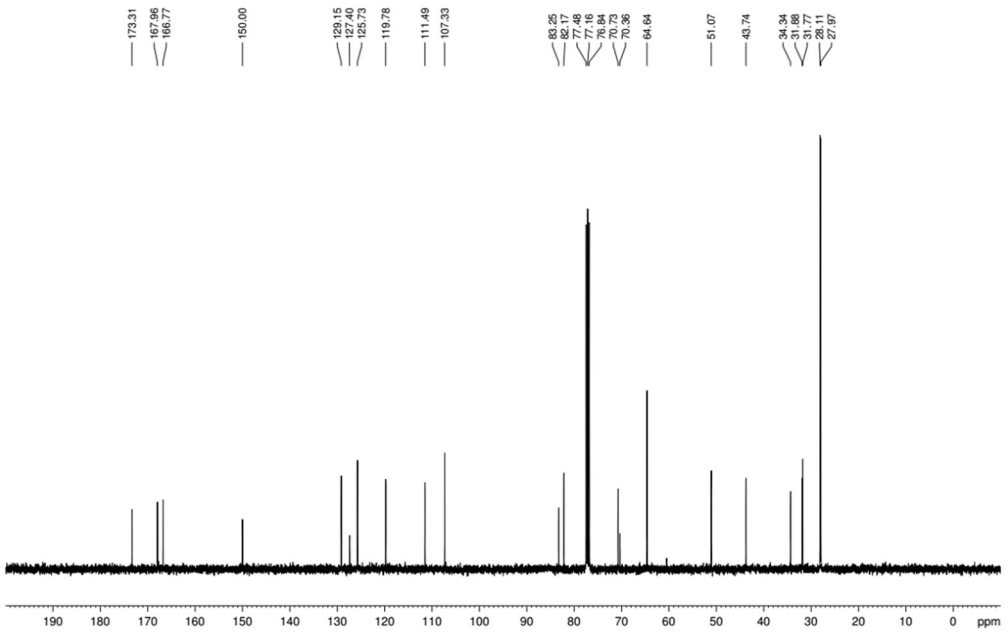

7.453
7.434
7.210
7.191
7.173
7.138
7.131
7.119
7.105
7.087
6.988
6.969
6.950
6.634
6.615
6.595
3.644
3.634
3.613
3.603
3.585
2.579
2.571
2.548
2.526
2.518
2.301
2.292
2.267
2.258
2.233
2.224
2.023
2.016
1.990
1.908
1.875
1.843
1.822
1.786
1.656
1.650
1.624
1.617
1.581
1.384
1.522
1.303
tBuO2C
tBuO2C
H
H
Ph
N
H
COOMe
7f
1.00
2.04
3.41
1.05
2.01
1.05
3.07
1.04
1.17
1.05
3.09
1.00
9.03
9.15
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 ppm

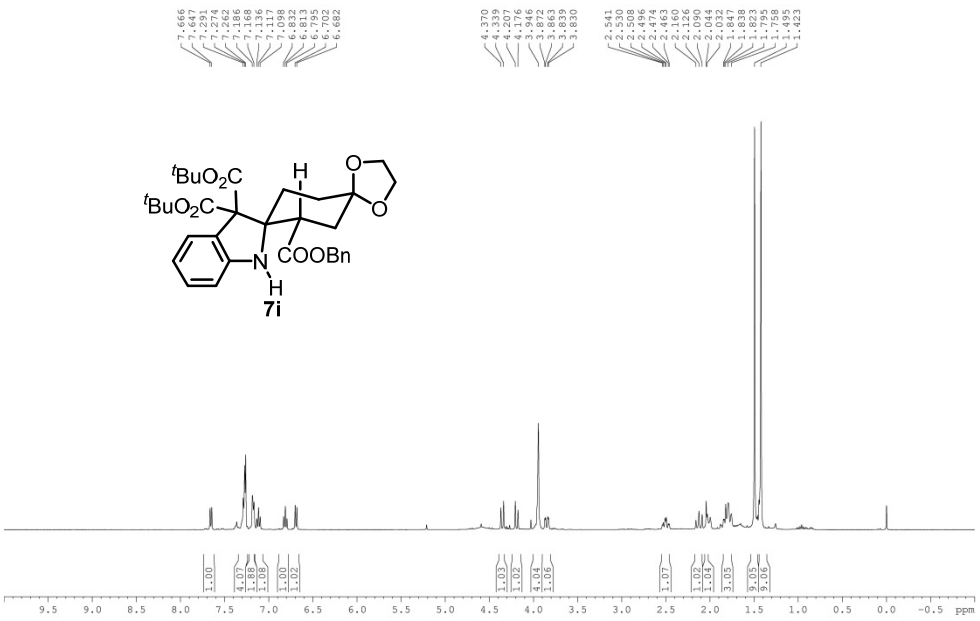

173.82
167.99
167.27
150.24
145.61
129.18
128.63
127.14
126.86
126.34
125.80
119.68
111.35
83.26
82.29
77.47
77.16
76.84
71.01
70.75
51.06
45.92
42.05
34.77
33.46
30.65
28.24
28.02
25.92
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

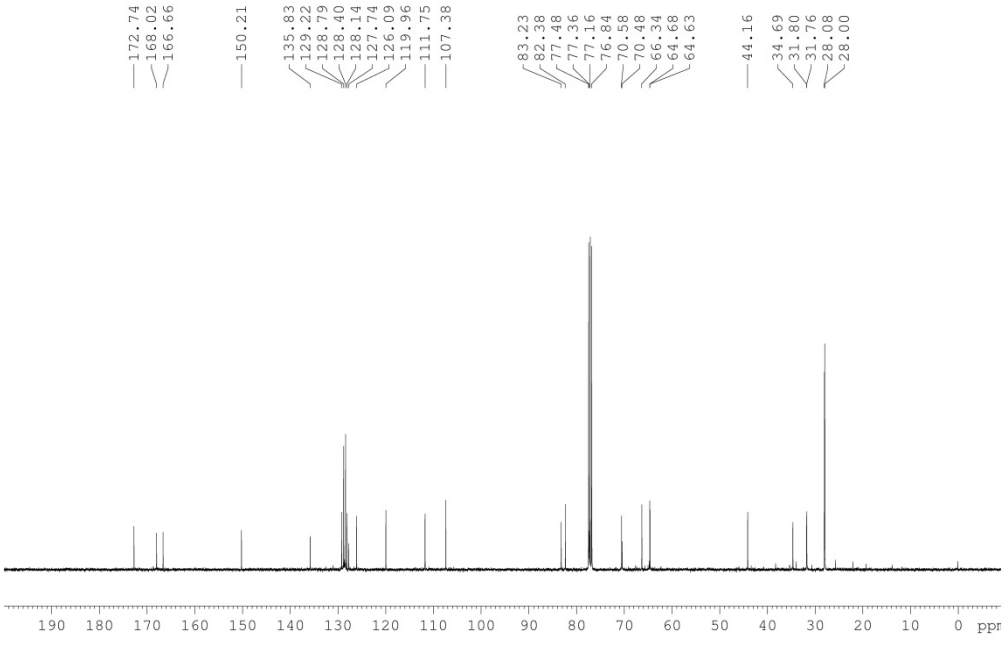

7.571
7.552
7.260
7.079
7.060
7.021
6.723
6.704
6.685
6.676
6.656
4.530
3.662
3.652
3.628
3.619
2.939
2.379
2.359
2.346
2.331
2.317
2.099
2.084
1.836
1.810
1.802
1.763
1.728
1.694
1.620
1.404
1.103
1.000
tBuO2C
tBuO2C
H
Me
Me
N
H
COOMe
7g
1.00
1.04
2.03
0.81
1.02
3.00
1.12
1.18
1.91
2.91
9.19
3.01
2.85
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 ppm

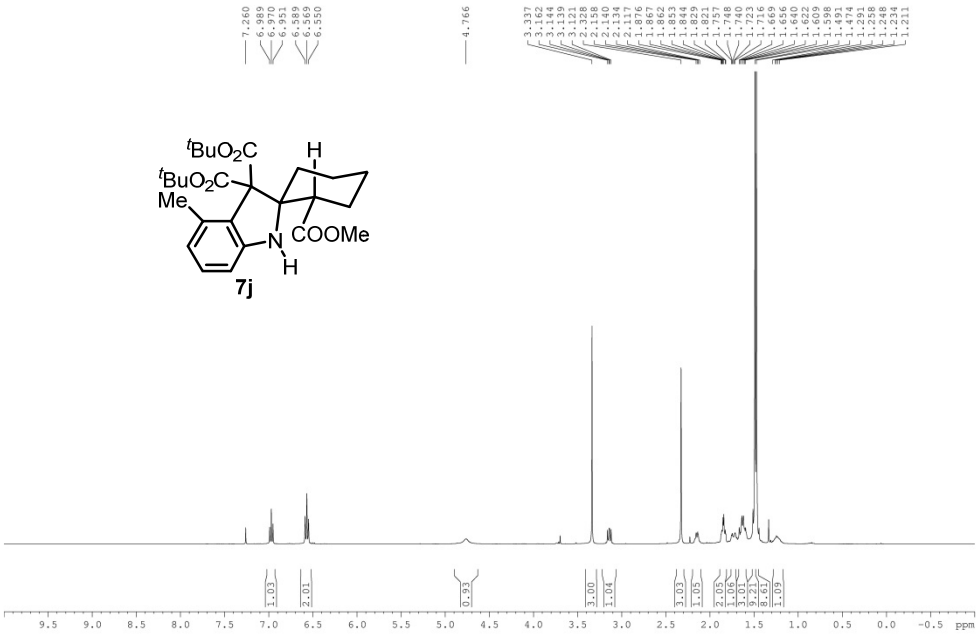

174.31
168.10
167.20
150.27
129.07
127.19
125.82
119.41
111.16
83.04
82.07
77.48
77.16
76.84
71.30
70.79
50.92
41.97
38.89
35.81
32.35
30.43
29.47
28.24
27.99
24.17
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

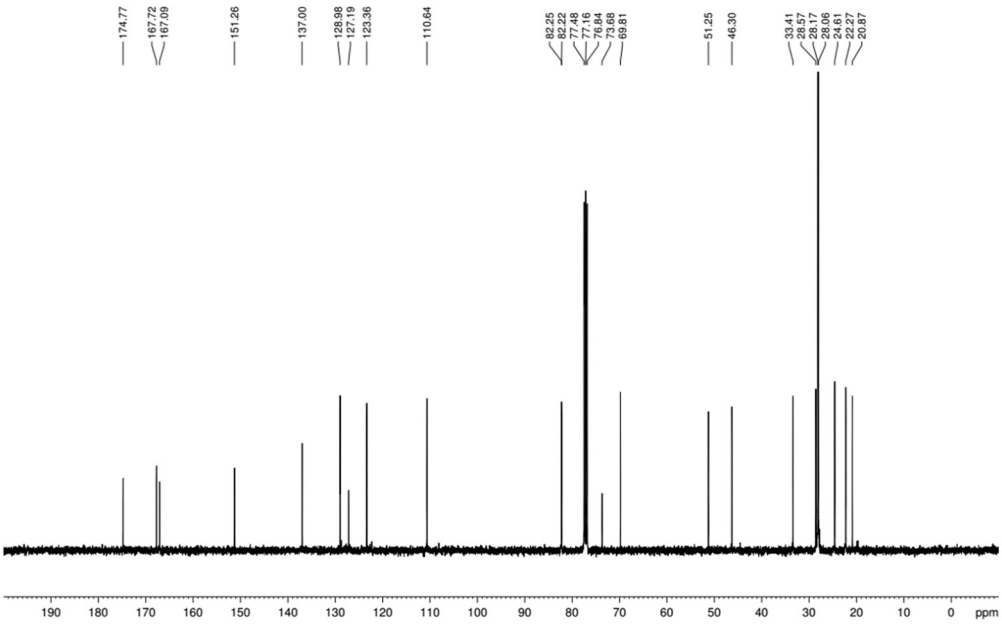

7.581
7.562
7.260
7.091
7.072
7.053
6.748
6.730
6.711
6.699
6.679
3.952
3.948
3.866
3.857
3.833
3.823
2.955
2.552
2.538
2.519
2.506
2.486
2.473
2.129
2.095
2.060
2.034
2.009
2.002
1.993
1.968
1.959
1.867
1.857
1.833
1.823
1.800
1.792
1.764
1.759
1.733
1.725
1.717
1.606
1.412
tBuO2C
tBuO2C
H
O
O
COOMe
N
H
7h
1.00
1.01
2.01
4.05
1.05
2.98
1.00
1.27
1.02
3.04
9.03
9.18
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 ppm

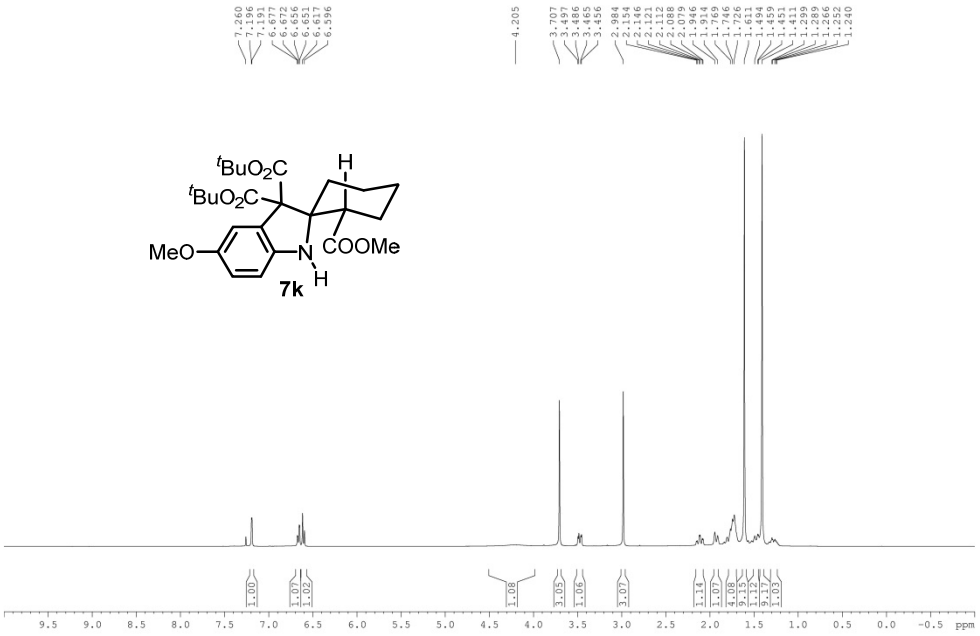

173.31
167.96
166.77
150.00
129.15
127.40
125.73
119.78
111.49
107.33
83.25
82.17
77.48
77.16
76.84
70.73
70.36
64.64
51.07
43.74
34.34
31.88
31.77
28.11
27.97
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

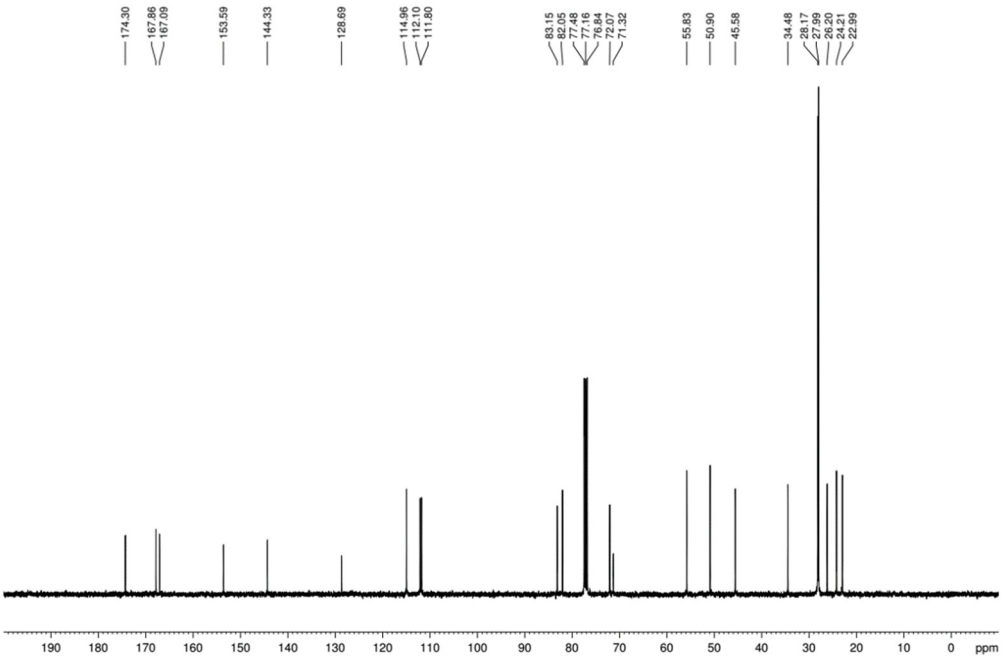

7.666
7.647
7.291
7.274
7.262
7.186
7.168
7.136
7.117
7.098
6.832
6.813
6.795
6.702
6.682
4.370
4.339
4.307
4.176
3.946
3.872
3.863
3.839
3.830
2.541
2.530
2.508
2.496
2.474
2.463
2.160
2.126
2.090
2.044
2.032
1.844
1.838
1.823
1.795
1.758
1.485
1.423
tBuO2C
tBuO2C
H
O
O
N
H
COOBn
7i
1.00
4.07
1.88
1.08
1.00
1.02
1.03
1.02
4.04
1.06
1.07
1.02
1.04
3.05
9.05
9.06
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 ppm

