Electronic Supplementary Material (ESI) for Green Chemistry.

Supplemental Information

[3+2] Radical Sulfuration of Alkenes by Organic Photocatalysis

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1. General Information

If no special indicated, commercially available reagents and dry solvents were used without further purification. Column chromatographic purification of all products was conducted using 200-300 dry mesh silica gel. ^{1}H and ^{13}C NMR spectra were measured on a JEOL JNM-ECZ400S/L1 spectrometers, NMR (400 MHz for ^{1}H NMR, 101 MHz for ^{13}C NMR). Multiplicity (s = singlet, D = doublet, t = triplet, m = multiplet, Q = quartet, Coupling Constant (J) in Hz). $CHCl_3$ (δ = 7.26 ppm) served as the internal standard for ^{1}H NMR, and $CDCl_3$ (δ = 77.16 ppm) served as the internal standard for ^{13}C NMR. Infrared spectra were collected on a Thermo Fisher Nicolet 6700 FT-IR spectrometer using ATR (Attenuated Total Reflectance) method. High-resolution mass spectra (HRSM) were obtained on a Waters I-Class VION IMS QTof and are reported as m/z (relative intensity). UV-vis spectra experiments were measured on an Ultraviolet-visible Spectrophotometer (YOKE T2600). Fluorescence emission spectrums were recorded using an Edinburgh FLS9 Fluorescence Spectrometer.

2. General Experimental Procedure

A 10 mL of Schlenk tube equipped with magnetic bar was added rhodamine 6G (5.8 mg, 6% equiv.), the tube was evacuated and backfilled with N_2 (3 times). Then, 4-methylstyrene (0.2 mmol, 1 equiv.), 2,4,6-trimethylbenzenethiol (0.4 mmol, 2 equiv.), carbon disulfide (1 mmol, 5 equiv.), *N*,*N*-diisopropylethylamine (0.05 mmol, 0.25 equiv.), 1.0 mL CH_2Cl_2 as a solvent were added. The Schlenk tube was sealed with a Teflon lined cap and degassed by three freeze-pump-thaw cycles. The reaction mixture was irradiated with green light (520-530 nm) for 12 h at room temperature. The solvent was removed under reduced pressure and purified by column chromatography (petroleum ether/CH_2Cl_2 = 20/1) to afford the title product.

3. Light On-off Experiments

A 10 mL of Schlenk tube equipped with magnetic bar was added rhodamine 6G (5.8 mg, 6% equiv.), the tube was evacuated and backfilled with N_2 (3 times). Then, 4-methylstyrene (0.2 mmol, 1 equiv.), 2,4,6-trimethylbenzenethiol (0.4 mmol, 2 equiv.), carbon disulfide (1 mmol, 5 equiv.), *N*,*N*-diisopropylethylamine (0.05 mmol, 0.25 equiv.), 1.0 mL CH_2Cl_2 as a solvent were added. The Schlenk tube was sealed with a Teflon lined cap and degassed by three freeze-pump-thaw cycles. Six reactions were setup in parallel under green light. After 1 h, the light was turned off, one reaction was isolated by flash column chromatography to give the desired product, the remaining five were kept stirring for another 1 h without irradiation. The experiments were cycled as above. Finally, the sixth reaction was ended after stirring for 2h without irradiation.

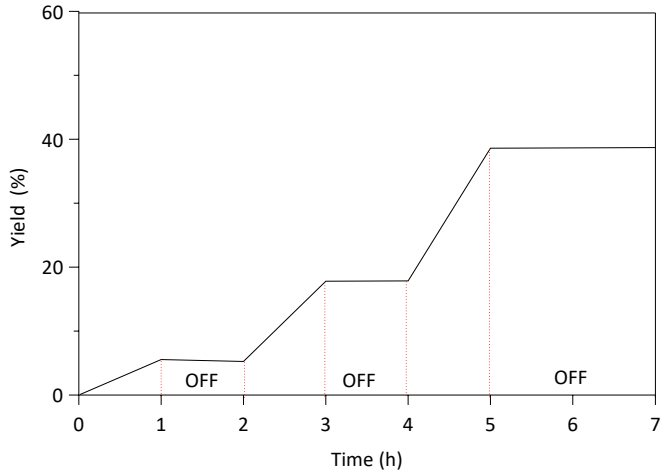


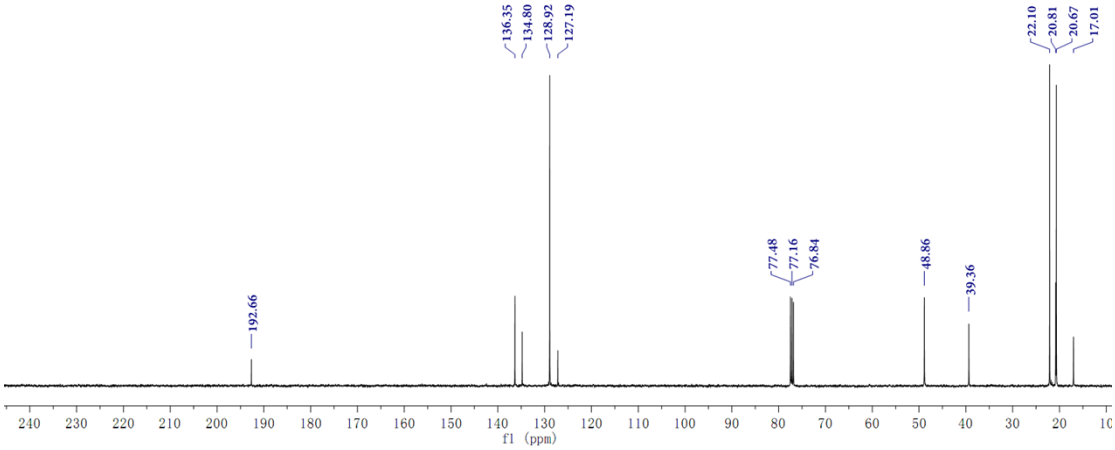
Figure S1: Light on-off experiments of the standard reaction. All yields are isolated.

4. Stern-Volmer Fluorescence Quenching

In a typical experiment, a 20 μM solution of rhodamine 6G in CH_2Cl_2 was added to variable concentrations of quenchers in a screw-top 1.0 cm quartz cuvette, after degassing by bubbling a stream of nitrogen, the emission spectrum of the sample was collected. All solutions were excited at λ = 490 nm and their maximum emission intensity were recorded. The ratio of I_0/I was plotted as a function of the quencher concentration (I_0 = emission intensity of the Rhodamine 6G; I = observed emission intensity of the mixed solution).

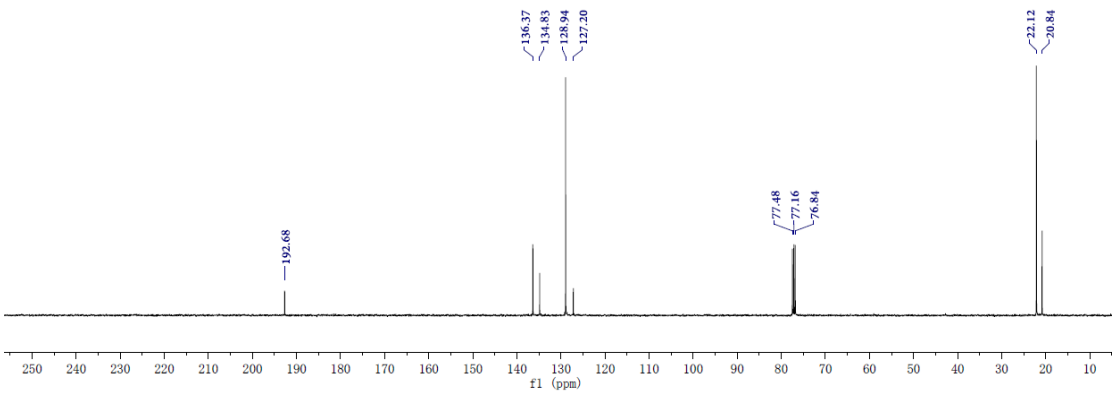
5. ^{13}C NMR Experiments

A 10 mL of Schlenk tube equipped with magnetic bar was evacuated and backfilled with N_2 (3 times). Then, 2,4,6-trimethylbenzenethiol (0.2 mmol, 1 equiv.), carbon disulfide (0.2 mmol, 1 equiv.), *N*,*N*-diisopropylethylamine (0.1 mmol, 0.5 equiv.), $CDCl_3$ as a solvent (0.6 mL) were added subsequently. The Schlenk tube was then sealed with a Teflon lined cap, and was degassed by three freeze-pump-thaw cycles. After stirring in room temperature for 12 h, the products were analyzed by ^{13}C NMR (Fig. S2). According to the same procedure, 2,4,6-trimethylbenzenethiol (0.2 mmol, 1 equiv.), carbon disulfide (0.2 mmol, 1 equiv.), $CDCl_3$ as a solvent (0.6 mL) were added to a 10 mL of Schlenk tube. After stirring in room temperature for 12 h, the products were analyzed by ^{13}C NMR (Fig. S3).



Note: **^{13}C NMR**: CS_2 (δ 192.66), 2,4,6-trimethylbenzenethiol (δ 136.35, 134.80, 128.92, 127.19, 22.10, 20.81), *N*,*N*-diisopropylethylamine (δ 48.86, 39.36, 20.67, 17.01), and no new peaks appeared.

Figure S2: The ^{13}C NMR of the reaction mixture 2,4,6-trimethylbenzenethiol, carbon disulfide and *N*,*N*-diisopropylethylamine in $CDCl_3$.



Note: **^{13}C NMR**: CS_2 (δ 192.68), 2,4,6-trimethylbenzenethiol (δ 136.37, 134.83, 128.94, 127.20, 22.12, 20.84), and no new peaks appeared.

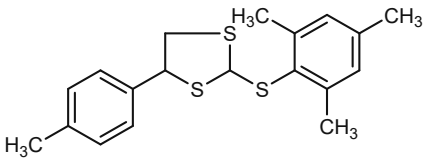
Figure S3: The ^{13}C NMR of the reaction mixture 2,4,6-trimethylbenzenethiol, carbon disulfide in $CDCl_3$.

6. Uv-vis Absorption Spectrum

In order to detect EDA complex, Uv-vis absorption spectra were recorded using the mixed solution in CH_2Cl_2 at room temperature. ([Rh-6G$^+$] = 1.6×10^{-5} M, [15] = 3.2×10^{-4} M, [14] = 3.2×10^{-4} M, [CS_2] = 3.2×10^{-4} M, [DIPEA] = 3.2×10^{-4} M)

In order to detect Rh-6G$^{\bullet}$, Uv-vis absorption spectra were recorded using the mixed solution ([Rh-6G$^+$] = 1.6×10^{-5} M, [DIPEA] = 3.2×10^{-4} M) in CH_2Cl_2 at different times using green light irradiation.

7. Characterization of Products



16

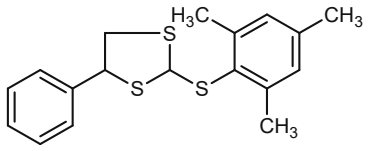
According to the general procedure, the title product was obtained in 86% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.0 Hz, 1H), 7.35 (d, *J* = 8.1 Hz, 1H), 7.17 (dd, *J* = 10.3, 8.1 Hz, 2H), 6.97 and 6.96 (s, 1H), 5.73 (s, 0.46), 5.65 (s, 0.48), 5.04 (dd, *J* = 8.7, 5.3 Hz, 0.52H), 4.88 (dd, *J* = 11.1, 4.9 Hz, 0.49), 3.74 – 3.58 (m, 1H), 3.43 – 3.34 (m, 1H), 2.59 and 2.58 (s, 6H), 2.37 and 2.35 (s, 3H), 2.29 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.18, 139.36, 138.12, 138.03, 134.46, 134.29, 129.51, 129.48, 129.26, 128.07, 127.85, 62.33, 62.20, 61.36, 57.13, 45.52, 43.83, 22.34, 22.31, 21.23.

HRMS (ESI) m/z Calcd. for $C_{19}H_{23}S_3$ $[M+H]^+$ 347.0956, found: 347.0974.

IR (film) ν_{max} (cm^{-1}) 2917, 1599, 1511, 1455, 1425, 1374, 1174, 1021, 854, 816, 731, 552, 515.



17

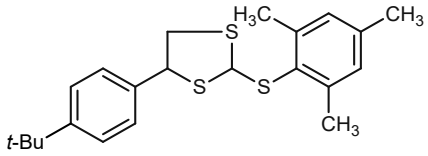
According to the general procedure, the title product was obtained in 81% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.54 (m, 1H), 7.49 – 7.44 (m, 1H), 7.40 – 7.30 (m, 3H), 6.98 and 6.97 (s, 2H), 5.75 (s, 0.45H), 5.66 (s, 0.46H), 5.10 – 5.01 (m, 0.53H), 4.92 – 4.88 (m, 0.50H), 3.77 – 3.60 (m, 1H), 3.45 – 3.38 (m, 1H), 2.60 and 2.59 (s, 6H), 2.30 and 2.29 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.19, 139.40, 137.66, 137.47, 130.70, 130.65, 129.29, 129.27, 128.86, 128.82, 128.31, 128.22, 128.00, 62.48, 62.26, 61.42, 57.35, 45.49, 43.88, 22.35, 22.32, 21.25.

HRMS (ESI) m/z Calcd. for $C_{18}H_{20}S_3$ $[M]^+$ 332.0722, found: 332.0685.

IR (film) ν_{max} (cm^{-1}) 2916, 1599, 1453, 1372, 1028, 852, 769, 723, 698, 596, 511.



18

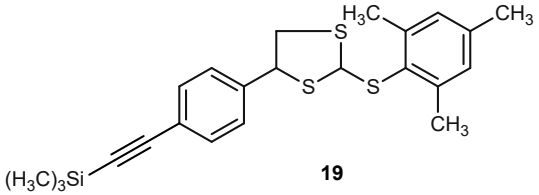
According to the general procedure, the title product was obtained in 61% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.4 Hz, 1H), 7.42 – 7.35 (m, 3H), 6.98 and 6.97 (s, 2H), 5.73 (s, 0.47H), 5.65 (s, 0.48H), 5.08 – 5.02 (m, 0.52H), 4.90 (dd, *J* = 11.1, 4.9 Hz, 0.51H), 3.75 – 3.61 (m, 1H), 3.41 (ddd, *J* = 10.8, 7.0, 4.0 Hz, 1H), 2.59 (s, 6H), 2.30 and 2.28 (s, 3H), 1.34 and 1.32 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 151.35, 151.26, 143.19, 139.35, 134.50, 134.20, 130.76, 130.71, 129.27, 129.25, 127.89, 127.68, 125.78, 125.76, 62.23, 62.17, 61.37, 57.01, 45.45, 43.79, 34.71, 34.68, 31.41, 31.40, 22.36, 22.33, 21.25.

HRMS (ESI) m/z Calcd. for $C_{22}H_{32}NS_3$ $[M+NH_4]^+$ 406.1691, found: 406.1701.

IR (film) ν_{max} (cm^{-1}) 2962, 2919, 1601, 1501, 1458, 1363, 1269, 1019, 850, 826, 732, 708, 563, 553.



19

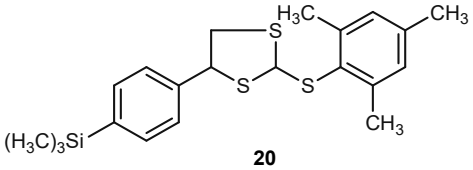
According to the general procedure, the title product was obtained in 41% yield as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.35 (m, 4H), 6.97 and 6.96 (s, 2H), 5.73 (s, 0.46H), 5.64 (s, 0.44H), 5.03 (dd, *J* = 8.2, 5.3 Hz, 0.49H), 4.86 (dd, *J* = 10.9, 5.0 Hz, 0.50H), 3.72 (dd, *J* = 11.2, 5.3 Hz, 0.51H), 3.59 (dd, *J* = 12.1, 11.1 Hz, 0.54H), 3.42 – 3.32 (m, 1H), 2.58 and 2.57 (s, 6H), 2.29 and 2.28 (s, 3H), 0.27 and 0.25 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.19, 139.48, 138.21, 132.40, 132.31, 130.59, 129.32, 128.11, 127.89, 123.15, 123.07, 104.73, 104.64, 95.00, 62.35, 62.12, 61.54, 57.23, 45.32, 43.80, 22.35, 21.25, 0.09.

HRMS (ESI) m/z Calcd. for $C_{23}H_{28}LiS_3Si$ $[M+Li]^+$ 435.1277, found: 435.1295.

IR (film) ν_{max} (cm^{-1}) 2954, 2920, 2160, 1601, 1501, 1410, 1247, 838, 759, 641, 551.



20

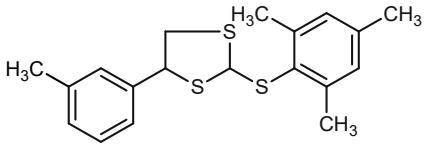
According to the general procedure, the title product was obtained in 80% yield as a light yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.43 (m, 4H), 6.98 and 6.96 (s, 2H), 5.74 (s, 0.48H), 5.67 (s, 0.50H), 5.09 – 5.02 (m, 0.58H), 4.90 (dd, *J* = 11.0, 5.0 Hz, 0.52H), 3.77 – 3.61 (m, 1H), 3.47 – 3.35 (m, 1H), 2.60 and 2.59 (s, 6H), 2.30 and 2.29 (s, 3H), 0.30 and 0.28 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.21, 140.82, 140.72, 139.42, 139.40, 138.25, 137.98, 133.89, 133.85, 130.73, 130.68, 129.30, 129.28, 127.57, 127.36, 62.47, 62.28, 61.48, 57.36, 45.42, 43.87, 22.36, 22.34, 21.26, -1.02, -1.04.

HRMS (ESI) m/z Calcd. for $C_{21}H_{28}NaS_3Si$ $[M+Na]^+$ 427.1015, found: 427.1005.

IR (film) ν_{max} (cm^{-1}) 2953, 2919, 1600, 1247, 1110, 908, 836, 816, 729, 552, 527.



21

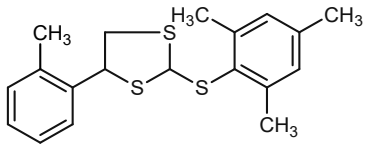
According to the general procedure, the title product was obtained in 72% yield as a yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.34 (m, 1H), 7.29 – 7.21 (m, 2H), 7.13 (dd, *J* = 10.0, 3.4 Hz, 1H), 6.98 and 6.96 (s, 2H), 5.74 (s, 0.50H), 5.66 (s, 0.51H), 5.07 – 5.00 (m, 0.50H), 4.87 (dd, *J* = 11.1, 4.9 Hz, 0.54H), 3.75 – 3.60 (m, 1H), 3.44 – 3.36 (m, 1H), 2.60 and 2.59 (s, 6H), 2.39 and 2.36 (s, 3H), 2.30 and 2.29 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.20, 139.38, 138.55, 137.43, 137.26, 130.68, 129.29, 129.26, 129.09, 129.00, 128.82, 128.75, 128.71, 128.67, 125.28, 125.05, 62.54, 62.22, 61.38, 57.34, 45.50, 43.80, 22.36, 22.33, 21.53, 21.25.

HRMS (ESI) m/z Calcd. for $C_{19}H_{23}S_3$ $[M+H]^+$ 347.0956, found: 347.0953.

IR (film) ν_{max} (cm^{-1}) 2916, 2851, 1600, 1455, 1434, 1374, 1032, 852, 768, 727, 711, 693, 551.



22

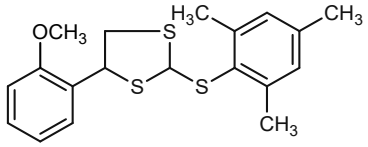
According to the general procedure, the title product was obtained in 43% yield as a yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.81 (m, 0.46H), 7.56 – 7.50 (m, 0.52H), 7.30 – 7.13 (m, 3H), 6.97 and 6.96 (s, 2H), 5.75 (s, 0.50H), 5.66 (s, 0.44H), 5.26 (dd, *J* = 9.0, 5.1 Hz, 0.51H), 5.15 (dd, *J* = 11.0, 4.7 Hz, 0.45H), 3.74 – 3.59 (m, 1H), 3.44 – 3.33 (m, 1H), 2.58 (s, 6H), 2.50 and 2.40 (s, 3H), 2.29 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.21, 143.17, 139.40, 136.26, 136.20, 135.42, 135.16, 130.82, 130.74, 130.69, 130.62, 129.29, 127.95, 127.53, 127.31, 126.73, 126.52, 61.99, 61.30, 58.18, 53.23, 44.59, 42.44, 22.34, 21.25, 19.81, 19.75.

