Supporting Information

Rhodium Catalyzed Sequential Dual C-H Annulation of 3-Arylisoxazoles with 1,6-diynes to Access Fused Naphthalenes

Ramesh Kotipalli,[a,b,‖] T. Mahipal Reddy,[a,b,‖] Jagadeesh Babu Nanubolu[c] and Maddi Sridhar Reddy*[a,b]

[a]Department of Organic Synthesis & Process Chemistry, CSIR-Indian Institute of Chemical Technology, Hyderabad 500007, India.

[b]Academy of Scientific and Innovative Research, Ghaziabad 201002, India.

[c]Analytical Department, CSIR-IICT, Hyderabad 500007, India.

[‖]Contributed equally.

S. No.	Table of Contents	Pages
1	General information and methods	S2
2	Experimental procedures	S2-S5
3	Optimization studies	S5-S7
4	General procedure for title compounds and characteristic data	S7-S25
5	Deuterium labelling & KIE Studies	S25-S28
6	General procedure and characteristic data of synthetic transformations	S28-S30
7	Copies of ^{1}**H**, ^{13}**C** & ^{19}**F NMR** spectra	S21-S67
8	X-ray crystallography data	S68-S74
9	References	S74

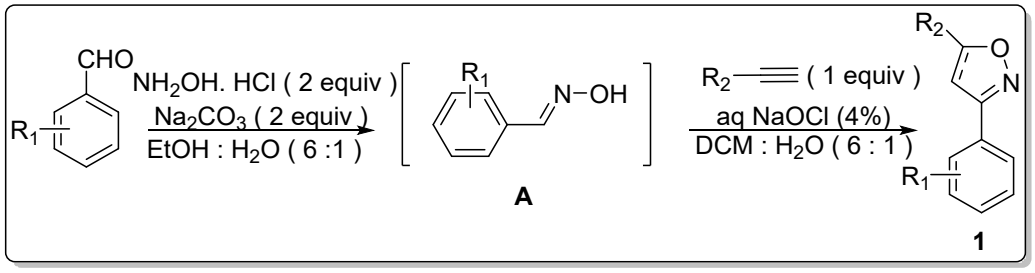
1. General Information and methods.

All reagents and solvents were purchased from commercial sources and used without purification. NMR spectra were recorded with a 300, 400 or 500 MHz spectrometer for ^{1}H NMR, 100 or 125 MHz for ^{13}C NMR spectroscopy. Chemical shifts are reported relative to the residual signals of tetramethylsilane in $CDCl_3$ or deuterated solvent $CDCl_3$ for ^{1}H and ^{13}C NMR spectroscopy. Multiplicities are reported as follows: singlet (s), doublet (d), doublet of doublets (dd), doublet of triplets (dt), triplet (t), quartet (q), multiplet (m). HRMS were recorded by using ORBITRAP and ESI mass spectrometer under positive and negative modes. Column chromatography was performed with silica gel (100–200 mesh) as the stationary phase. All reactions were monitored by using TLC.

Isoxazole and 1,6-Diynes were prepared following the known literature procedure (Table S_1 and S_2).[1-2]

2. Experimental Procedures

2.1. General procedure for the synthesis of Isoxazole and isooxazoline derivatives:[1]



Isoxazole and isooxazoline were prepared according to known literature method.[1]

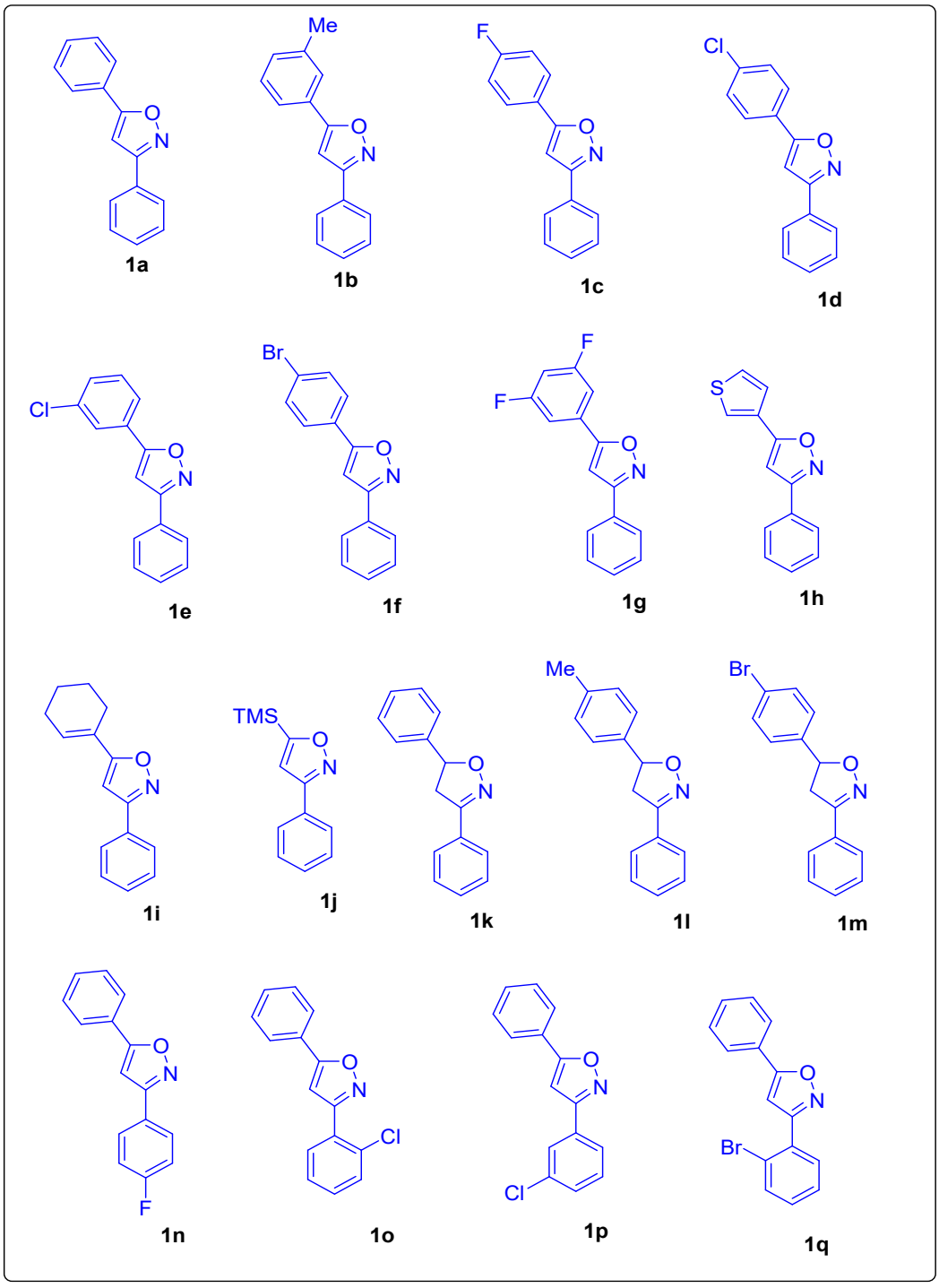
Preparation of A: A mixture of aldehydes (1 equiv.) and hydroxylamine hydrochloride (2 equiv.) along with Na_2CO_3 (2 equiv.) in EtOH/ H_2O (v:v = 6:1) was stirred for 3-4 h at room temperature. On completion (monitoring by TLC), the reaction mixture was diluted with water and extracted with EtOAc (3 x 10 ml). The combined organic extracts were dried over anhydrous Na_2SO_4 and concentrated by rotary evaporation under reduced pressure to get a residue, which was purified by using column chromatography to obtain aldoxime derivatives **A** (61-93%).

Conversion of A to 1.[1]

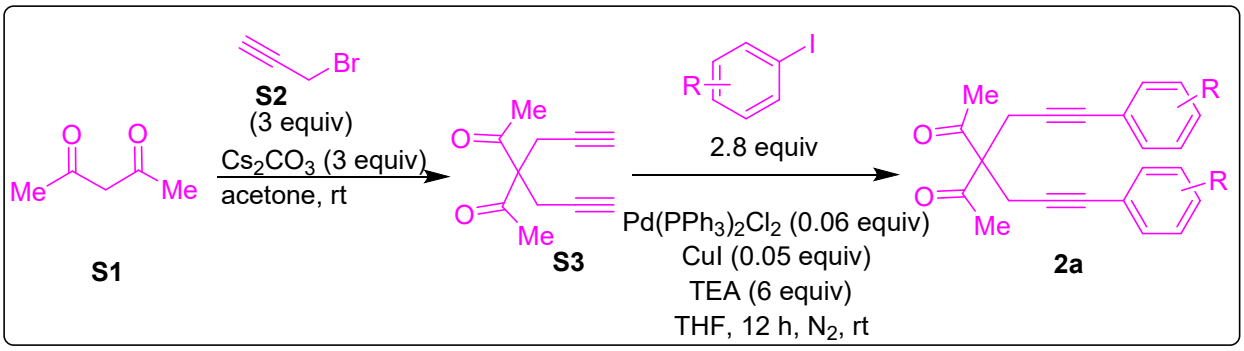
To a stirred solution of aldoximes **A** (1 equiv.) in DCM/H_2O (v:v = 6:1), alkynes/alkenes (1 equiv.) were added and the reaction mixture was stirred for 10 minutes at room temperature. Aqueous NaOCl (4%) (2 equiv.) was added slowly to the contents and the reaction was further stirred for 3-4 h. After completion (confirmed by TLC), water was added and product was

extracted with EtOAc (3X10 ml). The organic layer was collected, dried on anhydrous Na_2SO_4 and solvent was evaporated on rotary evaporator to get the crude product. The crude product was purified by column chromatography to get pure isoxazole/ isoxazoline products **1**.

Table S1: List of Isoxazoles:



2.2 General Procedure for synthesis of 3,3-di(prop-2-yn-1-yl)pentane-2,4-dione [2]

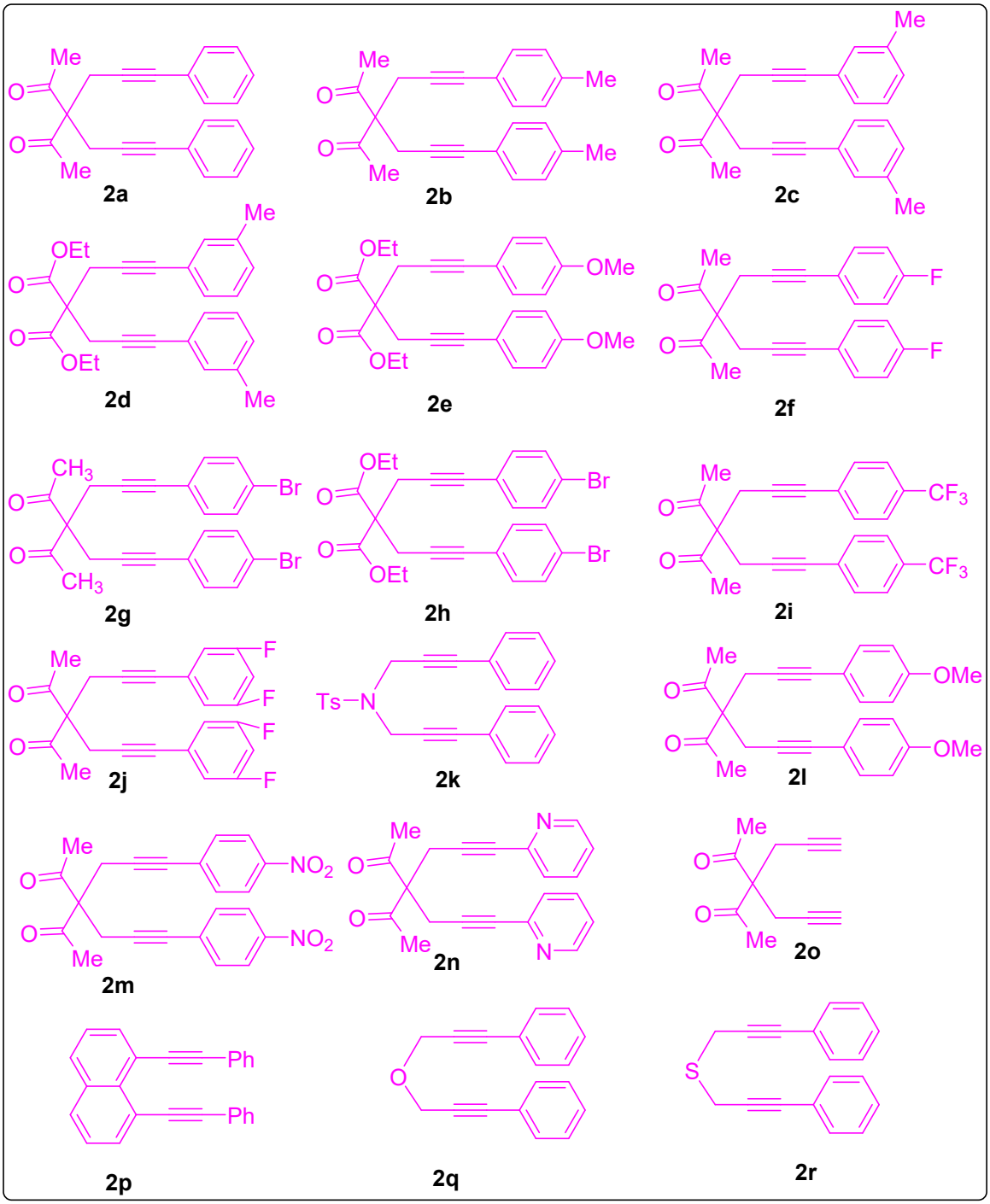


To a solution of pentane-2,4-dione (1.0 g, 10.00 mmol, 1.0 equiv) in acetone at room temperature cesium carbonate (9.78 g, 30.0 mmol, 3.0 equiv) was added. After 15 minutes 3-bromoprop-1-yne (3.57 g, 3.0 mmol, 3.0 equiv) was added. The resulting mixture was heated at room temperature for 6 h. The reaction mixture solvent was removed under reduced pressure and the resulting crude compound was dissolved in water and extracted using ethyl acetate and dried over $MgSO_4$ concentrated under the vacuum. The crude residue was purified through a silica gel column using petroleum ether/EtOAc (20:1) as an eluent to get the corresponding 3,3-di(prop-2-yn-1-yl)pentane-2,4-dione as off-white solid

General Procedure for synthesis 1,6-Diynes (2a)

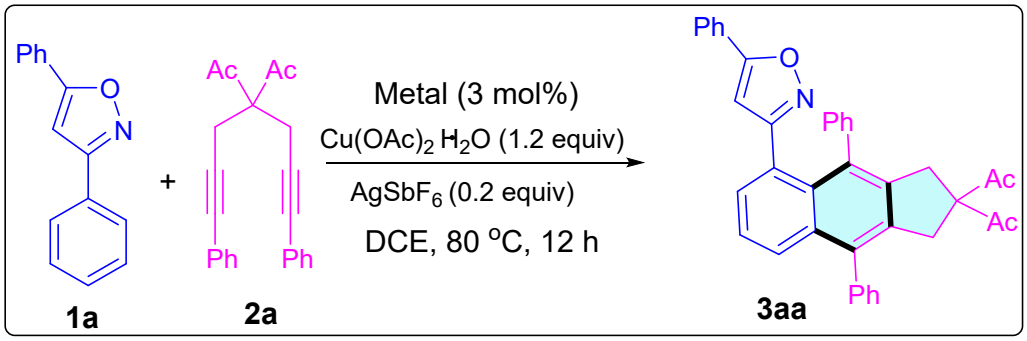
To a dried schlenk flask was charged with 3,3-di(prop-2-yn-1-yl)pentane-2,4-dione (1.0 equiv) and aryl halide (2.8 equiv) in dry THF followed by $Pd(PPh_3)_2Cl_2$ (6 mmol%), CuI (5 mmol%), in freshly distilled Et_3N (6.0 equiv) under nitrogen atmosphere. The resulting mixture was stirred at rt for 12 h under nitrogen atmosphere. After the completion of reaction on TLC, the reaction mixture was cooled to rt, diluted with water and extracted with ethyl acetate. The combined organic layer was dried over Na_2SO_4, filtered and concentrated to get crude material. The crude material was purified via column chromatography using hexane: ethyl acetate (95:5) to give the expected 1,6-diyne **2a**.

Table S2: List of 1,6-diynes:



3. Optimization Studies:

Table S3: Optimization of Metal Catalyst.[a]

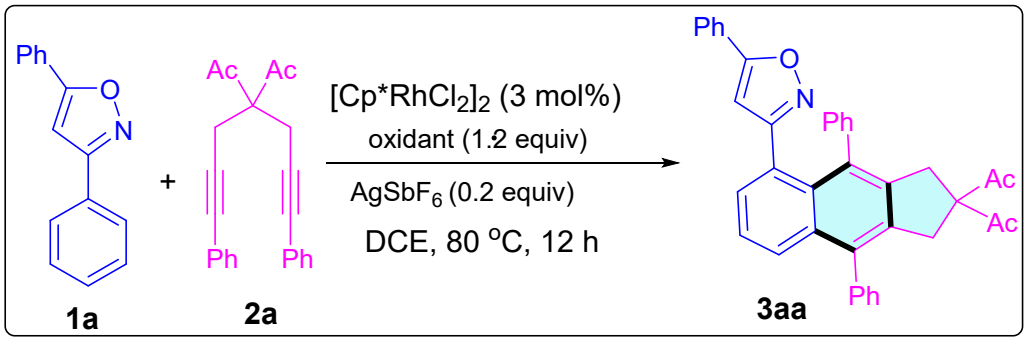


Entry	Metal Catalyst	Yield of **3aa**[b]
1	**$[Cp^*RhCl_2]_2$**	**79%**
2	$[Cp^*IrCl_2]_2$	76%
3	$[RuCl_2(p\text{-cymene})]_2$	--
4	$Pd(OAc)_2$	--
5	$[Cp^*Co(CO)I_2]$	--

[a]Reaction conditions: **1a** (0.3 mmol), **2a** (0.3 mmol), Metal catalyst (3 mol %), $AgSbF_6$ (0.2 equiv), $Cu(OAc)_2.H_2O$ (1.2 equiv), DCE, 80 °C for 12 h, N_2 balloon. [b]Isolated yield

---

Table S4: Optimization of Oxidant.[a]



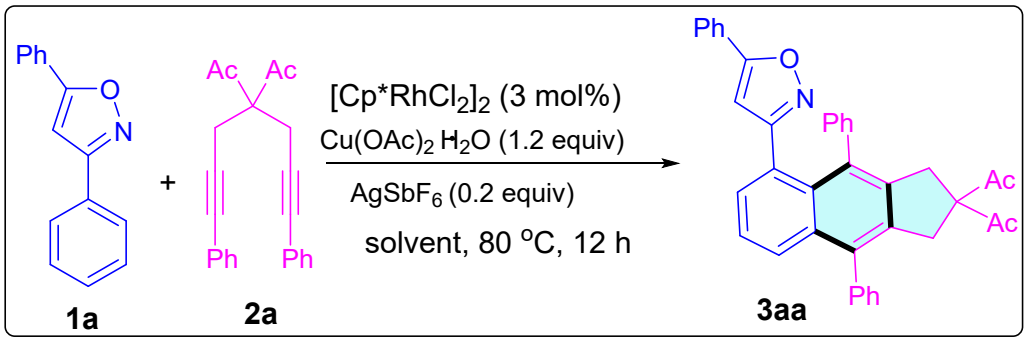
Entry	Oxidant	Yield of **3aa**[b]
1	**$Cu(OAc)_2.H_2O$**	**79%**
2	AgOAc	64%

3	$Zn(OAc)_2$	39%
4	$PhI(OAc)_2$	--

[a]Reaction conditions:**1a** (0.3 mmol), **2a** (0.3 mmol), Metal catalyst (3 mol %), $AgSbF_6$ (0.2 equiv), oxidant (1.2 equiv), DCE, 80 °C for 12 h N_2 balloon. [b]Isolated yield

---

Table S5: Optimization of Solvent.[a]



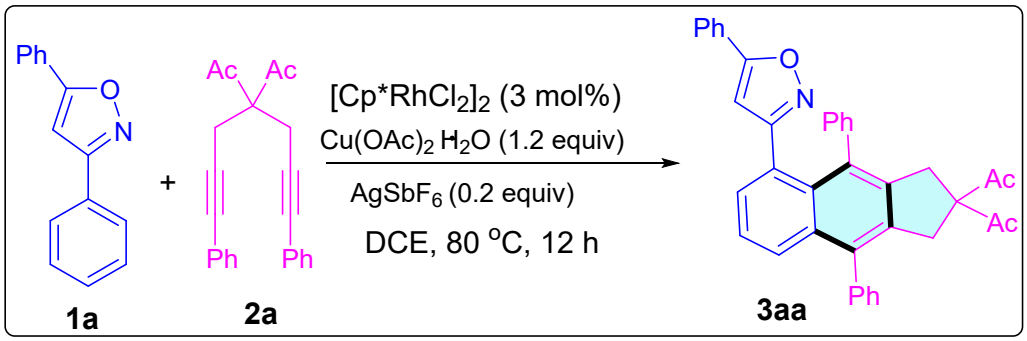
Entry	Solvent	Yield of **3aa**[b]
1	**DCE**	**79%**
2	CH_3CN	n.r.
3	Toluene	5%
4	THF	10%
5	DMF	n.r.
6	DMSO	n.r.

[a]Reaction conditions:**1a** (0.3 mmol), **2a** (0.3 mmol), Metal catalyst (3 mol %), $AgSbF_6$ (0.2 equiv), $Cu(OAc)_2.H_2O$ (1.2 equiv), solvent, 80 °C for 12 h N_2 balloon. [b]Isolated yield

---

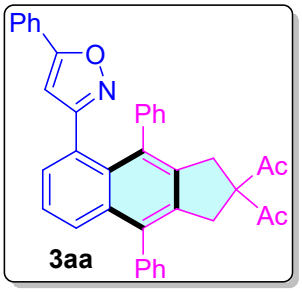
4. General Procedure for title compounds 3 and their Characteristic data:

General Procedure for title compounds taking 3aa as an example:



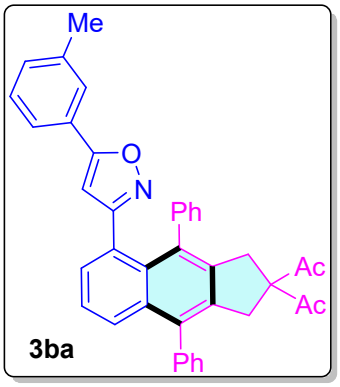
To a mixture of Isoxazole **1a** (66.3 mg, 0.3 mmol), 1,6 Diyne **2a** (98.4 mg, 0.3 mmol) in DCE, $[Cp^*RhCl_2]_2$ (5.56 mg, 3 mol %), $AgSbF_6$ (20.61 mg, 0.2 equiv), $Cu(OAc)_2.H_2O$ (72 mg, 1.2 equiv) were introduced and the reaction mixture was stirred at 80 °C (oil bath) for 12 hours under nitrogen balloon. After completion of reaction (monitored by TLC), DCE was evaporated, water was added and the contents were extracted with ethyl acetate (2×10 mL). The organic layer was evaporated and the residue was purified by column chromatography (Rf = 0.50) (SiO_2, EtOAc:Hexane, 12:88) to get **3aa** as white solid in 79% (129.64 mg) yield, mp 205-208 °C.

1,1'-(4,9-diphenyl-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3aa):



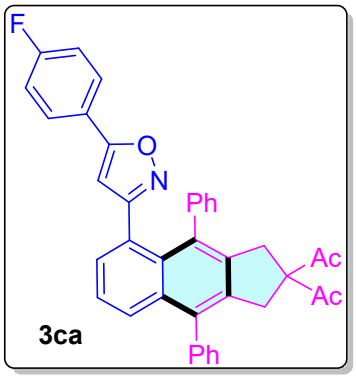
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.76 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.59 (d, *J* = 6.8 Hz, 1H), 7.53 (dd, *J* = 5.5, 4.6 Hz, 1H), 7.46 – 7.39 (m, 1H), 7.36 (t, *J* = 4.1 Hz, 1H), 7.19 – 7.15 (m, 1H), 7.12 (d, *J* = 8.1 Hz, 1H), 6.93 – 6.87 (m, 1H), 5.81 (s, 1H), 3.43 (s, 1H), 3.34 (s, 1H), 2.04 (s, 1H). **^{13}C NMR (75 MHz, $CDCl_3$)** δ 204.9, 167.8, 165.6, 139.8, 139.6, 139.0, 137.0, 135.9, 134.7, 133.8, 130.7, 130.6, 130.40, 129.9, 129.8, 129.0, 128.9, 128.7, 127.8, 127.7, 127.4, 127.2, 125.8, 124.5, 103.2, 74.5, 38.6, 37.9, 26.8. **HRMS (ESI)** calcd for $C_{38}H_{30}NO_3$ $[M+H]^+$ 548.2226, found 548.2197**.**

1,1'-(4,9-diphenyl-5-(5-(m-tolyl)isoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ba):



The title compound was prepared from **1b** (70.5 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 13:87) gave pure product **3ba** as a white solid (106 mg, 63% yield), mp 192-195°C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.76 (dd, *J* = 8.4, 1.3 Hz, 1H), 7.58 (t, *J* = 7.4 Hz, 2H), 7.50 (dd, *J* = 8.4, 6.4 Hz, 1H), 7.43 (dt, *J* = 8.3, 4.1 Hz, 3H), 7.37 (dd, *J* = 8.3, 7.1 Hz, 2H), 7.34 – 7.31 (m, 2H), 7.22 (d, *J* = 3.7 Hz, 1H), 7.19 – 7.12 (m, 4H), 6.94 – 6.90 (m, 1H), 5.80 (s, 1H), 3.43 (s, 2H), 3.34 (s, 2H), 2.42 (s, 3H), 2.04 (s, 6H).**^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.9, 168.0, 165.5, 139.8, 139.5, 139.0, 138.6, 137.0, 135.8, 134.7, 133.8, 130.7, 130.6, 130.4, 129.9, 128.9, 128.7, 128.6, 127.8, 127.6, 127.5, 127.2, 126.4, 124.5, 123.0, 103.1, 74.5, 38.6, 37.9, 26.8, 21.6. **HRMS (ESI)** calcd for $C_{39}H_{32}NO_3$ $[M+H]^+$ 562.2382, found 562.2388

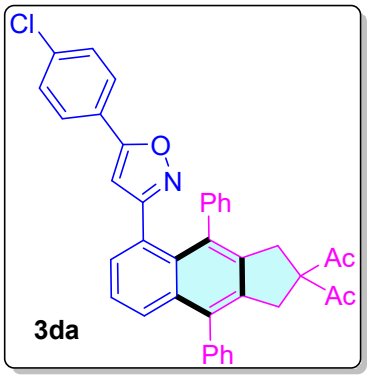
1,1'-(5-(5-(4-fluorophenyl)isoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ca):



The title compound was prepared from **1c** (71.7 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 11:89) gave pure product **3ca** as a white solid (120 mg, 71% yield), mp 228-231 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.76 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.58 (t, *J* = 7.3 Hz,

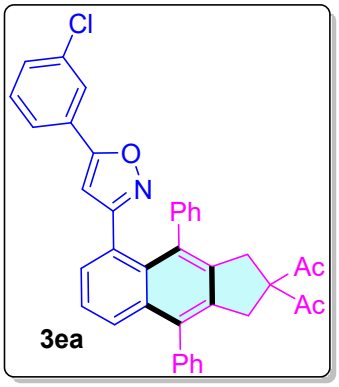
2H), 7.54 – 7.49 (m, 3H), 7.43 (dd, *J* = 9.5, 4.1 Hz, 3H), 7.39 – 7.35 (m, 1H), 7.19 – 7.15 (m, 3H), 7.12 (d, *J* = 8.5 Hz, 3H), 6.91 (t, *J* = 7.1 Hz, 1H), 5.76 (s, 1H), 3.43 (s, 2H), 3.33 (s, 2H), 2.04 (s, 6H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.9, 166.8, 165.7, 163.6 (d, *J* = 250.8 Hz), 139.7 (d, *J* = 23.1 Hz), 138.9, 137.0, 135.9, 134.6, 133.8, 130.6, 130.4, 130.1, 129.9, 129.8, 129.1, 128.8 (d, *J* = 21.0 Hz), 127.8, 127.7, 127.2, 124.5, 124.0, 124.0, 116.1 (d, *J* = 22.1 Hz). 103.0, 74.5, 38.6, 37.9, 26.8.**^{19}F NMR (471 MHz, $CDCl_3$)** δ -110.46 (s).**HRMS (ESI)** calcd for $C_{38}H_{29}FNO_3$ $[M+H]^+$ 566.2131, found 566.2134.

1,1'-(5-(5-(4-chlorophenyl)isoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3da):



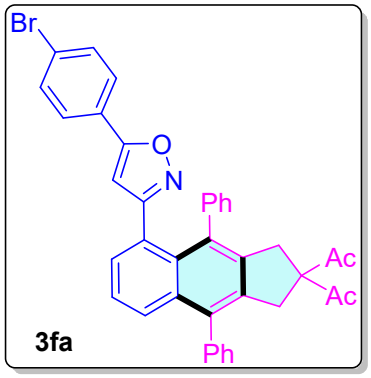
The title compound was prepared from **1d** (76.5 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 11:89) gave pure product **3da** as a white solid (113 mg, 65% yield), mp 217-220 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.76 (dd, *J* = 8.4, 1.5 Hz, 1H), 7.58 (t, *J* = 7.3 Hz, 2H), 7.53 – 7.50 (m, 1H), 7.49 (t, *J* = 2.1 Hz, 1H), 7.47 (d, *J* = 2.0 Hz, 1H), 7.42 (t, *J* = 1.9 Hz, 3H), 7.42 – 7.39 (m, 2H), 7.36 (t, *J* = 4.1 Hz, 1H), 7.16 (t, *J* = 6.2 Hz, 3H), 7.12 (d, *J* = 8.0 Hz, 1H), 6.93 – 6.88 (m, 1H), 5.80 (s, 1H), 3.43 (s, 2H), 3.33 (s, 2H), 2.04 (s, 6H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.9, 166.6, 165.7, 139.8, 139.6, 138.9, 137.1, 135.9, 135.8, 134.5, 133.8, 130.6, 130.4, 129.9, 129.2, 129.0, 128.8, 127.8, 127.2, 127.1, 127.0, 126.1, 124.5, 103.5, 74.6, 38.6, 37.9, 26.8. **HRMS (ESI)** calcd for $C_{38}H_{29}ClNO_3$ $[M+H]^+$ 582.1836, found 582.1790.

1,1'-(5-(5-(3-chlorophenyl)isoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ea):



The title compound was prepared from **1e** (94 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 11:89) gave pure product **3ea** as a white solid (109 mg, 63% yield), mp 195-198 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.77 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.58 (t, *J* = 7.4 Hz, 2H), 7.51 (dd, *J* = 11.1, 4.8 Hz, 2H), 7.43 (dd, *J* = 4.7, 1.5 Hz, 2H), 7.41 (s, 2H), 7.39 (d, *J* = 2.7 Hz, 2H), 7.38 – 7.37 (m, 1H), 7.17 (t, *J* = 5.1 Hz, 3H), 7.14 (d, *J* = 8.0 Hz, 1H), 6.92 (ddd, *J* = 8.6, 5.2, 1.6 Hz, 1H), 5.82 (s, 1H), 3.43 (s, 2H), 3.34 (s, 2H), 2.04 (s, 6H).**^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.9, 166.2, 165.7, 139.8, 139.6, 138.9, 137.1, 135.9, 134.9, 134.5, 133.8, 130.6, 130.4, 130.2, 129.9, 129.8, 129.2, 128.9, 128.8, 127.8, 127.2, 127.0, 125.8, 124.5, 123.8, 103.9, 74.5, 38.6, 37.9, 26.8. **HRMS (ESI)** calcd for $C_{38}H_{29}ClNO_3$ $[M+H]^+$ 582.1836, found 582.1790.

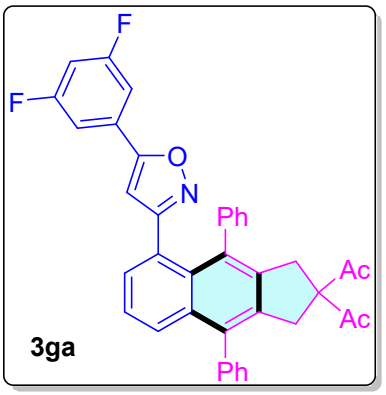
1,1'-(5-(5-(4-bromophenyl)isoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3fa):



The title compound was prepared from **1f** (89.4 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 12:88) gave pure product **3fa** as a white solid (127 mg, 68% yield), mp 222-225 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.76 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.58 (d, *J* = 1.2 Hz, 2H), 7.56 (s, 2H), 7.52 (d, *J* = 7.3 Hz, 1H), 7.44 – 7.40 (m, 5H), 7.39 (dd, *J* = 6.5, 5.1 Hz, 2H), 7.15 (d, *J* = 5.0 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 1H), 6.93 – 6.88 (m, 1H), 5.80 (s, 1H), 3.43 (s, 2H), 3.33 (s, 2H), 2.04 (s, 6H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 205.0, 166.7, 165.8, 139.9, 139.7, 139.0, 137.2, 136.0, 134.6, 133.9, 132.3, 130.7, 130.5, 130.0, 129.1, 128.9, 127.9, 127.3, 127.2, 126.6,

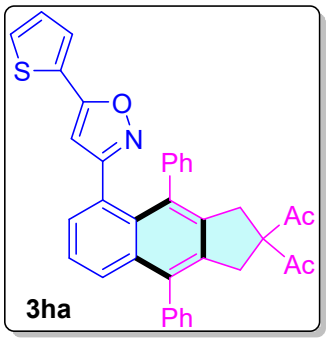
124.6, 124.2, 103.7, 74.7, 38.7, 38.0, 26.9. calcd for $C_{38}H_{29}BrNO_3$ $[M+H]^+$ 626.1331, found 626.1335

1,1'-(5-(5-(3,5-difluorophenyl)isoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ga):



The title compound was prepared from **1g** (77.1 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 12:88) gave pure product **3ga** as a white solid (113 mg, 65% yield), mp 230-233 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.77 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.58 (t, *J* = 7.2 Hz, 2H), 7.53 – 7.49 (m, 1H), 7.44 – 7.40 (m, 3H), 7.38 (d, *J* = 8.2 Hz, 1H), 7.17 (s, 2H), 7.15 (d, *J* = 3.3 Hz, 2H), 7.07 – 7.04 (m, 2H), 6.94 (td, *J* = 5.9, 2.9 Hz, 1H), 6.87 (ddd, *J* = 8.8, 6.5, 2.3 Hz, 1H), 5.83 (s, 1H), 3.43 (s, 2H), 3.33 (s, 2H), 2.04 (s, 6H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.8, 165.8, 165.3, 163.3 (d, *J* = 249.2 Hz), 163.2 (d, *J* = 249.3 Hz), 139.8, 139.7, 138.9, 137.1, 136.0, 134.4, 133.8, 130.7, 130.5, 130.4, 130.4, 129.9, 129.0, 127.8, 127.2, 126.7, 124.5, 108.7 (d, *J* = 14.2 Hz), 108.7 (d, *J* = 27.5 Hz), 105.1 (t, *J* = 25.4 Hz). 104.6, 74.7, 38.6, 37.9, 26.8. **^{19}F NMR (377 MHz, $CDCl_3$)** δ -108.31 (s).**HRMS (ESI)** calcd for $C_{38}H_{28}F_2NO_3$ $[M+H]^+$ 584.2037, found 584.2007.

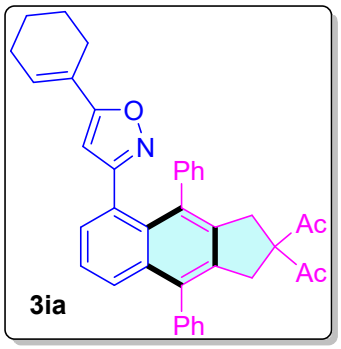
1,1'-(4,9-diphenyl-5-(5-(thiophen-2-yl)isoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ha):



The title compound was prepared from **1h** (68.1 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2,

EtOAc:Hexane, 1:4) gave pure product **3ha** as a white solid (92.90 mg, 56% yield), mp 209-212 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.75 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.65 (d, *J* = 7.3 Hz, 1H), 7.59 (d, *J* = 7.1 Hz, 2H), 7.56 (d, *J* = 3.0 Hz, 1H), 7.51 (d, *J* = 7.4 Hz, 1H), 7.44 – 7.42 (m, 1H), 7.41 (s, 2H), 7.39 – 7.36 (m, 2H), 7.18 (dd, *J* = 5.0, 1.1 Hz, 1H), 7.16 (d, *J* = 1.7 Hz, 2H), 7.13 (d, *J* = 8.1 Hz, 1H), 6.94 (ddd, *J* = 6.8, 4.5, 1.8 Hz, 1H), 5.67 (s, 1H), 3.43 (s, 2H), 3.33 (s, 2H), 2.04 (s, 6H).**^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.9, 165.4, 164.0, 139.8, 139.5, 138.9, 137.0, 135.8, 134.6, 133.7, 130.6, 130.4, 129.9, 129.0, 128.9, 128.6, 127.8, 127.3, 127.2, 127.0, 126.6, 125.4, 124.5, 123.9, 123.6, 103.0, 74.5, 38.6, 37.9, 26.8. **HRMS (ESI)** calcd for $C_{36}H_{27}NO_3S$ $[M+H]^+$ 554.1790, found 554.1791.