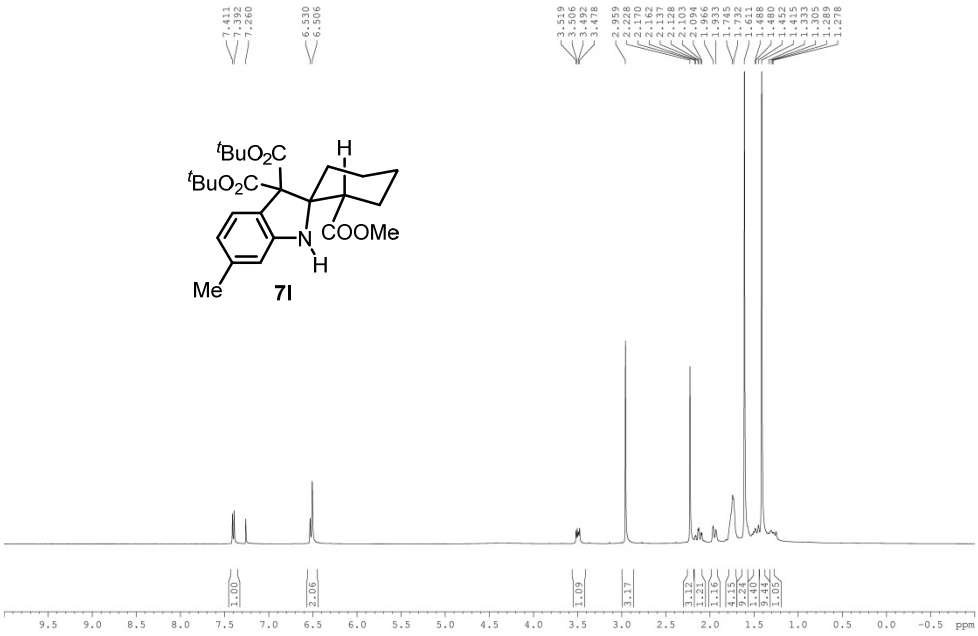

172.74
168.02
166.66
150.21
135.83
129.22
128.79
128.40
128.14
127.74
126.09
119.96
111.75
107.38
83.23
82.38
77.48
77.36
77.16
76.84
70.58
70.48
66.34
64.68
64.63
44.16
34.69
31.80
31.76
28.08
28.00
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

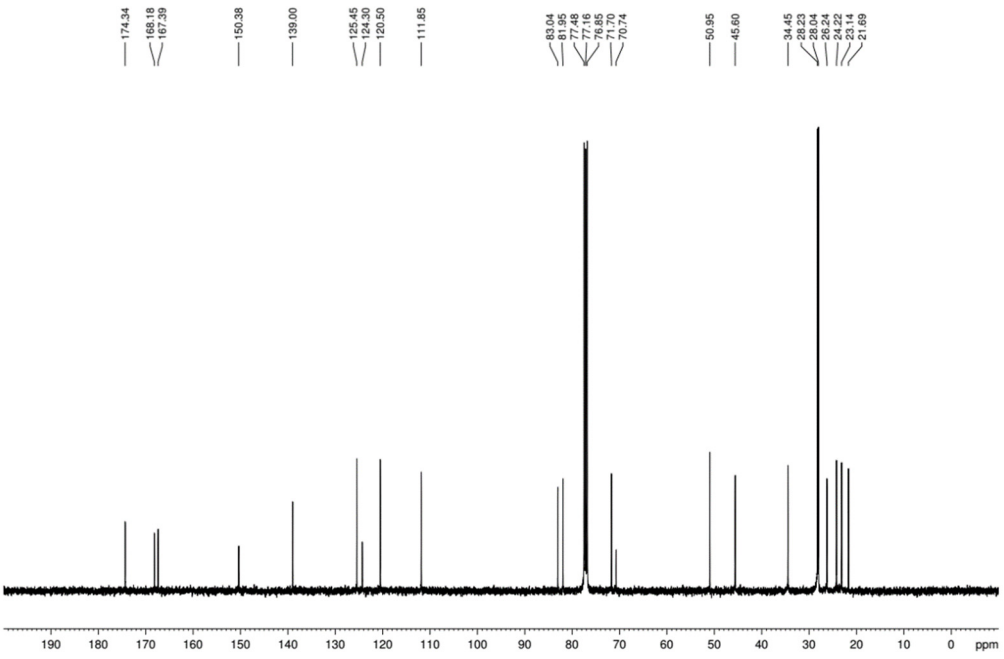

7.260
6.989
6.970
6.951
6.889
6.569
6.550
4.766
3.337
3.162
3.144
3.139
3.121
2.328
2.158
2.140
2.134
2.117
1.876
1.867
1.862
1.853
1.844
1.829
1.821
1.757
1.748
1.740
1.723
1.716
1.669
1.656
1.640
1.622
1.609
1.598
1.491
1.474
1.291
1.258
1.248
1.234
1.211
tBuO2C
tBuO2C
Me
H
N
H
COOMe
7j
1.03
2.01
0.93
3.00
1.04
3.03
1.05
2.05
1.06
9.21
8.61
1.09
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 ppm

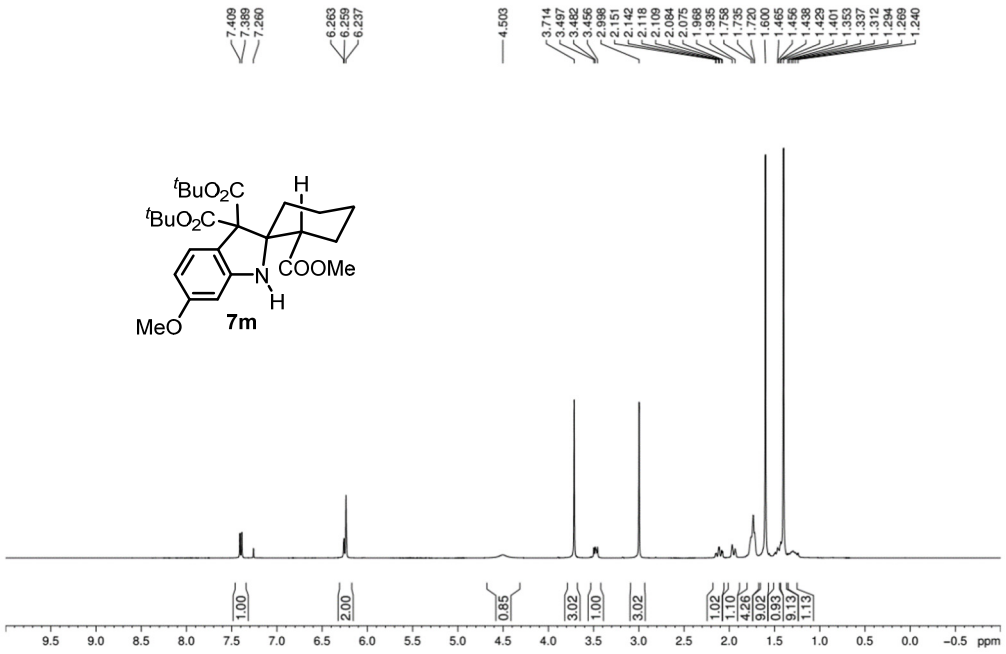

174.77
167.72
167.09
151.26
137.00
128.98
127.19
123.36
110.64
82.25
80.23
77.48
77.16
76.84
73.68
69.81
51.25
46.30
33.41
28.57
28.17
28.06
24.61
22.27
20.87
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

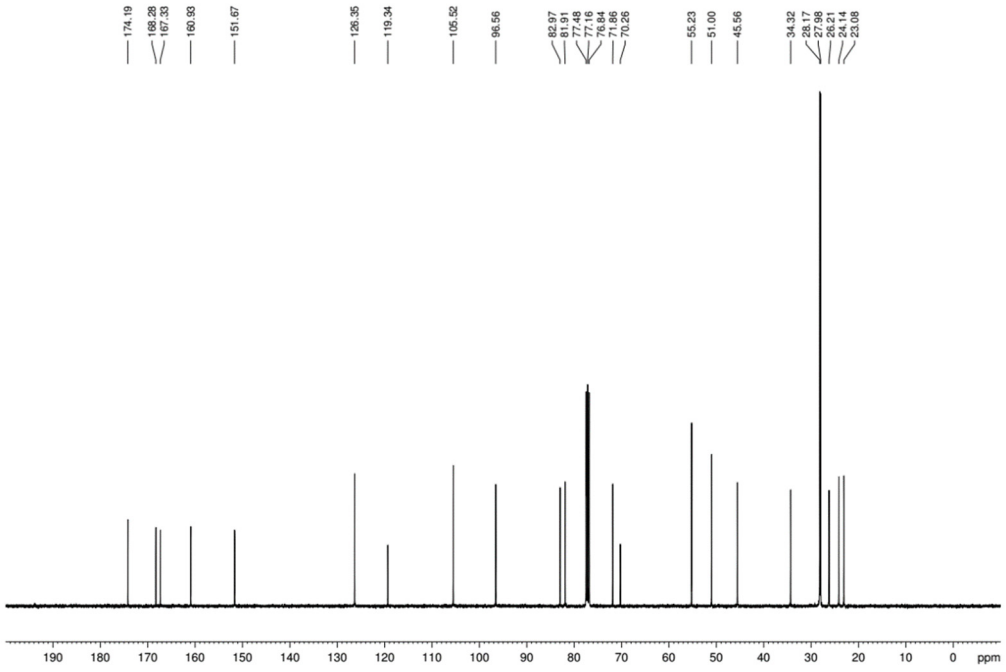

7.260
7.196
7.191
6.677
6.672
6.656
6.651
6.617
6.596
4.205
3.707
3.497
3.486
3.465
3.456
2.984
2.154
2.146
2.121
2.112
2.088
2.079
1.946
1.914
1.908
1.746
1.726
1.611
1.494
1.459
1.451
1.411
1.299
1.289
1.266
1.252
1.240
tBuO2C
tBuO2C
H
MeO
N
H
COOMe
7k
1.00
1.07
1.02
1.08
3.05
1.06
3.07
1.14
1.07
4.08
3.15
3.12
9.17
1.03
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 ppm

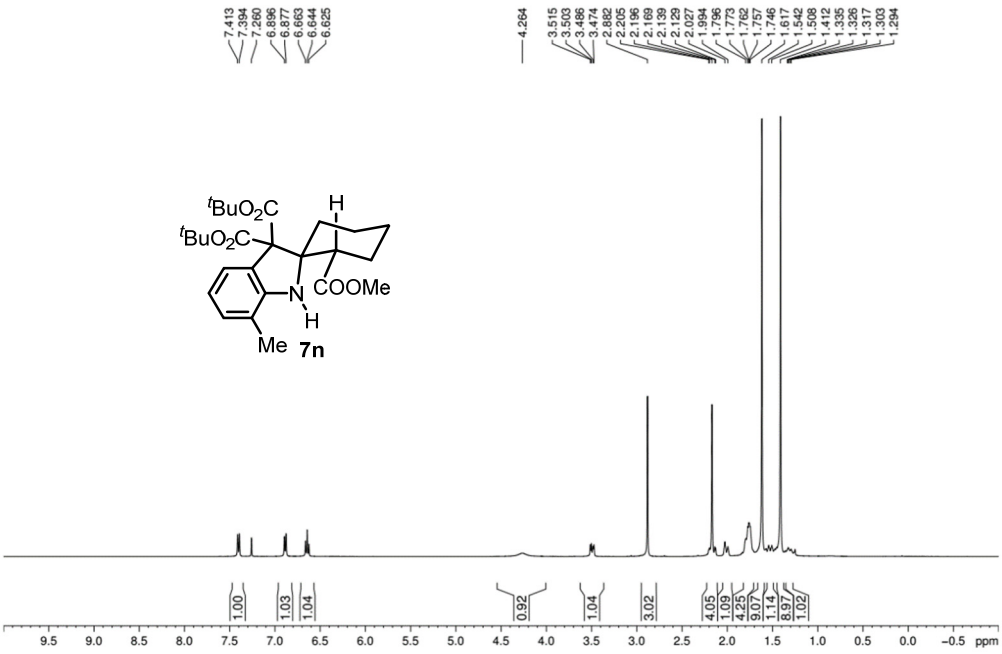

174.30
167.86
167.09
153.59
144.33
128.69
114.96
112.10
111.80
83.15
82.35
77.48
77.16
76.84
72.07
71.32
55.83
50.90
45.58
34.48
28.17
27.99
26.20
24.21
22.99
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

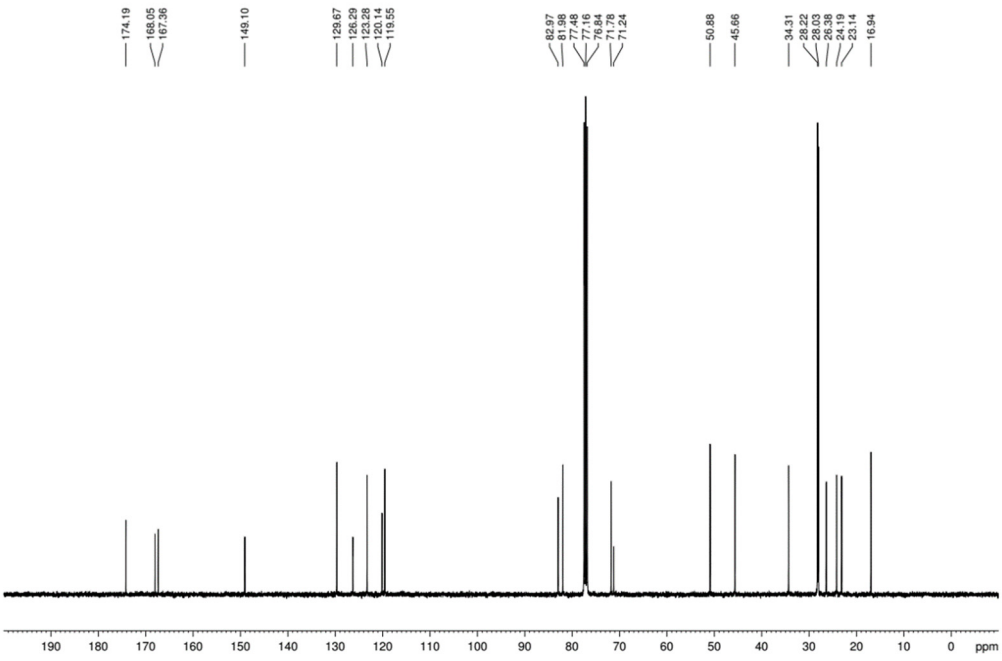

7.411
7.392
7.260
6.530
6.506
3.519
3.506
3.492
3.478
2.959
2.228
2.170
2.162
2.137
2.128
2.103
2.094
1.966
1.933
1.745
1.732
1.611
1.488
1.480
1.452
1.415
1.333
1.305
1.289
1.278
tBuO2C
tBuO2C
H
N
H
COOMe
Me
7l
1.00
2.06
1.09
3.17
3.12
1.21
1.16
4.25
4.24
1.40
9.44
1.05
ppm

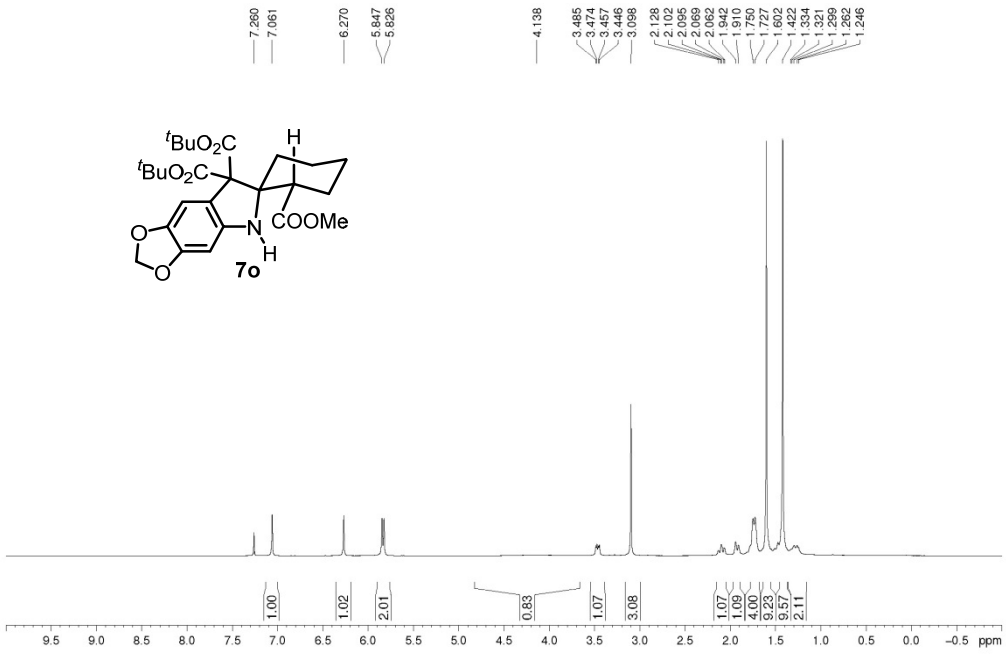

174.34
168.18
167.39
150.38
139.00
125.45
124.90
120.50
111.85
83.04
81.55
77.48
77.16
76.85
71.70
70.74
50.95
45.60
34.45
28.23
28.04
26.24
24.22
23.14
21.69
ppm

