Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Silver(I)-Catalyzed Novel *ipso*-Cycloaddition and retro-Friedel-Crafts Reaction of *ortho*-Hydroxyphenyl-Substituted *para*-Quinone Methides

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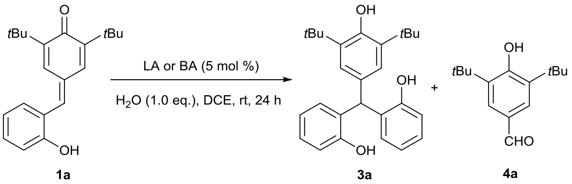
Table of Contents

1. General Experiment Information and Materials

All commercial reagents were used without further purification unless otherwise noted. Solvents were freshly dried according to *the purification handbook Purification of Laboratory Chemicals* before using. All of ***p*-QMs 1**[1] and 4-aryl or 5-aryl salicylic aldehyde[2] were prepared according to literature procedure. Proton and carbon magnetic resonance spectra (^{1}H NMR and ^{13}C NMR) were recorded on a Bruker Avance 500MHz spectrometer. Tetramethylsilane (TMS) served as the internal standard for ^{1}H NMR, and $CDCl_3$ served as the internal standard for ^{13}C NMR. ^{1}H NMR data were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet, td = triplet of doublet, dt = doublet of triplet, dd = doublet of doublet), coupling constants (Hz), and integration. Infrared Spectroscopy was conducted on Thermo Fisher Nicolet is10. The X-ray single-crystal diffraction was performed on Saturn 724+ instrument. High resolution mass spectra were obtained on an Ultima Global spectrometer with an ESI source.

2. Investigation of water effect

Table S1 Screening of reaction conditions [a]

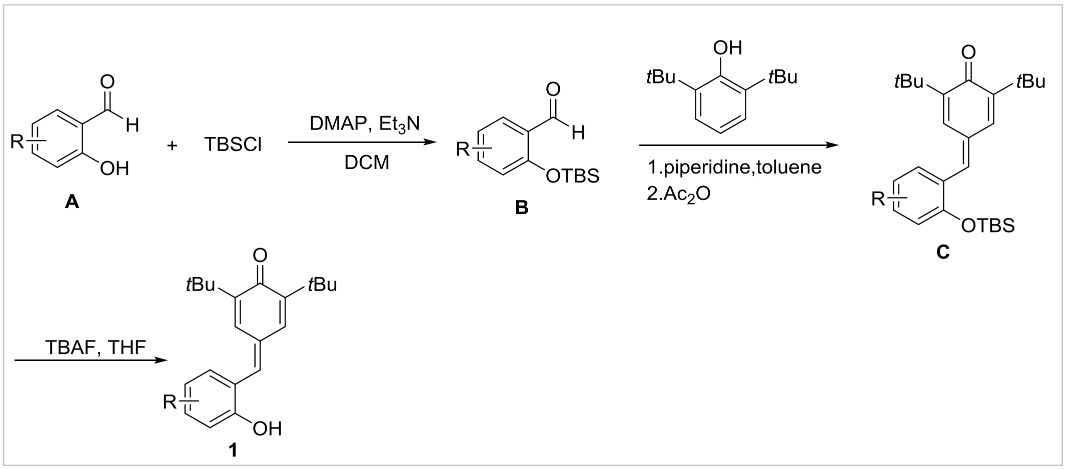


Entry	Acids	Yield (**3a**, %)[b]
1	$InCl_3$	60
2	$In(OAc)_3$	nr
3	$HfCl_4$	54
4	$Sc(OTf)_3$	62
5	$AgBF_4$	49
6	$AgSbF_6$	25

[a] Reaction conditions: **1a** (0.1 mmol) and Lewis acid (5 mol %) in DCE (1.0 mL) at room temperature for 24 h, DCE removing water with CaH_2. [b] Isolated yield. DCE = 1,2-dichloroethane, nr = no reaction.

3. Experimental Procedures and Characterization Data

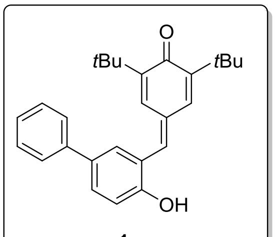
A) Synthesis of *ortho*-hydroxyphenyl-substituted *para*-quinone methides (*p*-QMs) 1:



General procedure I: To an oven-dried reaction tube was added 2-hydroxybenzaldehyde **A** (8 mmol, 1.0 equiv) and DMAP (0.4 mmol, 5 mol%) in CH_2Cl_2 (0.2 M, 40 mL), which was sealed at room temperature. Then TBSCl (8.8 mmol, 1.1 equiv) was added by dropwise slowly. The solvent was stirred overnight, and a saturated $NaHCO_3$ solution was added dropwise to quench the reaction. The resulting solution was extracted with CH_2Cl_2 (3×10 mL). Then the combined organic phases were washed with brine and dried over anhydrous Na_2SO_4, resulting crude product **S2** and used directly in the next step without purification.

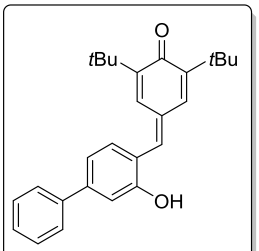
A solution of aldehydes **B** (7.2 mmol, 1.0 equiv) and phenols (7.92mmol, 1.1 equiv) in toluene (0.2 M, 36 mL) was placed in a Dean-Stark apparatus, and the solution was heated to reflux. Piperidine (14.4 mmol, 2.0 equiv) was added dropwise slowly. Then, the solution was stirred at 140 ^{o}C for 12 h. Then the reaction mixture was cooled to 120 ^{o}C, and acetic anhydride (14.4 mmol, 2.0 equiv) was dropwise added. After stirring for 30 min, the solution was poured on ice-water and extracted with CH_2Cl_2 (3×30 mL). The organic phases were combined, washed with brine and dried over anhydrous Na_2SO_4. Then the solvent was evaporated under reduced pressure and the corresponding products **C** were obtained after flash column chromatography (PE/ethyl acetate = 100/1).

To a solution of **C** (3.96 mmol, 1.0 equiv) in THF (0.2M, 20 mL) at 0 ^{o}C was added tetrabutylammonium fluoride trihydrate (TBAF) (4.36 mmol, 1.1 equiv). The reaction mixture was stirred for 15 minutes and a saturated NH_4Cl solution was added dropwise to quench the reaction. The resulting solution was extracted with ethyl acetate (3×10 mL). Then the combined organic phases were washed with brine and dried over anhydrous Na_2SO_4. The solvent was removed to give the crude product which was purified by flash column chromatography (PE/ethyl acetate = 80/1 to 10/1) to afford the desired compounds **1**.



1g

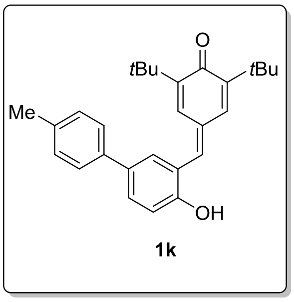
2,6-di-tert-butyl-4-((4-hydroxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1g): Prepared according to the general procedure **I** above and obtained as yellow solid (0.93 g, 35% yield for 4 steps), melting point: 159-160 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.47 (s, 1H), 7.65 – 7.55 (m, 6H), 7.42 (t, J = 7.5 Hz, 2H), 7.29 (t, J = 7.5 Hz, 1H), 7.25 (d, J = 1.0 Hz, 1H), 7.06 (d, J = 9.0 Hz, 1H), 1.25 (d, J = 20.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.6, 156.6, 147.6, 146.1, 140.9, 139.4, 135.6, 131.2, 130.1, 129.7, 129.3, 128.90, 128.3, 126.8, 125.9, 122.9, 116.5, 34.9, 34.6, 29.3, 29.2 ppm.



1i

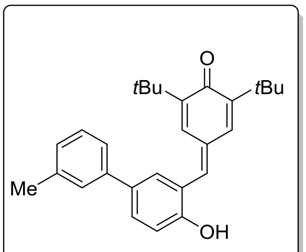
2,6-di-tert-butyl-4-((3-hydroxy-[1,1'-biphenyl]-4-yl)methylene)cyclohexa-2,5-dien-1-one (1i): Prepared according to the general procedure **I** above and obtained as yellow solid (0.98g, 36% yield for 4 steps), melting point: 232-233 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.41 (s, 1H), 7.66 – 7.63 (m, 3H), 7.54 (s, 1H), 7.50 – 7.47 (m, 3H), 7.40 (t, J = 7.5 Hz, 1H), 7.26-7.23 (m, 3H), 1.28 (d, J = 13.0 Hz, 18H) ppm; ^{13}C

NMR (125 MHz, DMSO-d_6) δ 185.7, 157.5, 147.6, 145.9, 143.1, 140.5, 139.2, 135.7, 132.0, 129.8, 129.0, 128.3, 128.0, 126.5, 121.9, 117.9, 113.7, 35.0, 34.7, 29.3, 29.2 ppm.



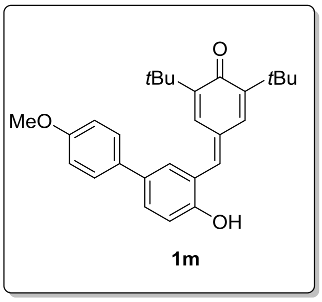
1k

2,6-di-tert-butyl-4-((4-hydroxy-4'-methyl-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1k): Prepared according to the general procedure **I** above and obtained as yellow solid (1.5 g, 39% yield for 4 steps), melting point: 190-192 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.36 (s, 1H), 7.64 (s, 1H), 7.59 (d, *J* = 7.5 Hz, 3H), 7.50 (d, *J* = 8.0 Hz, 2H), 7.26 – 7.23 (m, 3H), 7.03 (d, *J* = 8.0 Hz, 1H), 2.31 (s, 3H), 1.26 (d, *J* = 20.0 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.7, 156.4, 147.6, 146.1, 140.9, 136.6, 136.1, 135.7, 131.2, 130.1, 129.5, 129.44, 129.0, 128.3, 125.7, 122.8, 116.5, 34.7, 34.7, 29.3, 29.2, 20.5 ppm.



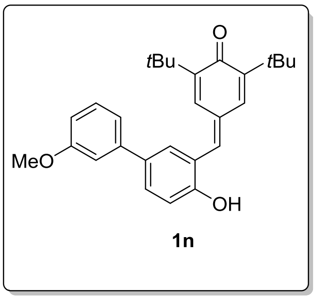
1l

2,6-di-tert-butyl-4-((4-hydroxy-3'-methyl-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1l): Prepared according to the general procedure **I** above and obtained as yellow solid (1.3 g, 34% yield for 4 steps), melting point: 170-171 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.43 (s, 1H), 7.65 (s, 1H), 7.61 – 7.59 (m, 3H), 7.43 – 7.39 (m, 2H), 7.31 (t, *J* = 7.5 Hz, 1H), 7.26 (d, *J* = 1.5 Hz, 1H), 7.12 (d, *J* = 7.0 Hz, 1H), 7.04 (d, *J* = 8.5 Hz, 1H), 2.34 (s, 3H), 1.27 (d, *J* = 9.0 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.7, 156.6, 147.6, 146.1, 140.8, 139.4, 138.0, 135.7, 131.3, 130.0, 129.6, 129.4, 128.8, 128.3, 127.5, 126.7, 122.7, 122.8, 116.4, 35.0, 34.7, 29.3, 29.2, 21.0 ppm.



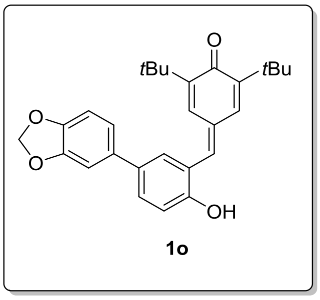
1m

2,6-di-tert-butyl-4-((4-hydroxy-4'-methoxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1m): Prepared according to the general procedure **I** above and obtained as yellow solid (1.26 g, 30% yield for 4 steps), melting point: 195-196 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.29 (s, 1H), 7.64 (s, 1H), 7.58 – 7.53 (m, 5H), 7.26 (s, 1H), 7.04 – 6.99 (m, 3H), 3.78 (s, 3H), 1.27 (d, *J* = 18.1 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 183.8, 156.6, 154.3, 145.8, 144.3, 139.2, 133.9, 130.1, 129.2, 128.2, 127.5, 126.9, 126.5, 125.1, 121.0, 114.6, 112.5, 53.3, 33.2, 32.8, 27.5, 27.4 ppm.



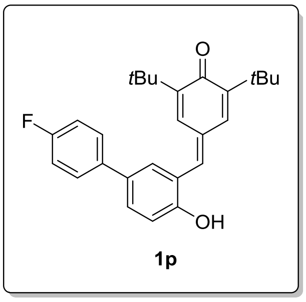
1n

2,6-di-tert-butyl-4-((4-hydroxy-3'-methoxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1n): Prepared according to the general procedure **I** above and obtained as yellow solid (1.1 g, 26% yield for 4 steps), melting point: 168-169 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.43 (s, 1H), 7.64 – 7.62 (m, 3H), 7.58 (d, *J* = 1.0 Hz, 1H), 7.33 (t, *J* = 8.0 Hz, 1H), 7.26 (s, 1H), 7.17 (d, *J* = 7.5 Hz, 1H), 7.13 (s, 1H), 7.05 (d, *J* = 8.5 Hz, 1H), 6.87 (dd, *J* = 8.1, 1.9 Hz, 1H), 3.80 (s, 3H), 1.27 (d, *J* = 17.0 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.7, 159.7, 156.8, 147.6, 146.1, 141.0, 140.9, 135.7, 131.1, 130.1, 129.9, 129.8, 129.3, 128.3, 122.8, 118.3, 116.4, 112.7, 111.2, 55.1, 35.0, 34.7, 29.3, 29.2 ppm.



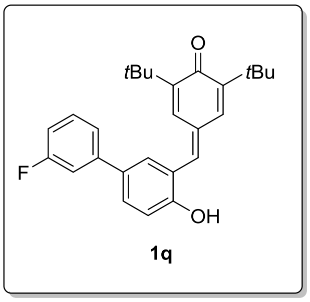
1o

4-(5-(benzo[d][1,3]dioxol-5-yl)-2-hydroxybenzylidene)-2,6-di-tert-butylcyclohexa-2,5-dien-1-one (1o): Prepared according to the general procedure **I** above and obtained as yellow solid (1.64 g, 38% yield for 4 steps), melting point: 175-176 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.33 (s, 1H), 7.62 (s, 1H), 7.57 – 7.53 (m, 3H), 7.26 (d, *J* = 1.5 Hz, 1H), 7.16 (d, *J* = 1.5 Hz, 1H), 7.07 (dd, *J* = 8.1, 1.6 Hz, 1H), 7.01 (d, *J* = 8.0 Hz, 1H), 6.96 (d, *J* = 8.0 Hz, 1H), 6.04 (s, 2H), 1.27 (d, *J* = 18.0 Hz, 18H) ppm; ^{13}C NMR (126 MHz, DMSO-d_6) δ 185.6, 156.3, 147.9, 147.6, 146.4, 146.1, 140.9, 135.7, 133.9, 131.1, 130.1, 129.5, 129.0, 128.3, 122.7, 119.3, 116.4, 108.6, 106.5, 101.1, 35.0, 34.7, 29.3, 29.2 ppm.



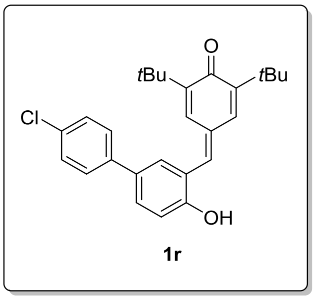
1p

2,6-di-tert-butyl-4-((4'-fluoro-4-hydroxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1p): Prepared according to the general procedure **I** above and obtained as yellow solid (1.4 g, 35% yield for 4 steps), melting point: 142-143 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.39 (s, 1H), 7.65 – 7.55 (m, 6H), 7.25 (t, *J* = 8.0 Hz, 3H), 7.04 (d, *J* = 8.0 Hz, 1H), 1.26 (d, *J* = 24.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.6, 161.4 (d, *J* = 243.7 Hz), 156.5, 147.6, 146.0, 140.8, 136.0, 135.6, 130.2 (d, *J* = 7.8 Hz), 129.6, 129.3, 128.3, 127.8, 127.7, 122.9, 116.5, 115.7 (d, *J* = 21.3 Hz), 35.0, 34.7, 29.3, 29.2 ppm.



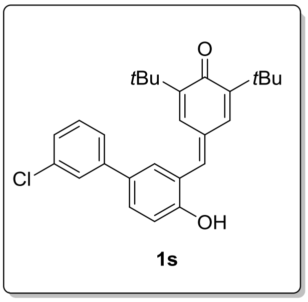
1q

2,6-di-tert-butyl-4-((3'-fluoro-4-hydroxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1q): Prepared according to the general procedure **I** above and obtained as yellow solid (1.52 g, 38% yield for 4 steps), melting point: 200-201 ℃; ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 10.50 (s, 1H), 7.69 – 7.61 (m, 3H), 7.56 (s, 1H), 7.49 – 7.44 (m, 3H), 7.27 (d, *J* = 2.0 Hz, 1H), 7.16 – 7.10 (m, 1H), 7.06 (d, *J* = 8.0Hz, 1H), 1.27 (d, *J* = 22.0 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-*d*$_6$) δ 185.7, 162.7 (d, *J* = 243.2 Hz), 157.0, 147.6, 146.2, 142.0 (d, *J* = 7.7 Hz), 140.6, 135.6, 130.8, 130.7 , 130.3, 129.7, 129.5, 128.3, 122.9, 121.8 (d, *J* = 2.3 Hz), 116.5, 113.4 (d, *J* = 21.0 Hz), 112.6(d, *J* = 21.0 Hz), 35.0, 34.7, 29.3, 29.2 ppm.



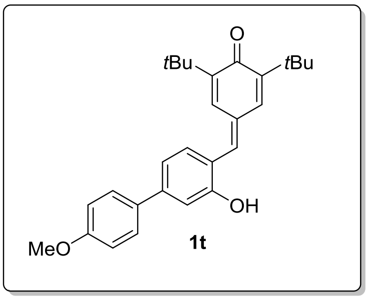
1r

2,6-di-tert-butyl-4-((4'-chloro-4-hydroxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1r): Prepared according to the general procedure **I** above and obtained as yellow solid (1.05 g, 25% yield for 4 steps), melting point: 174-175 ℃; ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 10.48 (s, 1H), 7.64– 7.60 (m, 5H), 7.53 (d, *J* = 1.5 Hz, 1H), 7.47 (d, *J* = 8.5 Hz, 2H), 7.25 (d, *J* = 2.0 Hz, 1H), 7.05 (d, *J* = 8.5 Hz, 1H), 1.25 (d, *J* = 27.0 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-*d*$_6$) δ 185.6, 156.8, 147.6, 146.2, 140.7, 138.3, 135.6, 131.6, 130.3, 129.8, 129.6, 129.31, 128.8, 128.3, 127.6, 123.0, 116.5, 35.0, 34.7, 29.3, 29.2 ppm.



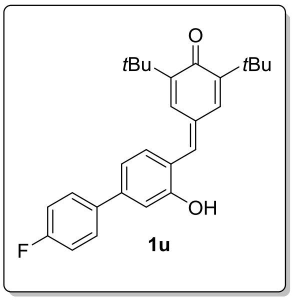
1s

2,6-di-tert-butyl-4-((3'-chloro-4-hydroxy-[1,1'-biphenyl]-3-yl)methylene)cyclohexa-2,5-dien-1-one (1s): Prepared according to the general procedure **I** above and obtained as yellow solid (0.95 g, 22% yield for 4 steps), melting point: 212-213 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.51 (s, 1H), 7.66– 7.63 (m, 4H), 7.60 – 7.57 (m, 2H), 7.46 (t, *J* = 8.0 Hz, 1H), 7.36 (d, *J* = 7.5 Hz, 1H), 7.27 (d, *J* = 1.5 Hz, 1H), 7.06 (d, *J* = 8.0 Hz, 1H), 1.27 (d, *J* = 15.5 Hz, 18H) ppm; ^{13}C NMR (126 MHz, DMSO) δ 186.2, 157.6, 148.1, 146.7, 142.1, 141.0, 136.1, 134.2, 131.2, 130.8, 130.2, 130.1, 130.1, 128.8, 127.1, 126.2, 125.0, 123.5, 117.0, 35.5, 35.2, 29.8, 29.7 ppm.



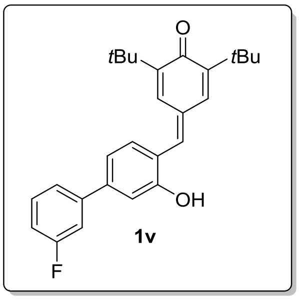
1t

2,6-di-tert-butyl-4-((3-hydroxy-4'-methoxy-[1,1'-biphenyl]-4-yl)methylene)cyclohexa-2,5-dien-1-one (1t): Prepared according to the general procedure **I** above and obtained as yellow solid (1.14 g, 27% yield for 4 steps), melting point: 248-249 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.36 (s, 1H), 7.66 – 7.58 (m, 3H), 7.55 (s, 1H), 7.46 (d, *J* = 8.0 Hz, 1H), 7.29 – 7.16 (m, 3H), 7.05 (d, *J* = 8.5 Hz, 2H), 3.81 (s, 3H), 1.28 (d, *J* = 11.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 186.1, 159.9, 158.0, 148.0, 146.3, 143.4, 141.1, 136.2, 132.4, 131.9, 130.0, 128.8, 128.17, 121.7, 117.9, 115.0, 113.6, 55.7, 35.5, 35.1, 29.8, 29.7 ppm.



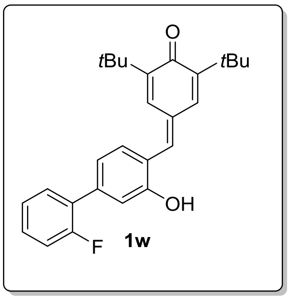
1u

2,6-di-tert-butyl-4-((4'-fluoro-3-hydroxy-[1,1'-biphenyl]-4-yl)methylene)cyclohexa-2,5-dien-1-one (1u): Prepared according to the general procedure **I** above and obtained as yellow solid (1.48 g, 37% yield for 4 steps), melting point: 247-248 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.42 (s, 1H), 7.70 – 7.68 (m, 2H), 7.62 (s, 1H), 7.53 (s, 1H), 7.47 (d, *J* = 8.5 Hz, 1H), 7.32 (t, *J* = 8.5 Hz, 2H), 7.24 – 7.22 (m, 2H), 7.19 (s, 1H), 1.27 (d, *J* = 13.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.8, 162.1 (d, *J* = 245.8 Hz), 157.4, 147.6, 146.0, 142.0, 140.4, 135.7, 132.0, 130.0, 128.6 ,128.5, 128.2, 121.9, 117.9, 115.9 (d, *J* = 21.5Hz), 113.7, 35.0, 34.6, 29.3, 29.2 ppm.



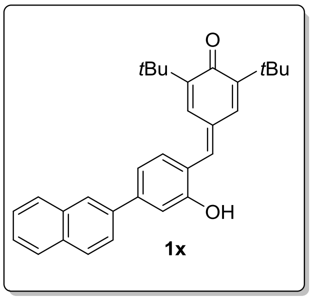
1v

2,6-di-tert-butyl-4-((3'-fluoro-3-hydroxy-[1,1'-biphenyl]-4-yl)methylene)cyclohexa-2,5-dien-1-one (1v): Prepared according to the general procedure **I** above and obtained as yellow solid (1.37 g, 34% yield for 4 steps), melting point: 243-244 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.60 (s, 1H), 7.51 – 7.46 (m, 5H), 7.27 – 7.21 (m, 4H), 1.25 (d, *J* = 13.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 186.2, 163.1 (d, *J* = 244.1 Hz), 157.9, 148.2, 146.5, 142.3 (d, *J* = 7.8 Hz),, 142.1, 140.8, 136.2, 132.5, 131.5 (d, *J* = 8.4 Hz), 130.5, 128.7, 123.1, 123.0, 118.5, 115.2 (d, *J* = 21.1 Hz), 114.4, 113.7 (d, *J* = 22.1 Hz), 35.5, 35.2, 29.8, 29.7 ppm.



1w

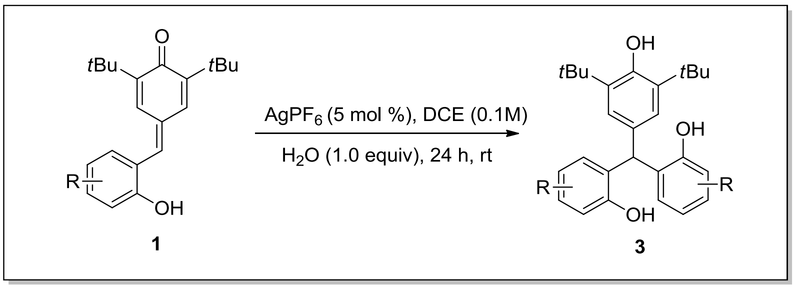
2,6-di-tert-butyl-4-((2'-fluoro-3-hydroxy-[1,1'-biphenyl]-4-yl)methylene)cyclohexa-2,5-dien-1-one (1w): Prepared according to the general procedure **I** above and obtained as yellow solid (1.3 g, 31% yield for 4 steps), melting point: 230-232 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.42 (s, 1H), 7.62 (s, 1H), 7.57 – 7.54 (m, 2H), 7.49 (d, J = 8.0 Hz, 1H), 7.46 – 7.43 (m, 1H), 7.35 – 7.30 (m, 2H), 7.26 (d, J = 2.0 Hz, 1H), 7.17 (s, 1H), 7.13 (d, J = 8.0 Hz, 1H), 1.27 (d, J = 14.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.7, 159.1 (d, J = 247.1 Hz), 156.9, 147.7, 146.1, 140.3, 137.9, 135.7, 131.6, 130.4 (d, J = 3.2 Hz), 130.0, 130.0 (d, J = 8.4 Hz), 128.2, 127.4 (d, J = 12.7 Hz), 125.0 (d, J = 3.4 Hz), 122.2, 119.9 (d, J = 2.3 Hz), 116.2 (d, J = 22.7 Hz), 116.1 (d, J = 3.4 Hz), 35.0, 34.7, 29.3, 29.2 ppm.



1x

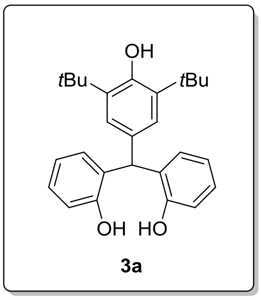
2,6-di-tert-butyl-4-(2-hydroxy-4-(naphthalen-2-yl)benzylidene)cyclohexa-2,5-dien-1-one (1x): Prepared according to the general procedure **I** above and obtained as yellow solid (1.57 g, 36% yield for 4 steps), melting point: 263-265 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.47 (s, 1H), 8.23 (s, 1H), 8.02 (d, J = 8.0 Hz, 2H), 7.95 (d, J = 7.3 Hz, 1H), 7.82 (d, J = 8.5 Hz, 1H), 7.66 (s, 1H), 7.61 – 7.50 (m, 4H), 7.45 – 7.35 (m, 2H), 7.26 (d, J = 0.5Hz, 1H), 1.28 (d, J = 9.5 Hz, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 186.2, 158.0, 148.1, 146.5, 143.4, 141.0, 137.1, 136.2, 133.7, 133.0, 132.5, 130.4, 129.1, 128.8, 128.0, 127.0, 126.9, 125.9, 125.2, 122.5, 118.7, 114.5, 35.5, 35.2, 29.8, 29.7 ppm.

B) Synthesis of triarylmethanes (TRAMs)



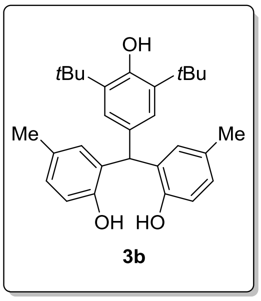
General Procedure II: To an oven-dried reaction tube was added *p*-QMs **1** (0.1 mmol) and $AgPF_6$ (5 mol %), and DCE (1.0 mL) was added, Then H_2O (0.1 mmol) was added by dropwise slowly. The mixture was stirred for 24 h at room temperature. Purification of mixture by column chromatography on silica gel (PE/EA = 5:1 as eluent) gave the desired product **3**.

Large-scale Reaction: To an oven-dried reaction tube was added *p*-QMs **1a** (1.0 g, 3.2 mmol) and $AgPF_6$ (5 mol %), and DCE (32 mL) was added, Then H_2O (58 μL, 3.2 mmol) was added by dropwise slowly. The mixture was stirred for 24 h at room temperature. Purification of mixture by column chromatography on silica gel (PE/EA = 5:1 as eluent) gave the desired product **3a** (0.65 g, 90% yield).



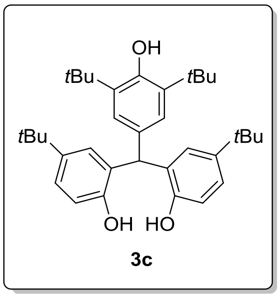
3a

2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)diphenol (3a): Prepared according to the general procedure **II** above and obtained as yellow solid (37.2 mg, 92% yield), melting point: 161-162 ℃; ^1H NMR (500 MHz, DMSO-d_6) δ 9.14 (s, 2H), 6.99-6.96 (m, 2H), 6.77 (s, 2H), 6.74 (d, *J* = 7.5 Hz, 2H), 6.68 (s, 1H), 6.66 (d, *J* = 4.0 Hz, 4H), 5.94 (s, 1H), 1.28 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ=154.6, 151.5, 138.4, 134.4, 131.0, 129.4, 126.5, 125.2, 118.2, 114.8, 42.2, 34.4, 30.4 ppm; IR (KBr,cm^{-1}): 3633, 2956, 1594, 1484, 1453, 1434, 1277, 1233, 1023, 820, 756; HRMS (ESI) calcd for $C_{27}H_{31}O_3^-$ [M-H]$^-$: 403.2279, found: 403.2280.



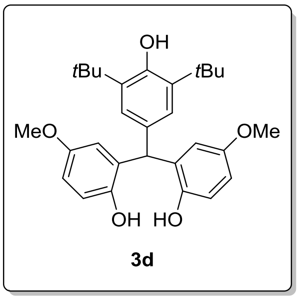
3b

2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4-methylphenol) (3b): Prepared according to the general procedure **II** above and obtained as colorless oil (42 mg, 97% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 8.87 (s, 2H), 6.80– 6.77 (m, 4H), 6.67 (s, 1H), 6.62 (d, *J* = 8.0 Hz, 2H), 6.53 (s, 2H), 5.87 (s, 1H), 2.08 (s, 6H), 1.29 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 152.4, 151.5, 138.3, 134.3, 130.8, 129.9, 126.8, 126.2, 125.3, 114.7, 42.2, 34.4, 30.4, 20.5 ppm; IR (KBr, cm^{-1}): 3643, 2956, 2924, 1610, 1506, 1434, 1232, 1034, 814, 769; HRMS (ESI) calcd for $C_{29}H_{35}O_3^-$[M-H]$^-$: 431.2592, found: 431.2590.



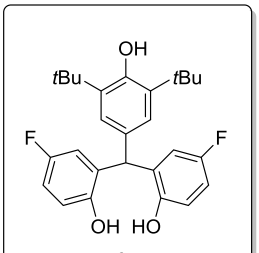
3c

2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4-(tert-butyl)phenol) (3c): Prepared according to the general procedure **II** above and obtained as yellow solid (40 mg, 78% yield), melting point: 108-109 ℃, ^{1}H NMR (500 MHz, DMSO-d_6) δ 8.92 (s, 2H), 6.95 (dd, *J* = 8.3, 2.2 Hz, 2H), 6.87 – 6.86 (m, 4H), 6.68 (s, 1H), 6.64 (d, J = 8.5 Hz, 2H), 6.00 (s, 1H), 1.30 (s, 18H), 1.11 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 152.1, 151.4, 139.8, 138.4, 134.5, 130.1, 126.6, 125.3, 122.6, 114.3, 41.7, 34.4, 33.5, 31.3, 30.4 ppm; IR (KBr, cm^{-1}):3636, 2956, 2868, 1609, 1508, 1427, 1231, 1202, 824, 765; HRMS (ESI) calcd for $C_{35}H_{47}O_3^-$[M-H]$^-$: 515.3531, found: 515.3523.



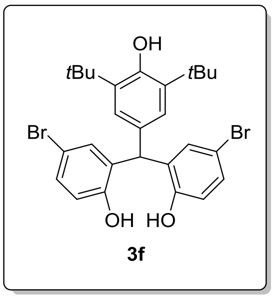
3d

2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4-methoxyphenol) (3d): Prepared according to the general procedure **II** above and obtained as colorless oil (20 mg, 43% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 8.74 (s, 2H), 6.81 (s, 2H), 6.74 (s, 1H), 6.66 (d, *J* = 8.5 Hz, 2H), 6.60– 6.58 (m, 2H), 6.24 (s, 2H), 5.84 (s, 1H), 3.54 (s, 6H), 1.30 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 151.7, 151.7, 148.6, 138.5, 133.8, 132.0, 125.1, 116.0, 115.1, 110.7, 55.1, 42.8, 34.4, 30.4 ppm; IR (KBr, cm^{-1}), 3606, 2958, 1590, 1502, 1431, 1275, 1235, 1148, 1040, 818, 721; HRMS (ESI) calcd for $C_{29}H_{35}O_5^-$[M-H]$^-$: 463.2490, found: 463.2490.



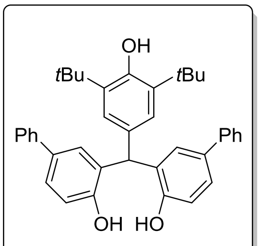
3e

2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4-fluorophenol) (3e): Prepared according to the general procedure **II** above and obtained as colorless oil (27 mg, 63% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.30 (s, 2H), 6.87 – 6.82 (m, 3H), 6.76– 6.73 (m, 4H), 6.34 (dd, *J* = 9.9, 3.0 Hz, 2H), 5.84 (s, 1H), 1.29 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 155.6 (d, *J* = 233.7 Hz), 152.5, 151.4, 139.3, 133.4, 132.7 (d, *J* = 5.6 Hz), 125.5, 116.1 (d, *J* = 7.6 Hz), 115.8 (d, *J* = 23.6 Hz), 113.4 (d, *J* = 22.6 Hz), 43.4, 34.9, 30.9 ppm; IR (KBr, cm^{-1}): 2954, 1555, 1506, 1436, 1258, 1026, 822, 760; HRMS (ESI) calcd for $C_{27}H_{29}F_2O_3^-$[M-H]$^-$: 439.2090, found: 439.2091.



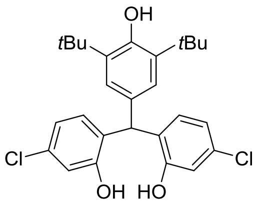
3f

2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4-bromophenol) (3f): Prepared according to the general procedure **II** above and obtained as colorless oil (18.5 mg, 33% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.66 (s, 2H), 7.19 (dd, *J* = 8.5, 2.3 Hz, 2H), 6.84 (s, 1H), 6.77 – 6.73 (m, 4H), 6.70 (d, *J* = 2.5 Hz, 2H), 5.80 (s, 1H), 1.30 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 154.1, 152.0, 138.9, 133.2, 132.3, 131.3, 129.6, 125.1, 117.1, 109.5, 42.9, 34.4, 30.4 ppm; IR (KBr, cm^{-1}): 3632, 2956, 1597, 1490, 1434, 1232, 816, 769; HRMS (ESI) calcd for $C_{27}H_{29}Br_2O_3^-$[M-H]$^-$: 559.0489, found: 559.0475.



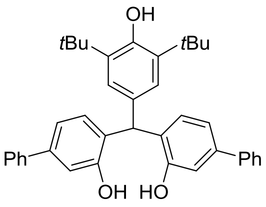
3g

3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis([1,1'-biphenyl]-4-ol) (3g): Prepared according to the general procedure **II** above and obtained as colorless oil (53 mg, 96% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 9.45 (s, 2H), 7.37 – 7,30 (m, 10H), 7.22 – 7.20 (m, 2H), 7.07 (d, *J* = 2.0 Hz, 2H), 6.99 (s, 2H), 6.86 (d, *J* = 8.0 Hz, 2H), 6.78 (s, 1H), 6.01 (s, 1H), 1.33 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 154.6, 151.8, 140.8, 138.7, 133.5, 131.3, 130.2, 128.8, 127.7, 126.2, 125.6, 125.4, 125.1, 115.5, 42.9, 34.5, 30.4 ppm; **IR** (KBr, cm^{-1}): 3627,2957, 1606, 1514, 1486, 1453, 1433, 1278, 1233, 764; **HRMS** (ESI) calcd for $C_{39}H_{39}O_3^-$[M-H]$^-$: 555.2905, found: 555.2897.



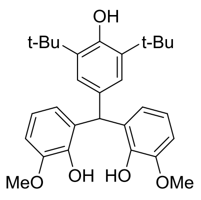
3h

6,6'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3-chlorophenol) (3h): Prepared according to the general procedure **II** above and obtained as colorless oil (39 mg, 83% yield); ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 9.79 (s, 2H), 6.78 – 6.74 (m, 7H), 6.61 (d, *J* = 8.5 Hz, 2H), 5.80 (s, 1H), 1.28 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-*d*$_6$) δ 155.6, 151.9, 138.7, 133.1, 130.6, 130.5, 129.9, 125.0, 118.2, 114.6, 41.8, 34.4, 30.4ppm; IR (KBr, cm^{-1}): 3633, 2957, 1587, 1501, 1414, 1262, 1232, 856,820; HRMS (ESI) calcd for $C_{27}H_{29}Cl_2O_3^-$[M-H]$^-$: 471.1499, found:471.1500.



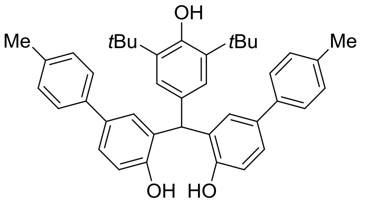
3i

4,4''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis([1,1'-biphenyl]-3-ol) (3i): Prepared according to the general procedure **II** above and obtained as colorless oil (42 mg, 42% yield); ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 9.40 (s, 2H), 7.56 (d, *J* = 8.0 Hz, 4H), 7.44 (t, *J* = 8.0 Hz, 4H), 7.32 (t, *J* = 7.5 Hz, 2H), 7.04 – 7.01 (m, 4H), 6.88 (s, 2H), 6.82 (d, *J* = 8.0 Hz, 2H), 6.73 (s, 1H), 5.99 (s, 1H), 1.31 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-*d*$_6$) δ 155.0, 151.70, 140.3, 138.7, 138.6, 134.0, 130.5, 129.9, 128.8, 127.1, 126.3, 125.2, 116.8, 113.1, 42.2, 34.4, 30.4 ppm; IR (KBr, cm^{-1}): 3629, 2957, 1610, 1568, 1488, 1433, 1232, 821; HRMS (ESI) calcd for $C_{39}H_{39}O_3^-$[M-H]$^-$: 555.2905, found: 555.2896.



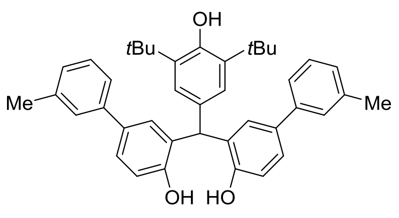
3j

6,6'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(2-methoxyphenol) (3j): Prepared according to the general procedure **II** above and obtained as yellow solid (22 mg, 47% yield), melting point: 80-82 ℃; ^{1}H NMR (500 MHz, DMSO-d_6) δ 8.31 (s, 2H), 6.77 (d, *J* = 8.0 Hz, 4H), 6.69 (s, 1H), 6.63 (t, *J* = 8.0 Hz, 2H), 6.30 (d, *J* = 7.5 Hz, 2H), 6.00 (s, 1H), 3.75 (s, 6H), 1.28 (s, 18H) ppm； ^{13}C NMR (125 MHz, DMSO-d_6) δ 151.6, 147.0, 143.5, 138.4, 134.4, 131.3, 125.1, 121.5, 117.7, 109.3, 55.7, 42.2, 34.4, 30.4 ppm；IR (KBr, cm^{-1}): 3622, 2957, 1610, 1479, 1434, 1275, 1214, 1025, 770,749; HRMS (ESI) calcd for $C_{29}H_{35}O_5^-$[M-H]$^-$: 463.2490, found: 463.2492.