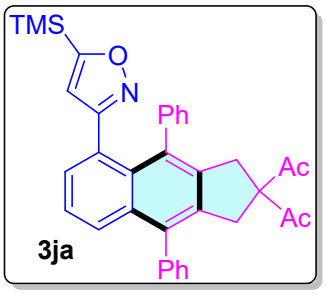
1,1'-(5-(5-(cyclohex-1-en-1-yl)isoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ia):



3ia

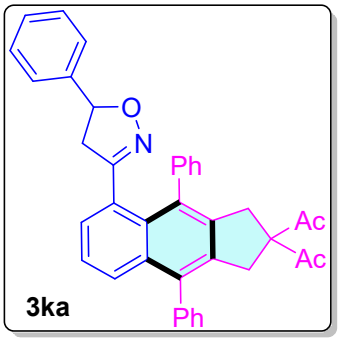
The title compound was prepared from **1i** (67.5 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 9:91) gave pure product **3ia** as a white solid (106 mg, 61% yield), mp 142-145 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.72 (d, *J* = 8.1 Hz, 1H), 7.57 (t, *J* = 7.2 Hz, 2H), 7.50 (d, *J* = 7.1 Hz, 1H), 7.40 (d, *J* = 7.1 Hz, 2H), 7.38 – 7.33 (m, 2H), 7.19 (d, *J* = 7.1 Hz, 2H), 7.13 (t, *J* = 7.4 Hz, 3H), 6.37 (s, 1H), 5.37 (s, 1H), 3.41 (s, 2H), 3.32 (s, 2H), 2.03 (s, 6H), 1.72 (dd, *J* = 11.6, 6.0 Hz, 4H), 1.69 – 1.63 (m, 4H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 205.0, 139.9, 139.4, 139.0, 136.9, 135.8, 134.7, 133.7, 130.6, 130.3, 129.9, 129.0, 128.9, 128.7, 128.5, 127.8, 127.7, 127.0, 125.3, 124.5, 74.5, 38.7, 38.0, 26.8, 25.5, 25.2, 22.3, 22.0. **HRMS (ESI)** calcd for $C_{38}H_{34}NO_3$ $[M+H]^+$ 552.2539, found 552.2493.

1,1'-(4,9-diphenyl-5-(5-(trimethylsilyl)isoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ja):



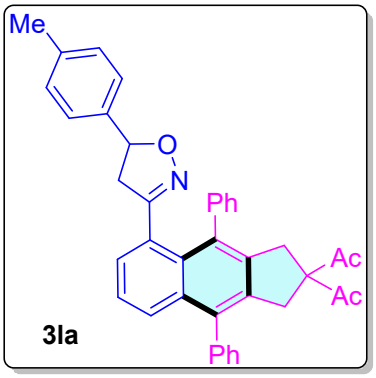
The title compound was prepared from **1j** (65.1 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 8:92) gave pure product **3ja** as a white solid (81 mg, 50% yield), mp 166-169 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.72 (dd, *J* = 7.5, 2.4 Hz, 1H), 7.58 – 7.55 (m, 2H), 7.50 (dt, *J* = 4.7, 1.9 Hz, 1H), 7.42 – 7.39 (m, 2H), 7.35 (dd, *J* = 4.9, 3.9 Hz, 2H), 7.17 (dd, *J* = 5.0, 2.1 Hz, 3H), 7.11 (dd, *J* = 5.4, 2.2 Hz, 2H), 5.79 (s, 1H), 3.41 (s, 2H), 3.30 (s, 2H), 2.03 (s, 6H), 0.25 (s, 9H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 205.0, 175.3, 163.1, 140.0, 139.5, 139.0, 136.9, 135.8, 134.7, 133.8, 130.7, 130.5, 129.9, 128.9, 128.3, 127.8, 127.7, 126.9, 124.5, 115.4, 74.5, 38.6, 37.9, 26.8, -1.6. **HRMS (ESI)** calcd for $C_{35}H_{34}NO_3Si$ $[M+H]^+$ 544.2308, found 544.2276.

1,1'-(4,9-diphenyl-5-(5-phenyl-4,5-dihydroisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ka):



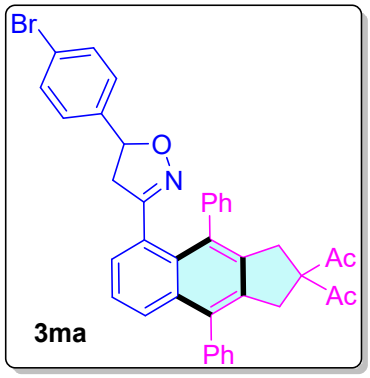
The title compound was prepared from **1k** (66.9 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 12:85) gave pure product **3ka** as a white solid (113 mg, 69% yield), mp 158-161 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.69 (dd, *J* = 7.7, 2.2 Hz, 1H), 7.58 (dd, *J* = 5.1, 2.4 Hz, 1H), 7.57 – 7.54 (m, 2H), 7.54 – 7.51 (m, 1H), 7.49 (d, *J* = 5.7 Hz, 2H), 7.41 (dd, *J* = 4.7, 2.7 Hz, 2H), 7.39 – 7.36 (m, 2H), 7.34 (dd, *J* = 4.3, 1.4 Hz, 2H), 7.34 – 7.31 (m, 2H), 7.30 – 7.27 (m, 1H), 7.25 – 7.22 (m, 2H), 4.59 (t, *J* = 10.7 Hz, 1H), 3.49 (d, *J* = 17.4 Hz, 1H), 3.42 (d, *J* = 6.0 Hz, 2H), 3.26 (d, *J* = 17.3 Hz, 1H), 3.07 (dd, *J* = 16.6, 10.0 Hz, 1H), 2.72 (dd, *J* = 16.6, 12.0 Hz, 1H), 2.07 (s, 3H), 2.03 (s, 3H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.8, 204.8, 160.4, 140.3, 140.0, 139.8, 138.8, 137.2, 135.9, 134.3, 134.0, 132.7, 130.6, 130.1, 129.9, 129.8, 129.0, 128.9, 128.8, 128.6, 128.6, 128.1, 128.0, 127.8, 127.6, 126.3, 124.7, 82.7, 74.6, 48.8, 38.6, 37.9, 26.8, 26.7. **HRMS (ESI)** calcd for $C_{38}H_{30}NO_3$ $[M+H]^+$ 550.2382, found 550.2359.

1,1'-(4,9-diphenyl-5-(5-(p-tolyl)-4,5-dihydroisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3la):



The title compound was prepared from **1l** (71.1 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 13:87) gave pure product **3la** as a white solid (108 mg, 66% yield), mp 183-186 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.69 (dd, *J* = 7.8, 2.0 Hz, 1H), 7.59 – 7.54 (m, 3H), 7.52 – 7.48 (m, 3H), 7.42 – 7.39 (m, 3H), 7.37 (dd, *J* = 7.0, 5.0 Hz, 3H), 7.32 (d, *J* = 7.1 Hz, 1H), 7.13 (d, *J* = 1.3 Hz, 3H), 4.54 (t, *J* = 11.1 Hz, 1H), 3.49 (d, *J* = 17.3 Hz, 1H), 3.41 (d, *J* = 5.9 Hz, 2H), 3.25 (d, *J* = 17.3 Hz, 1H), 3.03 (dd, *J* = 16.6, 9.9 Hz, 1H), 2.70 (dd, *J* = 16.6, 12.1 Hz, 1H), 2.33 (s, 3H), 2.07 (s, 3H), 2.03 (s, 3H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.9, 204.8, 160.5, 140.3, 139.8, 138.8, 137.9, 137.2, 136.8, 135.9, 134.3, 133.9, 132.7, 130.6, 130.1, 129.9, 129.8, 129.3, 129.0, 128.9, 128.8, 128.6, 128.1, 127.8, 127.6, 126.3, 124.7, 82.7, 74.6, 48.8, 38.6, 37.9, 26.8, 26.7, 21.3. **HRMS (ESI)** calcd for $C_{39}H_{34}NO_3$ $[M+H]^+$ 564.2514, found 564.2491.

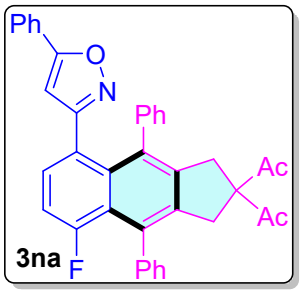
1,1'-(5-(5-(4-bromophenyl)-4,5-dihydroisoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ma):



The title compound was prepared from **1m** (90.3 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 14:86) gave pure product **3ma** as a white solid (112mg, 60% yield), mp 190-193 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.69 (p, *J* = 3.0 Hz, 1H), 7.59 – 7.56 (m, 1H), 7.56 – 7.53 (m, 2H), 7.53 – 7.49 (m, 2H), 7.48 – 7.46 (m, 2H), 7.45 (d, *J* = 1.8 Hz, 1H), 7.41 (d, *J* = 8.3 Hz, 2H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.33 (dd, *J* = 5.0, 0.8 Hz, 2H), 7.10 (d, *J* = 8.4 Hz, 2H), 4.56 (s, 1H),

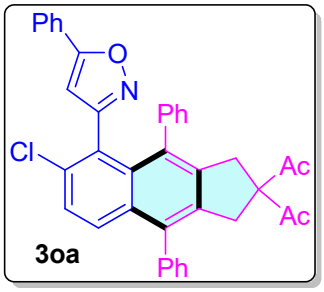
3.47 (t, *J* = 10.3 Hz, 1H), 3.40 (t, *J* = 13.7 Hz, 2H), 3.25 (d, *J* = 17.3 Hz, 1H), 3.07 (dd, *J* = 16.6, 10.0 Hz, 1H), 2.65 (dd, *J* = 16.6, 11.7 Hz, 1H), 2.07 (s, 3H), 2.03 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)**. δ 204.7, 160.3, 140.3, 139.9, 139.1, 138.7, 137.3, 135.9, 134.1, 133.9, 132.6, 131.7, 130.6, 130.1, 129.9, 129.8, 128.9, 128.9, 128.7, 128.5, 128.1, 127.9, 127.8, 127.7, 127.6, 124.6, 122.0, 81.9, 74.6, 48.8, 38.5, 37.9, 26.8, 26.7. **HRMS (ESI)** calcd for $C_{38}H_{31}BrNO_3$ $[M+H]^+$ 628.1487, found 628.1497.

1,1'-(5-fluoro-4,9-diphenyl-8-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3na):



The title compound was prepared from **1n** (71.1 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 15:85) gave pure product **3na** as a white solid (116 mg, 69% yield), mp 215-218 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.54 (d, *J* = 8.0 Hz, 2H), 7.51 (s, 2H), 7.50 (s, 1H), 7.47 (dd, *J* = 9.9, 4.7 Hz, 2H), 7.44 (s, 2H), 7.37 (d, *J* = 6.9 Hz, 2H), 7.14 (d, *J* = 4.1 Hz, 4H), 7.05 (dd, *J* = 12.2, 7.9 Hz, 1H), 6.91 (dt, *J* = 8.6, 4.2 Hz, 1H), 5.80 (s, 1H), 3.32 (s, 2H), 3.30 (s, 2H), 2.02 (s, 6H).**^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.6, 168.0, 165.1, 160.7 (d, *J* = 258.6 Hz), 140.6, 139.2 (d, *J* = 12.8 Hz), 134.9, 133.1, 132.6, 130.6, 130.5, 129.8, 128.9, 128.2 (d, *J* = 3.7 Hz), 128.6, 128.3, 127.9, 127.6, 127.4, 127.2, 126.4, 126.1, 125.8, 123.8, 123.7, 110.4 (d, *J* = 22.7 Hz),103.2, 74.3, 38.6, 38.0, 26.7. **^{19}F NMR (471 MHz, $CDCl_3$)** δ -103.13 (s).**HRMS (ESI)** calcd for $C_{38}H_{29}FNO_3$ $[M+H]^+$ 566.2131, found 566.2090.

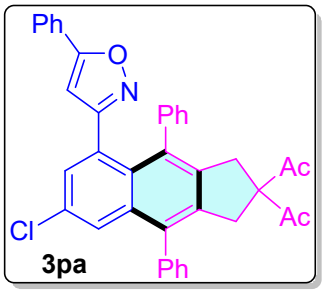
14)1,1'-(6-chloro-4,9-diphenyl-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3oa):



The title compound was prepared from **1o** (76.5 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 12:82) gave pure product **3oa** as a white solid (110 mg, 58% yield), mp 216-219

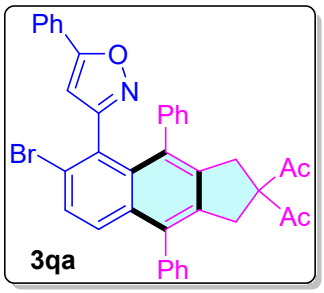
°C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.68 (d, *J* = 9.1 Hz, 1H), 7.60 – 7.56 (m, 4H), 7.52 (d, *J* = 7.3 Hz, 1H), 7.49 – 7.46 (m, 1H), 7.43 (d, *J* = 5.4 Hz, 3H), 7.37 (d, *J* = 6.1 Hz, 2H), 7.20 – 7.14 (m, 1H), 7.11 (d, *J* = 7.2 Hz, 2H), 6.92 (d, *J* = 6.7 Hz, 1H), 6.87 (t, *J* = 7.3 Hz, 1H), 5.91 (s, 1H), 3.39 (d, *J* = 4.3 Hz, 2H), 3.26 (dd, *J* = 17.5, 6.6 Hz, 1H), 3.06 (dd, *J* = 17.4, 9.3 Hz, 1H), 2.04 (d, *J* = 1.7 Hz, 3H), 2.00 (s, 3H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.7, 168.5, 162.6, 141.0, 139.9, 138.4, 137.2, 135.6, 134.8, 134.3, 133.1, 132.0, 130.7, 130.2, 129.8, 129.6, 129.5, 129.1, 129.0, 128.9, 128.4, 128.0, 127.7, 127.4, 127.0, 126.4, 125.8, 125.3, 103.6, 74.4, 38.4, 37.8, 26.8, 26.7.**HRMS (ESI)** calcd for $C_{38}H_{29}ClNO_3$ $[M+H]^+$ 582.1836, found 582.1801.

1,1'-(7-chloro-4,9-diphenyl-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3pa):



The title compound was prepared from **1p** (76.5 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 11:89) gave pure product **3pa** as a white solid (92 mg, 53% yield), mp 199-202 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.70 (d, *J* = 2.3 Hz, 1H), 7.60 (t, *J* = 7.4 Hz, 2H), 7.55 – 7.52 (m, 3H), 7.49 – 7.45 (m, 1H), 7.44 (s, 1H), 7.43 (s, 1H), 7.42 – 7.39 (m, 3H), 7.15 – 7.12 (m, 4H), 6.91 (ddd, *J* = 8.7, 5.9, 3.0 Hz, 1H), 5.81 (s, 1H), 3.41 (s, 2H), 3.31 (s, 2H), 2.04 (s, 6H).**^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.6, 168.1, 164.4, 139.9, 139.3, 138.3, 138.2, 135.2, 134.8, 134.7, 130.6, 130.5, 129.9, 129.8, 129.1, 128.9, 128.1, 127.9, 127.4, 127.2, 125.8, 102.9, 74.5, 38.5, 37.9, 26.7. **HRMS (ESI)** calcd for $C_{38}H_{29}ClNO_3$ $[M+H]^+$ 582.1836, found 582.1806.

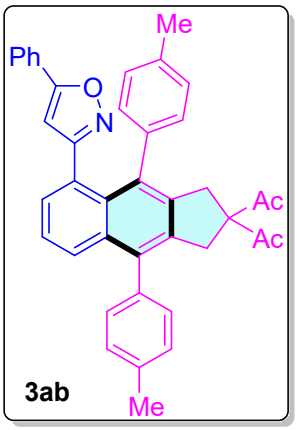
1,1'-(6-bromo-4,9-diphenyl-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3qa):



The title compound was prepared from **1q** (89.4 mg, 0.3 mmol) and **2a** (98.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 12:88) gave pure product **3qa** as a white solid (90 mg, 48% yield), mp 220-223 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.59 (s, 2H), 7.56 (s, 3H), 7.55 – 7.50 (m, 2H), 7.49 – 7.44

(m, 2H), 7.43 (s, 2H), 7.37 (d, *J* = 6.9 Hz, 2H), 7.11 (d, *J* = 5.5 Hz, 2H), 6.89 (dd, *J* = 18.4, 7.3 Hz, 2H), 5.90 (s, 1H), 3.38 (d, *J* = 5.9 Hz, 2H), 3.25 (d, *J* = 17.5 Hz, 1H), 3.06 (d, *J* = 17.5 Hz, 1H), 2.04 (s, 3H), 1.99 (s, 3H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.7, 168.4, 164.3, 140.9, 140.00, 138.3, 137.3, 135.6, 134.9, 133.5, 132.4, 130.7, 130.2, 129.8, 129.6, 129.5, 129.3, 129.1, 129.0, 128.9, 128.4, 128.0, 127.7, 127.4, 127.0, 125.9, 124.9, 103.7, 74.4, 38.5, 37.8, 26.8, 26.7. **HRMS (ESI)** calcd for $C_{38}H_{29}BrNO_3$ $[M+H]^+$ 626.1331, found 626.1290.

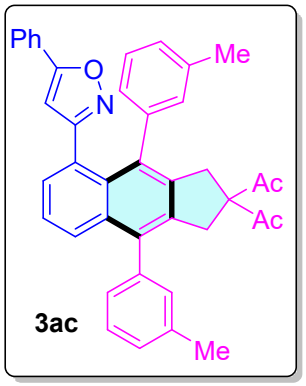
1,1'-(5-(5-phenylisoxazol-3-yl)-4,9-di-p-tolyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ab):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2b** (106.8 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 14:78) gave pure product **3ab** as a white solid (127 mg, 74% yield), mp 199-202 °C.

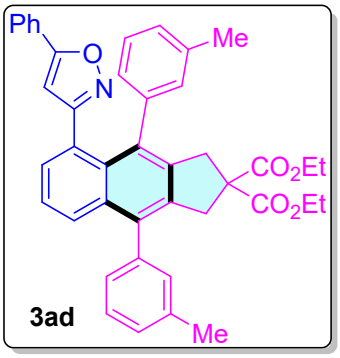
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.79 (dd, *J* = 8.3, 1.3 Hz, 1H), 7.56 (dd, *J* = 7.9, 1.5 Hz, 2H), 7.46 (dd, *J* = 11.4, 5.2 Hz, 4H), 7.38 (dd, *J* = 8.0, 4.9 Hz, 3H), 7.31 (t, *J* = 6.6 Hz, 2H), 7.02 (d, *J* = 7.8 Hz, 2H), 6.89 (d, *J* = 7.8 Hz, 2H), 5.74 (s, 1H), 3.43 (s, 2H), 3.34 (s, 2H), 2.51 (s, 3H), 2.04 (s, 6H), 1.79 (s, 3H).**^{13}C NMR (75 MHz, $CDCl_3$)** δ 205.1, 167.3, 165.7, 139.5, 137.4, 137.0, 137.0, 136.7, 135.9, 135.8, 134.5, 133.8, 130.8, 130.4, 130.2, 129.8, 129.6, 128.9, 128.8, 128.5, 127.6, 127.3, 125.6, 124.3, 103.1, 74.4, 38.7, 38.0, 26.8, 21.5, 20.6. **HRMS (ESI)** calcd for $C_{40}H_{34}NO_3$ $[M+H]^+$ 576.2539, found 576.2550.

1,1'-(5-(5-phenylisoxazol-3-yl)-4,9-di-m-tolyl-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ac):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2c** (108.6 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane,13:87 gave pure product **3ac** as a white solid (119 mg, 69% yield), mp 217-220 °C. **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.76 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.57 – 7.53 (m, 2H), 7.47 (t, *J* = 5.0 Hz, 2H), 7.44 – 7.41 (m, 3H), 7.37 (d, *J* = 8.3 Hz, 1H), 7.34 – 7.29 (m, 1H), 7.20 (d, *J* = 7.4 Hz, 2H), 7.07 – 7.00 (m, 2H), 6.92 (s, 1H), 6.66 (d, *J* = 6.7 Hz, 1H), 5.82 (s, 1H), 3.43 (s, 2H), 3.39 (d, *J* = 4.9 Hz, 1H), 3.33 (d, *J* = 4.7 Hz, 1H), 2.49 (s, 3H), 2.16 (s, 3H), 2.06 (s, 3H), 2.04 (d, *J* = 0.6 Hz, 3H).**^{13}C NMR (75 MHz, $CDCl_3$)** δ 205.1, 167.4, 165.7, 139.6, 139.3, 138.9, 138.5, 137.3, 136.9, 135.9, 134.7, 133.8, 131.5, 130.7, 130.5, 130.3, 129.7, 128.8, 128.5, 127.9, 127.7, 127.6, 127.3, 126.9, 125.6, 124.4, 102.9, 74.4, 38.7, 38.0, 29.8, 26.8, 21.7, 21.3.**HRMS (ESI)** calcd for $C_{40}H_{34}NO_3$ $[M+H]^+$ 576.2539, found 576.2540.

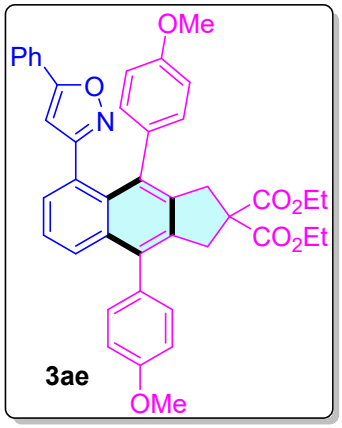
diethyl 5-(5-phenylisoxazol-3-yl)-4,9-di-m-tolyl-1,3-dihydro-2H-cyclopenta[b]naphthalene-2,2-dicarboxylate (3ad):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2d** (124.8 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 15:85) gave pure product **3ad** as a white solid (135 mg, 71% yield), mp 233-236 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.78 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.55 (dd, *J* = 7.6, 1.6 Hz, 2H), 7.44 (t, *J* = 4.3 Hz, 3H), 7.37 (dd, *J* = 17.6, 9.2 Hz, 3H), 7.29 (d, *J* = 7.8 Hz, 1H), 7.21 (d, *J* = 7.7 Hz, 2H), 7.01 (d, *J* = 5.0 Hz, 2H), 6.94 (s, 1H), 6.64 (s, 1H), 5.82 (s, 1H), 4.17 – 4.09 (m, 4H), 3.53 (s, 2H), 3.46 (dd, *J* = 20.5, 3.7 Hz, 2H), 2.47 (s, 3H), 2.15 (s, 3H), 1.21 – 1.14 (m, 6H).**^{13}C**

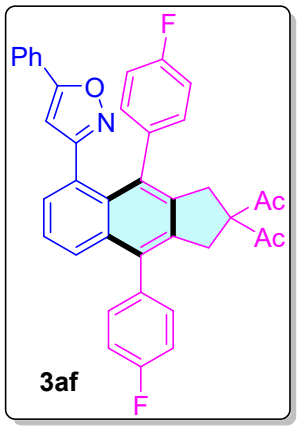
NMR (100 MHz, $CDCl_3$) δ 171.5, 167.4, 165.7, 139.7, 139.6, 139.0, 138.3, 137.2, 137.1, 135.6, 134.3, 133.8, 131.6, 130.6, 130.6, 130.1, 129.7, 128.8, 128.6, 128.3, 127.8, 127.5, 127.3, 127.1, 125.6, 124.2, 103.0, 61.8, 60.3, 41.3, 40.5, 29.8, 21.7, 21.3, 14.1.**HRMS (ESI)** calcd for $C_{42}H_{38}NO_5$ $[M+H]^+$ 636.2750, found 636.2754.

Diethyl4,9-bis(4-methoxyphenyl)-5-(5-phenylisoxazol-3-yl)-1,3-dihydro-2H-cyclopenta[b]naphthalene-2,2-dicarboxylate (3ae):



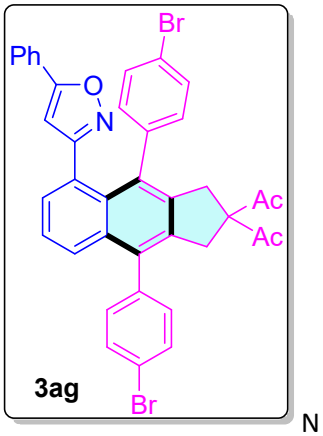
The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2e** (134.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 18:82) gave pure product **3ae** as a white solid (134 mg, 67% yield), mp 239-242 °C **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.82 (d, *J* = 8.2 Hz, 1H), 7.58 (d, *J* = 6.7 Hz, 2H), 7.43 (d, *J* = 6.9 Hz, 4H), 7.38 – 7.33 (m, 3H), 7.07 (dd, *J* = 12.1, 8.4 Hz, 4H), 6.61 (d, *J* = 8.3 Hz, 2H), 5.77 (s, 1H), 4.12 (q, *J* = 7.1 Hz, 4H), 3.93 (s, 3H), 3.53 (s, 2H), 3.44 (s, 2H), 3.28 (s, 3H), 1.17 (t, *J* = 7.1 Hz, 6H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.5, 167.3, 165.9, 159.0, 158.4, 140.1, 137.5, 135.1, 134.0, 133.8, 132.1, 131.8, 131.2, 131.2, 131.0, 130.1, 129.7, 128.8, 128.7, 127.6, 127.2, 125.7, 124.2, 114.2, 113.2, 103.2, 61.8, 60.2, 55.5, 54.7, 41.3, 40.6, 14.1.**HRMS (ESI)** calcd for $C_{42}H_{38}NO_5$ $[M+H]^+$ 668.2649, found 668.2653.

1,1'-(4,9-bis(4-fluorophenyl)-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3af):



The title compound was prepared from **1a** (66.3 mg, 0.3mmol) and **2f** (109.2 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 15:85) gave pure product **3af** as a white solid (113 mg, 65% yield), mp 215-218°C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.72 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.57 (dd, *J* = 7.9, 1.6 Hz, 2H), 7.46 (d, *J* = 1.5 Hz, 1H), 7.44 (s, 2H), 7.40 (dd, *J* = 4.8, 3.5 Hz, 2H), 7.38 (d, *J* = 3.2 Hz, 2H), 7.29 (d, *J* = 8.7 Hz, 2H), 7.15 – 7.10 (m, 2H), 6.83 (t, *J* = 8.7 Hz, 2H), 5.83 (s, 1H), 3.41 (s, 2H), 3.30 (s, 2H), 2.05 (s, 6H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.5, 168.2, 164.5 (d, *J* = 247.0 Hz), 162.9, 162.2 (dd, *J* = 247.2, 72.1 Hz), 161.5, 139.8, 137.2, 135.7 (d, *J* = 3.0 Hz), 134.9, 134.6 (d, *J* = 3.0 Hz), 133.8 (d, *J* = 6.1 Hz), 132.2 (d, *J* = 7.6 Hz), 131.6 (d, *J* = 7.9 Hz), 130.8, 130., 130.0, 129.0, 128.8, 128.4, 127.3 (d, *J* = 12.2 Hz), 125.7, 124.7, 116.0 (d, *J* = 21.4 Hz), 114.8 (d, *J* = 21.3 Hz). 103.0, 74.7, 38.5, 37.8, 26.7.**^{19}F NMR (376 MHz, $CDCl_3$)** δ -114.31 (s), -115.26 (s).**HRMS (ESI)** calcd for $C_{38}H_{28}F_2NO_3$ $[M+H]^+$ 584.2037, found 584.2003.

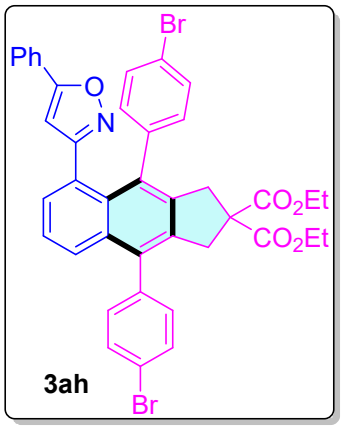
1,1'-(4,9-bis(4-bromophenyl)-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ag):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2g** (144.9 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 13:87) gave pure product **3ag** as a white solid (130 mg, 62% yield), mp 199-202 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.74 – 7.70 (m, 3H), 7.62 – 7.58 (m, 2H), 7.50 – 7.47 (m,

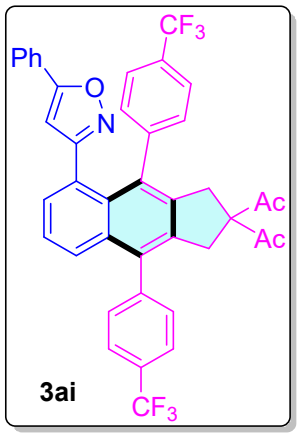
2H), 7.47 – 7.44 (m, 3H), 7.42 – 7.38 (m, 1H), 7.29 (d, J = 8.3 Hz, 2H), 7.24 (s, 1H), 7.01 (d, J = 8.2 Hz, 2H), 5.81 (s, 1H), 3.40 (s, 3H), 3.29 (s, 3H), 2.05 (s, 6H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.3, 168.4, 139.5, 138.6, 137.7, 137.0, 134.8, 133.7, 133.5, 132.2, 132.1, 131.6, 131.0, 130.6, 130.5, 130.0, 129.1, 128.4, 127.3, 127.2, 125.9, 124.8, 122.1, 121.8, 102.9, 74.8, 38.4, 37.7, 26.7. **HRMS (ESI)** calcd for $C_{38}H_{28}Br_2NO_3$ $[M+H]^+$ 704.0436, found 704.0416.

diethyl4,9-bis(4-bromophenyl)-5-(5-phenylisoxazol-3-yl)-1,3-dihydro-2H-cyclopenta[b]naphthalene-2,2-dicarboxylate (3ah):



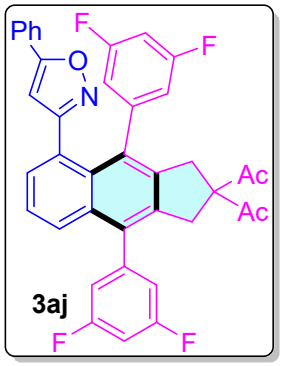
The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2h** (162.9 mg, 0.3mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 16:84) gave pure product **3ah** as a white solid (146 mg, 64% yield), mp 240-243 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.76 – 7.68 (m, 3H), 7.59 (dd, J = 8.1, 1.5 Hz, 2H), 7.50 – 7.47 (m, 2H), 7.45 (d, J = 2.3 Hz, 2H), 7.43 – 7.38 (m, 2H), 7.30 (d, J = 8.3 Hz, 2H), 7.23 (d, J = 8.5 Hz, 2H), 7.01 (d, J = 8.3 Hz, 1H), 5.81 (s, 1H), 4.13 (q, J = 7.1 Hz, 4H), 3.49 (s, 2H), 3.38 (s, 2H), 1.18 (t, J = 7.1 Hz, 6H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 171.2, 168.3, 165.4, 140.0, 138.7, 137.8, 137.4, 134.6, 133.4, 132.2, 132.1, 131.7, 130.9, 130.5, 130.4, 130.0, 129.0, 128.4, 127.3, 127.2, 125.9, 124.7, 122.0, 121.7, 102.9, ,61.9, 60.2, 41.2, 40.4, 14.1. **HRMS (ESI)** calcd for $C_{40}H_{32}Br_2NO_5$ $[M+H]^+$ 764.0647, found 764.0640

1,1'-(5-(5-phenylisoxazol-3-yl)-4,9-bis(4-(trifluoromethyl)phenyl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3ai):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2i** (139.2 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 17:83) gave pure product **3ai** as a pale yellow solid (118 mg, 58% yield), mp 241-243 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 – 7.84 (m, 2H), 7.67 (d, *J* = 8.1 Hz, 2H), 7.57 (d, *J* = 7.8 Hz, 2H), 7.53 (d, *J* = 3.6 Hz, 4H), 7.42 (s, 4H), 7.30 (d, *J* = 7.7 Hz, 2H), 5.86 (s, 1H), 3.40 (s, 2H), 3.29 (s, 2H), 2.05 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 204.2, 202.9 (d, *J* = 41.8 Hz), 168.7, 165.1, 143.5, 142.6, 139.6, 137.1, 134.8, 133.8, 133.3, 130.9, 130.6, 130.4, 128.9, 128.3, 126.9, 126.3 (d, *J* = 50.0 Hz), 126.0, 125.8, 125.6, 125.1, 124.8, 121.4 (d, *J* = 273.1 Hz), 121.3 (d, *J* = 272.0 Hz).119.0, 102.6, 74.9, 38.3, 37.6, 26.7. **^{19}F NMR (471 MHz, $CDCl_3$)** δ -62.46 (s), -63.02 (s).**HRMS (ESI)** calcd for $C_{40}H_{28}F_6NO_3B$ $[M+H]^+$ 684.1973, found 684.1924.

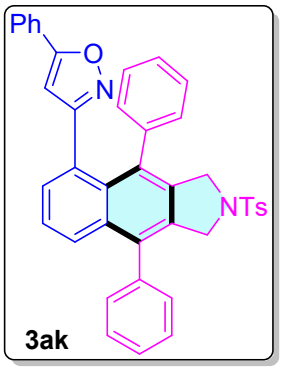
1,1'-(4,9-bis(3,5-difluorophenyl)-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3aj):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2j** (120.0 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 16:84) gave pure product **3aj** as a white solid (92 mg, 50% yield), mp 210-213 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.70 (dd, *J* = 8.1, 1.7 Hz, 1H), 7.64 (dd, *J* = 7.8, 1.7 Hz,

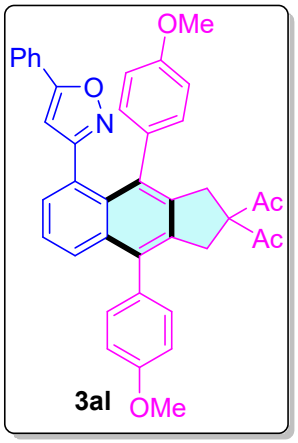
2H), 7.48 (d, J = 1.9 Hz, 2H), 7.47 – 7.43 (m, 3H), 6.97 (ddd, J = 9.8, 6.0, 2.2 Hz, 3H), 6.69 (dd, J = 8.0, 2.2 Hz, 2H), 6.35 (tt, J = 9.0, 2.3 Hz, 1H), 6.03 (s, 1H), 3.42 (s, 2H), 3.32 (s, 2H), 2.08 (s, 6H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.0, 168.7, 165.0, 163.5(d, J = 250.5 Hz), 163.4 (d, J = 250.5 Hz), 162.5 (d, J = 249.4 Hz), 162.4 (d, J = 249.6 Hz), 143.0 (t, J = 9.6 Hz), 141.9 (t, J = 9.3 Hz), 139.4, 137.0, 134.1, 133.1, 130.7, 130.4, 130.2, 129.1, 128.1, 127.2 (d, J = 8.8 Hz), 125.7, 125.2, 113.7 (d, J = 23.7 Hz), 113.0 (d, J = 24.7 Hz), 103.7 (t, J = 25.1 Hz), 102.7 (t, J = 25.1 Hz), 102.3, 74.8, 38.1, 37.4, 26.7.**^{19}F NMR (376 MHz, $CDCl_3$)** δ -108.62 (s), -110.15 (s). **HRMS (ESI)** calcd for $C_{38}H_{26}F_4NO_3$ $[M+H]^+$ 620.1849 found 620.1861.

3-(4,9-diphenyl-2-tosyl-2,3-dihydro-1H-benzo[f]isoindol-5-yl)-5-phenylisoxazole (3ak):



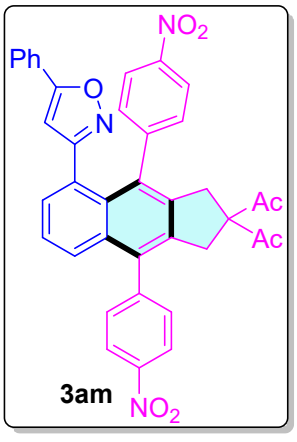
The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2k** (119.7 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 14:86) gave pure product **3ak** as a pale yellow solid (72 mg, 39% yield), mp 248-251 °C. **^{1}H NMR (300 MHz, $CDCl_3$)** δ 7.77 (dd, J = 8.3, 1.5 Hz, 1H), 7.63 (d, J = 8.3 Hz, 2H), 7.56 (s, 1H), 7.55 – 7.51 (m, 3H), 7.47 (dd, J = 5.4, 1.6 Hz, 2H), 7.44 – 7.39 (m, 5H), 7.35 – 7.31 (m, 2H), 7.28 (s, 1H), 7.12 (s, 1H), 7.11 – 7.06 (m, 3H), 6.91 (dt, J = 8.7, 1.7 Hz, 1H), 5.79 (s, 1H), 4.54 (s, 2H), 4.44 (s, 2H), 2.39 (s, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 168.0, 143.8, 138.8, 137.9, 136.0, 134.7, 133.8, 133.6, 133.4, 130.9, 130.1, 129.9, 129.9, 129.6, 129.1, 128.9, 128.8, 128.6, 128.2, 128.0, 127.7, 127.6, 126.4, 125.8, 125.1, 103.1, 54.4, 53.9, 29.8, 21.7. **HRMS (ESI)** calcd for $C_{40}H_{31}N_2O_3S$ $[M+H]^+$ 619.2055, found 619.2055.

