# Supporting information

## Nickel-PNN catalysed sustainable synthesis of polysubstituted quinolines under microwave irradiation

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**Crystal structure determination of complexes**.

Single crystals of all complexes were mounted on a Cryoloop with a drop of paratone oil and positioned in the cold nitrogen stream on a Bruker D8 Venture diffractometer. The data collections were performed at 100 K to 150 K using Bruker D8 Venture diffractometer with a graphite monochromated Mo Kα radiation source (λ = 0.71073 Å) with the ω-scan technique. The data were reduced using CrysalisPro Red 171.41_64.93a software.[1] The structures were solved using Olex2 1.5[2] with the ShelXT[3] structure solution program using intrinsic phasing and refined with SHELXL[3] refinement package using least-squares minimization. All non-hydrogen atoms were refined anisotropically. Hydrogen atoms were placed in calculated positions and included as riding contributions with isotropic displacement parameters tied to those of the attached non-hydrogen atoms. The given chemical formula and other crystal data do not take into account the unknown solvent molecule(s). The reflections with error/esd more than 10 were excluded in order to avoid problems related to better refinement of the data. The data completeness is more than 99.8% in most of the cases, which is enough to guarantee a very good refinement of data. The details of X-ray structural determinations are given in Tables S1. In complex **Ni1** the disordered solvent molecules could not be recognized or modelled to a known solvent; hence, it was *SQUEEZED* using PLATON. The results indicated 1461 electrons and a volume of 2905 Å$^3$ for **Ni1**. The given chemical formula and other crystal data do not take into account the unknown solvent molecule(s). Crystallographic data for the structures reported in this paper have been deposited with the Cambridge Crystallographic Data Centre as supplementary publication no. CCDC: 2362530(Comp. L2), 2362531(Comp. Ni1), 2362532(Comp. Ni2), 2362533(Comp. Ni3), 2362534(Comp. Ni4), -2362535(Comp. Ni5).

Table S1 Crystallographic information of **compounds L2 and Ni1-Ni5**

| | **L2** | **Ni1** | **Ni2** | **Ni3** | **Ni4** | **Ni5** |
|---|---|---|---|---|---|---|
| Formula | $C_{26}H_{22}N_5P$ | $C_{52}H_{40}Cl_2F_6N_{10}Ni_2O_6P_2S_2$ | $C_{27}H_{22}ClF_3N_5NiO_3PS$ | $C_{22}H_{28}ClF_3N_5NiO_3PS$ | $C_{25}H_{19}ClN_5NiP$ | $C_{48}H_{62}Cl_2N10Ni_2OP_2$ |
| Formula weight | 435.45 | 1329.32 | 678.68 | 624.68 | 514.58 | 1045.33 |
| Temperature/K | 150.00(10) | 293.15 | 273.15(10) | 150.0 | 150.00(10) | 113.00 |
| Crystal system | monoclinic | trigonal | triclinic | Orthorhombic | monoclinic | triclinic |
| Space group | P21/n | R-3 | P-1 | $Pna2_1$ | I2/a | P-1 |
| a/Å | 9.7622(2) | 42.930(3) | 8.5305(4) | 17.3501(8) | 21.2519(14) | 7.8912(7) |
| b/Å | 11.3546(2) | 42.930(3) | 9.4375(4) | 10.6515(5) | 10.0002(5) | 8.8336(10) |
| c/Å | 20.4691(3) | 16.9889(15) | 17.6861(6) | 14.9182(6) | 24.7491(15) | 18.4362(19) |
| α/° | 90 | 90 | 90.703(3) | 90 | 90 | 85.707(4) |
| β/° | 90.507(2) | 90 | 98.984(3) | 90 | 114.089(7) | 85.978(4) |
| γ/° | 90 | 120 | 99.254(4) | 90 | 90 | 74.077(4) |
| Volume/Å$^3$ | 2268.83(7) | 27115(4) | 1387.05(10) | 2757.0(2) | 4801.7(5) | 1230.7(2) |
| Z | 4 | 18 | 2 | 4 | 8 | 1 |
| $\rho_{calc}$g/cm$^3$ | 1.275 | 1.465 | 1.625 | 1.505 | 1.424 | 1.410 |
| μ/mm$^{-1}$ | 0.145 | 0.910 | 0.990 | 0.988 | 1.009 | 0.986 |
| F(000) | 912.0 | 12168.0 | 692.0 | 1288.0 | 2112.0 | 548.0 |
| Crystal size/mm$^3$ | 0.095 × 0.068 × 0.056 | 0.125 × 0.098 × 0.078 | 0.098 × 0.075 × 0.052 | 0.093 × 0.075 × 0.052 | 0.085 × 0.072 × 0.056 | 0.286 × 0.156 × 0.125 |
| 2θ range, deg | 5.504 to 50 | 3.762 to 50.106 | 4.376 to 63.658 | 5.254 to 49.996 | 4.198 to 50 | 4.438 to 57.068 |
| Total no of reflection | 23165 | 72220 | 42950 | 15439 | 13298 | 61201 |
| Independent reflections | 3974 [$R_{int}$ = 0.08343] | 10665 [$R_{int}$ = 0.1396] | 8927 [$R_{int}$ = 0.1133] | 4632 [$R_{int}$ = 0.0794] | 4213[$R_{int}$=0.1000] | 6249 [$R_{int}$ = 0.0550] |
| Goodness-of-fit on F$^2$ | 1.037 | 1.025 | 1.025 | 1.005 | 0.986 | 1.028 |
| $R_1$ (all data) | 0.0381 | 0.0596 | 0.0576 | 0.0389 | 0.0546 | 0.0264 |
| $wR_2$ (I > 2σ(I)) | 0.0817 | 0.1636 | 0.1262 | 0.0876 | 0.1331 | 0.0647 |

