

Chiral Cobalt(II) Complex-Promoted Asymmetric *para*-Claisen Rearrangement of Allyl α -Naphthol Ethers

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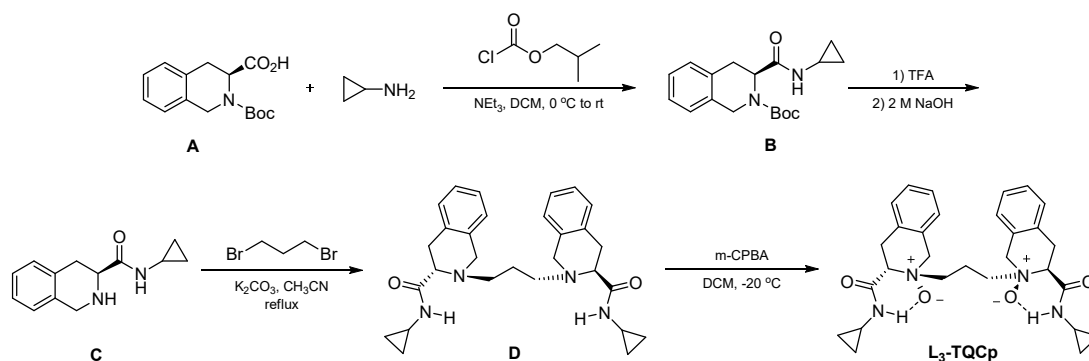
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1. General Information

Column chromatography was generally performed on silica gel (300–400 mesh) and reactions were monitored with thin-layer chromatography (TLC) using 254 nm UV light. NMR characterization data were collected on Bruker ASCEND™ operating at 400 MHz and 600 MHz for ^1H NMR, 101 MHz and 151 MHz for $^{13}\text{C}\{^1\text{H}\}$ NMR (with complete proton decoupling), and 376 MHz and 565 MHz for $^{19}\text{F}\{^1\text{H}\}$ NMR (with complete proton decoupling). ^1H NMR and $^{13}\text{C}\{^1\text{H}\}$ NMR: chemical shifts δ were recorded in ppm relative to tetramethylsilane and internally referenced to the residual solvent signal (for ^1H NMR: $\text{CDCl}_3 = 7.26$ ppm, $(\text{CD}_3)_2\text{CO} = 2.05$ ppm; for ^{13}C NMR: $\text{CDCl}_3 = 77.0$ ppm, $(\text{CD}_3)_2\text{CO} = 206.3$ ppm). Spectra were reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, td = triplet of doublets, dt = doublet of triplets, ddd = doublet of doublet of doublets, m = multiplet, hept = heptet), coupling constants (Hz), integration and assignment. High-resolution mass spectra (HRMS) were performed on Thermo Q-Exactive Focus (FTMS+c ESI) and data were reported as (m/z). Enantiomeric excesses (ee) were determined by HPLC or supercritical fluid chromatography (SFC) analysis using the corresponding commercial chiral column as stated in the experimental procedures at 25 °C with PDA detector. Optical rotations were measured on Rudolph Research Analytic Automatic Polarimeter, and reported as follows: $[\alpha]_D^{25}$ (c g/100 mL, in solvent). Infrared spectra (IR) were recorded on Bruker Tensor II spectrometer with Platinum ATR accessory and the peaks are reported as absorption maxima (ν , cm^{-1}). All catalytic reactions were run under air conditions. Tetrahydrofuran (THF) and toluene were distilled from sodium benzophenone ketyl. 1,1,2,2-TCE, Ethyl acetate (EtOAc), dichloromethane (DCM), and chloroform (CHCl_3) were distilled over CaH_2 . $\text{Co}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$ was purchased from Sigma-Aldrich. The N,N -dioxides,¹ C4-substituted 1-naphthols,² were prepared according to the methods reported in the literature were prepared according to the methods reported in the literature.

2. General Procedure for the Synthesis of L₃-TQCp



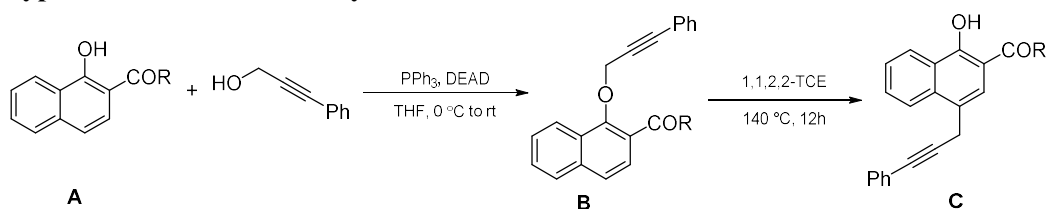
To a solution of (*S*)-Boc-tetrahydroisoquinoline-3-carboxylic acid (5.54 g, 20.0 mmol) in DCM (40 mL) was added Et₃N (2.43 g, 24.0 mmol), isobutyl carbonochloridate (3.28 g, 24.0 mmol) at 0 °C under stirring. After 15 min, cyclopropylamine (1.37 g, 24.0 mmol) was added. The reaction was allowed to warm to room temperature and detected by TLC. After 48 h, the mixture was washed with 1 M KHSO₄ solution, saturated NaHCO₃ solution, brine, dried over anhydrous Na₂SO₄. After filtration, the mixture was concentrated, and the residue was used in the next step without purification.

The residue in CH₂Cl₂ (10 mL) was added TFA (20 mL) at 0 °C. The reaction was allowed to warm to room temperature and stirred for 1 h. The reaction was diluted with CH₂Cl₂ (20 mL). The pH value of the mixture was brought into the range of 10–12 by the addition of 2 M NaOH solution at 0 °C. The aqueous phase was extracted with CH₂Cl₂ (3 × 20 mL). The combined organic phase was washed with brine, dried over anhydrous Na₂SO₄ and evaporated in vacuo. The residue was subjected to flash column chromatography on silica gel and eluted with EtOAc to afford the product **C** (3.05 g, 14.13 mmol) as a white solid.

To a solution of compound **C** (3.05 g, 14.13 mmol) in CH₃CN (8 mL) was added K₂CO₃ (5.85 g, 42.4 mmol) and 1,3-dibromopropane (1.43 g, 7.07 mmol). It was kept refluxing for 12 h. Then, K₂CO₃ was removed by filtration and washed by CH₂Cl₂. The filtrate was concentrated and was subjected to flash column chromatography on silica gel and eluted with Pet/EtOAc (1:1 – 1:4, v/v) to give the product **D** (3.08 g, 6.53 mmol) as a white solid.

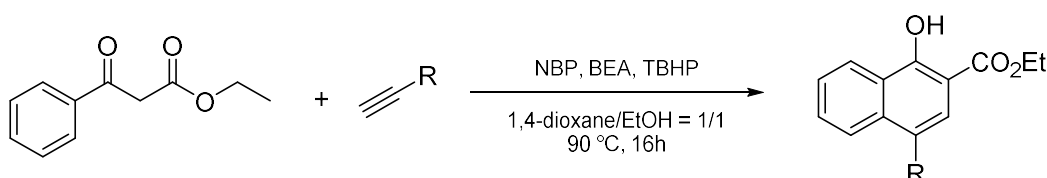
To a solution of compound **D** (0.94 g, 2.0 mmol) in CH₂Cl₂ (30 mL) was slowly added mixed solid of *m*-CPBA (0.862 g, 5 mmol) at -20 °C. The reaction mixture was stirred at -20 °C for 1 h. Then the reaction was concentrated and was subjected to flash column chromatography on silica gel and eluted with EtOAc/MeOH (10:1 – 1:2, v/v) to afford **L₃-TQCp** (0.61 g, 1.21 mmol) as a white solid.

3. Typical Procedure for the Synthesis of Substrates

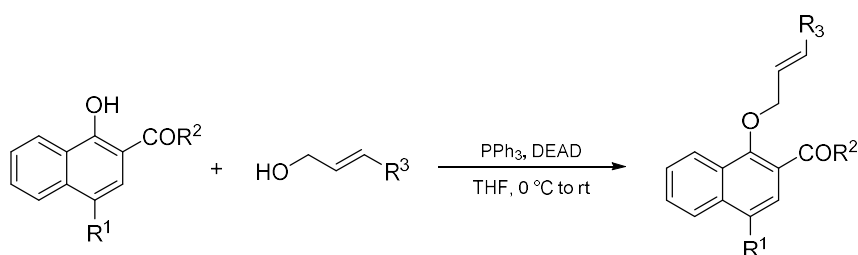


To a solution of naphthol (1.0 equiv), propargyl alcohol (1.2 equiv) and PPh_3 (1.5 equiv) in dry THF (4.0 mL/mmol of naphthol) at 0 °C, diethyl azodicarboxylate (1.5 equiv) was added dropwise. The reaction mixture was stirred at room temperature and detected by TLC. After removing the solvent under vacuo, the residue was subjected to flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (50:1 – 10:1, v/v) to afford the product **B**.

A round-bottomed flask was charged with product **B**, followed by the addition of 1,1,2,2-TCE (0.2 M). The reaction mixture was stirred at 140 °C for 16 h. After removing the solvent under vacuo, the residue was subjected to flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (50:1 – 10:1, v/v) to give the crude product, then wash with petroleum ether to afford product **C**.

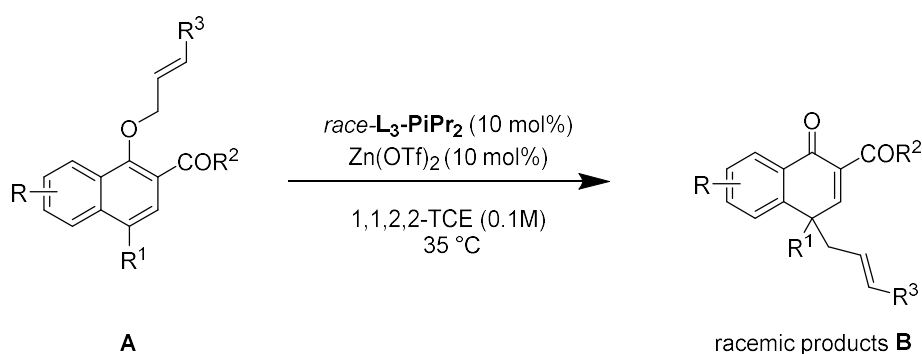


A round-bottomed flask was charged with ethyl benzoylacetate (10 mmol, 1.92 g, 1.0 equiv), alkyne (20 mmol, 2.0 equiv), N-bromophthalimide (NBP, 2 mmol, 0.45 g, 0.2 equiv), 2-bromoethylamine hydrobromide (BEA, 3 mmol, 0.62 g, 0.3 equiv) and 1-butyl hydroperoxide (TBHP, 35 mmol, 3.5 equiv), followed by the addition of 1,4-dioxane (20 ml) and EtOH (20ml). The reaction mixture was stirred at 90 °C for 16 h. After removing the solvent under vacuo, the residue was subjected to flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (50:1 – 10:1, v/v) to give the corresponding naphthol products.



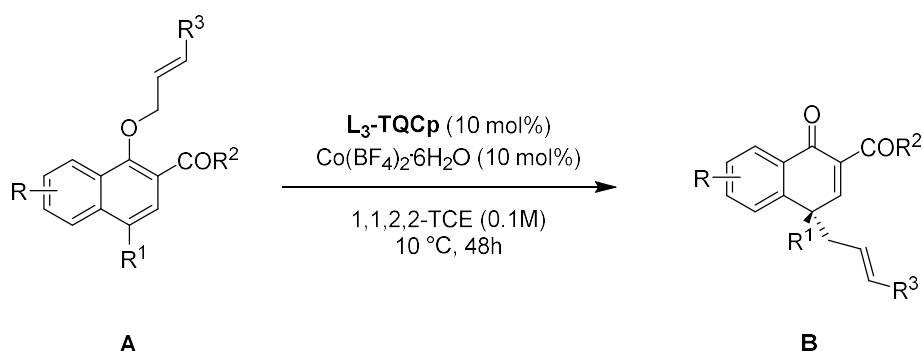
To a solution of naphthol (1.0 equiv), allyl alcohol (1.2 equiv) and PPh_3 (1.5 equiv) in dry THF (4.0 mL/mmol of naphthol) at 0 °C, diethyl azodicarboxylate (1.5 equiv) was added dropwise. The reaction mixture was stirred at room temperature and detected by TLC. After removing the solvent under vacuo, the residue was subjected to flash column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (50:1 – 10:1, v/v) to afford the product.

4. General Procedure for Preparation of the Racemic Product



A dry reaction tube was charged with *rac*-L₃-PiPr₂ (4.8 mg, 10 mol%) and Zn(OTf)₂ (3.6 mg, 10 mol%) followed by the addition of 1,1,2,2-TCE (1.0 mL). The mixture was stirred at 35 °C for 30 min followed by addition of the substrate **A** (0.1 mmol). The reaction mixture was stirred at 35 °C and detected by TLC. The reaction mixture was subjected to column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (8/1 and 4/1, v/v) to afford the desired racemic products **B**.

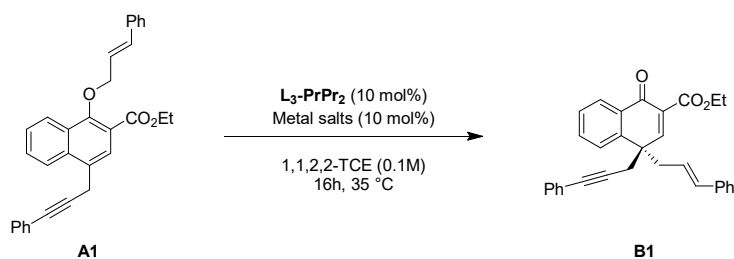
5. Representative Experimental Procedure for Asymmetric Catalytic Reactions



A dry reaction tube was charged with L₃-TQCp (5.0 mg, 10 mol%) and Co(BF₄)₂·6H₂O (3.4 mg, 10 mol%) followed by the addition of 1,1,2,2-TCE (1.0 mL). The mixture was stirred at 35 °C for 60 min followed by addition of the substrate **A** (0.1 mmol). The reaction mixture was stirred at 10 °C for 48 h. The reaction mixture was subjected to column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (8/1 and 4/1, v/v) to afford the corresponding products **B**.

6. Optimization of Reaction Conditions

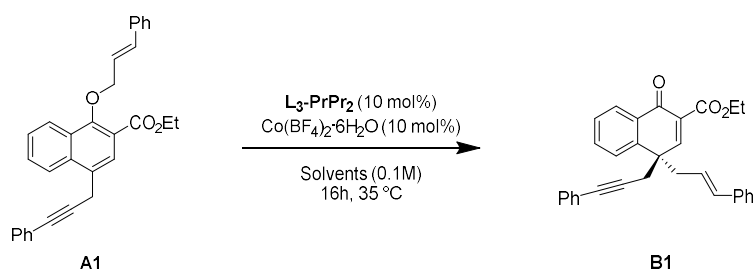
Table S1: Screening of metal salts^[a].



Entry ^[a]	Metal salts	Yield [%] ^[b]	ee [%] ^[c]
1	Zn(OTf) ₂	48	9
2	Mg(OTf) ₂	47	39
3	Co(OTf) ₂	45	50
4	Ni(OTf) ₂	31	39
5	Co(BF ₄) ₂ ·6H ₂ O	47	56
6	Co(ClO ₄) ₂ ·8H ₂ O	64	40

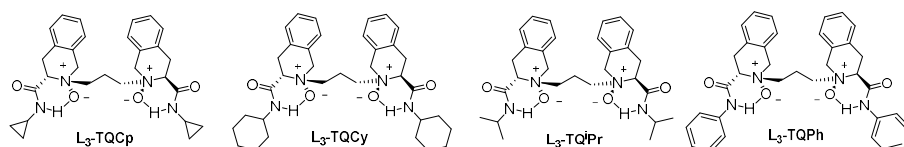
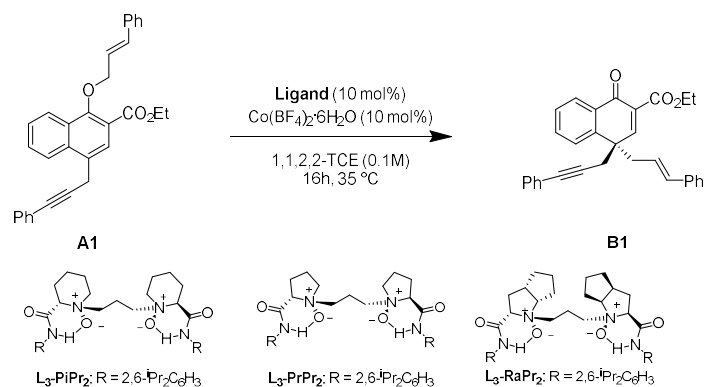
[a] Unless otherwise noted, all reactions were carried out with **A1** (0.05 mmol), **L₃-PrPr₂**/metal salts (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 35 °C for 16 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane.

Table S2: Screening of solvents^[a].



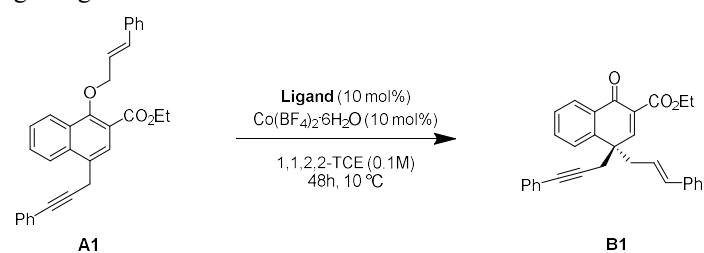
Entry ^[a]	Solvents	Yield [%] ^[b]	ee [%] ^[c]
1	1,1,2,2-TCE	47	56
2	DCM	32	51
3	DCE	41	55
4	CHCl ₃	50	45
5	EA	18	7
6	Toluene	11	30
7	THF	Trace	ND
8	CH ₃ CN	12	13

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.05 mmol), **L₃-PrPr₂**/Co(BF₄)₂·6H₂O (1:1, 10 mol %) in solvent (0.1 M) at 35 °C for 16 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane, DCM = Dichloromethane, DCE = 1,2-Dichloroethane, EA = Ethyl acetate, THF = Tetrahydrofuran, ND = not detected.

Table S3: Screening of ligands^[a].

Entry ^[a]	Ligand	Yield [%] ^[b]	ee [%] ^[c]
1	L₃-PrPr₂	47	56
2	L₃-PiPr₂	56	35
3	L₃-RaPr₂	17	37
4	L₃-TQPh	50	45
5	L₃-TQCy	Decomposed	--
6	L₃-TQⁱPr	Decomposed	--
7	L₃-TQCp	Decomposed	--

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.05 mmol), ligand/Co(BF₄)₂·6H₂O (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 35 °C for 16 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane.

Table S4: Screening of ligands^[a].

Entry ^[a]	Ligand	Yield [%] ^[b]	ee [%] ^[c]
1	L₃-PrPr₂	<5	63
2	L₃-PiPr₂	13	57
3	L₃-RaPr₂	<5	55
4	L₃-TQPh	73	74
5	L₃-TQCy	78	82
6	L₃-TQⁱPr	87	85
7	L₃-TQCp	86	92
8 ^[d]	L₃-TQCp	85	88

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.05 mmol), ligand/ $\text{Co}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$ (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 10 °C for 48 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. [d] Reaction was performed at 20 °C for 16 h. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane.

Table S5: Screening of solvents^[a].

Entry ^[a]	Solvents	Yield [%] ^[b]	ee [%] ^[c]
1	1,1,2,2-TCE	86	92
2	DCM	83	69
3	DCE	87	77
4	CHCl_3	82	88
5	EA	Trace	ND
6	Toluene	NR	--
7	THF	NR	--
8	CH_3CN	60	11

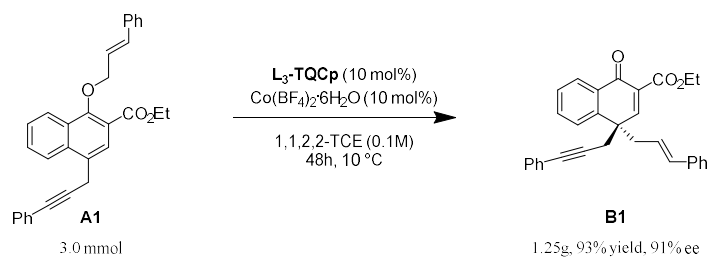
[a] Unless otherwise noted, all reactions were carried out with **A1** (0.05 mmol), $\text{L}_3\text{-TQCp}/\text{Co}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$ (1:1, 10 mol %) in solvent (0.1 M) at 10 °C for 48 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane, DCM = Dichloromethane, DCE = 1,2-Dichloroethane, EA = Ethyl acetate, THF = Tetrahydrofuran, ND = not detected, ND = not detected, NR = no reaction.

Table S6: Screening of metal salts^[a].

Entry ^[a]	Metal salts	Yield [%] ^[b]	ee [%] ^[c]
1	$\text{Co}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$	86	92
2	$\text{Co}(\text{ClO}_4)_2 \cdot 8\text{H}_2\text{O}$	82	91
3	$\text{Co}(\text{OTf})_2$	83	86
4	CoCl_2	Trace	ND
5	$\text{Zn}(\text{OTf})_2$	89	85
6	$\text{Mg}(\text{OTf})_2$	90	89
7	$\text{Ni}(\text{OTf})_2$	91	89

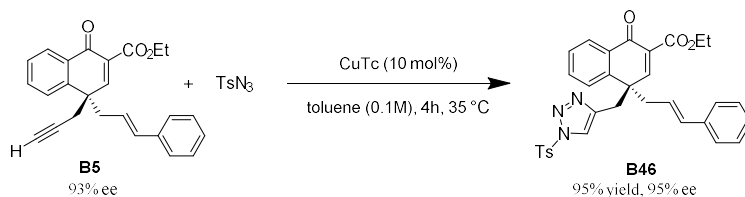
[a] Unless otherwise noted, all reactions were carried out with **A1** (0.05 mmol), $\text{L}_3\text{-TQCp}/\text{metal salts}$ (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 10 °C for 48 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane, ND = not detected.

7. Gram-Scale Synthesis of the Product B1

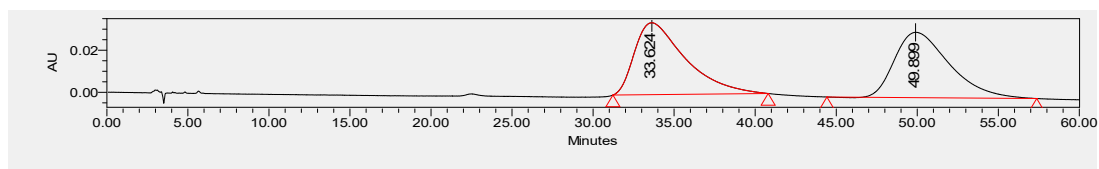


An oven dried round-bottom flask (100 mL) was charged with **L₃-TQCp** (153.5 mg, 10 mol%) and $\text{Co}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$ (102.0 mg, 10 mol%) followed by the addition of 1,1,2,2-TCE (30.0 mL). The mixture was stirred at 35 °C for 60 min followed by addition of the substrate **A1** (1.338 g, 3 mmol). The reaction mixture was stirred at 10 °C for 48 h. The reaction mixture was subjected to column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (8/1 and 4/1, v/v) to afford the corresponding products **B1**, in 93% yield (1.247 g) with 91% ee.

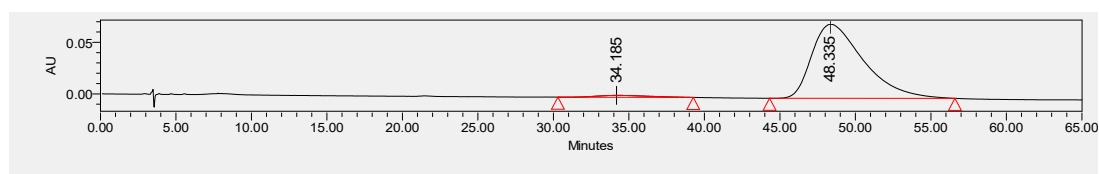
8. Synthetic Transformation



To a solution of Copper(I) thiophene-2-carboxylate (2.1 mg, 0.011 mmol) and **B5** (40.7 mg, 0.11 mmol) in toluene (1.1 mL) was added *p*-toluenesulfonyl azide (25.6 mg, 0.13 mmol), and the reaction was stirred at 35 °C for 4 h. The residue was subjected to flash column chromatography on silica gel and eluted with Pet/EtOAc (2:1, v/v) to yield the product **B46** (59.4 mg, 95% yield, 95% ee).

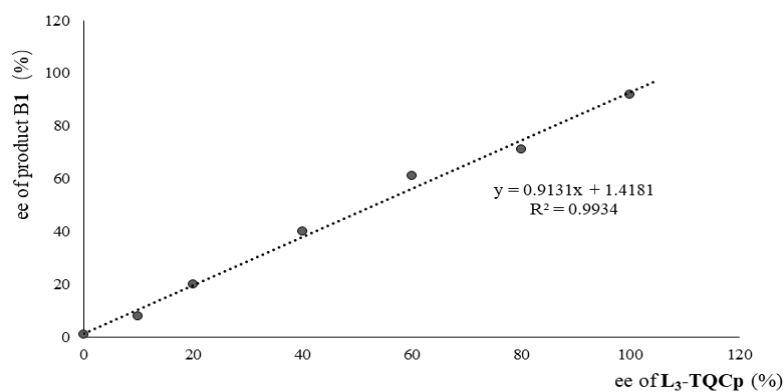
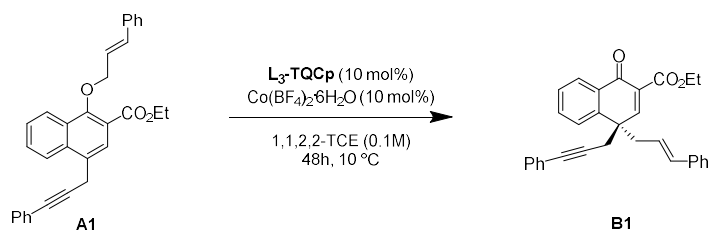


	Retention Time	Area	% Area
1	33.624	7446017	50.39
2	49.899	7330952	49.61



	Retention Time	Area	% Area
1	34.185	429532	2.45
2	48.335	17081735	97.55

9. Non-effect Study

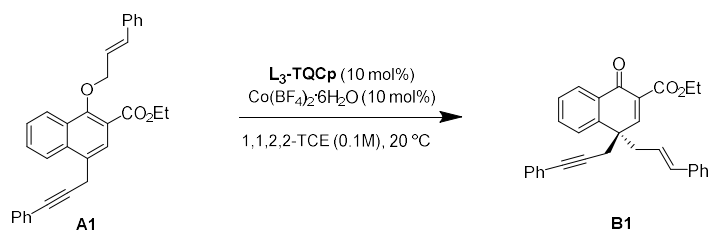


Entry ^[a]	Ee of L ₃ -TQCp [%]	Yield [%] ^[b]	ee [%] ^[c]
1	0	86	1
2	10	87	8
3	20	86	20
4	40	84	40
5	60	87	61
6	80	85	71
7	100	86	91

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.1 mmol), L₃-TQCp/Co(BF₄)₂·6H₂O (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 10 °C for 48 h. [b] Yield of isolated product. [c] Determined by HPLC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane.

10. Kinetic Studies

Procedure of react IR experiment for kinetic studies of **A1** and L₃-TQCp/Co(BF₄)₂·6H₂O catalyst. Kinetic analysis was performed using in situ attenuated total reflectance Fouriertransform infrared (ATR FTIR) spectroscopy to track the generation of the reactant **B1** under synthetically relevant conditions. A Mettler Toledo SW License iC IR 701L instrument was treated as main experiment equipment. All the kinetic experiments on each plot were performed using a single batch of reagents.



First, the infrared absorption spectra of each reactant **A1** and product **B1** in 1,1,2,2-TCE (1.0 mL) were collected. The following figure shows the absorption of each participant minus the absorption of solvent. Peak at 1663 cm^{-1} was identified as the characteristic absorption of product **B1**. Then **L₃-TQCp** and $\text{Co}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$ were added to the test tube and dissolved in 1,1,2,2-TCE (3.0 mL), the mixture was stirred at $35\text{ }^\circ\text{C}$ for 60 min. Finally, **A1** (dissolved in 1,1,2,2-TCE (2.0 mL)) was added to the test tube. The reaction mixture was allowed to stir at $20\text{ }^\circ\text{C}$. Reaction progression was monitored by the increasing absorbance of **B1** at 1663 cm^{-1} .

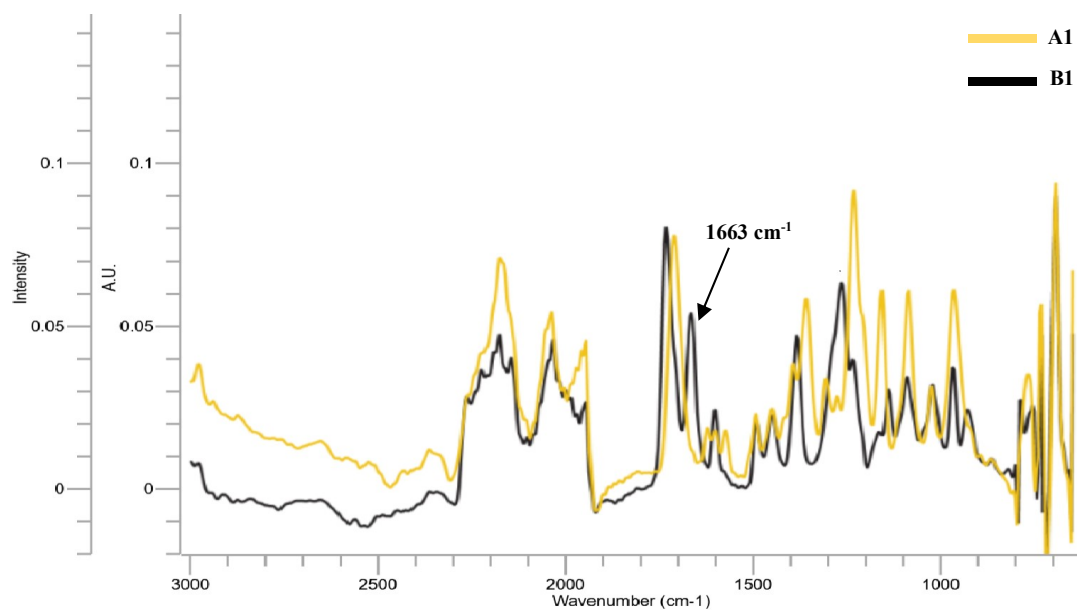


Figure S1. Absorption spectra of **A1** (0.1 mmol) and **B1** (0.1 mmol) in 1,1,2,2-TCE (1.0 mL)

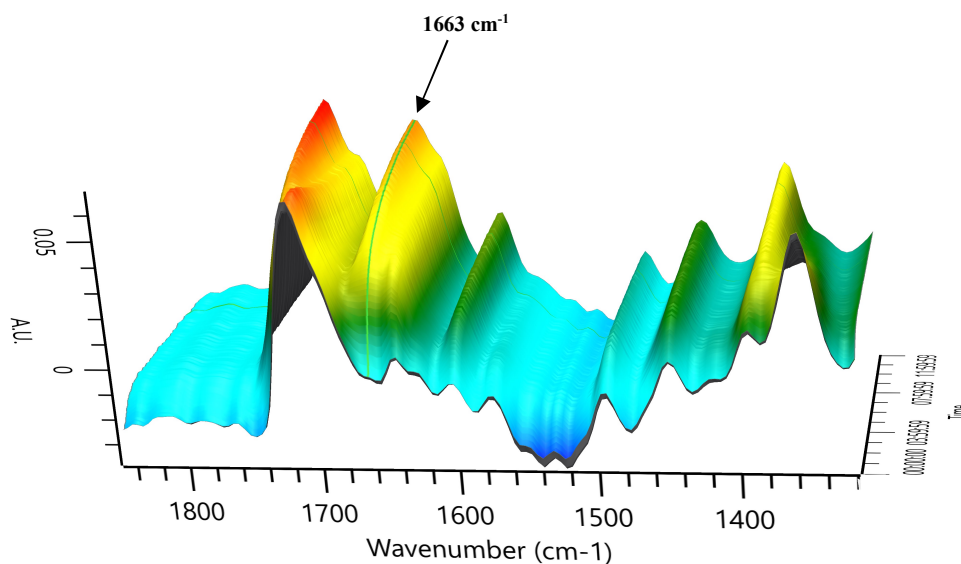
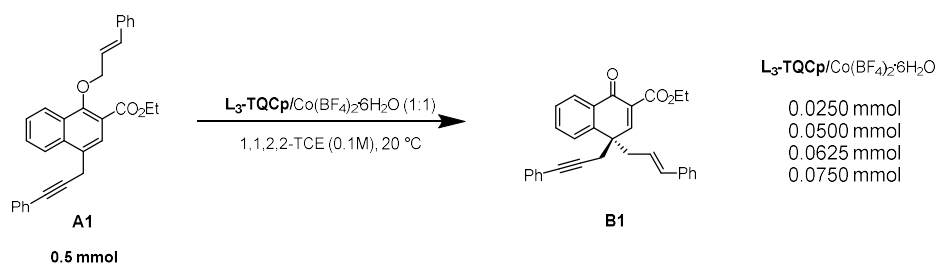
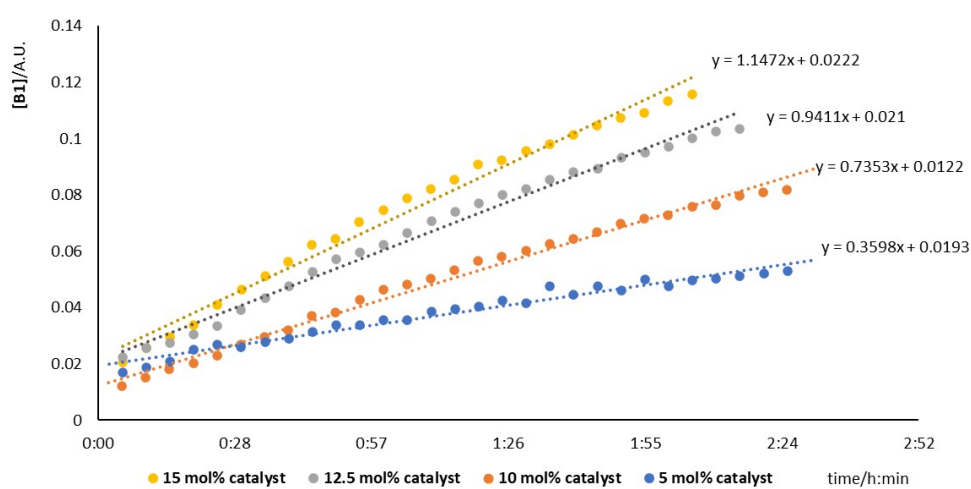


Figure S2. 3D ATR-FTIR profile of the catalytic asymmetric reaction **B1**.

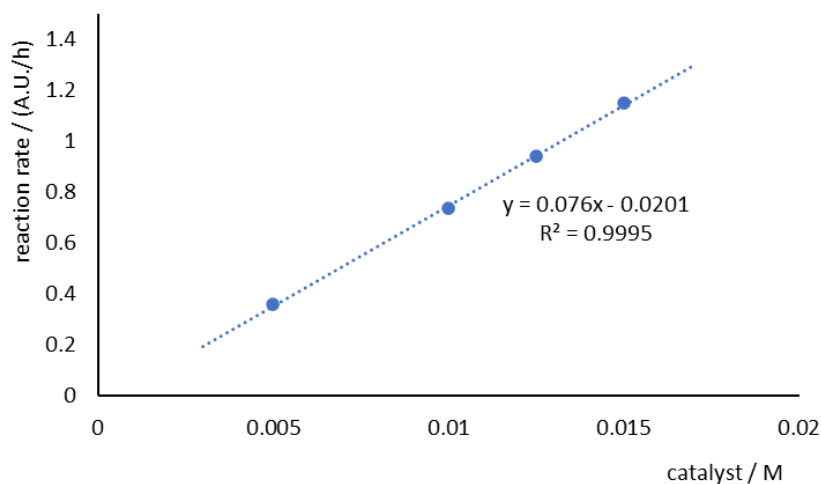
10.1 Dependence of the reaction rate on concentration of $L_3\text{-TQCp/Co(BF}_4)_2 \cdot 6\text{H}_2\text{O}$ catalyst.



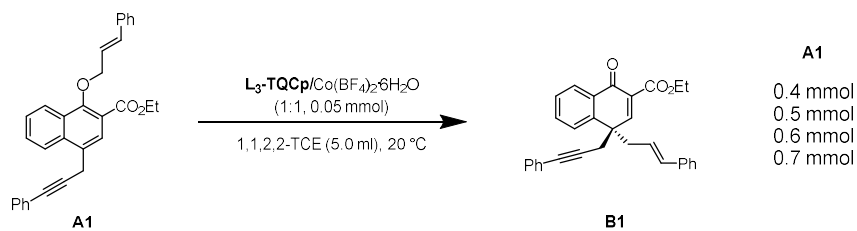
Kinetic profiles of different initial concentration of $L_3\text{-TQCp/Co(BF}_4)_2 \cdot 6\text{H}_2\text{O}$ (from 0.005 M to 0.015 M), The plot of k_{obs} vs $L_3\text{-TQCp/Co(BF}_4)_2 \cdot 6\text{H}_2\text{O}$ displayed a liner relationship, which indicates a first-order kinetic dependence in $L_3\text{-TQCp/Co(BF}_4)_2 \cdot 6\text{H}_2\text{O}$.



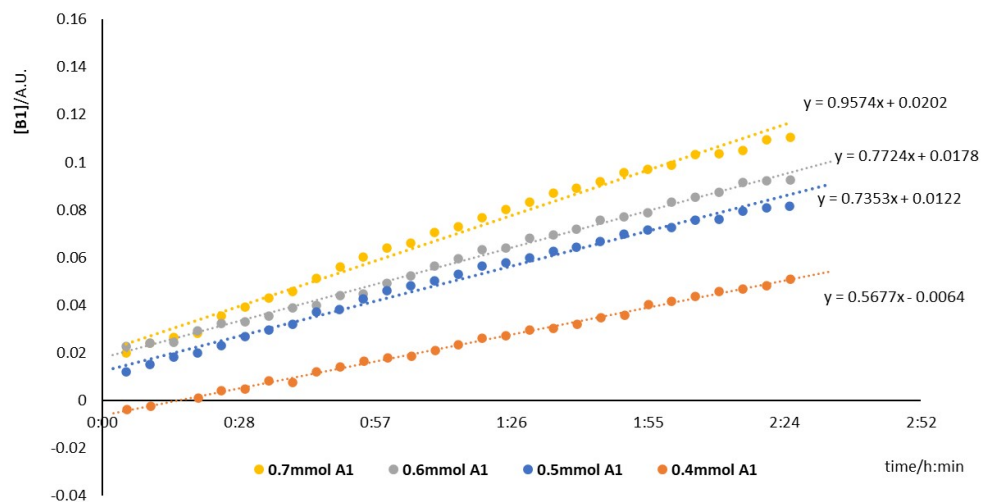
catalyst/M	reaction rate/(A.U./h)
0.0050	0.3598
0.0100	0.7353
0.0125	0.9411
0.0150	1.1472



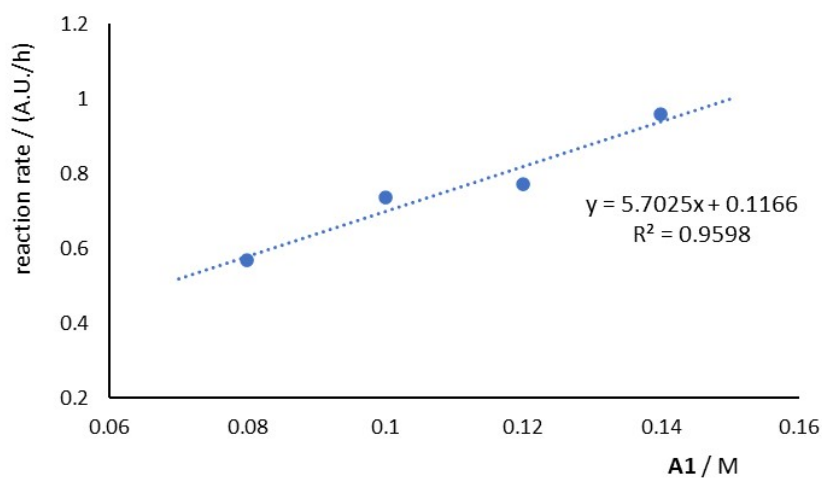
10.2 Dependence of the reaction rate on concentration of A1.



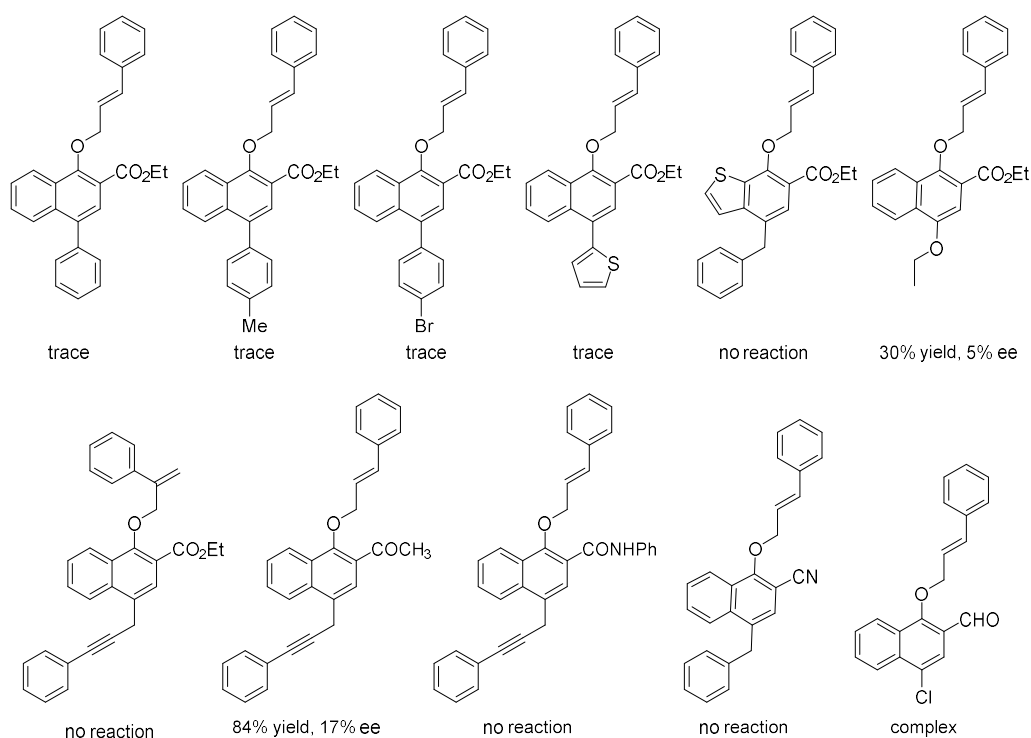
Kinetic profiles of different initial concentration of **A1** (from 0.08 M to 0.14 M), The plot of k_{obs} vs **A1** displayed a liner relationship, which indicates a first-order kinetic dependence in **A1**.



A1/M	reaction rate/(A.U./h)
0.080	0.5677
0.010	0.7353
0.012	0.7724
0.014	0.9574



11. Unsuccessful substrates



12. X-ray Crystal Data

The structure of product **B1** was determined by X-ray chromatography analysis. A single crystal of **B1** was obtained by recrystallization in dichloromethane and petroleum ether at room temperature. The crystal data and further details are listed in **Table S7**. CCDC 2289879 (**B1**) contains the supplementary crystallographic data for this paper. These data are provided free of charge by The Cambridge Crystallographic Data Centre.

The colourless crystal in flake-shape, with approximate dimensions of $0.100 \times 0.299 \times 0.391 \text{ mm}^3$, was selected and mounted for the single-crystal X-ray diffraction. The data set was collected by Bruker D8 Venture Photon II diffractometer at 173(2)K equipped with micro-focus Cu radiation source ($K_{\alpha} = 1.54178\text{\AA}$). Applied with face-indexed numerical absorption correction, the structure solution was solved and refinement was processed by SHELXTL (version 6.14) and OLEX 2.3 program package^{a, b, c}. The structure was analyzed by ADDSYM routine implemented in PLATON suite and no higher symmetry was suggested^c.

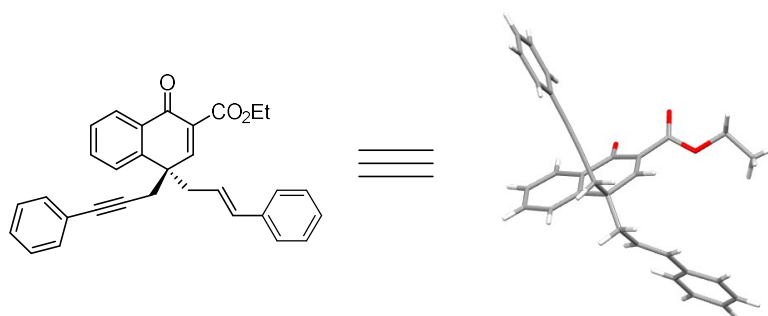


Table S7. Crystallographic Data for C₃₁H₂₆O₃ (**B1**).

Formula	C ₃₁ H ₂₆ O ₃ (B1)
Formula mass (amu)	446.52
Space group	P 21 21 21
<i>a</i> (Å)	7.8307(1)
<i>b</i> (Å)	15.5594(3)
<i>c</i> (Å)	21.1844(4)
<i>α</i> (deg)	90
<i>β</i> (deg)	90
<i>γ</i> (deg)	90
<i>V</i> (Å ³)	2581.13(8)
<i>Z</i>	4
<i>λ</i> (Å)	1.54178
<i>T</i> (K)	173 K
ρ_{calcd} (g cm ⁻³)	1.149
μ (mm ⁻¹)	0.576
Transmission factors	0.635, 1.000
$2\theta_{\text{max}}$ (deg)	68.274
No. of unique data, including $F_o^2 < 0$	3056
No. of unique data, with $F_o^2 > 2\sigma(F_o^2)$	2770
No. of variables	237
$R(F)$ for $F_o^2 > 2\sigma(F_o^2)$ ^a	0.0467
$R_w(F_o^2)$ ^b	0.1760
Goodness of fit	1.180

^a $R(F) = \sum ||F_o| - |F_c|| / \sum |F_o|$.

^b $R_w(F_o^2) = [\sum [w(F_o^2 - F_c^2)^2] / \sum wF_o^4]^{1/2}$; $w^{-1} = [\sigma^2(F_o^2) + (Ap)^2 + Bp]$, where $p = [\max(F_o^2, 0) + 2F_c^2] / 3$.

The structure of product **B35** was determined by X-ray chromatography analysis. A single crystal of **B35** was obtained by recrystallization in dichloromethane and petroleum ether at room temperature. The crystal data and further details are listed in **Table S8**. CCDC 2235350 (**B35**) contains the supplementary crystallographic data for this paper. These data are provided free of charge by The Cambridge Crystallographic Data Centre.

The colourless crystal in block-shape, with approximate dimensions of 0.136 × 0.139 × 0.256 mm³, was selected and mounted for the single-crystal X-ray diffraction. The data set was collected by Bruker D8 Venture Photon II diffractometer at 173(2)K equipped with micro-focus Cu radiation source ($K_\alpha = 1.54178\text{\AA}$). Applied with face-indexed numerical absorption correction, the structure solution was solved and refinement was processed by SHELXTL (version 6.14) and OLEX 2.3 program package^{a, b, c}.^d The structure was analyzed by ADDSYM routine implemented in PLATON suite and no higher symmetry was suggested^c.

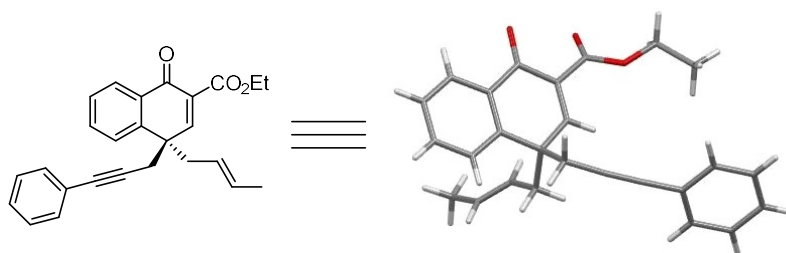


Table S8. Crystallographic Data for $C_{26}H_{24}O_3$ (**B35**).

Formula	$C_{26}H_{24}O_3$ (B35)
Formula mass (amu)	384.45
Space group	P 21 21 21
a (Å)	7.9089(2)
b (Å)	15.0721(3)
c (Å)	17.4446(4)
α (deg)	90
β (deg)	90
γ (deg)	90
V (Å ³)	2079.46(8)
Z	4
λ (Å)	1.54178
T (K)	173 K
ρ_{calcd} (g cm ⁻³)	1.228
μ (mm ⁻¹)	0.628
Transmission factors	0.820, 1.000
$2\theta_{\text{max}}$ (deg)	79.379
No. of unique data, including $F_o^2 < 0$	4362
No. of unique data, with $F_o^2 > 2\sigma(F_o^2)$	4170
No. of variables	264
$R(F)$ for $F_o^2 > 2\sigma(F_o^2)$ ^a	0.0321
$R_w(F_o^2)$ ^b	0.0775
Goodness of fit	1.060

^a $R(F) = \sum ||F_o| - |F_c|| / \sum |F_o|$.

^b $R_w(F_o^2) = [\sum [w(F_o^2 - F_c^2)^2] / \sum wF_o^4]^{1/2}$; $w^{-1} = [\sigma^2(F_o^2) + (Ap)^2 + Bp]$, where $p = [\max(F_o^2, 0) + 2F_c^2] / 3$.

References:

^a Sheldrick, G. M. *Acta Cryst.* **2008**, *A64*, 112–122.

^b Sheldrick, G. M. *Acta Cryst.* **2015**, *A71*, 3–8.

^c Sheldrick, G. M. *Acta Cryst.* **2015**, *C71*, 3–8.

^d Dolomanov, O.V., Bourhis, L.J., Gildea, R.J., Howard, J. A. K., Puschmann, H. *J. Appl. Cryst.* **2009**, *42*, 339–341.

^e Spek, A. L. *J. Appl. Cryst.* **2003**, *36*, 7–13

13. DFT Calculation of Reaction Mechanism

13.1 Computational Methods

All calculations were performed using Gaussian 09 program package,^[1] employing the B3LYP-D3 density functional with the 6-31G(d,p) basis set. Geometries were optimized in 1,1,2,2-TCE solvent and characterized by frequency analysis at 298 K. The self-consistent reaction field (SCRF) method based on the universal solvation model SMD^[2] was adopted to evaluate the effect of solvent. Grimme's DFT-D3 approach for the treatment of London-dispersion interactions were used in structural optimization.^[3-4] The intrinsic reaction coordinate (IRC) path was traced to check the energy profiles connecting each transition state to two associated minima of the proposed mechanism.^[5]

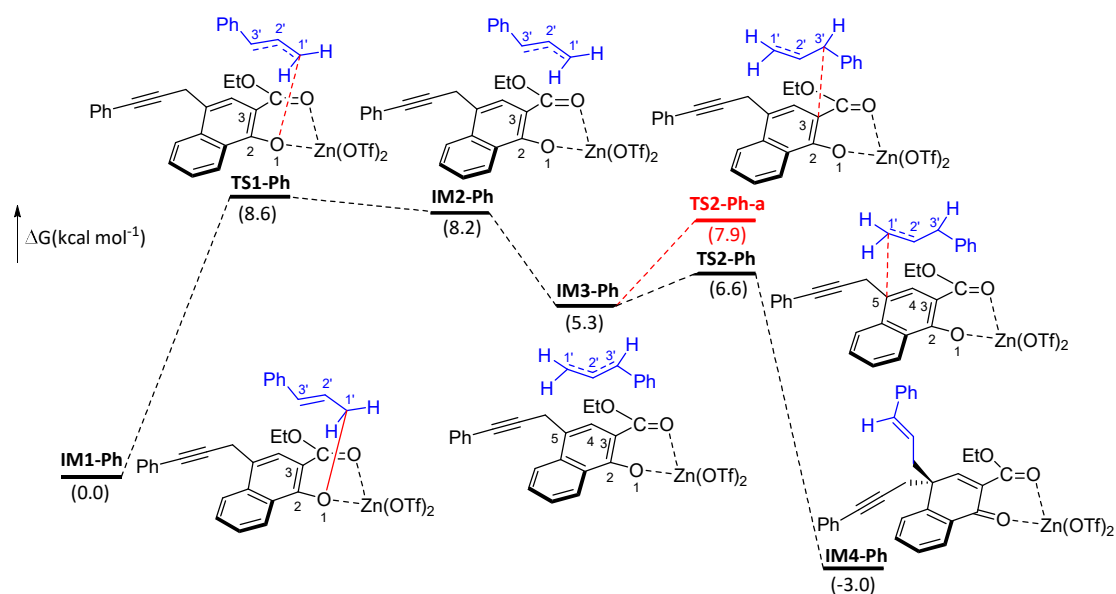


Figure S3. Energy profile for the rearrangement reaction of B1 catalyzed by Zn(OTf)₂.

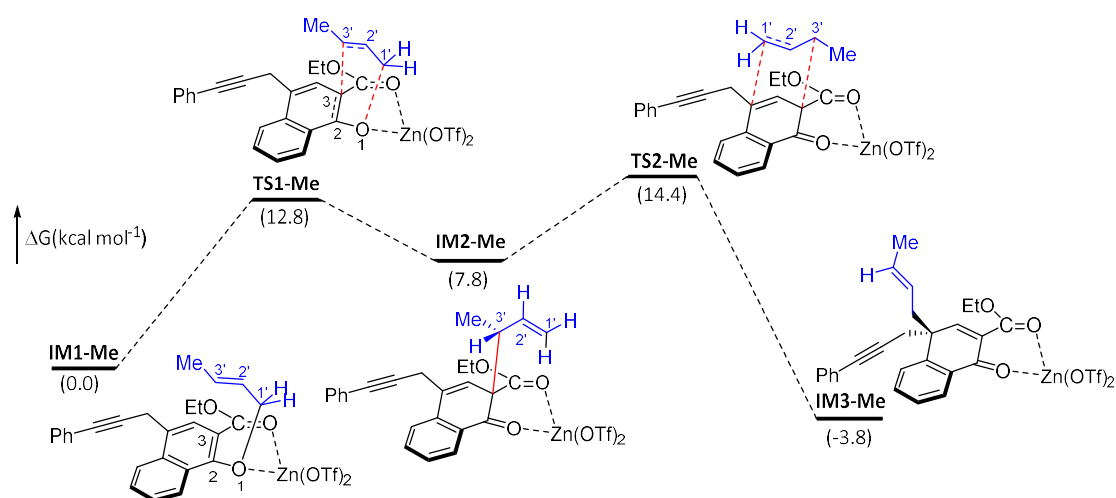


Figure S4. Energy profile for the rearrangement reaction of B34 catalyzed by Zn(OTf)₂.

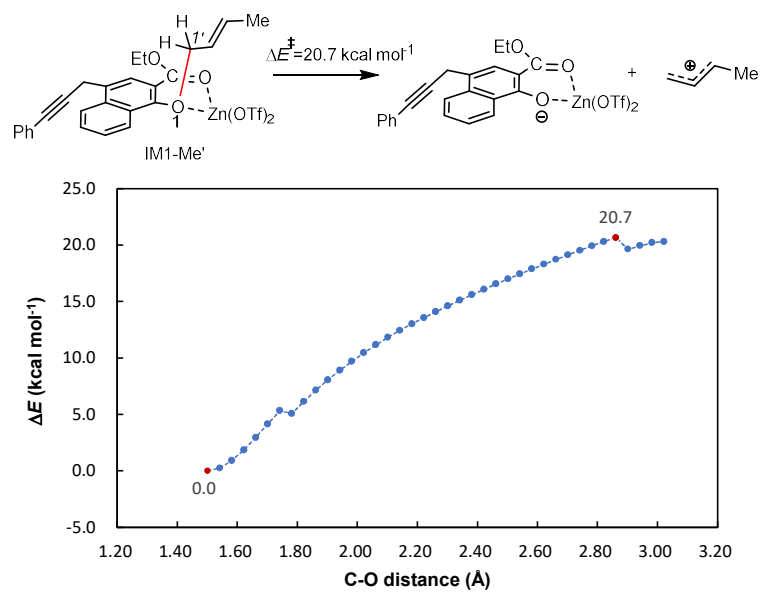


Figure S5. Evaluation of energy barrier associated with the formation of ion-pair by C₁-O bond relaxed scan.

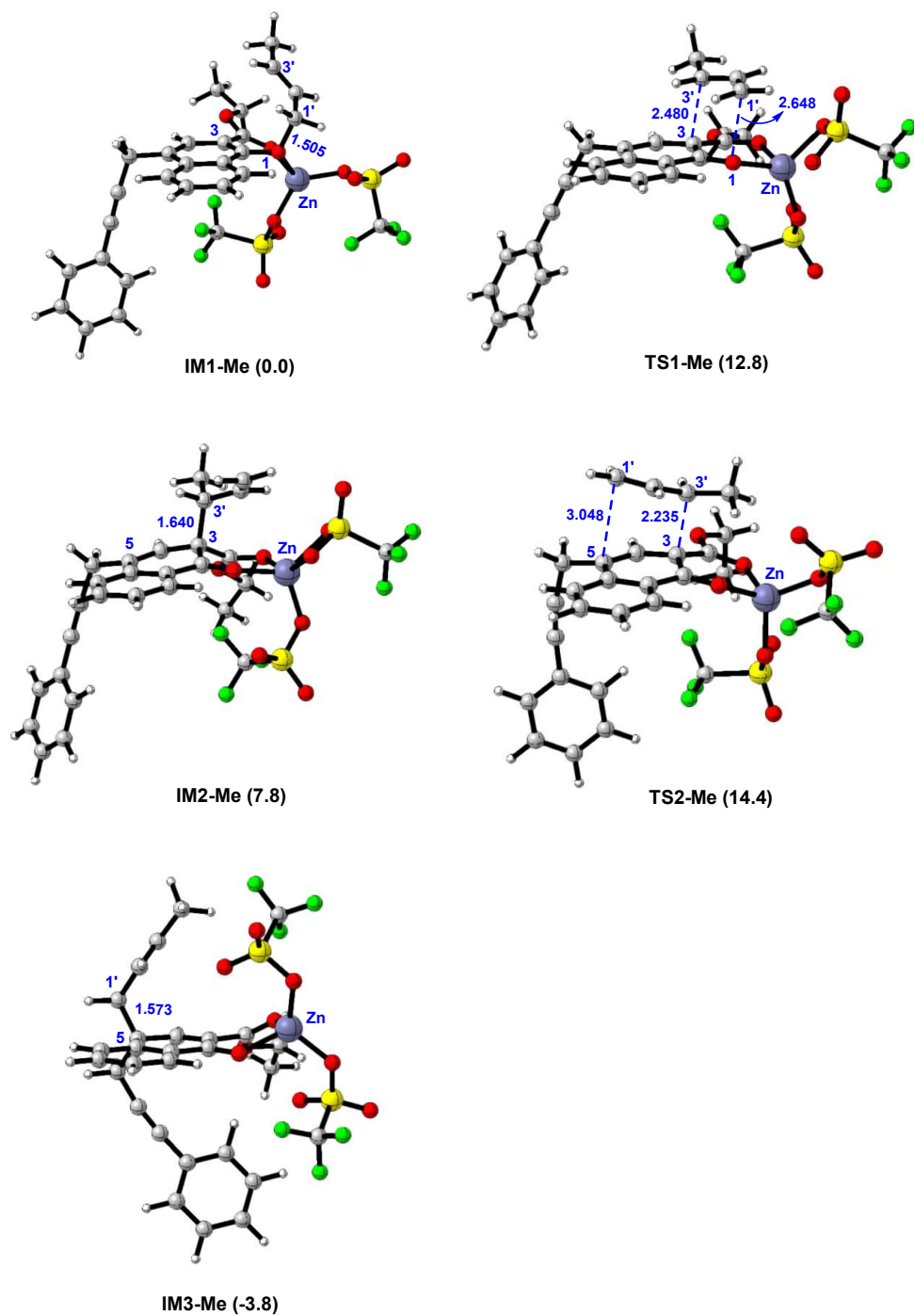


Figure S6. Optimized geometries of intermediates and transition states. Relative Gibbs free energy in parenthesis was in kcal mol⁻¹.