1,1'-(4,9-bis(4-methoxyphenyl)-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3al):



The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2l** (116.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 16:84) gave pure product **3al** as a white solid (109 mg, 60% yield), mp 214-217 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.80 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.60 – 7.57 (m, 2H), 7.44 (d, *J* = 7.3 Hz, 4H), 7.37 (d, *J* = 8.4 Hz, 1H), 7.33 (d, *J* = 8.5 Hz, 2H), 7.11 (d, *J* = 8.6 Hz, 2H), 7.05 (d, *J* = 8.1 Hz, 2H), 6.63 (d, *J* = 8.6 Hz, 2H), 5.78 (s, 1H), 3.94 (s, 4H), 3.44 (s, 2H), 3.34 (s, 2H), 3.29 (s, 2H), 2.04 (s, 6H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 205.0, 167.5, 165.8, 159.2, 158.5, 139.8, 137.2, 135.4, 134.2, 134.1, 132.0, 131.7, 131.1, 130.2, 129.7, 128.9, 128.8, 127.6, 127.3, 125.7, 124.4, 114.4, 113.3, 103.2, 74.5, 55.5, 54.7, 38.7, 38.0, 26.8. **HRMS (ESI)** calcd for $C_{40}H_{33}NO_5$ $[M+H]^+$ 608.2437, found 608.2441.

1,1'-(4,9-bis(4-nitrophenyl)-5-(5-phenylisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one) (3am):

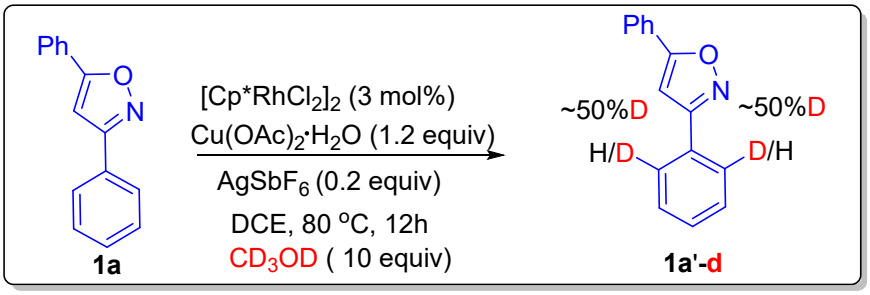


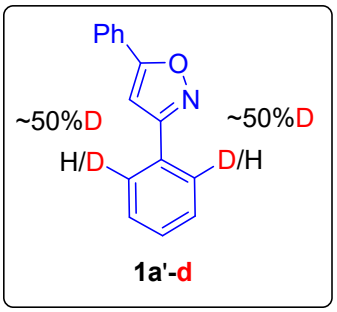
The title compound was prepared from **1a** (66.3 mg, 0.3 mmol) and **2m** (125.4 mg, 0.3 mmol) according to general procedure **A**. Purification using column chromatography (R_f = 0.55, SiO_2, EtOAc:Hexane, 15:85) gave pure product **3am** as a pale yellow solid (61 mg, 32% yield), mp 243-247 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.48 (d, *J* = 8.5 Hz, 2H), 8.08 (dd, *J* = 12.6, 8.7 Hz, 1H), 8.00 (d, *J* = 8.4 Hz, 2H), 7.73 (d, *J* = 8.5 Hz, 1H), 7.65 (s, 1H), 7.63 (d, *J* = 1.8 Hz, 1H),

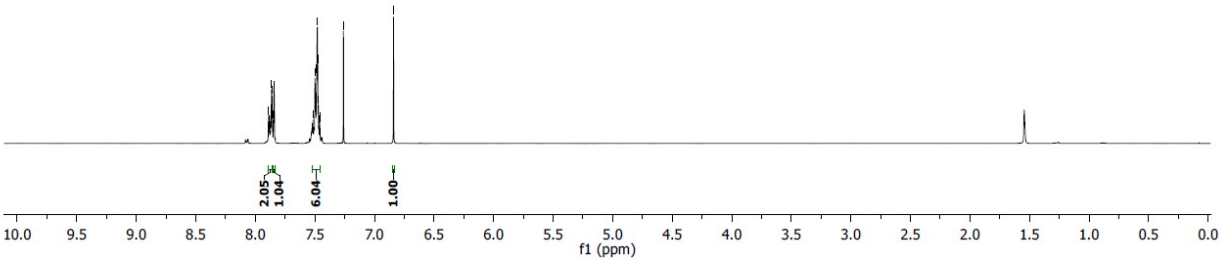
7.49 (s, 2H), 7.48 (s, 2H), 7.44 (s, 1H), 7.44 – 7.42 (m, 1H), 7.36 – 7.32 (m, 2H), 5.86 (s, 1H), 3.40 (s, 2H), 3.27 (s, 2H), 2.05 (s, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 203.6, 169.0, 164.8, 147.8, 146.8, 145.6, 139.5, 137.1, 134.4, 133.89 133.4, 133.0, 132.0, 131.8, 131.5, 131.0, 130.7, 130.6, 129.3, 128.0, 125.9, 125.4, 124.4, 124.2, 123.0, 102.7, 75.0, 38.1, 37.4, 26.6. **HRMS (ESI)** calcd for $C_{38}H_{27}N_3O_7$ $[M+H]^+$ 638.1927, found 638.1949.

5.Deuterium labelling studies:

To a mixture of isoxazole **1a** (33.15 mg, 0.15 mmol)) in DCE, $[Cp^*RhCl_2]_2$ (2.78 mg, 3 mol %), $AgSbF_6$ (10.30 mg, 0.2 equiv), $Cu(OAc)_2.H_2O$ (36 mg, 1.2 equiv) and excess of CD_3OD were added and the reaction mixture was stirred at 80 °C (oil bath) for 12h, DCE was evaporated, water was added and the contents were extracted with ethyl acetate (2×10 mL). The organic layer was evaporated and the residue was purified by column chromatography (R_f= 0.50) (SiO_2, EtOAc:Hexane, 3:97) to get **1a'-d.**

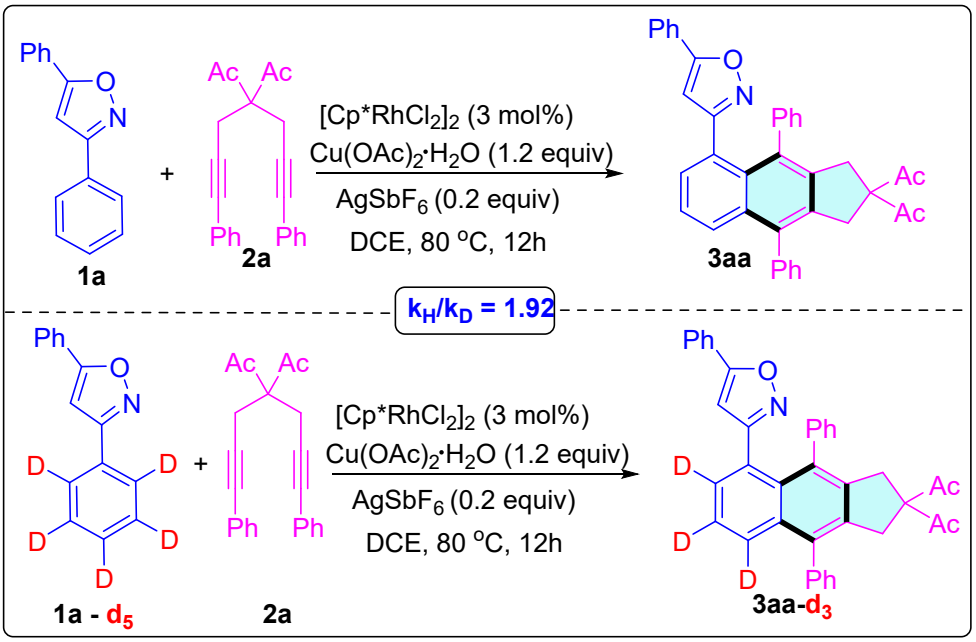






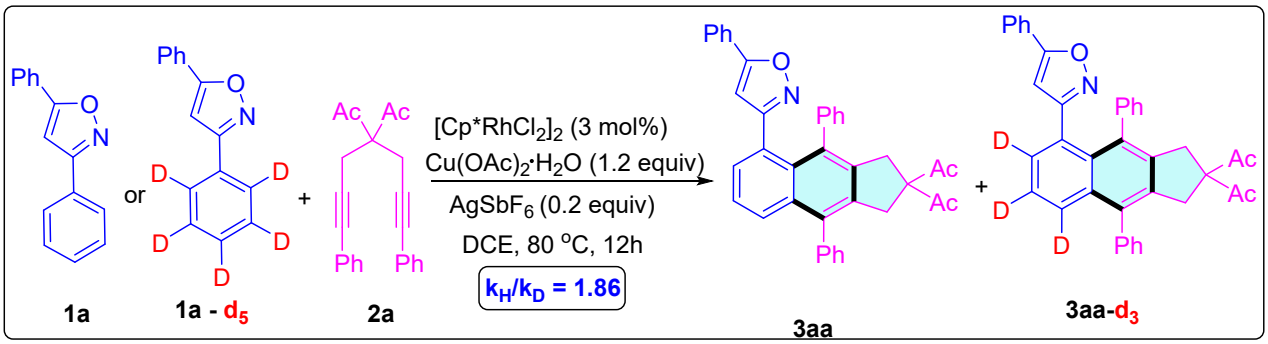
Kinetic Isotope Effect (KIE) Determined from Two Parallel Reactions:

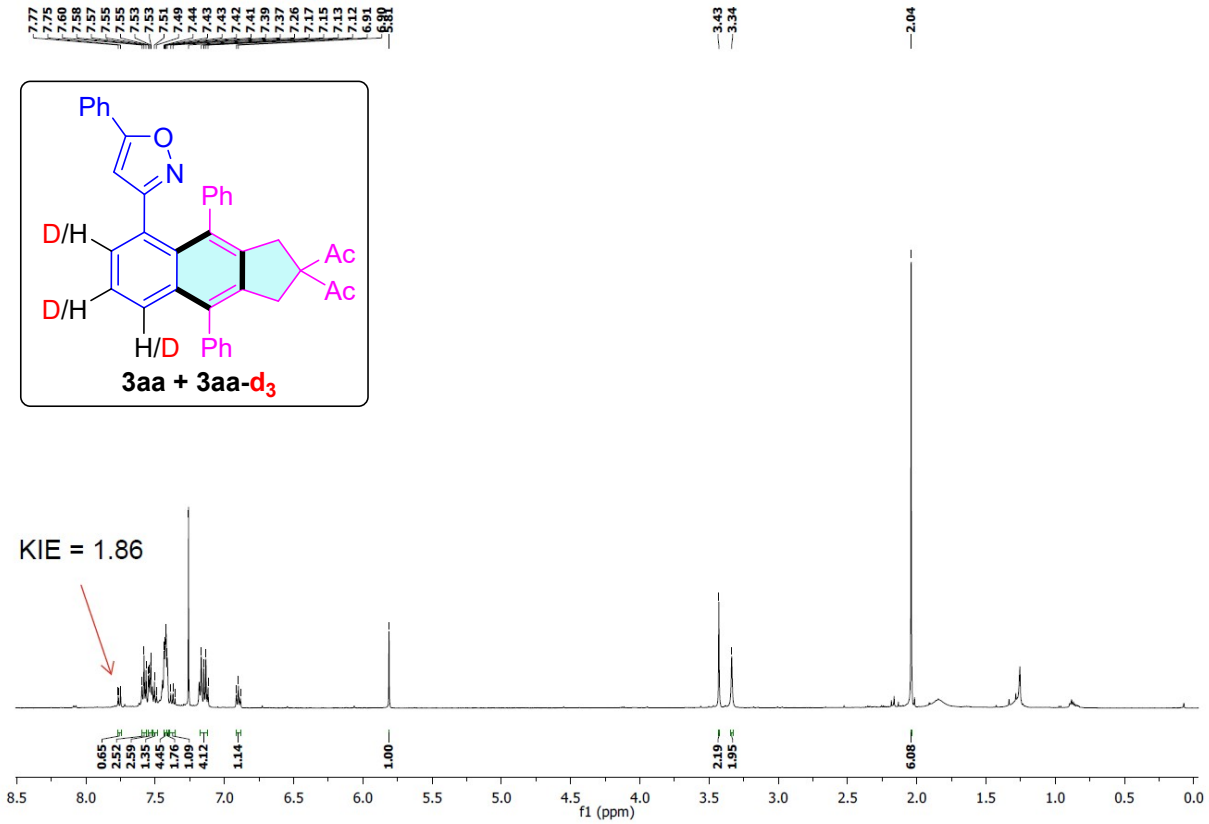
To a mixture of **1a** (66.3 mg, 0.3 mmol) or **1a-d$_5$** (67.8 mg, 0.3 mmol) and 1,6-diyne **2a** (98.4 mg, 0.3 mmol) in DCE, $[Cp^*RhCl_2]_2$ (5.56 mg, 3 mol %) was added along with $AgSbF_6$ (20.61 mg, 0.2 equiv) and $Cu(OAc)_2 \cdot H_2O$ (72 mg, 1.2 equiv). The reaction mixture was stirred at 80 °C (oil bath) under a nitrogen balloon for 12 hours. Upon completion of the reaction (monitored by TLC), DCE was removed under reduced pressure, and water was added. The mixture was then extracted with ethyl acetate (2 × 10 mL). The organic layer was dried, concentrated, and the residue was purified by column chromatography (Rf = 0.50) using silica gel and an EtOAc:Hexane (13:88) elution. The desired products, **3aa** (129.64 mg, 79%) or **3aa-d$_3$** (67.65 mg, 41%), were obtained as white solids. The determined k_H/k_D ratio was **1.92** based on the isolated yield.



Kinetic Isotope Effect (KIE) Determined from Combined Reactions:

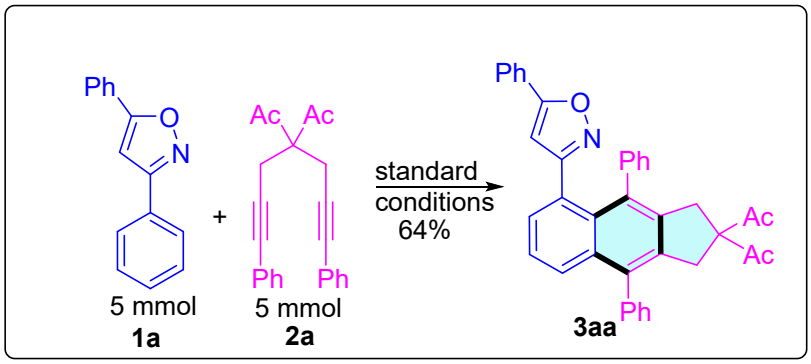
To a mixture of **1a** (33.15 mg, 0.15 mmol) or **1a-d$_5$** (33.15 mg, 0.15 mmol) and 1,6-diyne **2a** (49.20 mg, 0.15 mmol) in DCE, $[Cp^*RhCl_2]_2$ (2.78 mg, 3 mol %), $AgSbF_6$ (10.3 mg, 0.2 equiv), and $Cu(OAc)_2 \cdot H_2O$ (36 mg, 1.2 equiv) were added. The reaction mixture was stirred at 80 °C (oil bath) for 12 hours under a nitrogen balloon. After the reaction was complete, as monitored by TLC, DCE was evaporated, water was added, and the mixture was extracted with ethyl acetate. The organic layer was concentrated, and the residue was purified by column chromatography (Rf = 0.50) using silica gel and an EtOAc:Hexane (13:87) solvent mixture. The products, **3aa** and **3aa-d$_3$**, were obtained. The k_H/k_D value **1.86** was determined by ^{1}H NMR analysis.





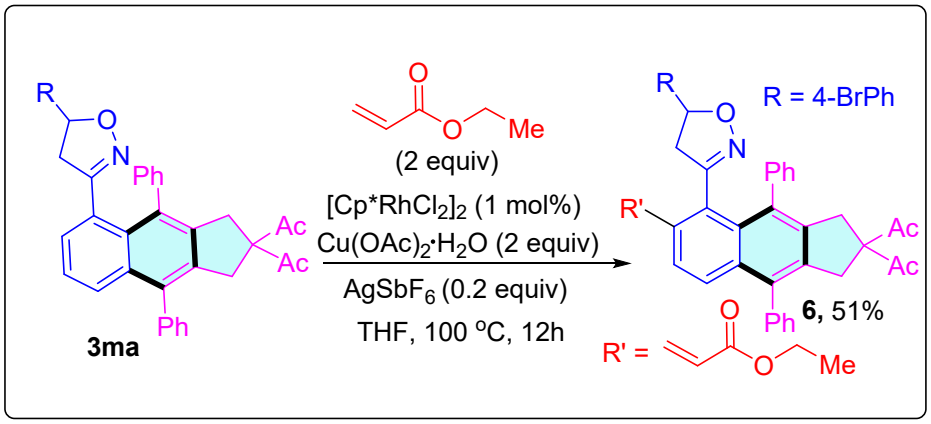
6. Scale-up Experiments:

To a mixture of Isoxazole **1a** (1105.0 mg, 5 mmol), 1,6 Diyne **2a** (1640.0 mg, 5 mmol) in DCE, $[Cp^*RhCl_2]_2$ (92.7 mg, 3 mol %), $AgSbF_6$ (343.62 mg, 0.2 equiv), $Cu(OAc)_2.H_2O$ (1200 mg, 1.2 equiv) were introduced and the reaction mixture was stirred at 80 °C (oil bath) for 12 hours under N_2 balloon. After completion of reaction, DCE was evaporated, water was added and the contents were extracted with ethyl acetate. The organic layer was evaporated and the residue was purified by column chromatography (Rf = 0.50) (SiO_2, EtOAc:Hexane, 13:87) to get **3aa** as white solid in 64% (1750 mg) yield.



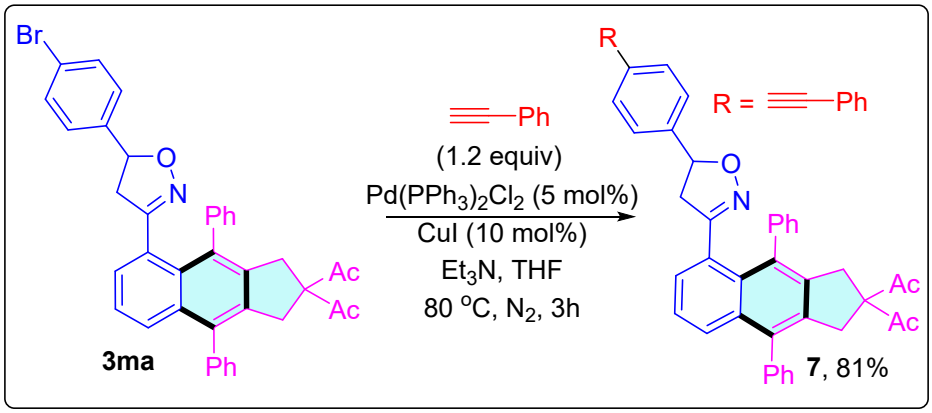
Product Modifications:

ethyl (E)-3-(2,2-diacetyl-5-(5-(4-bromophenyl)-4,5-dihydroisoxazol-3-yl)-4,9-diphenyl-2,3-dihydro-1H-cyclopenta[b]naphthalen-6-yl)acrylate:



To a mixture of **3ma** (31.35 mg, 0.05 mmol), ethyl acrylate (1.2 equiv) in THF, $[Cp^*RhCl_2]_2$ (1 mol %), $AgSbF_6$ (0.2 equiv), $Cu(OAc)_2.H_2O$ (2 equiv) were introduced and the reaction mixture was stirred at 100 °C (oil bath) for 12 hours under N_2 balloon. After completion of reaction, THF was evaporated, water was added and the contents were extracted with ethyl acetate. The organic layer was evaporated and the residue was purified by column chromatography (Rf = 0.50) (SiO_2, EtOAc:Hexane, 16:84) to get **6** as white solid in 51% (18.55 mg) yield. mp 220-223 °C. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.76 (d, *J* = 15.7 Hz, 1H), 7.71 (d, *J* = 9.0 Hz, 1H), 7.60 – 7.56 (m, 3H), 7.53 (d, *J* = 5.7 Hz, 3H), 7.52 – 7.47 (m, 3H), 7.43 (d, *J* = 10.9 Hz, 1H), 7.37 (dd, *J* = 5.8, 1.6 Hz, 2H), 7.33 (s, 1H), 7.23 (d, *J* = 6.8 Hz, 2H), 6.37 (d, *J* = 15.8 Hz, 1H), 4.42 (s, 1H), 4.24 (q, *J* = 7.0 Hz, 2H), 3.40 (d, *J* = 5.2 Hz, 2H), 3.29 (d, *J* = 17.5 Hz, 1H), 3.09 (d, *J* = 17.4 Hz, 2H), 2.72 – 2.57 (m, 1H), 2.05 (s, 3H), 2.02 (s, 3H), 1.30 (t, *J* = 7.1 Hz, 3H).**^{13}C NMR (100 MHz, $CDCl_3$)** δ 204.5, 166.3, 141.6, 141.2, 140.1, 138.3, 138.2, 136.1, 135.2, 134.1, 133.6, 132.5, 132.0, 131.0, 129.9, 129.7, 129.1, 129.0, 128.8, 128.3, 128.0, 127.7, 122.9, 122.2, 121.8, 82.2, 60.8, 51.1, 38.6, 37.9, 26.8, 26.7, 14.5. **HRMS (ESI)** calcd for $C_{43}H_{37}BrNO_5$ $[M+H]^+$ 726.1855, found 726.1872

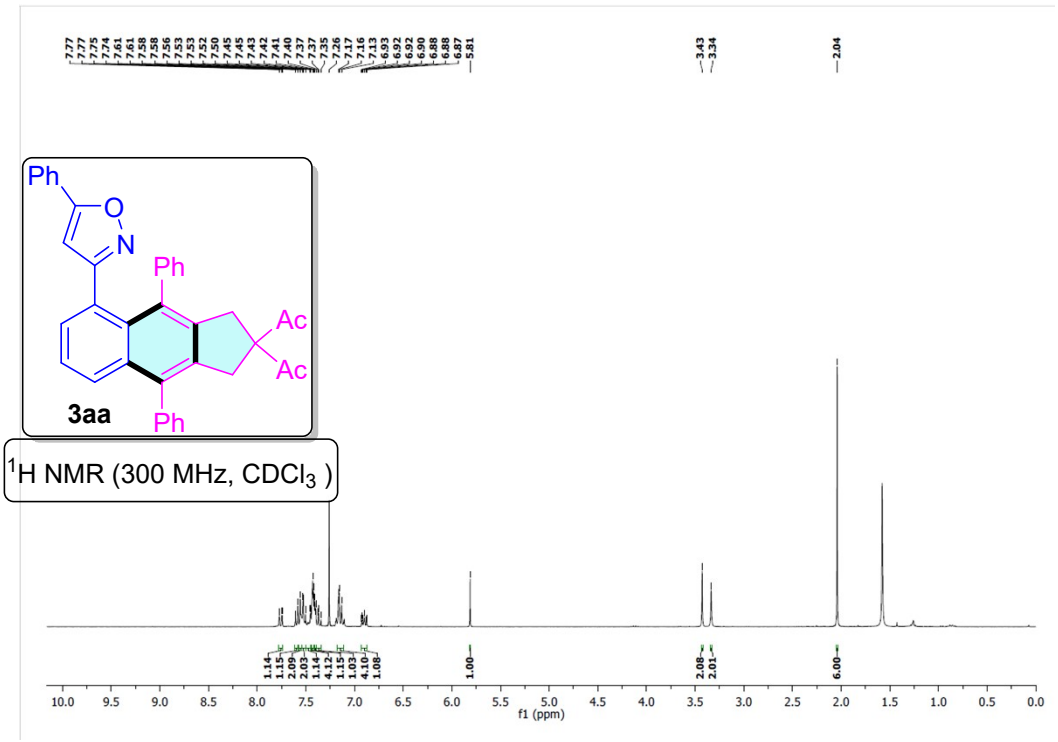
1,1'-(4,9-diphenyl-5-(5-(4-(phenylethynyl)phenyl)-4,5-dihydroisoxazol-3-yl)-2,3-dihydro-1H-cyclopenta[b]naphthalene-2,2-diyl)bis(ethan-1-one):

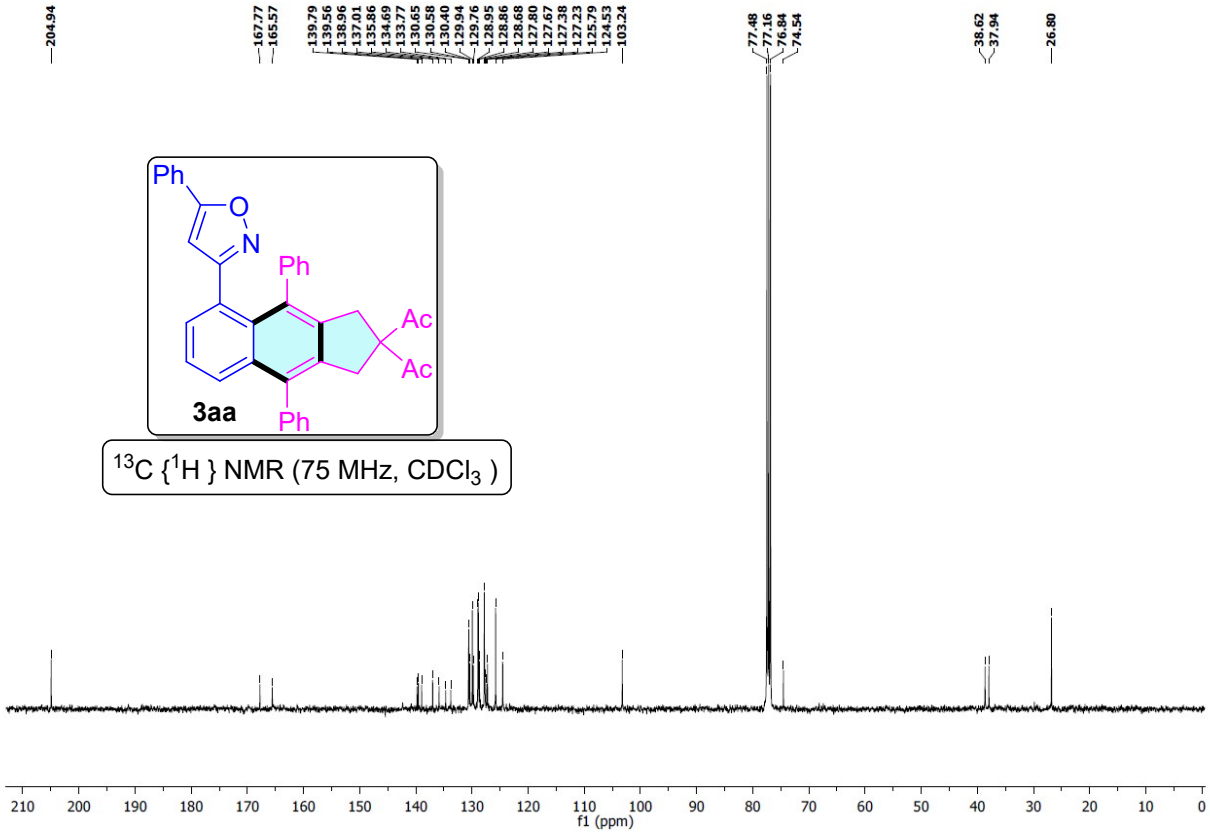


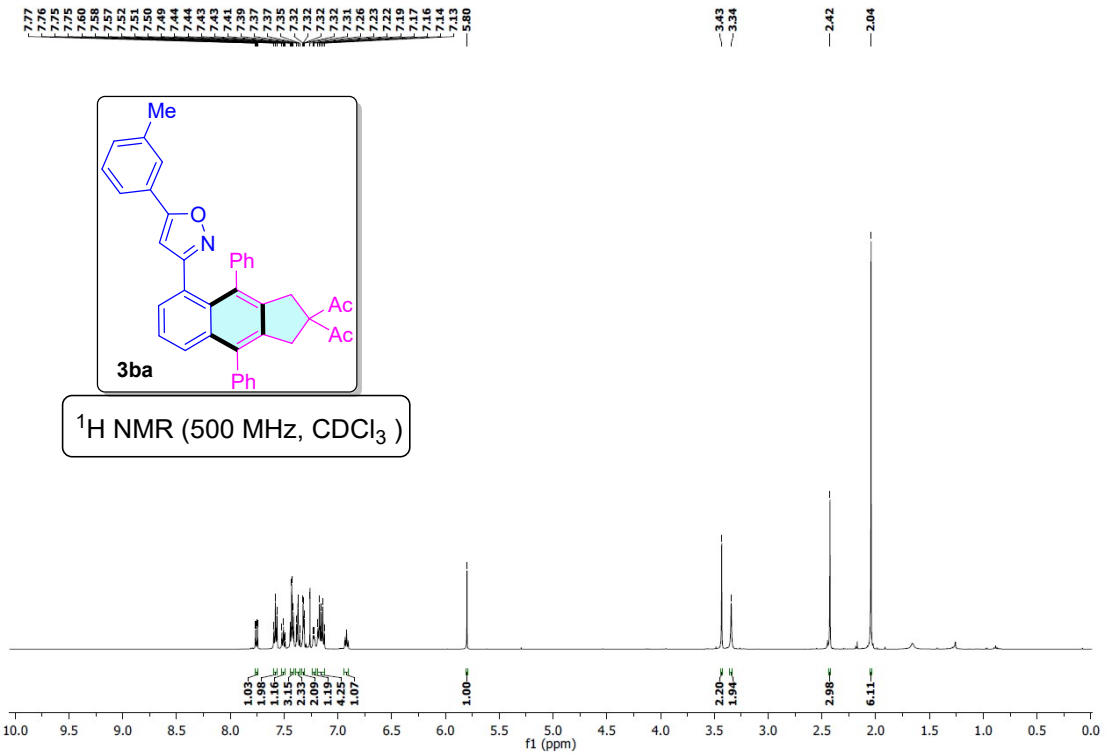
The following reagents were introduced into a Schlenk tube under a nitrogen atmosphere: compound **3ma**, (31.35 mg, 0.05 mmol,), phenylacetylene (1.2 equiv), $Pd(PPh_3)_2Cl_2$ (5 mol%), CuI (10 mol%), and Et_3N (3.0 mL). The mixture was stirred at 80 °C for 3 hours. Upon completion of the reaction (monitored by TLC), the reaction mixture was cooled to room temperature and extracted with ethyl acetate. The combined organic extracts were concentrated under reduced pressure. The product **7** was isolated in 81% yield (26.28 mg) as a brown solid. after purification by column chromatography (R_f = 0.50) (SiO_2, EtOAc:Hexane, 14:86). mp 180-183 °C. **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.61 (s, 2H), 7.47 (s, 4H), 7.41 (s, 7H), 7.31 (d, *J* = 7.4 Hz, 6H), 7.16 (d, *J* = 19.5 Hz, 3H), 4.54 (s, 1H), 3.37 (dd, *J* = 33.1, 13.0 Hz, 3H), 3.18 (d, *J* = 16.7 Hz, 1H), 3.00 (s, 1H), 2.69 – 2.57 (m, 1H), 1.99 (s, 3H), 1.95 (s, 3H). **^{13}C NMR (125 MHz, $CDCl_3$)** δ 204.8, 160.3, 140.3, 140.2, 139.8, 138.7, 137.3, 135.9, 134.2, 133.9, 131.9, 131.7, 130.6, 130.1, 129.9, 129.8, 129.0, 128.9, 128.8, 128.7, 128.6, 128.5, 128.2, 127.8, 127.6, 126.3, 124.7, 123.2, 123.1, 89.8, 89.1, 82.3, 74.6, 48.9, 38.6, 37.9, 29.8, 26.8, 26.7.

HRMS (ESI) calcd for $C_{46}H_{36}NO_3$ $[M+H]^+$ 650.2695, found 650.2704

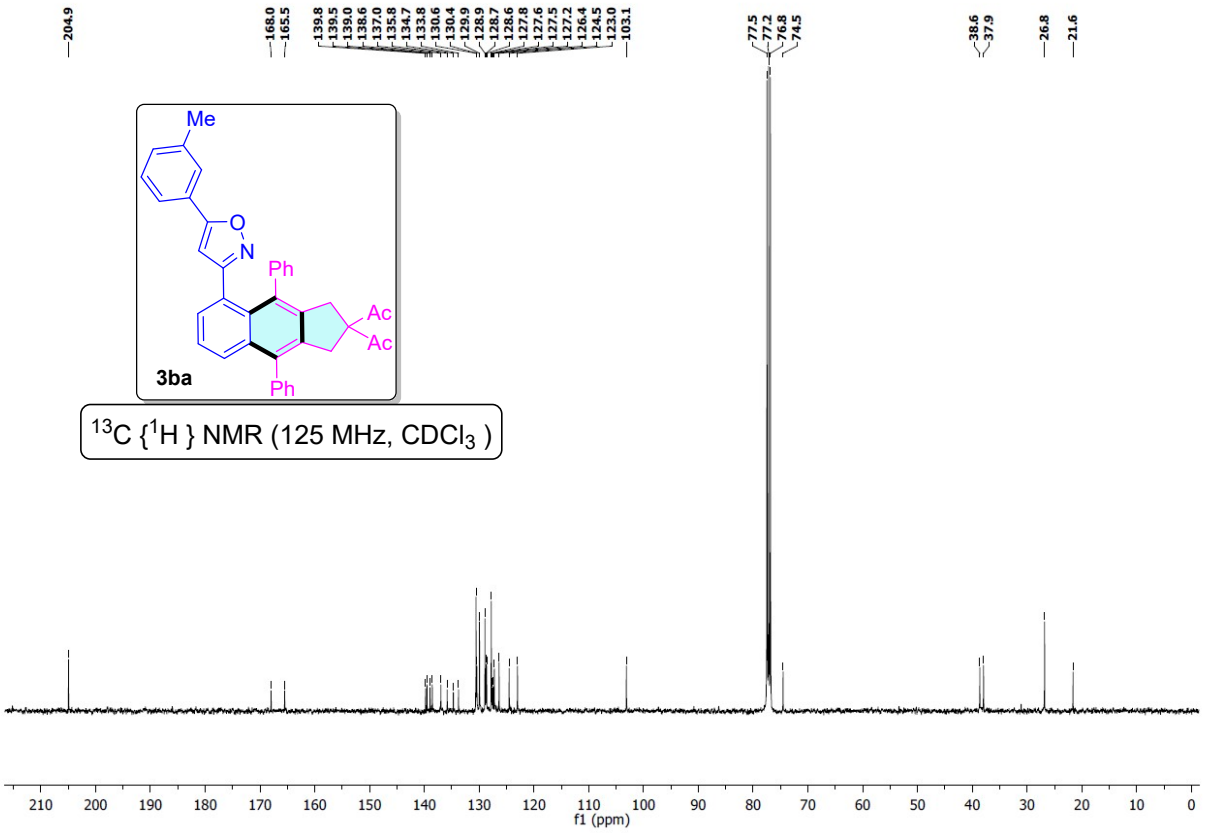
7. Copies of 1H and 13C NMR spectras:


Ph
O
N
Ph
Ac
Ac
Ph
3aa
1H NMR (300 MHz, CDCl3)
f1 (ppm)

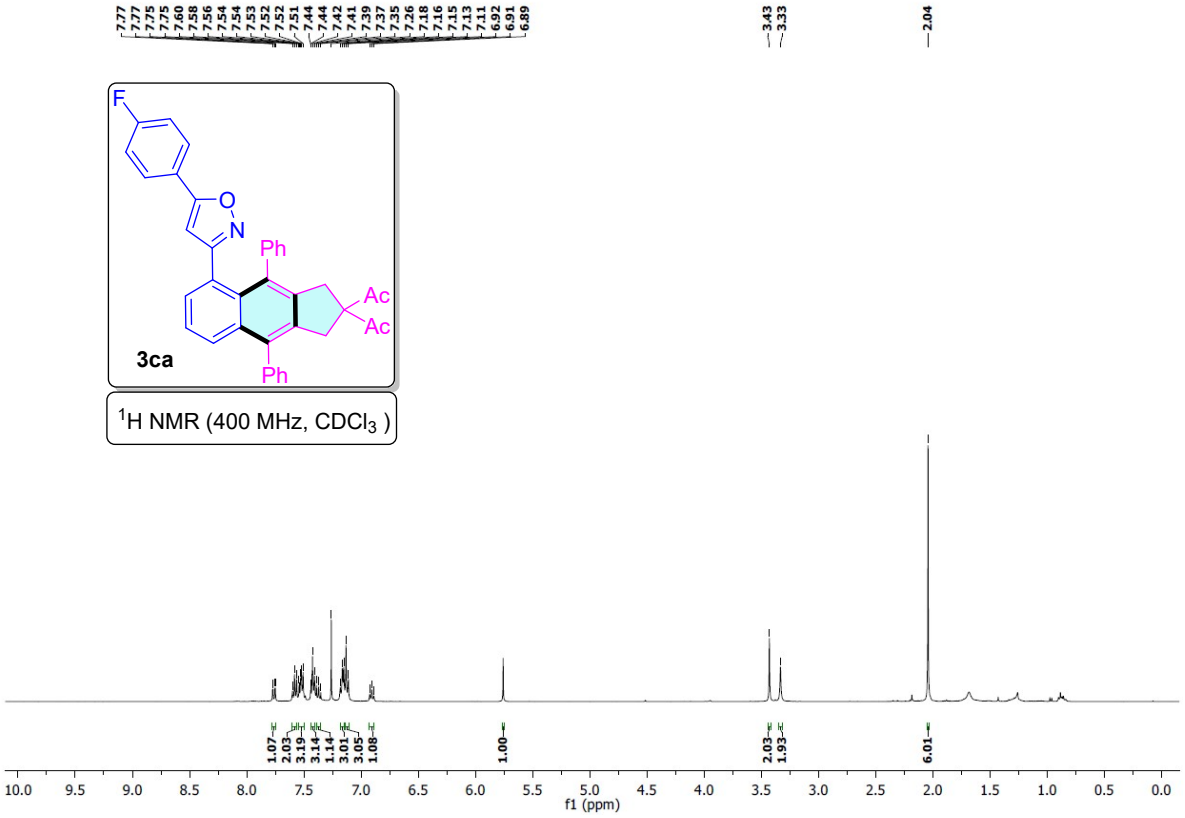

Ph
O
N
Ph
Ac
Ac
Ph
3aa
13C {1H } NMR (75 MHz, CDCl3)
f1 (ppm)



