Supporting Information for:

Secondary Phosphine Oxides Stabilized Au/Pd Nanoalloys: Metal Components-Controlled Regioselective Hydrogenation toward Phosphinyl (*Z*)-[3]Dendralenes

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Table of Contents for Supporting Information

1. General Information

Solvents and reagents were reagent grade and used without purification unless otherwise noted. Column chromatography was performed using silica gel (200-300 mesh). All ^{1}H-NMR (400 MHz) spectra were recorded on a Bruker-DMX 400 using $CDCl_3$ solution in the presence of tetramethylsilane (TMS) as an internal standard and are reported in ppm (δ). Coupling constants are reported in Hertz (Hz). Spectral splitting patterns are designated as s, singlet; d, doublet; t, triplet; q, quartet; p, pentet; m, multiplet; and br, broad. High resolution mass spectroscopic data of the products were collected on a Waters Micromass GCT instrument using EI (70 eV) or an Agilent Technologies 6540 UHD Accurate-Mass Q-TOF LC/MS using ESI. Transmission Electron Microscopy (TEM): the tetrahydrofuran dispersion of catalyst was drop-cast onto a 300 mesh carbon coated copper grid, and TEM pictures were taken on a FEI-Tecnai G2 F30 S-TWIN at an accelerating voltage of 75 kV. Fourier Transform Infrared Spectroscopy (FT-IR): FT-IR measurements were carried out on a Bruker Optics FT-IR Alpha spectrometer equipped with a DTGS detector, KBr beamsplitter at 4 cm^{-1} resolution in the range 4000–500 cm^{-1}. X-ray Photoelectron Spectroscopy (XPS): These experiments were carried out at the testing center of Yangzhou University, The instrument model: ESCALAB250Xi. Energy Dispersive X-ray Spectroscopy (EDX): EDX analyses were performed on a FEI-Tecnai G2 F30 equipped with an EDS Detector employing copper as internal standard. Samples were prepared drop casting (from various THF solutions). Inductively Coupled Plasma (ICP)**:** Inductively coupled plasma-mass spectra (ICP-MS) were taken from Optima 7300 DV (PerkinElmer). Phase Analysis of X-ray Diffraction (XRD): These experiments were carried out at the testing center of Nanjing University of Science and Technology, XRD data were collected with CuKa radiation on Bruker C8 ADVANCE. UV Spectrophotometer (UV): These experiments were carried out at the testing center of Nanjing University of Science and Technology, using Cary 5000, and the spectral range: 200 ~ 3300 nm, absorbance linear range: 0 ~ 8.0 Abs, wavelength accuracy: ±0.08 nm (UV/Vis); ±0.4 nm (NIR). The surface area of the catalysts was determined by the multi-point BET method using N_2 adsorption (V-Sorb 2800P analyzer, Jinaipu, China).

2. Synthesis of the Au(I)-SPO and Pd(II)-SPO Precursors

Au(I)-SPO: {[Ph_2(O)H]AuCl}[1]

To a 25 mL vial was added $HAuCl_4$•$3H_2O$ (500 mg, 1.27 mmol) and ethanol (10 ml), after tetrahydrothiophene (2.24 mL, 25.4 mmol, 20 eq.) was dropped until the yellow color had completely dissipated. The white precipitation [(tht)AuCl]) was collected by centrifugation and washed with cold ethanol for twice before drying in vacuum, giving the desired gold complex in a quantitative yield. Then diphenylphosphine oxide (101 mg, 0.5 mmol) and [(tht)AuCl] (160 mg, 0.5 mmol) were dissolved in dichloromethane (5 mL). The resulting solution was stirred for three hours, then concentrated under vacuum and diluted with hexane (10 mL). The mixture was kept overnight at -30 ºC. After filtration, a white solid of [Ph_2(O)H]AuCl (155 mg, 0.36 mmol) was obtained.

[1] I. Cano, A. M. Chapman, A. Urakawa, and P. W. N. M. van Leeuwen, *J. Am. Chem. Soc*., **2014**, *136*, 2520.

Pd(II)-SPO: {$PdCl_2$[Ph_2(O)H]$_2$}[2]

To a 25 mL vial was added allylpalladium chloride dimer [Pd(Cl)(C_3H_5)]$_2$ (182.9 mg, 0.5 mmol), diphenylphosphine oxide (202 mg, 1mmol) and CH_2Cl_2 (5 mL), the solution was stirred for three hours. The resulting solution was concentrated under vacuum and precipitated with 10 mL hexanes. A yellow solid (235 mg, 0.4 mmol) was obtained after filtration.

[2] Robin B. B., Samantha L. H., and Michael E. L.; *Organometallics*; **2003**, *22*, 1364.

3. Synthetic Procedures for SPOs-Au/PdNAs, SPOs-PdNPs and SPOs-AuNPs

3.1 Procedure for Synthesizing Au/PdNAs-2

The gold complex $[Ph_2(O)H]AuCl$ (0.1 mmol, 43 mg) and palladium complex $PdCl_2[Ph_2(O)H]_2$ (0.05 mmol, 29 mg) were dissolved in THF/CH_2Cl_2 (3 ml/10 ml) and cooled to 0 °C in an ice bath. A solution of $NaBH_4$ (60 mg, 1.6 mmol, 16 eq.) in degassed methanol (2 mL) was prepared immediately prior to use and then added via syringe to the rapidly stirred solution resulting in immediate formation of a deep purple-brown, homogenous solution. The reaction mixture was the extracted with dichloromethane (3 x 30 mL). The deep brown dichloromethane fractions were combined and washed with water (3 x 50 mL) and then concentrated under vacuum to give **Au/PdNAs-2** as black powder: 35.5 mg, 60 % (based on Au). The purified nanoalloys were obtained from precipitation with ice-cold methanol to remove unanchored ligands.

Au/PdNAs-1 and **Au/PdNAs-3:** The procedures for **Au/PdNAs-1** and **Au/PdNAs-3** were similar to the descriptions of **Au/PdNAs-2**, with differed precursor loadings as follows:

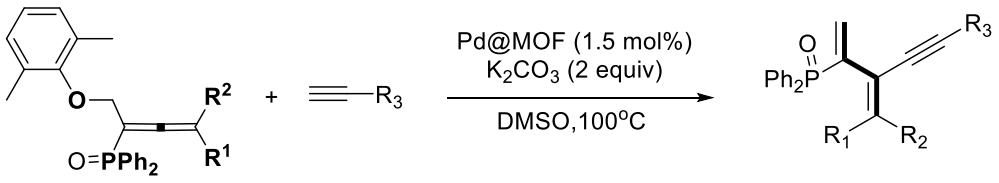
nanoalloys	**Au/PdNAs-1**	**Au/PdNAs-3**
amounts of metal precursors	$[Ph_2(O)H]AuCl$: 0.1 mmol, 43 mg $PdCl_2[Ph_2(O)H]_2$: 0.1 mmol, 58 mg	$[Ph_2(O)H]AuCl$: 0.1 mmol, 43 mg $PdCl_2[Ph_2(O)H]_2$: 0.033 mmol, 19 mg
yield	38.7 mg, 40% (based on Au)	37.2 mg, 49% (based on Au)

3.2 Procedure for Synthesizing SPOs-PdNPs

The palladium complex $PdCl_2[Ph_2(O)H]_2$ (0.1 mmol, 58.8 mg) was dissolved in a mixture of THF/CH_2Cl_2 (3 mL/10 ml) and cooled to 0 °C in an ice bath. A solution of $NaBH_4$ (60 mg, 1.6 mmol, 16 eq.) in degassed methanol (2 mL) was prepared immediately prior to use and then added in one portion via syringe to the rapidly stirred solution resulting in the immediate formation of homogenous dark-brown solution. The fractions were washed with water (3 x 50 mL) and then concentrated under vacuum to afford the palladium nanoparticles as black powder: 36.7 mg, 42 % (based on Pd).

The synthetic procedure for **SPOs-AuNPs** refers to: [3] Cano, I., Huertos, M. A., Chapman, A. M., and P. W. N. M. van Leeuwen, *J. Am. Chem. Soc.*, **2015**, *137*, 7718.

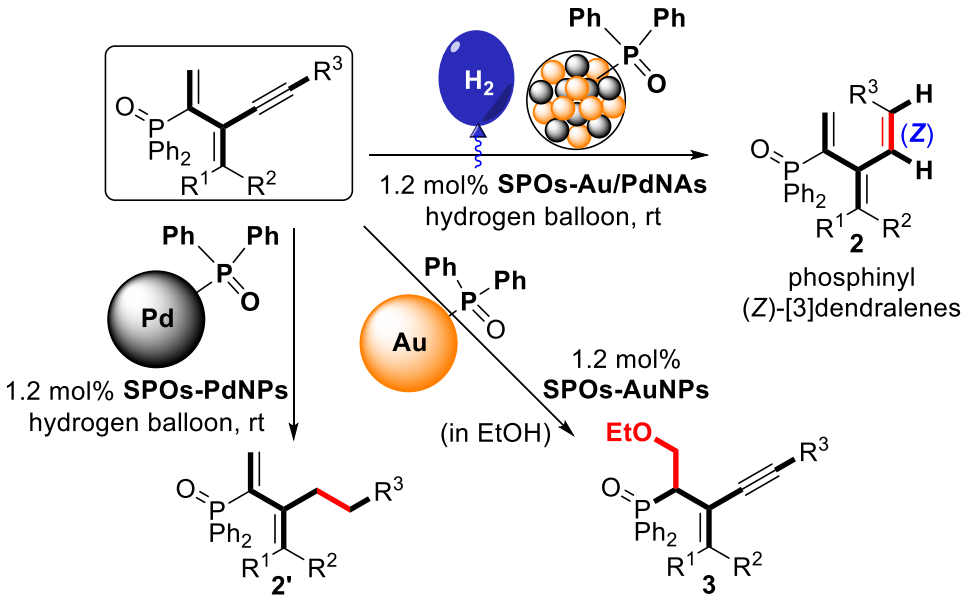
4. General Procedure for the Preparation of Phosphinyl Conjugated Enynes[4]



To a 25 mL vial was added allenylphosphine oxides (1 mmol, 526 mg), alkynes (2 mmol, 204 mg), potassium carbonate (K_2CO_3) (2 mmol, 276 mg), DMSO (10 mL) and Pd@MOF (1.5 mol%) respectively. The reaction was then allowed to react at 100 ^oC for a certain time until the complete consuming of starting materials monitored by TLC. The reaction mixture was extracted with EtOAc (10 mL×3). The combined organic extract was washed with brine and dried over anhydrous Na_2SO_4. The solvent was evaporated under reduced pressure and the residue was purified by column chromatography on silica gel using petroleum ether/ethylacetate (1.5/1) as the eluent to afford the enynes.

Note: please also refer to our previous work on synthesizing phosphinyl conjugated enynes: [4] X. D. Wang, J. J. Wu, X. Sun, W. C. Yang, Zhu. J, Wu. L, *Adv. Synth. Catal.*, **2018**, *360*, 3518.

5. General Procedures for the Catalytic Reactions in This Work.



Catalytic hydrogenations: To a 10 mL vial equipped with hydrogen balloon was added **1a** (0.2 mmol, 101 mg), DMAc (2 mL) and **Au/PdNAs-2** (0.0024 mmol, 4 mg). The reaction was then allowed to react at room temperature until the complete consuming of starting materials monitored by TLC. The reaction was quenched by adding 2 mL water, and then extracted with diethyl ether (2 mL×3). Purification on silica chromatography with ethyl acetate and petroleum ether (eluent: 1:2 (v/v) of ethyl acetate/petroleum ether) afforded the target product **2a** (96 mg, 94% yield) as a white solid.

Conditions for SPOs-AuNPs catalyzed Michael addition: **1a (**0.2 mmol), SPOs-AuNPs (1.2 mol%, 0.94 mg), NaOH (0.4 mmol) and ethanol (2 mL), 50 ^{o}C, 24 h;

Conditions for SPOs-PdNPs catalyzed hydrogenation: **1a (**0.2 mmol), SPOs-PdNPs (1.2 mol%, 2.1 mg), H_2 (balloon) and DMF (2 mL), 6 h;

6. ICP Data for All of the Nanocatalysts

Detecting element	Pd-NPs	Au/PdNAs-1	Au/PdNAs-2	Au/PdNAs-3
Au (wt%)	-	20.33 %	33.43 %	25.82 %
Pd (wt%)	12.12 %	7.33 %	6.61%	3.94 %

7. XPS Spectra for Au/PdNAs-2

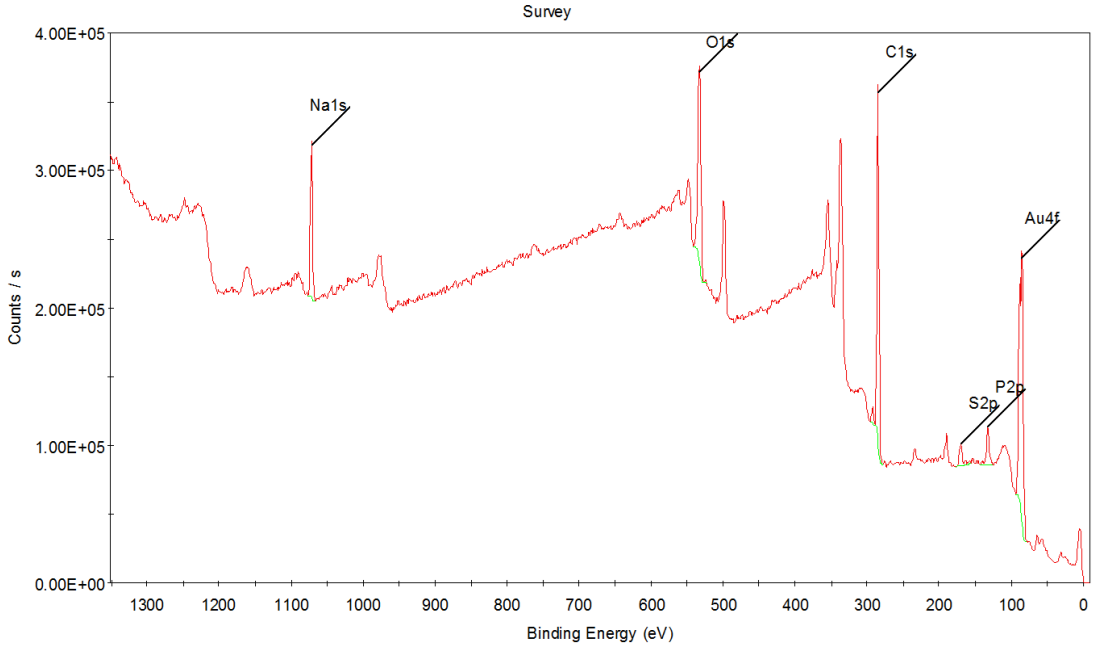


Figure S1. XPS spectrum of **Au/PdNAs-2**.

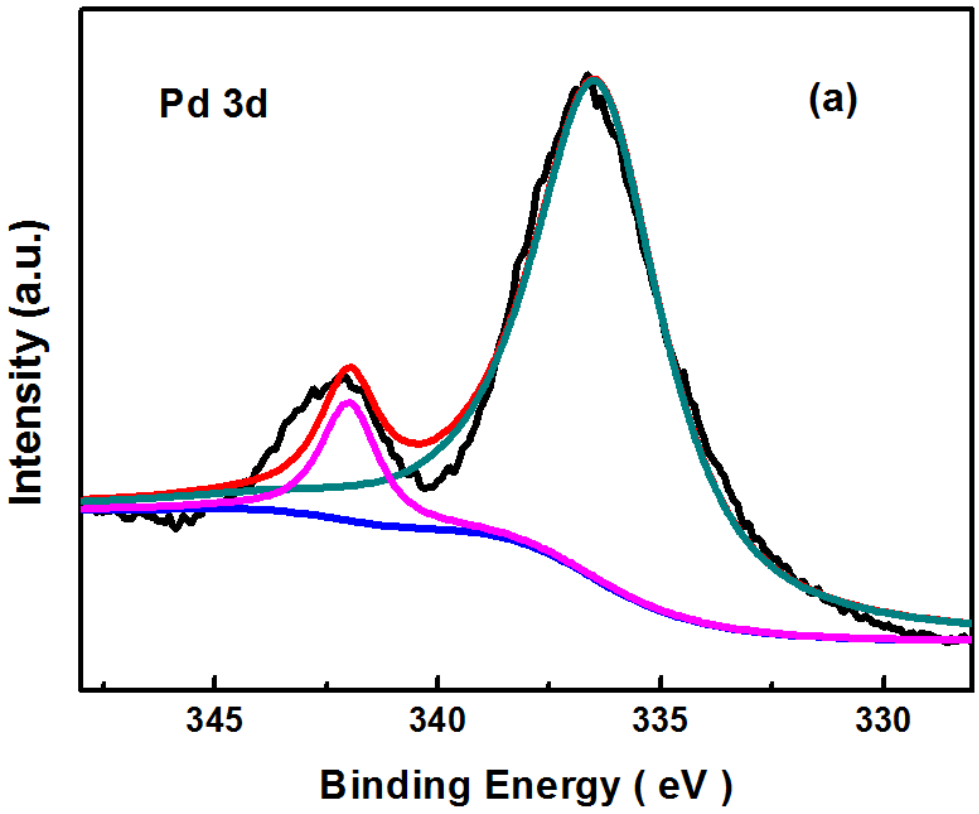


Figure S2. XPS spectrum of **Au/PdNAs-2**, which shows the presence of Pd 3d.

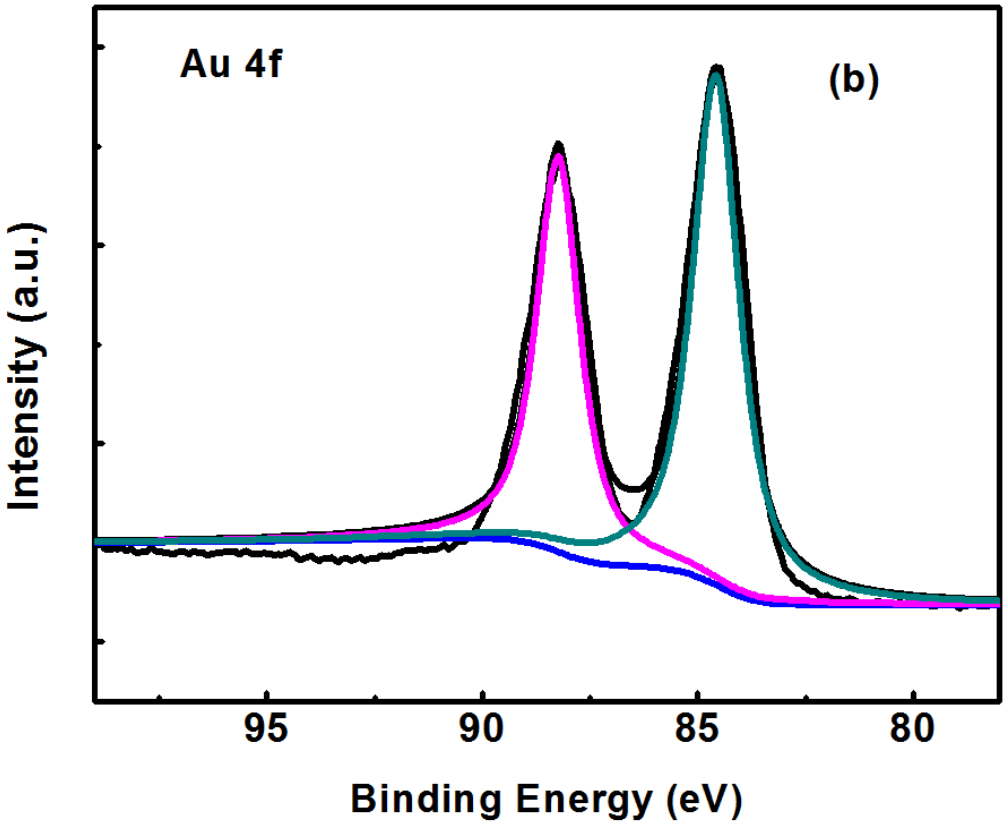


Figure S3. XPS spectrum of **Au/PdNAs-2**, which shows the presence of Au 4f.

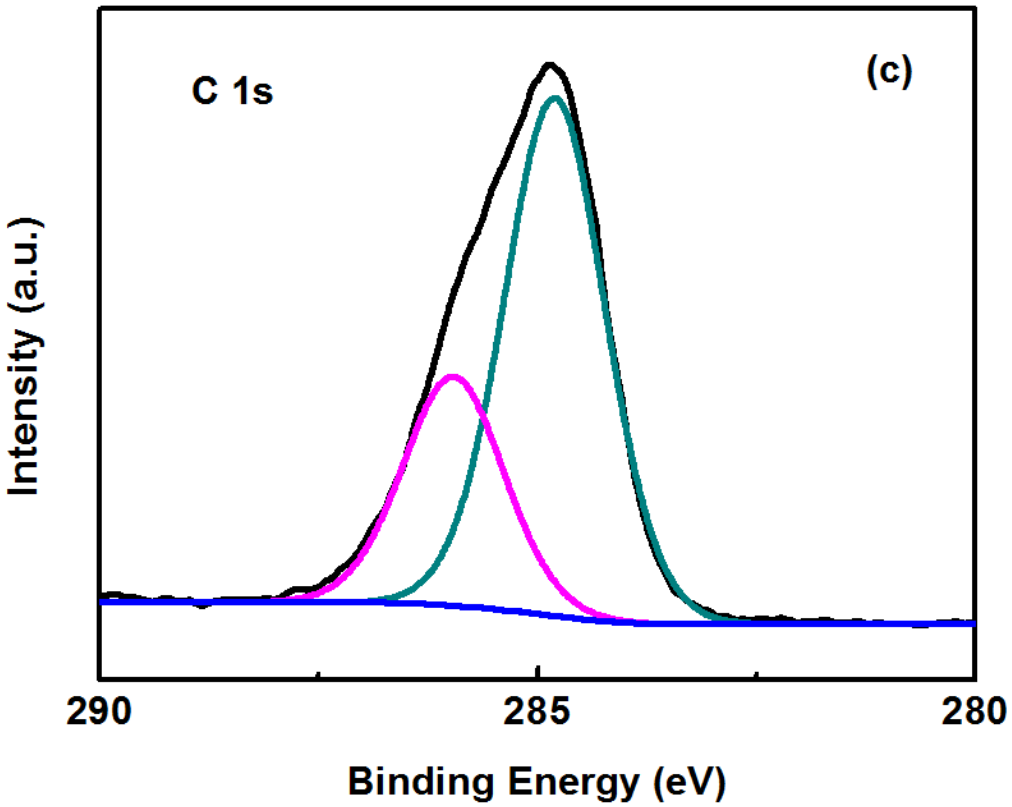


Figure S4. XPS spectrum of **Au/PdNAs-2**, which shows the presence of C 1s.

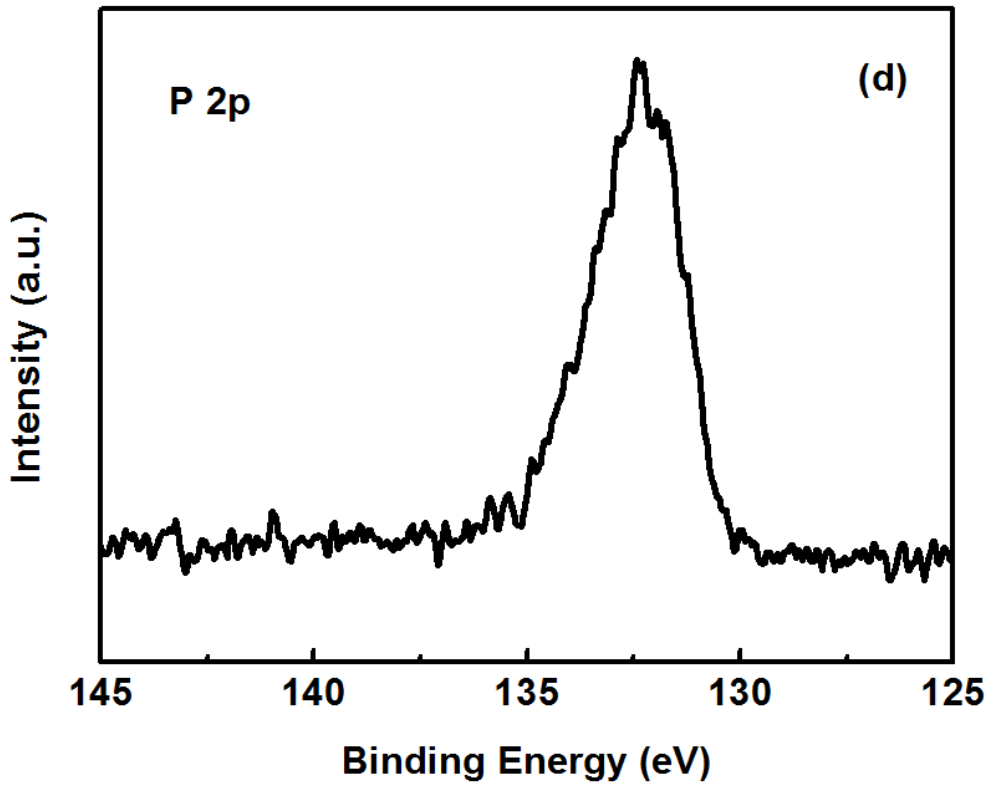


Figure S5. XPS spectrum of **Au/PdNAs-2**, which shows the presence of P 2p.

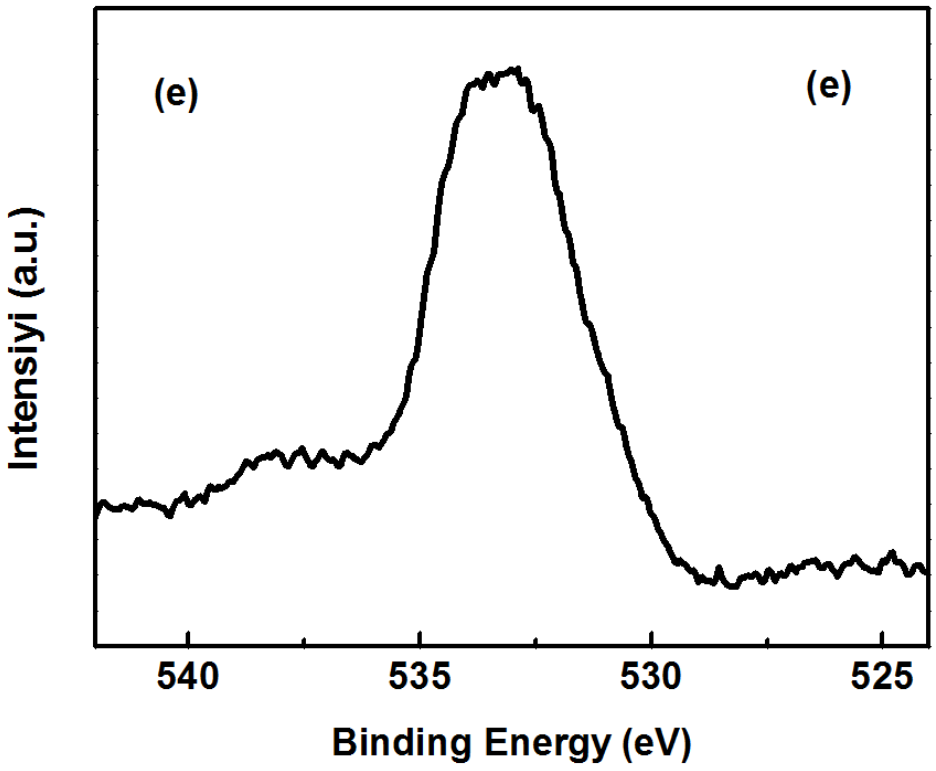


Figure S6. XPS spectrum of **Au/PdNAs-2**, which shows the presence of O1s.

8. EDX Spectra for SPOs-PdNPs, Au/PdNAs-1, Au/PdNAs-2 and Au/PdNAs-3

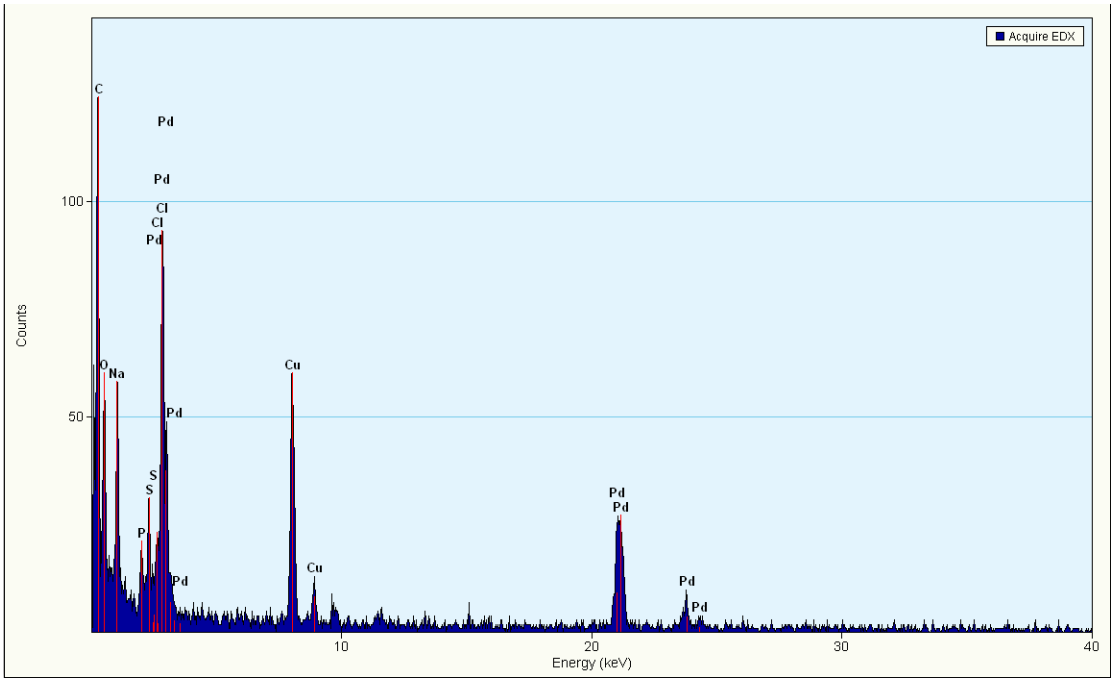


Figure S7. EDX spectrum for **SPOs-PdNPs**

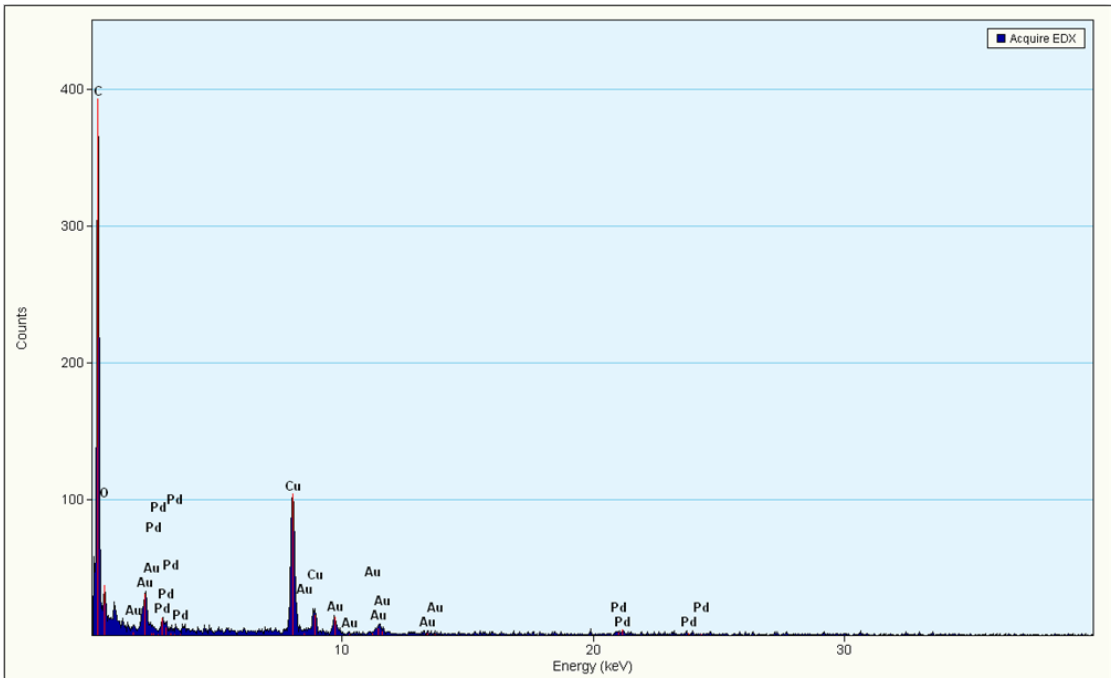


Figure S8. EDX spectrum for **Au/PdNAs-1**

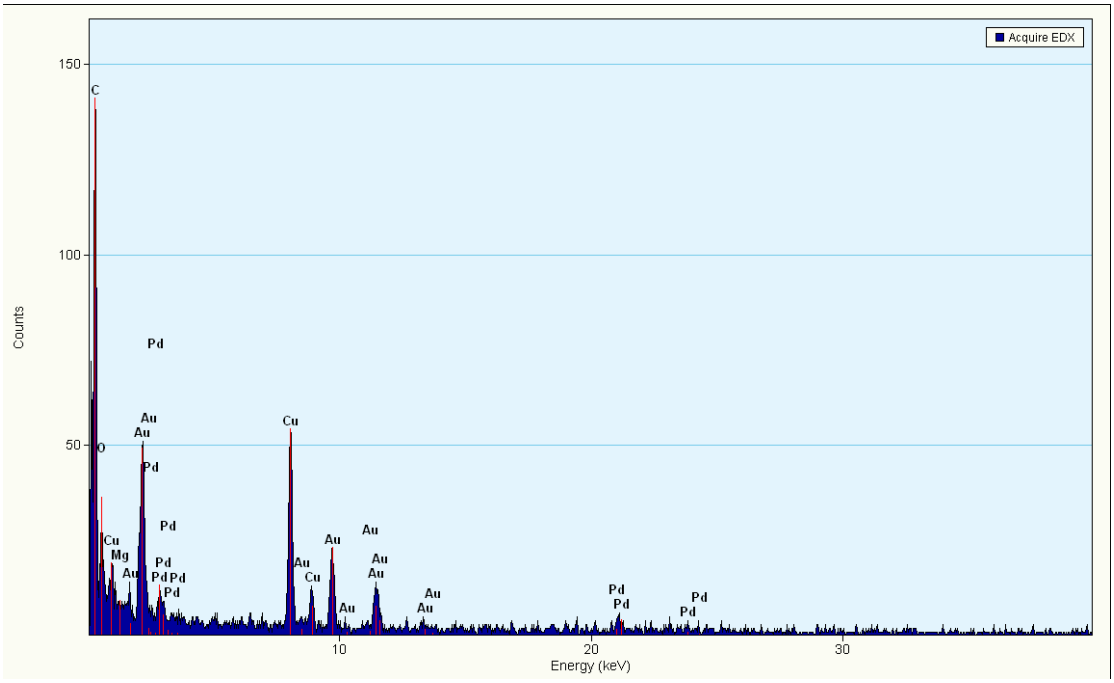


Figure S9. EDX spectrum for **Au/PdNAs-2**

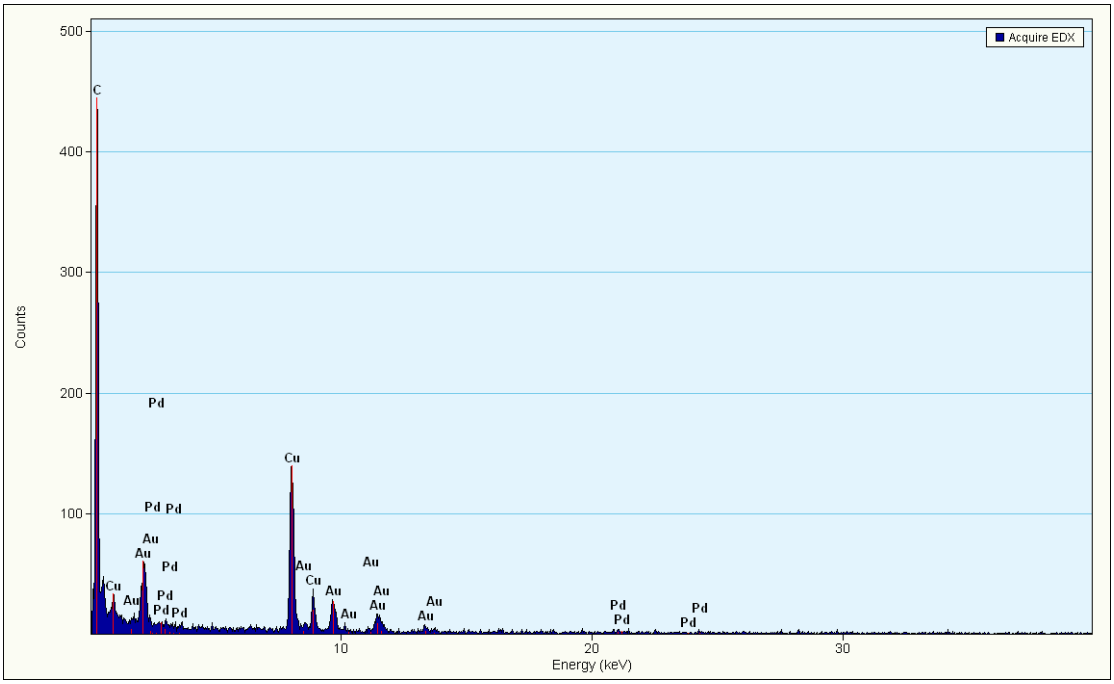


Figure S10. EDX spectrum for **Au/PdNAs-3**

Detecting element	Au/PdNAs-1 （Au/Pd）	Au/PdNAs-2 （Au/Pd）	Au/PdNAs-3 （Au/Pd）
EDX (TEM)	1.6:1	3.0:1	4.4:1

9. TEM Images for All of the Nanocatalysts and STEM-mappings for Nanoalloys

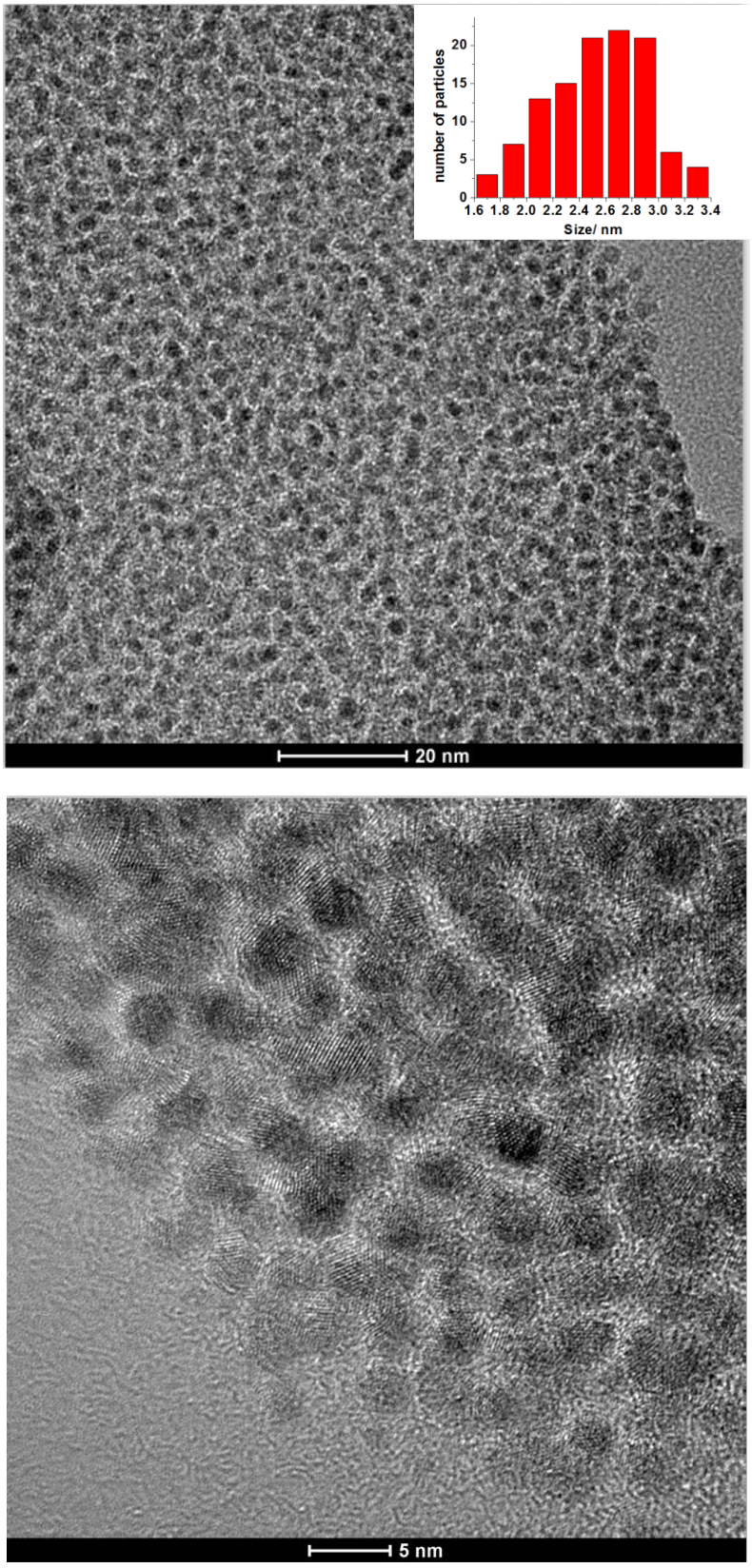
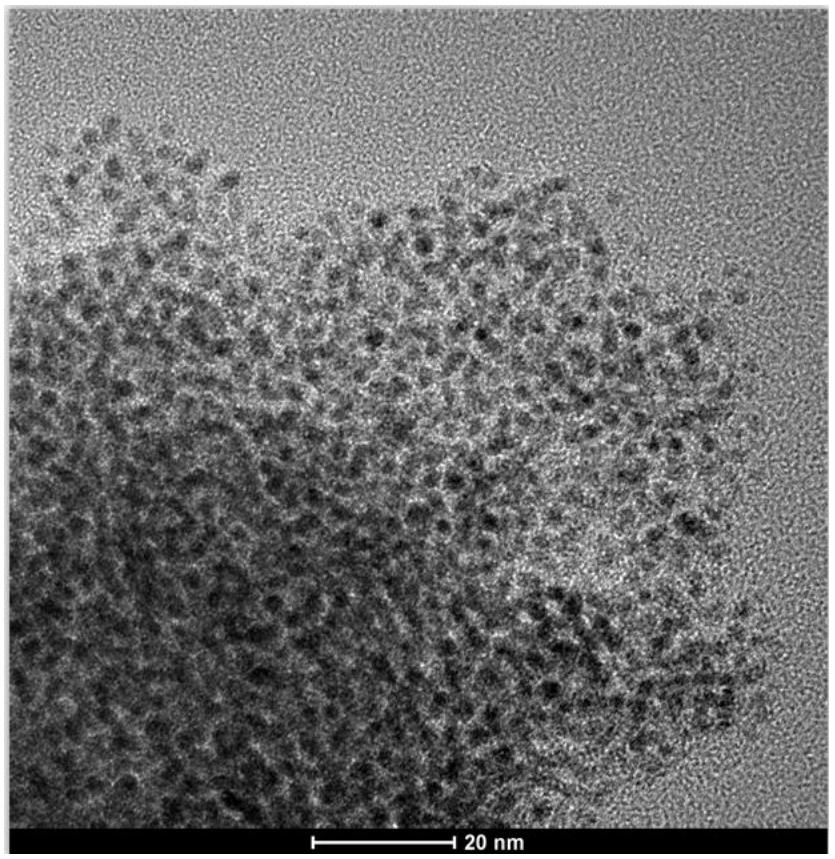


Figure S11. TEM images of **SPOs-PdNPs**



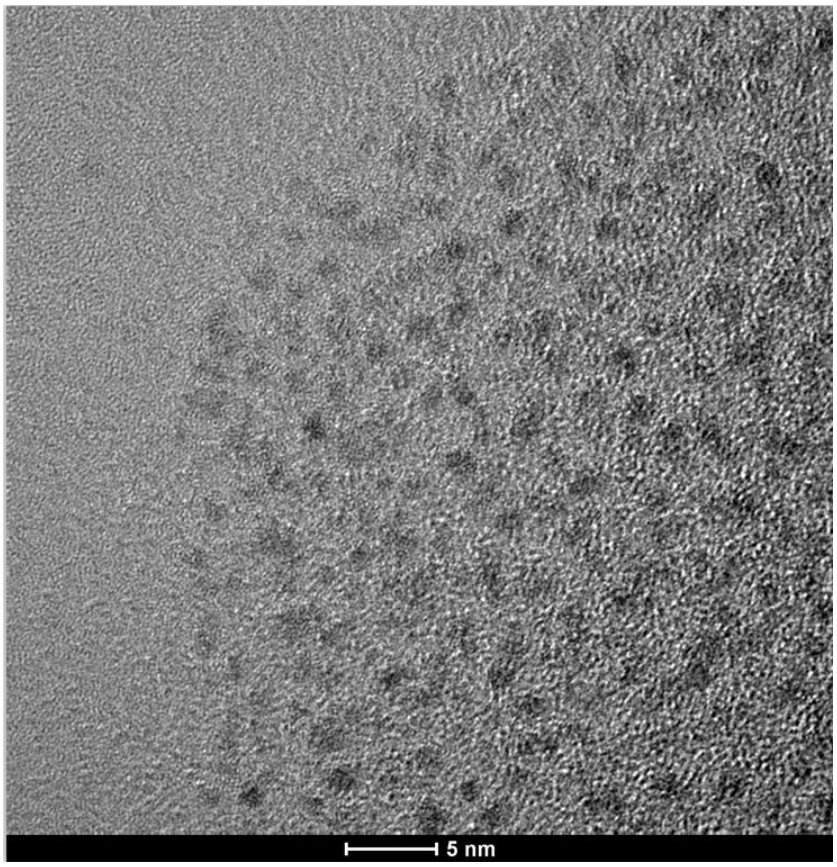
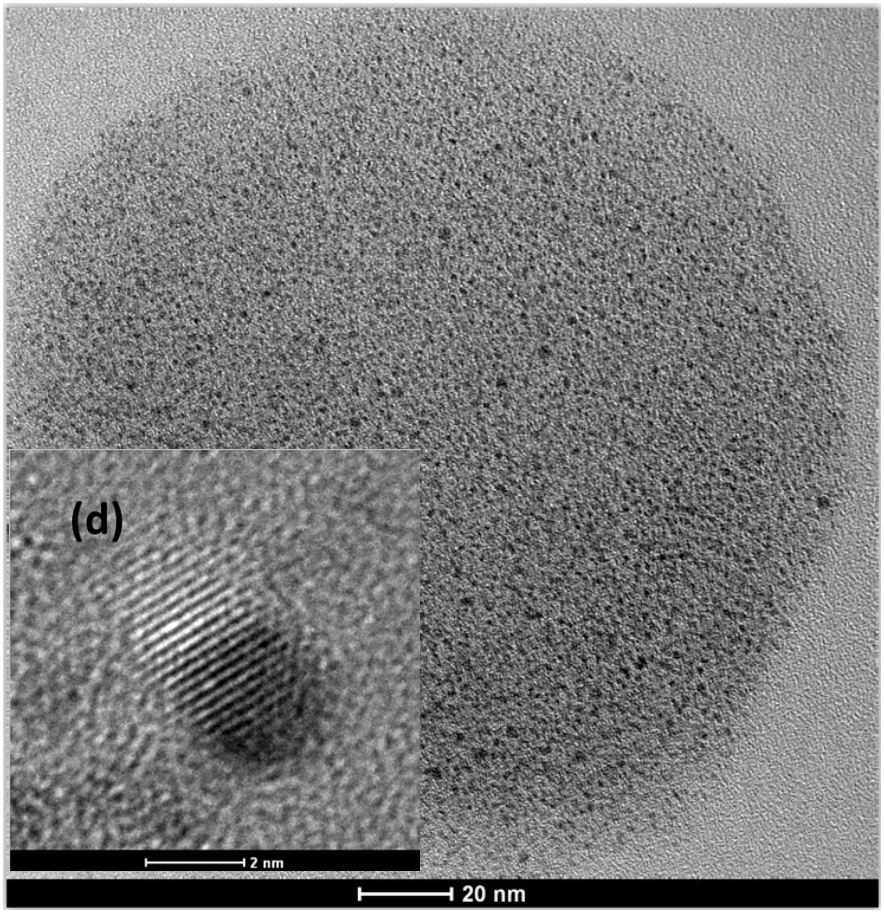


Figure S12. TEM images of **Au/PdNAs-1**



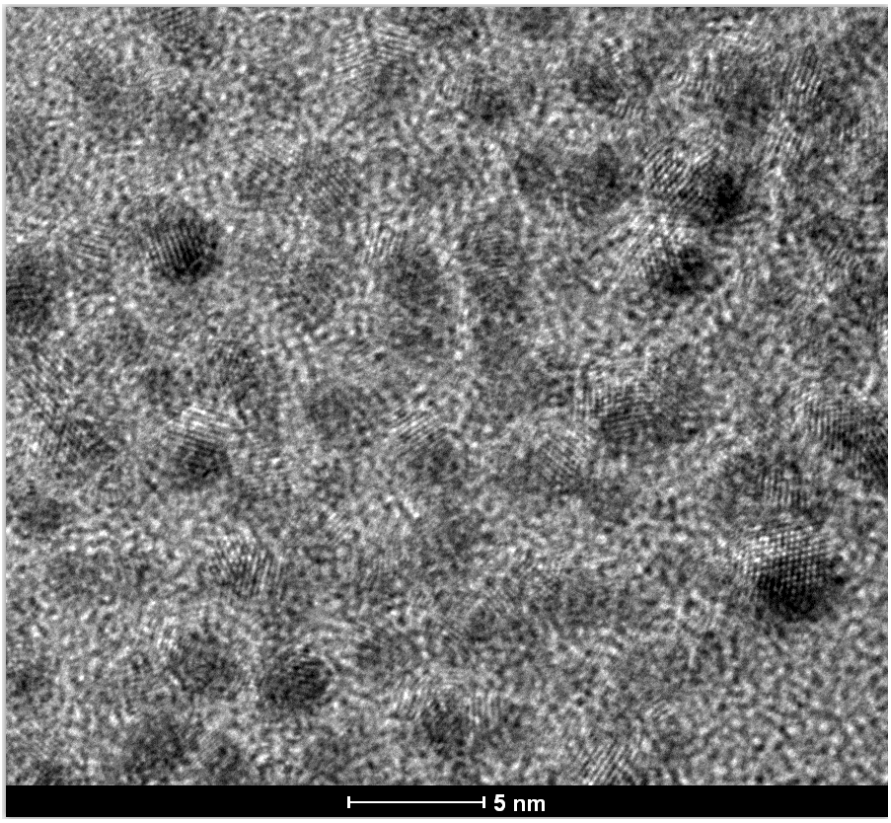


Figure S13. TEM images of **Au/PdNAs-2**

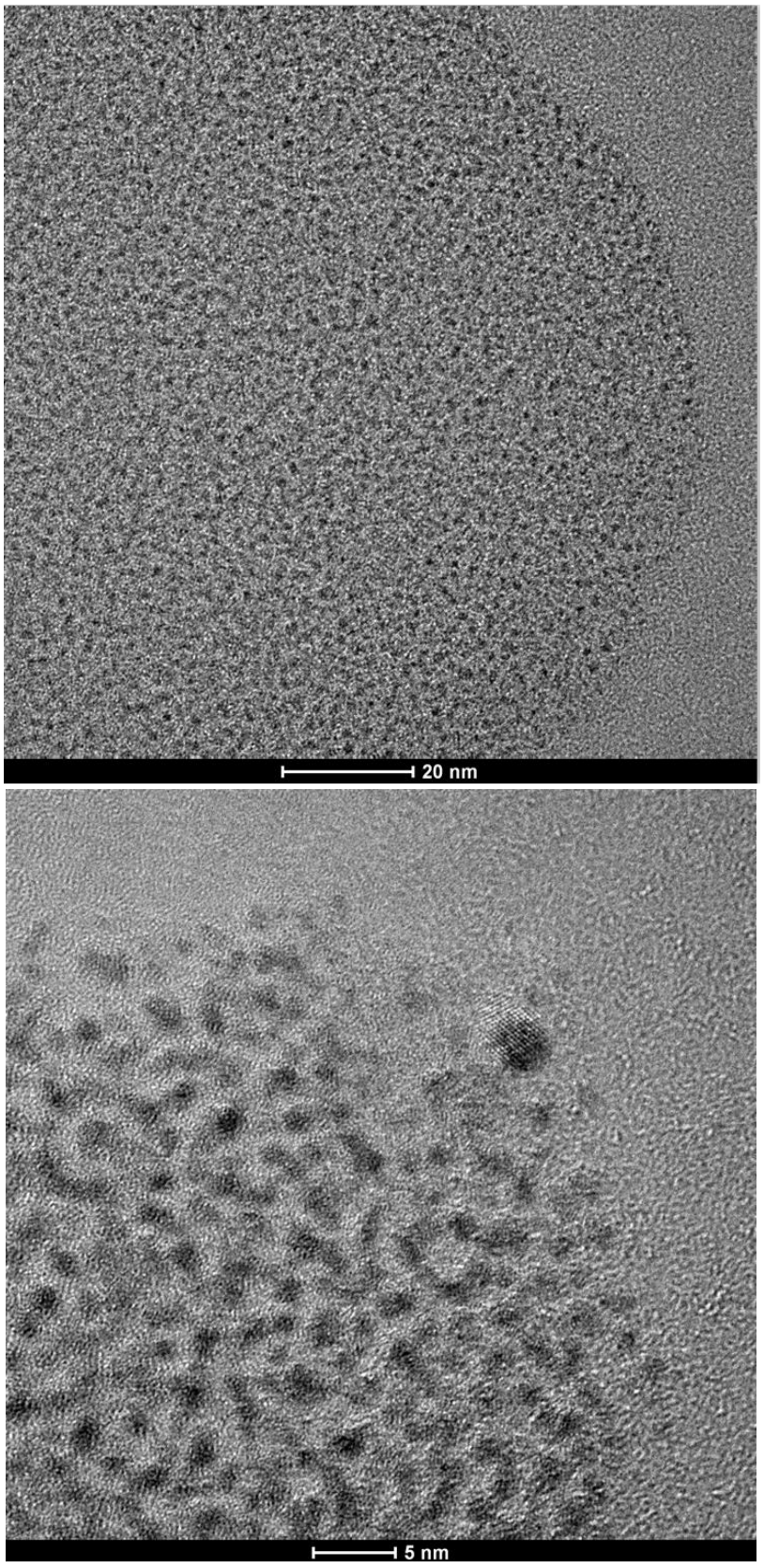


Figure S14. TEM images of **Au/PdNAs-3**

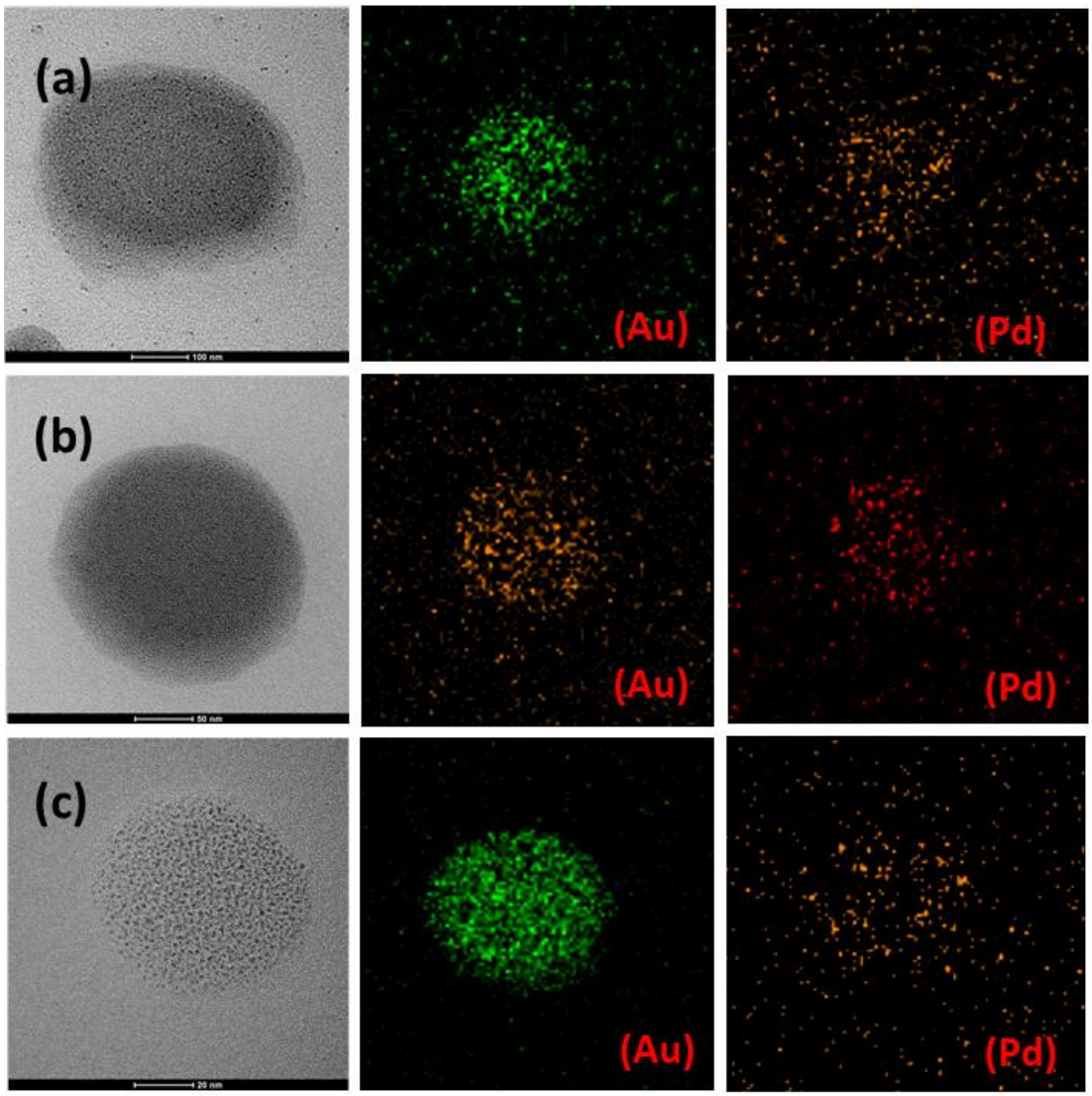


Figure S15. The STEM element-mappings of (a) **Au/Pd NAs-1**, (b) **Au/Pd NAs-2**, (c) **Au/Pd NAs-3**

10. ATR FT-IR Spectra

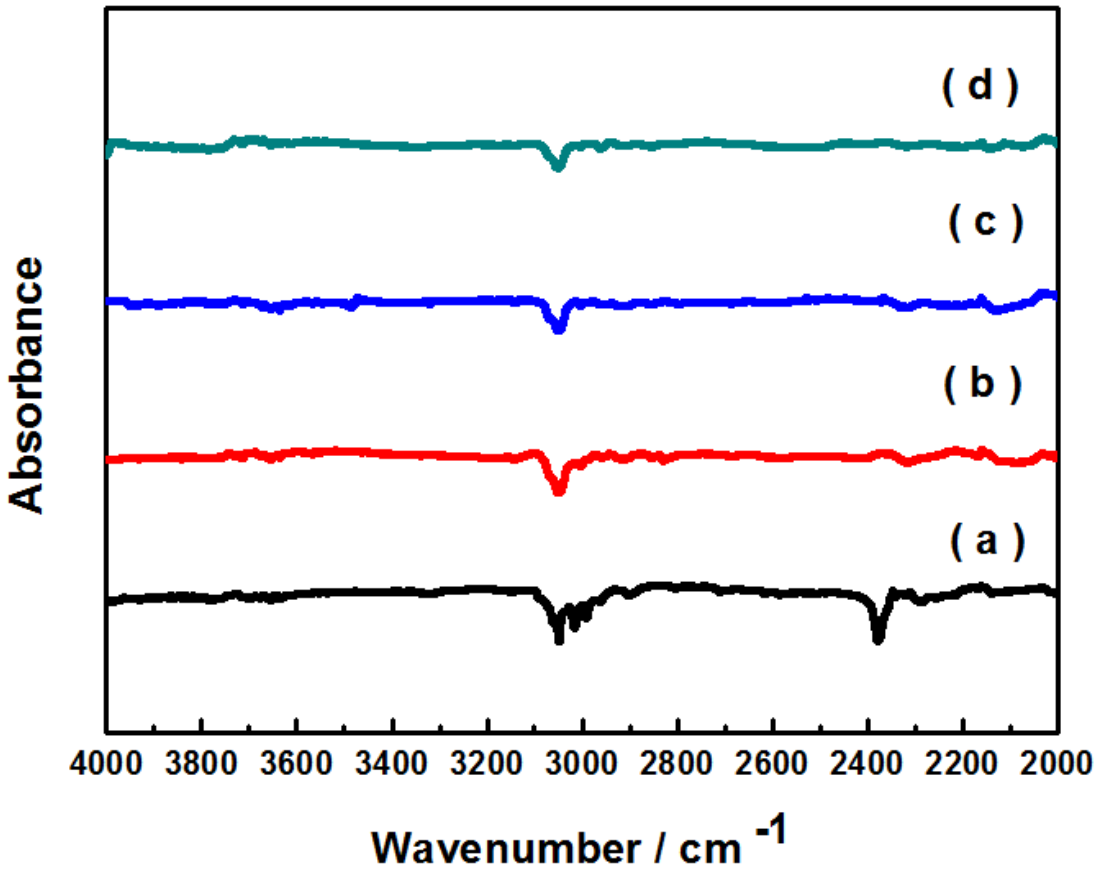


Figure S16. ATR FT-IR spectra: a (Diphenylphosphine Oxides), **b** (**SPOs-PdNPs**), **c** (**SPOs-AuNPs**), **d** (**Au/PdNAs-2**).

11. UV-Vis Spectra

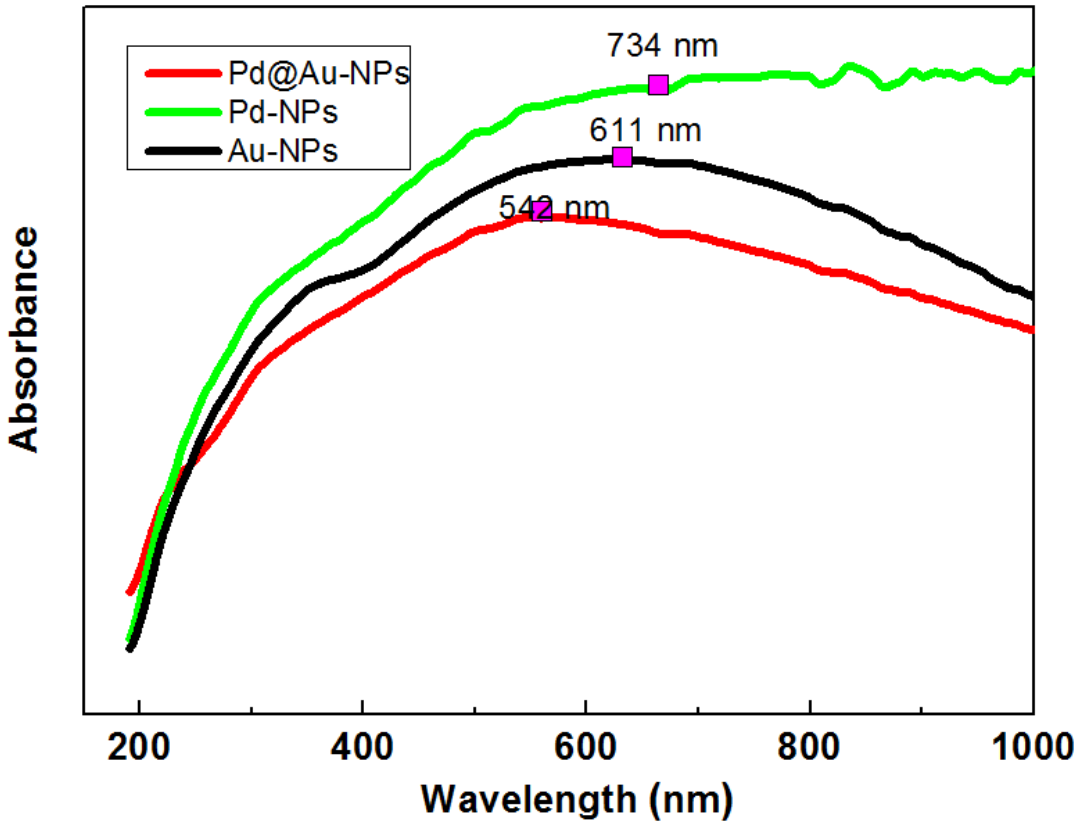


Figure S17. UV spectra of **SPOs-PdNPs**, **SPOs-AuNPs** and **Au/PdNAs-2**.

