

Electronic Supplementary Information

Organic photoredox catalysis enabled cross-coupling of arenediazonium and sulfinate salts: synthesis of (un)symmetrical diaryl/alkyl aryl sulfones

Ruchi Chawla and Lal Dhar S. Yadav*

Green Synthesis Lab, Department of Chemistry, University of Allahabad, Allahabad 211002, India

Tel.: (+91)-532-2500652; fax: (+91)-532-2460533; e-mail: lds Yadav@hotmail.com

General Information: Reagents were obtained from commercial suppliers, and used without further purification unless otherwise specified by a reference. All reactions were performed under a nitrogen atmosphere. Organic solutions were concentrated using a Buchi rotary evaporator. Column chromatography was carried out over silica gel (Merck 100–200 mesh) and TLC was performed using silica gel GF254 (Merck) plates. ¹H NMR spectra were recorded on a Bruker AVII 400 spectrometer in CDCl₃ using TMS as internal reference with chemical shift value being reported in ppm. All coupling constants (*J*) are reported in Hertz (Hz). ¹³C NMR spectra were recorded on the same instrument at 100 MHz in CDCl₃ and TMS was used as internal reference. Mass (EI) spectra were recorded on a JEOL D-300 mass spectrometer.

Typical procedure for VLPC enabled arylation of sulfinate salts

A solution of arenediazonium salt **1** (1.0 mmol), sulfinate salt **2** (1.3 mmol) and eosin Y (1 mol%) in CH₃CN/H₂O (10:1, 5 mL) was irradiated with visible-light (green light emitting diodes (LEDs), λ_{max} = 535 nm, 2.5 W) under a nitrogen atmosphere with stirring at rt for 8-18 h (Table 2 and 3). After completion of the reaction (monitored by TLC), water (5 mL) was added and the mixture was extracted with ethyl acetate (3 × 5 mL). The combined organic phase was dried over anhydrous Na₂SO₄, filtered, and concentrated under reduced pressure. The resulting crude product was purified by silica gel chromatography using a mixture of hexane/ethyl acetate (9:1) as eluent to afford an analytically pure sample of product **3/4**.

Typical procedure for one-pot VLPC enabled sulfonylation of anilines

To solution containing 1.0 mmol of aniline derivative **5** and 1 mol% of eosin Y in CH₃CN/H₂O 10:1 (5 mL) was successively added 0.2 mmol of methanesulfonic acid, 1.5 mmol of tert-butyl nitrite and 1.3 mmol of sulfinate salt **2a** under irradiation with visible-light (green light emitting diodes (LEDs), $\lambda_{\text{max}} = 535 \text{ nm}$, 2.5 W) and nitrogen atmosphere with stirring at rt for 10-13 h (Table 4). After completion of the reaction (monitored by TLC), water (5 mL) was added and the mixture was extracted with ethyl acetate (3 × 5 mL). The combined organic phase was dried over anhydrous Na₂SO₄, filtered, and concentrated under reduced pressure. The resulting crude product was purified by silica gel chromatography using a mixture of hexane/ethyl acetate (9:1) as eluent to afford an analytically pure sample of product **3**.

Light turn-ON/OFF experiment

The model reaction was alternatively irradiated with green LED ($\lambda_{\text{max}} = 535 \text{ nm}$, 2.50 W) and kept in the dark in two-hour intervals. The yield was determined by flash chromatography. The result has been shown in Fig. 1.

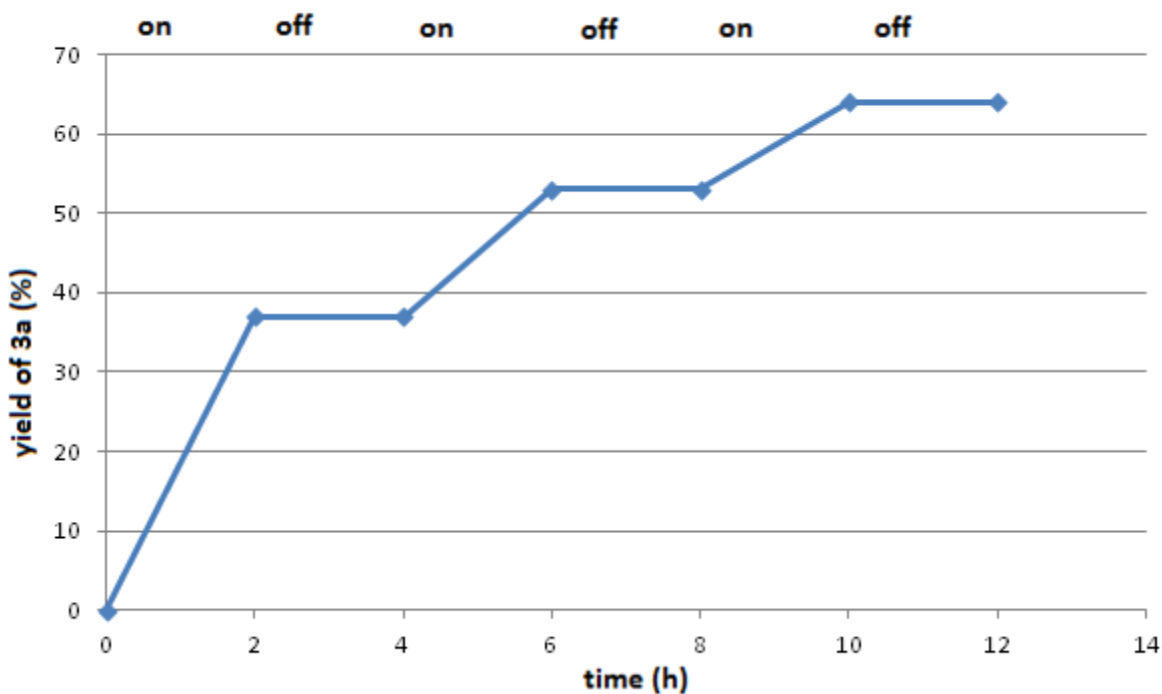


Fig. 1. Light turn-ON/OFF experiment.

Radical trapping experiment

1,1-Diphenylethylene (0.4 mmol, 2.0 equiv.) was added to the model reaction. The crude mixture of the reaction was detected by GC-MS. Products **3j**, **7** and **8** were detected, as shown in Fig. 2 and Fig. 3.

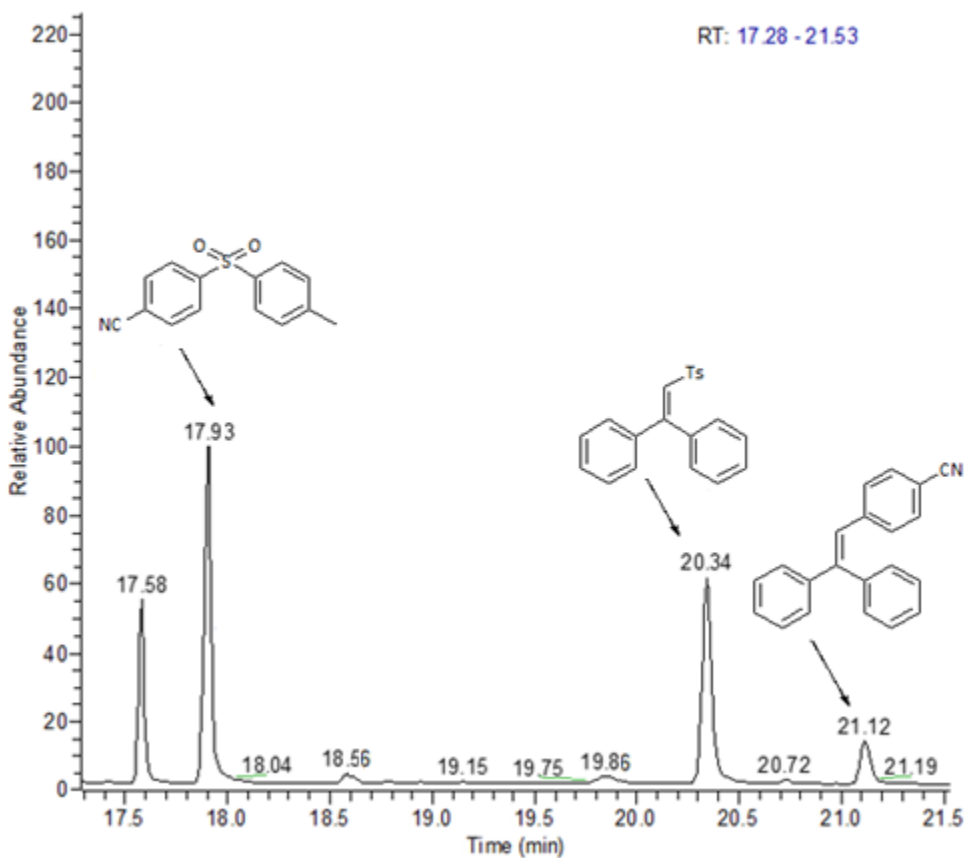
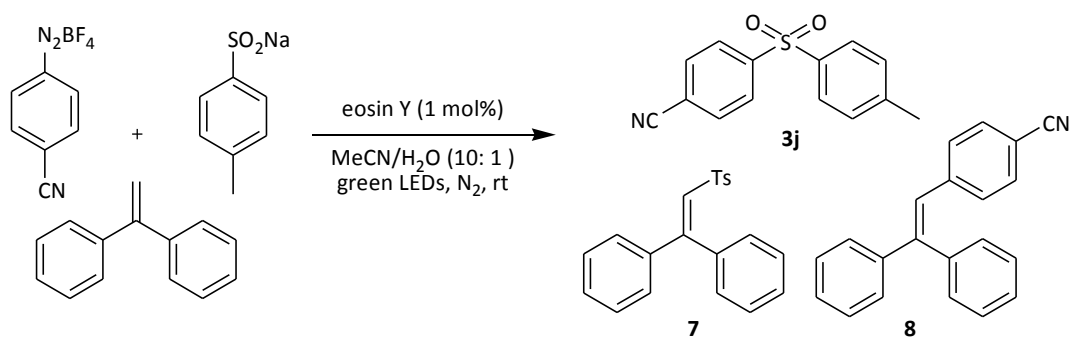


Fig. 2. GC of products **3j**, **7** and **8**.

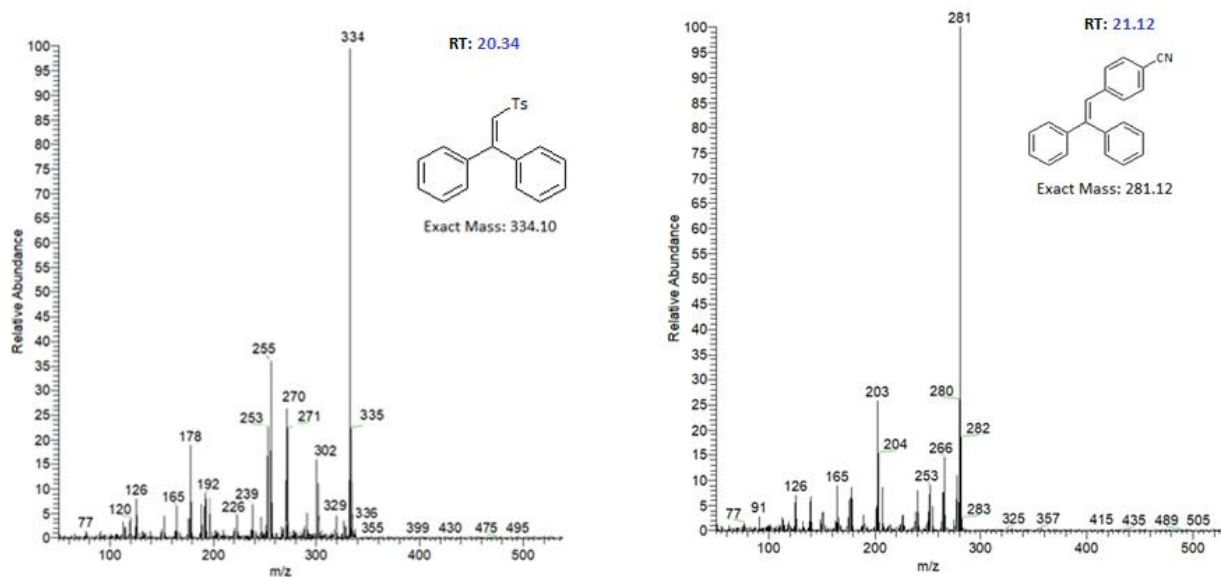
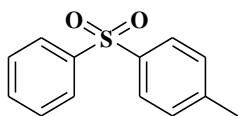


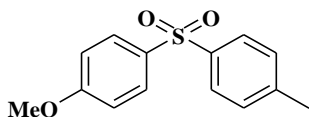
Fig. 3. MS (EI) of products **7** and **8**.

Spectroscopic and analytical data for compounds **3**



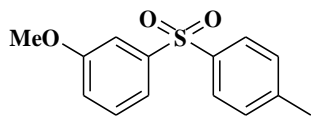
1-methyl-4-(phenylsulfonyl)benzene,¹⁻³ **3a**, yield 85%

¹H NMR (400 MHz, CDCl₃) δ 7.99 – 7.86 (m, 2H), 7.80 (d, *J* = 8.3 Hz, 2H), 7.59 – 7.43 (m, 3H), 7.31 (d, *J* = 8.0 Hz, 2H), 2.39 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 144.1, 142.0, 138.5, 132.9, 130.0, 129.1, 127.7, 127.5, 21.5. HRMS (EI); Mass calcd for C₁₃H₁₂O₂S [M]⁺: 232.0558; found 232.0562.



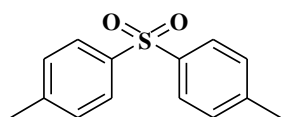
1-methoxy-4-tosylbenzene,^{1,3-5} **3b**, yield 72%

¹H NMR (400 MHz, CDCl₃) δ 7.87 – 7.85 (d, *J* = 8.8 Hz, 2H), 7.80 – 7.78 (d, *J* = 8.2 Hz, 2H), 7.28 – 7.26 (d, *J* = 7.9 Hz, 2H), 6.96 – 6.94 (d, *J* = 8.8 Hz, 2H), 3.83 (s, 3H), 2.38 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 163.2, 143.7, 139.3, 133.5, 129.7, 129.6, 127.3, 114.4, 55.6, 21.4. HRMS (EI); Mass calcd for C₁₄H₁₄O₃S [M]⁺: 262.0664; found 262.0662.



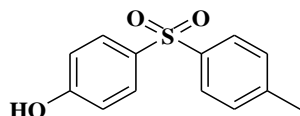
1-methoxy-3-tosylbenzene,¹ 3c, yield 74%

¹H NMR (400 MHz, CDCl₃) δ 7.82 (d, *J* = 8.2 Hz, 2H), 7.50-7.28 (m, 5H), 7.04 (m, 1H), 3.82 (s, 3H), 2.39 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃): δ 159.9, 144.2, 143.0, 138.5, 130.3, 130.0, 127.7, 119.7, 119.3, 112.1, 55.6, 21.5. **HRMS** (EI); Mass calcd for C₁₄H₁₄O₃S [M]⁺: 262.0664; found 262.0661.



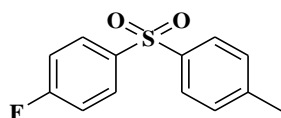
1-methyl-4-tosylbenzene,^{1,5} 3d, yield 75%

¹H NMR (400 MHz, CDCl₃) δ 7.80 (d, *J* = 8.3 Hz, 4H), 7.25 (d, *J* = 8.3 Hz, 4H), 2.39 (s, 6H). **¹³C NMR** (100 MHz, CDCl₃) δ 144.0, 139.0, 129.8, 127.5, 21.6. **HRMS** (EI); Mass calcd for C₁₄H₁₄O₂S [M]⁺: 246.0715; found 246.0713.



4-tosylphenol,² 3e, yield 73%

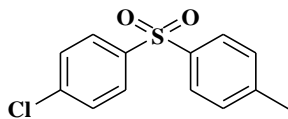
¹H NMR (400 MHz, CDCl₃) δ 7.77 (d, *J* = 8.2 Hz, 4H), 7.23 (d, *J* = 9.0 Hz, 2H), 6.85 (d, *J* = 8.4 Hz, 2H), 6.53 (s, 1H), 2.38 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 160.1, 143.9, 139.2, 133.1, 130.0, 129.8, 127.3, 116.2, 21.5. **HRMS** (EI); Mass calcd for C₁₃H₁₂O₃S [M]⁺: 246.0507; found 248.0508.



1-Fluoro-4-tosylbenzene,^{4,5} 3f, yield 91%

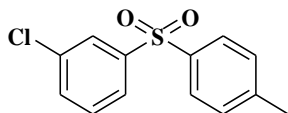
¹H NMR (400 MHz, CDCl₃) δ 7.99 – 7.93 (m, 2H), 7.82 – 7.79 (m, 2H), 7.31 – 7.29 (m, 2H), 7.21 – 7.14 (m, 2H), 2.38 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 165.2 (d, *J*_{CF} = 255.5 Hz), 144.3,

138.6, 138.0, 130.2 (d, $J_{CF} = 9.4$ Hz), 130.0, 127.7, 116.4 (d, $J_{CF} = 22.6$ Hz), 21.6. **HRMS** (EI); Mass calcd for $C_{13}H_{11}FO_2S$ $[M]^+$: 250.0464; found 250.0469.



