Nickel(0)-Catalyzed Linear-Selective Hydroarylation of Unactivated Alkenes and Styrenes with Aryl Boronic Acids

Honggui Lv, Li-Jun Xiao, Dongbing Zhao and Qi-Lin Zhou*

Table of Contents

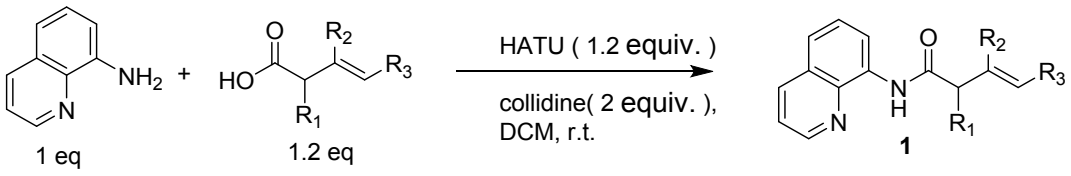
1. General Information

Unless otherwise noted, all manipulations were performed in an argon filled glove box or using standard Schlenk techniques. Commercially available reagents were received from commercial sources without further purification and Dry solvents (<50 ppm H_2O) were purchased and stored over molecular sieves under argon atmosphere and were transferred under argon.

NMR spectra were recorded on Bruker AV 400 spectrometer at 400 MHz (^{1}H NMR), 100 MHz (^{13}C NMR), 376 MHz (^{19}F NMR). Chemical shifts (δ) for ^{1}H and ^{13}C NMR spectra are given in ppm relative to TMS. The residual solvent signals were used as references for ^{1}H and ^{13}C NMR spectra and the chemical shifts converted to the TMS scale ($CDCl_3$: δ_H = 7.26 ppm, δ_C = 77.16 ppm; $(CD_3)_2SO$: δ_H = 2.50 ppm, δ_C = 39.52 ppm; CD_3OD: δ_H = 3.34 ppm, δ_C = 49.86 ppm). ^{1}H, ^{13}C and ^{19}F multiplicities are reported as follows: singlet (s), doublet (d), triplet (t), quartet (q), doublet of doublets (dd), triplet of quartets (tq), multiplet (m), and broad resonance (br). High resolution mass spectra (HRMS) were recorded on an Agilent 6520 Q-TOF LC/MS with Electron Spray Ionization (ESI) resource. Thin-layer chromatographies were done on pre-coated silica gel 60 F254 plates (Merck). Silica gel 60H (200-300 mesh) manufactured by Qingdao Haiyang Chemical Group Co. (China) was used for general chromatography.

2. Experimental Procedures

2.1 General Procedure for Synthesis of Alkene Substrates



Following the literatures' procedure,[1-4] corresponding vinyl acetic acid (30 mmol, 1.2 equiv.) was charged into a 250 mL RB flask containing 60 ml dichloromethane (DCM). 8-Amino-quinoline (25 mmol, 3.6 g, 1 equiv.), collidine (50 mmol, 2 equiv.),

and HATU (30 mmol, 1.2 equiv.) were added sequentially and the reaction was stirred at ambient temperature for 16 h. The solvent was removed by evaporation (T < 35 °C). Then the residue was dissolved in EtOAc (100 mL), washed with sat. $NaHCO_3$ (2 × 70 mL), brine (1 × 70 mL) and purified by column chromatography (10-15% EtOAc in Hexanes) to afford the target product.

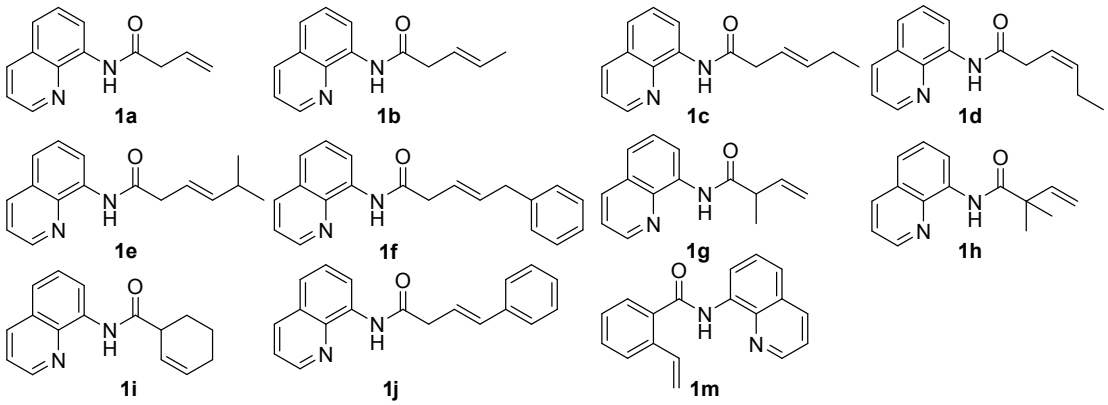
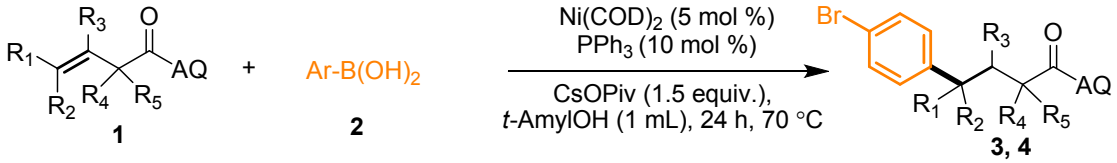


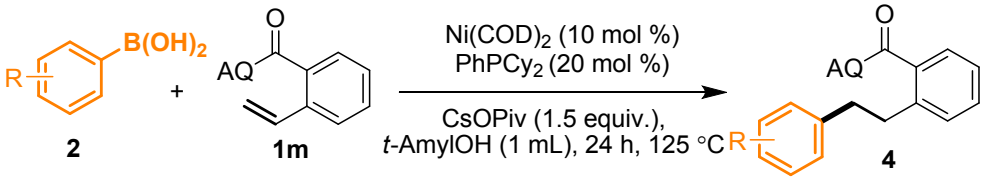
Figure S1. List of known alkene substrates

2.2 General Procedure for Hydroarylation of Alkenes



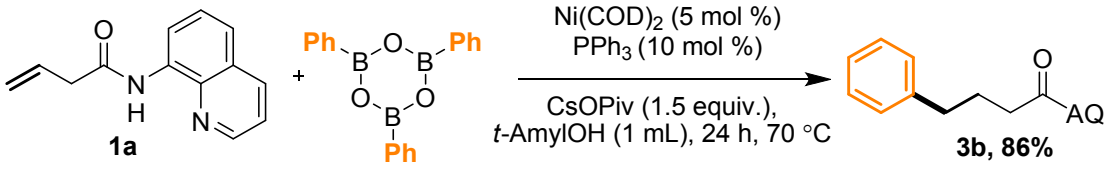
In an argon-filled glove-box, an oven-dried 25 mL Schlenk tube equipped with a Teflon stirrer bar were subsequently added alkene **1** (0.2 mmol, 1.0 equiv.), arylboronic acid **2** (0.4mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.), CsOPiv (0.3 mmol, 1.5 equiv.) and *t*-AmylOH (1 mL). The tube was sealed with a teflon cap and placed in a hotplate pre-heated to 70 °C with vigorous stirring. After 24 h, the reaction mixture was cooled to room temperature. The crude product was diluted with EtOAc, filtered through a short pad of Celite. The filtrate was concentrated under reduced pressure. The resulting residue was purified by column chromatography to give the corresponding product.

2.3 General Procedure for Hydroarylation of Styrenes



In an argon-filled glove-box, an oven-dried 25 mL Schlenk tube equipped with a Teflon stirrer bar were subsequently added alkene **1m** (0.2 mmol, 1.0 equiv.), arylboronic acid **2** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.02 mmol, 0.1 equiv.), $PhPCy_2$ (0.04 mmol, 0.2 equiv.), CsOPiv (0.3 mmol, 1.5 equiv.), *t*-AmylOH (1 mL). The tube was sealed with a Teflon cap and placed in a hotplate pre-heated to 125 °C with vigorous stirring. After 48 h, the reaction mixture was cooled to room temperature. The crude product was diluted with EtOAc, filtered through a short pad of Celite. The filtrate was concentrated under reduced pressure. The resulting residue was purified by column chromatography to give the corresponding product **4**.

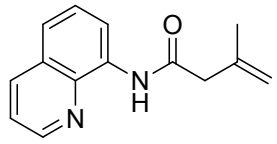
2.4 Gram-scale Experiment



In an argon-filled glove-box, an oven-dried 100 mL Schlenk tube equipped with a Teflon stirrer bar were subsequently added alkene **2a** (5 mmol, 1.06 g), 2,4,6-Triphenylboroxin (3.33 mmol, 1.04 g), $Ni(cod)_2$ (0.25 mmol, 68.8 mg), PPh_3 (0.5 mmol, 131.2 mg), CsOPiv (7.5 mmol, 1.76 mg) and *t*-AmylOH (25 mL). The tube was sealed with a teflon cap and placed in a hotplate pre-heated to 70 °C with vigorous stirring. After 24 h, the reaction mixture was cooled to room temperature. The crude product was diluted with EtOAc and filtered through a short pad of Celite. The filtrate was concentrated under vacuum. The resulting residue was purified by column chromatography (DCM/EtOAc = 50/1) to give **3b** (1.23 g) as a light yellow solid in 86% yield.

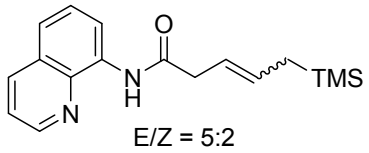
3. Characterization of New Substrates and Products 3-4

3-Methyl-*N*-(quinolin-8-yl)but-3-enamide (1k)



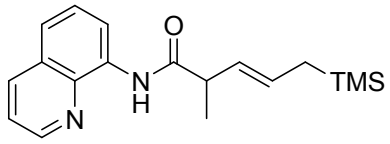
3-Methylbut-3-enoic acid was synthesized as reported by Smith.[5] Following the general procedure on 2.16 g (15 mmol, 1 equiv.) of 8-aminoquinoline, the reaction obtained 2.65 g of **1k** in 78 % yield as a yellow oil after flash column chromatography on silica gel (10-15% EtOAc in Hexanes). **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 10.05 (s, 1H), 8.78 (d, J = 6.5 Hz, 2H), 8.26 -7.99 (m, 1H), 7.71 - 7.31 (m, 3H), 5.11 (d, J = 6.8 Hz, 2H), 3.28 (s, 2H), 1.91 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)**: δ 169.2, 148.3, 139.9, 138.6, 136.3, 134.5, 128.0, 127.4, 121.6, 121.6, 116.4, 116.0, 48.0, 22.6. **HRMS (ESI)** m/z Calcd. for $C_{14}H_{14}N_2O$ $[M+H]^+$ 227.1184, Found . 227.1180.

***N*-(Quinolin-8-yl)-5-(trimethylsilyl)pent-3-enamide (1l)**



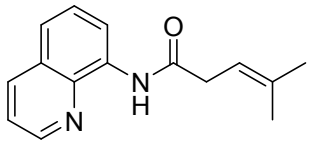
5-(Trimethylsilyl)pent-3-enoic acid (*E/Z* = 3/1) was synthesized as reported by Gouverneur.[6] Following the general procedure on 0.72 g (5 mmol, 1 equiv.) of 8-aminoquinoline, the reaction gave 1.2 g of **1l** in 80 % (*E/Z* = 2/1) yield as a yellow oil after flash column chromatography on silica gel (5-10 % EtOAc in Hexanes). NMR data of the mixture of *E/Z* isomers: **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.07 (s, $1H_Z$), 9.99 (s, $1H_E$), 8.84 - 8.73 (m, $2H_{E\,\&\,Z}$), 8.13 (dd, J = 8.3, 1.6 Hz, $1H_{E\,\&\,Z}$), 7.58 - 7.46 (m, $2H_{E\,\&\,Z}$), 7.43 (dd, J = 8.3, 4.2 Hz, $1H_{E\,\&\,Z}$), 5.94 - 5.85 (m, $1H_Z$), 5.80 (dt, J = 15.1, 8.1 Hz, $1H_E$), 5.74 - 5.65 (m, $1H_Z$), 5.64 - 5.52 (m, $1H_E$), 3.31 (d, J = 8.4 Hz, $2H_Z$), 3.27 (d, J = 6.7 Hz, $2H_E$), 1.64 (d, J = 9.1 Hz, $2H_Z$), 1.60 (d, J = 8.0 Hz, $2H_E$), 0.06 (s, $9H_E$), 0.05 (s, $8H_Z$). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.5_E, 170.1_Z, 148.2_E, 148.3_E, $138.6_{E\,\&\,Z}$, 136.3_E, $134.6_{E\,\&\,Z}$, 133.4_E, 131.8_Z, 128.0_E, 127.4_E, 121.6_E, $121.5_{E\,\&\,Z}$, 120.4_E, 118.7_Z 116.6_E, 42.7_E, 36.7_Z , 23.3_E, 19.1_Z , -1.7_Z , -1.8_E. **HRMS (ESI)** m/z Calcd. for $C_{17}H_{22}N_2OSi$ $[M+H]^+$ 299.1580, Found 299.1578.

(*E*)-2-Methyl-*N*-(quinolin-8-yl)-5-(trimethylsilyl)pent-3-enamide (1n)



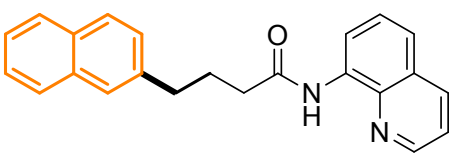
(*E*)-2-Methyl-5-(trimethylsilyl)pent-3-enoic acid was synthesized as reported by Gouverneur.[6] Following the general procedure on 3.6 g (25 mmol, 1 equiv.) of 8-aminoquinoline, the reaction gave 1.28 g of **1n** in 82% yield as a yellow oil after flash column chromatography on silica gel (5-10 % EtOAc in Hexanes). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.03 (s, 1H), 8.79 (dd, J = 10.5, 4.4 Hz, 2H), 8.13 (d, J = 8.3 Hz, 1H), 7.57 - 7.44 (m, 2H), 7.42 (dd, J = 8.2, 4.2 Hz, 1H), 5.88 - 5.69 (m, 1H), 5.51 (dd, J = 15.2, 8.3 Hz, 1H), 3.30 (m, J = 7.2 Hz, 1H), 1.56 (d, J = 8.2 Hz, 2H), 1.40 (d, J = 7.0 Hz, 3H), 0.03 (s, 9H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 173.7, 148.3, 138.7, 136.4, 134.8, 130.4, 128.1, 128.0, 127.5, 121.6, 121.4, 116.4, 46.5, 23.2, 17.8, -1.8. **HRMS (ESI)** m/z Calcd. for $C_{18}H_{24}N_2OSi$ $[M+H]^+$ 313.1736 , Found 313.1734.

4-Methyl-*N*-(quinolin-8-yl)pent-3-enamide (1o)



4-Methylpent-3-enoic acid was synthesized as reported by Glomb.[7] Following the general procedure on 1.44 g (10 mmol, 1 equiv.) of 8-aminoquinoline, the reaction gave 2.1 g of **1o** in 88% yield as a yellow oil after flash column chromatography on silica gel (DCM as eluent). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.12 (s, 1H), 8.77 -8.75 (m, 2H), 8.12 (d, J = 8.1 Hz, 1H), 7.56 - 7.44 (m, 2H), 7.42 (dd, J = 8.2, 4.2 Hz, 1H), 5.54 (t, J = 6.9 Hz, 1H), 3.28 (d, J = 7.5 Hz, 2H), 1.90 (s, 3H), 1.78 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.2, 148.3, 138.6, 138.3, 136.3, 134.6, 128.0, 127.5, 121.6, 121.5, 116.7, 116.3, 25.9, 18.2. **HRMS (ESI)** m/z Calcd. For $C_{15}H_{16}N_2O$ $[M+H]^+$ 241.1341 , Found 241.1338.

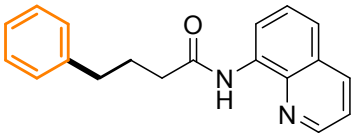
4-(Naphthalen-2-yl)-*N*-(quinolin-8-yl)butanamide (3a)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), naphthalen-2-ylboronic acid **2a** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv

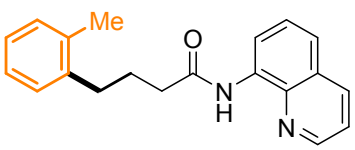
(0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(Naphthalen-2-yl)-*N*-(quinolin-8-yl)- butanamide (**3a**) was isolated by column chromatography (PE/EtOAc = 10/1) as a white solid in 85 % yield. **M.P.**: 91-92 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.81 (s, 1H), 8.83 - 8.78 (m, 2H), 8.15 (d, J = 9.4 Hz, 1H), 7.83 - 7.77 (m, 3H), 7.69 (s, 1H), 7.60 - 7.36 (m, 6H), 2.94 (t, J = 7.4 Hz, 2H), 2.61 (t, J = 7.4 Hz, 2H), 2.33 - 2.21 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.2, 139.1, 138.4, 136.5, 134.6, 133.7, 132.2, 128.1, 128.0, 127.7, 127.6, 127.5, 127.4, 126.8, 126.0, 125.3, 121.7, 121.5, 116.5, 37.3, 35.4, 27.0. **HRMS (ESI)** m/z Calcd. for $C_{23}H_{20}N_2O$ $[M+H]^+$ 341.1654, Found 341.1652.

4-Phenyl-*N*-(quinolin-8-yl)butanamide (3b)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), phenylboronic acid **2b** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-Phenyl-*N*-(quinolin-8-yl) - butanamide (**3b**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow solid in 70 % yield. **M.P.:** 46.5 - 47.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.80 (s, 1H), 8.81 - 8.79 (m, 2H), 8.15 (d, J = 8.2 Hz, 1H), 7.60 - 7.48 (m, 2H), 7.45 (dd, J = 8.2, 4.2 Hz, 1H), 7.36 - 7.17 (m, 5H), 2.78 (t, J = 7.5 Hz, 2H), 2.58 (t, J = 7.5 Hz, 2H), 2.24 - 2.11 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.1, 141.5, 138.3, 136.4, 134.5, 128.6, 128.5, 128.0, 127.5, 126.0, 121.6, 121.4, 116.5, 37.3, 35.2, 27.1. **HRMS (ESI)** m/z Calcd. for $C_{19}H_{18}N_2O$ $[M+H]^+$ 291.1497, Found 291.1495.

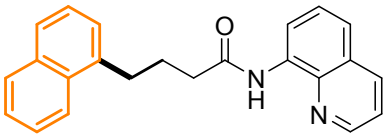
***N*-(Quinolin-8-yl)-4-*o*-tolylbutanamide (3c)**



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), *o*-tolylboronic acid **2c** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4-*o*-

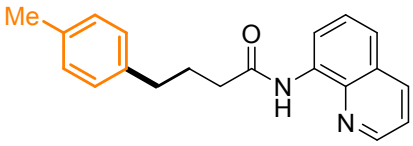
tolylbutanamide (**3c**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 65 % yield. **M.P.:** 78 - 79 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.88 (s, 1H), 8.97 - 8.75 (m, 2H), 8.22 (d, J = 8.2 Hz, 1H), 7.67 - 7.46 (m, 3H), 7.36 - 7.11 (m, 4H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 139.8, 138.4, 136.5, 136.2, 134.6, 130.4, 129.2, 128.1, 127.6, 126.2, 126.1, 121.7, 121.5, 116.6, 37.7, 32.8, 25.9, 19.4. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{20}N_2O$ $[M+H]^+$ 305.1654, Found 305.1651.

4-(Naphthalen-1-yl)-*N*-(quinolin-8-yl)butanamide (3d)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), naphthalen-1-ylboronic acid **2d** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(Naphthalen-1-yl)-*N*-(quinolin-8-yl)butanamide (**3d**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 57 % yield. **M.P.:** 108 - 109 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.83 (s, 1H), 8.96 - 8.65 (m, 2H), 8.15 (t, J = 7.6 Hz, 2H), 7.87 (d, J = 7.6 Hz, 1H), 7.74 (d, J = 7.0 Hz, 1H), 7.65 - 7.34 (m, 7H), 3.25 (t, J = 7.4 Hz, 2H), 2.67 (t, J = 7.1 Hz, 2H), 2.48 - 2.22 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 138.4, 137.8, 136.5, 134.6, 134.0, 132.0, 128.9, 128.1, 127.6, 126.9, 126.4, 126.0, 125.7, 125.6, 124.0, 121.7, 121.5, 116.6, 37.7, 32.5, 26.4. **HRMS (ESI)** m/z Calcd. for $C_{23}H_{20}N_2O$ $[M+H]^+$ 341.1654, Found 341.1652.

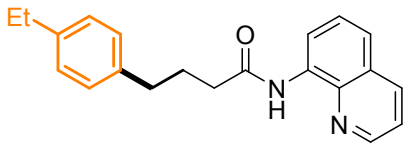
***N*-(Quinolin-8-yl)-4-*p*-tolylbutanamide (3e)**



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), *p*-tolylboronic acid **2e** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4-*p*-tolylbutanamide (**3e**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow solid in 84 % yield. **M.P.:** 56 - 57 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):**

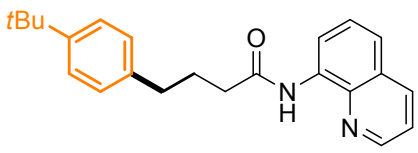
δ 9.80 (s, 1H), 8.81 (d, J = 7.1 Hz, 2H), 8.15 (d, J = 8.2 Hz, 1H), 7.56 - 7.46 (m, 2H), 7.45 (dd, J = 8.2, 4.2 Hz, 1H), 7.14 (q, J = 8.0 Hz, 4H), 2.75 (t, J = 7.5 Hz, 2H), 2.58 (t, J = 7.5 Hz, 2H), 2.34 (s, 3H), 2.20 - 2.12 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.2, 138.5, 138.4, 136.4, 135.5, 134.7, 129.2, 128.6, 128.0, 127.5, 121.7, 121.5, 116.5, 37.4, 34.9, 27.2, 21.1. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{20}N_2O$ $[M+H]^+$ 305.1654, Found 305.1652.

4-(4-Ethylphenyl)-*N*-(quinolin-8-yl)butanamide (3f)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-ethylphenylboronic acid **2f** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Ethylphenyl)-*N*-(quinolin-8-yl)butanamide (**3f**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow oil in 88 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.83 (s, 1H), 8.85 - 8.82 (m, 2H), 8.17 (d, J = 8.2 Hz, 1H), 7.59 - 7.51 (m, 2H), 7.47 (dd, J = 8.2, 4.2 Hz, 1H), 7.19 (q, J = 7.9 Hz, 4H), 2.78 (t, J = 7.5 Hz, 2H), 2.69 - 2.60 (m, 4H), 2.25 - 2.13 (m, 2H), 1.27 (t, J = 7.5 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.2, 141.9, 138.7, 138.4, 136.4, 134.6, 128.6, 128.0, 128.0, 127.5, 121.6, 121.4, 116.5, 37.5, 34.9, 28.5, 27.2, 15.7. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{22}N_2O$ $[M+H]^+$ 319.1810, Found 319.1808.

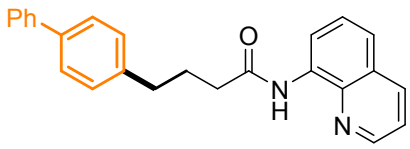
4-(4-*tert*-Butylphenyl)-*N*-(quinolin-8-yl)butanamide (3g)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-*tert*-butylphenylboronic acid **2g** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-*tert*-Butylphenyl)-*N*-(quinolin-8-yl)butanamide (**3g**) was isolated by column chromatography (DCM/EtOAc = 10/1) as a white solid in 74 % yield. **M.P.:** 64 - 65 ºC. **^{1}H NMR (400**

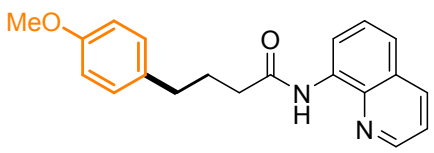
MHz, $CDCl_3$): δ 9.80 (s, 1H), 8.81 - 8.80 (m, 2H), 8.16 (d, J = 8.2 Hz, 1H), 7.59 - 7.48 (m, 2H), 7.45 (dd, J = 8.2, 4.2 Hz, 1H), 7.33 (d, J = 8.1 Hz, 2H), 7.19 (d, J = 8.0 Hz, 2H), 2.76 (t, J = 7.5 Hz, 2H), 2.60 (t, J = 7.4 Hz, 2H), 2.27 - 2.10 (m, 2H), 1.32 (s, 9H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.9, 148.2, 138.5, 138.4, 136.5, 134.6, 128.3, 128.1, 127.6, 125.4, 121.7, 121.5, 116.6, 37.6, 34.8, 34.5, 31.5, 27.1. **HRMS (ESI)** m/z Calcd. for $C_{23}H_{26}N_2O$ $[M+H]^+$ 347.2123, Found 347.2120.

4-(Biphenyl-4-yl)-*N*-(quinolin-8-yl)butanamide (3h)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), biphenyl-4-ylboronic acid **2h** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(Biphenyl-4-yl)-*N*-(quinolin-8-yl)butanamide (**3h**) was isolated by column chromatography (DCM/EtOAc = 10/1) as a white solid in 85 % yield. **M.P.:** 120 - 121 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.84 (s, 1H), 8.83-8.81 (m, 2H), 8.15 (d, J = 8.2 Hz, 1H), 7.67 - 7.39 (m, 9H), 7.37 - 7.33 (m, 3H), 2.84 (t, J = 7.5 Hz, 2H), 2.63 (t, J = 7.3 Hz, 2H), 2.29 - 2.17 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 141.1, 140.7, 139.0, 138.4, 136.5, 134.6, 129.1, 128.8, 128.0, 127.5, 127.2, 127.1, 127.1, 121.7, 121.5, 116.6, 37.4, 34.9, 27.1. **HRMS (ESI)** m/z Calcd. for $C_{25}H_{22}N_2O$ $[M+H]^+$ 367.1810, Found 367.1806.

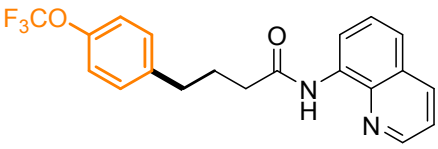
4-(4-Methoxyphenyl)-*N*-(quinolin-8-yl)butanamide (3i)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-methoxyphenyl- boronic acid **2i** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Methoxyphenyl)-*N*-(quinolin-8-yl)butanamide (**3i**) was isolated by column chromatography (PE/EtOAc = 10/1) as a white oil in 82 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.69 (s, 1H),

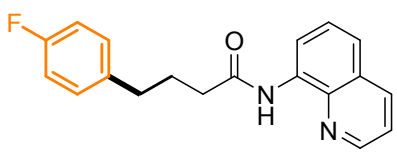
8.71 - 8.69 (m, 2H), 8.05 (d, J = 8.2 Hz, 1H), 7.44 - 7.35 (m, 3H), 7.06 (d, J = 8.4 Hz, 2H), 6.75 (d, J = 8.5 Hz, 2H), 3.69 (s, 3H), 2.62 (t, J = 7.5 Hz, 2H), 2.47 (t, J = 7.5 Hz, 2H), 2.09 - 1.97 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 158.0, 148.2, 138.4, 136.5, 134.6, 133.7, 129.6, 128.0, 127.5, 121.7, 121.5, 116.5, 113.9, 55.3, 37.4, 34.4, 27.4. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{20}N_2O_2$ $[M+H]^+$ 321.1603, Found 321.1601.

_N_-(Quinolin-8-yl)-4-(4-(trifluoromethoxy)phenyl)butanamide (3j)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-(trifluoromethoxy)- phenylboronic acid **2j** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4-(4-(trifluoromethoxy)phenyl)butanamide (**3j**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 85 % yield. **M.P.:** 56.5 - 57.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.69 (s, 1H), 8.70 - 8.68 (m, 2H), 8.04 (d, J = 8.2 Hz, 1H), 7.49 - 7.36 (m, 2H), 7.33 (dd, J = 8.2, 4.2 Hz, 1H), 7.14 (d, J = 8.4 Hz, 2H), 7.03 (d, J = 8.2 Hz, 2H), 2.66 (t, J = 7.6 Hz, 2H), 2.47 (t, J = 7.3 Hz, 2H), 2.08 - 2.00 (m, J = 7.5 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.2, 148.2, 147.6, 140.4, 138.4, 136.5, 134.5, 129.9, 128.0, 127.5, 121.7, 121.6, 121.1, 116.5, 37.2, 34.5, 27.0., **^{19}F NMR (376 MHz, $CDCl_3$):** δ -57.91 (s). **HRMS (ESI)** m/z Calcd. for $C_{20}H_{17}F_3N_2O_2$ $[M+H]+$ 375.1320, Found 375.1318.

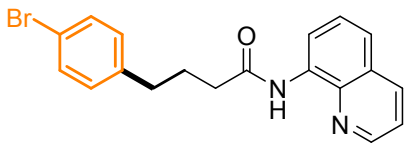
4-(4-Fluorophenyl)-_N_-(quinolin-8-yl)butanamide (3k)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-fluorophenylboronic acid **2k** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Fluorophenyl)-*N*-(quinolin-8-yl)butanamide (**3k**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow oil in 89 % yield. **^{1}H NMR (400 MHz,**

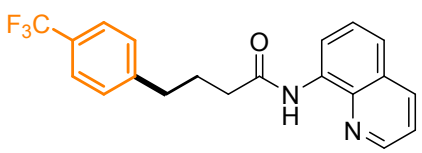
$CDCl_3$): δ 9.79 (s, 1H), 8.85 - 8.72 (m, 2H), 8.14 (d, J = 8.0 Hz, 1H), 7.61 - 7.35 (m, 3H), 7.18 (dd, *J* = 8.0, 5.7 Hz, 2H), 6.97 (t, *J* = 8.6 Hz, 2H), 2.73 (t, *J* = 7.5 Hz, 2H), 2.56 (t, *J* = 7.4 Hz, 2H), 2.20 - 2.06 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.3, 161.5 (d, *J* = 243.3 Hz), 148.2, 138.4, 137.2 (d, *J* = 3.0 Hz), 136.5, 134.6, 130.0 (d, *J* = 7.7 Hz), 128.0, 127.5, 121.6 (d, *J* = 15.0 Hz), 116.5, 115.3, 115.1, 37.2, 34.4, 27.2. **^{19}F NMR (376 MHz, $CDCl_3$):** δ -117.41 (d, *J* = 4.3 Hz). **HRMS (ESI)** m/z Calcd. for $C_{19}H_{17}FN_2O$ [M+H]+ 309.1403, Found 309.1401.

4-(4-Bromophenyl)-*N*-(quinolin-8-yl)butanamide (3l)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-*N*-(quinolin-8-yl)butanamide (**3l**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 93 % yield. **M.P.:** 55 - 56 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.78 (s, 1H), 8.80 - 8.77 (m, 2H), 8.13 (d, *J* = 8.0 Hz, 1H), 7.71 - 7.31 (m, 5H), 7.10 (d, *J* = 8.1 Hz, 2H), 2.70 (t, *J* = 7.5 Hz, 2H), 2.55 (t, *J* = 7.3 Hz, 2H), 2.16 - 2.08 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.2, 148.2, 140.5, 138.3, 136.4, 134.5, 131.5, 130.4, 128.0, 127.5, 121.7, 121.5, 119.8, 116.5, 37.1, 34.6, 26.9. **HRMS (ESI)** m/z Calcd. for $C_{19}H_{17}BrN_2O$ $[M+H]^+$ 369.0603 (100.0%), 371.0582 (97.3%), Found 369.0601(100.0%), 371.0582(97.3%).

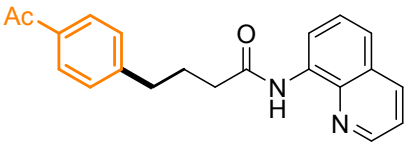
***N*-(Quinolin-8-yl)-4-(4-(trifluoromethyl)phenyl)butanamide (3m)**



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-(trifluoromethyl)phenyl- boronic acid **2m** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4-(4-(trifluoromethyl)phenyl)butanamide (**3m**) was isolated by

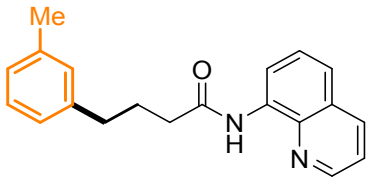
column chromatography (DCM/EtOAc = 50/1) as a white solid in 89 % yield. **M.P.:** 81 - 82 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.80 (s, 1H), 8.80 - 8.78 (m, 2H), 8.15 (dd, J = 8.2, 1.4 Hz, 1H), 7.51 (dt, J = 8.1, 7.5 Hz, 4H), 7.44 (dd, J = 8.3, 4.2 Hz, 1H), 7.38 - 7.28 (m, 2H), 2.82 (t, J = 7.6 Hz, 2H), 2.58 (t, J = 7.3 Hz, 2H), 2.21 - 2.13 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.1, 148.2, 145.7, 138.4, 136.5, 134.5, 129.0, 128.4 (q, J = 32.4 Hz), 128.0, 127.5, 125.4 (q, J = 3.8 Hz), 124.5 (q, J = 271.8 Hz), 121.7, 121.6, 116.5, 37.1, 35.0, 26.8. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -61.7, **HRMS (ESI)** m/z Calcd. for $C_{20}H_{17}F_3N_2O$ $[M+H]^+$ 359.1371, Found 359.1368.

4-(4-Acetylphenyl)-*N*-(quinolin-8-yl)butanamide (3n)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 4-acetylphenylboronic acid **2n** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Acetylphenyl)-*N*-(quinolin-8-yl)butanamide (**3n**) was isolated by column chromatography (DCM/EtOAc = 10/1) as a white solid in 85 % yield. **M.P.:** 87 - 88 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.78 (s, 1H), 8.87 - 8.70 (m, 2H), 8.15 (dd, J = 8.3, 1.4 Hz, 1H), 7.88 (d, J = 8.2 Hz, 2H), 7.57 - 7.47 (m, 2H), 7.44 (dd, J = 8.3, 4.2 Hz, 1H), 7.32 (d, J = 8.1 Hz, 2H), 2.82 (t, J = 7.6 Hz, 2H), 2.64 - 2.50 (m, 5H), 2.26 - 2.09 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 197.9, 171.1, 148.2, 147.4, 138.4, 136.5, 135.3, 134.5, 128.9, 128.7, 128.0, 127.5, 121.7, 121.6, 116.5, 37.2, 35.3, 26.7, 26.6. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{20}N_2O_2$ $[M+H]^+$ 333.1603, Found 333.1600.

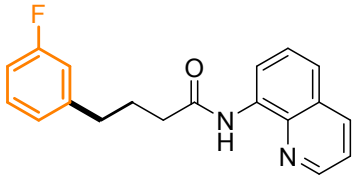
***N*-(Quinolin-8-yl)-4-*m*-tolylbutanamide (3o)**



Following the general procedure, the reaction was

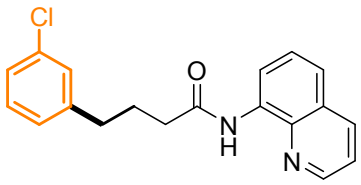
carried out with **1a** (0.2 mmol, 1.0 equiv.), *m*-tolylboronic acid **2o** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4-*m*-tolylbutanamide (**3o**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow oil in 84 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.81 (s, 1H), 8.84 - 8.80 (m, 2H), 8.15 (d, J = 8.2 Hz, 1H), 7.57 - 7.49 (m, 2H), 7.44 (dd, J = 8.2, 4.2 Hz, 1H), 7.21 (t, J = 7.4 Hz, 1H), 7.15 - 6.96 (m, 3H), 2.75 (t, J = 7.5 Hz, 2H), 2.59 (t, J = 7.4 Hz, 2H), 2.35 (s, 3H), 2.24 - 2.09 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 141.5, 138.4, 138.0, 136.4, 134.6, 129.5, 128.4, 128.0, 127.5, 126.8, 125.7, 121.6, 121.5, 116.5, 37.4, 35.2, 27.1, 21.5. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{20}N_2O$ $[M+H]^+$ 305.1654, Found 305.1652

4-(3-Fluorophenyl)-*N*-(quinolin-8-yl)butanamide (3p)



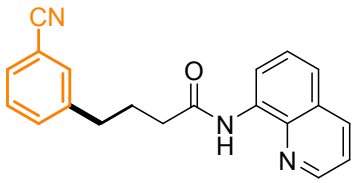
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 3-fluorophenylboronic acid **2p** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(3-Fluorophenyl)-*N*-(quinolin-8-yl)butanamide (**3p**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a colorless oil in 91 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.81 (s, 1H), 8.89 - 8.72 (m, 2H), 8.15 (d, J = 8.2 Hz, 1H), 7.59 - 7.48 (m, 2H), 7.46 (d, J = 4.2 Hz, 1H), 7.26 (dt, J = 14.2, 6.9 Hz, 1H), 7.02 (d, J = 7.6 Hz, 1H), 6.97 (d, J = 10.0 Hz, 1H), 6.91 (t, J = 8.5 Hz, 1H), 2.77 (t, J = 7.6 Hz, 2H), 2.58 (t, J = 7.4 Hz, 2H), 2.19 - 2.12 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.3, 163.02 (d, J = 245.4 Hz). 148.2, 144.2 (d, J = 7.2 Hz), 138.4, 136.5, 134.5, 129.9 (d, J = 8.3 Hz), 128.0, 127.5, 124.3 (d, J = 2.7 Hz), 121.7, 121.6, 116.5, 115.5 (d, J = 20.8 Hz), 113.0 (d, J = 21.0 Hz), 37.2, 35.0, 26.8. **^{19}F NMR (376 MHz, $CDCl_3$):** δ -113.33 (dd, J = 15.4, 9.0 Hz). **HRMS (ESI)** m/z Calcd. for $C_{19}H_{17}FN_2O$ $[M+H]^+$ 309.1403, Found 309.1402.

4-(3-Chlorophenyl)-*N*-(quinolin-8-yl)butanamide (3q)



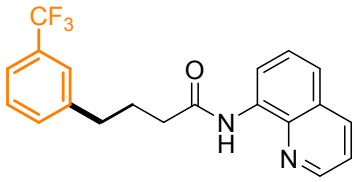
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 3-chlorophenylboronic acid **2q** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(3-Chlorophenyl)-*N*-(quinolin-8-yl)butanamide (**3q**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 93 % yield. **M.P.:** 74 - 75 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.80 (s, 1H), 8.80 - 8.78 (m, 2H), 8.15 (d, J = 7.9 Hz, 1H), 7.60 - 7.39 (m, 3H), 7.30 - 7.15 (m, 3H), 7.12 (d, J = 7.1 Hz, 1H), 2.74 (t, J = 7.5 Hz, 2H), 2.57 (t, J = 7.3 Hz, 2H), 2.20 - 2.08 (m, 2H)., **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.2, 148.2, 143.6, 138.4, 136.5, 134.5, 134.2, 129.8, 128.8, 128.0, 127.5, 126.9, 126.3, 121.7, 121.6, 116.5, 37.2, 34.9, 26.9. **HRMS (ESI)** m/z Calcd. for $C_{19}H_{17}ClN_2O$ $[M+H]^+$ 325.1108 (100.0%), 327.1078 (32.0%), Found 325.1104(100.0%), 327.1071 (32.0%).

4-(3-Cyanophenyl)-*N*-(quinolin-8-yl)butanamide (3r)



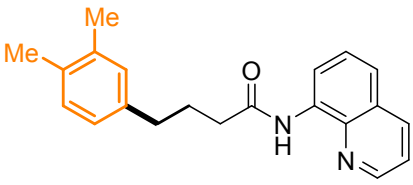
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 3-cyanophenylboronic acid **2r** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(3-Cyanophenyl)-*N*-(quinolin-8-yl)butanamide (**3r**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 87 % yield. **M.P.:** 74.5 - 75.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.79 (s, 1H), 8.81 - 8.80 (m, 2H), 8.14 (dd, J = 8.3, 1.5 Hz, 1H), 7.60 - 7.41 (m, 6H), 7.37 (t, J = 7.7 Hz, 1H), 2.78 (t, J = 7.6 Hz, 2H), 2.57 (t, J = 7.2 Hz, 2H), 2.20 - 2.06 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.9, 148.3, 143.0, 138.3, 136.5, 134.4, 133.2, 132.1, 129.9, 129.3, 128.0, 127.4, 121.7, 121.6, 119.0, 116.5, 112.5, 37.0, 34.7, 26.7. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{17}N_3O$ $[M+H]^+$ 316.1450, Found. 316.1448.

***N*-(Quinolin-8-yl)-4-(3-(trifluoromethyl)phenyl)butanamide (3s)**



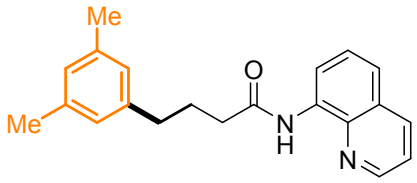
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 3-(trifluoromethyl)phenylboronic acid **2s** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4-(3-(trifluoromethyl)- phenyl)butanamide (**3s**) was isolated by column chromatography (DCM as eluent) as a white solid in 86 % yield. **M.P.:** 79 - 80 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.81 (s, 1H), 8.84 - 8.71 (m, 2H), 8.16 (dd, J = 8.3, 1.5 Hz, 1H), 7.61 – 7.35 (m, 7H), 2.88 - 2.78 (m, 2H), 2.60 (t, J = 7.3 Hz, 2H), 2.23 - 2.12 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.2, 148.3, 142.6, 138.4, 136.5, 134.5, 132.1, 130.8 (q, J = 31.9 Hz), 129.0, 128.1, 127.5, 125.3 (q, J = 3.7 Hz), 124.4 (q, J = 272.3 Hz), 123.0 (q, J = 3.9 Hz), 121.8, 121.6, 116.6, 37.2, 35.1, 27.0. **^{19}F NMR (376 MHz, $CDCl_3$):** δ -62.2., **HRMS (ESI)** m/z Calcd. for $C_{20}H_{17}F_3N_2O$ $[M+H]^+$ 359.1371, Found 359.1367.

4-(3, 4-Dimethylphenyl)-*N*-(quinolin-8-yl)butanamide (3t)



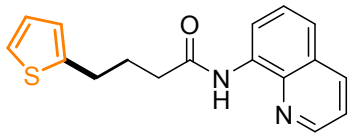
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 3,4-dimethylphenyl- boronic acid **2t** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(3,4-Dimethylphenyl)-*N*- (quinolin-8-yl)butanamide (**3t**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow oil in 86 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.80 (s, 1H), 8.82 - 8.81 (m, 2H), 8.16 (d, J = 8.2 Hz, 1H), 7.63 - 7.40 (m, 3H), 7.14 - 6.90 (m, 3H), 2.72 (t, J = 7.5 Hz, 2H), 2.58 (t, J = 7.4 Hz, 2H), 2.25 (s, 3H), 2.24 (s, 3H), 2.21 - 2.10 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.7, 148.2, 139.0, 138.4, 136.6, 136.5, 134.7, 134.1, 130.1, 129.8, 128.0, 127.5, 126.0, 121.7, 121.5, 116.5, 37.5, 34.8, 27.2, 19.8, 19.4. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{22}N_2O$ $[M+H]^+$ 319.1810, Found 319.1808.

4-(3, 5-Dimethylphenyl)-*N*-(quinolin-8-yl)butanamide (3u)



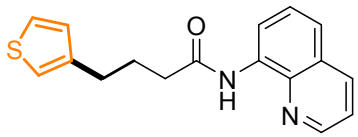
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), 3,5-dimethylphenylboronic acid **2u** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(3,5-Dimethylphenyl)-*N*-(quinolin-8-yl)- butanamide (**3u**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow solid in 82 % yield. **M.P.:** 57 - 58 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.82 (s, 1H), 8.84 - 8.80 (m, 2H), 8.15 (d, J = 8.1 Hz, 1H), 7.64 - 7.35 (m, 3H), 6.89 - 6.86 (m, 3H), 2.72 (t, J = 7.4 Hz, 2H), 2.59 (t, J = 7.4 Hz, 2H), 2.31 (s, 6H), 2.24 - 2.05 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.2, 141.5, 138.4, 137.9, 136.4, 134.6, 128.0, 127.7, 127.5, 126.5, 121.6, 121.4, 116.5, 37.4, 35.1, 27.1, 21.4. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{22}N_2O$ $[M+H]^+$ 319.1810, Found 319.1807.

***N*-(Quinolin-8-yl)-4-(thiophen-2-yl)butanamide (3v)**



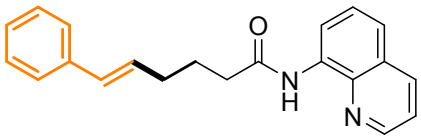
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), thiophen-2-ylboronic acid **2v** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)-4- (thiophen-2-yl)butanamide (**3v**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 66 % yield. **M.P.:** 73.5 - 74.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.70 (s, 1H), 8.70 -8.68 (m, 2H), 8.06 (d, J = 8.2 Hz, 1H), 7.51 - 7.38 (m, 2H), 7.35 (dd, J = 7.2, 3.8 Hz, 1H), 7.04 (d, J = 4.6 Hz, 1H), 6.89 - 6.80 (m, 1H), 6.80 - 6.72 (m, 1H), 2.90 (t, J = 7.2 Hz, 1H), 2.52 (t, J = 7.2 Hz, 1H), 2.11 (p, J = 7.2 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.3, 148.2, 144.4, 138.4, 136.5, 134.6, 128.1, 127.6, 126.9, 124.8, 123.4, 121.7, 121.6, 116.6, 37.0, 29.4, 27.5. **HRMS (ESI)** m/z Calcd. for $C_{17}H_{16}N_2OS$ $[M+H]^+$ 297.1062, Found 297.1059.

***N*-(Quinolin-8-yl)-4-(thiophen-3-yl)butanamide (3w)**



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), thiophen-3-ylboronic acid **2w** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. *N*-(Quinolin-8-yl)- 4-(thiophen-3-yl)butanamide (**3w**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 85 % yield. **M.P.:** 60 - 61 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.05 (s, 1H), 9.06 - 9.05 (m, 2H), 8.40 (dd, J = 8.2, 1.3 Hz, 1H), 7.87 - 7.73 (m, 2H), 7.70 (dd, J = 8.2, 4.2 Hz, 1H), 7.53 - 7.51 (m, 1H), 7.26 (dd, J = 7.1, 3.4 Hz, 2H), 3.05 (t, J = 7.4 Hz, 2H), 2.84 (t, J = 7.4 Hz, 2H), 2.42 (p, J = 7.4 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 141.9, 138.4, 136.5, 134.6, 128.3, 128.0, 127.5, 125.6, 121.7, 121.5, 120.7, 116.5, 37.4, 29.7, 26.3. **HRMS (ESI)** m/z Calcd. for $C_{17}H_{16}N_2OS$ $[M+H]^+$ 318.1858, Found 297.1058.

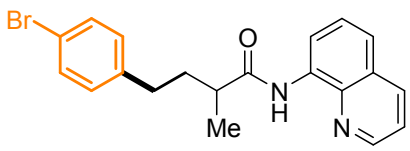
(*E*)-6-Phenyl-*N*-(quinolin-8-yl)hex-5-enamide (3x)



Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 1.0 equiv.), (*E*)-styrylboronic acid **2x** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. (*E*)-6-Phenyl-*N*-(quinolin-8-yl)hex-5-enamide (**3x**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 76 % yield. **M.P.:** 83 - 84 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.84 (s, 1H), 8.92 - 8.68 (m, 2H), 8.15 (dd, J = 8.3, 1.6 Hz, 1H), 7.61 - 7.47 (m, 2H), 7.47 - 7.38 (m, 1H), 7.36 - 7.34 (m, 2H), 7.29 (t, J = 7.6 Hz, 2H), 7.20 (t, J = 7.2 Hz, 1H), 6.46 (d, J = 15.8 Hz, 1H), 6.26 (dt, J = 15.8, 6.9 Hz, 1H), 2.62 (t, J = 7.5 Hz, 1H), 2.43 - 2.32 (m, J = 6.8 Hz, 1H), 2.03 (p, J = 7.5 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.7, 148.2, 138.4, 137.7, 136.5, 134.6, 131.0, 129.8, 128.6, 128.0, 127.5, 127.1, 126.1, 121.7, 121.5, 116.5, 37.5, 32.5, 25.2. **HRMS (ESI)** m/z Calcd. for

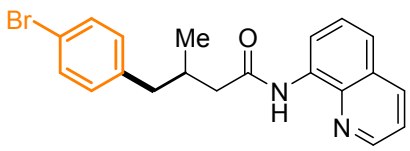
$C_{21}H_{20}N_2O$ $[M+H]^+$ 317.1654, Found 317.1652.

