Electronic Supplementary Material (ESI) for New Journal of Chemistry.


# Fe-MIL-101 modified by isatin-Schiff-base-Co: A heterogeneous catalyst for the C-C, C-O, C-N, and C-P cross coupling reactions

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## General information

FT-IR spectra were recorded by a JASCO FT-IR 460 plus spectrophotometer with a 400-4000 $cm^{-1}$ range using neat or KBr dispersed samples at room temperature. Thermogravimetric analysis (TGA) was performed using a Shimadzu thermogravimetric analyzer (TG-50) submitting the samples to a heating rate of 10 °C.$min^{-1}$ under atmospheric air. The surface area, pore volume and pore size distribution of the support and the catalyst were determined by $N_2$ adsorption desorption using BELSORP mini II instrument. TEM analyses was performed with a TEM microscope (Philips CM30). The $^1H$ NMR spectra were recorded in a Brucker Advance 300 and 400 MHz spectrometers using $CDCl_3$ and DMSO-$d_6$ and solvents containing tetramethylsilane as the internal standard. The coupling constants are given in Hz.

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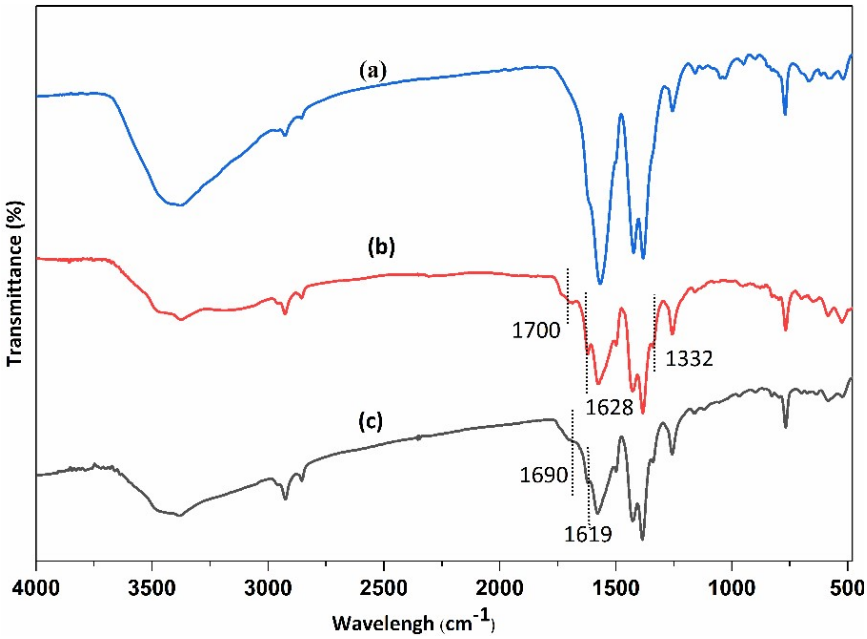



**Figure S1**. FT-IR spectra of (a) Fe-MIL-101-$NH_2$, (b) Fe-MIL-101-isatin-Schiff base and (c) Fe-MIL-101-isatin-Schiff-base-Co.

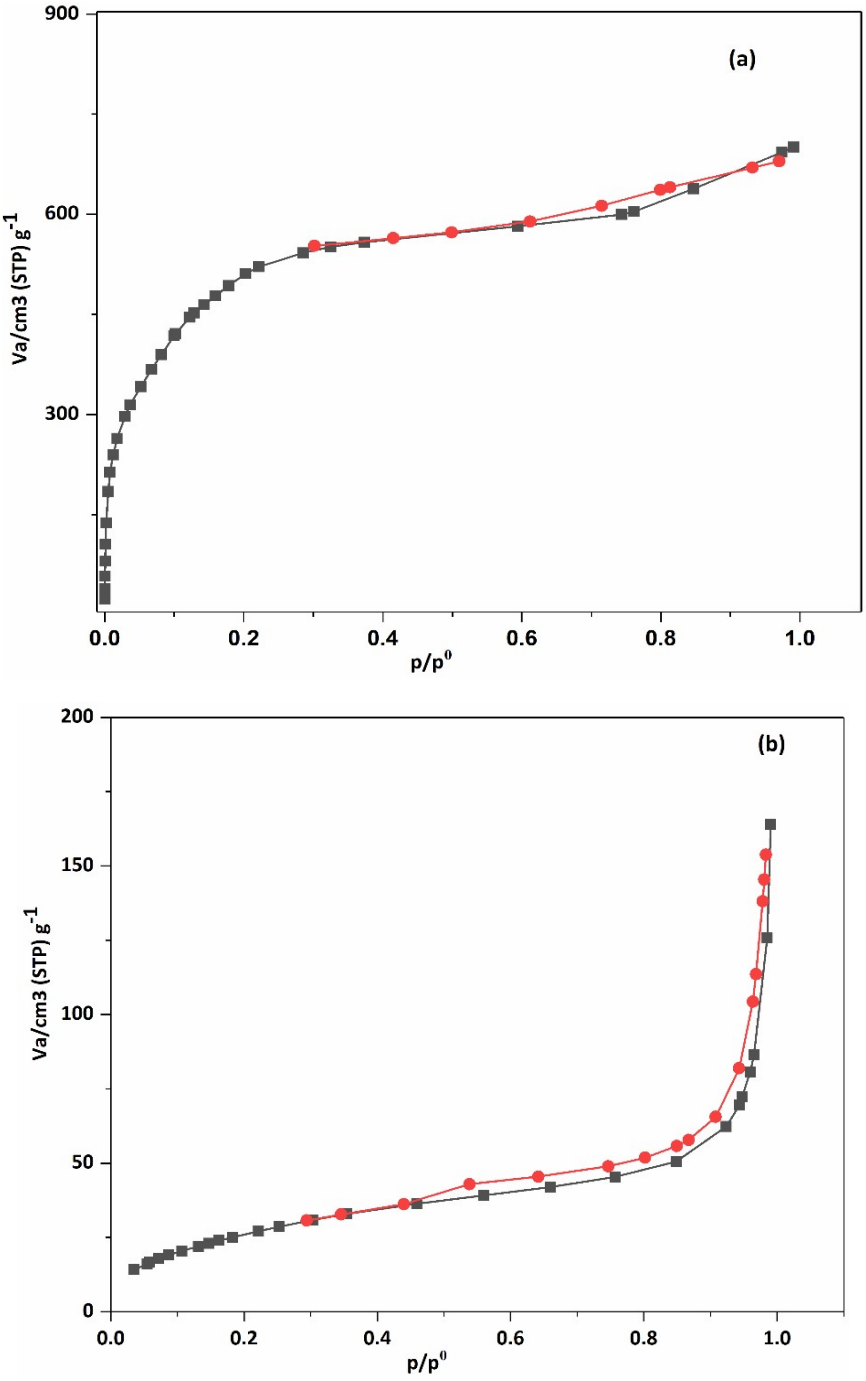



**Figure S2**. $N_2$ adsorption-desorption of (a) Fe-MIL-101-$NH_2$ and (b) Fe-MIL-101-isatin-Schiff-base-Co

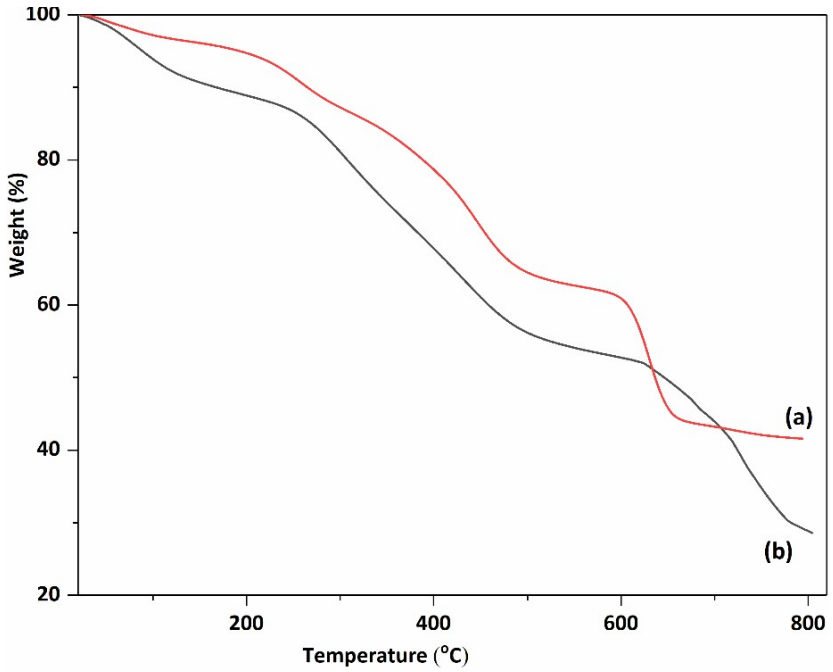



**Figure S3.** TGA curves of (a) Fe-MIL-101-$NH_2$ and (b) Fe-MIL-101-isatin-Schiff-base-Co.

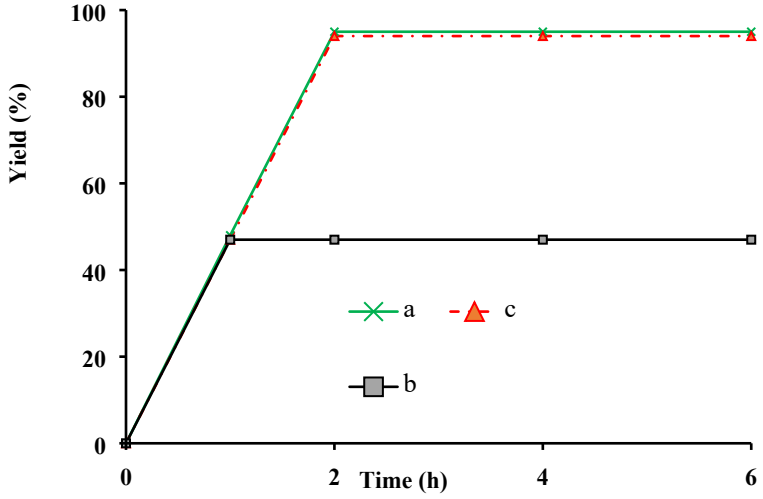



**Figure S4.** Ullmann-type reaction between iodobenzene and phenol using Fe-MIL-101-isatin-Schiff-base-Co as catalyst in DMF: (a) normal reaction, (b) using a hot filtration protocol and (c) employing a poison for the catalyst.

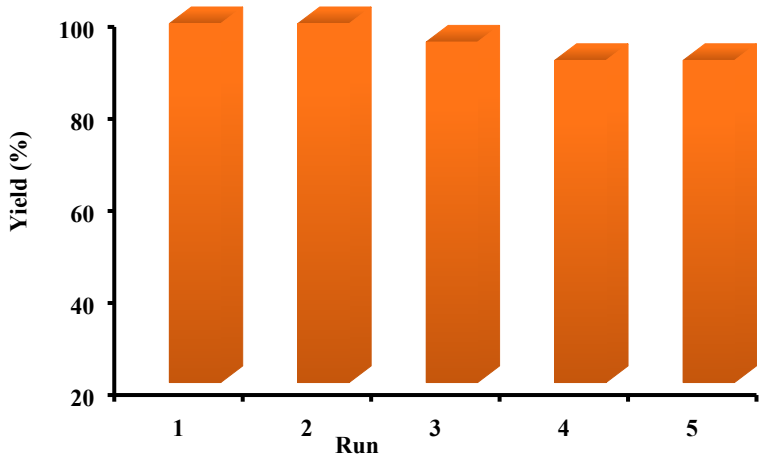
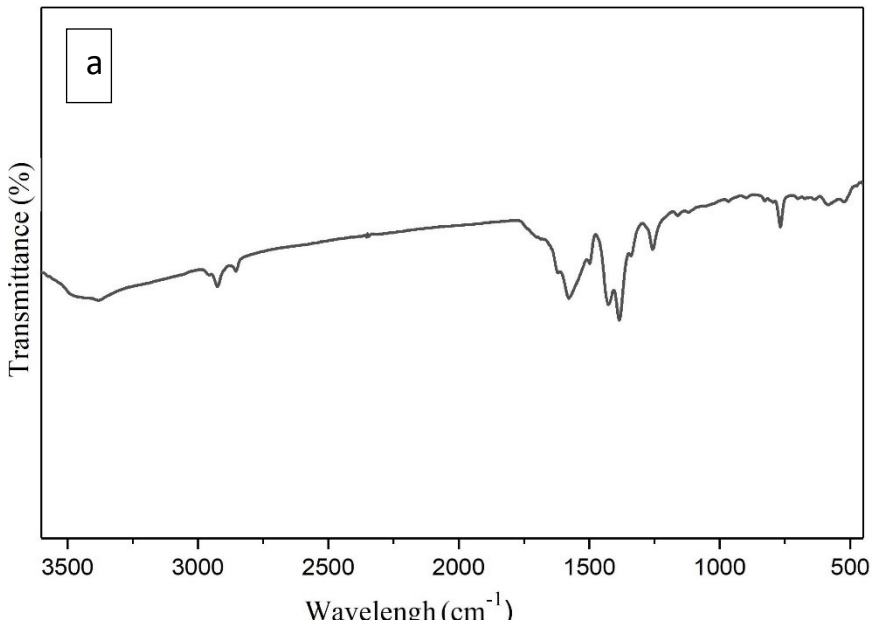



**Figure S5.** Reusability of the Fe-MIL-101-isatin-Schiff-base-Co during the Ullmann-type coupling reaction of iodobenzene with phenol in 4 h.



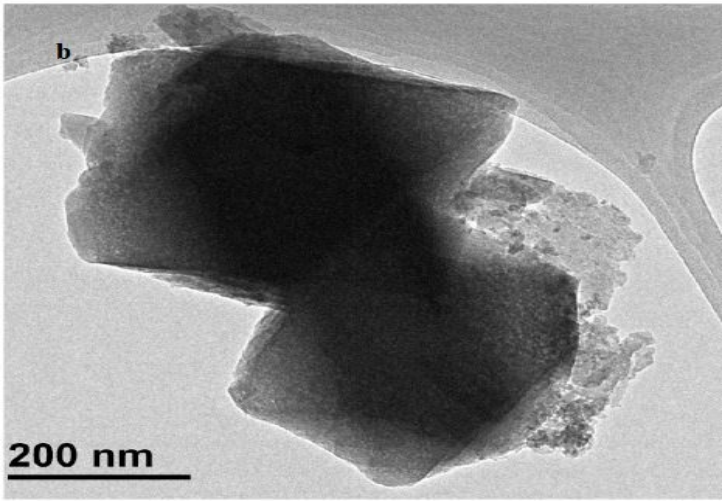




**Figure S6.** (a) FT-IR and (b) TEM image of the Fe-MIL-101-isatin-Schiff-base-Co after five times reuse in the Ullmann-type coupling reaction of iodobenzene with phenol in 4 h.

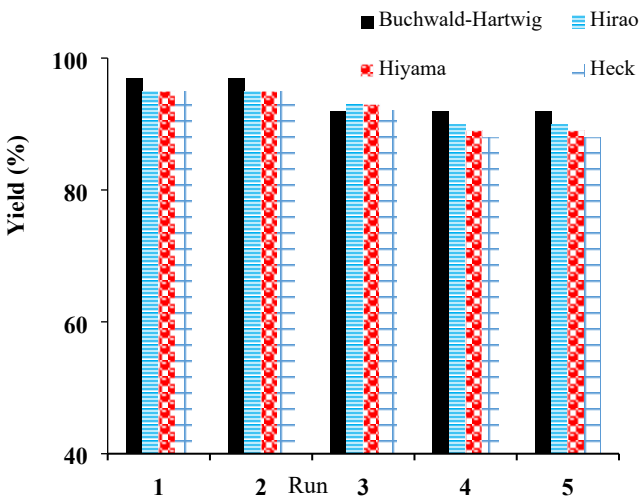



**Figure S7.** Reusability of the Fe-MIL-101-isatin-Schiff-base-Co in Buchwald-Hartwig (4.5 h), Hirao (6 h), Hiyama (1 h) and Mizoroki-Heck (2 h) reactions.

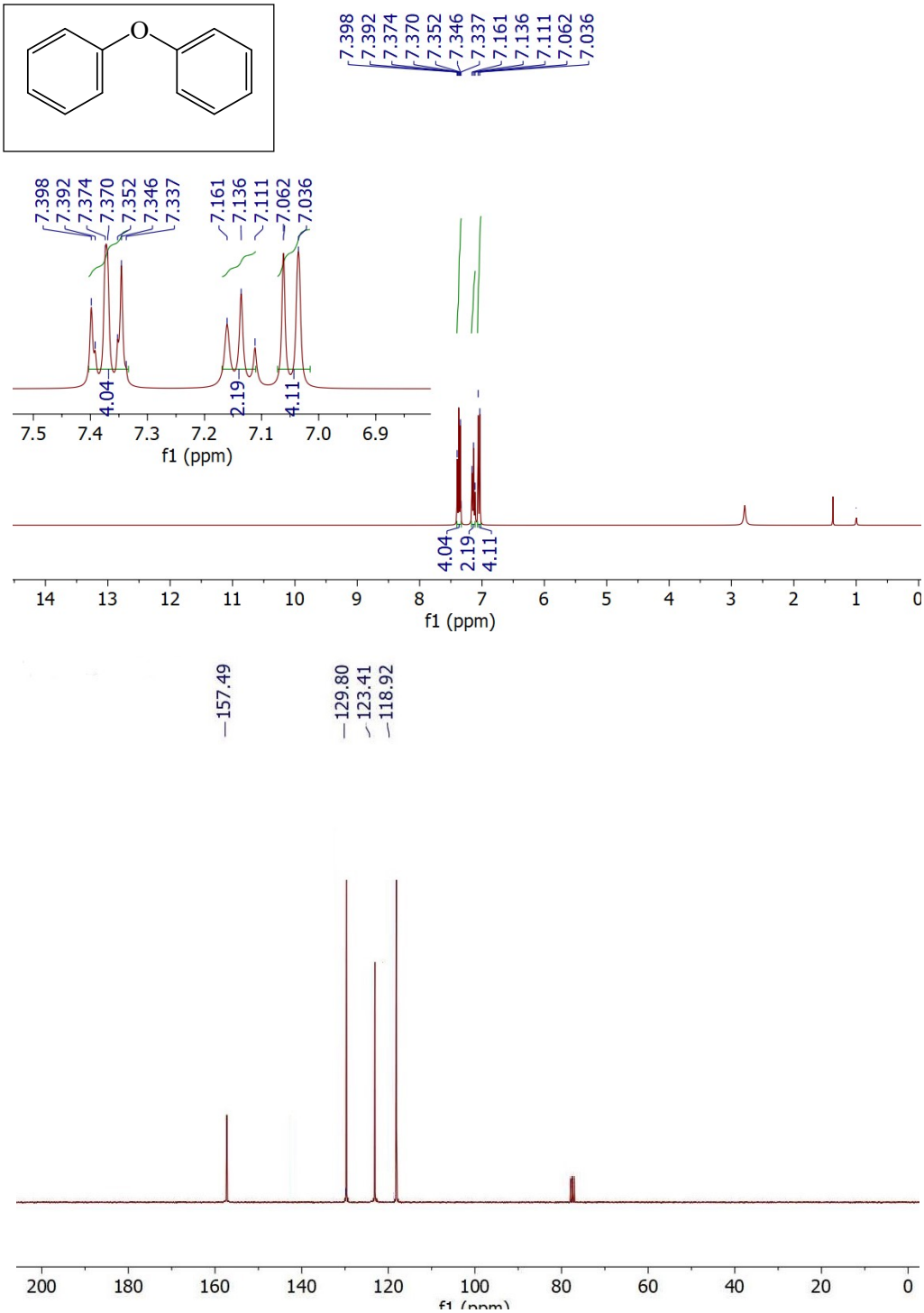



**Figure S8.** $^{1}$H NMR and $^{13}$C NMR spectra of oxydibenzene

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.34-7.39 (m, 4 H), 7.13 (t, 2 H, $J$ = 7.2 Hz), 7.04 (d, 4 H, $J$ = 7.8 Hz) ppm, $^{13}$C NMR (75 MHz, $CDCl_3$), δ 157.4, 129.8, 123.4, 118.9 ppm (Table 1, entries 1, 3, 8 and 12).

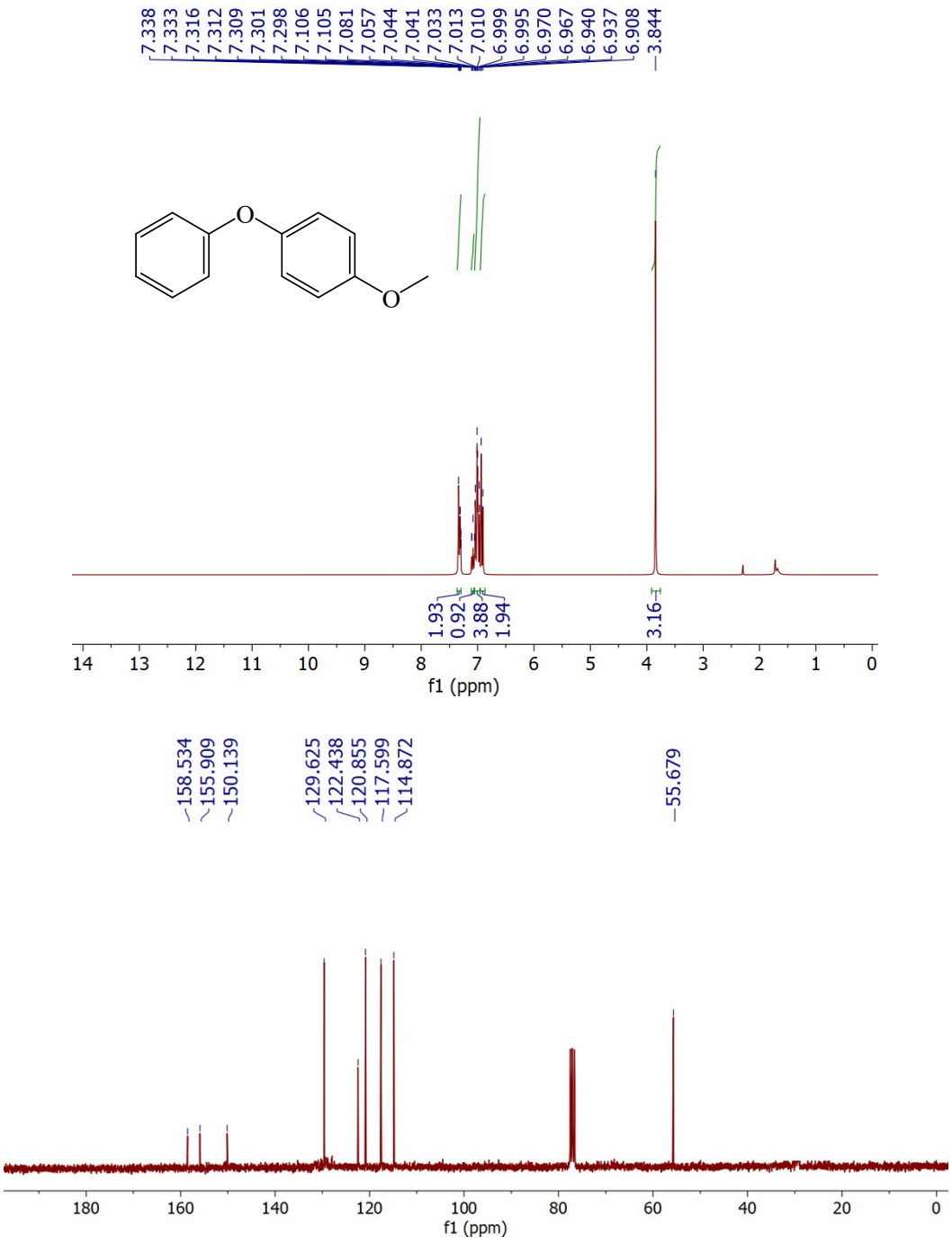



**Figure S9.** $^{1}$H NMR and $^{13}$C NMR spectra of 1-methoxy-4-phenoxybenzene

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.29-7.33 (m, 2 H), 7.04-7.10 (m, 1 H), 6.90-6.94 (m, 2 H), 6.96-7.01 (m, 4 H), 3.84 (s, 3 H) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 158.4, 155.9, 150.1, 129.6, 122.4, 120.8, 117.5, 114.8, 55.6 ppm (Table 1, entries 2 and 4).