12. XRD Spectra for SPOs-PdNPs, SPOs-AuNPs and Au/PdNAs-2

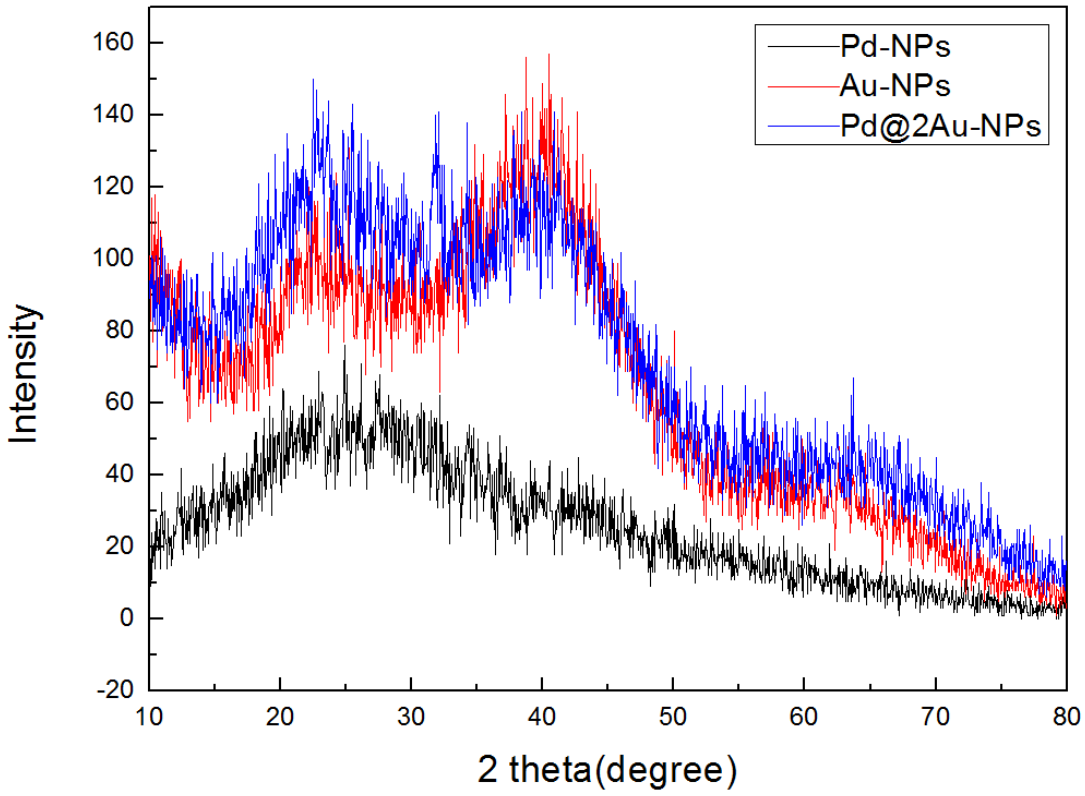
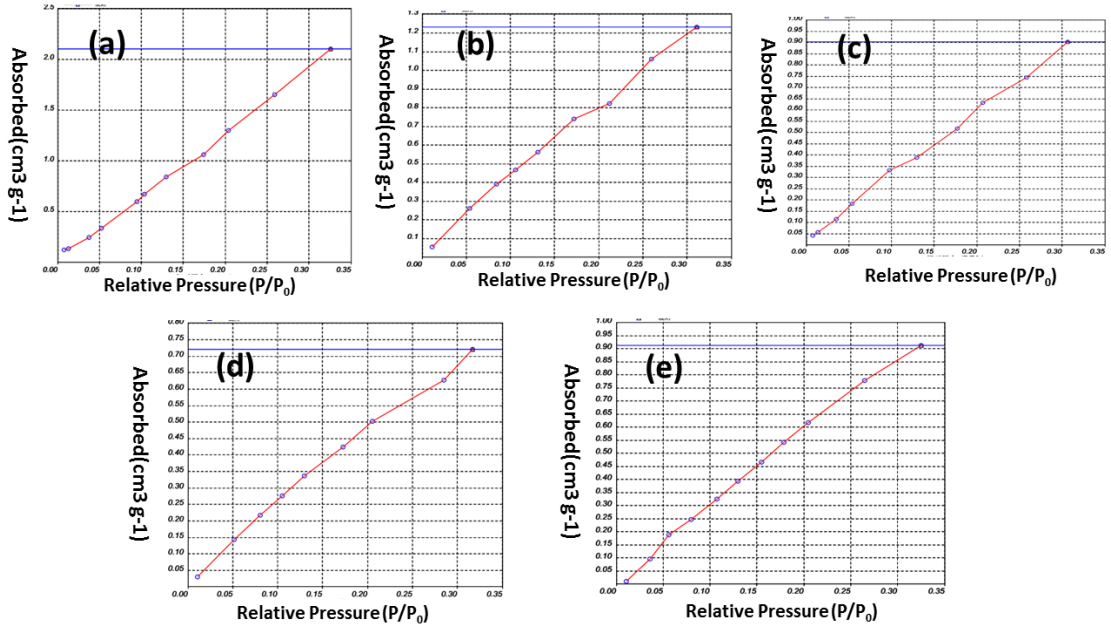


Figure S18. XRD spectra of **SPOs-PdNPs**, **SPOs-AuNPs** and **Au/PdNAs-2**.

13. BET Measurements



samples	temperature (°C)/time (h)	BET (m^2/g)
SPO-PdNPs	50/2	11.3
SPO-AuNPs	50/2	5.2
Au/PdNAs-1	50/2	4.2
Au/PdNAs-2	50/2	3.5
Au/PdNAs-3	50/2	4.8

Figure S19. BET surface area of (a) **SPO-PdNPs**, (b) **SPO-AuNPs**, (c) **Au/PdNAs-1**, (d) **Au/PdNAs-2**, and (e) **Au/PdNAs-3**

14. X-ray Crystal Structure of 2b

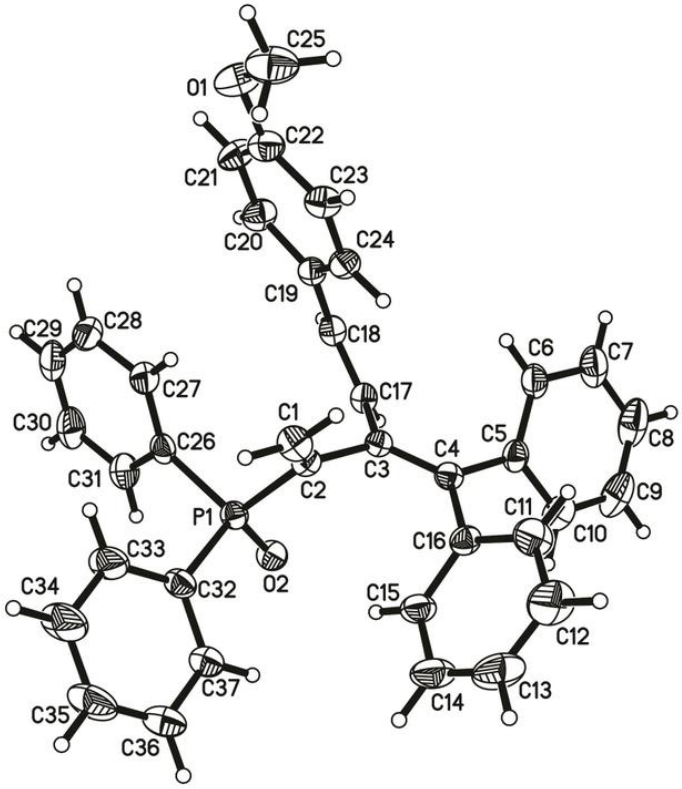


Table 1. Crystal data and structure refinement for $C_{37}\ H_{31}\ O_2\ P$ (**2b**).

Empirical formula	$C_{37}\ H_{31}\ O_2\ P$	
Formula weight	538.59	
Temperature	296(2) K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	P-1	
Unit cell dimensions	a = 10.2210(6) Å	α= 82.845(2)°.
	b = 11.6331(6) Å	β= 74.362(2)°.
	c = 13.5866(7) Å	γ = 72.425(2)°.
Volume	1481.42(14) $Å^3$	
Z	2	
Density (calculated)	1.207 Mg/m^3	
Absorption coefficient	0.124 mm^{-1}	
F(000)	568	
Crystal size	0.200 x 0.160 x 0.120 mm^3	
Theta range for data collection	2.156 to 27.535°.	
Index ranges	-13<=h<=13, -15<=k<=15, -17<=l<=17	

Reflections collected	22063
Independent reflections	6765 [R(int) = 0.0366]
Completeness to theta = 25.242°	98.9 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7456 and 0.6492
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	6765 / 0 / 362
Goodness-of-fit on F^2	1.012
Final R indices [I>2sigma(I)]	R1 = 0.0536, wR2 = 0.1209
R indices (all data)	R1 = 0.0988, wR2 = 0.1402
Extinction coefficient	n/a
Largest diff. peak and hole	0.182 and -0.275 e.$Å^{-3}$

Table 2. Bond lengths [Å] and angles [°] for C_{37} H_{31} O_2 P (**2b**).

C(1)-C(2)	1.321(2)
C(1)-H(1A)	0.9300
C(1)-H(1B)	0.9300
C(2)-C(3)	1.496(2)
C(2)-P(1)	1.8177(19)
C(3)-C(4)	1.341(2)
C(3)-C(17)	1.492(2)
C(4)-C(5)	1.493(3)
C(4)-C(16)	1.496(2)
C(5)-C(10)	1.384(3)
C(5)-C(6)	1.387(3)
C(6)-C(7)	1.383(3)
C(6)-H(6)	0.9300
C(7)-C(8)	1.355(4)
C(7)-H(7)	0.9300
C(8)-C(9)	1.354(4)
C(8)-H(8)	0.9300
C(9)-C(10)	1.392(4)
C(9)-H(9)	0.9300
C(10)-H(10)	0.9300
C(11)-C(16)	1.376(3)
C(11)-C(12)	1.392(3)
C(11)-H(11)	0.9300
C(12)-C(13)	1.365(4)
C(12)-H(12)	0.9300
C(13)-C(14)	1.349(4)
C(13)-H(13)	0.9300
C(14)-C(15)	1.371(3)
C(14)-H(14)	0.9300
C(15)-C(16)	1.379(3)
C(15)-H(15)	0.9300
C(17)-C(18)	1.328(3)
C(17)-H(17)	0.9300
C(18)-C(19)	1.457(3)
C(18)-H(18)	0.9300
C(19)-C(24)	1.389(3)

C(19)-C(20)	1.397(3)
C(20)-C(21)	1.374(3)
C(20)-H(20)	0.9300
C(21)-C(22)	1.380(3)
C(21)-H(21)	0.9300
C(22)-O(1)	1.370(3)
C(22)-C(23)	1.377(3)
C(23)-C(24)	1.378(3)
C(23)-H(23)	0.9300
C(24)-H(24)	0.9300
C(25)-O(1)	1.434(3)
C(25)-H(25A)	0.9600
C(25)-H(25B)	0.9600
C(25)-H(25C)	0.9600
C(26)-C(27)	1.375(3)
C(26)-C(31)	1.392(3)
C(26)-P(1)	1.801(2)
C(27)-C(28)	1.395(3)
C(27)-H(27)	0.9300
C(28)-C(29)	1.365(4)
C(28)-H(28)	0.9300
C(29)-C(30)	1.358(4)
C(29)-H(29)	0.9300
C(30)-C(31)	1.364(3)
C(30)-H(30)	0.9300
C(31)-H(31)	0.9300
C(32)-C(37)	1.376(3)
C(32)-C(33)	1.377(3)
C(32)-P(1)	1.8108(19)
C(33)-C(34)	1.381(3)
C(33)-H(33)	0.9300
C(34)-C(35)	1.360(4)
C(34)-H(34)	0.9300
C(35)-C(36)	1.360(4)
C(35)-H(35)	0.9300
C(36)-C(37)	1.379(3)
C(36)-H(36)	0.9300
C(37)-H(37)	0.9300

O(2)-P(1)	1.4771(13)
C(2)-C(1)-H(1A)	120.0
C(2)-C(1)-H(1B)	120.0
H(1A)-C(1)-H(1B)	120.0
C(1)-C(2)-C(3)	124.41(17)
C(1)-C(2)-P(1)	121.96(15)
C(3)-C(2)-P(1)	113.62(12)
C(4)-C(3)-C(17)	121.60(16)
C(4)-C(3)-C(2)	122.91(15)
C(17)-C(3)-C(2)	114.73(14)
C(3)-C(4)-C(5)	120.99(16)
C(3)-C(4)-C(16)	123.84(17)
C(5)-C(4)-C(16)	115.05(16)
C(10)-C(5)-C(6)	118.0(2)
C(10)-C(5)-C(4)	119.94(19)
C(6)-C(5)-C(4)	122.05(19)
C(7)-C(6)-C(5)	120.5(2)
C(7)-C(6)-H(6)	119.7
C(5)-C(6)-H(6)	119.7
C(8)-C(7)-C(6)	120.6(3)
C(8)-C(7)-H(7)	119.7
C(6)-C(7)-H(7)	119.7
C(9)-C(8)-C(7)	119.9(3)
C(9)-C(8)-H(8)	120.0
C(7)-C(8)-H(8)	120.0
C(8)-C(9)-C(10)	120.7(3)
C(8)-C(9)-H(9)	119.7
C(10)-C(9)-H(9)	119.7
C(5)-C(10)-C(9)	120.2(3)
C(5)-C(10)-H(10)	119.9
C(9)-C(10)-H(10)	119.9
C(16)-C(11)-C(12)	120.5(2)
C(16)-C(11)-H(11)	119.7
C(12)-C(11)-H(11)	119.7
C(13)-C(12)-C(11)	120.0(2)
C(13)-C(12)-H(12)	120.0
C(11)-C(12)-H(12)	120.0
C(14)-C(13)-C(12)	120.0(2)

C(14)-C(13)-H(13)	120.0
C(12)-C(13)-H(13)	120.0
C(13)-C(14)-C(15)	120.2(3)
C(13)-C(14)-H(14)	119.9
C(15)-C(14)-H(14)	119.9
C(14)-C(15)-C(16)	121.7(2)
C(14)-C(15)-H(15)	119.2
C(16)-C(15)-H(15)	119.2
C(11)-C(16)-C(15)	117.54(19)
C(11)-C(16)-C(4)	121.17(19)
C(15)-C(16)-C(4)	121.19(17)
C(18)-C(17)-C(3)	129.36(17)
C(18)-C(17)-H(17)	115.3
C(3)-C(17)-H(17)	115.3
C(17)-C(18)-C(19)	130.02(17)
C(17)-C(18)-H(18)	115.0
C(19)-C(18)-H(18)	115.0
C(24)-C(19)-C(20)	116.36(18)
C(24)-C(19)-C(18)	123.76(17)
C(20)-C(19)-C(18)	119.83(17)
C(21)-C(20)-C(19)	121.4(2)
C(21)-C(20)-H(20)	119.3
C(19)-C(20)-H(20)	119.3
C(20)-C(21)-C(22)	121.0(2)
C(20)-C(21)-H(21)	119.5
C(22)-C(21)-H(21)	119.5
O(1)-C(22)-C(23)	124.8(2)
O(1)-C(22)-C(21)	116.4(2)
C(23)-C(22)-C(21)	118.8(2)
C(22)-C(23)-C(24)	120.0(2)
C(22)-C(23)-H(23)	120.0
C(24)-C(23)-H(23)	120.0
C(23)-C(24)-C(19)	122.44(19)
C(23)-C(24)-H(24)	118.8
C(19)-C(24)-H(24)	118.8
O(1)-C(25)-H(25A)	109.5
O(1)-C(25)-H(25B)	109.5
H(25A)-C(25)-H(25B)	109.5

O(1)-C(25)-H(25C)	109.5
H(25A)-C(25)-H(25C)	109.5
H(25B)-C(25)-H(25C)	109.5
C(27)-C(26)-C(31)	118.52(19)
C(27)-C(26)-P(1)	125.07(16)
C(31)-C(26)-P(1)	116.40(16)
C(26)-C(27)-C(28)	119.7(2)
C(26)-C(27)-H(27)	120.2
C(28)-C(27)-H(27)	120.2
C(29)-C(28)-C(27)	120.4(2)
C(29)-C(28)-H(28)	119.8
C(27)-C(28)-H(28)	119.8
C(28)-C(29)-C(30)	120.1(2)
C(28)-C(29)-H(29)	119.9
C(30)-C(29)-H(29)	119.9
C(31)-C(30)-C(29)	120.3(2)
C(31)-C(30)-H(30)	119.9
C(29)-C(30)-H(30)	119.9
C(30)-C(31)-C(26)	121.0(2)
C(30)-C(31)-H(31)	119.5
C(26)-C(31)-H(31)	119.5
C(37)-C(32)-C(33)	118.99(19)
C(37)-C(32)-P(1)	118.03(15)
C(33)-C(32)-P(1)	122.88(17)
C(34)-C(33)-C(32)	120.1(2)
C(34)-C(33)-H(33)	120.0
C(32)-C(33)-H(33)	120.0
C(35)-C(34)-C(33)	120.1(3)
C(35)-C(34)-H(34)	119.9
C(33)-C(34)-H(34)	119.9
C(34)-C(35)-C(36)	120.5(2)
C(34)-C(35)-H(35)	119.8
C(36)-C(35)-H(35)	119.8
C(35)-C(36)-C(37)	119.9(2)
C(35)-C(36)-H(36)	120.1
C(37)-C(36)-H(36)	120.1
C(32)-C(37)-C(36)	120.5(2)
C(32)-C(37)-H(37)	119.8

C(36)-C(37)-H(37)	119.8
C(22)-O(1)-C(25)	116.9(2)
O(2)-P(1)-C(26)	112.50(9)
O(2)-P(1)-C(32)	111.66(8)
C(26)-P(1)-C(32)	104.66(9)
O(2)-P(1)-C(2)	110.98(8)
C(26)-P(1)-C(2)	108.99(9)
C(32)-P(1)-C(2)	107.76(9)

Symmetry transformations used to generate equivalent atoms:

Table 3. Hydrogen bonds for C_{37} H_{31} O_2 P (**2b**).

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
C(37)-H(37)...O(2)#1	0.93	2.45	3.223(3)	140.0

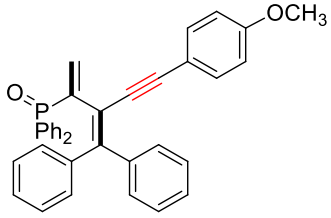
Symmetry transformations used to generate equivalent atoms: #1 -x,-y+1,-z+1

15. Characterizations of Substrates and Catalytic Products

15.1 Substrates

These substrates (**1b-1m**) are new compounds, for known compounds, see our previous work: *Adv. Synth. Catal.*, **2018**, *360*, 3518.

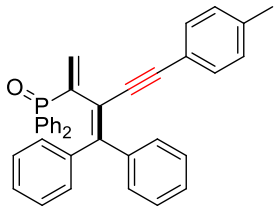
(3-(diphenylmethylene)-5-(4-methoxyphenyl)pent-1-en-4-yn-2yl)diphenyl-phosphine oxide (1b)



1b

A white solid (472 mg, 88 % yield), *m.p.*: 193.2 – 194.7 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 – 7.73 (m, 4H), 7.58 – 7.38 (m, 8H), 7.37 – 7.15 (m, 6H), 7.12 – 7.03 (m, 2H), 6.77 – 6.51 (m, 4H), 6.24 – 5.88 (m, 2H), 3.77 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.5, 151.3 (d, J = 7.1 Hz), 142.9, 141.9, 141.7, 140.7, 136.0 (d, J = 7.7 Hz), 132.7, 132.3, 132.2, 131.9, 131.8, 131.6, 130.4, 130.2, 128.4, 128.3, 127.9, 127.5, 127.4, 118.1, 118.0, 115.2, 113.5, 96.2, 88.7, 55.3. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.94 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{37}H_{30}O_2P^+$: 537.1978, Found: 537.1975. **IR** (film) ν 3064, 3010, 2921, 2839, 2192, 1912, 1604, 1508, 1464, 1435, 1249, 1209, 1190, 1158, 1022, 832, 693, 562 cm^{-1}.

(3-(diphenylmethylene)-5-(p-tolyl)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1c)

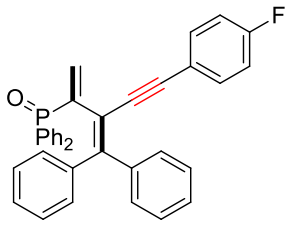


1c

A white solid (447 mg, 86% yield), m.p.: 181.6 – 183.4 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 – 7.73 (m, 4H), 7.60 – 7.40 (m, 8H), 7.37 – 7.15 (m, 6H), 7.17 – 7.02 (m, 2H), 6.96 (d, J = 8.0 Hz, 2H), 6.60 (d, J = 7.9 Hz, 2H), 6.07 (t, J = 28.5 Hz, 2H), 2.30 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 151.8 (d, J = 7.0 Hz), 142.9, 142.0, 141.6, 140.6, 138.2, 136.0 (d, J = 7.7 Hz), 132.6, 132.2, 132.1,

131.9, 131.8, 131.6, 131.1, 130.3, 130.2, 128.7, 128.4, 128.3, 127. 7 (d, J = 51.5 Hz), 127.8, 127.5, 118.0, 117.9, 96.2, 89.3, 21.5. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.77 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for$C_{37}H_{30}OP^+$: 521.2029, Found: 521.2026. **IR** (film) ν 3317, 3055, 2219, 1911, 1597, 1509, 1436, 1180, 705, 557 cm^{-1}.

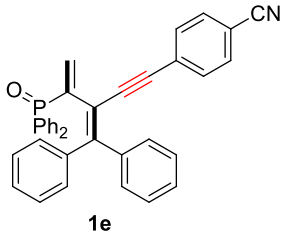
(3-(diphenylmethylene)-5-(4-fluorophenyl)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1d)



1d

A white solid (456 mg, 87% yield), m.p.: 173.8 – 175.0 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 – 7.70 (m, 4H), 7.60 – 7.50 (m, 2H), 7.47 – 7.35 (m, 6H), 7.35 – 7.28 (m, 3H), 7.28 – 7.20 (m, 3H), 7.20 – 7.09 (m, 2H), 6.83 (t, J = 8.7 Hz, 2H), 6.67 – 6.55 (m, 2H), 6.06 (d, J =40, 1H), 5.93 (d, J = 18.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 162.3 (d, J = 250.5 Hz), 152.5, 142.9, 141.9, 141.5, 140.6, 136.0 (d, J = 8.5 Hz), 133.0 (d, J = 8.1 Hz), 132.2, 132.1, 132.0 (d, J = 104.0 Hz), 131.9 (d, J = 12.1 Hz), 131.6, 130.3, 130.2, 128.4, 128.3, 128.1, 127.9, 127.6, 119.1 (d, J = 3.4 Hz), 117.8 (d, J = 8.8 Hz), 115.3, 115.0, 94.8, 89.5. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.81 (s). **HRMS (ESI)**: ($[M+H]^{+)}$ Calcd for $C_{36}H_{27}FOP^+$: 525.1778, Found: 525.1767. **IR** (film) ν 3052, 1896, 1597, 1503, 1435, 1209, 1115, 829, 711, 617 cm^{-1}.

4-(3-(diphenylmethylene)-4-(diphenylphosphoryl)pent-4-en-1-yn-1-yl)benzonitrie(1e)

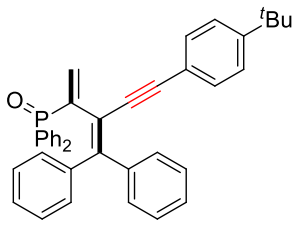


1e

A white solid (419 mg, 79% yield), m.p.: 191.0 – 193.0 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.91 – 7.69 (m, 4H), 7.54 (t, J = 7.3 Hz, 2H), 7.50 – 7.35 (m, 8H), 7.35 – 7.13 (m, 8H), 6.65 (d, J = 8.3 Hz, 2H), 6.03 (d, J = 38.8 Hz, 1H), 5.82 (d, J = 18.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 154.68 (d, J = 6.8 Hz), 142.6, 141.7, 141.3, 140.3, 136.19 (d, J = 8.8 Hz), 132.5, 132.1, 132.0, 131.9 (d, J = 2.0

Hz), 131.6, 131.5, 131.4, 130.3, 130.2, 128.5, 128.4, 128.3, 128.0, 127.9, 127.8, 127.7, 118.6, 117.3 (d, J = 8.6 Hz), 111.0, 94.1, 93.8. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.98 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{37}H_{27}NOP^+$: 532.1825, Found: 532.1823. **IR** (film) ν 3055, 2225, 2187, 1679, 1603, 1445, 1435, 1208, 1177, 946, 725, 635 cm^{-1}.

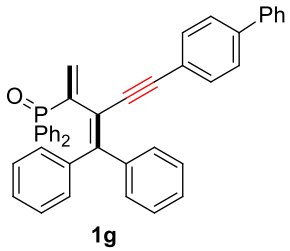
(5-(4-(tert-butyl)phenyl)-3-(diphenylmethylene)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1f)



1f

A white solid (461 mg, 82% yield), m.p.: 168.2 – 170.0 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.96 – 7.75 (m, 4H), 7.60 – 7.40 (m, 8H), 7.38 – 7.15 (m, 8H), 7.14 – 7.00 (m, 2H), 6.68 (d, J = 8.4 Hz, 2H), 6.10 (dd, J = 28.0, 20.6 Hz, 2H), 1.29 (s, 9H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 151.9 (d, J = 7.0 Hz), 151.4, 142.9, 142.0, 141.6, 140.6, 136.1 (d, J = 7.9 Hz), 132.6, 132.3, 132.1, 131.9, 131.8, 131.6, 131.0, 130.4, 130.2, 128.4, 128.3, 127.9, 127.7 (d, J = 50.5 Hz), 127.6, 124.9, 120.1, 118.0 (d, J = 9.0 Hz), 96.3, 89.4, 34.8, 31.2. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.74 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{40}H_{36}OP^+$: 563.2498, Found: 563.2498. **IR** (film) ν 3055, 2958, 2899, 2194, 1887, 1461, 1436, 1213, 1190, 1148, 946, 713, 693, 573 cm^{-1}.

(5-([1,1'-biphenyl]-4-yl)-3-(diphenylmethylene)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1g)

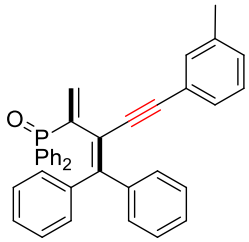


1g

A white solid (512 mg, 88% yield), m.p.: 172.4 – 174.2 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.99 – 7.80 (m, 4H), 7.65 – 7.54 (m, 4H), 7.53 – 7.40 (m, 10H), 7.39 – 7.31(m, 4H), 7.31 – 7.22 (m, 3H), 7.20 – 7.10 (m 2H), 6.79 (d, J = 8.3 Hz, 2H), 6.13 (d, J = 38.2 Hz, 1H), 6.04 (d, J = 18.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 152.45 (d, J = 6.9 Hz), 142.9, 142.0, 141.6, 140.8, 140.6, 140.3, 136.1 (d, J = 8.4 Hz), 132.7, 132.3, 132.2, 132.0, 131.9, 131.6, 130.4, 130.3, 128.9, 128.5, 128.4,

128.1, 128.0, 127.7, 127.6, 127.5, 127.0, 126.6, 122.0, 117.92 (d, J = 8.8 Hz), 96.0, 90.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.87 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{42}H_{32}OP^+$: 583.2185, Found: 583.2183. **IR** (film) ν 3052, 2222, 1902, 1597, 1484, 1437, 1210, 1178, 1117, 968, 840, 715, 617, 556 cm^{-1}.

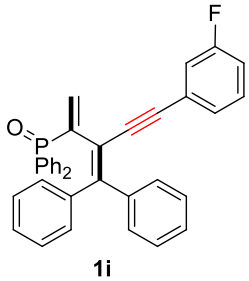
(3-(diphenylmethylene)-5-(m-tolyl)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1h)



1h

A white solid (452 mg, 87% yield), m.p.: 184.8 – 186.5 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.91 – 7.67 (m, 6H), 7.61 – 7.37 (m, 8H), 7.37 – 7.11 (m, 8H), 6.67 (d, J = 8.3 Hz, 2H), 5.98 (dd, J = 59.8, 28.3 Hz, 2H), 3.88 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 166.5, 153.8 (d, J = 6.9 Hz), 142.7, 141.8, 141.3, 140.4, 136.1 (d, J = 8.0 Hz), 132.5, 132.2, 132.1, 131.9 (d, J = 2.0 Hz), 131.5, 131.0, 130.3, 130.2 129.1, 129.0, 128.5, 128.4, 128.3, 127.9, 127.7 (d, J = 8.1 Hz), 127.6, 117.51 (d, J = 8.7 Hz), 94.9, 92.8, 52.2. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.93 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{37}H_{30}OP^+$: 521.2029, Found: 521.2027. **IR** (film) ν 3639, 3422, 3053, 2953, 1909, 1718, 1604, 1436, 1309, 1188, 1113, 791, 961, 643 cm^{-1}.

(3-(diphenylmethylene)-5-(3-fluorophenyl)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1i)

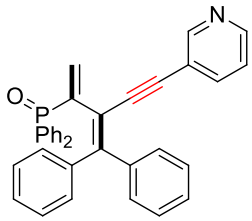


1i

A white solid (393 mg, 75 % yield), m.p.: 116.1 – 118.2 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 – 7.71 (m, 4H), 7.60 – 7.50 (m, 2H), 7.50 – 7.37 (m, 6H), 7.35 – 7.20 (m, 6H), 7.23– 7.12 (m, 2H), 7.11 – 7.01 (m, 1H), 6.95 – 6.80 (m, 1H), 6.48 (d, J = 7.7 Hz, 1H), 6.27 (d, J = 8.0 Hz, 1H), 5.99 (dd, J = 54.0, 28.4 Hz, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.2, 160.8, 153.3 (d, J = 7.0 Hz), 142.3 (d, J = 94.9 Hz), 141.4, 140.5, 136.1 (d, J = 8.2 Hz), 132.5, 132.2, 132.1, 132.0 (d, J = 6.1

Hz), 131.5, 130.3, 130.2, 129.4 (d, J = 8.7 Hz), 128.5, 128.4, 128.0 (d, J = 56.6 Hz), 127.9, 127.6, , 127.0 (d, J = 6.1 Hz), 124.8 (d, J = 9.7 Hz), 117.8 (d, J = 23.2 Hz), 117.5 (d, J = 9.1 Hz), 115.3 (d, J = 21 Hz), 94.5, 90.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.87 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{36}H_{27}FOP^+$: 525.1778, Found: 525.1774. **IR** (film) ν 3054, 2198, 1605, 1574, 1484, 1435, 1310, 1214, 1188, 1116, 998, 874, 755, 711, 680, 617 cm^{-1}.

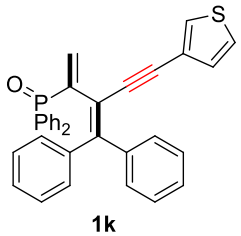
(3-(diphenylmethylene)-5-(pyridin-3-yl)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1j)



1j

A white solid (426 mg, 84% yield), m.p.: 186.4 – 187.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.43 – 8.29 (d, J = 4.0 Hz, 1H), 7.95 – 7.71 (m, 5H), 7.59 – 7.37 (m, 8H), 7.35 – 7.14 (m, 8H), 7.10 – 6.95 (m, 1H), 6.96 – 6.81 (m, 1H), 6.02 (d, J = 38.6 Hz, 1H), 5.86 (d, J = 18.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 153.8 (d, J = 6.9 Hz), 151.7, 148.2, 142.7, 141.8, 141.3, 140.4, 137.9, 136.1 (d, J = 8.6 Hz), 131.9 (d, J = 104 Hz), 132.2, 132.1,132.0 (d, J = 4.4 Hz), 131.4, 130.3, 130.1, 128.5, 128.4, 128.3, 128.0 , 127.7, 127.6, 122.6, 120.1, 117.41 (d, J = 8.7 Hz), 92.9, 92.3. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.83 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{35}H_{27}NOP^+$: 508.1825, Found: 508.1822. **IR** (film) ν 3053, 2922, 2219, 1588, 1475, 1436, 1403, 1209, 1180, 1116, 1022, 996.44, 900, 725, 694, 655, 630 cm^{-1}.

(3-(diphenylmethylene)-5-(thiophen-3-yl)pent-1-en-4-yn-2-yl)diphenylphosphine oxide (1k)

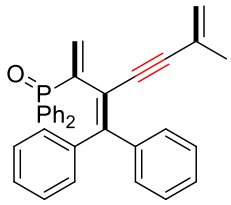


1k

A white solid (425 mg, 83% yield), m.p.: 190.6 – 192.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.98 – 7.70 (m, 4H), 7.65 – 7.37 (m, 8H), 7.35 – 7.15 (m, 5H), 7.16 – 7.00 (m, 3H), 6.81 – 6.33 (m, 2H), 6.02 (t, J = 29.2 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 152.02 (d, J = 7.0 Hz), 142.8, 141.9, 141.5,

140.6, 136.0 (d, J = 8.1 Hz), 132.6, 132.2, 132.1, 131.9, 131.8, 131.3, 130.1, 129.4, 128.5, 128.4, 128.3, 128.0, 127.9, 127.6, 127.5, 124.8, 122.0, 117.8 (d, J = 8.9 Hz), 91.4, 89.28 (d, J = 2.3 Hz). **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.76 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{34}H_{26}OPS^+$: 513.1436, Found: 513.1437. **IR** (film) ν 3055, 2195, 1824, 1589, 1489, 1435, 1386, 1213, 1188, 1148, 958, 906, 726, 692, 620 cm^{-1}.

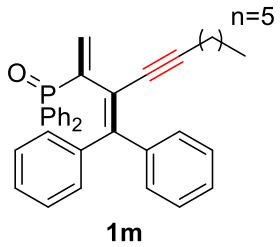
(3-(diphenylmethylene)-6-methylhepta-1,6-dien-4-yn-2-yl)diphenylphosphine oxide (1l)



1l

A white solid (348 mg, 74 % yield), m.p.: 113.2 – 114.7 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 – 7.69 (m, 4H), 7.58 – 7.50 (m, 2H), 7.49 – 7.40 (m, 4H), 7.40– 7.30 (m, 2H), 7.28 – 7.18 (m, 6H), 7.14 – 6.98 (m, 2H), 6.04 (d, J = 38.2, 1H), 5.93 (d, J = 18.3 , 1H), 5.04 – 4.87 (m, 1H), 4.56 (d, J = 0.9 Hz, 1H), 1.44 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 152.30 (d, J = 6.9 Hz), 142.9, 141.9, 141.5, 140.6, 135.9 (d, J = 7.9 Hz), 132.6, 132.2, 132.1, 131.9, 131.8, 131.5, 130.3, 130.0, 128.3, 128.2, , 127.8, 127.6 (d, J = 45.5 Hz), 127.5, 126.6, 121.8, 117.8, 97.0, 88.8, 22.4. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.93 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for $C_{33}H_{28}OP^+$: 471.1872, Found: 471.1869. **IR** (film) ν 3054, 2919, 2847, 2223, 1810, 1600, 1490, 1436, 1182, 1116, 1097, 898, 791, 773, 691, 618, 574 cm^{-1}.

(3-(diphenylmethylene)undec-1-en-4-yn-2-yl)diphenylphosphine oxide (1m)



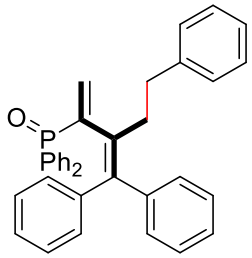
1m

A white solid (432 mg, 84 % yield), m.p.: 99.9 – 101.7 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77 (dd, J = 11.9, 7.2 Hz, 4H), 7.53 – 7.45 (m, 2H), 7.44 – 7.40 (m, 4H), 7.37 – 7.32 (m, 2H), 7.20 (d, J = 7.4 Hz, 3H), 7.17 – 7.12 (m, 3H), 7.02 – 6.96 (m, 2H), 5.95 (d, J = 26.0 Hz, 1H), 5.88 (d, J = 5.5 Hz, 1H), 1.70 – 1.65 (m, 2H), 1.29 – 1.18 (m, 2H), 1.12 (d, J = 19.3 Hz, 6H), 0.87 (t, J = 7.2 Hz,

3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 150.3 (d, J = 7.1 Hz), 143.5, 142.6, 141.6, 140.8, 135.2 (d, J = 8.0 Hz), 132.7, 132.2, 132.1, 131.7, 130.2, 129.9, 128.2, 128.1, 127.8, 127.6, 127.4, 127.1, 118.39 (d, J = 8.8 Hz), 98.6, 80.6, 31.3, 28.4, 27.8, 22.5, 19.3, 14.2. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.62 (s). **HRMS (ESI)**: ($[M+H]^+$) Calcd for: $C_{36}H_{36}OP^+$: 515.2498, Found: 515.2501. **IR** (film) ν3053, 2928, 2855, 2199, 1590, 1439, 1189, 1100, 948, 727, 691 cm^{-1}.

15.2 Catalytic Products

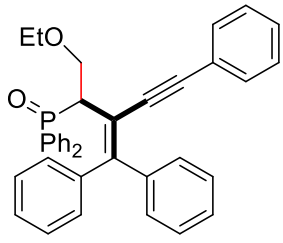
(3-(diphenylmethylene)-5-phenylpent-1-en-2-yl)diphenylphosphine oxide (2a')



2a'

A white solid (81.6 mg, 80% yield), *m.p.*: 93.4 – 95.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 – 7.65 (m, 4H), 7.60– 7.52 (m, 2H), 7.50 – 7.44 (m, 4H), 7.30 – 7.20 (m, 8H), 7.17 – 7.05 (m, 5H), 6.61 (dd, J = 7.3, 1.8 Hz, 2H), 5.87 (dd, J = 41.9, 1.1 Hz, 1H), 5.66 (dd, J = 19.5, 1.1 Hz, 1H), 2.65 – 2.50 (m, 2H), 2.45 – 2.32 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.4, 144.6, 143.4, 142.5, 142.0, 141.3, 137.3 (d, J = 2.5 Hz), 134.31 (d, J = 9.9 Hz), 132.4, 132.0, 131.9, 131.4, 130.0, 128.9, 128.5, 128.4, 128.2, 128.1, 128.0, 127.8, 127.7, 126.9, 126.4, 125.7, 35.2, 34.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.25 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{36}H_{32}OP^+$: 511.2185, Found: 511.2175. **IR** (film) ν 3679, 2989, 2900, 2241, 1598, 1574, 1491, 1436, 1178, 1074, 917, 716, 695, cm^{-1}.

(3-(diphenylmethylene)-1-ethoxy-5-phenylpent-4-yn-2-yl)diphenylphosphine oxide (3)

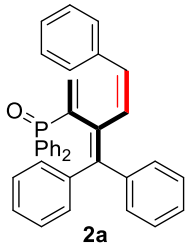


3

A white solid (84 mg, 76% yield), *m.p.*: 96.4 – 97.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.76 – 7.65 (m, 2H), 7.63 – 7.54 (m, 2H), 7.53 – 7.47 (m, 2H), 7.46 – 7.35 (m, 9H), 7.35 – 7.29 (m, 3H), 7.26 – 7.18

(m, 3H), 7.14 – 7.02 (m, 4H), 4.45 – 4.30 (m, 1H), 4.20 – 4.10 (m, 1H), 4.08 – 3.94 (m, 1H), 3.68 – 3.38 (m, 2H), 1.16 (t, J = 7.0 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 151 (d, J = 6.1 Hz), 141.7, 140.5, 132.7, 131.7, 131.6, 131.1 (d, J = 8.1 Hz), 130.2, 130.0, 128.6 (d, J = 11.1 Hz), 128.2, 128.1, 128.0, 127.7, 127.4, 123.58, 116.1, 88.7, 67.8, 66.9, 46.0, 45.3, 15.1. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 31.05 (s). **IR** (film) ν 3679, 2976, 2964, 2222, 1590, 1574, 1491, 1431, 1178, 1073, 916, 719, 696, cm^{-1}.

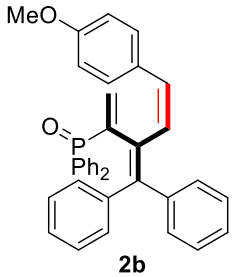
(*Z*)-(3-(diphenylmethylene)-5-phenylpenta-1,4-dien-2-yl)diphenylphosphine oxide (2a)



2a

A white solid (96 mg, 94% yield), *m.p.*: 166.4 – 167.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 – 7.37 (m, 8H), 7.35 – 7.15 (m, 12H), 7.10 (s, 5H), 6.05 (d, *J* = 12.0 Hz, 1H), 5.95 (d, *J* = 12.1 Hz, 1H), 5.76 (d, *J* = 42.0 Hz, 1H), 5.35 (d, *J* = 19.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.0 (d, *J* = 7.5 Hz), 143.5, 142.6, 142.3, 142.0, 136.8, 135.5 (d, *J* = 10.4 Hz), 133.6 (d, *J* = 7.1 Hz), 133.1, 132.4 (d, *J* = 103.0 Hz), 131.9, 131.8, 131.5 (d, *J* = 2.6 Hz), 130.4 (d, *J* = 85.8 Hz), 129.5, 129.3, 128.3, 128.2, 127.8, 127.7, 127.5, 127.3, 127.1, 126.9. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.62 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{36}H_{30}OP^+$: 509.2029, Found: 509.2022. **IR** (film) ν 3675, 2988, 2901, 2221, 1590, 1574, 1491, 1436, 1178, 1072, 916, 719, 694, 596 cm^{-1}.

(*Z*)-(3-(diphenylmethylene)-5-(4-methoxyphenyl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2b)

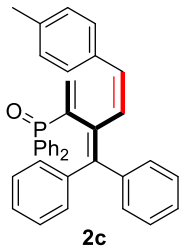


2b

A white solid (103 mg, 96% yield) *m.p.*: 164.7 – 168.5 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.55 – 7.44 (m, 8H), 7.38 – 7.24 (m, 9H), 7.20 – 7.07 (m, 5H), 6.82 (d, *J* = 8.7 Hz, 2H), 5.99 (dd, *J* = 12.0, 1.7 Hz, 1H), 5.91 (d, *J* = 12.0 Hz, 1H), 5.79 (d, *J* = 42.1 Hz, 1H), 5.38 (d, *J* = 19.5 Hz, 1H), 3.82 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.8, 144.8 (d, *J* = 8.1 Hz), 143.0 (d, *J* = 94.9 Hz), 142.3, 142.1, 135.3

(d, *J* = 10.3 Hz), 133.9 (d, *J* = 7.0 Hz), 132.7, 132.4 (d, *J* = 103.0 Hz), 131.9, 131.8, 131.4, 130.6, 130.3 (d, *J* = 89.9 Hz), 129.7, 128.2, 128.1, 127.8, 127.6, 127.5, 127.0 (d, *J* = 40.4 Hz), 113.1, 55.3. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.72 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{37}H_{32}O_2P^+$: 539.2134, Found: 539.2128. **IR** (film) ν 3675, 2987, 2900, 1889, 1605, 1571, 1454, 1026, 945, 825, 696, 634 cm^{-1}.

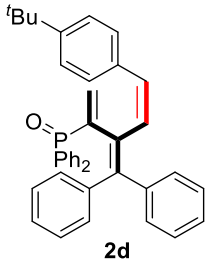
(*Z*)-(3-(diphenylmethylene)-5-(p-tolyl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2c)



2c

A white solid (97 mg, 93% yield) *m.p.*: 119.4 – 121.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.53 – 7.43 (m, 8H), 7.36 – 7.27 (m, 6H), 7.26 – 7.12 (m, 8H), 7.08 (d, *J* = 7.9 Hz, 2H), 6.04 (dd, *J* = 12.1, 1.6 Hz, 1H), 5.94 (d, *J* = 12.1 Hz, 1H), 5.78 (d, *J* = 42.1 Hz, 1H), 5.38 (d, *J* = 19.5 Hz, 1H), 2.36 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.8, 143.2, 142.3, 142.0, 137.0, 135.4, 134.0, 133.8, 133.1, 133.0, 131.9, 131.8, 131.4, 130.3 (d, *J* = 88.9 Hz), 129.3, 128.6, 128.4, 128.2, 128.1, 127.8, 127.5, 127.0 (d, *J* = 44.4 Hz), 21.3. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.75 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{37}H_{32}OP^+$: 523.2185, Found: 523.2183. **IR** (film) ν 3674, 2987, 2900, 2216, 1903, 1730, 1435, 1178, 1073, 923, 735, 692, 574 cm^{-1}.

(*Z*)-(5-(4-(tert-butyl)phenyl)-3-(diphenylmethylene)penta-1,4-dien-2-yl)diphenylphosphine oxide (2d)

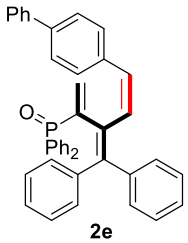


2d

A white solid (106 mg, 94% yield) *m.p.*: 115.5 – 117.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.55 – 7.43 (m, 8H), 7.39 – 7.30 (m, 5H), 7.25 – 7.13 (m, 6H), 7.12 (s, 5H), 6.02 (dd, *J* = 12.1, 1.6 Hz, 1H), 5.95 (d, *J* = 12.1 Hz, 1H), 5.83 (d, *J* = 42.0 Hz, 1H), 5.42 (d, *J* = 19.4 Hz, 1H), 1.40 – 1.32 (m, 9H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 150.2, 144.8 (d, *J* = 7.5 Hz), 143.1 (d, *J* = 93.9 Hz), 142.3, 142.1, 135.5 (d, *J* = 10.7 Hz), 134.0, 133.8 (d, *J* = 8.1 Hz), 133.0 (d, *J* = 2.9 Hz), 132.0, 131.9, 131.8, 131.4 (d, *J* =

2.7 Hz), 130.4 (d, *J* = 88.9 Hz), 129.0, 128.7, 128.2, 128.18, 127.8, 127.4, 127.0 (d, *J* = 15.2 Hz), 124.5, 34.6, 31.4. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.74 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{40}H_{38}OP^+$: 565.2655, Found: 565.2652. **IR** (film) ν 3675, 2987, 2971, 2900, 2205, 1907, 1406, 1250, 1056, 892, 765 cm^{-1}.

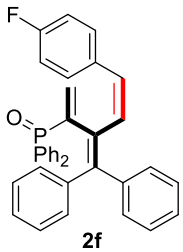
(*Z*)-(5-([1,1'-biphenyl]-4-yl)-3-(diphenylmethylene)penta-1,4-dien-2-yl)diphenylphosphine oxide (2e)



2e

A white solid (78 mg, 67% yield) *m.p.*: 177.3 – 179.0 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.5 Hz, 2H), 7.60 – 7.45 (m, 12H), 7.44 – 7.25 (m, 10H), 7.19 (d, *J* = 13.1 Hz, 5H), 6.14 (d, *J* = 12.1 Hz, 1H), 6.05 (d, *J* = 12.1 Hz, 1H), 5.89 (d, *J* = 42.0 Hz, 1H), 5.46 (d, *J* = 19.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.2 (d, *J* = 7.5 Hz), 143.4 (d, *J* = 94.9 Hz), 142.4, 142.1, 140.9, 139.7, 136.0, 135.5 (d, *J* = 10.1 Hz), 133.7 (d, *J* = 7.2 Hz), 133.0, 132.7, 131.9, 131.8, 131.5 (d, *J* = 2.6 Hz), 130.9, 130.0, 129.8, 128.9, 128.3, 128.2, 127.9, 127.6, 127.3 (d, *J* = 8.1 Hz), 127.0, 126.9, 126.3. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.67 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{42}H_{34}OP^+$: 585.2342, Found: 585.2341. **IR** (film) ν 3061, 3015, 1888, 1486, 1408, 1196, 1111, 943, 860, 790, 690, 639 cm^{-1}.

(*Z*)-(3-(diphenylmethylene)-5-(3-fluorophenyl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2f)

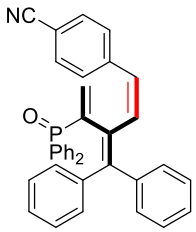


2f

A white solid (86 mg, 82% yield) *m.p.*: 116.1 – 118.2 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 – 7.52 (m, 4H), 7.49 – 7.42 (m, 4H), 7.39 – 7.33 (m, 4H), 7.32 – 7.23 (m, 5H) 7.17 – 7.10 (m, 3H), 7.10 – 7.04 (m, 2H), 6.94 – 6.84 (m, 2H), 6.11 (dd, *J* = 12.0, 1.3 Hz, 1H), 5.92 (d, *J* = 12.1 Hz, 1H), 5.81 (d, *J* = 41.9 Hz, 1H), 5.42 (d, *J* = 19.3 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.1, 160.6, 145.2, 144.2 (d, *J* = 34.3 Hz), 142.3, 142.0, 135.2 (d, *J* = 11.0 Hz), 133.2 (d, *J* = 44.4 Hz), 132.8, 131.9, 131.8, 131.6 (d,

J = 2.7 Hz), 130.7, 130.7, 129.9, 129.2, 128.3, 128.2, 127.8, 127.4, 127.1 (d, *J* = 16.3 Hz), 114.5 (d, *J* = 22.2 Hz). **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.68 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{36}H_{29}FOP^+$: 527.1935, Found: 527.1933. **IR** (film) ν 3658, 3379, 2988, 2213, 1921, 1681, 1610, 1437, 1312, 1170, 906, 821, 792, 694 cm^{-1}.

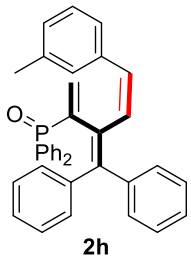
(*Z*)-4-(3-(diphenylmethylene)-4-(diphenylphosphoryl)penta-1,4-dien-1-yl)benzonitrile (2g)



2g

A white solid (92 mg, 86% yield) *m.p.*: 177.3 – 178.8 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.66 – 7.57 (m, 4H), 7.56 – 7.50 (m, 1.1 Hz, 2H), 7.48 – 7.33 (m, 10H), 7.33 – 7.22 (m, 3H), 7.12 – 6.95 (m, 3H), 6.92 – 6.71 (m, 2H), 5.99 (dd, *J* = 12.0, 1.2 Hz, 1H), 5.82 (dd, *J* = 27.1, 18.1 Hz, 2H), 5.39 (d, *J* = 19.1 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.9 (d, *J* = 8.1 Hz), 145.3, 144.3, 142.3, 141.7 (d, *J* = 12.7 Hz), 135.2 (d, *J* = 9.1 Hz), 132.9 (d, *J* = 7.1 Hz), 132.5, 132.2, 131.9, 131.8, 131.5, 131.1, 130.7, 123.0, 129.4, 128.4, 128.3, 127.9, 127.5, 127.2 (d, *J* = 18.2 Hz), 119.3, 109.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.78 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{37}H_{29}NOP^+$: 534.1981, Found: 534.1979. **IR** (film) ν 3674, 3057, 2961, 2900, 2223, 1906, 1603, 1438, 1177, 1116, 971, 862, 729, 574 cm^{-1}.

(*Z*)-(3-(diphenylmethylene)-5-(m-tolyl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2h)

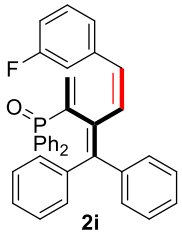


2h

A white solid (96 mg, 92% yield) *m.p.*: 102.0 – 103.4 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.55 – 7.42 (m, 8H), 7.37 – 7.24 (m, 7H), 7.16 (d, *J* = 3.1 Hz, 7H), 7.03 (d, *J* = 7.8 Hz, 2H), 6.10 (dd, *J* = 12.0, 1.8 Hz, 1H), 5.98 (d, *J* = 12.1 Hz, 1H), 5.80 (d, *J* = 41.9 Hz, 1H), 5.41 (d, *J* = 19.4 Hz, 1H), 2.34 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.9 (d, *J* = 7.5 Hz), 143.0 (d, *J* = 47.0 Hz), 142.3, 142.0, 136.8 (d, *J* = 25.2 Hz), 135.4 (d, *J* = 10.2 Hz), 133.7 (d, *J* = 7.2 Hz), 133.2, 132.9, 131.9, 131.8, 131.4 (d, *J* =

2.7 Hz), 130.4 (d, *J* = 82.8 Hz), 130.0, 129.4, 128.2, 128.1, 127.8, 127.6, 127.5, 127.2, 126.7 (d, *J* = 42.4 Hz), 21.5. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.57 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{37}H_{32}OP^+$: 523.2185, Found: 523.2185. **IR** (film) ν 3675, 2987, 2900, 2216, 1920, 1406, 1066, 1056, 891, 789, 736, 696 cm^{-1}.

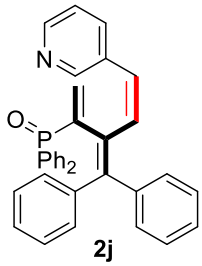
(*Z*)-(3-(diphenylmethylene)-5-(4-fluorophenyl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2i)



2i

A white solid (89 mg, 85% yield) *m.p.*: 169.5 – 171.9 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 – 7.51 (m, 4H), 7.50 – 7.42 (m, 4H), 7.40 – 7.23 (m, 8H), 7.16 – 7.07 (m, 4H), 7.03 (dd, *J* = 6.6, 3.1 Hz, 2H), 6.90 (t, *J* = 8.7 Hz, 2H), 5.97 (d, *J* = 12.0, 1H), 5.87 (d, *J* = 12.0 Hz, 1H), 5.77 (d, *J* = 41.9 Hz, 1H), 5.38 (d, *J* = 19.6 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.6, 161.2, 145.5 (d, *J* = 7.5 Hz), 143.5 (d, *J* = 93.9 Hz), 142.2, 141.8, 138.9 (d, *J* = 8.0 Hz), 135.4 (d, *J* = 10.5 Hz), 133.2 (d, *J* = 7.0 Hz), 132.8, 131.9, 131.8, 131.5 (d, *J* = 3.0 Hz), 130.3 (d, *J* = 83.8 Hz), 129.0 (d, *J* = 8.3 Hz), 128.3, 128.2, 127.9, 127.5, 127.2 (d, *J* = 29.3 Hz), 125.0, 115.6 (d, *J* = 22.2 Hz), 113.7 (d, *J* = 21.2 Hz). **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.51 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{36}H_{29}FOP^+$: 527.1935, Found: 527.1933. **IR** (film) ν 3641, 3408, 2987, 2919, 1922, 1504.56, 1435, 1194, 1092, 931, 618, 572 cm^{-1}.

(*Z*)-(3-(diphenylmethylene)-5-(pyridin-3-yl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2j)

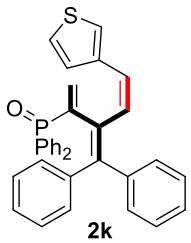


2j

A white solid (72 mg, 71% yield). *m.p.*: 173.2 – 174.7 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 3.7 Hz, 1H), 8.17 (s, 1H), 7.89 (d, *J* = 7.9 Hz, 1H), 7.58 – 6.90 (m, 21H), 6.10 (d, *J* = 12.0, 1H), 5.85 (dd, *J* = 27.0, 14.8 Hz, 2H), 5.41 (d, *J* = 19.2 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 149.8, 147.7,

145.7 (d, *J* = 7.4 Hz), 144.0 (d, *J* = 93.9 Hz), 142.1, 141.8, 136.0, 135.3 (d, *J* = 10.5 Hz), 133.0 (d, *J* = 7.2 Hz), 132.6 (d, *J* = 5.1 Hz), 131.8, 131.7, 131.7, 131.6, 131.6, 130.3 (d, *J* = 7.5 Hz), 129.3, 128.4, 128.2, 127.9, 127.5, 127.3 (d, *J* = 26.3 Hz), 122.8. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.55 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{35}H_{29}NOP^+$: 510.1981, Found: 510.1980. **IR** (film) ν 3672, 3052, 2219, 1673, 1588, 1436, 1311, 1264, 1179, 1114, 907, 842 cm^{-1}.

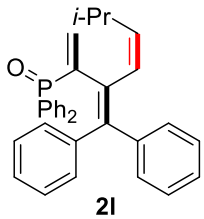
(*Z*)-(3-(diphenylmethylene)-5-(thiophen-3-yl)penta-1,4-dien-2-yl)diphenylphosphine oxide (2k)



2k

A white solid (71 mg, 69% yield). *m.p.*: 190.6 – 192.1 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.58 (dd, *J* = 11.7, 7.9 Hz, 4H), 7.48 (dd, *J* = 9.6, 8.1 Hz, 4H), 7.45 – 7.35 (m, 4H), 7.33 – 7.24 (m, 3H), 7.24 – 7.18 (m, 2H), 7.16 – 7.05 (m, 6H), 5.98 – 5.87 (m, 2H), 5.81 (d, *J* = 42.0 Hz, 1H), 5.40 (d, *J* = 19.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.1, 144.0 (d, *J* = 93.9 Hz), 142.3, 142.0, 138.4, 134.9 (d, *J* = 10.5 Hz), 133.8 (d, *J* = 7.2 Hz), 132.9, 131.9, 131.8, 131.5 (d, *J* = 2.8 Hz), 130.7, 129.9, 128.9, 128.6, 128.2, 128.1, 127.8, 127.4, 127.0 (d, *J* = 16.4 Hz), 124.3, 124.1. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.95 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{34}H_{28}OPS^+$: 515.1593, Found: 515.1590. **IR** (film) ν 2921, 2747, 2158, 1510, 1435, 1226, 1193, 964, 754, 696 cm^{-1}.

(*Z*)-(3-(diphenylmethylene)-6-methylhepta-1,4-dien-2-yl)diphenylphosphine oxide (2l)

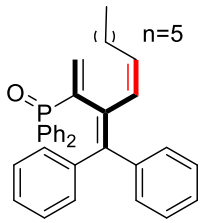


2l

A white solid (60 mg, 63% yield). *m.p.*: 91.6 – 92.7 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 – 7.56 (m, 4H), 7.50 (td, *J* = 7.3, 1.3 Hz, 2H), 7.45– 7.30 (m, 4H), 7.28 – 7.11 (m, 10H), 5.93 (dd, *J* = 41.2, 1.1 Hz, 1H), 5.58 (dd, *J* = 15.3, 12.5, 2H), 4.76 – 4.61 (m, 1H), 2.67 – 2.47 (m, 1H), 0.46 (d, *J* = 6.5 Hz, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.7, 145.8, 143.4, 142.6 (d, *J* = 31.3 Hz), 140.0, 134.0 (d, *J* = 12.8 Hz), 133.0, 132.0, 131.9, 131.5 (d, *J* = 2.8 Hz), 130.8 (d, *J* = 48.5 Hz), 128.2, 128.1, 127.6,

127.5, 126.8 (d, *J* = 2.4 Hz), 125.5, 100.0, 27.6, 21.6. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.88 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{33}H_{32}OP^+$: 475.2185, Found: 475.2185. **IR** (film) ν 3052, 2958, 2921, 2222, 1597, 1465, 1188, 1113, 1072, 1028, 945, 905, 759 cm^{-1}.

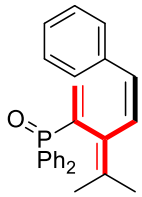
(*Z*)-(3-(diphenylmethylene)undeca-1,4-dien-2-yl)diphenylphosphine oxide (2m)



2m

A white solid (62 mg, 60% yield). *m.p.*: 116.6 – 117.7 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.70 – 7.58 (m, 4H), 7.55 – 7.45 (m, 2H), 7.45 – 7.36 (m, 4H), 7.28 – 7.20 (m, 5H), 7.20 – 7.08 (m, 5H), 5.90 (d, J = 41.1, 1H), 5.75 – 5.55 (m, 2H), 5.01 – 4.85 (m, 1H), 1.80 – 1.65 (m, 2H), 1.28 – 1.22 (m, 2H), 1.20 – 1.15(m, Hz, 4H), 0.91 – 0.84 (m, 5H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.6, 145.7, 143.8, 142.8, 142.4, 134.1, 133.9, 133.8, 132.9, 132.0, 131.9, 131.51 (d, J = 2.8 Hz), 130.9, 130.3, 128.2, 128.1, 127.7, 127.5, 126.8, 126.7, 31.9, 29.3, 29.0, 28.5, 22.7, 14.2. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 27.64 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{36}H_{38}OP^+$: 517.2655, Found: 517.2650. **IR** (film) ν 3057, 2924, 2850, 2323, 1596, 1491, 1437, 1313, 1069, 812, 755, 693 cm^{-1}.

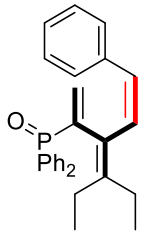
(*Z*)-(4-methyl-3-styrylpenta-1,3-dien-2-yl)diphenylphosphine oxide (2n)



2n

A pale yellow oil (71 mg, 93% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.72 – 7.64 (m, 4H), 7.52 – 7.46 (m, 2H), 7.43 – 7.35 (m, 4H), 7.30 – 7.14 (m, 5H), 6.14 (d, *J* = 12.1 Hz, 1H), 5.97 – 5.84 (m, 2H), 5.78 (dd, *J* = 19.5, 1.3 Hz, 1H), 1.66 (t, *J* = 2.0 Hz, 3H), 1.58 (t, *J* = 3.9 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.6, 143.7, 137.5, 135.7 (d, J = 7.4 Hz), 132.5, 132.4, 132.1, 132.0, 131.7(d, J = 2.2 Hz), 131.5, 130.7, 129.3, 128.6, 128.2, 128.1, 128.0, 127.0, 21.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.56 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{26}H_{26}OP^+$: 385.1716, Found: 385.1715. **IR** (film) ν 3674, 3397, 2987, 2900, 2216, 1908, 1589, 1436, 1175, 1099, 1027, 907, 692 cm^{-1}.

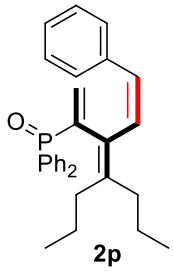
(*Z*)-(4-ethyl-3-styrylhexa-1,3-dien-2-yl)diphenylphosphine oxide (2o)



2o

A pale yellow oil (76 mg, 92% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 – 7.56 (m, 4H), 7.55 – 7.46 (m, 2H), 7.45 – 7.35 (m, 6H), 7.30 – 7.14 (m, 3H), 6.16 (d, *J* = 12.1 Hz, 1H), 6.01 – 5.74 (m, 3H), 2.24 – 1.96 (m, 4H), 0.93 (t, *J* = 7.5 Hz, 3H), 0.80 (t, *J* = 7.6 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.2, 146.1, 143.7, 142.8, 137.3, 132.6, 132.2, 132.1, 131.8 (d, *J* = 10.1 Hz), 131.6, 131.6, 130.9, 129.0, 128.8, 128.2, 128.0, 127.8, 127.2, 24.6, 24.4, 13.1, 11.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.16 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{28}H_{30}OP^+$:413.2029, Found: 413.2028. **IR** (film) ν 3675, 2967, 2931, 2220, 1590, 1436, 1347, 1171, 1027, 907, 836, 725, 692 cm^{-1}.

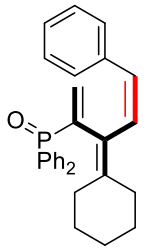
(*Z*)-diphenyl(4-propyl-3-styrylhepta-1,3-dien-2-yl)phosphine oxide (2p)



2p

A pale yellow oil (80 mg, 91% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.76 – 7.56 (m, 4H), 7.55 – 7.45 (m, 2H), 7.44 – 7.38 (m, 4H), 7.34 (d, *J* = 7.2 Hz, 2H), 7.29 – 7.18 (m, 3H), 6.16 (d, *J* = 12.1 Hz, 1H), 6.04 – 5.68 (m, 3H), 2.02 (dd, *J* = 11.3, 4.6 Hz, 3H), 1.44 – 1.32 (m, 2H), 1.32 – 1.18 (m, 3H), 0.87 (t, *J* = 7.3 Hz, 3H), 0.79 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.0 (d, J = 7.1 Hz) 143.7, 142.8, 137.3, 132.7, 132.1, 132.0, 131.9 (d, *J* = 10.1 Hz), 131.7, 131.6 (d, *J* = 3.0 Hz), 130.9, 129.2, 128.9, 128.7 (d, *J* = 7.1 Hz), 128.2, 128.1, 127.8, 127.2, 34.2, 34.1, 21.9 (d, *J* = 2.0 Hz), 20.7 (d, *J* = 2.4 Hz), 14.5, 14.4. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.12 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{30}H_{34}OP^+$: 441.2342, Found: 441.2341. **IR** (film) ν 3674, 2958, 2869, 2220, 1436, 1377, 1191, 1116, 1099, 906, 787, 724, 692, 643 cm^{-1}.

