Supporting Information

Rhodium-catalyzed olefination of aryl tetrazoles via direct C-H bond activation

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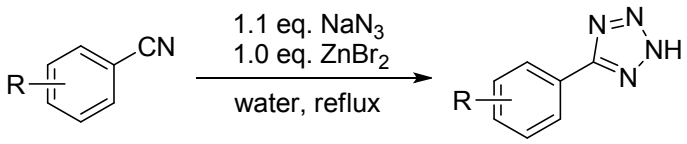
1 General experimental details

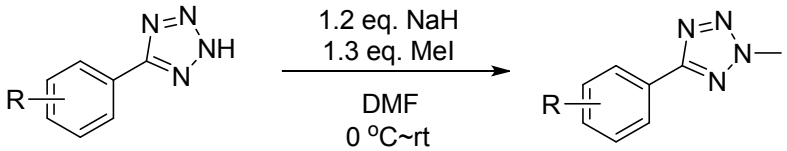
Chemicals were used as received without special purification unless stated otherwise. ^{1}H and ^{13}C NMR were recorded at ambient temperature on a 300 or 500 MHz NMR spectrometer (125 MHz for ^{13}C NMR). NMR experiments are reported in δ units, parts per million (ppm), and were referenced to $CDCl_3$ (δ 7.26 or 77.0 ppm) as the internal standard. The coupling constants J are given in Hz. Melting points (m.p.) are determined with a MPA 100 apparatus and are not corrected. High-resolution mass spectrometry (HRMS) was performed on a TOF MS instrument with an ESI source.

General procedure for the 5-aryl-1*H*-tetrazoles:



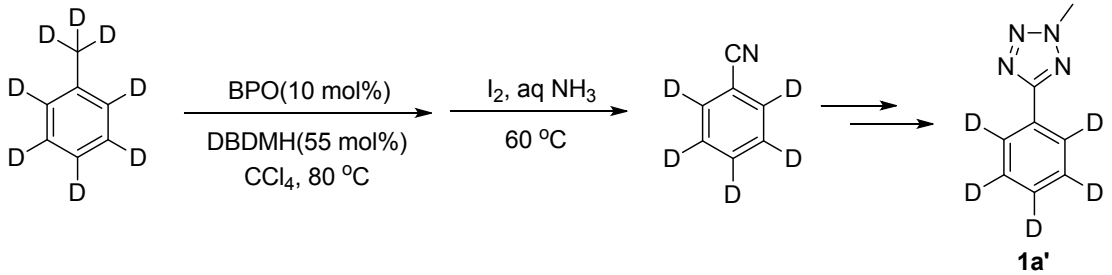
5-aryl-1H-tetrazoles were prepared according to the literature:[1] To a 250 mL round-bottomed flask was added the nitrile (20 mmol), sodium azide (1.43 g, 22 mmol), zinc bromide (4.50 g, 20 mmol) and 40 mL of water. The reaction mixture was refluxed for 24 h; vigorous stirring is essential. HCl (3 N, 30 mL) and ethyl acetate (100 mL) were added, and vigorous stirring was continued until no solid was present and the aqueous layer had a pH of 1. If necessary, additional ethyl acetate was added. The organic layer was isolated and the aqueous layer extracted with 2×100 mL of ethyl acetate. The combined organic layers were evaporated, 200 mL of 0.25 N NaOH was added, and the mixture was stirred for 30 min., until the original precipitate was dissolved and a suspension of zinc hydroxide was formed. The suspen-sion was filtered, and the solid washed with 20 mL of 1 N NaOH. To the filtrate was added 40 mL of 3 N HCl with vigorous stirring causing the tetrazole to precipitate. The tetrazole was filtered and washed with HCl (3 N, 2×20 mL) and dried in a drying oven to furnish the tetrazole as a white or slightly colored powder.

General procedure for N-methylation of 5-aryl-1*H*-tetrazoles:



N-methylation of 5-aryl-1H-tetrazoles were prepared as follows:[2] In a flame-dried 100-mL Schlenk flask, a solution of the corresponding *5-aryl-1H-tetrazoles* (10.0 mmol, 1.00 equiv) in dry DMF (20 mL) is added slowly via syringe to a suspension of oil-free sodium hydride (0.288 g, 12.0 mmol, 1.20 equiv) in dry DMF (40 mL) at 0°C. After complete addition, the reaction mixture is maintained at 0°C for an additional hour, followed by dropwise addition of methyl iodide (0.810 mL, 1.85 g, 13.0 mmol, 1.30 equiv). The reaction mixture is stirred at room temperature for 1-3 h until complete consumption of the starting materials (TLC). The reaction is carefully quenched with saturated aqueous NH_4Cl solution (25 mL), and the aqueous layer is extracted with tert-butyl methyl ether (25 mL×3). The combined organic phases are washed with brine (5 mL) and dried over anhydrous Na_2SO_4. After evaporation of the solvents under reduced pressure, the resulting residue is purified by flash column chromatography on silica gel using cyclohexane/tert-butyl methyl ether mixtures, affording the 2-methyl-5-aryl-2*H*-tetrazoles (**1a**~**1m**) in analytically pure form.

Synthesis of d_5-2-methyl-5-phenyl-2*H*-tetrazole:



The d_5-benzonitrile was prepared as follows:[3] To a solution of d_8-toluene (10 mmol, 1.00 g，99.5% of D) in dry CCl_4 (10 mL) were added DBDMH (5.5 mmol, 1.57 g) and benzoyl peroxide (1 mmol, 0.32 g) at room temperature, and the mixture was stirred for 3 hours at 80 °C. Then, the mixture was cooled to r.t., followed by

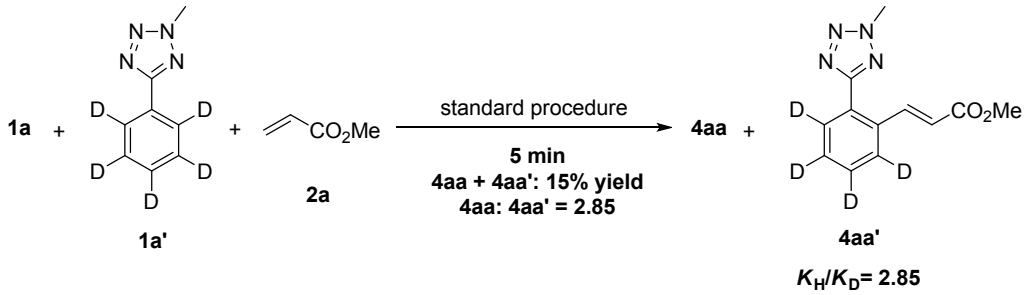
slow addition of aq. NH_3 (concentration: 28.0~30.0 %, 30 mL) and I_2 (25 mmol, 6.35 g), and then stirred for 12 hours at 60 °C. The reaction mixture was quenched by the addition of saturated aq. Na_2SO_3 (30 mL) and extracted with $CHCl_3$ (20 mL×3). The organic layer was dried over Na_2SO_4. After removal of the solvent under reduced pressure, the residue (without purification) reacted with NaN_3, followed by N-methylation with CH_3I to provide the d_5-2-methyl-5-phenyl-2*H*-tetrazole (**1a'**) in 51% yield.

General procedure for C–H olefination:

A sealed tube was charged with 2-methyl-5-aryl-2*H*-tetrazoles (0.1 mmol, 1 equiv), olefin (0.2 mmol, 2 equiv), $Cu(OAc)_2$ (0.2 mmol, 2 equiv), $RhCp^*(CH_3CN)_3(SbF_6)_2$ (0.005 mmol, 5 mol%) and dioxane (1.5 mL). The mixture was kept stirring under air at 110 ^oC for 12 h. After completion of the reaction (monitored by TLC), the mixture was cooled to room temperature, concentrated in vacuum, and the residue was purified by flash column chromatography on silica gel with petroleum ether-ethyl acetate-dichloromethane as eluent to give the desired product.

2 KIE experiment of 2-methyl-5-phenyl-2*H*-tetrazole:

In a sealed tube, the mixture of **1a** (0.1 mmol) and **1 a'** (0.1 mmol) was treated by standard procedures and heated for 5 min.. The mixture was concentrated in vacuum and the residue was purified by flash column chromatography on silica gel with petroleum ether-ethyl acetate-dichloromethane as eluent to give product **4aa** and **4aa'**. The mixture was analyzed using ^1H NMR spectrometer. As shown in Figure S1, the ratio of **4aa** and **4aa'** is 2.85:1.



Scheme S1 KIE experiment of **1a** and **la'**

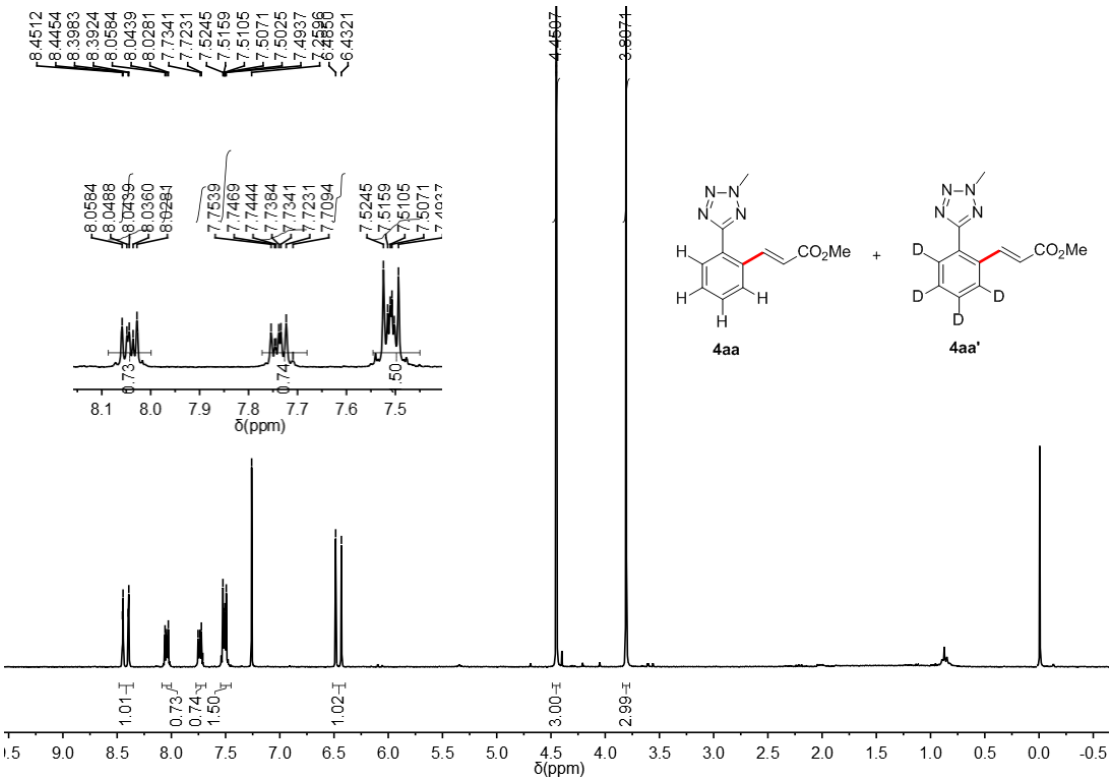
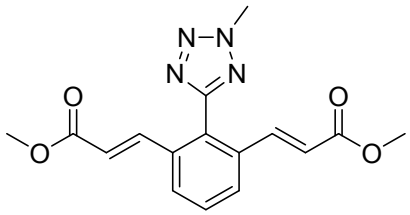


Figure S1 The ^{1}H NMR spectrum of the KIE results

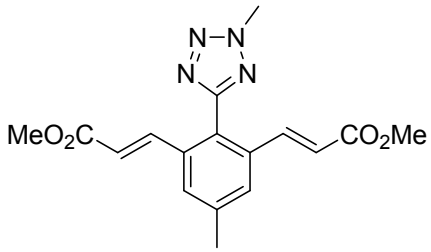
3 Characterization data for the products

(2E,2'E)-dimethyl 3,3'-(2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3aa):



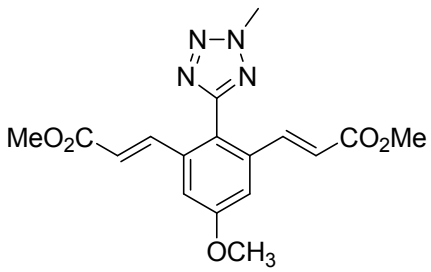
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (30.2 mg, 92% yield) as a white solid. mp: 146.1- 148.4 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.75 (d, J = 7.8 Hz, 2H), 7.56 (t, J = 7.8 Hz, 1H), 7.48 (d, J = 15.9 Hz, 2H), 6.38 (d, J = 15.9 Hz, 2H), 4.49 (s, 3H), 3.74 (s, 6H); ^{13}C NMR ($CDCl_3$,125 MHz): δ 166.6, 161.8, 141.8, 135.8, 130.5, 128.1, 127.5, 121.0, 51.7, 39.9. HRMS (ESI): Calcd. for $C_{16}H_{16}N_4O_4Na$ $(M+Na)^+$ 351.1064, found 351.1060.

(2E,2'E)-dimethyl 3,3'-(5-methyl-2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ba):



Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (32.2 mg, 94% yield) as a white solid. mp: 168.1- 169.4 °C.^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.55 (s, 2H), 7.46 (d, J = 15.9 Hz, 2H), 6.36 (d, J = 15.9 Hz, 2H), 4.46 (s, 3H), 3.72 (s, 6H), 2.44 (s, 3H); ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.7, 161.9, 142.0, 140.5, 135.7, 128.9, 124.9, 120.7, 51.7, 39.8, 21.4. HRMS (ESI): Calcd. for $C_{17}H_{18}N_4O_4Na$ $(M+Na)^+$ 365.1220, found 365.1217.

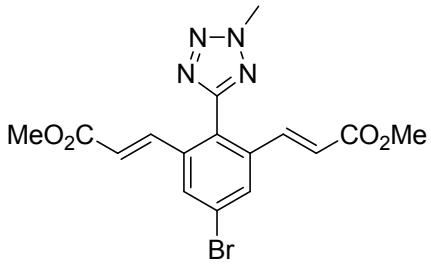
(2E,2'E)-dimethyl 3,3'-(5-methoxy-2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ca):



Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1)

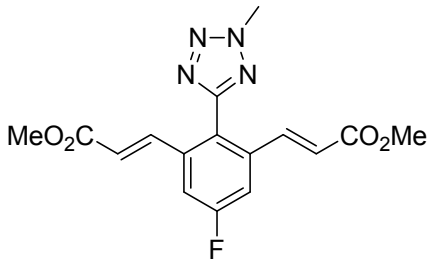
give the product (34.0 mg, 95% yield) as a white solid. mp: 141.9-144.6 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.47 (d, J = 15.8 Hz, 2H), 7.23 (s, 2H), 6.35 (d, J = 16.4 Hz, 2H), 4.46 (s, 3H), 3.89 (s, 3H), 3.72 (s, 6H); ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.6, 161.8, 160.5, 141.9, 137.2, 121.1, 120.3, 113.5, 55.5, 51.7, 39.8. HRMS (ESI): Calcd. for $C_{17}H_{18}N_4O_5Na$ $(M+Na)^+$ 381.1169, found 381.1165.

(2E,2'E)-dimethyl 3,3'-(5-bromo-2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3da):



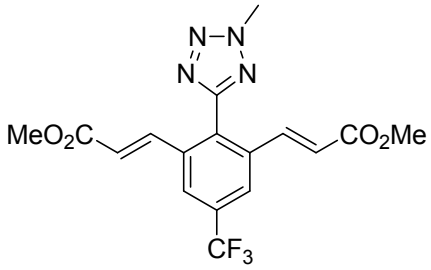
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane, 10:1:1) give the product (36.1 mg, 89% yield) as a white solid. mp: 178.3-180.1 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.86 (s, 2H), 7.43 (d, J = 15.8 Hz, 2H), 6.38 (d, J = 15.8 Hz, 2H), 4.48 (s, 3H), 3.74 (s, 6H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.3, 161.2, 140.5, 137.6, 130.8, 126.2, 124.9, 122.2, 51.9, 39.9. HRMS (ESI): Calcd. for $C_{16}H_{15}BrN_4O_4Na$ $(M+Na)^+$ 429.0169, found 429.0164.

(2E,2'E)-dimethyl 3,3'-(5-fluoro-2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ea):



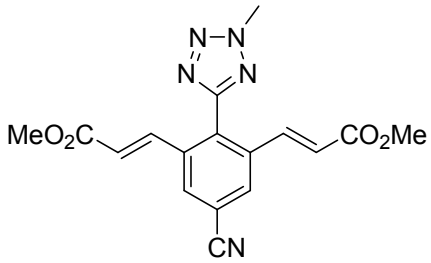
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (32.2 mg, 93% yield) as a white solid. mp: 164.4-166.0 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.45 (s, 1H), 7.44 (d, J = 15.8 Hz, 2H), 7.42 (s, 1H), 6.37 (d, J = 15.9 Hz, 2H), 4.49 (s, 3H), 3.75 (s, 6H); ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.3, 163.3 (d, $J_{C\text{-}F}$ = 251.1 Hz), 161.2, 140.7 (d, $J_{C\text{-}F}$ = 1.7 Hz), 138.4 (d, $J_{C\text{-}F}$ = 8.4 Hz), 123.8 (d, $J_{C\text{-}F}$ = 3.0 Hz), 122.1, 114.8 (d, $J_{C\text{-}F}$ = 23.0 Hz), 51.9, 39.9. HRMS (ESI): Calcd. for $C_{16}H_{16}FN_4O_4$ $(M+H)^+$ 347.1150, found 347.1152.