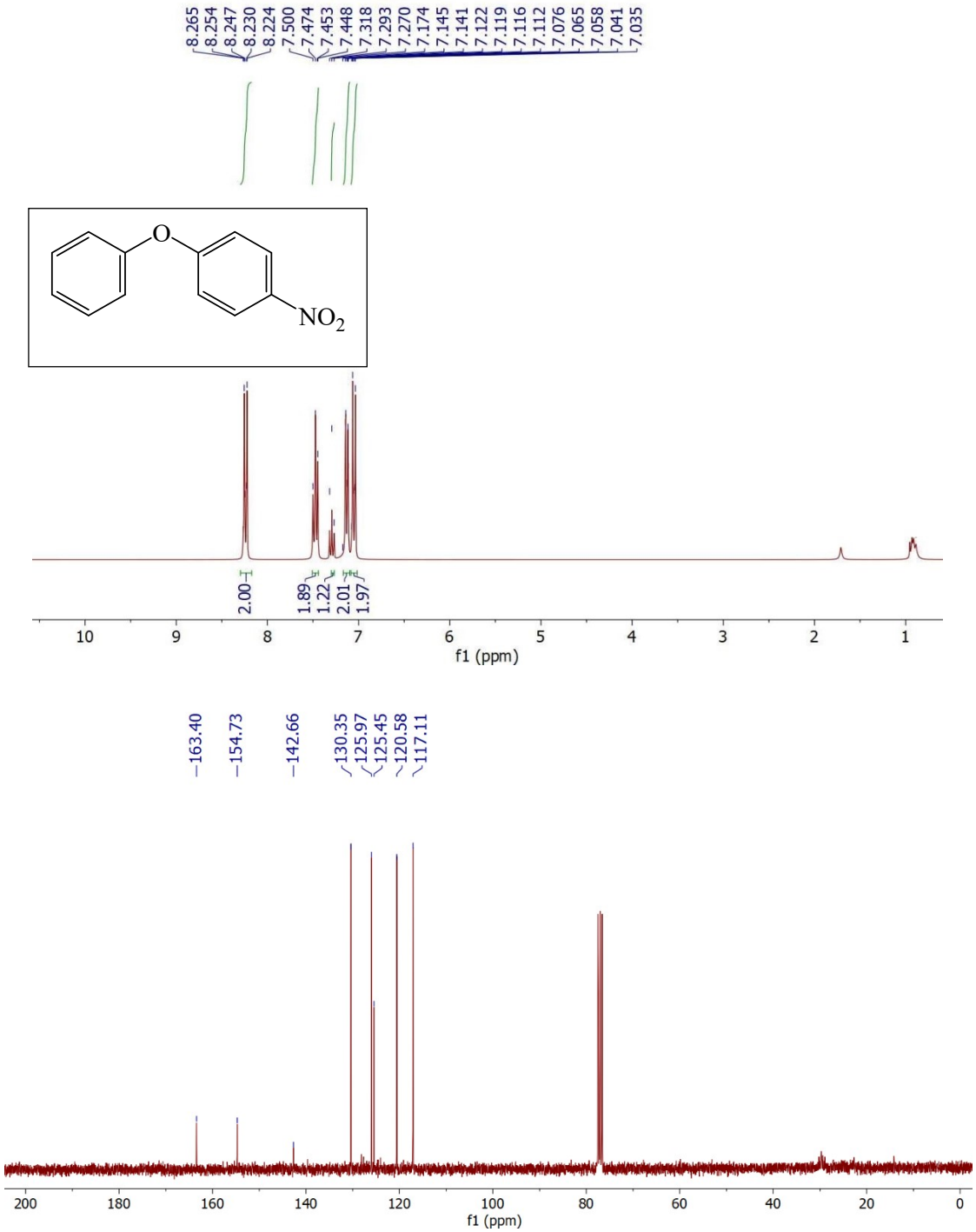



**Figure S10.** $^{1}$H NMR and $^{13}$C NMR spectra of 1-nitro-4-phenoxybenzene

$^{1}$H NMR ($CDCl_3$, 300 MHz,): δ 8.23 (d, 2 H, $J$ = 9 Hz), 7.47 (t, 2 H, $J$ = 7 .8 Hz), 7.29 (t, 1 H, $J$ = 7.5 Hz), 7.13 (d, 2 H, $J$ = 7.5 Hz), 7.05 (d, 2 H, $J$ = 9 Hz) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 163.4, 154.7, 142.6, 130.3, 125.9, 125.4, 120.5, 117.1 ppm (Table 1, entries 5 and 9).

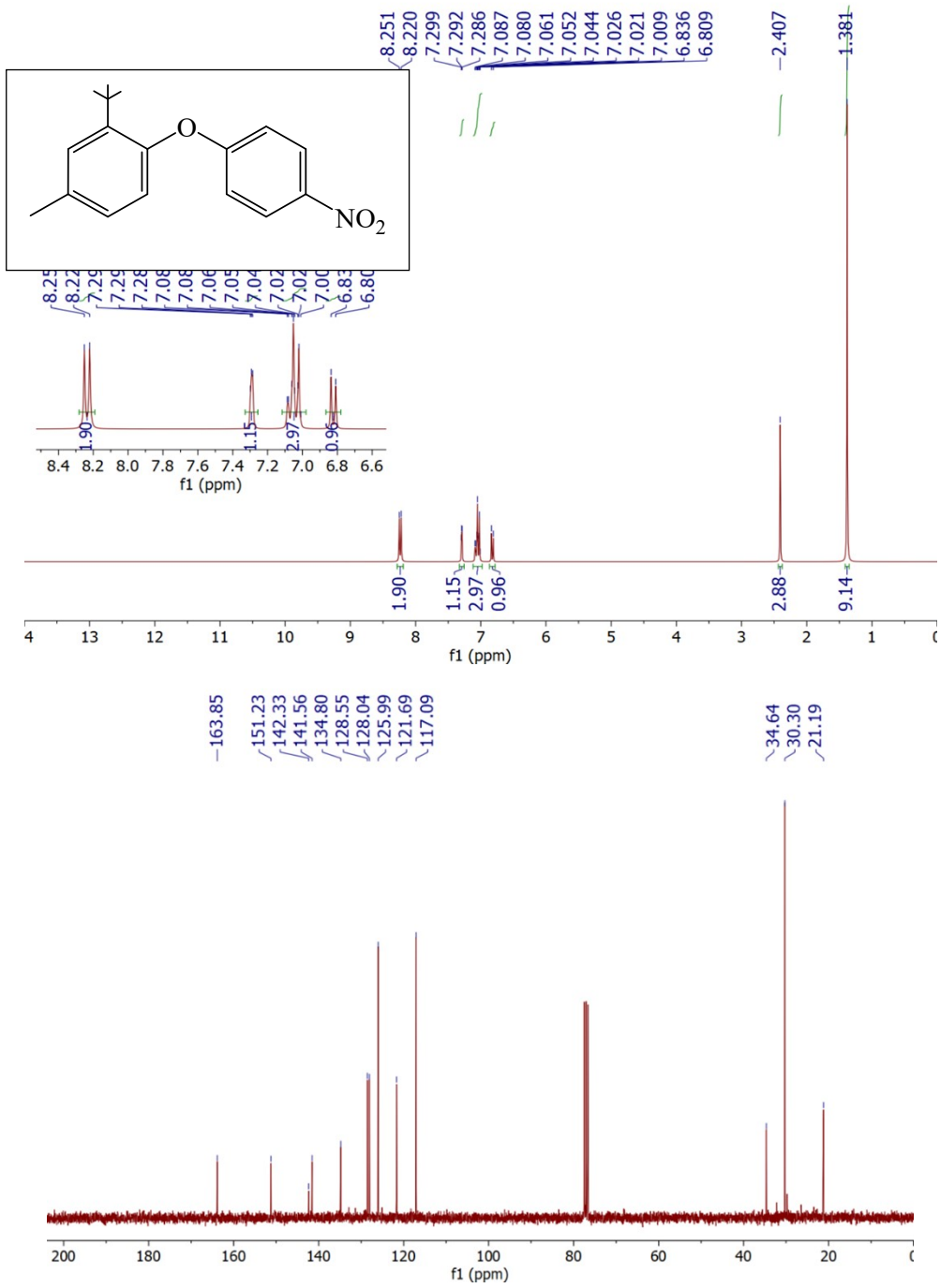



**Figure S11.** $^{1}$H NMR and $^{13}$C NMR spectra of 2-(*tert*-butyl)-4-methyl-1-(4-nitrophenoxy) benzene

$^{1}$H NMR ($CDCl_3$, 300 MHz,): δ 8.24 (d, 2 H, *J* = 9.3 Hz), 7.28-7.29 (m, 1 H), 7.02-708 (m, 3 H), 6.82 (d, 1 H, *J* = 7.5 Hz), 2.40 (s, 3 H,), 1.38 (s, 9 H) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 163.8, 151.2, 142.3, 141.5, 134.8, 128.5, 128.0, 125.9, 121.6, 117.0, 34.6, 30.3, 21.1 ppm (Table 1, entries 7 and 11).

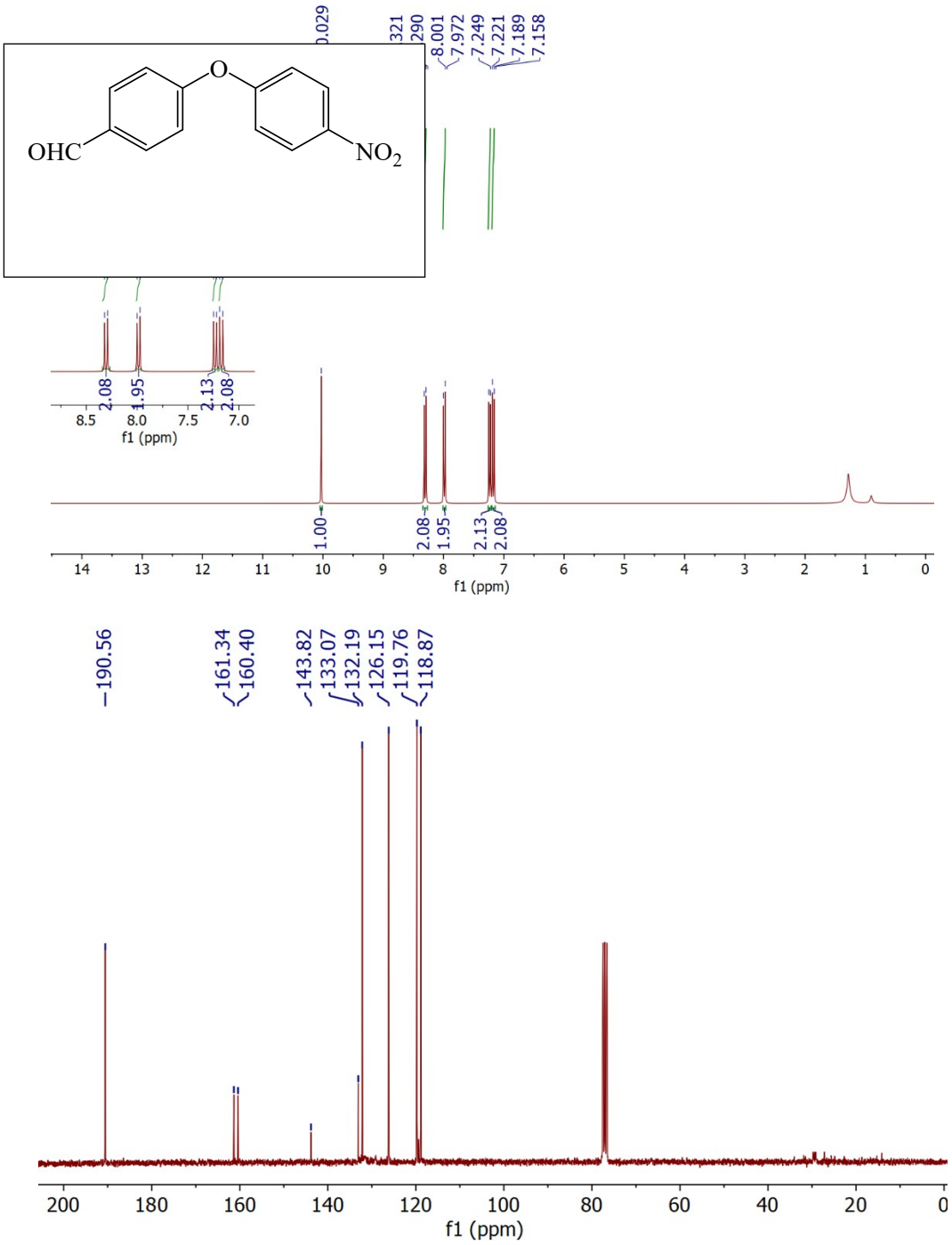



**Figure S12.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-(4-nitrophenoxy) benzaldehyde

$^{1}$H NMR ($CDCl_3$, 300 MHz): δ 10.02 (s, 1 H), 8.30 (d, 2 H, $J$ = 9.3 Hz), 7.90 (d, 2 H, $J$ = 8.7 Hz), 7.23 (d, 2 H, $J$ = 8.4 Hz), 7.17 (d, 2 H, $J$ = 9.3 Hz) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 190.5, 161.3, 160.4, 143.8, 133.0, 132.1, 126.1, 119.7, 118.8 ppm (Table 1, entries 6 and 10).

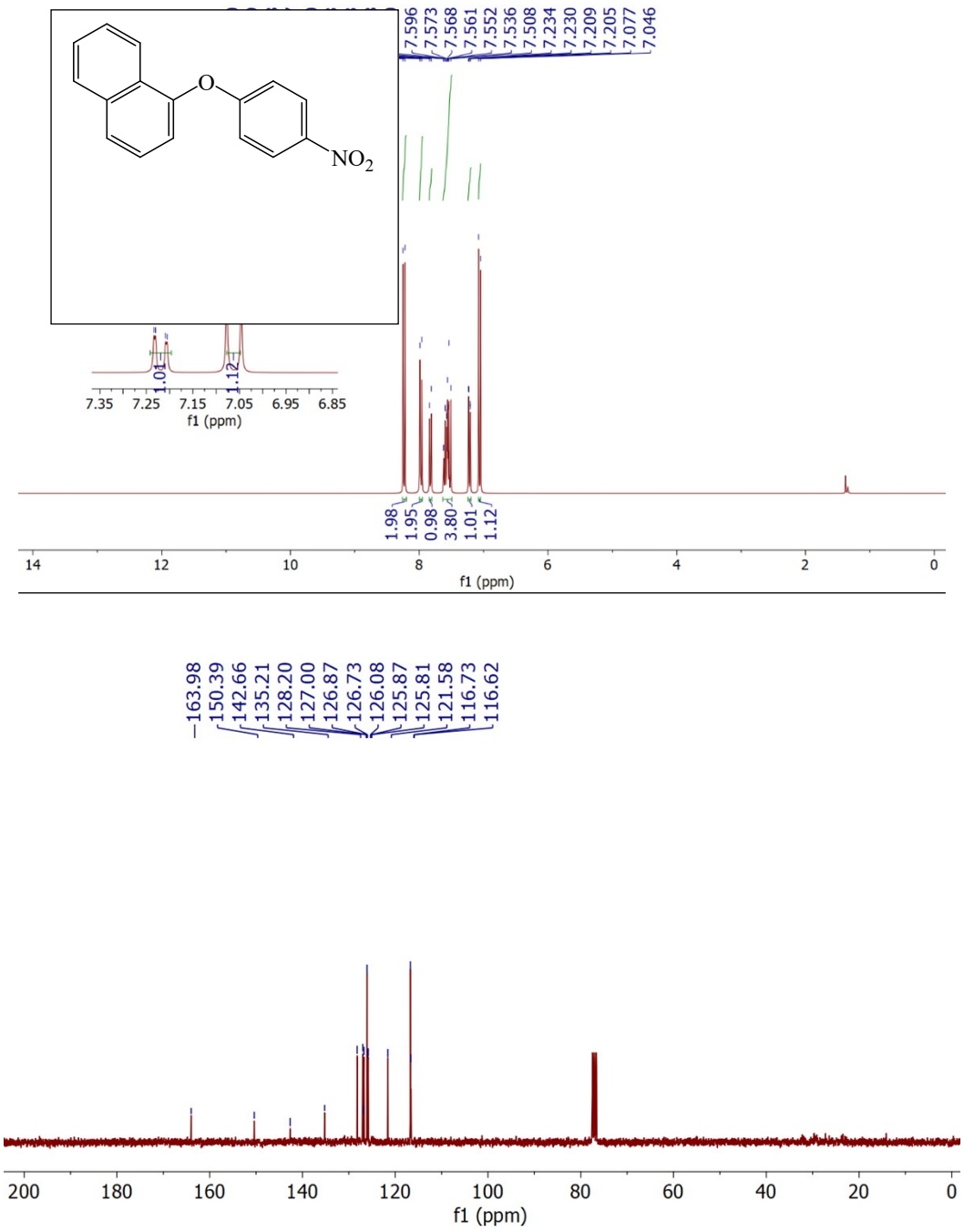



**Figure S13.** $^{1}$H NMR and $^{13}$C NMR spectra of 1-(4-nitrophenoxy) naphthalene

$^{1}$H NMR ($CDCl_3$, 300 MHz): δ 8.24 (d, 2 H, $J$ = 9.3 Hz), 7.90 (d, 2 H, $J$ = 9.3 Hz), 7.82 (d, 1 H, $J$ = 8.1 Hz), 7.20-7.60 (m, 5 H), 7.06 (d, 1 H, $J$ = 9.3 Hz) ppm, $^{13}$C NMR (75 MHz, $CDCl_3$), δ 163.98, 150.39, 142.66, 135.2, 128.2, 127.0, 126.8, 126.7, 126.0, 125.8, 125.8, 121.5, 116.7, 116.6 ppm (Scheme 3).

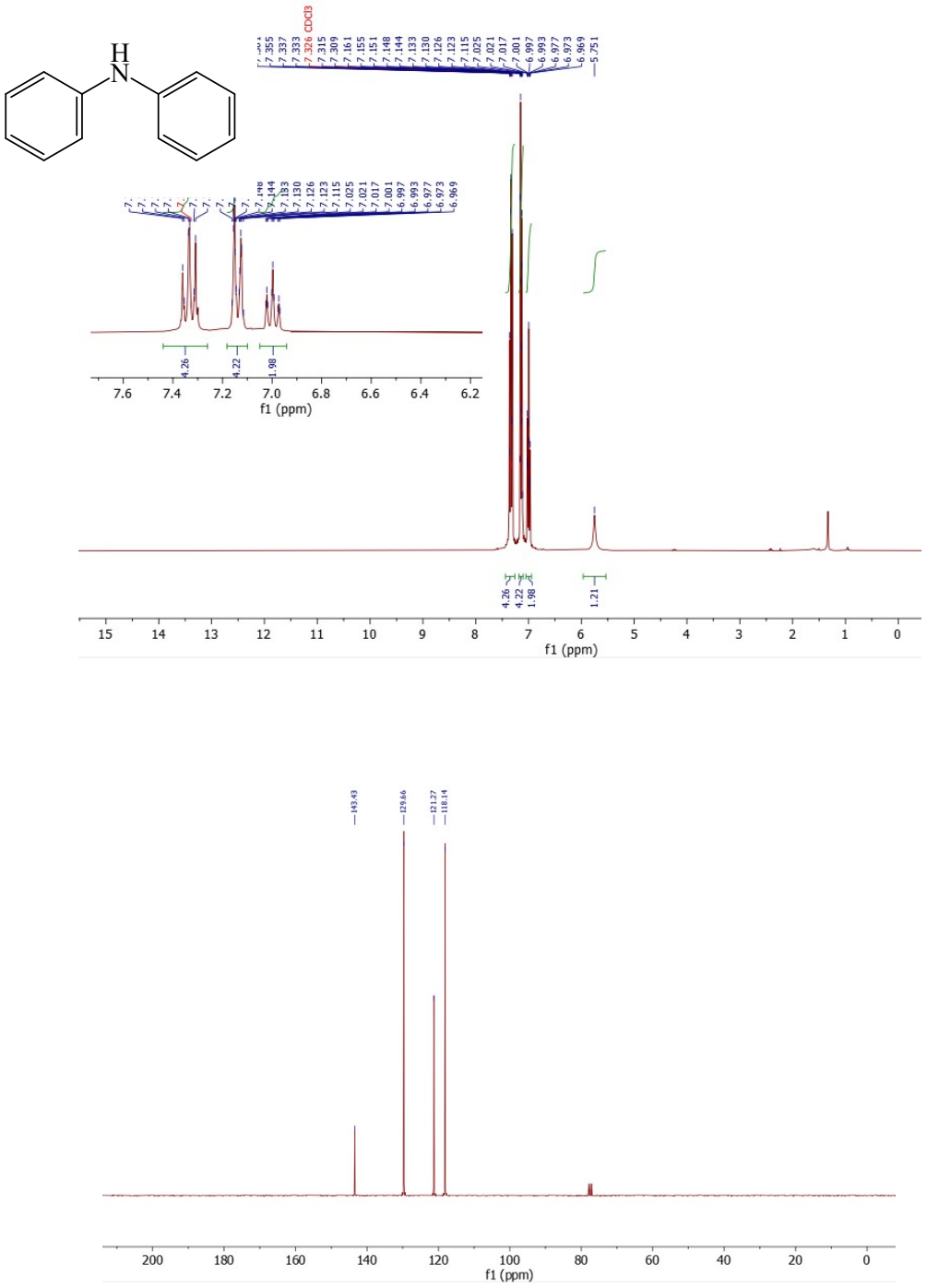


**Figure S14.** $^{1}$H NMR and $^{13}$C NMR spectra of diphenylamine

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.33 (t, 4 H, $J$ = 9.6 Hz), 7.15 (d, 4 H, $J$ = 10 Hz), 6.99 (d, 2 H, $J$ = 9.6 Hz), 5.75 (s, 1 H), ppm, $^{13}$C NMR (75 MHz, $CDCl_3$), δ 143.4, 129.6, 121.2, 118.1 ppm (Table 2, entries 1, 5, 9 and 12).