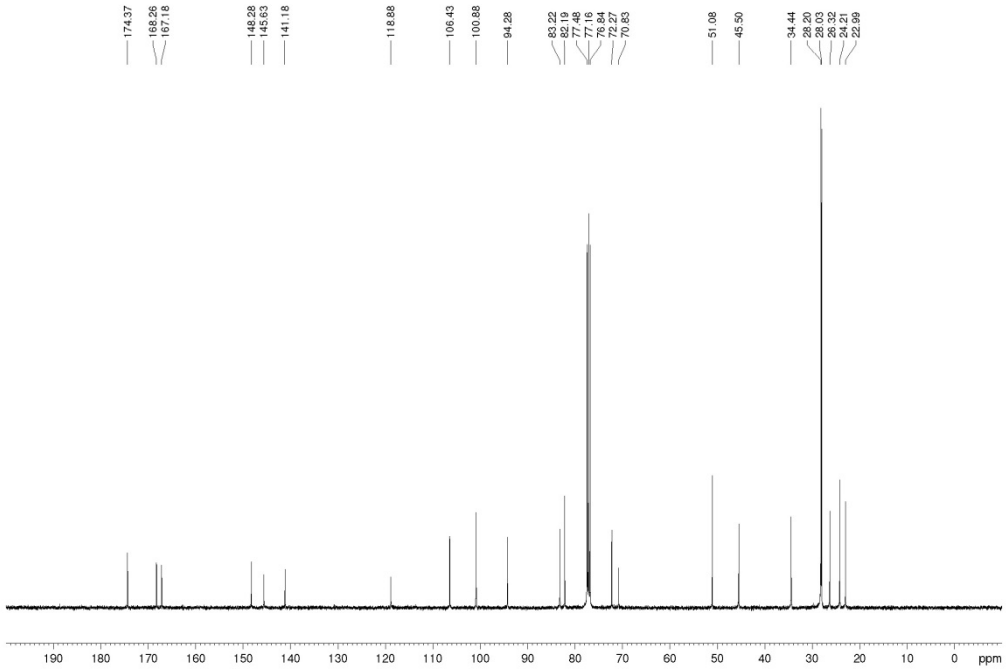

7.409
7.389
7.260
6.263
6.259
6.237
4.503
3.714
3.497
3.482
3.456
2.998
2.151
2.142
2.118
2.109
2.084
2.075
1.968
1.935
1.758
1.735
1.720
1.600
1.465
1.456
1.438
1.429
1.401
1.353
1.337
1.312
1.294
1.269
1.240
tBuO2C
tBuO2C
H
N
H
COOMe
MeO
7m
1.00
2.00
0.85
3.02
1.00
3.02
1.02
1.10
4.26
9.02
0.93
9.13
1.13
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 ppm

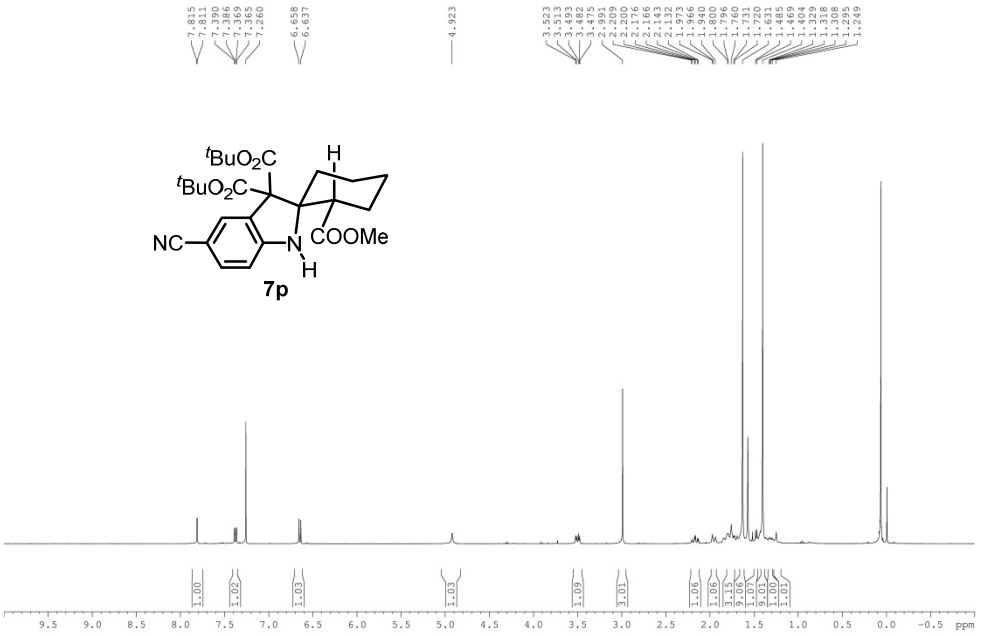

174.19
168.28
167.33
160.93
151.67
126.35
119.34
105.52
96.56
82.97
81.91
77.48
77.16
76.84
71.86
70.26
55.23
51.00
45.56
34.32
28.17
27.98
26.21
24.14
23.08
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

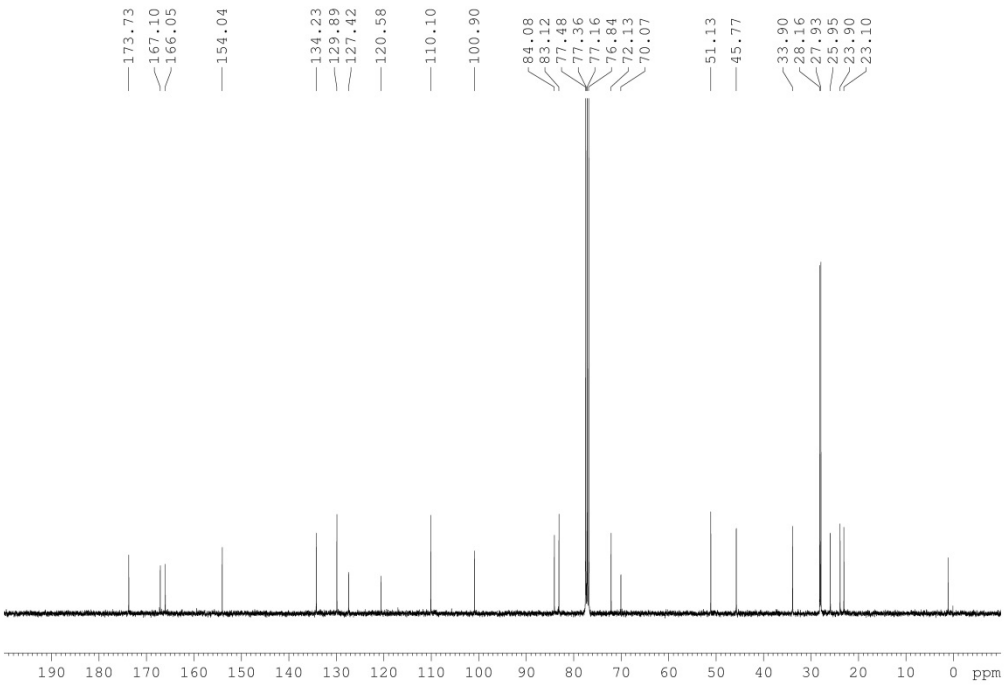

7.413
7.394
7.260
6.896
6.877
6.663
6.644
6.625
4.264
3.515
3.503
3.486
3.474
2.882
2.205
2.196
2.169
2.139
2.129
2.027
1.994
1.796
1.773
1.762
1.757
1.746
1.617
1.542
1.508
1.412
1.335
1.326
1.317
1.303
1.294
tBuO2C
tBuO2C
H
N
H
COOMe
Me
7n
1.00
1.03
1.04
0.92
1.04
3.02
4.05
1.09
4.25
9.07
1.14
8.97
1.02
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 ppm

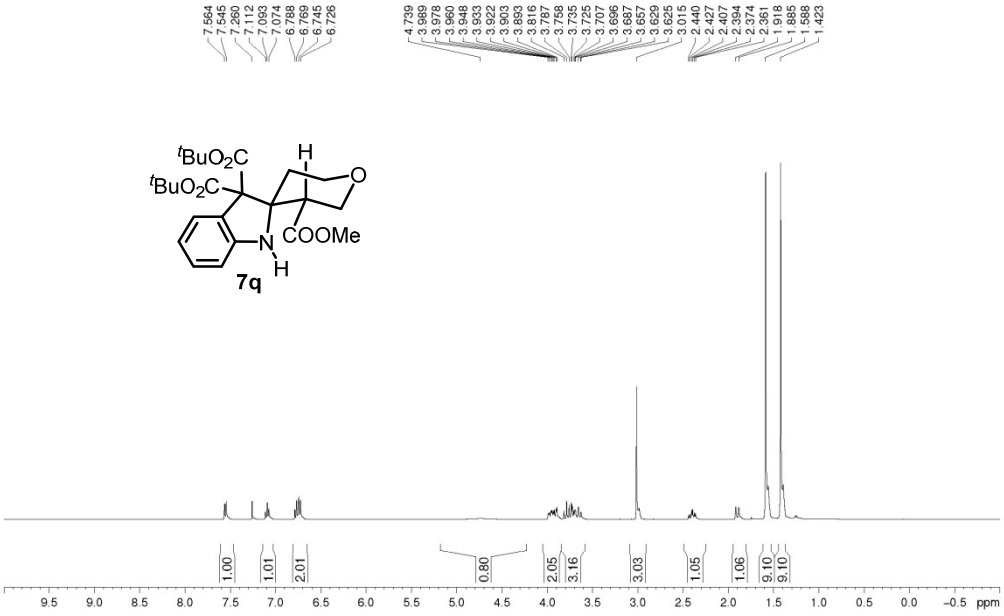

174.19
168.05
167.36
149.10
129.67
128.29
123.28
120.14
119.55
82.97
81.88
77.48
77.16
76.84
71.78
71.24
50.88
45.66
34.31
28.22
28.03
26.38
24.19
23.14
16.94
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

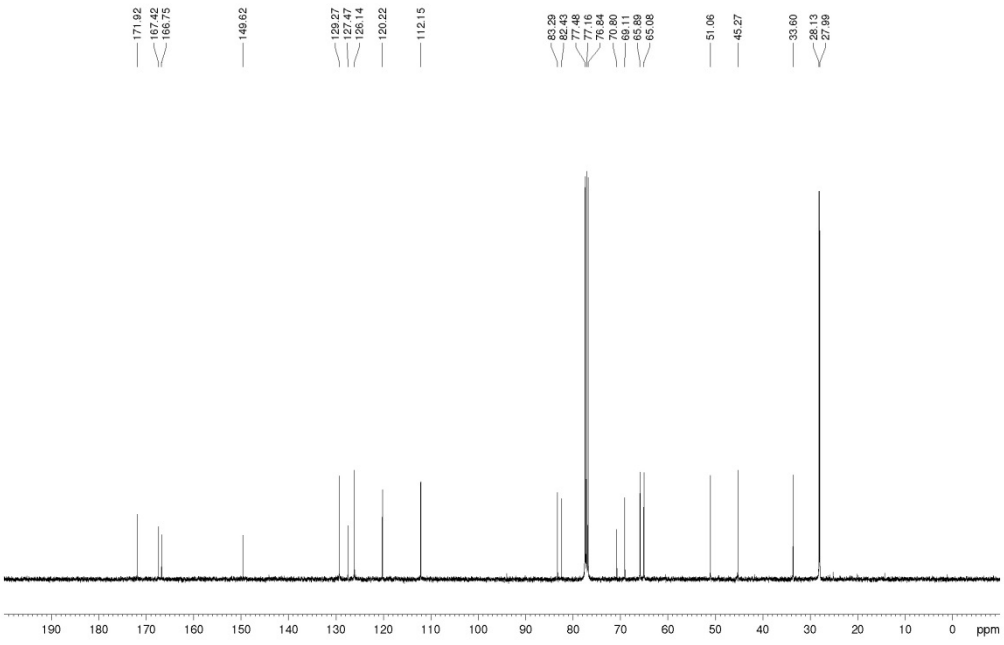

7.260
7.061
6.270
5.847
5.826
4.138
3.485
3.474
3.457
3.446
3.098
2.128
2.102
2.095
2.069
2.062
1.942
1.910
1.750
1.727
1.602
1.422
1.334
1.321
1.299
1.262
1.246
tBuO2C
tBuO2C
H
COOMe
N
H
O
O
O
7o
1.00
1.02
2.01
0.83
1.07
3.08
1.07
1.09
4.00
9.23
9.57
2.11
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5 ppm

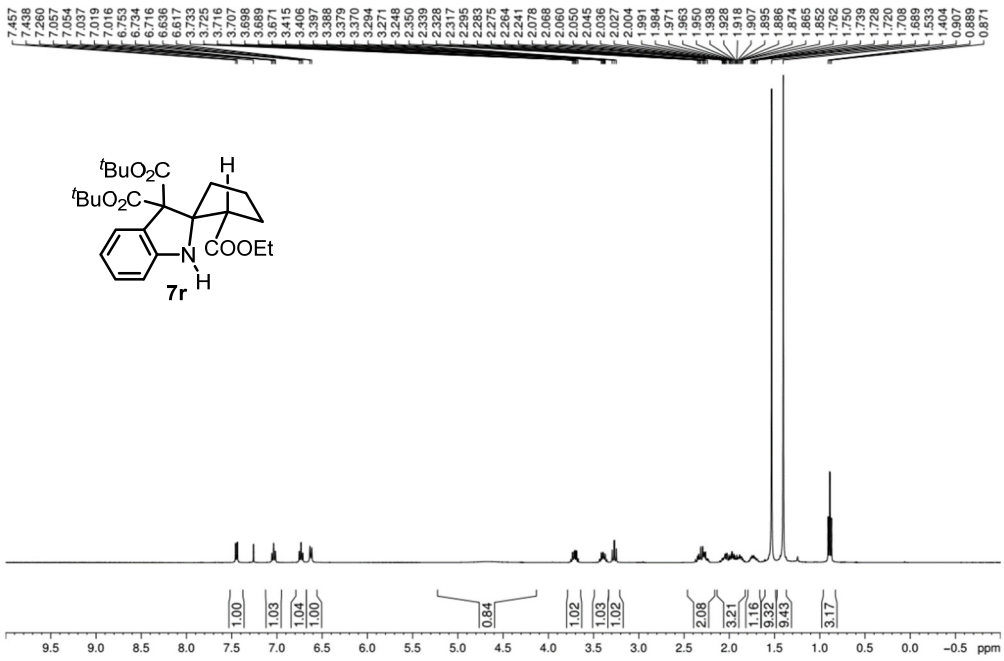

174.37
168.26
167.18
148.28
145.63
141.18
118.88
106.43
100.88
94.28
83.22
82.19
77.48
77.16
76.84
72.27
70.83
51.08
45.50
34.44
28.20
28.03
26.32
24.21
23.69
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

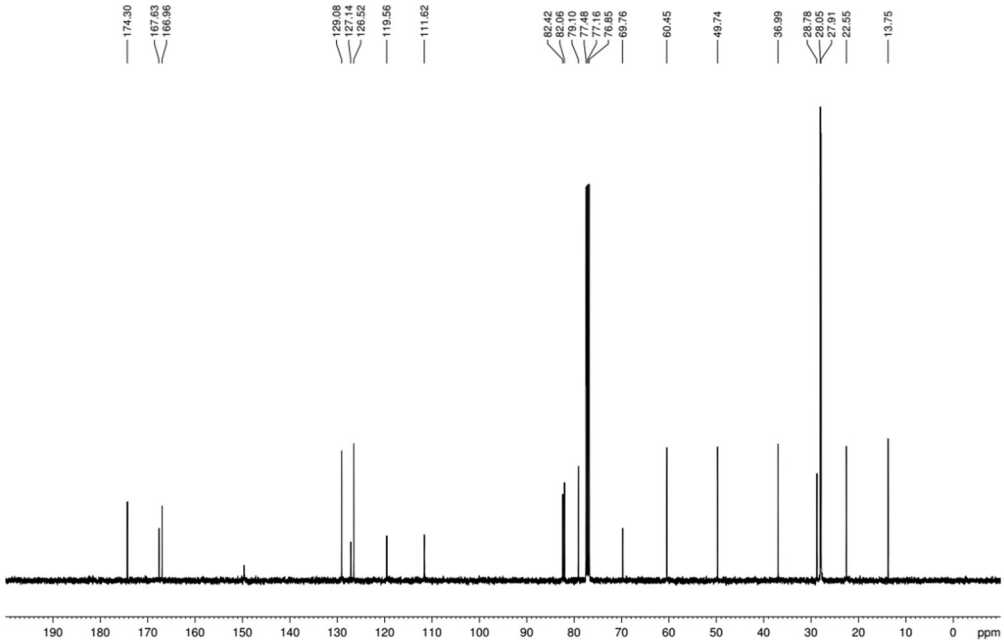

7.815
7.811
7.390
7.386
7.369
7.365
7.260
6.658
6.637
4.923
3.523
3.513
3.493
3.482
3.475
3.391
2.209
2.200
2.176
2.166
2.145
2.132
1.973
1.966
1.840
1.800
1.796
1.760
1.731
1.720
1.631
1.485
1.469
1.404
1.329
1.318
1.308
1.295
1.249
tBuO2C
tBuO2C
H
NC
N
H
COOMe
7p
1.00
1.02
1.03
1.03
1.09
3.01
1.06
1.06
3.15
9.06
1.07
9.01
1.00
1.01
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 ppm