(2E,2'E)-dimethyl 3,3'-(2-(2-methyl-2H-tetrazol-5-yl)-5-(trifluoromethyl)-1,3-phenylene)diacrylate (3fa):



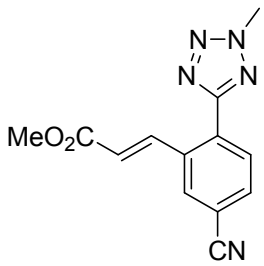
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (36.4 mg, 92% yield) as a white solid. mp: 159.9-162.0 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.94 (s, 2H), 7.49 (d, J = 15.9 Hz, 2H), 6.45 (d, J = 15.9 Hz, 2H), 4.50 (s, 3H), 3.75 (s, 6H); ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.2, 160.9, 140.5, 137.0, 132.8 (d, J = 33.2 Hz), 130.4, 124.5 (q, J = 3.6 Hz), 123.1 (q, J = 271.6 Hz), 122.7, 51.9, 40.0. HRMS (ESI): Calcd. for $C_{17}H_{15}F_3N_4O_4Na$ $(M+Na)^+$ 419.0938, found 419.0935.

(2E,2'E)-dimethyl 3,3'-(5-cyano-2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ga):



Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (20.5 mg, 58% yield) as a white solid. mp: 210.3-211.5 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.97 (s, 2H), 7.48 (d, J = 15.9 Hz, 2H), 6.42 (d, J = 15.9 Hz, 2H), 4.51 (s, 3H), 3.77 (s, 6H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.0, 160.6, 139.8, 137.5, 131.0, 130.8, 123.3, 117.1, 115.0, 52.0, 40.0. HRMS (ESI): Calcd. for $C_{17}H_{15}N_5O_4Na$ $(M+Na)^+$ 376.1016, found 376.1025.

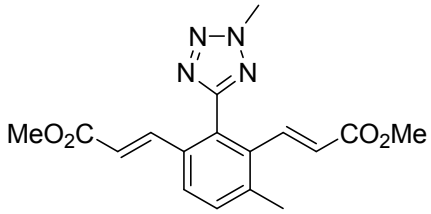
(E)-methyl 3-(5-cyano-2-(2-methyl-2H-tetrazol-5-yl)phenyl)acrylate (4ga):



Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (8.3 mg, 31% yield) as a white solid. mp: 161.1-164.5 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.44 (d, J = 15.9 Hz, 1H), 8.24 (d, J = 8.1 Hz, 1H), 7.98 (s, 1H), 7.77 (d, J = 9.7 Hz, 1H), 6.47 (d, J = 15.9 Hz, 1H), 4.47 (s, 3H), 3.83 (s, 3H). ^{13}C

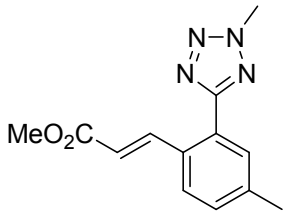
NMR ($CDCl_3$, 125 MHz): δ 166.6, 163.1, 141.3, 135.0, 132.5, 131.3, 130.7, 130.5, 122.6, 117.7, 114.3, 52.0, 39.8. HRMS (ESI): Calcd. for $C_{13}H_{12}N_5O_2$ $(M+H)^+$ 270.0986, found 270.0972.

(2E,2'E)-dimethyl 3,3'-(4-methyl-2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ha):



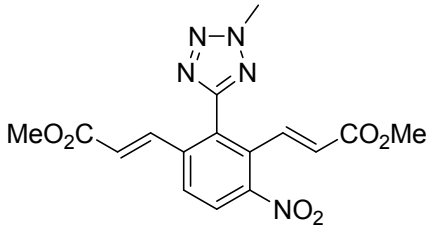
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (17.4 mg, 51% yield) as a white solid. mp: 108.2-109.0 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.58 (d, J = 8.0 Hz, 1H), 7.51 (d, J = 16.3 Hz, 1H), 7.34 (d, J = 8.2 Hz, 1H), 7.29 (d, J = 15.8 Hz, 1H), 6.31 (d, J = 15.8 Hz, 1H), 5.67 (d, J = 17.0 Hz, 1H), 4.40 (s, 3H), 3.66 (s, 6H), 2.36 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.8, 166.2, 162.6, 142.1, 141.6, 138.9, 136.3, 133.3, 132.5, 127.1, 126.4, 125.1, 120.0, 51.7(51.67, 51.66), 39.7, 21.0. HRMS (ESI): Calcd. for $C_{17}H_{18}N_4O_4Na$ $(M+Na)^+$ 365.1220, found 365.1216.

(E)-methyl 3-(4-methyl-2-(2-methyl-2H-tetrazol-5-yl)phenyl)acrylate (4ha):



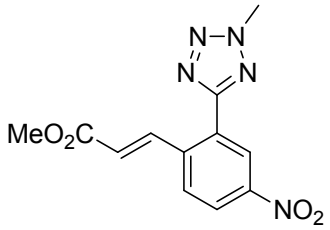
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (5.2 mg, 20% yield) as a white solid. mp: 117.2-118.0 °C. ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.39 (d, J = 15.9 Hz, 1H), 7.84 (s, 1H), 7.63 (d, J = 8.0 Hz, 1H), 7.30 (d, J = 7.9 Hz, 1H), 6.43 (d, J = 15.9 Hz, 1H), 4.43 (s, 3H), 3.78 (s, 3H), 2.42 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 167.3, 164.5, 143.1, 140.4, 131.1, 130.9, 130.6, 127.2, 126.8, 119.2, 51.6, 39.6, 21.2. HRMS (ESI): Calcd. for $C_{13}H_{15}N_4O_2$ $(M+H)^+$ 259.1190, found 259.1177.

(2E,2'E)-dimethyl 3,3'-(2-(2-methyl-2H-tetrazol-5-yl)-4-nitro-1,3-phenylene)diacrylate (3ia):



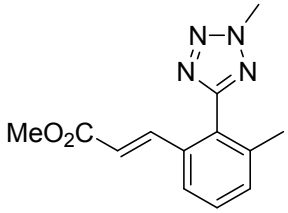
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (8.2 mg, 22% yield) as a white solid. mp: 135.9-137.2 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.14 (d, J = 8.7 Hz, 1H), 7.84 (d, J = 8.7 Hz, 1H), 7.58 (d, J = 16.3 Hz, 1H), 7.35 (d, J = 15.9 Hz, 1H), 6.46 (d, J = 15.9 Hz, 1H), 5.65 (d, J = 16.3 Hz, 1H), 4.44 (s, 3H), 3.75 (s, 3H), 3.70 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 165.9, 165.2, 160.9, 148.8, 140.4, 139.6, 139.0, 133.0, 129.0, 127.4, 126.0, 125.4, 124.2, 52.0, 51.9, 39.9. HRMS (ESI): Calcd. for $C_{16}H_{15}N_5O_6Na$ $(M+Na)^+$ 396.0915, found 396.0911.

(E)-methyl 3-(2-(2-methyl-2H-tetrazol-5-yl)-4-nitrophenyl)acrylate (4ia):



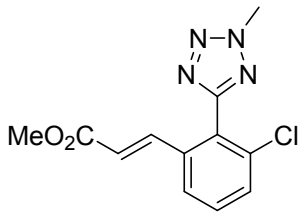
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (5.8 mg, 20% yield) as a white solid. mp: 124.7-127.4 °C.^{1}H NMR (300 MHz, $CDCl_3$): δ 8.94 (d, J = 2.4 Hz, 1H), 8.49 (d, J = 15.9 Hz, 1H), 8.32 (dd, J = 8.7, 2.3 Hz, 1H), 7.87 (d, J = 8.7 Hz, 1H), 6.54 (d, J = 15.9 Hz, 1H), 4.49 (s, 3H), 3.83 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.3, 162.9, 148.3, 141.2, 139.6, 128.8, 128.0, 125.1, 124.6, 123.8, 52.0, 39.9. HRMS (ESI): Calcd. for $C_{12}H_{11}N_5O_4Na$ $(M+Na)^+$ 312.0703, found 312.0693.

(E)-methyl 3-(3-methyl-2-(2-methyl-2H-tetrazol-5-yl)phenyl)acrylate (3ja):



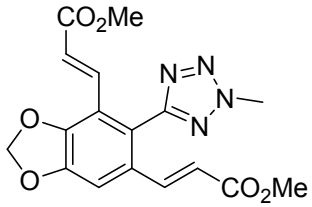
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (24.5 mg, 95% yield) as a colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.57 (d, J = 7.6 Hz, 1H), 7.43-7.32 (m, 2H), 7.42 (d, J = 15.8 Hz, 1H), 6.35 (d, J = 15.9 Hz, 1H), 4.46 (s, 3H), 3.72 (s, 3H), 2.20 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.9, 162.9, 142.5, 139.0, 135.0, 131. 8, 129.9, 127.5, 124.1, 119.9, 51.5, 39.6, 20.3. HRMS (ESI): Calcd. for $C_{13}H_{14}N_4O_2Na$ $(M+Na)^+$ 281.1009, found 281.0997.

(E)-methyl 3-(3-chloro-2-(2-methyl-2H-tetrazol-5-yl)phenyl)acrylate (3ka):



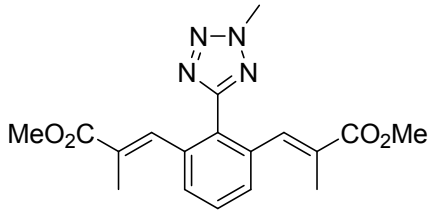
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (25.0 mg, 90% yield) as a white solid. mp: 102.9-104.8 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.71-7.68 (m, 1H), 7.59-7.57 (m, 2H), 7.08 (d, J = 15.9 Hz, 1H), 6.34 (d, J = 15.9 Hz, 1H), 4.41 (s, 3H), 3.65 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.4, 161.1, 140.9, 137.2, 135.6, 131.3, 131.0, 127.2, 124.9, 121.5, 51.7, 39.8. HRMS (ESI): Calcd. for $C_{12}H_{11}ClN_4O_2Na$ $(M+Na)^+$ 301.0463, found 301.0458.

(2E,2'E)-dimethyl 3,3'-(5-(2-methyl-2H-tetrazol-5-yl)benzo[d][1,3]dioxole-4,6-diyl)diacrylate (3la):



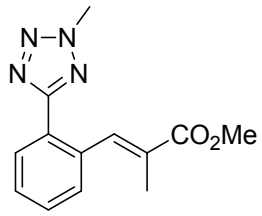
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (34.2 mg, 92% yield) as a white solid. mp: 201.3- 202.6 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.42 (d, J = 15.9 Hz, 1H), 7.41 (d, J = 17.3 Hz, 1H), 7.32 (s, 1H), 6.89 (d, J = 16.1 Hz, 1H), 6.39 (d, J = 15.8 Hz, 1H), 6.32 (s, 2H), 4.61 (s, 3H), 3.85 (s, 3H), 3.84 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 167.2, 166.8, 161.6, 149.5, 148.4, 141.5, 136.4, 130.3, 123.7, 122.6, 119.2, 117.7, 106.6, 102.5, 51.7 (51.71, 51.67), 39.9. HRMS (ESI): Calcd. for $C_{17}H_{16}N_4O_6Na$ $(M+Na)^+$ 395.0962, found 395.0964.

(2E,2'E)-dimethyl 3,3'-(2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)bis(but-2-enoate) (3ab):



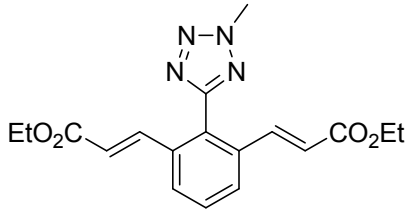
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (8.9 mg, 25% yield) as a colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.49 (d, J = 8.2 Hz, 2H), 7.47-7.35 (m, 3H), 4.39 (s, 3H), 3.73 (s, 6H), 1.95 (s, 6H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 168.4, 162.7, 137.4, 137.0, 130.0, 129.2, 126.7, 125.4, 52.0, 39.6, 14.0. HRMS (ESI): Calcd. for $C_{18}H_{20}N_4O_4Na$ $(M+Na)^+$ 379.1377, found 379.1369.

(E)-methyl 3-(2-(2-methyl-2H-tetrazol-5-yl)phenyl)but-2-enoate (4ab):



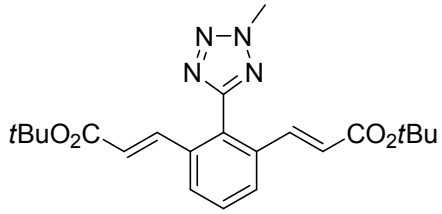
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (7.2 mg, 28% yield) as a colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.09 (dd, J = 7.3, 1.7 Hz, 1H), 8.03 (s, 1H), 7.53-7.35 (m, 3H), 4.39 (s, 3H), 3.81 (s, 3H), 1.98 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 168.8, 164.7, 138.9, 134.9, 130.1, 129.6, 129.4, 128.7, 128.3, 126.4, 51.9, 39.5, 14.0. HRMS (ESI): Calcd. for $C_{13}H_{14}N_4O_2Na$ $(M+Na)^+$ 281.1009, found 281.0997.

(2E,2'E)-diethyl 3,3'-(2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ac):



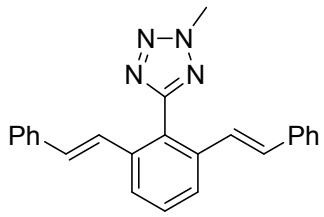
Flash column chromatography on a silica gel (PE/EtOAc/dichloromethane = 10:1:1) give the product (31.7 mg, 89% yield) as a white solid. mp:134.9- 136.7 ^{o}C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.74 (d, J = 7.8 Hz, 2H), 7.53 (d, J = 7.9 Hz, 1H), 7.46 (d, J = 15.9 Hz, 2H), 6.36 (d, J = 15.8 Hz, 2H), 4.47 (s, 3H), 4.17 (q, J = 7.1 Hz, 4H), 1.25 (t, J = 7.1 Hz, 6H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 166.2, 161.8, 141.5, 135.9, 130.4, 128.0, 127.6, 121.5, 60.6, 39.8, 14.2. HRMS (ESI): Calcd. for $C_{18}H_{20}N_4O_4Na$ $(M+Na)^+$ 379.1377, found 379.1370.

(2E,2'E)-di-tert-butyl 3,3'-(2-(2-methyl-2H-tetrazol-5-yl)-1,3-phenylene)diacrylate (3ad):



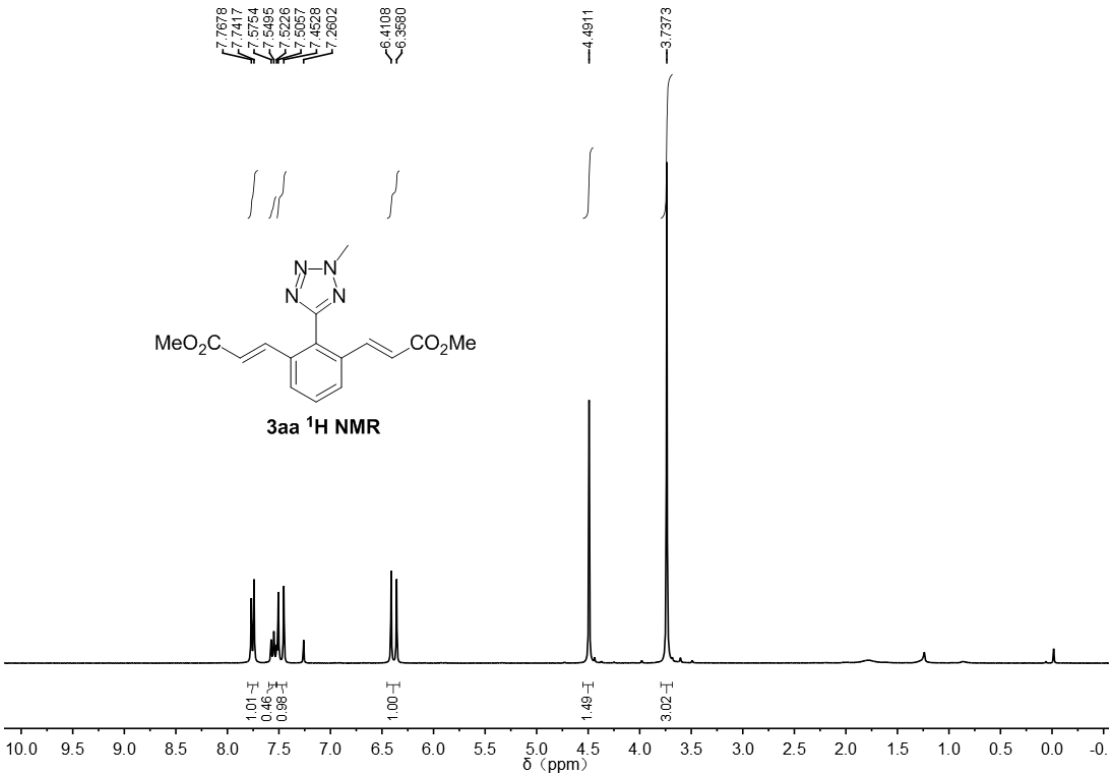
Flash column chromatography on a silica gel (PE/EtOAc = 10:1) give the product (25.6 mg, 62% yield) as a white solid. mp:171.8- 174.2 ^{o}C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.75 (d, J = 7.9 Hz, 2H), 7.51 (t, J = 7.9 Hz, 1H), 7.36 (d, J = 15.8 Hz, 2H), 6.32 (d, J = 15.8 Hz, 2H), 4.48 (s, 3H), 1.47 (s, 18H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 165.5, 161.9, 140.4, 136.0, 130.3, 127.6, 123.1, 121.1, 80.6, 39.7, 28.1. HRMS (ESI): Calcd. for $C_{22}H_{28}N_4O_4Na$ $(M+Na)^+$ 435.2003, found 435.1995.