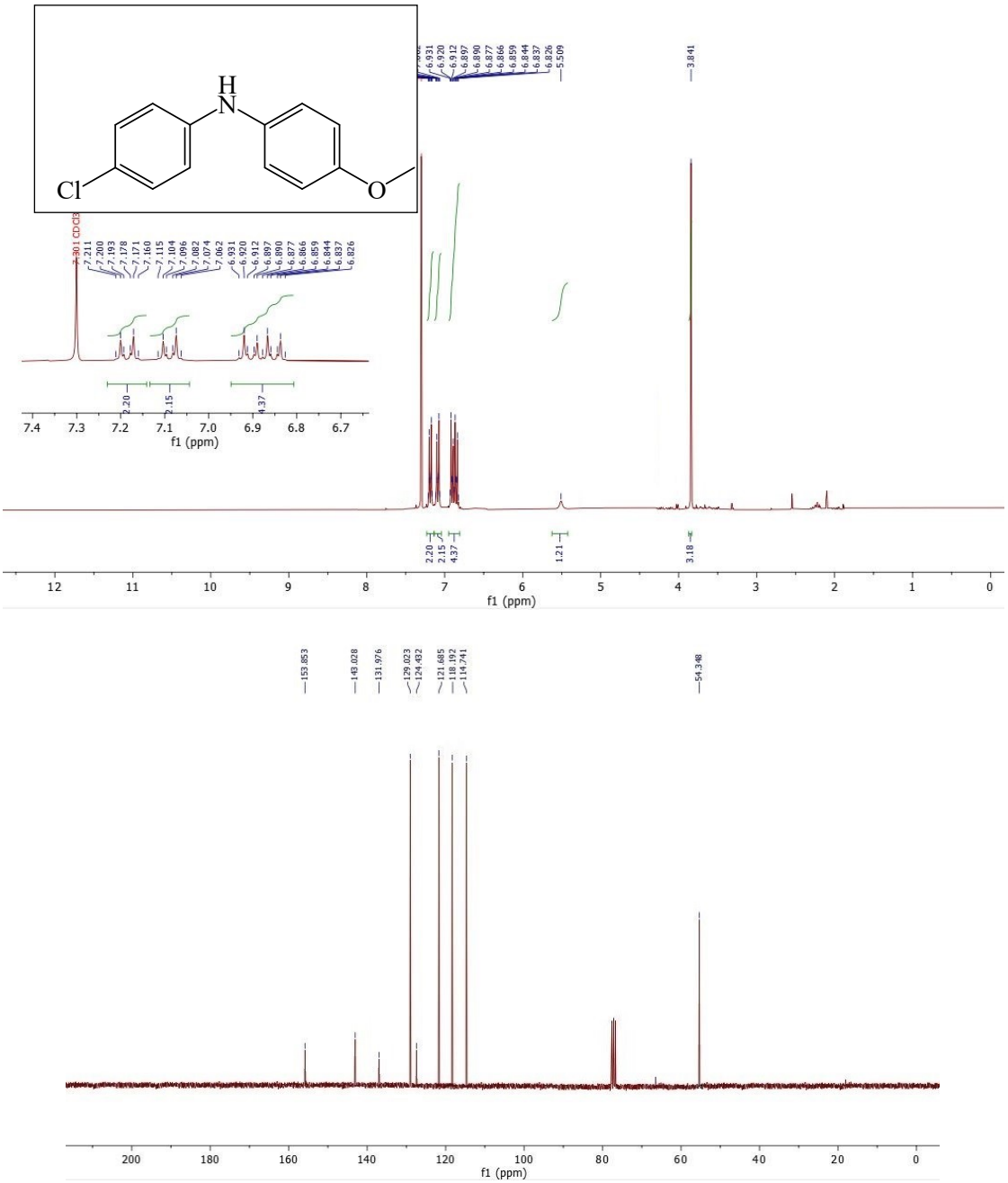



**Figure S15.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-chloro-N-(4-methoxyphenyl) aniline

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.20 (d, 2 H, $J$ = 11.6 Hz), 7.11 (d, 2 H, $J$ = 12 Hz), 6.82-6.93 (dd, 4 H, $J$ = 12 Hz, $J$ = 11.6 Hz), 5.50 (s, 1 H), 3.84 (s, 3 H) ppm, $^{13}$C NMR (75 MHz, $CDCl_3$), δ 153.8, 143.0, 131.9, 129.0, 124.4, 121.6, 118.1, 114.7, 54.3 ppm (Table 2, entries 2 and 6).

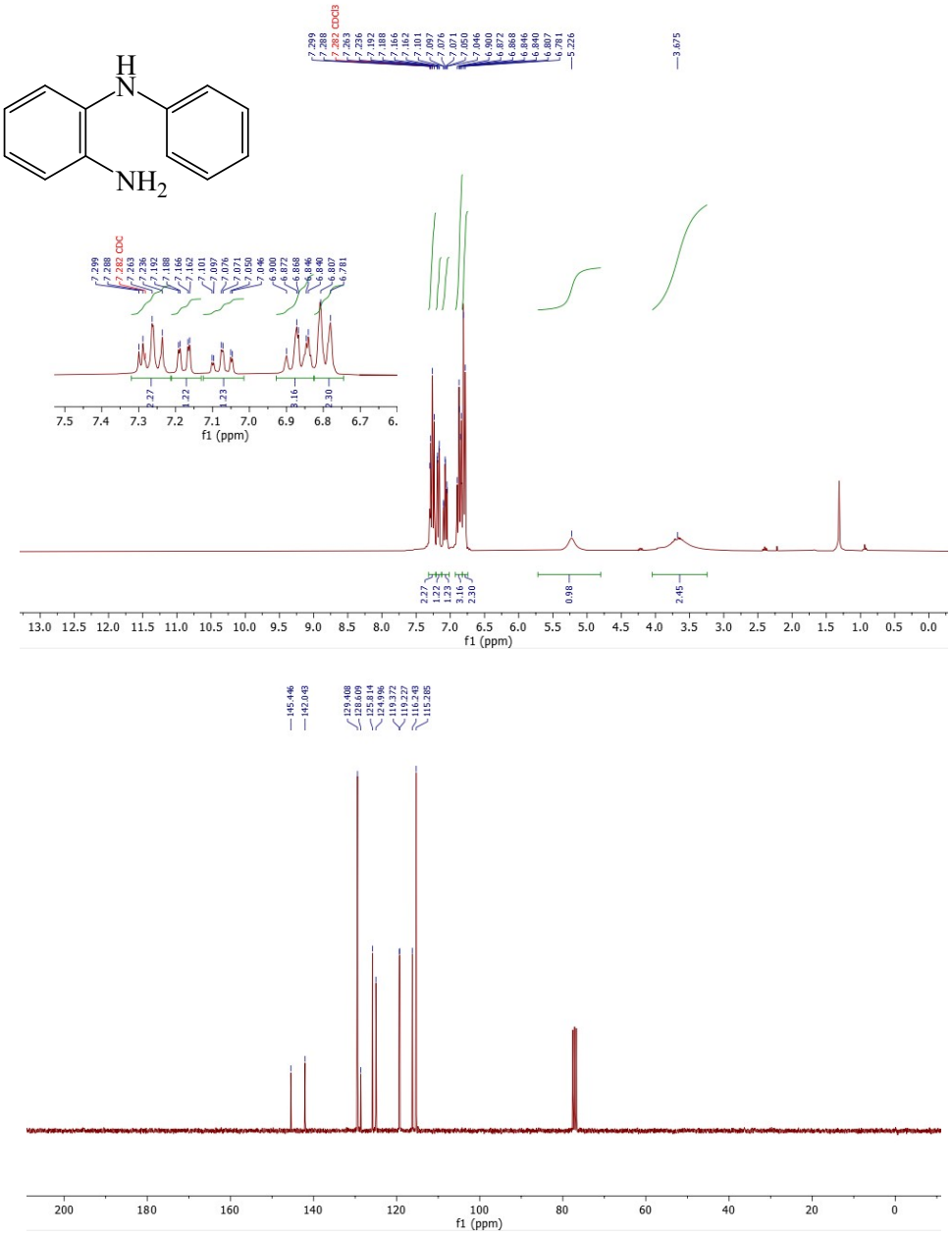



**Figure S16.**$^{1}$H NMR and $^{13}$C NMR spectra of 2-aminodiphenylamine

$^{1}$H NMR (300 MHz, DMSO): δ 7.23-7.29 (m, 2 H), 7.18 (dd, 1 H, *J* = 10.4 Hz), 7.07 (t, 1 H, *J* = 10.4 Hz), 6.86 (t, 3 H, *J* = 11.2 Hz), 6.80 (d, 2 H, *J* = 10.4 Hz), 5.22 (s, 1 H), 3.67 (s, 2 H) ppm, $^{13}$C NMR (75 MHz, $CDCl_3$), δ 145.4, 142.0, 129.4, 128.6, 125.8, 124.9, 119.3, 119.2, 116.2, 115.2 ppm (Table 2. entries 3, 7 and 10).

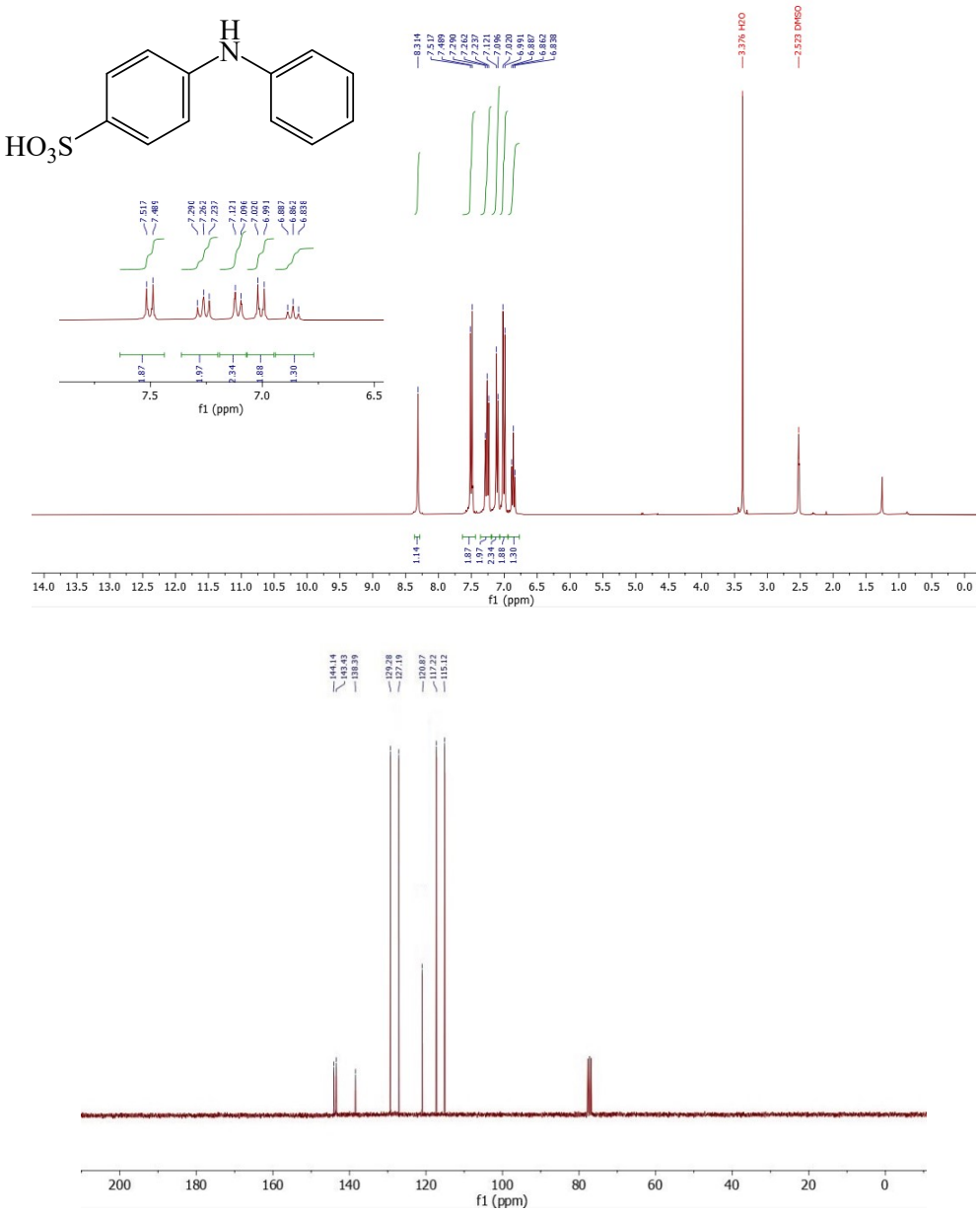



**Figure S17.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-sulfodiphenylamine

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 8.31 (s, 1 H), 7.51 (d, 2 H, $J$ = 11.2 Hz), 7.26 (t, 2 H, $J$ = 10.0 Hz), 7.12 (d, 2 H, $J$ = 10.0 Hz), 7.02 (d, 2 H, $J$ = 11.6 Hz), 6.86 (t, 1 H, $J$ = 9.6 Hz) ppm, $^{13}$C NMR (75 MHz, $CDCl_3$), δ 144.1, 143.4, 138.3, 129.2, 127.1, 120.8, 117.2, 115.1 ppm (Table 2, entries 4, 8 and 11).

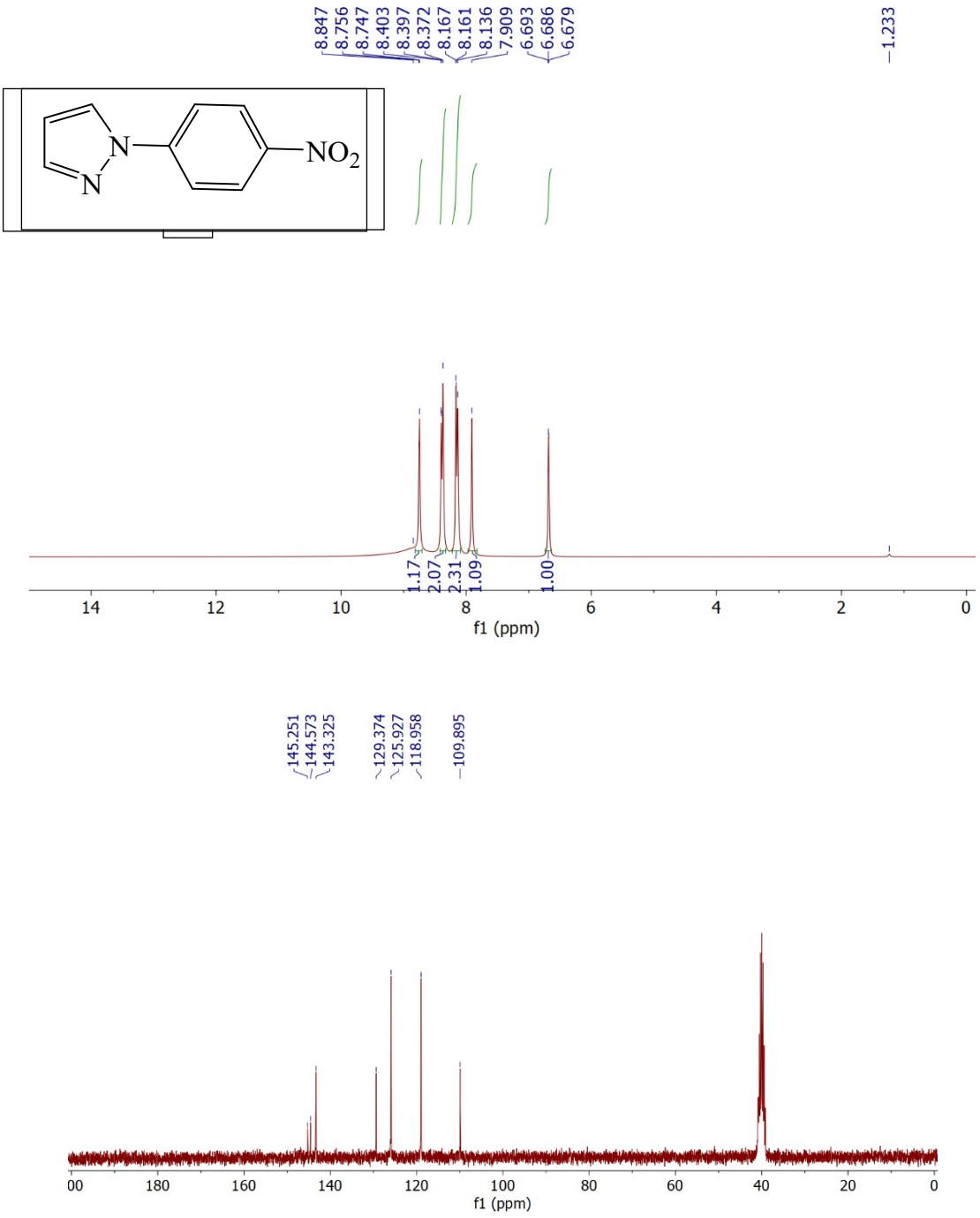



**Figure S18.** $^{1}$H NMR and $^{13}$C NMR spectra of 1-(4-nitrophenyl)-1H-pyrazole

$^{1}$H NMR (300 MHz, DMSO-$d_6$): δ 8.74-8.84 (m, 1H), 8.37-8.40 (m, 2H), 8.15 (m, 2H), 7.90 (s, 1H), 6.68 (t, $J$ = 2.1 Hz, 1H) ppm, $^{13}$C NMR (75 MHz, DMSO-$d_6$): δ 145.41, 144.42, 142.81, 127.12, 125.42, 118.60, 109.41 ppm (Table 3).

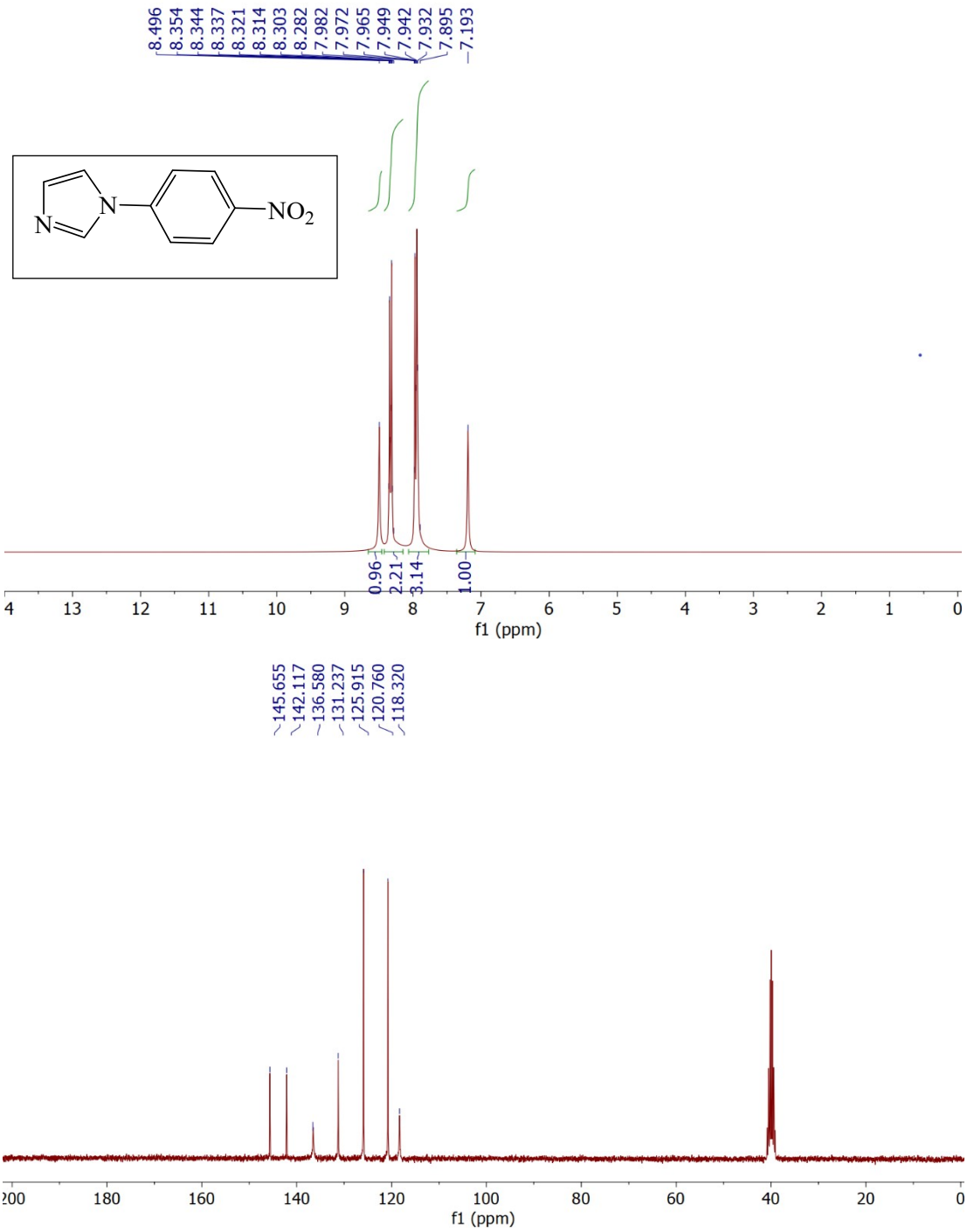



**Figure S19.** $^{1}$H NMR and $^{13}$C NMR spectra of 1-(4-Nitrophenyl)-1H-imidazole

$^{1}$ H NMR (300 MHz, DMSO-$d_6$): δ 8.49 (s, 1H), 8.30-8.35 (m, 2H), 7.93-7.98 (m, 3H), 7.19 (s, 1H) ppm, $^{13}$C NMR (75 MHz, DMSO-$d_6$): δ 145.6, 142.1, 136.5, 131.2, 125.9, 120.7, 118.3 ppm (Table 3).