4-(4-Bromophenyl)-2-methyl-*N*-(quinolin-8-yl)butanamide (4a)



Following the general procedure, the reaction was carried out with **1g** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-2-methyl-*N*-(quinolin-8-yl)butanamide (**4a**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 88 % yield. **M.P.:** 74 - 75 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.86 (s, 1H), 8.83 - 8.81 (m, 2H), 8.15 (dd, J = 8.2, 1.2 Hz, 1H), 7.56 - 7.51(m, 2H), 7.45 (dd, J = 8.2, 4.2 Hz, 1H), 7.37 (d, J = 8.2 Hz, 2H), 7.08 (d, J = 8.2 Hz, 2H), 2.76 - 2.45 (m, 3H), 2.33 - 2.08 (m, 1H), 1.86 - 1.77 (m, 1H), 1.35 (d, J = 6.9 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 174.8, 148.3, 140.7, 138.5, 136.5, 134.5, 131.5, 130.4, 128.0, 127.5, 121.7, 121.6, 119.7, 116.6, 42.2, 35.9, 33.1, 18.4. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{19}BrN_2O$ $[M+H]^+$ 383.0759 (100.0%), 385.0739 (97.3%), Found 383.0755 (100.0%), 385.0735(97.3%).

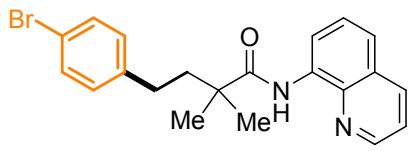
4-(4-Bromophenyl)-3-methyl-*N*-(quinolin-8-yl)butanamide (4b)



Following the general procedure, the reaction was carried out with **1k** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-3-methyl-*N*-(quinolin-8-yl)butanamide (**4b**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow oil in 75 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.78 (s, 1H), 8.84 - 8.73 (m, 2H), 8.15 (dd, J = 8.3, 1.6 Hz, 1H), 7.57 - 7.47 (m, 2H), 7.45 (dd, J = 8.3, 4.2 Hz, 1H), 7.39 (d, J = 8.3 Hz, 2H), 7.10 (d, J = 8.3 Hz, 2H), 2.74 (dd, J = 12.7, 6.1 Hz, 1H), 2.60 - 2.43 (m, 3H), 2.39 (dd, J = 12.7, 6.1 Hz, 1H), 1.03 (d, J = 6.1 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.9, 148.2, 139.4,

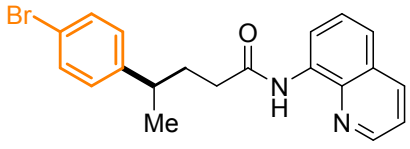
138.4, 136.5, 134.5, 131.4, 131.1, 128.0, 127.5, 121.7, 121.6, 119.9, 116.5, 45.0, 42.4, 32.6, 19.7. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{19}BrN_2O$ $[M+H]^+$ 383.0759 (100.0%), 385.0739 (97.3%), Found 383.0756 (100.0%), 385.0735 (97.3%).

4-(4-Bromophenyl)-2,2-dimethyl-*N*-(quinolin-8-yl)butanamide (4c)



Following the general procedure, the reaction was carried out with **1h** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), $PhPMe_2$ (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 125 °C for 24 h. 4-(4-Bromophenyl)-2,2-dimethyl-*N*-(quinolin-8-yl)butanamide (**4c**) was isolated by column chromatography (DCM as eluent) as a coloress oil in 67 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.31 (s, 1H), 8.83 - 8.80 (m, 2H), 8.17 (d, J = 9.5 Hz, 1H), 7.60 - 7.49 (m, 2H), 7.46 (dd, J = 8.2, 4.2 Hz, 1H), 7.34 (d, J = 8.2 Hz, 2H), 7.08 (d, J = 8.2 Hz, 2H), 2.72 -2.50 (m, 2H), 2.18 - 1.89 (m, 2H), 1.48 (s, 6H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 176.0, 148.4, 141.3, 138.9, 136.5, 134.6, 131.4, 130.3, 128.1, 127.6, 121.7, 121.5, 119.6, 116.4, 44.0, 43.6, 31.1, 29.8, 25.9. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{21}BrN_2O$ $[M+H]^+$ 397.0916 (100.0%), 399.0895 (97.3%), Found 397.0915 (100.0%), 399.0904(97.3%).

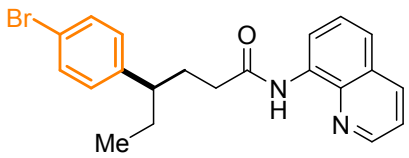
4-(4-Bromophenyl)-*N*-(quinolin-8-yl)pentanamide (4d)



Following the general procedure, the reaction was carried out with **1b** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-*N*-(quinolin-8-yl)pentanamide (**4d**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow oil in 92 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.68 (s, 1H), 8.81 - 8.70 (m, 2H), 8.13 (d, J = 8.2 Hz, 1H), 7.59 - 7.45 (m, 2H), 7.41 (d, J = 7.5 Hz, 3H), 7.11 (d, J = 7.5 Hz, 2H), 2.87 - 2.73 (m, 1H), 2.41 (t, J

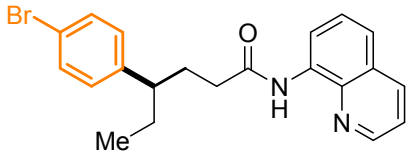
= 7.4 Hz, 2H), 2.19 - 2.11 (m, 1H), 2.06 - 1.96 (m, 1H), 1.29 (d, *J* = 6.7 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.4, 148.2, 145.4, 138.3, 136.4, 134.5, 131.7, 127.0, 128.0, 127.5, 121.7, 121.5, 119.9, 116.4, 39.0, 36.1, 33.6, 22.5. **HRMS (ESI)** m/z Calcd. for $C_{20}H_{19}BrN_2O$ $[M+H]^+$ 383.0759 (100.0%), 385.0739 (97.3%), Found 383.0756 (100.0%), 385.0735 (97.3%).

4-(4-Bromophenyl)-*N*-(quinolin-8-yl)hexanamide (4e, from *trans*)



Following the general procedure, the reaction was carried out with **1c** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-*N*-(quinolin-8-yl)- hexanamide (**4e**, from *trans*) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 91 % yield. **M.P.:** 60.5 - 61.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.64 (s, 1H), 8.77 - 8.75 (m, 2H), 8.13 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.58 - 7.45 (m, 2H), 7.45 -7.34 (m, 3H), 7.07 (d, *J* = 8.3 Hz, 2H), 2.56 - 2.49 (m, 1H), 2.45 - 2.31 (m, 2H), 2.31 - 2.18 (m, 1H), 2.06 - 1.88 (m, 1H), 1.81 - 1.67 (m, 1H), 1.67 - 1.51 (m, 1H), 0.78 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 143.7, 138.3, 136.4, 134.5, 131.6, 129.7, 128.0, 127.5, 121.7, 121.5, 120.0, 116.5, 46.9, 36.0, 31.9, 29.9, 12.1. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{21}BrN_2O$ $[M+H]^+$ 397.0916 (100.0%), 399.0895 (97.3%), Found 397.0914 (100.0%), 399.0891 (97.3%).

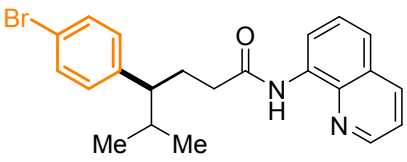
4-(4-Bromophenyl)-*N*-(quinolin-8-yl)hexanamide (4e, from *cis*)



Following the general procedure, the reaction was carried out with **1c** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.), and CsOPiv

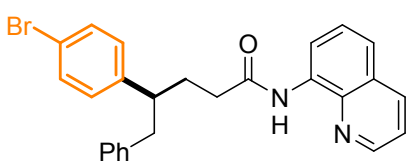
(0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-*N*-(quinolin-8-yl)hexanamide (**4e**, from *cis*) was isolated by column chromatography (DCM/EtOAc = 50/1) as a white solid in 87 % yield. **M.P.:** 60.5 - 61.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.64 (s, 1H), 8.77 - 8.75 (m, 2H), 8.13 (dd, J = 8.3, 1.6 Hz, 1H), 7.58 - 7.45 (m, 2H), 7.45 -7.34 (m, 3H), 7.07 (d, J = 8.3 Hz, 2H), 2.56 - 2.49 (m, 1H), 2.45 - 2.31 (m, 2H), 2.31 - 2.18 (m, 1H), 2.06 - 1.88 (m, 1H), 1.81 - 1.67 (m, 1H), 1.67 - 1.51 (m, 1H), 0.78 (t, J = 7.4 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 143.7, 138.3, 136.4, 134.5, 131.6, 129.7, 128.0, 127.5, 121.7, 121.5, 120.0, 116.5, 46.9, 36.0, 31.9, 29.9, 12.1. **HRMS (ESI)** m/z Calcd. for $C_{21}H_{21}BrN_2O$ $[M+H]^+$ 397.0916 (100.0%), 399.0895 (97.3%), Found 397.0914 (100.0%), 399.0891 (97.3%).

4-(4-Bromophenyl)-5-methyl-*N*-(quinolin-8-yl)hexanamide (4f)



Following the general procedure, the reaction was carried out with **1e** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-5-methyl-*N*-(quinolin-8-yl) -hexanamide (**4f**) was isolated by column chromatography (PE/EtOAc = 10/1) as a light yellow oil in 89 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.59 (s, 1H), 8.76 - 8.74 (m, 2H), 8.14 (d, J = 8.1 Hz, 1H), 7.54 - 7.70 (m, 5H), 7.05 (d, J = 7.1 Hz, 2H), 2.36 - 2.21 (m, 4H), 2.09 - 1.88 (m, 1H), 1.85 - 1.80 (m, 1H), 1.00 (d, J = 6.2 Hz, 3H), 0.72 (d, J = 6.2 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.2, 142.6, 138.3, 136.4, 134.5, 131.5, 130.4, 128.0, 127.5, 121.7, 121.5, 120.0, 116.4, 52.1, 36.3, 33.7, 28.7, 21.0, 20.8. **HRMS (ESI)** m/z Calcd. for $C_{22}H_{23}BrN_2O$ $[M+H]^+$ 411.1072 (100.0%), 413.1052 (97.3%), Found 411.1068 (100.0%), 413.1047 (97.3%).

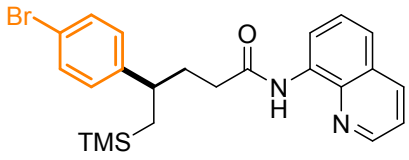
4-(4-Bromophenyl)-5-phenyl-*N*-(quinolin-8-yl)pentanamide (4g)



Following the general procedure, the reaction was

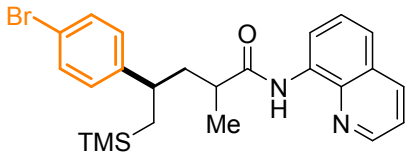
carried out with **1f** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-5-phenyl-*N*-(quinolin-8-yl) -pentanamide (**4g**) was isolated by column chromatography (DCM/EtOAc = 50/1) as a colorless oil in 91 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.62 (s, 1H), 8.79 - 8.63 (m, 1H), 8.14 (d, *J* = 8.2 Hz, 1H), 7.58 - 7.46 (m, 2H), 7.43 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.38 (d, J = 8.3 Hz, 2H), 7.21 - 7.11 (m, 3H), 7.07 - 6.97 (m, 4H), 3.05 - 2.80 (m, 3H), 2.46 - 2.24 (m, 3H), 2.15 - 1.99 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.3, 148.1, 142.9, 139.8, 138.3, 136.4, 134.4, 131.6, 129.7, 129.2, 128.3, 128.0, 127.5, 126.1, 121.7, 121.5, 120.2, 116.5, 47.1, 43.9, 36.0, 31.2. **HRMS (ESI)** m/z Calcd. for $C_{26}H_{23}BrN_2O$ $[M+H]^+$ 459.1072 (100.0%), 461.1052 (97.3%), Found 459.1070 (100.0%), 461.1050 (97.3%).

4-(4-Bromophenyl)-*N*-(quinolin-8-yl)-5-(trimethylsilyl)pentanamide (4h)



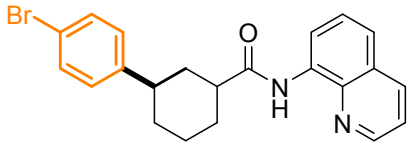
Following the general procedure, the reaction was carried out with **1l** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-*N*-(quinolin-8-yl)-5- (trimethylsilyl)pentanamide (**4h**) was isolated by column chromatography (DCM as eluent) as a white solid in 64 % yield. **M.P.:** 107.5 - 108.5 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.63 (s, 1H), 8.76 (ddd, *J* = 8.4, 5.7, 1.3 Hz, 2H), 8.15 (dd, *J* = 8.4, 1.3 Hz, 1H), 7.56 - 7.46 (m, 2H), 7.44 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.40 (d, *J* = 8.3 Hz, 2H), 7.10 (d, *J* = 8.3 Hz, 2H), 2.82 - 2.69 (m, 1H), 2.32 (t, *J* = 7.5 Hz, 2H), 2.27 - 2.15 (m, 1H), 2.05 - 1.92 (m, 1H), 1.08 - 0.92 (m, 2H), -0.18 (s, 9H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 148.2, 145.5, 138.4, 136.5, 134.6, 131.7, 129.5, 128.0, 127.5, 121.7, 121.5, 1120, 116.5, 41.3, 36.2, 25.6, -0.9. **HRMS (ESI)** m/z Calcd. for $C_{23}H_{27}BrN_2OSi$ $[M+H]^+$ 455.1154 (100.0%), 457.1134 (97.3%), Found 455.1150 (100.0%), 457.1130 (97.3%).

4-(4-Bromophenyl)-2-methyl-*N*-(quinolin-8-yl)-5-(trimethylsilyl)pentanamide(4i)



Following the general procedure, the reaction was carried out with **1n** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-2-methyl-*N*- (quinolin-8-yl)-5-(trimethylsilyl)pentanamide (**4i**) was isolated by column chromatography (DCM as eluent) as a white oil in 38 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.61 (s, 1H), 8.96 - 8.63 (m, 2H), 8.18 (dd, J = 8.3, 1.6 Hz, 1H), 7.60 - 7.51 (m, 2H), 7.48 (dd, J = 8.3, 4.2 Hz, 1H), 7.37 (d, J = 8.3 Hz, 2H), 7.07 (d, J = 8.4 Hz, 2H), 2.76 - 2.69 (m, 1H), 2.27 - 2.15 (m, 2H), 1.78 - 1.53 (m, 1H), 1.20 (d, J = 6.4 Hz, 3H), 0.92 (m, 2H), -0.24 (s, 9H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 175.1, 148.2, 145.8, 138.5, 136.5, 134.6, 131.7, 129.6, 128.1, 127.6, 121.8, 121.6, 119.9, 116.6, 45.7, 41.1, 39.9, 26.3, 19.4, -0.9. **HRMS (ESI)** m/z Calcd. for $C_{22}H_{24}NO$ [M+H]+ 318.1858, Found 318.1861.

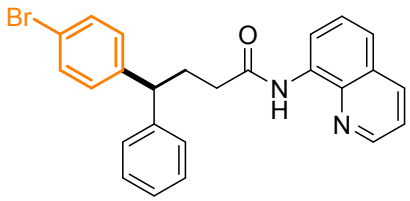
3-(4-Bromophenyl)-*N*-(quinolin-8-yl)cyclohexanecarboxamide (4j)



Following the general procedure, the reaction was carried out with **1i** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 3-(4-Bromophenyl)-*N*-(quinolin-8-yl)cyclohexanecarboxamide (**4j**) was isolated by column chromatography (DCM as eluent) as a white solid in 85 % yield. **M.P.:** 117 - 118 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.91 (s, 1H), 8.81 - 8.79 (m, 2H), 8.16 (d, J = 8.2 Hz, 1H), 7.65 - 7.37 (m, 5H), 7.13 (d, J = 8.3 Hz, 2H), 2.71 - 2.56 (m, 2H), 2.25 - 2.15 (m, 2H), 2.09 - 2.00 (m, 1H), 1.94 - 1.91 (m, 1H), 1.87 - 1.77 (m, 1H), 1.76 - 1.65 (m, 1H), 1.61 -1.41 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 174.2, 148.3, 145.7, 138.6, 136.5, 134.8, 131.6, 128.8, 128.1, 127.6, 121.7, 121.6, 119.9, 116.6, 47.3, 43.4, 36.8, 33.8, 29.3, 26.0. **HRMS (ESI)** m/z Calcd. for $C_{24}H_{29}BrN_2OSi$ $[M+H]^+$ 409.0916 (100.0%),

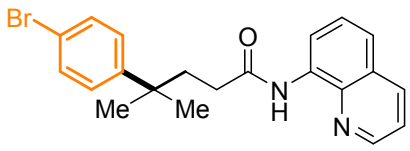
411.0895 (97.3%), Found 409.0913 (100.0%), 411.0891 (97.3%).

4-(4-Bromophenyl)-4-phenyl-*N*-(quinolin-8-yl)butanamide (4k)



Following the general procedure, the reaction was carried out with **1j** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-4-phenyl-*N*-(quinolin-8-yl)butanamide (**4k**) was isolated by column chromatography (DCM as eluent) as a white solid in 90 % yield. **M.P.:** 110 - 111 °C. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.74 (s, 1H), 8.83 - 8.80 (m, 2H), 8.18 (d, J = 8.1 Hz, 1H), 7.63 - 7.50 (m, 2H), 7.48 - 7.44 (m, 3H), 7.41 - 7.28 (m, 4H), 7.27 - 7.20 (m, 3H), 4.06 (t, J = 7.2 Hz, 1H), 2.85 - 2.25 (m, 4H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.1, 148.2, 143.7, 143.5, 138.4, 136.5, 134.5, 131.7, 129.8, 128.8, 128.0, 127.9, 127.5, 126.7, 121.7, 121.6, 120.3, 116.5, 50.0, 36.2, 30.9. **HRMS (ESI)** m/z Calcd. for $C_{25}H_{21}BrN_2O$ $[M+H]^+$ 445.0916 (100.0%), 447.0895 (97.3%), Found 445.0913 (100.0%), 447.0882 (97.3%).

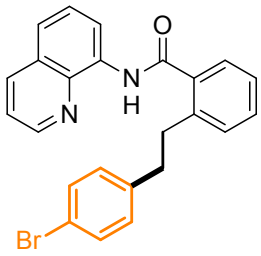
4-(4-Bromophenyl)-4-methyl-*N*-(quinolin-8-yl)pentanamide (4l)



Following the general procedure, the reaction was carried out with **1o** (0.2 mmol, 1.0 equiv.), 4-bromophenylboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.01 mmol, 0.05 equiv.), PPh_3 (0.02 mmol, 0.1 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 70 °C for 24 h. 4-(4-Bromophenyl)-4-methyl-*N*-(quinolin-8-yl)pentanamide (**4l**) was isolated by column chromatography (DCM as eluent) as a colorless oil in 88 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.62 (s, 1H), 8.76 - 8.71 (m, 2H), 8.11 (d, J = 8.3 Hz, 1H), 7.57 - 7.35 (m, 5H), 7.25 (d, J = 8.5 Hz, 2H), 2.28 (dd, J = 10.3, 5.6 Hz, 2H), 2.15 (dd, J = 10.3, 5.5 Hz, 2H), 1.35 (s, 6H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.6, 148.1, 147.4, 138.3, 136.4, 134.5, 131.4, 128.0, 127.9, 127.5, 121.7, 121.5, 119.8, 116.4, 39.2, 37.4, 33.8, 28.9.

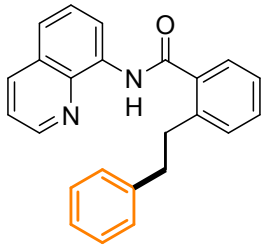
HRMS (ESI) m/z Calcd. for $C_{21}H_{21}BrN_2O$ $[M+H]^+$ 397.0916 (100.0%), 399.0895 (97.3%), Found 397.0913(100.0%), 399.0885(97.3%).

2-(4-Bromophenethyl)-*N*-(quinolin-8-yl)benzamide (4lm)



Following the general procedure, the reaction was carried out with **1m** (0.2 mmol, 1.0 equiv.), 4-bromophenyboronic acid **2l** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.02 mmol, 0.1 equiv.), $PhPCy_2$ (0.04 mmol, 0.2 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 125 °C for 48 h. 2-(4-Bromophenethyl)-*N*-(quinolin-8-yl)benzamide (**4lm**) was isolated by column chromatography (DCM as eluent) as a white solid in 68 % yield. **M.P.:** 77 - 78 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.11 (s, 1H), 8.92 (d, J = 6.6 Hz, 1H), 8.76 (dd, J = 4.2, 1.6 Hz, 1H), 8.16 (dd, J = 8.3, 1.6 Hz, 1H), 7.65 (dd, J = 7.5, 1.1 Hz, 1H), 7.63 - 7.53 (m, 2H), 7.45 - 7.40 (m, 2H), 7.33 (td, J = 7.5, 1.2 Hz, 1H), 7.28 - 7.21 (m, 3H), 6.99 (d, J = 8.3 Hz, 2H), 3.21 (t, J = 8.0 Hz, 2H), 2.94 (t, J = 8.0 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 168.2, 148.5, 140.7, 140.3, 138.6, 136.7, 136.5, 134.8, 131.3, 130.9, 130.5, 128.2, 127.5, 127.3, 126.6, 122.0, 121.8, 119.7, 116.5, 37.6, 35.4. **HRMS (ESI)** m/z Calcd. for $C_{24}H_{19}BrN_2O$ $[M+H]^+$ 431.0759 (100.0%), 433.0739 (97.3%), Found 431.0754 (100.0%), 433.0732 (97.3%).

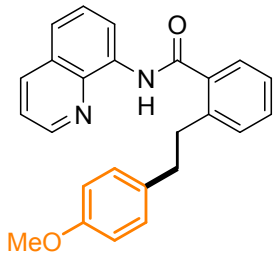
2-Phenethyl-*N*-(quinolin-8-yl)benzamide (4bm)



Following the general procedure, the reaction was carried out with **1m** (0.2 mmol, 1.0 equiv.), phenylboronic acid **2b** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.02 mmol, 0.1 equiv.), $PhPCy_2$ (0.04 mmol, 0.2 equiv.) and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 125 °C for 48 h. 2-Phenethyl-*N*-(quinolin-8-yl)benzamide (**4bm**) was isolated by column chromatography (DCM/hexane = 1/1)

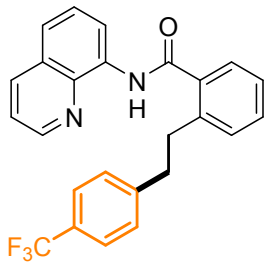
as a colorless oil in 74 % yield. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.25 (s, 1H), 9.06 (d, J = 7.2 Hz, 1H), 8.85 (s, 1H), 8.26 (d, J = 7.2 Hz, 1H), 7.77 - 7.72 (m, 1H), 7.71 - 7.61 (m, 2H), 7.55 - 7.49 (m, 2H), 7.47 - 7.35 (m, 2H), 7.26 (d, J = 3.1 Hz, 4H), 7.19 - 7.11 (m, 1H), 3.34 (t, J = 6.8 Hz, 2H), 3.2 (t, J = 6.8 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 168.3, 148.4, 141.8, 140.7, 138.6, 136.8, 136.5, 134.9, 130.8, 130.4, 128.7, 128.3, 128.1, 127.5, 127.3, 126.5, 125.9, 121.9, 121.8, 116.6, 38.2, 35.7. **HRMS (ESI)** m/z Calcd. for $C_{24}H_{20}N_2O$ $[M+H]^+$ 353.1654 Found 353.1650.

2-(4-Methoxyphenethyl)-*N*-(quinolin-8-yl)benzamide (4im)



Following the general procedure, the reaction was carried out with **1m** (0.2 mmol, 1.0 equiv.), 4-methoxyphenyl- boronic acid **2i** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.02 mmol, 0.1 equiv.), $PhPCy_2$ (0.04 mmol, 0.2 equiv.), and CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 125 °C for 48 h. 2-(4-Methoxyphenethyl)-*N*- (quinolin-8-yl)benzamide (**4im**) was isolated by column chromatography (DCM/hexane = 1/1) as a white solid in 62 % yield. **M.P.:** 121 -122 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.12 (s, 1H), 8.98 (d, J = 7.3 Hz, 1H), 8.78 (s, 1H), 8.17 (d, J = 8.2 Hz, 1H), 7.68 (d, J = 7.4 Hz, 1H), 7.62 (t, J = 7.9 Hz, 1H), 7.56 (d, J = 7.9 Hz, 1H), 7.46 - 7.42 (m, 2H), 7.37 - 7.31 (m, 2H), 7.07 (d, J = 8.0 Hz, 2H), 6.70 (d, J = 8.1 Hz, 2H), 3.61 (s, 3H), 3.26 (t, J = 7.8 Hz, 2H), 2.98 (t, J = 7.8 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 168.3, 157.8, 148.3, 140.7, 138.6, 136.9, 136.4, 134.9, 133.8, 130.9, 130.4, 129.6, 128.1, 127.5, 127.2, 126.4, 121.8, 121.7, 116.6, 113.7, 55.1, 37.4, 35.8. **HRMS (ESI)** m/z Calcd. for $C_{25}H_{22}N_2O_2$ $[M+H]^+$ 383.1760 Found 383.1756.

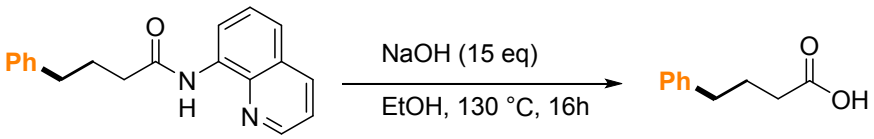
***N*-(Quinolin-8-yl)-2-(4-(trifluoromethyl)phenethyl)benzamide (4mm)**



Following the general procedure, the reaction was carried out with **1m** (0.2 mmol, 1.0 equiv.), 4-(trifluoromethyl)-phenylboronic acid **2m** (0.4 mmol, 2.0 equiv.), $Ni(cod)_2$ (0.02 mmol, 0.1 equiv.), $PhPCy_2$ (0.04 mmol, 0.2 equiv.) and

CsOPiv (0.3 mmol, 1.5 equiv.) in *t*-AmylOH (1 mL) at 125 °C for 48 h. *N*-(Quinolin-8-yl)-2-(4- (trifluoromethyl)phenethyl)benzamide (**4mm**) was isolated by column chromatography (DCM/hexane = 1/1) as a white solid in 77 % yield. **M.P.:** 117 - 118 ºC. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 10.22 (s, 1H), 9.00 (d, J = 7.3 Hz, 1H), 8.79 -8.77 (m, 1H), 8.18 (dd, J = 8.2, 1.4 Hz, 1H), 7.72 (d, J = 7.4 Hz, 1H), 7.63 (t, J = 7.9 Hz, 1H), 7.58 - 7.56 (m, 1H), 7.50 - 7.41 (m, 4H), 7.38 (t, J = 6.9 Hz, 1H), 7.30 (d, J = 7.8 Hz, 3H), 3.37 – 3.19 (m, 2H), 3.11 (t, J = 7.2 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 168.1, 148.4, 145.9, 140.3, 138.6, 136.6, 136.5, 134.8, 130.9, 130.6, 129. 0, 128.2 (q, J = 32.2 Hz), 128.1, 127.5, 127.4, 126.7, 125.2 (q, J = 3.7 Hz), 124.4 (q, J = 271.8 Hz), 122.0, 121.8, 116.6, 40.0, 35.4. **HRMS (ESI)** m/z Calcd. for $C_{25}H_{19}F_3N_2O$ $[M+H]^+$ 421.1528 Found 421.1526.

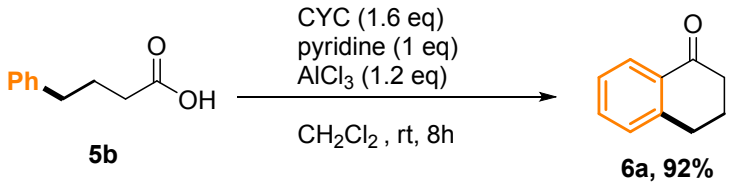
4. Removal of Directing Group & Derivative reaction



3b **5b , 97%**

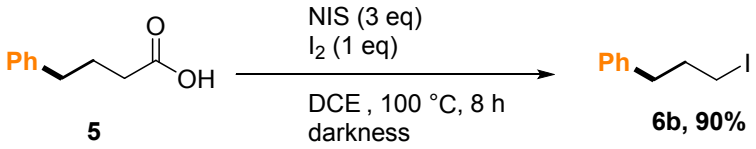
To an oven-dried 50 mL Schlenk tube equipped with a Teflon stirrer bar were subsequently added 4-phenyl-*N*-(quinolin-8-yl)butanamide **3b** (1 mmol, 0.29 g), NaOH (15 mmol, 0.6 g) and EtOH (20 mL). After stirred at 130 ºC for 16 h, the reaction was allowed to cool to room temperature, diluted with EtOAc (100 mL) and washed with HCl (1 M, 3 × 50 mL). The organic layers were combined, dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography (PE/EA = 5/1) to give **5b** (0.159 g, 97%) as a white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.32 - 7.29 (m, 2H), 7.23 - 7.19 (m, 2H), 2.69 (t, J = 7.6 Hz, 2H), 2.39 (t, J = 7.4 Hz, 2H), 2.05 - 1.92 (m, 2H).

Synthesis of 3,4-dihydronaphthalen-1(2*H*)-one[9]



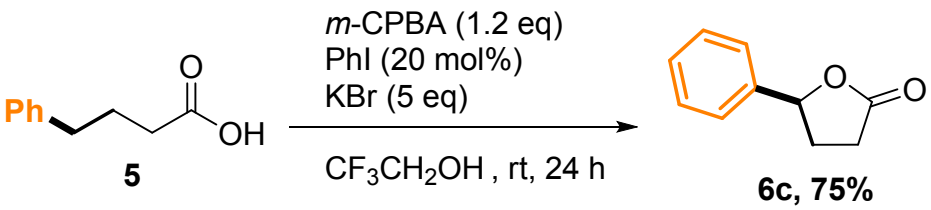
To a solution of 4-phenylbutyric acid **5b** (1 mmol, 0.164 g) and cyanuric chloride (1.6 mmol, 0.294 g) in CH_2Cl_2 (6 mL) at room temperature, pyridine (1 mmol, 82.0 μL) was added dropwise. After 15 min, $AlCl_3$ (1.2 mmol, 0.16 g) was added portion-wise and stirred for 8 h. The organic mixture was purified by column chromatography (PE/EA = 5/1) to give **6a** (0.159 g, 92%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.02 (dd, J = 7.8, 0.9 Hz, 1H), 7.46 (td, J = 7.8, 1.4 Hz, 1H), 7.29 (t, J = 7.8 Hz, 1H), 7.24 (d, J = 7.8 Hz, 1H), 2.96 (t, J = 6.1 Hz, 2H), 2.65 (t, J = 6.1 Hz, 2H), 2.17 - 2.10 (m, 2H).

Synthesis of (3-iodopropyl)benzene[10]



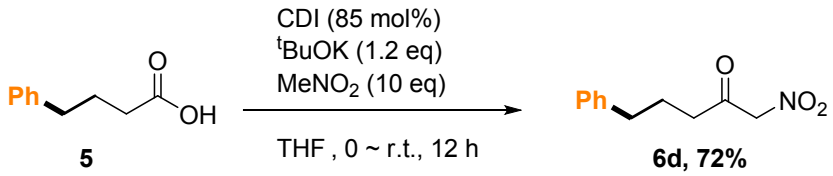
To a solution of 4-phenylbutyric acid **5** (1 mmol, 0.164 g) of 1,2-dichloroethane (10 mL) in a 25 mL screw-capped flask were added *N*-iodosuccinimide (3.0 mmol, 0.675 g) and molecular iodine (1.0 mmol, 0.254 g). The mixture was stirred at 100 ºC for 8h in dark. After cooling to room temperature, the organic mixture was diluted with 20 mL of DCM and washed with sat. aq. Na_2SO_3 (3 × 15 mL). The organic layers were combined, dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography (*n*-hexane as eluent) to give **6b** (0.221 g, 90%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.37 - 7.33 (m, 2H), 7.28 - 7.24 (m, 3H), 3.22 (t, J = 6.8 Hz, 2H), 2.78 (t, J = 7.3 Hz, 2H), 2.25 - 2.10 (m, 2H).

Synthesis of 5-phenyldihydrofuran-2(3*H*)-one[11]



The solution of 4-phenylbutyric acid **5** (0.5 mmol, 0.082 g), *m*-CPBA (0.6 mmol 0.207 g), PhI (0.1 mmol, 0.0204 g) and KBr (2.5 mmol, 0.595 g,) in 2,2,2-trifluoroethanol (10 mL) was stirred at room temperature for 24 h. Then, H_2O (20 ml), sat. aq. $Na_2S_2O_3$ (8 mL) and sat. aq. Na_2CO_3 (8 mL) were poured into the mixture. The mixture was extracted with CH_2Cl_2 (3 x 10 mL) and combined the organic layers, dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography (PE/EA = 5/1) to give **6c** (0.221 g, 75%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.41 - 7.32 (m, 5H), 5.54 - 5.48 (m, 1H), 2.71 - 2.62 (m, 2H), 2.23 – 2.16 (m, 2H).

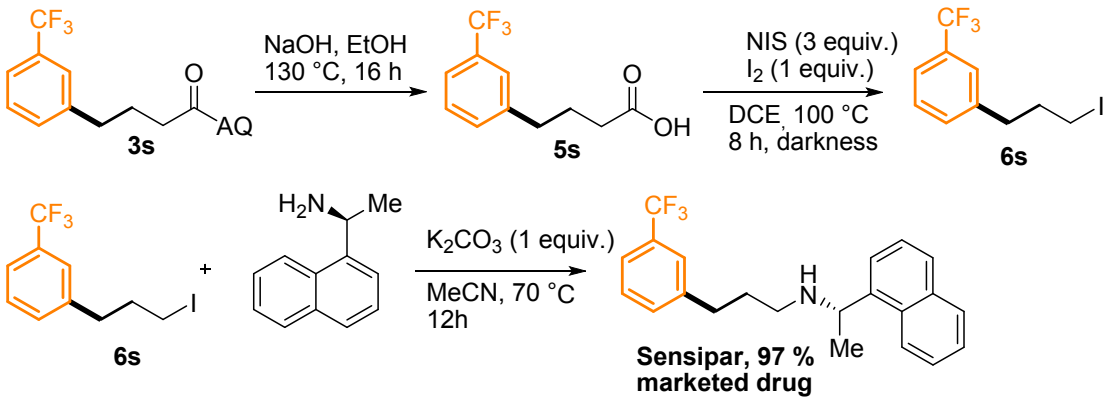
Synthesis of 1-nitro-5-phenylpentan-2-one[12]



5 **6d, 72%**

The solution of 4-phenylbutyric acid **5** (4.33 mmol, 0.71 g), carbonyl diimidazole (3.56 mmol, 0.58 g) in THF (25 ml) was stirred at room temperature for 5 h. To a separate 100 mL round-bottom flask, potassium *t*-butoxide (4.98 mmol, 0.56 g) was dissolved in THF (15 mL) and cooled to 0 °C. Nitromethane (43.3 mmol, 2.36 mL) was added dropwise. After warming to room temperature, the slurry was poured directly into the acyl imidazole flask pre-cooled to 0 °C. The mixture was stirred at room temperature for 12 h, quenched with 1M HCl (20 mL) and extracted with EtOAc (3 x 30 mL) and combined the organic layers, dried over Na_2SO_4, concentrated under reduced pressure and purified by column chromatography (DCM as eluent) to give **6d** (0.65 g, 72%). **^{1}H NMR (400 MHz, CDCl3):** δ 7.30 (t, J = 7.4 Hz, 2H), 7.22 (d, J = 7.4 Hz, 7.4 Hz, 1H), 7.16 (d, J = 7.4 Hz, 2H), 5.20 (s, 1H), 2.66 (t, J = 7.5 Hz, 1H), 2.52 (t, J = 7.5 Hz, 1H), 1.99 (p, J = 7.5 Hz, 1H).

Synthesis of Sensipar



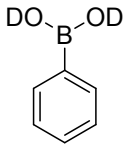
To an oven-dried 50 mL Schlenk tube equipped with a Teflon stirrer bar were subsequently added *N*-(quinolin-8-yl)-4-(3-(trifluoromethyl)phenyl) butanamide **3s** (1 mmol, 0.358 g), NaOH (15 mmol, 0.6 g), and 20 mL of EtOH. After stirred at 130 ºC for 16 h, the reaction was allowed to cool to room temperature, diluted with 100 mL of EtOAc and washed with HCl (1 M, 3 × 50 mL). The organic layers were combined, dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography (PE/EA = 5/1) to give **5s** (0.22 g, 96%) as a white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.48 - 7.76 (m, J = 9.3 Hz, 2H), 7.44 - 7.35 (m, 2H), 2.81 - 2.64 (m, 2H), 2.41 (t, J = 7.4 Hz, 2H), 2.07 - 1.89 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 180.0, 142.2, 132.0, 130.9 (q, J = 31.9 Hz), 129.0, 125.3 (q, J = 3.7 Hz), 124.3 (q, J = 271.9 Hz), 123.1 (q, J = 3.8 Hz), 34.9, 33.4, 26.1.

To a solution of 4-(3-(trifluoromethyl)phenyl)butanoic acid **5s** (0.9 mmol, 0.21 g) of 1,2-dichloroethane (10 mL) in a 25 mL screw-capped flask were added *N*-iodosuccinimide (2.7 mmol, 0.608 g) and molecular iodine (0.9 mmol, 0.228 g). The mixture was stirred at 100 ºC for 8h in dark. After cooling to room temperature, the mixture was diluted with 20 mL of DCM and washed with sat. aq. Na_2SO_3 (3 × 15 mL). The organic layers were combined, dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography (*n*-hexane as eluent) to give **6s** (0.24 g, 85%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.58 - 7.32 (m, 4H), 3.18 (t, J = 6.7 Hz, 2H), 2.81 (t, J = 7.3 Hz, 2H), 2.41 - 1.96 (m, 2H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 141.4, 132.1, 130.9 (q, J = 32.1 Hz), 129.1, 125.3 (q, J = 3.7 Hz),124.3 (q, J = 272.4 Hz), 123.2 (q, J = 3.7 Hz), 36.2, 34.6, 5.9.

To a solution of 1-(3-iodopropyl)-3-(trifluoromethyl)benzene **6s** (0.5 mmol, 0.157 g) of acetonitrile (3 mL) in a 25 mL screw-capped flask were added K_2CO_3 (0.5 mmol, 0.069 g) and *S*-(-)-1-(alpha-naphthyl) ethylamine (0.75 mmol, 0.128 g). The mixture was stirred at 70 ºC for 12 h. After cooling to room temperature, the mixture was diluted with 20 mL of DCM and filtrated by funnel. The organic layers were combined, concentrated under reduced pressure and purified by flash column chromatography (DCM/MeOH = 20/1) to give sensipar (0.173 g, 97 %) as a white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.25 (d, J = 8.0 Hz, 1H), 7.92 (d, J = 7.9 Hz, 1H), 7.80 (d, J = 8.1 Hz, 1H), 7.70 (d, J = 6.7 Hz, 1H), 7.61 - 7.43 (m, 5H), 7.42 - 7.30 (m, 2H), 4.67 (q, J = 6.4 Hz, 1H), 3.10 - 2.38 (m, 4H), 2.10 - 1.76 (m, 2H), 1.55 (d, J = 6.5 Hz, 3H), 1.55 - 1.45 (br, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 143.2, 141.4, 134.1, 131.9, 131.4, 130.7 (q, J = 32.0 Hz), 129.1, 128.8, 127.3, 125.9, 125.8, 125.4, 125.2 (q, J = 3.7 Hz), 124.4(q, J = 272.1 Hz), 123.1, 122.8, 122.7 (q, J = 3.7 Hz), 53.9, 47.4, 33.5, 32.0, 23.7. **^{19}F NMR (376 MHz, $CDCl_3$):** δ -62.53.

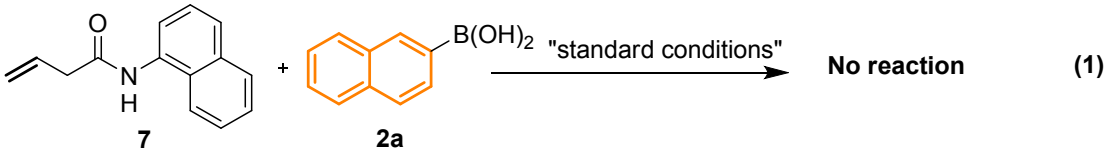
5. Control Experiment & Mechanistic Experiments

Deuterated phenylboronic acid (1b-D)

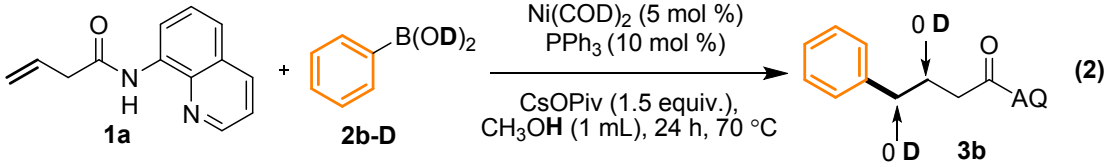


1b-D

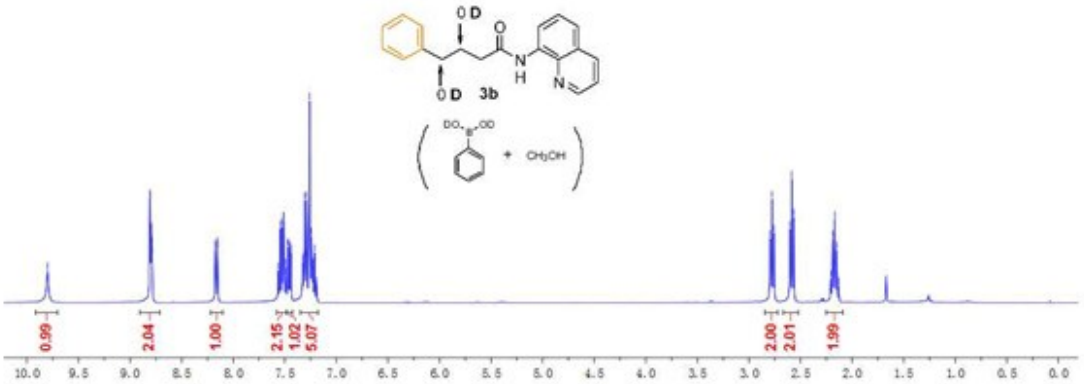
Deuterated phenylboronic acid (**1b-D**) was prepared by a modified procedure reported by Hou.[8] D_2O (11 mL) was heated to 75 ºC in a 50 mL round-bottomed flask. Triphenyl boroxine (1.1 g) was added to the flask. The resulting solution was stirred at this temperature for 12 h. The solution was filtered while it was still hot. The filtrate was cooled to room temperature and filtration. The white solid was dried under vacuum pump for 5 h. Deuterated phenylboronic acid (**2a-D**) (>90% D) containing 9 mol% triphenyl boroxine was obtained. **^{1}H NMR (400 MHz, DMSO):** δ 8.06 (s, 0.08H), 7.80 - 7.78 (m, 2H), 7.44 - 7.27 (m, 3H).

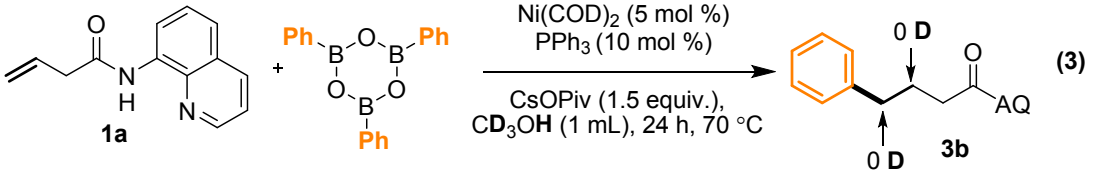


Following the general procedure, the reaction was carried out with **7** (0.2 mmol, 54.8 mg), naphthalen-2-ylboronic acid **2a** (0.4mmol, 68.8 mg), $Ni(cod)_2$ (0.01 mmol, 2.75 mg), PPh_3 (0.02 mmol, 5.3 mg), CsOPiv (0.3 mmol, 70.2 mg), t-AmylOH (1 mL) at 70 ºC for 24 h. The reaction was monitored by TLC plate and detected by 1H NMR, while no any product has been found in the reaction mixture.



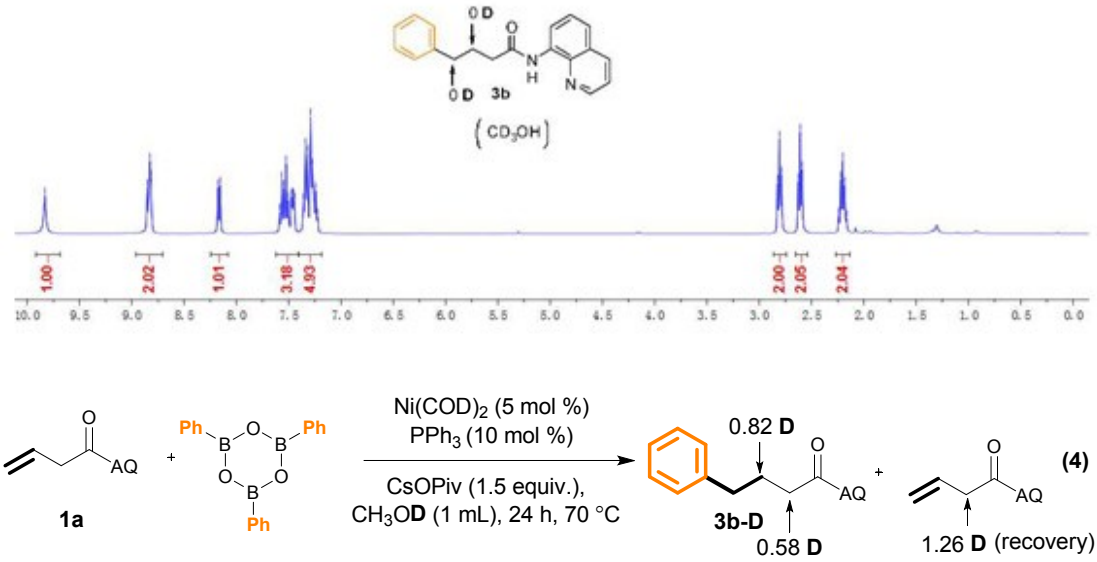
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 54.8 mg), deuterated phenylboronic acid (**1b-D**) (0.4mmol, 49.6 mg), $Ni(cod)_2$ (0.01 mmol, 2.75 mg), PPh_3 (0.02 mmol, 5.3 mg), CsOPiv (0.3 mmol, 70.2 mg), CH_3OH (1 mL) at 70 ºC for 24 h. **3b** was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow solid in 31 % yield.



