Electronic Supplementary Information (ESI) for

A novel fluorescent probe for Au(III)/Au(I) ions based on an intramolecular hydroamination of a BODIPY derivatives and its application to bioimagings

Jian-Bo Wang,[a] Qing-Qing Wu,[a] Yuan-Zeng Min,[b] Yang-Zhong Liu,[b] Qin-Hua Song*[a]

[a]*Department of Chemistry,* [b]*CAS Key Laboratory of Soft Matter Chemistry, University of Science and Technology of China, Hefei 230026, China*

E-mail:qhsong@ustc.edu.cn

Table of Contents

I. **General methods**

General chemicals were of the best grade available and were used without further purification. ^{1}H and ^{13}C NMR spectra were measured with a Bruker AV spectrometer operating at 300M and 75MHz, respectively and chemical shifts were reported in ppm using tetramethylsilane (TMS) as the internal standard. FT-IR spectra were measured with a Bruker Vector22 Infrared Spectrometer. Mass spectra were obtained with a Micromass GCF TOF mass spectrometer. UV-vis absorption and fluorescence emission spectra were performed at room temperature with a Shimadzu UV-2450 UV–vis spectrometer and Perkin-Elmer Instruments LS55 Luminescence Spectrometer, respectively.

Cell culture and fluorescence imaging HeLa cells were grown in Dulbecco's modified eagle Medium supplemented with 10% fetal calf serum, 1% penicillin, and 10000 unit/mL of streptomycin at 37ºC under humidified air containing 5% CO_2. Cells (50000) were located and stabilized in a single well of 24-well plate. Fluorescence imaging of the cells treated with probe **1** and Au^{3+} were undertaken by a confocal microscope (Zeiss LSM 510 Meta NLO), excitation wavelength was 480nm.

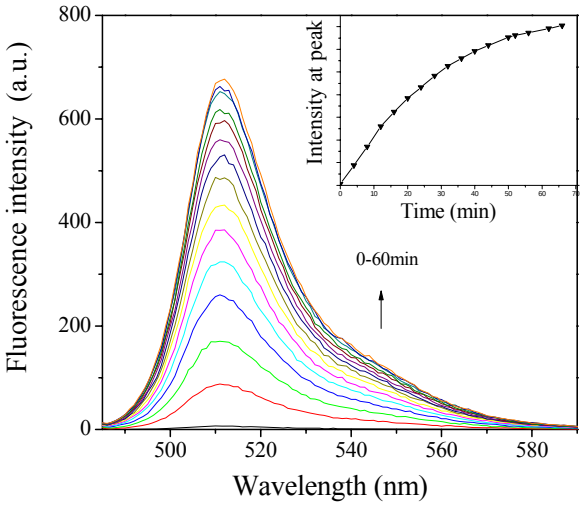


Figure S1 Time-dependent fluorescence spectral changes of probe **1** (5 μM) with addition of 5.0 equiv Au^{+} in EtOH/0.01M PBS buffer (1:1, v/v, pH 7.4), excitation at 480 nm. Insert : Time dependent fluorescence intensity changes (at 511nm) of **1** with Au^{+}.

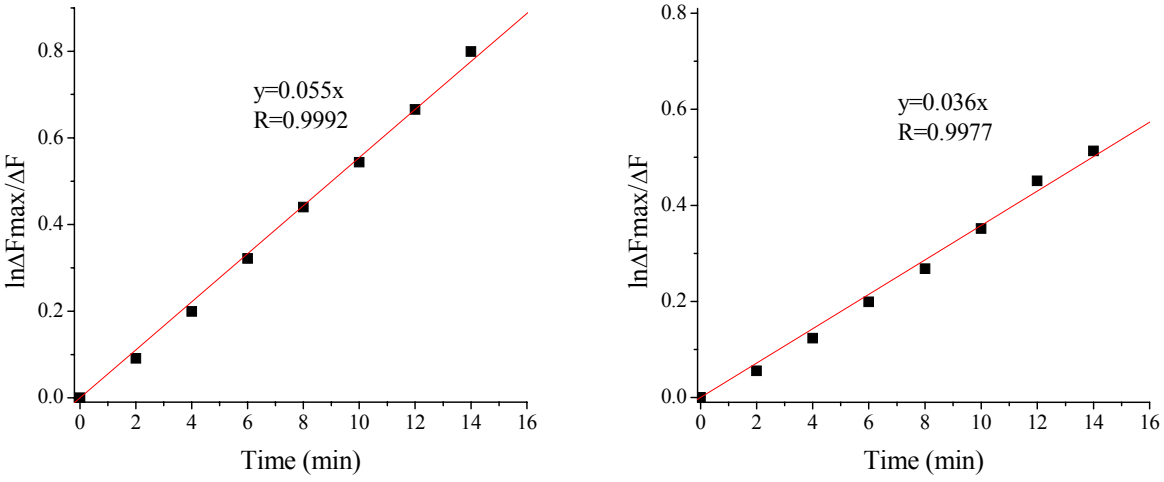


Figure S2 Kinetic analysis of probe **1** (5 μM) with 5 equiv. of gold ions in EtOH/0.01M PBS buffer (1:1, v/v, pH 7.4). Left: Au^{3+}; right: Au^{+}.

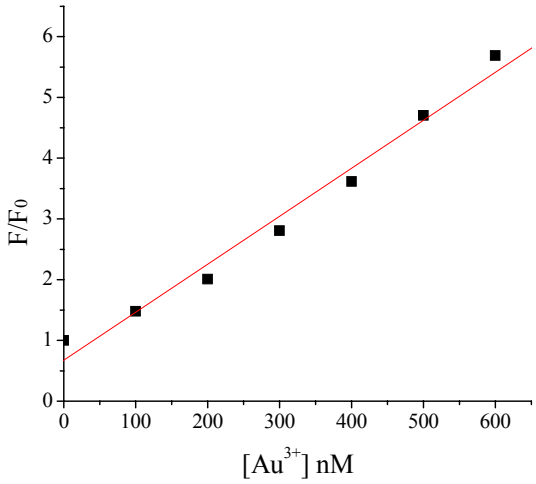


Figure S3 Fluorescence intensity changes (F/F_0 at 511nm) of probe **1** (5 μM) with $AuCl_3$ (in the range of 0.1 μM - 0.6 μM) in EtOH/0.01M PBS buffer (1:1, v/v, pH 7.4), excitation at 480 nm. All the fluorescence data were observed after 30 min.