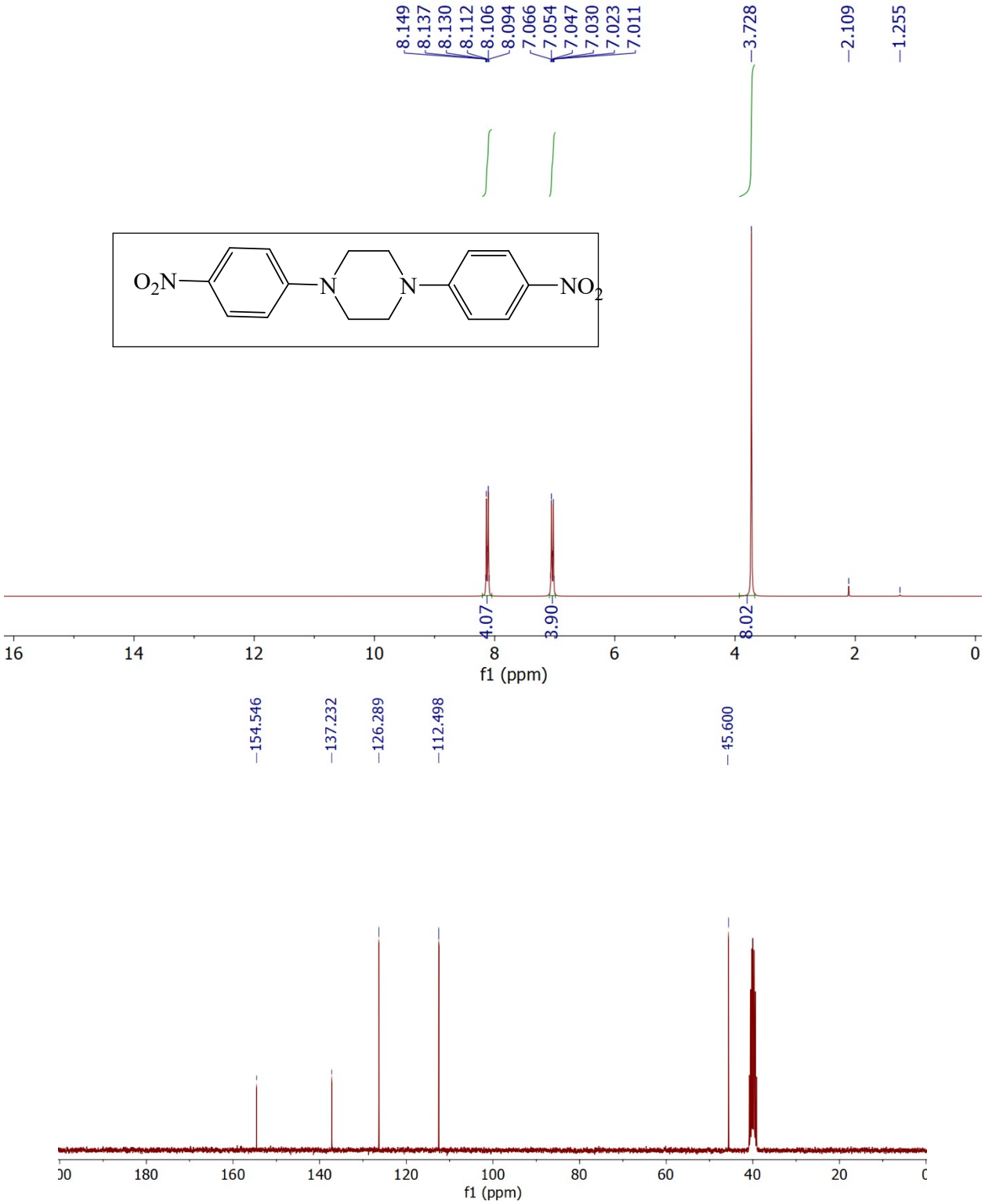



**Figure S20.**[1]H NMR and [13]C NMR spectra of 1,4-bis(4-nitrophenyl) piperazine

[1]H NMR (300 MHz, DMSO-$d_6$): δ 8.09-8.14 (m, 4 H), 7.01-7.06 (m, 4 H), 3.72 (s, 8 H) ppm, [13]C NMR (75 MHz, DMSO-$d_6$): δ 154.4, 137.2, 126.2, 122.2, 45.6 ppm (Table 3).

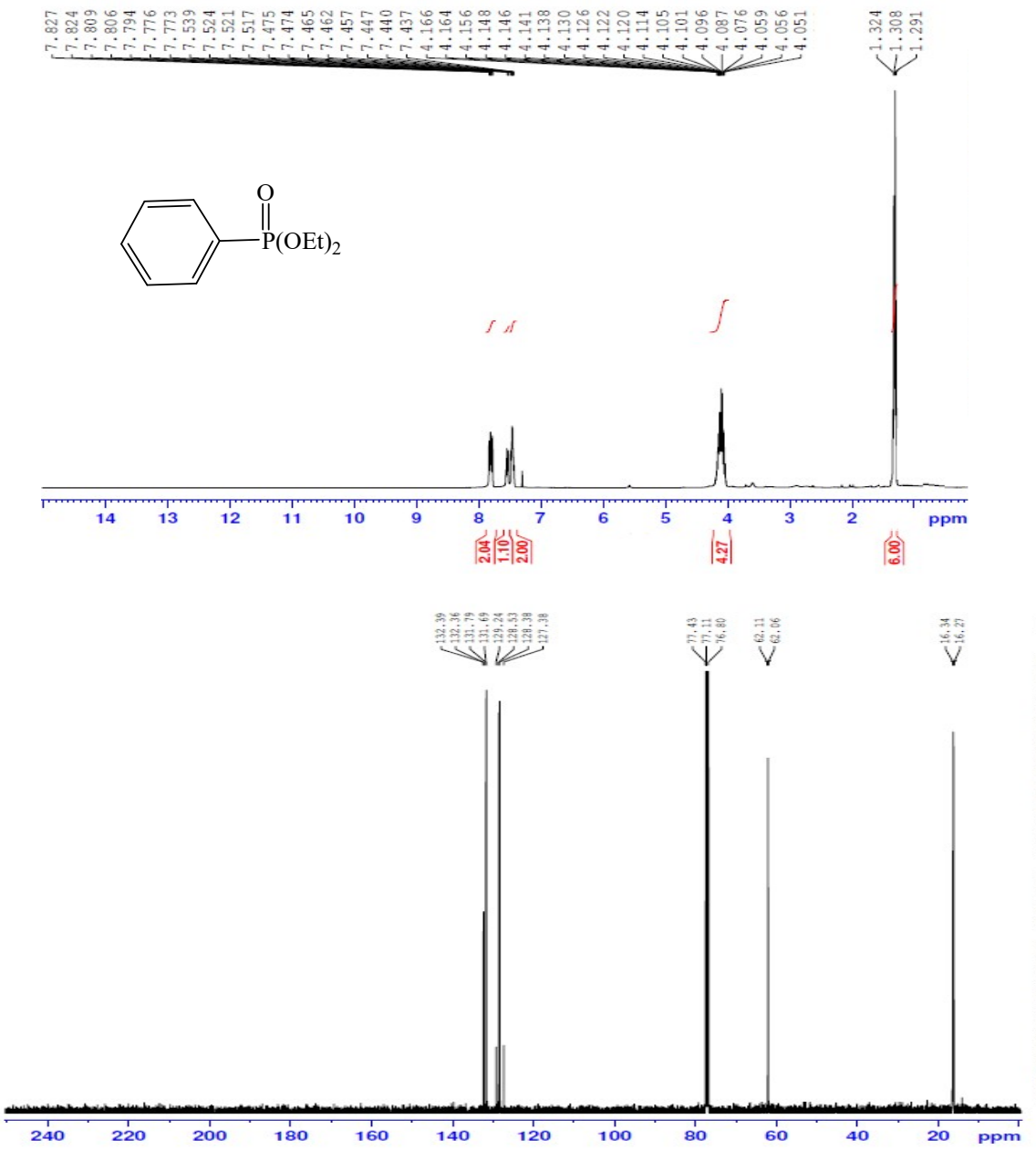



**Figure S21.** $^{1}$H NMR and $^{13}$C NMR spectra of diethylphenylphosphonate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.80 (dd, 2 H, $J$ = 13.2, $J_{HH}$ = 8.4Hz), 7.51-7.53 (m, 1 H), 7.42-7.47 (m, 2 H), 4.16-4.05 (m, 4 H), 1.30 (t, 6 H, $J_{HH}$ = 6.8 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 132.3 (d, $J_{CP}$ = 3.0 Hz), 131.7 (d, $J_{CP}$ = 10.0 Hz), 128.4 (d, $J_{CP}$ = 15.0 Hz), 128.3 (d, $J_{CP}$ = 186.0 Hz), 62.0 (d, $J_{CP}$ = 5.0 Hz), 16.3 (d, $J_{CP}$ = 7.0 Hz) ppm (Table 4, entries 1, 6, 12, 15 and 16).

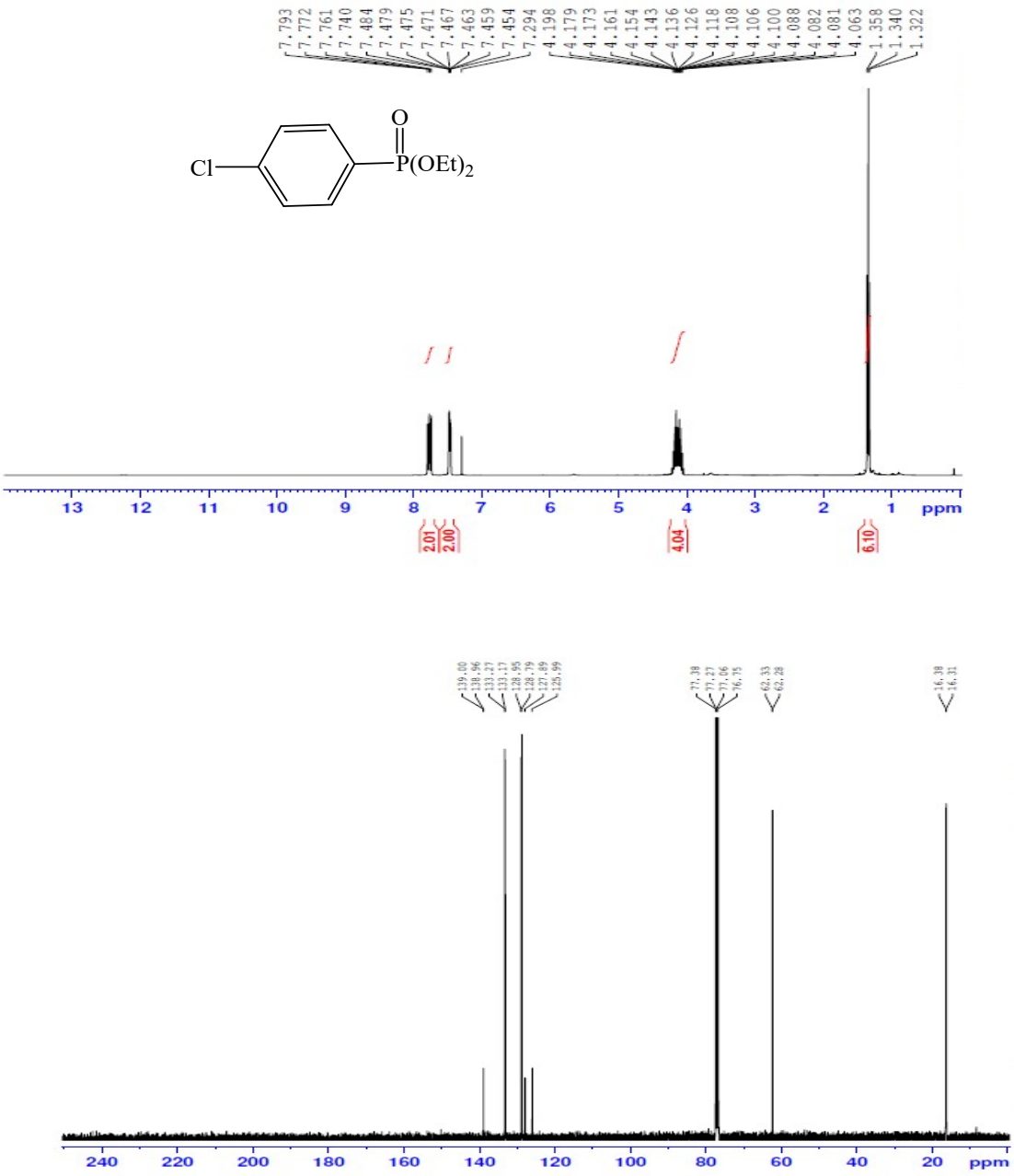



**Figure S22.** $^{1}$H NMR and $^{13}$C NMR spectra of diethyl 4-chlorophenylphosphonate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.76 (dd, 2 H, $J_{HH}$ = 12.8 Hz, $J_{HH}$ = 8.4 Hz), 7.46 (dd, 2 H, $J_{HH}$ = 8.2 Hz, $J_{HH}$ = 3.6 Hz), 4.06-4.19 (m, 4 H), 1.34 (t, 6 H, $J_{HH}$ = 7.2 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 138.9 (d, $J_{CP}$ = 4.0 Hz), 133.2 (d, $J_{CP}$ = 10.0 Hz), 128.8 (d, $J_{CP}$ = 16.0 Hz), 126.9 (d, $J_{CP}$ = 190.0 Hz), 62.2 (d, $J_{CP}$ = 5.0 Hz), 16.3 (d, $J_{CP}$ = 7.0 Hz) ppm (Table 4, entries 3 and 9).

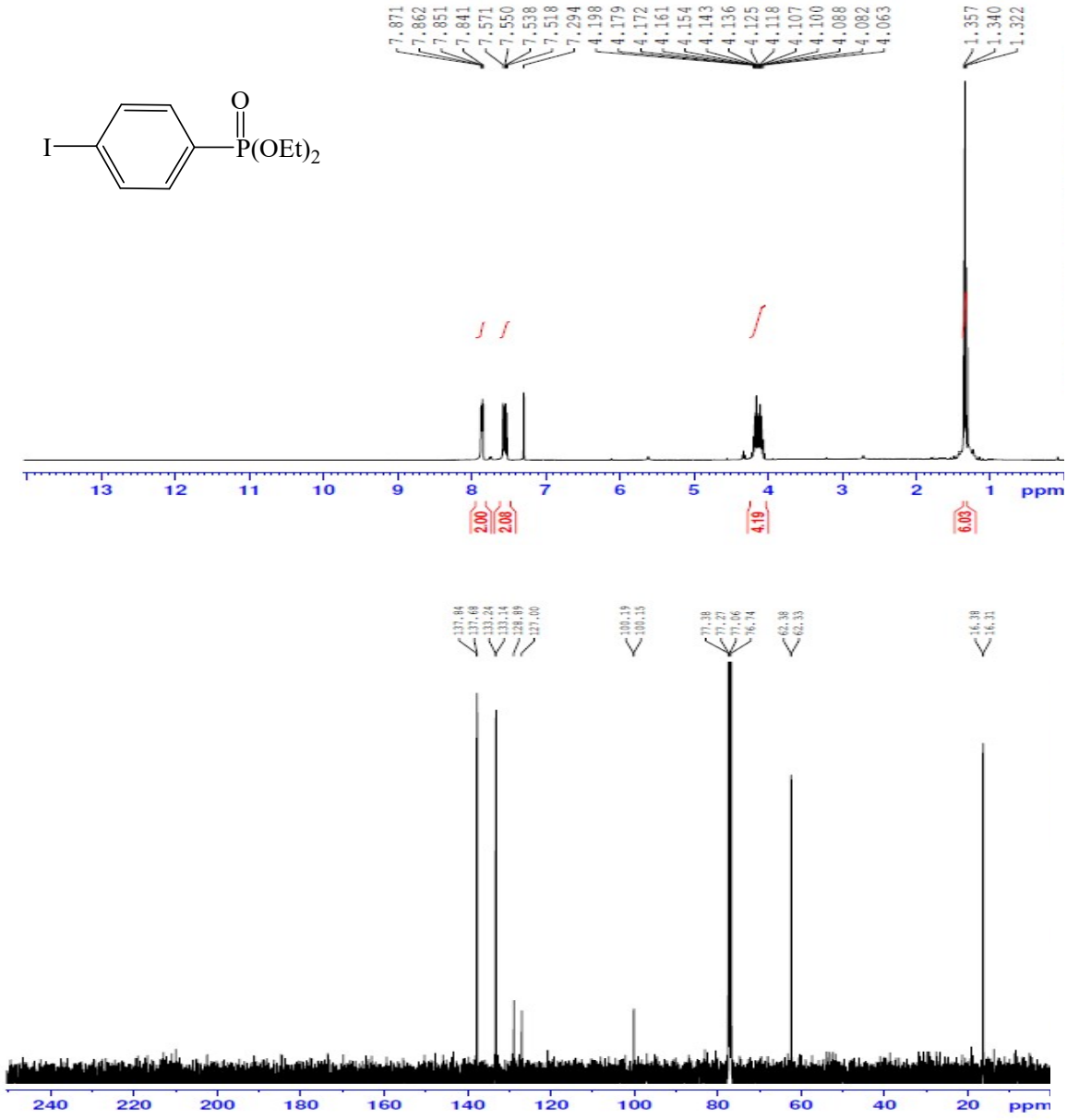



**Figure S23.** $^{1}$H NMR and $^{13}$C NMR spectra of diethyl 4-iodophenylphosphonate

$^{1}$HNMR (400 MHz, $CDCl_3$): δ 7.85 (dd, 2 H, $J_{HH}$ = 8.2 Hz, $J_{HH}$ = 3.6 Hz), 7.54 (dd, 2 H, $J_{HH}$ = 13 Hz, $J_{HH}$ = 8.0 Hz), 4.06-4.19 (m, 4 H), 1.34 (t, 6 H, $J_{HH}$ = 6.8 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 137.7 (d, $J_{CP}$ = 16.0 Hz), 133.1 (d, $J_{CP}$ = 10.0 Hz), 127.4 (d, $J_{CP}$ = 189.0 Hz), 100.1 (d, $J_{CP}$ = 4.0 Hz), 62.3 (d, $J_{CP}$ = 5.0 Hz), 16.3 (d, $J_{CP}$ = 7.0 Hz) ppm (Table 4, entry 4).

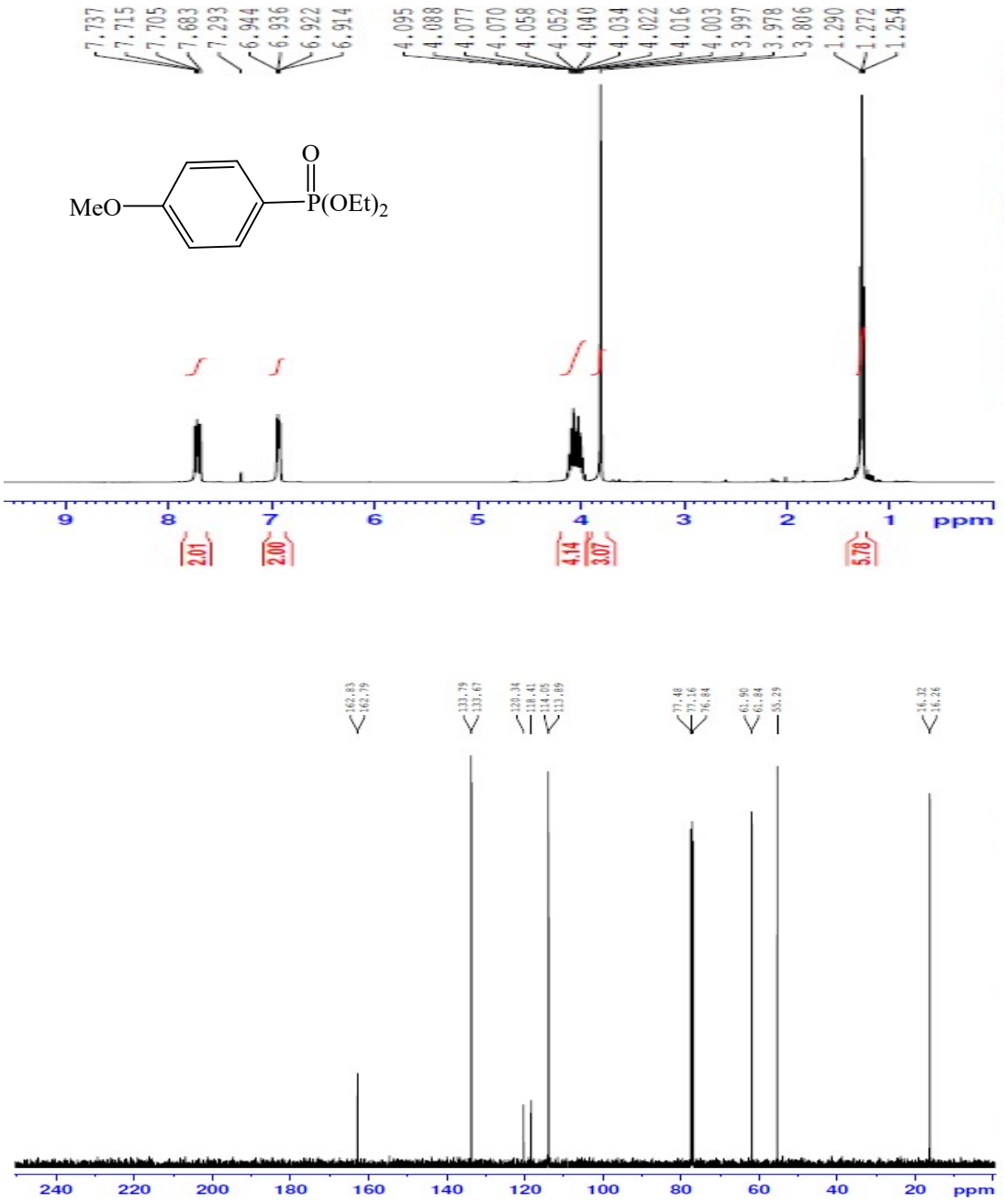



**Figure S24.** $^{1}$H NMR and $^{13}$C NMR spectra of diethyl 4-methoxyphenylphosphonate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.71 (dd, 1 H, $J_{HH}$ = 12.8 Hz, $J_{HH}$ = 8.8 Hz), 6.92 (dd, 1 H, $J_{HH}$ = 8.8 Hz, $J_{HH}$ = 3.2 Hz), 3.97-4.09 (m, 4 H), 3.80 (s, 3 H), 1.27 (t, 6 H, $J_{HH}$ = 7.2 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 162.8 (d, $J_{CP}$ = 4.0 Hz), 133.7 (d, $J_{CP}$ =12.0 Hz), 119.3 (d, $J_{CP}$ = 193.0 Hz), 113.9 (d, $J_{CP}$ = 16.0 Hz), 61.8 (d, $J_{CP}$ = 6.0 Hz), 16.2 (d, $J_{CP}$ = 6.0 Hz) ppm (Table 4, entries 2 and 8).

