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Supporting Information For

HOTf-Catalyzed Sustainable One-Pot Synthesis of Benzene and Pyridine Derivatives under Solvent-free Conditions

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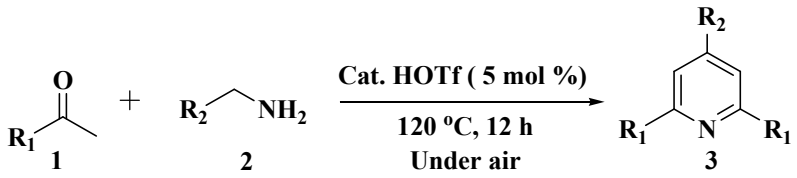
General Methods:

^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 solutions on a Bruker AVANCE 400 MHz spectrometer. High resolution mass spectra were obtained on a Waters Micromass GCT facility. HOTf was purchased from Adamas-beta. All other reagents and solvents were used as is from commercial sources. Unless noted below, all other compounds have been reported in the literature or are commercially available.

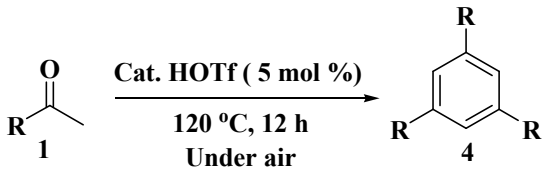
General procedure for the synthesis of pyridine deritives from ketones 1 and amine 2:



A reaction kettle (10 mL) was charged with ketone (1.0 mmol, 1.0 equiv), amine (0.75 mmol, 1.5 equiv), and the HOTf (0.025 mmol) was added. The mixture was stirred at 120 ^{o}C for 12 hours, the mixture was quenched by sat. aq. $NaHCO_3$, and diluted with 20 mL of dichloromethane and washed with 10 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 30: 1) to afford pyridine derivatives. All other compounds are synthesized in a similar manner, with the yields listed in the main text calculated from the isolated, pure products.

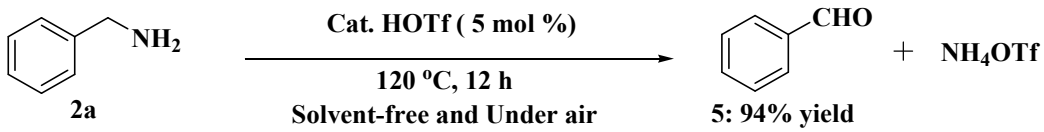
Mechanistic studies:

a)



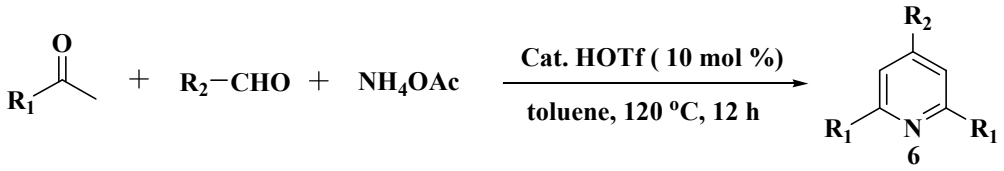
A reaction kettle (15 mL) was charged with ketone (0.5 mmol, 1.0 equiv), and HOTf (0.025 mmol) were added. The mixture was stirred at 120 °C for 12 hours, the reaction was cooled down to room temperature, and diluted with 10 mL of dichloromethane and washed with 10 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 50: 1) to afford benzene derivatives. All other compounds are synthesized in a similar manner, with the yields listed in the main text calculated from the isolated, pure products.0

b)



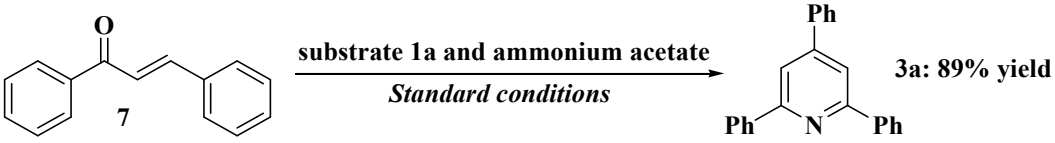
A reaction kettle (15 mL) was charged with benzylamine (1.0 mmol, 1.0 equiv), and HOTf (0.05 mmol) were added. The mixture was stirred at 120 °C for 12 hours, the reaction was cooled down to room temperature, and diluted with 10 mL of dichloromethane and washed with 10 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 20: 1) to afford the desired product.

c)



A reaction tube (15 mL) was charged with ketone (1.0 mmol, 2.0 equiv), aldehyde (0.5 mmol, 1.0 equiv), ammonium acetate (3.0 mmol, 6.0 equiv), HOTf (0.05 mmol) and toluene (0.5 mL) were added. The mixture was stirred at 120 °C for 12 hours, the reaction was cooled down to room temperature, and diluted with 10 mL of dichloromethane and washed with 10 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 30:1) to afford the desired product.

d)



A reaction kettle (15 mL) was charged with chalcone (0.5 mmol, 1.0 equiv), and acetophenone (**1a**, 0.5 mmol, 1.0 equiv), ammonium acetate (3.0 mmol, 6.0 equiv) and HOTf (0.025 mmol) were added. The mixture was stirred at 120 °C for 12 hours, the reaction was cooled down to room temperature, and diluted with 10 mL of dichloromethane and washed with 10 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 30: 1) to afford the desired product.

Characterizations of products 3a-3t, 4a-d and 6a-f:

2,4,6-Triphenylpyridine (**3a**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.34 (d, J = 7.2 Hz, 4H), 8.19 (s, 2H), 8.04 (d, J = 6.8 Hz, 2H), 7.49 - 7.59 (m, 9H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 157.0, 150.1, 139.3, 138.2, 129.8, 129.7, 129.6, 129.2, 127.8, 127.4, 117.1; HRMS (EI) Calcd. for $C_{23}H_{17}N$: [M^+], 307.1361. Found: m/z 307.1364.

2,6-Diphenyl-4-*p*-tolyl-pyridine (**3b**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.33 (d, J = 7.2 Hz, 4H), 8.18 (s, 2H), 7.96 (d, J = 8.4 Hz, 2H), 7.49 - 7.58 (m, 6H), 7.38 (d, J = 8.0 Hz, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 156.4, 149.9, 139.5, 139.3, 135.2, 130.2, 129.7, 129.2, 127.6, 127.4, 116.7, 21.3; HRMS (EI) Calcd. for $C_{24}H_{19}N$: [M^+], 321.1517. Found: m/z 321.1521.

4-(4-Fluorophenyl)-2,6-diphenylpyridine (**3c**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.36 (d, J = 7.6 Hz, 4H), 8.21 (s, 2H), 8.15 (q, 2H), 7.49 - 7.60 (m, 6H), 7.43 (t, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 164.7, 162.2, 157.0, 148.9, 139.2, 134.6, 130.1, 129.7, 129.2, 127.4, 116.5; HRMS (EI) Calcd. for $C_{23}H_{16}NF$: [M^+], 325.1267. Found: m/z 325.1268.

2,6-Diphenyl-4-m-tolyl-pyridine (**3d**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.22 (d, J = 7.6 Hz, 4H), 7.87 (q, 2H), 7.41 - 7.55 (m, 9H), 7.29 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 157.5, 150.4, 139.7, 139.1, 138.9, 129.8, 129.1, 128.8, 128.0, 127.2, 127.2, 124.4, 117.2, 21.6; HRMS (EI) Calcd. for $C_{24}H_{19}N$: [M^+], 321.1517. Found: m/z 321.1519.

4-(3-Fluoro-phenyl)-2,6-diphenylpyridine (**3e**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.35 (d, J = 7.6 Hz, 4H), 8.24 (s, 2H), 7.91 - 8.00 (m, 2H), 7.47 - 7.58 (m, 8H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 164.5, 162.0, 157.1, 148.6, 139.1, 131.5, 129.8, 129.2, 129.1, 128.4, 128.1, 127.5, 117.1; HRMS (EI) Calcd. for $C_{23}H_{16}NF$: [M^+], 325.1267. Found: m/z 325.1270.

2,6-Diphenyl-4-thiophen-2-yl-pyridine (**3f**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.29 (d, J = 7.2 Hz, 4H), 8.12 (s, 2H), 8.09 - 8.11 (q, 1H), 7.91 - 8.00 (m, 2H), 7.78 – 7.80 (m, 2H), 7.48 - 7.58 (m, 6H), 7.28 - 7.30 (m, 1H),; ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 157.2, 143.5, 141.2, 138.9, 129.9, 129.3, 129.3, 128.8, 127.6, 127.3, 115.1; HRMS (EI) Calcd. for $C_{21}H_{15}NS$: [M^+], 313.0925. Found: m/z 313.0926.

4-Benzyl-2,6-diphenylpyridine (**3g**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.09 (d, J = 7.2 Hz, 4H), 7.42 - 7.48 (m, 6H), 7.35 - 7.39 (m, 2H), 7.19 - 7.31 (m, 5H), 4.01 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 157.2, 151.4, 139.3, 139.3, 129.2, 129.1, 128.9, 128.8, 127.2, 126.8, 119.5, 41.8; HRMS (EI) Calcd. for $C_{24}H_{19}N$: [M^+], 321.1517. Found: m/z 321.1519.

4-Pentyl-2,6-diphenylpyridine (**3h**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.14 (d, J = 7.2 Hz, 4H), 7.39 - 7.51 (m, 8H), 2.69 - 2.73 (q, 2H), 1.68 - 1.73 (m, 2H), 1.32 - 1.37 (m, 4H), 0.89 - 0.92 (q, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 156.9, 153.2, 139.8, 128.8, 128.7, 127.1, 119.1, 35.8, 31.5, 30.3, 22.6, 14.1; HRMS (EI) Calcd. for $C_{22}H_{23}N$: [M^+], 301.1830. Found: m/z 301.1833.

4-Pentyl-2,6-di-*p*-tolyl-pyridine (**3i**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.96 (d, J = 8.0 Hz, 4H), 7.78 (s, 2H), 7.20 (d, J = 8.0 Hz, 4H), 2.59 - 2.63 (q, 2H), 2.33 (s, 6H), 1.61 - 1.65 (m, 2H), 1.28 - 1.29 (m, 4H), 0.81 - 0.84 (q, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 156.8, 153.0, 138.7, 137.1, 129.3, 126.9, 118.5, 35.8, 31.5, 30.3, 22.6, 21.3, 14.0; HRMS (EI) Calcd. for $C_{24}H_{27}N$: [M^+], 329.2143. Found: m/z 329.2145.

4-Pentyl-2,6-di-*m*-tolyl-pyridine (**3j**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.72 - 7.93 (m, 4H), 7.39 (s, 2H), 7.26 - 7.33 (m, 2H), 7.13 (d, J = 6.8 Hz, 2H), 2.59 - 2.63 (q, 2H), 2.37 (s, 6H), 1.61 - 1.64 (m, 2H), 1.27 - 1.33 (m, 4H), 0.81 - 0.85 (q, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 157.1, 153.1, 139.9, 138.2, 129.6, 128.6, 127.8, 124.3, 119.2, 35.8, 31.6, 30.4, 22.6, 21.7, 14.1; HRMS (EI) Calcd. for $C_{24}H_{27}N$: [M^+],

329.2143. Found: m/z 329.2144.

4-Phenyl-2,6-di-thiophen-2-yl-pyridine (**3k**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.62 - 7.66 (m, 6H), 7.38 - 7.49 (m, 5H), 7.08 - 7.11 (t, 2H), ; ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: 152.7, 150.2, 144.9, 138.6, 129.2, 129.2, 128.0, 127.9, 127.1, 124.9, 115.1; HRMS (EI) Calcd. for $C_{19}H_{13}NS_2$: [M^+], 319.0489. Found: m/z 319.0484.

2,6-Bis-benzofuran-2-yl-4-phenyl-pyridine (**3l**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.08 (s, 2H), 7.84 (d, J = 7.2 Hz, 2H), 7.69 (d, J = 7.6 Hz, 2H), 7.64 (s, 2H), 7.48 - 7.60 (m, 5H), 7.34 (t, 2H), 7.29 (t, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 155.4, 155.2, 150.1, 149.9, 138.1, 129.4, 129.2, 128.9, 127.2, 125.3, 123.3, 121.8, 116.8, 111.6, 105.5; HRMS (EI) Calcd. for $C_{27}H_{17}NO_2$: [M^+], 387.1259. Found: m/z 387.1265.

2,6-Bis-(4-chloro-phenyl)-4-phenylpyridine (**3m**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.16 (d, J = 7.6 Hz, 4H), 7.90 (s, 2H), 7.76 (d, J = 6.4Hz, 2H), 7.47 - 7.55 (m, 7H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 160.9, 155.3, 143.2, 142.5, 139.8, 134.0, 134.0, 133.6, 133.1, 131.9, 121.8; HRMS (EI) Calcd. for $C_{23}H_{15}NCl_2$: [M^+], 375.0582. Found: m/z 375.0786.

2,6-Di-naphthalen-2-yl-4-p-tolyl-pyridine (**3n**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.64 (s, 2H), 8.37 (d, J = 8.4 Hz, 2H), 7.95 - 7.98 (m, 6H), 7.87 (d, J = 8.4 Hz, 2H), 7.66 (d, J = 7.6 Hz, 2H), 7.50 (m, 4H), 7.31 (d, J = 7.6 Hz, 2H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 157.5, 150.2, 139.2, 137.1, 136.1, 133.9, 133.6, 129.9, 128.9, 128.5, 127.8, 127.1, 126.6, 126.3, 125.1, 117.3, 21.4; HRMS (EI) Calcd. for $C_{32}H_{23}N$: [M^+], 421.1830. Found: m/z 421.1832.

4-(4-Fluoro-phenyl)-2,6-di-naphthalen-2-yl-pyridine (**3o**): ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: δ 8.96 (s, 2H), 8.59 (dd, J = 8.4, 0.8 Hz, 2H), 8.41 (s, 2H), 8.20 - 8.22 (m, 2H), 8.10 - 8.15 (m, 4H), 8.00 - 8.02 (m, 2H), 7.57 - 7.63 (m, 4H), 7.44 -

7.57 (t, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: δ 150.7, 149.1, 136.6, 134.6, 133.9, 133.6, 130.2, 130.1, 129.2, 128.7, 128.1, 127.3, 127.0, 126.8, 125.3, 116.4; HRMS (EI) Calcd. for $C_{31}H_{20}NF$: [M^+], 425.1580. Found: m/z 425.1583.

4-Phenyl-2,6-di-*p*-tolyl-pyridine (**3p**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.08 (d, J = 8.0 Hz, 4H), 7.81 (s, 2H), 7.71 (d, J = 7.2 Hz, 2H), 7.44 - 7.51 (m, 3H), 7.29 (d, J = 8.0 Hz, 4H), 2.40 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 152.7, 145.3, 134.6, 134.2, 132.2, 124.7, 124.4, 124.1, 122.5, 122.3, 111.8, 16.6; HRMS (EI) Calcd. for $C_{25}H_{21}N$: [M^+], 335.1674. Found: m/z 335.1679.

2,4,6-Tri-p-tolyl-pyridine (**3q**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm:δ 8.09 (d, J = 7.6 Hz, 4H), 7.81 (s, 2H), 7.63 (d, J = 7.2 Hz, 2H), 7.30 (d, J = 6.4 Hz, 6H), 2.42 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 157.4, 149.9, 138.9, 137.0, 129.8, 129.4, 127.0, 116.3, 21.3; HRMS (EI) Calcd. for $C_{26}H_{23}N$: [M^+], 349.1834. Found: m/z 349.1830.

4-(4-Fluoro-phenyl)-2,6-di-*p*-tolyl-pyridine (**3r**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.08 (d, J = 8.0 Hz, 4H), 7.78 (s, 2H), 7.69 - 7.73 (t, 2H), 7.31 (d, J = 8.0 Hz, 2H), 7.19 - 7.25 (m, 4H), 2.43 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.6, 162.1, 157.5, 149.0, 139.1, 136.8, 129.4, 129.0, 128.9, 127.0, 116.0, 21.4; HRMS (EI) Calcd. for $C_{25}H_{20}NF$: [M^+], 353.1580. Found: m/z 353.1582.

2,4,6-Tri-*m*-tolyl-pyridine(**3s**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.79 – 8.01 (m, 4H), 7.85 (s, 2H), 7.56 (s, 2H), 7.39 - 7.43 (m, 3H), 7.25 - 7.29 (m, 3H), 2.48 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 157.7, 150.2, 139.7, 139.1, 138.8, 138.3, 129.8, 129.7, 129.0, 128.6, 127.9, 127.9, 124.4, 117.3, 21.7, 21.6; HRMS (EI) Calcd. for $C_{26}H_{23}N$: [M^+], 349.1830. Found: m/z 349.1833.

4-(3-Fluoro-phenyl)-2,6-di-*m*-tolyl-pyridine (**3t**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.97 (m, 4H), 7.80 (s, 2H), 7.38 = 7.52 (m, 5H), 7.26 (d, J = 7.6 Hz, 2H), 7.13 - 7.17 (t, 1H), 2.47 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.5, 162.1, 157.9, 148.8, 139.4, 138.4, 130.7, 130.0, 128.7, 127.9, 124.4, 122.9, 116.6, 21.7; HRMS (EI)

Calcd. for $C_{25}H_{20}NF$: [M^+], 353.1580. Found: m/z 353.1581.

1,3,5-Triphenylbenzene (**4a**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.78 (s, 3H), 7.70 (d, J = 7.6 Hz, 6H), 7.46 - 7.49 (t, J = 7.6 Hz, 6H), 7.37 - 7.40 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 142.4, 141.2, 128.9, 127.6, 127.4, 125.2; HRMS (EI) Calcd. for $C_{24}H_{19}$: [M^+], 306.1409. Found: m/z 306.1406.

1,3,5-Tri-*m*-tolyl-benzene (**4b**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.75 (s, 3H), 7.48-7.50 (m, 6H), 7.34 (m, 3H), 7.18 (m, 3H), 2.43 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 142.4, 141.3, 138.5, 128.8, 128.3, 128.2, 125.2, 124.6, 21.7; HRMS (EI) Calcd. for $C_{27}H_{24}$: [M^+], 348.1878. Found: m/z 348.1481.

1,3,5-Tri-*p*-tolyl-benzene (**4c**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.73 (s, 3H), 7.59 (d, J = 7.6 Hz, 6H), 7.28 (d, J = 8.0 Hz, 6H), 2.41 (s, 9H). 13C NMR (100 MHz, $CDCl_3$): δ 142.2, 138.5, 137.3, 129.6, 127.2, 124.6, 21.2; HRMS (EI) Calcd. for $C_{27}H_{24}$: [M^+], 348.1878. Found: m/z 348.1481.

1,3,5-Tri-2-naphthylbenzene (**4d**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.21 (m, 3H), 7.87 -7.93 (m, 6H), 7.76 (S, 3H), 7.62 (d, J = 6.8 Hz, 3H), 7.49 - 7.57 (m, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 140.8, 139.8, 133.9, 131.6, 130.7, 128.4, 127.9, 127.3, 126.3, 126.0, 125.9, 125.5; HRMS (EI) Calcd. for $C_{36}H_{24}$: [M^+], 456.1878. Found: m/z 456.1871.

2,6-Bis-(4-fluoro-phenyl)-4-p-tolyl-pyridine (**6a**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.61 (d, J = 8.0 Hz, 2H), 7.57 (s, 2H), 7.50 (t, 2H), 7.25 - 7.29 (m, 8H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 160.1, 148.8, 140.9, 139.2, 136.0, 130.8, 129.9, 128.3, 127.0, 125.9, 120.0, 21.3; HRMS (EI) Calcd. for $C_{24}H_{17}NF_2$: [M^+], 357.1329. Found: m/z 357.1332.

2,4,6-Tris-(4-fluoro-phenyl)-pyridine (**6b**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.18 (d, J = 8.0 Hz, 4H), 7.79 (s, 2H), 7.69 - 7.74 (t, 2H), 7.18 - 7.27 (m, 6H); ^{13}C

NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.9, 162.5, 156.6, 149.4, 135.5, 134.9, 128.9, 116.5, 116.3, 116.1, 115.8; HRMS (EI) Calcd. for $C_{23}H_{14}NF_3$: [M^+], 361.1078. Found: m/z 361.1082.

2,6-Bis-(3-fluoro-phenyl)-4-*p*-tolyl-pyridine (**6c**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.07 (t, 4H), 7.67 (s, 2H), 7.52 (d, J = 7.6 Hz, 2H), 7.25 (d, J = 7.6 Hz, 2H), 7.09 - 7.16 (m, 4H), 2.37 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.9, 162.4, 156.3, 150.2, 139.3, 129.9, 129.0, 128.9, 127.0, 116.4, 115.7, 21.3; HRMS (EI) Calcd. for $C_{24}H_{17}NF_2$: [M^+], 357.1329. Found: m/z 357.1333.

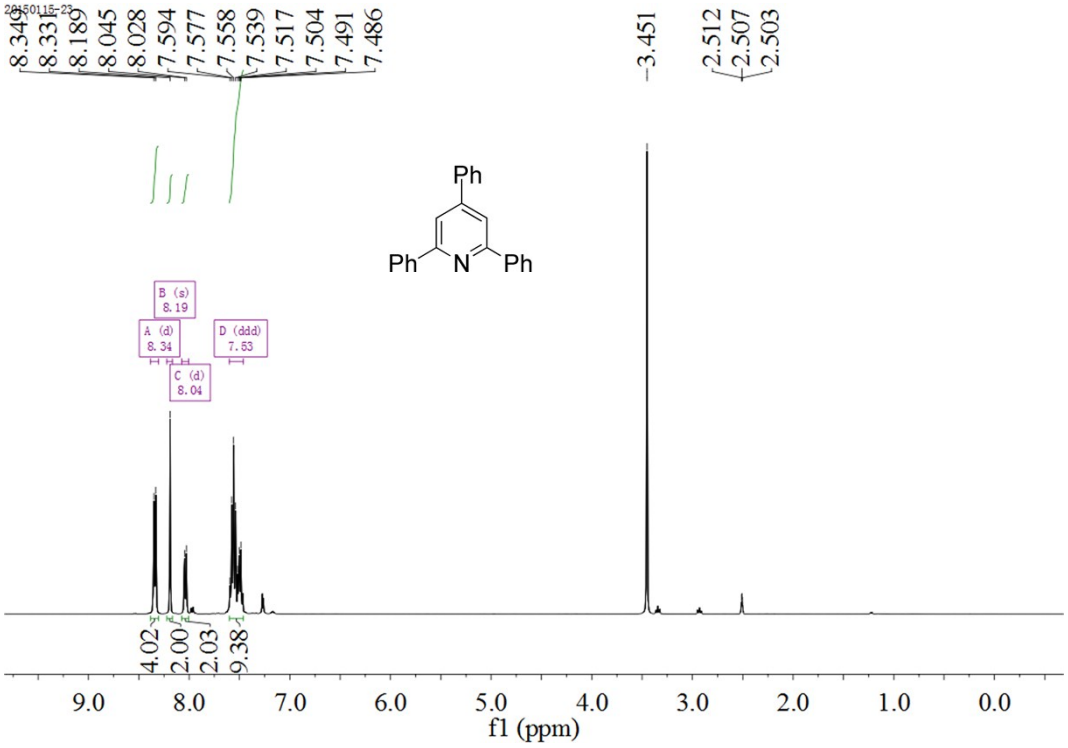
4-(4-Fluoro-phenyl)-2,6-bis-(3-fluoro-phenyl)-pyridine (**6d**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.95 (t, 4H), 7.85 (s, 2H), 7.42 - 7.52 (m, 5H), 7.13 - 7.22 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.6, 162.2, 156.3, 149.3, 141.3, 130.8, 130.3, 122.9, 122.6, 117.5, 116.2; HRMS (EI) Calcd. for $C_{23}H_{14}NF_3$: [M^+], 361.1078. Found: m/z 361.1079.