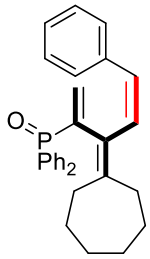
(*Z*)-(3-cyclohexylidene-5-phenylpenta-1,4-dien-2-yl)diphenylphosphine oxide (2q)



2q

A pale yellow oil (80 mg, 94% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.70 (dd, *J* = 11.5, 7.6 Hz, 4H), 7.55 – 7.49 (m, 2H), 7.43 (t, *J* = 7.7 Hz, 4H), 7.34 – 7.17 (m, 5H), 6.19 (d, *J* = 12.1 Hz, 1H), 6.01 – 5.77 (m, 3H), 2.11 (dd, *J* = 22.7, 17.5 Hz, 4H), 1.47 – 1.28 (m, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.1, 143.2, 142.4 (d, *J* = 8.1 Hz), 137.5, 132.6, 132.2, 132.1, 131.6 (d, *J* = 2.0 Hz), 131.5, 130.8, 129.1, 128.8, 128.2, 128.1, 127.9, 127.0, 125.6 (d, *J* = 7.1 Hz), 31.6, 31.6, 27.6, 26.8, 26.4. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.12 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{29}H_{30}OP^+$:425.2029, Found: 425.2027. **IR** (film) ν 3673, 2978, 2924, 1719, 1597, 1432, 1391, 1112, 1068, 996, 944, 721, 690 cm^{-1}.

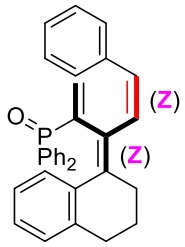
(*Z*)-(3-cycloheptylidene-5-phenylpenta-1,4-dien-2-yl)diphenylphosphine oxide (2r)



2r

A pale yellow oil (76 mg, 87% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.70 – 7.54 (m, 4H), 7.53 – 7.45 (m, 2H), 7.44 – 7.35 (m, 4H), 7.35 – 7.11 (m, 5H), 6.13 (d, *J* = 12.1 Hz, 1H), 6.07 – 5.65 (m, 3H), 2.29 (s, 4H), 1.47 (s, 8H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.3, 145.2, 143.5, 142.6, 137.3, 132.7, 132.3 (d, *J* = 10.1 Hz), 132.1, 132.0, 131.7, 131.6 (d, *J* = 2.8 Hz), 130.1, 129.2, 128.9, 128.2, 128.0, 127.8, 127.2, 33.2, 32.6, 29.6, 29.3, 28.3, 26.4. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.75 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{30}H_{32}OP^+$: 439.2185, Found: 439.2176. **IR** (film) ν 3675, 2977, 2921, 1713, 1590, 1436, 1393, 1116, 1066, 998, 949, 725, 691 cm^{-1}.

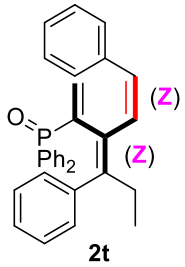
((*Z*)-3-((*Z*)-3,4-dihydronaphthalen-1(2H)-ylidene)-5-phenylpenta-1,4-dien-2-yl)diphenyl-phosphine oxide (2s)



2s

A pale yellow solid (82 mg, 87% yield). *m.p.*: 131.5-133.4 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.98 – 7.89 (m, 1H), 7.71 – 7.61 (m, 4H), 7.58 – 7.45 (m, 4H), 7.44 – 7.35 (m, 4H), 7.28 (dd, *J* = 9.1, 6.0 Hz, 2H), 7.20 – 7.11 (m, 3H), 7.06 – 7.00 (m, 1H), 6.21 (d, *J* = 12.1 Hz, 1H), 5.93 (t, *J* = 27.1 Hz, 2H), 5.59 (d, *J* = 19.2, 1H), 2.54 (t, *J* = 6.5 Hz, 2H), 2.30 (dd, *J* = 5.8, 4.1 Hz, 2H), 1.68 – 1.57 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.5, 144.6, 140.0, 139.1 (d, *J* = 7.0 Hz), 137.3, 136.5, 134.0 (d, *J* = 10.4 Hz), 132.3 (d, *J* = 102.0 Hz), 131.9, 131.8, 131.7, 131.5 (d, *J* = 3.0 Hz), 130.0 (d, *J* = 77.8 Hz), 129.4 (d, *J* = 7.1 Hz), 128.7, 128.3, 128.2, 128.1, 127.4 (d, *J* = 31.3 Hz), 127.3, 125.0, 29.5, 29.1, 22.5. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.76 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{33}H_{30}OP^+$: 473.2029, Found: 473.2028. **IR** (film) ν 3050, 2968, 2927, 2228, 1598, 1475, 1182, 1118, 1073, 1022, 944, 905, 786 cm^{-1}.

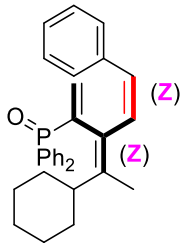
Diphenyl((*Z*)-4-phenyl-3-((*Z*)-styryl)hexa-1,3-dien-2-yl)phosphine oxide (2t)



2t

A pale yellow oil (77 mg, 84% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.51 – 7.45 (m, 6H), 7.42 (d, *J* = 7.3 Hz, 2H), 7.38 – 7.31 (m, 6H), 7.29 (d, *J* = 4.3 Hz, 4H), 7.25 – 7.20 (m, 2H), 6.29 – 6.15 (m, 2H), 5.55 (dd, *J* = 42.6, 0.8 Hz, 1H), 5.17 (dd, *J* = 19.9, 0.8 Hz, 1H), 2.49 (t, *J* = 7.3 Hz, 2H), 0.79 (t, *J* = 7.5 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.4, 145.3, 143.2, 142.3, 141.3, 137.1, 133.9 (d, *J* = 10.4 Hz), 132.9, 132.0, 131.9, 131.5 (d, *J* = 3.0 Hz), 130.8 (d, *J* = 6.6 Hz), 129.2, 129.1, 128.4, 128.2, 128.1, 127.9, 127.7, 127.3, 126.4, 28.7, 11.5 (d, *J* = 2.1 Hz). **^{31}P NMR** (162 MHz, $CDCl_3$) δ 29.36 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{32}H_{30}OP^+$: 461.2029, Found: 461.2030. **IR** (film) ν 3052, 2971, 2931, 2872, 2217, 1907, 1591, 1435, 1185, 949, 917, 759, 691 cm^{-1}.

((*Z*)-4-cyclohexyl-3-((*Z*)-styryl)penta-1,3-dien-2-yl)diphenylphosphine oxide (2u)

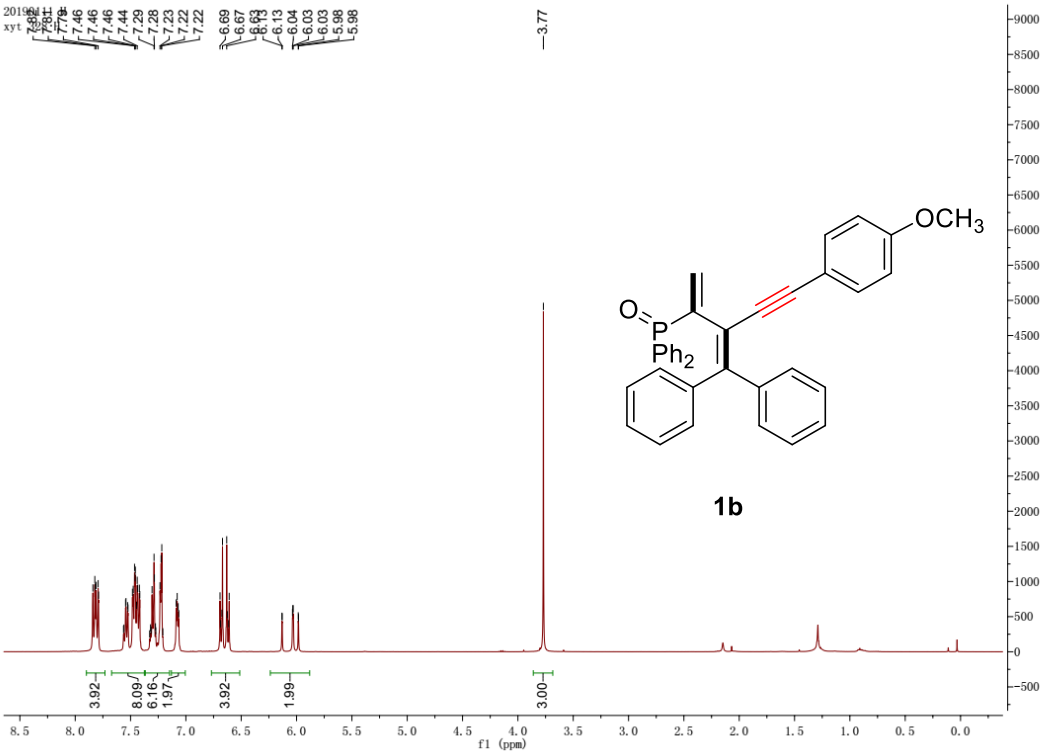


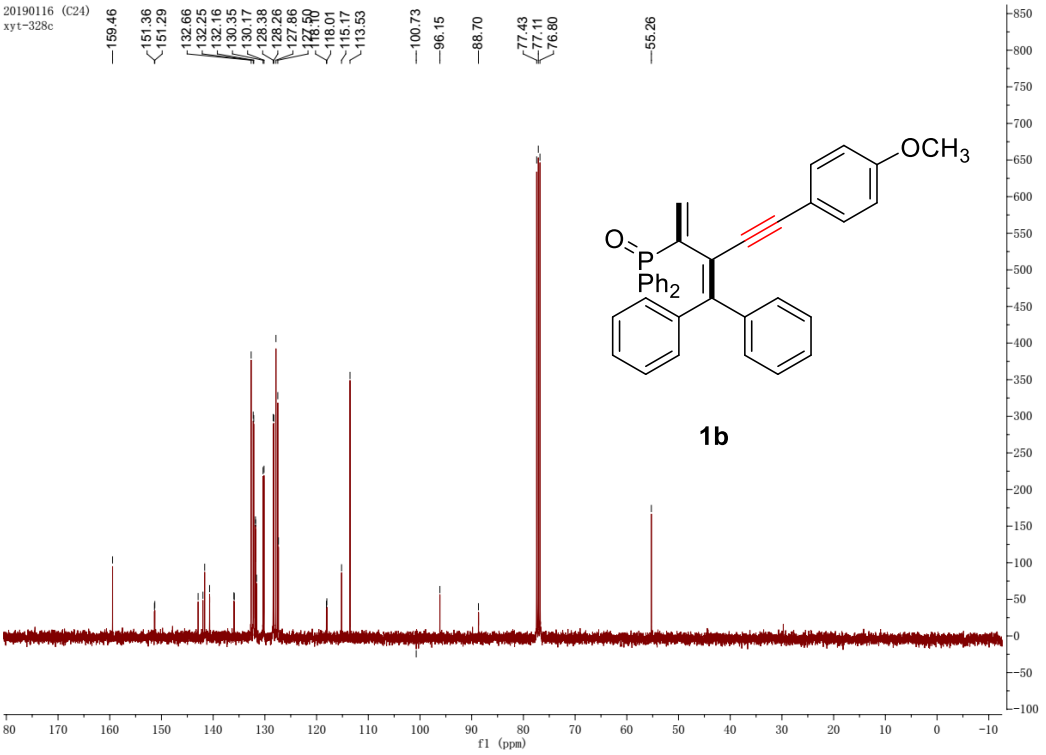
2u

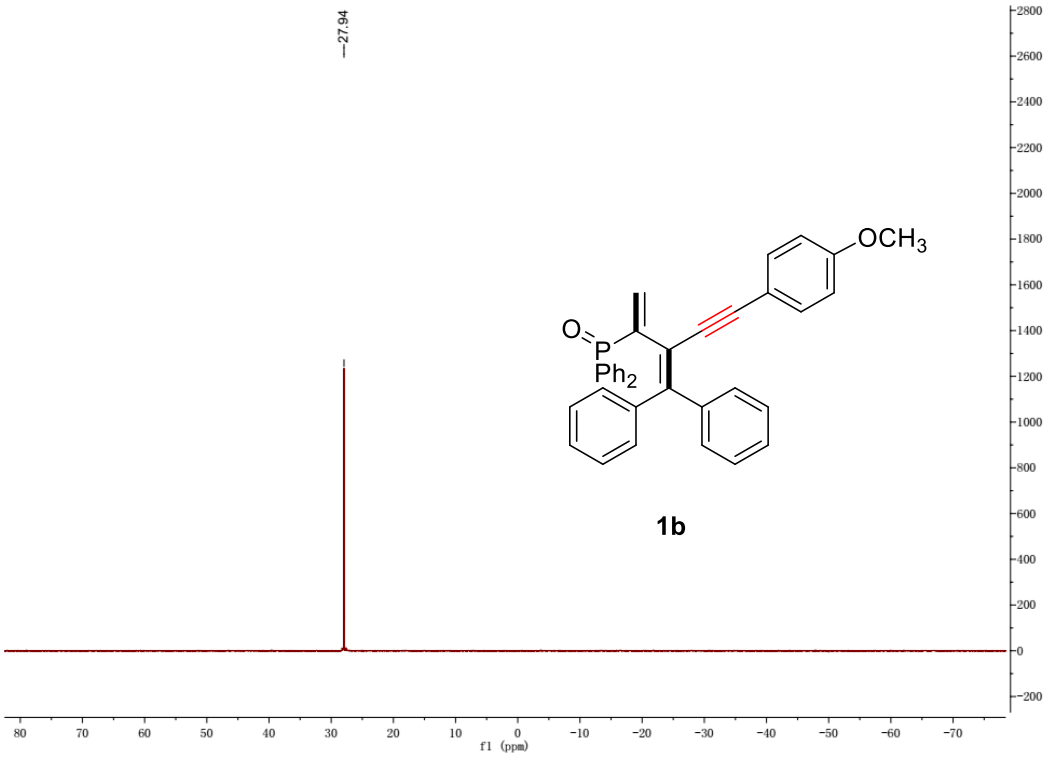
A pale yellow oil (70mg, 77% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.75 – 7.65 (m, 4H), 7.54 – 7.49 (m, 2H), 7.46 – 7.40 (m, 4H), 7.37 (d, *J* = 7.3 Hz, 2H), 7.29 – 7.23 (m, 2H), 7.21 – 7.16 (m, 1H), 6.21 (d, *J* = 12.1 Hz, 1H), 5.95 (d, *J* = 12.1 Hz, 1H), 5.87 (dd, *J* = 41.3, 1.4 Hz, 1H), 5.78 (dd, *J* = 19.5, 1.4 Hz, 1H), 2.42 (s, 1H), 1.68 – 1.59 (m, 3H), 1.53 – 1.47 (m, 3H), 1.20 (s, 3H), 1.09 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.4, 143.5, 143.3 (d, *J* = 8.1 Hz), 137.6, 132.2, 132.6, 131.6, 132.1, 131.7 (d, *J* = 2.7 Hz), 131.3 (d, *J* = 9.1 Hz), 130.5, 129.9, 128.6, 128.2, 128.1, 127.9, 127.1 (d, *J* = 5.1 Hz), 42.6, 30.6, 26.3, 26.2, 14.7. **^{31}P NMR** (162 MHz, $CDCl_3$) δ 28.11 (s). **HRMS (ESI):** ($[M+H]^+$) Calcd for $C_{31}H_{33}OP$: 453.2342, Found: 453.2343. **IR** (film) ν 3675, 2924, 2850, 2219, 1447, 1436, 1374, 1176, 1115, 907, 771, 725, 692, 620 cm^{-1}.

16. ^{1}H-NMR, ^{13}C-NMR, ^{31}P-NMR and HR-MS Spectra

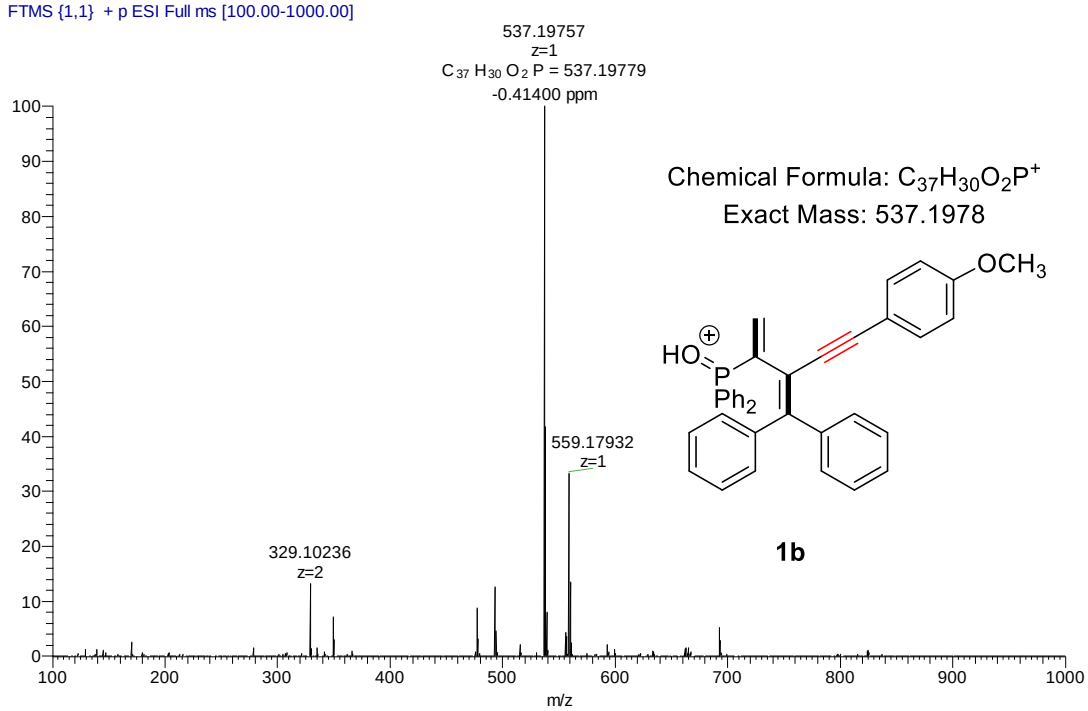
1b



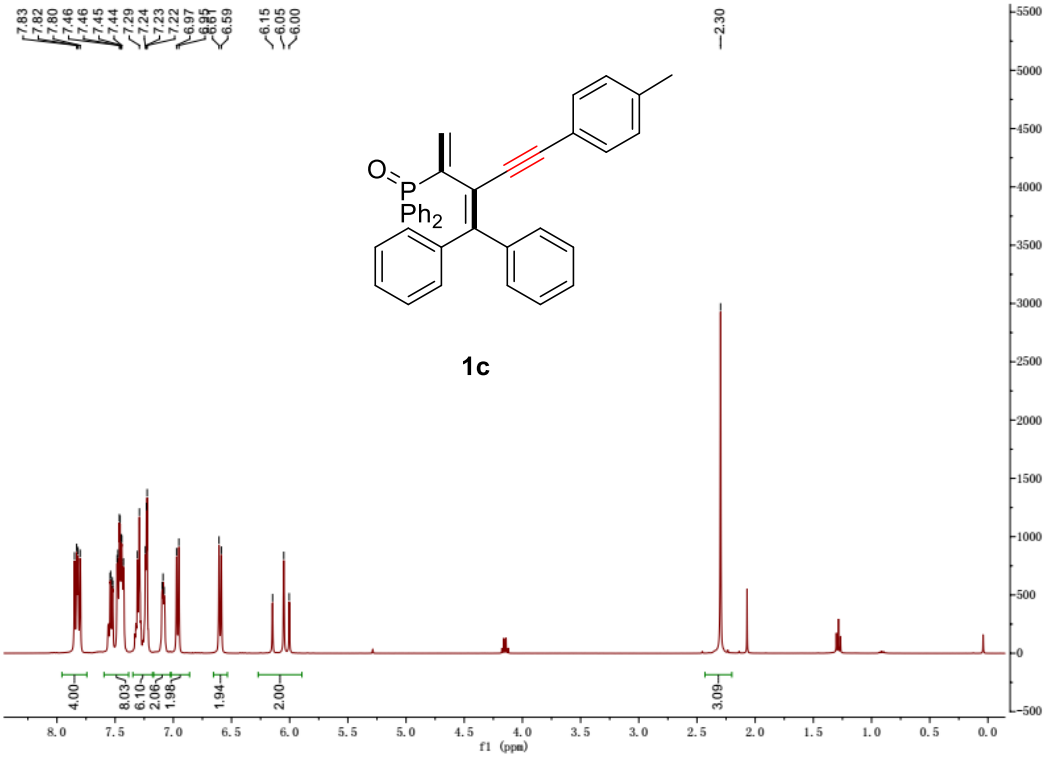


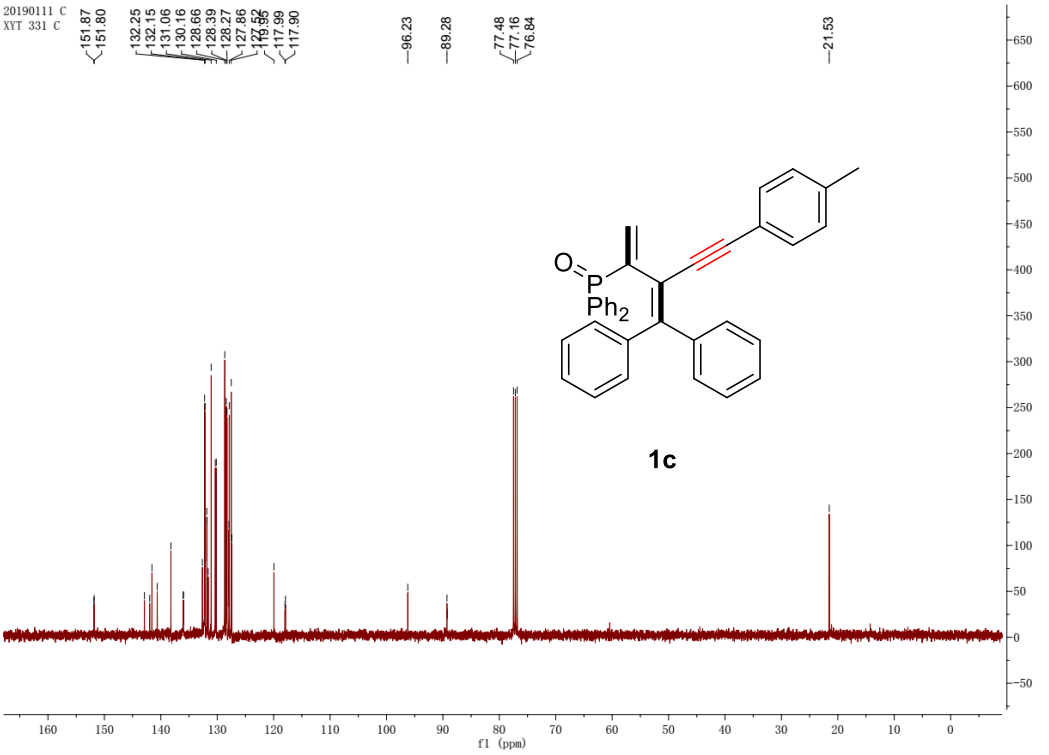


20190109-1 #33 RT: 0.49 AV: 1 NL: 7.27E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



1c


7.83
7.82
7.80
7.46
7.46
7.45
7.44
7.29
7.24
7.23
7.22
6.97
6.95
6.81
6.59
6.15
6.05
6.00
2.30
O
P
Ph2
1c
4.00
8.03
6.10
2.06
1.98
1.94
2.00
3.09
f1 (ppm)


20190111 C
XYT 331 C
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151.80
132.25
132.15
131.06
130.16
128.66
128.39
128.27
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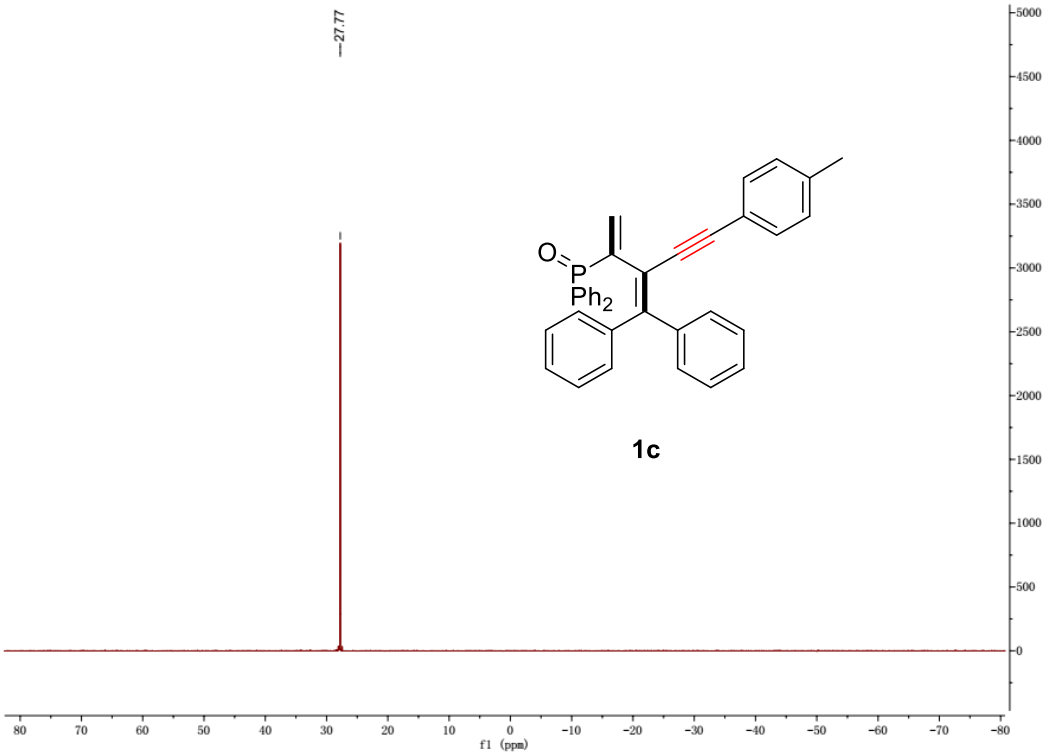
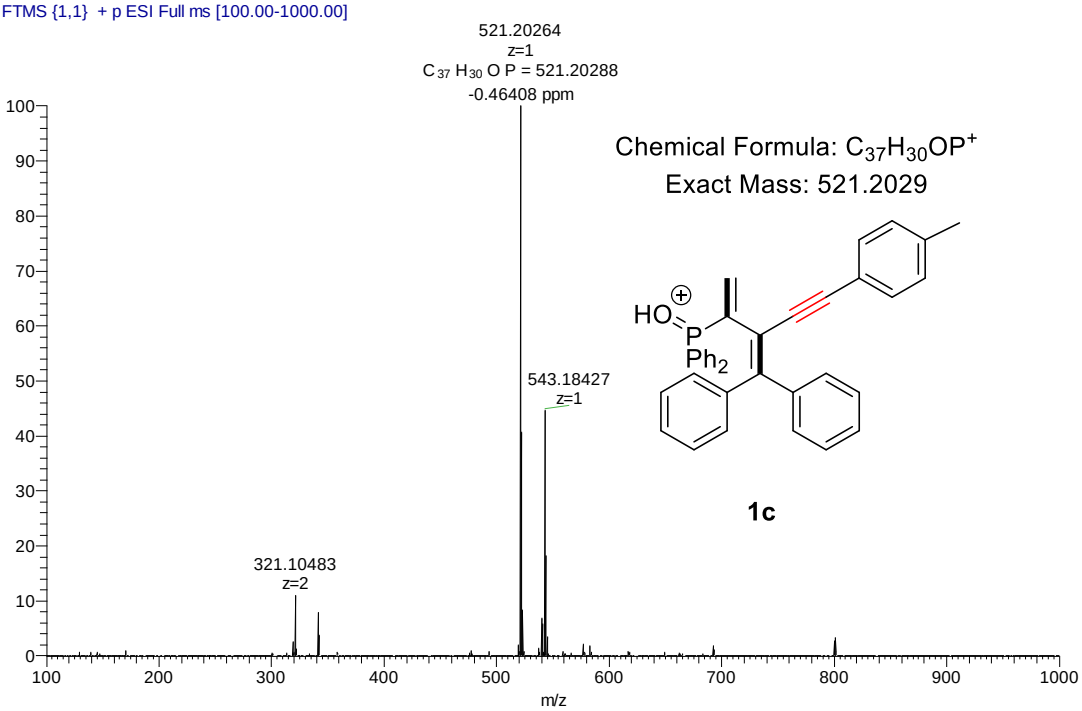
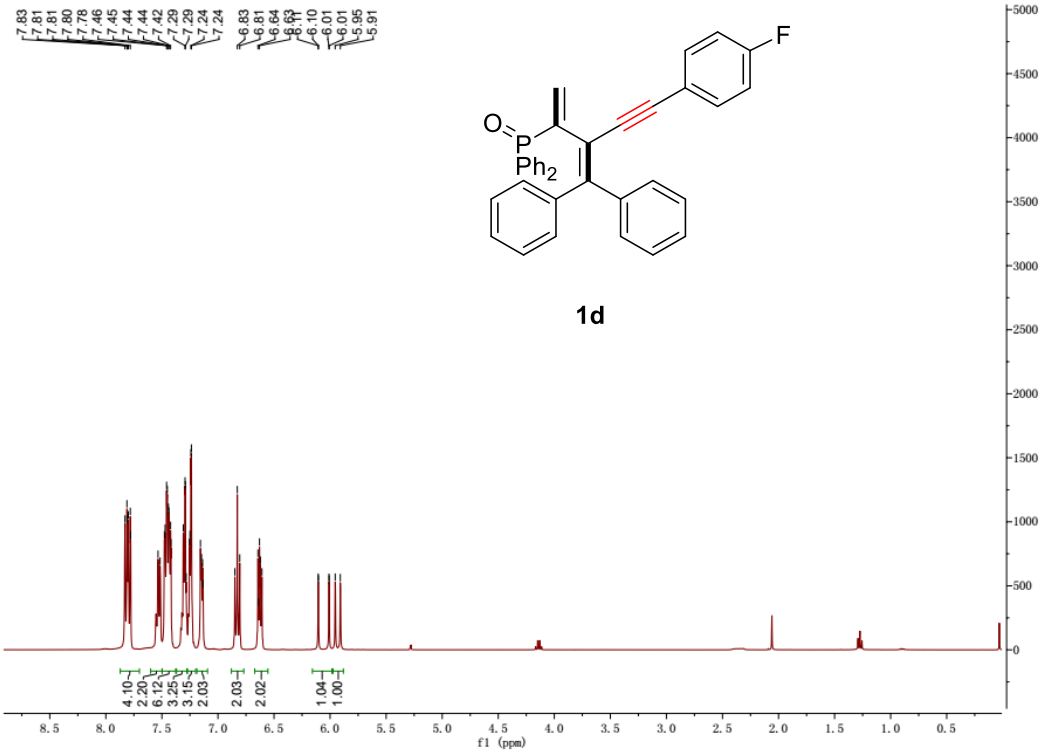
21.53
O
P
Ph2
1c
f1 (ppm)

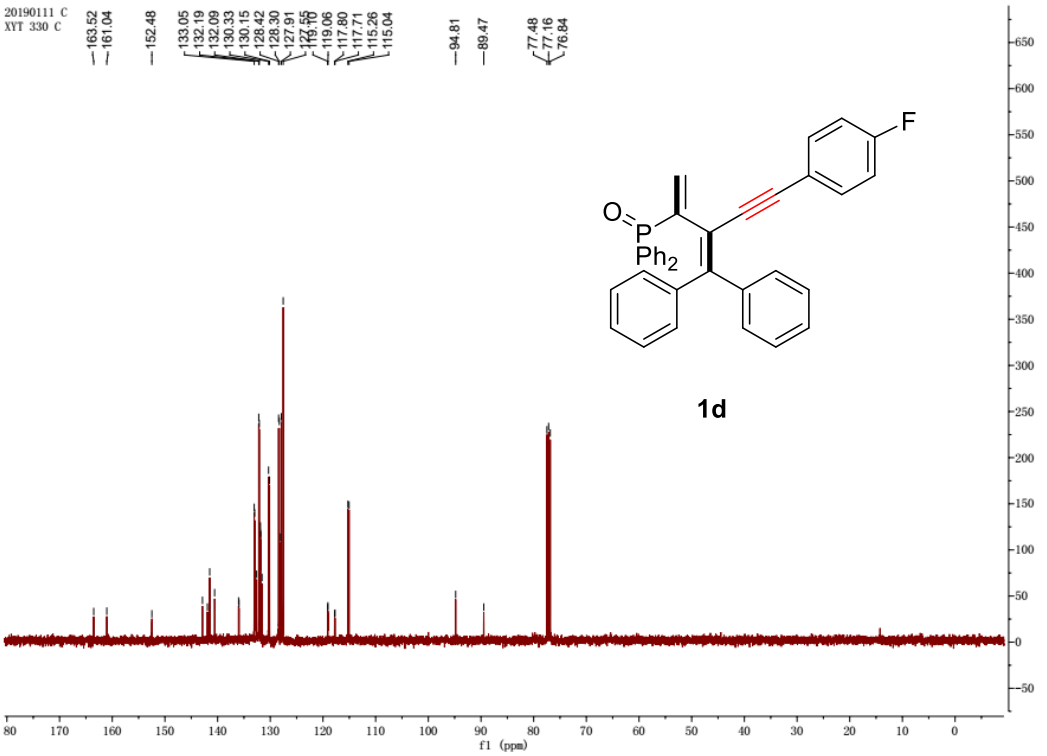


20190109-2 #33 RT: 0.49 AV: 1 NL: 1.49E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



1d


7.83
7.81
7.81
7.80
7.78
7.46
7.45
7.44
7.44
7.42
7.29
7.29
7.24
7.24
6.83
6.81
6.64
6.63
6.10
6.01
6.01
5.95
5.91
F
O
P
Ph2
1d
4.10
2.20
6.12
3.25
3.15
2.03
2.03
2.02
1.04
1.00
f1 (ppm)


20190111 C
XYT 330 C
163.52
161.04
152.48
133.05
132.19
132.09
130.33
130.15
128.42
128.30
127.91
127.55
119.10
119.06
117.80
117.71
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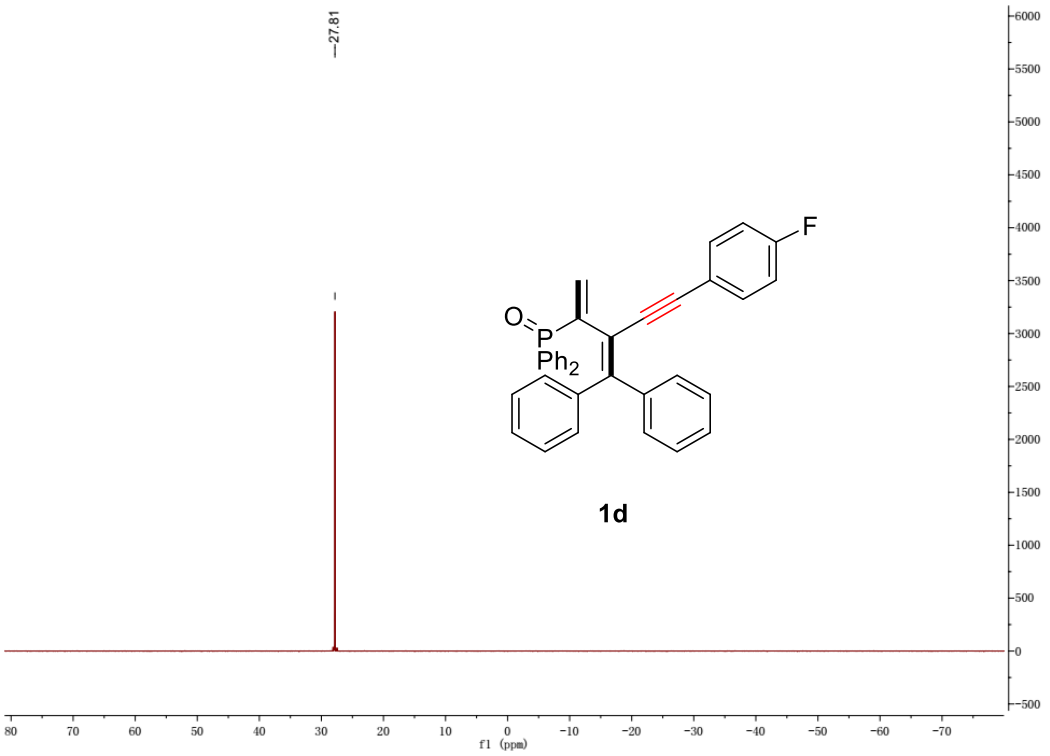
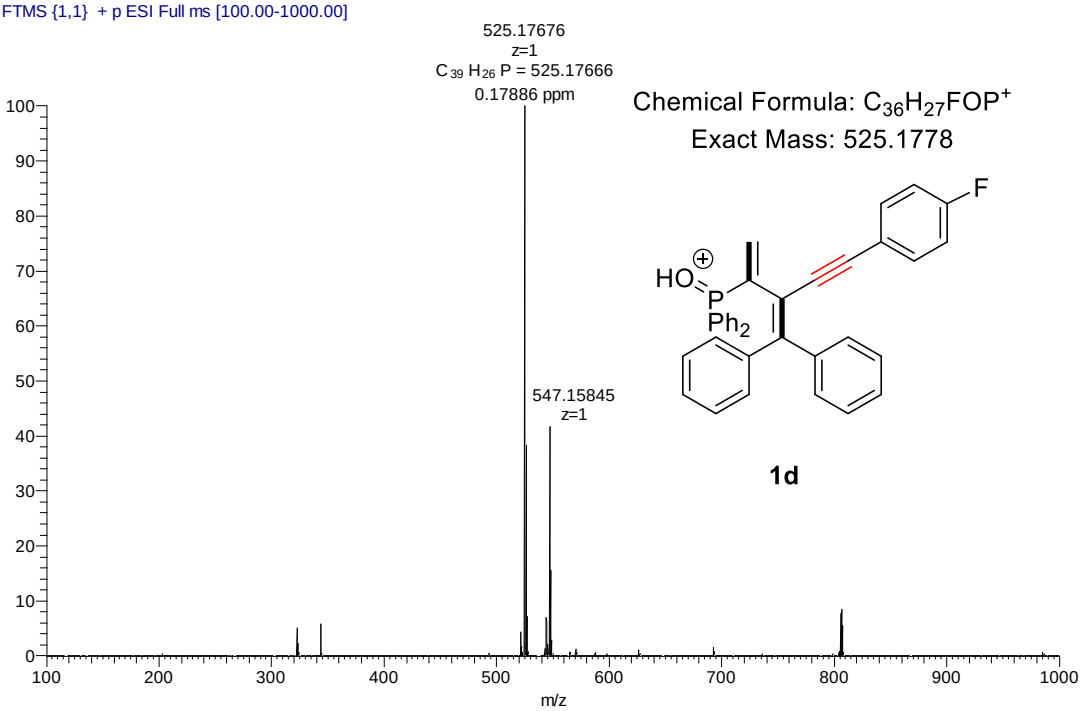
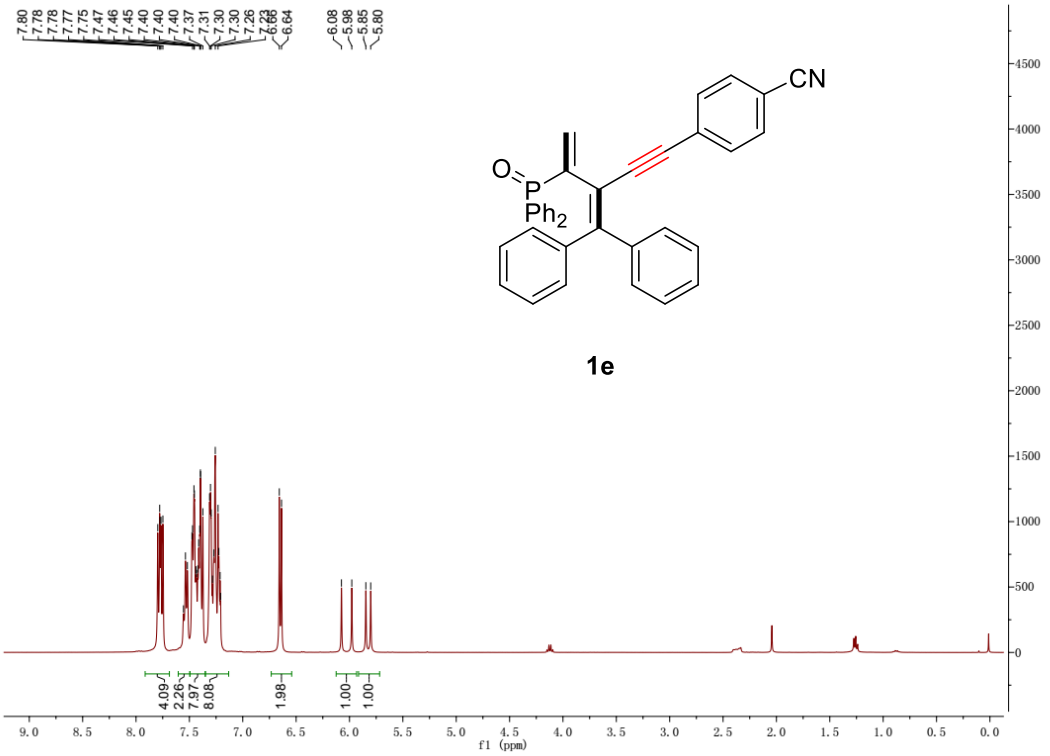
77.16
76.84
F
O
P
Ph2
1d
f1 (ppm)



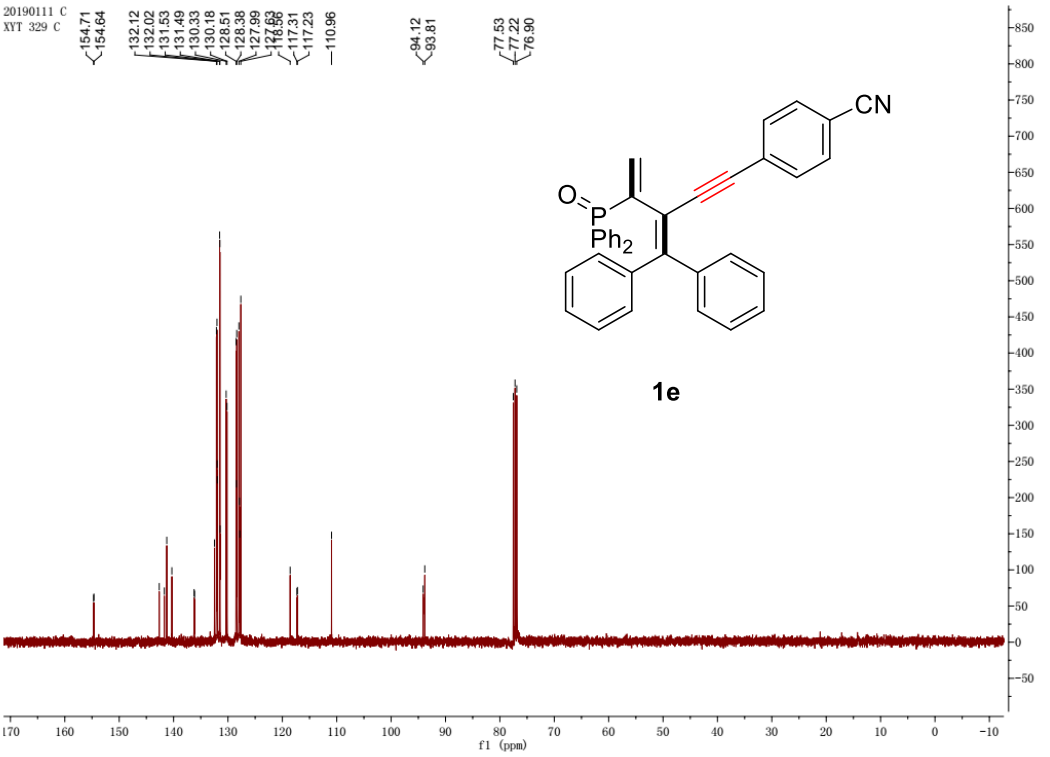
20190109-3 #25 RT: 0.37 AV: 1 NL: 5.23E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



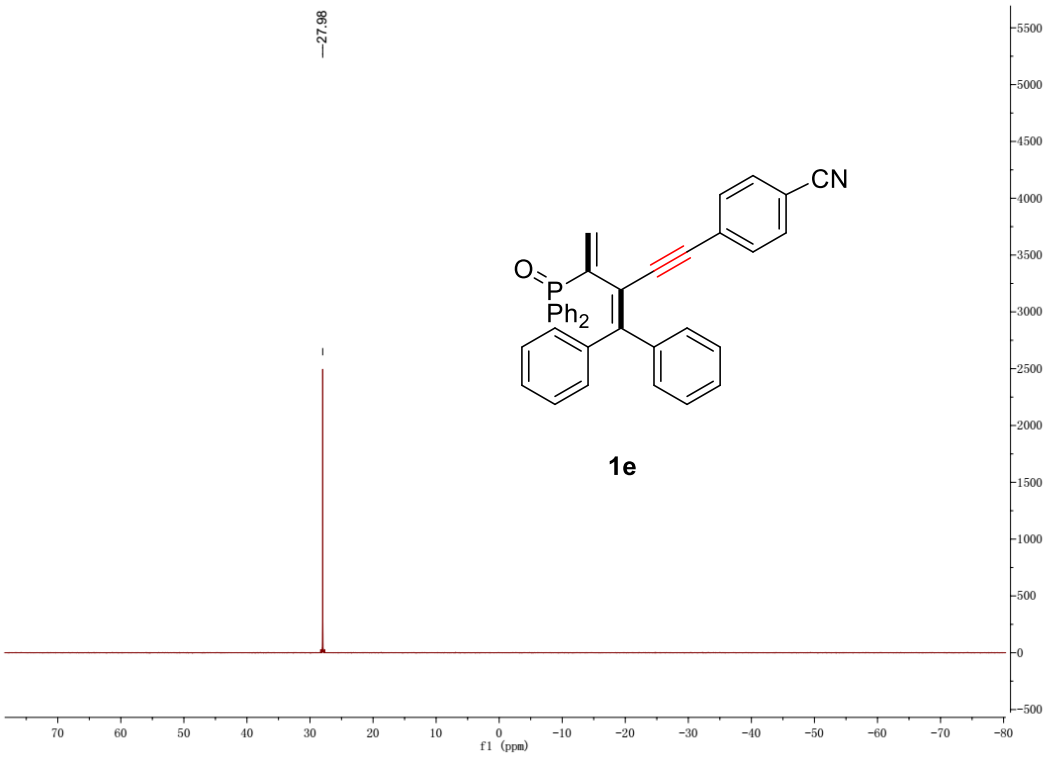
1e


7.80
7.78
7.78
7.77
7.75
7.47
7.46
7.45
7.40
7.40
7.40
7.37
7.31
7.30
7.30
7.26
6.64
6.08
5.98
5.85
5.80
CN
O
P
Ph2
4.09
2.26
7.97
8.08
1.98
1.00
1.00
f1 (ppm)

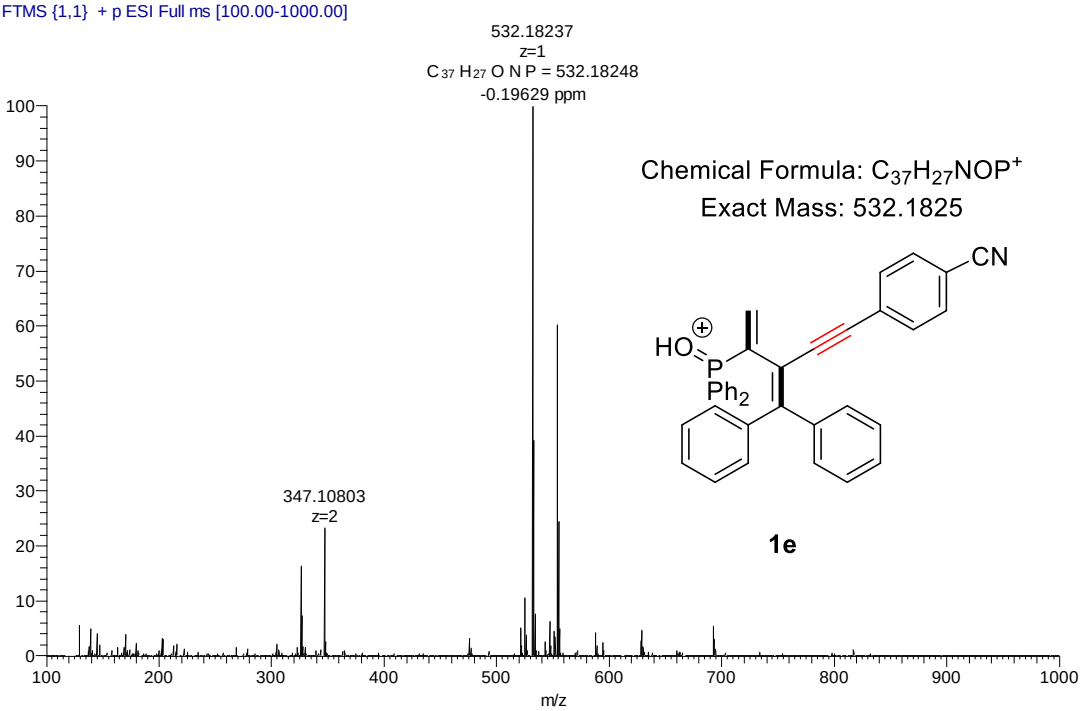
1e


20190111 C
XYT 329 C
154.71
154.64
132.12
132.02
131.53
131.49
130.33
130.18
128.51
128.38
127.99
117.31
117.23
110.96
94.12
93.81
77.53
77.22
76.90
CN
O
P
Ph2
f1 (ppm)

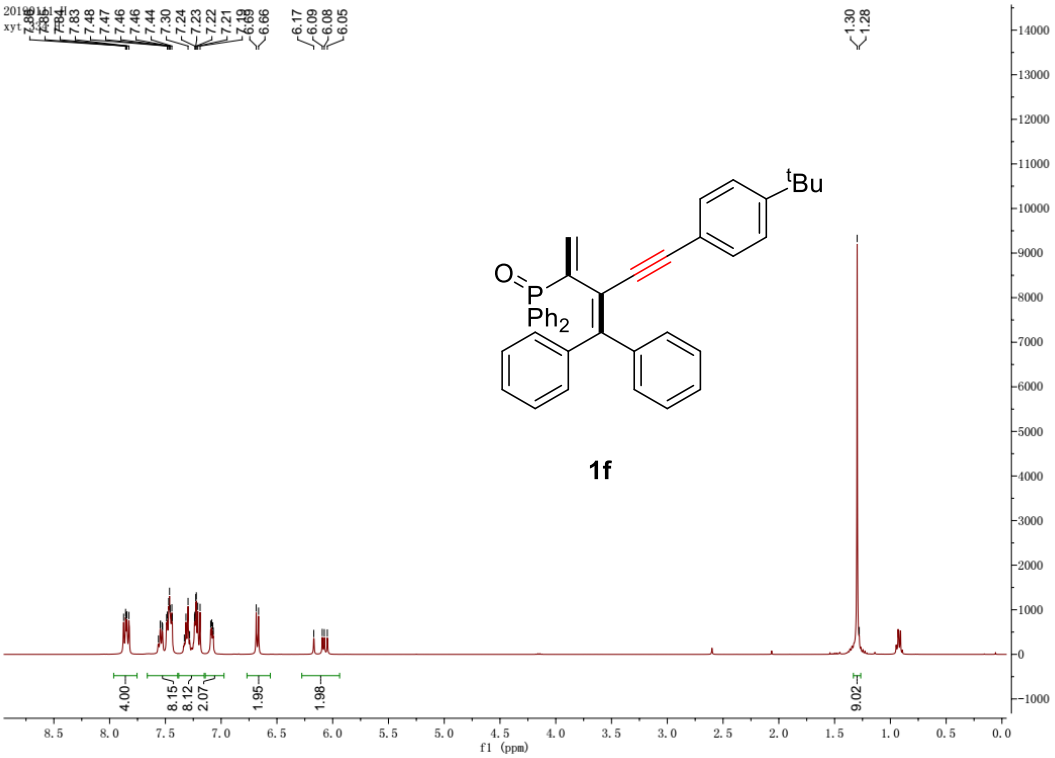
1e

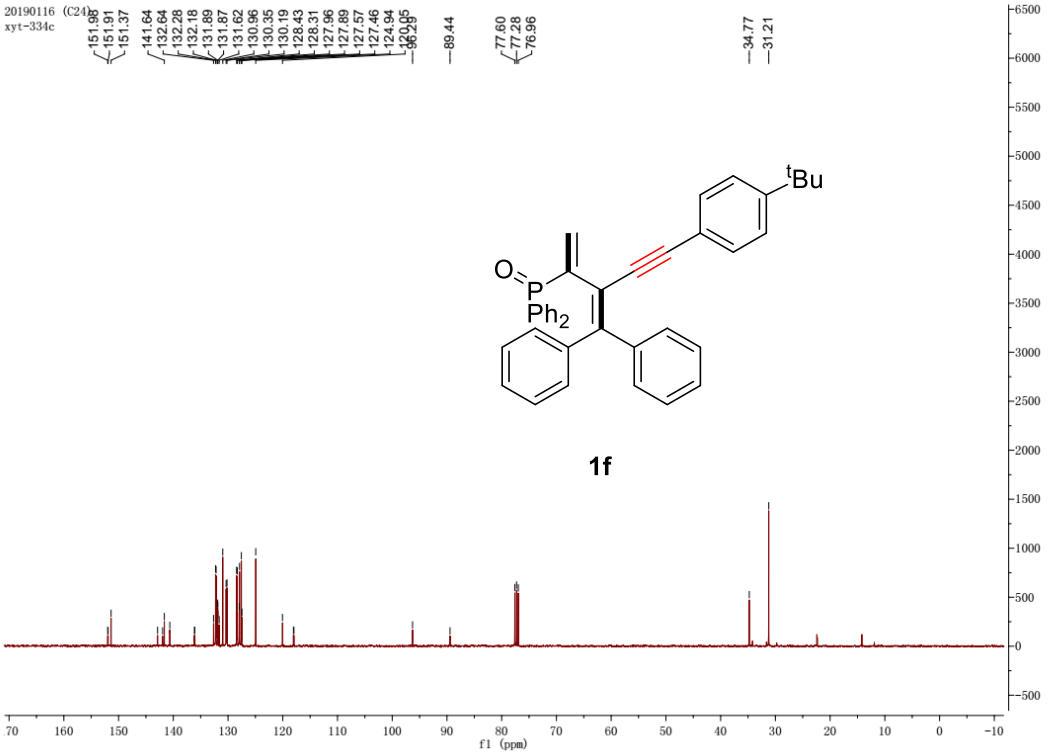


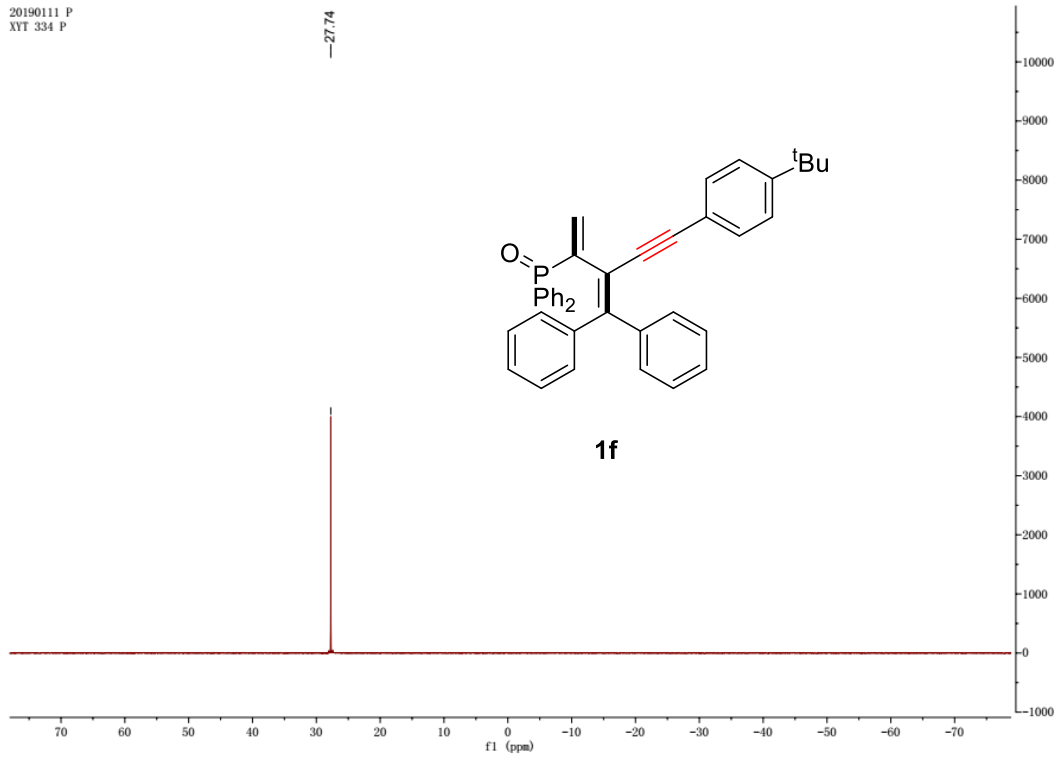
20190109-4 #37 RT: 0.57 AV: 1 NL: 2.34E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



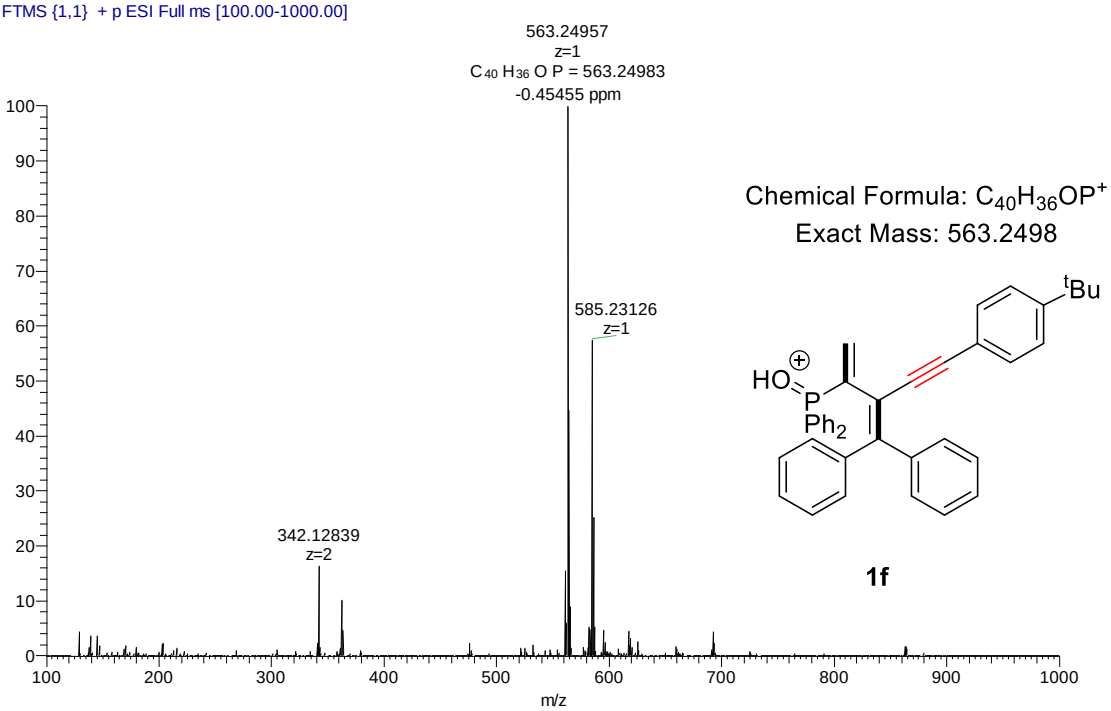
1f



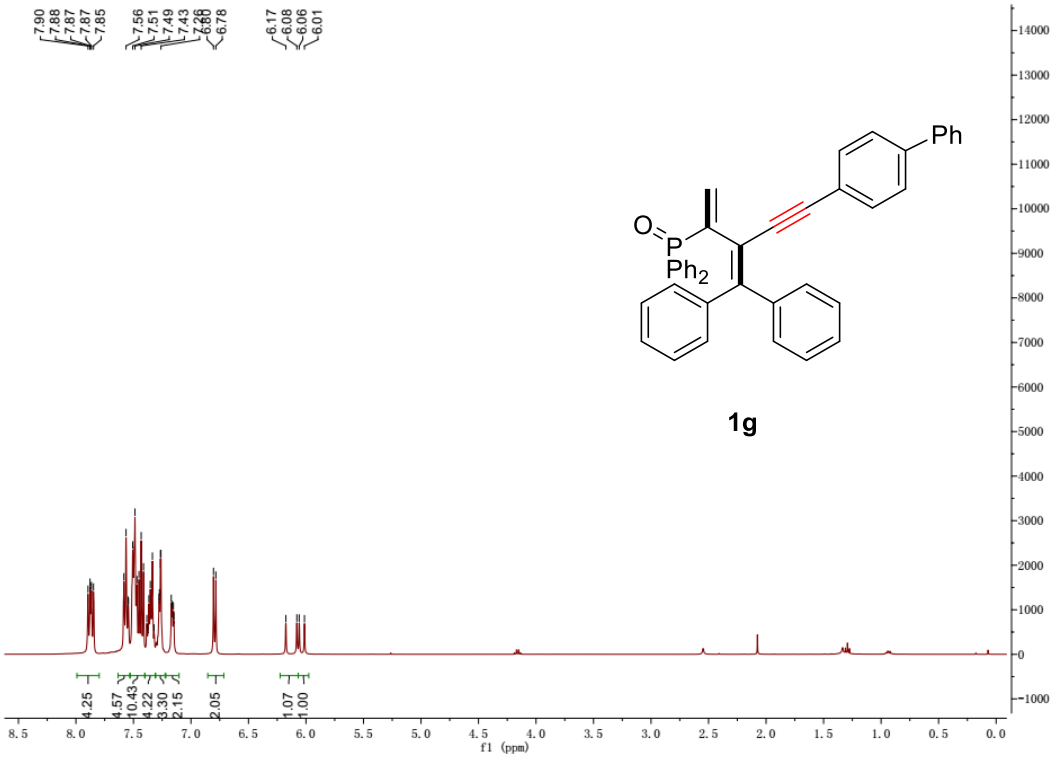


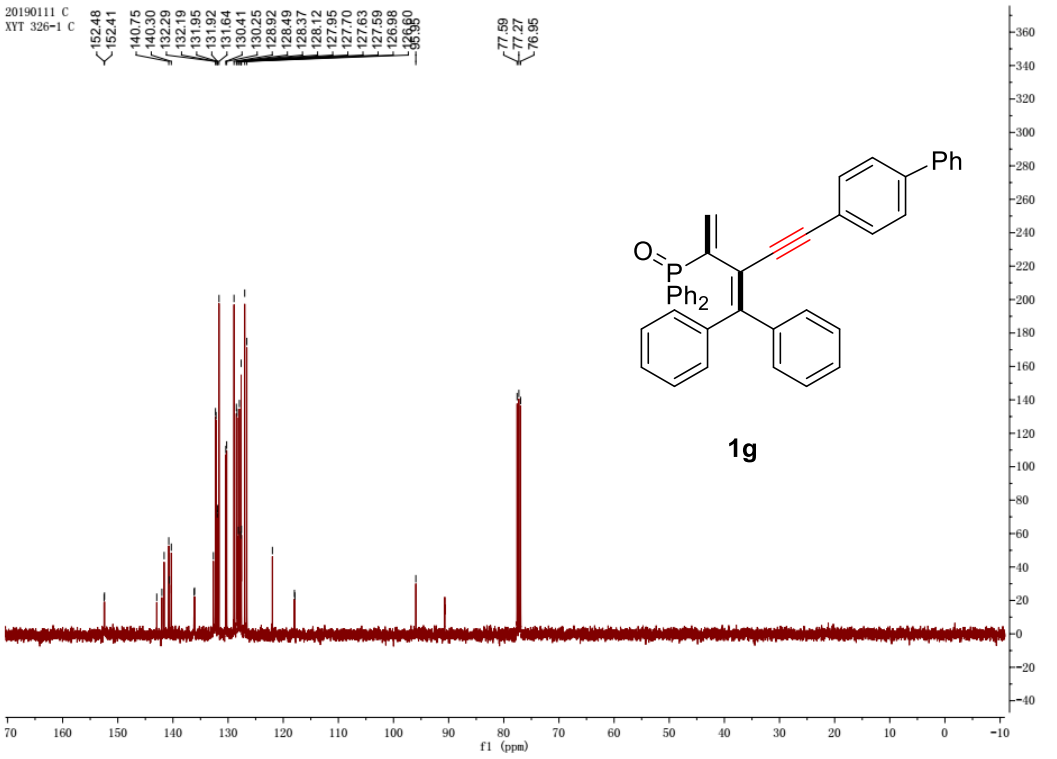


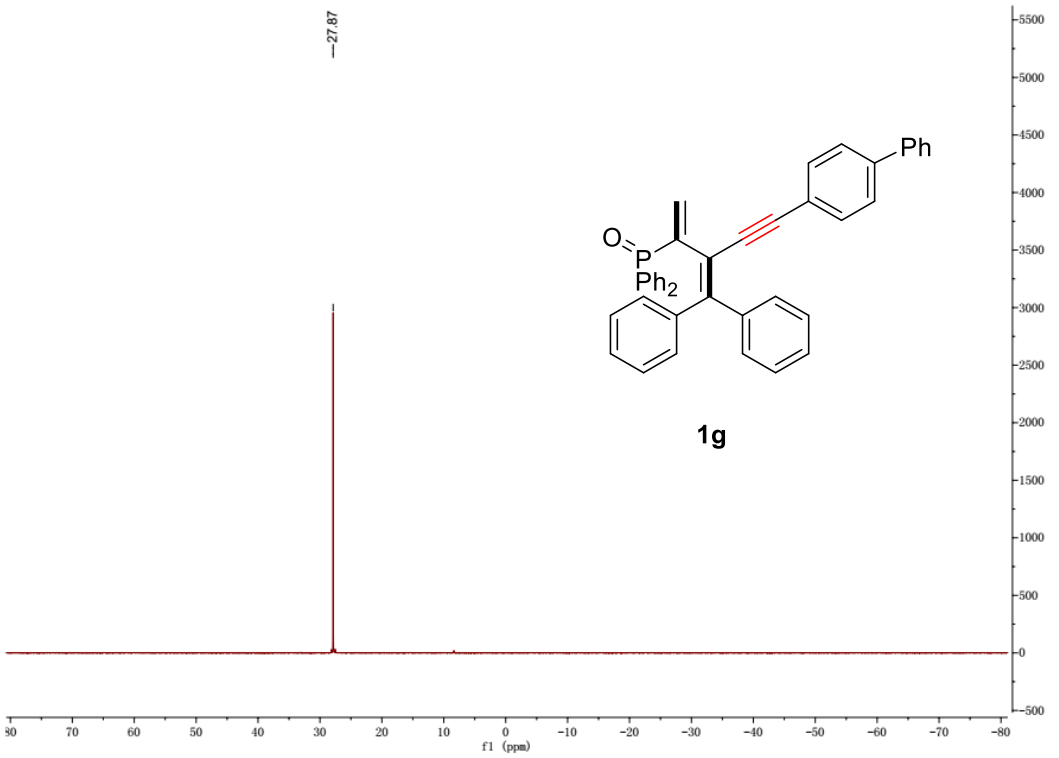
20190109-5 #37 RT: 0.56 AV: 1 NL: 4.14E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