5-(2,6-di((E)-styryl)phenyl)-2-methyl-2H-tetrazole (3ae):

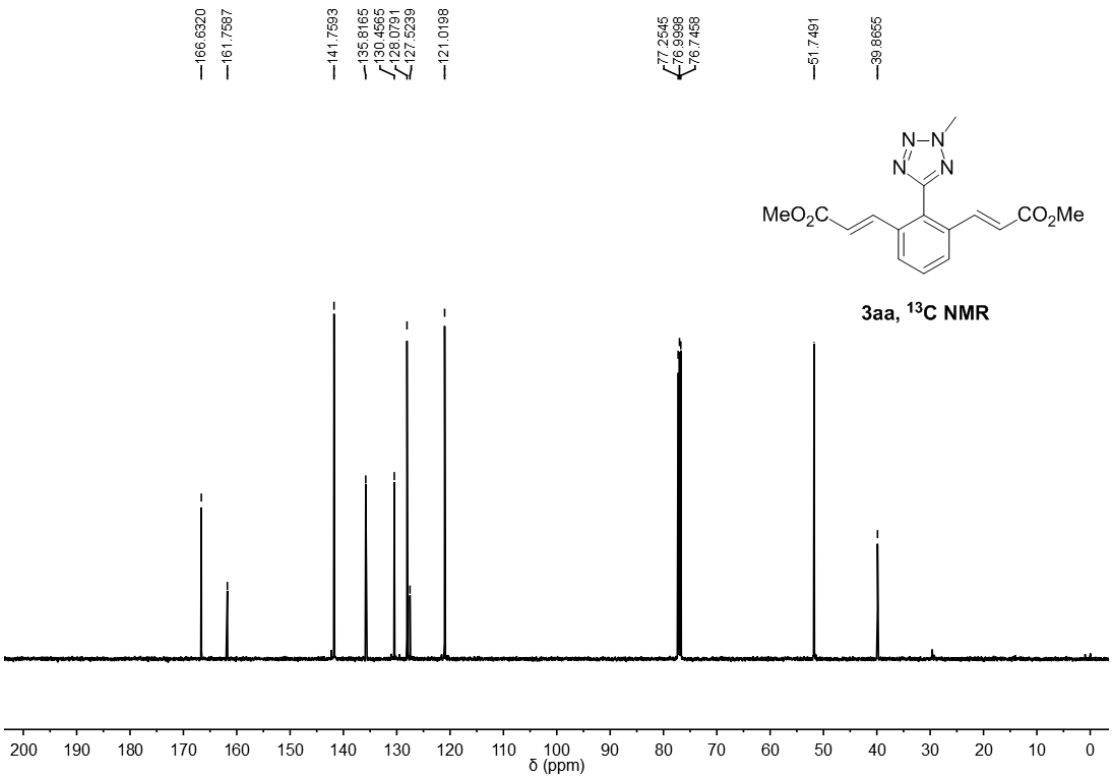


Flash column chromatography on a silica gel (PE/EtOAc = 10:1) give the product (33.5 mg, 92% yield) as a white solid. mp:164.7-165.9 ^{o}C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.70 (d, J = 7.8 Hz, 2H), 7.55-7.44 (m, 1H), 7.37-7.16 (m, 10H), 7.02 (d, J = 16.1 Hz, 2H), 6.85 (d, J = 16.1 Hz, 2H), 4.45 (s, 3H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 138.5, 137.1, 131.4, 130.2, 128.6, 127.8, 126.8, 126.7, 126.7, 126.3, 125.0, 39.7. HRMS (ESI): Calcd. for $C_{24}H_{20}N_4Na$ $(M+Na)^+$ 387.1580, found 387.1573.

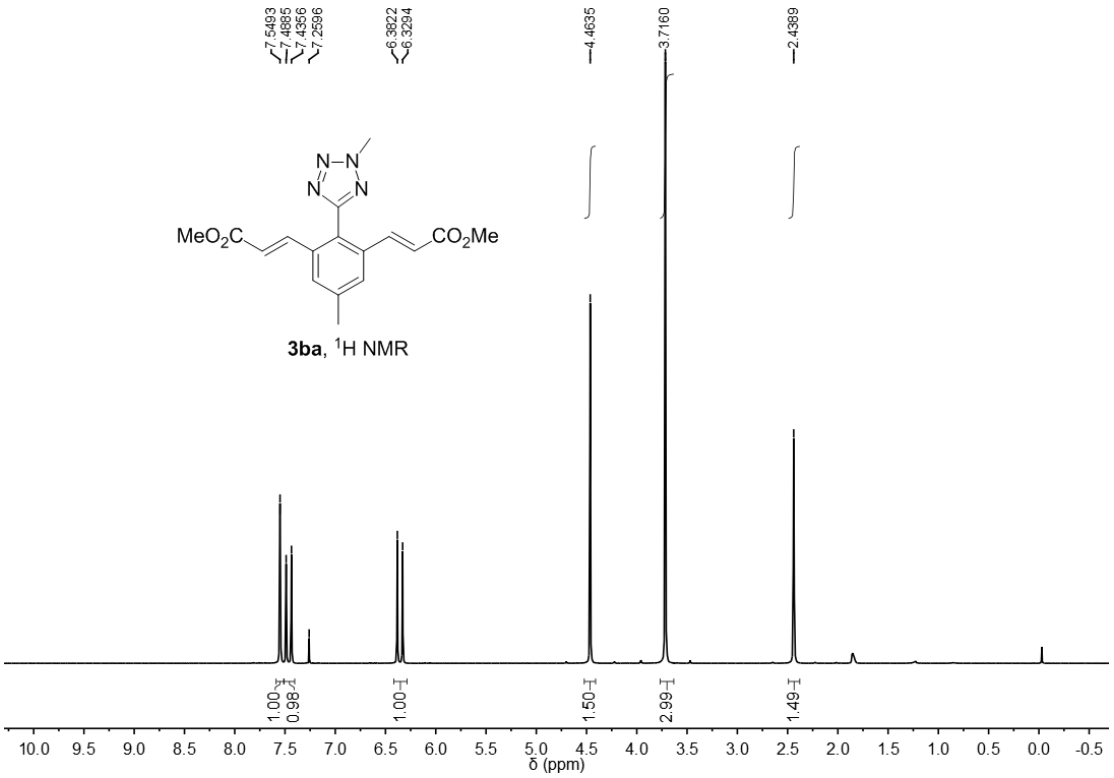
4 Copies of ^{1}H NMR and ^{13}C NMR spectra