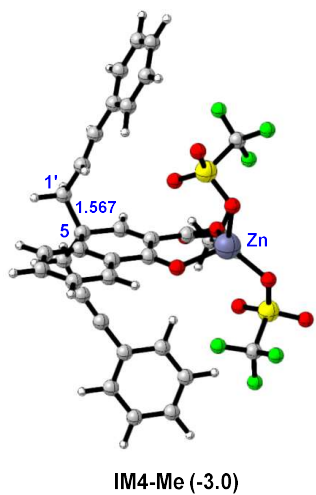
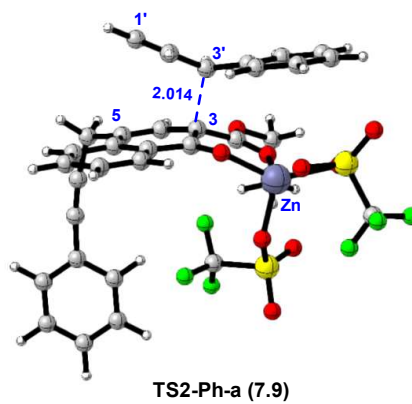
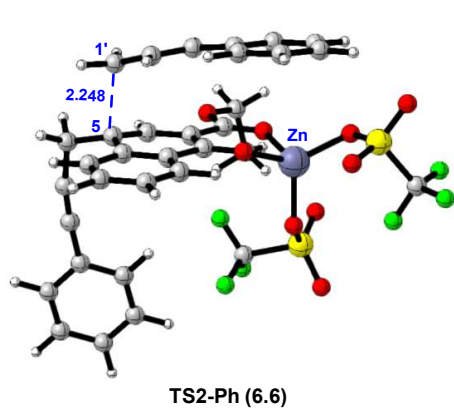
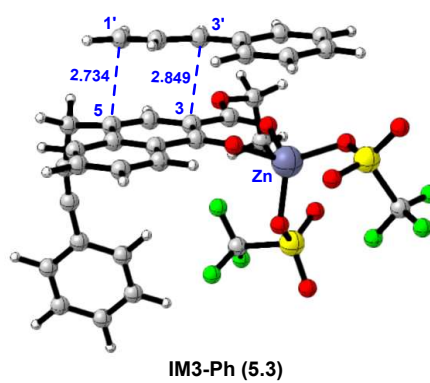
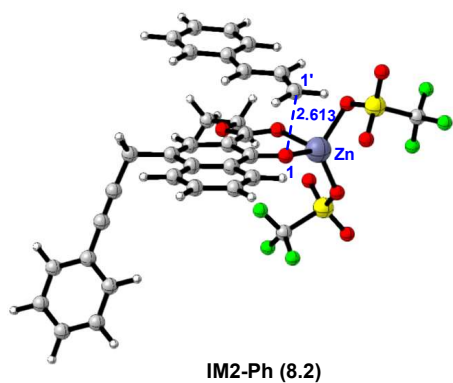
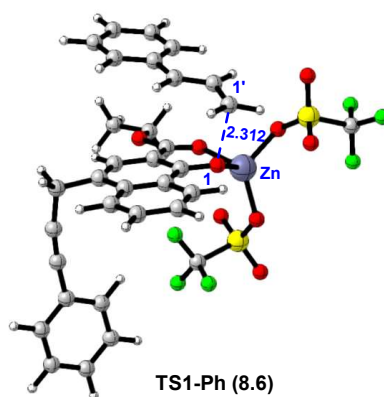
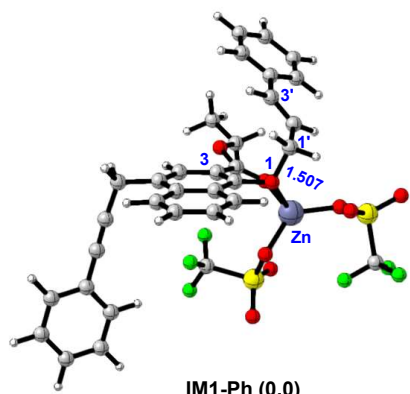


Figure S7. Optimized geometries of intermediates and transition states. Relative Gibbs free energy in parenthesis was in kcal mol⁻¹.

Table S9. The correct electronic energies (E_z), enthalpies (H), and Gibbs free energies (G) for all stationary points (in Hartree), obtained at the B3LYP-D3/6-31G(d,p) (SMD, CCl₄) level of theory.

Structures	^a ZPE	^b H _c	^c G _c	E_z	H	G
IM1-Me	0.49251	0.53566	0.41168	-4932.60362	-4932.56046	-4932.68444
TS1-Me	0.48937	0.53259	0.40680	-4932.58151	-4932.53829	-4932.66408
IM2-Me	0.49222	0.53512	0.41248	-4932.59220	-4932.54929	-4932.67193
TS2-Me	0.49032	0.53300	0.41120	-4932.58236	-4932.54057	-4932.66148
IM3-Me	0.49256	0.53544	0.41393	-4932.61181	-4932.56893	-4932.69044
IM1-Ph	0.54639	0.59199	0.46240	-5124.31128	-5124.26568	-5124.39527
TS1-Ph	0.54416	0.58959	0.46076	-5124.29843	-5124.25299	-5124.38182
IM2-Ph	0.54382	0.59016	0.45936	-5124.29773	-5124.25139	-5124.38219
IM3-Ph	0.54378	0.58986	0.46133	-5124.30443	-5124.25834	-5124.38688
TS2-Ph	0.54411	0.58935	0.46291	-5124.30349	-5124.25826	-5124.38469
IM4-Ph	0.54608	0.59161	0.46330	-5124.31734	-5124.27181	-5124.40012
TS1-Me-a	0.54355	0.59344	0.45423	-5124.29333	-5124.24345	-5124.38266

^a Zero-point correction energy;

^b Thermal correction to enthalpy;

^c Thermal correction to Gibbs free energy.

References:

- [1] Frisch, M. J.; Trucks, G. W.; Schlegel, H. B.; Scuseria, G. E.; Robb, M. A.; Cheeseman, J. R.; Scalmani, G.; Barone, V.; Mennucci, B.; Petersson, G. A.; Nakatsuji, H.; Caricato, M.; Li, X.; Hratchian, H. P.; Izmaylov, A. F.; Bloino, J.; Zheng, G.; Sonnenberg, J. L.; Hada, M.; Ehara, M.; Toyota, K.; Fukuda, R.; Hasegawa, J.; Ishida, M.; Nakajima, T.; Honda, Y.; Kitao, O.; Nakai, H.; Vreven, T.; Montgomery, J. A.; Peralta, J. J. E.; Ogliaro, F.; Bearpark, M.; Heyd, J. J.; Brothers, E.; Kudin, K. N.; taroverov, V. N.; Keith, T.; Kobayashi, R.; Normand, J.; Raghavachari, K.; Rendell, A.; Burant, J. C.; Iyengar, S. S.; Tomasi, J.; Cossi, M.; Rega, N.; Millam, J. M.; Klene, M.; Knox, J. E.; Cross, J. B.; Bakken, V.; Adamo, C.; Jaramillo, J.; Gomperts, R.; Stratmann, R. E.; Yazyev, O.; Austin, A. J.; Cammi, R.; Pomelli, C.; Ochterski, J. W.; Martin, R. L.; Morokuma, K.; Zakrzewski, V. G.; Voth, G. A.; Salvador, P.; Dannenberg, J. J.; Dapprich, S.; Daniels, A. D.; Farkas, O.; Foresman, J. B.; Ortiz, J. V.; Cioslowski, J.; Fox, D. J. Gaussian 09 (Revision D.01) I. Gaussian, Wallingford, CT, 2013.
- [2] Marenich, A. V.; Cramer, C. J.; Truhlar, D. Universal Solvation Model Based on Solute Electron Density and on a Continuum Model of the Solvent Defined by the Bulk Dielectric Constant and Atomic Surface Tensions. *J. Phys. Chem. B* 2009, 113, 6378–6396.
- [3] Grimme, S.; Antony, J.; Ehrlich, S.; Krieg, H. A Consistent and Accurate ab Initio Parametrization of Density Functional Dispersion Correction (DFT-D) for the 94 Elements H-Pu. *J. Chem. Phys.* 2010, 132, 154104–154119.
- [4] Grimme, S.; Ehrlich, S.; Goerigk, L. Effect of the Damping Function in Dispersion Corrected Density Functional Theory. *J. Comput. Chem.* 2011, 32, 1456–1465.

[5] Gonzalez, C.; Schlegel, H. B. An Improved Algorithm for Reaction Path Following. J. Chem. Phys. 1989, 90, 2154–2161.

13.2 Cartesian coordinates of all stationary points in this work

IM1-Me

C	2.50145000	1.97114000	1.81214100
C	2.97649200	2.89782500	0.74939100
C	2.49575700	4.13662400	0.59016100
C	2.87935300	5.07438000	-0.51096200
H	3.63300200	4.64006800	-1.17439000
H	1.99652100	5.33594100	-1.10838700
H	3.28259300	1.32260200	2.20703700
H	3.70680500	2.49665200	0.04870600
H	1.75735000	4.50610500	1.30301200
H	1.98317600	2.48133100	2.62638300
H	3.27443200	6.01526100	-0.10885300
C	-2.45213200	0.85862500	4.30776600
C	-1.10885200	0.43445000	4.42775600
C	-0.22813400	0.62787900	3.38902000
C	-0.66125300	1.26313500	2.19501000
C	-2.89962200	1.46751200	3.15504900
C	-2.02229600	1.69593400	2.06309300
H	-3.14263400	0.68922300	5.12825500
H	-0.77775600	-0.06073400	5.33497400
H	0.79427500	0.27423000	3.45400600
H	-3.94127300	1.75395000	3.07409000
C	-2.44580700	2.31822700	0.84242600
C	0.21817800	1.43410400	1.09637400
C	-0.20792200	2.02003500	-0.08648700
C	-1.55215500	2.47216400	-0.18789600
O	1.52328200	0.98092800	1.24091900
C	-3.89453400	2.74120000	0.63797200
H	-3.94922600	3.42520100	-0.21721100
C	-4.75942300	1.58251200	0.40210300
C	-5.40891800	0.57714100	0.20813400
H	-4.25465000	3.31113900	1.50383900
C	-6.17068400	-0.61001900	-0.02405400
C	-5.55248400	-1.75246700	-0.56859700
C	-7.54260800	-0.65624800	0.29040900
C	-6.29352000	-2.91043100	-0.79003900
H	-4.49744200	-1.72100300	-0.81310000
C	-8.27489100	-1.81915700	0.06435200
H	-8.02166300	0.22265000	0.71027800
C	-7.65417200	-2.94871600	-0.47512800

H	-5.80553000	-3.78557900	-1.20880100
H	-9.33250300	-1.84429200	0.31041800
H	-8.22790500	-3.85428900	-0.64899900
C	0.65922600	2.06256500	-1.27859300
O	1.56383500	1.24144900	-1.53079200
O	0.37602700	3.03048500	-2.12128200
C	1.11761800	3.06506200	-3.38820100
C	0.56459500	4.22050800	-4.18925400
H	2.17803200	3.18355800	-3.15188700
H	0.97777900	2.10181300	-3.88557600
H	0.70246400	5.16928100	-3.66277000
H	1.09287700	4.27758800	-5.14569800
H	-0.50107200	4.08207400	-4.39257000
H	-1.87510700	2.91015800	-1.12504900
Zn	2.02139300	-0.26791000	-0.32030000
O	3.88566400	-0.60344300	-0.54298200
S	4.63519500	-1.20483900	0.66756700
C	4.42736100	-3.02572600	0.32677700
O	6.06595800	-0.92225400	0.62233900
F	3.12084100	-3.31509400	0.25470600
F	5.01096700	-3.34859100	-0.82801500
F	4.97824200	-3.73435900	1.31478600
O	3.88064700	-0.95674600	1.91026500
O	0.58365000	-1.48644100	0.05580500
S	-0.02191400	-2.21560200	-1.15659400
C	-1.54694000	-1.17091300	-1.45814200
O	-0.52238300	-3.54474600	-0.82489100
F	-2.15456200	-0.86978200	-0.30583700
F	-2.40396400	-1.83412200	-2.24114900
O	0.82158300	-2.01511100	-2.34675400
F	-1.20875300	-0.02311600	-2.07546400

TS1-Me

C	-3.30268100	-3.28088100	-2.42303900
C	-2.04045300	-3.02459600	-2.98367700
C	-1.08390600	-2.35299400	-2.24182800
C	-1.36405000	-1.93343500	-0.92537900
C	-3.59962400	-2.86942000	-1.13309500
C	-2.64131300	-2.18823300	-0.34979800
H	-4.05745100	-3.80071500	-3.00550500
H	-1.81788600	-3.34593600	-3.99619200
H	-0.10681200	-2.13211900	-2.65593500
H	-4.58777800	-3.06001600	-0.73210200
C	-2.91469800	-1.73792300	1.00170500

C	-0.32684500	-1.23798300	-0.17136800
C	-0.60148300	-0.92445400	1.20620100
C	-1.93315100	-1.11738200	1.71381800
O	0.79585000	-1.03597100	-0.74847800
C	-4.28886200	-1.93464600	1.62638800
H	-4.23778400	-1.66554800	2.68733900
C	-5.33202500	-1.14369300	0.96902400
C	-6.16395200	-0.48549600	0.38220000
H	-4.56185500	-2.99904600	1.59556000
C	-7.13200200	0.28574300	-0.33244700
C	-6.91700000	0.60578700	-1.68734200
C	-8.30801800	0.73318300	0.29932800
C	-7.85814400	1.35545100	-2.38830300
H	-6.01026400	0.26247700	-2.17537300
C	-9.24363900	1.48187700	-0.41059500
H	-8.47630100	0.48905200	1.34342300
C	-9.02288500	1.79524100	-1.75405600
H	-7.68171000	1.59814100	-3.43207000
H	-10.14722400	1.82260700	0.08637000
H	-9.75436800	2.38009000	-2.30379200
C	0.34171800	-0.10236700	1.98487400
O	1.51074000	0.15670500	1.65898300
O	-0.14186800	0.33283100	3.13574300
C	0.71505100	1.23508700	3.91621700
C	-0.11550000	1.72177500	5.08124200
H	1.59685400	0.67223500	4.23513200
H	1.04019300	2.04076900	3.25456700
H	-0.44173800	0.88958900	5.71264000
H	0.48624300	2.40218600	5.69139000
H	-0.99771700	2.26488700	4.73062800
H	-2.14370000	-0.76299200	2.71538300
Zn	2.25803100	0.16327700	-0.20520900
O	4.07472400	-0.49857800	0.50589200
S	4.61850700	-1.05656800	-0.79953700
C	6.00099900	0.11292000	-1.23132300
O	5.20972400	-2.39325000	-0.72003600
F	5.52856000	1.35824300	-1.29582800
F	6.95210200	0.04757800	-0.29611700
F	6.52009100	-0.22695300	-2.41357800
O	3.55913100	-0.82341900	-1.82903000
O	2.21200800	1.94768500	-0.94568900
S	1.68082900	3.19709600	-0.23120700
C	-0.15002500	2.99949400	-0.51829600
O	2.05650500	4.42450100	-0.92844600

F	-0.42903400	2.92703400	-1.82165400
F	-0.81921300	4.02354000	0.01807200
O	1.83068200	3.12435300	1.22845500
F	-0.58451400	1.85946500	0.06800600
C	1.90392000	-3.33815100	-0.05190500
C	1.74037600	-3.00107300	1.25951600
C	0.47616000	-3.05301300	1.88381000
C	0.31958100	-2.93426300	3.35868300
H	1.06423800	-2.27017100	3.80493900
H	-0.68564300	-2.61712200	3.64285000
H	2.87923200	-3.31631200	-0.52562100
H	2.59009600	-2.62816300	1.82524500
H	-0.34292400	-3.51498100	1.33873600
H	1.07283700	-3.69788500	-0.64995400
H	0.47395300	-3.93614800	3.78794800

IM2-Me

O	4.18764700	-0.36079900	0.83189300
S	4.83717100	-0.55057700	-0.52716000
C	6.01328400	0.88723000	-0.66566900
O	5.63178200	-1.76003900	-0.71908100
F	5.33836200	2.02672900	-0.49948100
F	6.95564700	0.78954200	0.27425200
F	6.58538600	0.88163800	-1.87054600
O	3.74996100	-0.24895100	-1.52556200
C	2.55683200	-3.43422800	-0.40508200
C	2.04210800	-2.99061600	0.74348700
C	0.59948400	-3.15565900	1.13589300
C	0.49595300	-3.70411000	2.56744300
H	0.90827700	-3.00149700	3.30009900
H	-0.53301100	-3.93740800	2.84917100
H	3.61325600	-3.32806000	-0.62989600
H	2.69101100	-2.50054900	1.46554700
H	0.11625000	-3.85458100	0.44601100
H	1.94008000	-3.91660300	-1.16055700
H	1.07969300	-4.62620300	2.63595600
C	-3.05927300	-2.38311900	-3.35924700
C	-1.81806400	-1.88177800	-3.76860100
C	-0.86838700	-1.55206600	-2.81350400
C	-1.14548400	-1.73714700	-1.44617700
C	-3.35156700	-2.55352900	-2.00782000
C	-2.40458800	-2.23668300	-1.02229300
H	-3.81113300	-2.63654000	-4.10055100
H	-1.60084300	-1.74618400	-4.82282300

H	0.09674900	-1.14941100	-3.09836100
H	-4.33206000	-2.91556200	-1.72480800
C	-2.68347900	-2.37378400	0.41340600
C	-0.12606200	-1.36136900	-0.47691800
C	-0.30036200	-1.79316700	0.97898300
C	-1.72294300	-2.13709400	1.32070500
O	0.90643000	-0.79072600	-0.86883000
C	-4.08330600	-2.75686400	0.87645900
H	-4.06694600	-2.93226000	1.95769400
C	-5.07005900	-1.72378200	0.55374500
C	-5.83158500	-0.83373800	0.24147900
H	-4.37870900	-3.71153500	0.41875700
C	-6.70278600	0.22640400	-0.15781200
C	-6.37162000	1.02072400	-1.27335100
C	-7.89077700	0.49576600	0.54793700
C	-7.21149100	2.05841300	-1.66888600
H	-5.45477400	0.81486800	-1.81693100
C	-8.72437500	1.53617500	0.14413700
H	-8.14843800	-0.11368300	1.40836100
C	-8.38877400	2.31958500	-0.96296200
H	-6.94570700	2.66568000	-2.52911200
H	-9.63836500	1.73689000	0.69545800
H	-9.04075200	3.13049300	-1.27389700
C	0.27802300	-0.74371500	1.92525500
O	1.41835200	-0.28753600	1.81327300
O	-0.52978100	-0.38936400	2.89565500
C	-0.10328000	0.68759900	3.80405500
C	-1.36010300	1.37521000	4.28430700
H	0.46325500	0.21482500	4.61073200
H	0.55376900	1.36204400	3.25546800
H	-2.02721100	0.67803300	4.79872800
H	-1.08653700	2.17299700	4.98148700
H	-1.89245800	1.82315200	3.44167800
H	-1.95246400	-2.22636100	2.37431400
Zn	2.34296700	0.22315600	0.04631600
O	1.99523400	2.12329600	0.18466400
S	0.94139800	2.85922400	-0.65508200
C	-0.56554400	2.65358600	0.42982900
O	0.60492800	2.13594000	-1.88590000
F	-0.91394400	1.34698800	0.51249700
F	-1.59906300	3.32613700	-0.07555400
O	1.18084800	4.29929700	-0.69514300
F	-0.33004300	3.08963300	1.67697600

TS2-Me

C	2.01486500	3.45311600	-3.23247500
C	0.75252000	2.90960200	-3.51486900
C	0.04344900	2.27202100	-2.51100000
C	0.57314300	2.18885700	-1.20840100
C	2.55334400	3.37269300	-1.95506600
C	1.84332100	2.75251800	-0.90969200
H	2.58286900	3.93684900	-4.02137400
H	0.33930300	2.97755300	-4.51578000
H	-0.92453400	1.82448100	-2.70556300
H	3.53984900	3.78152100	-1.77217700
C	2.37188100	2.64389900	0.44584000
C	-0.17841600	1.46182900	-0.19323600
C	0.31132700	1.51663100	1.18503900
C	1.64409700	2.01649000	1.40850900
O	-1.24258900	0.86989100	-0.53912900
C	3.81095200	3.04380400	0.75032700
H	3.92391100	3.19951600	1.82958700
C	4.68318700	1.95548200	0.30066600
C	5.21663700	0.93717600	-0.08600900
H	4.07594400	3.99482500	0.27536700
C	5.69467800	-0.33753000	-0.51963000
C	4.81335800	-1.43469000	-0.44503200
C	6.99287900	-0.53154000	-1.02275100
C	5.21925700	-2.69467300	-0.87161400
H	3.81620900	-1.27735900	-0.05265400
C	7.39303600	-1.79842400	-1.44450300
H	7.67573900	0.31012900	-1.08127200
C	6.51107000	-2.88006100	-1.37226400
H	4.52341400	-3.52569900	-0.81270600
H	8.39734600	-1.94173900	-1.83225900
H	6.82912900	-3.86344500	-1.70547300
C	-0.22981400	0.57853400	2.19732200
O	-1.15137400	-0.23554900	2.01998800
O	0.33637800	0.70471800	3.38278100
C	-0.03525500	-0.25233700	4.43730400
C	0.71252500	-1.55698900	4.25154100
H	0.25143100	0.26735400	5.35257900
H	-1.11806600	-0.38743200	4.41629100
H	1.79292500	-1.38546500	4.23660800
H	0.48083700	-2.22035900	5.09107300
H	0.40971500	-2.05921500	3.33025700
H	2.06416100	1.89668300	2.39943000
Zn	-2.02670000	-0.70518700	0.29612000

O	-3.92222700	-0.84186700	0.53195700
S	-4.94088900	0.02541400	-0.22895800
C	-4.69622600	-0.61195700	-1.96300700
O	-6.31295300	-0.30413100	0.14559700
F	-3.39642700	-0.46961000	-2.30375400
F	-5.01765200	-1.90277200	-2.04774000
F	-5.43881600	0.08650500	-2.82491900
O	-4.53189700	1.43523500	-0.29615200
O	-1.26775500	-2.24174200	-0.61172900
S	-0.40582700	-3.27409300	0.12484300
C	1.27994100	-2.49501100	-0.05778300
O	-0.32018700	-4.54426200	-0.58866400
F	1.62166300	-2.36973100	-1.34034500
F	2.20638700	-3.22875700	0.57072900
O	-0.65915800	-3.26614400	1.57262600
F	1.28206200	-1.25924800	0.50100500
C	0.64149000	5.00057200	1.30865100
C	-0.47325100	4.31516000	0.97346500
C	-0.98160100	3.24123900	1.77760000
C	-2.38259400	2.76469300	1.60145900
H	-2.64168800	2.56672000	0.55962100
H	-2.61108000	1.87904900	2.19586000
H	1.03011800	5.79289600	0.67671300
H	-0.98343700	4.52493600	0.03661100
H	-0.55799200	3.15820000	2.77600100
H	1.16409600	4.81546000	2.24175300
H	-3.05138600	3.56573300	1.94840100

IM3-Me

C	0.50687500	-4.24841100	-3.29271900
C	0.34844800	-2.96038800	-3.81806000
C	0.24246100	-1.88252500	-2.95555800
C	0.28802200	-2.08036400	-1.56187000
C	0.55735000	-4.45004700	-1.91609000
C	0.44725500	-3.37543600	-1.02688600
H	0.59315700	-5.09951900	-3.96135000
H	0.31376400	-2.80626500	-4.89133600
H	0.12782400	-0.87350200	-3.33305100
H	0.67905400	-5.45848900	-1.53446800
C	0.49559900	-3.61348800	0.47197500
C	0.19973800	-0.90815300	-0.69481000
C	0.24474400	-1.11289700	0.75905100
C	0.35781100	-2.35812800	1.26605200
O	0.04359800	0.22715600	-1.20564400

C	-0.69397800	-4.55073200	0.91299200
H	-0.55258300	-4.81202700	1.96951200
C	-1.97734700	-3.88244600	0.72395300
C	-2.94123000	-3.16426100	0.56296600
H	-0.63519500	-5.48573200	0.34694700
C	-4.02616200	-2.24992400	0.39476300
C	-3.83125400	-0.88999700	0.70827700
C	-5.27846300	-2.67303000	-0.08796700
C	-4.86838300	0.02263000	0.54229300
H	-2.86981900	-0.55101200	1.07660900
C	-6.31029600	-1.75111800	-0.25105700
H	-5.42970900	-3.71952400	-0.33320100
C	-6.10913100	-0.40417500	0.06212000
H	-4.69552900	1.06516700	0.78063900
H	-7.27380600	-2.08474900	-0.62515500
H	-6.91522800	0.31145500	-0.07024600
C	0.17420300	0.04717000	1.68522900
O	0.67320400	1.15973300	1.45352800
O	-0.43988600	-0.21673600	2.81178900
C	-0.62673100	0.88865500	3.76669800
C	-1.57502000	0.37949600	4.82638400
H	0.35667500	1.15484000	4.16372900
H	-1.03400600	1.73277400	3.20814200
H	-1.16132100	-0.48868100	5.34765800
H	-1.75120600	1.17181200	5.56010400
H	-2.53498000	0.10260500	4.38180000
H	0.36668500	-2.48538400	2.34507600
Zn	0.66491800	1.90572700	-0.39038800
O	2.40061700	2.32267600	-1.07828200
S	3.51264900	1.25703200	-1.10557100
C	4.52652900	1.79905300	0.36065500
O	3.00201100	-0.07553100	-0.73934500
F	4.85022100	3.08932200	0.25926200
F	3.82337800	1.61619300	1.49096900
F	5.64822200	1.07172700	0.43095000
O	4.37956600	1.39400200	-2.27203900
O	-0.62864000	3.31895300	-0.39599700
S	-2.04217900	3.12193800	0.17755800
C	-2.99183600	2.75278900	-1.38307200
O	-2.59677200	4.35887900	0.71879500
F	-2.80860400	3.72371900	-2.28050000
F	-4.29820400	2.65738100	-1.10602500
O	-2.14412000	1.88588400	0.97828600
F	-2.57018800	1.59314300	-1.90228500

C	1.85999200	-4.26775800	0.90056200
C	3.02194100	-3.33702300	0.68565700
C	3.74029200	-2.79968700	1.67571000
C	4.84061900	-1.79883600	1.49740400
H	5.00381000	-1.56219900	0.44427700
H	4.59652300	-0.86223300	2.01215400
H	1.97653500	-5.19845000	0.33384700
H	3.23133900	-3.04571400	-0.34262400
H	3.51065400	-3.08627100	2.70454800
H	1.78724800	-4.54303000	1.95906400
H	5.78271600	-2.16049900	1.92921500

IM1-Ph

C	2.40257000	0.46298100	2.29476800
C	3.21165600	1.33641000	1.40636100
C	3.09098100	2.67500600	1.39876500
H	2.93176200	-0.42885200	2.62758300
H	3.84877800	0.82178700	0.69168800
H	2.41354300	3.12930200	2.12169000
H	1.96962100	0.99225200	3.14582700
C	-2.85893600	0.26500600	4.38381500
C	-1.68319800	-0.51694800	4.45476500
C	-0.70097000	-0.37614200	3.50191200
C	-0.85961300	0.55969200	2.44586700
C	-3.04098400	1.17355700	3.36340100
C	-2.05023000	1.35510700	2.36349400
H	-3.63310000	0.13733300	5.13420100
H	-1.56386800	-1.24194100	5.25352000
H	0.18837800	-0.99495200	3.52446900
H	-3.96450300	1.73731600	3.31024800
C	-2.20275800	2.27794600	1.27674300
C	0.11878800	0.68755600	1.42747900
C	-0.04966400	1.56862600	0.36940700
C	-1.22157900	2.37249200	0.32209600
O	1.24726300	-0.11791900	1.52094700
C	-3.47382200	3.10059700	1.11661000
H	-3.28273400	3.91456700	0.40735500
C	-4.58717100	2.27728900	0.63794000
C	-5.45920100	1.53767900	0.23450500
H	-3.74193600	3.58370500	2.06483200
C	-6.49211100	0.67163700	-0.24170900
C	-6.16623300	-0.49527300	-0.96003200
C	-7.84640900	0.97314800	-0.00023200
C	-7.17496900	-1.33740400	-1.42114500

H	-5.12557300	-0.72977500	-1.15017000
C	-8.84755700	0.12453700	-0.46607600
H	-8.09996700	1.87225000	0.55253900
C	-8.51625700	-1.03182700	-1.17695500
H	-6.91208000	-2.23498500	-1.97303500
H	-9.88889800	0.36637800	-0.27426600
H	-9.29948700	-1.69161400	-1.53841300
C	0.88955700	1.59966600	-0.76884100
O	1.57636300	0.62926300	-1.14971400
O	0.92212300	2.74240100	-1.41048600
C	1.75777800	2.82615300	-2.61654400
C	1.62374800	4.23478600	-3.14544300
H	2.78325600	2.58733700	-2.32883800
H	1.40025100	2.07038700	-3.32085400
H	1.96623400	4.96121500	-2.40459400
H	2.24410100	4.33860400	-4.04079100
H	0.58776700	4.45851000	-3.41604100
H	-1.34797600	3.04202200	-0.52056500
Zn	1.52742200	-1.13816700	-0.25177200
O	3.25656400	-1.90939200	-0.48027800
S	3.73986000	-2.90219500	0.60100400
C	3.07697800	-4.50205700	-0.08916100
O	5.19425800	-3.01737100	0.62582700
F	1.74667200	-4.40777500	-0.22214900
F	3.61937300	-4.74794900	-1.28234000
F	3.36318000	-5.50584000	0.74290100
O	3.00311300	-2.68825700	1.85990300
O	-0.20410400	-1.96759200	-0.15520600
S	-0.87616800	-2.28316700	-1.50330600
C	-2.06150100	-0.84001100	-1.64497400
O	-1.71781300	-3.47316400	-1.45011100
F	-2.67756500	-0.61201100	-0.48016800
F	-2.98175000	-1.09997000	-2.57896100
O	0.08258500	-2.09996600	-2.60590300
F	-1.39625000	0.27447300	-2.00197500
C	3.74321400	3.61797500	0.48280200
C	3.33920600	4.96477400	0.50358700
C	4.73120500	3.23078300	-0.44375300
C	3.89227100	5.89500700	-0.37541200
H	2.57814000	5.27909900	1.21297400
C	5.28122400	4.15963000	-1.32260400
H	5.07712000	2.20264700	-0.47445300
C	4.86354500	5.49442500	-1.29455300
H	3.56569900	6.93015600	-0.34248300

H	6.04318800	3.84333000	-2.02867700
H	5.29743100	6.21553600	-1.98065100

TS1-Ph

C	2.25916600	1.36825100	2.48013300
C	2.50696100	2.16796700	1.38414300
C	1.60266900	3.16980000	1.03975200
H	2.92620200	0.56257700	2.76134900
H	3.35140000	1.92204400	0.74891000
H	0.79787200	3.37148900	1.74325500
H	1.45974800	1.60695000	3.17343100
C	-2.92819000	0.80609600	4.68240800
C	-1.73495600	0.06138900	4.75068800
C	-0.88910000	0.01612300	3.65960500
C	-1.20114500	0.72419200	2.47616000
C	-3.25688100	1.50166100	3.53413100
C	-2.40304300	1.49070200	2.40433200
H	-3.60079800	0.82715500	5.53462800
H	-1.48864900	-0.48917400	5.65315000
H	0.01888300	-0.57512900	3.68256000
H	-4.19150900	2.04850500	3.49571600
C	-2.70810800	2.20365300	1.19026200
C	-0.31424800	0.62690400	1.33395800
C	-0.63613700	1.37036400	0.16847800
C	-1.83920100	2.13576800	0.13460900
O	0.76896000	-0.09055200	1.48168500
C	-4.06315700	2.87115200	0.98612100
H	-3.98627100	3.61502500	0.18411200
C	-5.01500400	1.82008000	0.61082200
C	-5.60413500	0.81530400	0.27160900
H	-4.39456400	3.41445600	1.87798200
C	-6.15096600	-0.43188700	-0.16129200
C	-5.26209900	-1.42872900	-0.61320900
C	-7.53155300	-0.69789900	-0.14676600
C	-5.74613400	-2.66158600	-1.03885100
H	-4.19816300	-1.22104700	-0.62344900
C	-8.00741100	-1.93572700	-0.57586700
H	-8.21890900	0.06689100	0.20073400
C	-7.11990500	-2.91891900	-1.02122200
H	-5.04612000	-3.41709200	-1.38172100
H	-9.07514200	-2.13438000	-0.56156300
H	-7.49709600	-3.88161400	-1.35345300
C	0.14065200	1.24536500	-1.06836900
O	1.10167500	0.47583100	-1.26080800

O	-0.26190700	2.03891100	-2.04803000
C	0.37386500	1.86223900	-3.35334200
C	-0.34139100	2.78512100	-4.31334800
H	1.43350100	2.10698900	-3.25145100
H	0.28640400	0.80905100	-3.63212400
H	-0.24964400	3.82744400	-3.99508500
H	0.10246500	2.68567000	-5.30866400
H	-1.40273000	2.53027100	-4.38359400
H	-2.08985100	2.64190300	-0.78956800
Zn	1.65848400	-0.96212300	-0.02530500
O	3.57361000	-0.75223100	-0.29042600
S	4.48293000	-0.96479300	0.92374700
C	5.62028400	-2.29593900	0.29192800
O	5.32115300	0.20664300	1.20170200
F	4.90894500	-3.36885400	-0.06135200
F	6.29929800	-1.84814900	-0.76828500
F	6.48413600	-2.63632800	1.25373800
O	3.73377000	-1.56396900	2.04484700
O	0.91804600	-2.72327500	-0.30405900
S	0.08536600	-3.06418700	-1.54995300
C	-1.62184300	-2.60830900	-0.95037400
O	0.03812800	-4.50122100	-1.80505700
F	-1.95078800	-3.28434600	0.15070000
F	-2.53059500	-2.85807900	-1.90304800
O	0.34201900	-2.13424500	-2.65773400
F	-1.66562900	-1.28728100	-0.66786400
C	1.63075000	3.99570900	-0.13580700
C	0.61178100	4.96255800	-0.30473700
C	2.60911900	3.84977500	-1.14878300
C	0.57844900	5.76540700	-1.43703900
H	-0.15145400	5.06456800	0.46139800
C	2.57049900	4.65680400	-2.27707800
H	3.39051000	3.10482700	-1.04984800
C	1.55854800	5.61486600	-2.42405500
H	-0.20602100	6.50555400	-1.55688900
H	3.32597400	4.54235600	-3.04772100
H	1.53597500	6.24275600	-3.30960400

IM2-Ph

C	3.51394400	-0.01928500	-4.09206200
C	2.27258200	-0.64863600	-4.29558200
C	1.30116500	-0.58607600	-3.31246500
C	1.54089300	0.10641500	-2.10629900
C	3.77243100	0.66210400	-2.91541500

C	2.79712800	0.74715600	-1.89280500
H	4.27968700	-0.07216900	-4.86038700
H	2.07920000	-1.18694800	-5.21823900
H	0.34166500	-1.07325900	-3.44262300
H	4.74363000	1.12018100	-2.77045400
C	3.02865200	1.45139500	-0.65354700
C	0.48482200	0.16830800	-1.10354500
C	0.75093000	0.90367000	0.08764100
C	2.03502400	1.49456800	0.28572400
O	-0.64036300	-0.39511100	-1.39424500
C	4.36038500	2.13445300	-0.37485700
H	4.26635200	2.73674900	0.53590300
C	5.46703400	1.18592400	-0.22443400
C	6.35405700	0.36429200	-0.13481100
H	4.59509100	2.84095500	-1.18388400
C	7.37699800	-0.62965400	-0.04470200
C	7.20793900	-1.87242900	-0.68649400
C	8.56255400	-0.38516700	0.67426900
C	8.20122900	-2.84482000	-0.60300500
H	6.29499600	-2.06157500	-1.24234600
C	9.55048500	-1.36409000	0.75142100
H	8.69601400	0.57134000	1.16956500
C	9.37431600	-2.59464500	0.11379000
H	8.06027700	-3.80027400	-1.09977700
H	10.46041900	-1.16560900	1.31021700
H	10.14666500	-3.35560500	0.17597100
C	-0.23865100	0.98542400	1.16307900
O	-1.42311800	0.61231500	1.09223800
O	0.20682300	1.54356200	2.27817600
C	-0.70390600	1.54243100	3.42510400
C	0.05505700	2.15451600	4.57995800
H	-1.59060000	2.12099700	3.15713400
H	-1.01162200	0.51010400	3.60911400
H	0.36046300	3.17942200	4.34847600
H	-0.58811700	2.17623100	5.46506500
H	0.94725100	1.56850100	4.81884800
H	2.21066300	2.00951400	1.22228200
Zn	-2.15990900	-0.72015000	-0.20040600
O	-3.93000500	0.35330200	-0.25829200
S	-4.48033300	-0.18530000	-1.56831400
C	-5.92609700	-1.23013300	-1.03681700
O	-5.00253900	0.82535700	-2.48979900
F	-5.51931400	-2.13510800	-0.14630100
F	-6.86333600	-0.45426500	-0.48476000

F	-6.44043500	-1.85334800	-2.10014100
O	-3.46639700	-1.14773200	-2.09610100
O	-2.30638400	-2.47624400	0.59792200
S	-1.94800700	-2.79249500	2.05590600
C	-0.09939200	-2.97817400	1.91607200
O	-2.44399600	-4.10407700	2.46705200
F	0.22148800	-3.95250200	1.06141600
F	0.43389600	-3.25038200	3.11121300
O	-2.13320600	-1.64068000	2.94889400
F	0.44448800	-1.82543100	1.46484700
C	-1.62872000	1.55401000	-2.82614700
C	-1.76728300	2.36129600	-1.73230500
C	-0.66251200	3.05176300	-1.20383800
H	-2.47020600	1.00748900	-3.23434600
H	-2.73078000	2.40180700	-1.23657200
H	0.26549400	3.01146500	-1.76874000
H	-0.68271200	1.47011600	-3.35142100
C	-0.66109100	3.88767000	-0.04084800
C	0.51720600	4.60908300	0.27377800
C	-1.77290800	3.97843300	0.83430200
C	0.57829900	5.40088400	1.41165800
H	1.37345000	4.53490000	-0.38971400
C	-1.70235800	4.77183700	1.96996200
H	-2.67349000	3.41007700	0.63389100
C	-0.53093900	5.48391200	2.26103300
H	1.48331500	5.95322400	1.64285900
H	-2.55546000	4.83424900	2.63762800
H	-0.48414100	6.10251700	3.15215200

IM3-Ph

C	1.82495400	4.73945400	1.10138400
C	0.53256700	4.55337100	0.69111100
C	-0.36772000	3.80577800	1.47142300
C	-1.71438700	3.45536800	1.16708400
H	2.53169700	5.30254000	0.50268300
H	0.22934800	4.91222800	-0.28697100
H	-0.01167600	3.51057600	2.45708000
H	2.14898100	4.43928600	2.09224100
C	-2.48474200	2.80795300	2.16958900
C	-2.30249400	3.67608200	-0.10572800
C	-3.79259900	2.43074700	1.92142500
C	-4.36089000	2.67595900	0.66467600
C	-3.61336500	3.29377100	-0.34471700
H	-2.03252400	2.61338700	3.13752900

H	-4.37041200	1.92312300	2.68580700
H	-5.37070400	2.34204900	0.45766500
H	-4.05305600	3.44435200	-1.32467400
H	-1.71983100	4.12751800	-0.90057900
C	2.56114300	3.54152100	-3.55000100
C	1.24151000	3.12016800	-3.78426900
C	0.53613600	2.48475900	-2.77723000
C	1.12458400	2.27299400	-1.51398400
C	3.15778400	3.33923600	-2.31569400
C	2.45507500	2.71229100	-1.26333300
H	3.12348200	4.02399600	-4.34379400
H	0.78186500	3.27909800	-4.75447900
H	-0.47444900	2.12805100	-2.93930500
H	4.18198500	3.66117600	-2.16817100
C	3.02067700	2.51400000	0.05578000
C	0.35410700	1.57267000	-0.49055400
C	0.97093300	1.38241600	0.79765900
C	2.29037600	1.82601700	1.00766200
O	-0.82898100	1.19548200	-0.78825500
C	4.49340300	2.78076700	0.35176400
H	4.60595300	3.07289200	1.40320900
C	5.22662600	1.53687100	0.09943000
C	5.62606700	0.40626200	-0.08496000
H	4.88957000	3.61215200	-0.23841800
C	5.94694500	-0.97396400	-0.26966300
C	4.90635500	-1.91807700	-0.15789100
C	7.25080000	-1.41836900	-0.55140900
C	5.16540600	-3.27469800	-0.32410300
H	3.90246000	-1.57103600	0.05572700
C	7.50168100	-2.77965900	-0.71469000
H	8.05511500	-0.69498000	-0.64006100
C	6.46467300	-3.70949600	-0.60058300
H	4.34986700	-3.98577400	-0.23719100
H	8.51119200	-3.11613600	-0.93218300
H	6.66818200	-4.76845000	-0.72925200
C	0.27578900	0.66335900	1.86779300
O	-0.81820900	0.07648100	1.76227700
O	0.90389500	0.69323600	3.03705600
C	0.39202700	-0.15604400	4.11718300
C	0.76423900	-1.60963500	3.89426600
H	0.87103300	0.26104200	5.00467800
H	-0.68887600	-0.01826400	4.18899500
H	1.84057000	-1.71232400	3.72795800
H	0.49843200	-2.18370400	4.78807700

H	0.22447700	-2.03299000	3.04599500
H	2.75157100	1.61774600	1.96604100
Zn	-1.71726200	-0.32203800	0.02750300
O	-3.60414700	-0.44425200	0.38522100
S	-4.55041400	-0.47749800	-0.82638900
C	-4.85411700	-2.30943100	-0.99162600
O	-5.85637600	0.11251000	-0.52050800
F	-3.70367000	-2.94505800	-1.23390600
F	-5.39042000	-2.78916600	0.13459400
F	-5.69735500	-2.53266500	-2.00605100
O	-3.85027900	-0.07240200	-2.05574600
O	-0.92370900	-1.86390600	-0.87991200
S	-0.55006200	-3.11044200	-0.07582500
C	1.28932500	-2.84535000	0.10929600
O	-0.67941800	-4.34805000	-0.84018200
F	1.90000200	-2.85628800	-1.07833600
F	1.82966500	-3.79532200	0.88235500
O	-1.07318700	-3.05082000	1.29861200
F	1.53147800	-1.64684600	0.69253200

TS2-Ph

C	2.08277000	4.35950900	1.37119200
C	0.77669400	4.45776900	0.86682600
C	-0.28803200	3.81970700	1.46918300
C	-1.62664900	3.66251600	0.95404800
H	2.86623900	4.98037800	0.94948000
H	0.64608900	4.92670700	-0.10301300
H	-0.10452700	3.36628200	2.44197700
H	2.24080600	4.04806300	2.39910100
C	-2.53544600	2.86338700	1.68333000
C	-2.03976400	4.18970700	-0.29129000
C	-3.80479100	2.59427100	1.18660600
C	-4.19577200	3.12411500	-0.04574400
C	-3.31235700	3.92627300	-0.77749900
H	-2.22351400	2.43562300	2.63195100
H	-4.47996700	1.94522900	1.73115300
H	-5.17426100	2.87974800	-0.44304500
H	-3.61665100	4.32681300	-1.73929200
H	-1.35907100	4.79552100	-0.87950900
C	2.65615400	3.64847600	-3.24274200
C	1.37018500	3.17508400	-3.54432300
C	0.65338500	2.47839800	-2.58565700
C	1.20395600	2.25276800	-1.30946500
C	3.20930500	3.44055000	-1.98655100

C	2.49567200	2.74747000	-0.99132400
H	3.22805600	4.17955100	-3.99764100
H	0.94281700	3.34410000	-4.52740000
H	-0.33626100	2.09006100	-2.79570300
H	4.20689000	3.81140900	-1.78312000
C	3.00181600	2.56936000	0.36891500
C	0.42295900	1.48390300	-0.33806500
C	1.02699900	1.21790100	0.95250300
C	2.29988800	1.70036600	1.22520900
O	-0.73253300	1.09061100	-0.68043400
C	4.48721200	2.76171700	0.68035000
H	4.60877100	2.95298800	1.75385800
C	5.18301600	1.52941200	0.30272000
C	5.55445900	0.41657500	-0.00592500
H	4.90091100	3.63516000	0.16774400
C	5.86445800	-0.93214500	-0.36242300
C	4.80609400	-1.85634600	-0.47454700
C	7.18185900	-1.36221600	-0.60142100
C	5.06266100	-3.18064600	-0.81558600
H	3.79108600	-1.52374000	-0.29027400
C	7.42904200	-2.69048500	-0.94312800
H	7.99927300	-0.65303300	-0.51812300
C	6.37467800	-3.60132100	-1.05010000
H	4.23529000	-3.87834200	-0.89663000
H	8.44874700	-3.01594000	-1.12708500
H	6.57459400	-4.63492800	-1.31651500
C	0.32338600	0.42831500	1.97363900
O	-0.77837900	-0.12908100	1.82629100
O	0.95845400	0.36146700	3.13330100
C	0.42685700	-0.54157100	4.16179100
C	0.75796300	-1.98655200	3.84162300
H	0.92211900	-0.19512100	5.07019300
H	-0.64905500	-0.37580000	4.24727600
H	1.83111800	-2.10862400	3.66774700
H	0.47551100	-2.61043300	4.69596500
H	0.20610200	-2.33735400	2.96840100
H	2.75652900	1.44525500	2.17466800
Zn	-1.70709700	-0.41282400	0.08167800
O	-3.56762900	-0.48641400	0.57192700
S	-4.56207600	-0.33735200	-0.59154300
C	-5.01867300	-2.11900400	-0.89448700
O	-5.80005300	0.33088500	-0.18373300
F	-3.92615800	-2.81974200	-1.21591100
F	-5.57034300	-2.64633600	0.20216700

F	-5.89576600	-2.19041800	-1.90213200
O	-3.86947600	0.10969000	-1.81214600
O	-1.00175300	-1.93003200	-0.92788000
S	-0.63203300	-3.22207700	-0.19536000
C	1.21354100	-2.98936000	-0.02693900
O	-0.79182600	-4.41523500	-1.02157300
F	1.80733500	-2.96324100	-1.22520900
F	1.75115700	-3.97242900	0.70148300
O	-1.12936600	-3.22625400	1.18925200
F	1.48048300	-1.81522200	0.59444200

TS2-Ph-a

C	1.15389100	5.25696100	0.00977400
C	0.10328400	4.45912900	-0.22518700
C	-0.45740400	3.57766800	0.80288900
C	-1.89289000	3.24896000	0.79865900
H	1.55530300	5.90413300	-0.76392000
H	-0.34585600	4.44108300	-1.21342400
H	-0.07444300	3.79335600	1.79893300
H	1.62900700	5.30357500	0.98541500
C	-2.54510900	3.05186700	2.03245100
C	-2.63170800	3.08761400	-0.38976300
C	-3.89023000	2.70528100	2.07899400
C	-4.60558200	2.53092700	0.89161100
C	-3.97534700	2.72868000	-0.33847400
H	-1.98351500	3.17203100	2.95501400
H	-4.37835200	2.55379000	3.03658200
H	-5.64207100	2.21485300	0.91653300
H	-4.52636000	2.56939500	-1.25816300
H	-2.15446100	3.21251500	-1.35375600
C	3.18619400	2.40676600	-3.70636500
C	1.91382200	1.95338500	-4.08266500
C	0.97420200	1.67174500	-3.10490100
C	1.28421200	1.85918600	-1.74420900
C	3.50982600	2.58756000	-2.36703000
C	2.56707300	2.33123300	-1.35528900
H	3.93353800	2.61076800	-4.46724700
H	1.67029000	1.81294600	-5.13067400
H	-0.00973200	1.29822900	-3.36487700
H	4.50979700	2.91303100	-2.10752300
C	2.87398200	2.49686200	0.06416100
C	0.29013700	1.49277800	-0.74339600
C	0.56224300	1.84661100	0.66596000
C	1.93435800	2.22448100	0.99731900

O	-0.79127900	0.96537700	-1.11336100
C	4.29199500	2.83874300	0.50650600
H	4.27234700	3.18282300	1.54701600
C	5.12481700	1.63939700	0.38942500
C	5.64278500	0.54860900	0.27800700
H	4.70194200	3.66863600	-0.08104800
C	6.09296200	-0.80270400	0.16825000
C	5.14298700	-1.82965500	0.33526900
C	7.42910800	-1.13975200	-0.10913500
C	5.52003600	-3.16333400	0.22124200
H	4.11793100	-1.56048600	0.55542300
C	7.79964600	-2.47918800	-0.21816800
H	8.16417900	-0.35168400	-0.23843500
C	6.85016300	-3.49187700	-0.05583000
H	4.77154800	-3.93973400	0.34583600
H	8.83340800	-2.73418500	-0.43263200
H	7.14562400	-4.53306500	-0.14553000
C	-0.15407500	1.06054900	1.71808300
O	-1.08315000	0.27200600	1.52334200
O	0.26698400	1.33102400	2.94023500
C	-0.29831400	0.54666200	4.04948200
C	0.37326000	-0.80962600	4.13237900
H	-0.09144800	1.16873300	4.92164200
H	-1.37671200	0.46604900	3.90150000
H	1.45784800	-0.69996900	4.22590100
H	0.00246600	-1.33486400	5.01852500
H	0.14248000	-1.41940200	3.25661900
H	2.17822400	2.31345600	2.04885500
Zn	-1.83422800	-0.45423400	-0.20436800
O	-3.69825700	-0.74902300	0.63299400
S	-4.47340200	-0.68242700	-0.67070000
C	-4.86623300	-2.46794700	-1.03492400
O	-5.75710600	0.01386000	-0.64789700
F	-3.74061800	-3.18458800	-1.04202900
F	-5.68957900	-2.94569000	-0.09868500
F	-5.45646200	-2.56046500	-2.22968000
O	-3.46538200	-0.28671400	-1.71320000
O	-0.90491300	-2.06924300	-0.77554500
S	-0.25765000	-3.04937800	0.20527600
C	1.48686100	-2.38773800	0.23435200
O	-0.14319100	-4.39856700	-0.34227200
F	2.02973200	-2.38922000	-0.98396900
F	2.24978600	-3.12678100	1.05185500
O	-0.74370600	-2.86453400	1.57970500

F	1.49991600	-1.11354400	0.69721800
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IM4-Ph

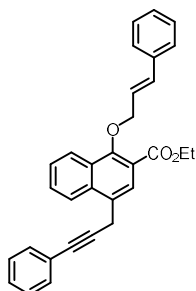
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C	0.07049500	2.05329600	-1.66121600
C	-0.58488200	4.33899000	-2.06037800
C	-0.40526300	3.28244400	-1.16089300
H	-0.45658200	5.01656300	-4.09266800
H	0.37750600	2.83754000	-4.96401100
H	0.71060900	0.94111800	-3.38606500
H	-0.94079500	5.29940400	-1.70236000
C	-0.68975000	3.47666600	0.31740400
C	0.26929700	0.90265500	-0.78144200
C	-0.03765100	1.05594500	0.64791700
C	-0.48962100	2.23638700	1.12062700
O	0.72351800	-0.16384600	-1.26205800
C	0.31925100	4.54229600	0.91117000
H	0.03576200	4.74097900	1.95246000
C	1.69744300	4.07280100	0.83805900
C	2.77880300	3.52996600	0.75627700
H	0.18477400	5.48099300	0.36300500
C	4.02796300	2.84126300	0.67380600
C	4.06307800	1.44455000	0.85410300
C	5.22522200	3.53101000	0.40460200
C	5.27036400	0.75762300	0.77066900
H	3.14945600	0.89839400	1.05929900
C	6.42859900	2.83432600	0.32257500
H	5.20025000	4.60689800	0.26298800
C	6.45478300	1.44892900	0.50405200
H	5.27491000	-0.31637100	0.90999200
H	7.34804900	3.37405500	0.11520900
H	7.39496500	0.90943200	0.43657100
C	0.15019900	-0.08435200	1.58363500
O	0.03936400	-1.28001600	1.28010300
O	0.44851900	0.28362800	2.80778400
C	0.73524800	-0.78851300	3.77601200
C	1.19527000	-0.11394700	5.04676800
H	-0.17944500	-1.37196100	3.91027200
H	1.50261500	-1.42593400	3.33065600
H	0.41699700	0.53687900	5.45583700
H	1.43054800	-0.87991200	5.79180100
H	2.09624100	0.47937400	4.86780400

H	-0.71224200	2.32395600	2.18042900
Zn	0.33174800	-1.96212300	-0.55894000
O	-1.25411100	-2.59085200	-1.45412200
S	-2.55971100	-1.81622100	-1.19034000
C	-3.27064400	-2.83627700	0.19872300
O	-2.28242500	-0.49543800	-0.59647700
F	-3.56034900	-4.06553000	-0.23392800
F	-2.36672000	-2.92639700	1.18829200
F	-4.37721400	-2.26668000	0.67865800
O	-3.50180500	-1.90812400	-2.30293800
O	1.78341800	-3.19926600	-0.43723100
S	3.09090500	-2.85141100	0.29648600
C	4.15309900	-2.34949500	-1.15051000
O	3.72019900	-4.02924800	0.88578200
F	4.18029600	-3.31815400	-2.06813100
F	5.40407700	-2.10766800	-0.73639400
O	2.96117800	-1.62709500	1.10858300
F	3.65756800	-1.23544100	-1.70597000
C	-2.15265800	3.97966000	0.56456100
C	-3.19058800	2.97233400	0.15763200
C	-4.13148800	2.49811700	0.98786800
H	-2.28000300	4.91703800	0.00948700
H	-3.14229600	2.62709900	-0.87249500
H	-4.15505900	2.88711900	2.00730400
H	-2.25716500	4.22506600	1.62746500
C	-5.17175700	1.50463000	0.68434000
C	-5.17449200	0.73155800	-0.49209000
C	-6.20380600	1.29836100	1.61697600
C	-6.17693400	-0.20480500	-0.72533900
H	-4.36730900	0.82793800	-1.20766300
C	-7.21126400	0.36379000	1.38094800
H	-6.21385300	1.88016700	2.53569500
C	-7.20211600	-0.39112000	0.20714800
H	-6.13728400	-0.80969500	-1.62570100
H	-7.99915900	0.22296900	2.11547500
H	-7.97922600	-1.12768800	0.02491600

14. Spectral Characterization Data for the Substrates

Ethyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A1)

White solid, Mp: 109–111 °C, 75% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.40 (dd, $J = 8.4, 1.4$ Hz, 1H), 8.13 (d, $J = 8.4$ Hz, 2H), 7.69 (ddd, $J = 8.4, 6.8, 1.4$ Hz, 1H), 7.61 (ddd, $J = 8.1, 6.9, 1.3$ Hz, 1H), 7.50 – 7.44 (m, 4H), 7.36 (td, $J = 7.1, 6.1, 1.3$ Hz, 2H), 7.30 (dq, $J = 6.3, 3.0$ Hz, 4H), 6.82 (d, $J = 15.8$ Hz, 1H), 6.61 (dt, $J = 16.0, 6.1$ Hz, 1H), 4.84 (dd, $J = 6.1, 1.4$ Hz, 2H), 4.45 (q, $J = 7.1$ Hz, 2H), 4.19 (s, 2H), 1.44 (t, $J = 7.2$ Hz, 3H).

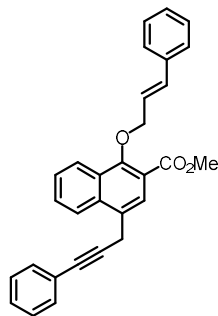
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Chloroform-*d*) δ 166.2, 156.2, 136.5, 134.6, 133.1, 131.6, 129.2, 128.6, 128.5, 128.2, 127.9, 126.6, 126.5, 126.4, 124.8, 124.5, 123.8, 123.5, 119.5, 86.8, 83.7, 76.6, 61.2, 23.5, 14.4.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{26}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 469.1774, Found 469.1781.

IR (neat) 2980, 1718, 1620, 1599, 1571, 1491, 1446, 1416, 1393, 1355, 1305, 1274, 1224, 1204, 1152, 1082, 1022, 961, 802, 754, 690, 639, 556, 529, 495, 432 cm^{-1} .

Methyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A2)

Colorless oil, 48% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.44 – 8.39 (m, 1H), 8.14 (dt, $J = 8.5, 0.9$ Hz, 1H), 8.11 (s, 1H), 7.70 (ddd, $J = 8.4, 6.9, 1.4$ Hz, 1H), 7.64 – 7.59 (m, 1H), 7.49 – 7.44 (m, 4H), 7.38 – 7.34 (m, 2H), 7.33 – 7.27 (m, 4H), 6.83 (d, $J = 15.8$ Hz, 1H), 6.62 (dt, $J = 15.9, 6.1$ Hz, 1H), 4.84 (dd, $J = 6.1, 1.4$ Hz, 2H), 4.19 (s, 2H), 3.99 (s, 3H).

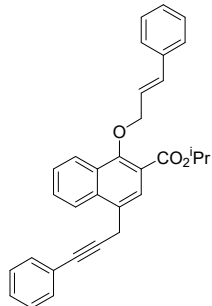
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Chloroform-*d*) δ 166.6, 156.3, 136.5, 134.6, 133.3, 131.6, 129.2, 128.6, 128.6, 128.5, 128.2, 127.9, 127.9, 126.6, 126.5, 126.4, 124.7, 124.5, 123.8, 123.5, 119.1, 86.8, 83.6, 76.7, 52.3, 23.5.

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{24}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 455.1618, Found 455.1620.

IR (neat) 3026, 2948, 1722, 1620, 1600, 1571, 1492, 1436, 1388, 1359, 1307, 1276, 1229, 1208, 1153, 1084, 1027, 965, 692, 529, 495 cm^{-1} .

Isopropyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A3)

White solid, Mp: 77–80 °C, 63% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.39 (d, $J = 8.4$ Hz, 1H), 8.14 – 8.08 (m, 2H), 7.68 (ddd, $J = 8.4, 6.8, 1.4$ Hz, 1H), 7.60 (ddd, $J = 8.1, 6.8, 1.2$ Hz, 1H), 7.46 (dt, $J = 5.9, 2.3$ Hz, 4H), 7.37 – 7.33 (m, 2H), 7.29 (p, $J = 3.8, 3.1$ Hz, 4H), 6.83 (d, $J = 15.9$ Hz, 1H), 6.61 (dt, $J = 15.9, 6.0$ Hz, 1H), 5.35 (hept, $J = 6.1$ Hz, 1H), 4.84 (dd, $J = 6.0, 1.5$ Hz, 2H), 4.19 (s, 2H), 1.42 (d, $J = 6.2$ Hz, 6H).

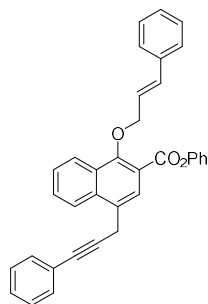
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.7, 156.0, 136.6, 134.5, 133.0, 131.6, 129.2, 128.6, 128.5, 128.4, 128.2, 127.9, 127.9, 126.6, 126.5, 126.4, 124.9, 124.5, 123.8, 123.5, 119.9, 86.8, 83.7, 76.5, 68.6, 23.5, 22.0.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 483.1931, Found 483.1948.

IR (neat) 3027, 2979, 2934, 1715, 1620, 1600, 1572, 1492, 1448, 1416, 1388, 1362, 1306, 1275, 1227, 1206, 1154, 1107, 1082, 1027, 963, 835, 691, 529, 496, 425 cm^{-1} .

Phenyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A4)

White solid, Mp: 96–99 °C, 60% yield.



$^1\text{H NMR}$ (600 MHz, Chloroform-*d*) δ 8.46 (t, J = 6.5 Hz, 1H), 8.32 (q, J = 3.0 Hz, 1H), 8.18 (d, J = 8.3 Hz, 1H), 7.74 (t, J = 7.6 Hz, 1H), 7.67 (d, J = 7.6 Hz, 1H), 7.46 (h, J = 3.2 Hz, 4H), 7.42 (t, J = 5.8 Hz, 2H), 7.39 – 7.27 (m, 9H), 6.81 (dd, J = 15.9, 4.6 Hz, 1H), 6.67 – 6.60 (m, 1H), 4.93 (d, J = 5.4 Hz, 2H), 4.24 (s, 2H).

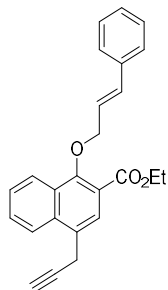
$^{13}\text{C}\{^1\text{H}\}$ NMR (151 MHz, Chloroform-*d*) δ 164.3, 157.4, 150.9, 136.4, 135.0, 133.6, 131.6, 129.5, 129.0, 128.8, 128.5, 128.2, 127.9, 126.7, 126.6, 126.5, 125.9, 124.7, 124.6, 123.9, 123.4, 121.8, 118.4, 86.7, 83.9, 77.0, 23.6.

HRMS (ESI) Calculated for $\text{C}_{35}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 517.1774, Found 517.1780.

IR (neat) 3059, 1738, 1620, 1595, 1571, 1491, 1452, 1415, 1388, 1358, 1306, 1274, 1191, 1160, 1140, 1069, 1025, 961, 897, 837, 756, 735, 689, 528, 499, 434 cm^{-1} .

Ethyl 1-(cinnamyloxy)-4-(prop-2-yn-1-yl)-2-naphthoate (A5)

White solid, Mp: 81–84 °C, 82% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.39 (dd, J = 8.3, 1.3 Hz, 1H), 8.04 (dt, J = 8.6, 0.9 Hz, 1H), 8.02 (s, 1H), 7.68 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H), 7.48 – 7.44 (m, 2H), 7.38 – 7.33 (m, 2H), 7.31 – 7.26 (m, 1H), 6.81 (d, J = 15.9 Hz, 1H), 6.60 (dt, J = 15.9, 6.1 Hz, 1H), 4.82 (dd, J = 6.1, 1.4 Hz, 2H), 4.45 (q, J = 7.1 Hz, 2H), 3.97 (dd, J = 2.7, 0.9 Hz, 2H), 2.28 (t, J = 2.7 Hz, 1H), 1.44 (t, J = 7.1 Hz, 3H).