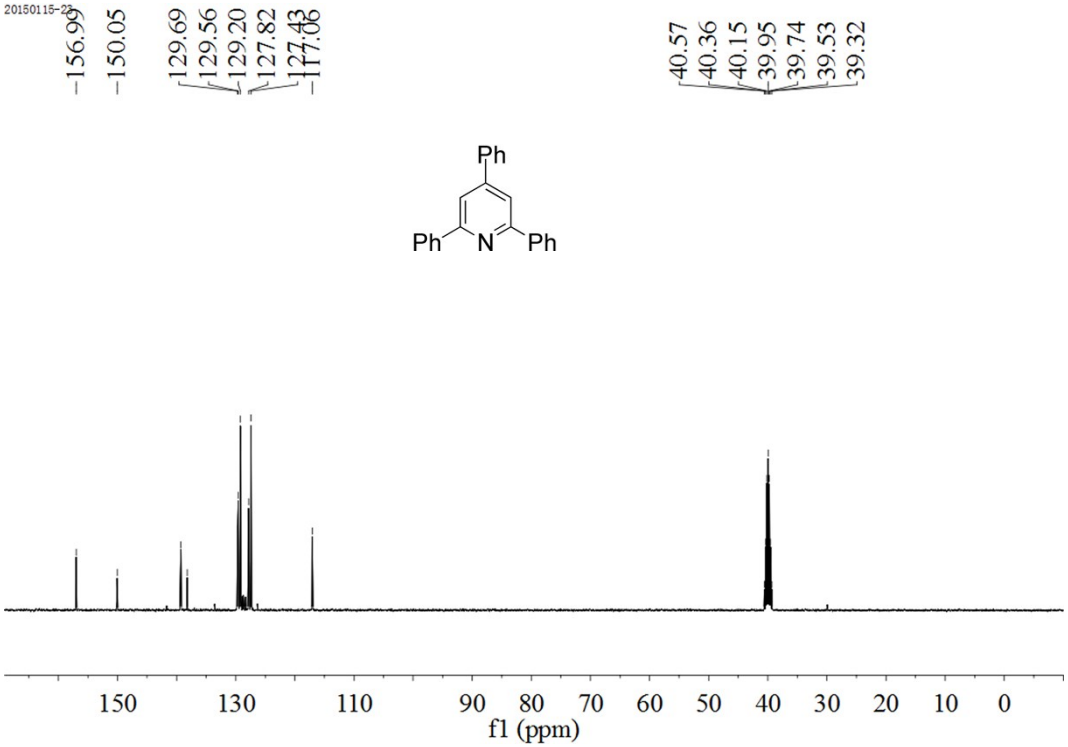
2,6-Bis-(2-fluoro-phenyl)-4-*p*-tolyl-pyridine (**6e**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 7.92 (m, 4H), 7.85 (s, 2H), 7.62 (d, J = 8.0 Hz, 2H), 7.43 - 7.49 (m, 2H), 7.33 (d, J = 8.0 Hz, 2H), 7.11 - 7.15 (m, 2H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.6, 162.2, 156.1, 150.5, 141.7, 139.4, 135.6, 130.2, 130.0, 127.0, 122.6, 117.4, 116.0, 114.2, 21.3; HRMS (EI) Calcd. for $C_{24}H_{17}NF_2$: [M^+], 357.1329. Found: m/z 357.1330.

4-(4-Fluoro-phenyl)-2,6-bis-(2-fluoro-phenyl)-pyridine (**6f**): ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm: δ 8.16 (t, 2H), 7.93 (s, 2H), 7.69 (m, 2H), 7.36 (m, 2H), 7.29 (t, 2H), 7.16 - 7.20 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ ppm: δ 164.7, 162.3, 162.0, 159.5, 153.7, 148.1, 134.7, 131.3, 130.6, 129.1, 127.5, 124.6, 121.2, 116.4; HRMS (EI) Calcd. for $C_{23}H_{14}NF_3$: [M^+], 361.1078. Found: m/z 361.1080.

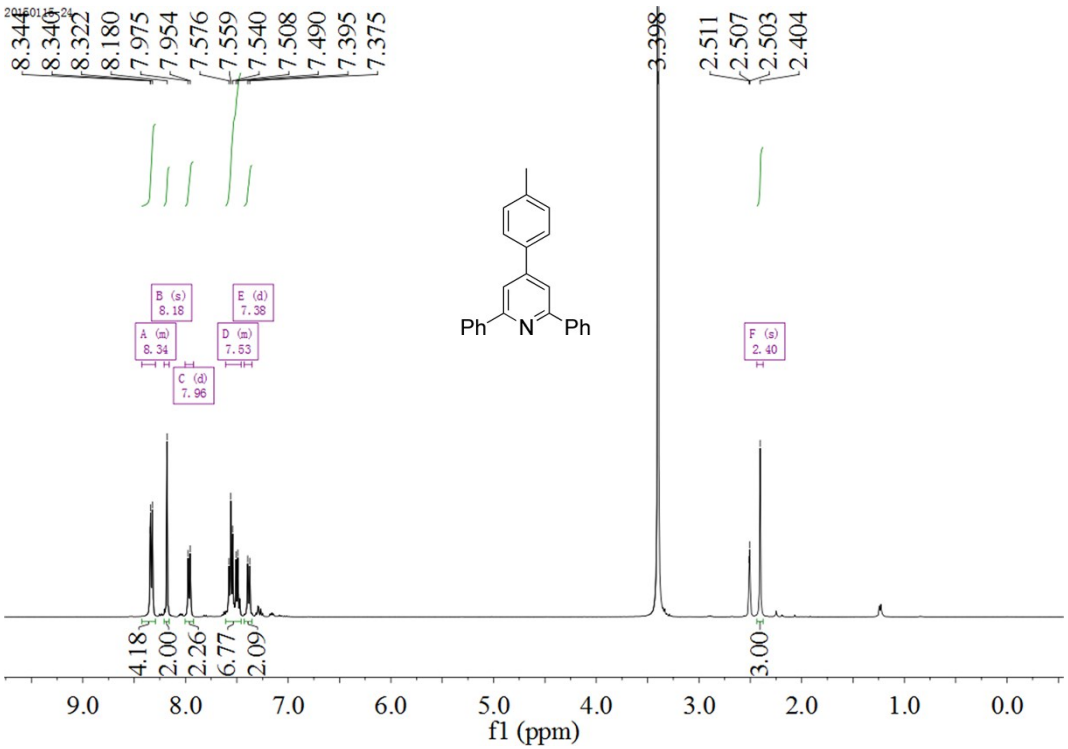
^{1}H and ^{13}C spectra of products 3a-3t, 4a-d and 6a-f:

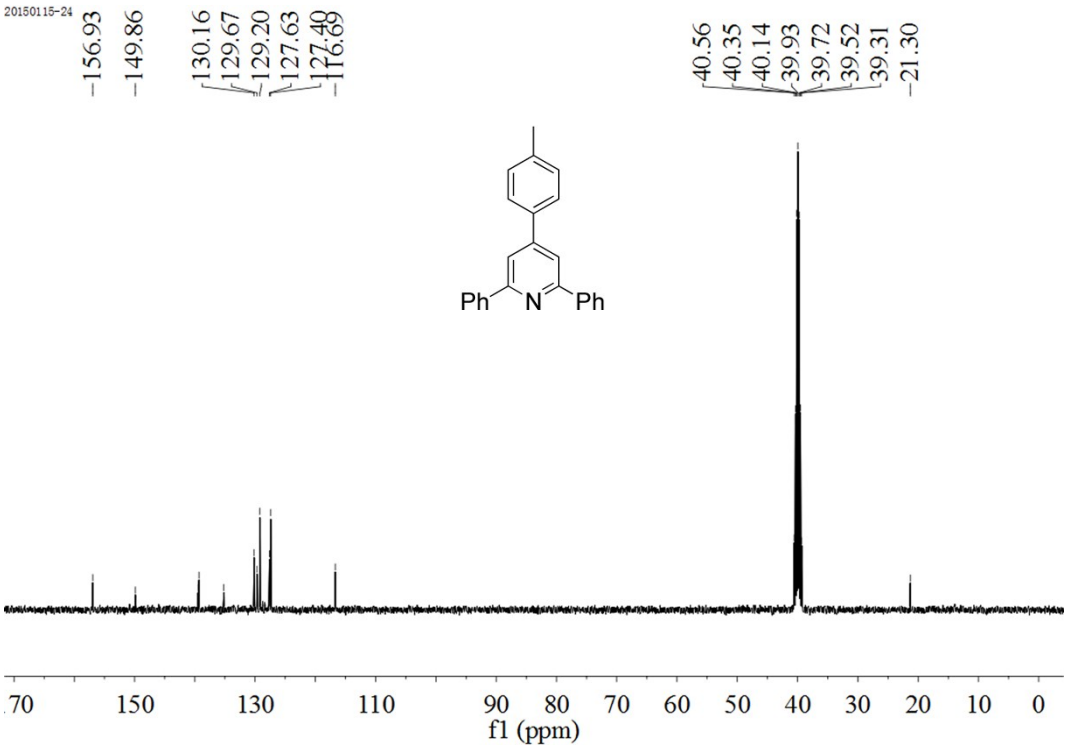
3a


8.349
8.331
8.189
8.045
8.028
7.594
7.577
7.558
7.539
7.517
7.504
7.491
7.486
3.451
2.512
2.507
2.503
Ph
Ph
N
Ph
B (s)
8.19
A (d)
8.34
D (ddd)
7.53
C (d)
8.04
4.02
2.00
2.03
9.38
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

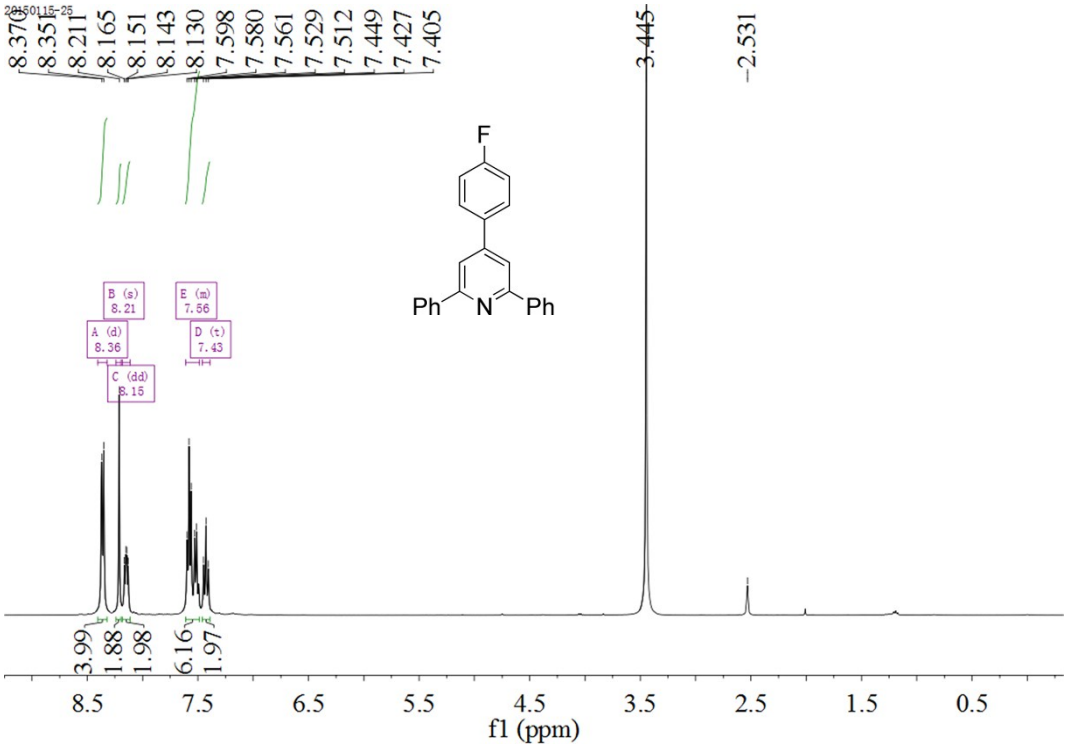

156.99
150.05
129.69
129.56
129.20
127.82
127.43
117.06
40.57
40.36
40.15
39.95
39.74
39.53
39.32
Ph
Ph
N
Ph
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

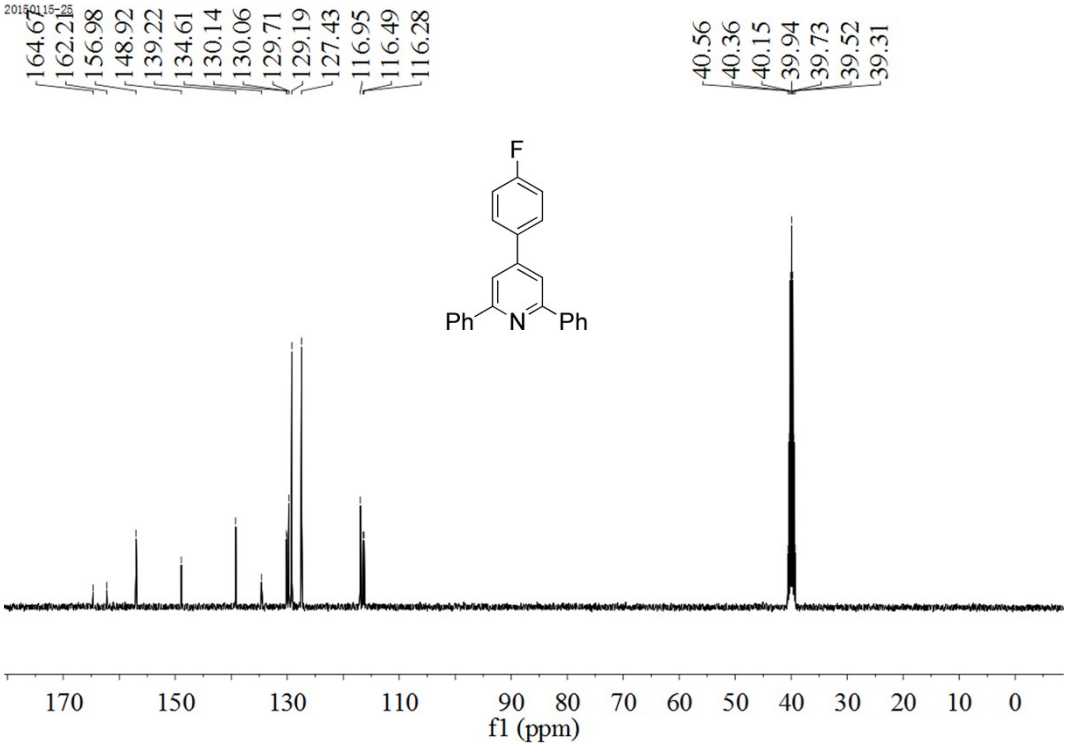
3b


8.344
8.340
8.322
8.180
7.975
7.954
7.576
7.559
7.540
7.508
7.490
7.395
7.375
3.398
2.511
2.507
2.503
2.404
B (s) 8.18
E (d) 7.38
A (m) 8.34
D (m) 7.53
C (d) 7.96
F (s) 2.40
Ph
N
Ph
4.18
2.00
2.26
6.77
2.09
3.00
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

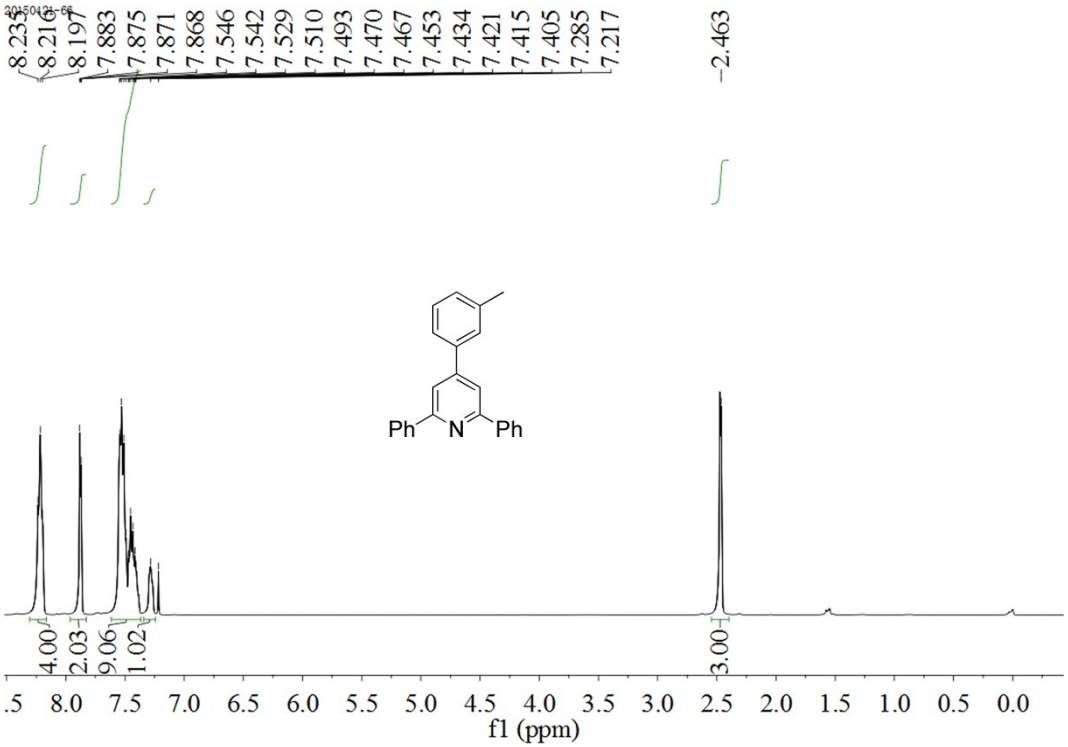

20150115-24
156.93
149.86
130.16
129.67
129.20
127.63
127.40
116.69
40.56
40.35
40.14
39.93
39.72
39.52
39.31
21.30
Ph
N
Ph
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

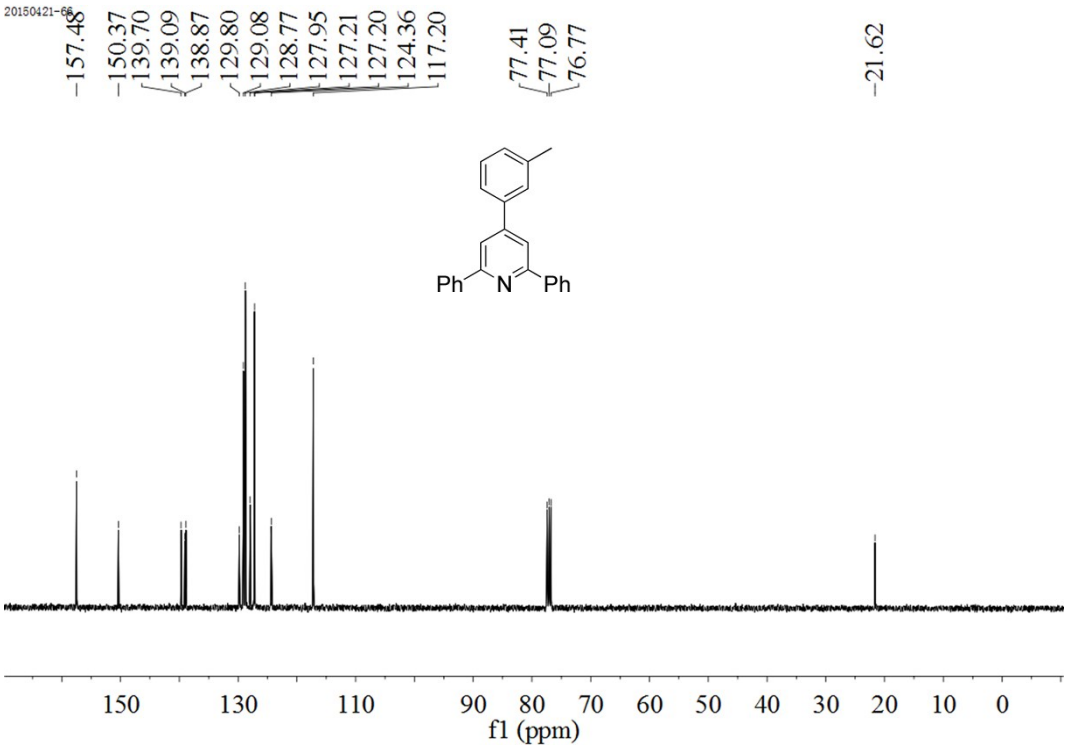
3c


20150115-25
8.370
8.351
8.211
8.165
8.151
8.143
8.130
7.598
7.580
7.561
7.529
7.512
7.449
7.427
7.405
3.445
2.531
F
Ph
N
Ph
B (s) 8.21
E (m) 7.56
A (d) 8.36
D (t) 7.43
C (dd) 8.15
3.99
1.88
1.98
6.16
1.97
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

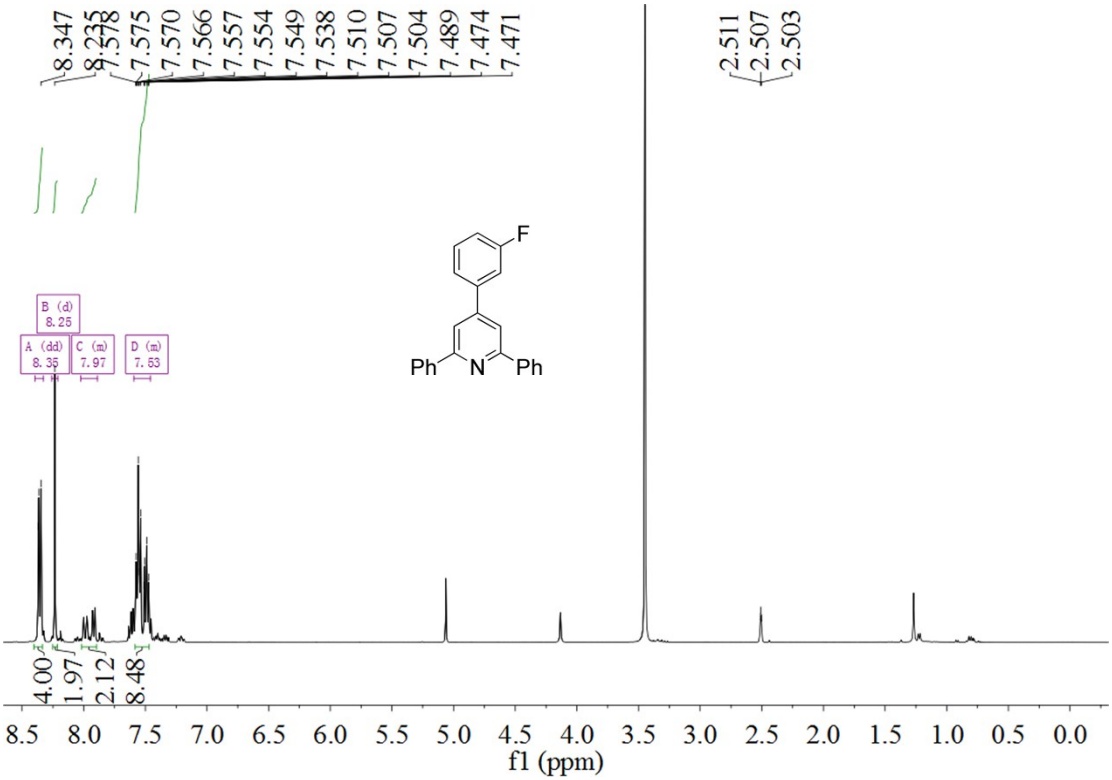

20150115-25
164.67
162.21
156.98
148.92
139.22
134.61
130.14
130.06
129.71
129.19
127.43
116.95
116.49
116.28
40.56
40.36
40.15
39.94
39.73
39.52
39.31
F
Ph
N
Ph
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