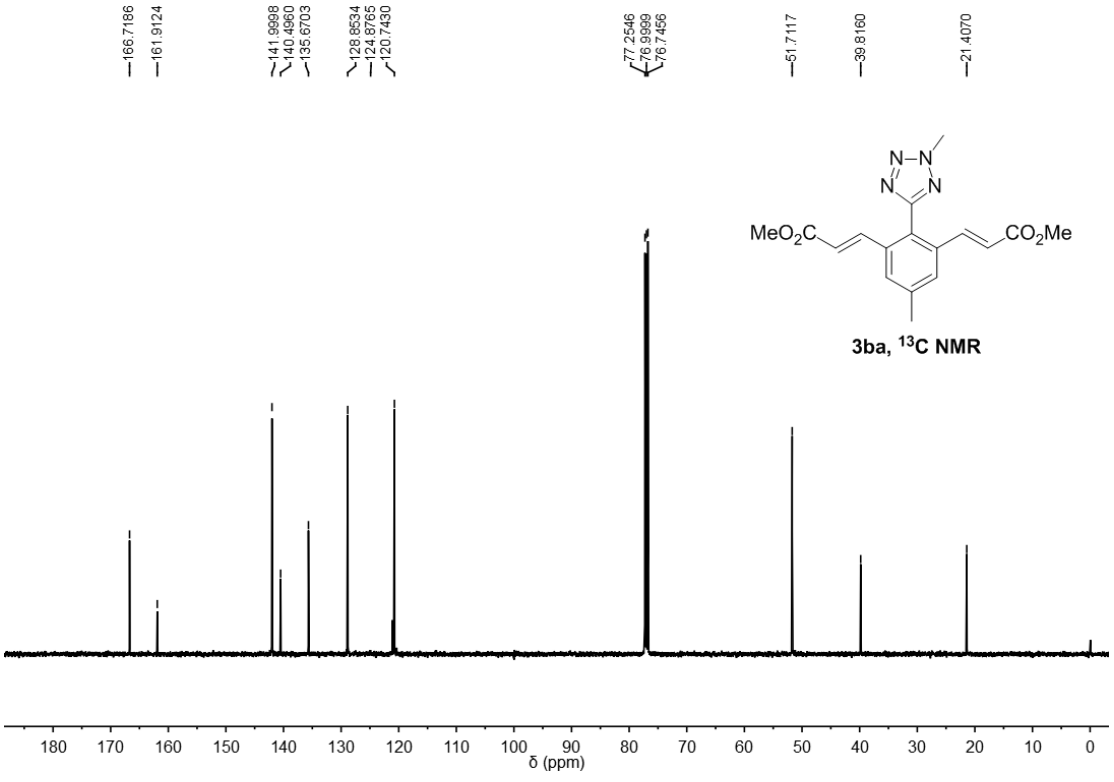
3aa ^{1}H NMR



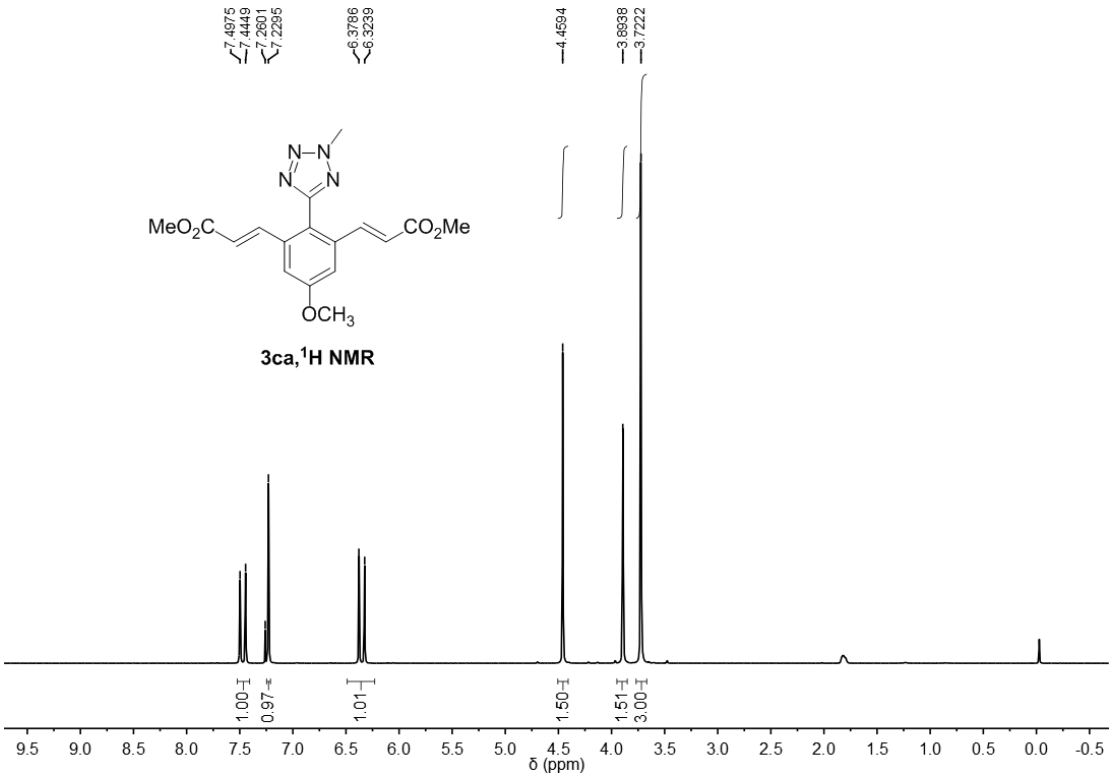
3aa, ^{13}C NMR



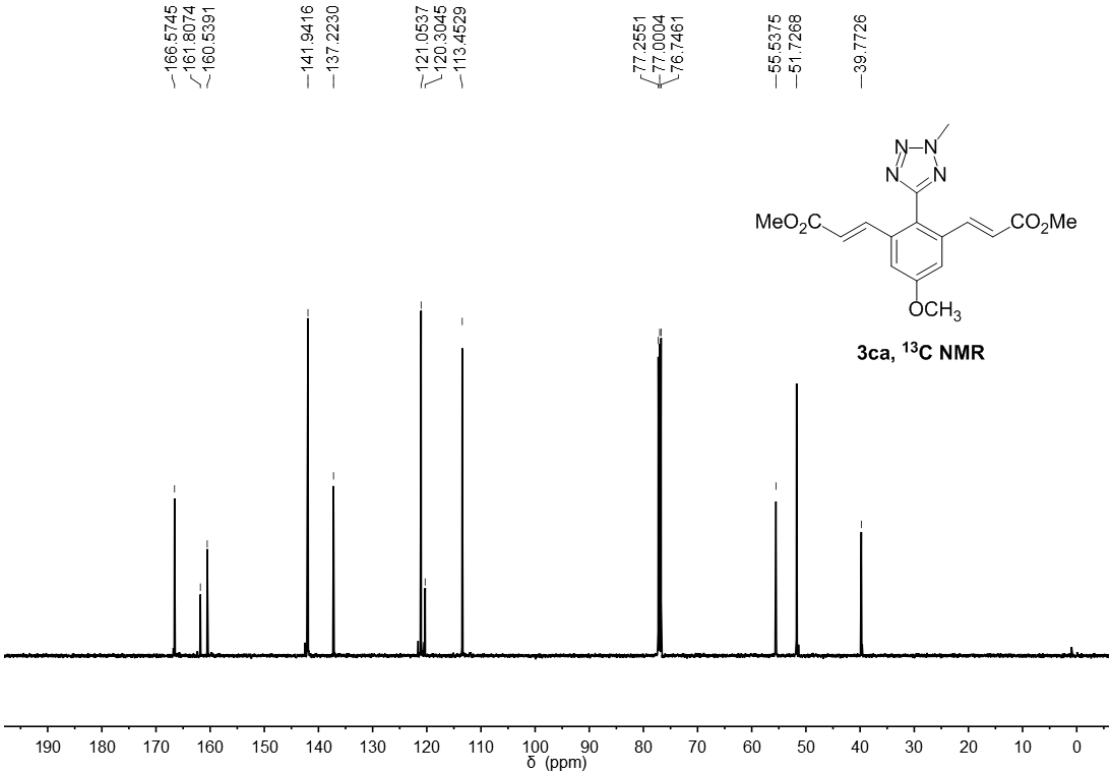
3ba, ^{1}H NMR



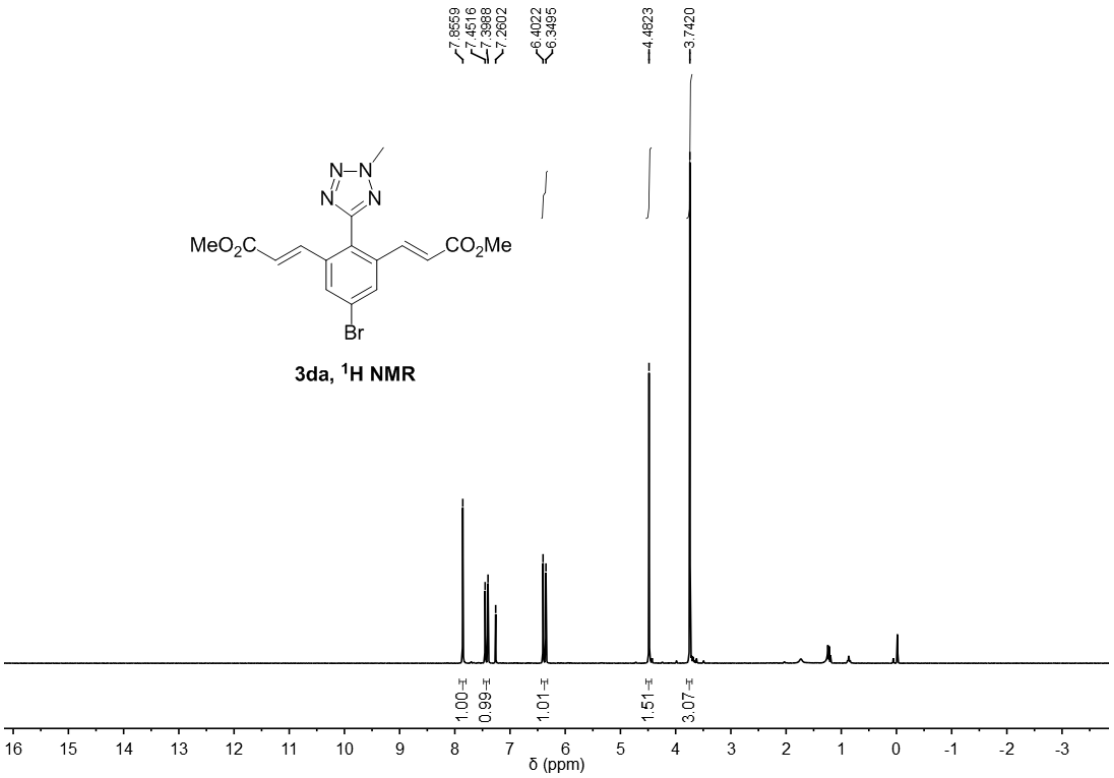
3ba, ^{13}C NMR



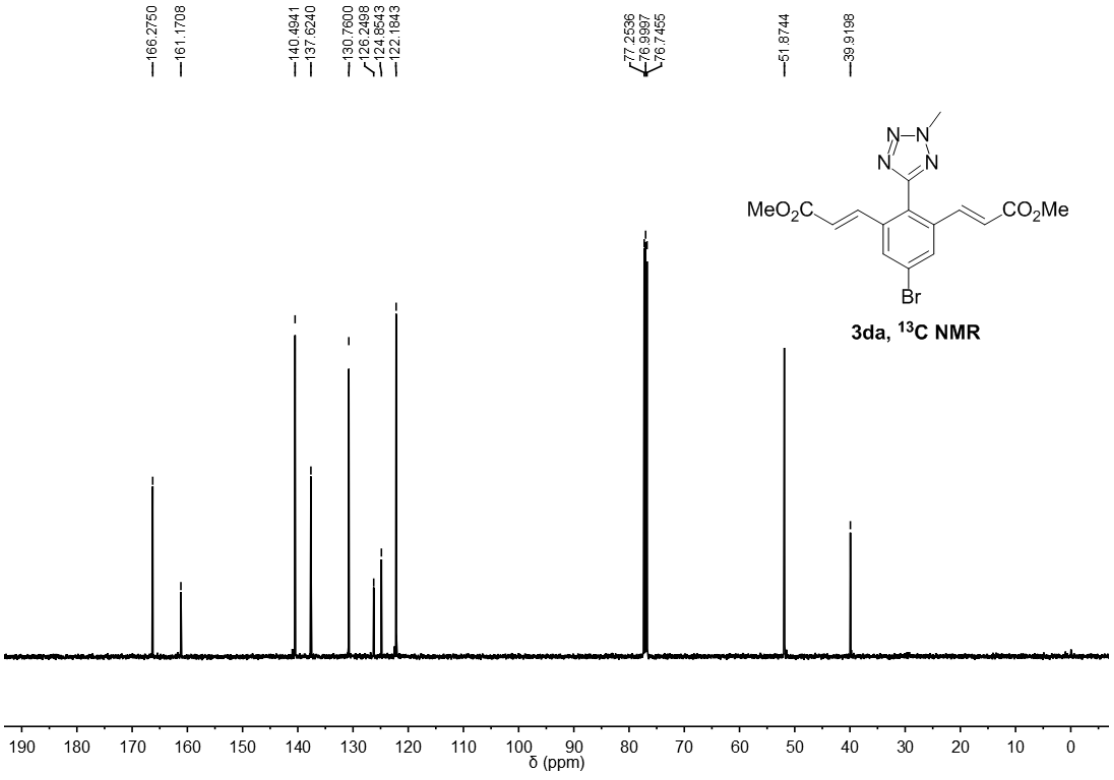
3ca,^{1}H NMR



3ca, ^{13}C NMR



3da, ^{1}H NMR



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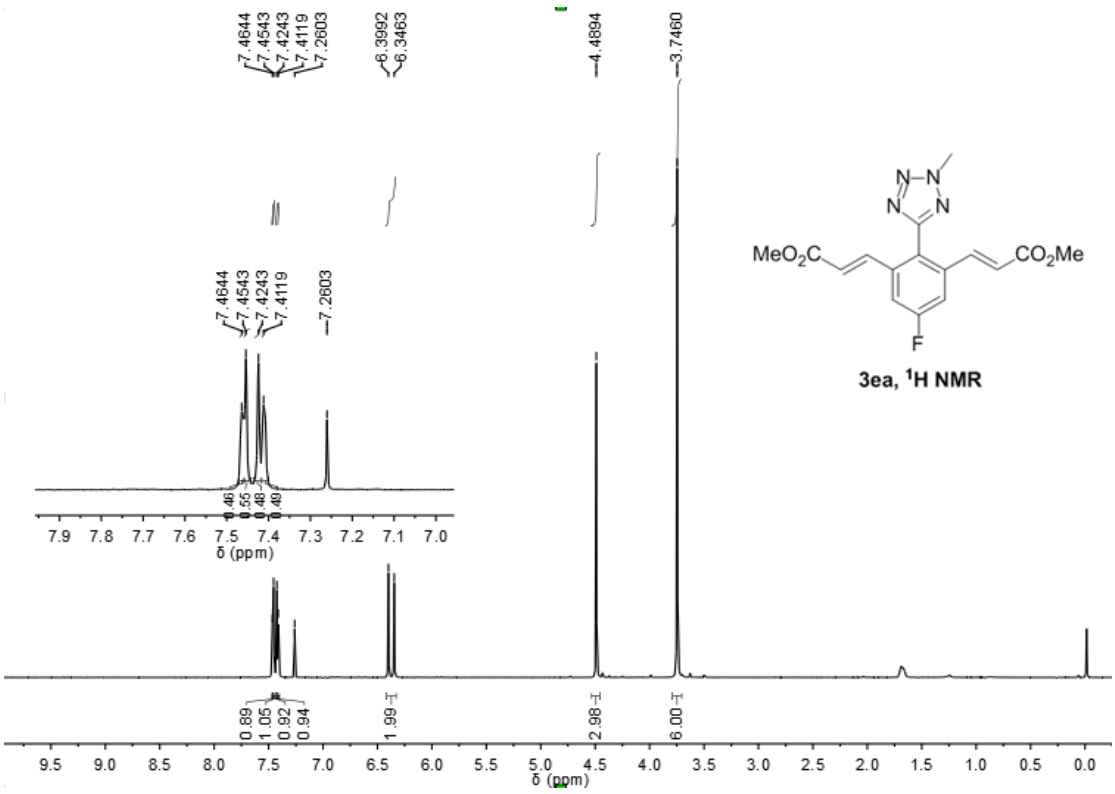
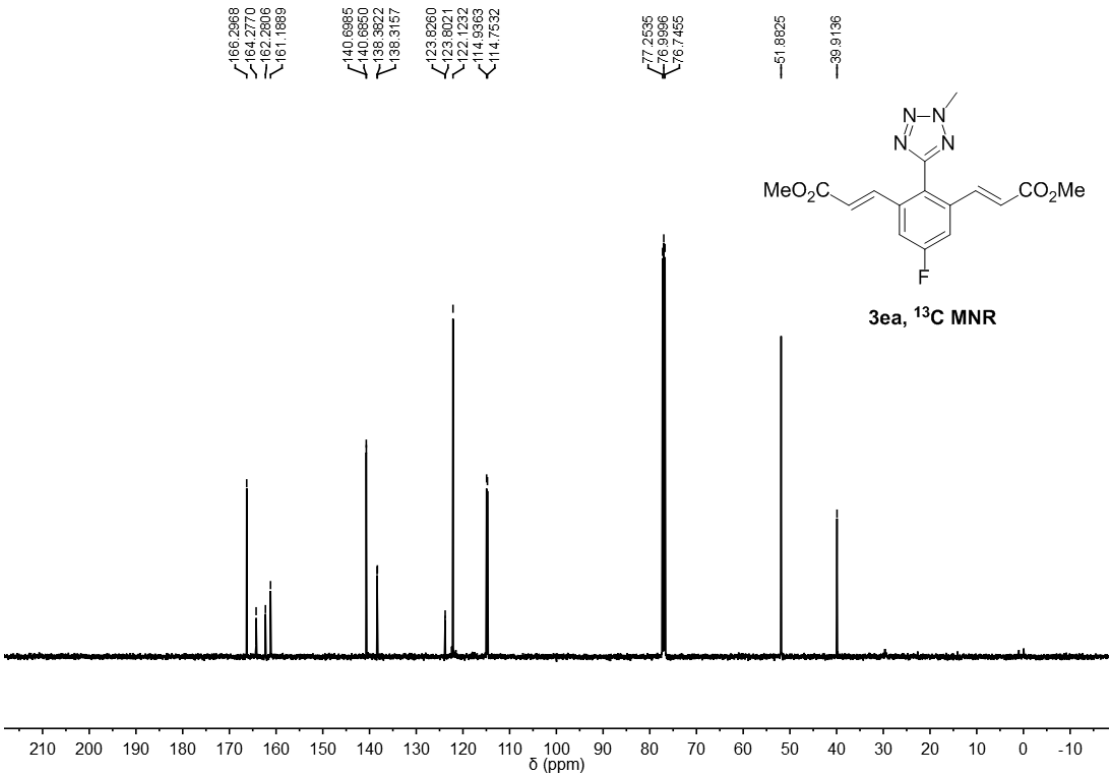
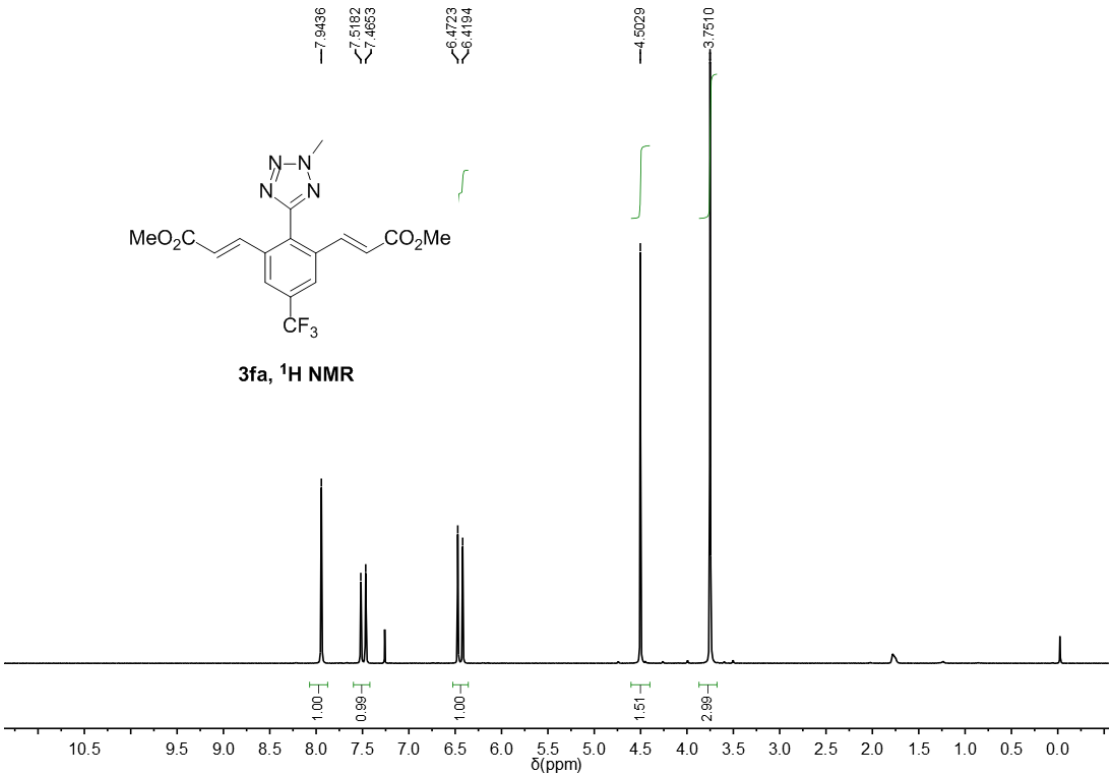