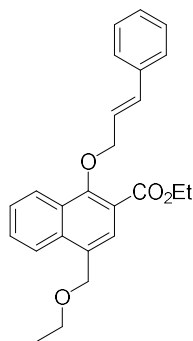
$^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 166.2, 156.2, 136.5, 134.4, 133.1, 128.6, 128.6, 127.9, 127.8, 126.6, 126.5, 124.8, 124.6, 123.7, 119.5, 81.22, 76.6, 71.5, 61.2, 22.5, 14.4.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{22}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 393.1461, Found 393.1465.

IR (neat) 3295, 2981, 1719, 1621, 1602, 1572, 1508, 1450, 1416, 1394, 1356, 1302, 1277, 1206, 1155, 1084, 1021, 965, 890, 765, 693, 645, 496 cm^{-1} .

Ethyl 1-(cinnamyloxy)-4-(ethoxymethyl)-2-naphthoate (A6)

White solid, Mp: 39–42 °C, 55% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.38 – 8.33 (m, 1H), 8.16 – 8.11 (m, 1H), 7.91 (s, 1H), 7.64 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.57 (ddd, J = 8.2, 6.8, 1.3 Hz, 1H), 7.46 – 7.42 (m, 2H), 7.36 – 7.31 (m, 2H), 7.28 – 7.24 (m, 1H), 6.80 (d, J = 15.8 Hz, 1H), 6.58 (dt, J = 15.9, 6.1 Hz, 1H), 4.90 (s, 2H), 4.81 (dd, J = 6.1, 1.4 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 3.63 (q, J = 7.0 Hz, 2H), 1.43 (t, J = 7.1 Hz, 3H), 1.27 (t, J = 7.0 Hz, 3H).

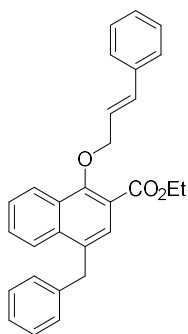
$^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 166.2, 156.9, 136.5, 135.0, 133.1, 129.9, 129.2, 128.5, 127.9, 127.4, 126.6, 126.4, 124.7, 124.4, 124.2, 119.1, 76.6, 70.9, 65.9, 61.2, 15.2, 14.3.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{26}\text{O}_4$ ($[\text{M}] + \text{Na}^+$) = 413.1723, Found 413.1724.

IR (neat) 2975, 2864, 1719, 1620, 1571, 1507, 1449, 1419, 1394, 1353, 1277, 1220, 1154, 1087, 1021, 963, 765, 692, 496, 435 cm^{-1} .

Ethyl 4-benzyl-1-(cinnamyloxy)-2-naphthoate (A7)

Colorless oil, 91% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.37 (dd, $J = 6.3, 3.6$ Hz, 1H), 7.95 (dt, $J = 6.9, 3.4$ Hz, 1H), 7.77 (s, 1H), 7.54 (dt, $J = 6.5, 2.9$ Hz, 2H), 7.48 – 7.44 (m, 2H), 7.35 (t, $J = 7.3$ Hz, 2H), 7.30 – 7.25 (m, 3H), 7.20 (d, $J = 7.4$ Hz, 3H), 6.82 (d, $J = 15.8$ Hz, 1H), 6.61 (dt, $J = 15.9, 6.0$ Hz, 1H), 4.84 (dd, $J = 6.0, 1.4$ Hz, 2H), 4.47 – 4.40 (m, 4H), 1.44 (d, $J = 7.1$ Hz, 3H).

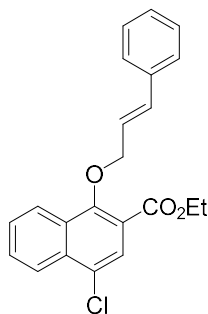
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Chloroform-*d*) δ 166.4, 155.7, 140.2, 136.5, 135.3, 133.0, 132.4, 129.3, 128.6, 128.5, 128.5, 128.3, 127.9, 127.9, 126.6, 126.2, 126.1, 124.9, 124.7, 124.4, 119.5, 76.5, 61.2, 38.8, 14.34.

HRMS (ESI) Calculated for $\text{C}_{29}\text{H}_{26}\text{O}_3$ ($[\text{M}+\text{Na}^+]$) = 445.1774, Found 445.1775.

IR (neat) 3026, 2979, 1718, 1619, 1600, 1571, 1494, 1450, 1416, 1393, 1355, 1276, 1225, 1205, 1152, 1081, 1022, 962, 866, 802, 765, 730, 694, 559, 495, 459 cm^{-1} .

Ethyl 4-chloro-1-(cinnamyloxy)-2-naphthoate (A8)

White solid, Mp: 66–69 °C, 84% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.37 (dt, $J = 8.3, 1.1$ Hz, 1H), 8.26 (dt, $J = 8.4, 0.9$ Hz, 1H), 8.02 (s, 1H), 7.72 (ddd, $J = 8.4, 6.8, 1.3$ Hz, 1H), 7.66 – 7.61 (m, 1H), 7.46 – 7.43 (m, 2H), 7.37 – 7.33 (m, 2H), 7.32 – 7.26 (m, 1H), 6.80 (d, $J = 15.9$ Hz, 1H), 6.58 (dt, $J = 15.9, 6.1$ Hz, 1H), 4.83 (dd, $J = 6.1, 1.4$ Hz, 2H), 4.47 – 4.42 (m, 2H), 1.44 (t, $J = 7.1$ Hz, 3H).

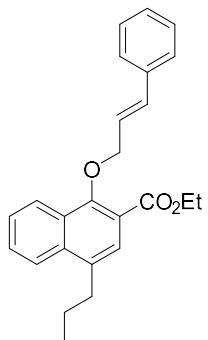
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Chloroform-*d*) δ 165.1, 155.8, 136.4, 133.6, 133.5, 130.0, 129.4, 128.6, 128.0, 127.3, 127.1, 126.7, 126.5, 124.7, 124.4, 124.3, 120.1, 76.8, 61.5, 14.3.

HRMS (ESI) Calculated for $\text{C}_{22}\text{H}_{21}\text{ClO}_3$ ($[\text{M}+\text{Na}^+]$) = 389.0915, Found 389.0913.

IR (neat) 2981, 1724, 1619, 1591, 1497, 1449, 1415, 1350, 1329, 1269, 1223, 1203, 1149, 1084, 1021, 966, 925, 801, 766, 732, 693, 532, 496 cm^{-1} .

Ethyl 1-(cinnamyloxy)-4-propyl-2-naphthoate (A9)

White solid, Mp: 31–34 °C, 66% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.37 (dd, $J = 8.3, 1.4$ Hz, 1H), 8.04 (dd, $J = 8.5, 1.6$ Hz, 1H), 7.73 (s, 1H), 7.64 – 7.54 (m, 2H), 7.48 – 7.44 (m, 2H), 7.38 – 7.33 (m, 2H), 7.31 – 7.26 (m, 1H), 6.82 (d, $J = 14.3$ Hz, 1H), 6.61 (dt, $J = 15.9, 6.0$ Hz, 1H), 4.81 (dd, $J = 6.0, 1.4$ Hz, 2H), 4.45 (q, $J = 7.1$ Hz, 2H), 3.06 – 3.00 (m, 2H), 1.84 – 1.75 (m, 2H), 1.45 (t, $J = 7.1$ Hz, 3H), 1.06 (t, $J = 7.3$ Hz, 3H).

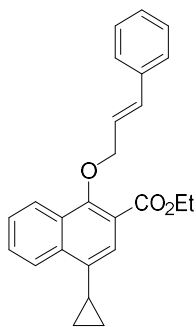
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Chloroform-*d*) δ 166.6, 155.0, 136.6, 135.1, 134.7, 132.9, 129.1, 128.6, 128.0, 127.8, 126.6, 126.2, 126.0, 125.0, 124.4, 124.2, 119.4, 76.4, 61.1, 34.8, 23.8, 14.4, 14.2.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{26}\text{O}_3$ ($[\text{M}+\text{Na}^+]$) = 397.1774, Found 397.1773.

IR (neat) 2959, 2932, 2870, 1619, 1600, 1572, 1495, 1451, 1416, 1394, 1357, 1273, 1208, 1153, 1024, 964, 766, 693, 496, 434 cm^{-1} .

Ethyl 1-(cinnamyloxy)-4-cyclopropyl-2-naphthoate (A10)

Colorless oil, 84% yield.



¹H NMR (400 MHz, Chloroform-*d*) δ 8.43 (dt, *J* = 8.5, 0.9 Hz, 1H), 8.39 – 8.34 (m, 1H), 7.72 – 7.69 (m, 1H), 7.69 – 7.64 (m, 1H), 7.60 (ddd, *J* = 8.1, 6.8, 1.3 Hz, 1H), 7.49 – 7.45 (m, 2H), 7.39 – 7.34 (m, 2H), 7.31 – 7.26 (m, 1H), 6.83 (d, *J* = 15.9 Hz, 1H), 6.61 (dt, *J* = 15.9, 6.0 Hz, 1H), 4.82 (dd, *J* = 6.0, 1.4 Hz, 2H), 4.46 (q, *J* = 7.1 Hz, 2H), 2.29 (dddd, *J* = 8.4, 7.3, 4.2, 2.7 Hz, 1H), 1.45 (t, *J* = 7.1 Hz, 3H), 1.12 – 1.06 (m, 2H), 0.85 – 0.79 (m, 2H).

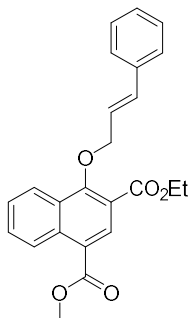
¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.6, 155.2, 136.6, 136.5, 135.00, 132.9, 128.7, 128.5, 128.1, 127.8, 126.6, 126.2, 124.9, 124.6, 124.6, 124.2, 119.4, 76.4, 61.1, 14.4, 13.0, 6.2.

HRMS (ESI) Calculated for C₂₅H₂₄O₃ ([M]⁺+Na⁺) = 395.1618, Found 395.1617.

IR (neat) 2980, 1702, 1599, 1571, 1496, 1448, 1404, 1372, 1332, 1268, 1225, 1205, 1151, 1081, 1021, 961, 896, 874, 801, 766, 750, 691, 634, 590, 495, 437 cm⁻¹.

3-ethyl 1-methyl 4-(cinnamyloxy)naphthalene-1,3-dicarboxylate (A11)

White solid, Mp: 73–76 °C, 36% yield.



¹H NMR (400 MHz, Chloroform-*d*) δ 9.00 (d, *J* = 8.5 Hz, 1H), 8.66 (s, 1H), 8.43 – 8.38 (m, 1H), 7.72 (ddd, *J* = 8.5, 6.8, 1.4 Hz, 1H), 7.61 (ddd, *J* = 8.4, 6.8, 1.2 Hz, 1H), 7.46 – 7.42 (m, 2H), 7.38 – 7.32 (m, 2H), 7.31 – 7.26 (m, 1H), 6.79 (d, *J* = 15.9 Hz, 1H), 6.56 (dt, *J* = 15.9, 6.1 Hz, 1H), 4.87 (dd, *J* = 6.2, 1.4 Hz, 2H), 4.47 (q, *J* = 7.1 Hz, 2H), 4.01 (s, 3H), 1.45 (t, *J* = 7.1 Hz, 3H).

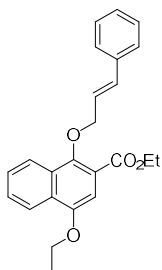
¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 167.1, 165.6, 160.3, 136.3, 134.5, 133.8, 132.1, 130.0, 129.4, 128.6, 128.1, 126.9, 126.7, 126.1, 124.2, 124.1, 122.7, 118.7, 77.0, 61.5, 52.2, 14.4.

HRMS (ESI) Calculated for C₂₂H₂₄O₅ ([M]⁺+Na⁺) = 413.1359, Found 413.1362.

IR (neat) 2951, 1617, 1567, 1505, 1448, 1416, 1356, 1283, 1236, 1147, 1086, 1025, 963, 793, 770, 749, 693 cm⁻¹.

Ethyl 1-(cinnamyloxy)-4-ethoxy-2-naphthoate (A12)

White solid, Mp: 92-94 °C, 76% yield.



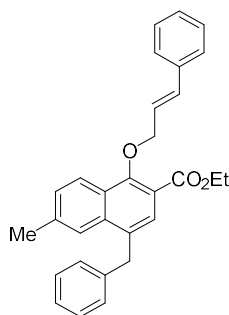
¹H NMR (600 MHz, Chloroform-*d*) δ 8.33 – 8.29 (m, 1H), 8.27 (dd, *J* = 7.0, 2.7 Hz, 1H), 7.61 – 7.57 (m, 2H), 7.46 (d, *J* = 7.3 Hz, 2H), 7.35 (t, *J* = 7.5 Hz, 2H), 7.28 (m, 1H), 7.19 (s, 1H), 6.82 (d, *J* = 15.9 Hz, 1H), 6.60 (m, 1H), 4.78 (d, *J* = 5.6 Hz, 2H), 4.46 (q, *J* = 7.0 Hz, 2H), 4.25 (q, *J* = 7.0 Hz, 2H), 1.56 (t, *J* = 7.0 Hz, 3H), 1.45 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (151 MHz, Chloroform-*d*) δ 166.6, 150.8, 150.1, 136.6, 132.7, 129.4, 128.8, 128.6, 127.8, 127.6, 127.0, 126.6, 125.1, 123.5, 122.4, 119.6, 104.4, 76.3, 64.0, 61.2, 14.8, 14.4.

HRMS (ESI) Calculated for C₂₄H₂₄O₄ ([M]⁺+Na⁺) = 399.1567, Found 399.1570.

IR (neat) 2981, 1701, 1595, 1453, 1349, 1272, 1228, 1157, 1101, 965, 863, 765, 693, 498 cm⁻¹.

Ethyl 4-benzyl-1-(cinnamyloxy)-6-methyl-2-naphthoate (A13)



White solid, Mp: 60–63°C, 67% yield.

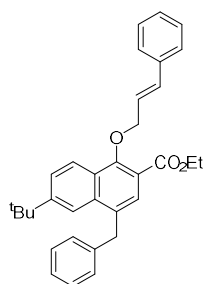
¹H NMR (400 MHz, Chloroform-*d*) δ 8.27 (d, *J* = 8.6 Hz, 1H), 7.74 (d, *J* = 2.5 Hz, 2H), 7.46 (d, *J* = 7.1 Hz, 2H), 7.40 – 7.33 (m, 3H), 7.28 (ddd, *J* = 9.0, 6.0, 2.2 Hz, 3H), 7.21 (d, *J* = 7.5 Hz, 3H), 6.82 (d, *J* = 15.9 Hz, 1H), 6.61 (dt, *J* = 15.9, 6.0 Hz, 1H), 4.82 (dd, *J* = 6.0, 1.4 Hz, 2H), 4.43 (dd, *J* = 14.1, 6.9 Hz, 4H), 2.48 (s, 3H), 1.42 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.5, 155.8, 140.3, 138.5, 136.6, 135.6, 130.0, 131.7, 128.6, 128.5, 128.4, 128.4, 128.1, 127.8, 127.4, 126.6, 126.1, 125.0, 124.3, 123.8, 118.5, 76.5, 61.1, 38.6, 22.1, 14.4.

HRMS (ESI) Calculated for C₃₀H₂₈O₃ ([M]+Na⁺) = 459.1931, Found 459.1930.

IR (neat) 3026, 2979, 1718, 1624, 1602, 1573, 1495, 1449, 1412, 1369, 1351, 1280, 1199, 1154, 1086, 1026, 964, 829, 797, 733, 695, 589, 558, 509, 434 cm⁻¹.

Ethyl 4-benzyl-6-(tert-butyl)-1-(cinnamyloxy)-2-naphthoate (A14)



Colorless oil, 85% yield.

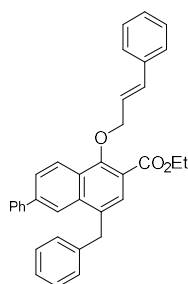
¹H NMR (400 MHz, Chloroform-*d*) δ 8.27 (d, *J* = 8.9 Hz, 1H), 7.89 (d, *J* = 1.8 Hz, 1H), 7.78 (s, 1H), 7.60 (dd, *J* = 8.9, 1.9 Hz, 1H), 7.45 (d, *J* = 6.8 Hz, 2H), 7.34 (m, 2H), 7.26 (m, 5H), 7.17 (m, 1H), 6.81 (d, *J* = 15.8 Hz, 1H), 6.60 (dt, *J* = 15.9, 6.0 Hz, 1H), 4.81 (d, *J* = 4.9 Hz, 2H), 4.46 – 4.37 (m, 4H), 1.42 (t, *J* = 7.1 Hz, 3H), 1.32 (s, 9H).

¹³C NMR (101 MHz, Chloroform-*d*) δ 166.5, 155.8, 151.1, 140.5, 136.6, 135.2, 132.9, 132.6, 128.6, 128.6, 128.4, 127.9, 127.8, 127.4, 126.6, 126.1, 125.0, 125.0, 124.1, 120.2, 118.6, 61.1, 39.3, 35.2, 31.1, 14.4.

HRMS (ESI) Calculated for C₃₁H₂₆O₃ ([M]+Na⁺) = 501.2400, Found 501.2401.

IR (neat) 3028, 2960, 1715, 1622, 1573, 1491, 1452, 1405, 1358, 1286, 1221, 1116, 1080, 1024, 964, 838, 803, 732, 695, 618, 536, 497 cm⁻¹.

Ethyl 4-benzyl-1-(cinnamyloxy)-6-phenyl-2-naphthoate (A15)



Colorless oil, 82% yield.

¹H NMR (600 MHz, Chloroform-*d*) δ 8.42 (d, *J* = 8.6 Hz, 1H), 8.15 (s, 1H), 7.80 – 7.77 (m, 2H), 7.57 (d, *J* = 7.9 Hz, 2H), 7.46 (m, 4H), 7.39 – 7.33 (m, 3H), 7.26 (m, 5H), 7.20 (t, *J* = 6.9 Hz, 1H), 6.83 (d, *J* = 15.9 Hz, 1H), 6.62 (m, 1H), 4.85 (d, *J* = 6.0 Hz, 2H), 4.45 (d, *J* = 15.1 Hz, 4H), 1.43 (t, *J* = 7.0 Hz, 3H).

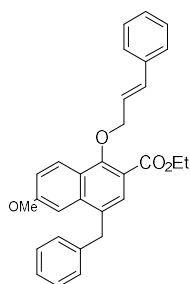
¹³C NMR (151 MHz, Chloroform-*d*) δ 166.4, 155.8, 140.9, 140.7, 140.3, 136.6, 135.6, 133.1, 132.7, 128.9, 128.6, 128.6, 128.5, 128.4, 128.4, 127.9, 127.8, 127.5, 126.7, 126.2, 125.9, 125.1, 124.9, 122.8, 119.3, 76.6, 61.2,

39.0, 14.4.

HRMS (ESI) Calculated for C₃₁H₂₆O₃ ([M]+Na⁺) = 521.2087, Found 521.2097.

IR (neat) 3028, 2981, 1716, 1618, 1571, 1492, 1452, 1407, 1351, 1284, 1230, 1196, 1091, 1024, 964, 839, 803, 760, 737, 697, 558 cm⁻¹.

Ethyl 4-benzyl-1-(cinnamyloxy)-6-methoxy-2-naphthoate (A16)



White solid, Mp: 85–87 °C, 54% yield.

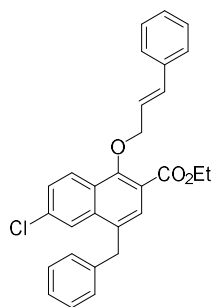
¹H NMR (600 MHz, Chloroform-*d*) δ 8.28 (d, *J* = 8.9 Hz, 1H), 7.82 (d, *J* = 2.4 Hz, 1H), 7.46 (d, *J* = 7.4 Hz, 2H), 7.36 (t, *J* = 7.6 Hz, 2H), 7.29 (m, 3H), 7.24 (m, 2H), 7.22 – 7.15 (m, 3H), 6.82 (d, *J* = 15.8 Hz, 1H), 6.61 (m, 1H), 4.83 (d, *J* = 5.3 Hz, 2H), 4.44 (q, *J* = 7.2 Hz, 2H), 4.37 (s, 2H), 3.79 (s, 3H), 1.44 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (151 MHz, Chloroform-*d*) δ 166.4 , 159.5 , 156.2 , 140.2 , 137.0 , 136.5 , 133.0 , 131.0 , 128.9 , 128.6 , 128.5 , 128.5 , 127.8 , 126.6 , 126.2 , 126.2 , 124.9 , 124.4 , 118.4 , 117.0 , 103.7 , 76.5 , 61.0 , 55.2 , 39.3 , 14.4 .

HRMS (ESI) Calculated for C₃₀H₂₅O₄ ([M]⁺+Na⁺) = 475.1880, Found 475.1890.

IR (neat) 2979, 1714, 1619, 1577, 1500, 1468, 1420, 1350, 1274, 1231, 1200, 1089, 1025, 965, 743, 699, 493 cm⁻¹.

Ethyl 4-benzyl-6-chloro-1-(cinnamyloxy)-2-naphthoate (A17)



White solid, Mp: 69–72 °C, 70% yield.

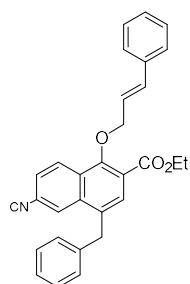
¹H NMR (400 MHz, Chloroform-*d*) δ 8.31 (d, *J* = 9.0 Hz, 1H), 7.95 (d, *J* = 2.1 Hz, 1H), 7.78 (s, 1H), 7.49 – 7.43 (m, 3H), 7.36 (dd, *J* = 8.3, 6.5 Hz, 2H), 7.30 (dd, *J* = 7.3, 2.3 Hz, 3H), 7.25 – 7.19 (m, 3H), 6.80 (d, *J* = 15.7 Hz, 1H), 6.58 (dt, *J* = 15.9, 6.1 Hz, 1H), 4.82 (dd, *J* = 6.1, 1.4 Hz, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 4.37 (s, 2H), 1.43 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.1 , 155.6 , 139.6 , 136.4 , 136.0 , 134.8 , 133.4 , 131.7 , 129.2 , 128.6 , 128.5 , 128.0 , 127.7 , 127.1 , 126.6 , 126.4 , 126.2 , 124.5 , 123.8 , 119.6 , 76.7 , 61.3 , 38.5 , 14.3 .

HRMS (ESI) Calculated for C₂₉H₂₅ClO₃ ([M]⁺+Na⁺) = 479.1384, Found 479.1389.

IR (neat) 3026, 2980, 1718, 1613, 1568, 1492, 1448, 1408, 1368, 1346, 1270, 1227, 1202, 1150, 1078, 1024, 961, 856, 829, 793, 730, 694, 621, 592, 555, 497, 459, 430 cm⁻¹.

Ethyl 4-benzyl-1-(cinnamyloxy)-6-cyano-2-naphthoate (A18)



White solid, Mp: 84–86 °C, 73% yield.

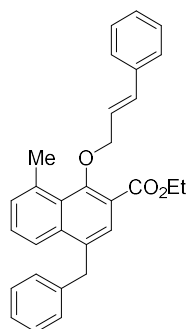
¹H NMR (600 MHz, Chloroform-*d*) δ 8.46 (d, *J* = 8.7 Hz, 1H), 8.33 (s, 1H), 7.85 (s, 1H), 7.67 (d, *J* = 8.7 Hz, 1H), 7.44 (d, *J* = 7.5 Hz, 2H), 7.36 (t, *J* = 7.5 Hz, 2H), 7.30 (m, 3H), 7.23 (t, *J* = 7.4 Hz, 1H), 7.17 (d, *J* = 7.5 Hz, 2H), 6.79 (d, *J* = 15.9 Hz, 1H), 6.55 (m, 1H), 4.83 (d, *J* = 6.2 Hz, 2H), 4.46 (q, *J* = 7.1 Hz, 2H), 4.42 (s, 2H), 1.44 (t, *J* = 7.2 Hz, 3H).

¹³C NMR (151 MHz, Chloroform-*d*) δ 165.8 , 155.0 , 139.1 , 136.2 , 134.1 , 133.8 , 133.0 , 131.1 , 130.6 , 129.7 , 128.7 , 128.6 , 128.4 , 128.1 , 126.8 , 126.6 , 125.8 , 124.1 , 122.4 , 118.9 , 111.7 , 76.9 , 61.6 , 38.5 , 14.3 .

HRMS (ESI) Calculated for C₃₀H₂₅NO₃ ([M]⁺+Na⁺) = 470.1727, Found 470.1734.

IR (neat) 3029, 2982, 2229, 1717, 1598, 1572, 1498, 1451, 1410, 1350, 1275, 1233, 1200, 1086, 1022, 963, 897, 838, 801, 738, 698, 540 cm⁻¹.

Ethyl 4-benzyl-1-(cinnamyloxy)-8-methyl-2-naphthoate (A19)



Colorless oil, 40% yield.

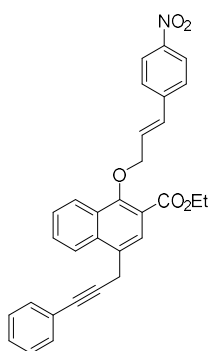
¹H NMR (400 MHz, Chloroform-*d*) δ 7.81 (d, *J* = 8.4 Hz, 1H), 7.72 (s, 1H), 7.47 – 7.43 (m, 2H), 7.40 – 7.33 (m, 3H), 7.31 – 7.26 (m, 3H), 7.25 (s, 1H), 7.21 – 7.17 (m, 3H), 6.78 (d, *J* = 16.0 Hz, 1H), 6.55 (dt, *J* = 15.9, 5.9 Hz, 1H), 4.66 (dd, *J* = 5.9, 1.5 Hz, 2H), 4.46 – 4.39 (m, 4H), 2.98 (s, 3H), 1.41 (t, *J* = 7.2 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 167.0, 157.3, 140.3, 136.5, 132.9, 132.6, 129.9, 128.7, 128.6, 128.5, 128.4, 128.1, 127.8, 127.7, 126.6, 126.1, 124.7, 123.1, 120.8, 77.3, 61.2, 39.5, 24.8, 14.3.

HRMS (ESI) Calculated for C₃₀H₂₈O₃ ([M]⁺+Na⁺) = 459.1931, Found 459.1929.

IR (neat) 3026, 2978, 1719, 1605, 1570, 1494, 1451, 1413, 1370, 1351, 1264, 1236, 1205, 1135, 1111, 1069, 1024, 963, 821, 762, 731, 694, 620, 576, 554, 521, 494, 458 cm⁻¹.

Ethyl (E)-1-(((4-nitrophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A20)



White solid, Mp: 125–128 °C, 55% yield.

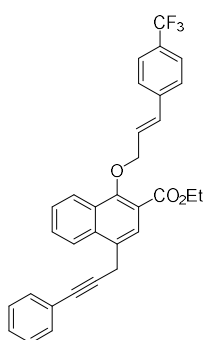
¹H NMR (400 MHz, Chloroform-*d*) δ 8.37 – 8.33 (m, 1H), 8.25 – 8.18 (m, 2H), 8.16 – 8.10 (m, 2H), 7.73 – 7.67 (m, 1H), 7.61 (dd, *J* = 15.1, 8.1 Hz, 3H), 7.45 (dd, *J* = 6.7, 3.0 Hz, 2H), 7.32 – 7.26 (m, 3H), 6.95 (d, *J* = 16.0 Hz, 1H), 6.77 (dt, *J* = 16.0, 5.5 Hz, 1H), 4.88 (dd, *J* = 5.4, 1.5 Hz, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 4.19 (s, 2H), 1.43 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 165.9, 155.9, 147.1, 143.1, 134.6, 131.6, 130.1, 129.9, 129.0, 128.8, 128.7, 128.2, 128.0, 127.1, 126.6, 126.4, 124.2, 124.0, 123.9, 123.4, 119.4, 86.7, 83.8, 75.6, 61.2, 23.5, 14.4.

HRMS (ESI) Calculated for C₃₁H₂₅NO₅ ([M]⁺+Na⁺) = 514.1625, Found 514.1633.

IR (neat) 2981, 1719, 1620, 1598, 1572, 1515, 1491, 1444, 1394, 1341, 1275, 1227, 1154, 1087, 1023, 970, 861, 759, 528 cm⁻¹.

Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-(((4-(trifluoromethyl)phenyl)allyl)oxy)-2-naphthoate (A21)



White solid, Mp: 129–132 °C, 66% yield.

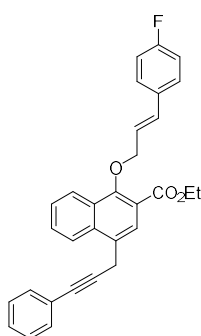
¹H NMR (400 MHz, Chloroform-*d*) δ 8.38 (dd, *J* = 8.4, 1.3 Hz, 1H), 8.13 (d, *J* = 7.8 Hz, 2H), 7.69 (ddd, *J* = 8.4, 6.8, 1.4 Hz, 1H), 7.66 – 7.58 (m, 3H), 7.55 (d, *J* = 8.2 Hz, 2H), 7.49 – 7.41 (m, 2H), 7.30 (qd, *J* = 4.0, 2.3 Hz, 3H), 6.88 (d, *J* = 15.8 Hz, 1H), 6.70 (dt, *J* = 15.9, 5.7 Hz, 1H), 4.86 (dd, *J* = 5.7, 1.5 Hz, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 4.19 (s, 2H), 1.43 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.0, 156.0, 140.1, 134.6, 131.6, 131.2, 129.7, 129.4, 129.1, 128.7, 128.6, 128.2, 127.9, 127.6, 126.8, 126.5, 126.5, 125.6, 125.6, 125.5, 125.5, 124.3, 123.9, 123.4, 122.8, 119.5, 86.7, 83.8, 76.0, 61.2, 23.5, 14.3.

HRMS (ESI) Calculated for C₃₂H₂₅F₃O₃ ([M]⁺+Na⁺) = 537.1648, Found 537.1653.

¹⁹F NMR (377 MHz, Chloroform-*d*) δ -62.48.

IR (neat) 2982, 1719, 1618, 1572, 1491, 1445, 1416, 1394, 1358, 1325, 1275, 1228, 1161, 1120, 1087, 1067, 1018, 969, 858, 758, 692, 597 cm⁻¹.

Ethyl (E)-1-((3-(4-fluorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A22)

White solid, Mp: 80–83 °C, 28% yield.

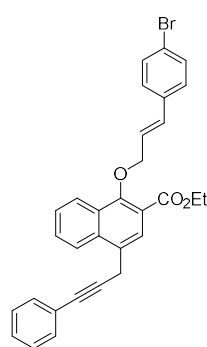
¹H NMR (400 MHz, Chloroform-d) δ 8.39 (dd, J = 8.4, 1.3 Hz, 1H), 8.12 (d, J = 9.5 Hz, 2H), 7.69 (ddd, J = 8.3, 6.8, 1.4 Hz, 1H), 7.61 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H), 7.43 (dtd, J = 14.2, 5.3, 3.0 Hz, 4H), 7.30 (q, J = 2.8 Hz, 3H), 7.04 (t, J = 8.7 Hz, 2H), 6.78 (d, J = 15.9 Hz, 1H), 6.52 (dt, J = 15.9, 6.1 Hz, 1H), 4.82 (dd, J = 6.1, 1.4 Hz, 2H), 4.45 (q, J = 7.1 Hz, 2H), 4.19 (s, 2H), 1.44 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.1, 162.5 (d, ¹J_{FC} = 247.0 Hz), 156.1, 134.6, 132.7, 132.0, 131.6, 129.2, 128.6, 128.5, 128.2 (d, ³J_{FC} = 6.7 Hz), 127.9, 126.5, 126.4, 124.6 (d, ⁴J_{FC} = 2.2 Hz), 124.5, 123.8, 123.5, 119.5, 115.5 (d, ²J_{FC} = 21.7 Hz), 86.8, 83.7, 76.5, 61.2, 23.5, 14.3.

¹⁹F NMR (377 MHz, Chloroform-d) δ -113.98.

HRMS (ESI) Calculated for C₃₁H₂₅FO₃ ([M]⁺+Na⁺) = 487.1680, Found 487.1684.

IR (neat) 2982, 1720, 1621, 1600, 1571, 1508, 1445, 1394, 1356, 1306, 1275, 1155, 1085, 1023, 965, 847, 758, 692, 525 cm⁻¹.

Ethyl (E)-1-((3-(4-bromophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A23)

White solid, Mp: 123–126 °C, 31% yield.

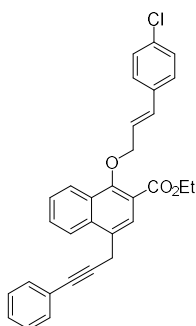
¹H NMR (400 MHz, Chloroform-d) δ 8.37 (dd, J = 8.4, 1.3 Hz, 1H), 8.17 – 8.06 (m, 2H), 7.69 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H), 7.50 – 7.42 (m, 4H), 7.34 – 7.27 (m, 5H), 6.77 (d, J = 15.9 Hz, 1H), 6.59 (dt, J = 15.9, 5.9 Hz, 1H), 4.82 (dd, J = 5.9, 1.4 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 4.19 (s, 2H), 1.43 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.1, 156.1, 135.5, 134.6, 131.8, 131.7, 131.6, 129.1, 128.6, 128.6, 128.2, 128.2, 127.9, 126.5, 125.7, 124.4, 123.9, 123.5, 121.7, 119.5, 86.8, 83.8, 76.3, 61.2, 23.5, 14.4.

HRMS (ESI) Calculated for C₃₁H₂₅BrO₃ ([M]⁺+Na⁺) = 547.0879, Found 547.0887.

HRMS (ESI) Calculated for C₃₁H₂₅⁸¹BrO₃ ([M]⁺+Na⁺) = 549.0859, Found 549.0865.

IR (neat) 2980, 1620, 1600, 1571, 1508, 1488, 1444, 1394, 1356, 1306, 1275, 1226, 1153, 1084, 1009, 965, 835, 758, 692, 528, 499 cm⁻¹.

Ethyl (E)-1-((3-(4-chlorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A24)

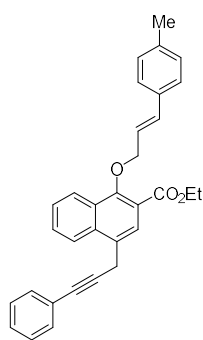
White solid, Mp: 119–122 °C, 39% yield.

¹H NMR (400 MHz, Chloroform-d) δ 8.38 (dd, J = 8.4, 1.3 Hz, 1H), 8.12 (d, J = 9.2 Hz, 2H), 7.72 – 7.66 (m, 1H), 7.61 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H), 7.49 – 7.43 (m, 2H), 7.38 (d, J = 8.5 Hz, 2H), 7.34 – 7.27 (m, 5H), 6.78 (d, J = 15.9 Hz, 1H), 6.58 (dt, J = 15.9, 6.0 Hz, 1H), 4.82 (dd, J = 5.9, 1.4 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 4.19 (s, 2H), 1.43 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.1, 156.1, 135.1, 134.6, 133.5, 131.8, 131.6, 129.1, 128.8, 128.6, 128.6, 128.2, 127.9, 127.8, 126.5, 125.5, 124.4, 123.8, 123.5, 119.5, 86.8, 83.8, 76.3, 61.2, 23.5, 14.3.

HRMS (ESI) Calculated for C₃₁H₂₅ClO₃ ([M]⁺+Na⁺) = 503.1384, Found 503.1389.

IR (neat) 2980, 1620, 1600, 1571, 1490, 1444, 1394, 1358, 1306, 1275, 1226, 1153, 1087, 1016, 965, 851, 692, 528, 504 cm⁻¹.

Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(p-tolyl)allyl)oxy)-2-naphthoate (A25)

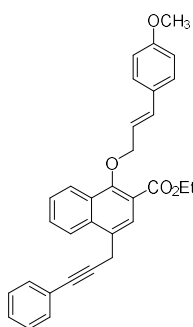
White solid, Mp: 90–93 °C, 30% yield.

¹H NMR (400 MHz, Chloroform-d) δ 8.40 (dd, J = 8.4, 1.4 Hz, 1H), 8.15 – 8.08 (m, 2H), 7.68 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (ddd, J = 8.2, 6.8, 1.2 Hz, 1H), 7.45 (dd, J = 6.6, 3.0 Hz, 2H), 7.35 (d, J = 7.9 Hz, 2H), 7.32 – 7.27 (m, 3H), 7.16 (d, J = 8.0 Hz, 2H), 6.77 (d, J = 15.9 Hz, 1H), 6.55 (dt, J = 15.9, 6.2 Hz, 1H), 4.82 (dd, J = 6.2, 1.4 Hz, 2H), 4.45 (q, J = 7.1 Hz, 2H), 4.19 (s, 2H), 2.36 (s, 3H), 1.44 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.2, 156.2, 137.8, 134.6, 133.7, 133.3, 131.6, 129.3, 129.2, 128.6, 128.4, 128.2, 127.9, 126.6, 126.5, 126.4, 124.6, 123.8, 123.7, 123.5, 119.5, 86.8, 83.7, 76.8, 61.2, 23.5, 21.2, 14.4.

HRMS (ESI) Calculated for C₃₂H₂₈O₃ ([M]⁺+Na⁺) = 483.1931, Found 483.1934.

IR (neat) 2980, 1620, 1601, 1571, 1511, 1490, 1445, 1416, 1394, 1356, 1306, 1275, 1226, 1153, 1084, 1023, 966, 832, 756, 692, 525, 502 cm⁻¹.

Ethyl (E)-1-((3-(4-methoxyphenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A26)

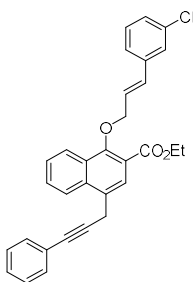
White solid, Mp: 97–100 °C, 36% yield.

¹H NMR (600 MHz, Chloroform-d) δ 8.10 (dd, J = 7.8, 1.4 Hz, 1H), 7.65 (td, J = 7.5, 1.5 Hz, 1H), 7.54 (dd, J = 8.0, 1.0 Hz, 1H), 7.42 (td, J = 7.5, 1.1 Hz, 1H), 7.34 – 7.30 (m, 2H), 7.30 – 7.23 (m, 3H), 7.08 – 7.03 (m, 2H), 6.69 – 6.63 (m, 2H), 6.42 – 6.34 (m, 2H), 5.87 (ddd, J = 15.4, 8.1, 7.0 Hz, 1H), 4.21 – 4.13 (m, 2H), 3.76 – 3.67 (m, 5H), 3.09 – 3.00 (m, 2H), 1.18 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (151 MHz, Chloroform-d) δ 196.2, 169.7, 158.8, 137.1, 134.7, 133.5, 131.5, 130.3, 129.9, 128.8, 129.2, 128.4, 128.2, 128.0, 127.5, 127.3, 124.0, 123.2, 121.3, 113.7, 85.6, 84.2, 61.9, 60.8, 55.2, 40.3, 23.7, 13.9.

HRMS (ESI) Calculated for C₃₂H₂₈O₄ ([M]⁺+Na⁺) = 499.1880, Found 499.1880.

IR (neat) 2980, 2836, 1738, 1678, 1605, 1574, 1511, 1489, 1444, 1393, 1366, 1300, 1247, 1209, 1175, 1083, 1032, 967, 843, 802, 757, 692, 527 cm⁻¹.

Ethyl (E)-1-((3-(3-chlorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A27)

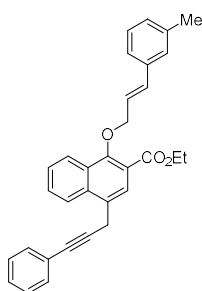
White solid, Mp: 110–113 °C, 24% yield.

¹H NMR (400 MHz, Chloroform-d) δ 8.36 (dd, J = 8.4, 1.3 Hz, 1H), 8.12 (d, J = 10.6 Hz, 2H), 7.68 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H), 7.49 – 7.41 (m, 3H), 7.34 – 7.23 (m, 6H), 6.77 (d, J = 15.7 Hz, 1H), 6.60 (dt, J = 15.9, 5.8 Hz, 1H), 4.82 (dd, J = 5.9, 1.5 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 4.18 (s, 2H), 1.43 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.0, 156.1, 138.5, 134.6, 134.5, 131.6, 131.5, 129.8, 129.1, 128.6, 128.6, 128.2, 127.9, 127.8, 126.6, 126.5, 126.5, 124.8, 124.4, 123.9, 123.5, 119.5, 86.8, 83.8, 76.1, 61.2, 23.5, 14.4.

HRMS (ESI) Calculated for C₃₂H₂₅ClO₃ ([M]⁺+Na⁺) = 503.1384, Found 503.1386.

IR (neat) 2980, 1621, 1596, 1569, 1508, 1490, 1475, 1418, 1394, 1356, 1307, 1275, 1227, 1207, 1154, 1085, 1023, 963, 888, 691, 527, 436 cm⁻¹.

Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(m-tolyl)allyl)oxy)-2-naphthoate (A28)

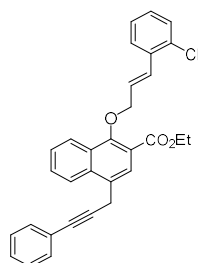
White solid, Mp: 92–95 °C, 68% yield.

¹H NMR (400 MHz, Chloroform-d) δ 8.39 (dd, J = 8.4, 1.3 Hz, 1H), 8.10 (t, J = 4.2 Hz, 2H), 7.66 (ddd, J = 8.4, 6.8, 1.5 Hz, 1H), 7.59 (ddd, J = 8.2, 6.8, 1.2 Hz, 1H), 7.48 – 7.41 (m, 2H), 7.32 – 7.21 (m, 6H), 7.08 (dd, J = 6.8, 1.9 Hz, 1H), 6.77 (d, J = 15.9 Hz, 1H), 6.58 (dt, J = 15.9, 6.1 Hz, 1H), 4.81 (dd, J = 6.0, 1.4 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 4.17 (s, 2H), 2.35 (s, 3H), 1.43 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.2, 156.2, 138.1, 136.5, 134.6, 133.3, 131.6, 129.2, 128.7, 128.5, 128.5, 128.4, 128.2, 127.9, 127.4, 126.5, 126.4, 124.6, 124.5, 123.8, 123.5, 119.4, 86.8, 83.7, 76.7, 61.2, 23.5, 21.4, 14.3.

HRMS (ESI) Calculated for C₃₂H₂₈O₃ ([M]⁺+Na⁺) = 483.1931, Found 483.1932.

IR (neat) 2980, 1719, 1620, 1601, 1571, 1508, 1489, 1444, 1416, 1393, 1354, 1307, 1275, 1224, 1153, 1084, 1023, 963, 691, 526, 435 cm⁻¹.

Ethyl (E)-1-((3-(2-chlorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A29)

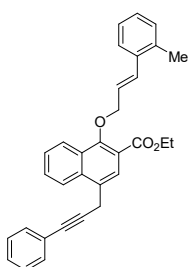
White solid, Mp: 112–115 °C, 58% yield.

¹H NMR (400 MHz, Chloroform-d) δ 8.40 (dd, J = 8.3, 1.5 Hz, 1H), 8.17 – 8.03 (m, 2H), 7.67 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (dtd, J = 6.8, 3.5, 1.2 Hz, 2H), 7.48 – 7.40 (m, 2H), 7.36 (dd, J = 7.7, 1.6 Hz, 1H), 7.27 (tt, J = 5.5, 2.2 Hz, 3H), 7.26 – 7.16 (m, 3H), 6.58 (dt, J = 15.9, 6.1 Hz, 1H), 4.86 (dd, J = 6.0, 1.6 Hz, 2H), 4.45 (q, J = 7.2 Hz, 2H), 4.17 (s, 2H), 1.43 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.13, 156.11, 134.67, 134.58, 133.23, 131.58, 129.68, 129.24, 128.85, 128.57, 128.51, 128.18, 127.87, 127.73, 127.05, 126.86, 126.46, 124.51, 123.79, 123.46, 119.42, 86.79, 83.74, 76.39, 61.20, 23.46, 14.36.

HRMS (ESI) Calculated for C₃₁H₂₅ClO₃ ([M]⁺+Na⁺) = 503.1384, Found 503.1386.

IR (neat) 2981, 1719, 1620, 1600, 1571, 1508, 1490, 1470, 1442, 1416, 1394, 1356, 1307, 1275, 1227, 1207, 1154, 1085, 1029, 964, 693, 527, 450 cm⁻¹.

Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(o-tolyl)allyl)oxy)-2-naphthoate (A30)

White solid, Mp: 95–98 °C, 55% yield.

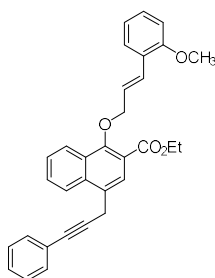
¹H NMR (400 MHz, Chloroform-d) δ 8.42 (dd, J = 8.4, 1.3 Hz, 1H), 8.12 (d, J = 11.0 Hz, 2H), 7.69 (ddd, J = 8.3, 6.8, 1.4 Hz, 1H), 7.61 (ddd, J = 8.1, 6.9, 1.1 Hz, 1H), 7.54 – 7.49 (m, 1H), 7.45 (dd, J = 6.7, 2.9 Hz, 2H), 7.30 (q, J = 2.8 Hz, 3H), 7.23 – 7.13 (m, 3H), 6.99 (d, J = 15.5 Hz, 1H), 6.48 (dt, J = 15.7, 6.2 Hz, 1H), 4.86 (dd, J = 6.2, 1.4 Hz, 2H), 4.45 (q, J = 7.1 Hz, 2H), 4.19 (s, 2H), 2.36 (s, 3H), 1.44 (t, J = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-d) δ 166.2, 156.2, 135.7, 134.6, 131.6, 131.3, 130.3, 129.3, 128.6, 128.4, 128.2, 127.9, 127.8, 126.5, 126.4, 126.1, 126.1, 125.9, 124.6, 123.8, 123.5, 119.5, 86.8, 83.7, 76.9, 61.2, 23.5, 19.8, 14.4

HRMS (ESI) Calculated for C₃₂H₂₈O₃ ([M]⁺+Na⁺) = 483.1931, Found 483.1934.

IR (neat) 2979, 1719, 1620, 1600, 1571, 1507, 1488, 1458, 1415, 1394, 1354, 1306, 1275, 1224, 1153, 1084, 1023, 964, 692, 527, 449 cm⁻¹.

Ethyl (E)-1-((3-(2-methoxyphenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A31)



White solid, Mp: 92–98 °C, 63% yield.

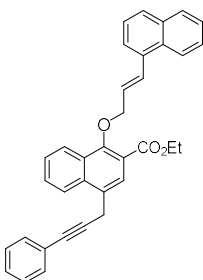
¹H NMR (400 MHz, Chloroform-*d*) δ 8.42 (dd, *J* = 8.5, 1.3 Hz, 1H), 8.15 – 8.07 (m, 2H), 7.67 (ddd, *J* = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (ddd, *J* = 8.1, 6.8, 1.2 Hz, 1H), 7.51 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.44 (dd, *J* = 6.7, 2.9 Hz, 2H), 7.31 – 7.27 (m, 3H), 7.24 (dd, *J* = 8.2, 0.9 Hz, 1H), 7.10 (d, *J* = 16.0 Hz, 1H), 6.95 (td, *J* = 7.5, 1.1 Hz, 1H), 6.88 (dd, *J* = 8.2, 1.0 Hz, 1H), 6.62 (dt, *J* = 16.0, 6.3 Hz, 1H), 4.84 (dd, *J* = 6.4, 1.4 Hz, 2H), 4.46 (q, *J* = 7.1 Hz, 2H), 4.18 (s, 2H), 3.85 (s, 3H), 1.44 (t, *J* = 7.2 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.3, 156.9, 156.3, 134.6, 131.6, 129.3, 129.0, 128.5, 128.4, 128.3, 128.2, 127.9, 127.2, 126.5, 126.3, 125.5, 125.4, 124.7, 123.7, 123.5, 120.6, 119.4, 110.8, 86.9, 83.7, 61.2, 55.4, 23.5, 14.3.

HRMS (ESI) Calculated for C₃₂H₂₈O₄ ([M]⁺+Na⁺) = 499.1880, Found 499.1879.

IR (neat) 2979, 1720, 1620, 1598, 1573, 1489, 1461, 1416, 1394, 1355, 1305, 1275, 1242, 1155, 1084, 1027, 972, 692, 527 cm⁻¹.

Ethyl (E)-1-((3-(naphthalen-1-yl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A32)



White solid, Mp: 112–115 °C, 60% yield.

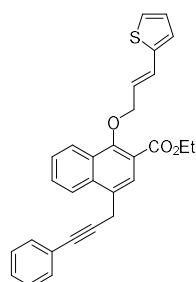
¹H NMR (400 MHz, Chloroform-*d*) δ 8.48 (dd, *J* = 8.3, 1.5 Hz, 1H), 8.20 – 8.05 (m, 3H), 7.86 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.72 – 7.61 (m, 3H), 7.58 – 7.44 (m, 6H), 7.30 (qd, *J* = 4.1, 2.2 Hz, 3H), 6.62 (dt, *J* = 15.5, 6.1 Hz, 1H), 4.96 (dd, *J* = 6.1, 1.6 Hz, 2H), 4.47 (q, *J* = 7.1 Hz, 2H), 4.20 (s, 2H), 1.44 (t, *J* = 7.2 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.2, 156.2, 134.6, 134.3, 133.6, 131.6, 131.1, 130.6, 129.3, 128.6, 128.5, 128.2, 128.0, 127.9, 126.5, 126.5, 126.1, 125.8, 125.6, 124.6, 124.1, 123.8, 123.8, 123.5, 119.5, 86.8, 83.7, 61.2, 23.5, 14.4.

HRMS (ESI) Calculated for C₃₅H₂₈O₃ ([M]⁺+Na⁺) = 519.1931, Found 519.1936.

IR (neat) 3058, 2980, 1620, 1599, 1571, 1508, 1490, 1444, 1416, 1393, 1357, 1307, 1275, 1227, 1154, 1084, 1022, 961, 692, 527, 425 cm⁻¹.

Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(thiophen-2-yl)allyl)oxy)-2-naphthoate (A33)



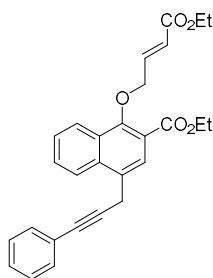
White solid, Mp: 80–83 °C, 20% yield.

¹H NMR (400 MHz, Chloroform-*d*) δ 8.38 (dd, *J* = 8.4, 1.3 Hz, 1H), 8.12 (d, *J* = 7.0 Hz, 2H), 7.69 (ddd, *J* = 8.3, 6.8, 1.4 Hz, 1H), 7.61 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.46 (dd, *J* = 6.5, 3.0 Hz, 2H), 7.30 (dq, *J* = 4.9, 2.8 Hz, 3H), 7.21 (d, *J* = 5.0 Hz, 1H), 7.06 – 6.93 (m, 3H), 6.44 (dt, *J* = 15.7, 6.1 Hz, 1H), 4.80 (dd, *J* = 6.1, 1.4 Hz, 2H), 4.46 (q, *J* = 7.1 Hz, 2H), 4.19 (s, 2H), 1.45 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.1, 156.1, 141.6, 134.6, 131.6, 129.1, 128.6, 128.5, 128.2, 127.9, 127.4, 126.5, 126.3, 124.7, 124.5, 124.3, 123.8, 123.5, 119.5, 86.8, 83.7, 76.2, 61.2, 23.5, 14.3.

HRMS (ESI) Calculated for C₂₉H₂₄O₃S ([M]⁺+Na⁺) = 475.1338, Found 475.1339.

IR (neat) 2980, 1621, 1600, 1571, 1508, 1444, 1416, 1394, 1367, 1344, 1306, 1275, 1226, 1154, 1084, 1023, 954, 855, 758, 693, 528 cm⁻¹.

Ethyl (E)-1-((4-ethoxy-4-oxobut-2-en-1-yl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A34)

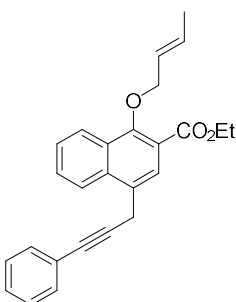
White solid, Mp: 116–119 °C, 58% yield.

¹H NMR (400 MHz, Chloroform-*d*) δ 8.25 (dd, *J* = 8.4, 1.4 Hz, 1H), 8.14 – 8.09 (m, 2H), 7.68 (ddd, *J* = 8.4, 6.8, 1.4 Hz, 1H), 7.60 (ddd, *J* = 8.0, 6.8, 1.2 Hz, 1H), 7.47 – 7.42 (m, 2H), 7.32 – 7.26 (m, 3H), 7.22 (dt, *J* = 15.7, 4.2 Hz, 1H), 6.45 (dt, *J* = 15.7, 2.1 Hz, 1H), 4.83 (dd, *J* = 4.2, 2.1 Hz, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 4.26 (q, *J* = 7.1 Hz, 2H), 4.17 (s, 2H), 1.42 (t, *J* = 7.2 Hz, 3H), 1.33 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.3, 165.8, 155.5, 142.7, 134.6, 131.6, 129.0, 128.7, 128.7, 128.2, 127.9, 126.7, 126.4, 124.0, 123.9, 123.4, 121.7, 119.5, 86.6, 83.8, 73.8, 61.2, 60.5, 23.5, 14.3, 14.2.

HRMS (ESI) Calculated for C₂₈H₂₆O₅ ([M]⁺+Na⁺) = 465.1672, Found 465.1682

IR (neat) 2981, 1717, 1665, 1620, 1600, 1571, 1508, 1491, 1444, 1394, 1367, 1303, 1274, 1228, 1177, 1093, 1036, 759, 692, 528 cm⁻¹.

Ethyl (E)-1-(but-2-en-1-yloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A35)

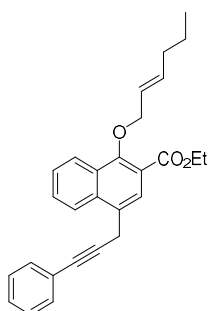
White solid, Mp: 65–68 °C, 17% yield.

¹H NMR (400 MHz, Chloroform-*d*) δ 8.35 (dd, *J* = 8.4, 1.3 Hz, 1H), 8.14 – 8.05 (m, 2H), 7.67 (ddd, *J* = 8.4, 6.9, 1.4 Hz, 1H), 7.59 (ddd, *J* = 8.2, 6.8, 1.2 Hz, 1H), 7.48 – 7.41 (m, 2H), 7.33 – 7.26 (m, 3H), 6.02 – 5.79 (m, 2H), 4.63 – 4.55 (m, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 4.17 (s, 2H), 1.79 (d, *J* = 4.5 Hz, 3H), 1.45 (t, *J* = 7.1 Hz, 3H).

¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 166.2, 156.3, 134.5, 131.6, 130.9, 129.3, 128.5, 128.2, 127.9, 126.6, 126.5, 126.3, 124.6, 123.7, 123.5, 119.4, 86.8, 83.7, 76.8, 61.1, 23.4, 17.9, 14.3.

HRMS (ESI) Calculated for C₂₆H₂₄O₃ ([M]⁺+Na⁺) = 407.1618, Found 407.1616.

IR (neat) 2978, 1620, 1600, 1571, 1508, 1491, 1445, 1416, 1394, 1354, 1306, 1275, 1226, 1206, 1154, 1085, 1023, 965, 912, 758, 692, 528 cm⁻¹.

Ethyl (E)-1-(hex-2-en-1-yloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A36)

Colorless oil, Mp: 28–31 °C, 30% yield.

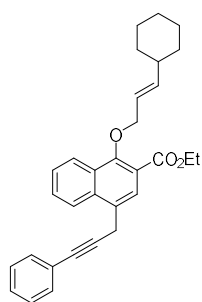
¹H NMR (400 MHz, Chloroform-*d*) δ 8.36 (dd, *J* = 8.4, 1.3 Hz, 1H), 8.10 (d, *J* = 8.7 Hz, 2H), 7.67 (ddd, *J* = 8.3, 6.8, 1.4 Hz, 1H), 7.59 (ddd, *J* = 8.1, 6.8, 1.1 Hz, 1H), 7.48 – 7.41 (m, 2H), 7.29 (p, *J* = 3.5 Hz, 3H), 5.96 – 5.83 (m, 2H), 4.62 (d, *J* = 5.2 Hz, 2H), 4.46 (q, *J* = 7.1 Hz, 2H), 4.17 (s, 2H), 2.10 (dt, *J* = 7.9, 5.9 Hz, 2H), 1.44 (dt, *J* = 9.9, 7.2 Hz, 5H), 0.91 (t, *J* = 7.4 Hz, 3H).

¹³C NMR (101 MHz, Chloroform-*d*) δ 166.3, 156.3, 136.0, 134.5, 131.6, 129.3, 128.4, 128.2, 128.1, 127.8, 126.5, 126.2, 125.4, 124.7, 123.7, 123.5, 119.4, 86.8, 83.6, 77.0, 61.1, 34.4, 23.4, 22.1, 14.3, 13.6.

HRMS (ESI) Calculated for C₂₈H₂₈O₃ ([M]⁺+Na⁺) = 435.1931, Found 435.1933.8

IR (neat) 2959, 2929, 2871, 1722, 1621, 1600, 1571, 1507, 1491, 1457, 1416, 1394, 1357, 1306, 1275, 1225, 1154, 1083, 1023, 972, 692, 527 cm⁻¹.

Ethyl (E)-1-((3-cyclohexylallyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A37)



White solid, Mp: 59–62 °C, 25% yield.

$^1\text{H NMR}$ (600 MHz, Chloroform-*d*) δ 8.35 (d, J = 8.4 Hz, 1H), 8.10 (d, J = 8.4 Hz, 1H), 8.08 (s, 1H), 7.67 (ddd, J = 8.3, 6.7, 1.3 Hz, 1H), 7.59 (ddd, J = 8.1, 6.8, 1.0 Hz, 1H), 7.44 (dd, J = 6.7, 3.0 Hz, 2H), 7.31 – 7.27 (m, 3H), 5.85 – 5.76 (m, 2H), 4.60 (d, J = 5.9 Hz, 2H), 4.45 (q, J = 7.1 Hz, 2H), 4.17 (s, 2H), 2.03 (dtd, J = 11.1, 6.8, 3.0 Hz, 1H), 1.76 – 1.71 (m, 4H), 1.68 – 1.63 (m, 1H), 1.45 (t, J = 7.2 Hz, 3H), 1.27 (tt, J = 12.9, 3.5 Hz, 2H), 1.18 – 1.06 (m, 3H).

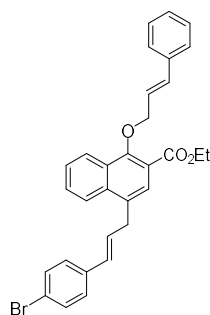
$^{13}\text{C}\{^1\text{H}\}$ NMR (151 MHz, Chloroform-*d*) δ 166.3, 156.3, 141.9, 134.5, 131.6, 129.4, 128.5, 128.2, 128.1, 127.9, 126.5, 126.2, 124.8, 123.7, 123.5, 122.7, 119.4, 86.9, 83.6, 77.2, 61.1, 40.3, 32.5, 26.1, 26.0, 23.5, 14.4.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{32}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 475.2244, Found 475.2246.

IR (neat) 2923, 2850, 1721, 1620, 1600, 1571, 1508, 1490, 1447, 1416, 1394, 1368, 1351, 1306, 1275, 1225, 1153, 1083, 1024, 971, 692, 528 cm^{-1} .

Ethyl 4-((E)-3-(4-bromophenyl)allyl)-1-(cinnamyloxy)-2-naphthoate (A38)

White solid, Mp: 96–99 °C, 84% yield.



$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.38 (d, J = 8.1 Hz, 1H), 8.04 (d, J = 8.2 Hz, 1H), 7.78 (s, 1H), 7.60 (dddd, J = 20.2, 8.1, 6.8, 1.3 Hz, 2H), 7.45 (d, J = 7.3 Hz, 2H), 7.42 – 7.30 (m, 4H), 7.29 – 7.25 (m, 1H), 7.18 (d, J = 8.2 Hz, 2H), 6.81 (d, J = 15.9 Hz, 1H), 6.59 (dt, J = 15.9, 6.0 Hz, 1H), 6.48 (dt, J = 15.9, 6.1 Hz, 1H), 6.38 (d, J = 16.0 Hz, 1H), 4.82 (dd, J = 6.0, 1.4 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 3.95 (d, J = 6.1 Hz, 2H), 1.43 (t, J = 7.1 Hz, 3H).

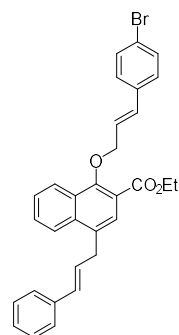
$^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 166.6, 155.8, 136.7, 136.4, 135.3, 133.3, 132.0, 131.7, 130.5, 129.5, 129.4, 128.8, 128.6, 128.1, 127.8, 127.2, 126.8, 126.5, 125.0, 124.7, 124.5, 121.0, 119.8, 76.7, 61.4, 36.3, 14.6.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{79}\text{BrO}_3$ ($[\text{M}] + \text{Na}^+$) = 549.1036, Found 549.1047.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{81}\text{BrO}_3$ ($[\text{M}] + \text{Na}^+$) = 551.1015, Found 551.1022.