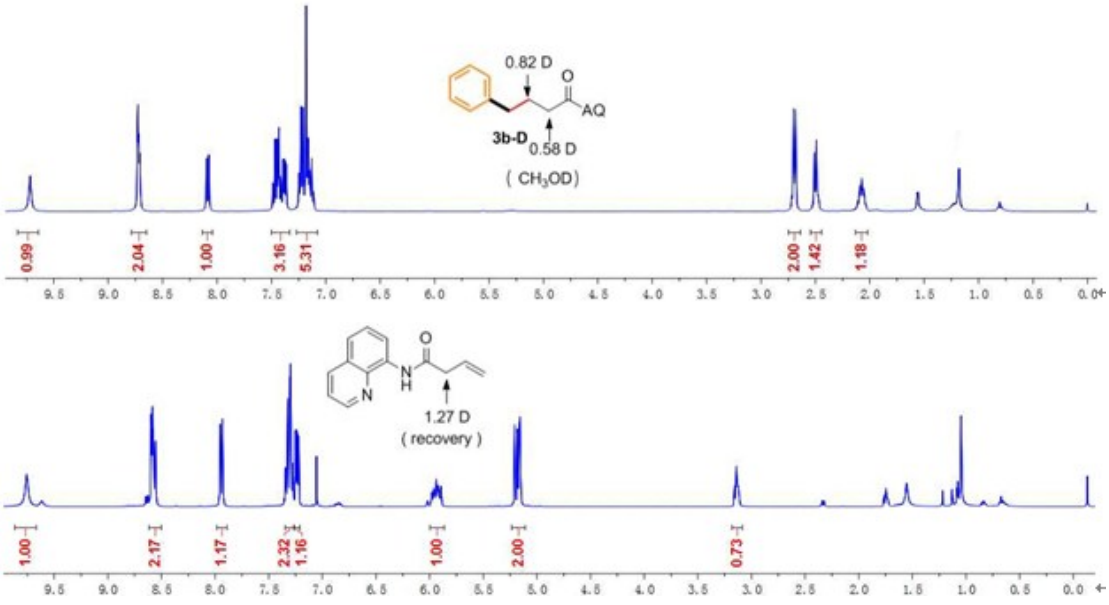


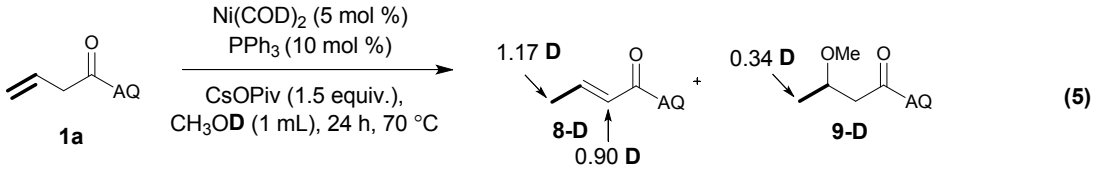
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 54.8 mg), 2,4,6-triphenylboroxin (0.13 mmol, 41.6 mg), $Ni(cod)_2$ (0.01 mmol, 2.75 mg),

PPh_3 (0.02 mmol, 5.3 mg), CsOPiv (0.3 mmol, 70.2 mg) and CD_3OH (1 mL) at 70 ºC for 24 h. **3b** was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow solid in 25 % yield.



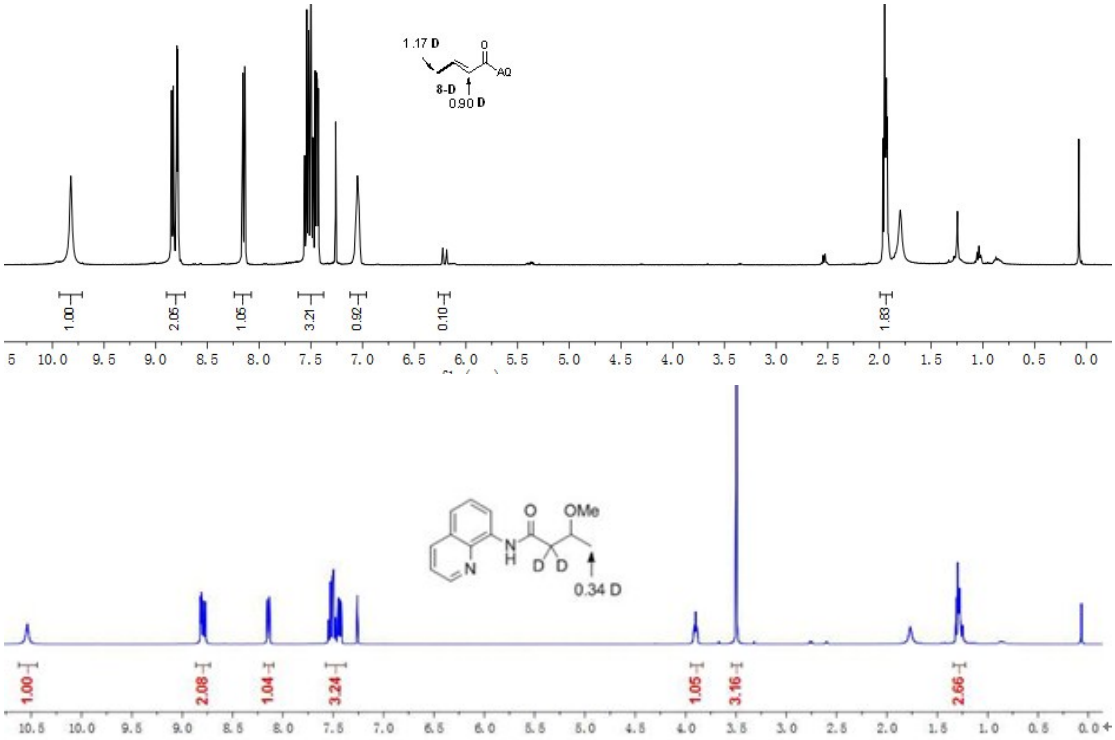
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 54.8 mg), 2,4,6-triphenylboroxin (0.13 mmol, 41.6 mg), $Ni(cod)_2$ (0.01 mmol, 2.75 mg), PPh_3 (0.02 mmol, 5.3 mg), CsOPiv (0.3 mmol, 70.2 mg), CH_3OD (1 mL) at 70 ºC for 24 h. **3b-D** was isolated by column chromatography (DCM/EtOAc = 50/1) as a light yellow solid in 19 % yield.

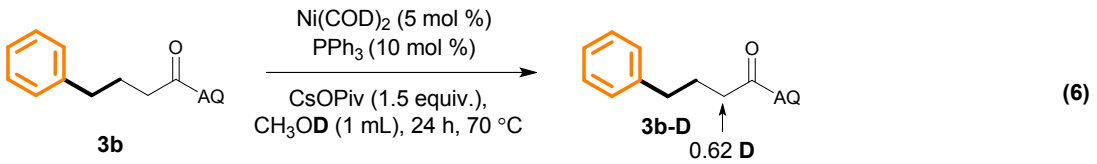




(5)

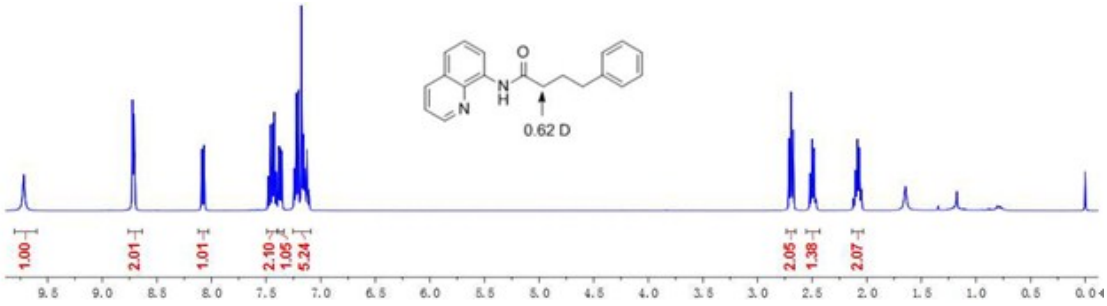
Following the general procedure, the reaction was carried out with **1a** (0.2 mmol, 54.8 mg), $Ni(cod)_2$ (0.01 mmol, 2.75 mg), PPh_3 (0.02 mmol, 5.3 mg), CsOPiv (0.3 mmol, 70.2 mg), and CH_3OD (1 mL) at 70 ºC for 24 h. **8-D** and 9-D was isolated by column chromatography.





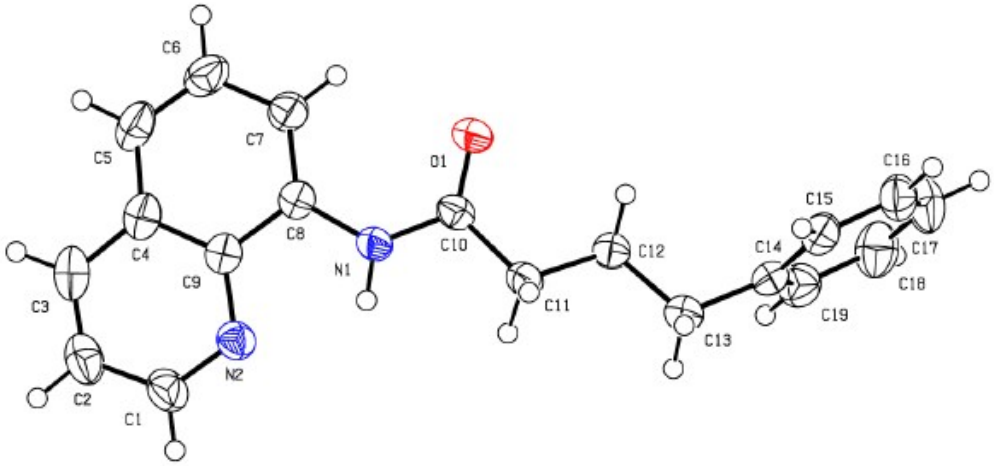
(6)

Following the general procedure, the reaction was carried out with **3b** (0.2 mmol), $Ni(cod)_2$ (0.01 mmol, 2.75 mg), PPh_3 (0.02 mmol, 5.3 mg), CsOPiv (0.3 mmol, 70.2 mg), and CH_3OD (1 mL) at 70 ºC for 24 h. **3b-D** was isolated.



6. X-Ray Crystallography Data

X-ray Crystal Structure Data for 4-Phenyl-*N*-(quinolin-8-yl) butanamide (3b)



CCDC: 1838875

Figure 2. ORTEP plot of compound **3b**. All H atoms have been omitted for clarity.

Identification code **3b**; Empirical formula C_{19} H_{18} N_2 O; Formula weight 290.35; Temperature 113(2) K; Wavelength 0.71073 A ; Crystal system, space group; Monoclinic, P2(1)/c; Unit cell dimensions a = 11.268(2) A alpha = 90 deg. b = 16.335(3) A beta = 114.91(3) deg. c = 9.5163(19) A gamma = 90 deg.; Volume 1588.6(7) A^3; Z, Calculated density 4, 1.214 Mg/m^3; Absorption coefficient 0.076 mm^-1; F(000) 616; Crystal size 0.200 x 0.180 x 0.120 mm; Theta range for data collection 2.351 to 27.793 deg.; Limiting indices -14<=h<=14, -21<=k<=21, -12<=l<=12; Reflections collected / unique 18791 / 3749 [R(int) = 0.0590]; Completeness to theta = 25.242 99.9 %; Absorption correction Semi-empirical from equivalents; Max. and min. transmission 1.0000 and 0.8322; Refinement

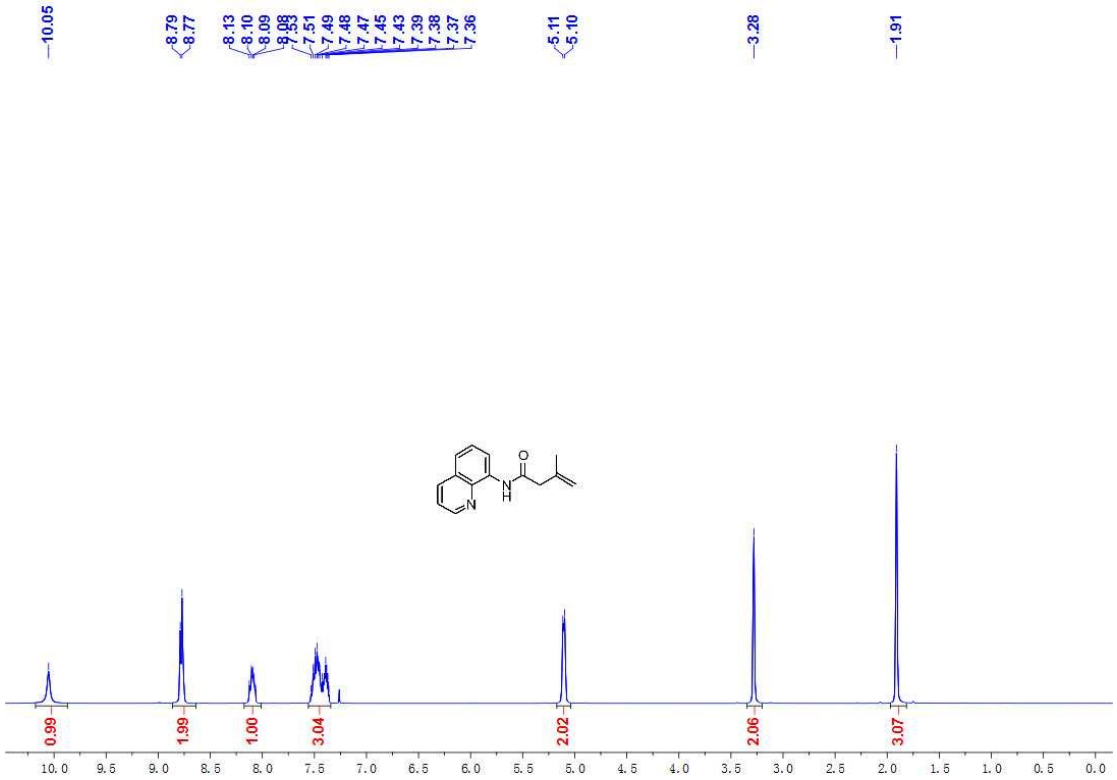
method Full-matrix least-squares on F^2; Data / restraints / parameters 3749 / 1 / 204; Goodness-of-fit on F^2 1.072; Final R indices [I>2sigma(I)] R1 = 0.0568, wR2 = 0.1233; R indices (all data) R1 = 0.0830, wR2 = 0.1393; Extinction coefficient 0.027(4); Largest diff. peak and hole 0.203 and -0.156 e.A^-3.

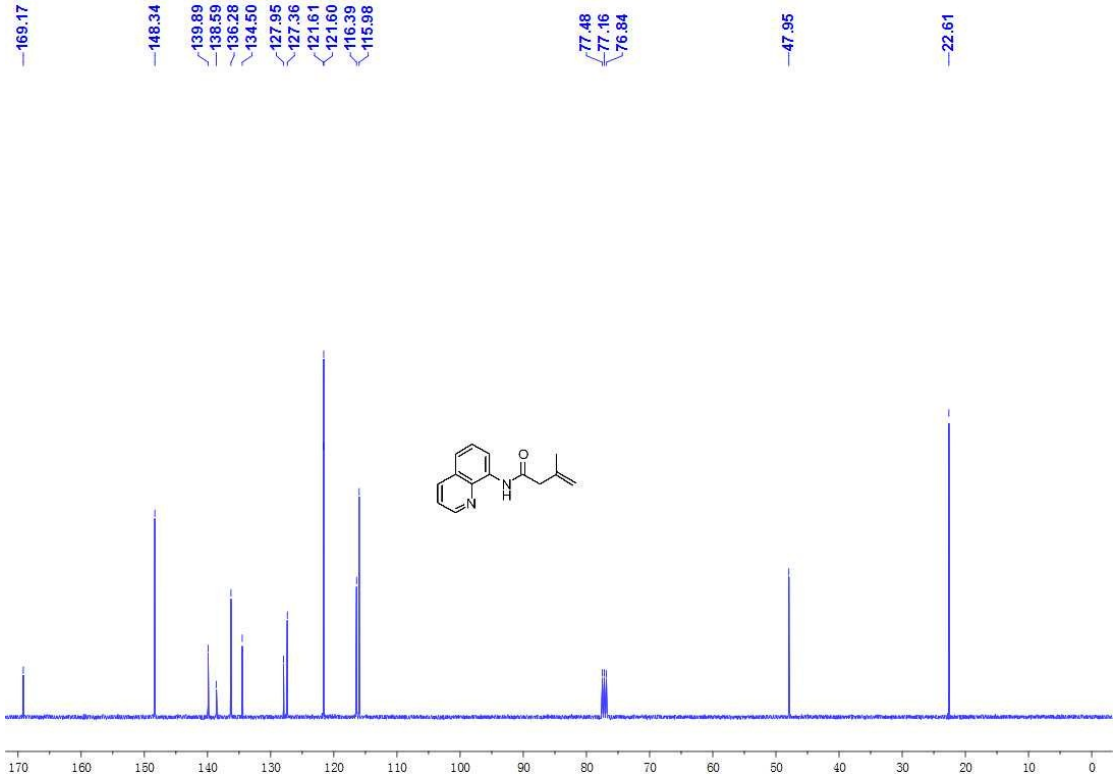
7. References

1. J. A. Jr. Gurak, K. S. Yang, Z. Liu and K. M. Engle, *J. Am. Chem. Soc.,* 2016, **138,** 5805 - 5808.
2. K. S. Yang, J. A. Jr. Gurak, Z. Liu and K. M. Engle, *J. Am. Chem. Soc.,* 2016, **138**, 14705 - 14712.
3. Y. Kawamata, T. Hashimoto and K. Maruoka, *J. Am. Chem. Soc.,* 2016, **138***,* 5206 - 5209.
4. E. P. A. Talbot, T. de A. Fernandes, J. M. McKenna and F. D. Toste, *J. Am. Chem. Soc.,* 2014, **136**, 4101 - 4104.
5. L. C. Morrill, S. M. Smith, A. M. Z. Slawin and A. D. Smith, *J. Org. Chem.,* 2014, **79**, 1640 - 1655.
6. M. Tredwell, J. A. R. Luft, M. Schuler, K. Tenza, K. N. Houk and V. Gouverneur, *Angew. Chem. Int. Ed.,* 2008, **47**, 357 - 360.
7. S. Rakete, R. Berger, S. Böhme and M. A. Glomb, *J. Agric. Food Chem.,* 2014, **62**, 7541−7549.
8. A. Gao, X. Liu, H. Li, C. Ding and X. Hou, *J. Org. Chem.,* 2017, **82**, 9988 - 9994.
9. C. O. Kangani and B. W. Day, *Org. Lett*, 2008, **10**, 2645-2648.
10. Y. Nakai, K. Moriyama and H. Togo, *Eur. J. Org. Chem*., 2016,768–772
11. T. Li, C. Xiang, B. Zhang and J. Yan, *Helv. Chim. Acta.* 2014, **97,** 854-860.
12. R. R. Nani and S. E. Reisman, *J. Am. Chem. Soc.* 2013, **135**, 7304 -7311.

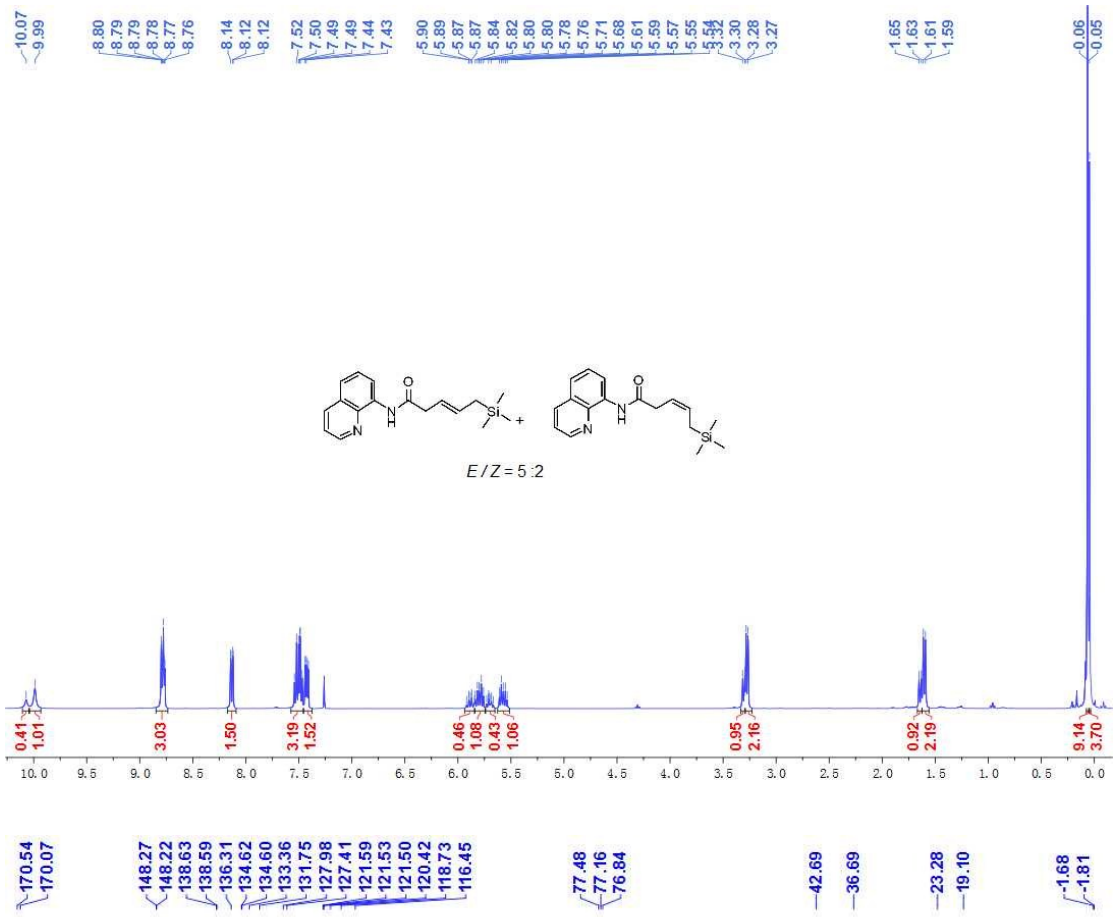
8. NMR Spectra

1k

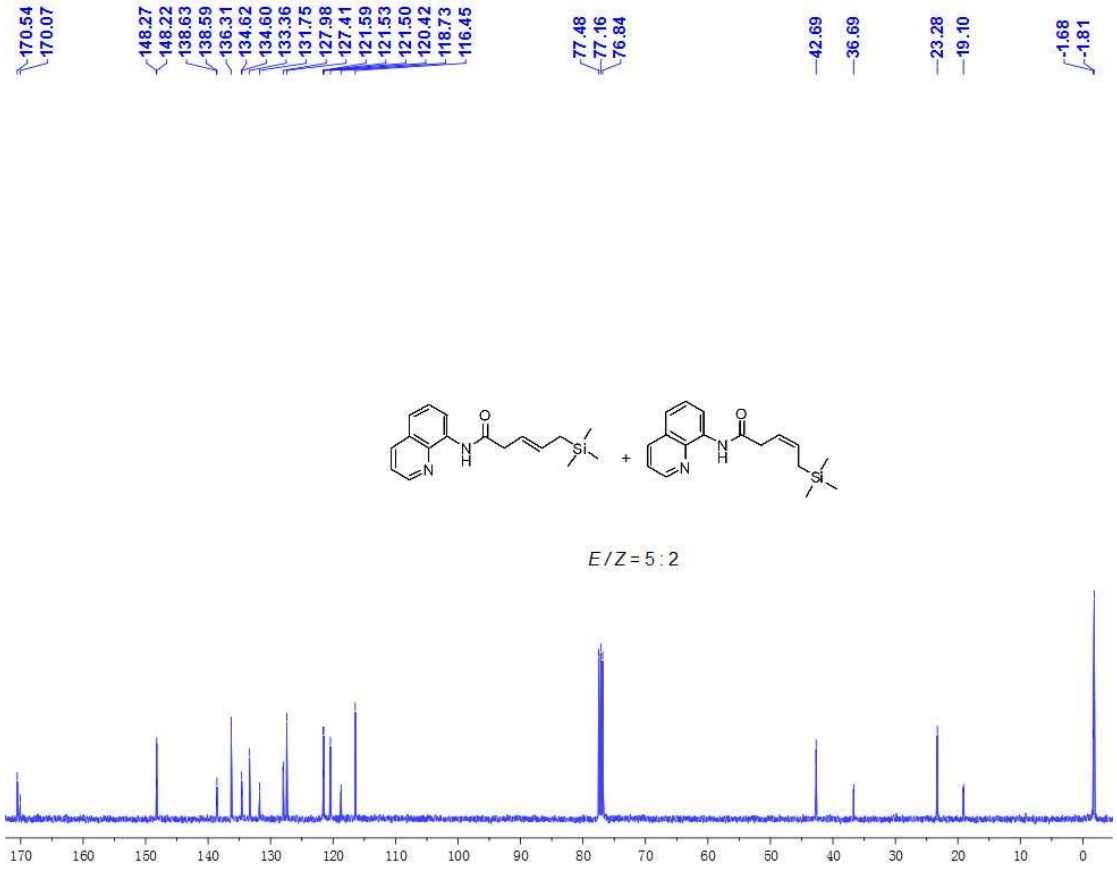

10.05
8.79
8.77
8.13
8.10
8.09
7.53
7.51
7.49
7.48
7.47
7.45
7.43
7.39
7.38
7.37
7.36
5.11
5.10
3.28
1.91
0.99
1.99
1.00
3.04
2.02
2.06
3.07


169.17
148.34
139.89
138.59
136.28
134.50
127.95
127.36
121.61
121.60
116.39
115.98
77.48
77.16
76.84
47.95
22.61

1l

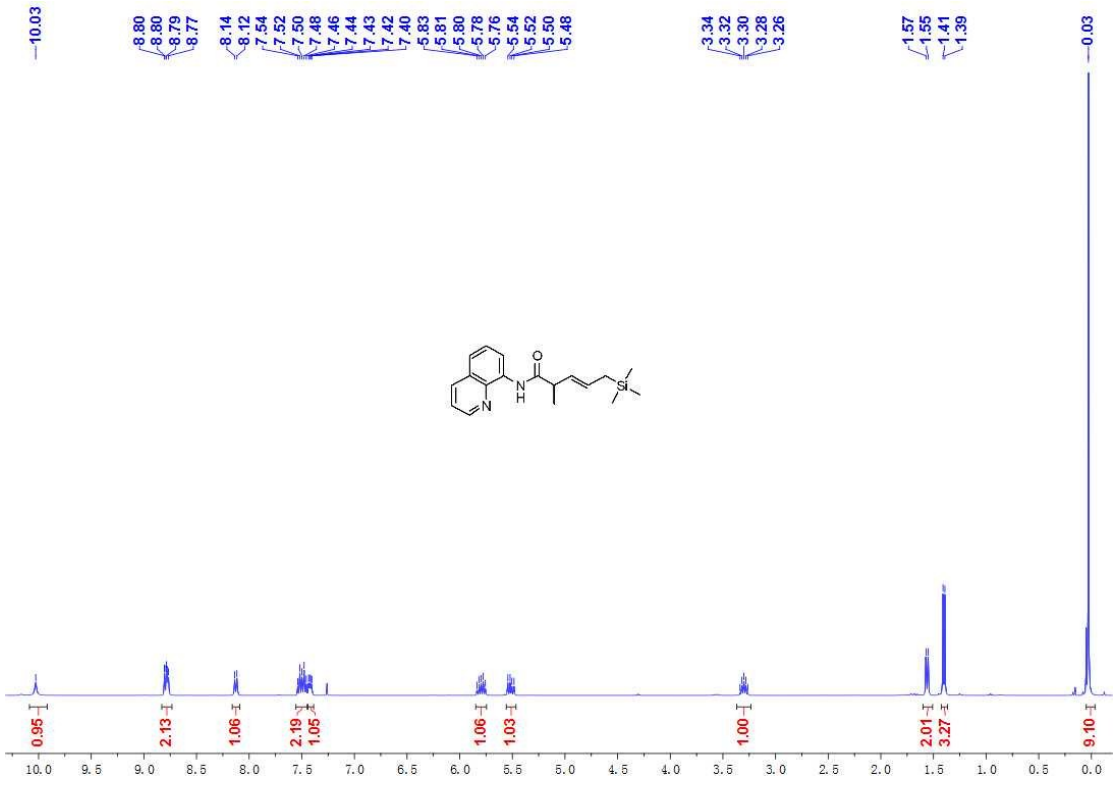

10.07
9.99
8.80
8.79
8.79
8.78
8.77
8.76
8.14
8.12
8.12
7.52
7.50
7.49
7.49
7.44
7.43
5.90
5.89
5.87
5.87
5.84
5.82
5.80
5.80
5.78
5.76
5.71
5.68
5.61
5.59
5.57
5.55
5.54
3.32
3.30
3.28
3.27
1.65
1.63
1.61
1.59
0.06
0.05
0.41
1.01
3.03
1.50
3.19
1.52
0.46
1.08
0.43
1.06
0.95
2.16
0.92
2.19
9.14
3.70
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

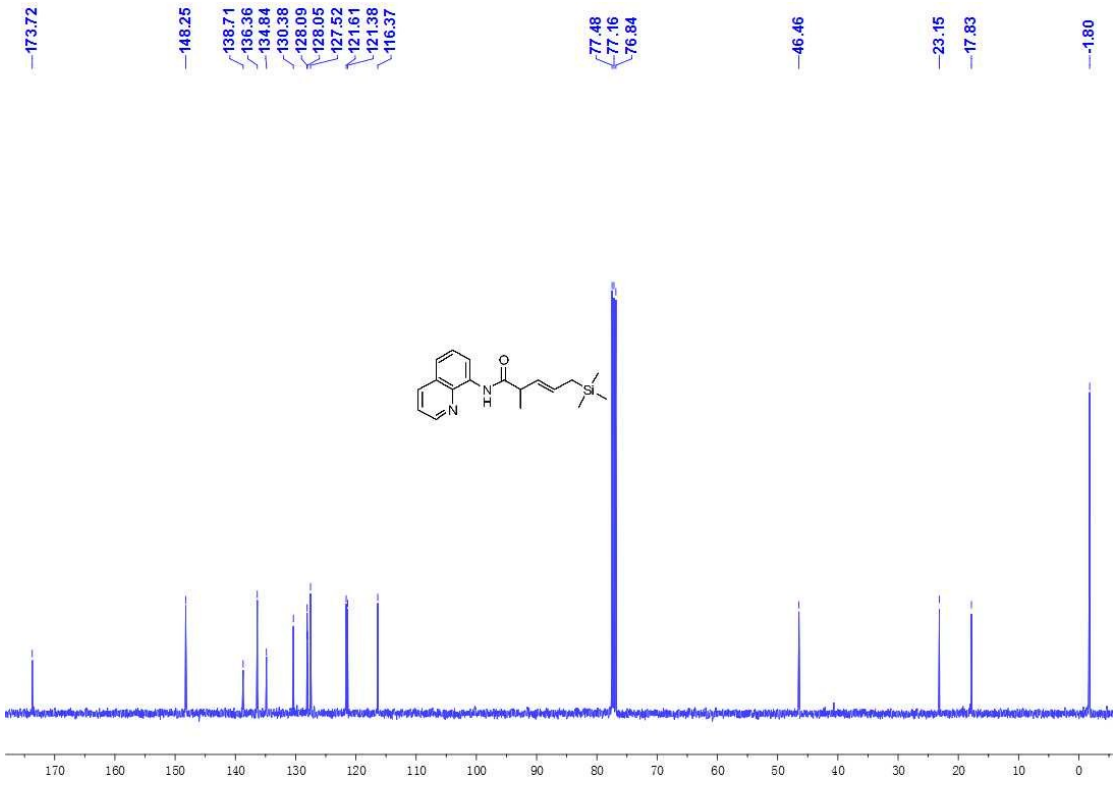
E / *Z* = 5 : 2


170.54
170.07
148.27
148.22
138.63
138.59
136.31
134.62
134.60
133.36
131.75
127.98
127.41
121.59
121.53
121.50
120.42
118.73
116.45
77.48
77.16
76.84
42.69
36.69
23.28
19.10
1.68
1.81
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

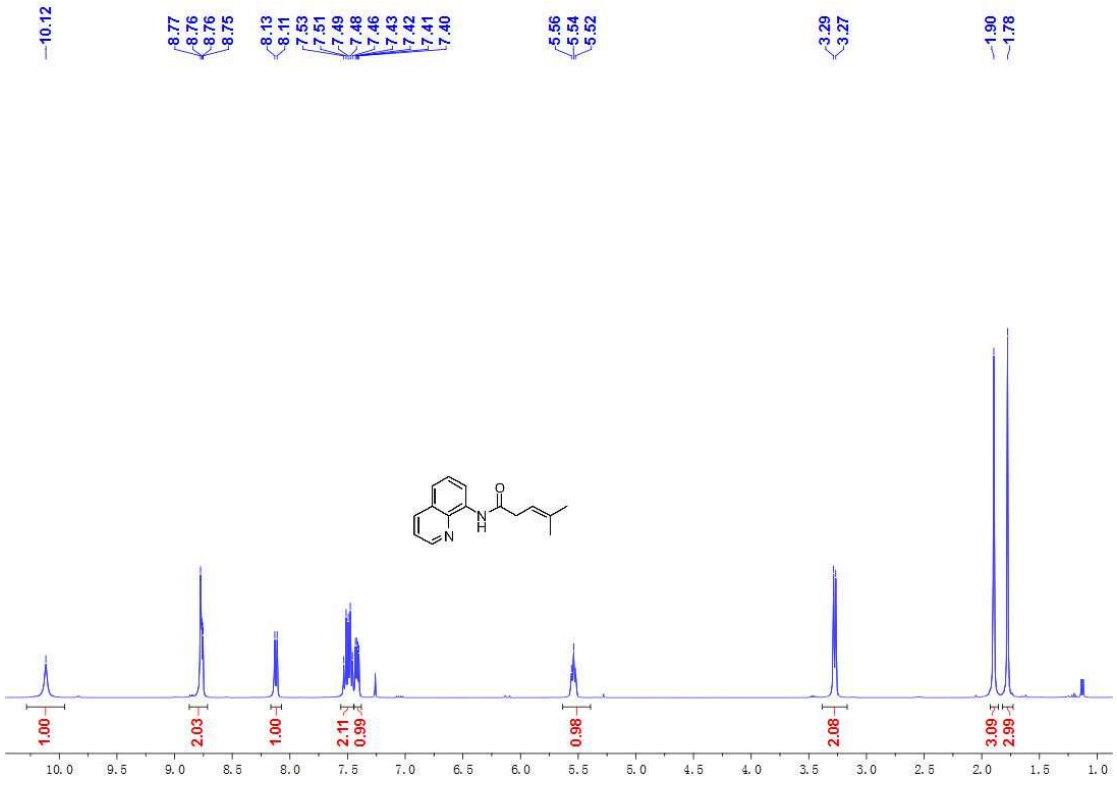
E / *Z* = 5 : 2

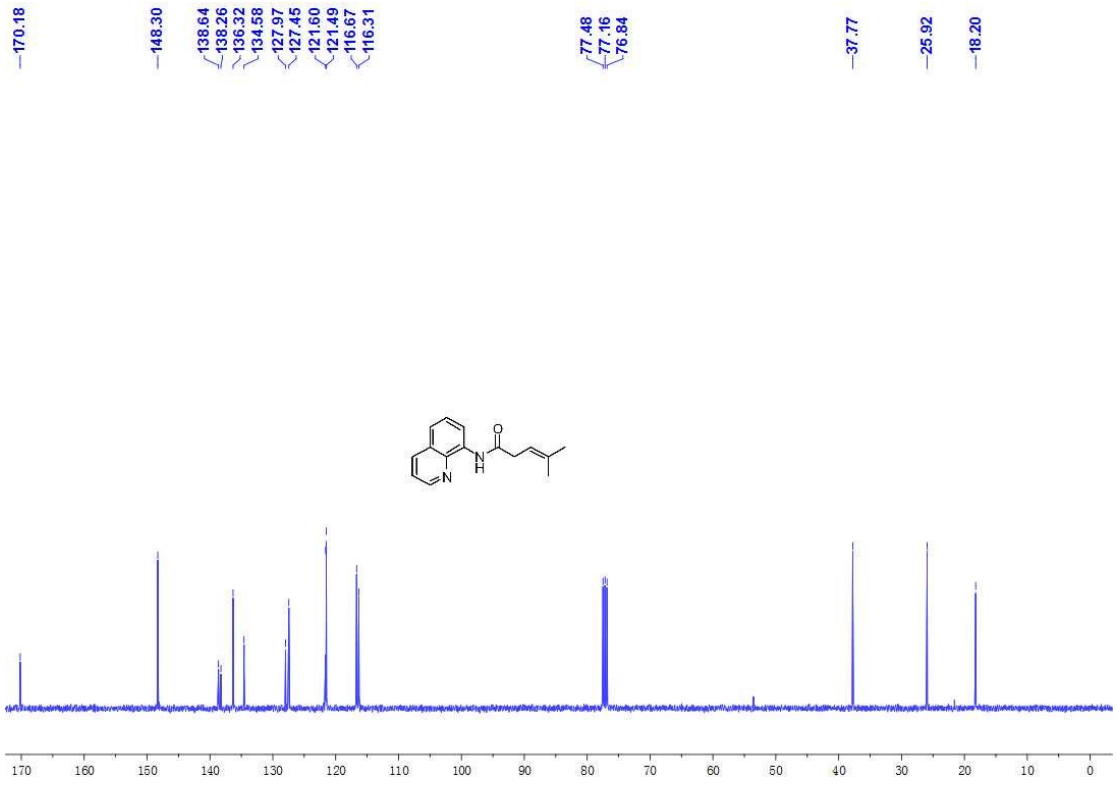
1n


10.03
8.80
8.80
8.79
8.77
8.14
8.12
7.54
7.52
7.50
7.48
7.46
7.44
7.43
7.42
7.40
5.83
5.81
5.80
5.78
5.76
5.54
5.52
5.50
5.48
3.34
3.32
3.30
3.28
3.26
1.57
1.55
1.41
1.39
0.03
0.95
2.13
1.06
2.19
1.05
1.06
1.03
1.00
2.01
3.27
9.10

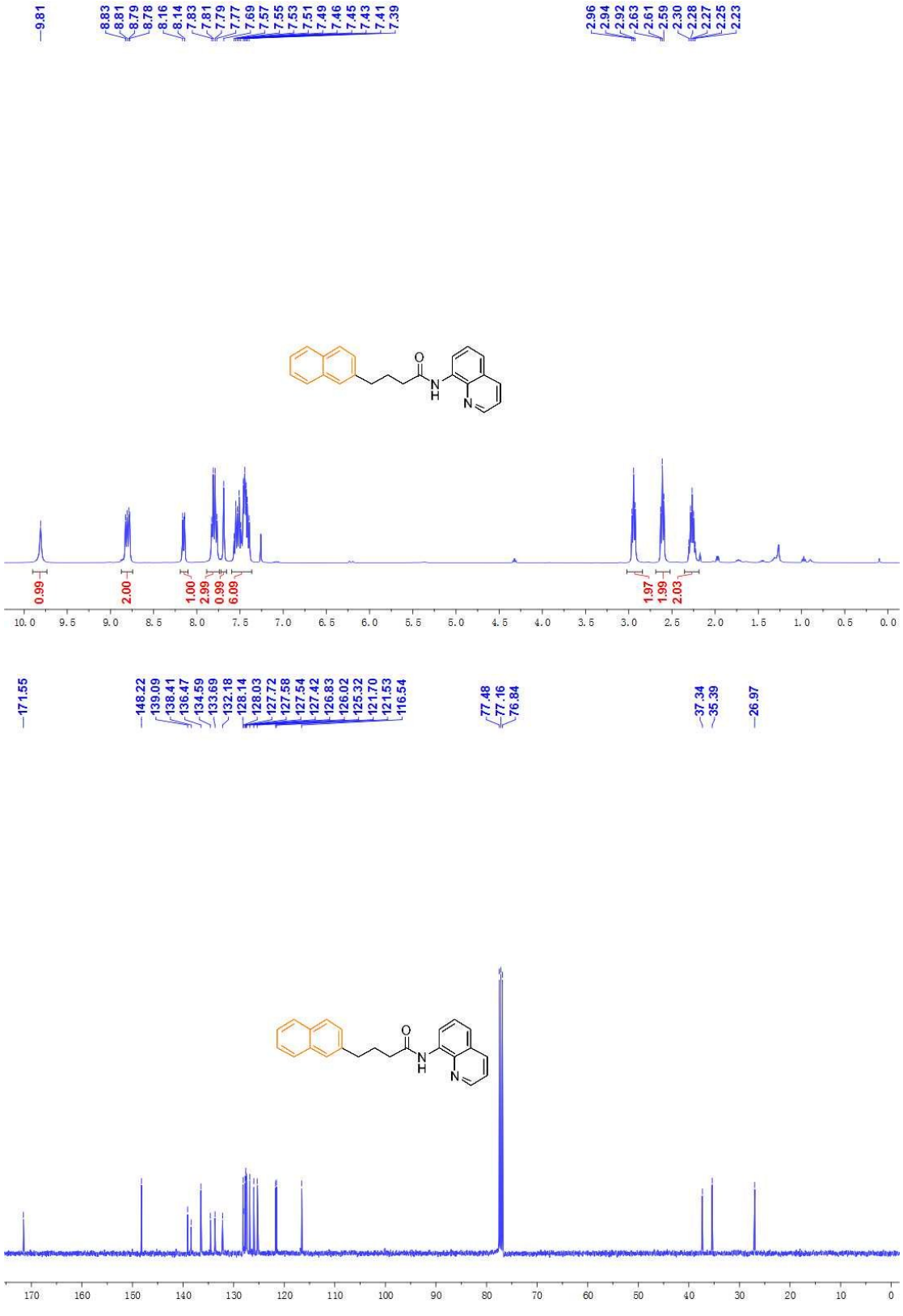

173.72
148.25
138.71
136.36
134.84
130.38
128.09
128.05
127.52
121.61
121.38
116.37
77.48
77.16
76.84
46.46
23.15
17.83
-1.80

1o

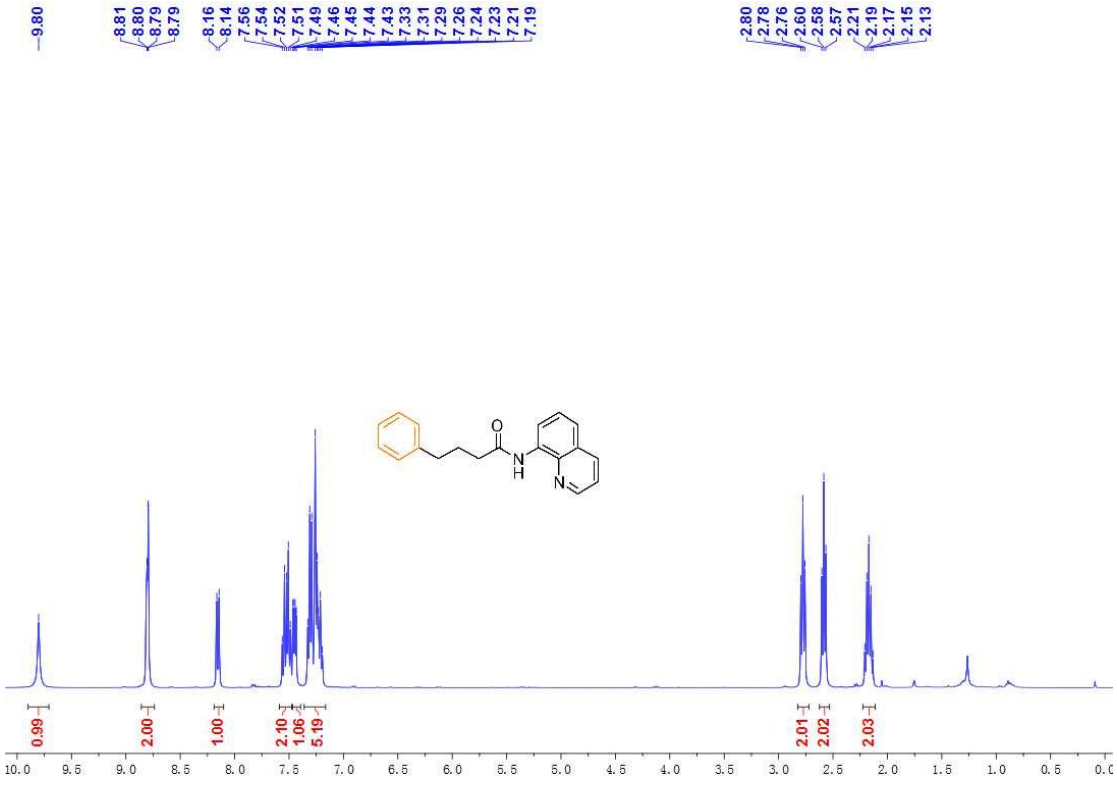

10.12
8.77
8.76
8.76
8.75
8.13
8.11
7.53
7.51
7.49
7.48
7.46
7.43
7.42
7.41
7.40
5.56
5.54
5.52
3.29
3.27
1.90
1.78
1.00
2.03
1.00
2.11
0.99
0.98
2.08
3.09
2.99

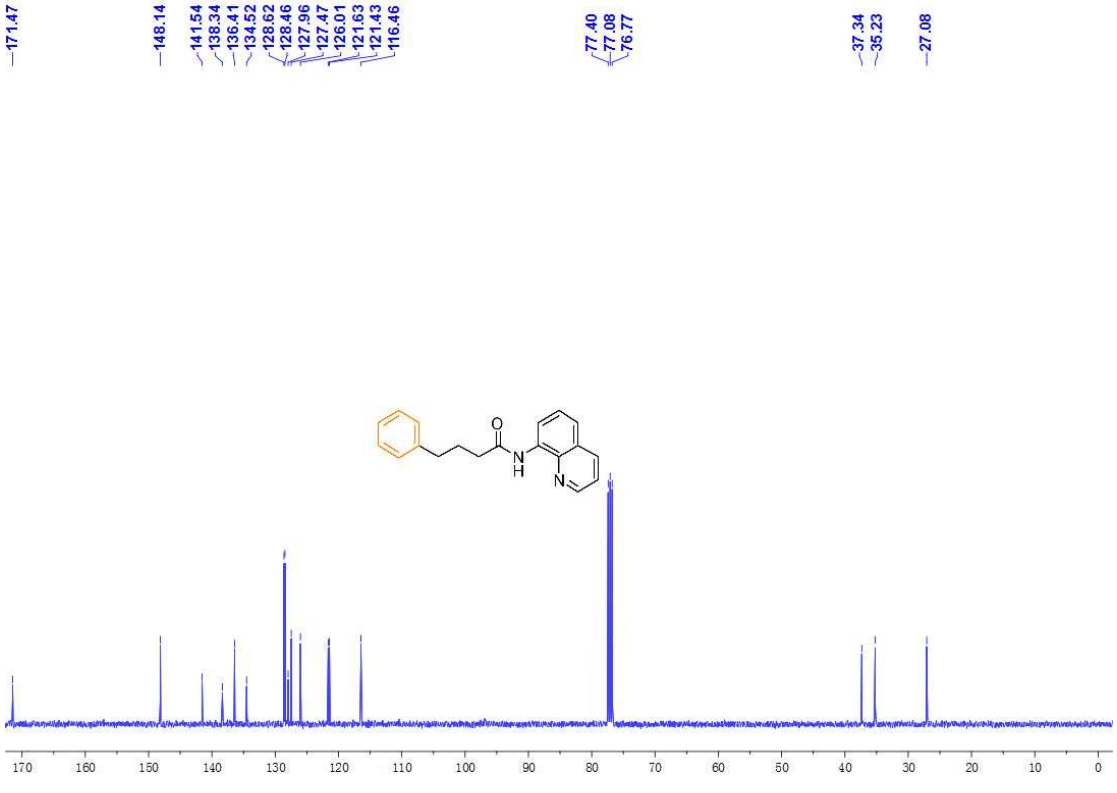

170.18
148.30
138.64
138.26
136.32
134.58
127.97
127.45
121.60
121.49
116.67
116.31
77.48
77.16
76.84
37.77
25.92
18.20

3a

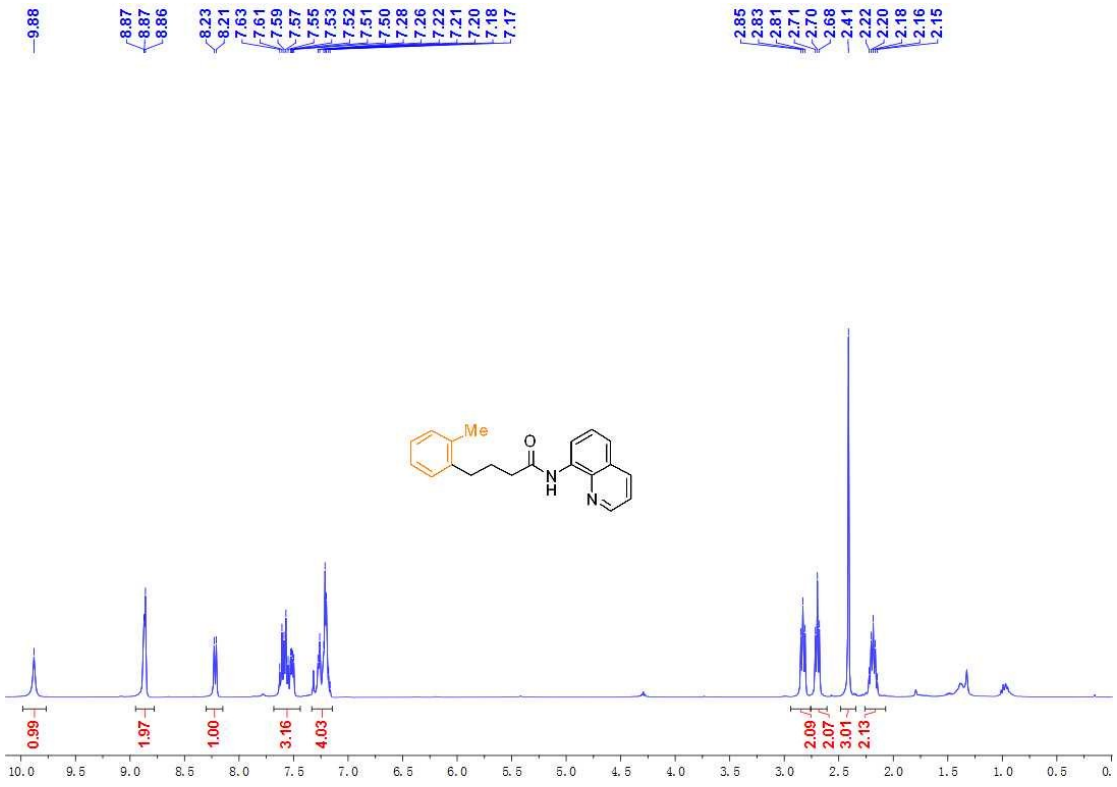

9.81
8.83
8.81
8.79
8.78
8.16
8.14
7.83
7.81
7.79
7.77
7.69
7.57
7.55
7.53
7.51
7.49
7.46
7.45
7.43
7.41
7.39
2.96
2.94
2.92
2.63
2.61
2.59
2.30
2.28
2.27
2.25
2.23
O
N
H
N
0.99
2.00
1.00
2.99
0.99
6.09
1.97
1.99
2.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
171.55
148.22
139.09
138.41
136.47
134.59
133.69
132.18
128.14
128.03
127.72
127.58
127.54
127.42
126.83
126.02
125.32
121.70
121.53
116.54
77.48
77.16
76.84
37.34
35.39
26.97
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