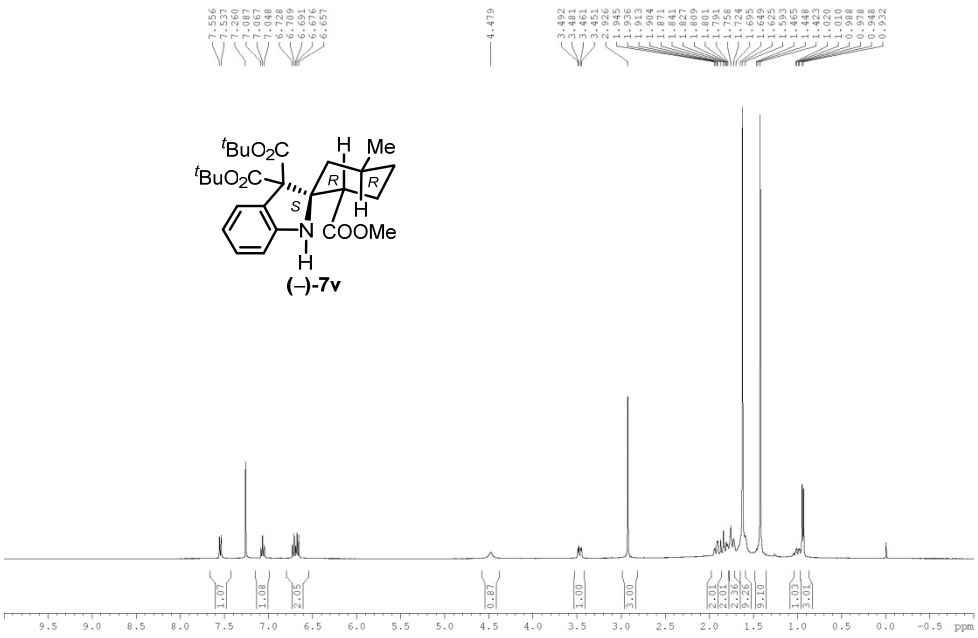

173.73
167.10
166.05
154.04
134.23
129.89
127.42
120.58
110.10
100.90
84.08
83.12
77.48
77.36
77.16
76.84
72.13
70.07
51.13
45.77
33.90
28.16
27.93
25.95
23.90
23.10
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

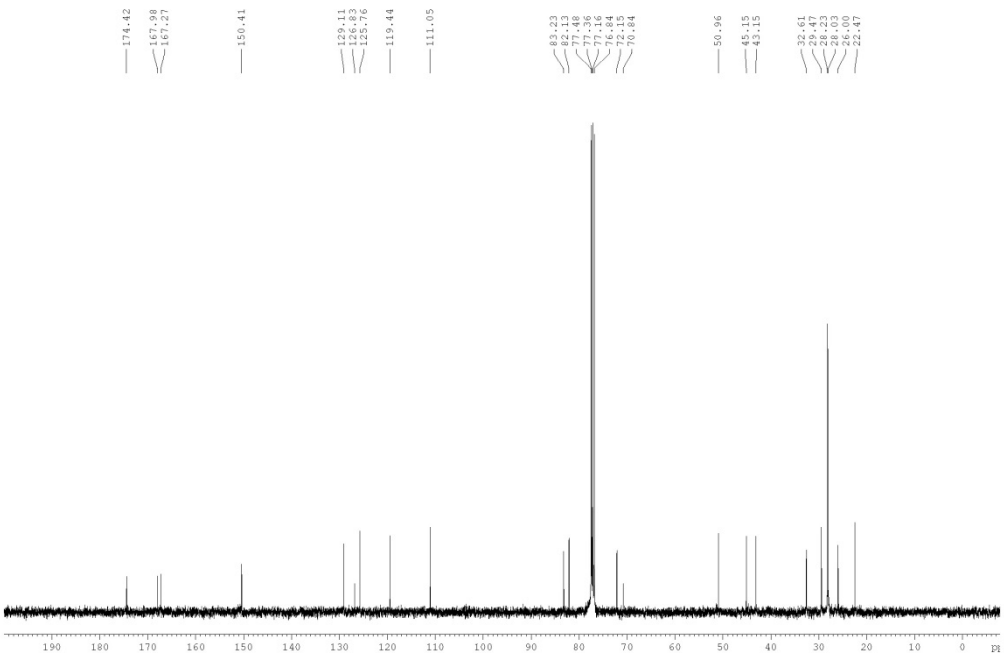

7.564
7.545
7.260
7.112
7.093
7.074
6.788
6.769
6.745
6.726
4.739
3.989
3.978
3.960
3.948
3.933
3.922
3.903
3.893
3.816
3.787
3.758
3.735
3.725
3.707
3.696
3.687
3.657
3.629
3.625
3.015
2.440
2.427
2.407
2.394
2.374
2.361
1.918
1.885
1.588
1.423
tBuO2C
tBuO2C
H
O
N
H
COOMe
7q
1.00
1.01
2.01
0.80
2.05
3.16
3.03
1.05
1.06
9.10
9.10
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 ppm

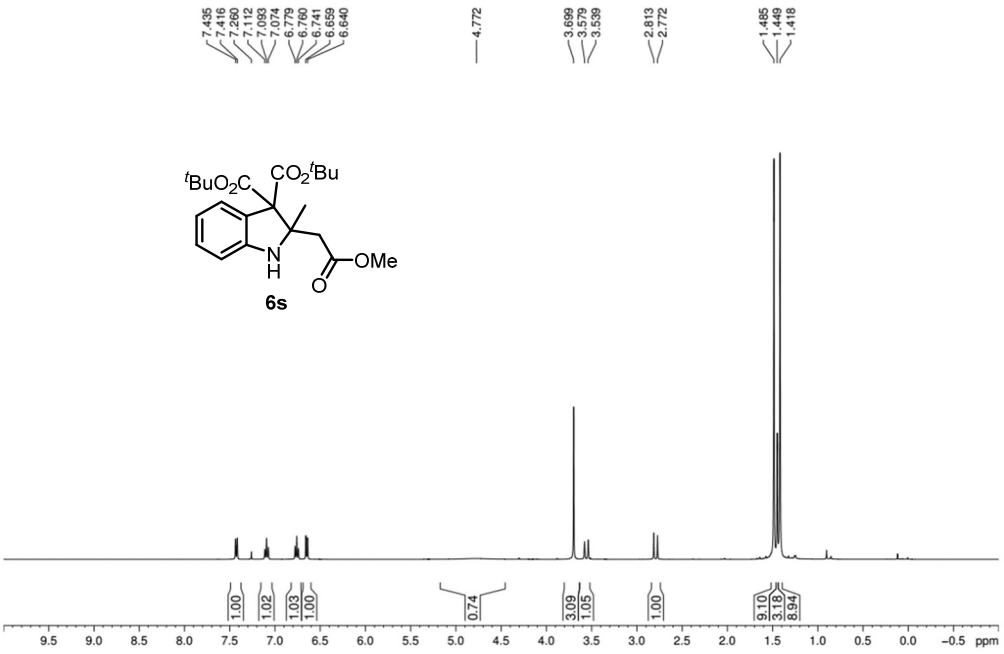

171.92
167.42
166.75
149.62
129.27
127.47
126.14
120.22
112.15
83.29
82.43
77.48
77.16
76.84
70.80
69.11
65.89
65.08
51.06
45.27
33.60
28.13
27.99
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

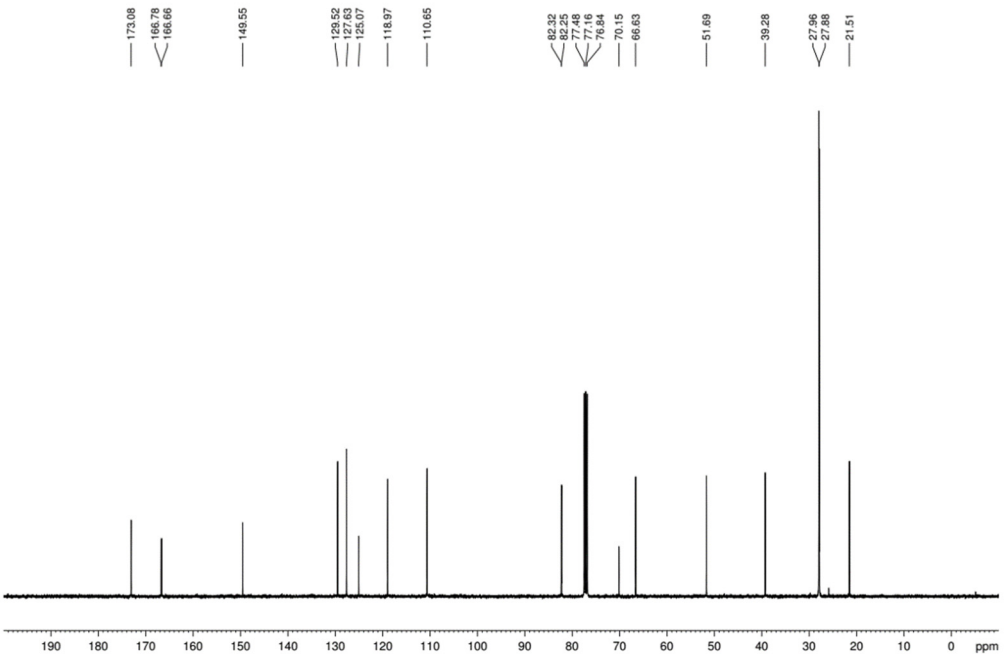

7.457
7.438
7.260
7.057
7.054
7.037
7.019
7.016
6.753
6.734
6.716
6.636
6.617
3.733
3.725
3.716
3.707
3.698
3.689
3.671
3.415
3.406
3.397
3.388
3.379
3.370
3.294
3.271
3.248
2.350
2.339
2.328
2.317
2.295
2.283
2.275
2.264
2.241
2.078
2.068
2.060
2.050
2.045
2.036
2.027
2.004
1.991
1.984
1.971
1.963
1.950
1.938
1.928
1.918
1.907
1.895
1.886
1.874
1.865
1.852
1.762
1.750
1.739
1.728
1.720
1.708
1.689
1.533
1.404
0.907
0.899
0.871
tBuO2C
tBuO2C
H
N
H
COOEt
7r
1.00
1.03
1.04
1.00
0.84
1.02
1.03
1.02
2.08
3.21
1.16
9.32
9.43
3.17
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 ppm

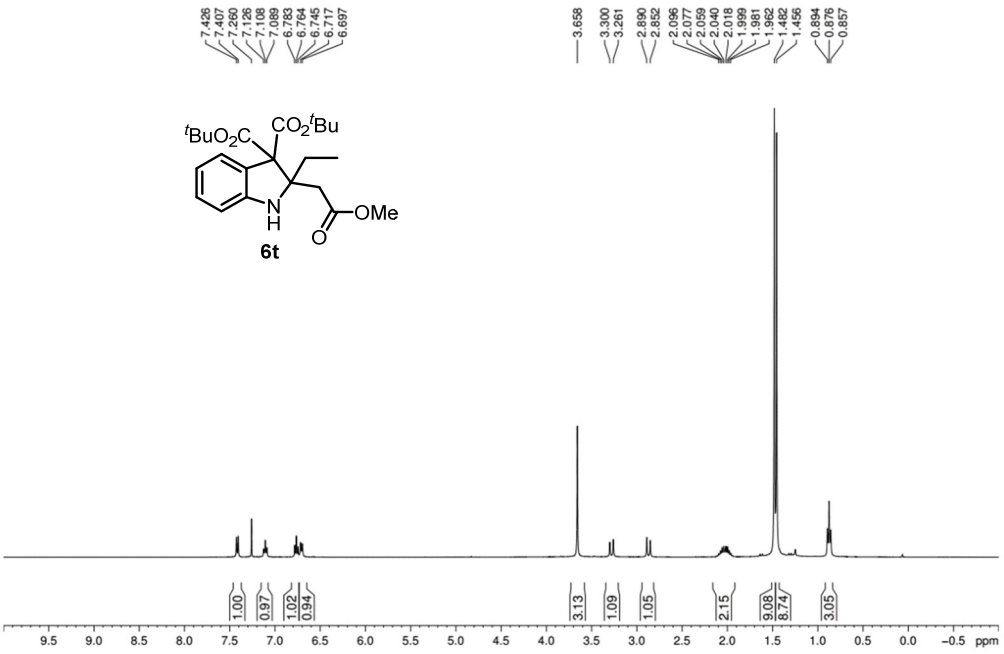

174.30
167.63
166.96
129.08
127.14
126.52
119.56
111.62
82.42
82.06
79.10
77.48
77.16
76.85
69.76
60.45
49.74
36.99
28.78
28.05
27.91
22.55
13.75
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

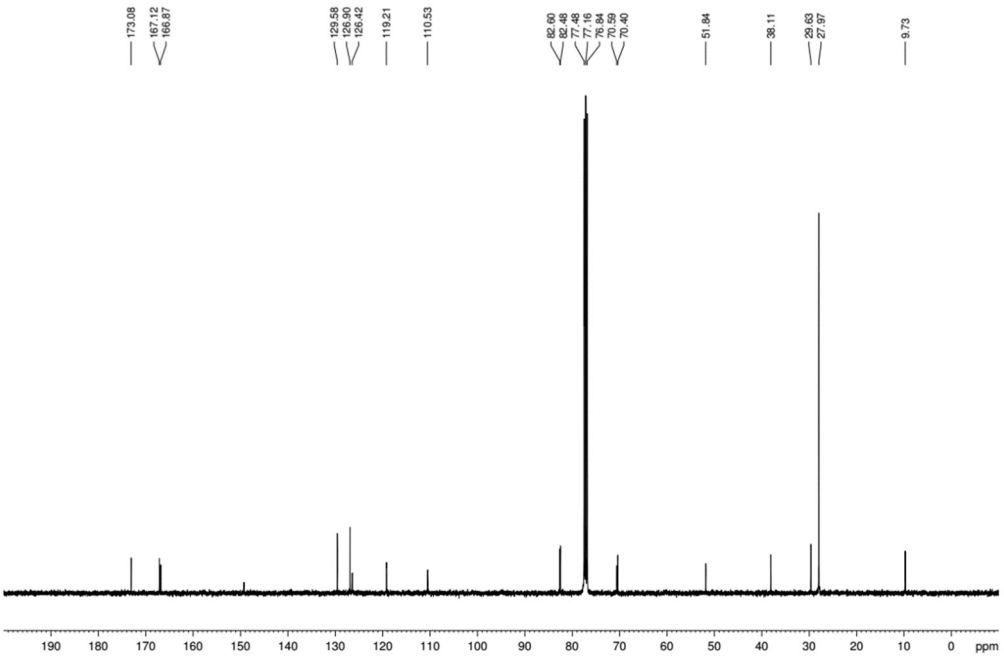

7.556
7.537
7.260
7.087
7.067
7.048
6.728
6.709
6.691
6.676
6.657
4.479
3.492
3.481
3.461
3.451
2.926
2.905
1.936
1.913
1.904
1.871
1.841
1.827
1.809
1.801
1.791
1.758
1.724
1.695
1.649
1.625
1.593
1.465
1.448
1.423
1.020
1.010
0.988
0.978
0.948
0.932
tBuO2C
tBuO2C
H
Me
R
R
S
H
N
COOMe
H
(–)-7v
1.07
1.08
2.05
0.87
1.00
3.00
2.01
2.01
2.36
9.26
9.10
1.03
3.01
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 ppm

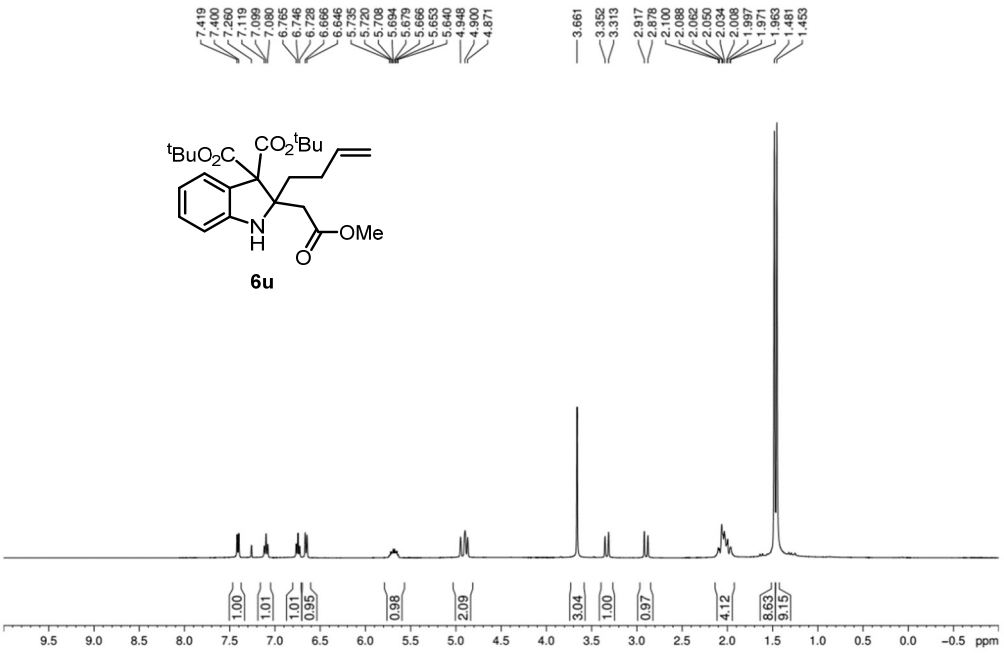

174.42
167.98
167.27
150.41
129.11
128.83
125.76
119.44
111.05
83.23
82.13
81.48
77.36
77.16
76.84
72.15
70.84
50.96
45.15
43.15
32.61
29.47
28.23
28.03
26.00
22.47
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