NMR and HRMS spectra

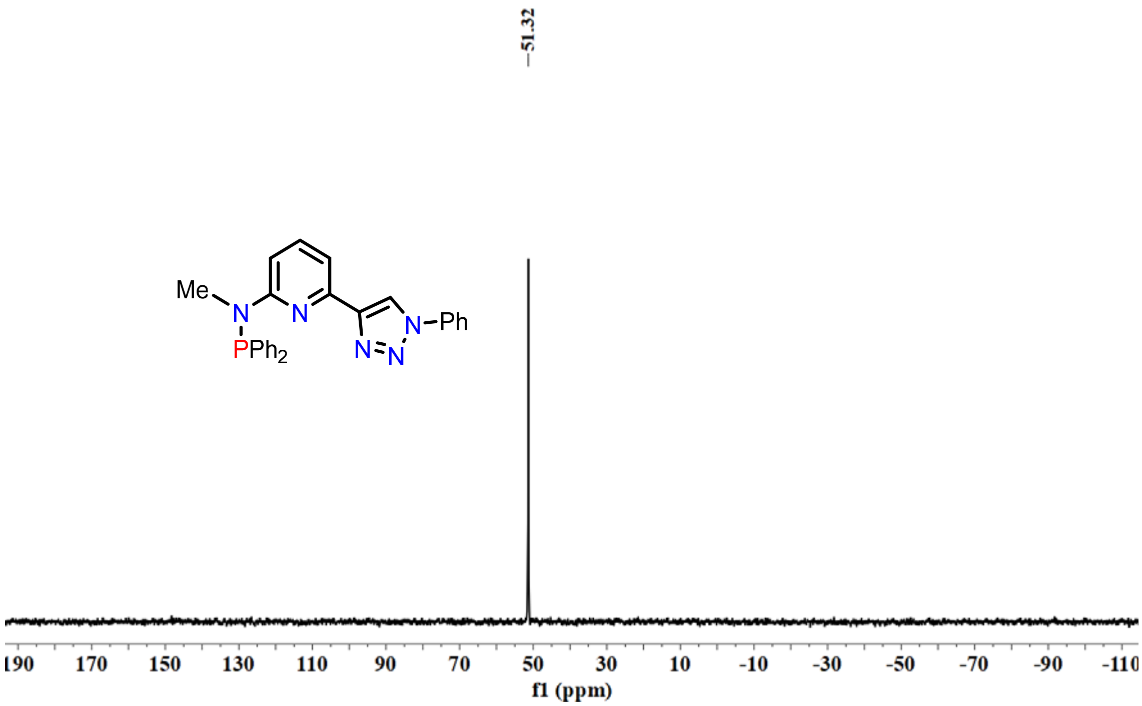



**Fig. S1** $^{31}$P NMR spectrum of **L2** in $CDCl_3$ (162 MHz).

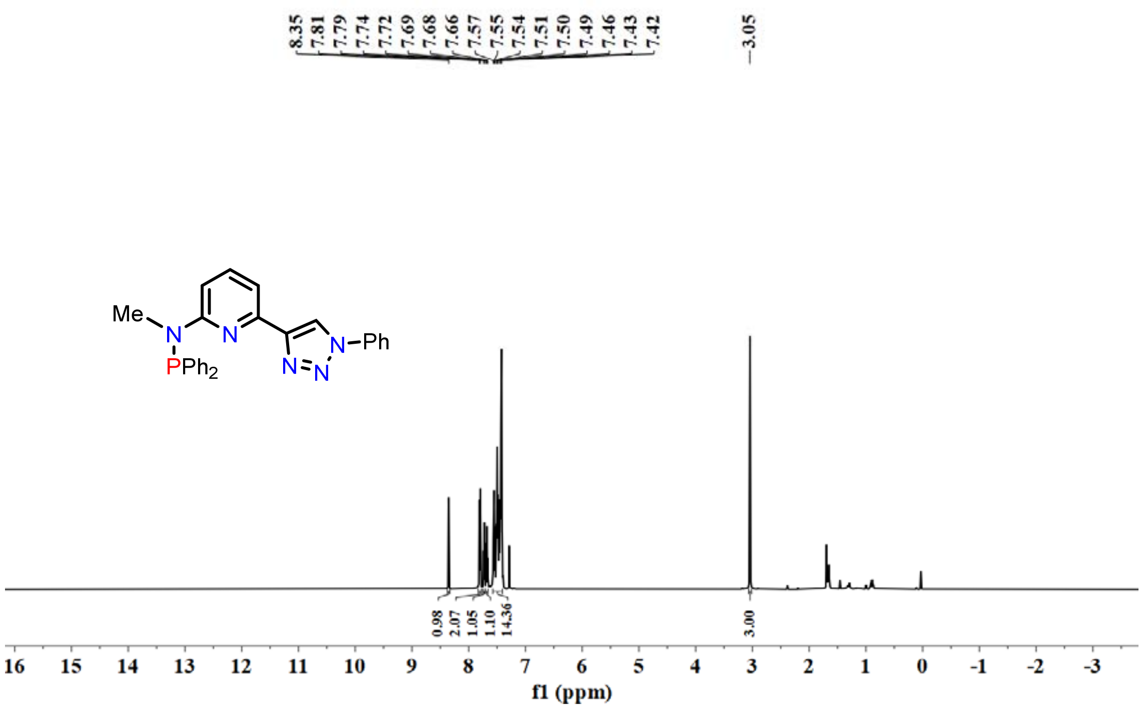



**Fig. S2** $^{1}$H NMR spectrum of L**2** in $CDCl_3$ (400 MHz).

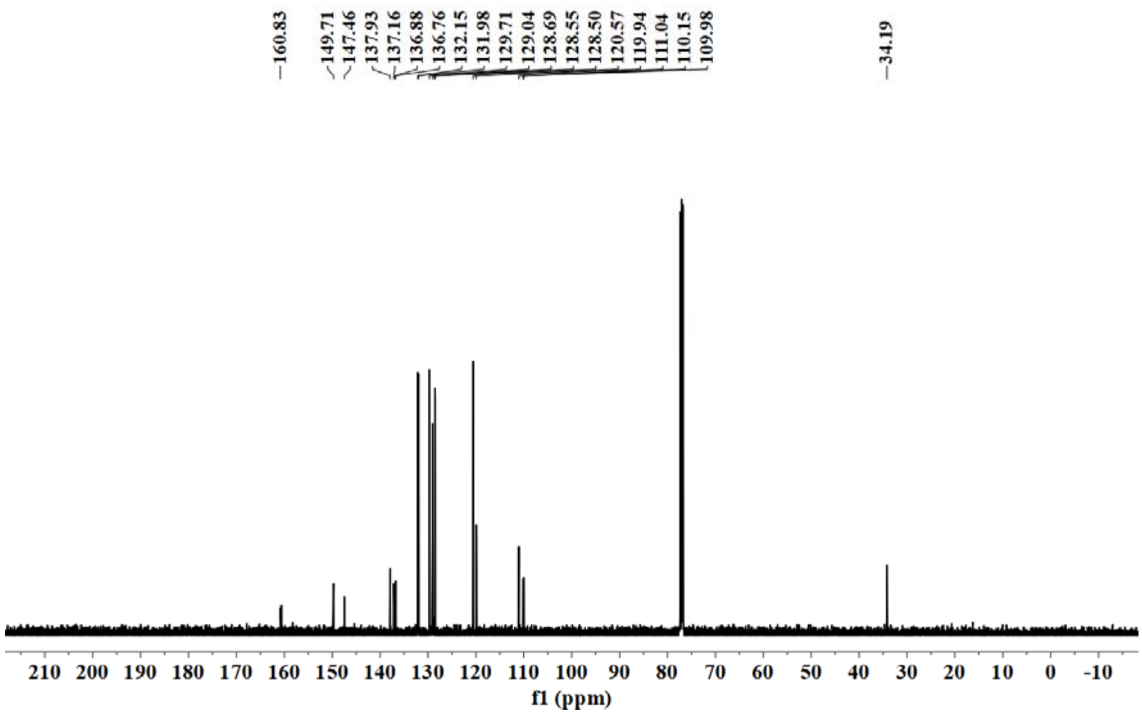



**Fig.S3** [13]C NMR spectrum of L**2** in $CDCl_3$ (101 MHz).

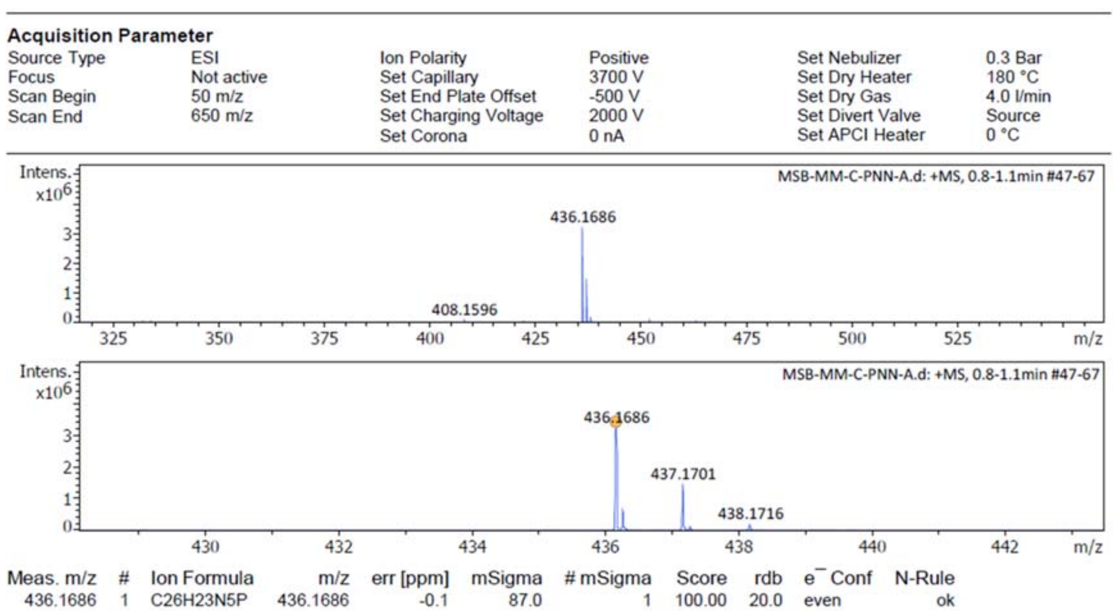



**Fig. S4** HRMS spectrum of L**2**.

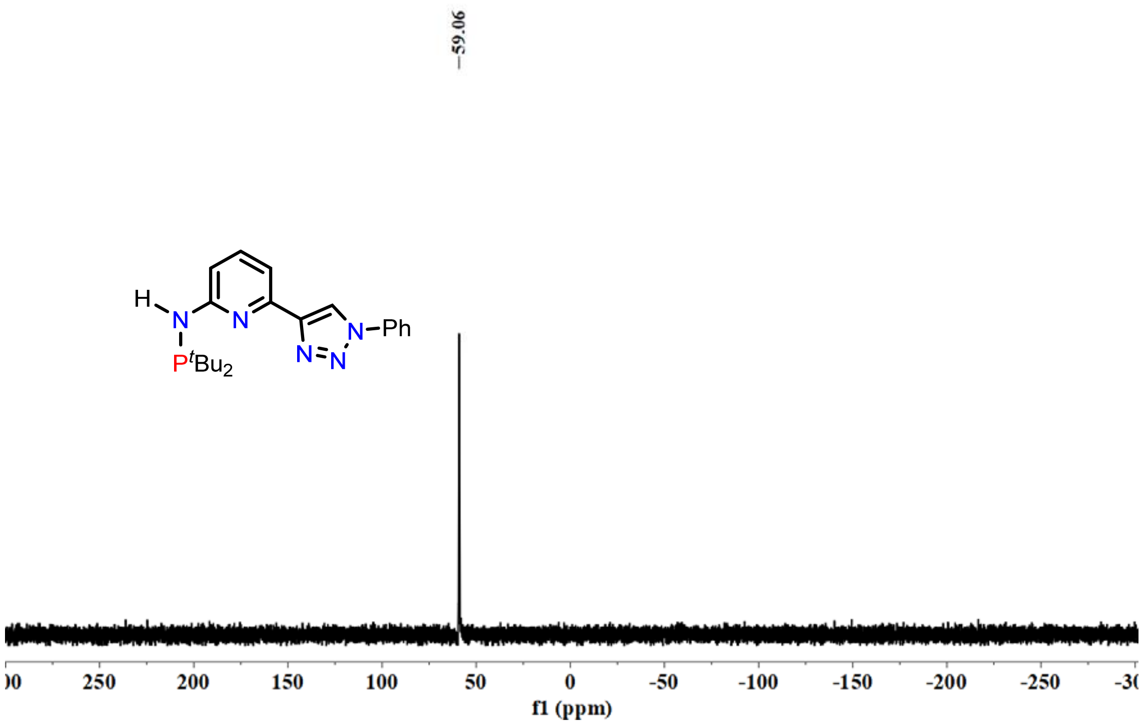



**Fig. S5** $^{31}$P NMR spectrum of **L3** in $CDCl_3$ (162 MHz).

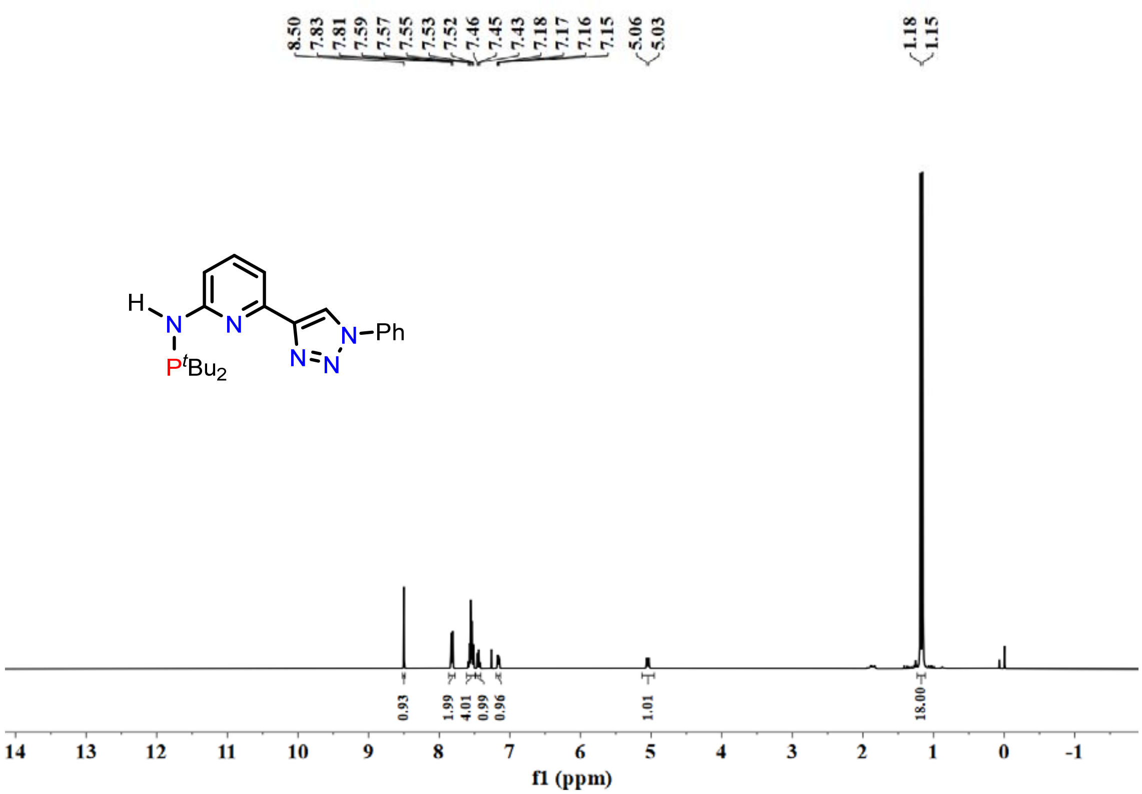



**Fig. S6** $^{1}$H NMR spectrum of **L3** in $CDCl_3$ (400 MHz).

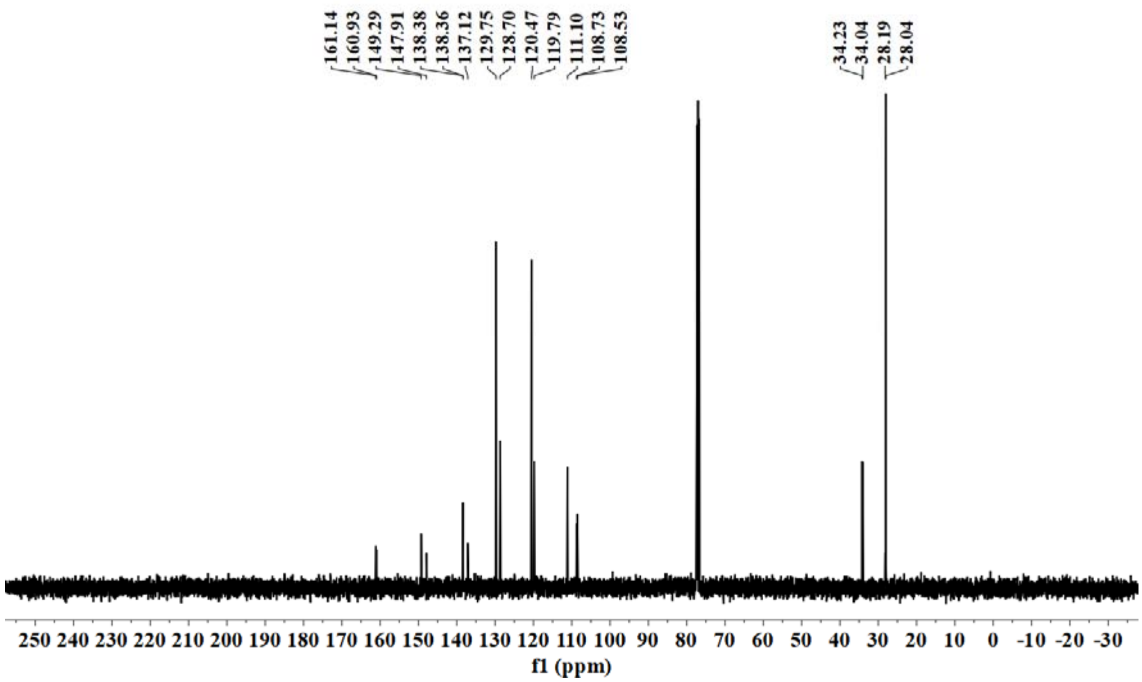



**Fig.S7** $^{13}$C NMR spectrum of **L3** in $CDCl_3$ (101 MHz).

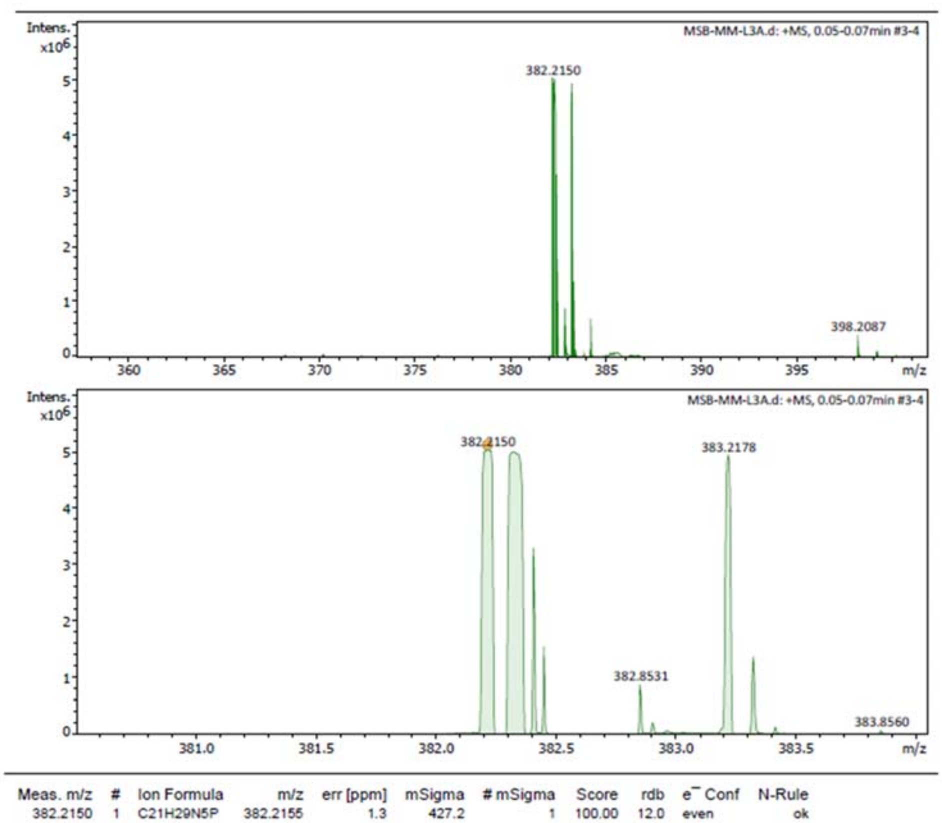



**Fig. S8** HRMS spectrum of **L3**.

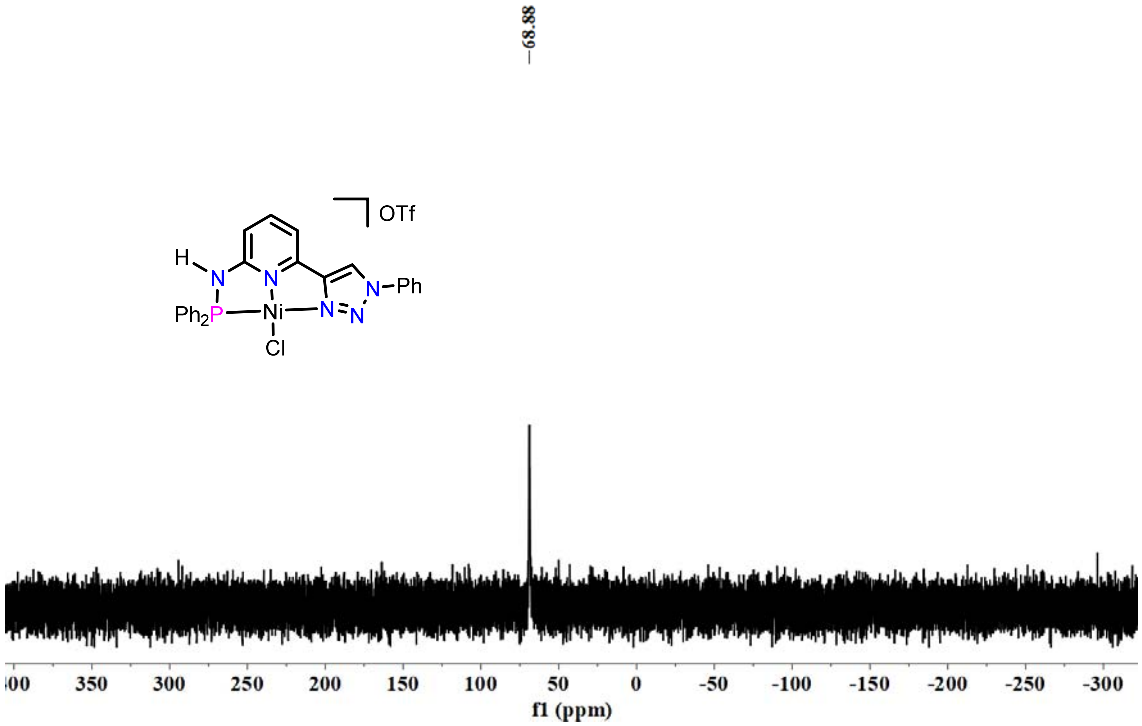


**Fig. S9** $^{31}$P NMR spectrum of **Ni1** in $CDCl_3$ (162 MHz).

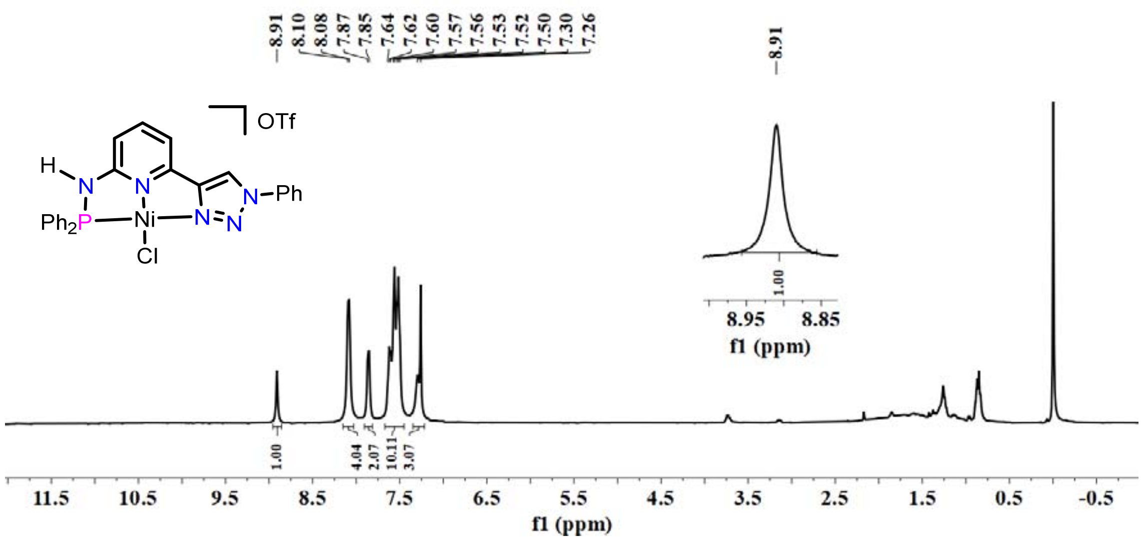


**Fig.S10** $^{1}$H NMR spectrum of **Ni1** in $CDCl_3$ (400 MHz).

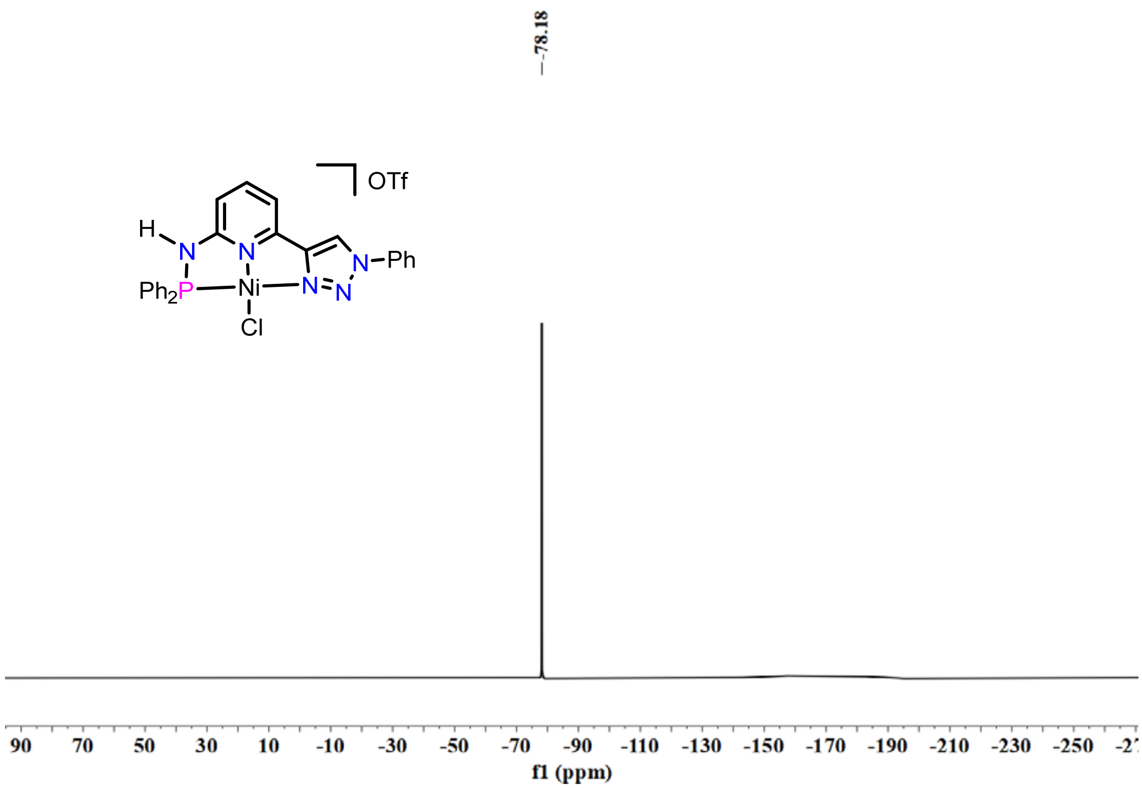



**Fig. S11** $^{19}$F NMR spectrum of **Ni1** in $CDCl_3$ (377 MHz).

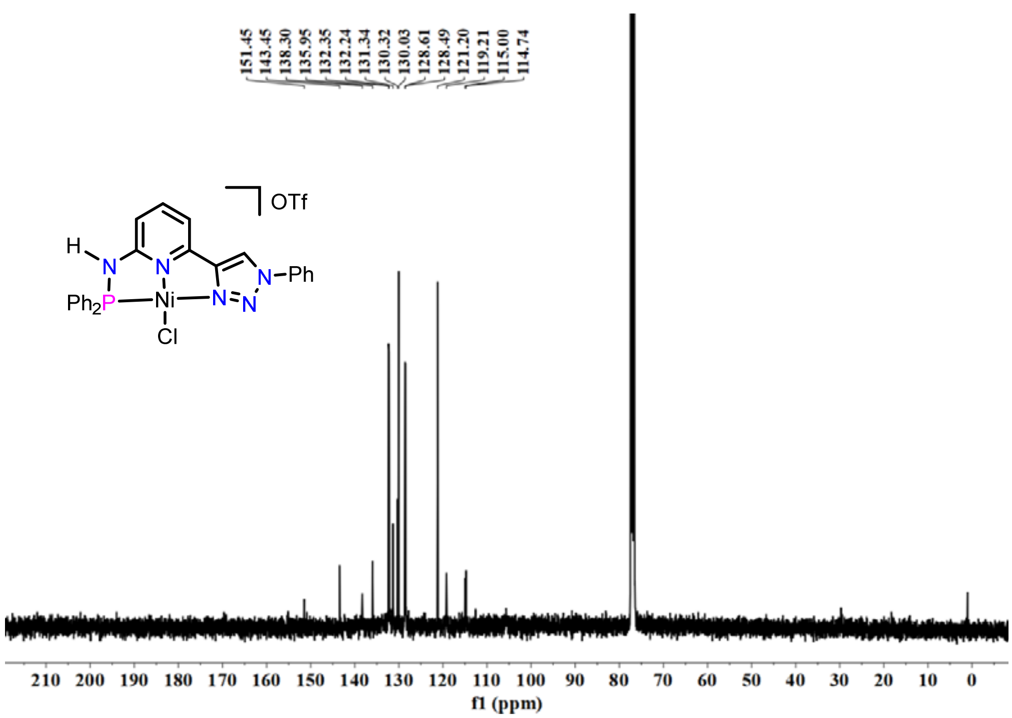



**Fig.S12** $^{13}$C NMR spectrum of **Ni1** in $CDCl_3$ (101 MHz).

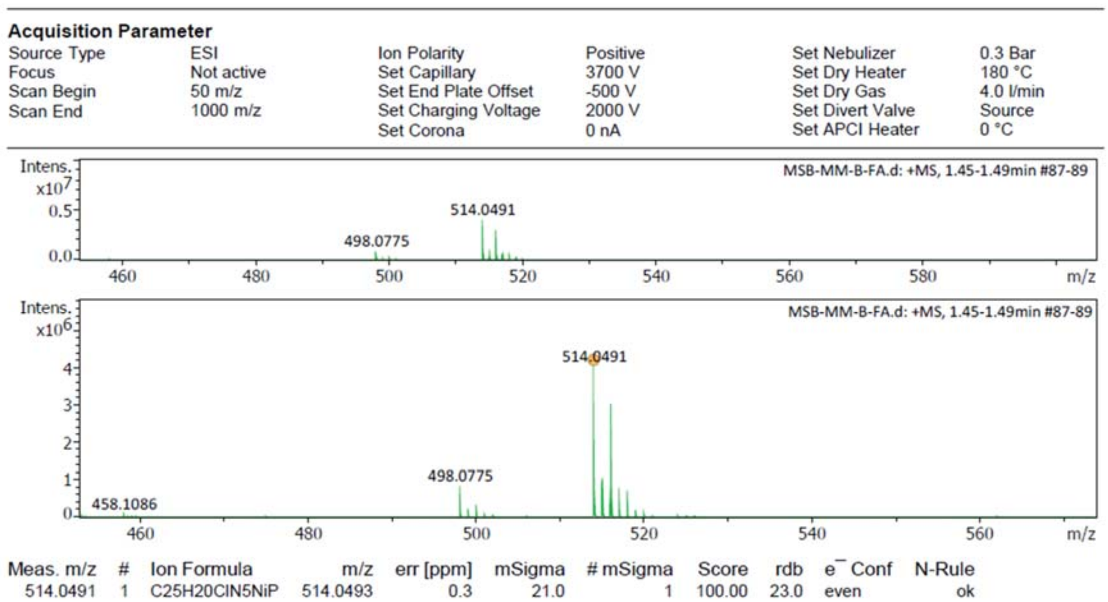



**Fig. S13** HRMS spectrum of **Ni1**.

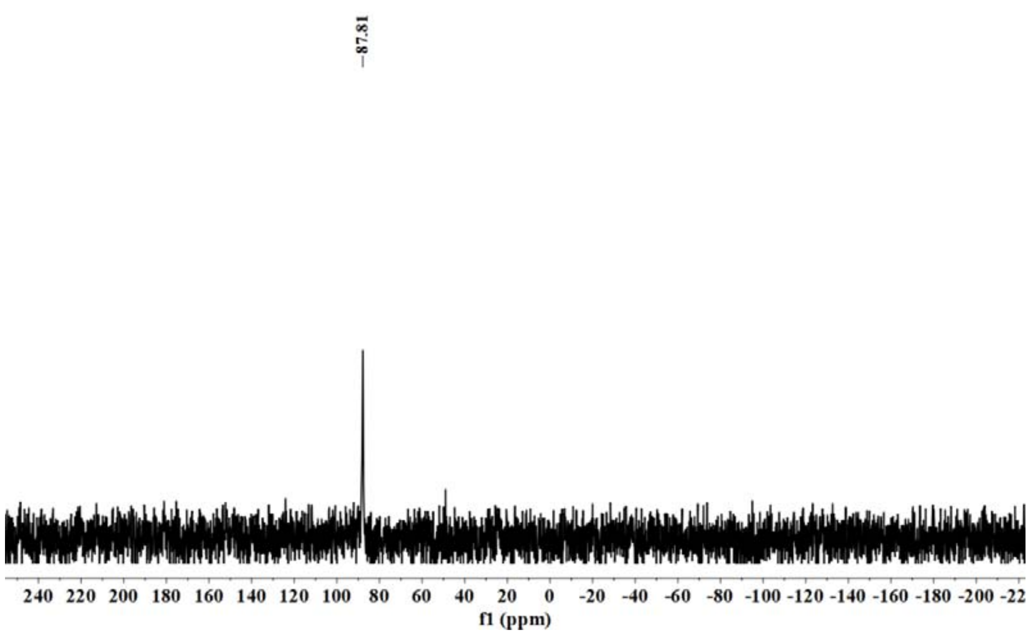



**Fig. S14** $^{31}$P NMR spectrum of **Ni2** in $CDCl_3$ (162 MHz).

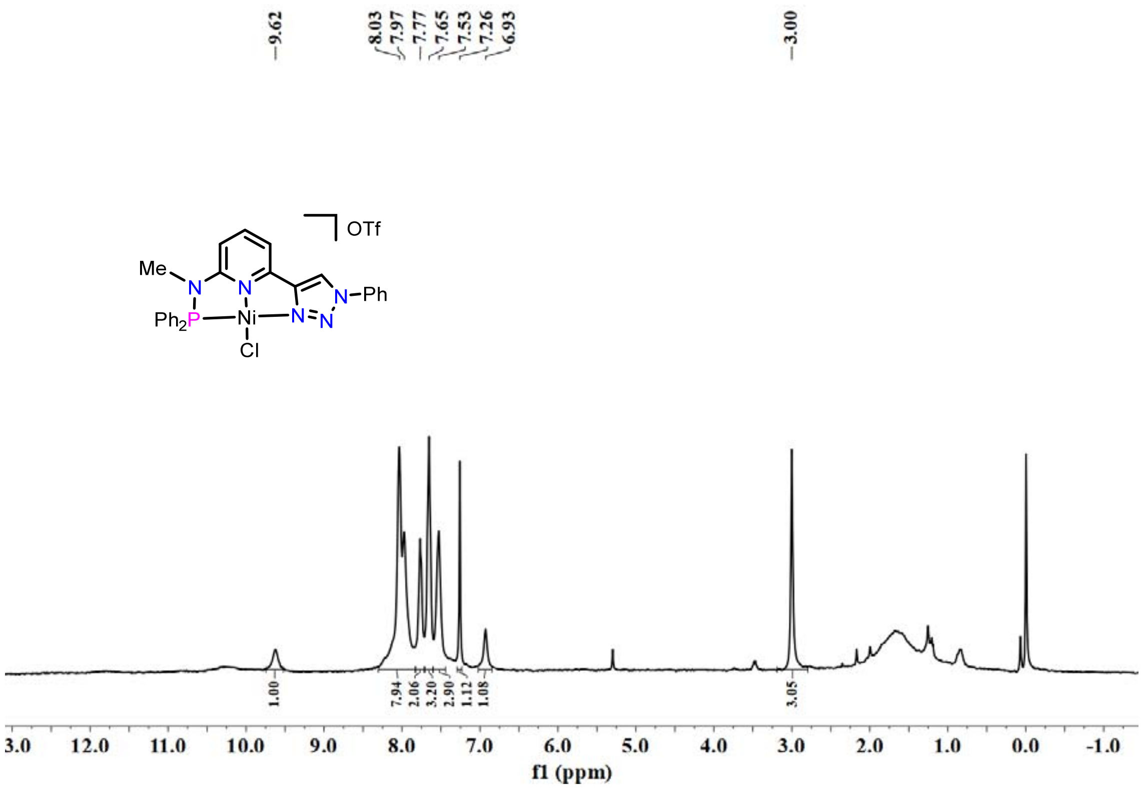



**Fig.S15** ¹H NMR spectrum of **Ni2** in $CDCl_3$ (400 MHz).

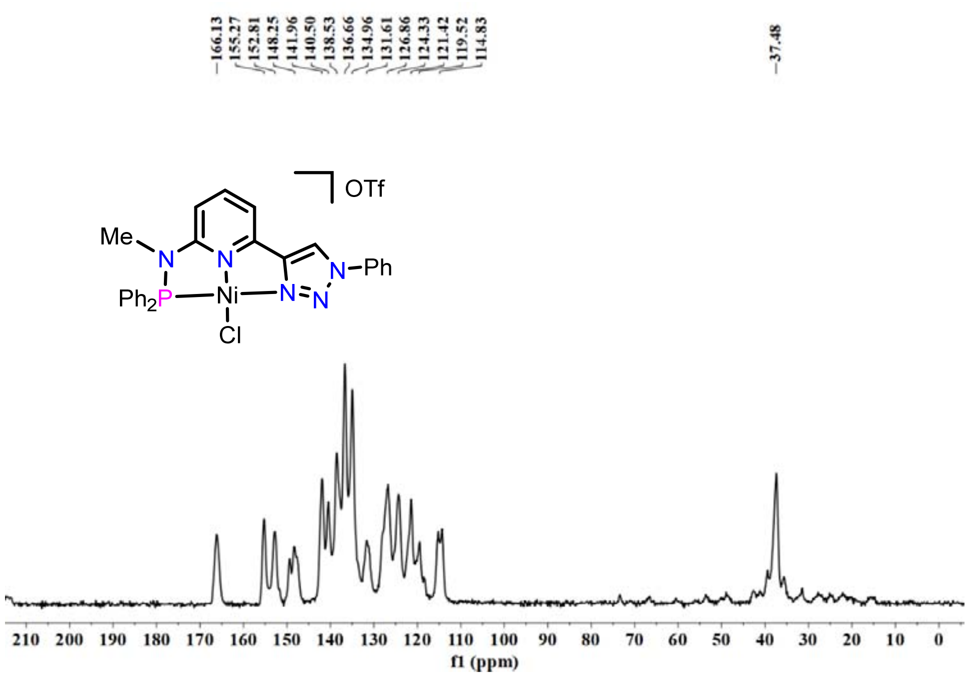



**Fig. S16** Solid state ¹³C NMR spectrum of **Ni2** (101 MHz, Solid State).

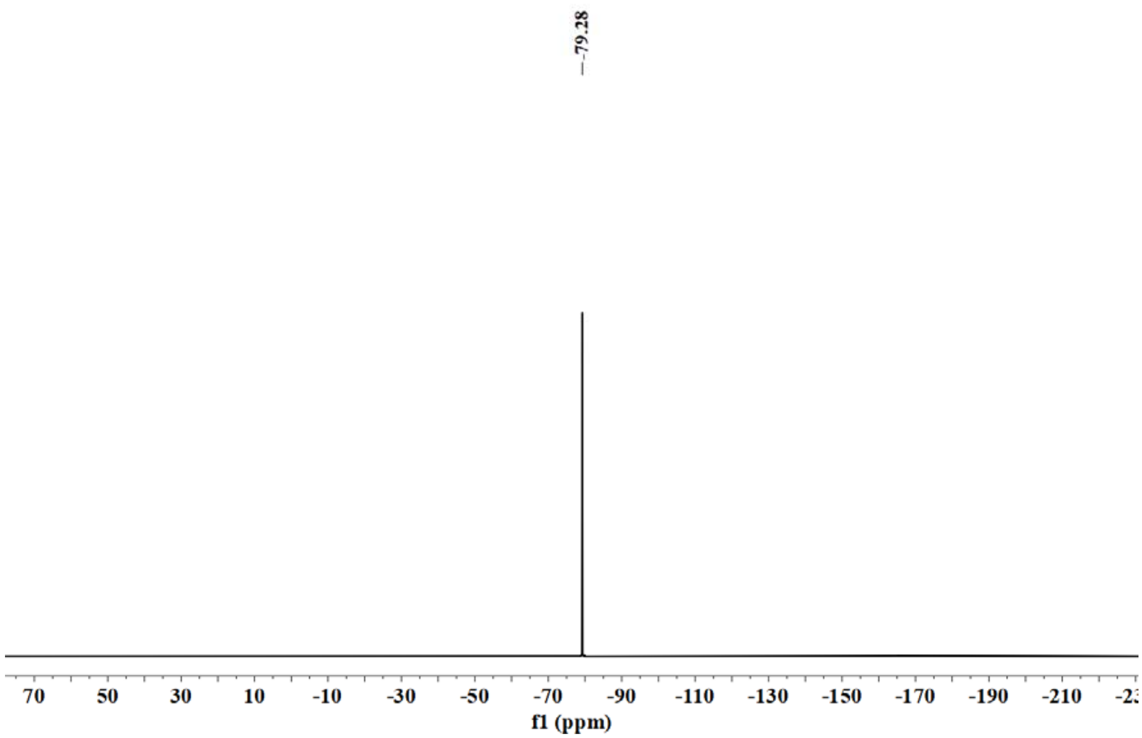



**Fig. S17** $^{19}$F NMR spectrum of **Ni2** in $CDCl_3$ (377MHz).

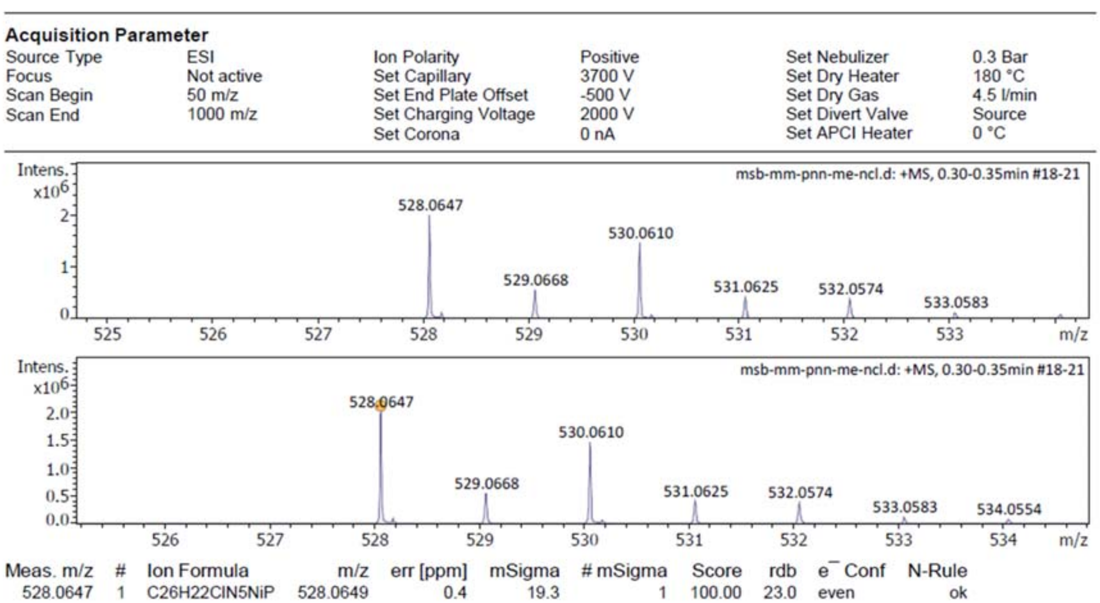



**Fig. S18** HRMS spectrum of **Ni2**

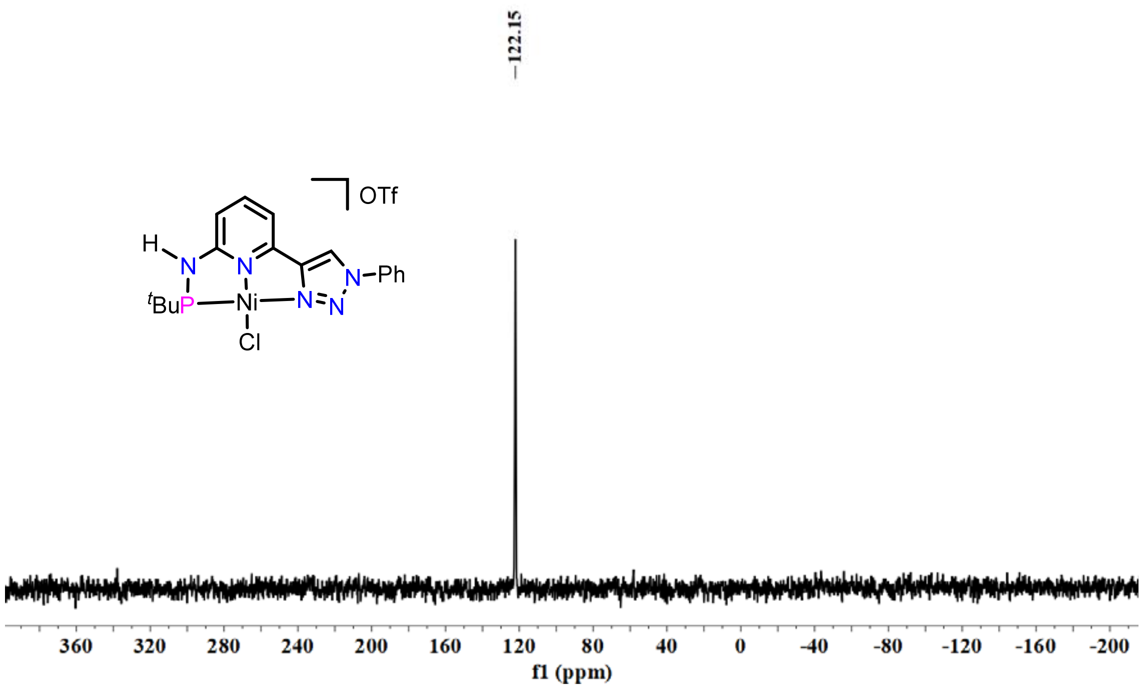



**Fig. S19** $^{31}P$ NMR spectrum of **Ni3** in $CDCl_3$ (162 MHz).

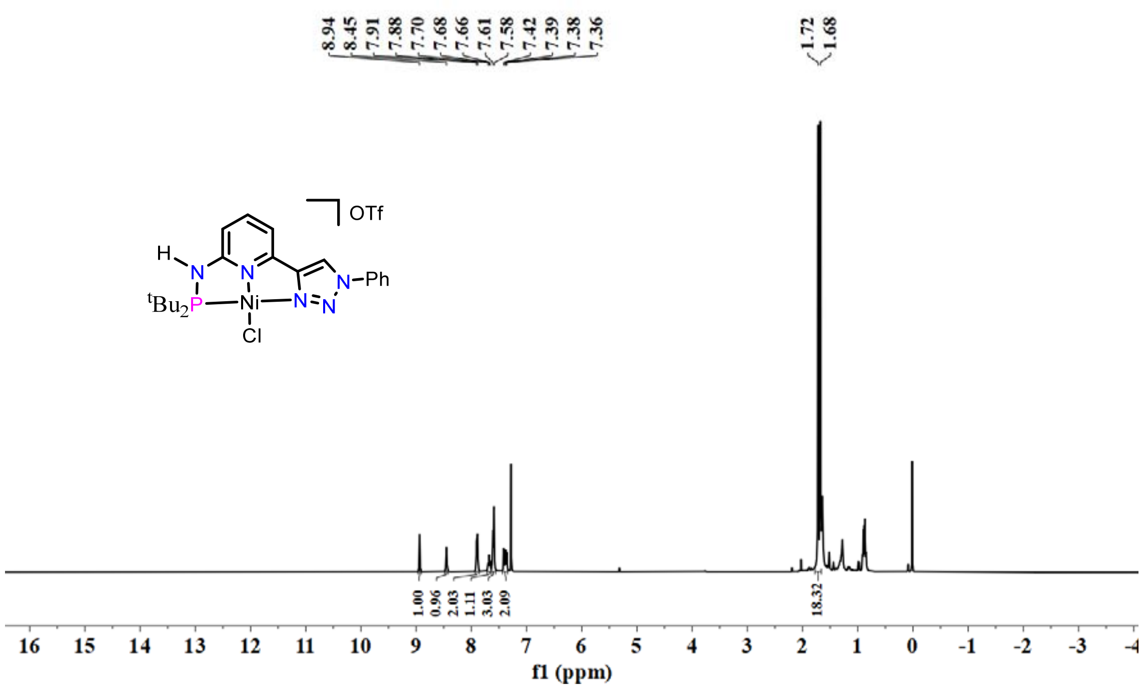



**Fig. S20** $^{1}H$ NMR spectrum of **Ni3** in $CDCl_3$ (400 MHz).

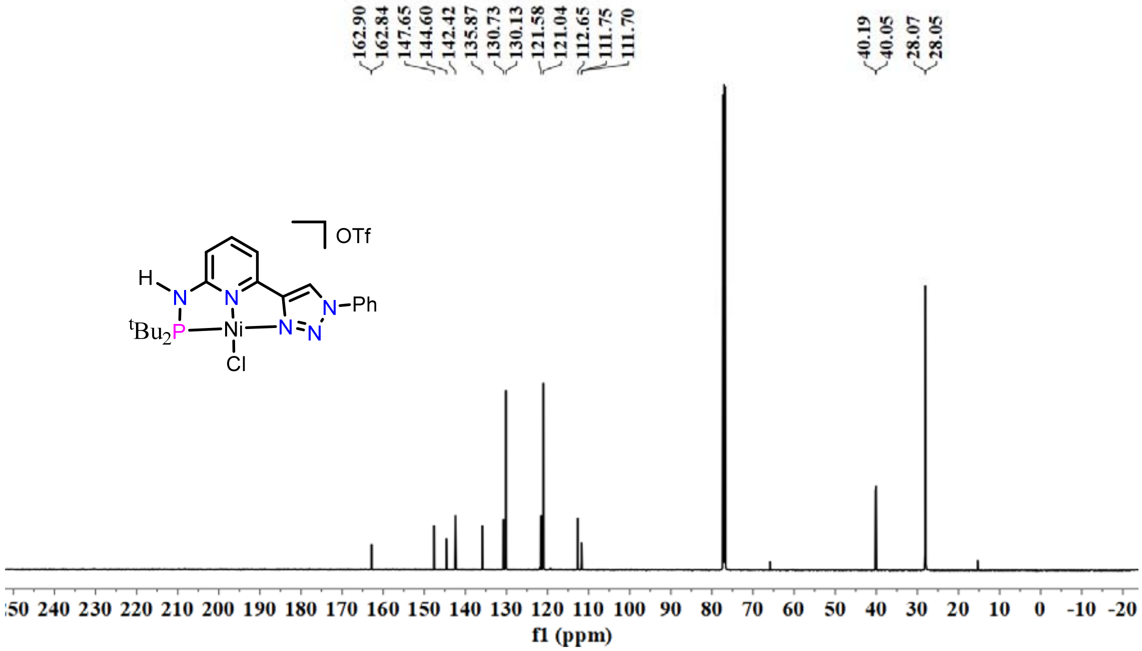



**Fig.S21** $^{13}$C NMR spectrum of **Ni3** in $CDCl_3$ (101 MHz).

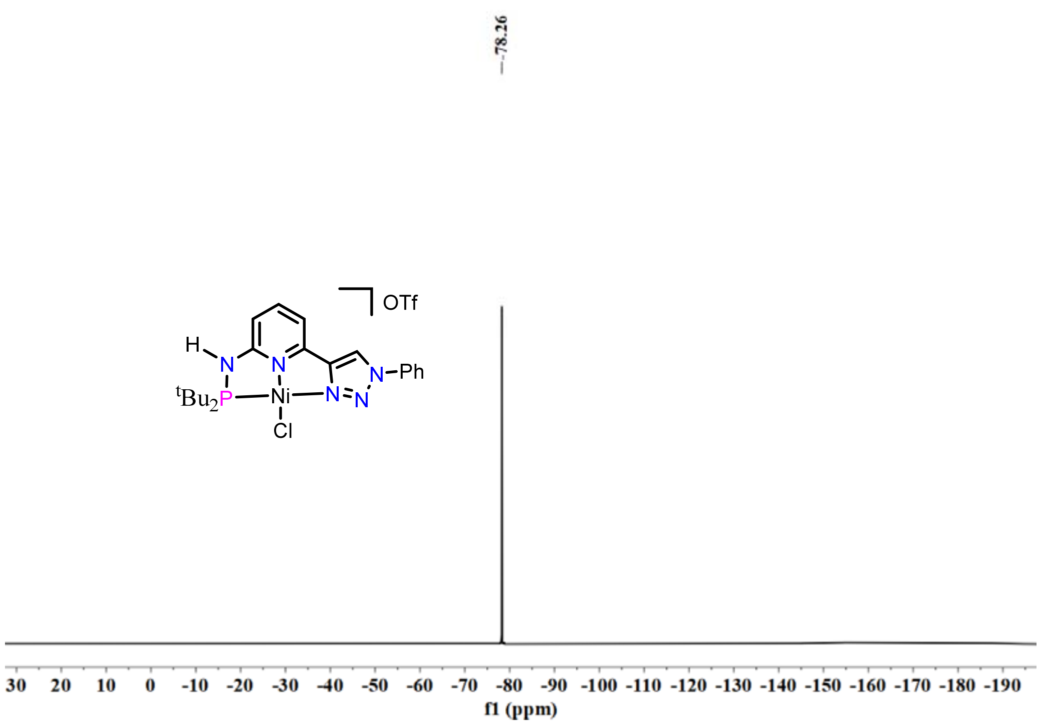



**Fig. S22** $^{19}$F NMR spectrum of **Ni3** in $CDCl_3$ (377 MHz).

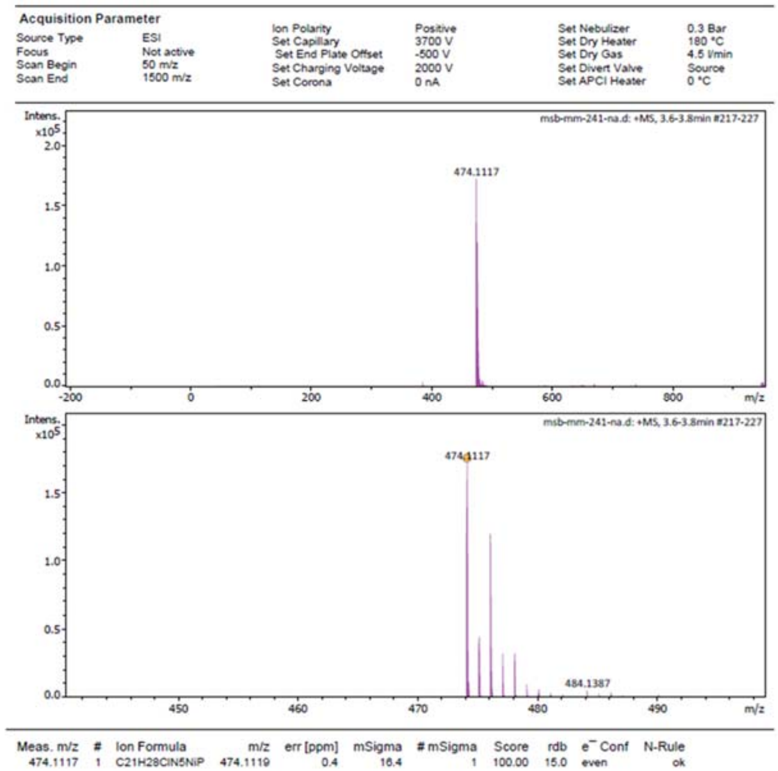



**Fig. S23** HRMS spectrum of **Ni3**

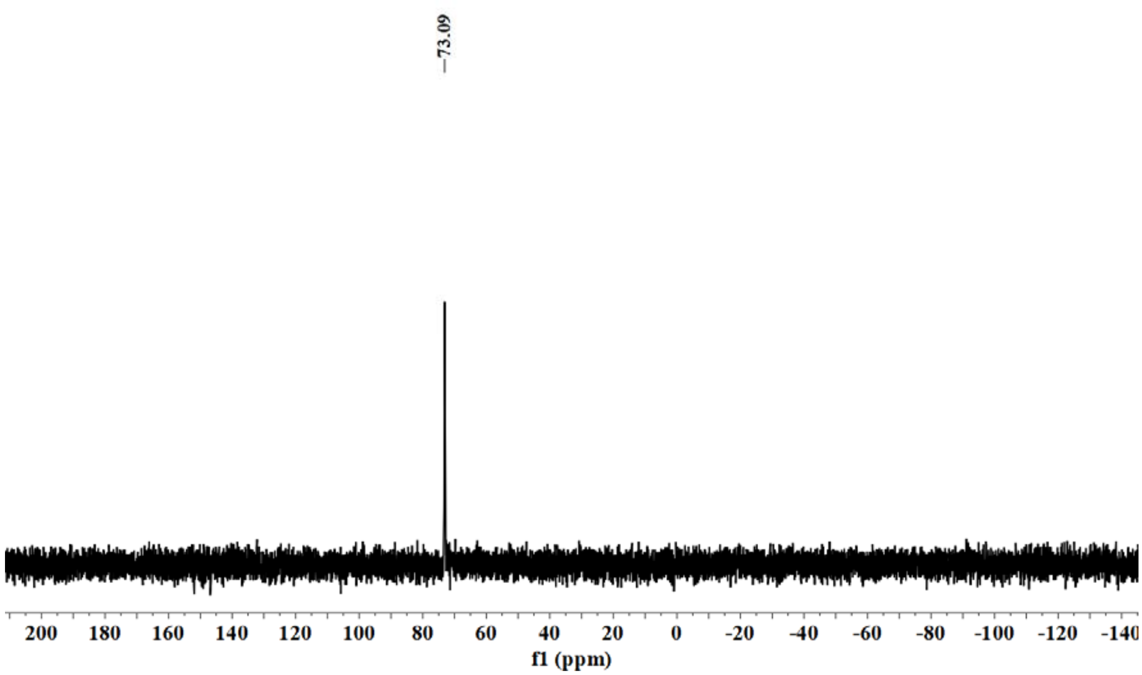



**Fig. S24** $^{31}$P NMR spectrum of **Ni4** in $CDCl_3$ (162 MHz).

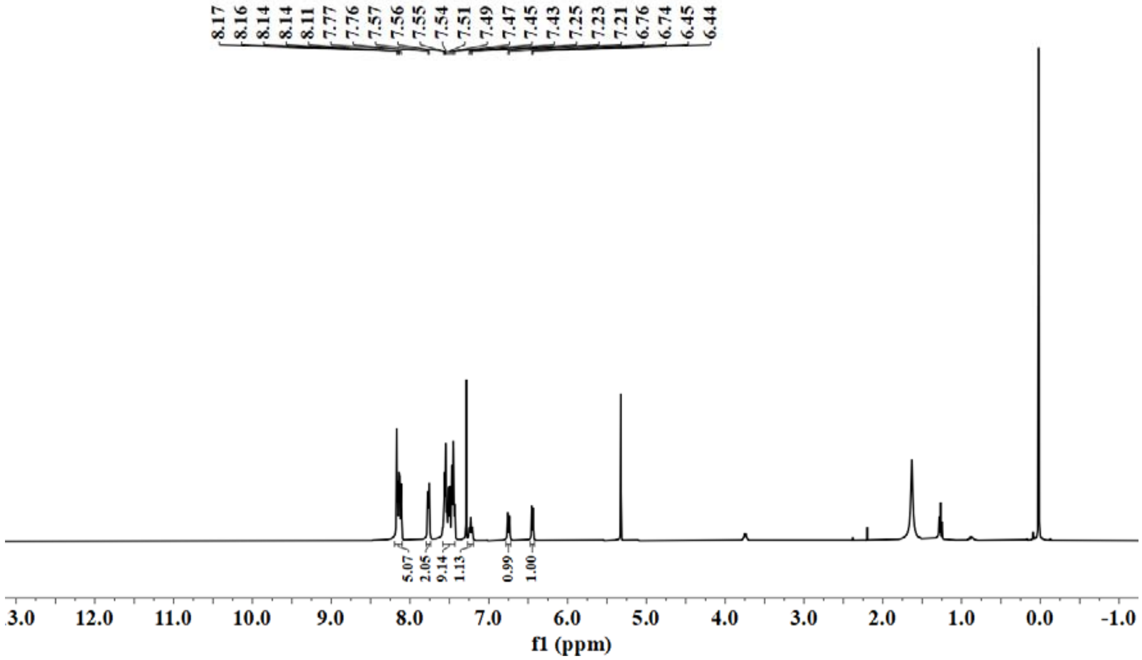



**Fig. S25** $^{1}H$ NMR spectrum of **Ni4** in $CDCl_3$ (400 MHz).

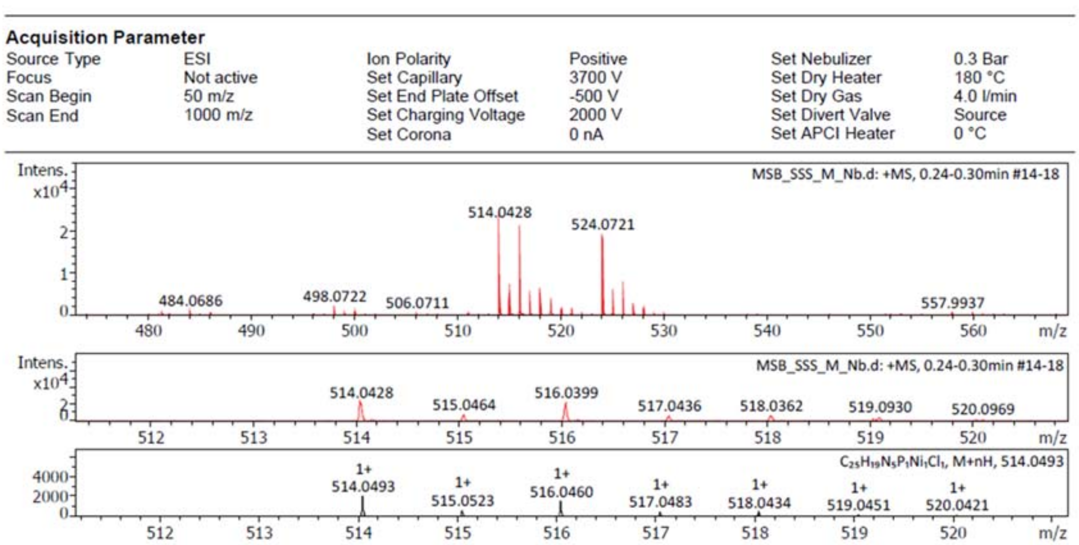



**Fig. S26** HRMS spectrum of **Ni4**

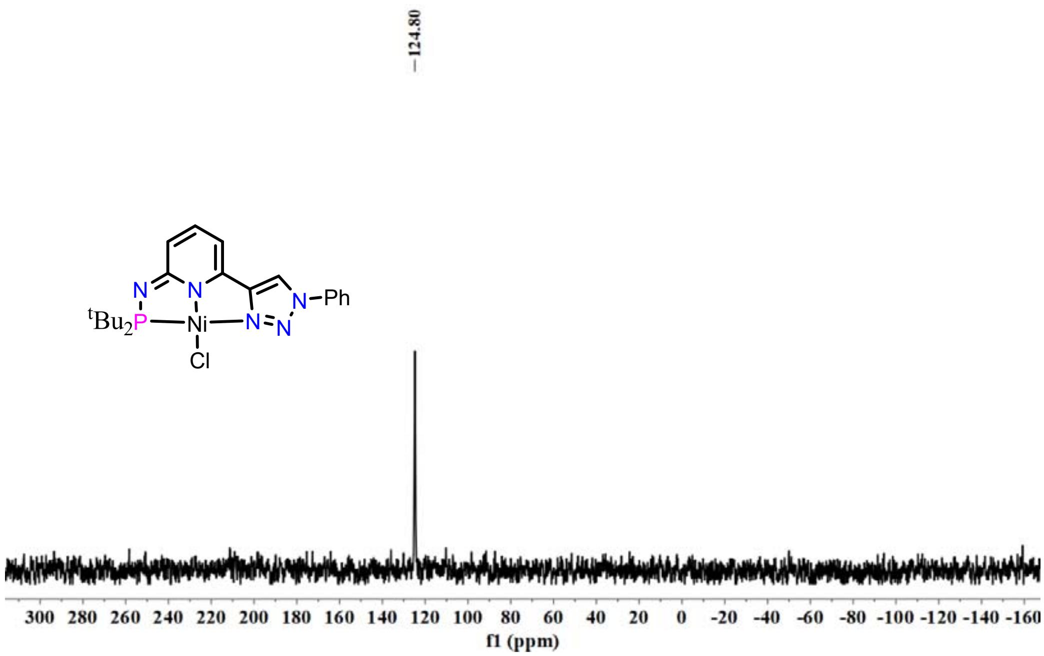



**Fig. S27** $^{31}$P NMR spectrum of **Ni5** in $CDCl_3$ (162 MHz).

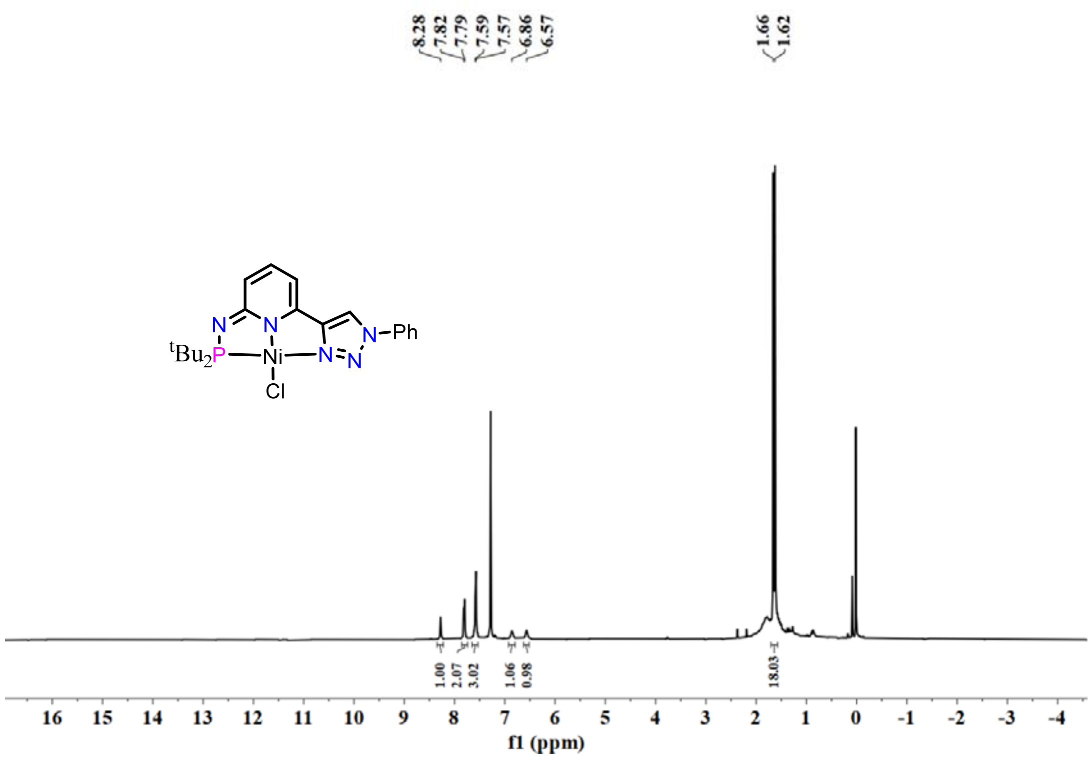



**Fig. S28** $^{1}$H NMR spectrum of **Ni5** in $CDCl_3$ (400 MHz).

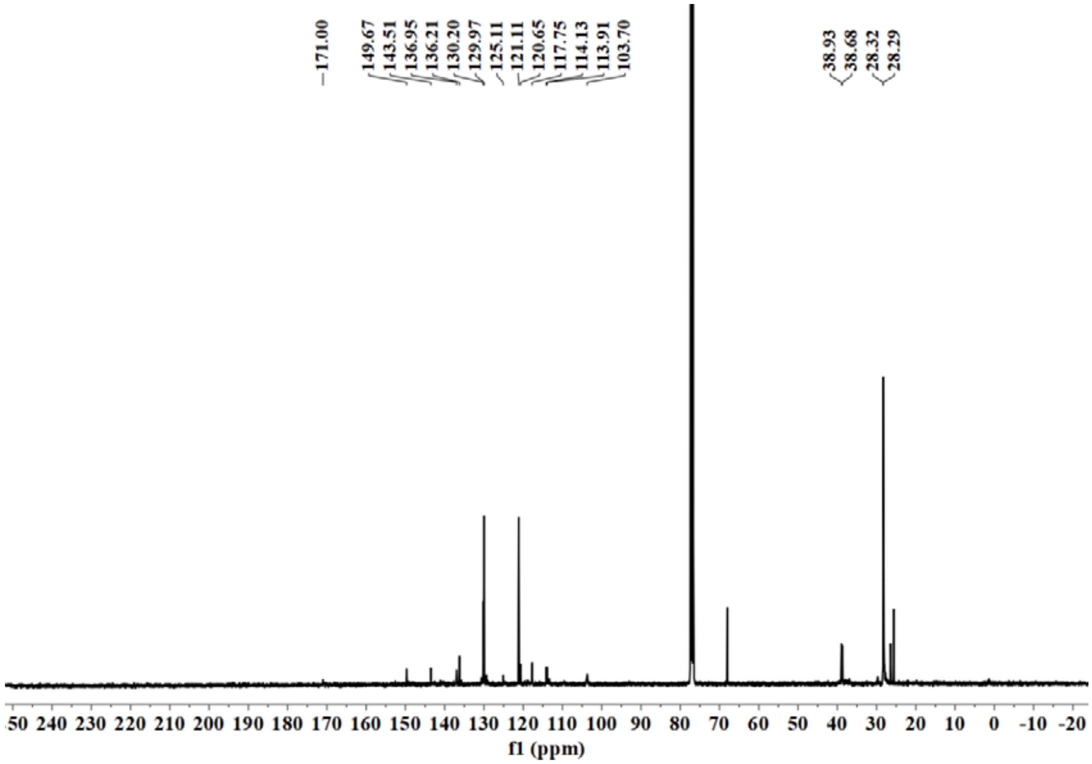
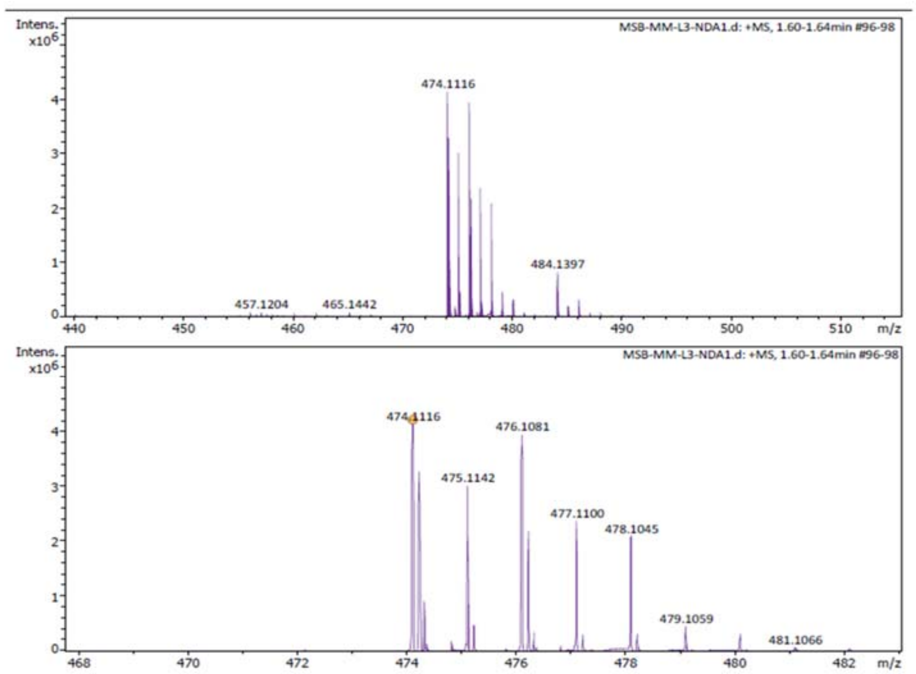



**Fig.S29** $^{13}C$ NMR spectrum of **Ni5** in $CDCl_3$ (101 MHz).




| Meas. m/z | # | Ion Formula | m/z | err [ppm] | mSigma | # mSigma | Score | rdb | e⁻ Conf | N-Rule |
|---|---|---|---|---|---|---|---|---|---|---|
| 474.1116 | 1 | C21H28ClN5NiP | 474.1119 | 0.6 | 254.2 | 1 | 100.00 | 15.0 | even | ok |

**Fig. S30** HRMS spectrum of **Ni5**

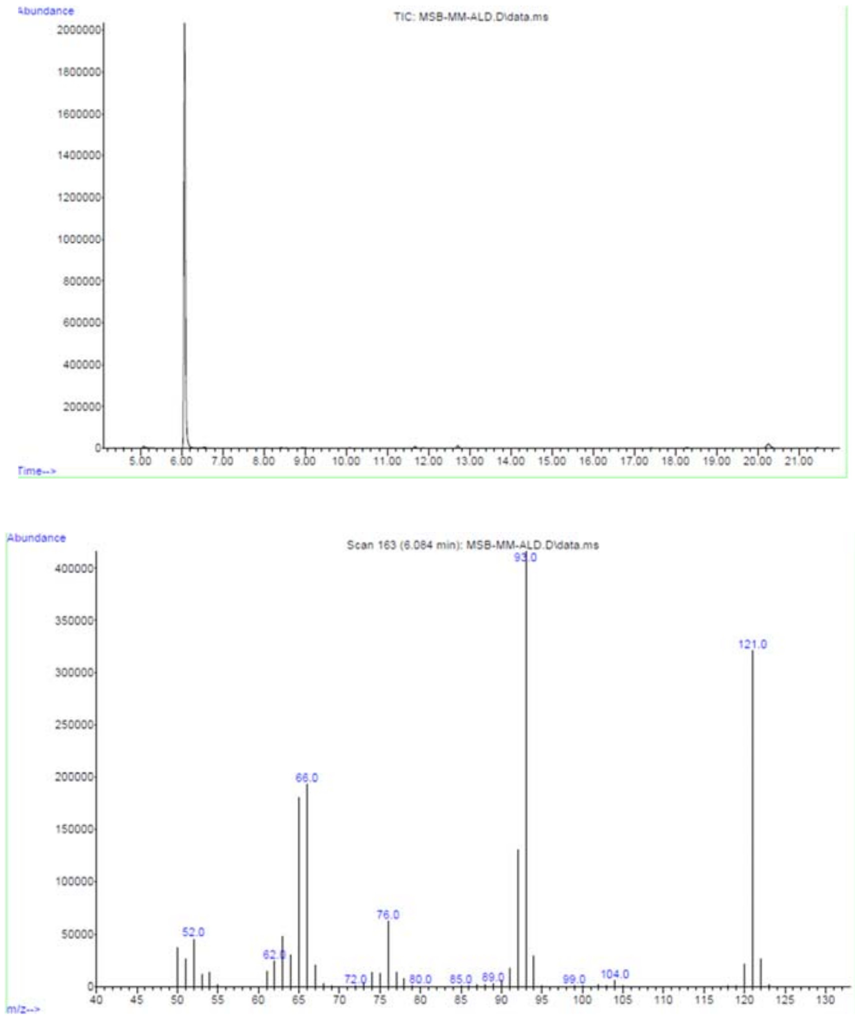
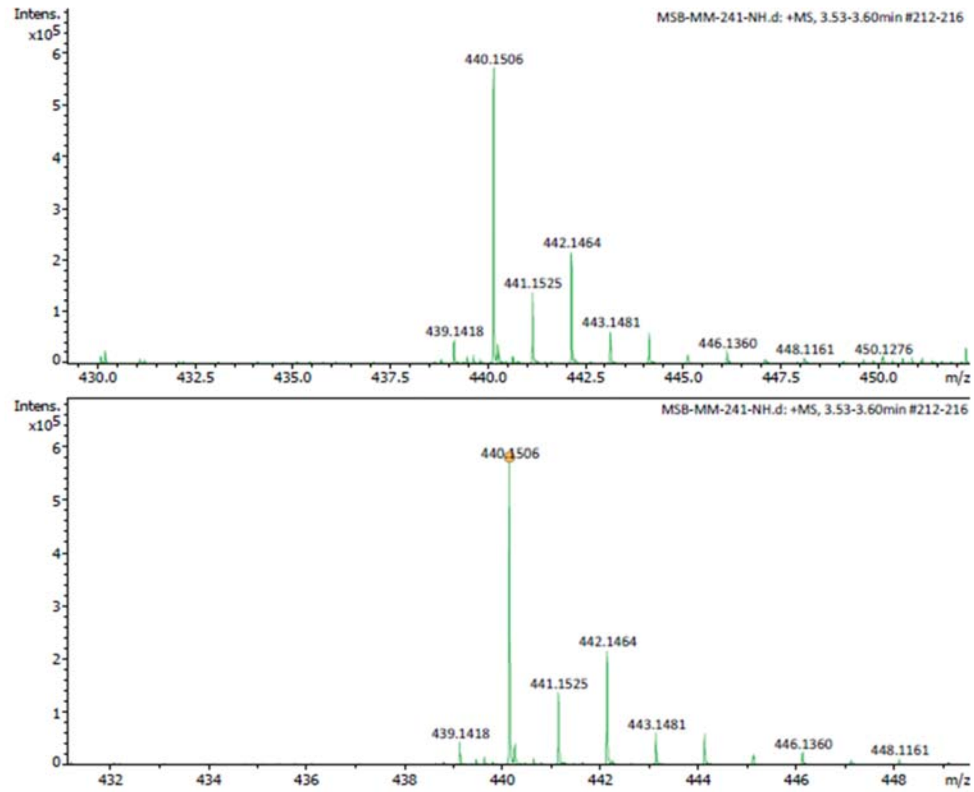



**Fig. S31** Formation of aldehyde from the independent reaction.

**Detection of Ni-H Intermediate:**

In a microwave tube mixture 2-aminobenzyl alcohol (0.5 mmol) Acetophenone (0.55 mmol), **Ni3** (0.5 mol%) and KOH (20 mol%) was taken in toluene. The reaction mixture was degassed and purged with nitrogen gas and then subjected to microwave irradiation at 110 °C for 10 min. After that aliquot was taken and HRMS analysis was carried out, which showed peak at 440.1506 corresponds to Nickel hydride $[P^{H}NNNiH\text{-}Cl]^{+}$ species.




| Meas. m/z | # | Ion Formula | m/z | err [ppm] | mSigma | # mSigma | Score | rdb | e⁻ Conf | N-Rule |
|---|---|---|---|---|---|---|---|---|---|---|
| 440.1506 | 1 | C21H29N5NiP | 440.1509 | 0.5 | 23.0 | 1 | 100.00 | 12.0 | even | ok |

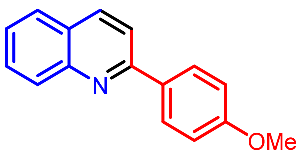
**Fig. S32** HRMS spectrum of Nickel hydride intermediate II.

**NMR Spectral data of catalytic products**

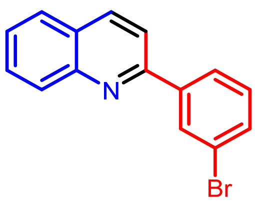
*2-phenylquinoline* (**1**) 98% (50 mg) [1]H NMR (400 MHz, $CDCl_3$): δ 8.21 (d, *J* = 7.3 Hz, 4H), 7.93 – 7.82 (m, 2H), 7.80 – 7.73 (m, 1H), 7.62 – 7.48 (m, 4H). [13]C NMR (101 MHz, $CDCl_3$): δ 157.4, 148.3, 139.7, 136.8, 129.8, 129.7, 129.4, 128.9, 127.6, 127.5, 127.2, 126.3, 119.0.

*2-(p-tolyl)quinoline* (**2**) 88% (96 mg). [1]H NMR (500 MHz, $CDCl_3$): δ 8.26 – 8.18 (m, 2H), 8.13 (d, *J* = 8.2 Hz, 2H), 7.91 – 7.82 (m, 2H), 7.76 (t, *J* = 7.6 Hz, 1H), 7.54 (t, *J* = 7.5 Hz, 1H), 7.38 (d, *J* =

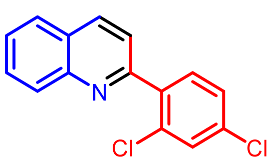
7.9 Hz, 2H), 2.50 (s, 3H).$^{13}$C NMR (126 MHz, CDCl$_3$): δ 157.4, 148.3, 139.4, 136.9, 136.7, 129.7, 129.6, 127.5, 127.1, 126.1, 118.9, 21.4.



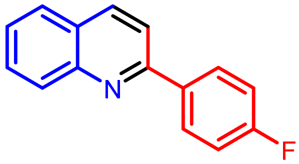

*2-(4-methoxyphenyl)quinoline* (**3**) 84% (98 mg). $^1$H NMR (400 MHz, CDCl$_3$): δ 8.16 (dd, *J* = 8.6, 6.3 Hz, 4H), 7.80 (t, *J* = 8.5 Hz, 2H), 7.71 (t, *J* = 8.5 Hz, 1H), 7.54 – 7.46 (m, 1H), 7.05 (d, *J* = 8.9 Hz, 2H), 3.87 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$): δ 160.8, 156.9, 148.3, 136.7, 132.3, 129.6, 129.5, 128.9, 127.5, 126.9, 125.3, 118.6, 114.3, 55.4.



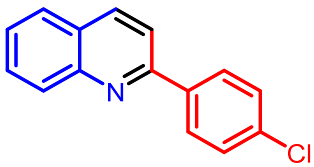

*2-(3-bromophenyl)quinoline* (**4**) 81% (114 mg). $^1$H NMR (500 MHz, CDCl$_3$): δ 8.39 (t, *J* = 1.9 Hz, 1H), 8.27 – 8.18 (m, 2H), 8.10 (d, *J* = 9.5 Hz, 1H), 7.88 – 7.82 (m, 2H), 7.77 (t, *J* = 7.6 Hz, 1H), 7.64 – 7.55 (m, 2H), 7.41 (t, *J* = 7.9 Hz, 1H).$^{13}$C NMR (126 MHz, CDCl$_3$): δ 155.6, 148.2, 141.7, 137.1, 132.2, 130.7, 130.3, 129.9, 129.8, 127.5 126.7, 126.1, 123.2, 118.7.



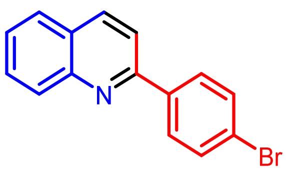

*2-(2,4-dichlorophenyl)quinoline* (**5**) 94% (129 mg). $^1$H NMR (500 MHz, CDCl$_3$): δ 8.25 (d, *J* = 8.4 Hz, 1H), 8.19 (d, *J* = 8.5 Hz, 1H), 7.90 (d, *J* = 8.2 Hz, 1H), 7.81 – 7.74 (m, 2H), 7.69 (d, *J* = 8.2 Hz, 1H), 7.62 (t, *J* = 7.6 Hz, 1H), 7.56 (d, *J* = 2.0 Hz, 1H), 7.43 (dd, *J* = 8.2, 2.1 Hz, 1H).$^{13}$C NMR (126 MHz, CDCl$_3$): δ 156.3, 148.1, 138.2, 135.9, 135.2, 133.1, 132.7, 129.9, 129.7, 127.6, 127.6, 127.2, 127.0, 122.5.



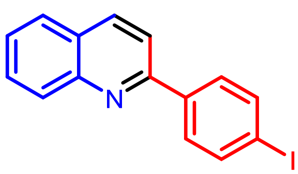
*2-(4-fluorophenyl)quinoline* (**6**) 87% (97 mg). $^1$H NMR (500 MHz, $CDCl_3$): δ 8.27 – 8.14 (m, 4H), 7.83 (d, *J* = 10.1 Hz, 2H), 7.74 (t, *J* = 8.5 Hz, 1H), 7.57 – 7.51 (m, 1H), 7.21 (t, *J* = 8.7 Hz, 2H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 164.8, 162.9, 156.2, 148.1, 137.0, 129.9, 129.6, 129.5, 129.4, 127.5, 127.1, 126.4, 118.7, 115.9, 115.7.



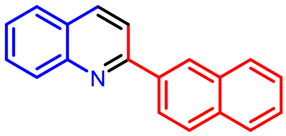
*2-(4-chlorophenyl)quinoline* (**7**) 83% (99 mg). $^1$H NMR (500 MHz, $CDCl_3$): δ 8.21 (dd, *J* = 14.4, 8.5 Hz, 2H), 8.14 (d, *J* = 6.6 Hz, 2H), 7.88 – 7.81 (m, 2H), 7.80 – 7.74 (m, 1H), 7.60 – 7.49 (m, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 156.0, 148.2, 138.0, 137.0, 135.6, 129.9, 129.7, 129.0, 128.8, 127.5, 127.2, 126.5, 118.6.



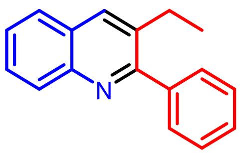
*2-(4-bromophenyl)quinoline* (**8**) 80% (113 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.25 – 8.00 (m, 4H), 7.88 – 7.69 (m, 3H), 7.64 (d, *J* = 8.6 Hz, 2H), 7.58 – 7.49 (m, 1H). $^{13}$C NMR (101 MHz, $CDCl_3$) δ 156.0, 148.3, 138.5, 137.0, 132.0, 129.9, 129.7, 129.1, 127.5, 127.3 126.5, 124.0, 118.5.



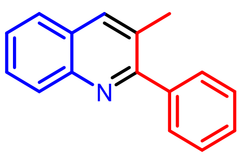
*2-(4-iodomophenyl)quinoline* (**9**) 79% (112 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.22 (dd, *J* = 8.6, 2.2 Hz, 1H), 8.16 (d, *J* = 8.4 Hz, 1H), 7.92 (d, *J* = 7.5 Hz, 2H), 7.84 (dd, *J* = 13.7, 8.7 Hz, 4H), 7.77 – 7.71 (m, 1H), 7.54 (t, *J* = 7.0 Hz, 1H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 156.2, 148.2, 139.1, 138.0, 137.0, 129.9, 129.7, 129.3, 127.5, 127.3, 126.6, 118.5, 95.9.



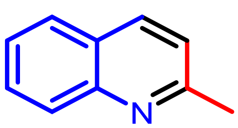
*2-(naphthalen-2-yl)quinoline* (**10**) 83% (106 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.34 – 8.25 (m, 2H), 8.19 – 8.13 (m, 1H), 8.03 – 7.92 (m, 3H), 7.85 – 7.79 (m, 1H), 7.79 – 7.73 (m, 2H), 7.68 – 7.61 (m, 2H), 7.59 – 7.48 (m, 2H).$^{13}$C NMR (126 MHz, $CDCl_3$): δ 159.5, 148.1, 138.8, 136.3, 134.0, 131.3, 129.8, 129.7 129.2, 128.4, 127.8, 127.6, 127.0, 126.6, 126.0, 125.7, 125.4, 123.3.



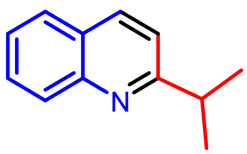
*3-ethyl-2-phenylquinoline* (**11**) 89% (104 mg). $^{1}$H (400 MHz, $CDCl_3$): δ 8.17 (d, $J$ = 8.4 Hz, 1H), 8.07 (s, 1H), 7.82 (d, $J$ = 8.0 Hz, 1H), 7.71 – 7.65 (m, 1H), 7.60 – 7.42 (m, 6H), 2.81 (q, $J$ = 7.5 Hz, 2H), 1.21 (t, $J$ = 7.5 Hz, 3H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 160.6, 146.2, 140.8, 135.4, 135.1, 129.2, 128.9, 128.8, 128.3, 128.2, 127.8, 1270, 126.5, 125.9, 26.0, 14.8.



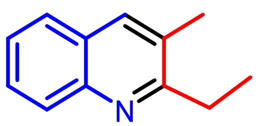
*3-methyl-2-phenylquinoline* (**12**) 88% (96 mg).$^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.19 (d, $J$ = 8.5 Hz, 1H), 8.03 (s, 1H), 7.81 (d, $J$ = 8.1 Hz, 1H), 7.70 (t, $J$ = 7.7 Hz, 1H), 7.63 (d, $J$ = 6.9 Hz, 2H), 7.58 – 7.45 (m, 4H), 2.51 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$) δ 160.6, 146.6, 140.8, 136.8, 129.3, 128.9, 128.8, 128.4, 128.3, 127.6, 126.8, 126.5, 20.7.



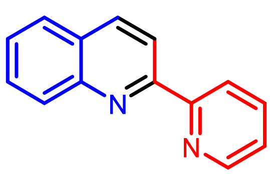
*2-methylquinoline*(**13**) 83% (59 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.04 (d, $J$ = 4.7 Hz, 2H), 7.76 (d, $J$ = 8.0 Hz, 1H), 7.73 – 7.65 (m, 1H), 7.48 (d, $J$ = 5.8 Hz, 1H), 7.26 (d, $J$ = 8.4 Hz, 1H), 2.76 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 158.9, 147.9, 136.2, 129.4, 128.6, 127.5, 126.5, 125.7, 122.0, 25.4.



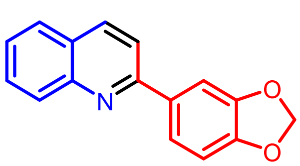
*2-isopropylquinoline* (**14**) 89% (76 mg). [1]H (500 MHz, $CDCl_3$): δ 8.11 (t, *J* = 7.6 Hz, 2H), 7.80 (d, *J* = 8.1 Hz, 1H), 7.74 – 7.68 (m, 1H), 7.53 – 7.48 (m, 1H), 7.37 (d, *J* = 8.5 Hz, 1H), 3.31 (p, *J* = 6.9 Hz, 1H), 1.43 (d, *J* = 7.0 Hz, 6H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 167.7, 147.6, 136.5, 129.3, 128.9, 127.5, 127.0, 125.7, 119.2, 37.2, 22.6..



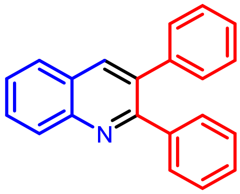
*2-ethyl-3-methylquinoline* (**15**) 93% (76 mg).[1]H NMR (500 MHz, $CDCl_3$): δ 8.05 (d, *J* = 8.4 Hz, 1H), 7.84 (s, 1H), 7.71 (d, *J* = 8.1 Hz, 1H), 7.66 – 7.61 (m, 1H), 7.49 – 7.44 (m, 1H), 3.02 (q, *J* = 7.6 Hz, 2H), 2.50 (s, 3H), 1.40 (t, *J* = 7.6 Hz, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 163.4, 146.7, 135.8, 129.4, 128.5, 128.3, 127.3, 126.7, 125.6, 29.5, 19.1, 12.9.



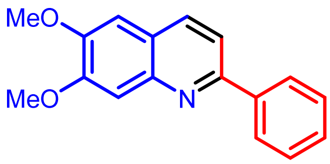
*2-(pyridin-4-yl)quinoline* (**16**) 75% (77 mg).[1]H NMR (500 MHz, $CDCl_3$): δ 8.77 (d, *J* = 4.9 Hz, 1H), 8.68 (d, *J* = 8.1 Hz, 1H), 8.59 (d, *J* = 8.7 Hz, 1H), 8.31 (d, *J* = 8.7 Hz, 1H), 8.21 (d, *J* = 8.4 Hz, 1H), 7.94 – 7.85 (m, 2H), 7.80 – 7.73 (m, 1H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.43 – 7.34 (m, 1H). $^{13}$C NMR (126 MHz, $CDCl_3$)1: δ 156.4, 156.2, 149.2, 147.94, 1, 136.9, 129.8, 129.6, 128.3, 127.7, 126.8, 124.1, 121.9, 119.0.



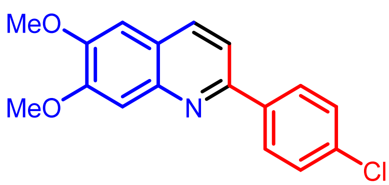
*2-(benzo[d][1,3]dioxol-5-yl)quinoline* (**17**) 85% (105mg). [1]H NMR (400 MHz, $CDCl_3$): δ 8.15 (dd, *J* = 12.4, 8.5 Hz, 2H), 7.84 – 7.64 (m, 5H), 7.56 – 7.47 (m, 1H), 6.94 (s, 1H), 6.04 (s, 2H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 156.7, 148.9, 148.4, 148.2, 136.7, 134.1, 129.7, 129.6 127.4, 127.0, 126.1, 121.8, 118.6, 108.5, 107.9, 101.4.



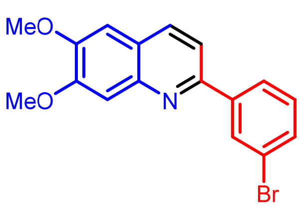
*2,3-diphenylquinoline* (**18**) 87% (122 mg) $^1$H NMR (500 MHz, $CDCl_3$): δ 8.27 (d, *J* = 8.4 Hz, 1H), 8.22 (s, 1H), 7.90 (d, *J* = 8.2 Hz, 1H), 7.80 – 7.75 (m, 1H), 7.63 – 7.58 (m, 1H), 7.51 – 7.47 (m, 2H), 7.34 – 7.27 (m, 8H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 158.4, 139.9, 137.7, 134.6, 130.1, 129.8, 129.7, 129.4, 128.3, 128.1, 127.9, 127.5, 127.3, 127.2, 126.8.



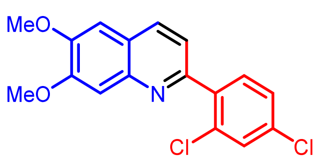

*6,7-dimethoxy-2-phenylquinoline*(**19**) 90% (119 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.16 – 8.10 (m, 2H), 8.04 (d, *J* = 8.6 Hz, 1H), 7.73 (d, *J* = 8.4 Hz, 1H), 7.56 – 7.50 (m, 3H), 7.48 – 7.42 (m, 1H), 7.05 (s, 1H), 4.07 (s, 3H), 4.02 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 155.4, 152.6, 149.7, 145.3, 140.0, 134.9, 128.9, 128.8, 127.3, 122.7, 117.3, 108.4, 104.9, 56.2, 56.1.



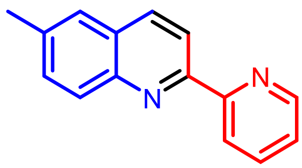

*2-(4-chlorophenyl)-6,7-dimethoxyquinoline*(**20**) 93% (139 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.07 – 7.98 (m, 3H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.46 (s, 3H), 7.03 (s, 1H), 4.05 (s, 3H), 4.01 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 153.9, 152.7, 149.8, 145.3, 138.4, 135.1, 134.9, 128.9, 128.5, 122.8, 116.9, 108.3, 104.9, 56.2, 56.1.



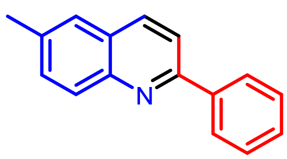

*2-(3-bromophenyl)-6,7-dimethoxyquinoline* (**21**) 92% (158 mg). $^1$H NMR (500 MHz, $CDCl_3$): δ 8.32 (s, 1H), 8.03 (dd, *J* = 13.3, 8.1 Hz, 2H), 7.68 (d, *J* = 8.4 Hz, 1H), 7.56 (d, *J* = 8.1 Hz, 1H), 7.49 (s, 1H), 7.37 (t, *J* = 7.9 Hz, 1H), 7.05 (s, 1H), 4.07 (s, 3H), 4.03 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 153.5, 152.7, 149.9, 145.2, 141.9, 135.1, 131.7, 130.3, 130.3, 125.7, 123.1, 123. 0, 116.9, 108.3, 104.9, 56.2, 56.1.



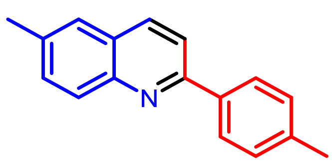

*2-(2,4-dichlorophenyl)-6,7-dimethoxyquinoline* (**22**) 85% (142 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.07 (d, *J* = 8.4 Hz, 1H), 7.67 – 7.56 (m, 2H), 7.54 (s, 1H), 7.50 (s, 1H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.11 (s, 1H), 4.05 (s, 6H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 153.9, 152., 150.2, 145.1, 138.4, 134.8, 134.0, 133., 132.5, 129.8, 127.4, 122., 120.8, 108.2, 104.9, 56.2, 56.1.



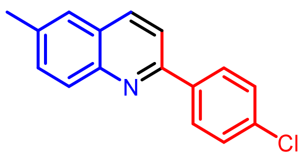

*6-methyl-2-(pyridin-2-yl)quinoline* (**23**) 82% (92 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.75 (d, *J* = 6.7 Hz, 1H), 8.64 (d, *J* = 7.9 Hz, 1H), 8.53 (d, *J* = 8.5 Hz, 1H), 8.18 (d, *J* = 8.7 Hz, 1H), 8.09 (d, *J* = 8.5 Hz, 1H), 7.85 (t, *J* = 7.7 Hz, 1H), 7.63 – 7.54 (m, 2H), 7.38 – 7.30 (m, 1H), 2.54 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 156.5, 155.3, 149.2, 146.5, 136.9, 136.7, 136.1, 131.9, 129.5, 128.3, 126.5, 123., 121.7, 118.9, 21.7.



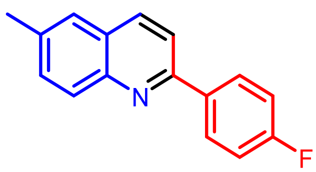

*6-methyl-2-phenylquinoline* (**24**) 91% (100 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.20 (d, *J* = 8.5 Hz, 2H), 8.13 (dd, *J* = 8.8, 2.2 Hz, 2H), 7.86 (s, 1H), 7.62 – 7.54 (m, 4H), 7.50 (d, *J* = 7.5 Hz, 1H), 2.57 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 156.5, 146.9, 139.8, 136.1, 131.9, 129.4, 129.2, 128.7, 127.5, 127.3, 126.4, 119.0, 21.7.



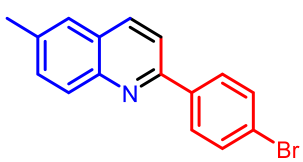

*6-methyl-2-(p-tolyl)quinoline* (**25**) 90% (105 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.11 (dd, *J* = 18.0, 8.4 Hz, 4H), 7.84 (d, *J* = 8.6 Hz, 1H), 7.62 – 7.56 (m, 2H), 7.36 (d, *J* = 7.9 Hz, 2H), 2.57 (s, 3H), 2.47 (s, 3H).$^{13}$C NMR (126 MHz, $CDCl_3$): δ 156.5, 146.9, 139.2, 137.0, 136.0, 135.9, 131.9, 129.6, 129.3, 127.4, 127.1, 126.4, 118.9, 21.6, 21.4



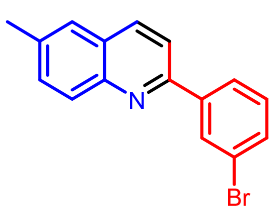

*2-(4-chlorophenyl)-6-methylquinoline* (**26**) 86% (109 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.09 (dd, *J* = 16.8, 8.9 Hz, 4H), 7.78 (d, *J* = 8.6 Hz, 1H), 7.58 (d, *J* = 7.1 Hz, 2H), 7.50 (d, *J* = 8.7 Hz, 2H), 2.57 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 155.1, 146.8, 138.2, 136.4, 136.3, 135.3, 132.2, 129.4, 128.9, 128.7, 127.3, 126.4, 118.5, 21.7.



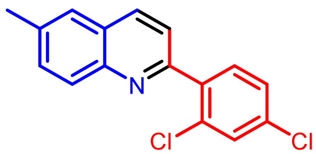

*2-(4-Fluorophenyl)-6-methylquinoline* (**27**) 88% (104 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.22 – 8.03 (m, 4H), 7.79 (d, *J* = 8.6 Hz, 1H), 7.58 (d, *J* = 7.4 Hz, 2H), 7.22 (t, *J* = 8.8 Hz, 2H), 2.59 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 164.9, 162.5, 155.4, 146.8, 136.2, 135.9, 132.1, 129.3, 129.3, 127.1, 126.4, 118.6, 115.8, 115.6, 21.6.



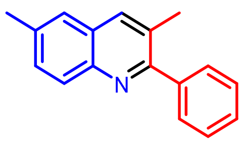

*2-(4-Bromophenyl)-6-methylquinoline* (**28**) 85% (127 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.16 – 8.01 (m, 4H), 7.78 (d, *J* = 8.7 Hz, 1H), 7.70 – 7.56 (m, 4H), 2.56 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 155.2, 146.8, 138.6, 136.5, 136.3, 132.2, 131.9, 129.4, 129.0, 127.3, 126.4, 123.7, 118.5, 21.7.



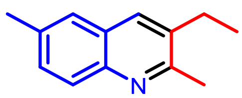

*2-(3-Bromophenyl)-6-methylquinoline* (**29**) 81% (121 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.37 (s, 1H), 8.13 – 8.04 (m, 3H), 7.77 (d, *J* = 8.5 Hz, 1H), 7.59 (d, *J* = 10.8 Hz, 3H), 7.39 (t, *J* = 7.9 Hz, 1H), 2.56 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 154.7, 146.8, 141.8, 136.6, 136.3, 132.2, 132.0, 130.5, 130.3, 129.5, 127.4, 126.4, 125.9, 123.2, 118.6, 21.7.



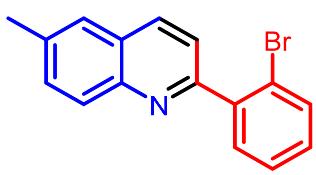
*2-(2,4-dichlorophenyl)-6-methylquinoline* (**30**) 84% (120 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.17 – 8.05 (m, 2H), 7.72 – 7.58 (m, 4H), 7.54 (d, *J* = 2.1 Hz, 1H), 7.40 (dd, *J* = 8.3, 2.1 Hz, 1H), 2.58 (d, *J* = 0.9 Hz, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 155.3, 146.7, 138.3, 136.9, 135.2, 135.0, 133.2, 132.7, 132.2, 129.8, 129.3, 127.5, 127.2, 126.4, 122.5, 21.7.



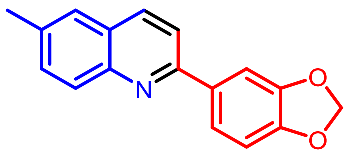
*3,6-dimethyl-2-phenylquinoline* (**31**) 78% (92 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.04 (d, *J* = 8.4 Hz, 1H), 7.90 (s, 1H), 7.63 – 7.57 (m, 2H), 7.54 – 7.40 (m, 5H), 2.54 (s, 3H), 2.44 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 159.6, 145.3, 141.0, 136.1, 131.1, 129.1, 129. 0, 128.9, 128.30, 128.1, 127.7, 126.0, 125.6, 21.7, 20.7.



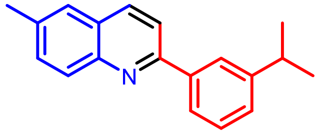
*3-ethyl-2,6-dimethylquinoline* (**32**) 72% (67 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.93 (d, *J* = 9.9 Hz, 1H), 7.73 (s, 1H), 7.45 (d, *J* = 6.7 Hz, 2H), 2.99 (q, *J* = 7.5 Hz, 2H), 2.53 – 2.45 (m, 6H), 1.38 (t, *J* = 7.5 Hz, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 162.3, 145.3, 135.3, 135.2, 130.5, 129.3, 128.2, 127.4, 125.6, 29.4, 21.5, 19.1, 12.9.



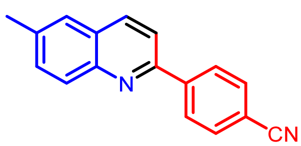
*2-(2-bromophenyl)-6-methylquinoline* (**33**) 81% (121 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.12 (dd, *J* = 12.1, 8.6 Hz, 2H), 7.76 – 7.63 (m, 4H), 7.60 (d, *J* = 8.6 Hz, 1H), 7.47 (t, *J* = 7.5 Hz, 1H), 7.35 – 7.28 (m, 1H), 2.58 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 157.9, 146.5, 141.8, 136.7, 135.0, 133.3, 132.0, 131.6, 129.9, 129.4, 127.7, 127.2, 126.4, 122.7, 121.9, 21.7.



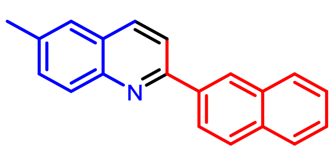
*2-(benzo[d][1,3]dioxol-5-yl)-6-methylquinoline* (**34**) 80% (105 mg). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.11 – 7.98 (m, 2H), 7.73 (d, *J* = 10.5 Hz, 2H), 7.63 (d, *J* = 6.3 Hz, 1H), 7.54 (d, *J* = 8.3 Hz, 2H), 6.94 (d, *J* = 8.2 Hz, 1H), 6.03 (s, 2H), 2.53 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$) δ 155.9, 148.7, 148.4, 146.8, 136.0, 135.9, 134.3, 131.9, 129.2, 127.0, 126.3, 121.6, 118.6, 108.5, 107.9, 101.3, 21.6.



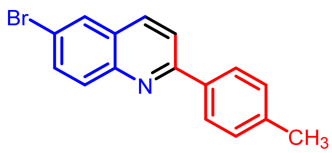
*2-(3-isopropylphenyl)-6-methylquinoline* (**35**) 77% (100 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.03 – 7.95 (m, 2H), 7.53 (d, *J* = 13.0 Hz, 2H), 7.32 (d, *J* = 8.5 Hz, 1H), 3.28 (dq, *J* = 13.9, 7.0 Hz, 1H), 2.53 (d, *J* = 0.9 Hz, 3H), 1.41 (d, *J* = 6.9 Hz, 6H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 166.7, 146.3, 135.8, 135.4, 131.5, 128.7, 126.9, 126.4, 119.1, 37.3, 22.6, 21.5.



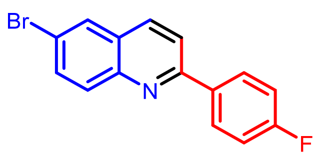
*4-(6-methylquinolin-2-yl)benzonitrile* (**36**) 87% (106 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.30 (d, *J* = 8.5 Hz, 2H), 8.21 (d, *J* = 8.6 Hz, 1H), 8.09 (d, *J* = 8.5 Hz, 1H), 7.89 – 7.80 (m, 3H), 7.63 (d, *J* = 11.7 Hz, 2H), 2.59 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 154.1, 146.9, 143.9, 137.2, 136.6, 132.6, 132.5, 129.6, 127.9, 127.6, 126.4, 118.9, 118.6, 112.5, 21.7.



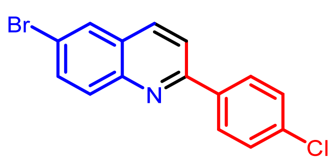
*6-methyl-2-(naphthalen-2-yl)quinoline* (**37**) 92% (124 mg). $^{1}$H NMR (500 MHz, $CDCl_3$): δ 8.24 – 8.15 (m, 3H), 7.98 (t, *J* = 6.7 Hz, 2H), 7.76 (d, *J* = 8.4 Hz, 1H), 7.72 – 7.67 (m, 2H), 7.67 – 7.61 (m, 2H), 7.58 – 7.48 (m, 2H), 2.62 (s, 3H). $^{13}$C NMR (126 MHz, $CDCl_3$): δ 158.5, 146.7, 138.9, 136.5, 135.6, 134.1 132.1, 131.4, 129.4, 129.0, 128.4, 127.7, 127.1, 126.6, 126.5, 125.9, 125.8, 125.4, 123.3, 21.7.



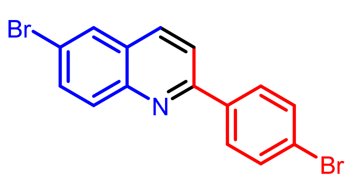
*6-bromo-2-(p-tolyl)quinoline* (**38**) 92% (137 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.10 – 7.99 (m, 4H), 7.95 (s, 1H), 7.86 (d, *J* = 8.7 Hz, 1H), 7.77 (d, *J* = 8.9 Hz, 1H), 7.33 (d, *J* = 8.2 Hz, 2H), 2.44 (s, 3H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 157.6, 146.9, 139.8, 136.4, 135.6, 133.0, 131.4, 129.7, 129.5, 128.2, 127.4, 119.8, 119.6, 21.4



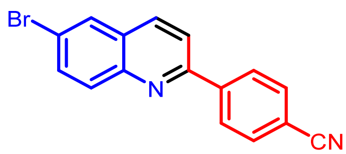
*6-bromo-2-(4-fluorophenyl)quinoline* (**39**) 88% (133 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.21 – 8.06 (m, 3H), 8.04 – 7.93 (m, 2H), 7.87 – 7.75 (m, 2H), 7.26 – 7.16 (m, 2H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 165.2, 162.7, 156.5, 146.8, 135.9, 135.3, 133.2, 131.4, 129.5, 129., 129.4, 128.1, 120.1, 119.4, 115.9, 115.8.



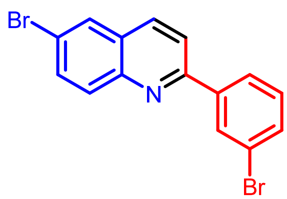
*6-bromo-2-(4-Chlorophenyl)quinoline* (**40**) 87% (137 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.10 (dd, *J* = 8.3, 3.9 Hz, 3H), 8.03 – 7.95 (m, 2H), 7.87 – 7.76 (m, 2H), 7.49 (d, *J* = 8.5 Hz, 2H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 156.3, 146.8, 137.6, 135.9, 135.9, 133.3, 131.4, 129.5, 129.1, 128.8, 128.3, 120.3, 119.3.