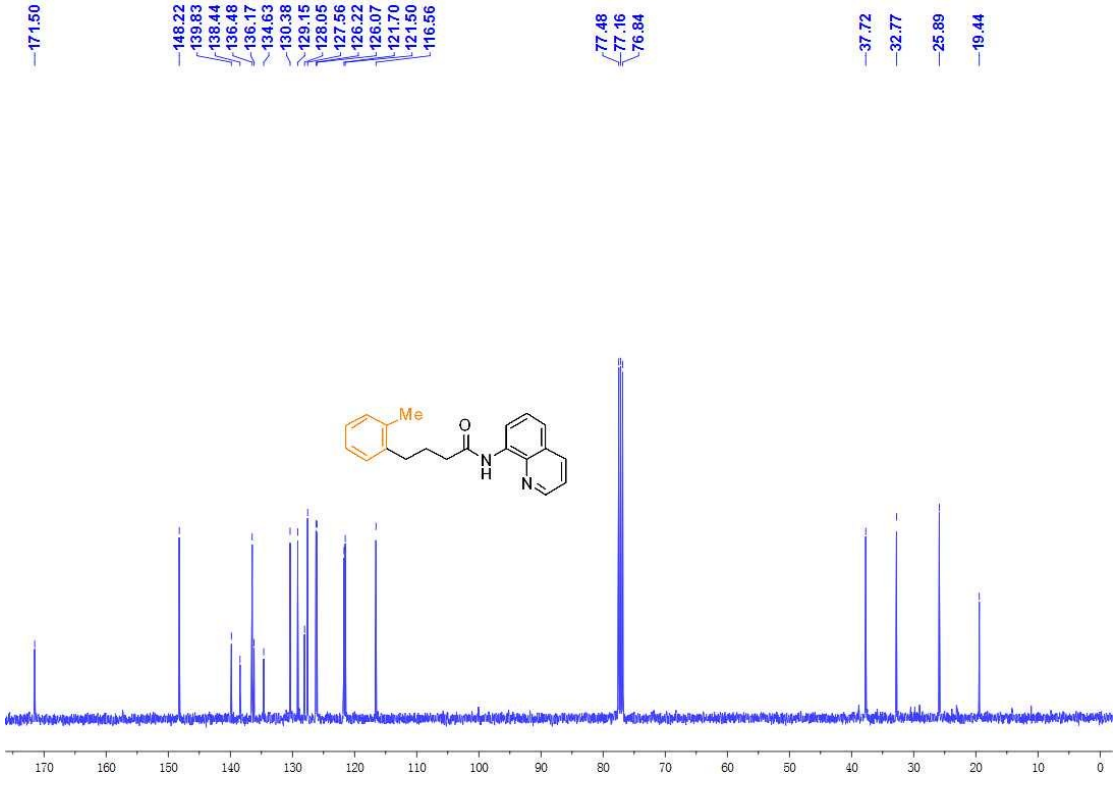
3b


9.80
8.81
8.80
8.79
8.79
8.16
8.14
7.56
7.54
7.52
7.51
7.49
7.46
7.45
7.44
7.43
7.33
7.31
7.29
7.26
7.24
7.23
7.21
7.19
2.80
2.78
2.76
2.60
2.58
2.57
2.21
2.19
2.17
2.15
2.13
O
N
H
N
0.99
2.00
1.00
2.10
1.06
5.19
2.01
2.02
2.03
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

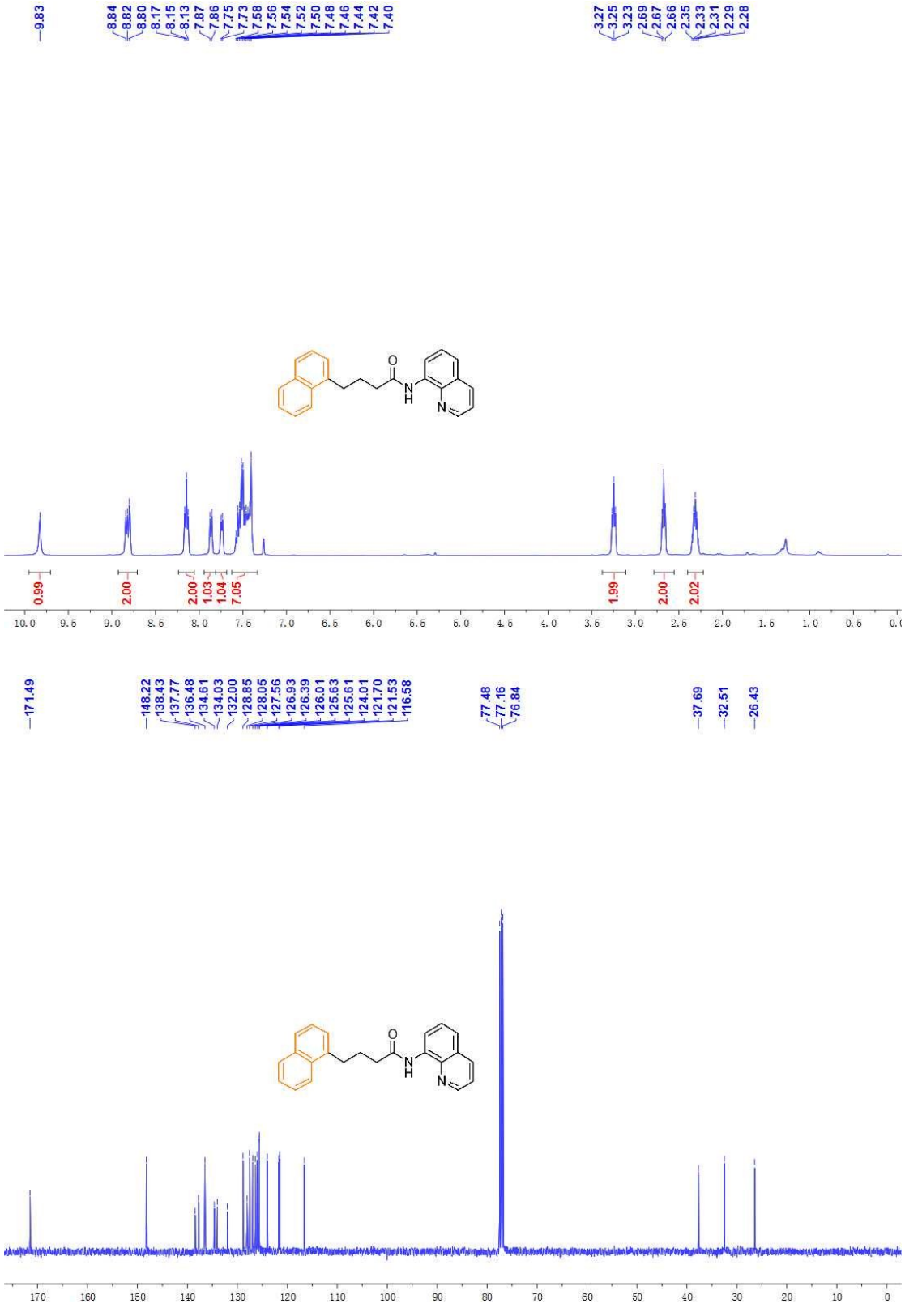

171.47
148.14
141.54
138.34
136.41
134.52
128.62
128.46
127.96
127.47
126.01
121.63
121.43
116.46
77.40
77.08
76.77
37.34
35.23
27.08
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3c

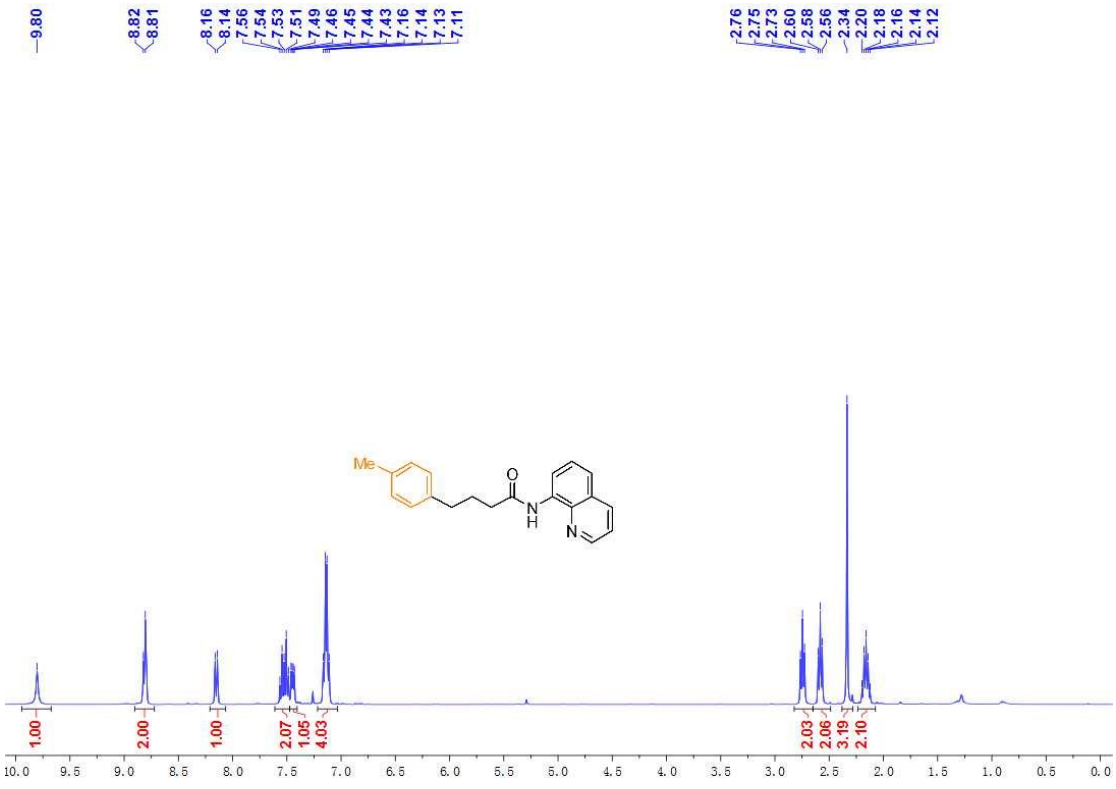

9.88
8.87
8.87
8.86
8.23
8.21
7.63
7.61
7.59
7.57
7.55
7.53
7.52
7.51
7.50
7.28
7.26
7.22
7.21
7.20
7.18
7.17
2.85
2.83
2.81
2.71
2.70
2.68
2.41
2.22
2.20
2.18
2.16
2.15
Me
O
N
H
N
0.99
1.97
1.00
3.16
4.03
2.09
2.07
3.01
2.13
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

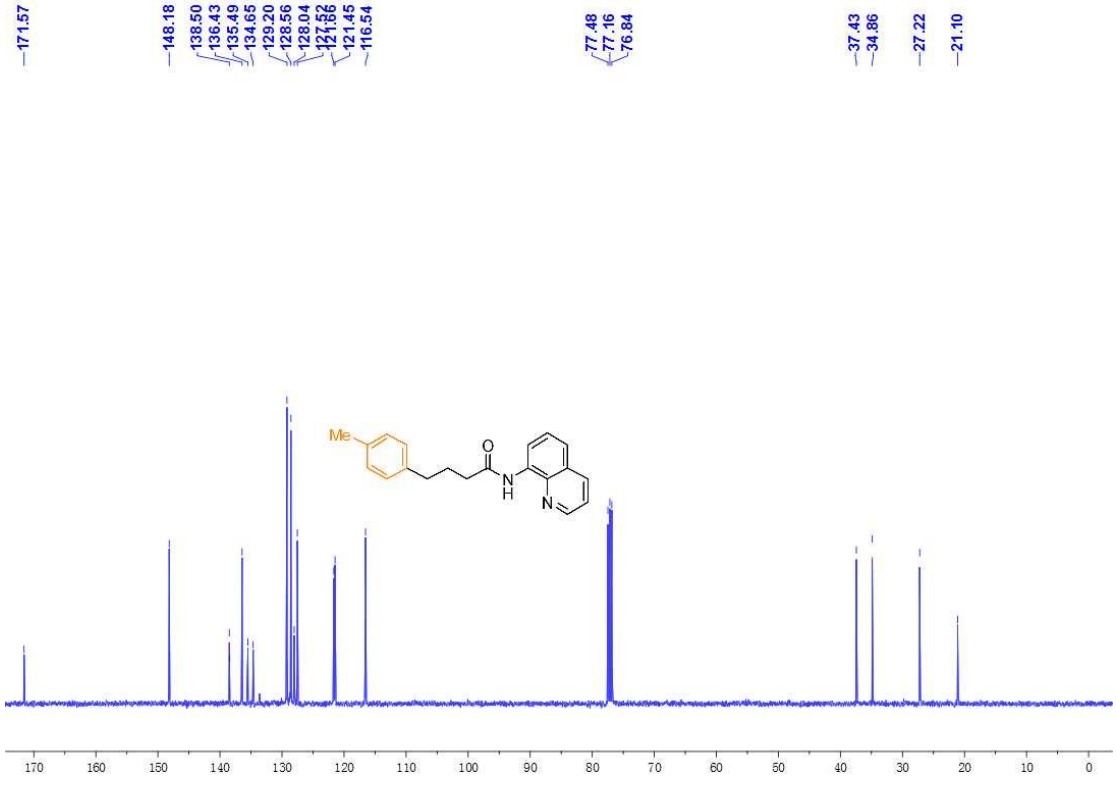

171.50
148.22
139.83
138.44
136.48
136.17
134.63
130.38
129.15
128.05
127.56
126.22
126.07
121.70
121.50
116.56
77.48
77.16
76.84
37.72
32.77
25.89
19.44
Me
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3d

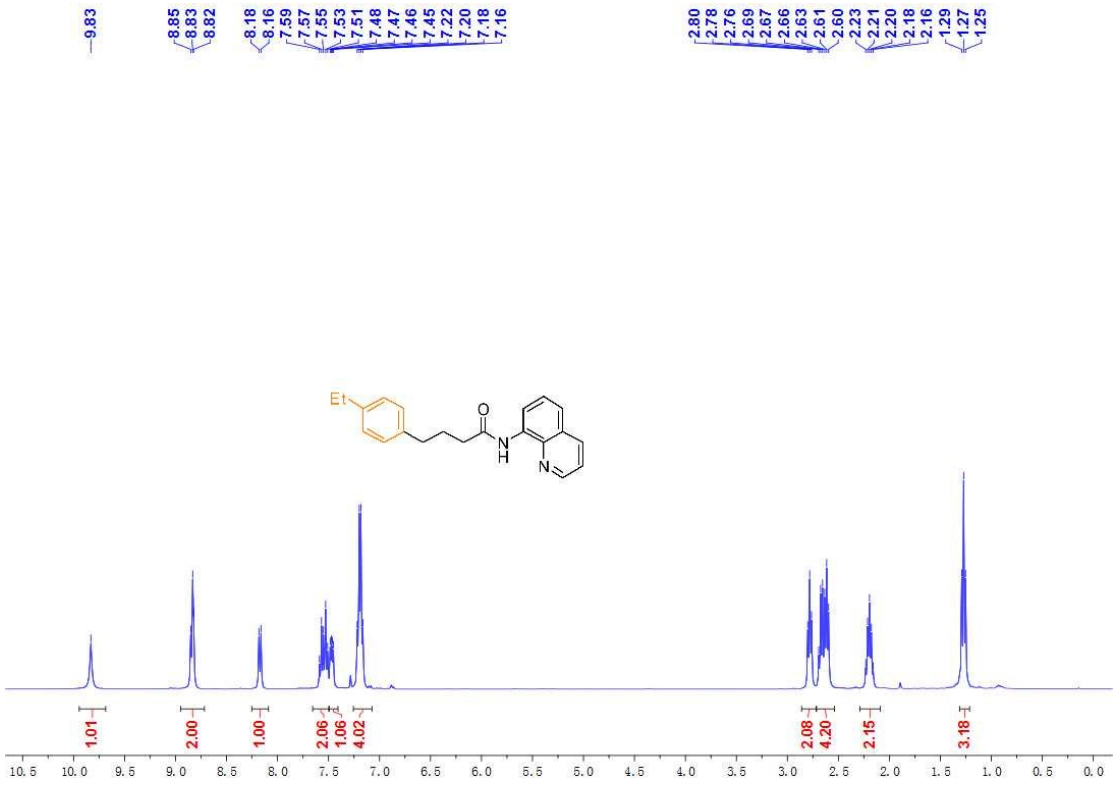

9.83
8.84
8.82
8.80
8.17
8.15
8.13
7.87
7.86
7.75
7.73
7.58
7.56
7.54
7.52
7.50
7.48
7.46
7.44
7.42
7.40
3.27
3.25
3.23
2.69
2.67
2.66
2.35
2.33
2.31
2.29
2.28
O
N
H
N
0.99
2.00
2.00
1.03
1.04
7.05
1.99
2.00
2.02
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
171.49
148.22
138.43
137.77
136.48
134.61
134.03
132.00
128.85
128.05
127.56
126.93
126.39
126.01
125.63
125.61
124.01
121.70
121.53
116.58
77.48
77.16
76.84
37.69
32.51
26.43
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

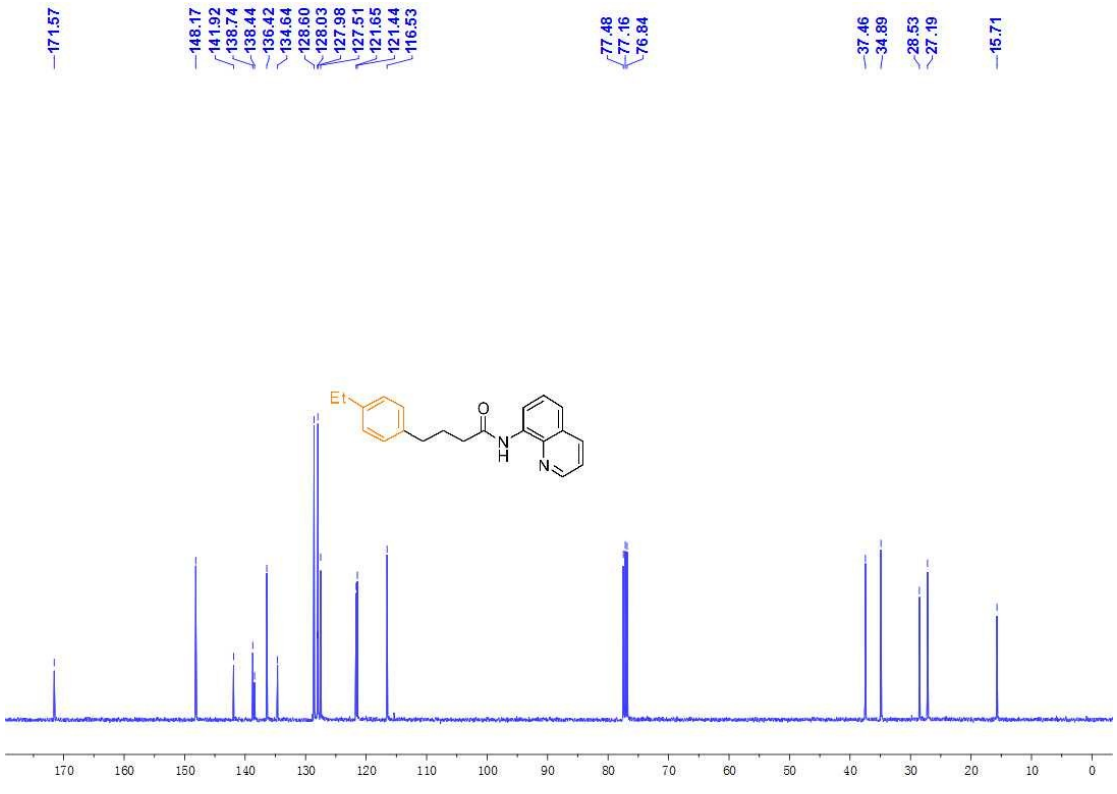
3e


9.80
8.82
8.81
8.16
8.14
7.56
7.54
7.53
7.51
7.49
7.46
7.45
7.44
7.43
7.16
7.14
7.13
7.11
2.76
2.75
2.73
2.60
2.58
2.56
2.34
2.20
2.18
2.16
2.14
2.12
Me
O
N
H
N
1.00
2.00
1.00
2.07
1.05
4.03
2.03
2.06
3.19
2.10
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

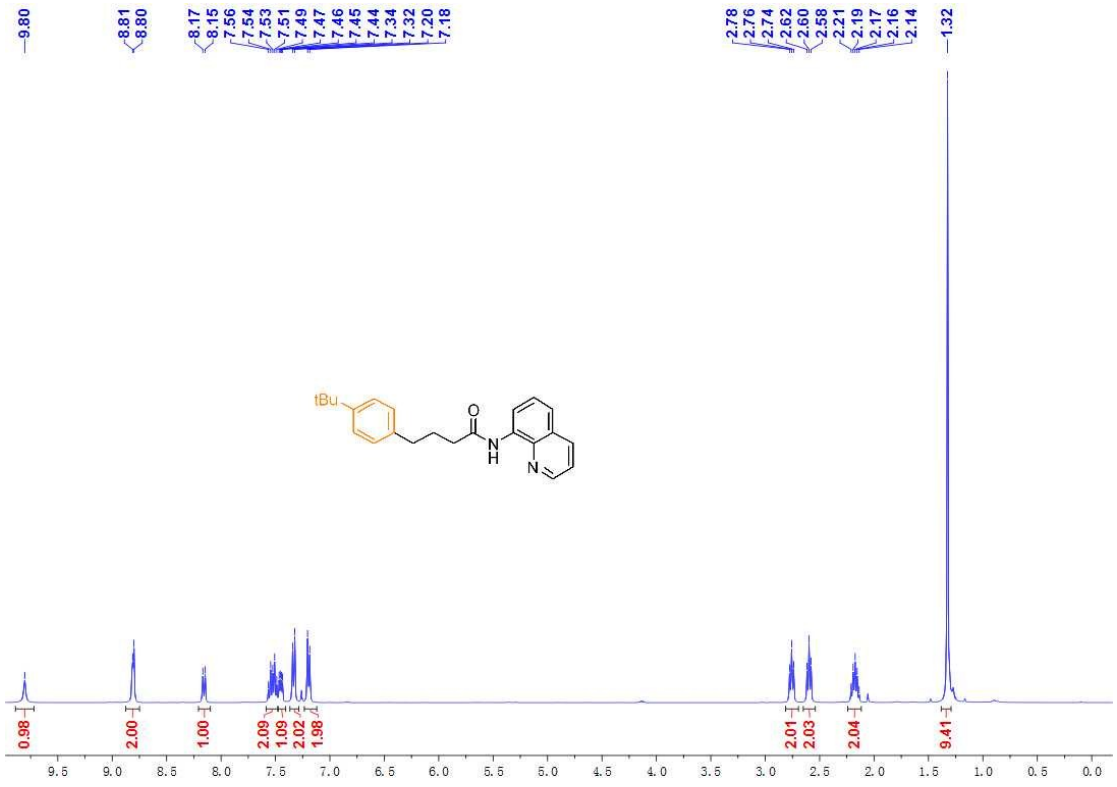

171.57
148.18
138.50
136.43
135.49
134.65
129.20
128.56
128.04
127.52
121.86
121.45
116.54
77.48
77.16
76.84
37.43
34.86
27.22
21.10
Me
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

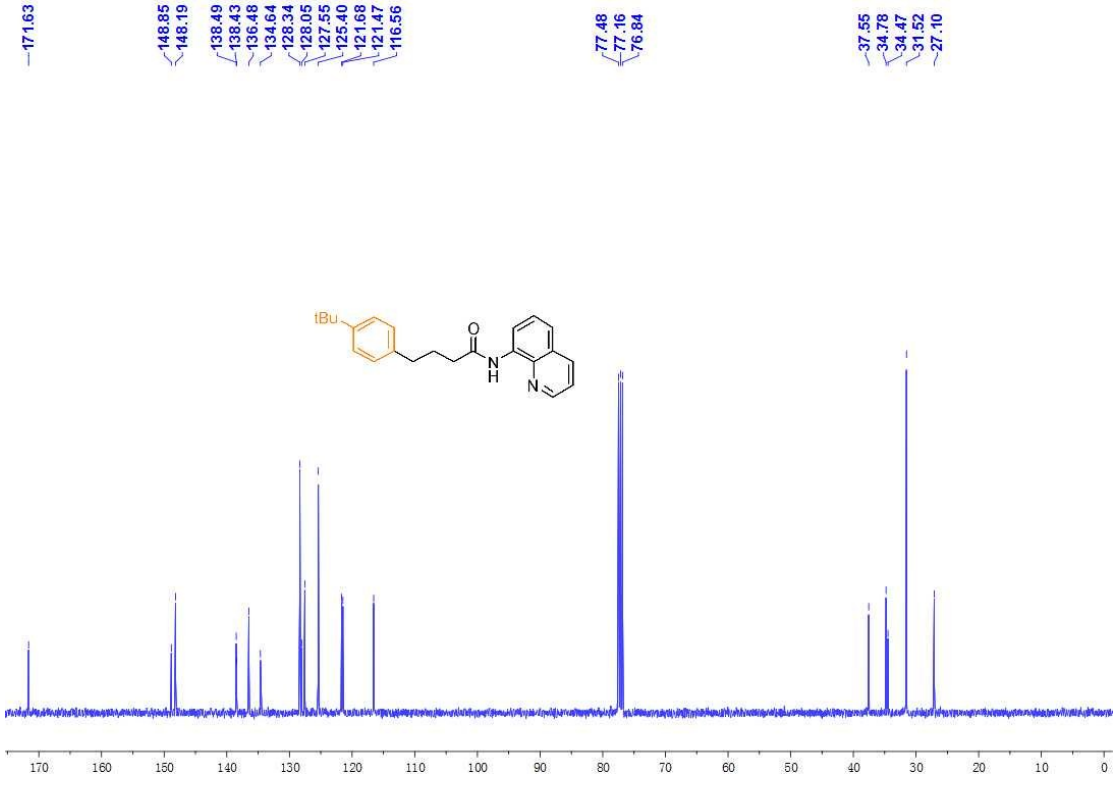
3f


9.83
8.85
8.83
8.82
8.18
8.16
7.59
7.57
7.55
7.53
7.51
7.48
7.47
7.46
7.45
7.22
7.20
7.18
7.16
2.80
2.78
2.76
2.69
2.67
2.66
2.63
2.61
2.60
2.23
2.21
2.20
2.18
2.16
1.29
1.27
1.25
Et
O
N
H
1.01
2.00
1.00
2.06
1.06
4.02
2.08
4.20
2.15
3.18
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

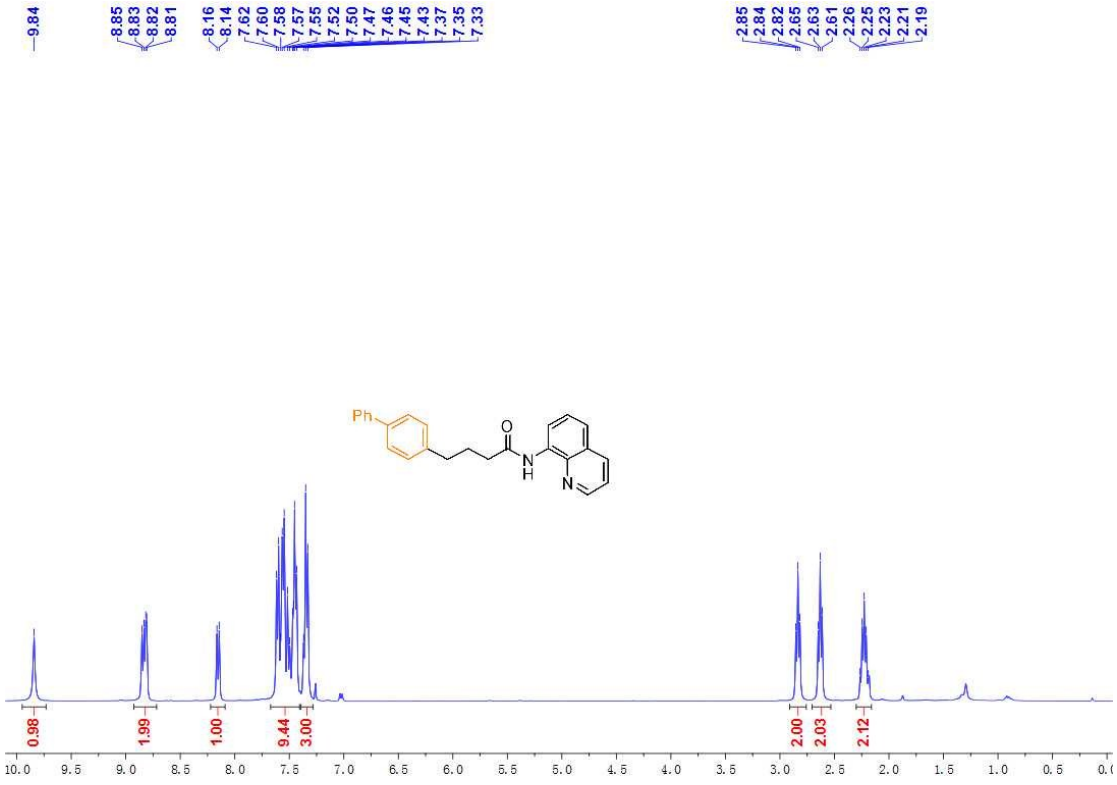

171.57
148.17
141.92
138.74
138.44
136.42
134.64
128.60
128.03
127.98
127.51
121.65
121.44
116.53
77.48
77.16
76.84
37.46
34.89
28.53
27.19
15.71
Et
O
N
H
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

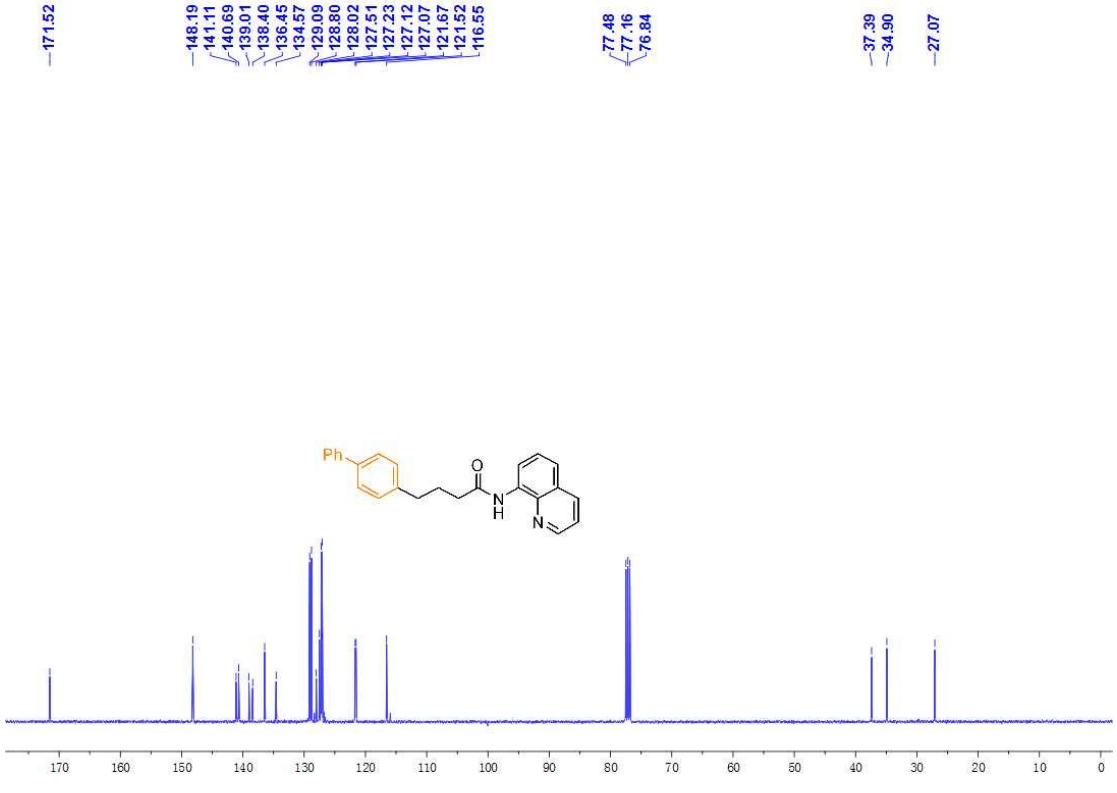
3g


9.80
8.81
8.80
8.17
8.15
7.56
7.54
7.53
7.51
7.49
7.47
7.46
7.45
7.44
7.34
7.32
7.20
7.18
2.78
2.76
2.74
2.62
2.60
2.58
2.21
2.19
2.17
2.16
2.14
1.32
tBu
O
N
H
N
0.98
2.00
1.00
2.09
1.09
2.02
1.98
2.01
2.03
2.04
9.41

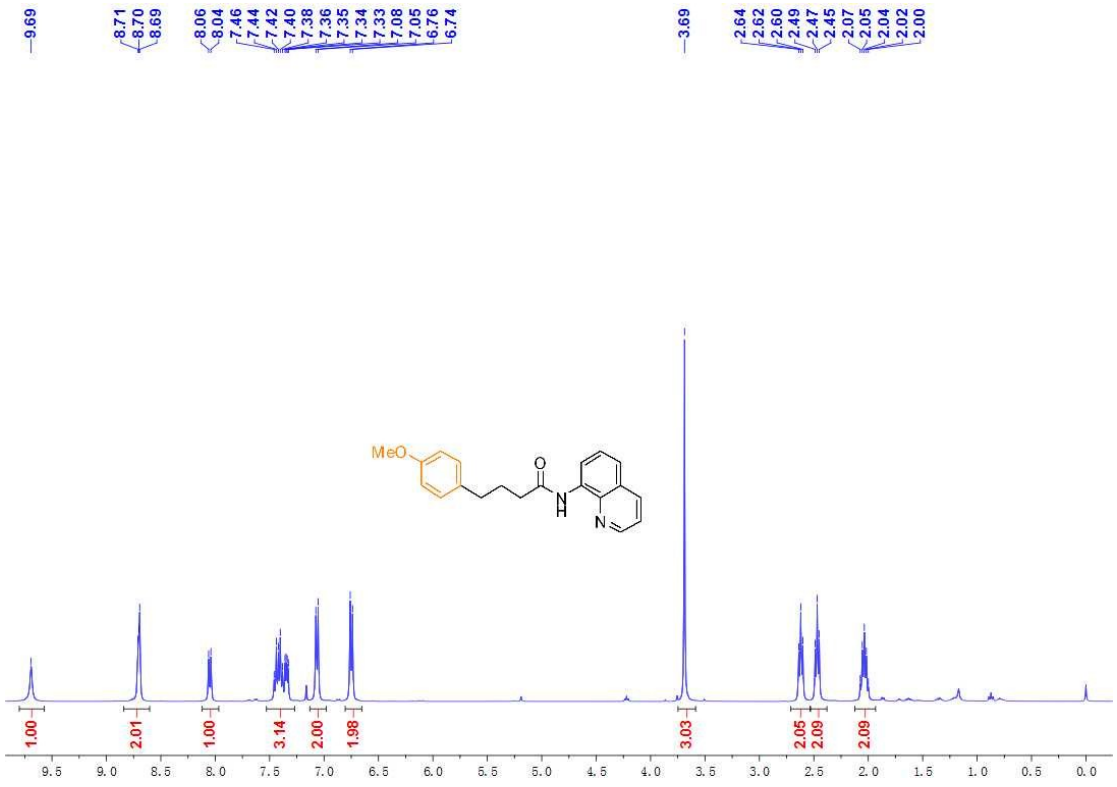

171.63
148.85
148.19
138.49
138.43
136.48
134.64
128.34
128.05
127.55
125.40
121.68
121.47
116.56
77.48
77.16
76.84
37.55
34.78
34.47
31.52
27.10
tBu
O
N
H
N

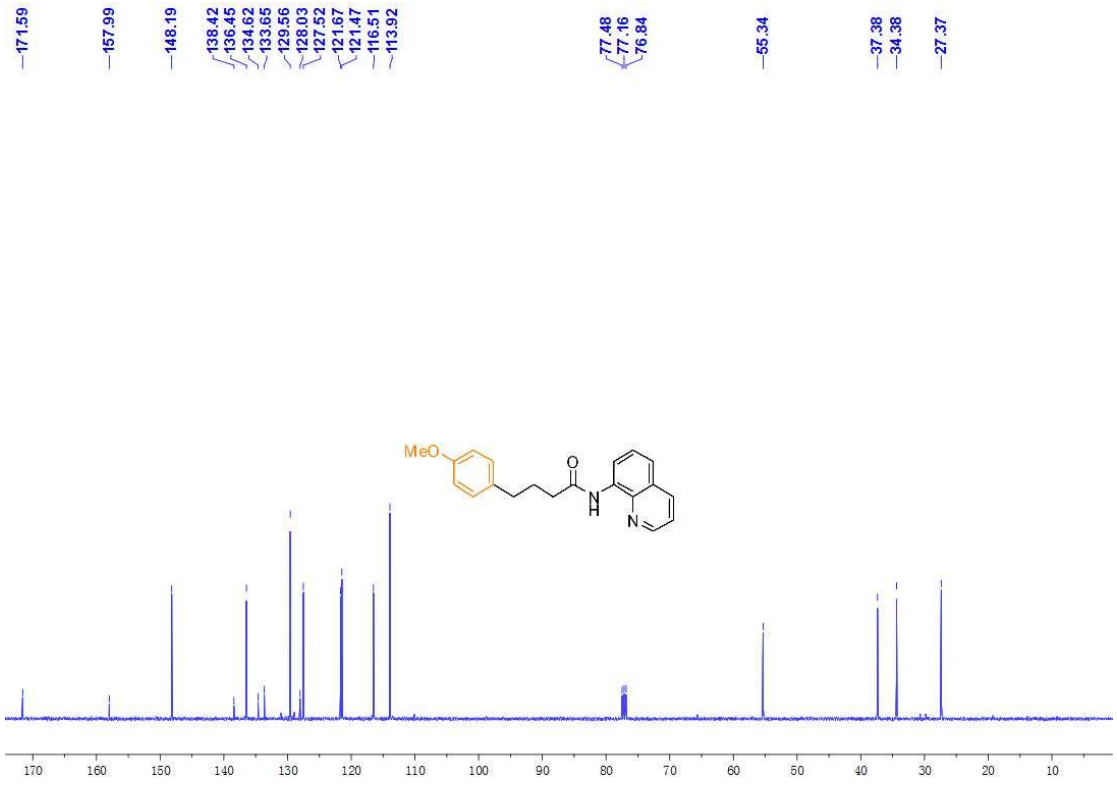
3h


9.84
8.85
8.83
8.82
8.81
8.16
8.14
7.62
7.60
7.58
7.57
7.55
7.52
7.50
7.47
7.46
7.45
7.43
7.37
7.35
7.33
2.85
2.84
2.82
2.65
2.63
2.61
2.26
2.25
2.23
2.21
2.19
Ph
O
N
H
N
0.98
1.99
1.00
9.44
3.00
2.00
2.03
2.12
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

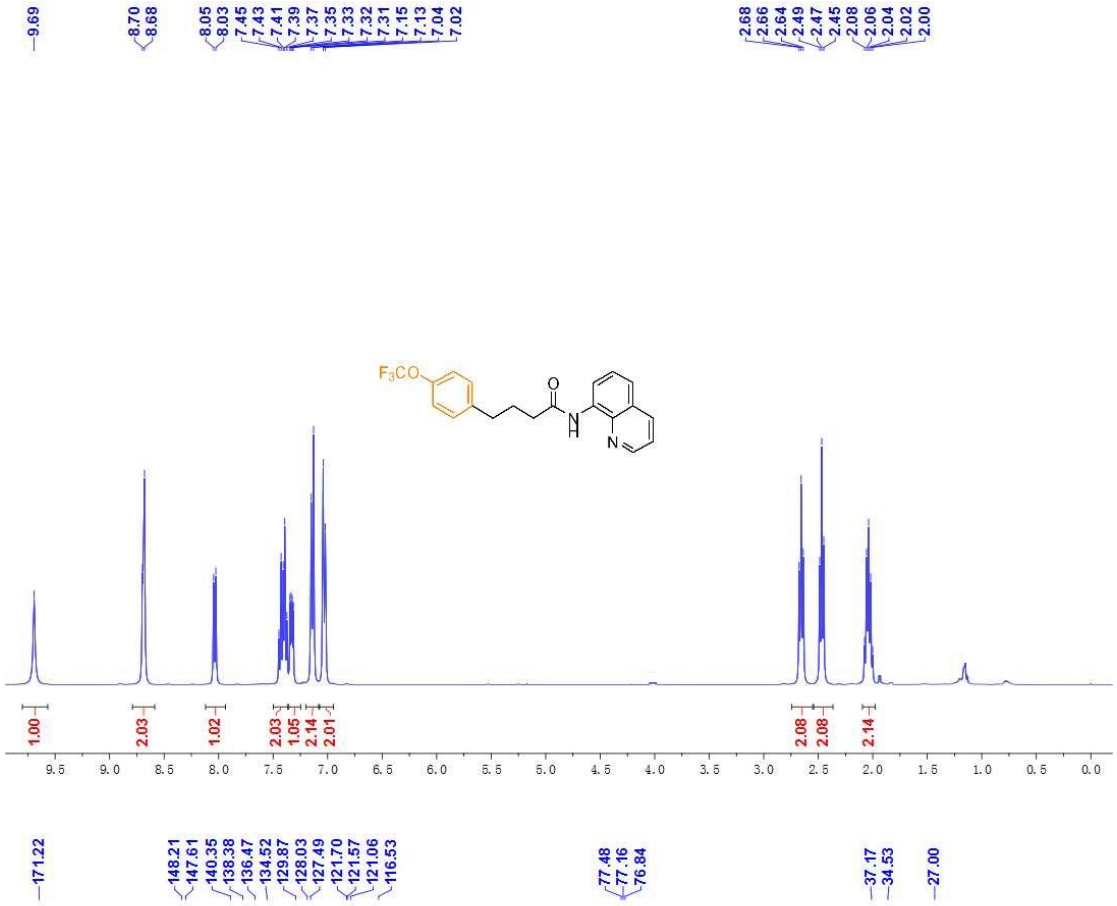

171.52
148.19
141.11
140.69
139.01
138.40
136.45
134.57
129.09
128.80
128.02
127.51
127.23
127.12
127.07
121.67
121.52
116.55
77.48
77.16
76.84
37.39
34.90
27.07
Ph
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

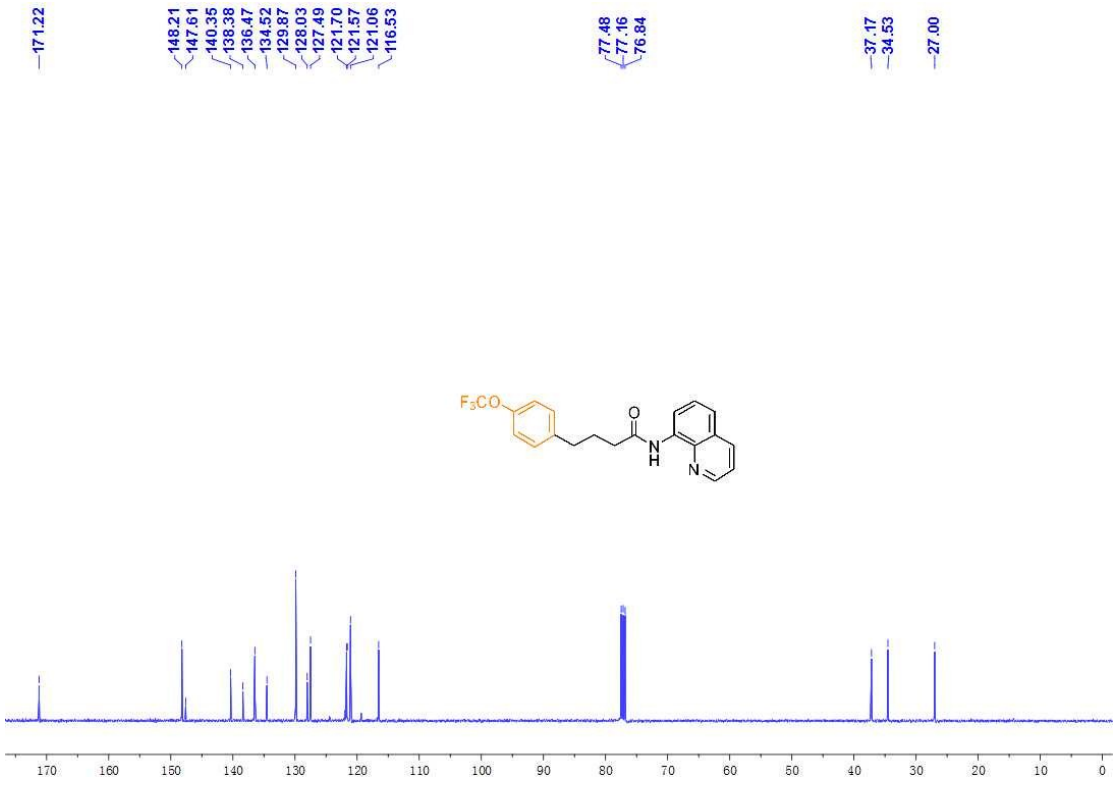
3i


9.69
8.71
8.70
8.69
8.06
8.04
7.46
7.44
7.42
7.40
7.38
7.36
7.35
7.34
7.33
7.08
7.05
6.76
6.74
3.69
2.64
2.62
2.60
2.49
2.47
2.45
2.07
2.05
2.04
2.02
2.00
MeO
O
N
H
N
1.00
2.01
1.00
3.14
2.00
1.98
3.03
2.05
2.09
2.09
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