HRMS (ESI) m/z Calcd. for $C_{19}H_{23}S_3$ $[M+H]^+$ 347.0956, found: 347.0946.

IR (film) ν_{max} (cm^{-1}) 2920, 1601, 1459, 1374, 1032, 906, 850, 757, 726, 648, 552.



23

According to the general procedure, the title product was obtained in 78% yield as a light yellow oil.

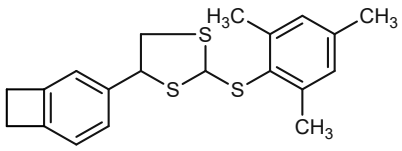
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (dd, *J* = 7.7, 1.6 Hz, 0.39H), 7.51 (dd, *J* = 7.6, 1.6 Hz, 0.47H), 7.32 – 7.23 (m, 1H), 7.06 – 6.86 (m, 4H), 5.76 (s, 0.47 H), 5.66 (s, 0.44H), 5.55 (dd, *J* = 7.2, 5.3 Hz, 0.45H), 5.41 (dd, *J* = 10.5, 5.0 Hz, 0.44H), 3.89 and 3.86 (s, 3H), 3.77 (dd, *J* = 11.2, 5.3 Hz, 0.48H), 3.53 (ddd, *J* = 17.1, 12.0, 7.8 Hz, 1H), 3.37 (dd, *J* = 11.2, 7.3 Hz, 0.44H), 2.60 and 2.59 (s, 6H), 2.30 and 2.29 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.19, 156.85, 143.24, 143.20, 139.29, 130.84, 129.25, 129.21, 129.06, 128.98, 128.59, 128.42, 126.22, 125.93, 120.88, 120.55, 110.68, 110.59, 61.83, 61.20, 55.60, 55.57, 54.89, 50.70, 43.81, 42.11, 22.33, 22.27,

21.23.

HRMS (ESI) m/z Calcd. for $C_{19}H_{22}OS_3$ $[M]^+$ 362.0827, found: 362.0780.

IR (film) ν_{max} (cm^{-1}) 2921, 2836, 1735, 1560, 1490, 1461, 1437, 1242, 1103, 1049, 1028, 850, 751, 735, 705, 552.



24

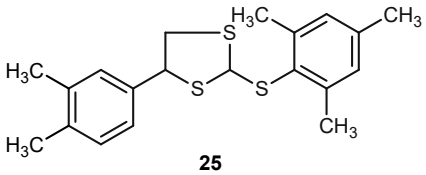
According to the general procedure, the title product was obtained in 91% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.29 (m, 1.5H), 7.21 (s, 0.49H), 7.05 (t, *J* = 6.9 Hz, 1H), 7.00 and 6.98 (s, 2H), 5.75 (s, 0.45H), 5.67 (s, 0.48H), 5.10 – 5.02 (m, 0.52H), 4.89 (dd, *J* = 11.1, 4.9 Hz, 0.50H), 3.76 – 3.60 (m, 1H), 3.45 – 3.36 (m, 1H), 3.21 and 3.19 (s, 4H), 2.62 and 2.61 (s, 6H), 2.32 and 2.30 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 146.30, 146.04, 145.94, 143.16, 139.32, 135.93, 135.72, 130.73, 130.68, 129.24, 126.96, 126.69, 122.83, 122.29, 122.13, 63.36, 62.23, 61.35, 58.05, 45.75, 44.00, 29.50, 22.33, 22.30, 21.22.

HRMS (ESI) m/z Calcd. for $C_{20}H_{26}NS_3$ $[M+NH_4]^+$ 376.1222, found: 376.1229.

IR (film) ν_{max} (cm^{-1}) 2917, 1600, 1470, 1456, 1432, 1418, 1373, 1032, 843, 817, 725, 706, 550.



25

According to the general procedure, the title product was obtained in 66% yield as a light brown oil.

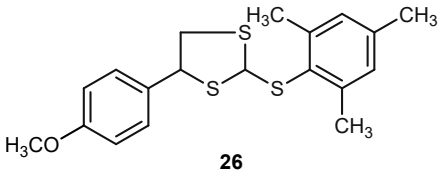
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.28 (m, 1H), 7.26 – 7.19 (m, 1H), 7.13 (dd, *J* = 10.2, 7.8 Hz, 1H), 6.99 and 6.97 (s, 2H), 5.74 (s, 0.38H), 5.66 (s, 0.42H), 5.03 (dd, *J* = 9.2, 5.2 Hz, 0.45H), 4.86 (dd, *J* = 11.1, 4.8 Hz, 0.44H), 3.75 – 3.61 (m, 1H), 3.44 – 3.36 (m, 1H), 2.61 and 2.60 (s, 6H), 2.34 – 2.25 (m, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.19, 139.33, 137.07, 136.78, 136.70, 134.73,

134.59, 130.71, 130.05, 130.02, 129.27, 129.14, 125.55, 125.33, 62.41, 62.18, 61.37, 57.16, 45.55, 43.80, 22.35, 22.32, 21.23, 19.90, 19.59, 19.55.

HRMS (ESI) m/z Calcd. for $C_{20}H_{28}NS_3$ $[M+NH_4]^+$ 378.1378, found: 378.1356.

IR (film) ν_{max} (cm^{-1}) 2919, 1600, 1499, 1451, 1374, 1029, 851, 823, 725, 712, 552.



26

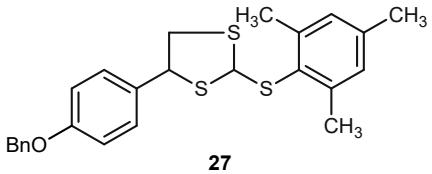
According to the general procedure, the title product was obtained in 51% yield as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.45 (m, 1H), 7.41 – 7.36 (m, 1H), 6.98 and 6.96 (s, 2H), 6.93 – 6.85 (m, 2H), 5.72 (s, 0.50H), 5.64 (s, 0.47H), 5.04 (dd, *J* = 8.9, 5.1 Hz, 0.50H), 4.88 (dd, *J* = 11.0, 4.9 Hz, 0.49H), 3.82 and 3.80 (s, 3H), 3.69 (dd, *J* = 11.0, 5.2 Hz, 0.51H), 3.61 (dd, *J* = 12.0, 11.3 Hz, 0.50H), 3.41 – 3.33 (m, 1H), 2.594 and 2.586 (s, 6H), 2.30 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.56, 159.50, 143.18, 139.37, 130.72, 130.69, 129.28, 129.07, 114.21, 114.18, 62.13, 61.32, 56.90, 55.43, 55.42, 45.57, 43.83, 22.34, 22.31, 21.23.

HRMS (ESI) m/z Calcd. for $C_{19}H_{22}NaOS_3$ $[M+Na]^+$ 385.5532, found: 385.0743.

IR (film) ν_{max} (cm^{-1}) 2910, 1612, 1511, 1253, 1172, 1033, 856, 825, 735, 547, 528.



27

According to the general procedure, the title product was obtained in 54% yield as a white solid.

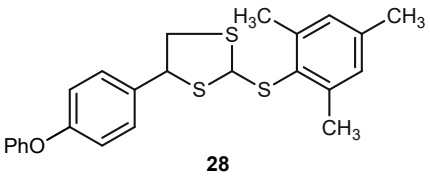
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.32 (m, 7H), 7.02 – 6.91 (m, 4H), 5.73 (s, 0.49H), 5.64 (s, 0.46H), 5.09 and 5.07 (s, 2H), 5.04 (dd, *J* = 8.9, 5.2 Hz, 0.54H), 4.88 (dd, *J* = 11.0, 4.9 Hz, 0.48H), 3.75 – 3.56 (m, 1H), 3.43 – 3.33 (m, 1H), 2.60 and 2.59 (s, 6H), 2.30 and 2.29 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.77, 158.71, 143.19, 139.38, 136.94, 136.91,

130.73, 130.69, 129.62, 129.54, 129.34, 129.27, 129.11, 128.72, 128.13, 127.55, 115.15, 115.11, 77.48, 62.15, 62.12, 61.34, 56.90, 45.56, 43.81, 22.35, 22.32, 21.24.

HRMS (ESI) m/z Calcd. for $C_{25}H_{26}OS_3$ $[M]^+$ 438.1140, found: 438.1121.

IR (film) ν_{max} (cm^{-1}) 2917, 1608, 1509, 1455, 1379, 1294, 1239, 1174, 1007, 854, 824, 739, 727, 528.



28

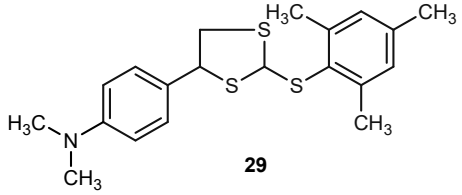
According to the general procedure, the title product was obtained in 75% yield as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.49 (m, 1H), 7.45 – 7.40 (m, 1H), 7.40 – 7.33 (m, 2H), 7.18 – 7.11 (m, 1H), 7.08 – 6.95 (m, 6H), 5.75 (s, 0.50H), 5.66 (s, 0.46H), 5.06 (dd, *J* = 8.7, 5.2 Hz, 0.50H), 4.90 (dd, *J* = 11.0, 4.9 Hz, 0.47H), 3.73 (dd, *J* = 11.1, 5.2 Hz, 0.51H), 3.68 – 3.60 (m, 0.47H), 3.46 – 3.34 (m, 1H), 2.600 and 2.596 (s, 6H), 2.301 and 2.293 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.34, 157.33, 156.95, 156.89, 143.16, 139.40, 132.14, 132.03, 130.65, 129.90, 129.56, 129.33, 129.28, 123.64, 123.63, 119.22, 119.21, 118.91, 118.83, 62.19, 61.92, 61.39, 56.83, 45.52, 43.88, 22.34, 22.31, 21.23.

HRMS (ESI) m/z Calcd. for $C_{24}H_{24}OS_3$ $[M]^+$ 424.0984, found: 424.0955.

IR (film) ν_{max} (cm^{-1}) 2918, 1586, 1504, 1488, 1237, 1165, 873, 847, 749, 731, 690, 517.



29

According to the general procedure, the title product was obtained in 86% yield as a yellow solid.

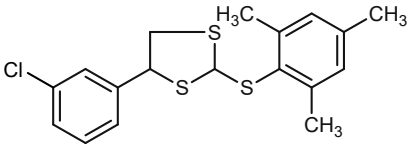
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.38 (m, 0.78H), 7.34 – 7.28 (m, 1.22H), 6.96 and 6.94 (s, 2H), 6.70 (t, *J* = 9.9 Hz, 2H), 5.69 (s, 0.56H), 5.61 (s, 0.35H), 5.01 (dd, *J* = 9.4, 5.1 Hz, 0.58H), 4.86 (dd, *J* = 11.2, 4.8 Hz, 0.36H), 3.67 – 3.57 (m, 1H), 3.40 –

3.29 (m, 1H), 2.96 and 2.94 (s, 3H), 2.58 and 2.57 (s, 3H), 2.28 and 2.26 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.56, 150.48, 143.24, 143.21, 139.32, 130.84, 130.80, 129.25, 129.23, 128.94, 128.72, 112.61, 112.58, 62.65, 62.02, 61.21, 57.17, 45.55, 43.67, 40.66, 40.63, 22.37, 22.34, 21.25.

HRMS (ESI) m/z Calcd. for $C_{20}H_{26}NS_3$ $[M+H]^+$ 376.1222, found: 376.1230.

IR (film) ν_{max} (cm^{-1}) 2918, 2851, 1613, 1520, 1444, 1349, 1166, 1059, 1046, 948, 853, 811, 709, 544, 527.



30

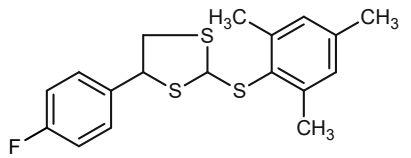
According to the general procedure, the title product was obtained in 65% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.23 (m, 4H), 6.96 and 6.95 (s, 2 H), 5.73 (s, 0.42H), 5.64 (s, 0.51H), 5.00 (dd, *J* = 8.1, 5.7 Hz, 0.52H), 4.82 (dd, *J* = 10.8, 5.0 Hz, 0.54H), 3.74 (dd, *J* = 11.1, 5.2 Hz, 0.45H), 3.62 – 3.52 (m, 0.55H), 3.46 – 3.29 (m, 1H), 2.57 and 2.56 (s, 3H), 2.28 and 2.27 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.22, 143.20, 140.20, 140.00, 139.53, 134.64, 134.60, 130.51, 130.13, 130.02, 129.35, 129.33, 128.51, 128.37, 128.36, 128.20, 126.47, 126.22, 62.31, 61.66, 61.54, 56.87, 45.33, 43.88, 22.37, 22.33, 21.26.

HRMS (ESI) m/z Calcd. for $C_{18}H_{19}ClLiS_3$ $[M+Li]^+$ 373.0492, found: 373.0487.

IR (film) ν_{max} (cm^{-1}) 2920, 1594, 1572, 1474, 1430, 1032, 906, 851, 788, 729, 691, 552.



31

According to the general procedure, the title product was obtained in 64% yield as a light yellow solid.

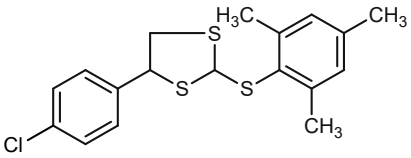
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.49 (m, 1H), 7.47 – 7.39 (m, 1H), 7.09 – 6.99 (m, 2H), 6.98 and 6.96 (s, 2H), 5.73 (s, 0.48H), 5.65 (s, 0.46H), 5.10 – 5.00 (m,

0.55H), 4.88 (dd, *J* = 10.9, 5.0 Hz, 0.48H), 3.73 (dd, *J* = 11.2, 5.3 Hz, 0.51H), 3.59 (dd, *J* = 12.2, 11.0 Hz, 0.49H), 3.38 (ddd, *J* = 19.5, 11.7, 6.7 Hz, 1H), 2.59 and 2.58 (s, 6H), 2.29 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 163.76, 161.27, 143.16, 139.46, 133.56, 130.58, 129.87, 129.79, 129.64, 129.56, 129.30, 115.84, 115.79, 115.63, 115.57, 62.25, 61.61, 61.44, 56.67, 45.55, 43.99, 22.32, 21.23.

HRMS (ESI) m/z Calcd. for $C_{18}H_{19}FNaS_3$ $[M+Na]^+$ 373.0525, found: 373.0517.

IR (film) ν_{max} (cm^{-1}) 2919, 1599, 1506, 1457, 1223, 1157, 837, 820, 792, 724, 710, 528.



32

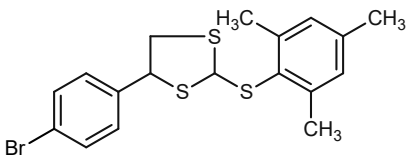
According to the general procedure, the title product was obtained in 56% yield as a light yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.5 Hz, 1H), 7.39 (d, *J* = 8.5 Hz, 1H), 7.36 – 7.27 (m, 2H), 6.97 and 6.96 (s, 2H), 5.73 (s, 0.48H), 5.65 (s, 0.46H), 5.06 – 5.00 (m, 0.57H), 4.86 (dd, *J* = 10.8, 5.0 Hz, 0.48H), 3.73 (dd, *J* = 11.2, 5.3 Hz, 0.50H), 3.64 – 3.54 (m, 0.48H), 3.38 (ddd, *J* = 19.3, 11.8, 6.5 Hz, 1H), 2.58 and 2.57 (s, 6H), 2.29 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.18, 139.51, 136.51, 136.40, 133.99, 130.55, 129.57, 129.33, 129.01, 128.94, 62.33, 61.59, 61.53, 56.76, 45.41, 43.94, 22.34, 22.31, 21.25.

HRMS (ESI) m/z Calcd. for $C_{18}H_{19}ClLiS_3$ $[M+Li]^+$ 373.0492, found: 373.0459.

IR (film) ν_{max} (cm^{-1}) 2917, 2850, 1600, 1488, 1456, 1374, 1086, 1040, 1014, 851, 814, 725, 710, 552, 518.



33

According to the general procedure, the title product was obtained in 54% yield as a

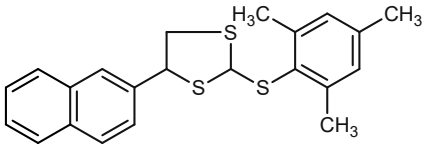
light yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.40 (m, 3H), 7.36 – 7.30 (m, 1H), 6.97 and 6.96 (s, 2H), 5.73 (s, 0.46H), 5.64 (s, 0.49H), 5.04 – 4.98 (m, 0.54H), 4.84 (dd, *J* = 10.8, 5.0 Hz, 0.49H), 3.73 (dd, *J* = 11.2, 5.3 Hz, 0.49H), 3.62 – 3.51 (m, 0.52H), 3.37 (ddd, *J* = 19.2, 11.8, 6.5 Hz, 1H), 2.574 and 2.566 (s, 6H), 2.29 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.16, 139.49, 137.07, 136.95, 131.96, 131.88, 130.53, 130.52, 129.89, 129.65, 129.31, 122.08, 62.33, 61.61, 61.55, 56.80, 45.34, 43.90, 22.34, 22.30, 21.25.

HRMS (ESI) m/z Calcd. for $C_{18}H_{19}BrLiS_3$ $[M+Li]^+$ 416.9987, found: 417.0104.

IR (film) ν_{max} (cm^{-1}) 2954, 2919, 2850, 1598, 1487, 1456, 1431, 1402, 1376, 1074, 1008, 852, 816, 721, 551, 508.



34

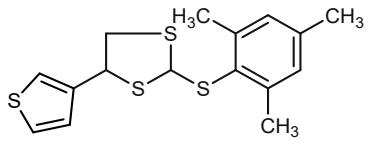
According to the general procedure, the title product was obtained in 57% yield as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.79 (m, 4H), 7.74 (dd, *J* = 8.5, 1.8 Hz, 0.55H), 7.58 (dd, *J* = 8.6, 1.8 Hz, 0.46H), 7.53 – 7.46 (m, 2H), 6.99 and 6.97 (s, 2H), 5.80 (s, 0.43H), 5.71 (s, 0.53H), 5.24 (dd, *J* = 8.4, 5.3 Hz, 0.44H), 5.08 (dd, *J* = 11.0, 5.0 Hz, 0.55H), 3.86 – 3.70 (m, 1H), 3.55 – 3.43 (m, 1H), 2.62 and 2.61 (s, 6H), 2.30 and 2.29 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.24, 139.46, 135.01, 134.97, 133.38, 133.30, 133.16, 130.70, 130.66, 129.33, 128.75, 128.64, 127.98, 127.92, 127.84, 127.78, 127.32, 126.99, 126.53, 126.39, 125.71, 62.75, 62.44, 61.62, 57.69, 45.45, 43.77, 22.39, 22.37, 21.27.

HRMS (ESI) m/z Calcd. for $C_{22}H_{26}NS_3$ $[M+NH_4]^+$ 400.1222, found: 400.1237.

IR (film) ν_{max} (cm^{-1}) 2918, 1598, 1508, 1455, 1430, 1373, 1173, 1125, 1030, 1014, 854, 823, 748, 711, 551, 479.



35

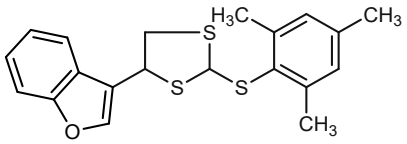
According to the general procedure, the title product was obtained in 75% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.12 (m, 3H), 6.97 (s, 2H), 5.72 (s, 0.44H), 5.63 (s, 0.51H), 5.17 (dd, *J* = 8.0, 5.2 Hz, 0.45H), 5.04 – 4.97 (m, 0.57H), 3.73 (dd, *J* = 11.1, 5.2 Hz, 0.46H), 3.63 (dd, *J* = 12.0, 10.9 Hz, 0.54H), 3.41 (ddd, *J* = 19.2, 11.6, 6.5 Hz, 1H), 2.58 (s, 6H), 2.291 and 2.286 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.17, 139.42, 139.40, 138.60, 138.57, 130.61, 130.59, 129.27, 127.05, 127.03, 126.51, 126.43, 123.02, 122.70, 61.93, 61.28, 57.13, 52.69, 44.82, 43.15, 22.33, 22.31, 21.24.