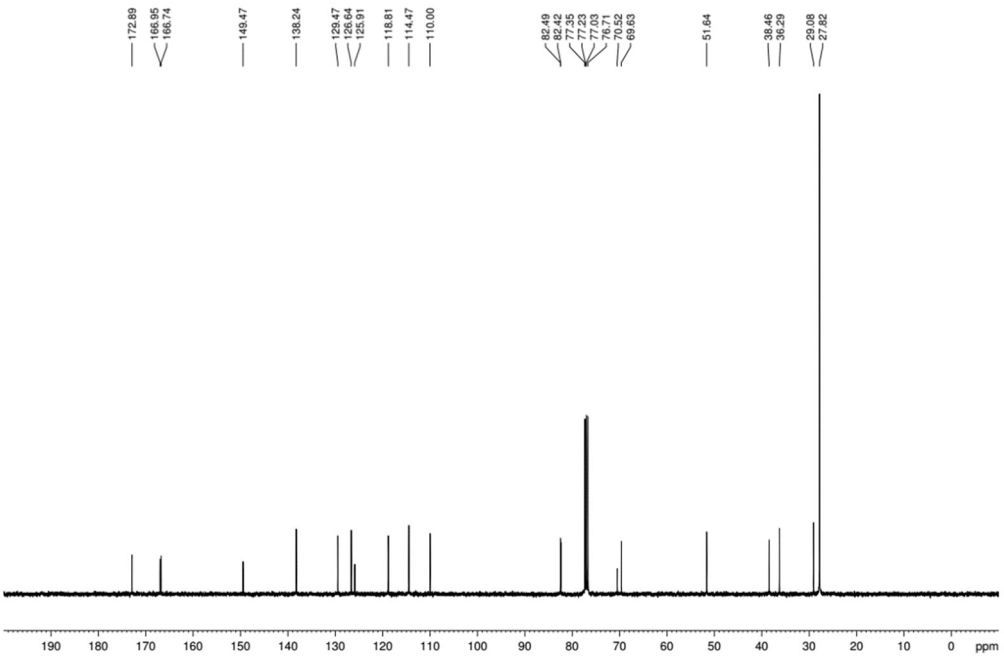

7.435
7.416
7.260
7.112
7.093
7.074
6.779
6.760
6.741
6.659
6.640
4.772
3.699
3.579
3.539
2.813
2.772
1.485
1.449
1.418
tBuO2C
CO2tBu
N
H
OMe
O
6s
1.00
1.02
1.03
1.00
0.74
3.09
1.05
1.00
9.10
3.18
8.94
ppm

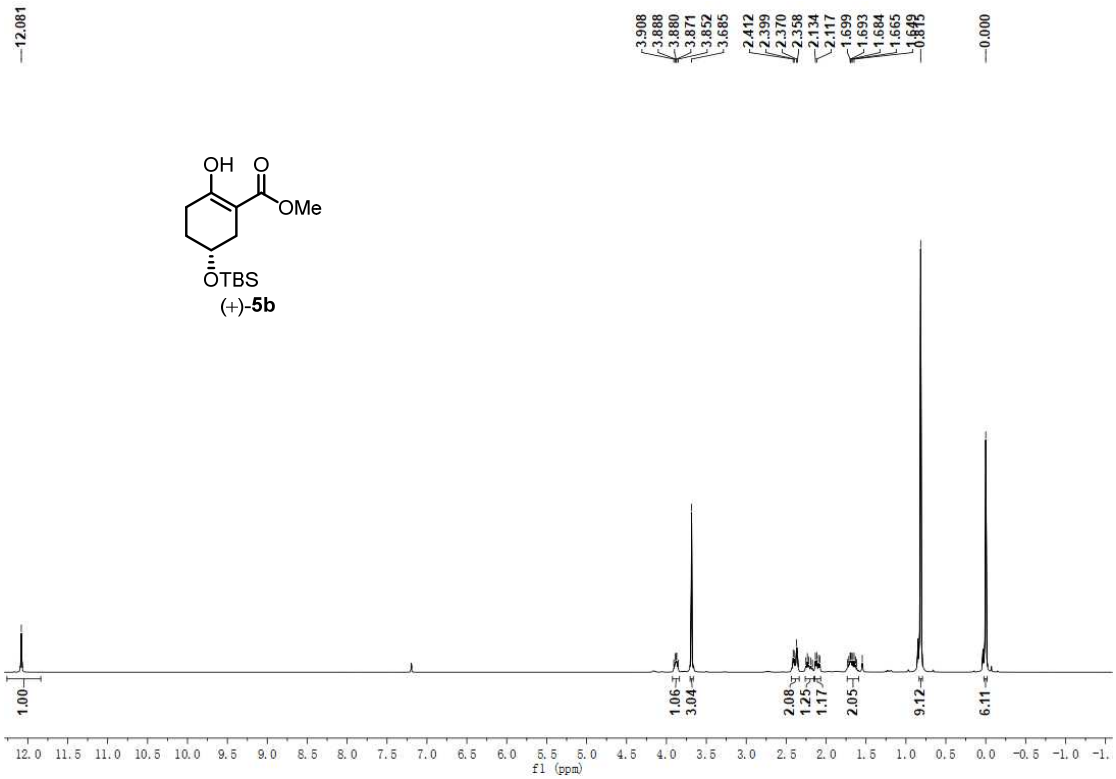

173.08
166.78
166.66
149.55
129.52
127.63
125.07
118.97
110.65
82.32
82.25
77.48
77.16
76.84
70.15
66.63
51.69
39.28
27.96
27.88
21.51
ppm


7.426
7.407
7.260
7.126
7.108
7.089
6.783
6.764
6.745
6.717
6.697
3.658
3.300
3.261
2.890
2.852
2.096
2.077
2.059
2.040
2.018
1.999
1.981
1.962
1.482
1.456
0.894
0.876
0.857
tBuO2C
CO2tBu
N
H
OMe
O
6t
1.00
0.97
1.02
0.94
3.13
1.09
1.05
2.15
9.08
8.74
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 −0.5 ppm

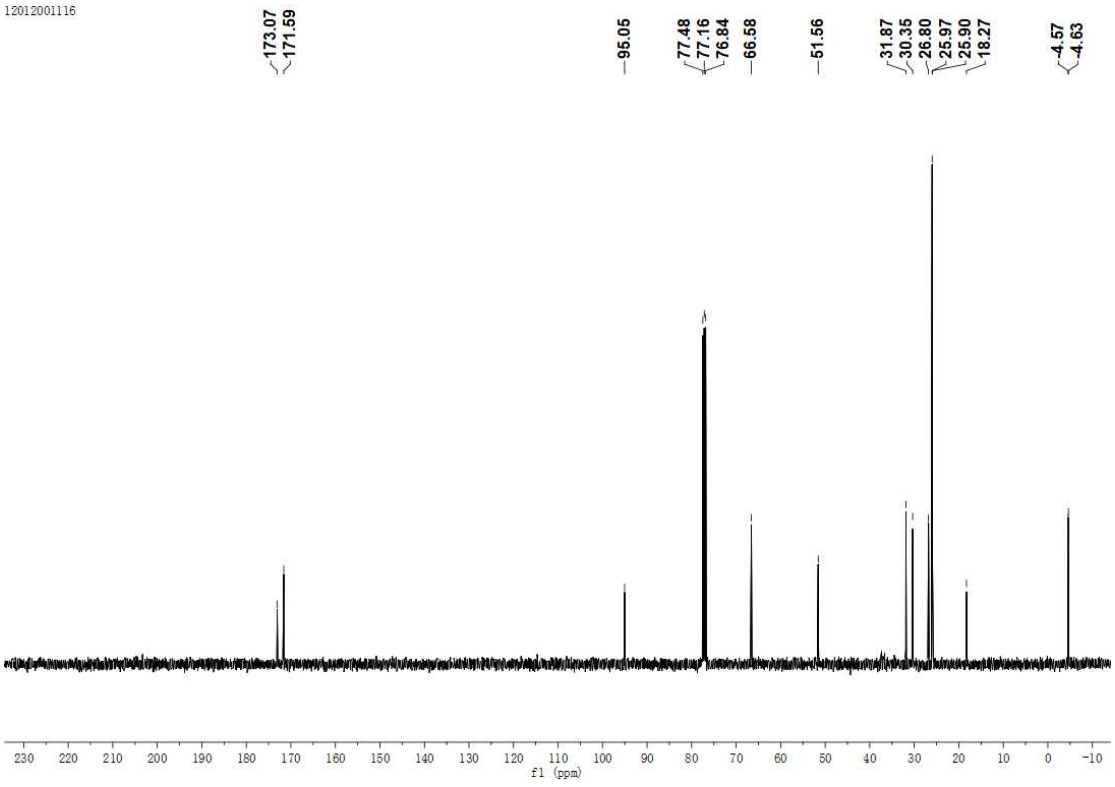

173.08
167.12
166.87
129.58
126.90
126.42
119.21
110.53
82.60
82.48
77.48
77.16
76.84
70.59
70.40
51.84
38.11
29.63
27.97
9.73
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

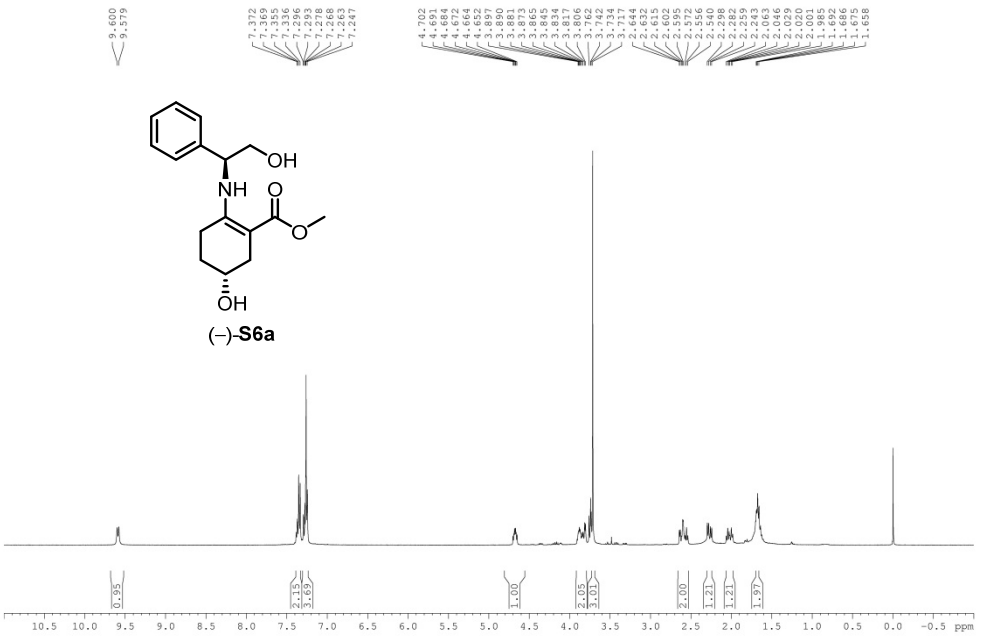

7.419
7.400
7.280
7.119
7.099
7.080
6.765
6.746
6.728
6.666
6.646
5.735
5.720
5.708
5.694
5.679
5.666
5.653
5.640
4.948
4.900
4.871
3.661
3.352
3.313
2.917
2.878
2.100
2.088
2.062
2.050
2.034
2.008
1.997
1.971
1.963
1.481
1.453
tBuO2C
CO2tBu
N
H
OMe
O
6u
1.00
1.01
1.01
0.95
0.98
2.09
3.04
1.00
0.97
4.12
8.63
9.15
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 ppm


172.89
166.95
166.74
149.47
138.24
129.47
126.64
125.91
118.81
114.47
110.00
82.49
82.42
77.35
77.23
77.03
76.71
70.52
69.83
51.64
38.46
36.29
29.08
27.82
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

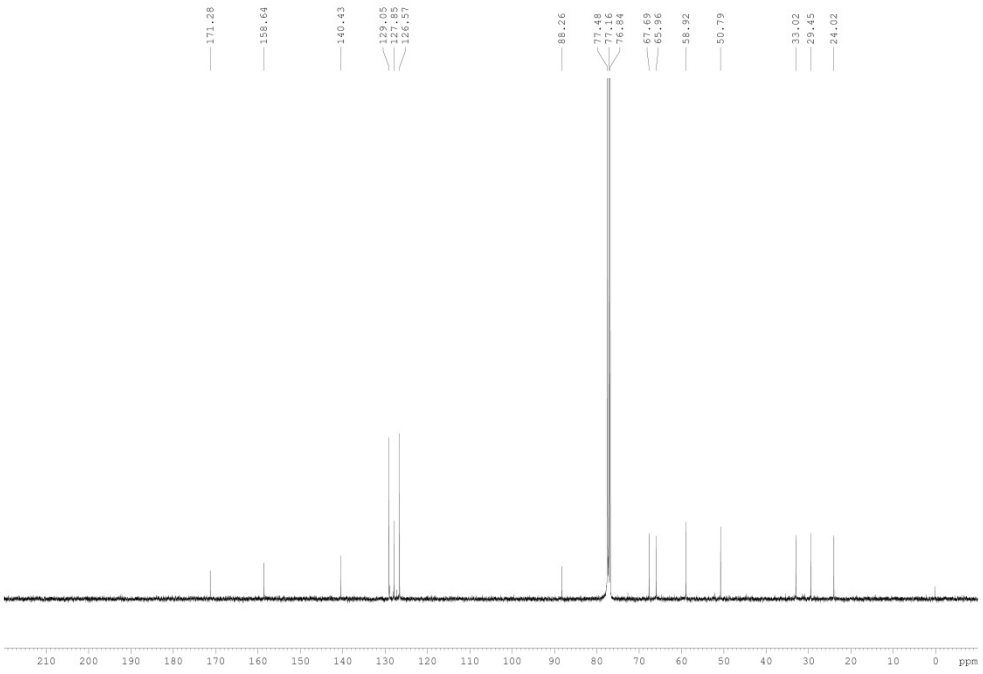

12.081
3.908
3.888
3.880
3.871
3.852
3.685
2.412
2.399
2.370
2.358
2.134
2.117
1.699
1.693
1.684
1.665
1.649
0.815
0.000
OH
O
OMe
OTBS
1.00
1.06
3.04
2.08
1.25
1.17
2.05
9.12
6.11
f1 (ppm)

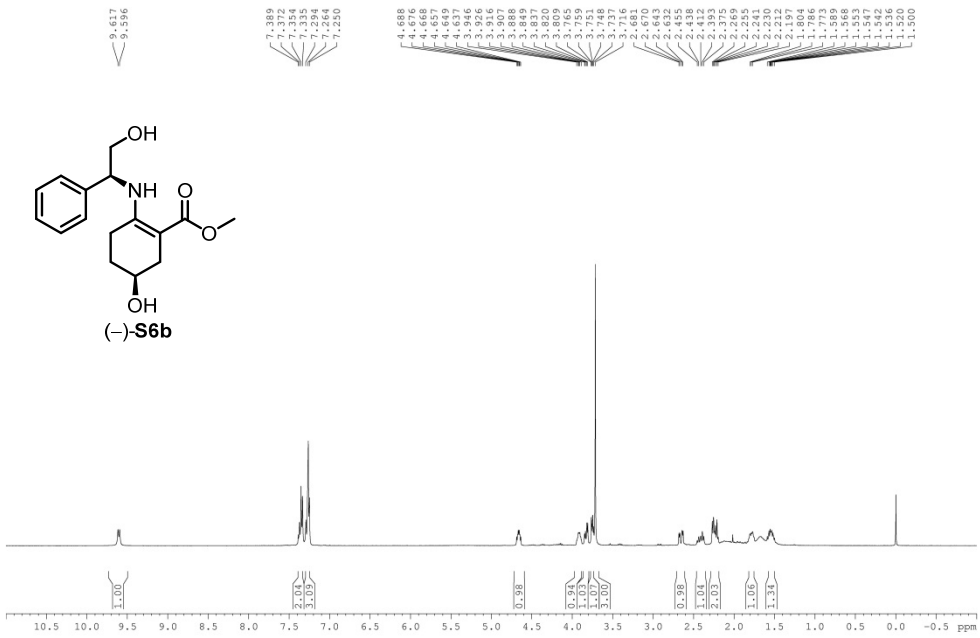
(+)-**5b**


12012001116
173.07
171.59
95.05
77.48
77.16
76.84
66.58
51.56
31.87
30.35
26.80
25.97
25.90
18.27
-4.57
-4.63
f1 (ppm)