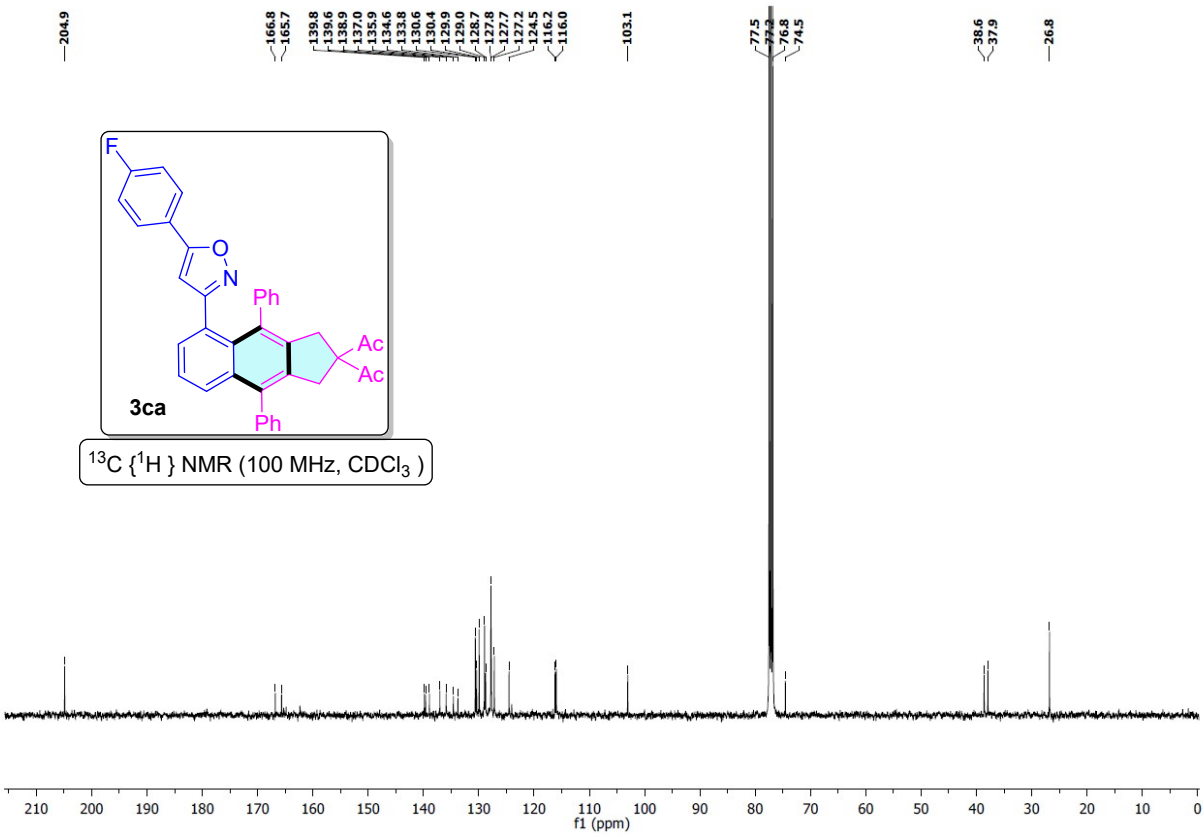
^{1}H NMR (500 MHz, $CDCl_3$)



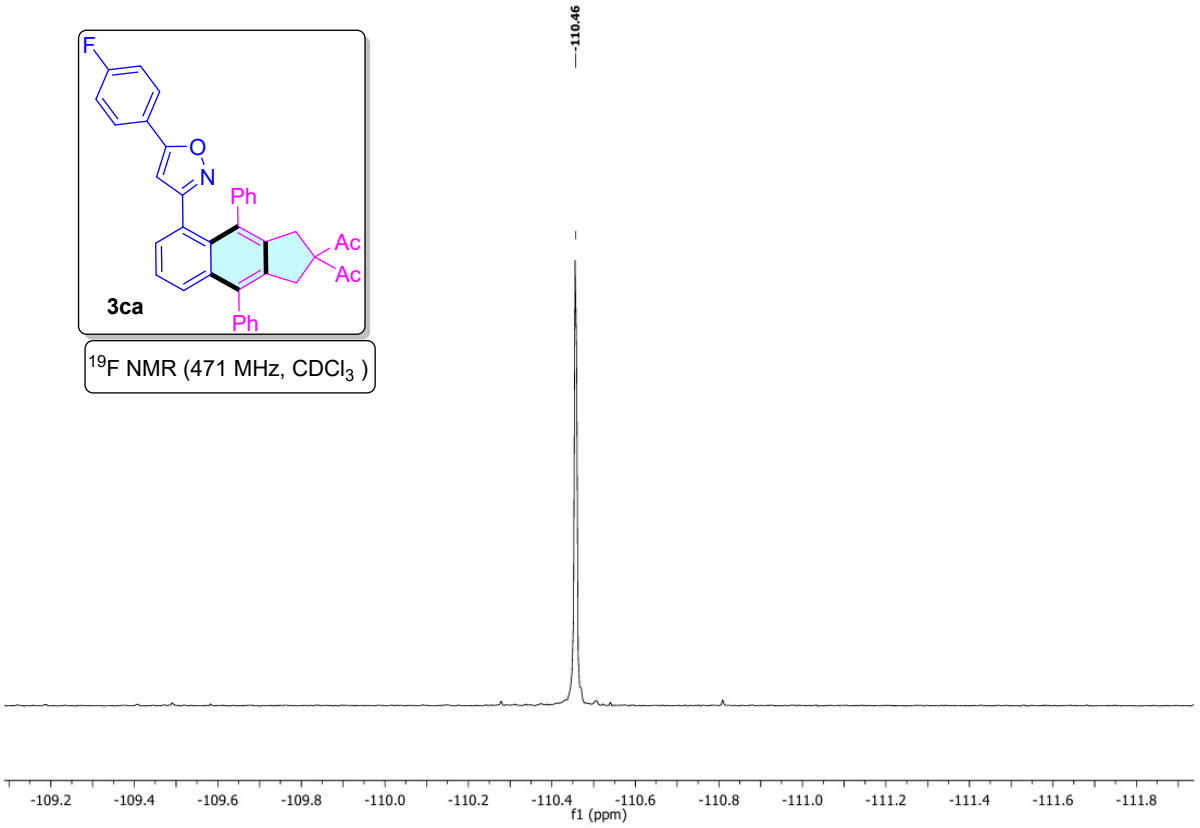
^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)



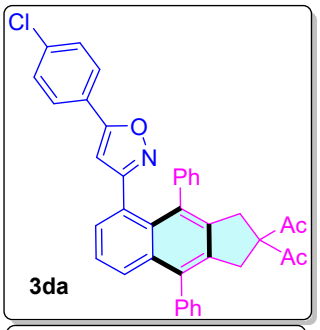
^{1}H NMR (400 MHz, $CDCl_3$)



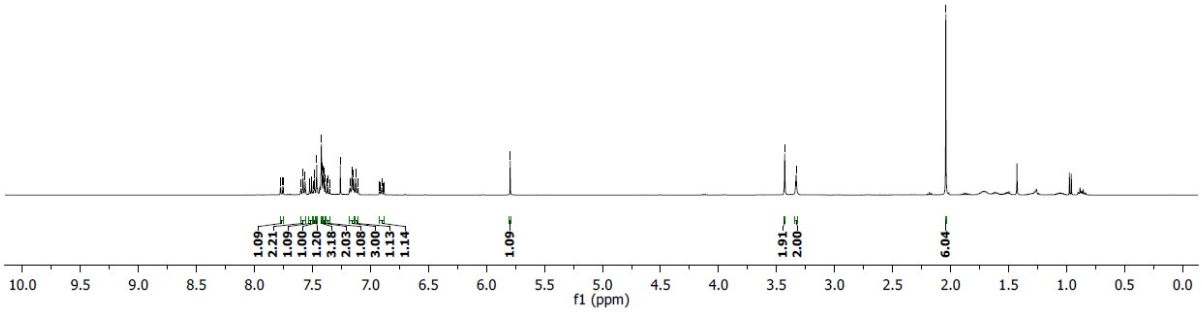
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

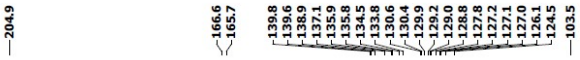


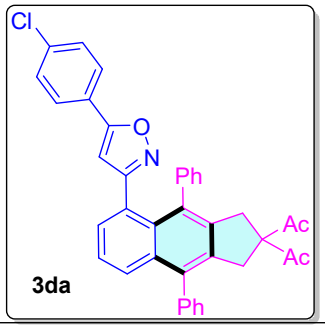
^{19}F NMR (471 MHz, $CDCl_3$)



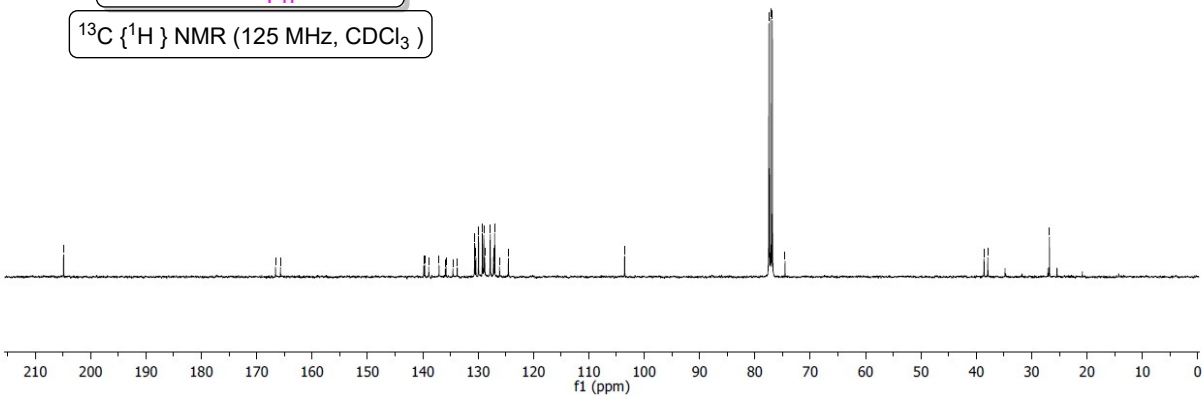
^{1}H NMR (500 MHz, $CDCl_3$)

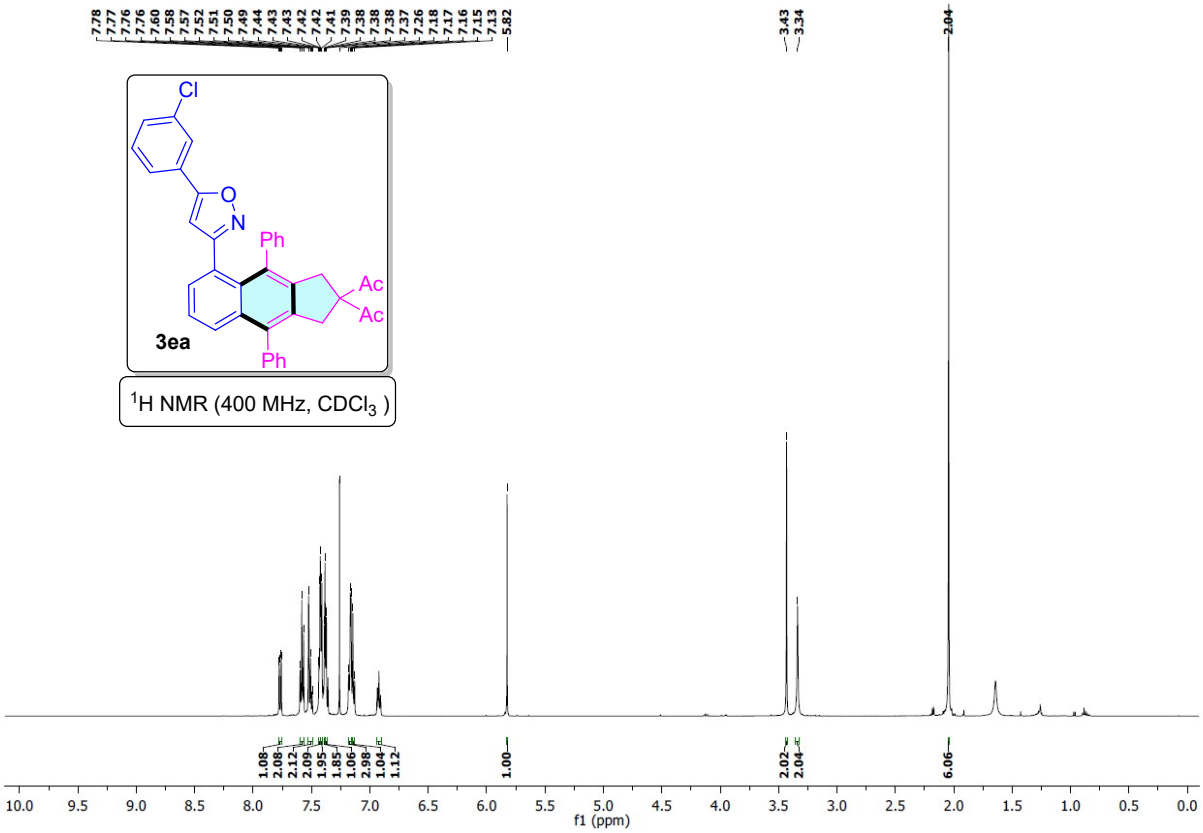




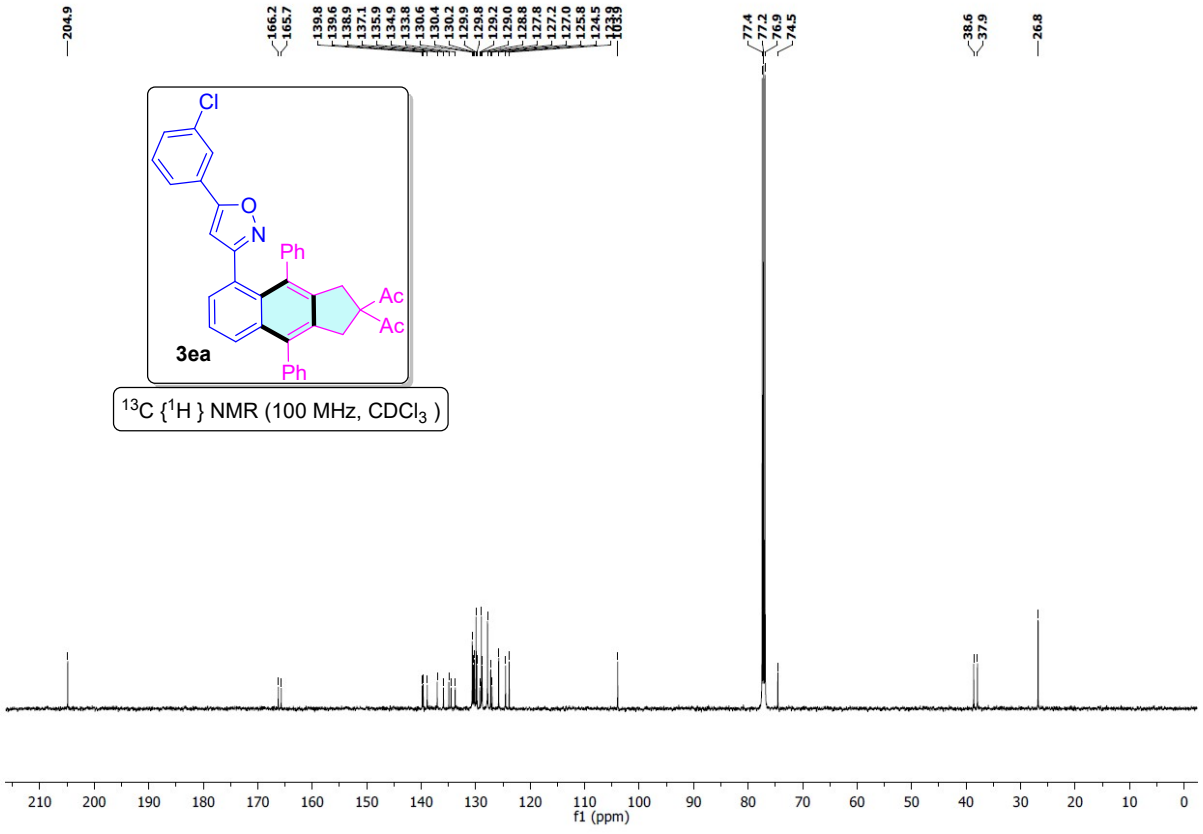


^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)

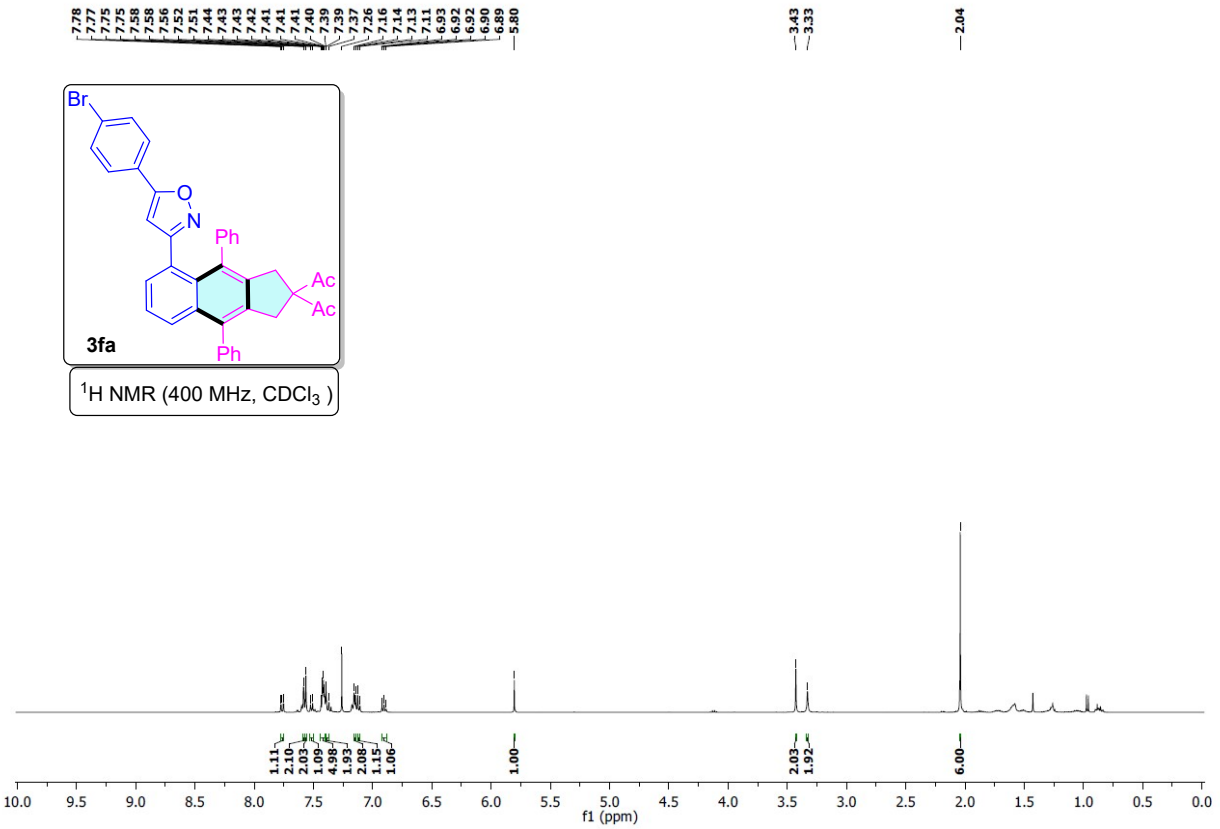




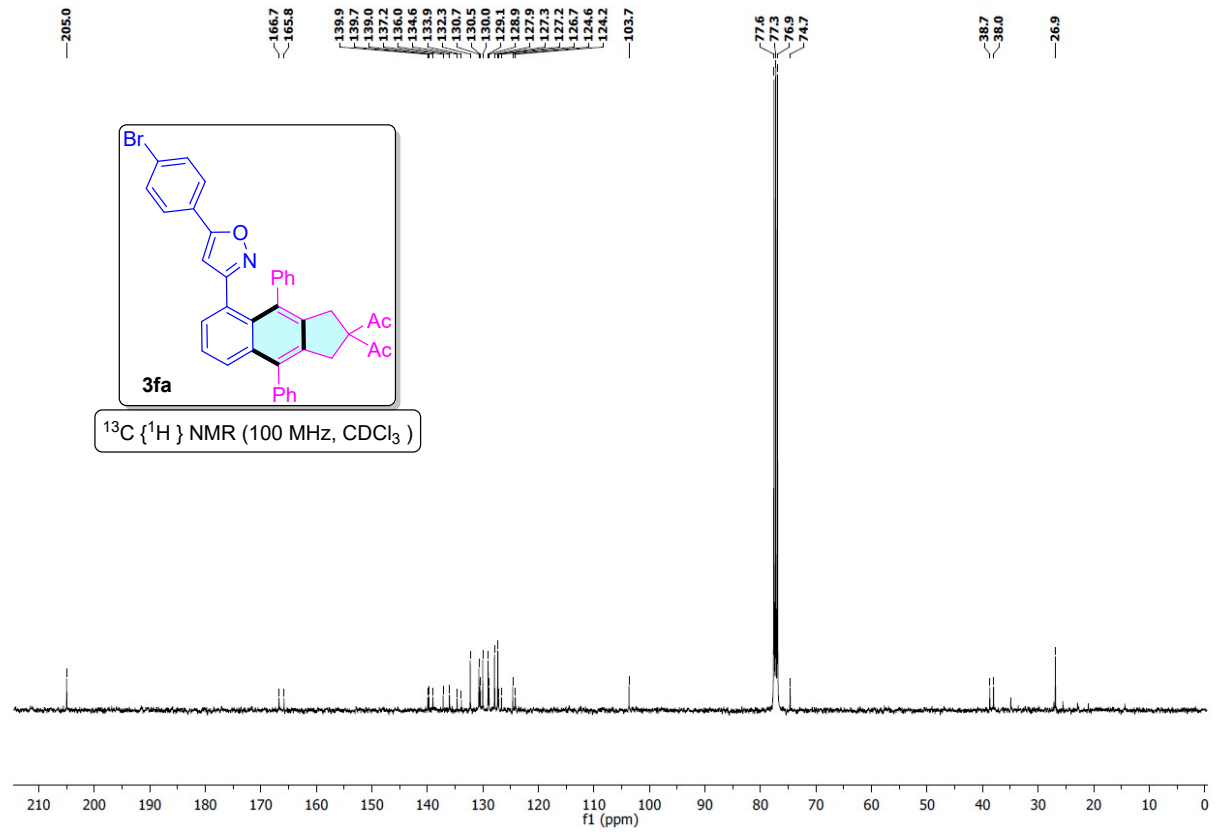
^{1}H NMR (400 MHz, $CDCl_3$)



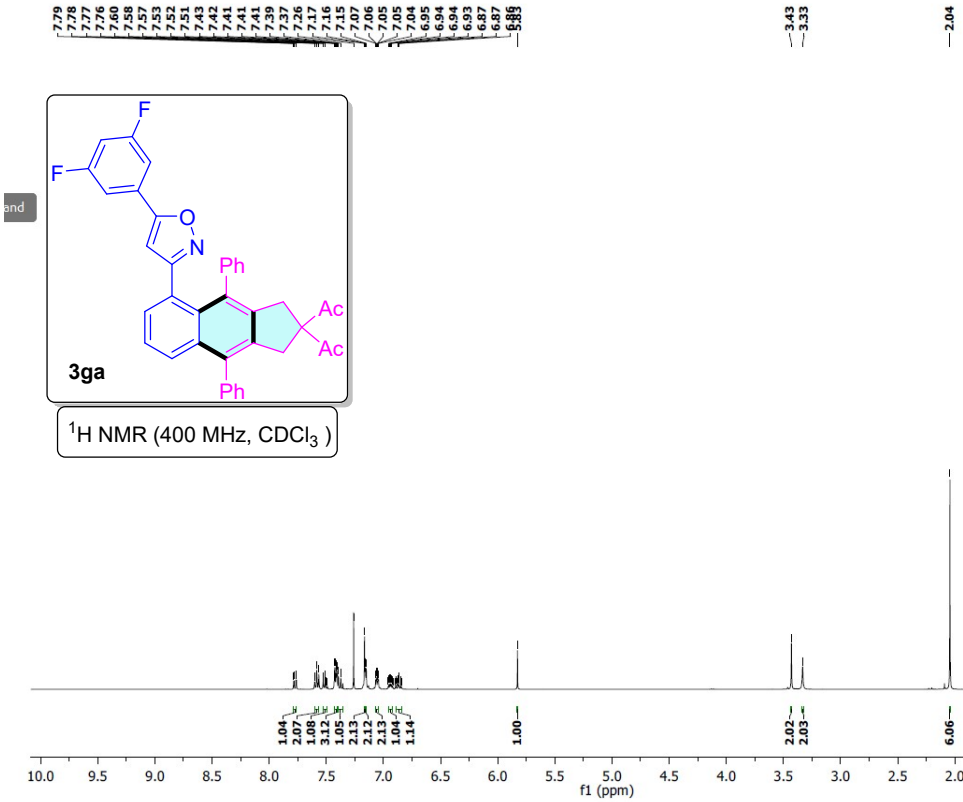
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



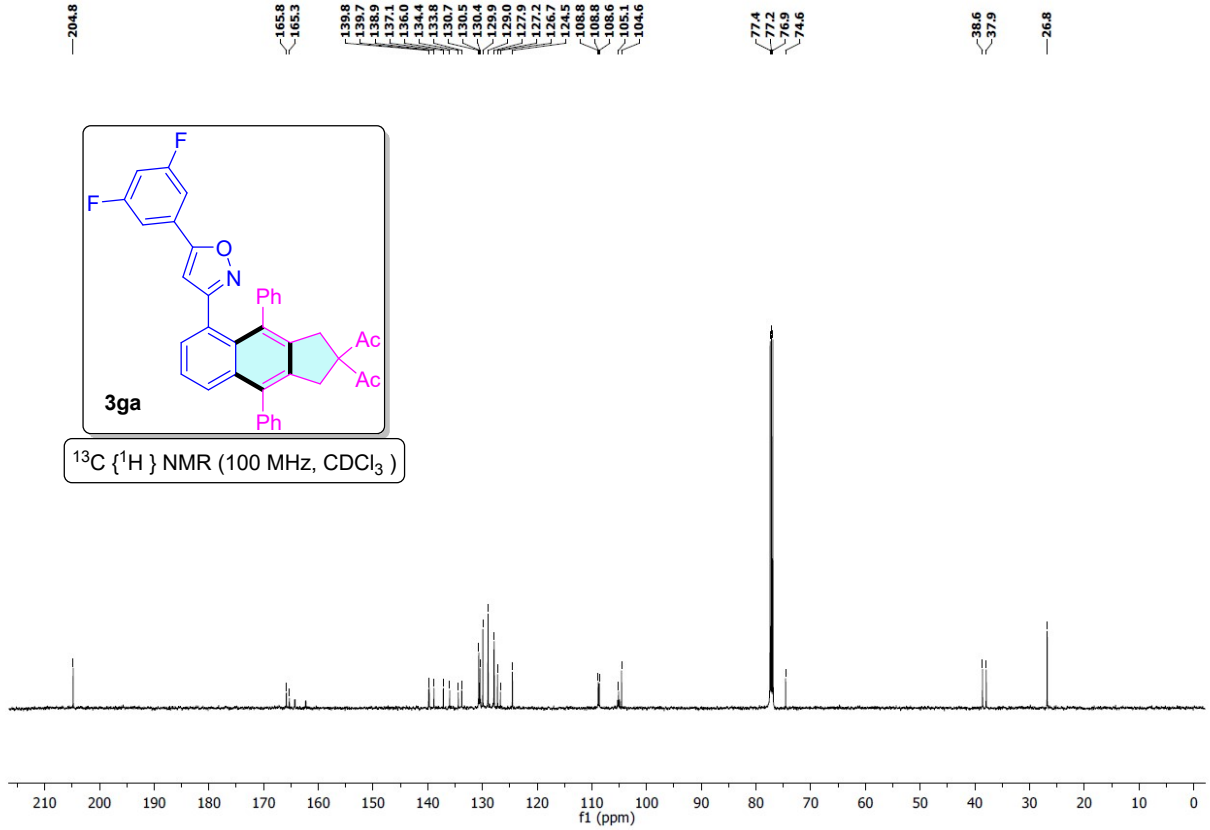
^{1}H NMR (400 MHz, $CDCl_3$)



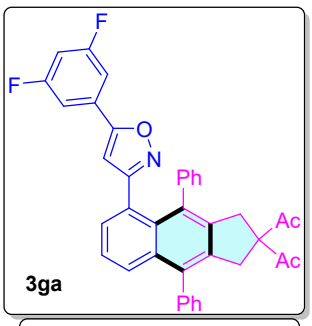
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



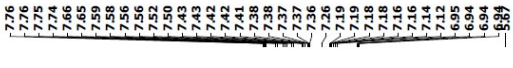
^{1}H NMR (400 MHz, $CDCl_3$)

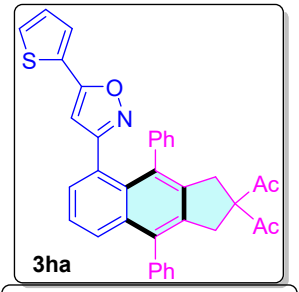


^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

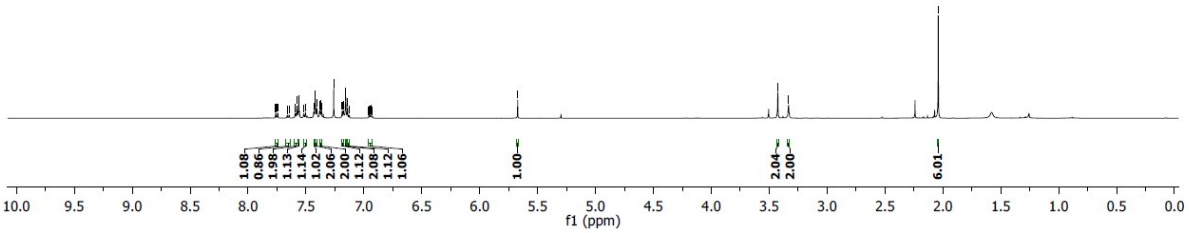


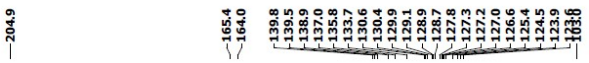
^{19}F NMR (377 MHz, $CDCl_3$)

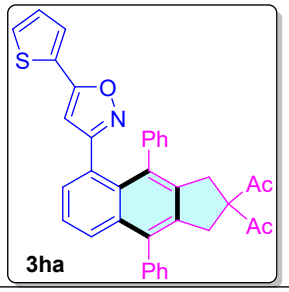




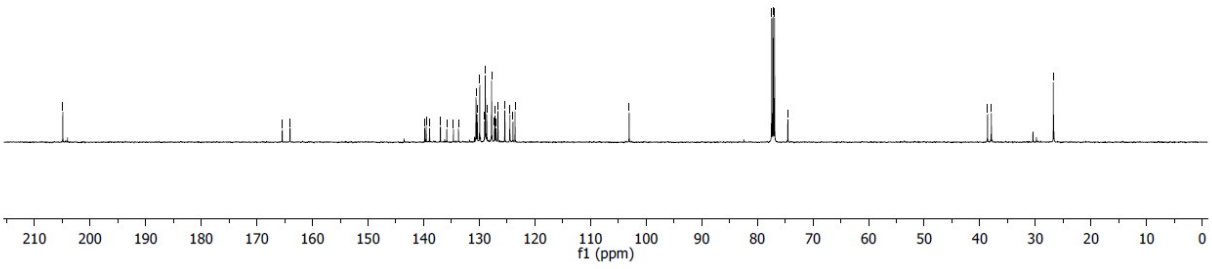
^{1}H NMR (500 MHz, $CDCl_3$)

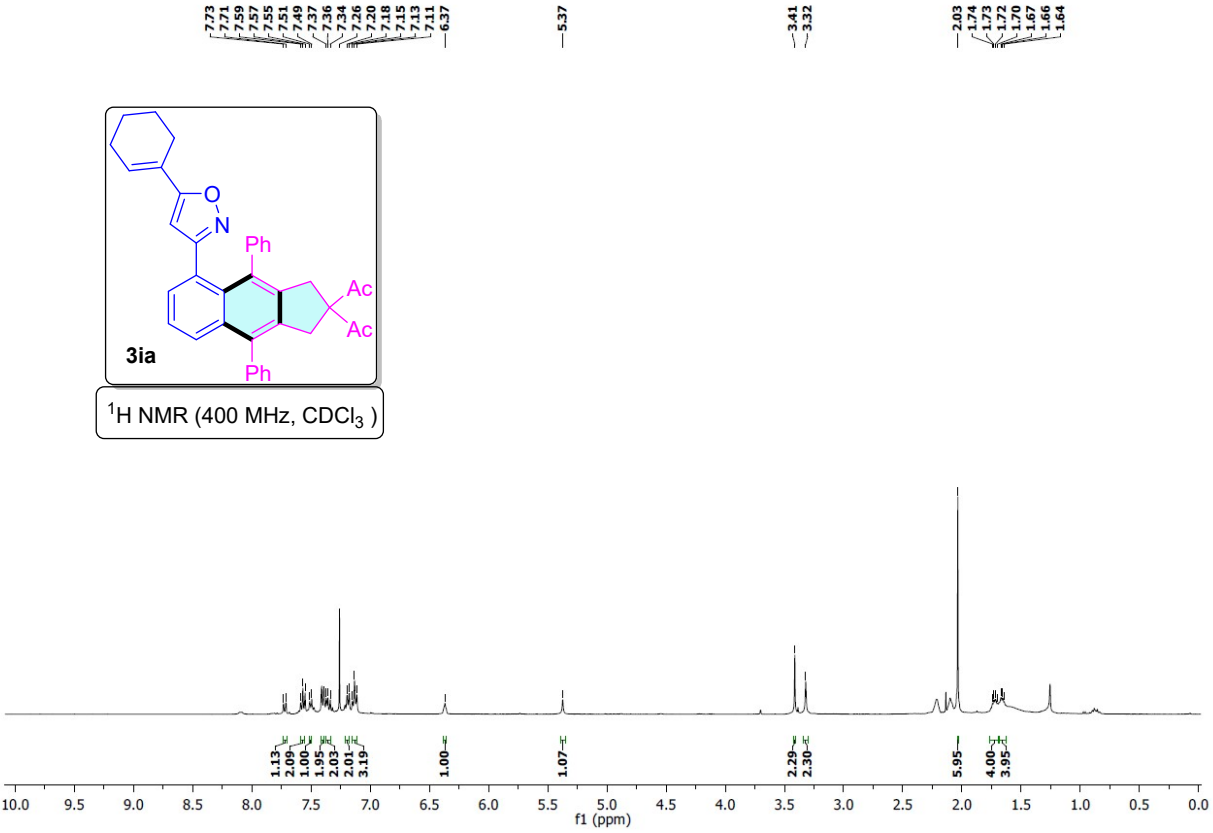




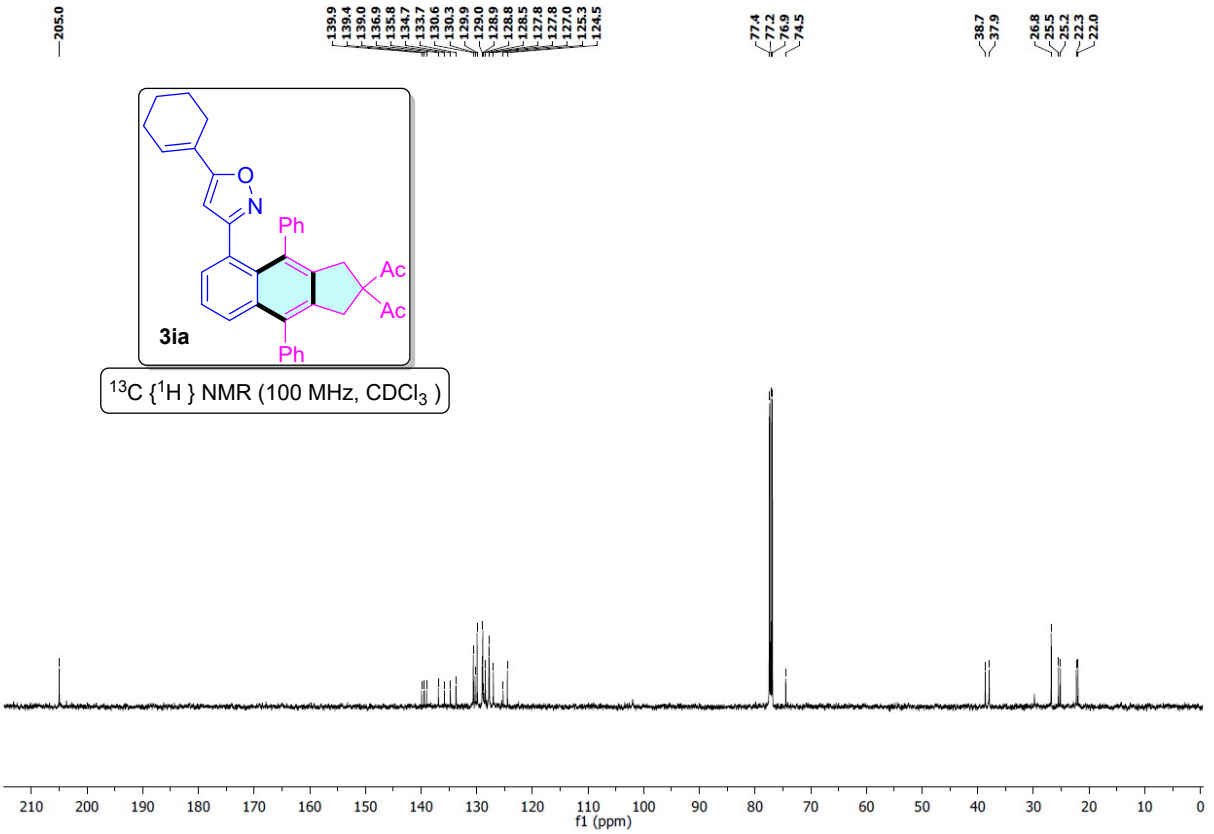


^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)