HRMS (ESI) m/z Calcd. for $C_{16}H_{18}KS_3$ $[M+K]^+$ 376.9923, found: 377.0135.

IR (film) ν_{max} (cm^{-1}) 2917, 2849, 1599, 1455, 1372, 1031, 849, 840, 784, 753, 726, 689, 626, 552.



36

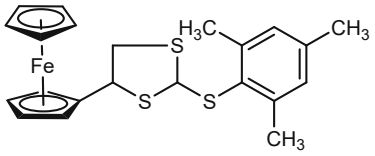
According to the general procedure, the title product was obtained in 52% yield as a light yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.90 (m, 0.62H), 7.73 (s, 0.6H), 7.72 – 7.67 (m, 0.43H), 7.65 (s, 0.31H), 7.54 – 7.47 (m, 1H), 7.32 (tdd, *J* = 14.8, 7.4, 1.3 Hz, 2H), 6.97 (s, 2H), 5.76 (s, 0.31H), 5.69 (s, 0.51H), 5.28 (dd, *J* = 7.2, 5.3 Hz, 0.31H), 5.09 (dd, *J* = 10.6, 4.9 Hz, 0.57H), 3.81 (ddd, *J* = 10.5, 8.4, 3.1 Hz, 1H), 3.52 (ddd, *J* = 12.2, 7.5, 6.1 Hz, 1H), 2.59 and 2.58 (s, 6H), 2.29 and 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 155.89, 155.73, 143.22, 142.96, 142.92, 139.51, 130.61, 129.34, 126.28, 124.92, 122.89, 120.70, 120.06, 118.34, 117.65, 111.94, 61.97, 61.35, 52.41, 48.28, 43.44, 41.63, 22.34, 21.26.

HRMS (ESI) m/z Calcd. for $C_{20}H_{24}NOS_3$ $[M+NH_4]^+$ 390.1015, found: 390.1022.

IR (film) ν_{max} (cm^{-1}) 2918, 1600, 1451, 1176, 1099, 854, 743, 552.



37

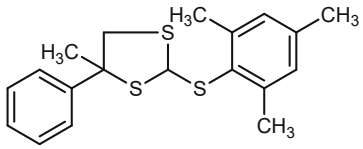
According to the general procedure, the title product was obtained in 42% yield as a brown oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.96 and 6.95 (s, 2H), 5.64 (s, 0.40H), 5.53 (s, 0.52H), 4.92 (dd, *J* = 8.1, 5.2 Hz, 0.43H), 4.77 (dd, *J* = 10.8, 4.9 Hz, 0.56H), 4.55 – 4.11 (m, 9H), 3.64 (dd, *J* = 11.0, 5.2 Hz, 0.42H), 3.44 – 3.35 (m, 0.58H), 3.30 – 3.18 (m, 1H), 2.58 and 2.56 (s, 6H), 2.28 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.17, 143.16, 139.35, 139.30, 130.76, 130.72, 129.25, 85.61, 84.67, 69.12, 68.54, 68.26, 68.22, 68.20, 68.09, 67.76, 67.66, 67.30, 61.32, 61.10, 59.15, 54.21, 44.87, 42.85, 22.34, 21.25.

HRMS (ESI) m/z Calcd. for $C_{22}H_{24}FeS_3$ $[M]^+$, 440.0384, found: 440.0384.

IR (film) ν_{max} (cm^{-1}) 2952, 2919, 2851, 1658, 1601, 1456, 1374, 1105, 1025, 1000, 850, 816, 734, 707, 552, 484.



38

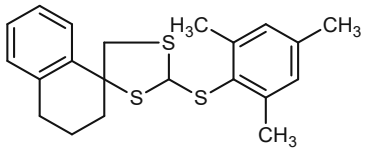
According to the general procedure, the title product was obtained in 43% yield as a light yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 7.5 Hz, 0.72H), 7.55 – 7.49 (m, 1.22H), 7.40 – 7.21 (m, 3H), 6.95 (s, 2H), 5.65 (s, 0.34H), 5.61 (s, 0.57H), 3.93 (d, *J* = 12.2 Hz, 0.37H), 3.64 – 3.59 (m, 1.22H), 3.19 (d, *J* = 12.2 Hz, 0.35H), 2.57 and 2.54 (s, 6H), 2.28 and 2.27 (s, 3), 2.05 (s, 2H), 1.91 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 144.27, 143.65, 143.28, 143.25, 139.41, 139.36, 130.57, 130.32, 129.30, 129.27, 128.53, 128.44, 127.45, 127.27, 127.14, 126.50, 68.63, 67.95, 62.05, 61.77, 50.73, 49.95, 30.29, 30.09, 22.39, 22.32, 21.25.

HRMS (ESI) m/z Calcd. for $C_{19}H_{23}S_3$ $[M+H]^+$ 347.0956, found: 347.0953.

IR (film) ν_{max} (cm^{-1}) 2920, 1600, 1493, 1443, 1374, 1058, 1028, 907, 850, 763, 729, 695, 552.



39

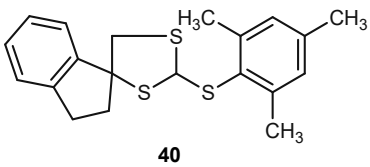
According to the general procedure, the title product was obtained in 50% yield as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 (d, *J* = 8.0 Hz, 0.21H), 7.78 – 7.71 (m, 0.78H), 7.30 –7.12 (m, 2H), 7.11 – 7.02 (m, 1H), 6.98 and 6.97 (s, 2H), 5.81 (s, 0.74H), 5.63 (s, 0.20H), 3.96 (d, *J* = 12.7 Hz, 0.21H), 3.67 (d, *J* = 12.0 Hz, 0.79H), 3.52 (d, *J* = 12.0 Hz, 0.78H), 3.24 (d, *J* = 12.7 Hz, 0.21H), 2.93 – 2.78 (m, 2H), 2.75 – 2.66 (m, 1H), 2.60 and 2.59 (s, 6H), 2.50 – 2.39 (m, 1H), 2.30 and 2.29 (s, 3H), 2.13 – 2.01 (m, 1H), 2.01 – 1.90 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.27, 143.22, 139.36, 139.34, 138.46, 137.68, 137.54, 136.75, 130.69, 130.46, 129.79, 129.70, 129.39, 129.29, 128.70, 127.39, 127.36, 126.48, 126.25, 68.80, 66.78, 62.12, 62.07, 52.43, 49.34, 38.81, 38.55, 30.34, 30.07, 22.34, 21.78, 21.26, 21.22.

HRMS (ESI) m/z Calcd. for $C_{21}H_{25}S_3$ $[M+H]^+$ 373.1113, found: 373.1139.

IR (film) ν_{max} (cm^{-1}) 2919, 2854, 1599, 1483, 1445, 1435, 1372, 1188, 1040, 852, 751, 717, 712, 658, 552.



40

According to the general procedure, the title product was obtained in 66% yield as a light green oil.

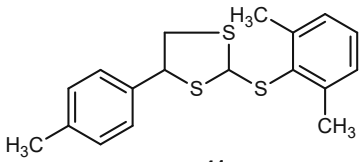
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.43 (m, 1H), 7.33 – 7.17 (m, 3H), 6.96 (s, 2H), 5.77 (s, 0.70H), 5.67 (s, 0.24H), 3.74 (dd, *J* = 12.2, 0.8 Hz, 0.27H), 3.51 (s, 1.47H), 3.14 (d, *J* = 12.2 Hz, 0.28H), 3.10 – 2.86 (m, 3H), 2.64 – 2.56 (m, 7H), 2.29 and 2.28

(s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.93, 143.34, 143.22, 139.36, 139.33, 130.45, 129.78, 129.30, 128.44, 128.39, 127.16, 126.92, 125.04, 124.91, 124.34, 124.04, 75.21, 73.13, 62.02, 61.93, 50.28, 47.61, 42.90, 41.14, 30.64, 30.02, 22.35, 21.23.

HRMS (ESI) m/z Calcd. for $C_{20}H_{22}LiS_3$ $[M+Li]^+$ 365.1038, found: 365.1076.

IR (film) ν_{max} (cm^{-1}) 2916, 2848, 1601, 1458, 1373, 1174, 1031, 850, 758, 735, 552.



41

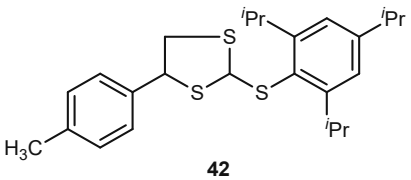
According to the general procedure, the title product was obtained in 60% yield as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.1 Hz, 1H), 7.36 (d, *J* = 8.1 Hz, 1H), 7.25 – 7.12 (m, 5H), 5.77 (s, 0.39H), 5.69 (s, 0.36H), 5.05 (dd, *J* = 8.9, 5.1 Hz, 0.49H), 4.89 (dd, *J* = 11.0, 4.9 Hz, 0.46H), 3.68 (ddd, *J* = 23.3, 11.5, 8.2 Hz, 1H), 3.48 – 3.33 (m, 1H), 2.64 and 2.63 (s, 6H), 2.37 and 2.35 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.39, 138.17, 138.09, 134.38, 134.21, 133.93, 133.88, 129.54, 129.50, 129.39, 129.38, 128.42, 128.40, 128.07, 127.86, 62.39, 62.07, 61.25, 57.20, 45.57, 43.88, 22.48, 22.45, 21.28, 21.24.

HRMS (ESI) m/z Calcd. for $C_{18}H_{24}NS_3$ $[M+NH_4]^+$ 350.1065, found: 350.1070.

IR (film) ν_{max} (cm^{-1}) 2953, 2919, 2851, 1514, 1457, 1425, 1376, 1163, 1022, 816, 769, 731, 714, 514.



42

According to the general procedure, the title product was obtained in 53% yield as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (dd, *J* = 8.1, 1.9 Hz, 1.11H), 7.36 (dd, *J* = 8.1, 2.0 Hz, 0.81H), 7.17 (dd, *J* = 13.7, 4.7 Hz, 2H), 7.07 (dd, *J* = 5.5, 2.5 Hz, 2H), 5.66 –

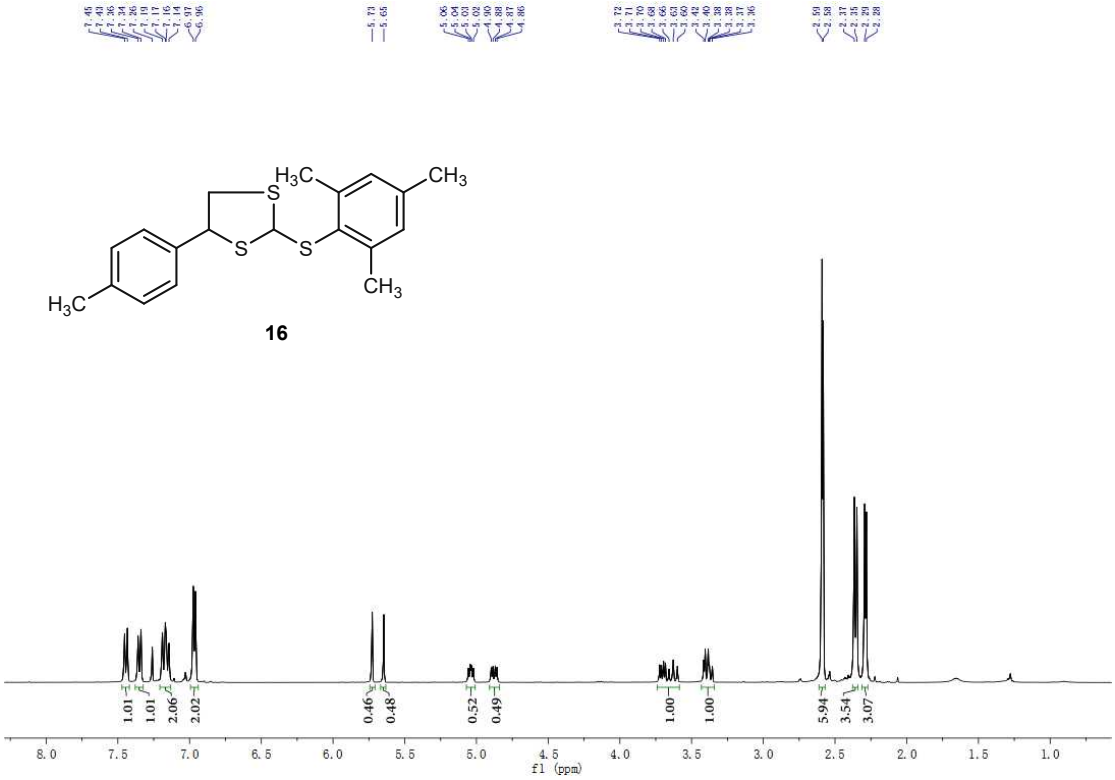
5.61 (m, 0.37H), 5.57 – 5.52 (m, 0.54H), 5.04 – 4.97 (m, 0.37H), 4.88 (ddd, *J* = 10.9, 4.7, 2.1 Hz, 0.54H), 4.10 – 3.94 (m, 2H), 3.69 (ddd, *J* = 11.1, 5.1, 1.7 Hz, 0.38H), 3.63 – 3.53 (m, 0.58H), 3.45 – 3.34 (m, 1H), 2.98 – 2.85 (m, 1H), 2.38 and 2.35 (s, 3H), 1.33 – 1.24 (m, 18H).

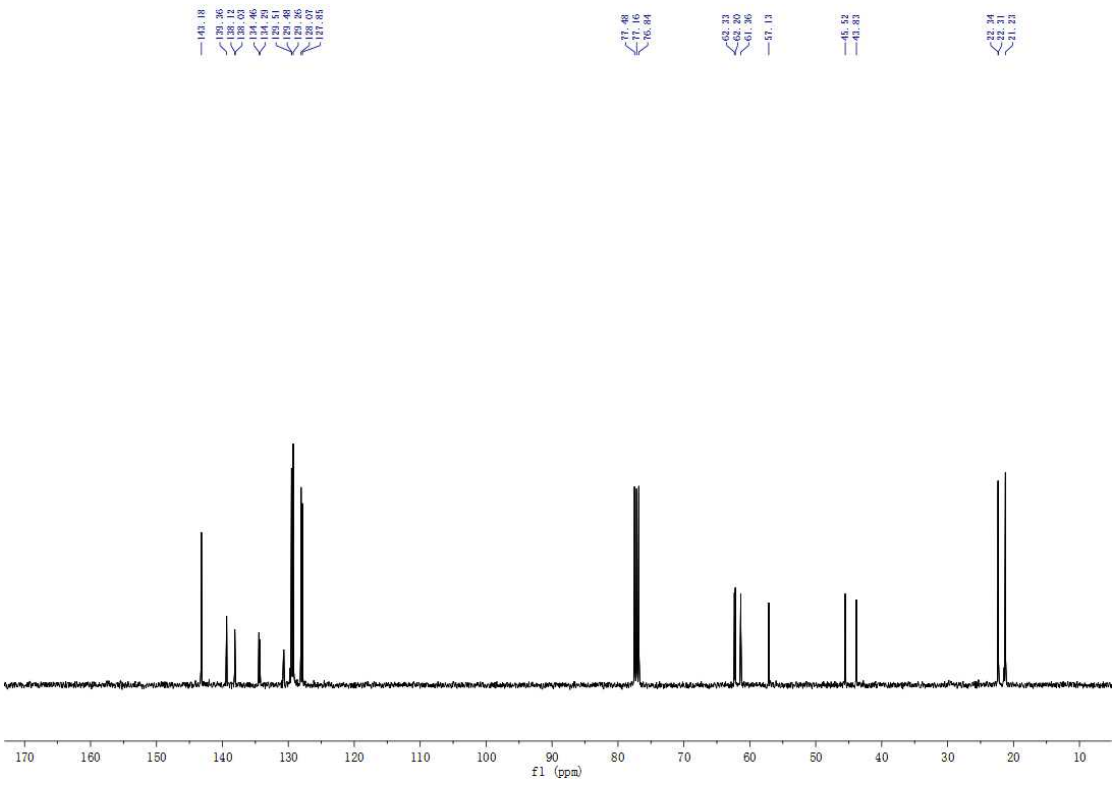
^{13}C NMR (101 MHz, $CDCl_3$) δ 153.36, 150.65, 138.15, 138.04, 134.39, 134.25, 129.52, 128.69, 128.63, 128.08, 127.86, 122.02, 63.92, 63.22, 62.36, 57.35, 45.64, 44.09, 34.44, 31.72, 24.76, 24.53, 24.48, 23.99, 21.29, 21.25.

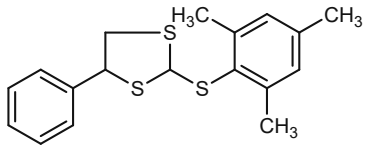
HRMS (ESI) m/z Calcd. for $C_{25}H_{34}LiS_3$ $[M+Li]^+$ 437.1977, found: 437.1944.

IR (film) ν_{max} (cm^{-1}) 2959, 2924, 2866, 1597, 1513, 1461, 1425, 1382, 1361, 1102, 1059, 908, 878, 816, 734, 648, 516.