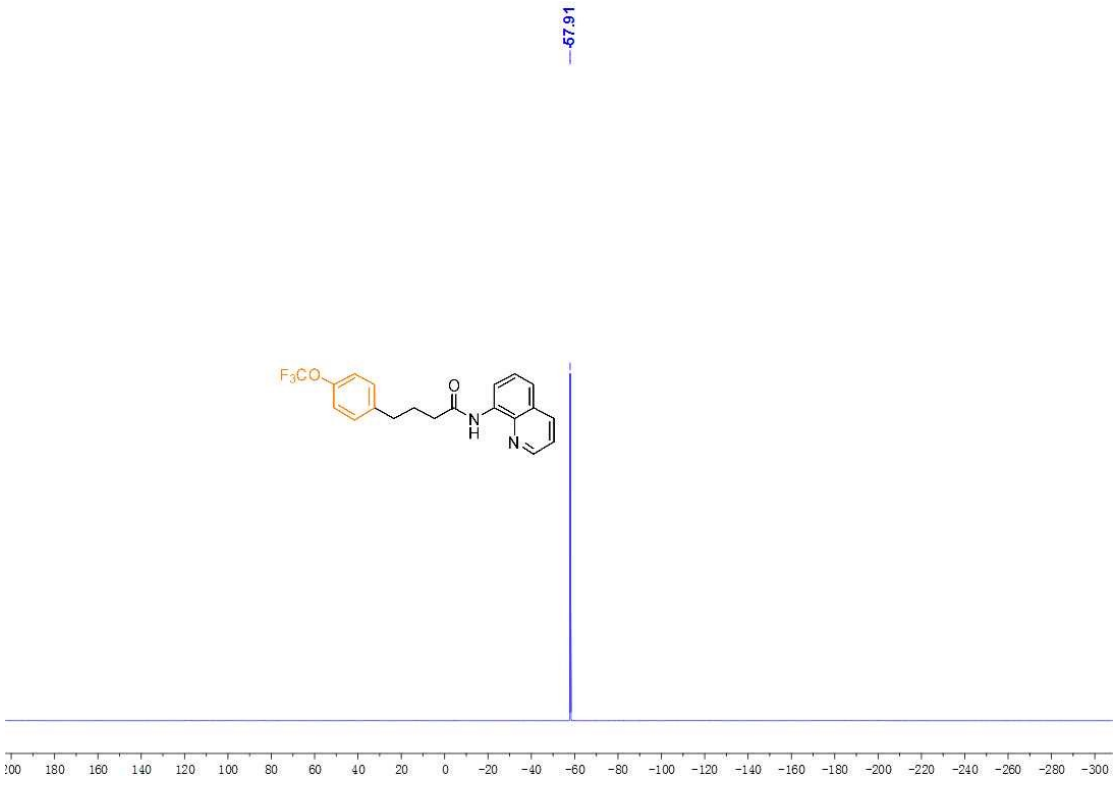

171.59
157.99
148.19
138.42
136.45
134.62
133.65
129.56
128.03
127.52
121.67
121.47
116.51
113.92
77.48
77.16
76.84
55.34
37.38
34.38
27.37
MeO
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

3j

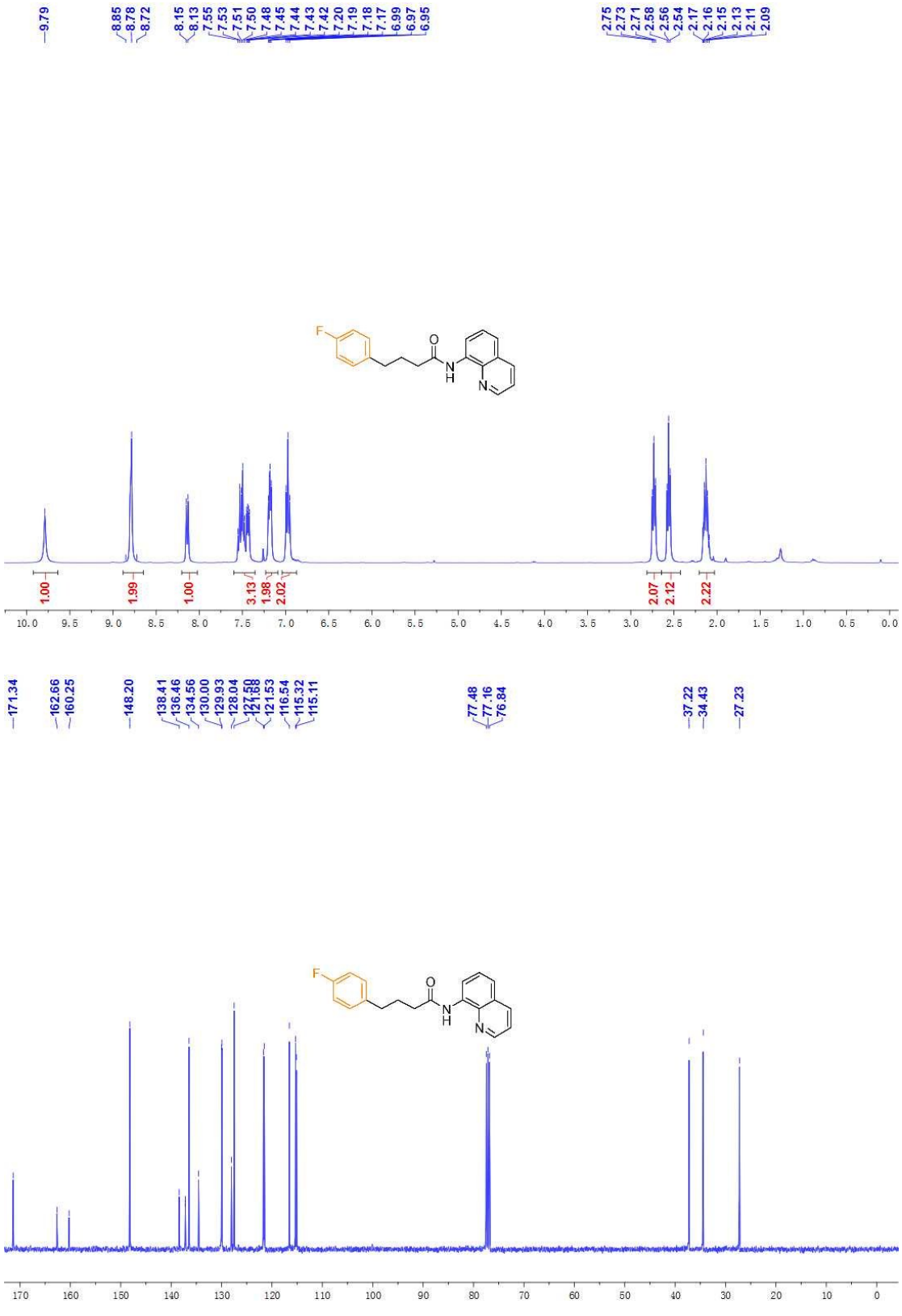

9.69
8.70
8.68
8.05
8.03
7.45
7.43
7.41
7.39
7.37
7.35
7.33
7.32
7.31
7.15
7.13
7.04
7.02
2.68
2.66
2.64
2.49
2.47
2.45
2.08
2.06
2.04
2.02
2.00
F3CO
O
N
H
N
1.00
2.03
1.02
2.03
1.05
2.14
2.01
2.08
2.08
2.14
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


171.22
148.21
147.61
140.35
138.38
136.47
134.52
129.87
128.03
127.49
121.70
121.57
121.06
116.53
77.48
77.16
76.84
37.17
34.53
27.00
F3CO
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

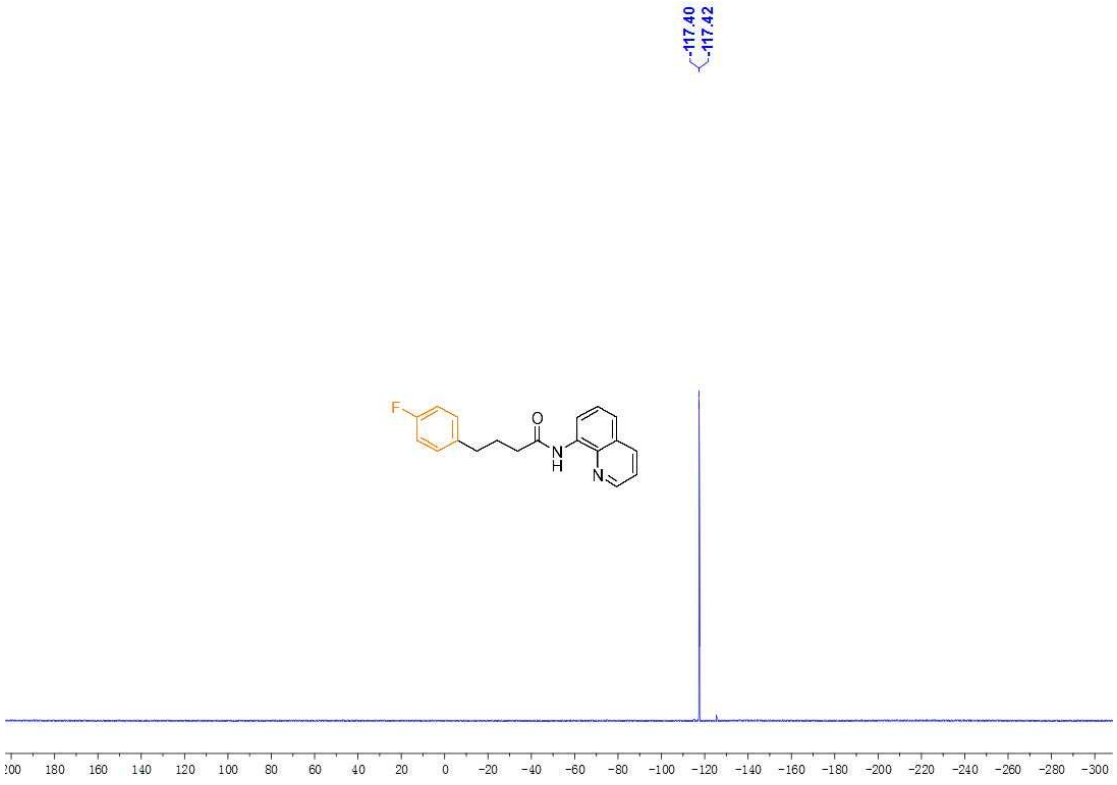
3j


-57.91
F3CO
O
N
H
N
200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300

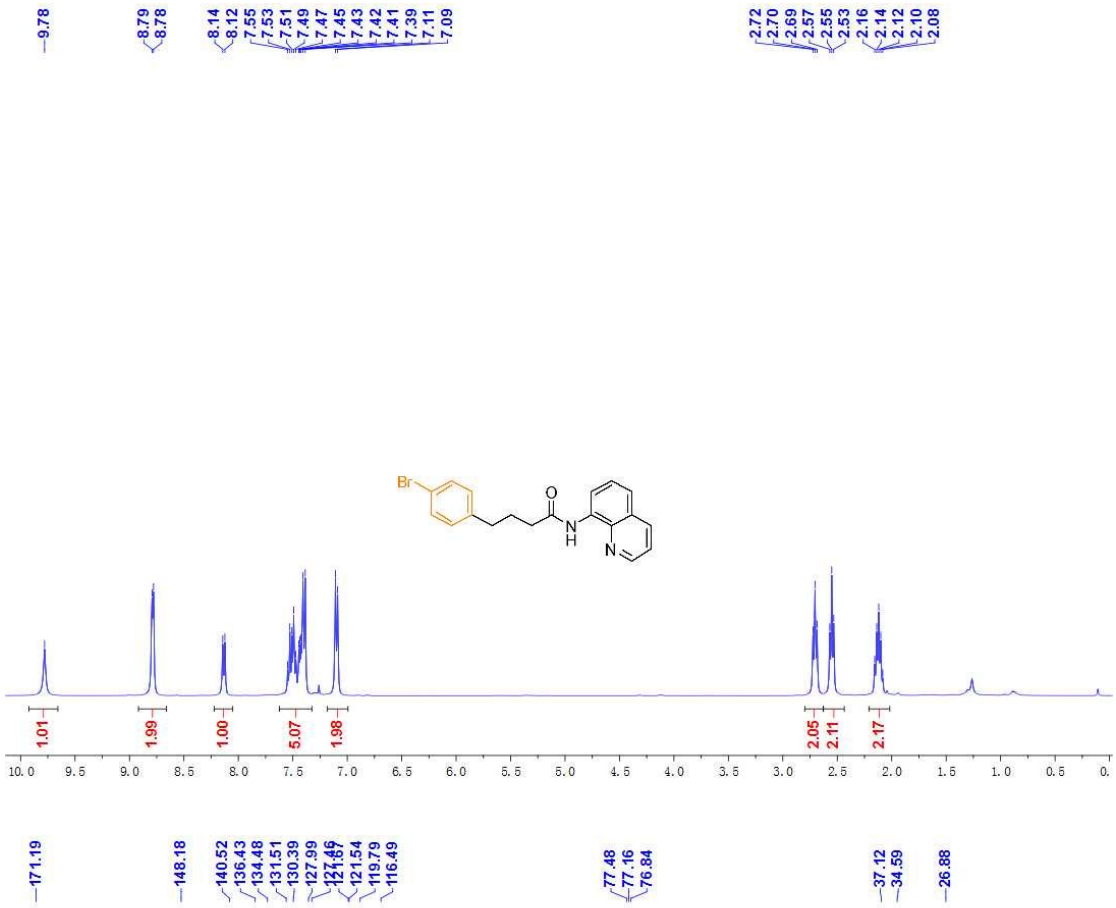
3k

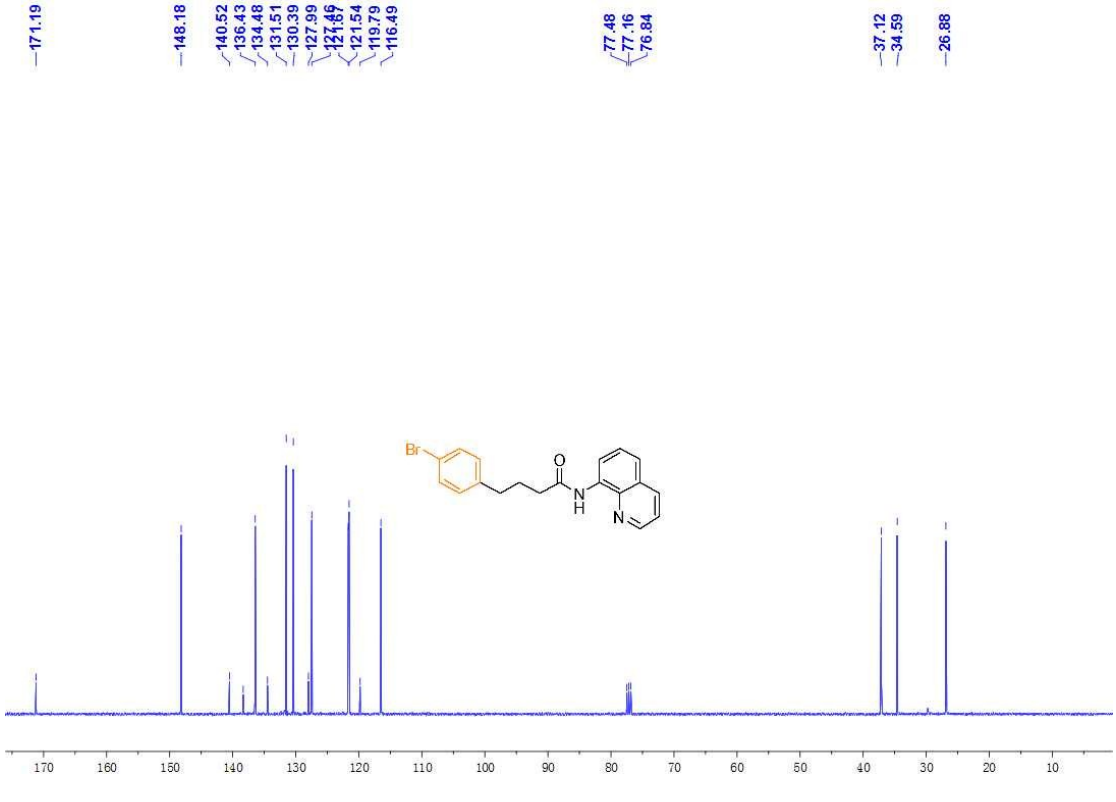

9.79
8.85
8.78
8.72
8.15
8.13
7.55
7.53
7.51
7.50
7.48
7.45
7.44
7.43
7.42
7.20
7.19
7.18
7.17
6.99
6.97
6.95
2.75
2.73
2.71
2.58
2.56
2.54
2.17
2.16
2.15
2.13
2.11
2.09
F
O
N
H
N
1.00
1.99
1.00
3.13
1.98
2.02
2.07
2.12
2.22
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
171.34
162.66
160.25
148.20
138.41
136.46
134.56
130.00
129.93
128.04
121.53
116.54
115.32
115.11
77.48
77.16
76.84
37.22
34.43
27.23
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3k

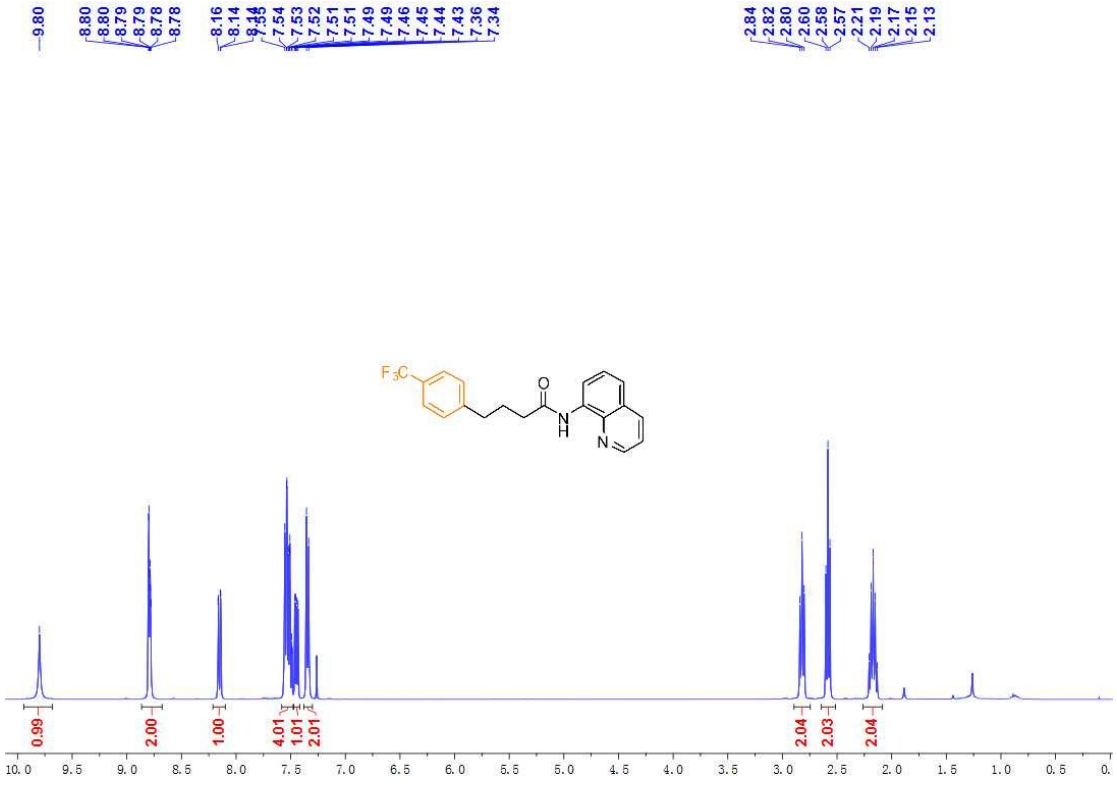

-117.40
-117.42
F
O
N
H
N
200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300

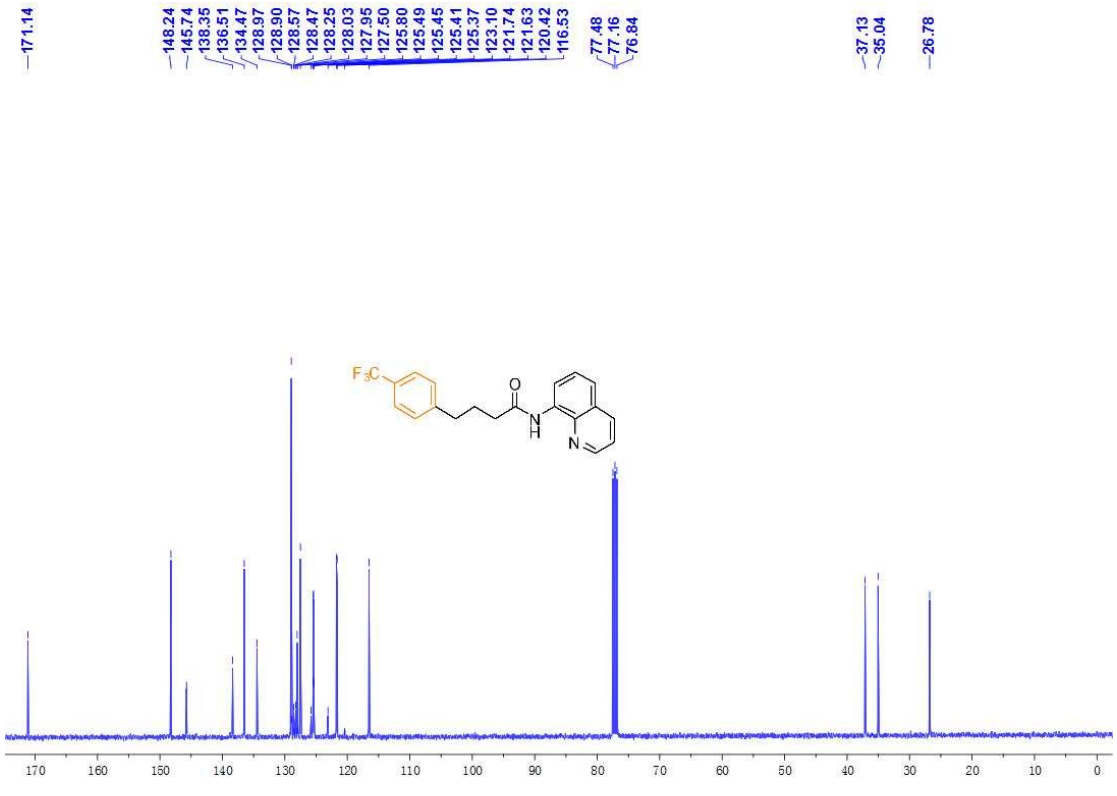
3l


9.78
8.79
8.78
8.14
8.12
7.55
7.53
7.51
7.49
7.47
7.45
7.43
7.42
7.41
7.39
7.11
7.09
2.72
2.70
2.69
2.57
2.55
2.53
2.16
2.14
2.12
2.10
2.08
Br
O
N
H
N
1.01
1.99
1.00
5.07
1.98
2.05
2.11
2.17
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.

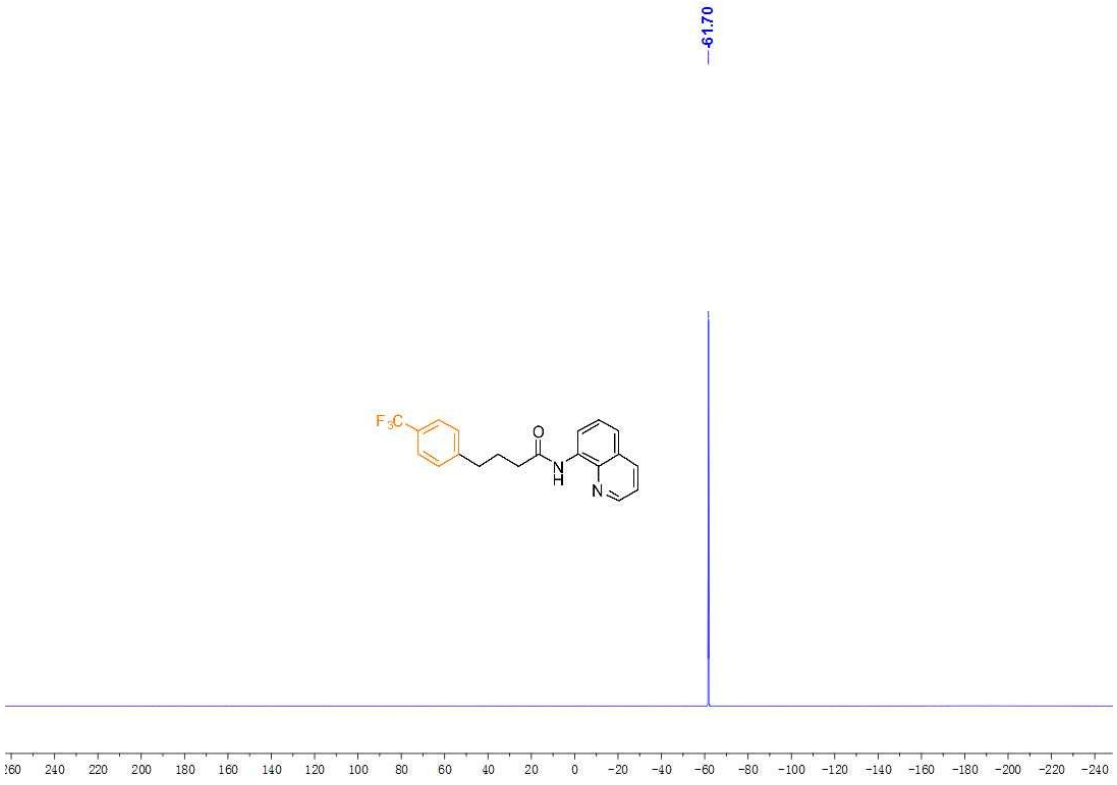

171.19
148.18
140.52
136.43
134.48
131.51
130.39
127.99
121.54
119.79
116.49
77.48
77.16
76.84
37.12
34.59
26.88
Br
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

3m

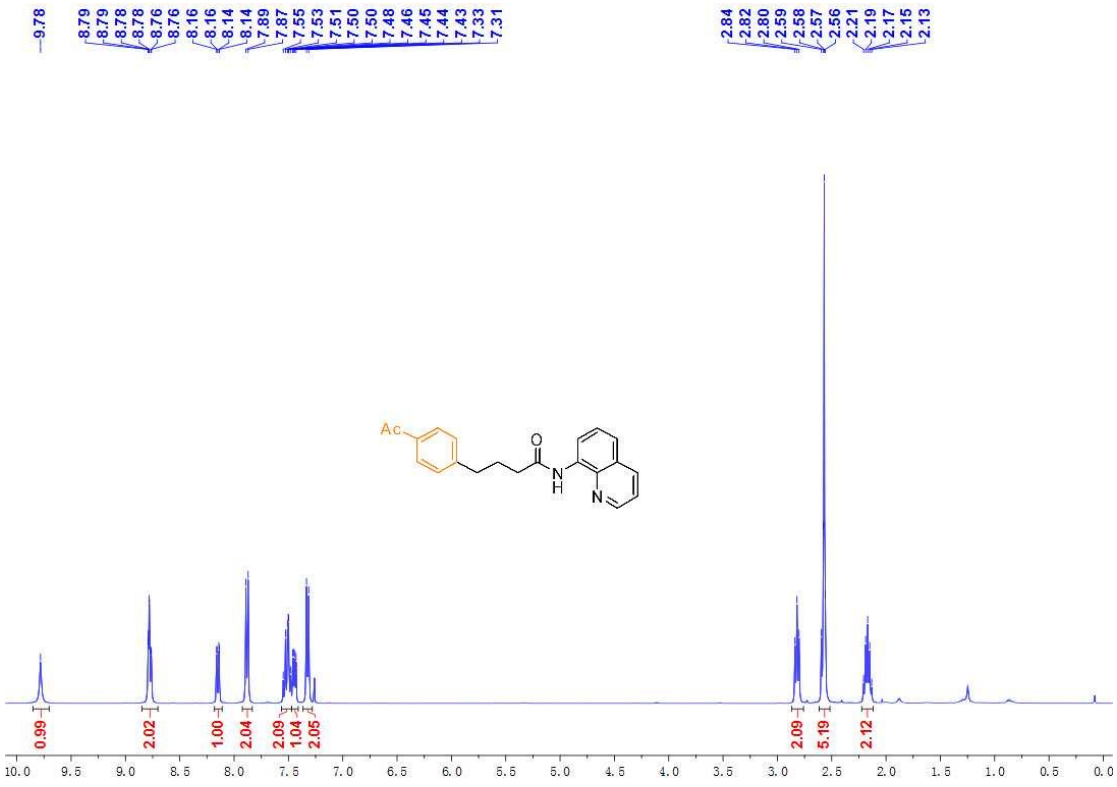

9.80
8.80
8.80
8.79
8.79
8.78
8.78
8.16
8.14
7.54
7.53
7.52
7.51
7.51
7.49
7.49
7.46
7.45
7.44
7.43
7.36
7.34
2.84
2.82
2.80
2.60
2.58
2.57
2.21
2.19
2.17
2.15
2.13
F3C
O
N
H
N
0.99
2.00
1.00
4.01
1.01
2.01
2.04
2.03
2.04
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

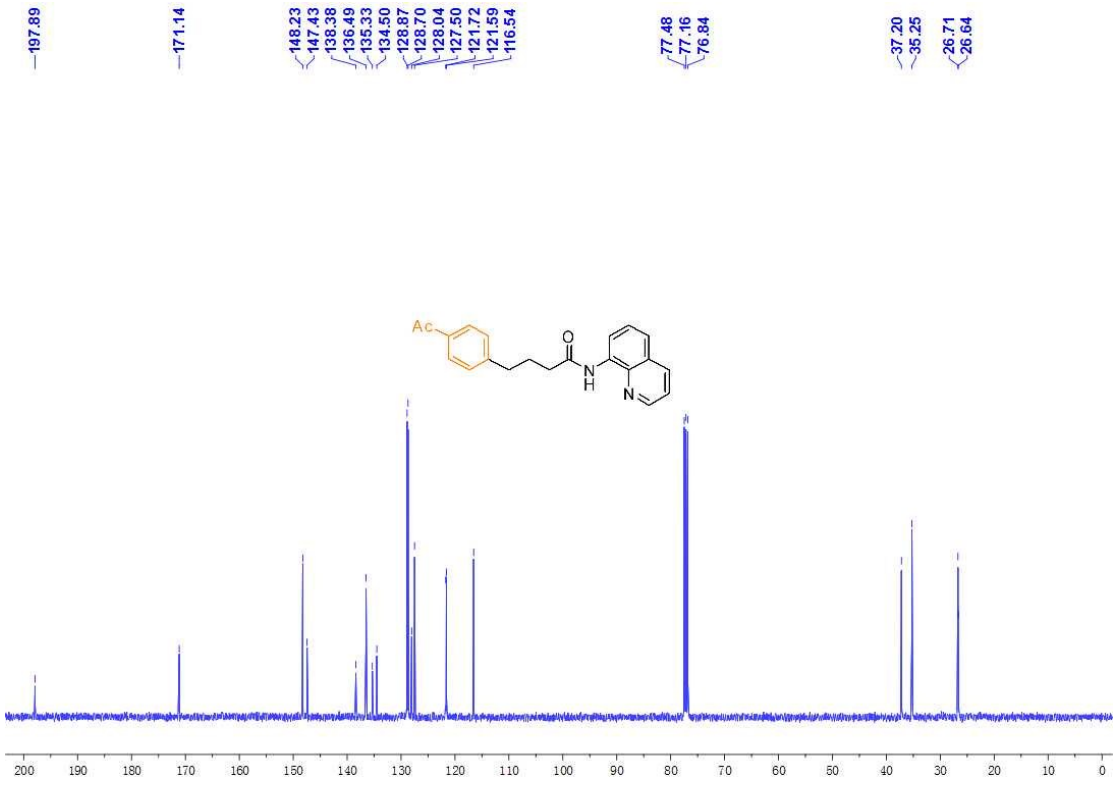

171.14
148.24
145.74
138.35
136.51
134.47
128.97
128.90
128.57
128.47
128.25
128.03
127.95
127.50
125.80
125.49
125.45
125.41
125.37
123.10
121.74
121.63
120.42
116.53
77.48
77.16
76.84
37.13
35.04
26.78
F3C
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3m

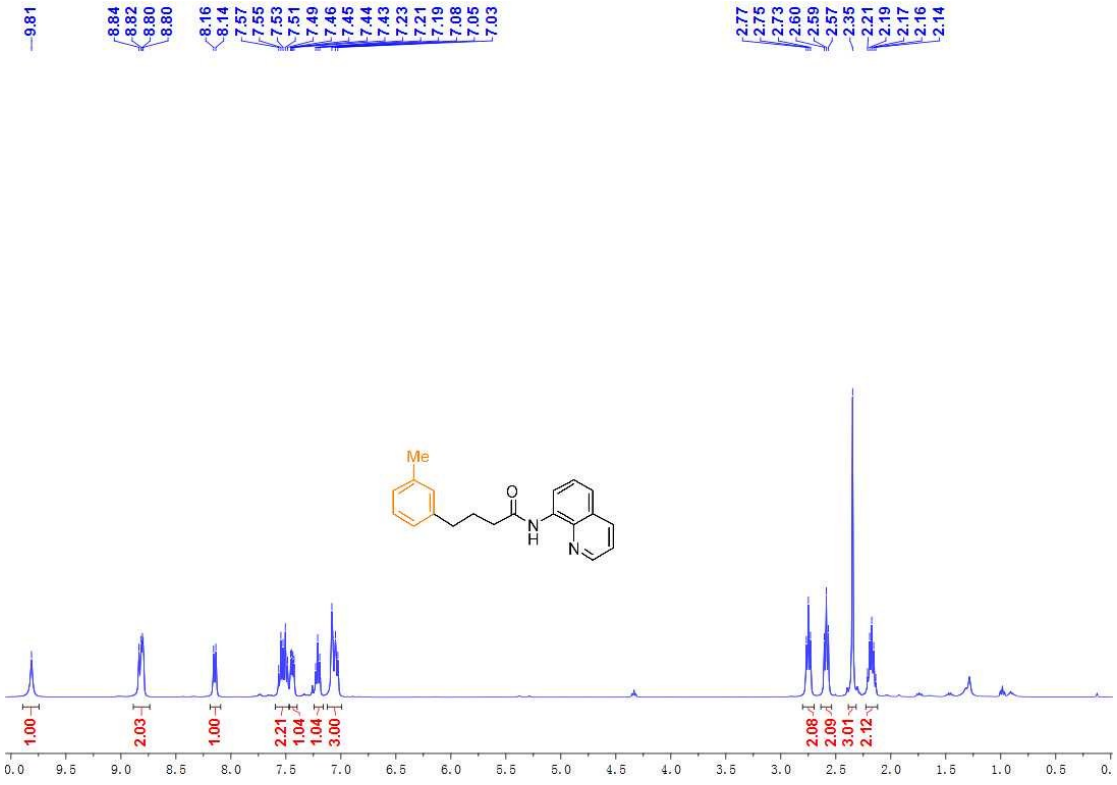

-61.70
F3C
O
N
H
N
260 240 220 200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240

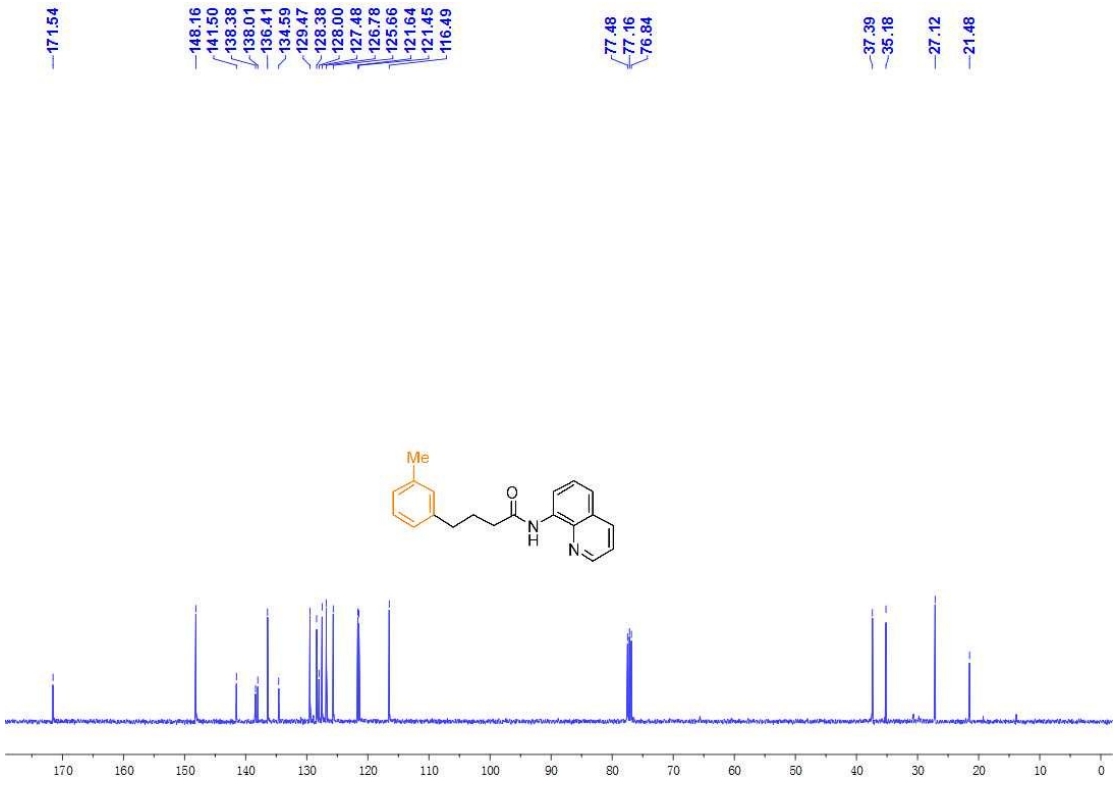
3n


9.78
8.79
8.79
8.78
8.78
8.76
8.76
8.16
8.16
8.14
8.14
7.89
7.87
7.55
7.53
7.51
7.50
7.50
7.48
7.46
7.45
7.44
7.43
7.33
7.31
2.84
2.82
2.80
2.59
2.58
2.57
2.56
2.21
2.19
2.17
2.15
2.13
Ac
O
N
H
N
0.99
2.02
1.00
2.04
2.09
1.04
2.05
2.09
5.19
2.12
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


197.89
171.14
148.23
147.43
138.38
136.49
135.33
134.50
128.87
128.70
128.04
127.50
121.72
121.59
116.54
77.48
77.16
76.84
37.20
35.25
26.71
26.64
Ac
O
N
H
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

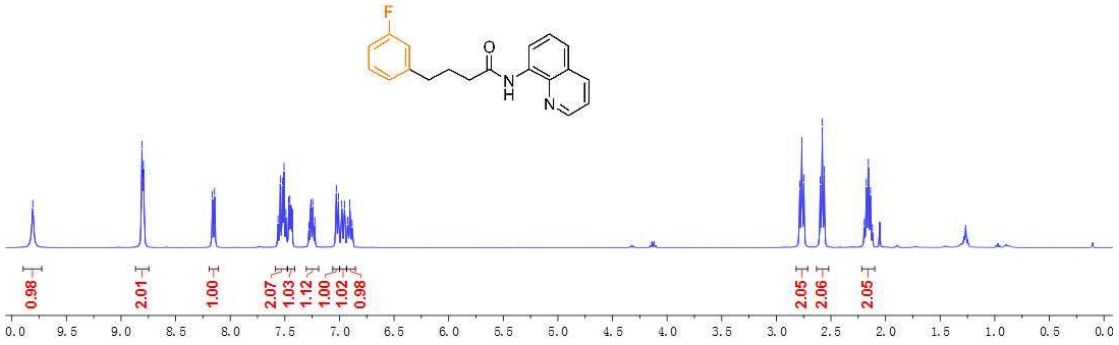
3o


9.81
8.84
8.82
8.80
8.80
8.16
8.14
7.57
7.55
7.53
7.51
7.49
7.46
7.45
7.44
7.43
7.23
7.21
7.19
7.08
7.05
7.03
2.77
2.75
2.73
2.60
2.59
2.57
2.35
2.21
2.19
2.17
2.16
2.14
Me
O
N
H
N
1.00
2.03
1.00
2.21
1.04
1.04
3.00
2.08
2.09
3.01
2.12
0.0
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.

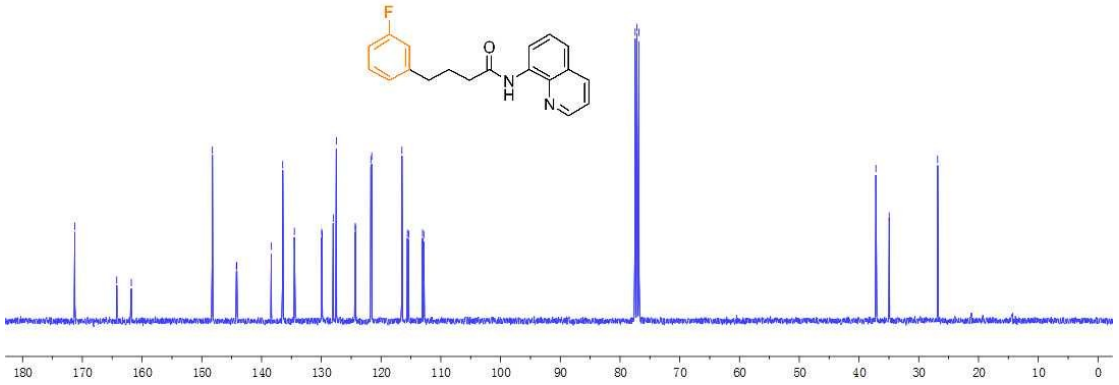

171.54
148.16
141.50
138.38
138.01
136.41
134.59
129.47
128.38
128.00
127.48
126.78
125.66
121.64
121.45
116.49
77.48
77.16
76.84
37.39
35.18
27.12
21.48
Me
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3p

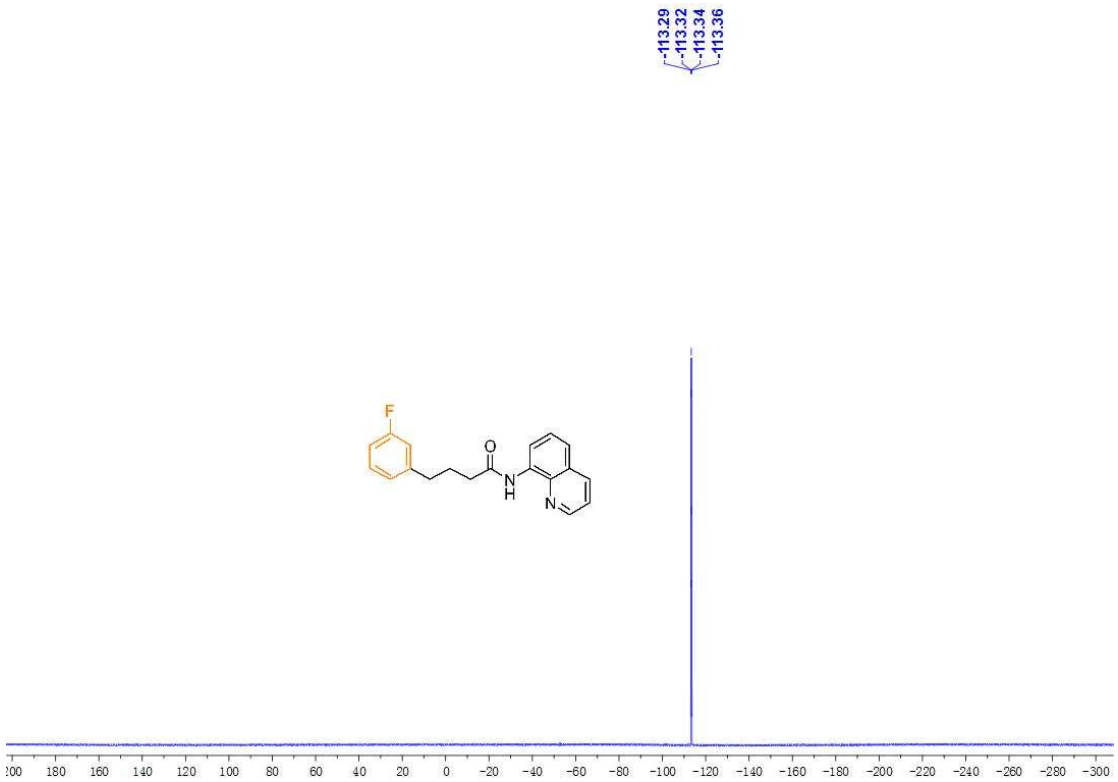

9.81
8.81
8.80
8.79
8.16
8.14
7.56
7.54
7.52
7.51
7.49
7.46
7.45
7.28
7.26
7.26
7.24
7.23
7.03
7.01
6.98
6.95
6.93
6.91
6.88
2.79
2.77
2.75
2.60
2.58
2.56
2.19
2.18
2.16
2.14
2.12


F
O
N
H
N
0.98
2.01
1.00
2.07
1.03
1.12
1.00
1.02
0.98
2.05
2.06
2.05
0.0
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

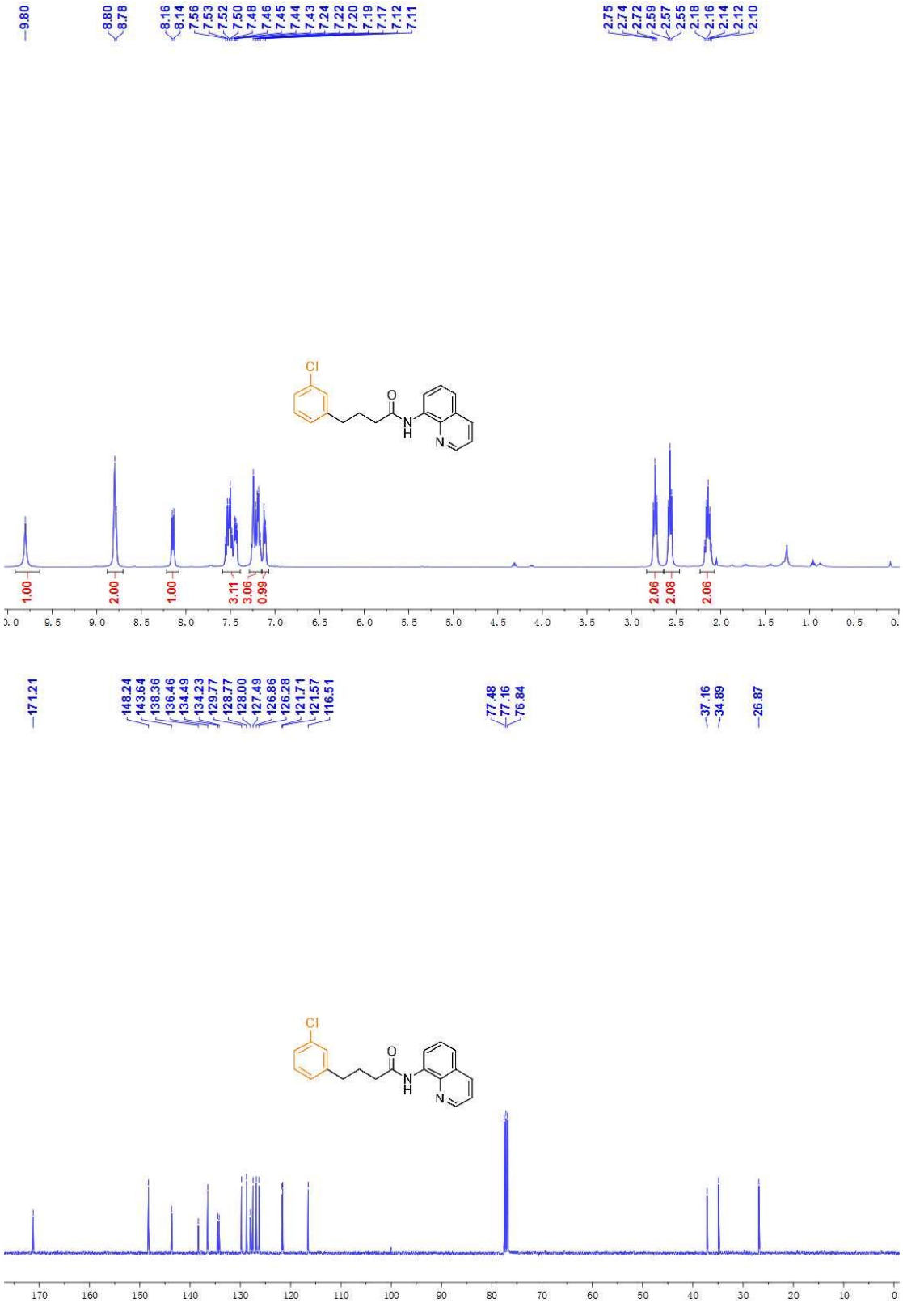

171.26
164.24
161.80
148.23
144.21
144.13
138.36
136.46
134.50
129.94
129.86
128.01
127.48
124.31
124.28
121.71
121.56
116.51
115.58
115.37
113.05
112.84
77.48
77.16
76.84
37.17
34.95
26.84