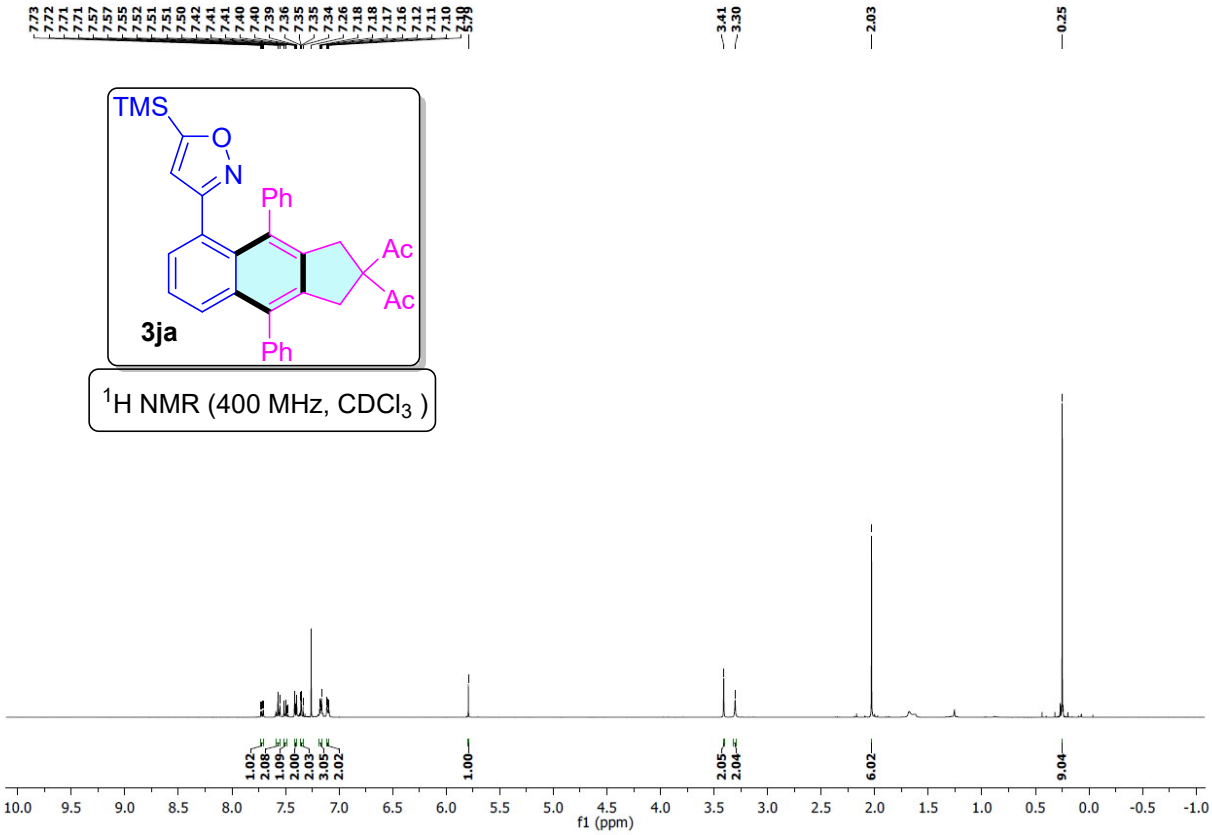




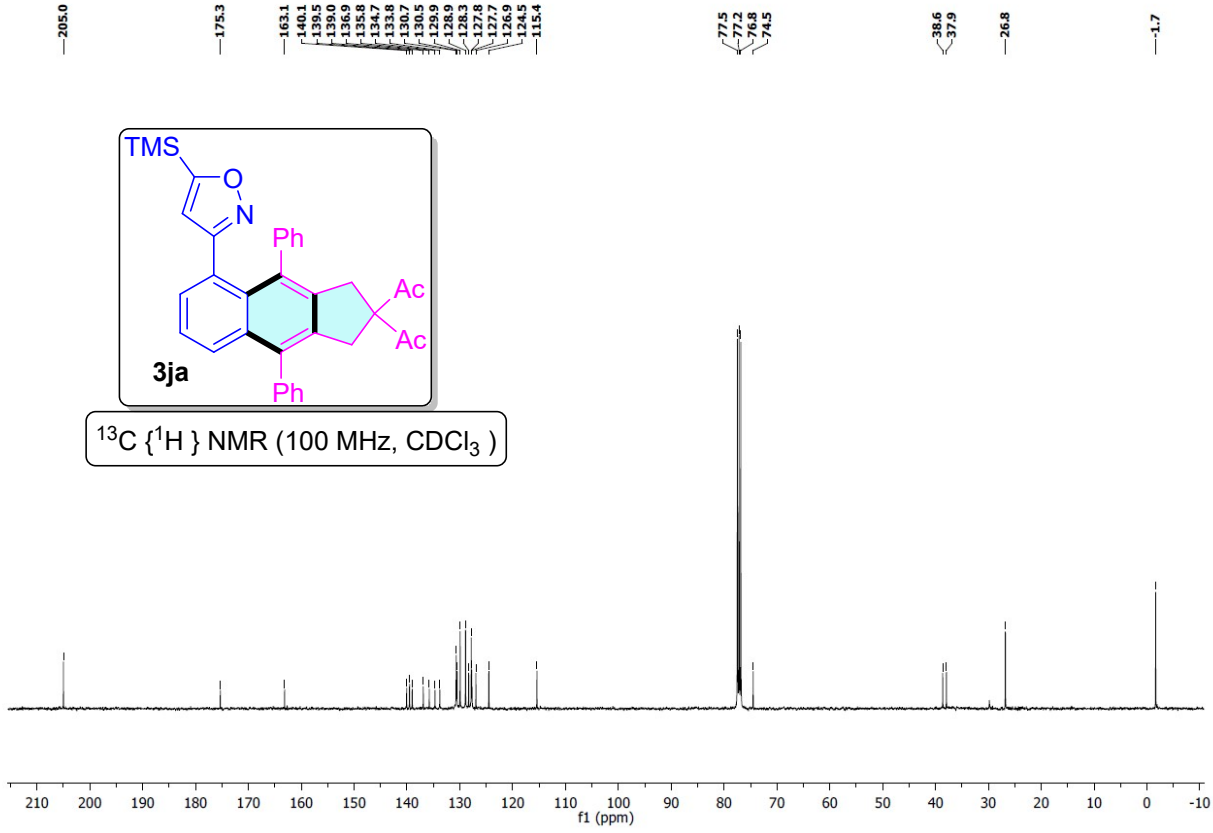
^{1}H NMR (400 MHz, $CDCl_3$)



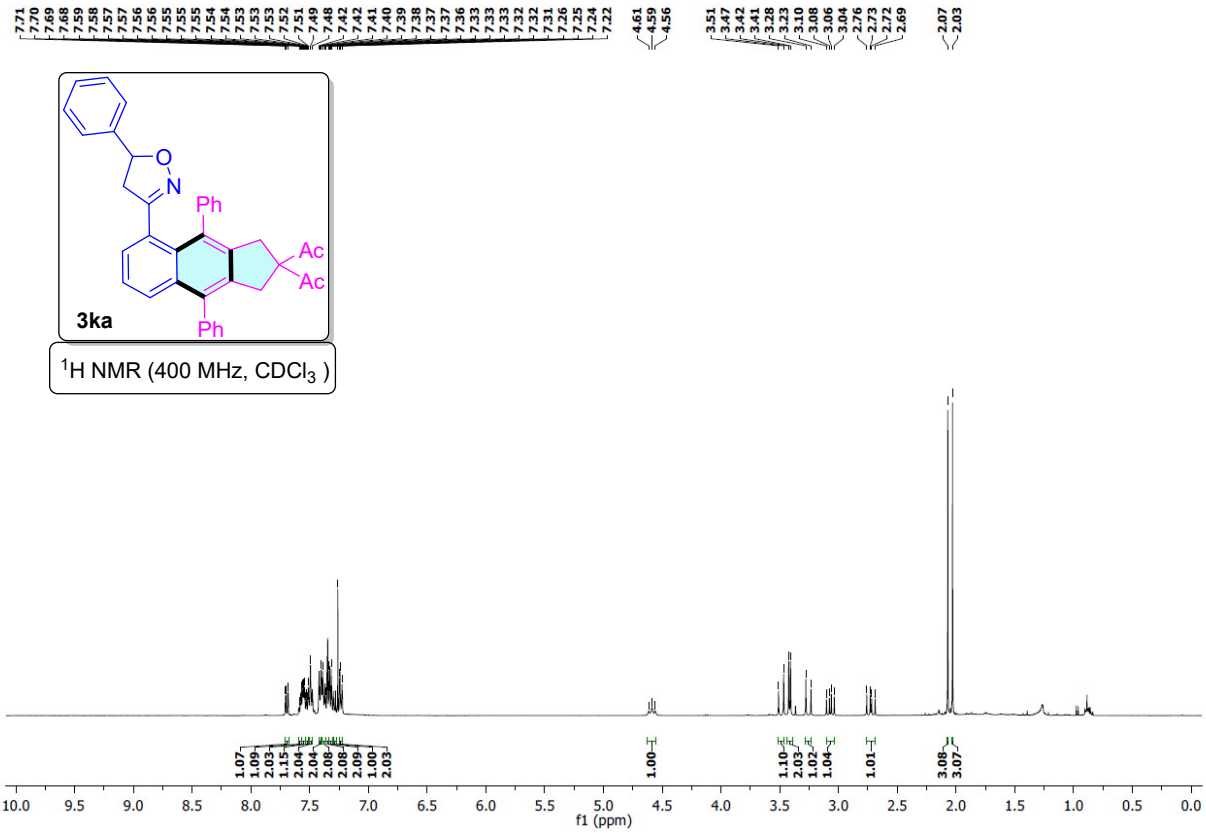
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



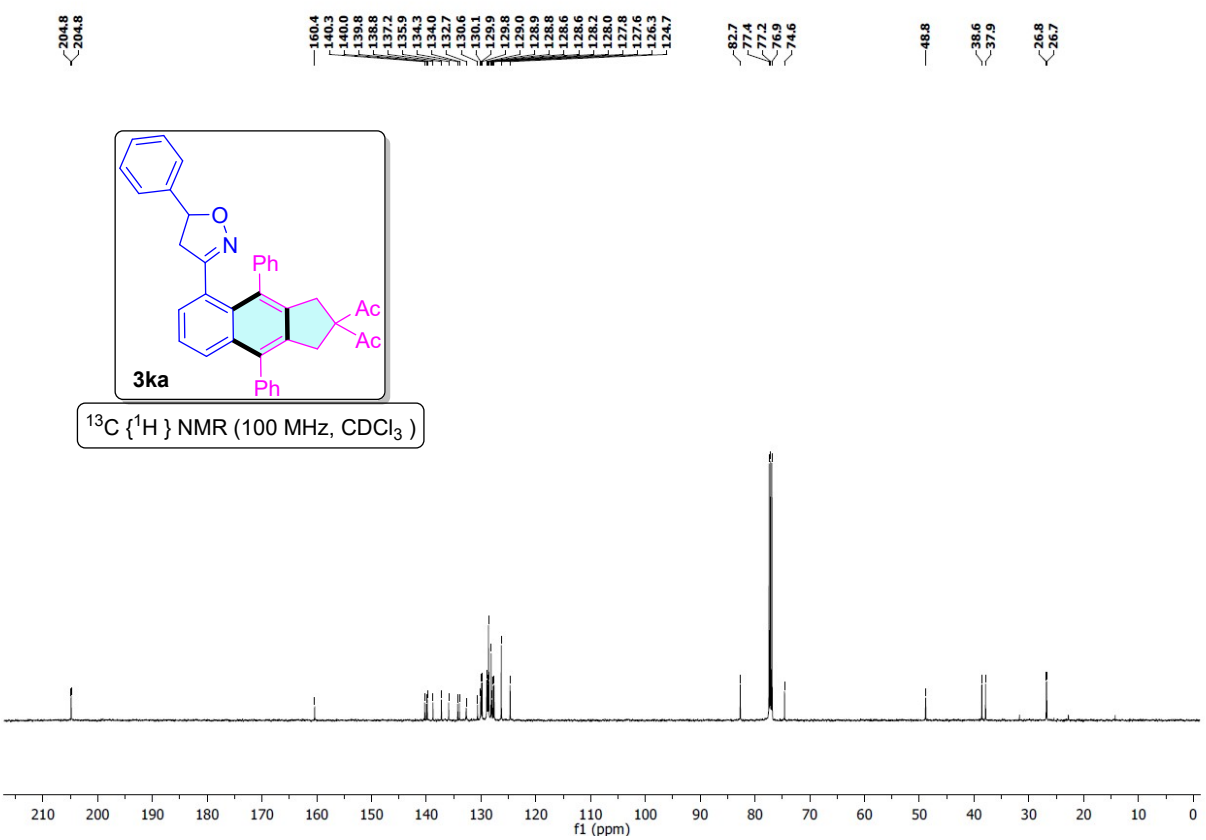
^{1}H NMR (400 MHz, $CDCl_3$)



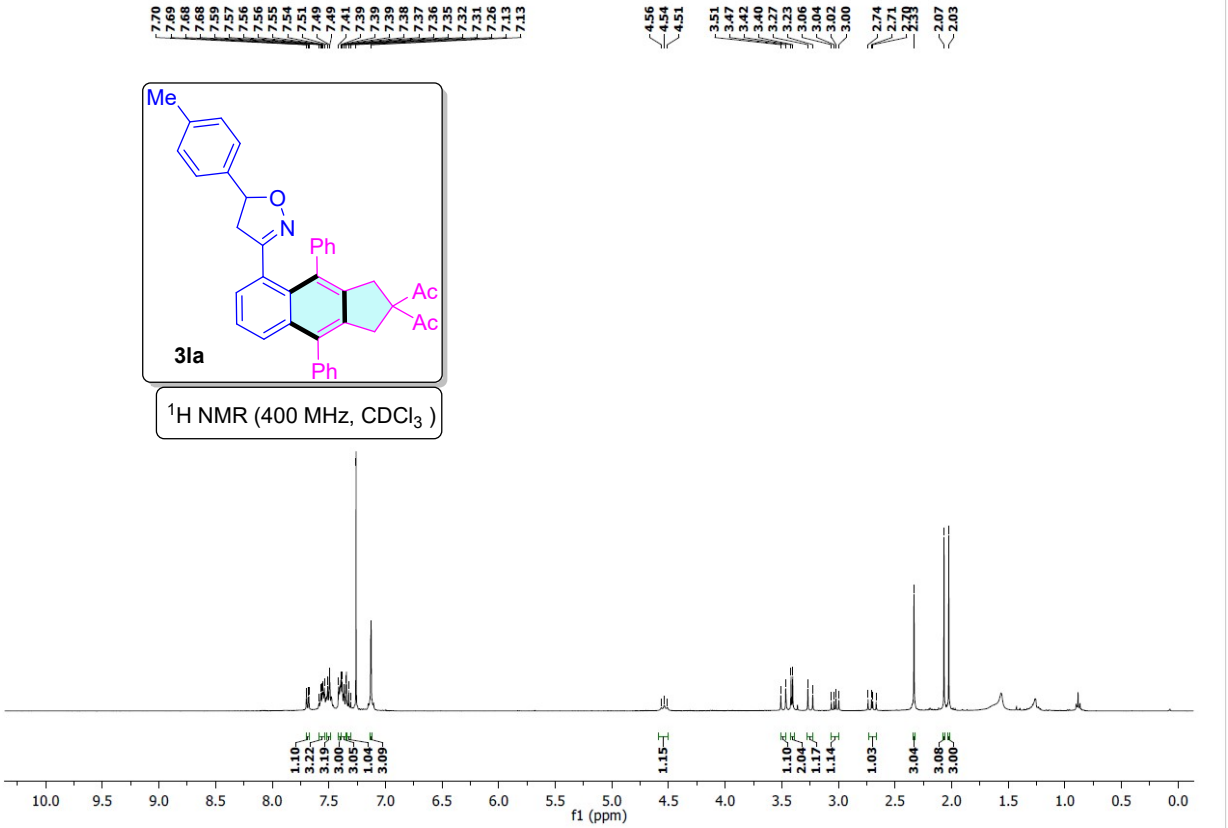
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



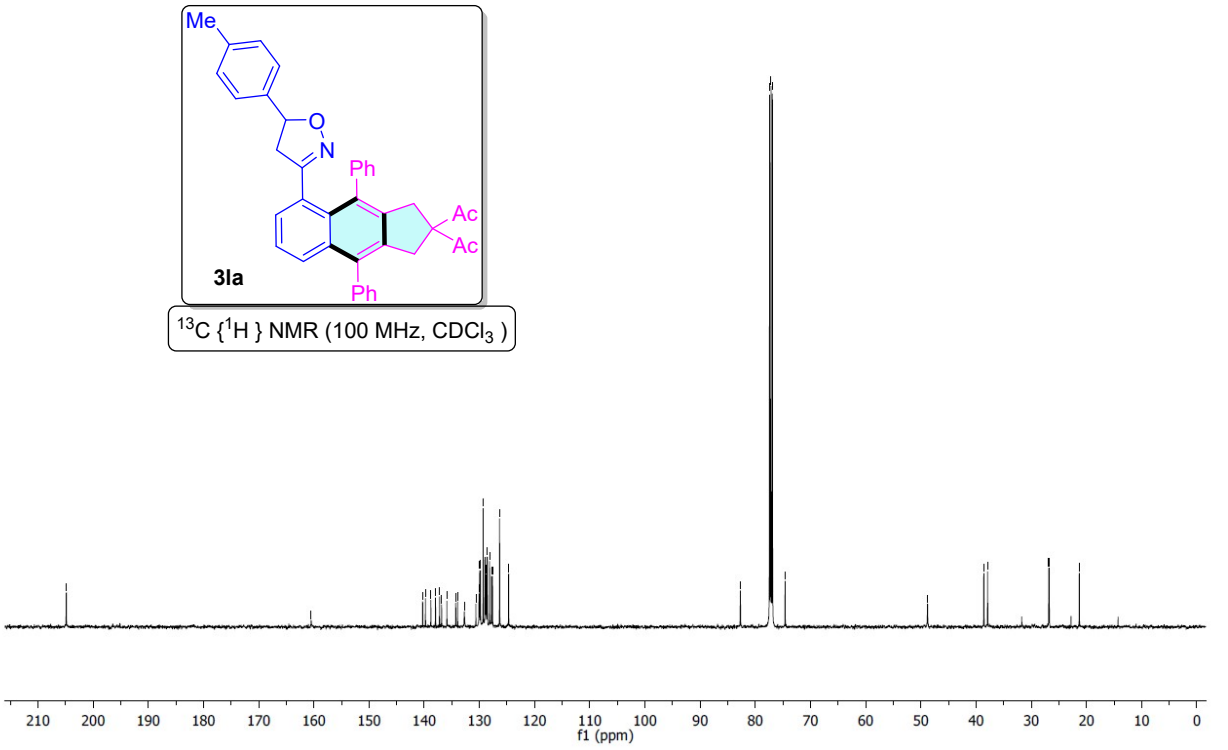
^{1}H NMR (400 MHz, $CDCl_3$)



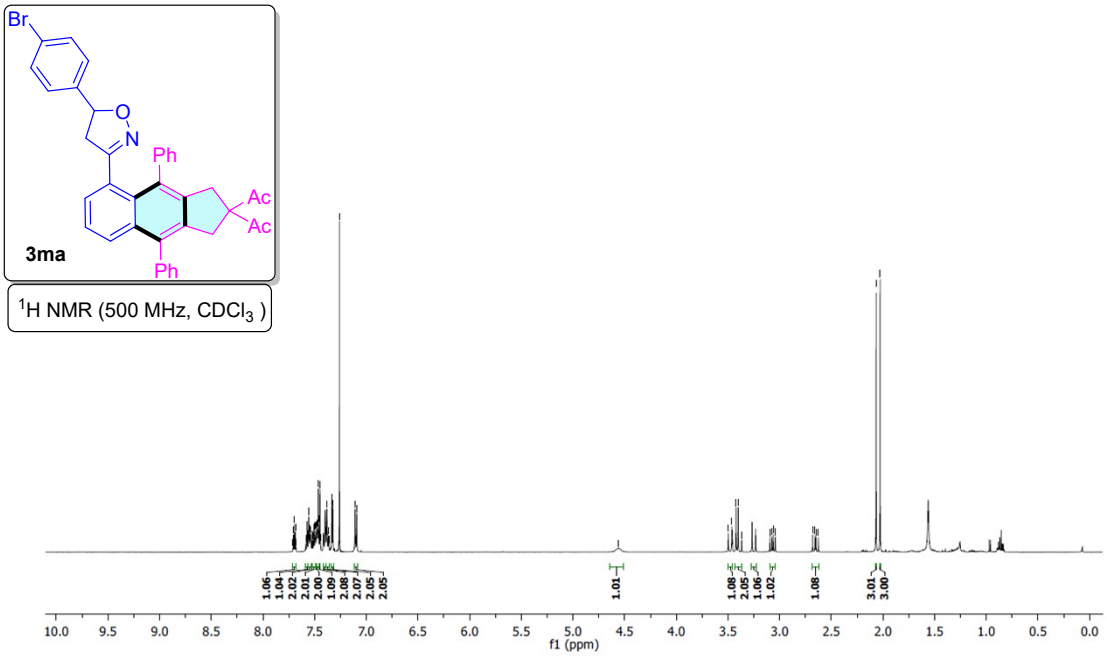
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



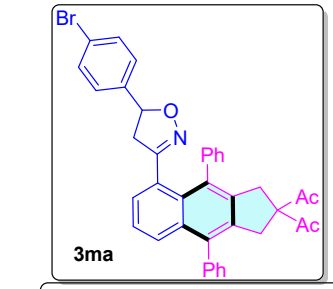
^{1}H NMR (400 MHz, $CDCl_3$)



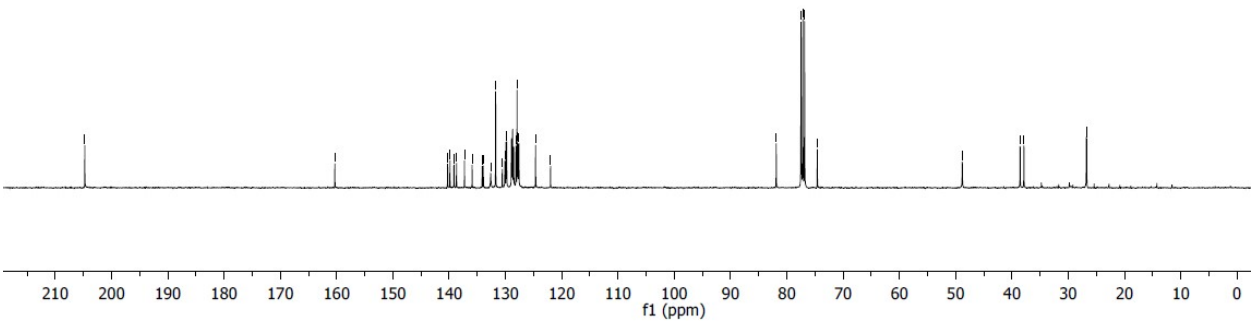
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

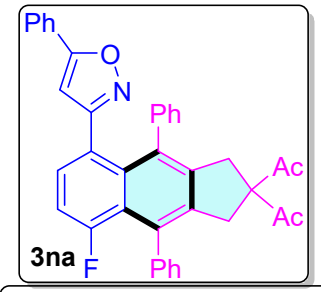


^{1}H NMR (500 MHz, $CDCl_3$)

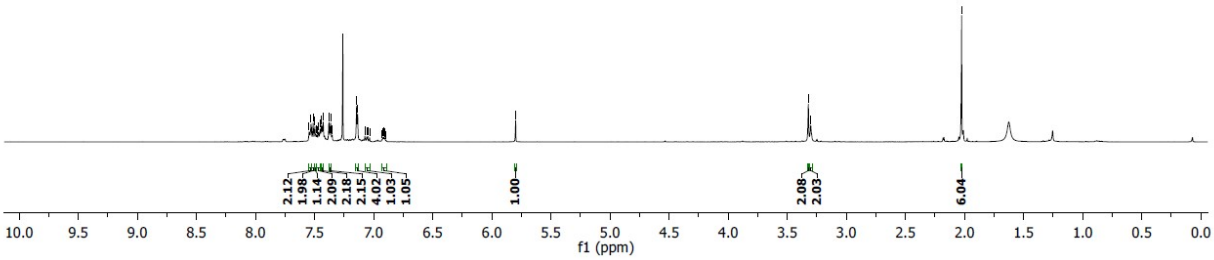


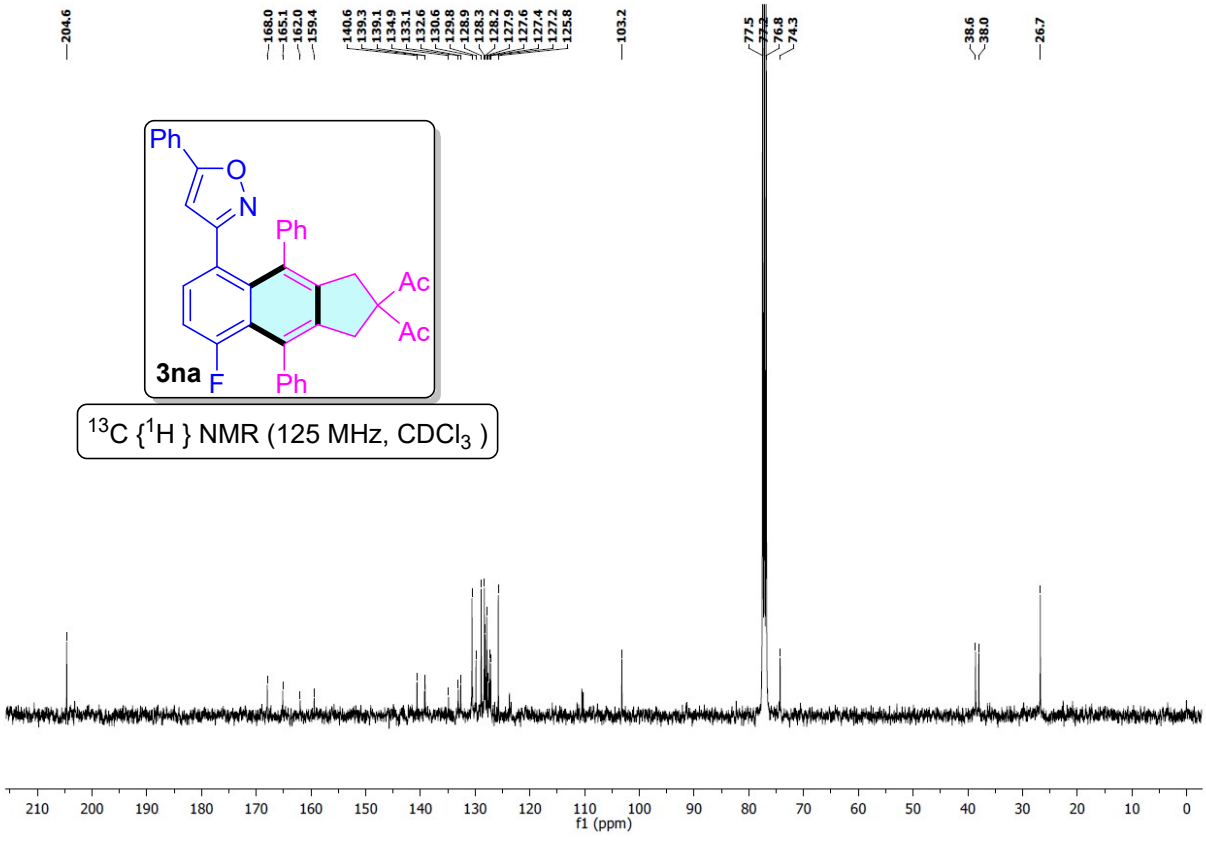
^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)



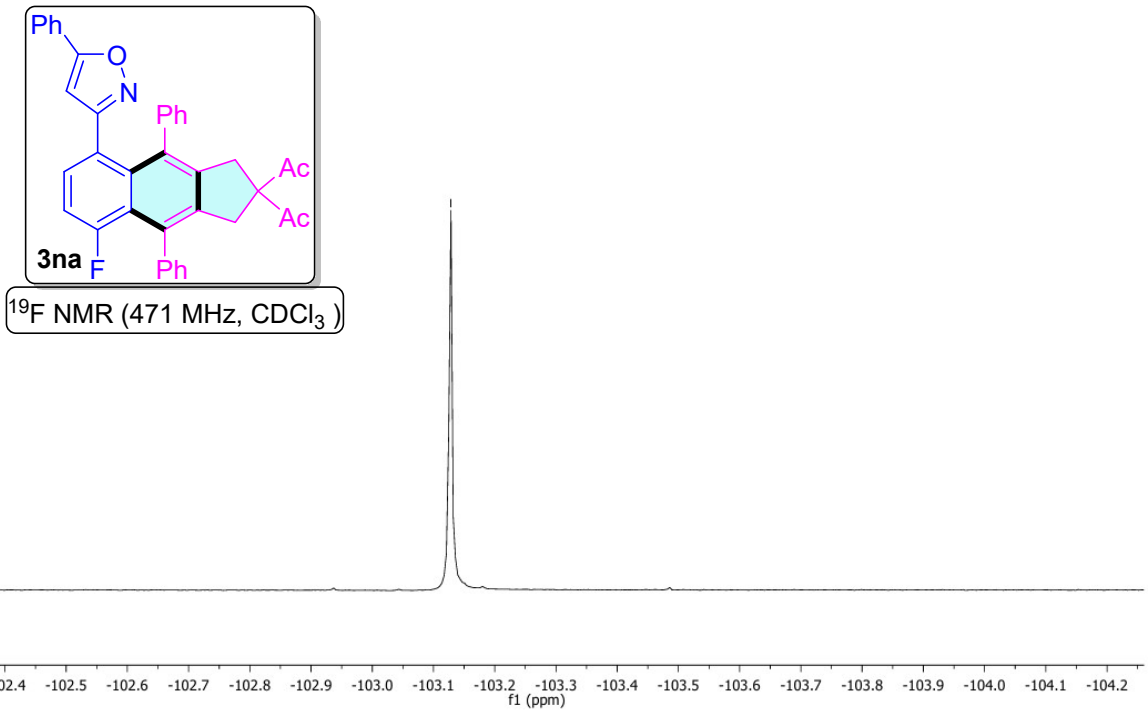


^{1}H NMR (500 MHz, $CDCl_3$)

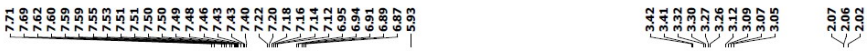


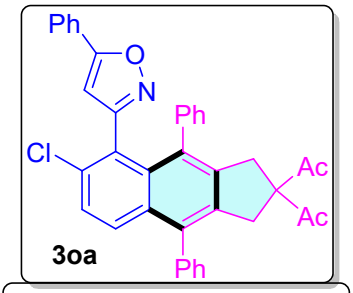


^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)

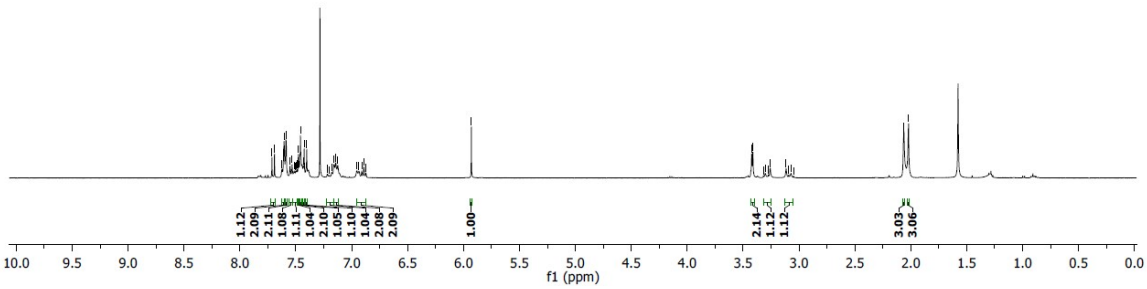


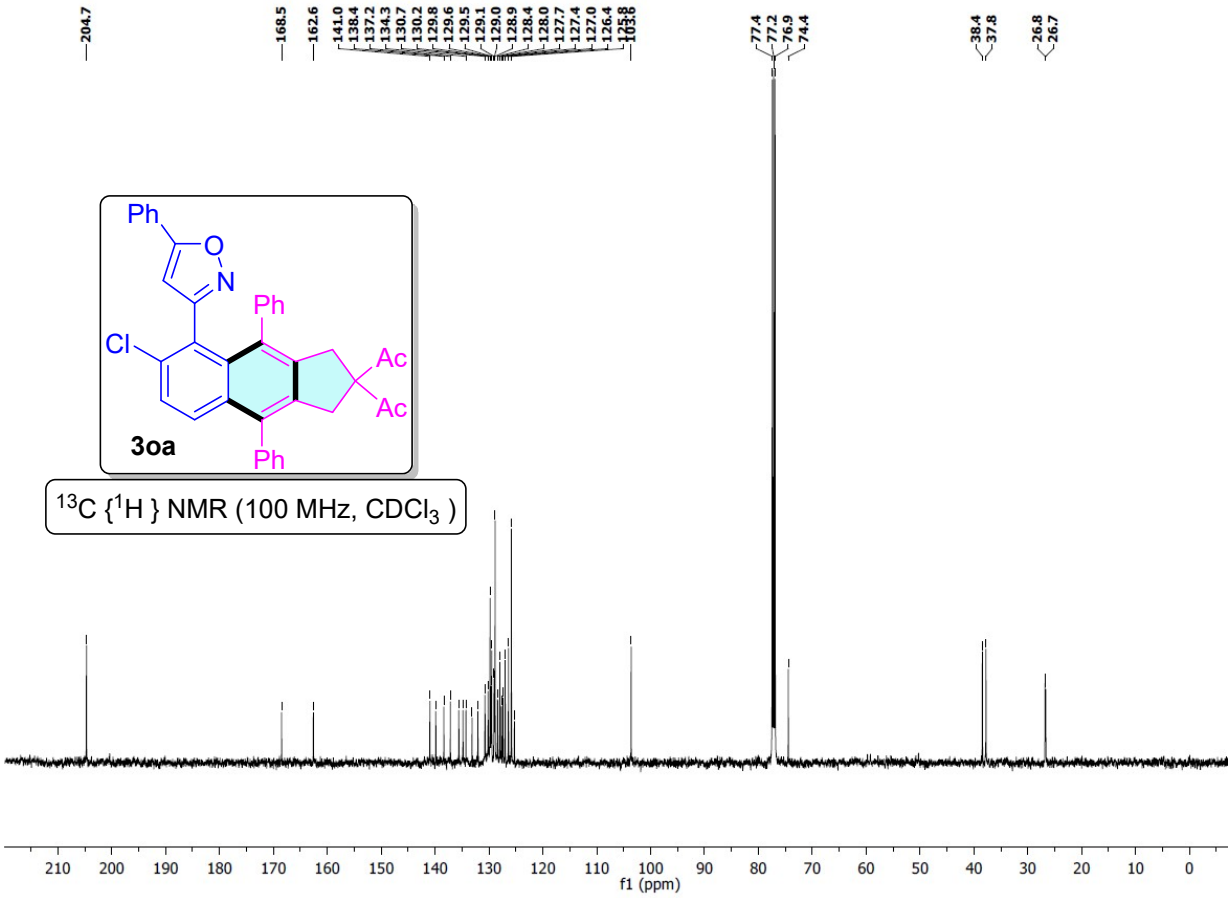
^{19}F NMR (471 MHz, $CDCl_3$)