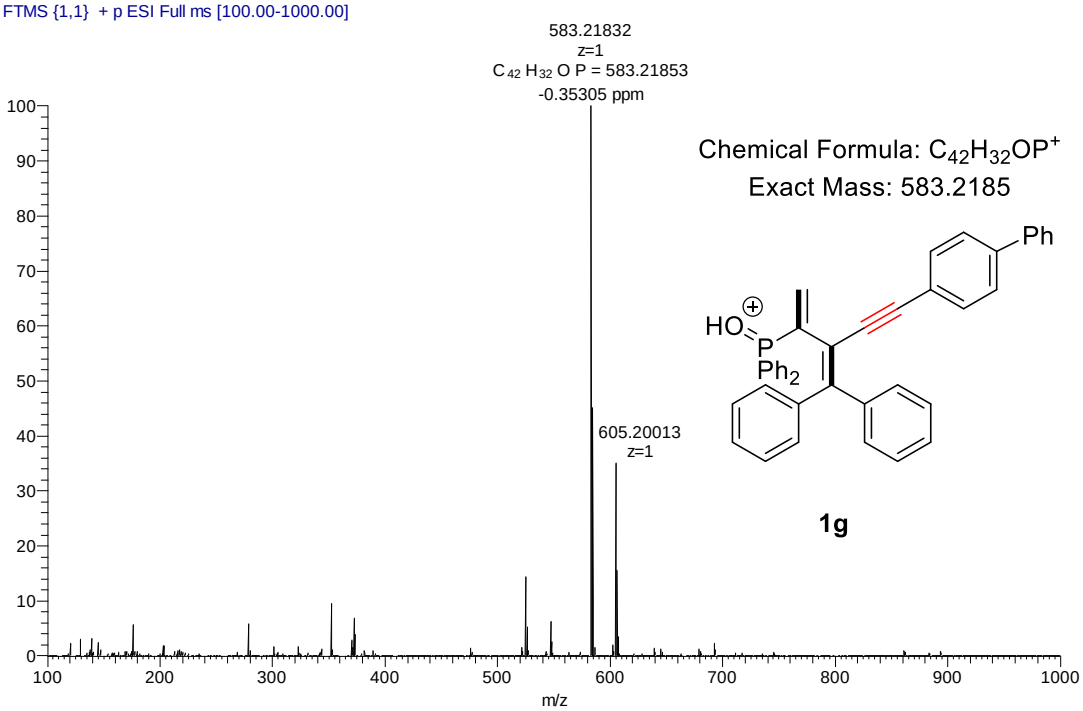
1g


7.90
7.88
7.87
7.87
7.85
7.56
7.51
7.49
7.43
6.78
6.17
6.08
6.06
6.01
Ph
O
P
Ph2
1g
4.25
4.57
10.43
4.22
3.30
2.15
2.05
1.07
1.00
f1 (ppm)

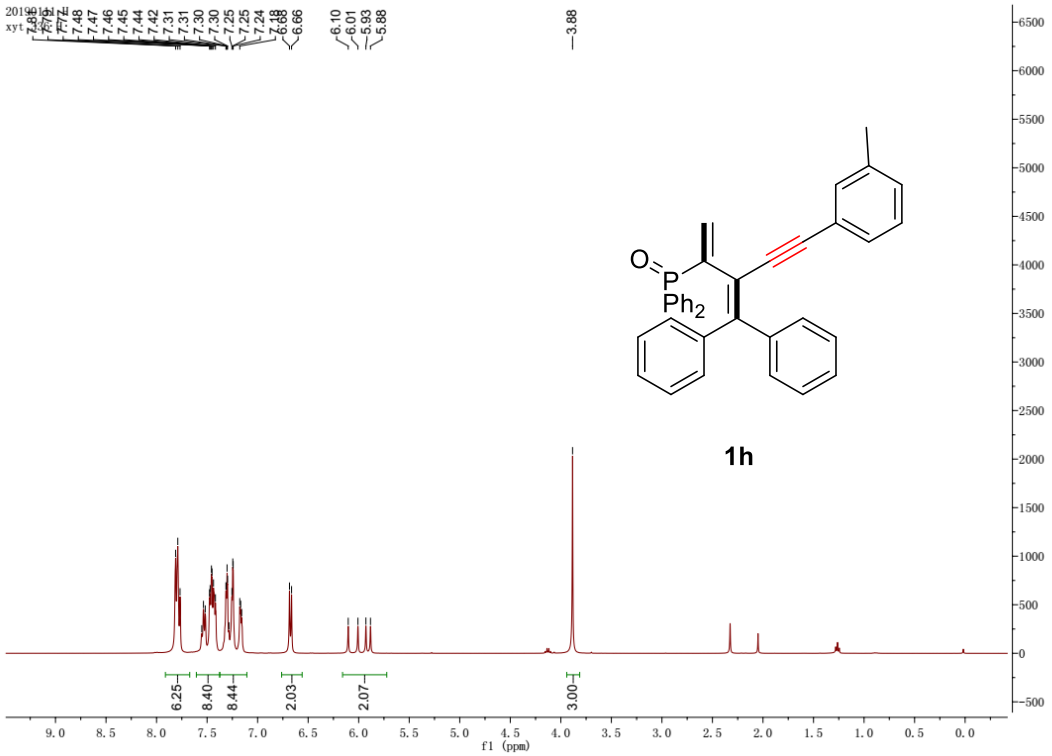

20190111 C
XYT 326-1 C
152.48
152.41
140.75
140.30
132.29
132.19
131.95
131.92
131.64
130.41
130.25
128.92
128.49
128.37
128.12
127.95
127.70
127.63
127.59
126.98
77.59
77.27
76.95
Ph
O
P
Ph2
1g
f1 (ppm)

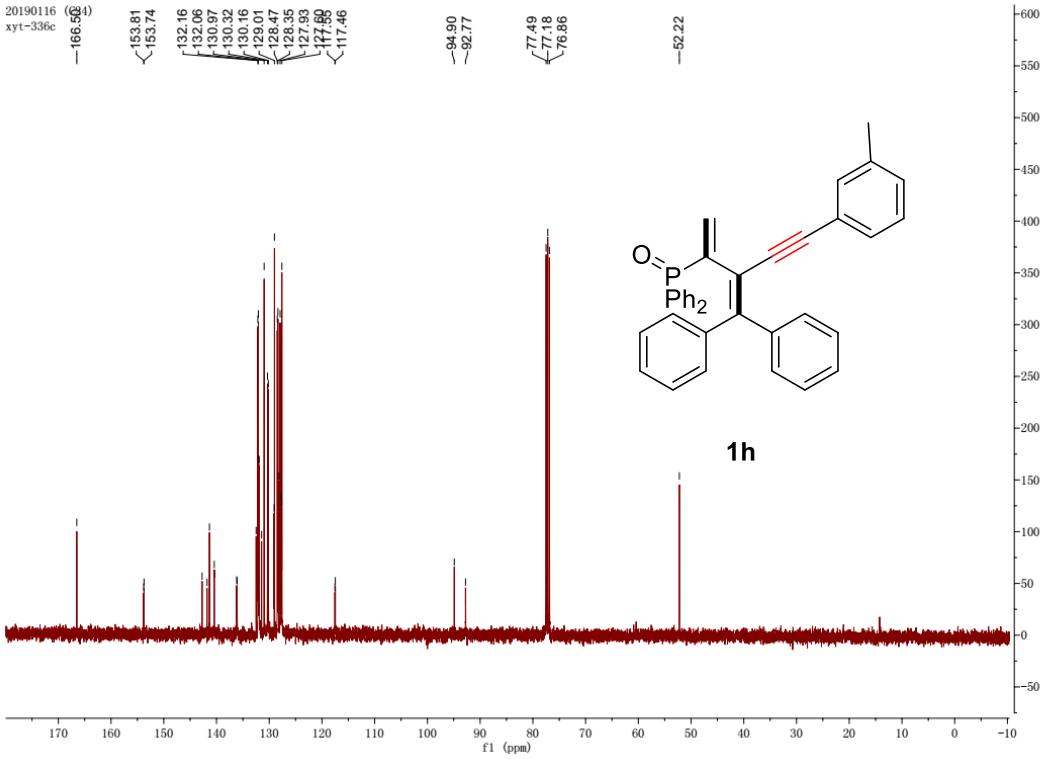


20190109-8 #29 RT: 0.44 AV: 1 NL: 4.96E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



1h


7.48
7.47
7.46
7.45
7.44
7.42
7.31
7.31
7.30
7.30
7.25
7.25
7.24
7.18
6.88
6.66
6.10
6.01
5.93
5.88
3.88
O
P
Ph2
1h
6.25
8.40
8.44
2.03
2.07
3.00
f1 (ppm)


153.81
153.74
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132.06
130.97
130.32
130.16
129.01
128.47
128.35
127.93
94.90
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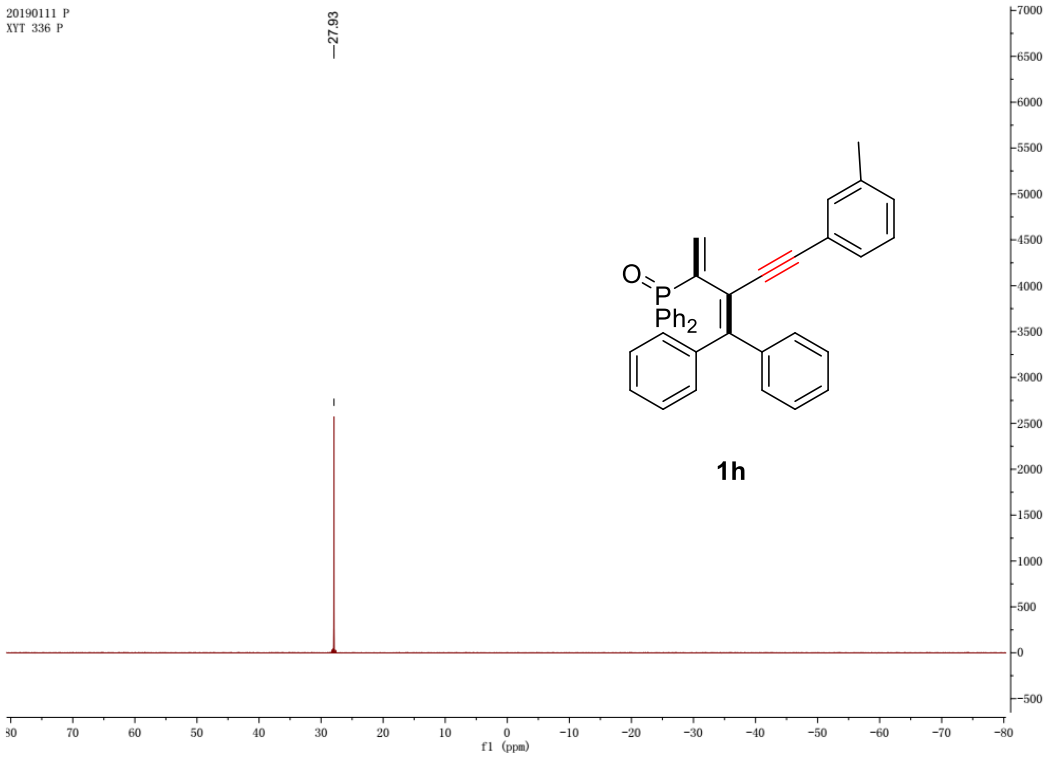
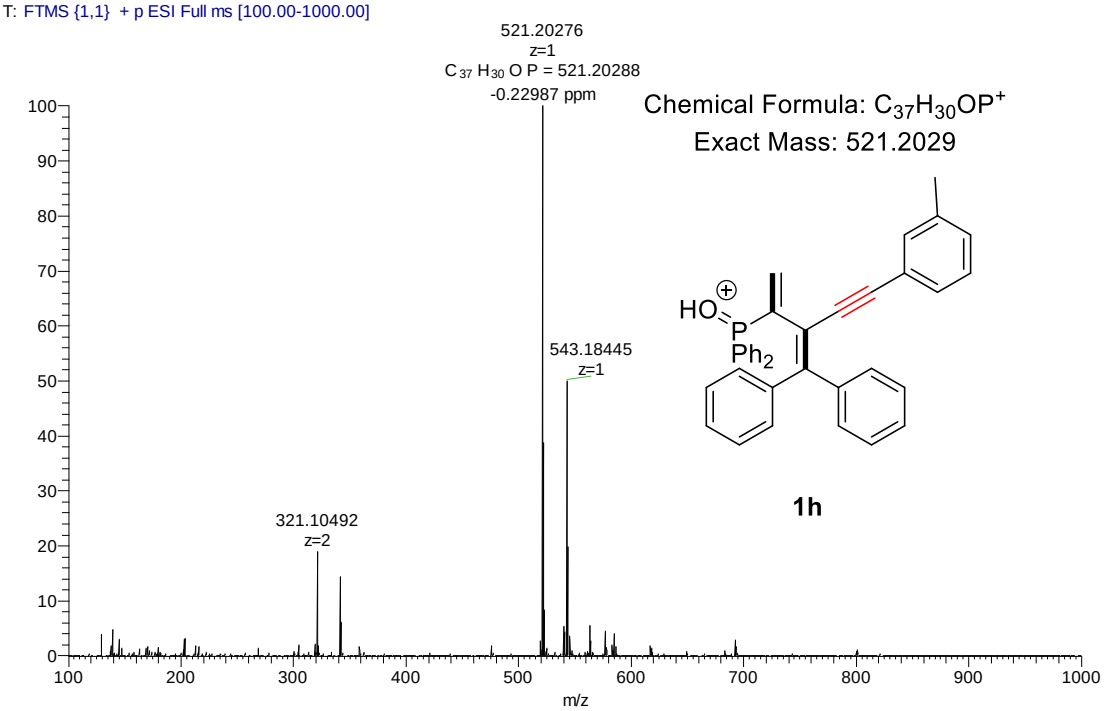
52.22
O
P
Ph2
1h
f1 (ppm)



20190109-6 #37 RT: 0.56 AV: 1 NL: 2.71E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



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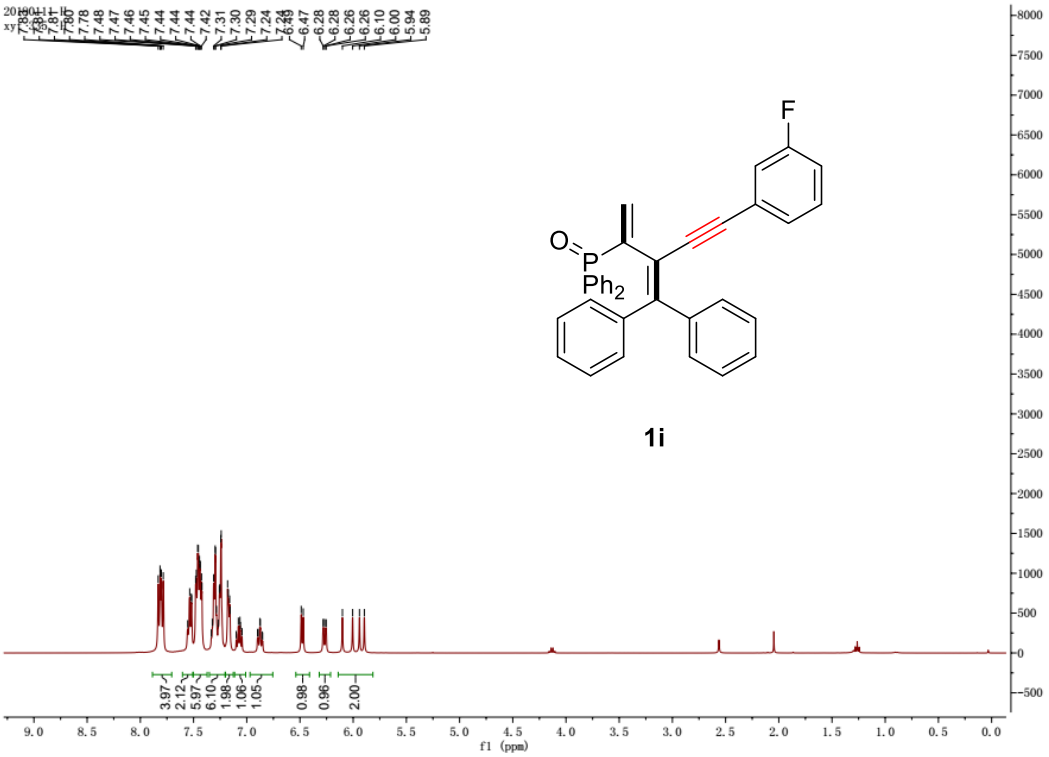
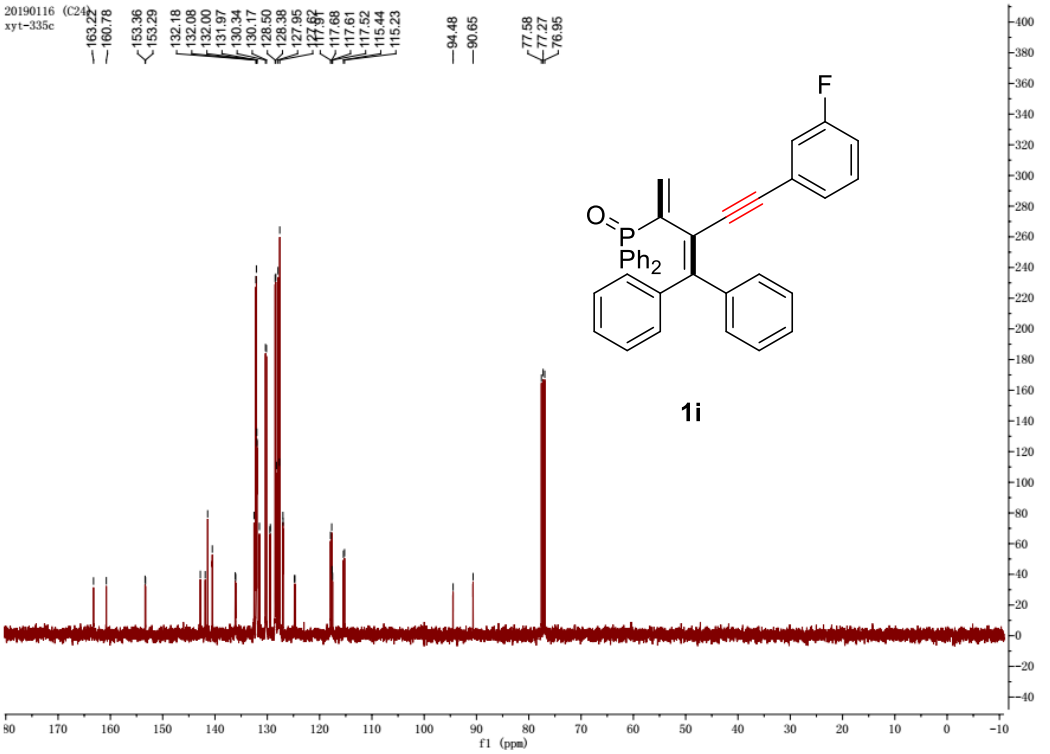
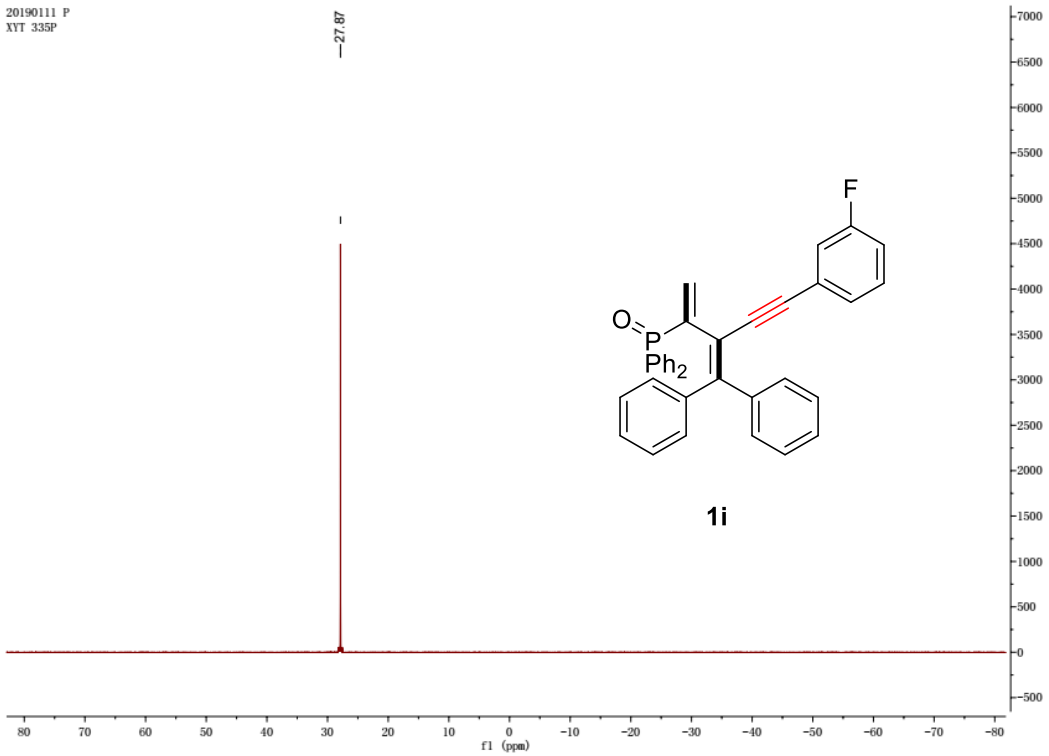
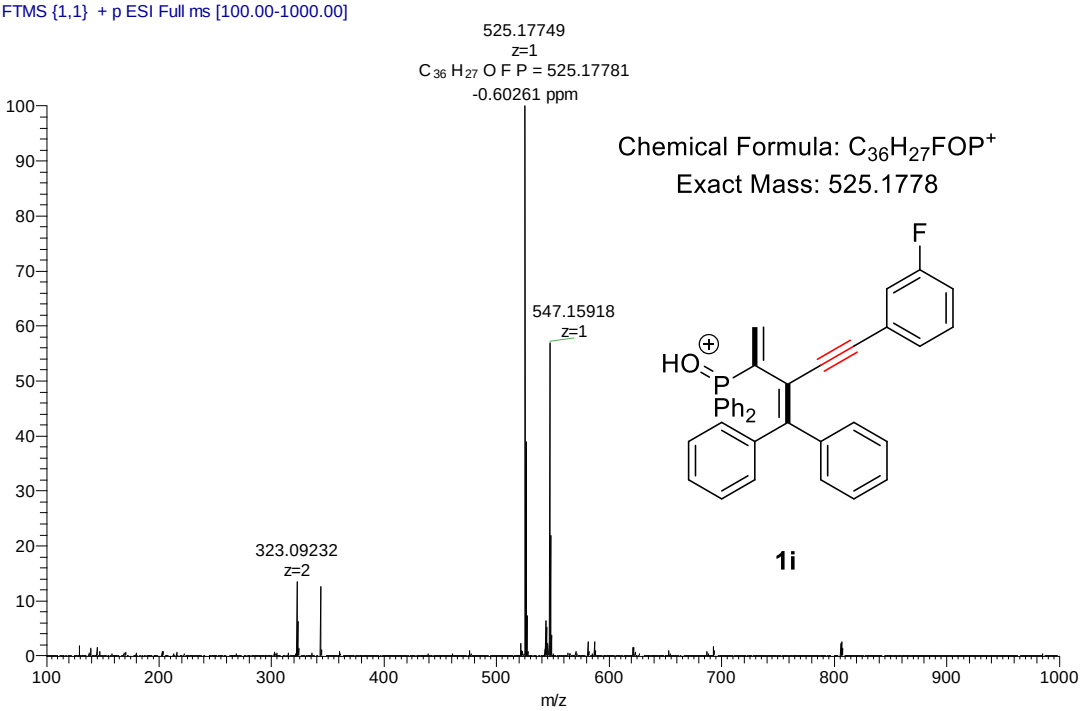


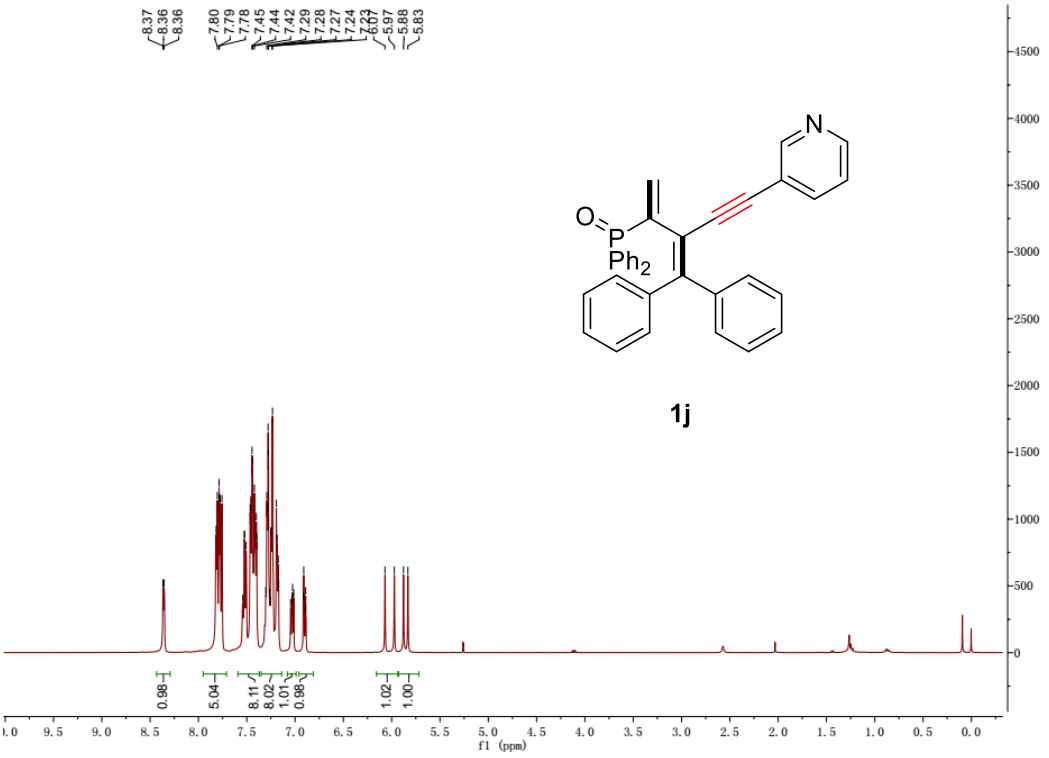


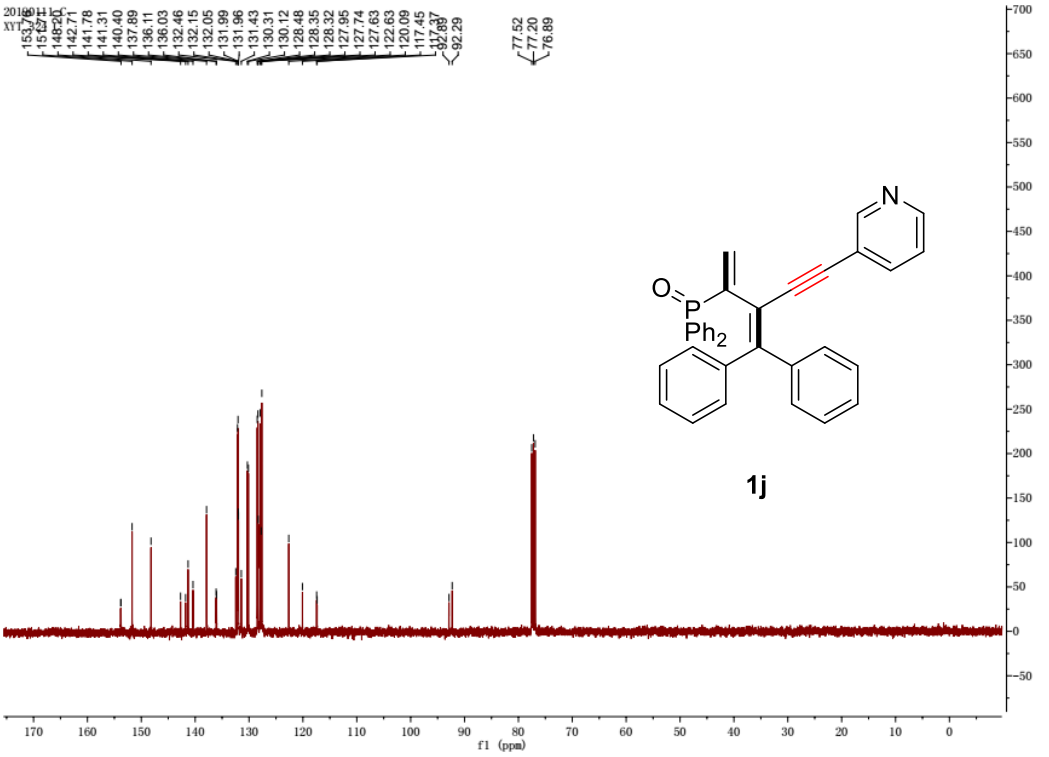


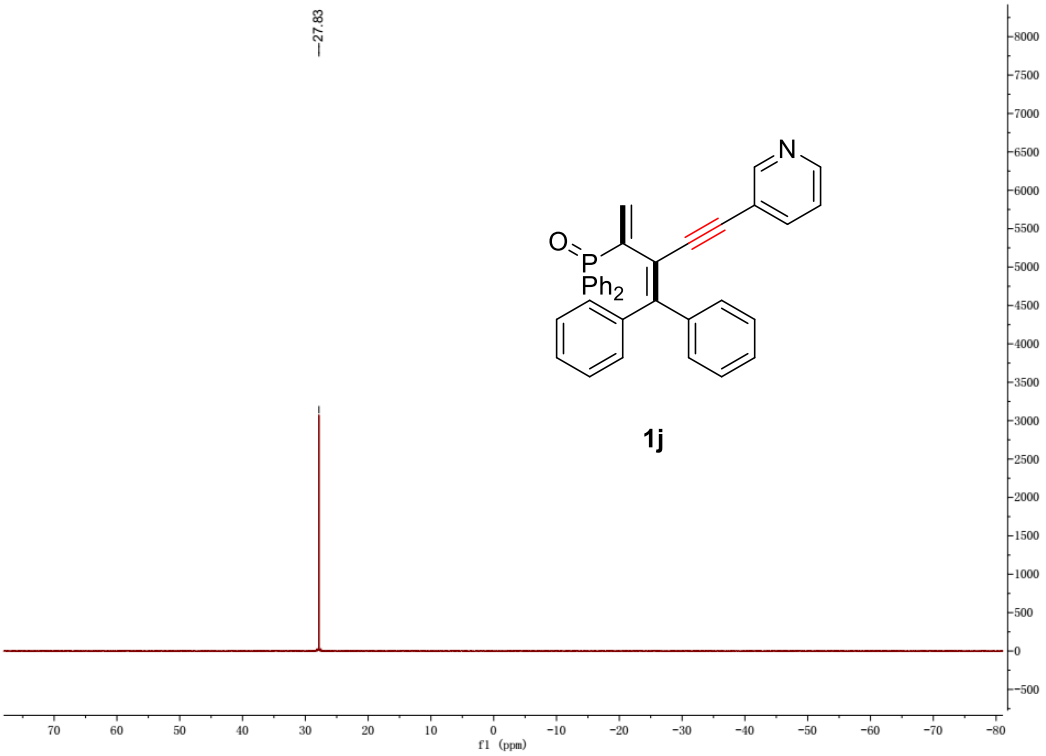
20190109-7 #37 RT: 0.55 AV: 1 NL: 7.98E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]



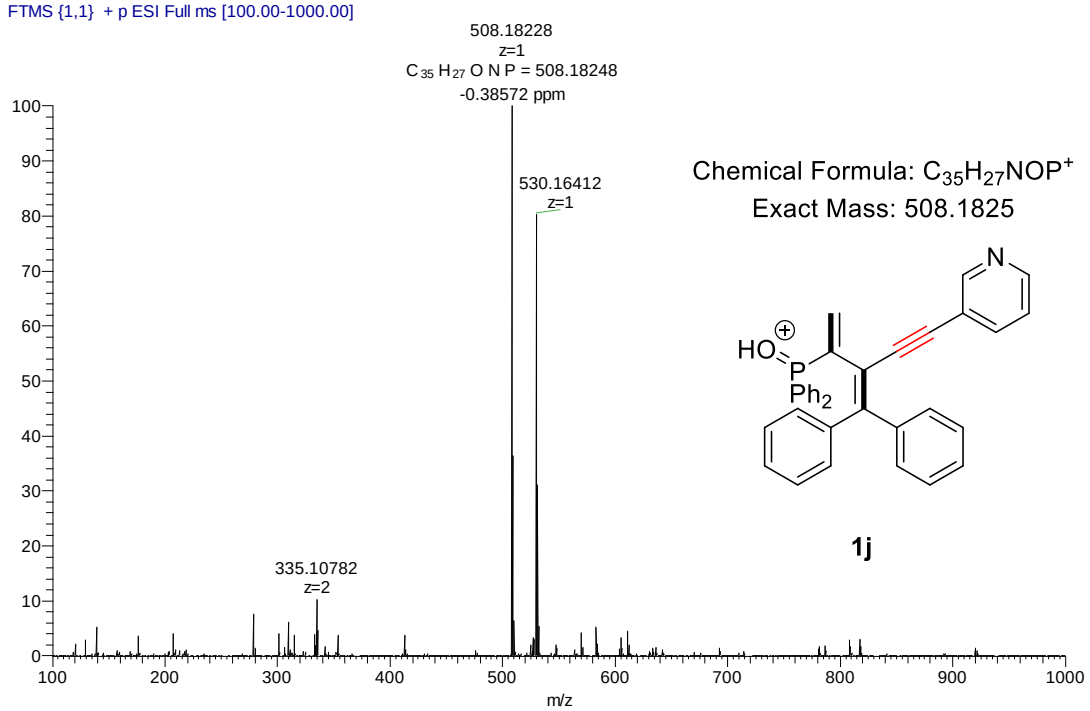
1j


8.37
8.36
8.36
7.80
7.79
7.78
7.45
7.44
7.42
7.29
7.28
7.27
7.24
6.03
6.01
5.97
5.88
5.83
O
P
Ph2
N
1j
0.98
5.04
8.11
8.02
1.01
0.98
1.02
1.00
f1 (ppm)


153.76
148.20
142.71
141.78
141.31
140.40
137.89
136.11
136.03
132.46
132.15
132.05
131.99
131.96
131.43
130.31
130.12
128.48
128.35
128.32
127.95
127.74
127.63
122.63
120.09
117.45
92.29
77.52
77.20
76.89
O
P
Ph2
N
1j
f1 (ppm)



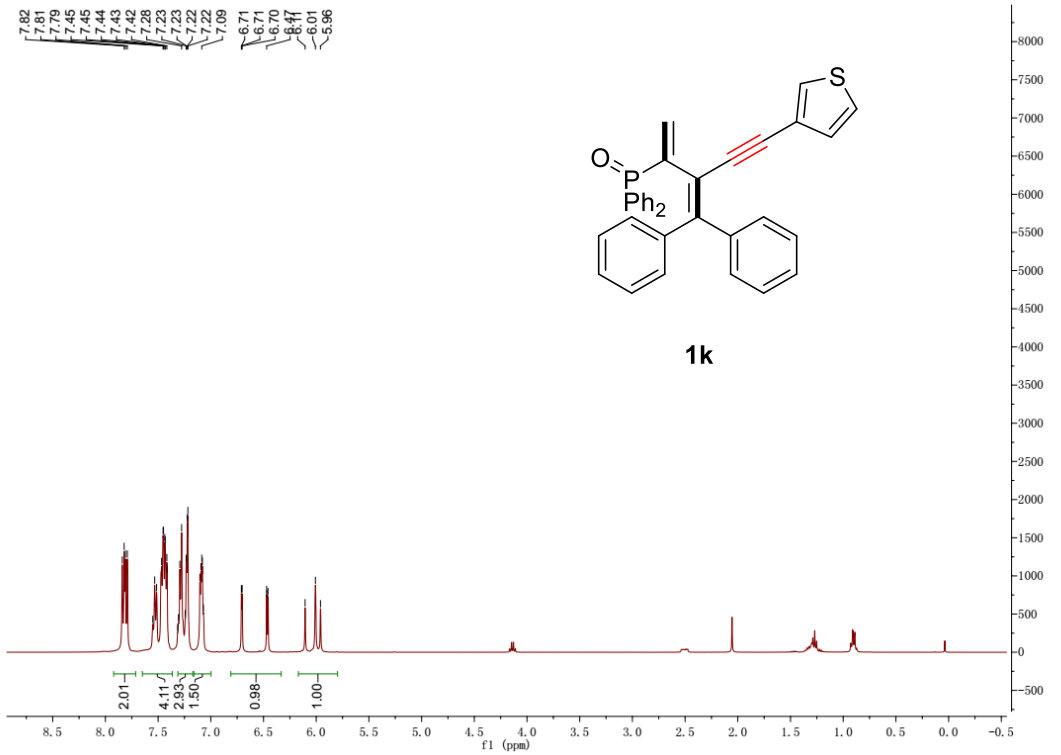
20190109-9 #29 RT: 0.43 AV: 1 NL: 5.56E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]

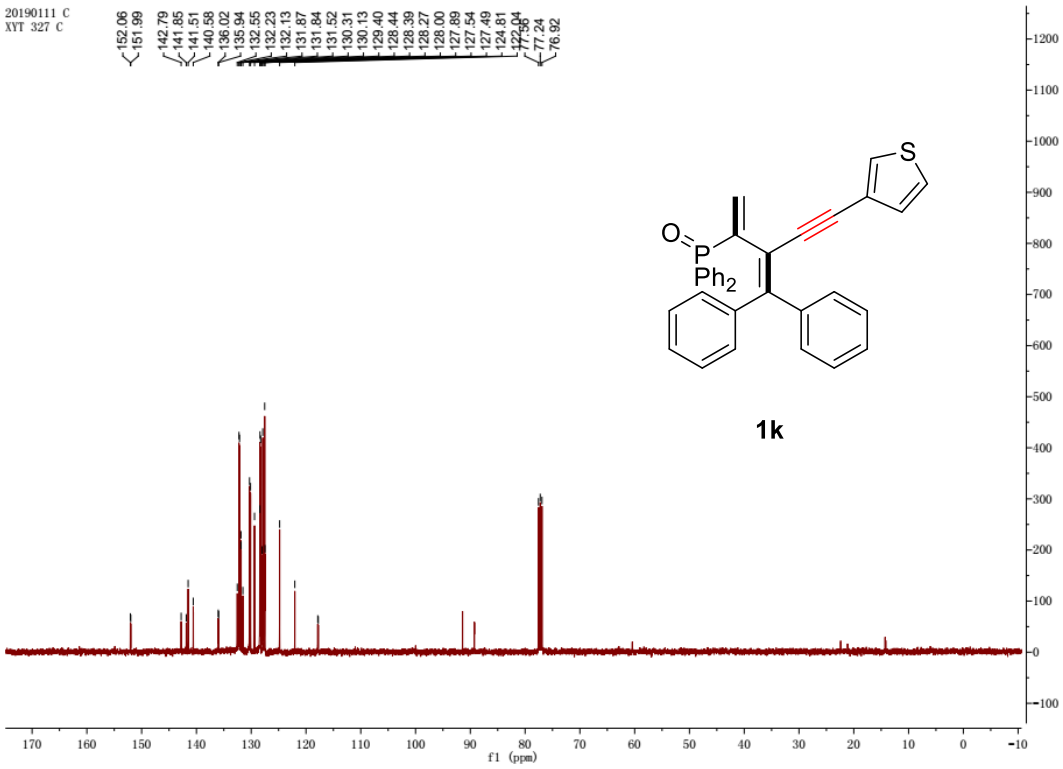


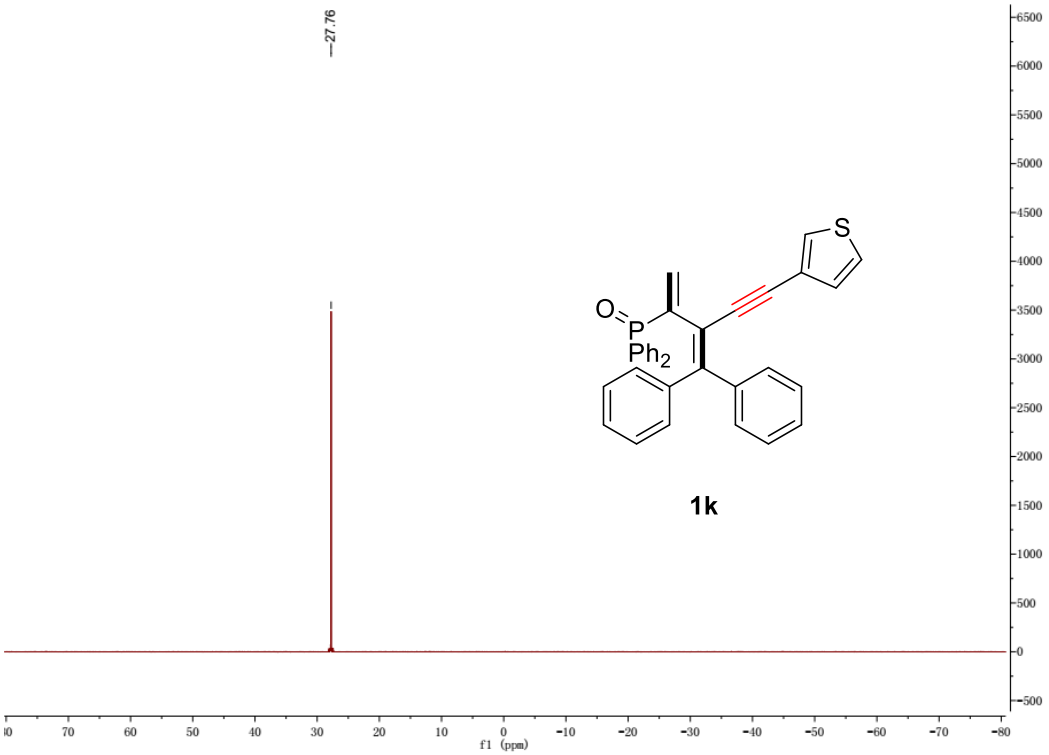
Chemical Formula: $C_{35}H_{27}NOP^{+}$
Exact Mass: 508.1825

1j

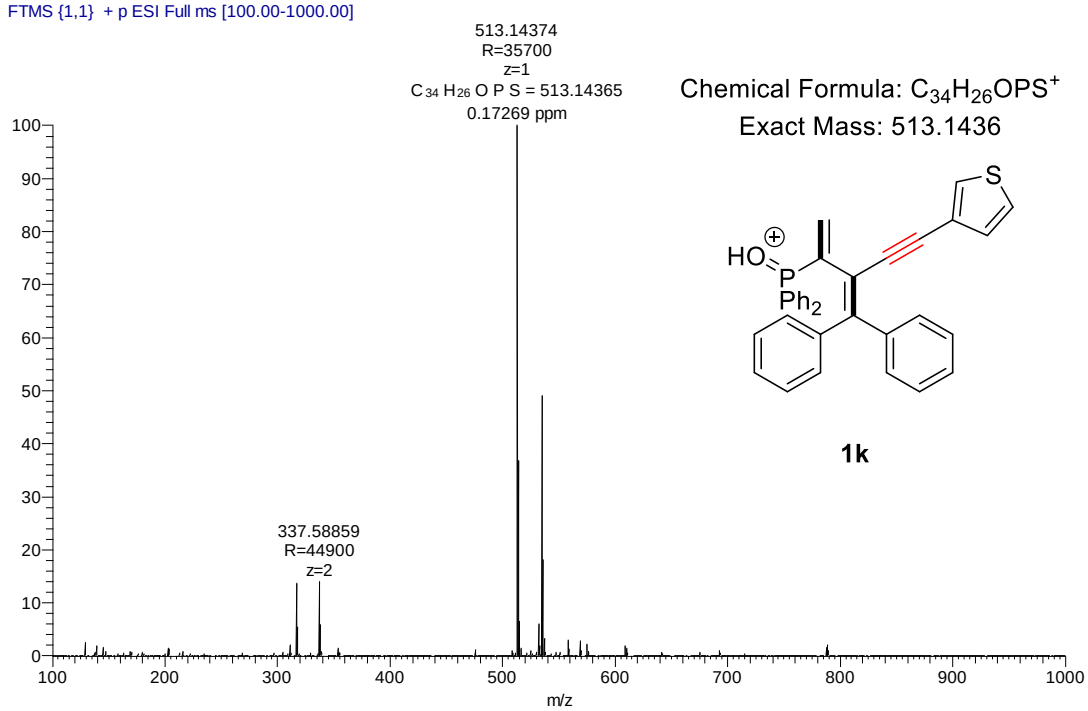
1k


7.82
7.81
7.79
7.45
7.45
7.44
7.43
7.42
7.28
7.23
7.23
7.22
7.22
7.09
6.71
6.71
6.70
6.47
6.41
6.01
5.96
S
O
P
Ph2
1k
2.01
4.11
2.93
1.50
0.98
1.00
f1 (ppm)


20190111 C
XYT 327 C
152.06
151.99
142.79
141.85
141.51
140.58
136.02
135.94
132.55
132.23
132.13
131.87
131.84
131.52
130.31
130.13
129.40
128.44
128.39
128.27
128.00
127.89
127.54
127.49
124.81
122.04
77.56
77.24
76.92
S
O
P
Ph2
1k
f1 (ppm)



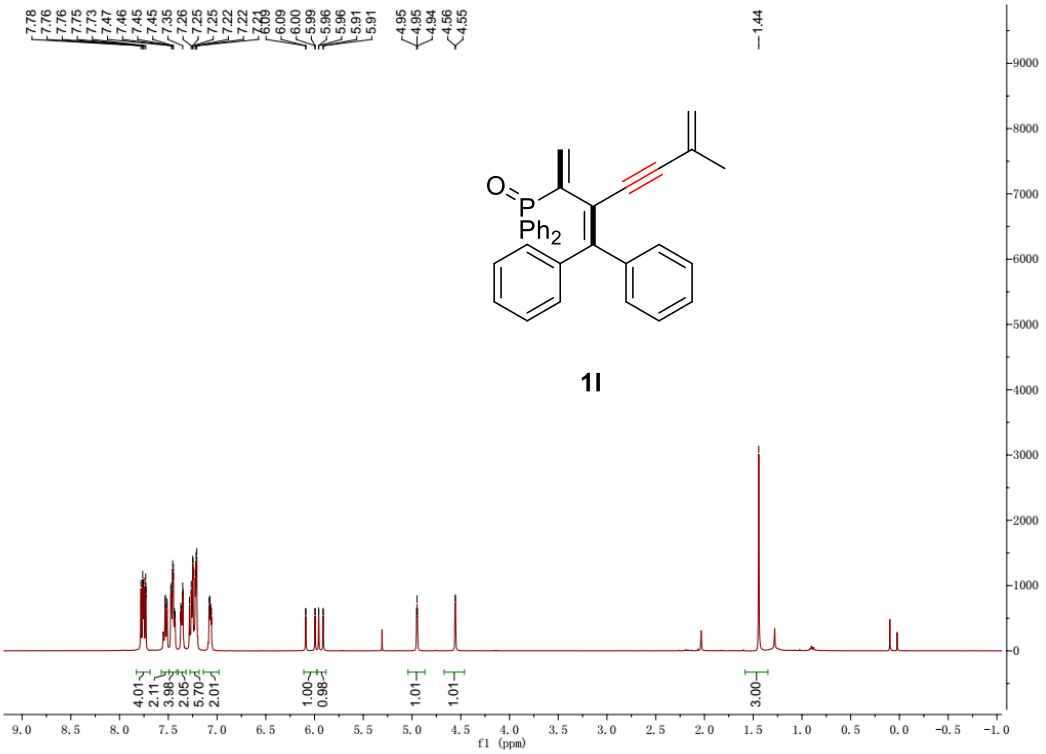
20190109-10 #37 RT: 0.55 AV: 1 NL: 4.84E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]

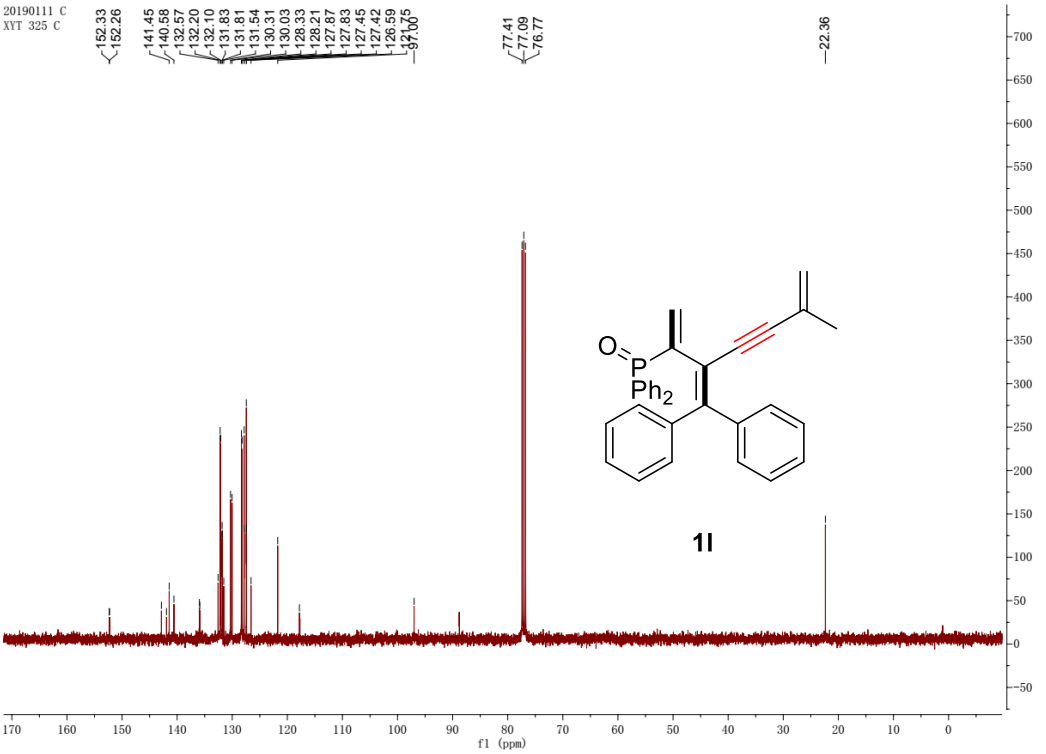


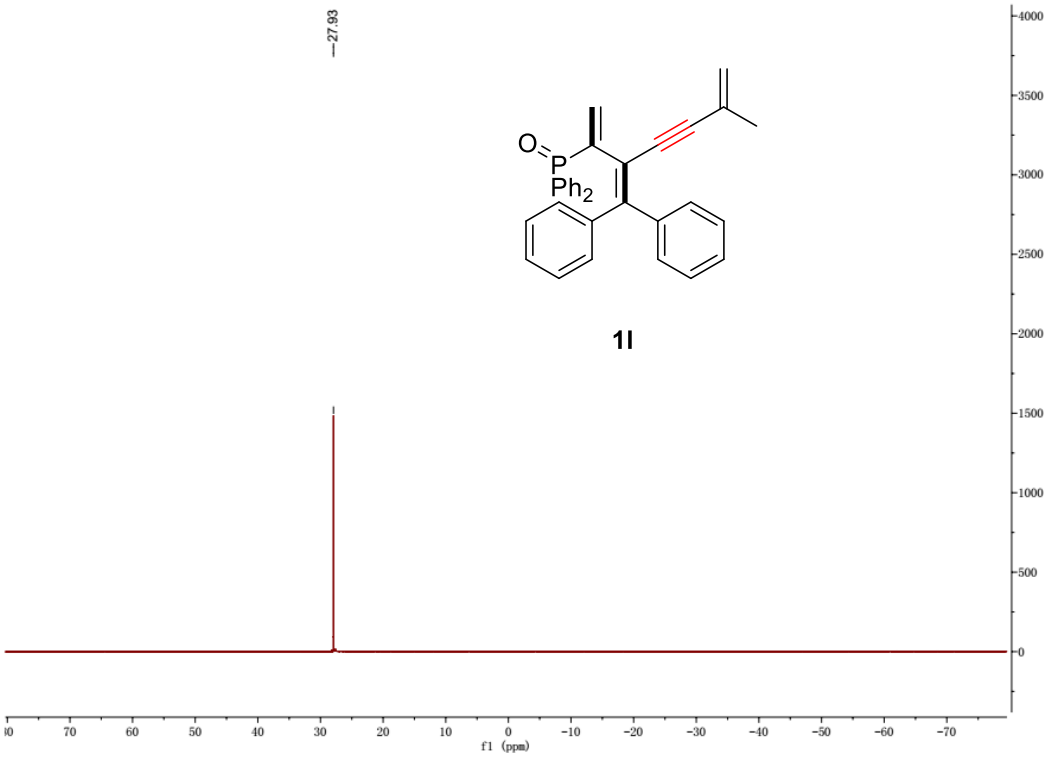
Chemical Formula: $C_{34}H_{26}OPS^{+}$
Exact Mass: 513.1436

1k

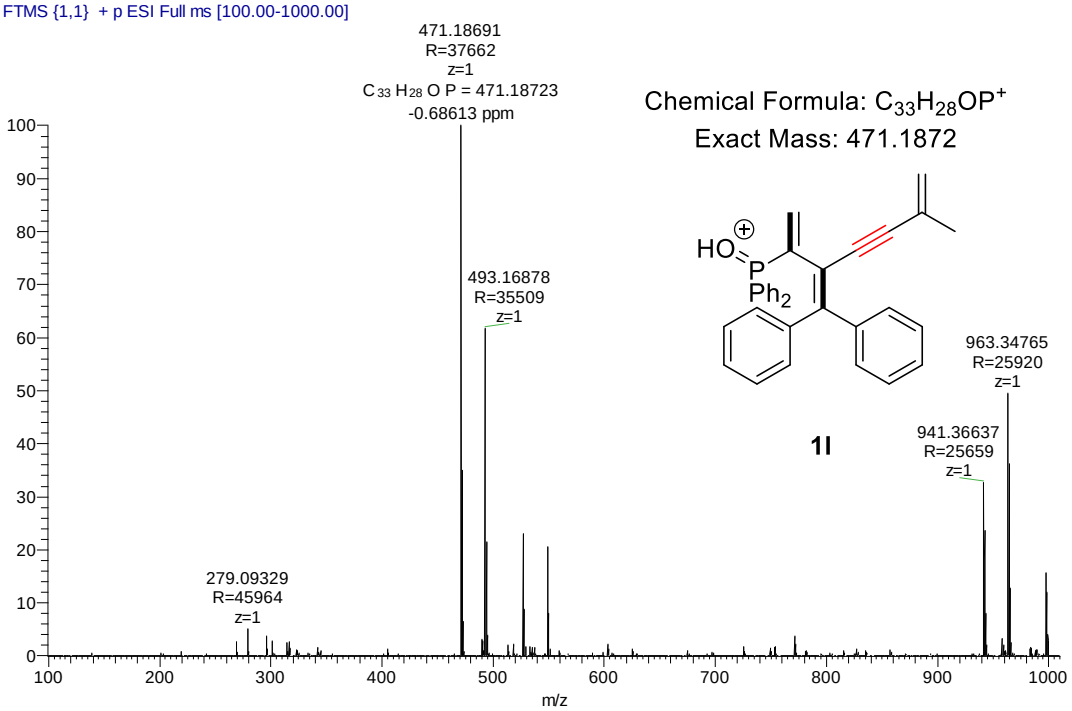
1l


7.78
7.76
7.76
7.75
7.73
7.47
7.46
7.45
7.45
7.35
7.26
7.25
7.25
7.22
7.22
7.21
6.09
6.09
6.00
5.99
5.96
5.96
5.91
5.91
4.95
4.95
4.94
4.56
4.55
1.44
O
P
Ph2
1l
4.01
2.11
3.98
2.05
5.70
2.01
1.00
0.98
1.01
1.01
3.00
f1 (ppm)

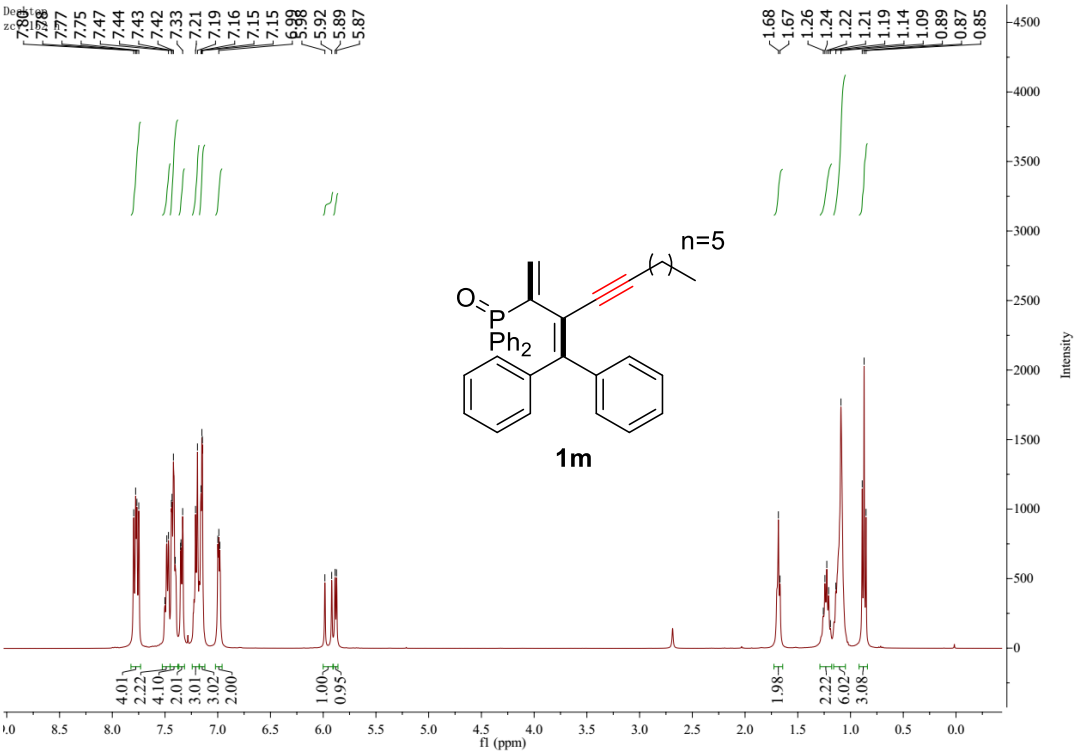

20190111 C
XYT 325 C
152.33
152.26
141.45
140.58
132.57
132.20
132.10
131.83
131.81
131.54
130.31
130.03
128.33
128.21
127.87
127.83
127.45
127.42
126.59
97.00
77.41
77.09
76.77
22.36
O
P
Ph2
1l
f1 (ppm)

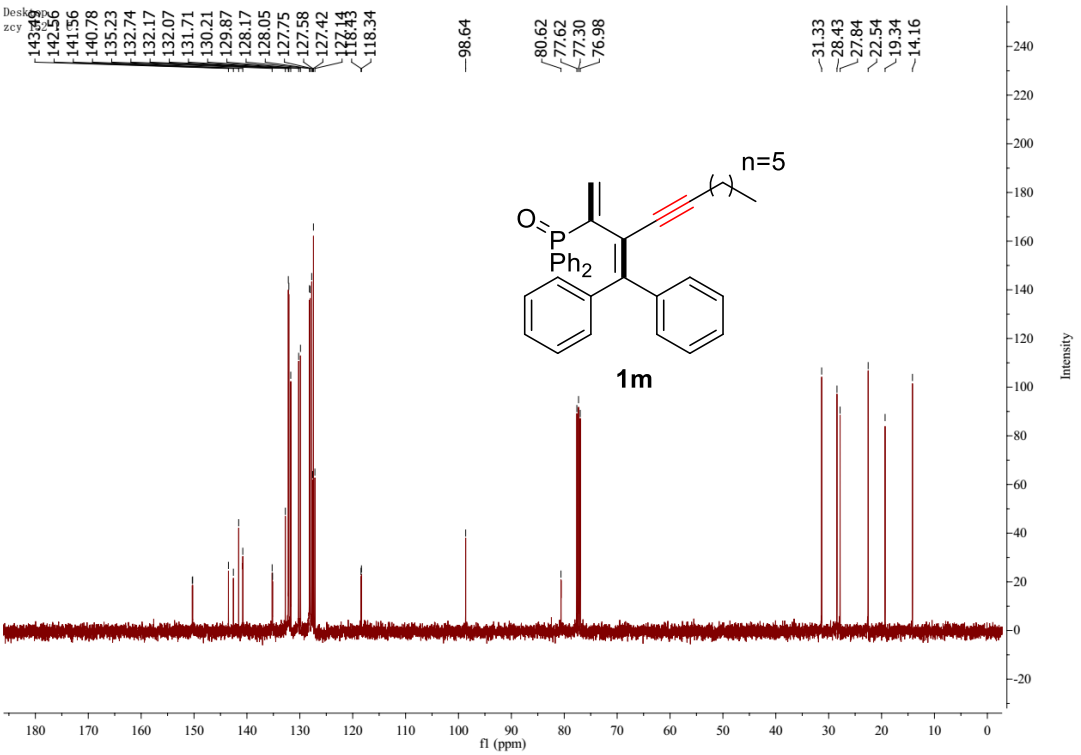


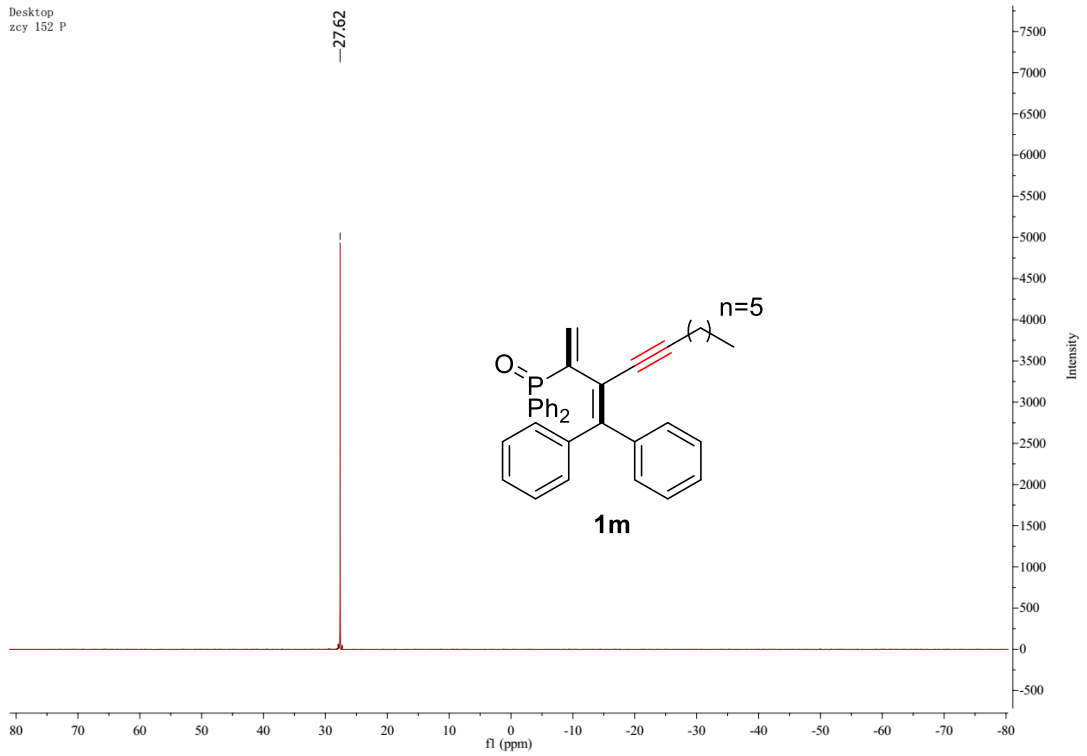
20190109-11 #27 RT: 0.39 AV: 1 SB: 24 0.01-0.06 , 0.70-1.03 NL: 1.01E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]