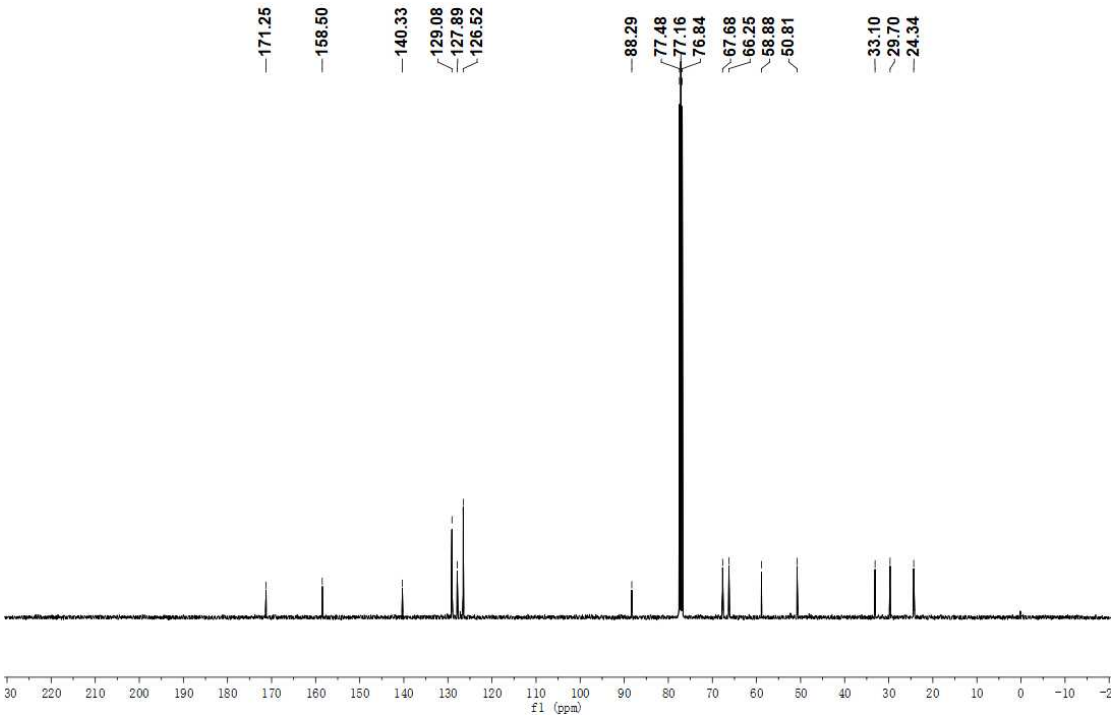

9.600
9.579
7.372
7.369
7.355
7.336
7.296
7.293
7.278
7.268
7.263
7.247
4.702
4.691
4.684
4.672
4.664
4.652
3.897
3.890
3.881
3.873
3.865
3.845
3.834
3.817
3.806
3.762
3.742
3.734
3.717
2.644
2.632
2.615
2.602
2.595
2.572
2.556
2.540
2.298
2.282
2.259
2.243
2.063
2.046
2.029
2.020
2.001
1.985
1.692
1.686
1.675
1.658
OH
NH
O
O
OH
0.95
2.15
3.69
1.00
2.05
3.01
2.00
1.21
1.21
1.97
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 -0.5 ppm

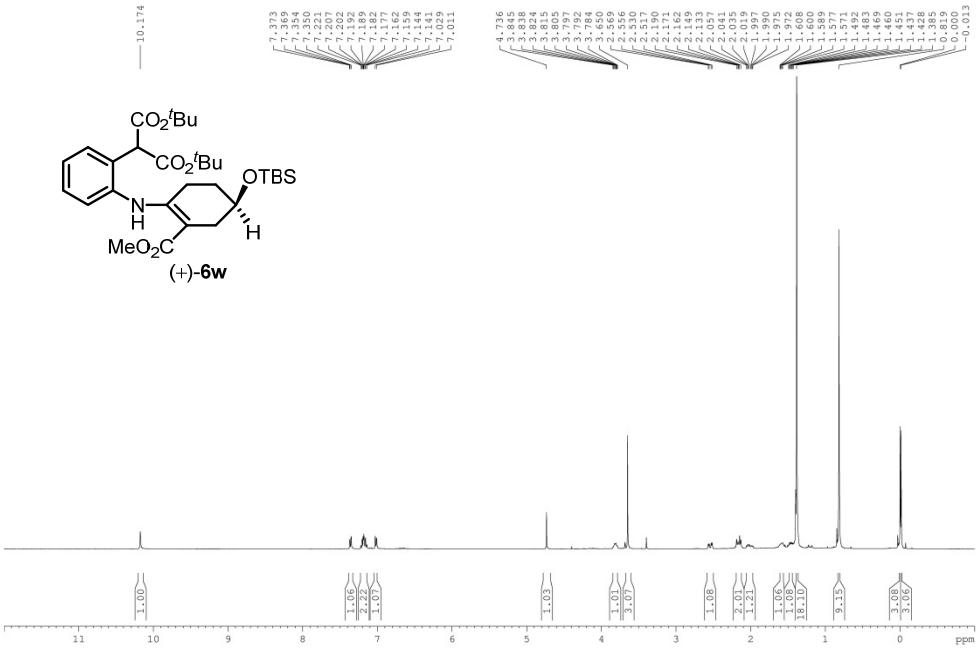
(–)-**S6a**

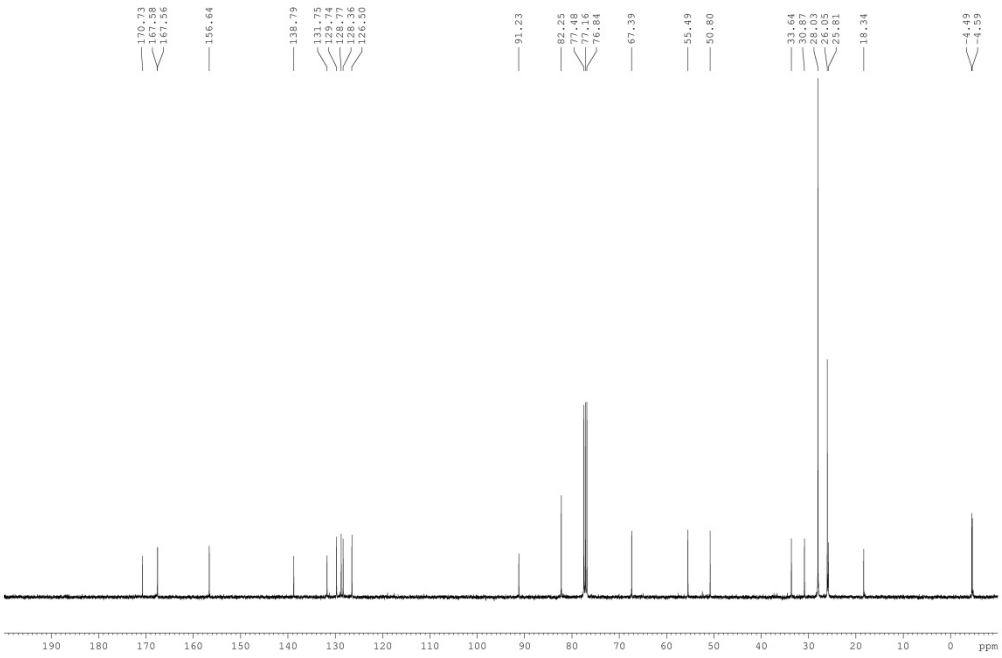

171.28
158.64
140.43
129.05
127.85
126.57
88.26
77.48
77.16
76.84
67.69
65.96
58.92
50.79
33.02
29.45
24.02
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

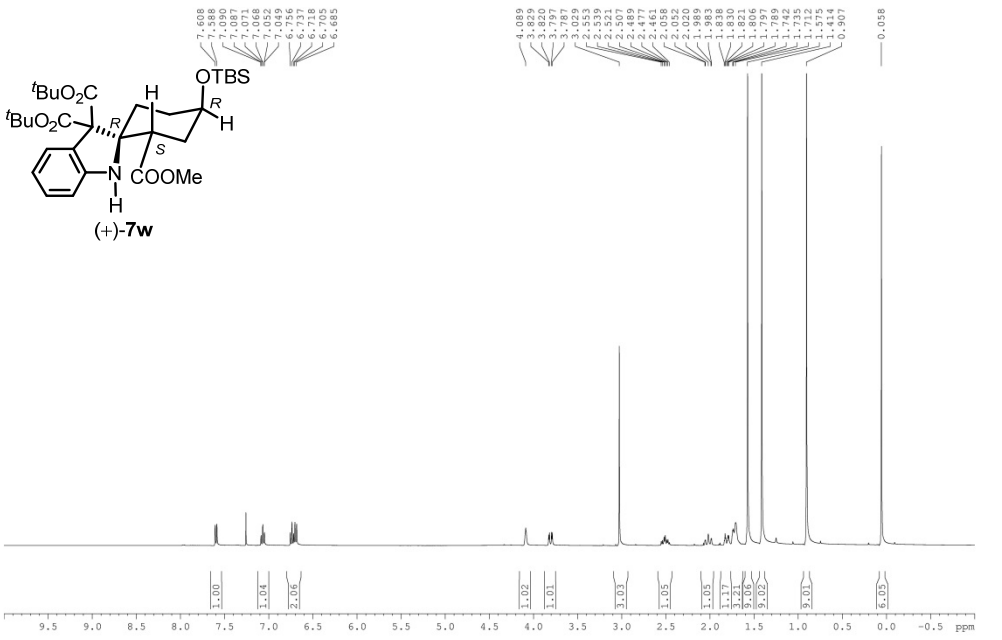


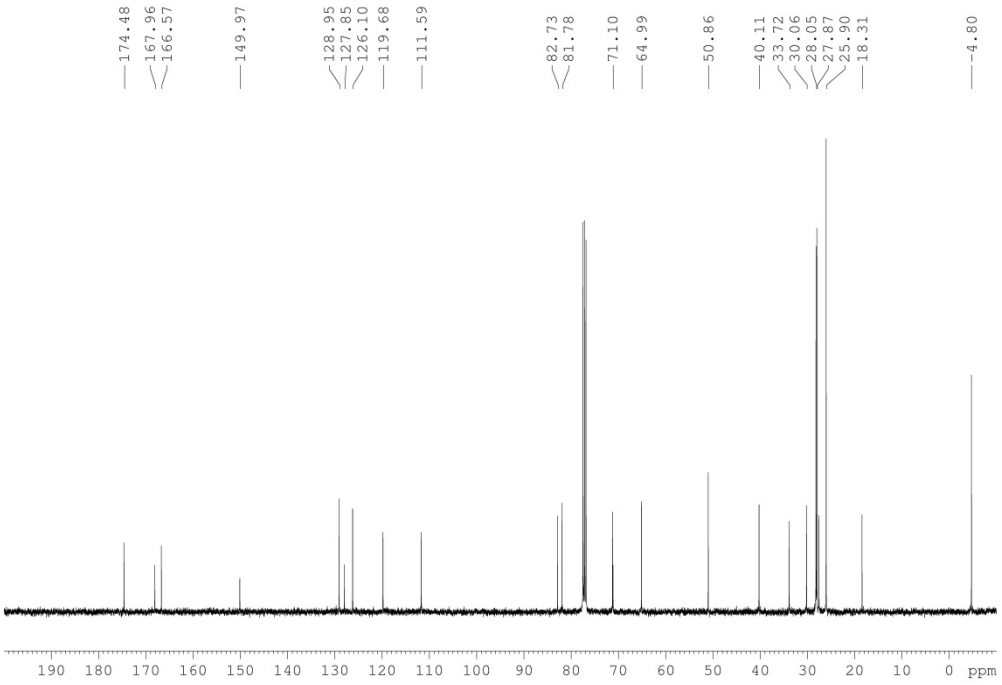
(–)-**S6b**

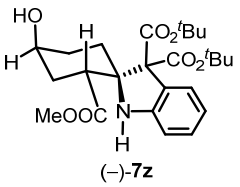



CO2tBu
CO2tBu
OTBS
N
H
H
MeO2C
(+)-6w
ppm


ppm

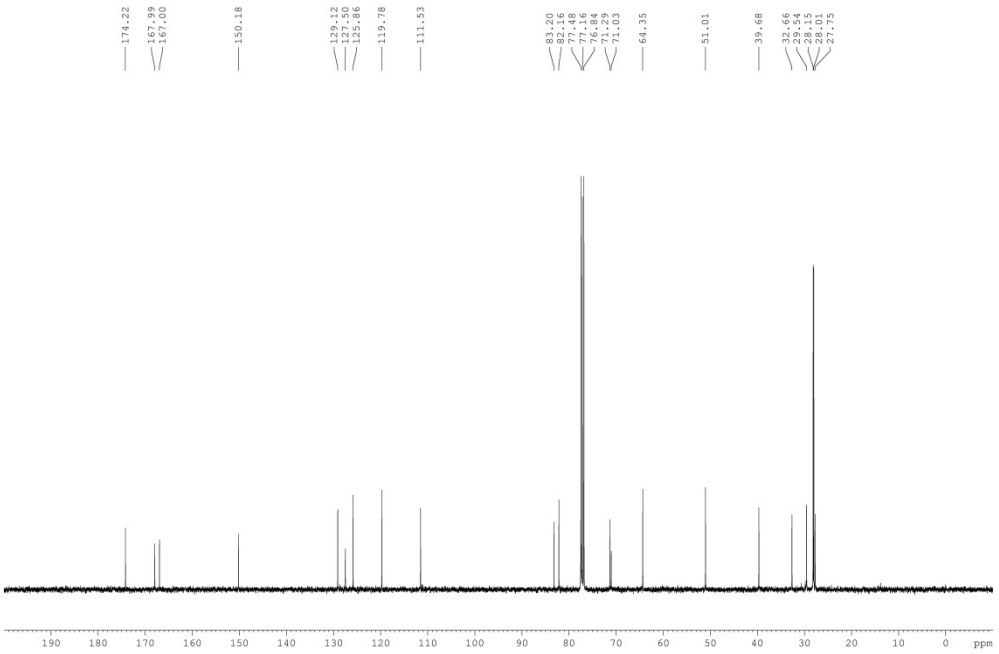

OTBS
H
tBuO2C
tBuO2C
R
R
S
N
H
COOMe
(+)-7w

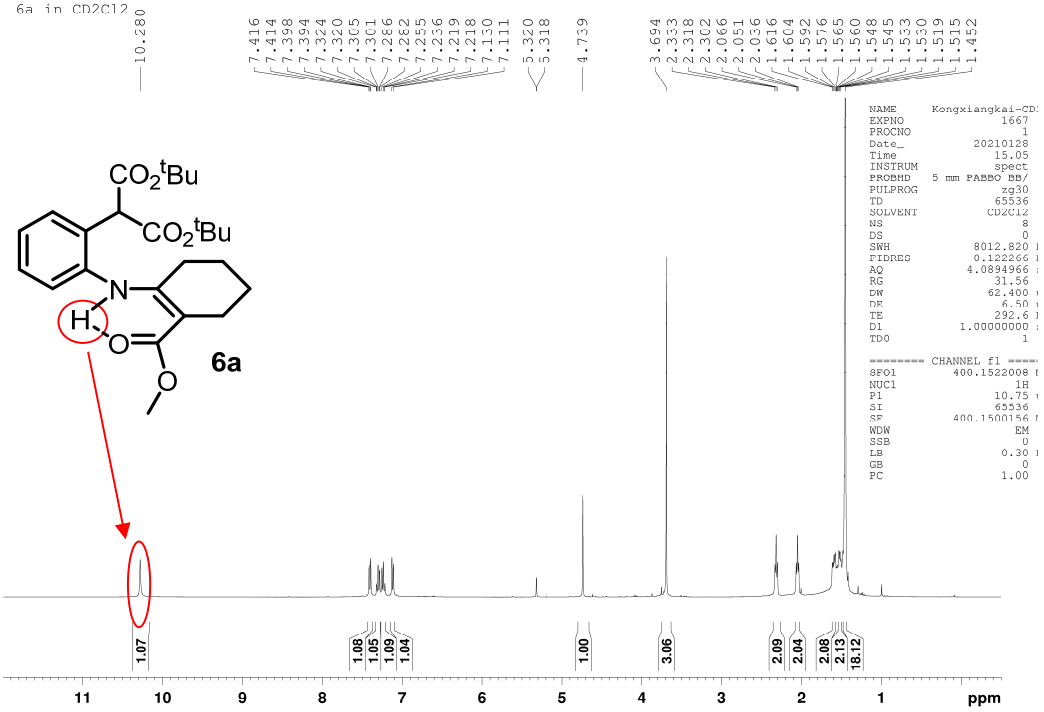



HO
H
H
CO2tBu
CO2tBu
MeOOC
N
H

(–)-**7z**

7.595
7.584
7.576
7.268
7.101
7.098
7.082
7.079
7.063
7.060
6.761
6.759
6.742
6.740
6.723
6.721
6.700
6.680
4.184
3.981
3.971
3.948
3.938
2.975
2.663
2.650
2.626
2.613
2.598
2.578
2.104
2.099
2.067
2.062
2.046
2.034
2.028
1.875
1.819
1.814
1.786
1.614
1.614
1.426
1.00
1.01
2.02
1.02
1.02
3.00
1.04
1.09
4.05
9.18
9.07
ppm

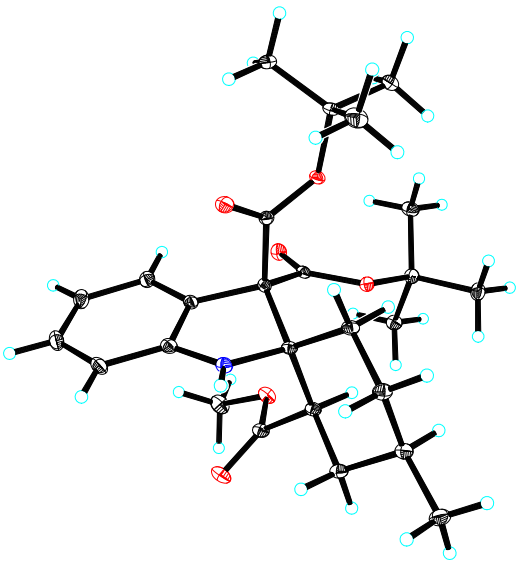

174.22
167.99
167.00
150.18
129.12
127.50
125.86
119.78
111.53
83.20
82.16
77.48
77.16
76.84
71.29
71.03
64.35
51.01
39.68
32.66
29.54
28.15
28.01
27.75
ppm



S2 ^{1}H NMR of **6a** in CD_2Cl_2

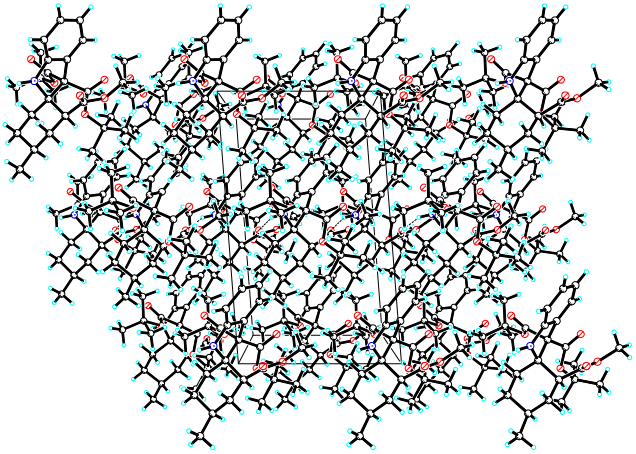
4. X-ray single crystal diffraction data

Crystal data for **7b**: $C_{26}H_{37}NO_6$, M = 459.56, a = 14.5546(4) Å, b = 19.3096(6) Å, c = 8.6608(3) Å, α = 90°, β = 94.4460(10)°, γ = 90°, V = 2426.74(13) Å^3, T = 100.(2) K, space group $C1c1$, Z = 4, μ(Cu Kα) = 0.718 mm^{-1}, 10507 reflections mEtOAcsured, 3811 independent reflections (R_{int} = 0.0265). The final R_1 values were 0.0287 ($I > 2\sigma(I)$). The final $wR(F^2)$ values were 0.0877 ($I > 2\sigma(I)$). The final R_1 values were 0.0289 (all data). The final $wR(F^2)$ values were 0.0882 (all data). The goodness of fit on F^2 was 0.829. Flack parameter = 0.12(7).