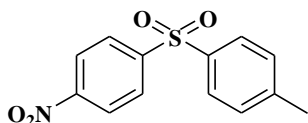
1-(4-chlorophenylsulfonyl)-4-methylbenzene,^{1,2} **3g, yield 88%**

1H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, $J = 8.5$ Hz, 2H), 7.79 (d, $J = 8.1$ Hz, 2H), 7.41 (d, $J = 8.5$ Hz, 2H), 7.29 (d, $J = 8.0$ Hz, 2H), 2.39 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 144.5, 140.4, 139.6, 138.1, 130.2, 129.5, 128.9, 127.7, 21.6. **HRMS** (EI); Mass calcd for $C_{13}H_{11}ClO_2S$ $[M]^+$: 266.0168; found 266.0170.



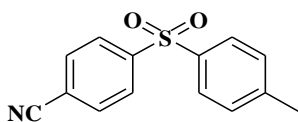
1-(3-chlorophenylsulfonyl)-4-methylbenzene,¹ **3h, yield 86%**

1H NMR (400 MHz, $CDCl_3$) δ 7.91-7.80 (m, 2H), 7.43-7.29 (m, 6H), 2.39 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 144.7, 143.6, 137.8, 135.4, 133.2, 130.6, 130.2, 127.8, 127.5, 125.4, 21.6. **HRMS** (EI); Mass calcd for $C_{13}H_{11}ClO_2S$ $[M]^+$: 266.0168; found 266.0171.



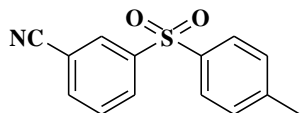
1-Methyl-4-((4-nitrophenyl)sulfonyl)benzene,⁵ **3i, yield 94%**

1H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, $J = 8.7$ Hz, 2H), 8.12 (d, $J = 8.7$ Hz, 2H), 7.85 (d, $J = 8.3$ Hz, 2H), 7.34 (d, $J = 8.1$ Hz, 2H), 2.43 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 150.2, 147.8, 145.5, 137.0, 130.3, 128.7, 128.1, 124.3, 21.6. **HRMS** (EI); Mass calcd for $C_{13}H_{11}NO_4S$ $[M]^+$: 277.0409; found 277.0406.



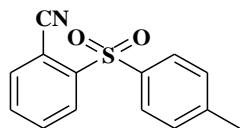
4-tosylbenzonitrile,^{2,5} **3j, yield 93%**

¹H NMR (400 MHz, CDCl₃) δ 8.04 (d, *J* = 8.4 Hz, 2H), 7.83 (d, *J* = 8.2 Hz, 2H), 7.78 (d, *J* = 8.3 Hz, 2H), 7.33 (d, *J* = 8.1 Hz, 2H), 2.43 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 146.2, 145.2, 137.2, 133.0, 130.3, 128.2, 128.0, 117.2, 116.7, 21.6. **HRMS** (EI); Mass calcd for C₁₄H₁₁NO₂S [M]⁺: 257.0510; found 257.0513.



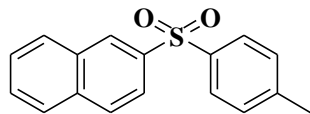
3-tosylbenzonitrile,^{2,5} 3k, yield 87%

¹H NMR (400 MHz, CDCl₃) δ 8.23–8.08 (m, 2H), 7.88–7.76 (m, 3H), 7.65 (t, *J* = 7.9 Hz, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 2.41 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 145.2, 143.9, 137.1, 136.0, 131.3, 131.2, 130.3, 128.0, 117.0, 113.8, 21.6. **HRMS** (EI); Mass calcd for C₁₄H₁₁NO₂S [M]⁺: 257.0510; found 257.0512.



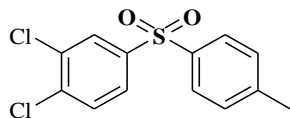
2-Tosylbenzonitrile,⁵ 3l, yield 88%

¹H NMR (400 MHz, CDCl₃) δ 8.35–8.27 (m, 1H), 7.97 (d, *J* = 8.2 Hz, 2H), 7.86–7.77 (m, 2H), 7.72–7.62 (m, 1H), 7.33 (d, *J* = 8.1 Hz, 2H), 2.43 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 145.3, 144.1, 136.5, 135.6, 133.2, 133.0, 130.1, 129.6, 128.7, 115.6, 111.2, 21.6. **HRMS** (EI); Mass calcd for C₁₄H₁₁NO₂S [M]⁺: 257.0510; found 257.0509.



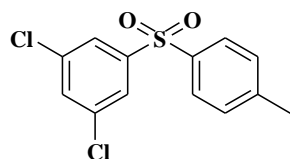
2-tosyl-naphthalene,² 3m, yield 78%

¹H NMR (400 MHz, CDCl₃) δ 8.58 (s, 1H), 8.01 – 7.79 (m, 6H), 7.67 – 7.53 (m, 2H), 7.29 (d, *J* = 8.4 Hz, 2H), 2.37 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 144.1, 138.8, 138.7, 134.9, 129.8, 129.6, 129.4, 129.1, 128.8, 127.9, 127.7, 127.5, 122.5, 21.5. **HRMS** (EI); Mass calcd for C₁₇H₁₄O₂S [M]⁺: 282.0715; found 282.0718.



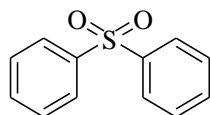
1,2-dichloro-4-tosylbenzene,¹ 3n, yield 92%

¹H NMR (400 MHz, CDCl₃) δ 8.01 - 7.74 (m, 3H), 7.57 - 7.53 (d, *J* = 8.8 Hz, 2H), 7.32 - 7.29 (d, *J* = 7.6 Hz, 2H), 2.40 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃): δ 144.9, 141.8, 138.0, 137.6, 131.4, 130.9, 130.1, 129.4, 128.6, 127.8, 21.5. **HRMS** (EI); Mass calcd for C₁₃H₁₀Cl₂O₂S [M]⁺: 299.9779; found 299.9776.



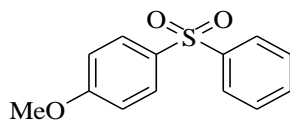
1,3-dichloro-5-tosylbenzene,¹ 3o, yield 91%

¹H NMR (400 MHz, CDCl₃) δ 7.79-7.75 (m, 3H), 7.49-7.30 (m, 4H), 2.41 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃): δ 145.2, 144.8, 137.1, 136.2, 133.0, 130.3, 128.0, 125.8, 21.6. **HRMS** (EI); Mass calcd for C₁₃H₁₀Cl₂O₂S [M]⁺: 299.9779; found 299.9777.



Sulfonyldibenzene,^{3,4} 4a, yield 92%

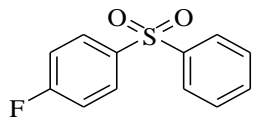
¹H NMR (400 MHz, CDCl₃) δ 7.98 - 7.93 (m, 4H), 7.59 - 7.56 (m, 2H), 7.53 - 7.45 (m, 4H). **¹³C NMR** (100 MHz, CDCl₃) δ 141.7, 133.2, 129.4, 127.7. **HRMS** (EI); Mass calcd for C₁₂H₁₀O₂S [M]⁺: 218.0402; found 218.0401.



1-Methoxy-4-(phenylsulfonyl)benzene,^{3,4} 4b, yield 88%

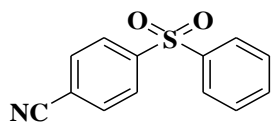
¹H NMR (400 MHz, CDCl₃) δ 7.93 - 7.90 (m, 2H), 7.89 - 7.86 (m, 2H), 7.58 - 7.43 (m, 3H), 6.98 - 6.95 (m, 2H), 3.84 (s, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 164.4, 142.4, 133.3, 133.0, 130.1,

129.2, 127.3, 114.6, 55.7. **HRMS** (EI); Mass calcd for C₁₃H₁₂O₃S [M]⁺: 248.0507; found 248.0509.



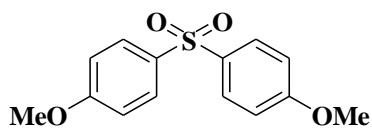
1-Fluoro-4-(phenylsulfonyl)benzene,^{3,4} 4c, yield 95%

¹H NMR (400 MHz, CDCl₃) δ 8.00–7.91 (m, 4H), 7.61–7.54 (m, 1H), 7.55–7.50 (m, 2H), 7.21–7.14 (m, 2H). **¹³C NMR** (100 MHz, CDCl₃) δ 165.4 (d, *J*_{CF} = 256.0 Hz), 141.6, 137.8, 133.4, 130.5 (d, *J*_{CF} = 9.6 Hz), 129.3, 127.6, 116.7 (d, *J*_{CF} = 23.2 Hz). **HRMS** (EI); Mass calcd for C₁₂H₉FO₂S [M]⁺: 236.0307; found 236.0305.



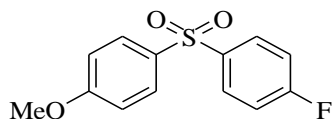
4-(phenylsulfonyl)benzonitrile,³ 4d, yield 93%

¹H NMR (400 MHz, CDCl₃) δ 8.07–8.00 (m, 2H), 7.97–7.91 (m, 2H), 7.83–7.76 (m, 2H), 7.65–7.50 (m, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 146.0, 140.3, 134.1, 133.2, 129.8, 128.4, 128.1, 117.3, 117.0. **HRMS** (EI); Mass calcd for C₁₃H₉NO₂S [M]⁺: 243.0354; found 243.0355.



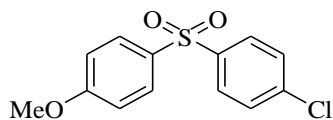
1-(4-methoxyphenylsulfonyl)-4-methoxybenzene,³ 4e, yield 78%

¹H NMR (400 MHz, CDCl₃) δ 7.89–7.79 (m, 4H), 7.03–6.92 (m, 4H), 3.85 (s, 6H). **¹³C NMR** (100 MHz, CDCl₃) δ 163.3, 134.2, 129.7, 114.7, 55.7. **HRMS** (EI); Mass calcd for C₁₄H₁₄O₄S [M]⁺: 278.0613; found 278.0615.



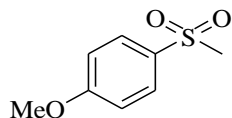
1-Fluoro-4-((4-methoxyphenyl)sulfonyl)benzene,⁴ 4f, yield 84%

¹H NMR (400 MHz, CDCl₃) δ 7.96–7.91 (m, 2H), 7.88–7.83 (m, 2H), 7.17–7.12 (m, 2H), 7.00–6.93 (m, 2H), 3.84 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 165.2 (d, *J*_{CF} = 255.4 Hz), 163.4, 138.5 (d, *J*_{CF} = 3.2 Hz), 132.9, 130.1 (d, *J*_{CF} = 9.5 Hz), 129.9, 116.4 (d, *J*_{CF} = 22.8 Hz), 114.7, 55.7. **HRMS** (EI); Mass calcd for C₁₃H₁₁FO₃S [M]⁺: 266.0413; found 266.0411.



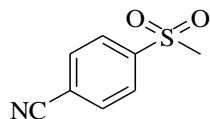
1-Chloro-4-((4-methoxyphenyl)sulfonyl)benzene,⁴ 4g, yield 80%

¹H NMR (400 MHz, CDCl₃) δ 7.88–7.83 (m, 4H), 7.45–7.41 (m, 2H), 6.98–6.93 (m, 2H), 3.83 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 163.5, 141.0, 139.3, 132.6, 129.9, 129.4, 128.6, 114.7, 55.5. **HRMS** (EI); Mass calcd for C₁₃H₁₁ClO₃S [M]⁺: 282.0117; found 282.0118.



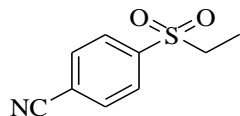
1-methoxy-4-(methylsulfonyl)benzene,³ 4h, yield 48%

¹H NMR (400 MHz, CDCl₃) δ 7.92–7.81 (m, 2H), 7.07–6.95 (m, 2H), 3.90 (s, 3H), 3.05 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 163.9, 132.4, 129.5, 114.6, 55.8, 45.1. **HRMS** (EI); Mass calcd for C₈H₁₀O₃S [M]⁺: 186.0351; found 186.0349.



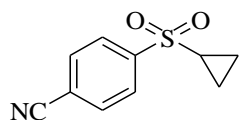
4-(Methylsulfonyl)benzonitrile,⁵ 4i, yield 60%

¹H NMR (400 MHz, CDCl₃) δ 8.08 (d, *J* = 8.5 Hz, 2H), 7.92 (d, *J* = 8.5 Hz, 2H), 3.08 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 144.5, 133.2, 128.3, 117.6, 117.1, 44.1. **HRMS** (EI); Mass calcd for C₈H₇NO₂S [M]⁺: 181.0192; found 181.0194.



4-(Ethylsulfonyl)benzonitrile,⁵ 4j, yield 62%

¹H NMR (400 MHz, CDCl₃) δ 8.03 (d, *J* = 8.4 Hz, 2H), 7.90 (d, *J* = 8.4 Hz, 2H), 3.13 (q, *J* = 7.2 Hz, 2H), 1.32 (t, *J* = 7.2 Hz, 3H). **¹³C NMR** (100 MHz, CDCl₃) δ 142.7, 133.1, 129.1, 117.5, 117.0, 50.5, 7.2. **HRMS** (EI); Mass calcd for C₉H₉NO₂S [M]⁺: 195.0349; found 195.0347.



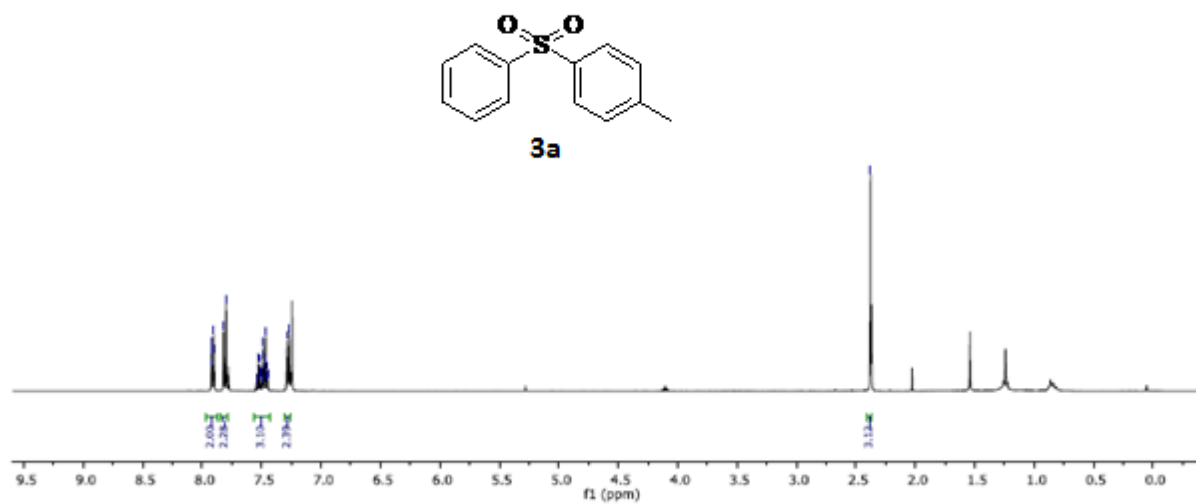
4-(Cyclopropylsulfonyl)benzonitrile,⁵ 4k, yield 58%

¹H NMR (400 MHz, CDCl₃) δ 8.01 (d, *J* = 8.3 Hz, 2H), 7.87 (d, *J* = 8.3 Hz, 2H), 2.44–2.55 (m, 1H), 1.50–1.37 (m, 2H), 1.19–1.07 (m, 2H). **¹³C NMR** (100 MHz, CDCl₃) δ 144.8, 132.9, 128.3, 117.1, 116.1, 32.6, 6.4. **HRMS** (EI); Mass calcd for C₁₀H₉NO₂S [M]⁺: 207.0349; found: 207.0351.