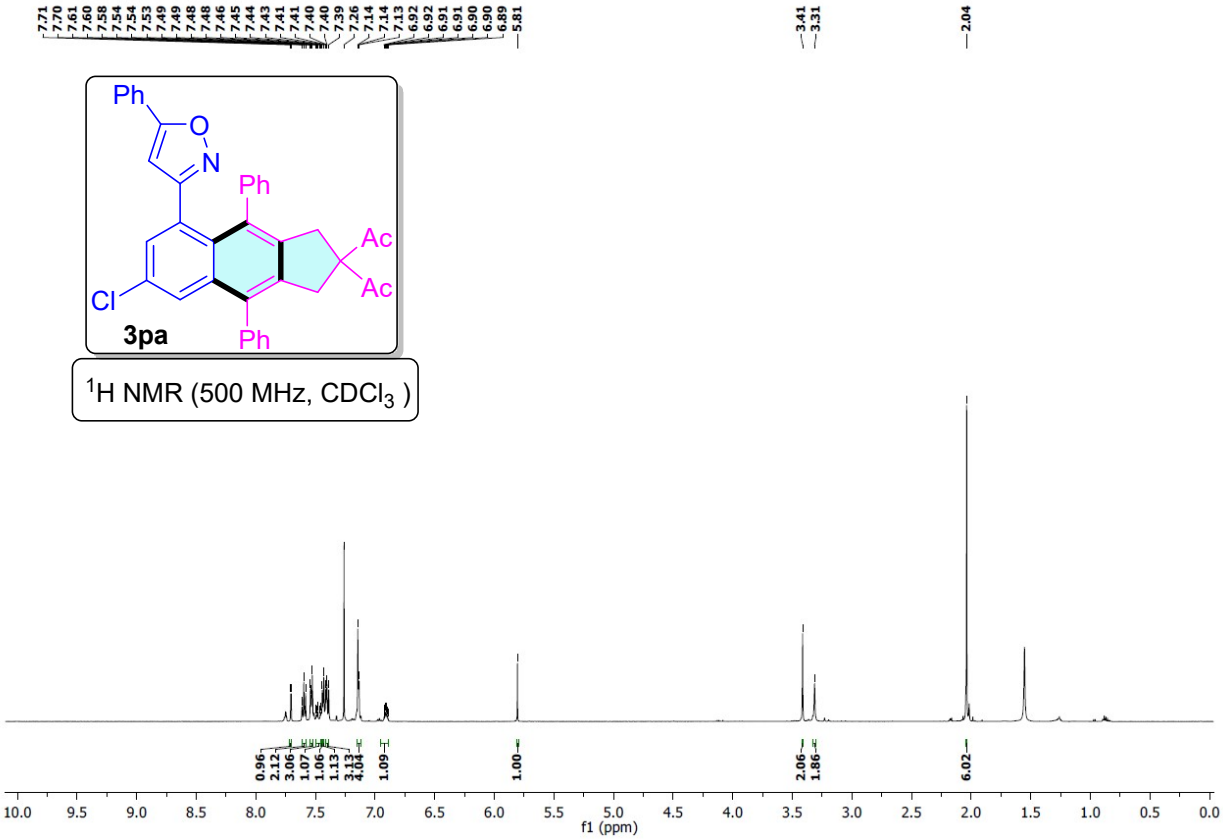




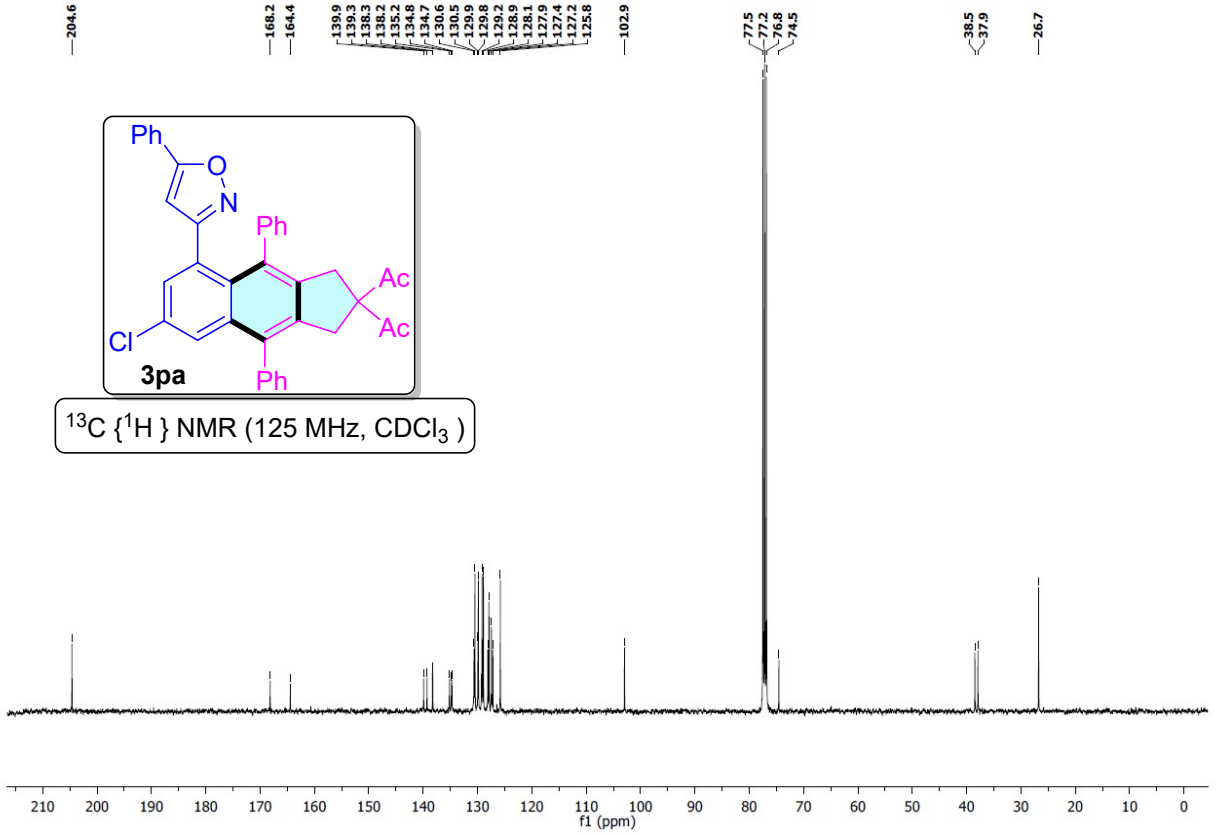
^{1}H NMR (400 MHz, $CDCl_3$)



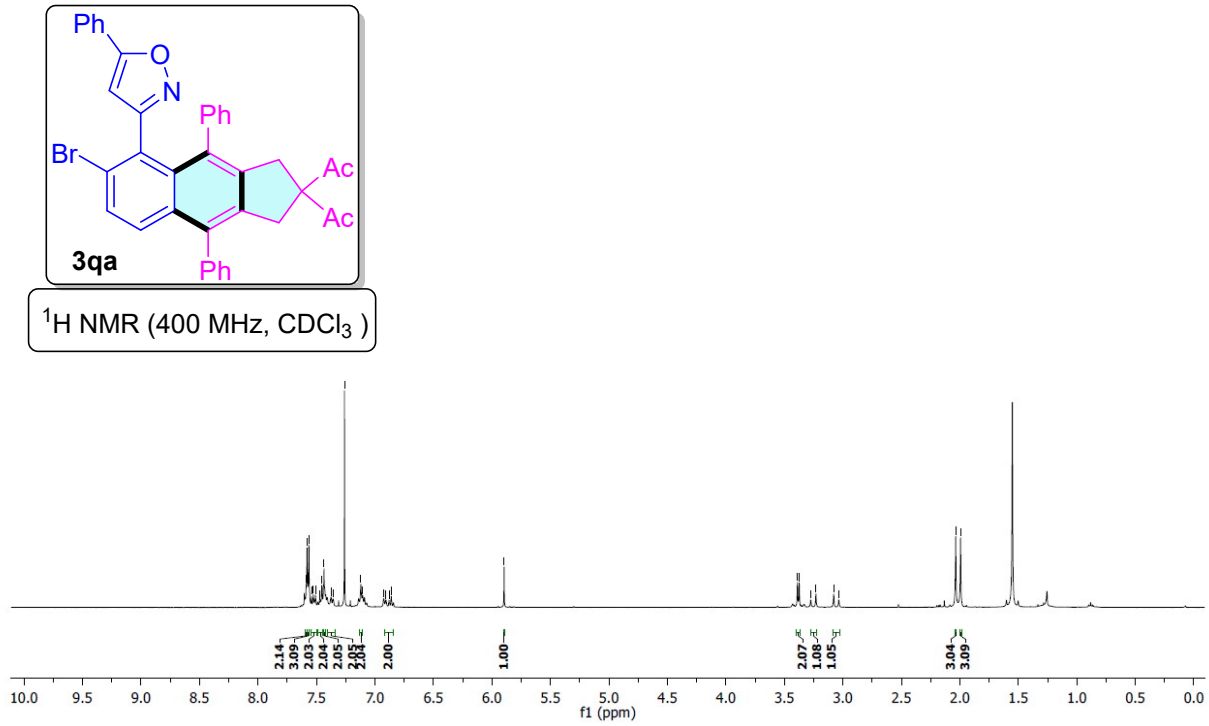

204.7
168.5
162.6
141.0
138.4
137.2
134.3
130.7
130.2
129.8
129.6
129.5
129.1
129.0
128.9
128.4
128.0
127.7
127.4
127.0
126.4
77.4
77.2
76.9
74.4
38.4
37.8
26.8
26.7
Ph
O
N
Ph
Cl
Ac
Ac
Ph
3oa
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



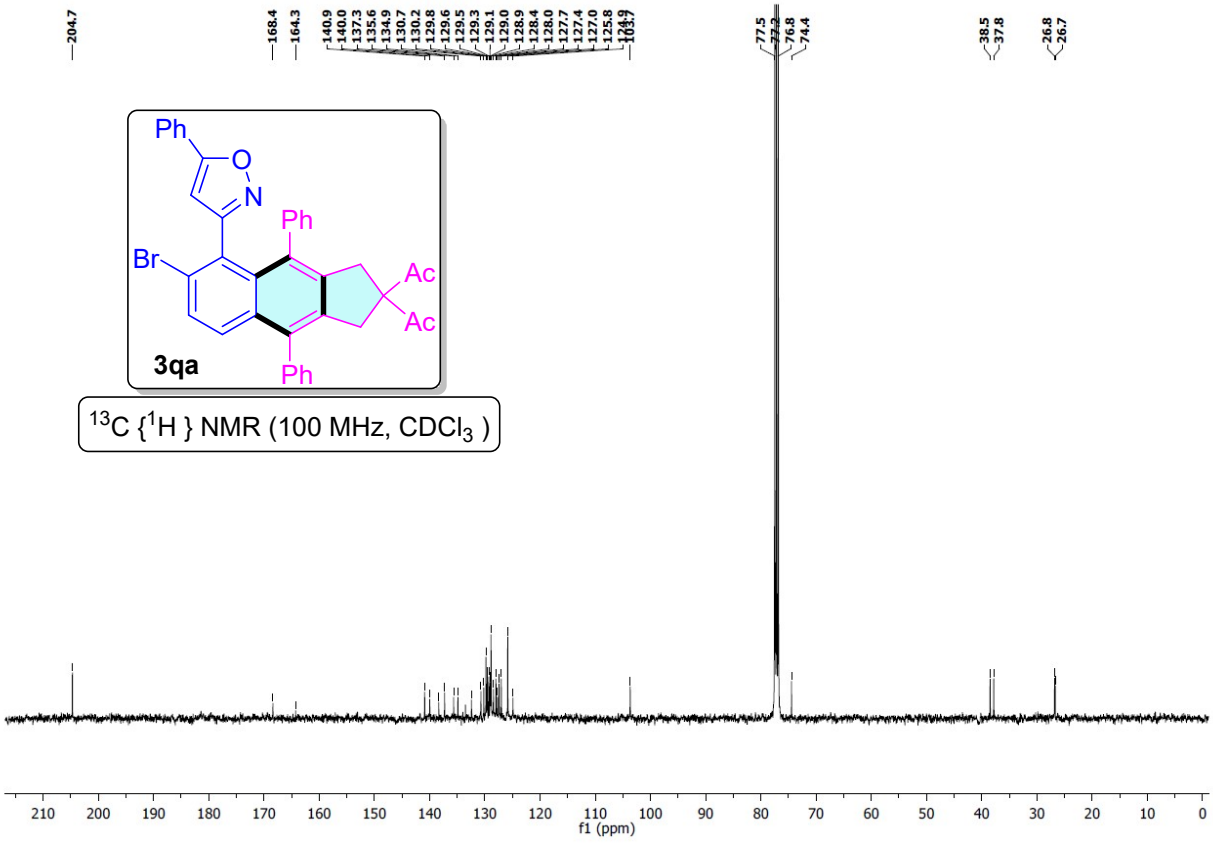
^{1}H NMR (500 MHz, $CDCl_3$)



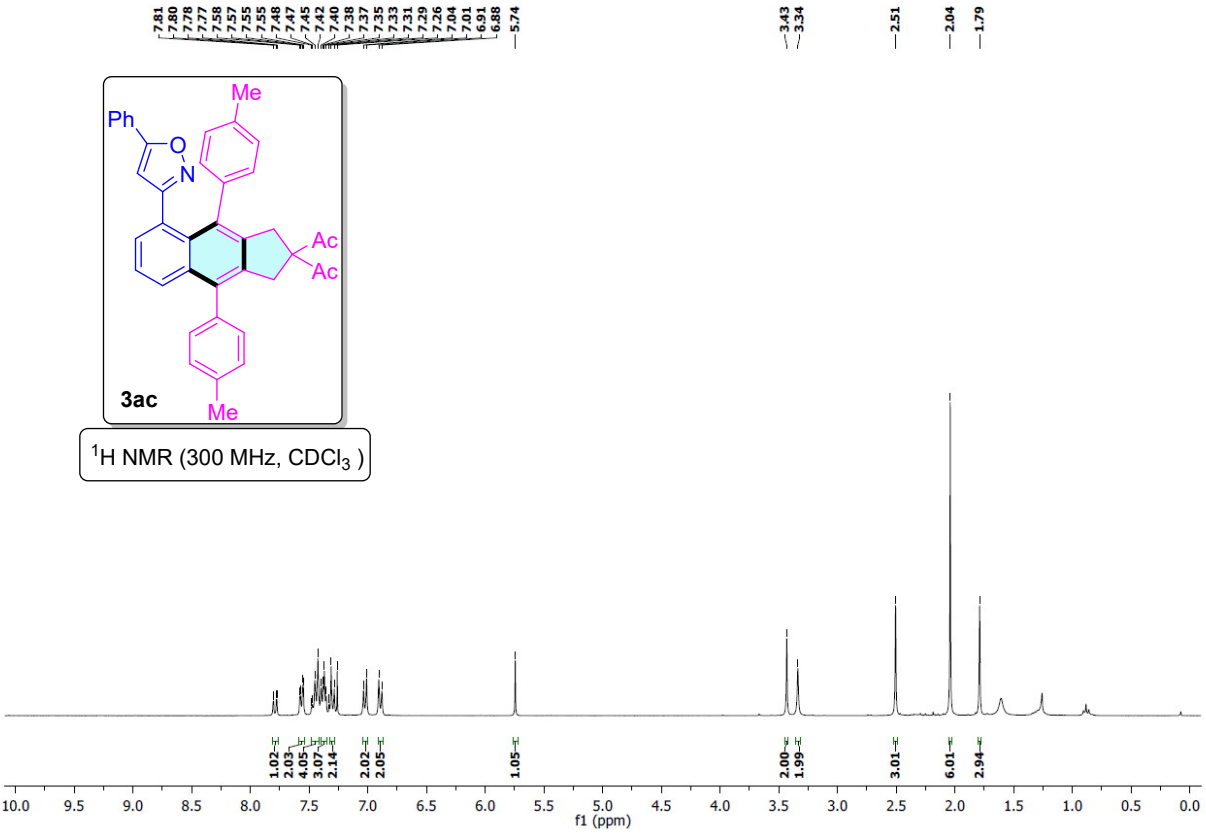
^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)



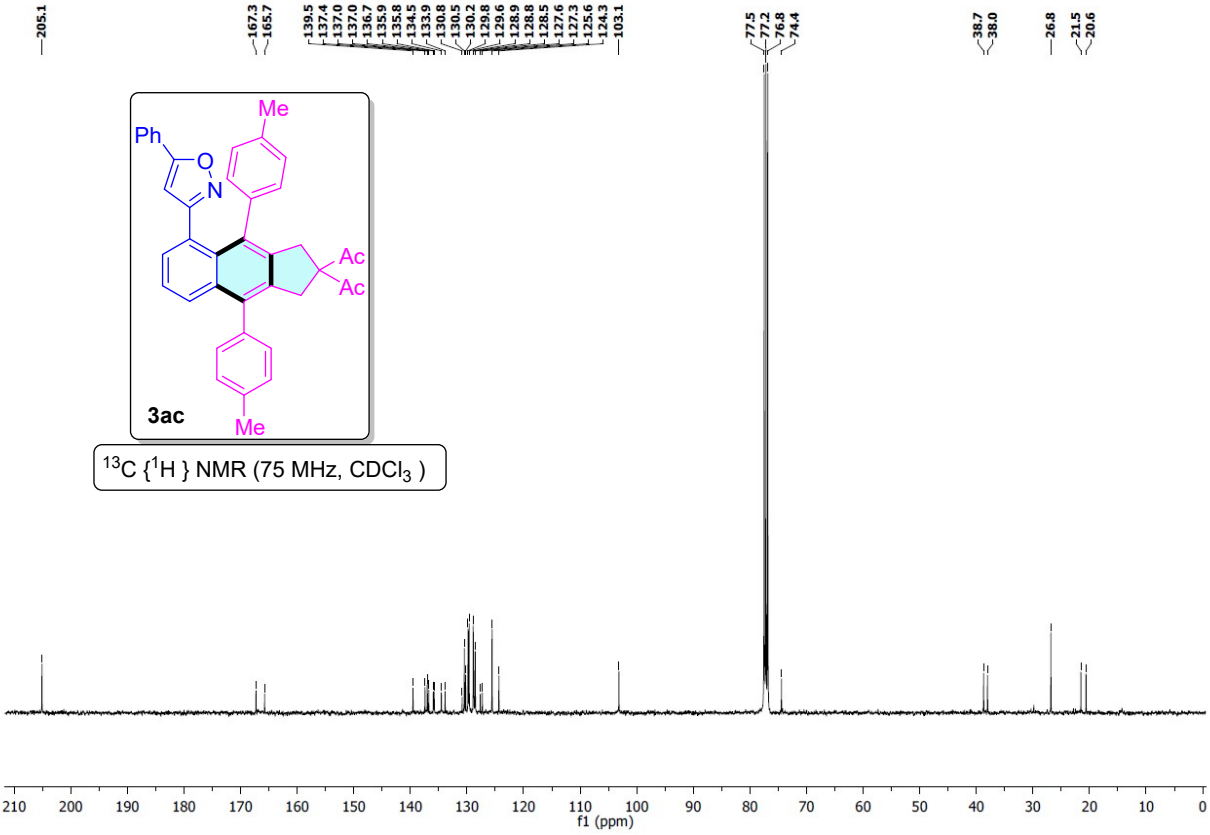
^{1}H NMR (400 MHz, $CDCl_3$)



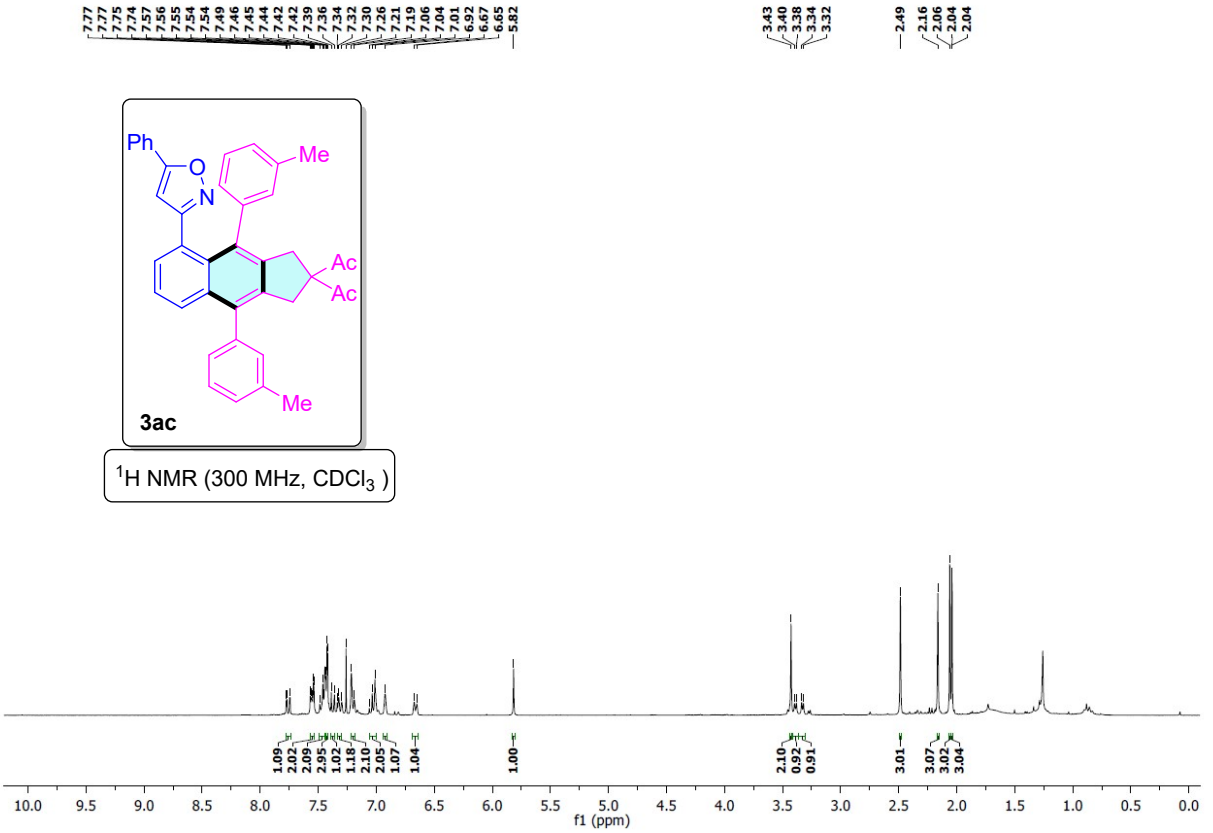
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



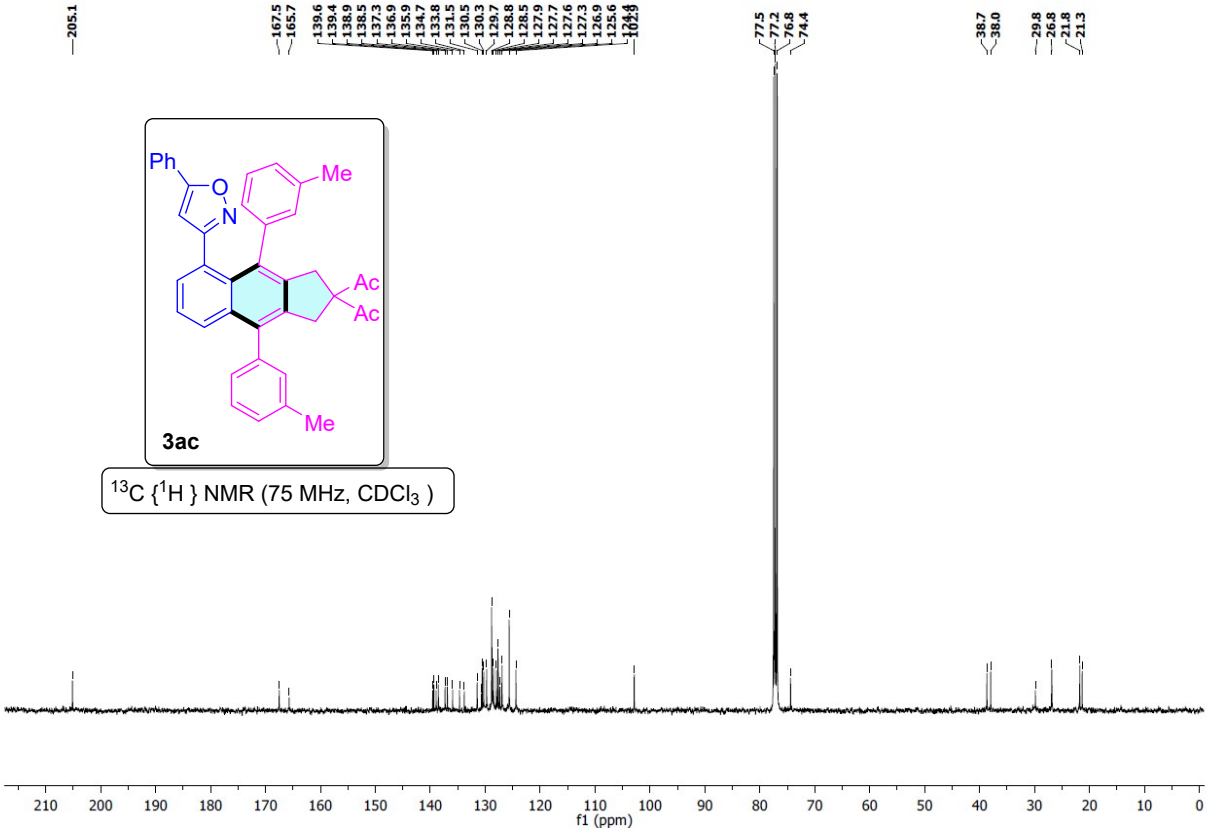
^{1}H NMR (300 MHz, $CDCl_3$)



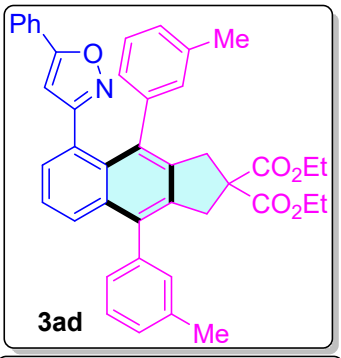
^{13}C {^{1}H } NMR (75 MHz, $CDCl_3$)



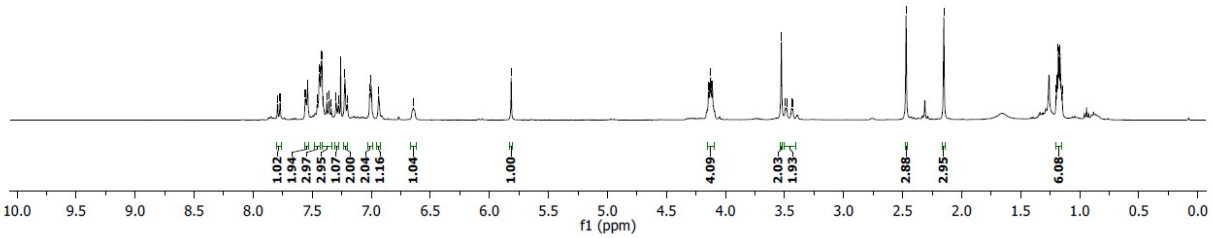
^{1}H NMR (300 MHz, $CDCl_3$)

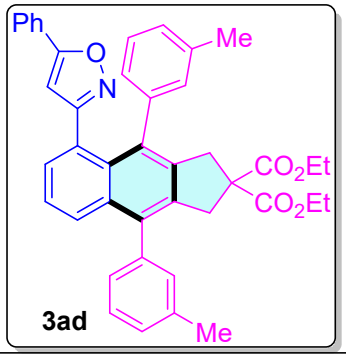


^{13}C {^{1}H } NMR (75 MHz, $CDCl_3$)

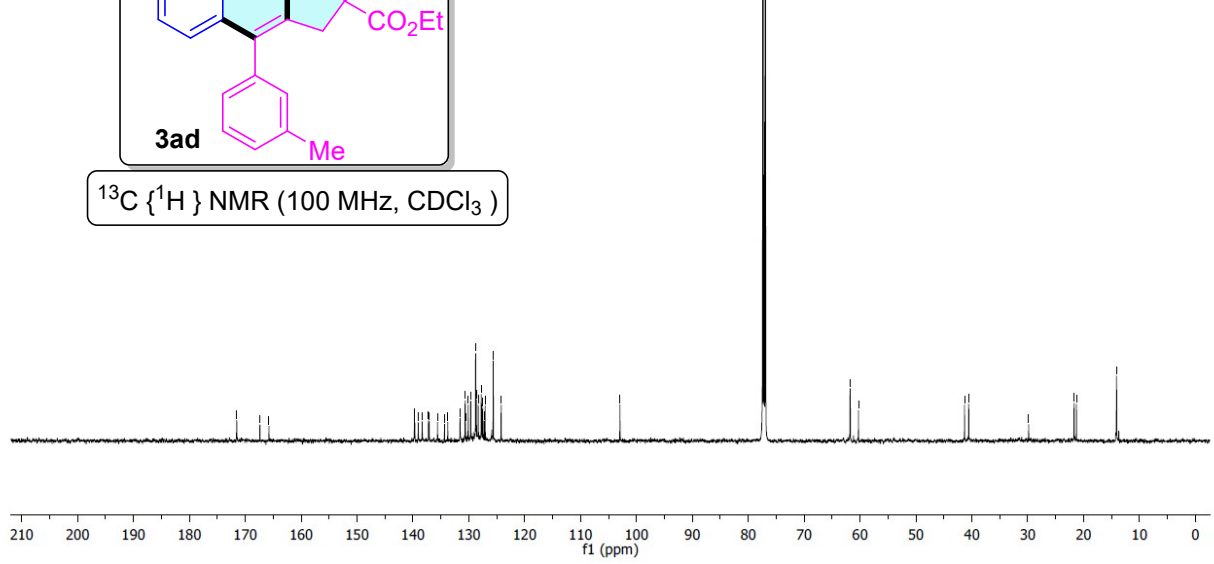


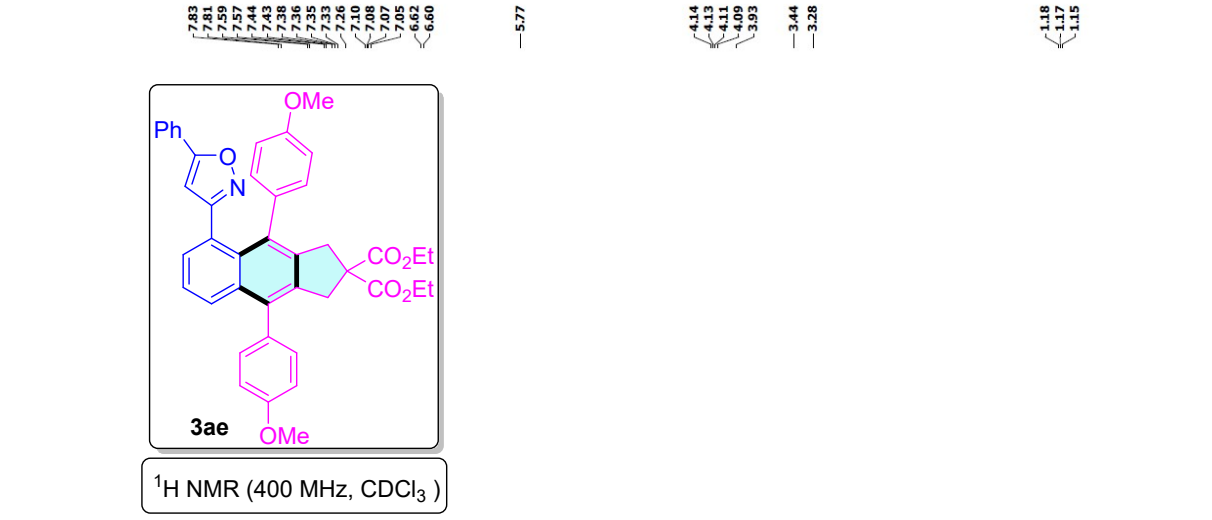
^{1}H NMR (400 MHz, $CDCl_3$)



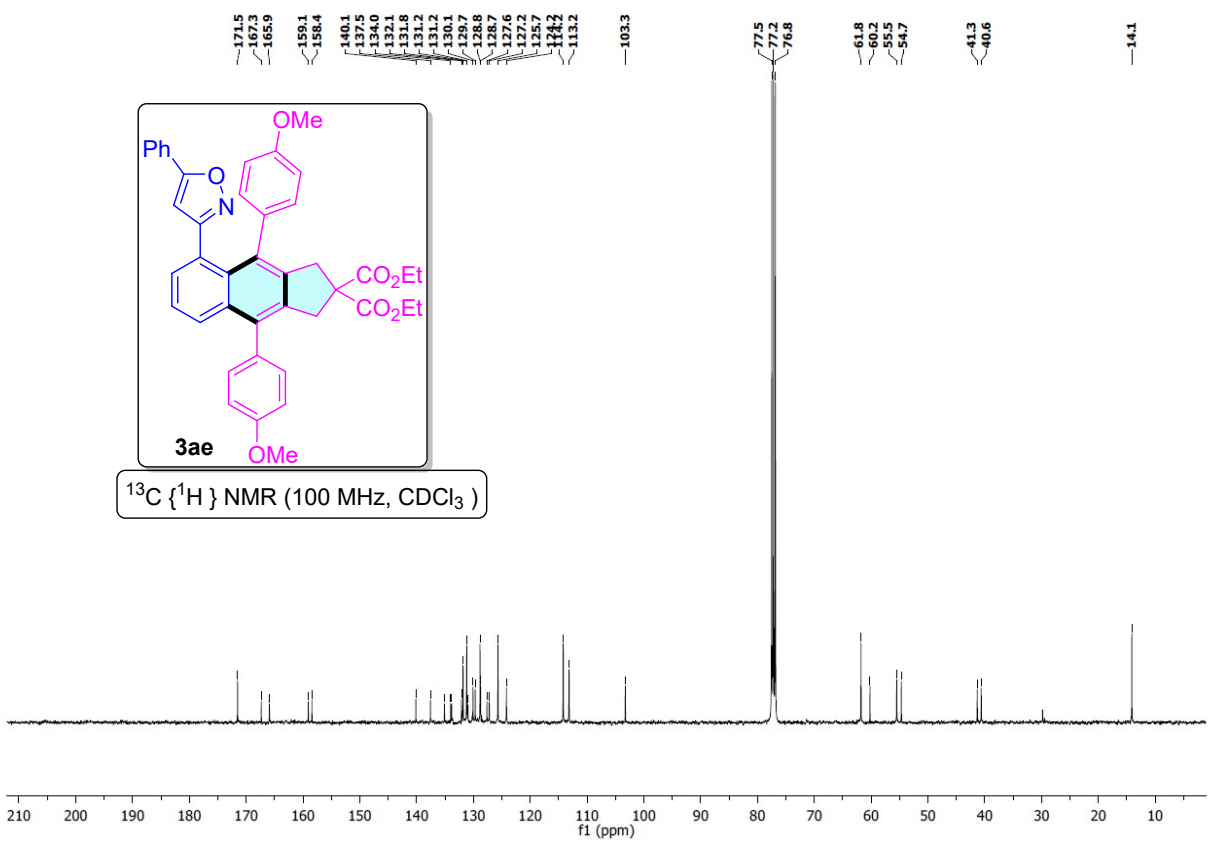


^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

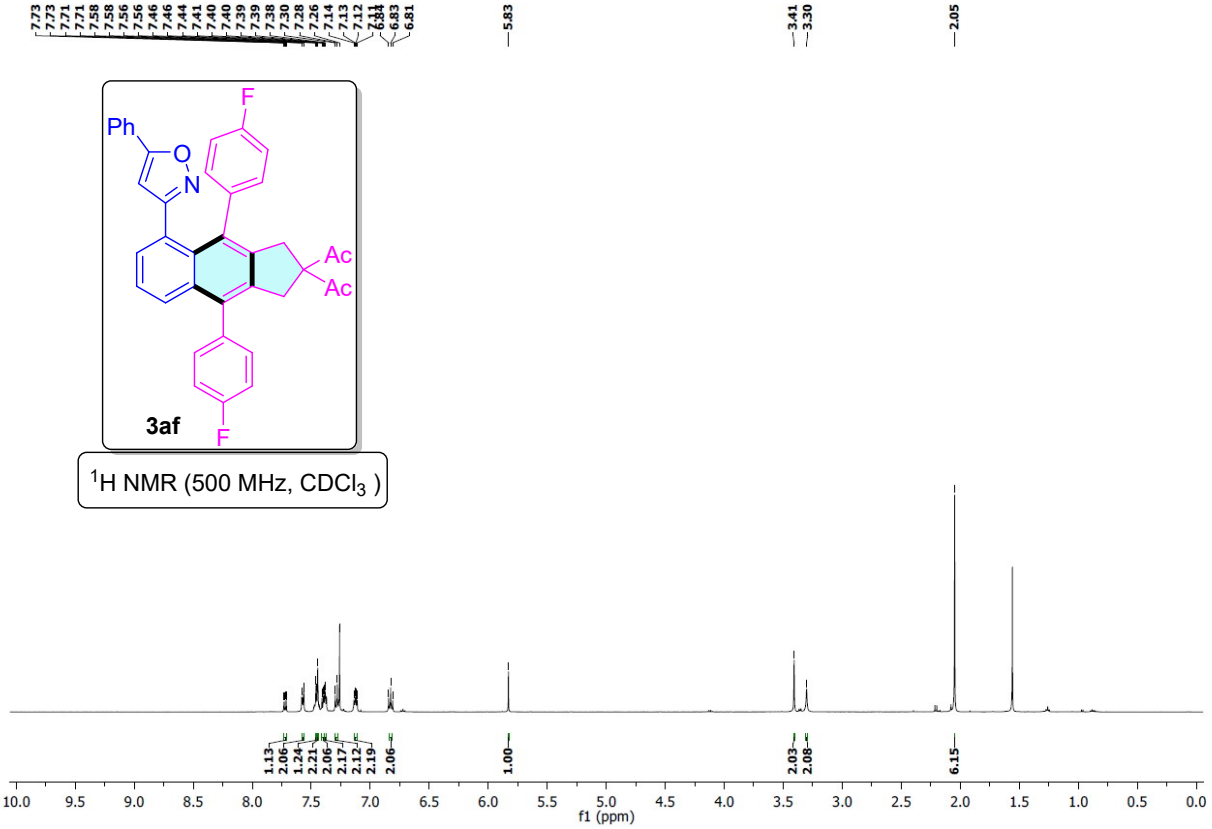




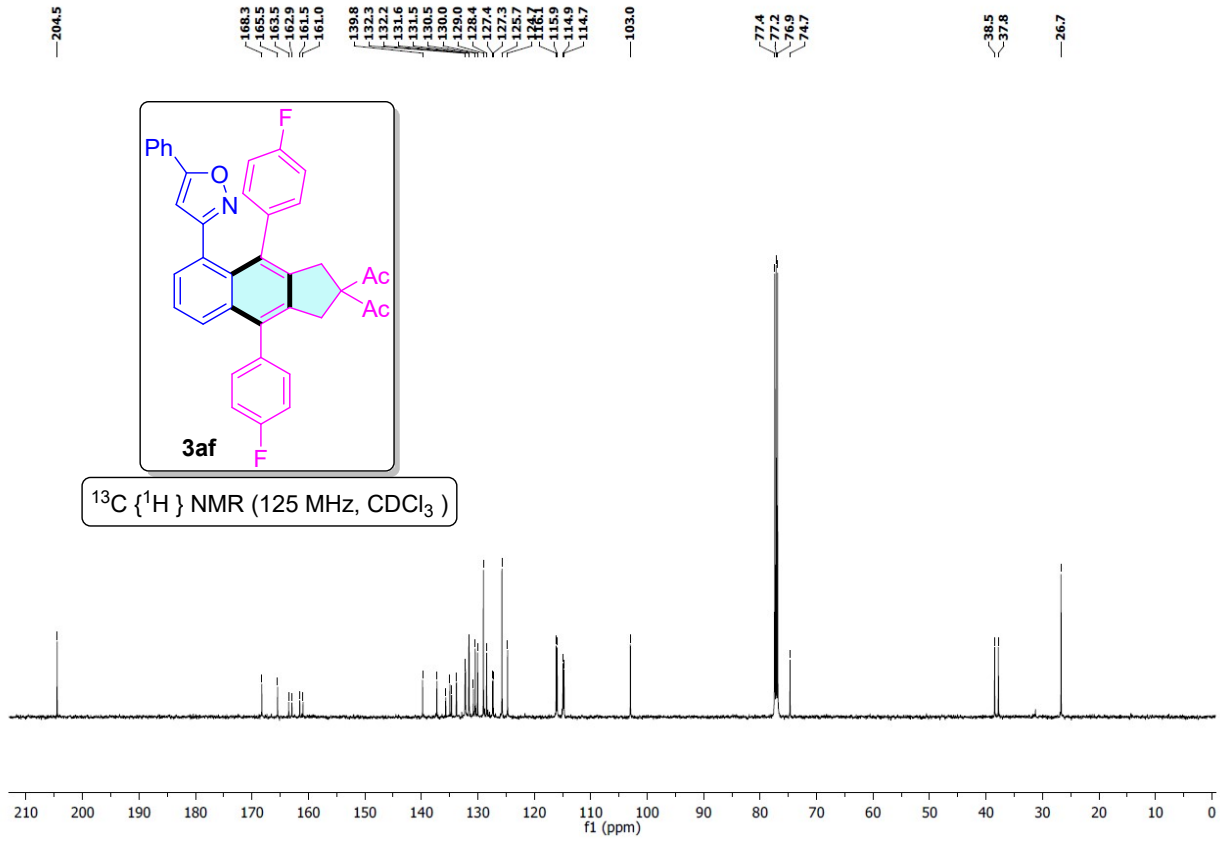
^{1}H NMR (400 MHz, $CDCl_3$)