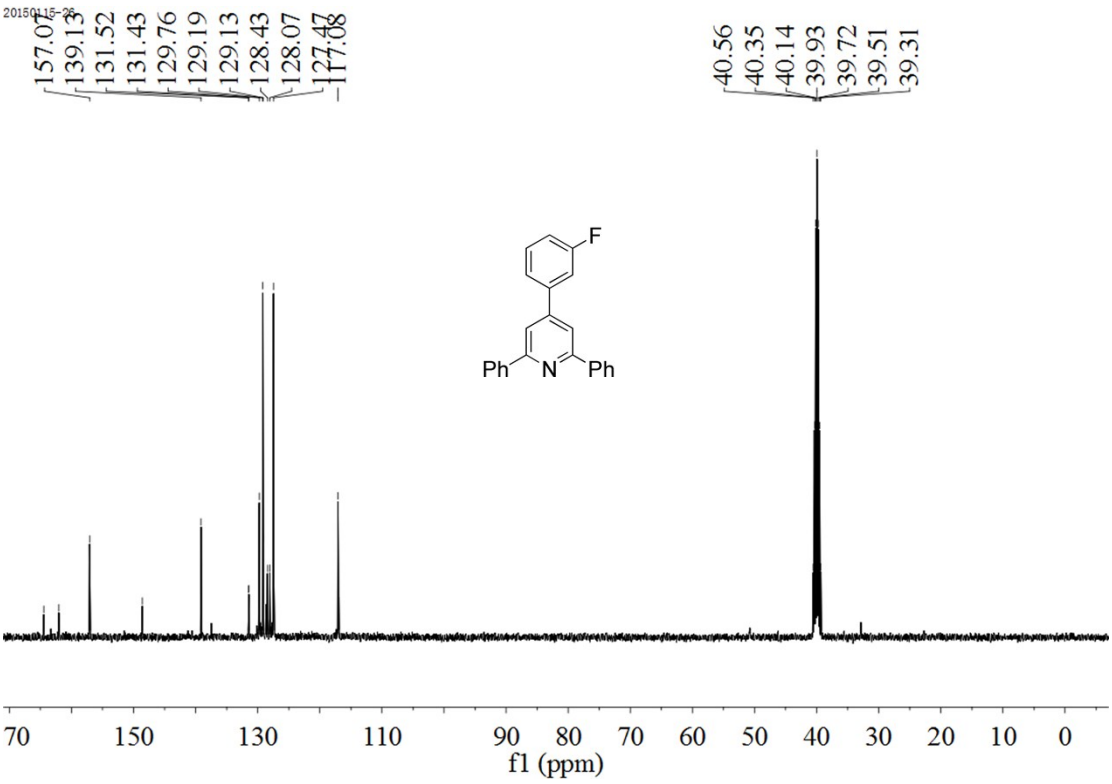
3d


8.233
8.216
8.197
7.883
7.875
7.871
7.868
7.546
7.542
7.529
7.510
7.493
7.470
7.467
7.453
7.434
7.421
7.415
7.405
7.285
7.217
2.463
Ph
N
Ph
4.00
2.03
9.06
1.02
3.00
f1 (ppm)

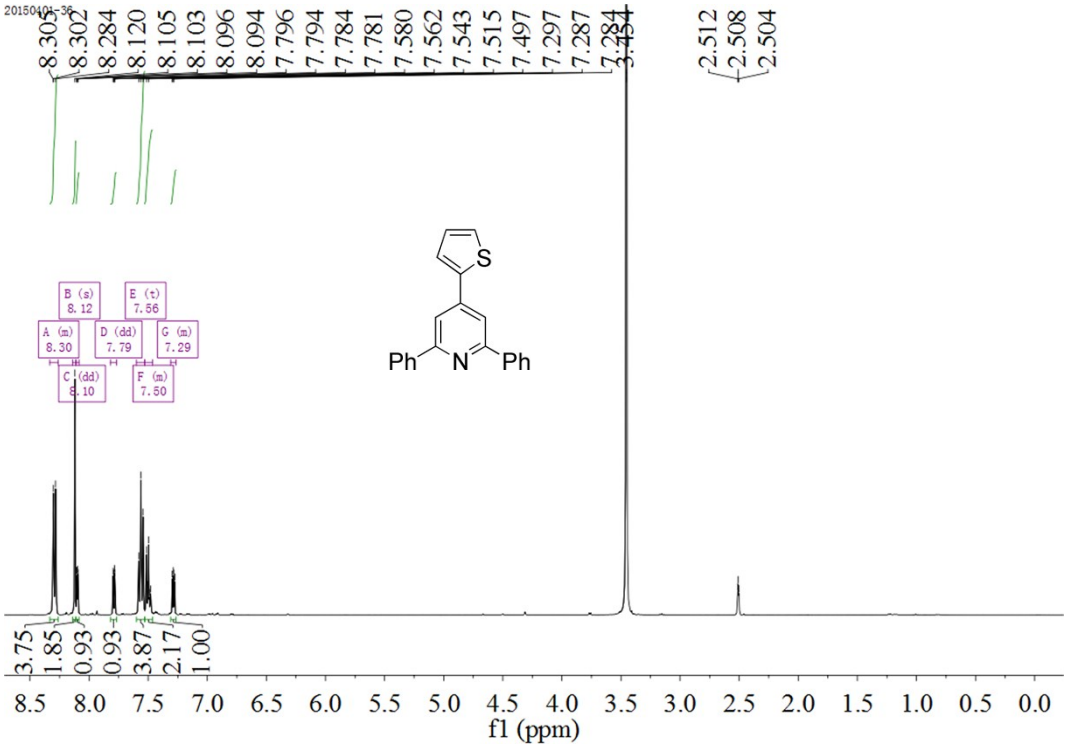

157.48
150.37
139.70
139.09
138.87
129.80
129.08
128.77
127.95
127.21
127.20
124.36
117.20
77.41
77.09
76.77
21.62
Ph
N
Ph
f1 (ppm)

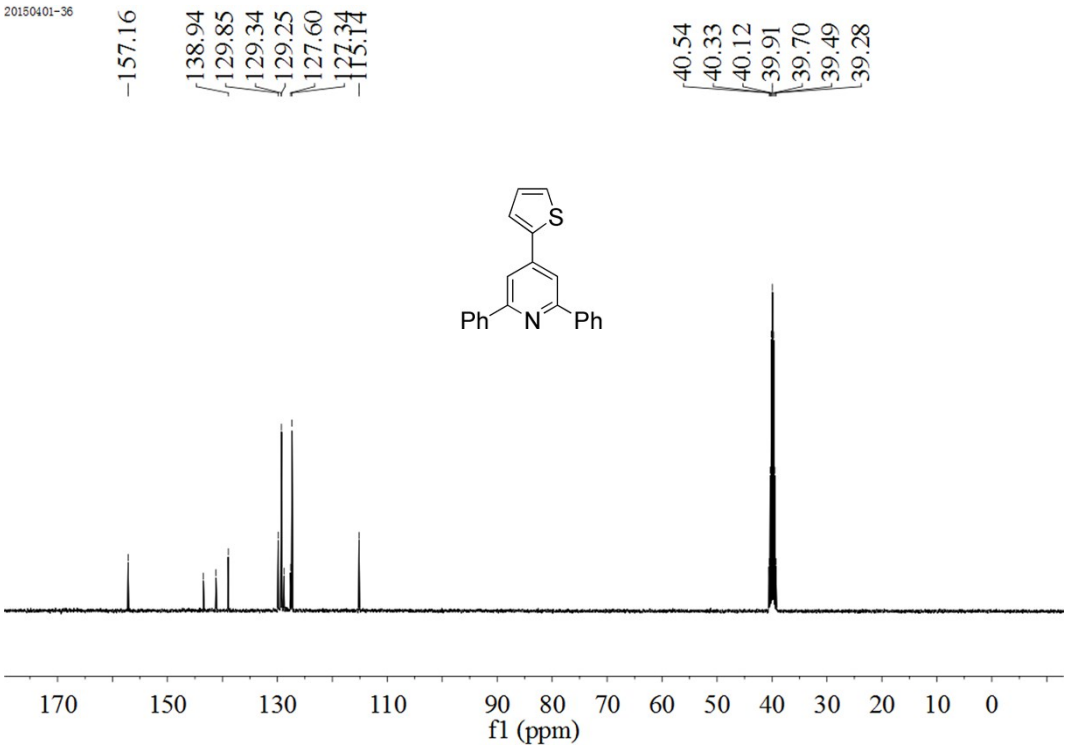
3e


8.347
8.235
7.578
7.575
7.570
7.566
7.557
7.554
7.549
7.538
7.510
7.507
7.504
7.489
7.474
7.471
2.511
2.507
2.503
B (d) 8.25
A (dd) 8.35
C (m) 7.97
D (m) 7.53
F
Ph
N
Ph
4.00
1.97
2.12
8.48
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

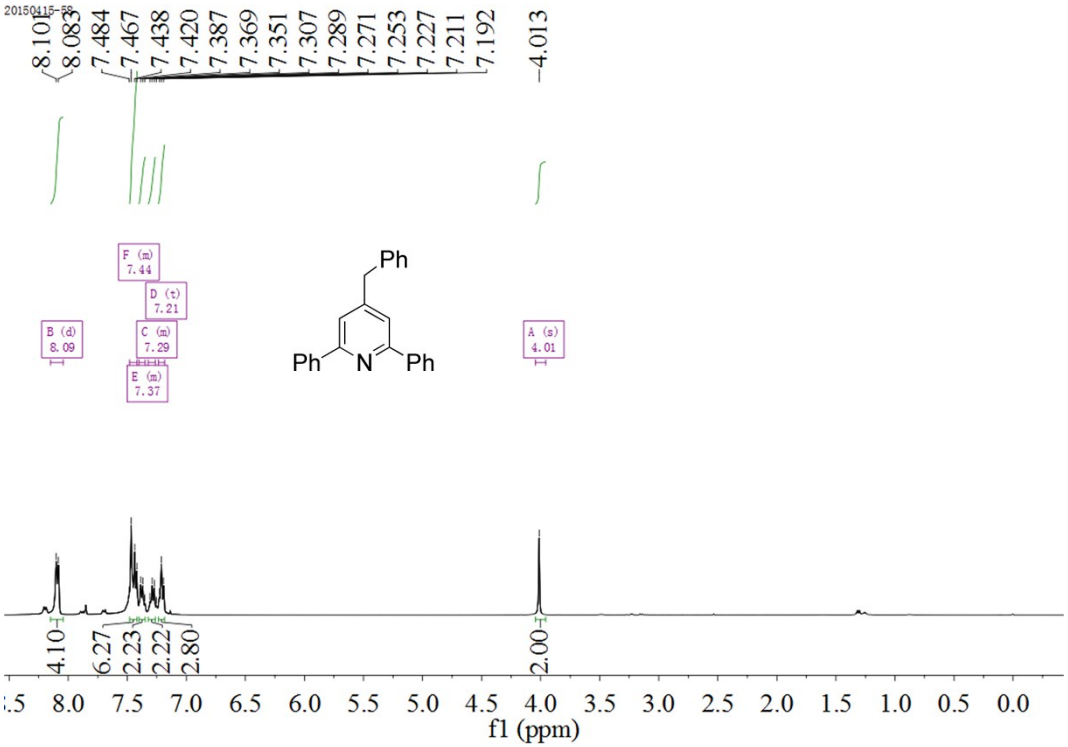

157.07
139.13
131.52
131.43
129.76
129.19
129.13
128.43
128.07
127.47
117.08
40.56
40.35
40.14
39.93
39.72
39.51
39.31
F
Ph
N
Ph
70 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

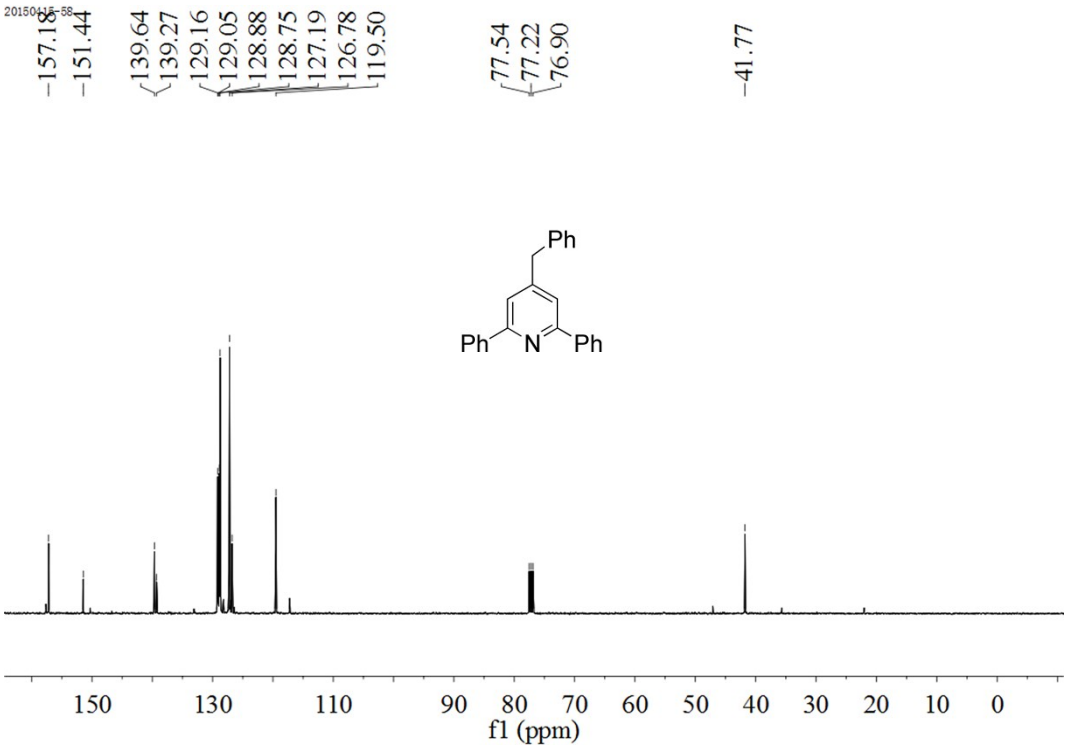
3f


20150401-36
8.303
8.302
8.284
8.120
8.105
8.103
8.096
8.094
7.796
7.794
7.784
7.781
7.580
7.562
7.543
7.515
7.497
7.297
7.287
7.284
3.454
2.512
2.508
2.504
B (s) 8.12
E (t) 7.56
A (m) 8.30
D (dd) 7.79
G (m) 7.29
C (dd) 8.10
F (m) 7.50
S
Ph
N
Ph
3.75
1.85
0.93
0.93
3.87
2.17
1.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

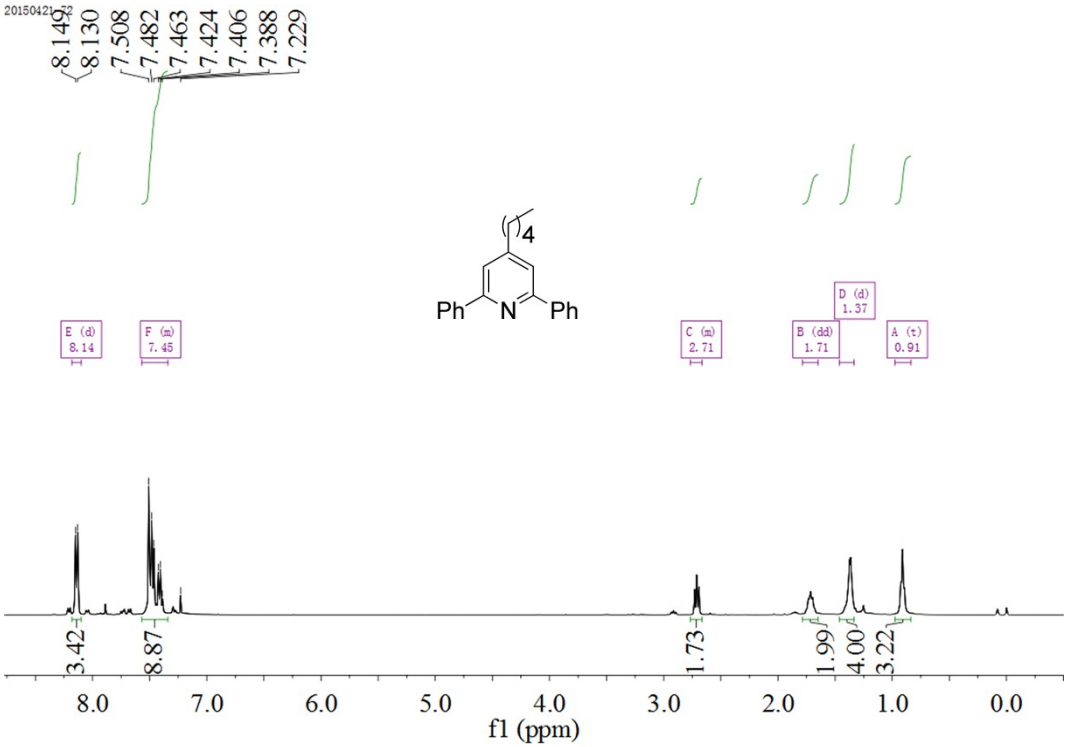

20150401-36
157.16
138.94
129.85
129.34
129.25
127.60
127.34
115.14
40.54
40.33
40.12
39.91
39.70
39.49
39.28
S
Ph
N
Ph
170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

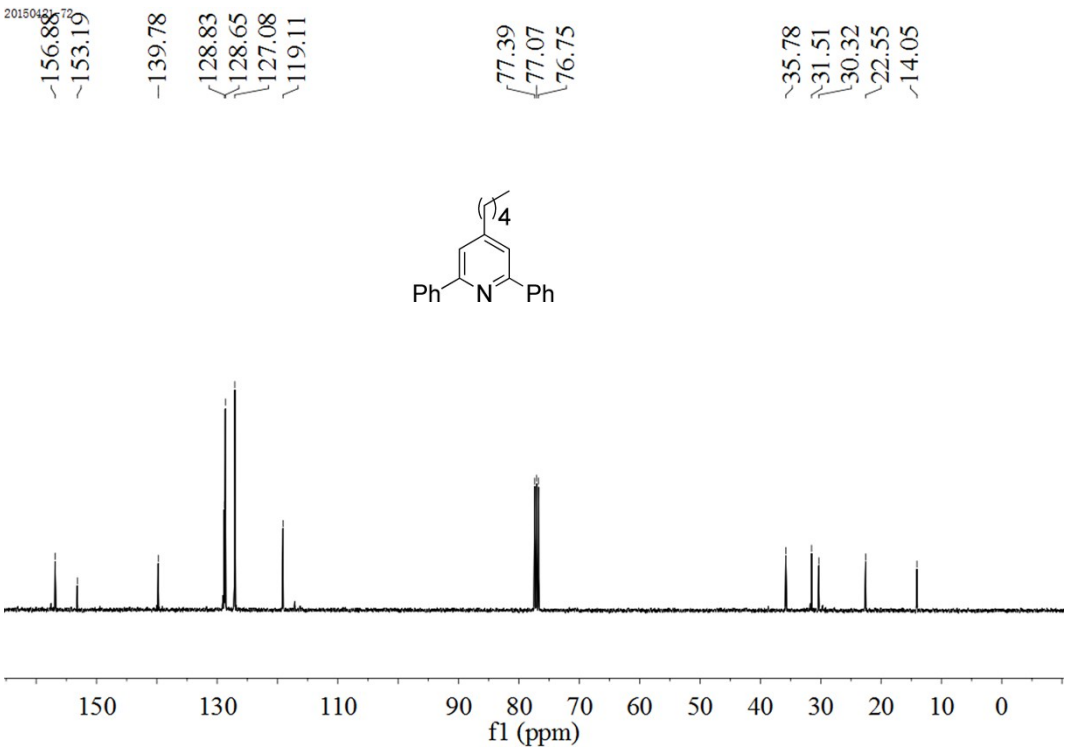
3g


20150415-58
8.101
8.083
7.484
7.467
7.438
7.420
7.387
7.369
7.351
7.307
7.289
7.271
7.253
7.227
7.211
7.192
4.013
F (m) 7.44
D (t) 7.21
B (d) 8.09
C (m) 7.29
E (m) 7.37
A (s) 4.01
Ph
Ph
N
Ph
4.10
6.27
2.23
2.22
2.80
2.00
f1 (ppm)

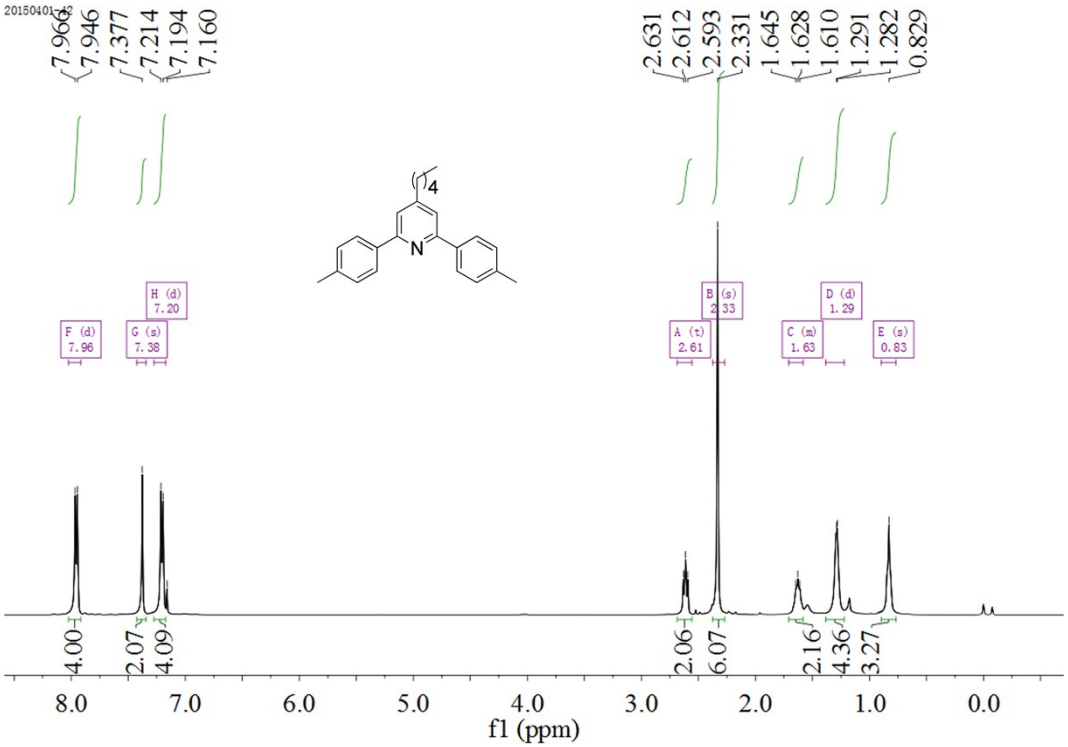

20150415-58
157.18
151.44
139.64
139.27
129.16
129.05
128.88
128.75
127.19
126.78
119.50
77.54
77.22
76.90
41.77
Ph
Ph
N
Ph
f1 (ppm)

3h


8.149
8.130
7.508
7.482
7.463
7.424
7.406
7.388
7.229
E (d) 8.14
F (m) 7.45
C (m) 2.71
B (dd) 1.71
D (d) 1.37
A (t) 0.91
Ph
N
Ph
4
3.42
8.87
1.73
1.99
4.00
3.22
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


156.88
153.19
139.78
128.83
128.65
127.08
119.11
77.39
77.07
76.75
35.78
31.51
30.32
22.55
14.05
Ph
N
Ph
4
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

3i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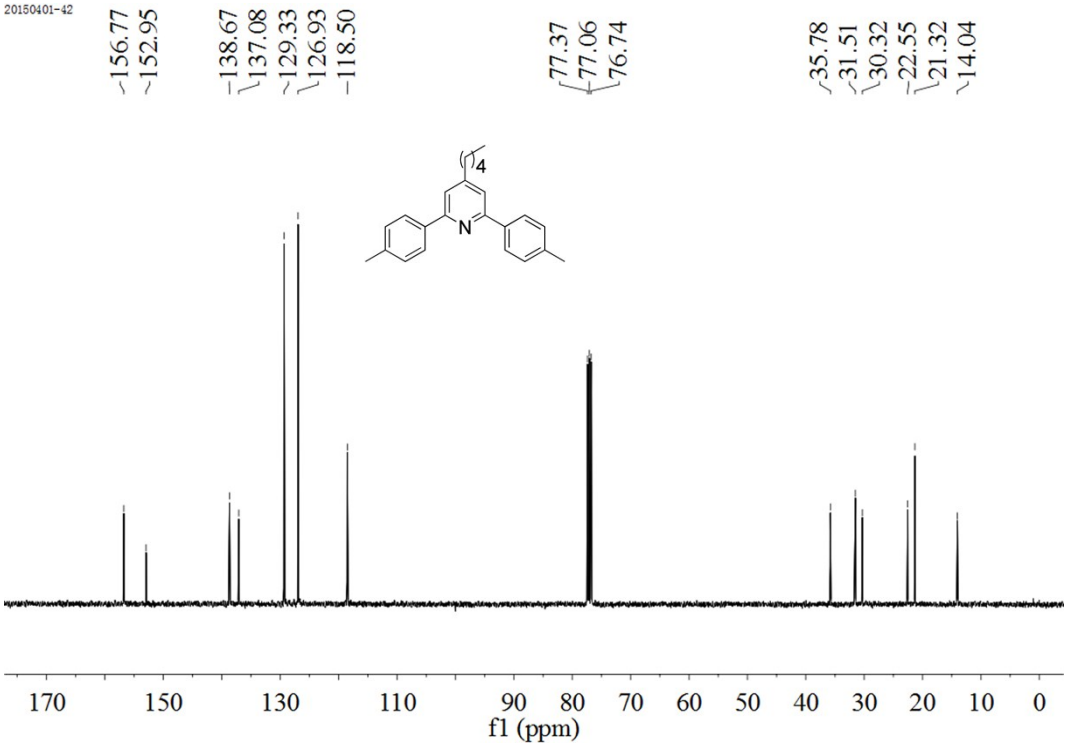
7.966
7.946
7.377
7.214
7.194
7.160
2.631
2.612
2.593
2.331
1.645
1.628
1.610
1.291
1.282
0.829
F (d) 7.96
G (s) 7.38
H (d) 7.20
A (t) 2.61
B (s) 2.33
C (m) 1.63
D (d) 1.29
E (s) 0.83
4.00
2.07
4.09
2.06
6.07
2.16
4.36
3.27
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