F
O
N
H
N
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

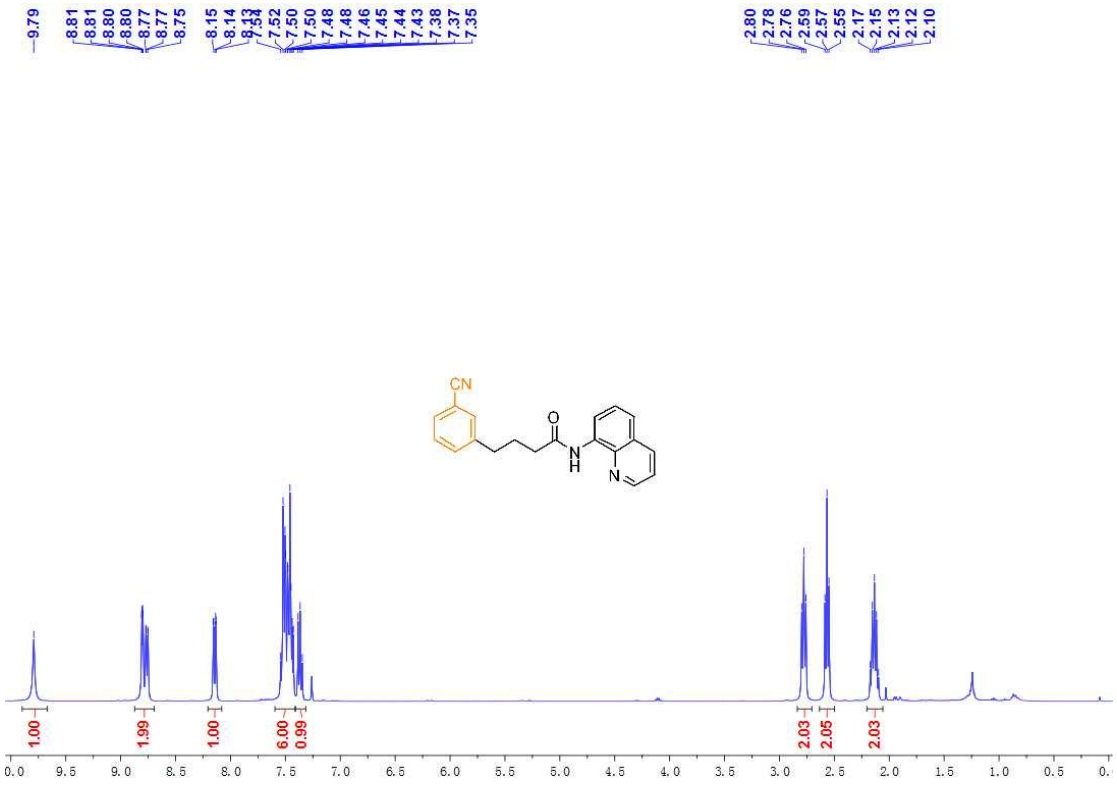
3p

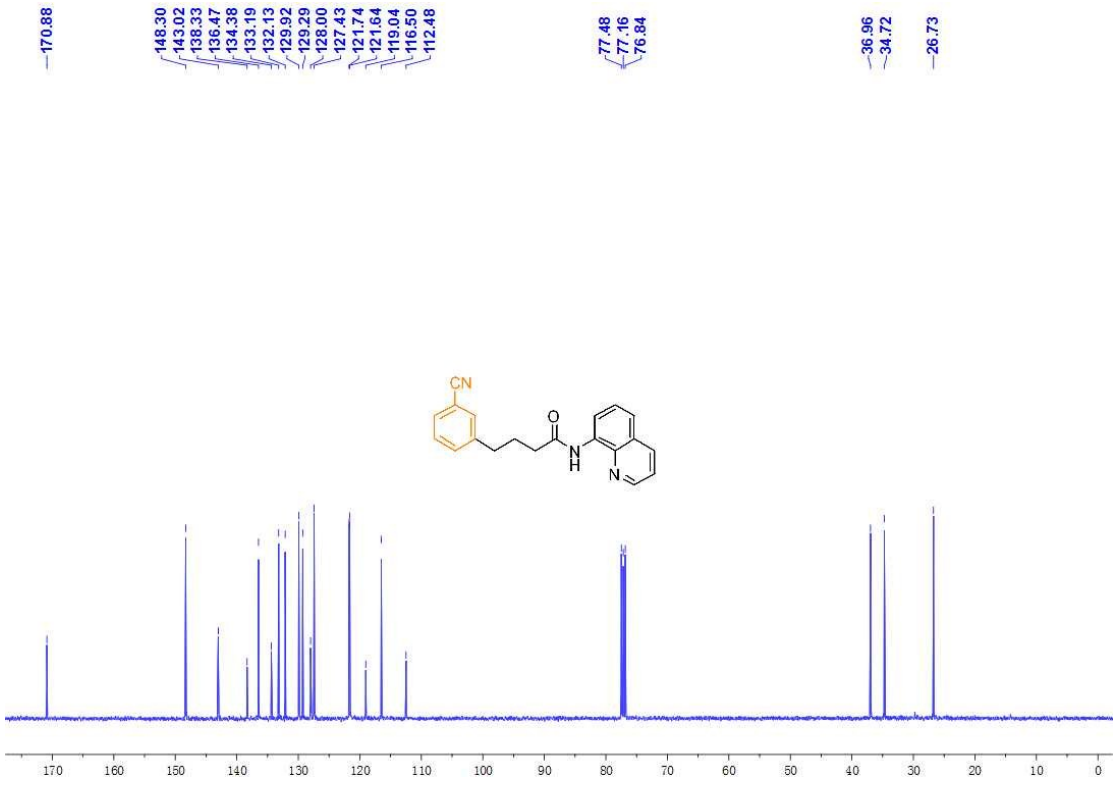

-113.29
-113.32
-113.34
-113.36
F
O
N
H
N
200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300

3q

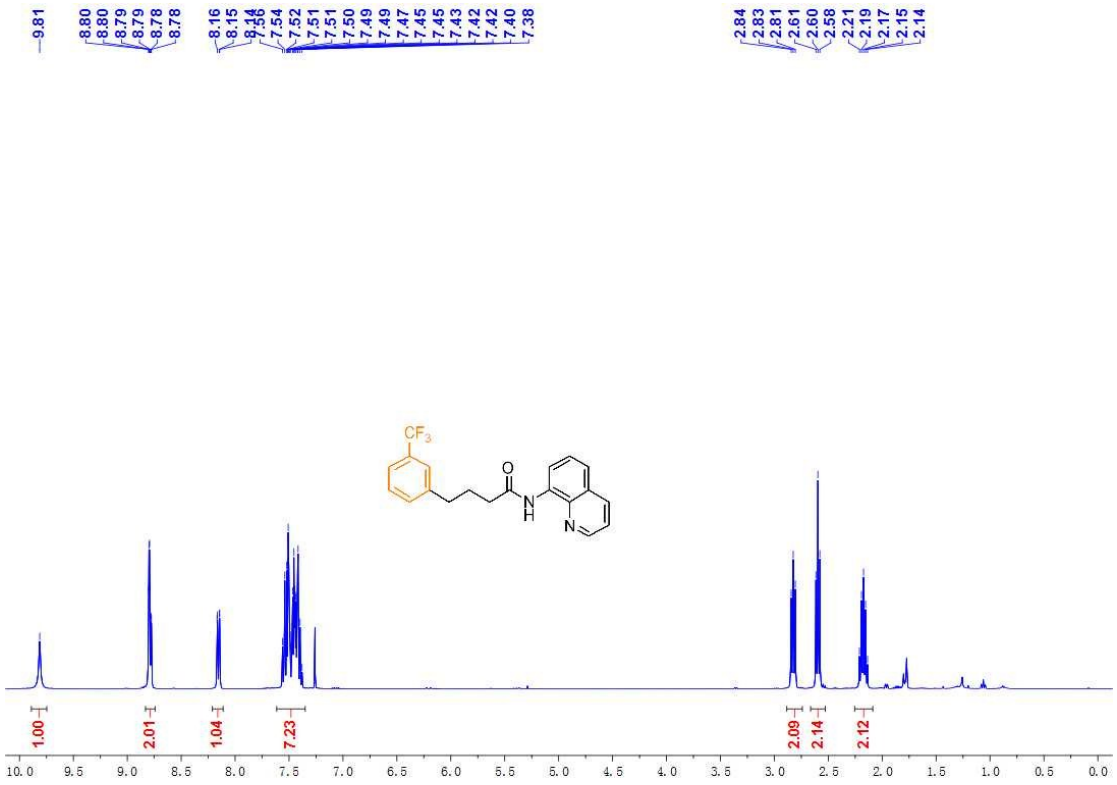

9.80
8.80
8.78
8.16
8.14
7.56
7.53
7.52
7.50
7.48
7.46
7.45
7.44
7.43
7.24
7.22
7.20
7.19
7.17
7.12
7.11
2.75
2.74
2.72
2.59
2.57
2.55
2.18
2.16
2.14
2.12
2.10
Cl
O
N
H
N
1.00
2.00
1.00
3.11
3.06
0.99
2.06
2.08
2.06
171.21
148.24
143.64
138.36
136.46
134.49
134.23
129.77
128.77
128.00
127.49
126.86
126.28
121.71
121.57
116.51
77.48
77.16
76.84
37.16
34.89
26.87

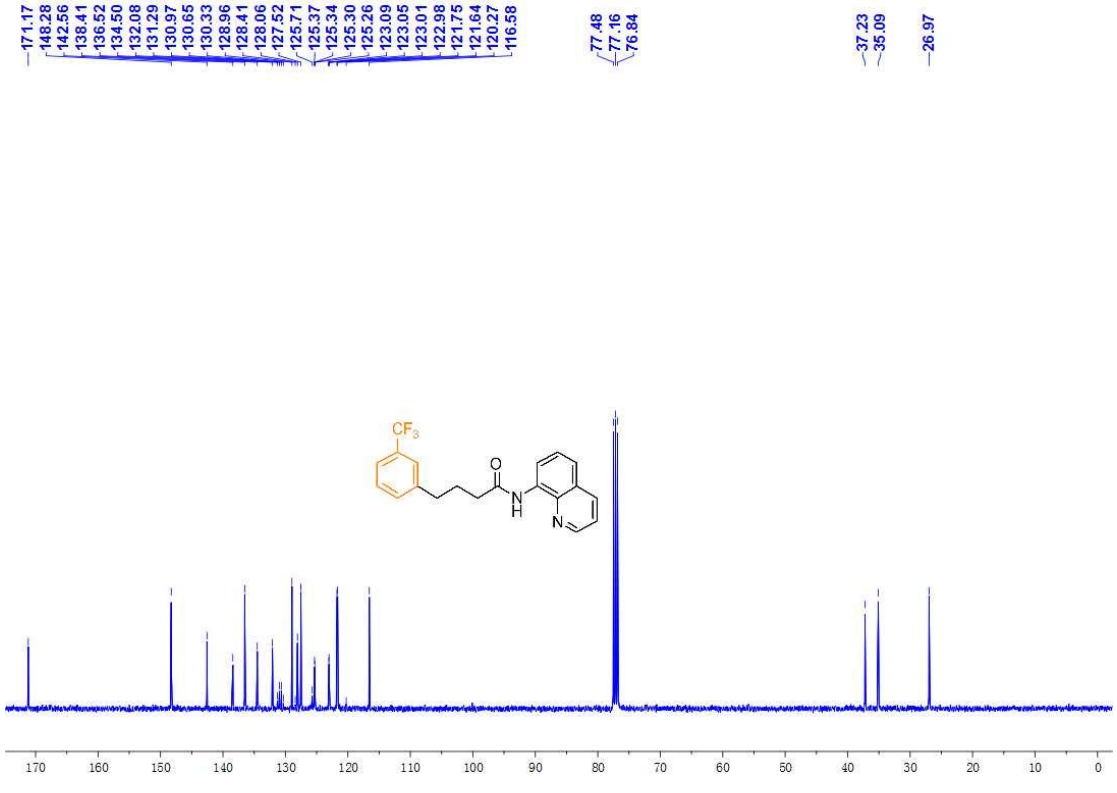
3r


9.79
8.81
8.81
8.80
8.80
8.77
8.77
8.75
8.15
8.14
8.13
7.54
7.52
7.50
7.50
7.48
7.48
7.46
7.45
7.44
7.43
7.38
7.37
7.35
2.80
2.78
2.76
2.59
2.57
2.55
2.17
2.15
2.13
2.12
2.10
CN
O
N
H
N
1.00
1.99
1.00
6.00
0.99
2.03
2.05
2.03
0.0
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

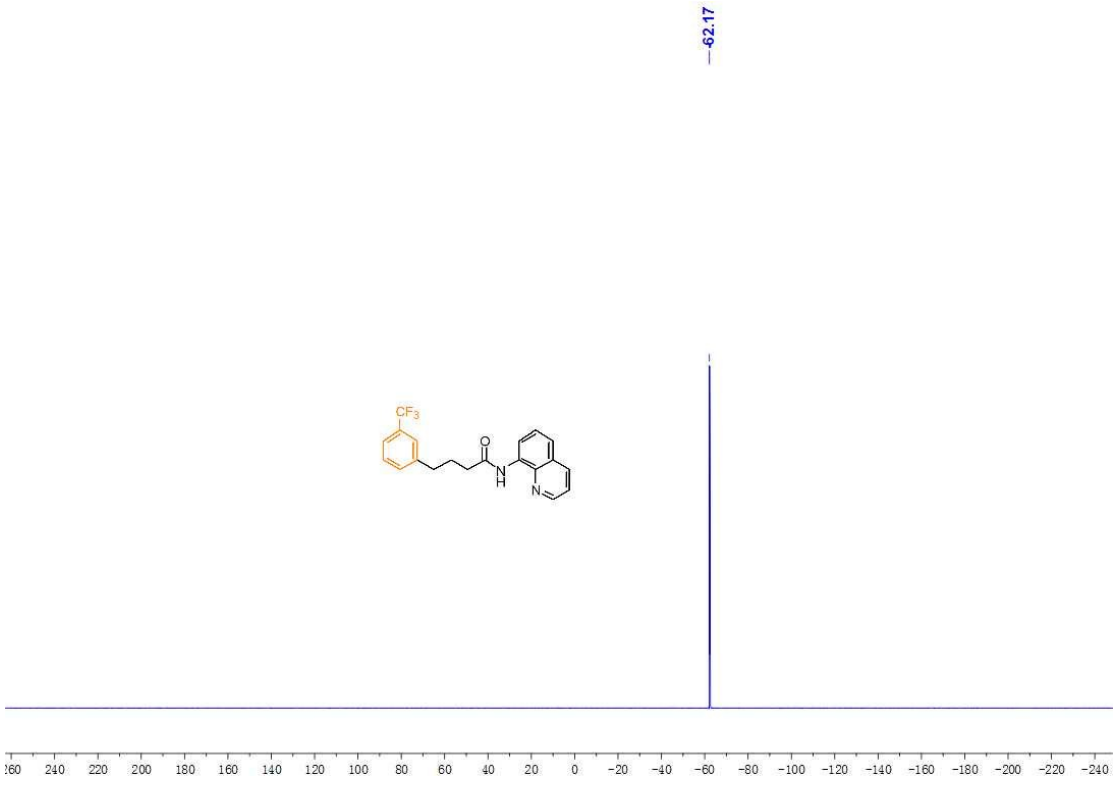

170.88
148.30
143.02
138.33
136.47
134.38
133.19
132.13
129.92
129.29
128.00
127.43
121.74
121.64
119.04
116.50
112.48
77.48
77.16
76.84
36.96
34.72
26.73
CN
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3s

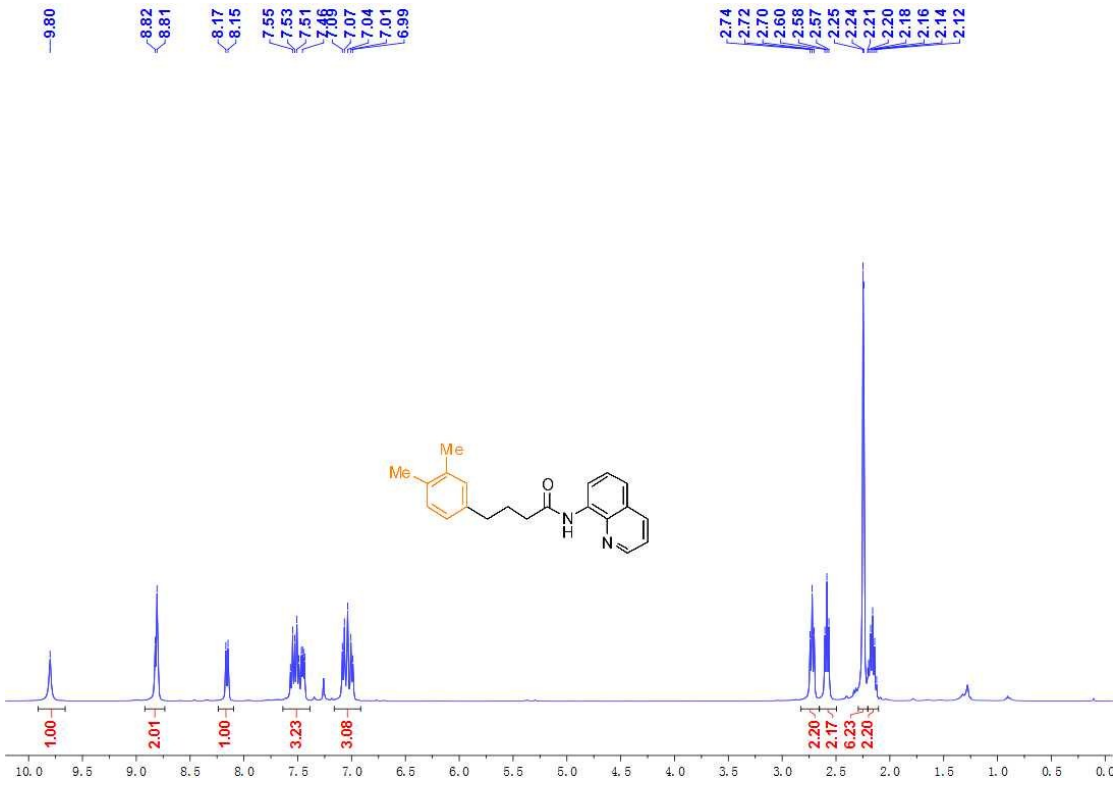

9.81
8.80
8.80
8.79
8.79
8.78
8.78
8.16
8.15
8.14
7.54
7.52
7.51
7.51
7.50
7.49
7.49
7.47
7.45
7.45
7.43
7.42
7.42
7.40
7.38
2.84
2.83
2.81
2.61
2.60
2.58
2.21
2.19
2.17
2.15
2.14
CF3
O
N
H
N
1.00
2.01
1.04
7.23
2.09
2.14
2.12
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

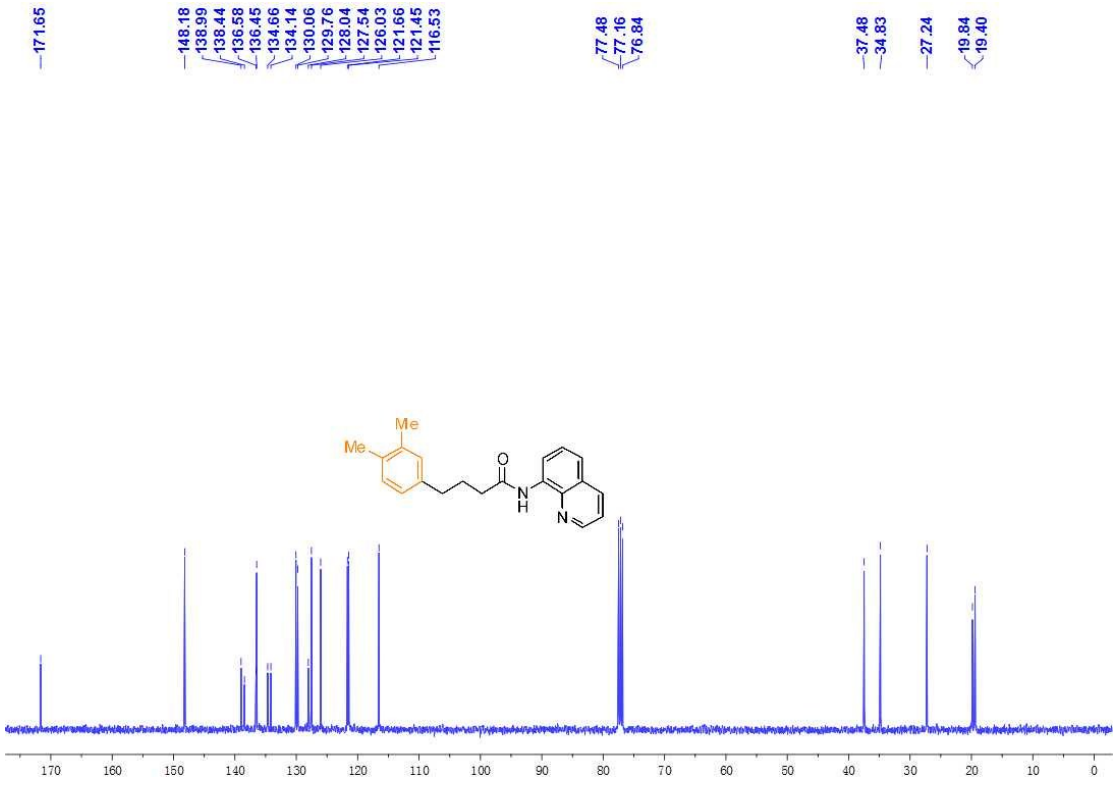

171.17
148.28
142.56
138.41
136.52
134.50
132.08
131.29
130.97
130.65
130.33
128.96
128.41
128.06
127.52
125.71
125.37
125.34
125.30
125.26
123.09
123.05
123.01
122.98
121.75
121.64
120.27
116.58
77.48
77.16
76.84
37.23
35.09
26.97
CF3
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

3s

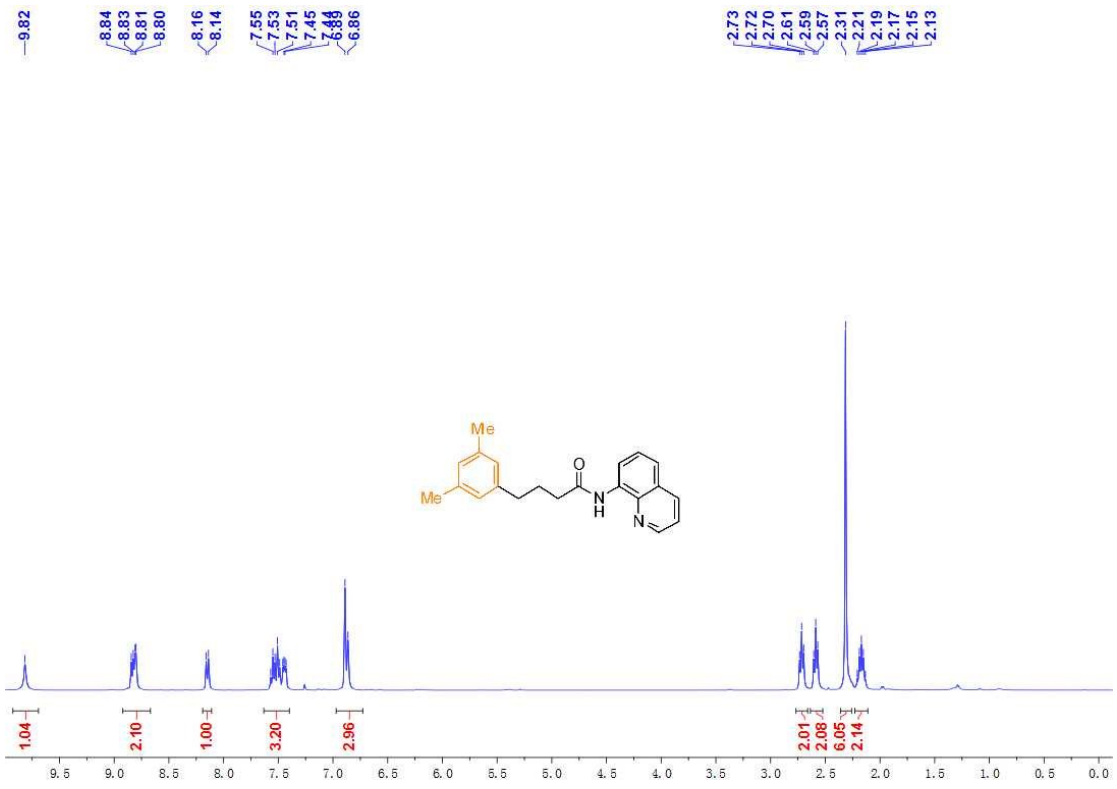

-62.17
CF3
O
N
H
N
260 240 220 200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240

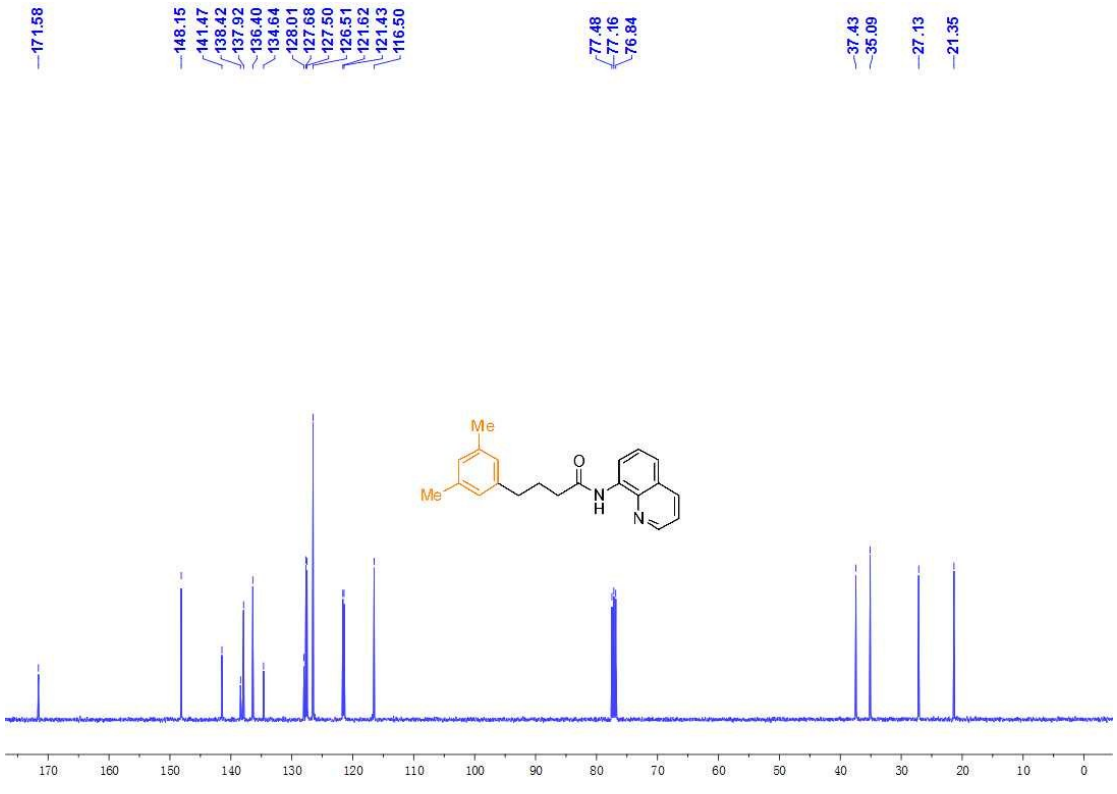
3t


9.80
8.82
8.81
8.17
8.15
7.55
7.53
7.51
7.07
7.04
7.01
6.99
2.74
2.72
2.70
2.60
2.58
2.57
2.25
2.24
2.21
2.20
2.18
2.16
2.14
2.12
Me
Me
O
N
H
N
1.00
2.01
1.00
3.23
3.08
2.20
2.17
6.23
2.20
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

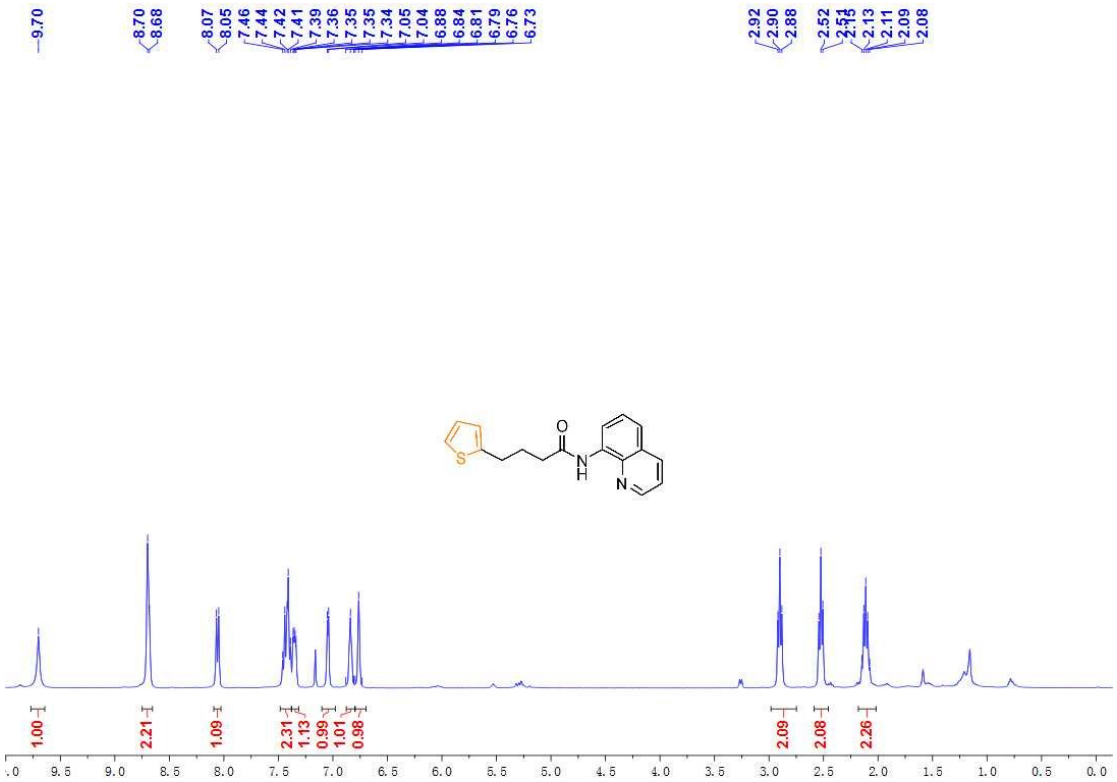

171.65
148.18
138.99
138.44
136.58
136.45
134.66
134.14
130.06
129.76
128.04
127.54
126.03
121.66
121.45
116.53
77.48
77.16
76.84
37.48
34.83
27.24
19.84
19.40
Me
Me
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

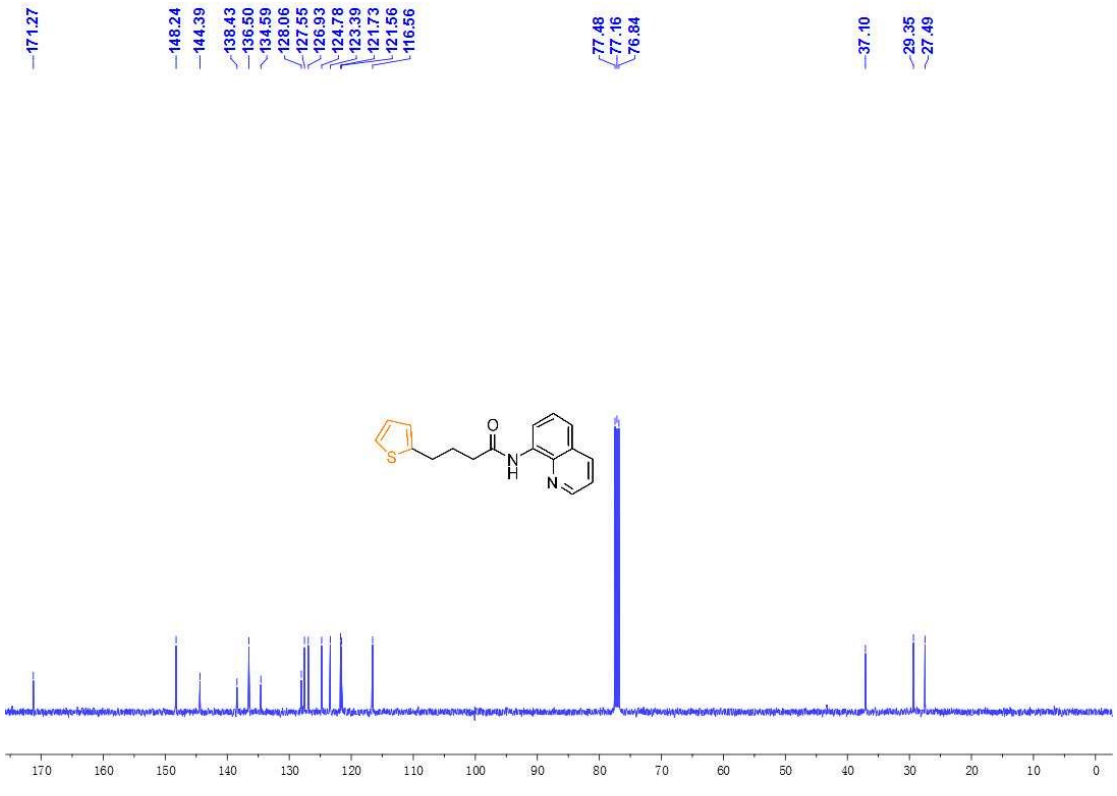
3u


9.82
8.84
8.83
8.81
8.80
8.16
8.14
7.55
7.53
7.51
7.45
7.44
6.89
6.86
2.73
2.72
2.70
2.61
2.59
2.57
2.31
2.21
2.19
2.17
2.15
2.13
Me
Me
O
N
H
N
1.04
2.10
1.00
3.20
2.96
2.01
2.08
6.05
2.14
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

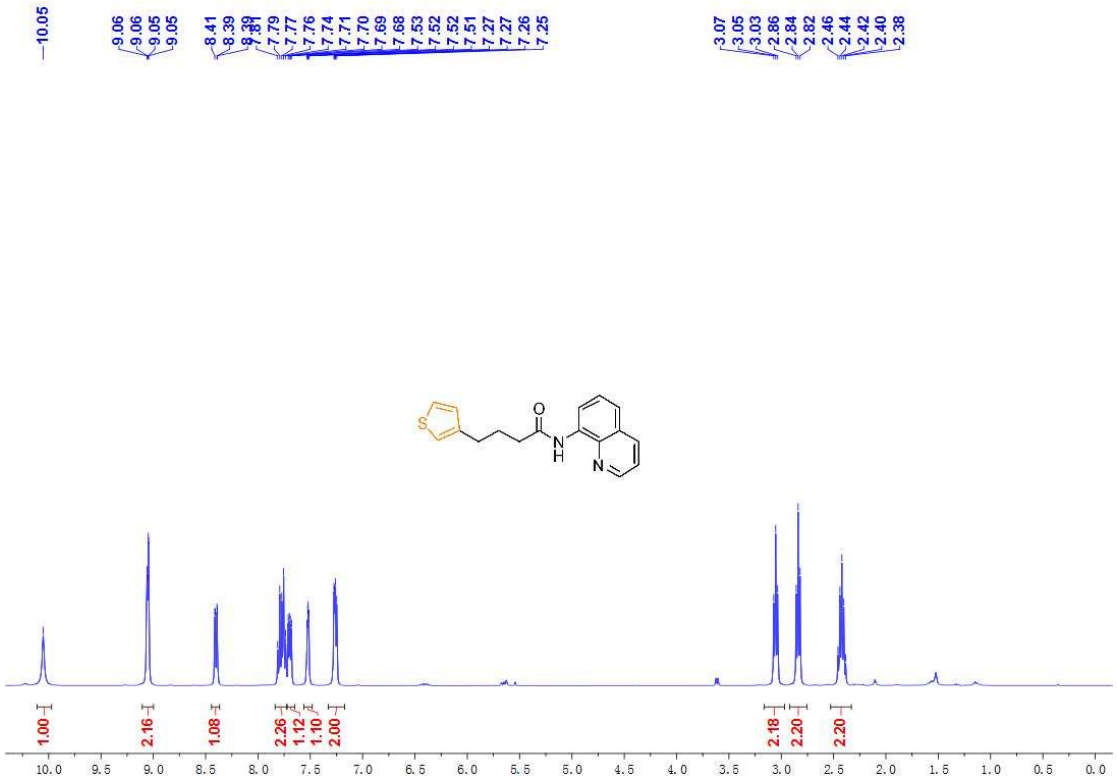

171.58
148.15
141.47
138.42
137.92
136.40
134.64
128.01
127.68
127.50
126.51
121.62
121.43
116.50
77.48
77.16
76.84
37.43
35.09
27.13
21.35
Me
Me
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

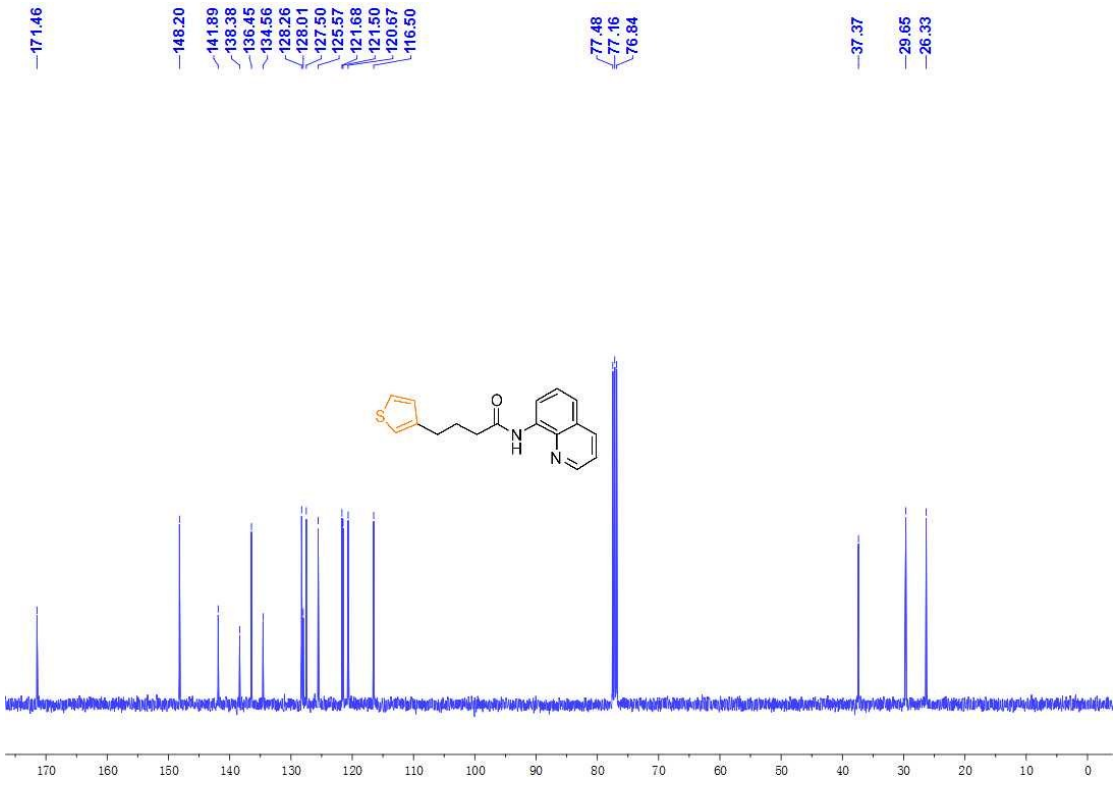
3v


9.70
8.70
8.68
8.07
8.05
7.46
7.44
7.42
7.41
7.39
7.36
7.35
7.35
7.34
7.05
7.04
6.88
6.84
6.81
6.79
6.76
6.73
2.92
2.90
2.88
2.52
2.13
2.11
2.09
2.08
O
N
H
S
N
1.00
2.21
1.09
2.31
1.13
0.99
1.01
0.98
2.09
2.08
2.26

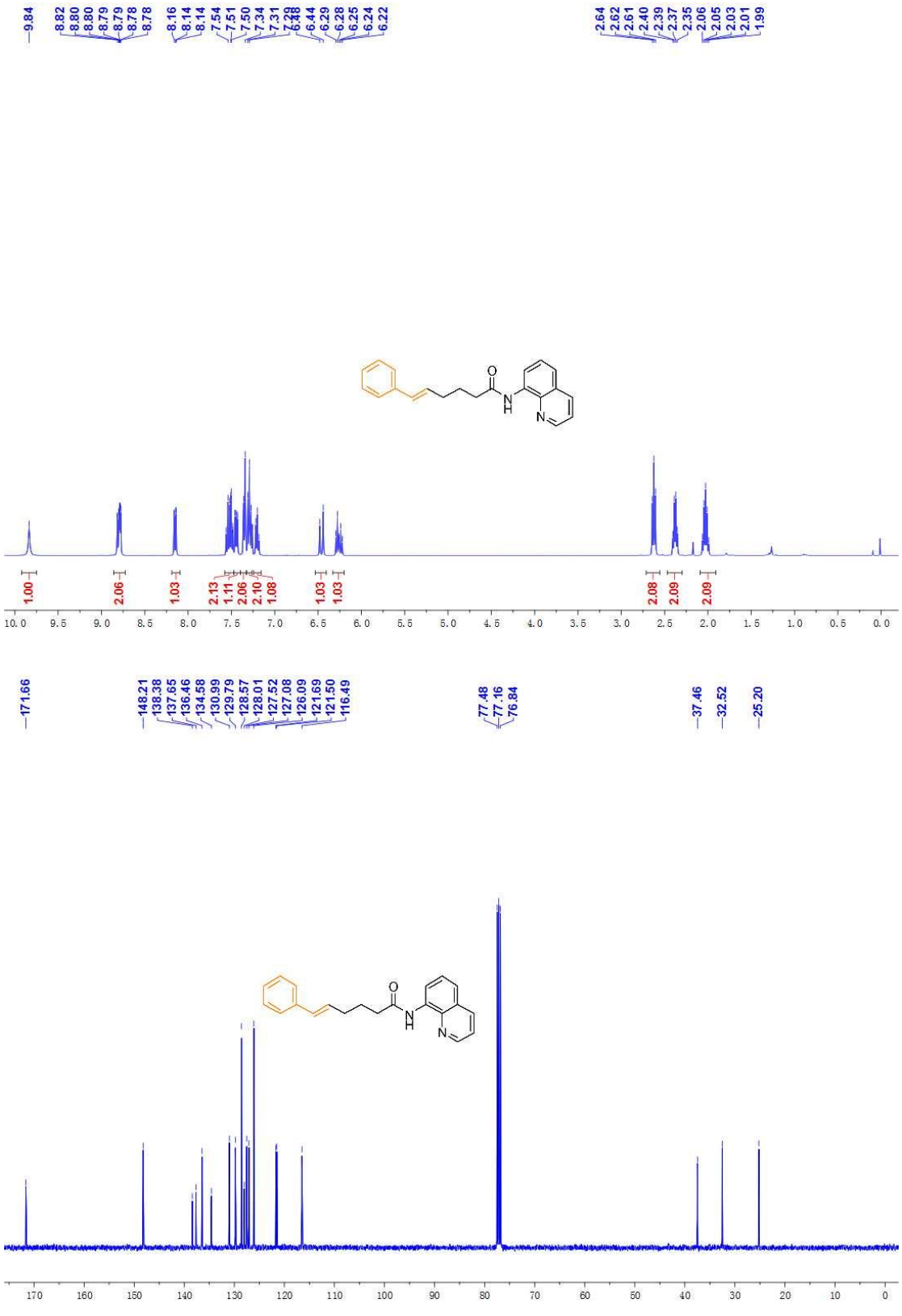

171.27
148.24
144.39
138.43
136.50
134.59
128.06
127.55
126.93
124.78
123.39
121.73
121.56
116.56
77.48
77.16
76.84
37.10
29.35
27.49
O
N
H
S
N

3w

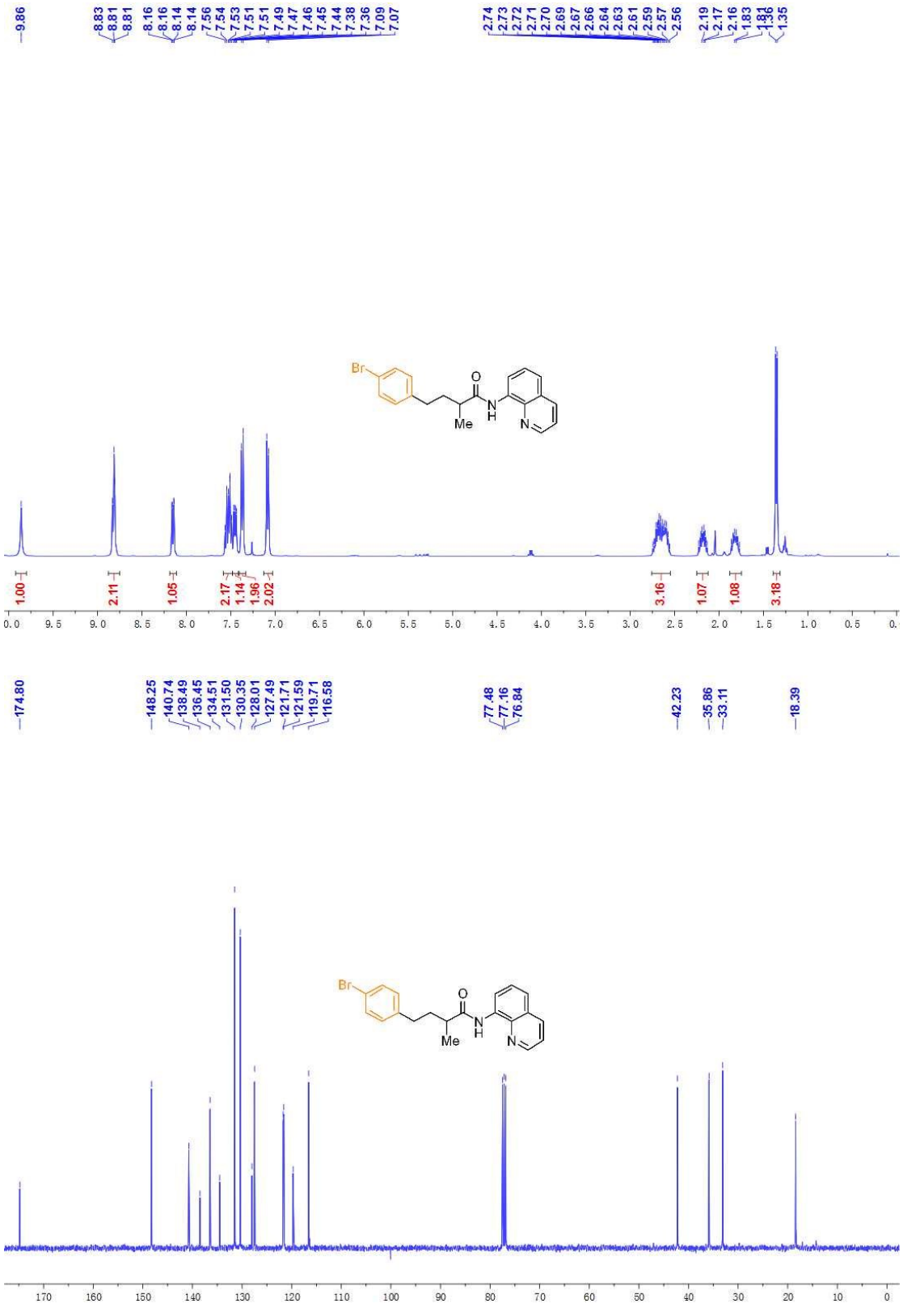

10.05
9.06
9.06
9.05
9.05
8.41
8.39
7.79
7.77
7.76
7.74
7.71
7.70
7.69
7.68
7.53
7.52
7.51
7.27
7.27
7.26
7.25
3.07
3.05
3.03
2.86
2.84
2.82
2.46
2.44
2.42
2.40
2.38
1.00
2.16
1.08
2.26
1.12
1.10
2.00
2.18
2.20
2.20


171.46
148.20
141.89
138.38
136.45
134.56
128.26
128.01
127.50
125.57
121.68
121.50
120.67
116.50
77.48
77.16
76.84
37.37
29.65
26.33