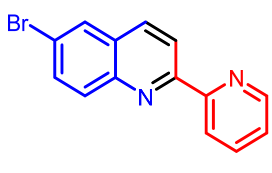
*6-bromo-2-(4-Bromophenyl)quinoline* (**41**)83% (151 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.11 (d, *J* = 8.8 Hz, 1H), 8.07 – 7.96 (m, 4H), 7.84 (d, *J* = 8.7 Hz, 1H), 7.79 (dd, *J* = 8.9, 2.3 Hz, 1H), 7.68 – 7.62 (m, 2H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 156.5, 146.8, 135.9, 133.2, 131.5, 129.5, 129.4, 129.4, 128.1, 120.1, 119.4, 115.9, 115.8.



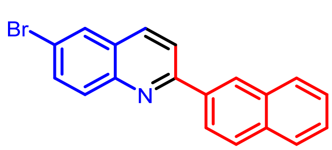
*4-(6-bromoquinolin-2-yl)benzonitrile* (**42**) 82% (127 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.73 (d, *J* = 2.9 Hz, 1H), 8.66 – 8.53 (m, 2H), 8.15 (d, *J* = 8.7 Hz, 1H), 8.06 – 7.95 (m, 2H), 7.86 (td, *J* = 7.7, 1.9 Hz, 1H), 7.77 (dd, *J* = 9.0, 2.2 Hz, 1H), 7.41 – 7.31 (m, 1H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 156.5, 155.9, 149.2, 146.5, 137.0, 135.8, 133.1, 131.5, 129.7, 129.3, 124.3, 121.3, 120., 119.8.



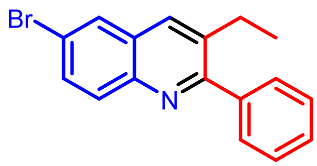
*6-bromo-2-(3-bromophenyl)quinoline* (**43**) 84% (152 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.35 (d, *J* = 3.7 Hz, 1H), 8.13 – 7.95 (m, 4H), 7.85 – 7.78 (m, 2H), 7.61 (d, *J* = 7.9 Hz, 1H), 7.39 (t, *J* = 7.9 Hz, 1H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 155.9, 146.8, 141.1, 135.9, 133.4, 132.5, 131.5, 130.6, 130.4, 129.5, 128.4, 125.9, 123.2, 120.5, 119.4.



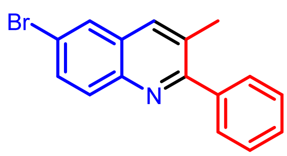
*6-bromo-2-(pyridin-2-yl)quinoline* (**44**) 80% (114 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.28 (d, *J* = 8.7 Hz, 2H), 8.19 (d, *J* = 8.9 Hz, 1H), 8.03 (d, *J* = 8.7 Hz, 2H), 7.90 (d, *J* = 8.5 Hz, 1H), 7.82 (dd, *J* = 8.8, 4.3 Hz, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 155.2, 146.8, 143.2, 136.3, 133.7, 132.7, 131.6, 129.6, 128.56, 128.0, 121.1, 119.4, 118.8, 113.0.



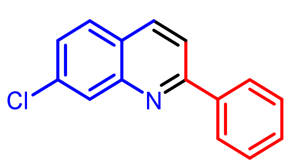
*6-bromo-2-(naphthalen-2-yl)quinoline* (**45**) 83% (139 mg). $^1$H NMR (400 MHz, $CDCl_3$): δ 8.21 – 8.07 (m, 4H), 7.98 (t, *J* = 8.9 Hz, 2H), 7.86 (dd, *J* = 8.9, 2.2 Hz, 1H), 7.78 – 7.71 (m, 2H), 7.65 – 7.60 (m, 1H), 7.58 – 7.49 (m, 2H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 159.9, 146.7, 138.3, 135.3, 134.0, 133.3, 131.5, 131.1, 129.6, 129.4, 128.5, 128.1, 127.9, 126.8, 126.1, 125.5, 125.4, 124.1, 120.5.



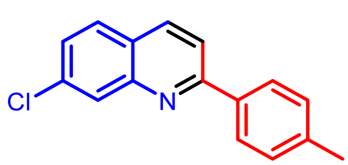
*6-bromo-3-ethyl-2-phenylquinoline* (**46**) 76% (118 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.97 (dd, *J* = 13.8, 9.8 Hz, 3H), 7.72 (dd, *J* = 8.9, 2.3 Hz, 1H), 7.54 (d, *J* = 6.4 Hz, 2H), 7.52 – 7.42 (m, 3H), 2.79 (q, *J* = 7.5 Hz, 2H), 1.19 (t, *J* = 7.5 Hz, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 161.1, 144.9, 140.5, 136.4, 133.9, 132.2, 131.1, 128.9, 128.9, 128.7, 128.4, 128.3, 120.2, 26.1, 14.6



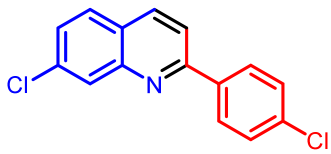
*6-bromo-3-methyl-2-phenylquinoline* (**47**) 78% (116 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.98 (d, *J* = 9.0 Hz, 1H), 7.93 – 7.85 (m, 2H), 7.70 (dd, *J* = 8.9, 2.3 Hz, 1H), 7.58 (d, *J* = 6.5 Hz, 2H), 7.53 – 7.41 (m, 3H), 2.45 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 160.9, 145.2, 140.5, 135.7, 132.2, 131.1, 130.4, 128.8, 128.7, 128.7, 128.4, 128.4, 120.2, 20.7.



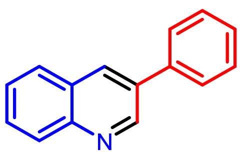
*7-chloro-2-phenylquinoline* (**48**) 84% (100 mg). $^{1}$H NMR (400 MHz, CDCl3): δ 8.22 – 8.10 (m, 4H), 7.84 (d, *J* = 8.6 Hz, 1H), 7.72 (d, *J* = 8.6 Hz, 1H), 7.60 – 7.43 (m, 4H). $^{13}$C NMR (101 MHz, CDCl3): δ 158.2, 148.7, 139.2, 136.6, 135.5, 129.7, 128.9, 128.7, 127.6, 127.3, 125.5, 119.1.



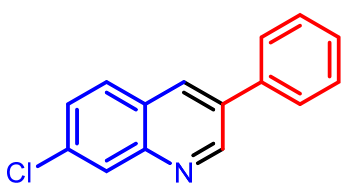
*7-chloro-2-(p-tolyl)quinoline* (**49**) 77% (98 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.19 – 8.12 (m, 2H), 8.07 (d, *J* = 8.4 Hz, 2H), 7.84 (d, *J* = 8.5 Hz, 1H), 7.72 (d, *J* = 8.7 Hz, 1H), 7.45 (dd, *J* = 8.6, 2.0 Hz, 1H), 7.34 (d, *J* = 7.9 Hz, 2H), 2.44 (s, 3H). $^{13}$C NMR (101 MHz, $CDCl_3$): δ 158.21, 148.7, 139.9, 136.5, 136.4, 135.4, 129.7, 128.7, 128.6, 127.5, 127.1, 125.4, 118.9, 21.4.



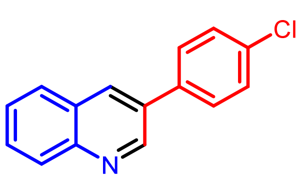
*7-chloro-2-(4-chlorophenyl)quinoline* (**50**) [1]H NMR (400 MHz, $CDCl_3$): δ 8.21 – 8.09 (m, 4H), 7.82 (d, *J* = 8.6 Hz, 1H), 7.75 (d, *J* = 8.6 Hz, 1H), 7.54 – 7.46 (m, 3H).[13]C NMR (101 MHz, $CDCl_3$): δ 156.85, 148.58, 137.51, 136.75, 135.93, 135.67, 129.08, 128.82, 128.69, 128.66, 127.5, 125.5, 118.6.



*3-phenylquinoline* (**51**) 86% (44 mg). [1]H NMR (400 MHz, $CDCl_3$): δ 9.19 (d, *J* = 2.4 Hz, 1H), 8.29 (d, *J* = 2.5 Hz, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.87 (d, *J* = 9.8 Hz, 1H), 7.71 (d, *J* = 8.2 Hz, 3H), 7.61 – 7.49 (m, 3H), 7.44 (t, *J* = 8.0 Hz, 1H). [13]C NMR (101 MHz, $CDCl_3$): δ 149.9, 147.4, 137.8, 133.9, 133.3, 129.4, 129.3, 129.1, 128.1, 128.0, 127.4, 127.0.

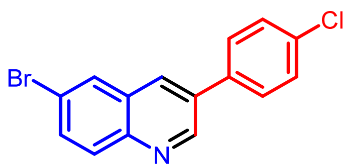


*7-chloro-3-phenylquinoline* (**52**) 81% (97 mg). [1]H NMR (400 MHz, $CDCl_3$): δ 9.18 (s, 1H), 8.27 (d, *J* = 2.5 Hz, 1H), 8.13 (d, *J* = 2.4 Hz, 1H), 7.81 (d, *J* = 8.7 Hz, 1H), 7.70 (d, *J* = 8.7 Hz, 2H), 7.58 – 7.49 (m, 3H), 7.49 – 7.42 (m, 1H). [13]C NMR (101 MHz, $CDCl_3$): δ 150.9, 147.6, 137.5, 135.2, 134.1, 132.9, 129.3, 129.2, 128.4, 128.3, 128., 127.4, 126.4.

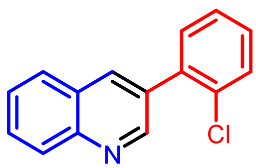


*3-(4-chlorophenyl)quinoline* (**53**) 79% (93 mg). [1]H NMR (400 MHz, $CDCl_3$): δ 9.14 (d, *J* = 2.4 Hz, 1H), 8.25 (d, *J* = 1.6 Hz, 1H), 8.19 – 8.13 (m, 1H), 7.89 – 7.84 (m, 1H), 7.73 (ddd, *J* = 8.4, 6.9, 1.5 Hz, 1H), 7.64 – 7.56 (m, 3H), 7.50 – 7.46 (m, 2H).[13]C NMR (101 MHz, $CDCl_3$):

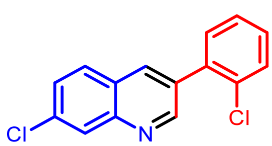
δ 152.2, 147.5, 136.6, 135.9, 135.6, 132.9, 132.6, 131.5, 130.3, 129.7, 129.3, 128.3, 128.1, 127.3, 125.9.



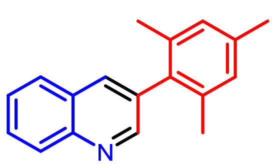

*6-bromo-3-(4-chlorophenyl)quinoline* (**54**) 75% (119 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 9.16 (d, *J* = 2.3 Hz, 1H), 8.20 (d, *J* = 2.1 Hz, 1H), 8.09 – 8.02 (m, 2H), 7.82 (d, *J* = 11.0 Hz, 1H), 7.65 (d, *J* = 6.6 Hz, 2H), 7.53 (d, *J* = 8.7 Hz, 2H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 149.8, 145.8, 135.8, 134.8, 133.6, 133.2, 132.2, 131.0, 130.0, 129.5, 129.1, 128.7, 121.2.




*3-(2-chlorophenyl)quinoline* (**55**) 78% (93 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 9.01 (d, *J* = 2.3 Hz, 1H), 8.24 – 8.12 (m, 2H), 7.85 (d, *J* = 8.2 Hz, 1H), 7.74 (t, *J* = 6.9 Hz, 1H), 7.60 – 7.51 (m, 2H), 7.45 – 7.34 (m, 3H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 151.2, 147.2, 137.0, 136.1, 133.0, 132.4, 131.6, 130.2, 129.8, 129.5 129.2, 128.1, 127.6, 127.3, 127.0

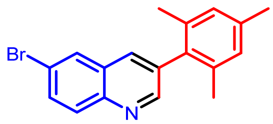



*7-chloro-3-(2-chlorophenyl)quinoline* (**56**) 75% (102 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 9.04 (s, 1H), 8.23 (s, 1H), 8.18 (s, 1H), 7.83 (d, *J* = 8.7 Hz, 1H), 7.60 – 7.55 (m, 2H), 7.47 – 7.40 (m, 3H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 152.2, 147.5, 136.6, 135.9, 135.6, 132.9, 132.6, 131.5, 130.3, 129.7, 129.3, 128.3, 128.1, 127.3, 125.9.

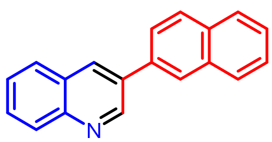



*3-mesitylquinoline* (**57**) 83% (102 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.77 (d, *J* = 2.2 Hz, 1H), 8.20 (d, *J* = 8.4 Hz, 1H), 8.00 (d, *J* = 3.2 Hz, 1H), 7.87 (d, *J* = 9.9 Hz, 1H), 7.78 (t, *J* = 7.7 Hz, 1H), 7.65 – 7.59 (m, 1H), 7.04 (s, 1H), 2.40 (s, 3H), 2.07 (s, 6H).$^{13}$C NMR (101 MHz, $CDCl_3$):

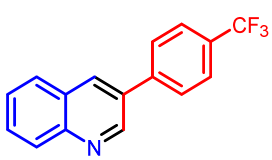
δ 151.8, 146.9, 137.7, 136.5, 136.0, 135.8, 135.2, 134.9, 134.1, 129.4, 129.2, 128.5, 127.8, 126.9, 21.1, 20.9.



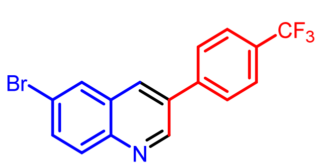

*6-bromo-3-mesitylquinoline* (**58**) 81% (132 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.74 (s, 1H), 8.07 – 7.99 (m, 2H), 7.88 (d, *J* = 2.4 Hz, 1H), 7.81 (d, *J* = 11.2 Hz, 1H), 7.01 (s, 2H), 2.37 (s, 3H), 2.02 (s, 6H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 152.2, 145.5, 137.9, 136.4, 135.0, 134.9, 134.4, 132.8, 131.0, 129.8, 129.2, 128.5, 120.8, 21.1, 20.9.




*3-(naphthalen-2-yl)quinoline* (**59**) 80% (102 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 9.10 (s, 1H), 8.32 – 8.22 (m, 2H), 7.95 (dd, *J* = 8.2, 3.4 Hz, 2H), 7.88 (t, *J* = 7.2 Hz, 2H), 7.84 – 7.76 (m, 1H), 7.66 – 7.51 (m, 4H), 7.49 – 7.44 (m, 1H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 151.9, 147.3, 136.4, 136.3, 135.7, 135.2, 133.9, 133.8, 131.7, 129.8, 129.3, 128.7, 128.6, 128.0, 127.9, 127.1, 126.7, 126.2, 125.5, 125.4.




*3-(4-(trifluoromethyl)phenyl)quinoline* (**60**) 79% (107 mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 9.15 (s, 1H), 8.24 (d, *J* = 2.6 Hz, 1H), 8.16 (d, *J* = 8.2 Hz, 1H), 7.87 (d, *J* = 9.8 Hz, 1H), 7.74 (t, *J* = 7.6 Hz, 1H), 7.67 (dd, *J* = 8.9, 5.2 Hz, 2H), 7.59 (t, *J* = 6.9 Hz, 1H), 7.26 – 7.20 (m, 2H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 163.9, 161.9, 149.7, 147.3, 134.0, 133.9, 133.1, 132.9, 129.5, 129.3, 129.1, 129.1, 128.0, 127.9, 127.1.




*6-bromo-3-(4-(trifluoromethyl)phenyl)quinoline* (**61**) 74% (130mg). $^{1}$H NMR (400 MHz, $CDCl_3$): δ 9.14 (s, 1H), 8.15 (d, *J* = 2.6 Hz, 1H), 8.06 – 7.98 (m, 2H), 7.79 (d, *J* = 6.7 Hz, 1H), 7.67 (dd, $J$ = 8.9, 5.2 Hz, 2H), 7.28 – 7.21 (m, 2H).$^{13}$C NMR (101 MHz, $CDCl_3$): δ 164.1, 162.1, 150.0, 145.8, 133.7, 133.5, 133.5, 132.9, 131.9, 130.9, 129.9, 129.2, 129.1, 129.1, 121.1, 116.4, 116.2.

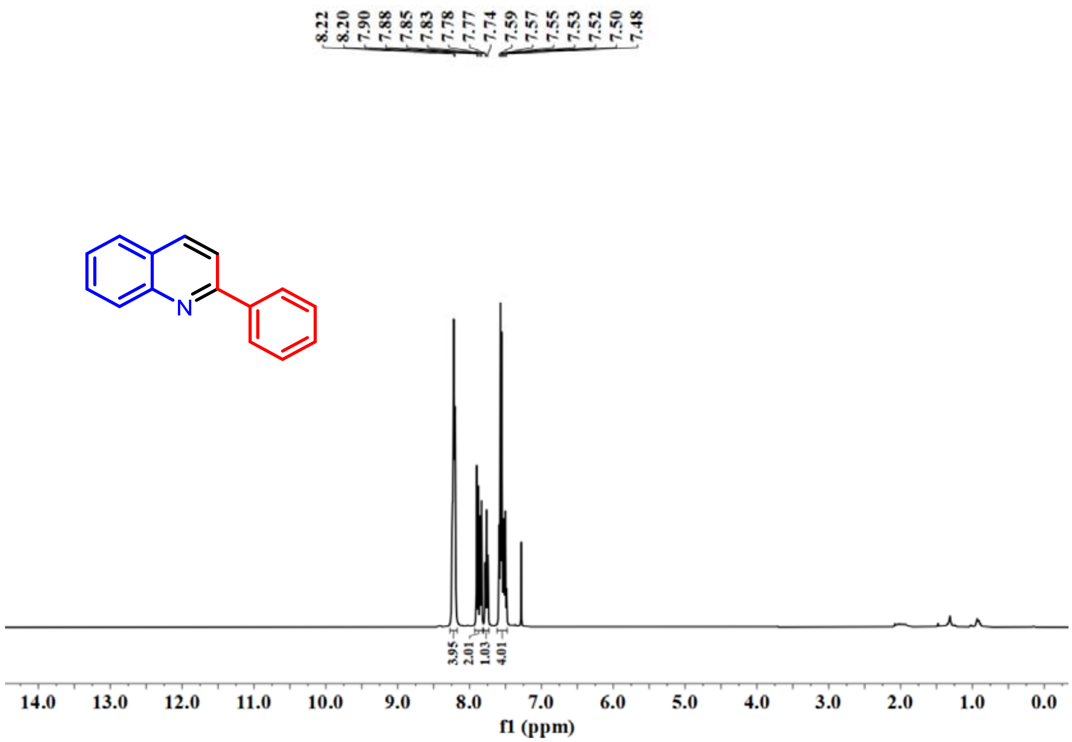



**Fig. S33.** $^1$H NMR spectrum of **1** in $CDCl_3$ (500 MHz).

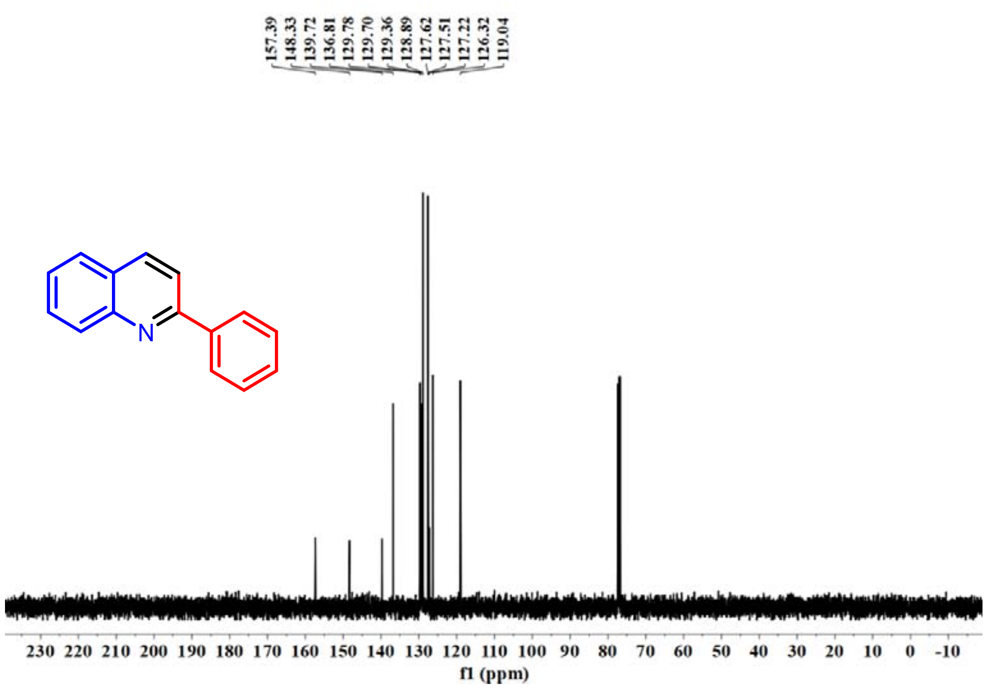



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**Fig. S34** $^{13}C\{^{1}H\}$ NMR spectrum of **1** in $CDCl_3$ (126 MHz).