20150401-42
156.77
152.95
138.67
137.08
129.33
126.93
118.50
77.37
77.06
76.74
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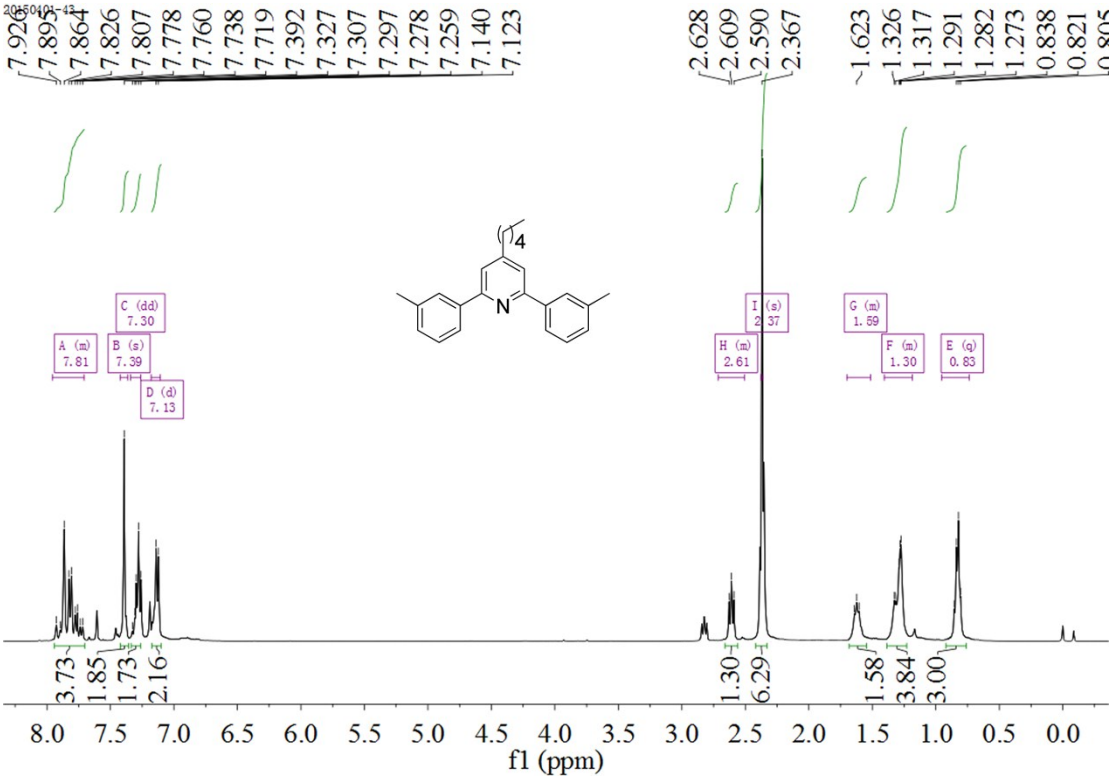
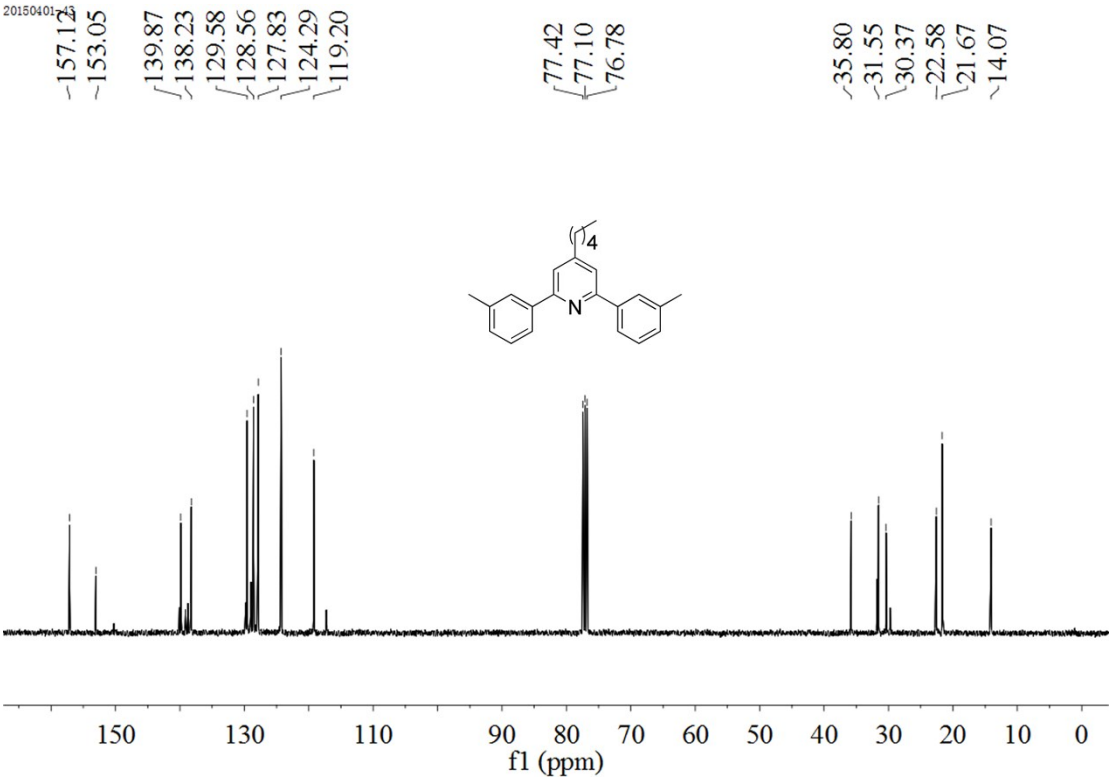
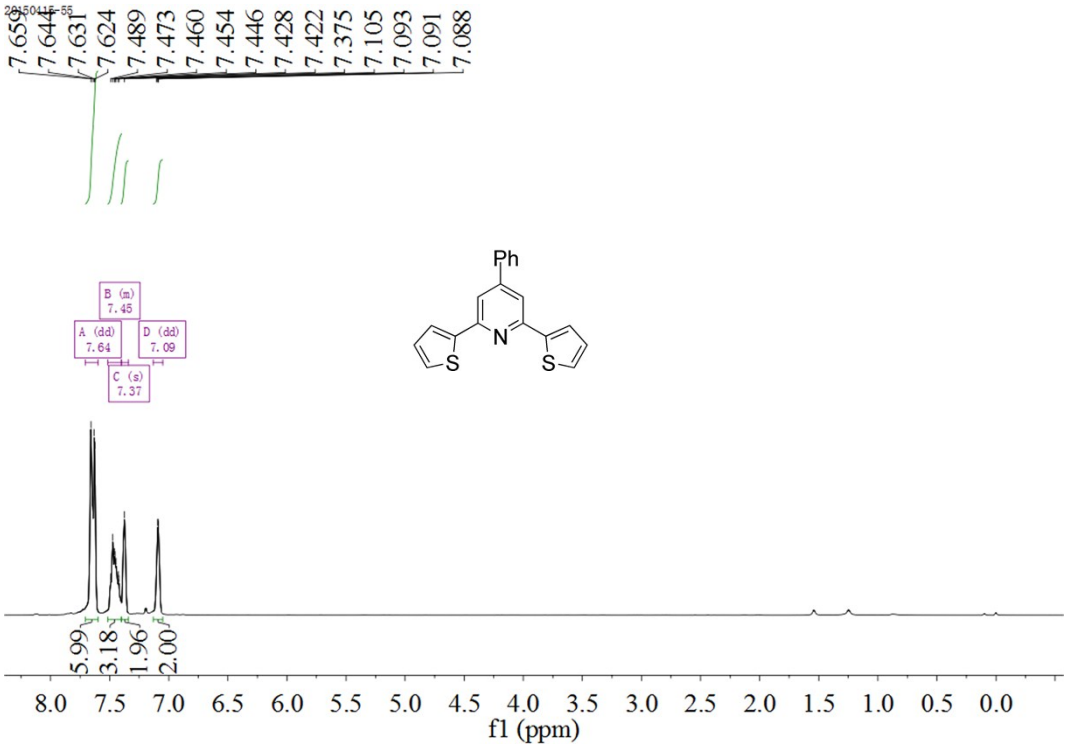
31.51
30.32
22.55
21.32
14.04
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

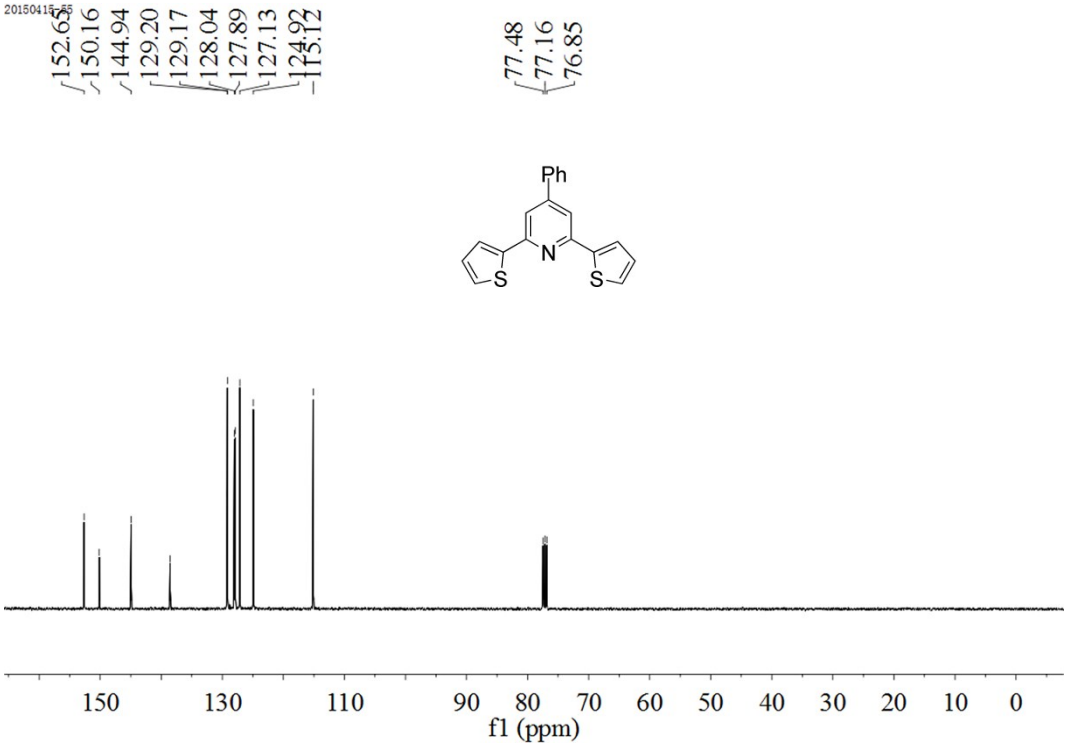
3j


20150401-43
7.926
7.895
7.864
7.826
7.807
7.778
7.760
7.738
7.719
7.392
7.327
7.307
7.297
7.278
7.259
7.140
7.123
2.628
2.609
2.590
2.367
1.623
1.326
1.317
1.291
1.282
1.273
0.838
0.821
A (m) 7.81
B (s) 7.39
C (dd) 7.30
D (d) 7.13
I (s) 2.37
H (m) 2.61
G (m) 1.59
F (m) 1.30
E (q) 0.83
3.73
1.85
1.73
2.16
1.30
6.29
1.58
3.84
3.00
f1 (ppm)

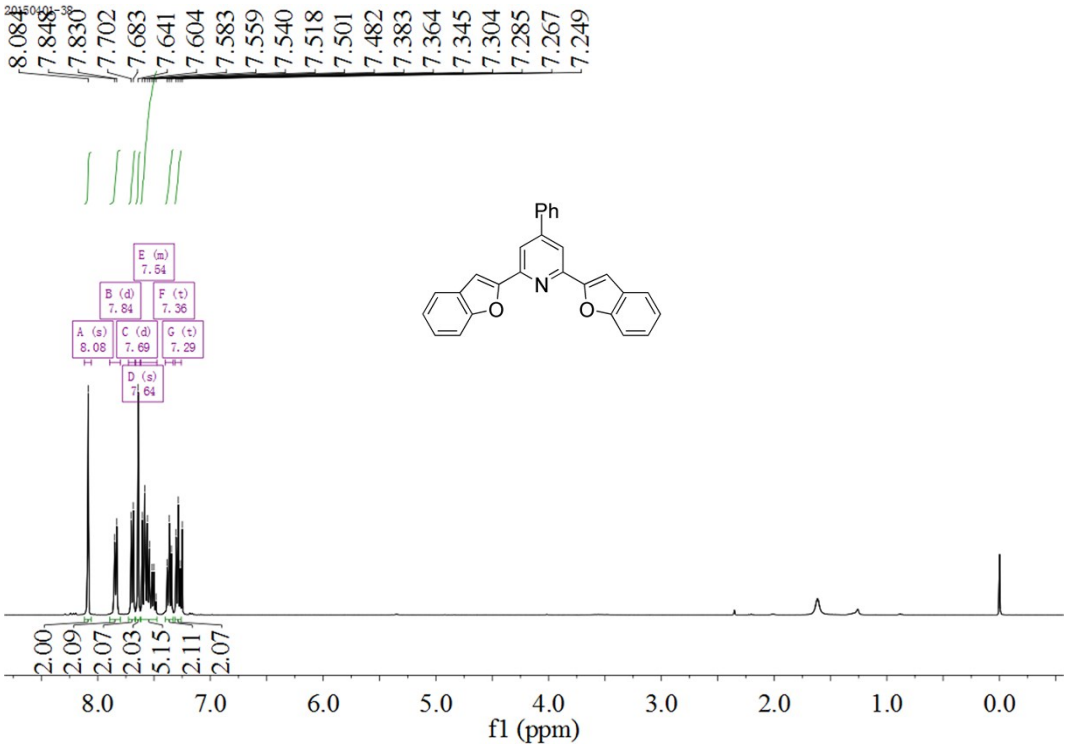

20150401-43
157.12
153.05
139.87
138.23
129.58
128.56
127.83
124.29
119.20
77.42
77.10
76.78
35.80
31.55
30.37
22.58
21.67
14.07
f1 (ppm)

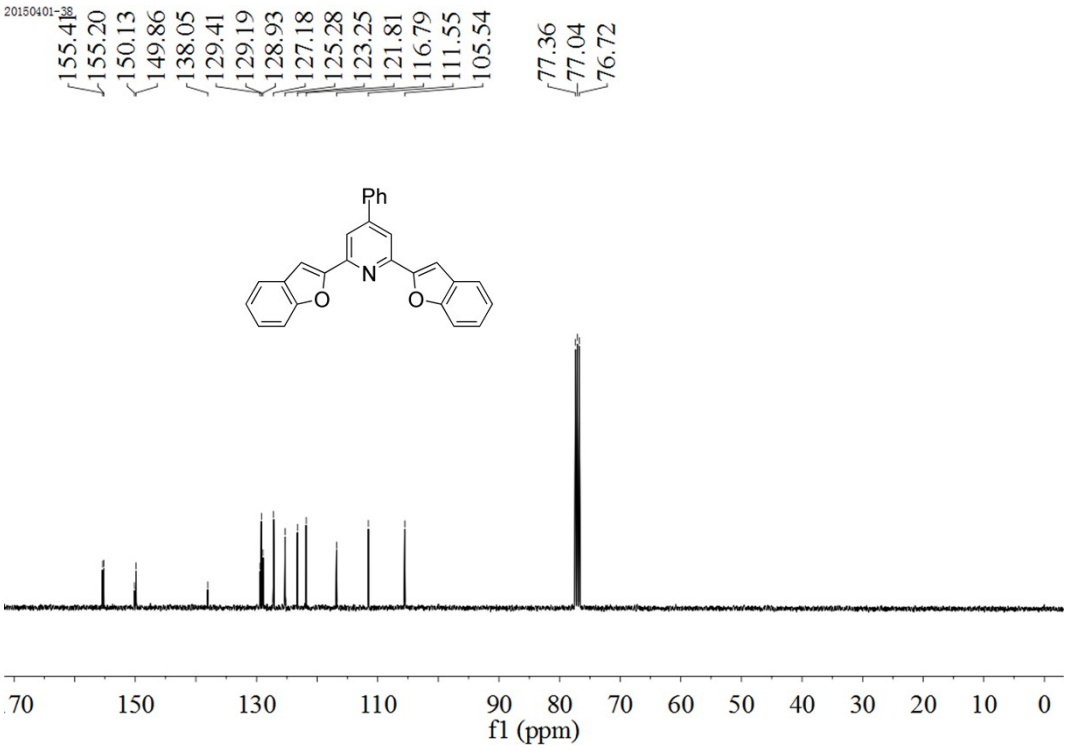
3k


7.650
7.644
7.631
7.624
7.489
7.473
7.460
7.454
7.446
7.428
7.422
7.375
7.105
7.093
7.091
7.088
B (m)
7.45
A (dd)
7.64
D (dd)
7.09
C (s)
7.37
Ph
N
S
S
5.99
3.18
1.96
2.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

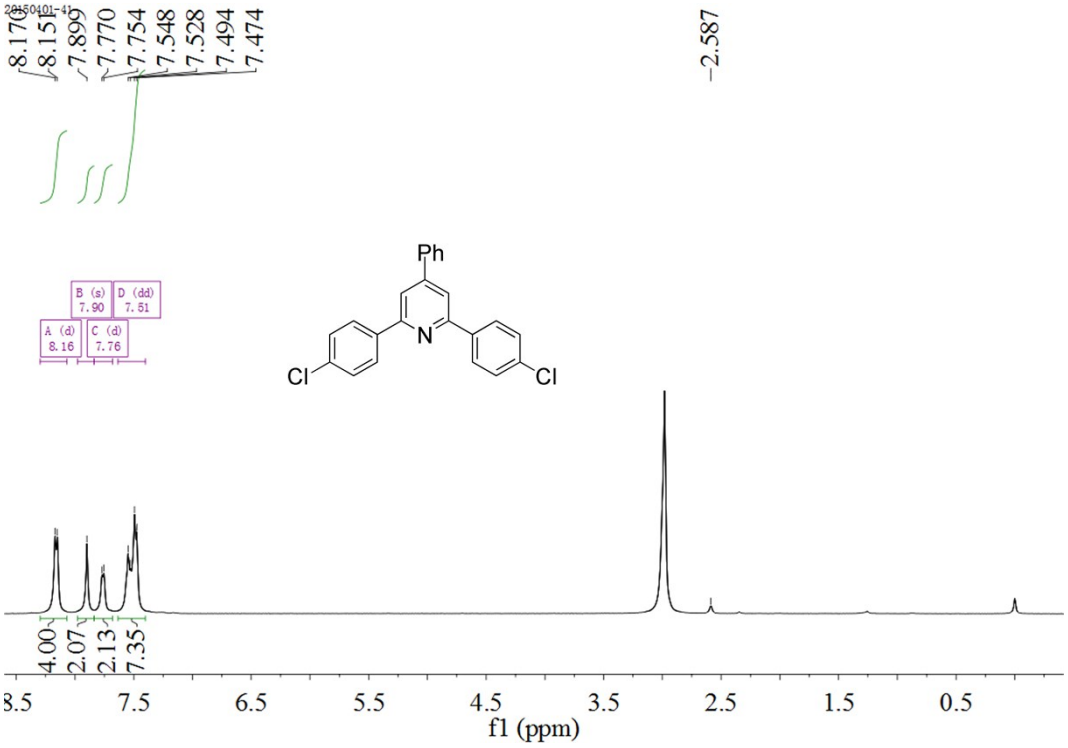

152.65
150.16
144.94
129.20
129.17
128.04
127.89
127.13
124.92
115.12
77.48
77.16
76.85
Ph
N
S
S
150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

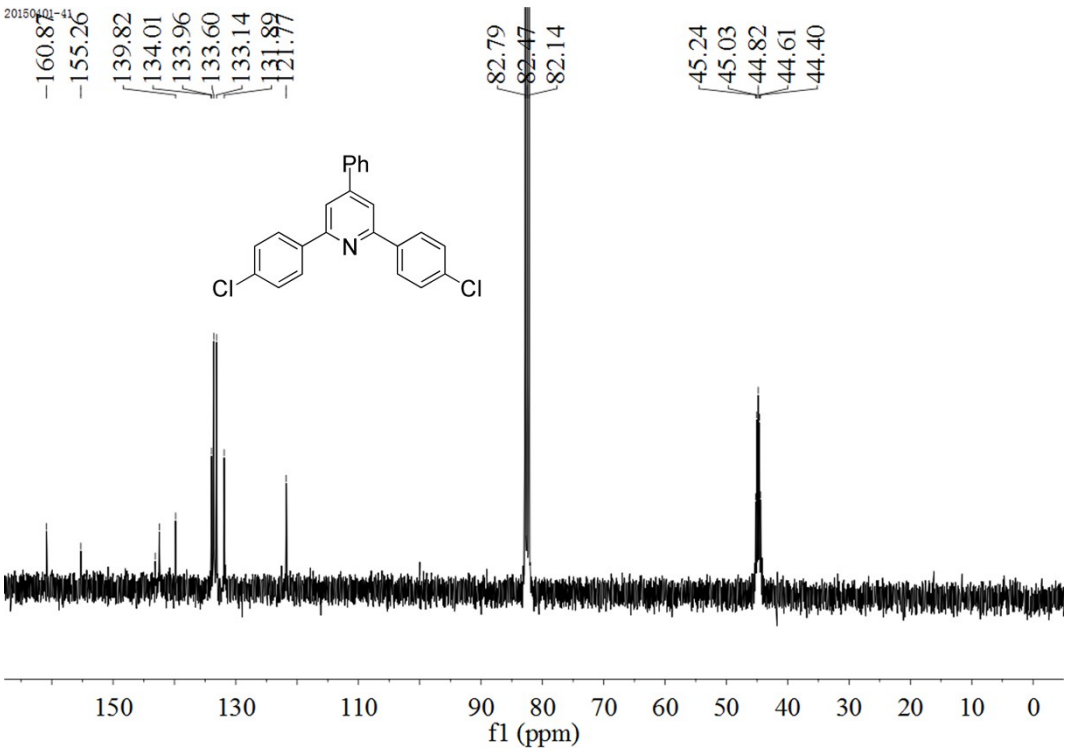
3l


20150401-38
8.084
7.848
7.830
7.702
7.683
7.641
7.604
7.583
7.559
7.540
7.518
7.501
7.482
7.383
7.364
7.345
7.304
7.285
7.267
7.249
E (m) 7.54
B (d) 7.84
F (t) 7.36
A (s) 8.08
C (d) 7.69
G (t) 7.29
D (s) 7.64
Ph
N
O
O
2.00
2.09
2.07
2.03
5.15
2.11
2.07
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