IR (neat) 3026, 2980, 2361, 1619, 1571, 1487, 1449, 1395, 1356, 1276, 1228, 1206, 1154, 1079, 1011, 965, 833, 765, 693, 498 cm^{-1} .

Ethyl 1-(((E)-3-(4-bromophenyl)allyl)oxy)-4-cinnamyl-2-naphthoate (*ent*-A38)



White solid, Mp: 110–113 °C, 76% yield.

$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 8.35 (d, J = 8.1 Hz, 1H), 8.05 (d, J = 8.2 Hz, 1H), 7.80 (s, 1H), 7.57 (dddd, J = 19.4, 8.0, 6.8, 1.4 Hz, 2H), 7.47 – 7.41 (m, 2H), 7.32 – 7.22 (m, 6H), 7.19 – 7.14 (m, 1H), 6.74 (d, J = 15.9 Hz, 1H), 6.57 (dt, J = 15.9, 5.9 Hz, 1H), 6.45 (d, J = 2.6 Hz, 2H), 4.80 (dd, J = 5.8, 1.4 Hz, 2H), 4.42 (q, J = 7.1 Hz, 2H), 4.02 – 3.87 (m, 2H), 1.41 (t, J = 7.1 Hz, 3H).

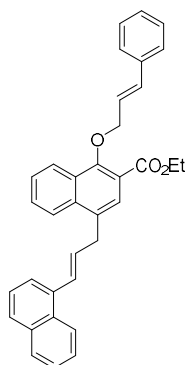
$^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 166.4, 155.6, 137.4, 135.6, 135.3, 132.4, 131.8, 131.8, 131.6, 129.3, 128.6, 128.5, 128.2, 127.3, 127.0, 126.4, 126.2, 125.8, 124.5, 124.4, 121.8, 119.7, 76.3, 61.3, 36.3, 14.5.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{79}\text{BrO}_3$ ($[\text{M}] + \text{Na}^+$) = 549.1036, Found 549.1047.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{81}\text{BrO}_3$ ($[\text{M}] + \text{Na}^+$) = 551.1015, Found 551.1024.

IR (neat) 3026, 2980, 1619, 1599, 1571, 1487, 1448, 1417, 1393, 1357, 1277, 1227, 1207, 1152, 1073, 1009, 966, 847, 767, 741, 693, 498 cm⁻¹.

Ethyl 1-(cinnamyloxy)-4-((E)-3-(naphthalen-1-yl)allyl)-2-naphthoate (A39)



White solid, Mp: 74–77 °C, 71% yield.

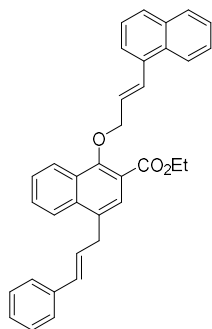
¹H NMR (400 MHz, Chloroform-*d*) δ 8.61 (d, *J* = 8.3 Hz, 1H), 8.35 (d, *J* = 8.3 Hz, 1H), 8.26 – 8.15 (m, 1H), 8.10 (s, 1H), 8.04 – 7.98 (m, 1H), 7.92 (d, *J* = 8.1 Hz, 1H), 7.79 (ddd, *J* = 26.9, 13.3, 7.1 Hz, 3H), 7.65 (d, *J* = 7.6 Hz, 4H), 7.60 – 7.51 (m, 3H), 7.46 (t, *J* = 7.7 Hz, 1H), 7.41 (d, *J* = 15.7 Hz, 1H), 7.02 (d, *J* = 15.9 Hz, 1H), 6.81 (dt, *J* = 15.4, 5.8 Hz, 1H), 6.74 – 6.63 (dt, 1H), 5.04 (d, *J* = 6.1 Hz, 2H), 4.65 (q, *J* = 7.1 Hz, 2H), 4.28 (d, *J* = 6.4 Hz, 2H), 1.63 (t, *J* = 7.2 Hz, 3H).

¹³C NMR (101 MHz, Chloroform-*d*) δ 166.4 , 155.6 , 136.5 , 135.2 , 135.1 , 133.5 , 133.0 , 132.1 , 131.6 , 131.0 , 129.2 , 128.9 , 128.5 , 128.4 , 128.3 , 127.8 , 127.5 , 126.9 , 126.6 , 126.3 , 125.8 , 125.6 , 125.5 , 124.8 , 124.4 , 124.4 , 123.8 , 123.7 , 119.6 , 76.5 , 61.2 , 36.5 , 14.3 .

HRMS (ESI) Calculated for C₃₅H₃₀O₃ ([M]⁺+Na⁺) = 521.2087, Found 521.2094.

IR (neat) 3058, 2980, 1619, 1598, 1572, 1507, 1448, 1516, 1393, 1356, 1276, 1226, 1206, 1153, 1083, 1022, 965, 863, 768, 692, 561, 496, 424cm⁻¹.

Ethyl 4-cinnamyl-1-((E)-3-(naphthalen-1-yl)allyloxy)-2-naphthoate (ent-A39)



White solid, Mp: 98–101 °C, 77% yield.

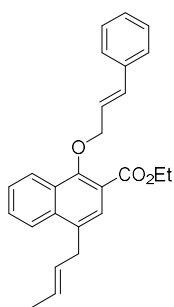
¹H NMR (400 MHz, Chloroform-*d*) δ 8.51 – 8.37 (m, 1H), 8.09 (dd, *J* = 8.8, 4.3 Hz, 2H), 7.91 – 7.77 (m, 3H), 7.67 – 7.44 (m, 7H), 7.36 – 7.30 (m, 2H), 7.29 – 7.25 (m, 2H), 7.23 – 7.14 (m, 1H), 6.61 (dt, *J* = 15.5, 6.0 Hz, 1H), 6.48 (d, *J* = 2.0 Hz, 2H), 4.95 (dd, *J* = 6.1, 1.5 Hz, 2H), 4.46 (qd, *J* = 7.1, 1.5 Hz, 2H), 3.98 (d, *J* = 4.1 Hz, 2H), 1.44 (t, *J* = 7.1 Hz, 3H).

¹³C NMR (101 MHz, Chloroform-*d*) δ 166.7 , 155.7 , 137.4 , 135.3 , 134.4 , 133.7 , 132.3 , 131.6 , 131.3 , 130.6 , 129.5 , 128.7 , 128.6 , 128.6 , 128.5 , 128.3 , 128.2 , 127.3 , 127.1 , 126.4 , 126.3 , 126.2 , 126.0 , 125.8 , 124.7 , 124.6 , 124.2 , 123.9 , 119.8 , 76.8 , 61.4 , 36.4 , 14.6 .

HRMS (ESI) Calculated for C₃₅H₃₀O₃ ([M]⁺+Na⁺) = 521.2087, Found 521.2092.

IR (neat) 3057, 2980, 1619, 1597, 1571, 1505, 1448, 1416, 1392, 1360, 1277, 1228, 1205, 1154, 1084, 1021, 964, 866, 769, 738, 693, 493, 426 cm⁻¹.

Ethyl 4-((E)-but-2-en-1-yl)-1-(cinnamyloxy)-2-naphthoate (A40)



White solid, Mp: 40–43 °C, 75% yield.

¹H NMR (400 MHz, Chloroform-*d*) δ 8.35 (dd, *J* = 7.8, 1.4 Hz, 1H), 8.07 – 8.00 (m, 1H), 7.73 (s, 1H), 7.64 – 7.54 (m, 2H), 7.47 – 7.43 (m, 2H), 7.37 – 7.31 (m, 2H), 7.29 – 7.24 (m, 1H), 6.85 – 6.77 (m, 1H), 6.59 (dt, *J* = 15.9, 6.0 Hz, 1H), 5.82 – 5.65 (m, 1H), 5.66 – 5.50 (m, 1H), 4.80 (dd, *J* = 6.0, 1.4 Hz, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.74 (dq, *J* = 6.3, 1.3 Hz, 2H), 1.68 (dt, *J* = 6.4, 1.5 Hz, 3H), 1.43 (t, *J* = 7.1 Hz, 3H).

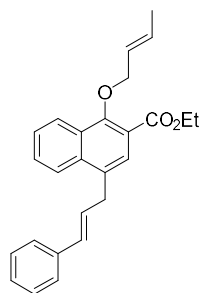
¹³C NMR (101 MHz, Chloroform-*d*) δ 166.7 , 155.5 , 136.7 , 135.3 , 133.2 ,

133.1 , 129.3 , 129.2 , 128.7 , 128.3 , 128.0 , 127.2 , 126.8 , 126.6 , 126.3 , 125.1 , 124.6 , 124.5 , 119.7 , 76.6 , 61.3 , 36.0 , 18.1 , 14.5 .

HRMS (ESI) Calculated for $C_{26}H_{26}O_3$ ($[M]+Na^+$) = 409.1774, Found 409.1775.

IR (neat) 2978, 2361, 1720, 1619, 1571, 1500, 1448, 1416, 1393, 1358, 1276, 1228, 1205, 1154, 1083, 1023, 965, 766, 693 cm^{-1} .

Ethyl 1-(((E)-but-2-en-1-yl)oxy)-4-cinnamyl-2-naphthoate (*ent*-A40)



White solid, Mp: 72–75 °C, 74% yield.

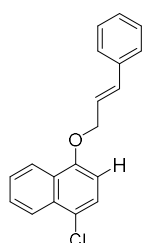
1H NMR (400 MHz, Chloroform-*d*) δ 8.33 (dd, J = 8.3, 1.6 Hz, 1H), 8.06 (dd, J = 8.0, 1.3 Hz, 1H), 7.77 (s, 1H), 7.58 (dddd, J = 20.8, 8.2, 6.8, 1.4 Hz, 2H), 7.33 (dt, J = 6.4, 1.4 Hz, 2H), 7.27 (d, J = 4.2 Hz, 2H), 7.23 – 7.15 (m, 1H), 6.48 (d, J = 3.5 Hz, 2H), 6.05 – 5.74 (m, 2H), 4.58 (d, J = 3.3 Hz, 2H), 4.44 (q, J = 7.1 Hz, 2H), 3.96 (d, J = 3.8 Hz, 2H), 1.79 (d, J = 4.3 Hz, 3H), 1.44 (t, J = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.7 , 155.8 , 137.5 , 135.3 , 132.0 , 131.6 , 131.0 , 129.4 , 128.7 , 128.6 , 128.4 , 127.3 , 127.1 , 126.8 , 126.3 , 124.7 , 124.5 , 119.7 , 76.9 , 61.3 , 36.4 , 18.1 , 14.5 .

HRMS (ESI) Calculated for $C_{26}H_{26}O_3$ ($[M]+Na^+$) = 409.1774, Found 409.1773.

IR (neat) 3025, 2978, 2361, 1619, 1600, 1571, 1500, 1448, 1416, 1393, 1356, 1277, 1228, 1205, 1154, 1085, 1024, 965, 767, 738, 693, 493 cm^{-1} .

1-chloro-4-(cinnamyloxy)naphthalene (A41)



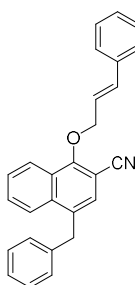
Colorless oil, 91% yield.

1H NMR (400 MHz, Chloroform-*d*) δ 8.17 (d, J = 8.8 Hz, 1H), 7.80 (d, J = 7.8 Hz, 1H), 7.56 – 7.45 (m, 3H), 7.44 – 7.41 (m, 2H), 7.34 – 7.30 (m, 3H), 7.28 – 7.23 (m, 1H), 6.78 (d, J = 15.7 Hz, 1H), 6.58 (dt, J = 15.9, 6.2 Hz, 1H), 4.80 (dd, J = 6.2, 1.4 Hz, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 150.6 , 136.4 , 133.5 , 133.4 , 129.3 , 128.6 , 127.9 , 127.5 , 126.7 , 126.6 , 126.4 , 124.9 , 124.5 , 122.1 , 74.6 .

HRMS (ESI) Calculated for $C_{19}H_{15}ClO$ ($[M]+Na^+$) = 317.0704, Found 317.0706.

4-benzyl-1-(cinnamyloxy)-2-naphthonitrile (A43)



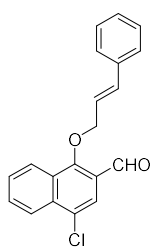
Colorless oil, 64% yield.

1H NMR (600 MHz, Chloroform-*d*) δ 8.32 (d, J = 7.4 Hz, 1H), 7.99 (d, J = 7.9 Hz, 1H), 7.62 – 7.56 (m, 2H), 7.43 (m, 2H), 7.33 (m, 2H), 7.31 – 7.25 (m, 3H), 7.25 – 7.20 (m, 2H), 7.17 (d, J = 6.9 Hz, 2H), 6.76 (d, J = 15.8 Hz, 1H), 6.61 – 6.53 (m, 1H), 5.09 (d, J = 6.4 Hz, 2H), 4.36 (s, 2H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 159.0 , 139.2 , 136.1 , 135.1 , 134.7 , 133.3 , 129.4 , 128.7 , 128.6 , 128.2 , 128.0 , 127.5 , 126.9 , 126.8 , 126.5 , 124.7 , 123.7 , 123.6 , 117.8 , 99.6 , 76.2 , 38.4 .

HRMS (ESI) Calculated for $C_{27}H_{21}NO$ ($[M]+Na^+$) = 398.1515, Found 398.1507.

4-chloro-1-(cinnamyloxy)-2-naphthaldehyde (A44)



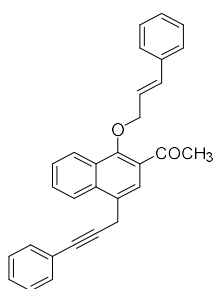
¹H NMR (600 MHz, Chloroform-*d*) δ 10.56 (s, 1H), 8.32 (dd, *J* = 12.8, 8.4 Hz, 2H), 7.96 (s, 1H), 7.78 (t, *J* = 7.7 Hz, 1H), 7.70 – 7.67 (m, 1H), 7.42 (d, *J* = 7.6 Hz, 2H), 7.36 (t, *J* = 7.5 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 1H), 6.76 (d, *J* = 15.9 Hz, 1H), 6.54 – 6.49 (m, 1H), 4.88 (d, *J* = 6.1 Hz, 2H).

¹³C NMR (151 MHz, Chloroform-*d*) δ 188.51, 159.71, 135.81, 135.06, 134.91, 130.41, 129.36, 128.72, 128.68, 128.42, 127.64, 126.74, 125.49, 125.42, 123.88, 122.90, 122.47, 79.02.

HRMS (ESI) Calculated for C₂₀H₁₅ClO₂ ([M]⁺Na⁺) = 345.0653, Found 345.0658.

IR (neat) 3027, 2886, 1678, 1618, 1587, 1496, 1449, 1411, 1349, 1259, 1218, 1185, 1095, 1030, 963, 921, 836, 746, 685, 615, 510 cm⁻¹.

1-(1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)naphthalen-2-yl)ethan-1-one (A45)



Yellow solid, Mp: 107–110 °C, 28% yield.

¹H NMR (400 MHz, Chloroform-*d*) δ 8.34 (dd, *J* = 8.1, 1.6 Hz, 1H), 8.15 (d, *J* = 8.3 Hz, 1H), 7.93 (d, *J* = 4.1 Hz, 1H), 7.69 (ddd, *J* = 8.3, 6.8, 1.4 Hz, 1H), 7.62 (ddd, *J* = 8.2, 6.8, 1.3 Hz, 1H), 7.45 (h, *J* = 2.1 Hz, 4H), 7.40 – 7.34 (m, 2H), 7.30 (td, *J* = 5.2, 2.1 Hz, 4H), 6.82 (d, *J* = 15.8 Hz, 1H), 6.53 (dt, *J* = 15.8, 6.0 Hz, 1H), 4.74 (dd, *J* = 6.1, 1.4 Hz, 2H), 4.18 (s, 2H), 2.81 (s, 3H).

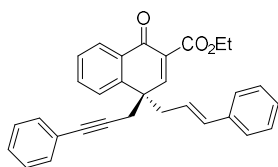
¹³C{¹H} NMR (101 MHz, Chloroform-*d*) δ 200.4, 155.2, 136.2, 134.7, 133.6, 131.6, 129.1, 128.7, 128.7, 128.6, 128.2, 128.1, 128.1, 127.9, 126.7, 126.6, 125.3, 124.2, 124.1, 124.0, 123.4, 86.7, 83.7, 77.3, 31.0, 23.5.

HRMS (ESI) Calculated for C₃₀H₂₄O₂ ([M]⁺Na⁺) = 439.1669, Found 439.1669.

IR (neat) 3057, 1670, 1619, 1599, 1570, 1491, 1446, 1412, 1386, 1360, 1305, 1272, 1225, 1186, 1153, 1070, 1025, 965, 611, 529, 504, 433 cm⁻¹.

15. Spectral Characterization Data for the Products

Ethyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B1)



White solid, Mp: 82–85 °C, 88% yield, 91% *ee*; $[\alpha]^{12.6} = -28.2$ ($c = 1.79$ in CH_2Cl_2 , $\lambda = 589$ nm).

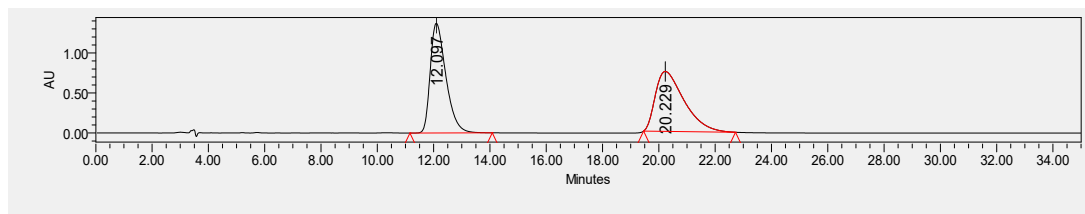
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 12.68$ min, $t_{R(\text{major})} = 21.40$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.93 (d, $J = 8.1$ Hz, 1H), 7.78 (s, 1H), 7.74 (ddd, $J = 8.1, 7.3, 1.5$ Hz, 1H), 7.51 – 7.46 (m, 1H), 7.28 – 7.14 (m, 10H), 6.45 – 6.39 (m, 1H), 5.89 – 5.81 (m, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.28 (s, 2H), 3.26 – 3.20 (m, 1H), 3.13 (ddd, $J = 14.0, 7.5, 1.3$ Hz, 1H), 1.28 (t, $J = 7.1$ Hz, 3H).

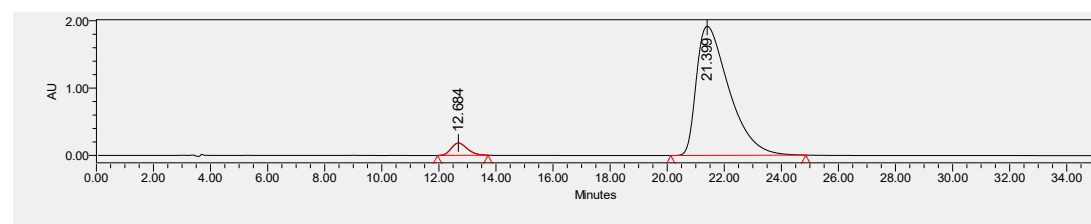
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 157.2, 145.7, 137.9, 134.99, 135.2, 135.0, 134.0, 134.0, 133.9, 132.2, 129.4, 129.3, 129.0, 128.4, 128.3, 127.5, 127.3, 127.0, 124.9, 124.1, 86.2, 84.7, 61.7, 46.7, 44.1, 32.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 469.1774, Found 469.1786.

IR (neat) 3028, 2982, 1733, 1662, 1600, 1490, 1451, 1378, 1275, 1231, 1161, 1138, 1086, 1019, 967, 928, 862, 756, 692, 618, 527 cm^{-1} .

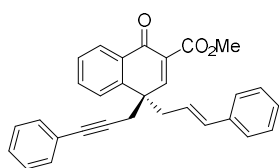


	Retention Time	Area	% Area
1	12.097	53013334	49.95
2	20.229	53112670	50.05



	Retention Time	Area	% Area
1	12.684	7172585	4.50
2	21.389	152140239	95.50

Methyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B2)



Colorless oil, 72% yield, 81% *ee*; $[\alpha]^{12.3} = -24.3$ ($c = 0.59$ in CH_2Cl_2 , $\lambda = 589$ nm).

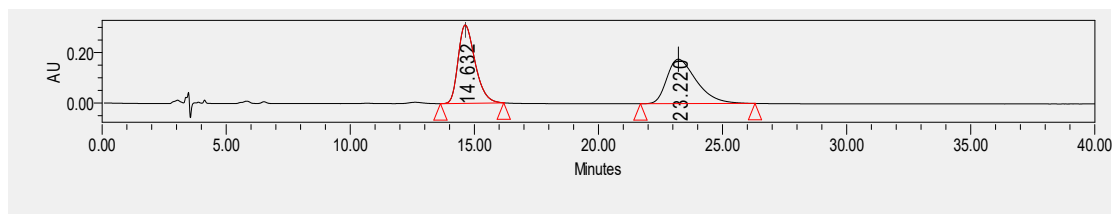
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R(minor)}} = 15.27$ min, $t_{\text{R(major)}} = 24.53$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.19 – 8.06 (m, 1H), 7.93 (d, $J = 7.9$ Hz, 1H), 7.81 (s, 1H), 7.77 – 7.72 (m, 1H), 7.51 – 7.47 (m, 1H), 7.28 – 7.13 (m, 10H), 6.42 (d, $J = 15.7$ Hz, 1H), 5.89 – 5.81 (m, 1H), 3.79 (s, 3H), 3.28 (s, 2H), 3.26 – 3.11 (m, 2H).

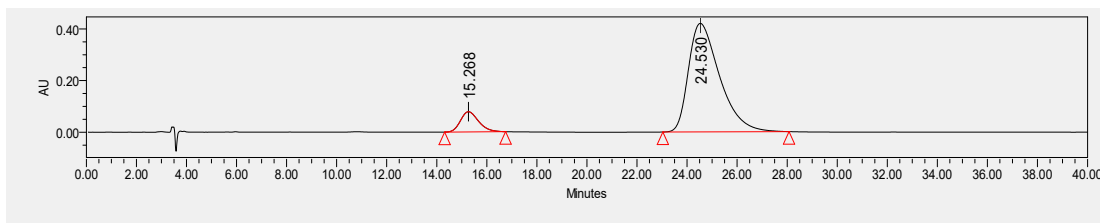
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 166.0, 157.7, 145.6, 137.9, 135.0, 134.8, 134.1, 133.9, 132.2, 129.4, 129.3, 129.0, 128.4, 128.3, 127.5, 127.3, 127.0, 124.9, 124.0, 86.2, 84.7, 52.5, 46.8, 44.1, 32.8

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{24}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 455.1618, Found 455.1621.

IR (neat) 3028, 2950, 1738, 1663, 1600, 1491, 1437, 1380, 1279, 1234, 1188, 1161, 1137, 1086, 984, 873, 693, 619, 528 cm^{-1} .

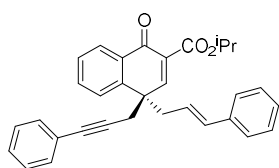


	Retention Time	Area	% Area
1	14.632	14721219	50.21
2	23.220	14597445	49.79



	Retention Time	Area	% Area
1	15.268	3929691	9.75
2	24.530	36354578	90.25

Isopropyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B3)



White solid, Mp: 50–53 °C, 78% yield, 97% *ee*; $[\alpha]^{25}_D = -30.7$ ($c = 0.68$ in CH_2Cl_2 , $\lambda = 589$ nm).

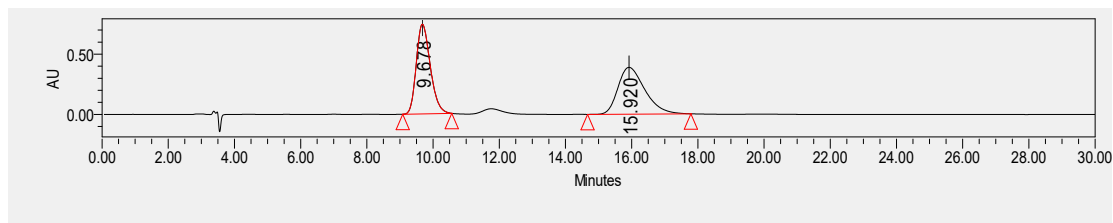
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 9.95$ min, $t_{R(\text{major})} = 16.44$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.93 (d, $J = 7.4$ Hz, 1H), 7.76 – 7.72 (m, 2H), 7.51 – 7.46 (m, 1H), 7.28 – 7.15 (m, 10H), 6.42 (d, $J = 15.8$ Hz, 1H), 5.89 – 5.81 (m, 1H), 5.14 (hept, $J = 6.2$ Hz, 1H), 3.28 (s, 2H), 3.24 – 3.10 (m, 2H), 1.29 (dd, $J = 6.3, 2.6$ Hz, 6H).

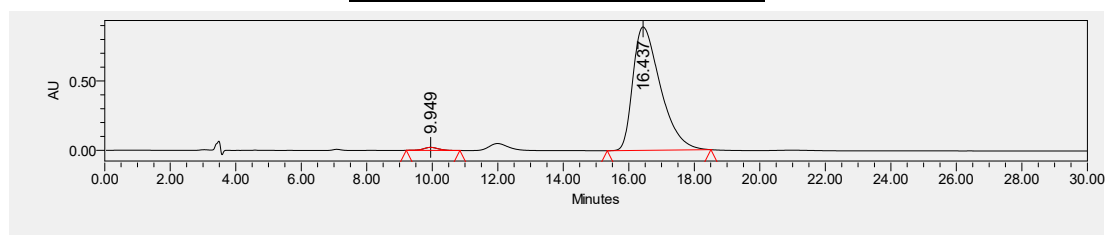
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.3, 156.6, 145.7, 138.0, 135.6, 135.0, 134.0, 133.9, 132.3, 129.4, 129.3, 129.0, 128.4, 128.3, 127.5, 127.3, 127.0, 124.9, 124.1, 86.3, 84.7, 69.3, 46.7, 44.1, 32.8, 22.1.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 483.1931, Found 483.1935.

IR (neat) 3028, 2981, 2934, 1730, 1663, 1600, 1491, 1452, 1378, 1277, 1234, 1181, 1142, 1105, 1085, 1027, 966, 942, 836, 692, 618, 527 cm^{-1} .

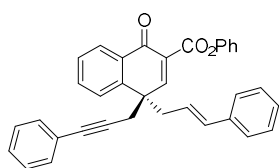


	Retention Time	Area	% Area
1	9.678	21878327	49.97
2	15.920	21904318	50.03



	Retention Time	Area	% Area
1	9.949	697318	1.32
2	16.437	51941290	98.68

Phenyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B4)



White solid, Mp: 46–49 °C, 87% yield, 97% *ee*; $[\alpha]^{13.0} = -43.0$ ($c = 0.83$ in CH_2Cl_2 , $\lambda = 589$ nm).

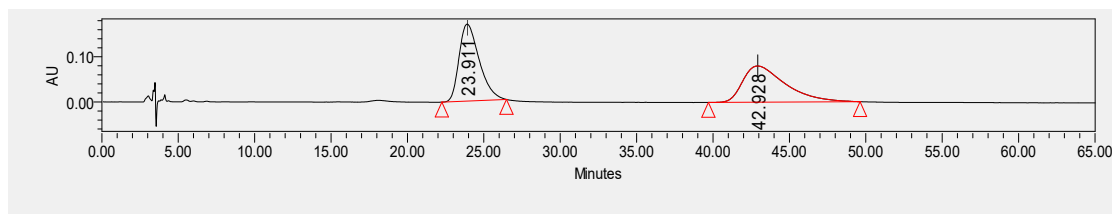
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 25.41$ min, $t_{R(\text{major})} = 45.28$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.17 (dd, $J = 7.9, 1.5$ Hz, 1H), 8.10 (s, 1H), 7.97 (d, $J = 7.8$ Hz, 1H), 7.80 – 7.75 (m, 1H), 7.51 (ddd, $J = 8.1, 7.3, 1.1$ Hz, 1H), 7.44 (ddd, $J = 7.6, 6.4, 2.0$ Hz, 2H), 7.30 – 7.13 (m, 13H), 6.47 (d, $J = 15.8$ Hz, 1H), 5.92 (dt, $J = 15.4, 7.5$ Hz, 1H), 3.34 (s, 2H), 3.31 – 3.17 (m, 2H).

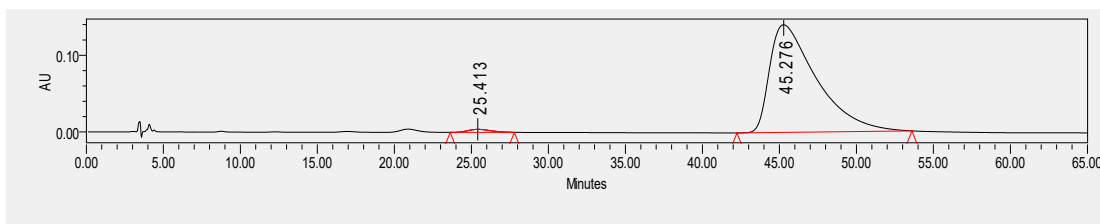
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.1, 164.0, 159.1, 152.0, 145.6, 137.9, 135.1, 134.2, 134.2, 133.8, 132.2, 130.4, 129.4, 129.3, 129.0, 128.5, 128.3, 127.5, 127.0, 127.0, 126.9, 124.8, 124.0, 122.7, 86.2, 84.8, 47.1, 44.1, 32.8.

HRMS (ESI) Calculated for $\text{C}_{35}\text{H}_{26}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 517.1774, Found 517.1777.

IR (neat) 3028, 1752, 1665, 1598, 1490, 1454, 1379, 1267, 1215, 1189, 1161, 1129, 1072, 1025, 966, 928, 897, 838, 754, 691, 528, 499 cm^{-1} .

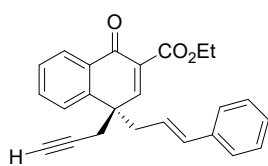


	Retention Time	Area	% Area
1	23.911	15641370	50.14
2	42.928	15553890	49.86



	Retention Time	Area	% Area
1	25.413	410151	1.36
2	45.276	29657342	98.64

Ethyl (R)-4-cinnamyl-1-oxo-4-(prop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B5)



Colorless oil, 86% yield, 93% *ee*; $[\alpha]^{19.5} = 51.2$ ($c = 0.52$ in CH_2Cl_2 , $\lambda = 589$ nm).

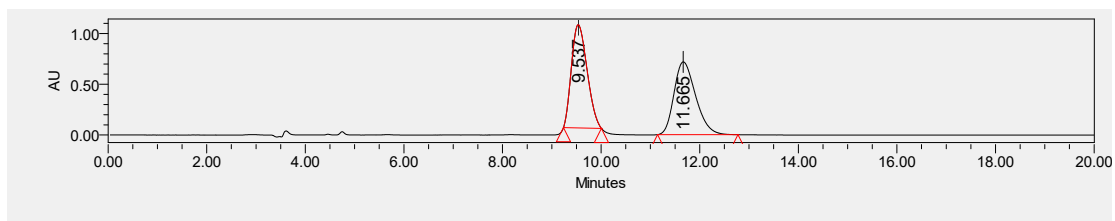
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 9.59$ min, $t_{R(\text{major})} = 11.45$ min.

$^1\text{H NMR}$ (400 MHz, Acetone- d_6) δ 8.11 – 8.09 (m, 1H), 7.89 – 7.87 (m, 1H), 7.74 (d, $J = 3.2$ Hz, 2H), 7.51 – 7.48 (m, 1H), 7.23 – 7.19 (m, 2H), 7.16 – 7.14 (m, 3H), 6.36 (d, $J = 15.8$ Hz, 1H), 5.80 – 5.75 (m, 1H), 4.28 (d, $J = 7.1$ Hz, 2H), 3.11 – 3.08 (m, 4H), 2.37 (t, $J = 2.6$ Hz, 1H), 1.30 (s, 3H).

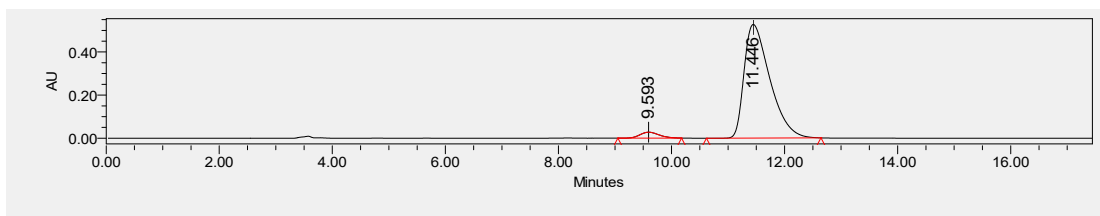
$^{13}\text{C NMR}$ (101 MHz, Acetone- d_6) δ 206.3, 181.1, 165.5, 157.1, 145.4, 137.9, 135.1, 134.9, 134.0, 133.8, 129.4, 128.4, 128.3, 127.4, 127.4, 127.0, 124.6, 80.3, 73.3, 61.7, 46.1, 44.4, 31.3, 14.6.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{22}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 393.1461, Found 393.1463.

IR (neat) 3293, 3028, 2982, 1735, 1664, 1601, 1453, 1380, 1276, 1233, 1162, 1139, 1087, 1019, 967, 929, 862, 752, 647, 514 cm^{-1}

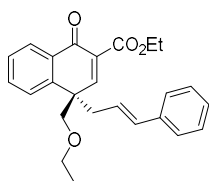


	Retention Time	Area	% Area
1	9.537	22387892	50.61
2	11.665	21850927	49.39



	Retention Time	Area	% Area
1	9.593	647641	3.74
2	11.446	16671273	96.26

Ethyl (R)-4-cinnamyl-4-(ethoxymethyl)-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B6)



Colorless oil, 42% yield, 93% *ee*; $[\alpha]^{13.5} = 69.8$ ($c = 0.32$ in CH_2Cl_2 , $\lambda = 589$ nm).

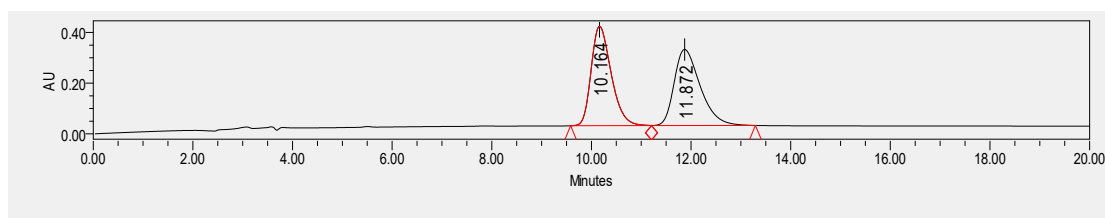
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R}(\text{minor})} = 9.90$ min, $t_{\text{R}(\text{major})} = 11.34$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.09 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.86 (d, $J = 7.8$ Hz, 1H), 7.76 (s, 1H), 7.71 (ddd, $J = 7.9, 7.2, 1.5$ Hz, 1H), 7.48 (ddd, $J = 8.2, 7.3, 1.2$ Hz, 1H), 7.21 – 7.12 (m, 5H), 6.34 (d, $J = 15.7$ Hz, 1H), 5.75 (dd, $J = 15.6, 7.6$ Hz, 1H), 4.25 (t, $J = 7.1$ Hz, 2H), 3.98 – 3.87 (m, 2H), 3.48 – 3.38 (m, 2H), 3.02 (ddd, $J = 7.6, 2.9, 1.3$ Hz, 2H), 1.29 (t, $J = 7.1$ Hz, 3H), 1.04 (t, $J = 7.0$ Hz, 3H)

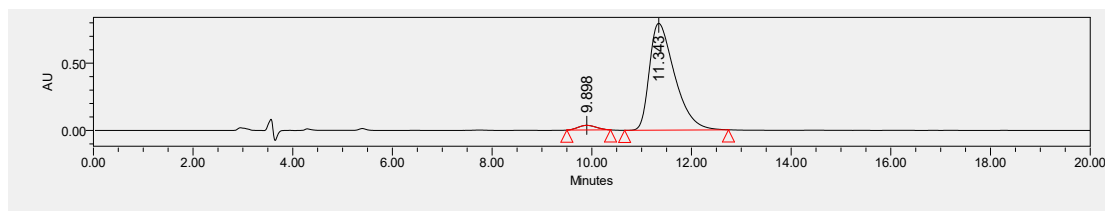
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 157.6, 145.0, 138.0, 134.8, 134.7, 133.9, 133.7, 129.4, 128.3, 128.2, 127.5, 127.4, 126.9, 124.5, 77.9, 67.7, 61.6, 48.1, 41.5, 15.3, 14.6.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{26}\text{O}_4$ ($[\text{M}] + \text{Na}^+$) = 413.1723, Found 413.1721.

IR (neat) 2978, 2869, 1736, 1663, 1601, 1453, 1378, 1277, 1230, 1110, 1020, 966, 929, 754, 695, 620, 514 cm^{-1} .

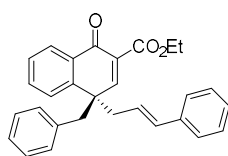


	Retention Time	Area	% Area
1	10.164	10929043	50.05
2	11.872	10905940	49.95



	Retention Time	Area	% Area
1	9.898	879071	3.05
2	11.343	27900035	96.95

Ethyl (R)-4-benzyl-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B7)



Colorless oil, 55% yield, 94% *ee*; $[\alpha]^{13.2} = 13.2$ ($c = 0.46$ in CH_2Cl_2 , $\lambda = 436$ nm).

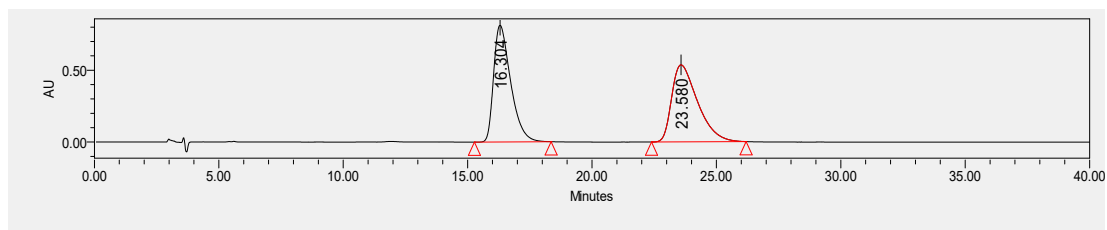
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R}(\text{minor})} = 16.18$ min, $t_{\text{R}(\text{major})} = 22.88$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.04 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.91 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.80 (s, 1H), 7.77 (ddd, $J = 8.0, 7.3, 1.5$ Hz, 1H), 7.44 – 7.40 (m, 1H), 7.21 – 7.17 (m, 2H), 7.15 – 7.10 (m, 3H), 7.04 – 6.99 (m, 3H), 6.82 – 6.78 (m, 2H), 6.40 (d, $J = 15.6$ Hz, 1H), 5.82 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.22 (q, $J = 7.1$ Hz, 2H), 3.54 – 3.44 (m, 2H), 3.33 – 3.07 (m, 2H), 1.28 (t, $J = 7.1$ Hz, 3H).

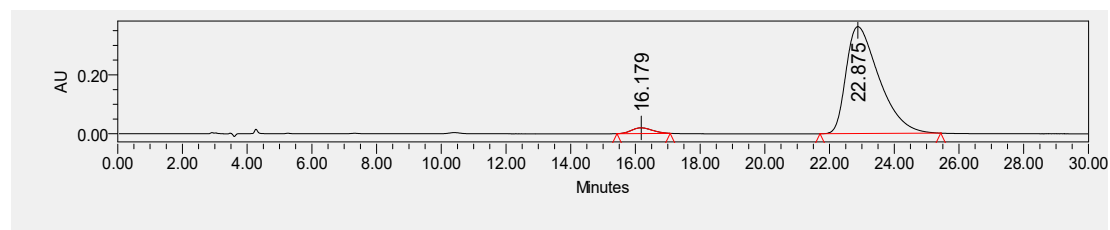
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 180.8, 165.4, 158.7, 145.8, 138.0, 137.0, 134.7, 134.5, 134.0, 133.6, 130.9, 129.4, 128.4, 128.2, 128.1, 128.1, 127.4, 127.2, 127.0, 125.2, 61.5, 48.6, 48.4, 45.3, 14.6.

HRMS (ESI) Calculated for $\text{C}_{29}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 445.1774, Found 445.1775.

IR (neat) 3029, 2982, 1736, 1662, 1601, 1494, 1452, 1380, 1276, 1230, 1159, 1138, 1087, 1020, 966, 929, 748, 699, 617 cm^{-1} .

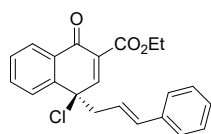


	Retention Time	Area	% Area
1	16.304	38619181	49.95
2	23.580	38699015	50.05



	Retention Time	Area	% Area
1	16.179	863343	3.24
2	22.875	25757539	96.76

Ethyl (R)-4-chloro-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B8)



Colorless oil, 83% yield, 93% *ee*; $[\alpha]^{13.5} = 24.3$ ($c = 0.59$ in CH_2Cl_2 , $\lambda = 589$ nm).

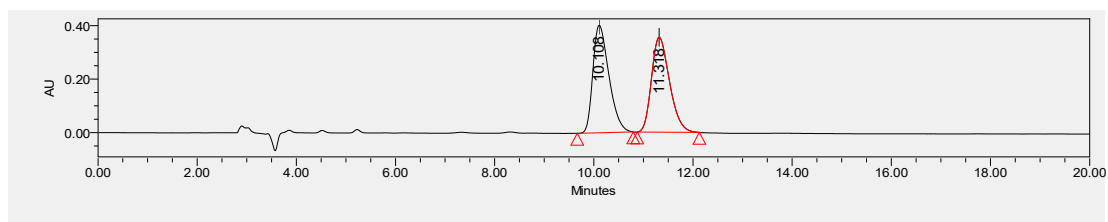
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 11.44$ min, $t_{R(\text{major})} = 10.02$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.05 (ddd, $J = 9.6, 8.0, 1.3$ Hz, 2H), 7.84 (td, $J = 7.7, 1.5$ Hz, 1H), 7.72 (s, 1H), 7.60 (td, $J = 7.6, 1.2$ Hz, 1H), 7.21 (qd, $J = 7.0, 2.4$ Hz, 5H), 6.49 (d, $J = 15.8$ Hz, 1H), 5.87 (dd, $J = 15.6, 7.6$ Hz, 1H), 4.29 (q, $J = 7.1$ Hz, 2H), 3.53 – 3.43 (m, 2H), 1.30 (t, $J = 7.1$ Hz, 3H).

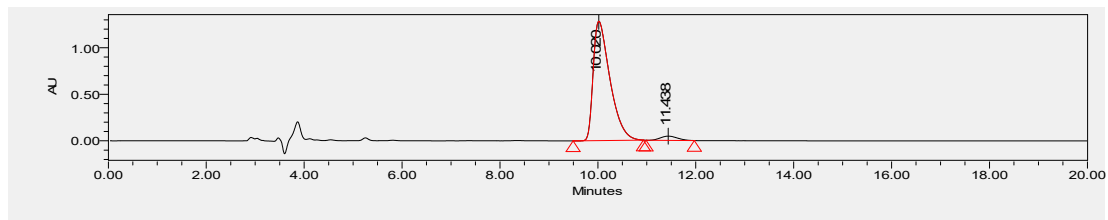
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 180.1, 164.7, 151.4, 143.3, 137.6, 137.0, 134.9, 132.6, 131.0, 130.3, 129.5, 129.3, 128.8, 127.3, 127.2, 122.5, 65.1, 62.2, 48.6, 14.5.

HRMS (ESI) Calculated for $\text{C}_{22}\text{H}_{19}\text{ClO}_3$ ($[\text{M}] + \text{Na}^+$) = 389.0915, Found 389.0912.

IR (neat) 2982, 1740, 1670, 1600, 1453, 1375, 1278, 1230, 1138, 1087, 968, 930, 757, 694, 511 cm^{-1} .

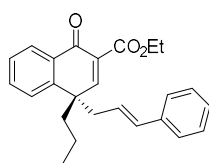


	Retention Time	Area	% Area
1	10.108	9053558	50.25
2	11.318	8961994	49.75



	Retention Time	Area	% Area
1	10.020	30429365	96.48
2	11.438	1109263	3.52

Ethyl (S)-4-cinnamyl-1-oxo-4-propyl-1,4-dihydronaphthalene-2-carboxylate (B9)



Colorless oil, 62% yield, 93% *ee*; $[\alpha]^{13.5} = 100.2$ ($c = 0.47$ in CH_2Cl_2 , $\lambda = 589$ nm).

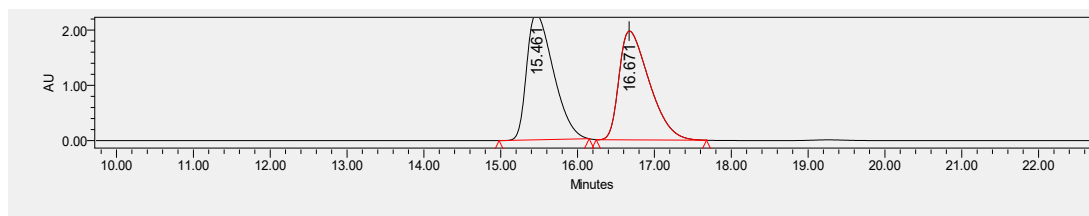
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 16.37$ min, $t_{R(\text{major})} = 15.02$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.09 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.79 (d, $J = 7.4$ Hz, 1H), 7.74 – 7.70 (m, 1H), 7.62 (s, 1H), 7.48 – 7.44 (m, 1H), 7.22 – 7.17 (m, 2H), 7.13 (td, $J = 5.6, 1.5$ Hz, 3H), 6.31 (d, $J = 15.7$ Hz, 1H), 5.75 (dd, $J = 15.6, 7.7$ Hz, 1H), 4.25 (t, $J = 7.1$ Hz, 2H), 3.05 – 2.91 (m, 2H), 2.31 – 2.07 (m, 2H), 1.02 (dq, $J = 12.8, 6.7, 6.0$ Hz, 1H), 0.80 – 0.74 (m, 4H).

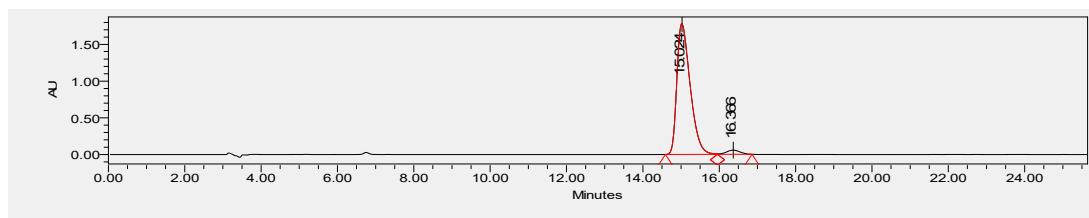
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.7, 159.3, 146.6, 138.1, 134.9, 134.7, 134.1, 133.9, 129.4, 128.2, 128.0, 127.4, 127.4, 126.9, 125.0, 61.6, 47.4, 46.3, 44.1, 18.9, 14.6, 14.5.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 397.1774, Found 397.1772.

IR (neat) 3028, 2959, 2932, 2872, 1737, 1661, 1601, 1452, 1380, 1274, 1231, 1141, 1087, 1022, 966, 927, 748, 695, 619, 513 cm^{-1} .

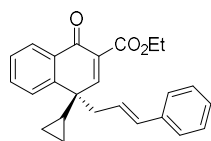


	Retention Time	Area	% Area
1	15.461	54777180	50.46
2	16.671	53779228	49.54



	Retention Time	Area	% Area
1	15.024	43097389	96.75
2	16.366	1448819	3.25

Ethyl (R)-4-cinnamyl-4-cyclopropyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B10)



Colorless oil, 34% yield, 78% *ee*; $[\alpha]^{13.4} = 74.0$ ($c = 0.19$ in CH_2Cl_2 , $\lambda = 589$ nm).

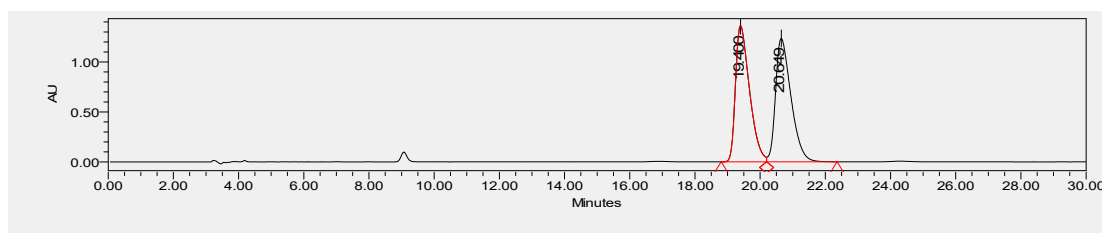
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 17.64$ min, $t_{R(\text{major})} = 18.51$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.07 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.90 (dd, $J = 8.1, 1.1$ Hz, 1H), 7.73 (ddd, $J = 8.0, 7.2, 1.5$ Hz, 1H), 7.55 (s, 1H), 7.47 (ddd, $J = 8.2, 7.2, 1.1$ Hz, 1H), 7.21 – 7.16 (m, 2H), 7.14 – 7.11 (m, 3H), 6.37 (d, $J = 15.8$ Hz, 1H), 5.82 – 5.74 (m, 1H), 4.27 – 4.21 (m, 2H), 3.15 – 2.91 (m, 2H), 1.48 (tt, $J = 8.1, 5.8$ Hz, 1H), 1.28 (t, $J = 7.1$ Hz, 3H), 0.61 – 0.56 (m, 2H), 0.46 – 0.41 (m, 1H), 0.28 – 0.23 (m, 1H).

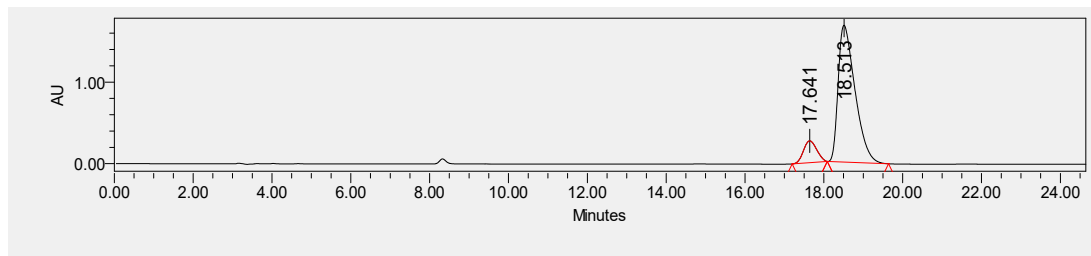
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.1, 165.6, 157.0, 147.2, 138.1, 134.6, 134.6, 133.8, 133.0, 129.4, 128.2, 128.1, 127.3, 126.9, 125.2, 61.7, 45.2, 42.9, 23.0, 14.6, 14.2.

HRMS (ESI) Calculated for $\text{C}_{25}\text{H}_{24}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 395.1618, Found 395.1616.

IR (neat) 2983, 1737, 1664, 1601, 1453, 1380, 1278, 1230, 1136, 1086, 1022, 966, 928, 761, 695 cm^{-1} .

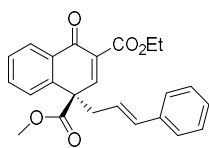


	Retention Time	Area	% Area
1	19.400	40604549	49.90
2	20.649	40762037	50.10



	Retention Time	Area	% Area
1	17.641	6147421	11.00
2	18.513	49758753	89.00

3-ethyl 1-methyl (R)-1-cinnamyl-4-oxo-1,4-dihydronaphthalene-1,3-dicarboxylate (B11)



Colorless oil, 36% yield, 80% *ee*; $[\alpha]^{13.8} = 115.0$ ($c = 0.22$ in CH_2Cl_2 , $\lambda = 589$ nm).

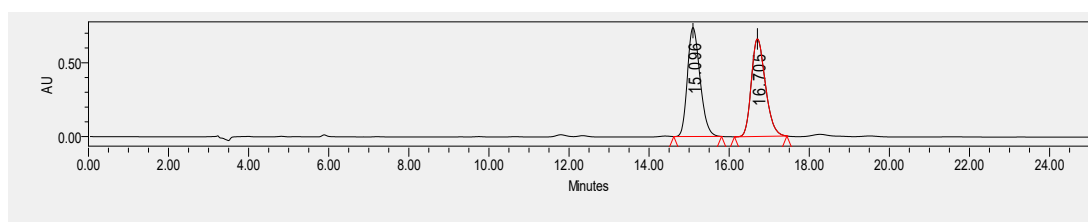
HPLC: Daicel chiralcel IE, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 14.55$ min, $t_{R(\text{major})} = 15.94$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dt, $J = 7.6, 1.1$ Hz, 1H), 7.78 – 7.73 (m, 3H), 7.56 (ddd, $J = 8.2, 6.0, 2.4$ Hz, 1H), 7.24 – 7.19 (m, 2H), 7.16 (dq, $J = 5.6, 1.9, 1.4$ Hz, 3H), 6.38 (d, $J = 15.8$ Hz, 1H), 5.81 – 5.73 (m, 1H), 4.30 – 4.24 (m, 2H), 3.70 (s, 3H), 3.30 (ddd, $J = 7.7, 6.7, 1.3$ Hz, 2H), 1.29 (t, $J = 7.1$ Hz, 3H).

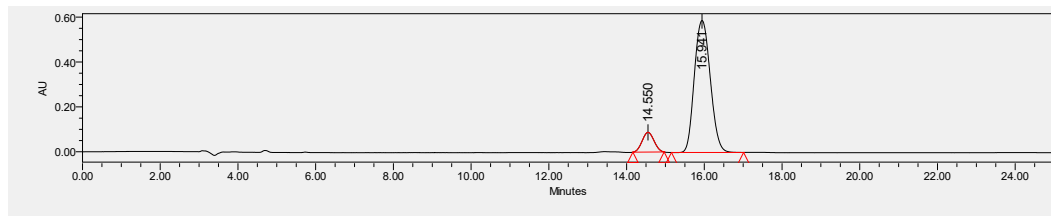
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 180.6, 171.6, 165.3, 151.6, 141.3, 137.8, 136.0, 134.5, 134.3, 132.8, 129.4, 129.3, 128.4, 128.0, 127.6, 127.0, 123.4, 61.9, 53.9, 53.5, 43.2, 14.6.

HRMS (ESI) Calculated for $\text{C}_{24}\text{H}_{22}\text{O}_5$ ($[\text{M}] + \text{Na}^+$) = 413.1359, Found 413.1358.

IR (neat) 2955, 1668, 1600, 1452, 1379, 1280, 1230, 1137, 1086, 1020, 969, 927, 754, 695 cm^{-1} .

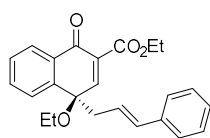


	Retention Time	Area	% Area
1	15.096	16152875	50.05
2	16.705	16120807	49.95



	Retention Time	Area	% Area
1	14.550	1865585	10.03
2	15.941	16733800	89.97

Ethyl (R)-4-cinnamyl-4-ethoxy-1-oxo-1,4-dihydronaphthalene-2-carboxylate (A12)



Colorless oil, 30% yield, 5% *ee*.

HPLC: Daicel chiralcel IC *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm,

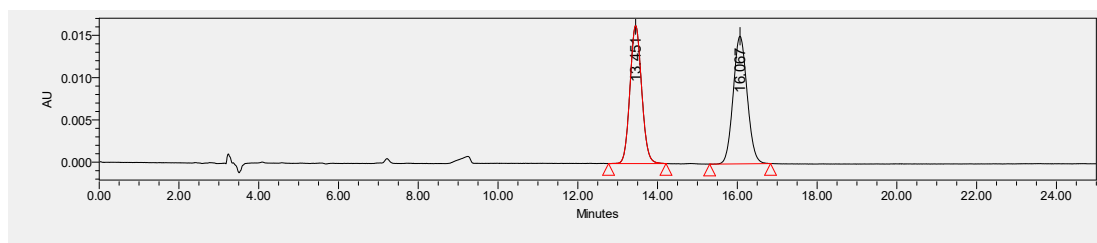
$t_{R(\text{minor})} = 13.45$ min, $t_{R(\text{major})} = 16.07$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.04 (d, $J = 7.9$ Hz, 1H), 7.81 – 7.77 (m, 2H), 7.61 (s, 1H), 7.55 (m, 1H), 7.24 (m, 2H), 7.19 – 7.15 (m, 3H), 6.26 (d, $J = 15.9$ Hz, 1H), 5.82 (dt, $J = 15.6, 7.6$ Hz, 1H), 4.26 (t, $J = 7.2$ Hz, 2H), 3.40 – 3.34 (m, 1H), 3.20 – 3.14 (m, 1H), 2.97 – 2.92 (m, 1H), 2.88 – 2.82 (m, 1H), 1.29 (t, $J = 7.1$ Hz, 3H), 1.17 (t, $J = 7.0$ Hz, 3H).

^{13}C NMR (101 MHz, Acetone- d_6) δ 180.5, 164.9, 155.4, 144.2, 138.1, 136.1, 135.8, 134.4, 133.1, 129.4, 129.4, 128.3, 127.3, 127.1, 127.0, 123.3, 77.6, 61.9, 61.7, 47.5, 16.1, 14.5.

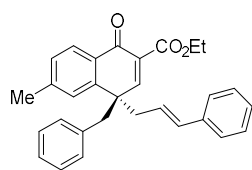
HRMS (ESI) Calculated for $\text{C}_{24}\text{H}_{24}\text{O}_4$ ($[\text{M}+\text{Na}^+]$) = 399.1567, Found 399.1568.

IR (neat) 2978, 2931, 1738, 1672, 1600, 1451, 1368, 1276, 1073, 1019, 970, 922, 757, 697, 579, 450 cm^{-1} .



	Retention Time	Area	% Area
1	13.451	331169	47.38
2	16.067	367779	52.62

Ethyl (R)-4-benzyl-4-cinnamyl-6-methyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B13)



Colorless oil, 59% yield, 92% *ee*; $[\alpha]^{13.7} = 23.2$ ($c = 0.50$ in CH_2Cl_2 , $\lambda = 589$ nm).

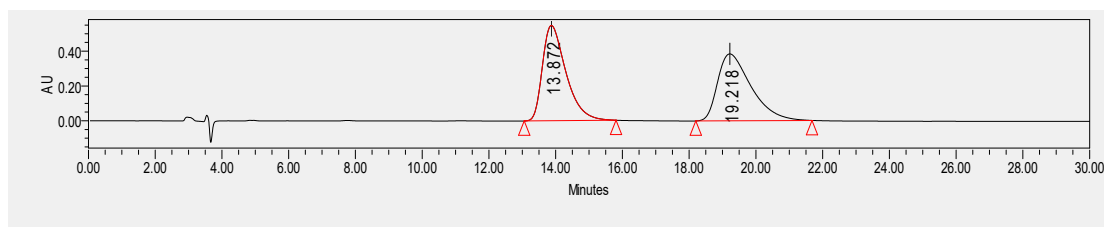
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 13.64$ min, $t_{R(\text{major})} = 18.18$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 7.87 (s, 1H), 7.81 (d, $J = 8.0$ Hz, 1H), 7.74 (s, 1H), 7.25 – 7.12 (m, 6H), 7.05 – 6.99 (m, 3H), 6.84 – 6.80 (m, 2H), 6.41 (d, $J = 15.7$ Hz, 1H), 5.81 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.21 (q, $J = 7.1$ Hz, 2H), 3.53 – 3.40 (m, 2H), 3.31 – 3.04 (m, 2H), 2.52 (s, 3H), 1.27 (t, $J = 7.1$ Hz, 3H).

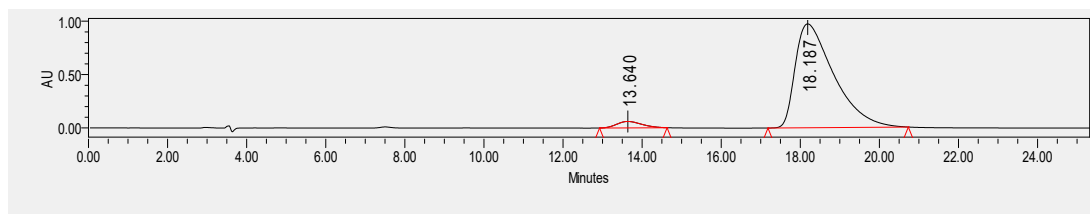
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 180.6, 165.6, 158.4, 145.9, 144.3, 138.1, 137.1, 134.6, 134.5, 131.7, 131.0, 129.4, 129.1, 128.4, 128.4, 128.2, 127.4, 127.3, 126.9, 125.3, 61.4, 48.4, 48.3, 45.3, 22.0, 14.6.

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{28}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 459.1931, Found 459.1927.

IR (neat) 3028, 2981, 1736, 1661, 1608, 1494, 1450, 1381, 1275, 1232, 1160, 1085, 1021, 966, 931, 842, 799, 738, 699, 529, 480 cm^{-1} .