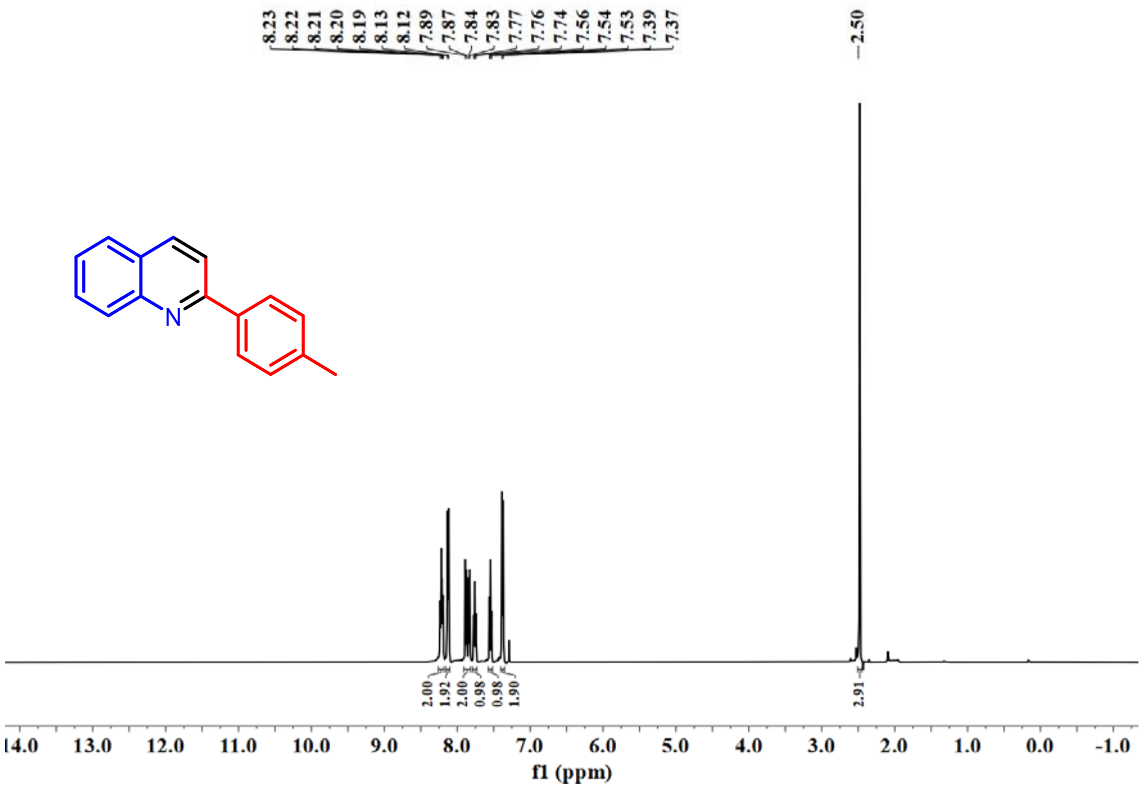


**Fig. S35** $^{1}H$ NMR spectrum of **2** in $CDCl_3$ (500 MHz).

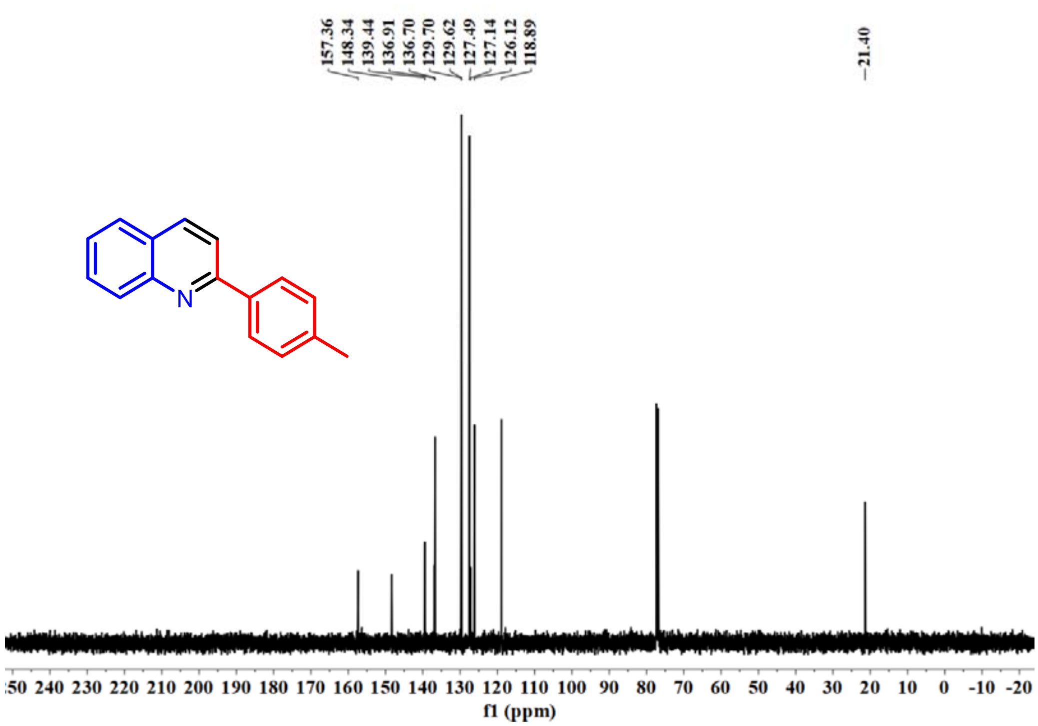


**Fig. S36** $^{13}C\{^{1}H\}$ NMR spectrum of **2** in $CDCl_3$ (101 MHz).

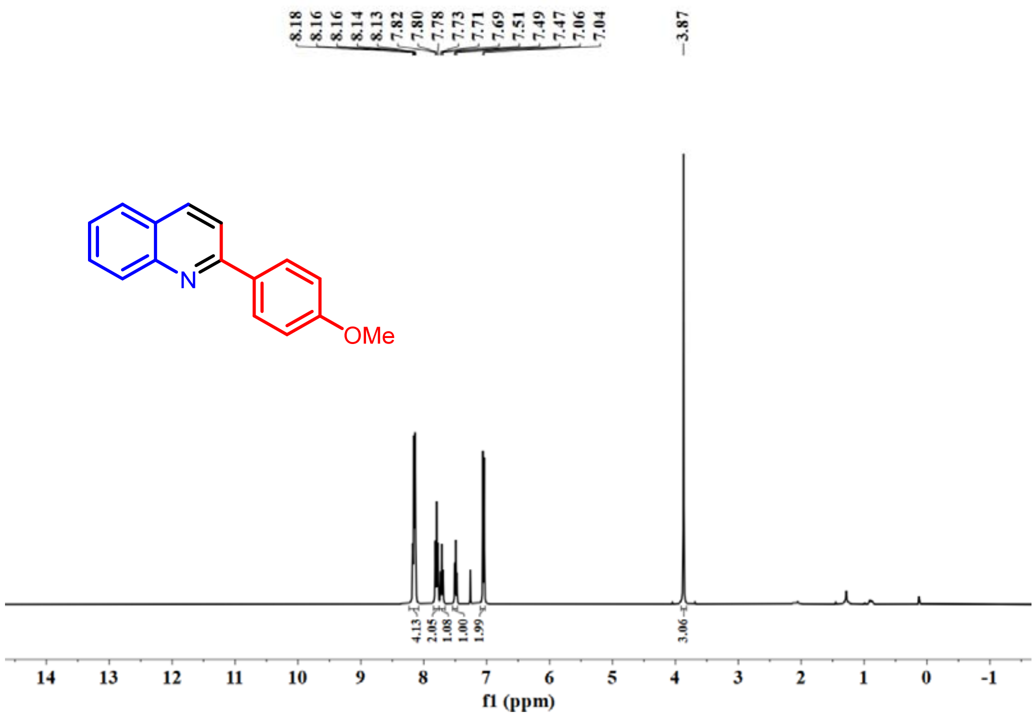



**Fig. S37** $^{1}H$ NMR spectrum of **3** in $CDCl_3$ (400 MHz).

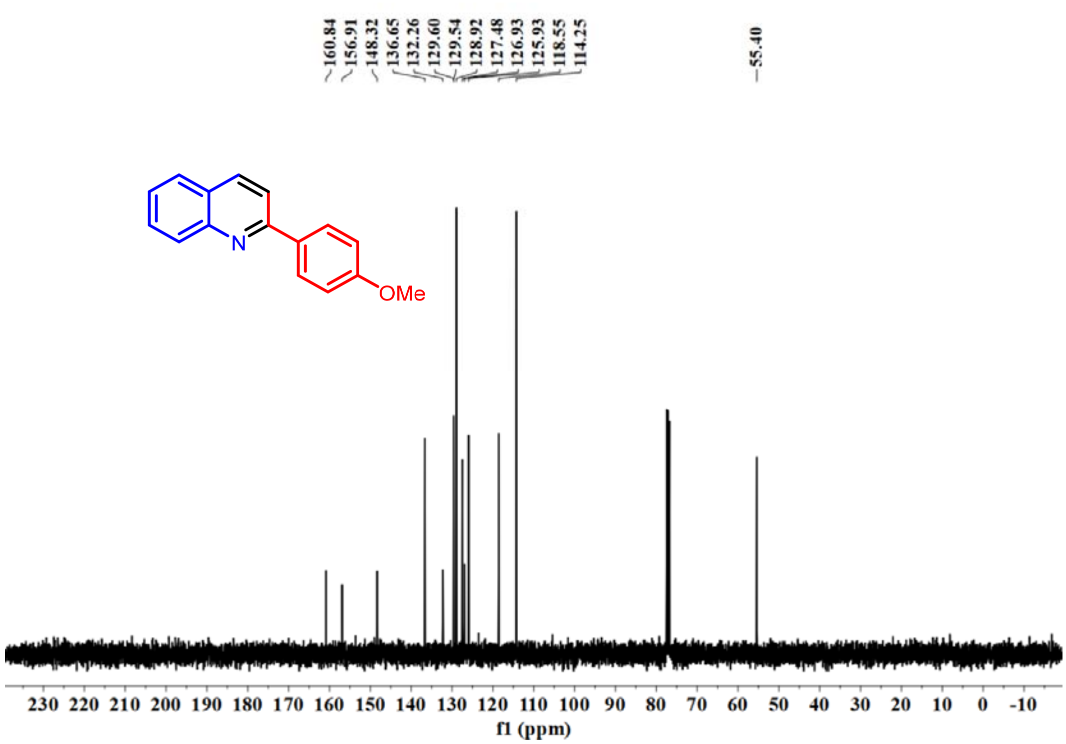


**Fig. S38** $^{13}C\{^{1}H\}$ NMR spectrum of **3** in $CDCl_3$ (101MHz).

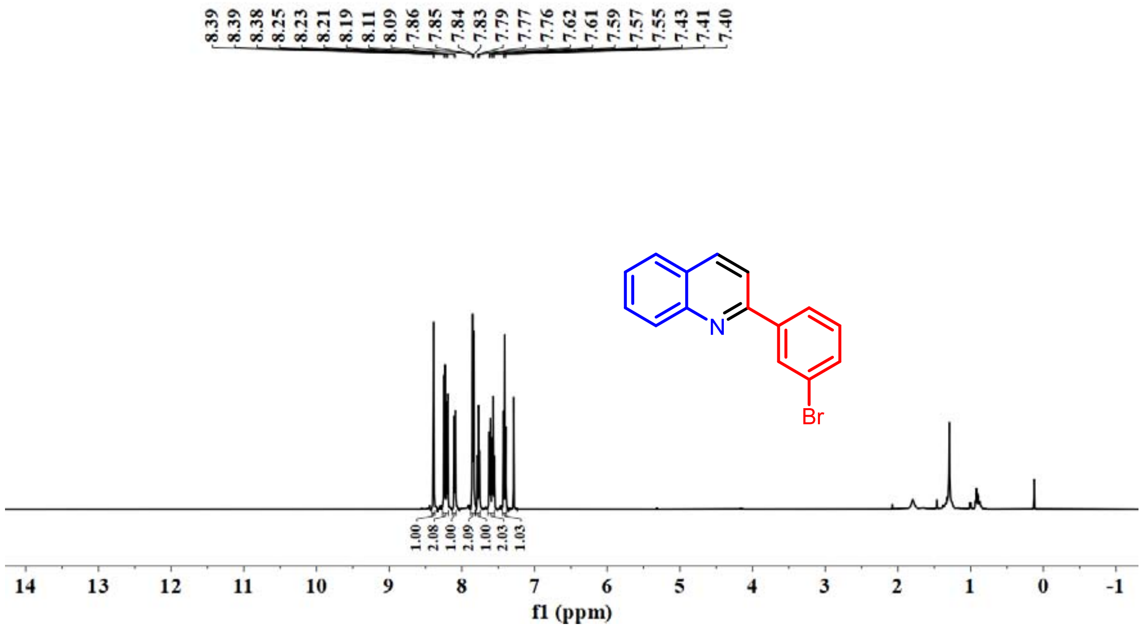



**Fig. S39** $^{1}H$ NMR spectrum of **4** in $CDCl_3$ (500 MHz).

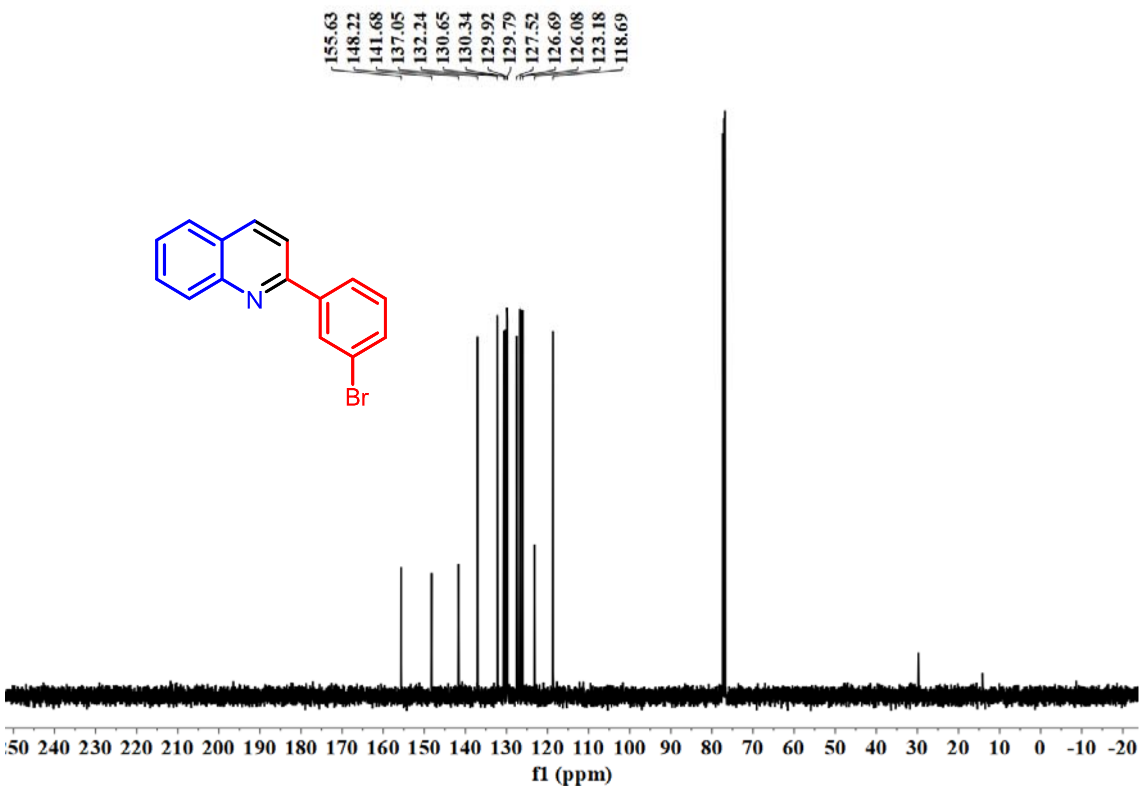



**Fig. S40** $^{13}C\{^{1}H\}$ NMR spectrum of **4** in $CDCl_3$ (126 MHz).

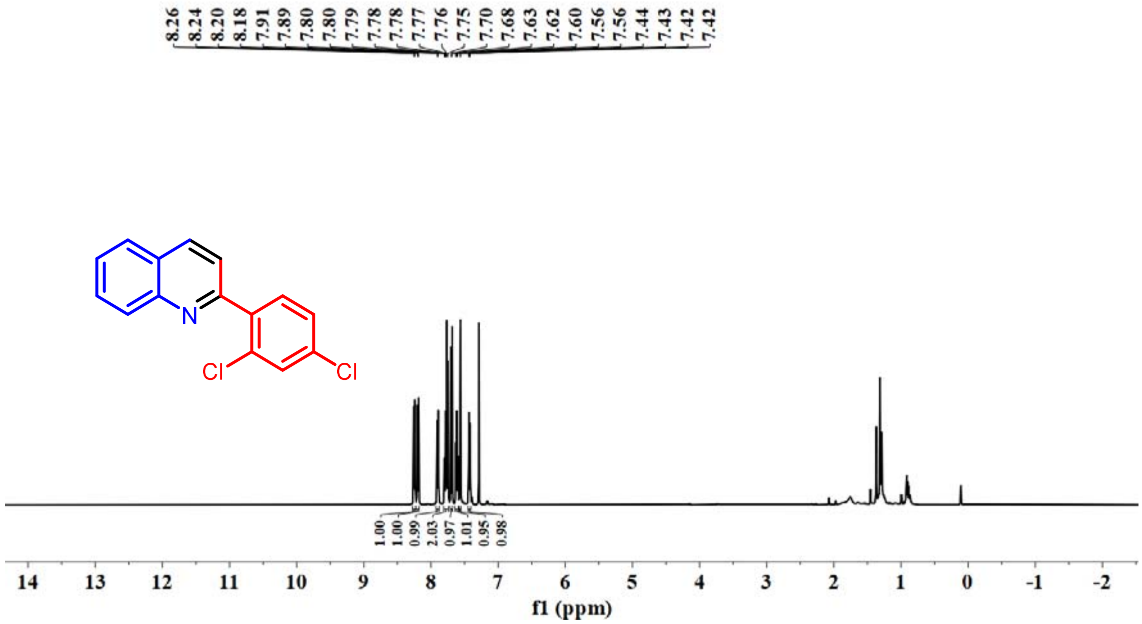



**Fig. S41** $^{1}H$ NMR spectrum of **5** in $CDCl_3$ (500 MHz).

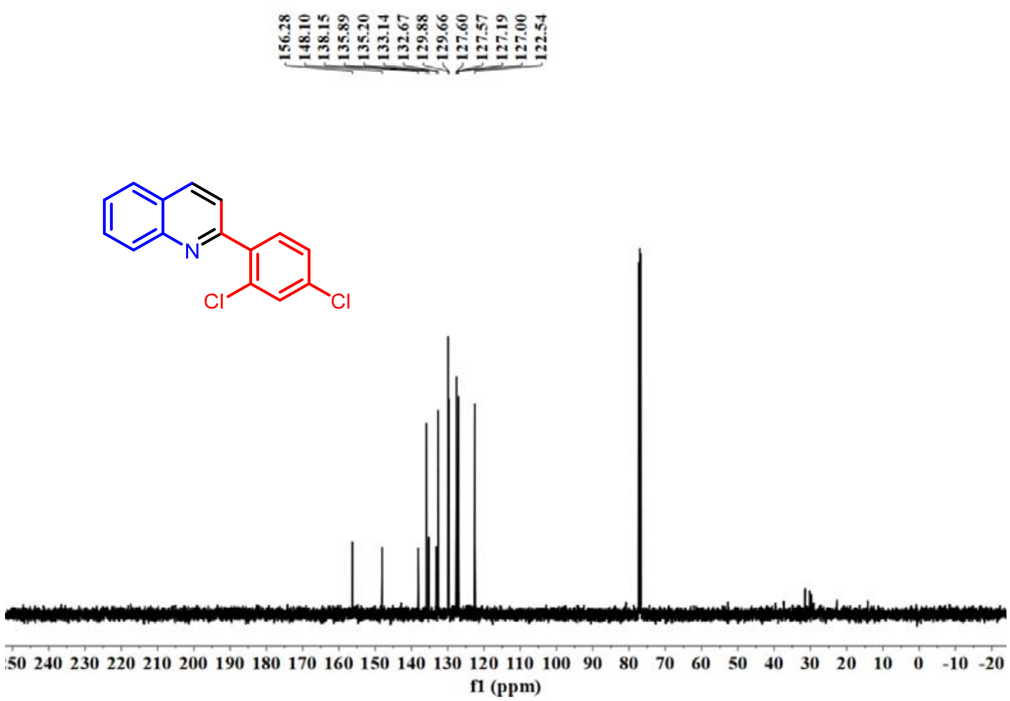



**Fig. S42** $^{13}C\{^{1}H\}$ NMR spectrum of **5** in $CDCl_3$ (126 MHz).

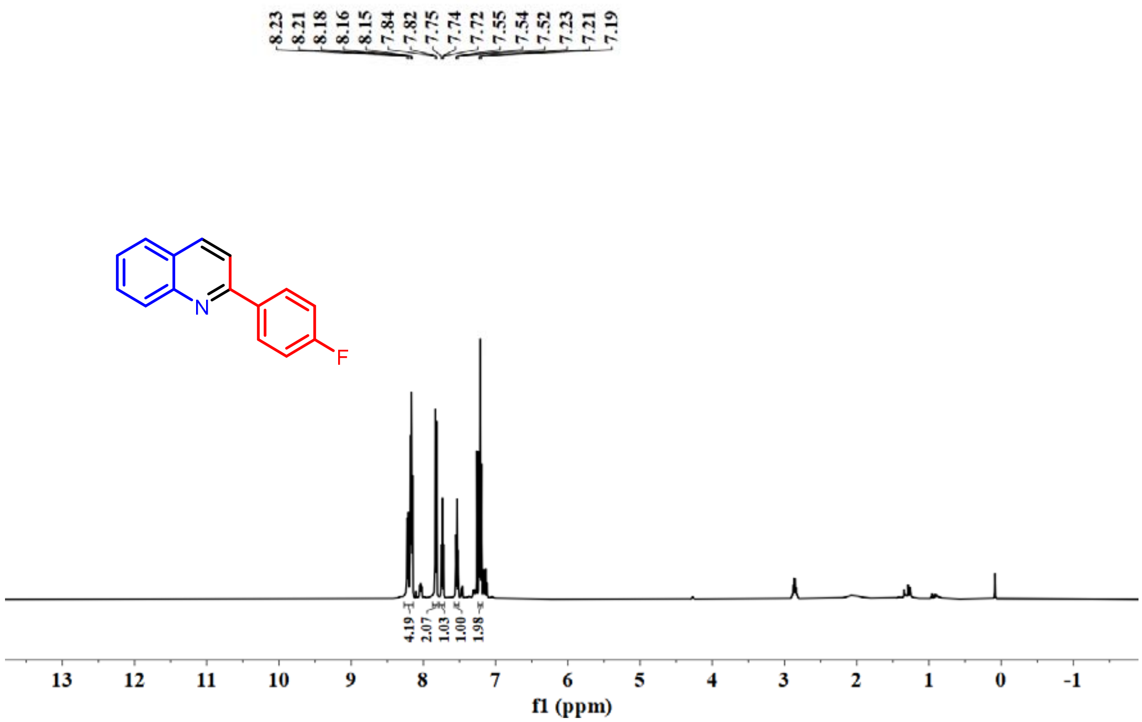


**Fig. S43** $^{1}$H NMR spectrum of **6** in $CDCl_3$ (500 MHz).

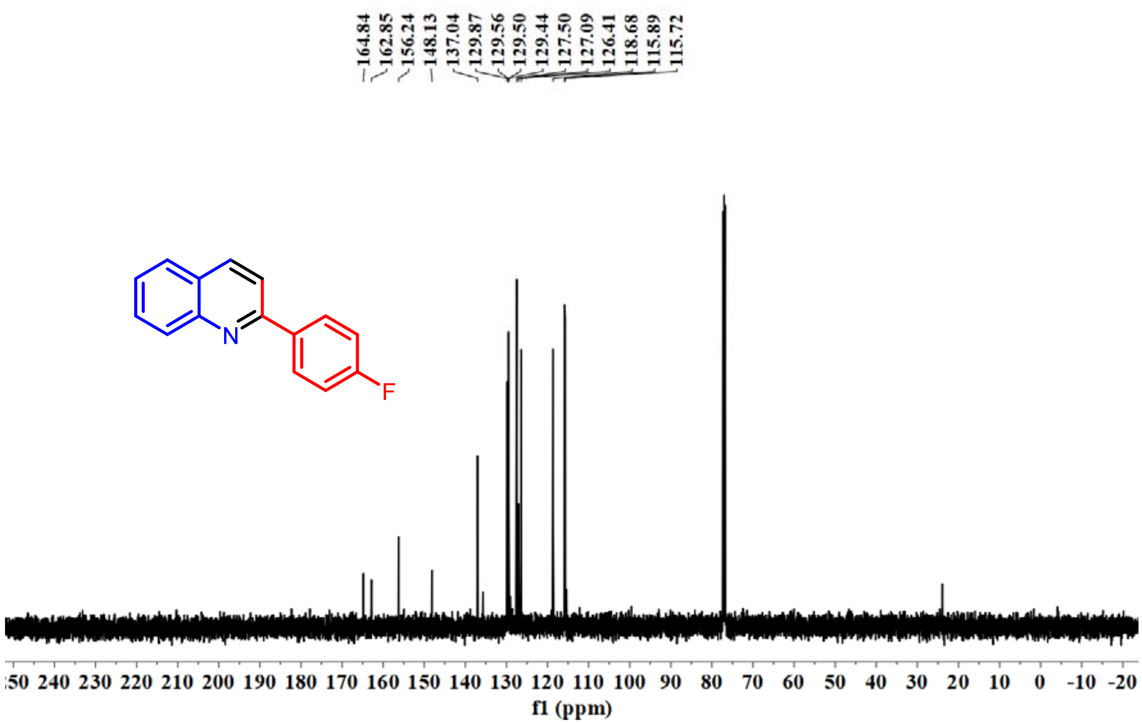


**Fig. S44** $^{13}C\{^{1}H\}$ NMR spectrum of **6** in $CDCl_3$ (126MHz).

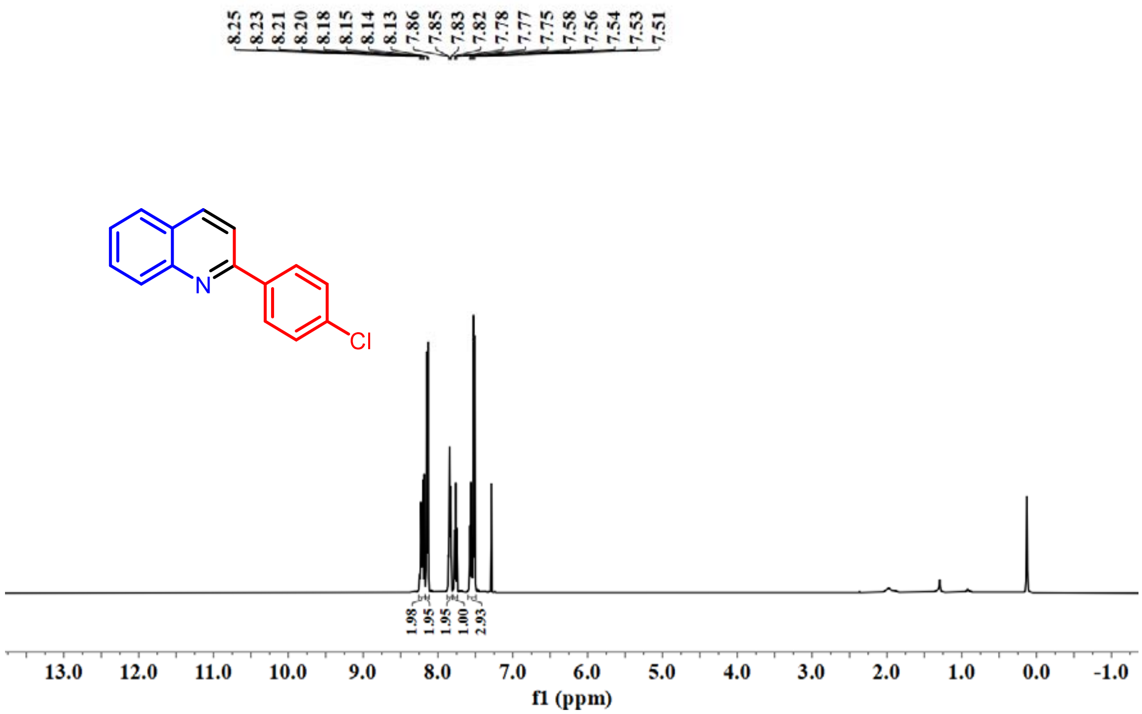



**Fig. S45** $^{1}$H NMR spectrum of **7** in $CDCl_3$ (500 MHz).

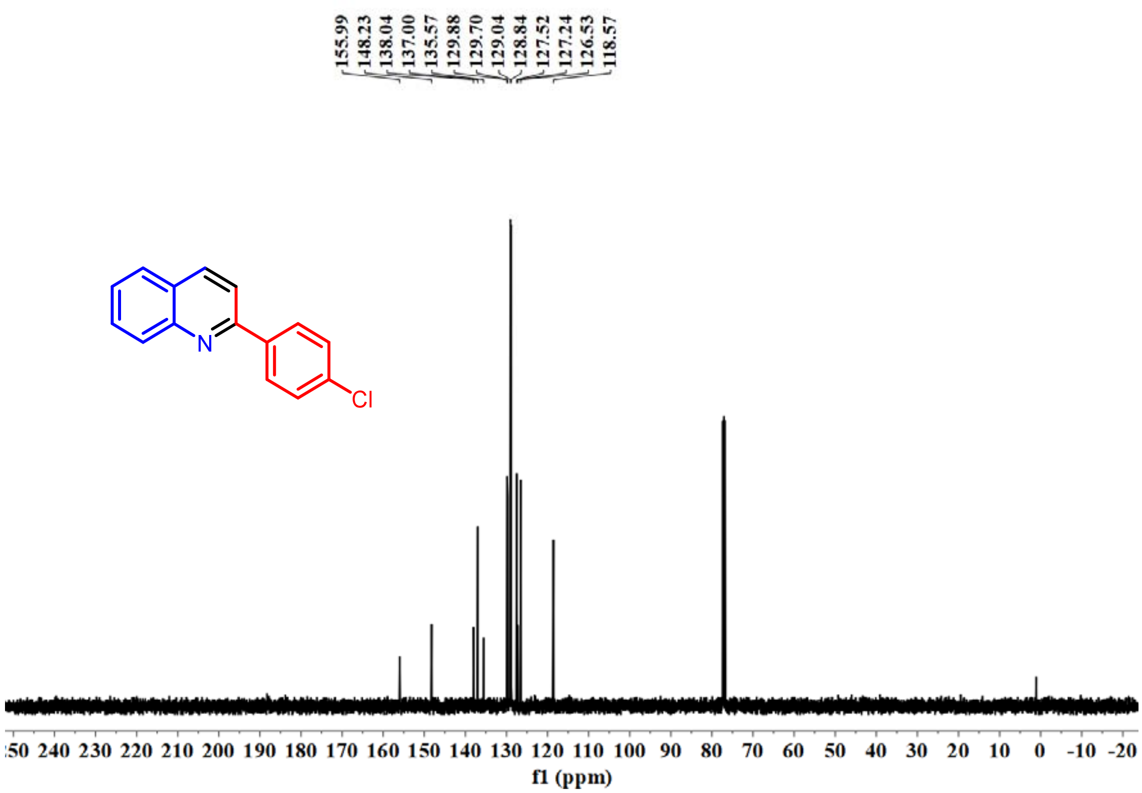



**Fig. S46** $^{13}C\{^{1}H\}$ NMR spectrum of **7** in $CDCl_3$ (126 MHz).

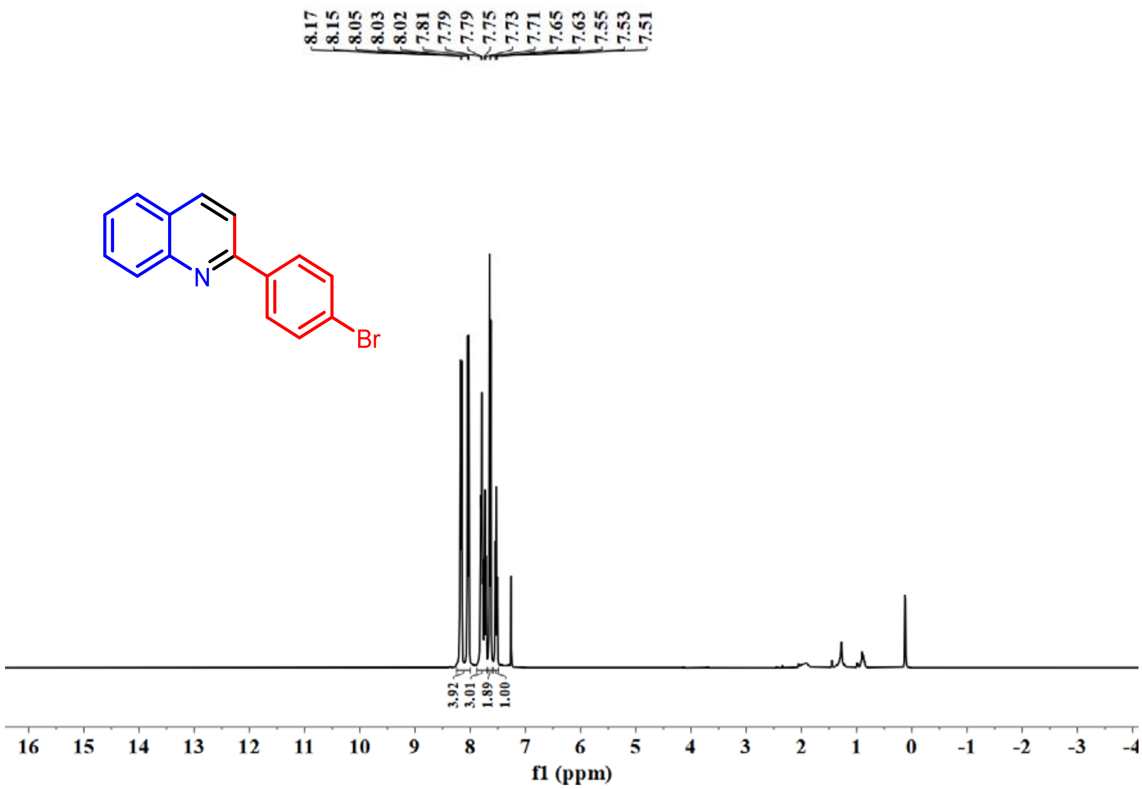



**Fig. S47** $^{1}H$ NMR spectrum of **8** in $CDCl_3$ (400MHz).

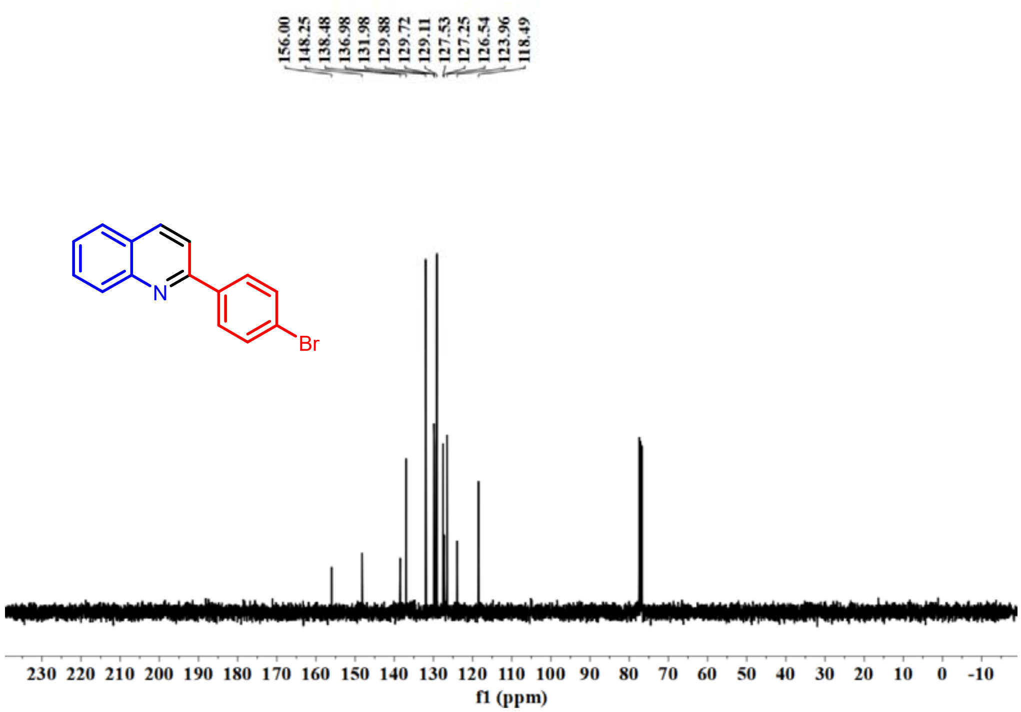



**Fig. S48** $^{13}C\{^{1}H\}$ NMR spectrum of **8** in $CDCl_3$ (101 MHz).

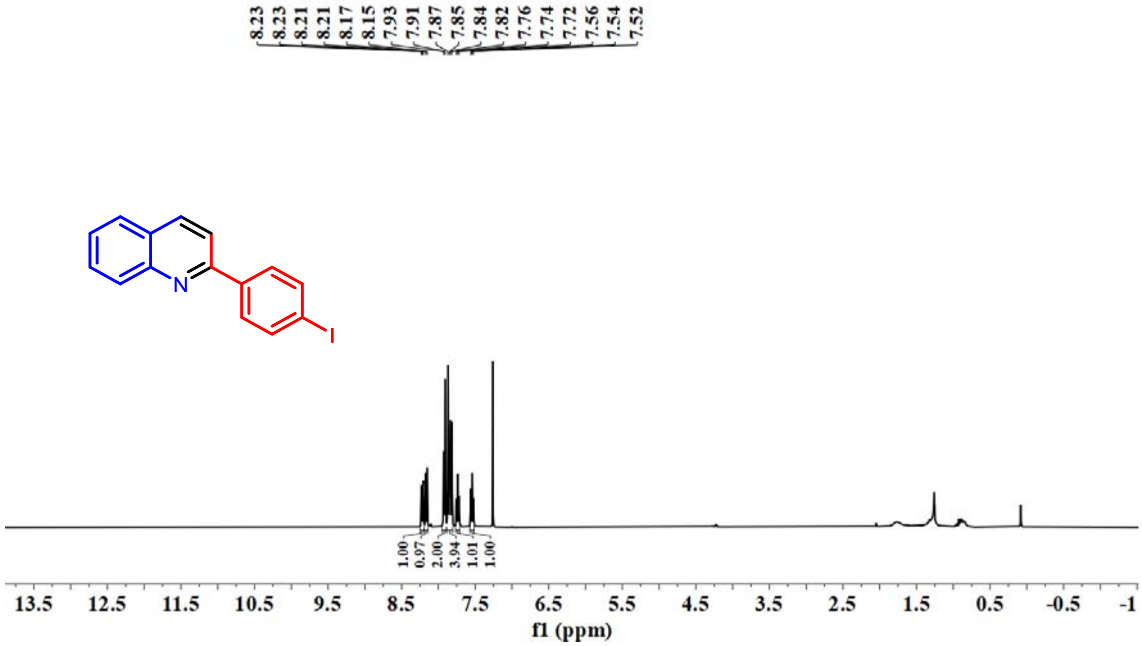



**Fig. S49** $^{1}$H NMR spectrum of **9** in $CDCl_3$ (400 MHz).

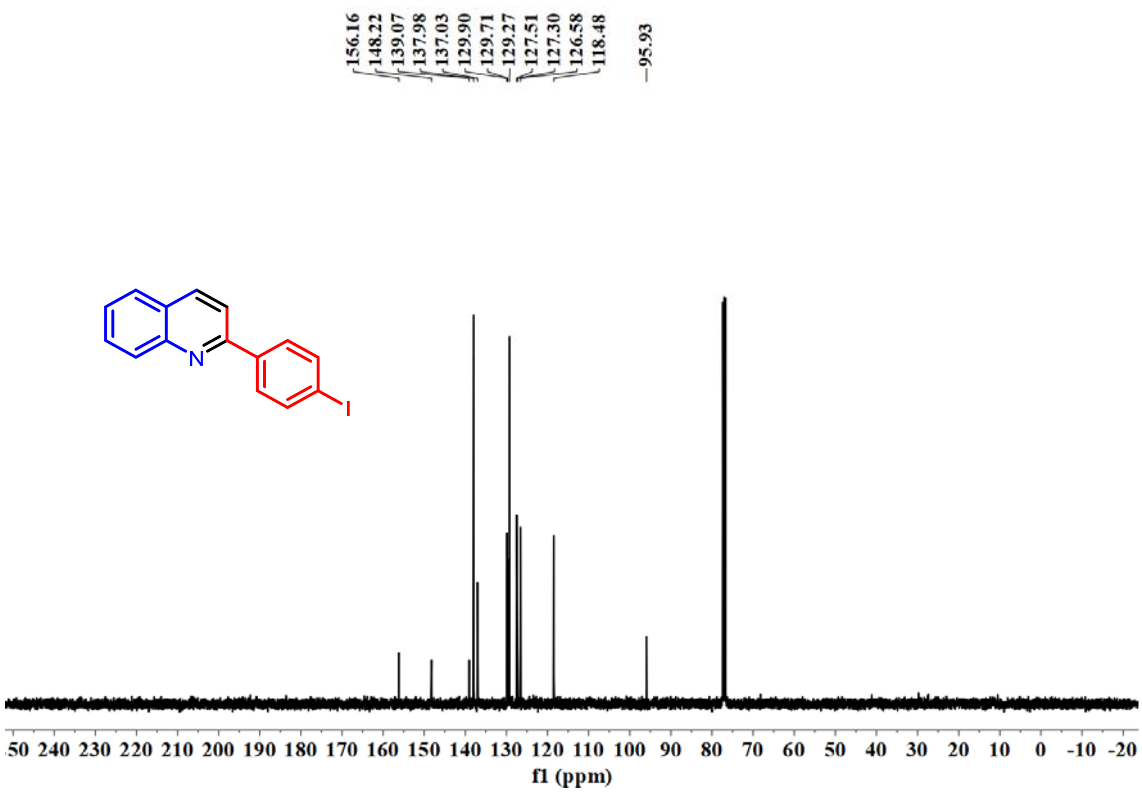



**Fig. S50** $^{13}C\{^{1}H\}$ NMR spectrum of **9** in $CDCl_3$ (101 MHz).

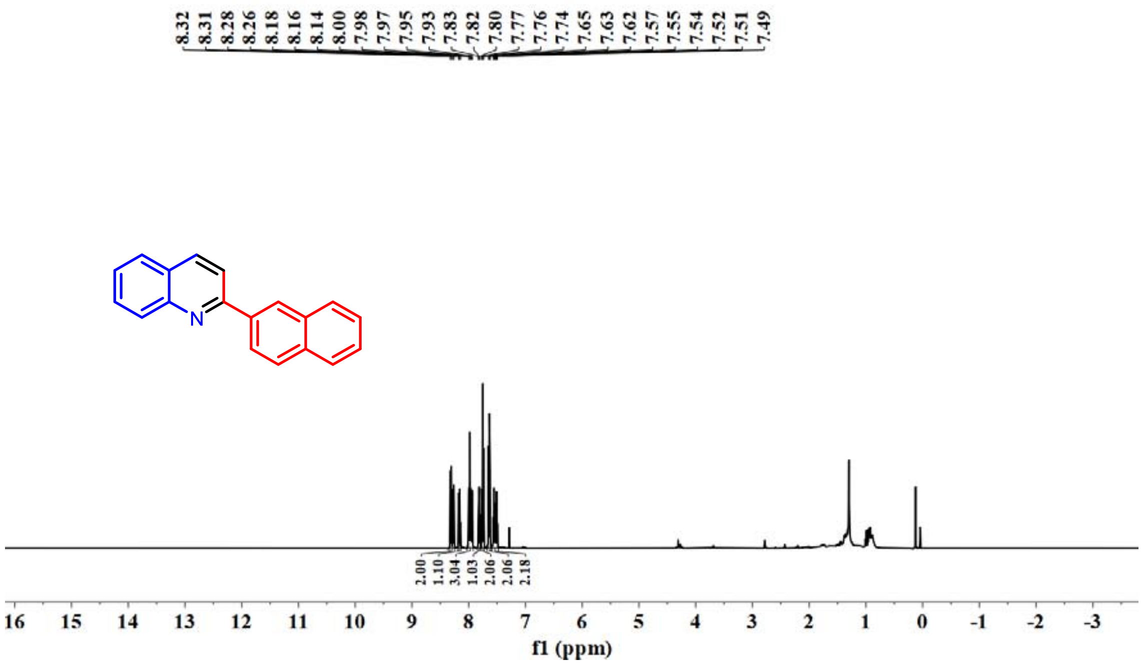



**Fig. S51** $^{1}H$ NMR spectrum of **10** in $CDCl_3$ (500 MHz).

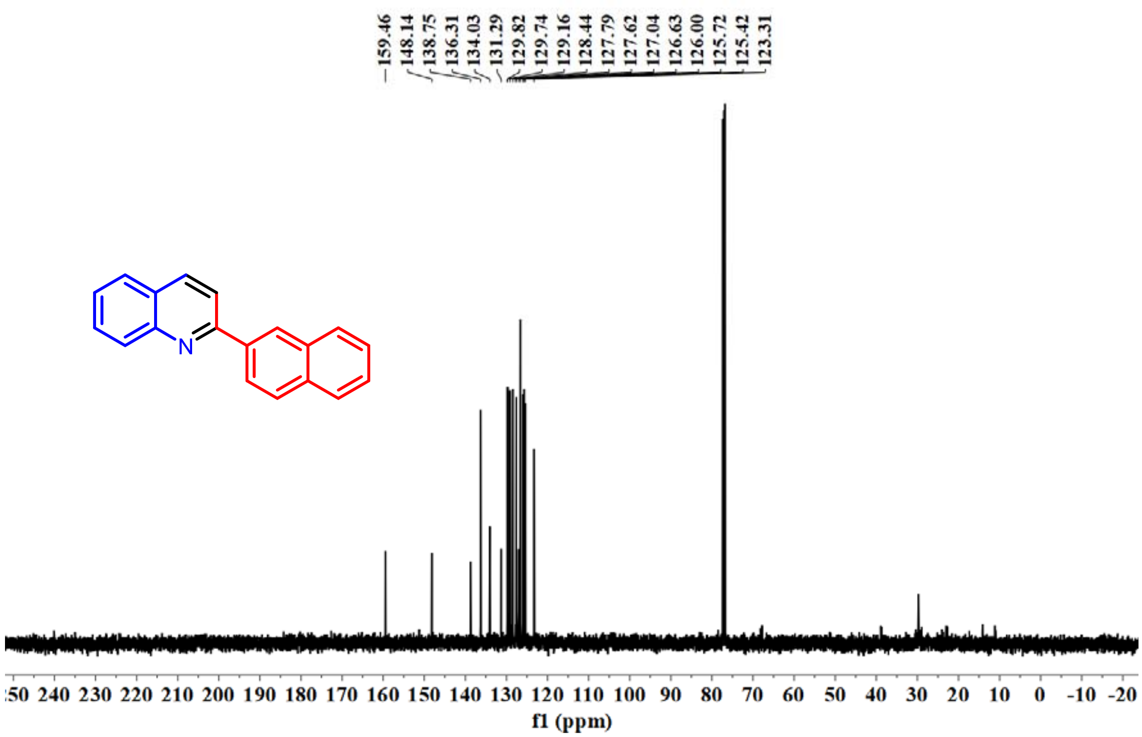



**Fig. S52** $^{13}C\{^{1}H\}$ NMR spectrum of **10** in $CDCl_3$ (126MHz).

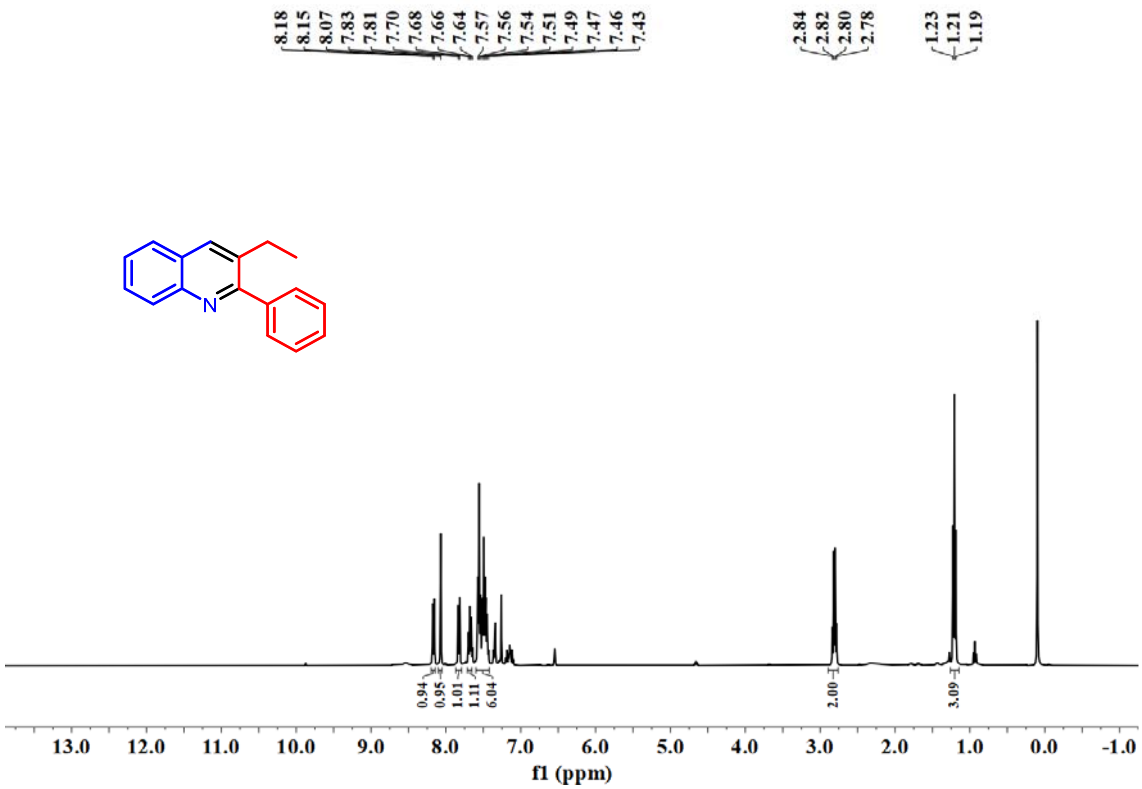



**Fig. S53** $^{1}H$ NMR spectrum of **11** in $CDCl_3$ (400 MHz).

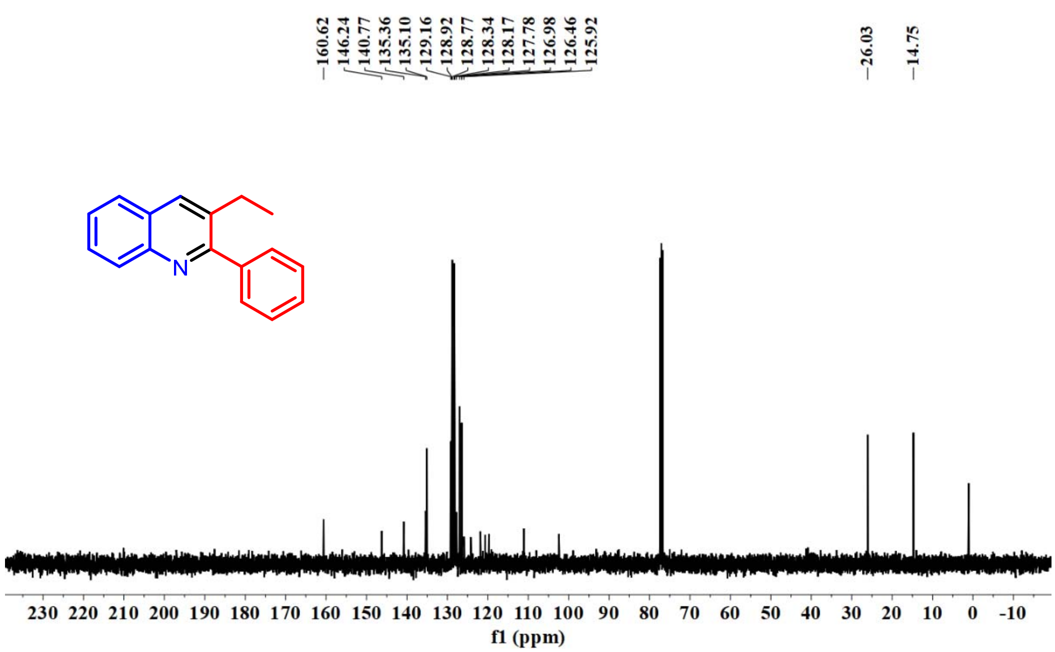



**Fig. S54** $^{13}C\{^{1}H\}$ NMR spectrum of **11** in $CDCl_3$ (101MHz).

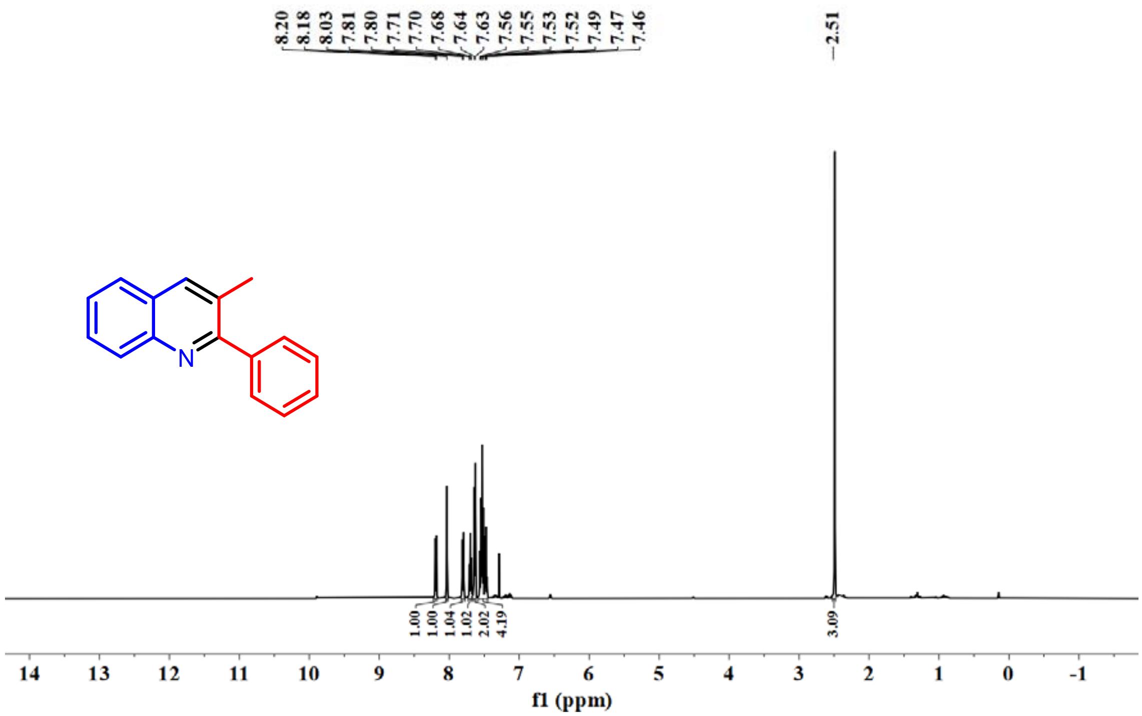



**Fig. S55** $^{1}H$ NMR spectrum of **12** in $CDCl_3$ (500 MHz).

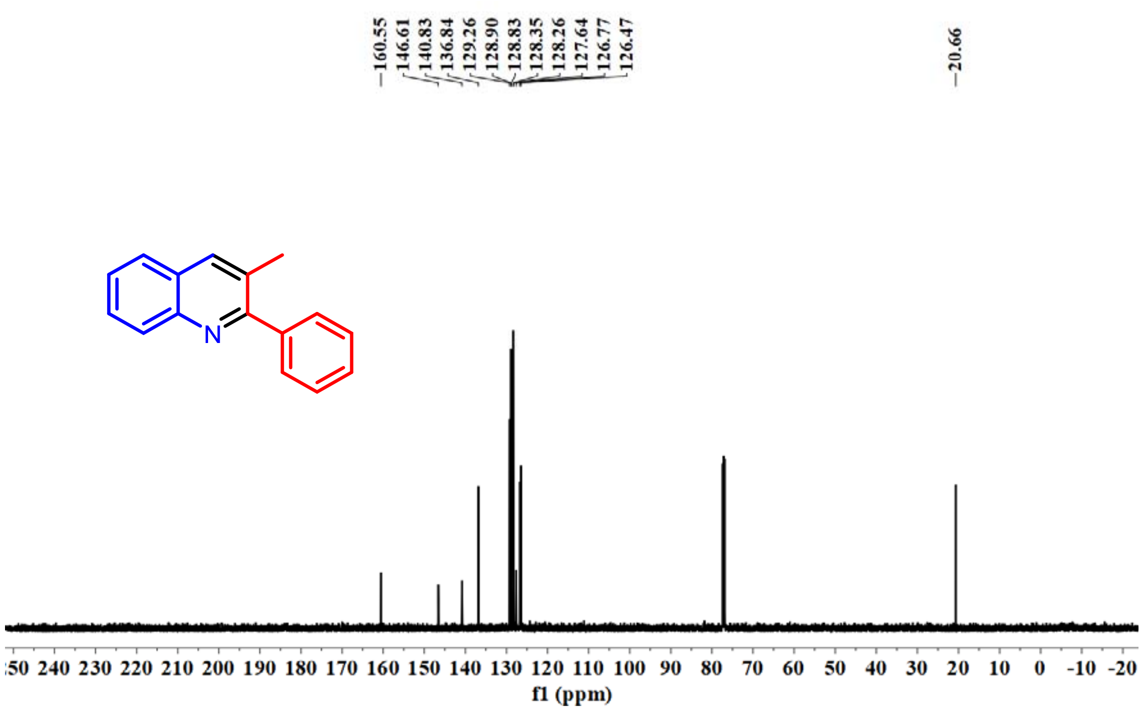



**Fig. S56** $^{13}C\{^{1}H\}$ NMR spectrum of **12** in $CDCl_3$ (126MHz).

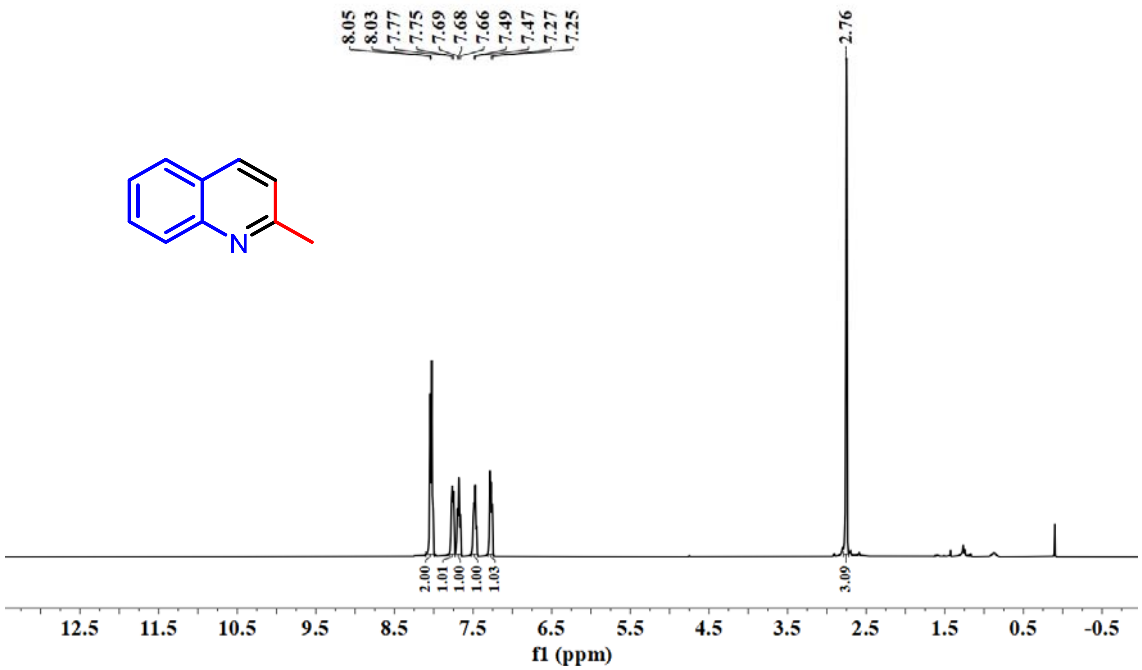