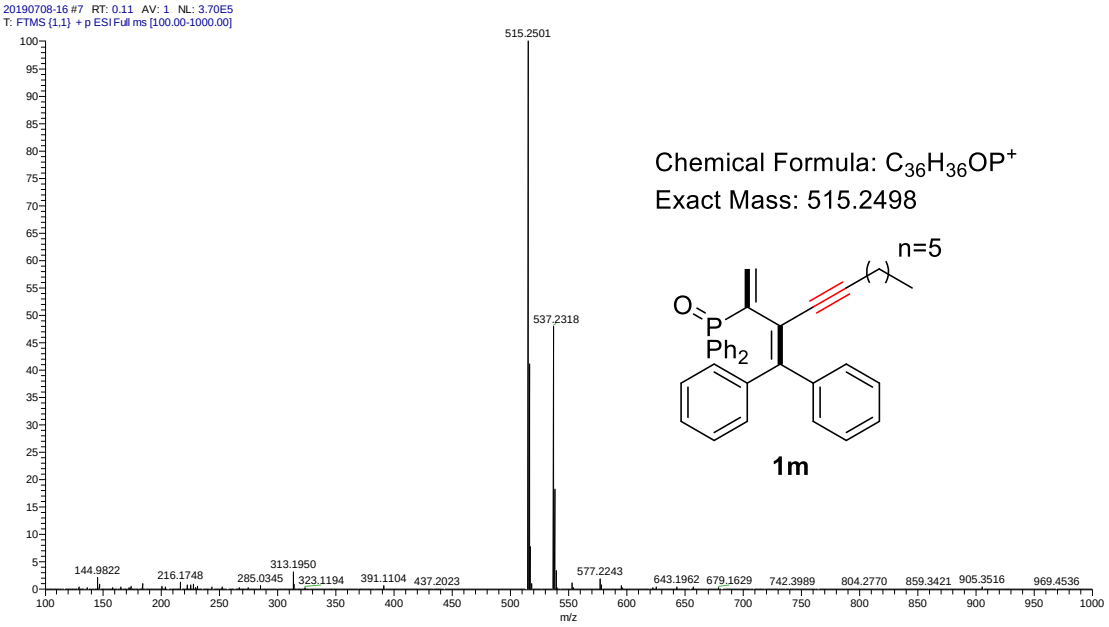


1m







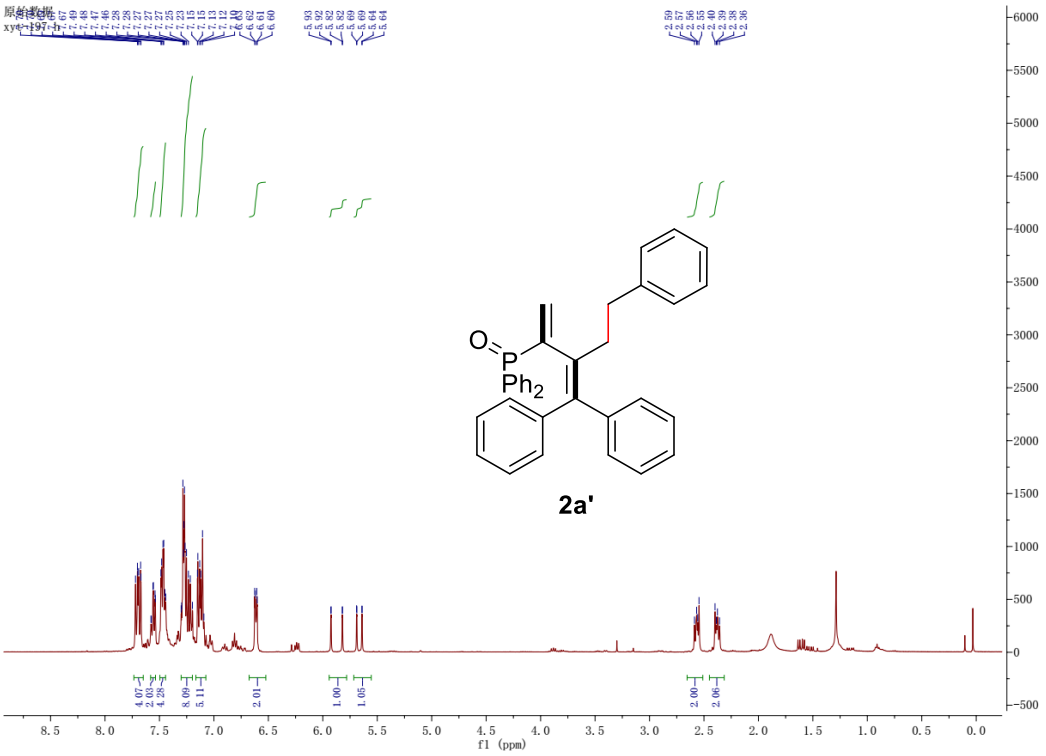


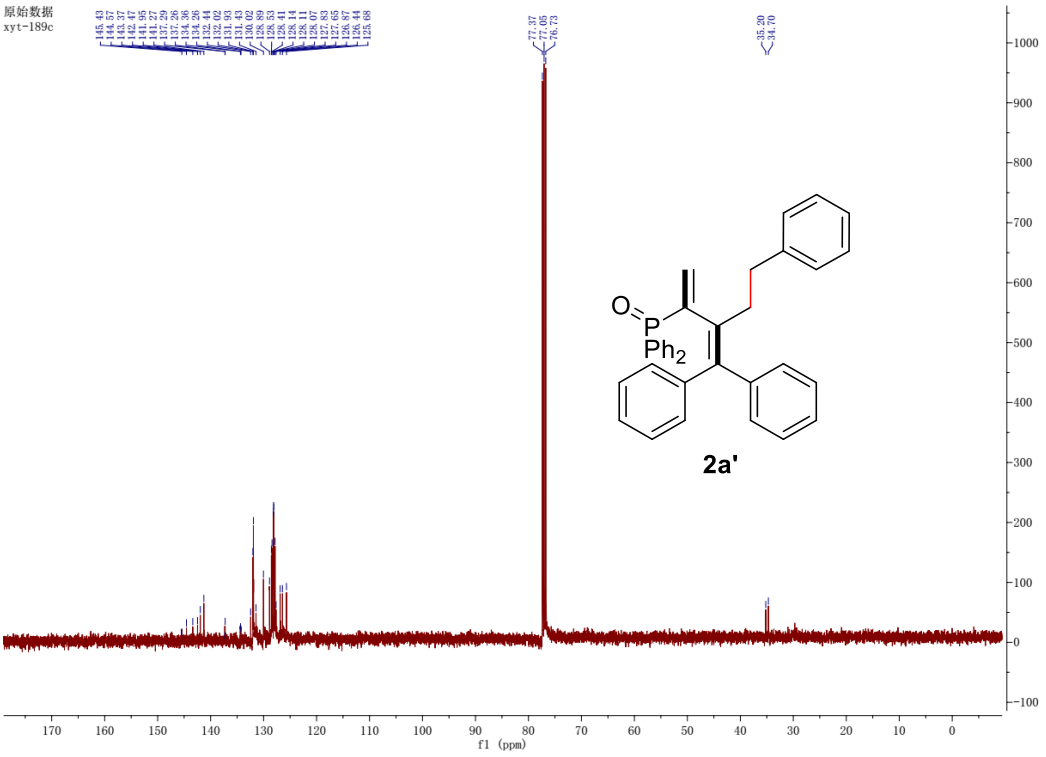
Chemical Formula: $C_{36}H_{36}OP^+$

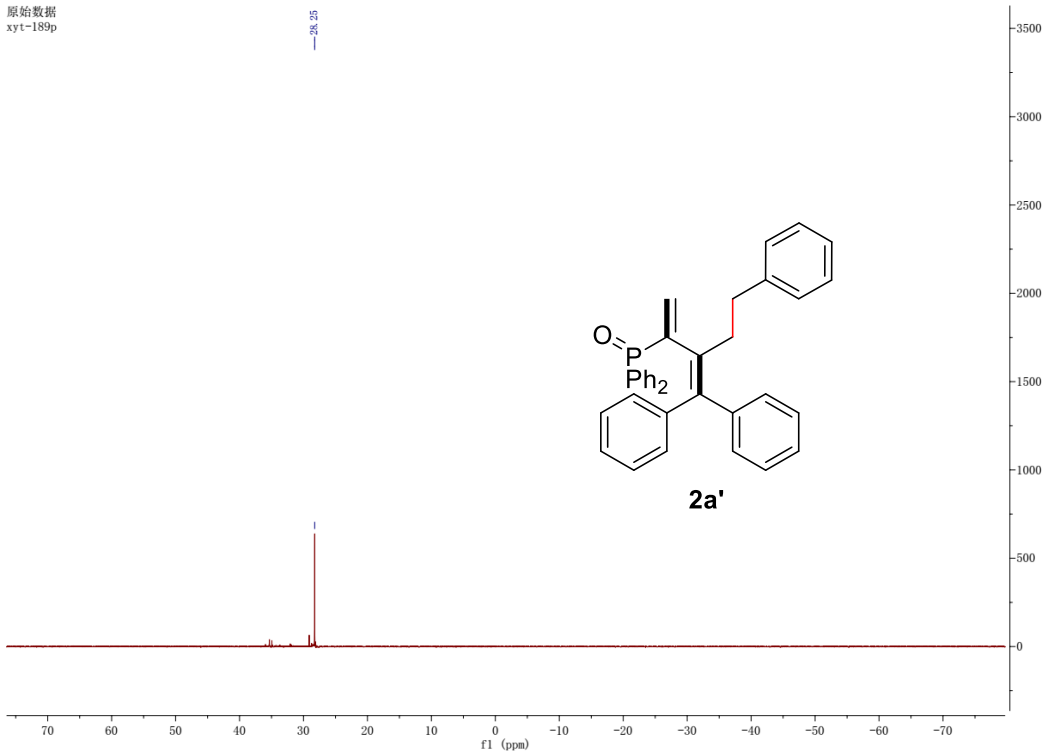
Exact Mass: 515.2498

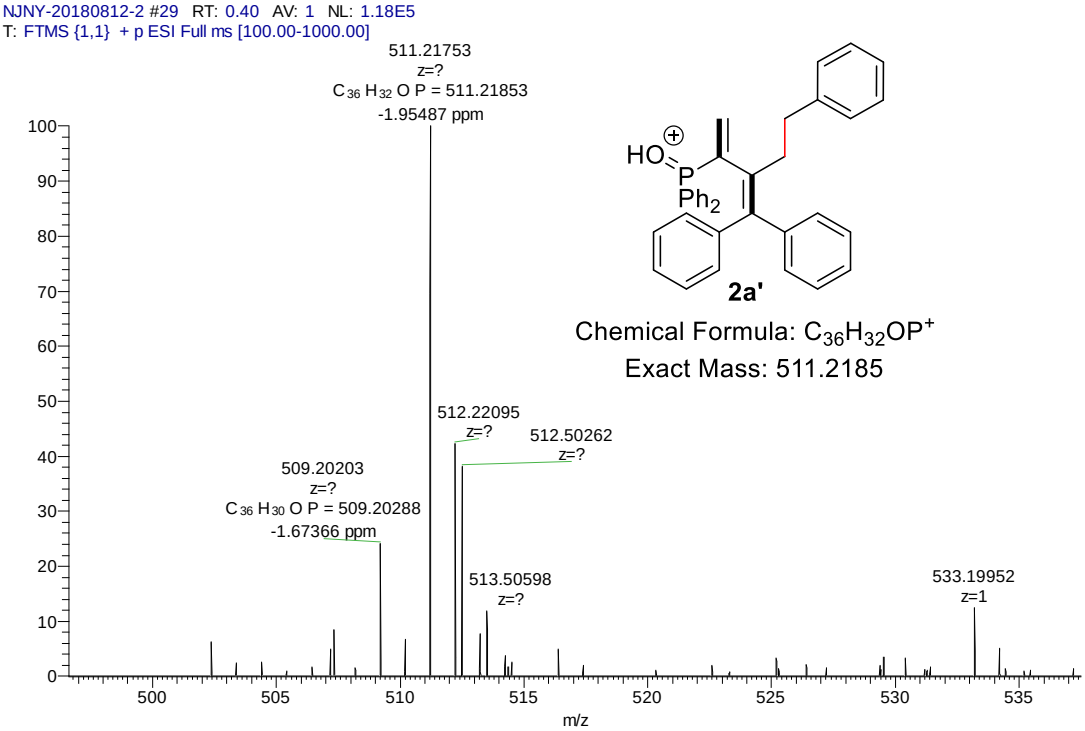
1m

2a’

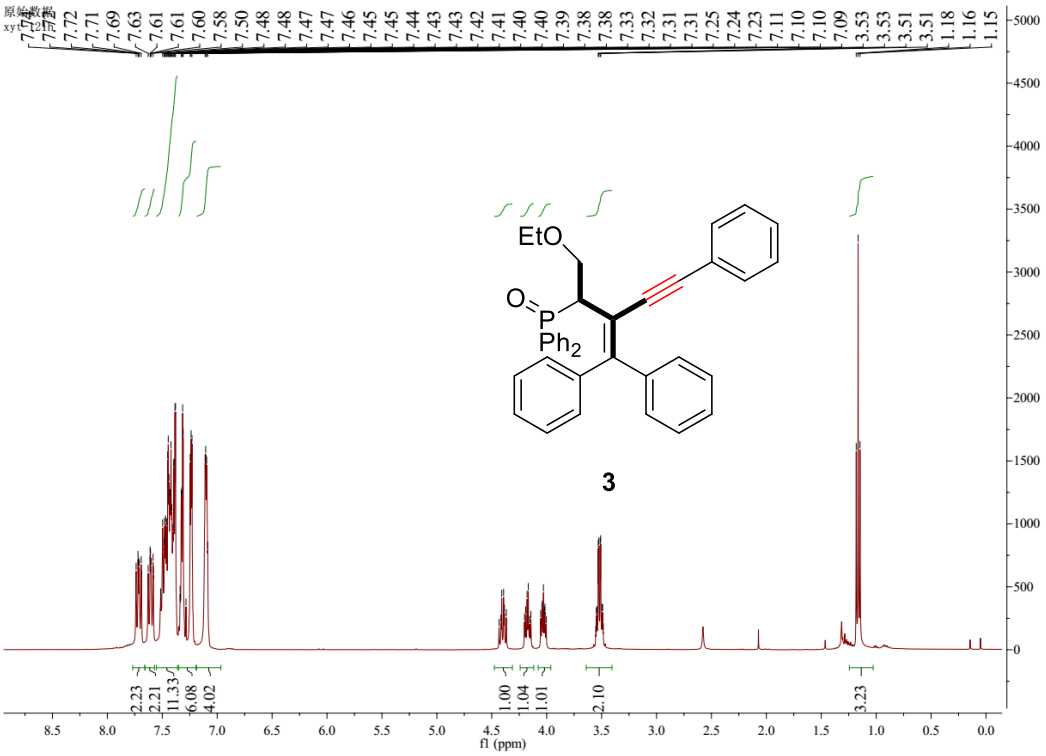


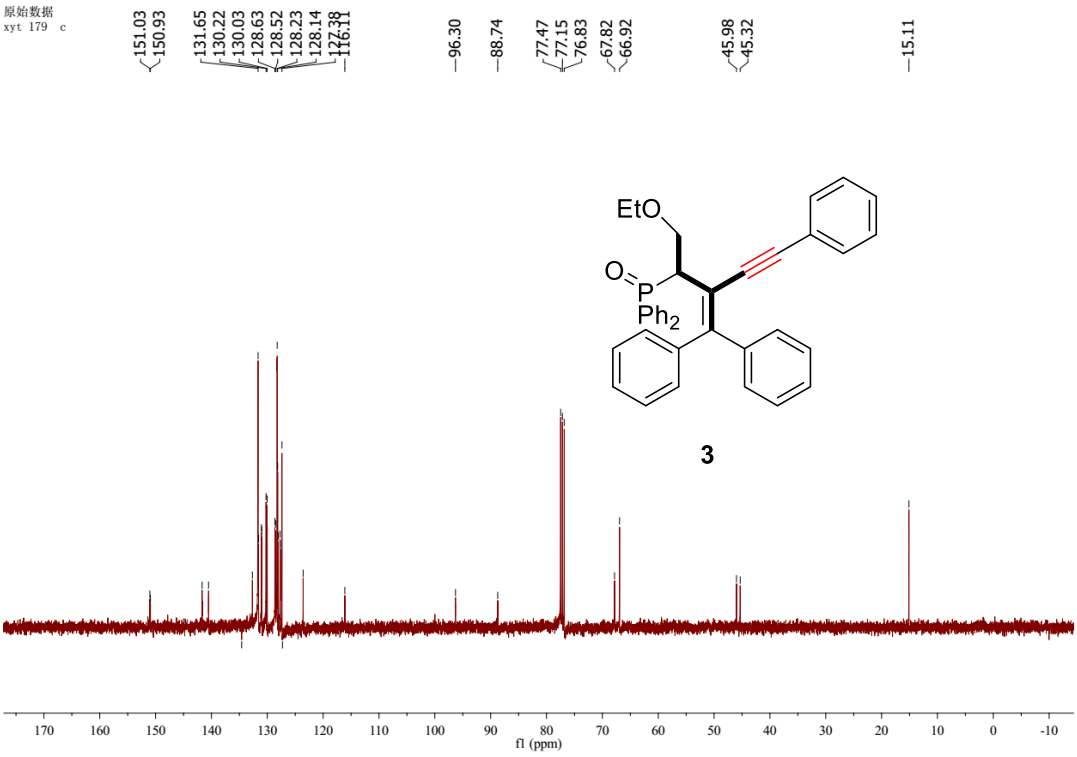


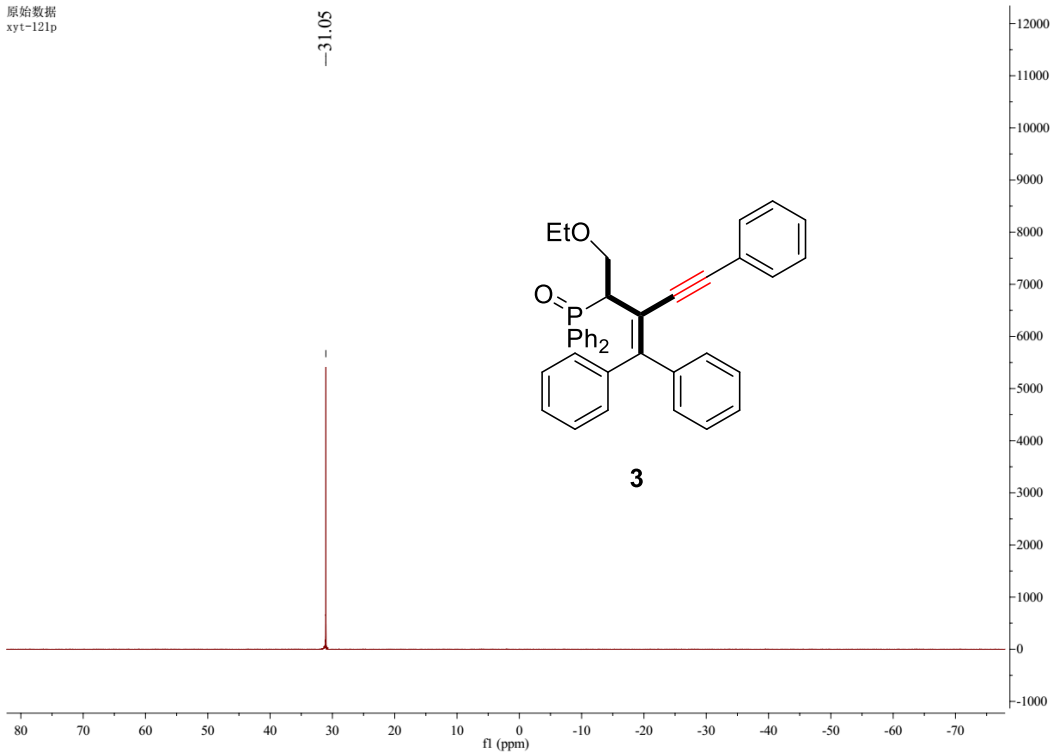

原始数据
xyt-189p
26.25
3500
3000
2500
2000
1500
1000
500
0
O
P
Ph2
2a'
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
f1 (ppm)


NJNY-20180812-2 #29 RT: 0.40 AV: 1 NL: 1.18E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
511.21753
z=?
C36 H32 O P = 511.21853
-1.95487 ppm
HO
P
Ph2
2a'
Chemical Formula: C36H32OP+
Exact Mass: 511.2185
512.22095
z=?
512.50262
z=?
509.20203
z=?
C36 H30 O P = 509.20288
-1.67366 ppm
513.50598
z=?
533.19952
z=1
100
90
80
70
60
50
40
30
20
10
0
500
505
510
515
520
525
530
535
m/z

3

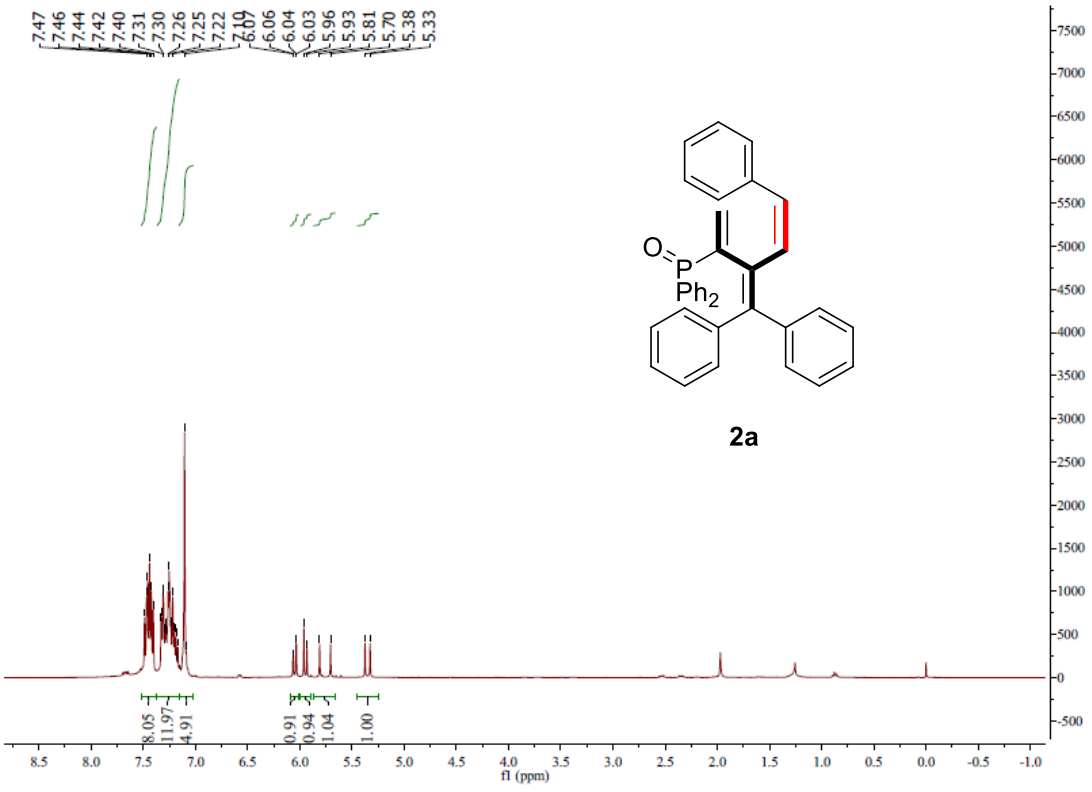




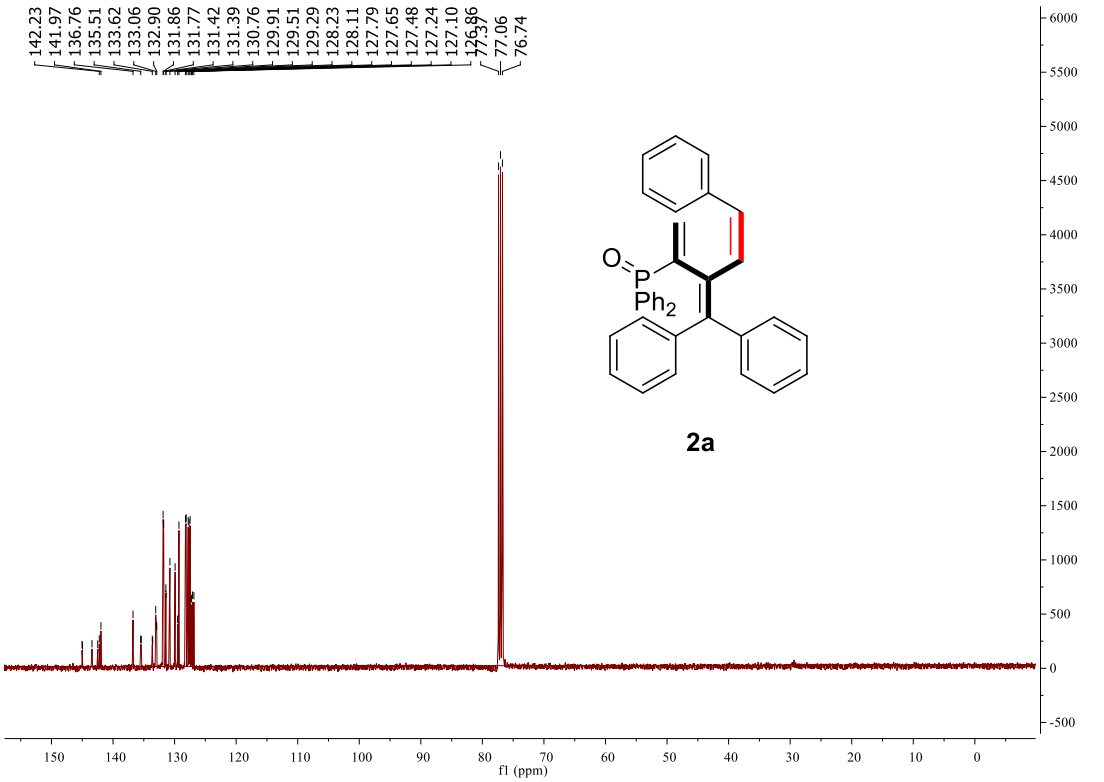

原始数据
xyt-121p
31.05
EtO
O
P
Ph2
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70
f1 (ppm)

3

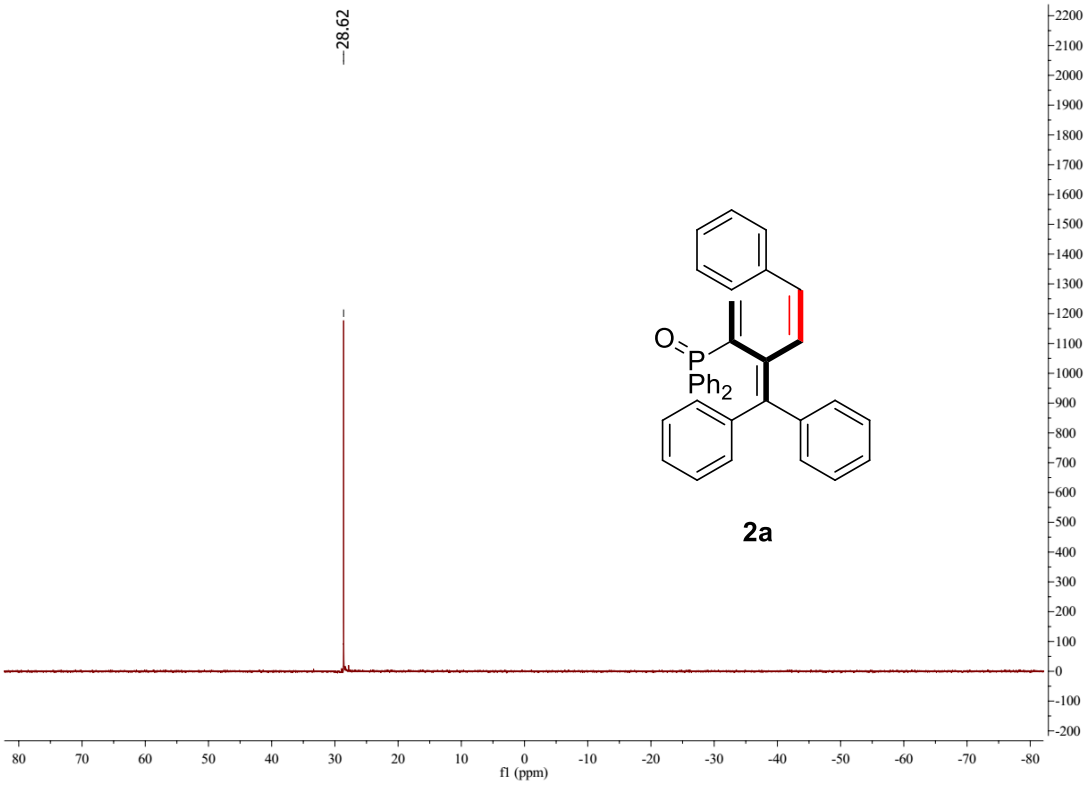
2a


7.47
7.46
7.44
7.42
7.40
7.31
7.30
7.26
7.25
7.22
7.10
6.07
6.06
6.04
6.03
5.96
5.93
5.81
5.70
5.38
5.33
O
P
Ph2
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
8.05
11.97
4.91
0.91
0.94
1.04
1.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

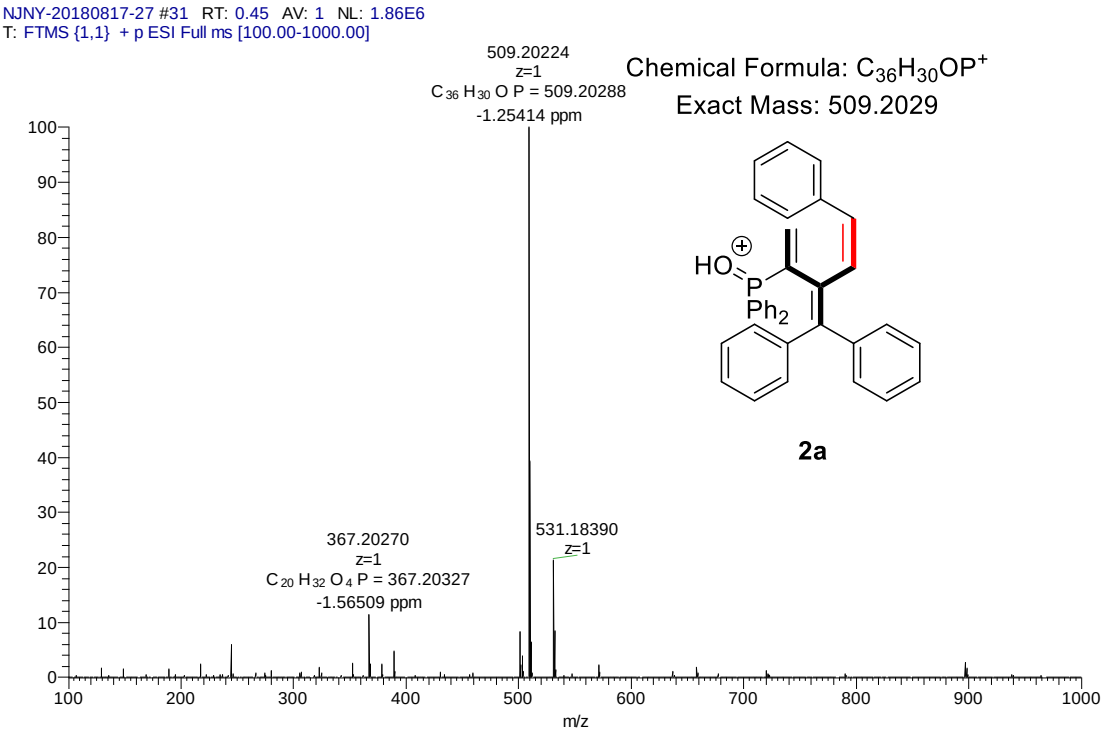
2a


142.23
141.97
136.76
135.51
133.62
133.06
132.90
131.86
131.77
131.42
131.39
130.76
129.91
129.51
129.29
128.23
128.11
127.79
127.65
127.48
127.24
127.10
126.86
77.37
77.06
76.74
O
P
Ph2
f1 (ppm)

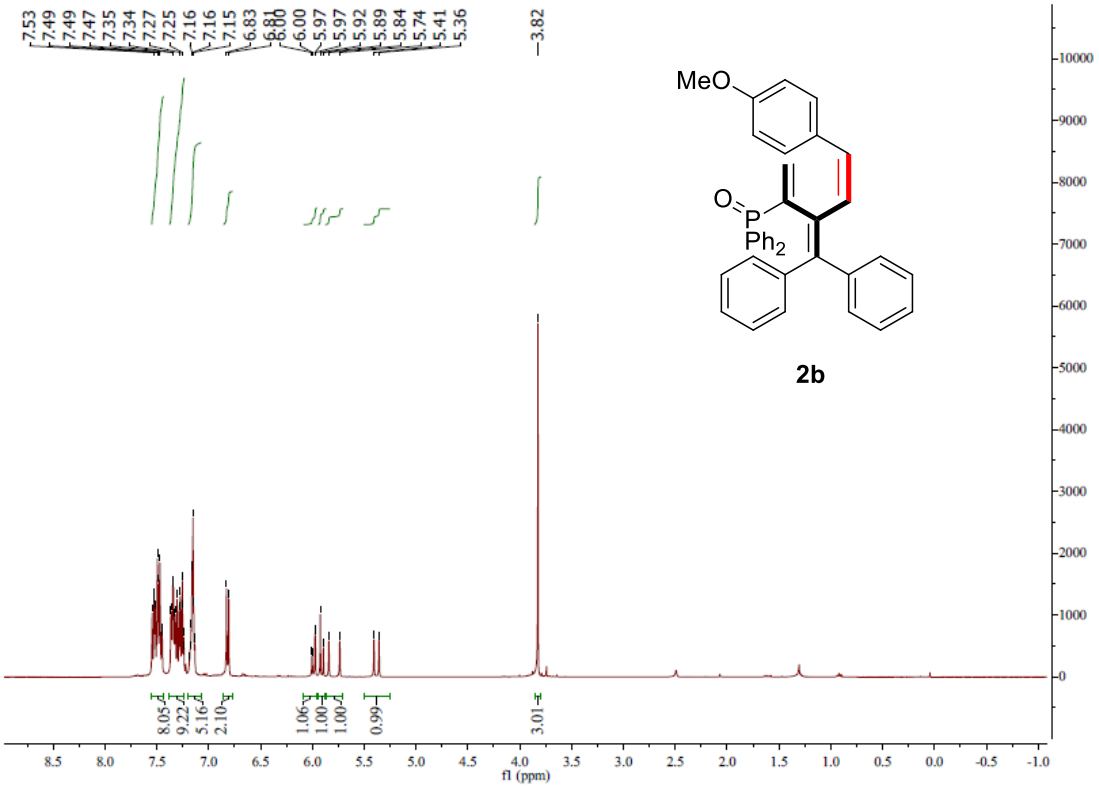
2a

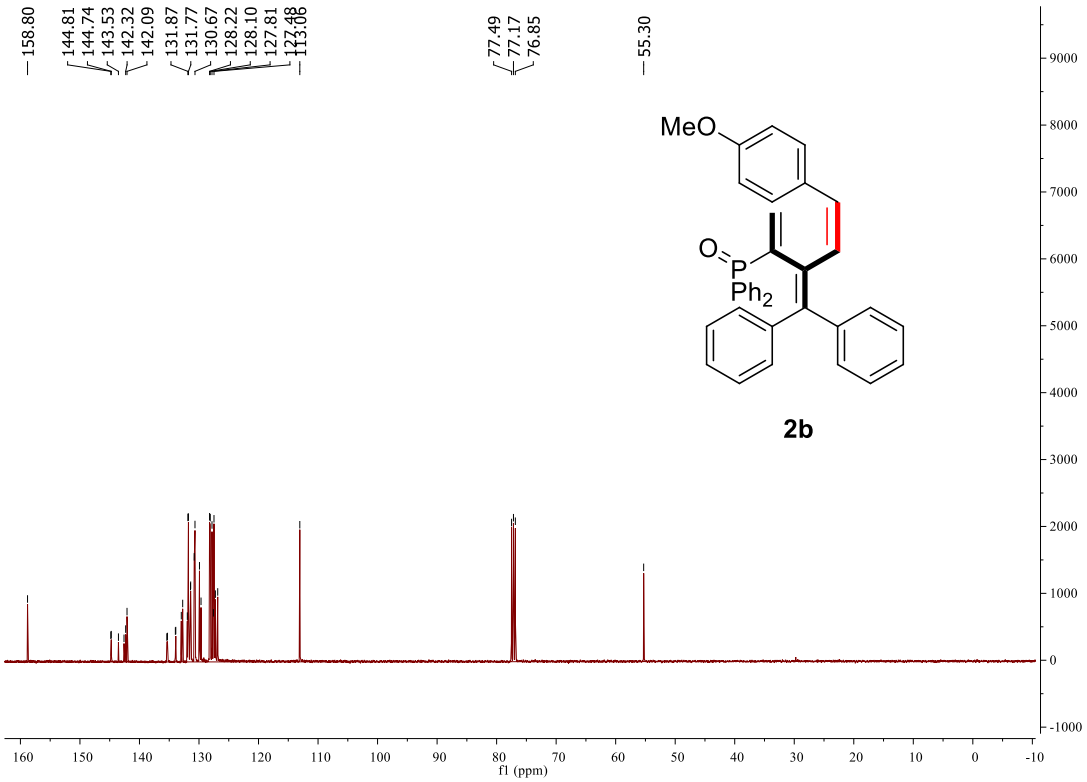

28.62
O
P
Ph2
f1 (ppm)

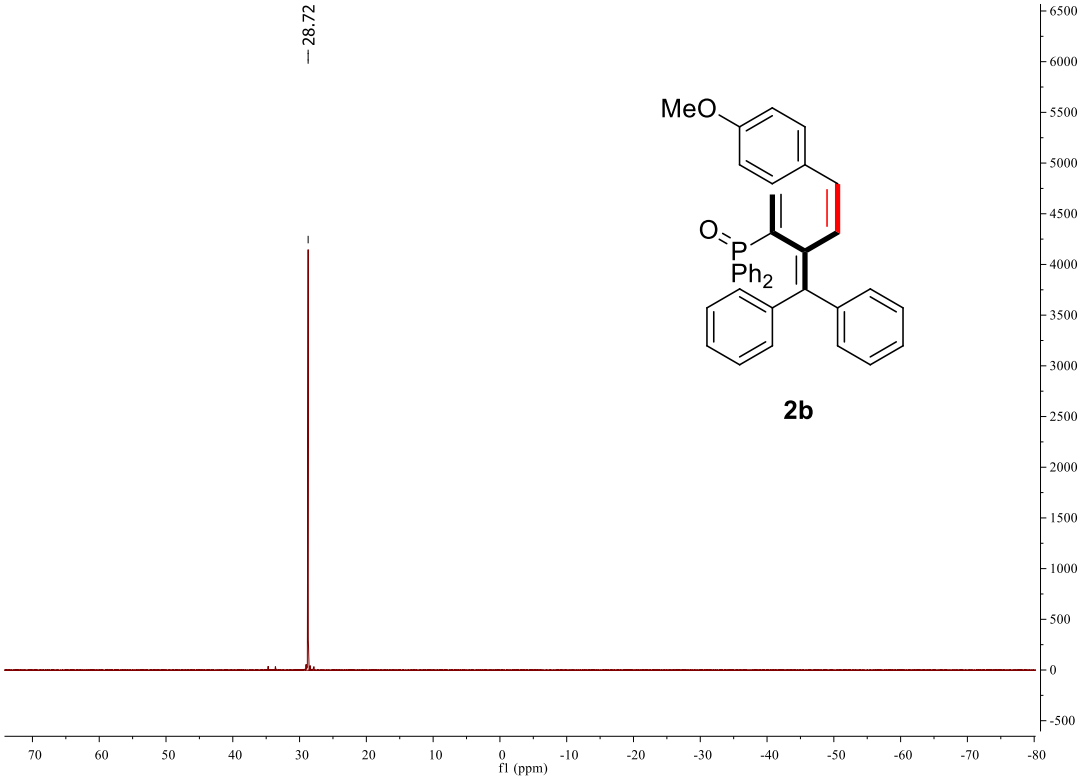
2a

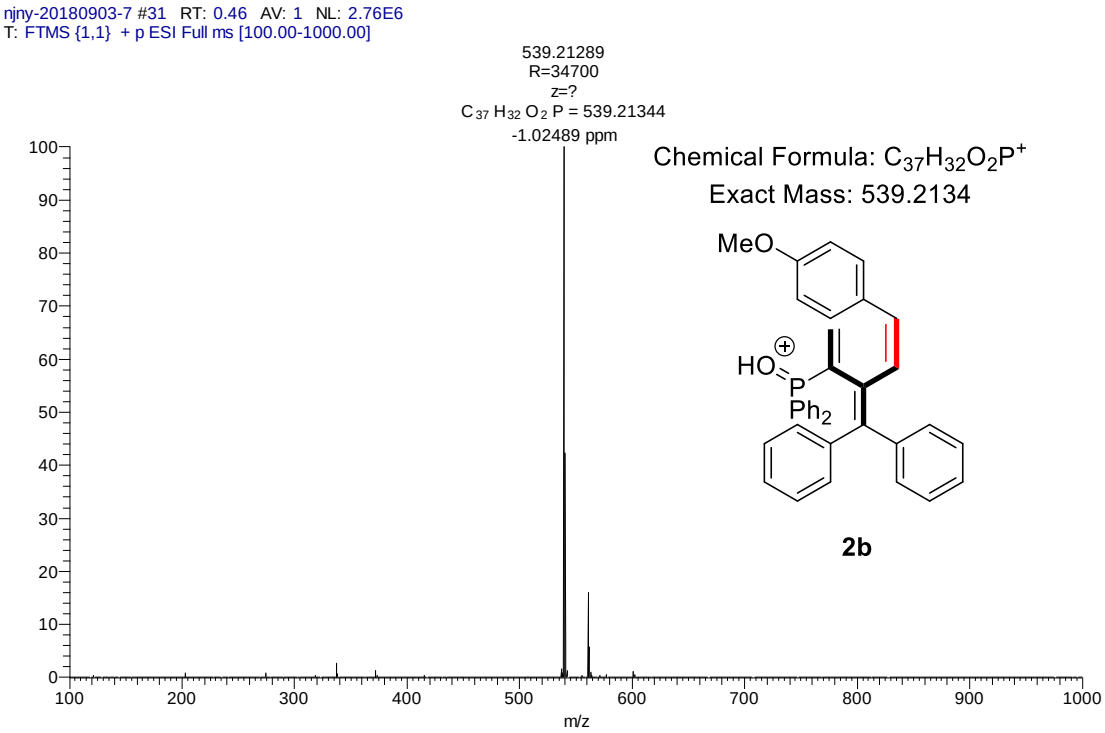

NJNY-20180817-27 #31 RT: 0.45 AV: 1 NL: 1.86E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
509.20224
z=1
C 36 H 30 O P = 509.20288
-1.25414 ppm
Chemical Formula: C36H30OP+
Exact Mass: 509.2029
HO
P
Ph2
2a
367.20270
z=1
C 20 H 32 O 4 P = 367.20327
-1.56509 ppm
531.18390
z=1
m/z

2b

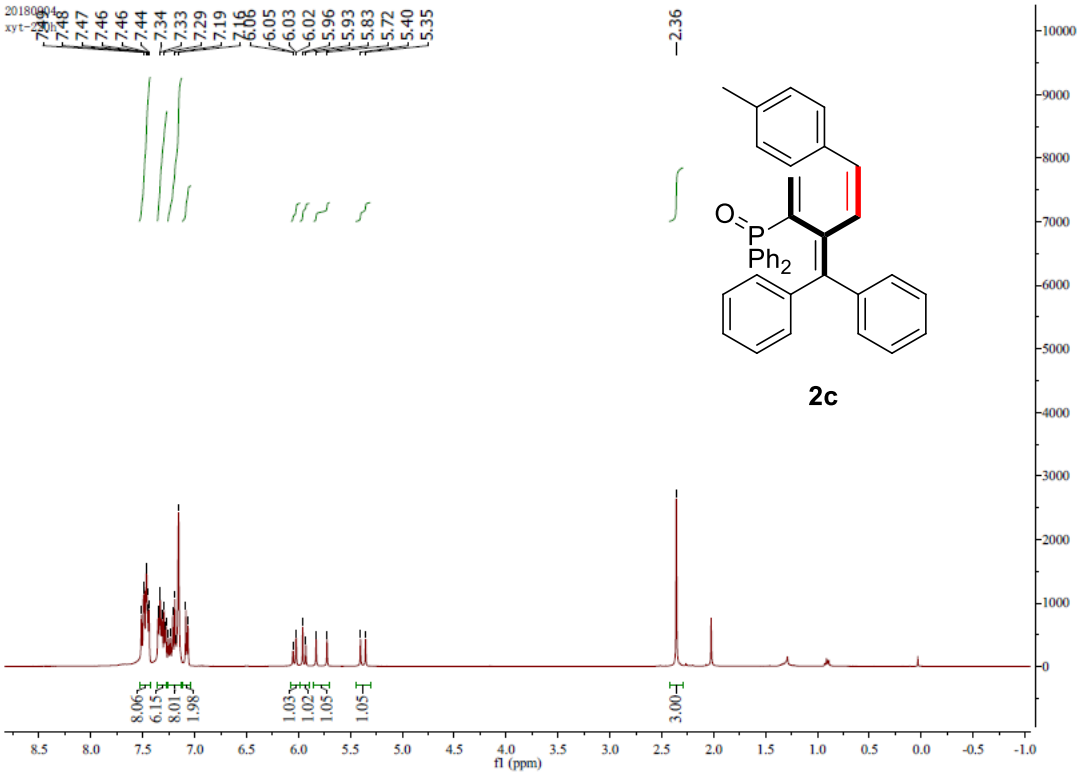

MeO
O
P
Ph2
2b
fl (ppm)

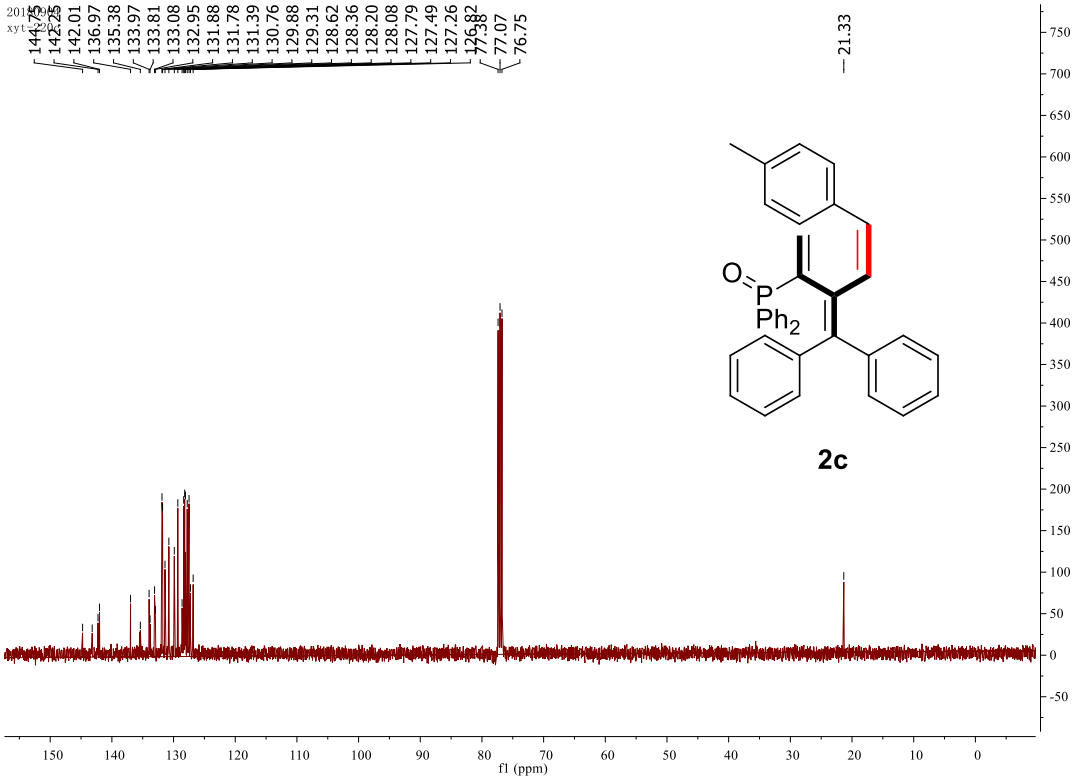

158.80
144.81
144.74
143.53
142.32
142.09
131.87
131.77
130.67
128.22
128.10
127.81
127.48
113.06
77.49
77.17
76.85
55.30
MeO
O
P
Ph2
2b
fl (ppm)

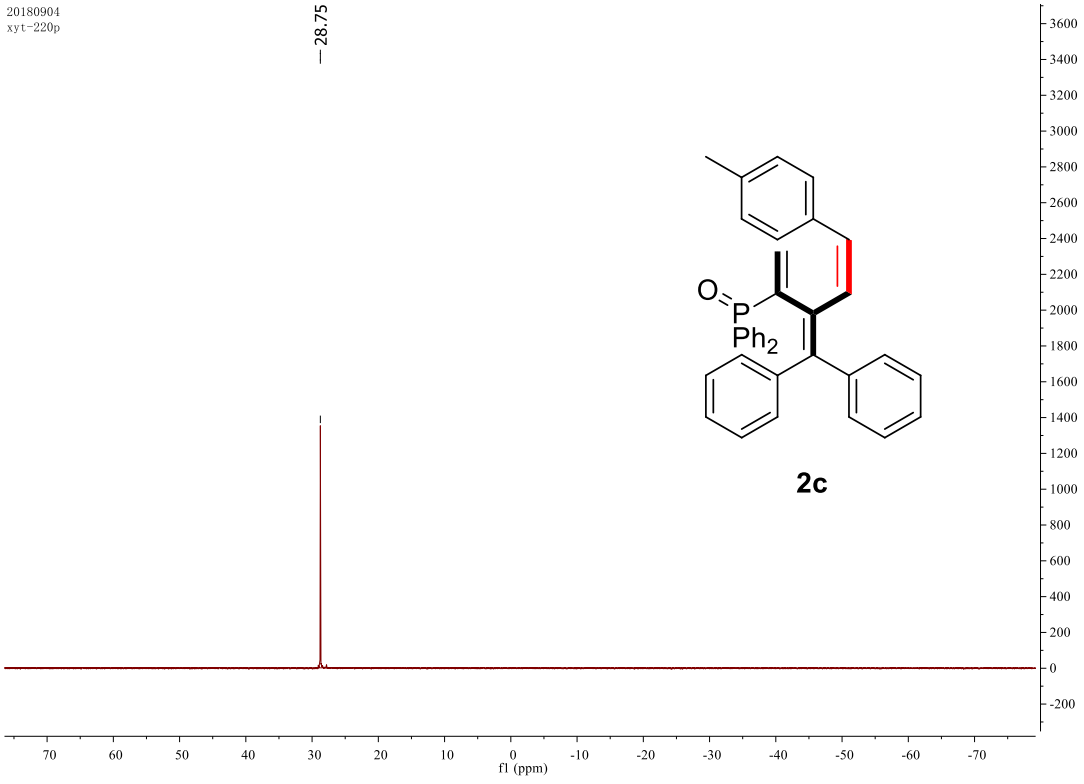

28.72
MeO
O
P
Ph2
2b
fl (ppm)

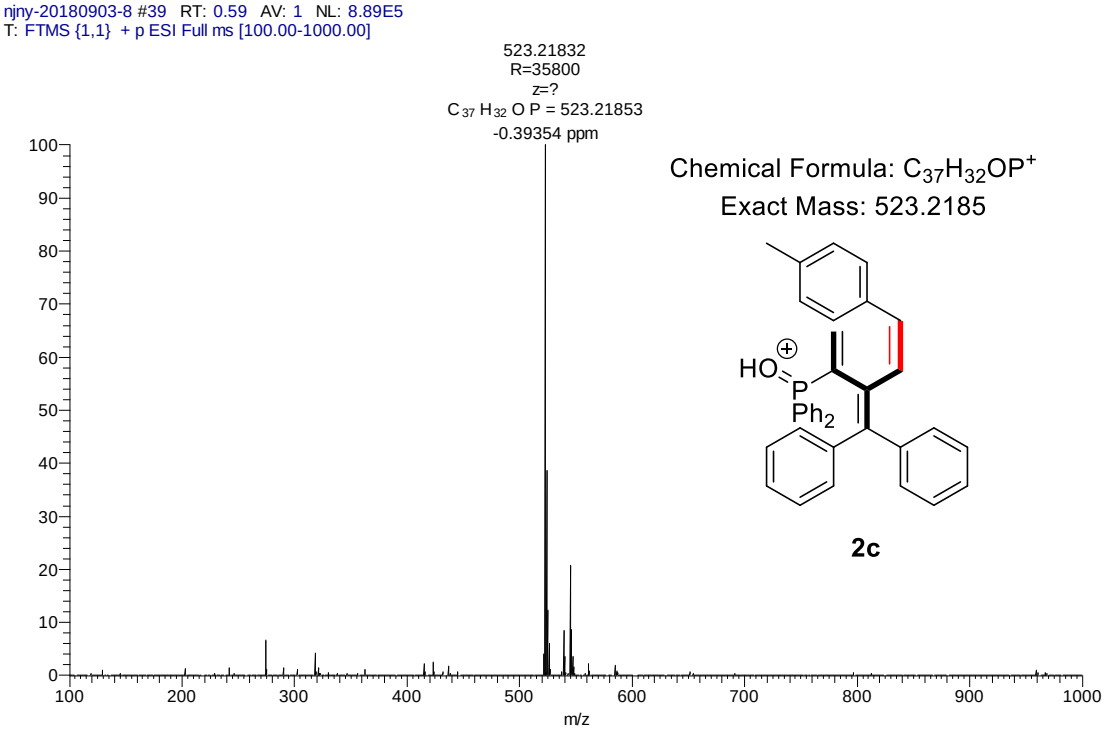

njny-20180903-7 #31 RT: 0.46 AV: 1 NL: 2.76E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
539.21289
R=34700
z=?
C37 H32 O2 P = 539.21344
-1.02489 ppm
Chemical Formula: C37H32O2P+
Exact Mass: 539.2134
MeO
HO
P
Ph2
2b
m/z

2c

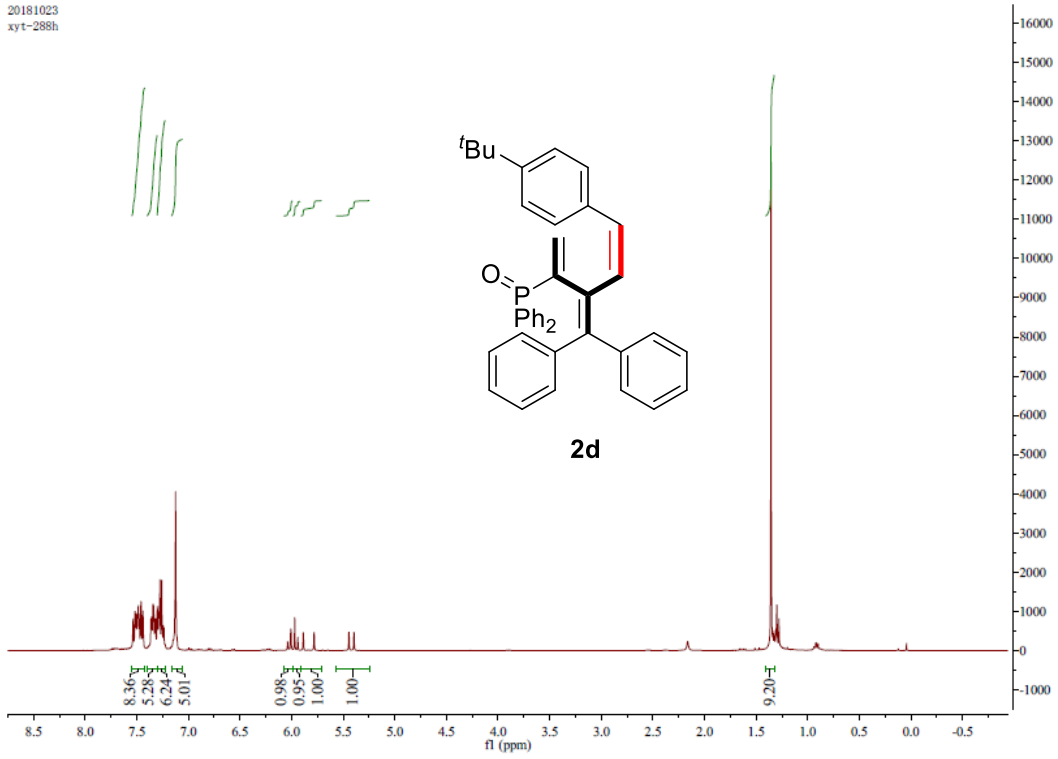

O
P
Ph2
2c
fl (ppm)

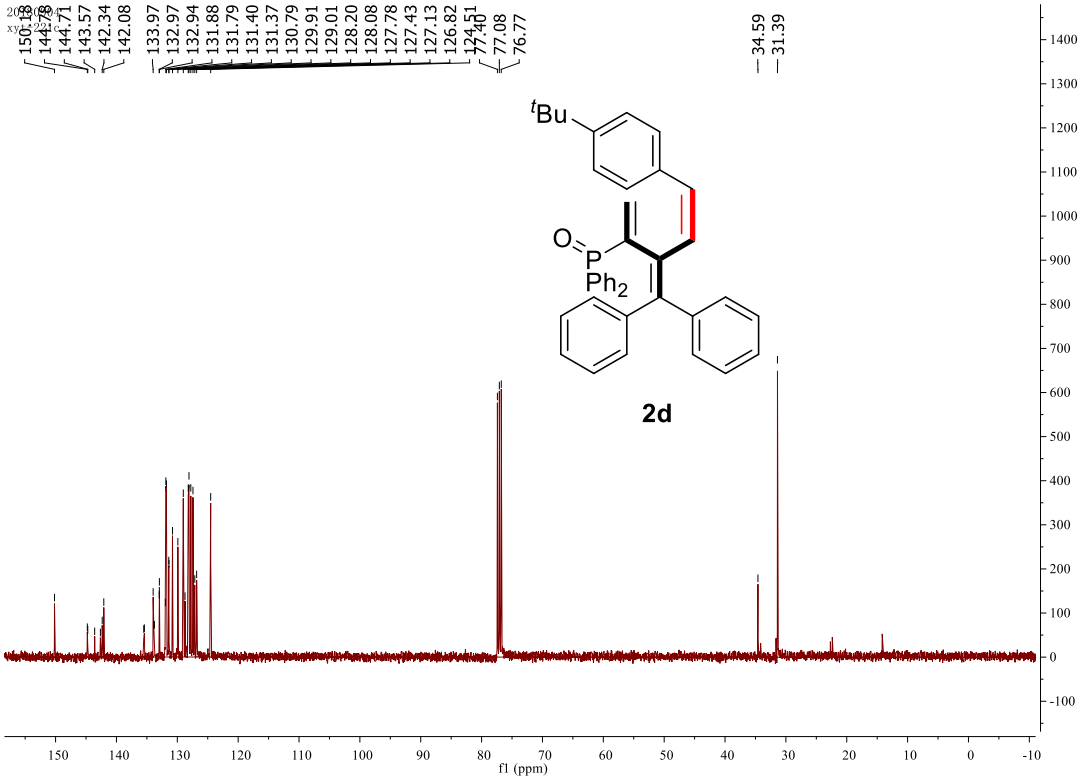

144.75
142.25
142.01
136.97
135.38
133.97
133.81
133.08
132.95
131.88
131.78
131.39
130.76
129.88
129.31
128.62
128.36
128.20
128.08
127.79
127.49
127.26
126.82
77.38
77.07
76.75
21.33
O
P
Ph2
2c
f1 (ppm)

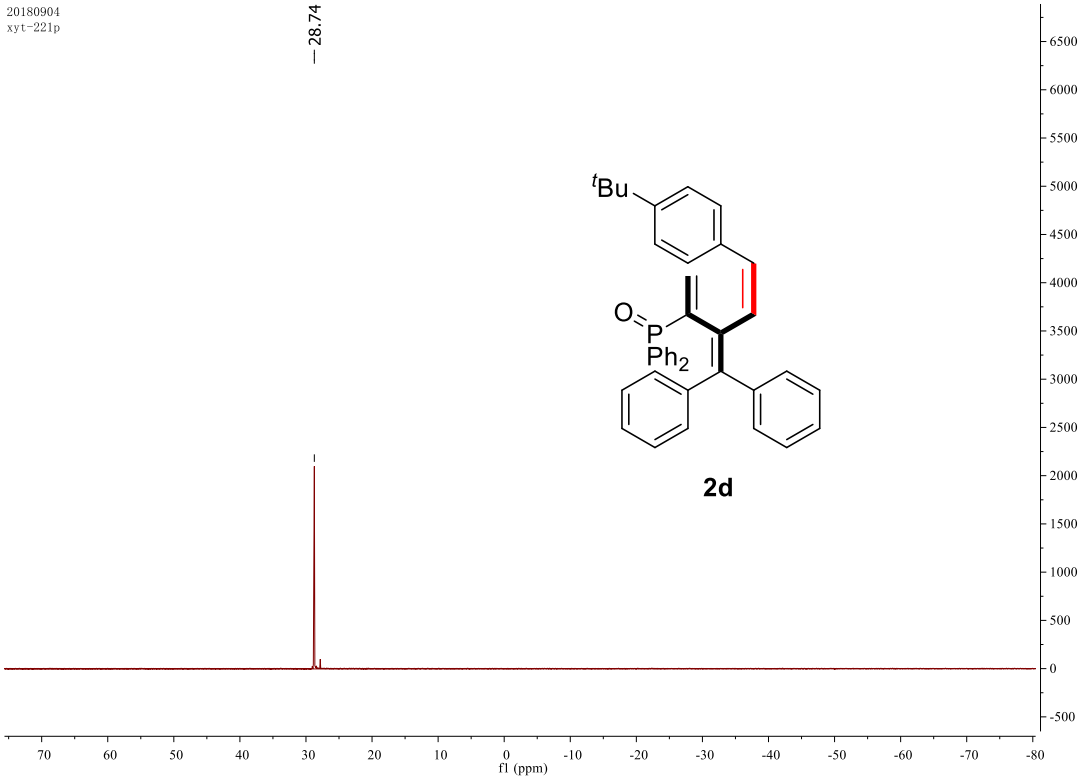

20180904
xyt-220p
28.75
O
P
Ph2
2c
f1 (ppm)