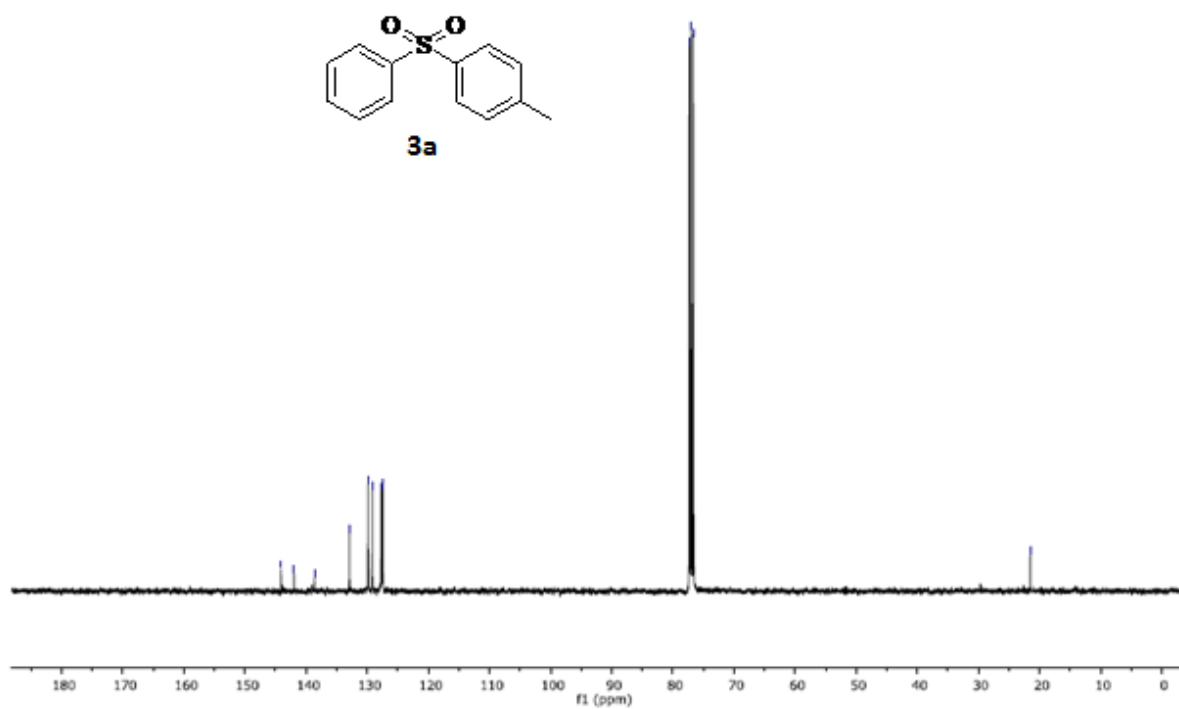
References

1. S. H. Gund, R. S. Shelkar and J. M. Nagarkar, *RSC Adv.*, 2015, **5**, 62926.
2. H. Yue, C. Zhu and M. Rueping, *Angew. Chem., Int. Ed.*, 2018, **57**, 1371.
3. N.-W. Liu, K. Hofman, A. Herbert and G. Manolikakes, *Org. Lett.*, 2018, **20**, 760.
4. D. H. Kim, J. Lee and A. Lee, *Org. Lett.*, 2018, **20**, 764.
5. L. Chen, J. Liang, Z.-yu Chen, J. Chen, M. Yan and X. Zhang, *Adv. Synth. Catal.*, 2019, **361**, 956.

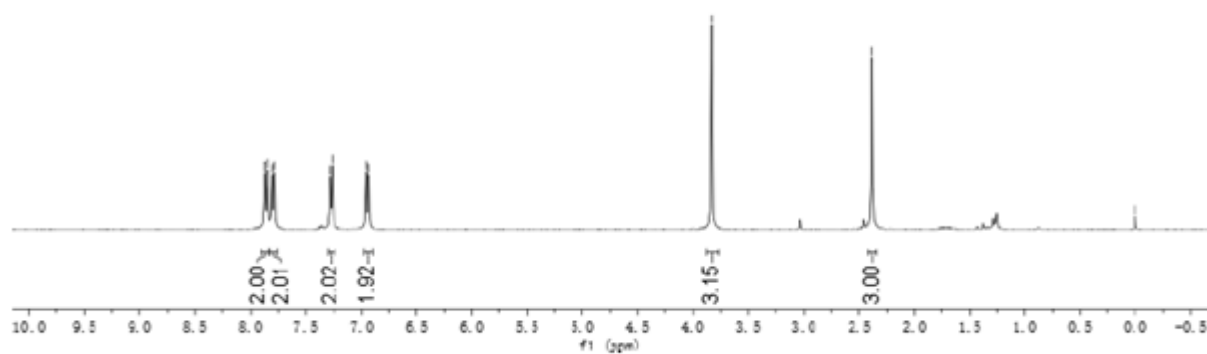
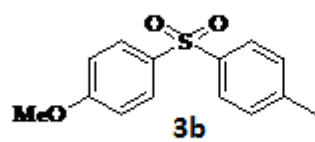
Copies of ¹H and ¹³C-NMR spectra of compounds 3a-o and 4a-k.



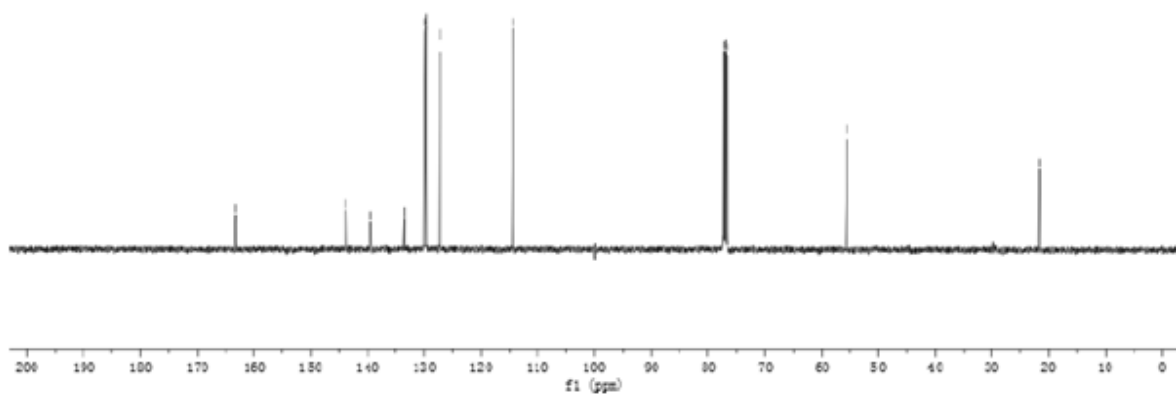
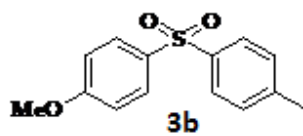
¹H-NMR Spectrum



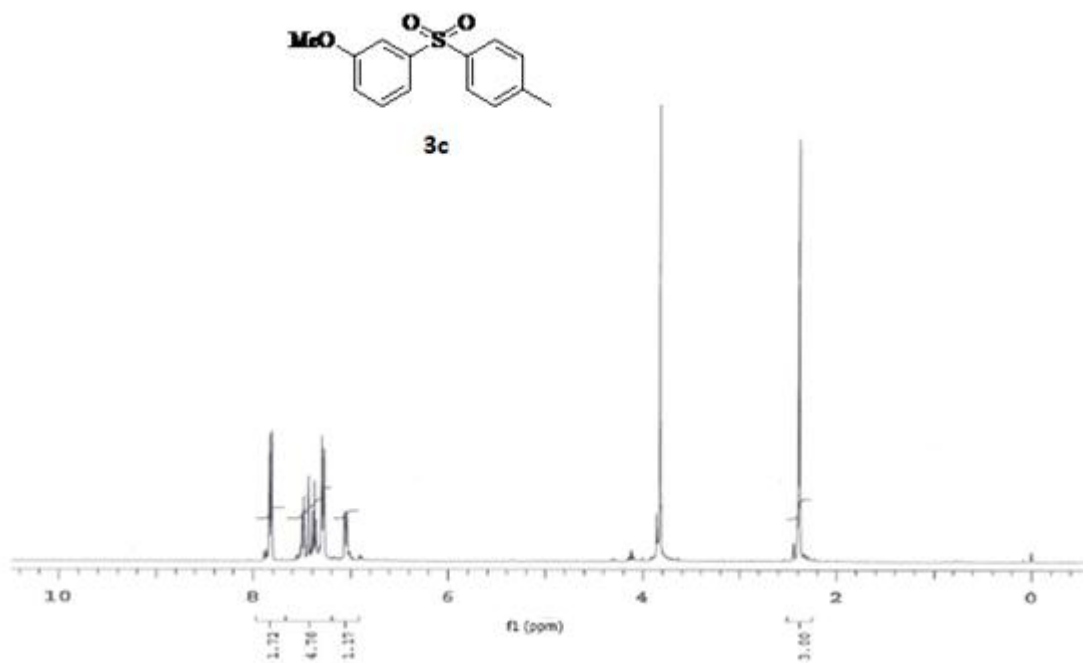
¹³C-NMR Spectrum



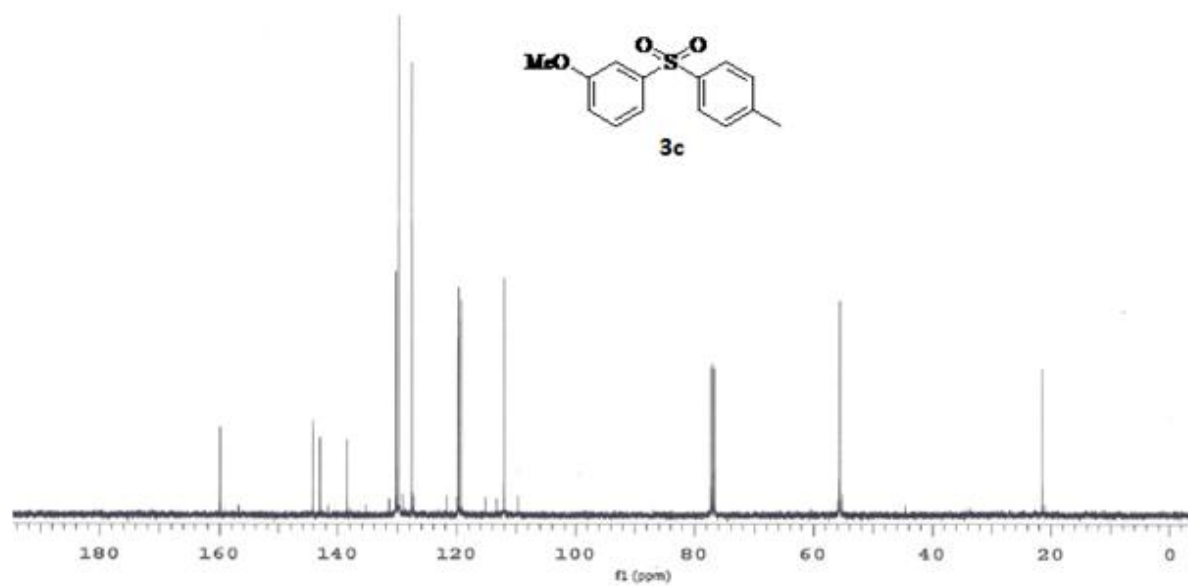
¹H-NMR Spectrum



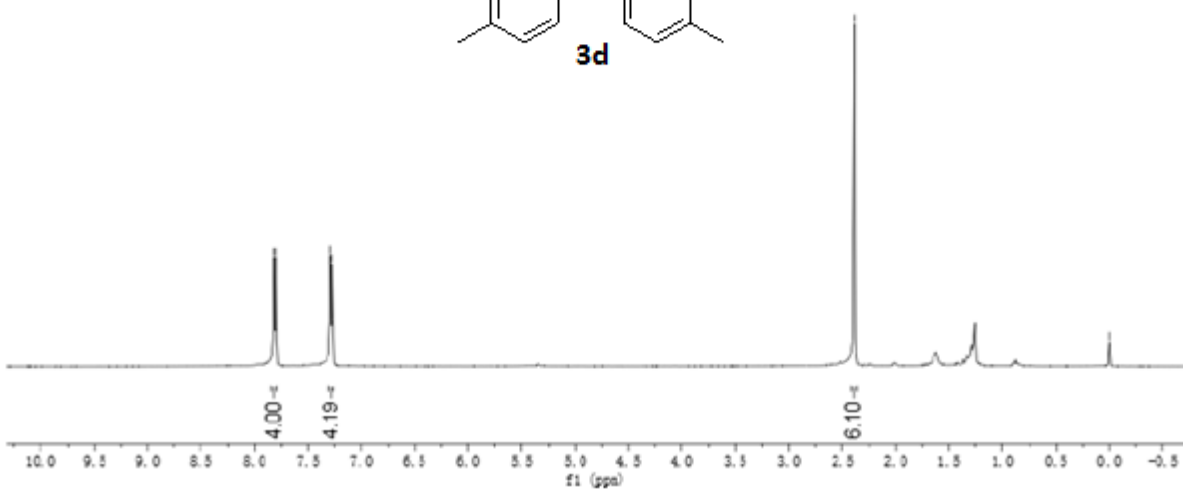
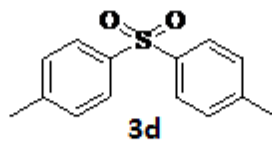
¹³C-NMR Spectrum



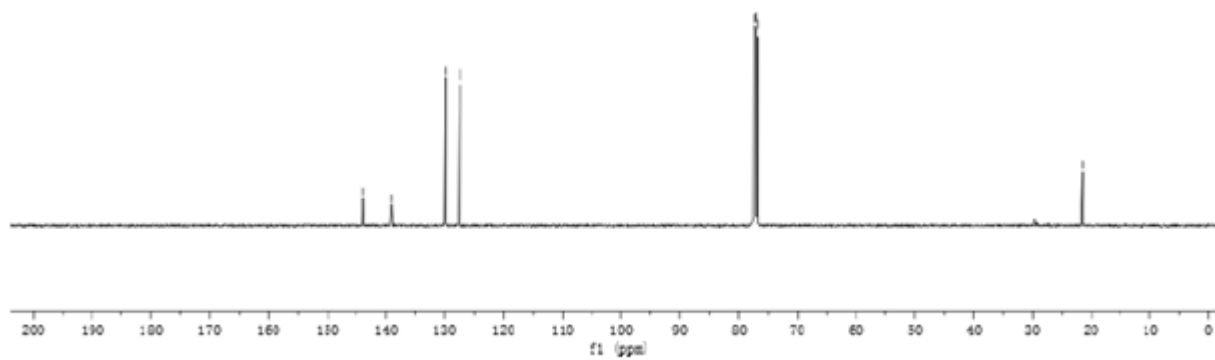
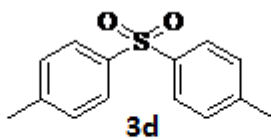
¹H-NMR Spectrum



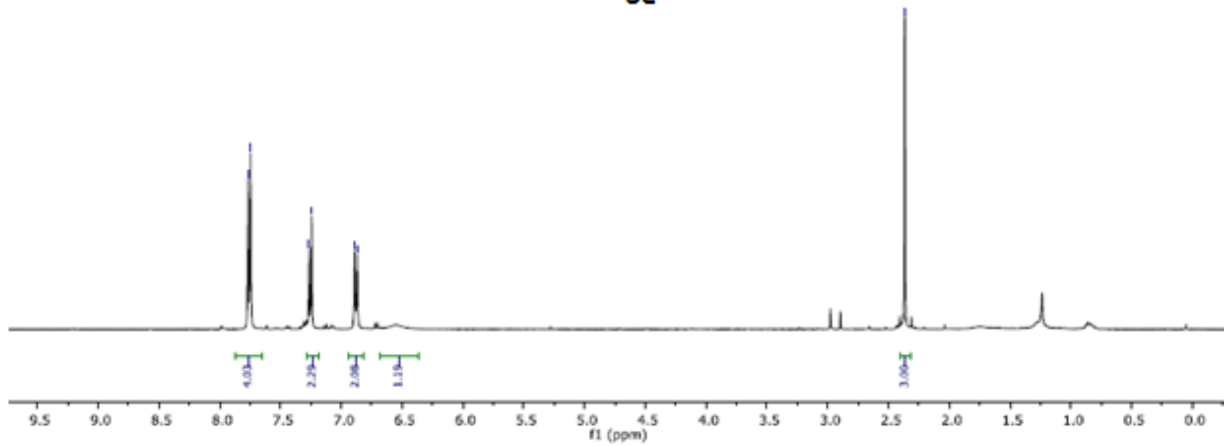
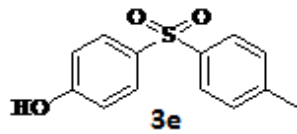
¹³C-NMR Spectrum



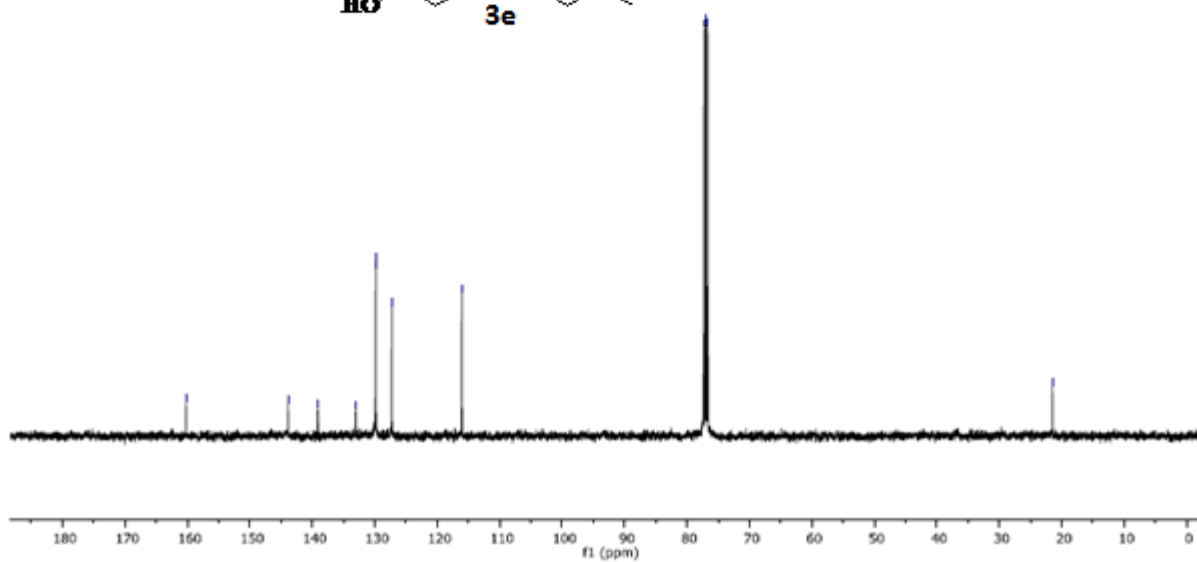
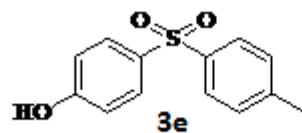
¹H-NMR Spectrum