**Fig. S57** $^{1}H$ NMR spectrum of **13** in $CDCl_3$ (400 MHz).

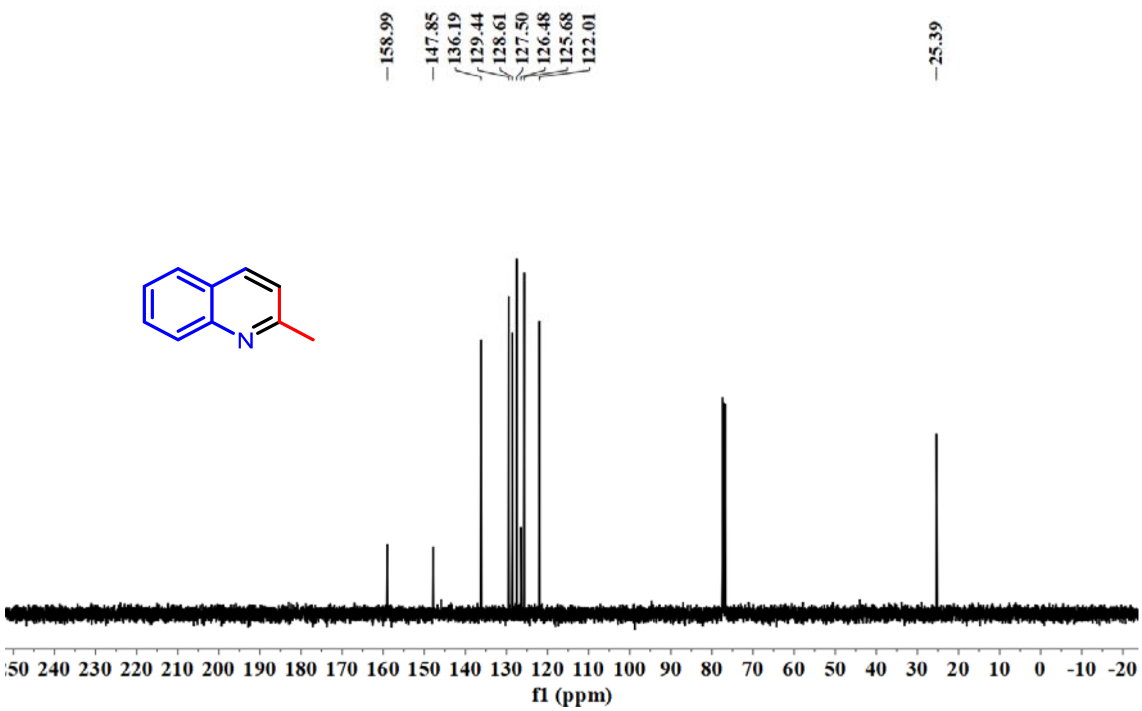



**Fig. S58** $^{13}C\{^{1}H\}$ NMR spectrum of **13** in $CDCl_3$ (101 MHz).

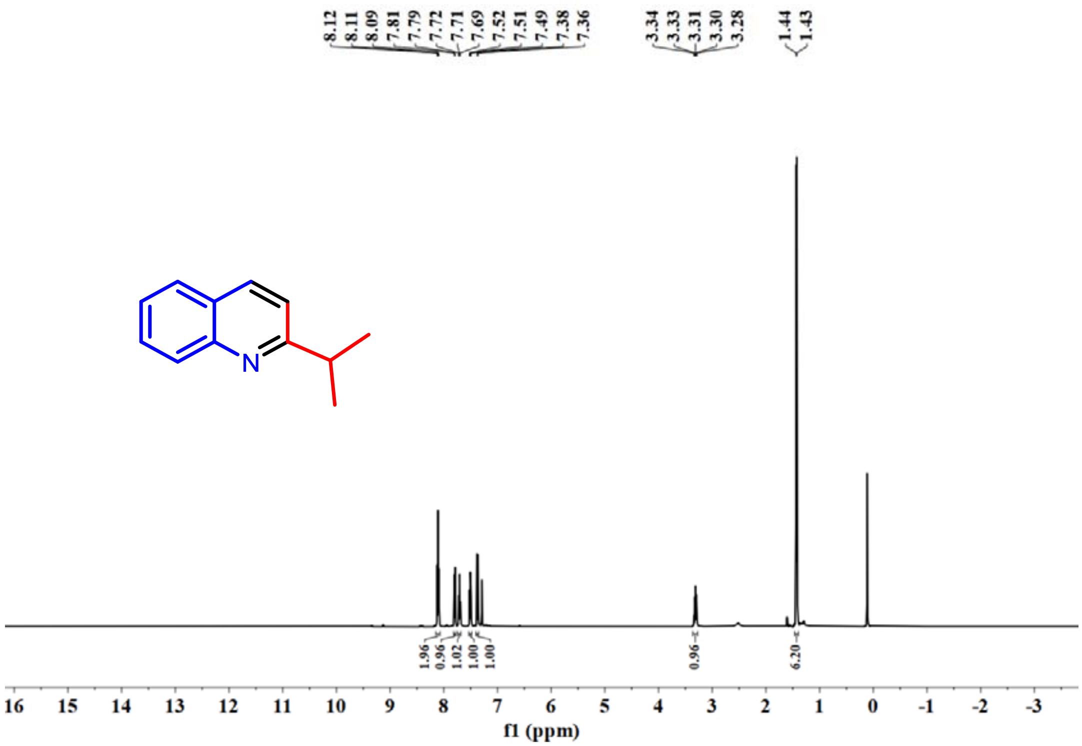



**Fig. S59** $^{1}H$ NMR spectrum of **14** in $CDCl_3$ (500 MHz).

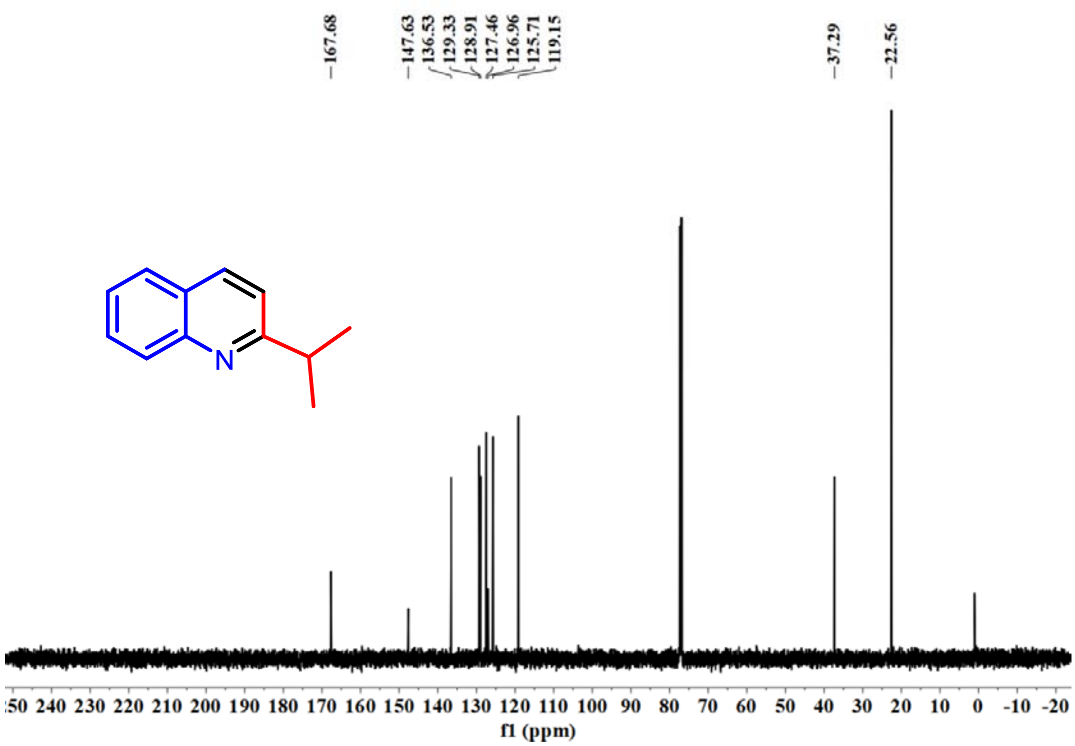



**Fig. S60** $^{13}C\{^{1}H\}$ NMR spectrum of **14** in $CDCl_3$ (126 MHz).

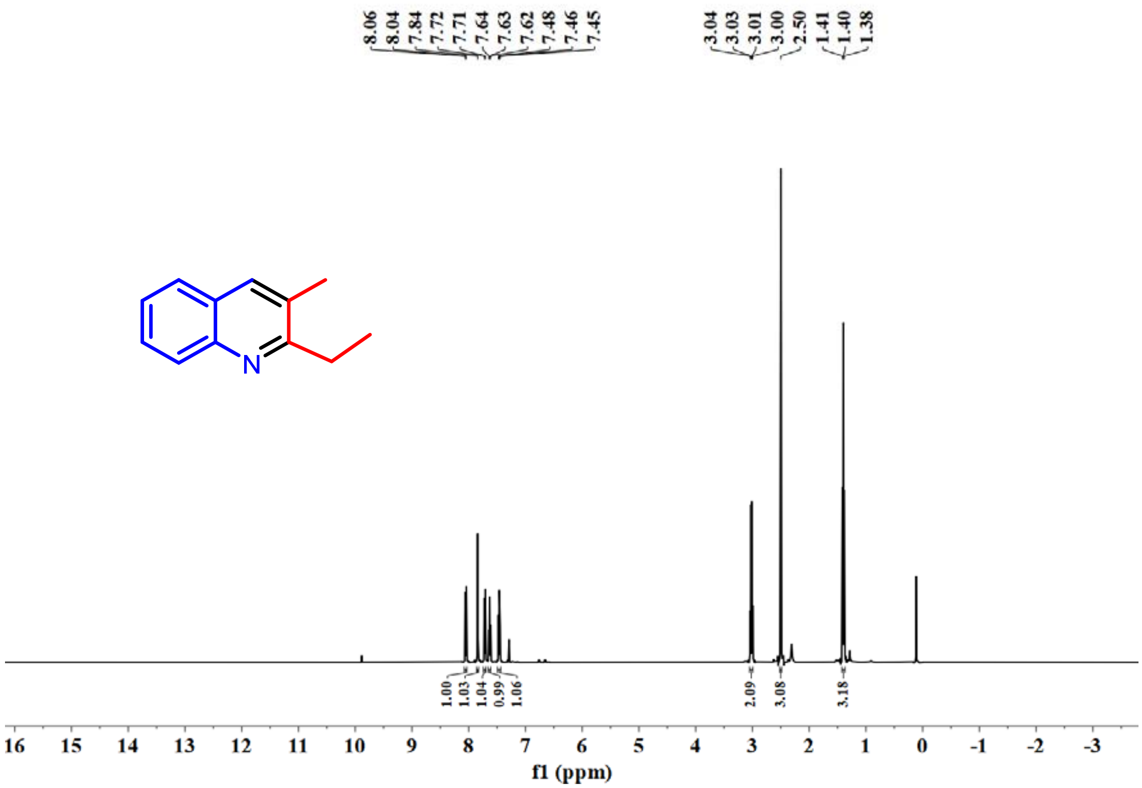



**Fig. S61** $^{1}H$ NMR spectrum of **15** in $CDCl_3$ (500 MHz).

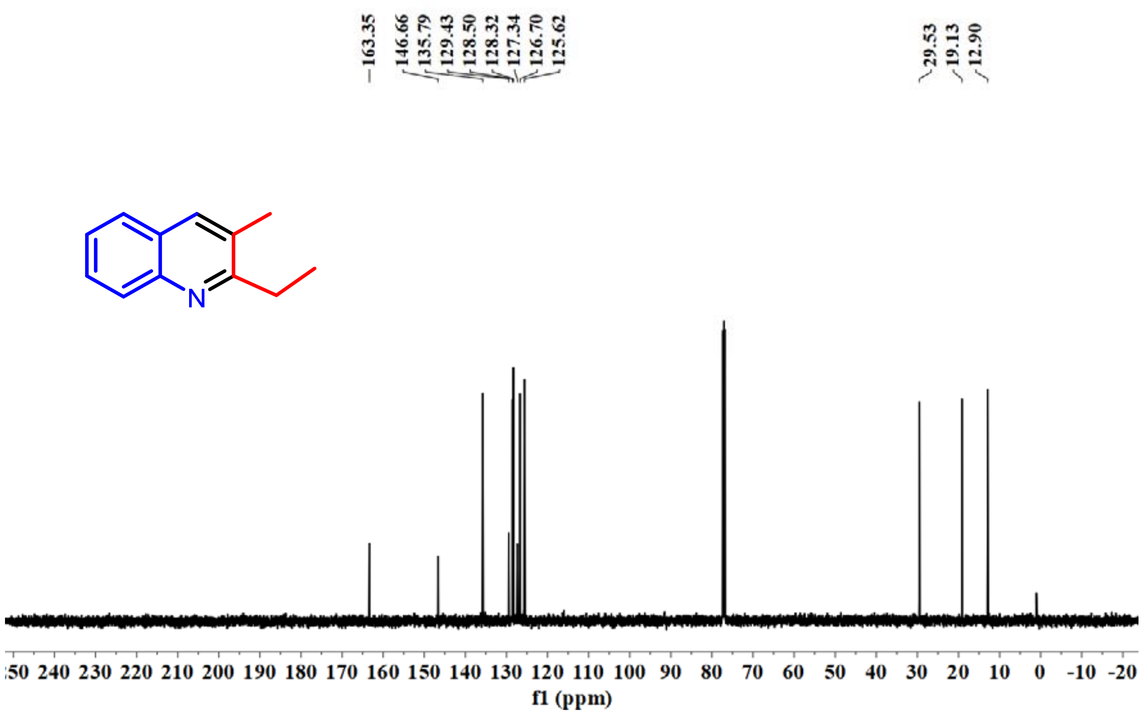



**Fig. S62** $^{13}C\{^{1}H\}$ NMR spectrum of **15** in $CDCl_3$ (126 MHz).

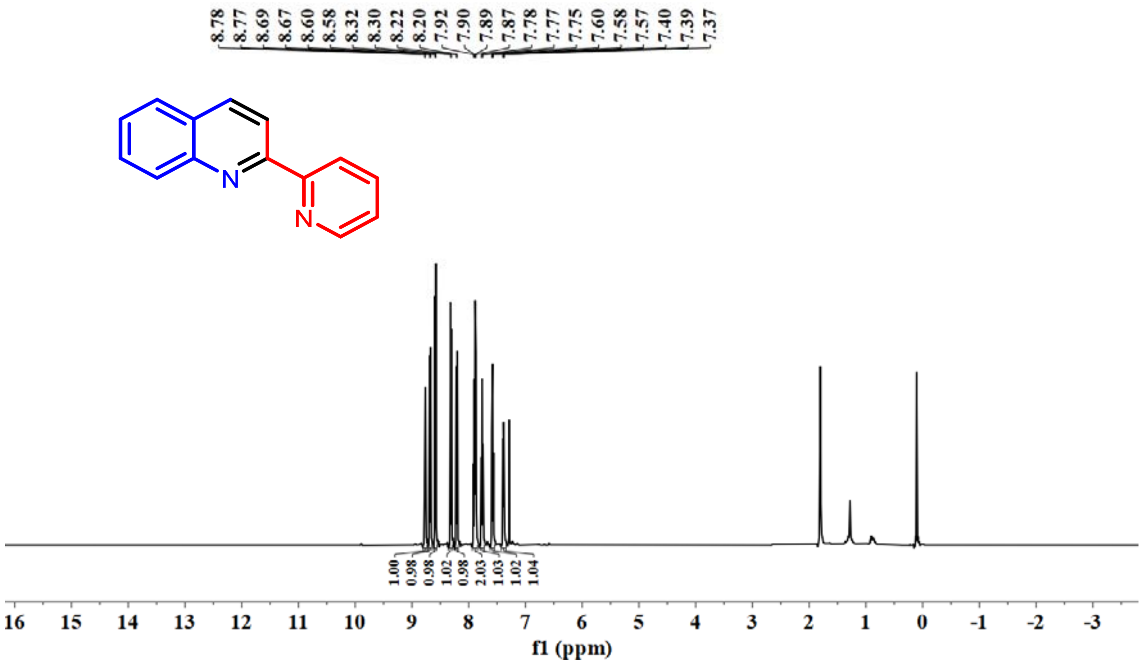



**Fig. S63** ¹H NMR spectrum of **16** in $CDCl_3$ (500 MHz).

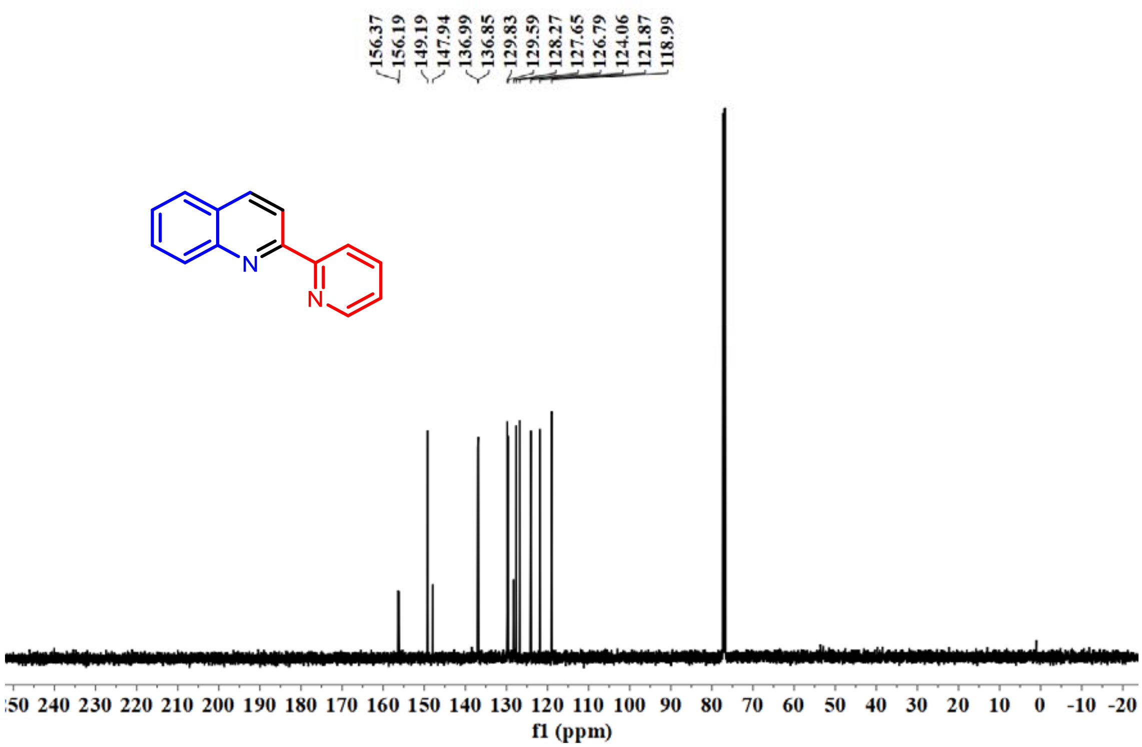



**Fig. S64** ¹³C{¹H} NMR spectrum of **16** in $CDCl_3$ (126 MHz).

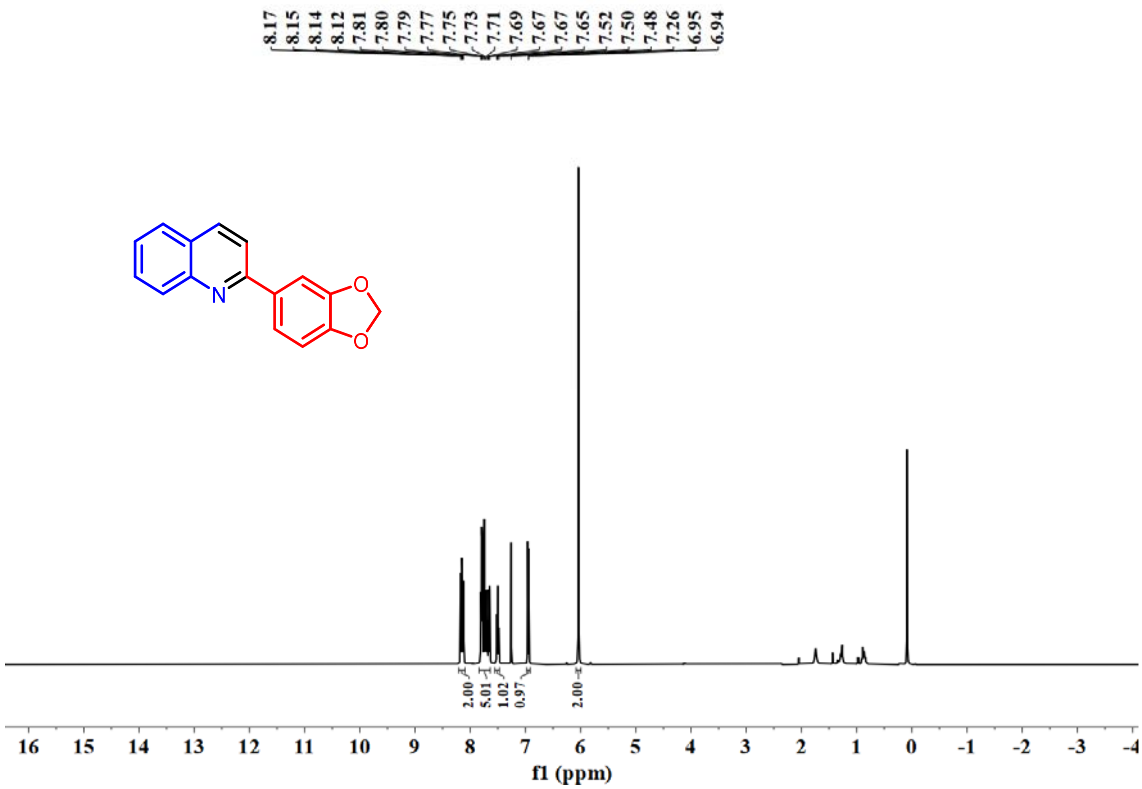



**Fig. S65** $^{1}H$ NMR spectrum of **17** in $CDCl_3$ (400 MHz).

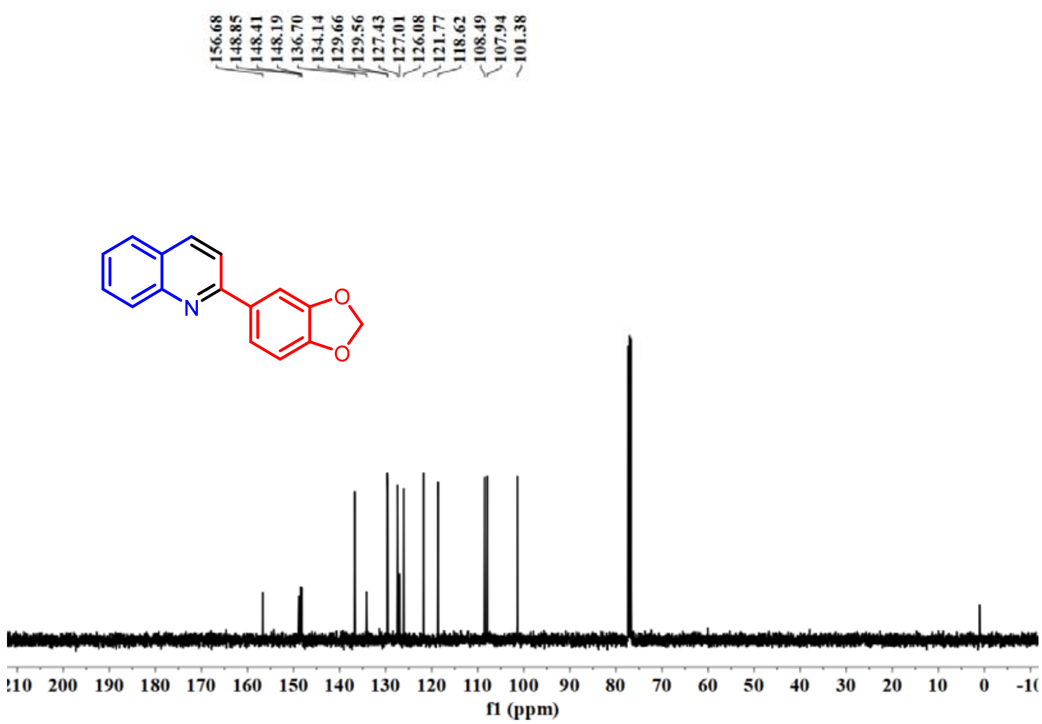



**Fig. S66** $^{13}C\{^{1}H\}$ NMR spectrum of **17** in $CDCl_3$ (101 MHz).

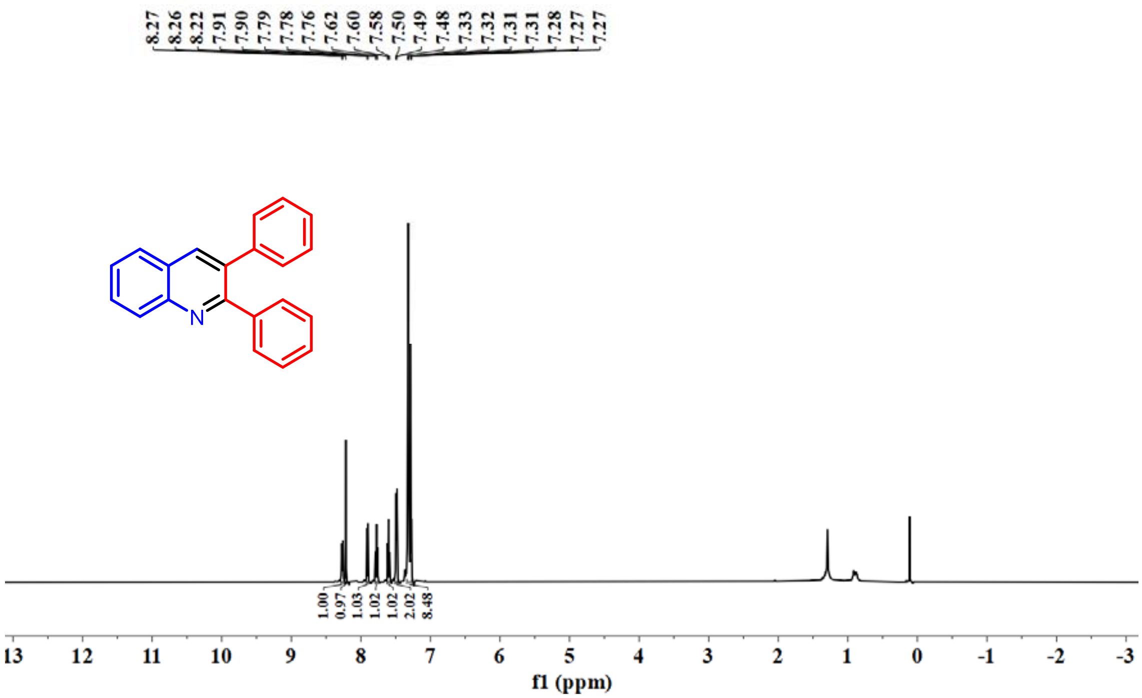



**Fig. S67** $^{1}H$ NMR spectrum of **18** in $CDCl_3$ (500 MHz).

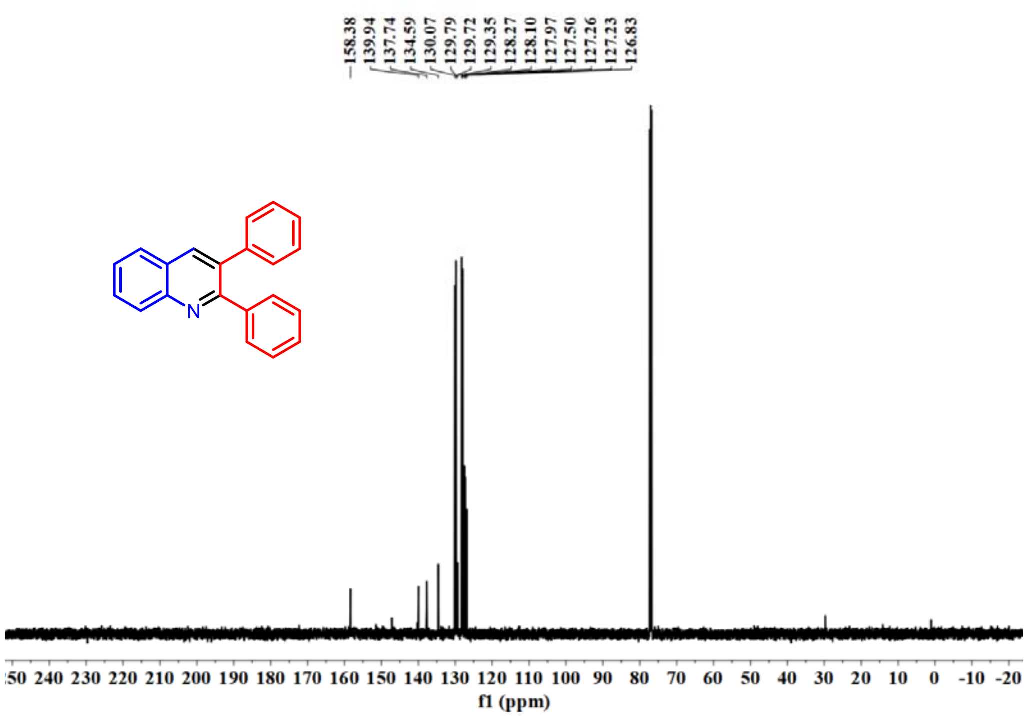



**Fig. S68** $^{13}C\{^{1}H\}$ NMR spectrum of **18** in $CDCl_3$ (126 MHz).

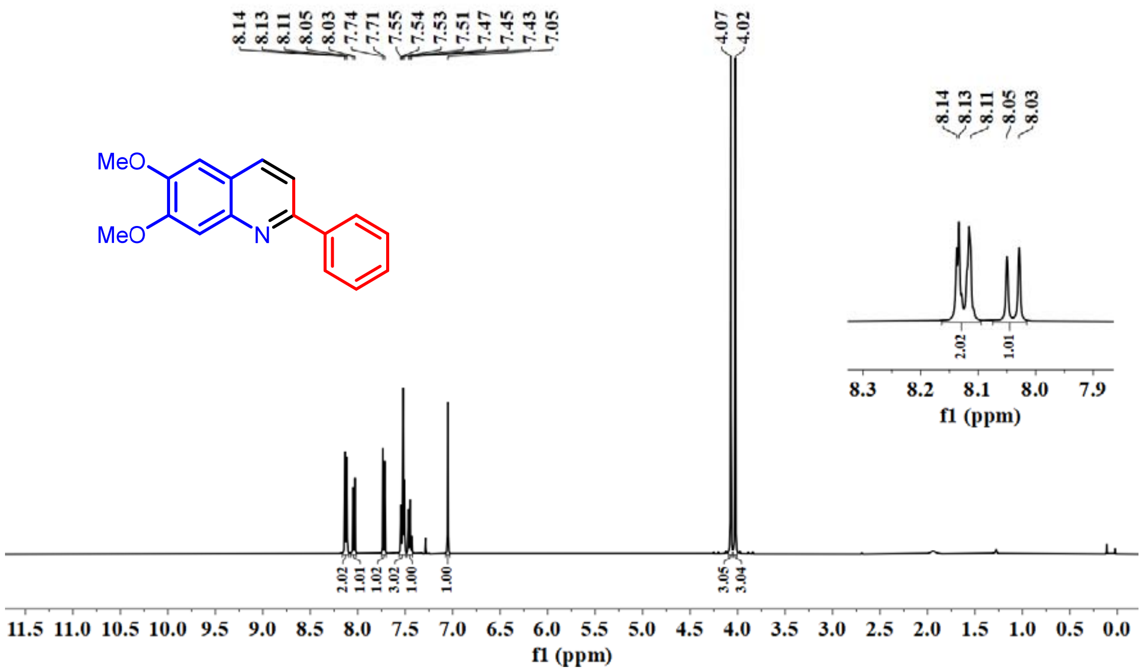



**Fig. S69** $^{1}H$ NMR spectrum of **19** in $CDCl_3$ (400 MHz).

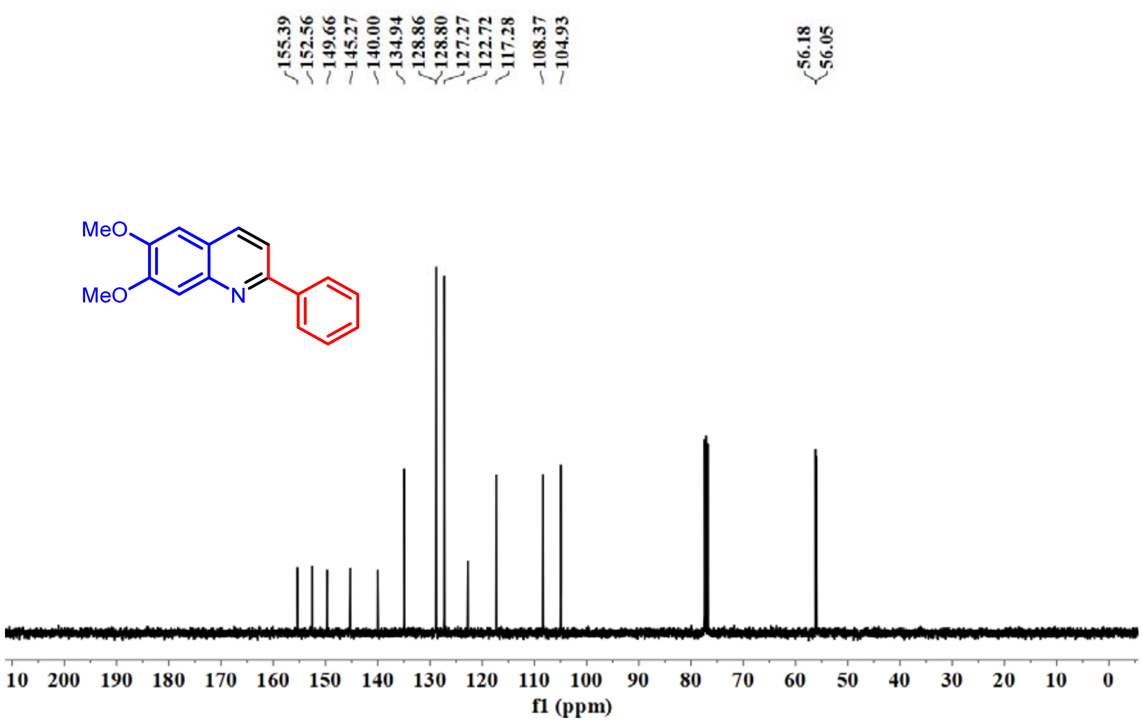



**Fig. S70** $^{13}C\{^{1}H\}$ NMR spectrum of **19** in $CDCl_3$ (101 MHz).

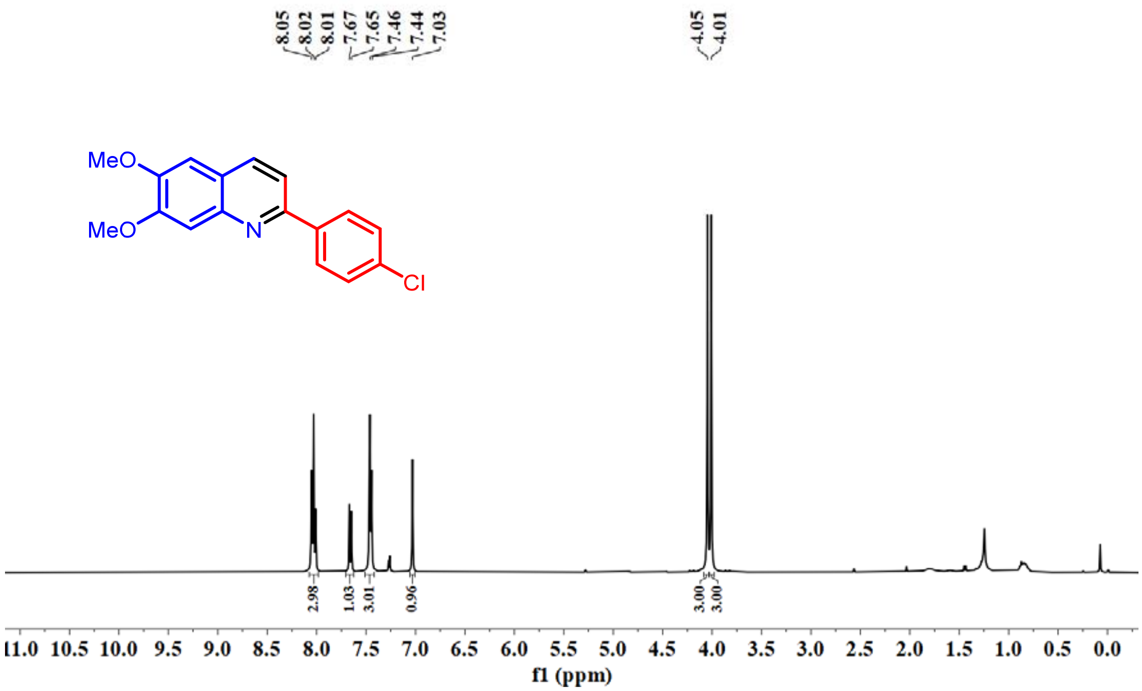



**Fig. S71** $^{1}H$ NMR spectrum of **20** in $CDCl_3$ (400 MHz).

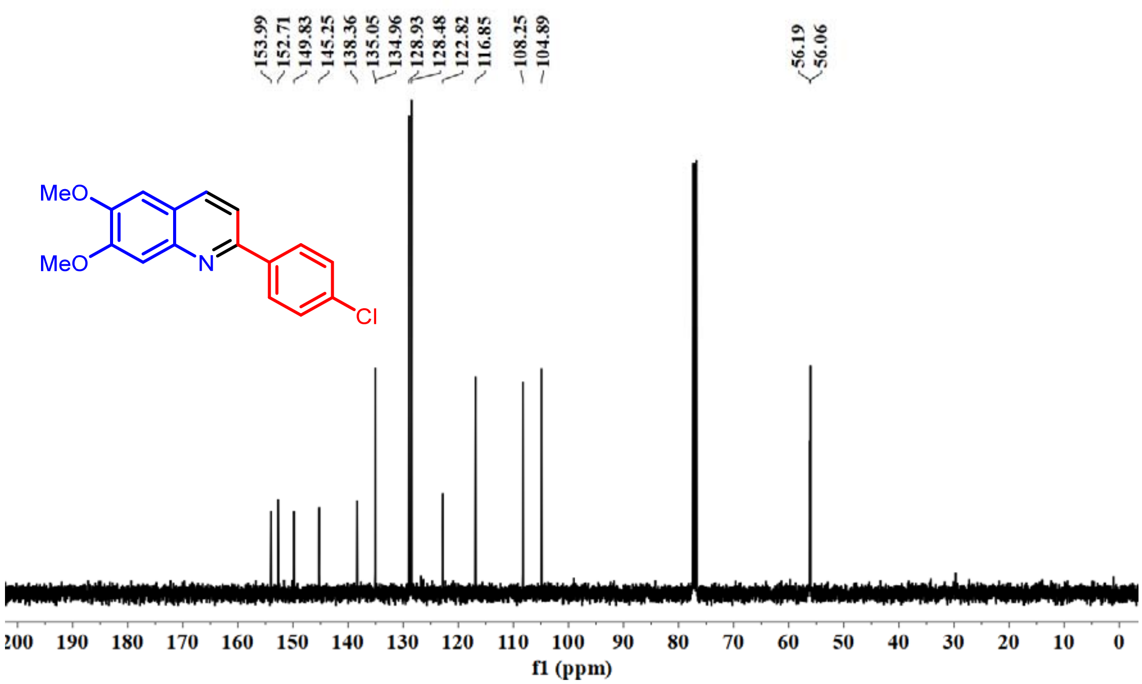



**Fig. S72** $^{13}C\{^{1}H\}$ NMR spectrum of **20** in $CDCl_3$ (101 MHz).

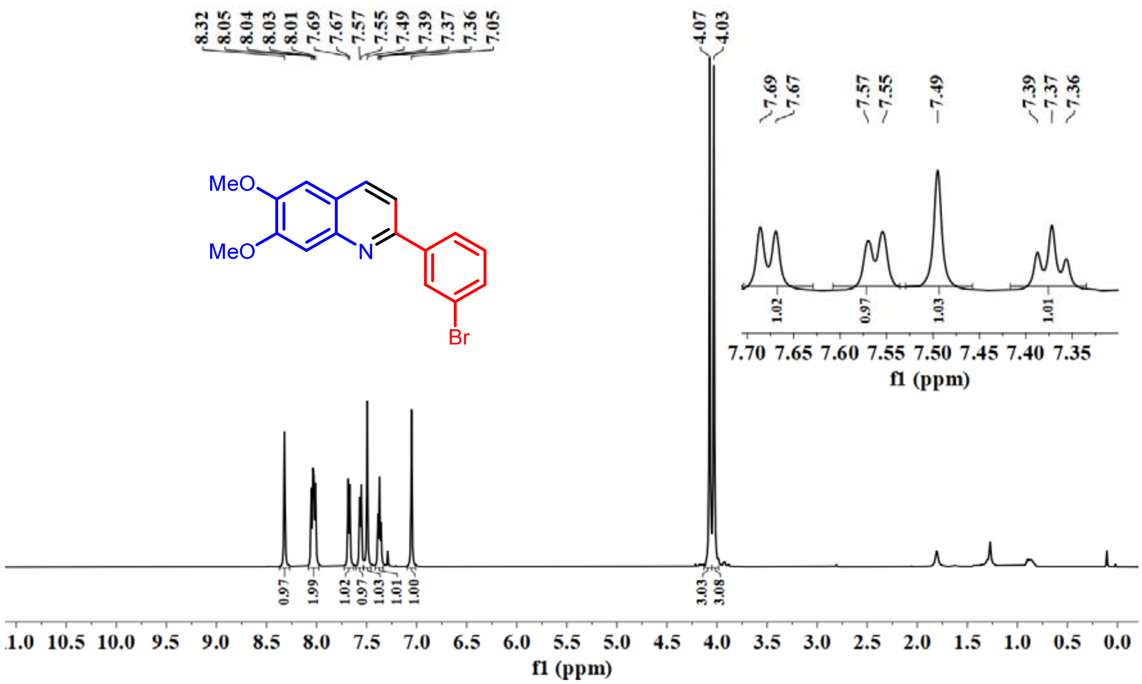



**Fig. S73** $^{1}$H NMR spectrum of **21** in $CDCl_3$ (500 MHz).

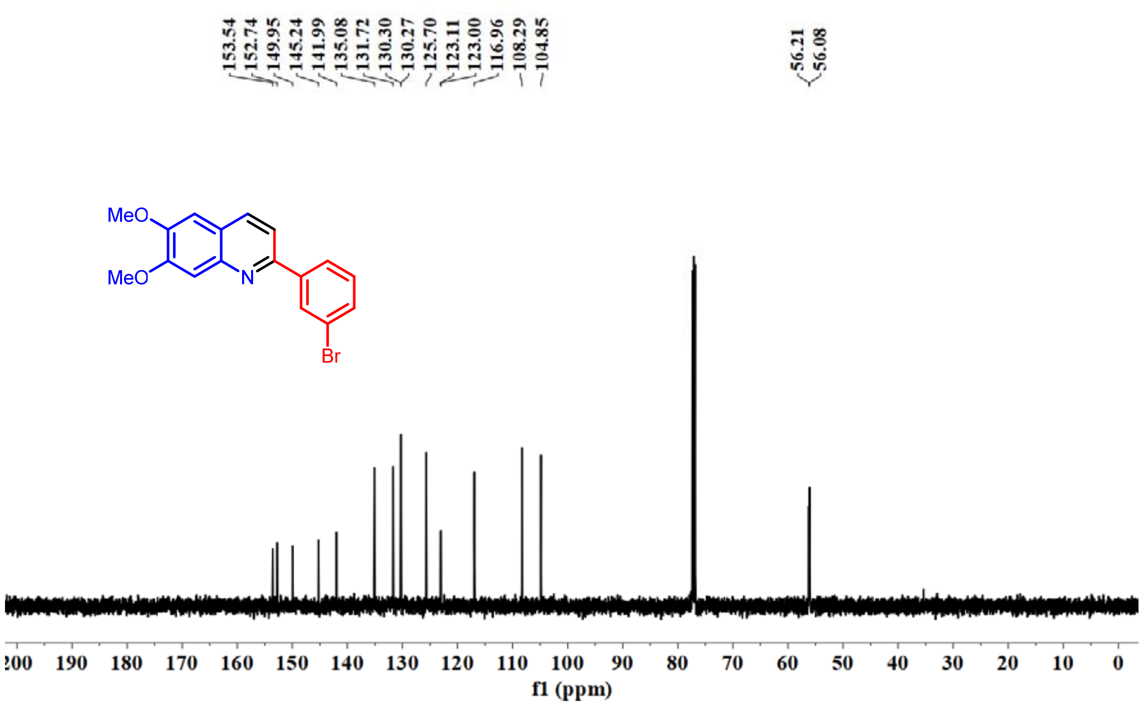



**Fig. S74** $^{13}C\{^{1}H\}$ NMR spectrum of **21** in $CDCl_3$ (126 MHz).

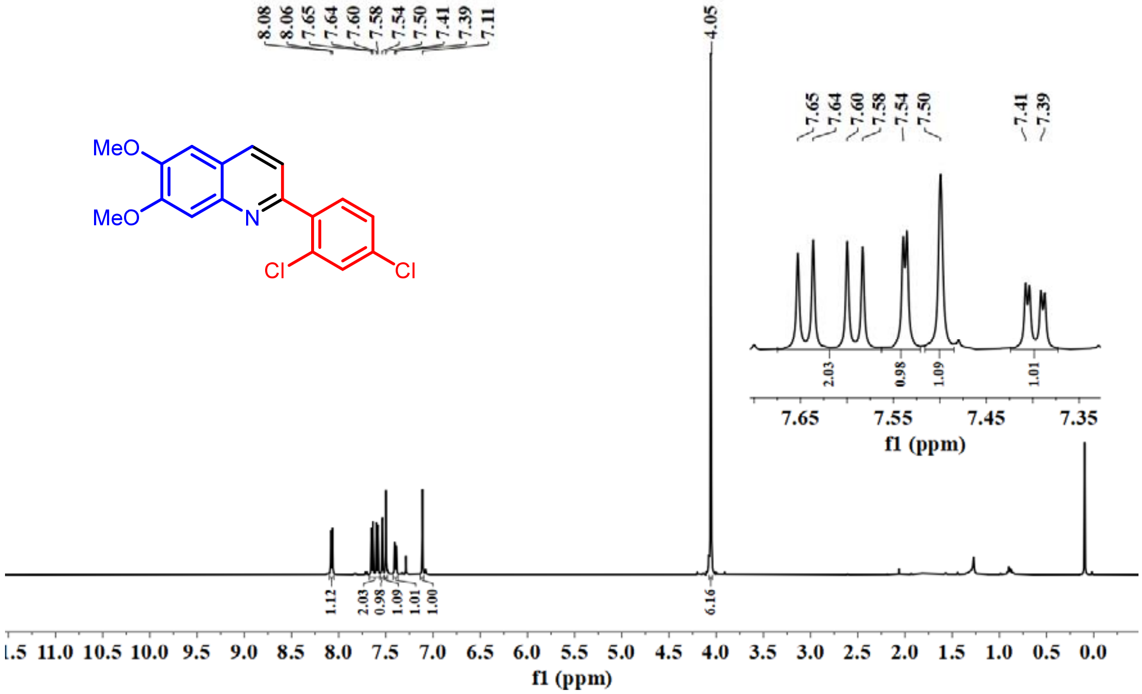



**Fig. S75** [1]H NMR spectrum of **22** in $CDCl_3$ (500 MHz).

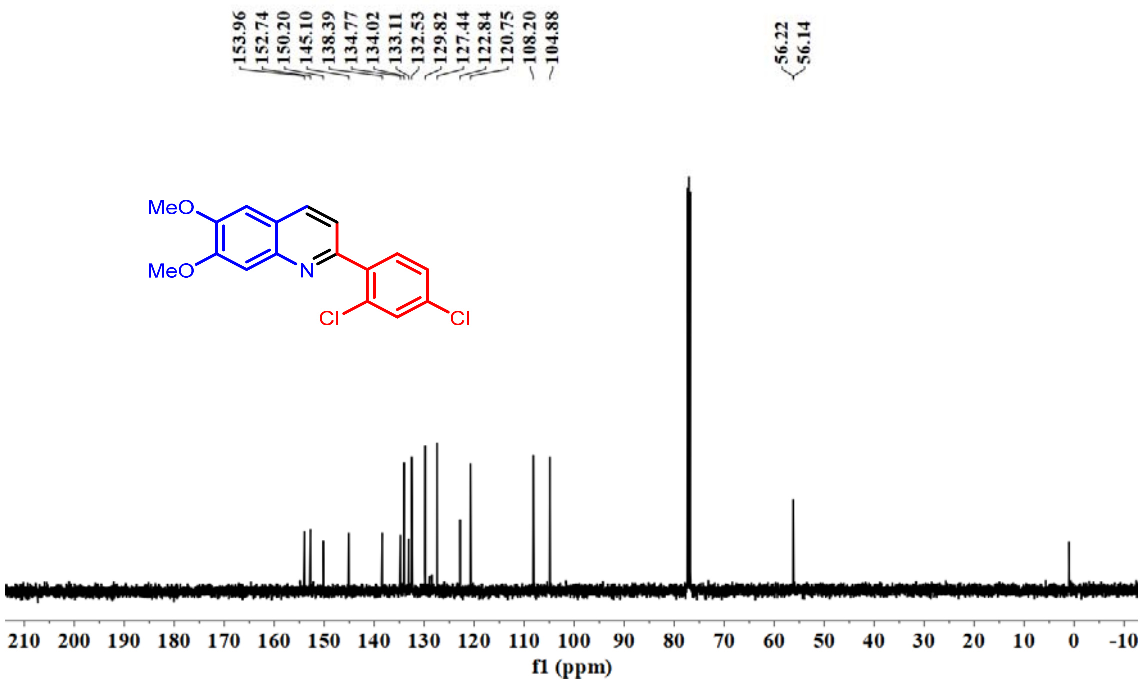



**Fig. S76** [13]C{[1]H} NMR spectrum of **22** in $CDCl_3$ (126 MHz).

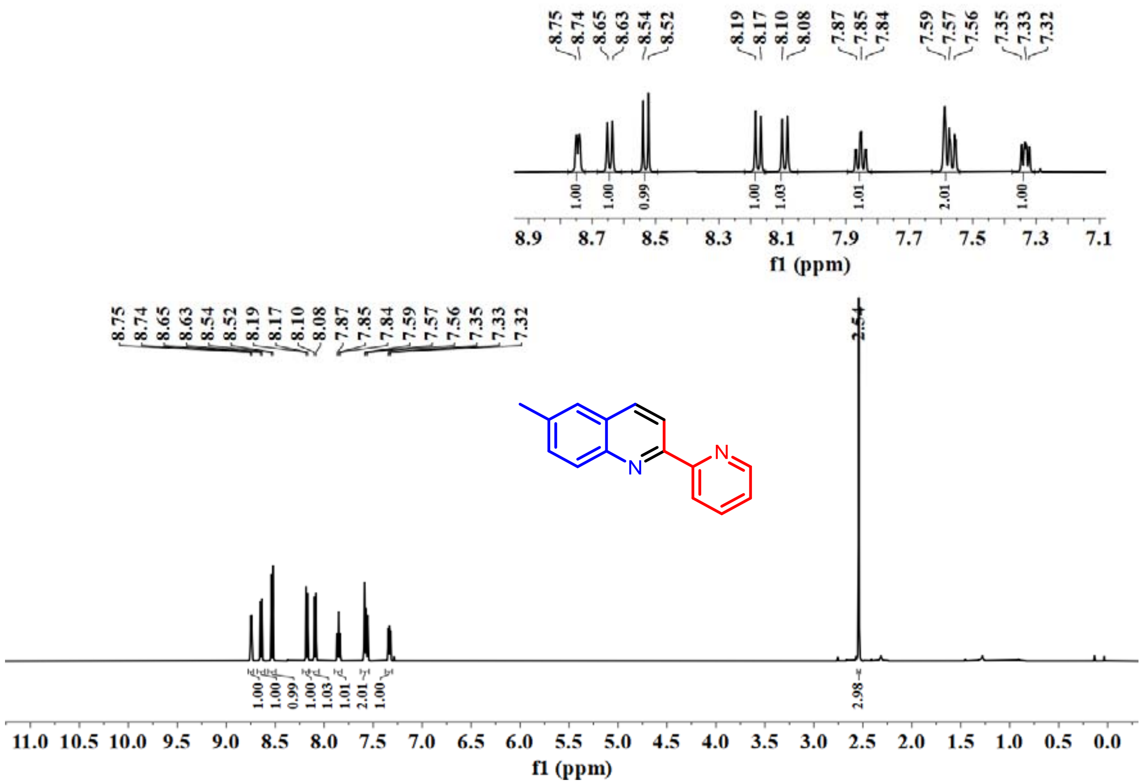



Fig. S77 $^{1}H$ NMR spectrum of **23** in $CDCl_3$ (500 MHz).

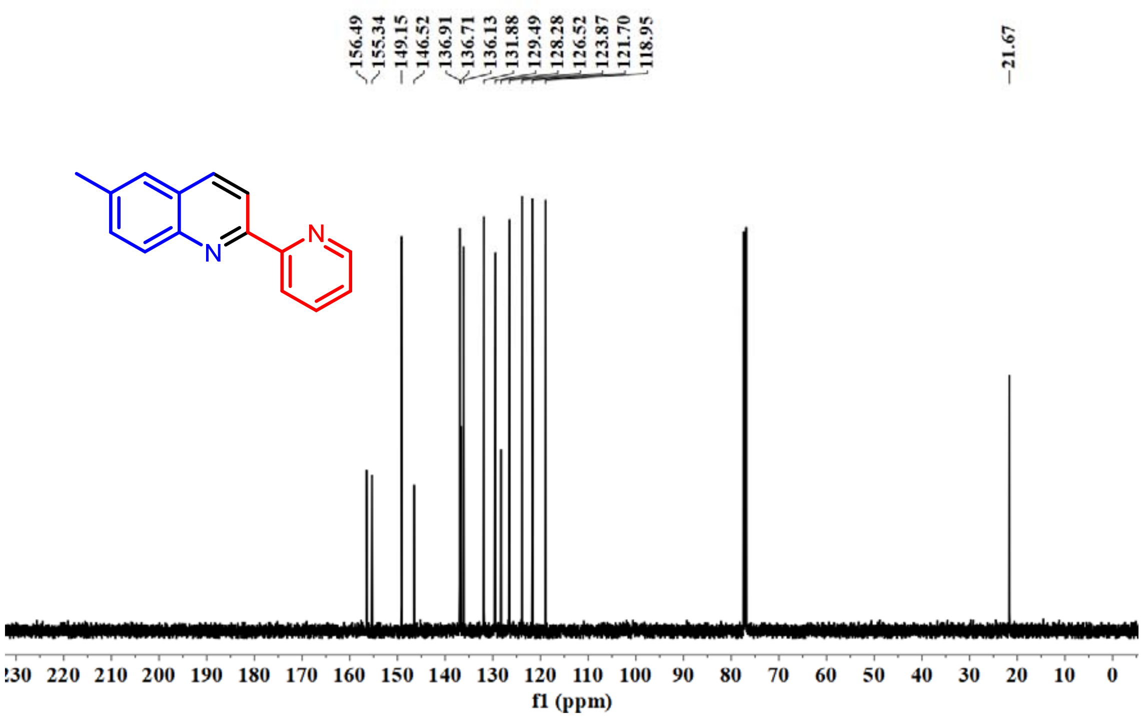



Fig. S78 $^{13}C\{^{1}H\}$ NMR spectrum of **23** in $CDCl_3$ (126 MHz).