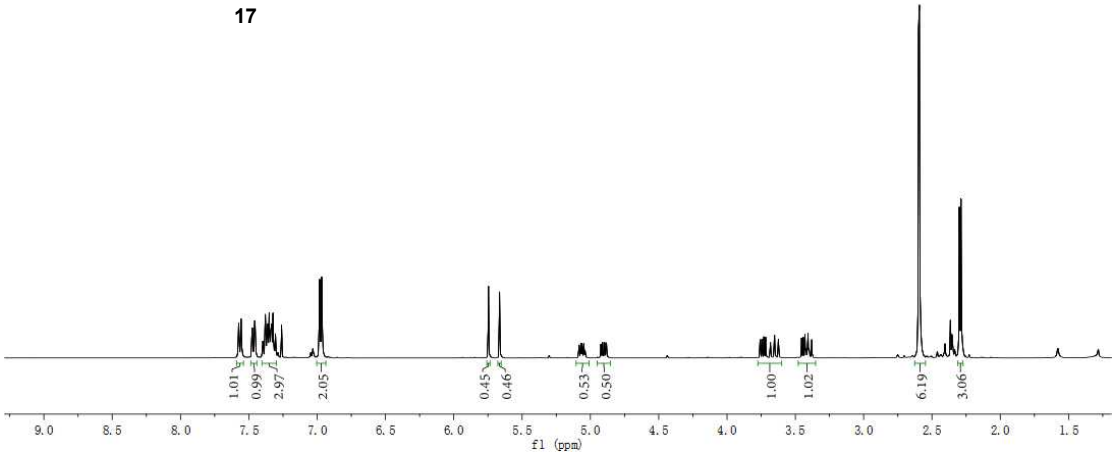
8. NMR Spectral Data

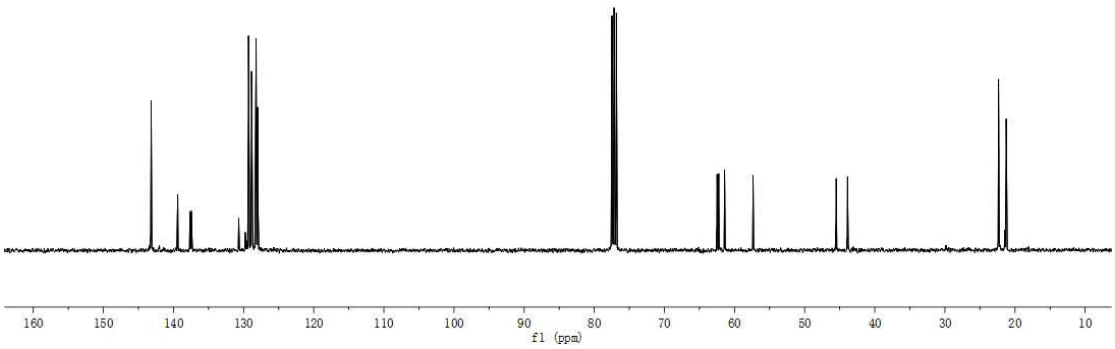


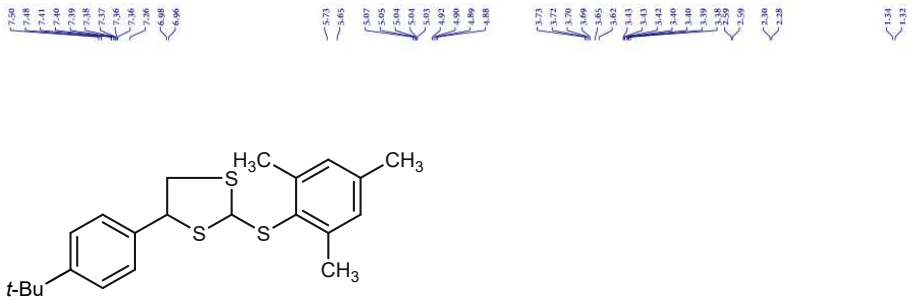




17

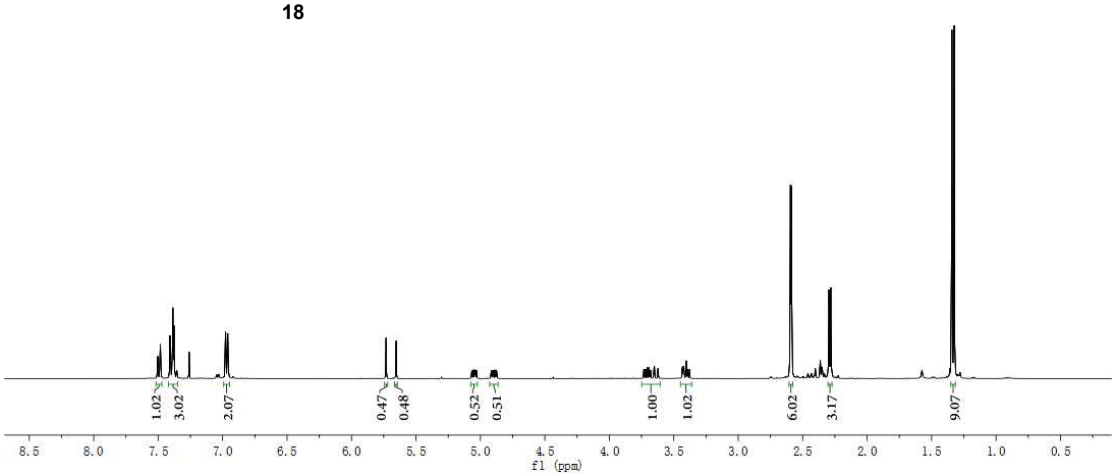

1.01
0.99
2.97
2.05
0.45
0.46
0.53
0.50
1.00
1.02
6.19
3.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
f1 (ppm)

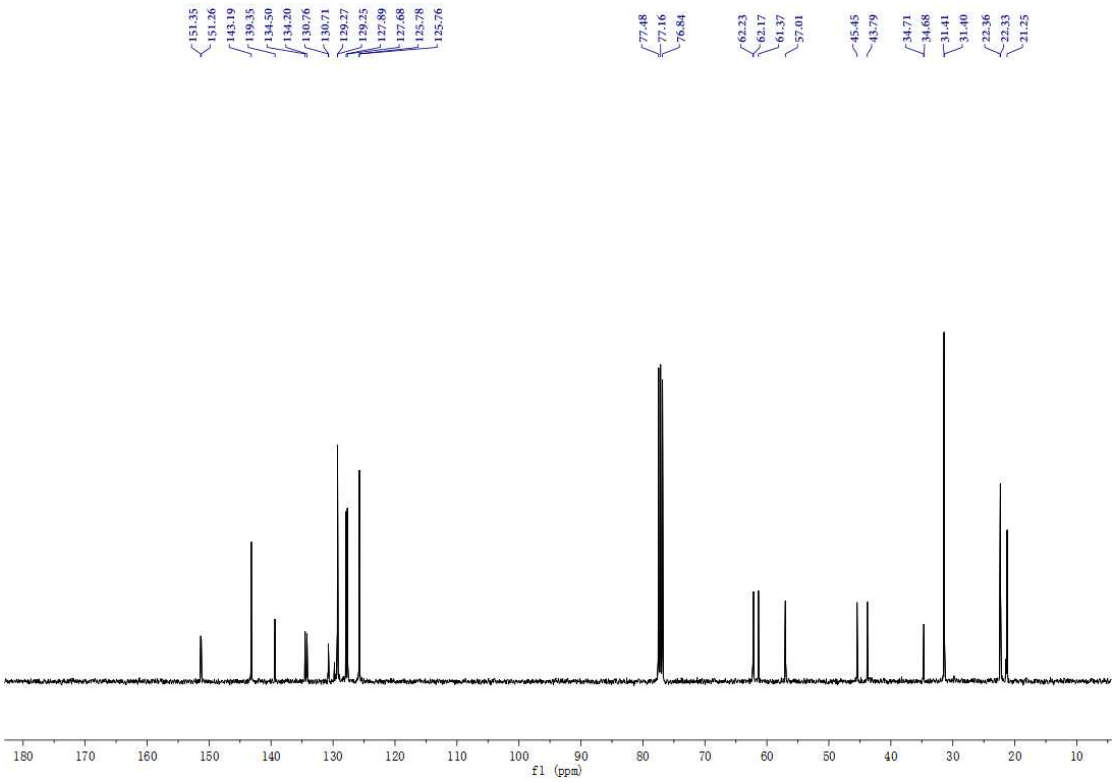

160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

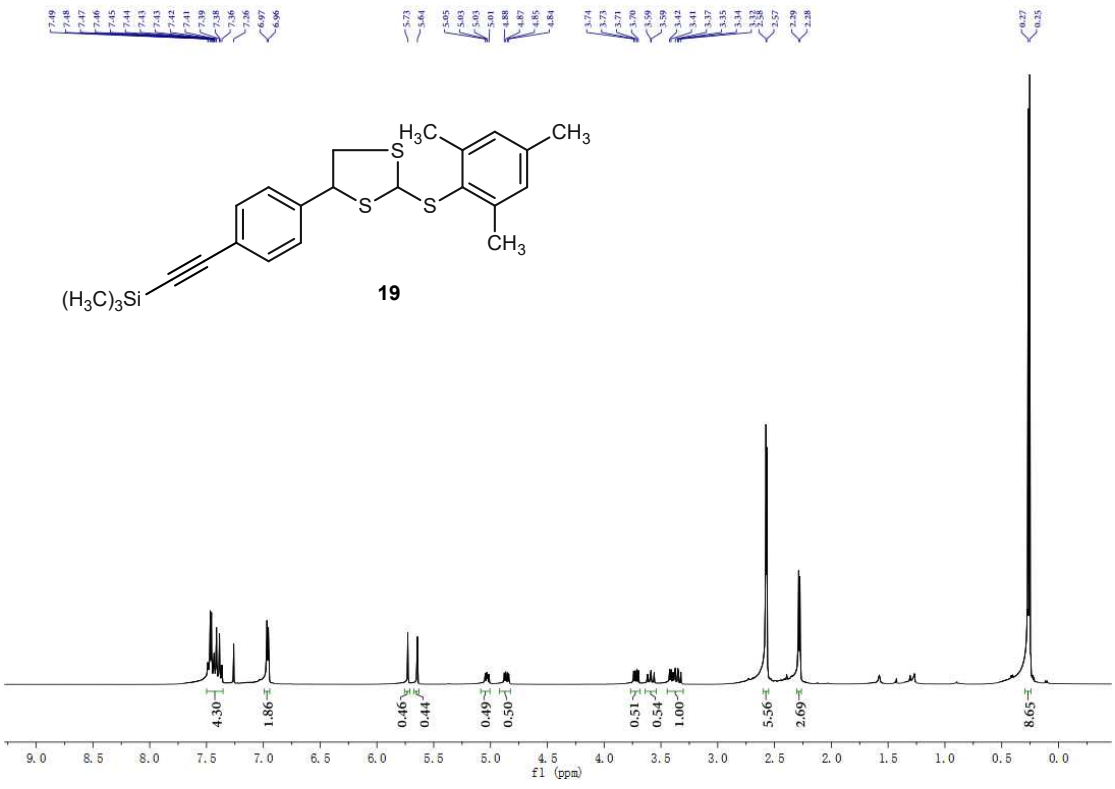


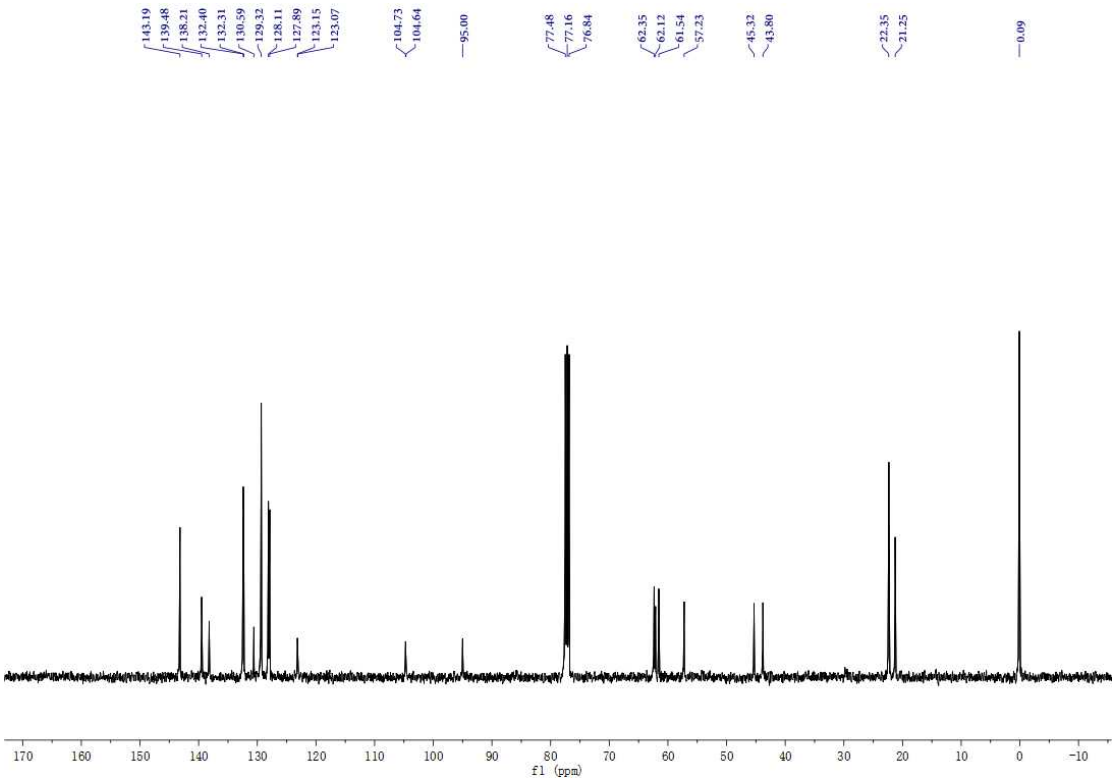
H3C
CH3
S
S
S
CH3
t-Bu

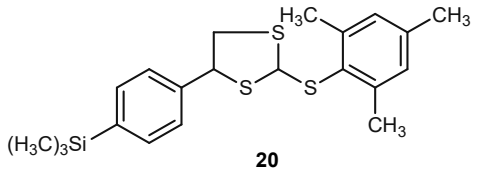
18


1.02
3.02
2.07
0.47
0.48
0.52
0.51
1.00
1.02
6.02
3.17
9.07
f1 (ppm)


f1 (ppm)

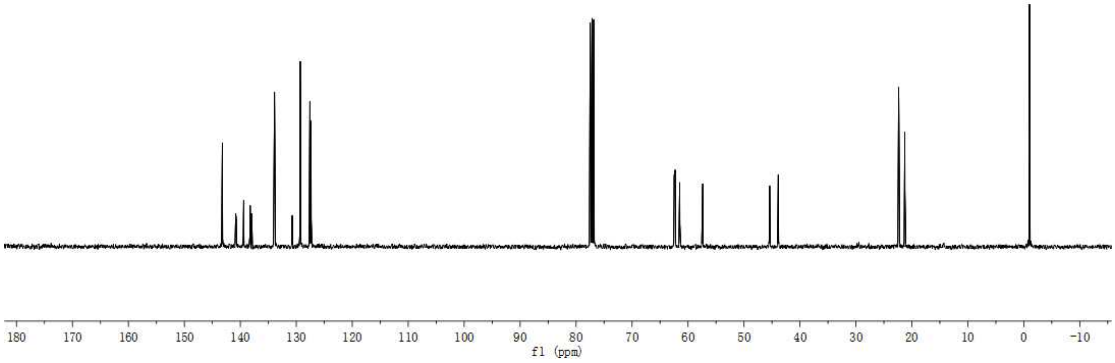

H3C
CH3
S
S
S
CH3
(H3C)3Si
19
f1 (ppm)

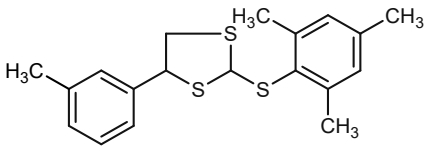

f1 (ppm)


H3C
CH3
S
S
S
CH3
(H3C)3Si

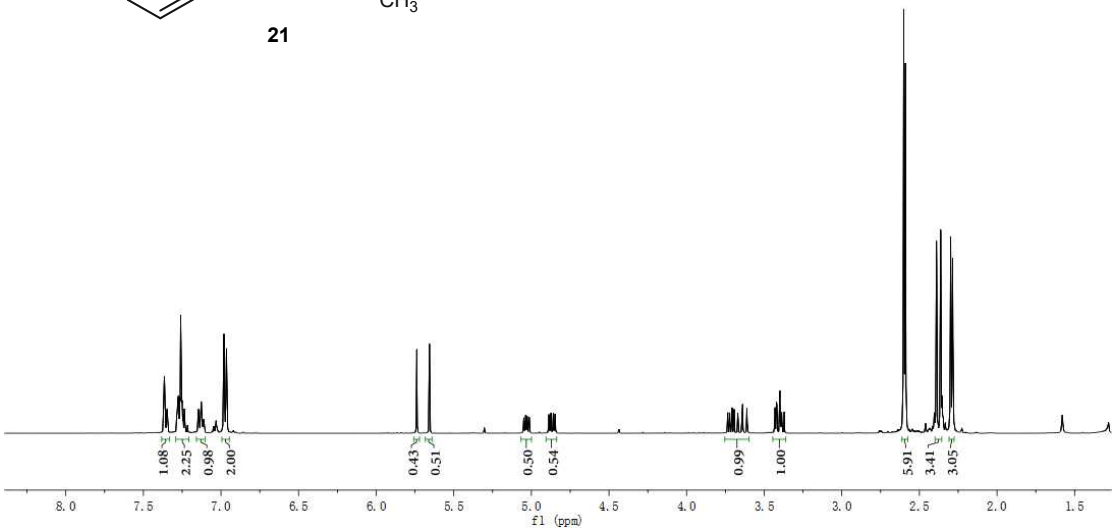
20

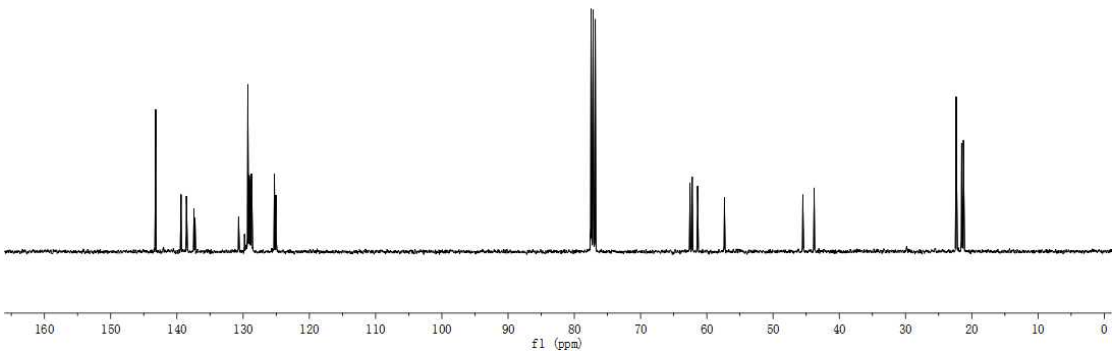
4.20
2.07
0.48
0.50
0.58
0.52
1.00
1.02
6.22
3.20
9.29
f1 (ppm)

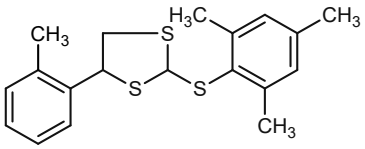

f1 (ppm)


H3C
CH3
S
S
S
H3C
CH3

21

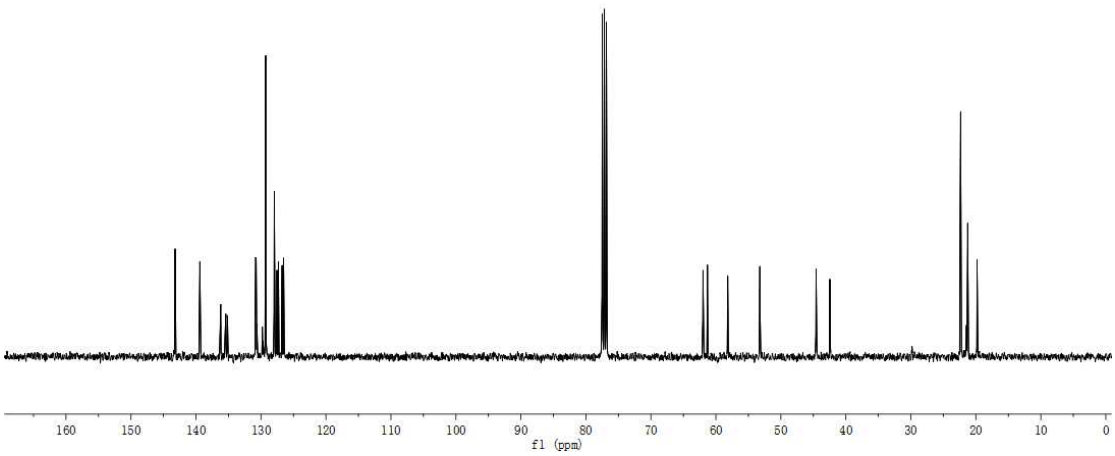

1.08
2.25
0.98
2.00
0.43
0.51
0.50
0.54
0.99
1.00
5.91
3.41
3.05
f1 (ppm)

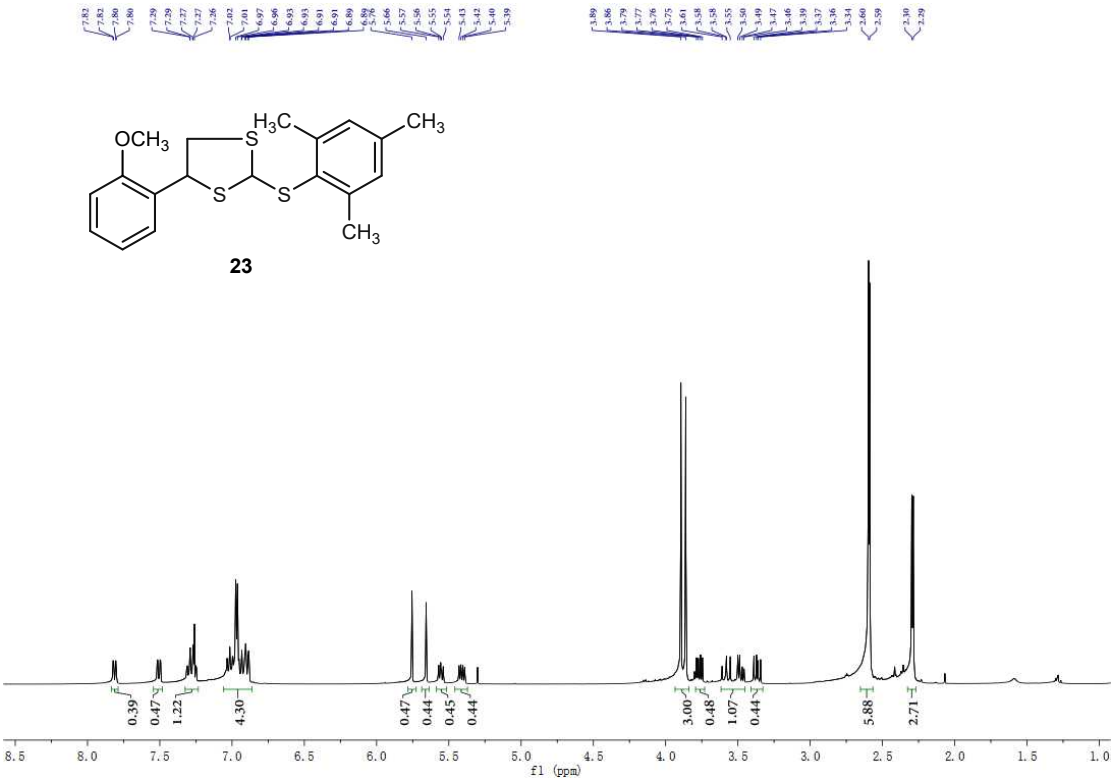

f1 (ppm)