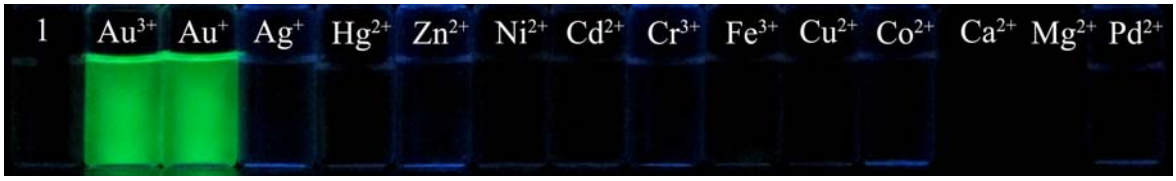


Figure S4 Fluorescence photographs of probe **1** (5 μM) with 5 equiv. of different metal ions in EtOH/0.01M PBS buffer (1:1, v/v, pH 7.4).

II. Synthesis Procedures and Characterization of New Compounds

Starting materials 2-bromo-1-iodo-4-methylbenzene[1], 4-bromo-3-nitrobenzaldehyde [2] and 3, 5-dimethyl-4-(ethoxycarbonyl)pyrrole [3] were prepared according to published procedures. All other chemical were purchased from commercial suppliers and were used as received without further purification.

3-(2-bromo-4-methylphenyl)prop-2-yn-1-ol (3): $Pd(PPh_3)_2Cl_2$ (165 mg, 5 mol%) and CuI (89 mg, 10 mol%) were placed in a two necked dry round bottom flask equipped with magnetic stir bar. The flask was evacuated and refilled with N_2 three times. The 2-bromo-1-iodo-4-methylbenzene (1.4 g, 4.7 mmol) and progargyl alcohol (318 mg, 5.7 mmol) were dissolved in triethylamine (25 ml) and added to the flask with the catalyst. The mixture was stirred at room temperature for 12 h and was stopped by addition of water and ethyl acetate (EtOAc). The organic phase was separated, washed several times with water, dried over $MgSO_4$ and evaporated. Purified using flash chromatography and **3** was obtained as yellow oil (0.68 g, 64%). R_f = 0.45, (EtOAc / petroleum ether 1:5); IR: nu(tilde) = 3343s, 2921m, 2964m, 2227m, 1600s, 1488s, 1025s, 819s cm^{-1}; ^1H NMR (300Hz, $CDCl_3$): δ = 7.41 (s, 1H), 7.35 (d, *J*=7.8Hz, 1H), 7.06 (d, *J*=7.8Hz, 1H), 4.54 (s, 2H), 2.33 (s, 3H), 1.69 (s, 1H); ^{13}C NMR (75Hz, $CDCl_3$): δ = 140.2, 133.1, 132.7, 127.8, 125.0, 121.4, 90.9, 84.1, 51.5, 20.9; TOFMS (EI) calcd for (M^+) $C_{10}H_9OBr$: 223.9837, found 223.9825.

2-bromo-1-(3-methoxyprop-1-ynyl)-4-methylbenzene (4): The compound **3** (2.7 g, 12 mmol) was dissolved in THF (25 ml) and the solution was cooled to 0ºC with an ice bath before NaH (60% in mineral oil) (0.58 g, 14.4 mmol) was added portion wise. The mixture was stirred at this temperature 30 min. Then, MeI (0.9 ml, 14.4 mmol) was added and the reaction was stirred at room temperature for additional 12 h. The reaction was stopped by addition of sat.NH_4Cl solution and EtOAc. The organic phase was separated, washed several times with water, dried over $MgSO_4$ and

evaporated. Purified using flash chromatography and **4** as yellow oil was obtained (2.5g. 87%). R_f = 0.42, (petroleum ether); IR: nu(tilde) = 2926m, 2821m, 2229m, 1600s, 1488s, 1356s, 1100s, 819s cm^{-1}; ^1H NMR (300Hz, $CDCl_3$): δ = 7.41 (s, 1H), 7.36 (d, *J*=7.8Hz, 1H), 7.06 (d, *J*=7.8Hz, 1H), 4.37 (s, 2H), 3.49 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (75Hz, $CDCl_3$): δ = 140.1, 133.1, 132.7, 127.7, 125.1, 121.6, 88.7, 84.8, 60.2, 57.5, 20.9; TOFMS (EI) calcd for (M^+) $C_{11}H_{11}OBr$: 237.9993, found 237.9988.

2'-(3-methoxyprop-1-yn-1-yl)-5'-methyl-2-nitro-[1,1'-biphenyl]-4-carbaldehyde (5): n-BuLi (3.7 ml, 2.2 M, 8.1mmol, 1.2 eq) was added dropwise to a solution of compound **4** (1.6 g, 6.7 mmol) in anhyd THF (30 mL) at –78˚C. The mixture was stirred at this temperature for 30 min, then $B(O^iPr)_3$ (13.4 mmol, 2eq) was added and the mixture was stirred for 16 h while allowing the temperature to rise to 20˚C**.** The HCl (24 mL, 2 M) was added, the organic layer separated, the aqueous layer extracted with diethyl ether (50 ml) three times, the combined organic layer dried over $MgSO_4$, and concentrated under reduce pressure. The product was obtained as white solid by flash chromatography (0.62g. 45%) and was used directly for next step reaction.

Boronic acid (0.62 g, 3 mmol), 4-bromo-3-nitrobenzaldehyde (0.71g, 3.1 mmol) and $Pd(PPh_3)_4$ (0.22 g, 0.31 mmol, 10 mol%) were added into a 100 mL flask. Degassed toluene (40 mL), ethanol (20 ml) and degassed aqueous K_2CO_3 solution (5 mL, 2 M) was then added into the flask. The solution was kept at 80˚C and stirred vigorously under nitrogen for 24 h. The resulting solution was extracted with excess CH_2Cl_2, dried by $MgSO_4$, and evaporated. Purified by flash chromatography and **5** was obtained as a white solid (0.67g, 66%). R_f = 0.28, (EtOAc / petroleum ether 1:10); IR (KBr): nu(tilde) = 2946m, 2876m, 2228m, 1702s, 1530s, 1353s, 1100s, 946s, 828s cm^{-1}; ^1H NMR (300Hz, $CDCl_3$): δ =10.13 (s, 1H), 8.51 (d, *J*=1.2Hz, 1H), 8.17-8.14 (m, 1H), 7.62 (d, *J*=7.8Hz, 1H), 7.45 (d, *J*=7.8Hz, 1H), 7.26-7.20 (m, 1H), 7.13 (s, 1H), 4.09 (s, 2H), 3.19 (s, 3H), 2.42 (s, 3H); ^{13}C

NMR (75Hz, $CDCl_3$): δ = 189.4, 149.2, 140.8, 140.7, 139.0, 135.9, 133.5, 132.3, 132.0, 129.2, 128.5, 124.8, 117.9, 88.5, 83.6, 59.7, 56.9, 21.1; TOFMS (EI) calcd for (M^+) $C_{18}H_{15}NO_4$: 309.1001, found 309.0999.