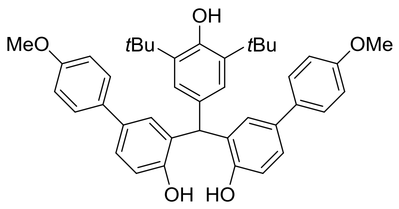
3k

3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4'-methyl-[1,1'-biphenyl]-4-ol) (3k): Prepared according to the general procedure **II** above and obtained as colorless oil (52 mg, 90% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.39 (s, 2H), 7.28 – 7.23 (m, 6H), 7.14 (d, *J* = 8.0 Hz, 4H), 7.04 (s, 2H), 6.98 (s, 2H), 6.83 (d, *J* = 8.5 Hz, 2H), 6.77 (s, 1H), 6.00 (s, 1H), 2.25 (s, 6H), 1.32 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 154.3, 151.8, 138.6, 137.9, 135.4, 133.5, 131.3, 130.2, 129.4, 127.5, 125.5, 125.4, 124.8, 115.4, 42.7, 34.5, 30.4, 20.5 ppm; IR (KBr, cm^{-1}): 3626, 2957, 1606, 1498, 1432, 1231, 1024, 888, 811,762; HRMS (ESI) calcd for $C_{41}H_{43}O_3^-$[M-H]$^-$: 583.3218, found:583.3210.



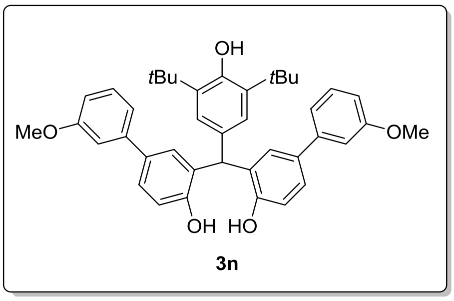
3l

3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3'-methyl-[1,1'-biphenyl]-4-ol) (3l): Prepared according to the general procedure **II** above and obtained as colorless oil (32 mg, 56% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.48 (s, 2H), 7.30 – 7.29 (m, 2H), 7.23 – 7.16 (m, 6H) , 7.10 (s, 2H), 7.02 (d, *J* = 7.5 Hz, 4H), 6.85 (d, *J* = 8.0 Hz, 2H), 6.81 (s, 1H), 6.03 (s, 1H), 2.27 (s, 6H), 1.34 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 154.5, 151.8, 140.7, 138.7, 137.7, 133.4, 131.2, 130.3, 128.7, 127.8, 126.9, 126.4, 125.4, 125.1, 122.8, 115.4, 42.6, 34.5, 30.4, 21.1 ppm; IR (KBr, cm^{-1}): 2955, 1604, 1511, 1481, 1433, 1232, 1024, 888, 824, 703; HRMS (ESI) calcd for$C_{41}H_{43}O^{3-}$[M-H]$^-$: 583.3218, found: 583.3207.



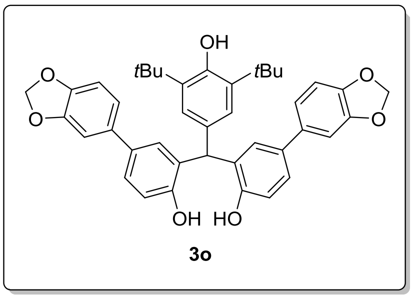
3m

3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4'-methoxy-[1,1'-biphenyl]-4-ol) (3m): Prepared according to the general procedure **II** above and obtained as colorless oil (22 mg, 36% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.33 (s, 2H), 7.27 (d, *J* = 8.5 Hz, 4H), 7.24 (dd, *J* = 8.3, 2.2 Hz, 2H), 6.99 (d, *J* = 2.0 Hz, 2H), 6.97 (s, 2H), 6.91 (d, *J* = 8.5 Hz, 4H), 6.81 (d, *J* = 8.0 Hz, 2H), 6.77 (s, 1H), 5.98 (s, 1H), 3.73 (s, 6H), 1.32 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 158.0, 154.0, 151.7, 138.6, 133.6, 133.3, 131.3, 130.0, 127.2, 126.7, 125.4, 124.6, 115.4, 114.3, 55.1, 42.7, 34.5, 30.4 ppm; IR (KBr, cm^{-1}): 3625, 2956, 1607, 1498, 1434, 1245, 1025, 822,763; HRMS (ESI) calcd for $C_{41}H_{43}O_5^{3-}$[M-H]$^-$: 615.3116, found: 615.3105.



3n

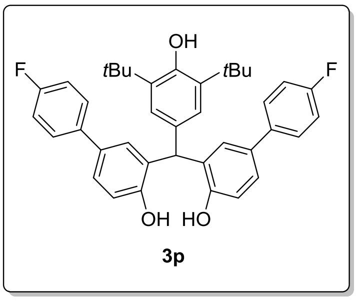
3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3'-methoxy-[1,1'-biphenyl]-4-ol) (3n): Prepared according to the general procedure **II** above and obtained as colorless oil (30 mg, 49% yield); ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 9.47 (s, 2H), 7.31 (dd, *J* = 8.2, 2.1 Hz, 2H), 7.25 (t, *J* = 8.0Hz, 2H), 7.05 (d, *J* = 2.0 Hz, 2H), 6.98 (s, 2H), 6.94 (d, *J* = 7.5 Hz, 2H), 6.86 – 6.83(m, 4H), 6.80 – 6.78 (m, 3H), 6.01 (s, 1H), 3.72 (s, 6H), 1.32 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-*d*$_6$) δ 159.6, 154.7, 151.8， 142.1, 138.7, 133.4, 131.2, 130.0, 129.8, 127.7, 125.4, 125.1, 118.0, 115.4, 111.8, 111.2, 54.8, 42.6，34.5, 30.4 ppm; IR (KBr, cm^{-1}): 3626, 2956, 1604, 1578, 1481, 1435, 1363, 1278, 1219, 1024, 888, 824, 699; HRMS (ESI) calcd for $C_{41}H_{43}O_5^-$[M-H]$^-$: 615.3116, found: 615.3111.



3o

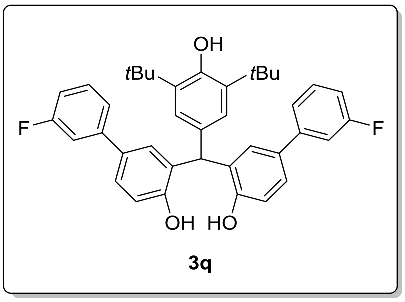
2,2'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4-(benzo[d][1,3]dioxol-5-yl)phenol) (3o): Prepared according to the general procedure **II** above and obtained as colorless oil (29 mg, 45% yield). ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 9.46 (s, 2H), 7.23 (dd, *J* = 8.3, 1.6 Hz, 2H), 6.95 (d, *J* = 4.0 Hz, 4H), 6.89 – 6.85 (m, 4H), 6.81 (d, *J* = 7.5 Hz, 5H), 5.97 (d, *J* = 2.0 Hz, 5H), 1.32 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-*d*$_6$) δ 154.2, 151.8, 147.8, 145.9, 138.7, 135.2, 133.4, 131.2, 130.0, 127.4, 125.4, 124.9, 118.9, 115.3, 108.6, 106.1, 100.9, 42.8, 34.5, 30.4 ppm; IR (KBr, cm^{-1}):

3623, 2955, 1605, 1482, 1430, 1228, 1026, 859, 809, 763; HRMS (ESI) calcd for $C_{41}H_{39}O_7^-$[M-H]$^-$: 643.2701, found: 643.2690.



3p

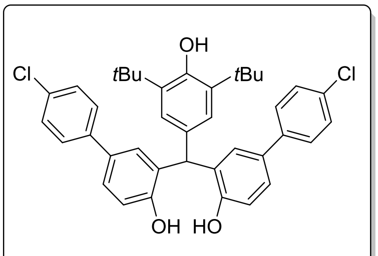
3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4'-fluoro-[1,1'-biphenyl]-4-ol) (3p): Prepared according to the general procedure **II** above and obtained as colorless oil (27 mg, 47% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.46 (s, 2H), 7.37 – 7.34 (m, 4H), 7.29 – 7.27 (m, 2H), 7.18 (t, *J* = 8.5 Hz, 4H), 7.00 (d, *J* = 2.0 Hz, 2H), 6.95 (s, 2H), 6.84 (d, *J* = 8.0 Hz, 2H), 6.78 (s, 1H), 5.98 (s, 1H), 1.31 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 161.1 (d, *J* = 243.6 Hz), 154.6, 151.8, 138.6, 137.3 (d, *J* = 3.0 Hz), 133.4, 131.3, 129.3, 127.6, 127.4 (d, *J* = 8.1 Hz), 125.4, 125.2, 115.6 (d, *J* = 21.3 Hz), 115.5, 42.9, 34.4, 30.4 ppm; IR (KBr, cm^{-1}): 2955, 1605, 1496, 1433, 1225, 1025, 821, 762; HRMS (ESI) calcd for $C_{39}H_{37}F_2O_3^-$[M-H]$^-$: 591.2716, found: 591.2708.



3q

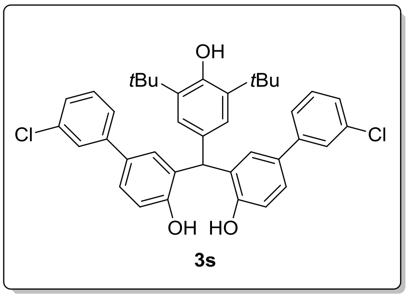
3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3'-fluoro-[1,1'-biphenyl]-4-ol) (3q): Prepared according to the general procedure **II** above and obtained as colorless oil (15.4 mg, 26% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.59 (s, 2H), 7.40 – 7.36 (m, 4H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 10.5 Hz, 2H), 7.06 – 7.02 (m, 4H), 6.97 (s, 2H), 6.86 (d, *J* = 8.5 Hz, 2H), 6.81 (s, 1H), 5.98 (s, 1H), 1.32 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 164.1, 162.2, 155.7, 152.4, 143.7 (d, *J* = 7.3

Hz), 139.3, 133.7, 131.8, 131.3 (d, J = 8.2 Hz), 129.2, 128.1, 125.9, 122.0, 116.0, 113.4 (d, J = 21.2 Hz), 112.6 (d, J = 21.8 Hz), 43.5, 35.0, 30.9 ppm; IR (KBr, cm^{-1}): 2957, 1608, 1581, 1481, 1435, 1233, 1025, 889, 784, 695; HRMS (ESI) calcd for $C_{39}H_{37}F_2O_3^-$[M-H]$^-$: 591.2716, found: 591.2709.



3r

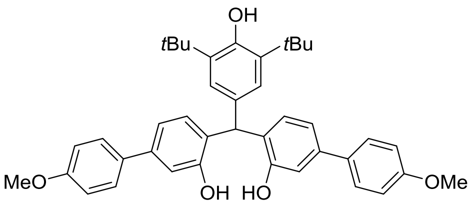
3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4'-chloro-[1,1'-biphenyl]-4-ol) (3r): Prepared according to the general procedure **II** above and obtained as colorless oil (20 mg, 32% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.55 (s, 2H), 7.40 (d, J = 8.5 Hz, 4H), 7.35 (d, J = 8.5 Hz, 4H), 7.32 (dd, J = 8.2, 2.2 Hz, 2H), 7.02 (d, J = 2.5 Hz, 2H), 6.94 (s, 2H), 6.85 (d, J = 8.0 Hz, 2H), 6.79 (s, 1H), 5.98 (s, 1H), 1.31 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 154.9, 151.8, 139.6, 138.7, 133.3, 131.4, 131.0, 128.9, 128.8, 127.5, 127.3, 125.3, 125.2, 115.6, 42.9, 34.5, 30.4 ppm; IR (KBr, cm^{-1}): 3629, 2957, 1606, 1485, 1432, 1232, 1024, 818, 760; HRMS (ESI) calcd for $C_{39}H_{37}Cl_2O_3^-$[M-H]$^-$: 623.2125, found: 623.2117.



3s

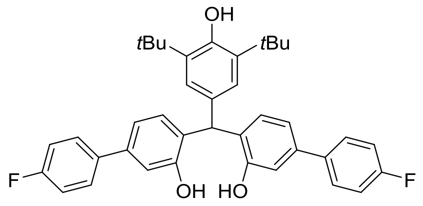
3,3''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3'-chloro-[1,1'-biphenyl]-4-ol) (3s): Prepared according to the general procedure **II** above and obtained as colorless oil (23 mg, 38% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.60 (s, 2H), 7.39 – 7.32 (m, 8H), 7.27 (d, J = 8.0 Hz, 2H), 7.06 (d, J = 1.5 Hz, 2H), 6.98 (s, 2H), 6.86 (d, J = 8.5 Hz, 2H), 6.81 (s, 1H), 5.99 (s, 1H), 1.33 (s, 18H) ppm; ^{13}C NMR (125

MHz, DMSO-d_6) δ 155.2, 151.9, 142.8, 138.8, 133.6, 133.1, 131.3, 130.7, 128.5, 127.6, 126.0, 125.4, 125.3, 124.2, 115.6, 42.9, 34.5, 30.4 ppm; IR (KBr, cm^{-1}): 3629, 2957, 1595, 1564,1512, 1434, 1232, 1024, 884, 825, 695; HRMS (ESI) calcd for $C_{39}H_{37}Cl_2O_3^-$[M-H]$^-$: 623.2125, found: 623.2112.



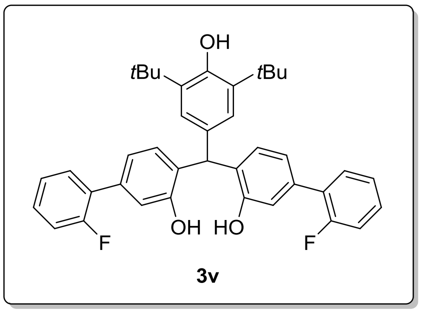
3t

4,4''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4'-methoxy-[1,1'-biphenyl]-3-ol) (3t): Prepared according to the general procedure **II** above and obtained as colorless oil (20 mg, 33% yield); **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.32 (s, 2H), 7.49 (d, J = 8.5 Hz, 4H), 7.00 – 6.95 (m, 8H), 6.87 (s, 2H), 6.78 (d, J = 8.0 Hz, 2H), 6.73 (s, 1H), 5.95 (s, 1H), 3.78 (s, 6H), 1.31 (s, 18H) ppm; **^{13}C NMR** (125 MHz, DMSO-d_6) δ 159.1, 155.4, 152.2, 139.1, 138.8, 134.7, 133.1, 130.2, 127.8, 125.7, 116.8, 114.8, 113.1, 55.6, 42.6, 34.9, 30.9 ppm; **IR** (KBr, cm^{-1}): 3634, 2949, 1607, 1501, 1431, 1405, 1231, 1046, 833; **HRMS** (ESI) calcd for $C_{41}H_{43}O_5^-$[M-H]$^-$: 615.3116, found: 615.3110.



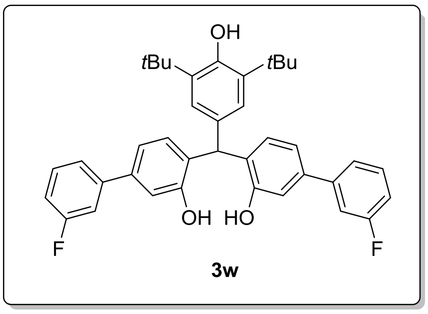
3u

4,4''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(4'-fluoro-[1,1'-biphenyl]-3-ol) (3u): Prepared according to the general procedure **II** above and obtained as colorless oil (25mg, 42% yield). ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.45 (s, 2H), 7.60 – 7.57 (m, 4H), 7.25 (t, J = 9.0 Hz, 4H), 7.01 – 6.98 (m, 4H), 6.87 (s, 2H), 6.80 (d, J = 7.5Hz, 2H), 6.75 (s, 1H), 5.97 (s, 1H), 1.31 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 155.5, 152.2, 139.1, 138.2, 137.2, 134.4, 130.9, 130.4, 128.7 (d, *J* = 7.4 Hz), 125.7, 117.2, 116.1 (d, *J* = 21.3 Hz), 113.5, 42.6, 34.9, 30.9 ppm; IR (KBr, cm^{-1}): 3635, 2959, 1601, 1499, 1432, 1230, 833, 811; HRMS (ESI) calcd for $C_{39}H_{37}F_2O_3^-$[M-H]$^-$: 591.2716, found: 591.2701.



3v

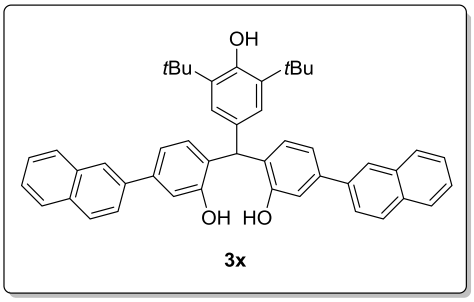
4,4''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(2'-fluoro-[1,1'-biphenyl]-3-ol) (3v): Prepared according to the general procedure **II** above and obtained as colorless oil (29mg, 49%); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.46 (s, 2H), 7.48 – 7.45 (m, 2H), 7.39 – 7.35 (m, 2H), 7.29– 7.25 (m, 4H), 6.98 (s, 2H), 6.92 – 6.87 (m, 4H), 6.83 (d, *J* = 8.0 Hz, 2H), 6.74 (s, 1H), 6.00 (s, 1H), 1.31 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 159.0(d, *J* = 244.3 Hz), 154.5, 151.8, 138.6, 133.5, 130.8, 130.4, 129.5, 129.1 (d, *J* = 7.1 Hz), 128.3, 128.2, 125.3, 124.8, 118.8, 116.1 (d, *J* = 22.7 Hz), 115.3, 42.3, 34.4, 30.4 ppm; IR (KBr, cm^{-1}): 3631, 2957, 1612, 1585, 1485, 1413, 1232, 1025,812; HRMS (ESI) calcd for $C_{39}H_{37}F_2O_3^-$[M-H]$^-$: 591.2716, found: 591.2708.



3w

4,4''-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3'-fluoro-[1,1'-biphenyl]-3-ol) (3w): Prepared according to the general procedure **II** above and obtained as colorless oil (20mg, 34%); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.50 (s, 2H), 7.49 – 7.45 (m, 2H), 7.45 – 7.36 (m, 4H), 7.15 (t, *J* = 8.0 Hz, 2H), 7.06 (d, *J* = 8.0 Hz, 4H), 6.87

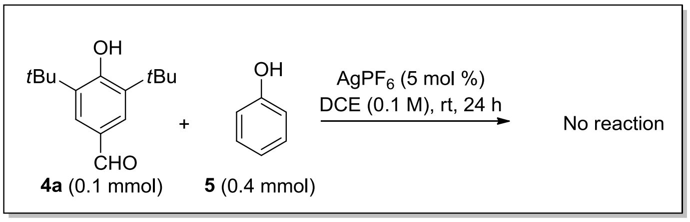
(s, 2H), 6.82 (d, *J* = 8.0 Hz, 2H), 6.77 (s, 1H), 5.98 (s, 1H), 1.31 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 163.1 (d, *J* = 243.7 Hz), 155.6, 152.3, 143.2 (d, *J* = 7.3 Hz), 139.2, 137.8, 134.2, 131.6, 131.3 (d, *J* = 8.3 Hz), 130.4, 125.7, 122.9, 117.4, 114.3 (d, *J* = 20.9 Hz), 113.6, 113.4 (d, *J* = 22.1 Hz), 42.8, 34.9, 30.9 ppm; IR (KBr, cm^{-1}): 2958, 1611, 1573, 1483, 1433, 1025, 864, 829; HRMS (ESI) calcd for $C_{39}H_{37}F_2O_3^-$[M-H]$^-$: 591.2716, found: 591.2709.



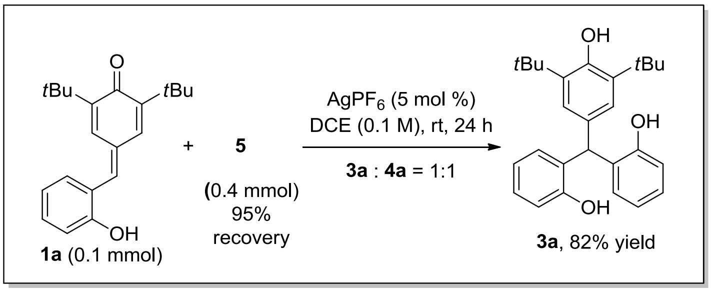
3x

6,6'-((3,5-di-tert-butyl-4-hydroxyphenyl)methylene)bis(3-(naphthalen-2-yl)phenol) (3x): Prepared according to the general procedure **II** above and obtained as colorless oil (45mg, 69% yield); ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.50 (s, 2H), 8.10 (s, 2H), 7.98 (d, *J* = 8.5 Hz, 4H), 7.92 (d, *J* = 7.5 Hz, 2H), 7.76 (d, *J* = 8.5 Hz, 2H), 7.54 – 7.48 (m, 4H), 7.21 – 7.18 (m, 4H), 6.94 (s, 2H), 6.91 (d, *J* = 8.0 Hz, 2H), 6.78 (s, 1H), 6.05 (s, 1H), 1.34 (s, 18H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 155.6, 152.3, 139.2, 139.1, 138.2, 134.5, 133.8, 132.6, 131.2, 130.5, 128.9, 128.6, 127.9, 126.8, 126.4, 125.8, 125.5, 125.2, 117.7, 113.9, 42.8, 35.0, 31.0 ppm; IR (KBr, cm^{-1}): 3631, 2922, 1600, 1500, 1433, 1415, 1242, 846, 817; HRMS (ESI) calcd for $C_{47}H_{43}O_3^-$[M-H]$^-$: 655.3218, found: 655.3204.

4. Control Experiments

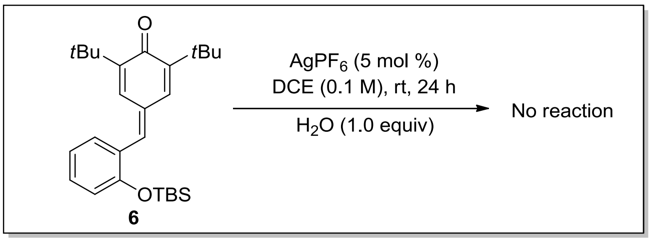


A) Friedel-Crafts reaction of 3,5-di-*tert*-butyl-4-hydroxy benzaldehyde 4a with phenol 5: To an oven-dried reaction tube was added 3,5-di-tert-butyl-4-hydroxy benzaldehyde **4a** (0.1 mmol), phenol **5** (0.4 mmol) and $AgPF_6$ (5 mol %), and DCE (1.0 mL) was added. The mixture was stirred for 24 h at room temperature, and no reaction was observed.

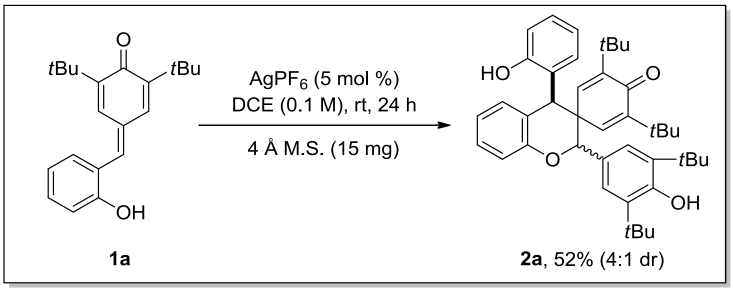


B) 1,6-Michael addition of *ortho*-hydroxyphenyl-substituted *para*-quinone methide 1a with phenol 5: To an oven-dried reaction tube was added *ortho*-hydroxyphenyl-substituted *para*-quinone methide **1a** (0.1 mmol), phenol **5** (0.4 mmol) and $AgPF_6$ (5 mol %), and DCE (1.0 mL) was added. The mixture was stirred for 24 h at room temperature. Purification of mixture by column chromatography on silica gel (PE/EA = 5:1 as eluent) gave the desired product **3a** (33.1 mg, 82% yield) and the recovered phenol **5** (34.6 mg, 95% yield).

Two observations can exclude the possibility of Michael addition reaction with simple phenol 5



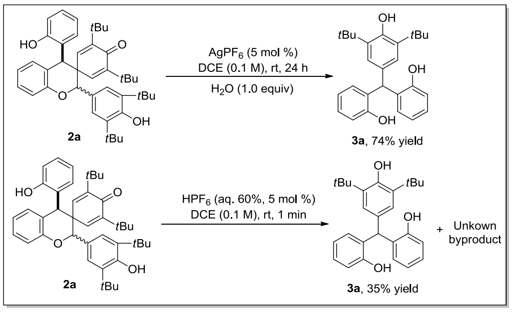
C) $AgPF_6$ catalyzed O-TBS protected *ortho*-hydroxyphenyl-substituted *para*-quinone methide 6: To an oven-dried reaction tube was added **6** (0.1 mmol) and $AgPF_6$ (5 mol %), and DCE (1.0 mL) was added, Then H_2O (0.1 mmol) was added by dropwise slowly. The mixture was stirred for 24 h at room temperature. No reaction was observed.



1a

2a, 52% (4:1 dr)

D) Synthesis of intermediate 2a: To an oven-dried reaction tube was added *p*-QMs **1a** (0.1 mmol, 1.0 equiv), $AgPF_6$ (5 mol %), 4Å M.S. (15 mg) and DCE (1.0 mL). The reaction mixture was then stirred for 24 h at room temperature. Purification of mixture by column chromatography on silica gel (PE/EA = 5:1 as eluent) gave the desired product **2a** (32.0 mg, 52% yield, and 4:1 dr), melting point: 220-222 ℃; ^1H NMR (500 MHz, DMSO-d_6) δ 9.70 (s, 0.3H), 9.52 (s, 1H), 7.23-7.18 (m, 1.42H), 7.07 (s, 2H), 7.05-6.97 (m, 3H), 6.93-6.80 (m, 7H), 6.75-6.69 (m, 3.2H), 6.60-6.57 (t, *J* = 5 Hz, 0.5H), 6.52-6.45 (m, 2.2H), 5.83 (s, 0.3H), 5.70 (s, 1H), 5.40 (s, 1H), 4.95 (s, 0.3H), 1.34 (s, 23H), 0.98-0.97 (m, 11.6H), 0.92-0.91 (m, 11.8H) ppm; ^{13}C NMR (125 MHz, DMSO-d_6) δ 185.0, 184.9, 156.1, 154.9, 154.8, 153.9, 153.3, 152.5, 148.9, 148.7, 146.1, 145.0, 142.7, 137.6, 137.5, 136.3, 130.7, 130.1, 129.5, 128.7, 128.2, 127.8, 127.6 (d, *J* = 6.3 Hz), 123.9, 123.7, 123.5, 123.1, 122.6, 120.8, 117.2, 116.4, 116.3, 114.3, 114.2, 83.7, 77.5, 59.7, 47.2, 46.7, 44.3, 34.4, 34.1, 30.2, 28.6, 28.5 ppm; IR (KBr, cm^{-1}): 3638, 2957, 1618, 1582, 1545, 1231, 803, 754; HRMS (ESI) calcd for $C_{42}H_{52}O_4Na^+$ $[M+Na]^+$: 643.3758, found: 643.3775.



E) Transformation of intermediate 2a: 1) To an oven-dried reaction tube was added **2a** (0.1 mmol, 1.0 equiv), $AgPF_6$ (5 mol %), H_2O (0.1 mmol, 1.0 equiv) and DCE (1.0 mL). The reaction mixture was then stirred for 24 h at room temperature. Purification of mixture by column chromatography on silica gel (PE/EA = 5:1 as eluent) gave the desired product **3a** (29.9 mg, 74% yield); 2) To an oven-dried reaction tube was added **2a** (0.1 mmol, 1.0 equiv), HPF_6 (aq. 60%, 5 mol %), and DCE (1.0 mL). The reaction mixture was then stirred for 1 min at room temperature. Purification of mixture by column chromatography on silica gel (PE/EA = 5:1 as eluent) gave the desired product **3a** (14.1 mg, 35% yield).

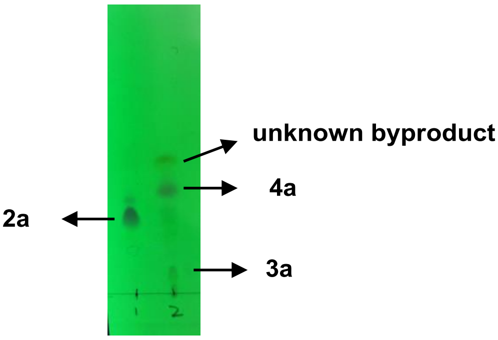
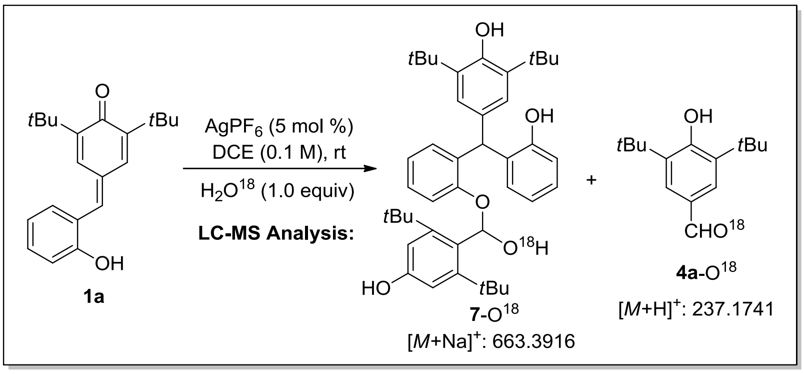
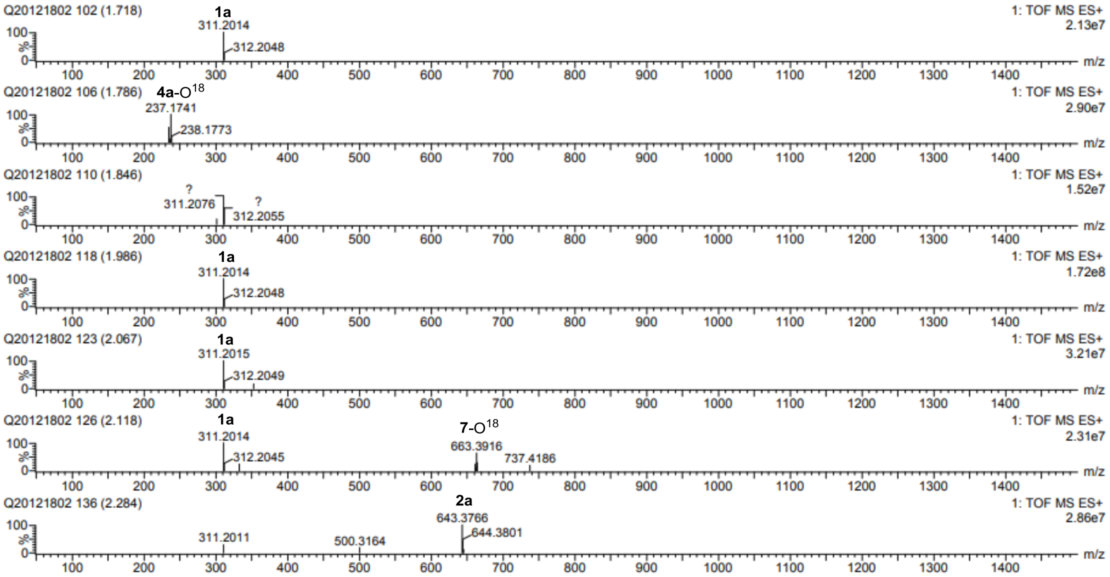


Figure S1 TCL detection in the transformation of intermediate **2a** for 1 min: 1) reaction **E1**; 2) reaction **E2**.



F) The LC-HRMS spectra of the reaction in the presence of H_2O^{18}.



4. X-ray crystal Data

A) X-Ray Structure of product 3a (CCDC 2039963)

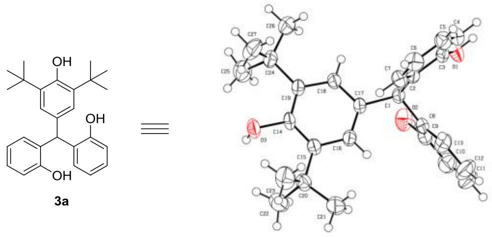


Figure S2 X-Ray Structure of **3a**

Table S1 Crystal data and structure refinement for **3a**

Empirical formula	C13.50 H16 O1.50	
Formula weight	202.26	
Temperature	298(2) K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	P -1	
Unit cell dimensions	a = 10.835(17) Å	a= 84.933(17) °.
	b = 10.925(17) Å	b= 64.499(17) °.
	c = 10.995(17) Å	g = 79.764(19) °.
Volume	1156(3) Å^3	
Z	4	
Density (calculated)	1.162 Mg/m^3	
Absorption coefficient	0.074 mm^{-1}	
F(000)	436	
Crystal size	0.43 x 0.40 x 0.38 mm^3	
Theta range for data collection	2.052 to 25.015 °.	
Index ranges	-7<=h<=12, -12<=k<=12, -12<=l<=13	
Reflections collected	5822	
Independent reflections	4006 [R(int) = 0.0382]	
Completeness to theta = 25.015 °	98.6 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.9724 and 0.9689	

Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	4006 / 0 / 278
Goodness-of-fit on F^2	1.056
Final R indices [I>2sigma(I)]	R1 = 0.0579, wR2 = 0.1433
R indices (all data)	R1 = 0.0867, wR2 = 0.1576
Extinction coefficient	0.046(5)
Largest diff. peak and hole	0.248 and -0.239 e.Å^{-3}

B) X-Ray Structure of intermediate 2a (CCDC 2085323)

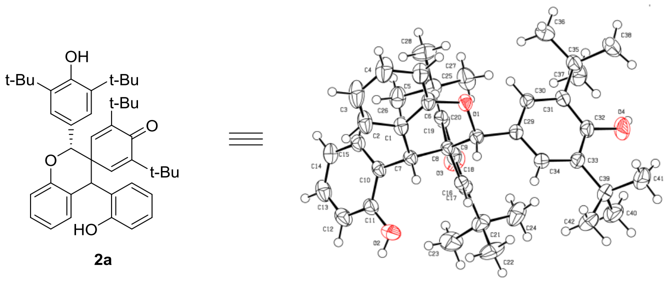


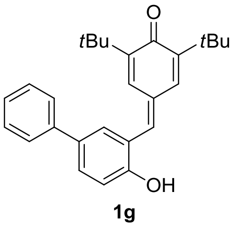
Figure S3 X-Ray Structure of **2a**

Table S2 Crystal data and structure refinement for **2a**

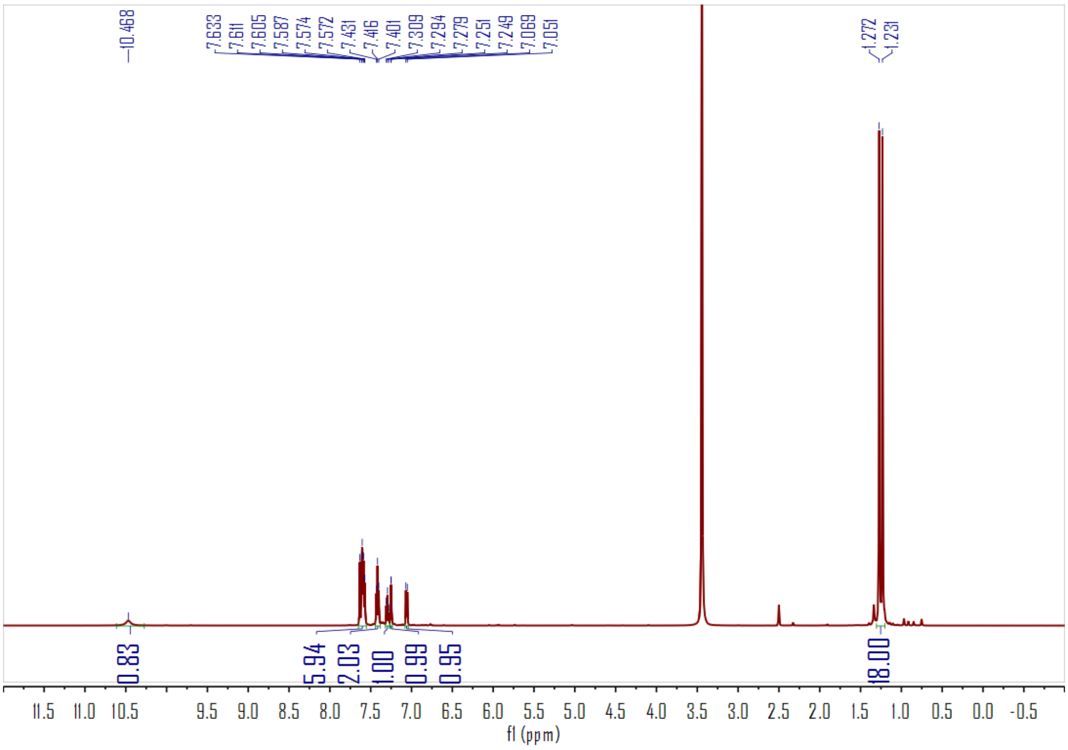
Empirical formula	$C_{42}H_{52}O_4$
Formula weight	620.83
Temperature/K	170.00(10)
Crystal system	monoclinic
Space group	$P2_1/n$
a/Å	12.5033(6)
b/Å	31.9324(10)
c/Å	12.5127(5)
α/°	90
β/°	108.215(4)
γ/°	90
Volume/Å^3	4745.5(3)
Z	4
ρ_{calc}g/cm^3	0.869
μ/mm^{-1}	0.054
F(000)	1344.0
Crystal size/mm^3	0.28 × 0.23 × 0.17
Radiation	Mo Kα (λ = 0.71073)
2Θ range for data collection/°	3.656 to 62.162
Index ranges	$-16 \leq h \leq 17$, $-45 \leq k \leq 45$, $-13 \leq l \leq 17$

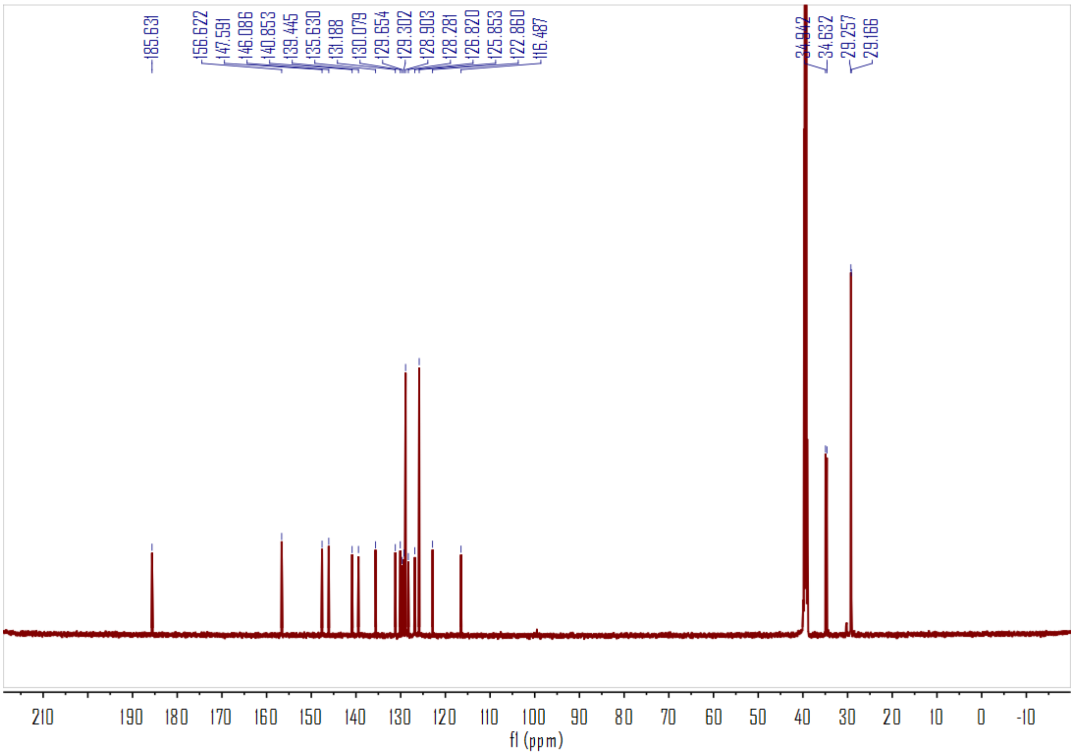
Reflections collected	43438
Independent reflections	12726 [R_{int} = 0.0311, R_{sigma} = 0.0414]
Data/restraints/parameters	12726/1/427
Goodness-of-fit on F^2	1.091
Final R indexes [I>=2σ (I)]	R_1 = 0.0473, wR_2 = 0.1247
Final R indexes [all data]	R_1 = 0.0733, wR_2 = 0.1334
Largest diff. peak/hole / e $Å^{-3}$	0.21/-0.29