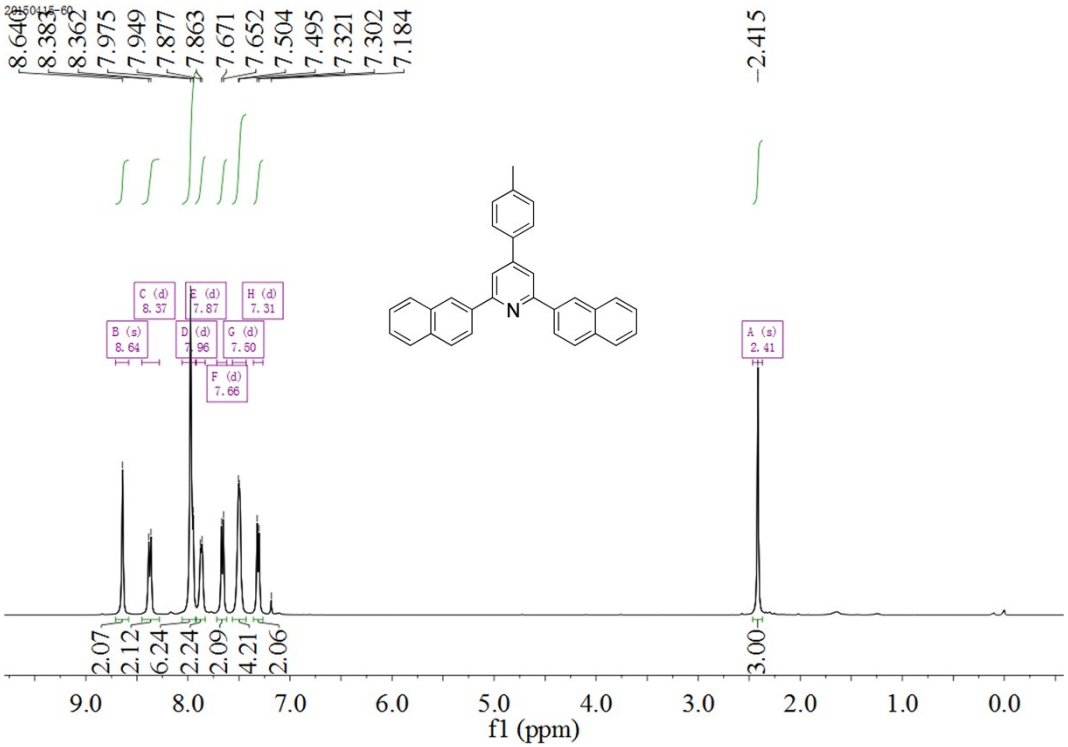

20150401-38
155.41
155.20
150.13
149.86
138.05
129.41
129.19
128.93
127.18
125.28
123.25
121.81
116.79
111.55
105.54
77.36
77.04
76.72
Ph
N
O
O
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

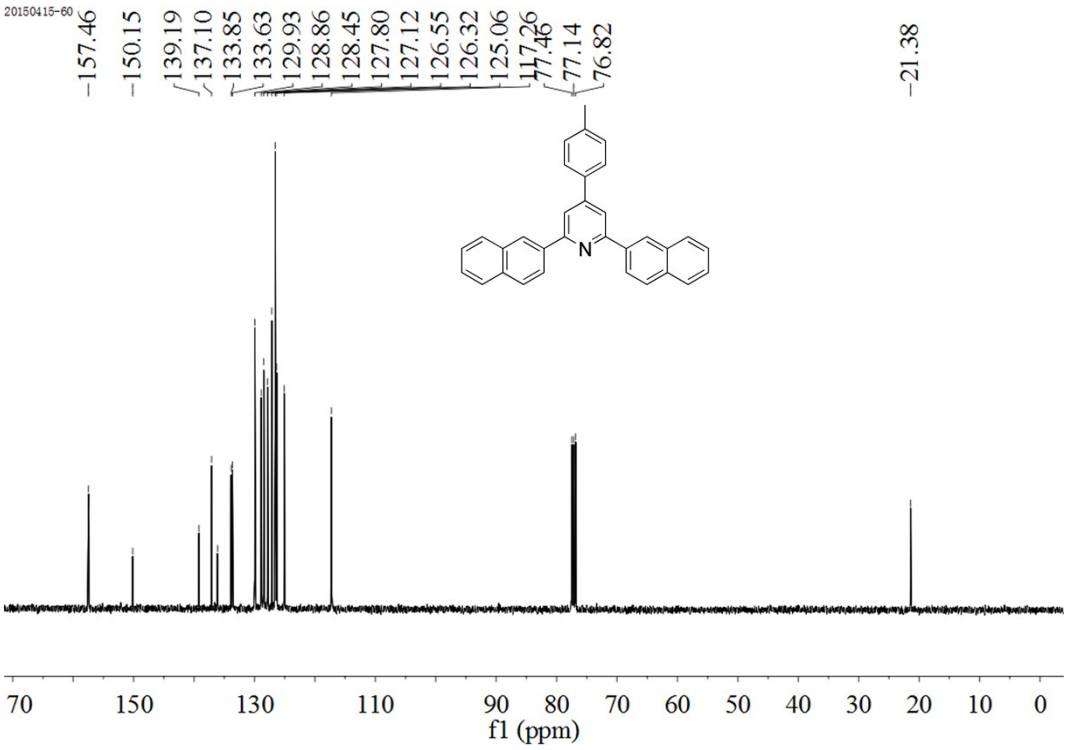
3m


8.170
8.151
7.899
7.770
7.754
7.548
7.528
7.494
7.474
2.587
B (s) 7.90
D (dd) 7.51
A (d) 8.16
C (d) 7.76
Ph
N
Cl
Cl
4.00
2.07
2.13
7.35
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

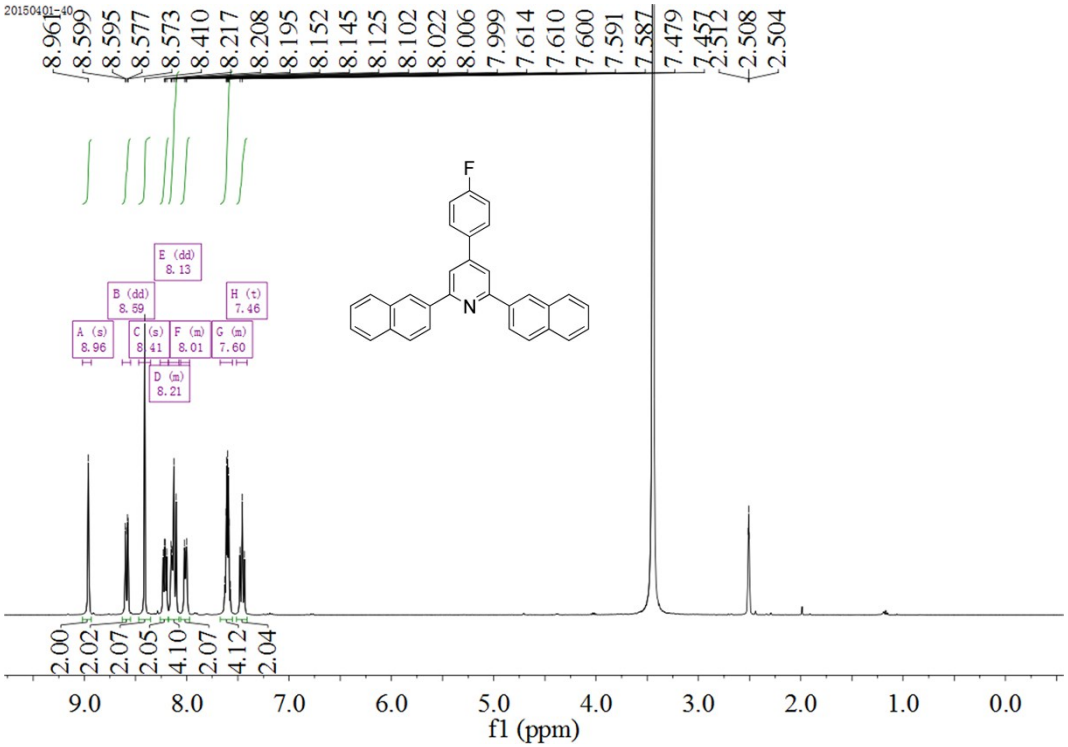

160.87
155.26
139.82
134.01
133.96
133.60
133.14
131.89
121.97
82.79
82.47
82.14
45.24
45.03
44.82
44.61
44.40
Ph
N
Cl
Cl
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

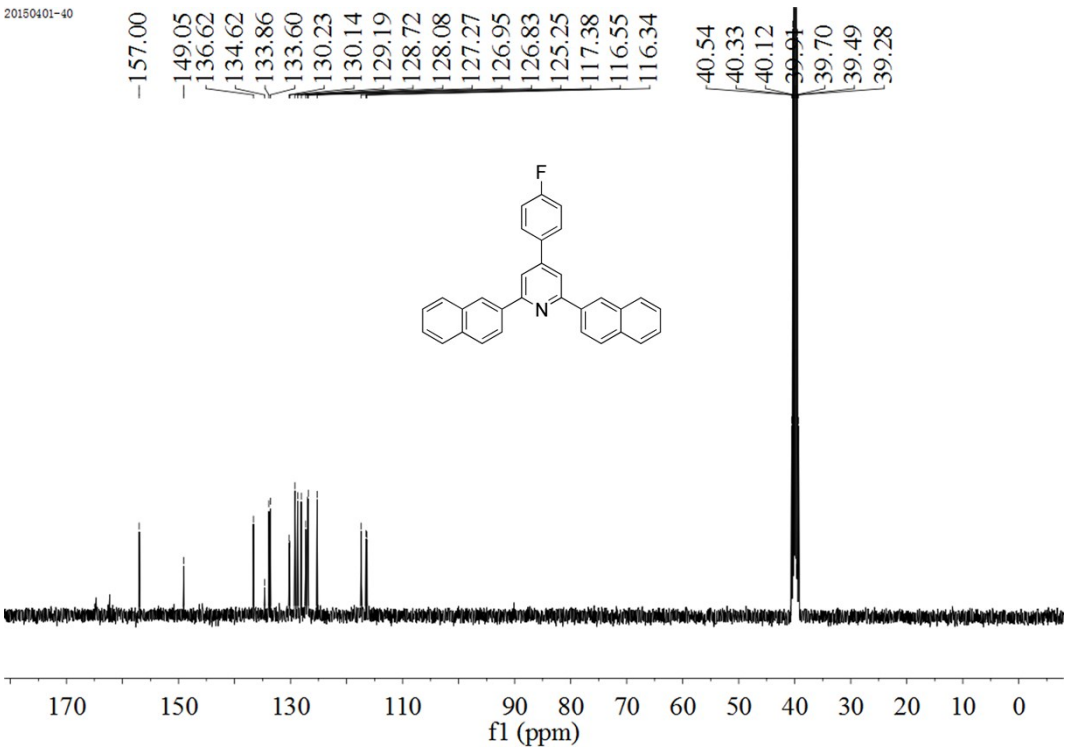
3n


8.640
8.383
8.362
7.975
7.949
7.877
7.863
7.671
7.652
7.504
7.495
7.321
7.302
7.184
2.415
C (d) 8.37
E (d) 7.87
H (d) 7.31
B (s) 8.64
D (d) 7.96
G (d) 7.50
F (d) 7.66
A (s) 2.41
2.07
2.12
6.24
2.24
2.09
4.21
2.06
3.00
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

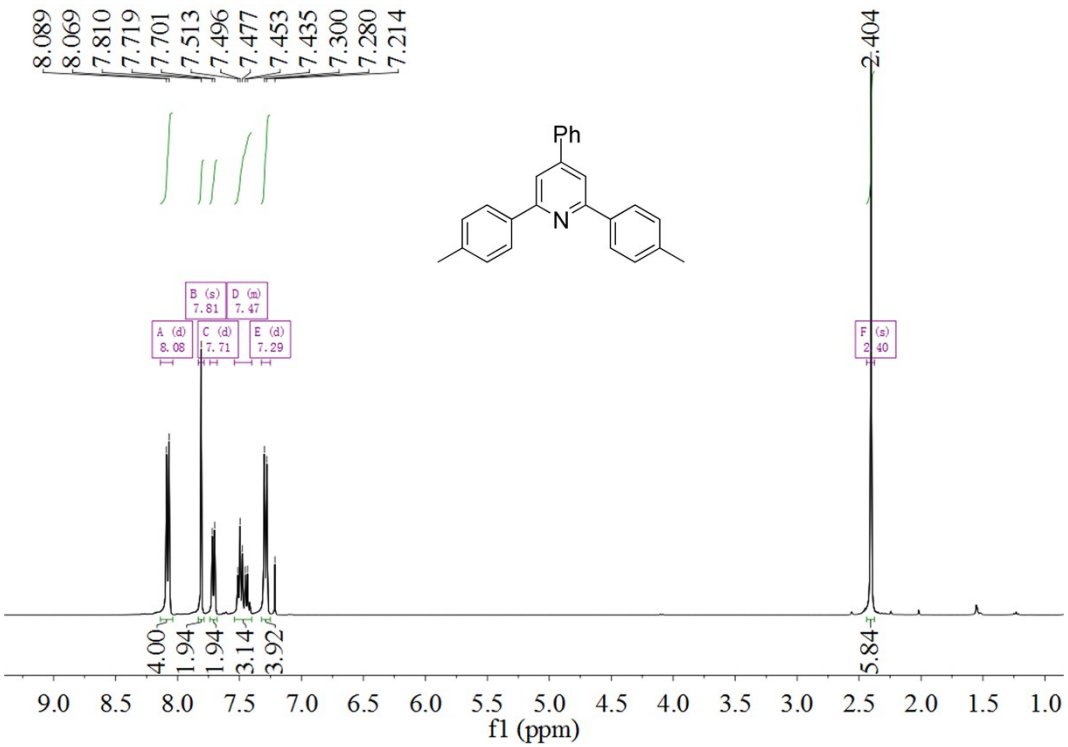

20150415-60
157.46
150.15
139.19
137.10
133.85
133.63
129.93
128.86
128.45
127.80
127.12
126.55
126.32
125.06
77.14
76.82
21.38
70
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

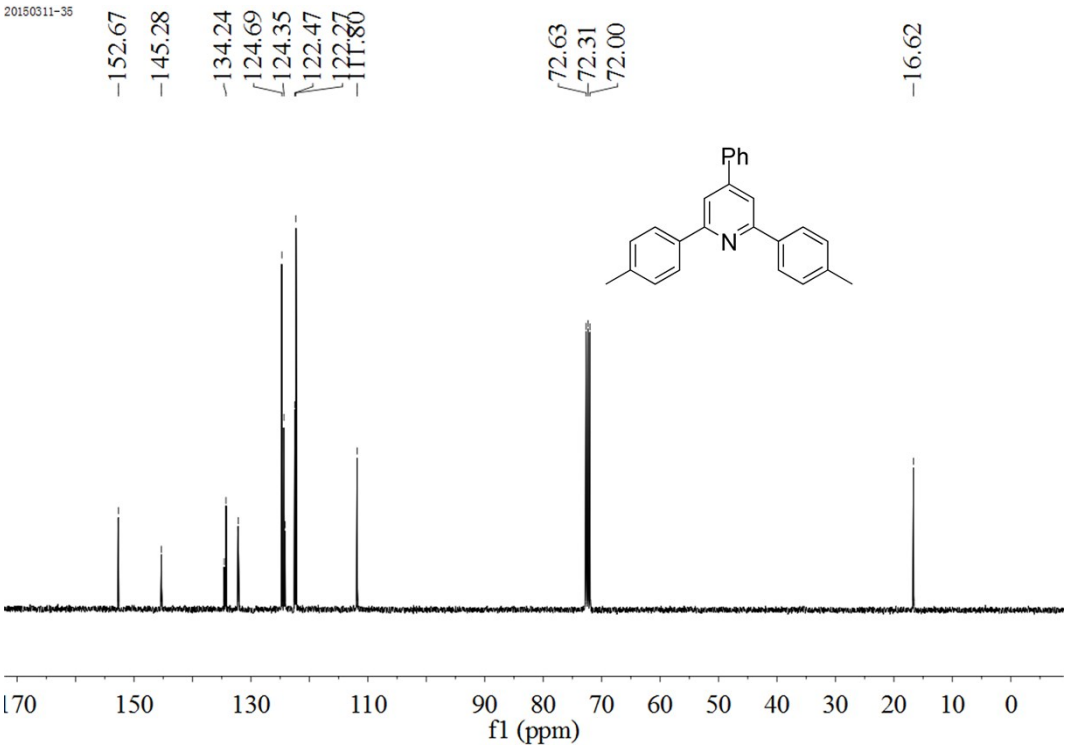
3o


20150401-40
8.961
8.599
8.595
8.577
8.573
8.410
8.217
8.208
8.195
8.152
8.145
8.125
8.102
8.022
8.006
7.999
7.614
7.610
7.600
7.591
7.587
7.479
7.457
2.512
2.508
2.504
E (dd) 8.13
B (dd) 8.59
H (t) 7.46
A (s) 8.96
C (s) 8.41
F (m) 8.01
G (m) 7.60
D (m) 8.21
F
N
2.00
2.02
2.07
2.05
4.10
2.07
4.12
2.04
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

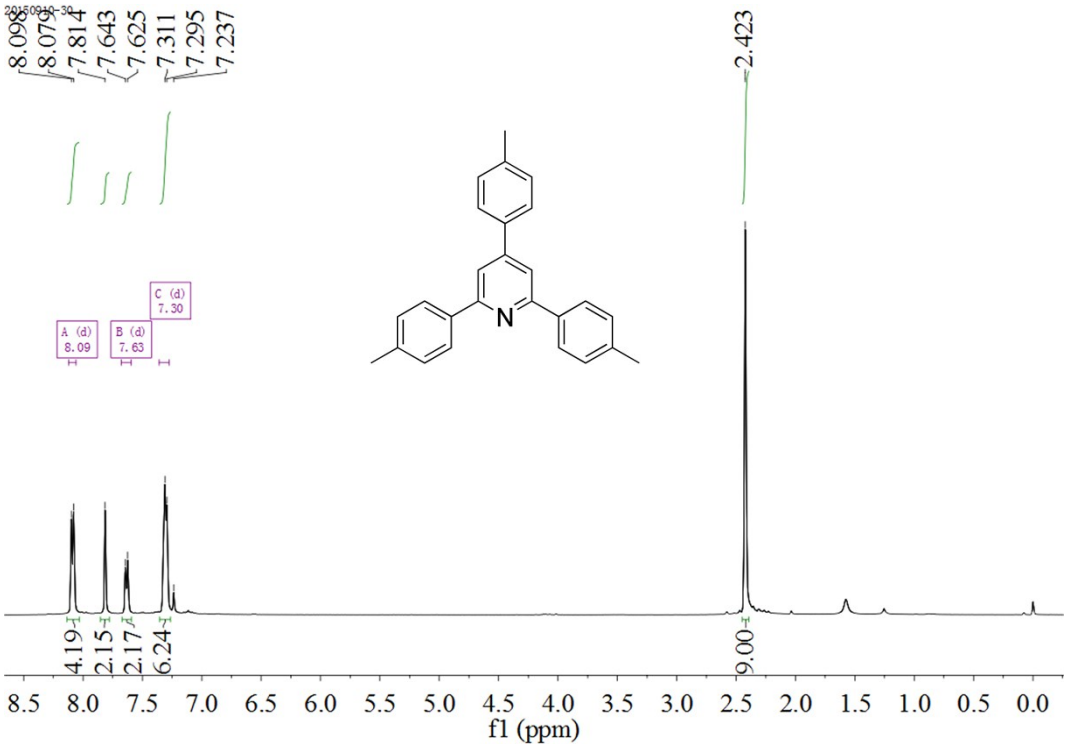

20150401-40
157.00
149.05
136.62
134.62
133.86
133.60
130.23
130.14
129.19
128.72
128.08
127.27
126.95
126.83
125.25
117.38
116.55
116.34
40.54
40.33
40.12
39.91
39.70
39.49
39.28
F
N
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

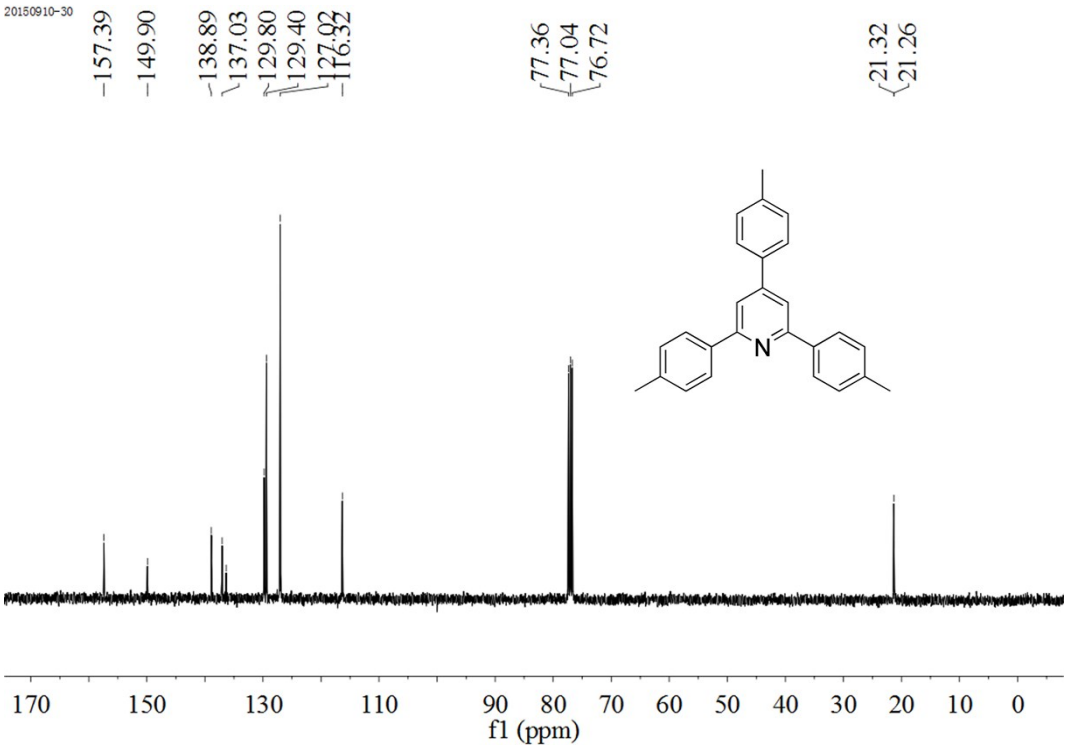
3p


8.089
8.069
7.810
7.719
7.701
7.513
7.496
7.477
7.453
7.435
7.300
7.280
7.214
2.404
Ph
N
B (s) 7.81
D (m) 7.47
A (d) 8.08
C (d) 7.71
E (d) 7.29
F (s) 2.40
4.00
1.94
1.94
3.14
3.92
5.84
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
f1 (ppm)

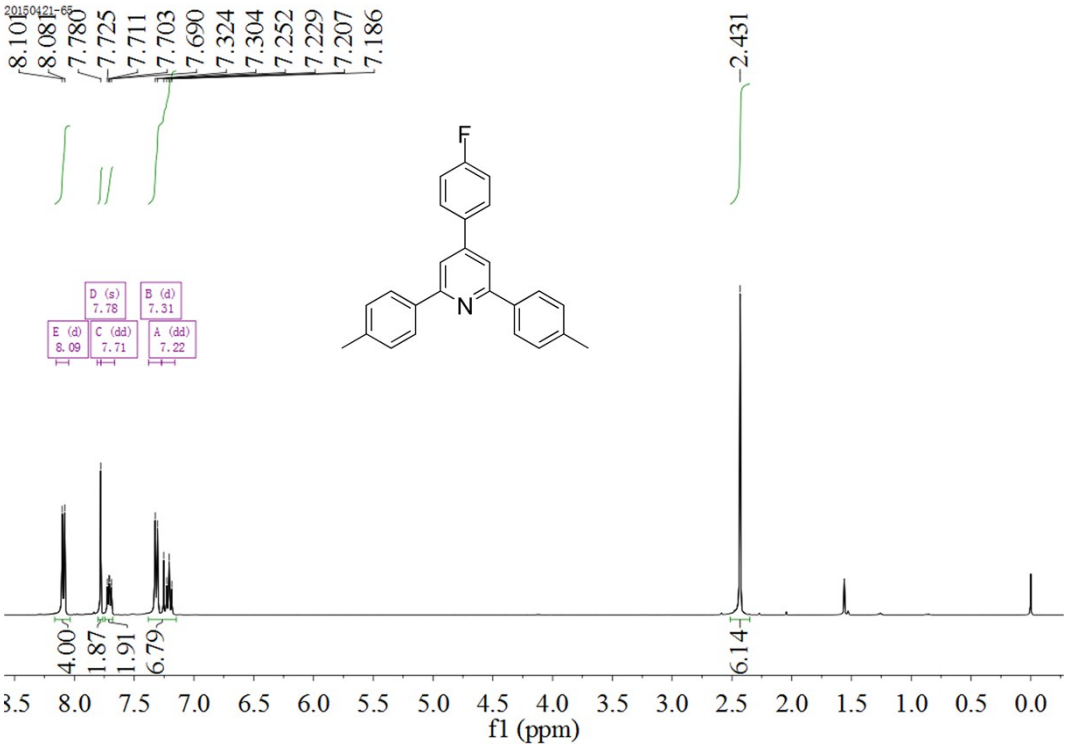

20150311-35
152.67
145.28
134.24
124.69
124.35
122.47
122.27
111.80
72.63
72.31
72.00
16.62
Ph
N
170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