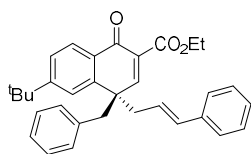


	Retention Time	Area	% Area
1	13.872	26767449	50.07
2	19.218	26689224	49.93



	Retention Time	Area	% Area
1	13.640	2642178	3.85
2	18.187	65970340	96.15

Ethyl (R)-4-benzyl-6-(tert-butyl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B14)



Colorless oil, 52% yield, 91% *ee*; $[\alpha]^{18.6} = 14.6$ ($c = 0.46$ in CH_2Cl_2 , $\lambda = 589$ nm).

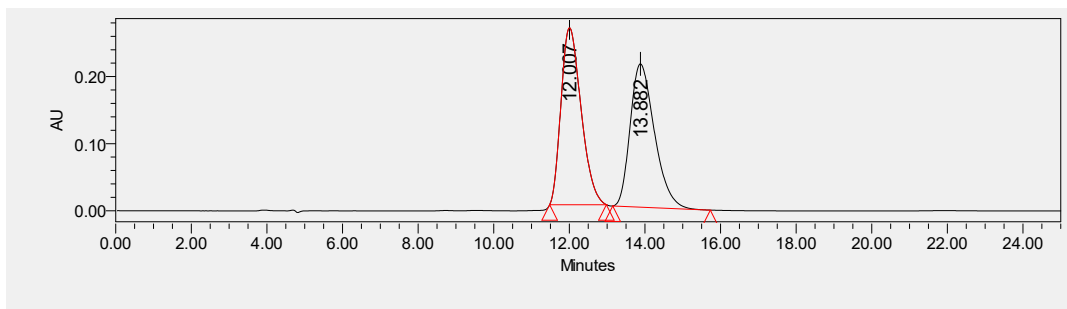
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 12.03$ min, $t_{R(\text{major})} = 13.82$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.00 (d, $J = 1.9$ Hz, 1H), 7.83 (d, $J = 8.4$ Hz, 1H), 7.79 (s, 1H), 7.45 (dd, $J = 8.4, 1.9$ Hz, 1H), 7.22 – 7.17 (m, 2H), 7.14 (m, 3H), 7.02 (m, 3H), 6.82 (dd, $J = 7.1, 2.4$ Hz, 2H), 6.38 (d, $J = 15.6$ Hz, 1H), 5.85 (dt, $J = 15.4, 7.5$ Hz, 1H), 4.23 (q, $J = 7.1$ Hz, 2H), 3.60 – 3.41 (m, 2H), 3.37 – 3.05 (m, 2H), 1.45 (s, 9H), 1.28 (t, $J = 7.1$ Hz, 3H).

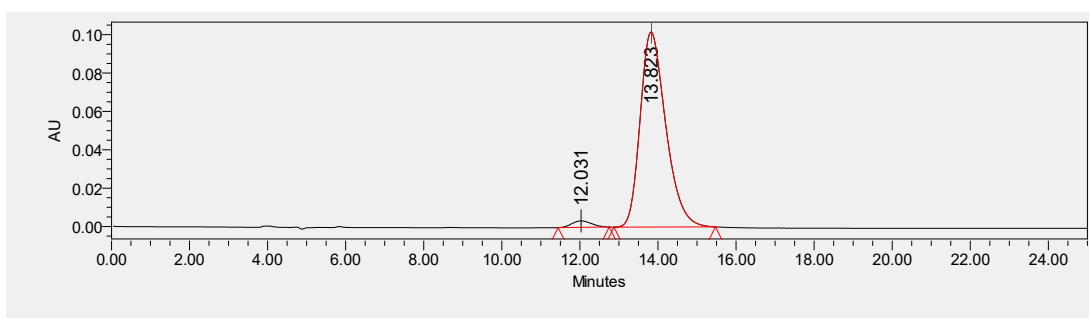
^{13}C NMR (101 MHz, Acetone- d_6) δ 180.6, 165.6, 158.7, 156.9, 145.3, 138.1, 137.2, 134.7, 134.5, 131.6, 131.0, 129.4, 128.4, 128.2, 127.4, 127.2, 126.9, 125.4, 125.2, 125.1, 61.4, 48.7, 48.3, 45.3, 36.0, 31.5, 14.6.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 501.2400, Found 502.2381.

IR (neat) 3028, 2962, 1736, 1663, 1605, 1490, 1451, 1417, 1381, 1270, 1238, 1171, 1022, 966, 930, 850, 806, 744, 699, 597, 491 cm^{-1} .

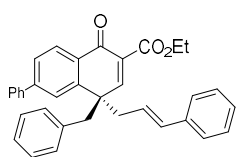


	Retention Time	Area	% Area
1	12.007	9714877	50.47
2	13.882	9533159	49.53



	Retention Time	Area	% Area
1	12.031	118827	2.50
2	13.823	4626142	97.50

Ethyl (R)-4-benzyl-4-cinnamyl-1-oxo-6-phenyl-1,4-dihydronaphthalene-2-carboxylate (B15)



Colorless oil, 45% yield, 94% *ee*; $[\alpha]^{18.6} = 87.7$ ($c = 0.34$ in CH_2Cl_2 , $\lambda = 589$ nm).

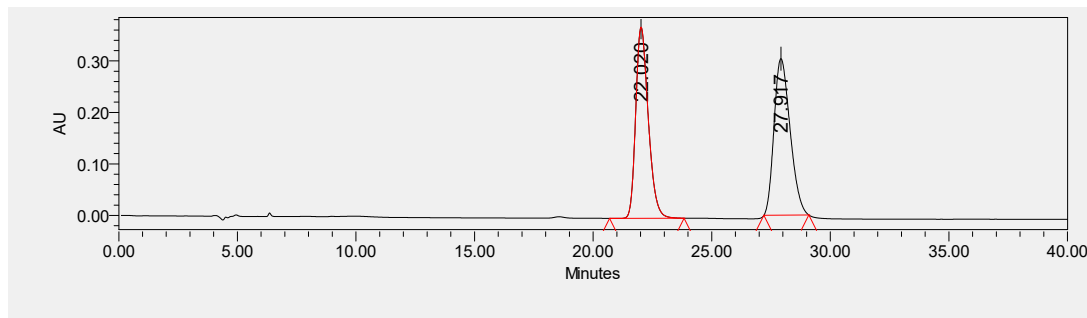
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 23.31$ min, $t_{R(\text{major})} = 29.21$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.31 (d, $J = 1.9$ Hz, 1H), 7.99 (d, $J = 8.2$ Hz, 1H), 7.89 – 7.85 (m, 2H), 7.84 (s, 1H), 7.72 (dd, $J = 8.2, 1.8$ Hz, 1H), 7.55 (t, $J = 7.5$ Hz, 2H), 7.50 – 7.42 (m, 1H), 7.21 – 7.10 (m, 5H), 7.04 (m, 3H), 6.88 (dd, $J = 6.4, 3.2$ Hz, 2H), 6.45 (d, $J = 15.8$ Hz, 1H), 5.91 (dt, $J = 15.4, 7.5$ Hz, 1H), 4.24 (q, $J = 7.1$ Hz, 2H), 3.60 (dd, $J = 73.5, 13.4$ Hz, 2H), 3.49 – 3.11 (m, 2H), 1.29 (t, $J = 7.1$ Hz, 3H).

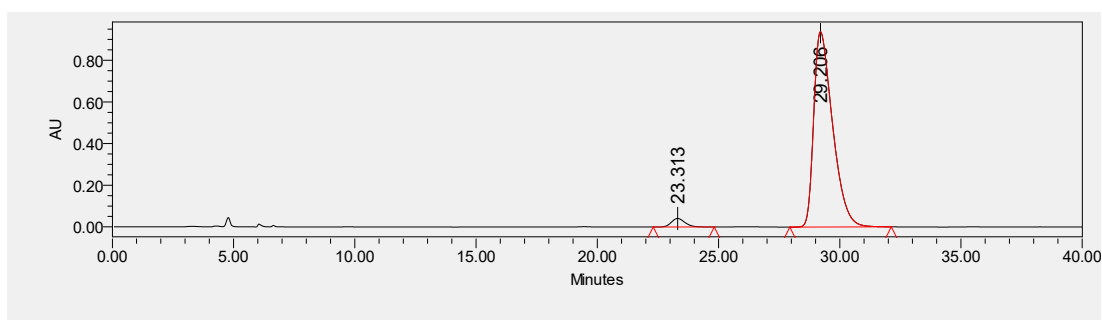
^{13}C NMR (101 MHz, Acetone- d_6) δ 180.5, 165.5, 158.9, 146.4, 145.9, 140.9, 138.0, 137.2, 134.7, 134.5, 132.8, 131.0, 130.0, 129.4, 129.3, 128.5, 128.4, 128.2, 128.0, 127.4, 127.0, 126.8, 126.5, 125.4, 61.5, 48.8, 48.3, 45.2, 14.6.

HRMS (ESI) Calculated for $\text{C}_{35}\text{H}_{34}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 501.2400, Found 501.2381.

IR (neat) 3029, 2982, 2927, 1734, 1661, 1603, 1492, 1449, 1409, 1381, 1268, 1235, 1166, 1090, 1022, 967, 927, 849, 806, 760, 698, 487 cm^{-1} .

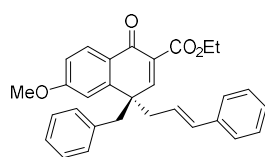


	Retention Time	Area	% Area
1	22.020	13650694	48.87
2	27.917	14279248	51.13



	Retention Time	Area	% Area
1	23.313	1603846	3.07
2	29.206	50565777	96.93

Ethyl (R)-4-benzyl-4-cinnamyl-6-methoxy-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B16)



Colorless oil, 61% yield, 93% *ee*; $[\alpha]^{18.6} = 21.0$ ($c = 0.53$ in CH_2Cl_2 , $\lambda = 589$ nm).

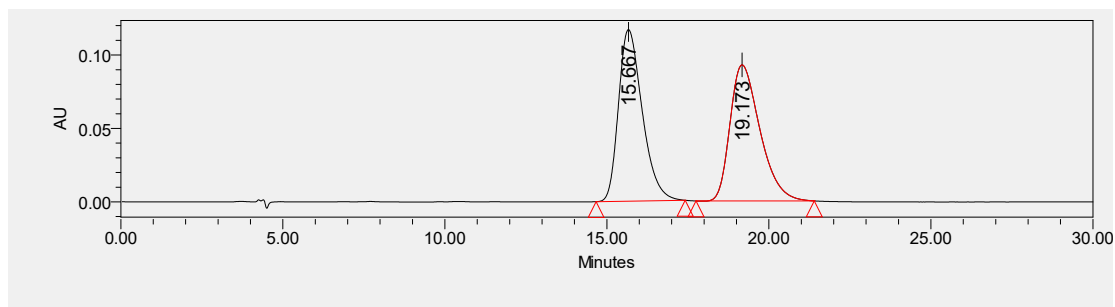
HPLC: Daicel chiralce ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 16.59$ min, $t_{R(\text{major})} = 19.78$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 7.87 (d, $J = 8.8$ Hz, 1H), 7.70 (s, 1H), 7.50 (d, $J = 2.4$ Hz, 1H), 7.21 – 7.11 (m, 5H), 7.04 (m, 3H), 6.98 (dd, $J = 8.8, 2.5$ Hz, 1H), 6.87 (dd, $J = 6.5, 3.1$ Hz, 2H), 6.42 (d, $J = 15.7$ Hz, 1H), 5.84 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.21 (q, $J = 7.1$ Hz, 2H), 4.00 (s, 3H), 3.55 – 3.40 (m, 2H), 3.33 – 3.03 (m, 2H), 1.27 (t, $J = 7.1$ Hz, 3H).

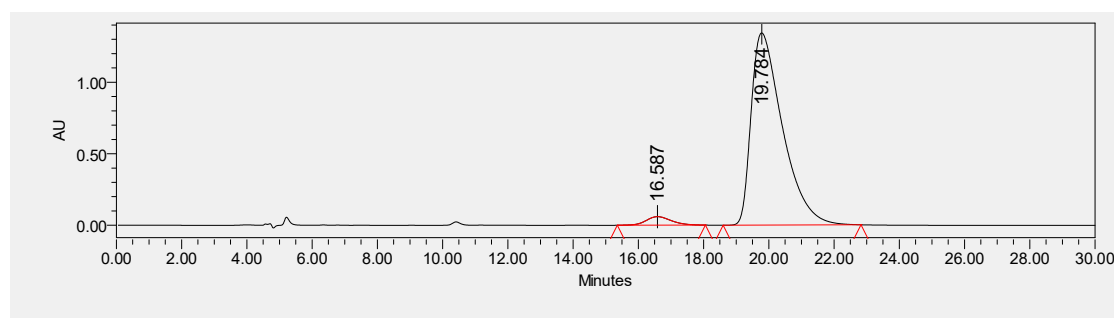
^{13}C NMR (101 MHz, Acetone- d_6) δ 179.9, 165.7, 164.3, 157.8, 148.2, 138.1, 137.1, 134.5, 134.5, 130.9, 129.6, 129.4, 128.4, 128.2, 127.5, 127.4, 126.9, 125.3, 115.2, 111.8, 61.3, 56.2, 48.6, 48.4, 45.4, 14.6.

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{28}\text{O}_4$ ($[\text{M}] + \text{Na}^+$) = 475.1880, Found 475.1886.

IR (neat) 3028, 2360, 2242, 1734, 1659, 1600, 1492, 1450, 1381, 1275, 1233, 1085, 1022, 968, 931, 801, 744, 699, 576, 489 cm^{-1} .

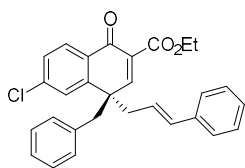


	Retention Time	Area	% Area
1	15.667	5949304	50.02
2	19.173	5944016	49.98



	Retention Time	Area	% Area
1	16.587	3214549	3.47
2	19.784	89548507	96.53

Ethyl (R)-4-benzyl-6-chloro-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B17)



Colorless oil, 51% yield, 88% *ee*; $[\alpha]^{13.4} = -11.9$ ($c = 0.37$ in CH_2Cl_2 , $\lambda = 436$ nm).

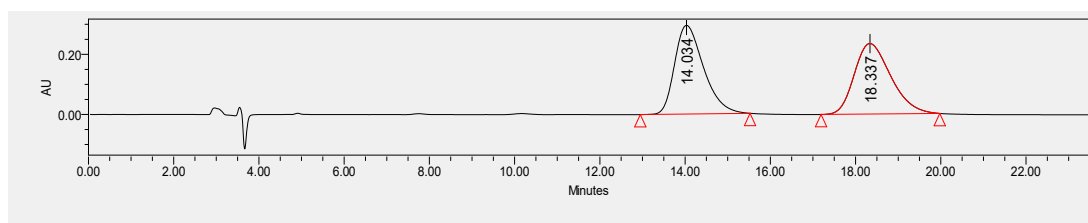
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R}(\text{minor})} = 14.40$ min, $t_{\text{R}(\text{major})} = 18.49$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (d, $J = 2.0$ Hz, 1H), 7.88 (d, $J = 8.5$ Hz, 1H), 7.84 (s, 1H), 7.45 (dd, $J = 8.5, 2.0$ Hz, 1H), 7.22 – 7.13 (m, 5H), 7.07 – 7.03 (m, 3H), 6.86 – 6.82 (m, 2H), 6.43 (d, $J = 15.7$ Hz, 1H), 5.86 (dt, $J = 15.4, 7.5$ Hz, 1H), 4.23 (q, $J = 7.1$ Hz, 2H), 3.58 – 3.47 (m, 2H), 3.38 – 3.10 (m, 2H), 1.28 (t, $J = 7.1$ Hz, 3H).

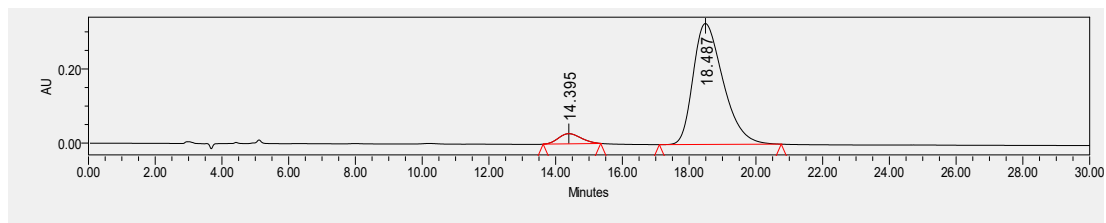
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 179.9, 165.1, 158.8, 147.9, 139.8, 137.9, 136.8, 135.0, 134.3, 132.6, 130.9, 129.4, 129.3, 128.6, 128.6, 128.3, 128.2, 127.6, 127.00, 124.9, 61.6, 48.8, 48.2, 45.0, 14.6, 14.5.

HRMS (ESI) Calculated for $\text{C}_{29}\text{H}_{25}\text{ClO}_3$ ($[\text{M}] + \text{Na}^+$) = 479.1384, Found 479.1384.

IR (neat) 3028, 2982, 1736, 1665, 1599, 1491, 1442, 1379, 1276, 1232, 1162, 1138, 1086, 1020, 967, 928, 799, 756, 693, 619, 546, 509 cm^{-1} .

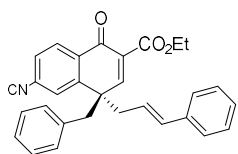


	Retention Time	Area	% Area
1	14.034	13923040	49.99
2	18.337	13930135	50.01



	Retention Time	Area	% Area
1	14.395	1291349	5.96
2	18.487	20371987	94.04

Ethyl (R)-4-benzyl-4-cinnamyl-6-cyano-1,4-dihydronaphthalene-2-carboxylate (B18)



Colorless oil, 35% yield, 80% *ee*; $[\alpha]^{18.6} = 46.0$ ($c = 0.28$ in CH_2Cl_2 , $\lambda = 589$ nm).

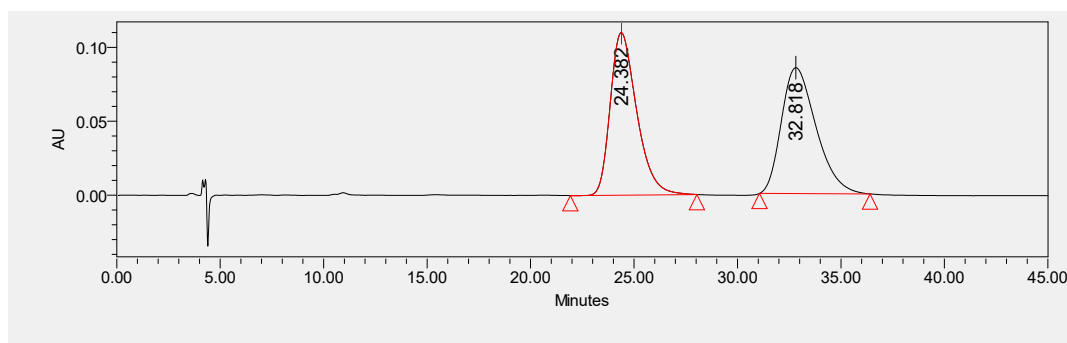
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 26.28$ min, $t_{R(\text{major})} = 34.73$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.57 (d, $J = 1.5$ Hz, 1H), 8.01 (d, $J = 8.1$ Hz, 1H), 7.97 (s, 1H), 7.80 (dd, $J = 8.1, 1.5$ Hz, 1H), 7.21 – 7.12 (m, 5H), 7.04 (m, 3H), 6.83 (dd, $J = 6.4, 3.1$ Hz, 2H), 6.45 (d, $J = 15.7$ Hz, 1H), 5.88 (dt, $J = 15.5, 7.5$ Hz, 1H), 4.25 (q, $J = 7.1$ Hz, 2H), 3.65 – 3.52 (m, 2H), 3.32 (ddd, $J = 97.4, 14.5, 8.0$ Hz, 2H), 1.29 (t, $J = 7.1$ Hz, 3H).

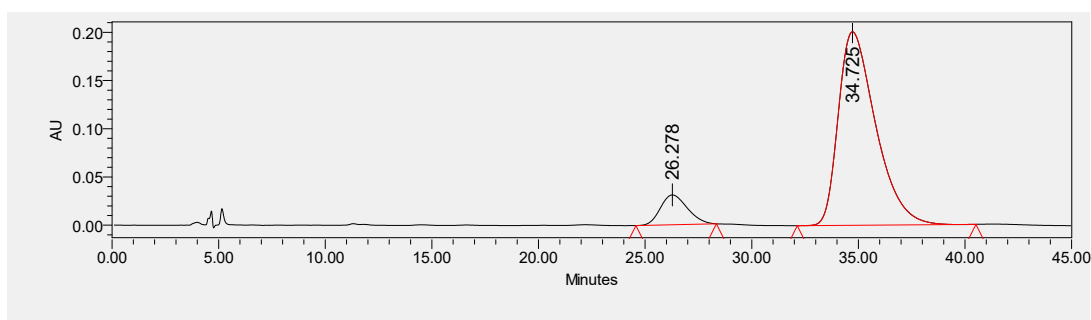
^{13}C NMR (101 MHz, Acetone- d_6) δ 179.6, 164.8, 159.7, 146.7, 137.8, 136.7, 136.5, 135.2, 134.3, 132.9, 131.3, 131.0, 129.4, 128.6, 128.3, 128.1, 127.6, 127.0, 124.7, 119.0, 116.9, 61.7, 49.0, 48.1, 44.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{25}\text{NO}_3$ ($[\text{M}] + \text{Na}^+$) = 470.1727, Found 470.1731.

IR (neat) 3030, 2927, 2233, 1734, 1667, 1605, 1494, 1449, 1416, 1382, 1273, 1230, 1154, 1082, 1020, 969, 930, 853, 804, 742, 699, 587, 495 cm^{-1} .

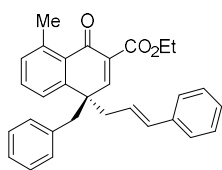


	Retention Time	Area	% Area
1	24.382	9750522	49.57
2	32.818	9918282	50.43



	Retention Time	Area	% Area
1	26.278	2719661	10.03

Ethyl (R)-4-benzyl-4-cinnamyl-8-methyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B19)



Colorless oil, 62% yield, 60% *ee*; $[\alpha]^{13.3} = -25.9$ ($c = 0.51$ in CH_2Cl_2 , $\lambda = 436$ nm).

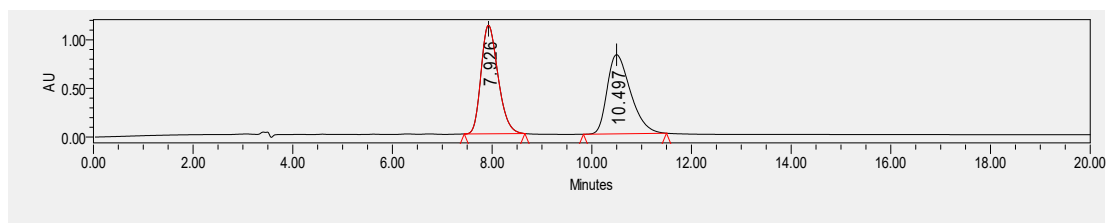
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 8.04$ min, $t_{R(\text{major})} = 10.62$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 7.87 (d, $J = 7.9$ Hz, 1H), 7.65 – 7.56 (m, 2H), 7.26 – 7.08 (m, 6H), 7.07 – 6.98 (m, 3H), 6.86 – 6.77 (m, 2H), 6.41 (d, $J = 15.8$ Hz, 1H), 5.83 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.21 (q, $J = 7.1$ Hz, 2H), 3.42 (q, $J = 13.3$ Hz, 2H), 3.31 – 3.01 (m, 2H), 2.52 (s, 3H), 1.27 (t, $J = 7.1$ Hz, 3H).

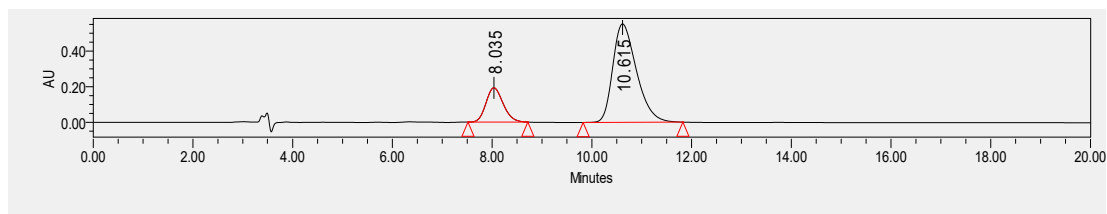
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 183.3, 165.7, 155.5, 147.2, 141.2, 138.1, 137.1, 136.2, 134.5, 132.7, 132.4, 131.8, 131.1, 129.4, 128.4, 128.2, 127.4, 127.0, 126.4, 125.4, 61.4, 49.1, 48.6, 45.7, 23.7, 14.6.

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{28}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 459.1931, Found 459.1926.

IR (neat) 3028, 2980, 2928, 1735, 1665, 1593, 1494, 1469, 1450, 1422, 1376, 1269, 1229, 1126, 1088, 1021, 966, 928, 792, 749, 699, 476 cm^{-1} .

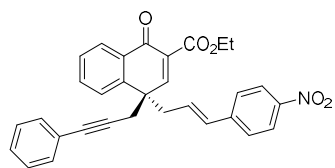


	Retention Time	Area	% Area
1	7.926	26443859	50.00
2	10.497	26446568	50.00



	Retention Time	Area	% Area
1	8.035	4603208	20.17
2	10.615	18222112	79.83

Ethyl (R,E)-4-(3-(4-nitrophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B20)



in CH₂Cl₂, λ = 589 nm). White solid, Mp: 37–40 °C, 76% yield, 90% *ee*; [α]^{14.0} = -22.3 (*c* = 0.72)

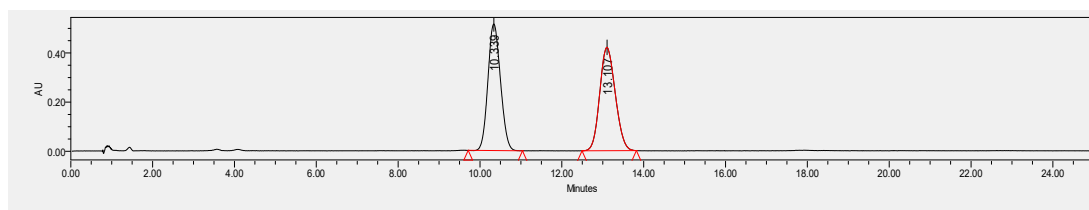
SFC Chiralcel BYPASS, CO₂/MeOH = 80/20, 1.5 mL/min, λ = 224 nm, *t*_{R(minor)} = 10.34 min, *t*_{R(major)} = 12.95 min

¹H NMR (400 MHz, Acetone-d₆) δ 8.16 – 8.03 (m, 3H), 7.95 (d, *J* = 7.9 Hz, 1H), 7.80 (s, 1H), 7.75 (ddd, *J* = 8.0, 7.2, 1.5 Hz, 1H), 7.50 (ddd, *J* = 8.2, 7.3, 1.1 Hz, 1H), 7.45 – 7.42 (m, 2H), 7.30 – 7.22 (m, 3H), 7.21 – 7.16 (m, 2H), 6.61 – 6.55 (m, 1H), 6.19 – 6.11 (m, 1H), 4.27 (q, *J* = 7.1 Hz, 2H), 3.35 – 3.20 (m, 4H), 1.28 (t, *J* = 7.1 Hz, 3H).

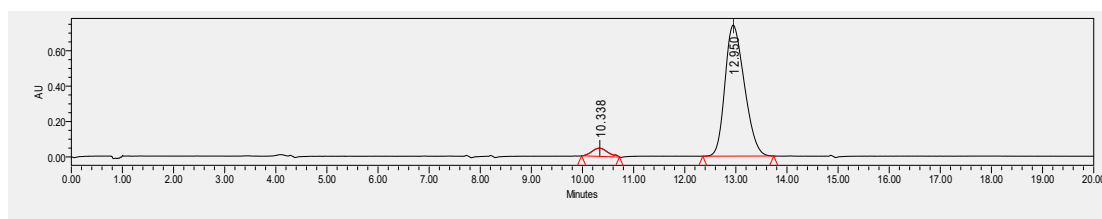
¹³C{¹H} NMR (101 MHz, Acetone-d₆) δ 181.1, 165.6, 156.8, 147.8, 145.4, 144.4, 135.3, 134.1, 133.8, 133.1, 132.2, 130.5, 129.3, 129.0, 128.5, 127.8, 127.5, 127.4, 124.7, 124.0, 86.1, 84.8, 61.7, 46.6, 44.1, 32.9, 14.6, 14.4.

HRMS (ESI) Calculated for C₃₁H₂₅NO₅ ([M]⁺+Na⁺) = 514.1625, Found 514.1626.

IR (neat) 2982, 1734, 1662, 1597, 1514, 1490, 1453, 1379, 1340, 1276, 1232, 1181, 1138, 1109, 1087, 1018, 971, 928, 860, 831, 758, 692, 636, 528 cm⁻¹.

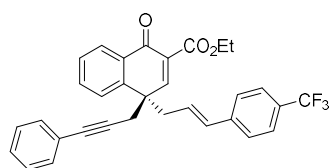


	Retention Time	Area	% Area
1	10.339	10961098	49.84
2	13.107	11030813	50.16



	Retention Time	Area	% Area
1	10.338	1007441	4.91
2	12.950	19497495	95.09

Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(4-(trifluoromethyl)phenyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B21)



White solid, Mp: 34–37 °C, 54% yield, 92% *ee*; $[\alpha]^{14.0} = -30.3$ ($c = 0.52$ in CH_2Cl_2 , $\lambda = 589$ nm).

HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 95/5, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 28.80$ min, $t_{R(\text{major})} = 30.98$ min.

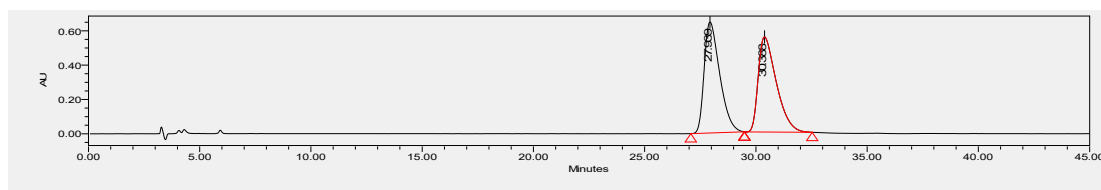
^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.8, 1.5$ Hz, 1H), 7.94 (dd, $J = 8.0, 1.0$ Hz, 1H), 7.79 (s, 1H), 7.75 (td, $J = 7.7, 1.5$ Hz, 1H), 7.55 (d, $J = 8.2$ Hz, 2H), 7.49 (td, $J = 7.6, 1.0$ Hz, 1H), 7.39 (d, $J = 8.1$ Hz, 2H), 7.26 (qd, $J = 4.7, 1.6$ Hz, 3H), 7.21 – 7.16 (m, 2H), 6.52 (d, $J = 15.7$ Hz, 1H), 6.04 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.32 – 3.16 (m, 4H), 1.28 (t, $J = 7.1$ Hz, 3H).

$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 156.9, 145.5, 141.9, 135.3, 134.1, 133.9, 133.6, 132.3, 129.3, 129.0, 128.5, 128.4, 127.5, 127.5, 127.4, 126.4, 126.4, 126.3, 126.3, 124.1, 86.1, 84.8, 61.7, 46.6, 44.0, 32.9, 14.6.

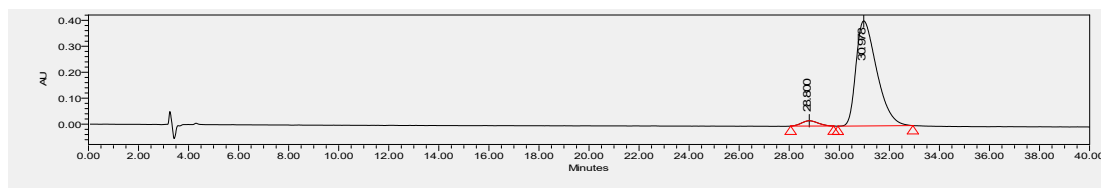
^{19}F NMR (377 MHz, Acetone- d_6) δ -63.0.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{25}\text{F}_3\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 537.1648, Found 537.1651.

IR (neat) 2984, 1736, 1665, 1602, 1490, 1454, 1380, 1325, 1277, 1233, 1164, 1120, 1067, 1017, 970, 929, 860, 759, 596, 526 cm^{-1} .

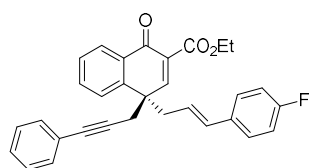


	Retention Time	Area	% Area
1	27.939	31409931	50.08
2	30.388	31303501	49.92



	Retention Time	Area	% Area
1	28.800	945659	3.90
2	30.978	23273402	96.10

Ethyl (R,E)-4-(3-(4-fluorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B22)



Colorless oil, 84% yield, 94% *ee*; $[\alpha]^{14.2} = -26.5$ ($c = 0.75$ in CH_2Cl_2 , $\lambda = 589$ nm).

HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 254$ nm, $t_{R(\text{minor})} = 19.73$ min, $t_{R(\text{major})} = 23.53$ min.

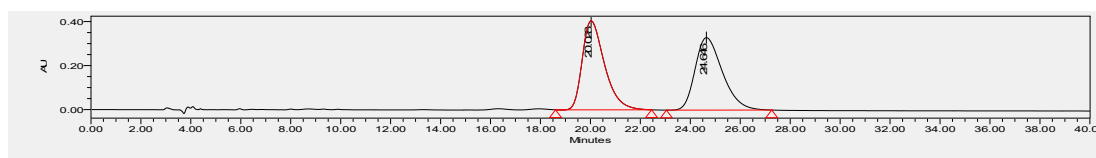
^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.92 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.77 (s, 1H), 7.76 – 7.72 (m, 1H), 7.51 – 7.46 (m, 1H), 7.26 (pd, $J = 4.3, 1.8$ Hz, 3H), 7.23 – 7.17 (m, 4H), 7.00 – 6.94 (m, 2H), 6.41 (d, $J = 15.7$ Hz, 1H), 5.80 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.28 (s, 2H), 3.25 – 3.10 (m, 2H), 1.28 (t, $J = 7.1$ Hz, 3H).

$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 163.0 (d, $^1J_{\text{FC}} = 244.8$ Hz), 157.1, 145.6, 135.2, 134.4, 133.9, 133.7, 132.2, 129.0, 129.0, 128.8 (d, $^3J_{\text{FC}} = 8.1$ Hz), 128.4, 127.4, 127.3, 124.9 (d, $^4J_{\text{FC}} = 2.5$ Hz), 124.1, 116.1 (d, $^2J_{\text{FC}} = 21.7$ Hz), 86.2, 84.7, 61.7, 46.7, 44.1, 32.8, 14.6.

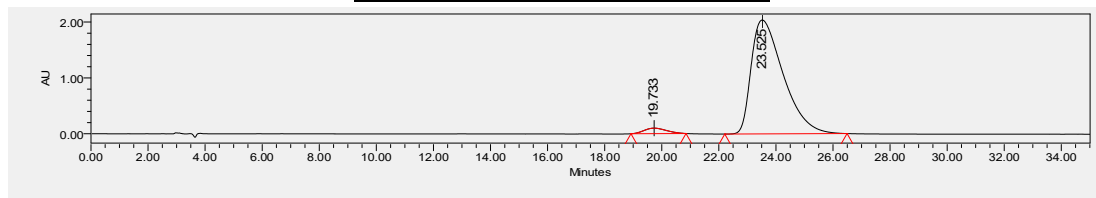
^{19}F NMR (377 MHz, Acetone- d_6) δ -116.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{25}\text{FO}_3$ ($[\text{M}] + \text{Na}^+$) = 487.1680, Found 487.1678.

IR (neat) 2983, 1734, 1663, 1600, 1508, 1490, 1454, 1379, 1276, 1228, 1159, 1138, 1088, 1017, 967, 930, 847, 816, 759, 692, 640, 572, 523 cm^{-1} .

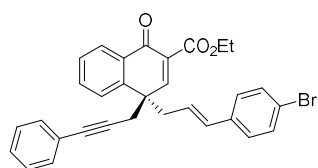


	Retention Time	Area	% Area
1	20.028	24961068	50.02
2	24.646	24945141	49.98



	Retention Time	Area	% Area
1	19.733	5379672	3.27
2	23.525	158938968	96.73

Ethyl (R,E)-4-(3-(4-bromophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B23)



White solid, Mp: 42–45 °C, 85% yield, 91% *ee*; $[\alpha]^{14.0} = -16.6$ ($c = 0.78$ in CH_2Cl_2 , $\lambda = 589$ nm).

HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 26.07$ min, $t_{R(\text{major})} = 28.11$ min.

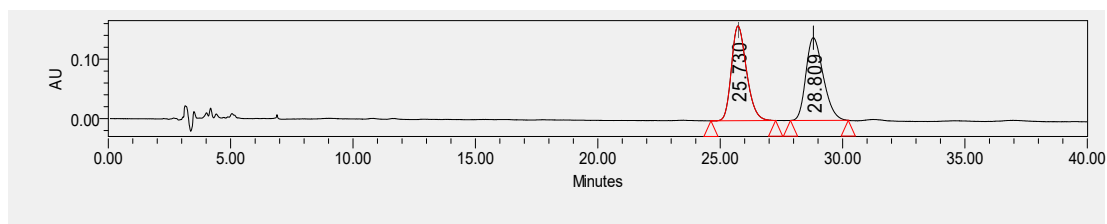
^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.92 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.77 – 7.72 (m, 2H), 7.48 (td, $J = 7.6, 1.1$ Hz, 1H), 7.40 – 7.36 (m, 2H), 7.29 – 7.22 (m, 3H), 7.20 – 7.16 (m, 2H), 7.14 – 7.11 (m, 2H), 6.40 (d, $J = 15.7$ Hz, 1H), 5.90 (dt, $J = 15.4, 7.5$ Hz, 1H), 4.26 (q, $J = 7.1$ Hz, 2H), 3.27 (s, 2H), 3.24 – 3.10 (m, 2H), 1.28 (t, $J = 7.1$ Hz, 3H).

$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 157.0, 145.6, 137.2, 135.2, 134.1, 133.9, 133.7, 132.4, 132.2, 129.3, 129.0, 128.9, 128.5, 127.4, 127.3, 126.1, 124.0, 121.5, 86.2, 84.7, 61.7, 55.1, 46.6, 44.1, 32.8, 14.6.

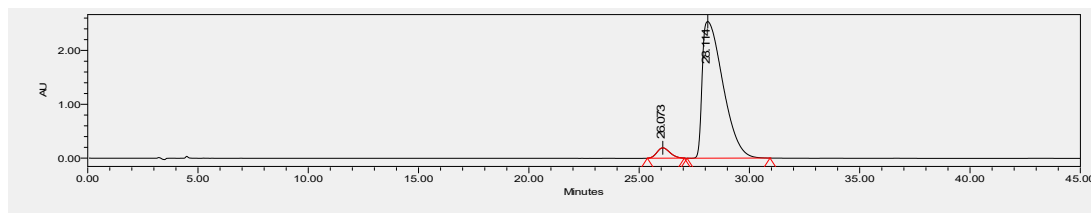
HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{25}^{79}\text{BrO}_3$ ($[\text{M}] + \text{Na}^+$) = 547.0879, Found 547.0879.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{25}^{81}\text{BrO}_3$ ($[\text{M}] + \text{Na}^+$) = 549.0859, Found 549.0861.

IR (neat) 2982, 2926, 1735, 1663, 1601, 1487, 1454, 1379, 1276, 1232, 1162, 1138, 1087, 1073, 1010, 967, 929, 853, 814, 759, 692, 636, 525 cm^{-1} .

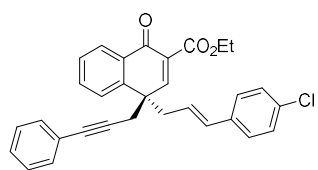


	Retention Time	Area	% Area
1	25.730	6826483	49.88
2	28.809	6860189	50.12



	Retention Time	Area	% Area
1	26.073	7787519	4.50
2	28.114	165290709	95.50

Ethyl (R,E)-4-(3-(4-chlorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B24)



White solid, Mp: 43–46 °C, 81% yield, 92% *ee*; $[\alpha]^{14.0} = -20.9$ ($c = 0.72$ in CH_2Cl_2 , $\lambda = 589$ nm).

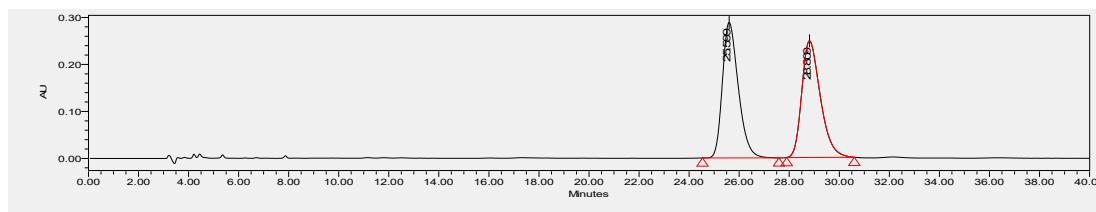
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 24.06$ min, $t_{R(\text{major})} = 26.78$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.8, 1.4$ Hz, 1H), 7.92 (dd, $J = 8.1, 1.2$ Hz, 1H), 7.78 – 7.72 (m, 2H), 7.48 (td, $J = 8.1, 1.2$ Hz, 1H), 7.28 – 7.16 (m, 9H), 6.41 (d, $J = 15.8$ Hz, 1H), 5.88 (dt, $J = 15.5, 7.5$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.28 (s, 2H), 3.25 – 3.10 (m, 2H), 1.28 (t, $J = 7.1$ Hz, 3H).

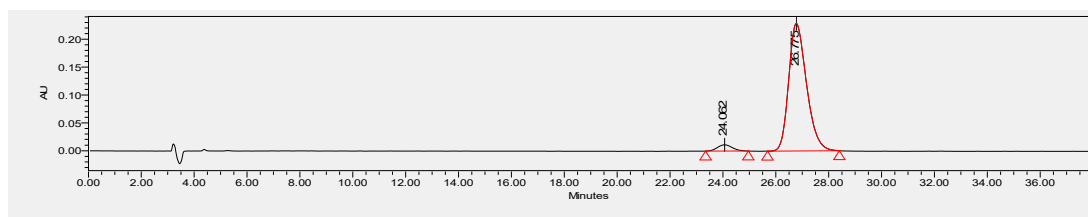
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 157.0, 145.6, 136.8, 135.2, 134.1, 133.9, 133.7, 133.4, 132.2, 129.5, 129.3, 129.0, 128.6, 128.5, 127.4, 127.3, 126.0, 124.1, 86.2, 84.7, 61.7, 46.6, 44.0, 32.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{25}\text{ClO}_3$ ($[\text{M}] + \text{Na}^+$) = 503.1384, Found 503.1386.

IR (neat) 2982, 1736, 1665, 1600, 1490, 1454, 1379, 1277, 1232, 1162, 1138, 1090, 1014, 968, 929, 816, 759, 692, 528 cm^{-1} .

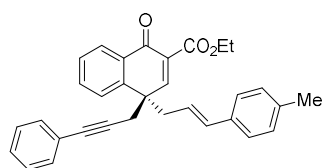


	Retention Time	Area	% Area
1	25.599	12736390	49.96
2	28.809	12756652	50.04



	Retention Time	Area	% Area
1	24.062	439704	3.95
2	26.775	10689853	96.05

Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(p-tolyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B25)



White solid, Mp: 40–43 °C, 81% yield, 81% *ee*; $[\alpha]^{14.0} = -16.4$ ($c = 0.72$ in CH_2Cl_2 , $\lambda = 589$ nm).

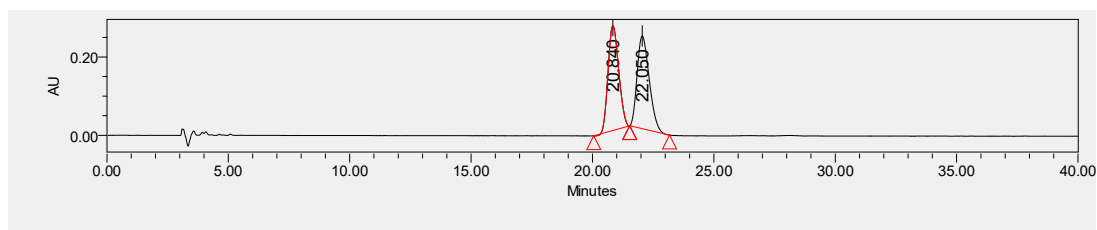
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 21.50$ min, $t_{R(\text{major})} = 22.61$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.91 (dd, $J = 8.1, 1.1$ Hz, 1H), 7.77 (s, 1H), 7.74 (td, $J = 7.7, 1.5$ Hz, 1H), 7.50 – 7.46 (m, 1H), 7.29 – 7.23 (m, 3H), 7.20 – 7.16 (m, 2H), 7.07 – 7.00 (m, 4H), 6.37 (d, $J = 15.7$ Hz, 1H), 5.78 (dt, $J = 15.4, 7.4$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.28 – 3.25 (m, 2H), 3.23 – 3.08 (m, 2H), 2.22 (s, 3H), 1.29 (t, $J = 7.1$ Hz, 3H).

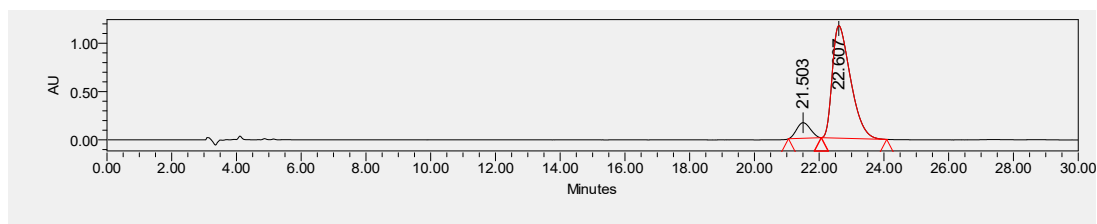
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 157.2, 145.7, 138.0, 135.2, 135.1, 134.9, 134.0, 133.9, 132.2, 130.0, 129.3, 129.0, 128.4, 127.4, 127.3, 126.9, 124.1, 123.7, 86.3, 84.7, 61.7, 46.7, 44.2, 32.8, 32.4, 21.2, 14.6.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 483.1931, Found 483.1930.

IR (neat) 2981, 1735, 1665, 1601, 1512, 1490, 1454, 1379, 1276, 1232, 1162, 1138, 1087, 1020, 968, 929, 803, 759, 692, 641, 526 cm^{-1} .

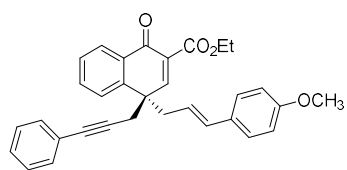


	Retention Time	Area	% Area
1	20.840	8200281	49.96
2	22.050	8212246	50.04



	Retention Time	Area	% Area
1	21.503	4727308	9.42
2	22.607	45467170	90.58

Ethyl (R,E)-4-(3-(4-methoxyphenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B26)



Colorless oil, 45% yield, 39% *ee*; $[\alpha]^{14.1} = -3.8$ ($c = 0.39$ in CH_2Cl_2 , $\lambda = 589$ nm).

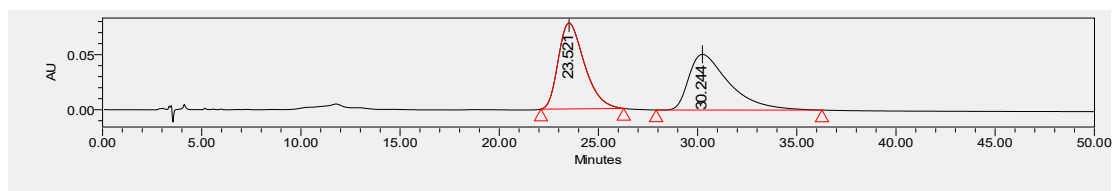
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 30.85$ min, $t_{R(\text{major})} = 23.84$ min.

^1H NMR ^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (ddd, $J = 7.9, 1.4, 0.6$ Hz, 1H), 7.91 (dt, $J = 7.9, 0.9$ Hz, 1H), 7.76 (s, 1H), 7.76 – 7.72 (m, 1H), 7.48 (ddd, $J = 8.2, 7.3, 1.1$ Hz, 1H), 7.29 – 7.22 (m, 3H), 7.20 – 7.16 (m, 2H), 7.12 – 7.08 (m, 2H), 6.79 – 6.75 (m, 2H), 6.35 (d, $J = 15.8$ Hz, 1H), 5.73 – 5.65 (m, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.72 (s, 3H), 3.27 (s, 2H), 3.22 – 3.07 (m, 2H), 1.29 (t, $J = 7.1$ Hz, 3H).

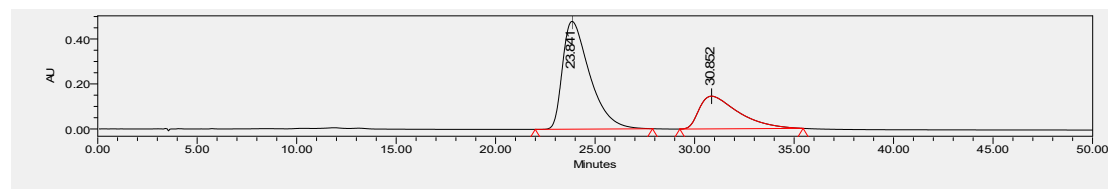
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.6, 160.3, 157.3, 145.8, 135.1, 134.5, 134.0, 133.9, 132.3, 130.6, 129.3, 129.0, 128.4, 128.2, 127.5, 127.3, 124.1, 122.4, 114.8, 86.3, 84.7, 61.7, 55.6, 46.8, 44.2, 32.7, 14.6.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_4$ ($[\text{M}] + \text{Na}^+$) = 499.1880, Found 499.1879.

IR (neat) 2933, 1736, 1665, 1605, 1511, 1490, 1456, 1379, 1277, 1249, 1176, 1138, 1087, 1030, 967, 930, 840, 759, 693, 527 cm^{-1} .

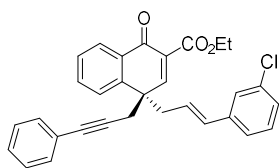


	Retention Time	Area	% Area
1	23.521	7138349	50.01
2	30.244	7135055	49.99



	Retention Time	Area	% Area
1	23.841	45483502	69.48
2	30.852	19978327	30.52

Ethyl (R,E)-4-(3-(3-chlorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B27)



White solid, Mp: 102–105 °C, 84% yield, 95% *ee*; $[\alpha]^{13.8} = -28.5$ ($c = 0.66$ in CH_2Cl_2 , $\lambda = 589$ nm).

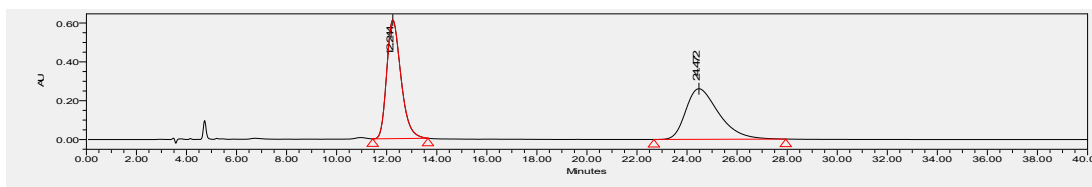
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 12.05$ min, $t_{R(\text{major})} = 23.07$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.93 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.78 (s, 1H), 7.77 – 7.72 (m, 1H), 7.49 (ddd, $J = 8.2, 7.3, 1.1$ Hz, 1H), 7.29 – 7.24 (m, 3H), 7.23 – 7.20 (m, 2H), 7.18 (ddd, $J = 6.6, 3.5, 1.8$ Hz, 3H), 7.12 (dt, $J = 7.6, 1.5$ Hz, 1H), 6.41 (d, $J = 15.7$ Hz, 1H), 5.95 (dd, $J = 15.6, 7.6$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.28 (d, $J = 2.2$ Hz, 2H), 3.26 – 3.12 (m, 2H), 1.29 (t, $J = 7.1$ Hz, 3H).

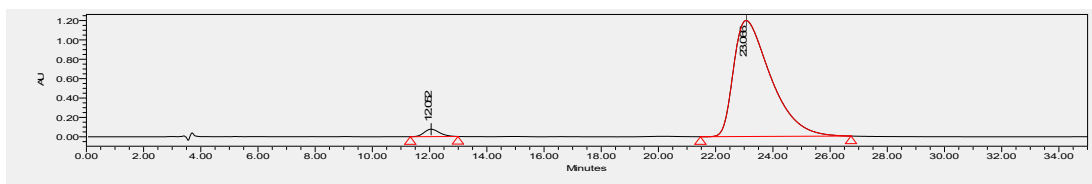
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 156.9, 145.5, 140.2, 135.2, 134.9, 134.1, 133.9, 133.6, 132.2, 131.1, 129.3, 129.0, 128.5, 128.1, 127.5, 127.4, 127.0, 126.8, 125.5, 124.1, 86.2, 84.7, 61.7, 46.6, 44.0, 32.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{25}\text{ClO}_3$ ($[\text{M}] + \text{Na}^+$) = 503.1384, Found 503.1383.

IR (neat) 2982, 1736, 1665, 1598, 1567, 1489, 1454, 1380, 1277, 1232, 1162, 1138, 1086, 1020, 966, 928, 759, 692, 528 cm^{-1} .

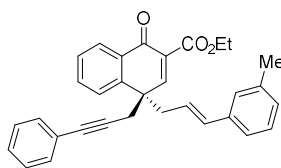


	Retention Time	Area	% Area
1	12.244	24181368	50.29
2	24.472	23900032	49.71



	Retention Time	Area	% Area
1	12.052	2860647	2.58
2	23.066	108056165	97.42

Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(m-tolyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B28)



White solid, Mp: 93–96 °C, 89% yield, 90% *ee*; $[\alpha]^{13.8} = -20.0$ ($c = 0.74$ in CH_2Cl_2 , $\lambda = 589$ nm).

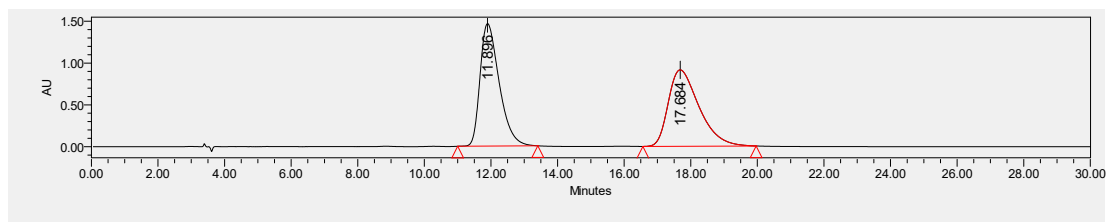
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 11.85$ min, $t_{R(\text{major})} = 16.93$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.92 (dd, $J = 7.9, 1.1$ Hz, 1H), 7.78 (s, 1H), 7.76 – 7.72 (m, 1H), 7.48 (ddd, $J = 8.2, 7.3, 1.1$ Hz, 1H), 7.29 – 7.23 (m, 3H), 7.21 – 7.16 (m, 2H), 7.08 (t, $J = 7.5$ Hz, 1H), 7.00 – 6.94 (m, 3H), 6.38 (d, $J = 15.8$ Hz, 1H), 5.85 (dd, $J = 15.5, 7.7$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.27 (s, 2H), 3.25 – 3.10 (m, 2H), 2.21 (s, 3H), 1.29 (t, $J = 7.1$ Hz, 3H).

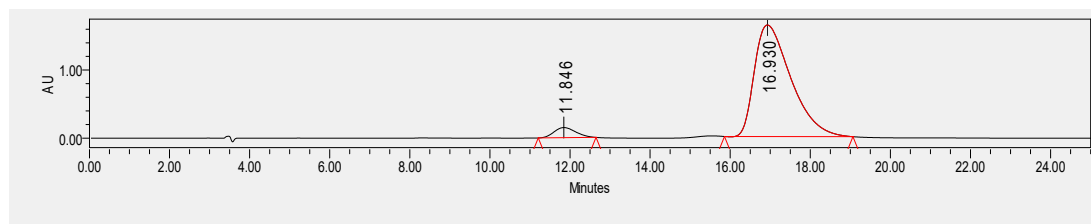
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.6, 157.2, 145.7, 138.8, 137.9, 135.2, 135.1, 134.0, 133.9, 132.2, 129.3, 129.3, 129.0, 129.0, 128.4, 127.7, 127.5, 127.3, 124.6, 124.2, 124.1, 86.2, 84.7, 61.7, 46.7, 44.2, 32.9, 21.4, 14.6.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 483.1931, Found 483.1929.

IR (neat) 2982, 2361, 2160, 1736, 1666, 1601, 1489, 1454, 1379, 1276, 1232, 1162, 1138, 1087, 1019, 967, 927, 759, 692, 528 cm^{-1} .

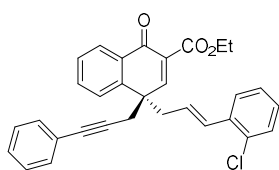


	Retention Time	Area	% Area
1	11.896	58454374	50.00
2	17.684	58454728	50.00



	Retention Time	Area	% Area
1	11.846	5650913	5.17
2	16.930	103617955	94.83

Ethyl (R,E)-4-(3-(2-chlorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B29)



White solid, Mp: 31–34 °C, 40% yield, 96% *ee*; $[\alpha]^{14.0} = -29.2$ ($c = 0.37$ in CH_2Cl_2 , $\lambda = 589$ nm).

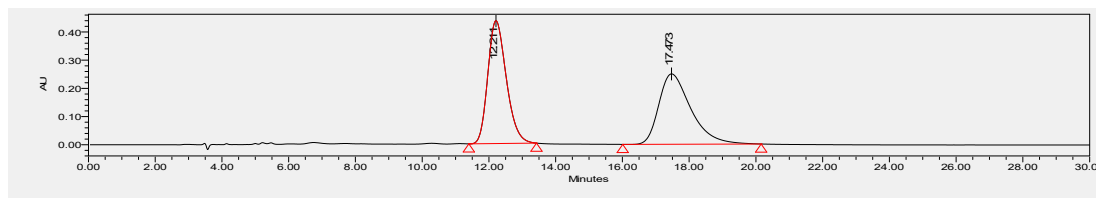
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 11.89$ min, $t_{R(\text{major})} = 16.52$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.96 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.80 (s, 1H), 7.75 (ddd, $J = 8.1, 7.3, 1.5$ Hz, 1H), 7.49 (ddd, $J = 8.2, 7.3, 1.1$ Hz, 1H), 7.31 – 7.24 (m, 5H), 7.20 – 7.15 (m, 4H), 6.71 (d, $J = 15.7$ Hz, 1H), 5.89 – 5.82 (m, 1H), 4.26 (t, $J = 7.1$ Hz, 2H), 3.32 – 3.19 (m, 4H), 1.29 (d, $J = 7.1$ Hz, 3H).

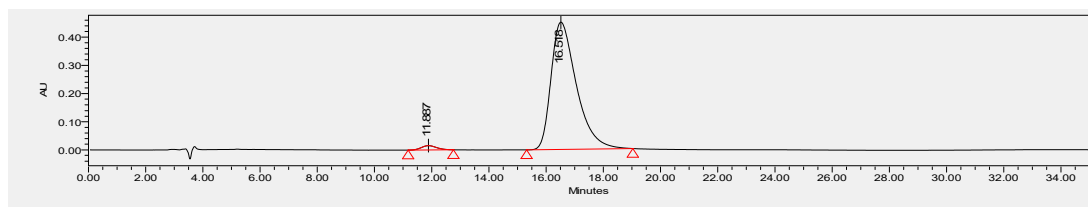
$^{13}\text{C}\{^1\text{H}\}$ NMR ^{13}C NMR (101 MHz, Acetone- d_6) δ 181.3 , 165.5 , 157.1 , 145.5 , 136.0 , 135.2 , 134.1 , 133.9 , 133.1 , 132.3 , 131.0 , 130.3 , 129.8 , 129.3 , 129.0 , 128.5 , 128.5 , 128.1 , 127.9 , 127.5 , 127.4 , 124.1 , 86.2 , 84.8 , 61.7 , 46.7 , 44.0 , 32.9 , 14.6 .

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{25}\text{ClO}_3$ ($[\text{M}] + \text{Na}^+$) = 503.1384, Found 503.1382 .

IR (neat) 2982, 1736, 1665, 1601, 1490, 1470, 1441, 1379, 1276, 1232, 1162, 1138, 1087, 1021, 967, 929, 693, 528 cm^{-1} .

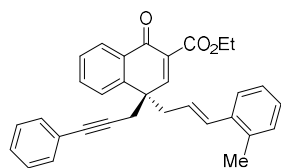


	Retention Time	Area	% Area
1	12.211	16780639	50.20
2	17.473	16648726	49.80



	Retention Time	Area	% Area
1	11.887	566875	2.00
2	16.518	27803693	98.00

Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(*o*-tolyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B30)



White solid, Mp: 33–36 °C, 72% yield, 93% *ee*; $[\alpha]^{14.2} = -26.6$ ($c = 0.56$ in CH_2Cl_2 , $\lambda = 589$ nm).