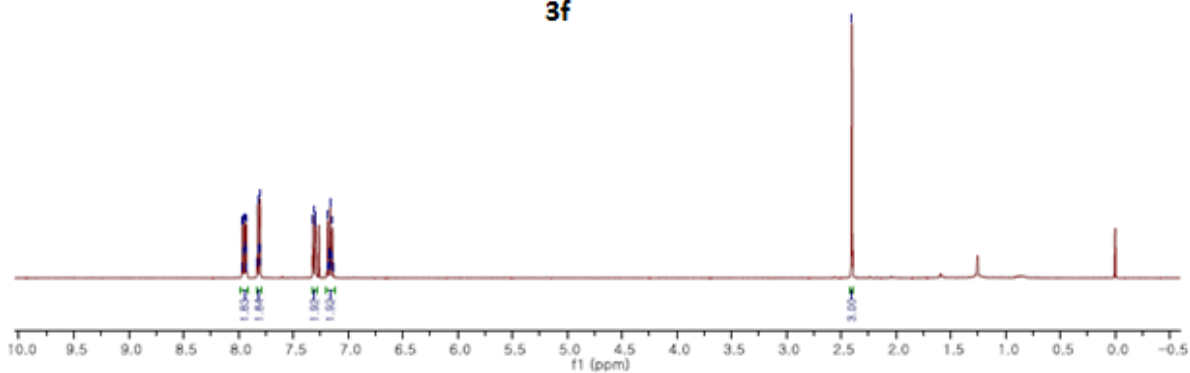
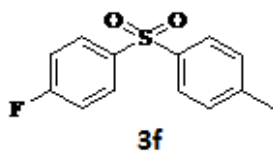
¹³C-NMR Spectrum



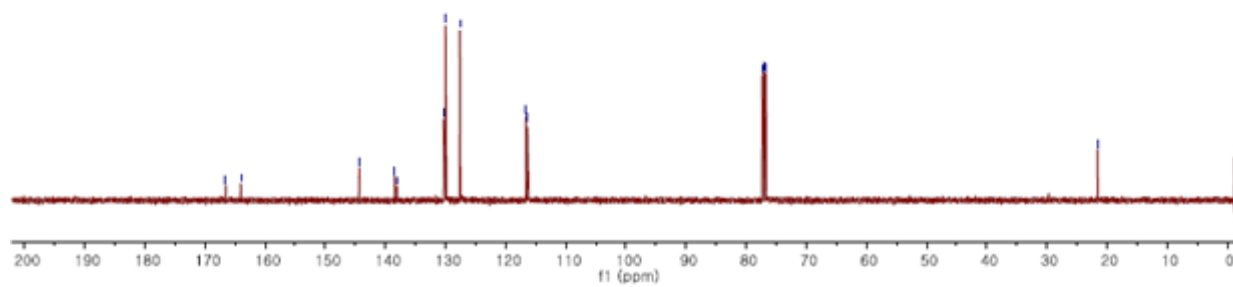
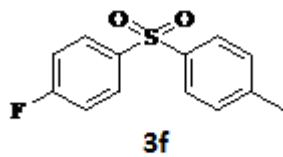
¹H-NMR Spectrum



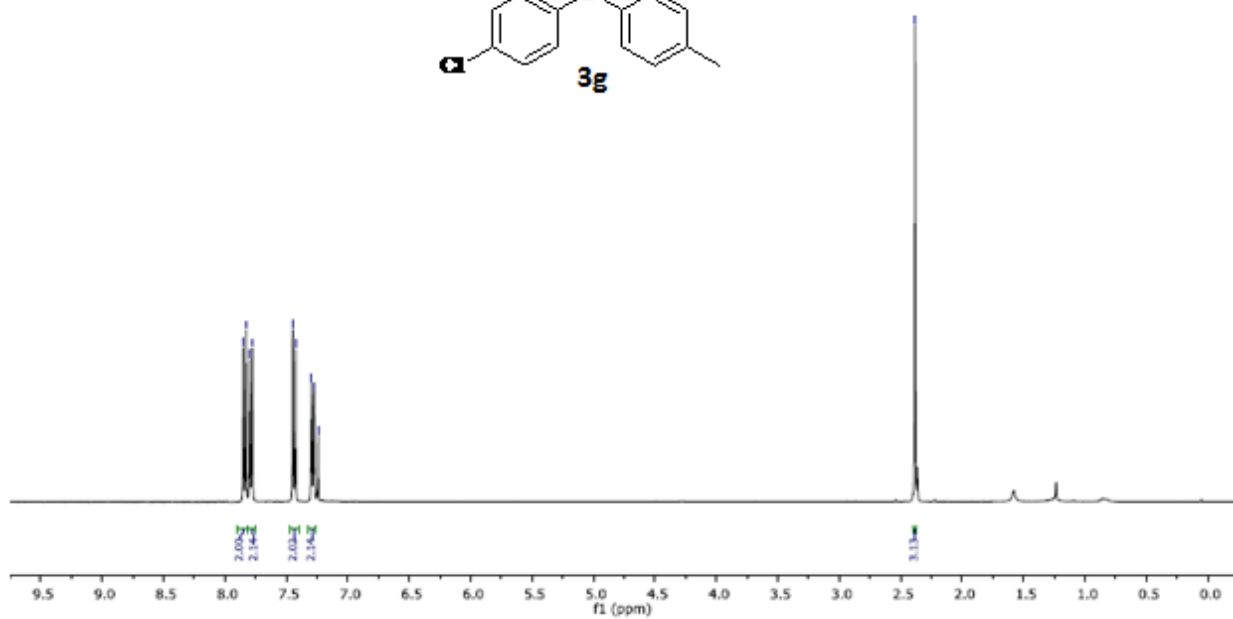
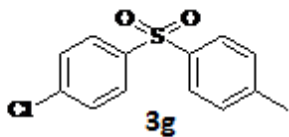
¹³C-NMR Spectrum



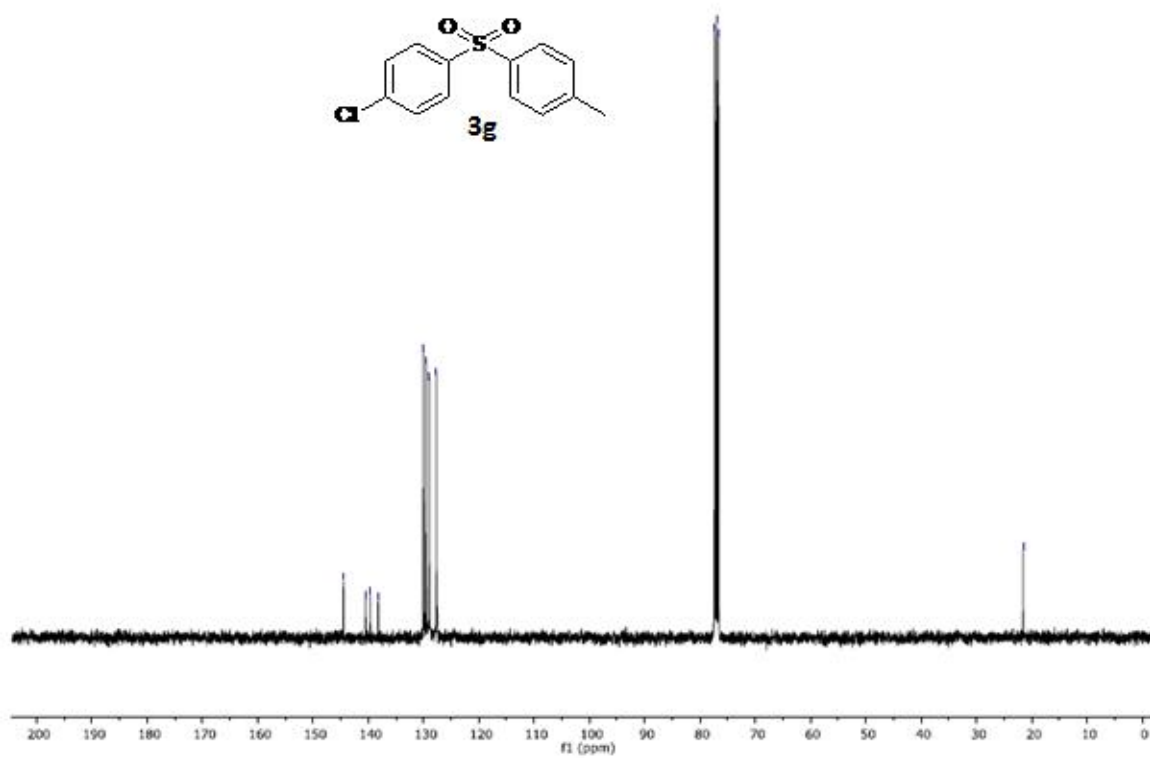
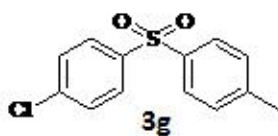
¹H-NMR Spectrum



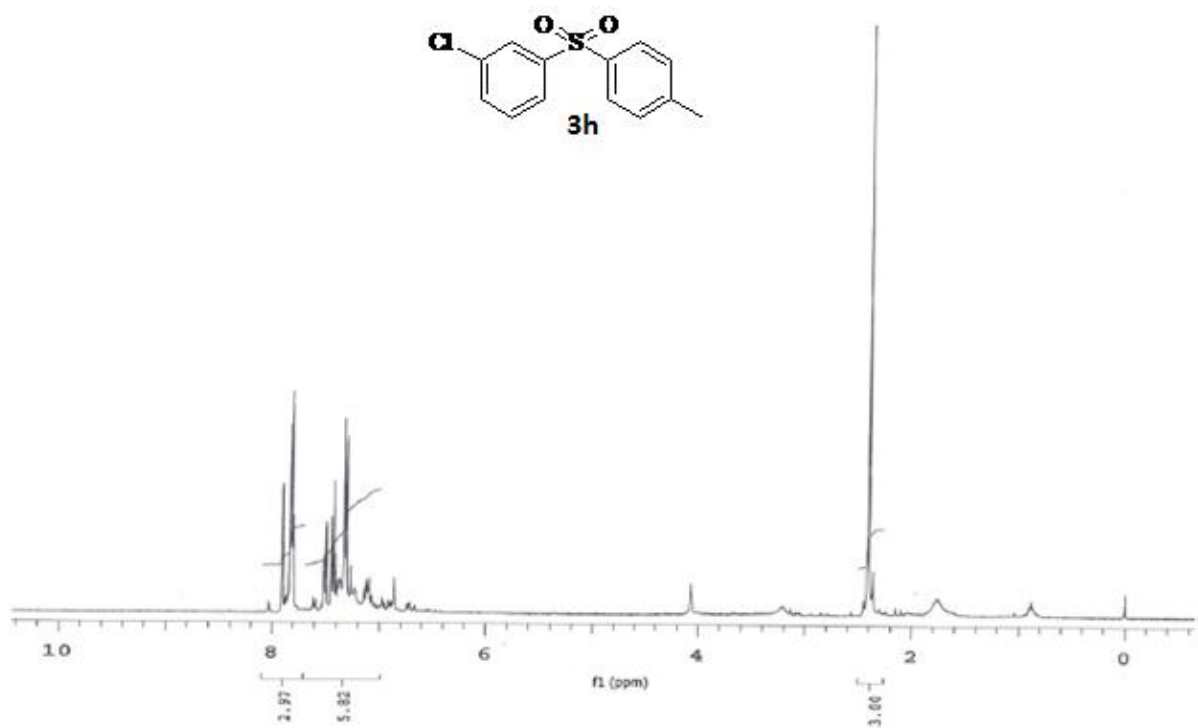
¹³C-NMR Spectrum



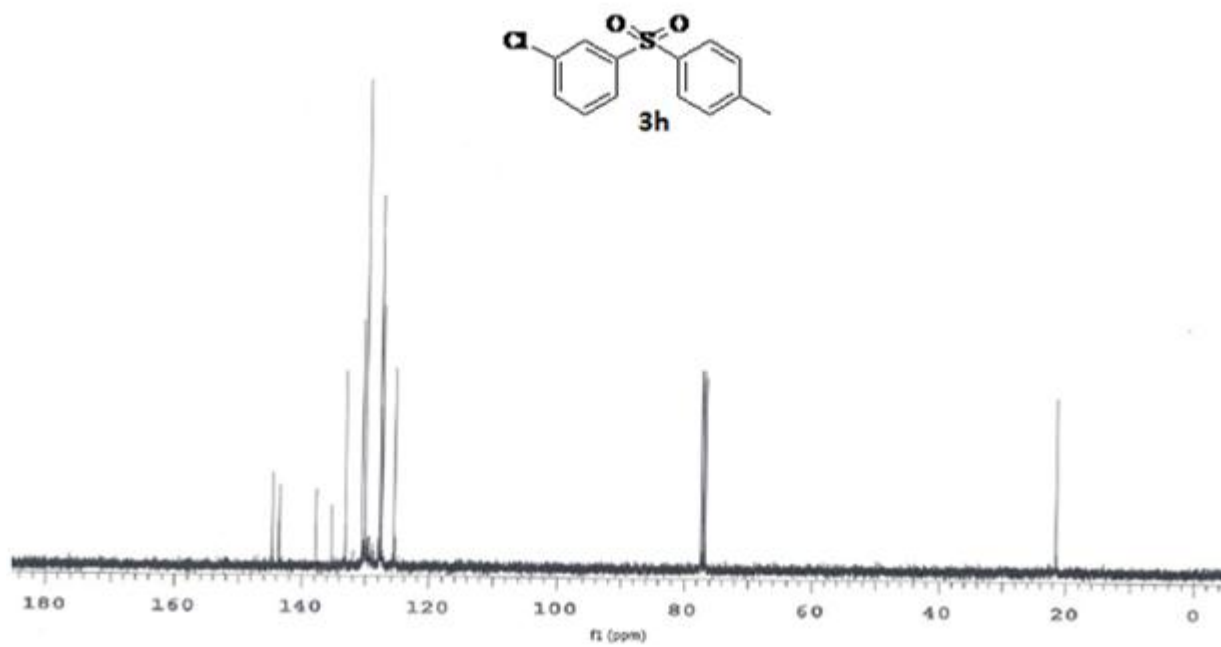
¹H-NMR Spectrum



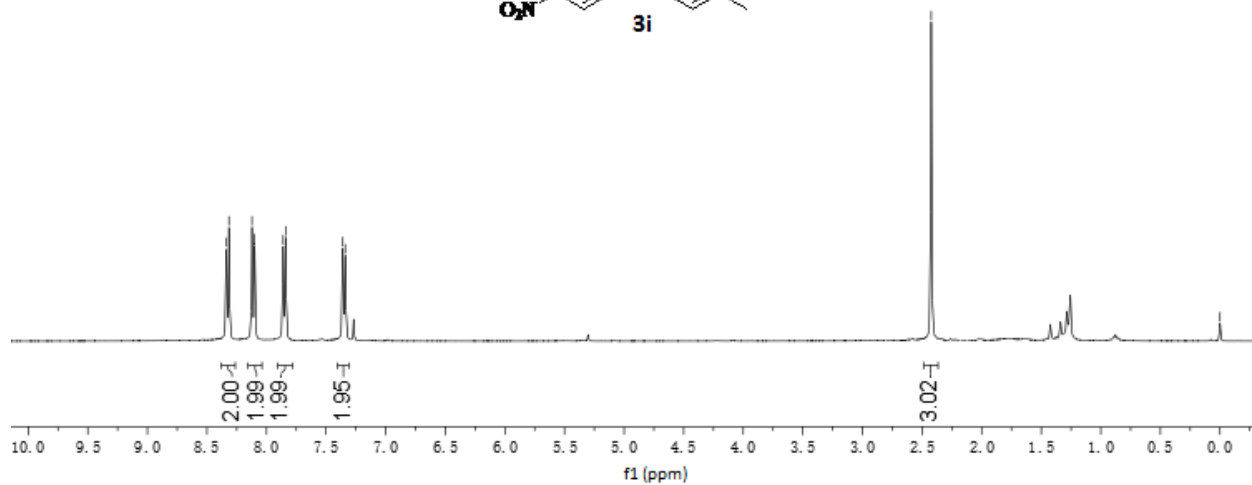
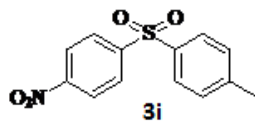
¹³C-NMR Spectrum