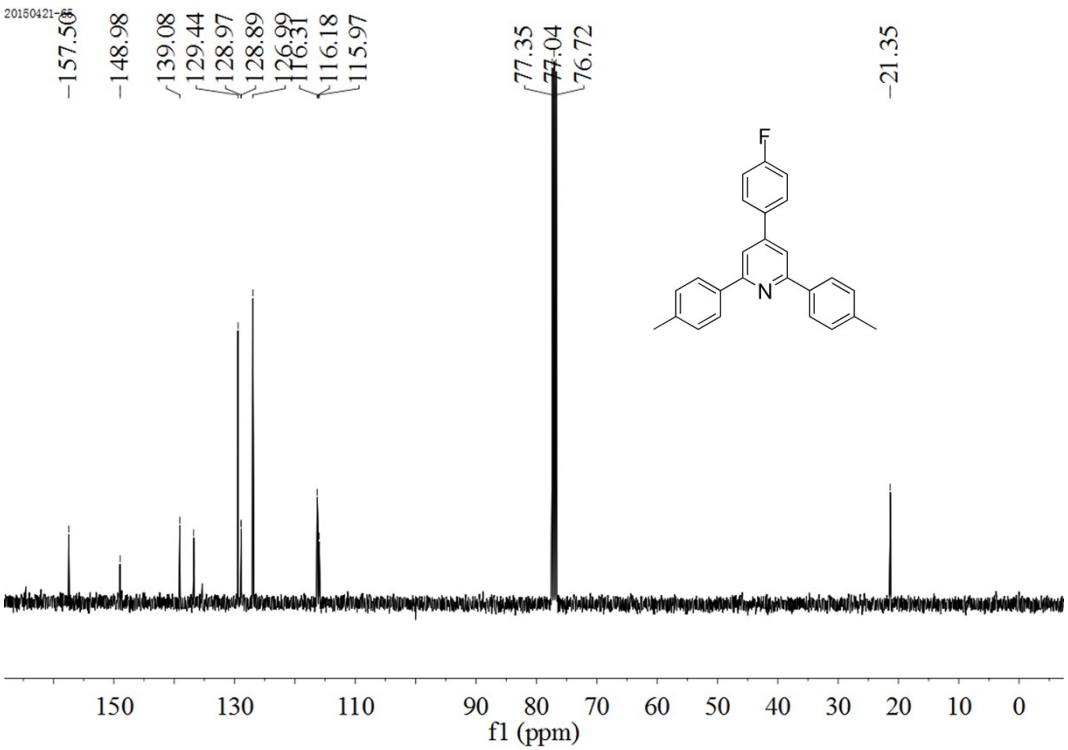
3q


8.098
8.079
7.814
7.643
7.625
7.311
7.295
7.237
2.423
A (d) 8.09
B (d) 7.63
C (d) 7.30
4.19
2.15
2.17
6.24
9.00
f1 (ppm)

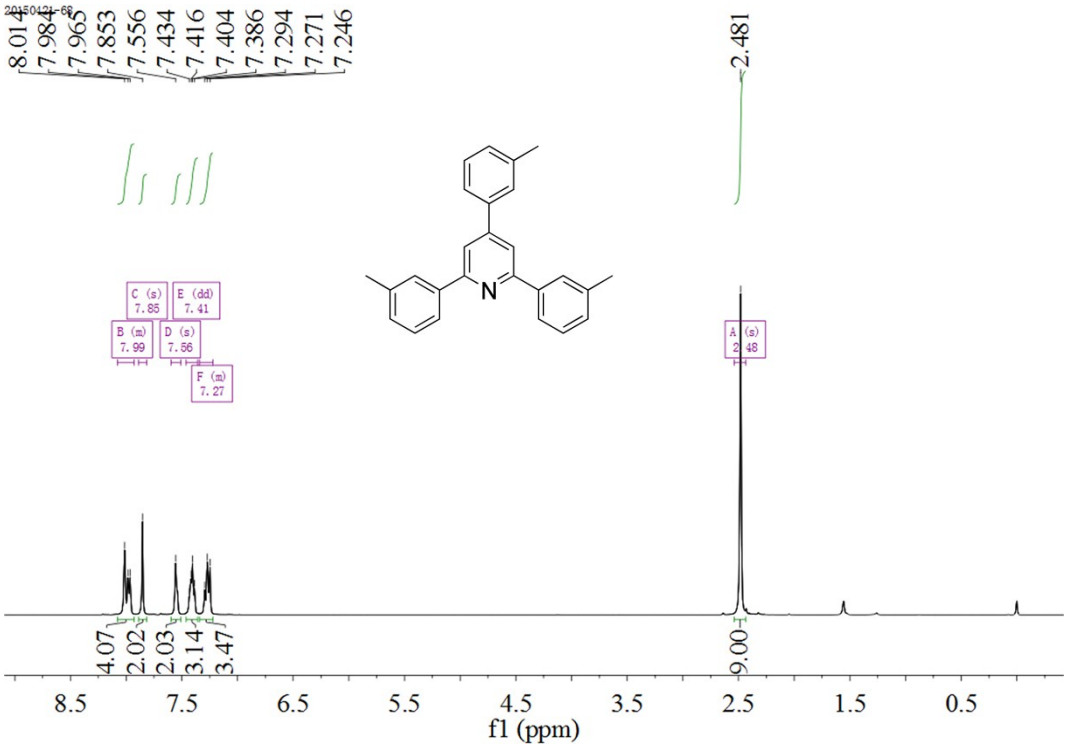

157.39
149.90
138.89
137.03
129.80
129.40
77.36
77.04
76.72
21.32
21.26
f1 (ppm)

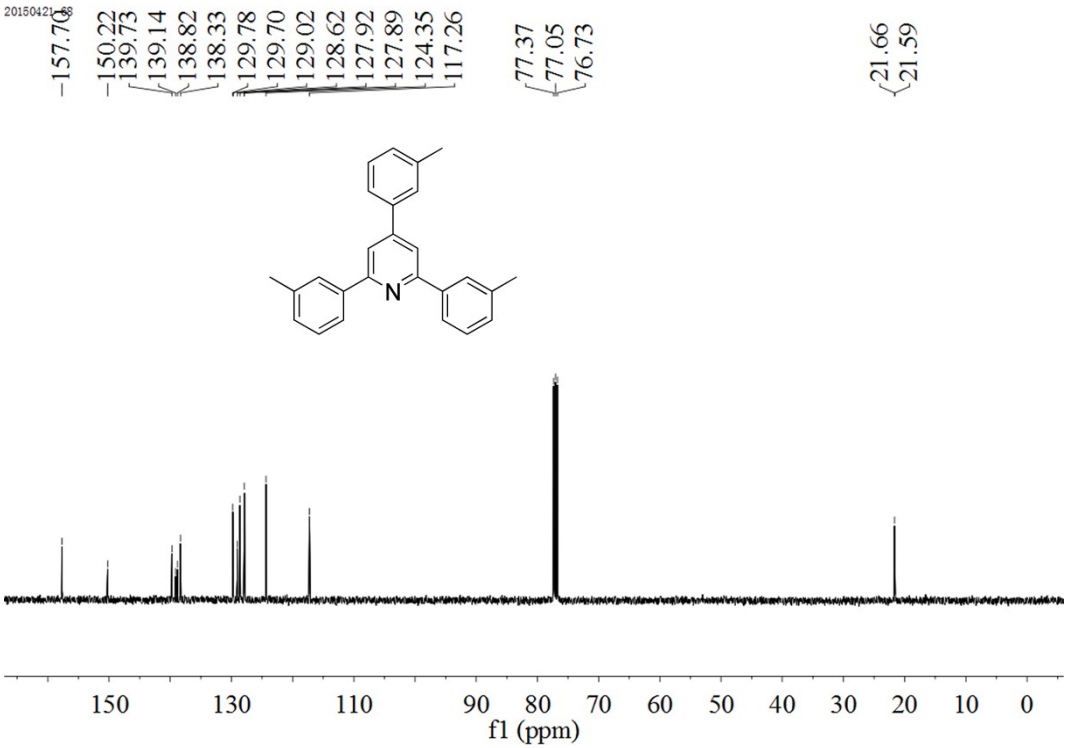
3r


20150421-65
8.101
8.081
7.780
7.725
7.711
7.703
7.690
7.324
7.304
7.252
7.229
7.207
7.186
2.431
D (s) 7.78
B (d) 7.31
E (d) 8.09
C (dd) 7.71
A (dd) 7.22
4.00
1.87
1.91
6.79
6.14
F
N
f1 (ppm)

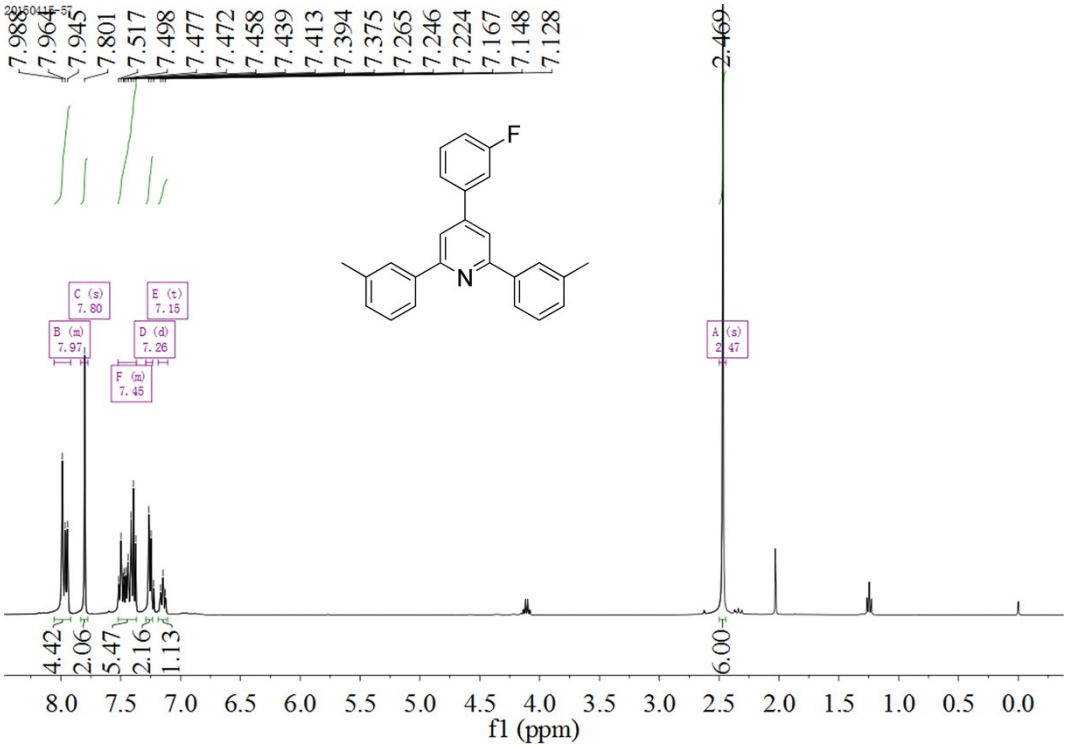

20150421-65
157.50
148.98
139.08
129.44
128.97
128.89
126.99
116.31
116.18
115.97
77.35
77.04
76.72
21.35
F
N
f1 (ppm)

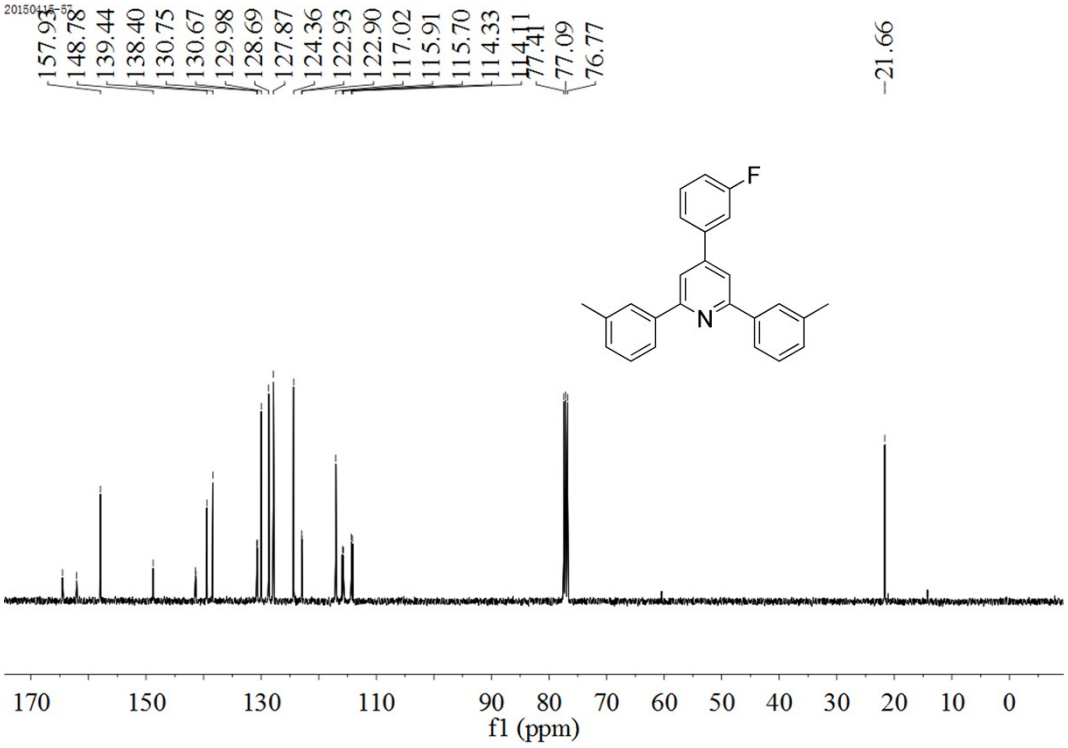
3s


8.014
7.984
7.965
7.853
7.556
7.434
7.416
7.404
7.386
7.294
7.271
7.246
2.481
C (s) 7.85
E (dd) 7.41
B (m) 7.99
D (s) 7.56
F (m) 7.27
A (s) 2.48
4.07
2.02
2.03
3.14
3.47
9.00
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

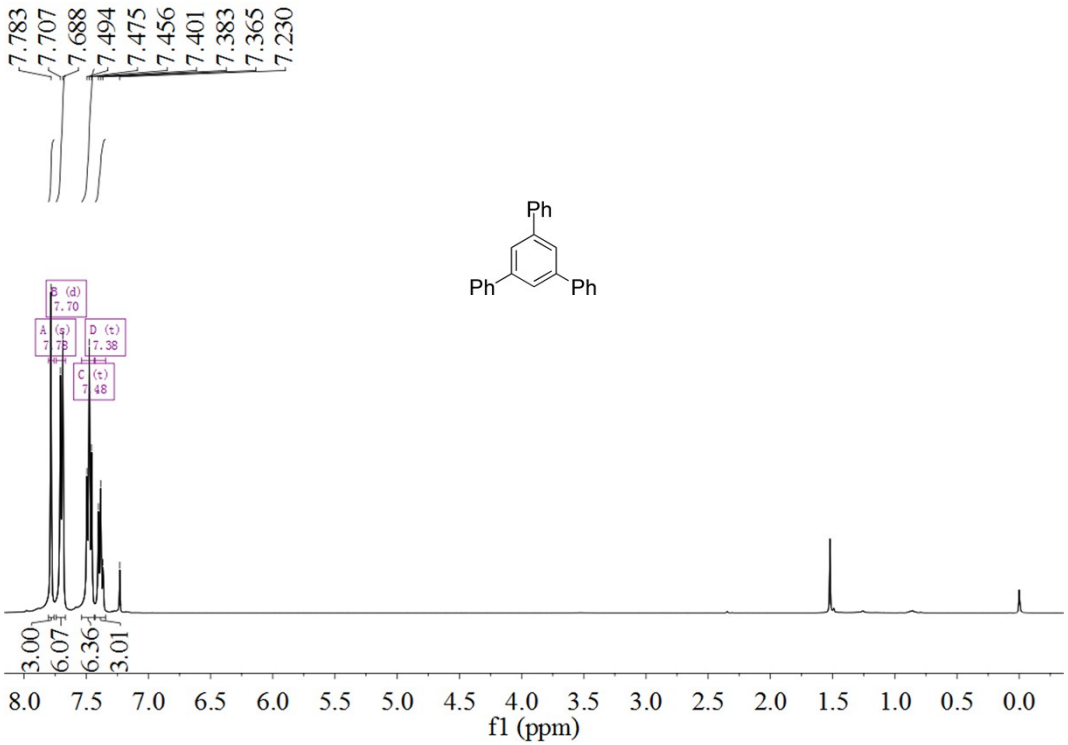

157.70
150.22
139.73
139.14
138.82
138.33
129.78
129.70
129.02
128.62
127.92
127.89
124.35
117.26
77.37
77.05
76.73
21.66
21.59
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

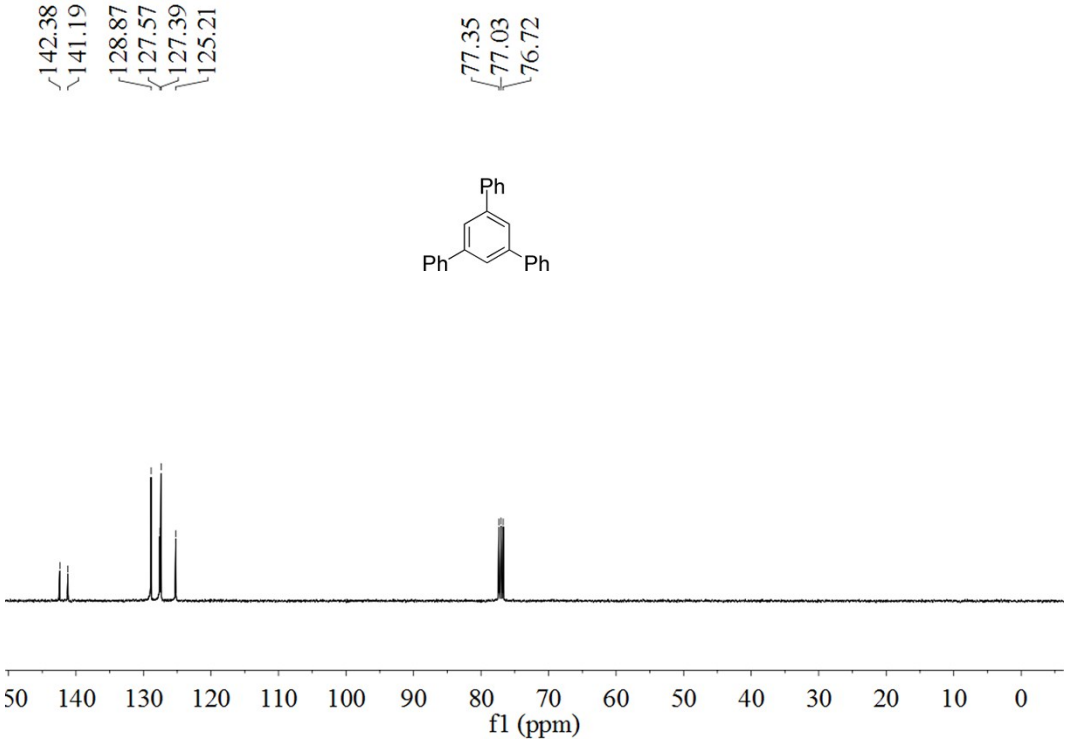
3t


7.988
7.964
7.945
7.801
7.517
7.498
7.477
7.472
7.458
7.439
7.413
7.394
7.375
7.265
7.246
7.224
7.167
7.148
7.128
2.469
F
N
C (s) 7.80
E (t) 7.15
B (m) 7.97
D (d) 7.26
F (m) 7.45
A (s) 2.47
4.42
2.06
5.47
2.16
1.13
6.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

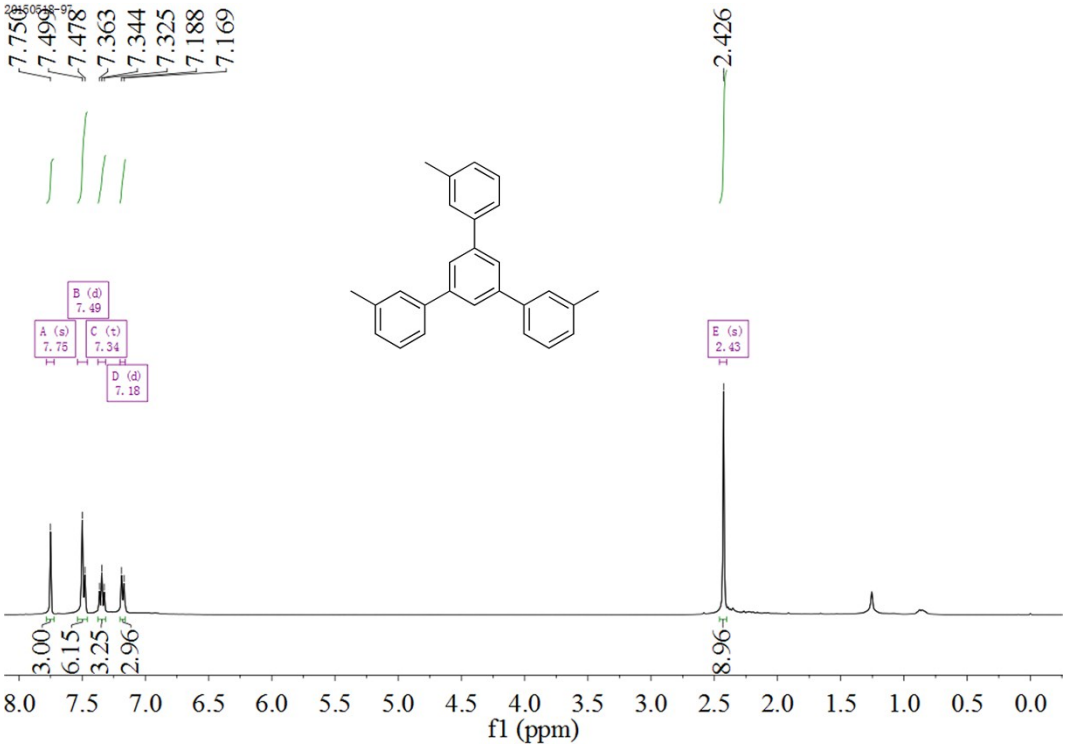

157.93
148.78
139.44
138.40
130.75
130.67
129.98
128.69
127.87
124.36
122.93
122.90
117.02
115.91
115.70
114.33
114.11
77.41
77.09
76.77
21.66
F
N
170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