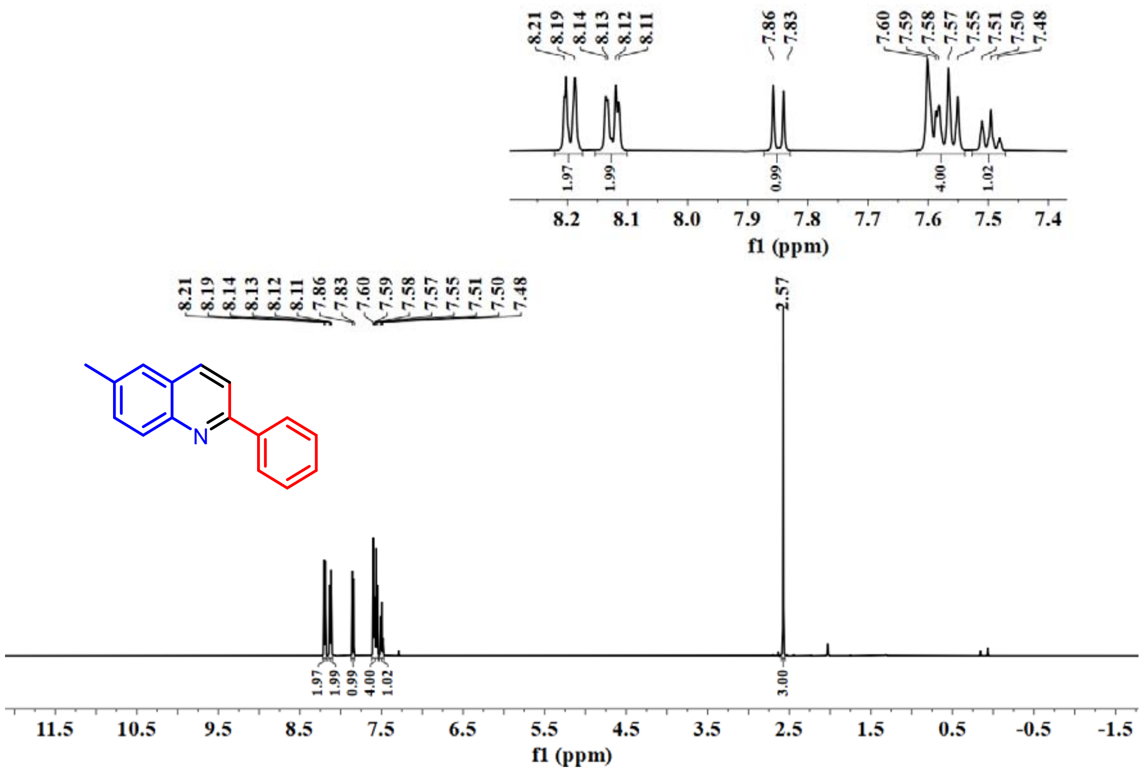



**Fig. S79** $^{1}H$ NMR spectrum of **24** in $CDCl_3$ (500 MHz).

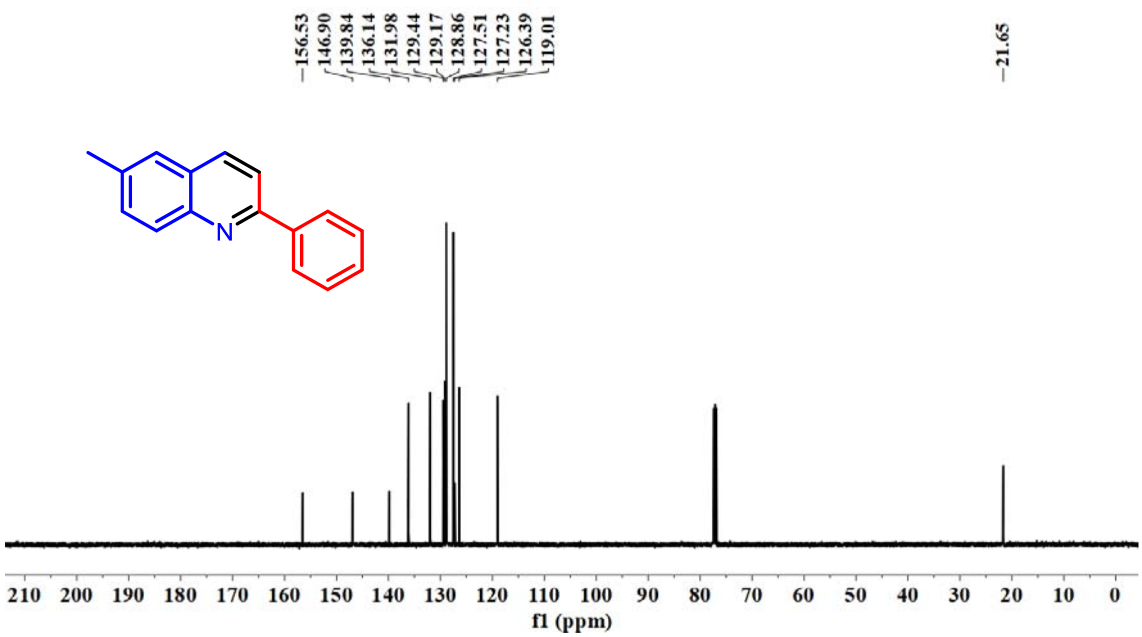



**Fig. S80** $^{13}C\{^{1}H\}$ NMR spectrum of **24** in $CDCl_3$ (126 MHz).

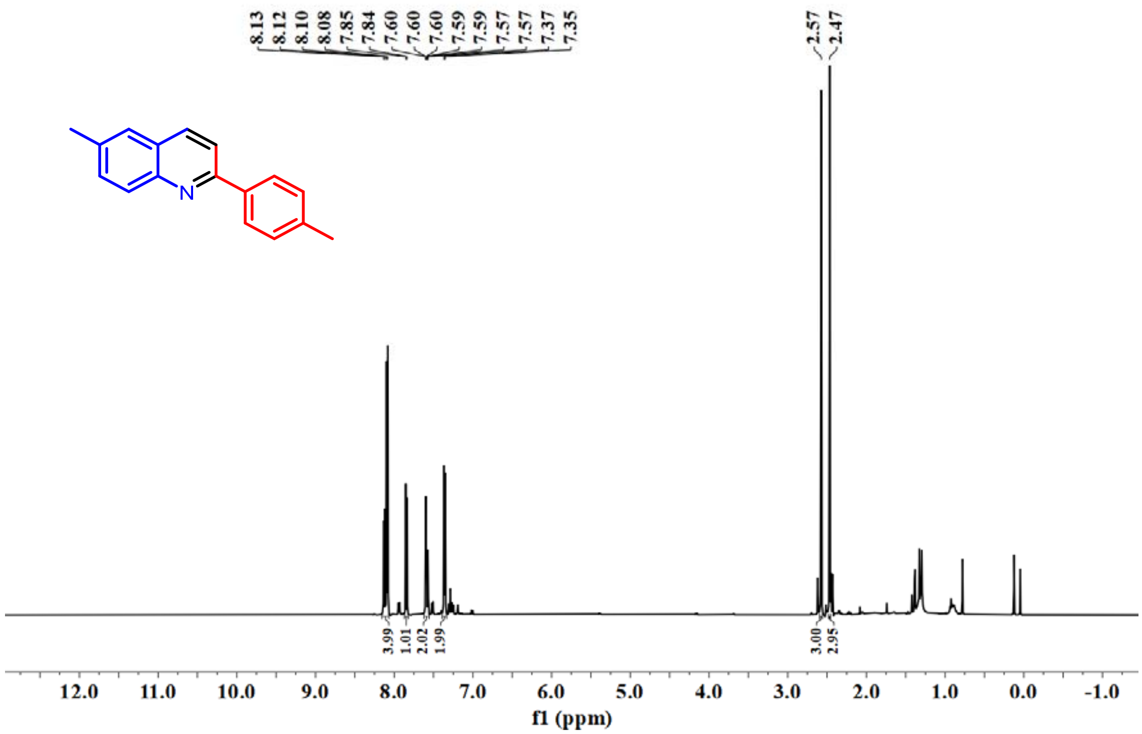



**Fig. S81** $^{1}H$ NMR spectrum of **25** in $CDCl_3$ (400 MHz).

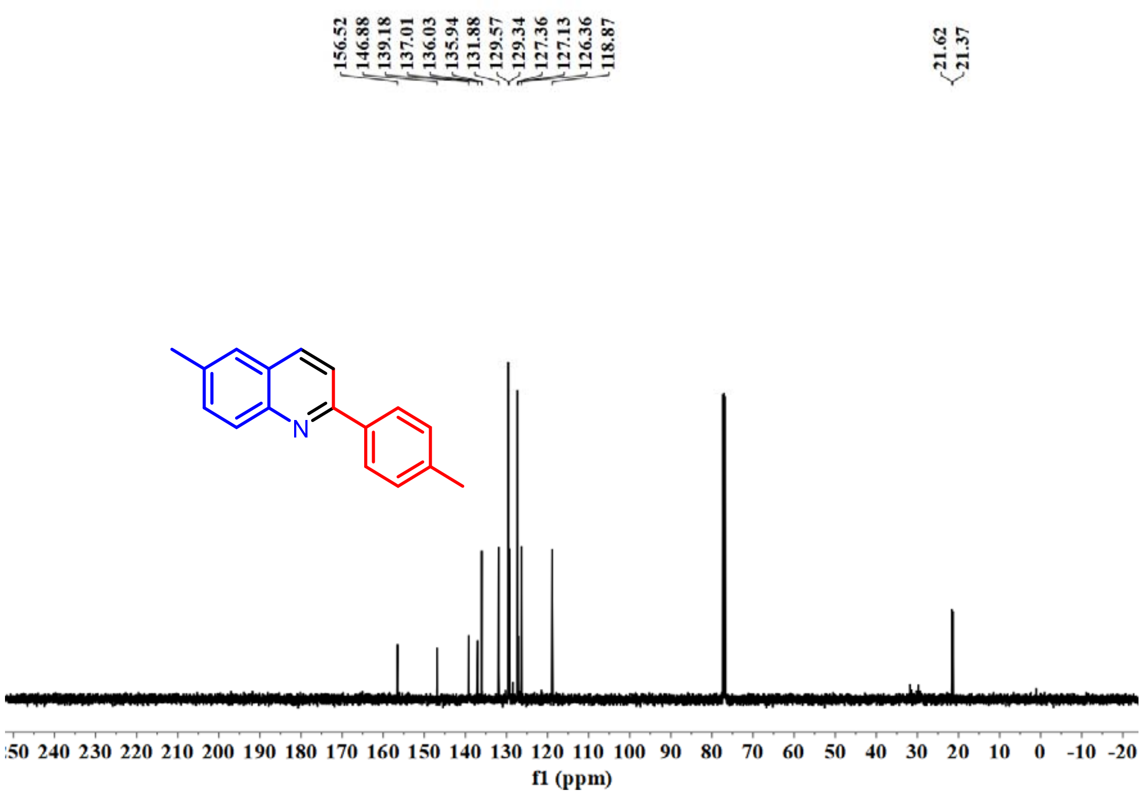



**Fig. S82** $^{13}C\{^{1}H\}$ NMR spectrum of **25** in $CDCl_3$ (101 MHz).

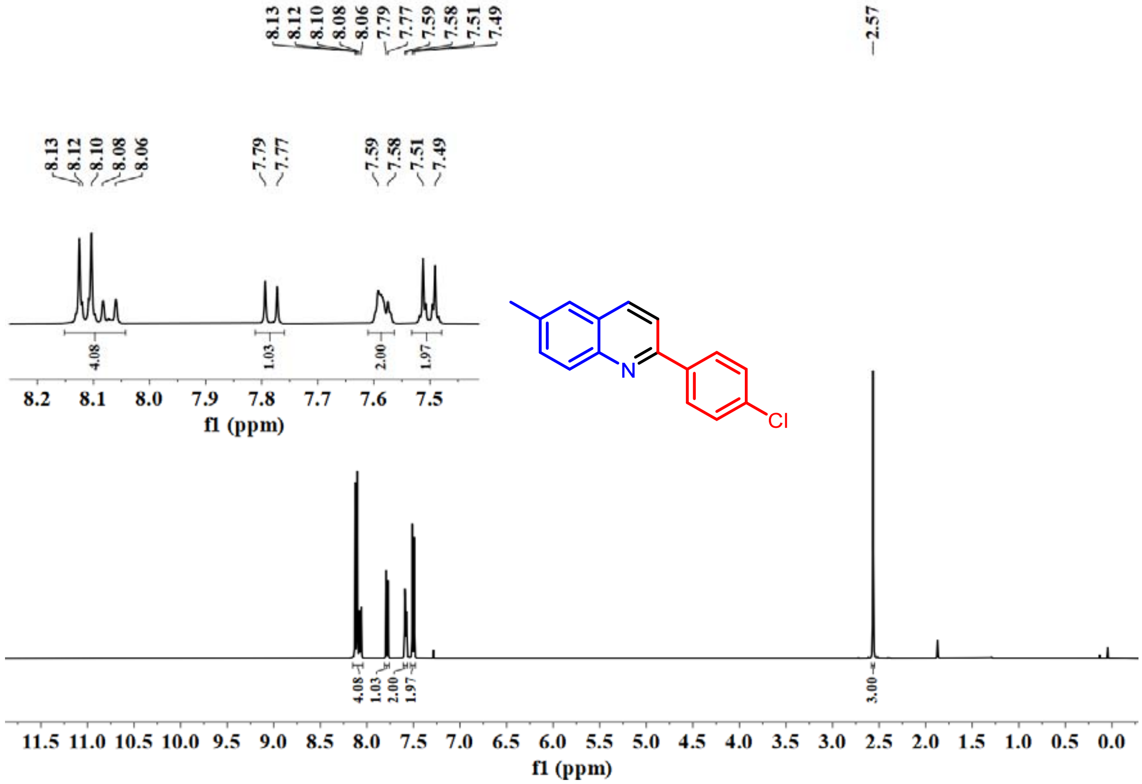



**Fig. S83** $^{1}H$ NMR spectrum of **26** in $CDCl_3$ (400 MHz).

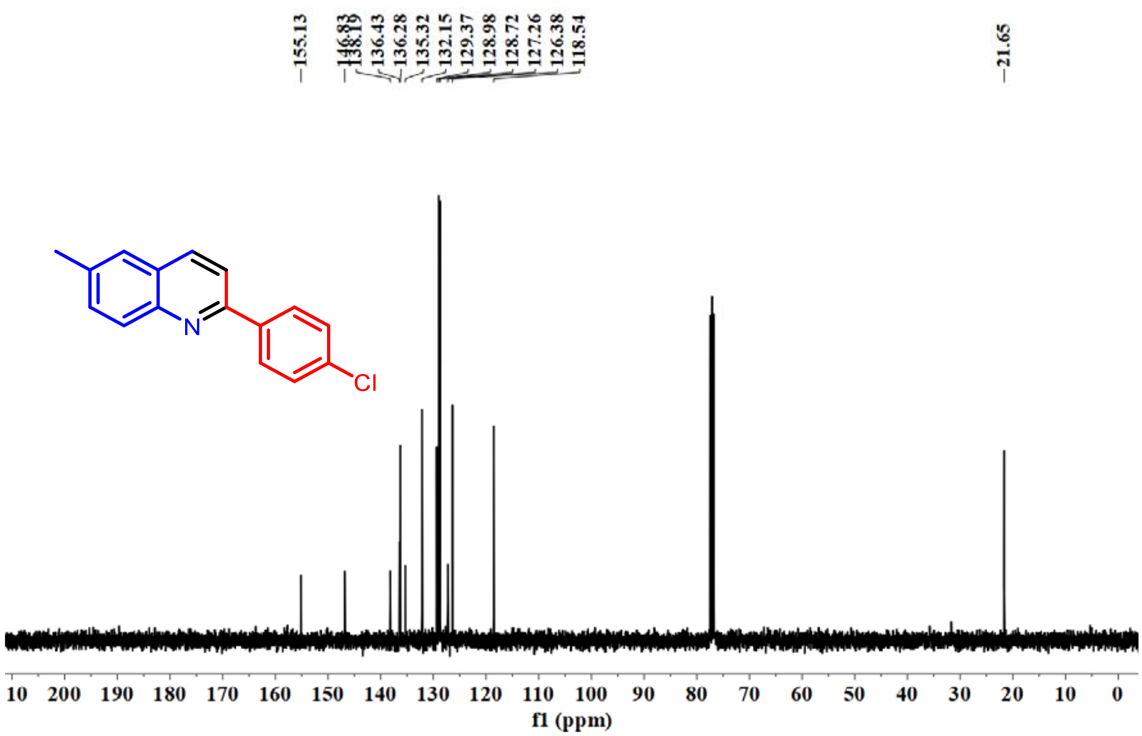



**Fig. S84** $^{13}C\{^{1}H\}$ NMR spectrum of **26** in $CDCl_3$ (101 MHz).

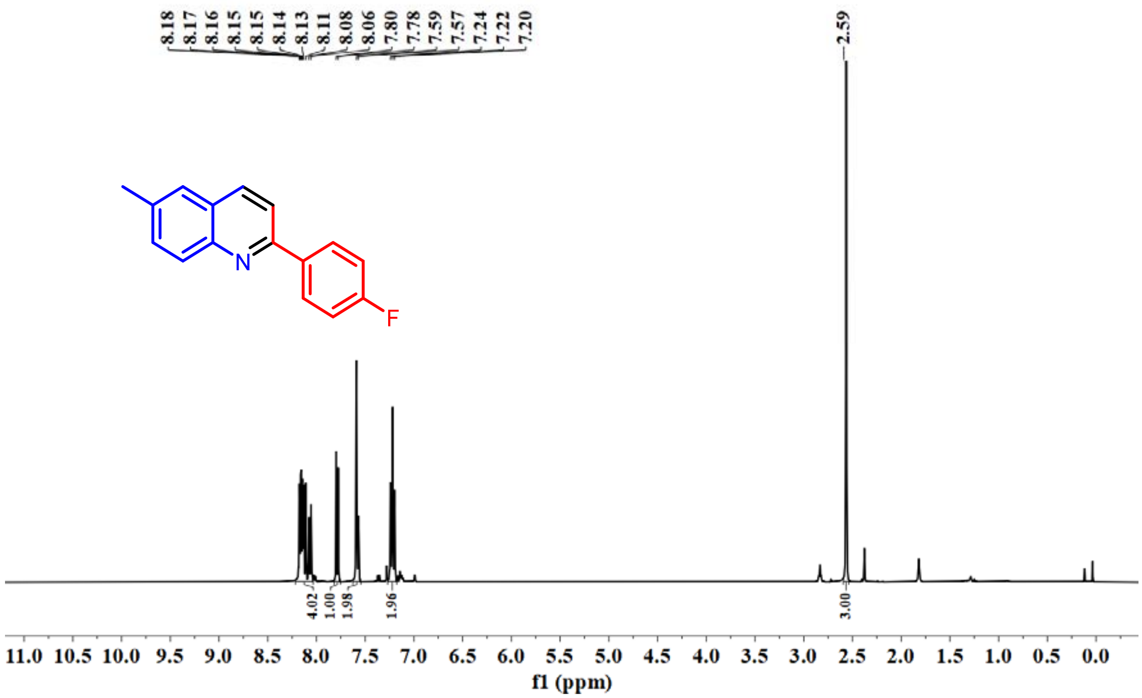



**Fig. S85** [1]H NMR spectrum of **27** in $CDCl_3$ (400 MHz).

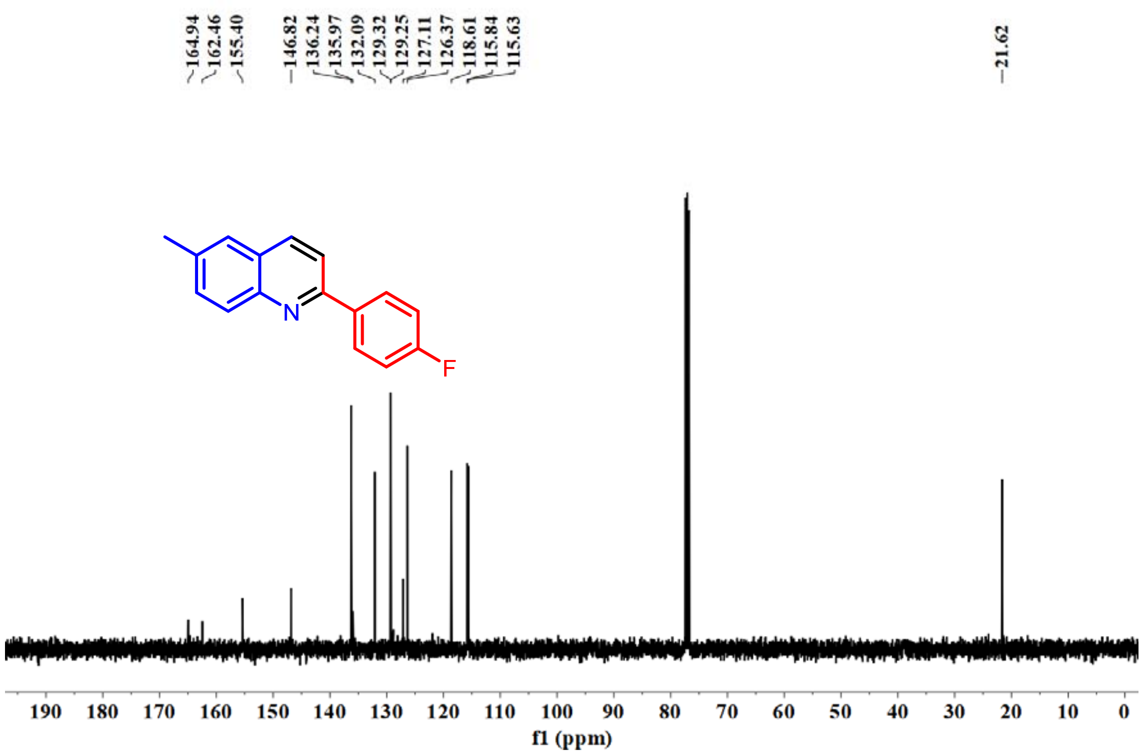



**Fig. S86** [13]C{[1]H} NMR spectrum of **27** in $CDCl_3$ (101 MHz).

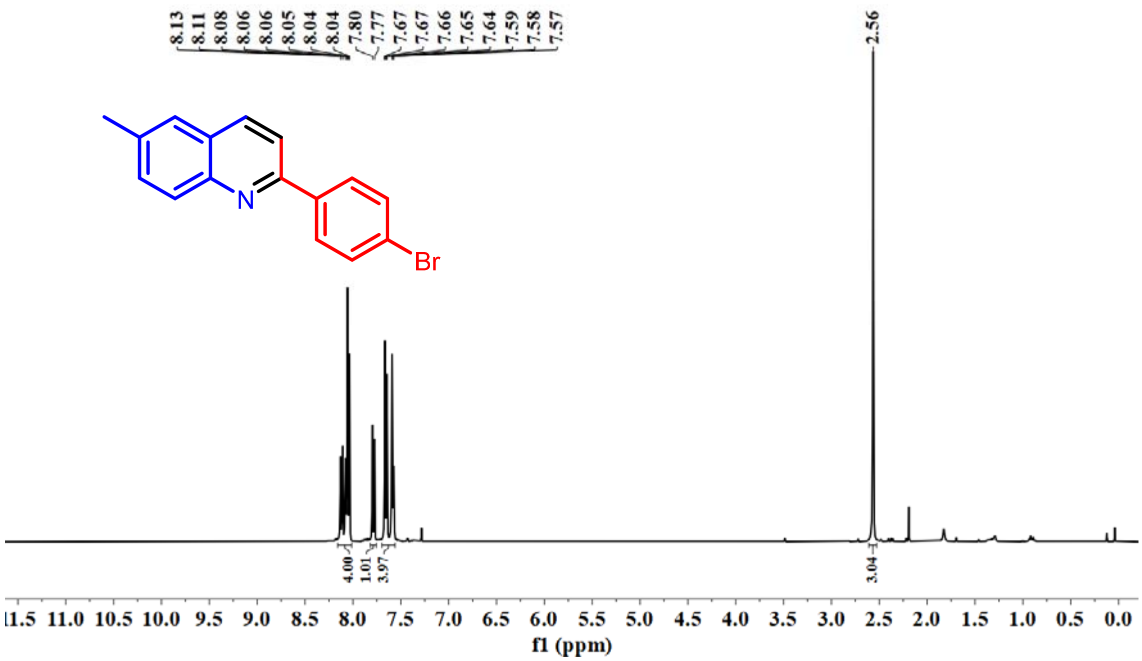



**Fig. S87** $^{1}$H NMR spectrum of **28** in $CDCl_3$ (500 MHz).

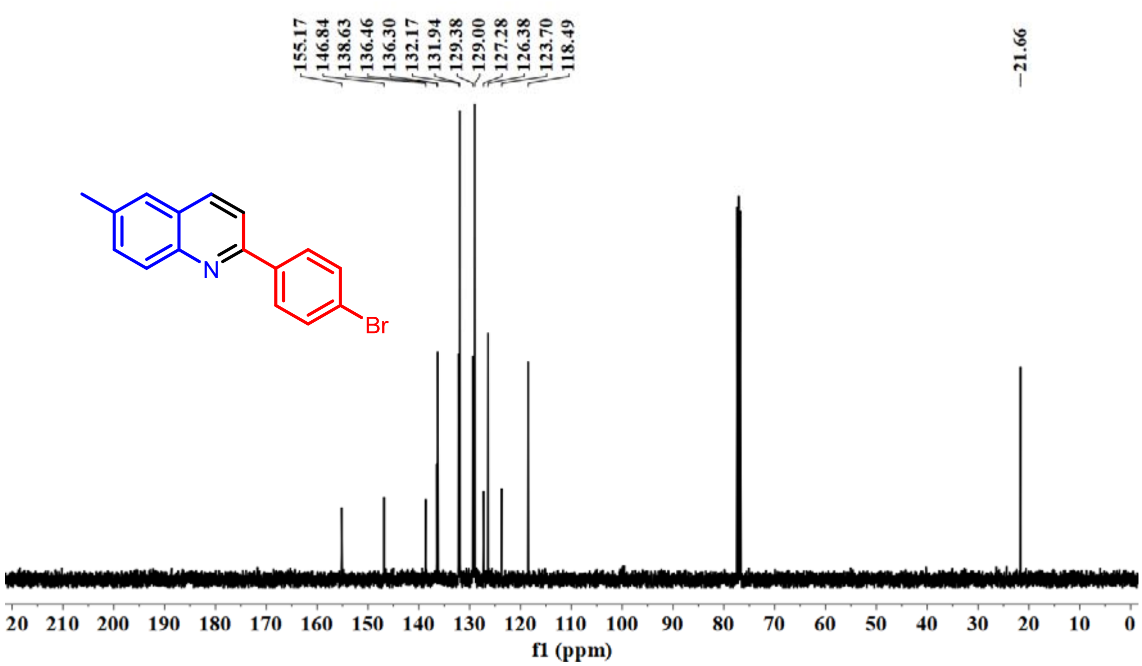



**Fig. S88** $^{13}C\{^{1}H\}$ NMR spectrum of **28** in $CDCl_3$ (126 MHz).

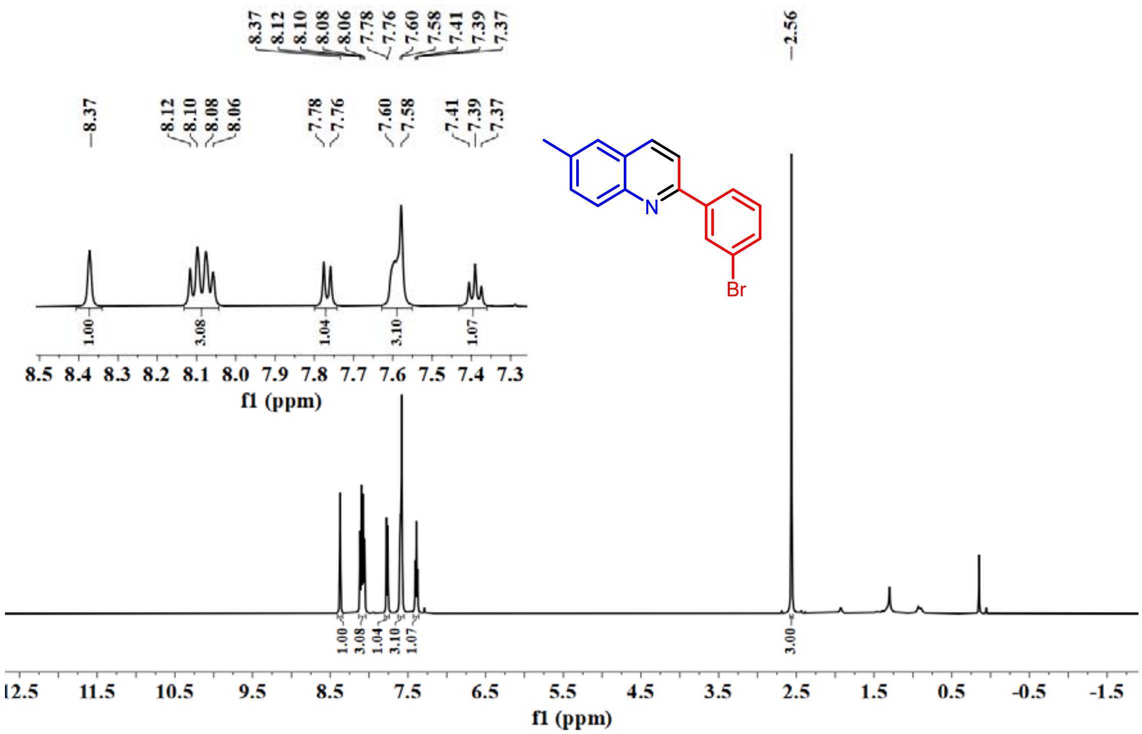



**Fig. S89** $^{1}H$ NMR spectrum of **29** in $CDCl_3$ (400 MHz).

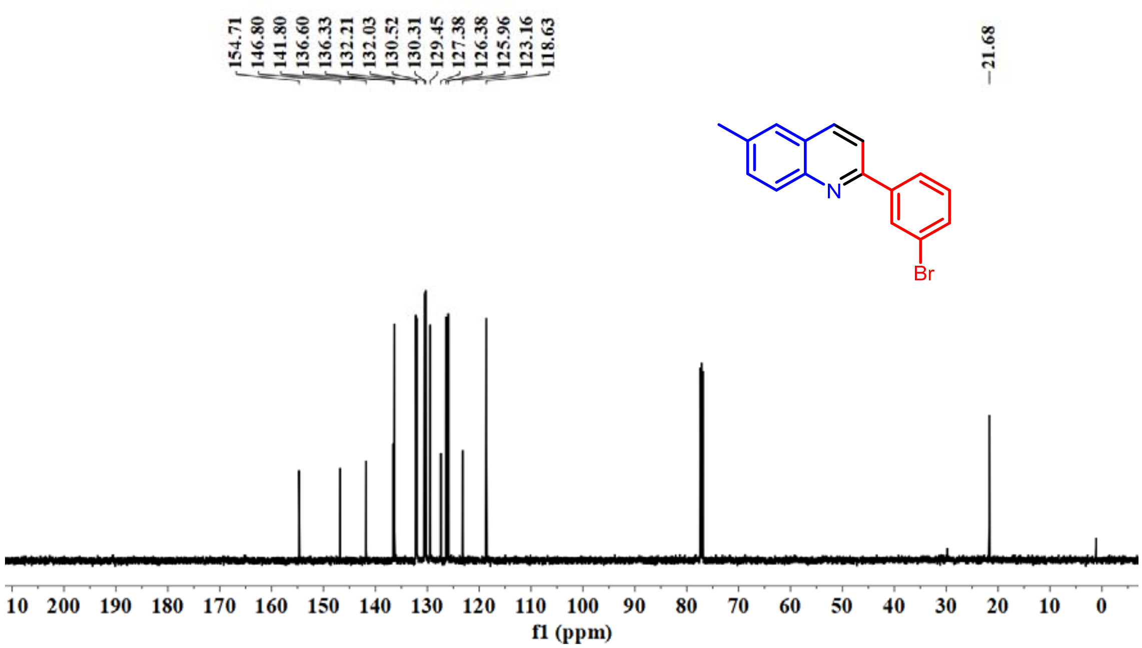



**Fig. S90** $^{13}C\{^{1}H\}$ NMR spectrum of **29** in $CDCl_3$ (101 MHz).

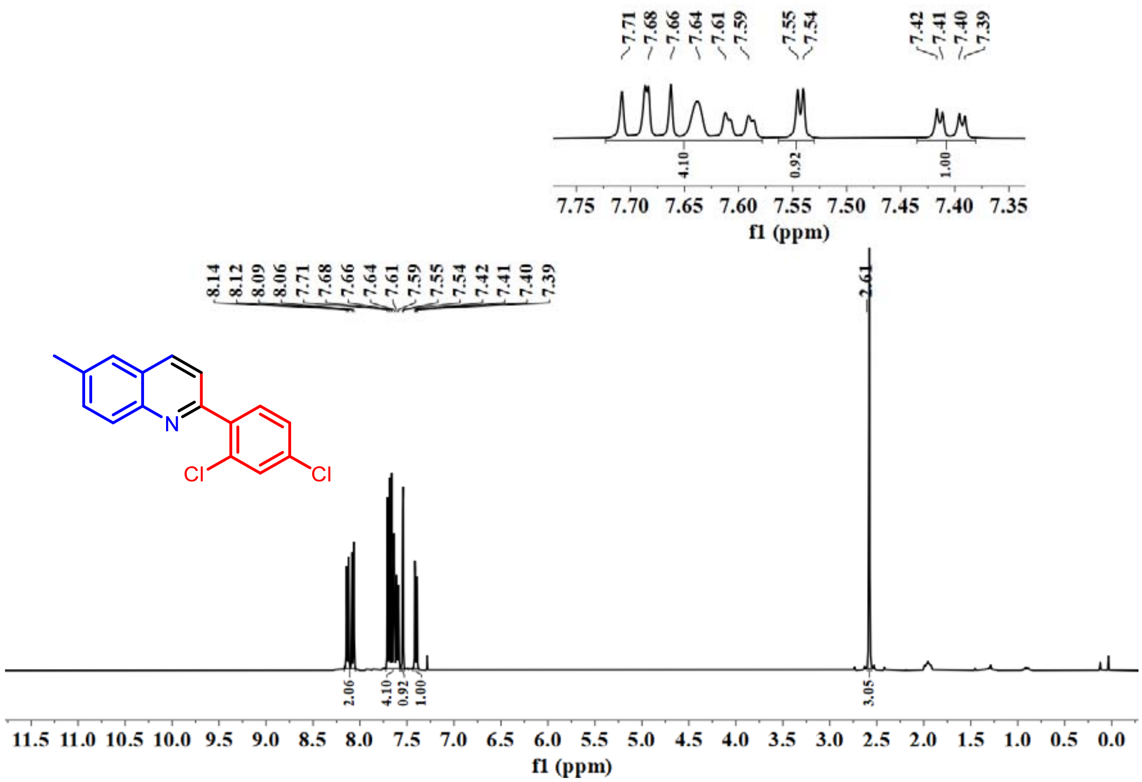



**Fig. S91** $^{1}H$ NMR spectrum of **30** in $CDCl_3$ (400 MHz).

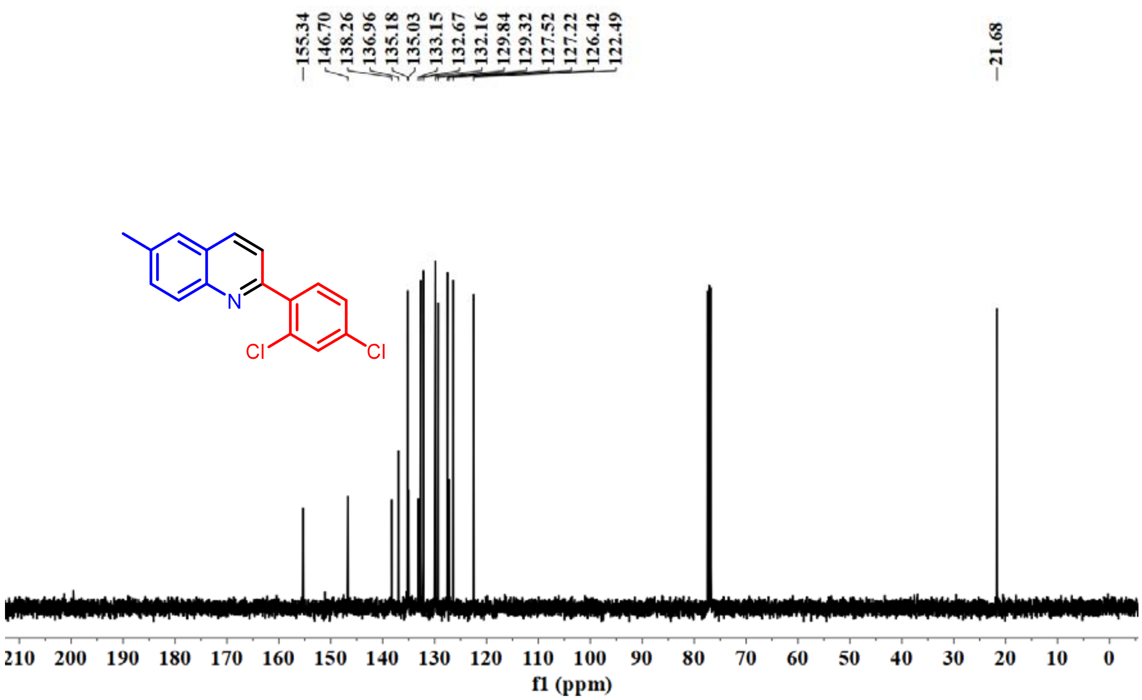



**Fig. S92** $^{13}C\{^{1}H\}$ NMR spectrum of **30** in $CDCl_3$ (101 MHz).

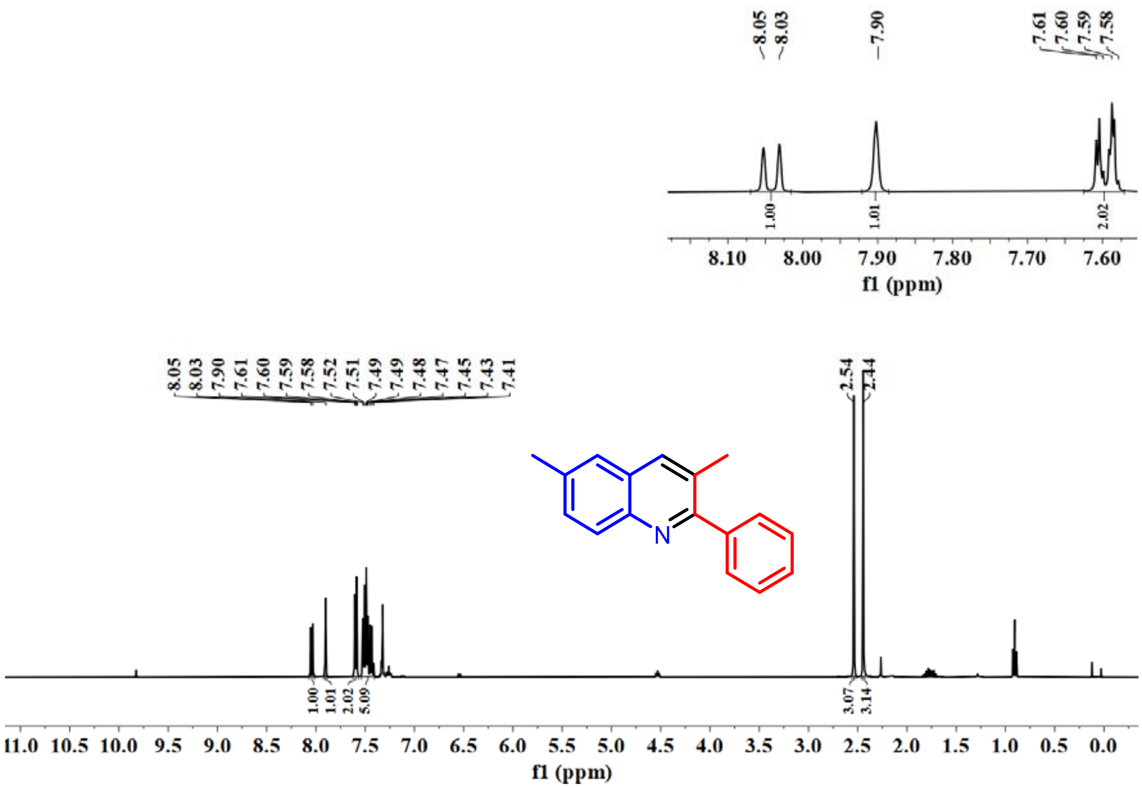



**Fig. S93** $^{1}$H NMR spectrum of **31** in $CDCl_3$ (400 MHz).

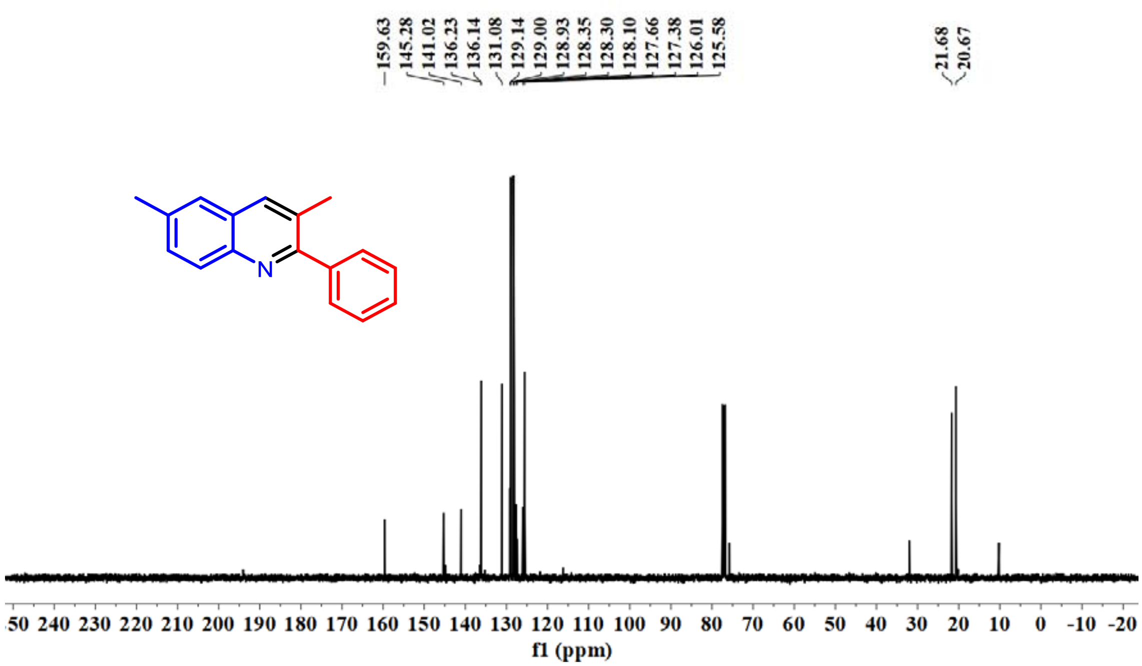



**Fig. S94** $^{13}C\{^{1}H\}$ NMR spectrum of **31** in $CDCl_3$ (101 MHz).

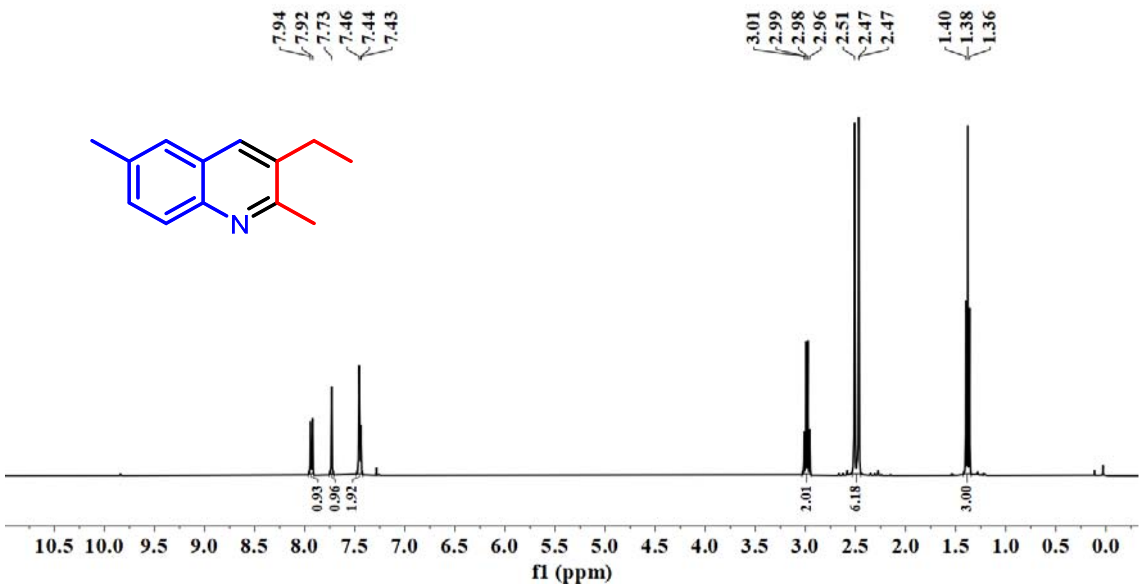



**Fig. S95** $^{1}H$ NMR spectrum of **32** in $CDCl_3$ (400 MHz).

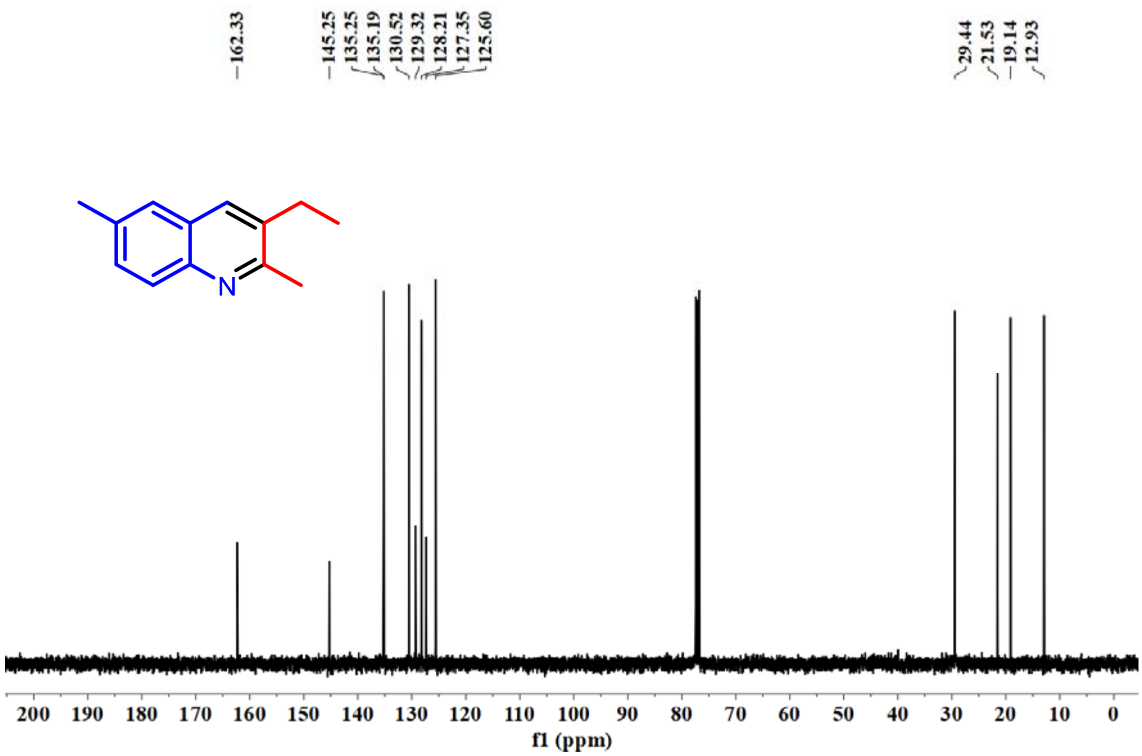



**Fig. S96** $^{13}C\{^{1}H\}$ NMR spectrum of **32** in $CDCl_3$ (101 MHz).

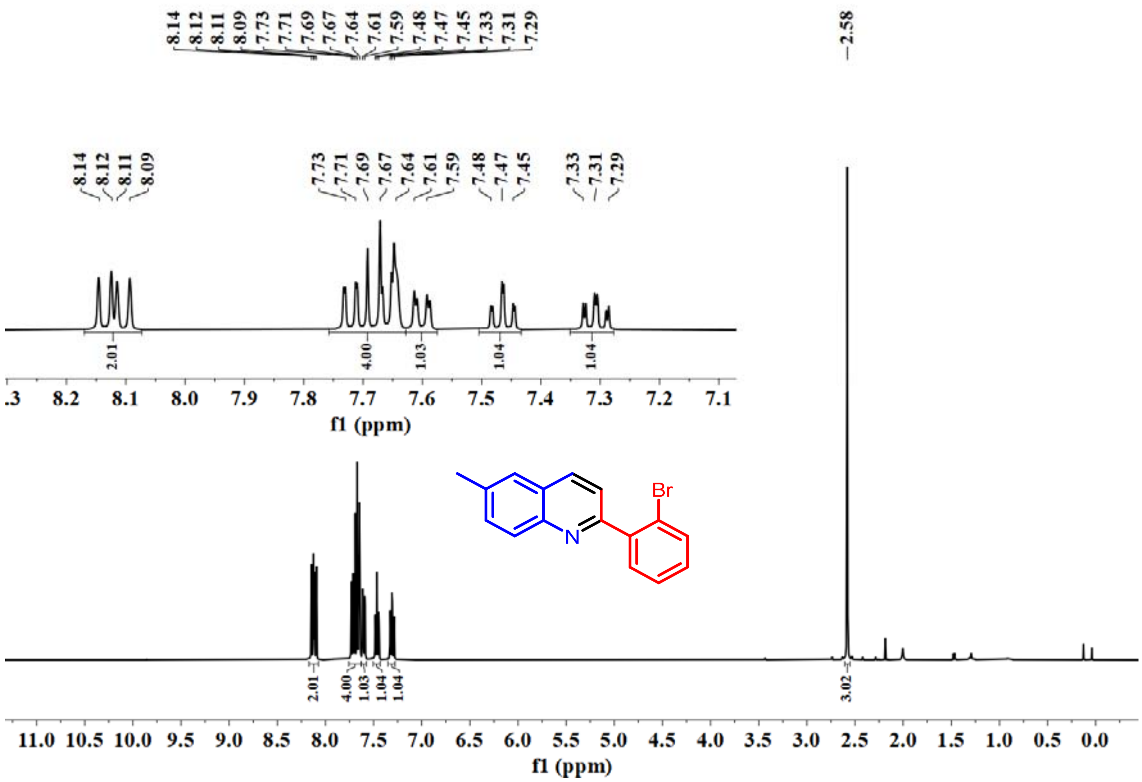



**Fig. S97** $^{1}H$ NMR spectrum of **33** in $CDCl_3$ (400 MHz).

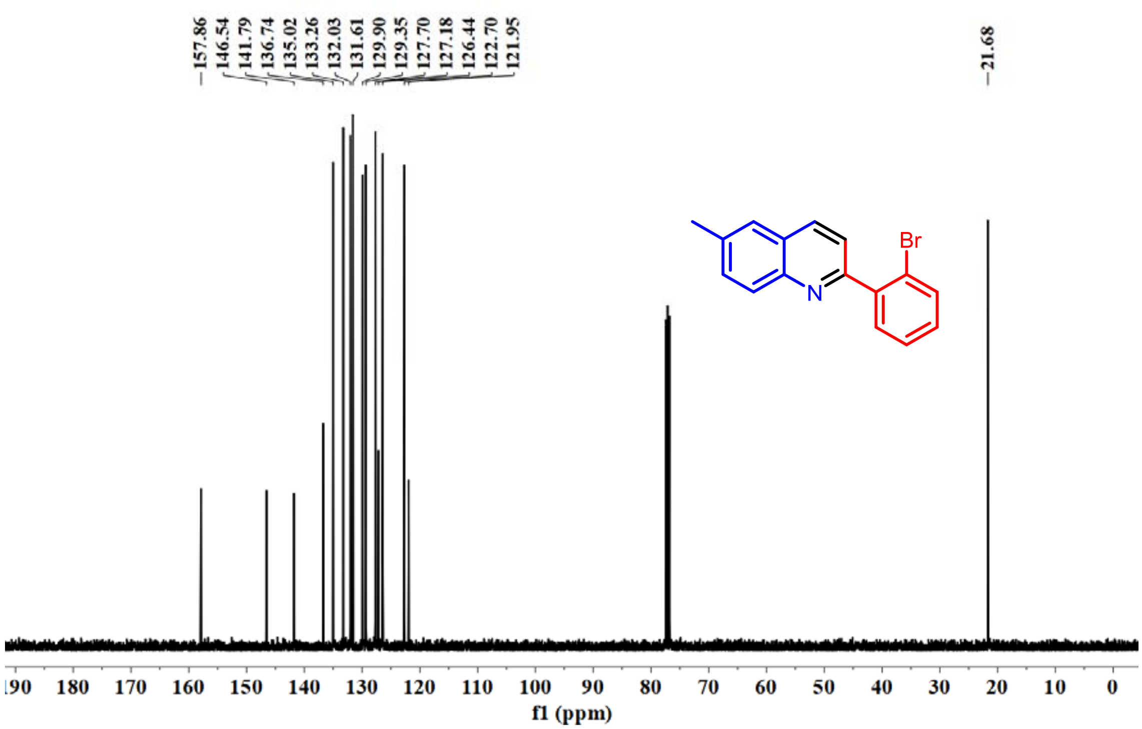



**Fig. S98** $^{13}C\{^{1}H\}$ NMR spectrum of **33** in $CDCl_3$ (101 MHz).

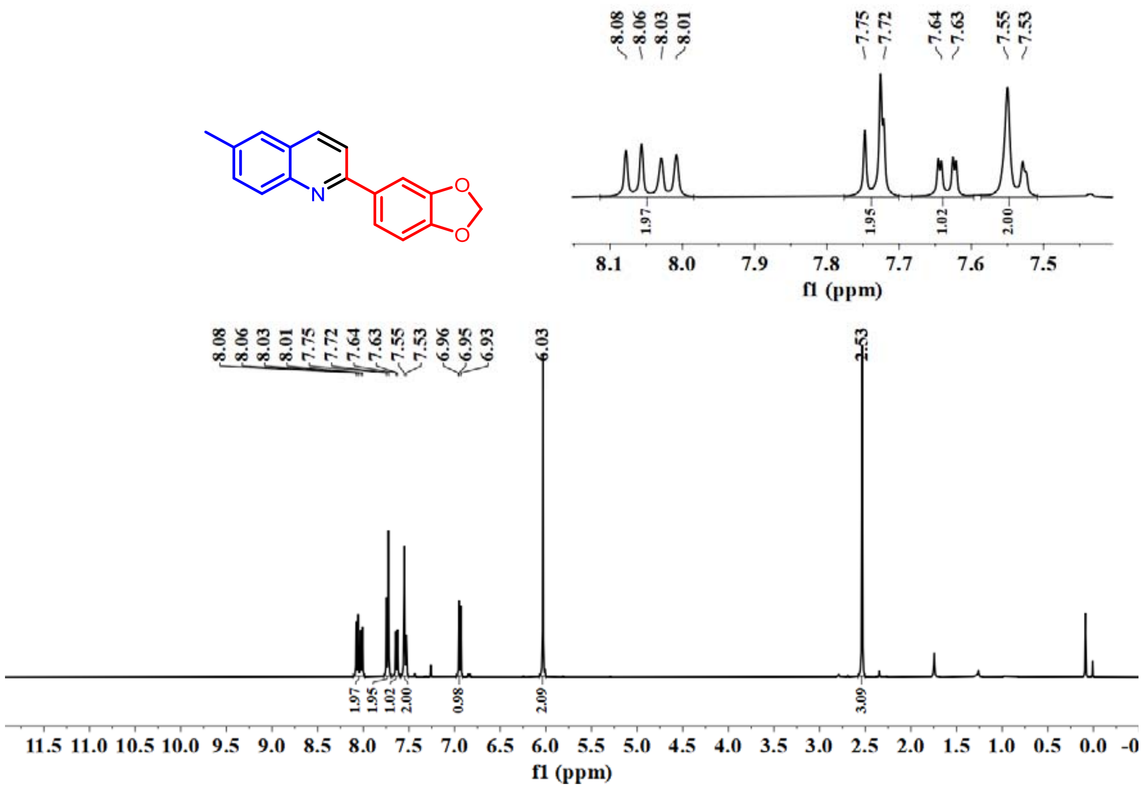



**Fig. S99** $^{1}H$ NMR spectrum of **34** in $CDCl_3$ (500 MHz).

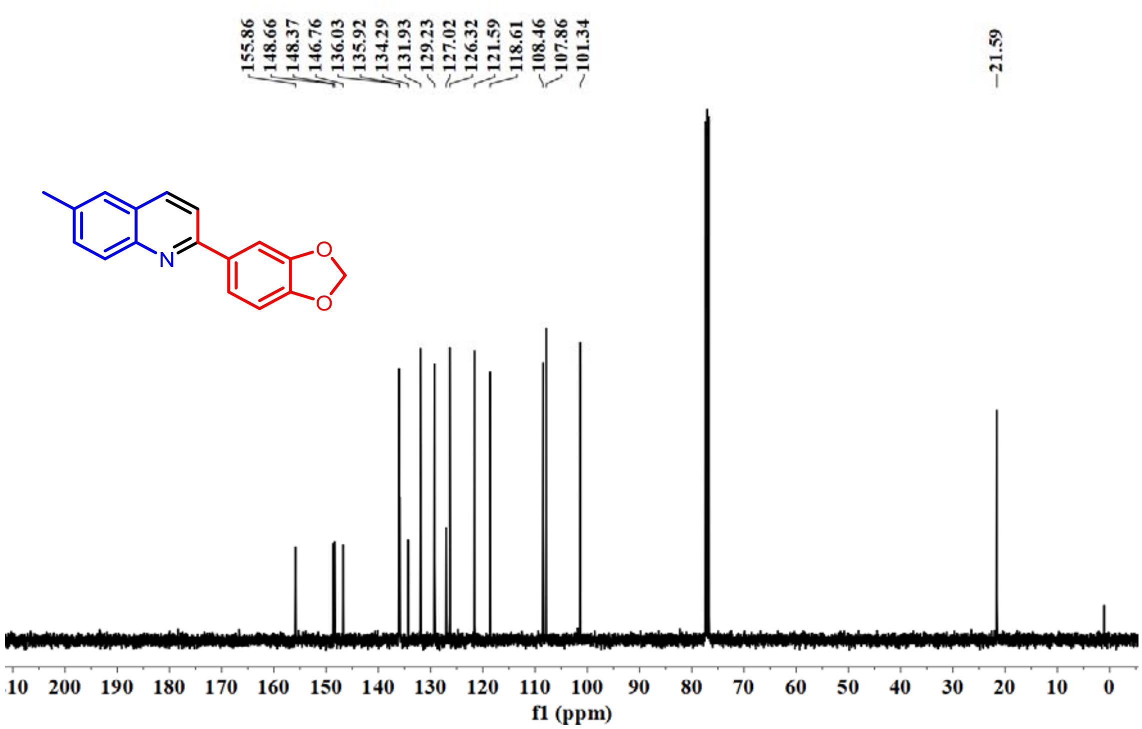



**Fig. S100** $^{13}C\{^{1}H\}$ NMR spectrum of **34** in $CDCl_3$ (126 MHz).

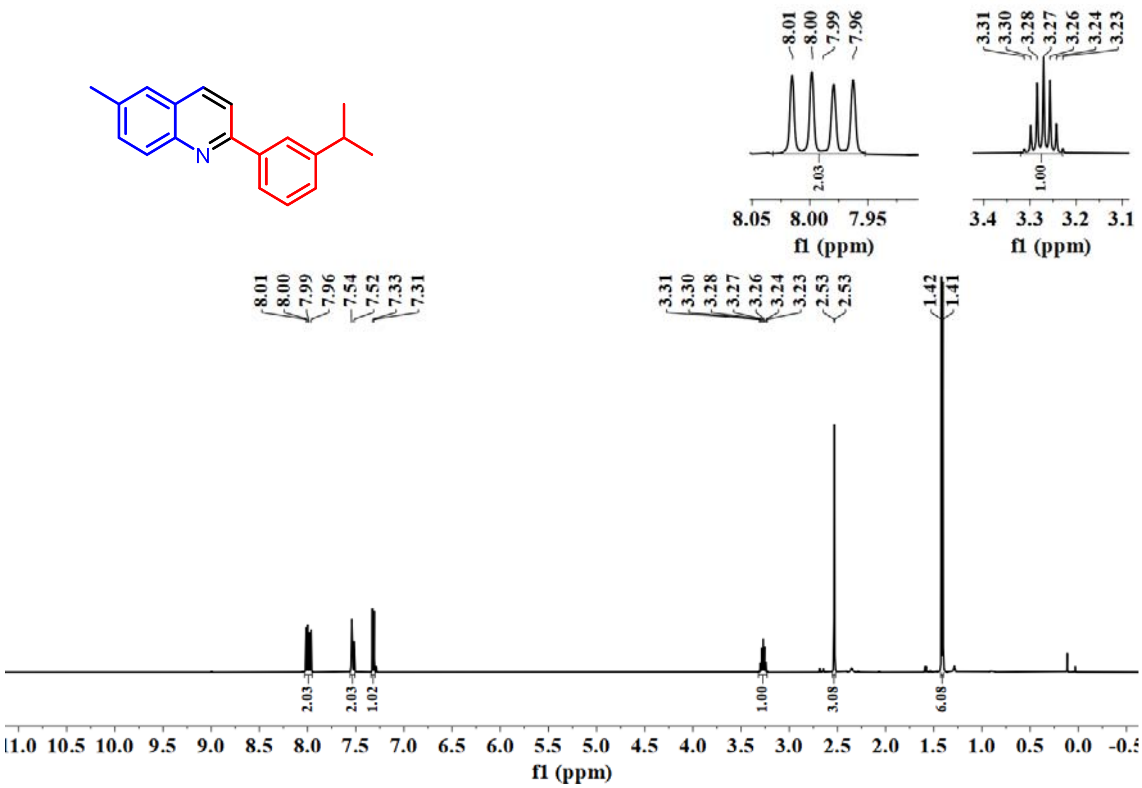



**Fig. S101** $^{1}H$ NMR spectrum of **35** in $CDCl_3$ (500 MHz).

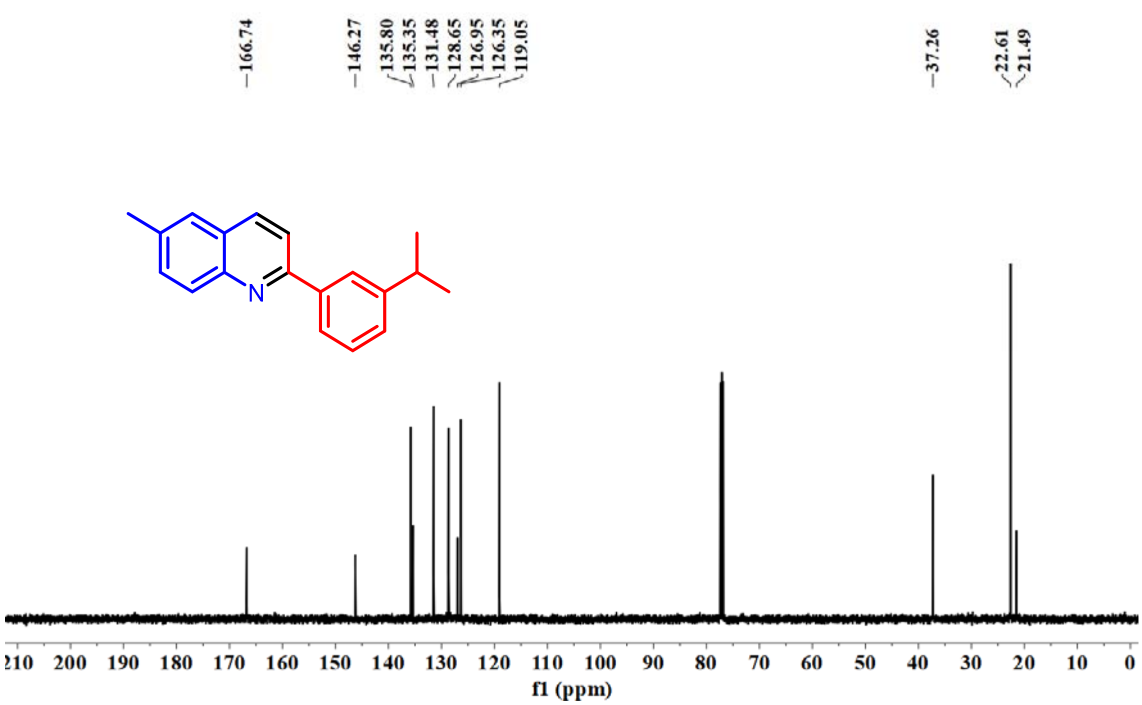



**Fig. S102** $^{13}C\{^{1}H\}$ NMR spectrum of **35** in $CDCl_3$ (126 MHz).

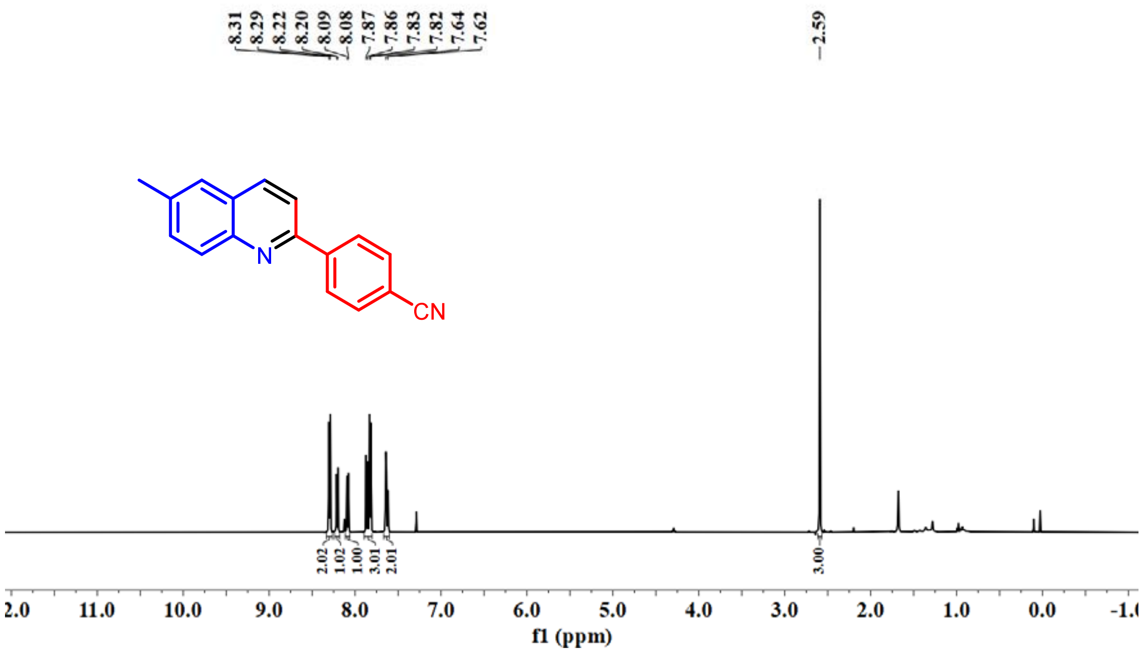


**Fig. S103** [1]H NMR spectrum of **36** in $CDCl_3$ (500 MHz).

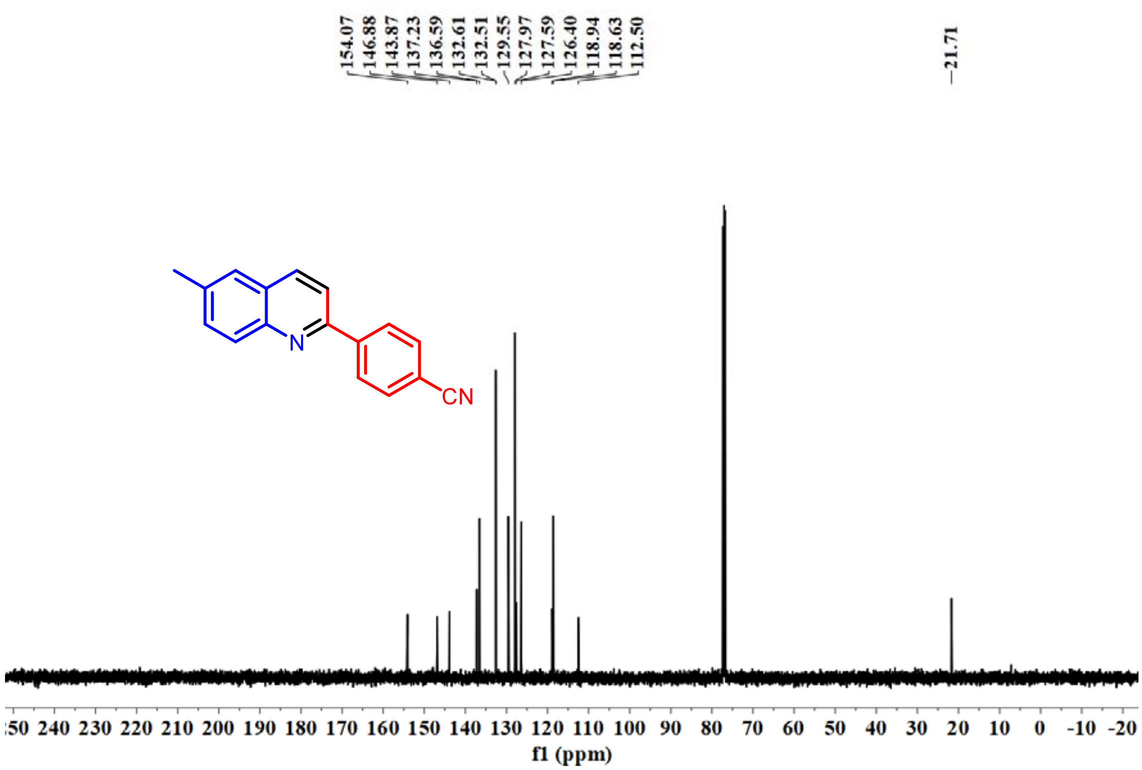


**Fig. S104** $^{13}C\{^1H\}$ NMR spectrum of **36** in $CDCl_3$ (126 MHz).

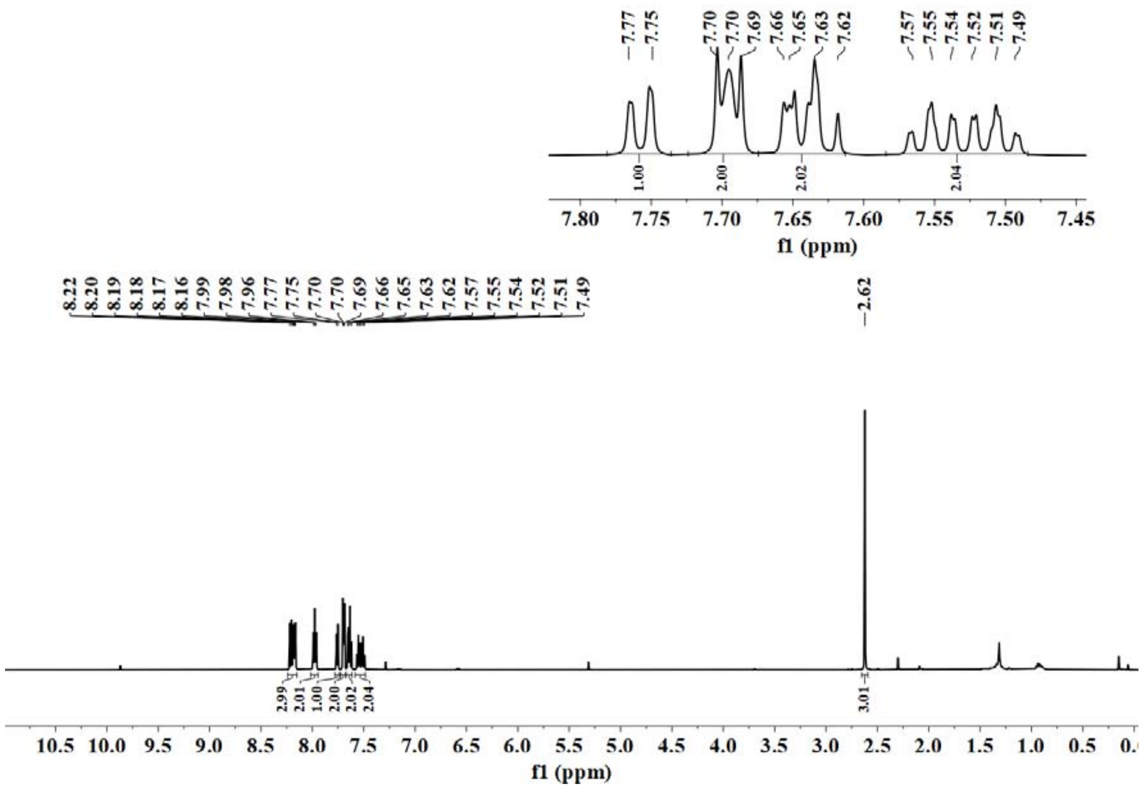


**Fig. S105** $^{1}$H NMR spectrum of **37** in $CDCl_3$ (400 MHz).

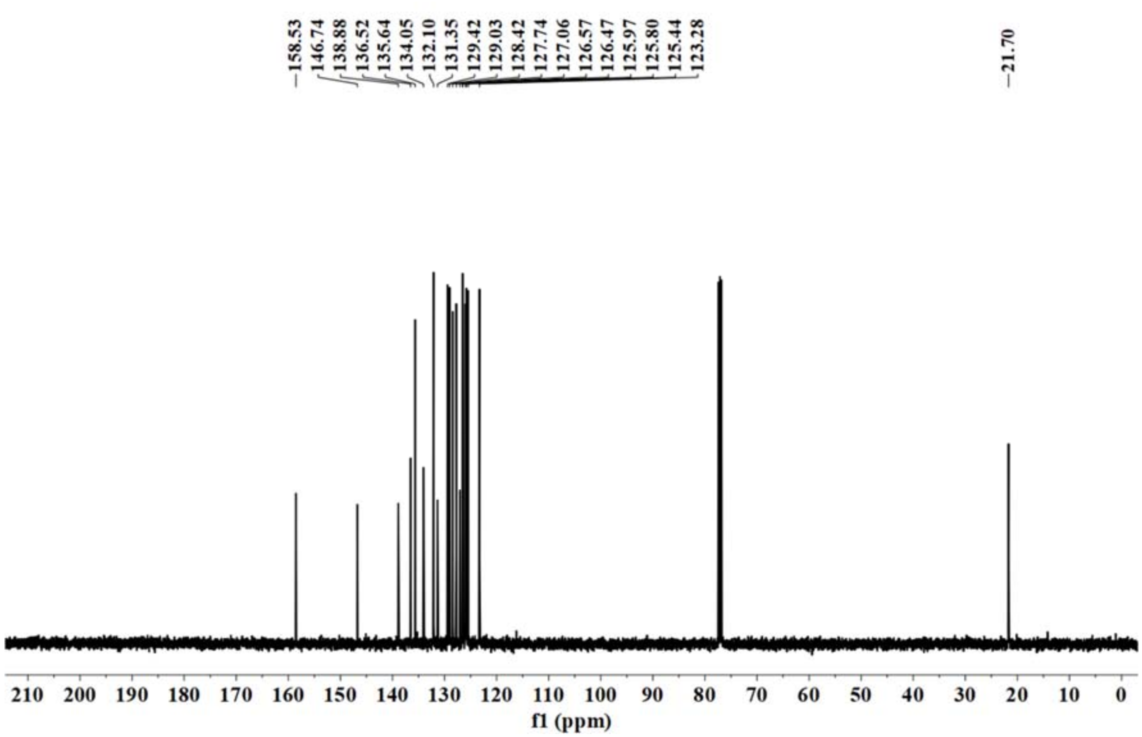


**Fig. S106** $^{13}C\{^{1}H\}$ NMR spectrum of **37** in $CDCl_3$ (1201 MHz).

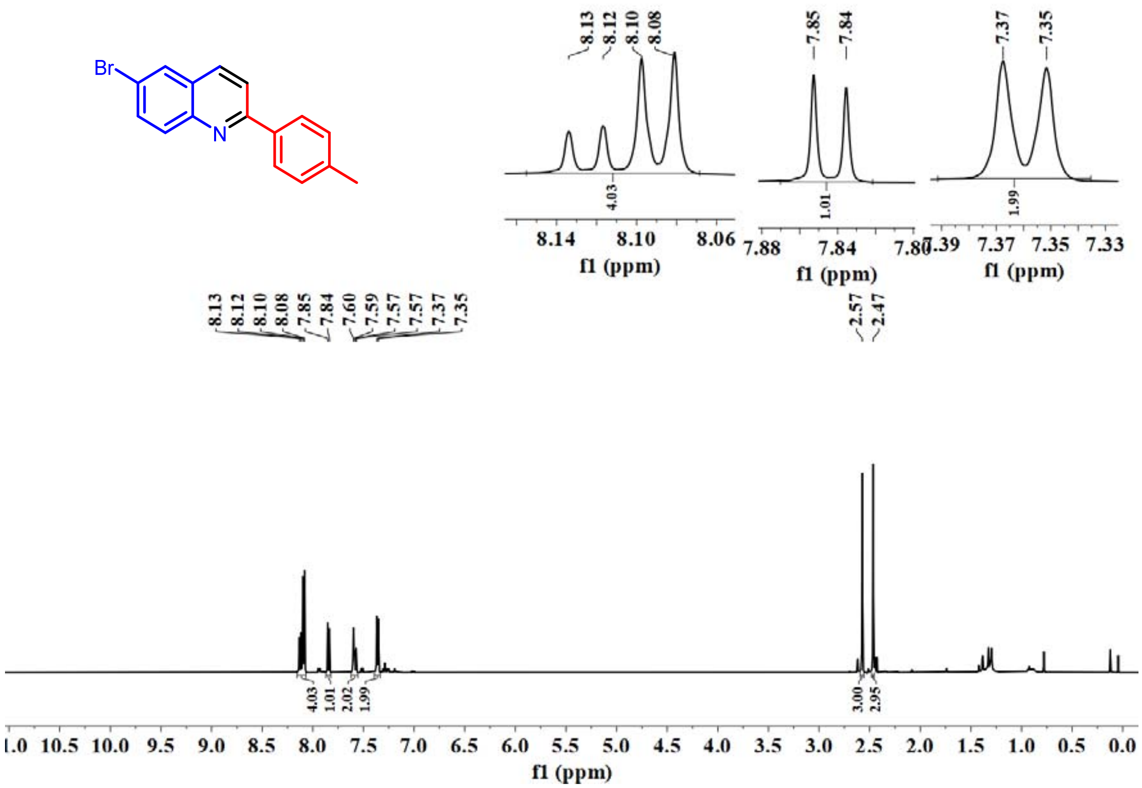



**Fig. S107** $^{1}H$ NMR spectrum of **38** in $CDCl_3$ (400 MHz).

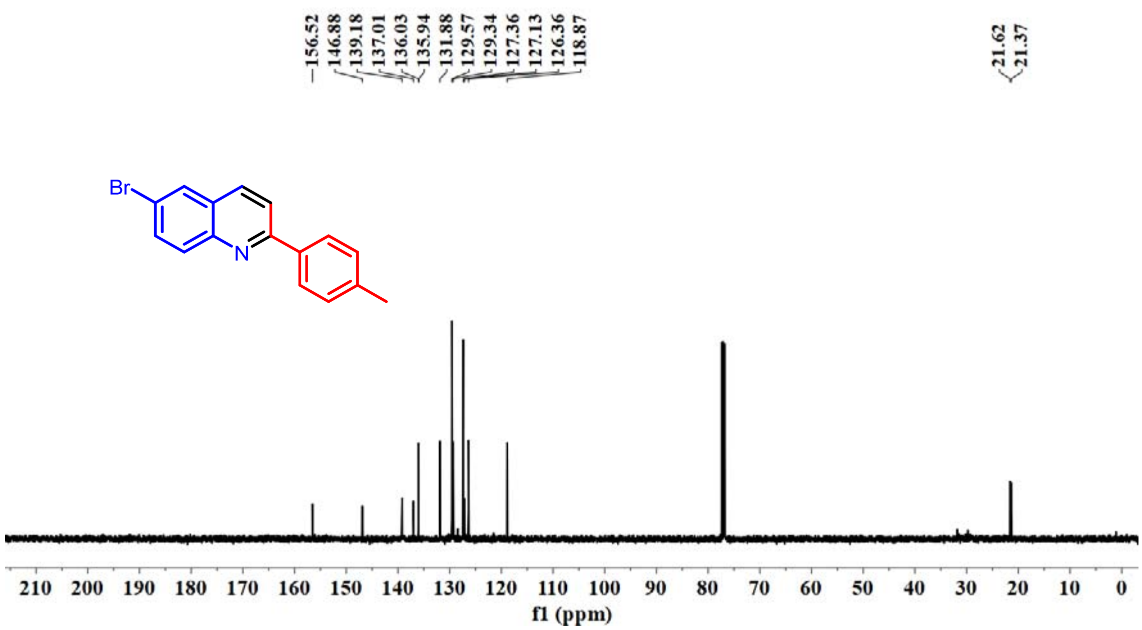