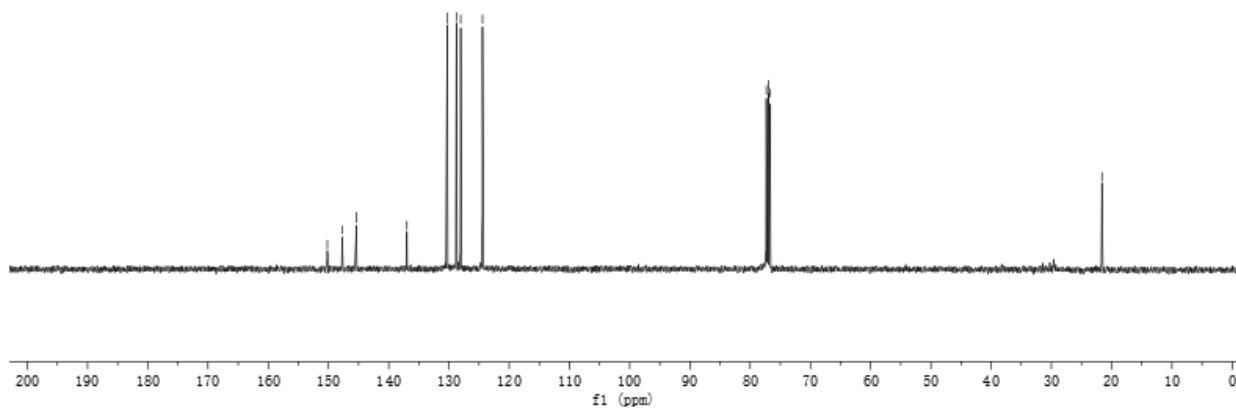
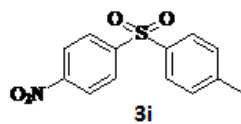
¹H-NMR Spectrum



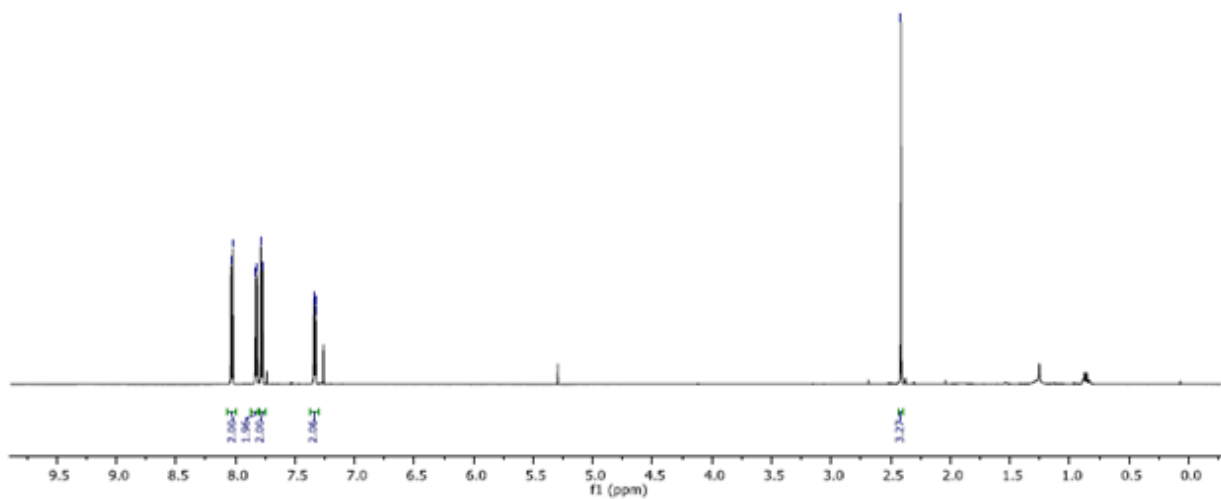
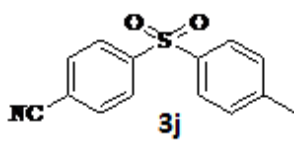
¹³C-NMR Spectrum



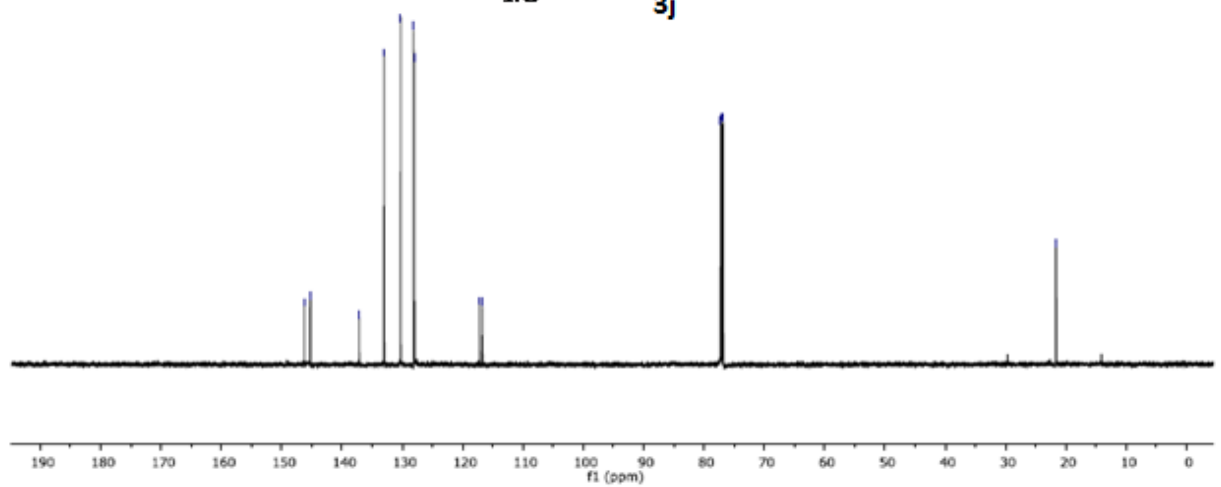
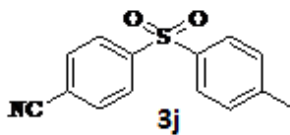
¹H-NMR Spectrum



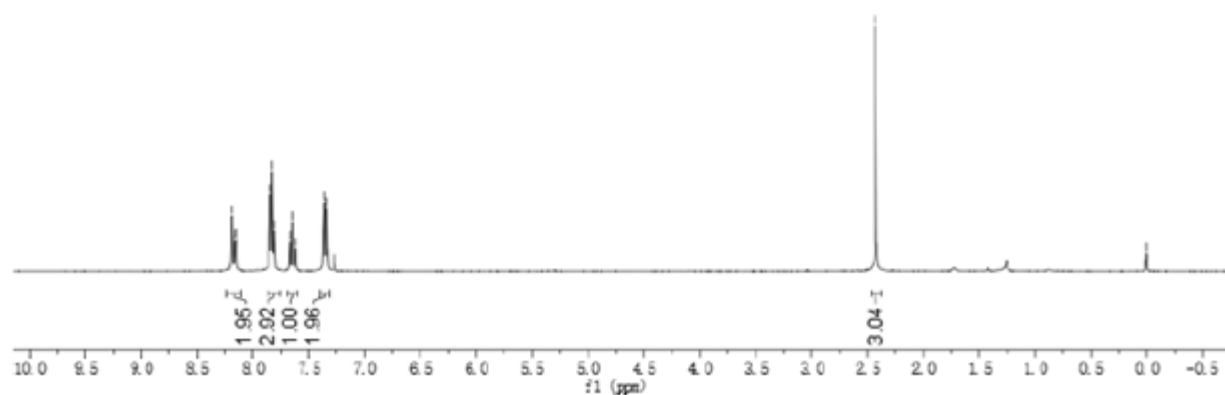
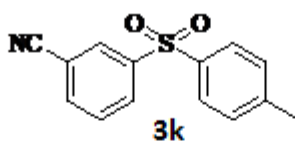
¹³C-NMR Spectrum



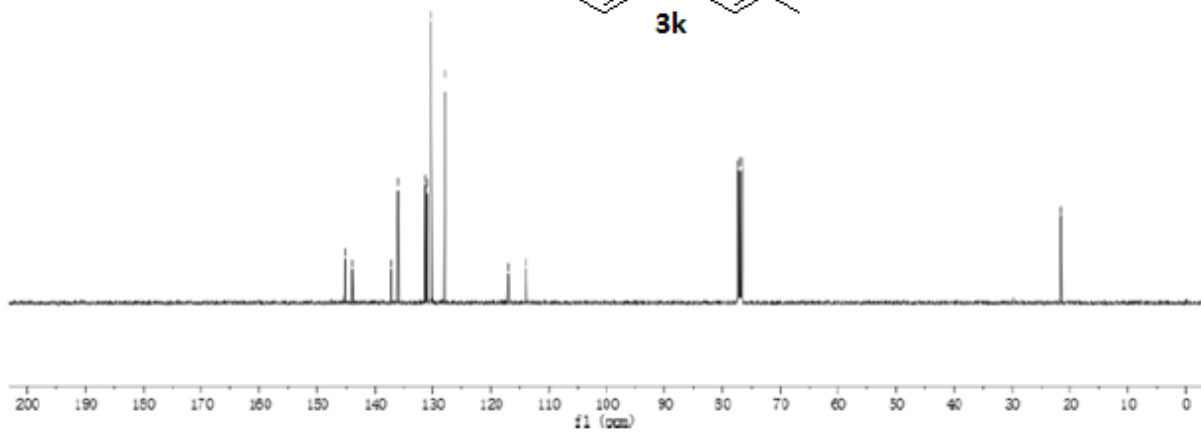
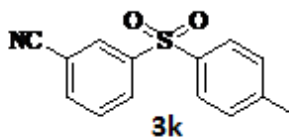
¹H-NMR Spectrum



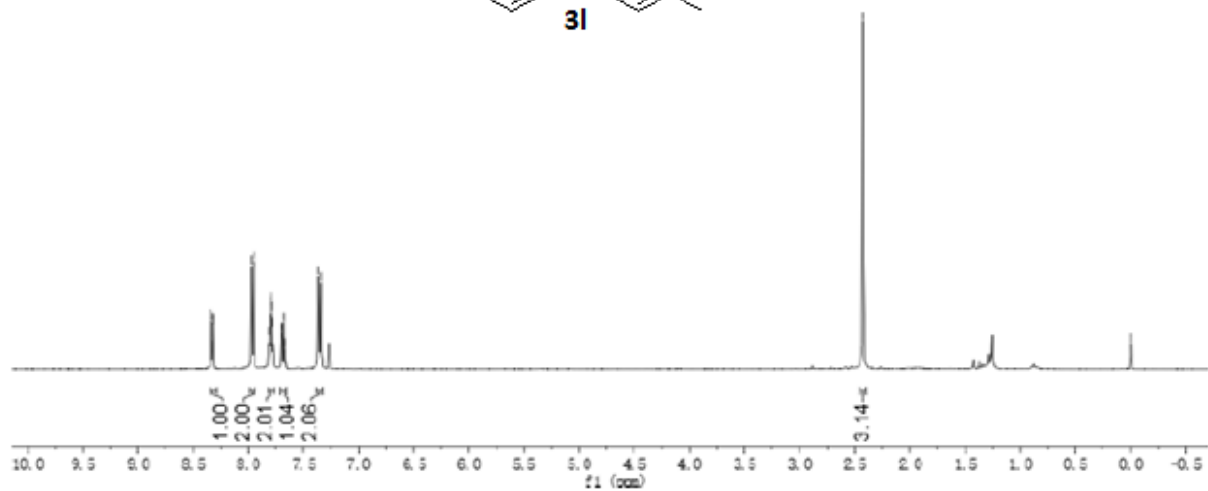
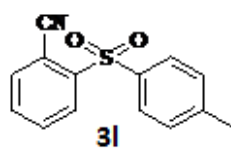
¹³C-NMR Spectrum



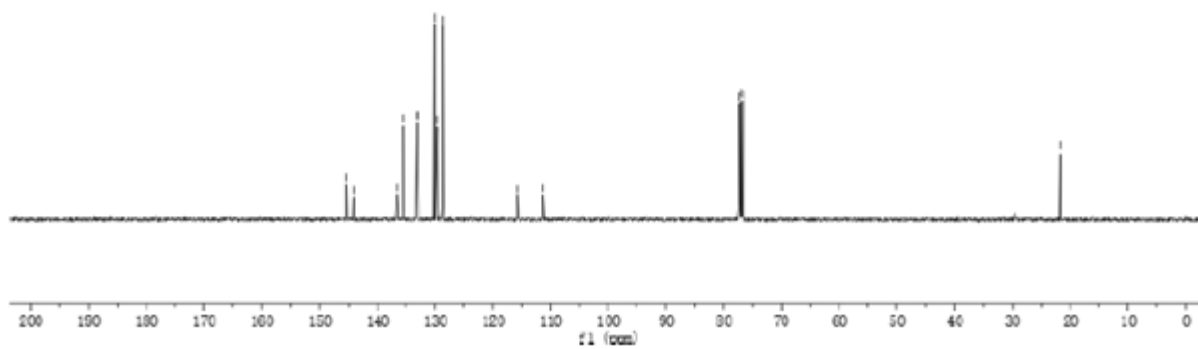
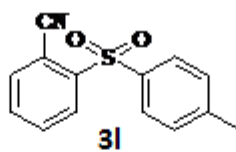
¹H-NMR Spectrum



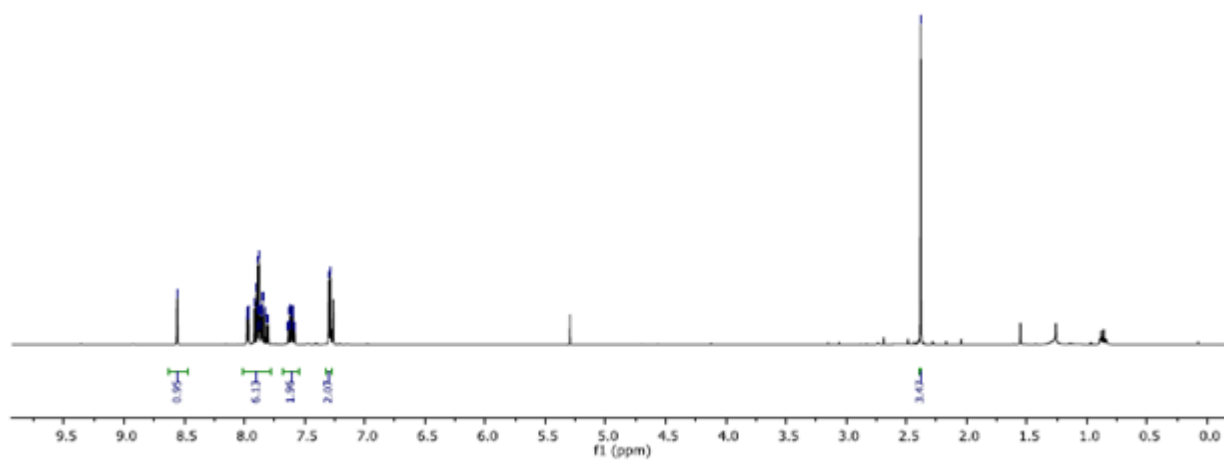
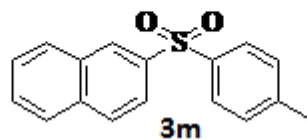
¹³C-NMR Spectrum



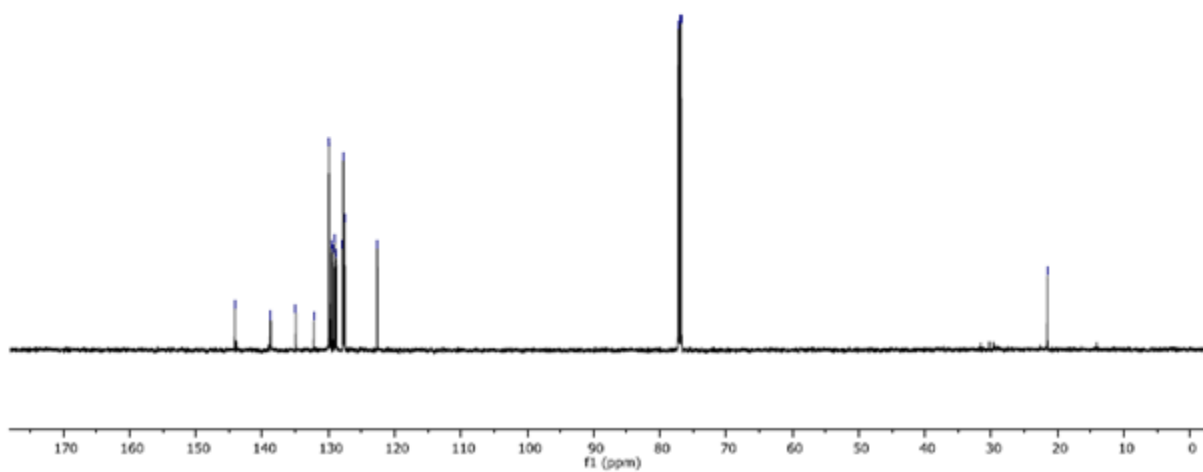
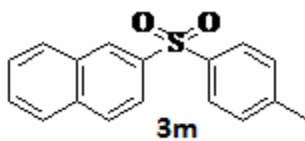
¹H-NMR Spectrum