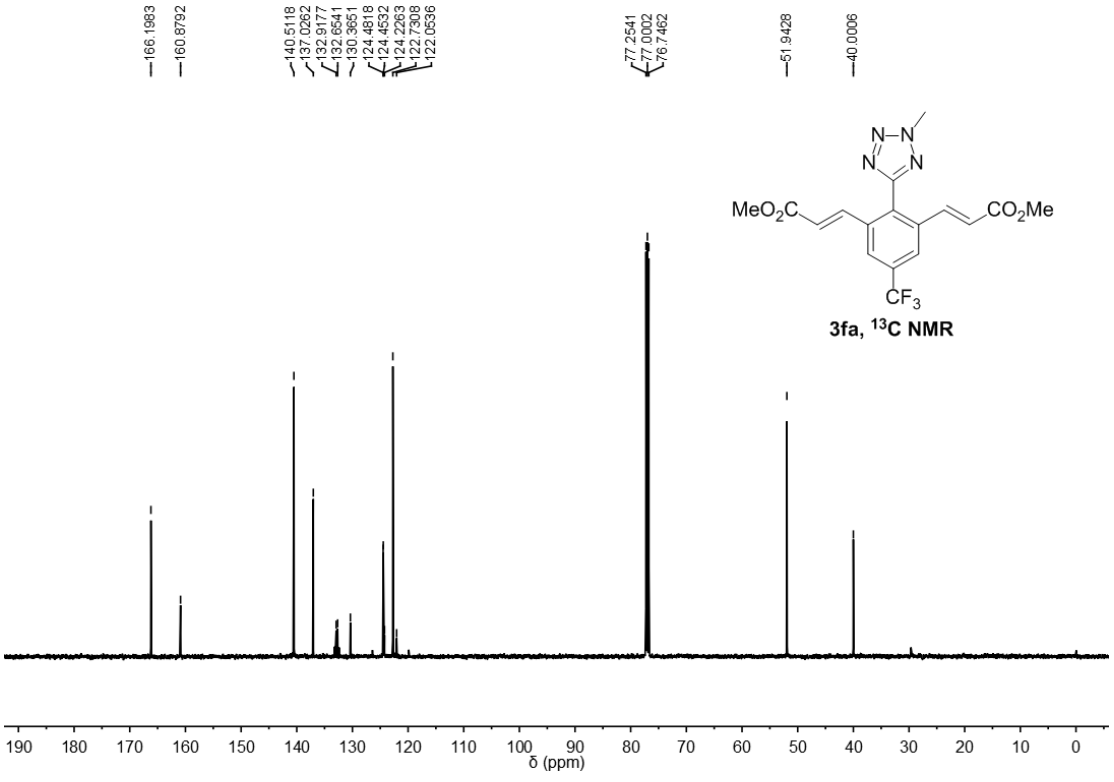
3ea, ^{1}H NMR



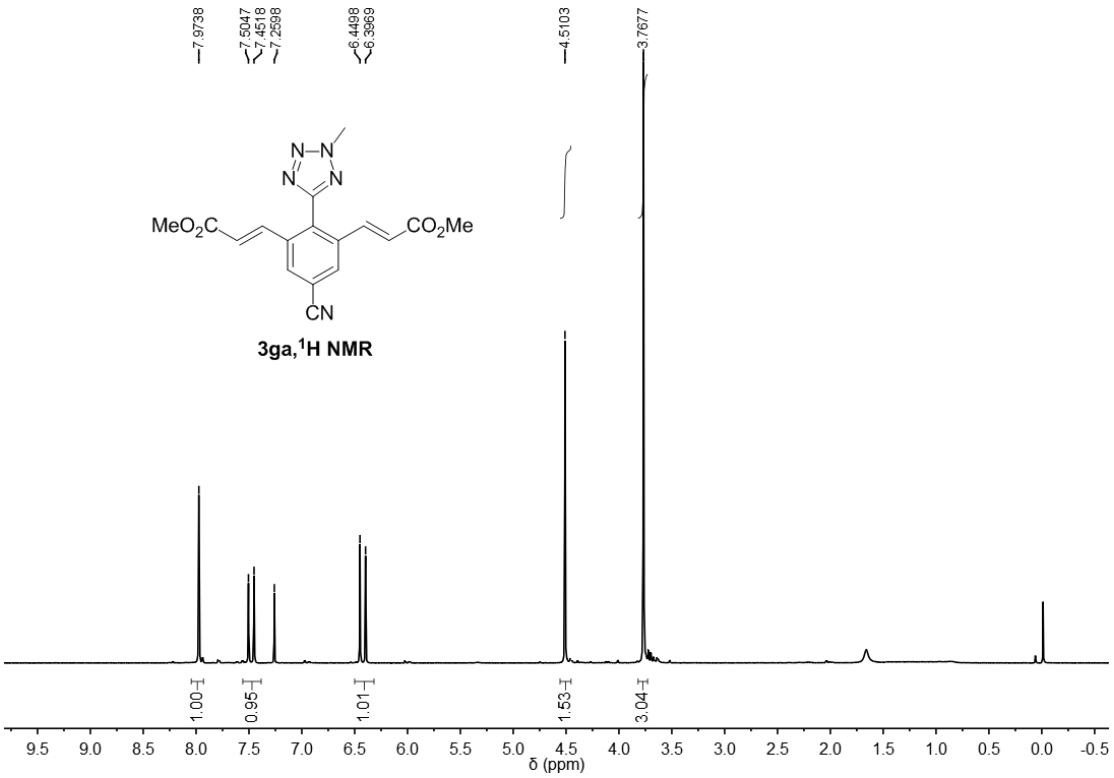
3ea, ^{13}C MNR



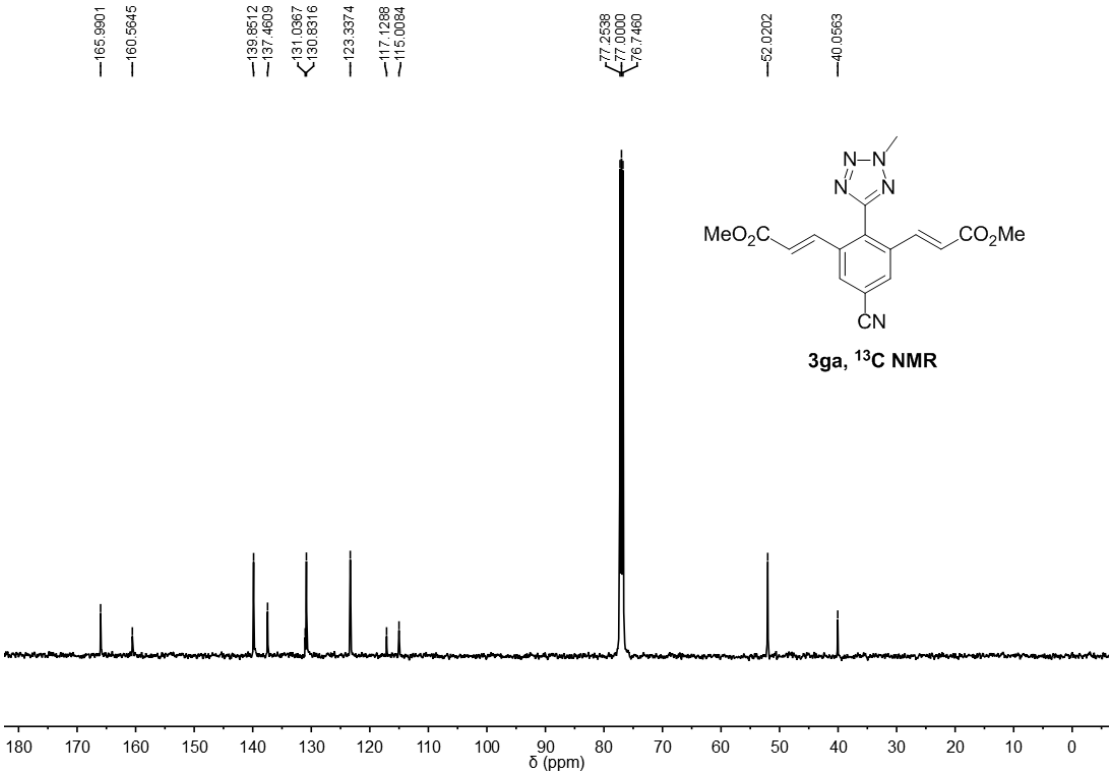
3fa, ^{1}H NMR



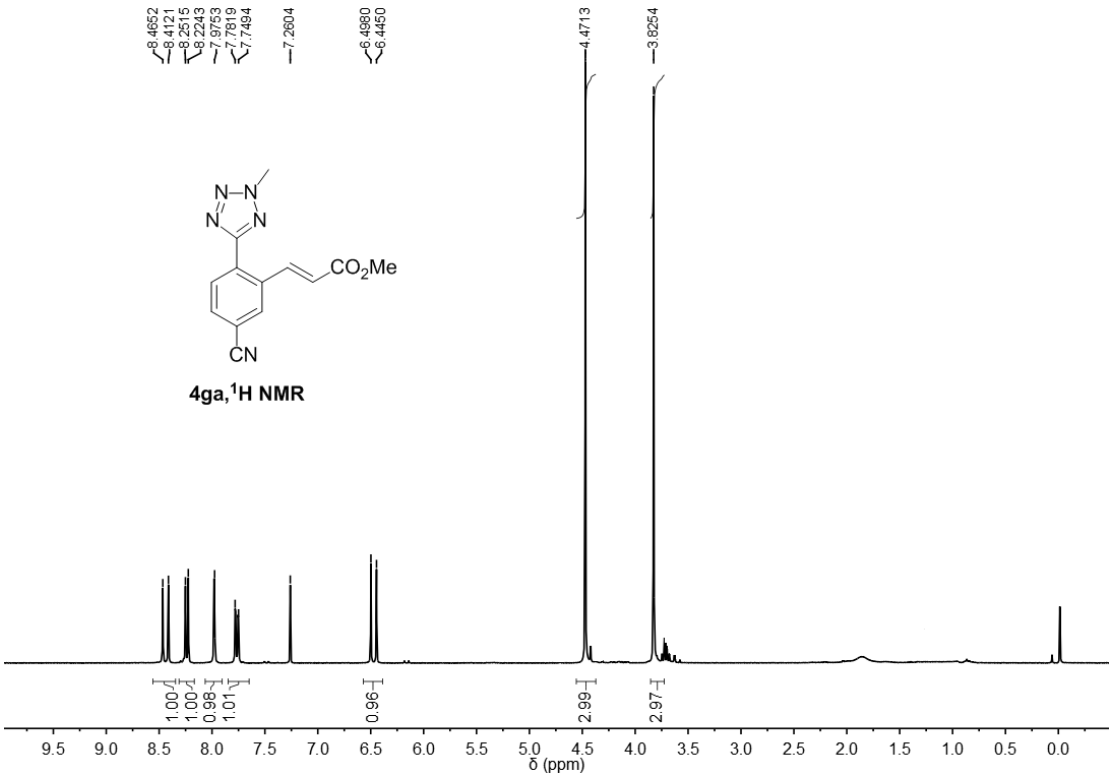
3fa, ^{13}C NMR



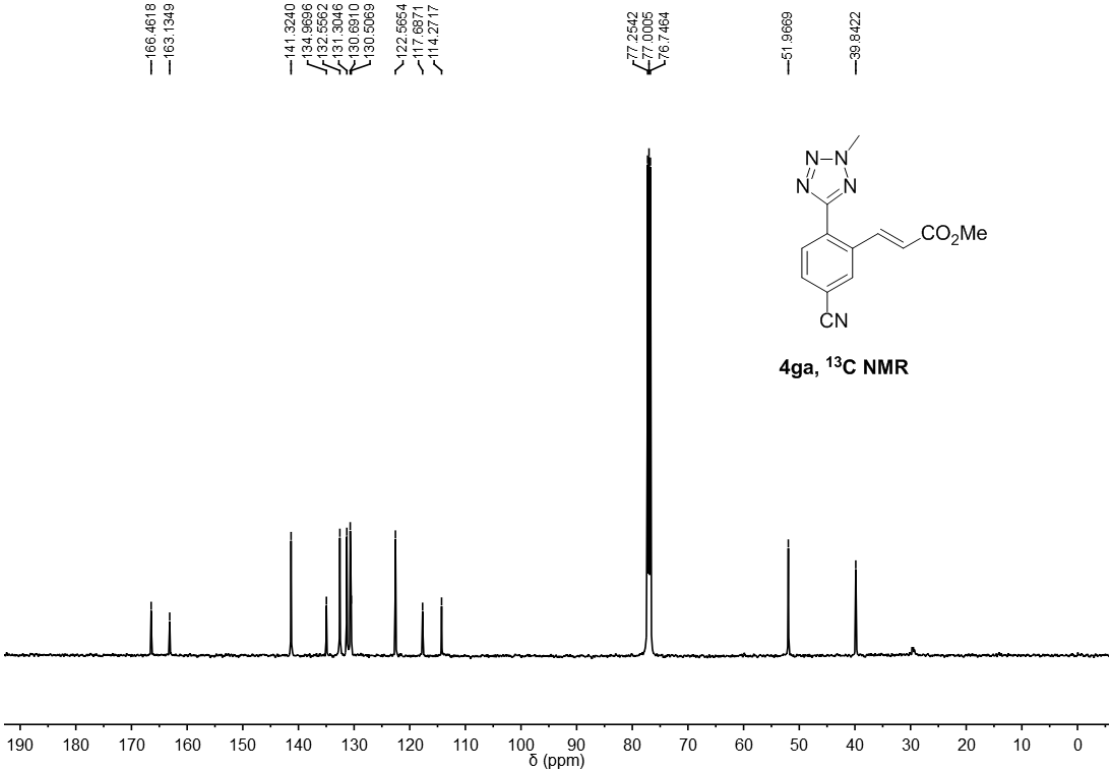
3ga,^{1}H NMR



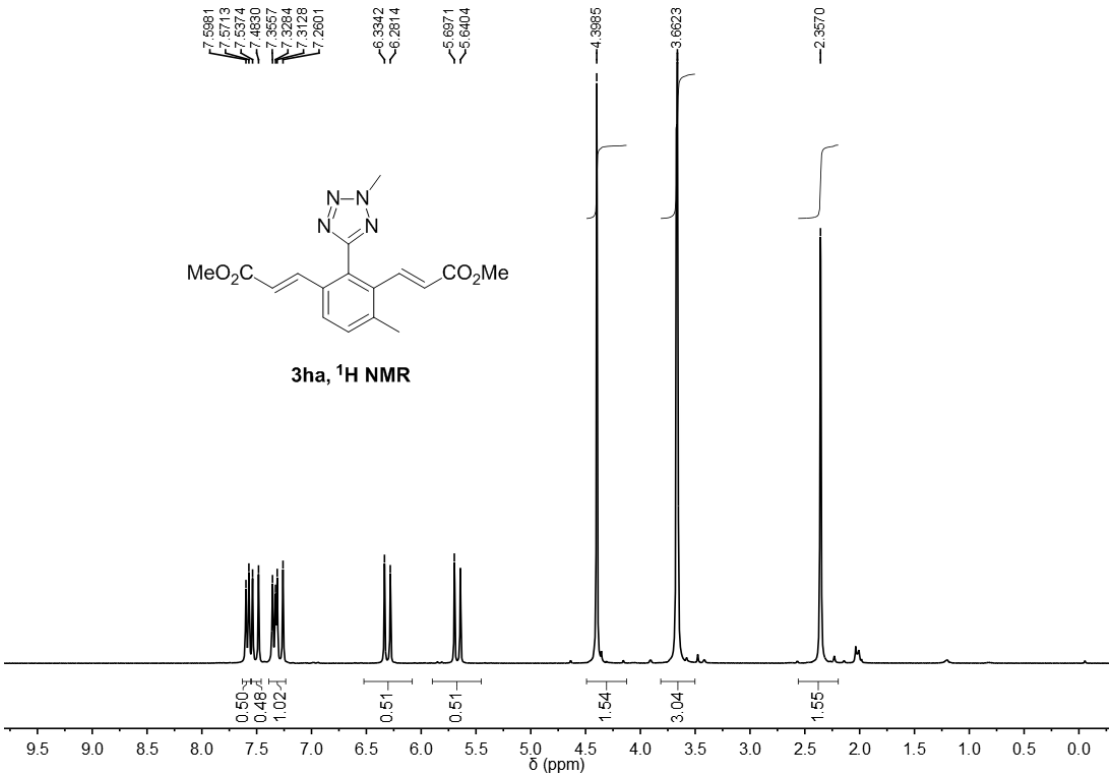
3ga, ^{13}C NMR



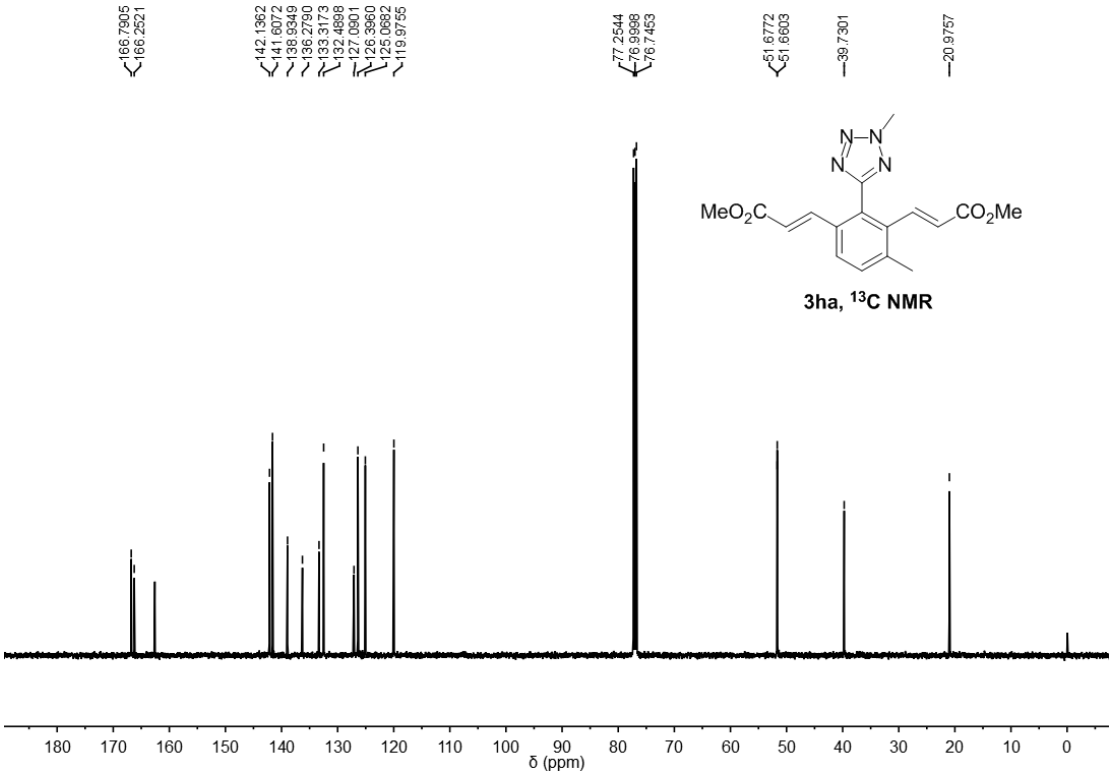
4ga,^{1}H NMR



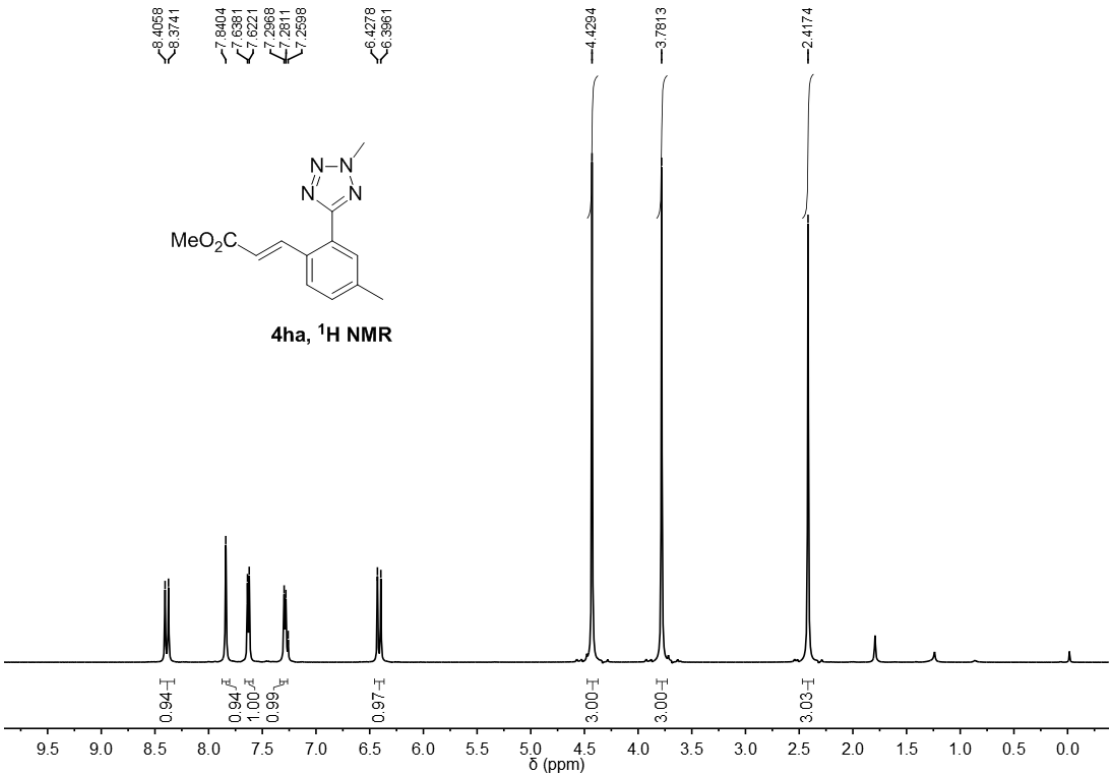
4ga, ^{13}C NMR



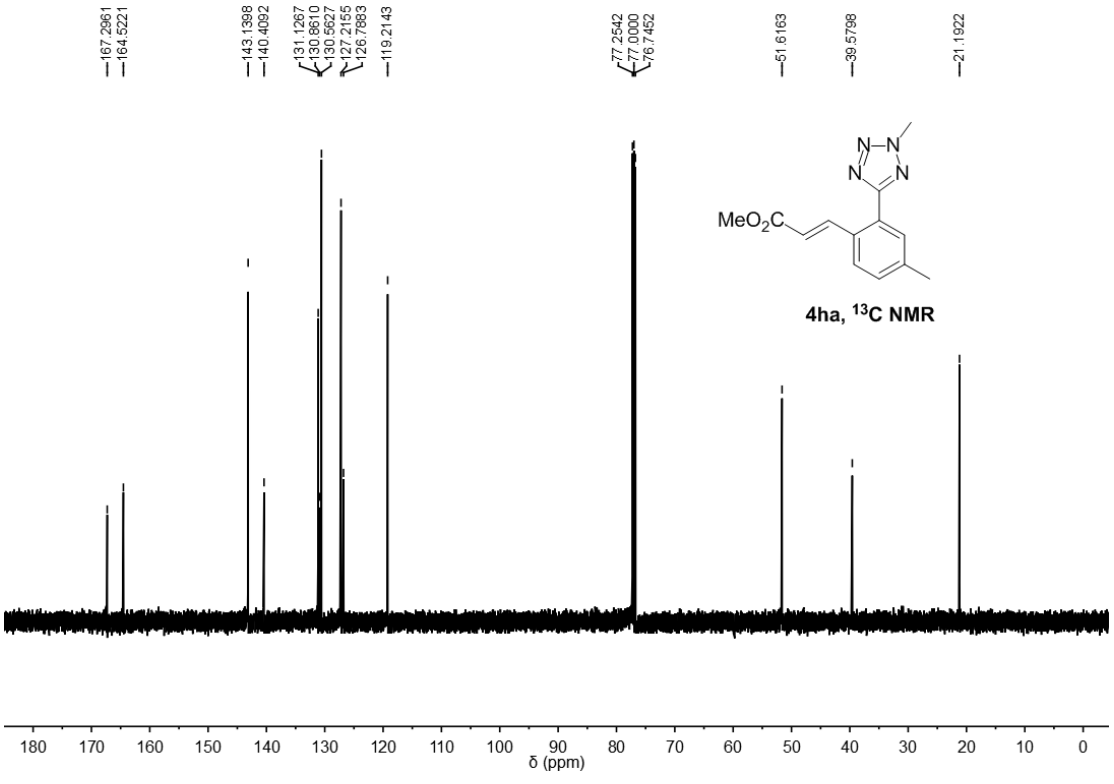
3ha, ^{1}H NMR



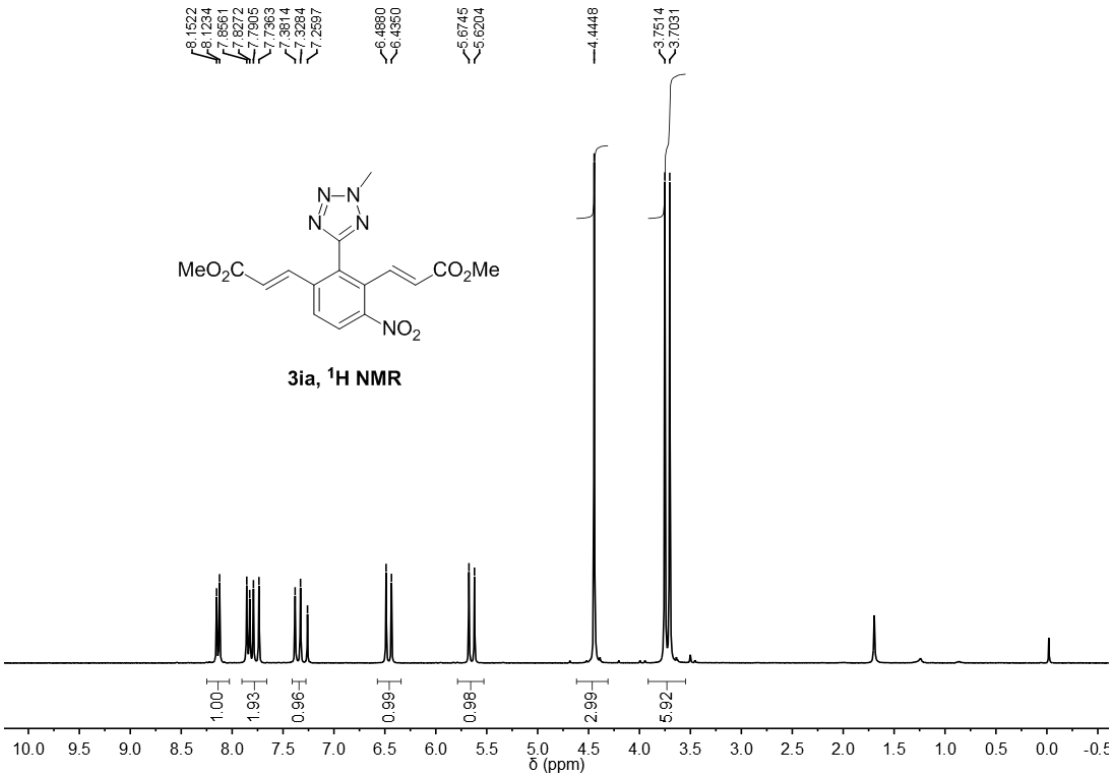
3ha, ^{13}C NMR