2,8-bis(ethoxycarbonyl)-5,5-difluoro-10-(2'-(3-methoxyprop-1-yn-1-yl)-5'-methyl-2-nitro-[1,1'-biphenyl]-4-yl)-1,3,7,9-tetramethyl-5H-dipyrrolo[1,2-c:2',1'-f][1,3,2]diazaborinin-4-ium-5-uide (6): The compound **5** (0.54 g, 1.7 mmol) and 3,5-dimethyl-4-(ethoxycarbonyl)pyrrole (0.58 g, 3.5 mmol) were dissolved in 150 ml of absolute CH_2Cl_2 under an N_2 atmosphere. Three drop of TFA was added, and the solution was stirred at room temperature overnight. When TLC monitoring showed complete consumption of **5**, a solution of DDQ (0.43 g, 1.9 mmol) in CH_2Cl_2 was added, and stirring was continued for 20 min. The reaction mixture was washed with water, dried over Na_2SO_4, filtered, and evaporated. The compound was purified by short column chromatography over alumina (CH_2Cl_2). The brown powder thus obtained and TEA (4 ml, 28 mmol) were dissolved in 200 ml of toluene under an N_2 atmosphere. Then BF_3-Et_2O (4 ml, 32 mmol) was added, and the solution was stirred at room temperature for 30 min. The reaction mixture was washed with water, dried over Na_2SO_4, filtered, and evaporated. Purified using flash chromatography and **6** as a red solid was obtained (0.28g, 24%). R_f = 0.47, (EtOAc / petroleum ether 1:4); IR (KBr): nu(tilde) = 2983m, 2932m, 1706s, 1530s, 1315s, 1187s, 1007s, 564s cm^{-1}; ^1H NMR (300Hz, $CDCl_3$): δ =8.02 (s, 1H), 7.65-7.61 (m, 2H), 7.48 (d, *J*=7.8Hz, 1H), 7.26-7.21 (m, 2H), 4.34-4.27(m, 4H), 4.07 (s, 2H), 3.31 (s, 3H), 2.86 (s, 6H), 2.45 (s, 3H), 1.80 (s, 6H), 1.35 (t, *J*=7.2Hz, 6H); ^{13}C NMR (75Hz, $CDCl_3$): δ =163.8, 160.4, 149.6, 146.8, 141.5, 139.2, 139.1, 137.2, 134.8, 134.0, 132.4, 132.0, 131.0, 129.3, 128.8, 124.0, 123.0, 118.4, 88.5, 83.7, 60.3, 59.9, 57.5, 21.3, 14.9, 14.1, 14.0; HRMS (ESI) calcd for $(M+H)^+$ $C_{36}H_{37}O_7BN_3F_2$: 672.2687, found 672.2685.

10-(2-amino-2'-(3-methoxyprop-1-yn-1-yl)-5'-methyl-[1,1'-biphenyl]-4-yl)-2,8-bis(ethoxycarbo

nyl)-5,5-difluoro-1,3,7,9-tetramethyl-5H-dipyrrolo[1,2-c:2',1'-f][1,3,2]diazaborinin-4-ium-5-ui de (1): Tin(II) chloride (168 mg, 0.75mmol) and con. HCl (1ml) were added to a solution of compound **6** (50mg, 0.075mmol) in THF-EtOH (1:1, 14 ml), and the reaction mixture was stirred for 6 h. A sat.solution of K_2CO_3 was added and the reaction mixture was partitioned between EtOAc (40.0 ml) and water (10ml). The organic phase was separated, washed several times with water, dried over $MgSO_4$ and evaporated. Purified using flash chromatography and **1** as a red solid was obtained (36mg, 75%). R_f = 0.27, (EtOAc / petroleum ether 1:4); IR (KBr): nu(tilde) = 3482m, 3382m, 2980m, 2932m, 1710s, 1689s, 1619s, 1521s, 1314s, 1186s 1109s, 1010, 566s cm^{-1}; ^1H NMR (300Hz, $CDCl_3$): δ =7.51 (d, *J*=7.8Hz, 1H), 7.30-7.18 (m, 3H), 6.84-6.78 (m, 2H), 4.33-4.26 (m, 4H), 4.10 (s, 2H), 3.33 (s, 3H), 2.84 (s, 6H), 2.41 (s, 3H), 1.91 (s, 6H), 1.34 (t, *J*=7.2Hz, 6H); ^{13}C NMR (75Hz, $CDCl_3$): δ =164.2, 159.2, 147.7, 146.2, 145.2, 140.4, 139.3, 134.4, 133.2, 131.8, 131.3, 130.7, 128.7, 127.9, 122.3, 119.3, 116.8, 113.9, 87.4, 84.7, 60.1, 60.0, 57.5, 21.3, 14.8, 14.2, 13.6; HRMS (ESI) calcd for $(M+H)^+$ $C_{36}H_{39}O_5BN_3F_2$: 642.2945, found 642.2938.

2,8-bis(ethoxycarbonyl)-5,5-difluoro-10-(6-(2-methoxyethyl)-9-methylphenanthridin-3-yl)-1,3, 7,9-tetramethyl-5H-dipyrrolo[1,2-c:2',1'-f][1,3,2]diazaborinin-4-ium-5-uide (2): $AuCl_3$ (10 mmol%) was added to the solution of compound **1** (20 mg, 0.031 mmol) in 20ml EtOH, and the reaction mixture was stirred for 4h. The solvent was evaporated and water (30ml) was added. The aqueous phase was extracted with EtOAc, the combined organic extract was dried over $MgSO_4$ and evaporated. Purified using flash chromatography and **2** as a red solid was obtained (9 mg, 45%). R_f = 0.31, (EtOAc / petroleum ether 1:4); IR (KBr): nu(tilde) = 3439m, 2962m, 2925m, 1709s, 1628s, 1523s, 1314s, 1184s 1118s, 1075s, 562s cm^{-1}; ^1H NMR (300Hz, $CDCl_3$): δ = 8.80 (d, *J*=8.7Hz, 1H), 8.57 (s, 1H), 8.46 (d, *J*=6.9Hz, 1H), 7.77-7.70 (m, 2H), 7.54-7.51 (m, 1H), 4.31 (t, *J*=6.9Hz, 2H), 4.29-4.22 (m, 4H), 4.10-4.08 (m, 2H), 3.37 (s, 3H), 2.86 (s, 6H), 2.76 (s, 3H), 1.61 (s, 6H), 1.30 (t,

J=6.9Hz, 6H); HRMS (ESI) calcd for $(M+H)^+$ $C_{36}H_{39}O_5BN_3F_2$: 642.2945, found 642.2949.