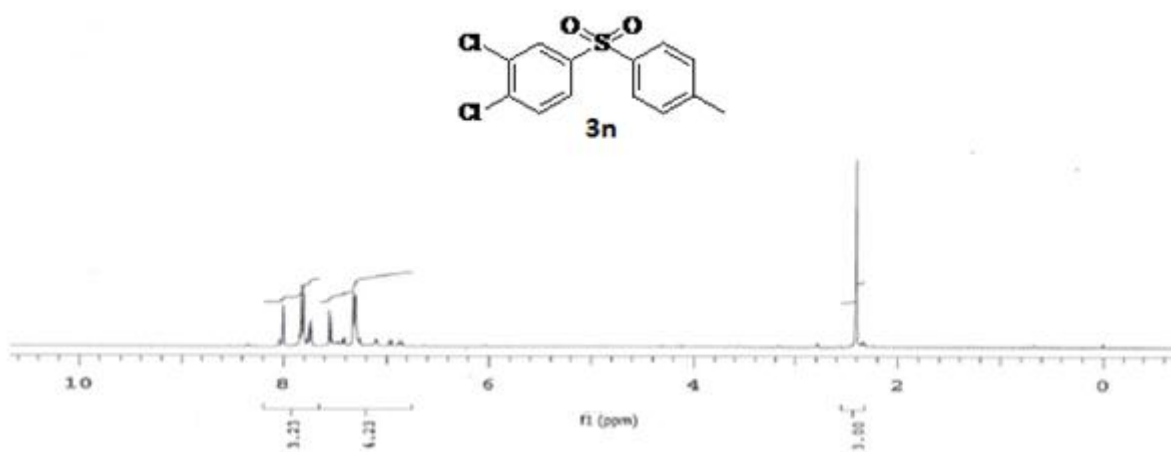
¹³C-NMR Spectrum



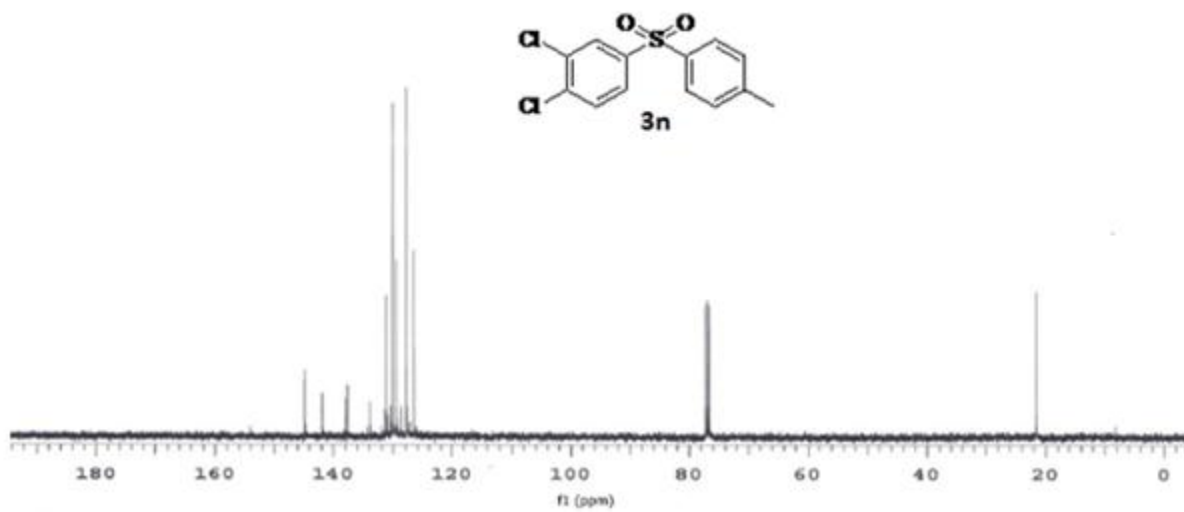
¹H-NMR Spectrum



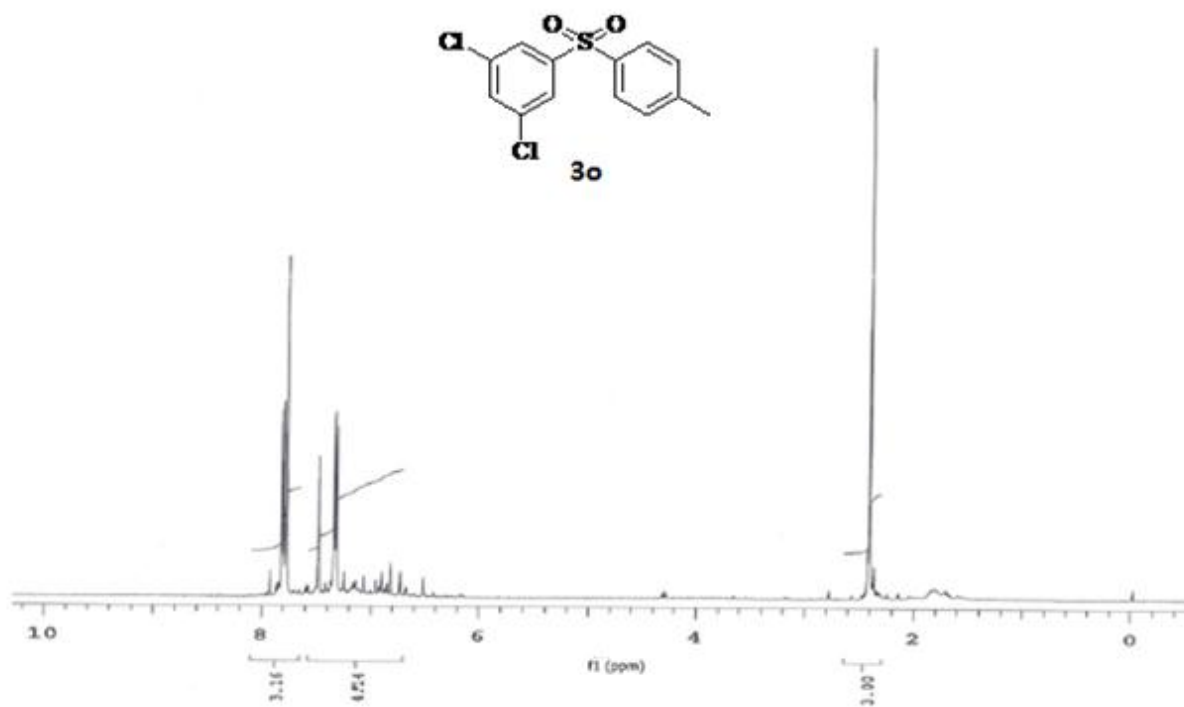
¹³C-NMR Spectrum



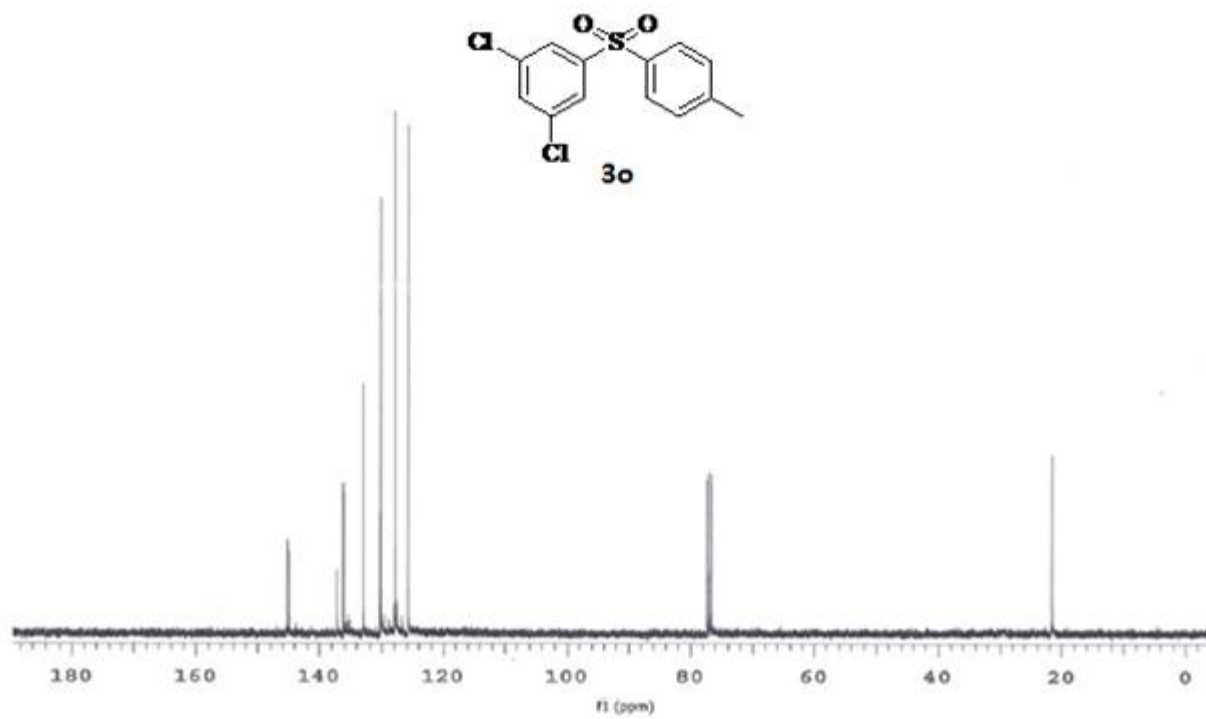
¹H-NMR Spectrum



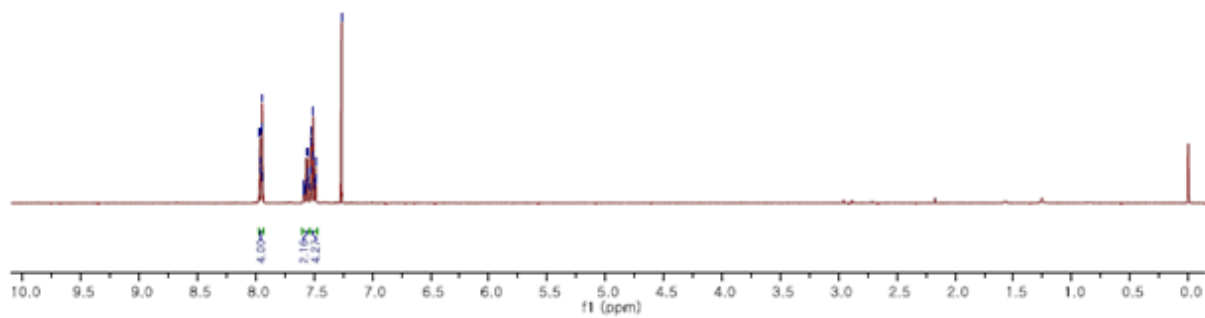
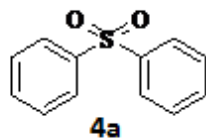
¹³C-NMR Spectrum



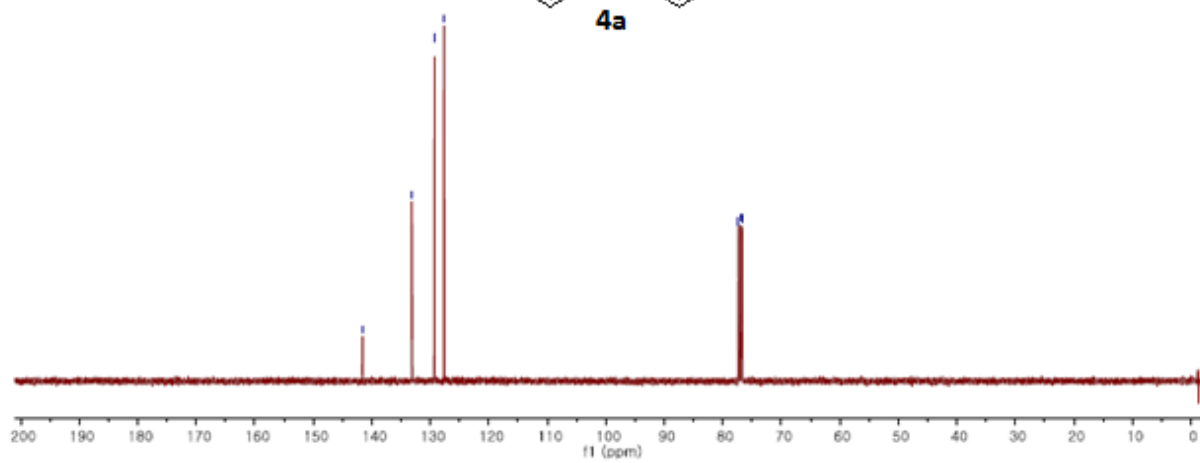
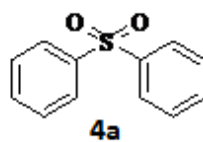
¹H-NMR Spectrum



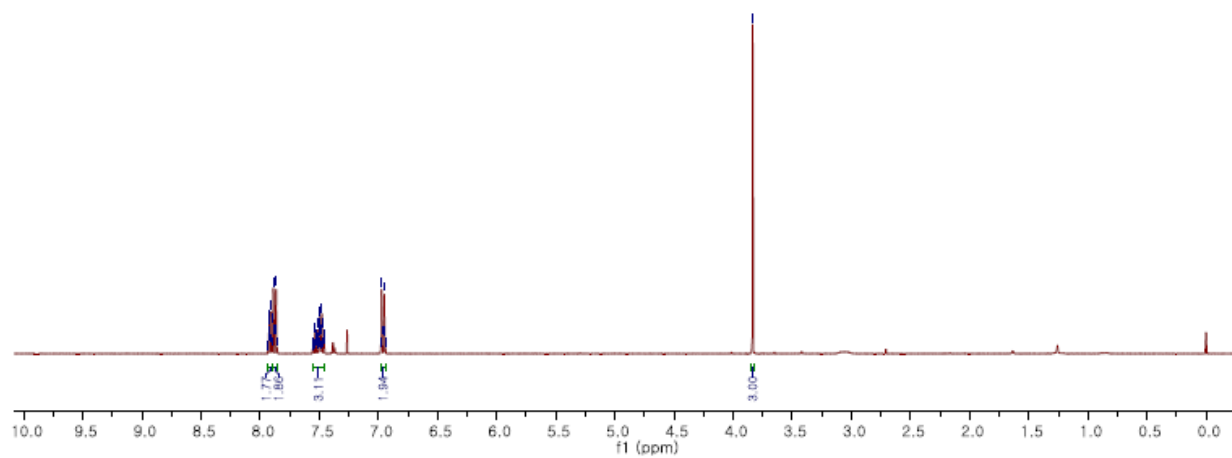
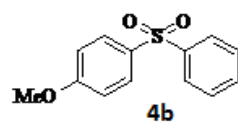
¹³C-NMR Spectrum



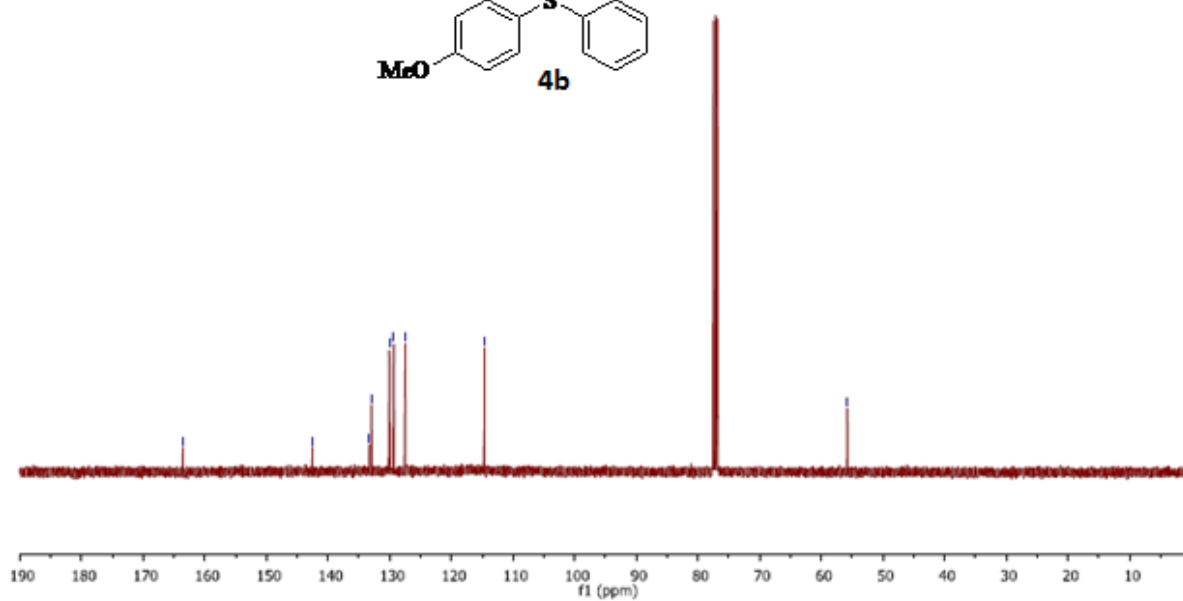
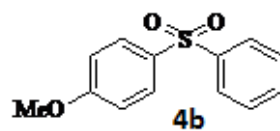
¹H-NMR Spectrum