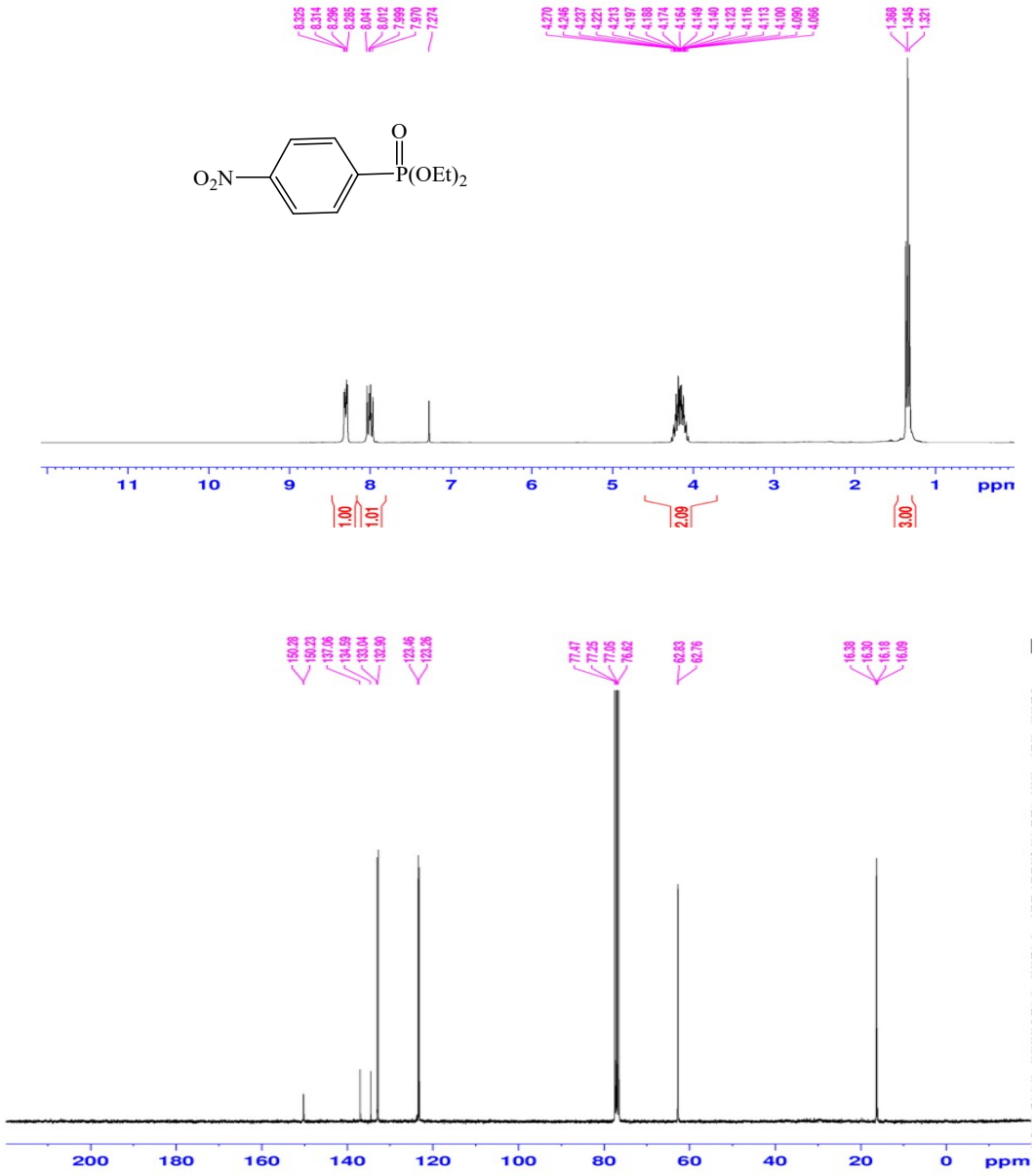



**Figure S25.** $^{1}$H NMR and $^{13}$C NMR spectra of diethyl (4-nitrophenyl) phosphonate

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 8.30 (dd, 1 H, $J_{HH}$ = 8.7 Hz, $J_{HH}$ = 3.3 Hz), 8.00 (dd, 1 H, $J_{HH}$ = 12.7 Hz, $J_{HH}$ = 8.7 Hz), 4.06-4.27 (m, 4 H), 1.34 (t, 6 H, $J_{HH}$ = 6.9 Hz) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 150.2 (d, $J_{CP}$ = 3.7 Hz), 135.8 (d, $J_{CP}$ = 185.2 Hz), 133.0 (d, $J_{CP}$ = 10.5 Hz), 123.3 (d, $J_{CP}$ = 15.0 Hz), 62.7 (d, $J_{CP}$ = 5.2 Hz), 16.3 (d, $J_{CP}$ = 6.0 Hz), 16.1 (d, $J_{CP}$ = 6.7 Hz) ppm (Table 4, entries 7 and 14).

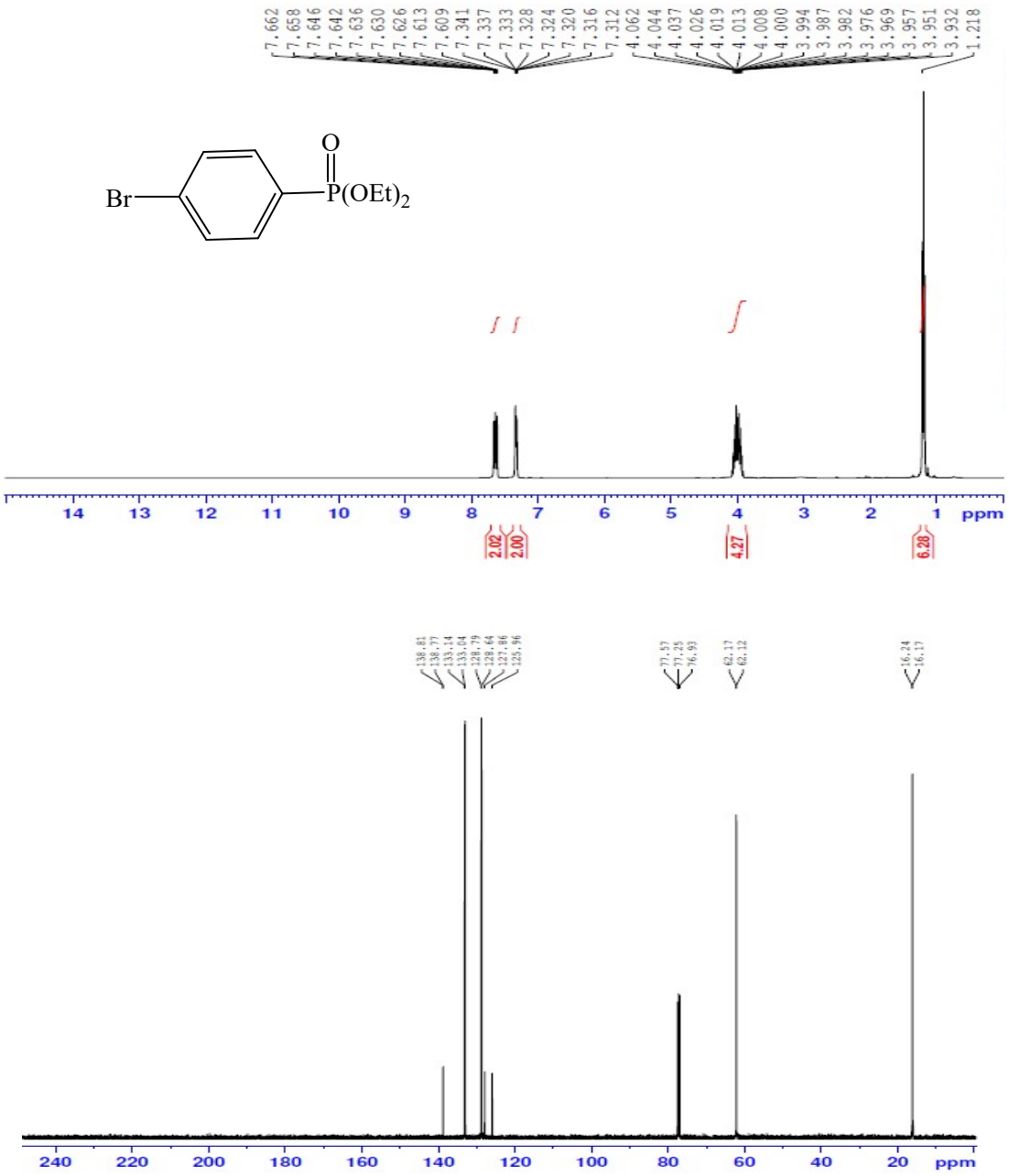



**Figure S26.** $^{1}$H NMR and $^{13}$C NMR spectra of diethyl 4-bromophenylphosphonate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.63 (dd, 2 H, $J_{HH}$ = 13.2 Hz, $J_{HH}$ = 8.4 Hz), 7.32 (dd, 2 H, $J_{HH}$ = 8.4 Hz, $J_{HH}$ = 3.2 Hz), 3.93-4.06 (m, 4 H), 1.20 (t, 6 H, $J_{HH}$ = 7.2 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 138.7 (d, $J_{CP}$ = 4.0 Hz), 133.0 (d, $J_{CP}$ = 10.0 Hz), 128.7 (d, $J_{CP}$ = 15.0 Hz), 126.9 (d, $J_{CP}$ = 190.0 Hz), 62.1 (d, $J_{CP}$ = 5.0 Hz), 16.2 (d, $J_{CP}$ = 7.0 Hz) ppm (Table 4, entry 10).

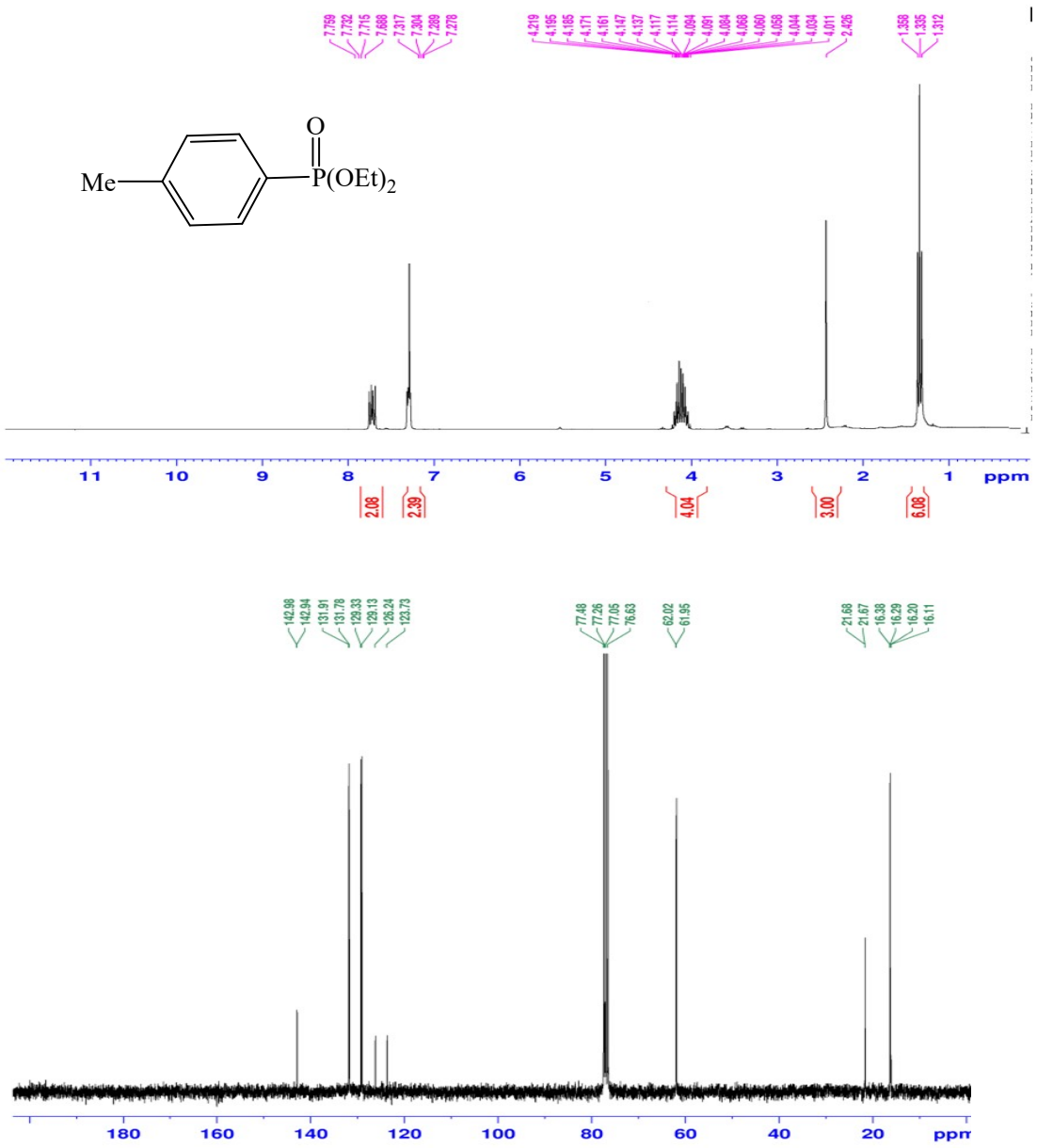



**Figure S27.** $^{1}$H NMR and $^{13}$C NMR spectra of diethyl 4-tolylphosphonate

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.72 (dd, 2 H, $J_{HH}$ = 13.2 Hz, $J_{HH}$ = 8.1 Hz), 7.29 (dd, 2 H, $J_{HH}$ = 8.1 Hz, $J_{HH}$ = 3.3 Hz), 4.01-4.21 (m, 4 H), 2.42 (s, 3 H), 1.33 (t, 6 H, $J_{HH}$ = 6.9 Hz) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 142.9 (d, $J_{CP}$ = 3.0 Hz), 131.8 (d, $J_{CP}$ = 9.7 Hz), 129.2 (d, $J_{CP}$ = 15.0 Hz), 124.9 (d, $J_{CP}$ = 188.2 Hz), 61.9 (d, $J_{CP}$ = 5.2 Hz), 21.6, 16.3 (d, $J_{CP}$ = 6.7 Hz), 16.1 (d, $J_{CP}$ = 6.7 Hz) ppm (Table 4, entry 13).

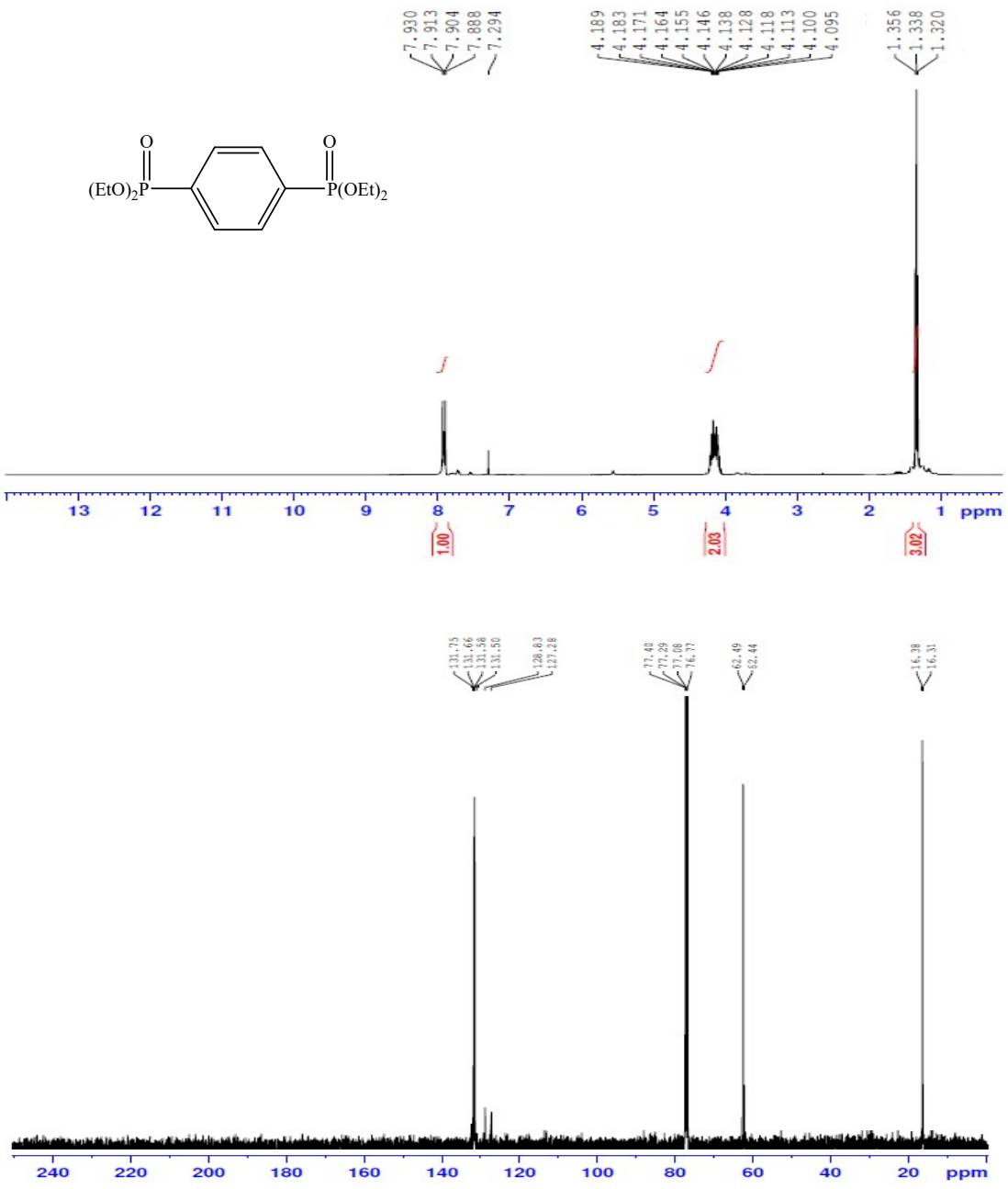
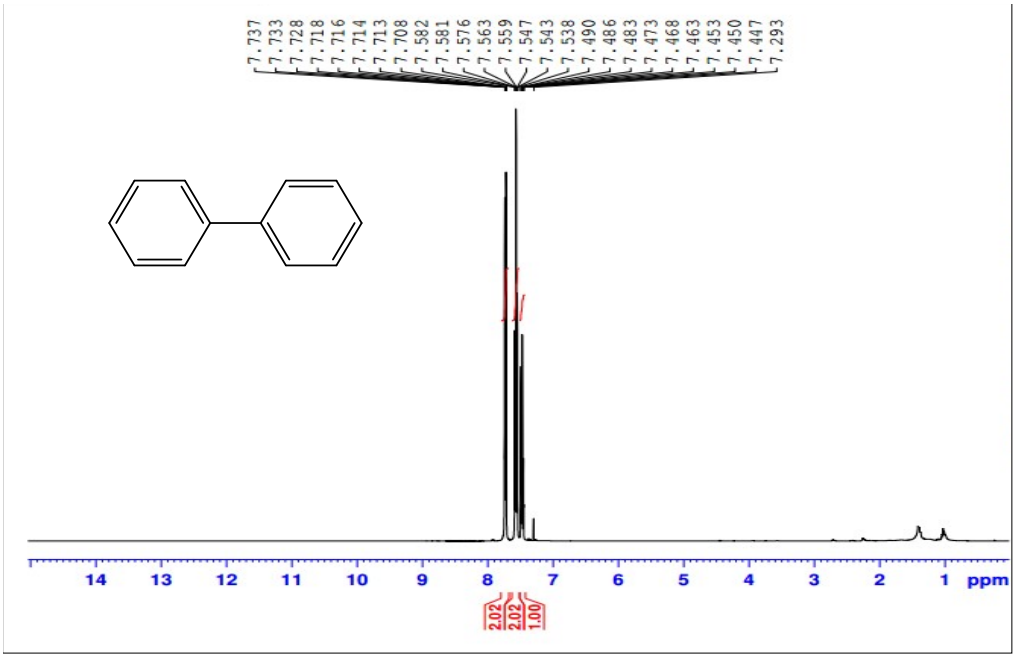



**Figure S28.** $^{1}$H NMR and $^{13}$C NMR spectra of tetraethylphenylbis (phosphonate)

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.90 (dd, 4 H, $J_{HH}$ = 10.2 Hz, $J_{HH}$ = 6.8 Hz), 4.09-4.18 (m, 8 H), 1.33 (t, 12 H, $J_{HH}$ = 7.2 Hz), ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 131.6 (dd, $J_{CP}$ = 16.5 Hz, $J_{CP}$ = 8.0 Hz), 128.0 (d, $J_{CP}$ = 155.0 Hz), 62.4 (d, $J_{CP}$ = 5.0 Hz), 16.3 (d, $J_{CP}$ = 7.0 Hz) ppm (Table 4, entries 5 and 11).



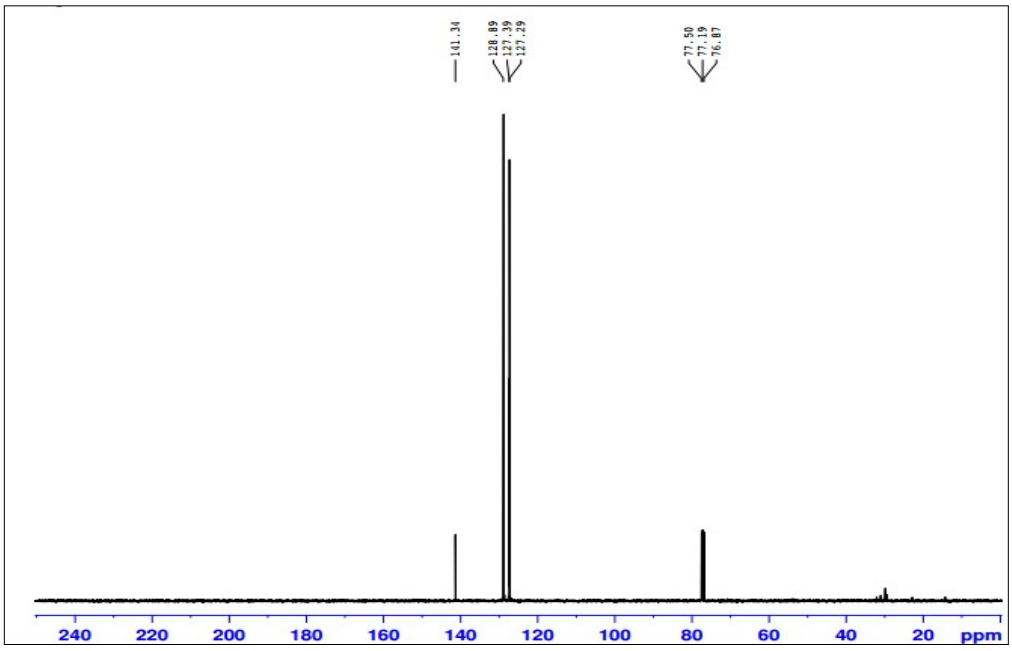




**Figure S29.** $^{1}$H NMR and $^{13}$C NMR spectra of biphenyl

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.72 (d, 4 H, $J$ = 6.8 Hz), 7.56 (t, 4 H, $J$ = 8.0 Hz), 7.46 (t, 2 H, $J$ = 7.2 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 141.3, 128.8, 127.3, 127.2 ppm (Table 5, entries 1, 5 and 10).