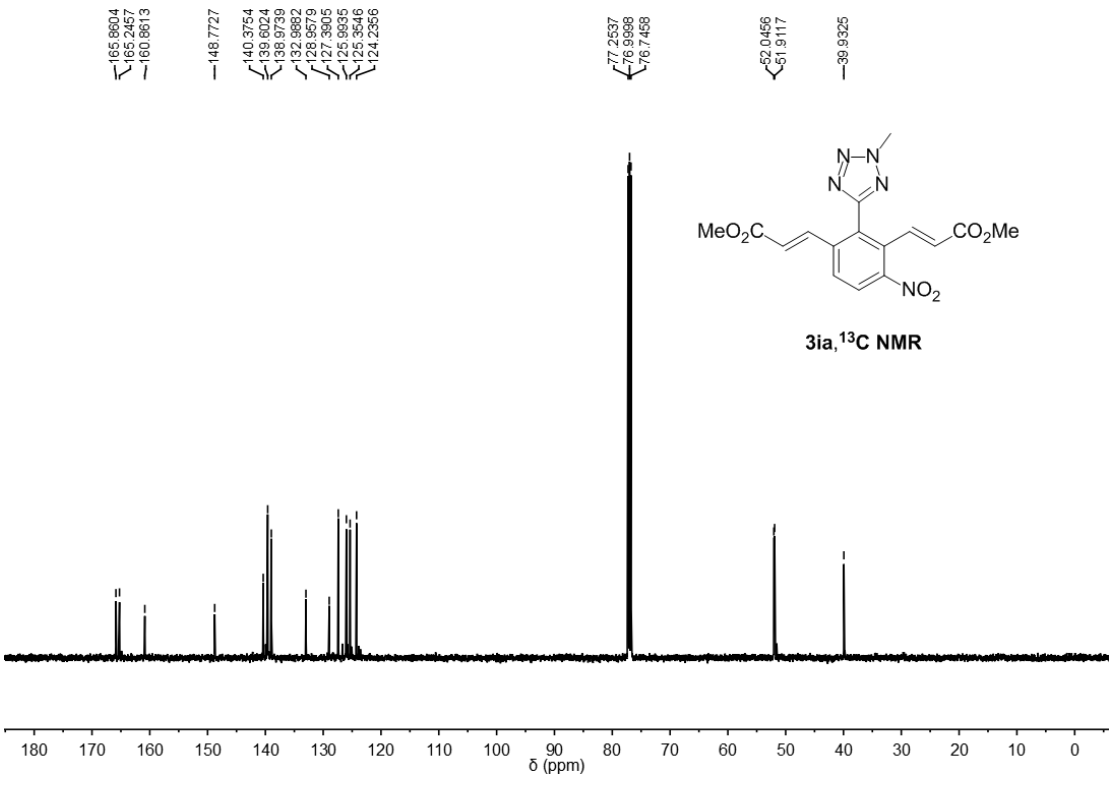
4ha, ^{1}H NMR



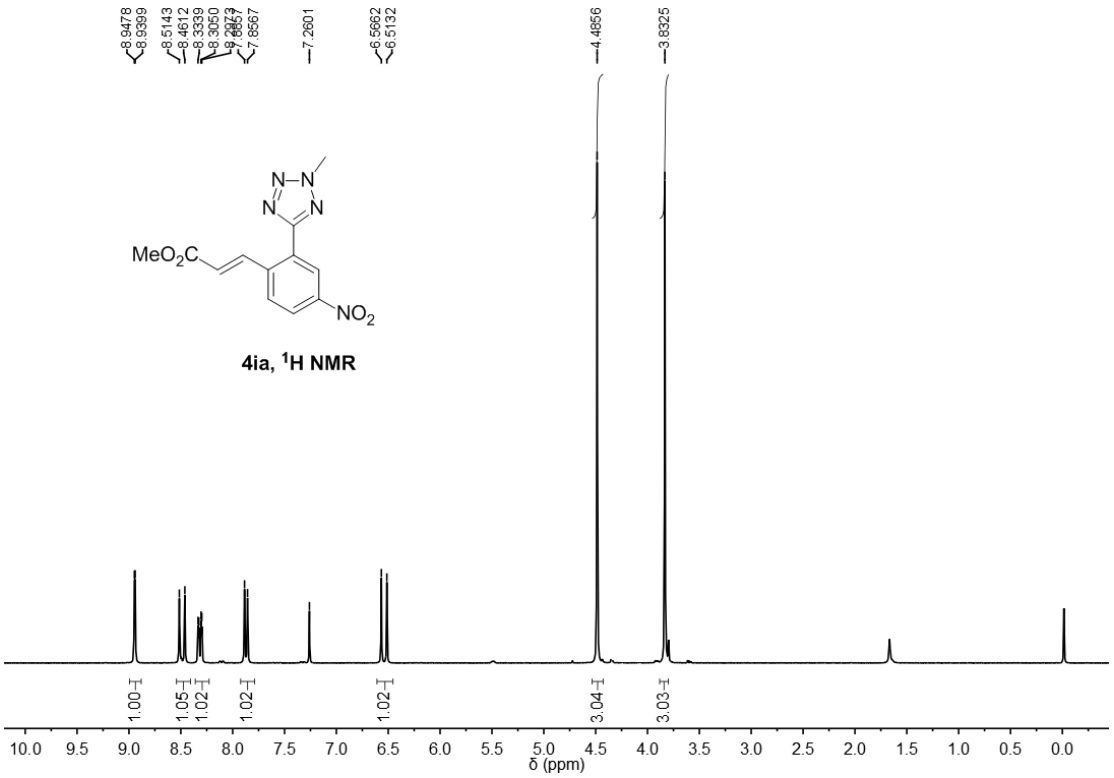
4ha, ^{13}C NMR



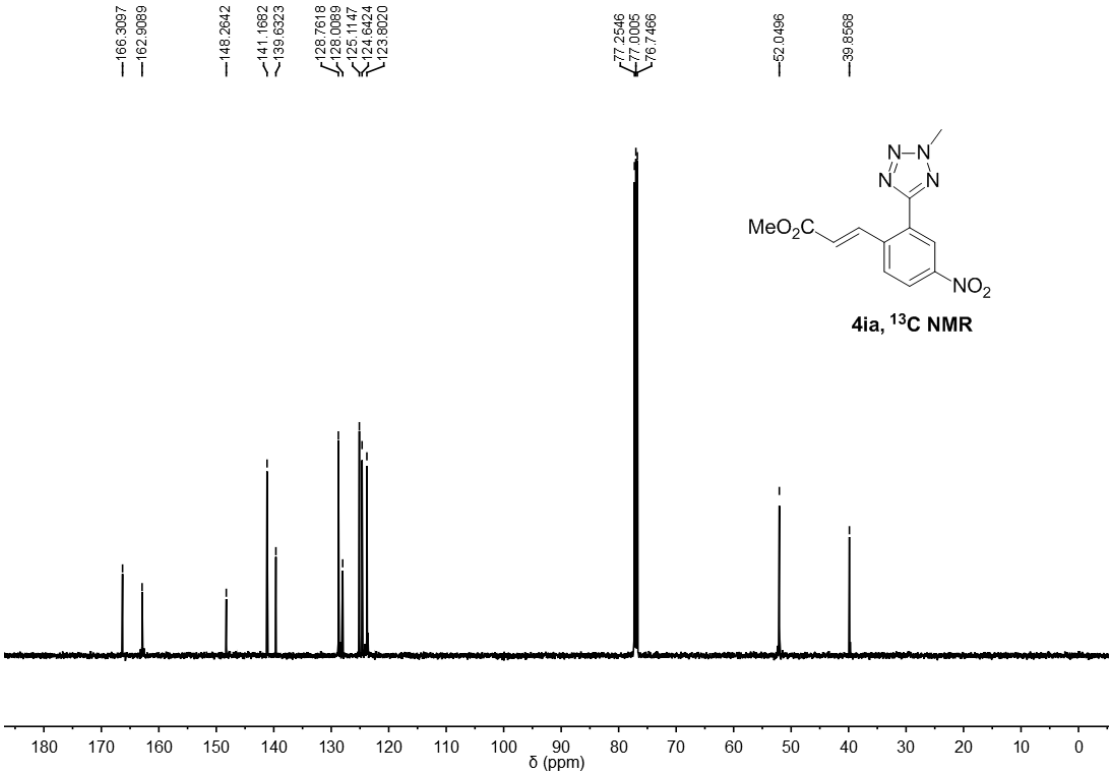
3ia, ^{1}H NMR



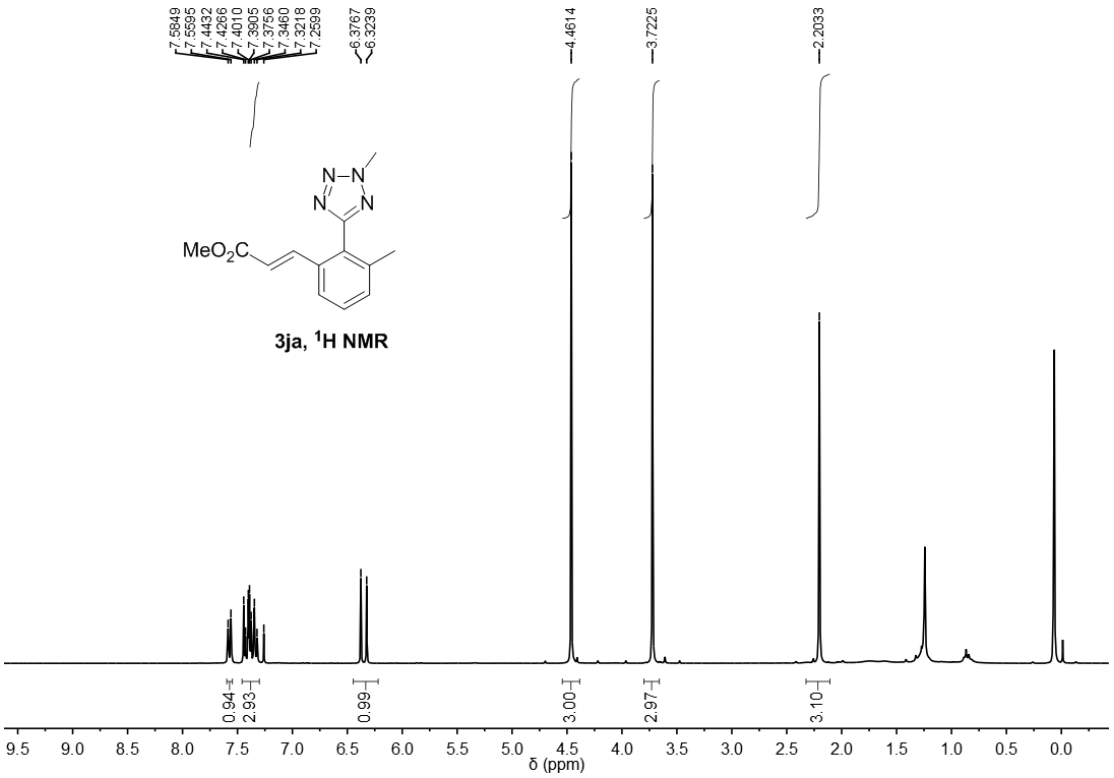
3ia,^{13}C NMR



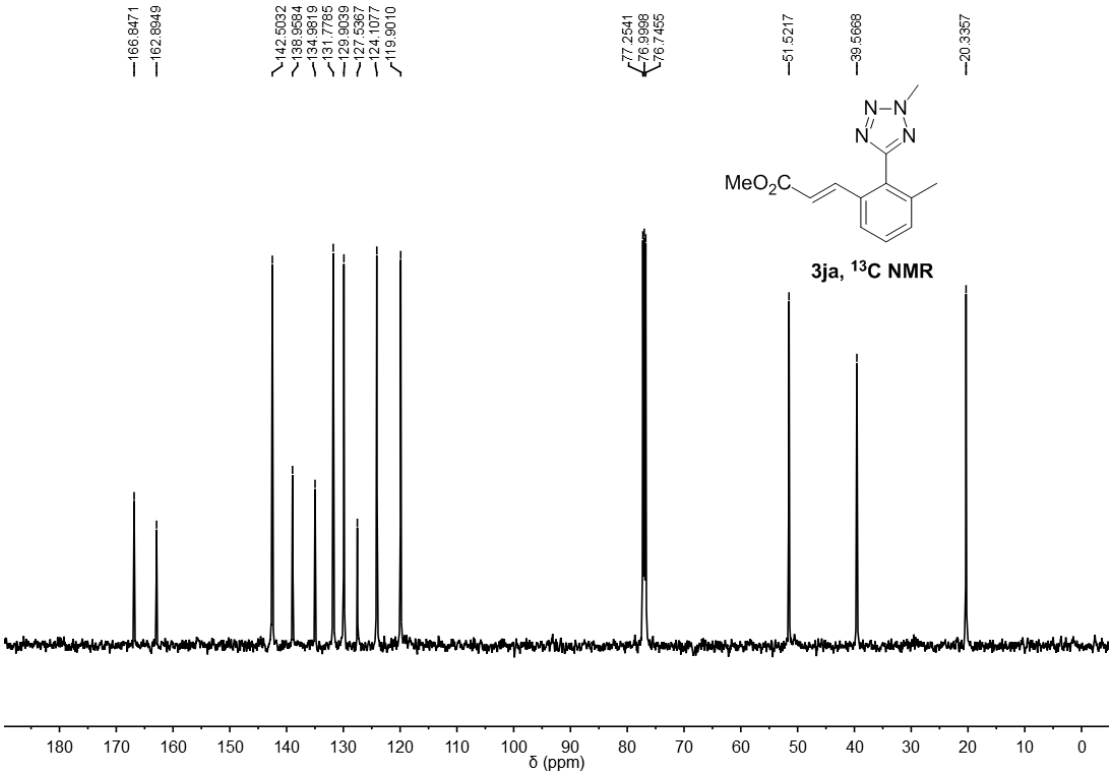
4ia, ^{1}H NMR



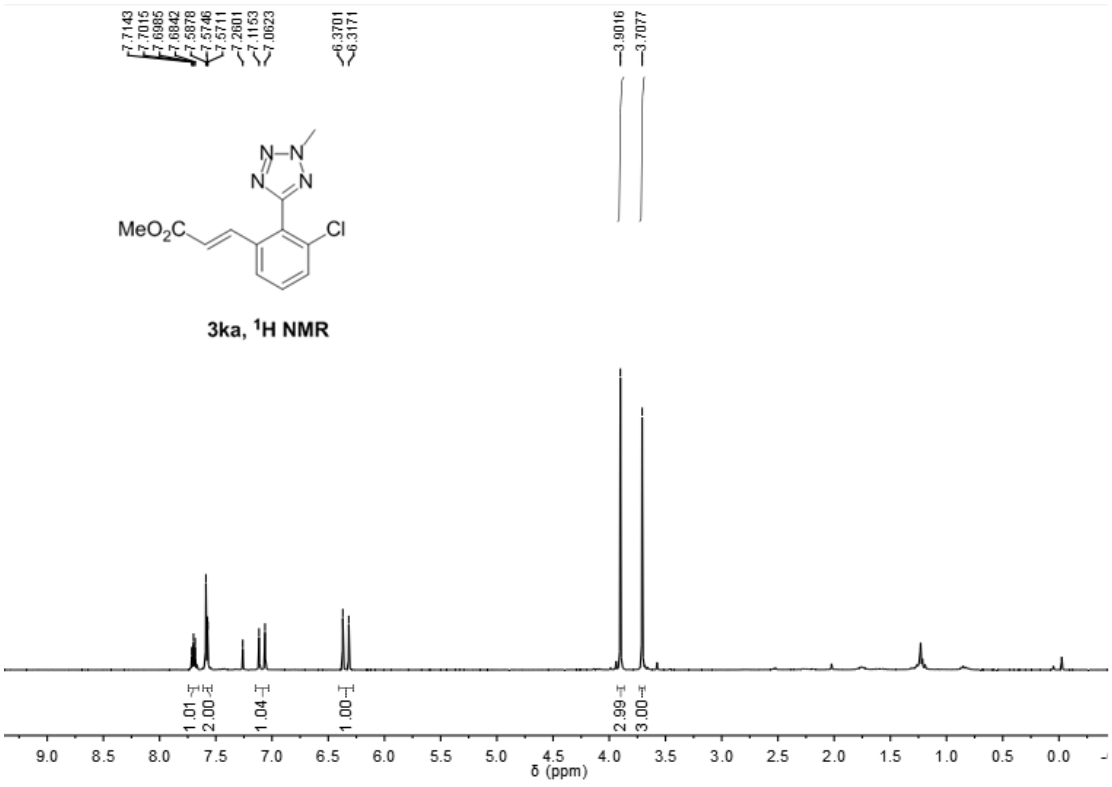
4ia, ^{13}C NMR



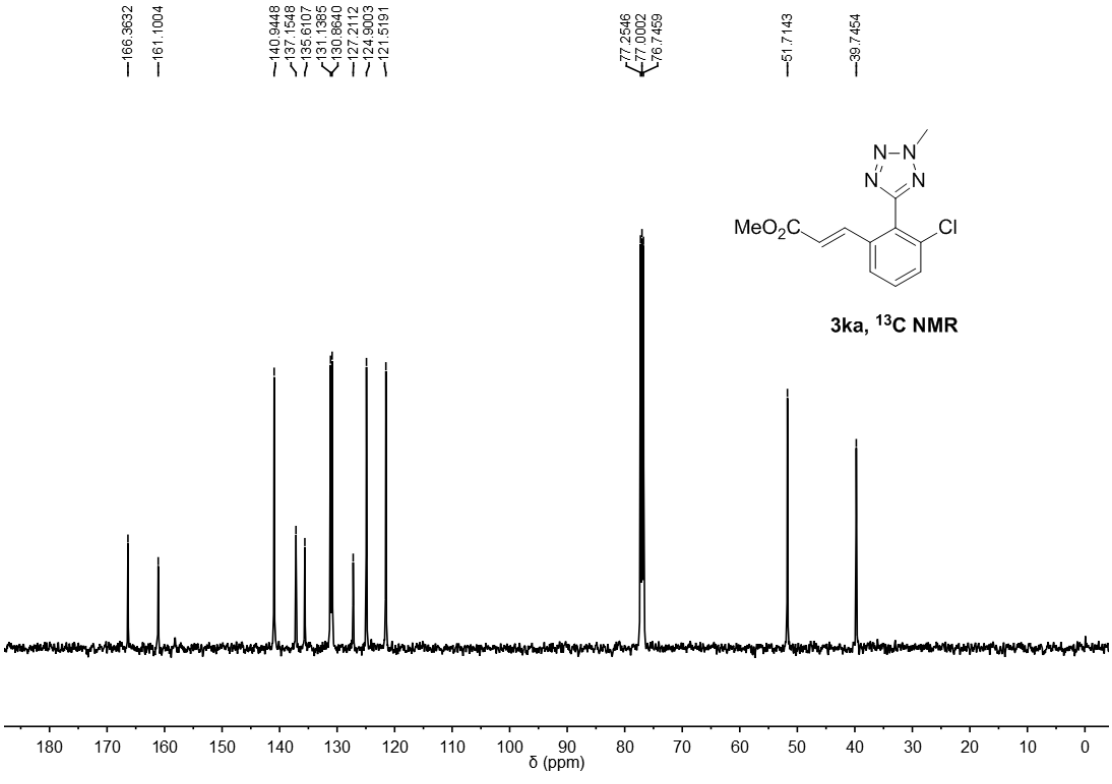
3ja, ^{1}H NMR



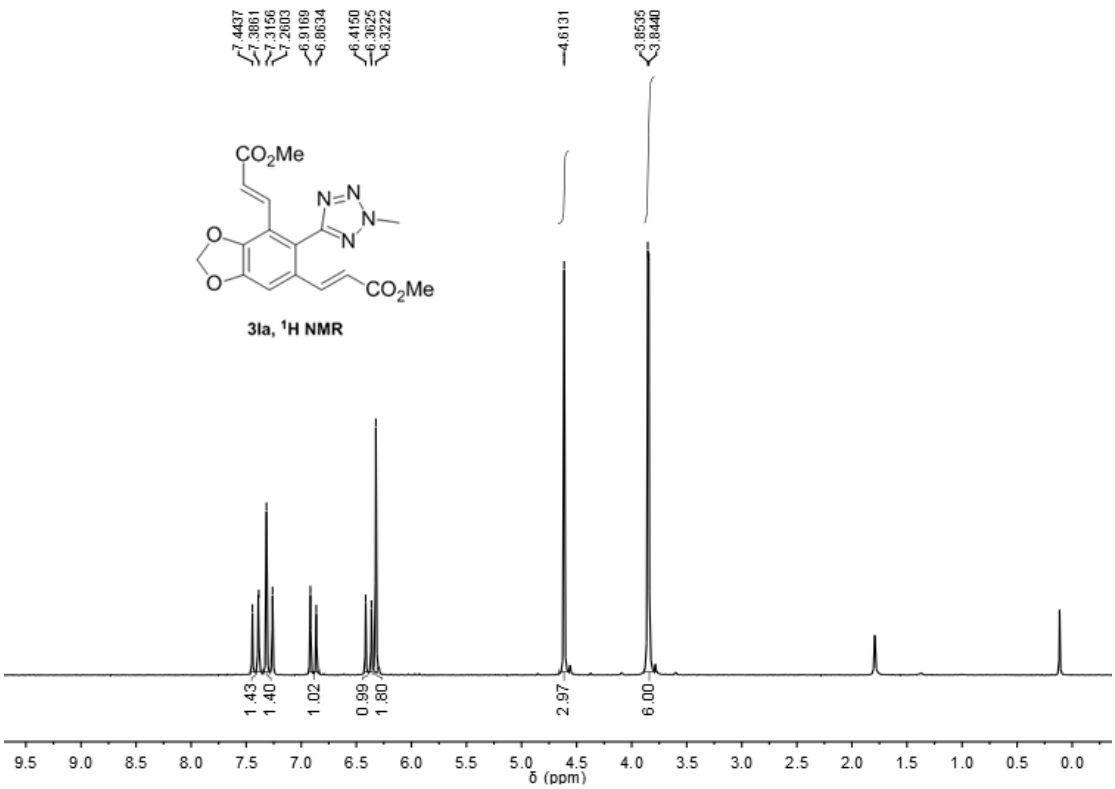
3ja, ^{13}C NMR



3ka, ^{1}H NMR



3ka, ^{13}C NMR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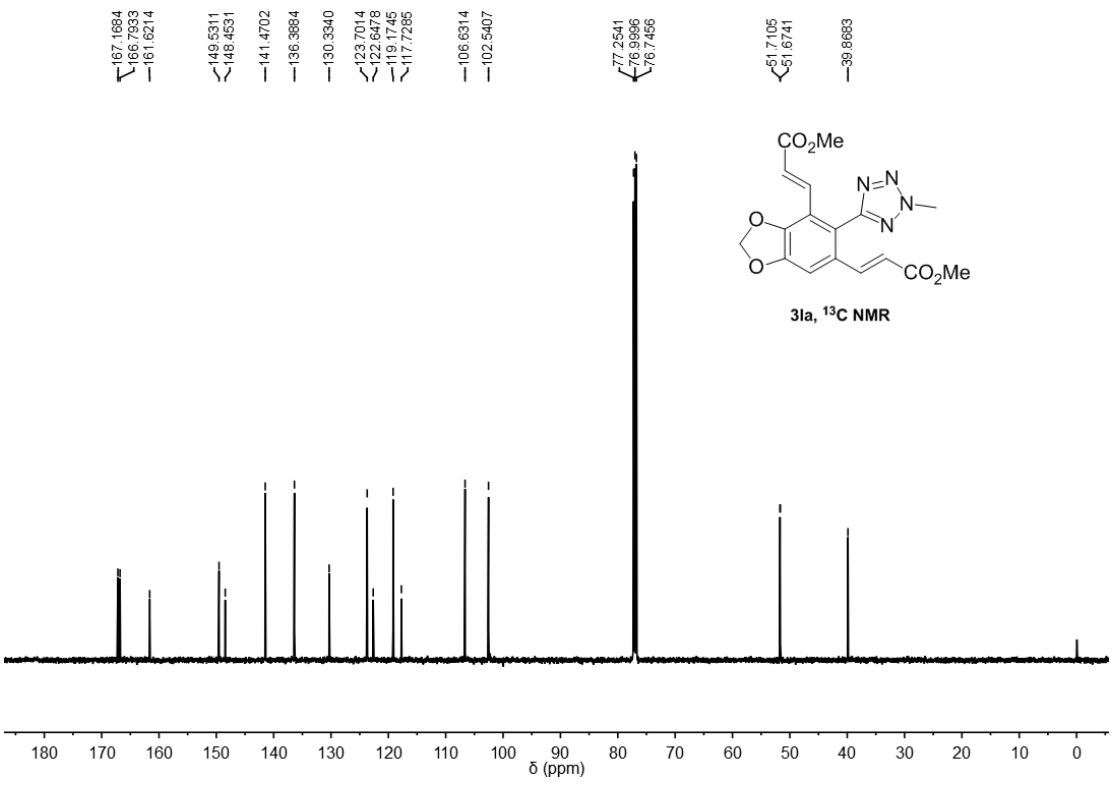