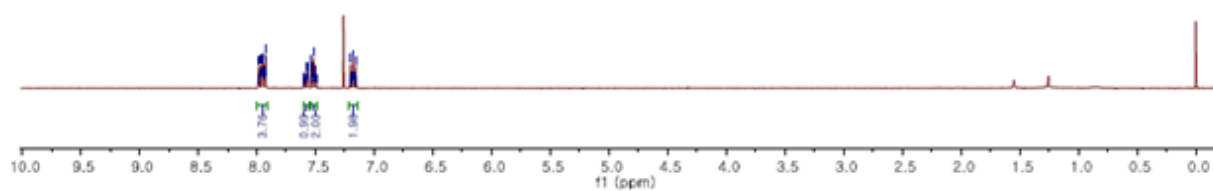
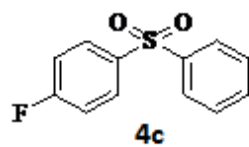
¹³C-NMR Spectrum



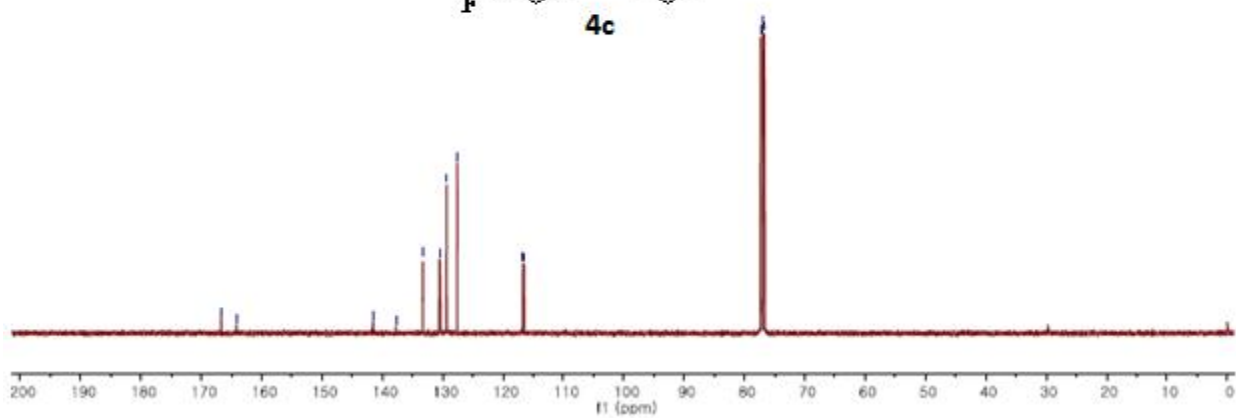
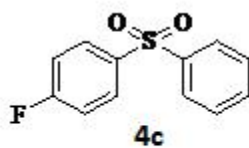
¹H-NMR Spectrum



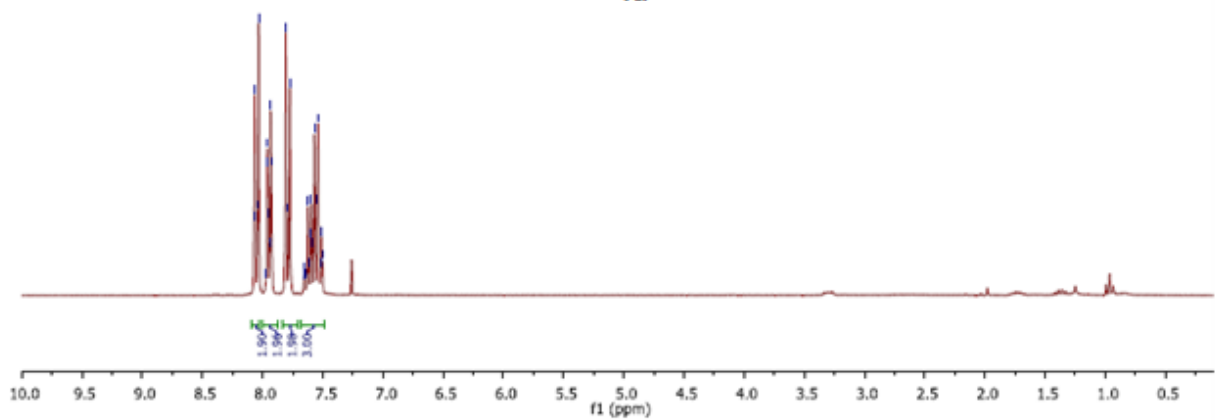
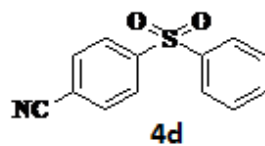
¹³C-NMR Spectrum



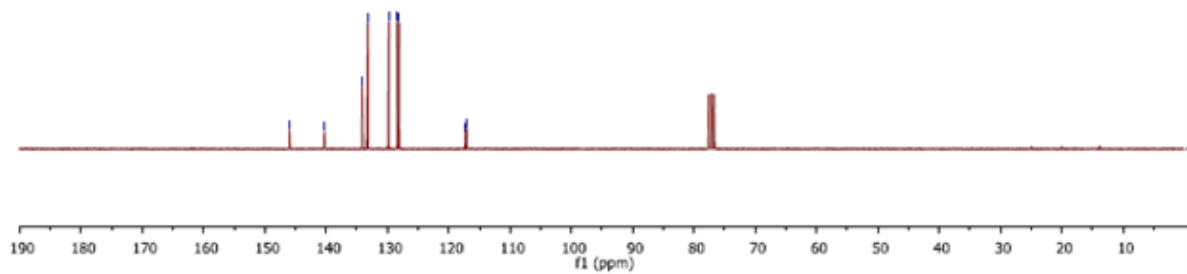
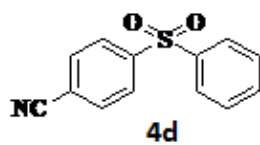
¹H-NMR Spectrum



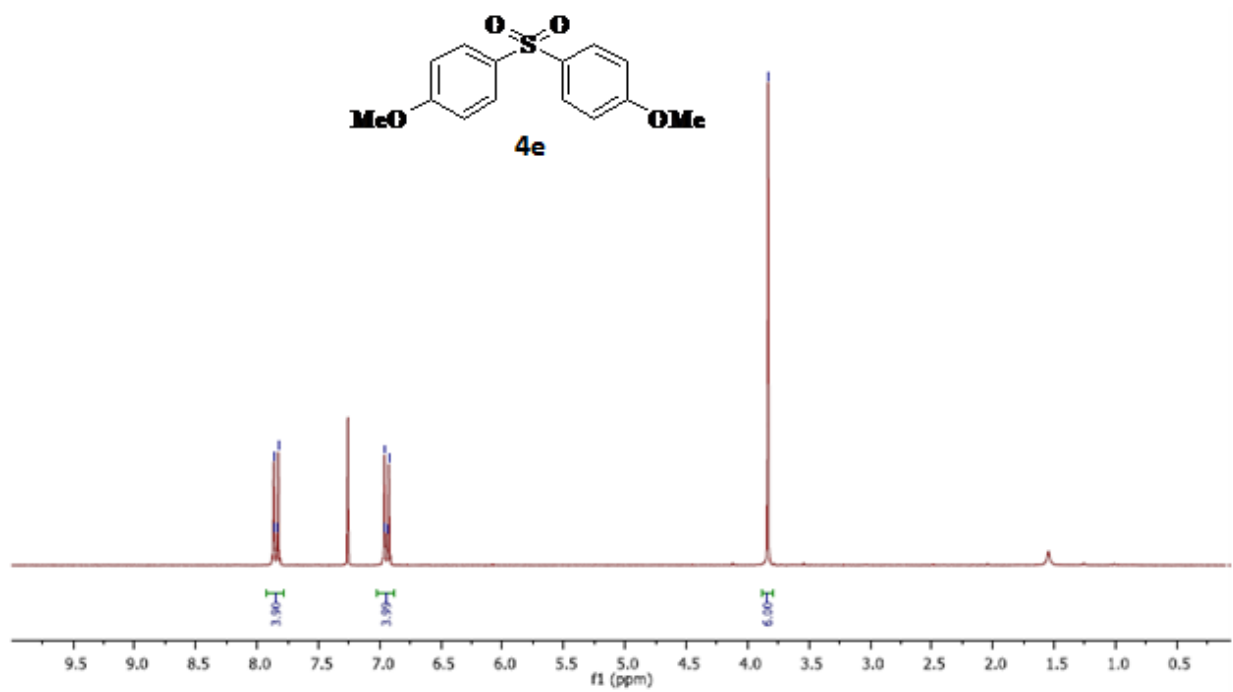
¹³C-NMR Spectrum



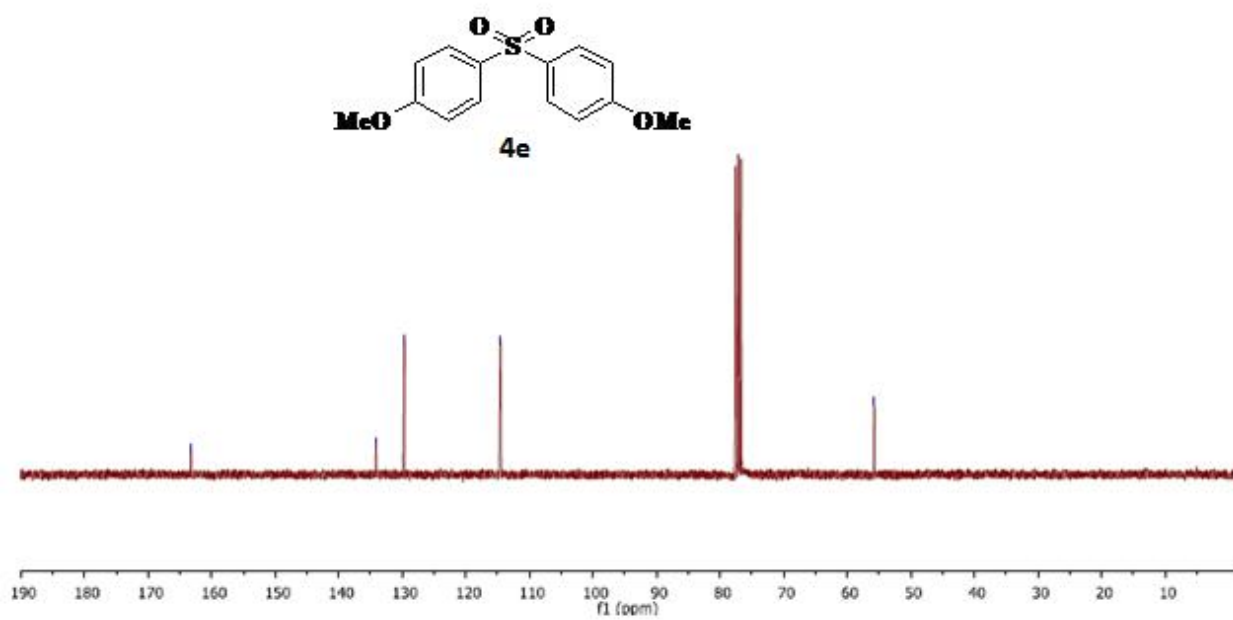
¹H-NMR Spectrum



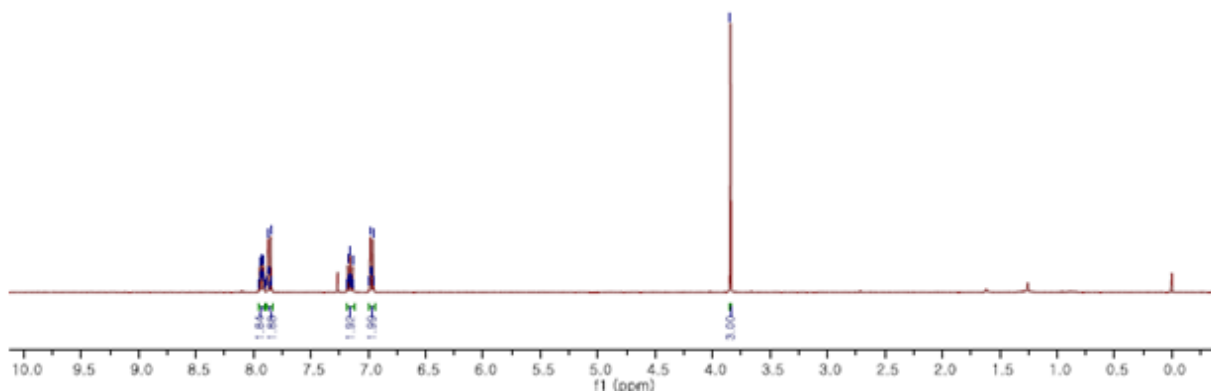
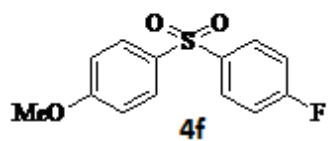
¹³C-NMR Spectrum



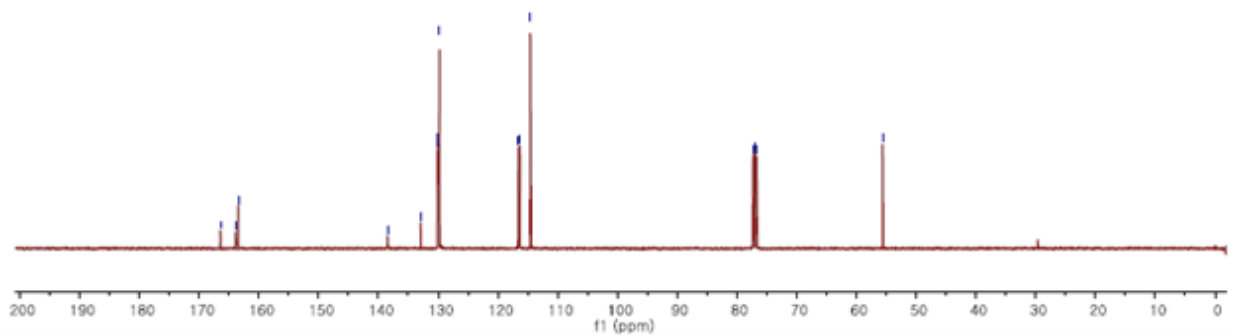
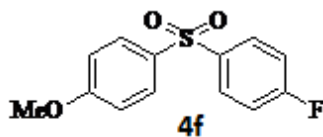
¹H-NMR Spectrum