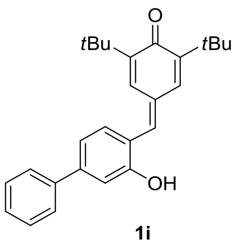
5. NMR Spectrum



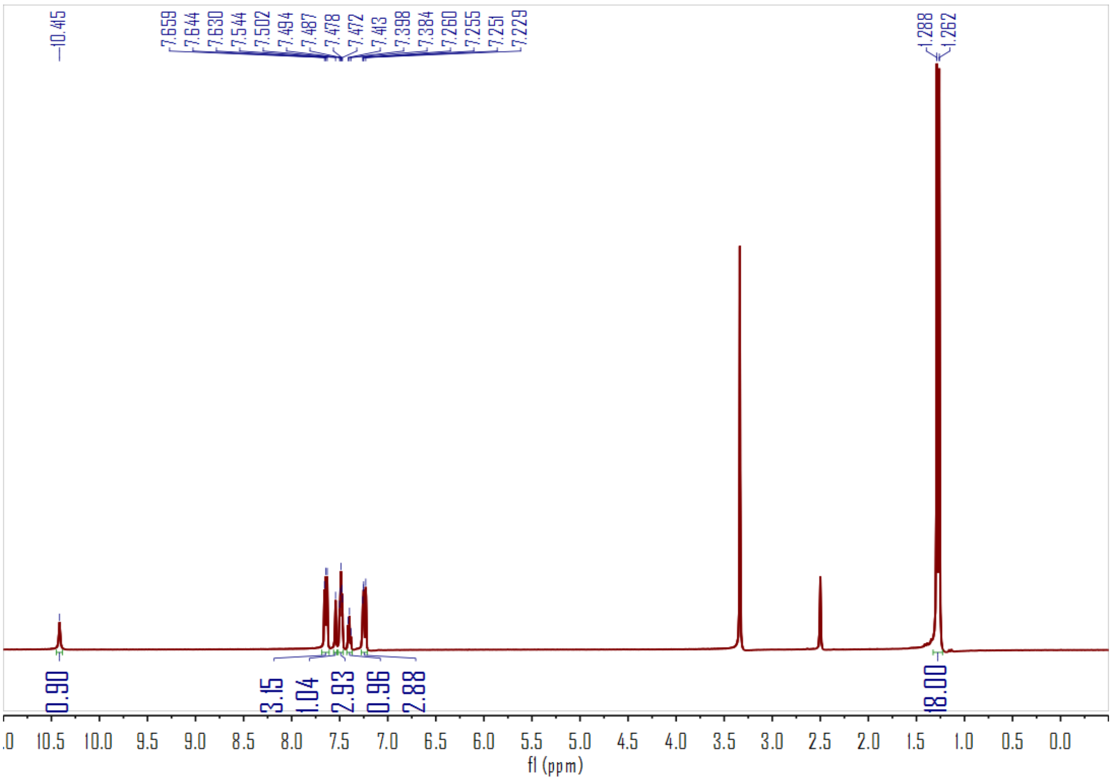
1g






O
tBu
tBu
OH

1i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7.502
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7.487
7.478
7.472
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7.398
7.384
7.260
7.255
7.251
7.229
1.288
1.262
0.90
3.15
1.04
2.93
0.96
2.88
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
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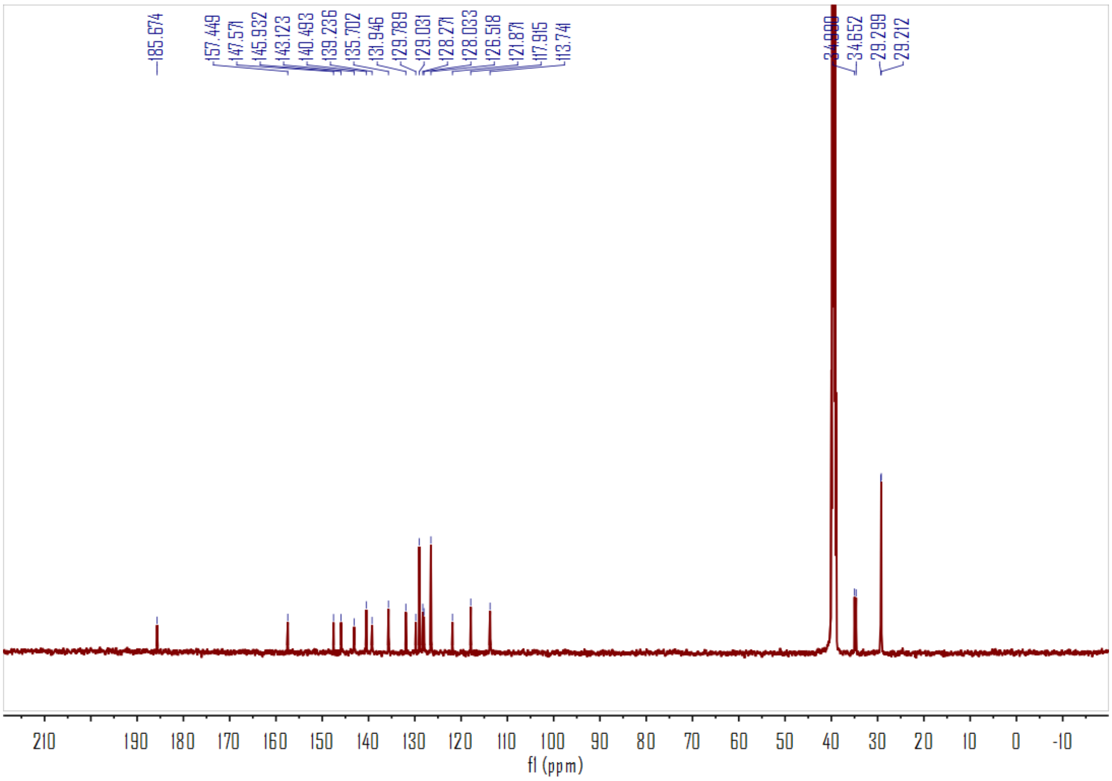
f1 (ppm)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126.518
121.871
117.915
113.741
34.990
34.652
29.299
29.212
210
190
180
170
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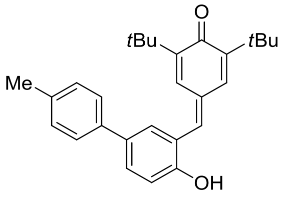
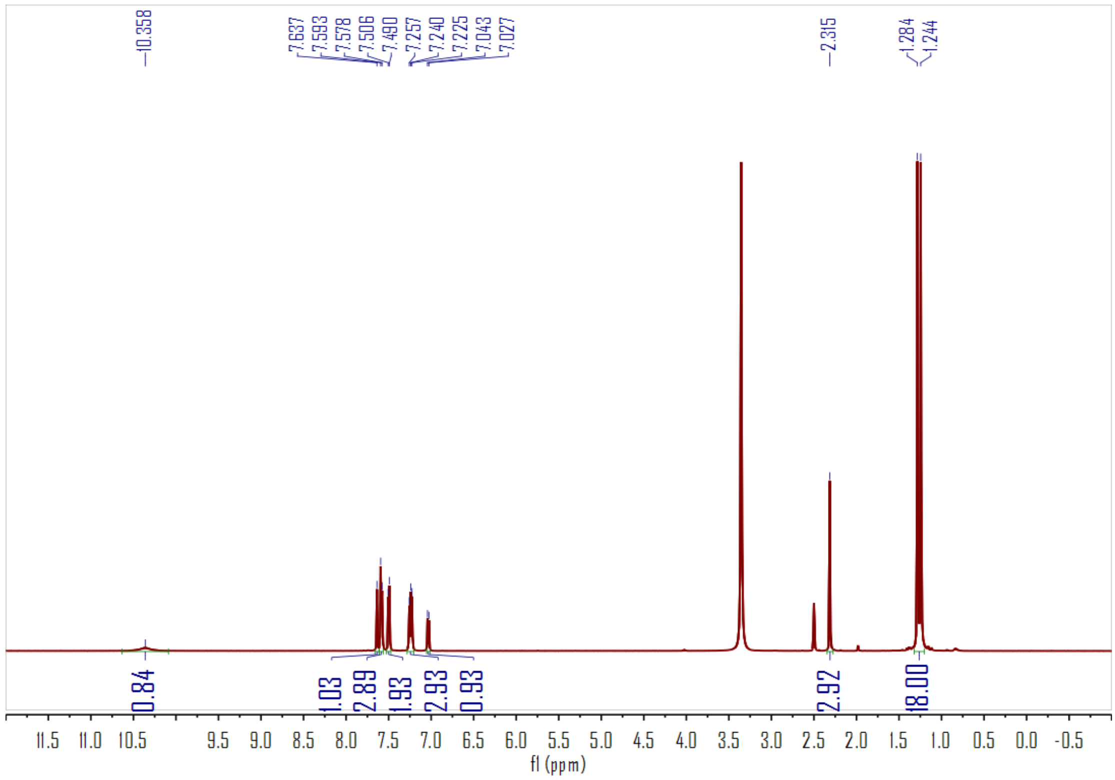
f1 (ppm)


O
tBu
tBu
Me
OH

1k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7.240
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7.043
7.027
2.315
1.284
1.244
0.84
1.03
2.89
1.93
2.93
0.93
2.92
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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2.5
2.0
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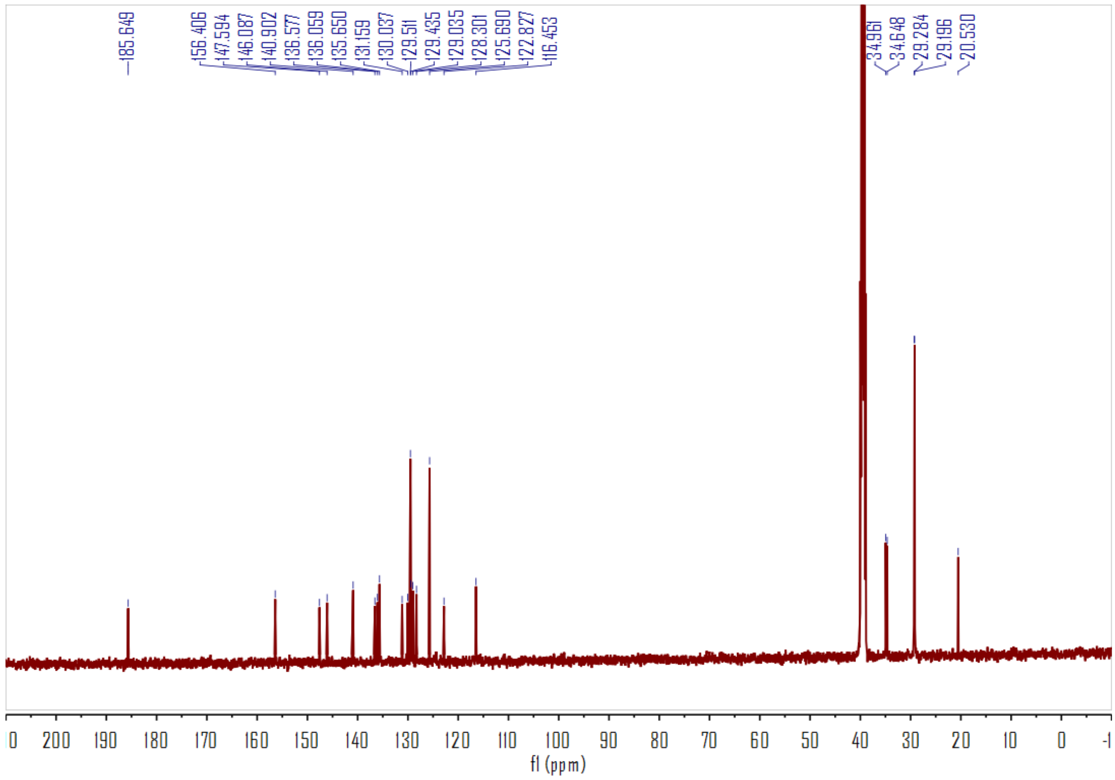
f1 (ppm)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130.037
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129.435
129.035
128.301
125.690
122.827
116.453
34.961
34.648
29.284
29.196
20.530
200
190
180
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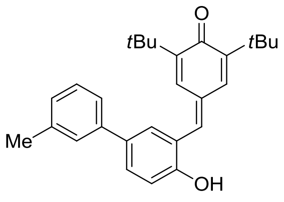
f1 (ppm)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tBu
tBu
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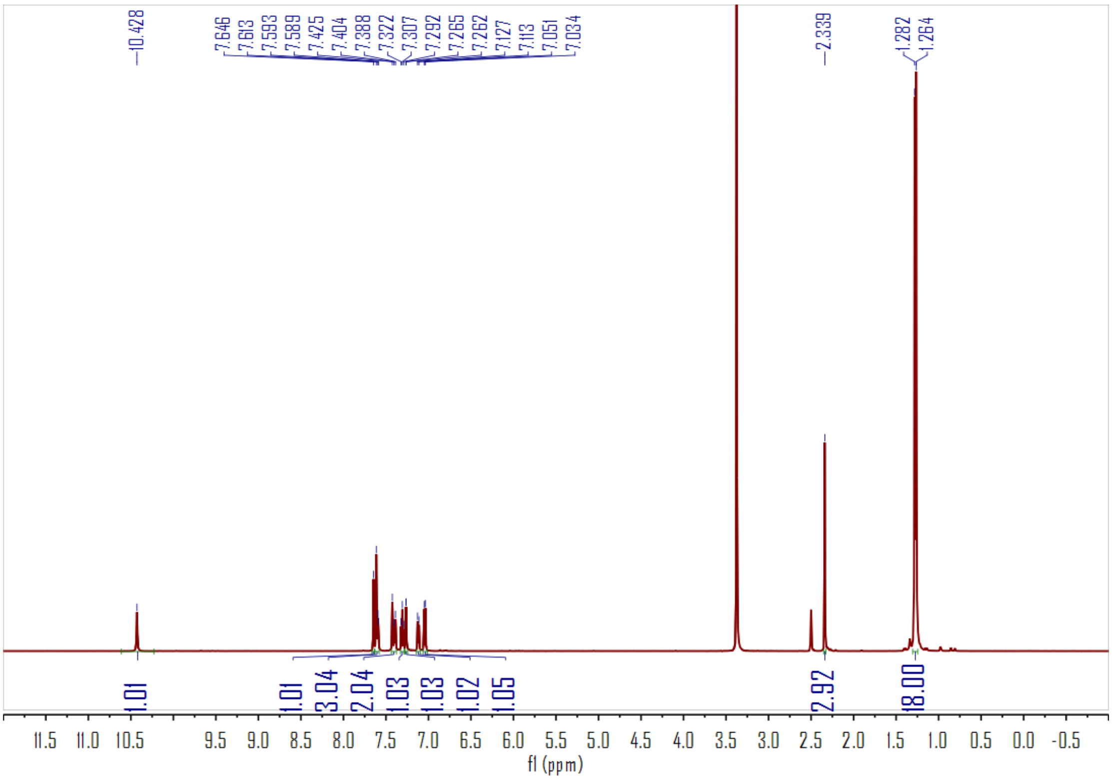
OH

1l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7.307
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7.265
7.262
7.127
7.113
7.051
7.034
2.339
1.282
1.264
1.01
1.01
3.04
2.04
1.03
1.03
1.02
1.05
2.92
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
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3.0
2.5
2.0
1.5
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0.5
0.0
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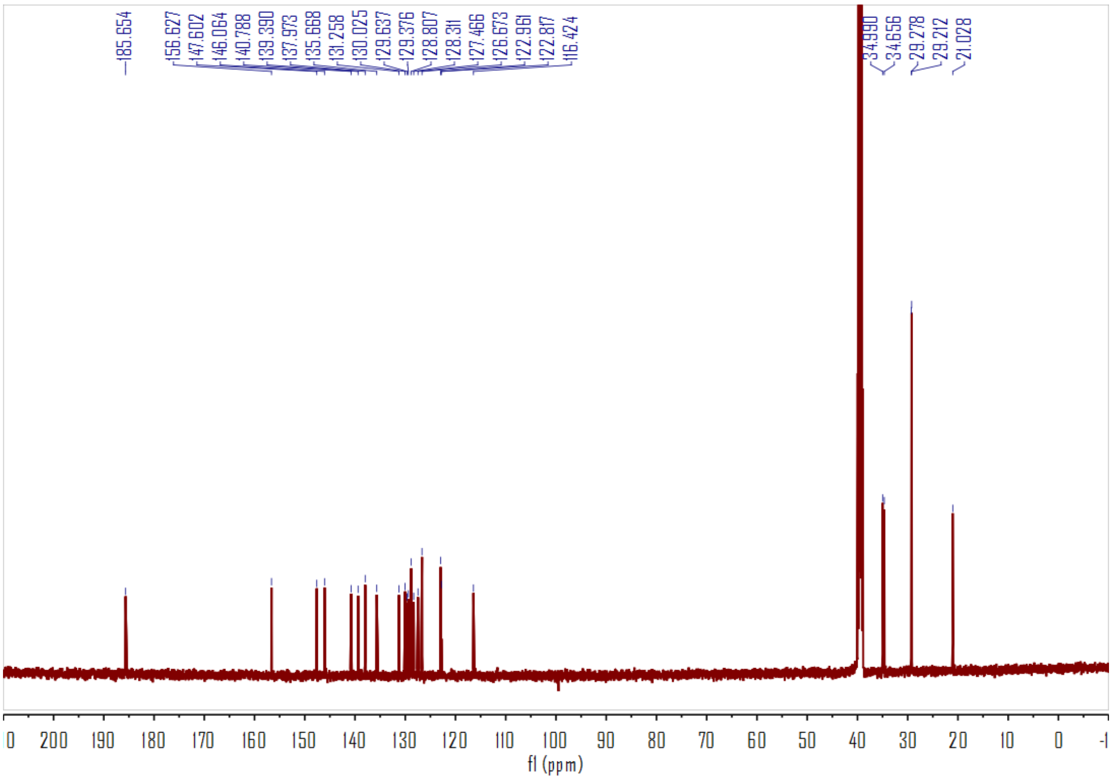
f1 (ppm)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128.807
128.311
127.466
126.673
122.961
122.817
116.424
34.990
34.656
29.278
29.212
21.028
200
190
180
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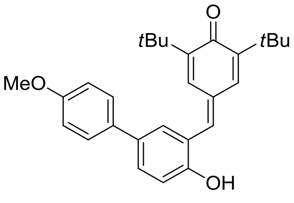
10
0
f1 (ppm)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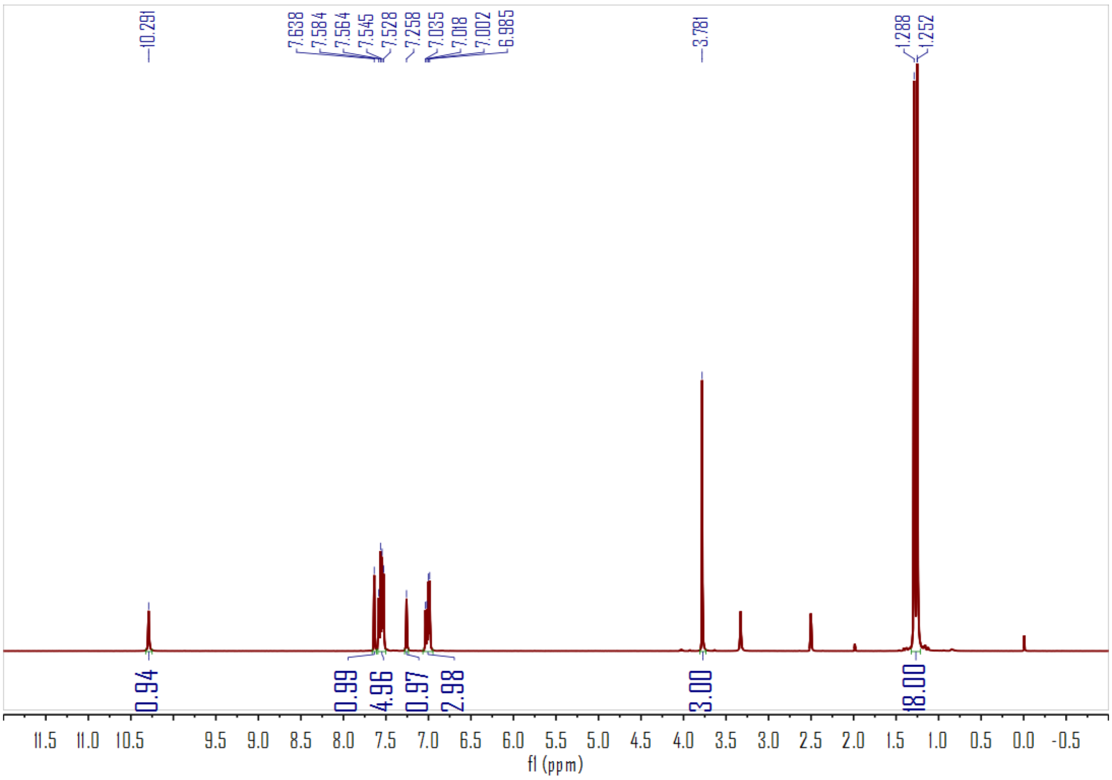
tBu
tBu
MeO
OH

1m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7.528
7.258
7.035
7.018
7.002
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1.288
1.252
0.94
0.99
4.96
0.97
2.98
3.00
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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3.0
2.5
2.0
1.5
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0.5
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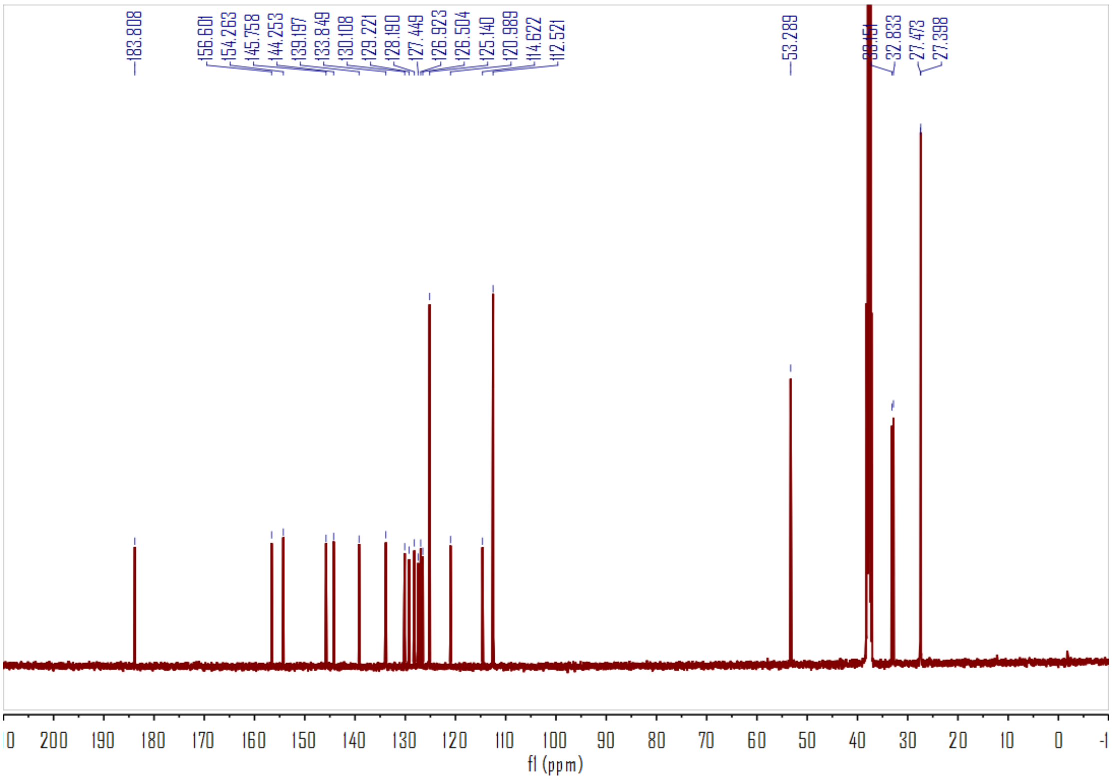
f1 (ppm)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139.197
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130.108
129.221
128.190
127.449
126.923
126.504
125.140
120.989
114.622
112.521
53.289
33.151
32.833
27.473
27.398
0
200
190
180
170
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150
140
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120
110
100
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80
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60
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30
20
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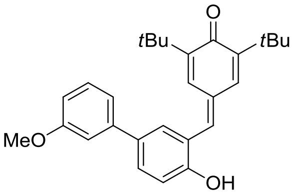
-1
f1 (ppm)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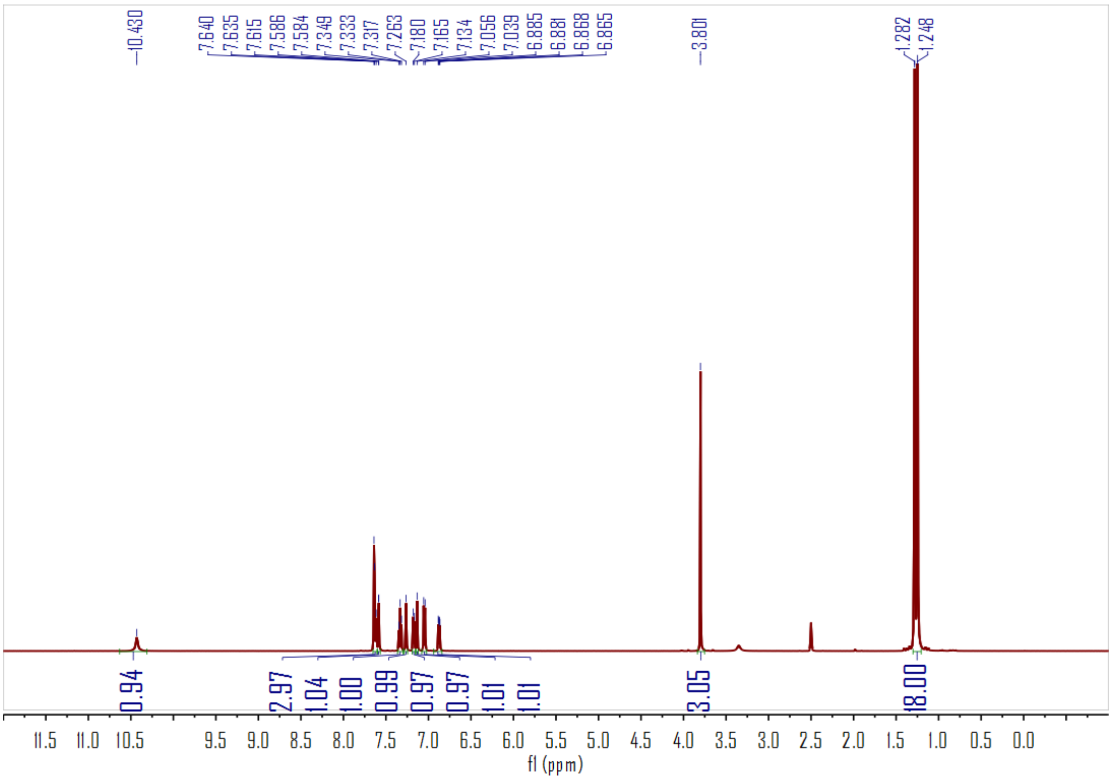
tBu
tBu
MeO
OH

1n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7.333
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7.263
7.180
7.165
7.134
7.056
7.039
6.885
6.881
6.868
6.865
3.801
1.282
1.248
0.94
2.97
1.04
1.00
0.99
0.97
0.97
1.01
1.01
3.05
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
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6.5
6.0
5.5
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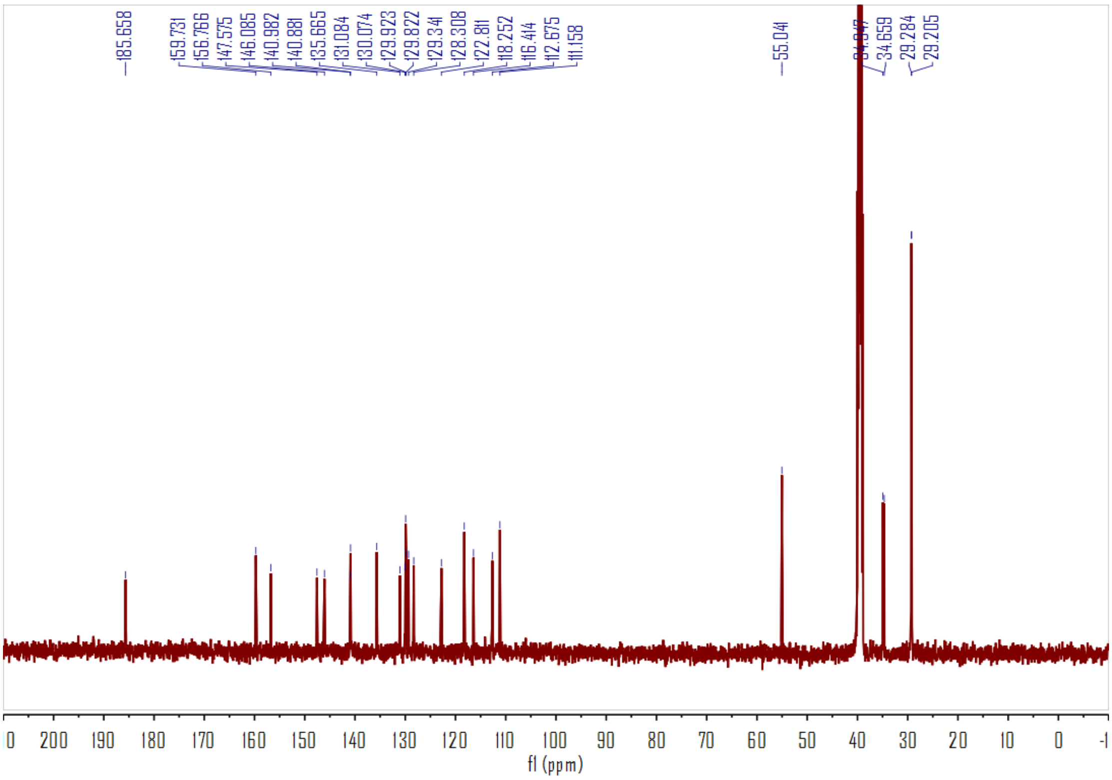
0.0
f1 (ppm)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140.881
135.665
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130.074
129.923
129.822
129.341
128.308
122.811
118.252
116.414
112.675
111.158
55.041
34.947
34.659
29.284
29.205
200
190
180
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30
20
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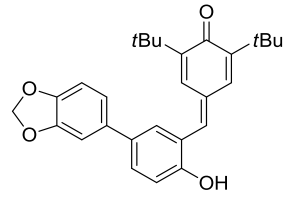
f1 (ppm)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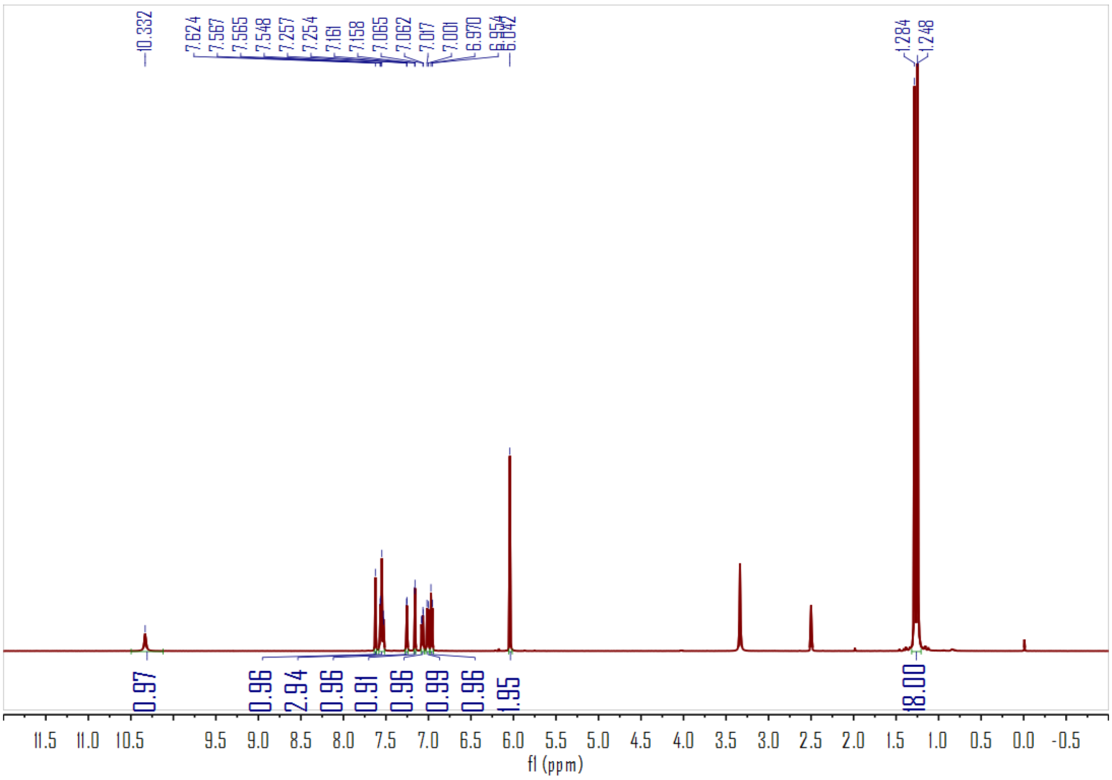
tBu
O
O
OH

1o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7.062
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7.001
6.970
6.954
6.042
1.284
1.248
0.97
0.96
2.94
0.96
0.91
0.96
0.99
0.96
1.95
18.00
11.5
11.0
10.5
9.5
9.0
8.5
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7.0
6.5
6.0
5.5
5.0
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1.5
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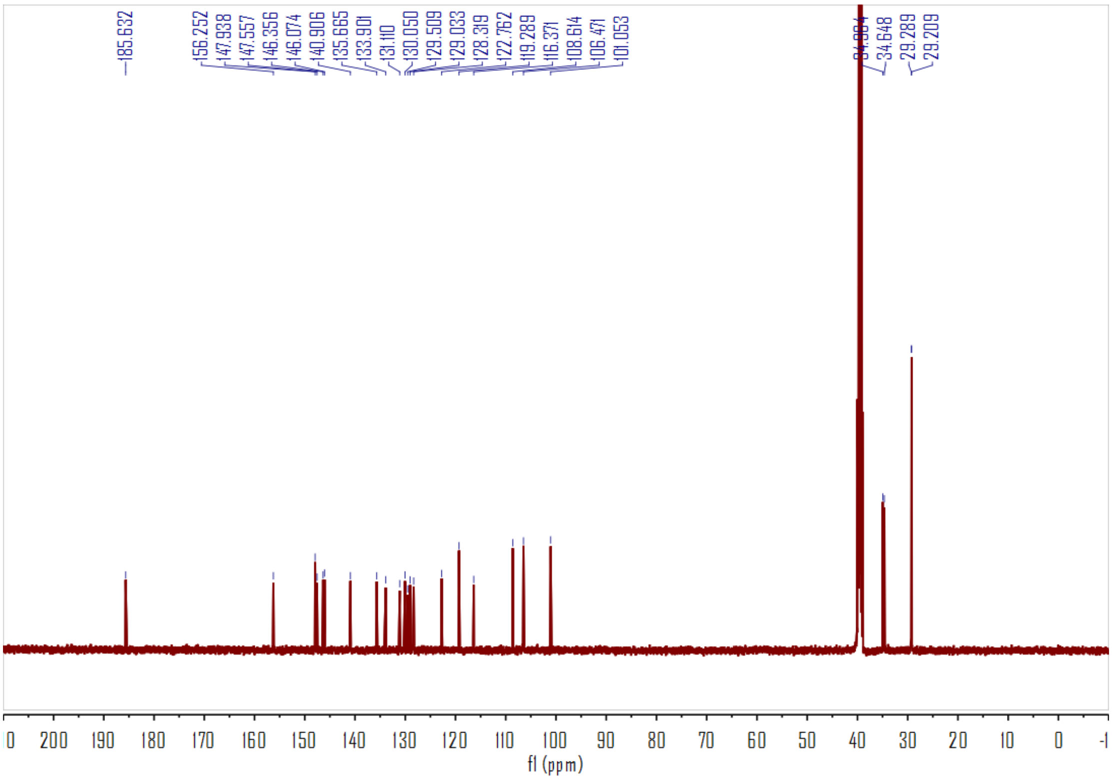
fl (ppm)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129.033
128.319
122.762
119.289
116.371
108.614
106.471
101.053
34.964
34.648
29.289
29.209
200
190
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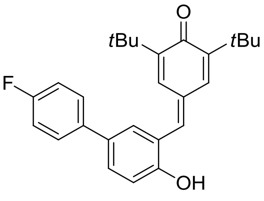
fl (ppm)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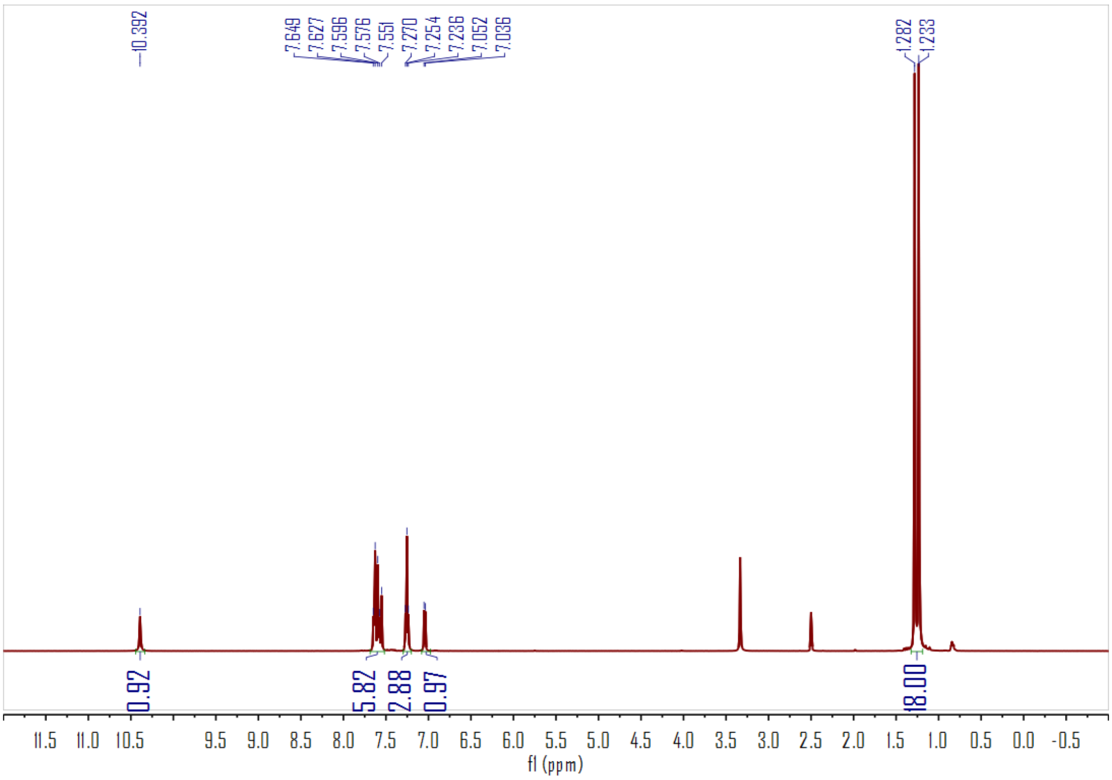
tBu
tBu
F
OH