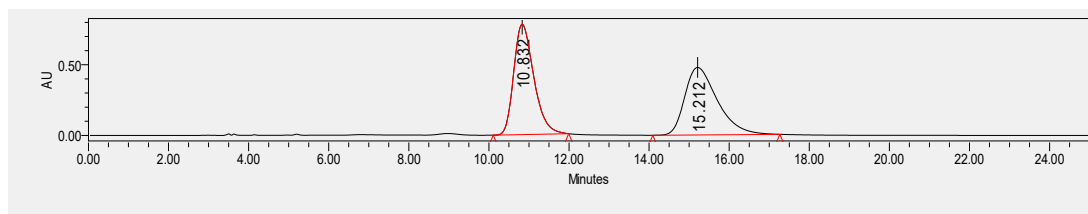
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 11.01$ min, $t_{R(\text{major})} = 14.94$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.10 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.95 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.80 (s, 1H), 7.78 – 7.73 (m, 1H), 7.48 (ddd, $J = 8.1, 7.3, 1.1$ Hz, 1H), 7.29 – 7.23 (m, 3H), 7.21 – 7.16 (m, 2H), 7.10 – 7.07 (m, 1H), 7.05 – 6.98 (m, 3H), 6.58 (d, $J = 15.6$ Hz, 1H), 5.67 – 5.60 (m, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.29 (s, 2H), 3.27 – 3.12 (m, 2H), 2.11 (s, 3H), 1.29 (t, $J = 7.1$ Hz, 3H).

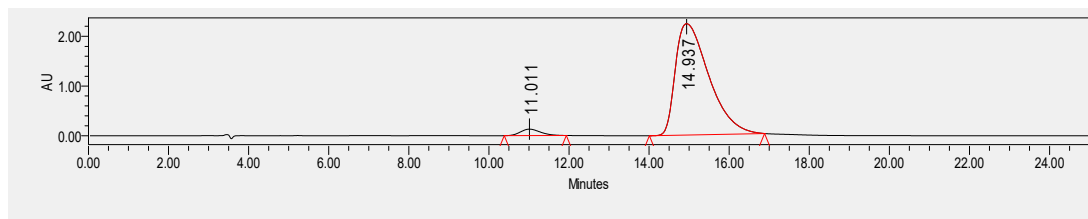
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.6, 157.3, 145.7, 137.3, 135.9, 135.2, 134.0, 134.0, 133.4, 132.3, 130.9, 129.3, 129.0, 128.4, 128.2, 127.5, 127.3, 126.9, 126.5, 126.4, 124.1, 86.2, 84.7, 61.7, 46.9, 44.3, 32.8, 19.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 483.1931, Found 483.1929.

IR (neat) 2981, 1736, 1665, 1601, 1488, 1455, 1379, 1277, 1232, 1162, 1138, 1087, 1020, 967, 929, 756, 692, 528 cm^{-1} .

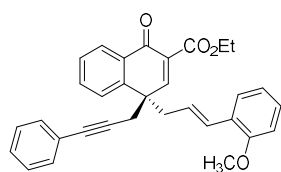


	Retention Time	Area	% Area
1	10.832	27190118	50.20
2	15.212	26973053	49.80



	Retention Time	Area	% Area
1	11.011	4526312	3.36
2	14.937	130116361	96.64

Ethyl (R,E)-4-(3-(2-methoxyphenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B31)



White solid, Mp: 36–39 °C, 78% yield, 92% *ee*; $[\alpha]^{14.2} = -19.5$ ($c = 0.70$ in CH_2Cl_2 , $\lambda = 589$ nm).

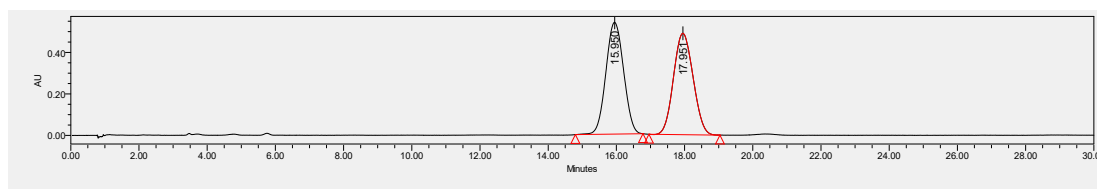
SFC Chiralcel BYPASS, $\text{CO}_2/\text{MeOH} = 90/10$, 1.5 mL/min, $\lambda = 224$ nm, $t_{\text{R}}(\text{minor}) = 15.68$ min, $t_{\text{R}}(\text{major}) = 17.46$ min

^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.92 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.78 (s, 1H), 7.74 (ddd, $J = 8.1, 7.3, 1.5$ Hz, 1H), 7.48 (ddd, $J = 8.2, 7.4, 1.1$ Hz, 1H), 7.29 – 7.23 (m, 3H), 7.21 – 7.16 (m, 2H), 7.15 – 7.10 (m, 2H), 6.87 (d, $J = 8.1$ Hz, 1H), 6.77 (td, $J = 7.4, 1.1$ Hz, 1H), 6.64 (d, $J = 15.9$ Hz, 1H), 5.87 – 5.79 (m, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.74 (s, 3H), 3.28 (s, 2H), 3.24 – 3.10 (m, 2H), 1.29 (t, $J = 7.1$ Hz, 3H).

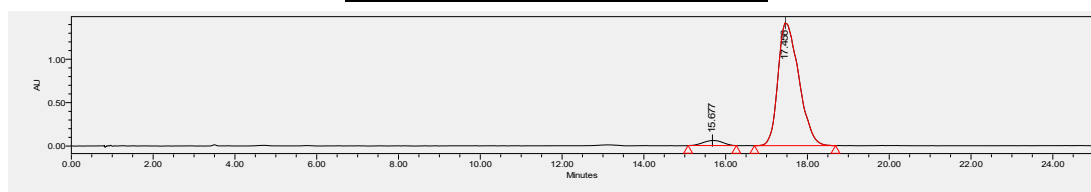
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.6, 157.5, 157.3, 145.8, 135.1, 134.0, 133.9, 132.2, 129.8, 129.5, 129.3, 129.0, 128.4, 127.5, 127.4, 127.3, 126.7, 125.4, 124.1, 121.4, 112.0, 86.3, 84.7, 61.7, 55.8, 46.8, 44.6, 32.7, 14.6.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{28}\text{O}_4$ ($[\text{M}] + \text{Na}^+$) = 499.1880, Found 499.1877.

IR (neat) 2936, 2837, 1736, 1665, 1599, 1489, 1459, 1379, 1276, 1244, 1180, 1162, 1138, 1087, 1049, 1025, 972, 929, 693, 528 cm^{-1} .

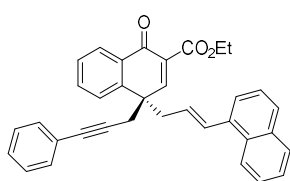


	Retention Time	Area	% Area
1	15.950	19431438	49.99
2	17.951	19442131	50.01



	Retention Time	Area	% Area
1	15.677	1941932	3.74
2	17.456	50042543	96.26

Ethyl (R,E)-4-(3-(naphthalen-1-yl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B32)



Colorless oil, 94% yield, 95% *ee*; $[\alpha]^{14.1} = -32.0$ ($c = 0.82$ in CH_2Cl_2 , $\lambda = 589$ nm).

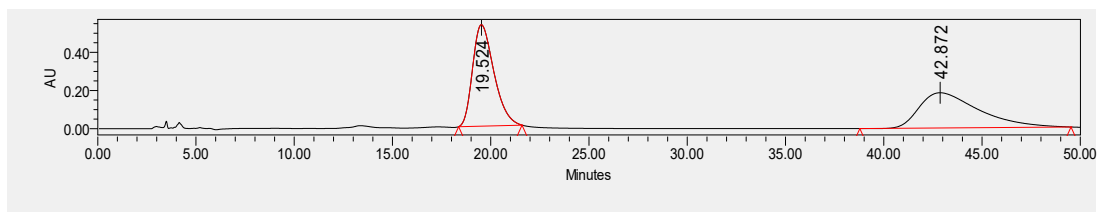
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 20.31$ min, $t_{R(\text{major})} = 42.88$ min.

^1H NMR ^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 8.01 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.88 (s, 1H), 7.85 – 7.72 (m, 4H), 7.52 – 7.43 (m, 3H), 7.33 (t, $J = 7.6$ Hz, 1H), 7.30 – 7.23 (m, 4H), 7.21 (dq, $J = 4.5, 2.6$ Hz, 2H), 7.12 (d, $J = 15.5$ Hz, 1H), 5.79 (dt, $J = 15.3, 7.5$ Hz, 1H), 4.27 (q, $J = 7.1$ Hz, 2H), 3.39 – 3.24 (m, 4H), 1.27 (t, $J = 7.1$ Hz, 3H).

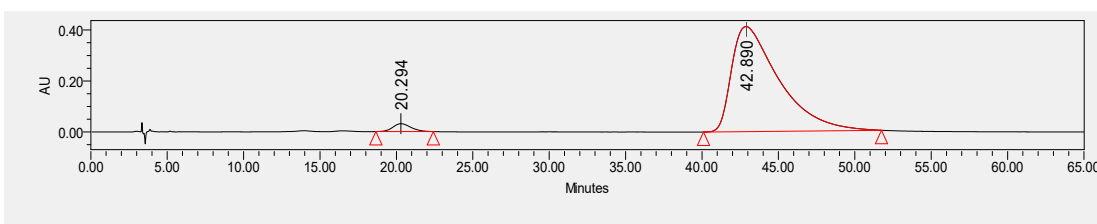
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.3, 165.6, 157.3, 145.7, 135.9, 135.3, 134.5, 134.1, 134.0, 132.8, 132.3, 131.9, 129.3, 129.2, 129.0, 128.6, 128.4, 128.4, 127.6, 127.4, 126.9, 126.7, 126.5, 124.8, 124.6, 124.1, 86.2, 84.8, 61.7, 55.1, 46.9, 44.3, 32.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{35}\text{H}_{28}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 519.1931, Found 519.1933.

IR (neat) 3060, 2982, 1735, 1664, 1601, 1490, 1454, 1379, 1277, 1232, 1162, 1138, 1087, 968, 928, 862, 759, 692, 528 cm^{-1} .

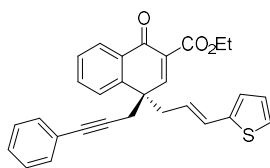


	Retention Time	Area	% Area
1	19.524	39959525	50.68
2	42.872	38885134	49.32



	Retention Time	Area	% Area
1	20.307	2789580	2.74
2	42.877	99126450	97.26

Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(thiophen-2-yl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B33)



Colorless oil, 45% yield, 43% *ee*; $[\alpha]^{13.9} = -13.6$ ($c = 0.39$ in CH_2Cl_2 , $\lambda = 589$ nm).

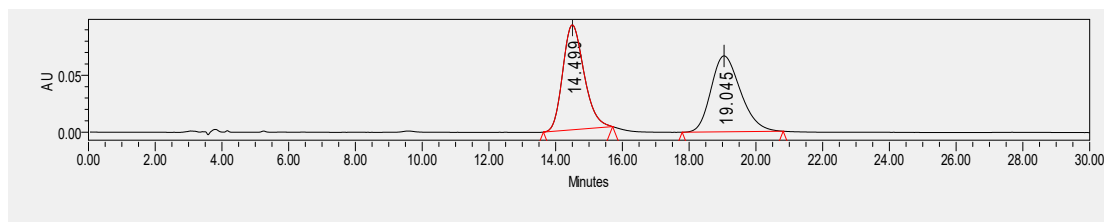
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 14.25$ min, $t_{R(\text{major})} = 18.18$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.11 (dd, $J = 7.9, 1.6$ Hz, 1H), 7.93 – 7.90 (m, 1H), 7.76 – 7.72 (m, 2H), 7.51 – 7.47 (m, 1H), 7.28 – 7.24 (m, 3H), 7.21 – 7.15 (m, 3H), 6.88 (dd, $J = 5.1, 3.5$ Hz, 1H), 6.84 – 6.81 (m, 1H), 6.56 (d, $J = 15.5$ Hz, 1H), 5.62 (dt, $J = 15.3, 7.5$ Hz, 1H), 4.27 (d, $J = 7.1$ Hz, 2H), 3.26 (s, 2H), 3.21 (td, $J = 7.5, 7.0, 1.3$ Hz, 1H), 3.14 – 3.07 (m, 1H), 1.29 (t, $J = 7.1$ Hz, 3H).

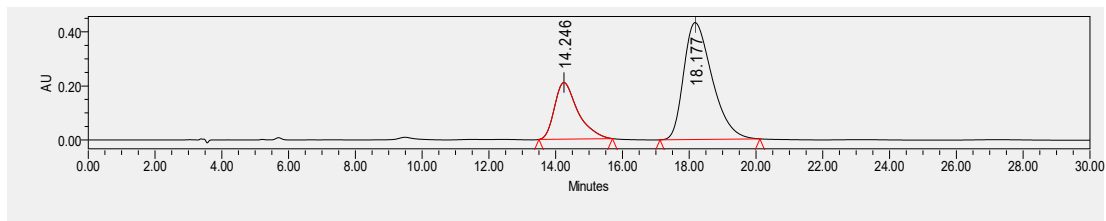
^{13}C NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 157.0, 145.5, 142.7, 134.1, 133.9, 132.2, 129.3, 129.0, 128.5, 128.3, 128.1, 127.4, 127.4, 126.4, 125.1, 124.4, 124.1, 86.2, 84.7, 61.7, 46.7, 43.9, 32.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{29}\text{H}_{24}\text{O}_3\text{S}$ ($[\text{M}]+\text{Na}^+$) = 475.1338, Found 475.1338.

IR (neat) 2984, 1735, 1665, 1601, 1490, 1454, 1380, 1277, 1232, 1161, 1138, 1087, 1019, 957, 929, 854, 759, 693, 528 cm^{-1} .

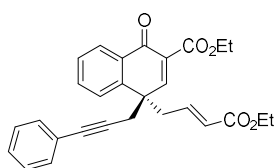


	Retention Time	Area	% Area
1	14.499	4097664	49.96
2	19.045	4104119	50.04



	Retention Time	Area	% Area
1	14.246	10156754	28.42
2	18.177	25585604	71.58

Ethyl (R,E)-4-(4-ethoxy-4-oxobut-2-en-1-yl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B34)



Colorless oil, 51% yield, 85% *ee*; $[\alpha]^{14.1} = -57.9$ ($c = 0.43$ in CH_2Cl_2 , $\lambda = 589$ nm).

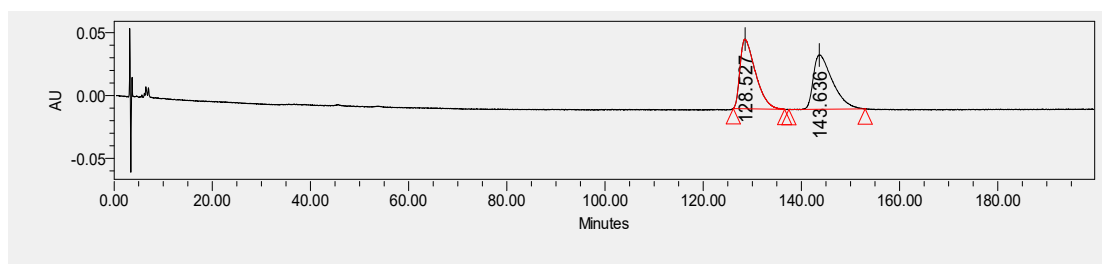
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 95/5, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 122.40$ min, $t_{R(\text{major})} = 140.72$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.14 (dd, $J = 7.9, 1.2$ Hz, 1H), 7.91 (dt, $J = 8.0, 0.9$ Hz, 1H), 7.78 – 7.73 (m, 1H), 7.73 (s, 1H), 7.52 (ddd, $J = 7.9, 7.1, 1.0$ Hz, 1H), 7.29 – 7.23 (m, 3H), 7.21 – 7.16 (m, 2H), 6.44 (dt, $J = 15.4, 7.6$ Hz, 1H), 5.84 (dt, $J = 15.5, 1.4$ Hz, 1H), 4.28 (q, $J = 7.1$ Hz, 2H), 4.01 (qd, $J = 7.1, 0.7$ Hz, 2H), 3.36 (ddd, $J = 14.4, 7.7, 1.4$ Hz, 1H), 3.26 (s, 2H), 3.22 – 3.17 (m, 1H), 1.30 (t, $J = 7.1$ Hz, 3H), 1.13 (t, $J = 7.1$ Hz, 3H).

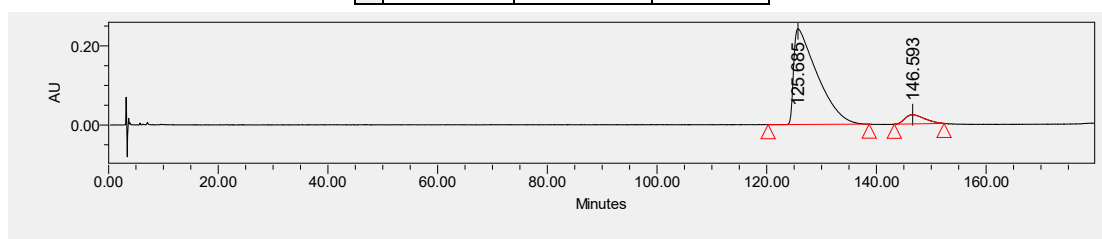
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.0, 165.9, 165.5, 156.2, 144.9, 143.2, 135.6, 134.2, 133.8, 132.2, 129.3, 129.0, 128.7, 127.5, 127.4, 125.8, 124.0, 85.8, 85.0, 61.8, 60.7, 46.1, 42.5, 33.5, 14.6, 14.5.

HRMS (ESI) Calculated for $\text{C}_{28}\text{H}_{26}\text{O}_5$ ($[\text{M}] + \text{Na}^+$) = 465.1672, Found 465.1671.

IR (neat) 2983, 1716, 1661, 1601, 1490, 1453, 1379, 1275, 1232, 1207, 1168, 1139, 1114, 1088, 1026, 982, 928, 861, 758, 693, 529 cm^{-1} .

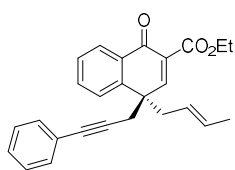


	Retention Time	Area	% Area
1	128.527	12110256	50.69
2	143.636	11779369	49.31



	Retention Time	Area	% Area
1	125.685	72483076	92.57
2	146.593	5814645	7.43

Ethyl (R,E)-4-(but-2-en-1-yl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B35)



White solid, Mp: 101–104 °C, 70% yield, 99% *ee*; $[\alpha]^{14.2} = -65.3$ ($c = 0.41$ in CH_2Cl_2 , $\lambda = 589$ nm).

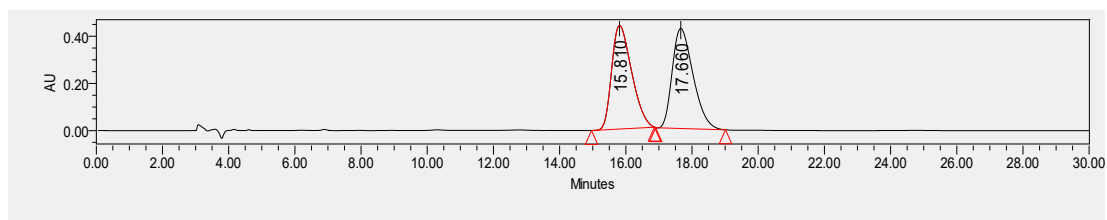
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 95/5, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 15.51$ min, $t_{R(\text{major})} = 16.84$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.83 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.74 – 7.69 (m, 1H), 7.65 (s, 1H), 7.48 (ddd, $J = 8.1, 7.2, 1.2$ Hz, 1H), 7.28 – 7.22 (m, 3H), 7.18 – 7.14 (m, 2H), 5.48 – 5.39 (m, 1H), 5.02 (ddd, $J = 15.1, 7.5, 1.7$ Hz, 1H), 4.28 (q, $J = 7.1$ Hz, 2H), 3.18 (s, 2H), 3.01 – 2.84 (m, 2H), 1.45 – 1.42 (m, 3H), 1.31 (t, $J = 7.1$ Hz, 3H).

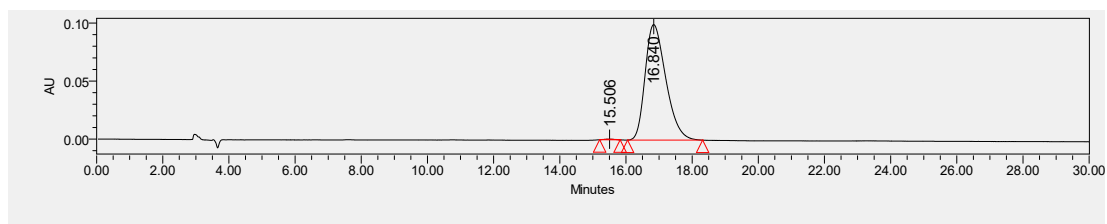
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.4, 165.7, 157.4, 145.8, 135.1, 134.0, 133.9, 132.2, 130.5, 129.3, 129.0, 128.3, 127.4, 127.2, 125.82, 124.1, 86.3, 84.6, 61.7, 46.6, 43.9, 32.7, 18.1, 14.6.

HRMS (ESI) Calculated for $\text{C}_{26}\text{H}_{24}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 407.1618, Found 407.1615.

IR (neat) 2980, 1736, 1664, 1601, 1490, 1452, 1379, 1276, 1231, 1186, 1162, 1139, 1085, 1019, 967, 928, 861, 692, 638, 529 cm^{-1} .

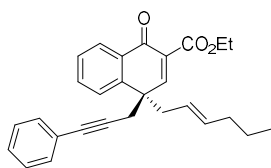


	Retention Time	Area	% Area
1	15.810	18398426	49.79
2	17.660	18554458	50.21



	Retention Time	Area	% Area
1	15.506	10563	0.24
2	16.840	4326482	99.76

Ethyl (R,E)-4-(hex-2-en-1-yl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B36)



Colorless oil, 35% yield, 99% *ee*; $[\alpha]^{14.1} = -66.2$ ($c = 0.27$ in CH_2Cl_2 , $\lambda = 589$ nm).

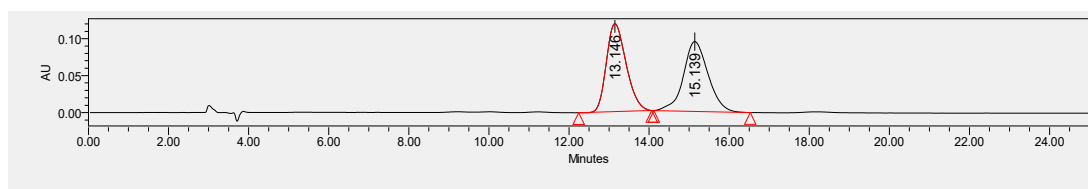
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 13.57$ min, $t_{R(\text{major})} = 15.24$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.84 (dd, $J = 8.1, 1.2$ Hz, 1H), 7.72 (td, $J = 8.5, 7.9, 1.5$ Hz, 1H), 7.66 (s, 1H), 7.48 (ddd, $J = 8.1, 7.3, 1.2$ Hz, 1H), 7.31 – 7.22 (m, 3H), 7.19 – 7.12 (m, 2H), 5.44 – 5.36 (m, 1H), 4.97 (dddd, $J = 15.0, 7.4, 5.9, 1.4$ Hz, 1H), 4.28 (q, $J = 7.1$ Hz, 2H), 3.19 (s, 2H), 3.02 – 2.85 (m, 2H), 1.78 – 1.72 (m, 2H), 1.31 (t, $J = 7.1$ Hz, 3H), 1.14 (q, $J = 7.3$ Hz, 2H), 0.67 (t, $J = 7.4$ Hz, 3H).

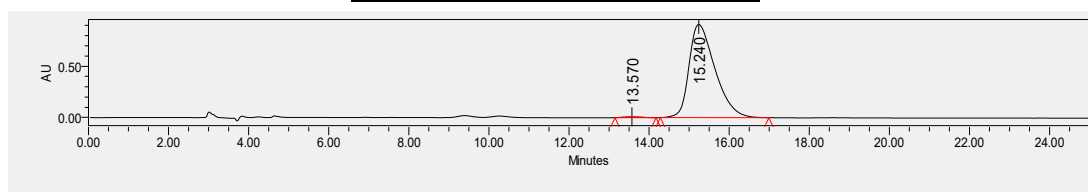
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.4, 165.6, 157.5, 145.8, 136.1, 135.1, 134.0, 133.9, 132.2, 129.3, 129.0, 128.3, 127.4, 127.2, 124.9, 124.1, 86.3, 84.6, 61.6, 46.7, 43.9, 35.2, 32.7, 23.1, 14.6, 13.7.

HRMS (ESI) Calculated for $\text{C}_{28}\text{H}_{28}\text{O}_3$ ($[\text{M}]+\text{Na}^+$) = 435.1931, Found 435.1928.

IR (neat) 2959, 2928, 2870, 1737, 1666, 1601, 1490, 1454, 1379, 1275, 1231, 1162, 1139, 1086, 1020, 969, 928, 759, 692, 640, 528 cm^{-1} .

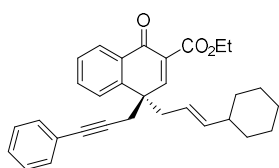


	Retention Time	Area	% Area
1	13.146	4072511	50.20
2	15.139	4039543	49.80



	Retention Time	Area	% Area
1	13.570	212990	0.52
2	15.240	40871541	99.48

Ethyl (R,E)-4-(3-cyclohexylallyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B37)



Colorless oil, 55% yield, 95% *ee*; $[\alpha]^{14.2} = -42.4$ ($c = 0.47$ in CH_2Cl_2 , $\lambda = 589$ nm).

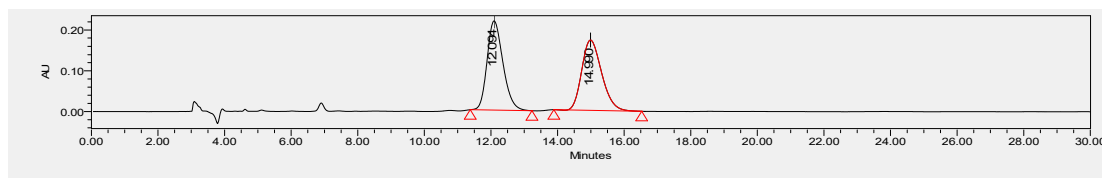
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 95/5, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 12.44$ min, $t_{R(\text{major})} = 15.15$ min.

$^1\text{H NMR}$ (400 MHz, Acetone- d_6) δ 8.12 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.84 (dd, $J = 8.1, 1.1$ Hz, 1H), 7.72 (td, $J = 7.7, 1.5$ Hz, 1H), 7.64 (s, 1H), 7.48 (ddd, $J = 8.1, 7.2, 1.1$ Hz, 1H), 7.29 – 7.22 (m, 3H), 7.19 – 7.14 (m, 2H), 5.31 (dd, $J = 15.3, 7.1$ Hz, 1H), 4.95 – 4.87 (m, 1H), 4.28 (q, $J = 7.1$ Hz, 2H), 3.21 (s, 2H), 2.97 – 2.81 (m, 2H), 1.68 (dp, $J = 11.1, 3.6$ Hz, 1H), 1.58 – 1.38 (m, 5H), 1.31 (t, $J = 7.1$ Hz, 3H), 1.16 – 1.02 (m, 3H), 0.84 (tq, $J = 12.2, 3.8$ Hz, 2H).

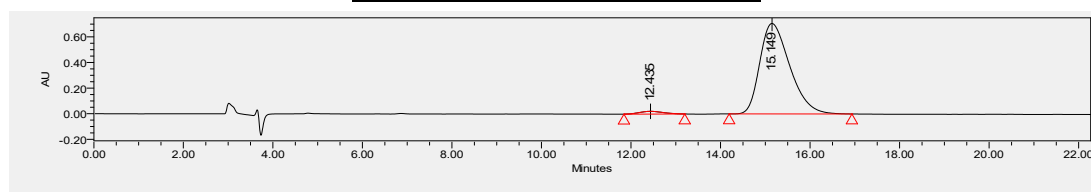
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 181.4, 165.7, 157.4, 145.9, 142.3, 135.1, 134.0, 133.9, 132.2, 129.3, 129.0, 128.2, 127.4, 127.2, 124.1, 122.0, 86.4, 84.5, 61.6, 46.8, 44.0, 41.4, 33.6, 33.6, 32.4, 26.8, 26.5, 14.7.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{32}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 475.2244, Found 475.2243.

IR (neat) 2923, 2850, 1737, 1667, 1601, 1490, 1448, 1379, 1276, 1231, 1138, 1087, 1021, 970, 928, 759, 692, 528 cm^{-1} .

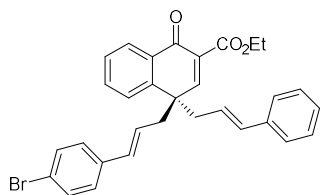


	Retention Time	Area	% Area
1	12.094	7244408	50.29
2	14.990	7159569	49.71



	Retention Time	Area	% Area
1	12.435	775597	2.31
2	15.149	32799082	97.69

Ethyl (R)-4-((E)-3-(4-bromophenyl)allyl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B38)



White solid, Mp: 37–40 °C, 62% yield, 90% *ee*; $[\alpha]^{23.0} = -9.0$ ($c = 0.65$ in CH_2Cl_2 , $\lambda = 589$ nm).

HPLC: Daicel chiralcel IC, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 34.84$ min, $t_{R(\text{major})} = 39.85$ min.

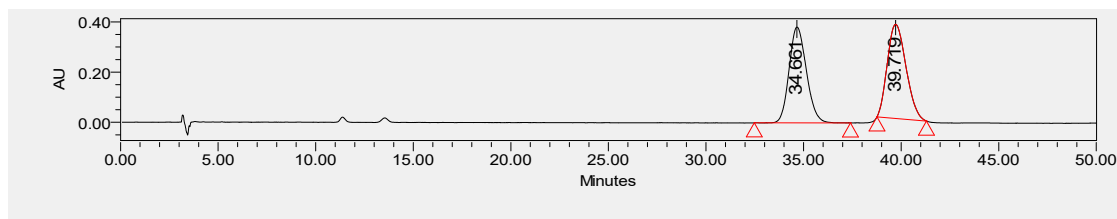
^1H NMR (400 MHz, Acetone- d_6) δ 8.06 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.90 (dd, $J = 8.1, 1.1$ Hz, 1H), 7.77 – 7.72 (m, 2H), 7.48 – 7.43 (m, 1H), 7.40 – 7.35 (m, 2H), 7.22 – 7.17 (m, 2H), 7.16 – 7.09 (m, 5H), 6.35 (dd, $J = 15.8, 7.8$ Hz, 2H), 5.89 – 5.77 (m, 2H), 4.23 (q, $J = 7.1$ Hz, 2H), 3.15 (ddt, $J = 13.9, 7.4, 1.6$ Hz, 2H), 3.04 (ddd, $J = 13.9, 7.6, 1.3$ Hz, 2H), 1.26 (t, $J = 7.2$ Hz, 3H).

^{13}C NMR (101 MHz, Acetone- d_6) δ 181.1, 165.6, 158.6, 146.1, 138.0, 137.3, 134.9, 134.8, 134.0, 133.7, 133.6, 132.4, 129.4, 128.8, 128.2, 128.2, 127.7, 127.4, 127.0, 126.2, 124.9, 121.5, 61.6, 47.5, 45.3, 45.2, 14.6.

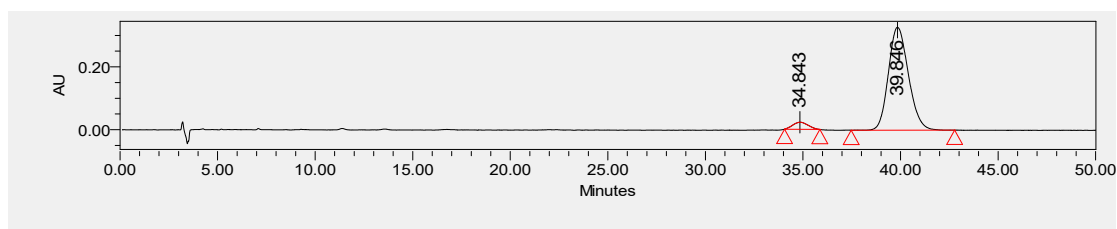
HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{79}\text{BrO}_3$ ($[\text{M}]+\text{Na}^+$) = 549.1036, Found 549.1044.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{81}\text{BrO}_3$ ($[\text{M}]+\text{Na}^+$) = 551.1015, Found 551.1019.

IR (neat) 3027, 2982, 2361, 1734, 1660, 1600, 1486, 1450, 1379, 1269, 1229, 1161, 1137, 1073, 1011, 966, 929, 805, 739, 695, 626, 515 cm^{-1} .

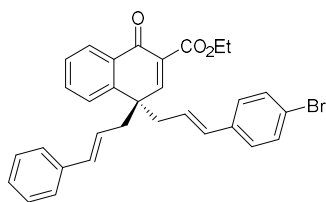


	Retention Time	Area	% Area
1	34.661	23540855	48.51
2	39.719	24987710	51.49



	Retention Time	Area	% Area
1	34.843	1232104	5.01
2	39.846	23348137	94.99

Ethyl (S)-4-((E)-3-(4-bromophenyl)allyl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (*ent*-B38)



White solid, Mp: 37–40 °C, 55% yield, 93% *ee*; $[\alpha]^{23.9} = 9.5$ ($c = 0.58$ in CH_2Cl_2 , $\lambda = 589$ nm).

HPLC: Daicel chiralcel IC, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 39.96$ min, $t_{R(\text{major})} = 34.67$ min.

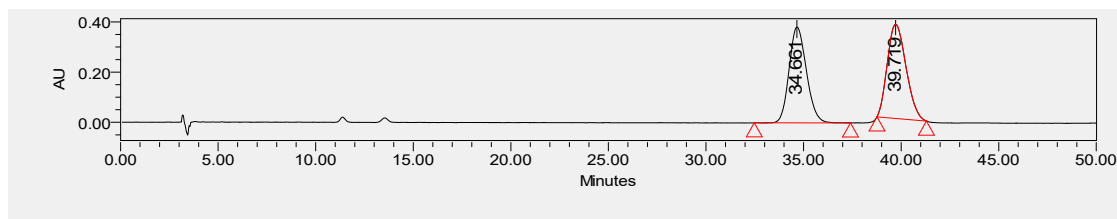
^1H NMR (400 MHz, Acetone- d_6) δ 8.06 (dd, $J = 7.9, 1.4$ Hz, 1H), 7.90 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.77 – 7.72 (m, 2H), 7.48 – 7.43 (m, 1H), 7.40 – 7.35 (m, 2H), 7.22 – 7.18 (m, 2H), 7.16 – 7.09 (m, 5H), 6.35 (dd, $J = 15.8, 7.5$ Hz, 2H), 5.89 – 5.77 (m, 2H), 4.23 (q, $J = 7.1$ Hz, 2H), 3.15 (ddt, $J = 13.9, 7.4, 1.6$ Hz, 2H), 3.04 (ddd, $J = 13.8, 7.6, 1.3$ Hz, 2H), 1.26 (t, $J = 7.1$ Hz, 3H).

^{13}C NMR (101 MHz, Acetone- d_6) δ 181.1, 165.6, 158.6, 146.1, 138.0, 137.3, 134.9, 134.8, 134.0, 133.8, 133.6, 132.4, 129.4, 128.8, 128.2, 128.2, 127.7, 127.4, 127.0, 126.2, 124.9, 121.5, 61.6, 47.5, 45.3, 45.2, 14.6.

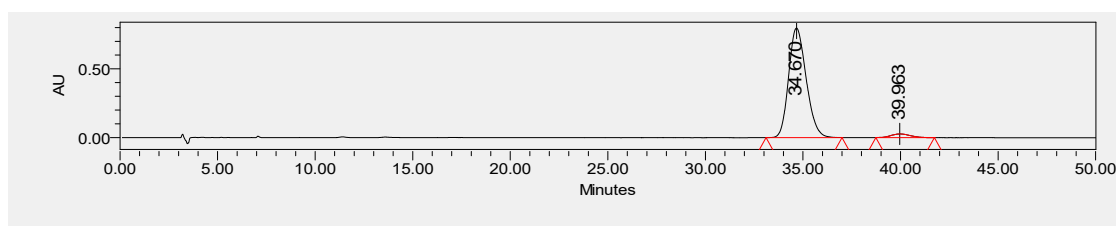
HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{79}\text{BrO}_3$ ($[\text{M}]+\text{Na}^+$) = 549.1036, Found 549.1046.

HRMS (ESI) Calculated for $\text{C}_{31}\text{H}_{27}^{81}\text{BrO}_3$ ($[\text{M}]+\text{Na}^+$) = 551.1015, Found 551.1020.

IR (neat) 3027, 2982, 2361, 1734, 1660, 1600, 1486, 1450, 1379, 1269, 1229, 1161, 1137, 1073, 1011, 966, 929, 805, 739, 695, 626, 515 cm^{-1} .

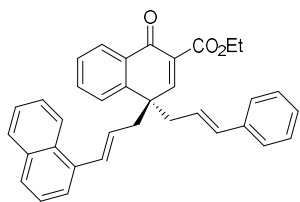


	Retention Time	Area	% Area
1	34.661	23540855	48.51
2	39.719	24987710	51.49



	Retention Time	Area	% Area
1	34.670	49735969	96.45
2	39.963	1830803	3.55

Ethyl (R)-4-cinnamyl-4-((E)-3-(naphthalen-1-yl)allyl)-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B39)



White solid, Mp: 52–55 °C, 76% yield, 97% *ee*; $[\alpha]^{24.5} = 15.2$ ($c = 0.66$ in CH_2Cl_2 , $\lambda = 589$ nm).

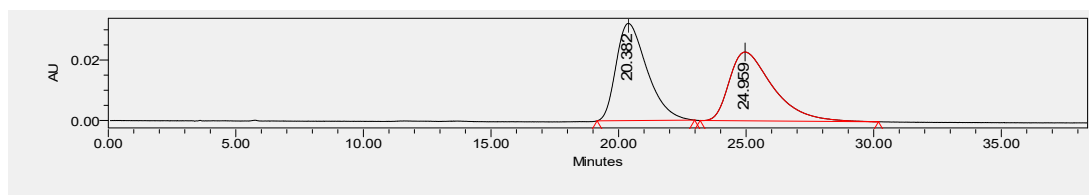
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R}(\text{minor})} = 25.80$ min, $t_{\text{R}(\text{major})} = 20.23$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.06 (dd, $J = 7.8, 1.5$ Hz, 1H), 7.98 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.85 (s, 1H), 7.84 – 7.76 (m, 3H), 7.73 (d, $J = 8.1$ Hz, 1H), 7.49 – 7.42 (m, 3H), 7.35 – 7.30 (m, 1H), 7.26 – 7.14 (m, 6H), 7.07 (d, $J = 15.5$ Hz, 1H), 6.40 (d, $J = 15.7$ Hz, 1H), 5.90 – 5.82 (m, 1H), 5.74 (dt, $J = 15.3, 7.6$ Hz, 1H), 4.23 (q, $J = 7.1$ Hz, 2H), 3.29 (ddd, $J = 13.6, 7.6, 1.3$ Hz, 1H), 3.22 – 3.14 (m, 2H), 3.08 (ddd, $J = 13.9, 7.6, 1.3$ Hz, 1H), 1.24 (t, $J = 7.1$ Hz, 3H).

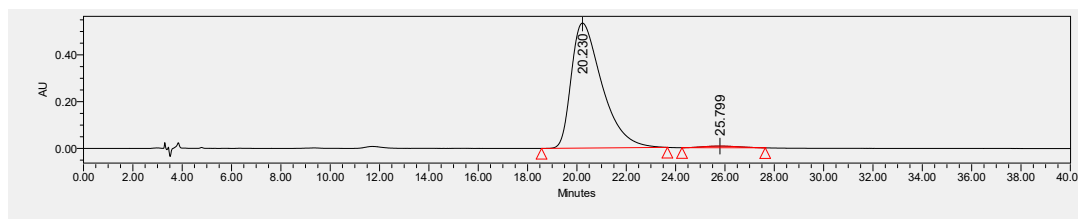
^{13}C NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 158.9, 146.3, 138.1, 136.0, 134.8, 134.6, 134.0, 133.9, 132.6, 132.0, 129.4, 129.3, 128.6, 128.5, 128.3, 128.2, 127.8, 127.5, 127.0, 126.9, 126.7, 126.5, 125.0, 124.8, 124.6, 61.6, 47.8, 45.5, 45.4, 14.6.

HRMS (ESI) Calculated for $\text{C}_{35}\text{H}_{30}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 521.2087, Found 521.2093.

IR (neat) 3029, 2983, 2361, 1734, 1661, 1600, 1450, 1380, 1268, 1230, 1162, 1138, 1087, 1019, 966, 928, 863, 775, 695, 618, 553, 515 cm^{-1} .

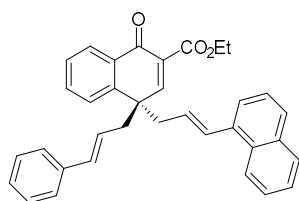


	Retention Time	Area	% Area
1	20.382	2710533	50.15
2	24.959	2694175	49.85



	Retention Time	Area	% Area
1	20.230	46162220	98.44
2	25.799	733541	1.56

Ethyl (S)-4-cinnamyl-4-((E)-3-(naphthalen-1-yl)allyl)-1-oxo-1,4-dihydronaphthalene-2-carboxylate (*ent*-B39)



White solid, Mp: 52–55 °C, 67% yield, 96% *ee*; $[\alpha]^{24.7} = -14.6$ ($c = 0.47$ in CH_2Cl_2 , $\lambda = 589$ nm).

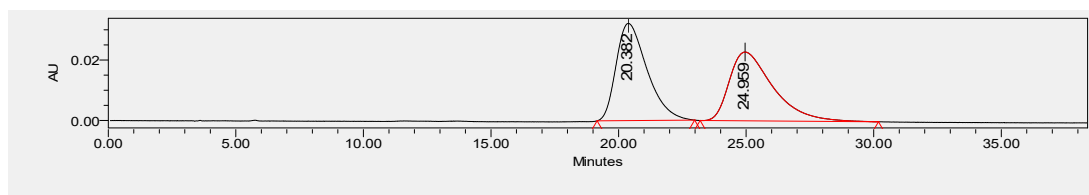
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R}(\text{minor})} = 20.95$ min, $t_{\text{R}(\text{major})} = 24.64$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.06 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.98 (dd, $J = 8.0, 1.1$ Hz, 1H), 7.85 (s, 1H), 7.84 – 7.77 (m, 3H), 7.73 (d, $J = 8.1$ Hz, 1H), 7.49 – 7.43 (m, 3H), 7.35 – 7.30 (m, 1H), 7.26 – 7.14 (m, 6H), 7.06 (d, $J = 15.5$ Hz, 1H), 6.40 (d, $J = 15.8$ Hz, 1H), 5.90 – 5.82 (m, 1H), 5.74 (dt, $J = 15.3, 7.5$ Hz, 1H), 4.23 (q, $J = 7.1$ Hz, 2H), 3.28 (ddd, $J = 13.7, 7.5, 1.3$ Hz, 1H), 3.22 – 3.14 (m, 2H), 3.08 (ddd, $J = 13.9, 7.6, 1.3$ Hz, 1H), 1.24 (t, $J = 7.1$ Hz, 3H).

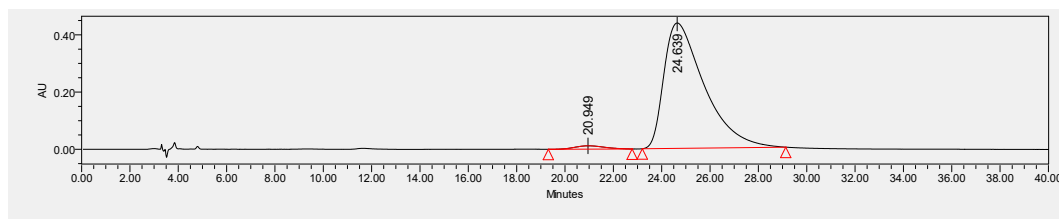
^{13}C NMR (101 MHz, Acetone- d_6) δ 181.2, 165.6, 158.8, 146.3, 138.0, 136.0, 134.8, 134.6, 134.0, 133.9, 132.6, 131.9, 129.4, 129.2, 128.6, 128.5, 128.2, 128.2, 127.8, 127.5, 127.0, 126.8, 126.7, 126.5, 125.0, 124.8, 124.6, 61.6, 47.8, 45.5, 45.4, 14.6.

HRMS (ESI) Calculated for $\text{C}_{35}\text{H}_{30}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 521.2087, Found 521.2088.

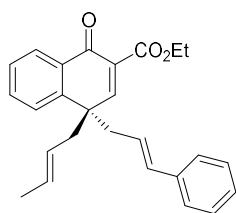
IR (neat) 3029, 2982, 2361, 1735, 1662, 1600, 1450, 1380, 1270, 1230, 1161, 1138, 1087, 1019, 966, 928, 863, 775, 695, 618, 552, 514 cm^{-1} .



	Retention Time	Area	% Area
1	20.382	2710533	50.15
2	24.959	2694175	49.85



	Retention Time	Area	% Area
1	20.949	995406	1.92
2	24.639	50789067	98.08

Ethyl (S)-4-((E)-but-2-en-1-yl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B40)

White solid, Mp: 79–82 °C, 64% yield, 89% *ee*; $[\alpha]^{21.8} = 41.7$ ($c = 0.50$ in CH_2Cl_2 , $\lambda = 589$ nm).

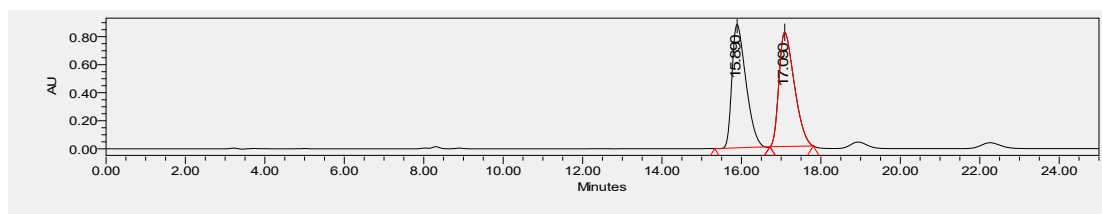
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 16.07$ min, $t_{R(\text{major})} = 17.17$ min.

$^1\text{H NMR}$ (400 MHz, Acetone- d_6) δ 8.07 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.81 (dd, $J = 8.0, 1.2$ Hz, 1H), 7.72 (td, $J = 7.6, 1.5$ Hz, 1H), 7.64 (s, 1H), 7.45 (ddd, $J = 8.1, 7.1, 1.2$ Hz, 1H), 7.21 – 7.17 (m, 2H), 7.15 – 7.11 (m, 3H), 6.33 (d, $J = 15.8$ Hz, 1H), 5.77 (dd, $J = 15.5, 7.8$ Hz, 1H), 5.42 – 5.34 (m, 1H), 4.97 (dtq, $J = 15.0, 7.4, 1.7$ Hz, 1H), 4.24 (q, $J = 7.1$ Hz, 2H), 3.09 – 3.03 (m, 1H), 2.97 – 2.88 (m, 2H), 2.81 – 2.75 (m, 1H), 1.42 (d, $J = 6.3$ Hz, 3H), 1.29 (t, $J = 7.1$ Hz, 3H).

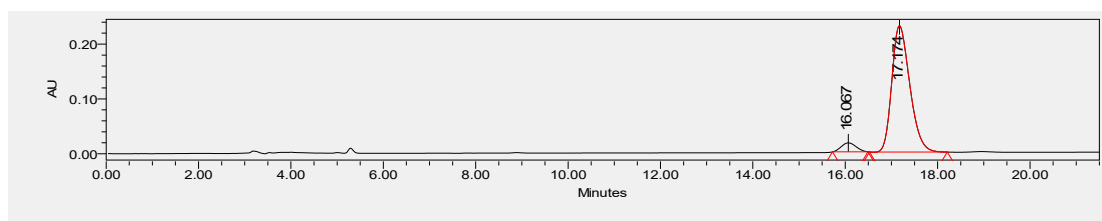
$^{13}\text{C NMR}$ (101 MHz, Acetone- d_6) δ 181.3, 165.6, 159.0, 146.4, 138.1, 134.7, 134.6, 133.9, 130.2, 129.4, 128.2, 128.0, 127.6, 127.3, 126.9, 125.8, 125.1, 61.6, 47.4, 45.3, 45.1, 18.1, 14.6.

HRMS (ESI) Calculated for $\text{C}_{26}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 409.1774, Found 409.1772.

IR (neat) 3027, 2980, 2361, 1736, 1663, 1601, 1450, 1380, 1273, 1230, 1138, 1087, 1020, 967, 929, 757, 695, 618 cm^{-1} .

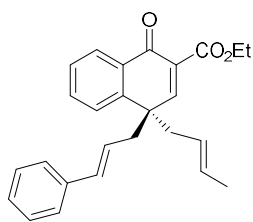


	Retention Time	Area	% Area
1	15.890	21577141	49.60
2	17.090	21924149	50.40



	Retention Time	Area	% Area
1	16.067	365132	5.53
2	17.174	6232654	94.47

Ethyl (R)-4-((E)-but-2-en-1-yl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate
(*ent*-B40)



White solid, Mp: 79–82 °C, 57% yield, 95% *ee*; $[\alpha]^{25.2} = -45.7$ ($c = 0.30$ in CH_2Cl_2 , $\lambda = 589$ nm).

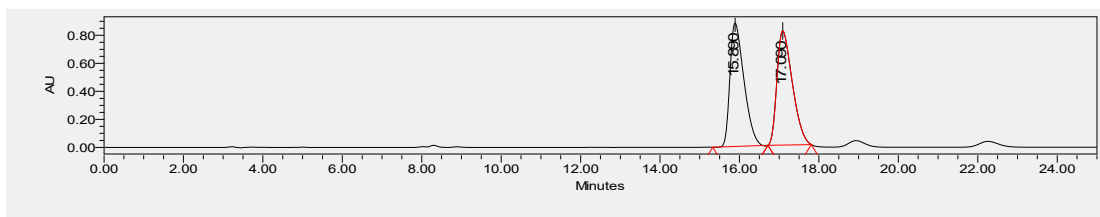
HPLC: Daicel chiralcel ID, *n*-hexane/*i*-PrOH = 90/10, 1.0 mL/min, $\lambda = 224$ nm, $t_{\text{R}(\text{minor})} = 17.22$ min, $t_{\text{R}(\text{major})} = 15.96$ min.

$^1\text{H NMR}$ (400 MHz, Acetone- d_6) δ 8.07 (dd, $J = 7.9, 1.4$ Hz, 1H), 7.82 (dd, $J = 8.1, 1.1$ Hz, 1H), 7.72 (td, $J = 7.6, 1.5$ Hz, 1H), 7.64 (s, 1H), 7.45 (ddd, $J = 8.2, 7.2, 1.2$ Hz, 1H), 7.21 – 7.17 (m, 2H), 7.15 – 7.11 (m, 3H), 6.33 (d, $J = 15.7$ Hz, 1H), 5.76 (dd, $J = 15.5, 7.8$ Hz, 1H), 5.42 – 5.34 (m, 1H), 4.97 (dtq, $J = 15.0, 7.4, 1.7$ Hz, 1H), 4.25 (q, $J = 7.1$ Hz, 2H), 3.09 – 3.03 (m, 1H), 2.97 – 2.88 (m, 2H), 2.81 – 2.75 (m, 1H), 1.42 (d, $J = 6.3$ Hz, 3H), 1.29 (t, $J = 7.1$ Hz, 3H).

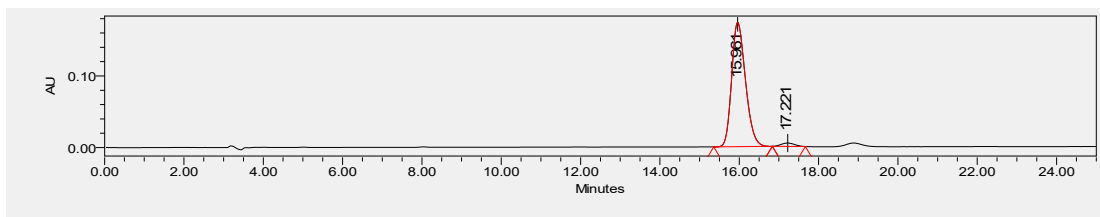
$^{13}\text{C NMR}$ (101 MHz, Acetone- d_6) δ 181.3, 165.6, 159.0, 146.4, 138.1, 134.7, 134.6, 133.9, 130.2, 129.4, 128.2, 128.0, 127.6, 127.3, 126.9, 125.8, 125.1, 61.6, 47.4, 45.3, 45.1, 18.1, 14.6.

HRMS (ESI) Calculated for $\text{C}_{26}\text{H}_{26}\text{O}_3$ ($[\text{M}] + \text{Na}^+$) = 409.1774, Found 409.1775.

IR (neat) 3027, 2980, 2361, 1736, 1662, 1601, 1450, 1380, 1272, 1230, 1138, 1087, 1020, 966, 929, 757, 695, 618 cm^{-1} .

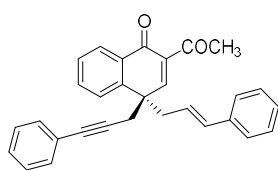


	Retention Time	Area	% Area
1	15.890	21577141	49.60
2	17.090	21924149	50.40



	Retention Time	Area	% Area
1	15.961	4191273	97.39
2	17.221	112338	2.61

(R)-2-acetyl-4-cinnamyl-4-(3-phenylprop-2-yn-1-yl)naphthalen-1(4H)-one (B45)



White solid, Mp: 101–104 °C, 84% yield, 17% *ee*; $[\alpha]^{13.0} = -2.2$ ($c = 0.69$ in CH_2Cl_2 , $\lambda = 589$ nm).

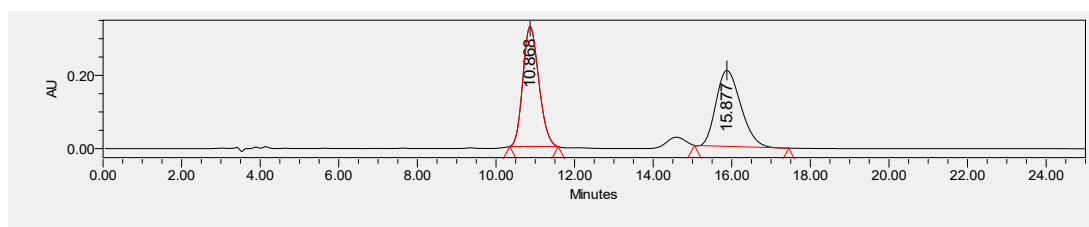
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 11.32$ min, $t_{R(\text{major})} = 17.31$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 8.17 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.93 (d, $J = 7.9$ Hz, 1H), 7.78 – 7.73 (m, 2H), 7.52 – 7.48 (m, 1H), 7.28 – 7.13 (m, 10H), 6.41 (dd, $J = 15.8, 1.4$ Hz, 1H), 5.87 – 5.80 (m, 1H), 3.28 (d, $J = 5.5$ Hz, 2H), 3.25 – 3.12 (m, 2H), 2.49 (s, 3H).

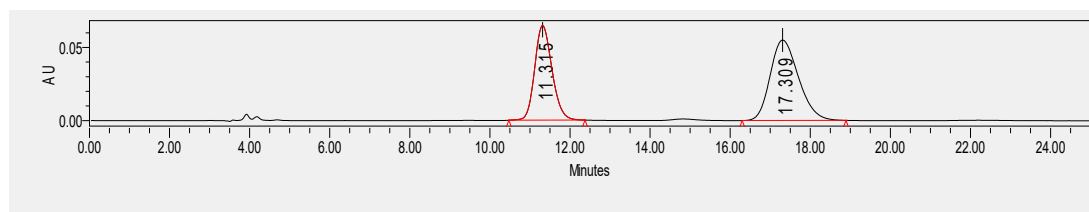
$^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Acetone- d_6) δ 198.4, 183.5, 158.0, 145.9, 141.0, 137.9, 134.9, 134.1, 134.1, 132.2, 129.4, 129.3, 129.0, 128.4, 128.3, 127.4, 127.4, 127.0, 124.9, 124.0, 86.3, 84.6, 46.9, 44.1, 32.8, 31.1.

HRMS (ESI) Calculated for $\text{C}_{30}\text{H}_{24}\text{O}_2$ ($[\text{M}] + \text{Na}^+$) = 439.1669, Found 439.1667.

IR (neat) 3028, 1693, 1658, 1600, 1491, 1453, 1372, 1260, 1160, 1131, 1071, 966, 864, 758, 717, 692, 623, 528 cm^{-1} .

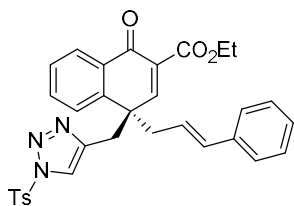


	Retention Time	Area	% Area
1	10.868	9227601	50.34
2	15.877	9103802	49.66



	Retention Time	Area	% Area
1	11.315	1939329	41.86
2	17.309	2693353	58.14

Ethyl (R)-4-cinnamyl-1-oxo-4-((1-tosyl-1H-1,2,3-triazol-4-yl)methyl)-1,4-dihydronaphthalene-2-carboxylate (B46)



White solid, Mp: 50–53 °C, 95% yield, 95% *ee*; $[\alpha]^{19.2} = 49.6$ ($c = 1.04$ in CH_2Cl_2 , $\lambda = 589$ nm).

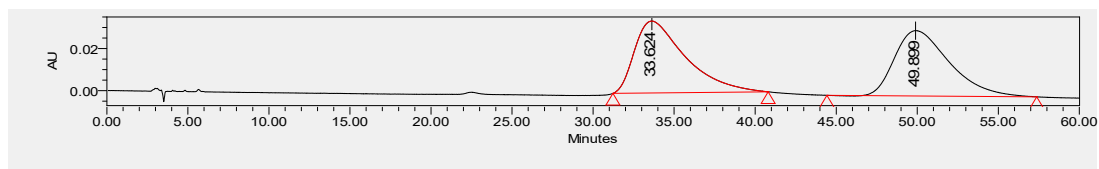
HPLC: Daicel chiralcel ODH, *n*-hexane/*i*-PrOH = 80/20, 1.0 mL/min, $\lambda = 224$ nm, $t_{R(\text{minor})} = 34.18$ min, $t_{R(\text{major})} = 48.34$ min.

^1H NMR (400 MHz, Acetone- d_6) δ 7.94 (dd, $J = 8.1, 1.2$ Hz, 1H), 7.86 (dd, $J = 7.9, 1.5$ Hz, 1H), 7.75 (d, $J = 6.1$ Hz, 2H), 7.70 (dt, $J = 7.2, 2.2$ Hz, 3H), 7.46 (d, $J = 8.1$ Hz, 2H), 7.41 – 7.37 (m, 1H), 7.21 – 7.13 (m, 5H), 6.38 (d, $J = 15.7$ Hz, 1H), 5.83 (dd, $J = 15.5, 7.7$ Hz, 1H), 4.26 (t, $J = 7.1$ Hz, 2H), 3.74 (d, $J = 14.6$ Hz, 1H), 3.58 (d, $J = 14.5$ Hz, 1H), 3.25 – 3.19 (m, 1H), 3.11 (ddd, $J = 13.8, 7.6, 1.3$ Hz, 1H), 2.46 (s, 3H), 1.29 (t, $J = 7.1$ Hz, 3H).

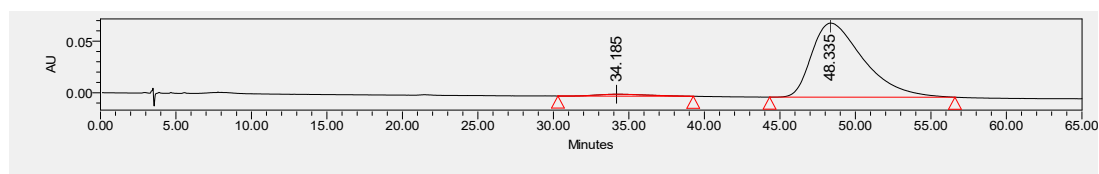
^{13}C NMR (101 MHz, Acetone- d_6) δ 180.6, 165.4, 157.3, 148.3, 145.0, 144.1, 137.9, 135.1, 135.0, 134.1, 134.0, 133.4, 131.6, 129.4, 128.7, 128.3, 128.3, 127.9, 127.2, 127.0, 124.6, 123.5, 61.7, 47.4, 45.2, 37.2, 21.8, 14.6.

HRMS (ESI) Calculated for $\text{C}_{32}\text{H}_{29}\text{N}_3\text{O}_5\text{S}$ ($[\text{M}] + \text{Na}^+$) = 590.1720, Found 590.1732.

IR (neat) 3028, 2950, 2827, 1741, 1670, 1600, 1495, 1452, 1435, 1365, 1277, 1247, 1157, 1133, 1081, 970, 874, 754, 695, 610, 496 cm^{-1} .