References

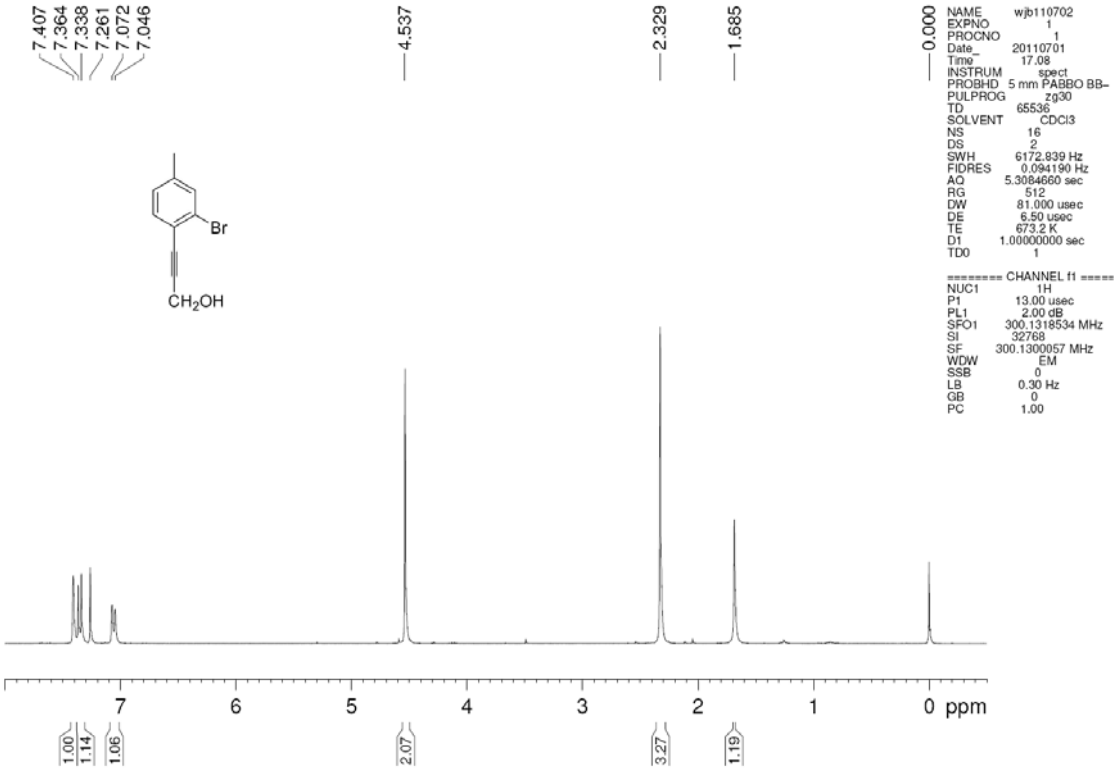
1. R. S. Liu, H. K. Chang, S. Datta, A. Das and A. Odedra, *Angew. Chem. Int. Edit.*, 2007, **46**, 4744.

2. P. Swoboda, R. Saf, K. Hummel, F. Hofer and R. Czaputa, *Macromolecules*, 1995, **28**, 4255.

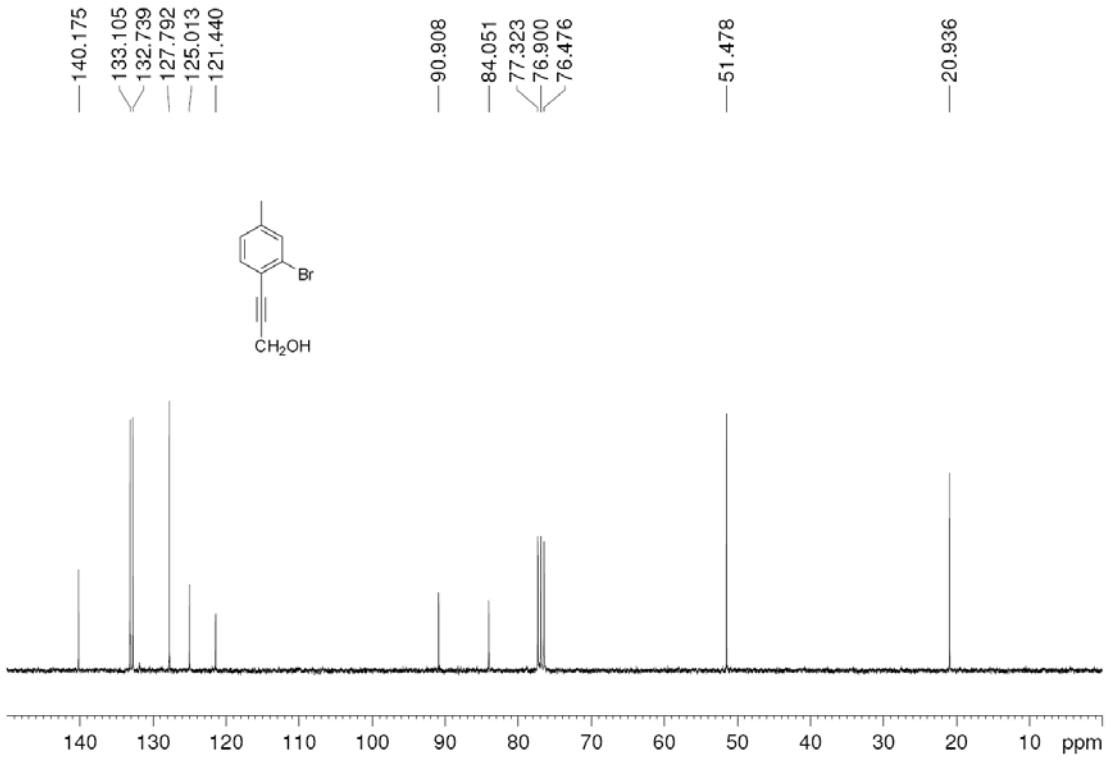
3. S. C. Burdette, D. P. Kennedy and C. M. Kormos, *J. Am. Chem. Soc.*, 2009, **131**, 8578.