1p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1.233
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5.82
2.88
0.97
18.00
11.5
11.0
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8.5
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7.0
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6.0
5.5
5.0
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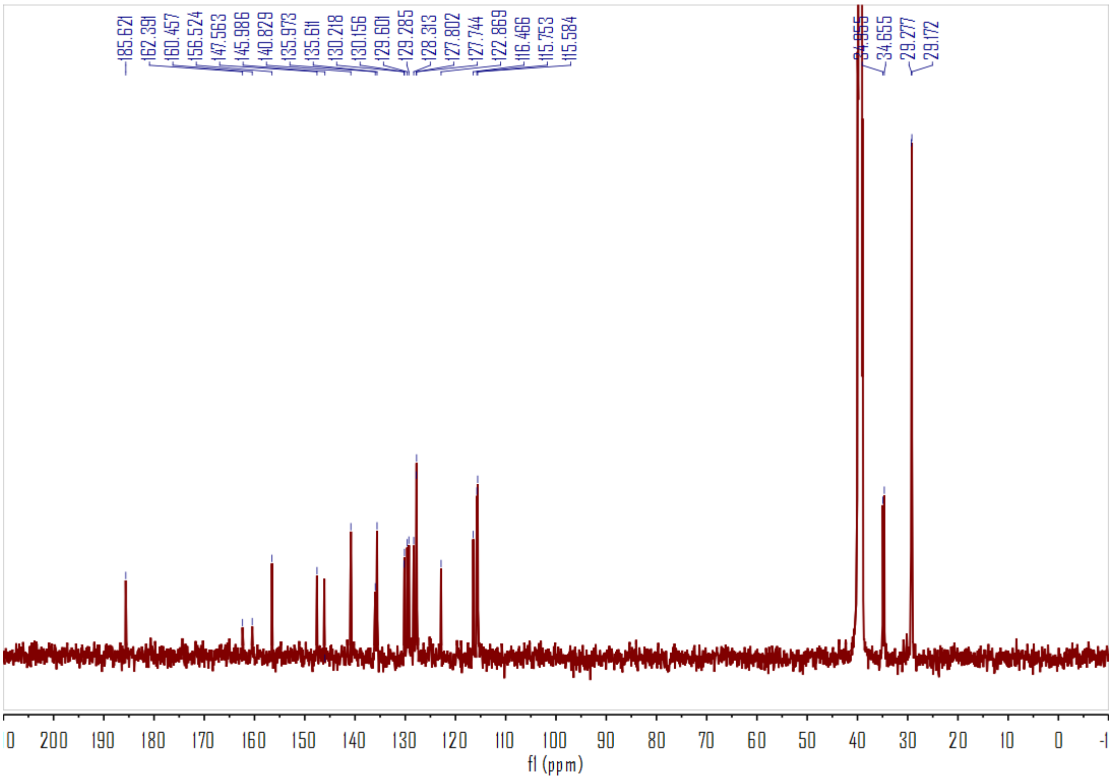
f1 (ppm)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127.802
127.744
122.869
116.466
115.753
115.584
34.955
34.655
29.277
29.172
200
190
180
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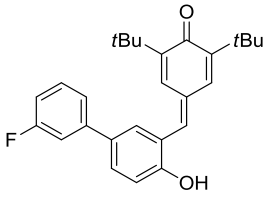
f1 (ppm)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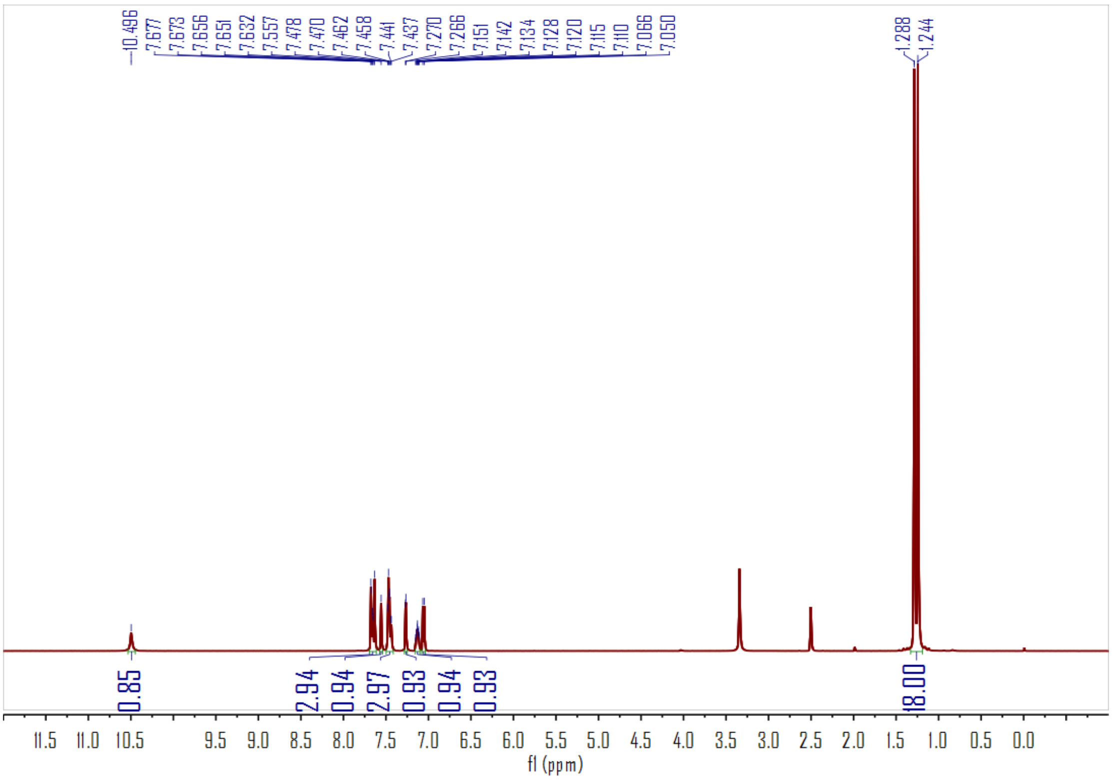
tBu
F
OH

1q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7.270
7.266
7.151
7.142
7.134
7.128
7.120
7.115
7.110
7.066
7.050
1.288
1.244
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0.94
2.97
0.93
0.94
0.93
18.00
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2.5
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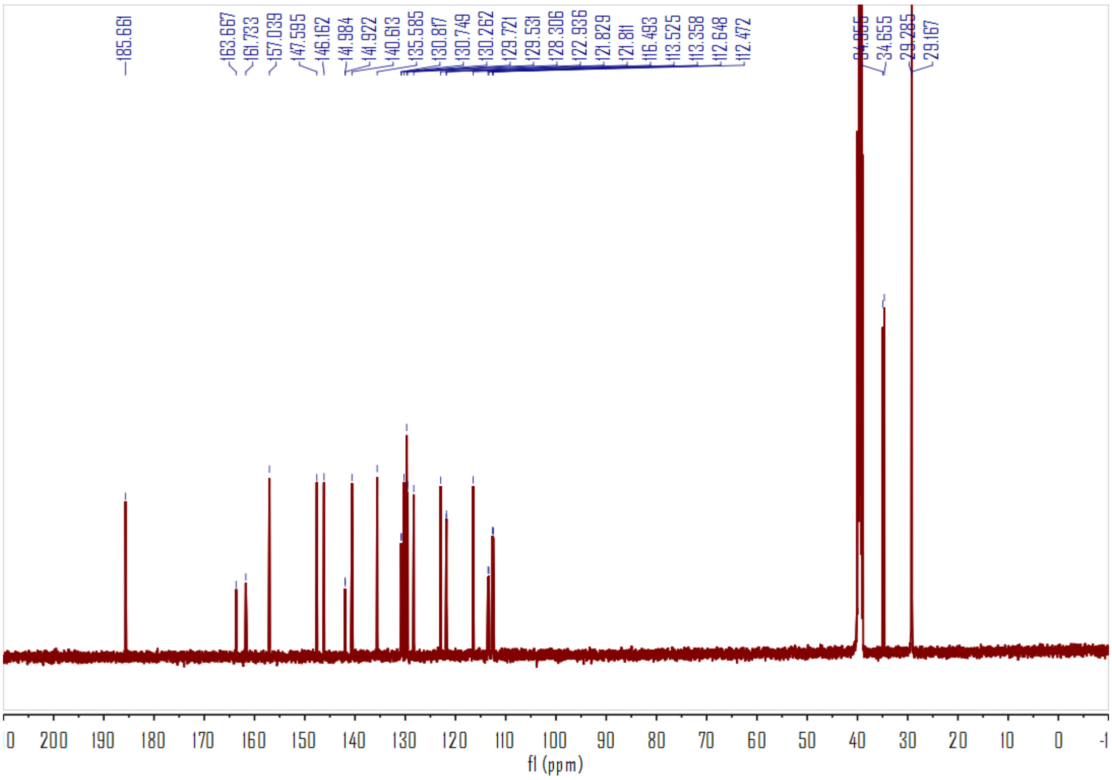
f1 (ppm)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130.262
129.721
129.531
128.306
122.936
121.829
121.811
116.493
113.525
113.358
112.648
112.472
34.955
34.655
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29.167
200
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180
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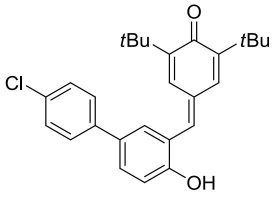
f1 (ppm)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tBu
Cl
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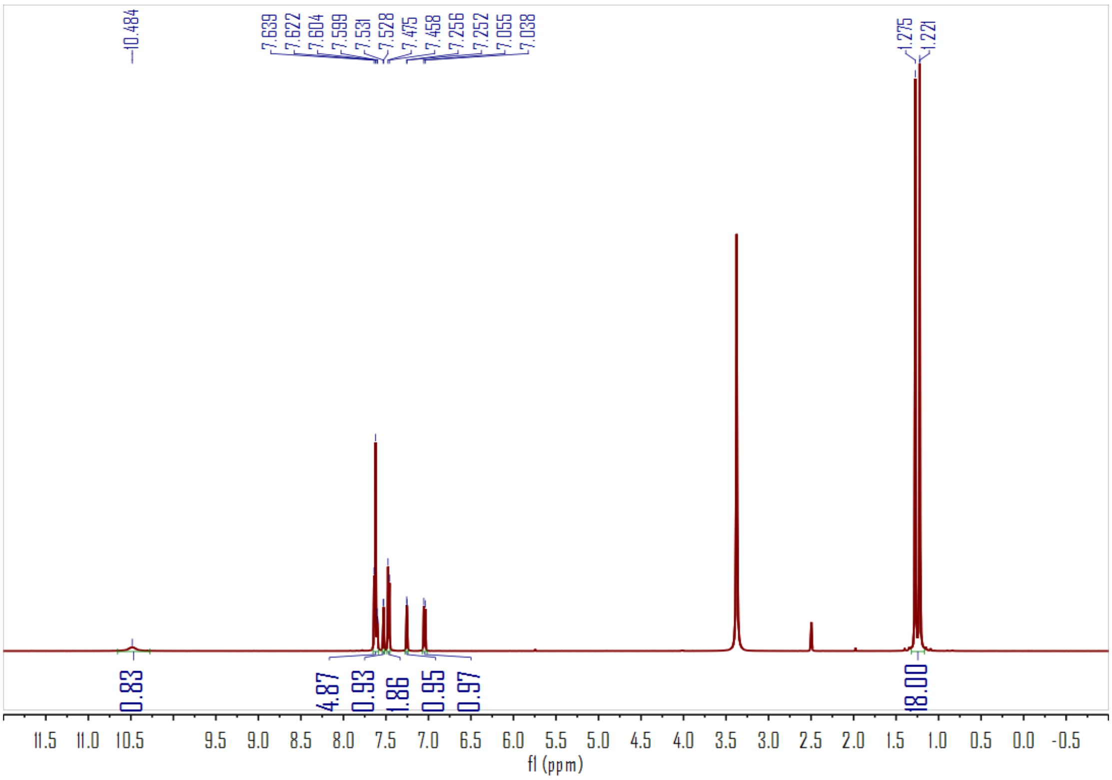
1r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7.038
1.275
1.221
0.83
4.87
0.93
1.86
0.95
0.97
18.00
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11.0
10.5
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7.0
6.5
6.0
5.5
5.0
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3.0
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2.0
1.5
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0.5
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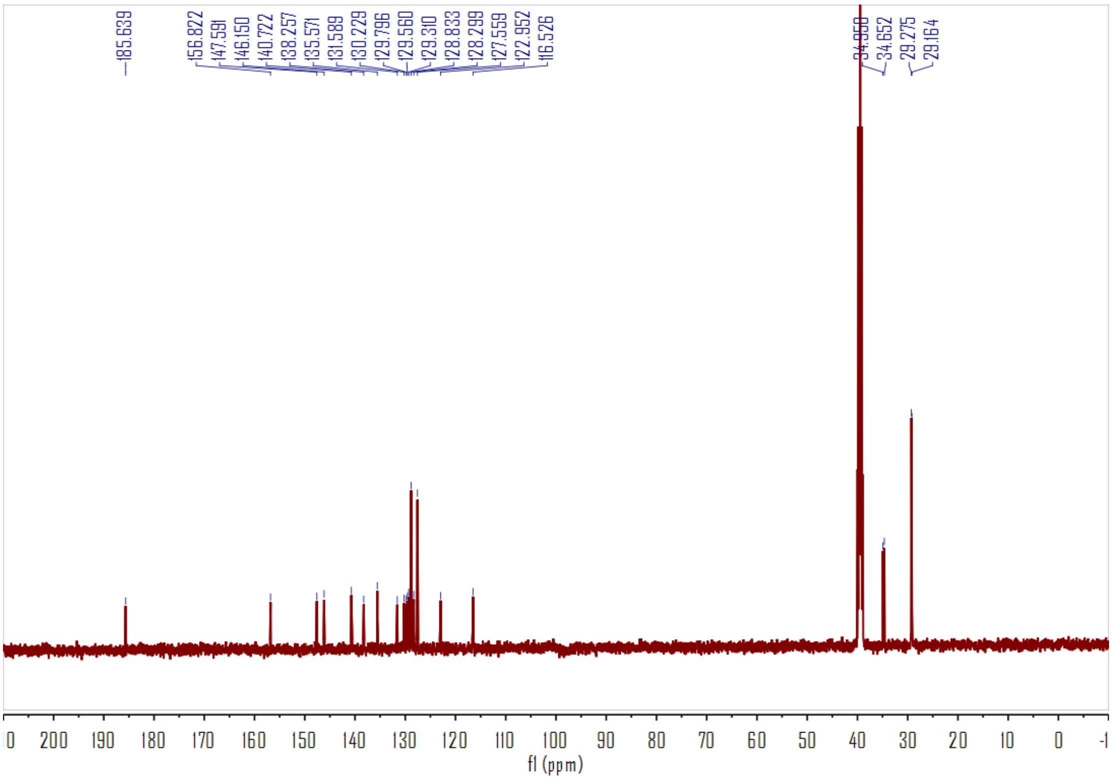
-0.5
f1 (ppm)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131.589
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128.833
128.299
127.559
122.952
116.526
34.950
34.652
29.275
29.164
200
190
180
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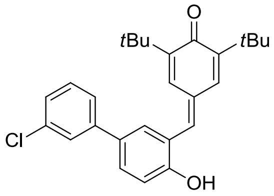
20
10
0
f1 (ppm)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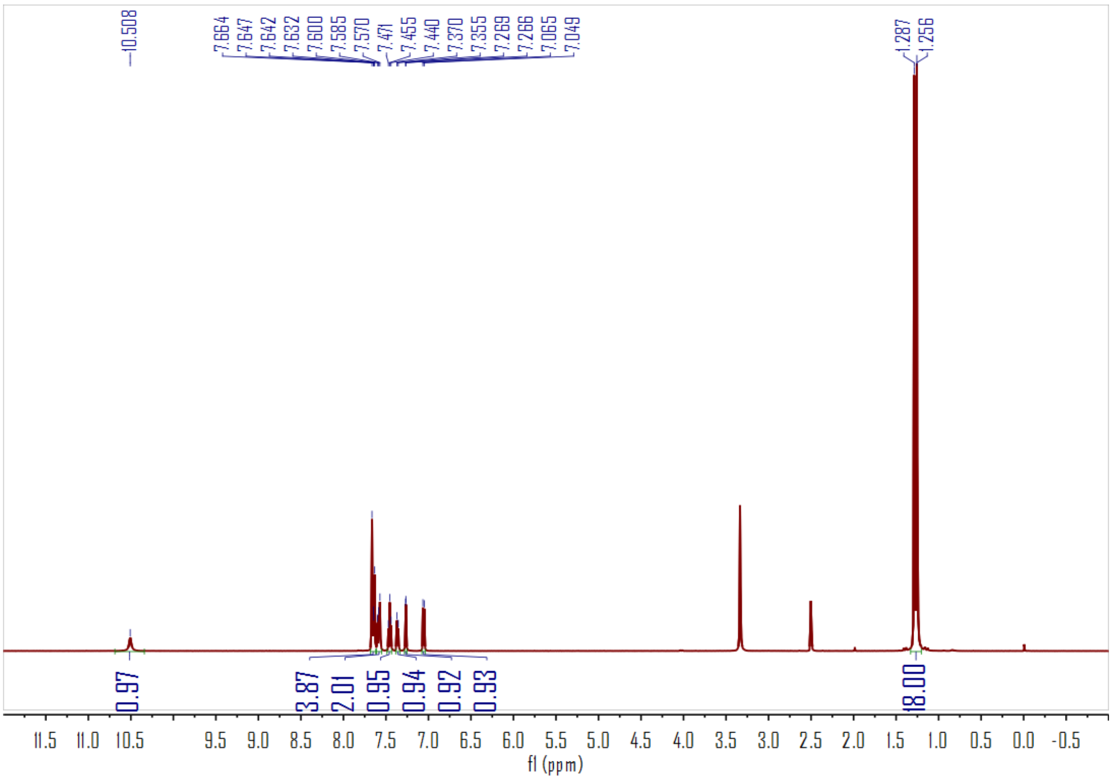
tBu
tBu
Cl
OH

1s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7.355
7.269
7.266
7.065
7.049
1.287
1.256
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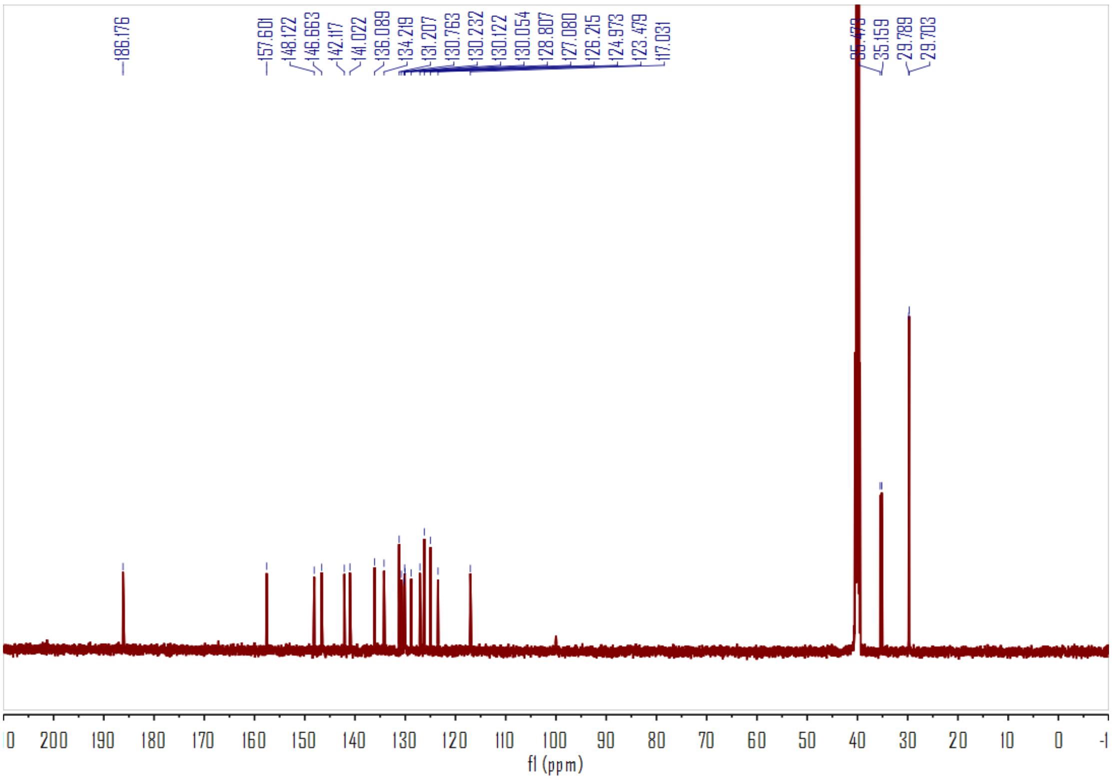
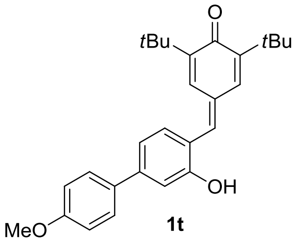
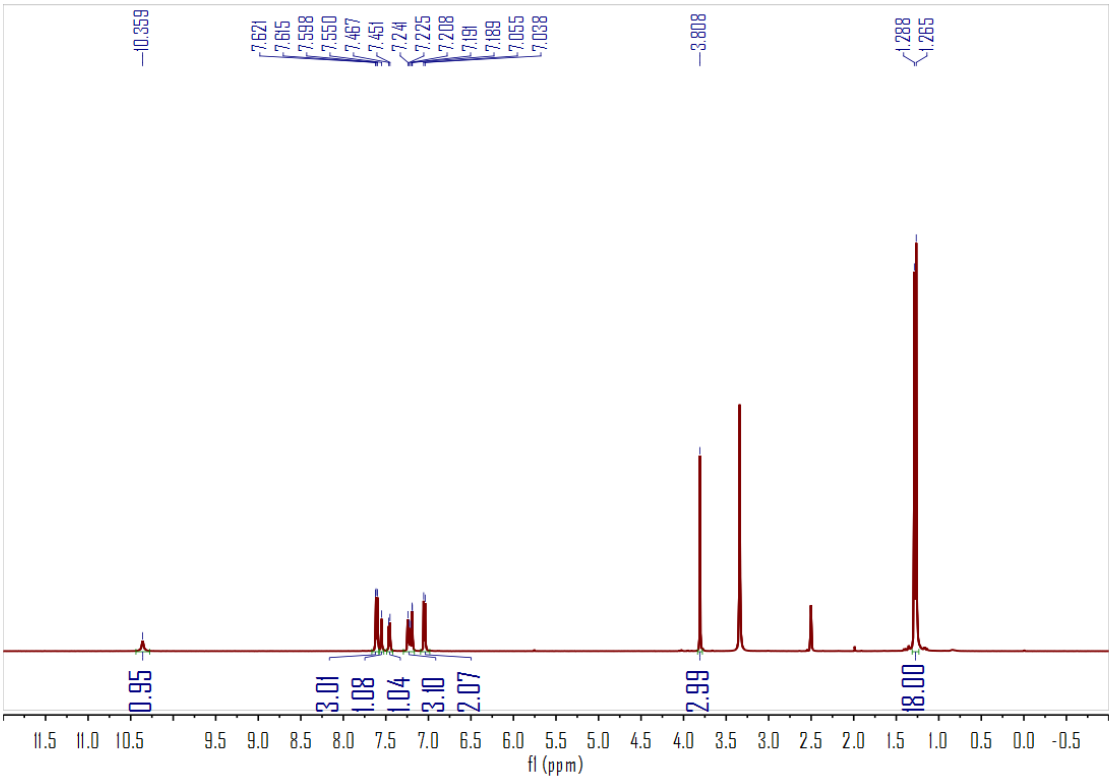
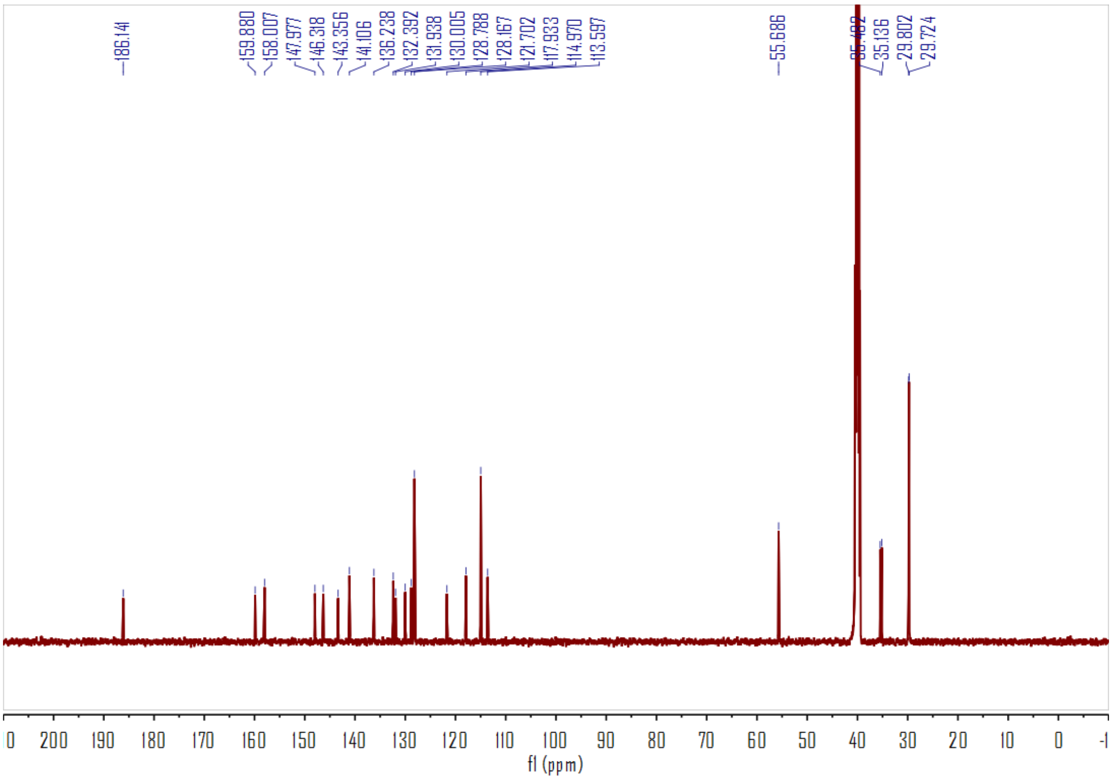
3.87
2.01
0.95
0.94
0.92
0.93
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
fl (ppm)

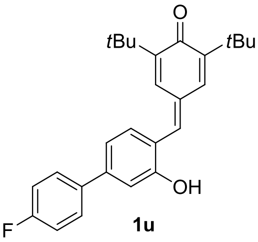

186.176
157.601
148.122
146.663
142.117
141.022
136.089
134.219
131.207
130.763
130.232
130.122
130.054
128.807
127.080
126.215
124.973
123.479
117.031
35.478
35.159
29.789
29.703
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
fl (ppm)


O
tBu
tBu
OH
MeO

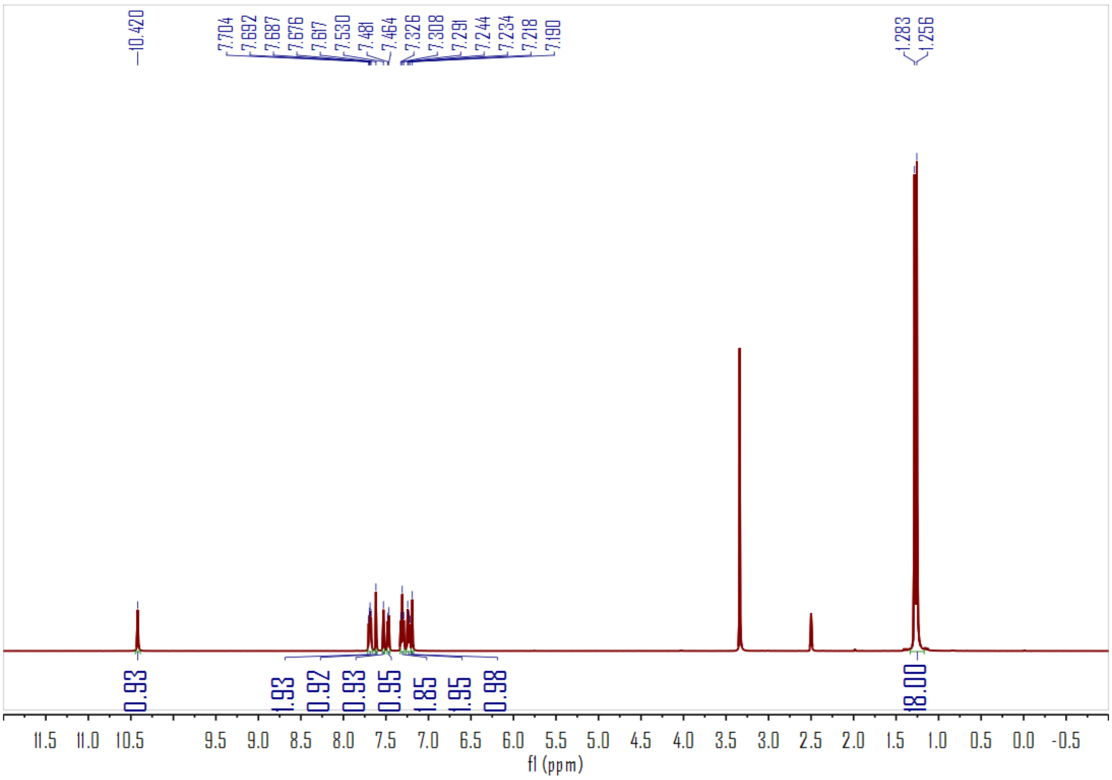
1t

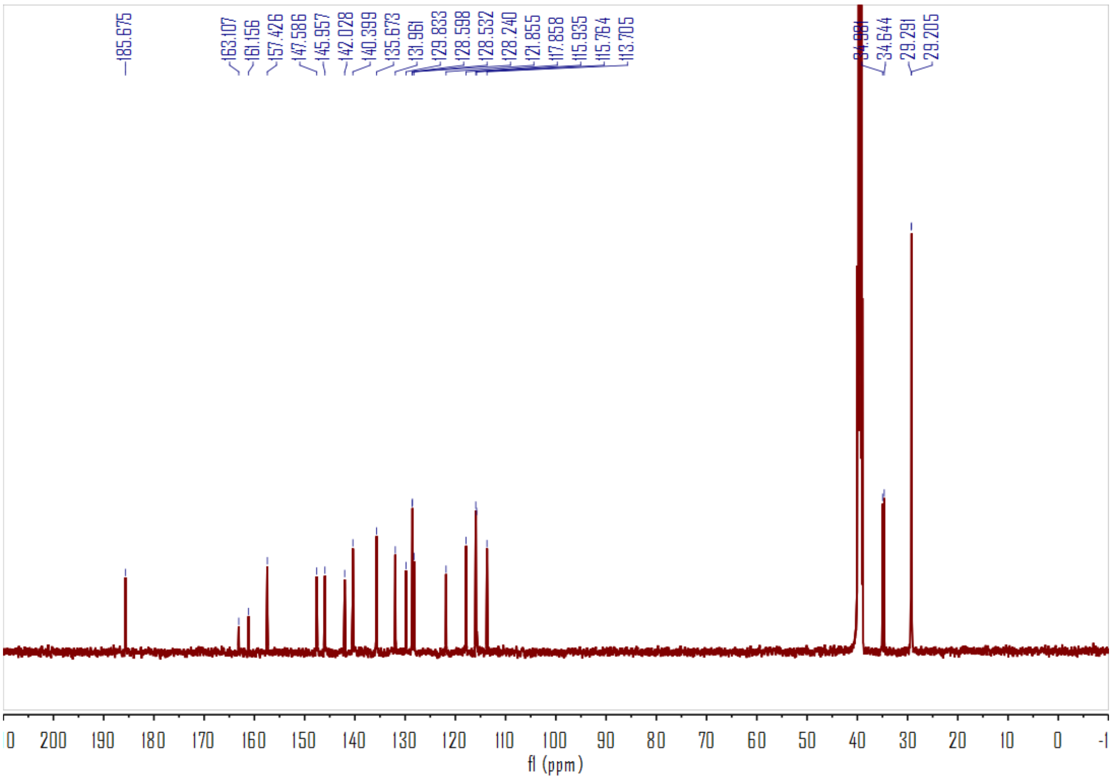

10.359
7.621
7.615
7.598
7.550
7.467
7.451
7.241
7.225
7.208
7.191
7.189
7.055
7.038
3.808
1.288
1.265
0.95
3.01
1.08
1.04
3.10
2.07
2.99
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

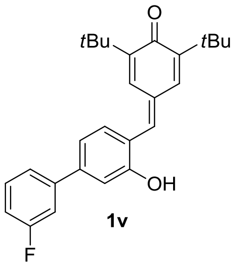

186.141
159.880
158.007
147.977
146.318
143.356
141.106
136.238
132.392
131.938
130.005
128.788
128.167
121.702
117.933
114.970
113.597
55.686
35.482
35.136
29.802
29.724
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


O
tBu
tBu
OH
F

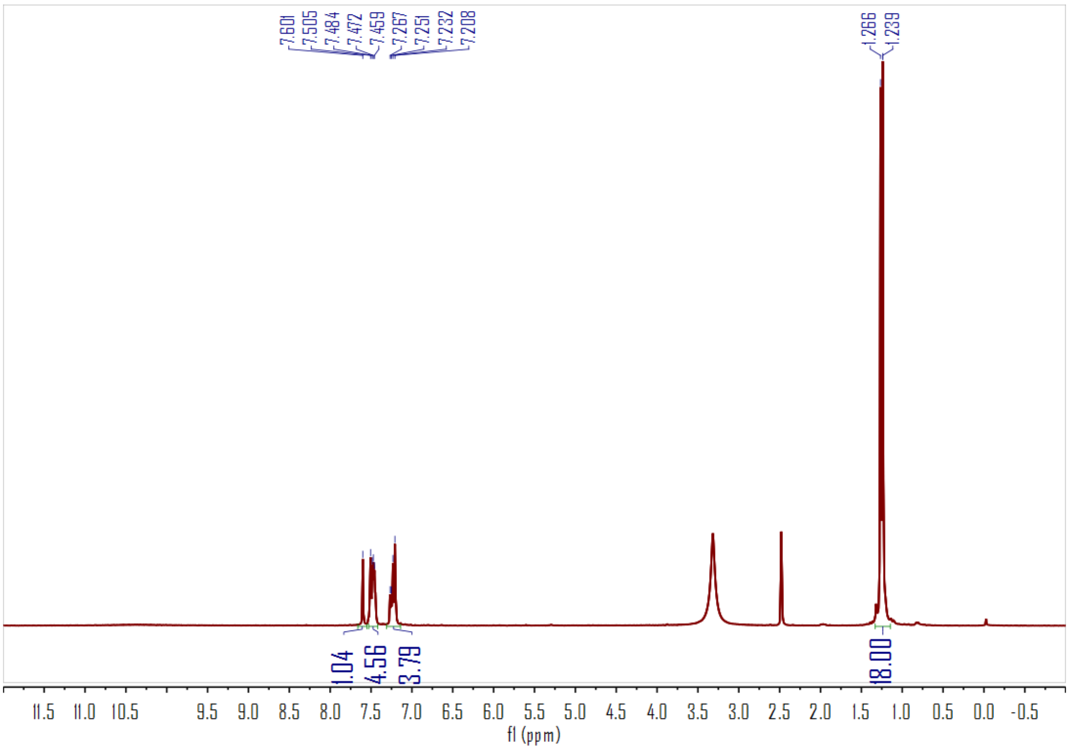
1u

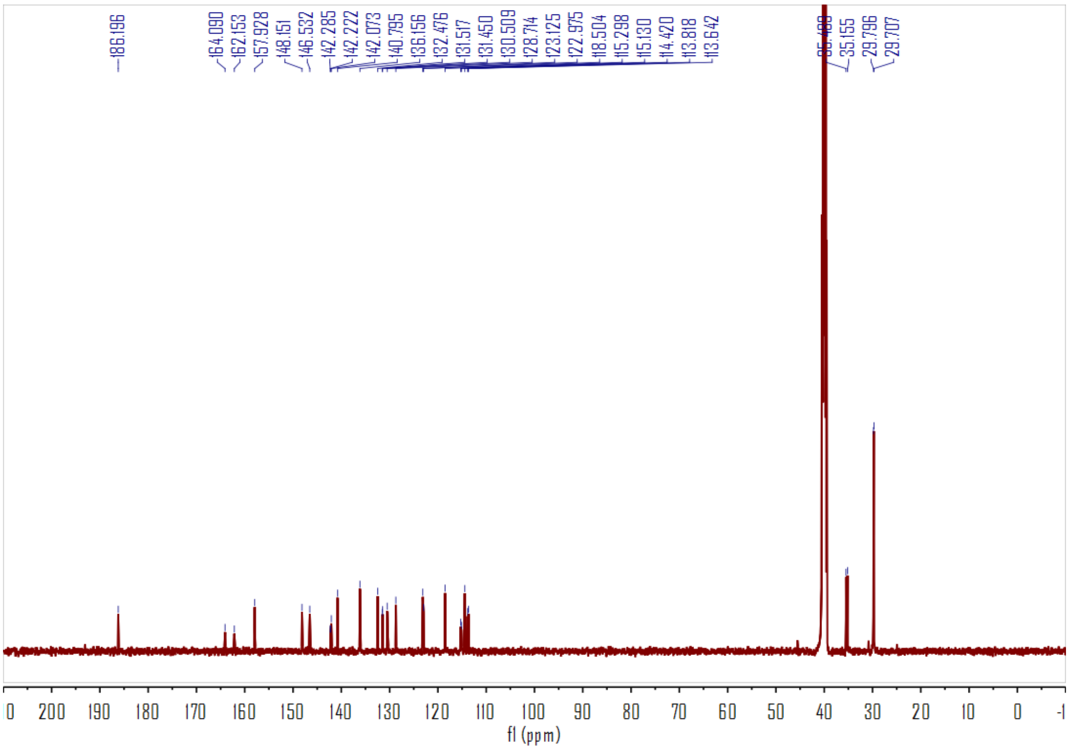

10.420
7.704
7.692
7.687
7.676
7.617
7.530
7.481
7.464
7.326
7.308
7.291
7.244
7.234
7.218
7.190
1.283
1.256
0.93
1.93
0.92
0.93
0.95
1.85
1.95
0.98
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

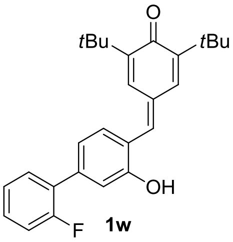

185.675
163.107
161.156
157.426
147.586
145.957
142.028
140.399
135.673
131.961
129.833
128.598
128.532
128.240
121.855
117.858
115.935
115.764
113.705
34.981
34.644
29.291
29.205
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