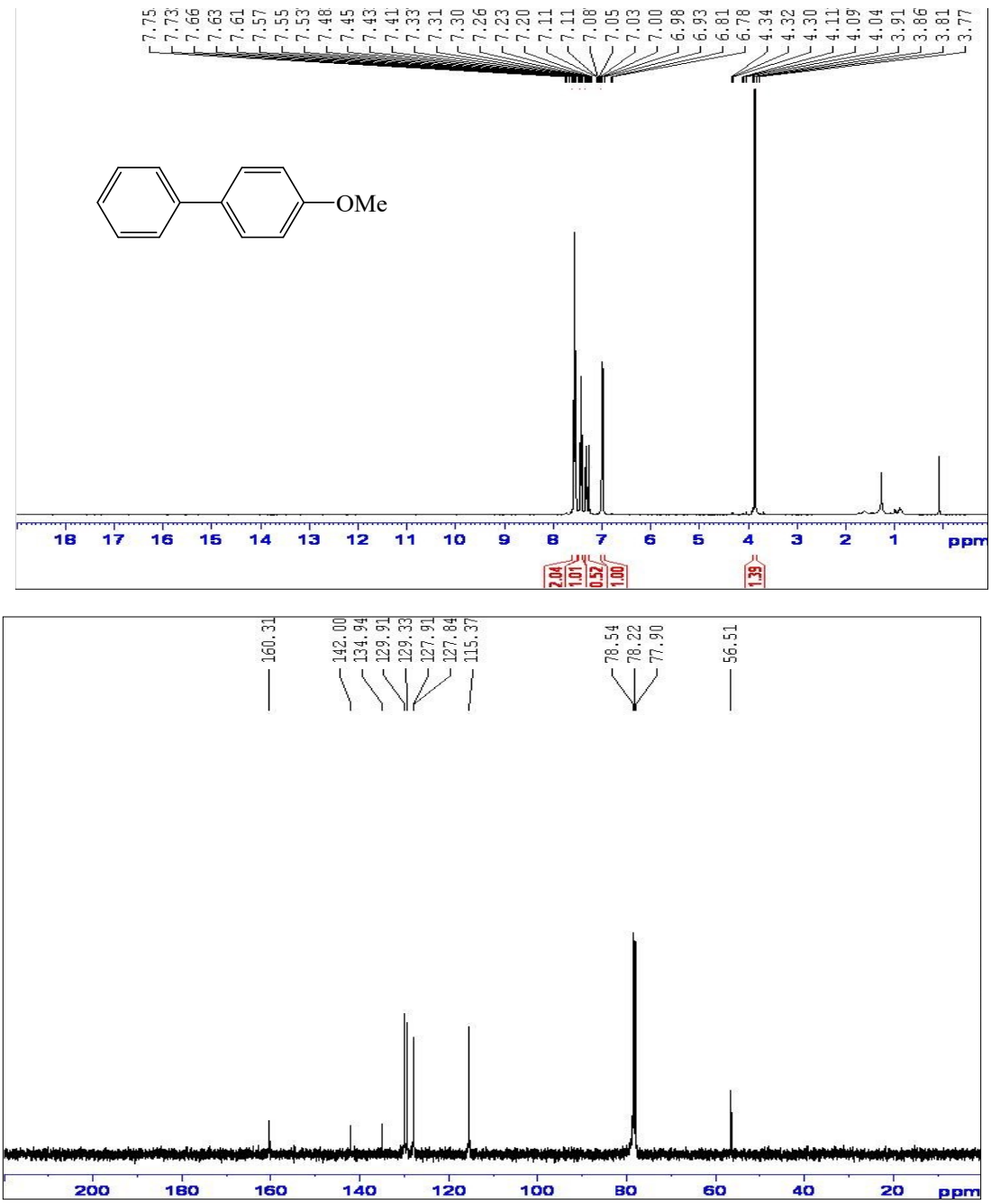



**Figure S30.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-methoxybiphenyl

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.55 (t, 4 H, $J$ = 8.8 Hz), 7.43 (t, 2 H, $J$ = 8.0 Hz), 7.31 (t, 1 H, $J$ = 7.2 Hz), 6.99 (d, 2 H, $J$ = 8.8 Hz), 3.83 (s, 3 H) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 160.3, 142.0, 134.9, 129.9, 129.3, 127.9, 127.8, 115.3, 56.5 ppm (Table 5, entries 2 and 6).

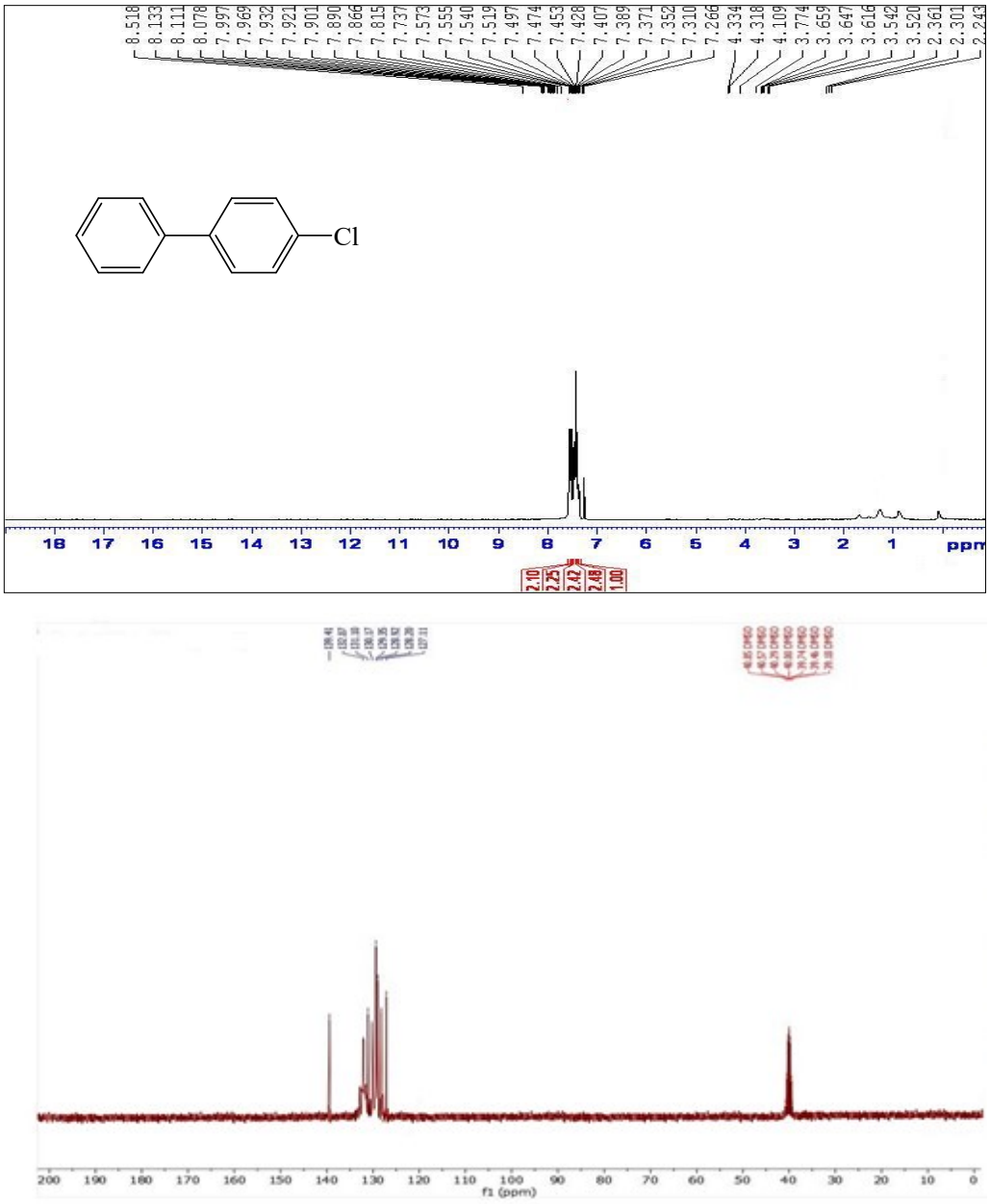



**Figure S31.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-chlorobiphenyl

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.51-7.57 (m, 4 H), 7.31-7.49 (m, 5 H) ppm. $^{13}$C NMR (75 MHz, DMSO-$d_6$), δ 139.4, 132.0, 131.1, 130.1, 129.3, 128.9, 128.2, 127.1 ppm (Table 5, entries 3 and 9).

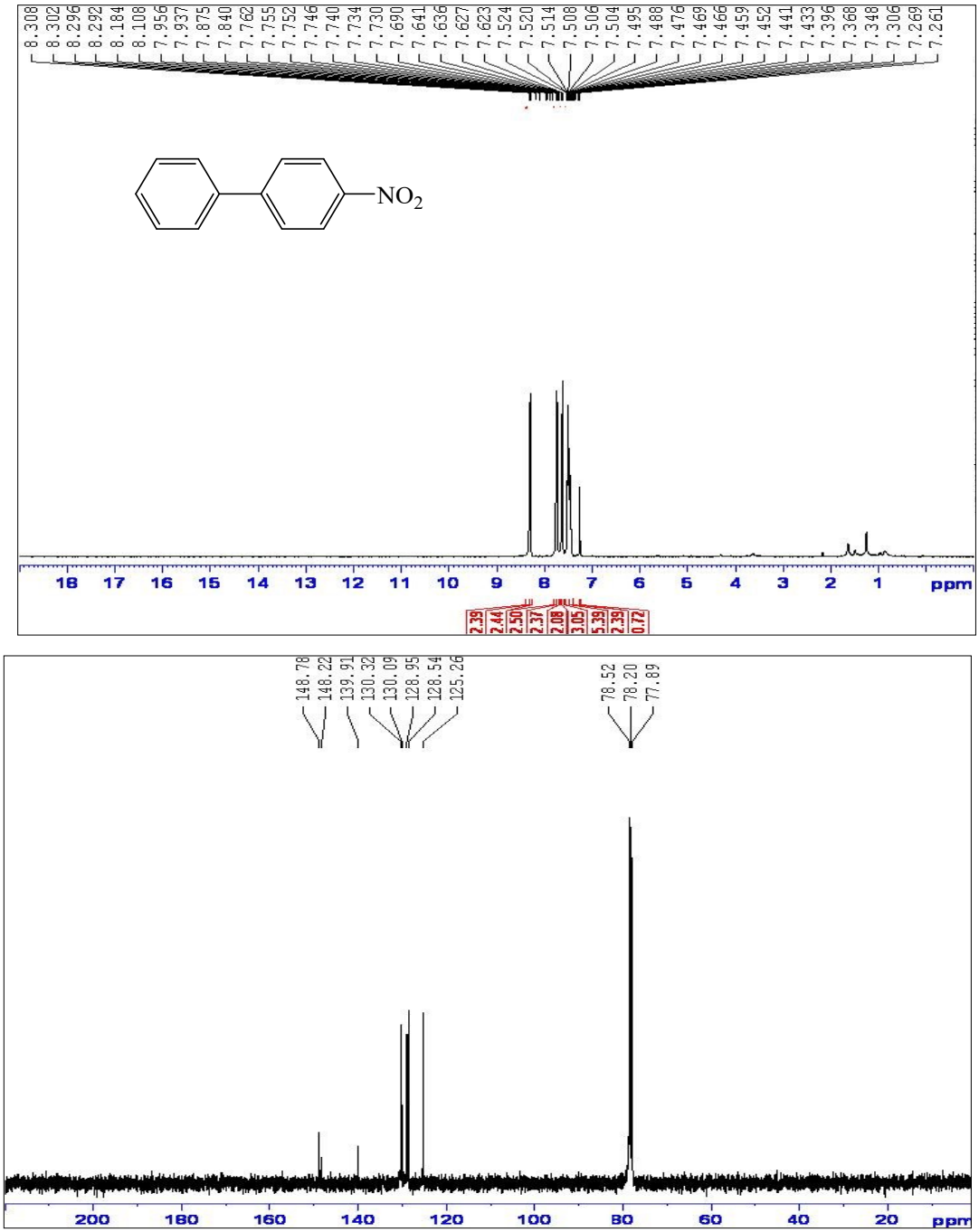



**Figure S32.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-nitrobiphenyl

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.29-8.30 (m, 2 H), 7.73-7.76 (m, 2 H), 7.62-7.64 (m, 2 H), 7.43-7.52 (m, 3 H) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 148.7, 148.2, 139.9, 130.3, 130.0, 128.9, 128.5, 125.2 ppm (Table 5, entries 7 and 11).

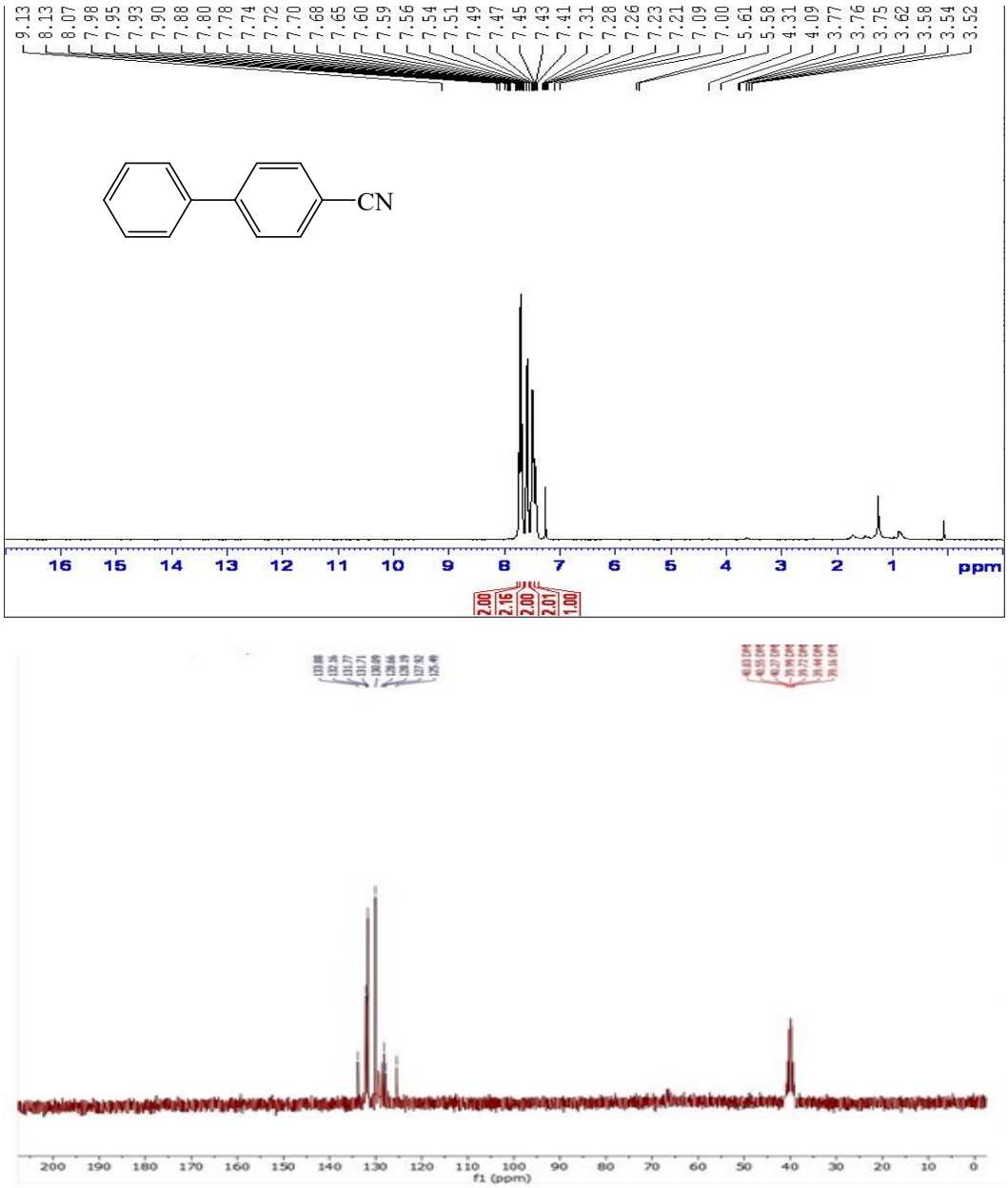



**Figure S33.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-cyanobiphenyl

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.68-7.74 (m, 4 H), 7.56-7.60 (m, 2 H), 7.41-7.51 (m, 3 H) ppm. $^{13}$C NMR (75 MHz, DMSO-$d_6$), δ 133.8, 132.1, 131.7, 131.7, 130.0, 128.6, 128.1, 127.9, 125.4 ppm (Table 5, entries 8 and 12).

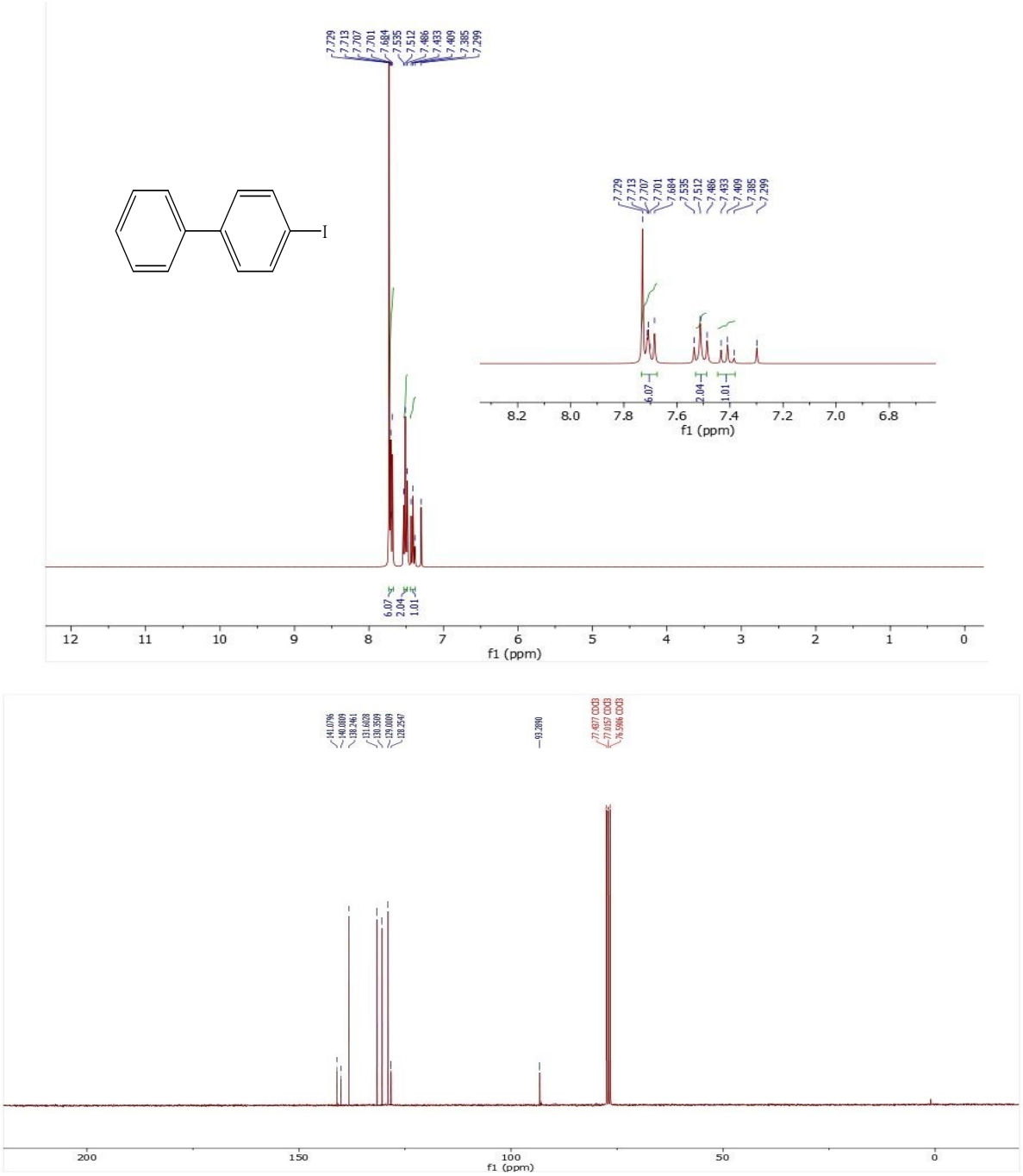



**Figure S34.** $^{1}$H NMR and $^{13}$C NMR spectra of 4-iodo-1, 1'-biphenyl

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.67-7.73 (m, 6 H), 7.51 (t, 2 H, $J$ = 7.8 Hz), 7.40 (t, 1 H, $J$ = 7.2 Hz) ppm. $^{13}$C NMR (75 MHz, $CDCl_3$), δ 141.0, 140.0, 138.2, 131.6, 130.3, 129.0, 128.2, 93.2 ppm (Table 5, entry 4).