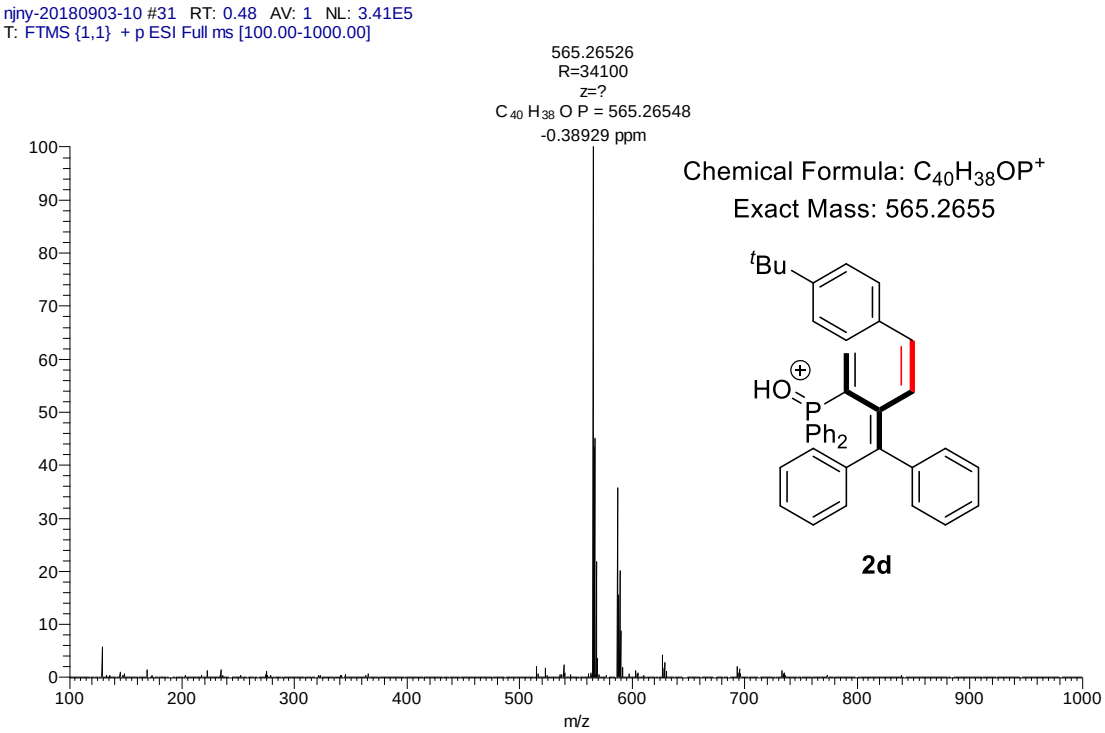

njny-20180903-8 #39 RT: 0.59 AV: 1 NL: 8.89E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
523.21832
R=35800
z=?
C 37 H 32 O P = 523.21853
-0.39354 ppm
Chemical Formula: C37H32OP+
Exact Mass: 523.2185
HO
P
Ph2
2c
m/z

2d

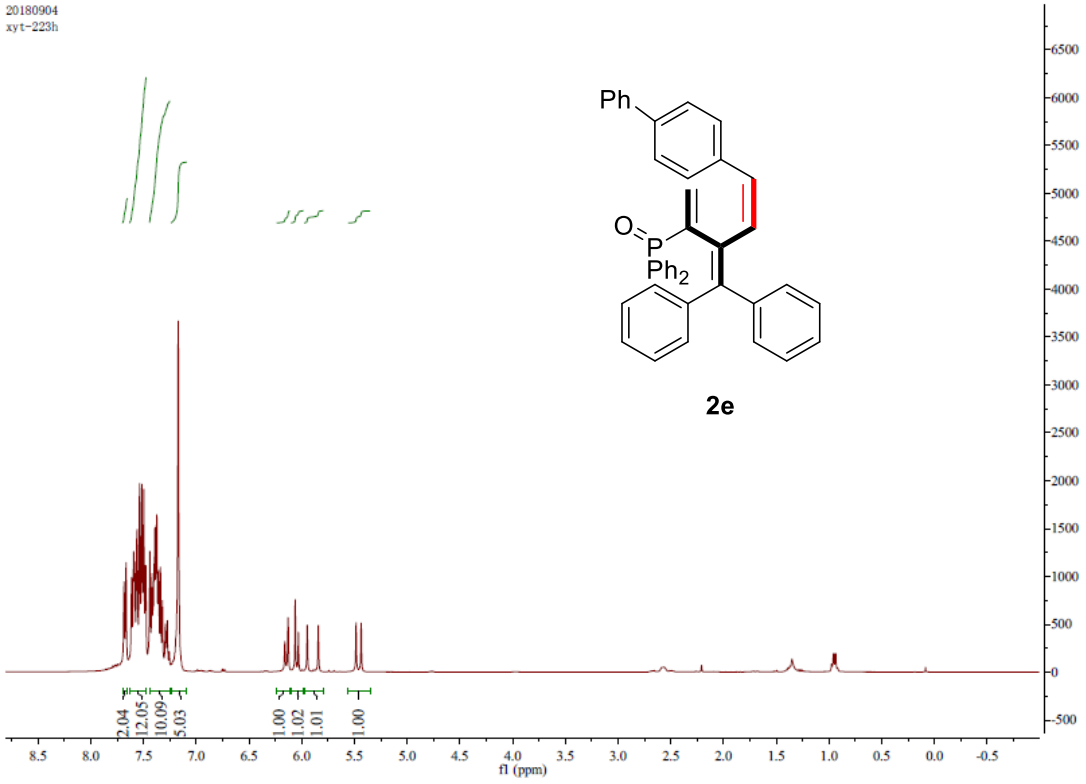

20181023
xyt-288h
tBu
O
P
Ph2
2d
8.36
5.28
6.24
5.01
0.98
0.95
1.00
1.00
9.20
f1 (ppm)

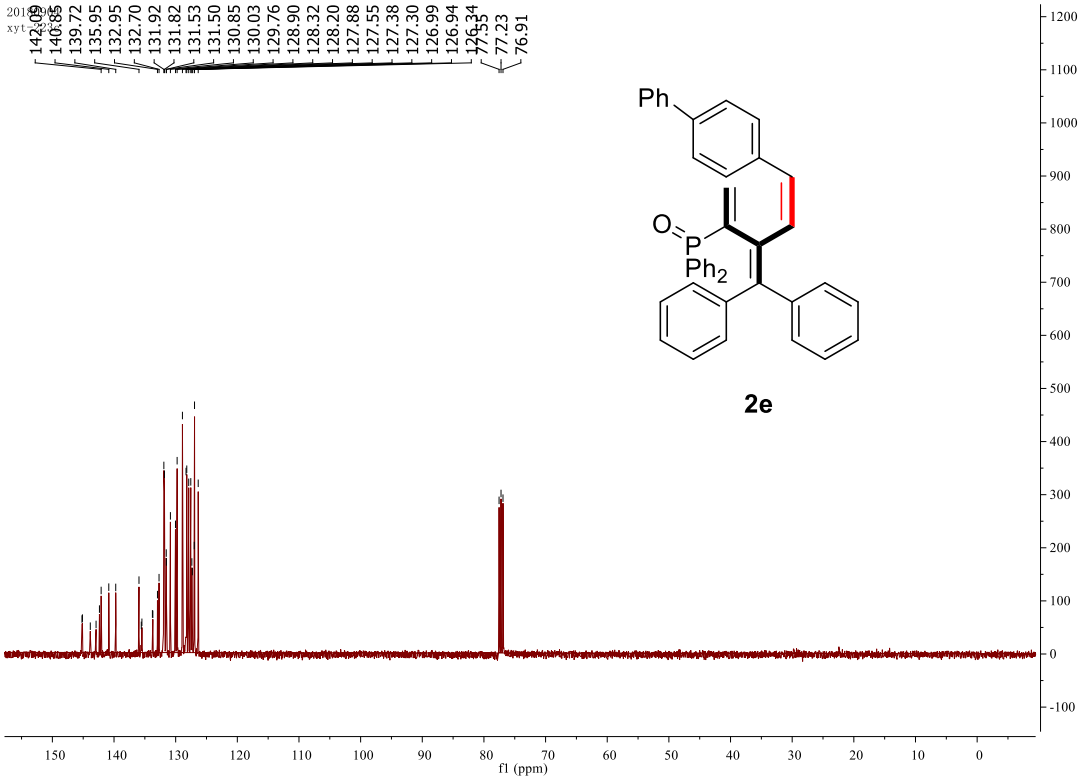

150.18
144.78
144.71
143.57
142.34
142.08
133.97
132.97
132.94
131.88
131.79
131.40
131.37
130.79
129.91
129.01
128.20
128.08
127.78
127.43
127.13
126.82
124.51
77.40
77.08
76.77
34.59
31.39
tBu
O
P
Ph2
2d
f1 (ppm)

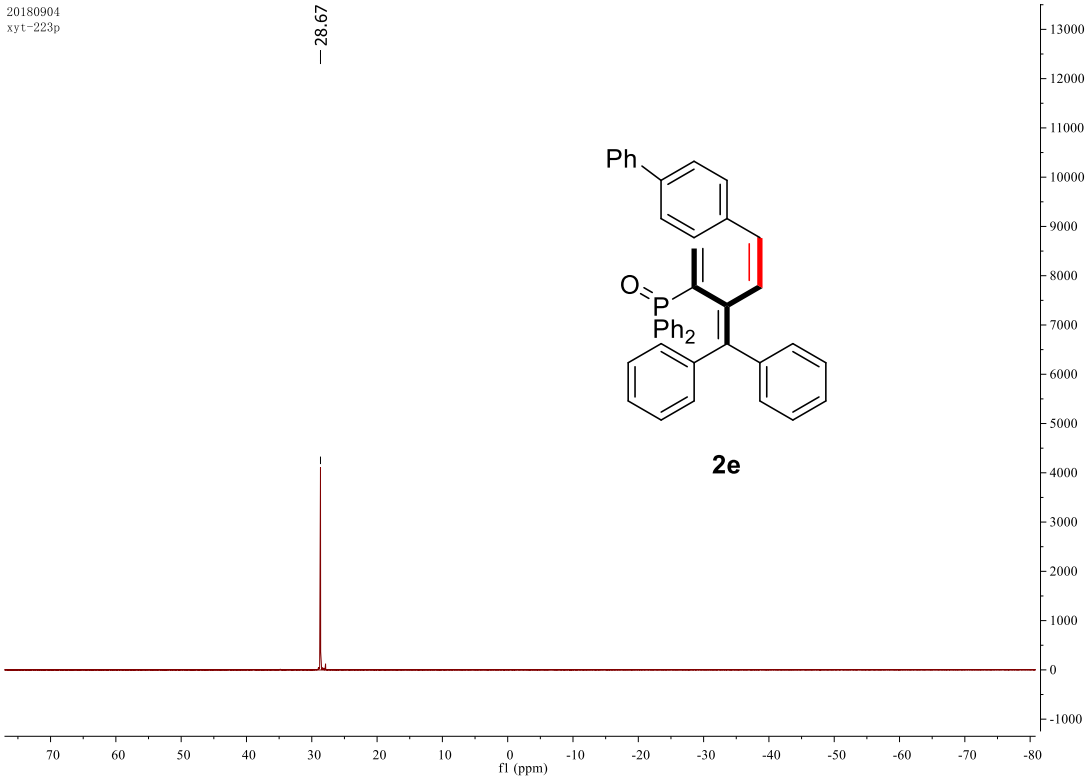

20180904
xyt-221p
28.74
tBu
O
P
Ph2
2d
f1 (ppm)

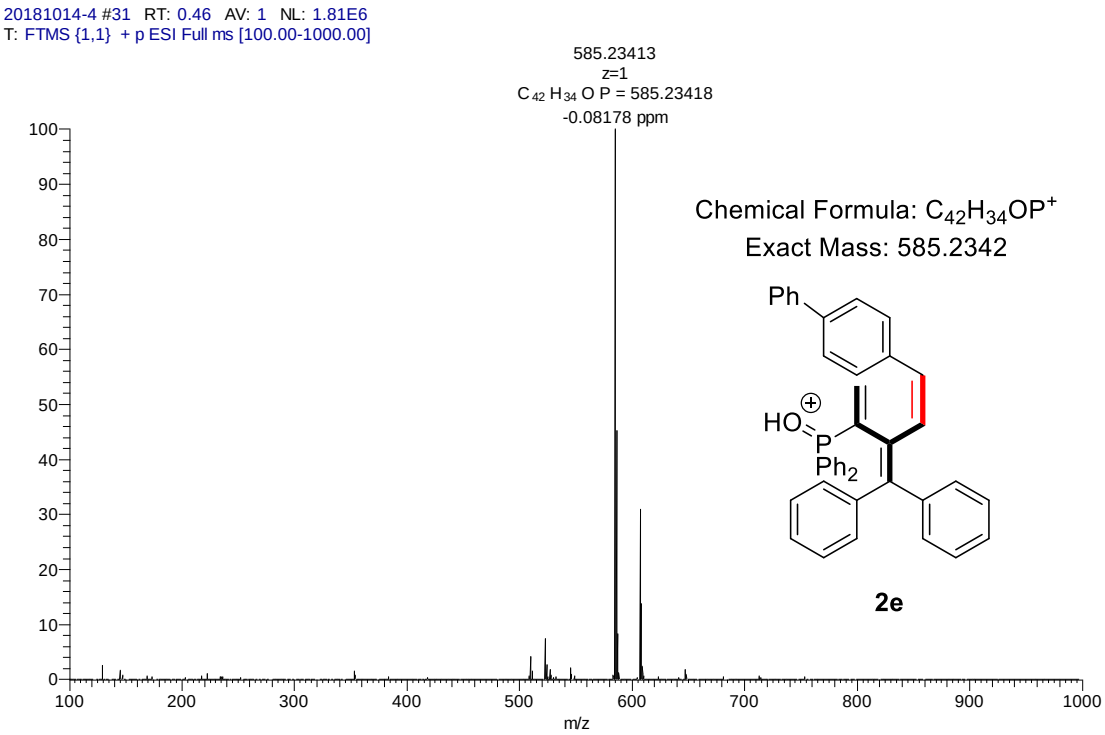

njny-20180903-10 #31 RT: 0.48 AV: 1 NL: 3.41E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
565.26526
R=34100
z=?
C 40 H 38 O P = 565.26548
-0.38929 ppm
Chemical Formula: C40H38OP+
Exact Mass: 565.2655
tBu
HO
P
Ph2
2d
m/z

2e

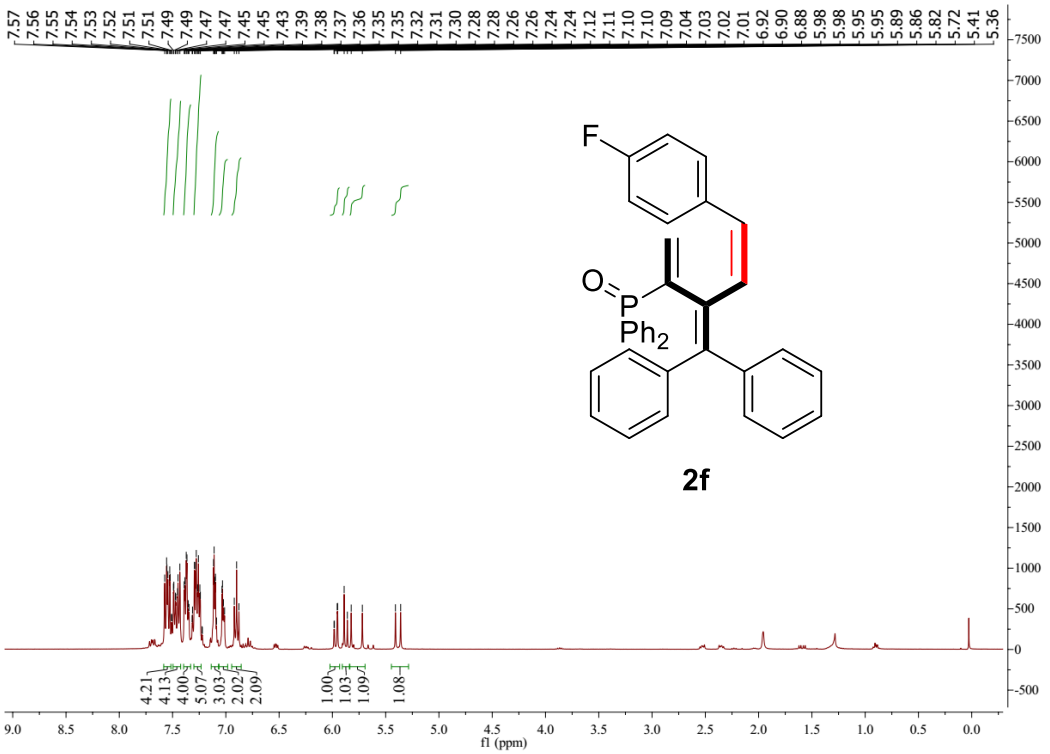

20180904
xyt-223h
Ph
O
P
Ph2
2e
2.04
12.05
10.09
5.03
1.00
1.02
1.01
1.00
f1 (ppm)

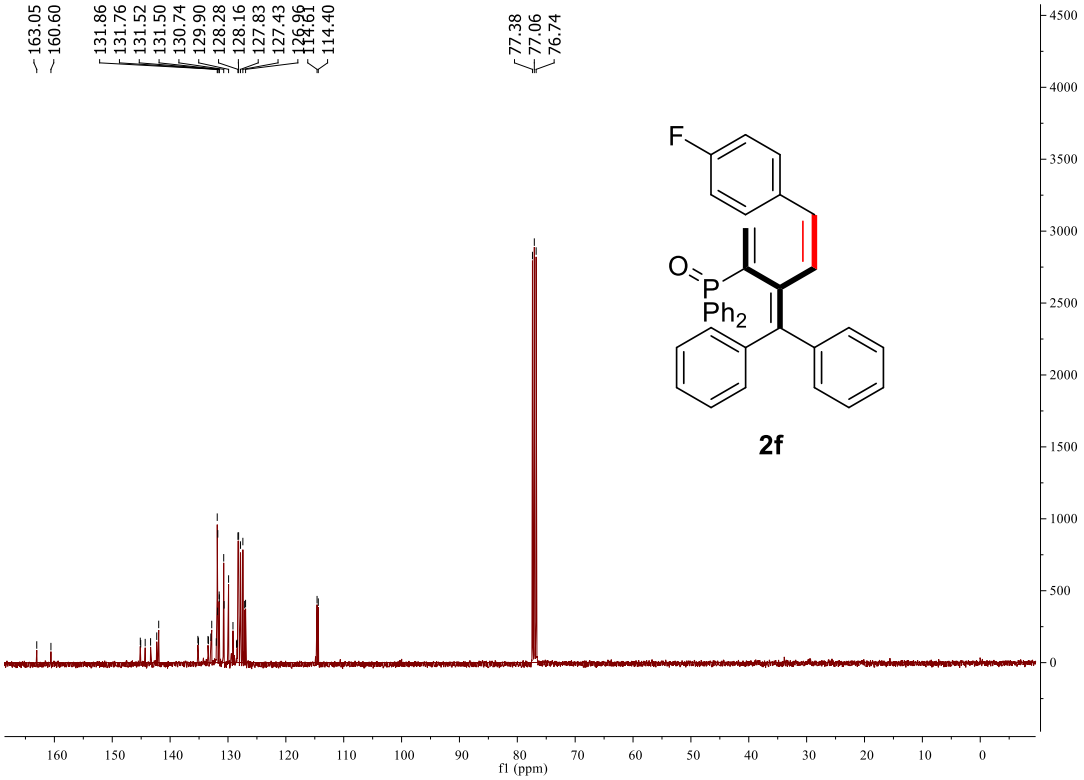

142.09
140.85
139.72
135.95
132.95
132.70
131.92
131.82
131.53
131.50
130.85
130.03
129.76
128.90
128.32
128.20
127.88
127.55
127.38
127.30
126.99
126.94
126.34
77.55
77.23
76.91
Ph
O
P
Ph2
2e
f1 (ppm)

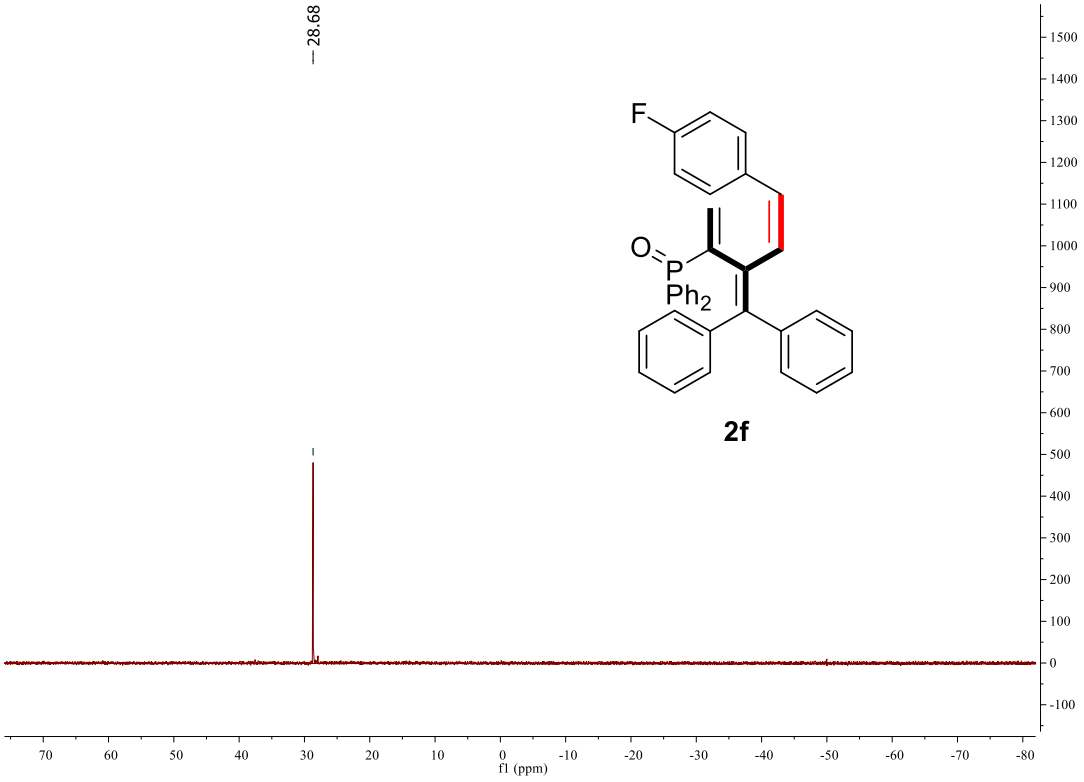

20180904
xyt-223p
28.67
Ph
O
P
Ph2
2e
f1 (ppm)

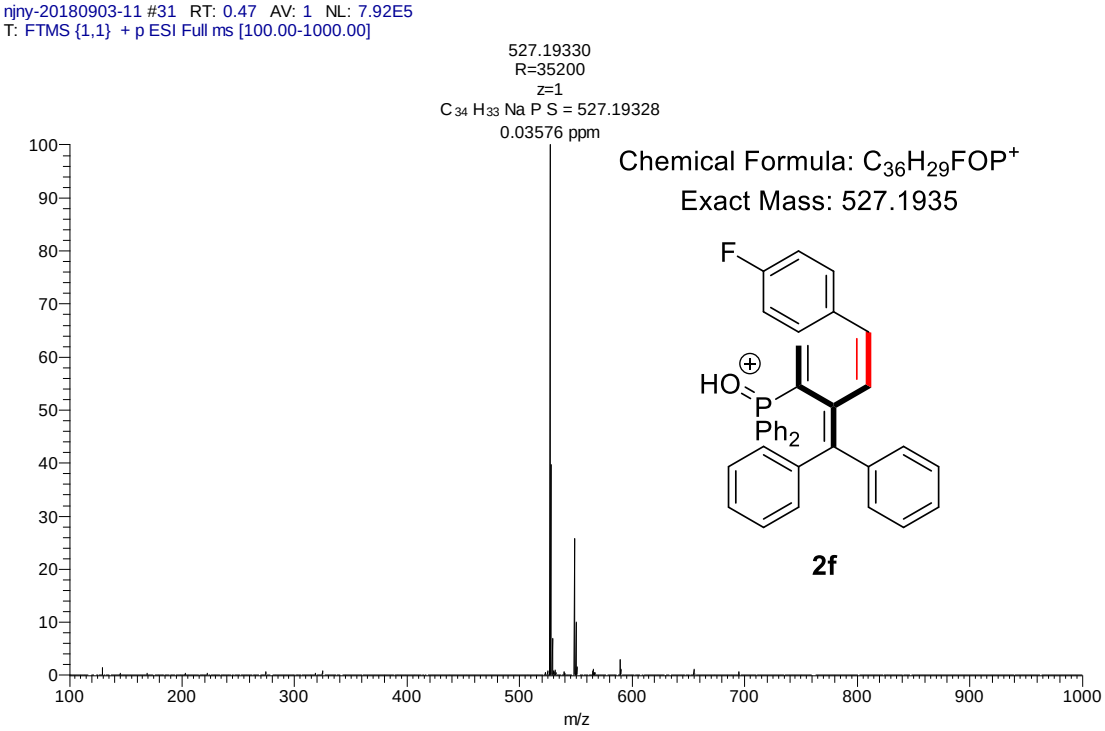

20181014-4 #31 RT: 0.46 AV: 1 NL: 1.81E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
585.23413
z=1
C 42 H 34 O P = 585.23418
-0.08178 ppm
Chemical Formula: C42H34OP+
Exact Mass: 585.2342
Ph
HO
P
Ph2
2e
m/z

2f

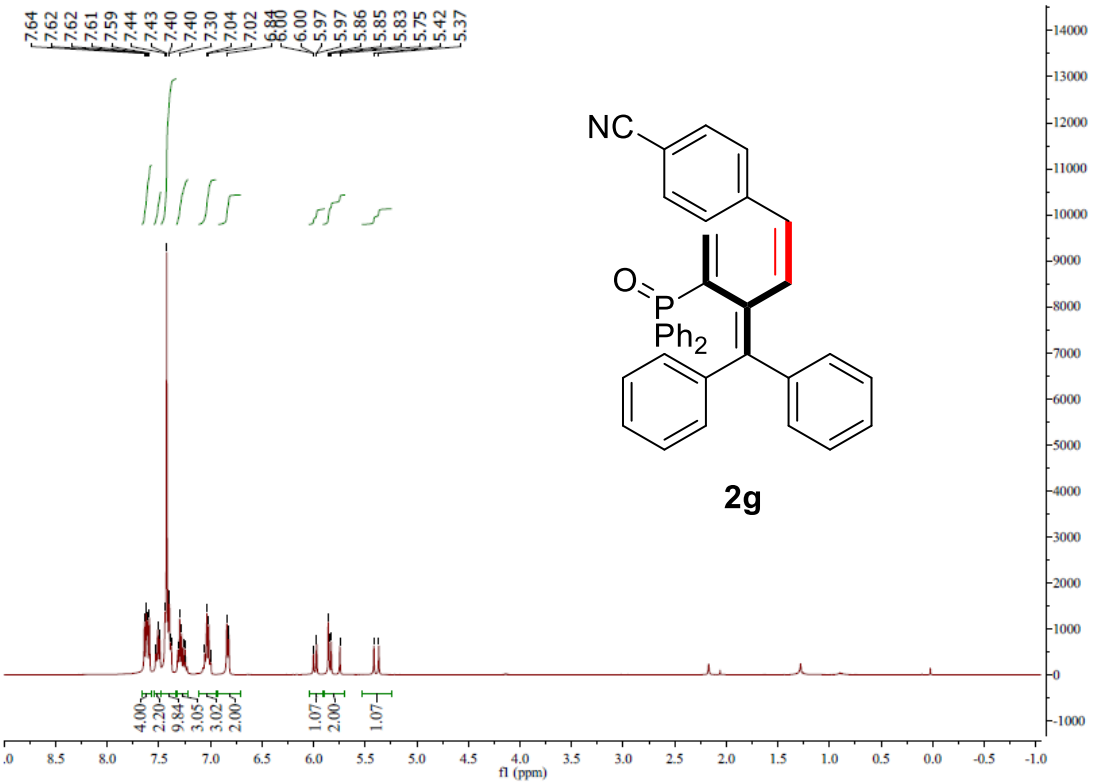

F
O
P
Ph2
2f
fl (ppm)

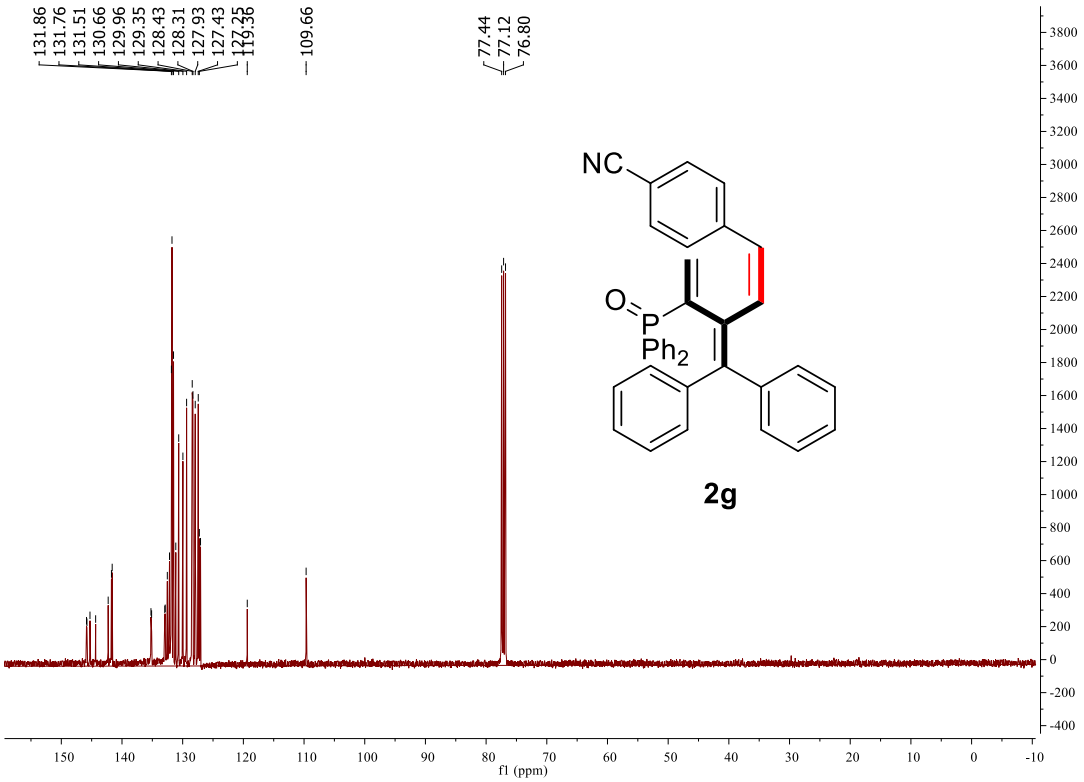

163.05
160.60
131.86
131.76
131.52
131.50
130.74
129.90
128.28
128.16
127.83
127.43
114.61
114.40
77.38
77.06
76.74
F
O
P
Ph2
2f
f1 (ppm)

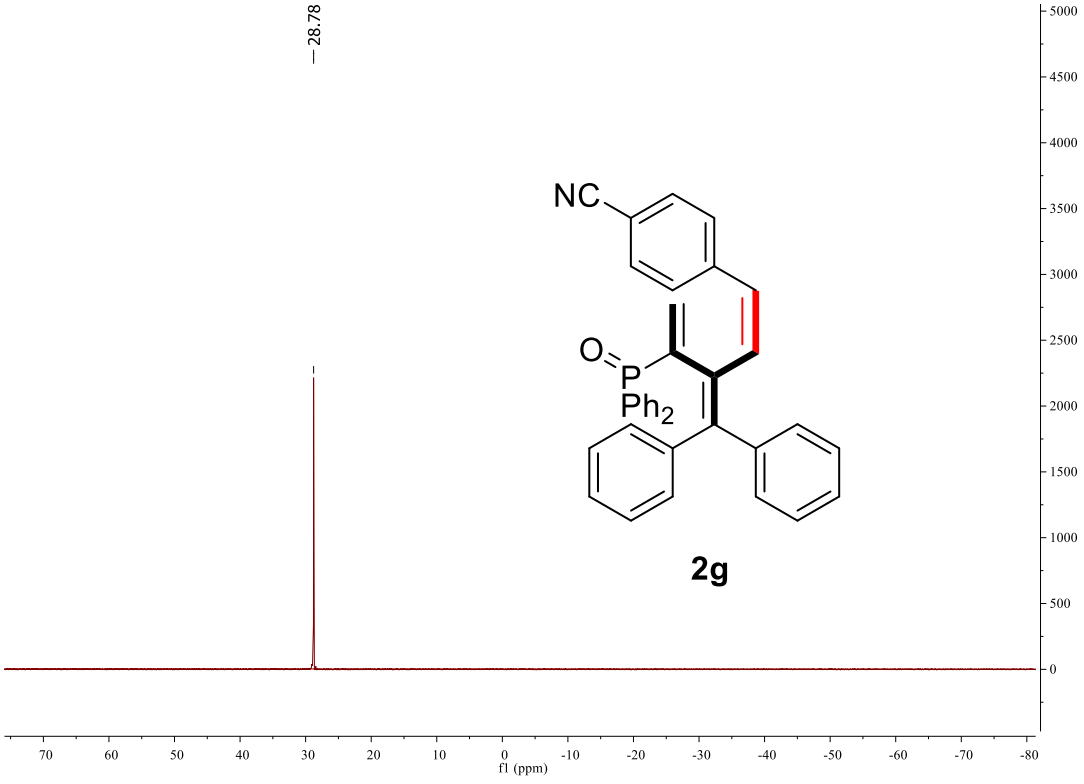

28.68
F
O
P
Ph2
2f
f1 (ppm)

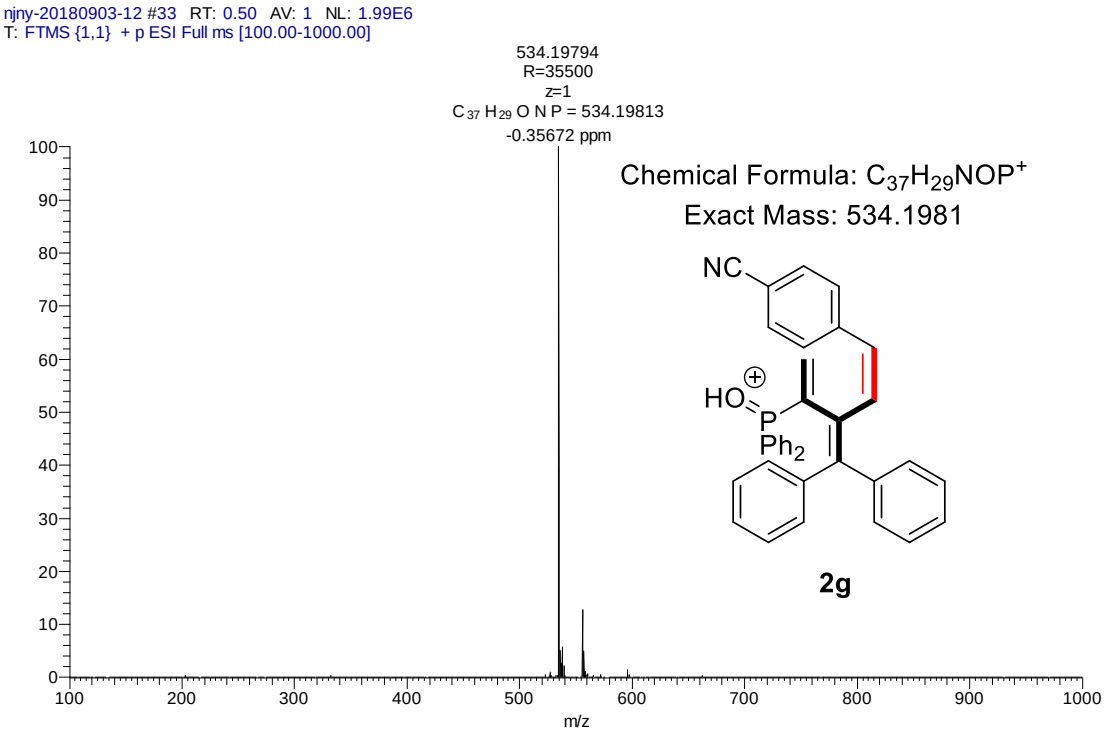

njny-20180903-11 #31 RT: 0.47 AV: 1 NL: 7.92E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
527.19330
R=35200
z=1
C34 H33 Na P S = 527.19328
0.03576 ppm
Chemical Formula: C36H29FOP+
Exact Mass: 527.1935
F
HO
P
Ph2
2f
m/z

2g

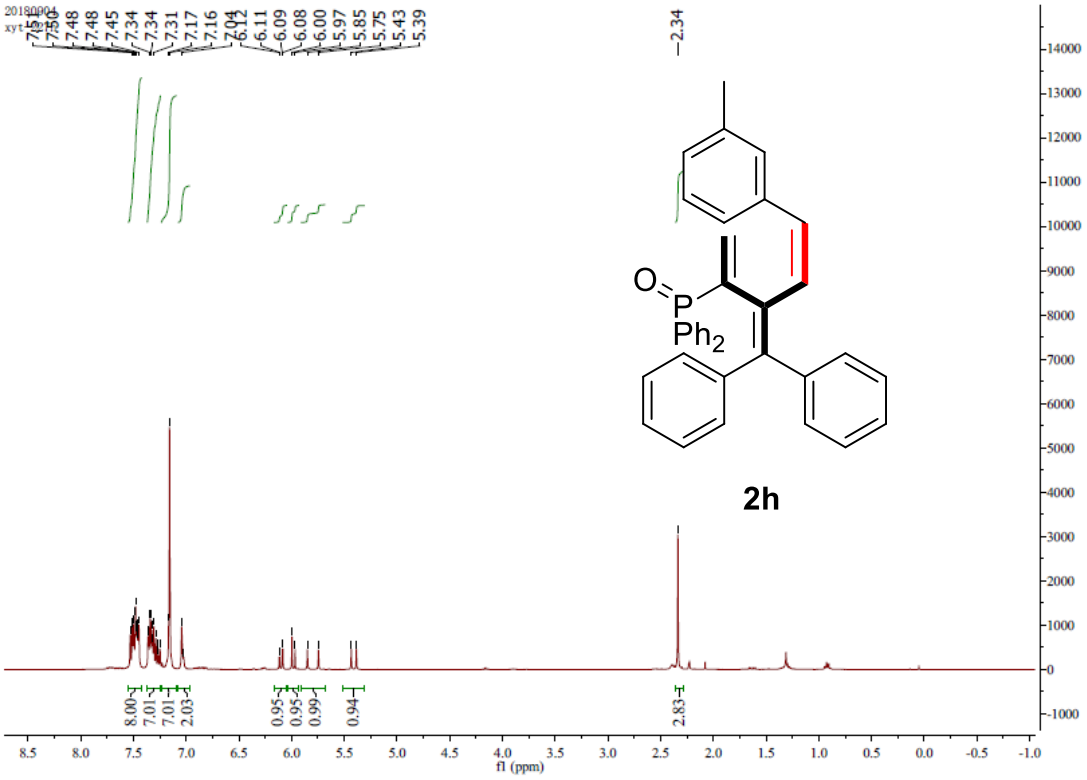

NC
O
P
Ph2
2g
f1 (ppm)

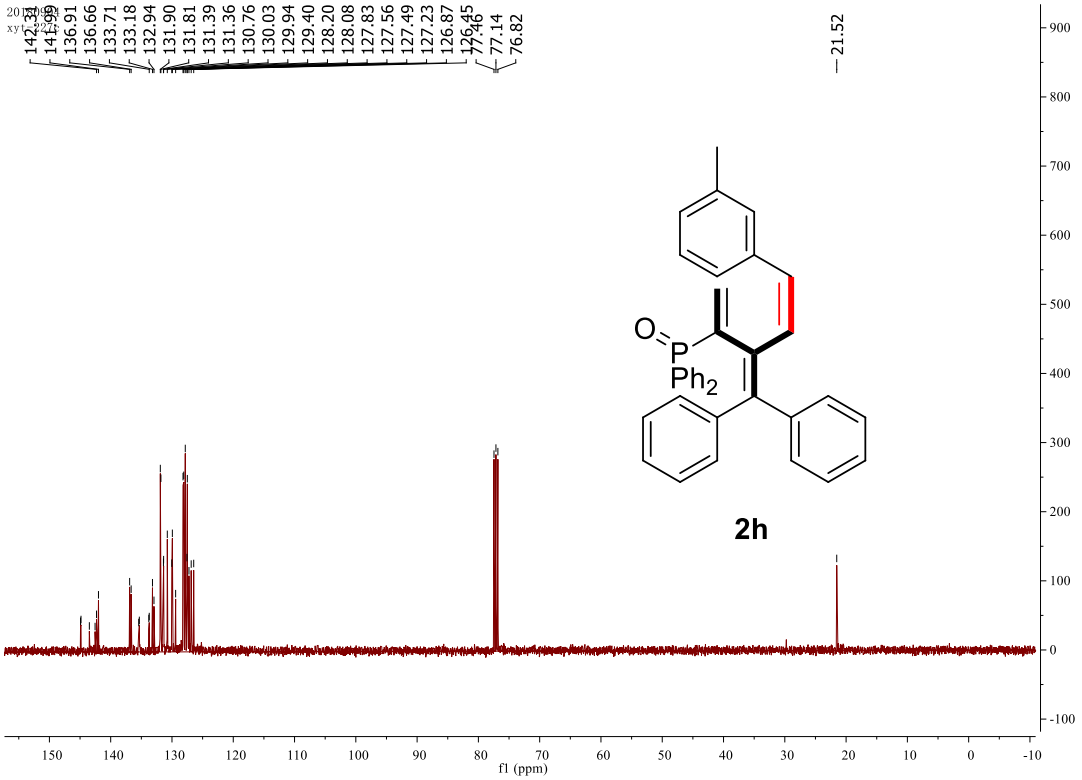

131.86
131.76
131.51
130.66
129.96
129.35
128.43
128.31
127.93
127.43
127.25
119.36
109.66
77.44
77.12
76.80
NC
O
P
Ph2
2g
fl (ppm)

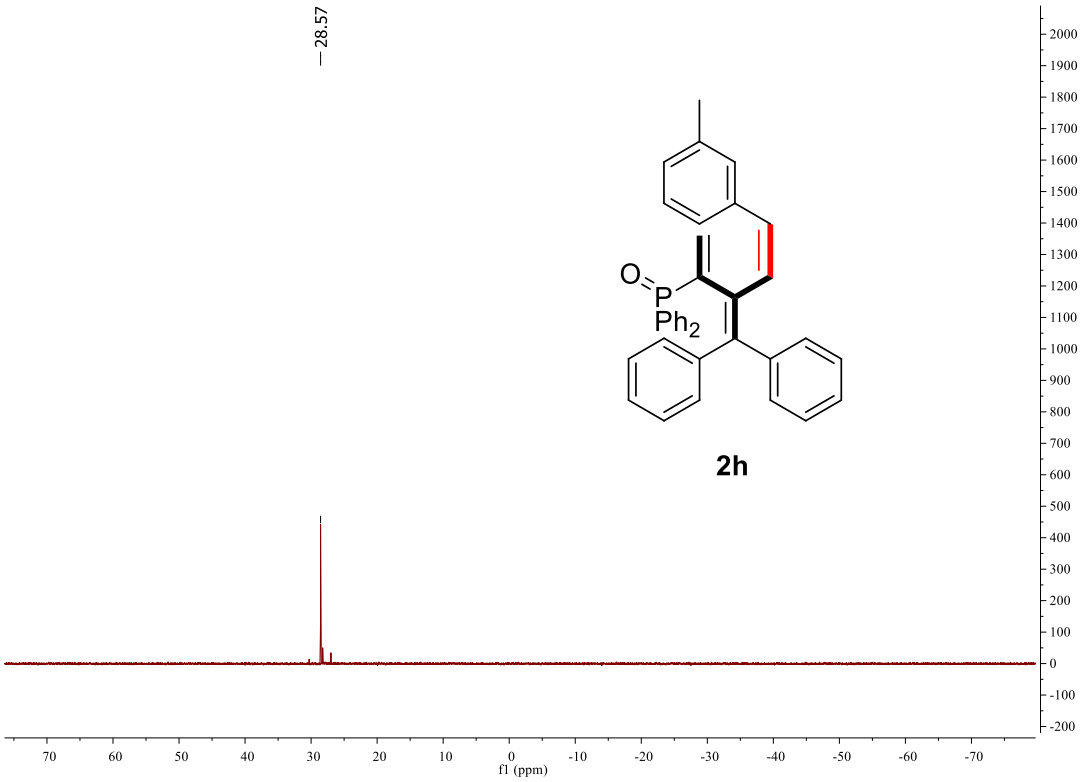

28.78
NC
O
P
Ph2
2g
fl (ppm)

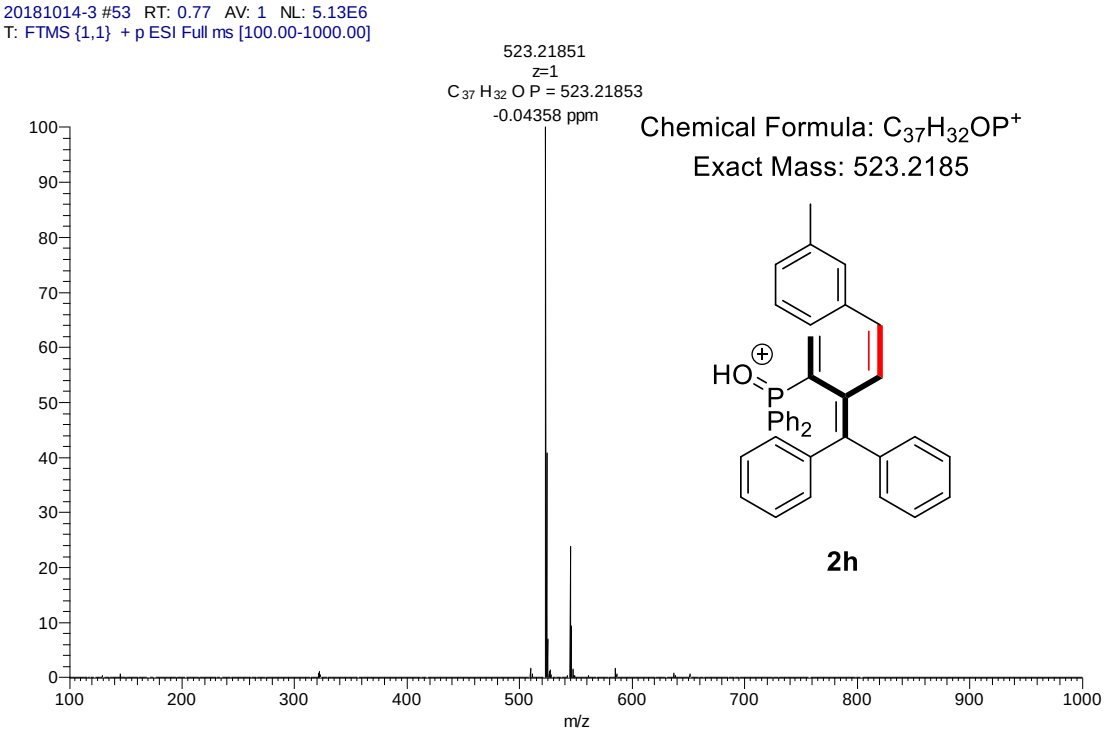

njny-20180903-12 #33 RT: 0.50 AV: 1 NL: 1.99E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
534.19794
R=35500
z=1
C 37 H 29 O N P = 534.19813
-0.35672 ppm
Chemical Formula: C37H29NOP+
Exact Mass: 534.1981
NC
HO
P
Ph2
2g
m/z

2h

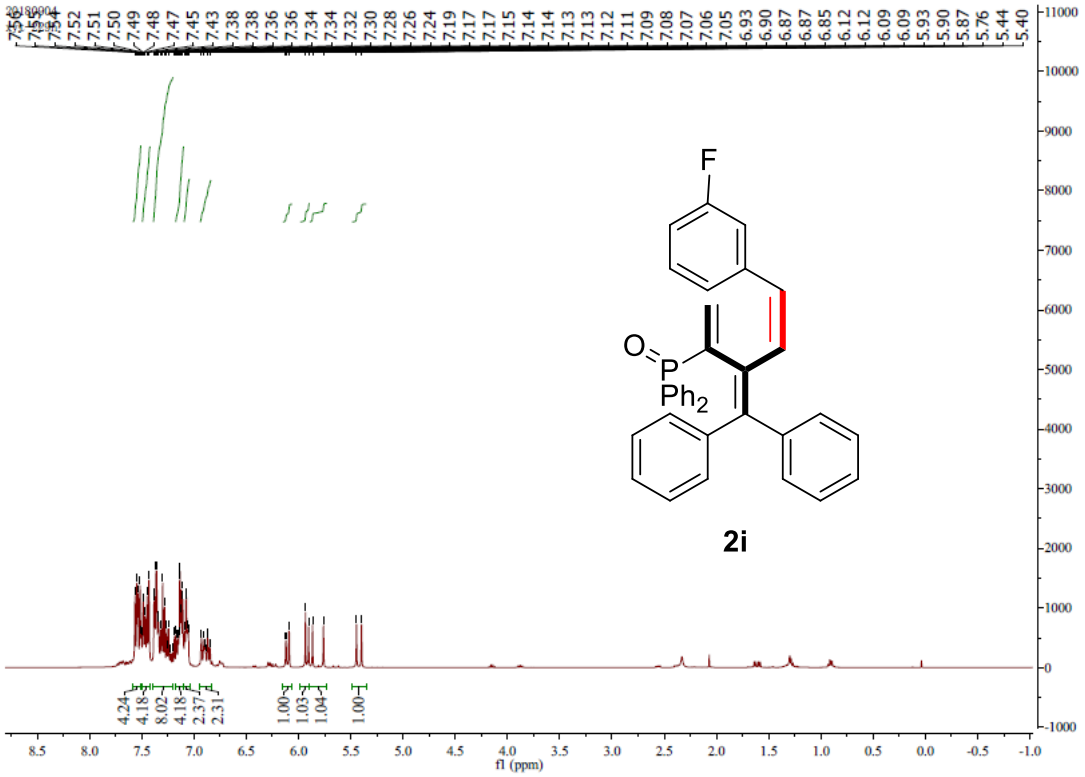

O
P
Ph2
2h
fl (ppm)

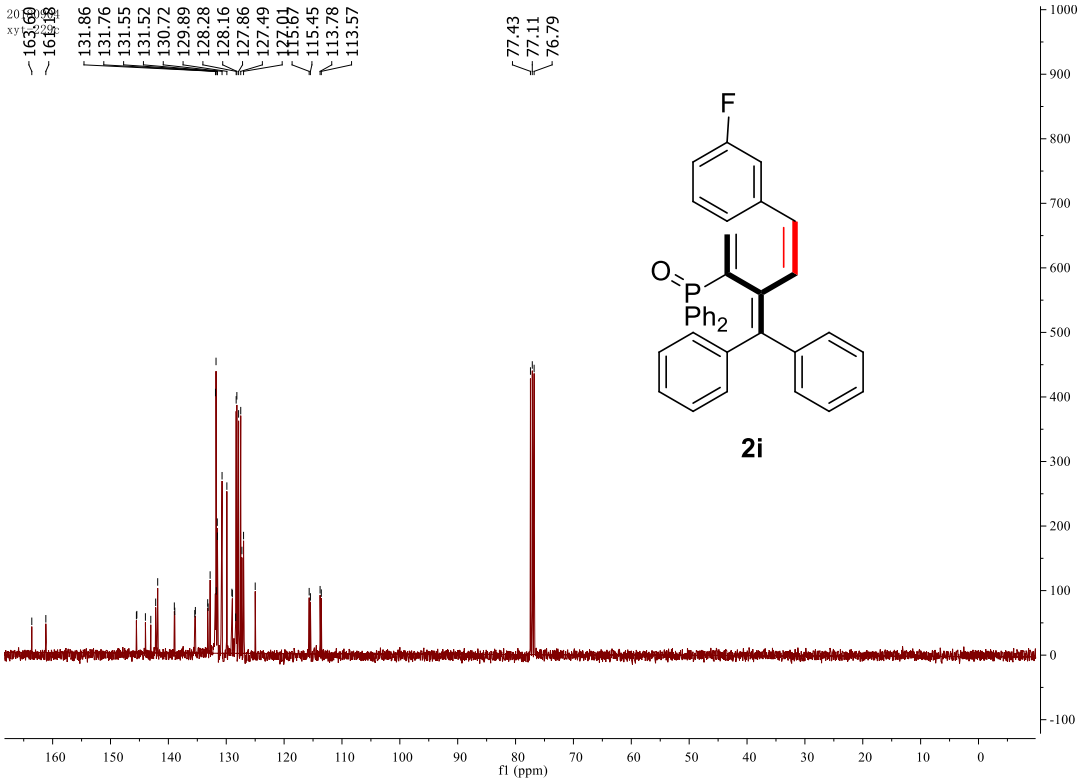

142.34
141.99
136.91
136.66
133.71
133.18
132.94
131.90
131.81
131.39
131.36
130.76
130.03
129.94
129.40
128.20
128.08
127.83
127.56
127.49
127.23
126.87
126.45
77.46
77.14
76.82
21.52
O
P
Ph2
2h
f1 (ppm)

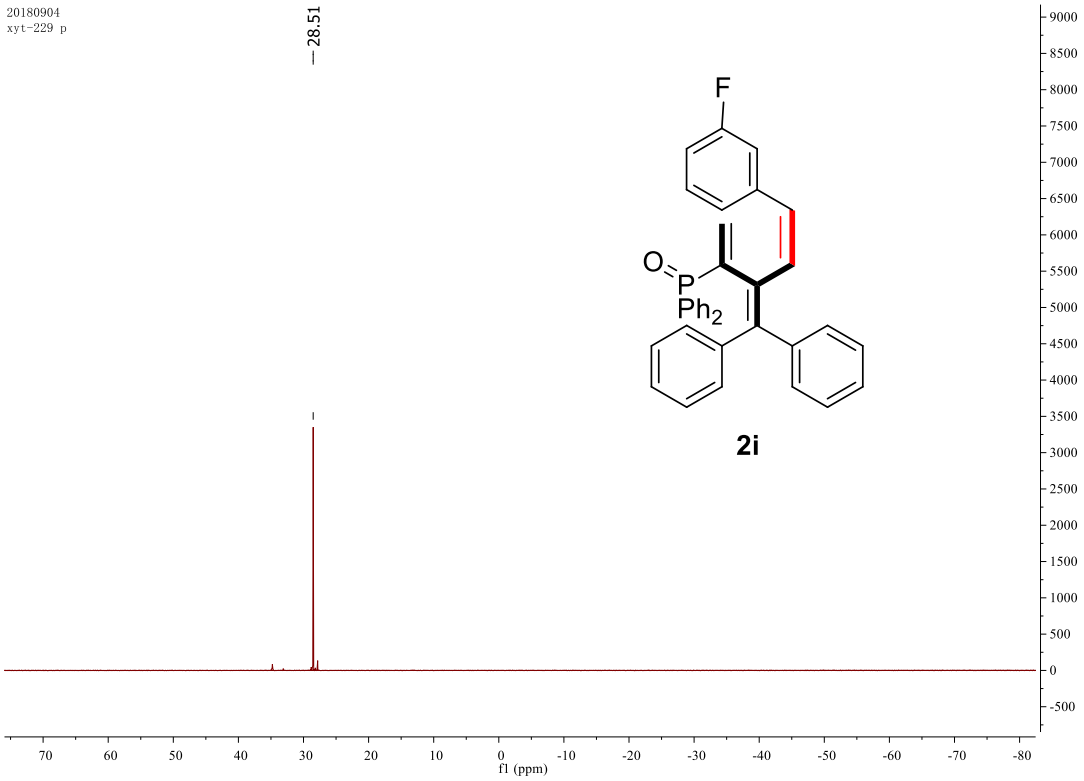

28.57
O
P
Ph2
2h
f1 (ppm)

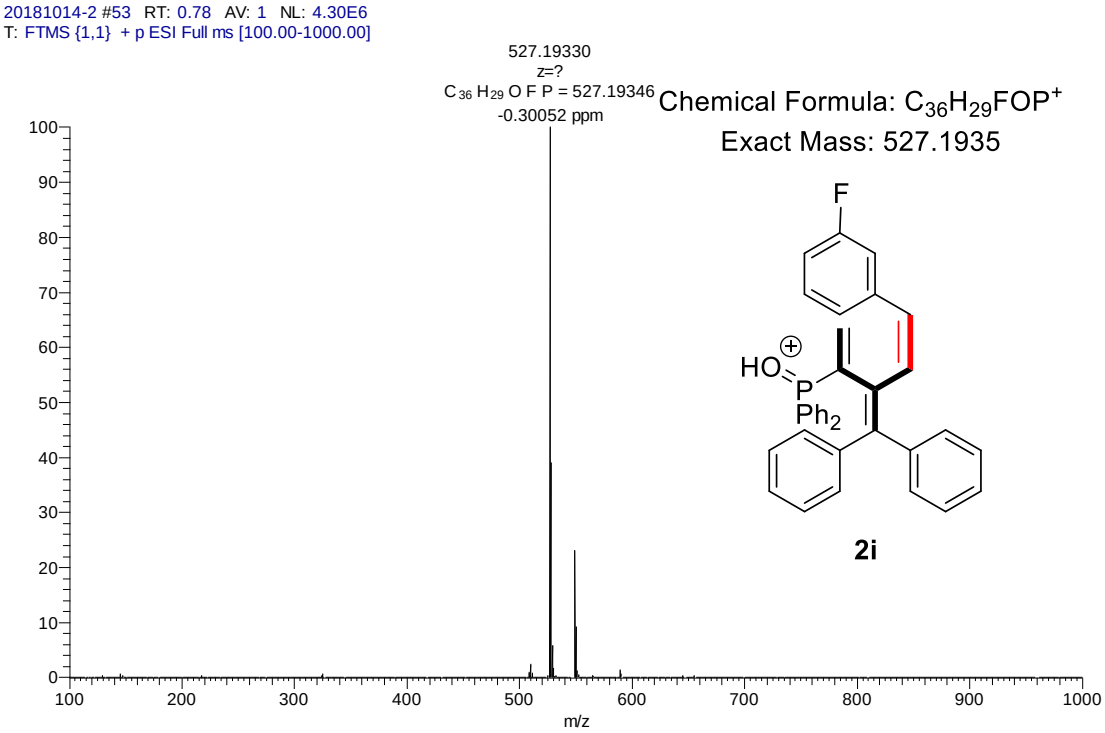

20181014-3 #53 RT: 0.77 AV: 1 NL: 5.13E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
523.21851
z=1
C 37 H 32 O P = 523.21853
-0.04358 ppm
Chemical Formula: C37H32OP+
Exact Mass: 523.2185
HO
P
Ph2
2h
m/z

2i

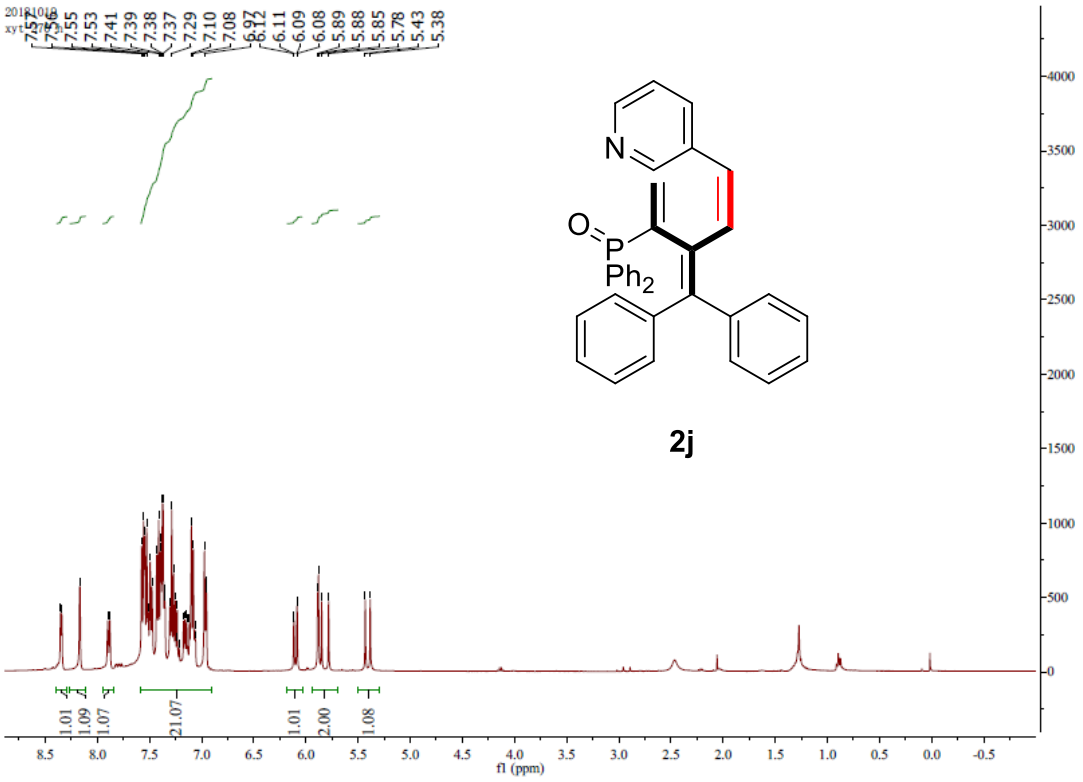

F
O
P
Ph2
2i
f1 (ppm)

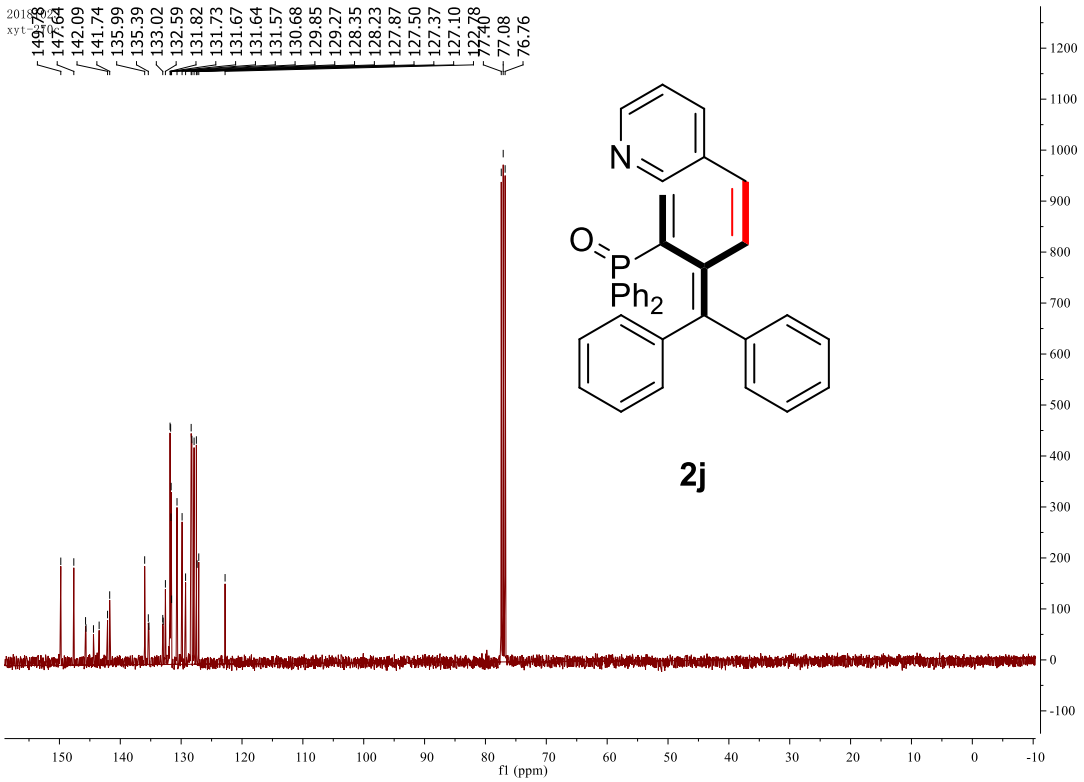

163.60
161.18
131.86
131.76
131.55
131.52
130.72
129.89
128.28
128.16
127.86
127.49
115.45
113.78
113.57
77.43
77.11
76.79
F
O
P
Ph2
2i
f1 (ppm)