O
tBu
tBu
OH
F

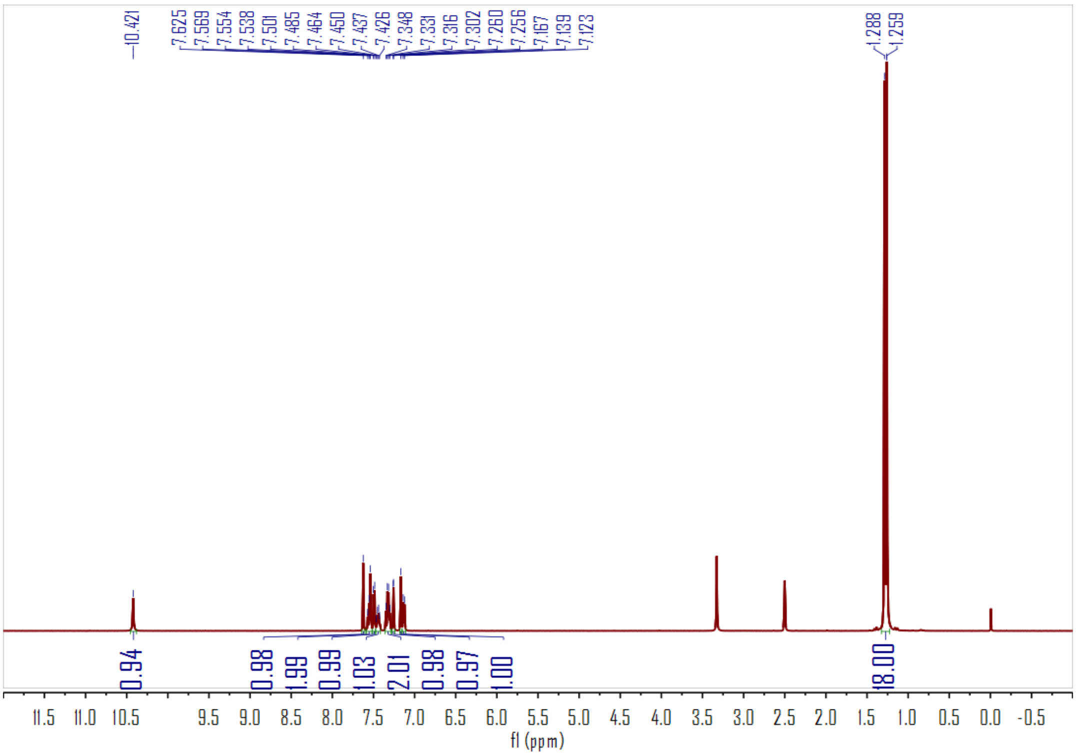
1v

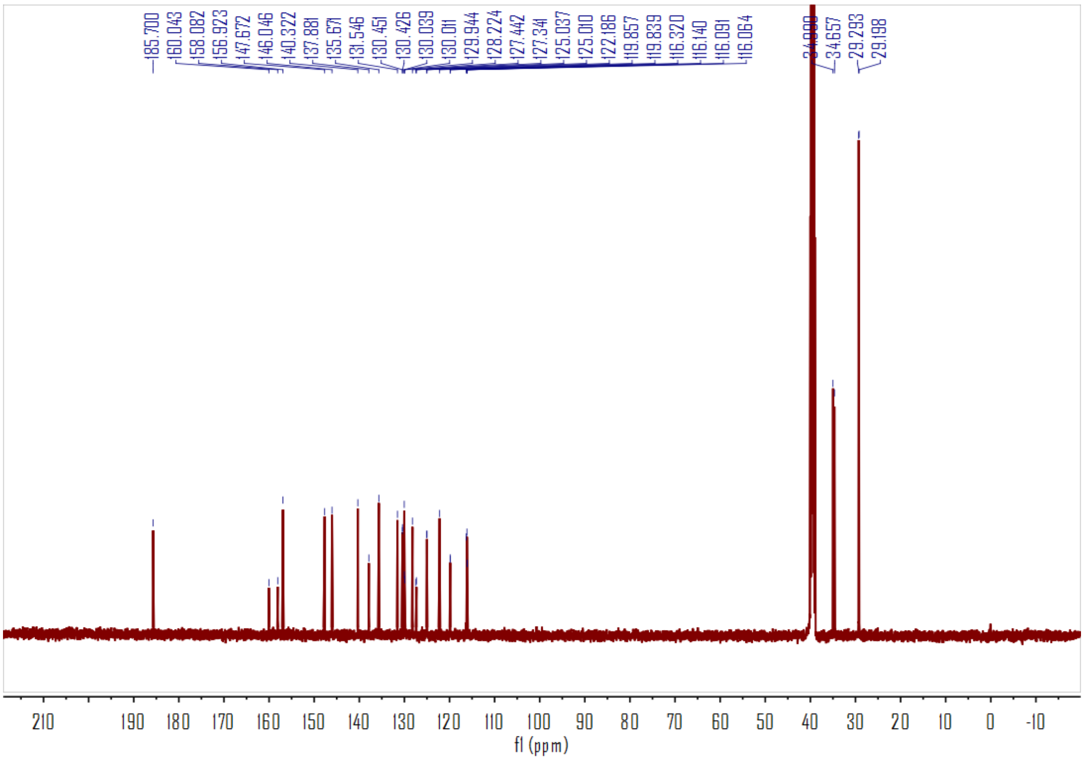

7.601
7.505
7.484
7.472
7.459
7.267
7.251
7.232
7.208
1.266
1.239
1.04
4.56
3.79
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

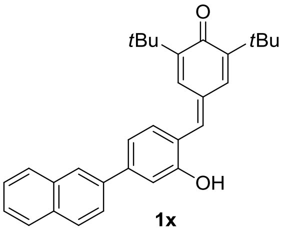

186.196
164.090
162.153
157.928
148.151
146.532
142.285
142.222
142.073
140.795
136.156
132.476
131.517
131.450
130.509
128.714
123.125
122.975
118.504
115.298
115.130
114.420
113.818
113.642
35.489
35.155
29.796
29.707
0
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)


O
tBu
tBu
OH
F

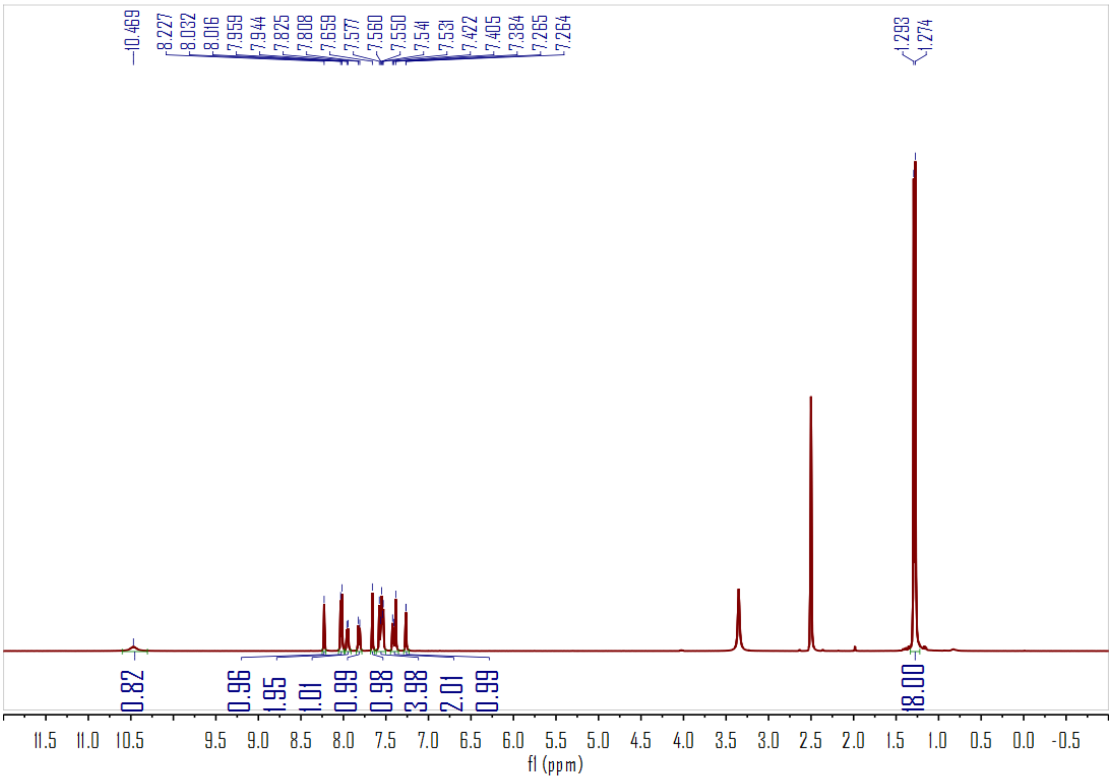
1w

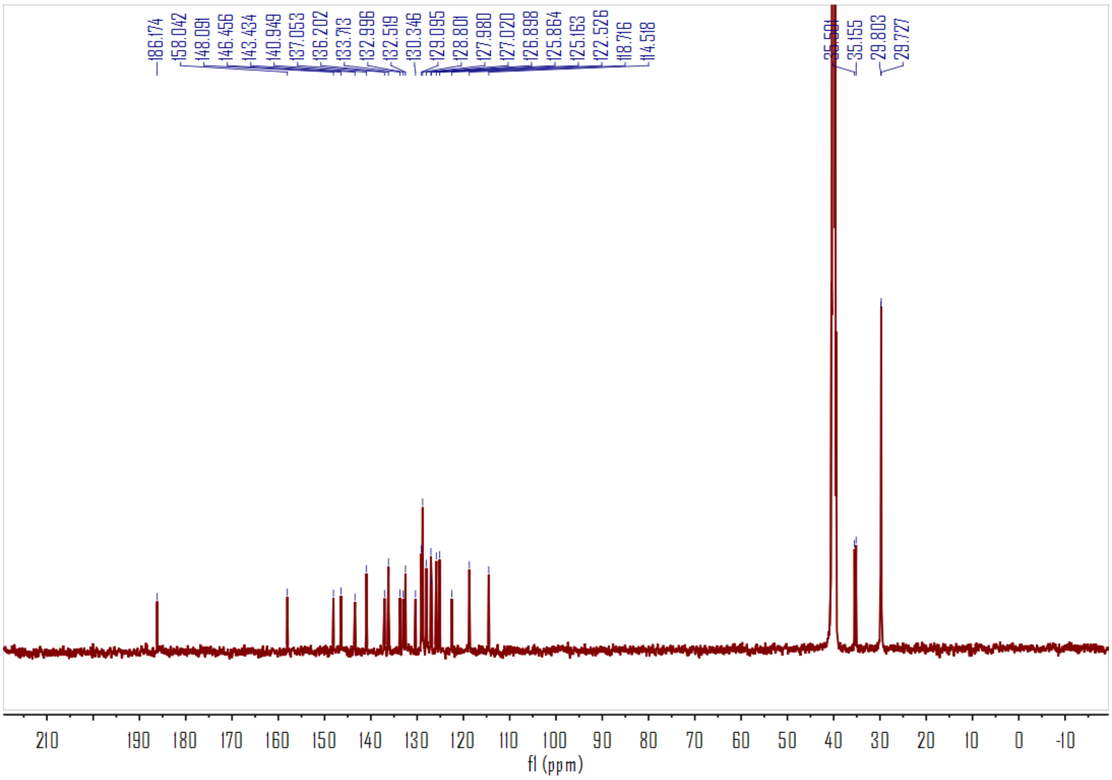

10.421
7.625
7.569
7.554
7.538
7.501
7.485
7.464
7.450
7.437
7.426
7.348
7.331
7.316
7.302
7.260
7.256
7.167
7.139
7.123
1.288
1.259
0.94
0.98
1.99
0.99
1.03
2.01
0.98
0.97
1.00
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

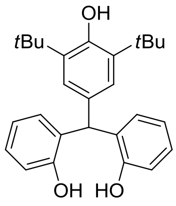

185.700
160.043
158.082
156.923
147.672
146.046
140.322
137.881
135.671
131.546
130.451
130.426
130.039
130.011
129.944
128.224
127.442
127.341
125.037
125.010
122.186
119.857
119.839
116.320
116.140
116.091
116.064
34.990
34.657
29.293
29.198
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


O
*t*Bu
*t*Bu
OH

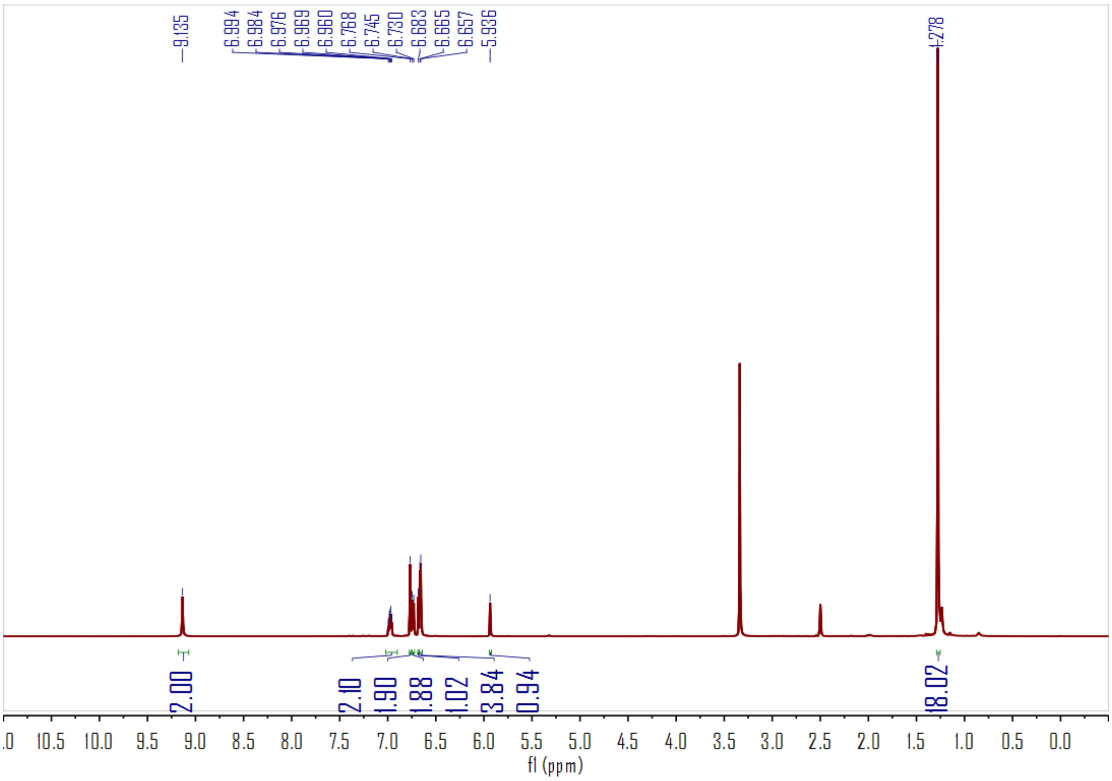
1x

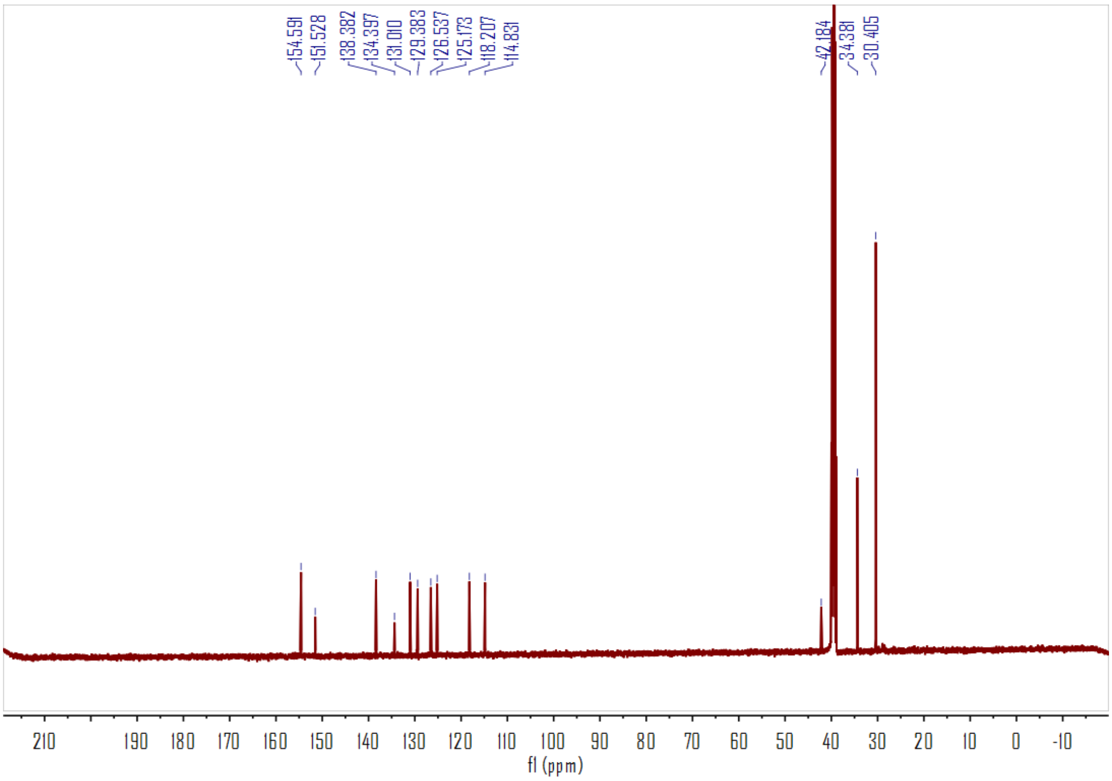

10.469
8.227
8.032
8.016
7.959
7.944
7.825
7.808
7.659
7.577
7.560
7.550
7.54
7.531
7.422
7.405
7.384
7.265
7.264
1.293
1.274
0.82
0.96
1.95
1.01
0.99
0.98
3.98
2.01
0.99
18.00
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

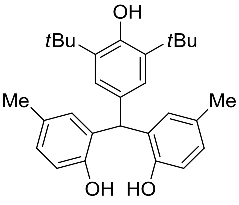

186.174
158.042
148.091
146.456
143.434
140.949
137.053
136.202
133.713
132.996
132.519
130.346
129.095
128.801
127.980
127.020
126.898
125.864
125.163
122.526
118.716
114.518
35.581
35.155
29.803
29.727
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
OH
HO

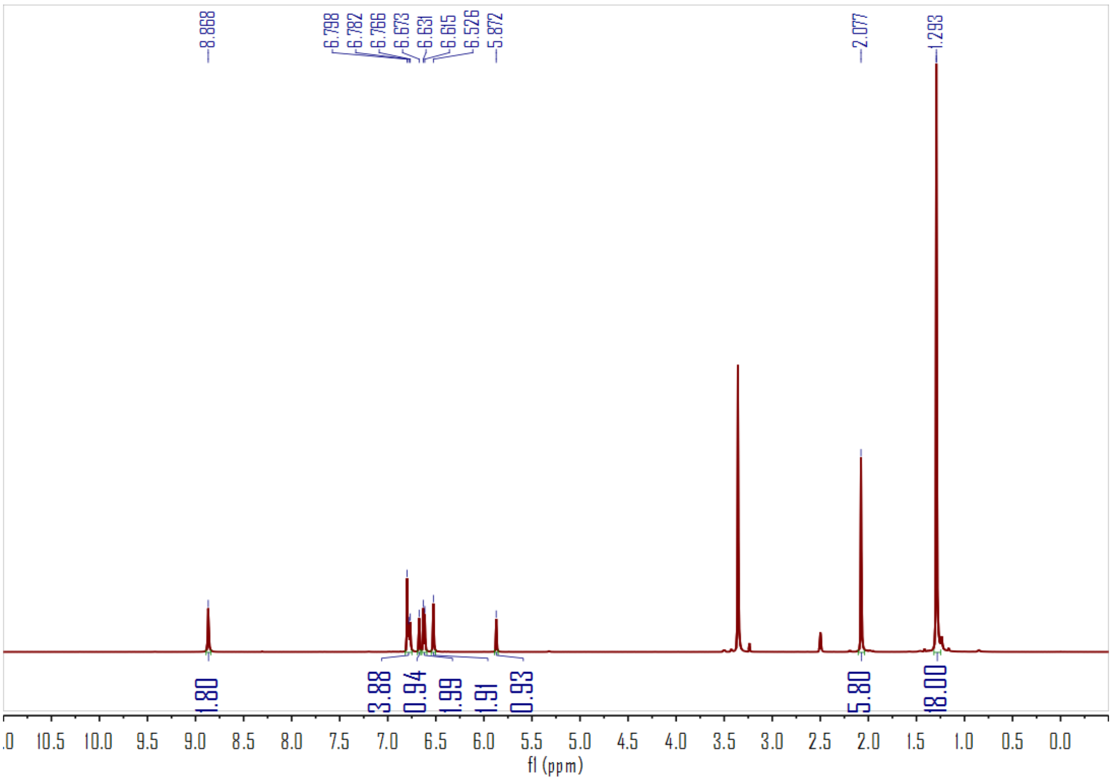
3a

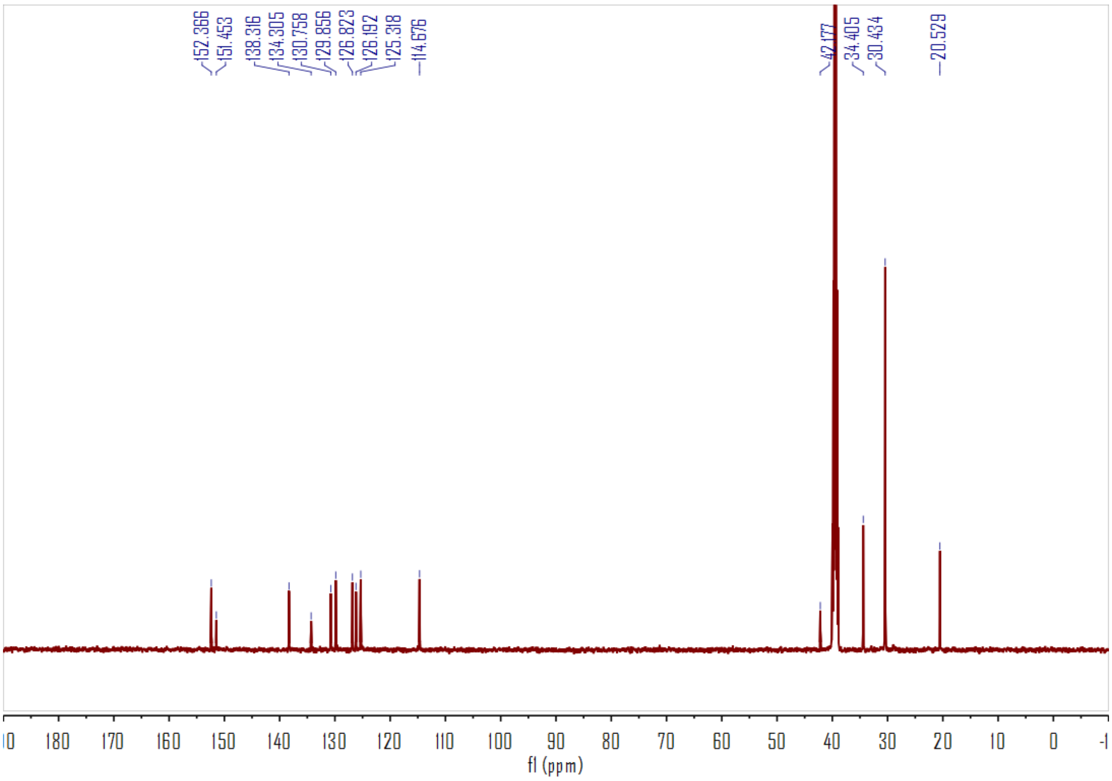

9.135
6.994
6.984
6.976
6.969
6.960
6.768
6.745
6.730
6.683
6.665
6.657
5.936
1.278
2.00
2.10
1.90
1.88
1.02
3.84
0.94
18.02
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

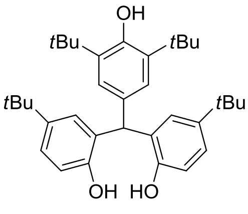

154.591
151.528
138.382
134.397
131.010
129.383
126.537
125.173
118.207
114.831
42.184
34.381
30.405
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Me
Me
OH
HO

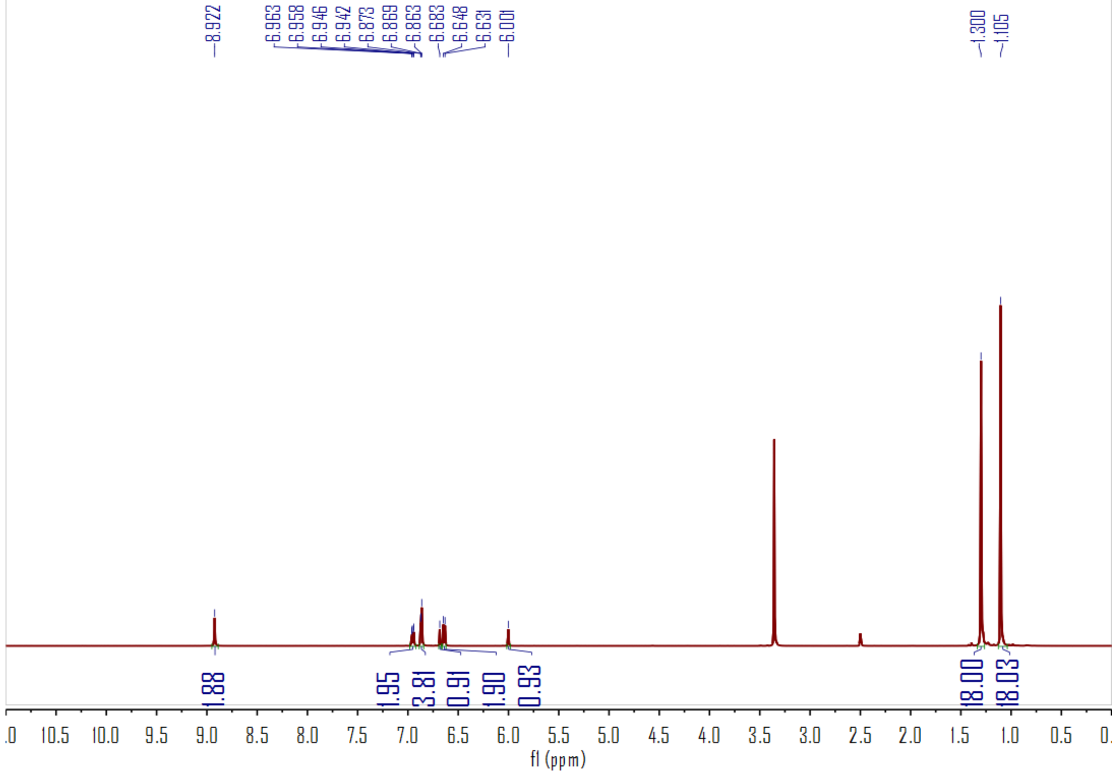
3b

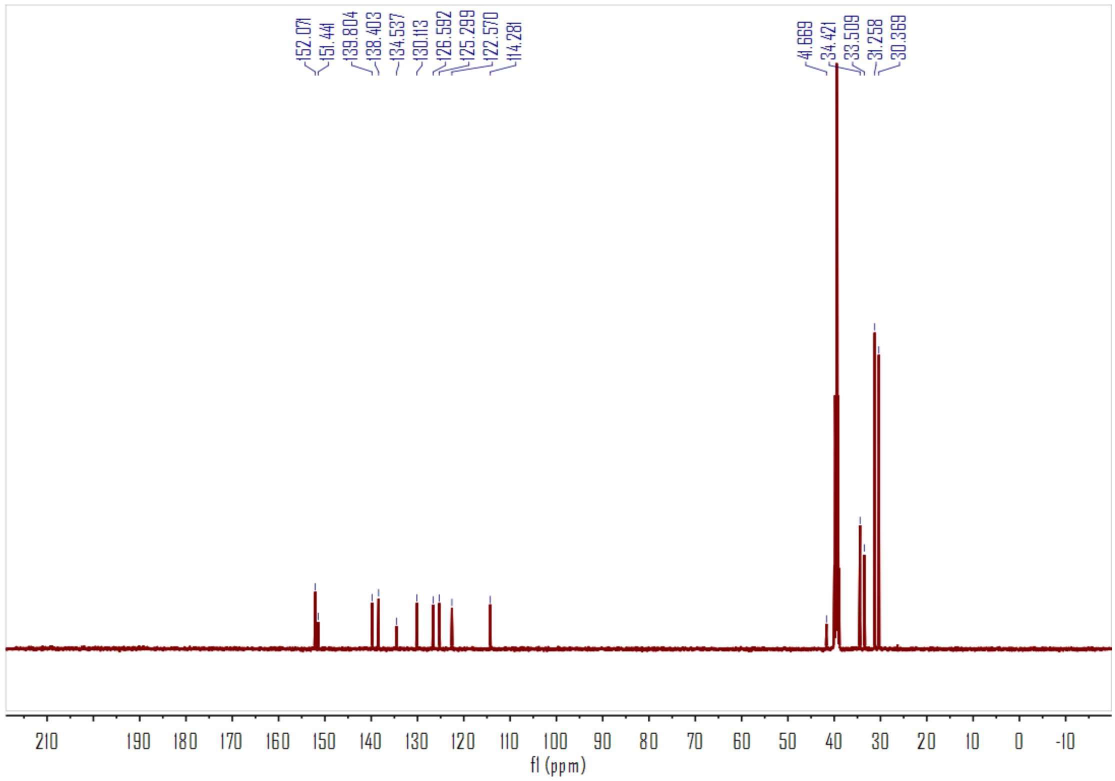

8.868
6.798
6.782
6.766
6.673
6.631
6.615
6.526
5.872
2.077
1.293
1.80
3.88
0.94
1.99
1.91
0.93
5.80
18.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

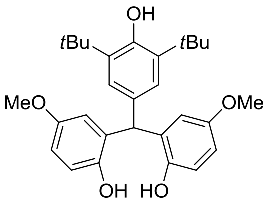

152.366
151.453
138.316
134.305
130.758
129.856
126.823
126.192
125.318
114.676
42.177
34.405
30.434
20.529
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


OH
tBu
tBu
tBu
tBu
OH
HO

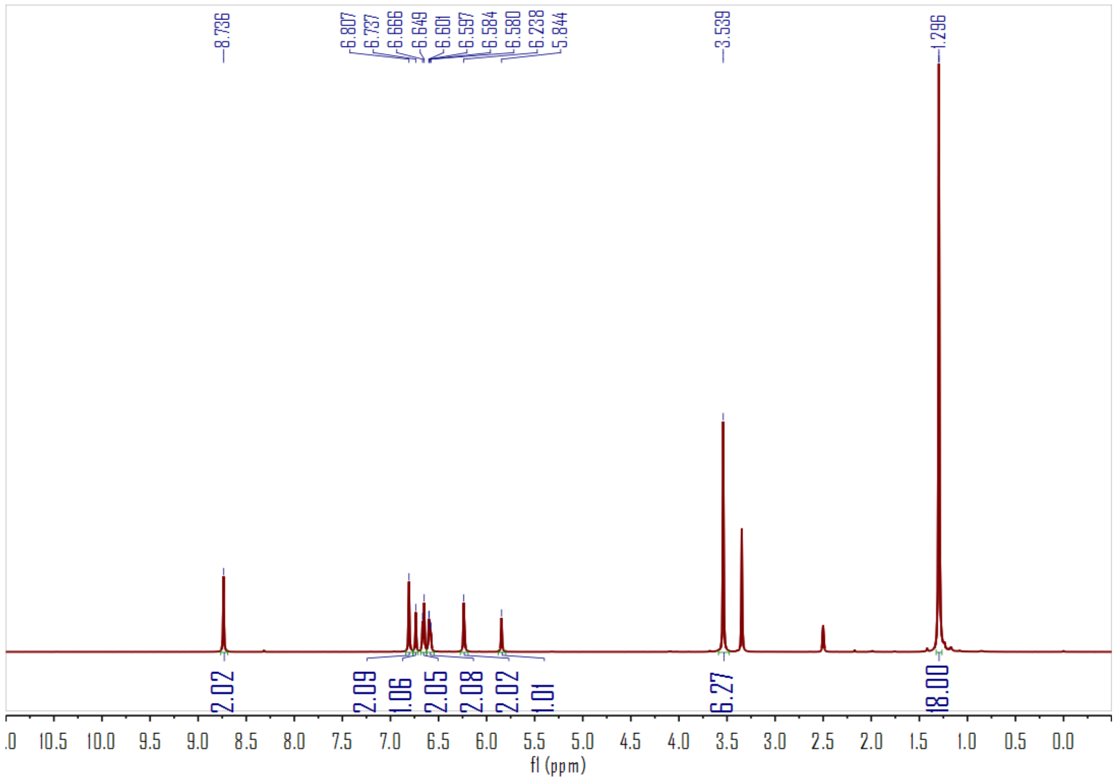
3c

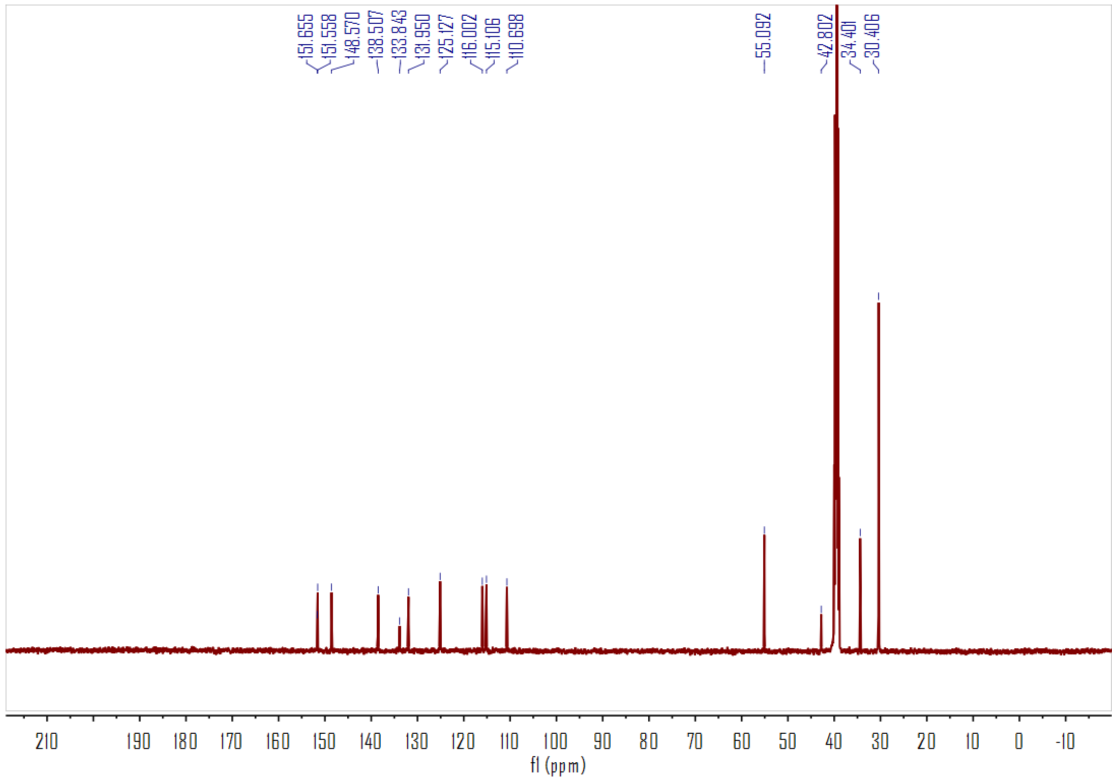

8.922
6.963
6.958
6.946
6.942
6.873
6.869
6.863
6.683
6.648
6.631
6.001
1.300
1.105
1.88
1.95
3.81
0.91
1.90
0.93
18.00
18.03
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

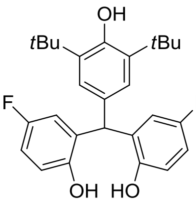

152.071
151.441
139.804
138.403
134.537
130.113
126.592
125.299
122.570
114.281
41.669
34.421
33.509
31.258
30.369
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
MeO
OMe
OH
HO

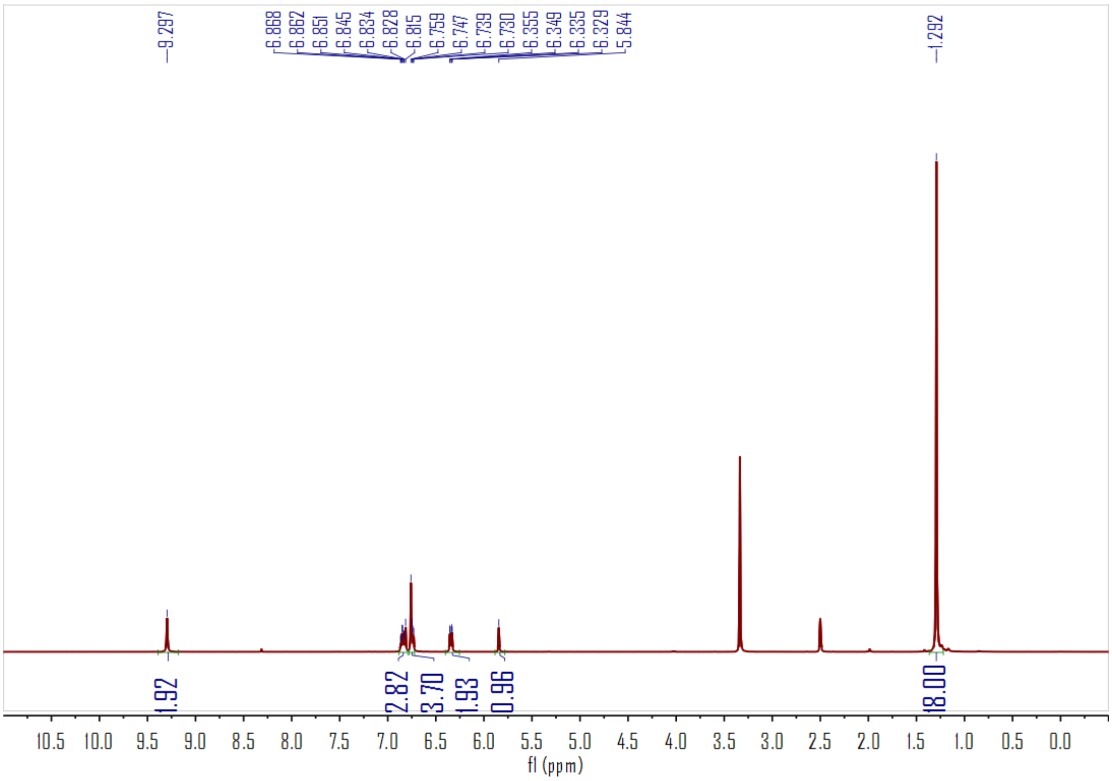
3d

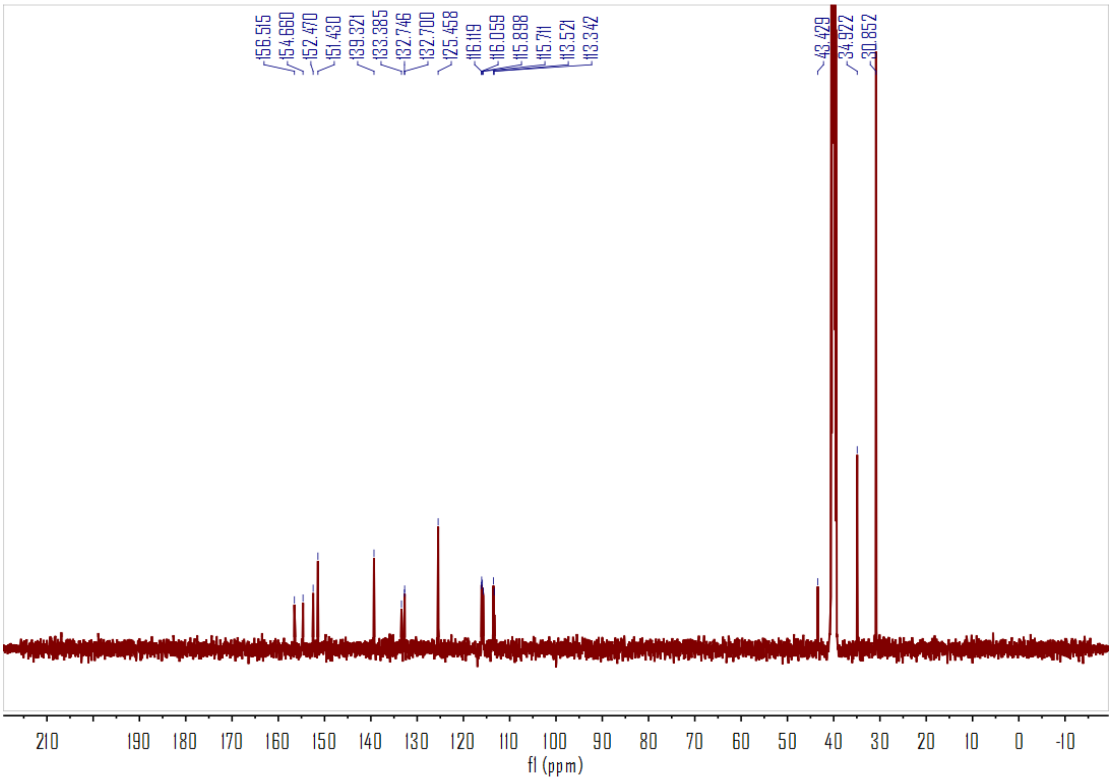

8.736
6.807
6.737
6.666
6.649
6.601
6.597
6.584
6.580
6.238
5.844
3.539
1.296
2.02
2.09
1.06
2.05
2.08
2.02
1.01
6.27
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
fl (ppm)

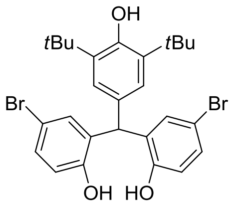

151.655
151.558
148.570
138.507
133.843
131.950
125.127
116.002
115.106
110.698
55.092
42.802
34.401
30.406
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)