**Fig. S108** $^{13}C\{^{1}H\}$ NMR spectrum of **38** in $CDCl_3$ (101 MHz).

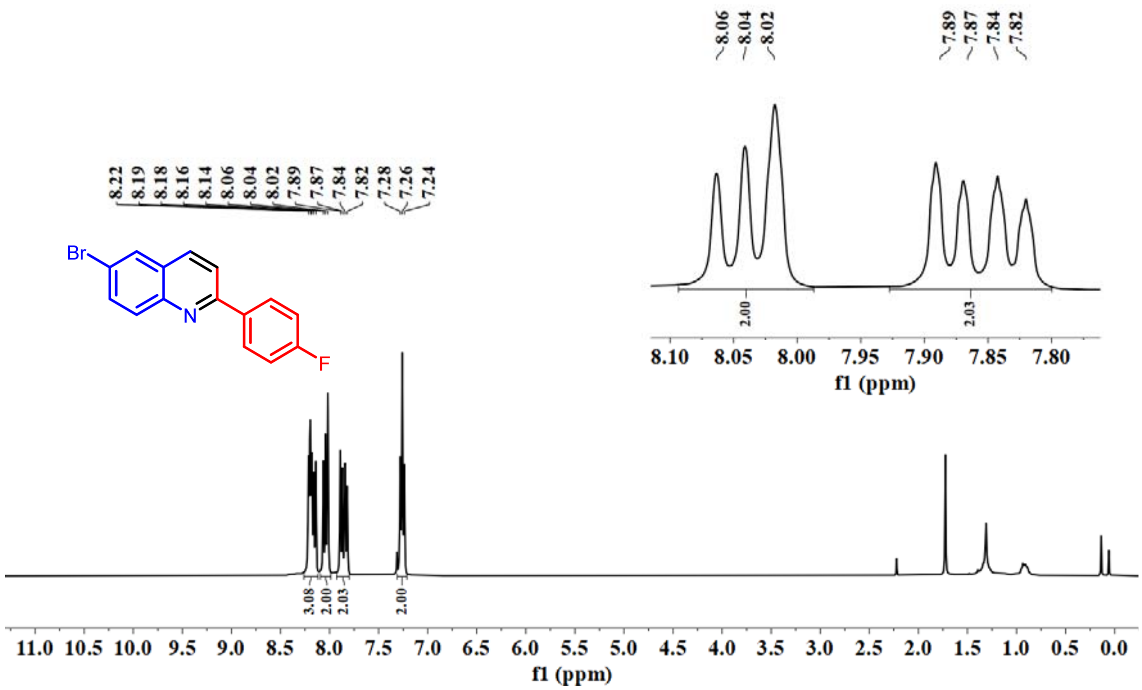


**Fig. S109** $^{1}$H NMR spectrum of **39** in $CDCl_3$ (400 MHz).

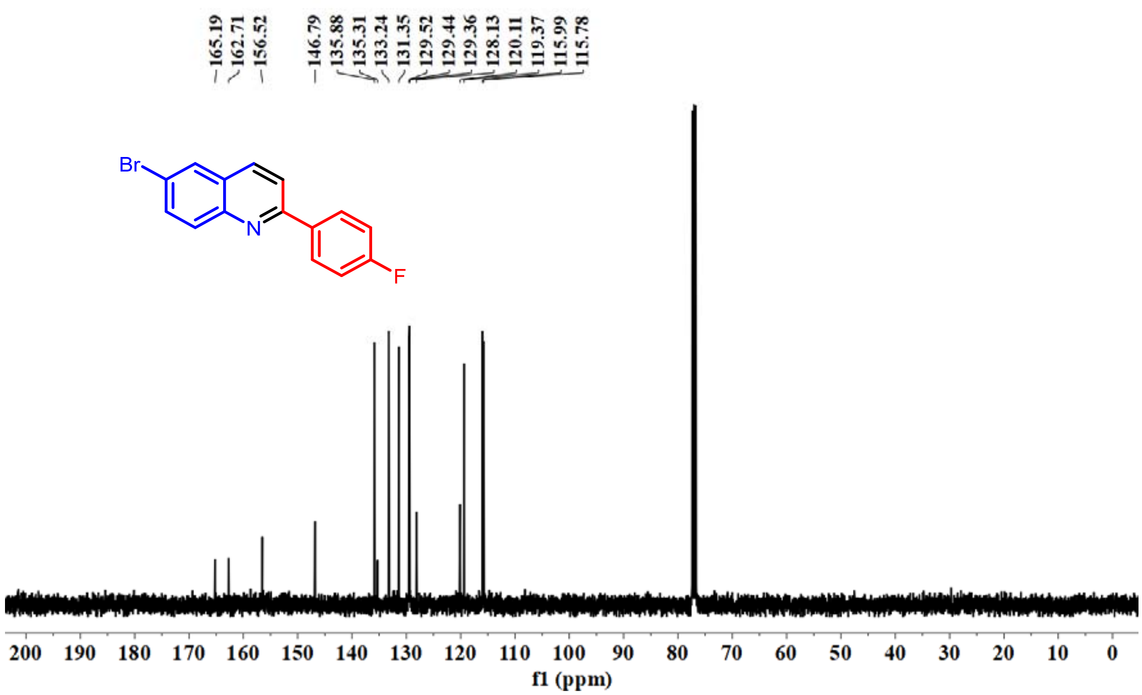


**Fig. S110** $^{13}C\{^{1}H\}$ NMR spectrum of **39** in $CDCl_3$ (101 MHz).

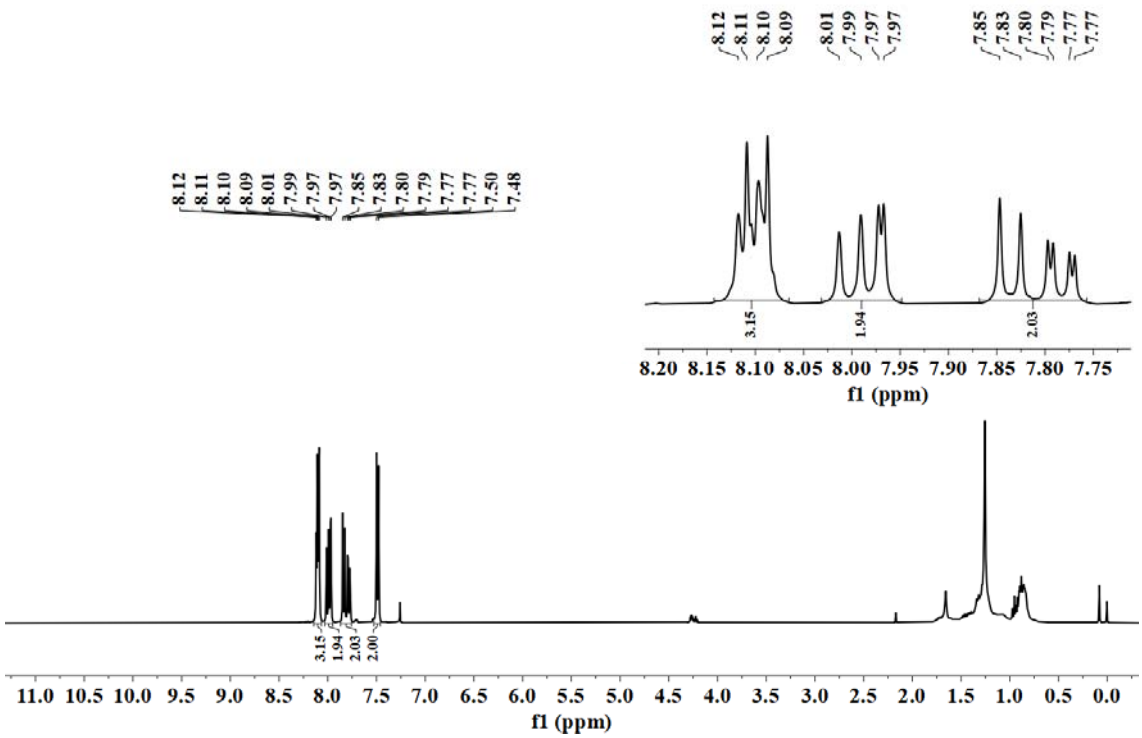



**Fig. S111** $^{1}$H NMR spectrum of **40** in $CDCl_3$ (400 MHz).

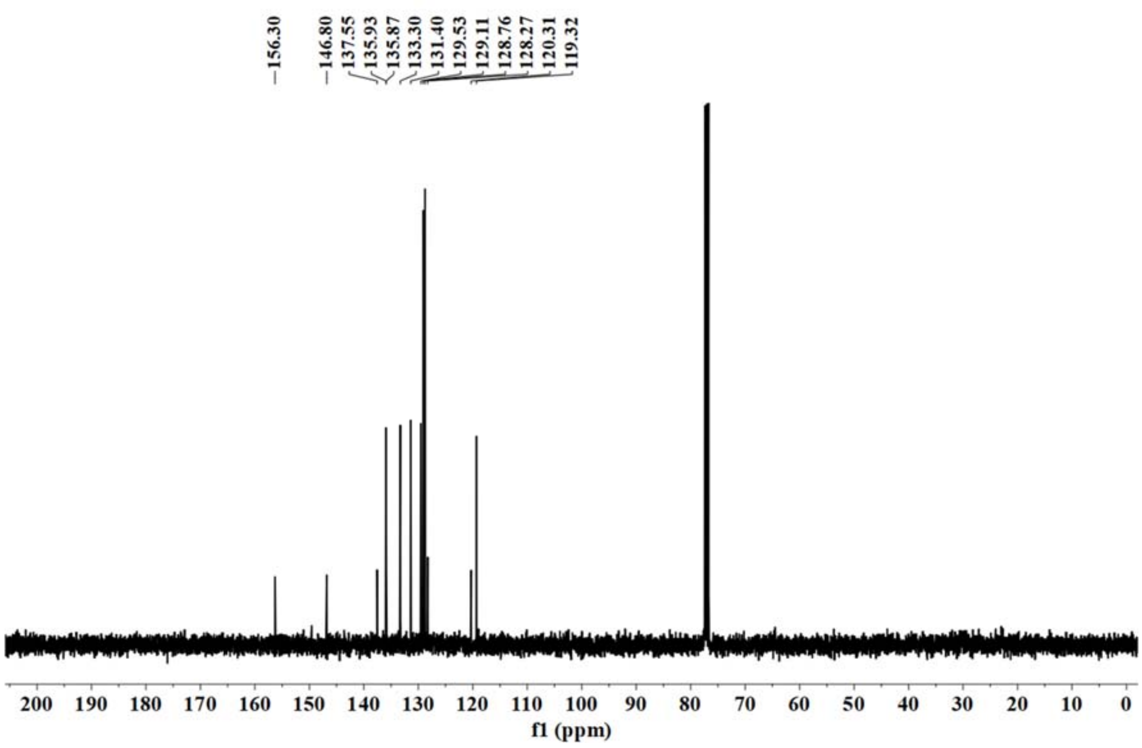



**Fig. S112** $^{13}C\{^{1}H\}$ NMR spectrum of **40** in $CDCl_3$ (101 MHz).

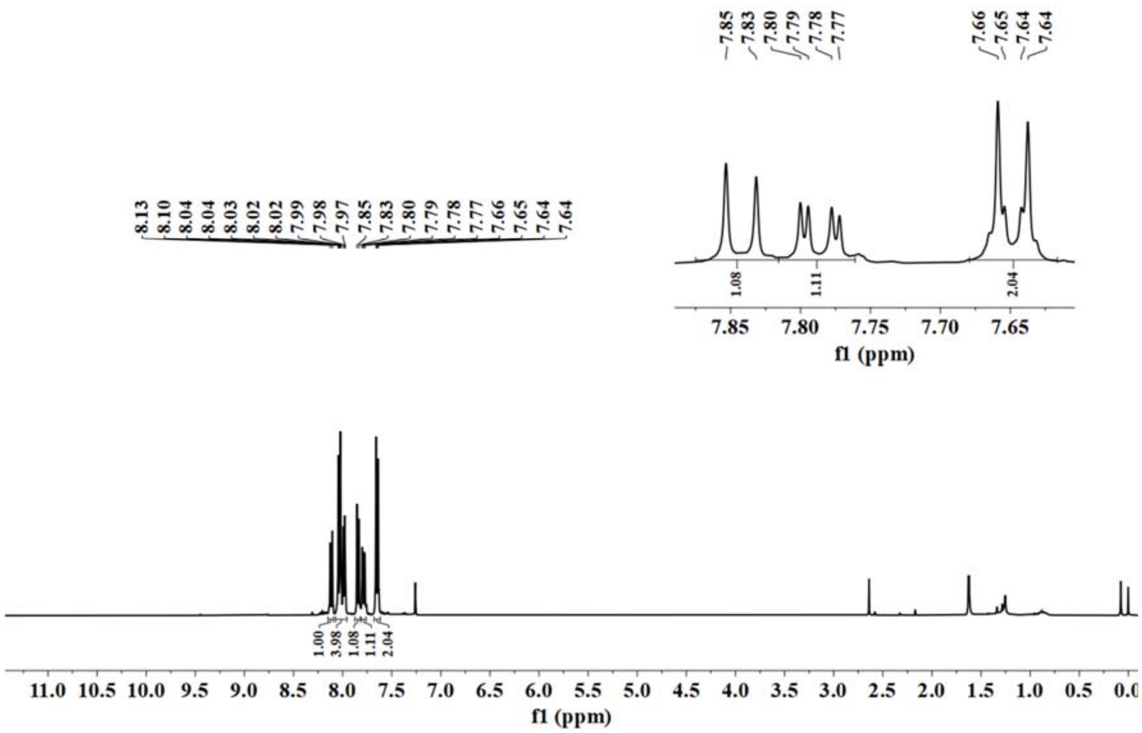


**Fig. S113** $^{1}H$ NMR spectrum of **41** in $CDCl_3$ (400 MHz).

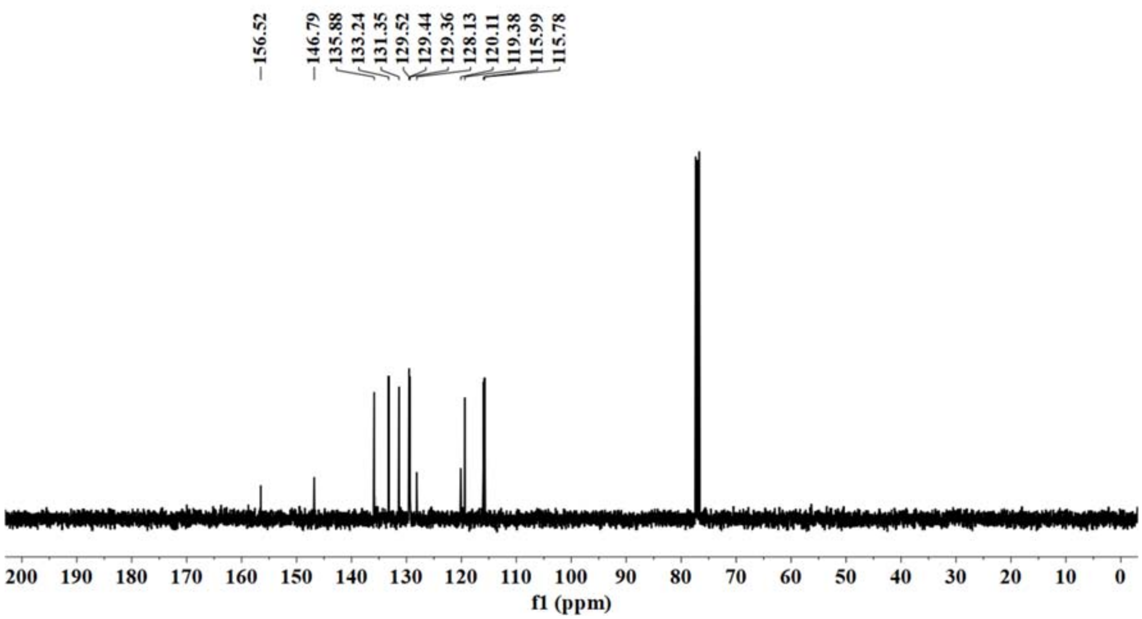


**Fig. S114** $^{13}C\{^{1}H\}$ NMR spectrum of **41** in $CDCl_3$ (101 MHz).

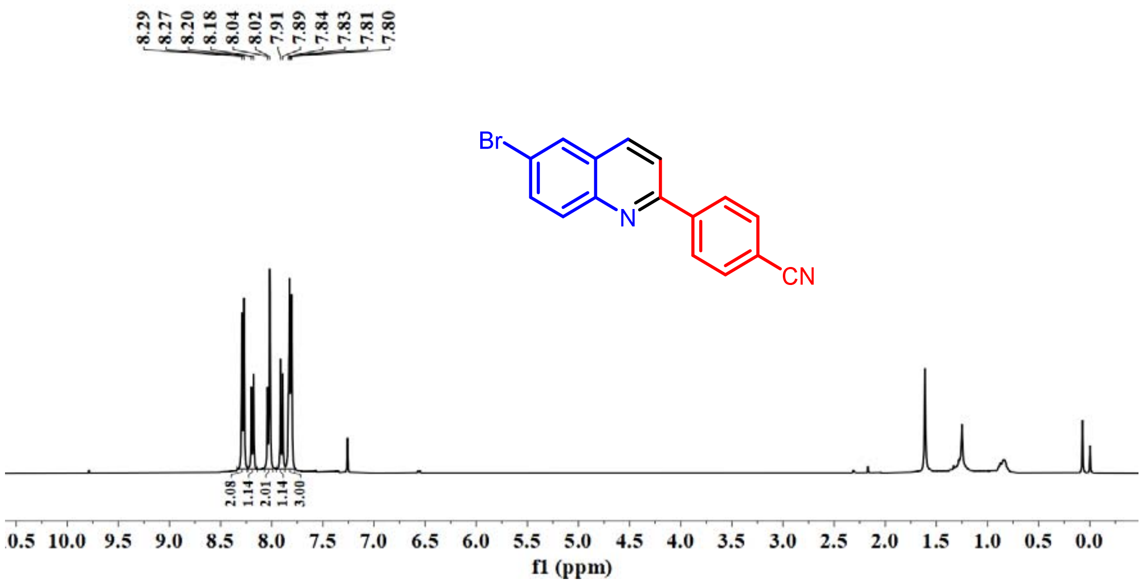



**Fig. S115** $^{1}H$ NMR spectrum of **42** in $CDCl_3$ (400 MHz).

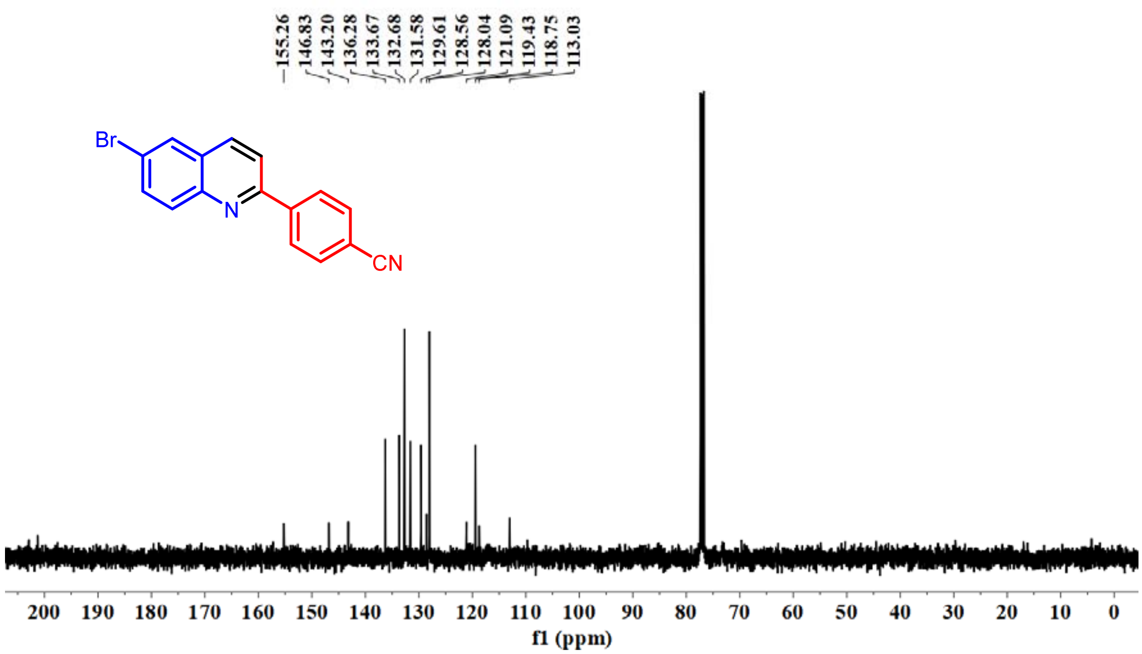



**Fig. S116** $^{13}C\{^{1}H\}$ NMR spectrum of **42** in $CDCl_3$ (101MHz).

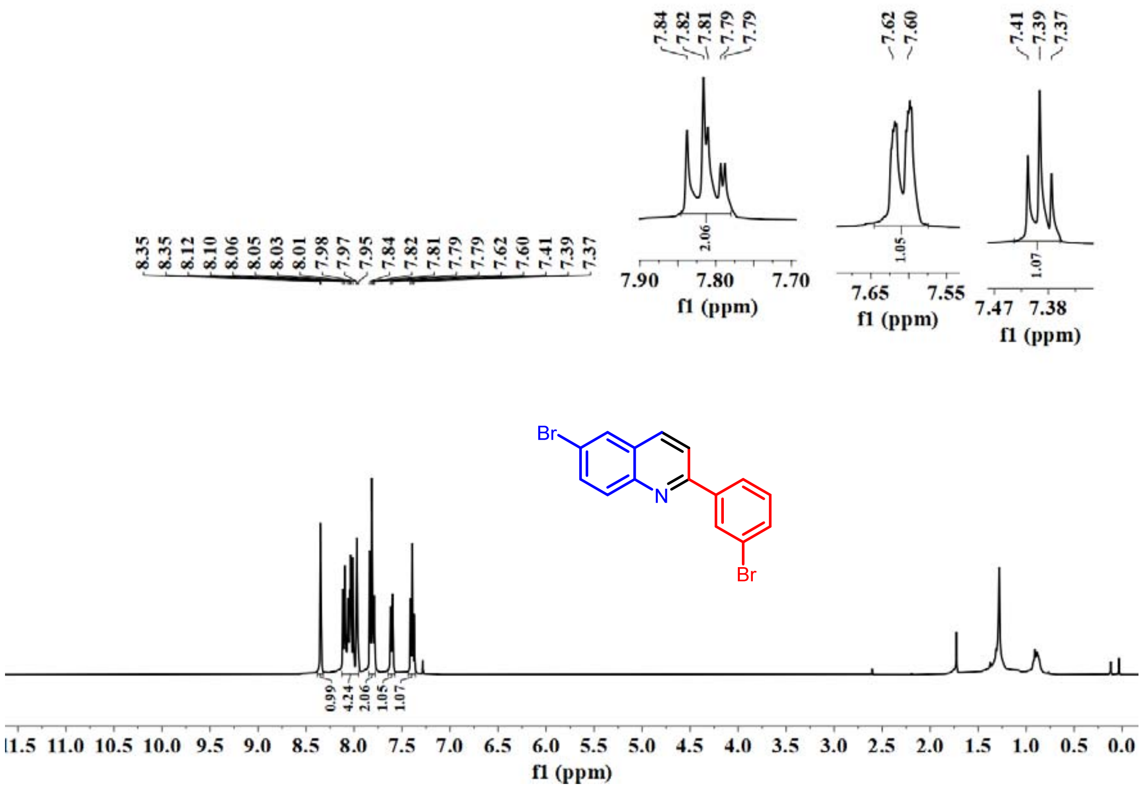


**Fig. S117** $^{1}H$ NMR spectrum of **43** in $CDCl_3$ (400 MHz).

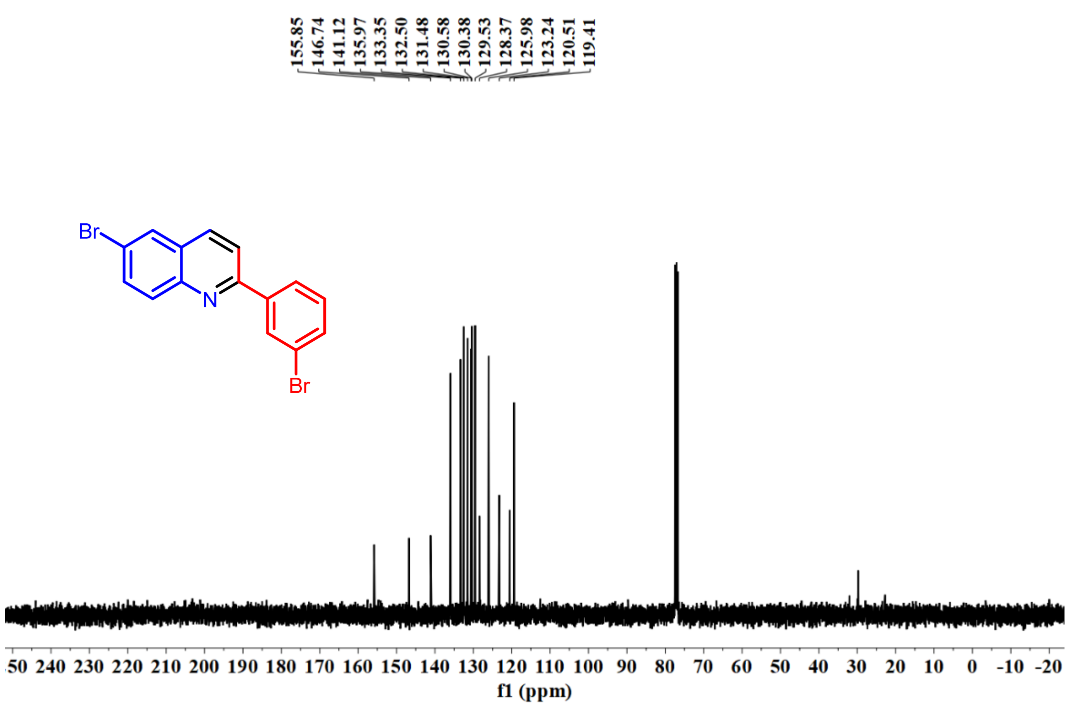


**Fig. S118** $^{13}C\{^{1}H\}$ NMR spectrum of **43** in $CDCl_3$ (101 MHz).

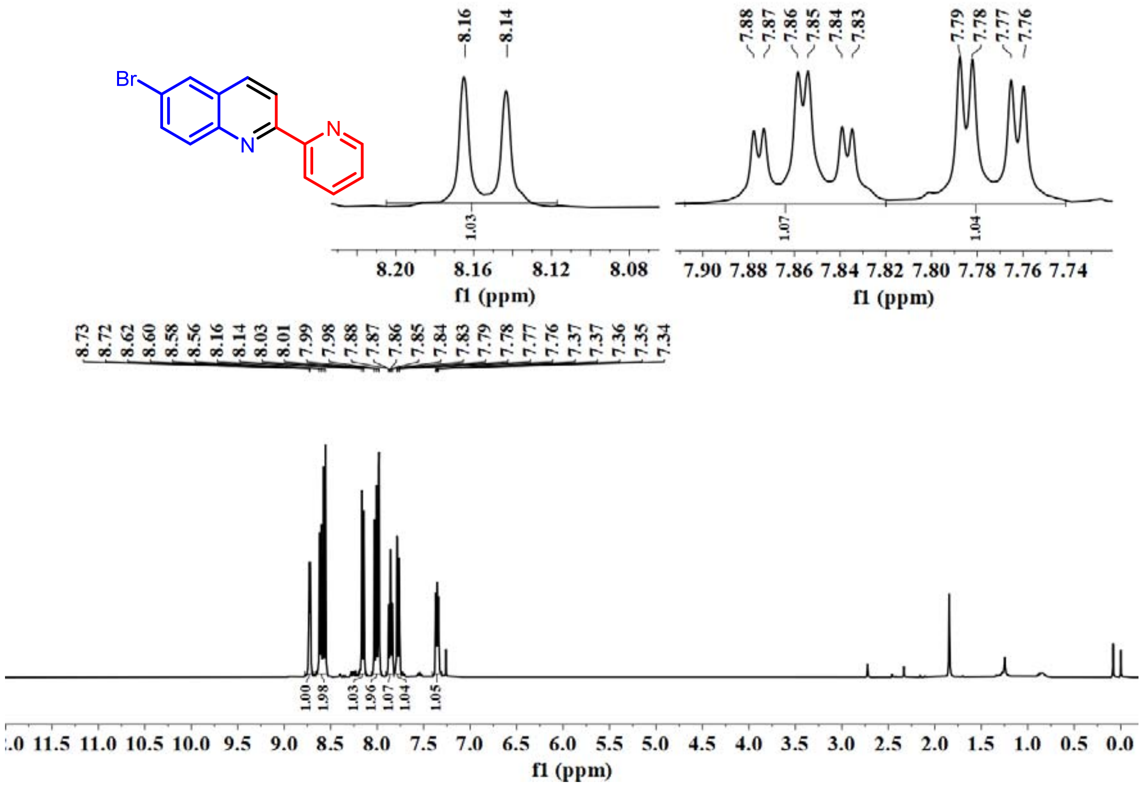


**Fig. S119** $^{1}H$ NMR spectrum of **44** in $CDCl_3$ (400 MHz).

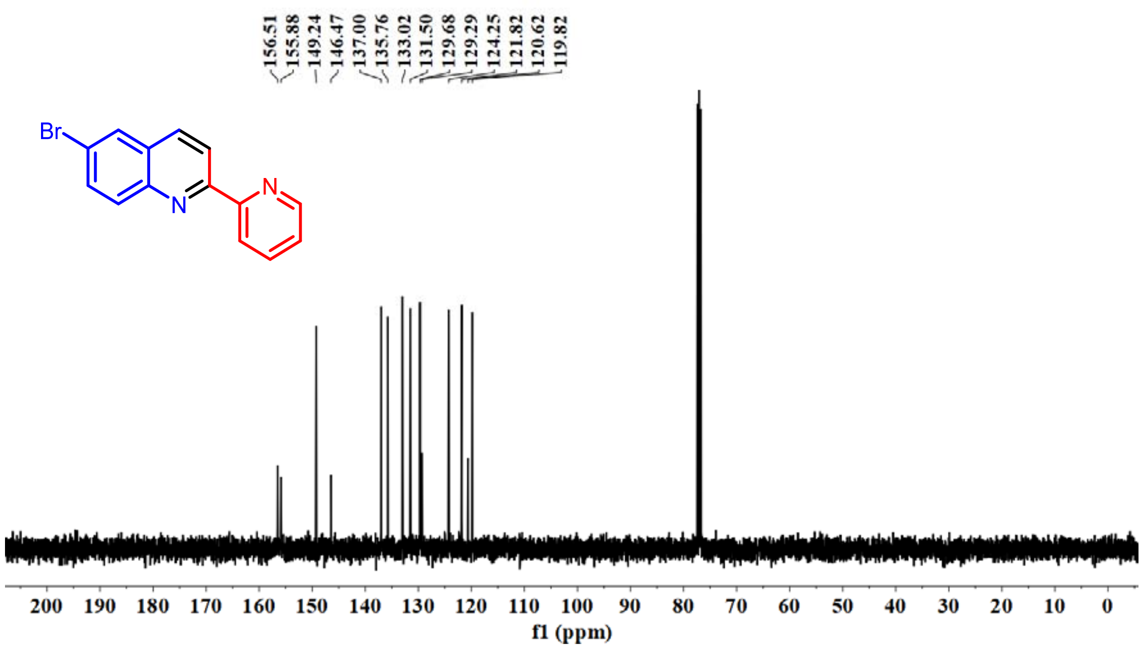


**Fig. S120.** $^{13}C\{^{1}H\}$ NMR spectrum of **44** in $CDCl_3$ (1101 MHz).

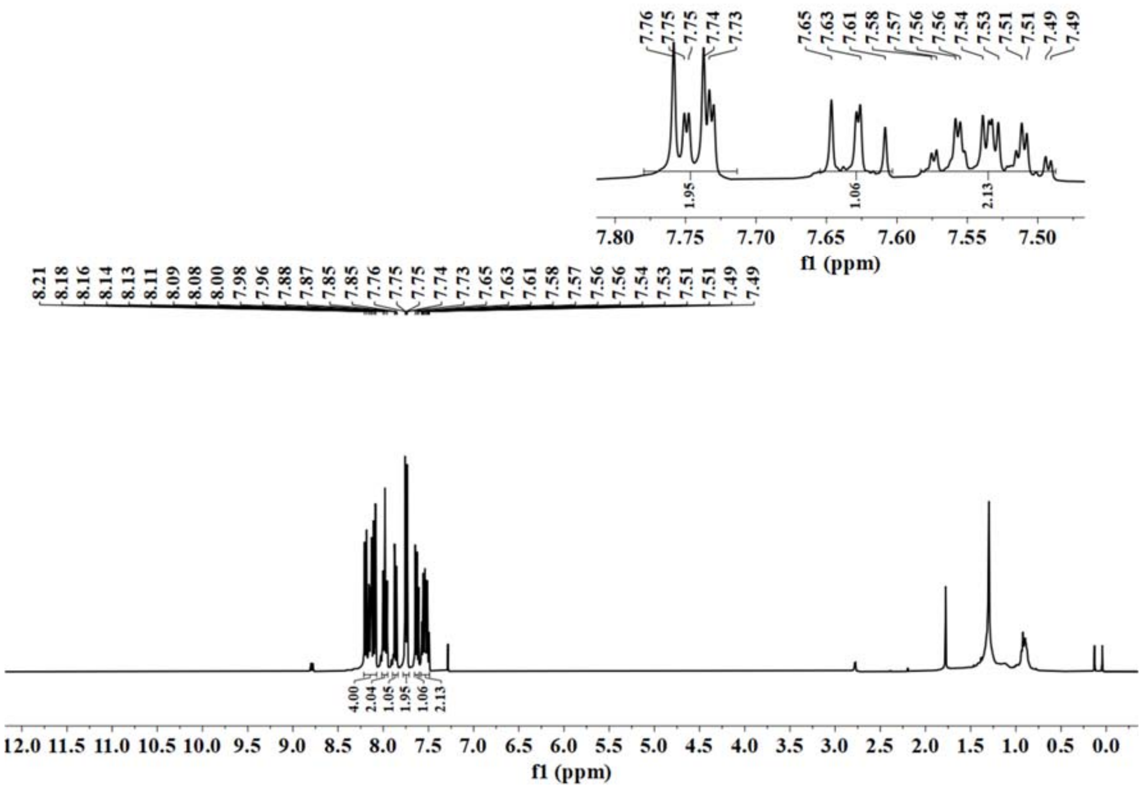



**Fig. S121** $^{1}$H NMR spectrum of **45** in $CDCl_3$ 4 MHz).

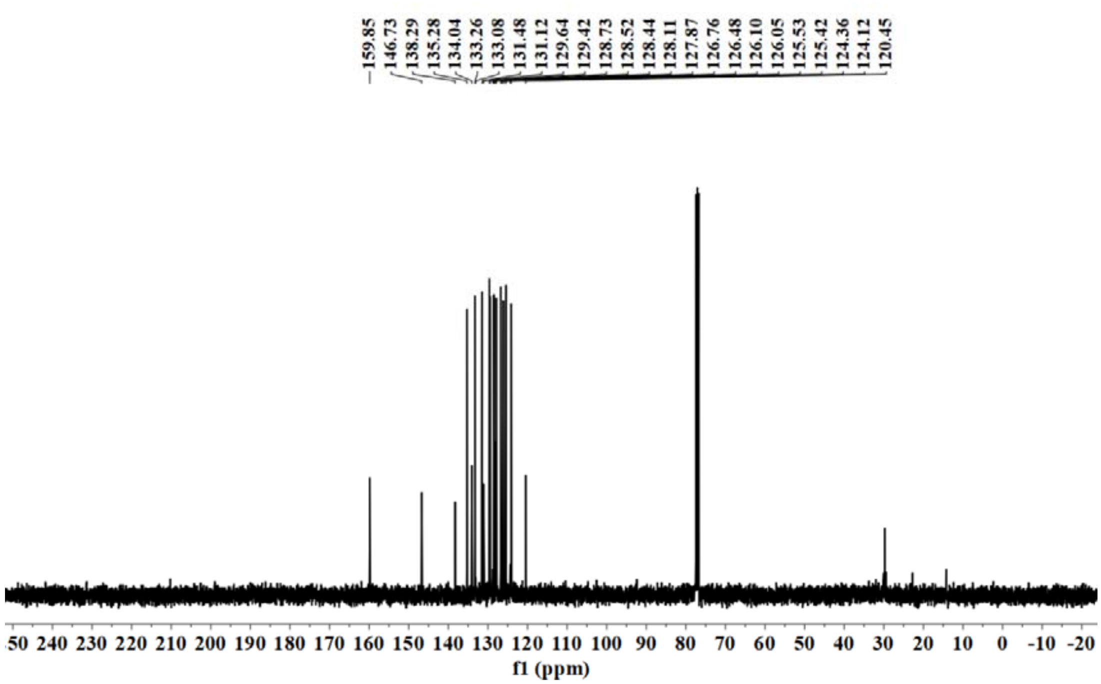



**Fig. S122** $^{13}C\{^{1}H\}$ NMR spectrum of **45** in $CDCl_3$ (101MHz).

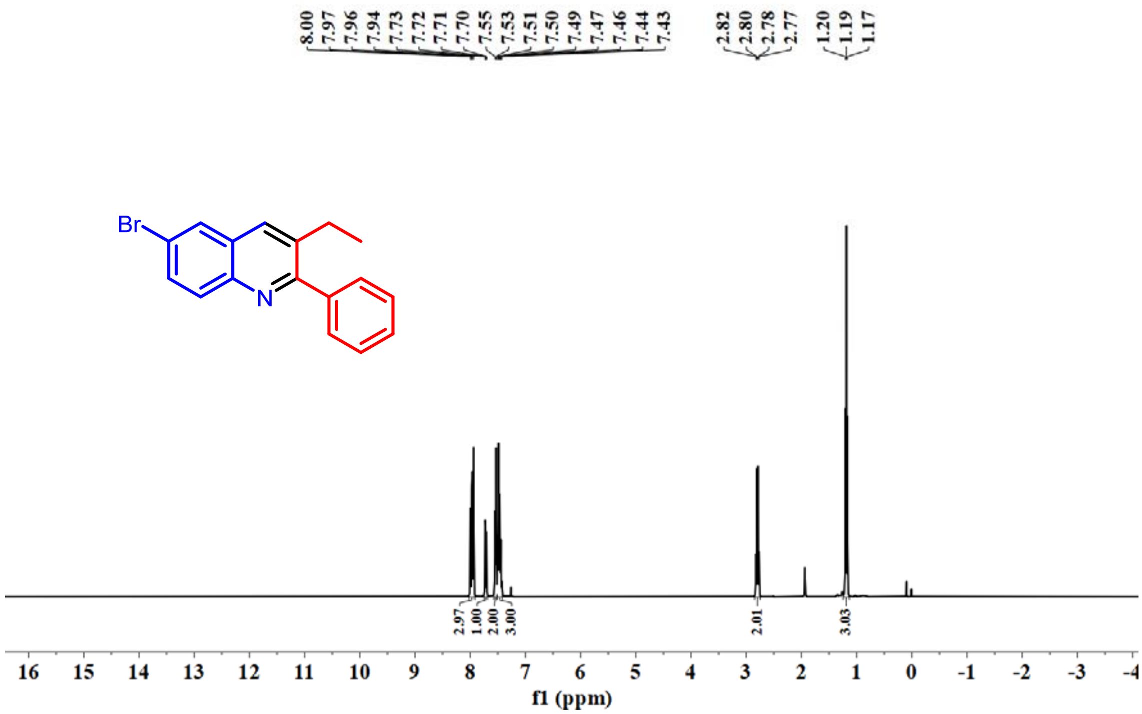



**Fig. S123** $^{1}$H NMR spectrum of **46** in $CDCl_3$ (400 MHz).

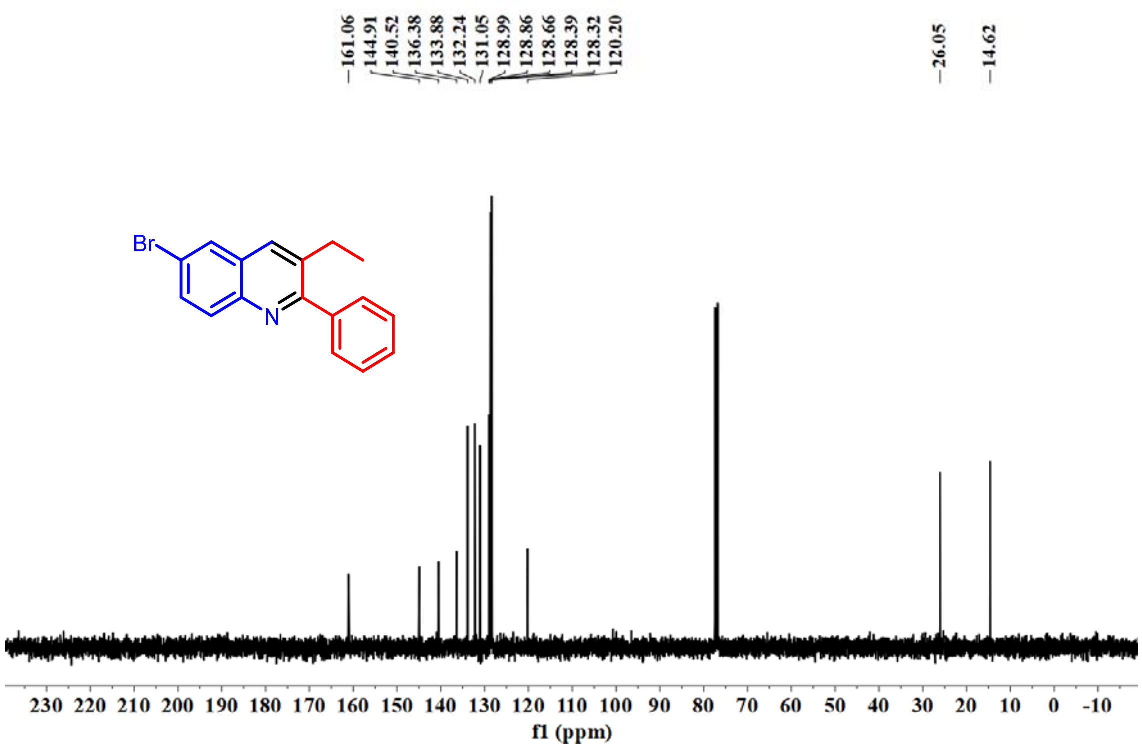



**Fig. S124** $^{13}C\{^{1}H\}$ NMR spectrum of **46** in $CDCl_3$ (101 MHz).

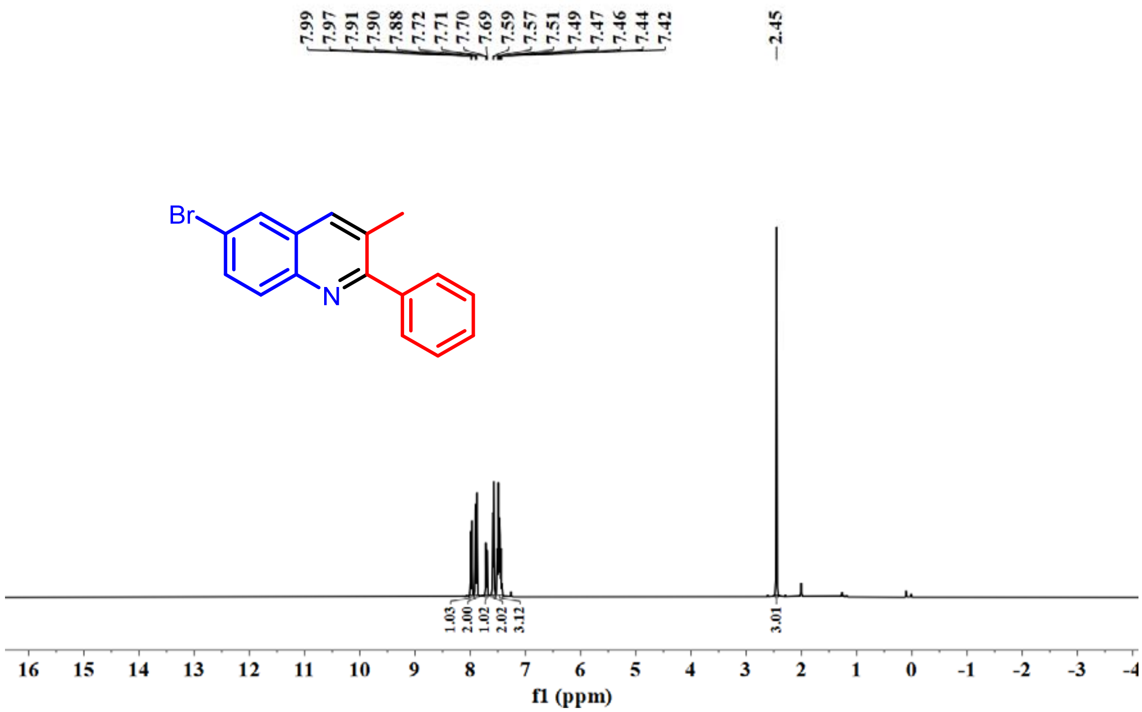



**Fig. S125** $^{1}H$ NMR spectrum of **47** in $CDCl_3$ (400 MHz).

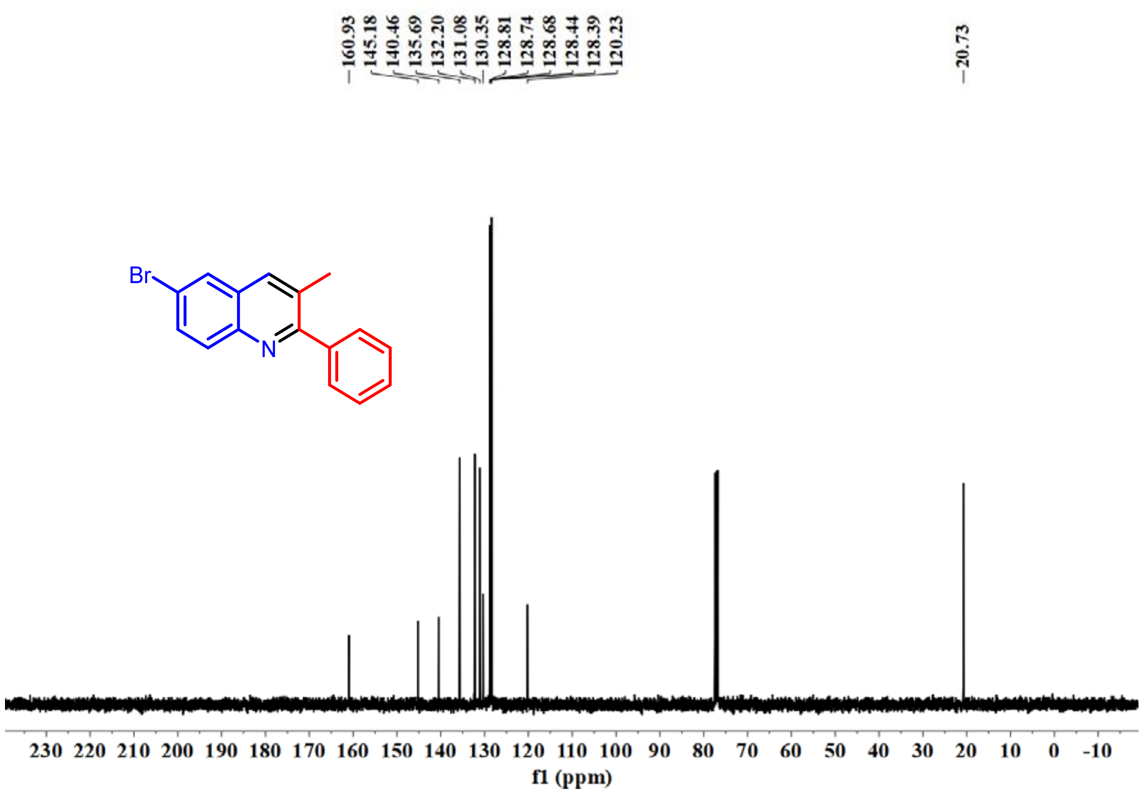



**Fig. S126** $^{13}C\{^{1}H\}$ NMR spectrum of **47** in $CDCl_3$ (101 MHz).

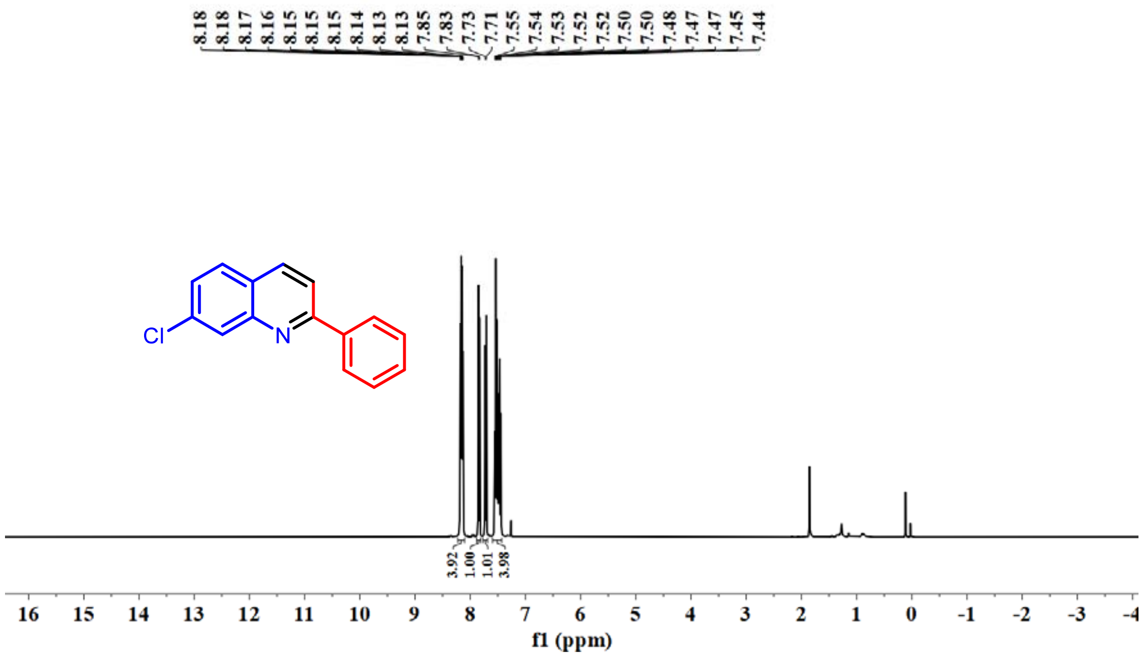



**Fig. S127** $^{1}H$ NMR spectrum of **48** in $CDCl_3$ (400 MHz).

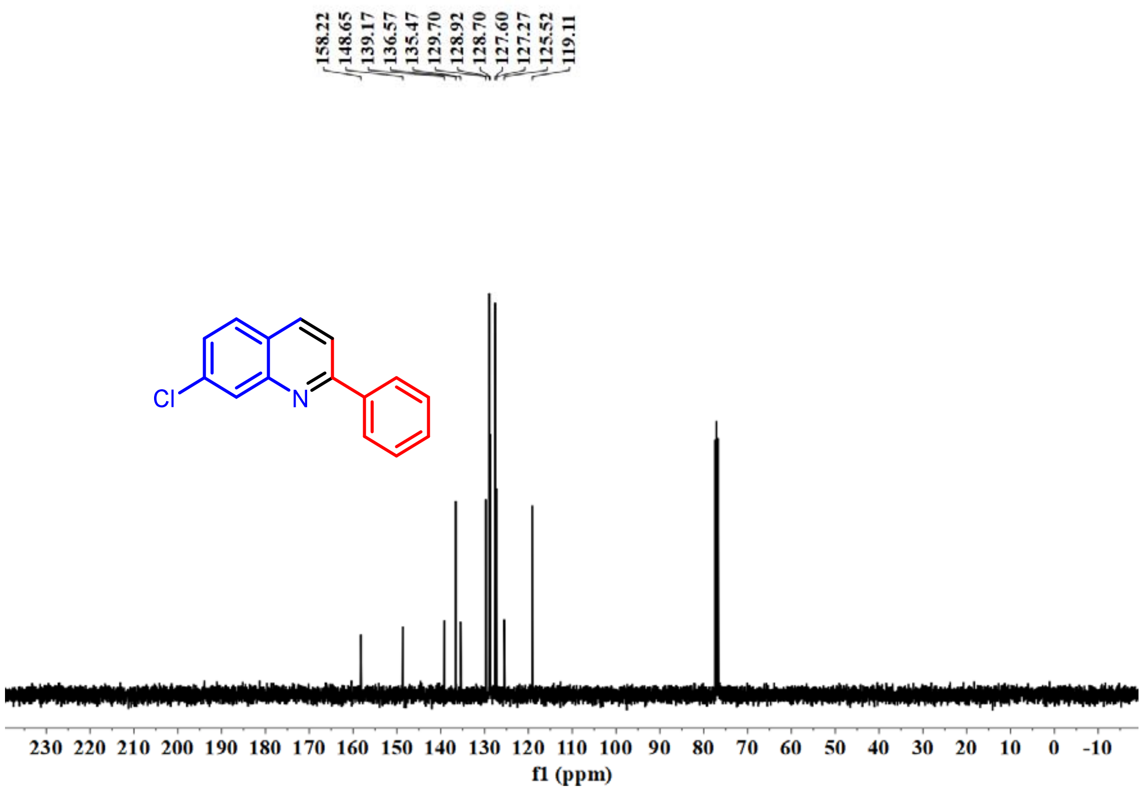



**Fig. S128** $^{13}C\{^{1}H\}$ NMR spectrum of **48** in $CDCl_3$ (101MHz).

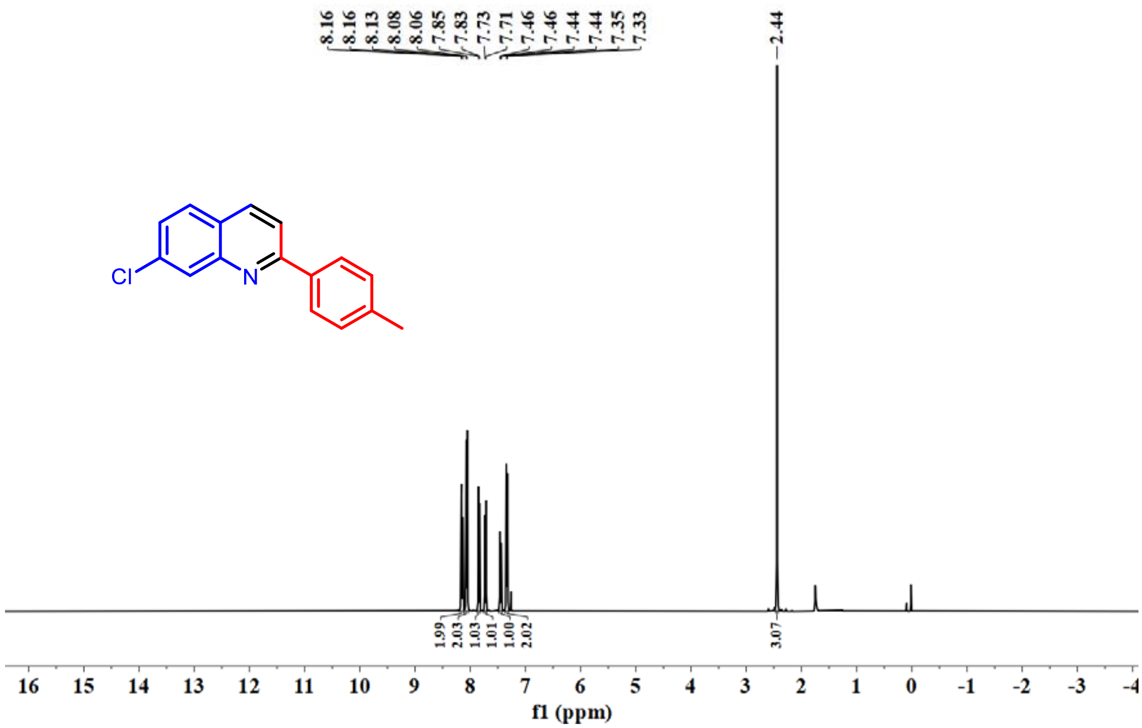



**Fig. S129** ¹H NMR spectrum of **49** in $CDCl_3$ (400 MHz).

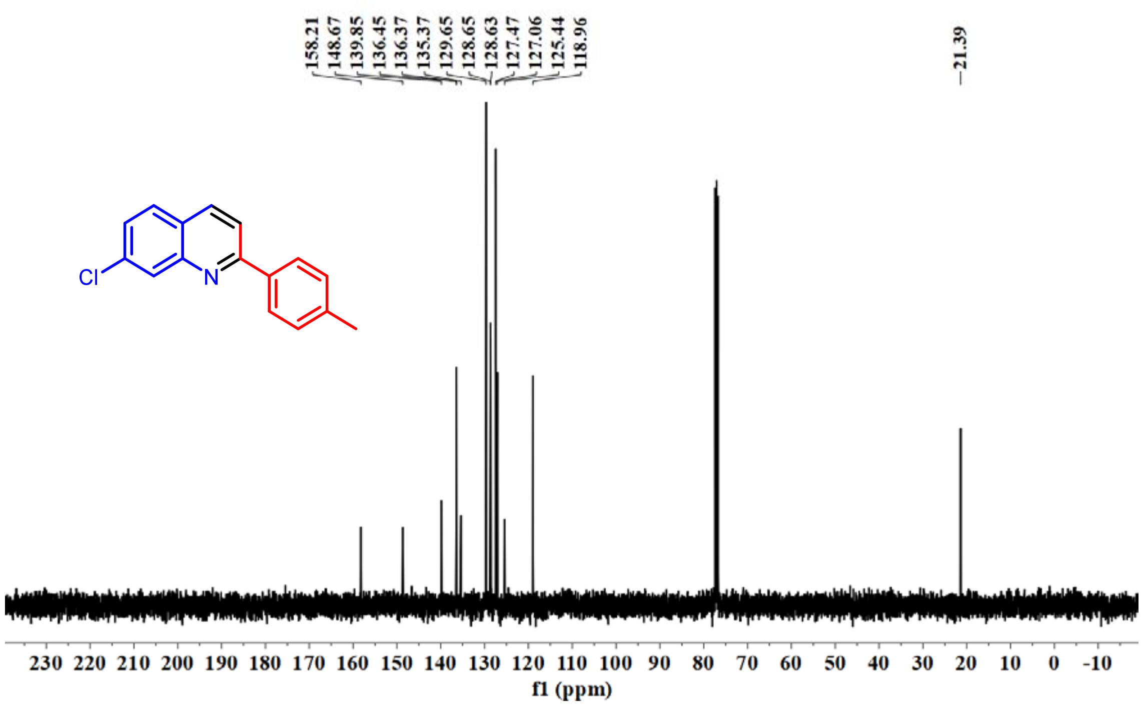



**Fig. S130** ¹³C{¹H} NMR spectrum of **49** in $CDCl_3$ (101 MHz).

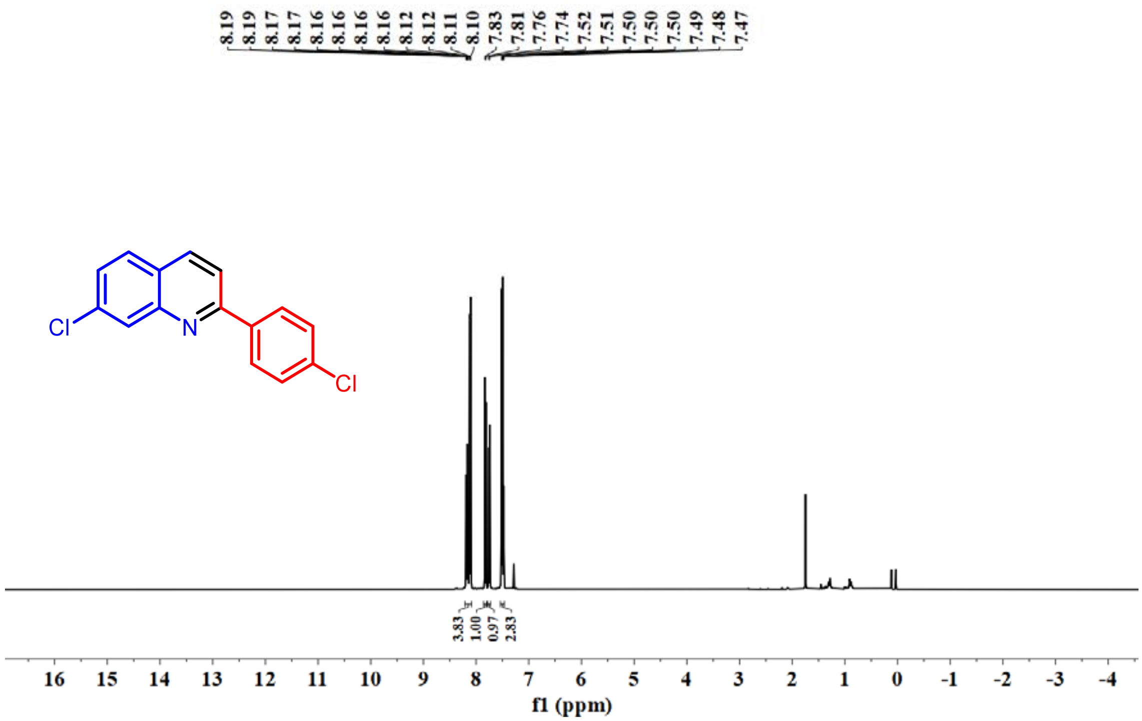



**Fig. S131** $^{1}$H NMR spectrum of **50** in $CDCl_3$ (400 MHz).

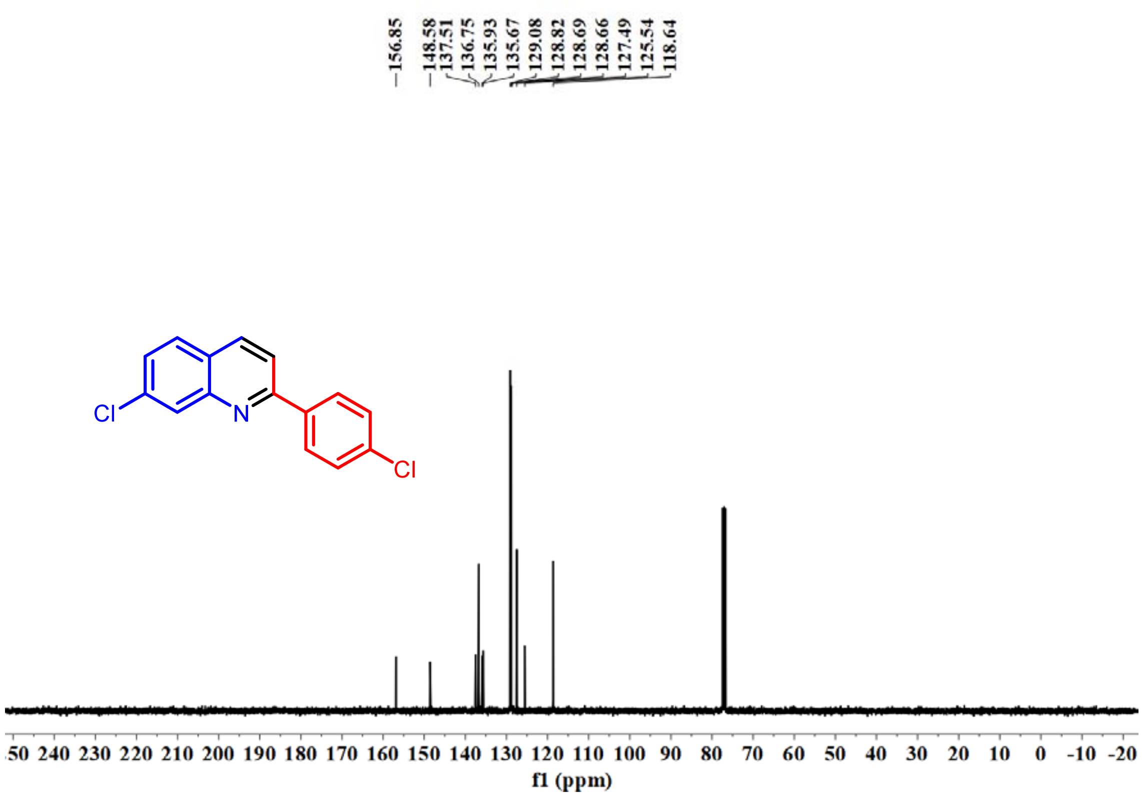



**Fig. S132** $^{13}C\{^{1}H\}$ NMR spectrum of **50** in $CDCl_3$ (101MHz).

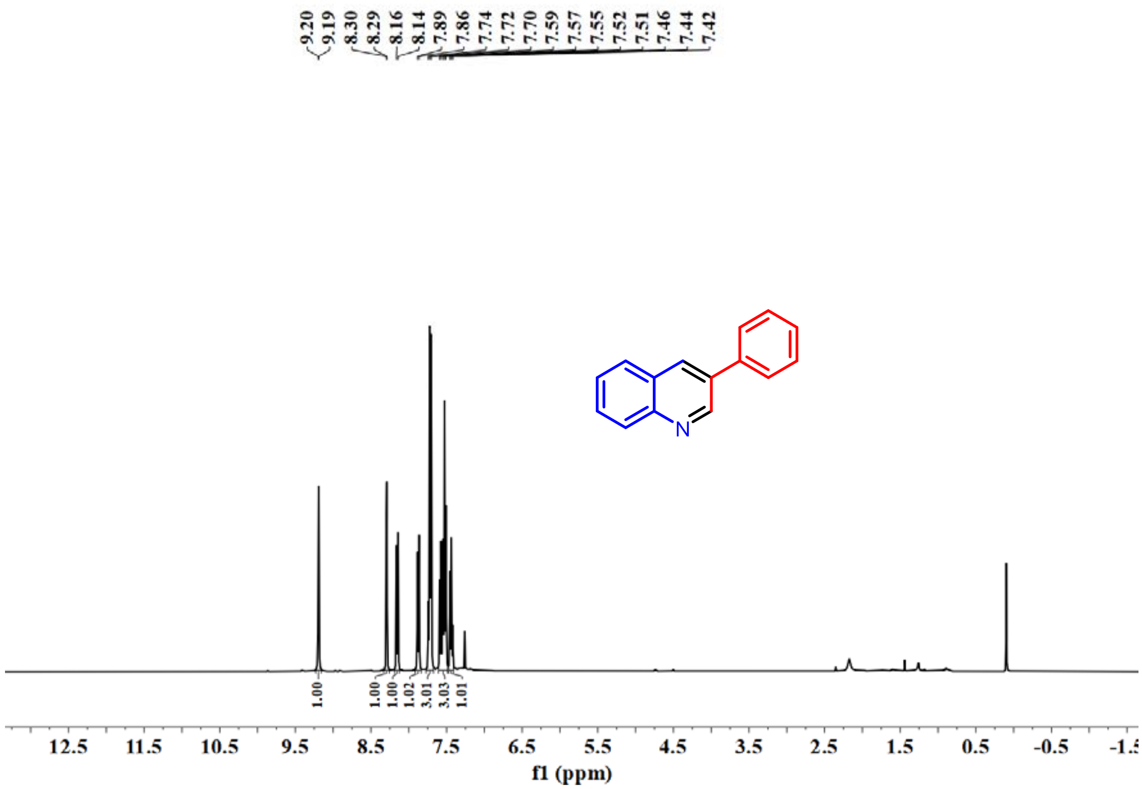



**Fig. S133** $^{1}H$ NMR spectrum of **51** in $CDCl_3$ (400 MHz).

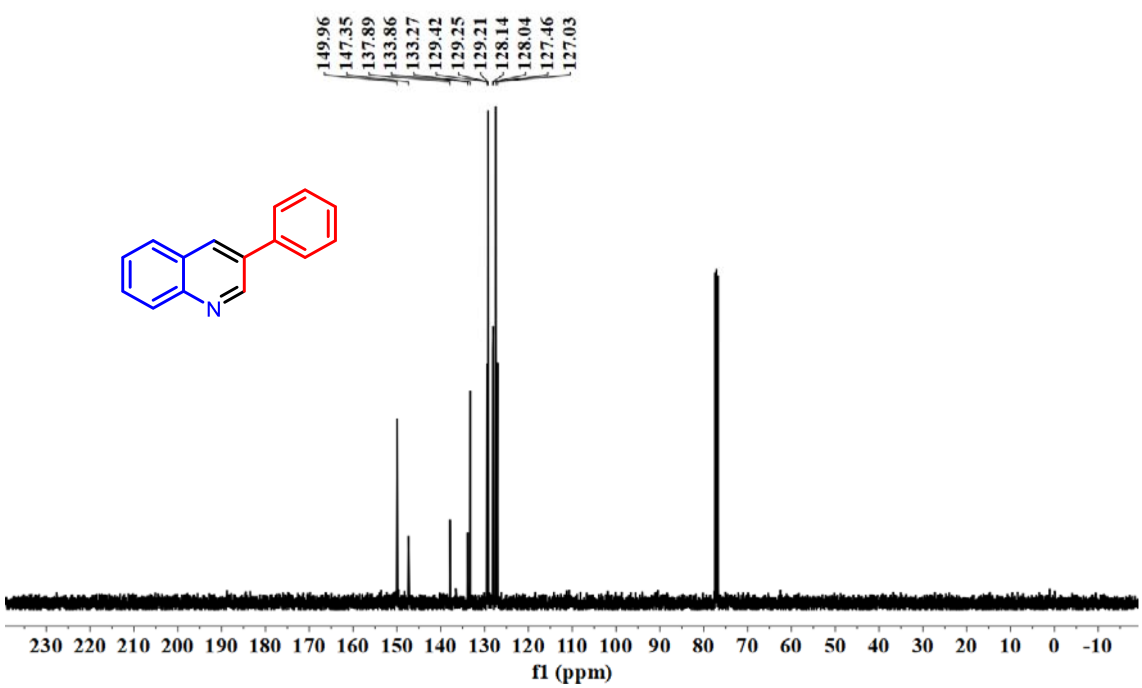



**Fig. S134** $^{13}C\{^{1}H\}$ NMR spectrum of **51** in $CDCl_3$ (101 MHz).

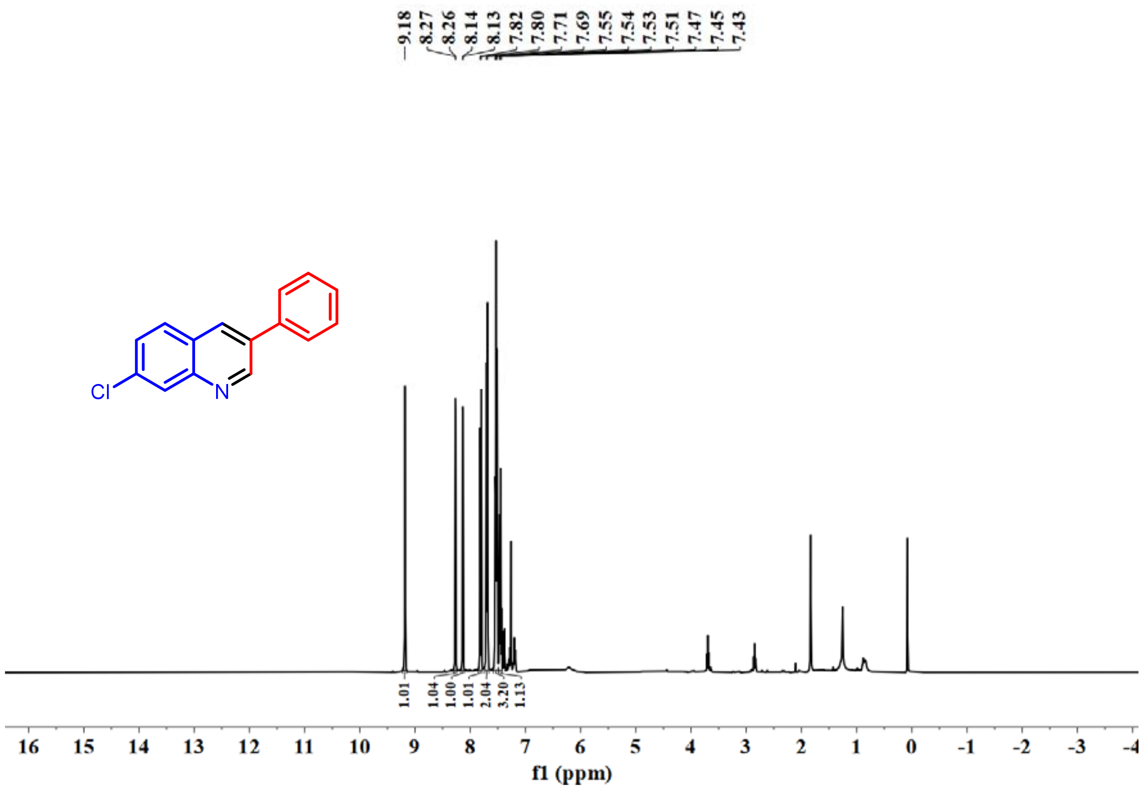


**Fig. S135** $^{1}$H NMR spectrum of **52** in $CDCl_3$ (400 MHz).

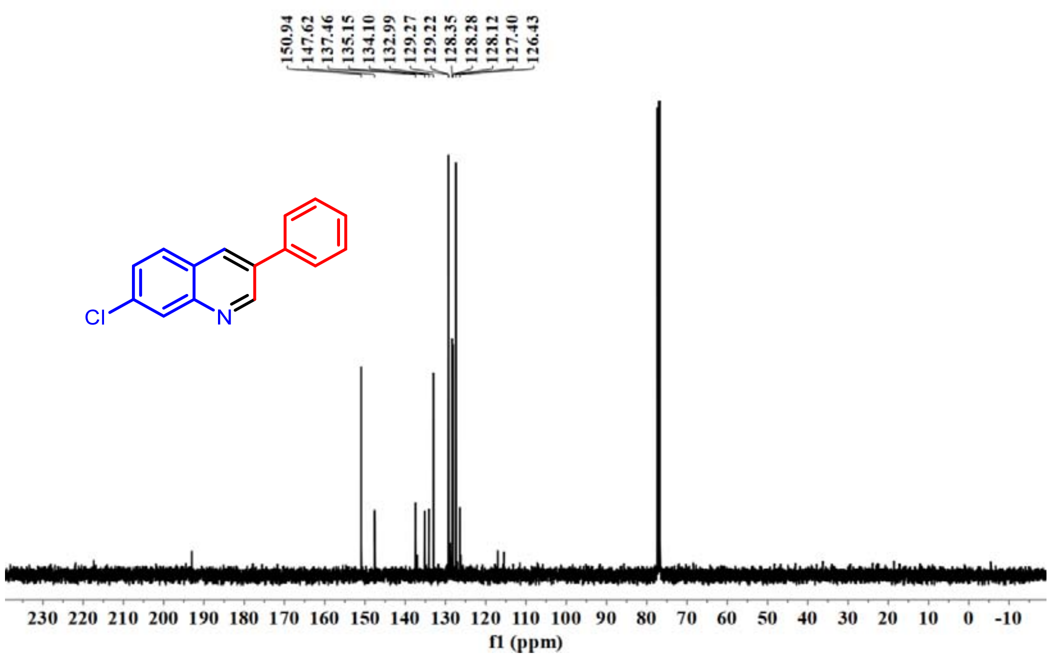


**Fig. S136** $^{13}C\{^{1}H\}$ NMR spectrum of **52** in $CDCl_3$ (101 MHz).

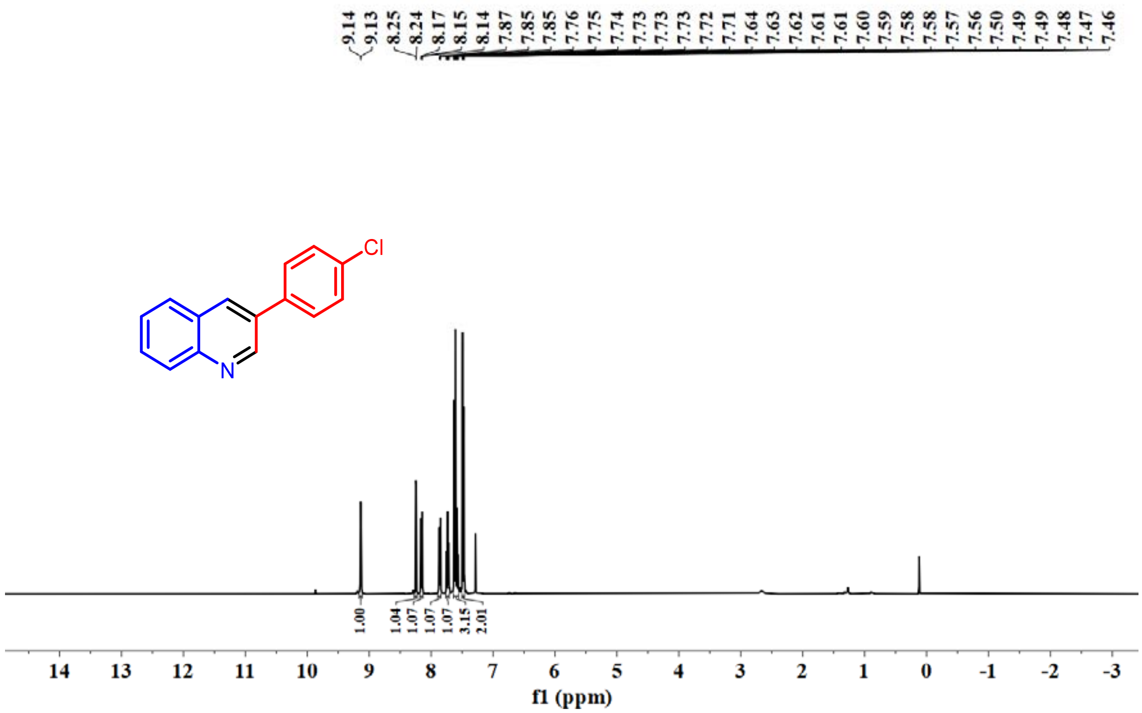



**Fig. S137** $^{1}H$ NMR spectrum of **53** in $CDCl_3$ (400 MHz).

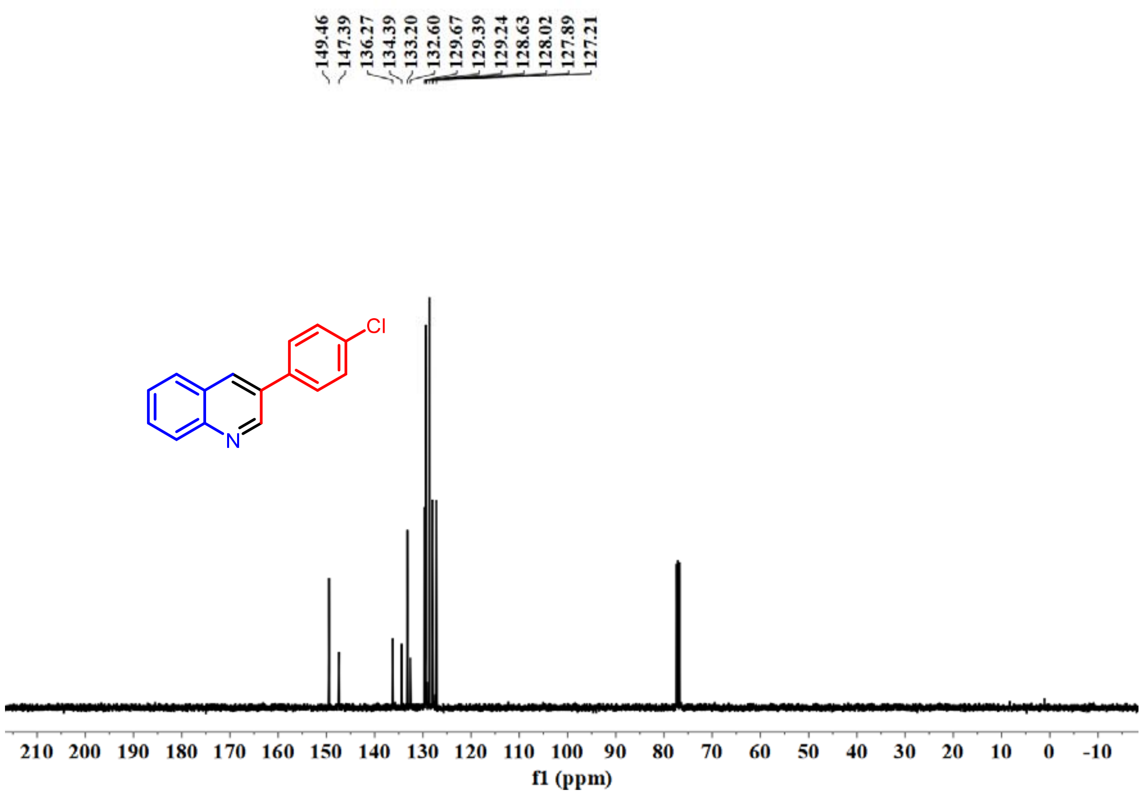