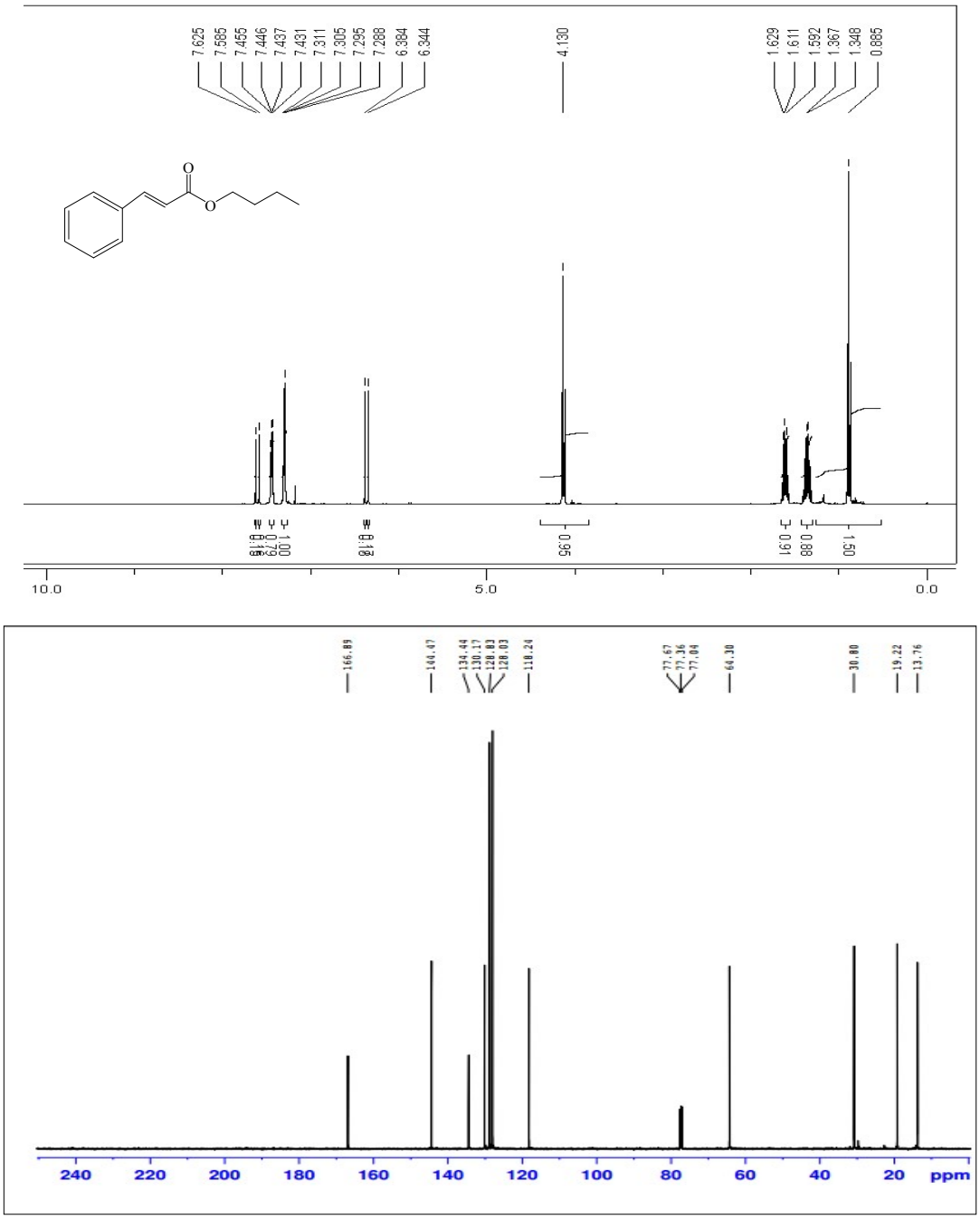



**Figure S35.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-*n*-butyl cinnamate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.60 (d, 1 H, *J* = 16.0 Hz), 7.43-7.45 (m, 2 H), 7.29-7.30 (m, 3 H), 6.36 (d, 1 H, *J* = 16.0 Hz), 4.13 (t, 2 H, *J* = 6.8 Hz), 1.59-1.62 (m, 2 H), 1.34-1.36 (m, 2 H), δ 0.88 (t, 3 H, *J* = 7.6 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 166.8, 144.4, 134.4, 130.1, 128.8, 128.0, 118.2, 64.3, 30.8, 19.2, 13.7 ppm (Table 6, entries 1, 7 and 10).

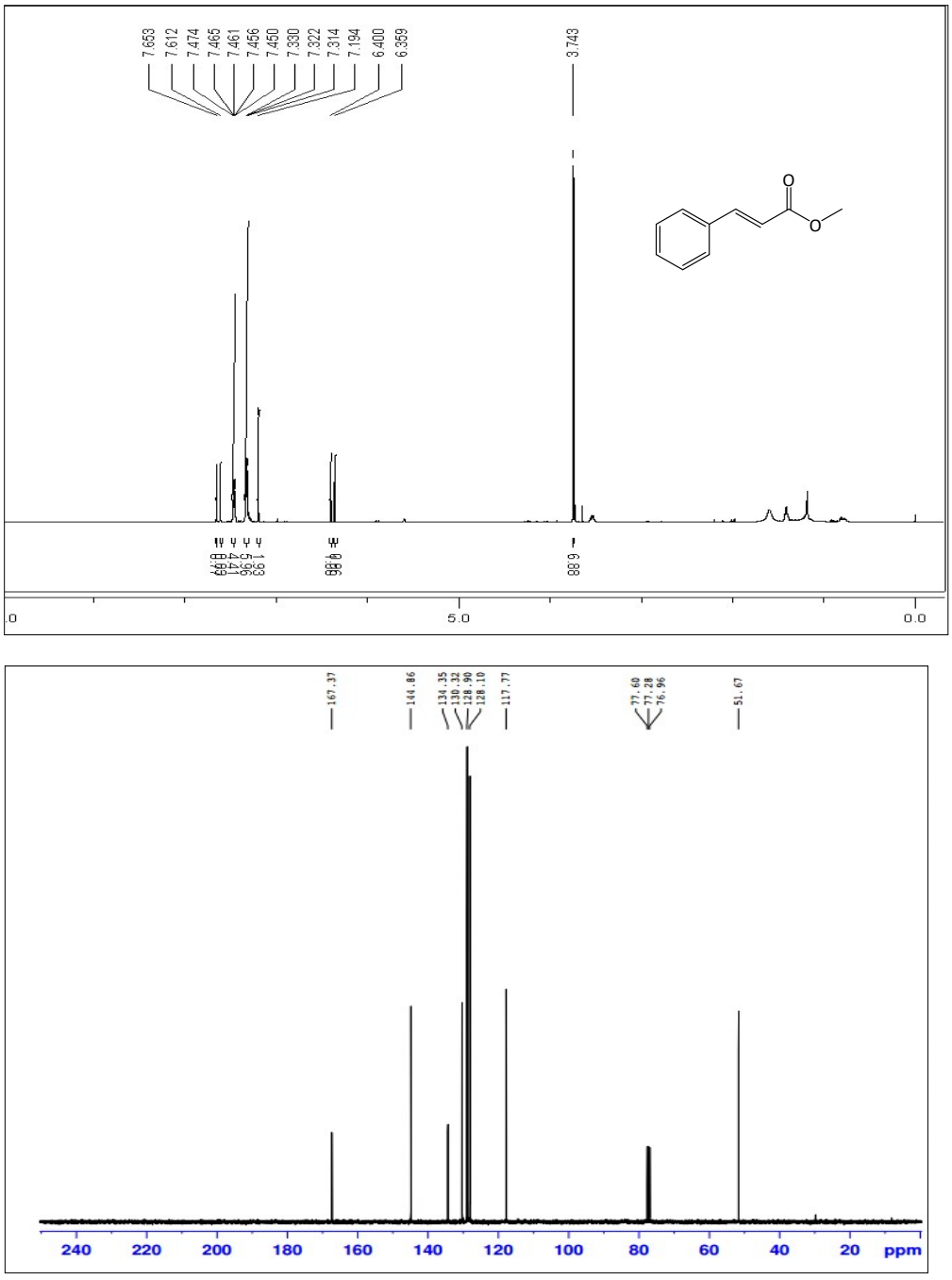



**Figure S36.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-methyl cinnamate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.63 (d, 1 H, *J* = 16.4 Hz), 7.45-7.47 (m, 2 H), 7.31-7.33 (m, 3 H), 6.38 (d, 1 H, *J* = 16.4 Hz), 3.74 (s, 3 H) ppm.$^{13}$C NMR (100 MHz, $CDCl_3$), δ 167.3, 144.8, 134.3, 130.3, 128.9, 128.1, 117.7, 51.6 ppm (Table 6, entry 2).

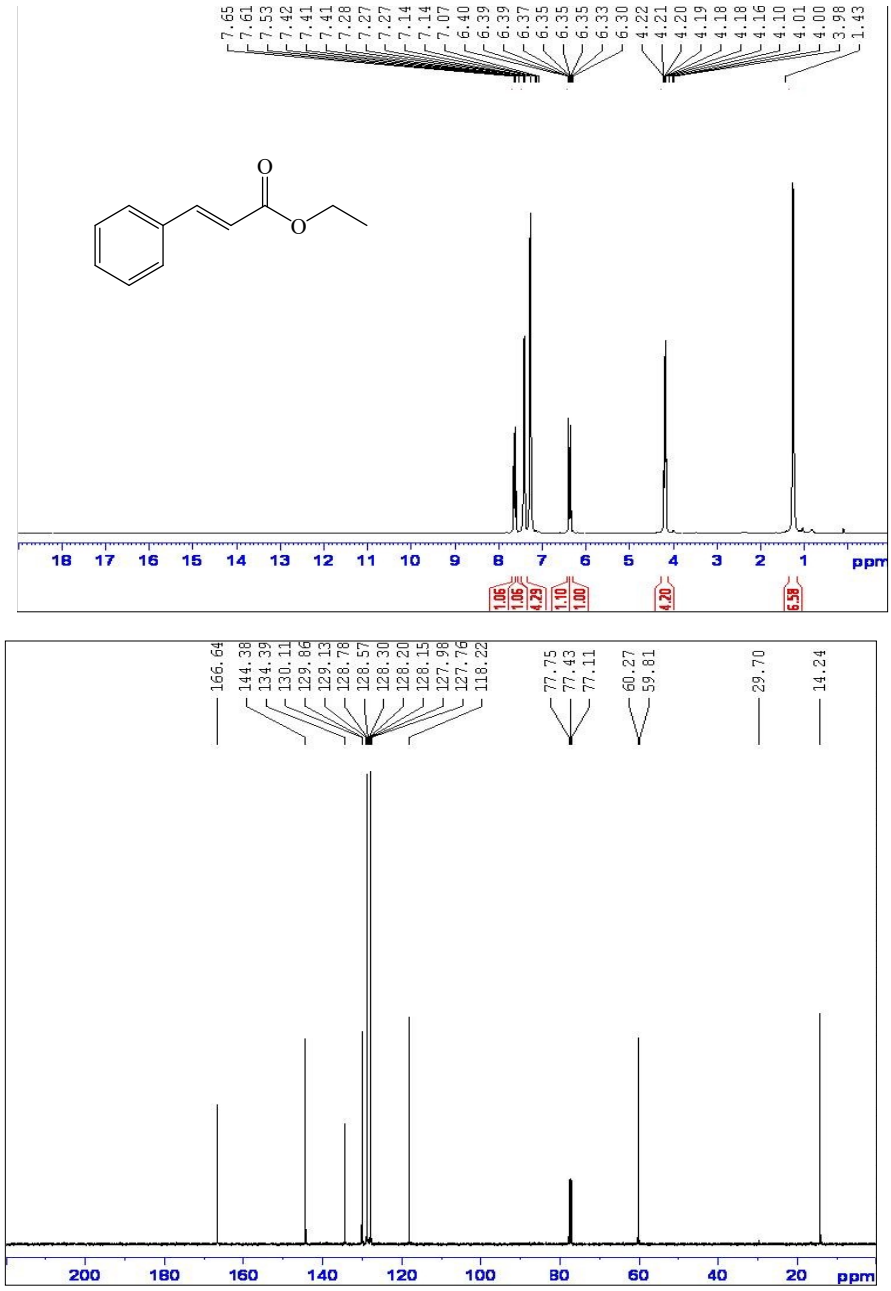



**Figure S37.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-ethyl cinnamate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.63 (d, 1 H, *J* = 16.0 Hz), 7.41-7.42 (m, 2 H), 7.27-7.28 (m, 3 H), 6.35 (d, 1 H, *J* = 16.0 Hz), 4.19 (q, 2 H, *J* = 8.0 Hz), 1.43 (t, 3 H, *J* = 8.0 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 166.6, 144.3, 134.3, 130.1, 128.7, 127.9, 11.2, 60.0, 14.2 ppm (Table 6, entry 3).

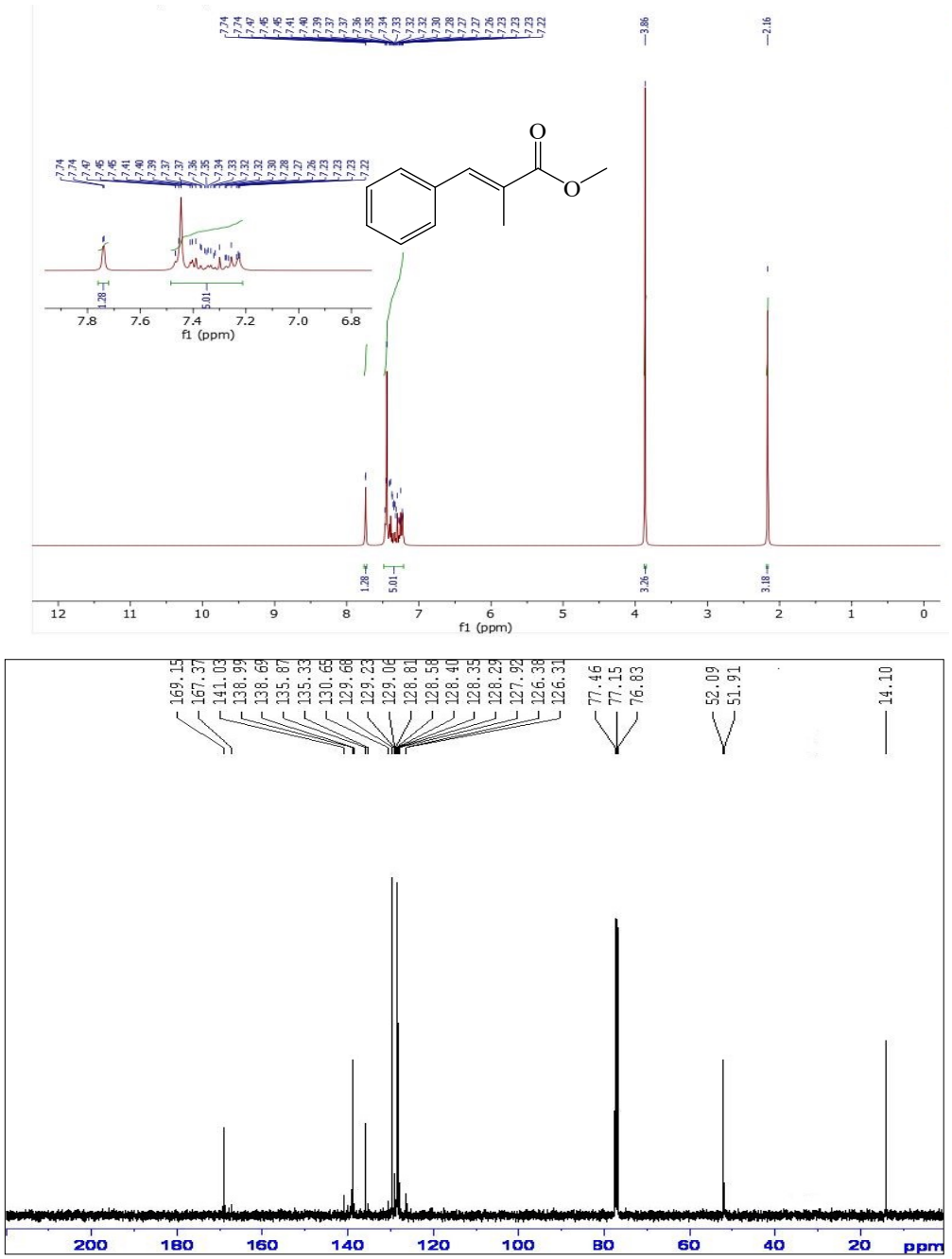



**Figure S38.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-methyl 2-methyl-3-phenylacrylate

$^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.74 (s, 1 H), 7.22-7.47 (m, 5 H), 3.86 (s, 3 H), 2.16 (s, 3 H) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 169.1, 138.9, 135.8, 129.6, 127.9, 52.0, 14.1 ppm (Table 6, entry 4).

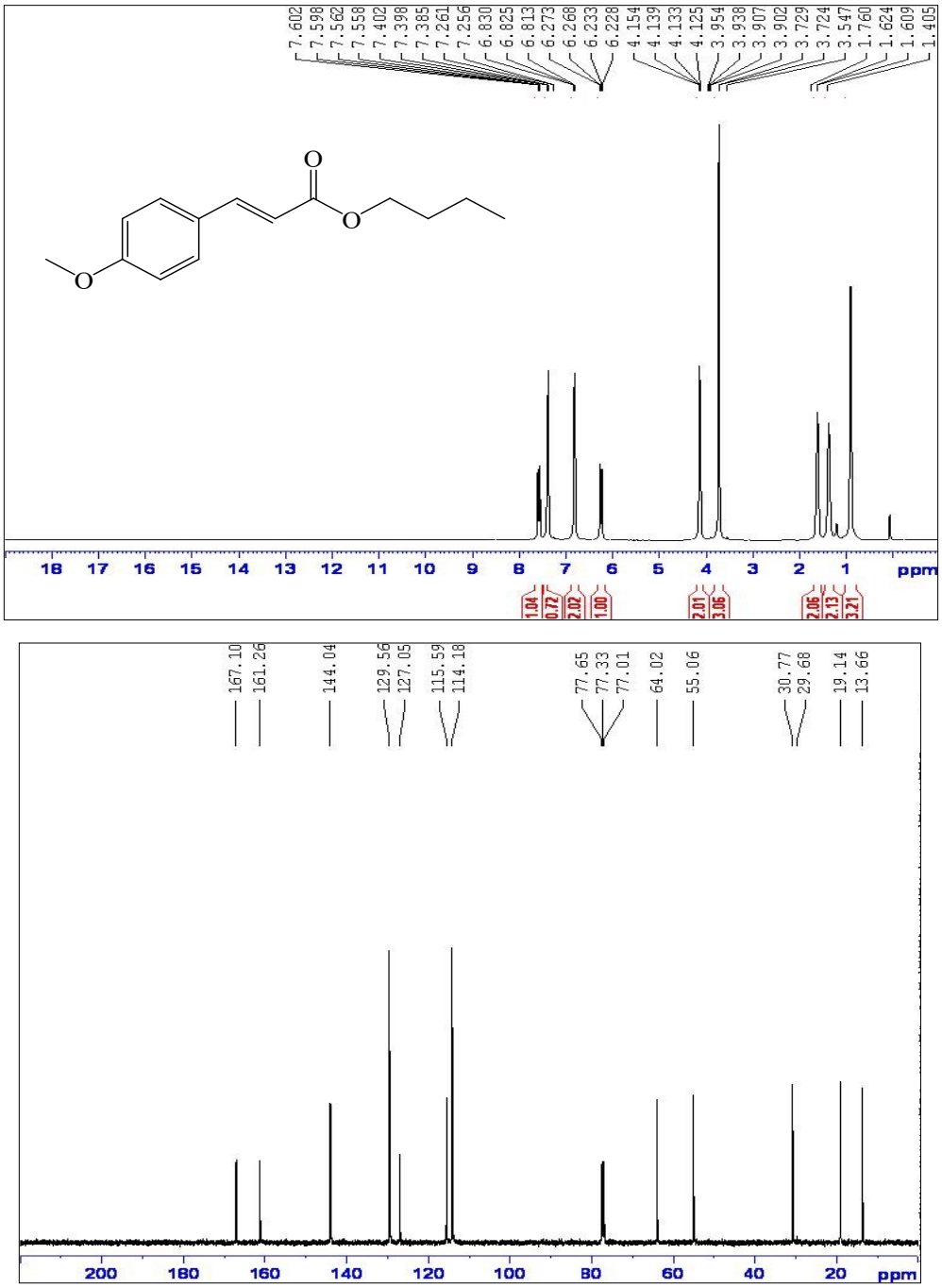



**Figure S39.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-*n*-butyl 3-(4-methoxyphenyl) acrylate $^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.58 (d, 1 H, *J* = 16.0 Hz), 7.39 (d, 3 H, *J* =4.2 Hz), 6.24 (d, 1 H, *J* = 16.0 Hz), 4.13 (m, 2 H, *J* =7.0 Hz), 3.72 (s, 3 H), 1.60-1.62 (m, 2 H), 1.35-1.40 (m, 2 H), 0.91 (t, 3 H, *J* =7.0 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 167.1, 161.2, 144.0, 129.5, 127.0, 115.5, 114.1, 64.0, 55.0, 30.7, 19.1, 13.6 ppm (Table 6, entry 5).

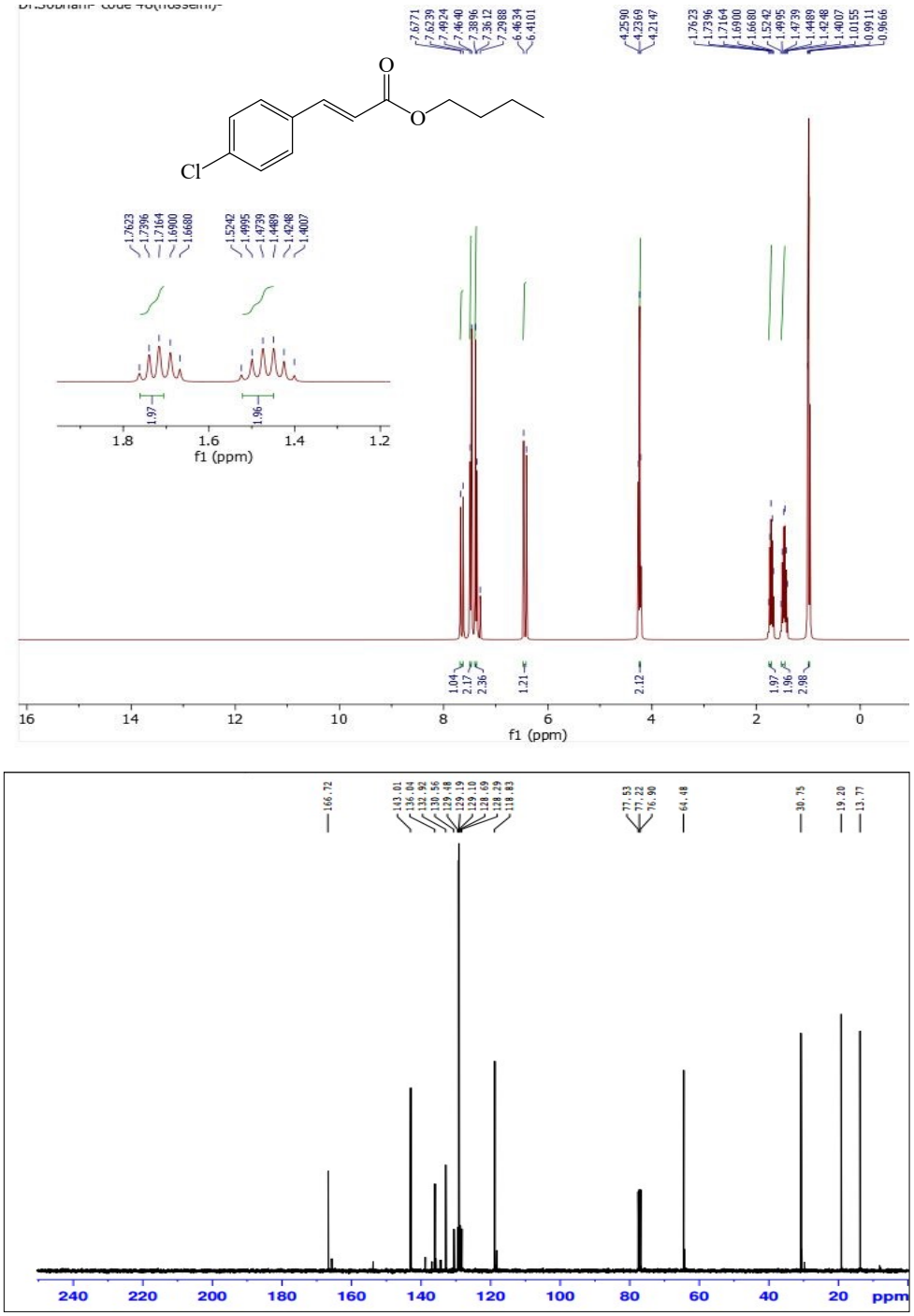



**Figure S40.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-*n*-butyl 3-(4-chlorophenyl) acrylate $^{1}$H NMR (300 MHz, $CDCl_3$): δ 7.65 (d, 1 H, *J* = 16.0 Hz), 7.47 (d, 2 H, *J* = 8.5 Hz), 7.37 (d, 2 H, *J* = 8.5 Hz), 6.43 (d, 1 H, *J* = 16.0 Hz), 4.24 (t, 2 H, *J* = 6.6 Hz), 1.40-1.52 (m, 2 H), 1.67-1.76 (m, 2 H), 0.99 (t, 3 H, *J* = 7.3 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 166.7, 143.0, 136.0, 132.9, 129.4, 129.1, 118.8, 64.4, 30.7, 19.2, 13.7 ppm (Table 6, entry 6).