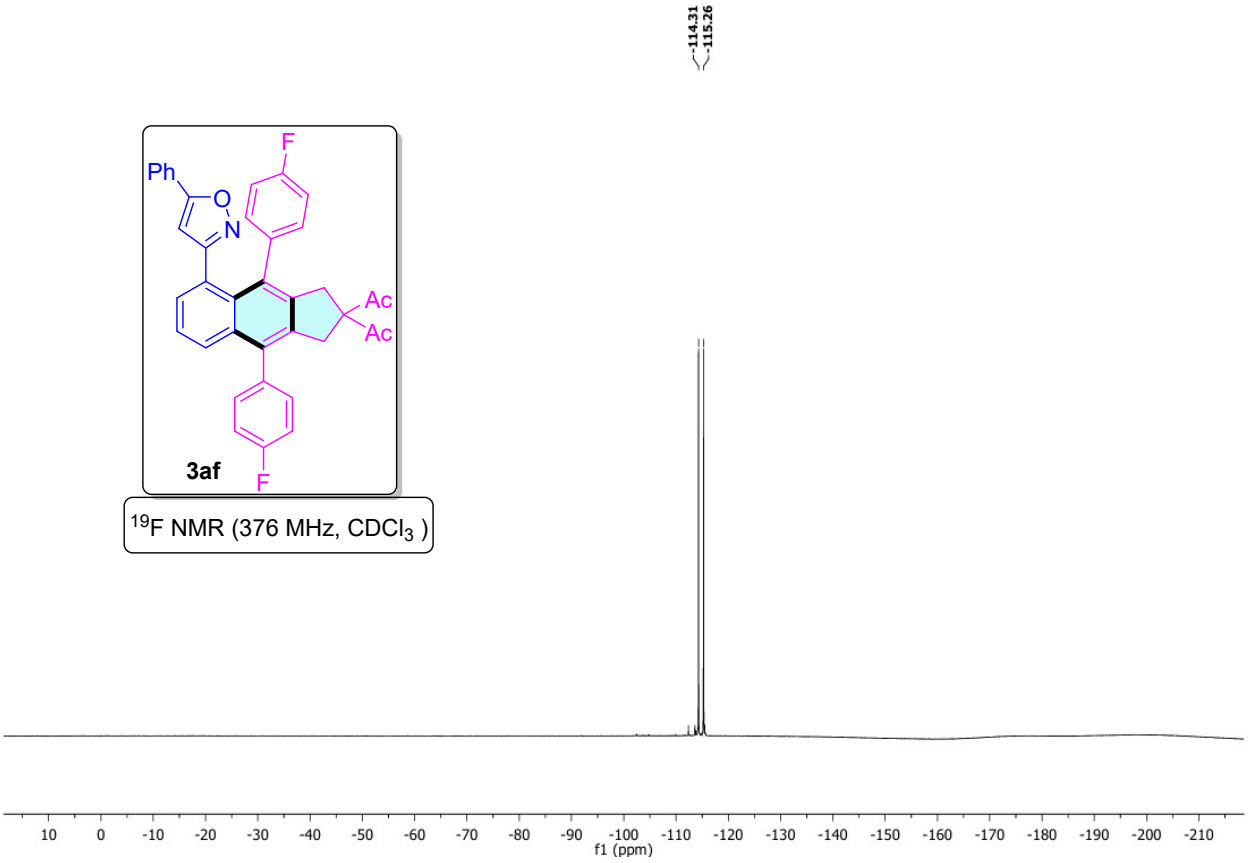
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)



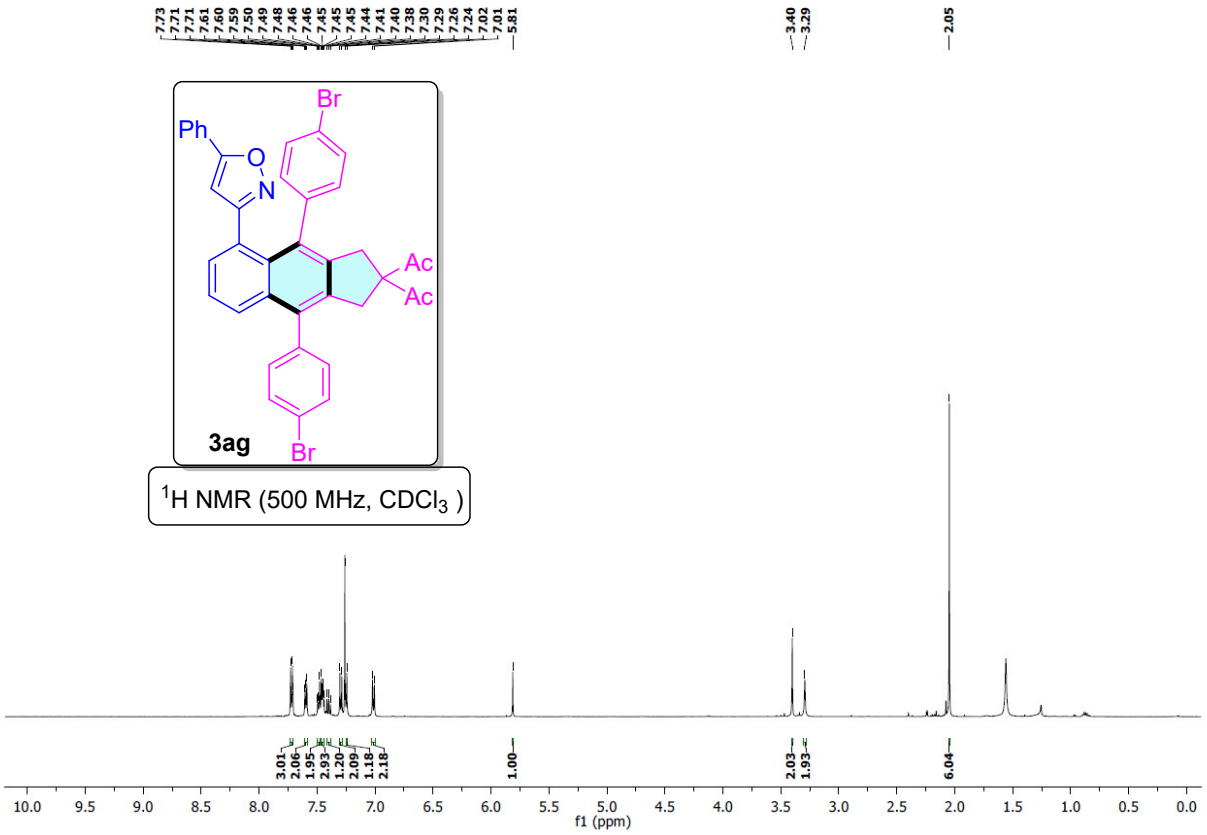
^{1}H NMR (500 MHz, $CDCl_3$)

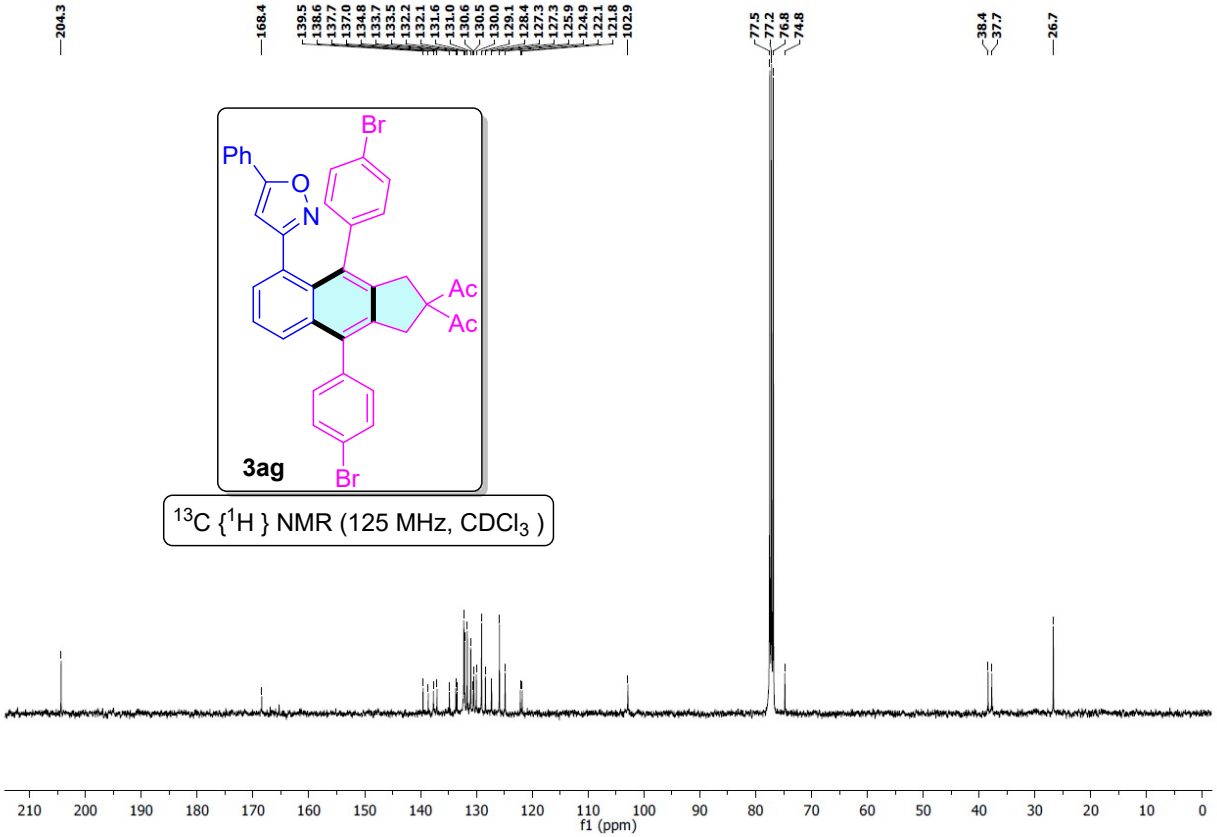


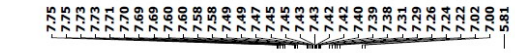
^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)

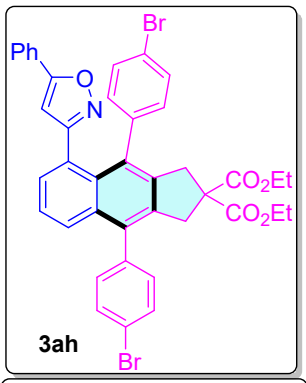


^{19}F NMR (376 MHz, $CDCl_3$)

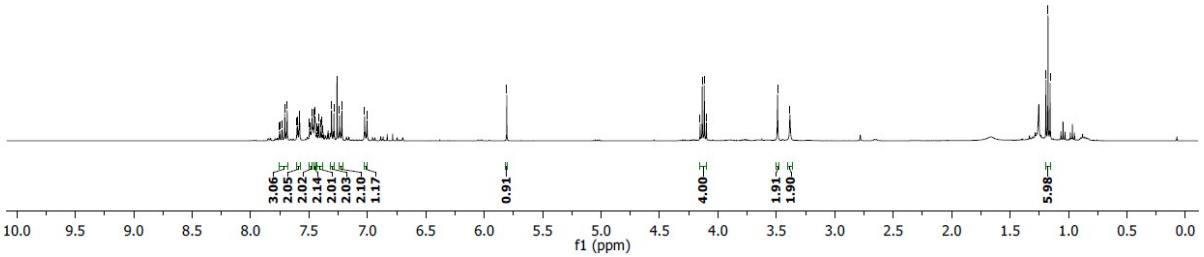

Br
Ph
O
N
Ac
Ac
3ag
Br
^{1}H NMR (500 MHz, CDCl$_3$)
f1 (ppm)

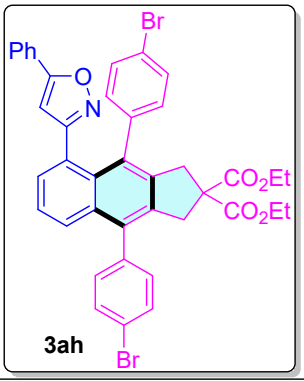

Br
Ph
O
N
Ac
Ac
3ag
Br
^{13}C {^{1}H } NMR (125 MHz, CDCl$_3$)
f1 (ppm)



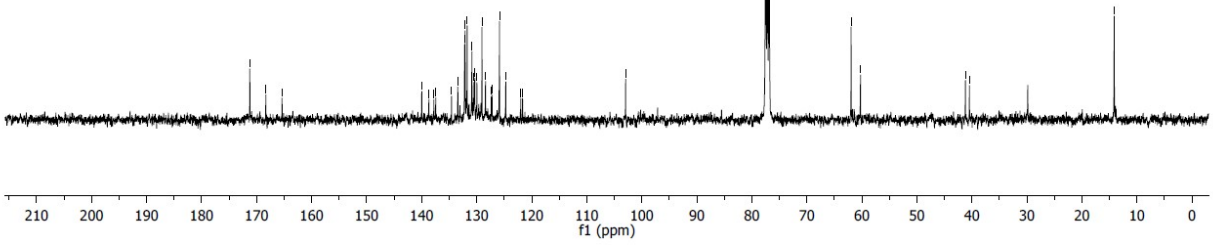


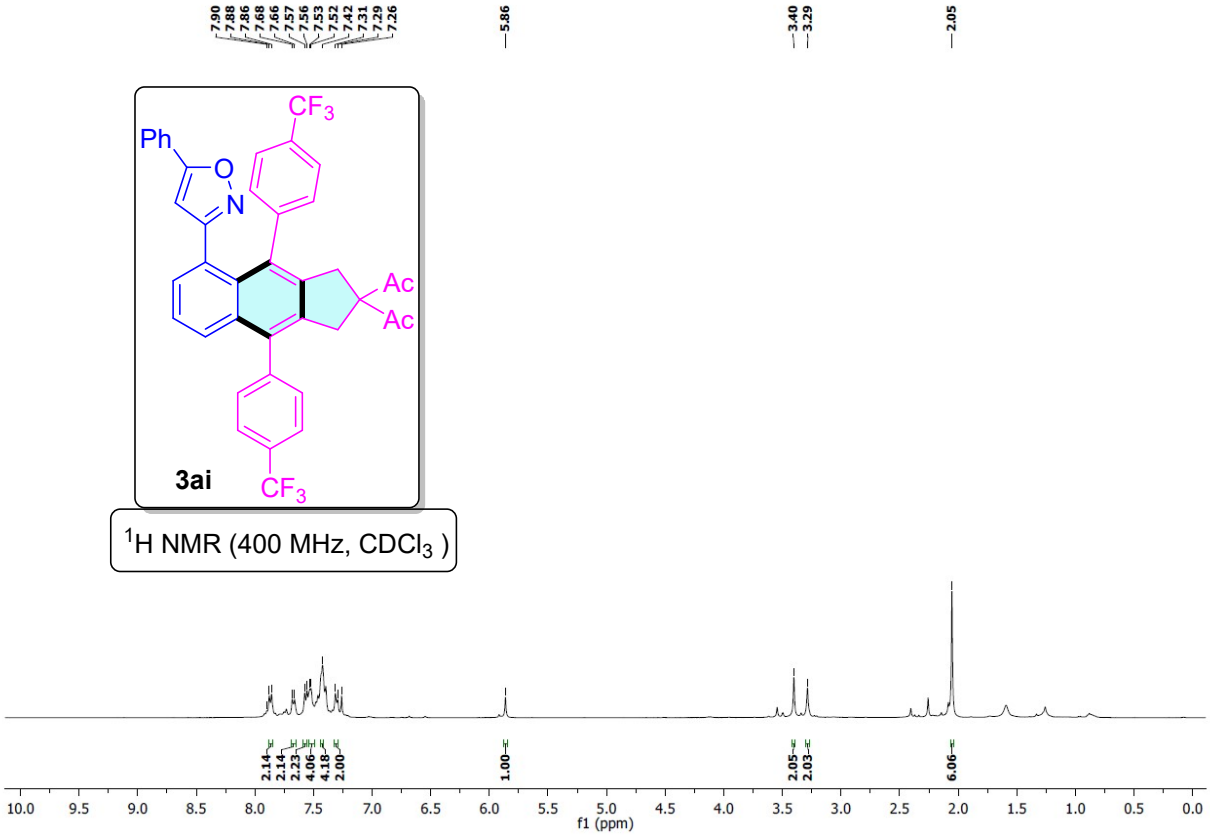
^{1}H NMR (400 MHz, $CDCl_3$)



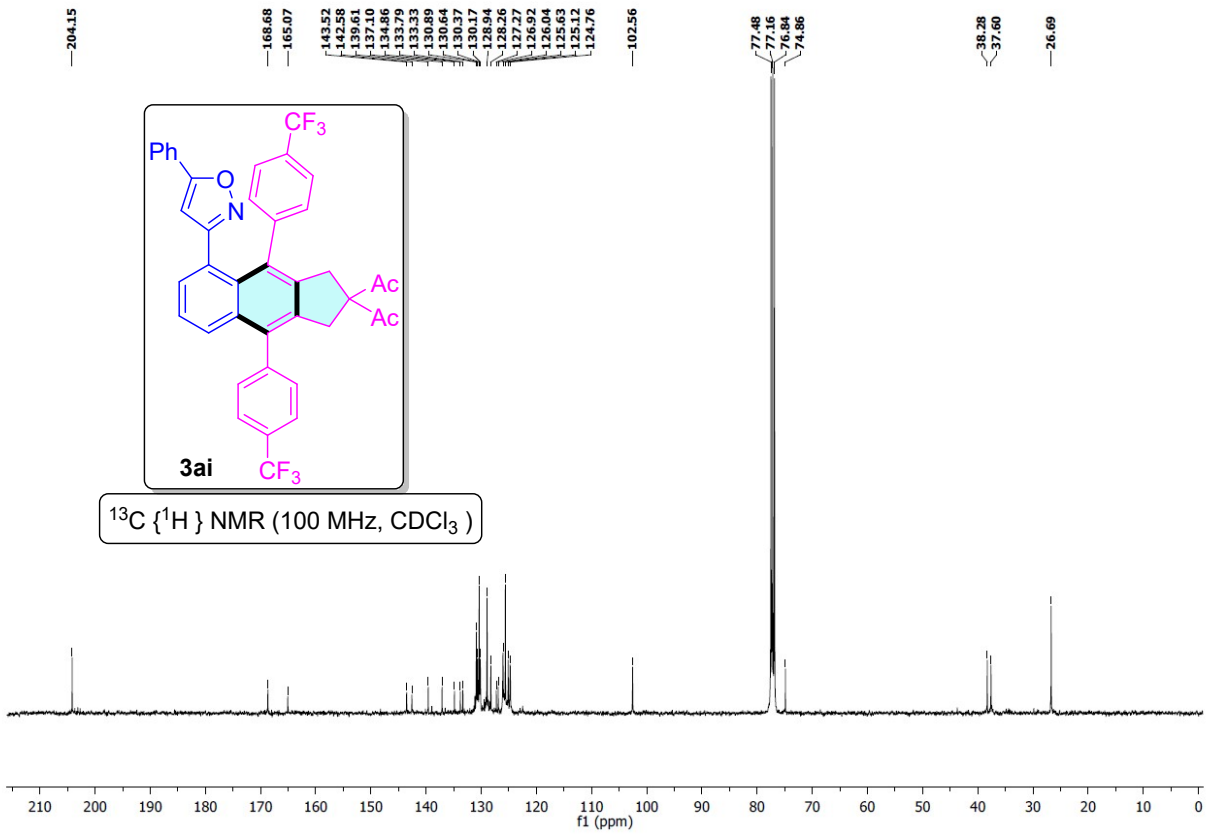


^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

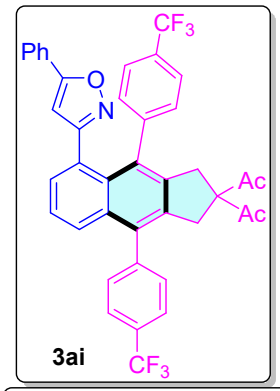




^{1}H NMR (400 MHz, $CDCl_3$)

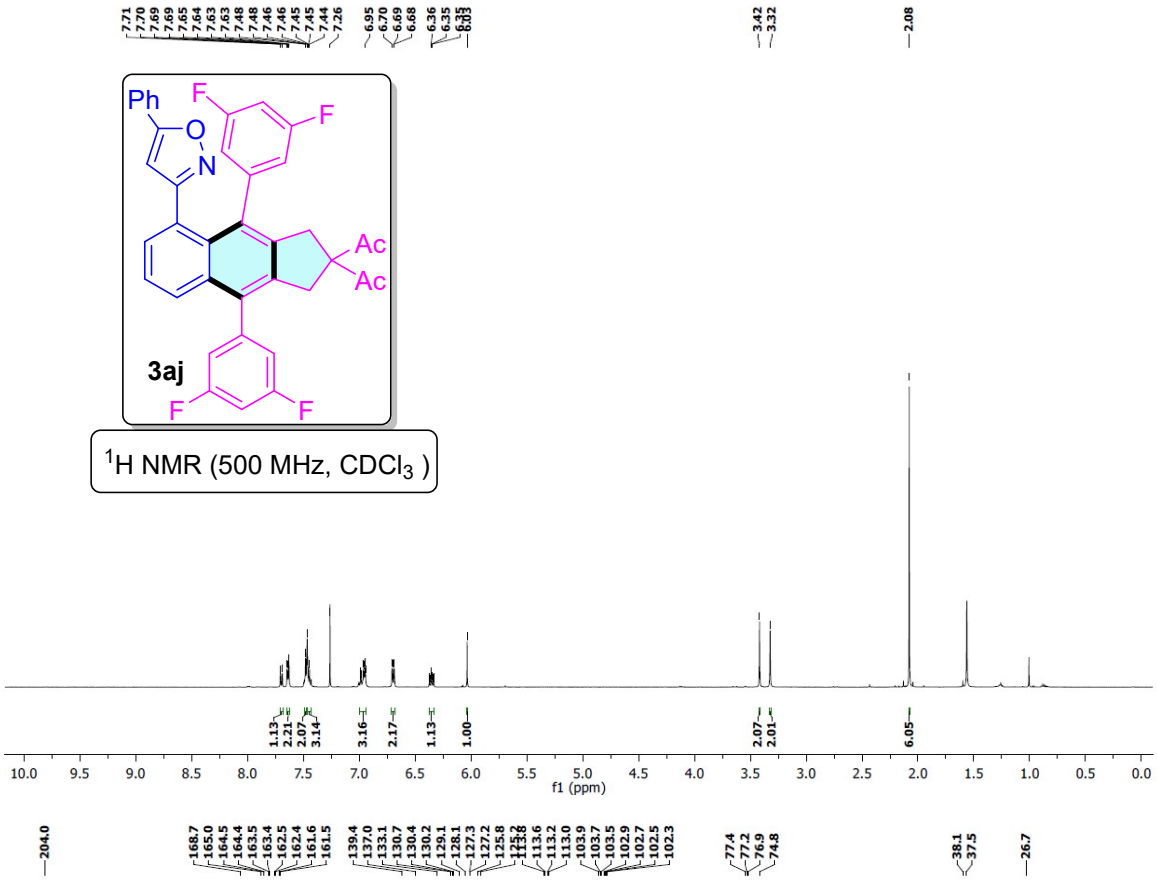


^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

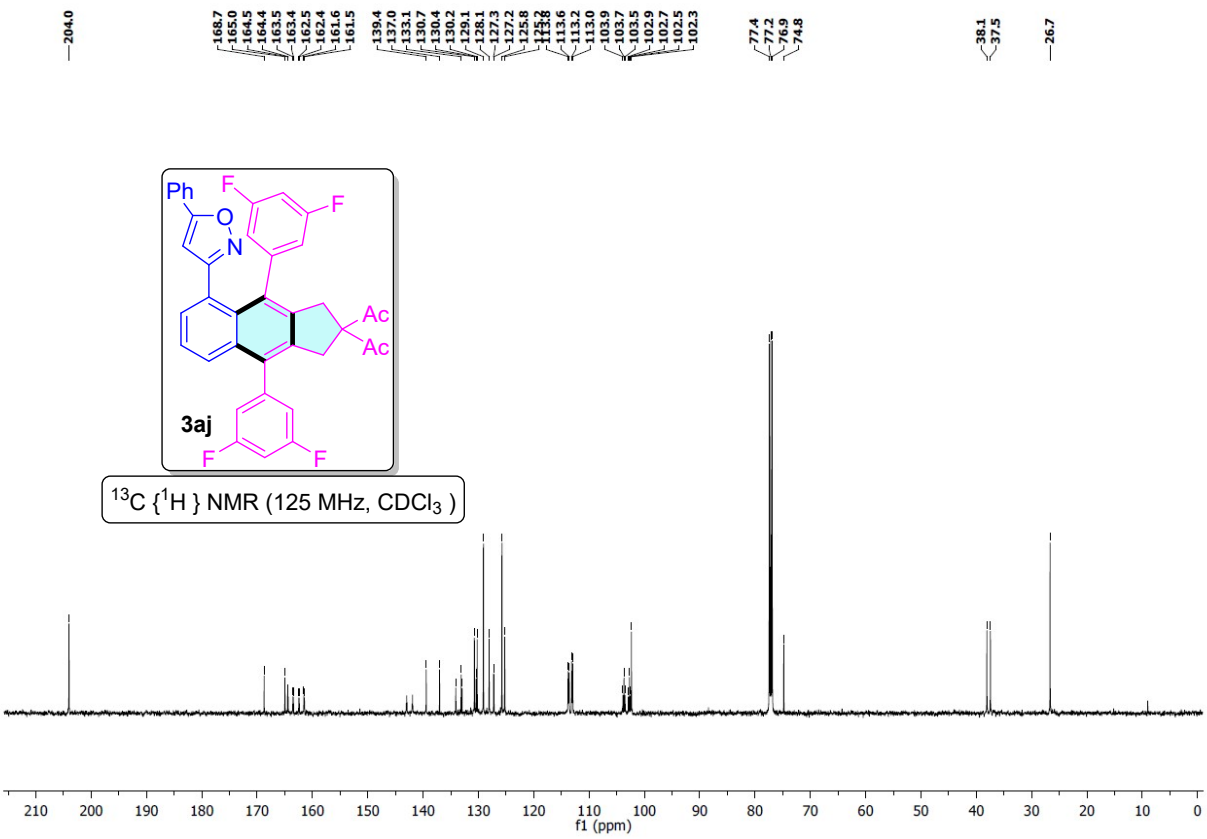


3ai

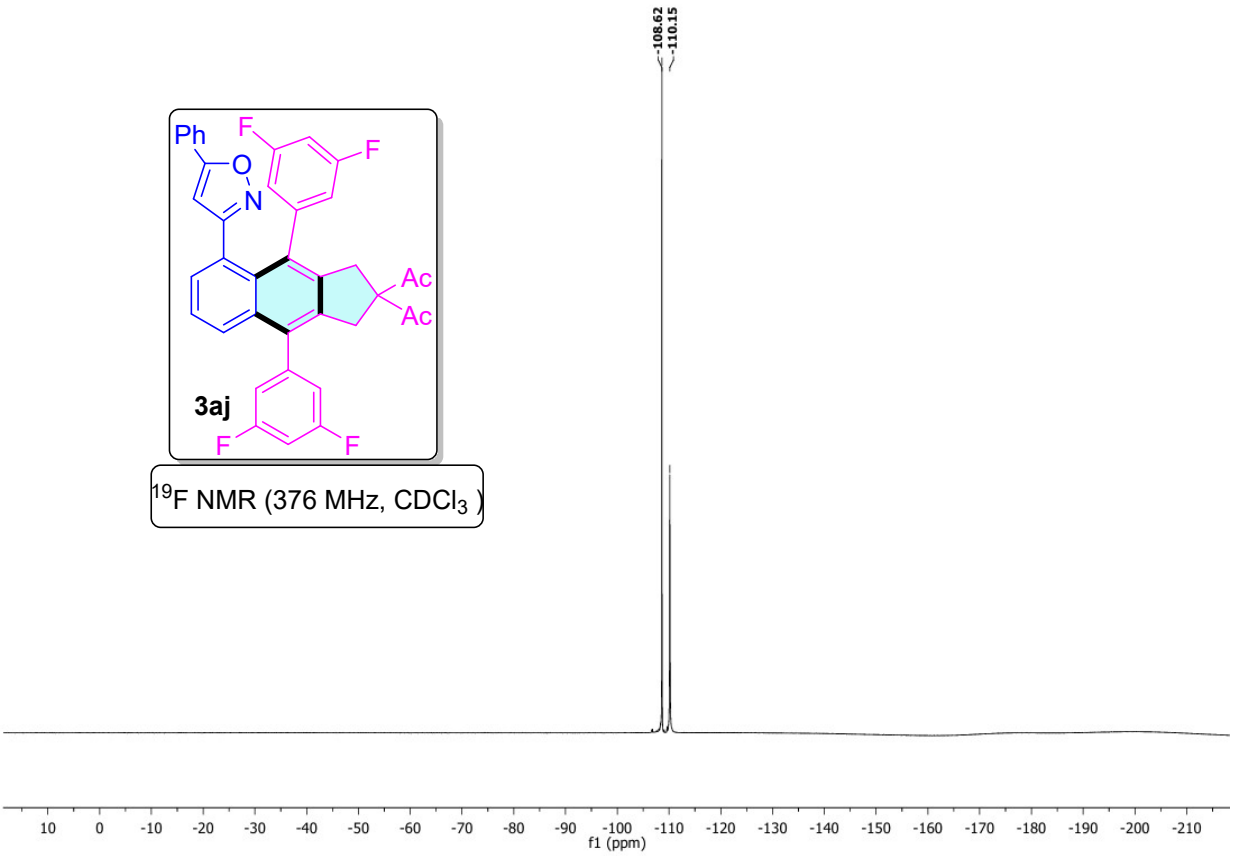
^{19}F NMR (471 MHz, $CDCl_3$)



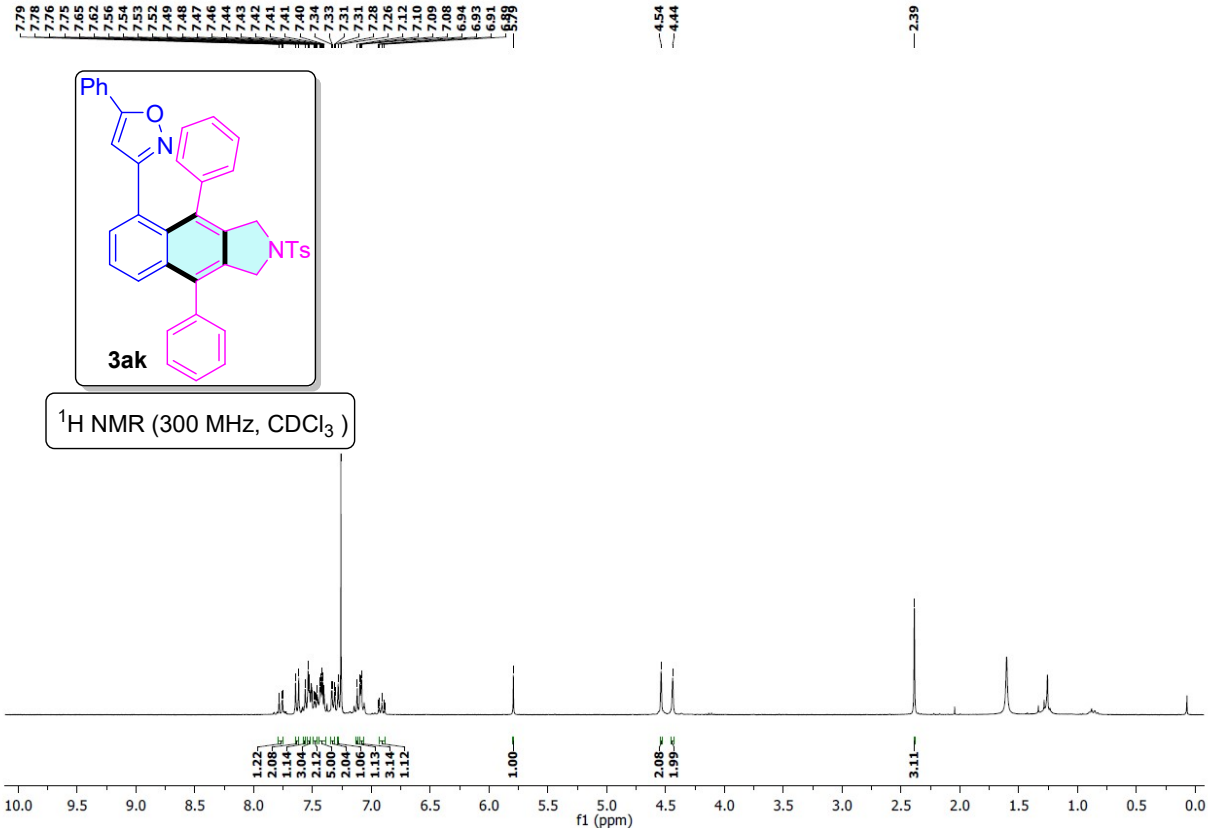
^{1}H NMR (500 MHz, $CDCl_3$)