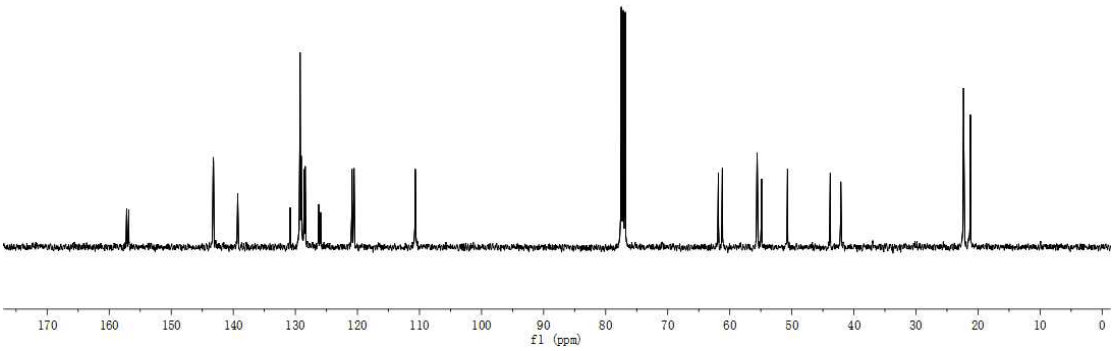

CH3
H3C
CH3
S
S
S
CH3

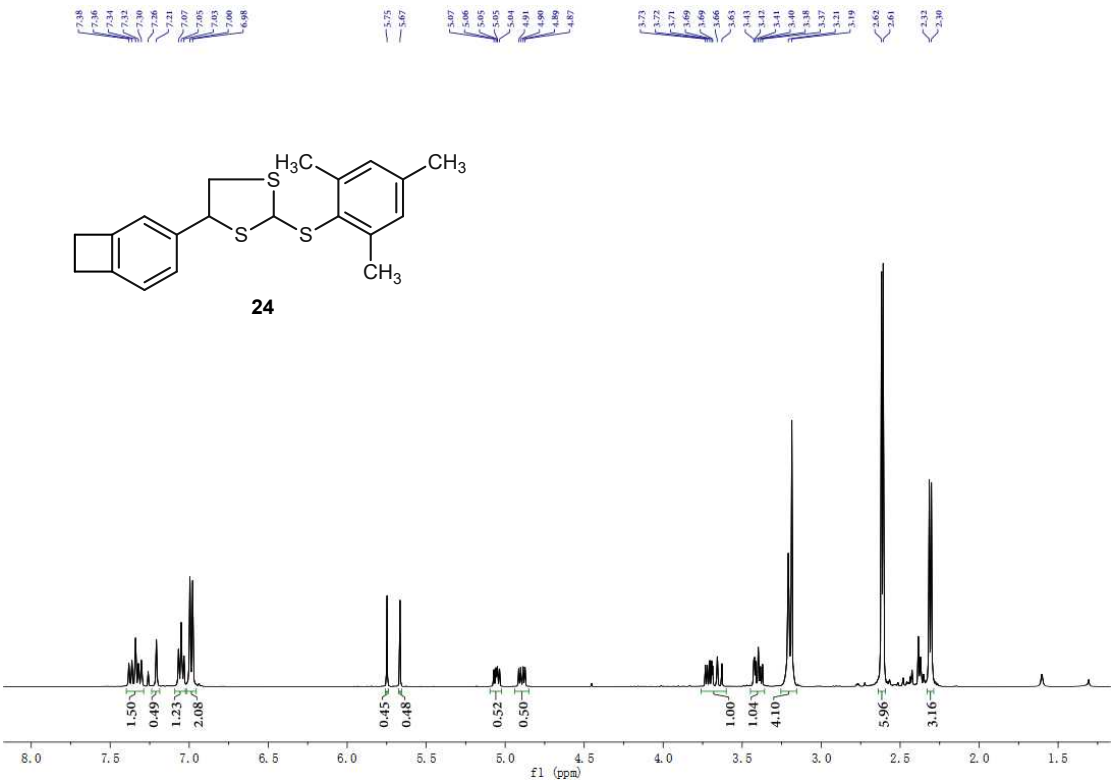
22

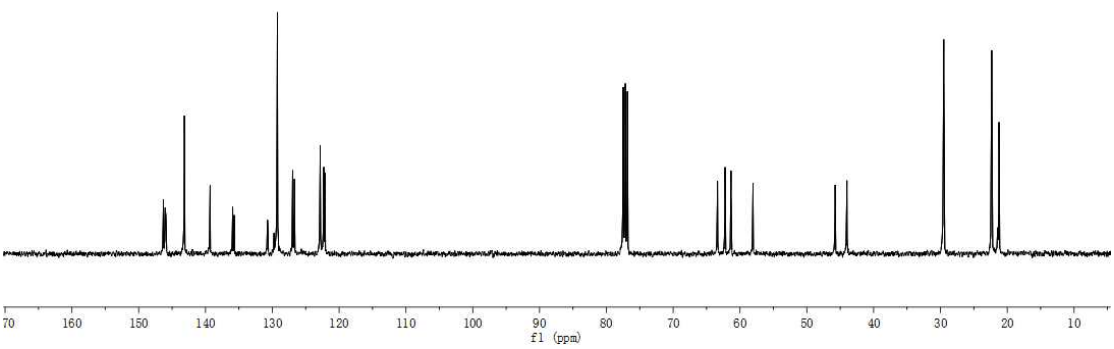
0.46
0.52
3.30
2.00
0.50
0.44
0.51
0.45
1.00
1.01
5.93
1.53
1.49
2.97
f1 (ppm)

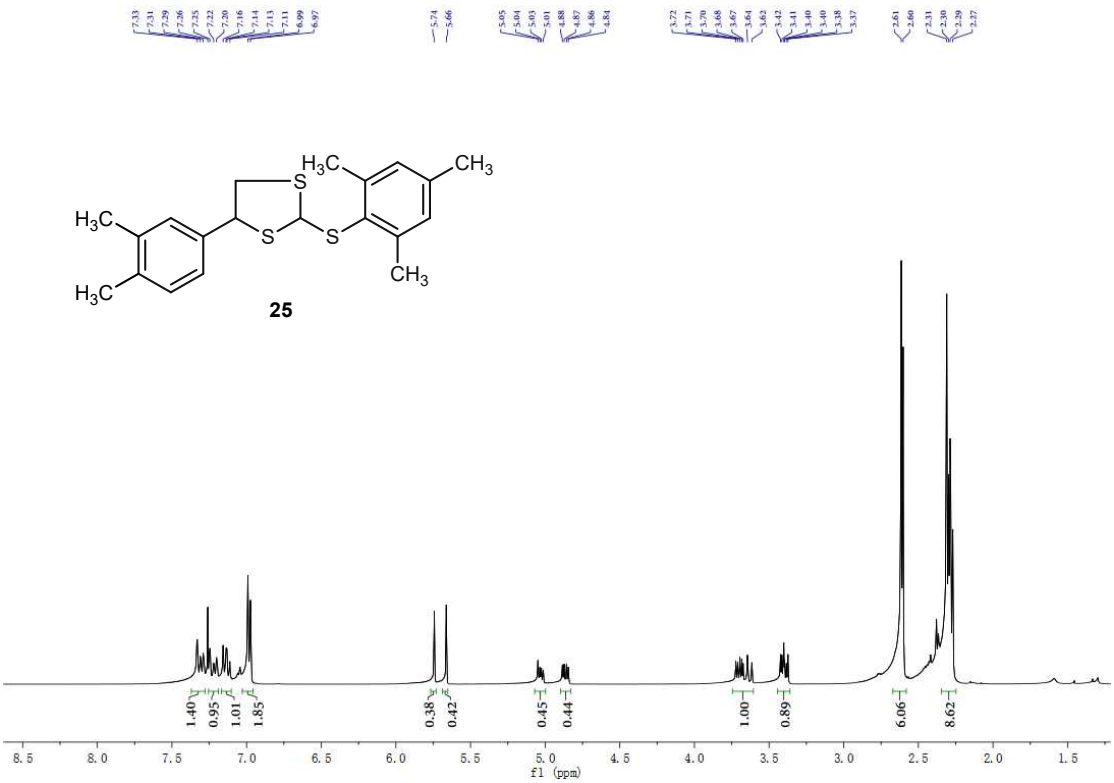

f1 (ppm)

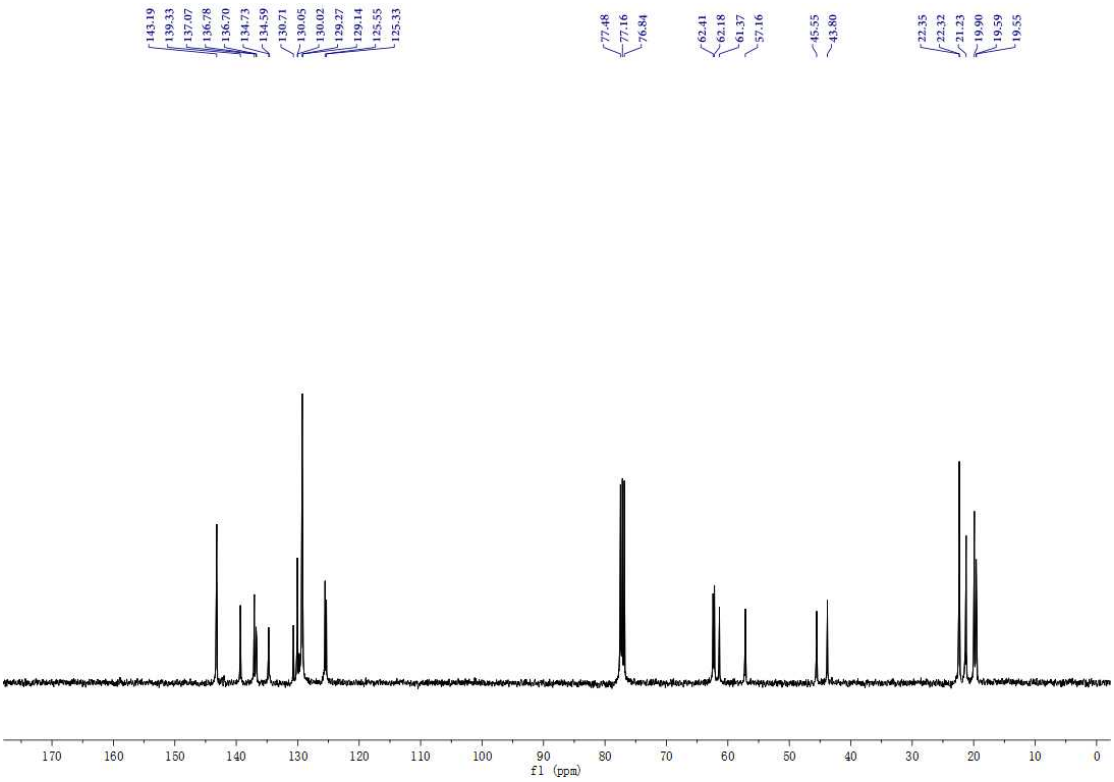

OCH3
H3C
CH3
S
S
S
CH3
23
0.39
0.47
1.22
4.30
0.47
0.44
0.45
0.44
3.00
0.48
1.07
0.44
5.88
2.71
f1 (ppm)

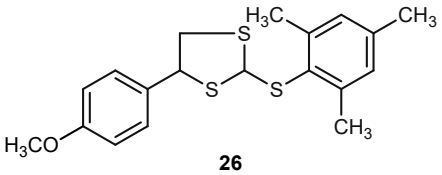

f1 (ppm)


H3C
CH3
S
S
S
CH3
24
1.50
0.49
1.23
2.08
0.45
0.48
0.52
0.50
1.00
1.04
4.10
5.96
3.16
f1 (ppm)

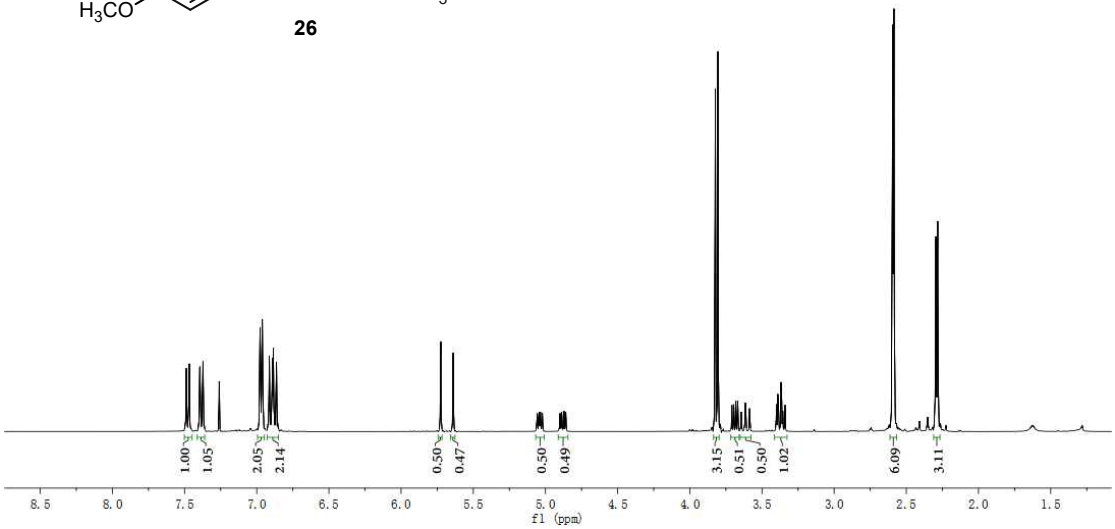

f1 (ppm)

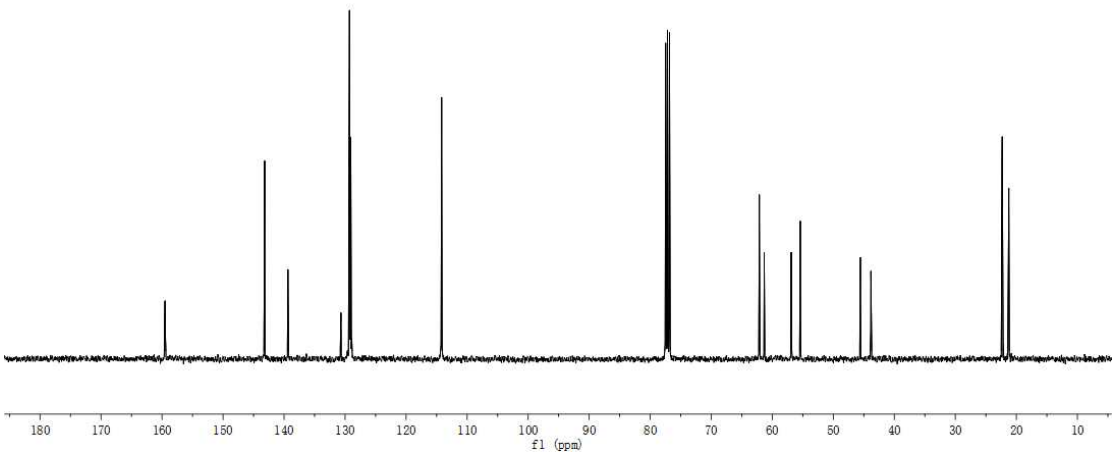

H3C
CH3
S
S
S
H3C
H3C
CH3
25
1.40
0.95
1.01
1.85
0.38
0.42
0.45
0.44
1.00
0.89
6.06
8.62
f1 (ppm)

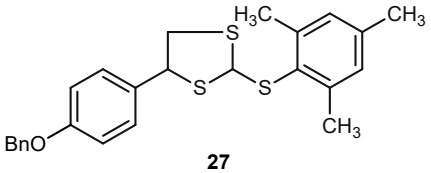

f1 (ppm)


H3C
CH3
S
S
S
CH3
H3CO

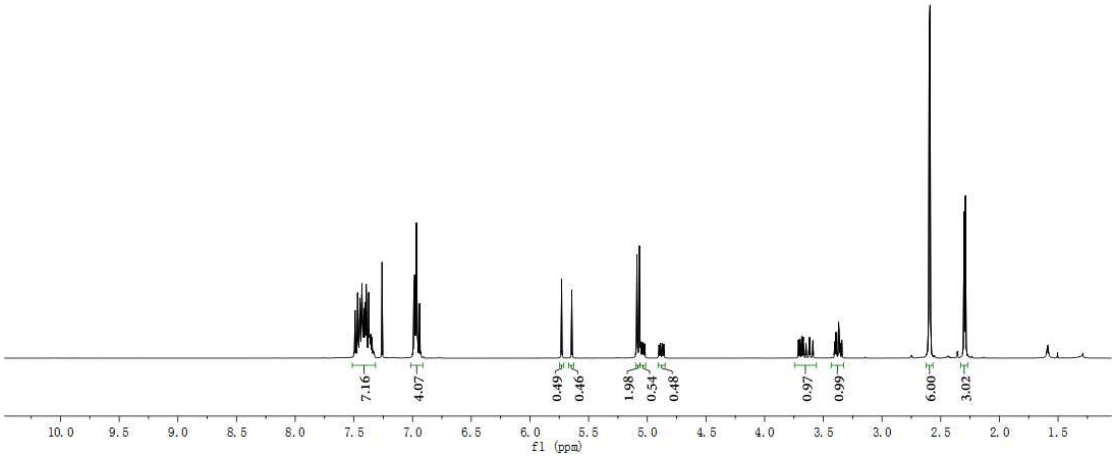
26


1.00
1.05
2.05
2.14
0.50
0.47
0.50
0.49
3.15
0.51
0.50
1.02
6.09
3.11
f1 (ppm)


f1 (ppm)