III. Copies of ^{1}H and ^{13}C NMR Spectra of New Compounds

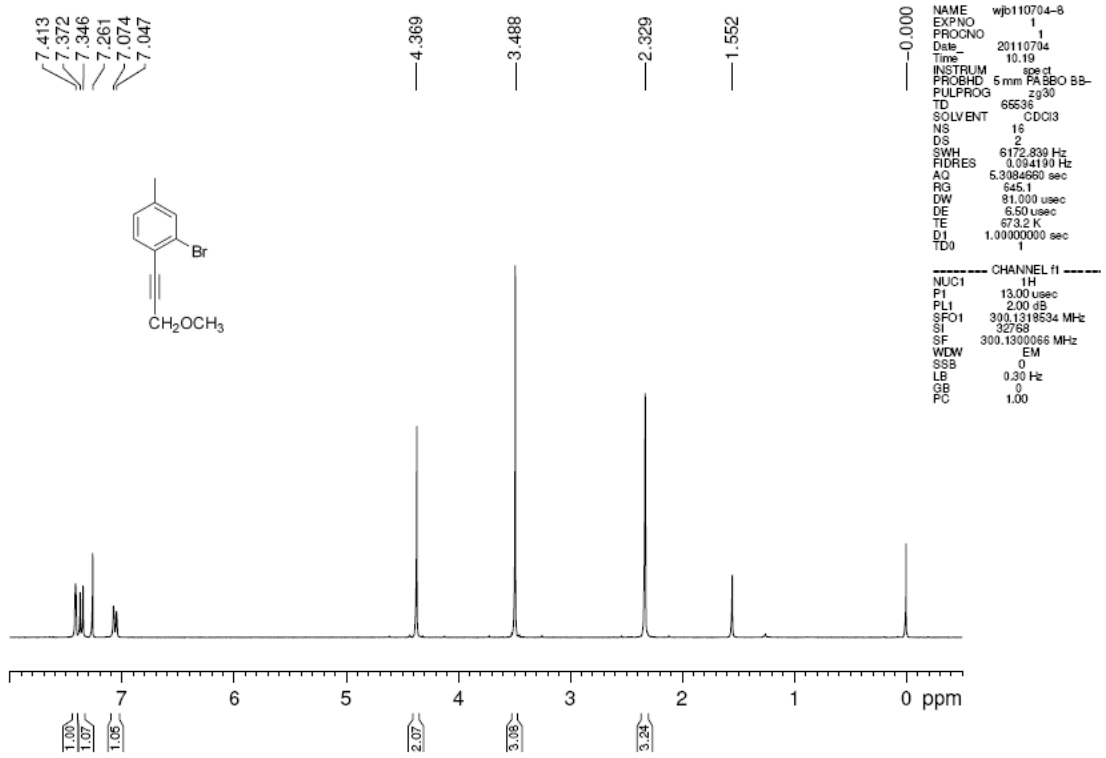
^{1}H NMR (300 MHz) spectra of compound **3**



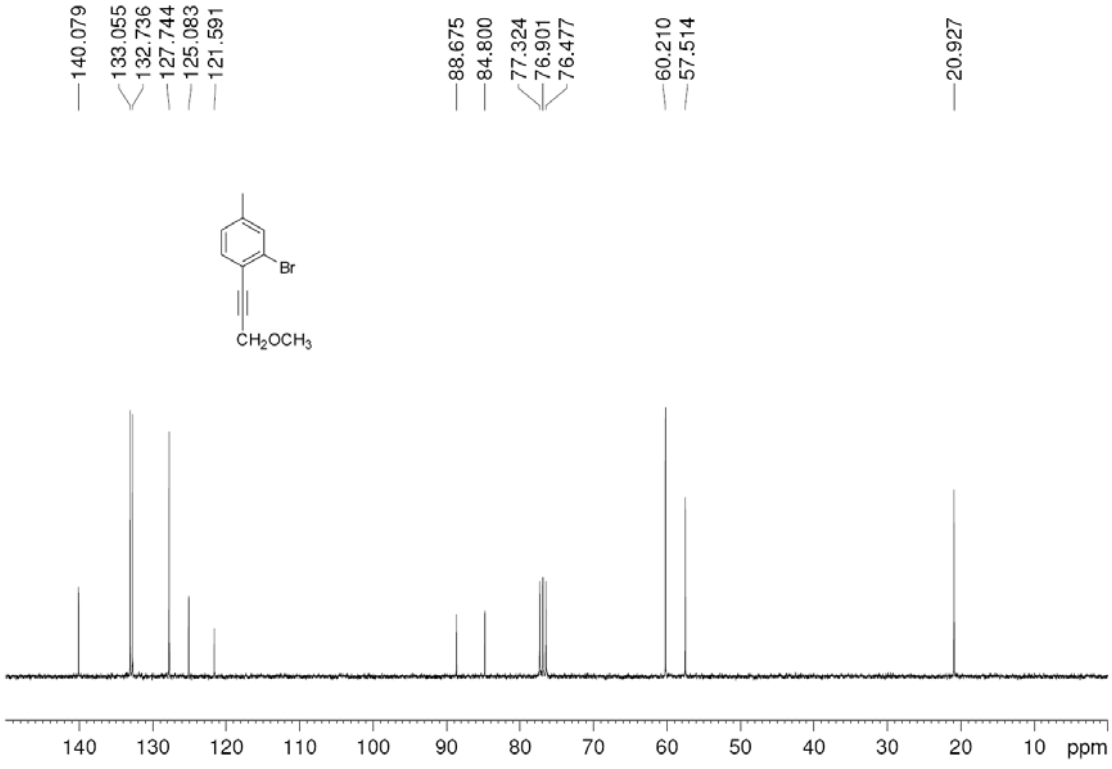
^{13}C NMR (75 MHz) spectra of compound **3**



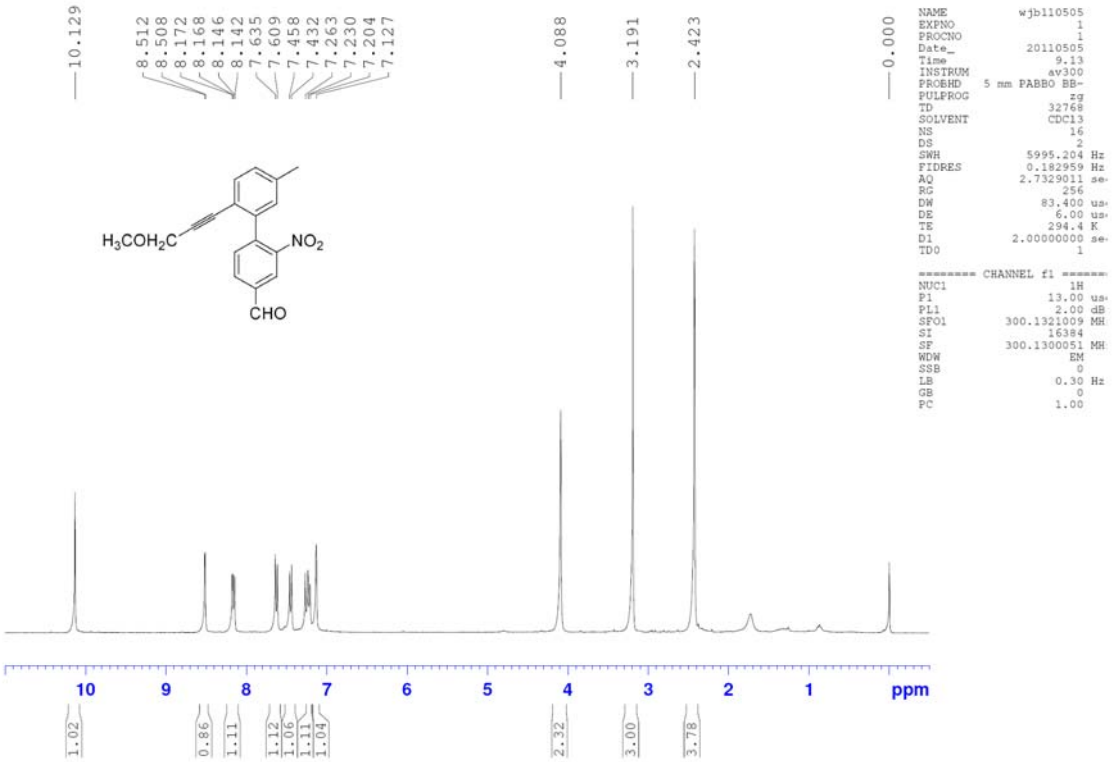
^{1}H NMR (300 MHz) spectra of compound **4**