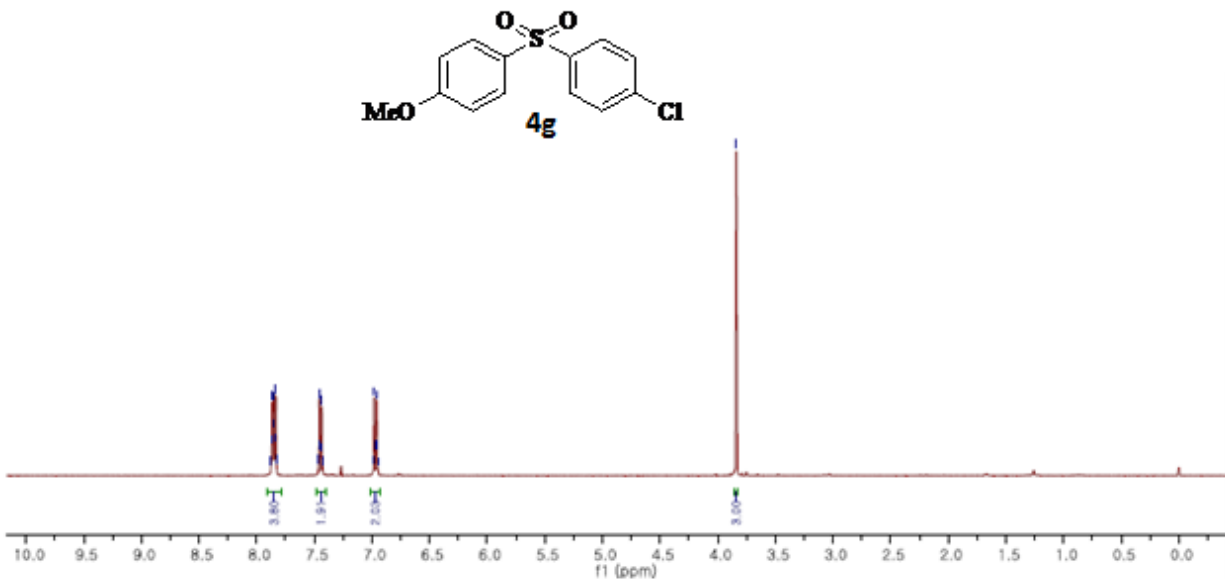
¹³C-NMR Spectrum



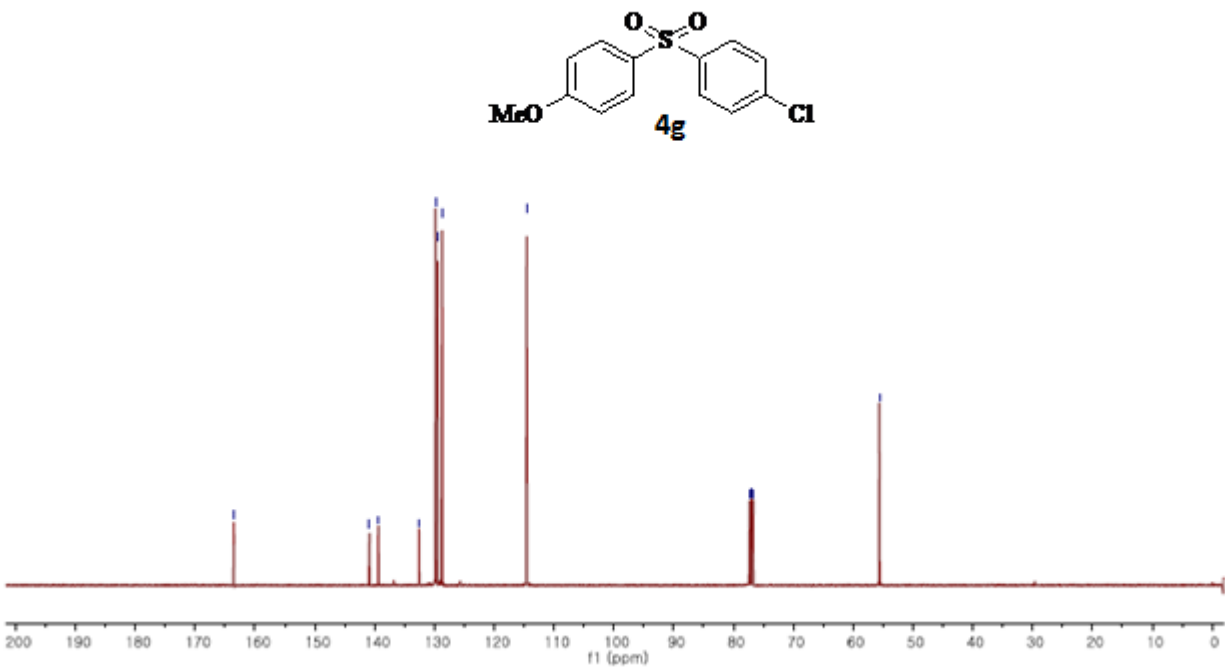
¹H-NMR Spectrum



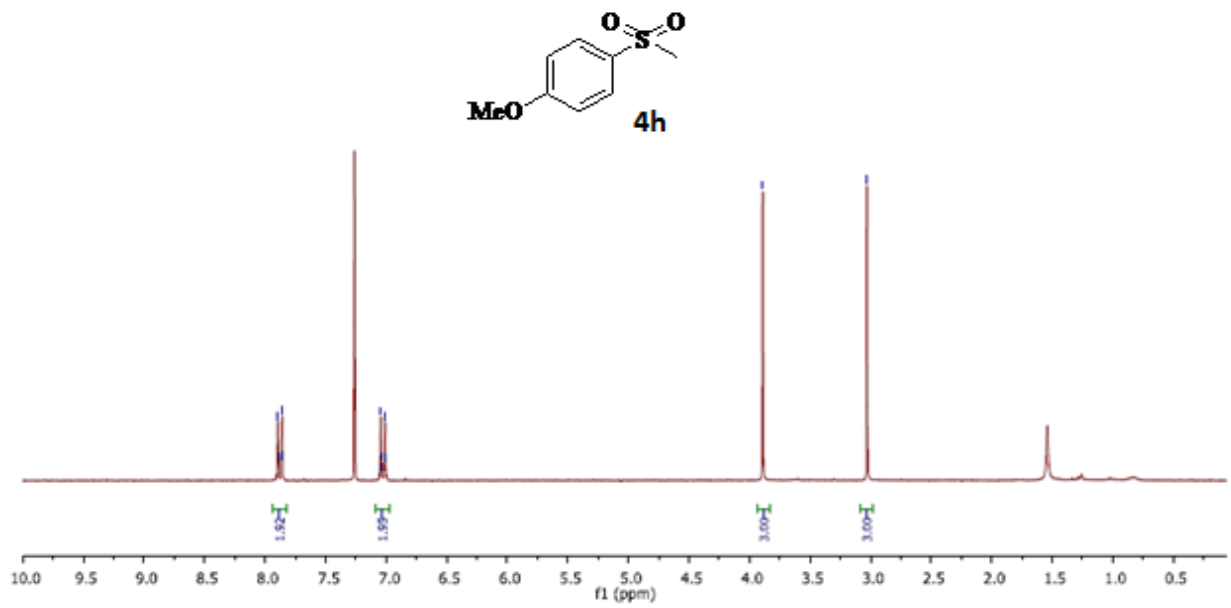
¹³C-NMR Spectrum



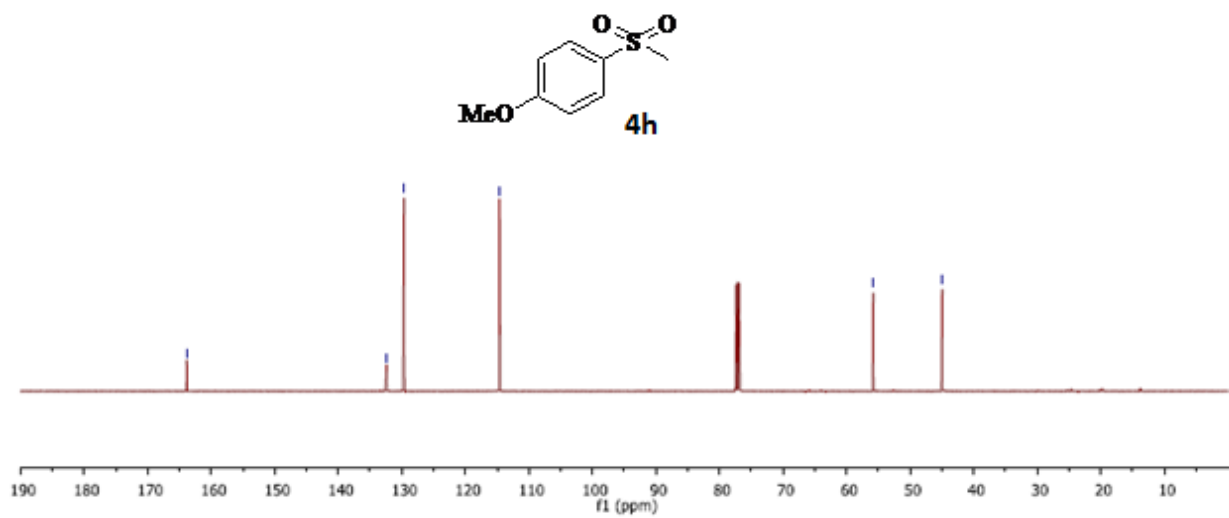
¹H-NMR Spectrum



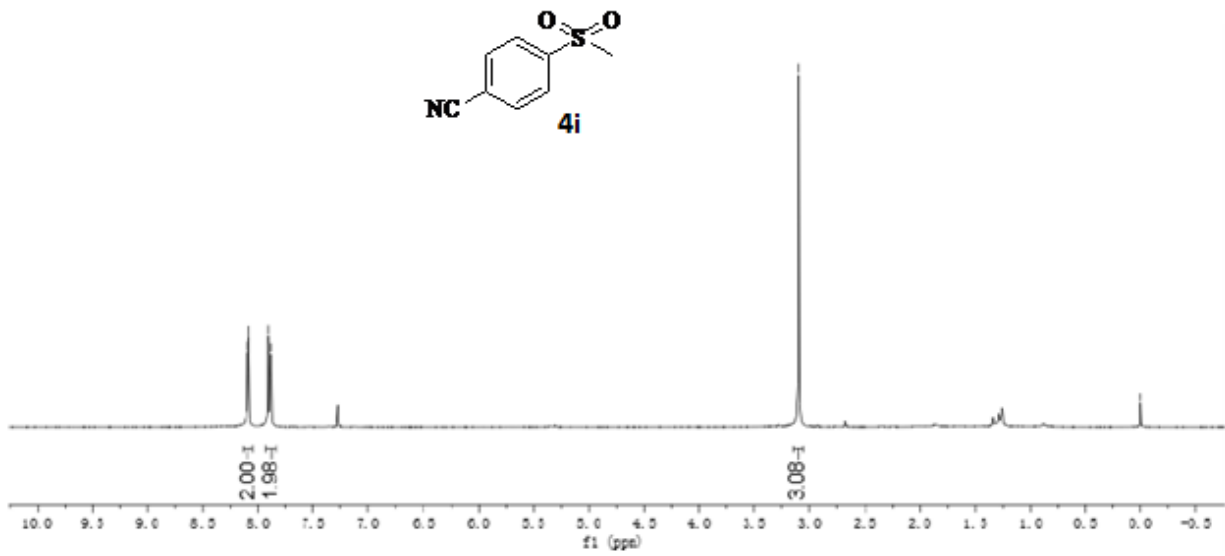
¹³C-NMR Spectrum



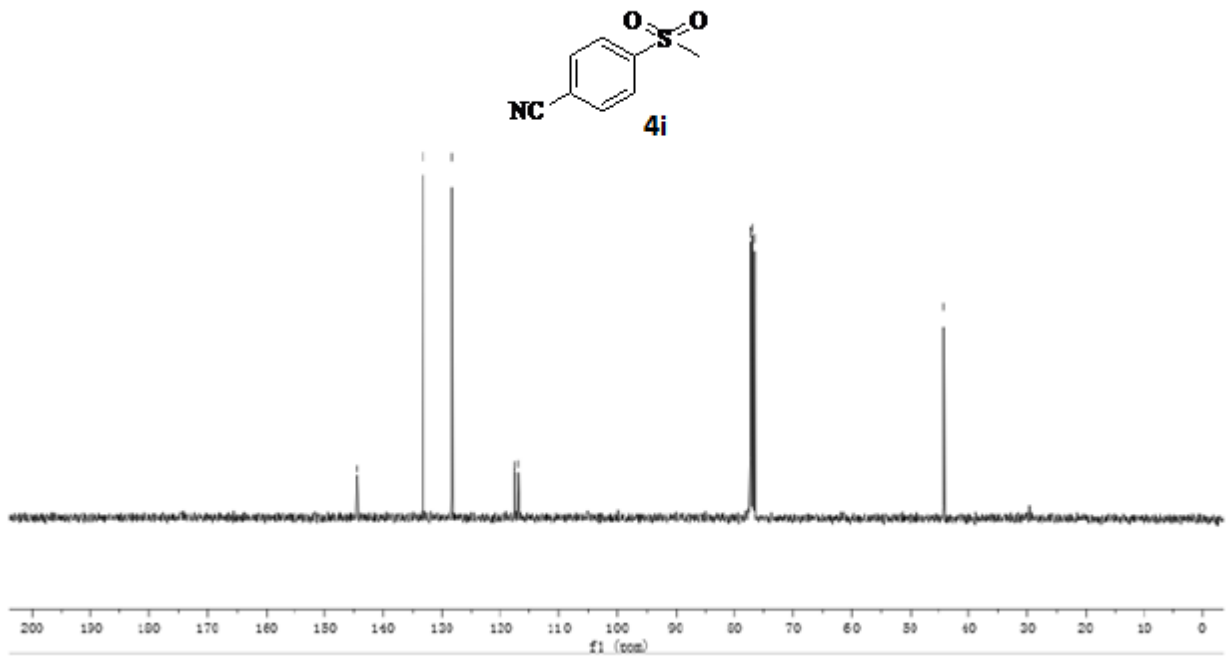
¹H-NMR Spectrum



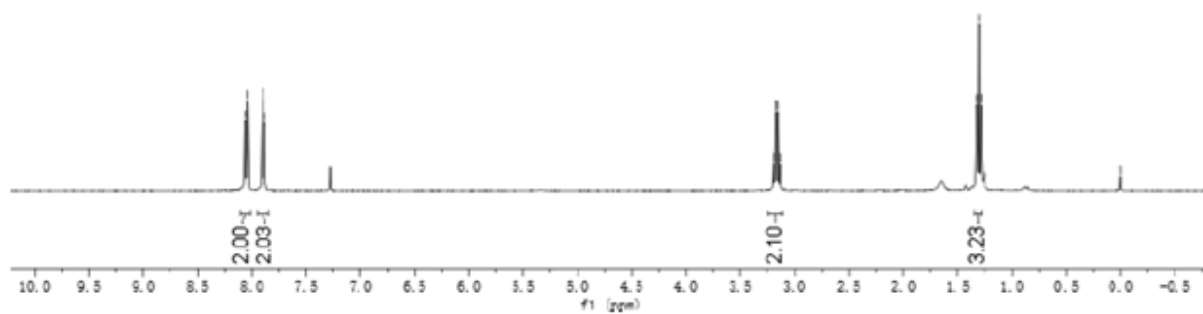
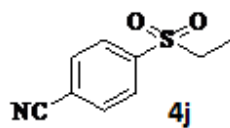
¹³C-NMR Spectrum



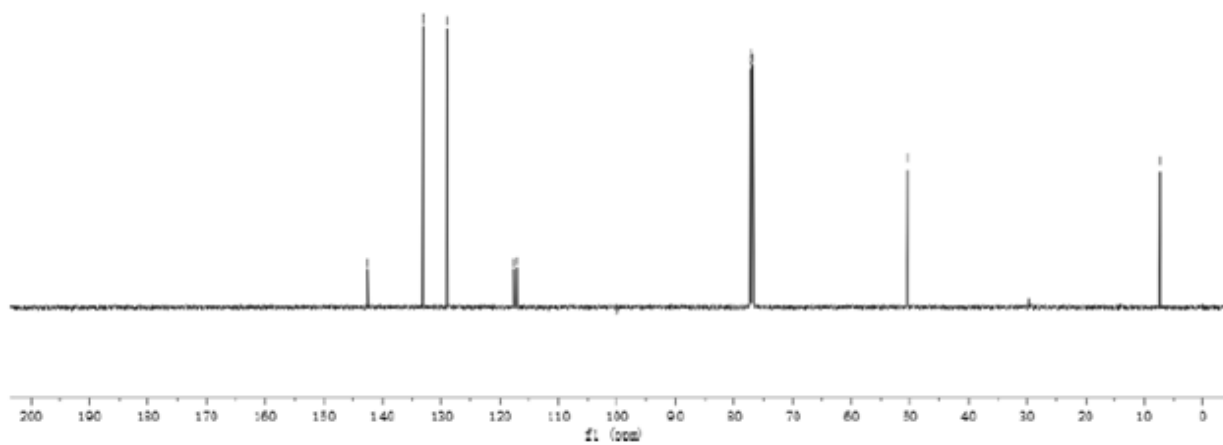
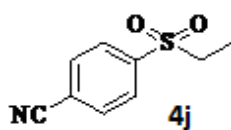
¹H-NMR Spectrum



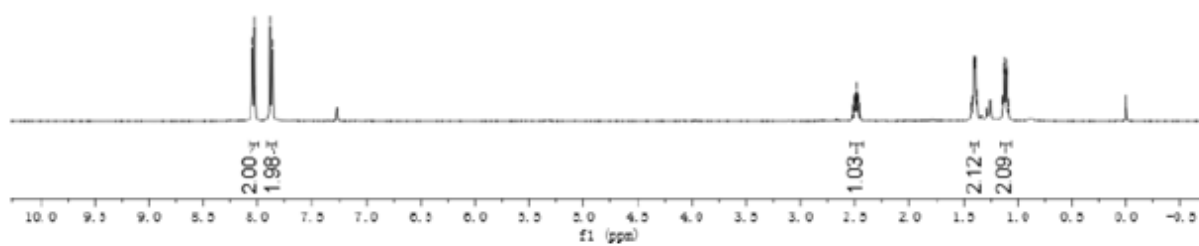
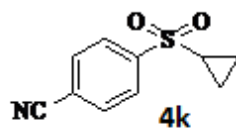
¹³C-NMR Spectrum



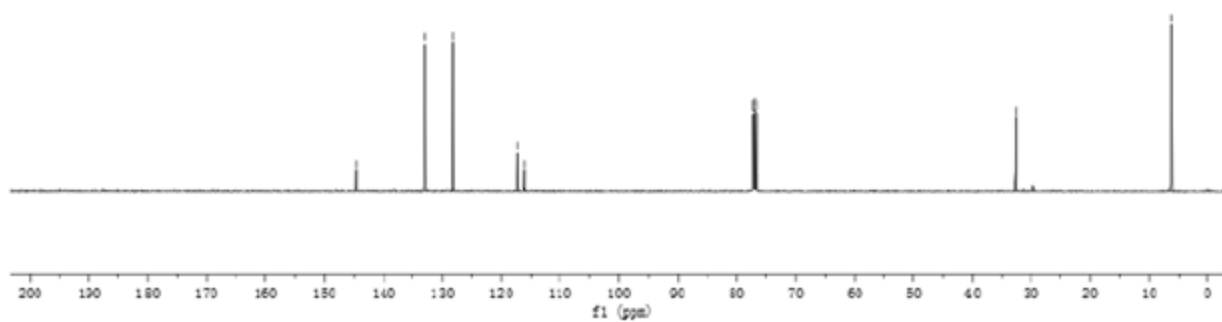
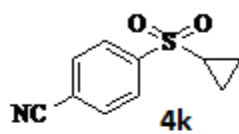
¹H-NMR Spectrum



¹³C-NMR Spectrum



¹H-NMR Spectrum



¹³C-NMR Spectrum