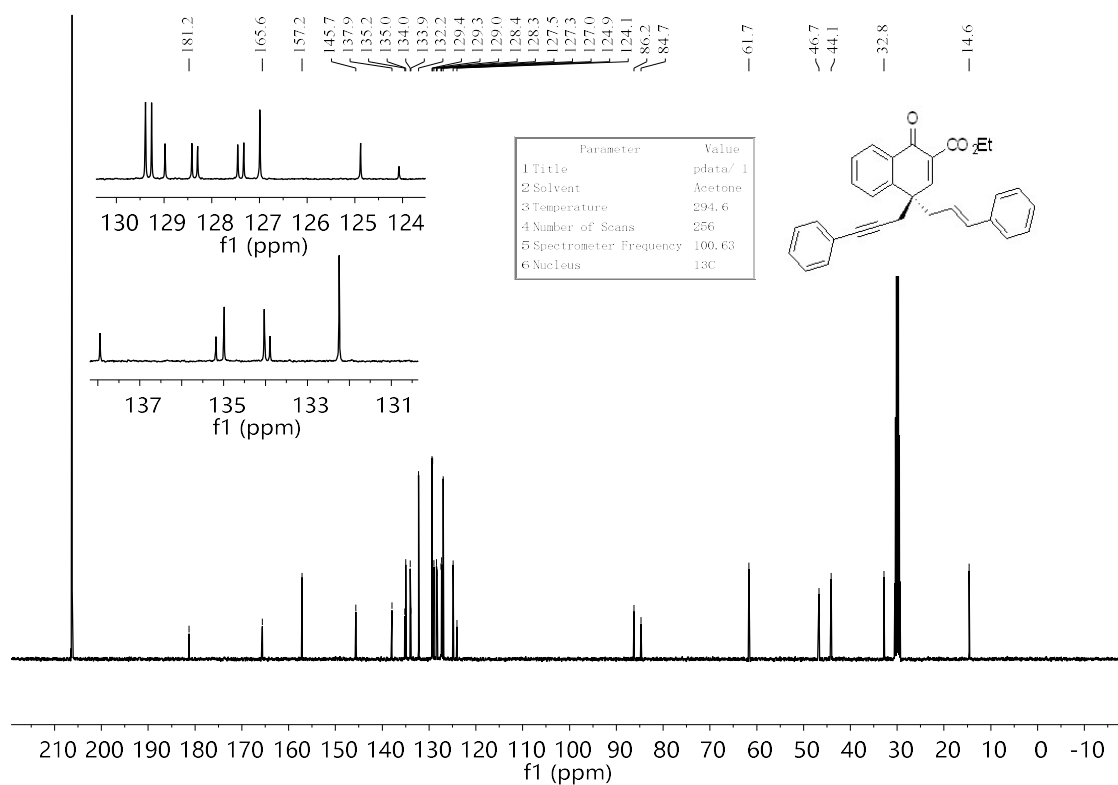
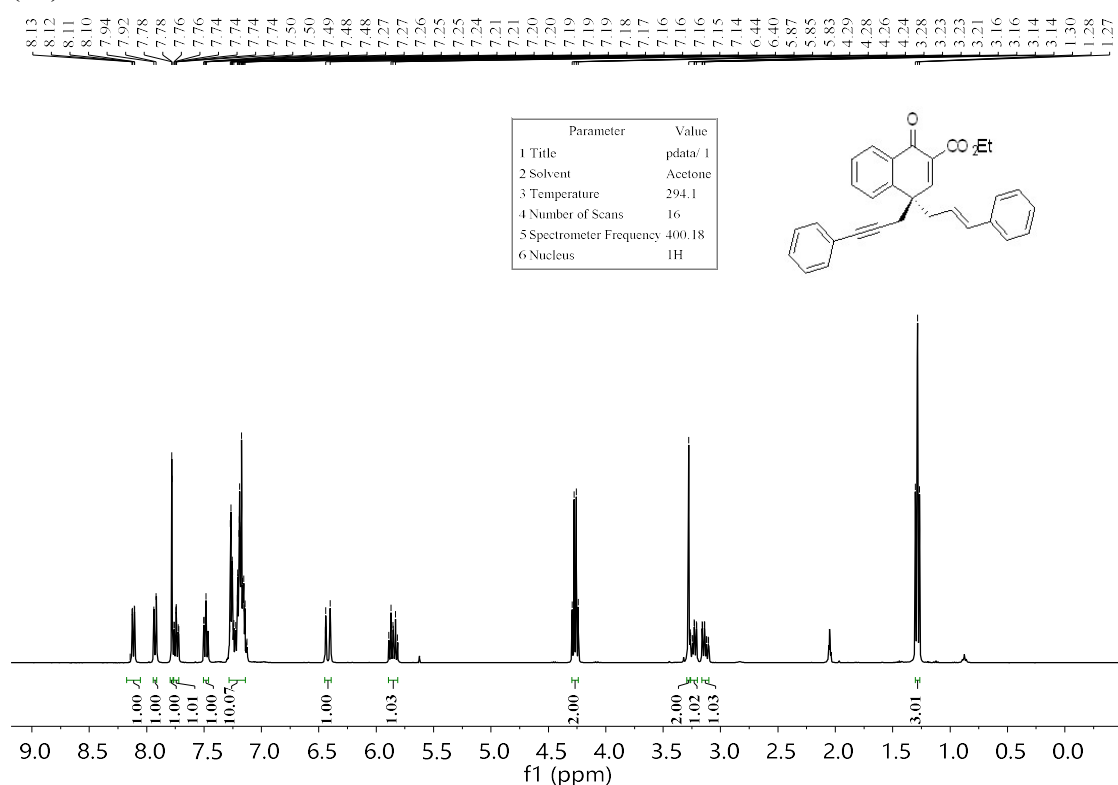
	Retention Time	Area	% Area
1	33.624	7446017	50.39
2	49.899	7330952	49.61



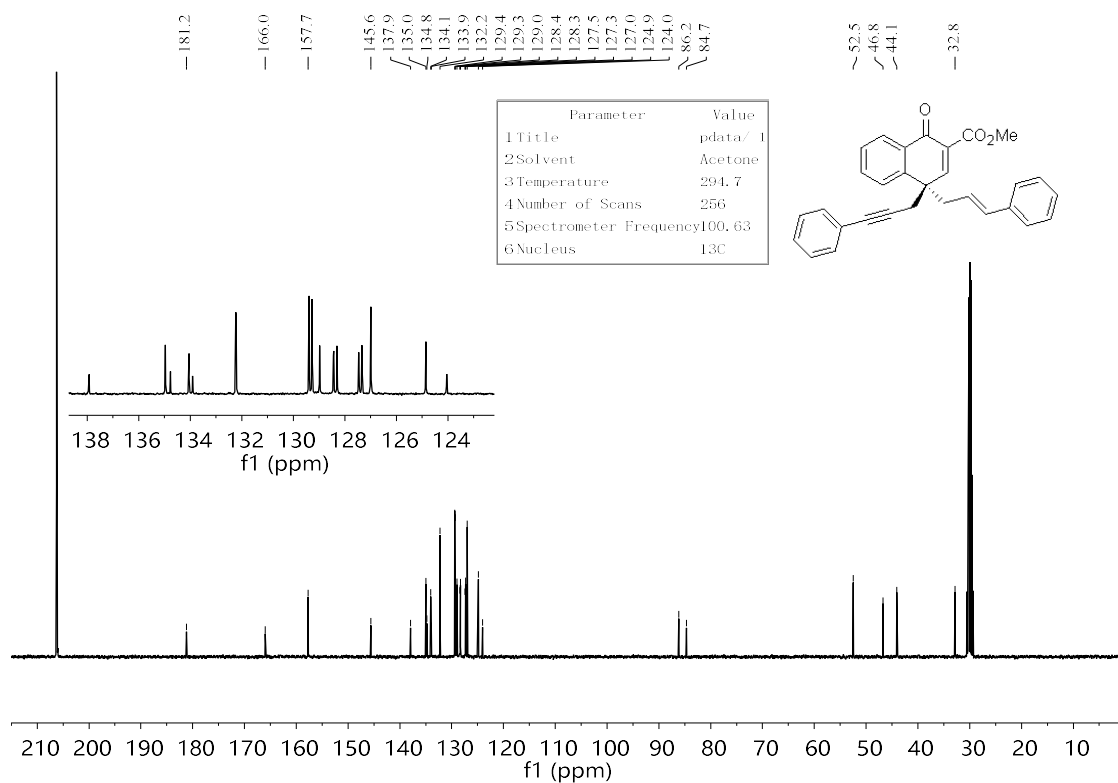
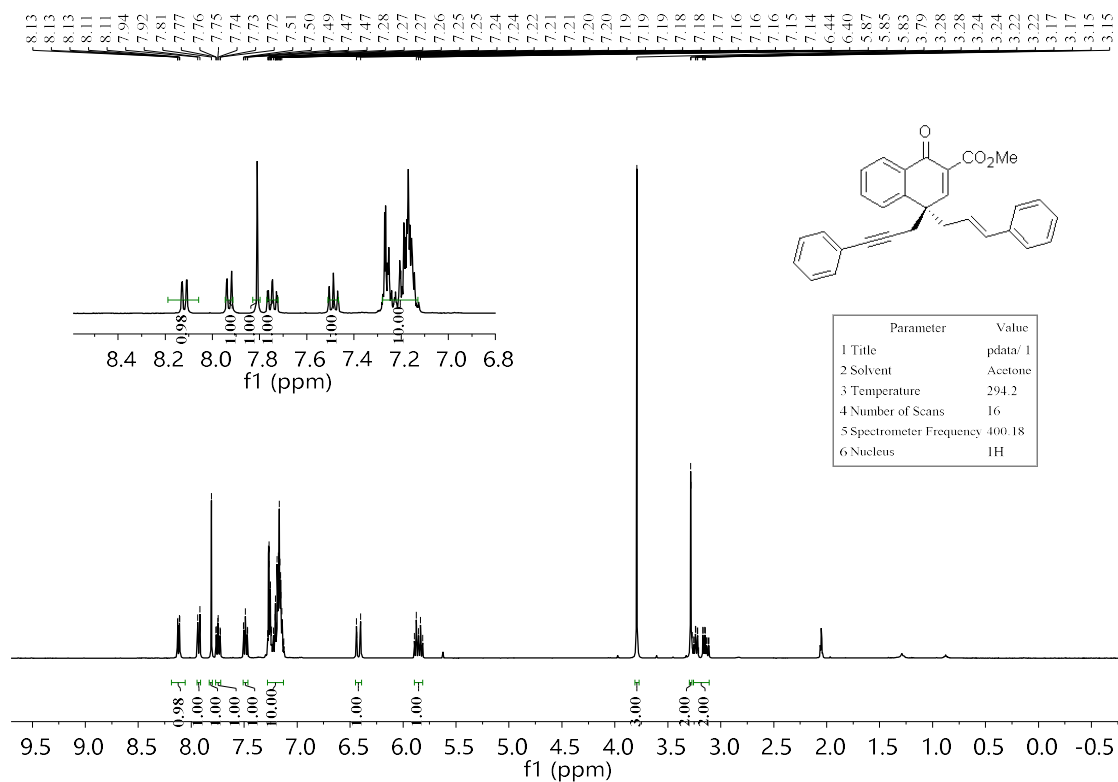
	Retention Time	Area	% Area
1	34.185	429532	2.45
2	48.335	17081735	97.55

16. Copies of NMR Spectra for the Reaction Products

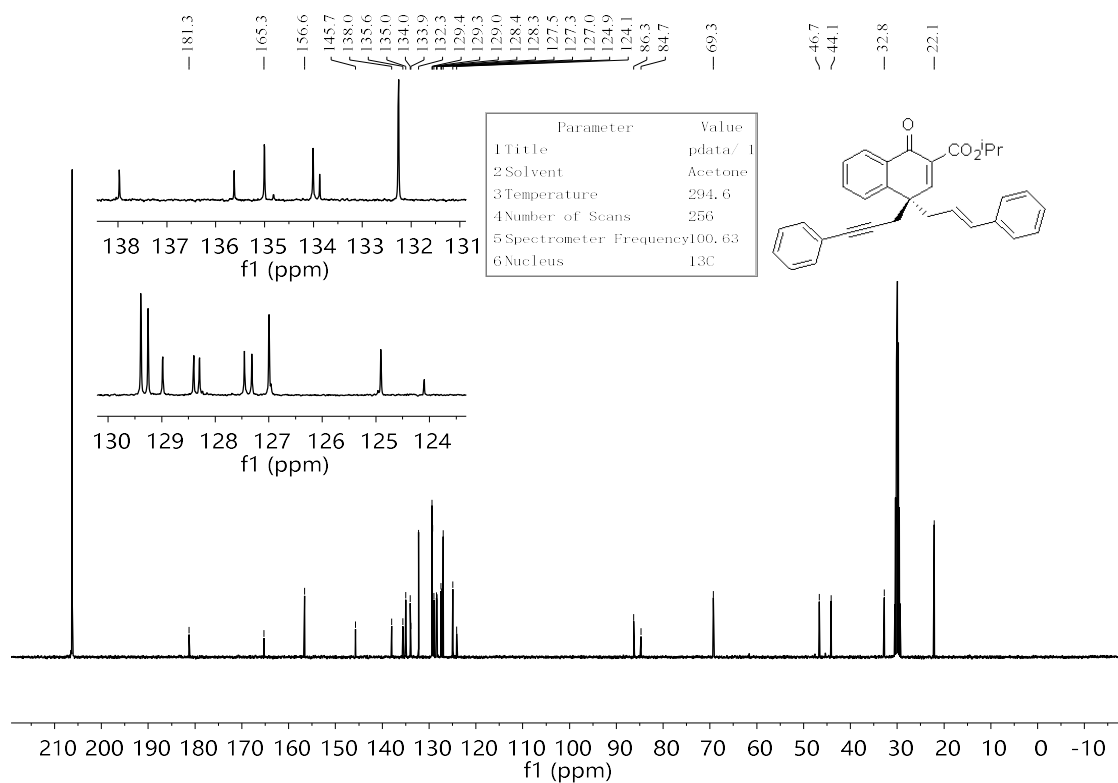
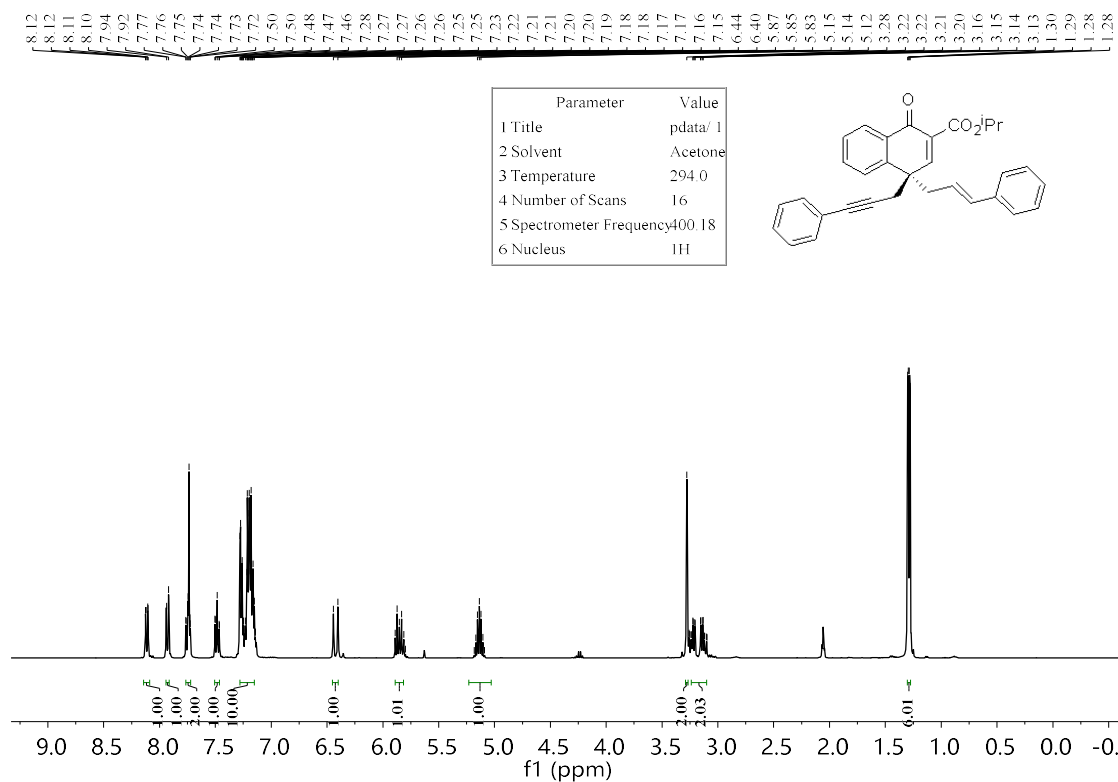
Ethyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B1)



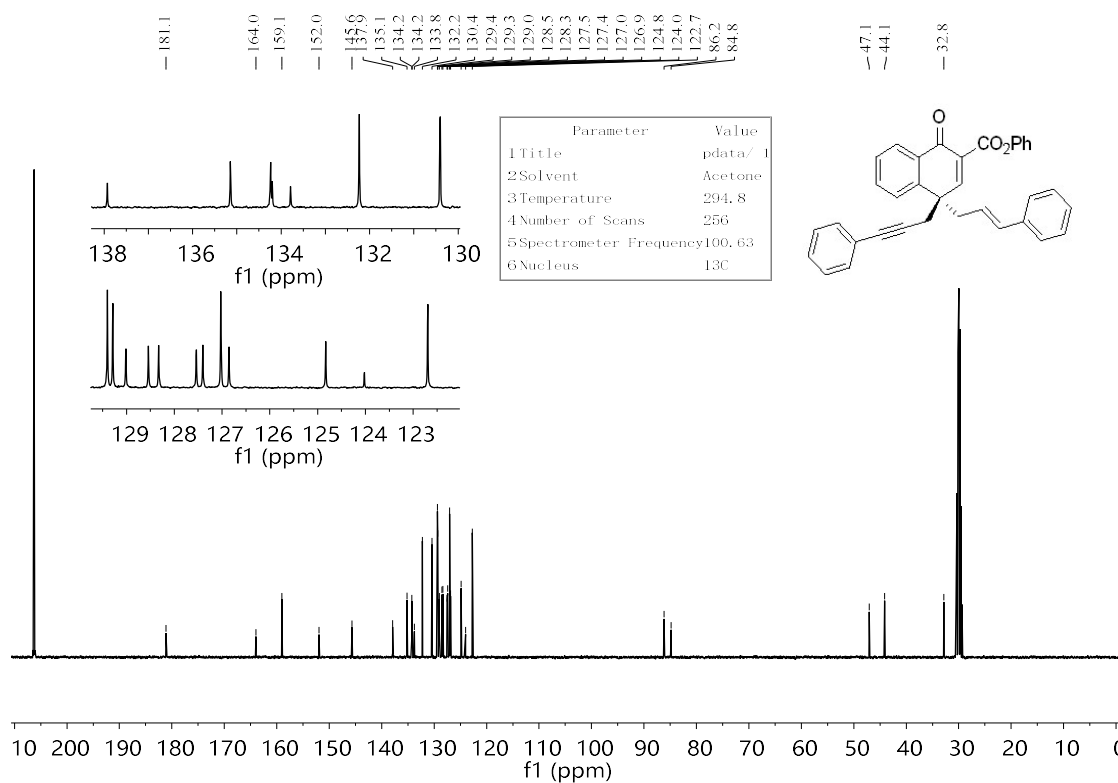
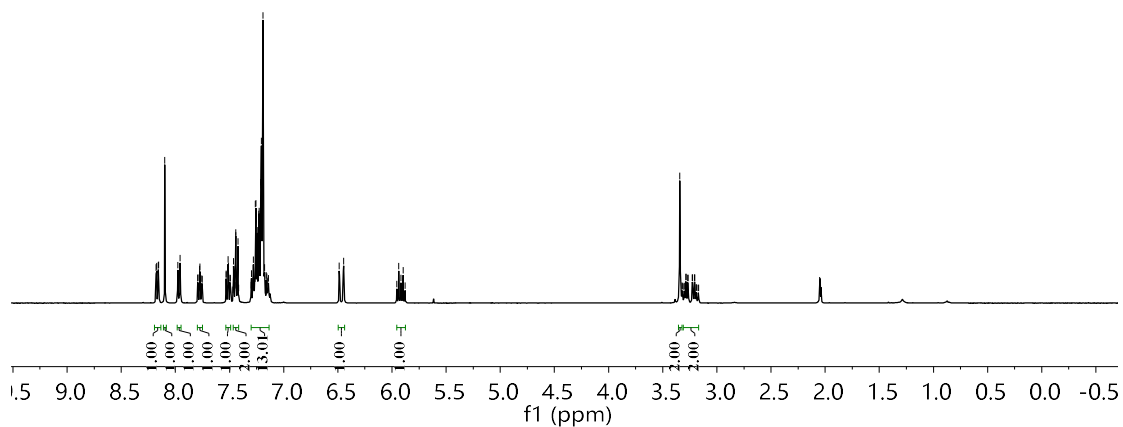
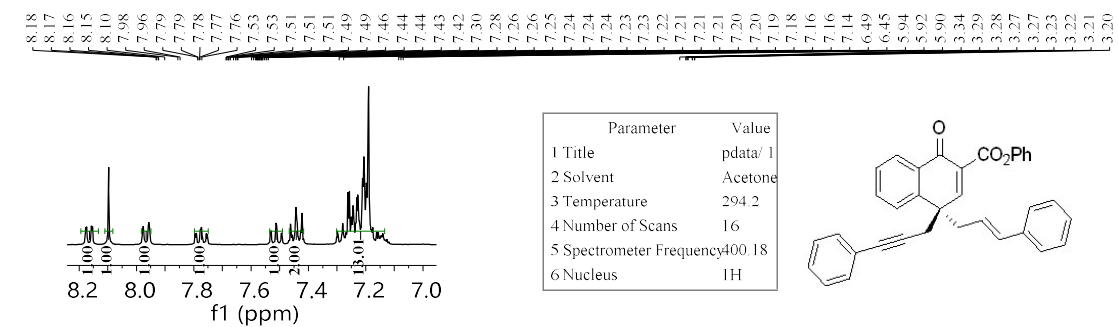
Methyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B2)



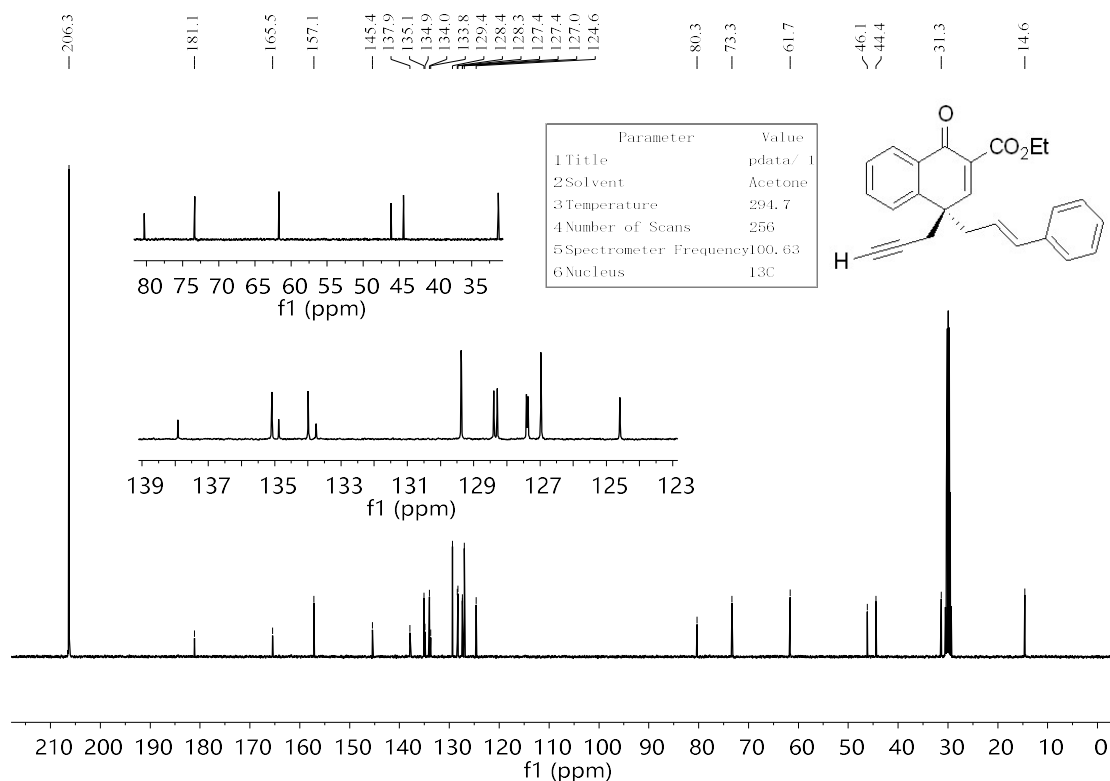
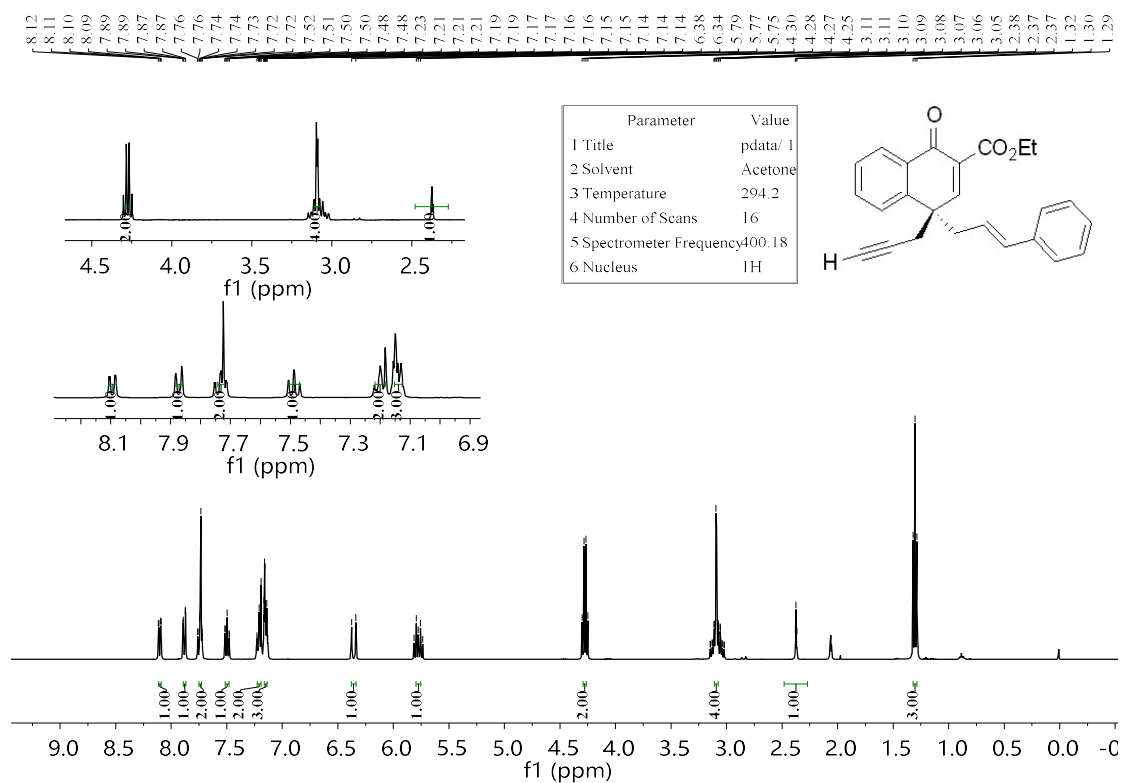
Isopropyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B3)



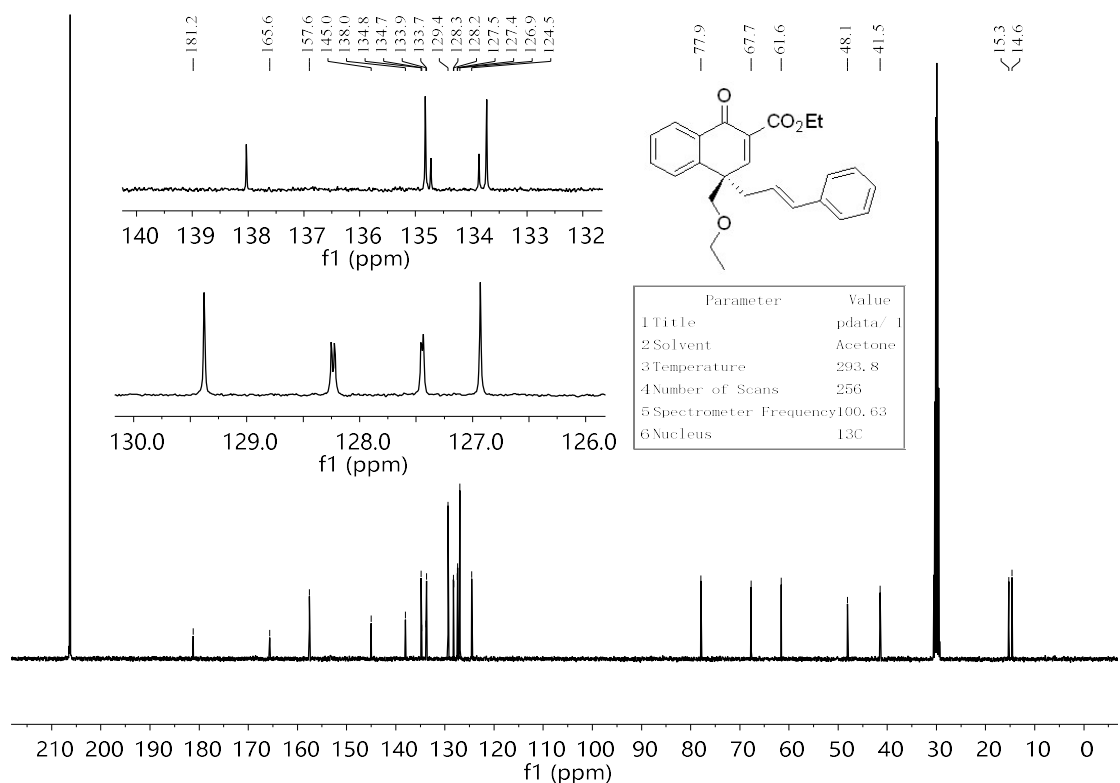
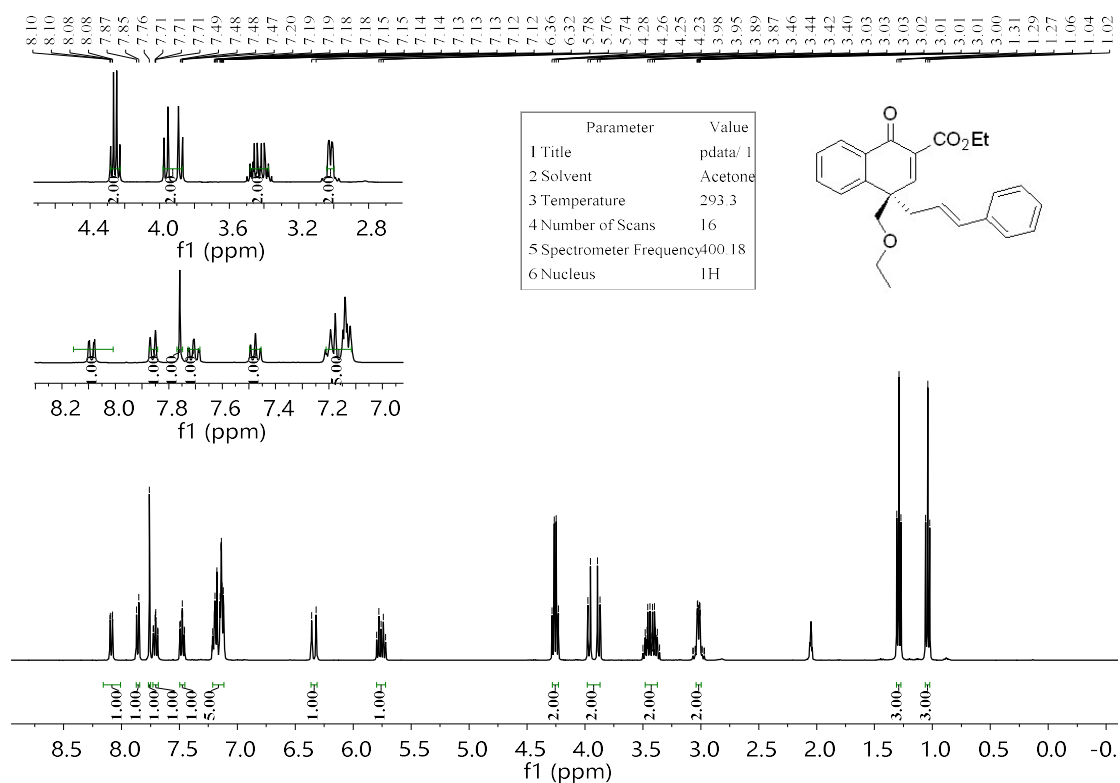
Phenyl (R)-4-cinnamyl-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B4)



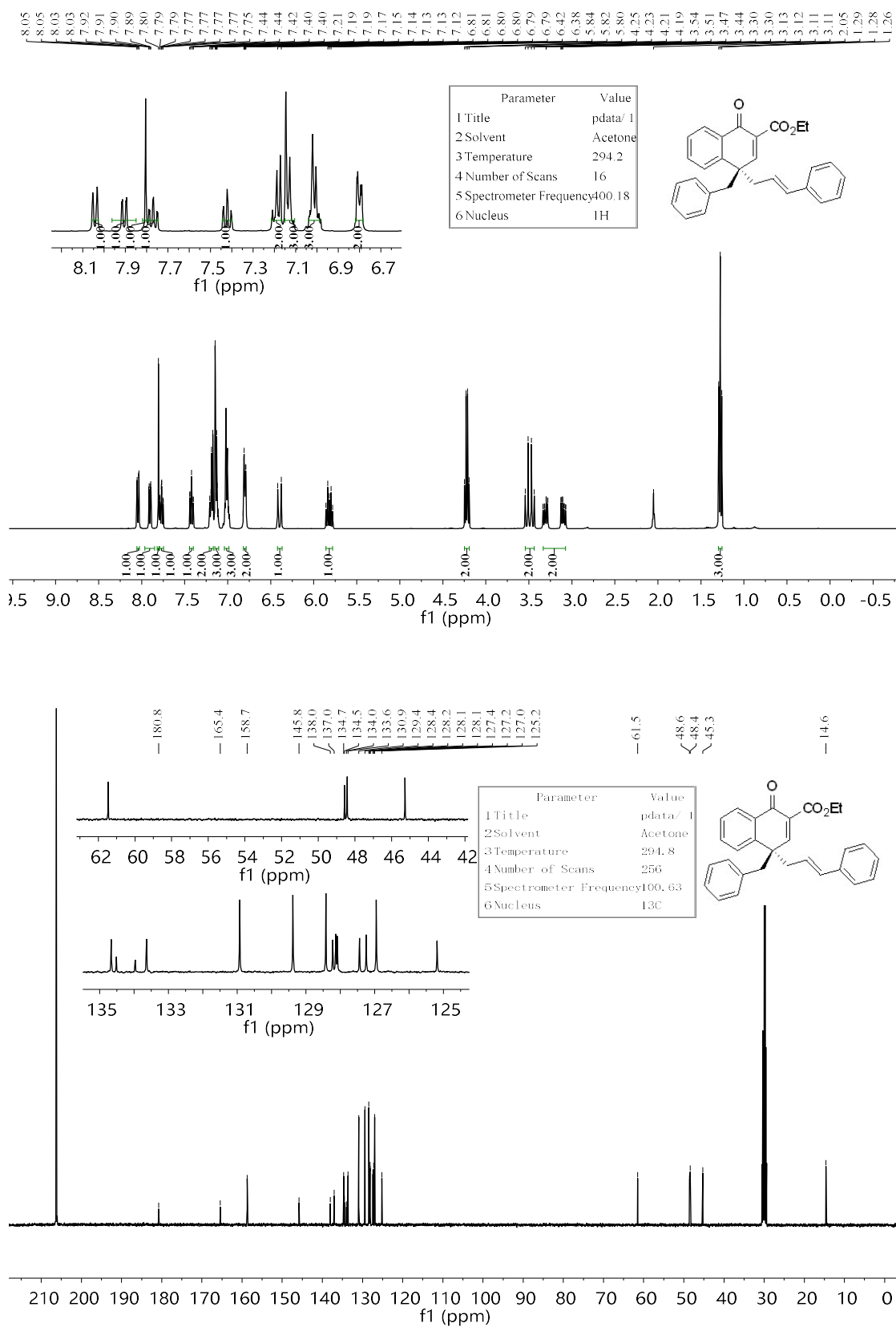
Ethyl (R)-4-cinnamyl-1-oxo-4-(prop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B5)



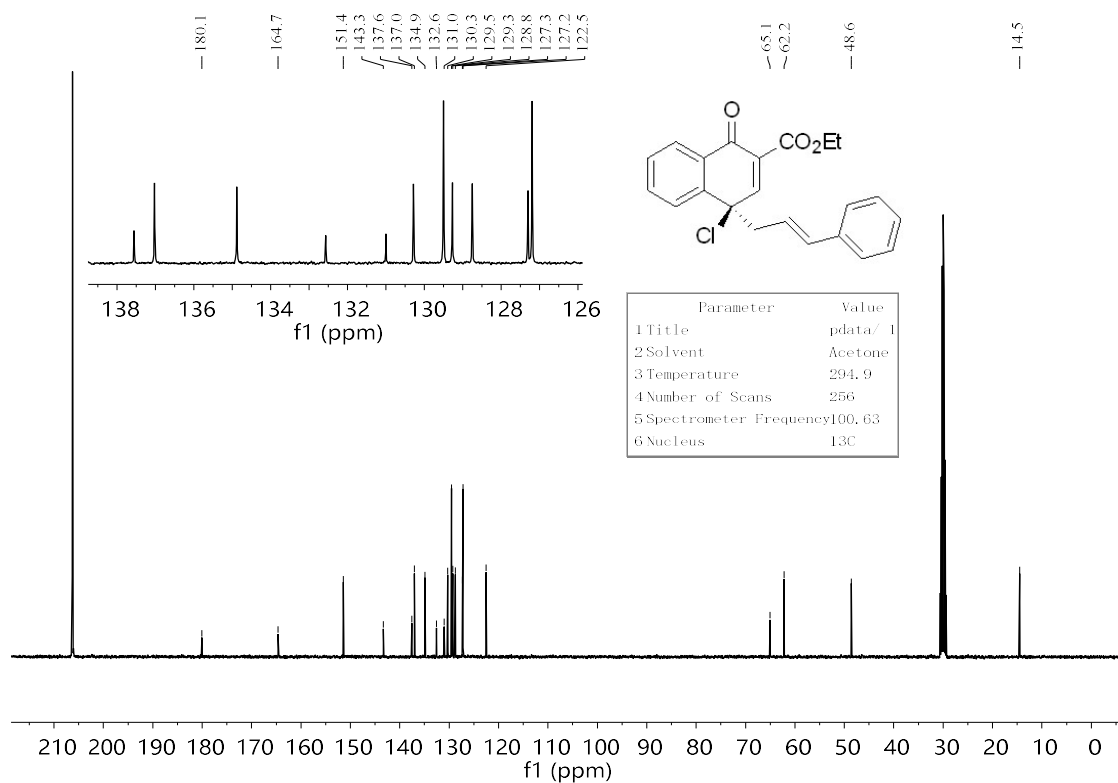
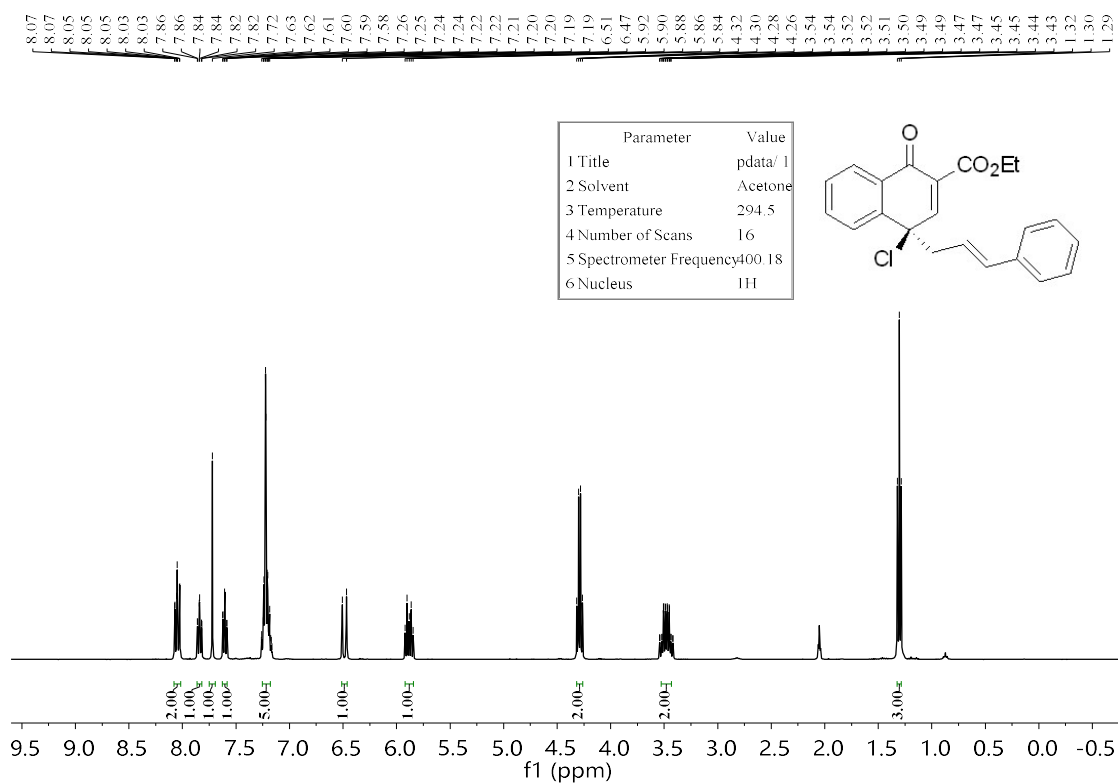
Ethyl (R)-4-cinnamyl-4-(ethoxymethyl)-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B6)



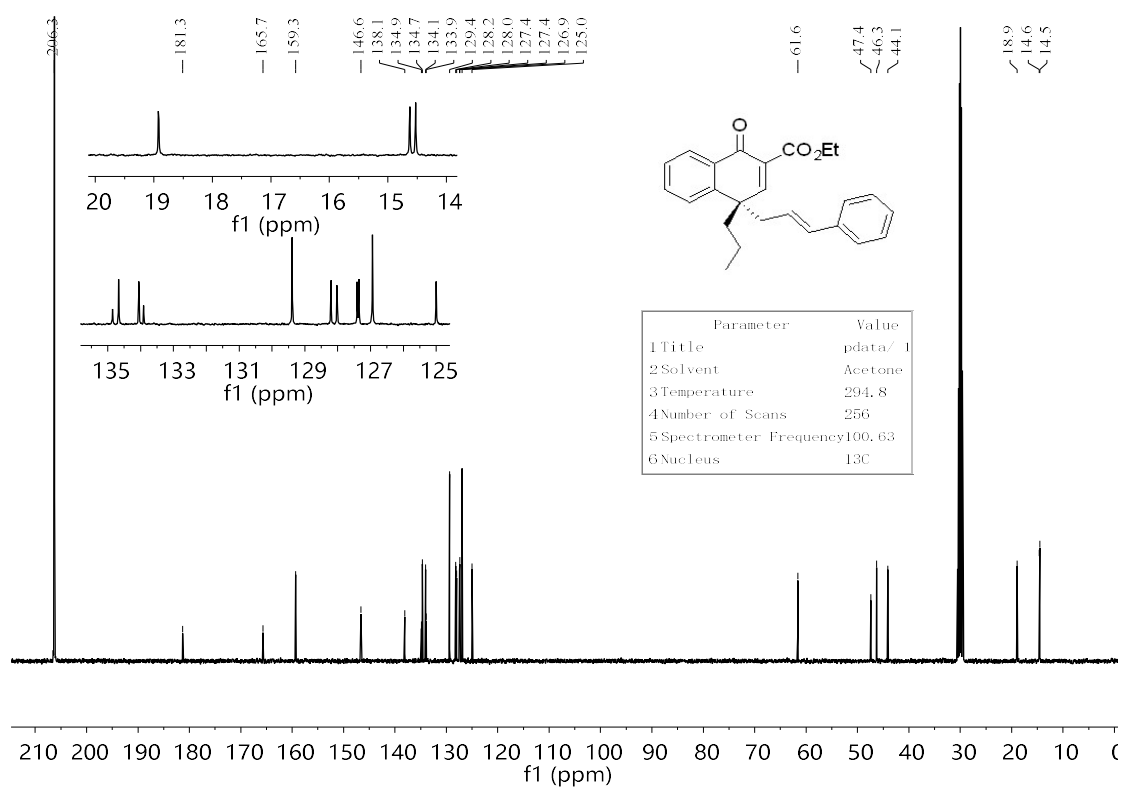
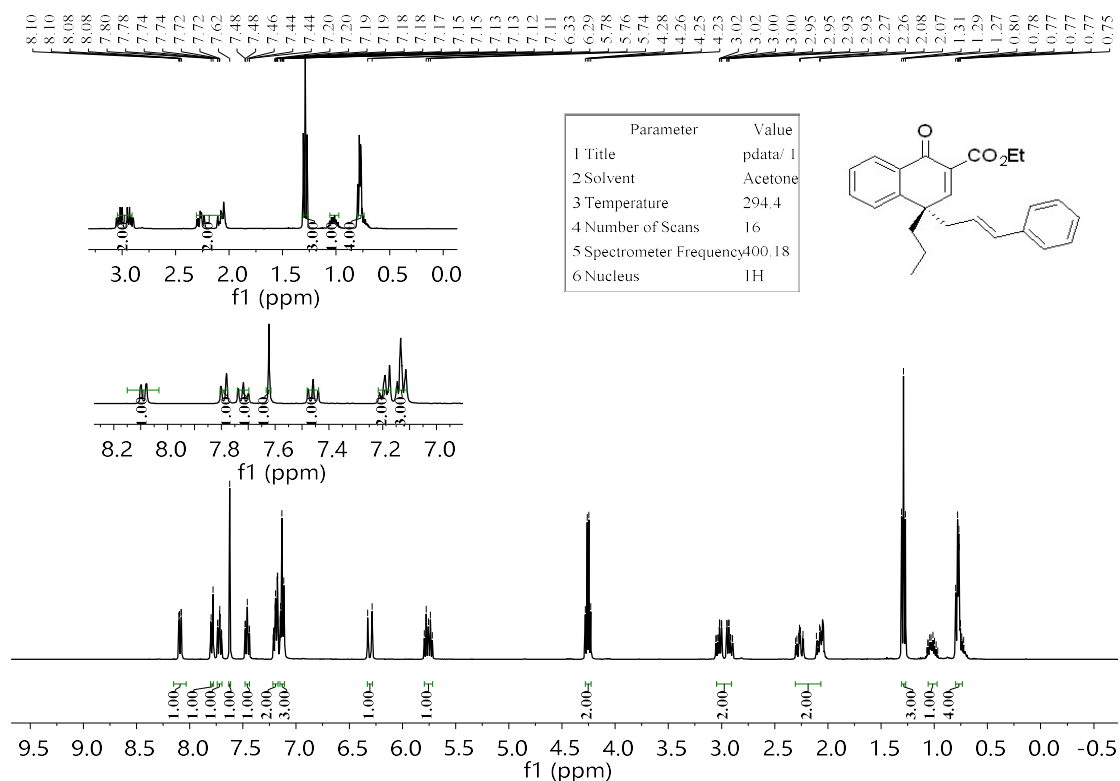
(R)-2-acetyl-4-cinnamyl-4-(3-phenylprop-2-yn-1-yl)naphthalen-1(4H)-one (B7)



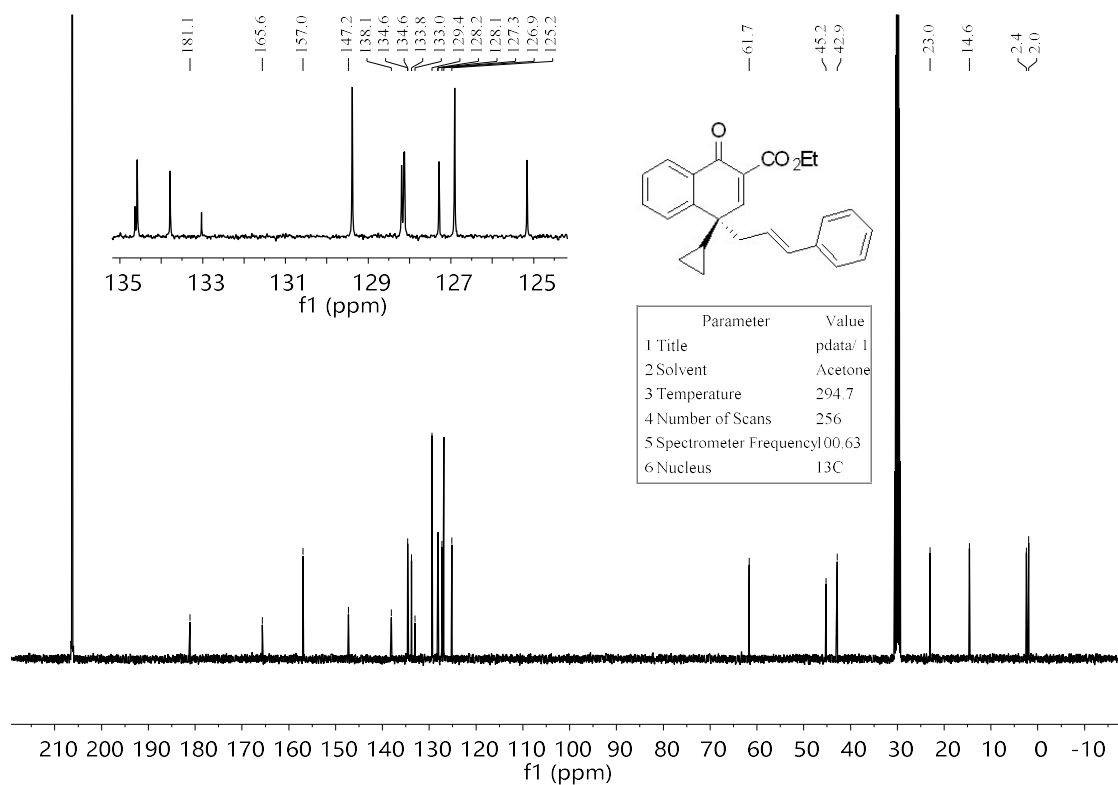
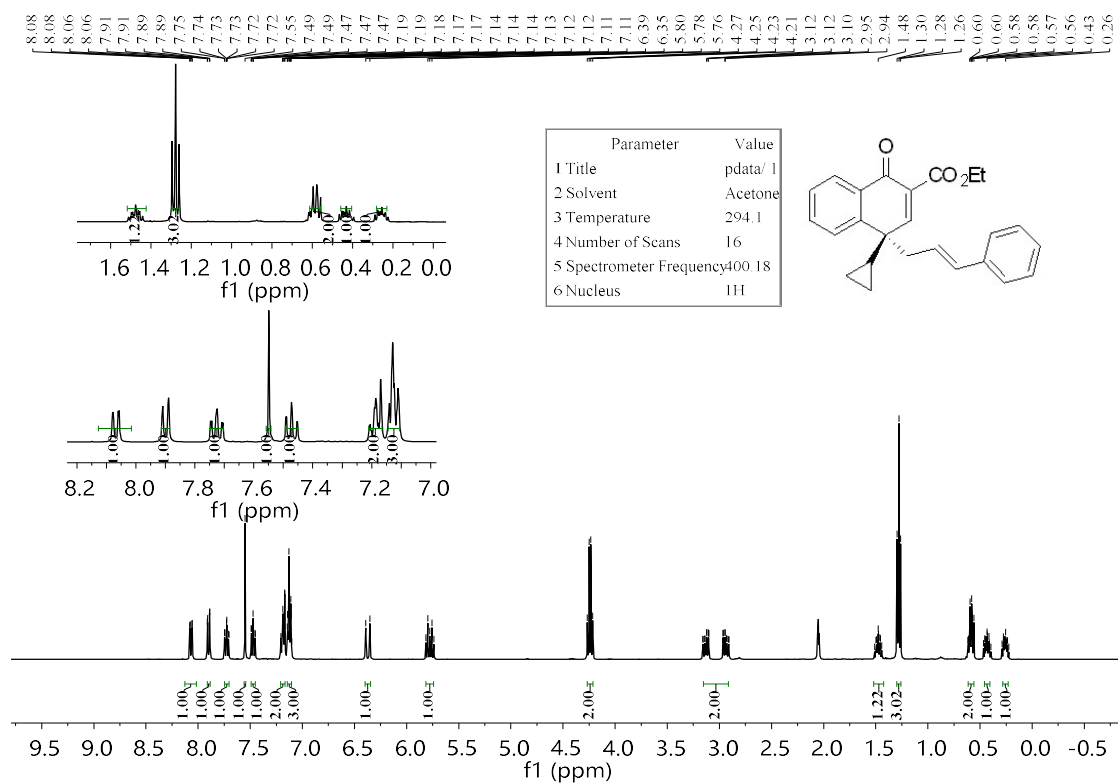
Ethyl (R)-4-chloro-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B8)



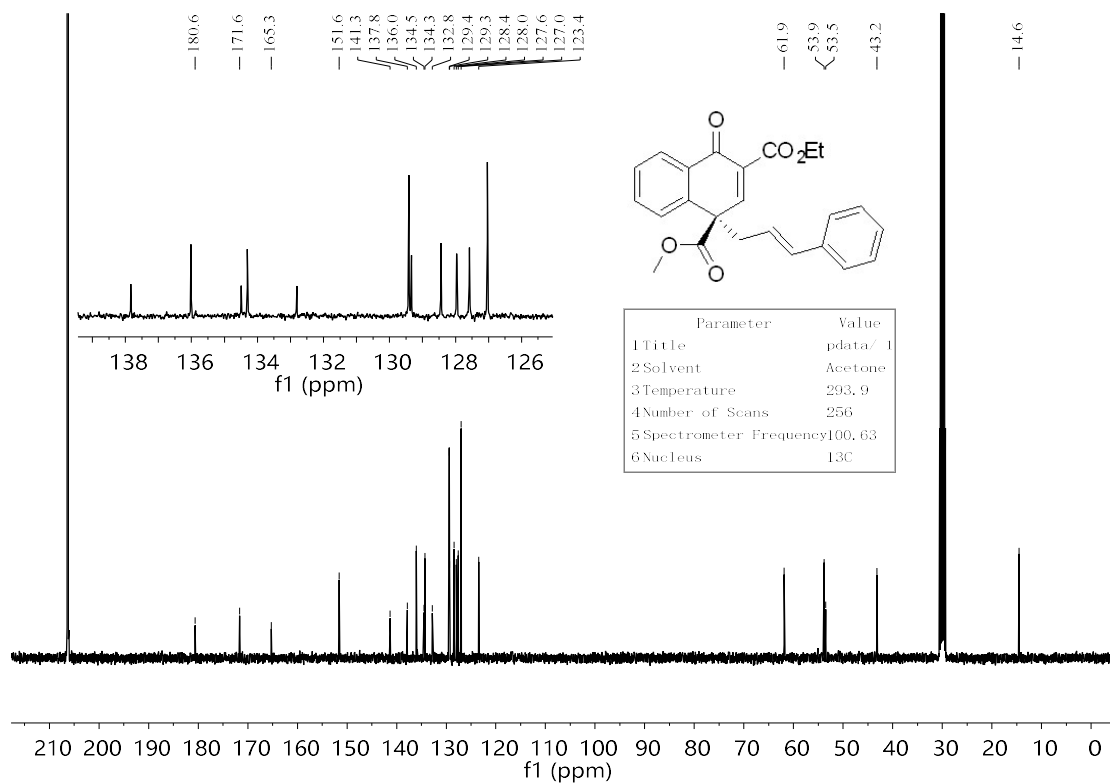
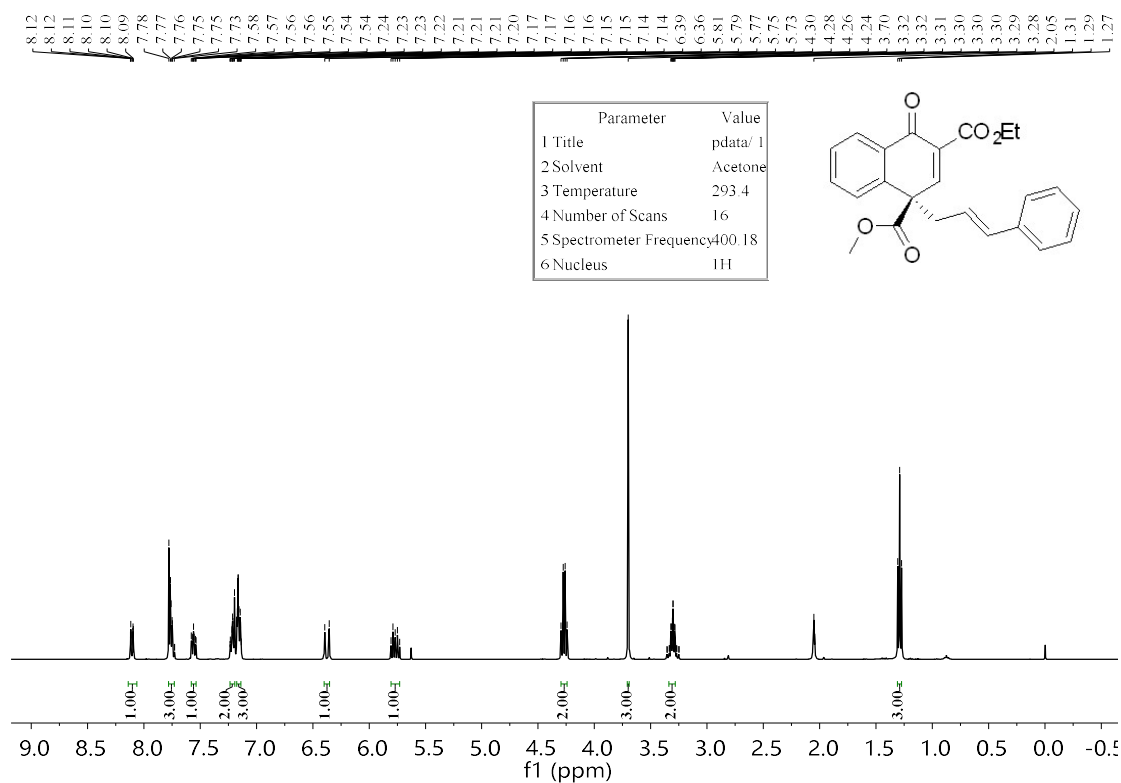
Ethyl (S)-4-cinnamyl-1-oxo-4-propyl-1,4-dihydronaphthalene-2-carboxylate (B9)