7.3861
7.3156
7.2603
6.9169
6.8634
6.4150
6.3625
6.3222
4.6131
3.8535
3.8440
CO2Me
CO2Me
3Ia, 1H NMR
1.43
1.40
1.02
0.99
1.80
2.97
6.00
δ (ppm)


167.1684
166.7933
161.6214
149.5311
148.4531
141.4702
136.3884
130.3340
123.7014
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117.7285
106.6314
102.5407
77.2541
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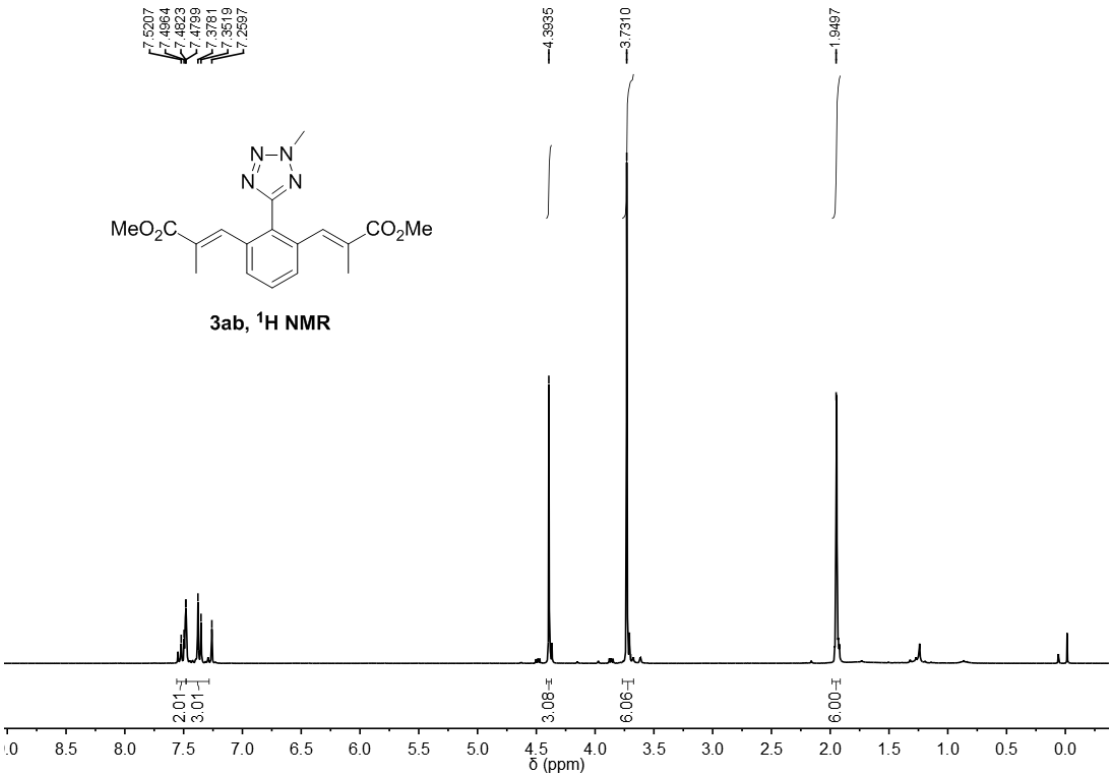
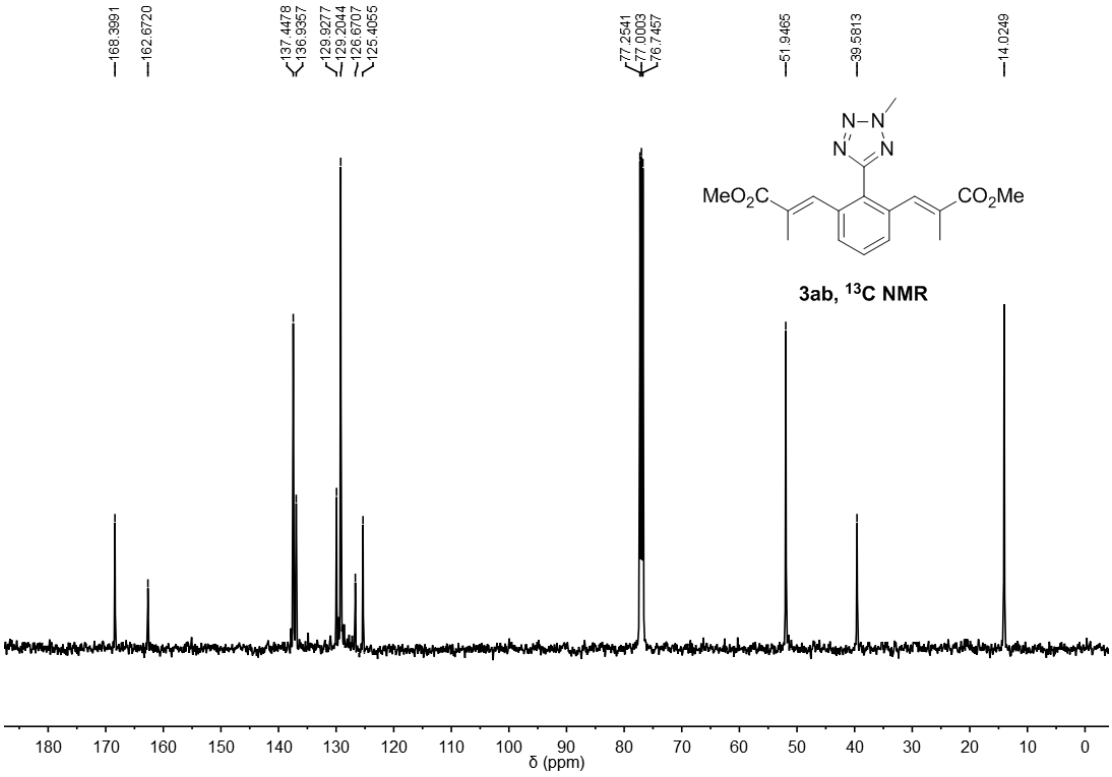
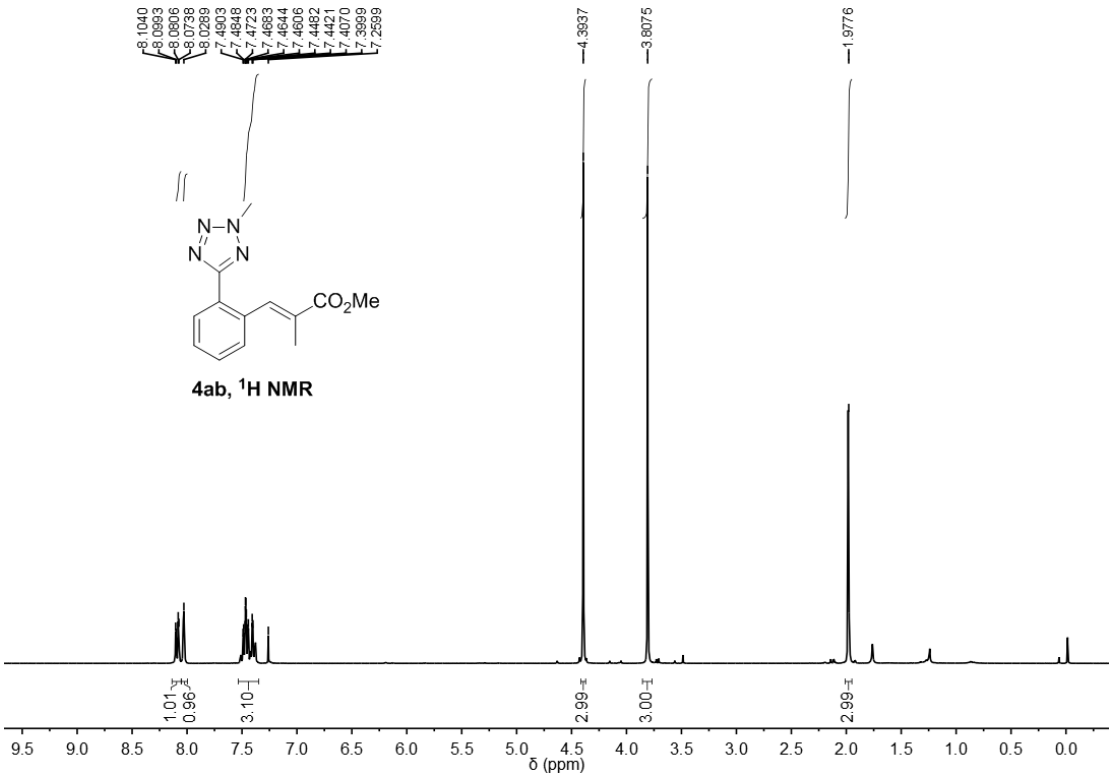
76.7456
51.7105
51.6741
39.8683
CO2Me
CO2Me
3Ia, 13C NMR
δ (ppm)