View of a molecule of **7b** with the atom-labelling scheme.

Displacement ellipsoids are drawn at the 30% probability level.



View of the pack drawing of **7b**.

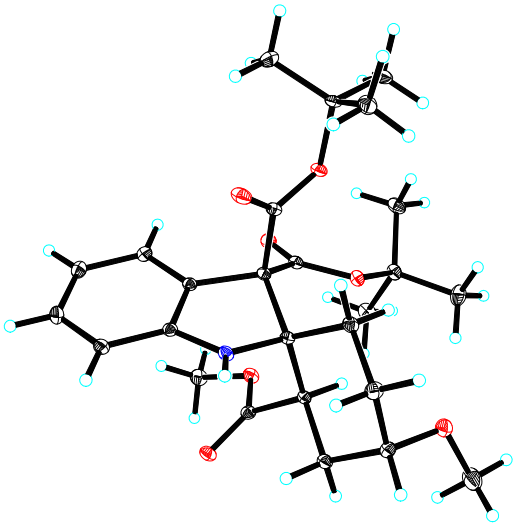
Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for **7b**.

Identification code	global
Empirical formula	C26 H37 N O6
Formula weight	459.56
Temperature	100(2) K
Wavelength	1.54178 Å

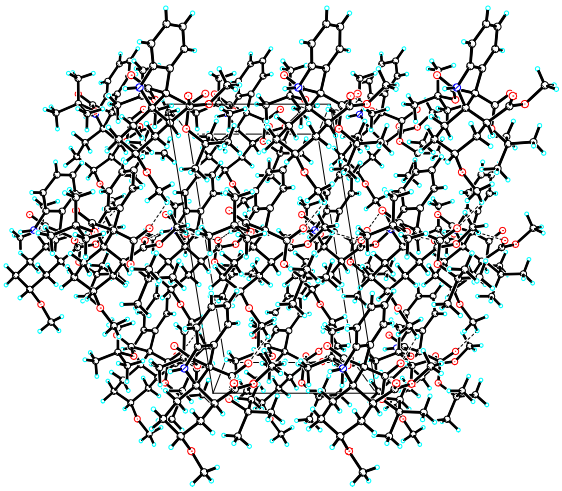
Crystal system	Monoclinic	
Space group	C 1 c 1	
Unit cell dimensions	a = 14.5546(4) Å	α= 90°.
	b = 19.3096(6) Å	β= 94.4460(10)°.
	c = 8.6608(3) Å	γ = 90°.
Volume	2426.74(13) $Å^3$	
Z	4	
Density (calculated)	1.258 Mg/m^3	
Absorption coefficient	0.718 mm^{-1}	
F(000)	992	
Crystal size	0.300 x 0.280 x 0.070 mm^3	
Theta range for data collection	3.81 to 72.38°.	
Index ranges	-17<=h<=17, -23<=k<=23, -10<=l<=10	
Reflections collected	10507	
Independent reflections	3811 [R(int) = 0.0265]	
Completeness to theta = 72.38°	99.4 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.95 and 0.82	
Refinement method	Full-matrix lEtOAcst-squares on F^2	
Data / restraints / parameters	3811 / 2 / 306	
Goodness-of-fit on F^2	0.829	
Final R indices [I>2sigma(I)]	R1 = 0.0287, wR2 = 0.0877	
R indices (all data)	R1 = 0.0289, wR2 = 0.0882	
Absolute structure parameter	0.12(7)	
Largest diff. pEtOAck and hole	0.383 and -0.356 $e.Å^{-3}$	

Crystal data for **7e**: $C_{26}H_{37}NO_7$, M = 475.56, a = 15.3793(4) Å, b = 19.2972(5) Å, c = 8.5773(2) Å, α = 90°, β = 99.0460(10)°, γ = 90°, V = 2513.89(11) $Å^3$, T = 100.(2) K, space group $C1c1$, Z = 4, μ(Cu Kα) = 0.742 mm^{-1}, 14331 reflections mEtOAcsured, 4740 independent reflections (R_{int} = 0.0257). The final R_1 values were 0.0305 ($I > 2\sigma(I)$). The final $wR(F^2)$ values were 0.0941 ($I > 2\sigma(I)$). The final R_1 values were 0.0305 (all data). The final $wR(F^2)$ values were 0.0941 (all data). The goodness of fit on F^2 was 0.911. Flack parameter = 0.02(3).



View of the molecules in an asymmetric unit.

Displacement ellipsoids are drawn at the 30% probability level.



View of the pack drawing of **7e**.

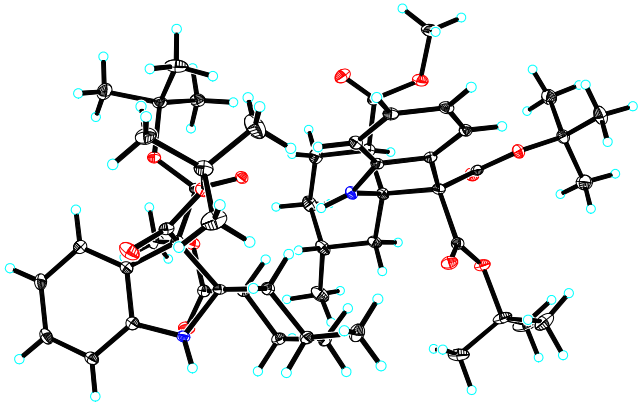
Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for **7e**.

Identification code	global
Empirical formula	C26 H37 N O7
Formula weight	475.56
Temperature	100(2) K
Wavelength	1.54178 Å

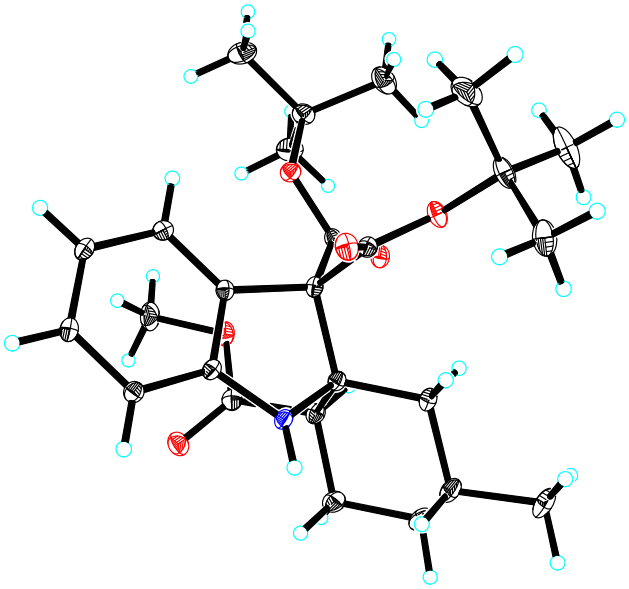
Crystal system	Monoclinic	
Space group	C 1 c 1	
Unit cell dimensions	a = 15.3793(4) Å	α= 90°.
	b = 19.2972(5) Å	β= 99.0460(10)°.
	c = 8.5773(2) Å	γ = 90°.
Volume	2513.89(11) $Å^3$	
Z	4	
Density (calculated)	1.257 Mg/m^3	
Absorption coefficient	0.742 mm^{-1}	
F(000)	1024	
Crystal size	0.310 x 0.290 x 0.160 mm^3	
Theta range for data collection	7.42 to 72.32°.	
Index ranges	-18<=h<=18, -21<=k<=23, -10<=l<=10	
Reflections collected	14331	
Independent reflections	4740 [R(int) = 0.0257]	
Completeness to theta = 72.32°	99.1 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.89 and 0.79	
Refinement method	Full-matrix lEtOAcst-squares on F^2	
Data / restraints / parameters	4740 / 2 / 315	
Goodness-of-fit on F^2	0.911	
Final R indices [I>2sigma(I)]	R1 = 0.0305, wR2 = 0.0941	
R indices (all data)	R1 = 0.0305, wR2 = 0.0941	
Absolute structure parameter	0.02(3)	
Largest diff. pEtOAck and hole	0.367 and -0.324 e.$Å^{-3}$	

Crystal data for **7v**: $C_{26}H_{37}NO_6$, M = 459.56, a = 10.5703(2) Å, b = 18.2177(4) Å, c = 13.5717(3) Å, α = 90°, β = 98.1910(10)°, γ = 90°, V = 2586.79(9) $Å^3$, T = 100.(2) K, space group $P1211$, Z = 4, μ(Cu Kα) = 0.674 mm^{-1}, 49073 reflections measured, 10163 independent reflections (R_{int} = 0.0282). The final R_1 values were 0.0282 ($I > 2\sigma(I)$). The final $wR(F^2)$ values were 0.0727 ($I > 2\sigma(I)$). The final R_1 values were 0.0285 (all data). The final $wR(F^2)$ values were 0.0731 (all data). The goodness of fit on F^2 was 1.040. Flack parameter = 0.00(2).



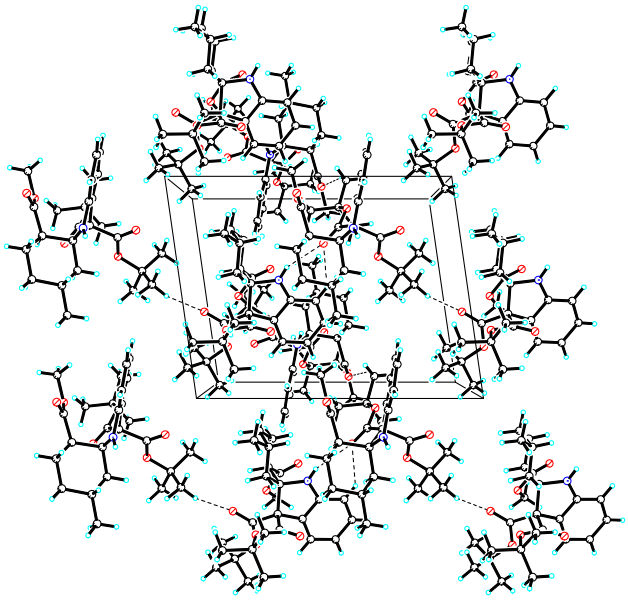
View of the molecules in an asymmetric unit.

Displacement ellipsoids are drawn at the 30% probability level.



View of a molecule of **7v** with the atom-labelling scheme.

Displacement ellipsoids are drawn at the 30% probability level.



View of the pack drawing of **7v**.

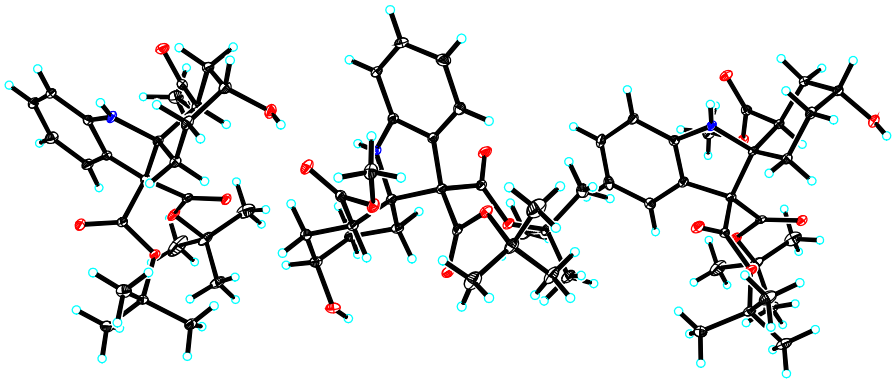
Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for **7v**.

Identification code	global	
Empirical formula	C26 H37 N O6	
Formula weight	459.56	
Temperature	100(2) K	
Wavelength	1.54178 Å	
Crystal system	Monoclinic	
Space group	P 1 21 1	
Unit cell dimensions	a = 10.5703(2) Å	α= 90°.
	b = 18.2177(4) Å	β= 98.1910(10)°.
	c = 13.5717(3) Å	γ = 90°.
Volume	2586.79(9) $Å^3$	
Z	4	
Density (calculated)	1.180 Mg/m^3	
Absorption coefficient	0.674 mm^{-1}	
F(000)	992	
Crystal size	0.390 x 0.250 x 0.120 mm^3	
Theta range for data collection	4.09 to 72.49°.	
Index ranges	-13<=h<=12, -22<=k<=22, -16<=l<=16	
Reflections collected	49073	

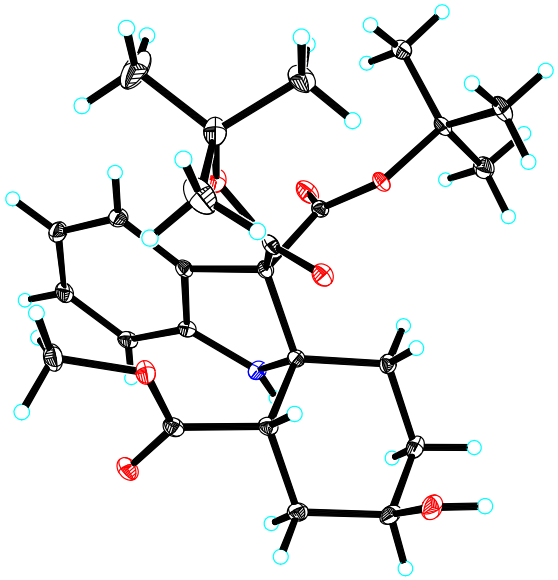
Independent reflections	10163 [R(int) = 0.0282]
Completeness to theta = 72.49°	99.8 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.92 and 0.82
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	10163 / 1 / 611
Goodness-of-fit on F^2	1.040
Final R indices [I>2sigma(I)]	R1 = 0.0282, wR2 = 0.0727
R indices (all data)	R1 = 0.0285, wR2 = 0.0731
Absolute structure parameter	0.00(2)
Largest diff. peak and hole	0.503 and -0.341 e.Å^{-3}

Crystal data for (+)-**7y**: $C_{25}H_{35}NO_7$, M = 461.54, a = 10.8932(2) Å, b = 17.0966(3) Å, c = 39.2989(7) Å, α = 90°, β = 90°, γ = 90°, V = 7318.9(2) Å^3, T = 100.(2) K, space group $P212121$, Z = 12, μ(Cu Kα) = 0.750 mm^{-1}, 79501 reflections measured, 14460 independent reflections (R_{int} = 0.0541). The final R_1 values were 0.0328 ($I > 2\sigma(I)$). The final $wR(F^2)$ values were 0.0821 ($I > 2\sigma(I)$). The final R_1 values were 0.0353 (all data). The final $wR(F^2)$ values were 0.0840 (all data). The goodness of fit on F^2 was 1.023. Flack parameter = 0.02(4).



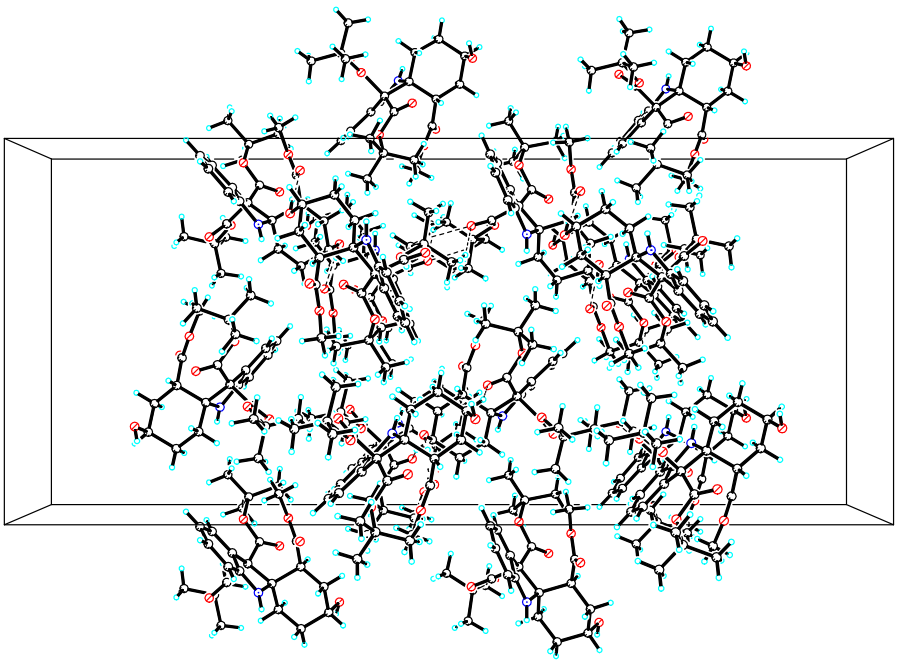
View of the molecules in an asymmetric unit.