**Fig. S138** $^{13}C\{^{1}H\}$ NMR spectrum of **53** in $CDCl_3$ (101 MHz).

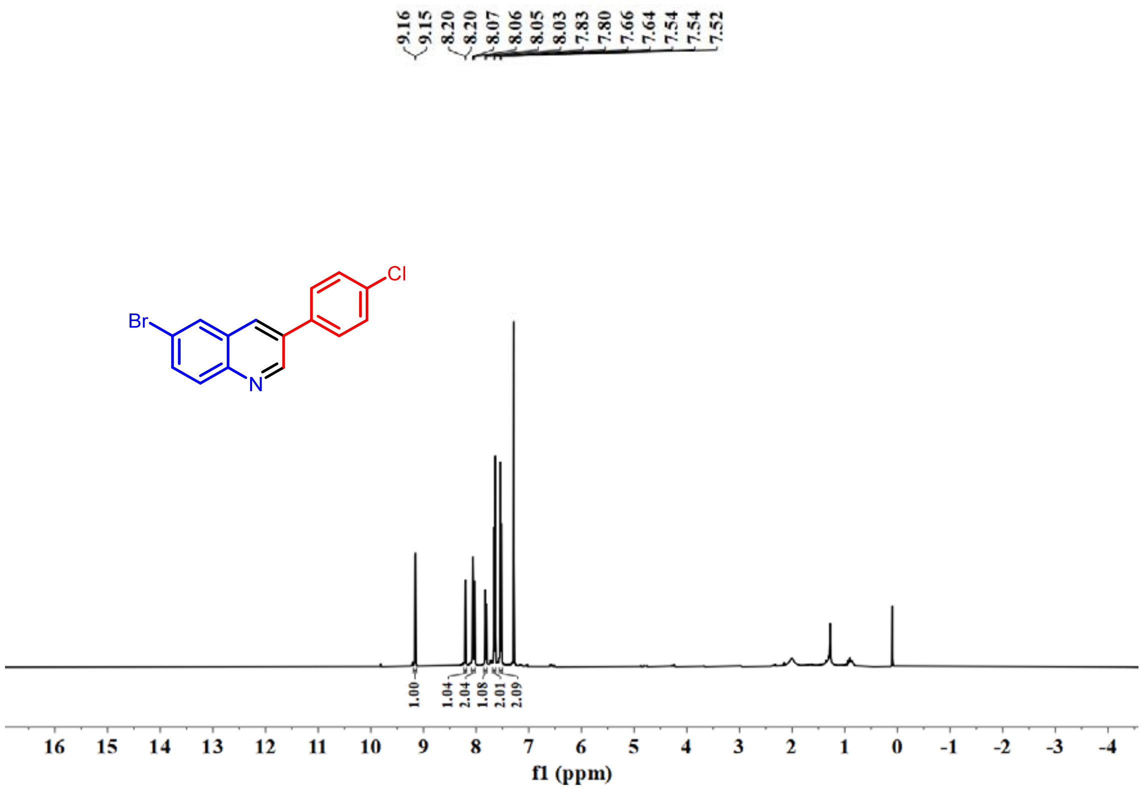



**Fig. S139** $^{1}H$ NMR spectrum of **54** in $CDCl_3$ (400 MHz).

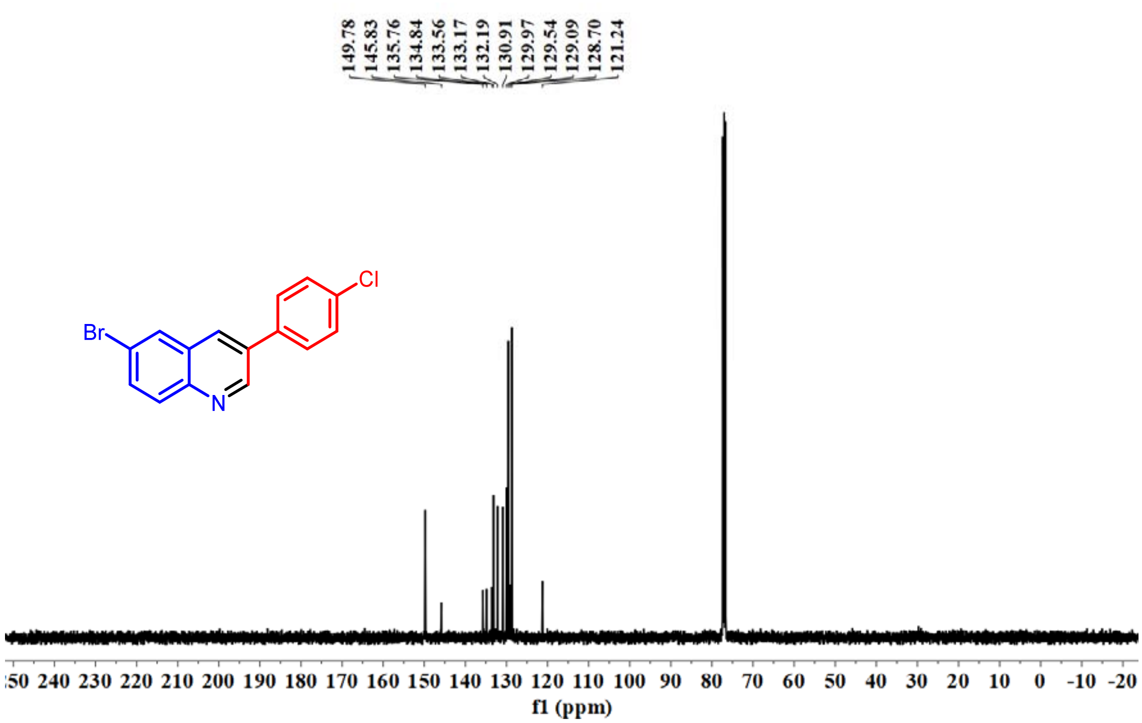



**Fig. S140** $^{13}C\{^{1}H\}$ NMR spectrum of **54** in $CDCl_3$ (101 MHz).

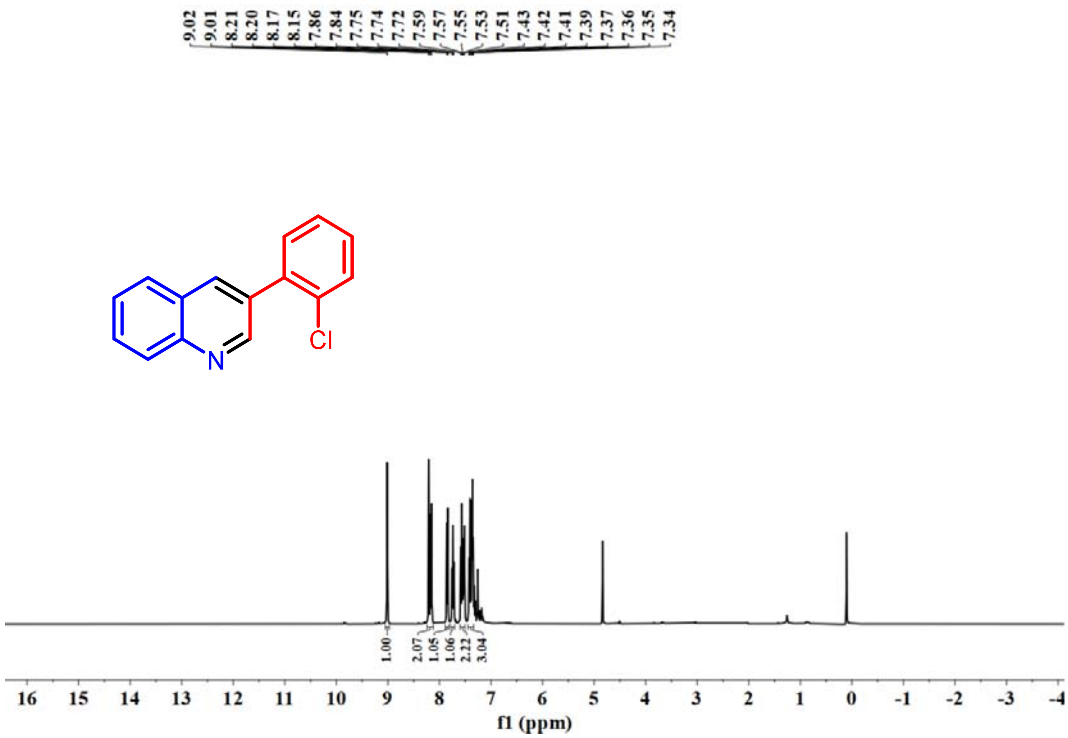



**Fig. S141** $^{1}H$ NMR spectrum of **55** in $CDCl_3$ (400 MHz).

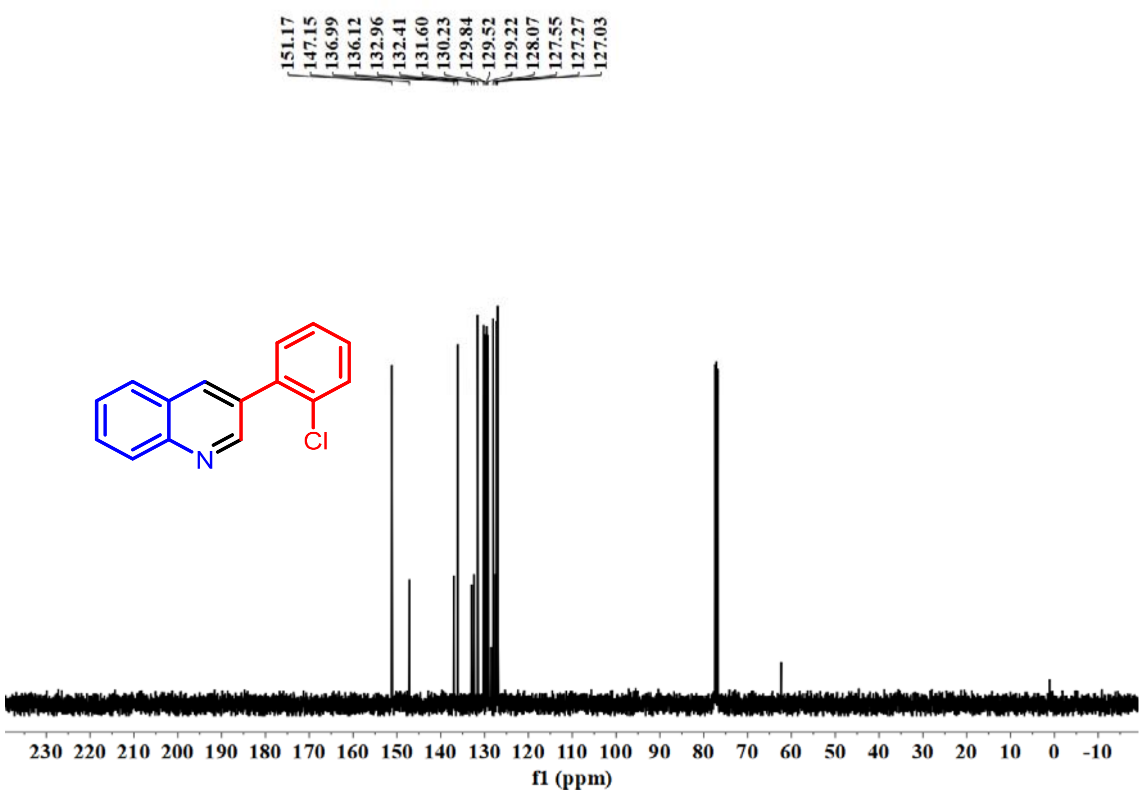



**Fig. S142** $^{13}C\{^{1}H\}$ NMR spectrum of **55** in $CDCl_3$ (101 MHz).

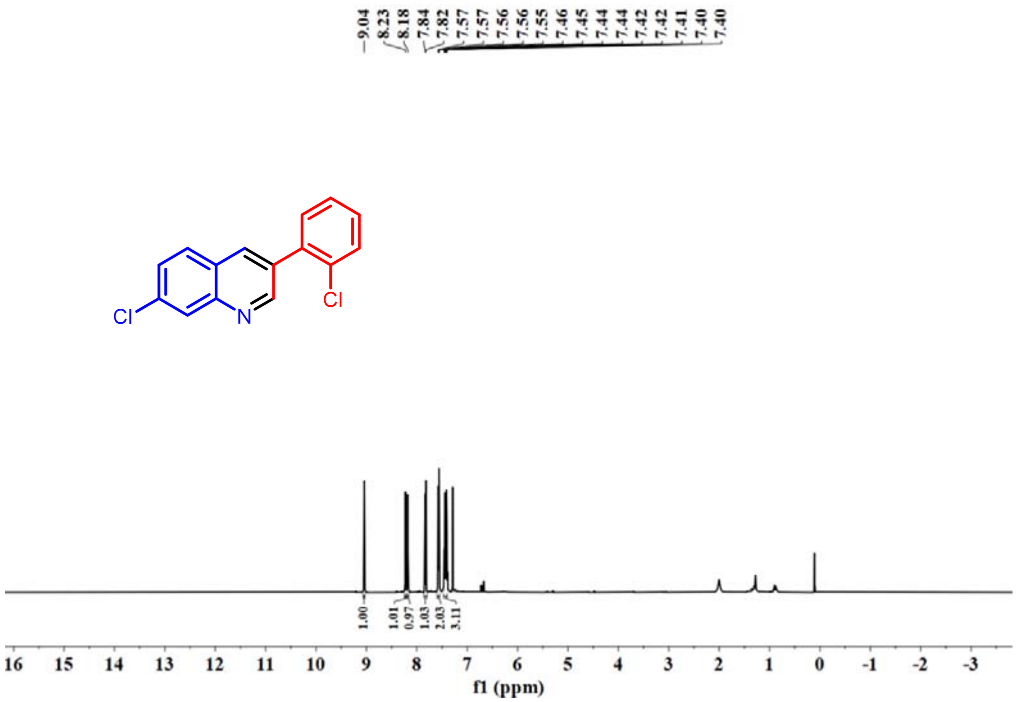



**Fig. S143** $^{1}H$ NMR spectrum of **56** in $CDCl_3$ (400 MHz).

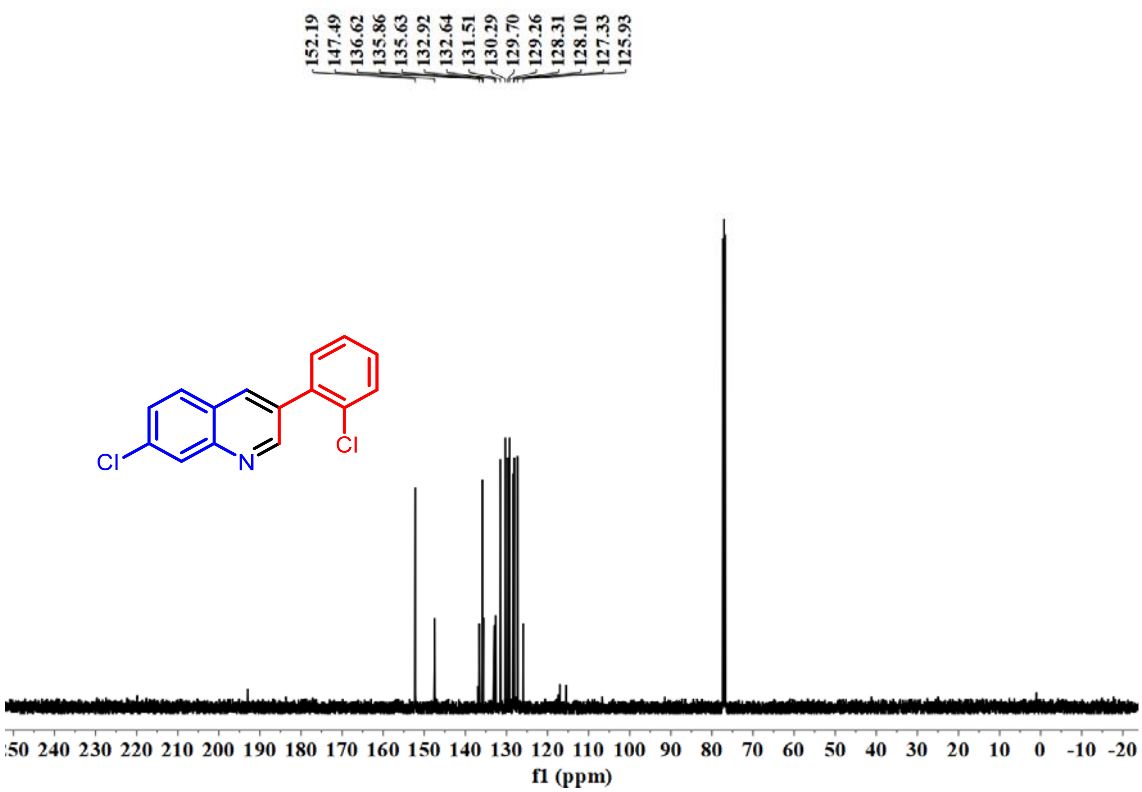



**Fig. S144** $^{13}C\{^{1}H\}$ NMR spectrum of **56** in $CDCl_3$ (101 MHz).

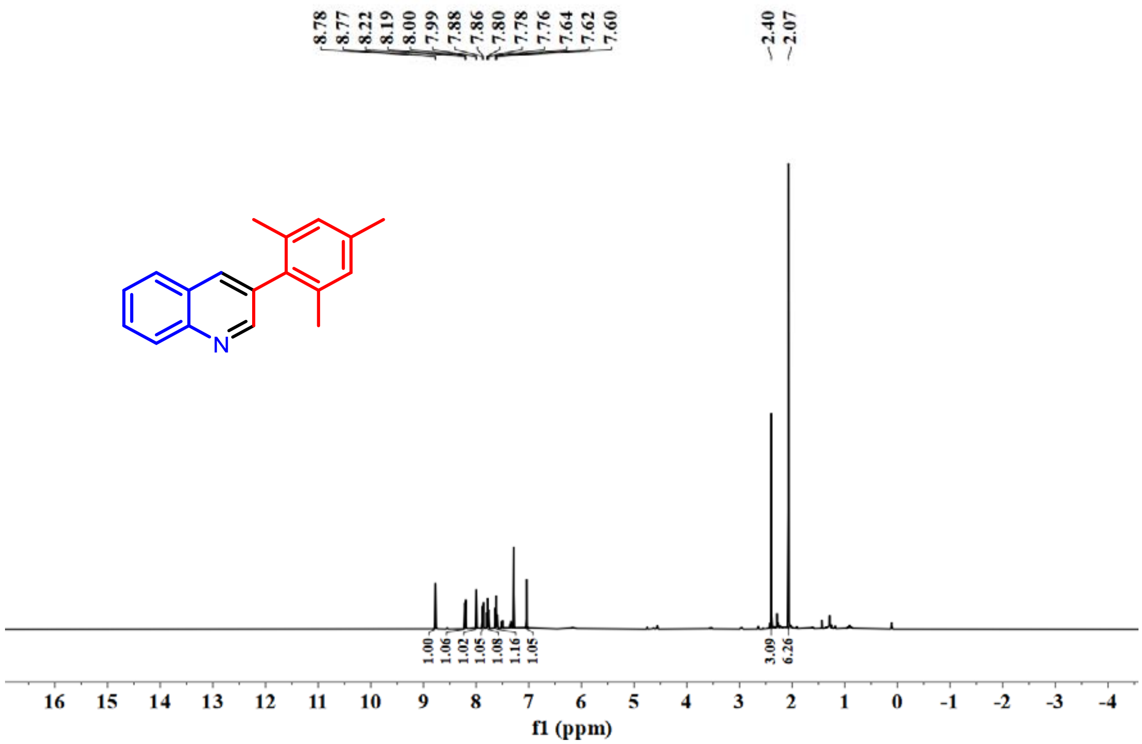



**Fig. S145** [1]H NMR spectrum of **57** in $CDCl_3$ (400 MHz).

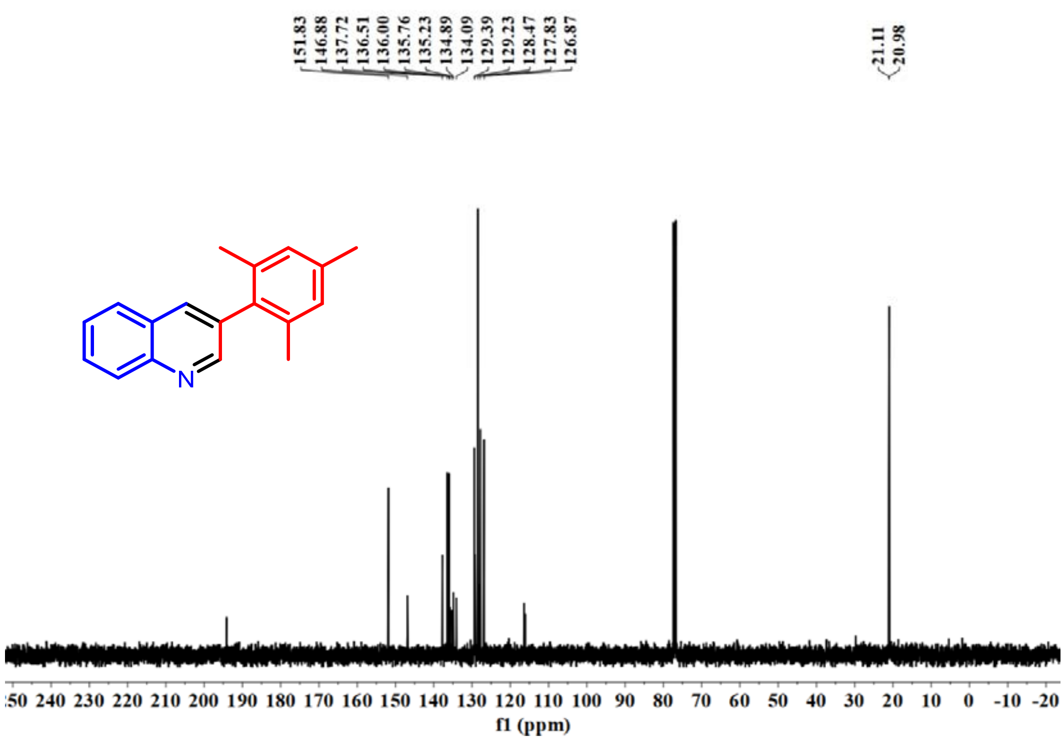



**Fig. S146** $^{13}C\{^1H\}$ NMR spectrum of **57** in $CDCl_3$ (101 MHz).

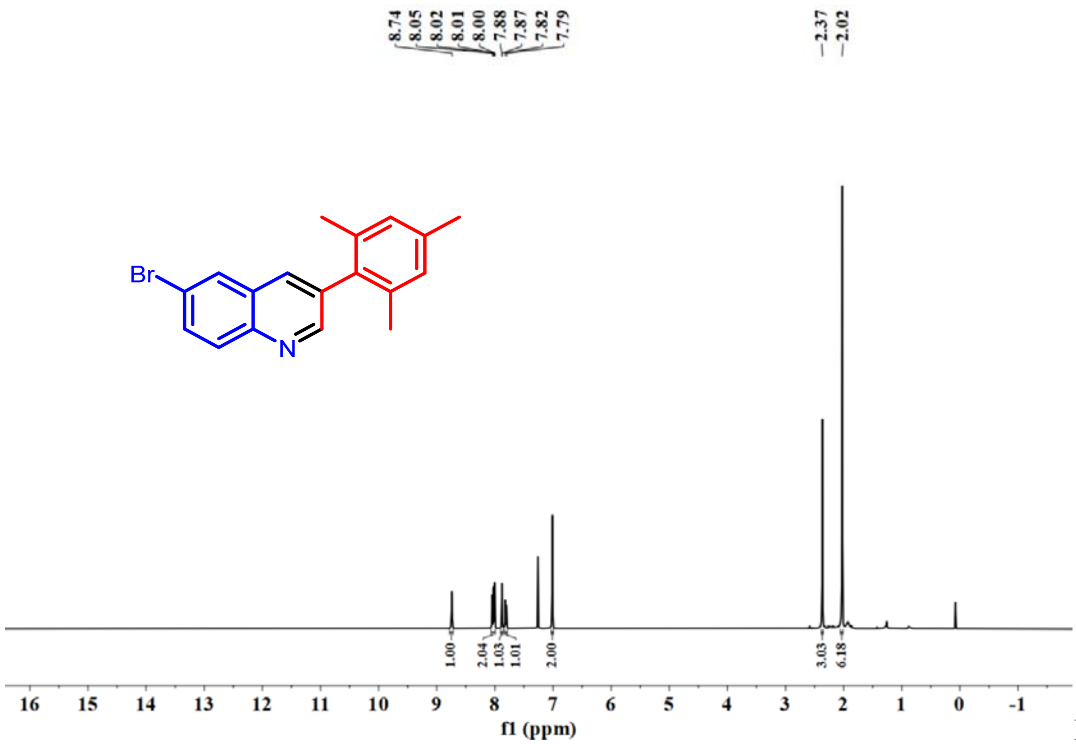



**Fig. S147** ¹H NMR spectrum of **58** in $CDCl_3$ (400 MHz).

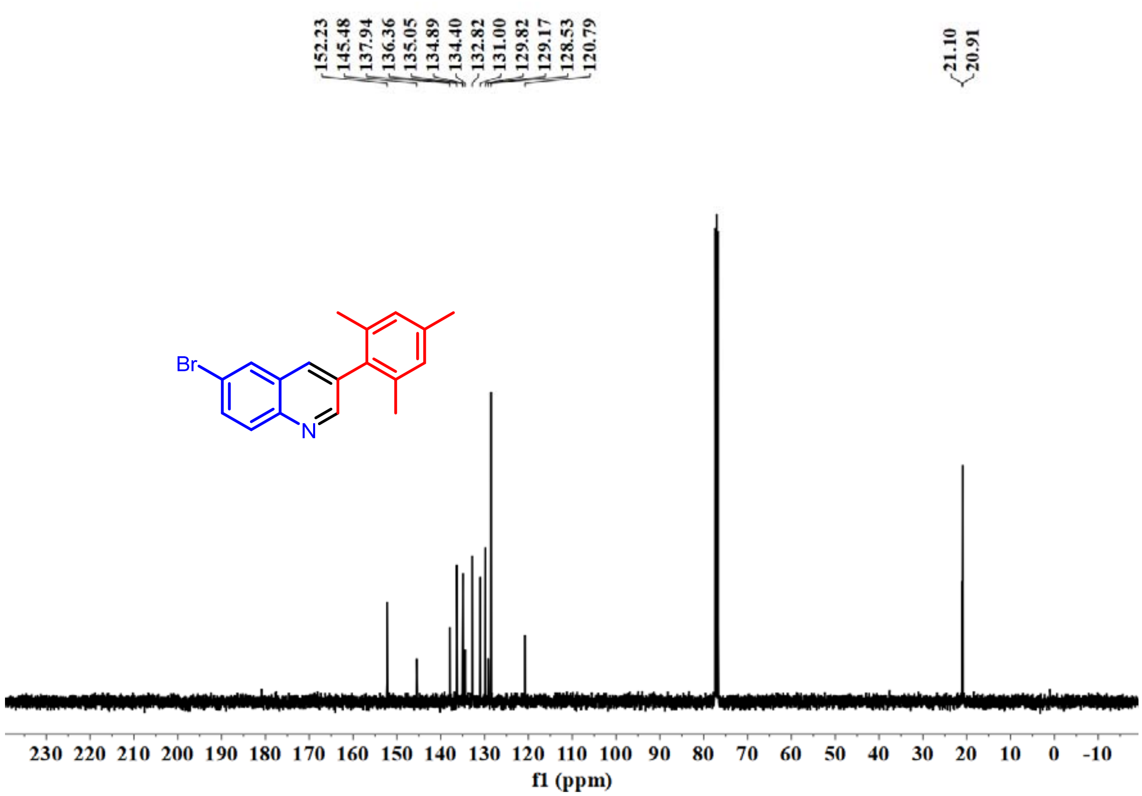



**Fig. S148** $^{13}C\{^1H\}$ NMR spectrum of **58** in $CDCl_3$ (101 MHz).

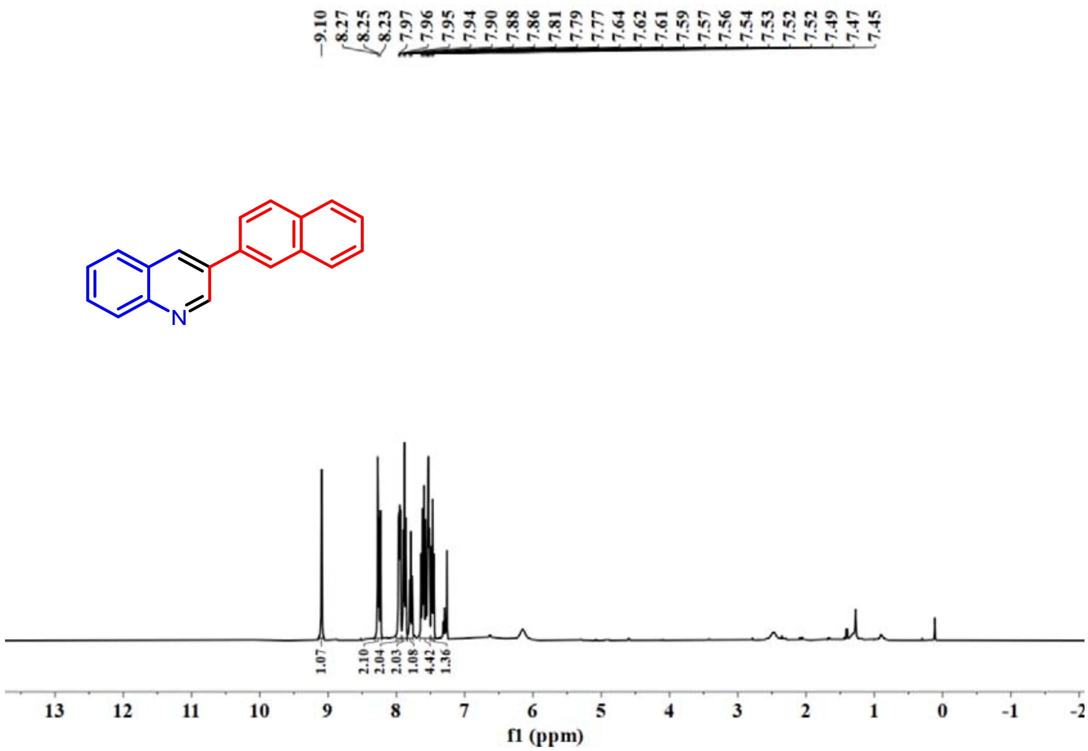


**Fig. S149** $^{1}H$ NMR spectrum of **59** in $CDCl_3$ (400 MHz).

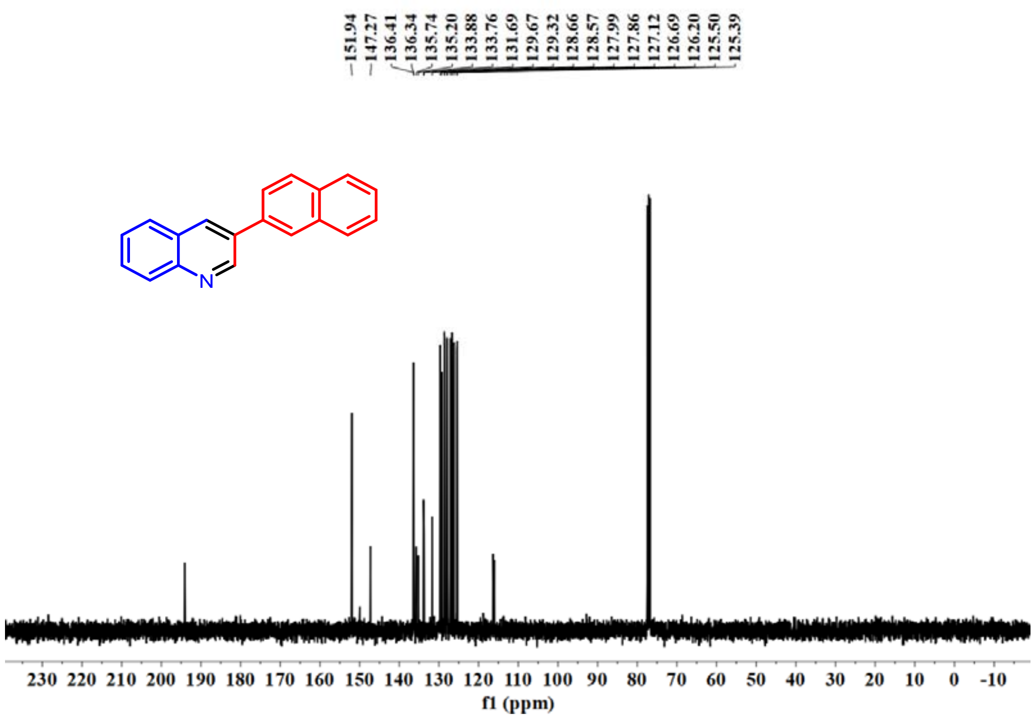


**Fig. S150** $^{13}C\{^{1}H\}$ NMR spectrum of **59** in $CDCl_3$ (101 MHz).

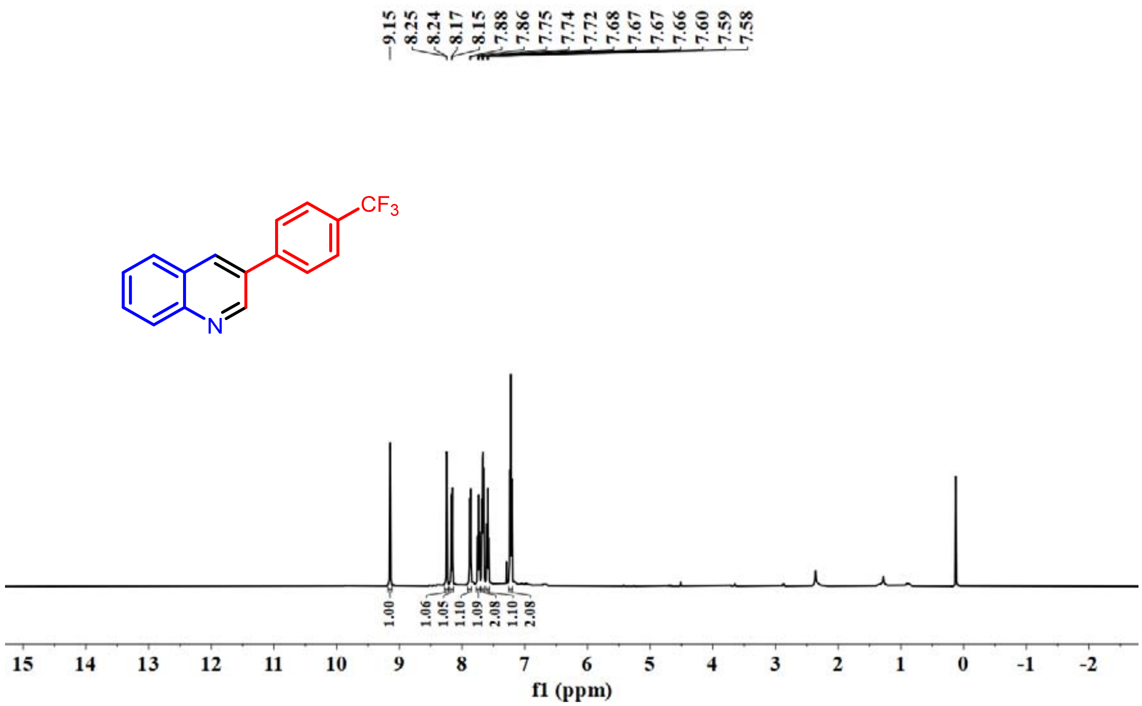



**Fig. S151** $^{1}H$ NMR spectrum of **60** in $CDCl_3$ (400 MHz).

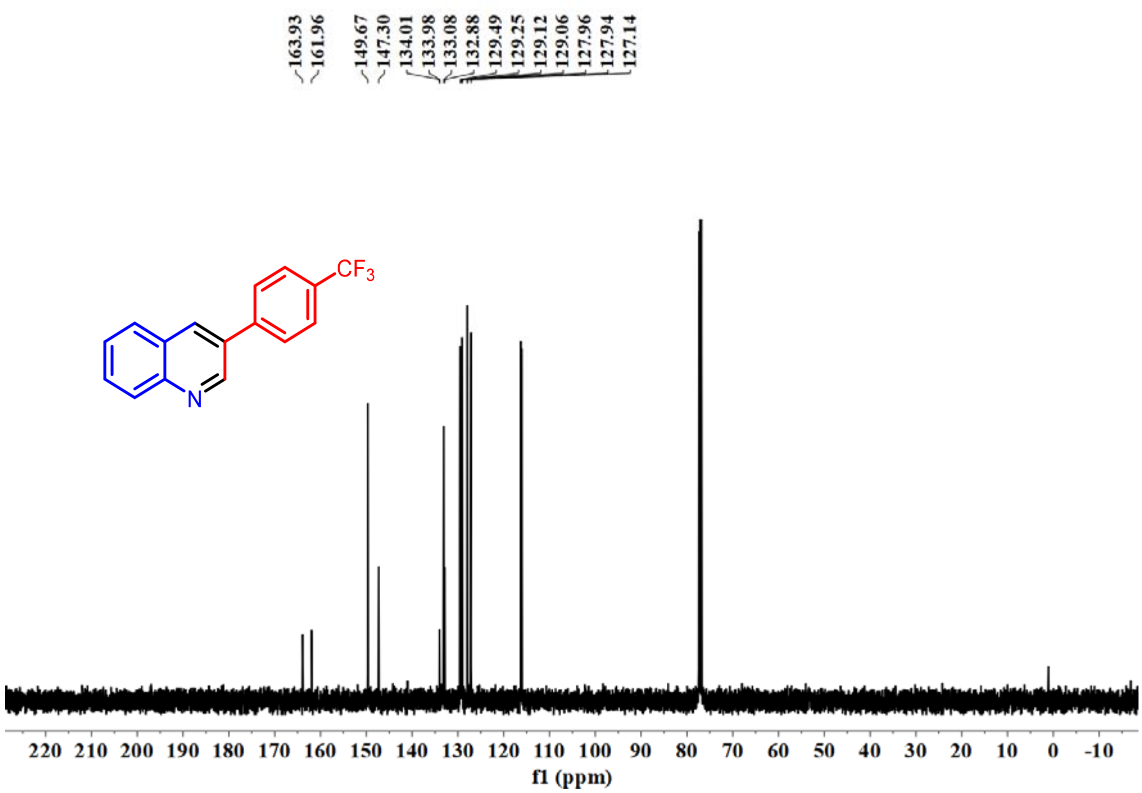



**Fig. S152** $^{13}C\{^{1}H\}$ NMR spectrum of **60** in $CDCl_3$ (101 MHz).

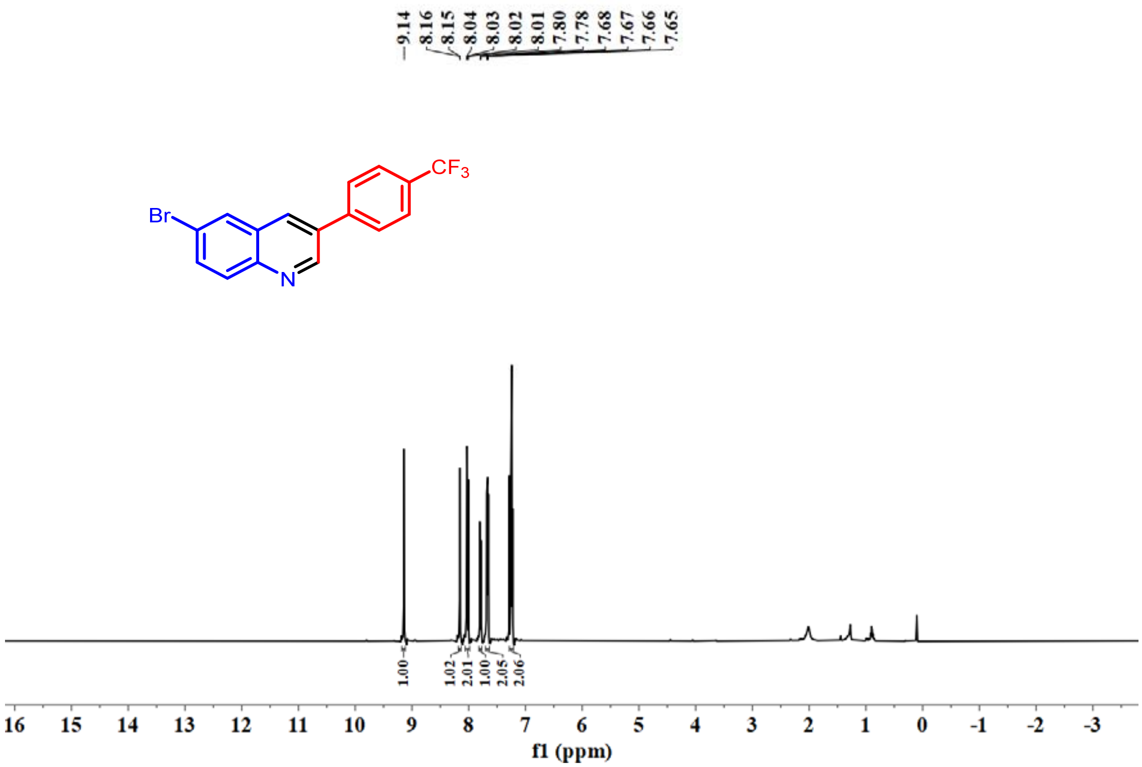


**Fig. S153** [1]H NMR spectrum of **61** in $CDCl_3$ (400 MHz).

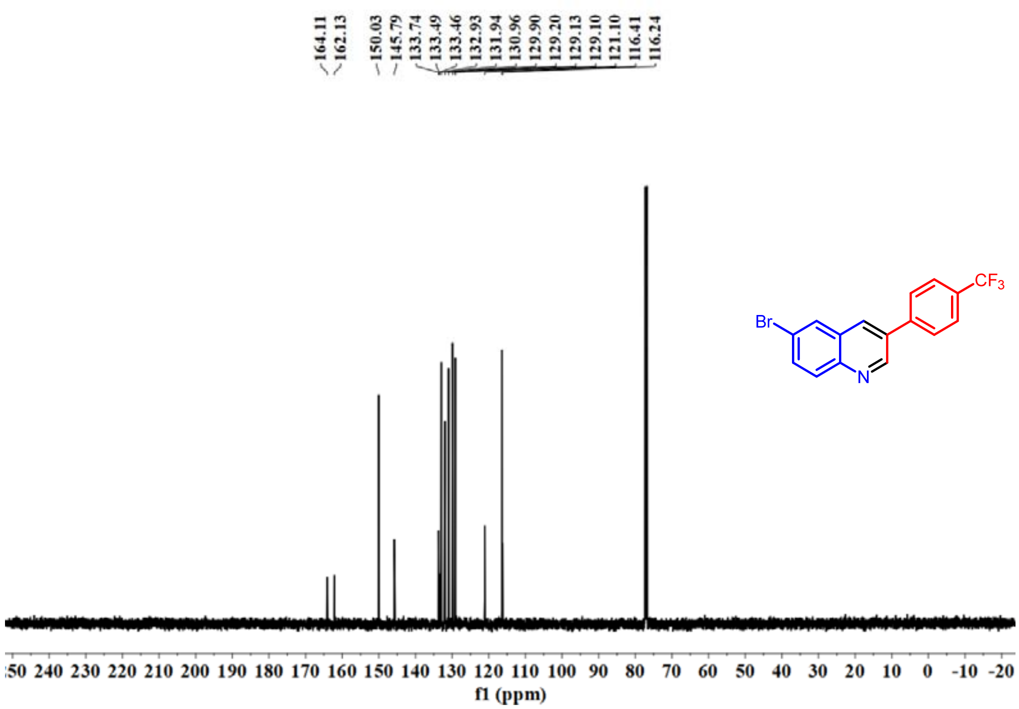
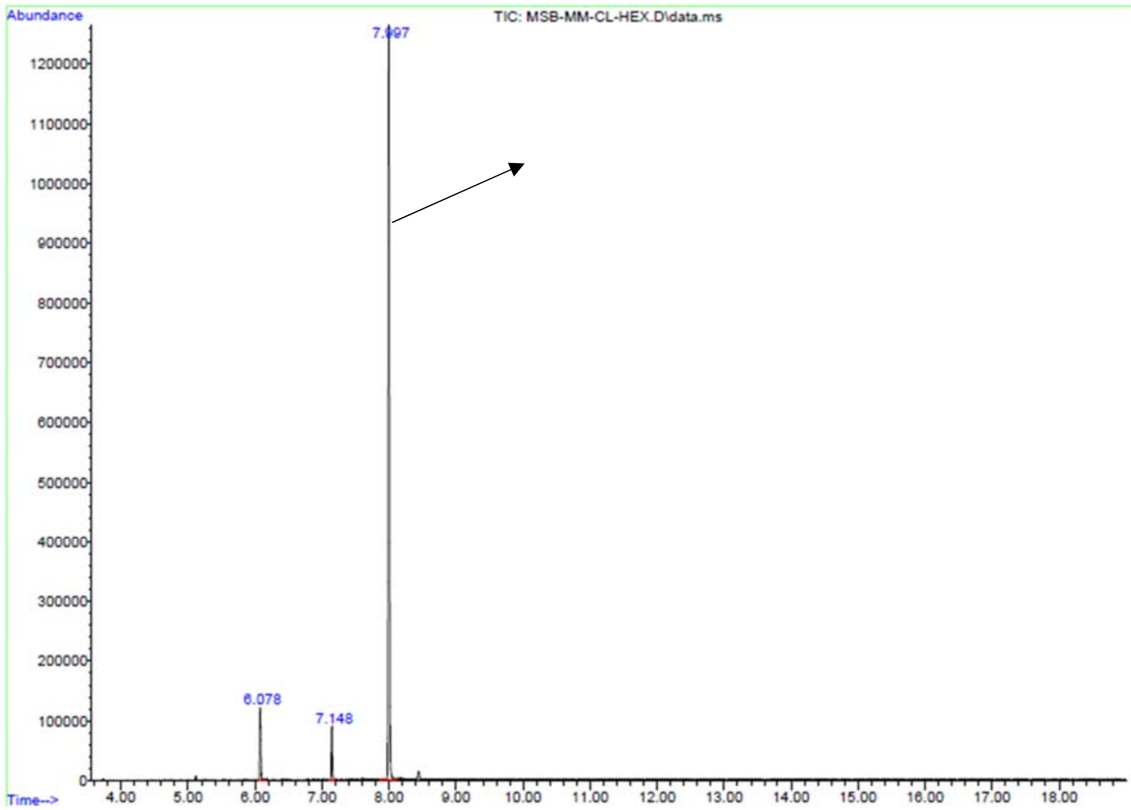


**Fig. S154** $^{13}C\{^1H\}$ NMR spectrum of **61** in $CDCl_3$ (101 MHz).




Area Percent Report

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Data Path : D:\GCMS DATA\2024\MAR2024\
Data File : MSB-MM-CL-HEX.D
Acq On    : 07 Mar 2024  12:46
Operator  : HA
Sample    : MSB-MM-CL-HEX
Misc      :
ALS Vial  : 1   Sample Multiplier: 1

Integration Parameters: autoint1.e
Integrator: ChemStation

Method    : D:\SRK\CF_29SEP2023.M
Title     :

Signal     : TIC: MSB-MM-CL-HEX.D\data.ms
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| peak # | R.T. min | first scan | max scan | last scan | PK TY | peak height | corr. area | corr. % max. | % of total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.078 | 439 | 444 | 458 | BV | 119016 | 1330705 | 9.39% | 8.063% |
| 2 | 7.148 | 623 | 631 | 639 | BV | 88994 | 997655 | 7.04% | 6.045% |
| 3 | 7.997 | 756 | 779 | 797 | BV | 1182811 | 14175591 | 100.00% | 85.892% |

**Fig. S155** GC-MS spectra of compound **62**.

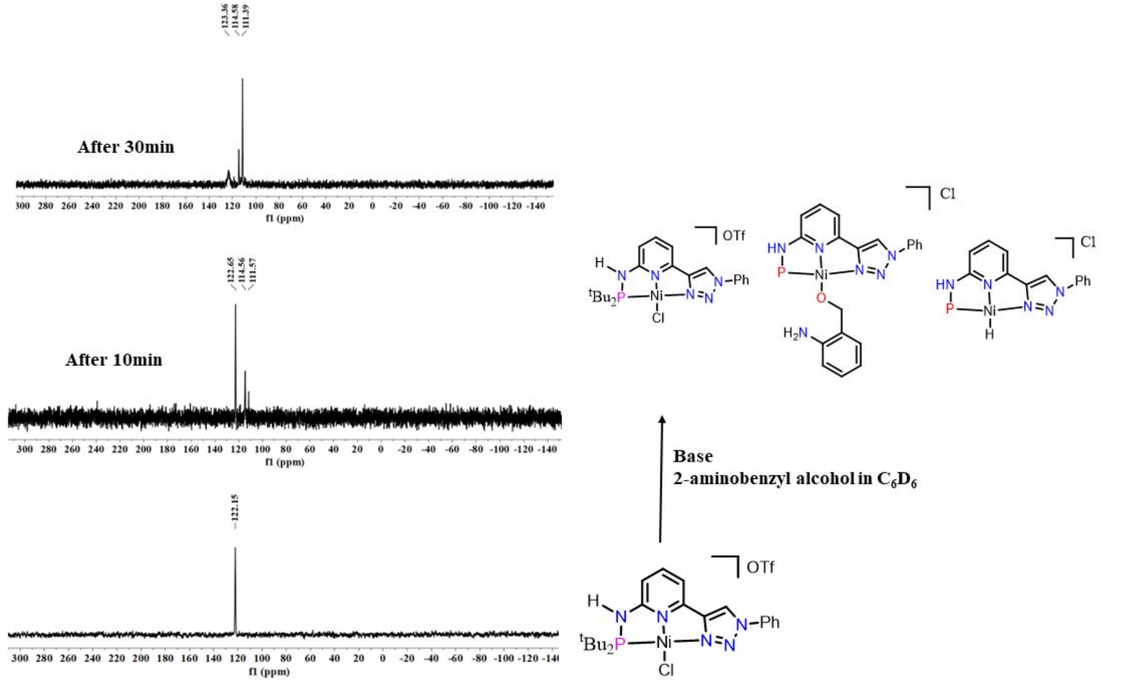


**Fig. S156** $^{31}P\{^1H\}$ NMR spectrum of reaction mixture at variable time in $C_6D_6$ (101 MHz).

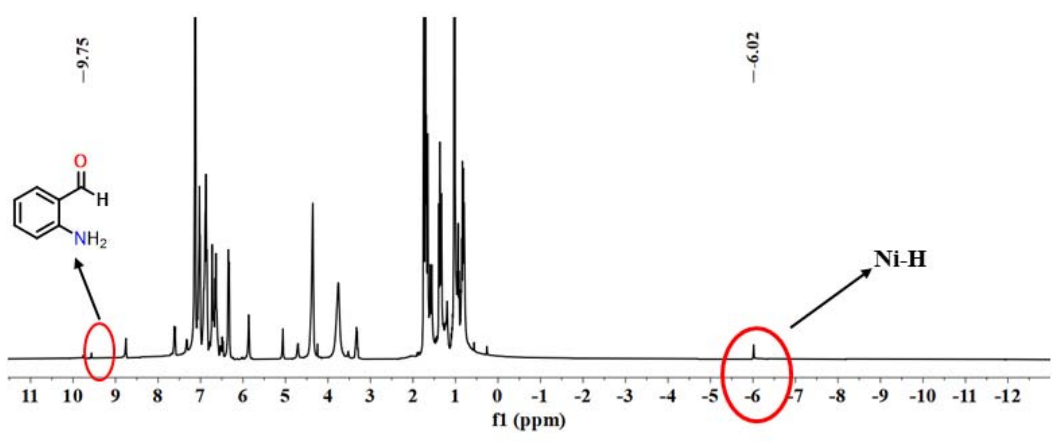


**Fig. S157** $^1H$ NMR spectrum of **r**eaction mixture in $C_6D_6$ (400 MHz).

**References:**


1. Z. Li, C. Brouwer and C. He, *Chem. Rev.*, 2008, **108**, 3239-3265.
2. O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Cryst.*, 2009, **42**, 339-341.
3. G. Sheldrick, *Acta Crystallographica Section A*, 2015, **71**, 3-8.