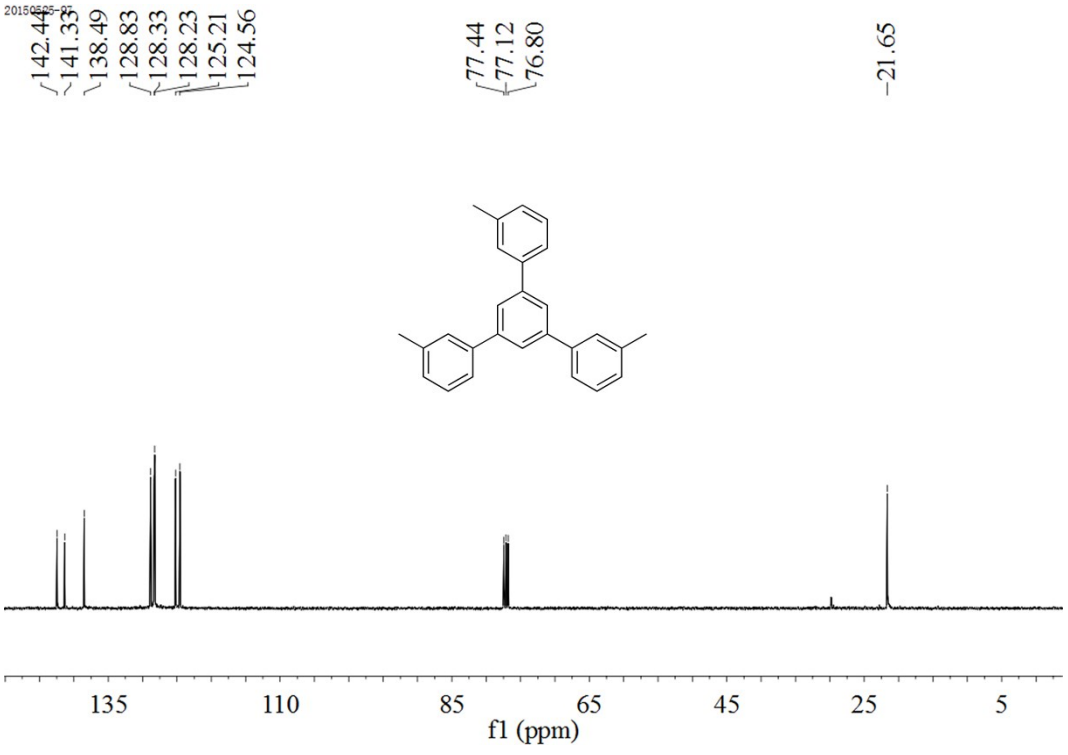
4a


7.783
7.707
7.688
7.494
7.475
7.456
7.401
7.383
7.365
7.230
Ph
Ph
Ph
B (d)
7.70
A (s)
7.73
D (t)
7.38
C (t)
7.48
3.00
6.07
6.36
3.01
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

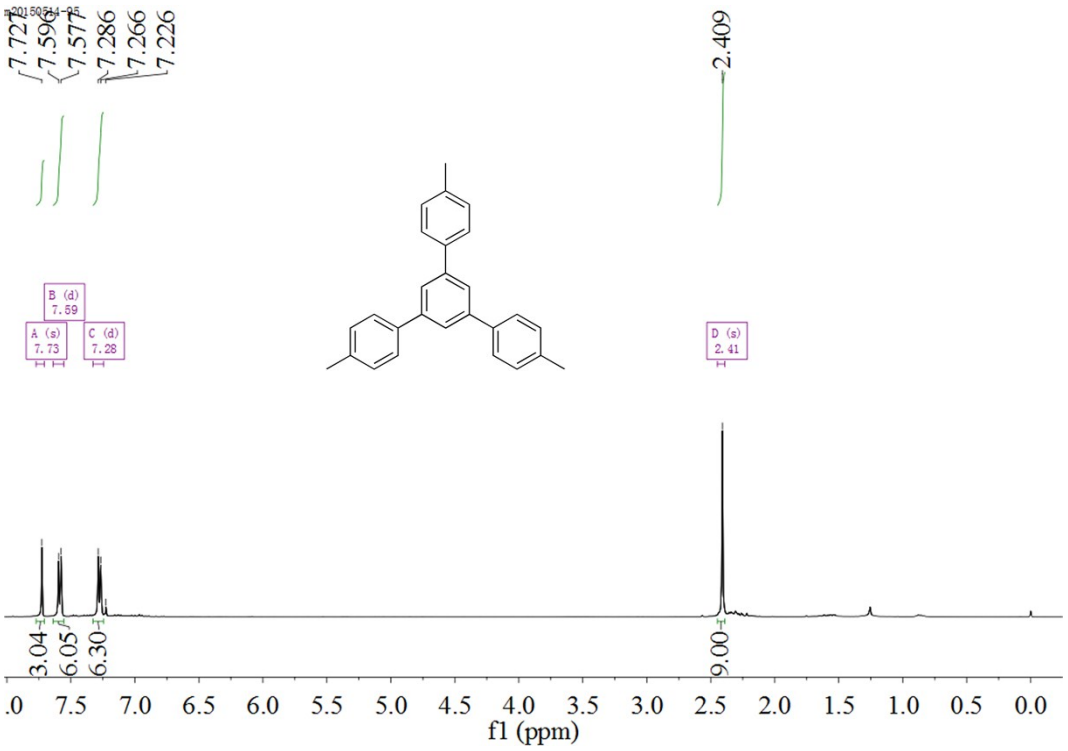

142.38
141.19
128.87
127.57
127.39
125.21
77.35
77.03
76.72
Ph
Ph
Ph
50 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

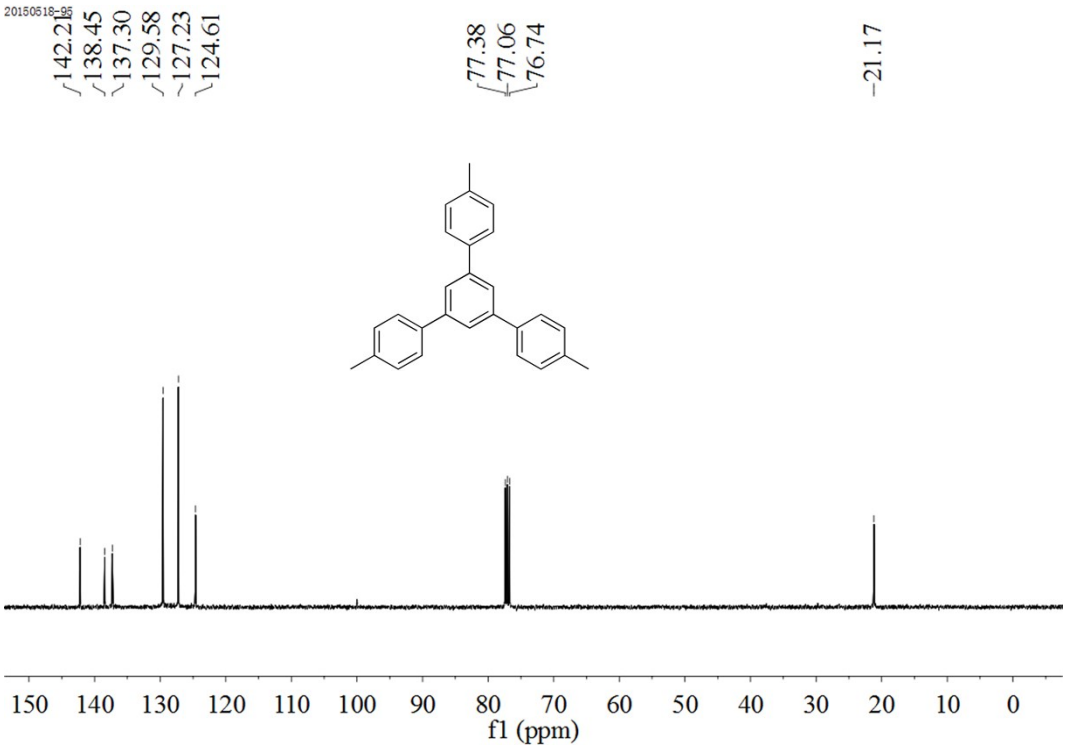
4b


7.756
7.499
7.478
7.363
7.344
7.325
7.188
7.169
2.426
B (d) 7.49
A (s) 7.75
C (t) 7.34
D (d) 7.18
E (s) 2.43
3.00
6.15
3.25
2.96
8.96
f1 (ppm)

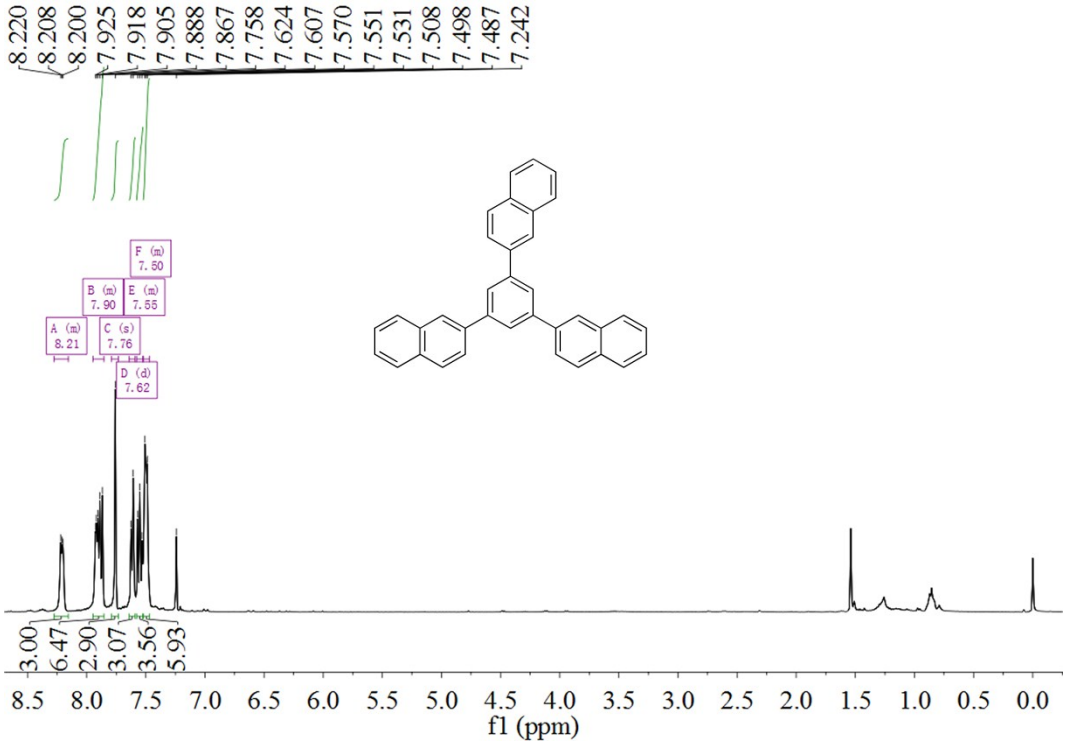

142.44
141.33
138.49
128.83
128.33
128.23
125.21
124.56
77.44
77.12
76.80
21.65
f1 (ppm)

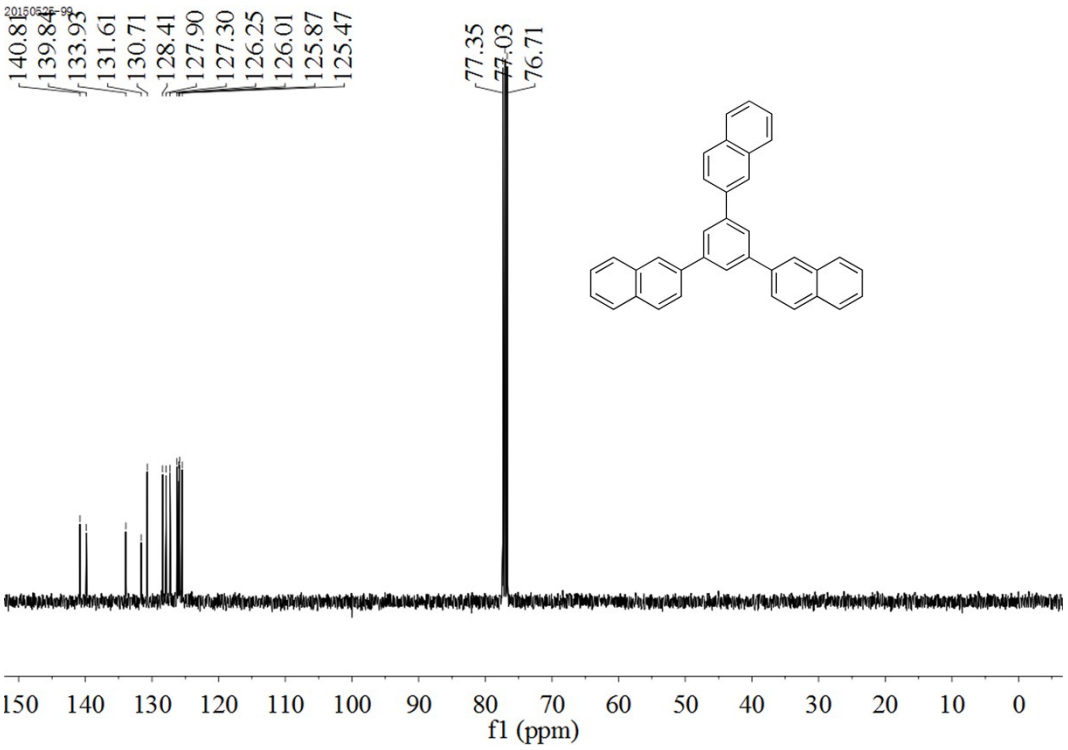
4c


7.727
7.596
7.577
7.286
7.266
7.226
2.409
B (d)
7.59
A (s)
7.73
C (d)
7.28
D (s)
2.41
3.04
6.05
6.30
9.00
f1 (ppm)

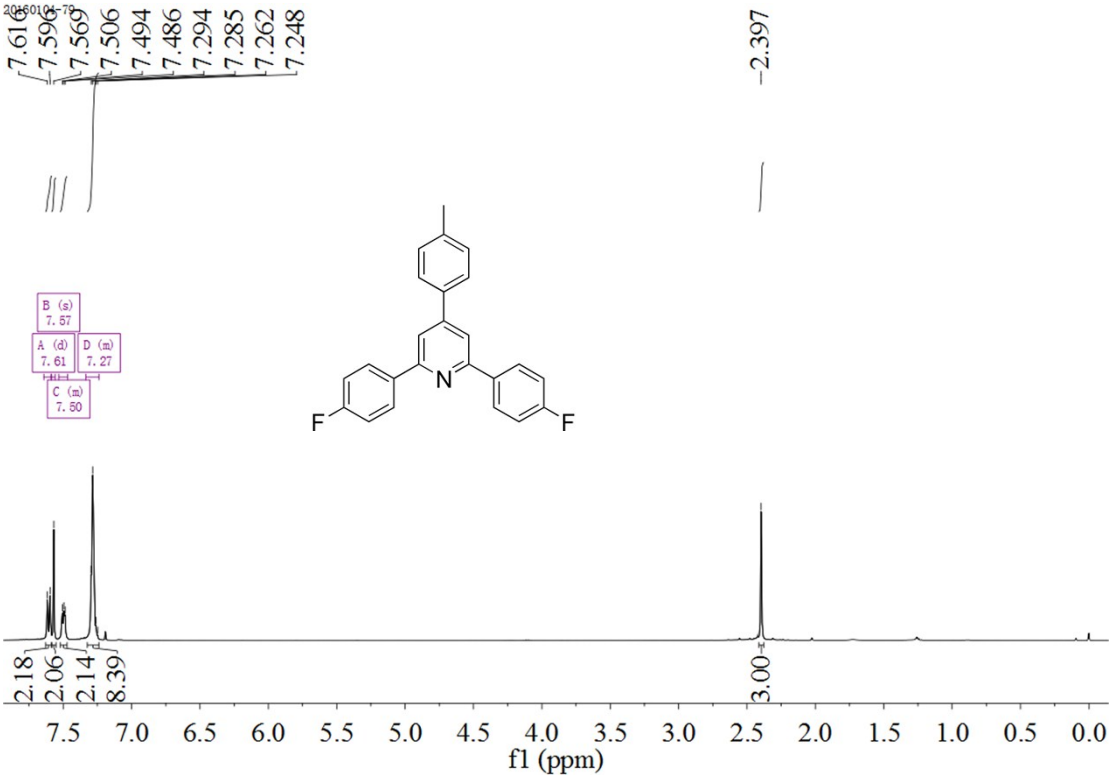

142.21
138.45
137.30
129.58
127.23
124.61
77.38
77.06
76.74
21.17
f1 (ppm)

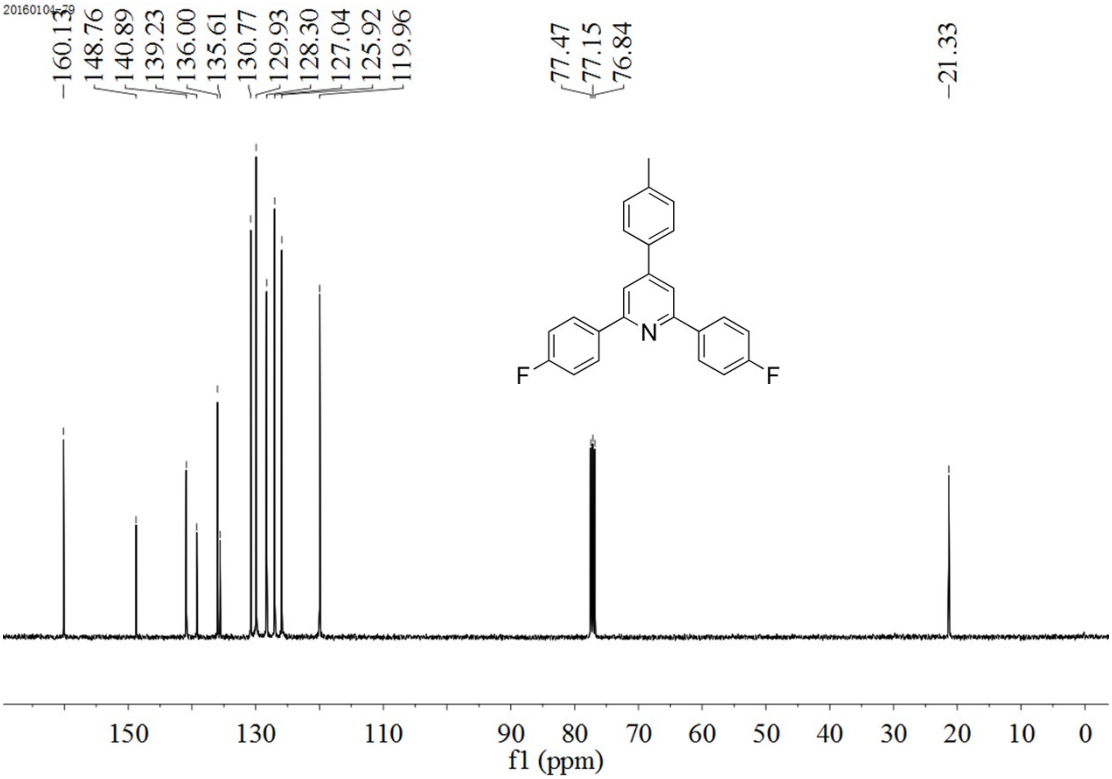
4d


8.220
8.208
8.200
7.925
7.918
7.905
7.888
7.867
7.758
7.624
7.607
7.570
7.551
7.531
7.508
7.498
7.487
7.242
F (m) 7.50
B (m) 7.90
E (m) 7.55
A (m) 8.21
C (s) 7.76
D (d) 7.62
3.00
6.47
2.90
3.07
3.56
5.93
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

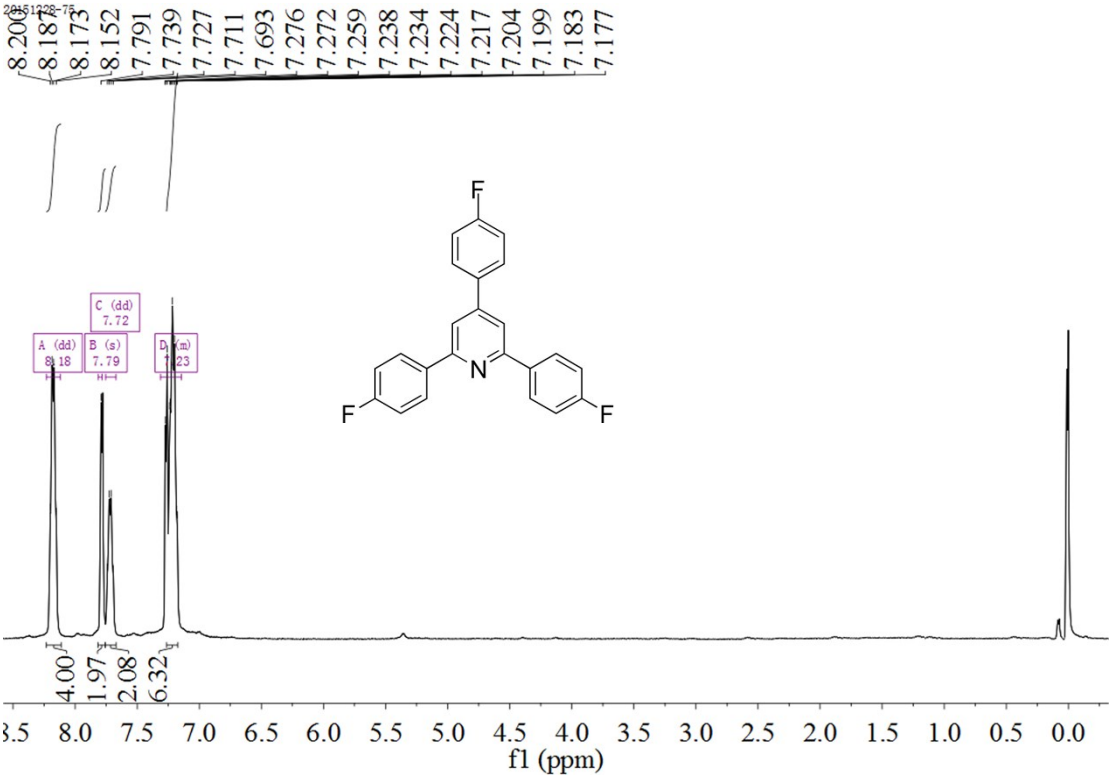

20150526-99
140.81
139.84
133.93
131.61
130.71
128.41
127.90
127.30
126.25
126.01
125.87
125.47
77.35
77.03
76.71
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

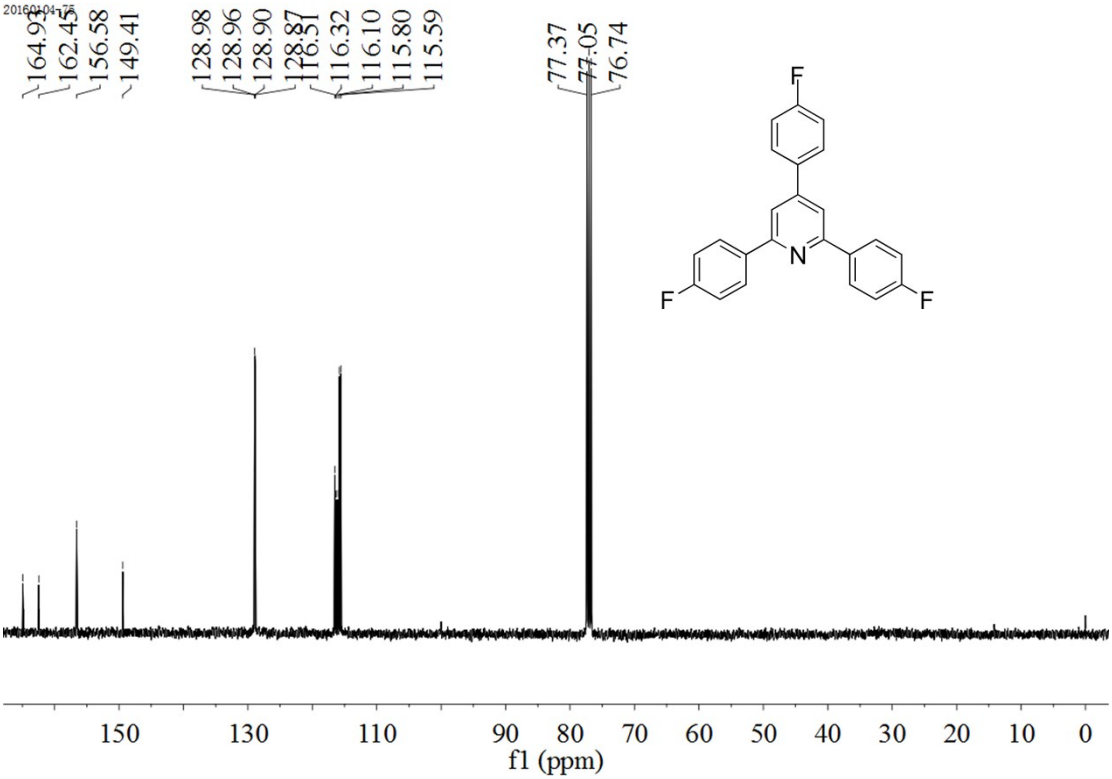
6a


7.616
7.596
7.569
7.506
7.494
7.486
7.294
7.285
7.262
7.248
2.397
B (s) 7.57
A (d) 7.61
D (m) 7.27
C (m) 7.50
N
F
F
2.18
2.06
2.14
8.39
3.00
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