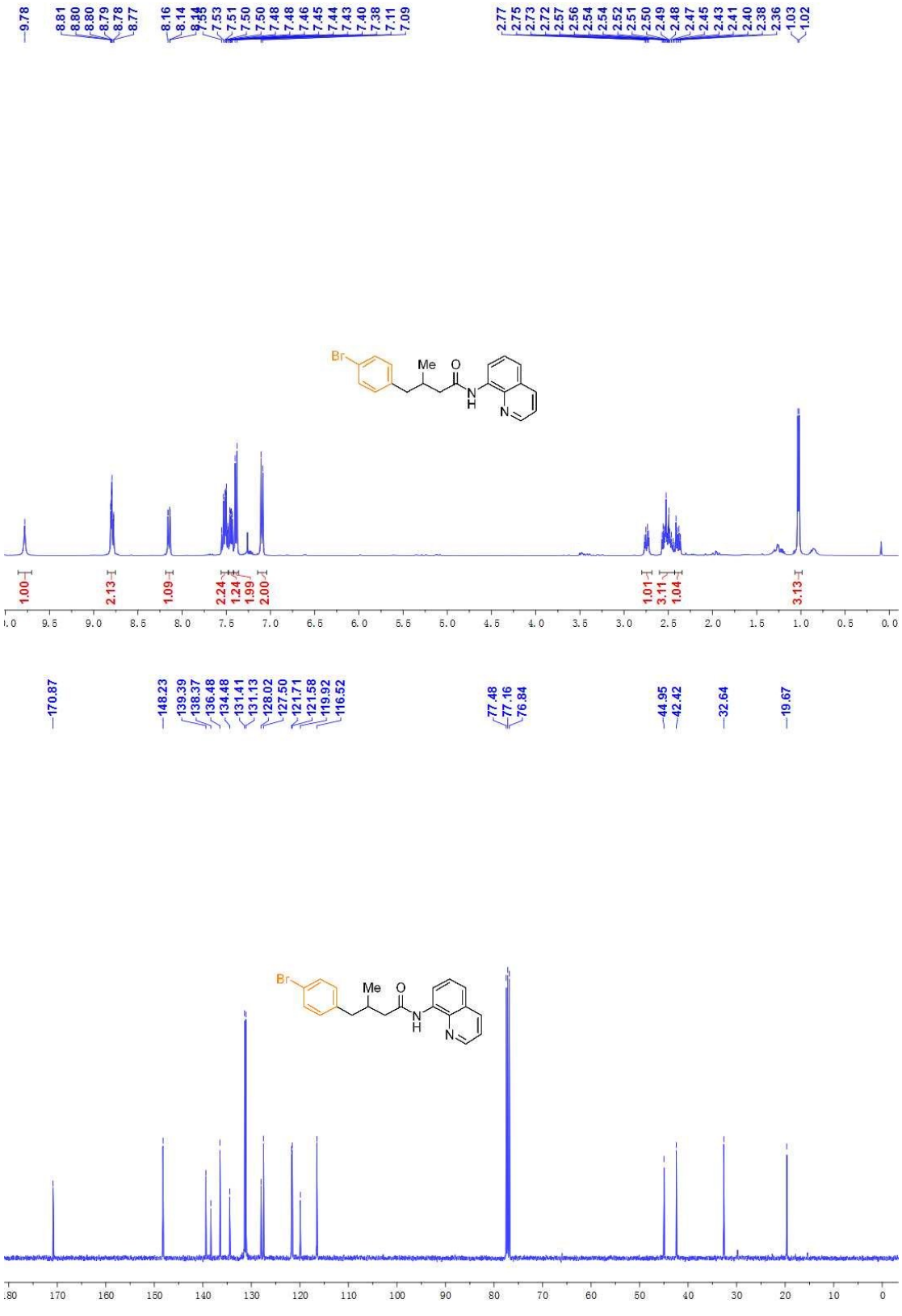
3x


9.84
8.82
8.80
8.80
8.79
8.79
8.78
8.78
8.16
8.14
8.14
7.54
7.51
7.50
7.34
7.31
7.29
6.44
6.29
6.28
6.25
6.24
6.22
2.64
2.62
2.61
2.40
2.39
2.37
2.35
2.06
2.05
2.03
2.01
1.99
O
N
H
N
1.00
2.06
1.03
2.13
1.11
2.06
2.10
1.08
1.03
1.03
2.08
2.09
2.09
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
171.66
148.21
138.38
137.65
136.46
134.58
130.99
129.79
128.57
128.01
127.52
127.08
126.09
121.69
121.50
116.49
77.48
77.16
76.84
37.46
32.52
25.20
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

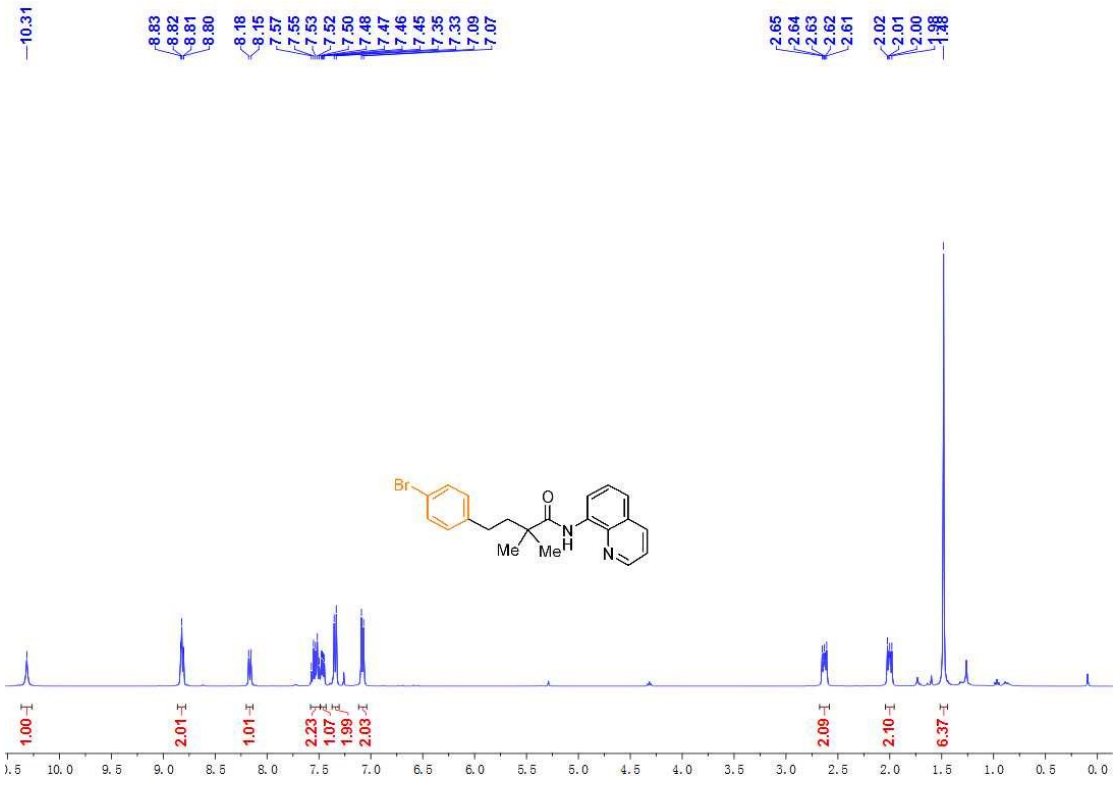
4a

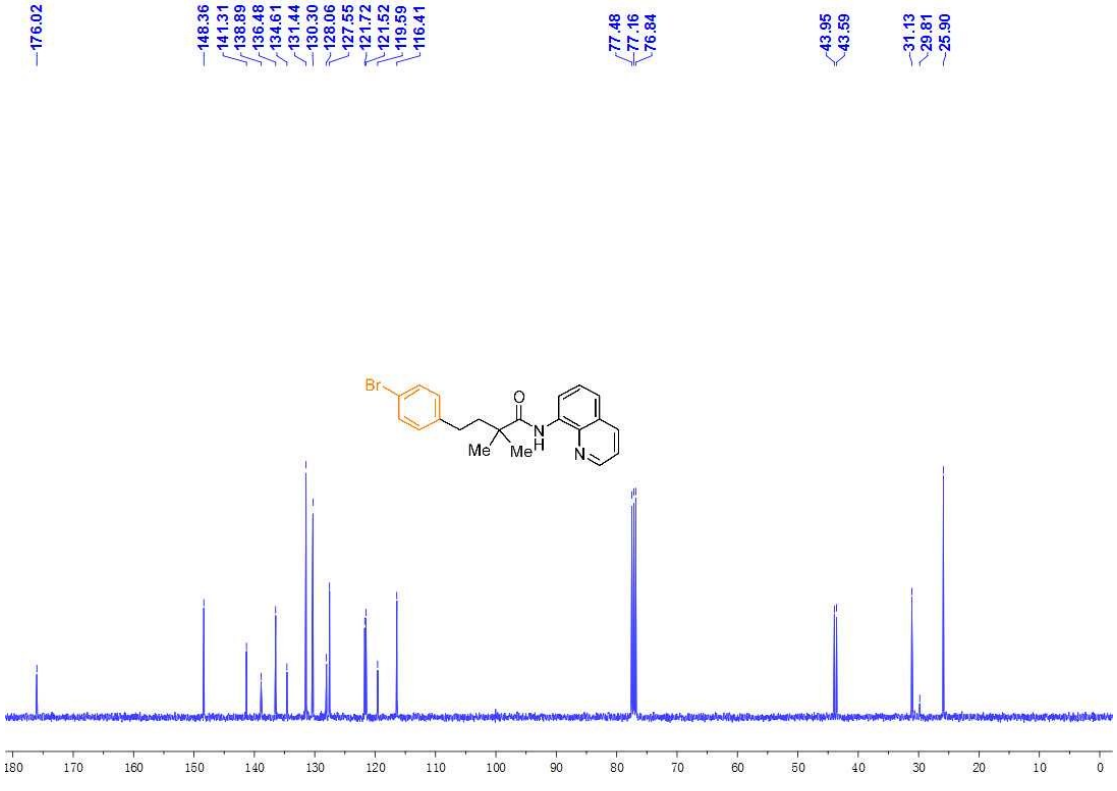

9.86
8.83
8.81
8.81
8.16
8.16
8.14
8.14
7.56
7.54
7.53
7.51
7.51
7.49
7.47
7.46
7.45
7.44
7.38
7.36
7.09
7.07
2.74
2.73
2.72
2.71
2.70
2.69
2.67
2.66
2.64
2.63
2.61
2.59
2.57
2.56
2.19
2.17
2.16
1.83
1.36
1.35
Br
O
N
H
Me
N
1.00
2.11
1.05
2.17
1.14
1.96
2.02
3.16
1.07
1.08
3.18
174.80
148.25
140.74
138.49
136.45
134.51
131.50
130.35
128.01
127.49
121.71
121.59
119.71
116.58
77.48
77.16
76.84
42.23
35.86
33.11
18.39

4b

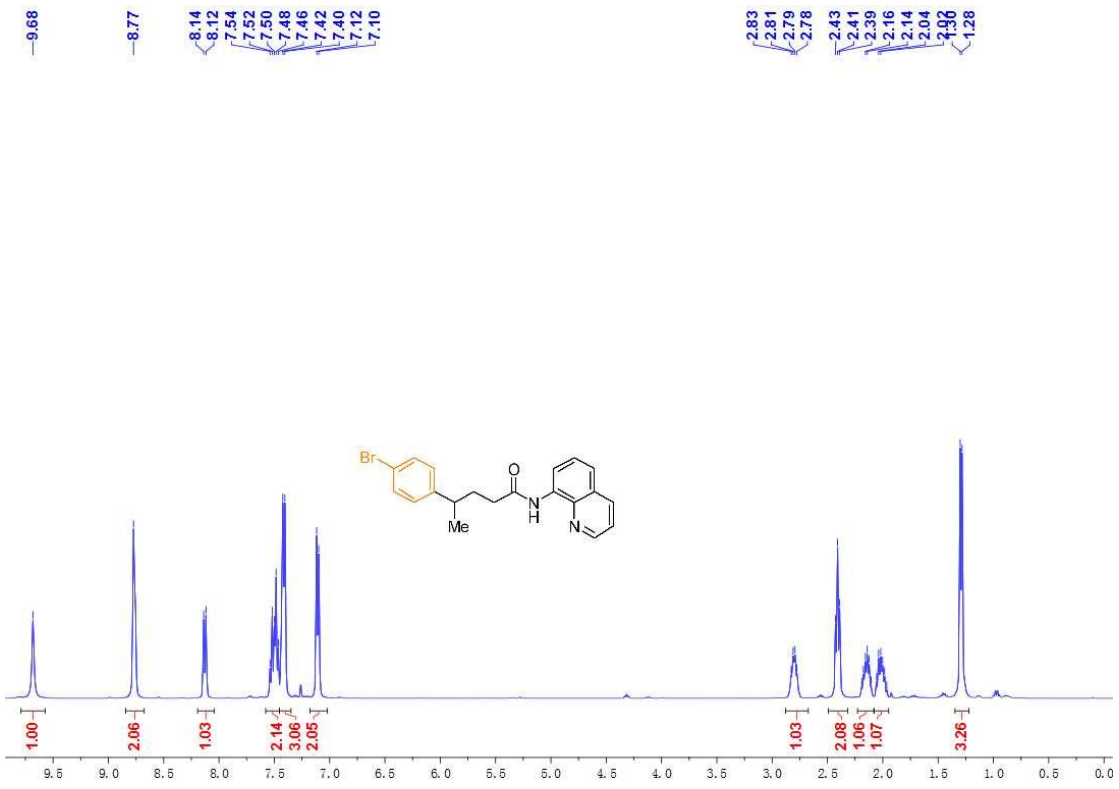

9.78
8.81
8.80
8.80
8.79
8.78
8.77
8.16
8.14
7.53
7.51
7.50
7.50
7.48
7.48
7.46
7.45
7.44
7.43
7.40
7.38
7.11
7.09
2.77
2.75
2.73
2.72
2.57
2.56
2.54
2.54
2.52
2.51
2.50
2.49
2.48
2.47
2.45
2.43
2.41
2.40
2.38
2.36
1.03
1.02
Br
Me
O
N
H
N
1.00
2.13
1.09
2.24
1.24
1.99
2.00
1.01
3.11
1.04
3.13
170.87
148.23
139.39
138.37
136.48
134.48
131.41
131.13
128.02
127.50
121.71
121.58
119.92
116.52
77.48
77.16
76.84
44.95
42.42
32.64
19.67

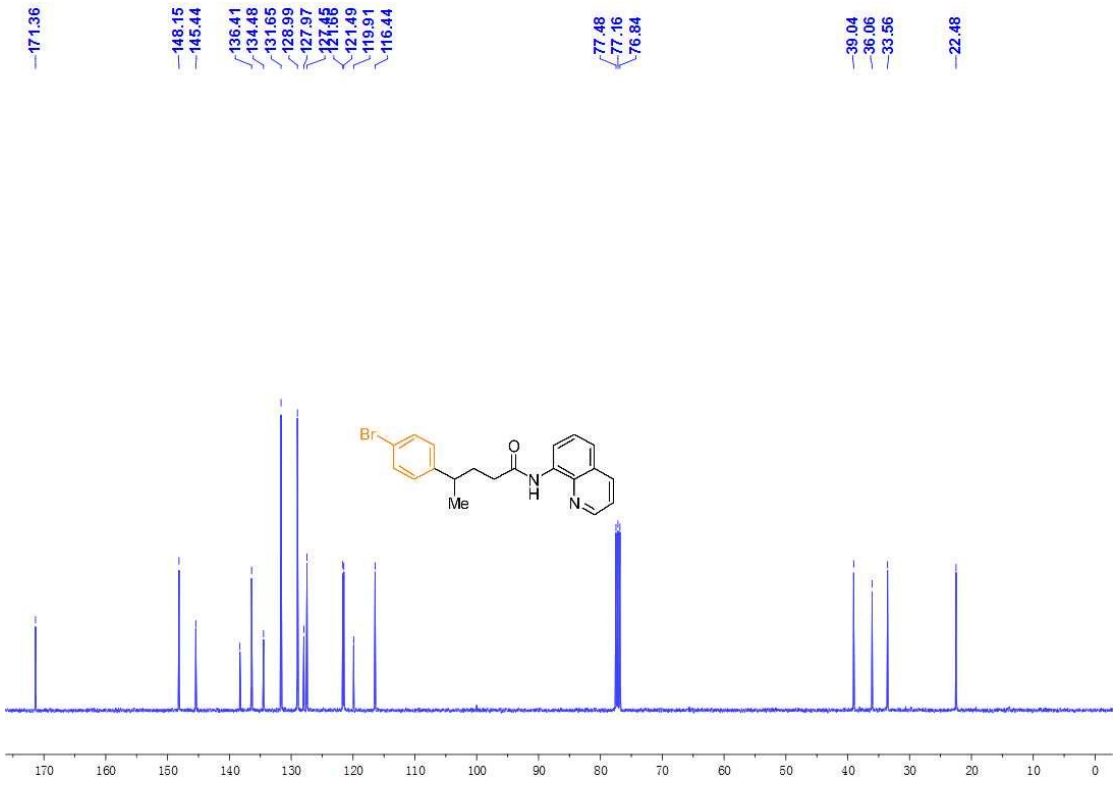
4c


10.31
8.83
8.82
8.81
8.80
8.18
8.15
7.57
7.55
7.53
7.52
7.50
7.48
7.47
7.46
7.45
7.35
7.33
7.09
7.07
2.65
2.64
2.63
2.62
2.61
2.02
2.01
2.00
1.98
Br
O
N
H
Me
Me
N
1.00
2.01
1.01
2.23
1.07
1.99
2.03
2.09
2.10
6.37

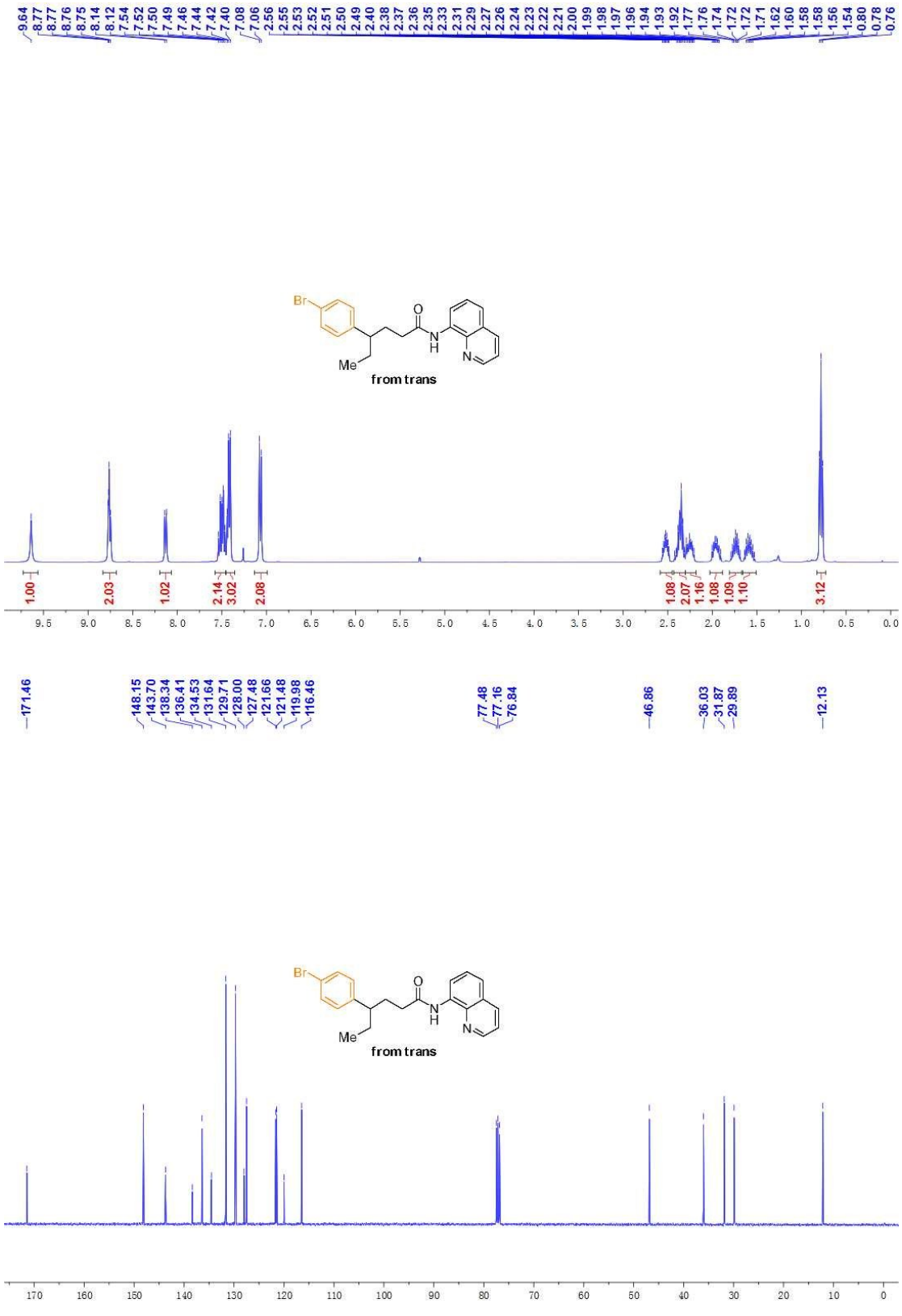

176.02
148.36
141.31
138.89
136.48
134.61
131.44
130.30
128.06
127.55
121.72
121.52
119.59
116.41
77.48
77.16
76.84
43.95
43.59
31.13
29.81
25.90
Br
O
N
H
Me
Me
N

4d

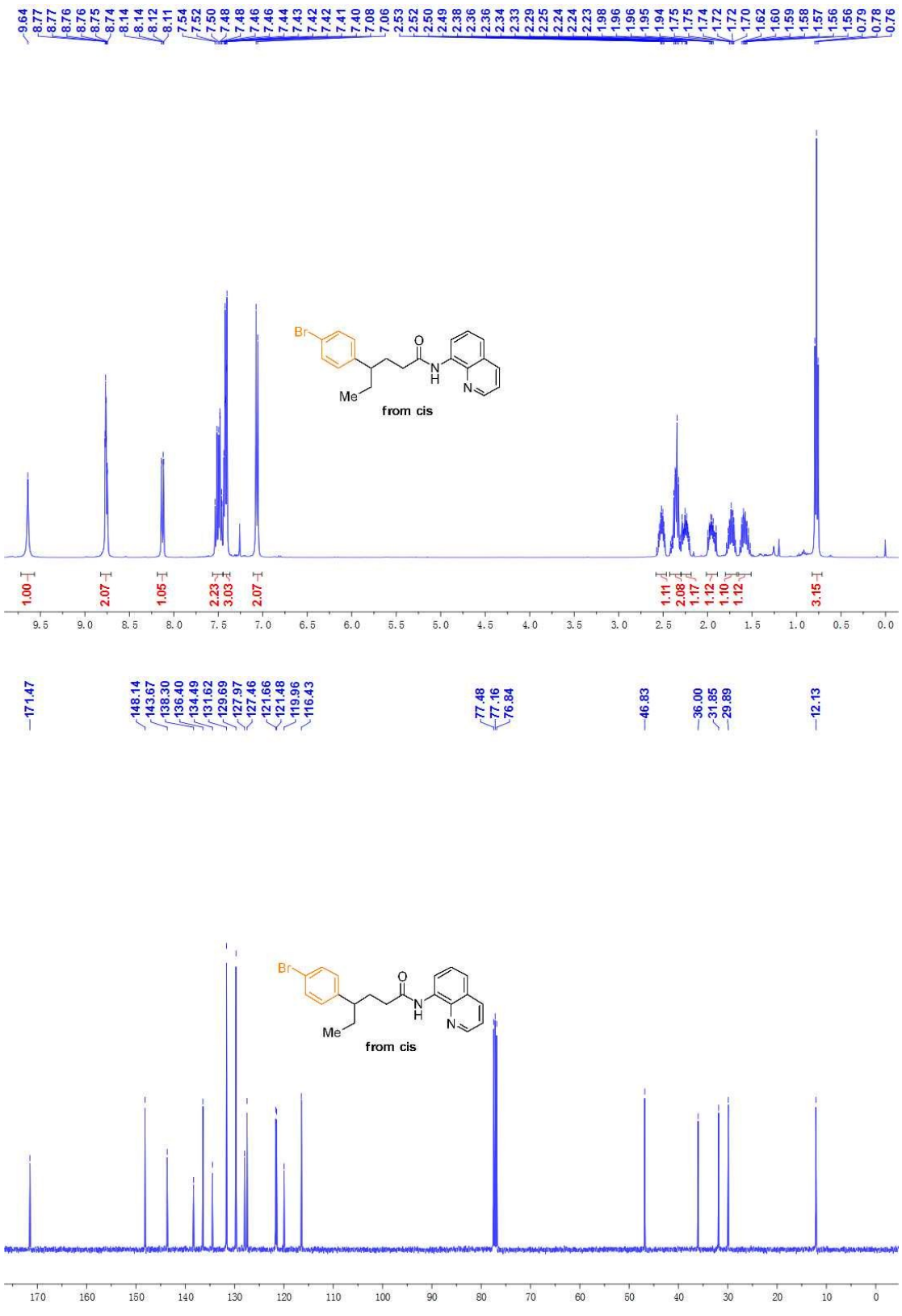




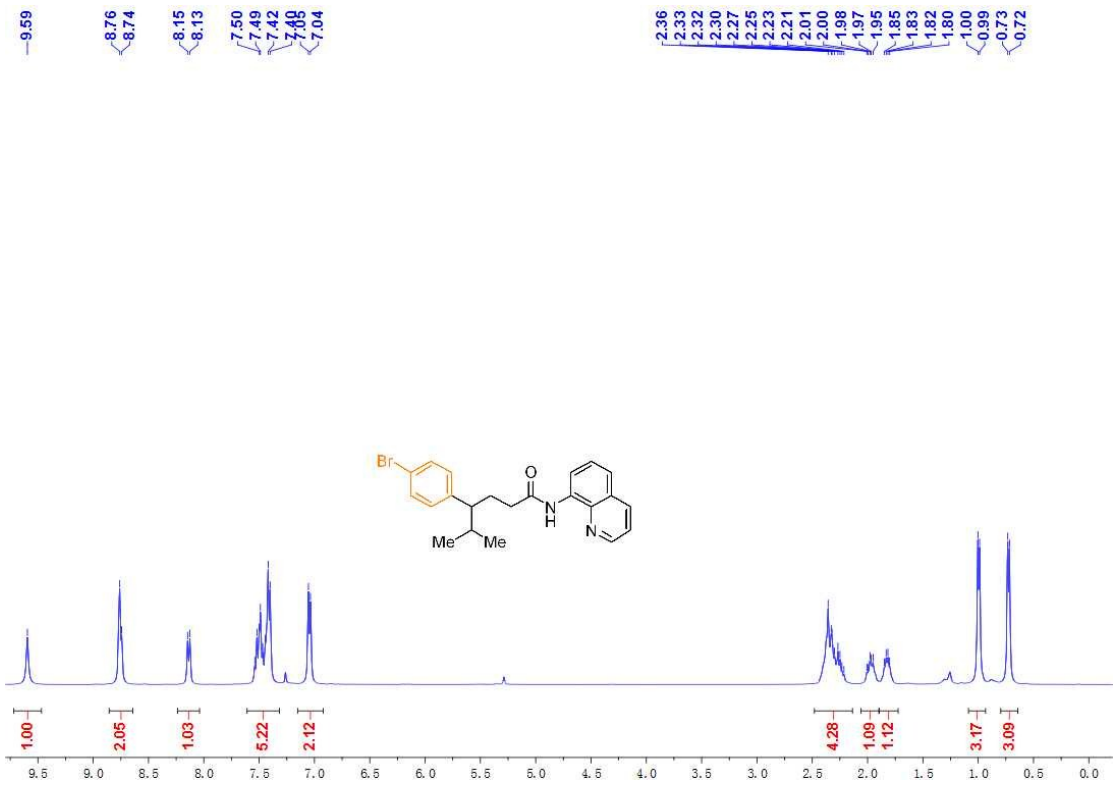
4e, from *trans*

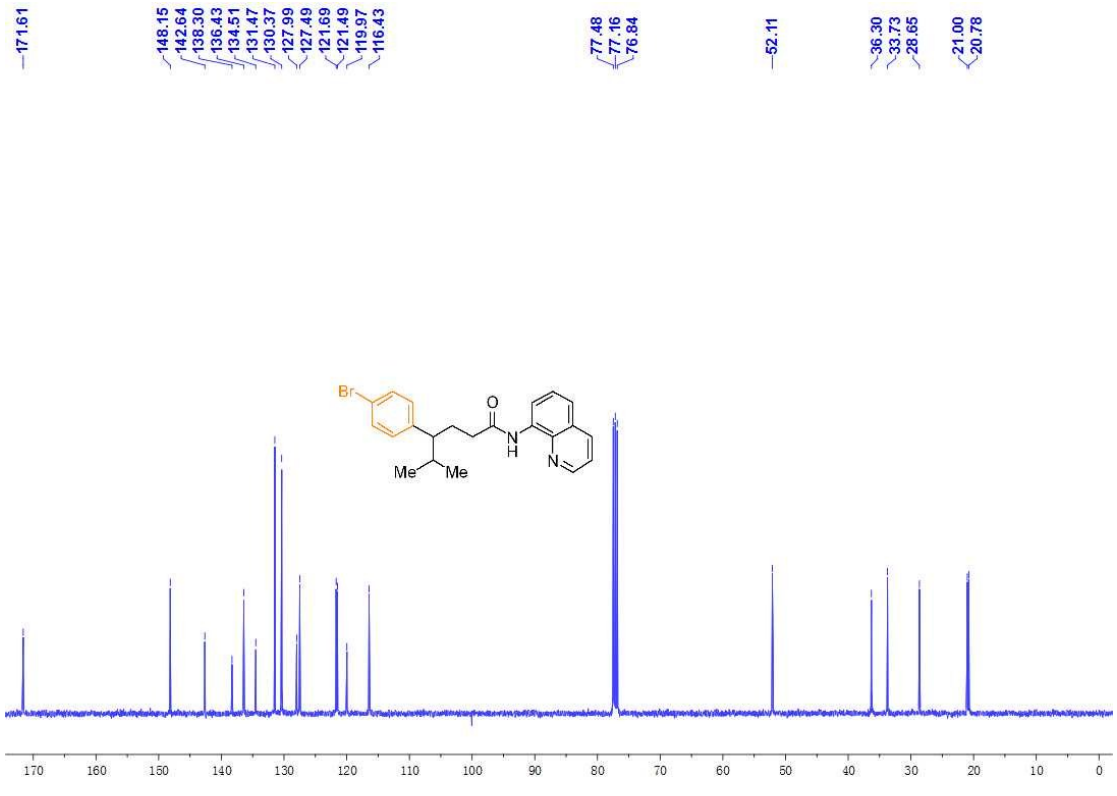

9.64 8.77 8.77 8.76 8.75 8.14 8.12 7.54 7.52 7.50 7.49 7.46 7.44 7.42 7.40 7.08 7.06 2.56 2.55 2.53 2.52 2.51 2.50 2.49 2.40 2.38 2.37 2.36 2.35 2.33 2.31 2.29 2.27 2.26 2.24 2.23 2.22 2.21 2.00 1.99 1.98 1.97 1.96 1.94 1.93 1.92 1.77 1.76 1.74 1.72 1.72 1.71 1.62 1.60 1.58 1.58 1.56 1.54 0.80 0.78 0.76
Br
O
N
H
N
Me
from trans
1.00 2.03 1.02 2.14 3.02 2.08 1.08 2.07 1.16 1.08 1.09 1.10 3.12
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
171.46 148.15 143.70 138.34 136.41 134.53 131.64 129.71 128.00 127.48 121.66 121.48 119.98 116.46 77.48 77.16 76.84 46.86 36.03 31.87 29.89 12.13
Br
O
N
H
N
Me
from trans
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

4e, from *cis*

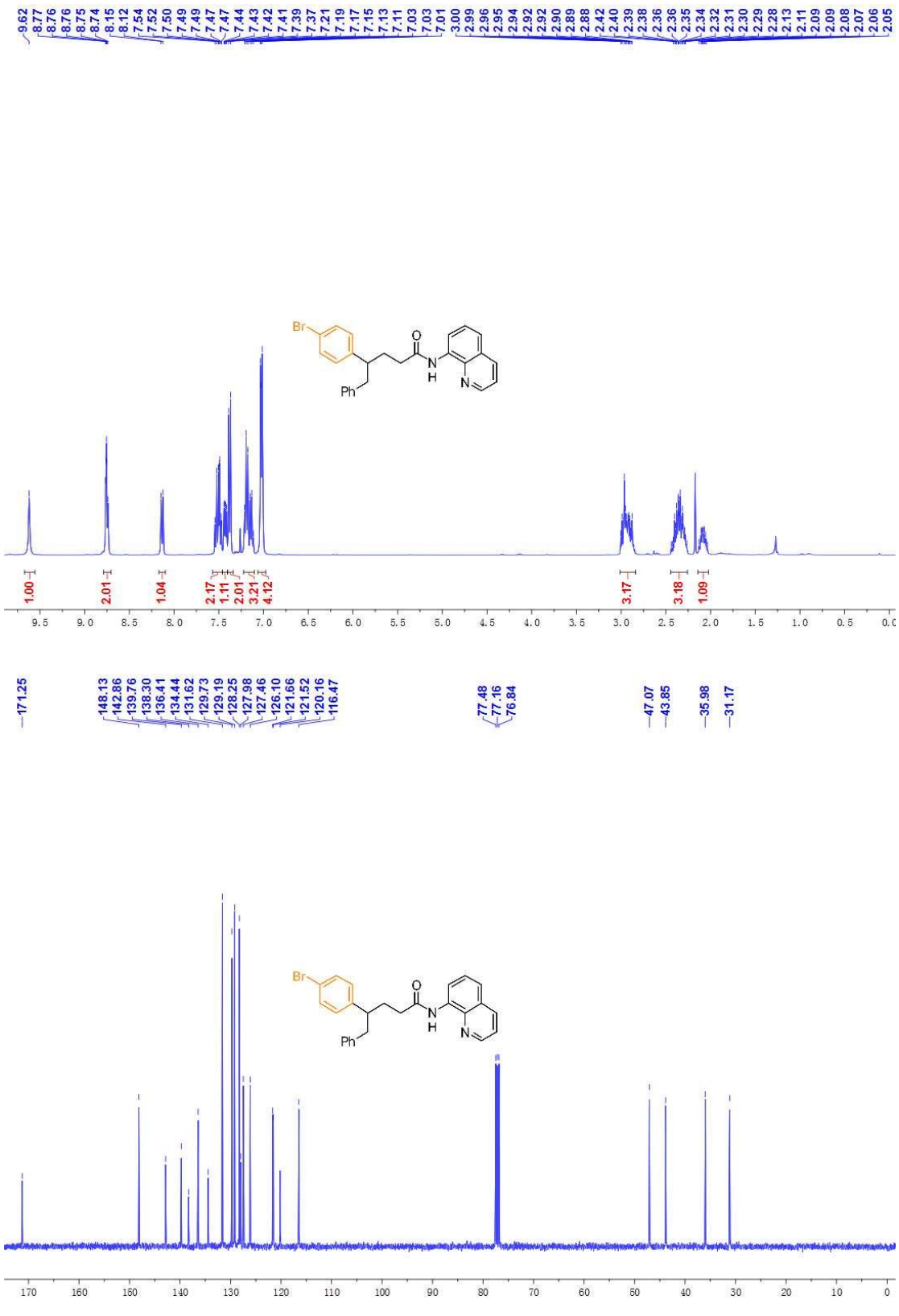

9.64 8.77 8.77 8.76 8.76 8.75 8.74 8.14 8.14 8.12 8.11 7.54 7.52 7.50 7.48 7.48 7.46 7.46 7.44 7.43 7.42 7.42 7.41 7.40 7.08 7.06 2.53 2.52 2.50 2.49 2.38 2.36 2.36 2.34 2.33 2.29 2.25 2.24 2.24 2.23 1.98 1.96 1.96 1.95 1.94 1.75 1.75 1.74 1.72 1.72 1.70 1.62 1.60 1.59 1.58 1.57 1.56 1.56 0.79 0.78 0.76
Br
O
N
H
N
Me
from cis
1.00 2.07 1.05 2.23 3.03 2.07 1.11 2.08 1.17 1.12 1.10 1.12 3.15
171.47 148.14 143.67 138.30 136.40 134.49 131.62 129.69 127.97 127.46 121.66 121.48 119.96 116.43 77.48 77.16 76.84 46.83 36.00 31.85 29.89 12.13
Br
O
N
H
N
Me
from cis

4f

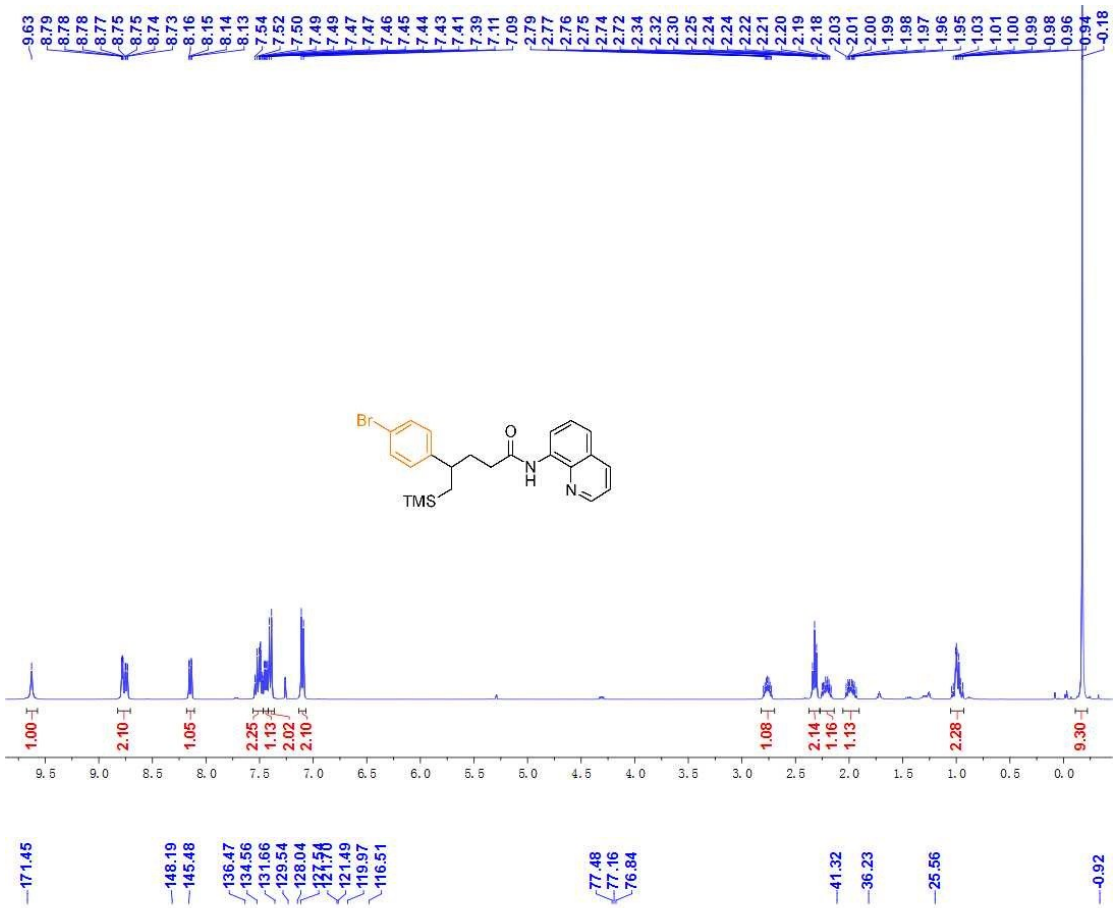

9.59
8.76
8.74
8.15
8.13
7.50
7.49
7.42
7.40
7.05
7.04
2.36
2.33
2.32
2.30
2.27
2.25
2.23
2.21
2.01
2.00
1.98
1.97
1.95
1.85
1.83
1.82
1.80
1.00
0.99
0.73
0.72
Br
O
N
H
N
Me
Me
1.00
2.05
1.03
5.22
2.12
4.28
1.09
1.12
3.17
3.09
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

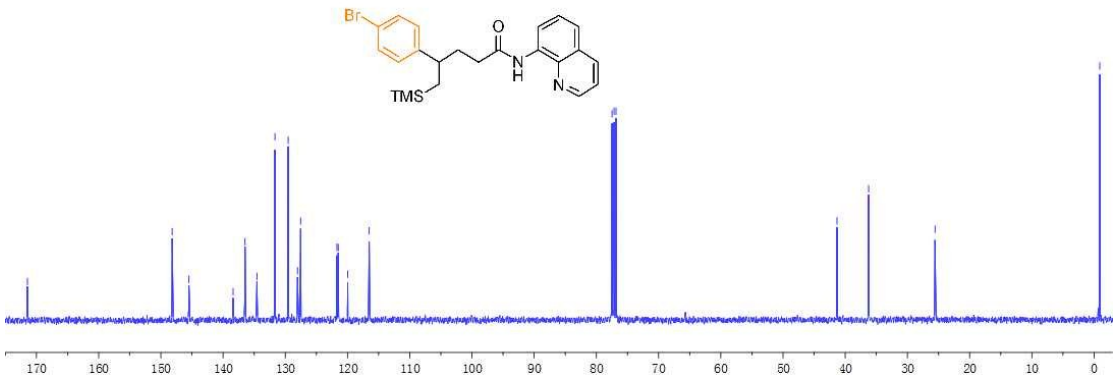

171.61
148.15
142.64
138.30
136.43
134.51
131.47
130.37
127.99
127.49
121.69
121.49
119.97
116.43
77.48
77.16
76.84
52.11
36.30
33.73
28.65
21.00
20.78
Br
O
N
H
N
Me
Me
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

4g

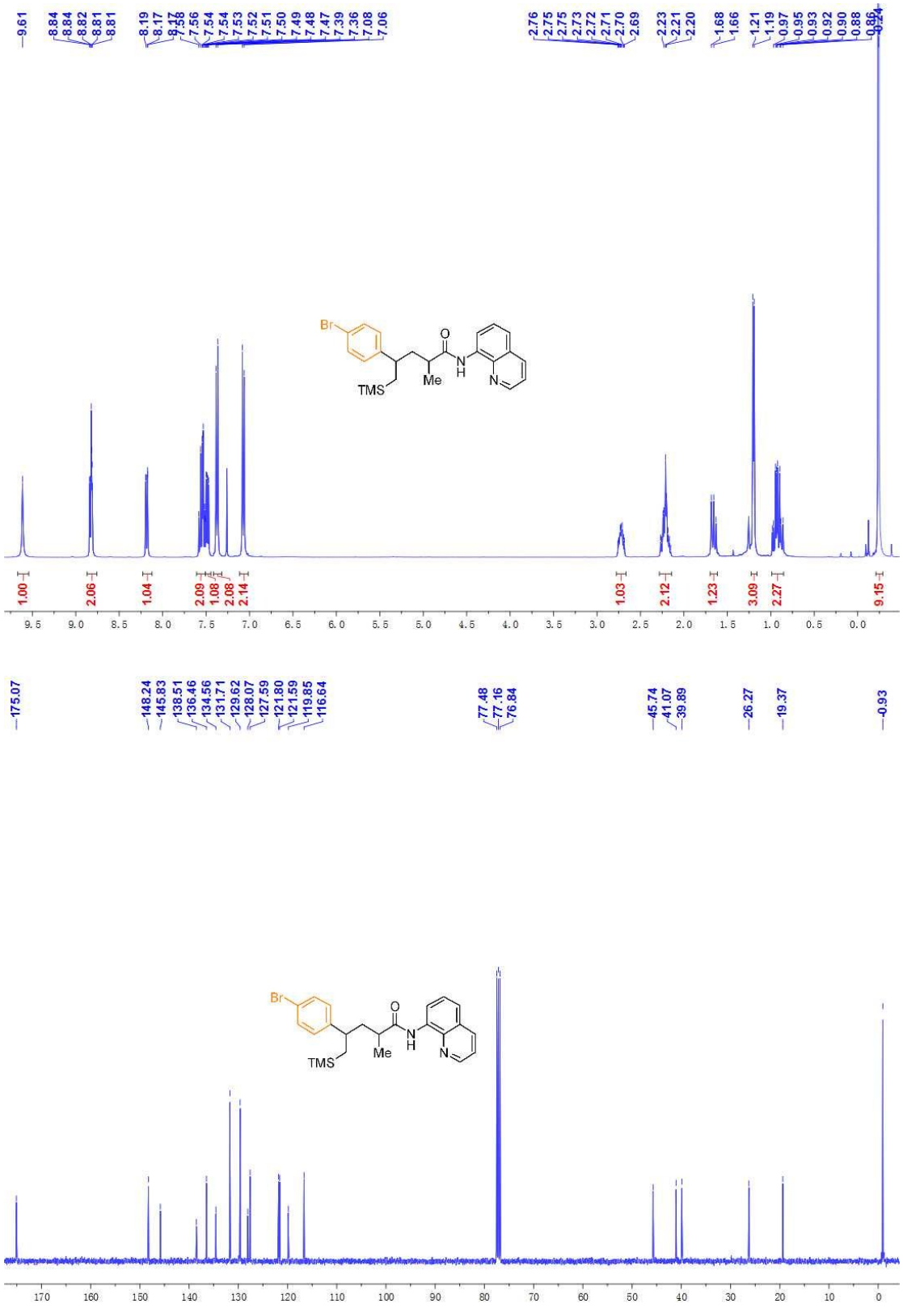

9.62 8.77 8.76 8.76 8.75 8.74 8.15 8.12 7.54 7.52 7.50 7.49 7.49 7.47 7.47 7.44 7.43 7.42 7.41 7.39 7.37 7.21 7.19 7.17 7.15 7.13 7.11 7.03 7.03 7.01 3.00 2.99 2.96 2.95 2.94 2.92 2.92 2.90 2.89 2.88 2.42 2.40 2.39 2.38 2.36 2.36 2.35 2.34 2.32 2.31 2.30 2.29 2.28 2.13 2.11 2.09 2.09 2.08 2.07 2.06 2.05
Br
O
N
H
Ph
N
1.00 2.01 1.04 2.17 1.11 2.01 3.21 4.12 3.17 3.18 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
171.25 148.13 142.86 139.76 138.30 136.41 134.44 131.62 129.73 129.19 128.25 127.98 127.46 126.10 121.66 121.52 120.16 116.47 77.48 77.16 76.84 47.07 43.85 35.98 31.17
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

4h



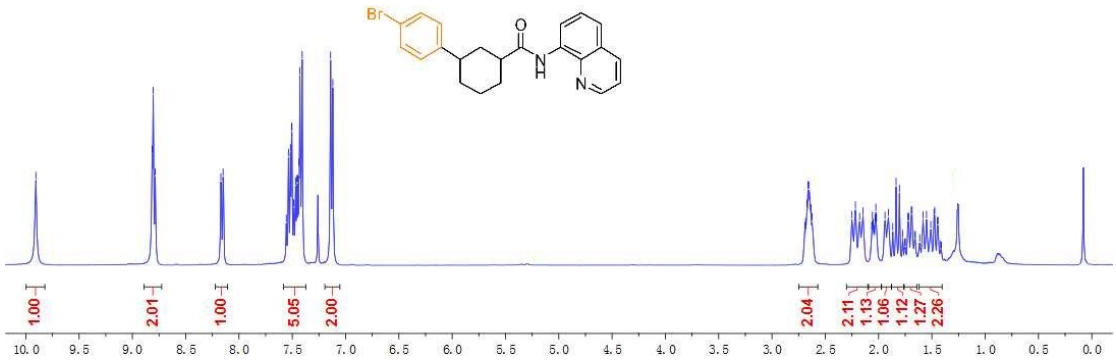


4i

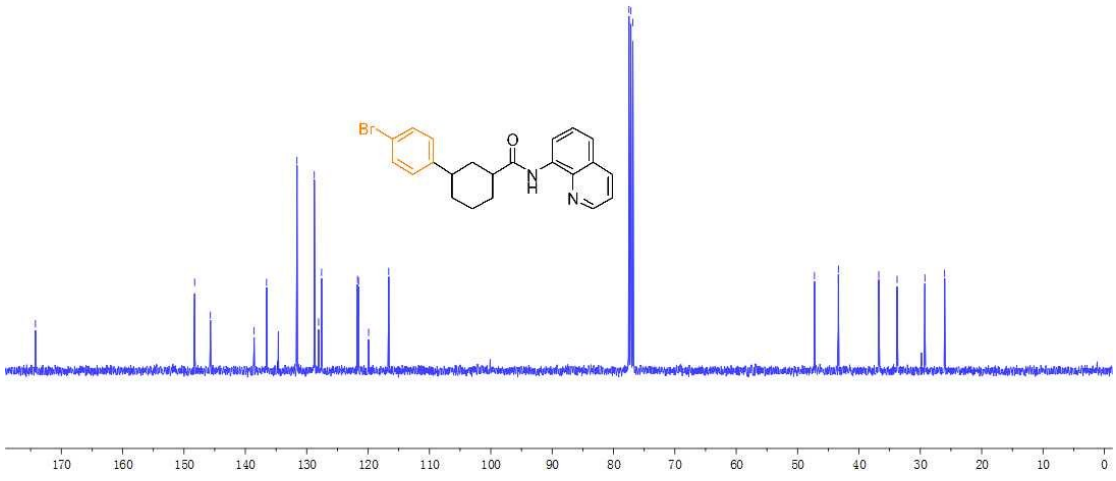

9.61
8.84
8.84
8.82
8.81
8.81
8.19
8.17
7.58
7.56
7.54
7.54
7.53
7.52
7.51
7.50
7.49
7.48
7.47
7.39
7.36
7.08
7.06
2.76
2.75
2.75
2.73
2.72
2.71
2.70
2.69
2.23
2.21
2.20
1.68
1.66
1.21
1.19
0.97
0.95
0.93
0.92
0.90
0.88
0.86
0.24
Br
O
N
H
N
TMS
Me
1.00
2.06
1.04
2.09
1.08
2.08
2.14
1.03
2.12
1.23
3.09
2.27
9.15
175.07
148.24
145.83
138.51
136.46
134.56
131.71
129.62
128.07
127.59
121.80
121.59
119.85
116.64
77.48
77.16
76.84
45.74
41.07
39.89
26.27
19.37
-0.93