OH
*t*Bu
*t*Bu
F
F
OH
HO

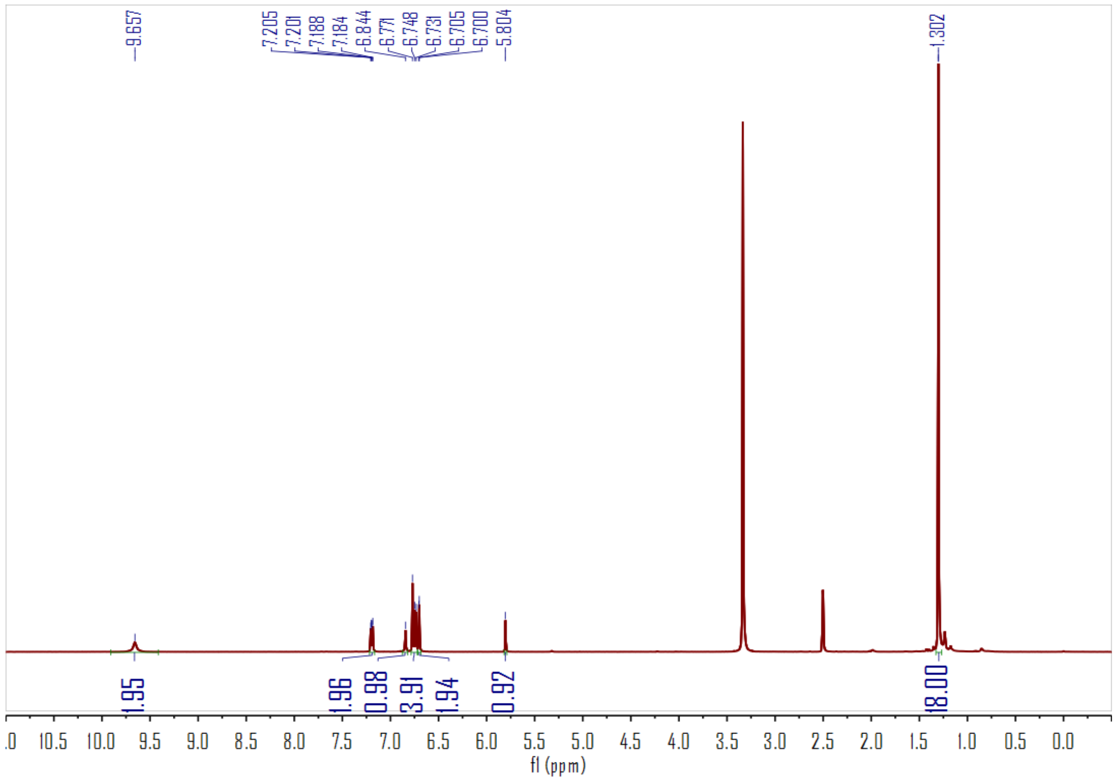
3e


9.297
6.868
6.862
6.851
6.845
6.834
6.828
6.815
6.759
6.747
6.739
6.730
6.355
6.349
6.335
6.329
5.844
1.292
1.92
2.82
3.70
1.93
0.96
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


156.515
154.660
152.470
151.430
139.321
133.385
132.746
132.700
125.458
116.119
116.059
115.898
115.711
113.521
113.342
43.429
34.922
30.852
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Br
Br
OH
HO

3f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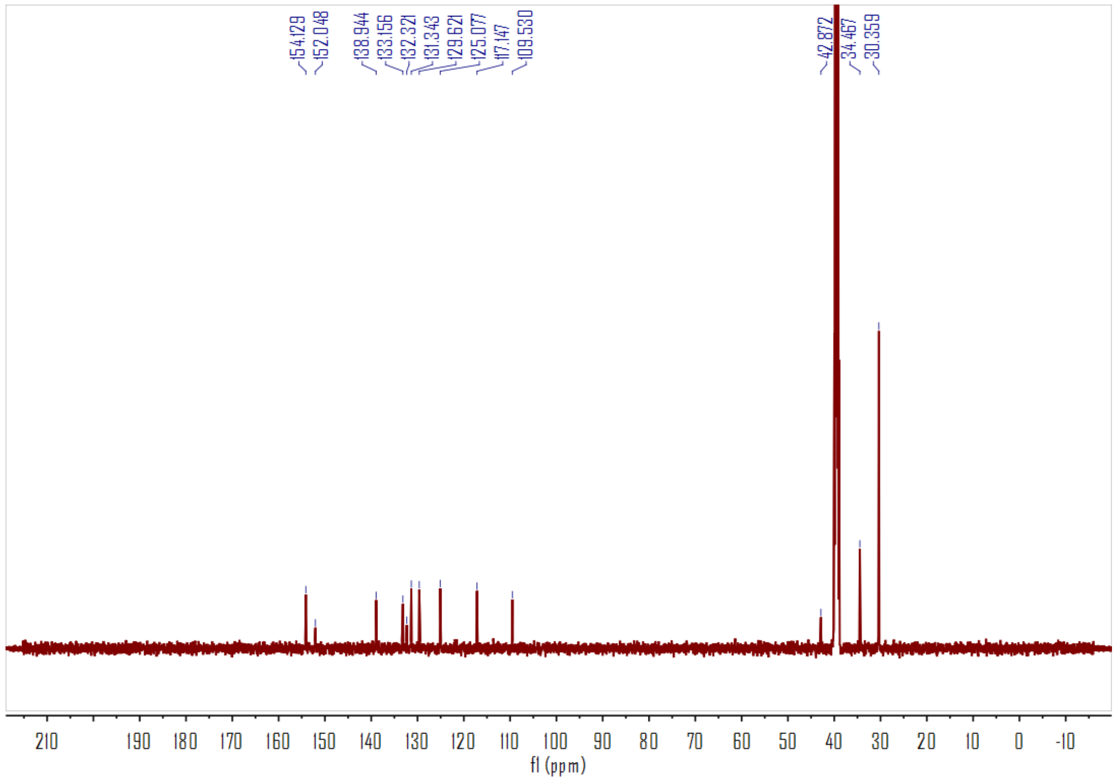
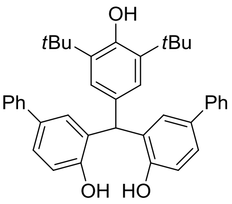
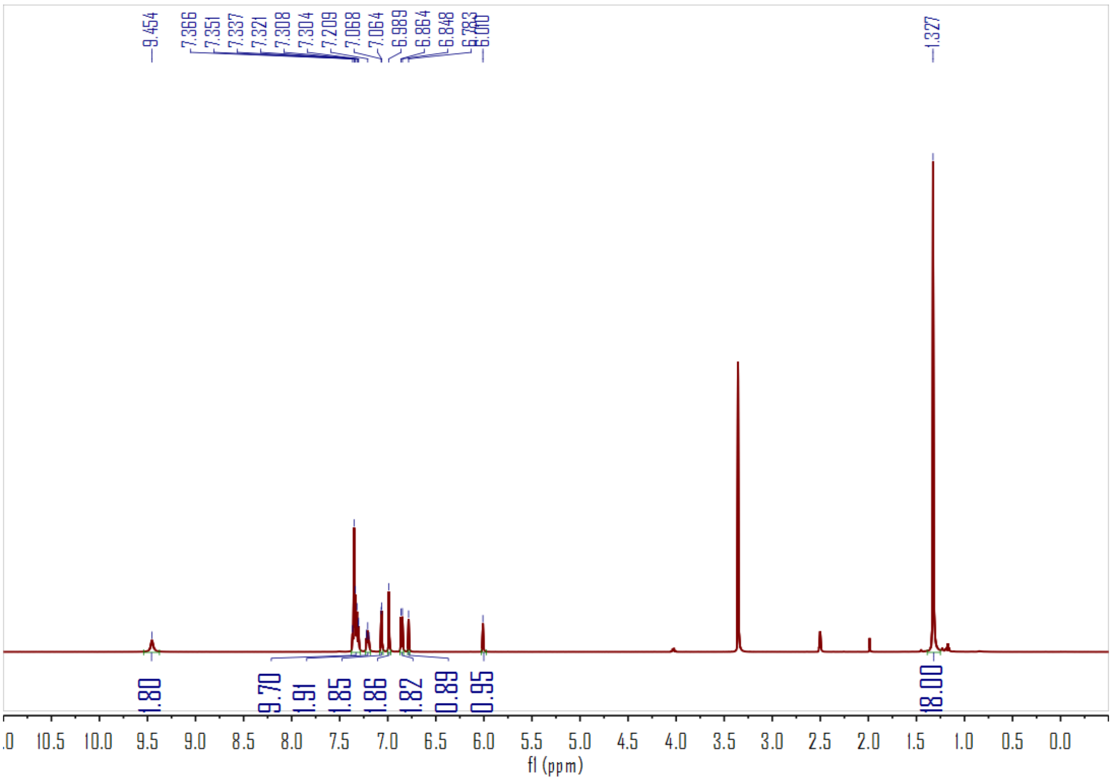
7.205
7.201
7.188
7.184
6.844
6.771
6.748
6.731
6.705
6.700
5.804
1.302
1.95
1.96
0.98
3.91
1.94
0.92
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


154.129
152.048
138.944
133.156
132.321
131.343
129.621
125.077
117.147
109.530
42.872
34.467
30.359
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Ph
Ph
OH
HO

3g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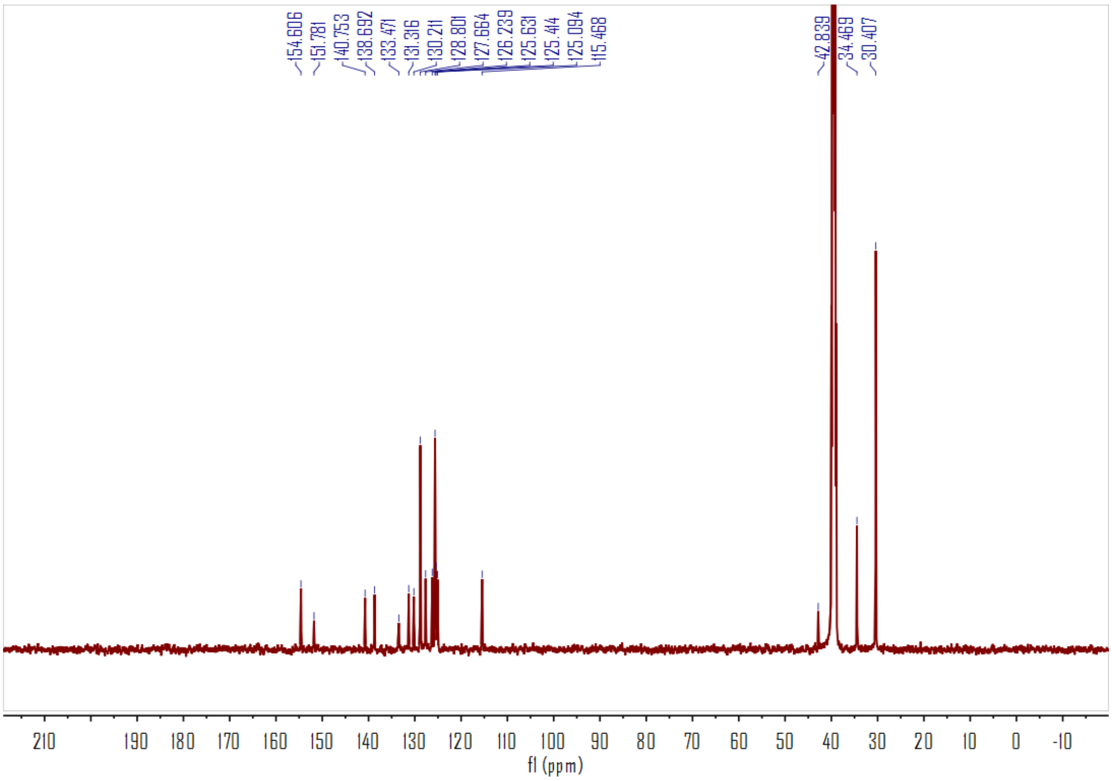
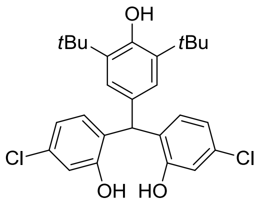
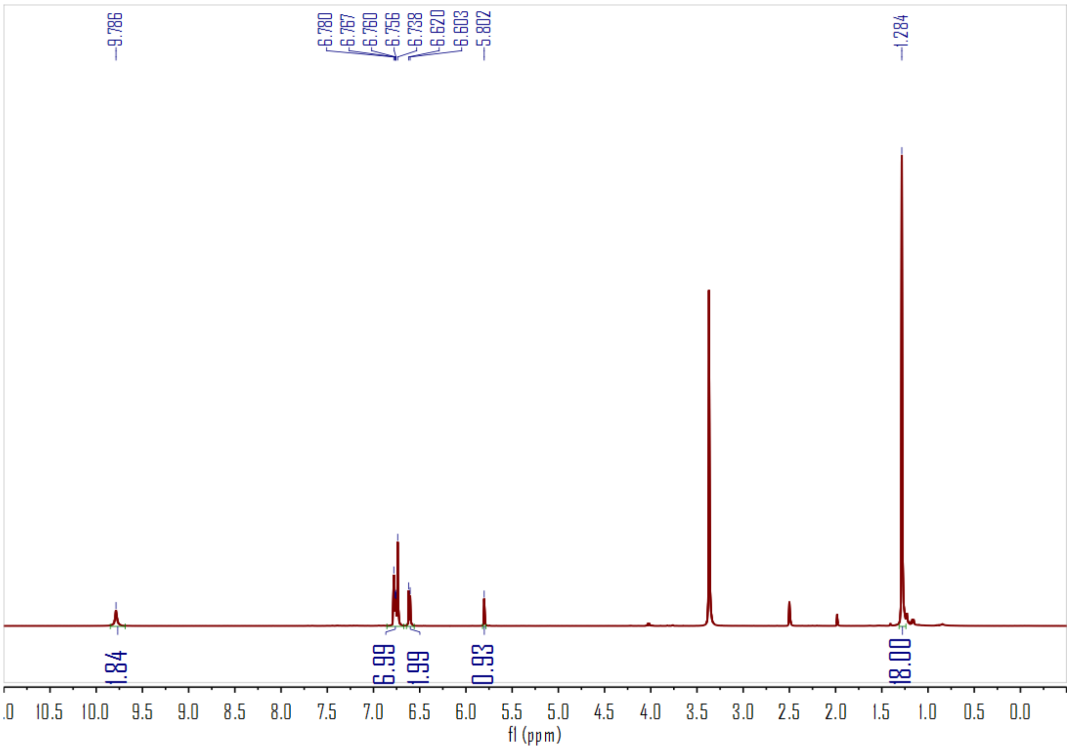
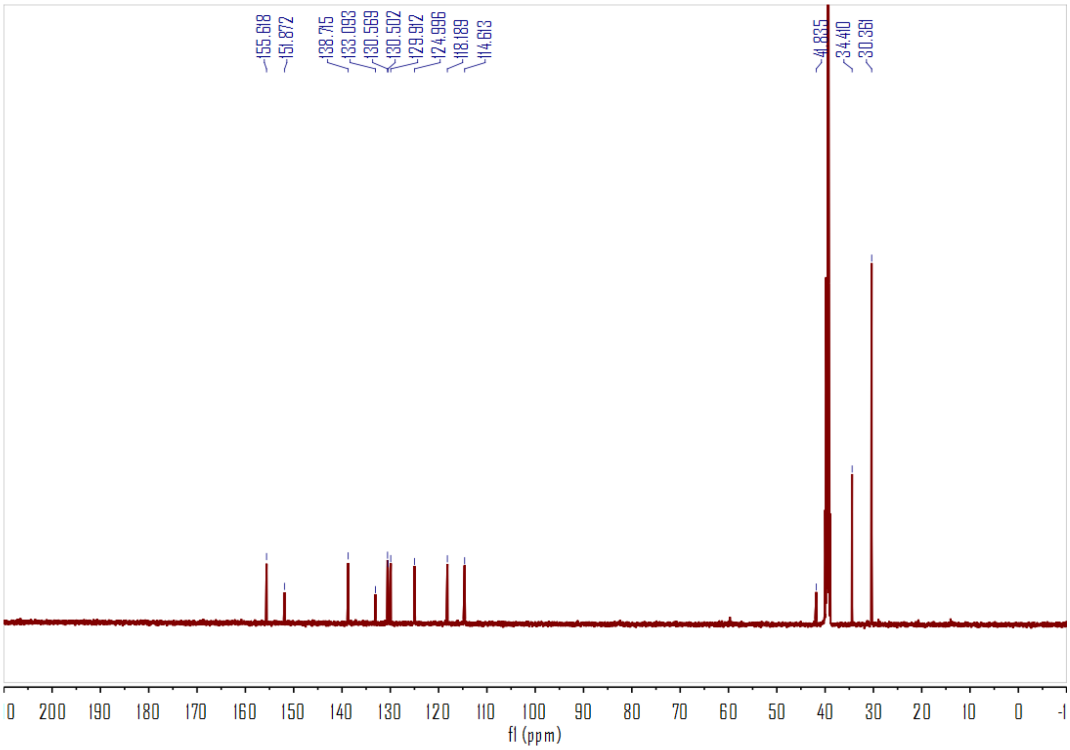
7.366
7.351
7.337
7.321
7.308
7.304
7.209
7.068
7.064
6.989
6.864
6.848
6.783
6.010
1.327
1.80
9.70
1.91
1.85
1.86
1.82
0.89
0.95
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

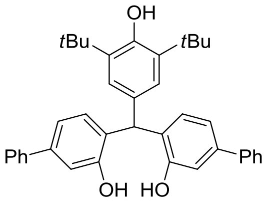

154.606
151.781
140.753
138.692
133.471
131.316
130.211
128.801
127.664
126.239
125.631
125.414
125.094
115.468
42.839
34.469
30.407
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Cl
Cl
OH
HO

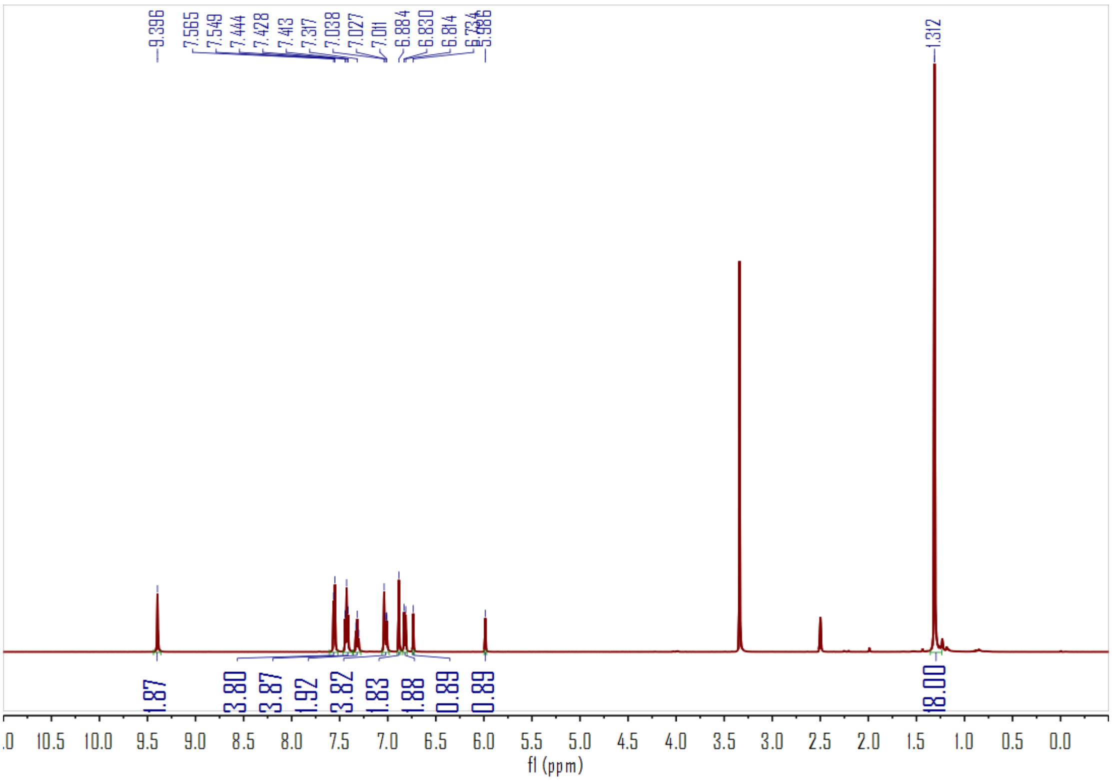
3h

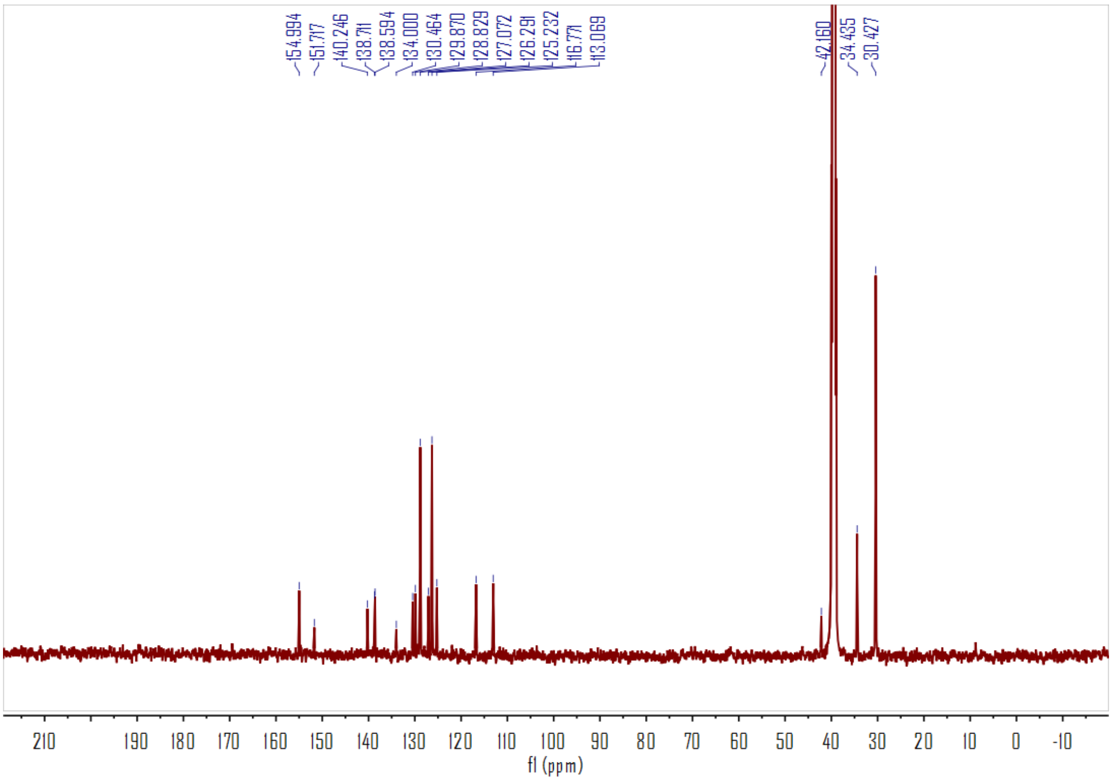

9.786
6.780
6.767
6.760
6.756
6.738
6.620
6.603
5.802
1.284
1.84
6.99
1.99
0.93
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

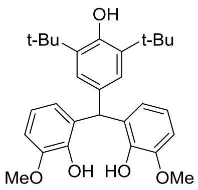

155.618
151.872
138.715
133.093
130.569
130.502
129.912
124.996
118.189
114.613
41.835
34.410
30.361
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


OH
tBu
tBu
Ph
Ph
OH
HO

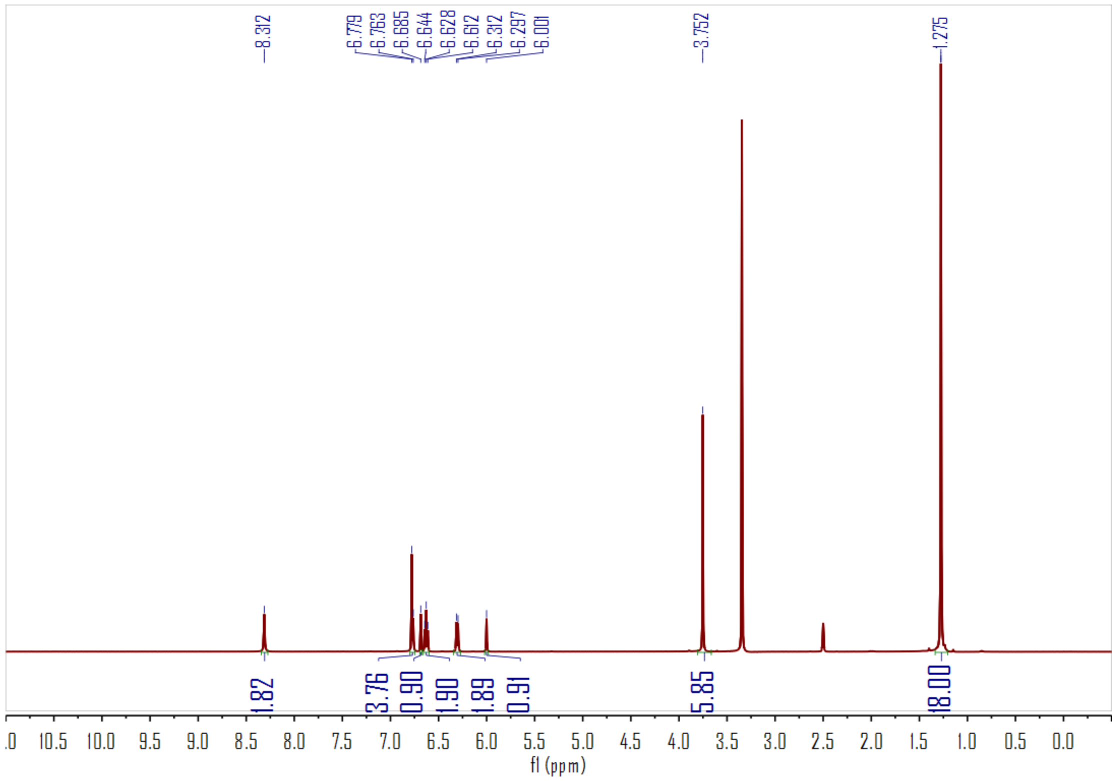
3i

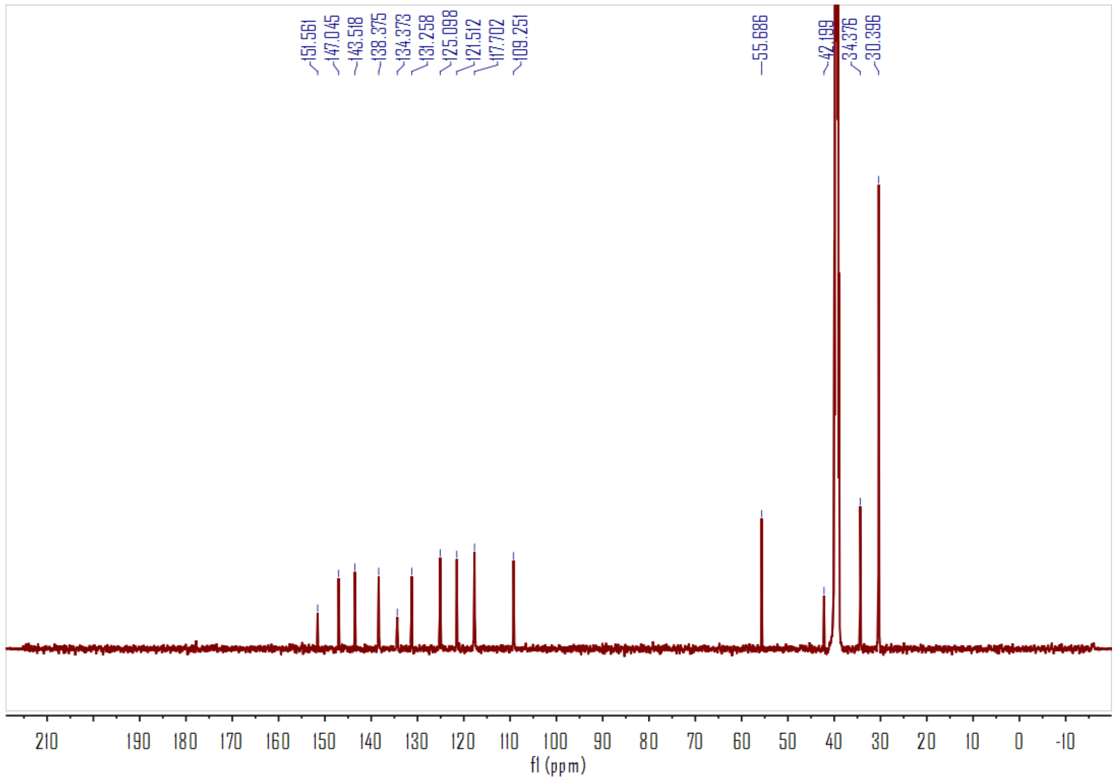

9.396
7.565
7.549
7.444
7.428
7.413
7.317
7.038
7.027
7.011
6.884
6.830
6.814
6.734
5.986
1.312
1.87
3.80
3.87
1.92
3.82
1.83
1.88
0.89
0.89
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

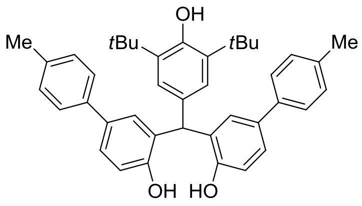

154.994
151.717
140.246
138.711
138.594
134.000
130.464
129.870
128.829
127.072
126.291
125.232
116.771
113.069
42.160
34.435
30.427
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
t-Bu
t-Bu
MeO
OH
HO
OMe

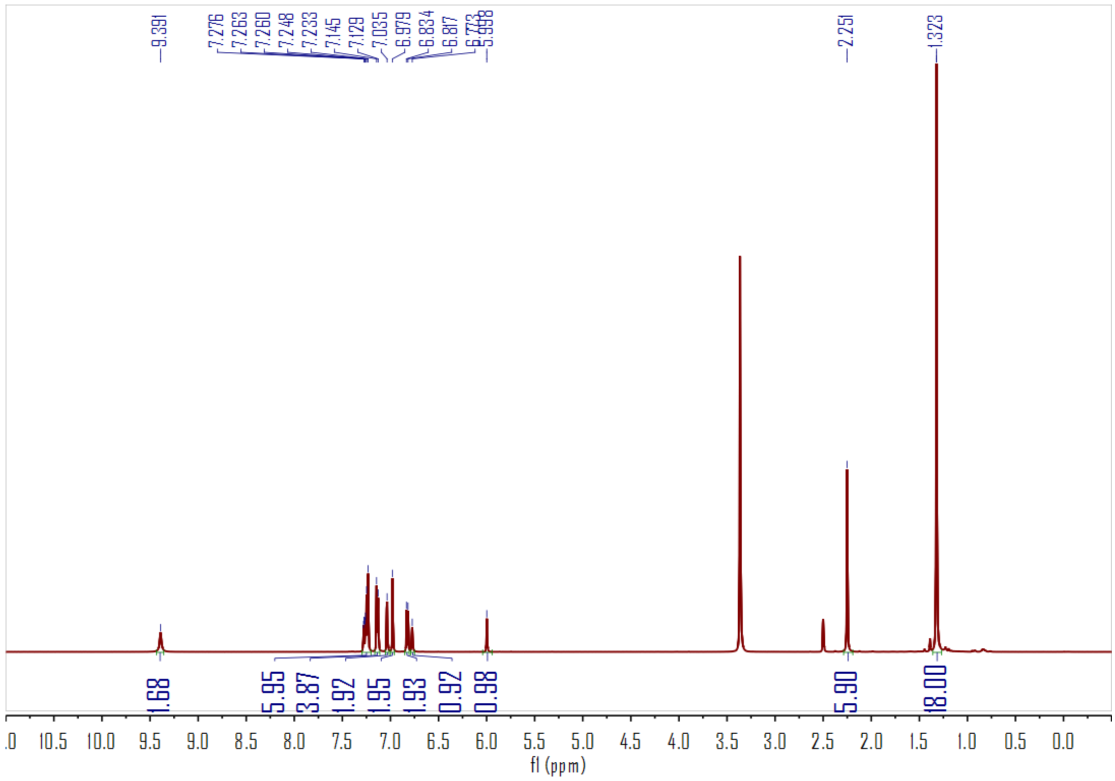
3j

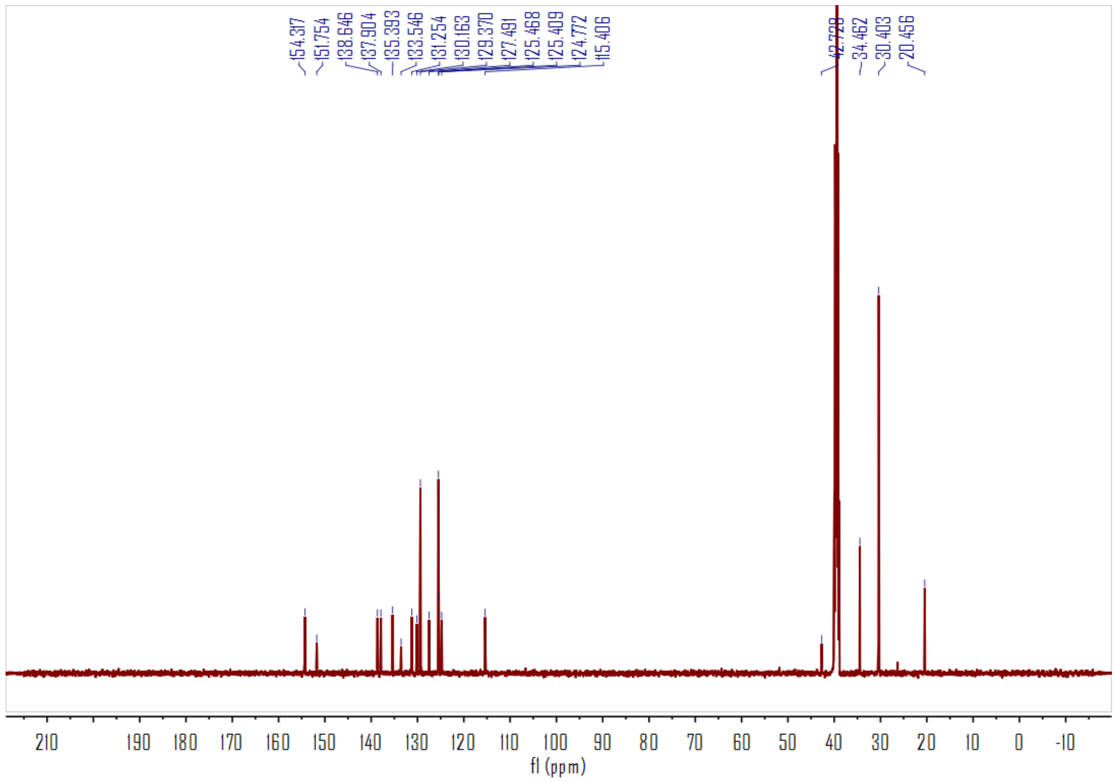

8.312
6.779
6.763
6.685
6.644
6.628
6.612
6.312
6.297
6.001
3.752
1.275
1.82
3.76
0.90
1.90
1.89
0.91
5.85
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

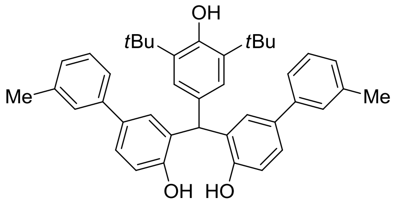

151.561
147.045
143.518
138.375
134.373
131.258
125.098
121.512
117.702
109.251
55.686
42.199
34.376
30.396
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Me
Me
OH
HO

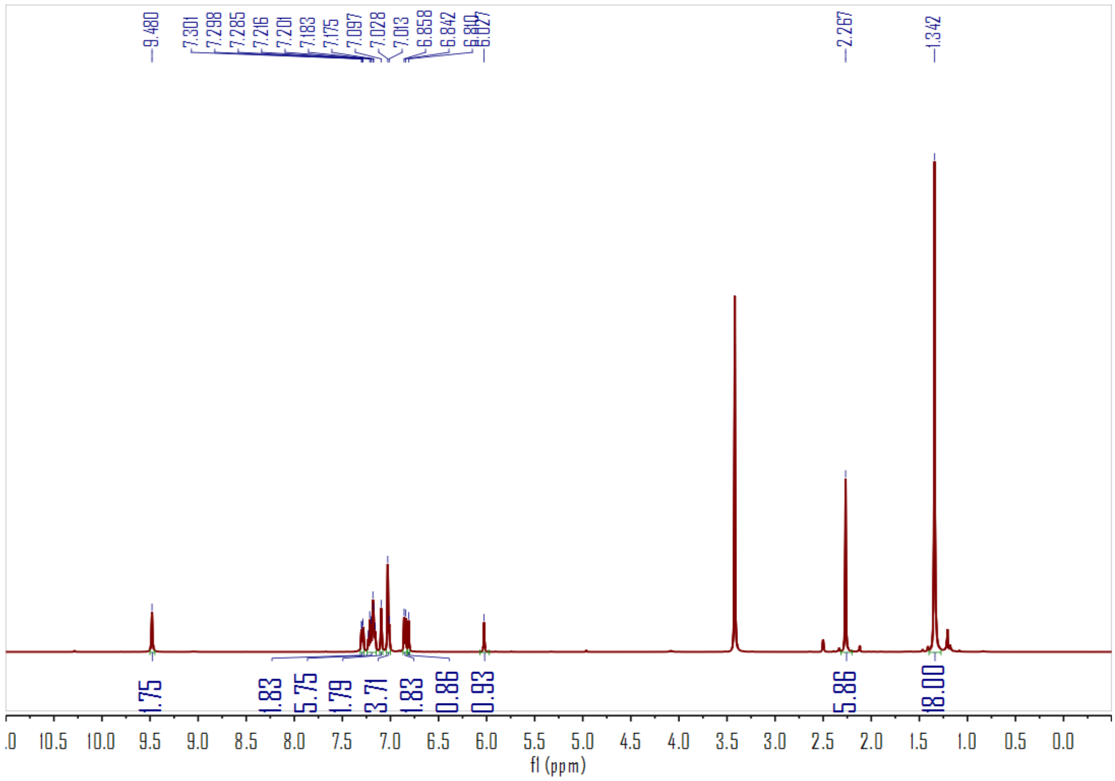
3k

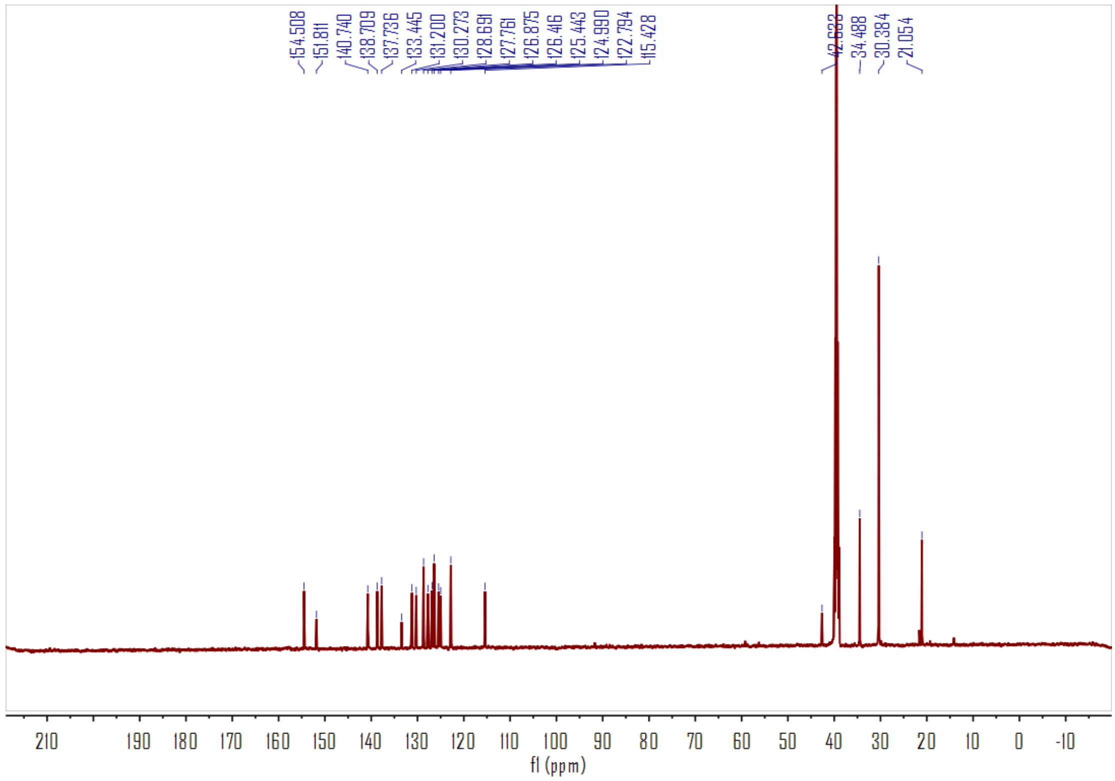

9.391
7.276
7.263
7.260
7.248
7.233
7.145
7.129
7.035
6.979
6.834
6.817
6.773
5.998
2.251
1.323
1.68
5.95
3.87
1.92
1.95
1.93
0.92
0.98
5.90
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