H3C
CH3
S
S
S
CH3
BnO

27


7.16
4.07
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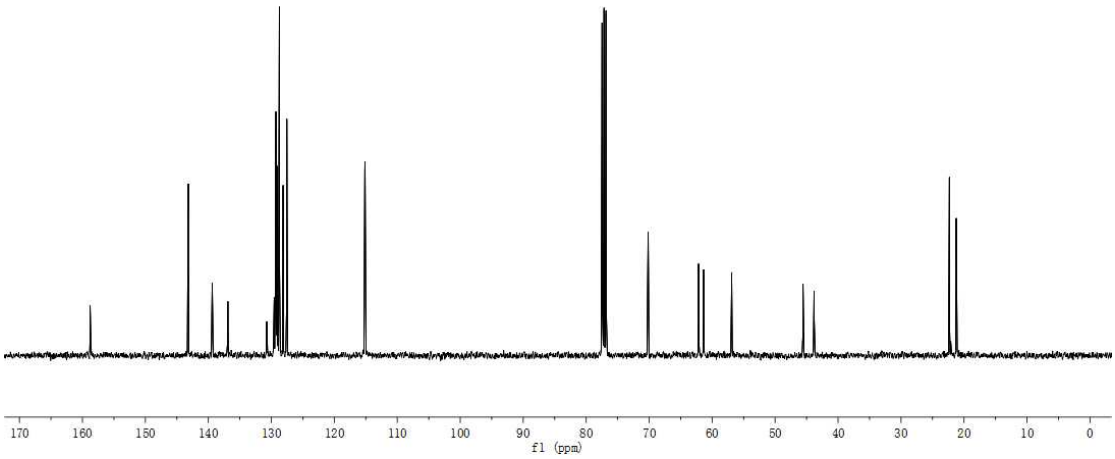
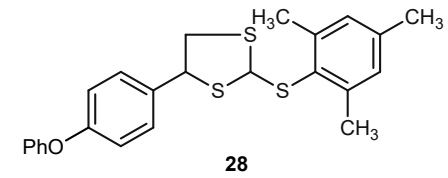
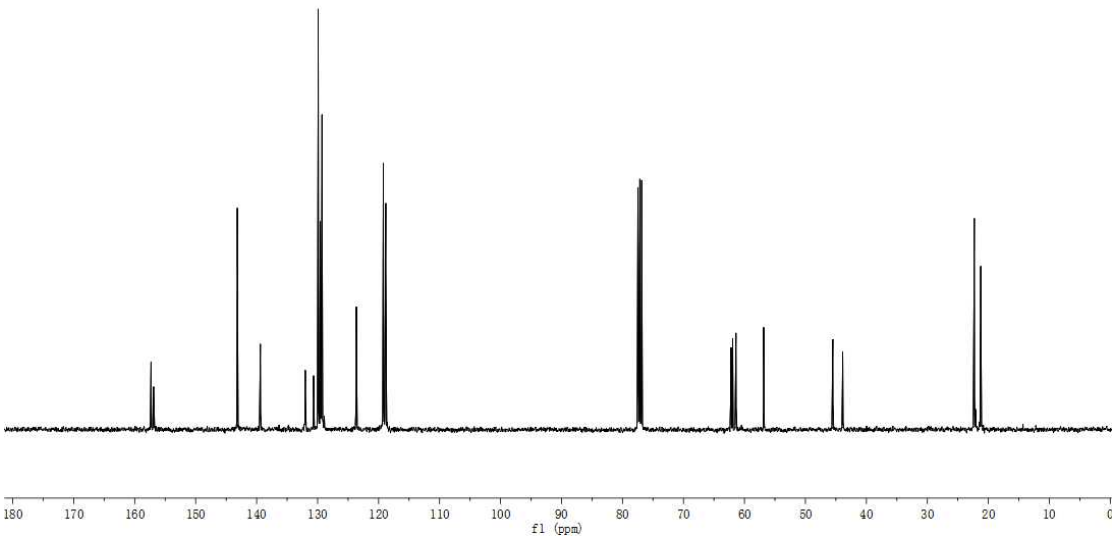
0.46
1.98
0.54
0.48
0.97
0.99
6.00
3.02
f1 (ppm)

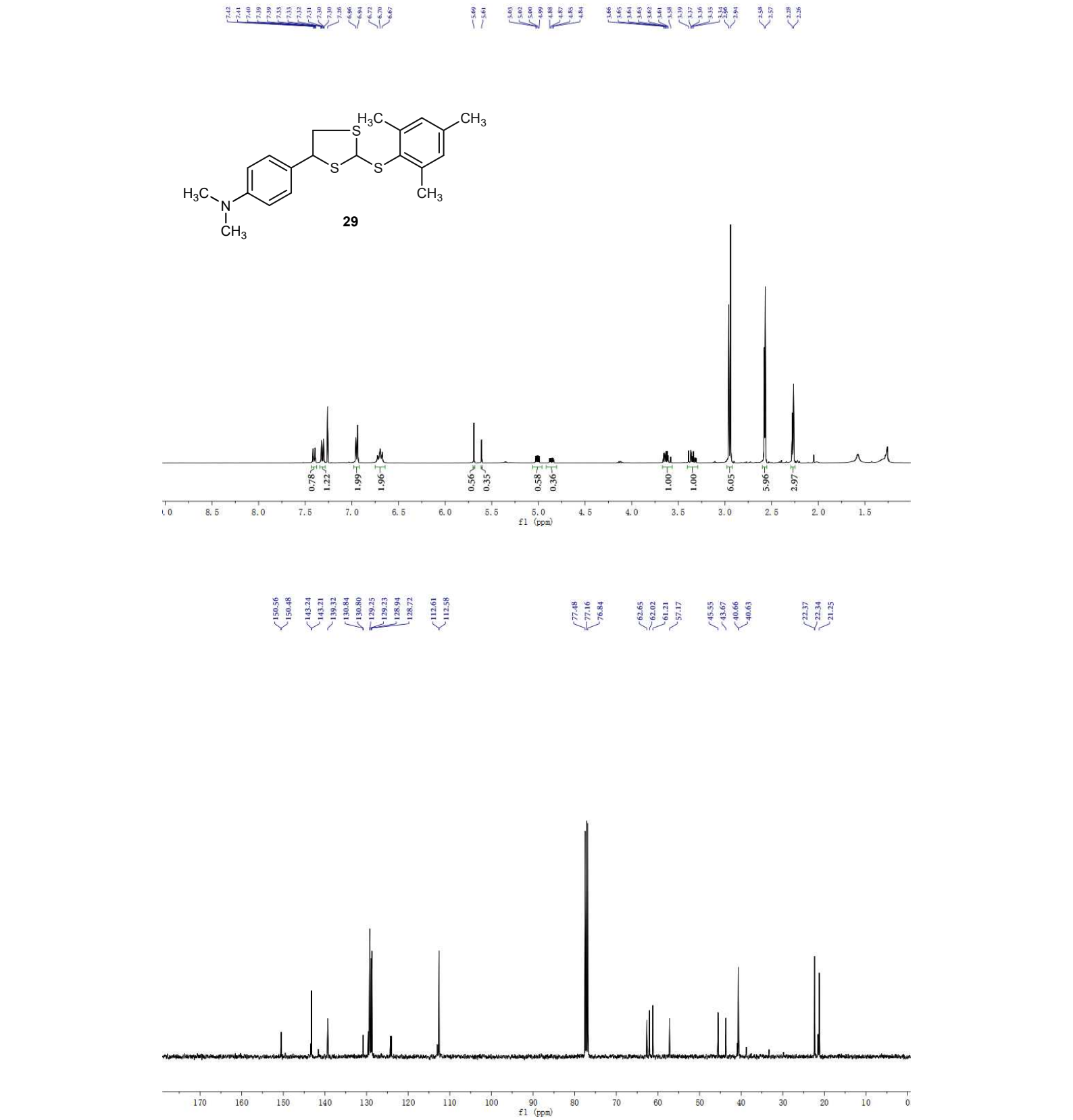

f1 (ppm)

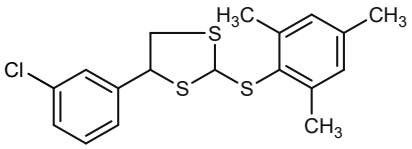

H3C
CH3
S
S
S
CH3
PhO

28

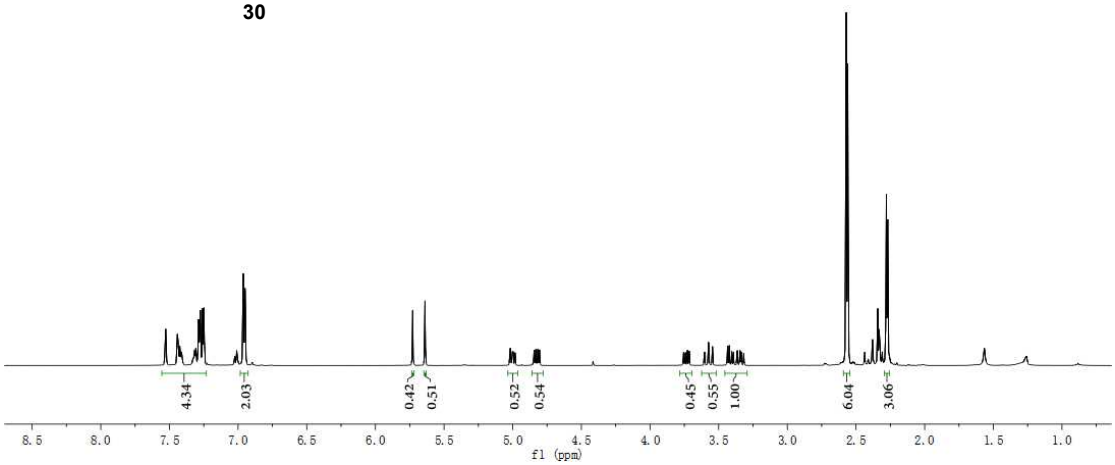
0.98
1.07
2.08
1.10
6.31
0.50
0.46
0.50
0.47
0.51
0.47
1.00
6.00
3.07
f1 (ppm)

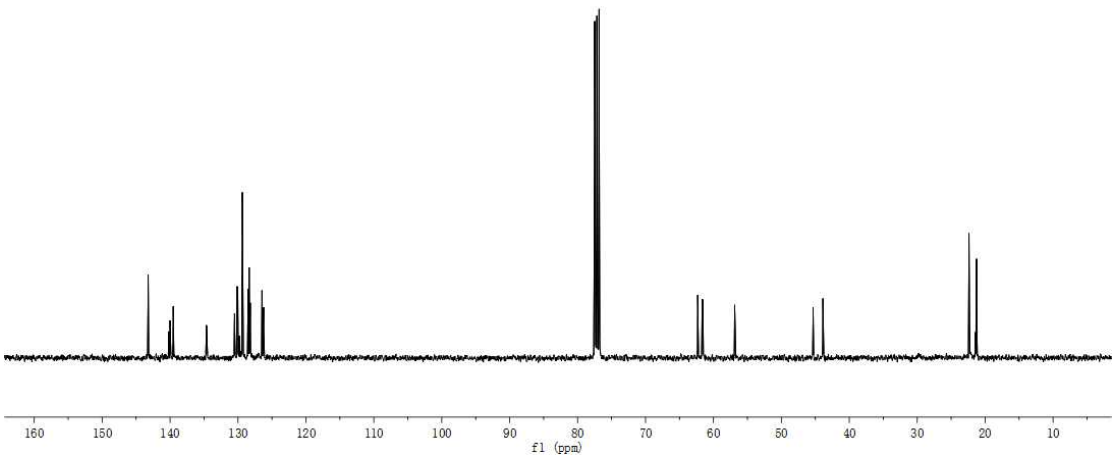

f1 (ppm)

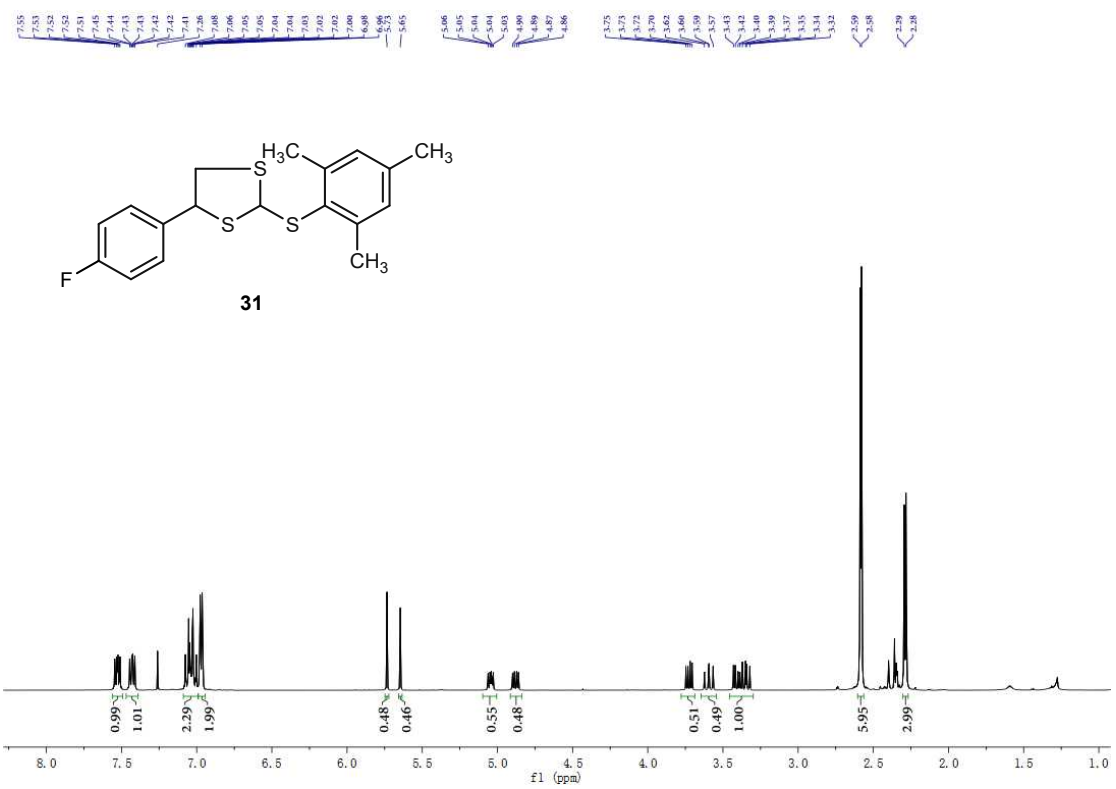

H3C
CH3
S
S
S
CH3
H3C
N
CH3
29
0.78
1.22
1.99
1.96
0.56
0.35
0.58
0.36
1.00
1.00
6.05
5.96
2.97
f1 (ppm)

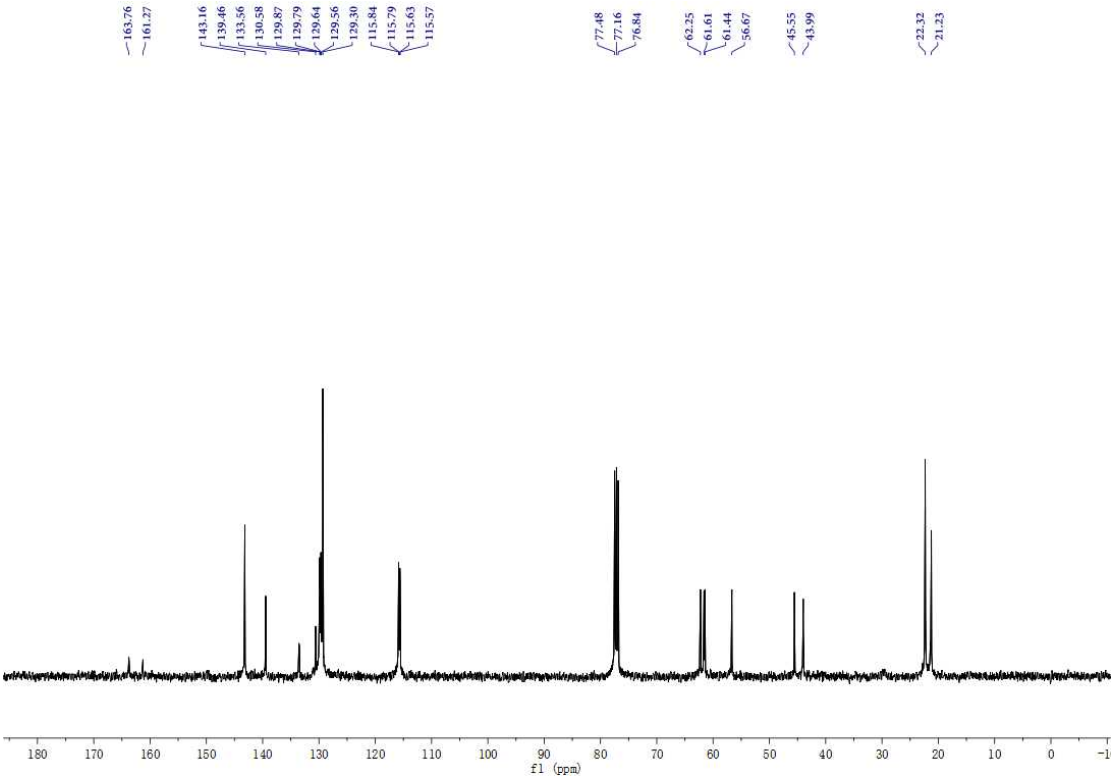

H3C
CH3
S
Cl
S
S
CH3

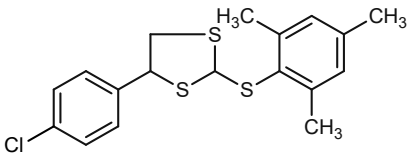
30


4.34
2.03
0.42
0.51
0.52
0.54
0.45
0.55
1.00
6.04
3.06
f1 (ppm)

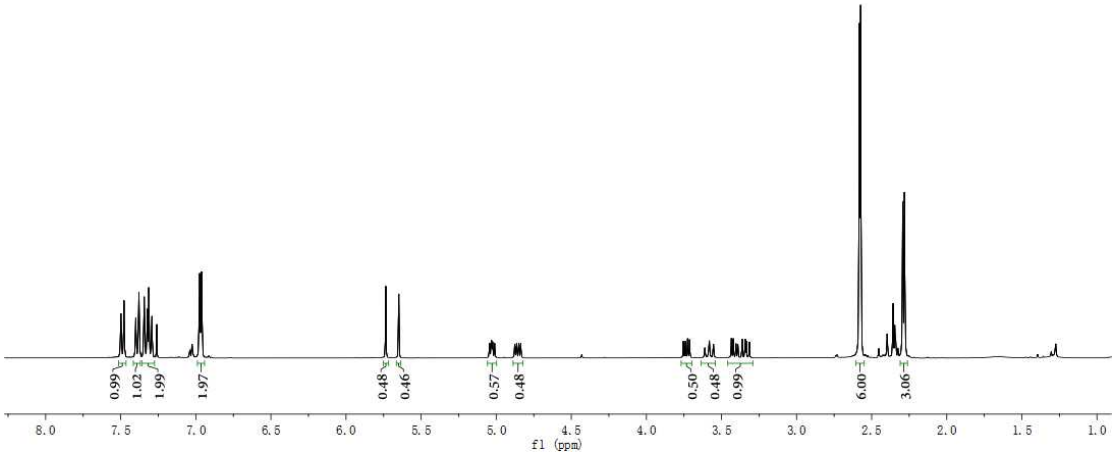

f1 (ppm)

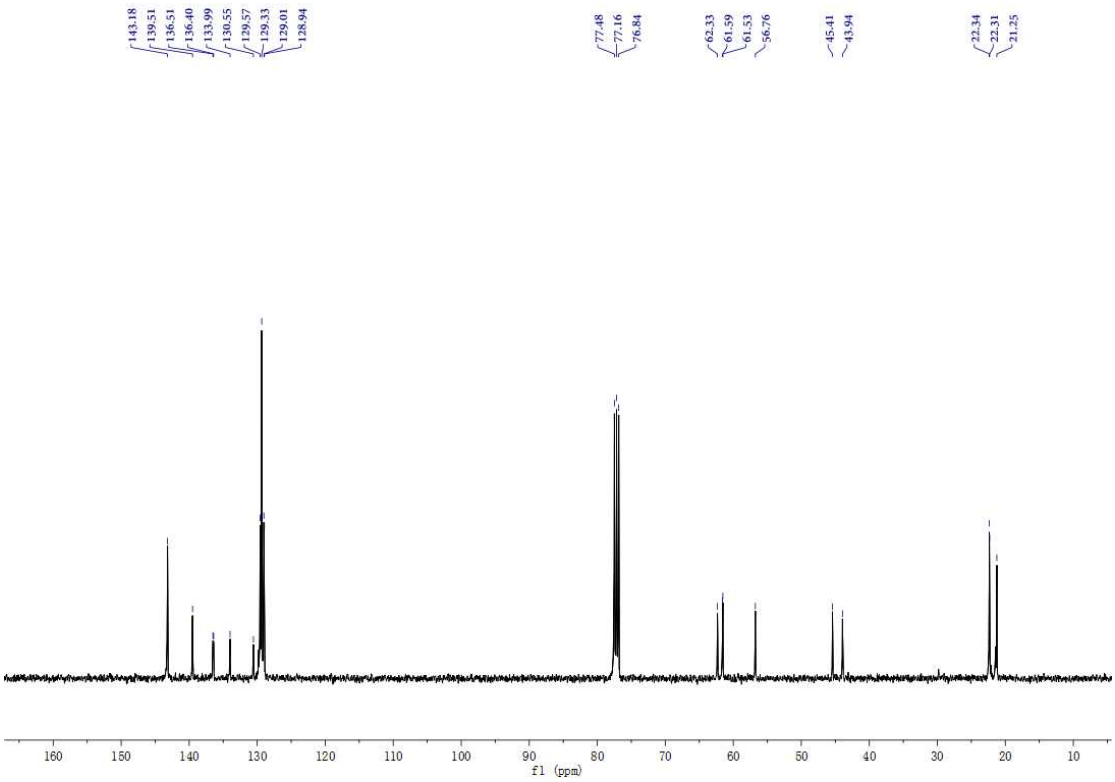

H3C
CH3
S
S
S
CH3
F
31
0.99
1.01
2.29
1.99
0.48
0.46
0.55
0.48
0.51
0.49
1.00
5.95
2.99
f1 (ppm)