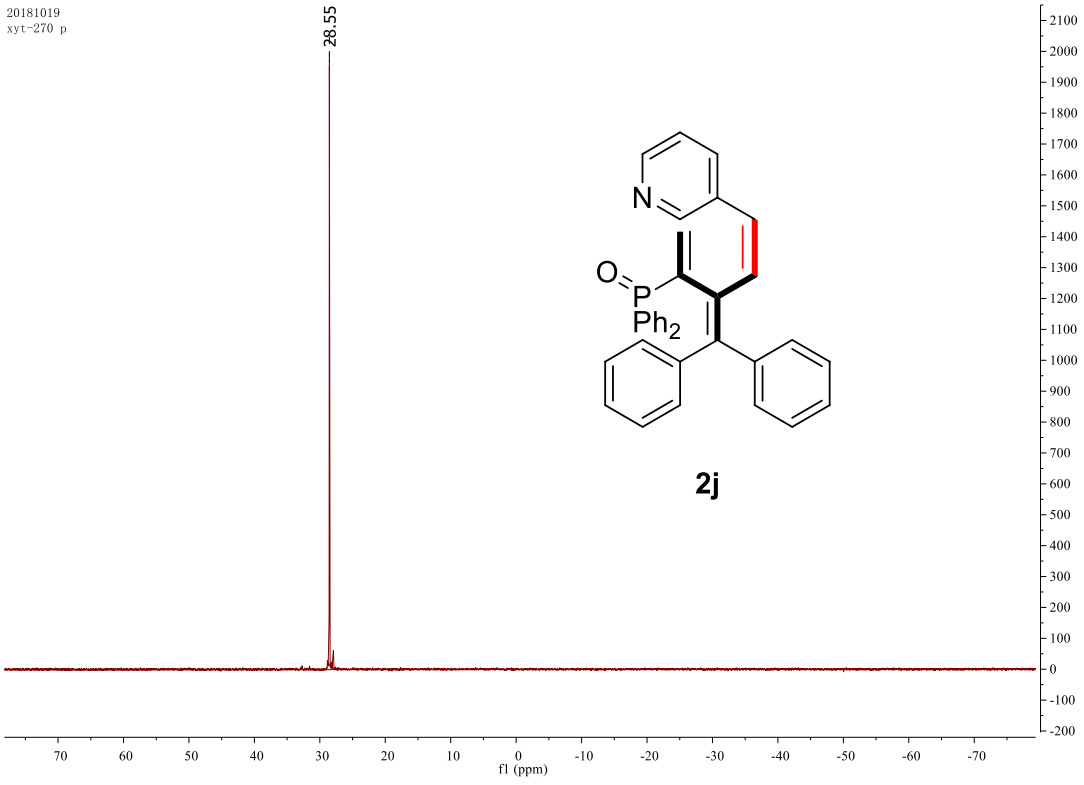

20180904
xyt-229 p
28.51
F
O
P
Ph2
2i
f1 (ppm)

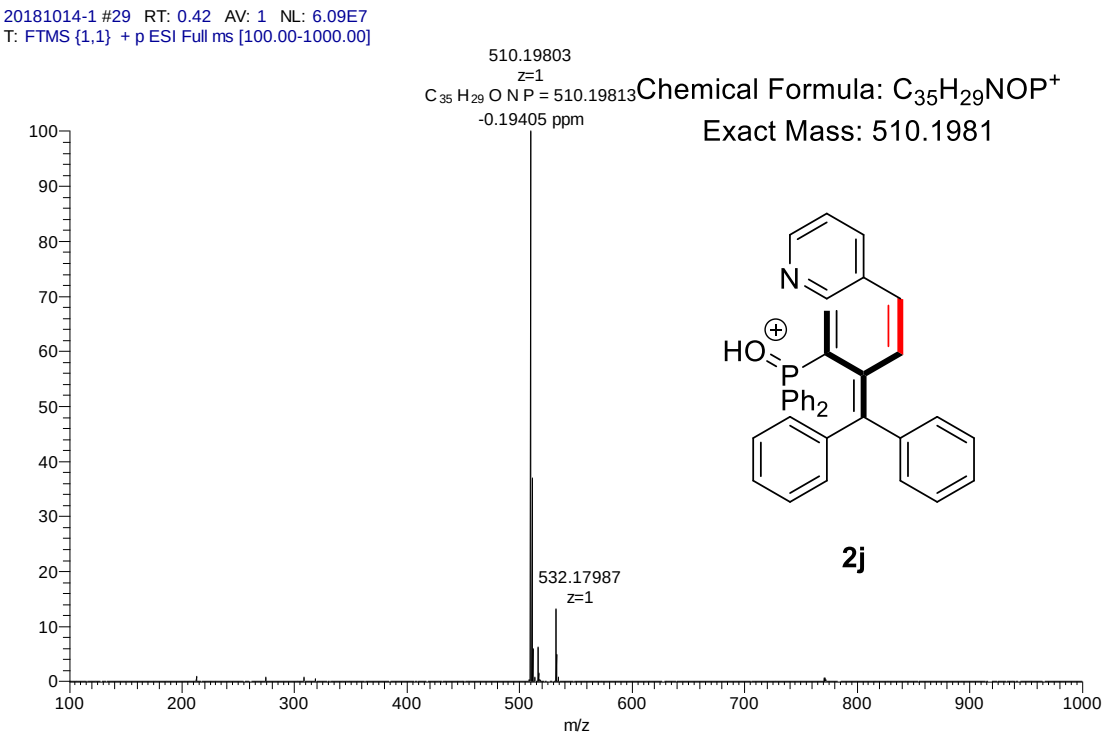

20181014-2 #53 RT: 0.78 AV: 1 NL: 4.30E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
527.19330
z=?
C36 H29 O F P = 527.19346
-0.30052 ppm
Chemical Formula: C36H29FOP+
Exact Mass: 527.1935
F
HO
P
Ph2
2i
m/z

2j


7.57
7.56
7.55
7.53
7.41
7.39
7.38
7.37
7.29
7.10
7.08
6.97
6.12
6.11
6.09
6.08
5.89
5.88
5.85
5.78
5.43
5.38
N
O
P
Ph2
2j
1.01
1.09
1.07
21.07
1.01
2.00
1.08
f1 (ppm)

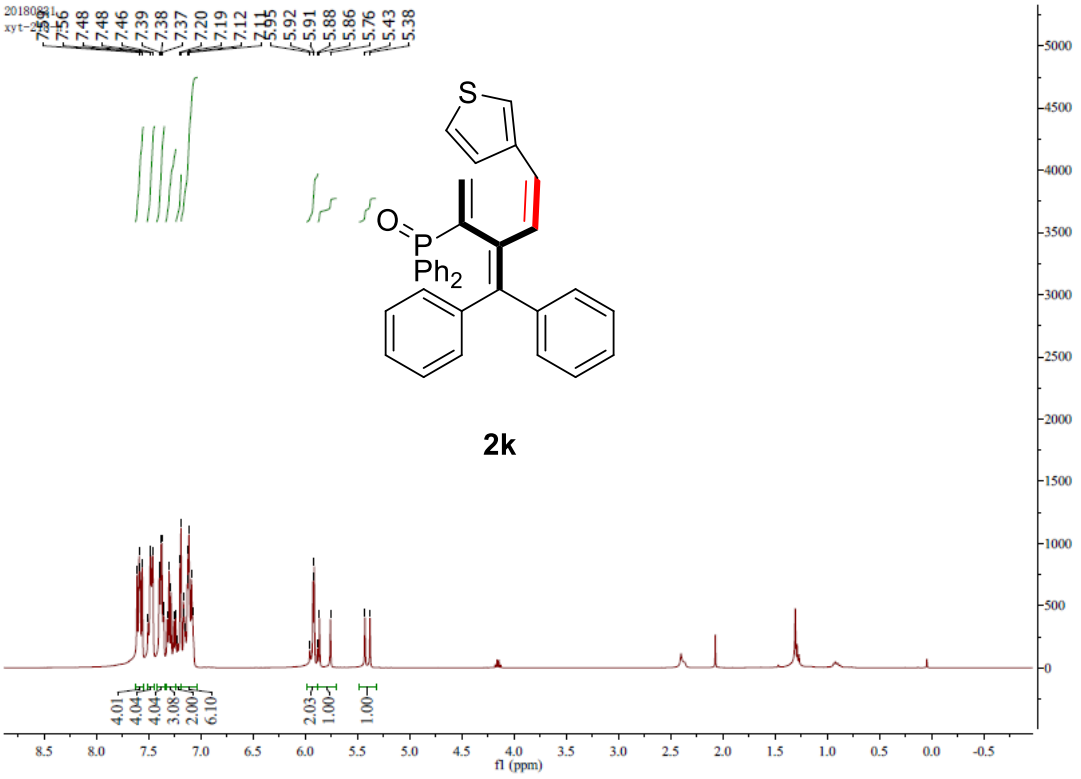

149.78
147.64
142.09
141.74
135.99
135.39
133.02
132.59
131.82
131.73
131.67
131.64
131.57
130.68
129.85
129.27
128.35
128.23
127.87
127.50
127.37
127.10
122.78
77.40
77.08
76.76
N
O
P
Ph2
2j
f1 (ppm)


20181019
xyt-270 p
28.55
N
O
P
Ph2
2j
f1 (ppm)

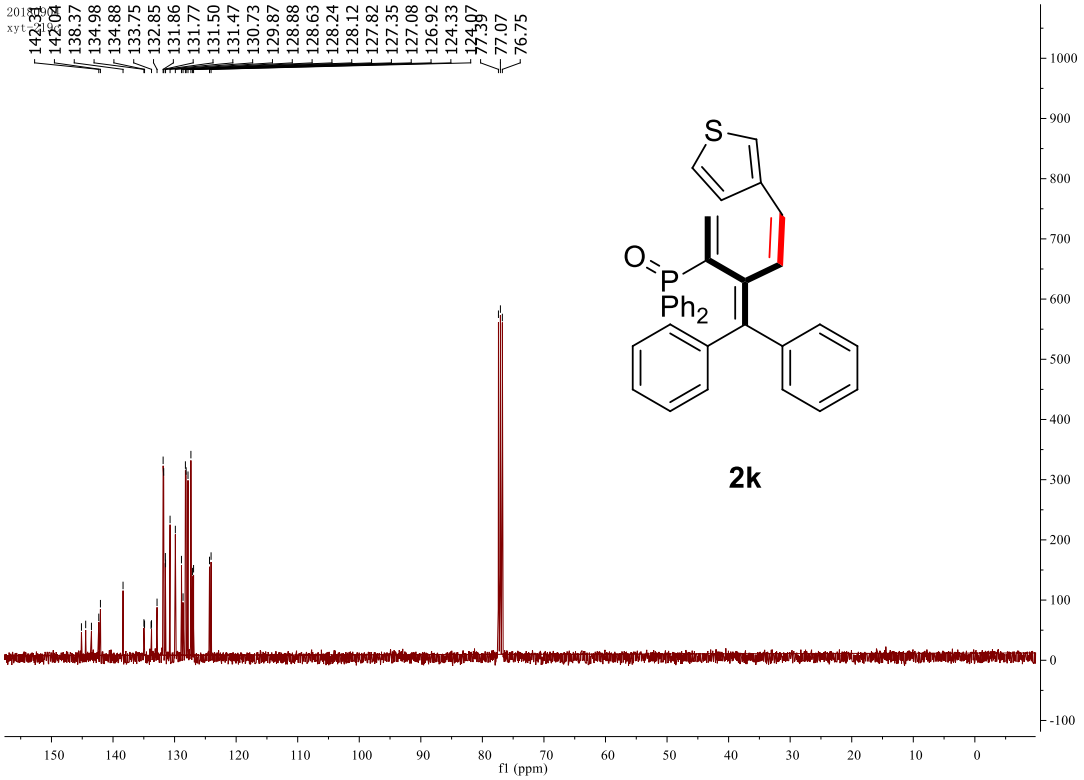

20181014-1 #29 RT: 0.42 AV: 1 NL: 6.09E7
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
510.19803
z=1
C35 H29 O N P = 510.19813
-0.19405 ppm
Chemical Formula: C35H29NOP+
Exact Mass: 510.1981
532.17987
z=1
m/z

2j

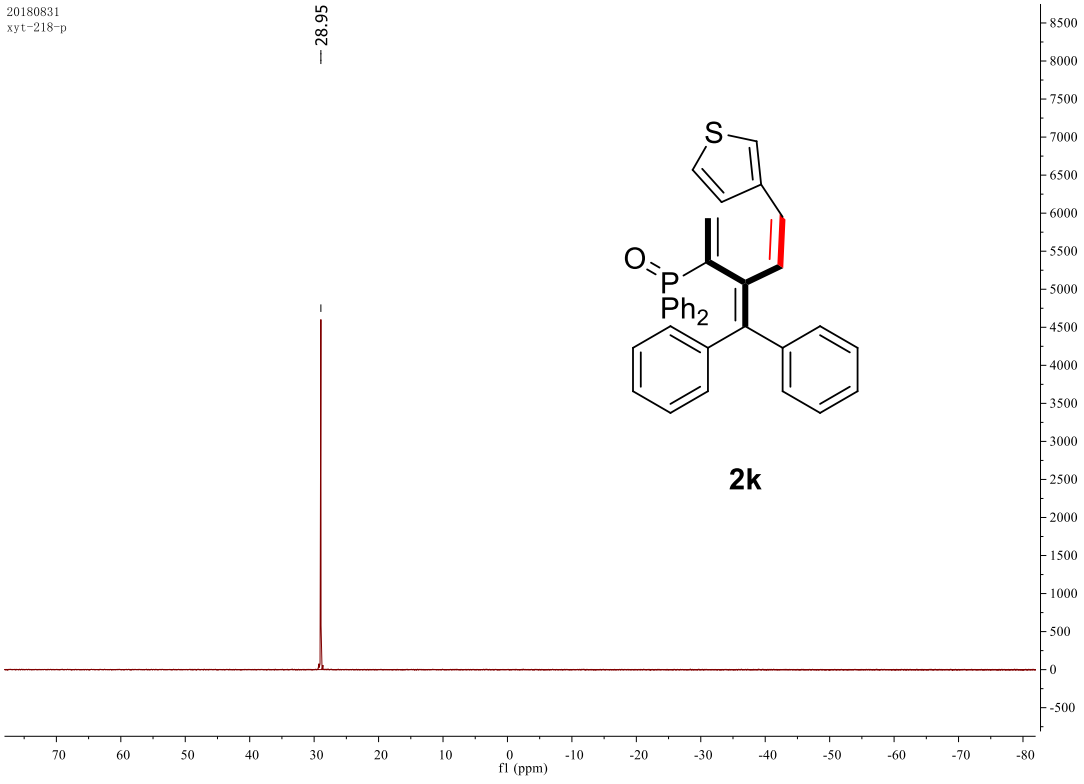
2k



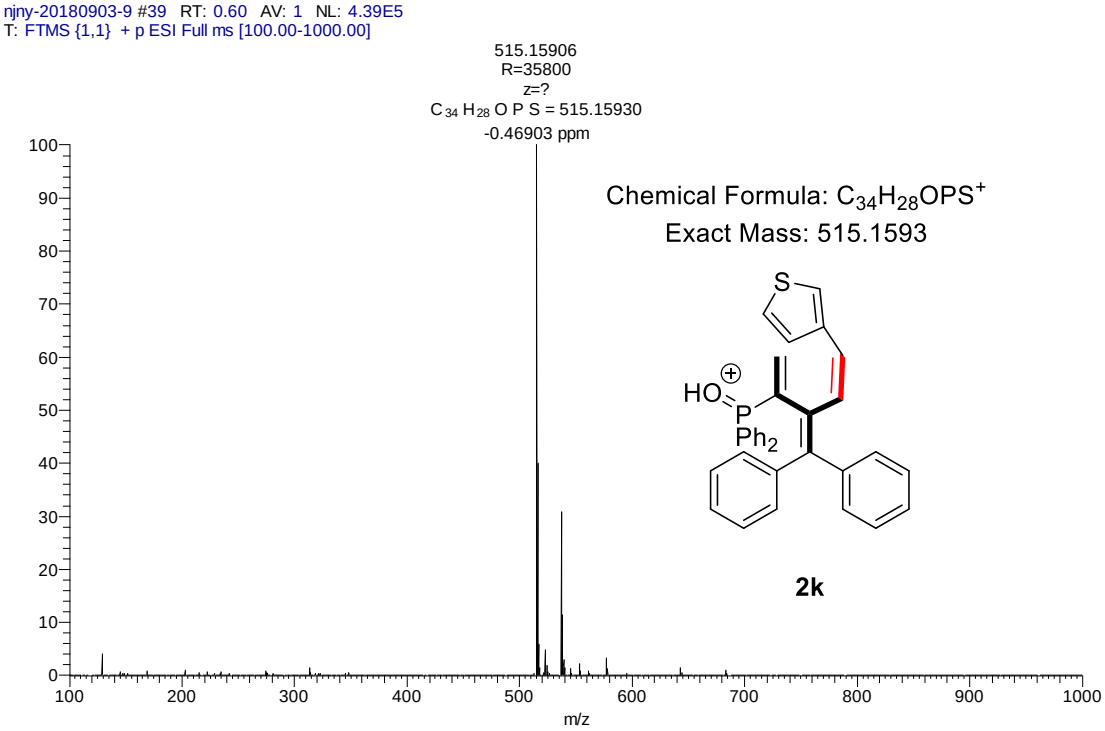
2k


142.33
142.04
138.37
134.98
134.88
133.75
132.85
131.86
131.77
131.50
131.47
130.73
129.87
128.88
128.63
128.24
128.12
127.82
127.35
127.08
126.92
124.33
77.39
77.07
76.75
S
O
P
Ph2
f1 (ppm)

2k

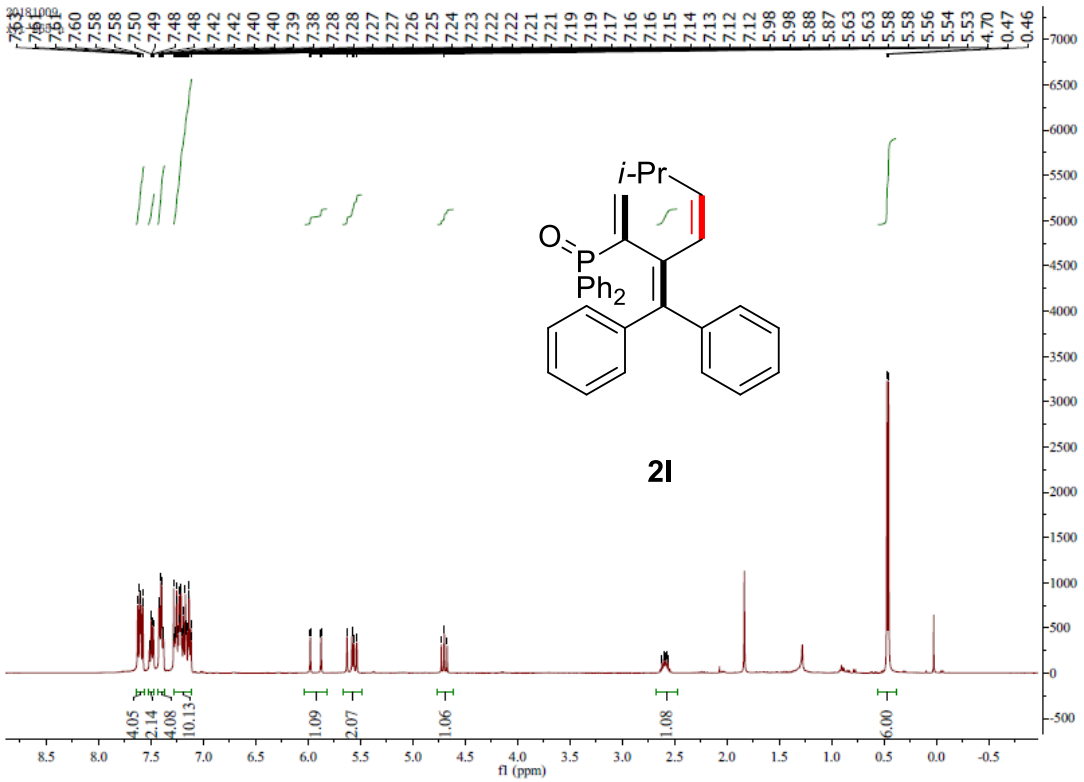

20180831
xyt-218-p
28.95
S
O
P
Ph2
f1 (ppm)

2k

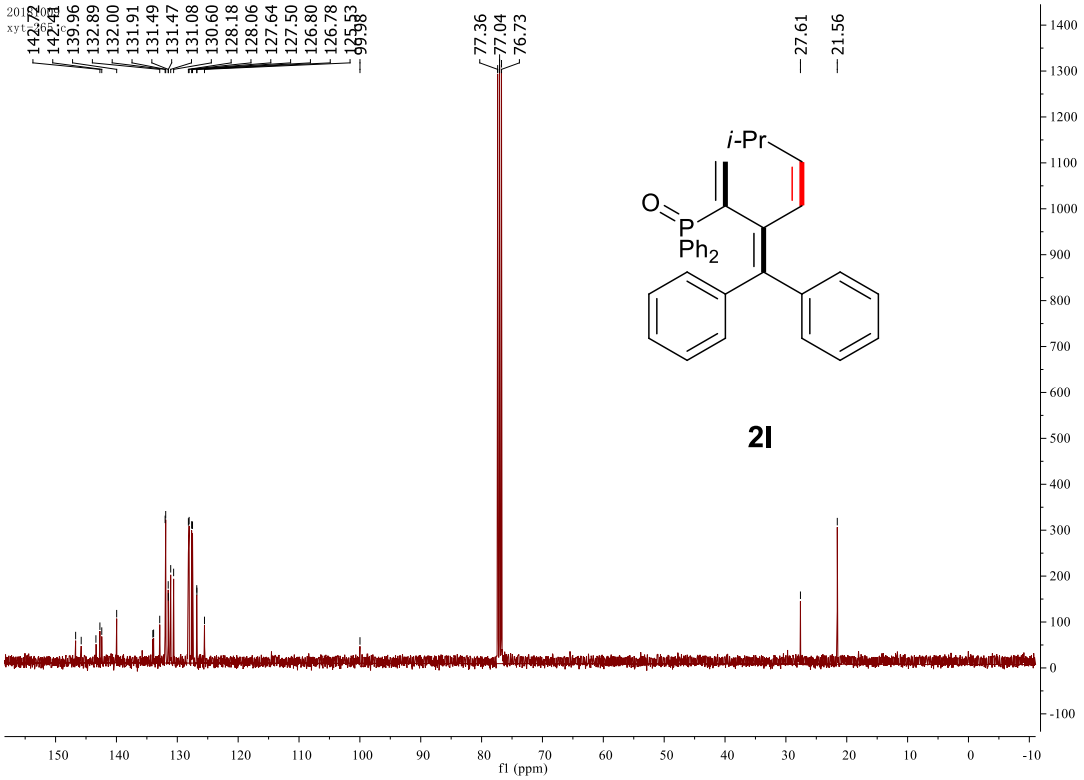

njny-20180903-9 #39 RT: 0.60 AV: 1 NL: 4.39E5
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
515.15906
R=35800
z=?
C 34 H 28 O P S = 515.15930
-0.46903 ppm
Chemical Formula: C34H28OPS+
Exact Mass: 515.1593
HO
P
Ph2
S
m/z

2k

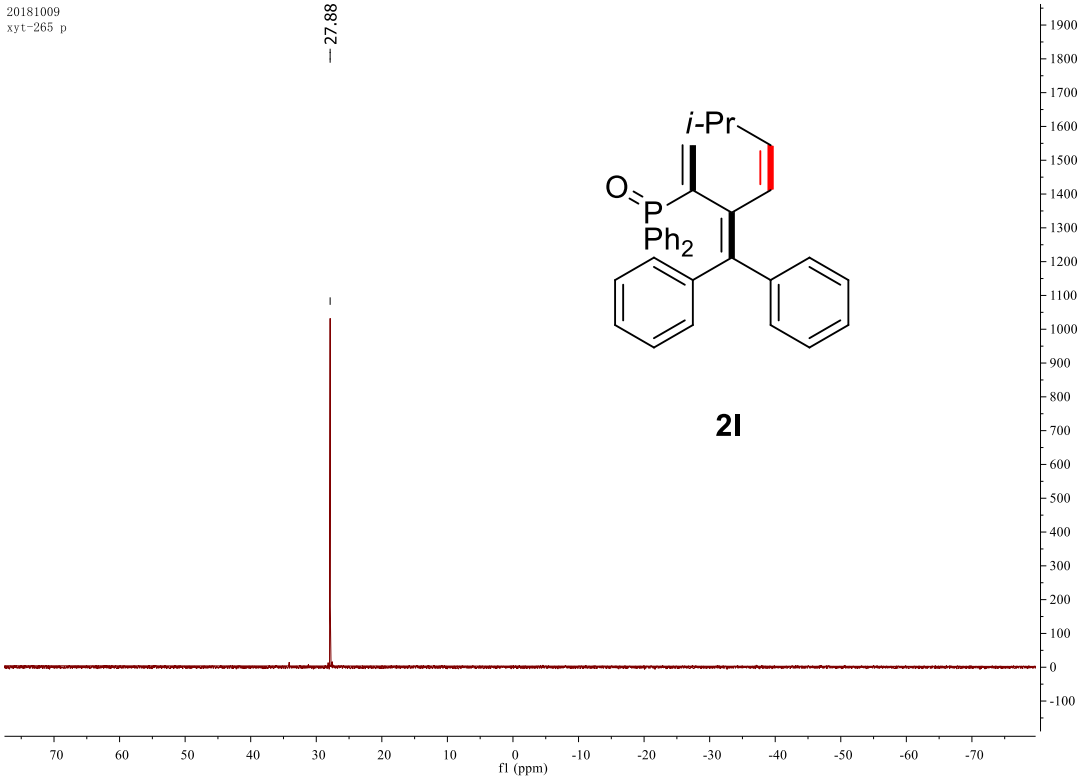
2l


i-Pr
O
P
Ph2
fl (ppm)

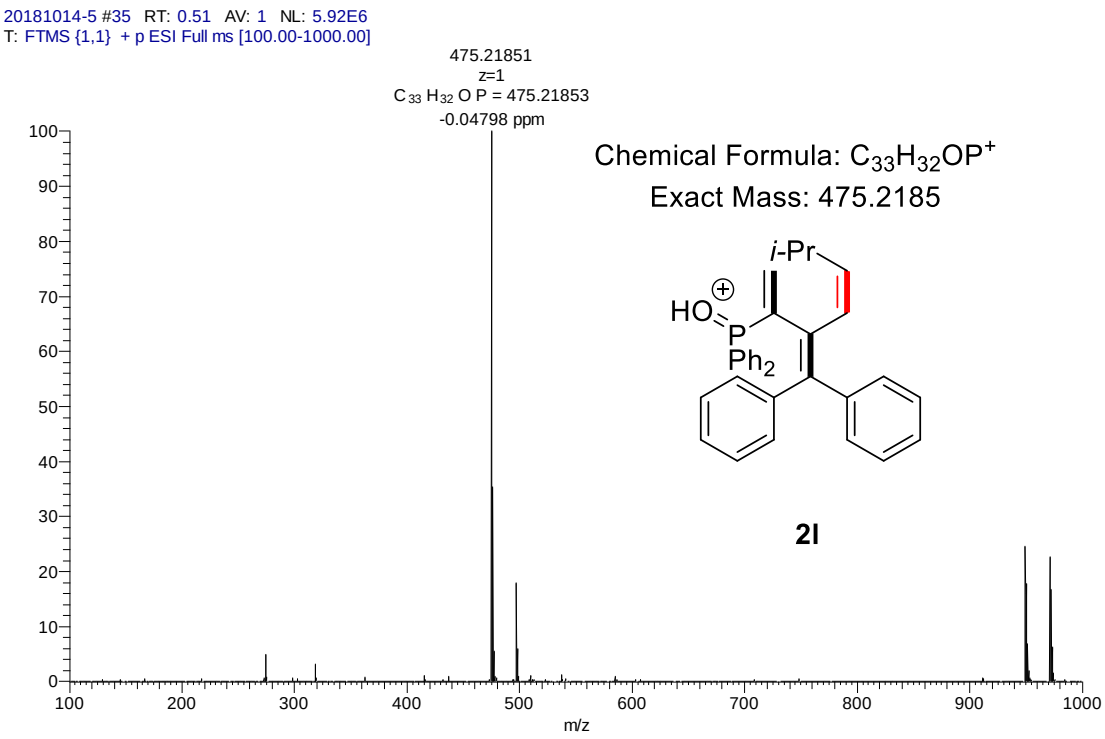
2l


142.72
142.41
139.96
132.89
132.00
131.91
131.49
131.47
131.08
130.60
128.18
128.06
127.64
127.50
126.80
125.53
77.36
77.04
76.73
27.61
21.56
i-Pr
O
P
Ph2
fl (ppm)

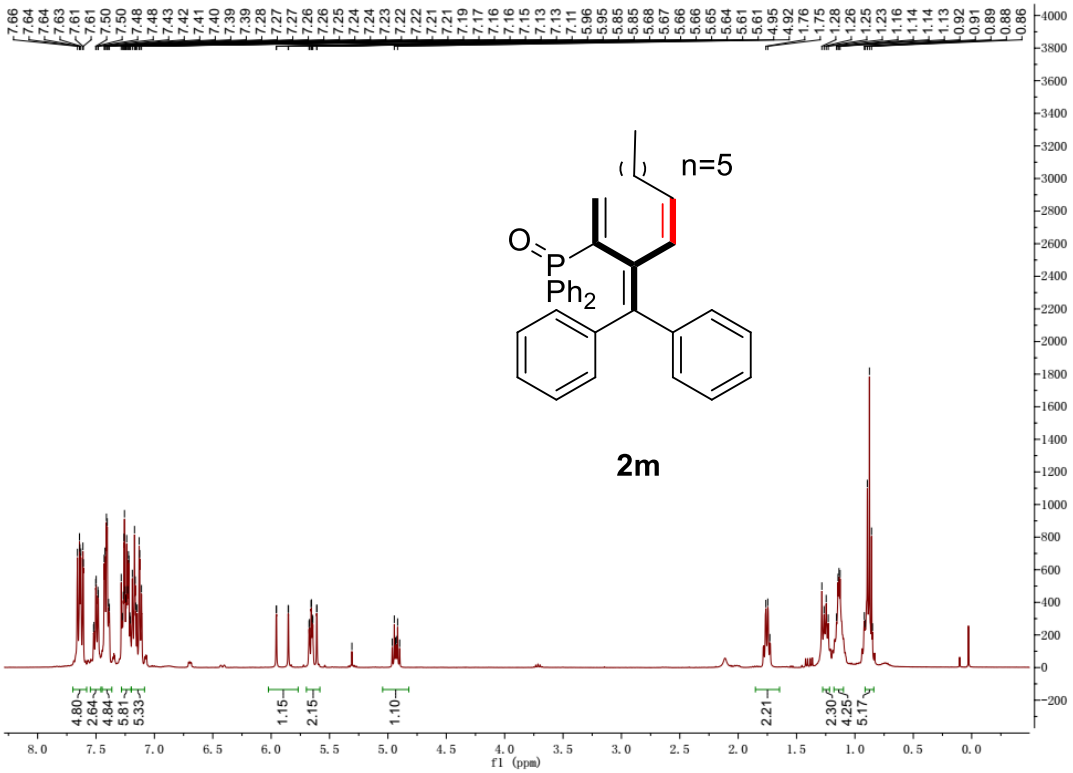
2l

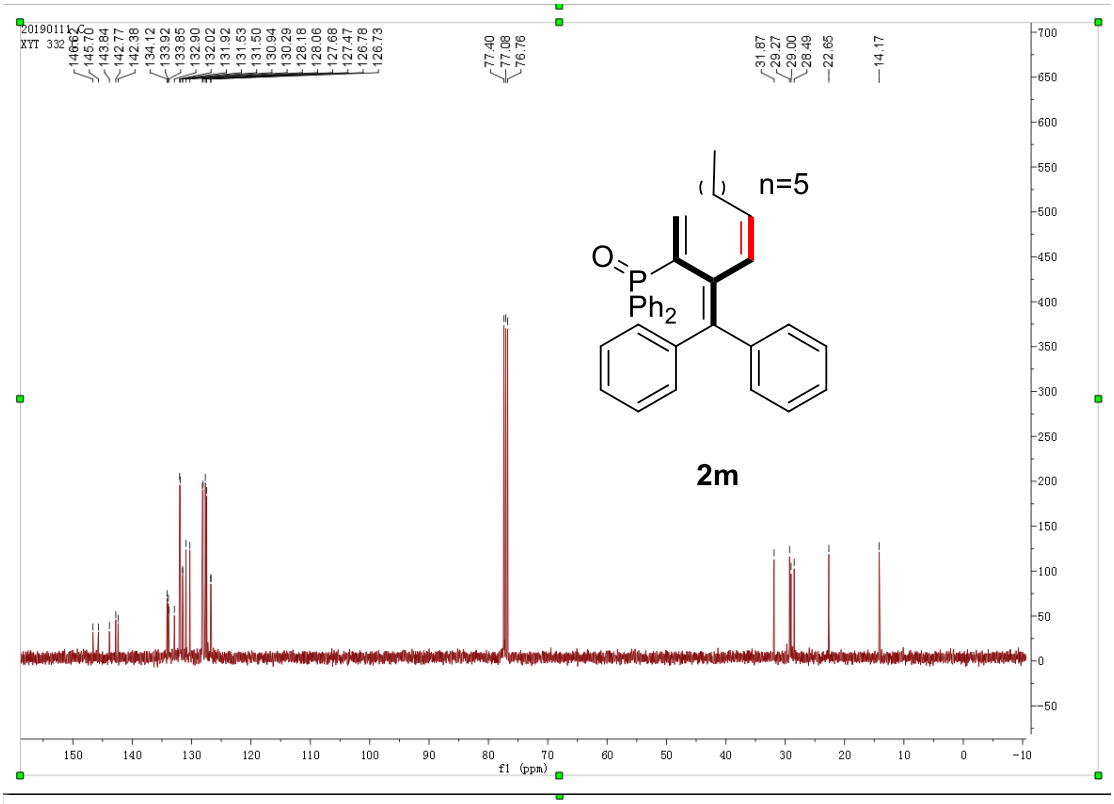

20181009
xyt-265 p
27.88
i-Pr
O
P
Ph2
fl (ppm)

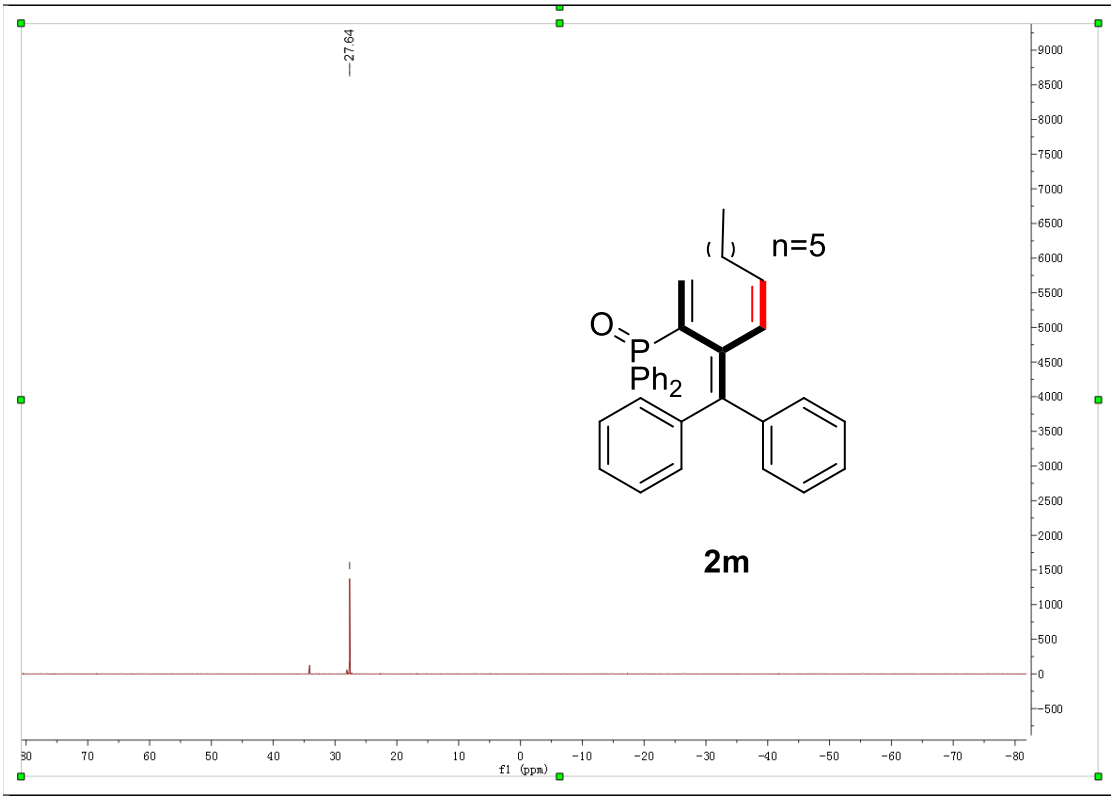
2l

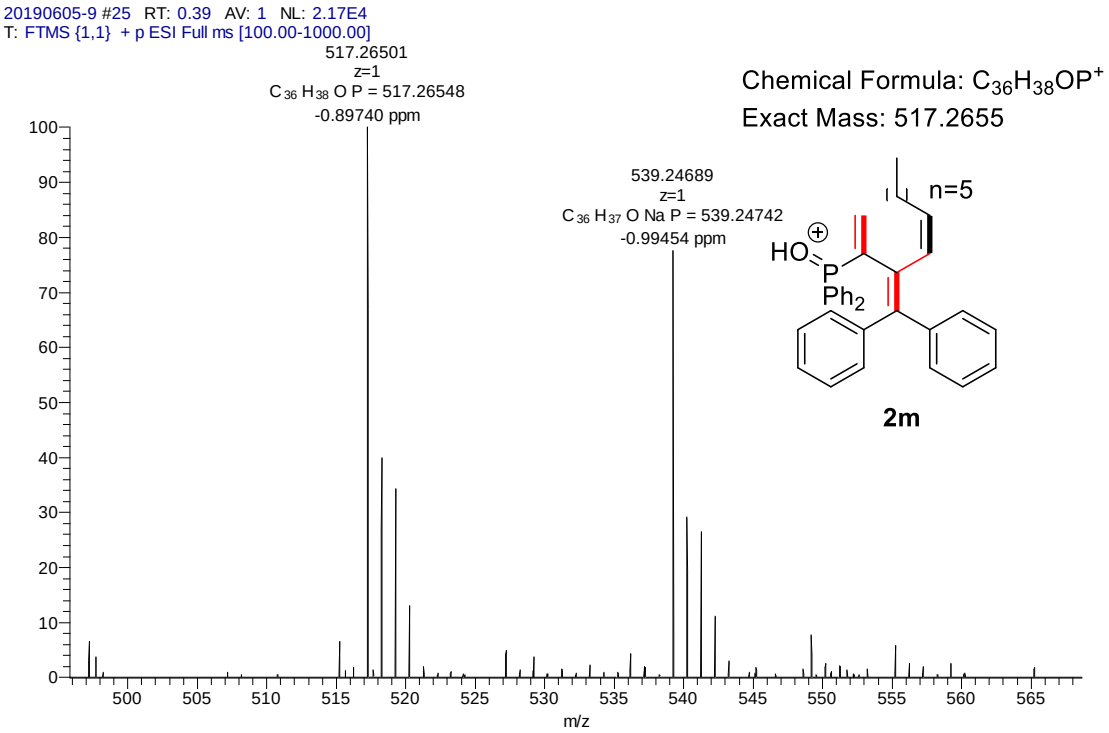

20181014-5 #35 RT: 0.51 AV: 1 NL: 5.92E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
475.21851
z=1
C 33 H 32 O P = 475.21853
-0.04798 ppm
Chemical Formula: C33H32OP+
Exact Mass: 475.2185
i-Pr
HO
P
Ph2
2l
m/z

2m

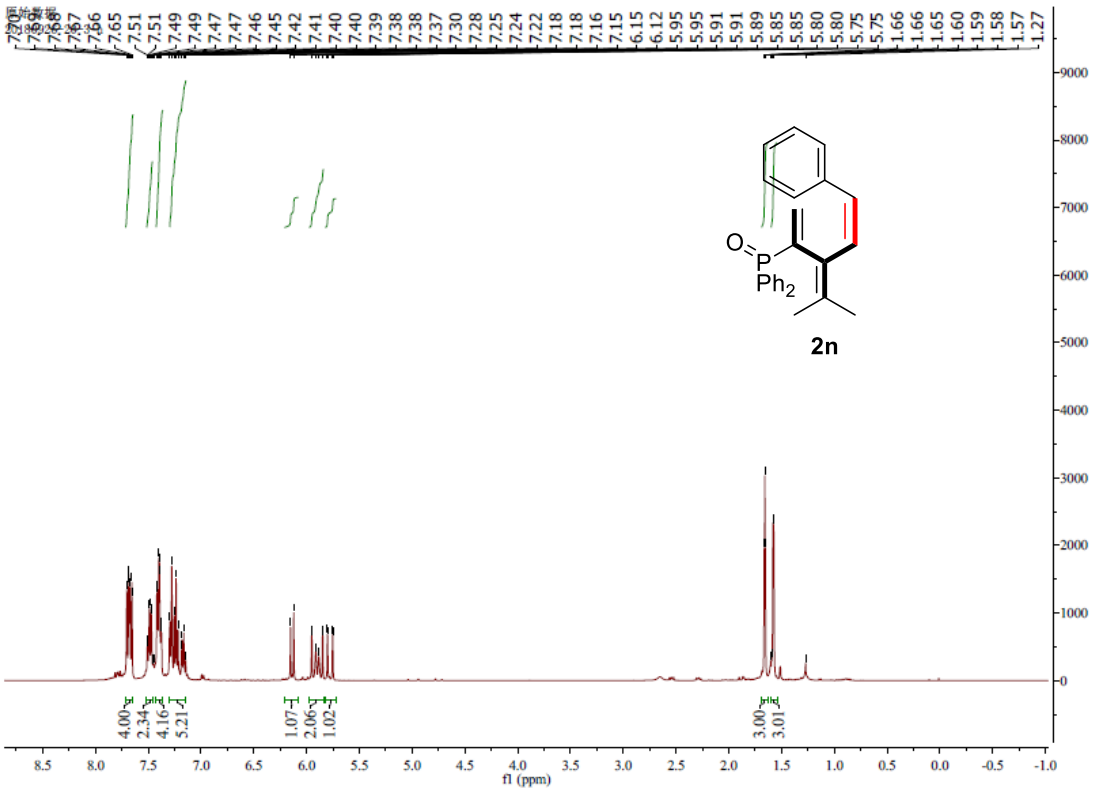

n=5
O
P
Ph2
2m
f1 (ppm)

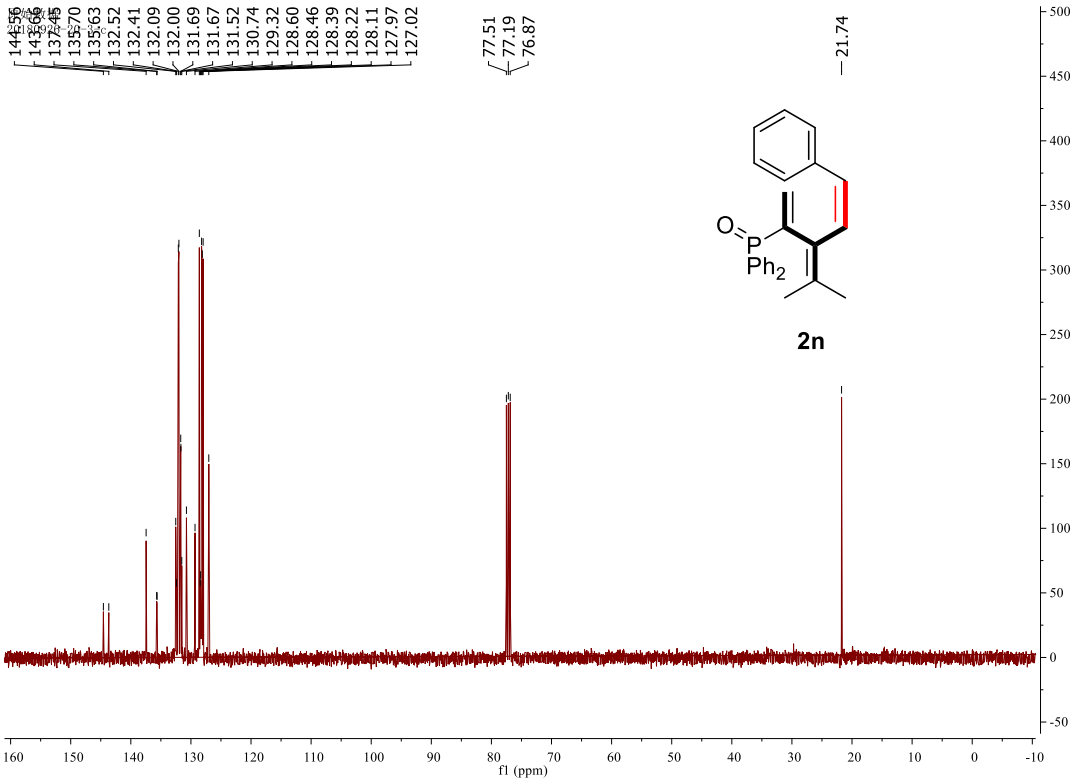

n=5
O
P
Ph2
2m
f1 (ppm)

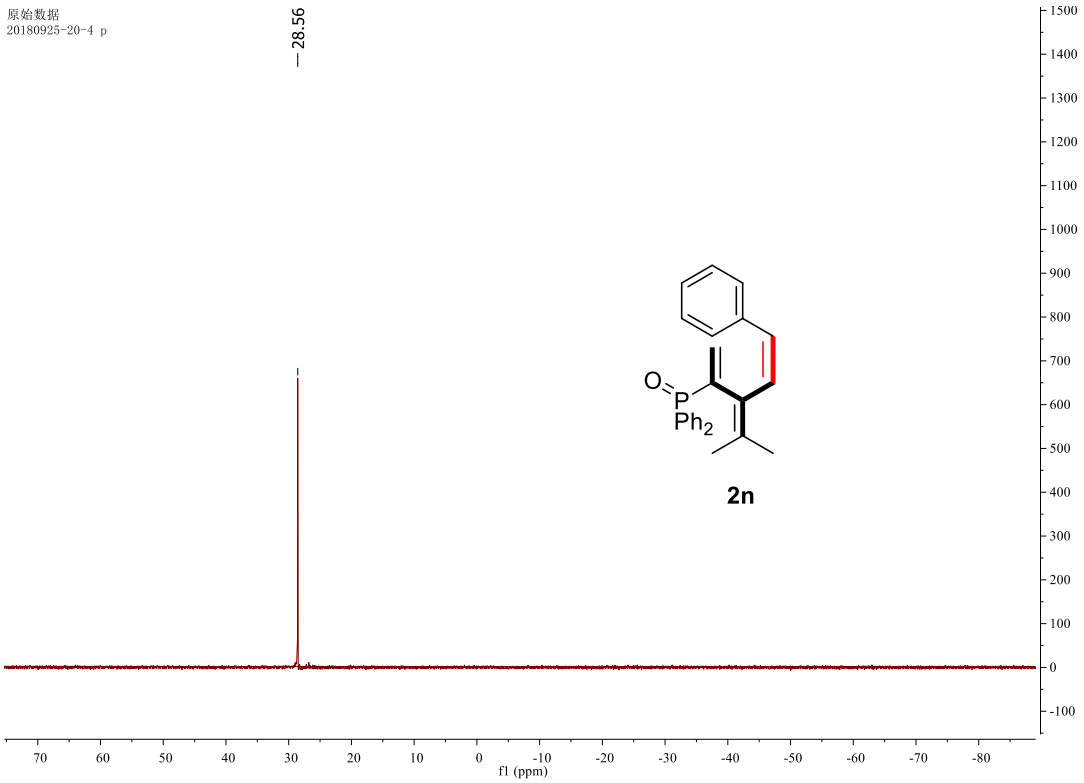

n=5
O
P
Ph2
2m
f1 (ppm)

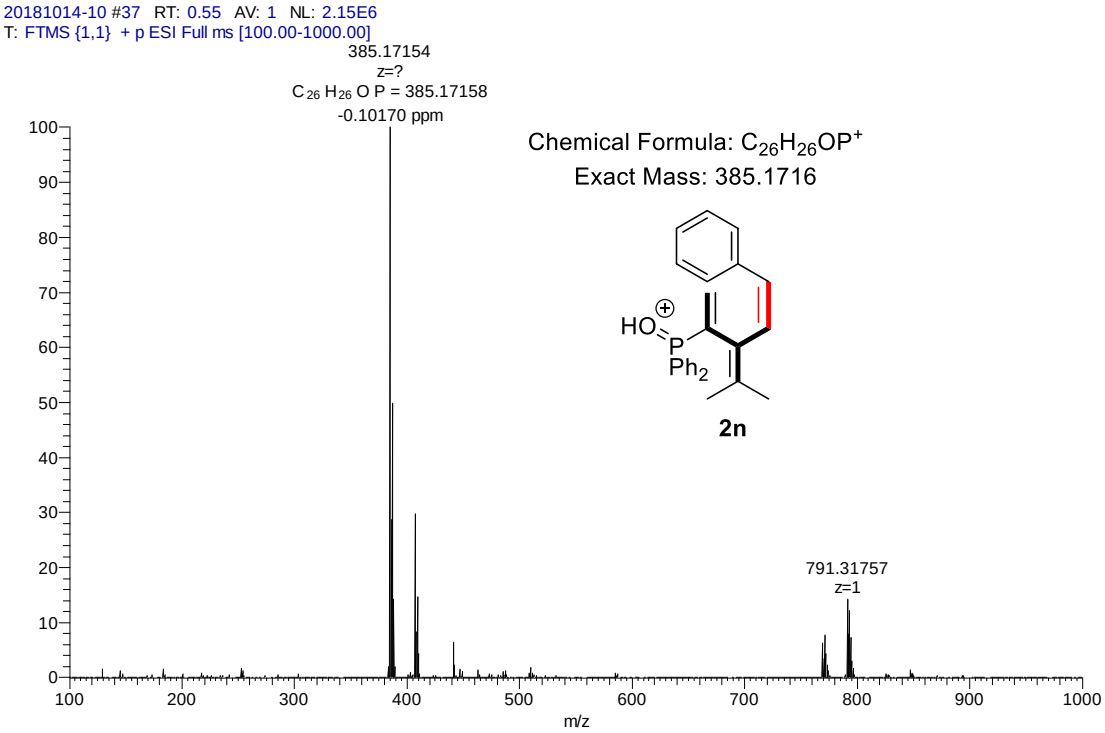

20190605-9 #25 RT: 0.39 AV: 1 NL: 2.17E4
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
517.26501
z=1
C 36 H 38 O P = 517.26548
-0.89740 ppm
539.24689
z=1
C 36 H 37 O Na P = 539.24742
-0.99454 ppm
Chemical Formula: C36H38OP+
Exact Mass: 517.2655
n=5
HO
P
Ph2
2m
m/z

2n

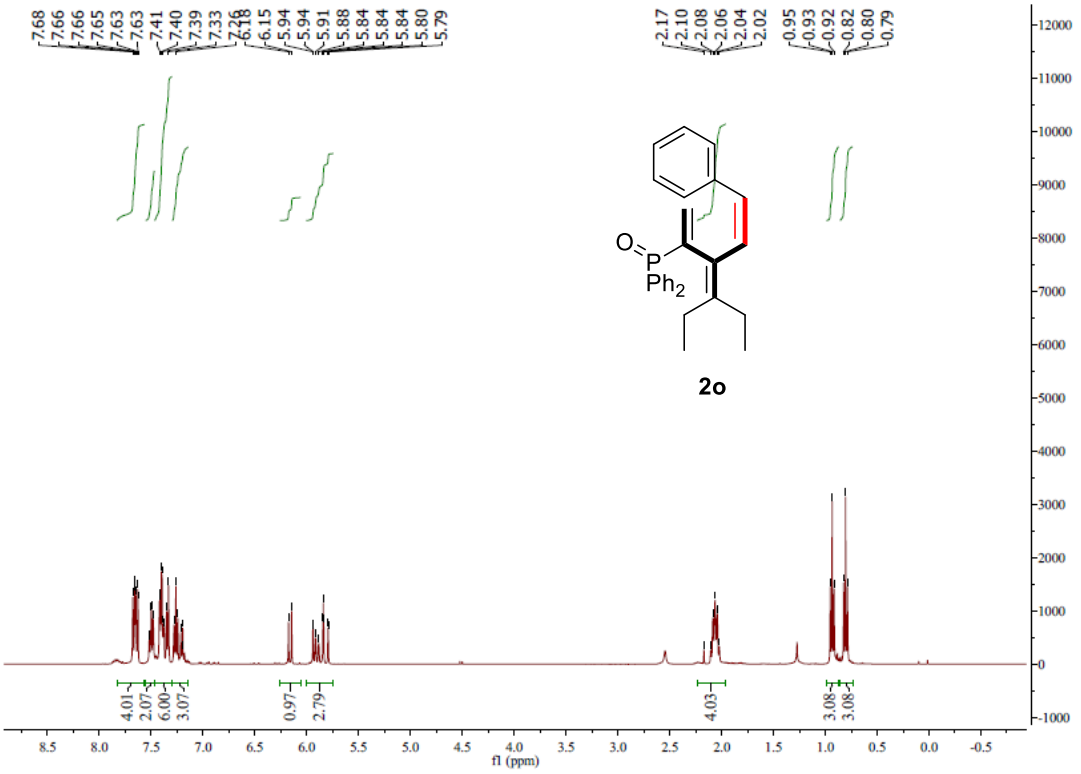

O
P
Ph2
2n
fl (ppm)

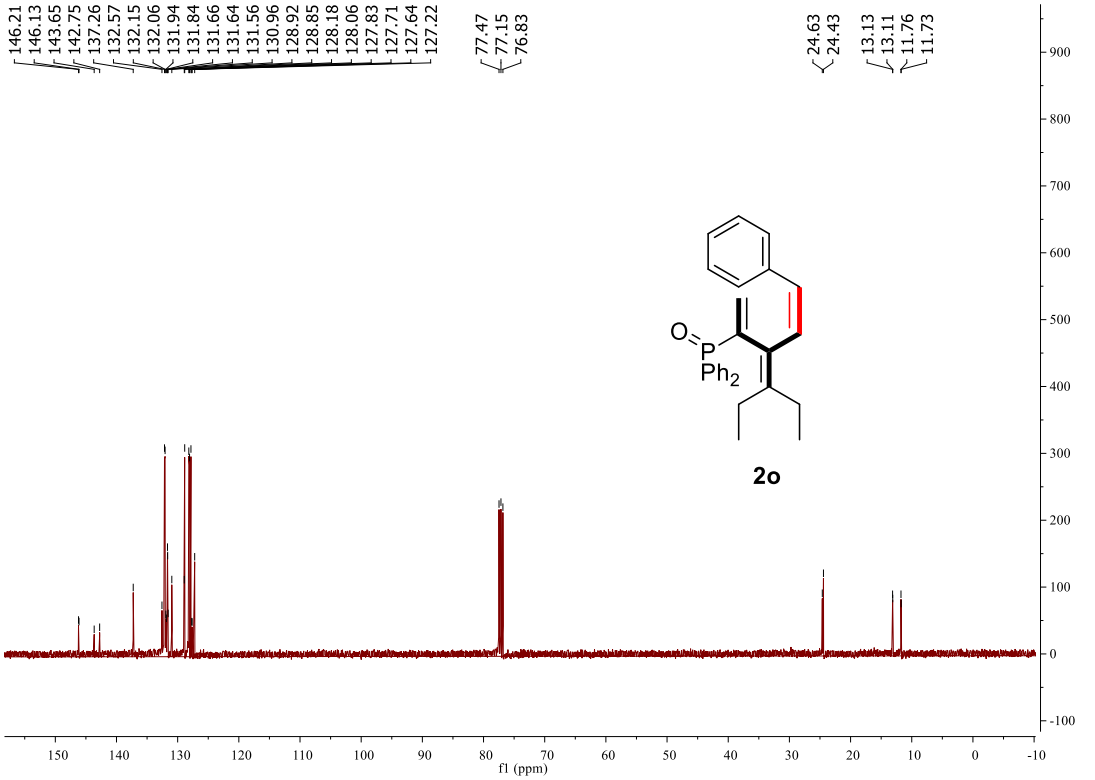

144.55
143.66
137.45
135.70
135.63
132.52
132.41
132.09
132.00
131.69
131.67
131.52
130.74
129.32
128.60
128.46
128.39
128.22
128.11
127.97
127.02
77.51
77.19
76.87
21.74
O
P
Ph2
2n
fl (ppm)

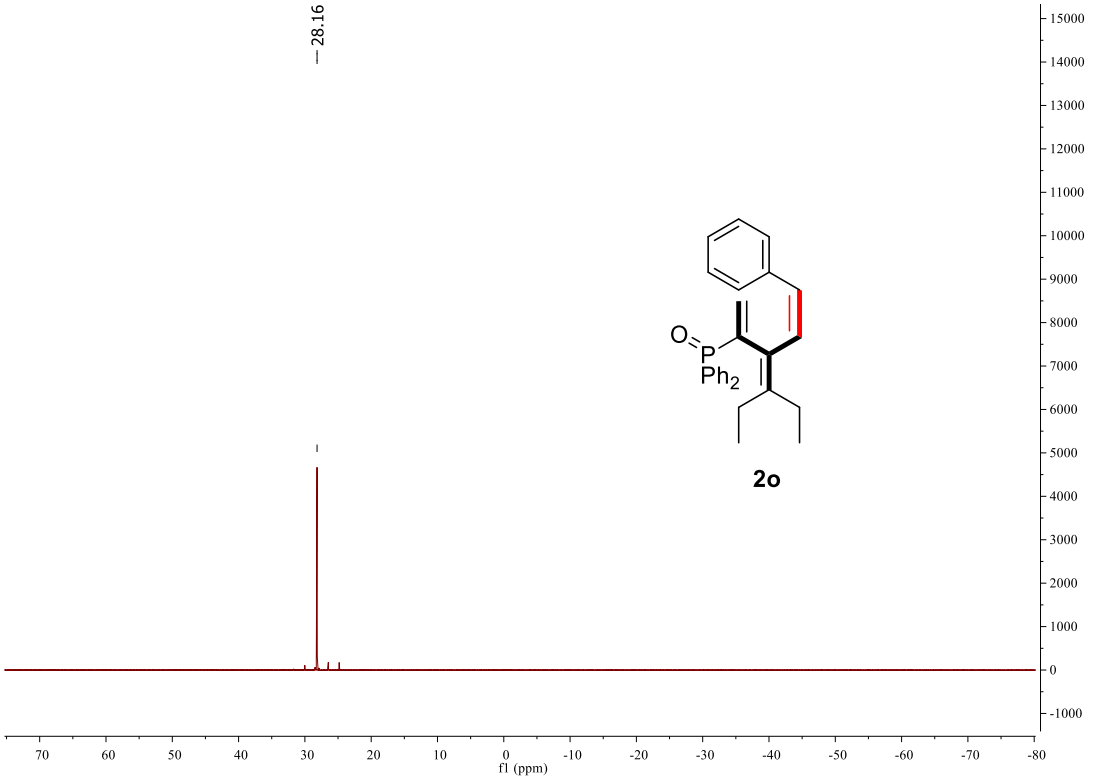

原始数据
20180925-20-4 p
28.56
O
P
Ph2
2n
fl (ppm)

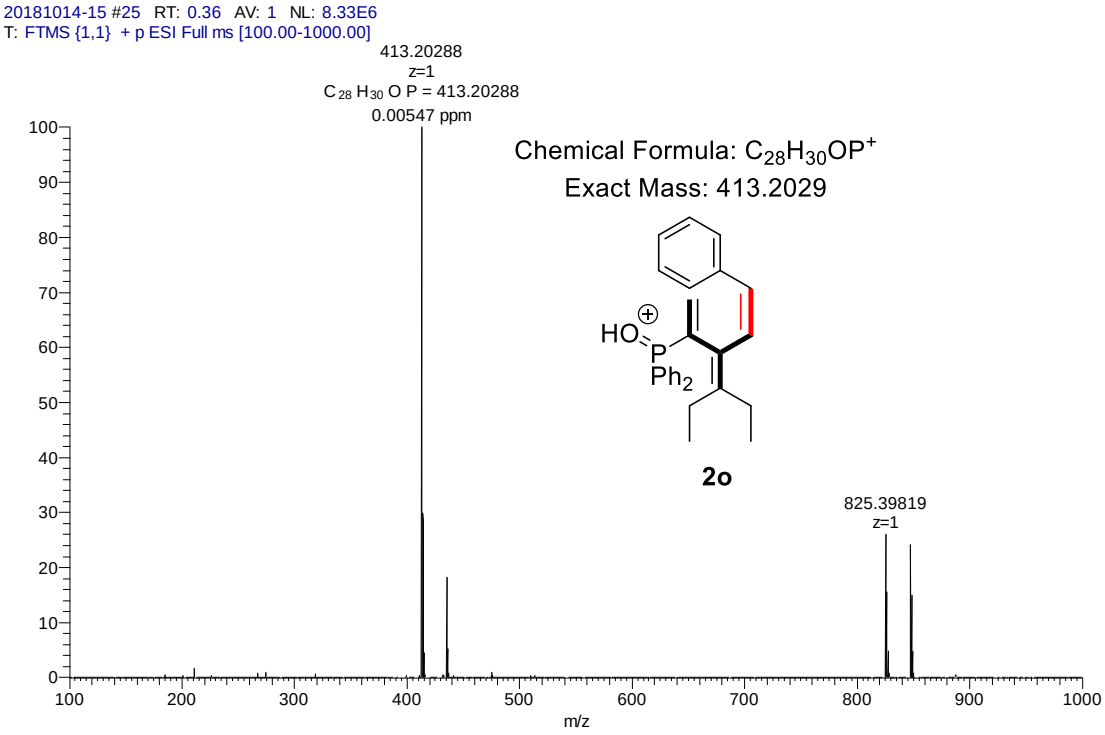

20181014-10 #37 RT: 0.55 AV: 1 NL: 2.15E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
385.17154
z=?
C 26 H 26 O P = 385.17158
-0.10170 ppm
Chemical Formula: C26H26OP+
Exact Mass: 385.1716
HO
P
Ph2
2n
791.31757
z=1
m/z

2o

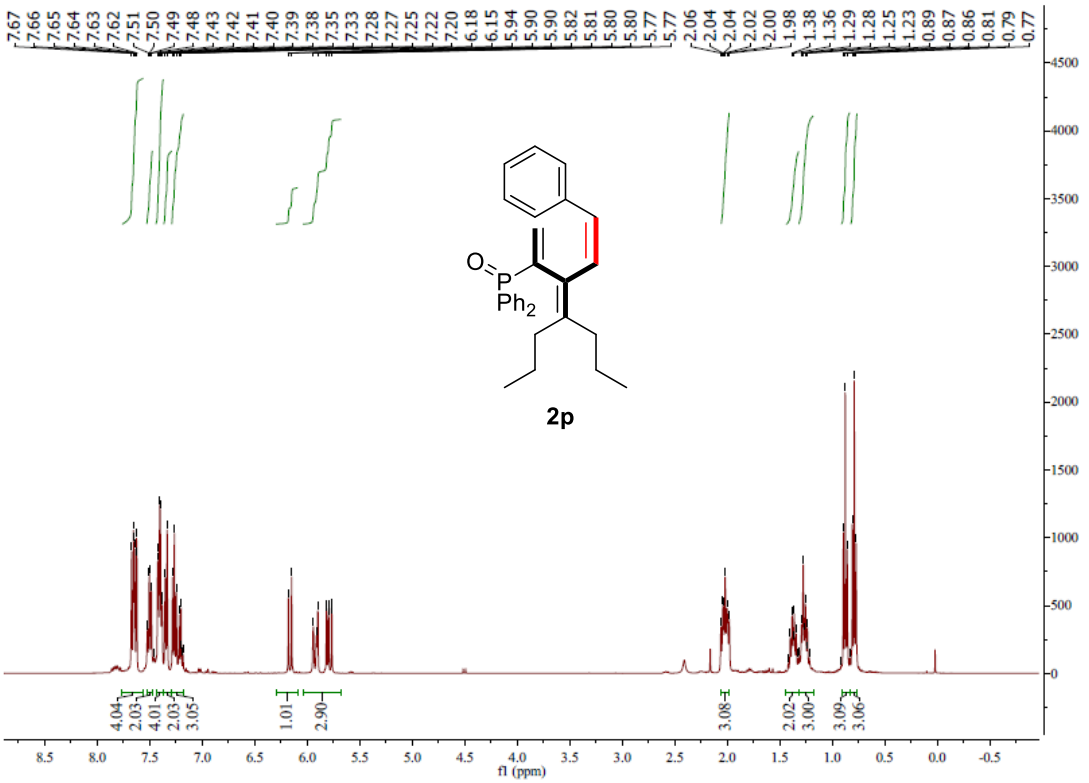

O
P
Ph2
2o
f1 (ppm)