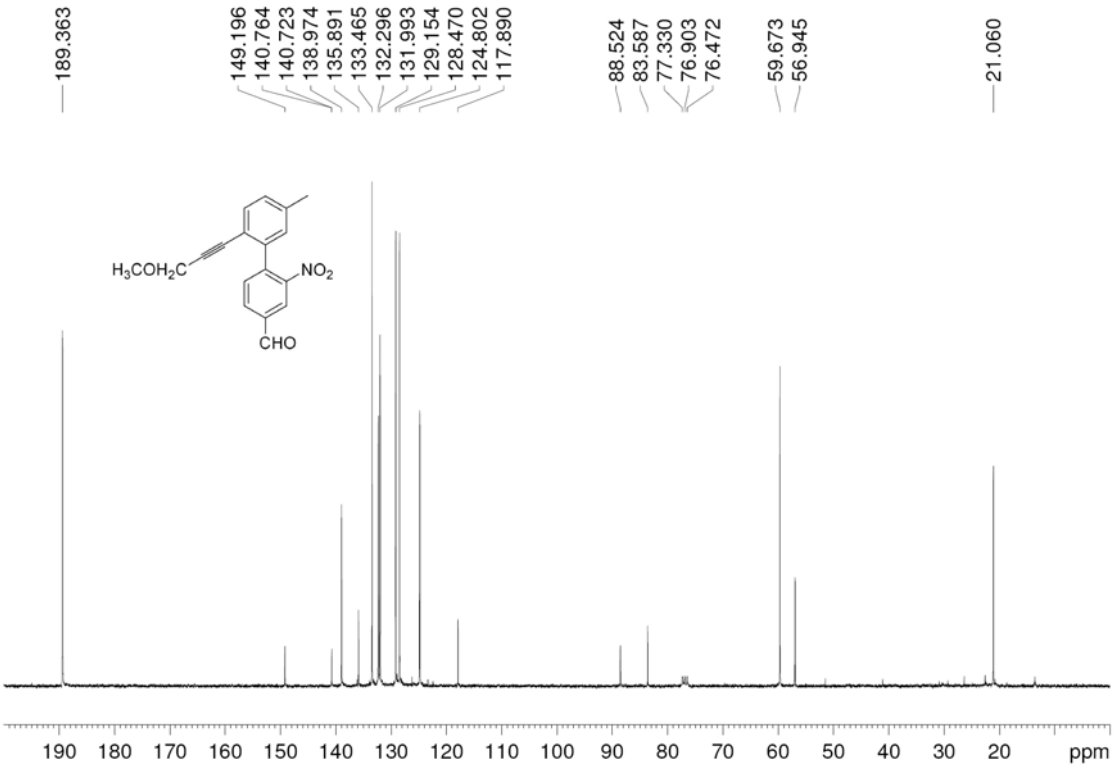
^{13}C NMR (75 MHz) spectra of compound **4**



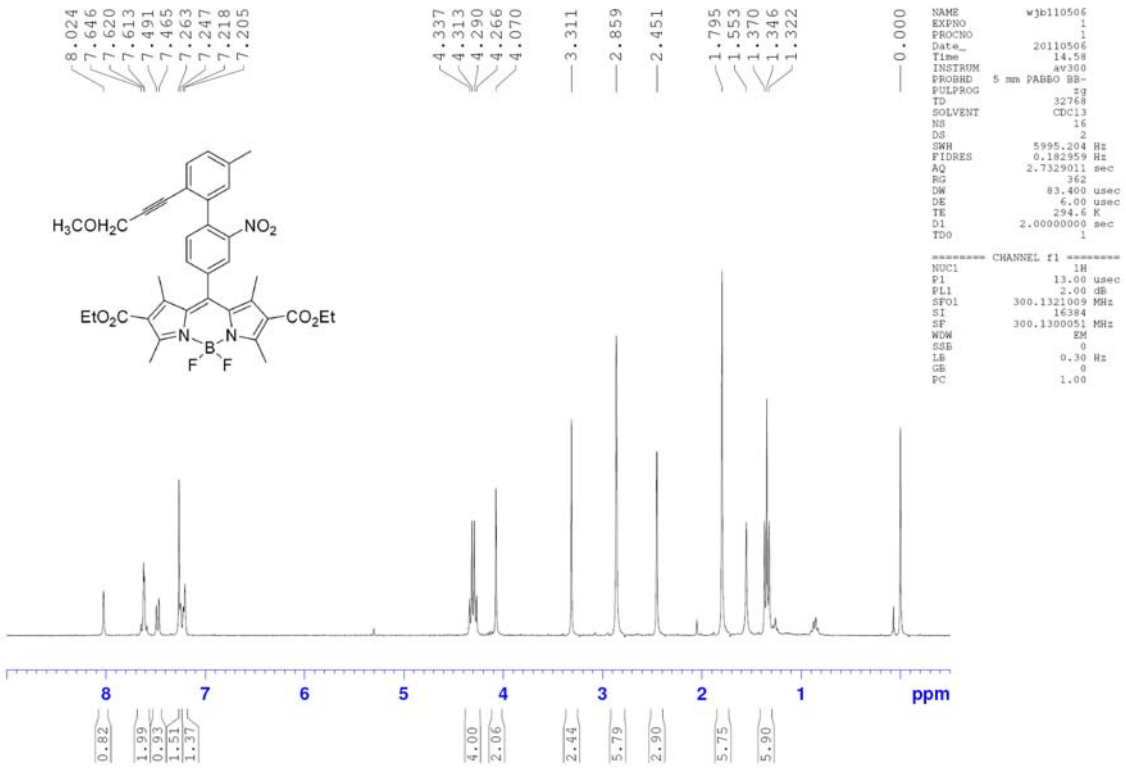
^{1}H NMR (300 MHz) spectra of compound **5**