Displacement ellipsoids are drawn at the 30% probability level.



View of a molecule of (+)-**7y** with the atom-labelling scheme.

Displacement ellipsoids are drawn at the 30% probability level.



View of the pack drawing of (+)-**7y**.

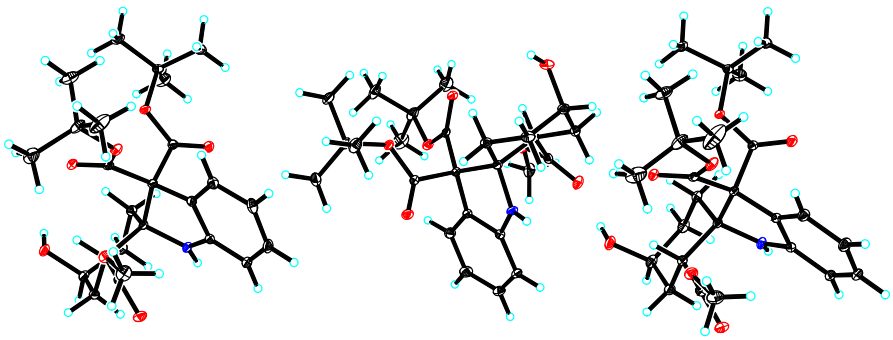
Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for (+)-**7y**.

Identification code	global	
Empirical formula	C25 H35 N O7	
Formula weight	461.54	
Temperature	100(2) K	
Wavelength	1.54178 Å	
Crystal system	Orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 10.8932(2) Å	α= 90°.
	b = 17.0966(3) Å	β= 90°.
	c = 39.2989(7) Å	γ = 90°.
Volume	7318.9(2) $Å^3$	
Z	12	
Density (calculated)	1.257 Mg/m^3	
Absorption coefficient	0.750 mm^{-1}	
F(000)	2976	
Crystal size	0.420 x 0.200 x 0.200 mm^3	
Theta range for data collection	2.25 to 72.40°.	
Index ranges	-13<=h<=10, -21<=k<=21, -48<=l<=48	
Reflections collected	79501	
Independent reflections	14460 [R(int) = 0.0541]	
Completeness to theta = 72.40°	99.8 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.86 and 0.75	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	14460 / 0 / 916	
Goodness-of-fit on F^2	1.023	
Final R indices [I>2sigma(I)]	R1 = 0.0328, wR2 = 0.0821	
R indices (all data)	R1 = 0.0353, wR2 = 0.0840	
Absolute structure parameter	0.02(4)	
Largest diff. peak and hole	0.487 and -0.391 $e.Å^{-3}$	

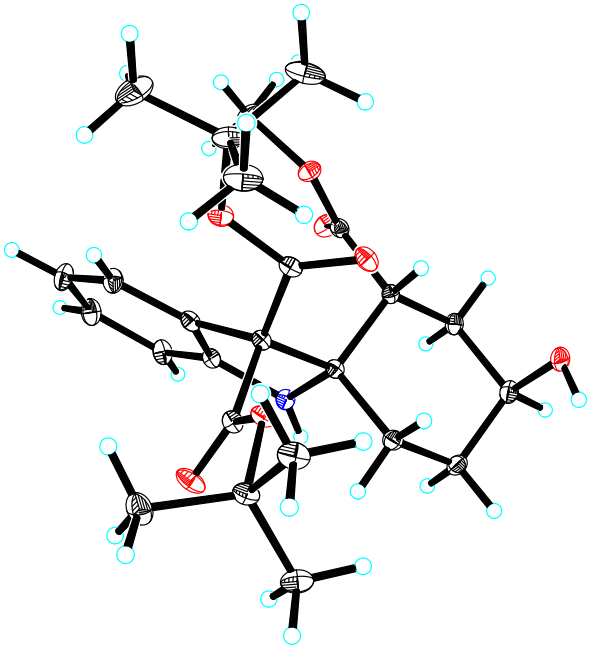
Crystal data for (–)-**7z**: $C_{25}H_{35}NO_7$, M = 461.54, a = 10.8971(2) Å, b = 17.1101(3) Å, c = 39.2778(7) Å, α = 90°, β = 90°, γ = 90°, V = 7323.4(2) $Å^3$, T = 100.(2) K, space group $P212121$, Z = 12, μ(Cu Kα) = 0.749 mm^{-1}, 147122 reflections measured, 14487 independent reflections (R_{int} = 0.0390). The final R_1 values were 0.0282 ($I > 2\sigma(I)$).

The final $wR(F^2)$ values were 0.0750 ($I > 2\sigma(I)$). The final R_1 values were 0.0288 (all data). The final $wR(F^2)$ values were 0.0756 (all data). The goodness of fit on F^2 was 1.032. Flack parameter = 0.010(19).



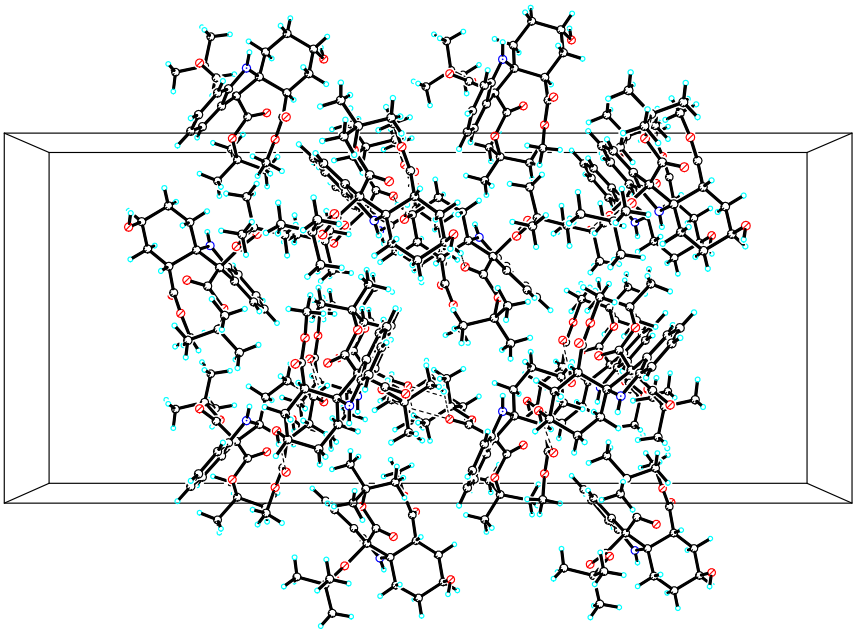
View of the molecules in an asymmetric unit.

Displacement ellipsoids are drawn at the 30% probability level.



View of a molecule of (–)-**7z** with the atom-labelling scheme.

Displacement ellipsoids are drawn at the 30% probability level.



View of the pack drawing of (–)-**7z**.

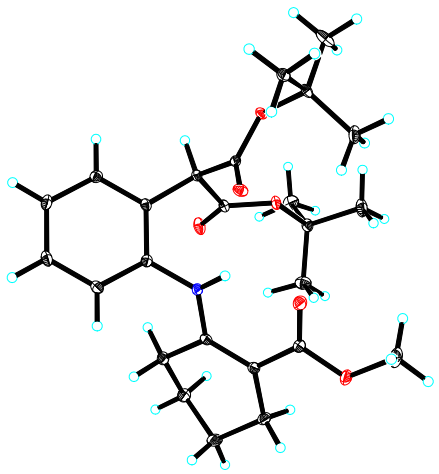
Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for (–)-**7z**.

Identification code	global	
Empirical formula	C25 H35 N O7	
Formula weight	461.54	
Temperature	100(2) K	
Wavelength	1.54178 Å	
Crystal system	Orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 10.8971(2) Å	α= 90°.
	b = 17.1101(3) Å	β= 90°.
	c = 39.2778(7) Å	γ = 90°.
Volume	7323.4(2) $Å^3$	
Z	12	
Density (calculated)	1.256 Mg/m^3	
Absorption coefficient	0.749 mm^{-1}	
F(000)	2976	
Crystal size	0.270 x 0.180 x 0.160 mm^3	
Theta range for data collection	2.25 to 72.31°.	
Index ranges	-12<=h<=13, -21<=k<=21, -48<=l<=47	

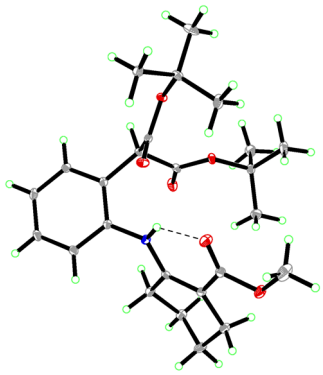
Reflections collected	147122
Independent reflections	14487 [R(int) = 0.0390]
Completeness to theta = 72.31°	99.9 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.89 and 0.76
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	14487 / 0 / 916
Goodness-of-fit on F^2	1.032
Final R indices [I>2sigma(I)]	R1 = 0.0282, wR2 = 0.0750
R indices (all data)	R1 = 0.0288, wR2 = 0.0756
Absolute structure parameter	0.010(19)
Largest diff. peak and hole	0.440 and -0.412 e.Å^{-3}

Crystal data for **6a**: $C_{25}H_{35}NO_6$, M = 445.54, a = 9.2271(3) Å, b = 17.1809(5) Å, c = 15.5673(5) Å, α = 90°, β = 103.8030(10)°, γ = 90°, V = 2396.61(13) Å^3, T = 100.(2) K, space group $P121/n1$, Z = 4, μ(Cu Kα) = 0.712 mm^{-1}, 25019 reflections measured, 4711 independent reflections (R_{int} = 0.0393). The final R_1 values were 0.0365 ($I > 2\sigma(I)$). The final $wR(F^2)$ values were 0.0871 ($I > 2\sigma(I)$). The final R_1 values were 0.0386 (all data). The final $wR(F^2)$ values were 0.0888 (all data). The goodness of fit on F^2 was 1.039.



View of a molecule of **6a** with the atom-labelling scheme.

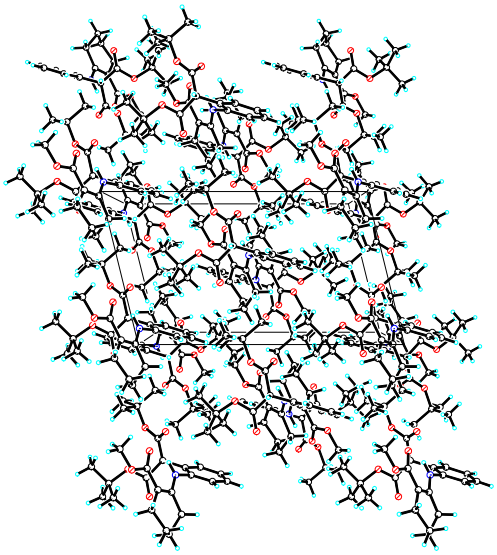
Displacement ellipsoids are drawn at the 30% probability level.



View of a molecule of **6a** with the atom-labelling scheme.

Displacement ellipsoids are drawn at the 30% probability level.

Hydrogen-bonds are shown as dashed lines



View of the pack drawing of **6a**.

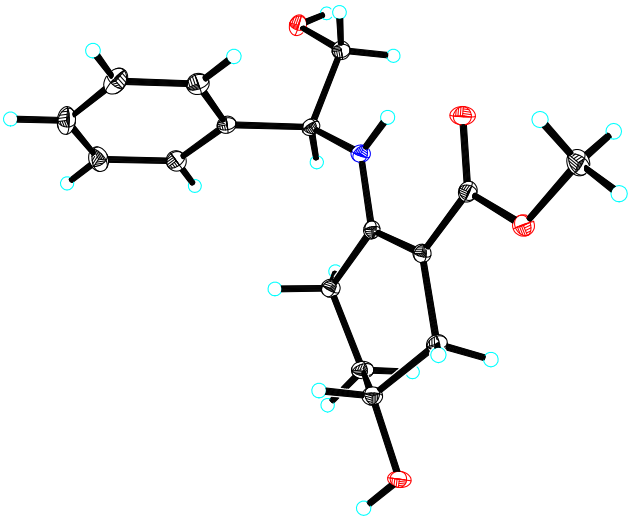
Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for **6a**.

Identification code	global	
Empirical formula	C25 H35 N O6	
Formula weight	445.54	
Temperature	100(2) K	
Wavelength	1.54178 Å	
Crystal system	Monoclinic	
Space group	P 1 21/n 1	
Unit cell dimensions	a = 9.2271(3) Å	α= 90°.

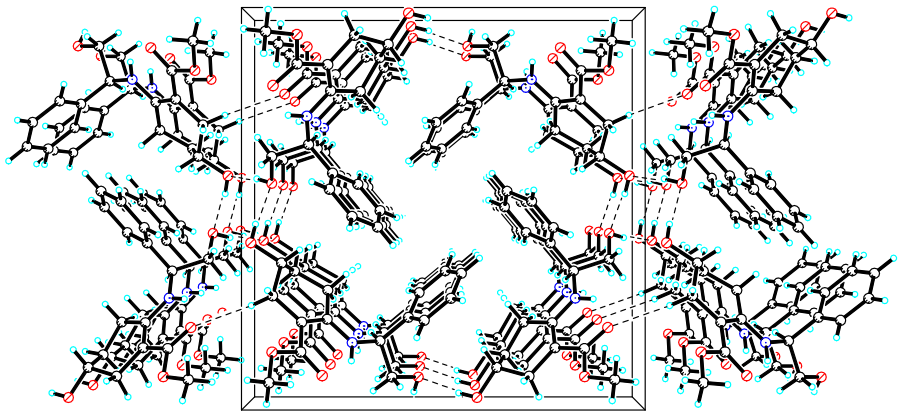
	b = 17.1809(5) Å	β= 103.8030(10)°.
	c = 15.5673(5) Å	γ = 90°.
Volume	2396.61(13) Å^3	
Z	4	
Density (calculated)	1.235 Mg/m^3	
Absorption coefficient	0.712 mm^{-1}	
F(000)	960	
Crystal size	0.360 x 0.350 x 0.250 mm^3	
Theta range for data collection	3.90 to 72.22°.	
Index ranges	-11<=h<=11, -18<=k<=21, -17<=l<=19	
Reflections collected	25019	
Independent reflections	4711 [R(int) = 0.0393]	
Completeness to theta = 72.22°	99.6 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.84 and 0.72	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	4711 / 0 / 300	
Goodness-of-fit on F^2	1.039	
Final R indices [I>2sigma(I)]	R1 = 0.0365, wR2 = 0.0871	
R indices (all data)	R1 = 0.0386, wR2 = 0.0888	
Largest diff. peak and hole	0.288 and -0.224 e.Å^{-3}	

Crystal data for **S6a**: $C_{16}H_{21}NO_4$, M = 291.34, a = 16.2391(4) Å, b = 16.2391(4) Å, c = 5.8098(2) Å, α = 90°, β = 90°, γ = 90°, V = 1532.09(9) Å^3, T = 100.(2) K, space group $P43$, Z = 4, μ(Cu Kα) = 0.742 mm^{-1}, 13244 reflections measured, 2367 independent reflections (R_{int} = 0.0353). The final R_1 values were 0.0287 ($I > 2\sigma(I)$). The final $wR(F^2)$ values were 0.0725 ($I > 2\sigma(I)$). The final R_1 values were 0.0294 (all data). The final $wR(F^2)$ values were 0.0732 (all data). The goodness of fit on F^2 was 1.062. Flack parameter = -0.01(12).



View of a molecule of **S6a** with the atom-labelling scheme.

Displacement ellipsoids are drawn at the 30% probability level.



View of the pack drawing of **S6a**.

Hydrogen-bonds are shown as dashed lines.

Table 1. Crystal data and structure refinement for **S6a**.

Identification code	global
Empirical formula	C16 H21 N O4
Formula weight	291.34
Temperature	100(2) K
Wavelength	1.54178 Å
Crystal system	Tetragonal
Space group	$P4_3$

Unit cell dimensions	a = 16.2391(4) Å	α= 90°.
	b = 16.2391(4) Å	β= 90°.
	c = 5.8098(2) Å	γ = 90°.
Volume	1532.09(9) $Å^3$	
Z	4	
Density (calculated)	1.263 Mg/m^3	
Absorption coefficient	0.742 mm^{-1}	
F(000)	624	
Crystal size	0.660 x 0.120 x 0.090 mm^3	
Theta range for data collection	2.72 to 72.32°.	
Index ranges	-20<=h<=20, -20<=k<=19, -7<=l<=5	
Reflections collected	13244	
Independent reflections	2367 [R(int) = 0.0353]	
Completeness to theta = 72.32°	99.6 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.94 and 0.80	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	2367 / 1 / 195	
Goodness-of-fit on F^2	1.062	
Final R indices [I>2sigma(I)]	R1 = 0.0287, wR2 = 0.0725	
R indices (all data)	R1 = 0.0294, wR2 = 0.0732	
Absolute structure parameter	-0.01(12)	
Largest diff. peak and hole	0.123 and -0.182 $e.Å^{-3}$	