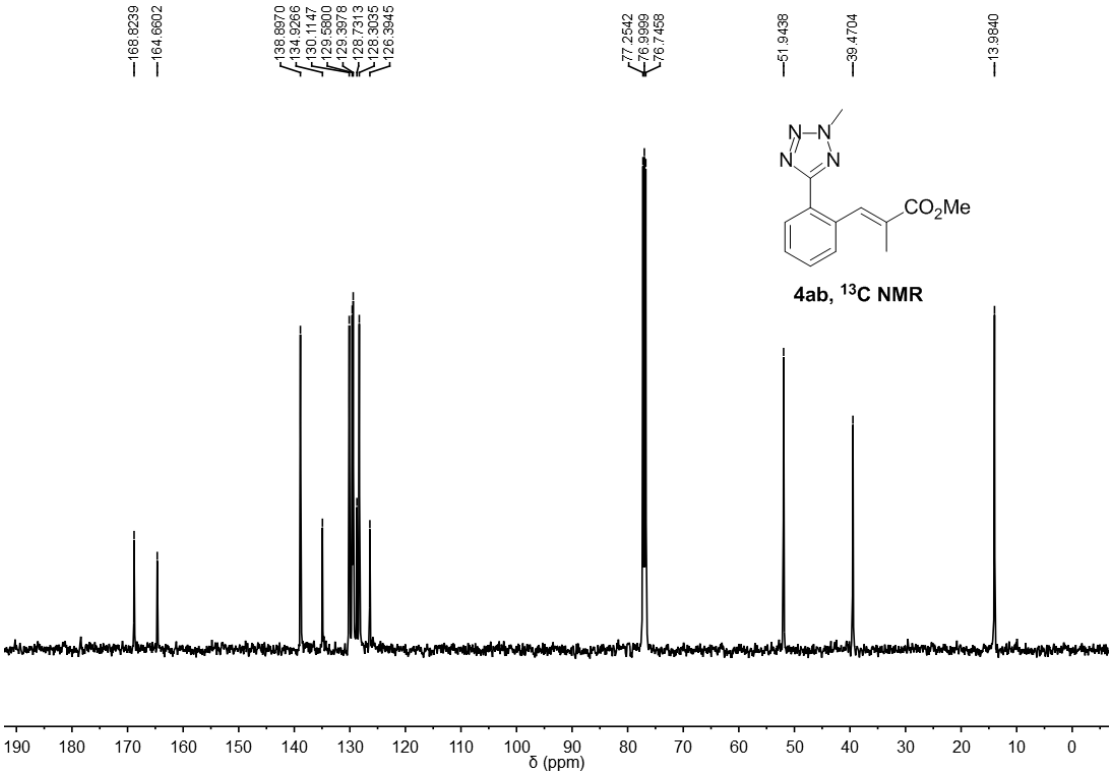
3ab, ^{1}H NMR



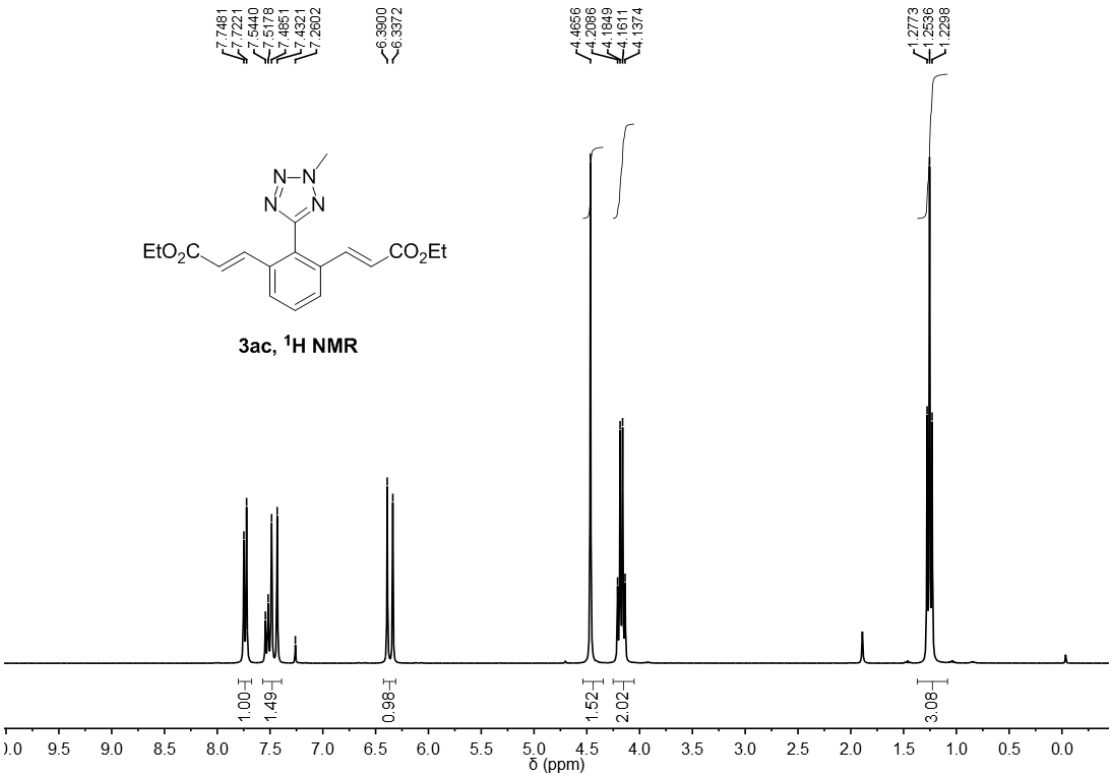
3ab, ^{13}C NMR



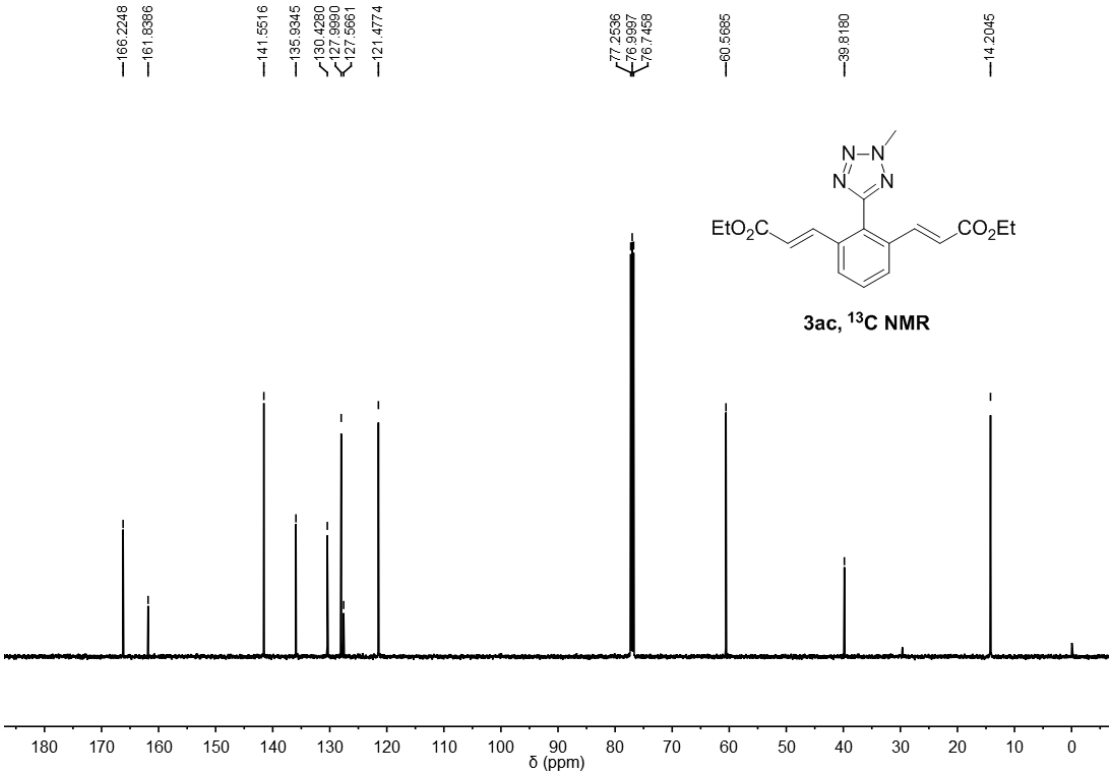
4ab, ^{1}H NMR



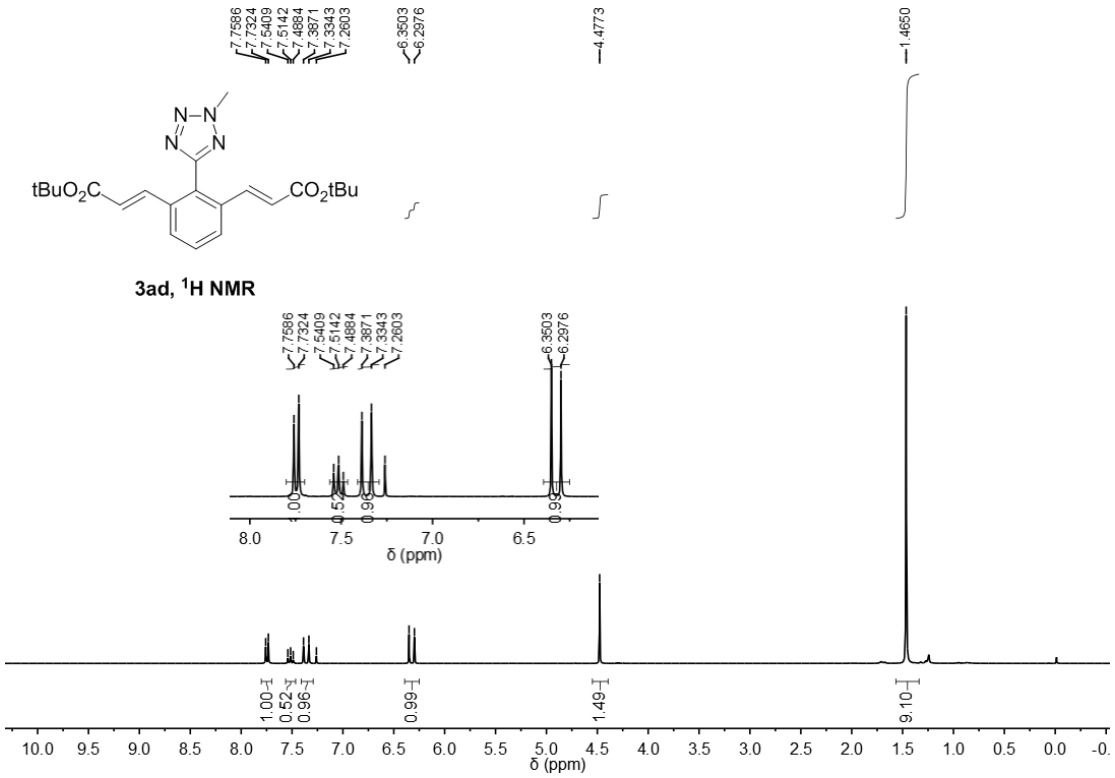
4ab, ^{13}C NMR



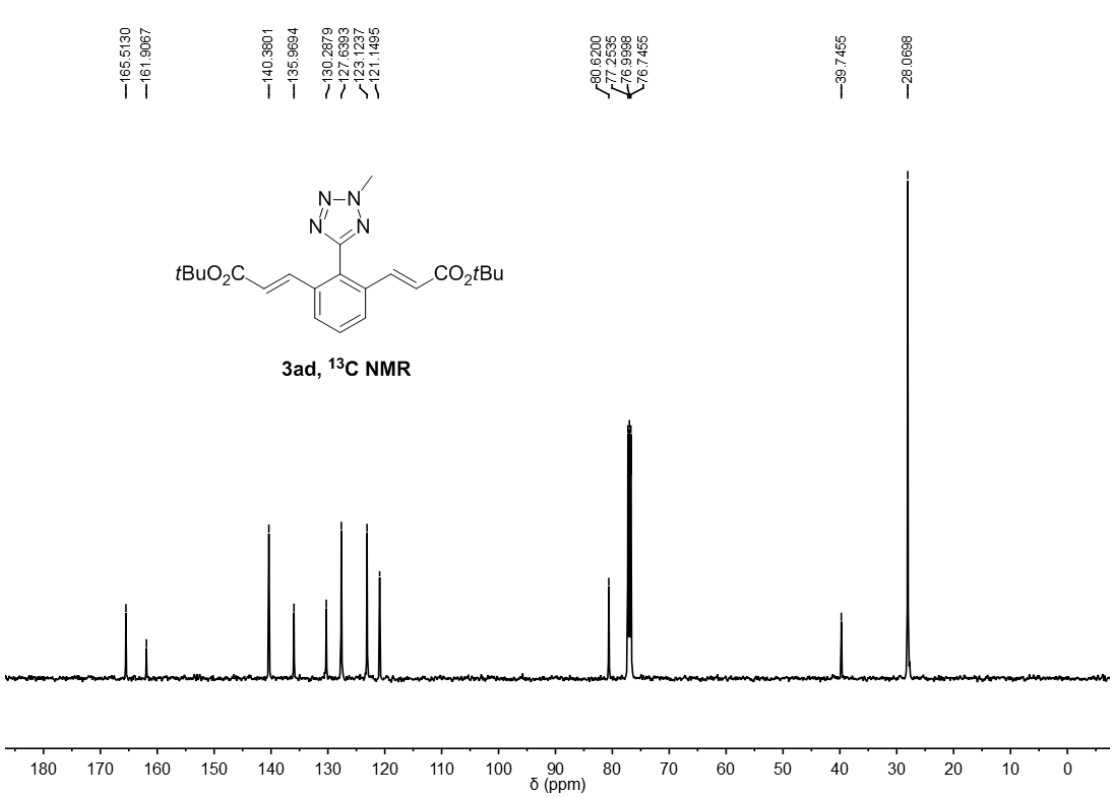
3ac, ^{1}H NMR



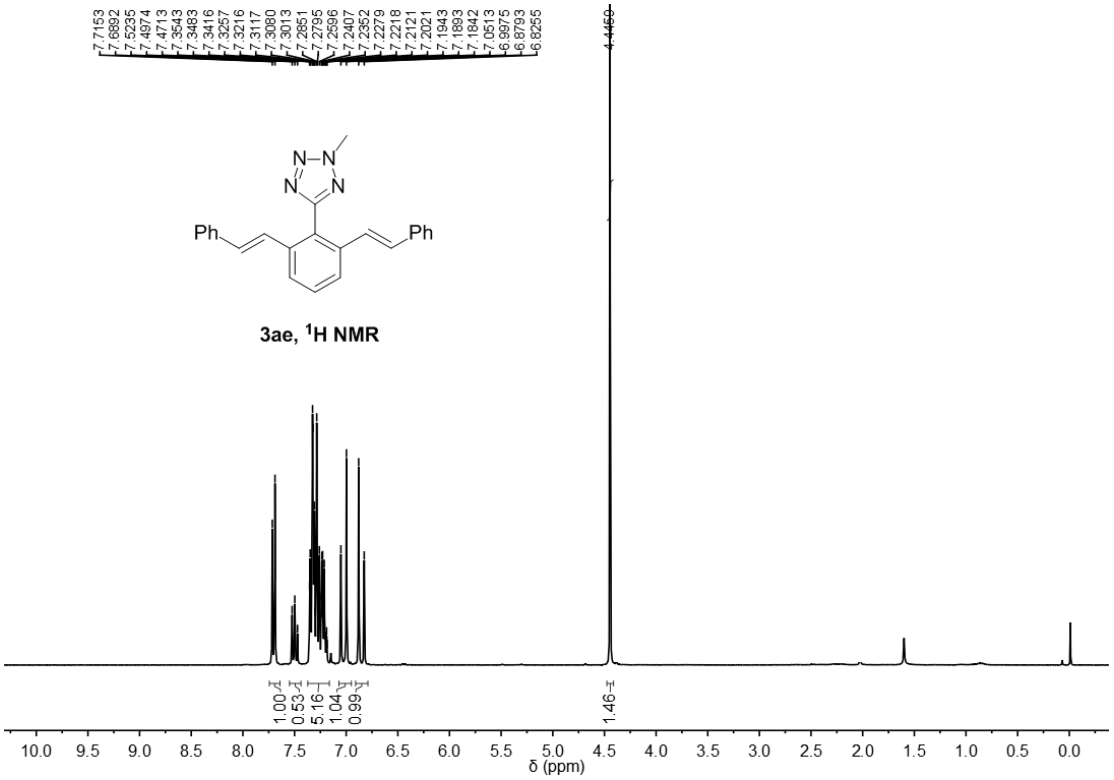
3ac, ^{13}C NMR



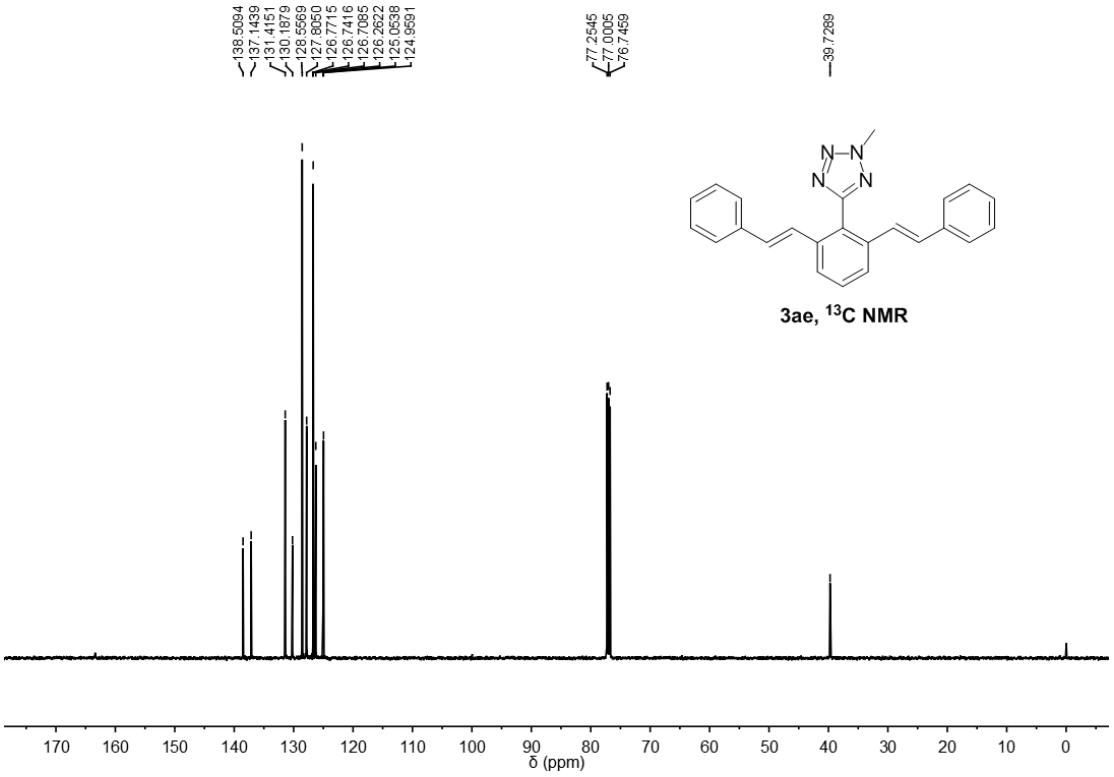
3ad, ^{1}H NMR



3ad, ^{13}C NMR



3ae, ^{1}H NMR



3ae, ^{13}C NMR

5 Reference

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