4j

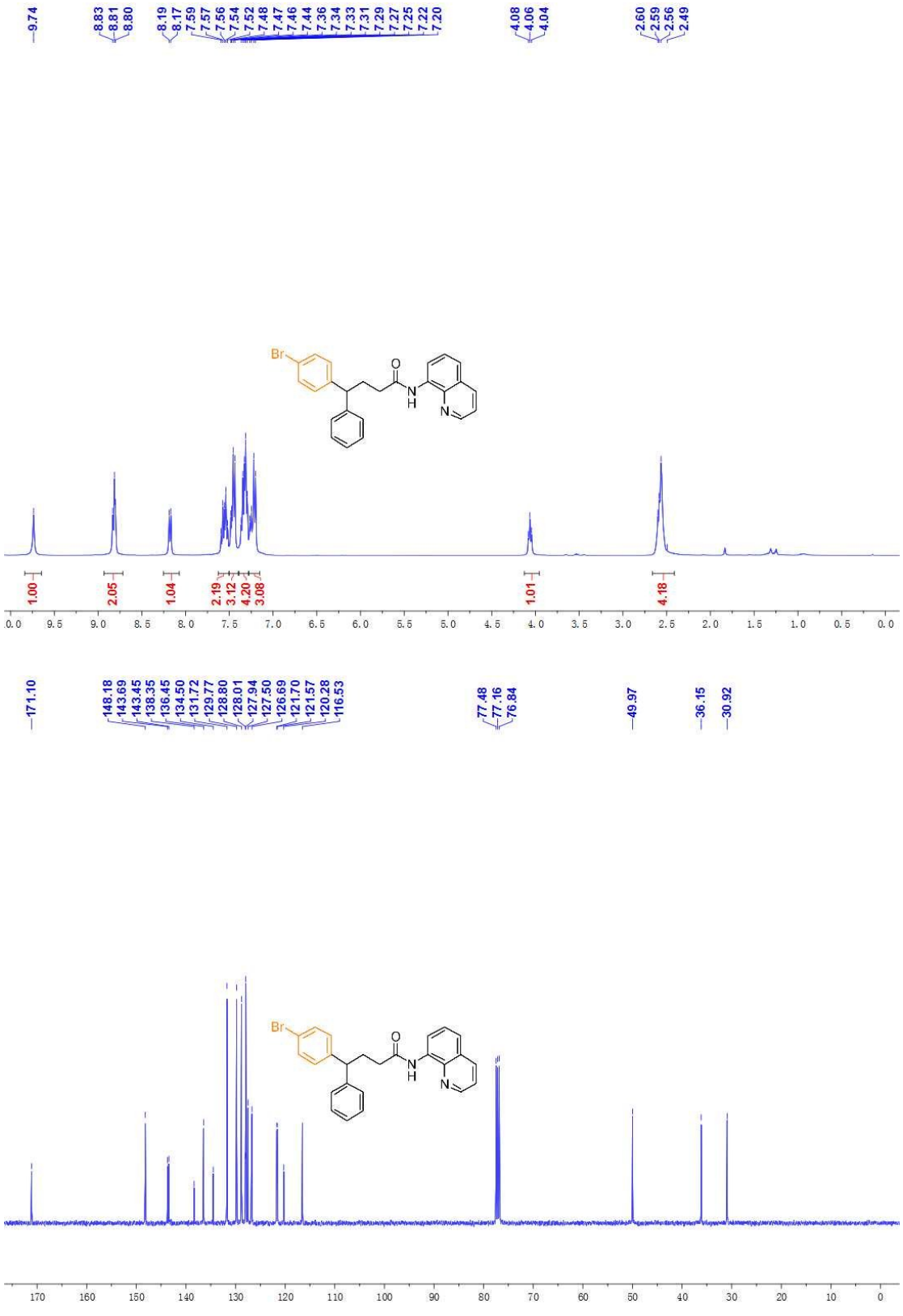

9.91
8.81
8.80
8.79
8.17
8.15
7.56
7.54
7.52
7.51
7.50
7.49
7.47
7.46
7.45
7.44
7.43
7.41
7.14
7.12
2.69
2.68
2.67
2.66
2.65
2.63
2.62
2.25
2.22
2.18
2.15
2.06
2.06
2.05
2.04
2.03
2.03
2.02
1.94
1.91
1.87
1.84
1.80
1.77
1.76
1.75
1.72
1.72
1.69
1.69
1.66
1.65
1.61
1.58
1.55
1.51
1.48
1.47
1.45
1.44
1.42


Br
O
N
H
1.00
2.01
1.00
5.05
2.00
2.04
2.11
1.13
1.06
1.12
1.27
2.26
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

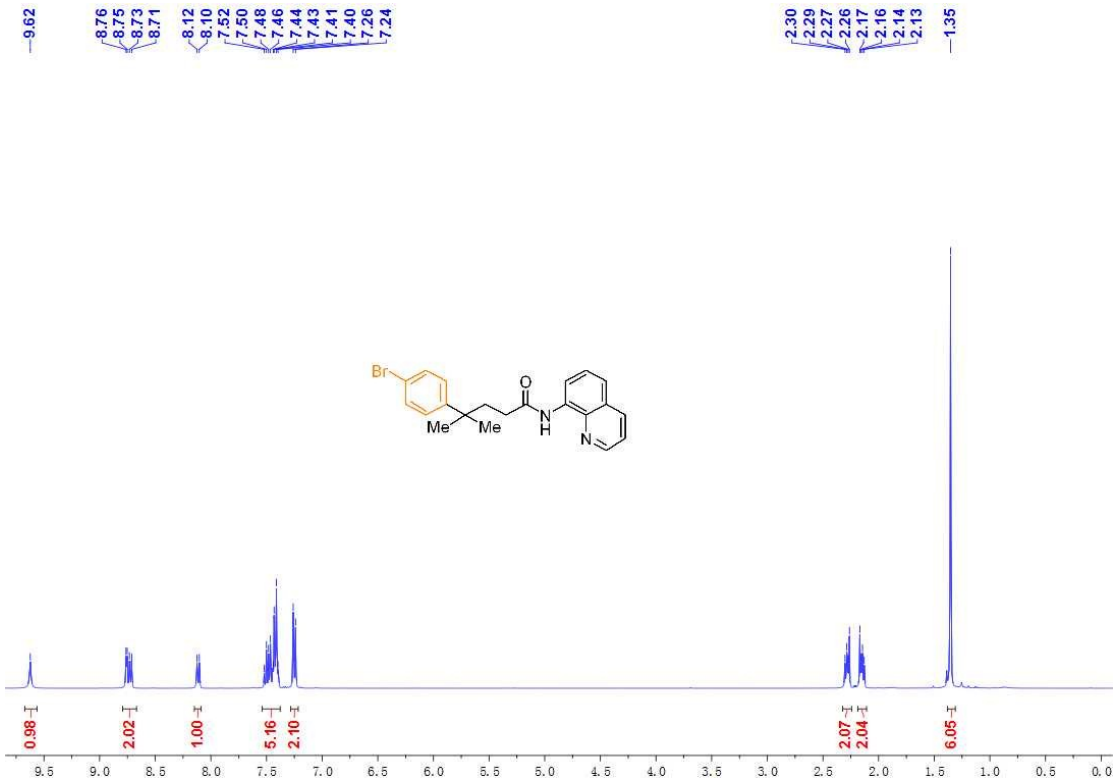

174.21
148.27
145.69
138.57
136.54
131.59
128.76
128.06
121.72
121.56
119.91
116.63
77.48
77.16
76.84
47.25
43.35
36.77
33.78
29.25
26.03

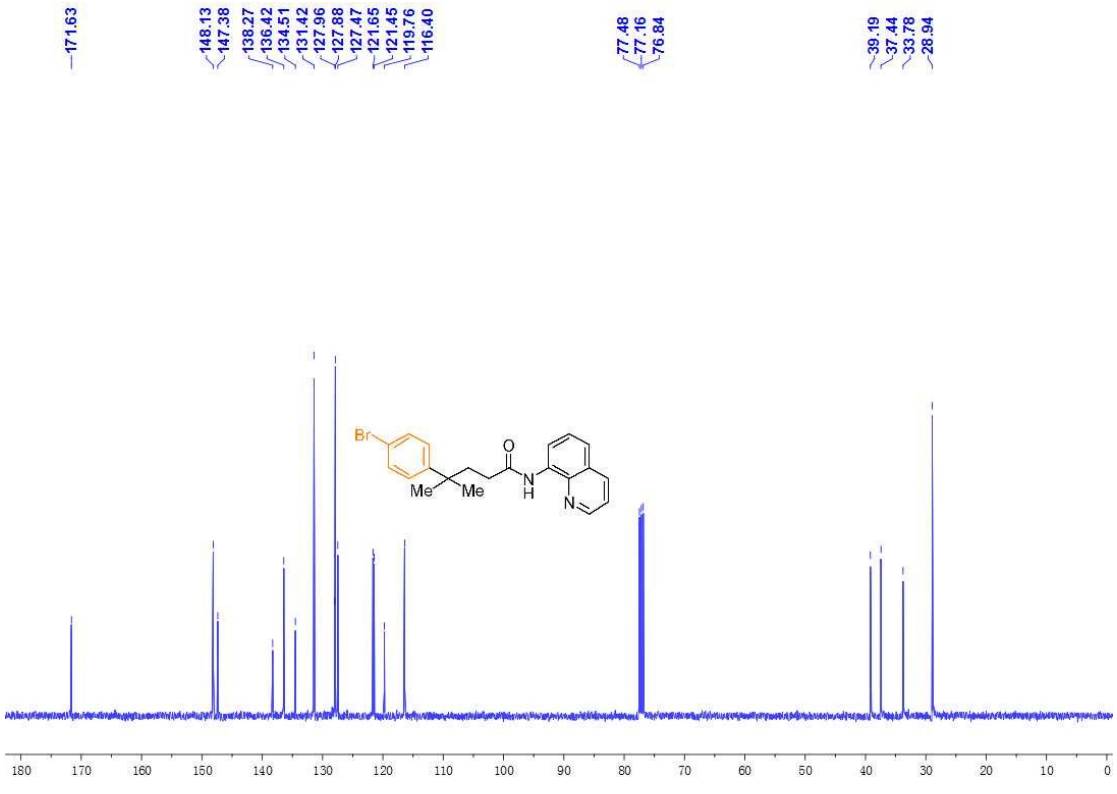

Br
O
N
H
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

4k

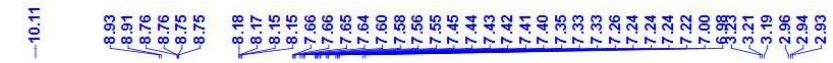

9.74
8.83
8.81
8.80
8.19
8.17
7.59
7.57
7.56
7.54
7.52
7.48
7.47
7.46
7.44
7.36
7.34
7.33
7.31
7.29
7.27
7.25
7.22
7.20
4.08
4.06
4.04
2.60
2.59
2.56
2.49
Br
O
N
H
N
1.00
2.05
1.04
2.19
3.12
4.20
3.08
1.01
4.18
0.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
171.10
148.18
143.69
143.45
138.35
136.45
134.50
131.72
129.77
128.80
128.01
127.94
127.50
126.69
121.70
121.57
120.28
116.53
77.48
77.16
76.84
49.97
36.15
30.92
Br
O
N
H
N
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

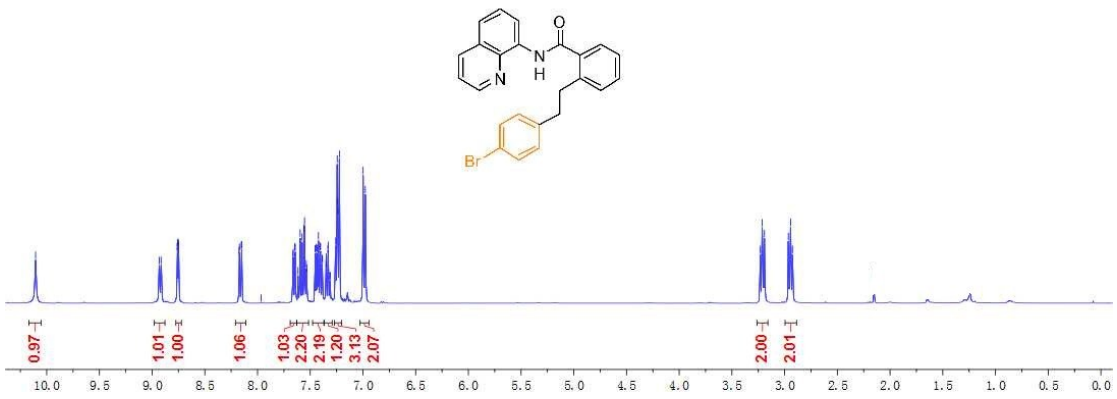
4l


9.62
8.76
8.75
8.73
8.71
8.12
8.10
7.52
7.50
7.48
7.46
7.44
7.43
7.41
7.40
7.26
7.24
2.30
2.29
2.27
2.26
2.17
2.16
2.14
2.13
1.35
Br
Me
Me
O
N
H
N
0.98
2.02
1.00
5.16
2.10
2.07
2.04
6.05

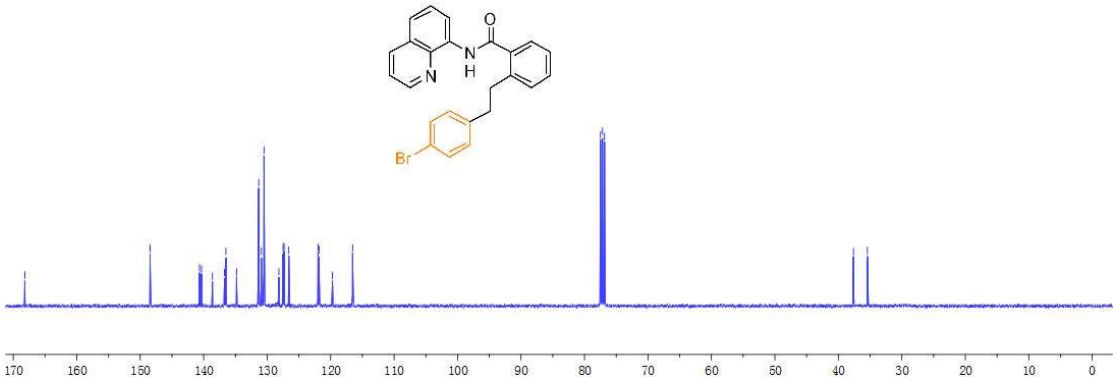

171.63
148.13
147.38
138.27
136.42
134.51
131.42
127.96
127.88
127.47
121.65
121.45
119.76
116.40
77.48
77.16
76.84
39.19
37.44
33.78
28.94
Br
Me
Me
O
N
H
N

4lm

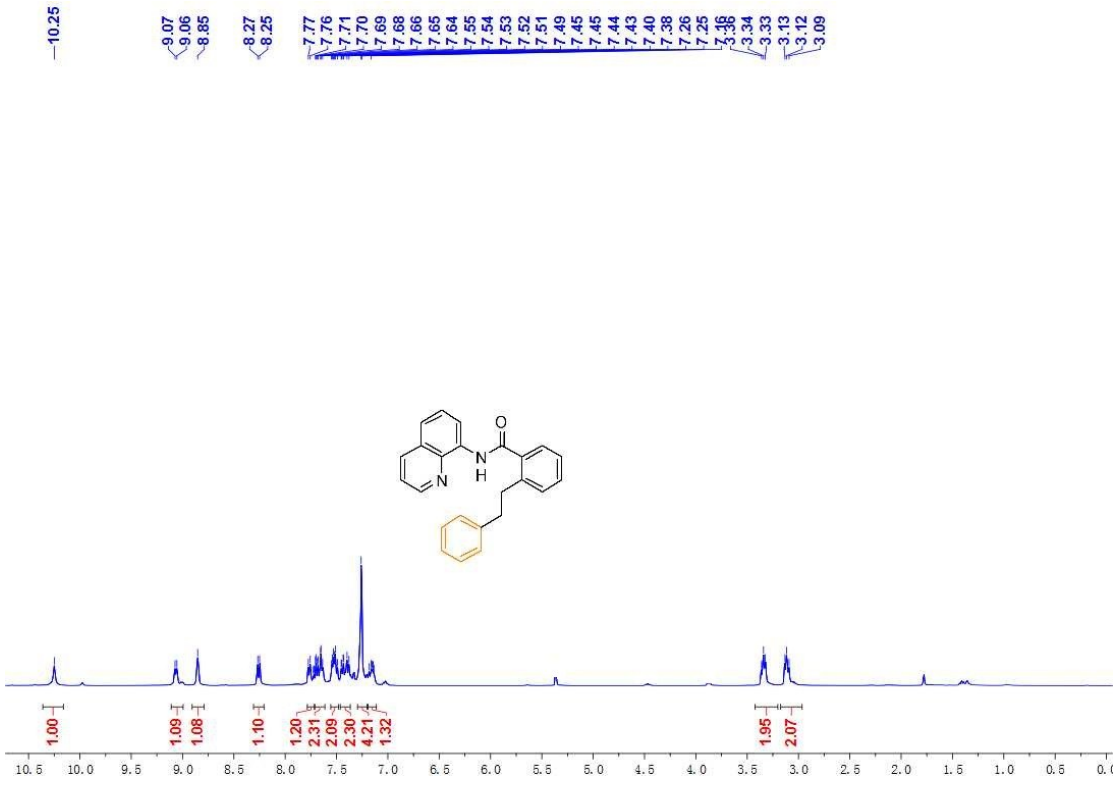

10.11
8.93
8.91
8.76
8.76
8.75
8.75
8.18
8.17
8.15
8.15
7.66
7.66
7.65
7.64
7.60
7.58
7.56
7.55
7.45
7.44
7.43
7.42
7.41
7.40
7.35
7.33
7.33
7.26
7.24
7.24
7.24
7.22
7.00
6.98
3.23
3.21
3.19
2.96
2.94
2.93

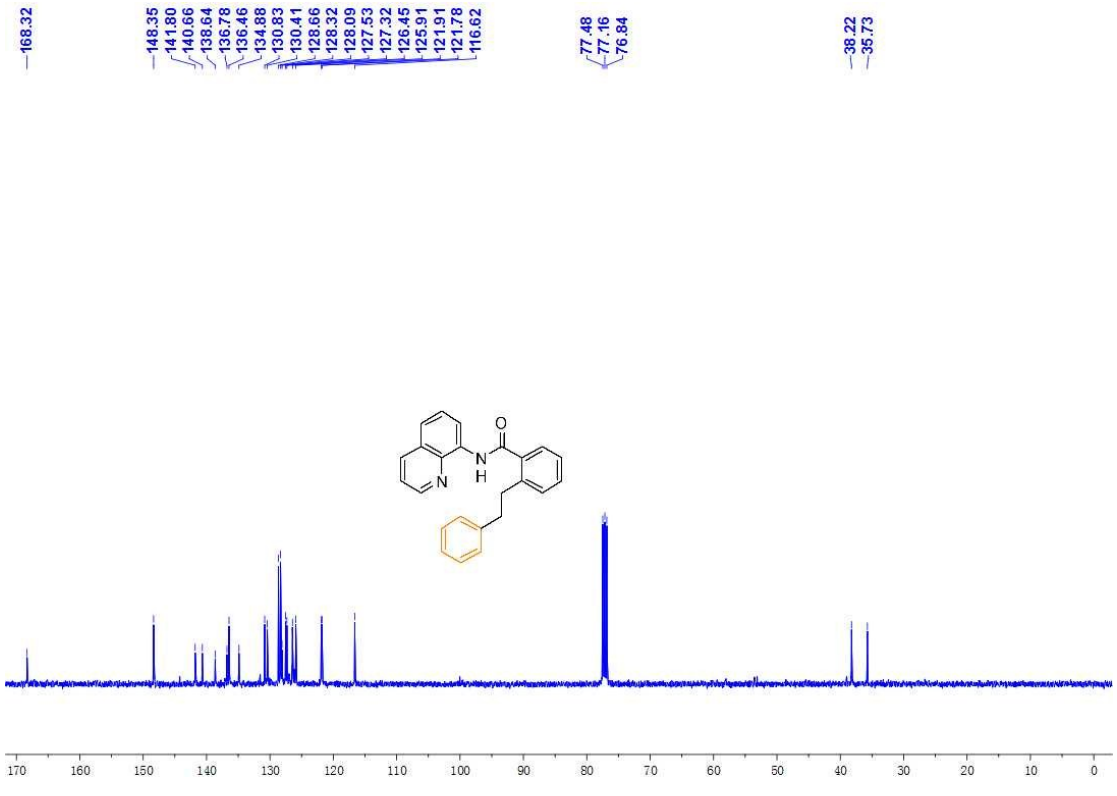

O
N
H
N
Br
0.97
1.01
1.00
1.06
1.03
2.20
2.19
1.20
3.13
2.07
2.00
2.01
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


168.19
148.45
140.66
140.34
138.62
136.72
136.50
134.82
131.33
130.91
130.50
128.15
127.50
127.33
126.59
121.99
121.83
119.70
116.54
77.48
77.16
76.84
37.62
35.43

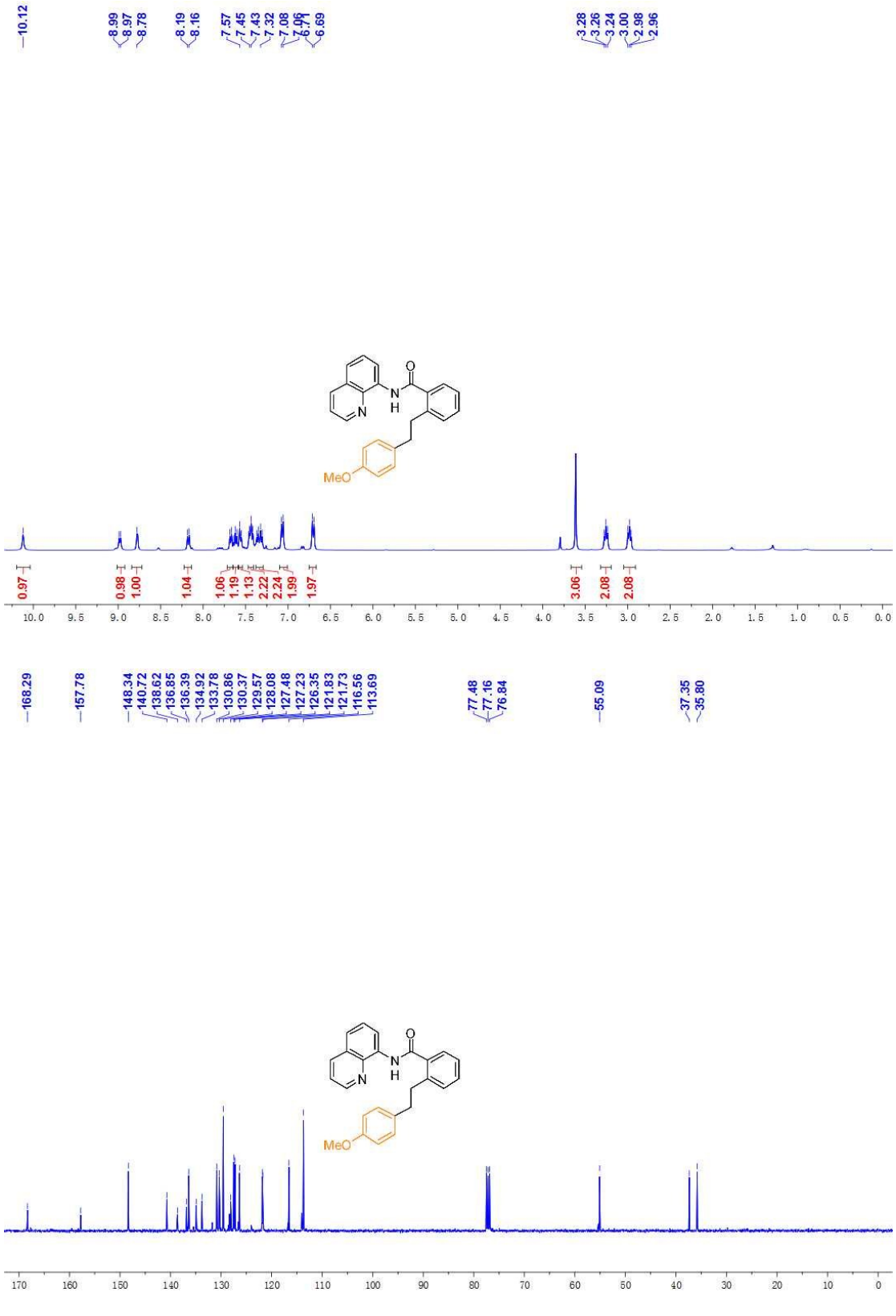

O
N
H
N
Br
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

4bm

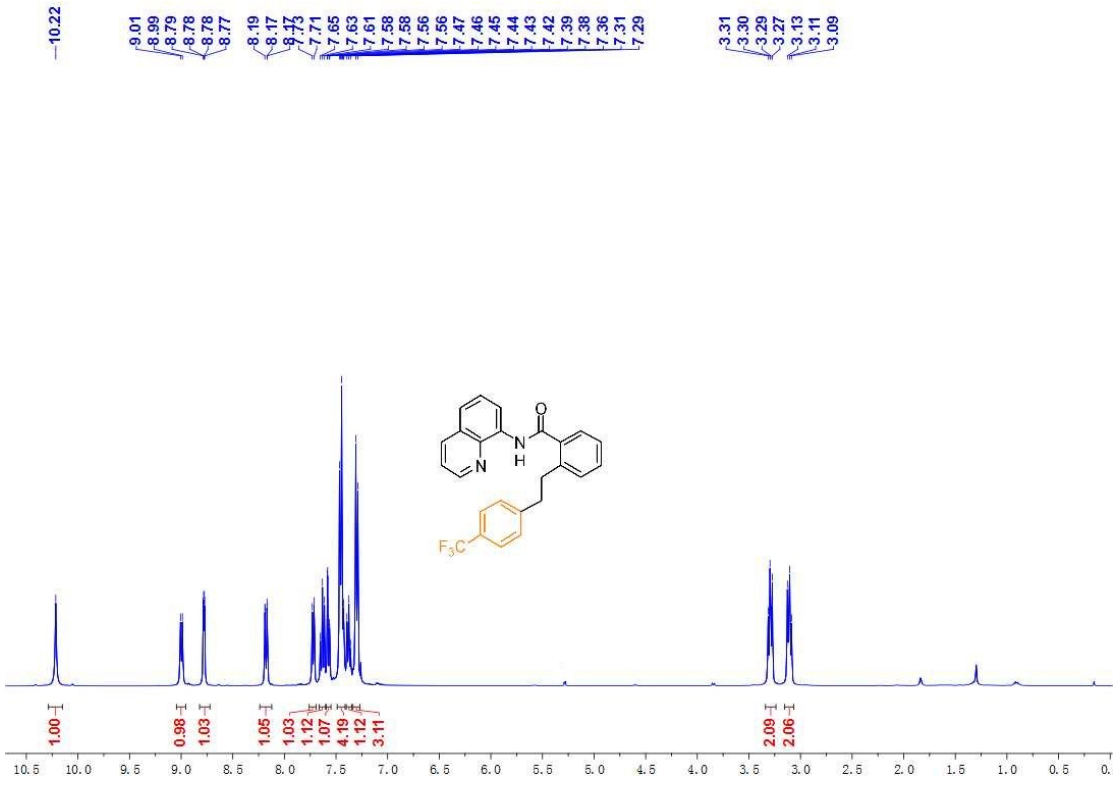

10.25
9.07
9.06
8.85
8.27
8.25
7.77
7.76
7.71
7.70
7.69
7.68
7.66
7.65
7.64
7.55
7.54
7.53
7.52
7.51
7.49
7.45
7.45
7.44
7.43
7.40
7.38
7.26
7.25
3.36
3.34
3.33
3.13
3.12
3.09
1.00
1.09
1.08
1.10
1.20
2.31
2.09
2.30
4.21
1.32
1.95
2.07

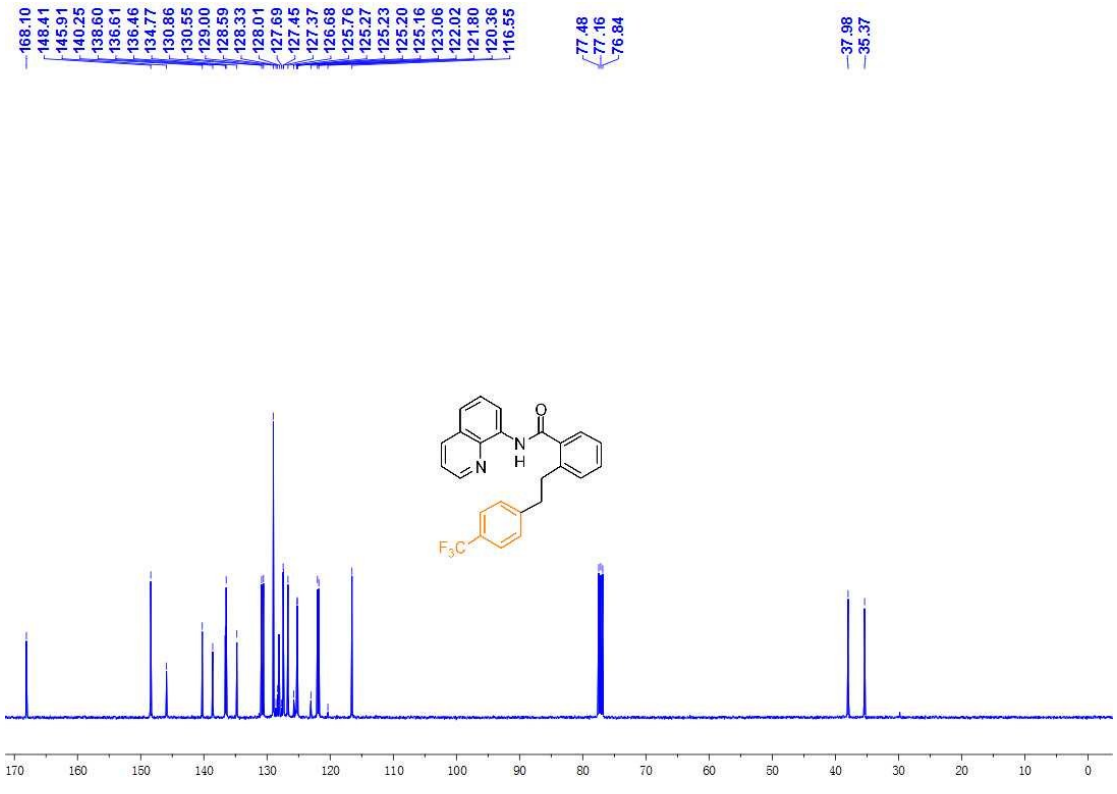

168.32
148.35
141.80
140.66
138.64
136.78
136.46
134.88
130.83
130.41
128.66
128.32
128.09
127.53
127.32
126.45
125.91
121.91
121.78
116.62
77.48
77.16
76.84
38.22
35.73

4im

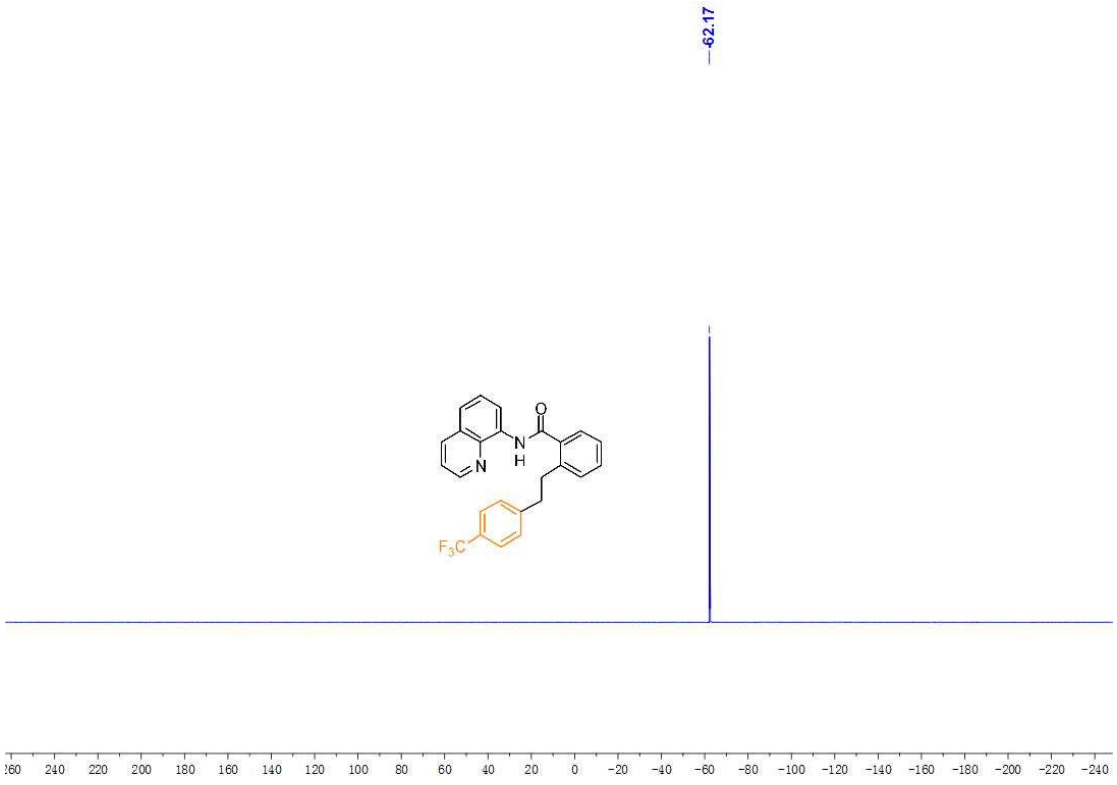

10.12
8.99
8.97
8.78
8.19
8.16
7.57
7.45
7.43
7.32
7.08
7.06
7.01
6.69
3.28
3.26
3.24
3.00
2.98
2.96
MeO
0.97
0.98
1.00
1.04
1.06
1.19
1.13
2.22
2.24
1.99
1.97
3.06
2.08
2.08
168.29
157.78
148.34
140.72
138.62
136.85
136.39
134.92
133.78
130.86
130.37
129.57
128.08
127.48
127.23
126.35
121.83
121.73
116.56
113.69
77.48
77.16
76.84
55.09
37.35
35.80

4mm

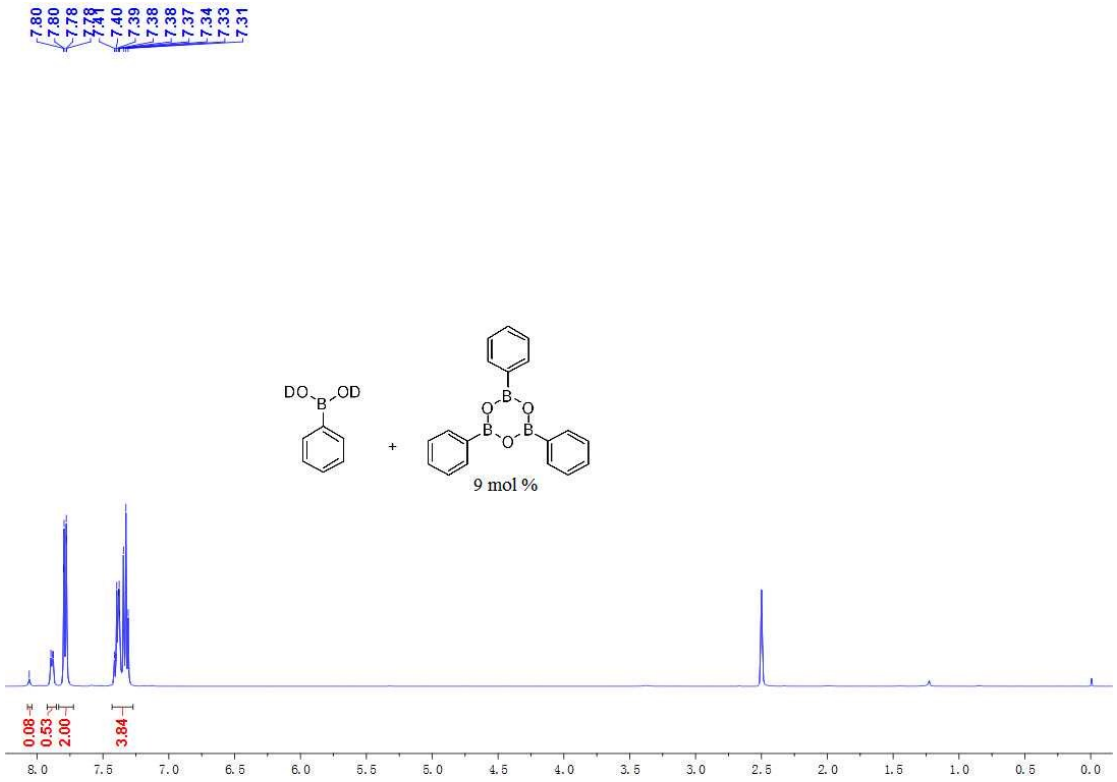

10.22
9.01
8.99
8.79
8.78
8.78
8.77
8.19
8.17
8.17
7.73
7.71
7.65
7.63
7.61
7.58
7.58
7.56
7.56
7.47
7.46
7.45
7.44
7.43
7.42
7.39
7.38
7.36
7.31
7.29
3.31
3.30
3.29
3.27
3.13
3.11
3.09
1.00
0.98
1.03
1.05
1.03
1.12
1.07
4.19
1.12
3.11
2.09
2.06
O
N
H
F3C


168.10
148.41
145.91
140.25
138.60
136.61
136.46
134.77
130.86
130.55
129.00
128.59
128.33
128.01
127.69
127.45
127.37
126.68
125.76
125.27
125.23
125.20
125.16
123.06
122.02
121.80
120.36
116.55
77.48
77.16
76.84
37.98
35.37
O
N
H
F3C

4mm


-62.17
F3C
260 240 220 200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240

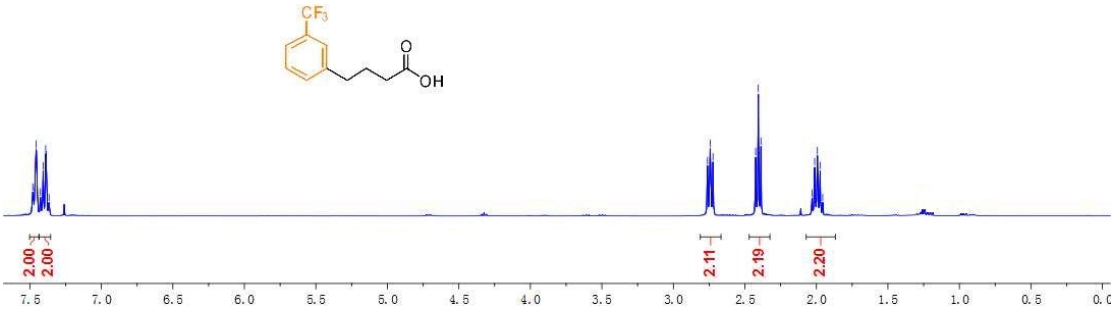
1b-D


7.80
7.80
7.78
7.41
7.40
7.39
7.38
7.38
7.37
7.34
7.33
7.31
DO
B
OD
+
9 mol %
0.08
0.53
2.00
3.84
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

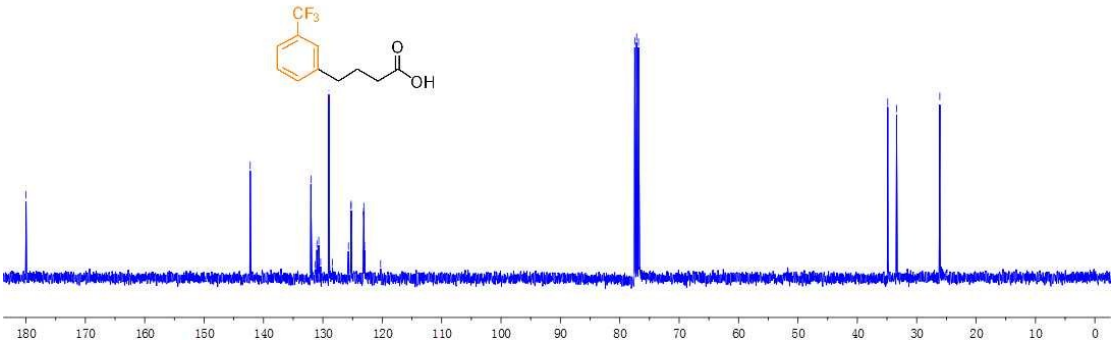
5s


7.48
7.46
7.43
7.41
7.39
7.39
7.37


2.76
2.74
2.72
2.41
2.39
2.03
2.01
1.99
1.97
1.96

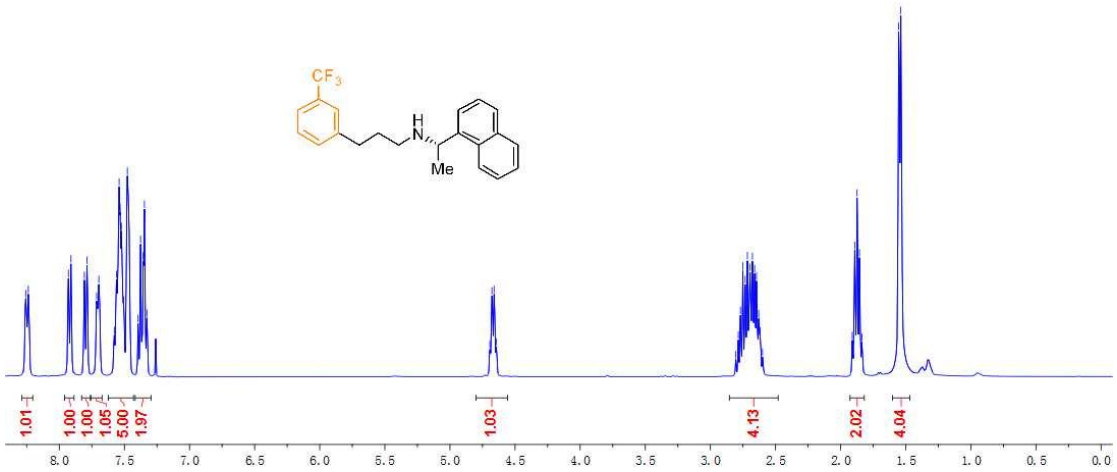

CF3
O
OH
2.00
2.00
2.11
2.19
2.20
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5


179.99
142.24
132.01
131.33
131.01
130.69
130.37
128.99
128.39
125.69
125.30
125.27
125.23
125.19
123.18
123.15
123.11
123.07
122.98
120.28
77.48
77.16
76.84
34.88
33.38
26.11

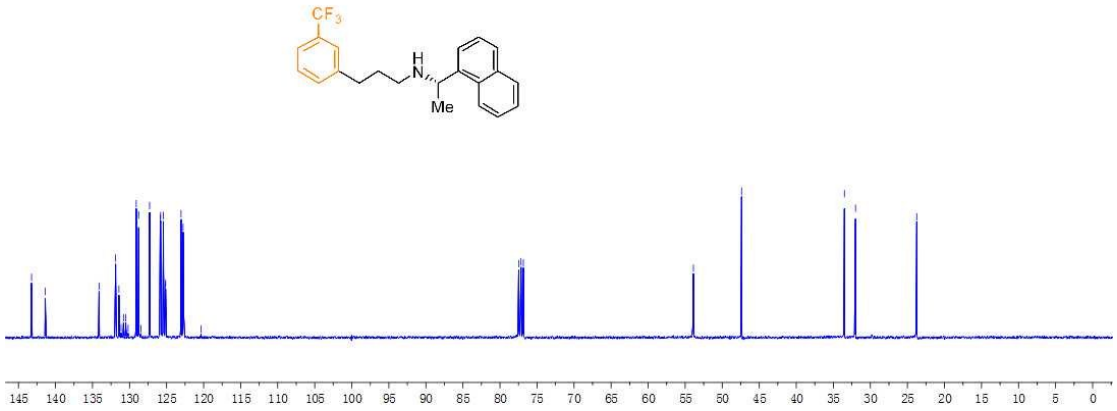

CF3
O
OH
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Sensipar

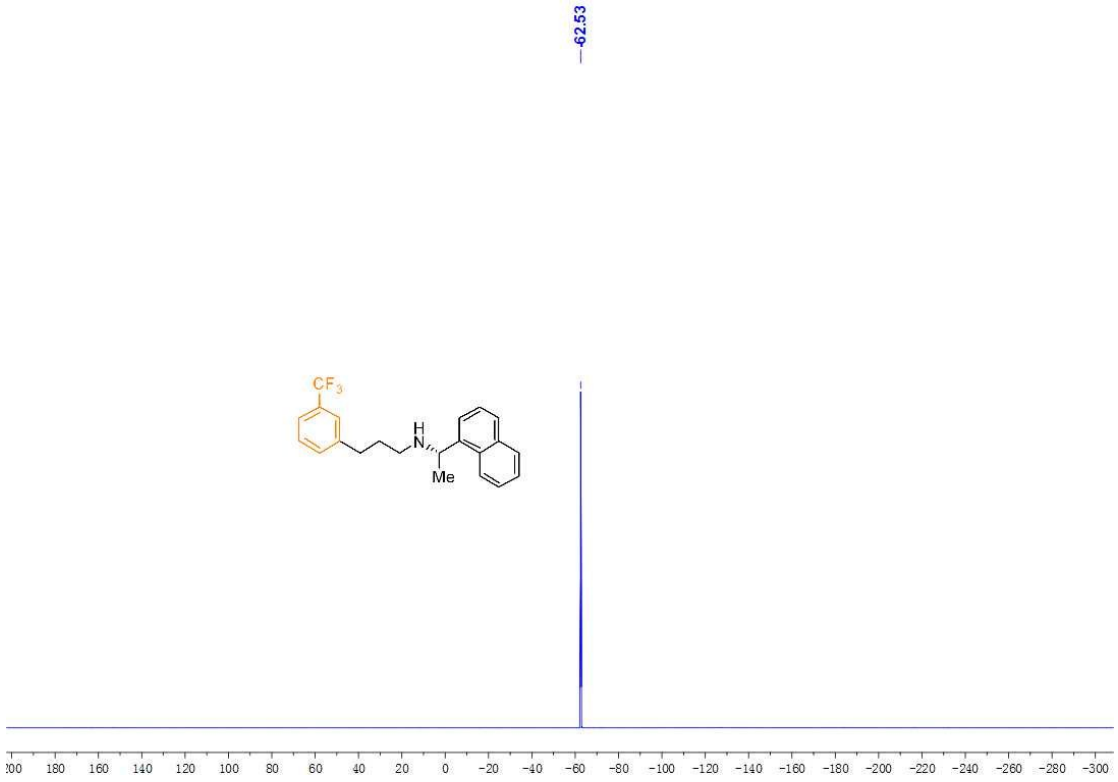

8.26
8.24
7.93
7.91
7.81
7.79
7.71
7.70
7.58
7.56
7.54
7.53
7.52
7.51
7.48
7.39
7.38
7.36
7.35
7.33
4.69
4.68
4.66
4.65
2.81
2.79
2.77
2.75
2.73
2.72
2.70
2.68
2.66
2.65
2.63
2.62
2.60
1.91
1.89
1.87
1.54


CF3
H
N
Me
1.01
1.00
1.00
1.05
5.00
1.97
1.03
4.13
2.02
4.04
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


143.23
141.37
134.11
131.88
131.43
131.14
130.82
130.51
130.19
129.10
128.77
128.47
127.29
125.86
125.80
125.43
125.20
125.17
125.13
125.09
123.05
122.77
122.71
120.36
77.48
77.16
76.84
53.89
47.39
33.51
32.00
23.74


CF3
H
N
Me
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0

Sensipar


-62.53
CF3
H
N
Me
200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300