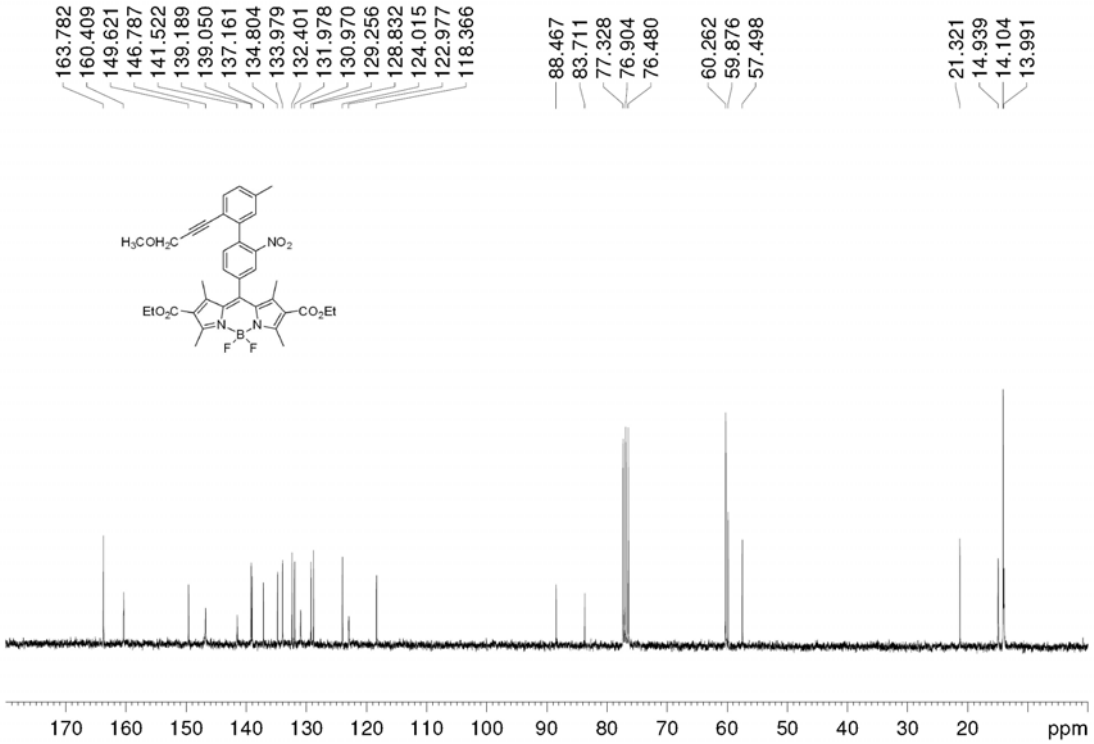
^{13}C NMR (75 MHz) spectra of compound **5**



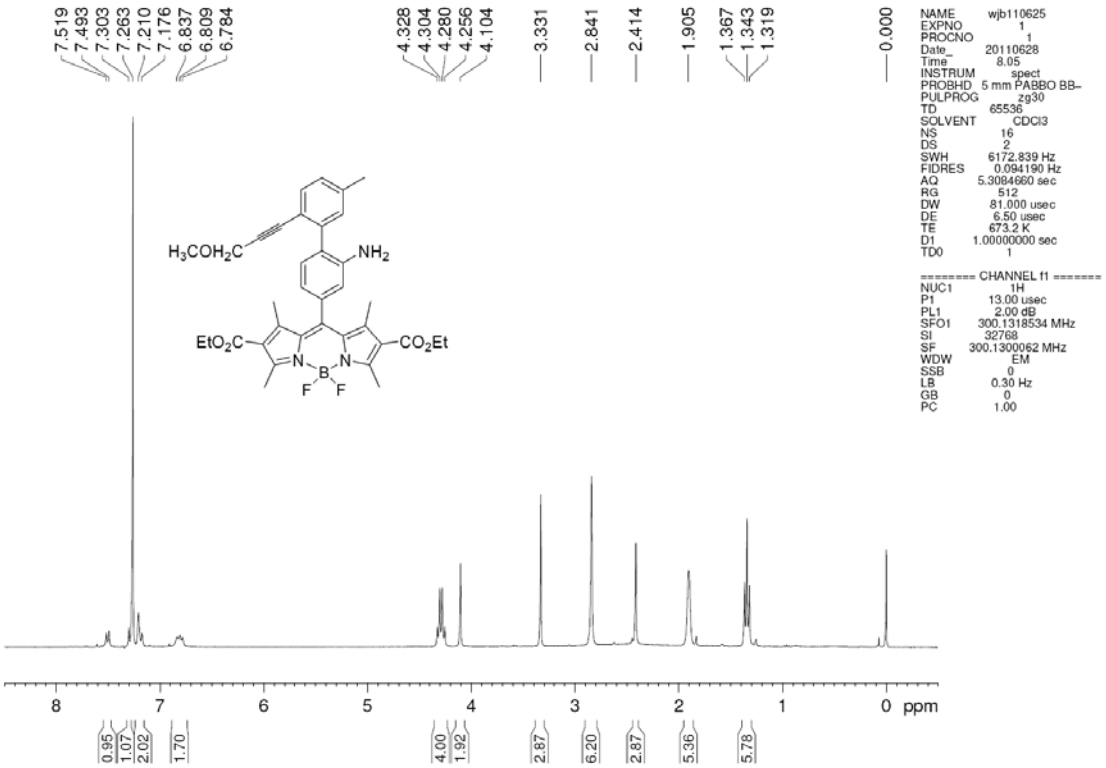
^{1}H NMR (300 MHz) spectra of compound **6**



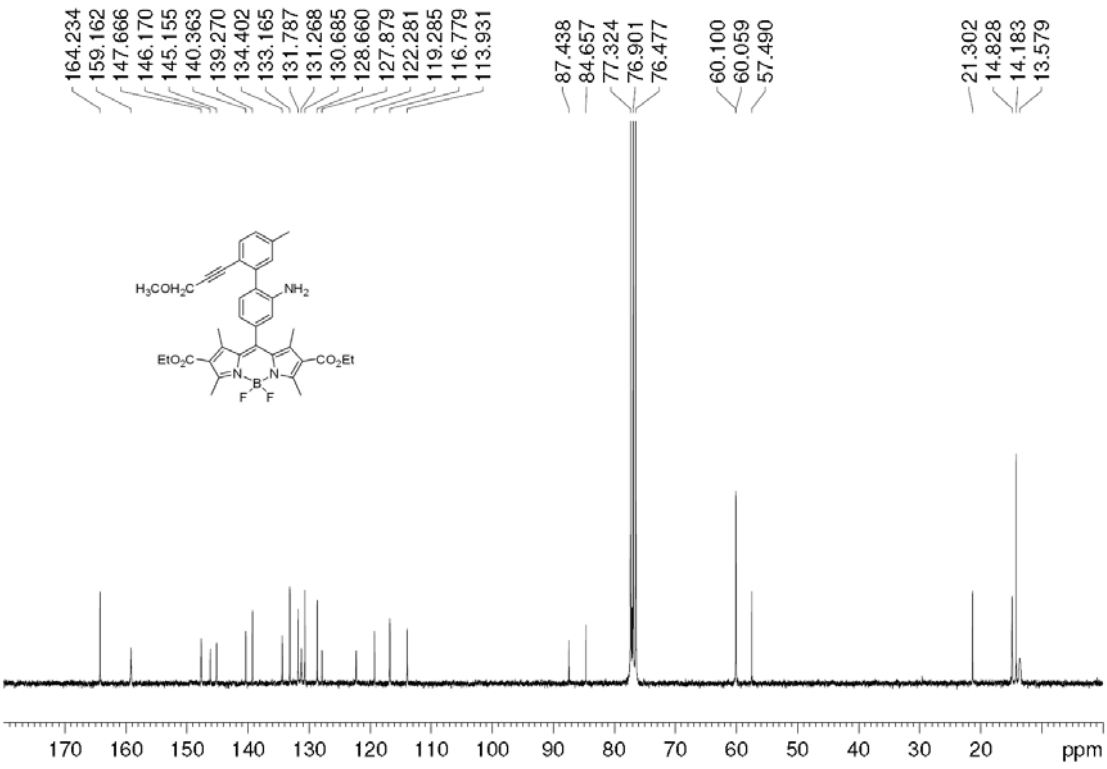
^{13}C NMR (75 MHz) spectra of compound **6**