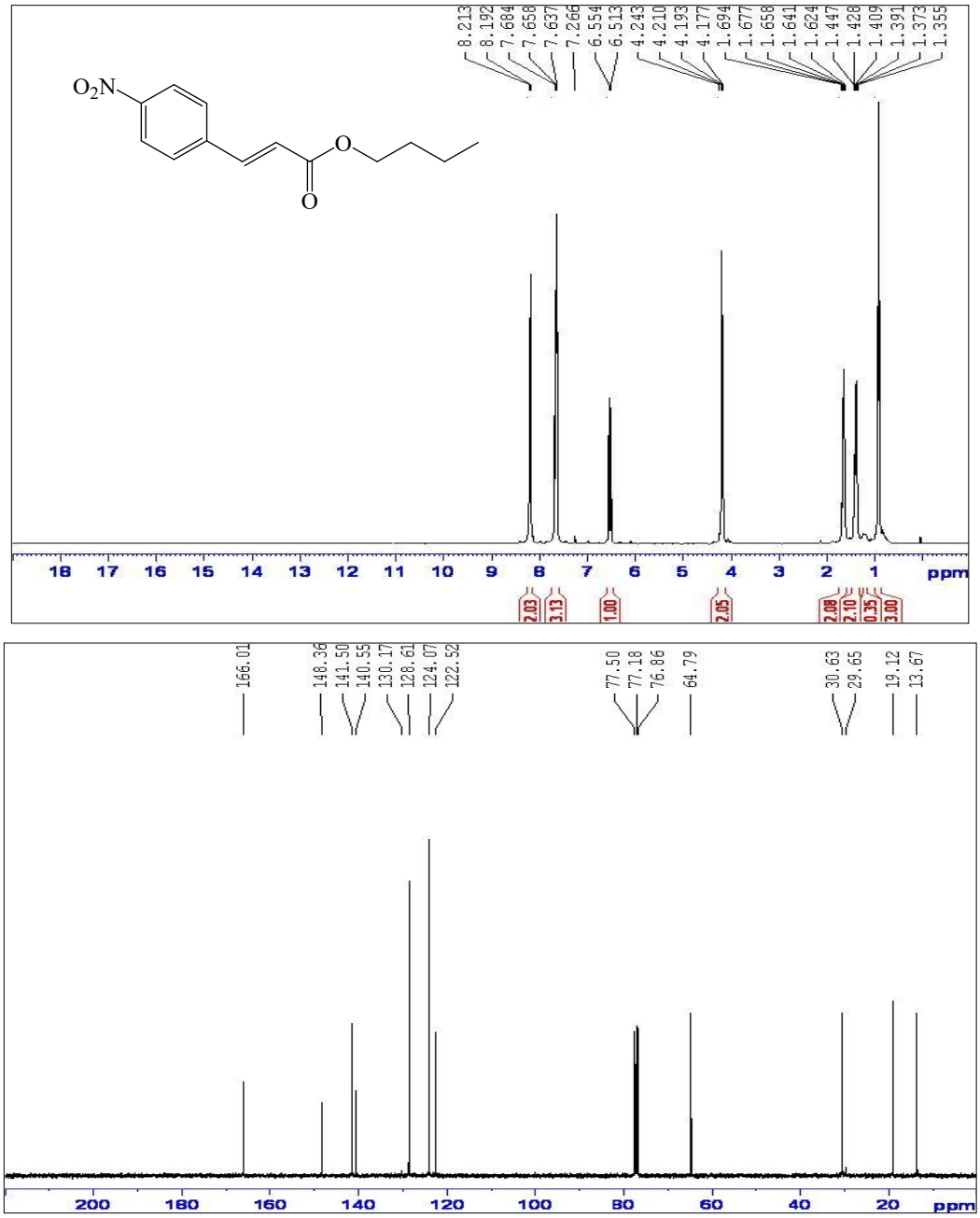



**Figure S41.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-*n*-butyl 3-(4-nitrophenyl) acrylate $^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.20 (d, 2 H, *J* = 8.0 Hz), 7.63-7.68 (m, 3 H), 6.53 (d, 1 H, *J* = 16.0 Hz), 4.17-4.24 (m, 2 H), 1.62-1.69 (m, 2 H), 1.35-1.44 (m, 2 H), 0.92 (t, 3 H, *J* = 7.2 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 166.0, 148.3, 141.5, 140.5, 128.6, 124.0, 122.5, 64.7, 30.6, 19.1, 13.6 ppm (Table 6, entries 8 and 11).

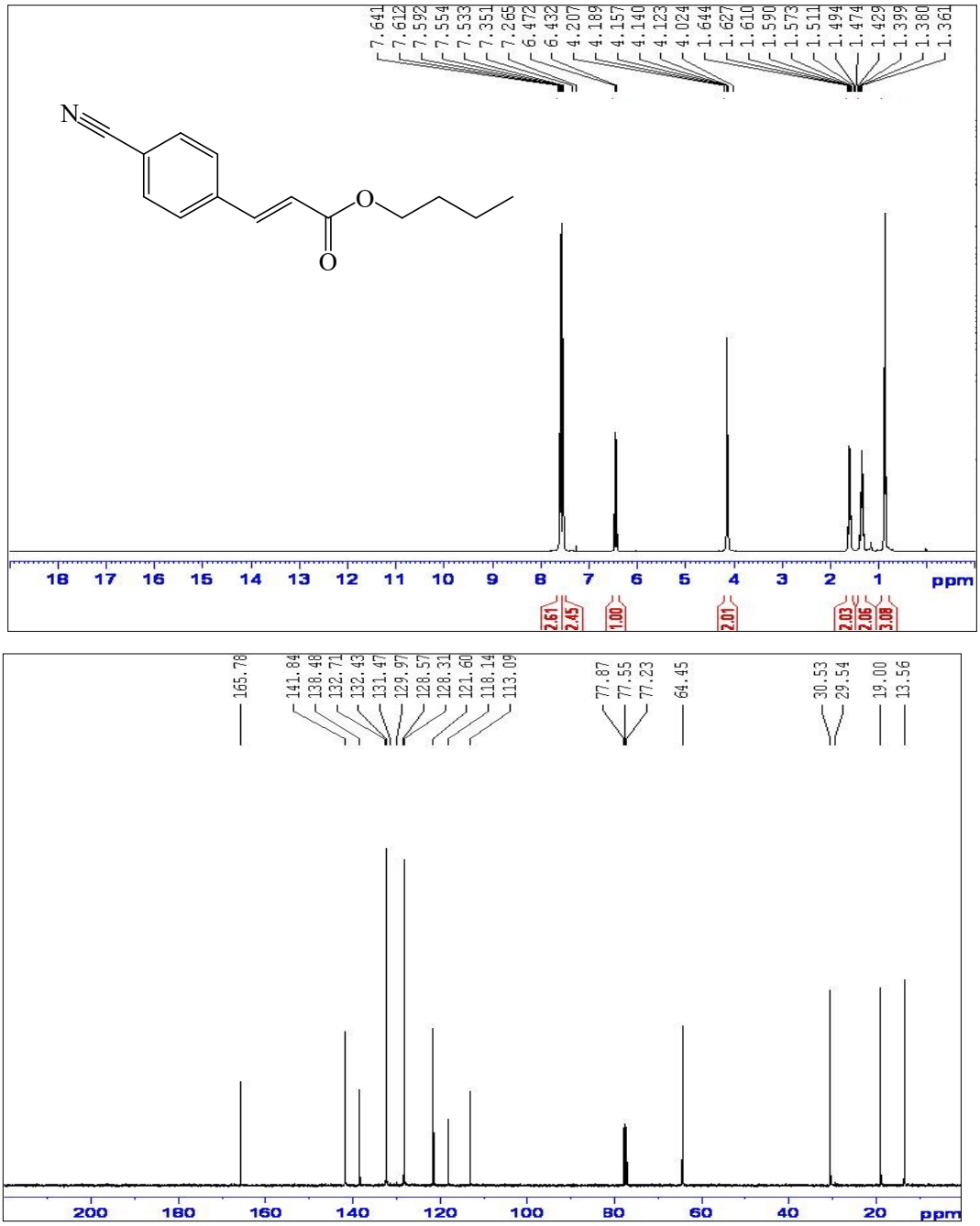



**Figure S42.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-*n*-butyl 3-(4-cyanophenyl) acrylate

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.60 (d, 2 H, *J* = 8.0 Hz), 7.57 (d, 1 H, *J* = 15.2 Hz), 7.54 (d, 2 H, *J* = 8.4 Hz), 6.45 (d, 1 H, *J* = 16.0 Hz), 4.14 (t, 2 H, *J* = 6.8 Hz), 1.57-1.64 (m, 2 H), 1.30-1.38 (m, 2 H), 0.77 (t, 3 H, *J* = 7.0 Hz) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 165.7, 141.8, 138.4, 132.4, 128.3, 121.6, 118.1, 113.0, 64.4, 30.5, 19.0, 13.5 ppm (Table 6, entries 9 and 12).

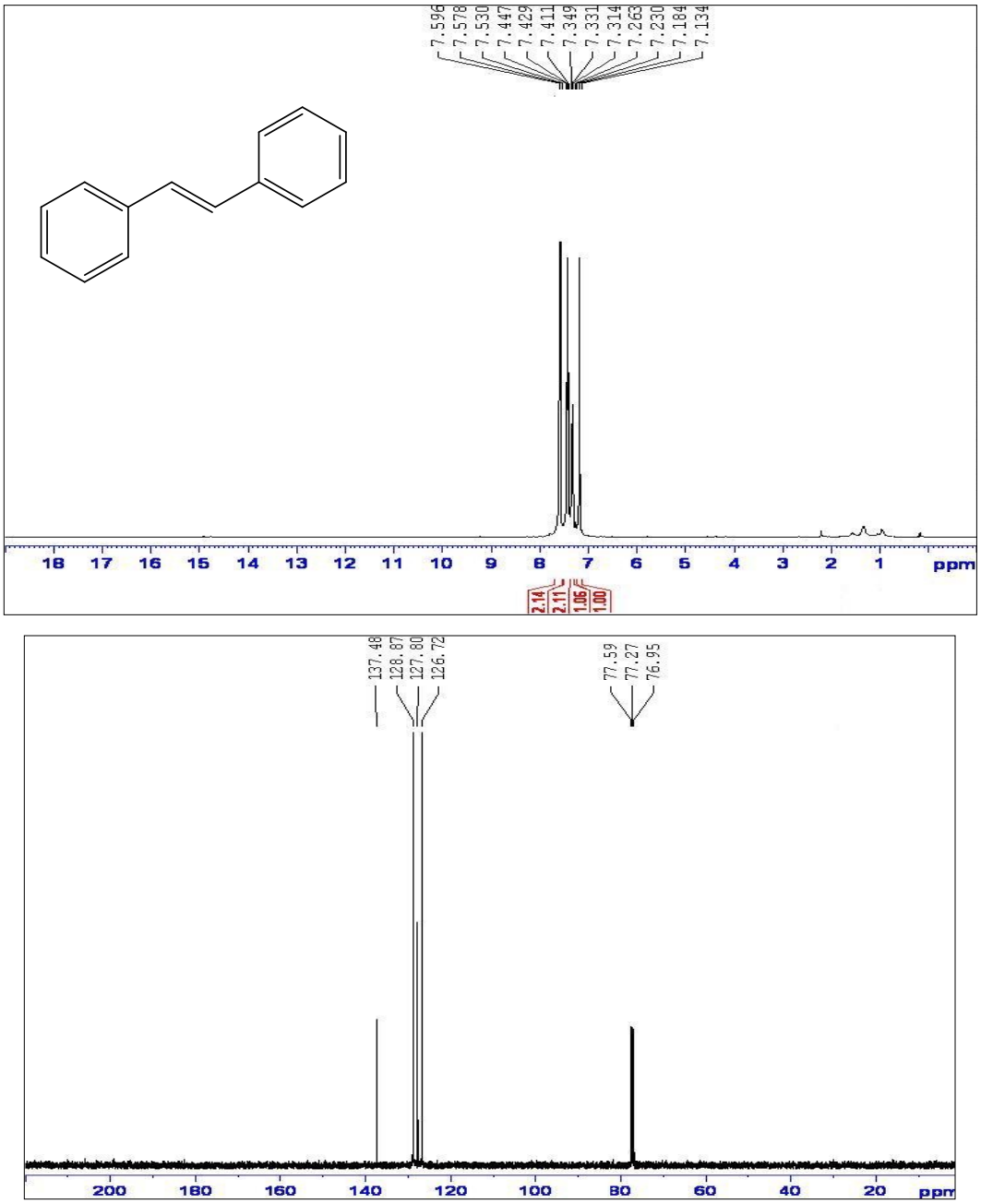



**Figure S43.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-1,2-diphenylethene

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.58 (d, 4 H, *J* = 7.2 Hz), 7.42 (t, 4 H, *J* = 7.0 Hz), 7.33 (t, 2 H, *J* = 6.8 Hz), 7.18 (s, 2 H) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 137.4, 128.8, 127.8, 126.7 ppm (Table 6, entries 13, 15 and 17).

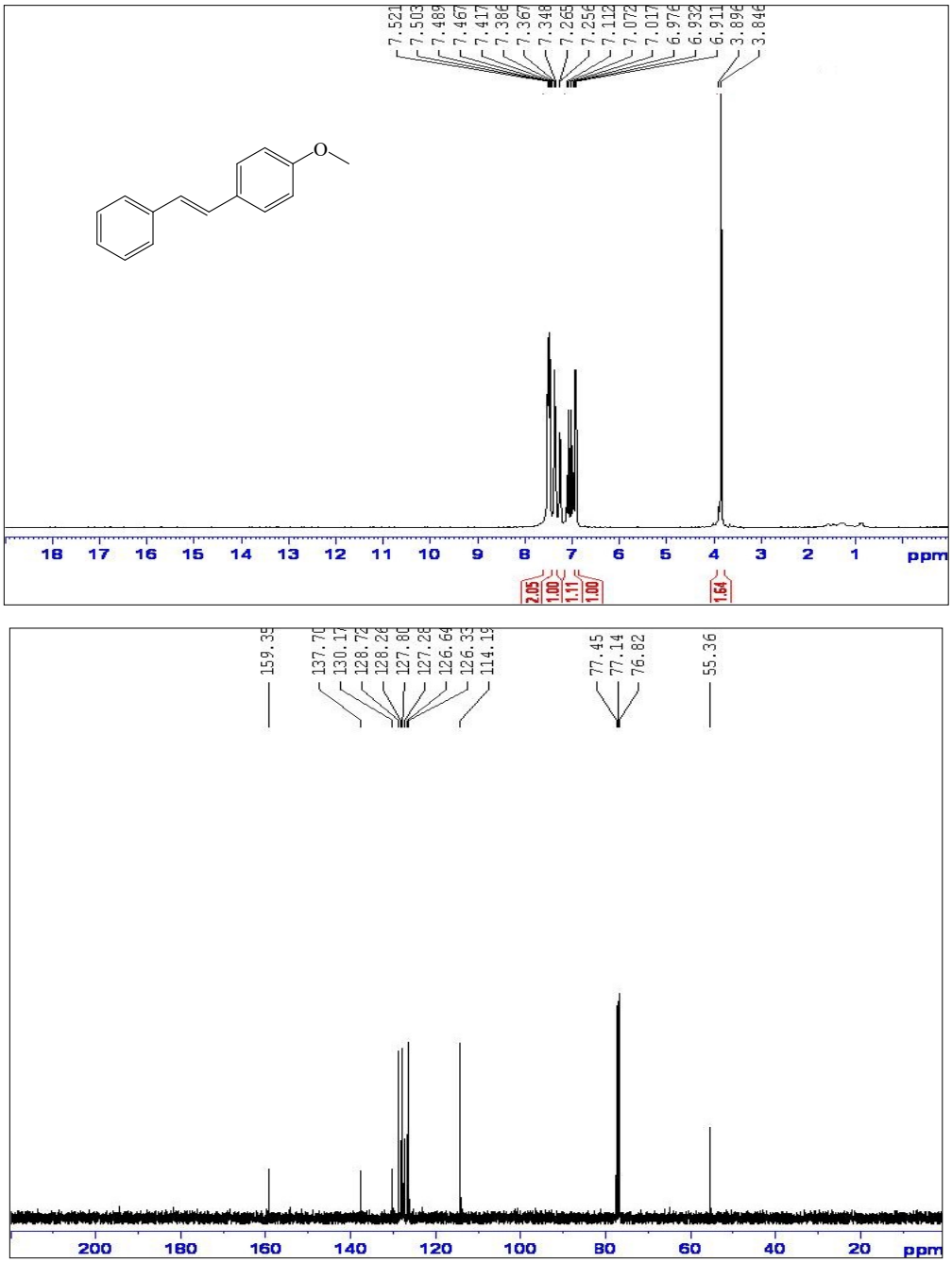



**Figure S44.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-1-methoxy-4-styrylbenzene

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 7.46-7.52 (m, 3 H), 7.36 (t, 2 H, *J* = 7.6 Hz), 7.09 (d, 2 H, *J* = 16.0 Hz), 6.99 (d, 2 H, *J* = 16.4 Hz), 6.92 (d, 2 H, *J* = 8.4 Hz), 3.89 (s, 3 H) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 159.3, 137.7, 130.1, 128.7, 128.2, 127.8, 127.2, 126.6, 126.3, 114.1, 55.3 ppm (Table 6, entry 14).

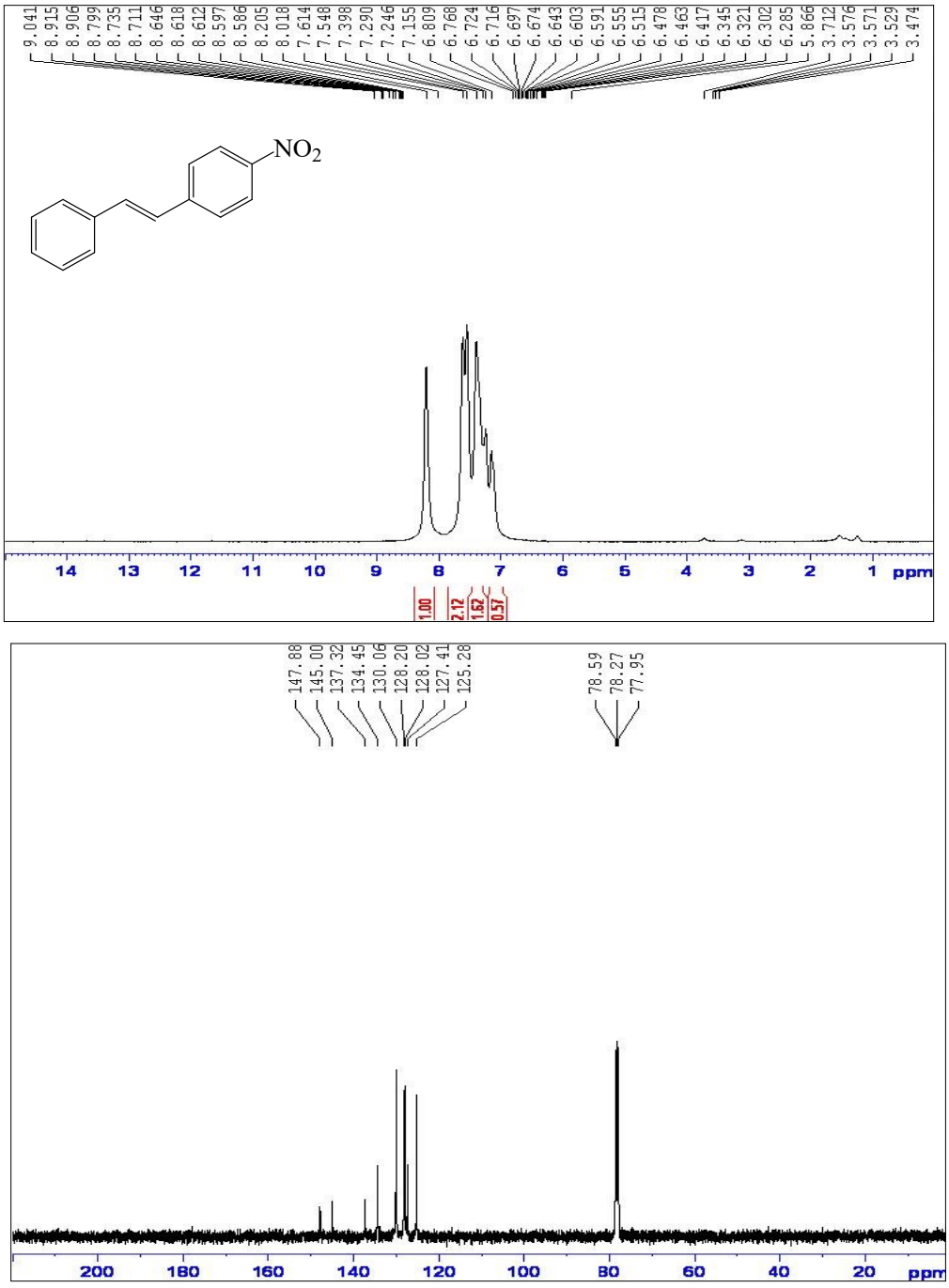



**Figure S45.** $^{1}$H NMR and $^{13}$C NMR spectra of (*E*)-1-nitro-4-styrylbenzene

$^{1}$H NMR (400 MHz, $CDCl_3$): δ 8.15-8.26 (m, 2 H), 7.49-766 (m, 4 H), 7.40-7.45 (m, 4 H), 7.06-7.18 (m, 1 H) ppm. $^{13}$C NMR (100 MHz, $CDCl_3$), δ 147.8, 145.0, 137.3, 134.4, 130.0, 128.2, 128.0, 127.4, 125.2 ppm (Table 6, entry 16).