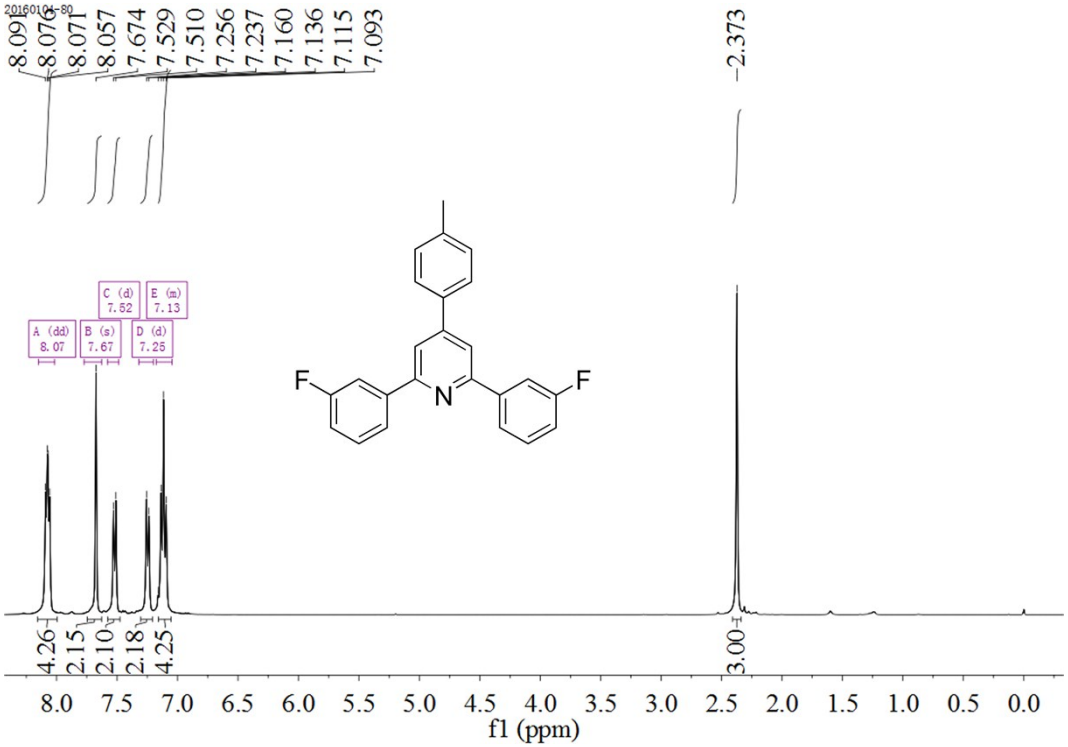

160.13
148.76
140.89
139.23
136.00
135.61
130.77
129.93
128.30
127.04
125.92
119.96
77.47
77.15
76.84
21.33
N
F
F
150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

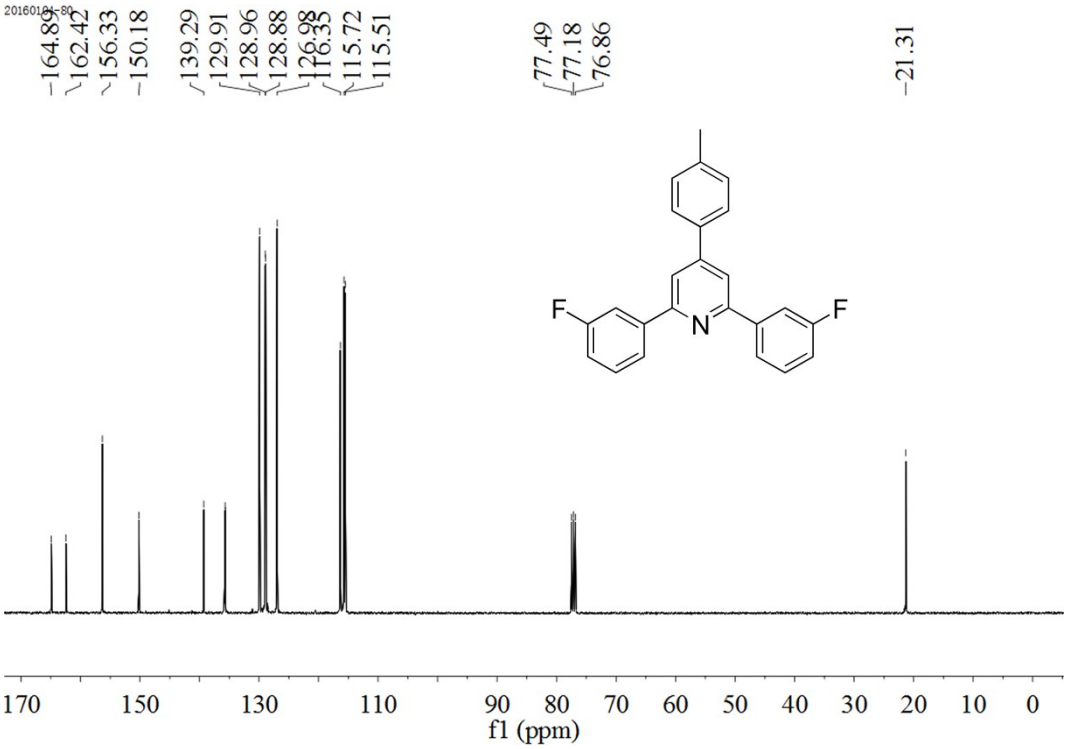
6b


8.200
8.187
8.173
8.152
7.791
7.739
7.727
7.711
7.693
7.276
7.272
7.259
7.238
7.234
7.224
7.217
7.204
7.199
7.183
7.177
A (dd) 8.18
B (s) 7.79
C (dd) 7.72
D (m) 7.23
4.00
1.97
2.08
6.32
F
N
F
F
f1 (ppm)

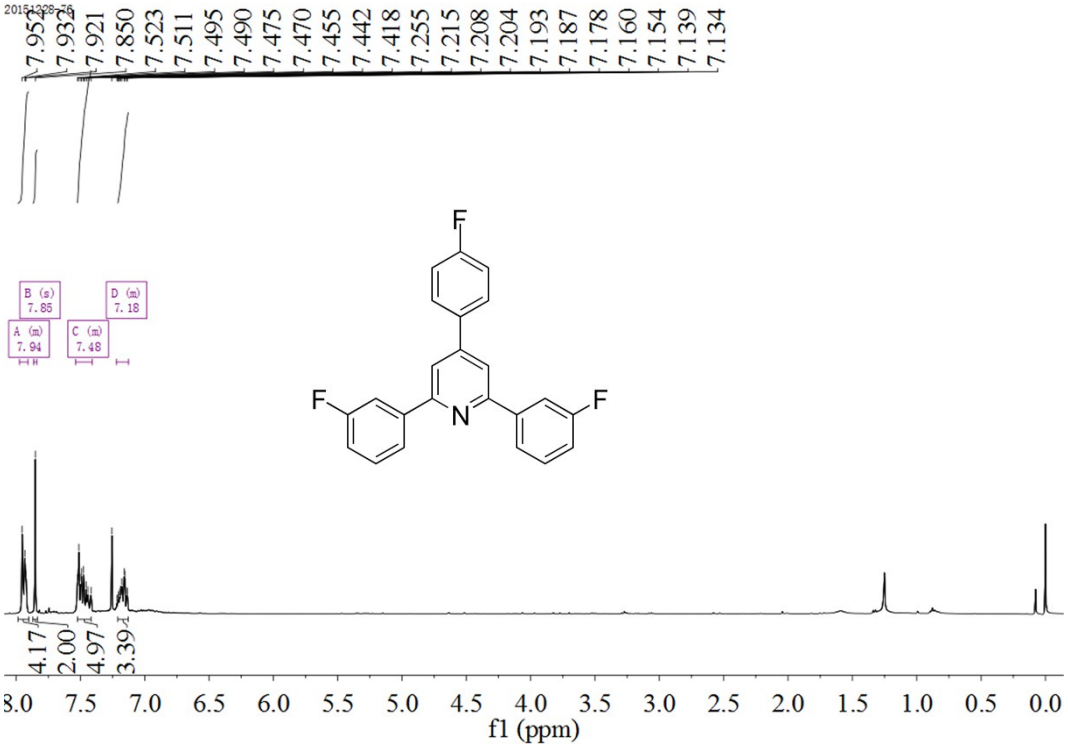

164.92
162.45
156.58
149.41
128.98
128.96
128.90
128.87
116.51
116.32
116.10
115.80
115.59
77.37
77.05
76.74
F
N
F
F
f1 (ppm)

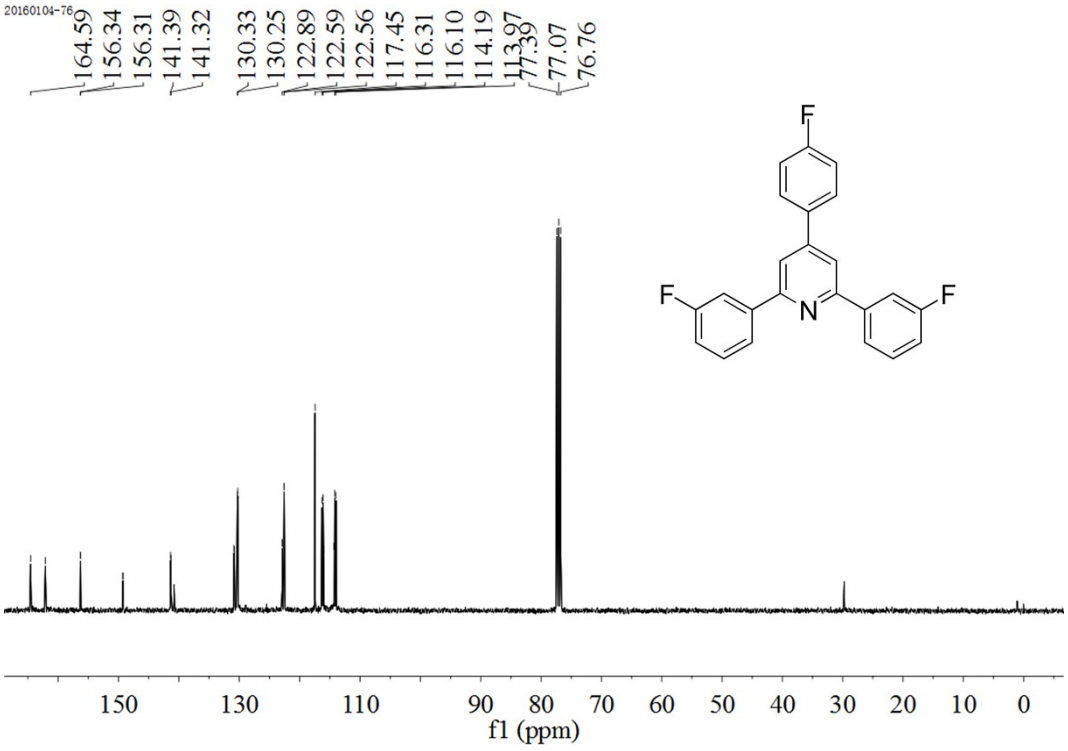
6c


8.091
8.076
8.071
8.057
7.674
7.529
7.510
7.256
7.237
7.160
7.136
7.115
7.093
2.373
A (dd) 8.07
B (s) 7.67
C (d) 7.52
D (d) 7.25
E (m) 7.13
F
N
F
4.26
2.15
2.10
2.18
4.25
3.00
f1 (ppm)

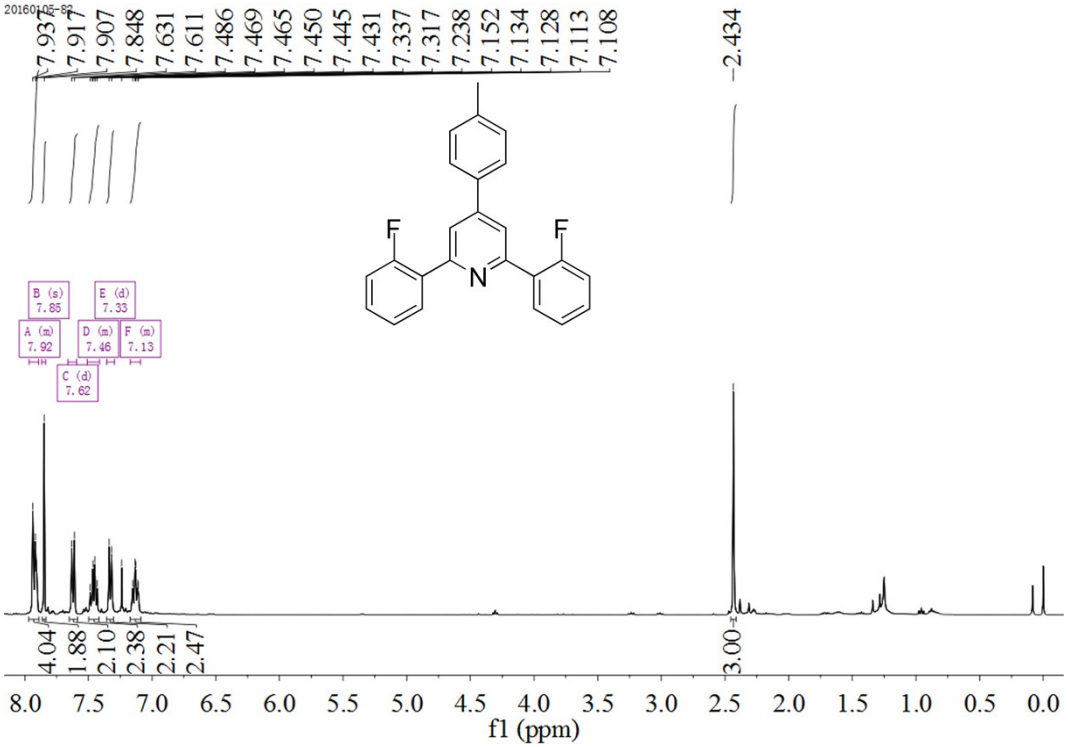

164.89
162.42
156.33
150.18
139.29
129.91
128.96
128.88
126.98
118.35
115.72
115.51
77.49
77.18
76.86
21.31
F
N
F
f1 (ppm)

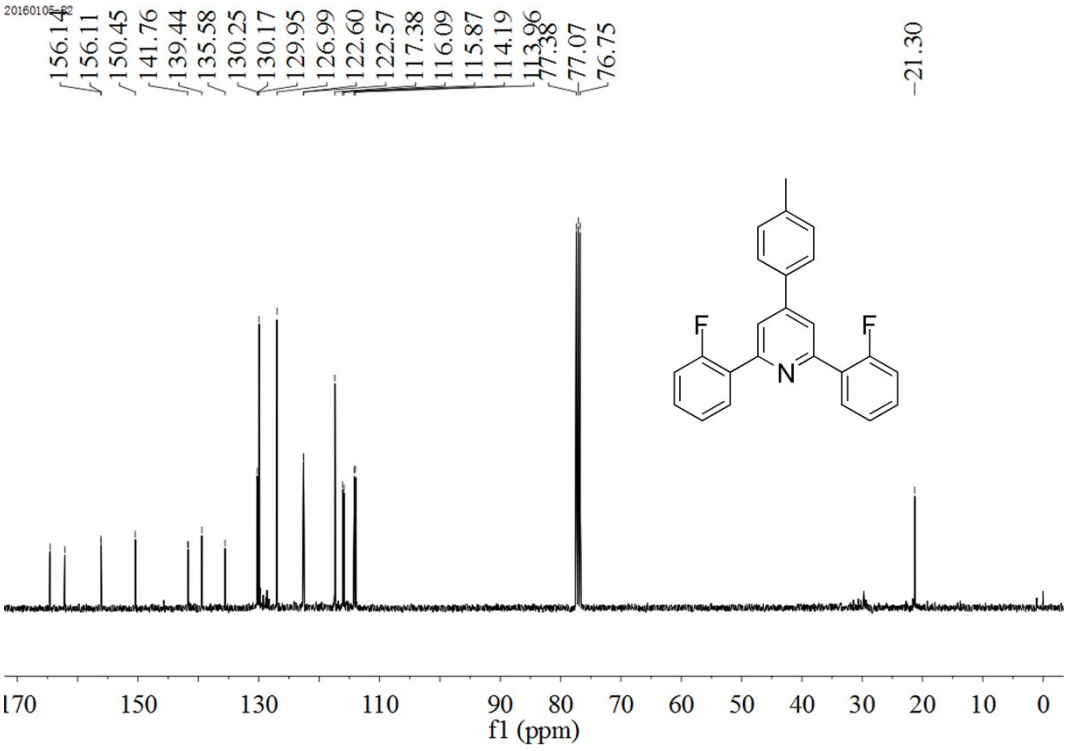
6d


20151228-76
7.952
7.932
7.921
7.850
7.523
7.511
7.495
7.490
7.475
7.470
7.455
7.442
7.418
7.255
7.215
7.208
7.204
7.193
7.187
7.178
7.160
7.154
7.139
7.134
B (s) 7.85
D (m) 7.18
A (m) 7.94
C (m) 7.48
F
F
N
F
4.17
2.00
4.97
3.39
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

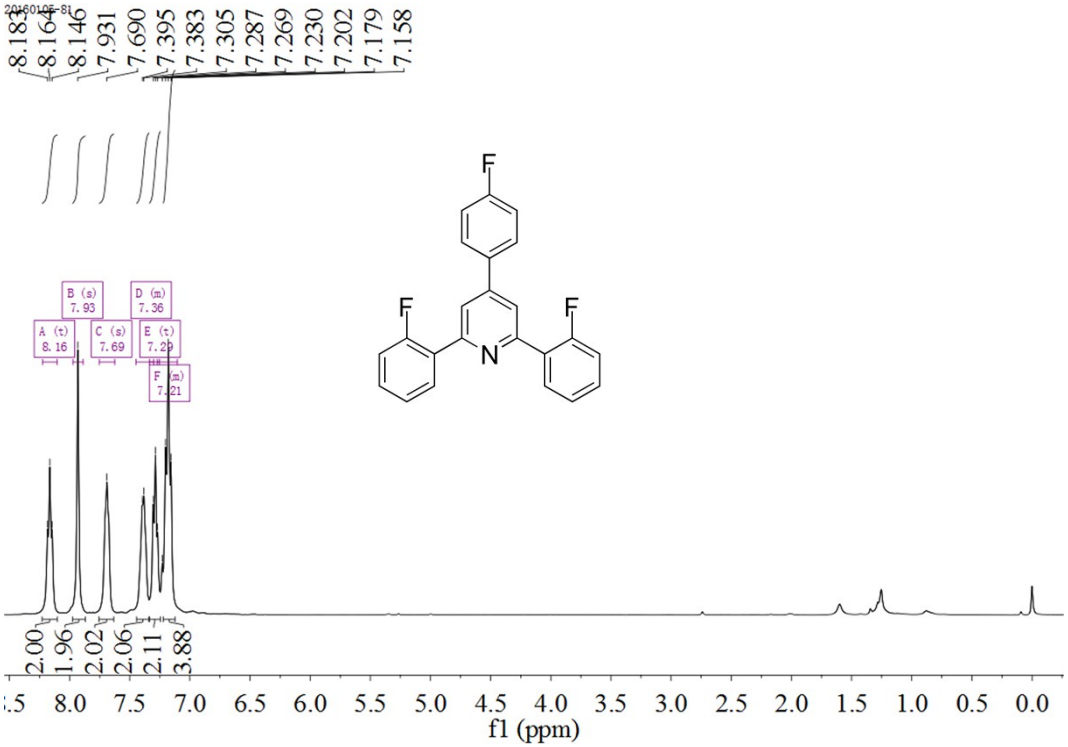

20160104-76
164.59
156.34
156.31
141.39
141.32
130.33
130.25
122.89
122.59
122.56
117.45
116.31
116.10
114.19
113.97
77.39
77.07
76.76
F
F
N
F
150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

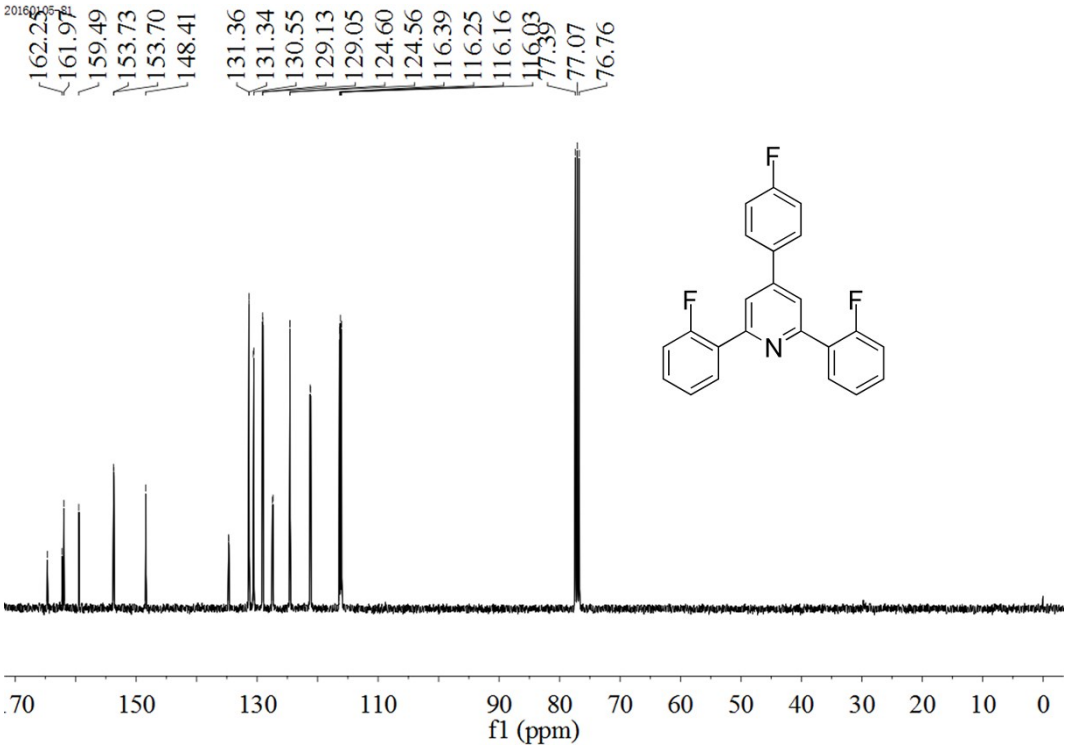
6e


7.937
7.917
7.907
7.848
7.631
7.611
7.486
7.469
7.465
7.450
7.445
7.431
7.337
7.317
7.238
7.152
7.134
7.128
7.113
7.108
2.434
F
F
N
B (s) 7.85
E (d) 7.33
A (m) 7.92
D (m) 7.46
F (m) 7.13
C (d) 7.62
4.04
1.88
2.10
2.38
2.21
2.47
3.00
f1 (ppm)


156.14
156.11
150.45
141.76
139.44
135.58
130.25
130.17
129.95
126.99
122.60
122.57
117.38
116.09
115.87
114.19
113.96
77.38
77.07
76.75
21.30
F
F
N
f1 (ppm)

6f


20160105-81
8.183
8.164
8.146
7.931
7.690
7.395
7.383
7.305
7.287
7.269
7.230
7.202
7.179
7.158
B (s) 7.93
D (m) 7.36
A (t) 8.16
C (s) 7.69
E (t) 7.29
F (m) 7.21
2.00
1.96
2.02
2.06
2.11
3.88
f1 (ppm)


20160105-81
162.25
161.97
159.49
153.73
153.70
148.41
131.36
131.34
130.55
129.13
129.05
124.60
124.56
116.39
116.25
116.16
116.03
77.39
77.07
76.76
f1 (ppm)