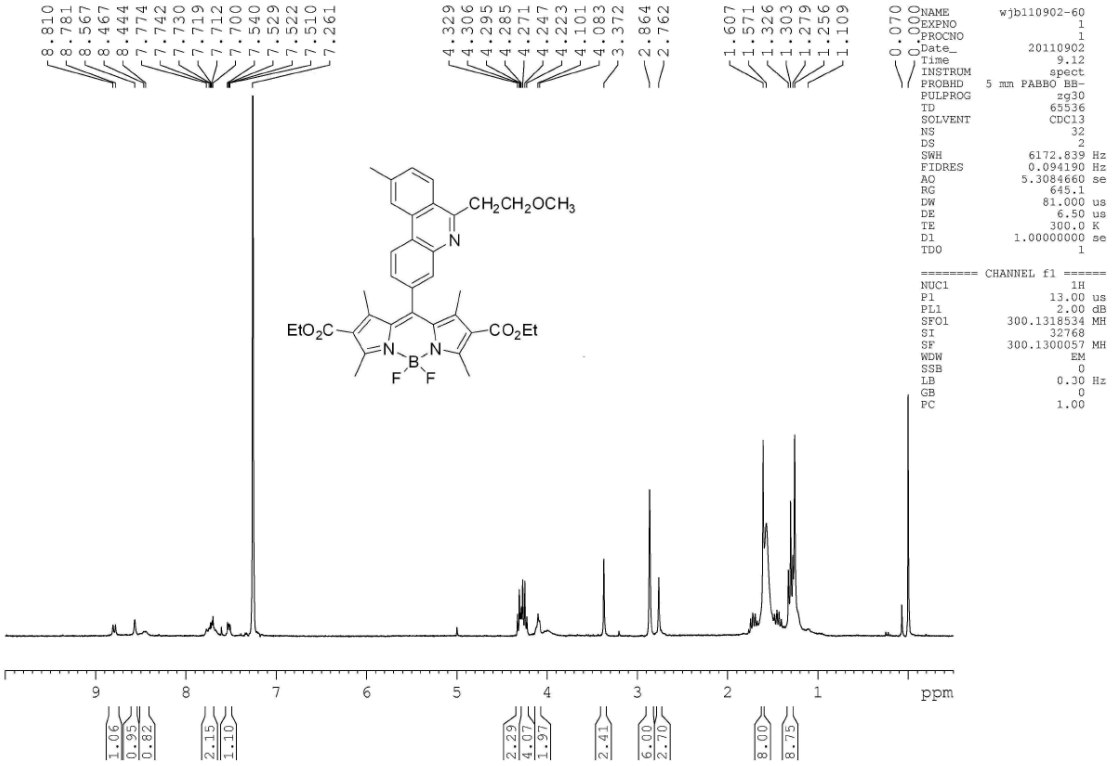
^{1}H NMR (300 MHz) spectra of compound **1**



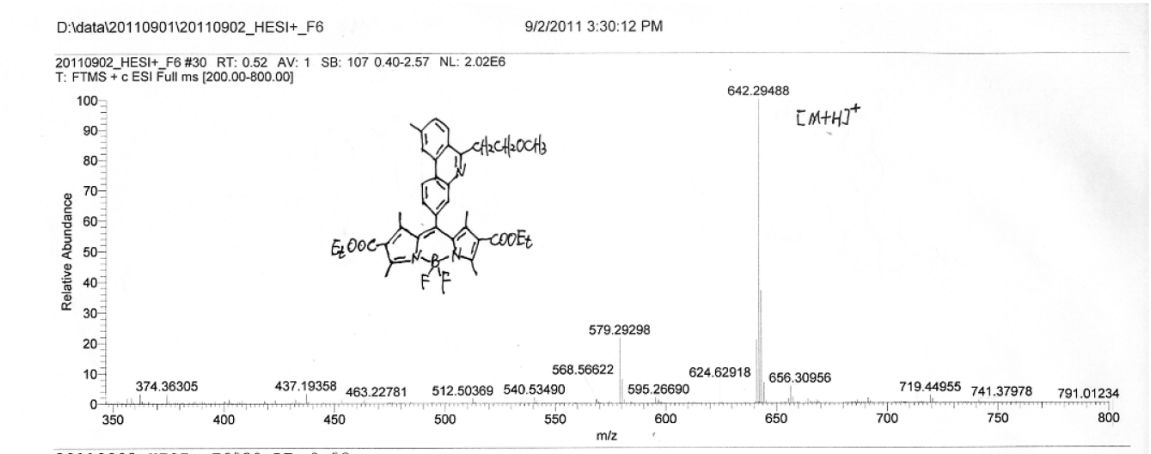
^{13}C NMR (75 MHz) spectra of compound **1**



^{1}H NMR (300 MHz) spectra of compound **2**



ESI mass spectral of compound **2** [M+H$^+$]



20110902_HESI+_F6#30 RT: 0.52
SB: 107 0.40-2.57
T: FTMS + c ESI Full ms [200.00-800.00]
m/z= 346.64537-800.00000

m/z	Intensity	Relative	Theo. Mass	Delta (mmu)	Composition
362.32673	62561.6	3.10	362.32649	0.24	$C_{20}H_{44}O_4N$
374.36305	64198.0	3.18	374.36287	0.18	$C_{22}H_{48}O_3N$
437.19358	65486.3	3.24	437.19301	0.58	$C_{25}H_{27}O_5BF$
579.29298	434235.5	21.49	579.29166	1.32	$C_{35}H_{41}O_5F_2$
580.29640	160474.7	7.94	580.29700	-0.60	$C_{36}H_{39}O_3N_3F$
641.29815	421264.9	20.85			
642.29488	2020494.8	100.00	642.29453	0.35	$C_{36}H_{39}O_5N_3BF_2$
643.29787	745539.6	36.90	643.30236	-4.49	$C_{36}H_{40}O_5N_3BF_2$
644.30084	136572.0	6.76	644.31018	-9.35	$C_{36}H_{41}O_5N_3BF_2$
656.30956	112259.0	5.56			