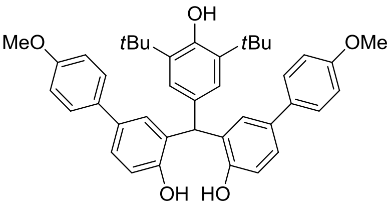

154.317
151.754
138.646
137.904
135.393
133.546
131.254
130.163
129.370
127.491
125.468
125.409
124.772
115.406
42.728
34.462
30.403
20.456
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Me
Me
OH
HO

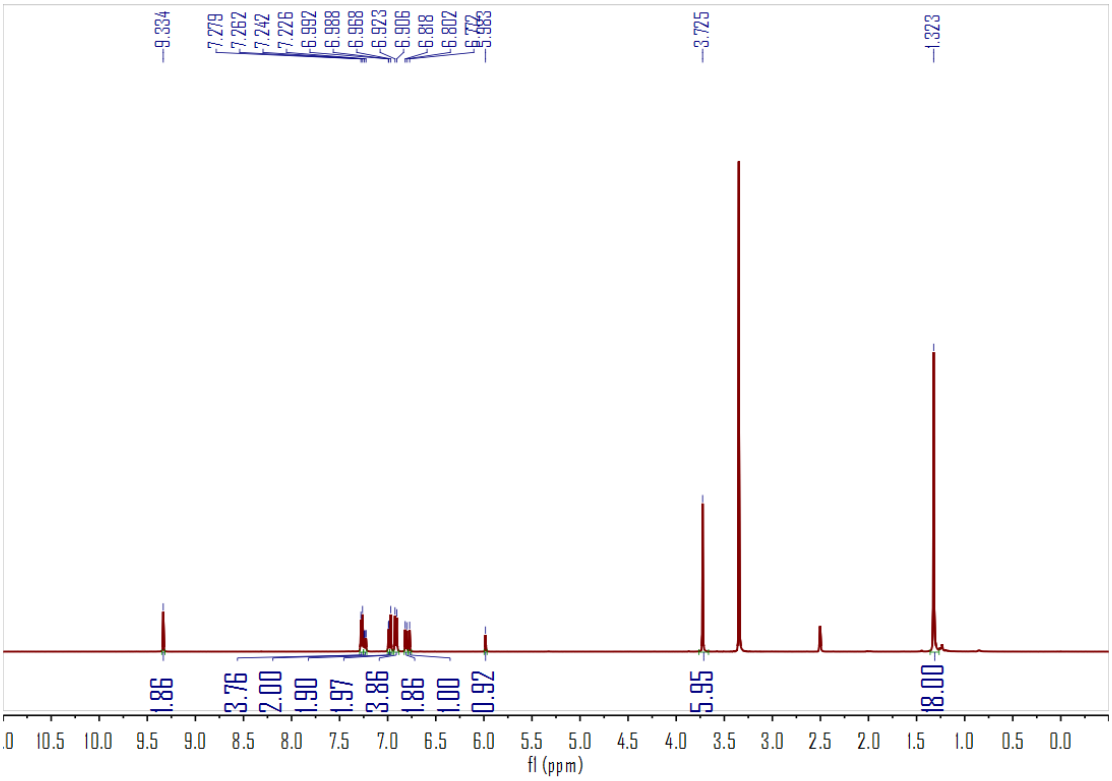
3l

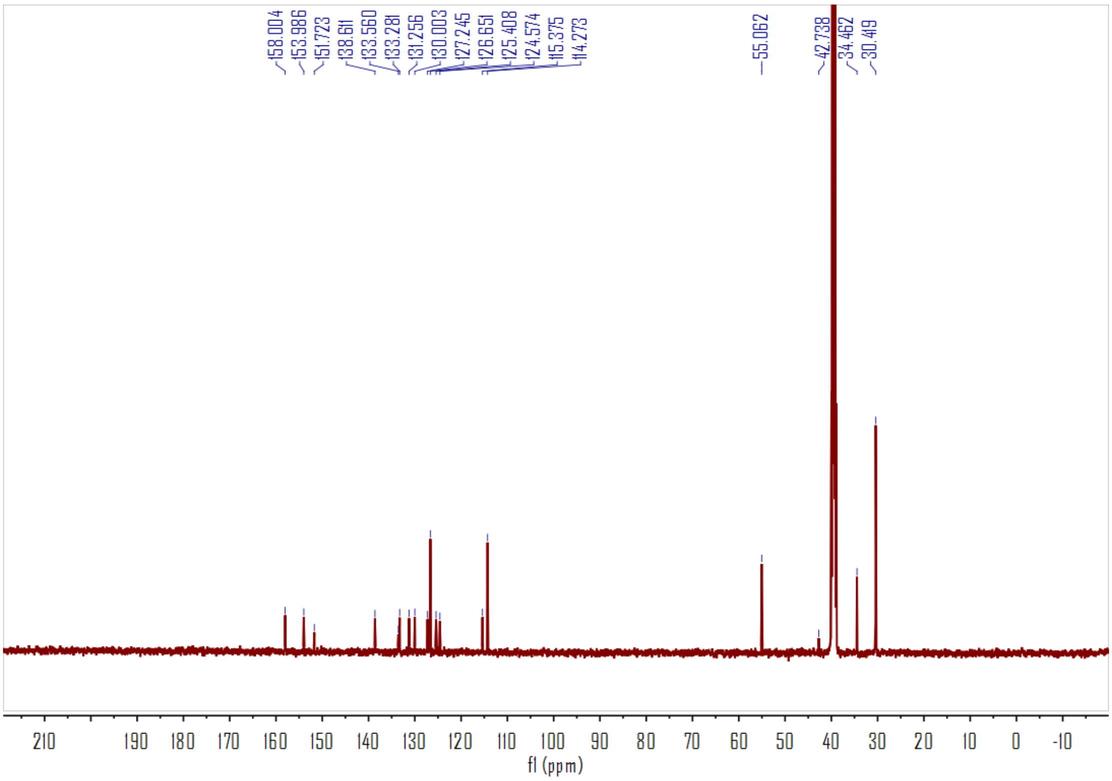

9.480
7.301
7.298
7.285
7.216
7.201
7.183
7.175
7.097
7.028
7.013
6.858
6.842
6.840
6.027
2.267
1.342
1.75
1.83
5.75
1.79
3.71
1.83
0.86
0.93
5.86
18.00
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

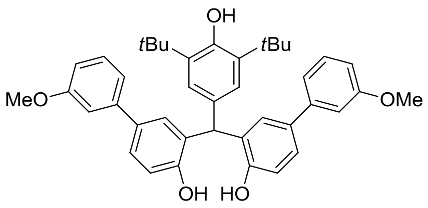

154.508
151.811
140.740
138.709
137.736
133.445
131.200
130.273
128.691
127.761
126.875
126.416
125.443
124.990
122.794
115.428
42.633
34.488
30.384
21.054
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
MeO
tBu
tBu
OMe
OH
HO

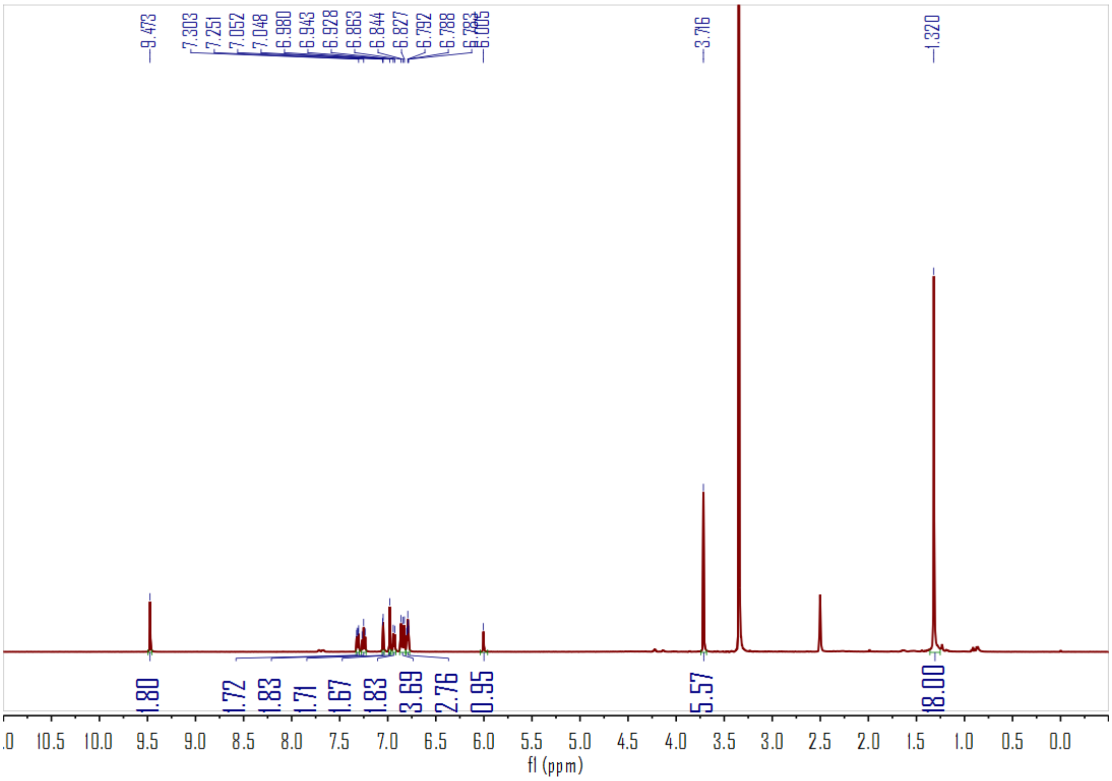
3m

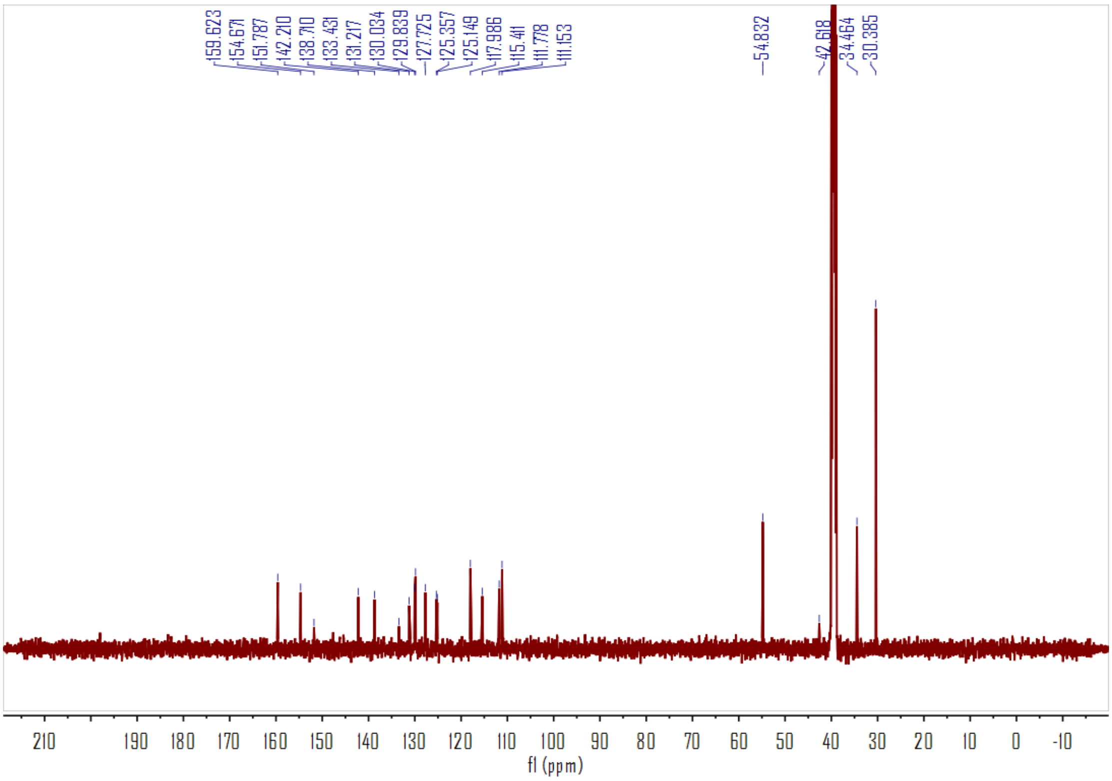

9.334
7.279
7.262
7.242
7.226
6.992
6.988
6.968
6.923
6.906
6.818
6.802
6.772
5.983
3.725
1.323
1.86
3.76
2.00
1.90
1.97
3.86
1.86
1.00
0.92
5.95
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

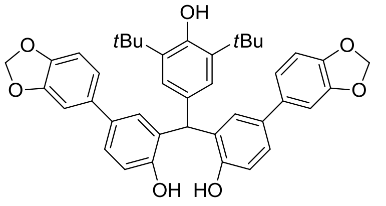

158.004
153.986
151.723
138.611
133.560
133.281
131.256
130.003
127.245
126.651
125.408
124.574
115.375
114.273
55.062
42.738
34.462
30.419
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
MeO
OMe
OH
HO

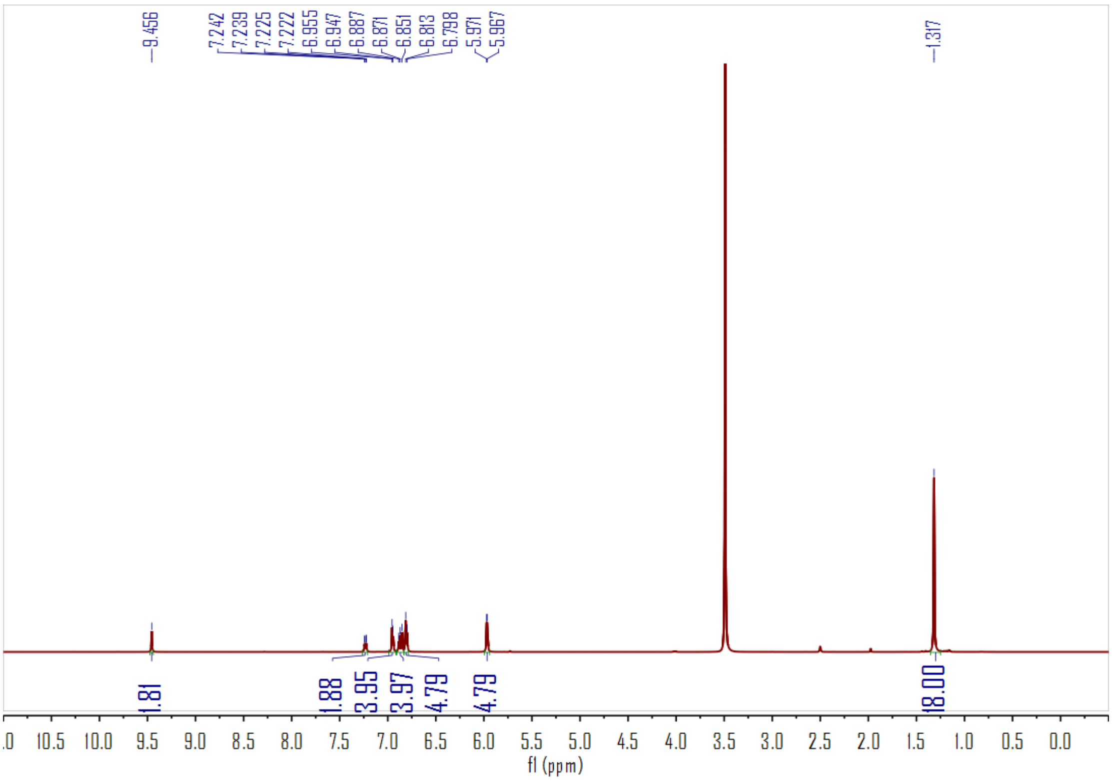
3n

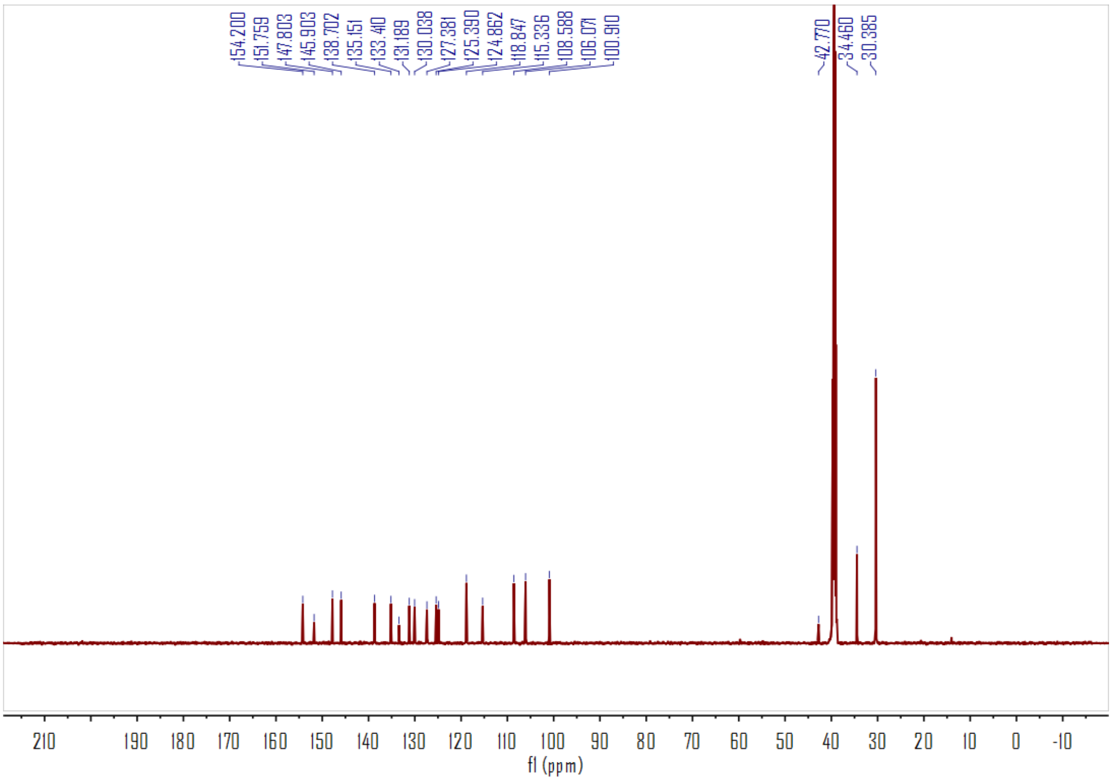

9.473
7.303
7.251
7.052
7.048
6.980
6.943
6.928
6.863
6.844
6.827
6.792
6.788
6.783
6.005
3.716
1.320
1.80
1.72
1.83
1.71
1.67
1.83
3.69
2.76
0.95
5.57
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

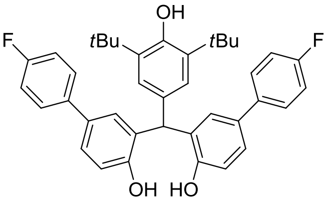

159.623
154.671
151.787
142.210
138.710
133.431
131.217
130.034
129.839
127.725
125.357
125.149
117.986
115.411
111.778
111.153
54.832
42.618
34.464
30.385
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
O
O
O
O
OH
HO

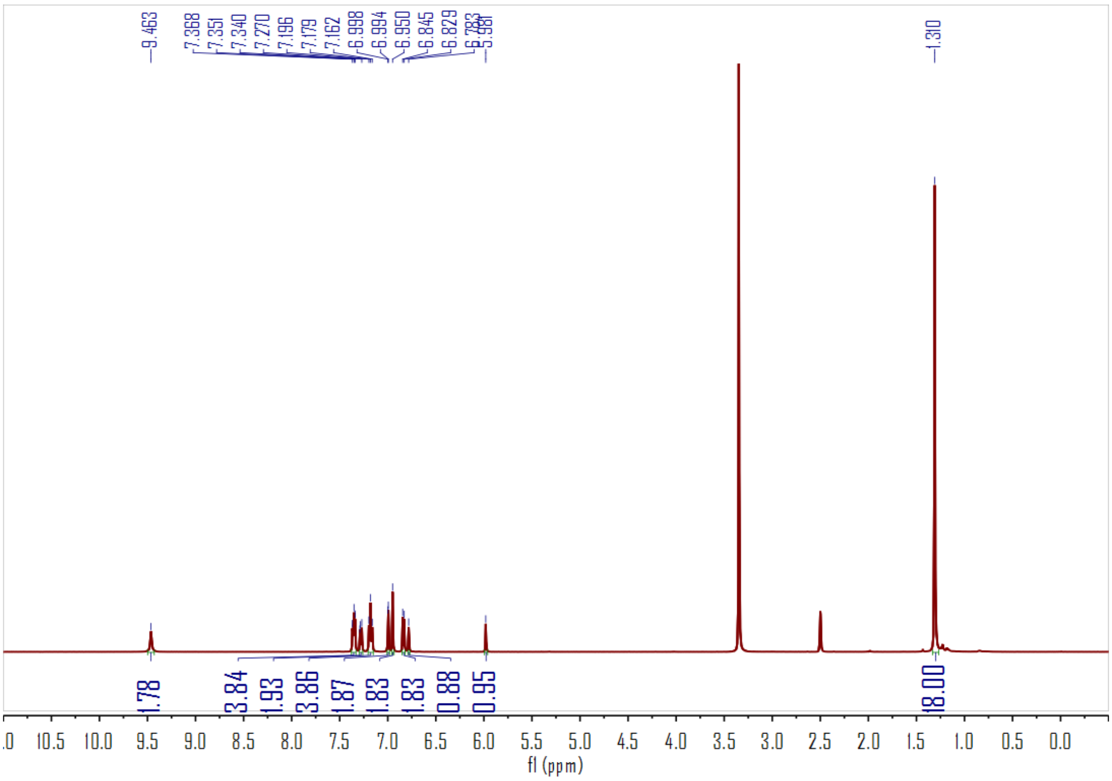
3o

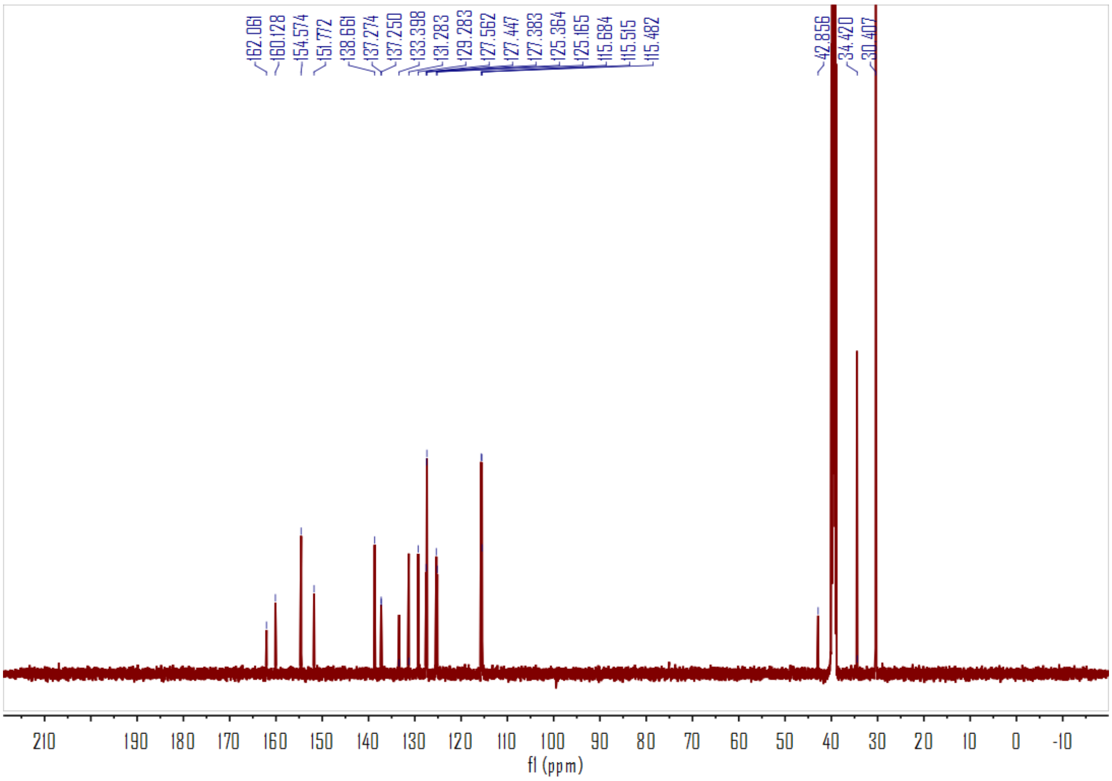

9.456
7.242
7.239
7.225
7.222
6.955
6.947
6.887
6.871
6.851
6.813
6.798
5.971
5.967
1.317
1.81
1.88
3.95
3.97
4.79
4.79
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

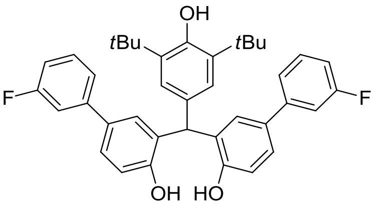

154.200
151.759
147.803
145.903
138.702
135.151
133.410
131.189
130.038
127.381
125.390
124.862
118.847
115.336
108.588
106.071
100.910
42.770
34.460
30.385
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


F
tBu
OH
tBu
F
OH
HO

3p


9.463
7.368
7.351
7.340
7.270
7.196
7.179
7.162
6.998
6.994
6.950
6.845
6.829
6.783
5.981
1.310
1.78
3.84
1.93
3.86
1.87
1.83
1.83
0.88
0.95
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


162.061
160.128
154.574
151.772
138.661
137.274
137.250
133.398
131.283
129.283
127.562
127.447
127.383
125.364
125.165
115.684
115.515
115.482
42.856
34.420
30.407
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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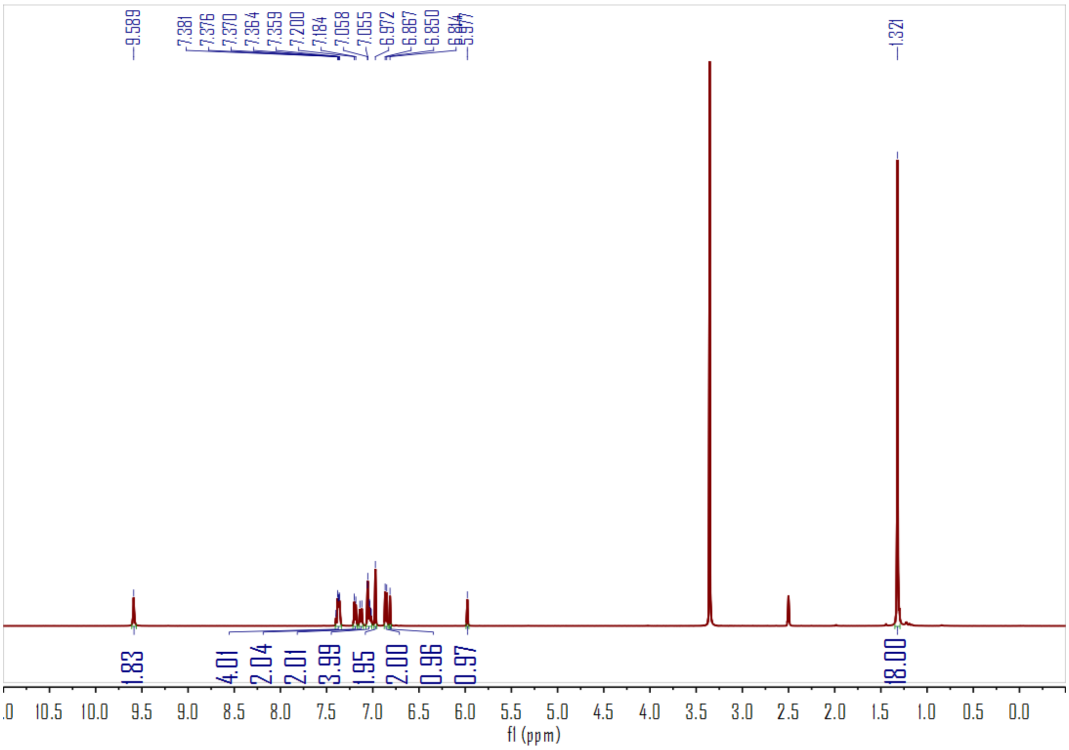
tBu
tBu
F
F
OH
HO

3q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7.376
7.370
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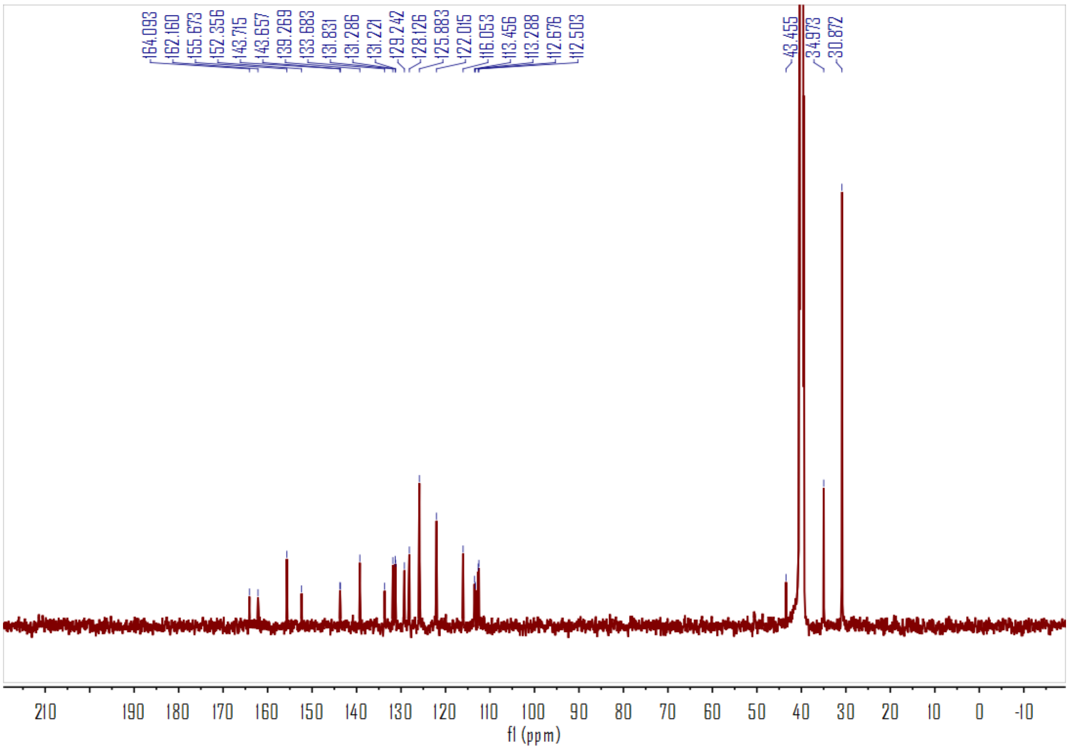
7.359
7.200
7.184
7.058
7.055
6.972
6.867
6.850
6.814
5.977
1.321
1.83
4.01
2.04
2.01
3.99
1.95
2.00
0.96
0.97
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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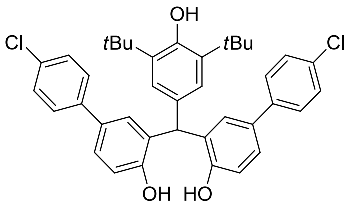
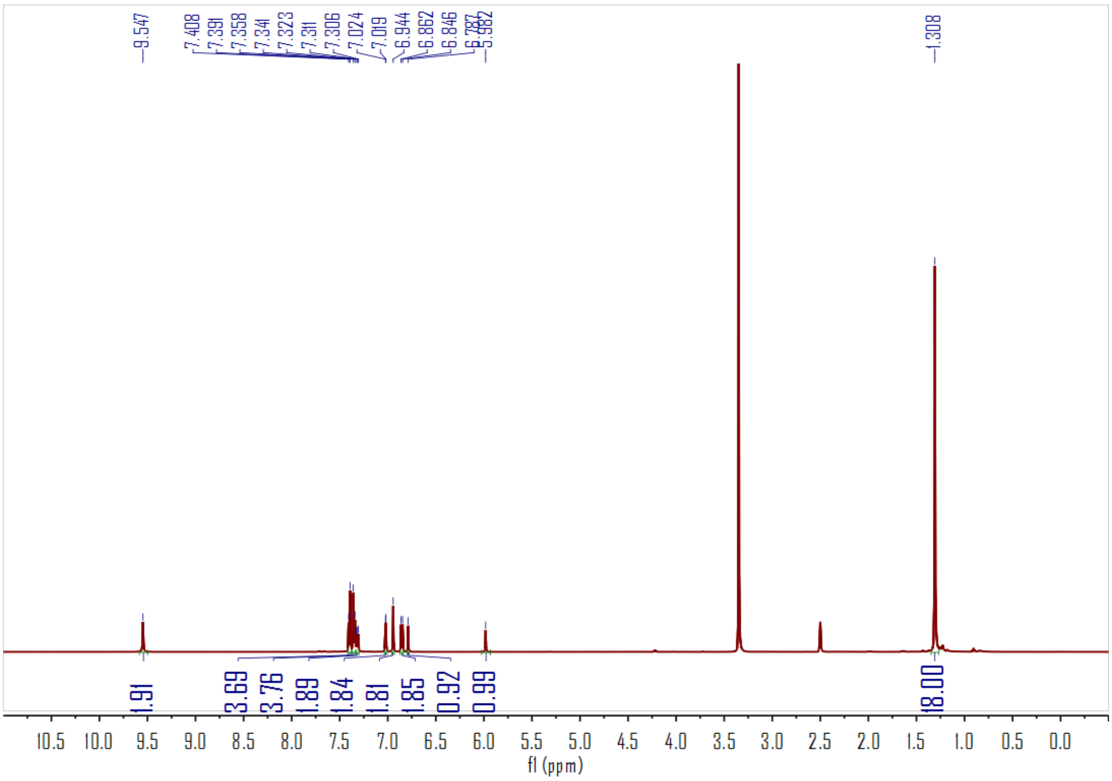
162.160
155.673
152.356
143.715
143.657
139.269
133.683
131.831
131.286
131.221
129.242
128.126
125.883
122.015
116.053
113.456
113.288
112.676
112.503
43.455
34.973
30.872
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
Cl
Cl
OH
HO

3r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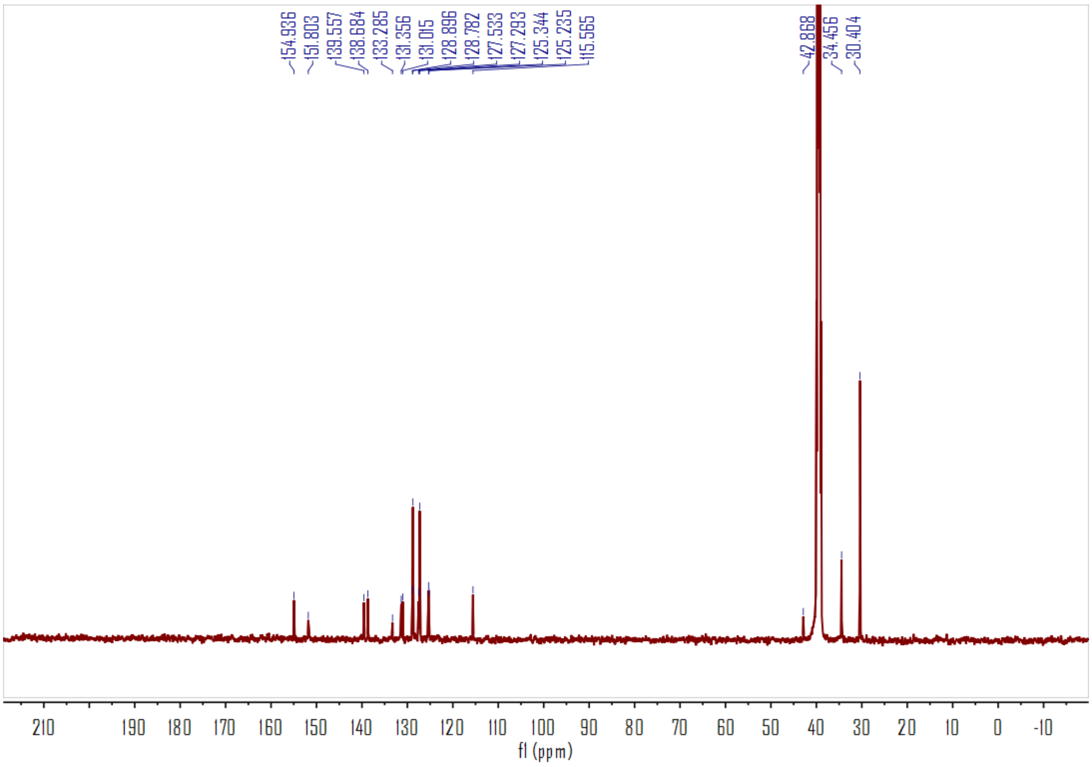
7.391
7.358
7.341
7.323
7.311
7.306
7.024
7.019
6.944
6.862
6.846
6.787
5.982
1.308
1.91
3.69
3.76
1.89
1.84
1.81
1.85
0.92
0.99
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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139.557
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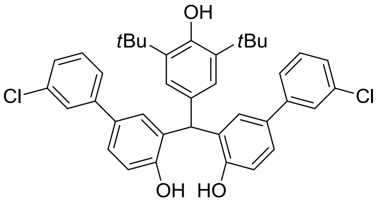
133.285
131.356
131.015
128.896
128.782
127.533
127.293
125.344
125.235
115.565
42.868
34.456
30.404
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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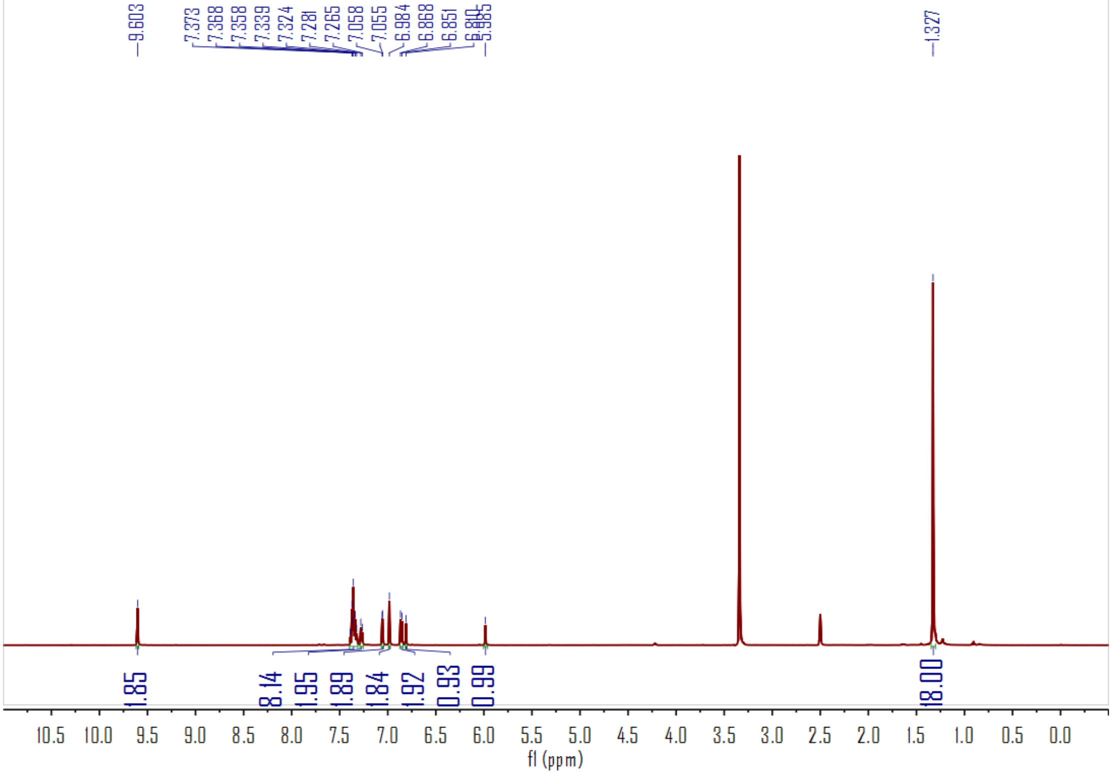
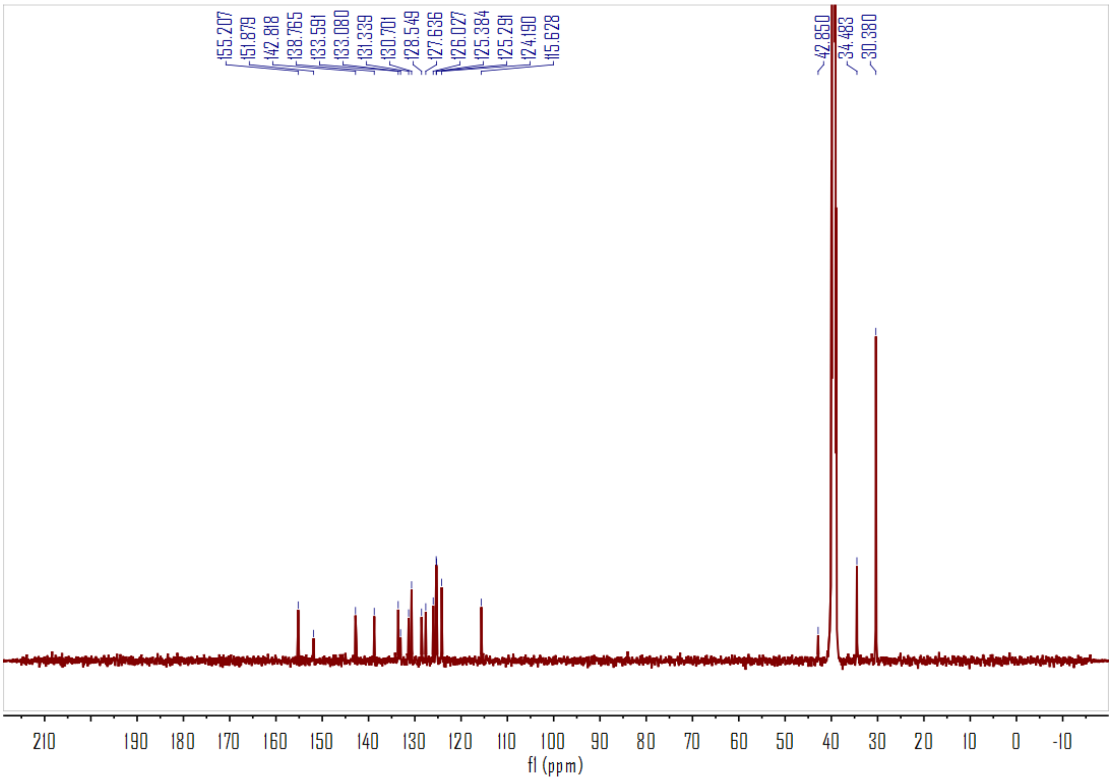
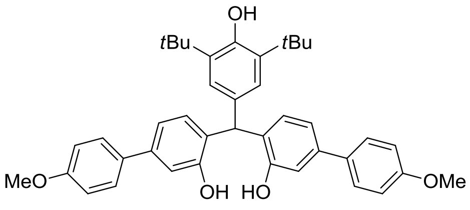
tBu
tBu
Cl
Cl
OH
HO