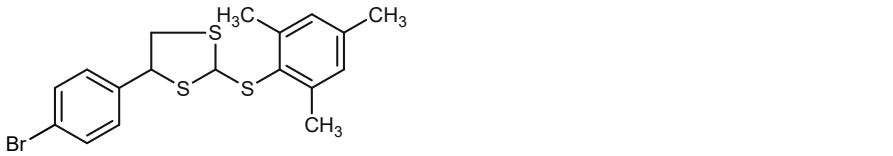

163.76
161.27
143.16
139.46
133.56
130.58
129.87
129.79
129.64
129.56
129.30
115.84
115.79
115.63
115.57
77.48
77.16
76.84
62.25
61.61
61.44
56.67
45.55
43.99
22.32
21.23
f1 (ppm)


H3C
CH3
S
S
S
CH3
Cl

32

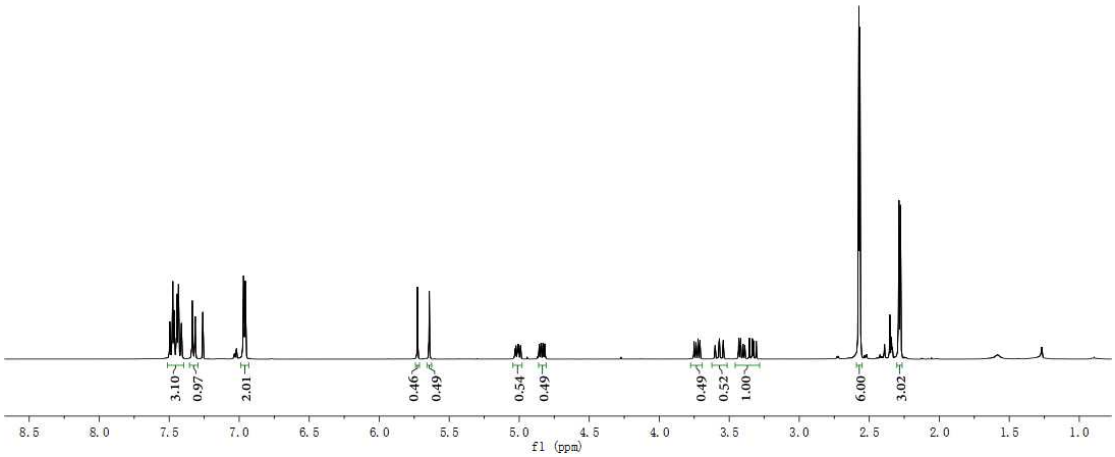

0.99
1.02
1.99
1.97
0.48
0.46
0.57
0.48
0.50
0.48
0.99
6.00
3.06
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)

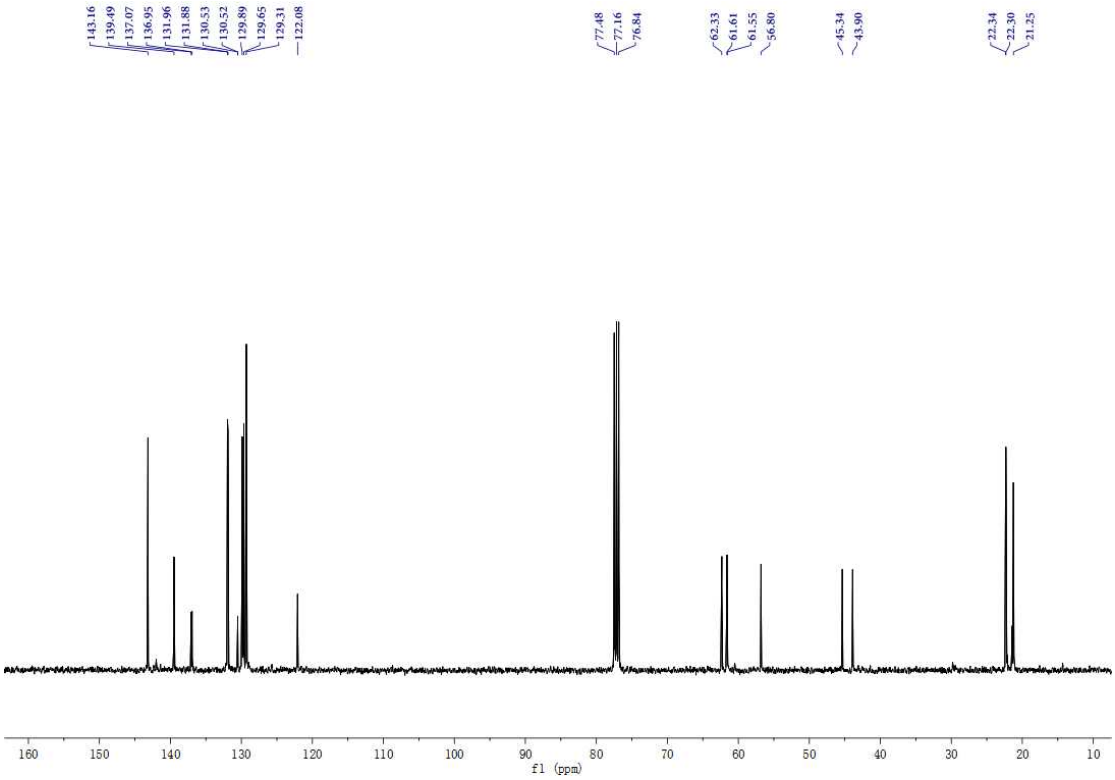

160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

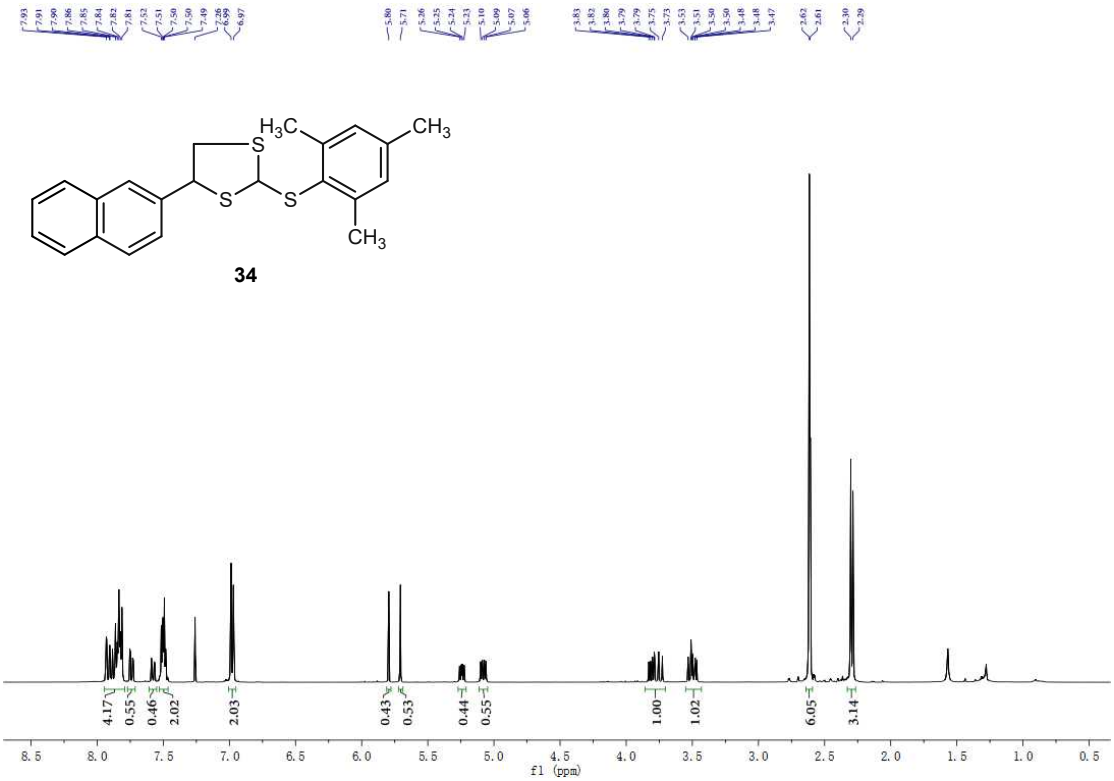


H3C
CH3
S
S
S
CH3
Br

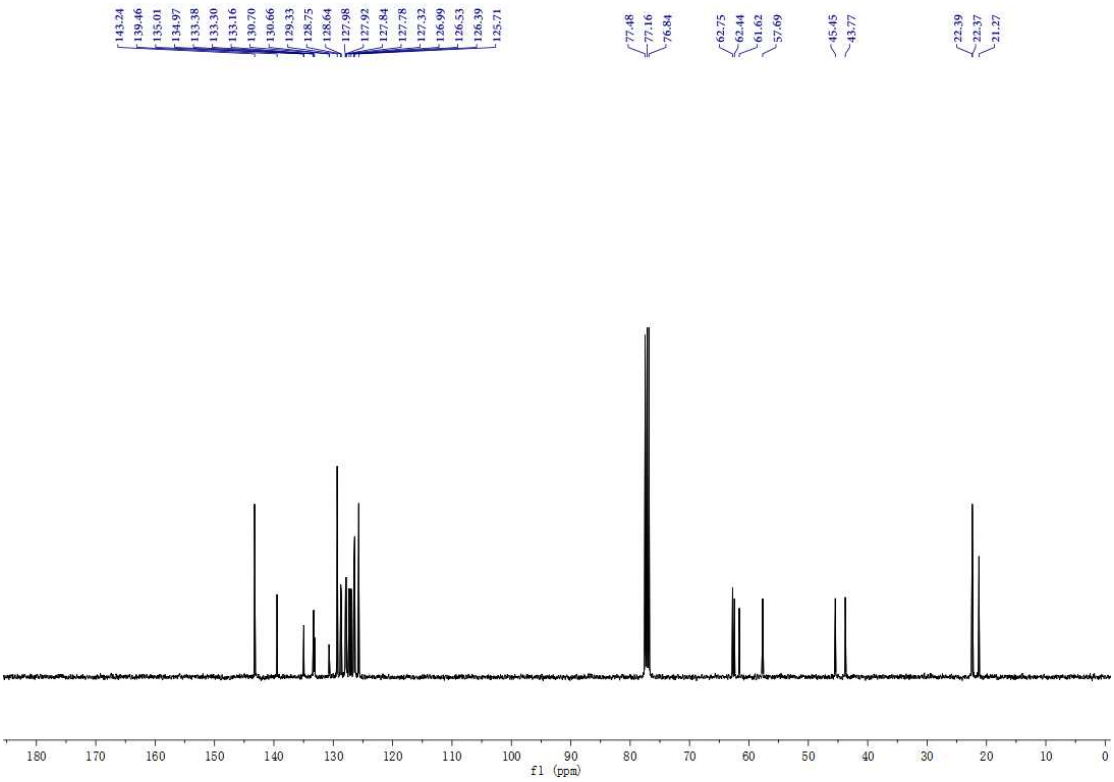
33

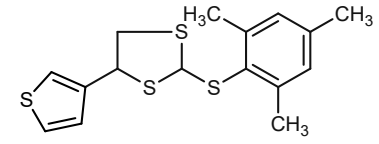

3.10
0.97
2.01
0.46
0.49
0.54
0.49
0.49
0.52
1.00
6.00
3.02
f1 (ppm)


f1 (ppm)


H3C
CH3
S
S
S
CH3
4.17
0.55
0.46
2.02
2.03
0.43
0.53
0.44
0.55
1.00
1.02
6.05
3.14
f1 (ppm)

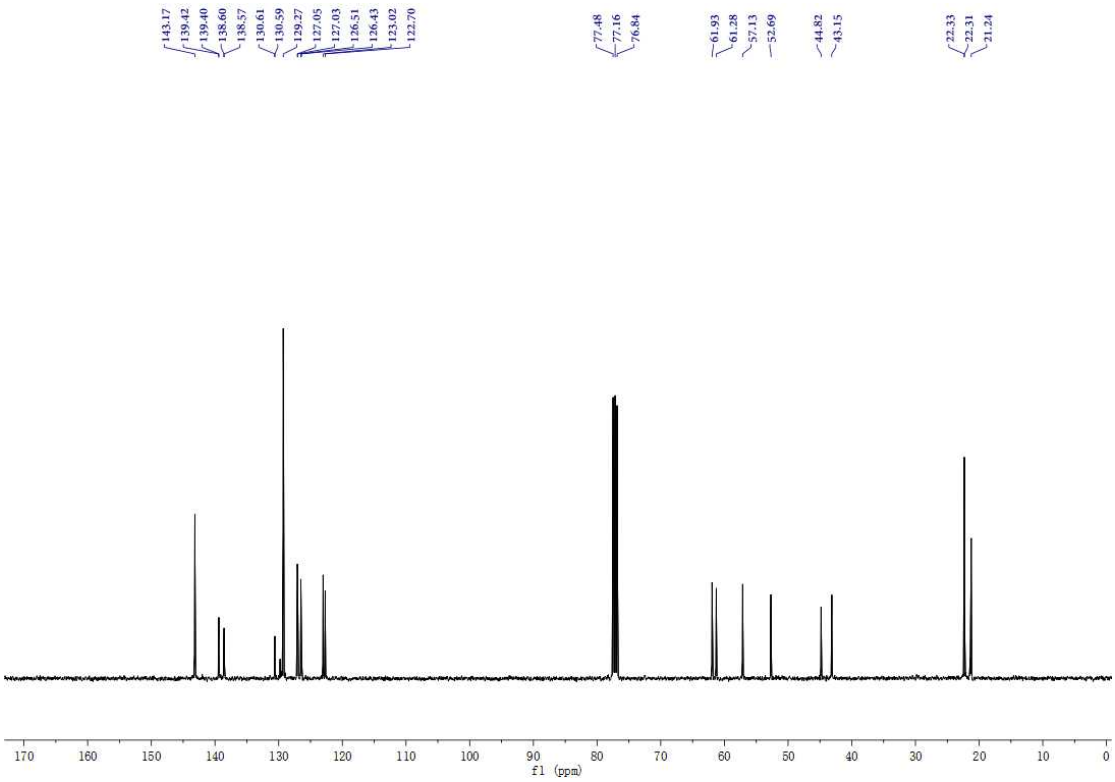
34

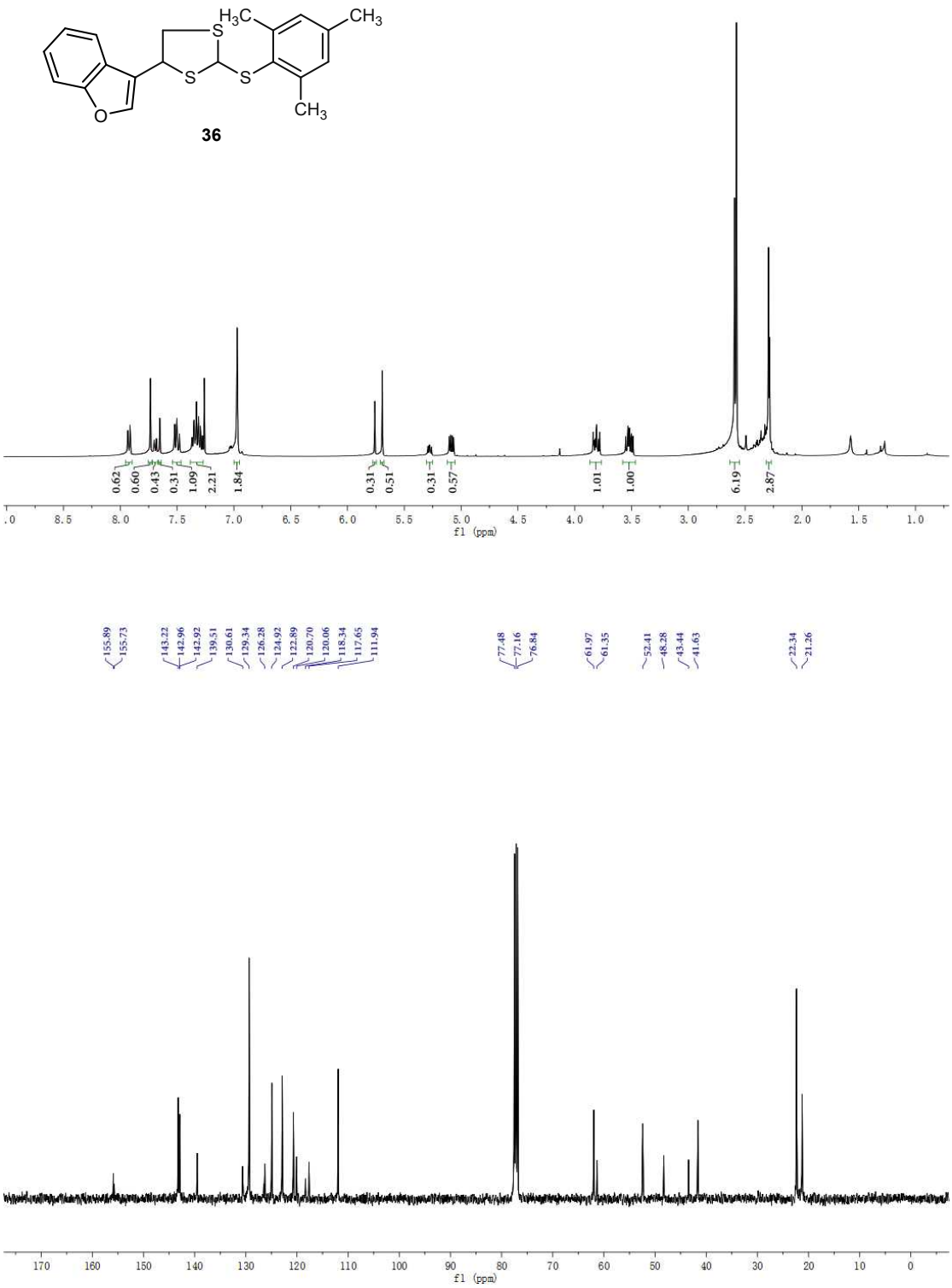

f1 (ppm)