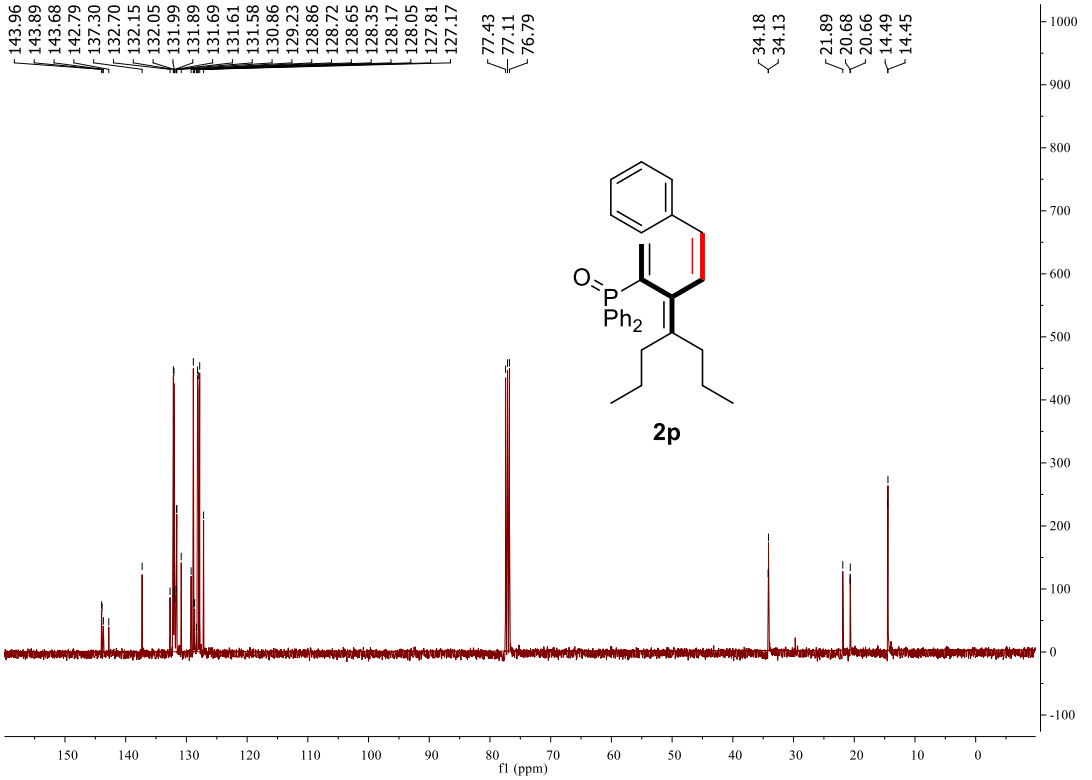

146.21
146.13
143.65
142.75
137.26
132.57
132.15
132.06
131.94
131.84
131.66
131.64
131.56
130.96
128.92
128.85
128.18
128.06
127.83
127.71
127.64
127.22
77.47
77.15
76.83
24.63
24.43
13.13
13.11
11.76
11.73
O
P
Ph2
2o
fl (ppm)

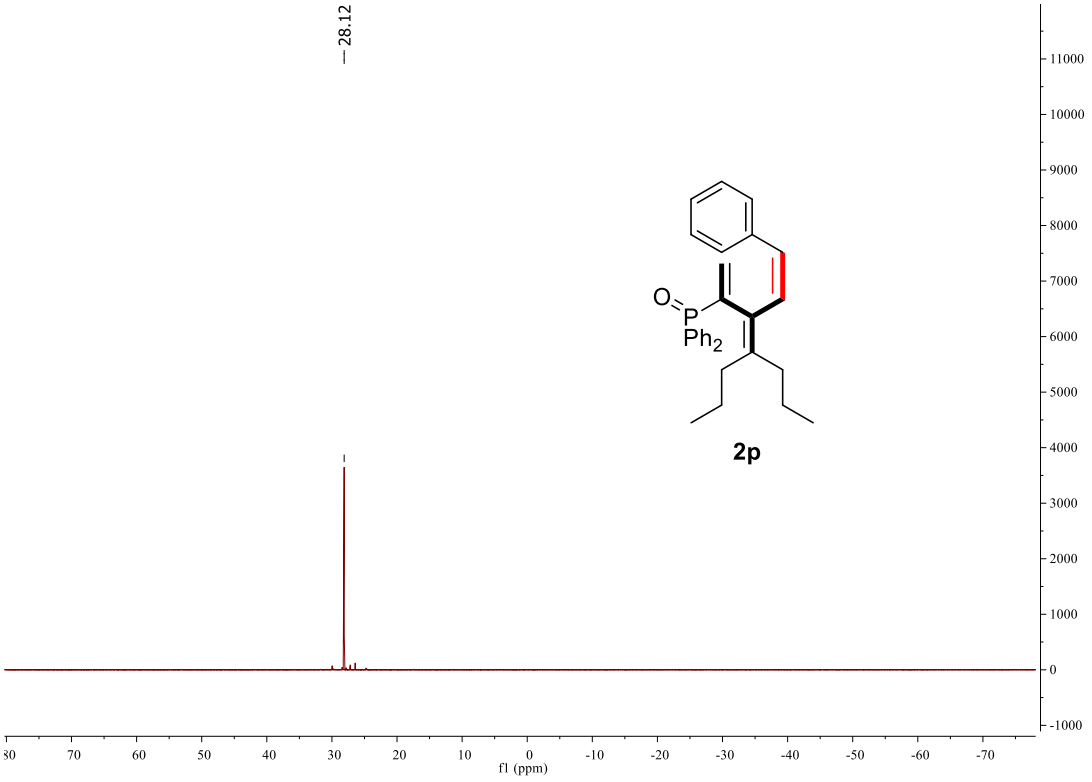

28.16
O
P
Ph2
2o
fl (ppm)

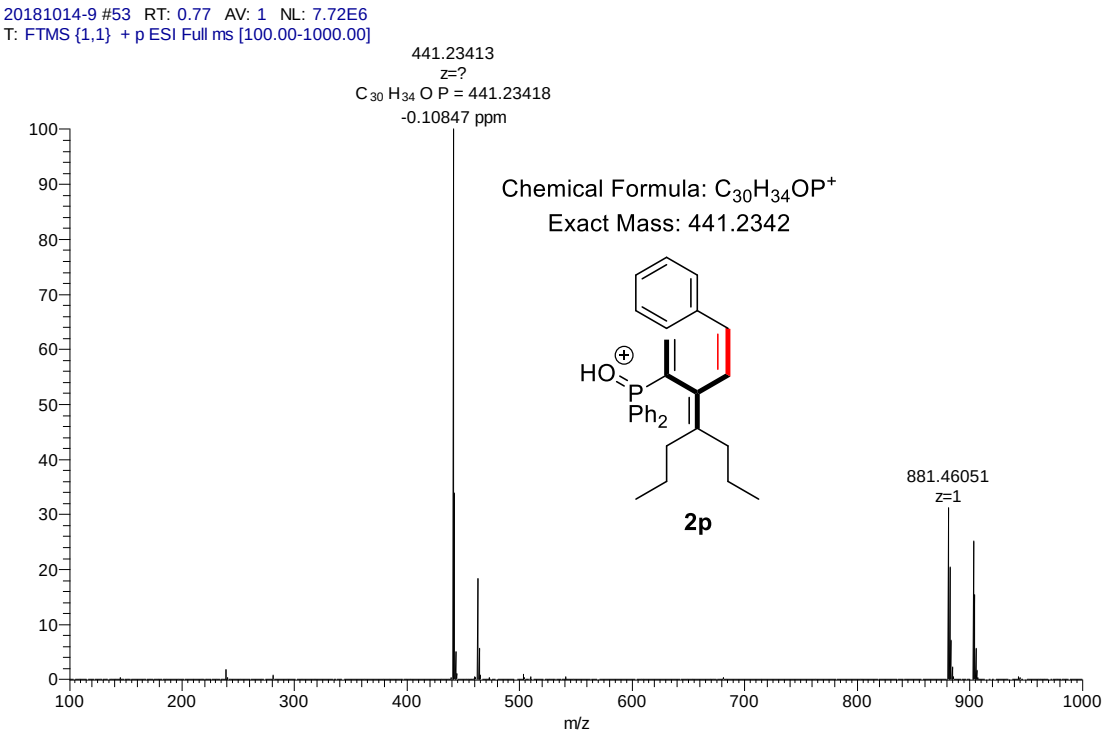

20181014-15 #25 RT: 0.36 AV: 1 NL: 8.33E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
413.20288
z=1
C 28 H 30 O P = 413.20288
0.00547 ppm
Chemical Formula: C28H30OP+
Exact Mass: 413.2029
HO
P
Ph2
2o
825.39819
z=1
m/z

2p

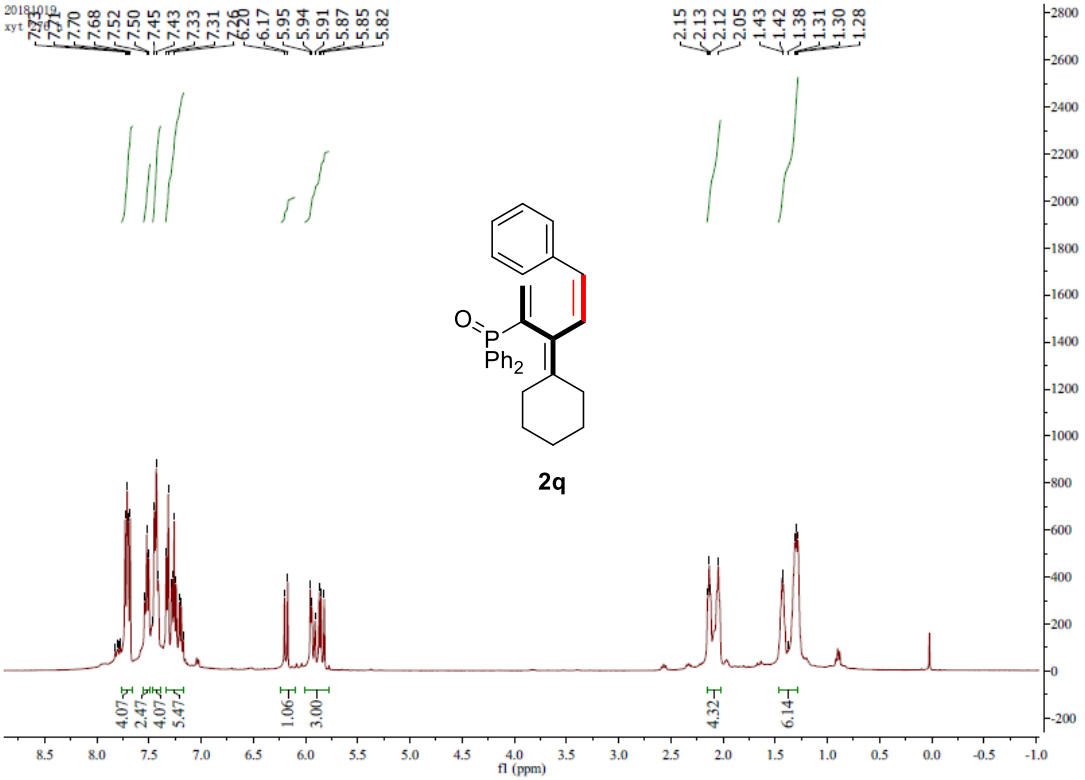

O
P
Ph2
2p
fl (ppm)

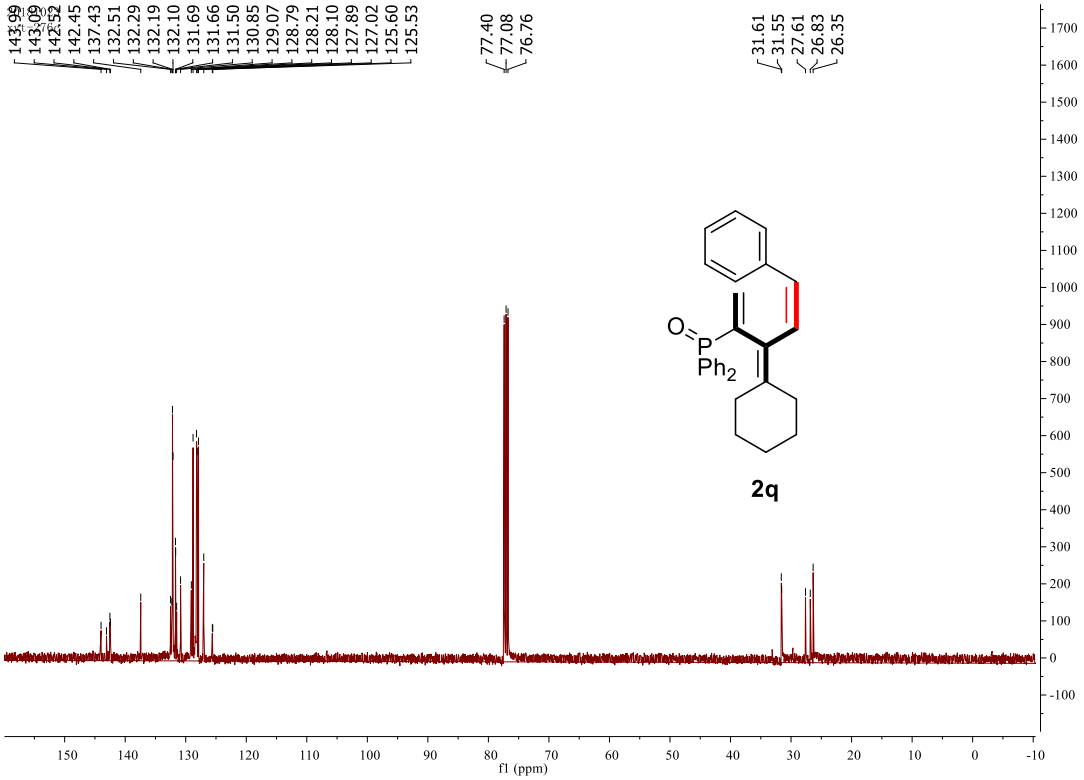

143.96
143.89
143.68
142.79
137.30
132.70
132.15
132.05
131.99
131.89
131.69
131.61
131.58
130.86
129.23
128.86
128.72
128.65
128.35
128.17
128.05
127.81
127.17
77.43
77.11
76.79
34.18
34.13
21.89
20.68
20.66
14.49
14.45
O
P
Ph2
2p
fl (ppm)

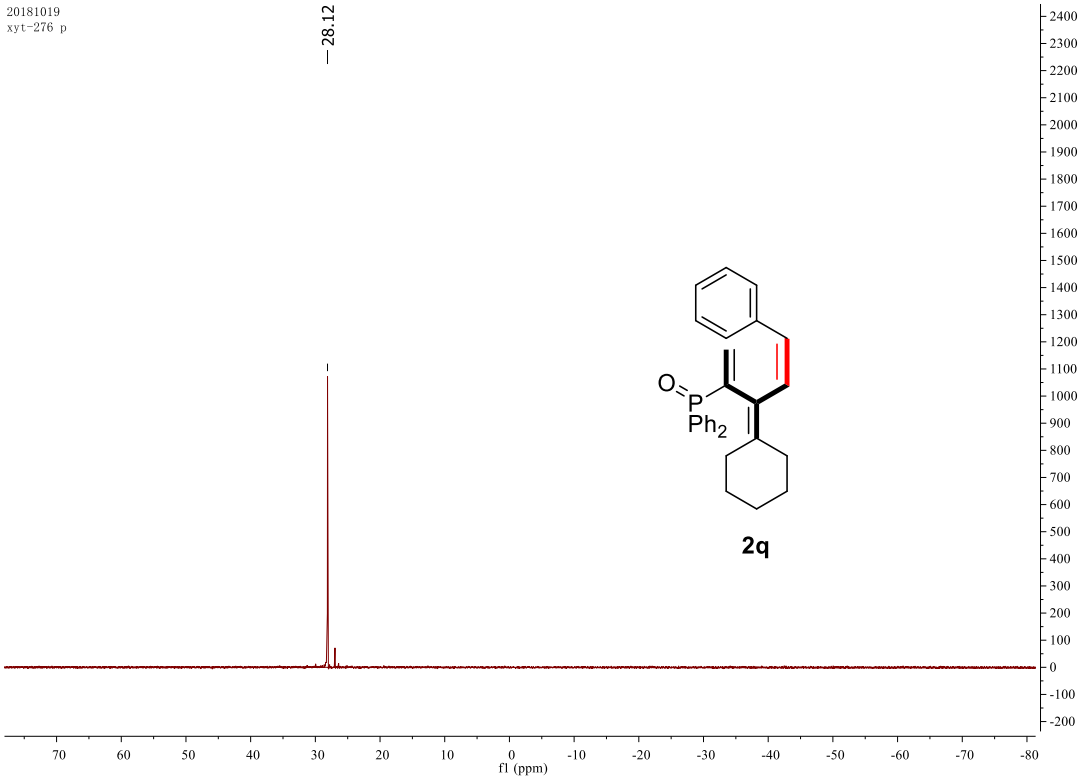

28.12
O
P
Ph2
2p
fl (ppm)

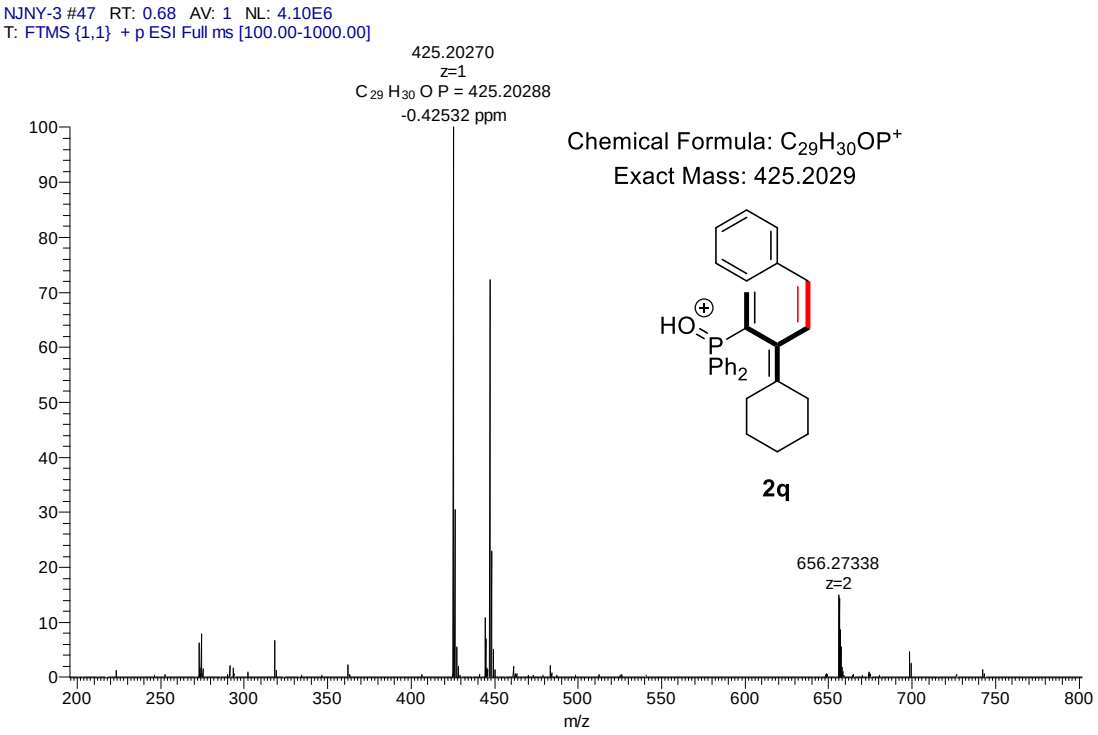

20181014-9 #53 RT: 0.77 AV: 1 NL: 7.72E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
441.23413
z=?
C 30 H 34 O P = 441.23418
-0.10847 ppm
Chemical Formula: C30H34OP+
Exact Mass: 441.2342
HO
P
Ph2
2p
881.46051
z=1
m/z

2q

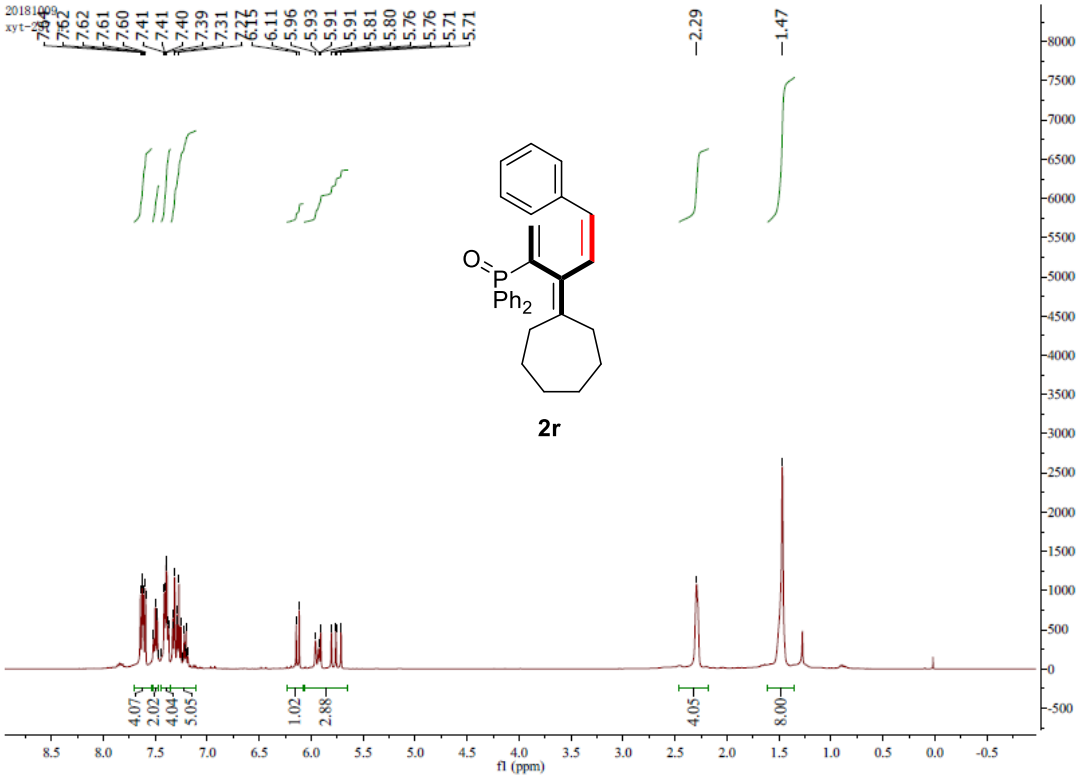

O
P
Ph2
2q
f1 (ppm)

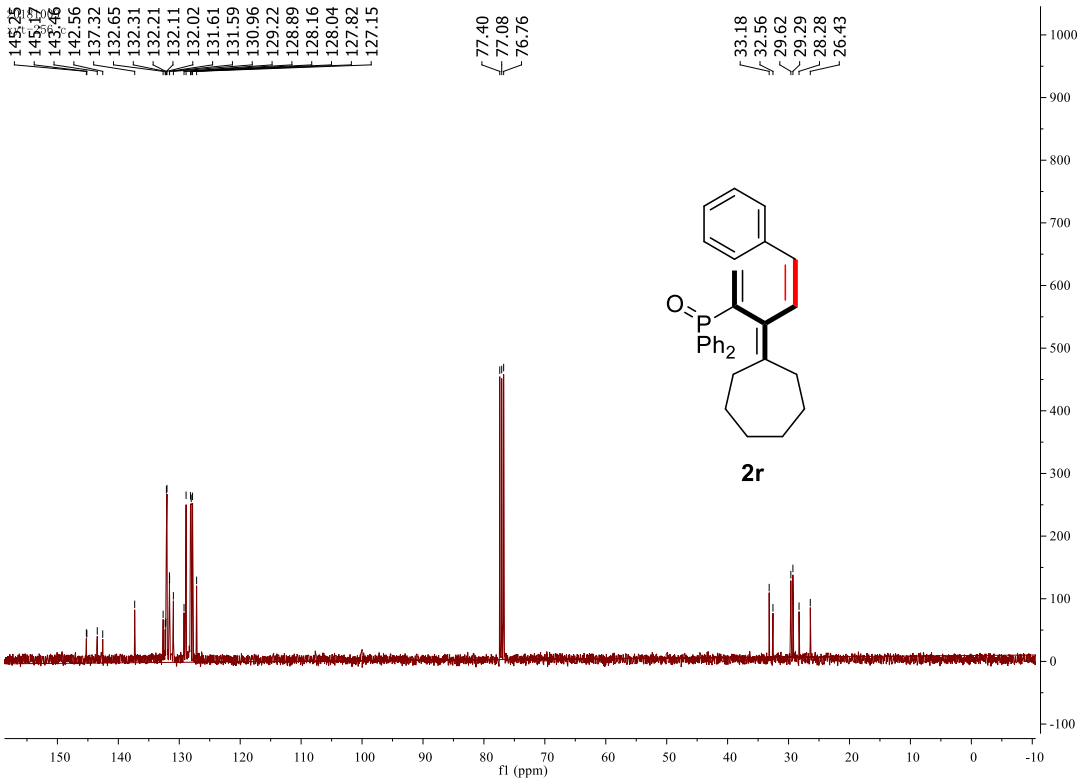

143.99
143.09
142.52
142.45
137.43
132.51
132.29
132.19
132.10
131.69
131.66
131.50
130.85
129.07
128.79
128.21
128.10
127.89
127.02
125.60
125.53
77.40
77.08
76.76
31.61
31.55
27.61
26.83
26.35
O
P
Ph2
2q
f1 (ppm)

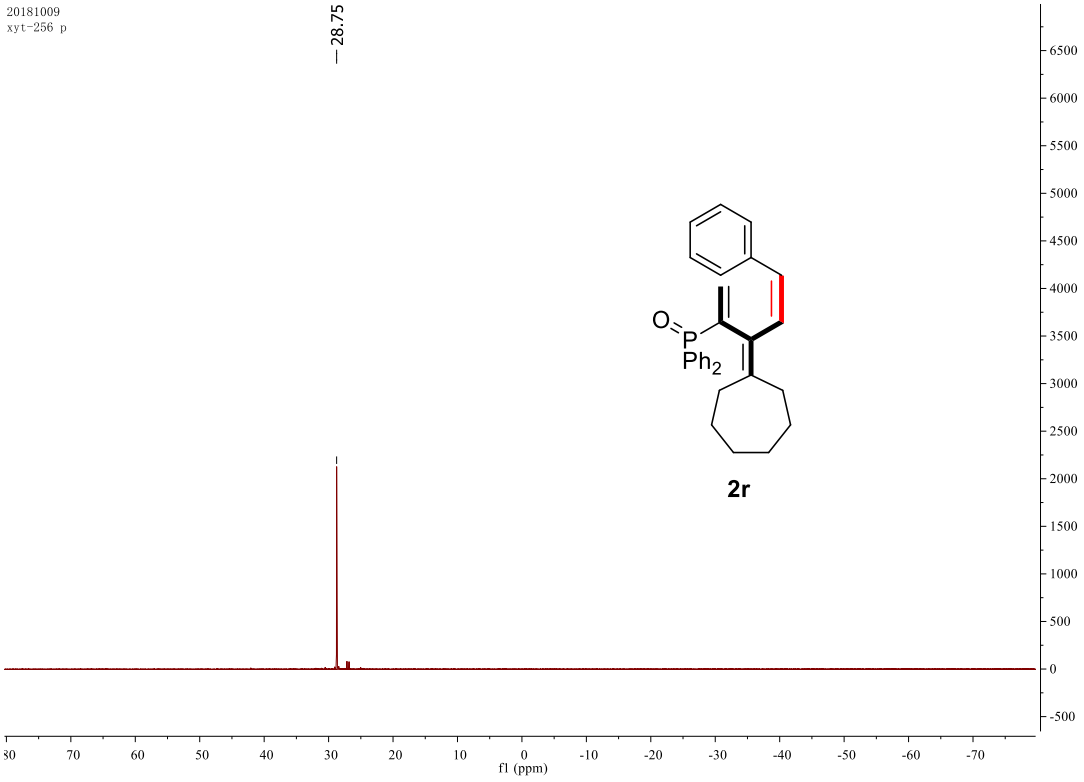

20181019
xyt-276 p
28.12
O
P
Ph2
2q
f1 (ppm)

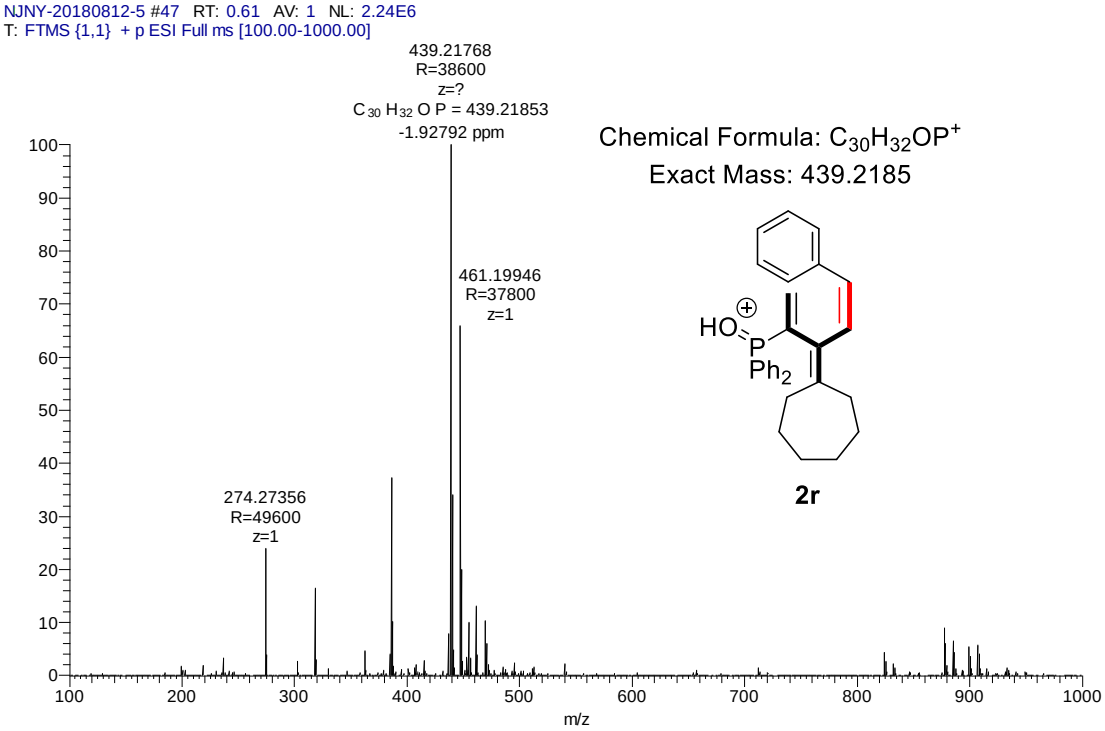

NJNY-3 #47 RT: 0.68 AV: 1 NL: 4.10E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
425.20270
z=1
C 29 H 30 O P = 425.20288
-0.42532 ppm
Chemical Formula: C29H30OP+
Exact Mass: 425.2029
HO
P
Ph2
2q
656.27338
z=2
m/z

2r

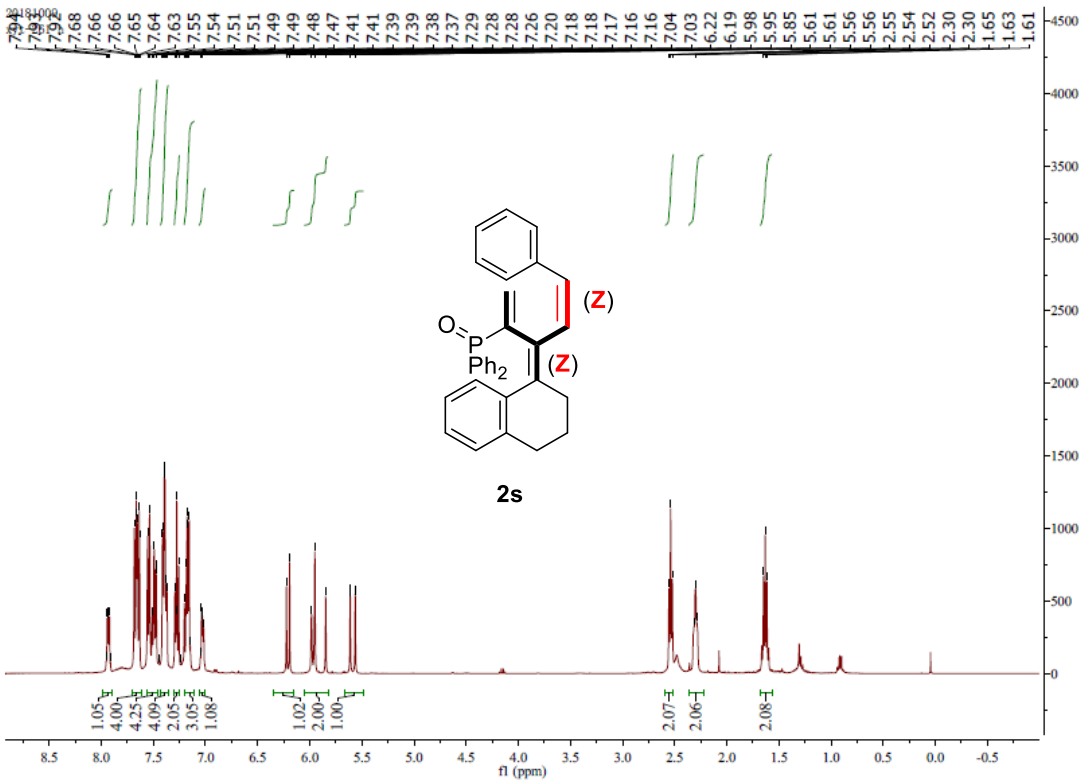

O
P
Ph2
2r
fl (ppm)

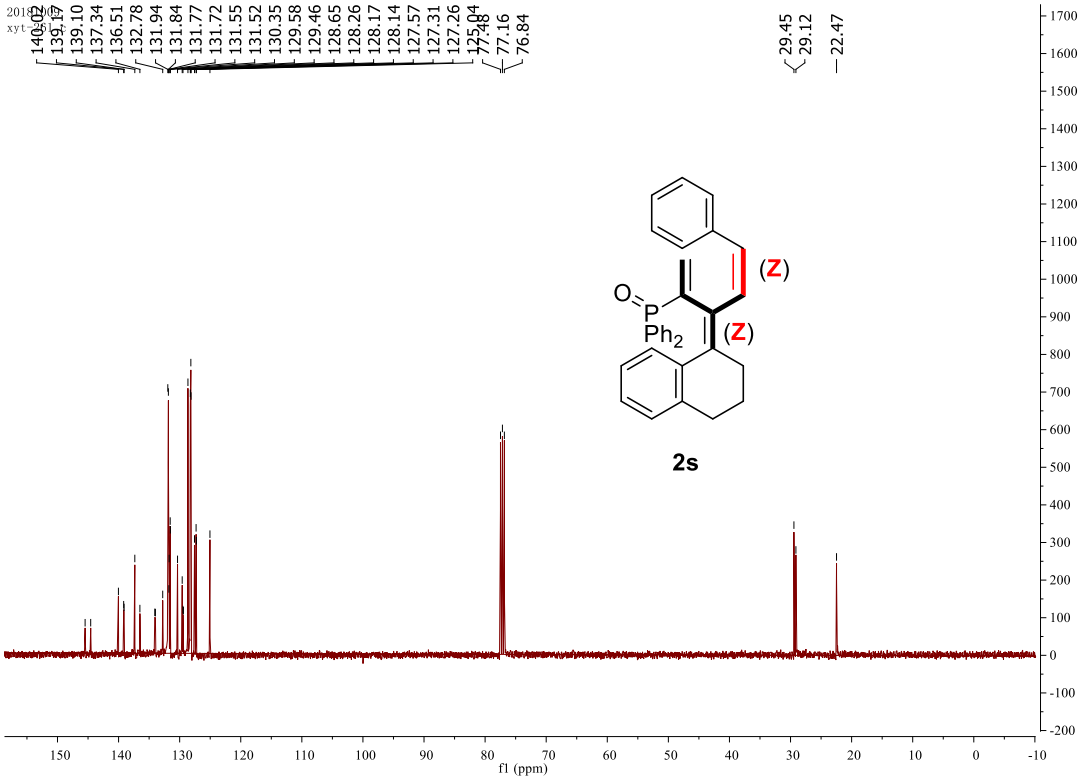

145.25
145.17
143.46
142.56
137.32
132.65
132.31
132.21
132.11
132.02
131.61
131.59
130.96
129.22
128.89
128.16
128.04
127.82
127.15
77.40
77.08
76.76
33.18
32.56
29.62
29.29
28.28
26.43
O
P
Ph2
2r
f1 (ppm)

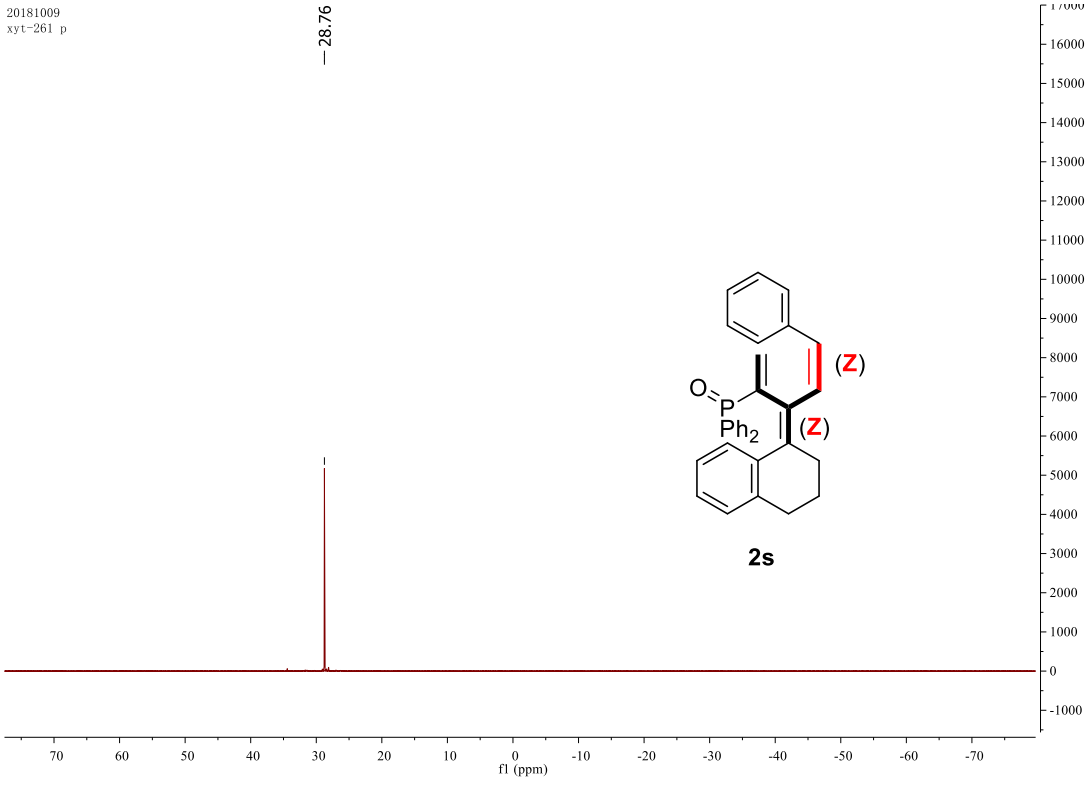

20181009
xyt-256 p
28.75
O
P
Ph2
2r
f1 (ppm)

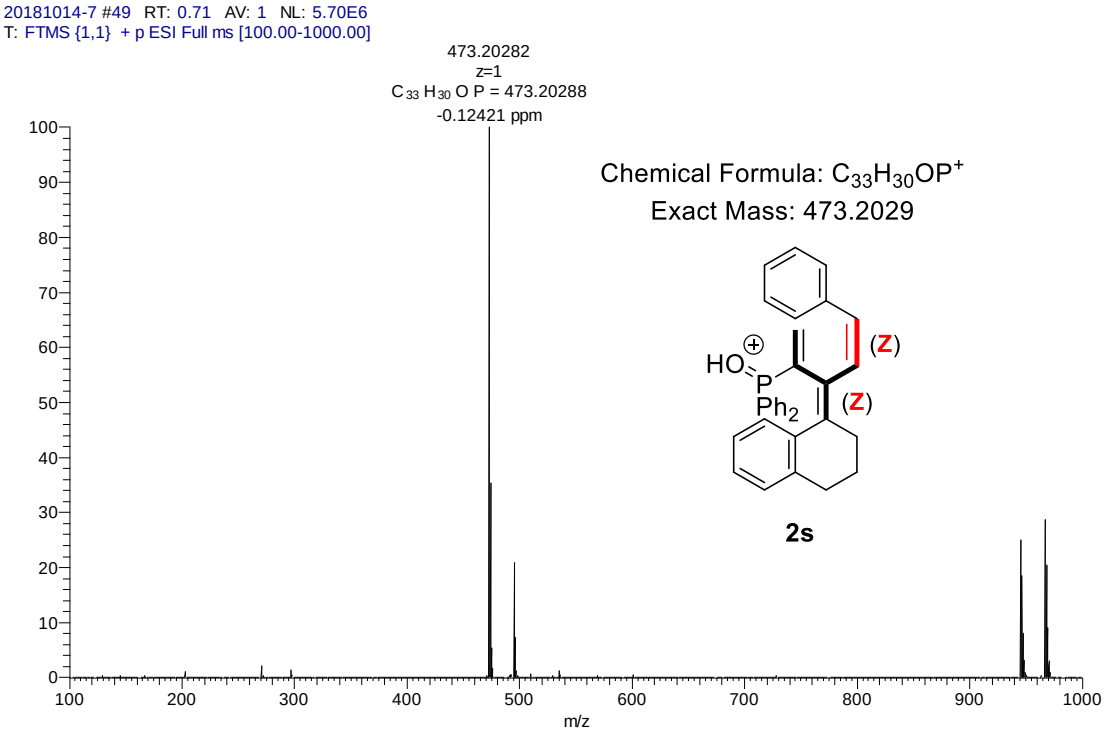

NJNY-20180812-5 #47 RT: 0.61 AV: 1 NL: 2.24E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
439.21768
R=38600
z=?
C30 H32 O P = 439.21853
-1.92792 ppm
461.19946
R=37800
z=1
274.27356
R=49600
z=1
Chemical Formula: C30H32OP+
Exact Mass: 439.2185
HO
P
Ph2
2r
m/z

2s

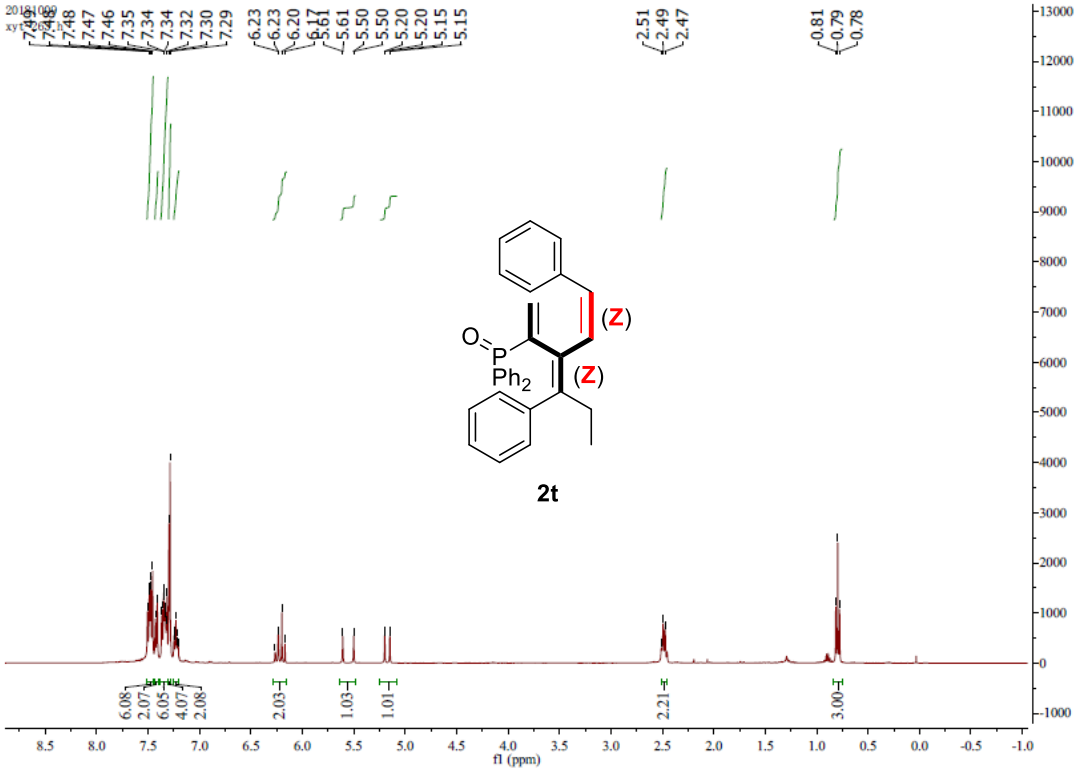

O
P
Ph2
(Z)
(Z)
2s
f1 (ppm)

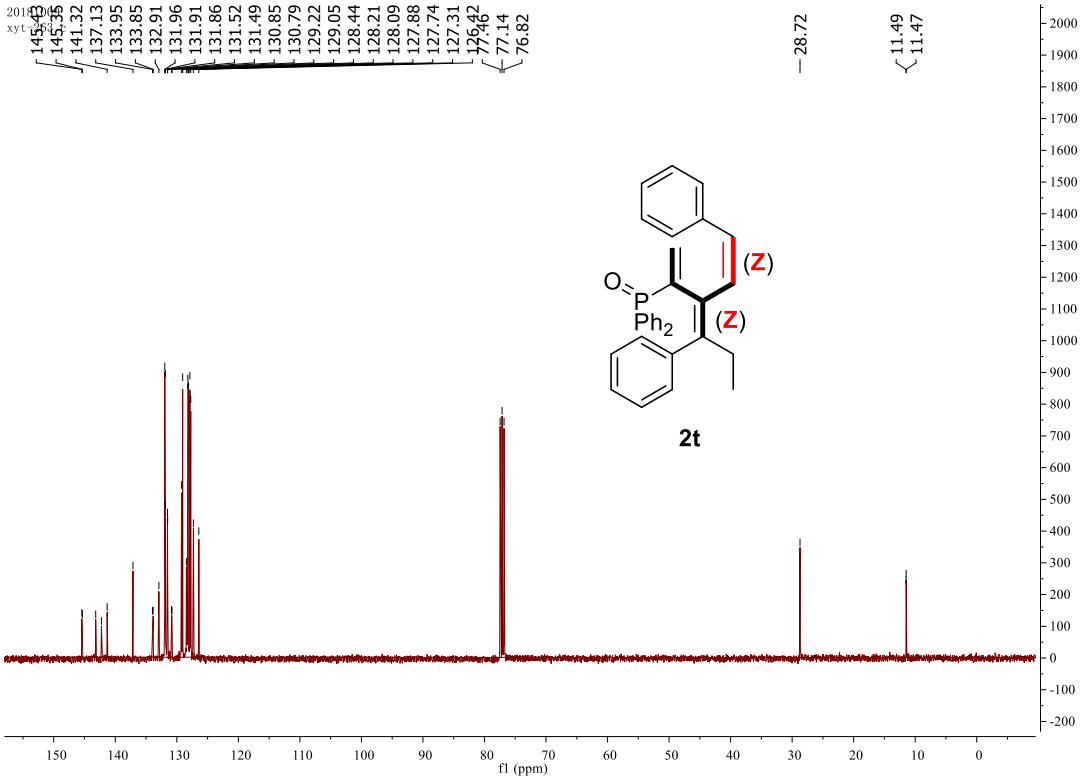

140.02
139.17
139.10
137.34
136.51
132.78
131.94
131.84
131.77
131.72
131.55
131.52
130.35
129.58
129.46
128.65
128.26
128.17
128.14
127.57
127.31
127.26
125.04
77.48
77.16
76.84
29.45
29.12
22.47
(Z)
(Z)
O
P
Ph2
2s
fl (ppm)

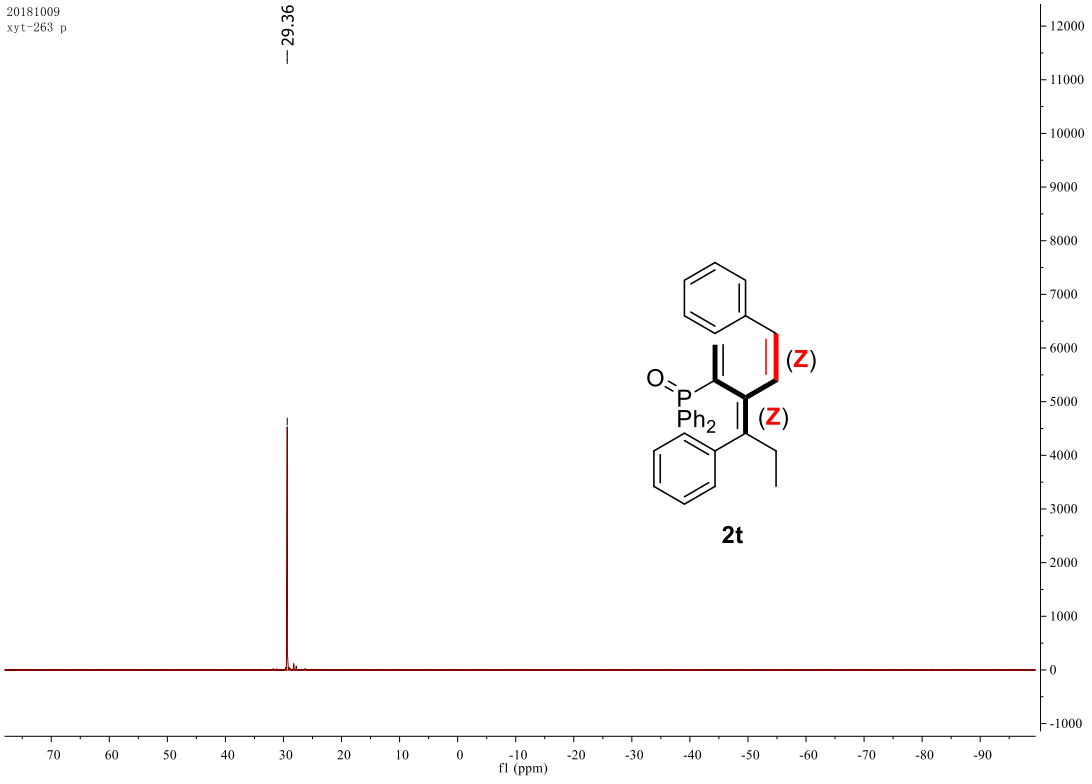

20181009
xyt-261 p
28.76
(Z)
(Z)
O
P
Ph2
2s
fl (ppm)

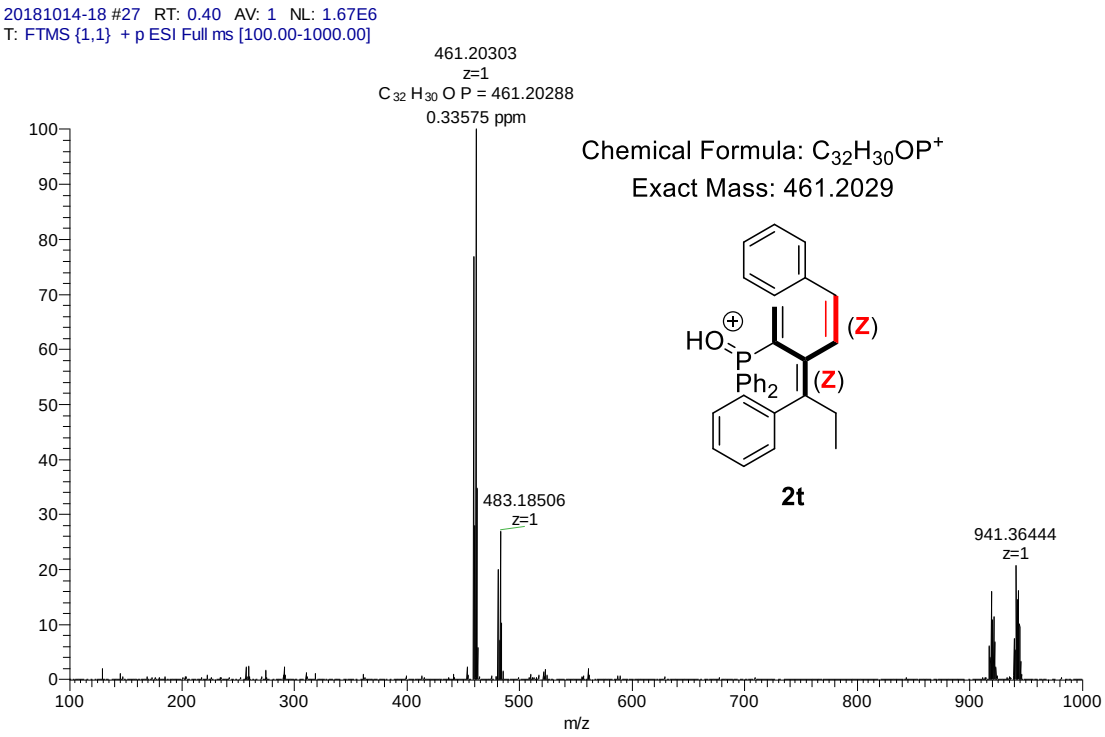

20181014-7 #49 RT: 0.71 AV: 1 NL: 5.70E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
473.20282
z=1
C 33 H 30 O P = 473.20288
-0.12421 ppm
Chemical Formula: C33H30OP+
Exact Mass: 473.2029
HO
P
Ph2
(Z)
(Z)
2s
m/z

2t

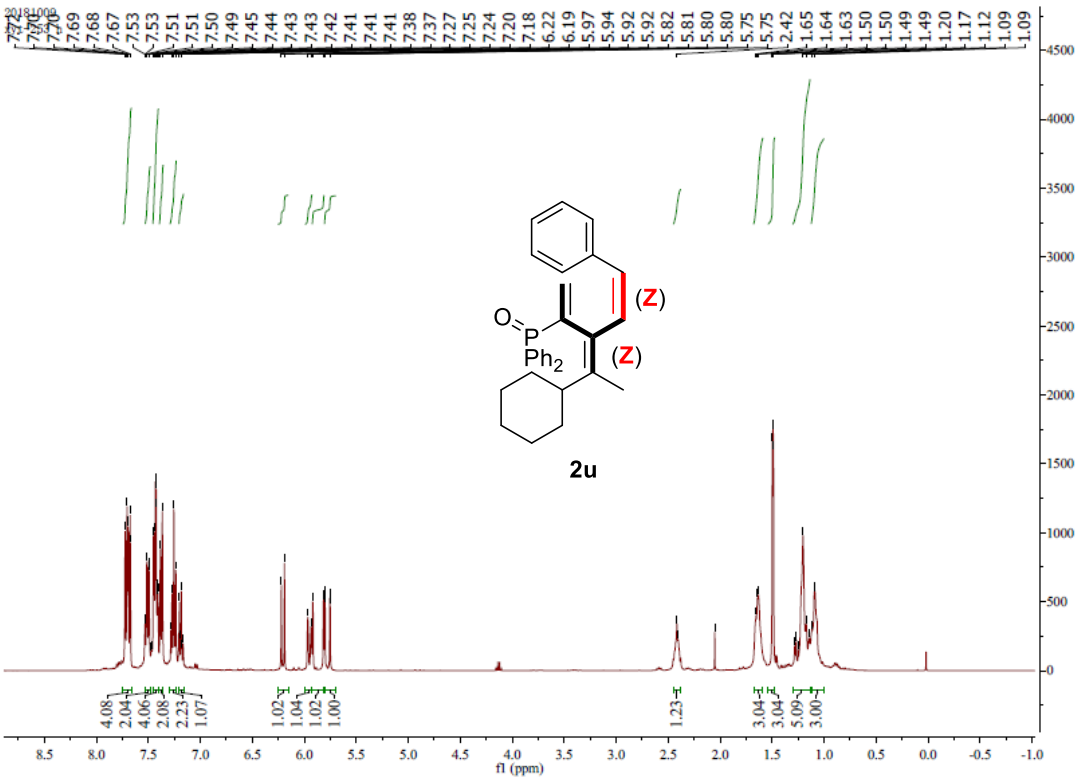

O
P
Ph2
(Z)
(Z)
2t
fl (ppm)

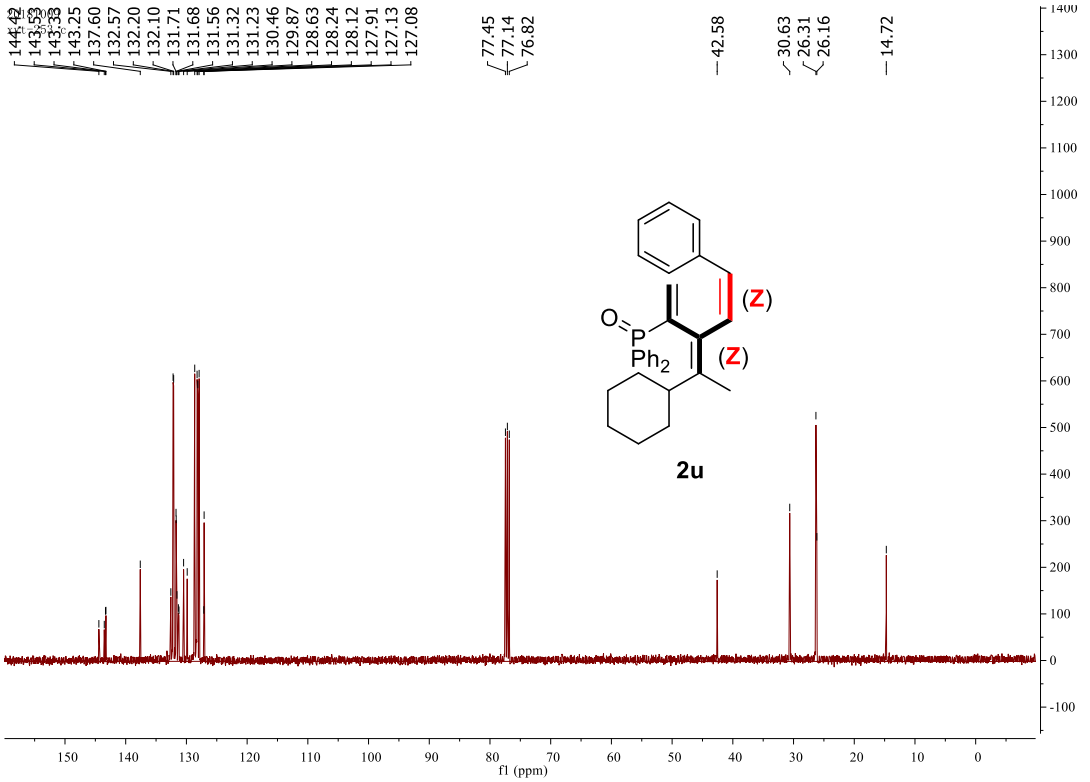

145.43
145.35
141.32
137.13
133.95
133.85
132.91
131.96
131.91
131.86
131.52
131.49
130.85
130.79
129.22
129.05
128.44
128.21
128.09
127.88
127.74
127.31
126.42
77.46
77.14
76.82
28.72
11.49
11.47
(Z)
(Z)
O
P
Ph2
2t
fl (ppm)

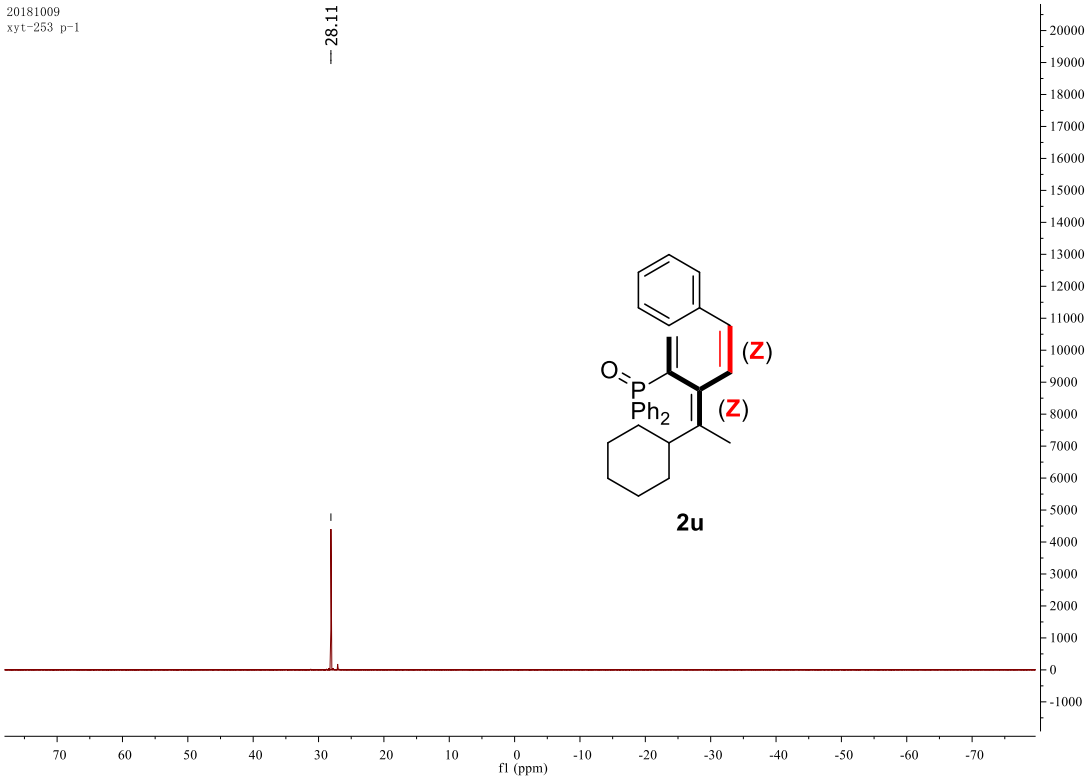

20181009
xyt-263 p
29.36
(Z)
(Z)
O
P
Ph2
2t
fl (ppm)

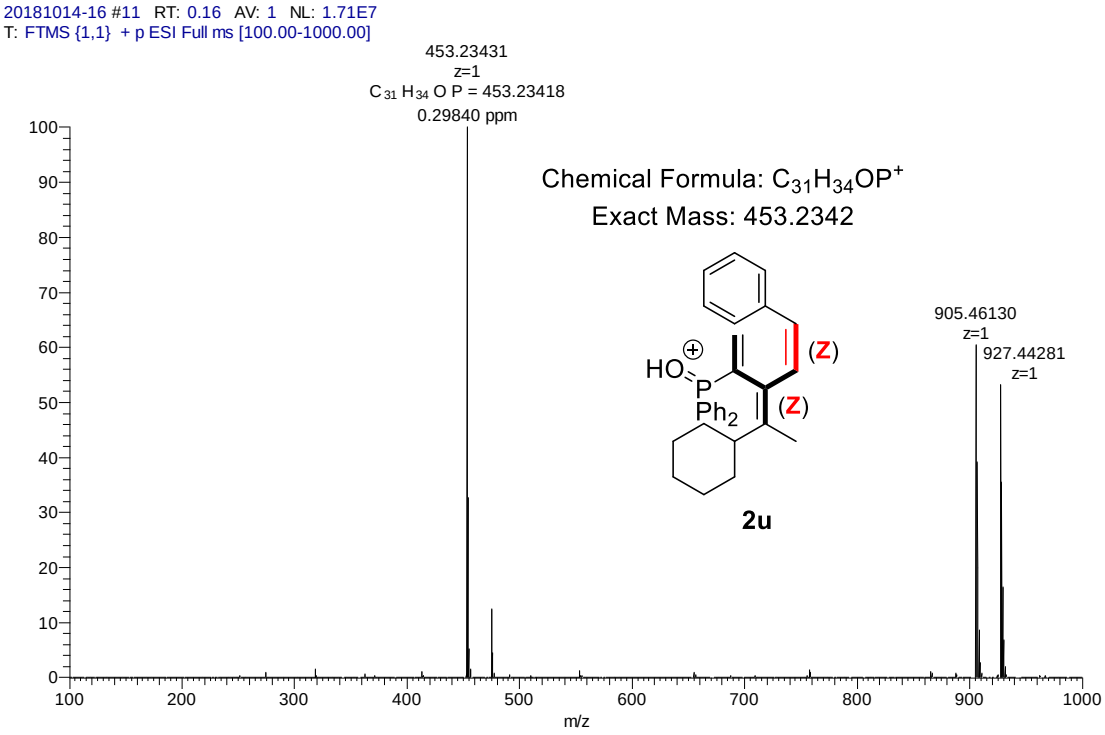

20181014-18 #27 RT: 0.40 AV: 1 NL: 1.67E6
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
461.20303
z=1
C 32 H 30 O P = 461.20288
0.33575 ppm
Chemical Formula: C32H30OP+
Exact Mass: 461.2029
(Z)
(Z)
2t
483.18506
z=1
941.36444
z=1
m/z

2u


(Z)
(Z)
2u
fl (ppm)


144.42
143.53
143.33
143.25
137.60
132.57
132.20
132.10
131.71
131.68
131.56
131.32
131.23
130.46
129.87
128.63
128.24
128.12
127.91
127.13
127.08
77.45
77.14
76.82
42.58
30.63
26.31
26.16
14.72
(Z)
(Z)
O
P
Ph2
2u
f1 (ppm)


20181009
xyt-253 p-1
28.11
(Z)
(Z)
O
P
Ph2
2u
f1 (ppm)


20181014-16 #11 RT: 0.16 AV: 1 NL: 1.71E7
T: FTMS {1,1} + p ESI Full ms [100.00-1000.00]
453.23431
z=1
C 31 H 34 O P = 453.23418
0.29840 ppm
Chemical Formula: C31H34OP+
Exact Mass: 453.2342
905.46130
z=1
927.44281
z=1
(Z)
(Z)
HO
P
Ph2
2u
m/z