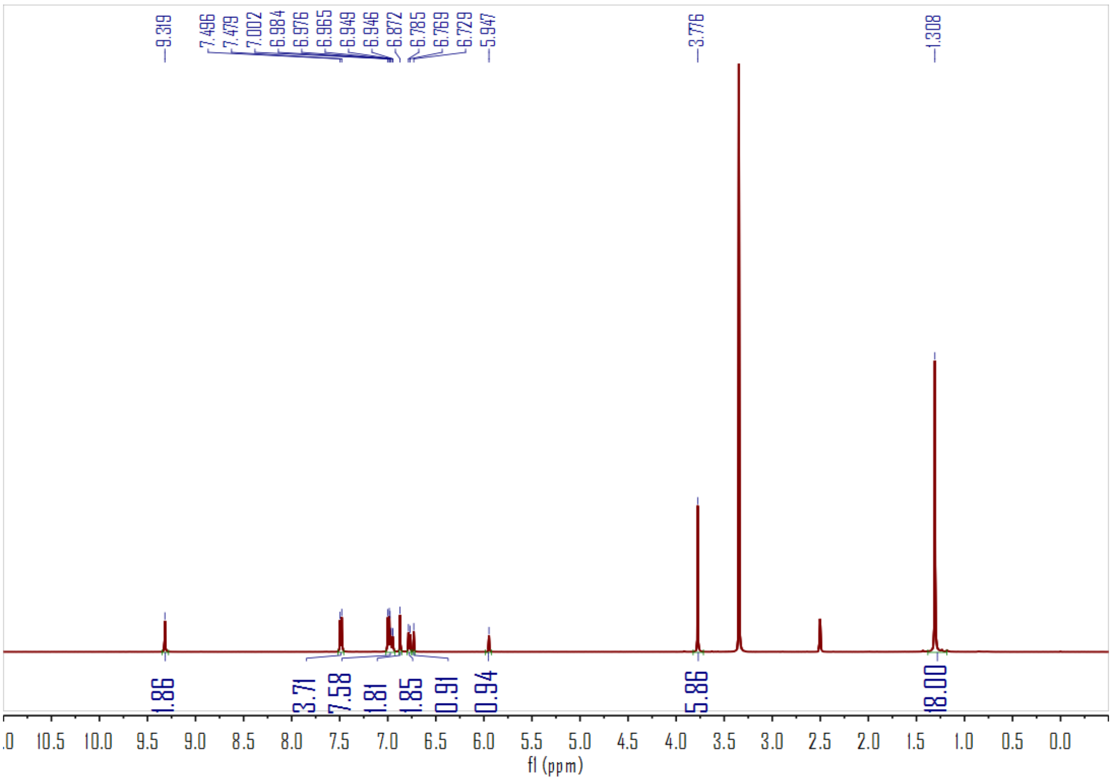
3s

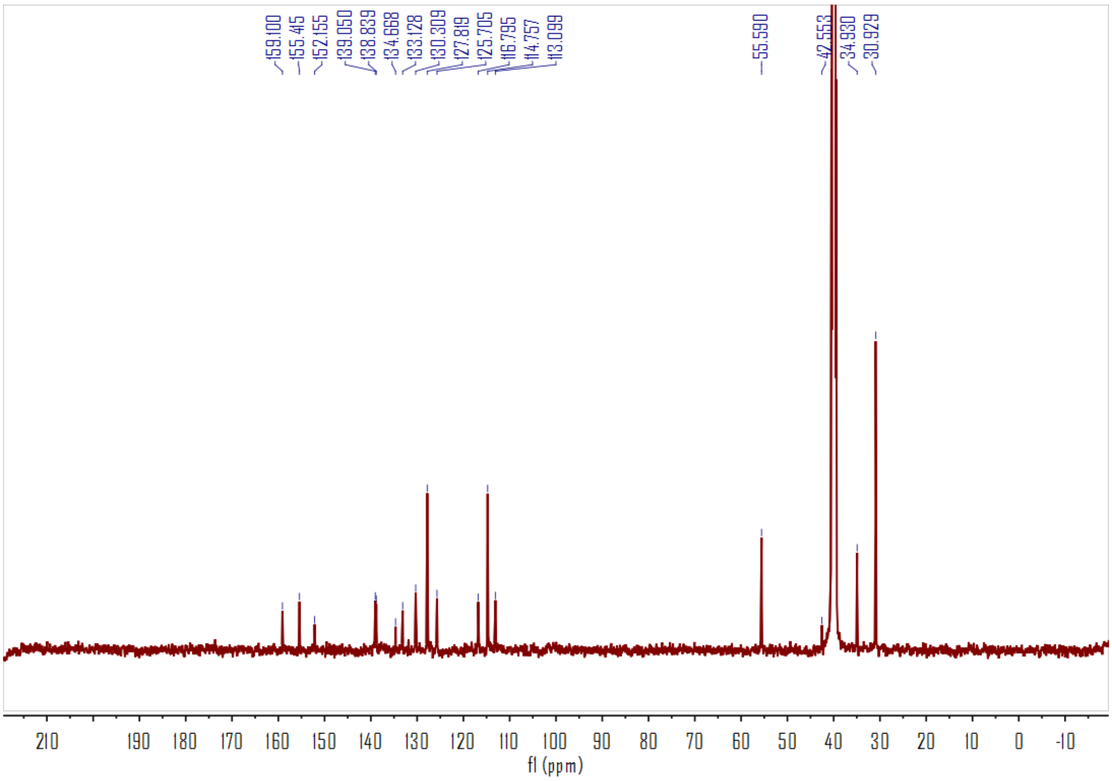

9.603
7.373
7.368
7.358
7.339
7.324
7.281
7.265
7.058
7.055
6.984
6.868
6.851
6.810
5.985
1.327
1.85
8.14
1.95
1.89
1.84
1.92
0.93
0.99
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
fl (ppm)

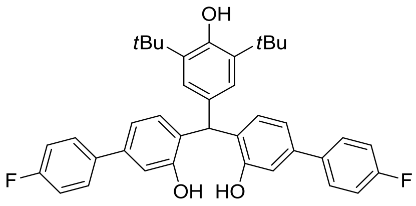

155.207
151.879
142.818
138.765
133.591
133.080
131.339
130.701
128.549
127.636
126.027
125.384
125.291
124.190
115.628
42.850
34.483
30.380
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)


OH
tBu
tBu
MeO
OH
HO
OMe

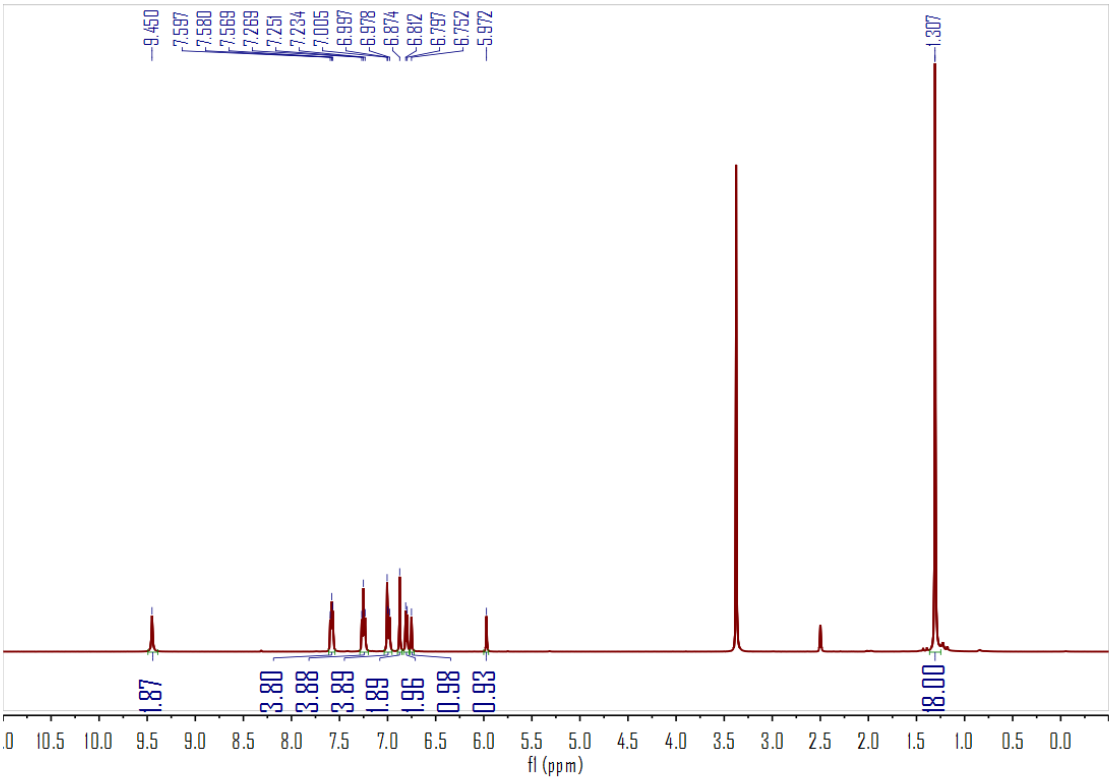
3t

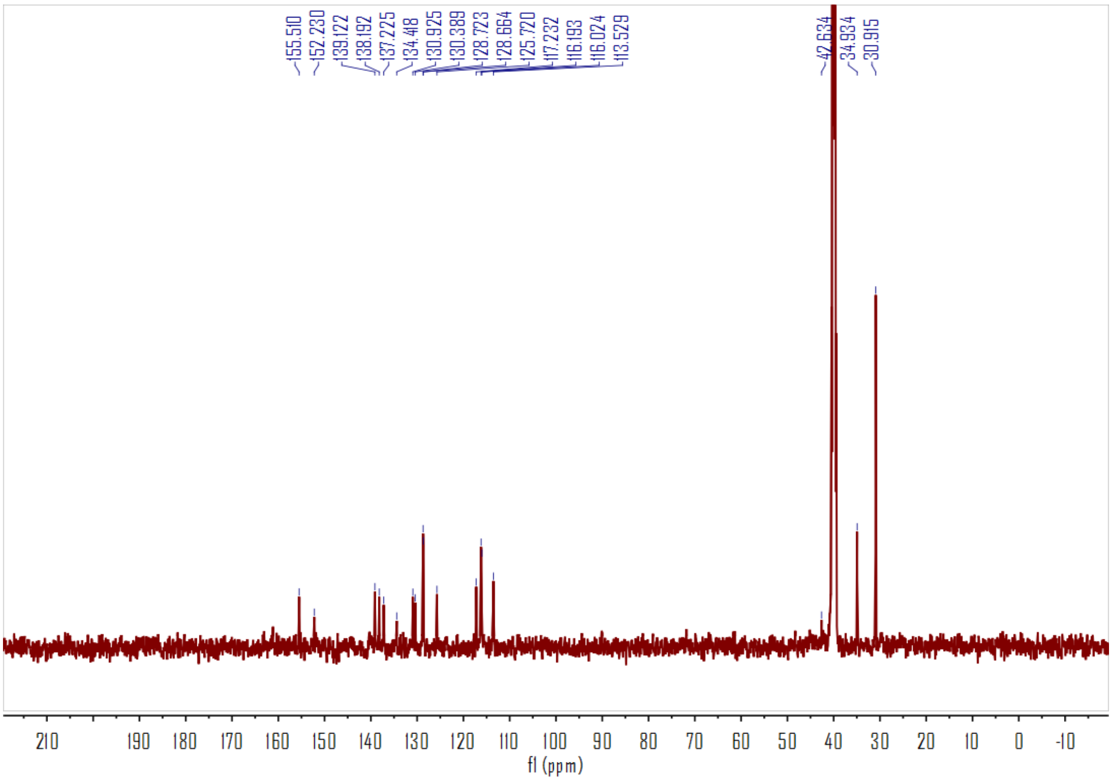

9.319
7.496
7.479
7.002
6.984
6.976
6.965
6.949
6.946
6.872
6.785
6.769
6.729
5.947
3.776
1.308
1.86
3.71
7.58
1.81
1.85
0.91
0.94
5.86
18.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

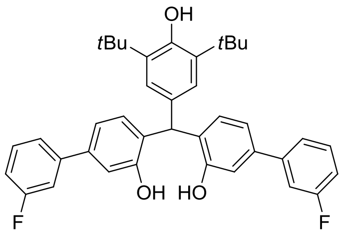

159.100
155.415
152.155
139.050
138.839
134.668
133.128
130.309
127.819
125.705
116.795
114.757
113.099
55.590
42.553
34.930
30.929
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
F
OH
HO
F

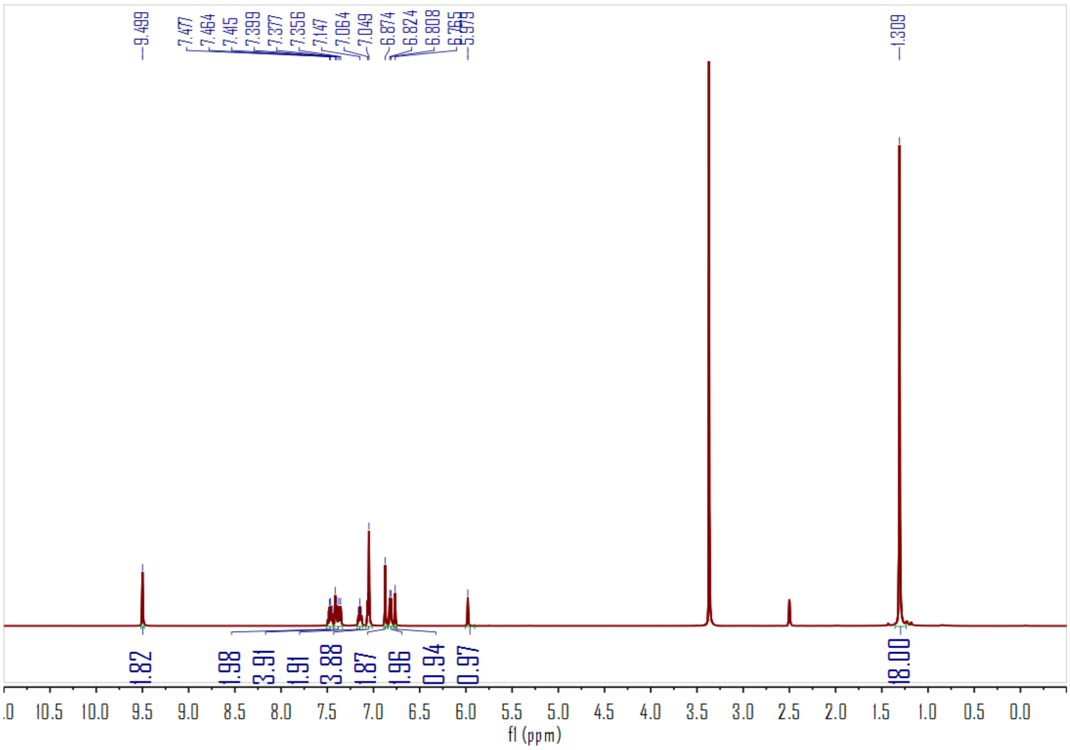
3u

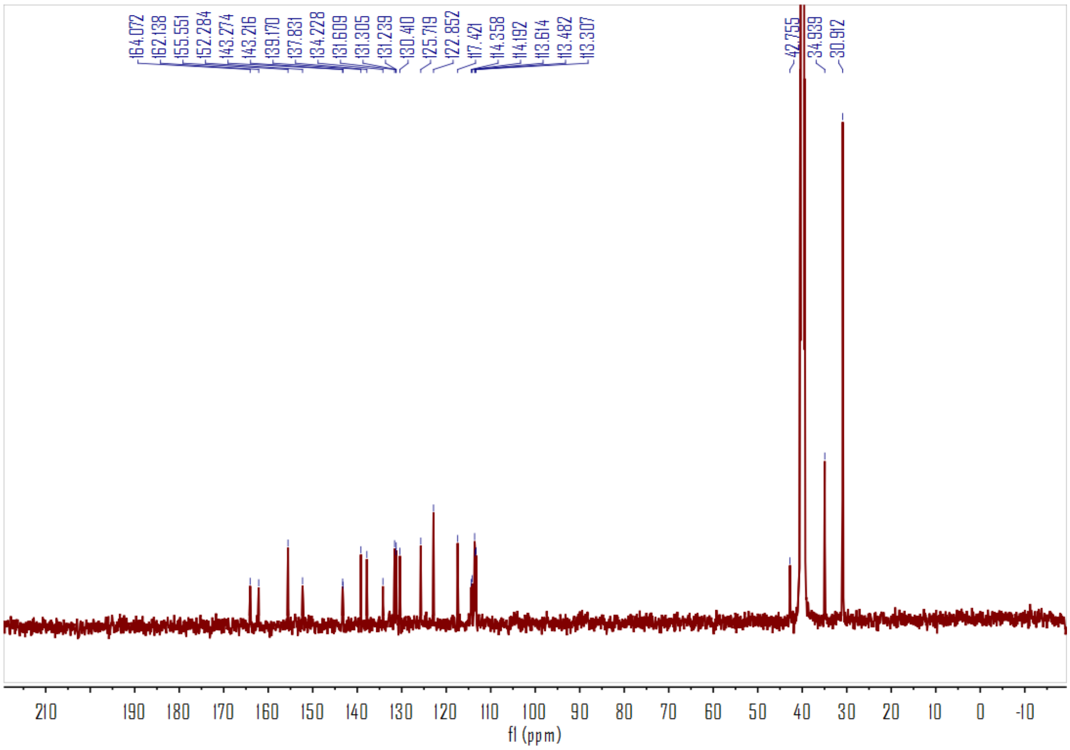

9.450
7.597
7.580
7.569
7.269
7.251
7.234
7.005
6.997
6.978
6.874
6.812
6.797
6.752
5.972
1.307
1.87
3.80
3.88
3.89
1.89
1.96
0.98
0.93
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
fl (ppm)

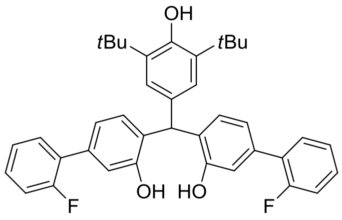

155.510
152.230
139.122
138.192
137.225
134.418
130.925
130.389
128.723
128.664
125.720
117.232
116.193
116.024
113.529
42.634
34.934
30.915
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)


OH
tBu
tBu
OH
HO
F
F

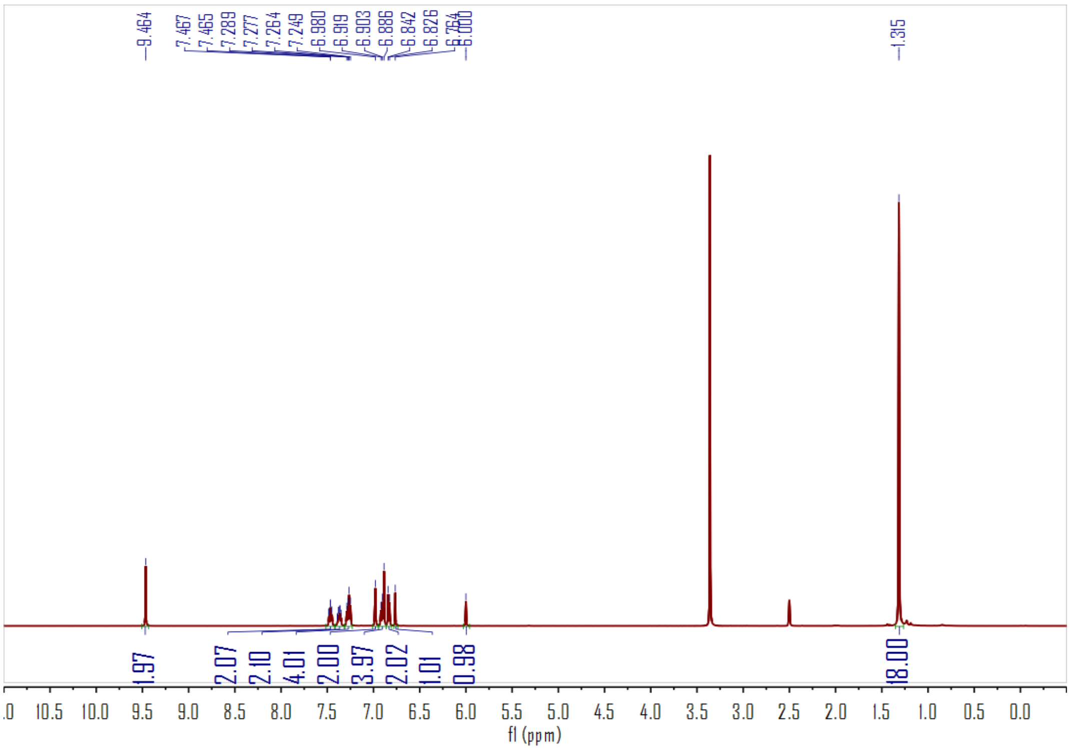
3v

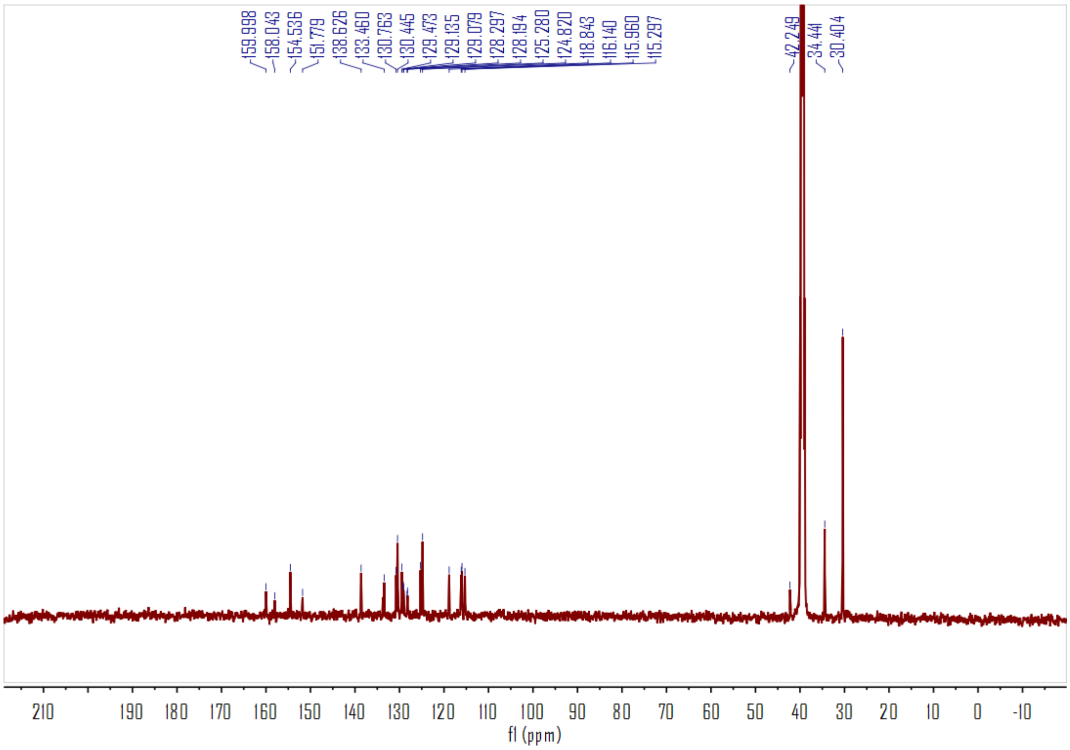

9.499
7.477
7.464
7.415
7.399
7.377
7.356
7.147
7.064
7.049
6.874
6.824
6.808
6.765
5.979
1.309
1.82
1.98
3.91
1.91
3.88
1.87
1.96
0.94
0.97
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

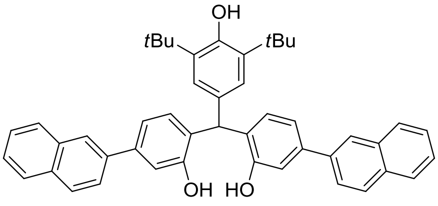

164.072
162.138
155.551
152.284
143.274
143.216
139.170
137.831
134.228
131.609
131.305
131.239
130.410
125.719
122.852
117.421
114.358
114.192
113.614
113.482
113.307
42.755
34.939
30.912
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
tBu
tBu
OH
HO
F
F

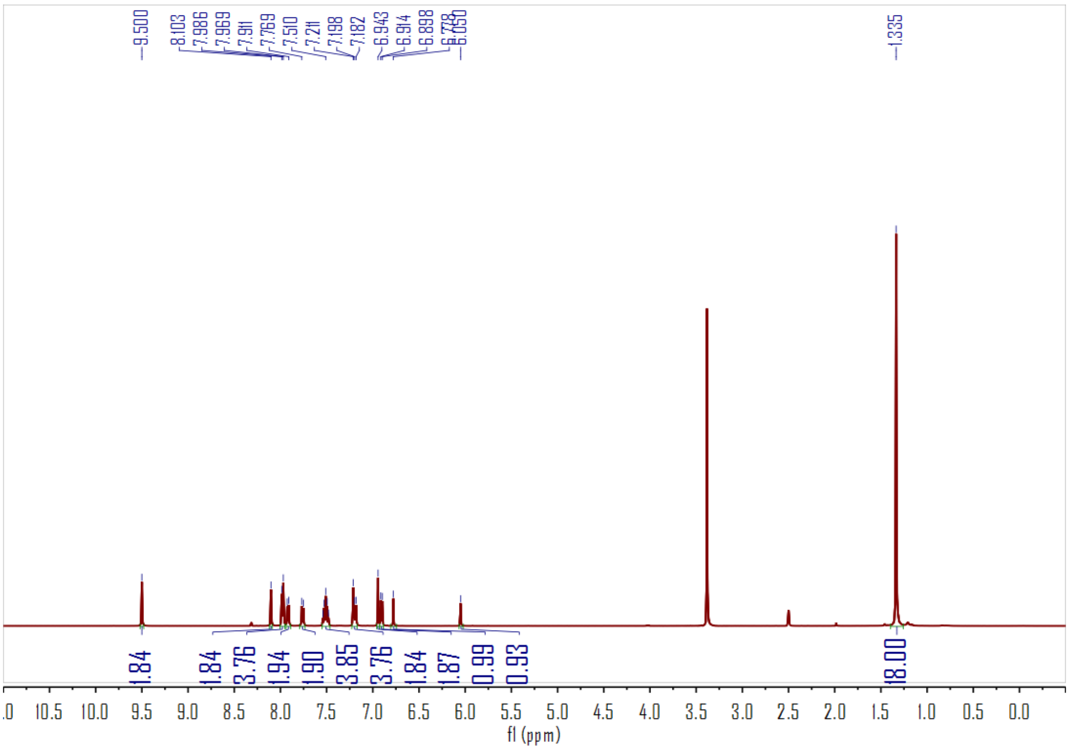
3w

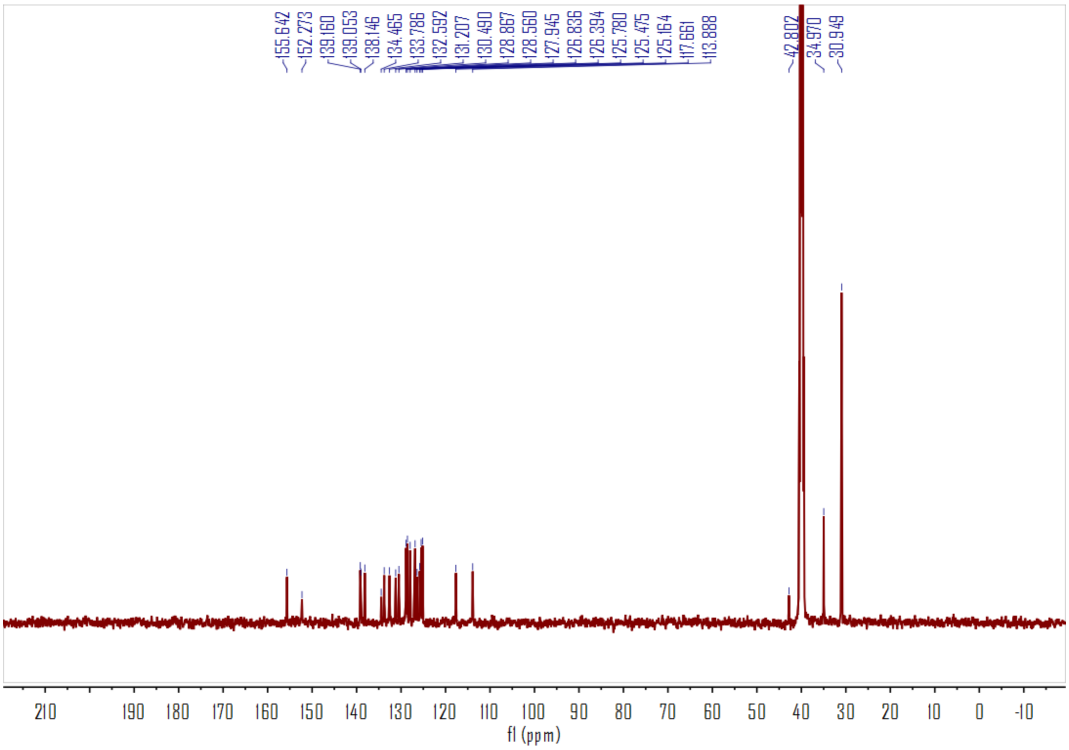

9.464
7.467
7.465
7.289
7.277
7.264
7.249
6.980
6.919
6.903
6.886
6.842
6.826
6.764
6.000
1.315
1.97
2.07
2.10
4.01
2.00
3.97
2.02
1.01
0.98
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
fl (ppm)


159.998
158.043
154.536
151.779
138.626
133.460
130.763
130.445
129.473
129.135
129.079
128.297
128.194
125.280
124.820
118.843
116.140
115.960
115.297
42.249
34.441
30.404
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)


OH
tBu
tBu
OH
HO

3x


9.500
8.103
7.986
7.969
7.911
7.769
7.510
7.211
7.198
7.182
6.943
6.914
6.898
6.778
6.050
1.335
1.84
1.84
3.76
1.94
1.90
3.85
3.76
1.84
1.87
0.99
0.93
18.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
fl (ppm)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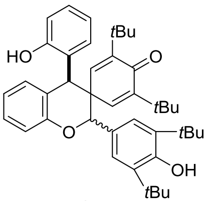
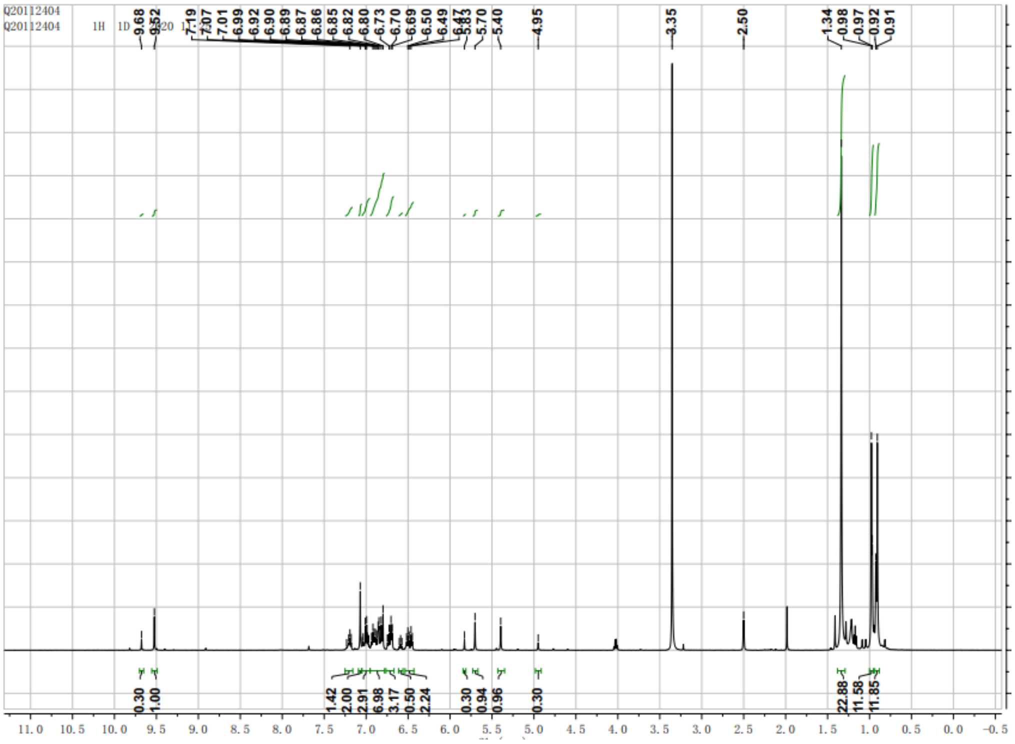
139.053
138.146
134.465
133.786
132.592
131.207
130.490
128.867
128.560
127.945
126.836
126.394
125.780
125.475
125.164
117.661
113.888
42.802
34.970
30.949
210
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
fl (ppm)


HO
tBu
O
tBu
O
tBu
OH
tBu

2a


Q20112404
Q20112404 1H 1D 2020
9.68
9.52
7.19
7.07
7.01
6.99
6.92
6.90
6.89
6.87
6.86
6.85
6.82
6.80
6.73
6.70
6.69
6.50
6.49
6.47
5.83
5.70
5.40
4.95
3.35
2.50
1.34
0.98
0.97
0.92
0.91
0.30
1.00
1.42
2.00
2.91
6.98
3.17
0.50
2.24
0.30
0.94
0.96
0.30
22.88
11.58
11.85
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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3.5
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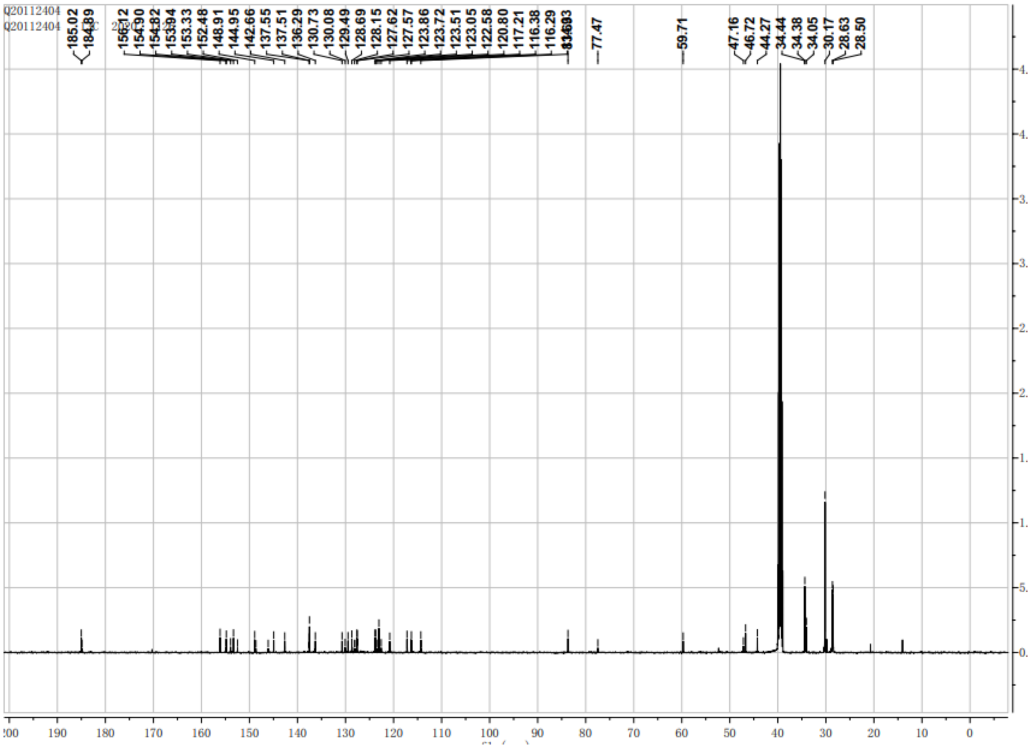
2.5
2.0
1.5
1.0
0.5
0.0
-0.5


Q20112404
Q20112404 13C 2020
185.02
184.89
156.12
154.90
154.82
153.94
153.33
152.48
148.91
144.95
142.66
137.55
137.51
136.29
130.73
130.08
129.49
128.69
128.15
127.62
127.57
123.86
123.72
123.51
123.05
122.58
120.80
117.21
116.38
116.29
83.63
77.47
59.71
47.16
46.72
44.27
34.44
34.38
34.05
30.17
28.63
28.50
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

6. References

1. (a) Zhao, K.; Zhi, Y.; Shu, T.; Valkonen, A.; Rissanen, K.; Enders, D. *Angew. Chem. Int. Ed*. **2016**, *55*, 12104-12108. (b) Liu, S.; Lan, X.-C.; Chen, K.; Hao, W.-J.; Li, G.; Tu, S.-J.; Jiang, B. *Org. Lett.* **2017**, *19*, 3831-3834.

2. Sun, P.; Gao, S.; Yang, C.; Guo, S.; Lin, A.; Yao, H.; *Org. Lett*. **2016**, *18*, 6464-6467.