H3C
CH3
S
S
S
S
CH3

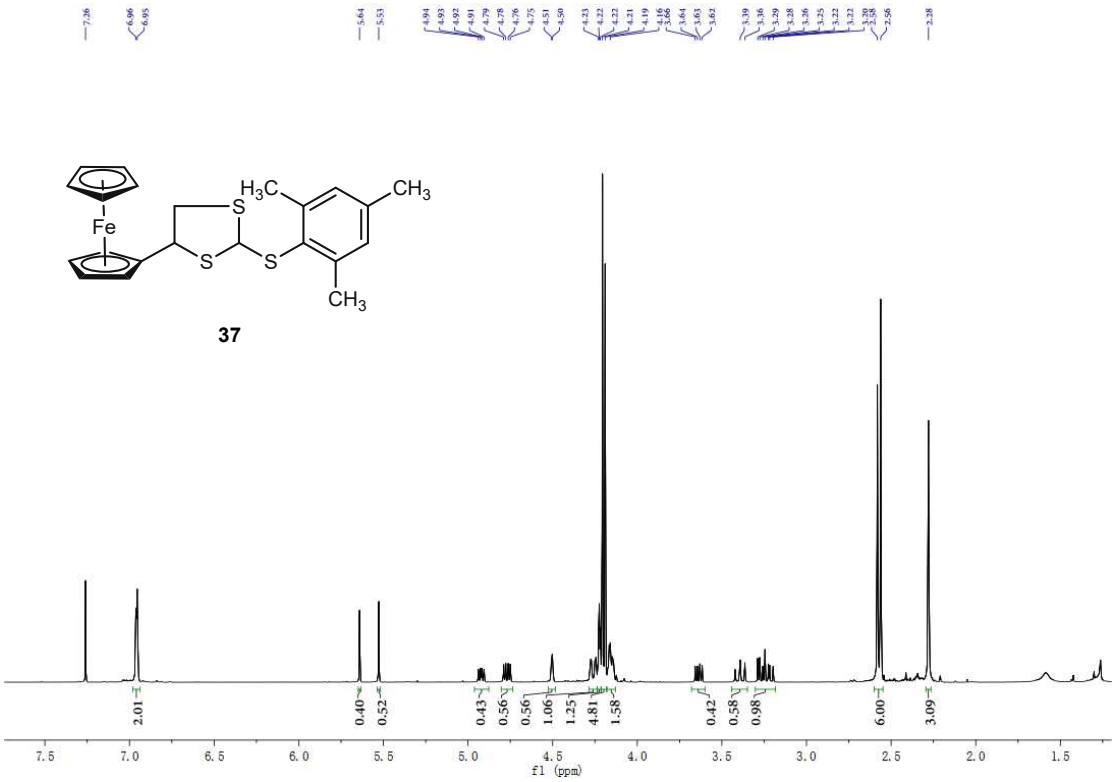
35

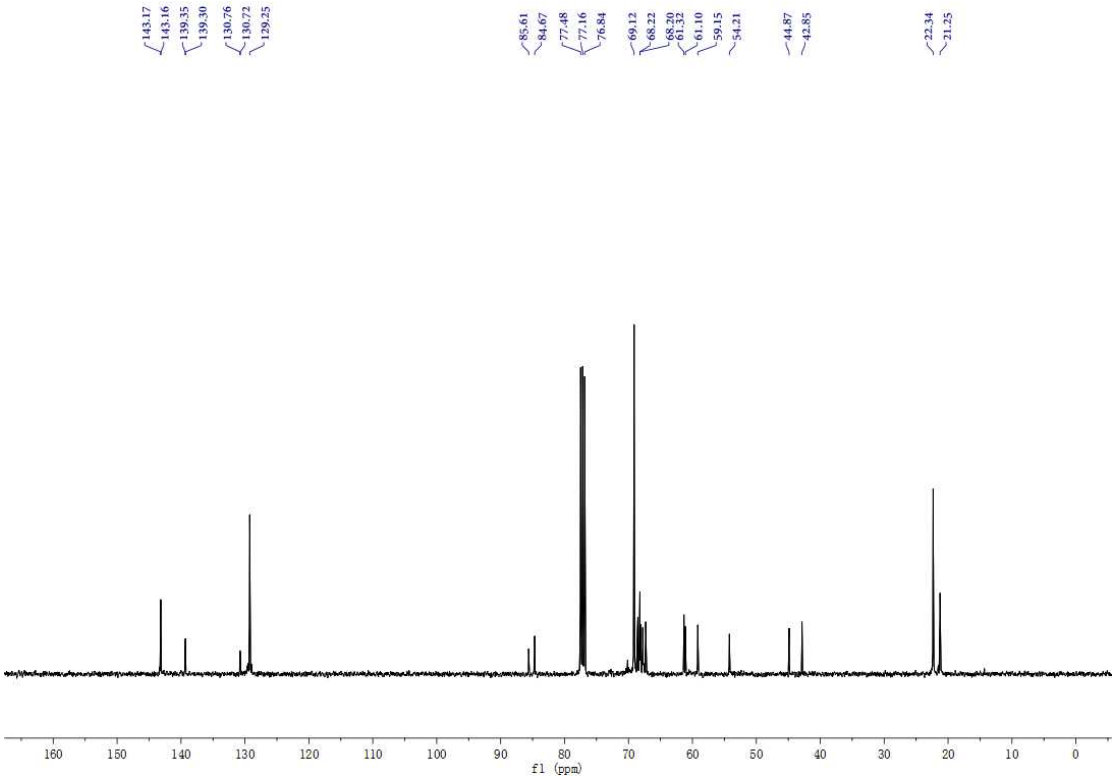
2.45
0.45
2.00
0.44
0.51
0.45
0.57
0.46
0.54
1.01
6.00
3.04
f1 (ppm)

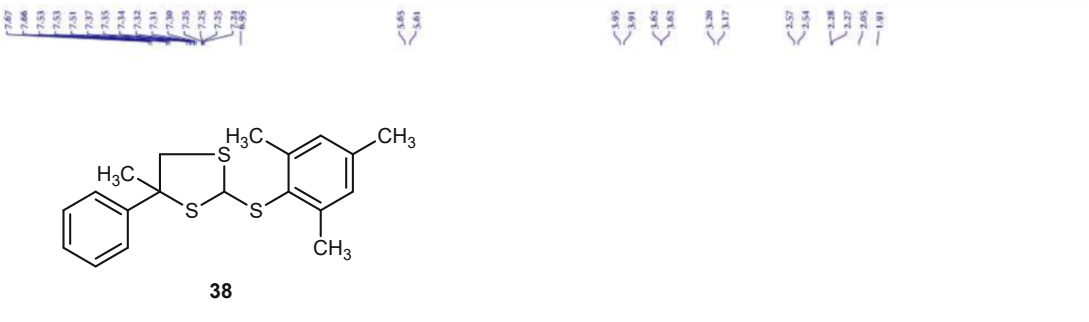

f1 (ppm)


H3C
CH3
S
S
S
CH3
O
0.62
0.60
0.43
0.31
1.09
2.21
1.84
0.31
0.51
0.31
0.57
1.01
1.00
6.19
2.87
f1 (ppm)
155.89
155.73
143.22
142.96
142.92
139.51
130.61
129.34
126.28
124.92
122.89
120.70
120.06
118.34
117.65
111.94
77.48
77.16
76.84
61.97
61.35
52.41
48.28
43.44
41.63
22.34
21.26
f1 (ppm)

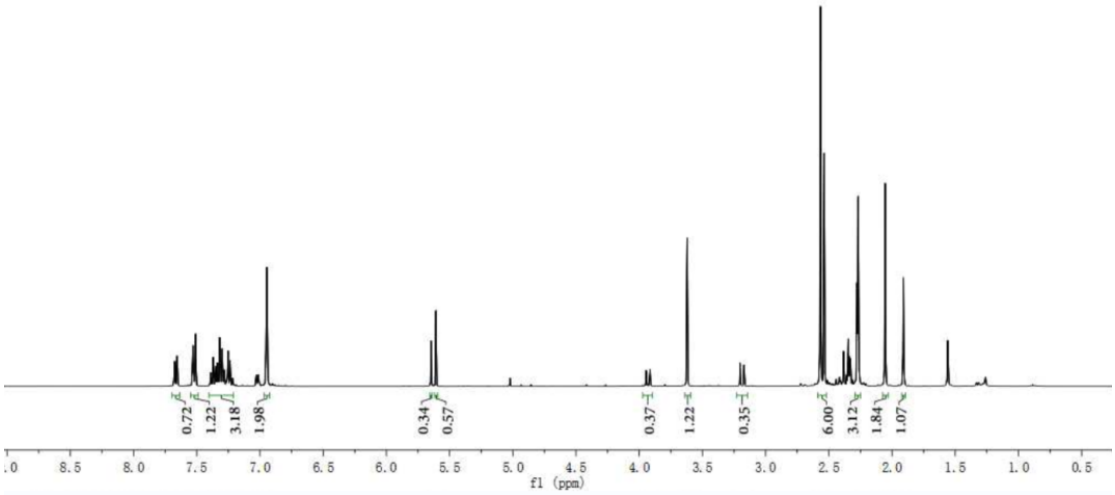
36

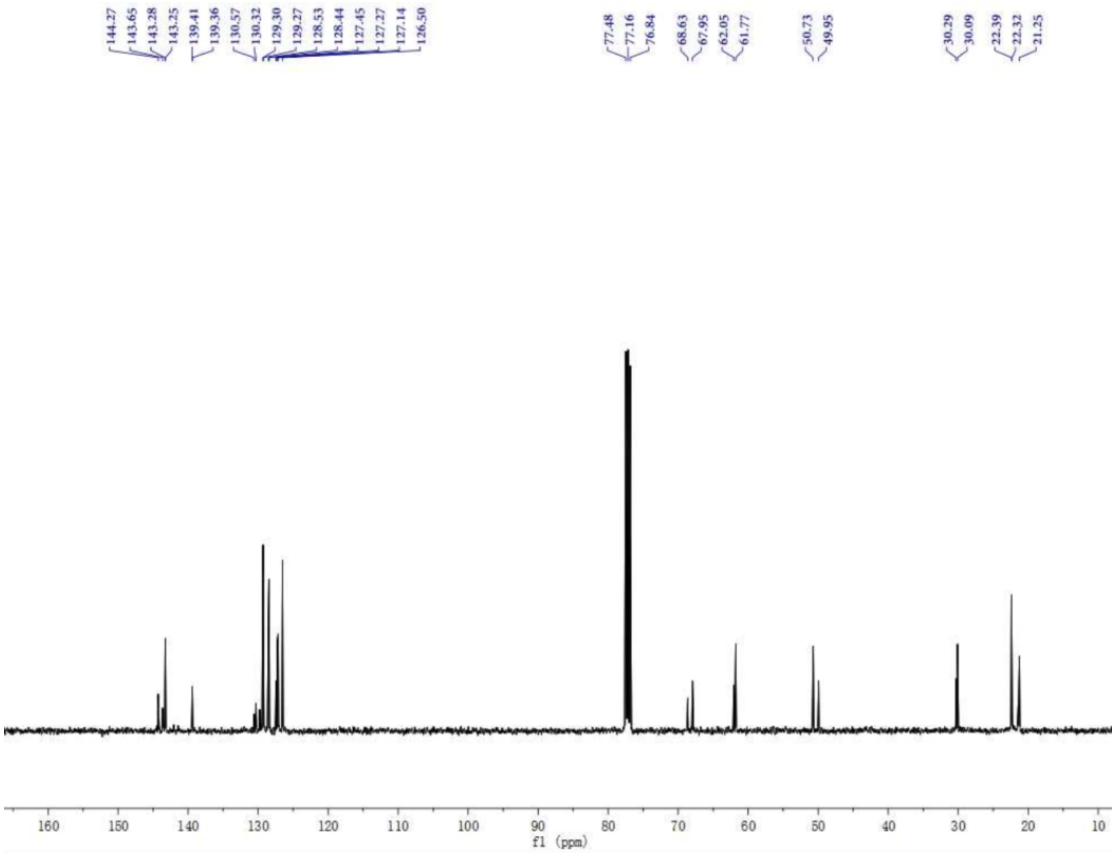

Fe
S
S
S
H3C
CH3
CH3
37
2.01
0.40
0.52
0.43
0.56
0.56
1.06
1.25
4.81
1.58
0.42
0.58
0.98
6.00
3.09
f1 (ppm)

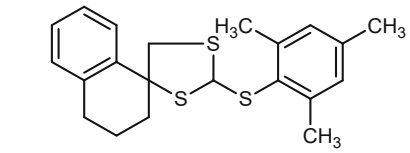

143.17
143.16
139.35
139.30
130.76
130.72
129.25
85.61
84.67
77.48
77.16
76.84
69.12
68.22
68.20
61.32
61.10
59.15
54.21
44.87
42.85
22.34
21.25
f1 (ppm)



38

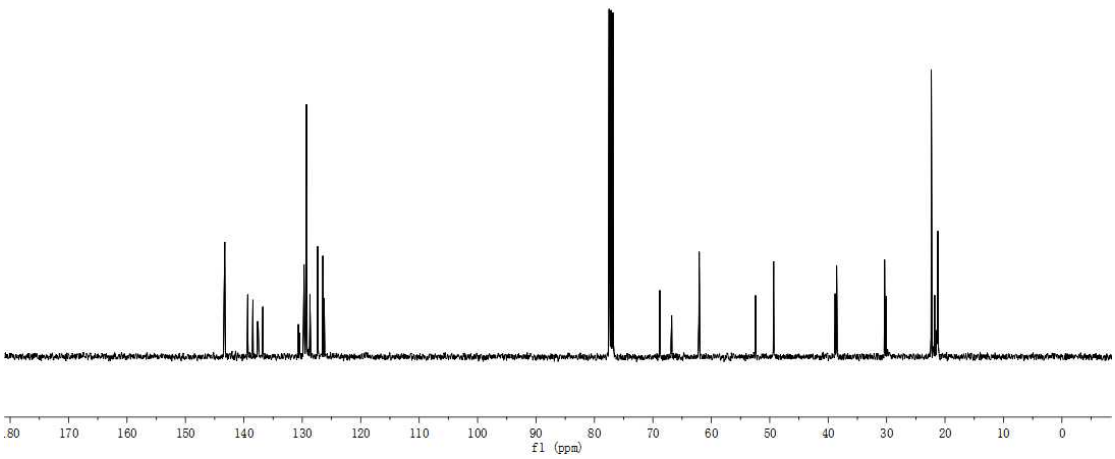


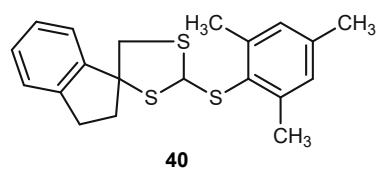



H3C
CH3
S
S
S
CH3

39

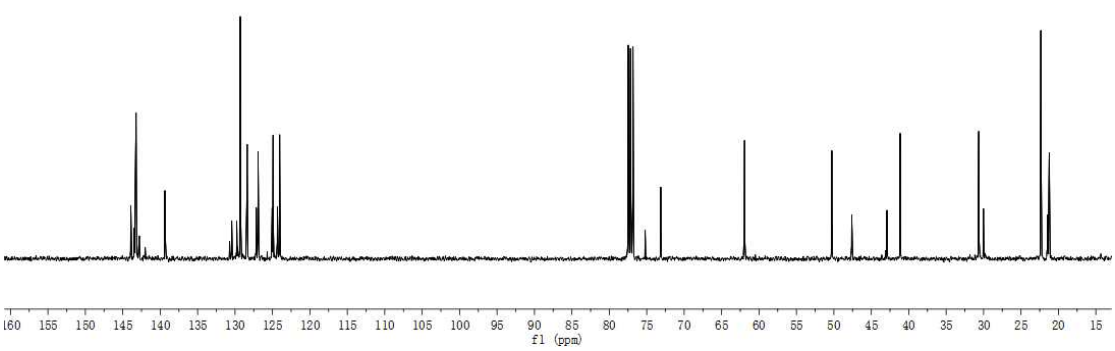
0.21
0.78
0.21
0.07
1.88
1.31
2.00
0.74
0.20
0.21
0.79
0.78
0.21
2.06
0.91
6.05
1.28
3.17
0.80
0.88
f1 (ppm)

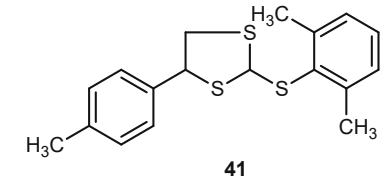

f1 (ppm)


H3C
CH3
S
S
S
CH3

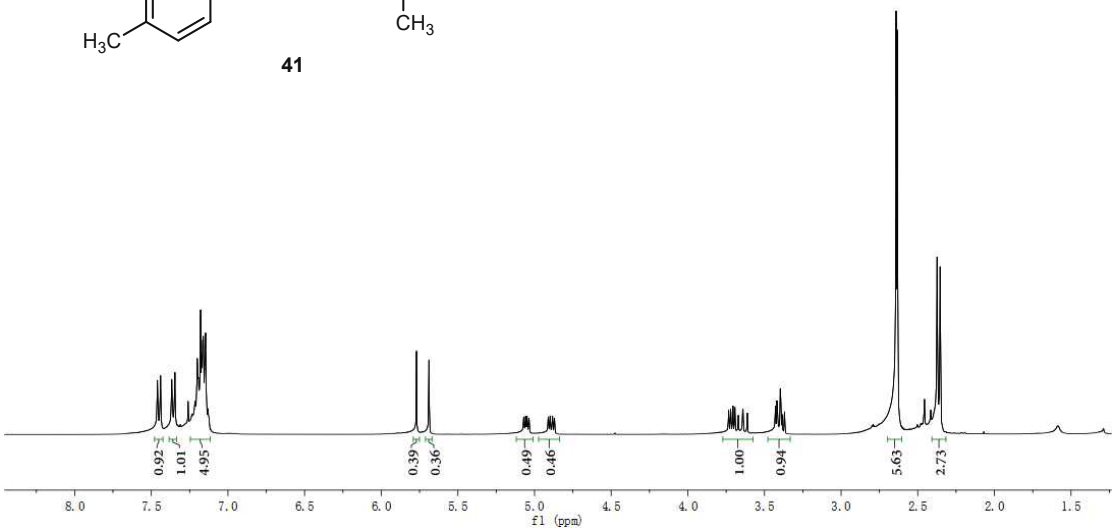
40

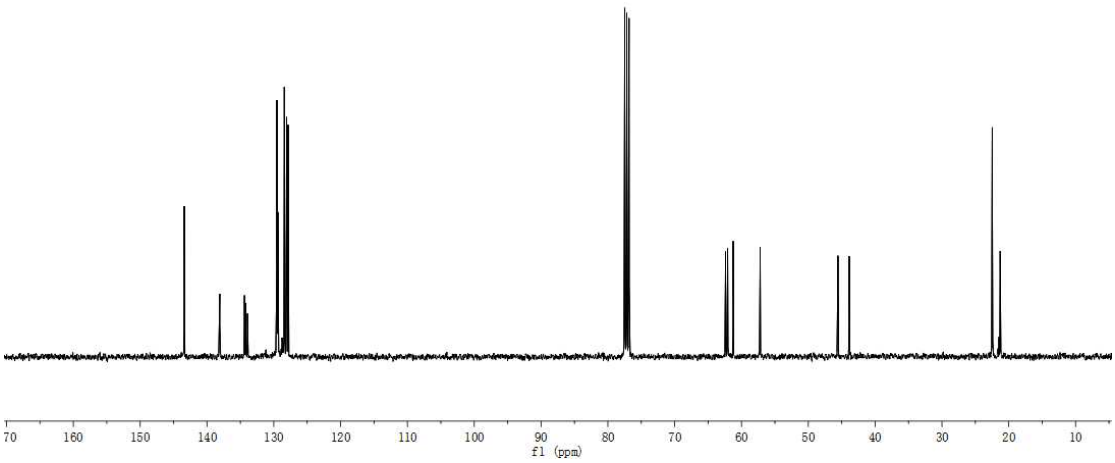
0.98
3.38
1.96
0.70
0.24
0.27
1.47
0.28
2.77
7.11
3.00
f1 (ppm)

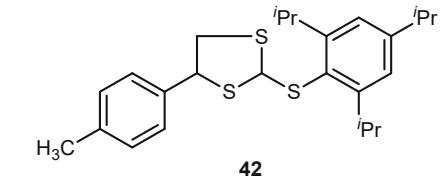

f1 (ppm)


H3C
S
S
S
CH3
H3C

41

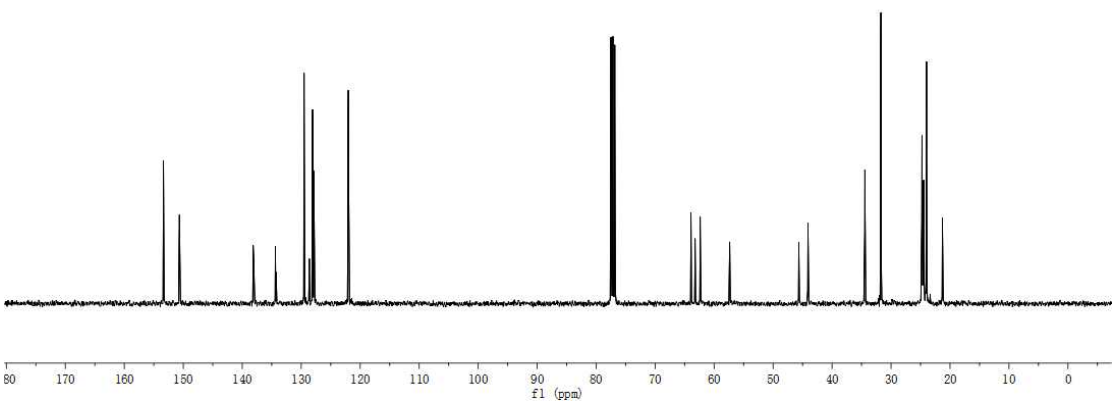

0.92
1.01
4.95
0.39
0.36
0.49
0.46
1.00
0.94
5.63
2.73
f1 (ppm)


f1 (ppm)


iPr
iPr
iPr
S
S
S
H3C

42

1.11
0.81
2.00
1.96
0.37
0.54
0.37
0.54
1.94
0.38
0.58
0.98
1.00
2.97
18.57
f1 (ppm)


f1 (ppm)