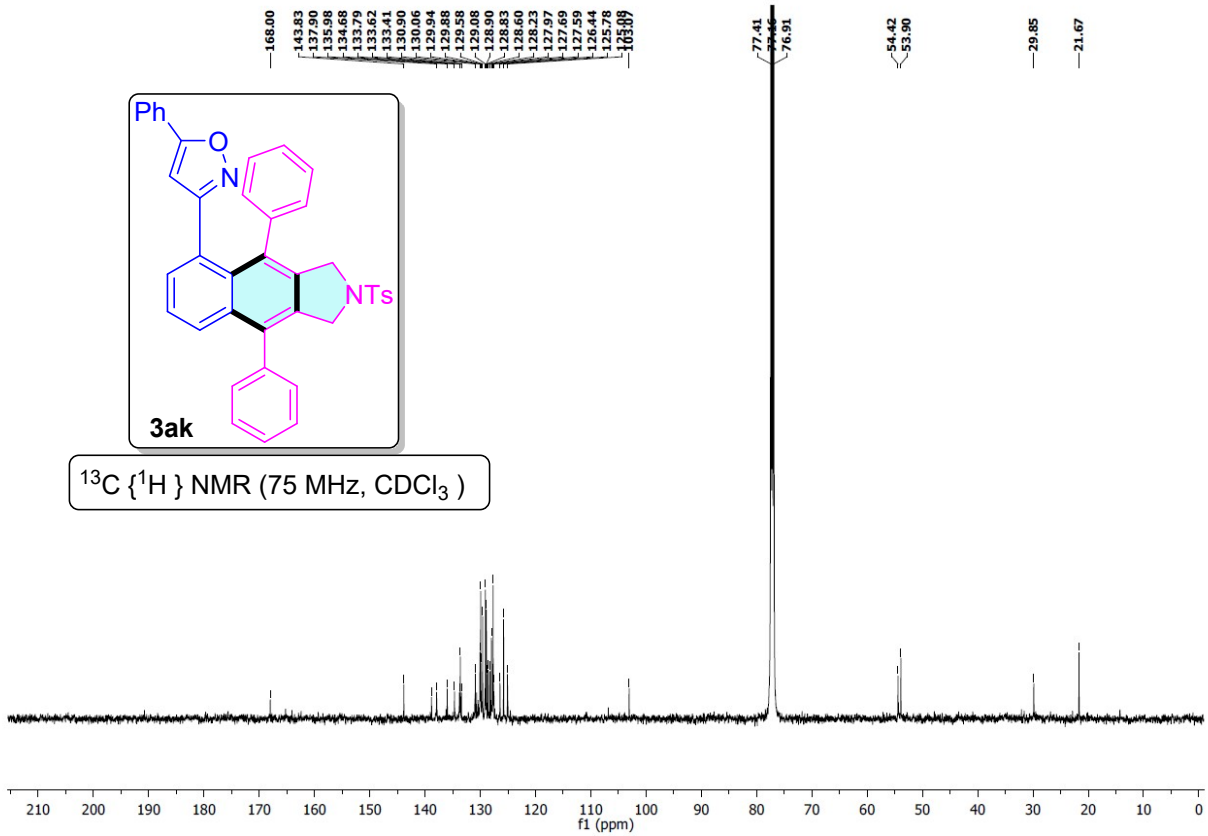
^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)



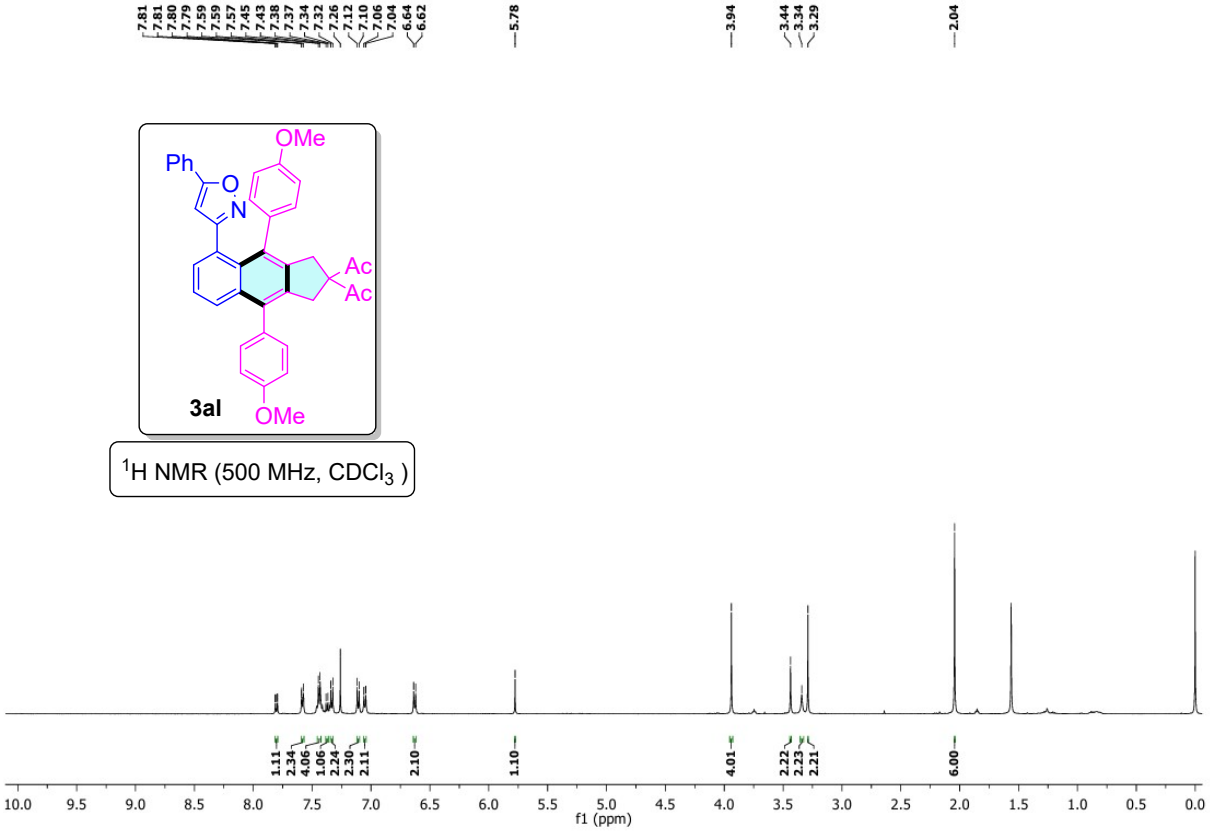
^{19}F NMR (376 MHz, $CDCl_3$)



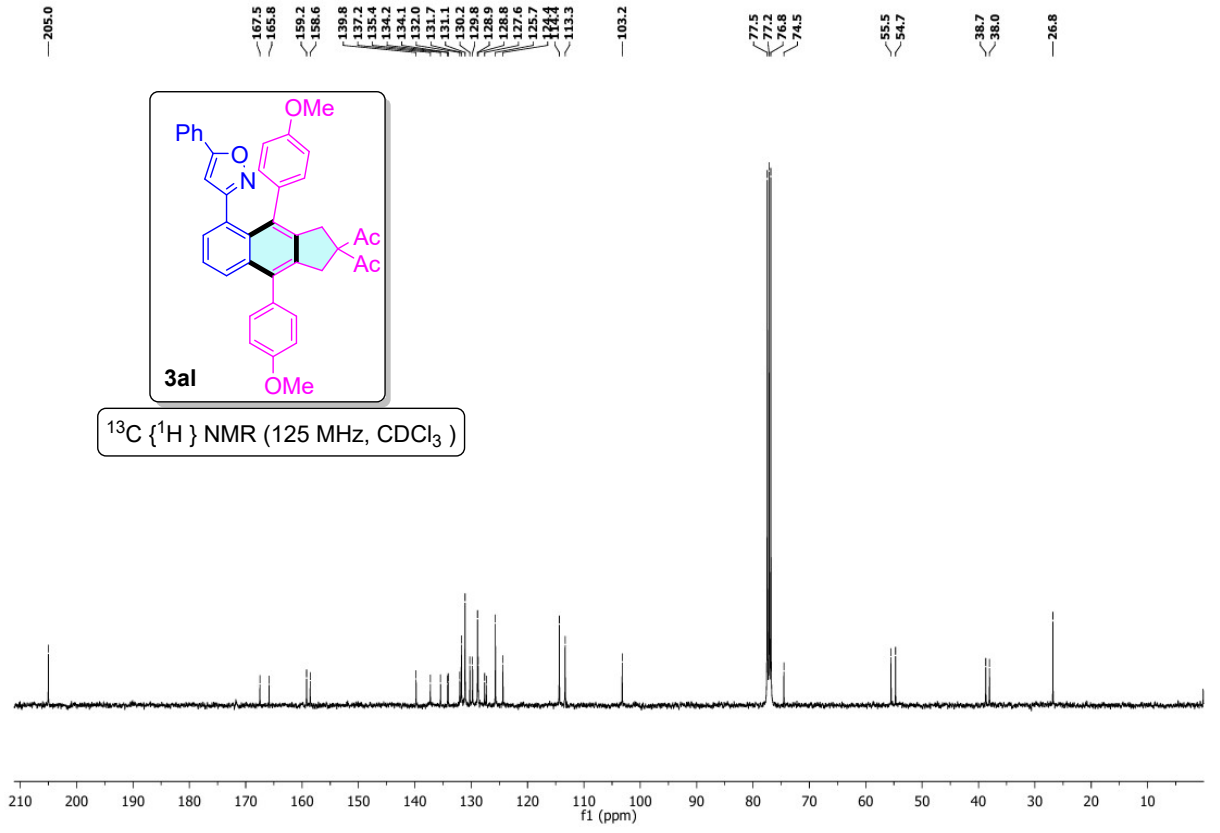
^{1}H NMR (300 MHz, $CDCl_3$)



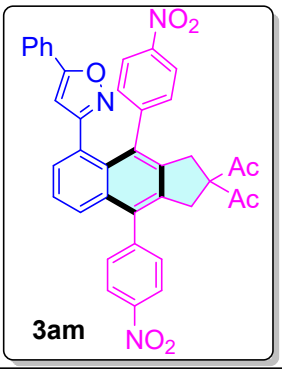
^{13}C {^{1}H } NMR (75 MHz, $CDCl_3$)



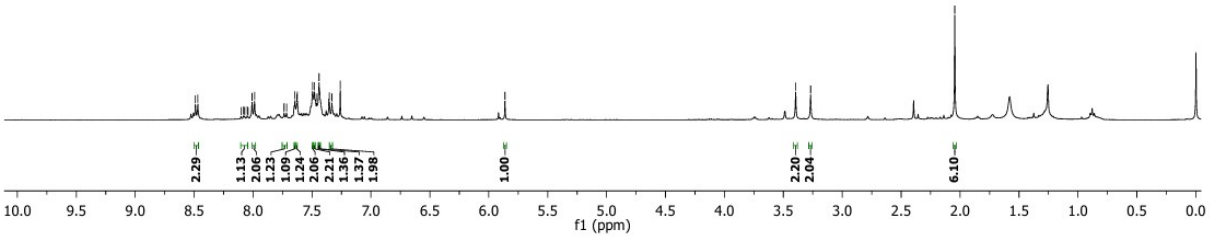
^{1}H NMR (500 MHz, $CDCl_3$)

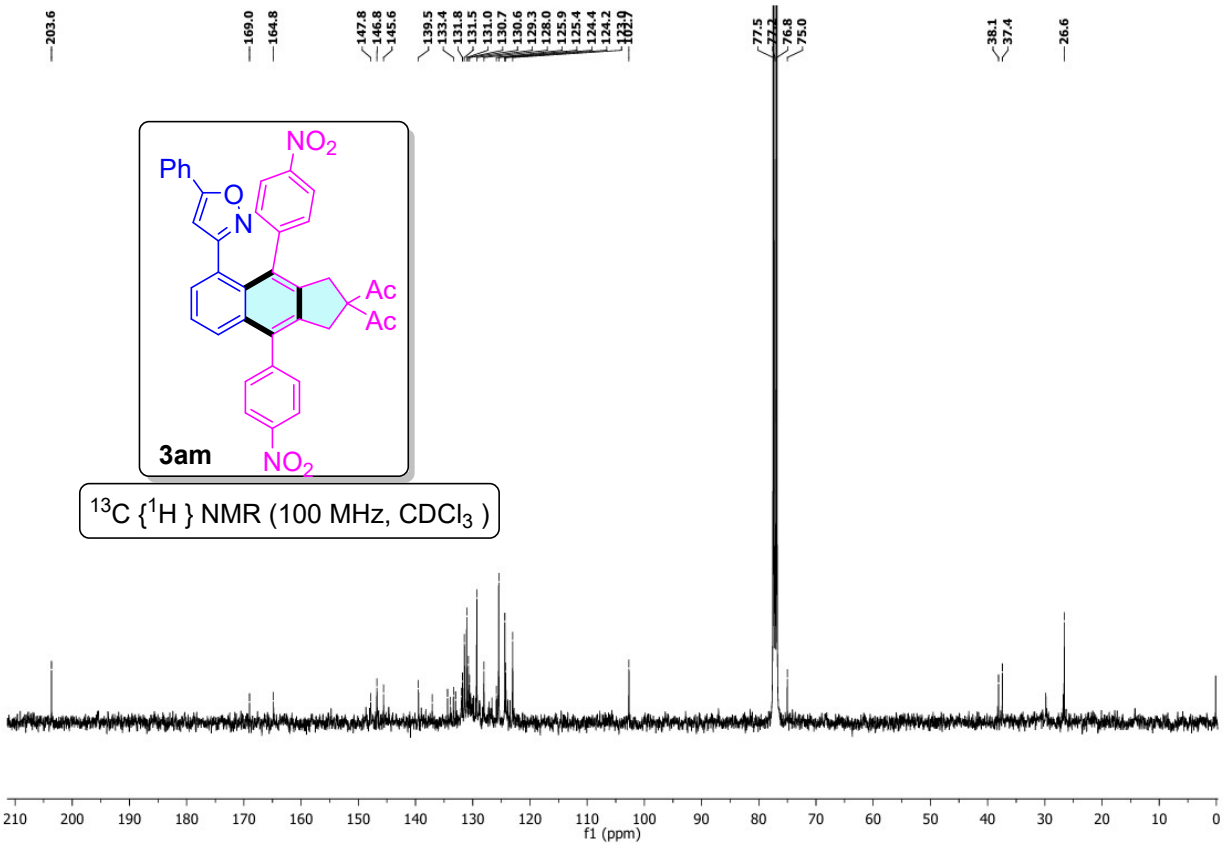


^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)

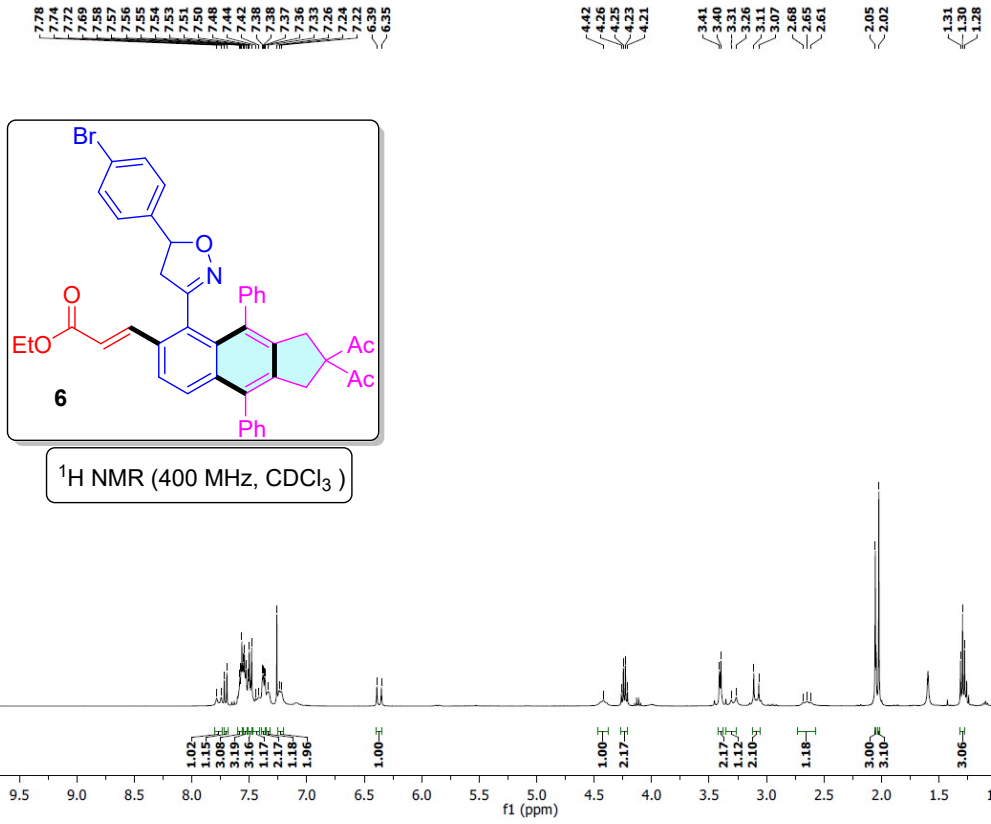


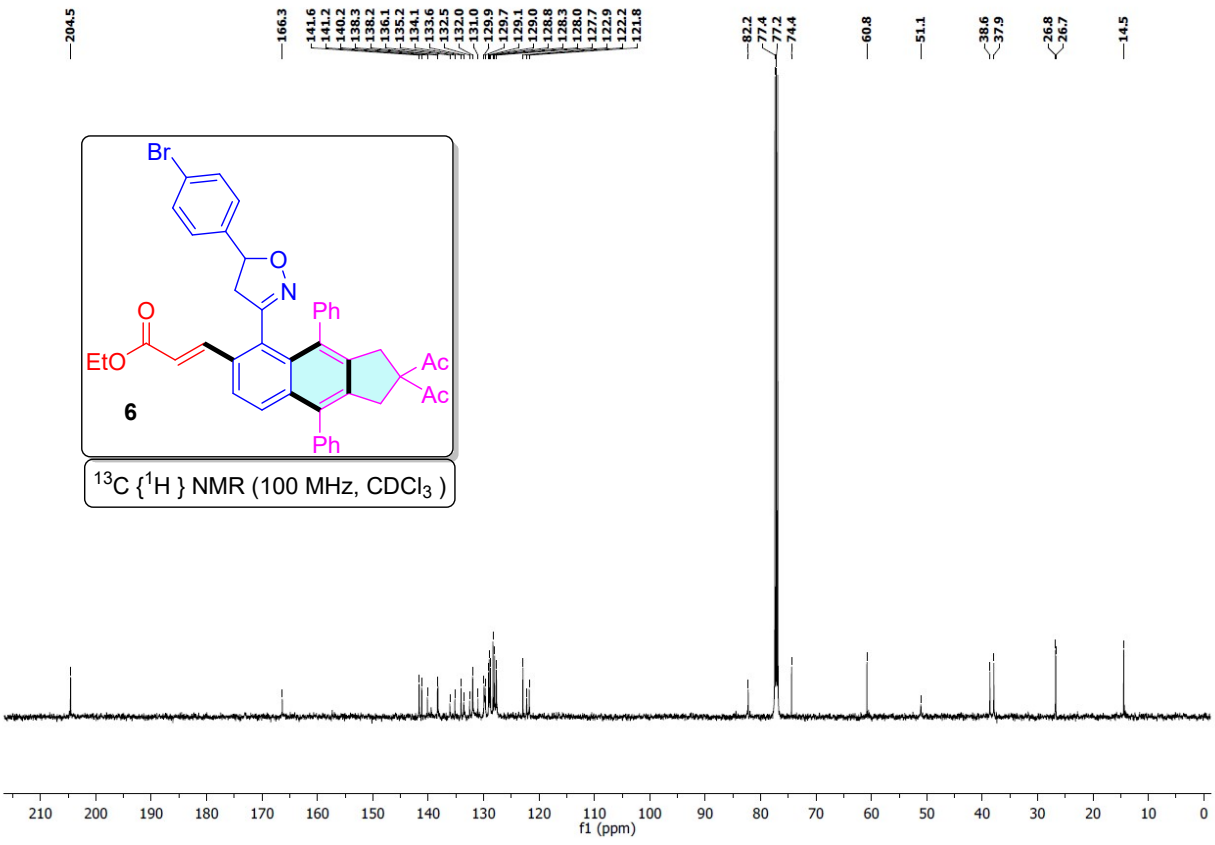
^{1}H NMR (400 MHz, $CDCl_3$)

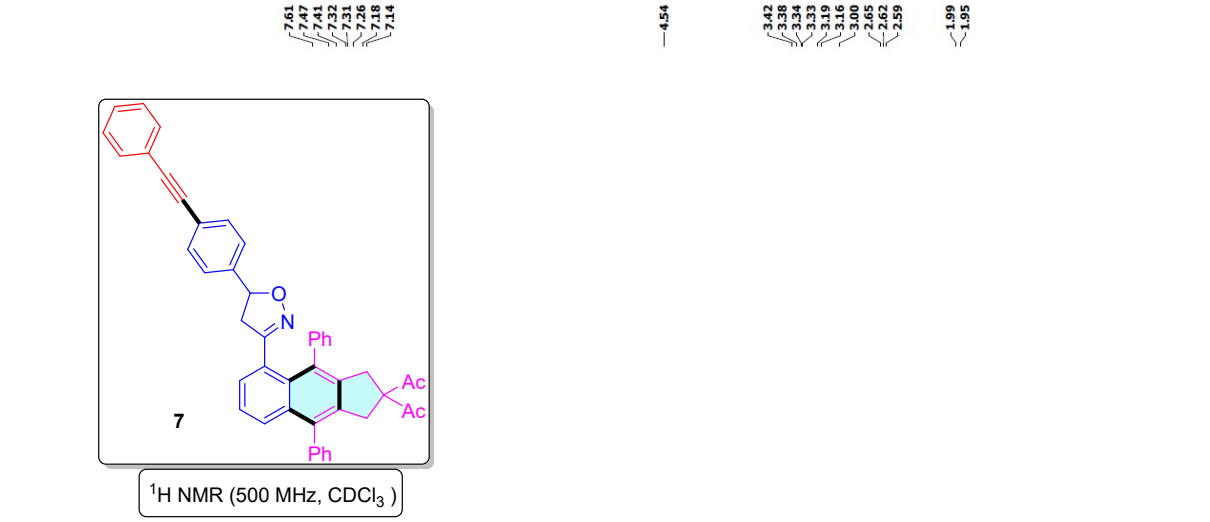




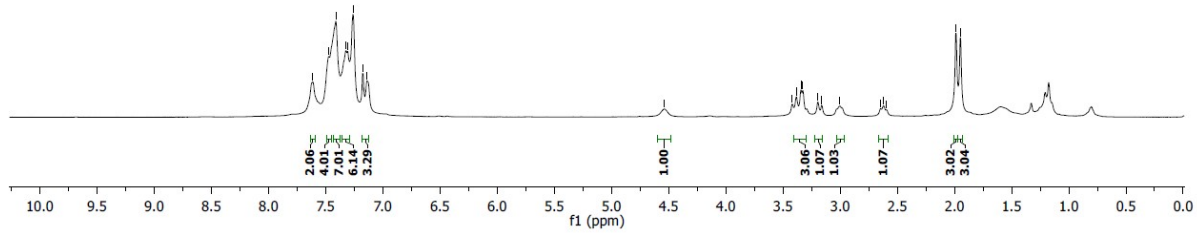
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)

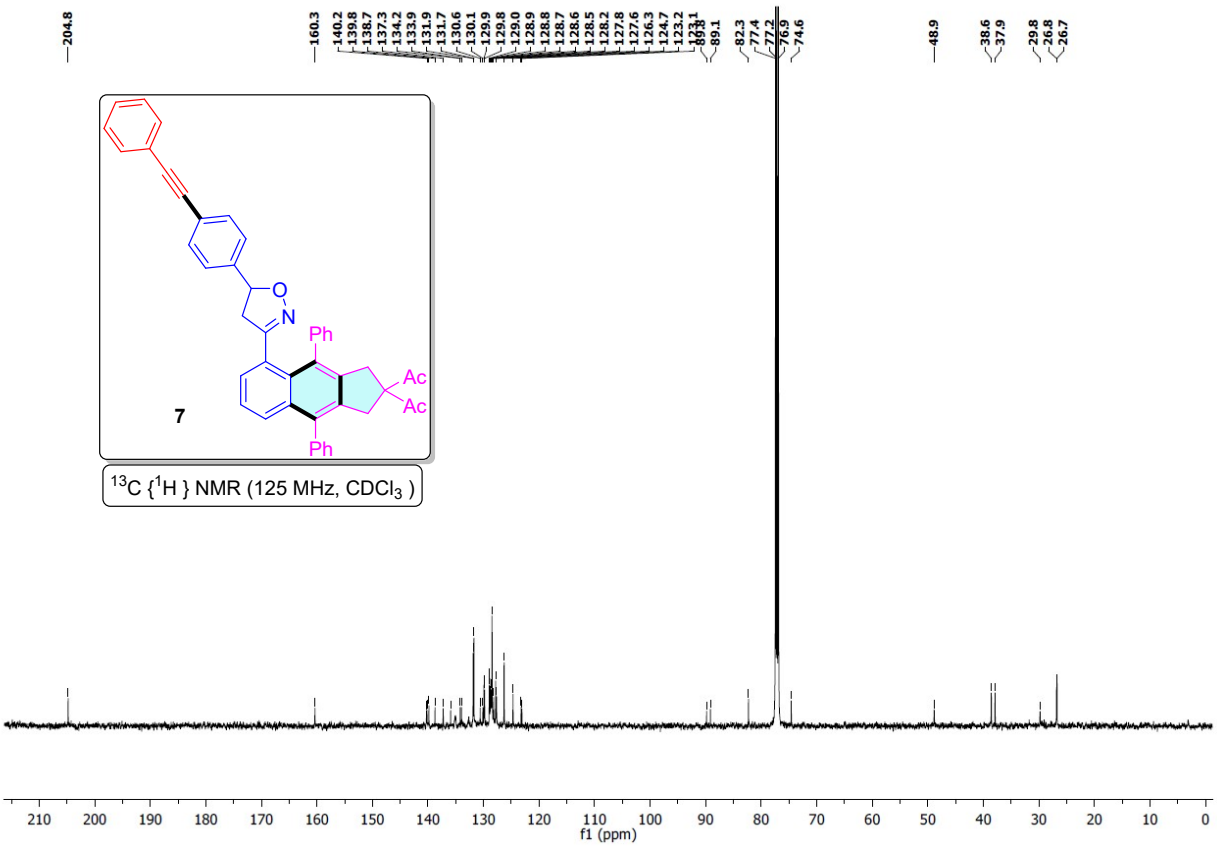

Br
O
N
O
EtO
Ph
Ac
Ac
Ph
6
^{1}H NMR (400 MHz, $CDCl_3$)
f1 (ppm)


Br
O
N
O
EtO
Ph
Ac
Ac
Ph
6
^{13}C {^{1}H } NMR (100 MHz, $CDCl_3$)
f1 (ppm)



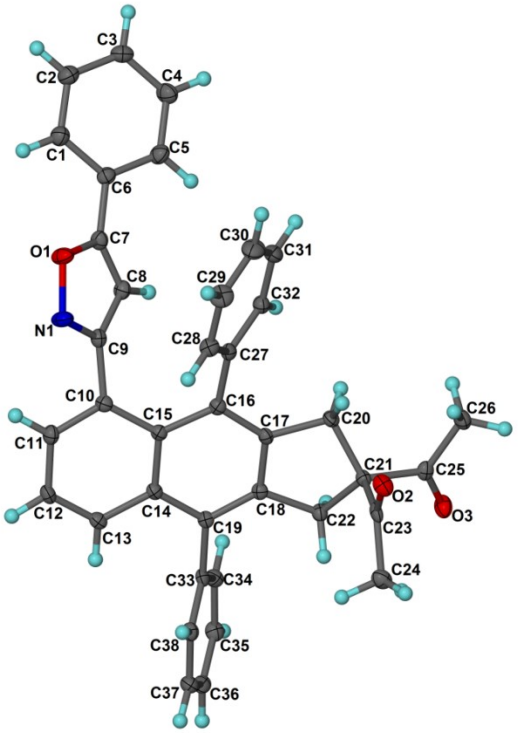
^{1}H NMR (500 MHz, $CDCl_3$)





^{13}C {^{1}H } NMR (125 MHz, $CDCl_3$)

8. X-ray crystallography data:



Sample Preparation for Crystal Growth: The compound **3aa** was dissolved in THF in beaker and kept for slow evaporation at room temperature. Formation of needle shape crystals was observed after six days. The single crystals were then subjected to X-ray diffraction analysis.

Figure caption: ORTEP diagram of **3aa (KB1649)** compound with the atom-numbering. Displacement ellipsoids are drawn at the 50% probability level and H atoms are shown as small spheres of arbitrary radius.

Crystal data for 3aa (KB1649): $C_{38}H_{29}NO_3$, M = 547.62, Triclinic, Space group $P\bar{1}$ (No.2), a = 6.4891(6)Å, b = 15.3488(14)Å, c = 16.4646(14)Å, α = 96.394(3)°, β = 100.990(3)°, γ = 95.099(3)°, V = 1589.6(2)Å3, Z = 2, Dc = 1.144 g/cm3, F000 = 576, Bruker D8 QUEST PHOTON III C7 HPAD detector, Mo-Kα radiation, λ = 0.71073 Å, T = 100(2)K, 2θmax = 55º, μ = 0.072 mm-1, 40871 reflections collected, 7969 unique (Rint = 0.0912), 382 parameters, R1 = 0.0531, wR2 = 0.1268, R indices based on 4478 reflections with I > 2σ(I) (refinement on F2), Final GooF = 1.007, largest difference hole and peak = -0.270 and 0.294 e.Å-3. The solvent molecule THF was included in the crystal lattice found to be severely disordered. The SQUEEZE module in PLATON software is used to remove the contribution of the disordered

solvent from the crystal. The CCDC deposition number **2428998** contains the supplementary crystallographic data for this paper which can be obtained free of charge at https://www.ccdc.cam.ac.uk/structures/

Data collection and Structure solution details:

X-ray data for the compound **3aa (KB1649)** were collected at low temperature (100K) collected at room temperature (294K) on a Bruker D8 QUEST instrument with an IμS Mo microsource (λ = 0.7107 Å) and a PHOTON-III C7 HPAD detector. The raw data frames were reduced and corrected for absorption effects using the Bruker Apex 3 software suite programs [1]. The structure was solved using intrinsic phasing method [2] and further refined with the SHELXL [2-4] program and expanded using Fourier techniques. Anisotropic displacement parameters were included for all non-hydrogen atoms. All C bound H atoms were positioned geometrically and treated as riding on their parent C atoms [C-H = 0.93-0.97 Å, and Uiso(H) = 1.5Ueq(C) for methyl H or 1.2Ueq(C) for other H atoms]. In **3aa (KB1649)** crystal, the solvent of crystallization tetrahydrofuran (THF) is included in the crystal lattice of **3aa (KB1649)** compound. These solvent molecules are occupied on the special positions and found to be severely disordered to obtain a reliable structural model. The SQUEEZE utility in PLATON is used to remove the contribution of the disordered solvent. An electron count of 99 is suggested per unit cell (void volume of 303 Å3) which matches the calculated electron count for approximately two THF molecules (molecular formula C4H8O each with 40 electron count). The files (.hkl and .ins) generated by PLATON after the SQUEEZE treatment were used in the final refinement of the structure [5]. CCDC deposition numbers **2428998** contain the supplementary crystallographic data for this paper which can be obtained free of charge at https://www.ccdc.cam.ac.uk/structures/

1. Bruker (2016). APEX3, SAINT and SADABS. Bruker AXS, Inc., Madison, Wisconsin, USA.
2. G. M. Sheldrick, Acta Crystallogr., 2015, C71: 3-8.
3. C. B. Hübschle, G. M. Sheldrick and B. Dittrich, ShelXle: a Qt graphical user interface for SHELXL, J. Appl. Cryst., 2011, 44, 1281-1284.

4. Muller, P, Herbst-Imer, R, Spek, A. L, Schneider, T. R, and Sawaya, M. R. Crystal Structure Refinement: A Crystallographer's Guide to SHELXL. Muller, P. Ed. 2006 Oxford University Press: Oxford, New York, pp. 57–91.

5. (a) A.L. Speck, "PLATON, a multipurpose crystallographic tool." Utrecht University, Utrecht, The Netherlands, 2001, http://www.cryst.chem.uu.nl/platon/ (b) D. van der Sluis and A. L. Spek, Acta Crystallogr., Sect. A, 1990, 46, 194-201.

checkCIF/PLATON report

Structure factors have been supplied for datablock(s) kb1649_0m_a_sq

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found. CIF dictionary Interpreting this report

Datablock: kb1649_0m_a_sq

Bond precision: C-C = 0.0030 A Wavelength=0.71073

Cell: a=6.4891(6) b=15.3488(14) c=16.4646(14)
alpha=96.394(3) beta=100.990(3) gamma=95.099(3)
Temperature: 100 K

	Calculated	Reported
Volume	1589.6(2)	1589.6(2)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C38 H29 N O3 [+ solvent]	C38 H29 N O3
Sum formula	C38 H29 N O3 [+ solvent]	C38 H29 N O3
Mr	547.62	547.62
Dx,g cm-3	1.144	1.144
Z	2	2
Mu (mm-1)	0.072	0.072
F000	576.0	576.0
F000'	576.25	
h,k,lmax	8,20,22	8,20,22
Nref	8010	7969
Tmin,Tmax	0.986,0.991	0.646,0.746
Tmin'	0.984	

Correction method= # Reported T Limits: Tmin=0.646 Tmax=0.746
AbsCorr = MULTI-SCAN

Data completeness= 0.995 Theta(max)= 28.404

The following ALERTS were generated. Each ALERT has the format
test-name_ALERT_alert-type_alert-level.
Click on the hyperlinks for more details of the test.

Alert level C

```
PLAT767_ALERT_4_C INS Embedded LIST 6 Instruction Should be LIST 4     Please Check
PLAT905_ALERT_3_C Negative K value in the Analysis of Variance ...     -8.274 Report
```

Alert level G

```
PLAT154_ALERT_1_G The s.u.'s on the Cell Angles are Equal ..(Note)      0.003 Degree
PLAT395_ALERT_2_G Deviating  X-O-Y   Angle From 120 for O1       .      108.8 Degree
PLAT605_ALERT_4_G Largest Solvent Accessible VOID in the Structure       163 A**3
PLAT869_ALERT_4_G ALERTS Related to the Use of SQUEEZE  Suppressed         ! Info
PLAT883_ALERT_1_G Absent Datum for _atom_sites_solution_primary ..     Please Do !
PLAT910_ALERT_3_G Missing # of FCF Reflection(s) Below Theta(Min).         4 Note
              0  1  0,   0 -1  1,   0  0  1,   0  1  1,
PLAT912_ALERT_4_G Missing # of FCF Reflections Above STh/L=  0.600        37 Note
PLAT933_ALERT_2_G Number of HKL-OMIT Records in Embedded .res File         3 Note
              0  1  0,   0  0  1,   0 -1  2,
PLAT969_ALERT_5_G The 'Henn et al.' R-Factor-gap value .....      3.623 Note
             Predicted wR2: Based on SigI**2  4.21 or SHELX Weight 15.16
PLAT978_ALERT_2_G Number C-C Bonds with Positive Residual Density.         7 Info
```

```
   0 ALERT level A = Most likely a serious problem - resolve or explain
   0 ALERT level B = A potentially serious problem, consider carefully
   2 ALERT level C = Check. Ensure it is not caused by an omission or oversight
  10 ALERT level G = General information/check it is not something unexpected

   2 ALERT type 1 CIF construction/syntax error, inconsistent or missing data
   3 ALERT type 2 Indicator that the structure model may be wrong or deficient
   2 ALERT type 3 Indicator that the structure quality may be low
   4 ALERT type 4 Improvement, methodology, query or suggestion
   1 ALERT type 5 Informative message, check
```

It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

Publication of your CIF in IUCr journals

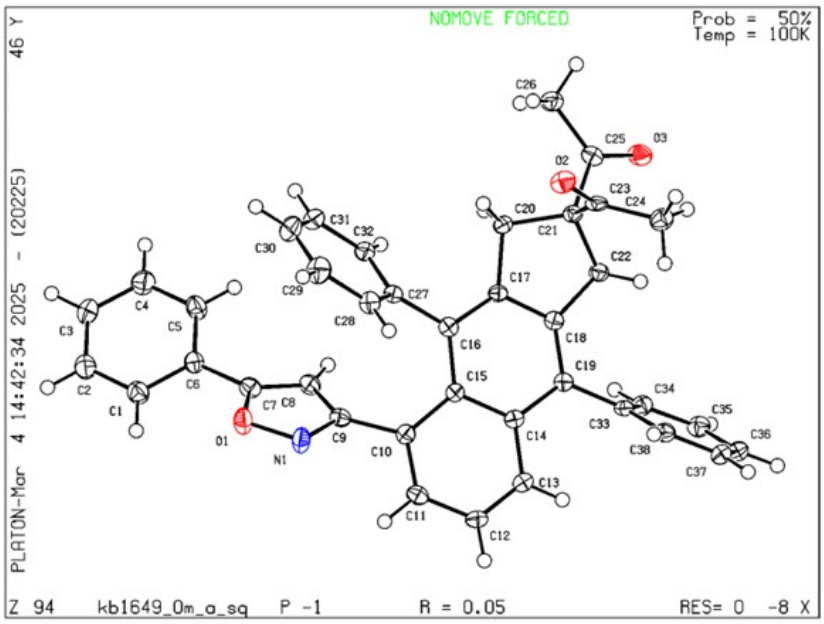
A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica*, *Journal of Applied Crystallography*, *Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E* or *IUCrData*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

Publication of your CIF in other journals

Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.

PLATON version of 02/02/2025; check.def file version of 02/02/2025

Datablock kb1649_0m_a_sq - ellipsoid plot



9. References:

1. (a). S. Das, T. Datta, Md. A. Sk, B. Royand R. K. Nandi, *Org. Biomol. Chem.,* 2024, **22**, 6922-6927; (b) P. Kumar and M. Kapur, Org. Lett., 2019, 21, 2134-2138.
2. a) S. K. Yadav, M. Jeganmohan. *Org. Lett.,* 2024, **26**, 7809−7816; b) Q. Li, Y. Wang, B. Li, B. Wang. *Org. Lett*., 2018, **20**, 7884−7887; c) S. K. Yadav, M. Jeganmohan. *Chem. Commun.,* 2024, **60**, 8296–8299.
3. T. Noguchi, Y. Nishii, M. Miura, Synthesis., 2019, 51, 258-270