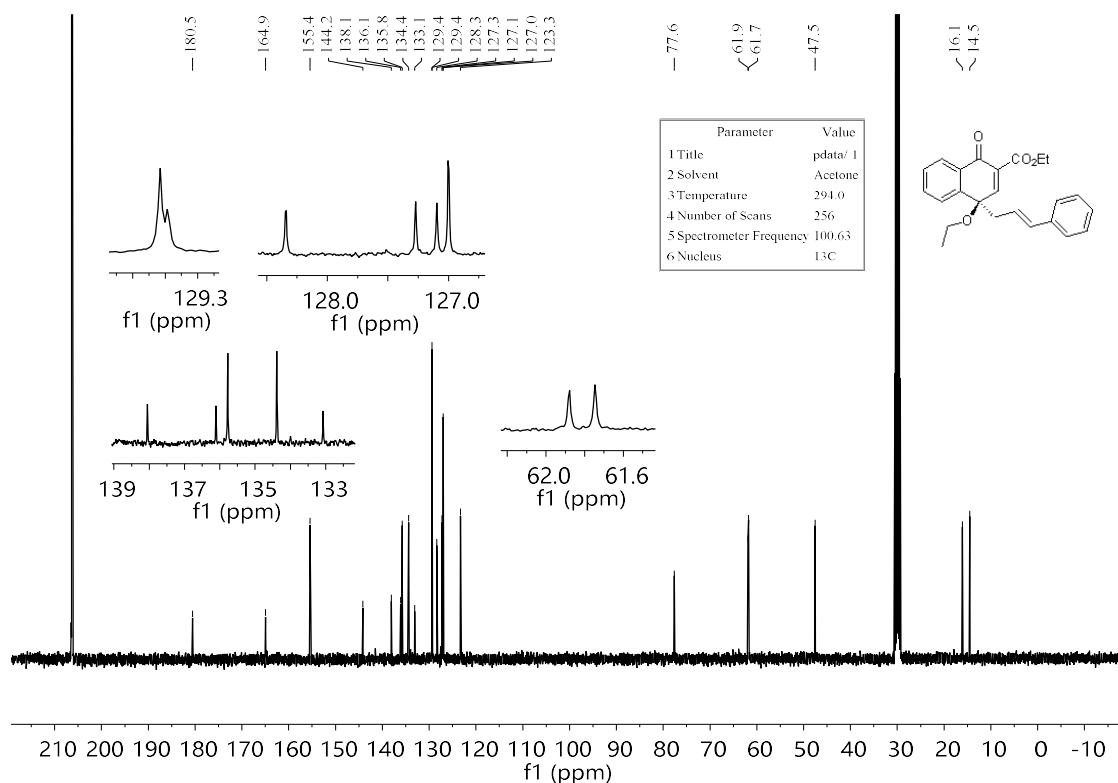
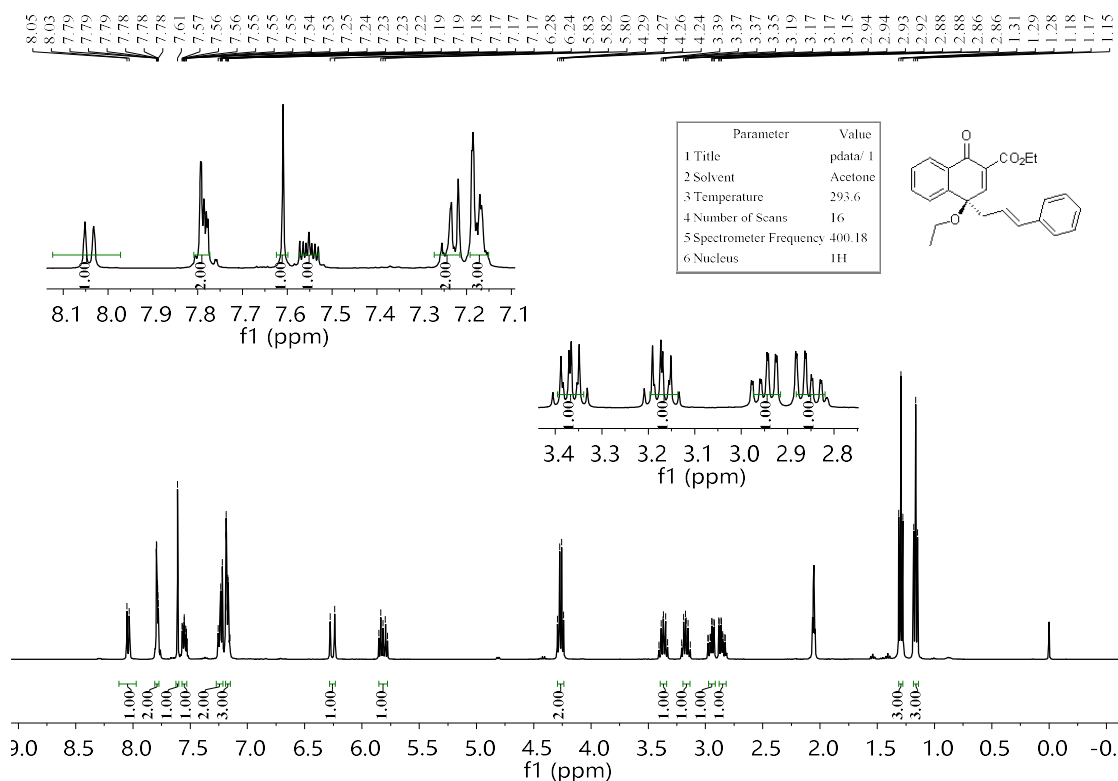
Ethyl (R)-4-cinnamyl-4-cyclopropyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B10)



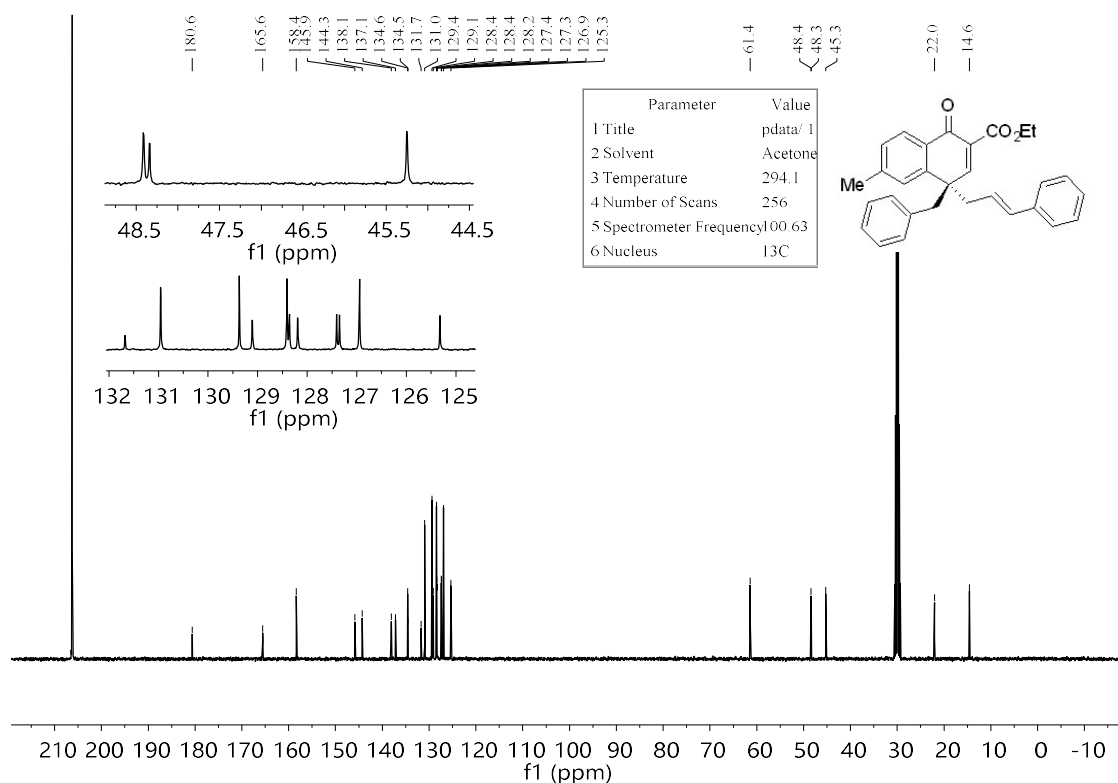
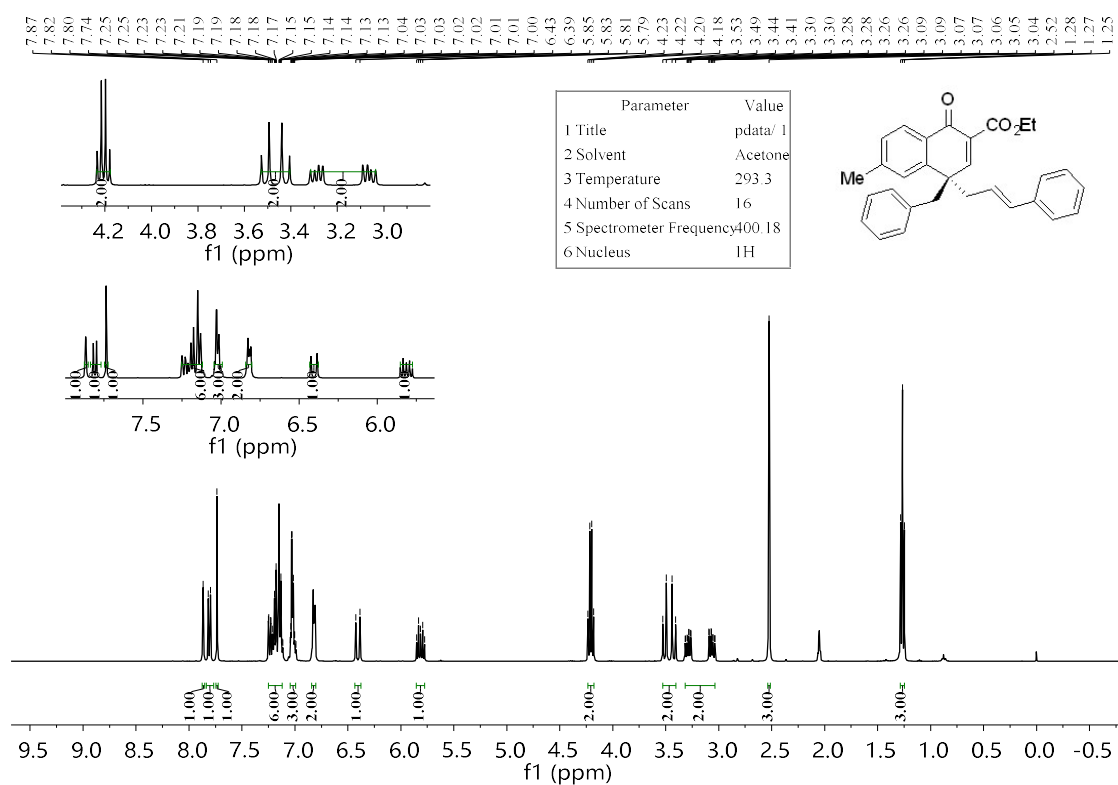
3-ethyl 1-methyl (R)-1-cinnamyl-4-oxo-1,4-dihydronaphthalene-1,3-dicarboxylate (B11)



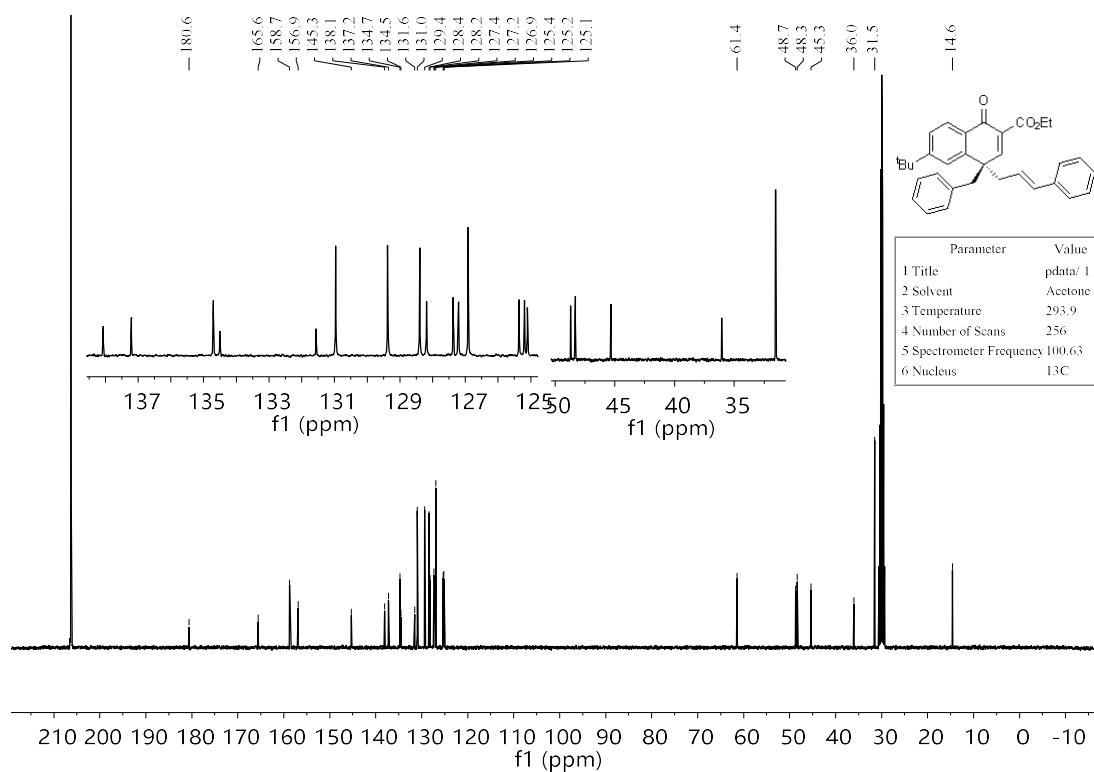
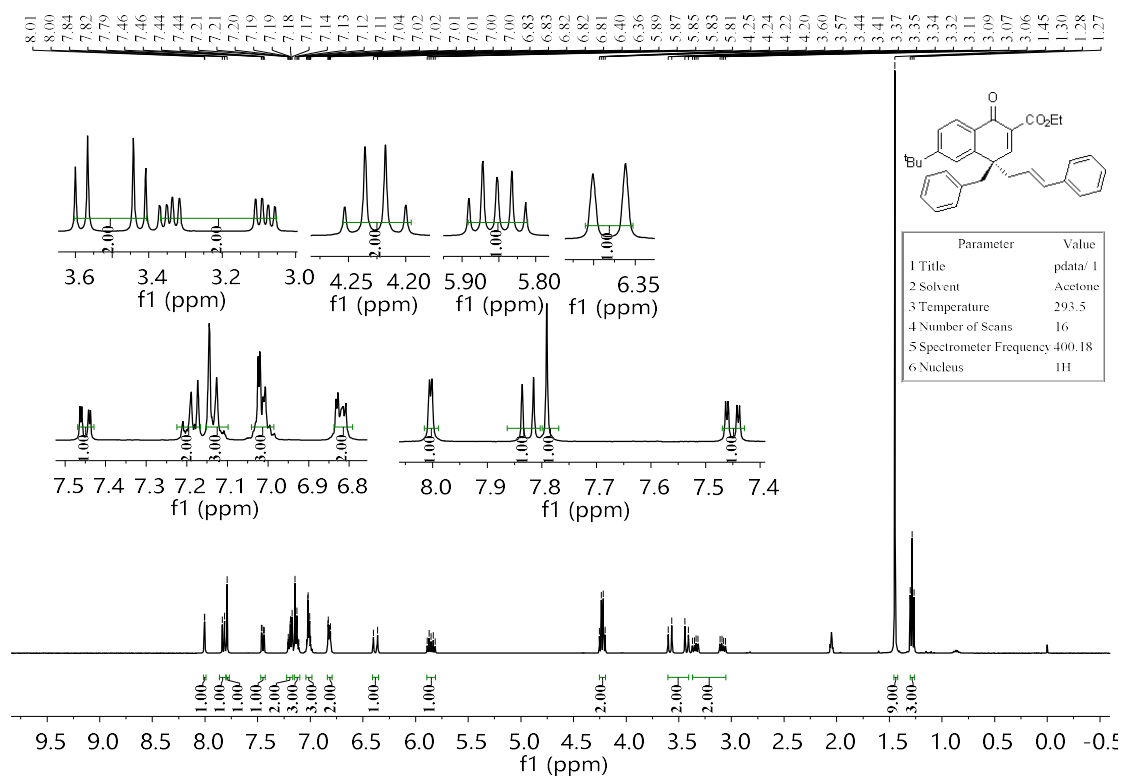
Ethyl (R)-4-cinnamyl-4-ethoxy-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B12)



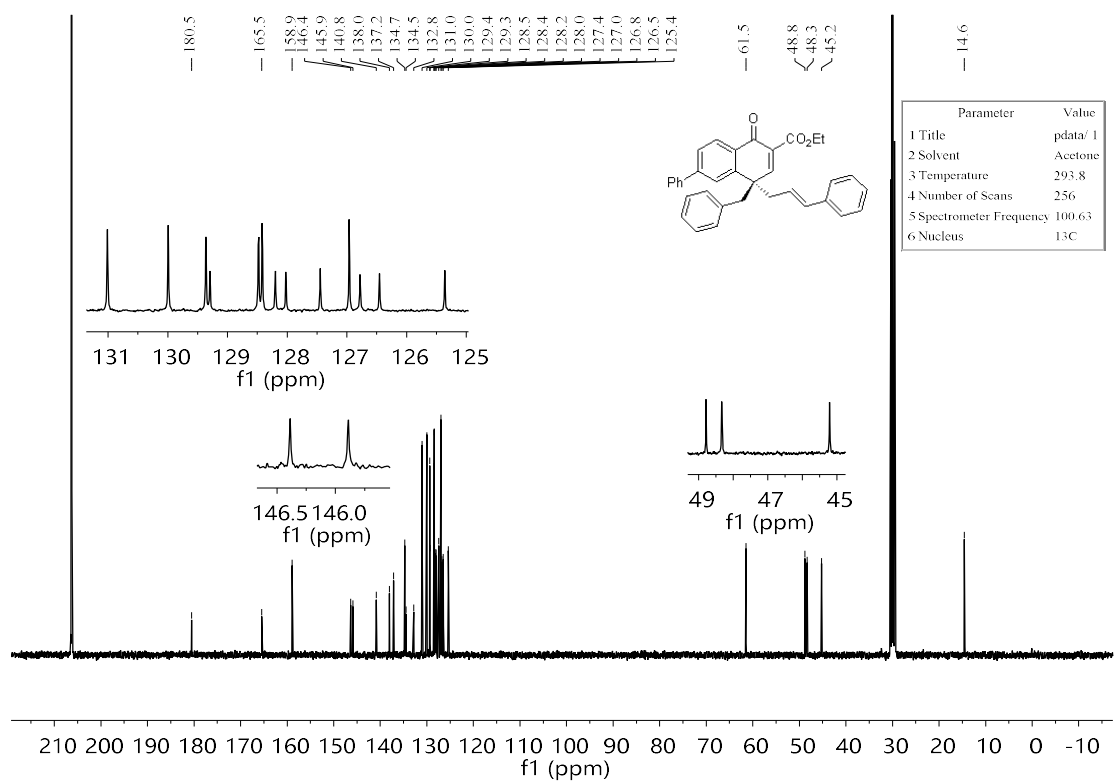
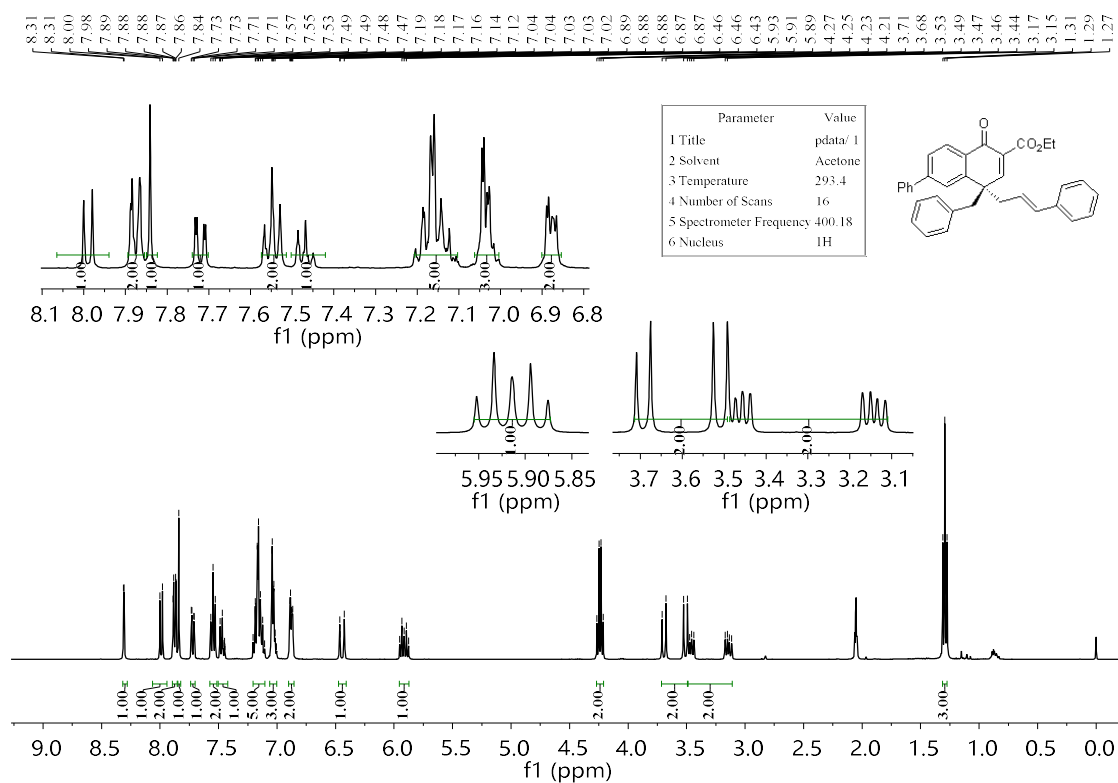
Ethyl (R)-4-benzyl-4-cinnamyl-6-methyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B13)



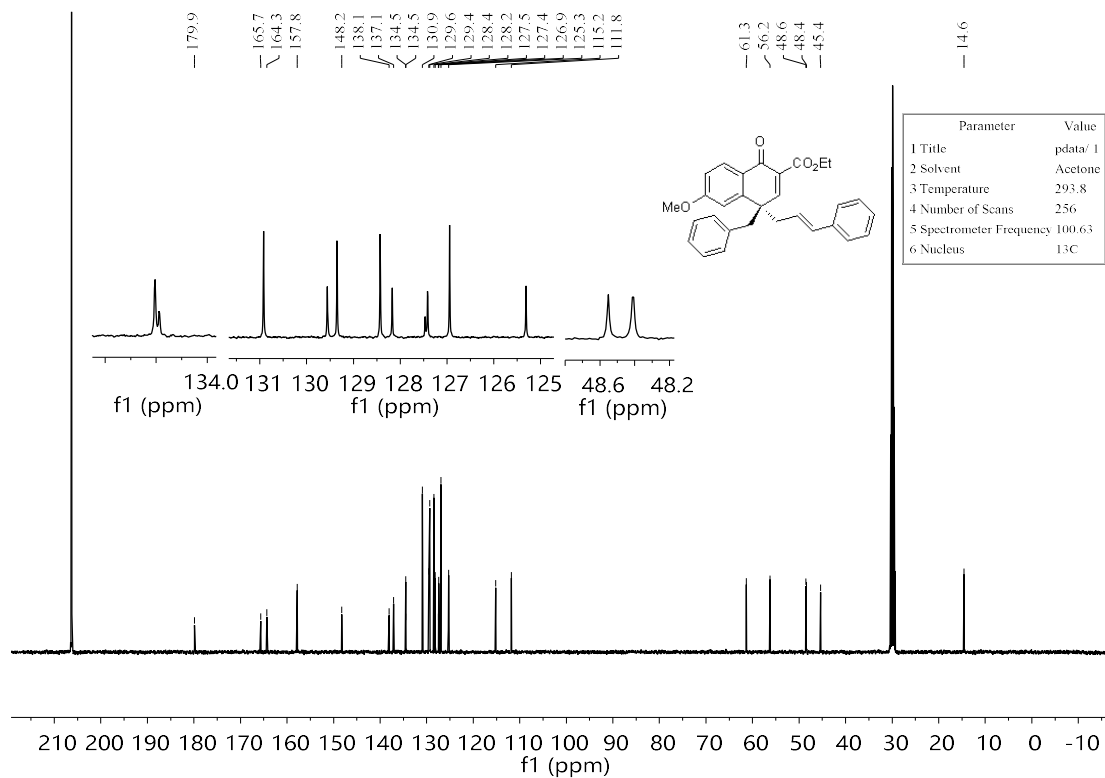
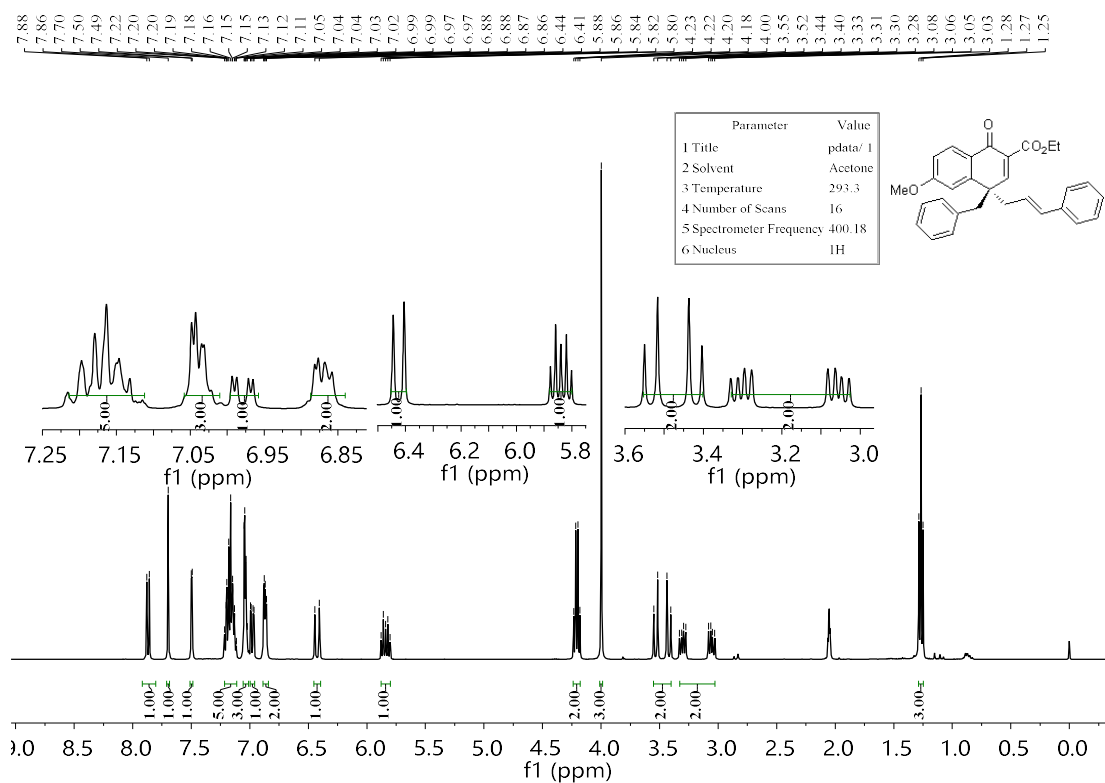
Ethyl (R)-4-benzyl-6-(tert-butyl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B14)



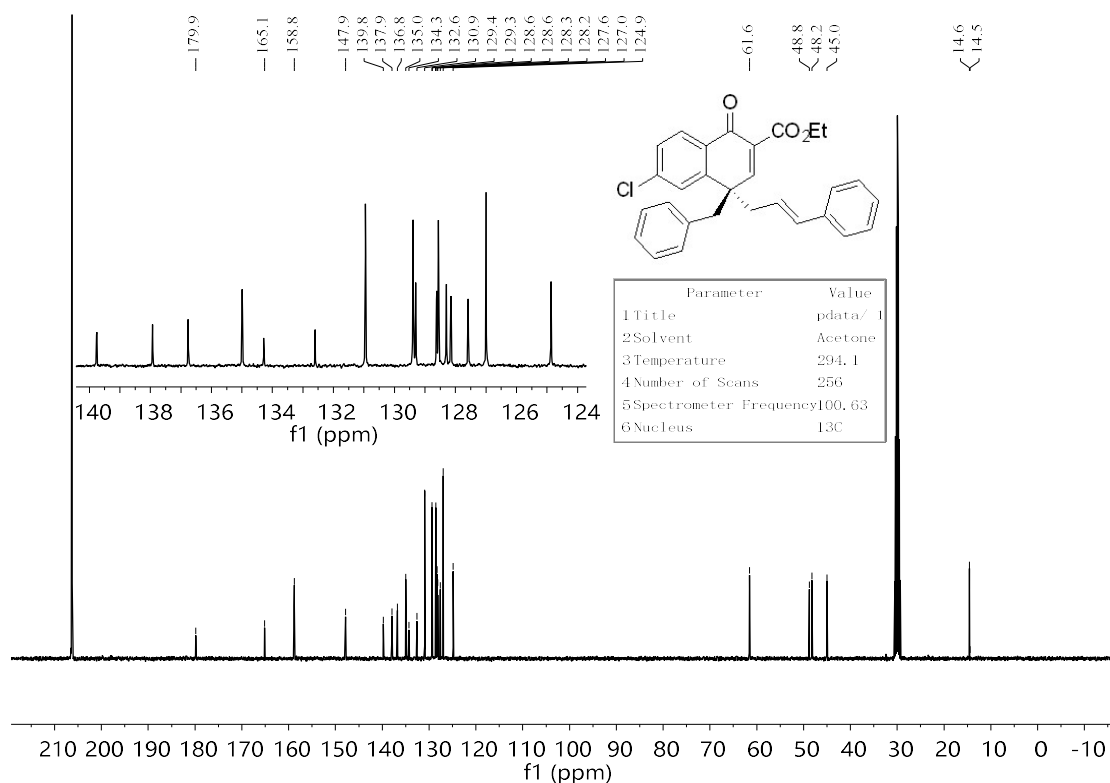
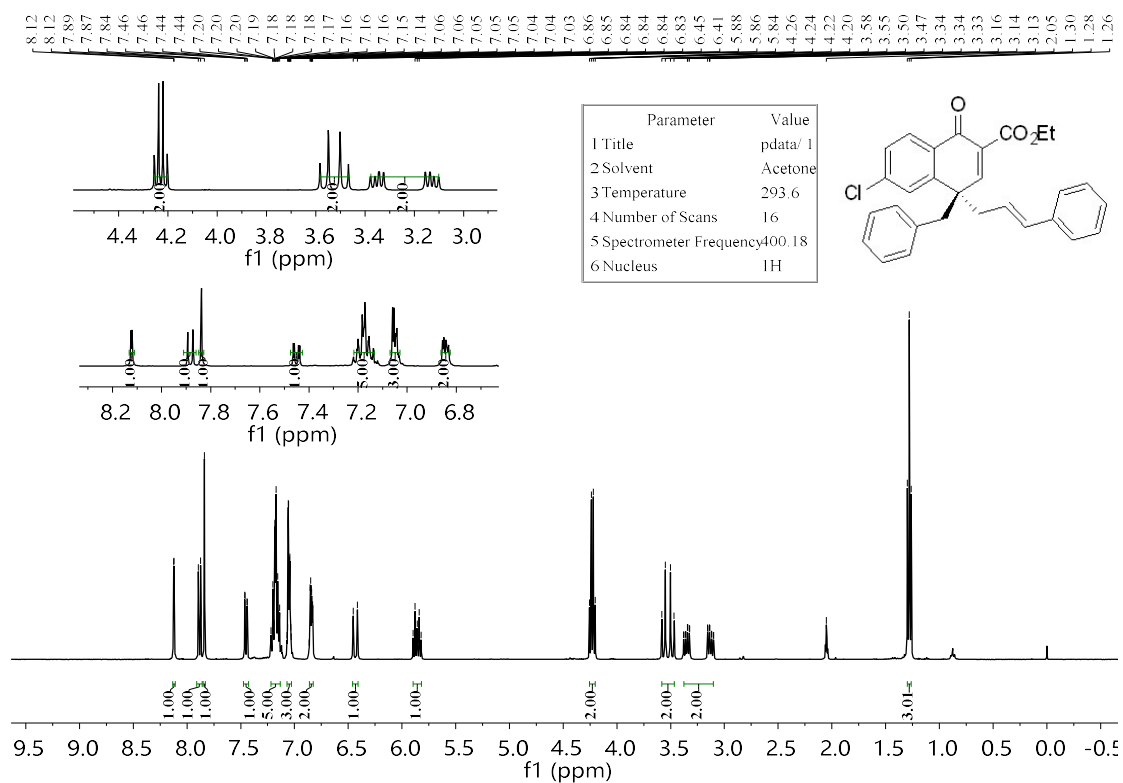
Ethyl (R)-4-benzyl-4-cinnamyl-1-oxo-6-phenyl-1,4-dihydronaphthalene-2-carboxylate (B15)



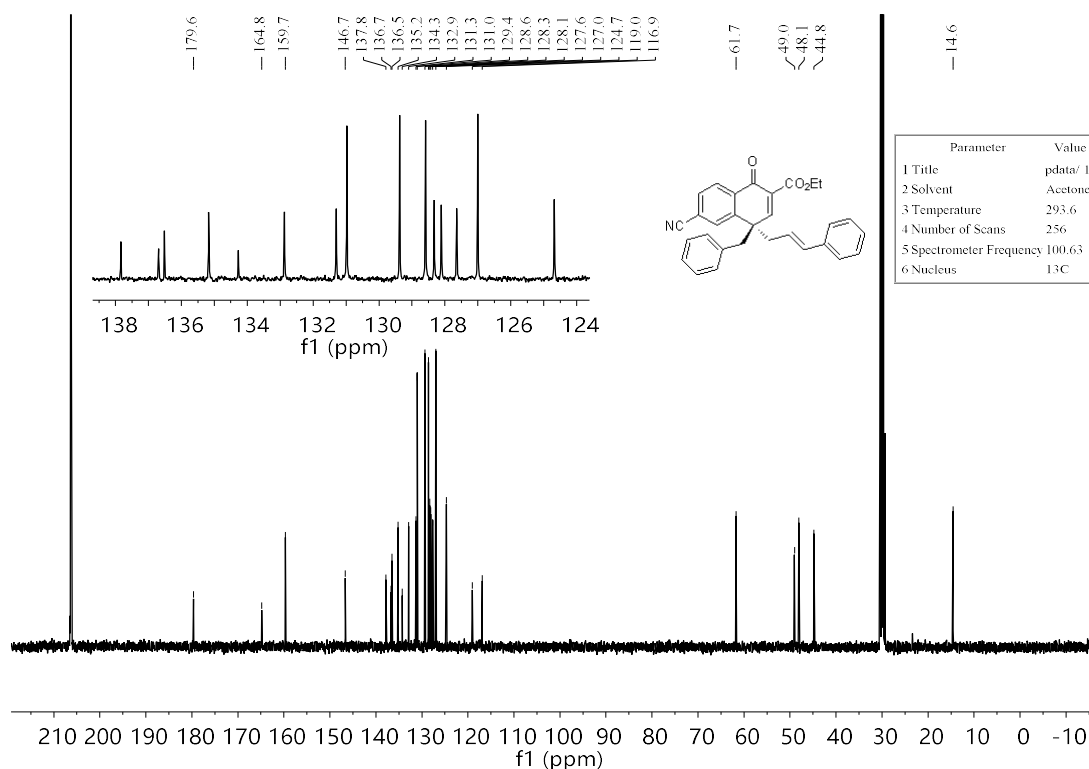
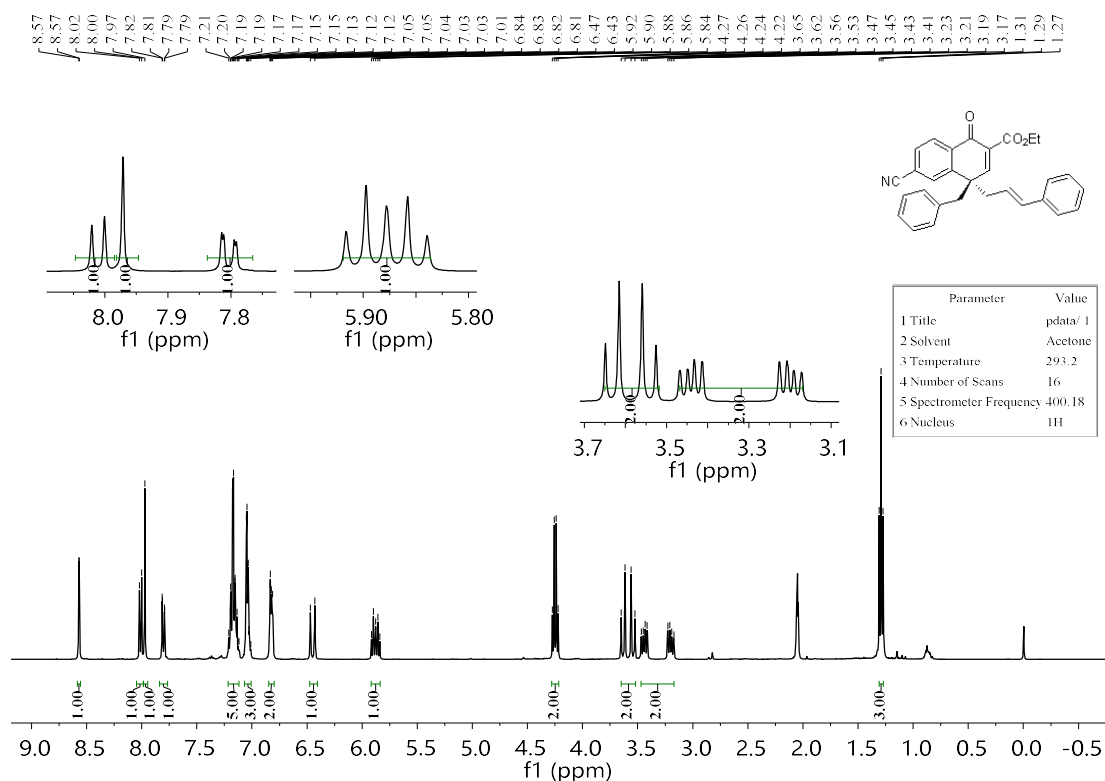
Ethyl (R)-4-benzyl-4-cinnamyl-6-methoxy-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B16)



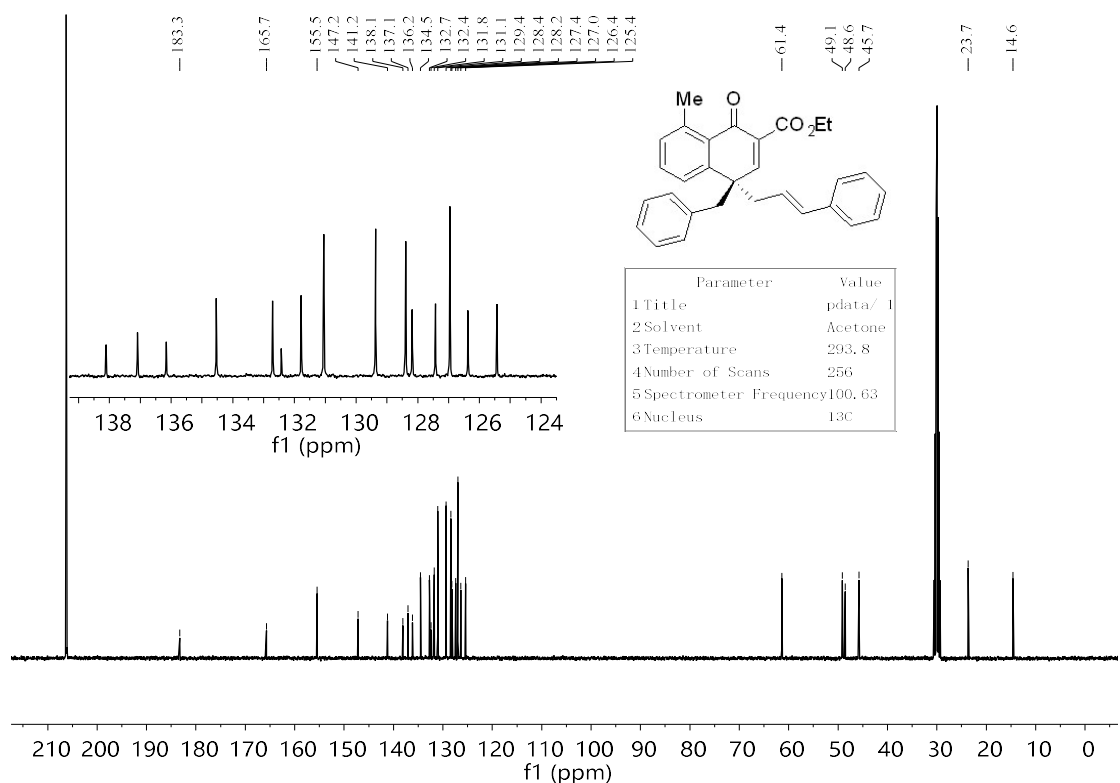
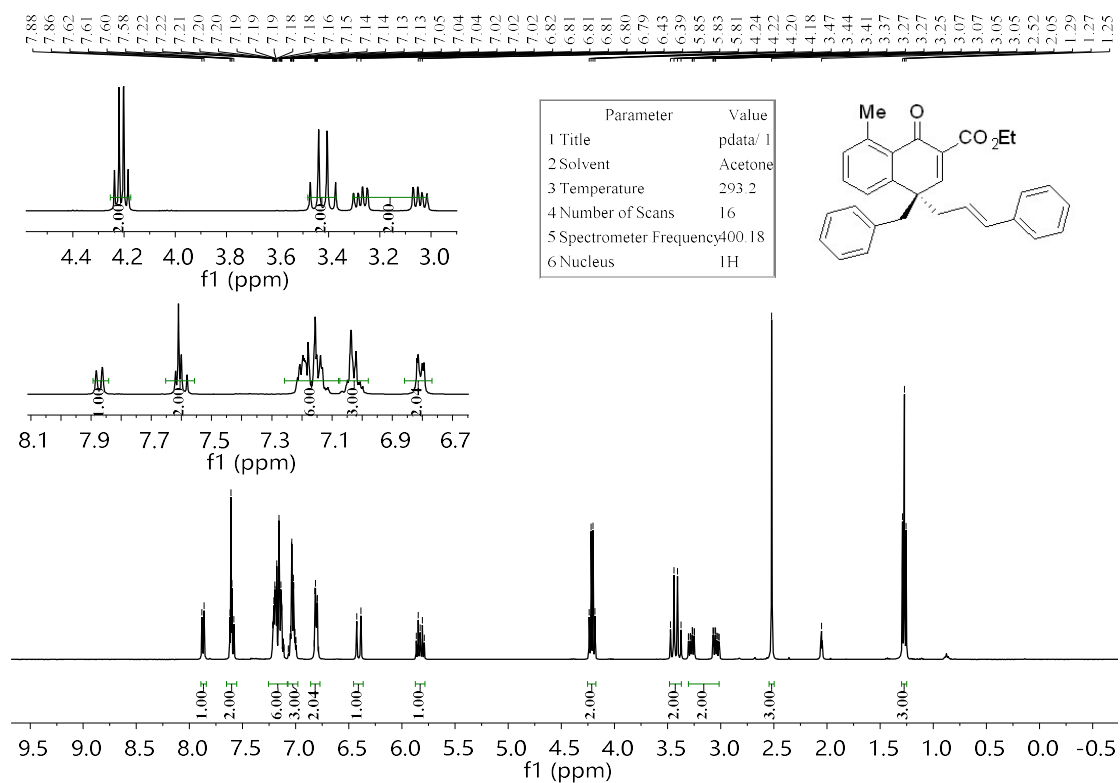
Ethyl (R)-4-benzyl-6-chloro-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B17)



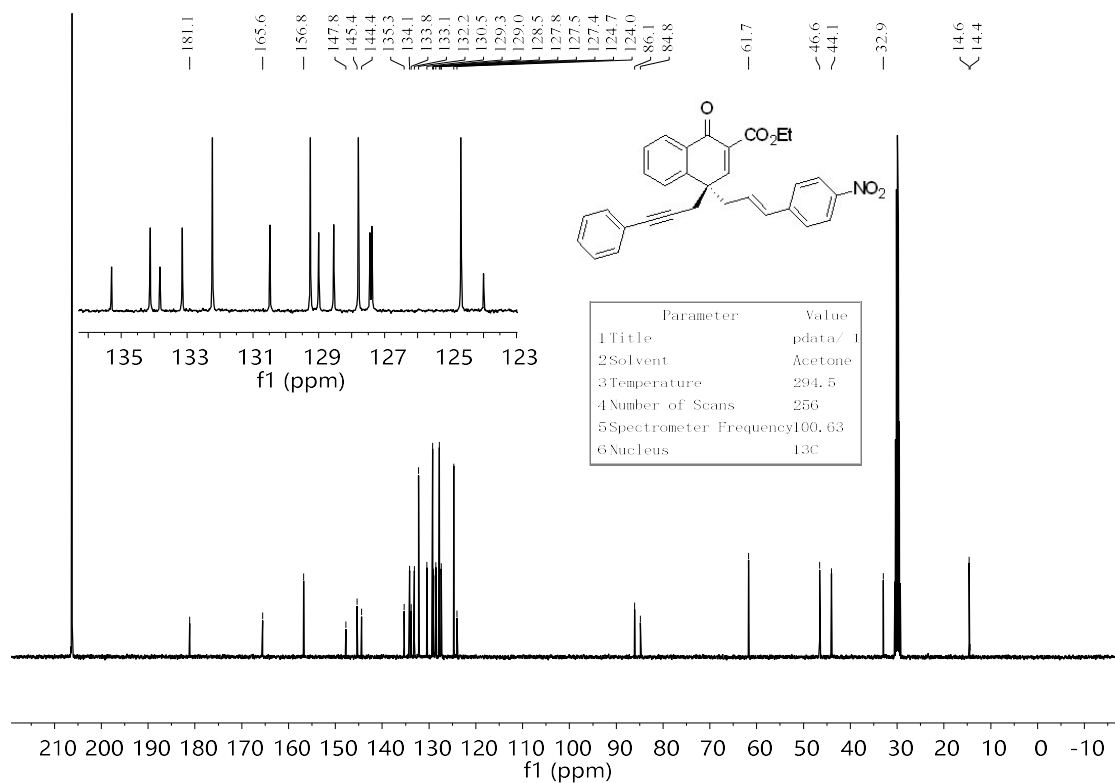
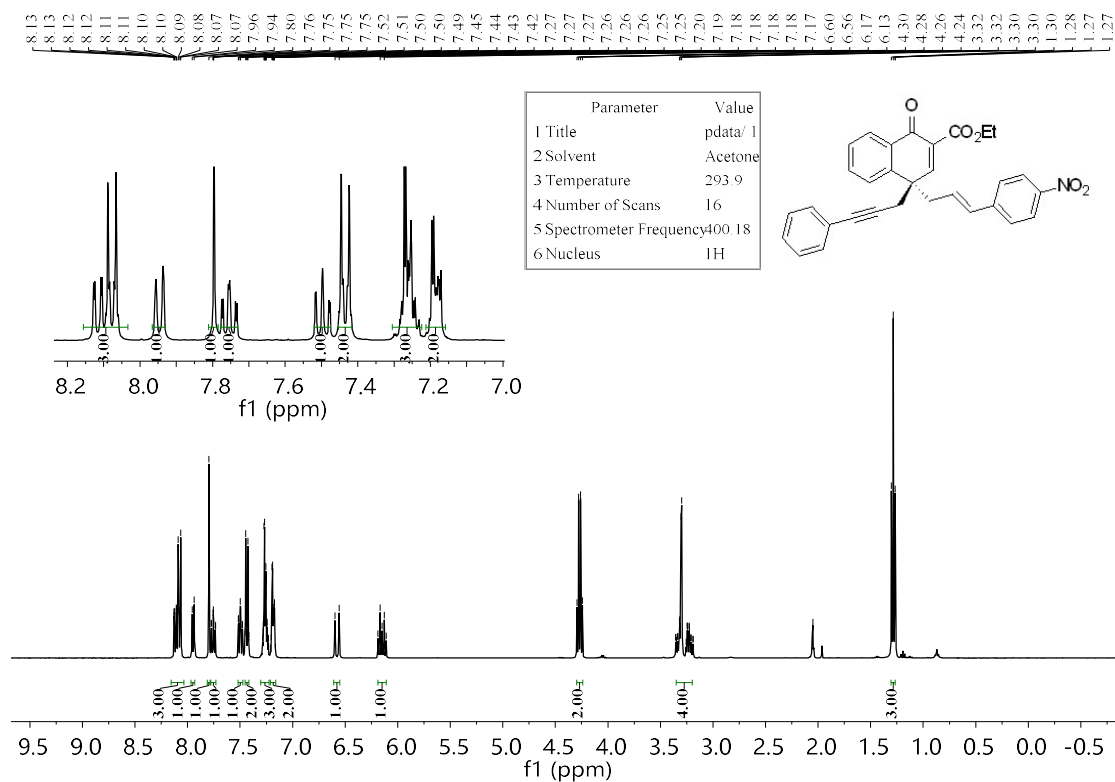
Ethyl (R)-4-benzyl-4-cinnamyl-6-cyano-1,4-dihydronaphthalene-2-carboxylate (B18)



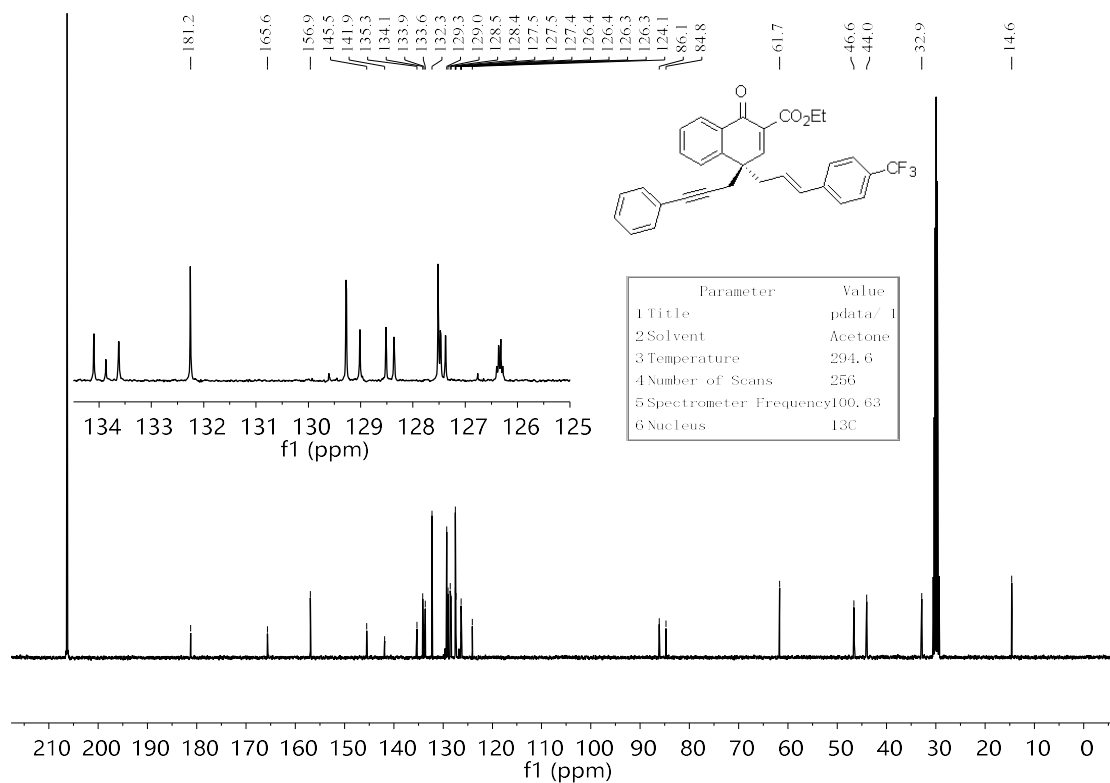
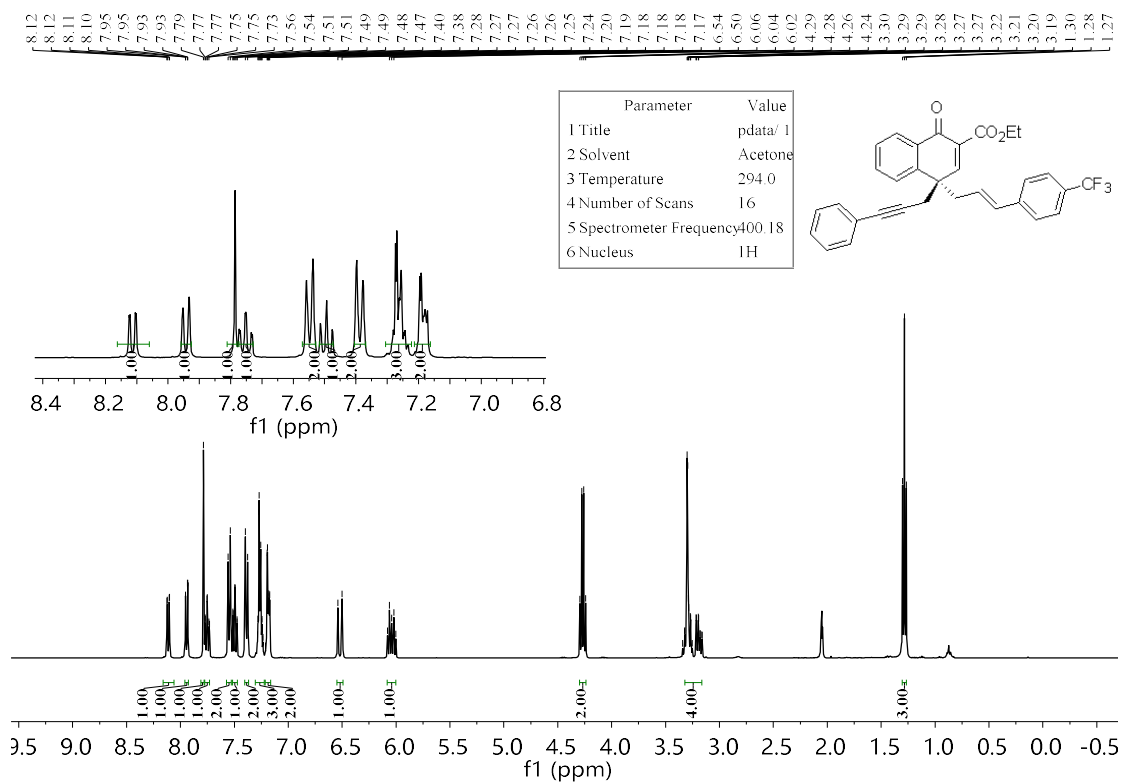
Ethyl (R)-4-benzyl-4-cinnamyl-8-methyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B19)

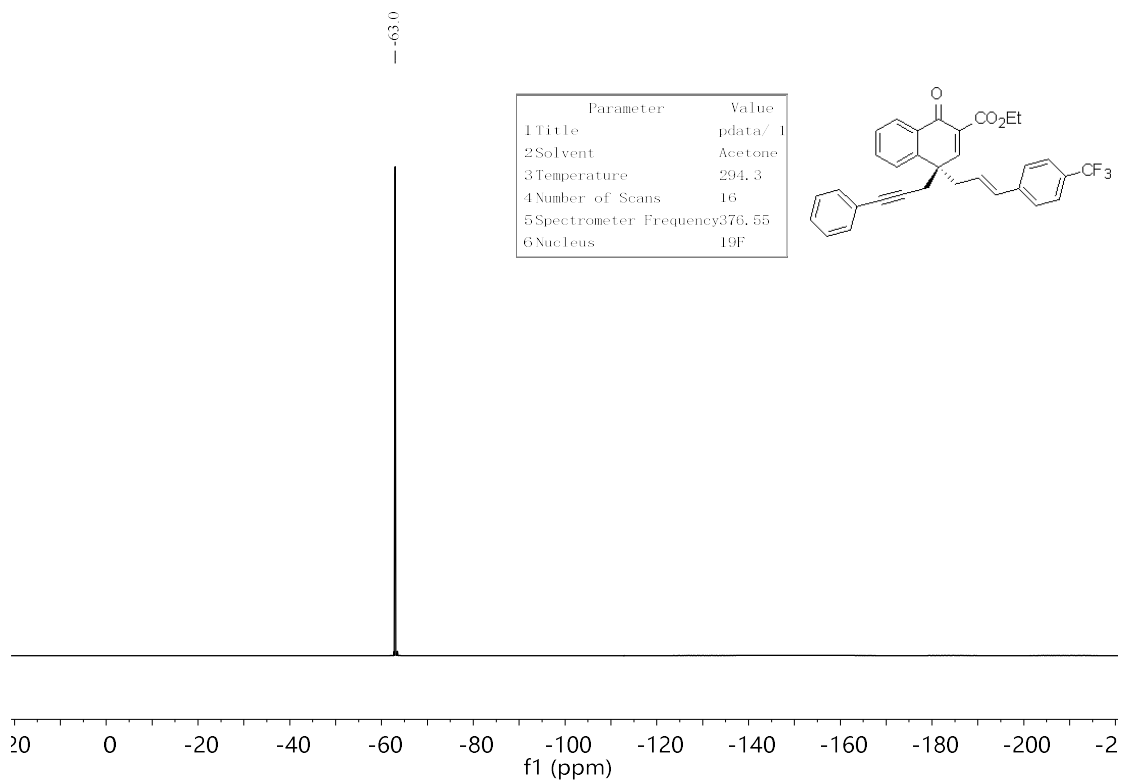


Ethyl (R,E)-4-(3-(4-nitrophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B20)

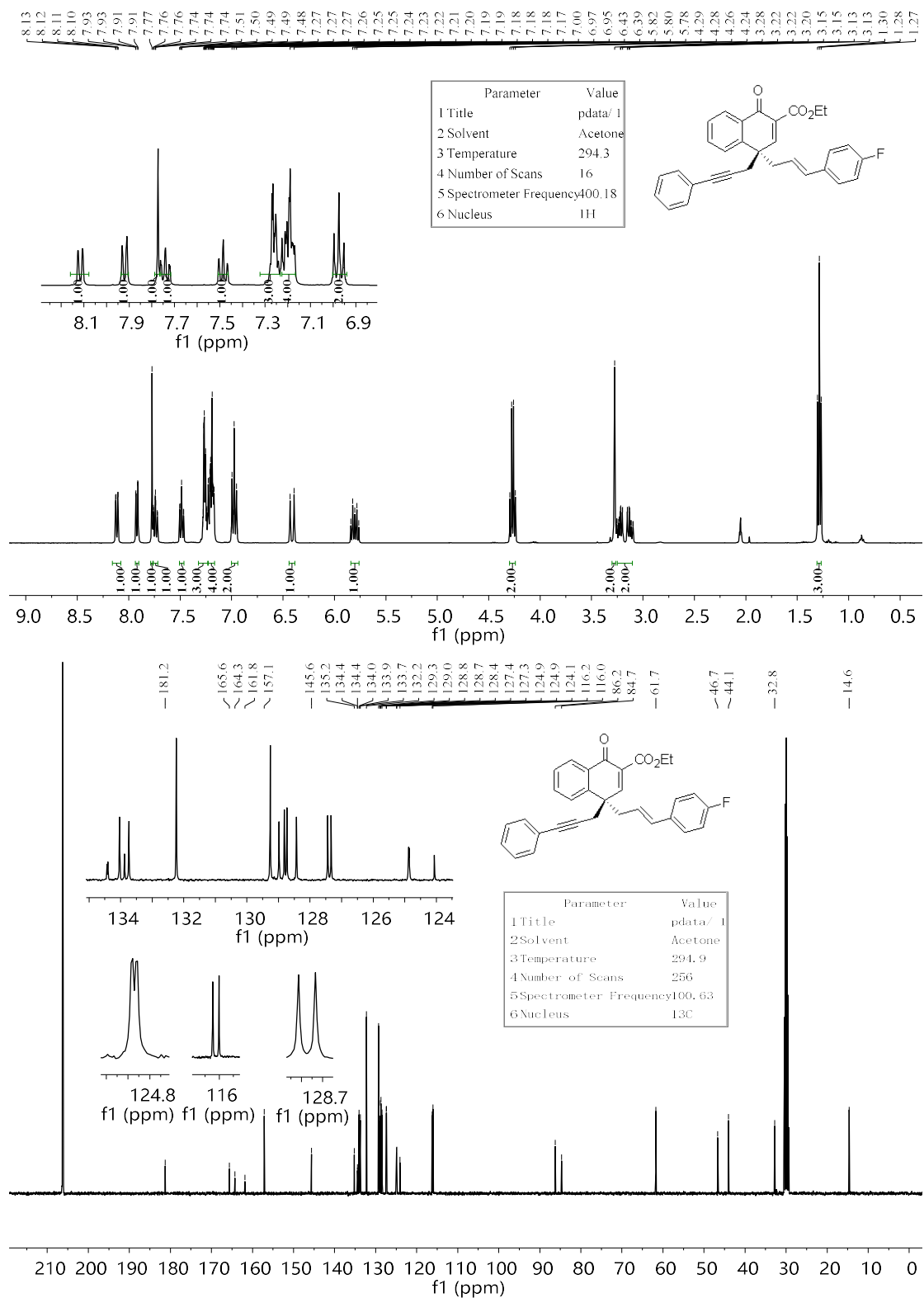


Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(4-(trifluoromethyl)phenyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B21)



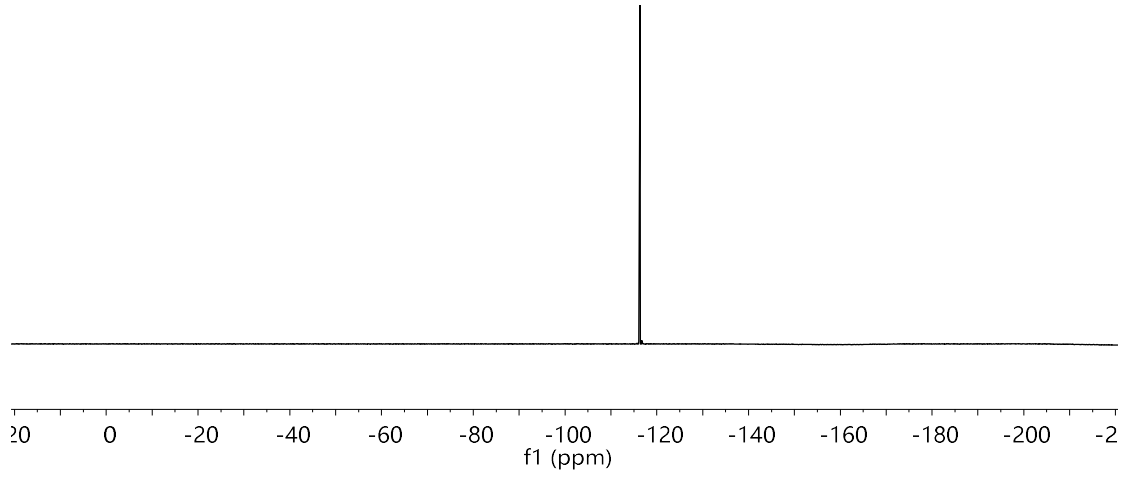
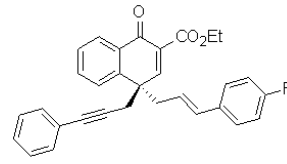


Ethyl (R,E)-4-(3-(4-fluorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B22)



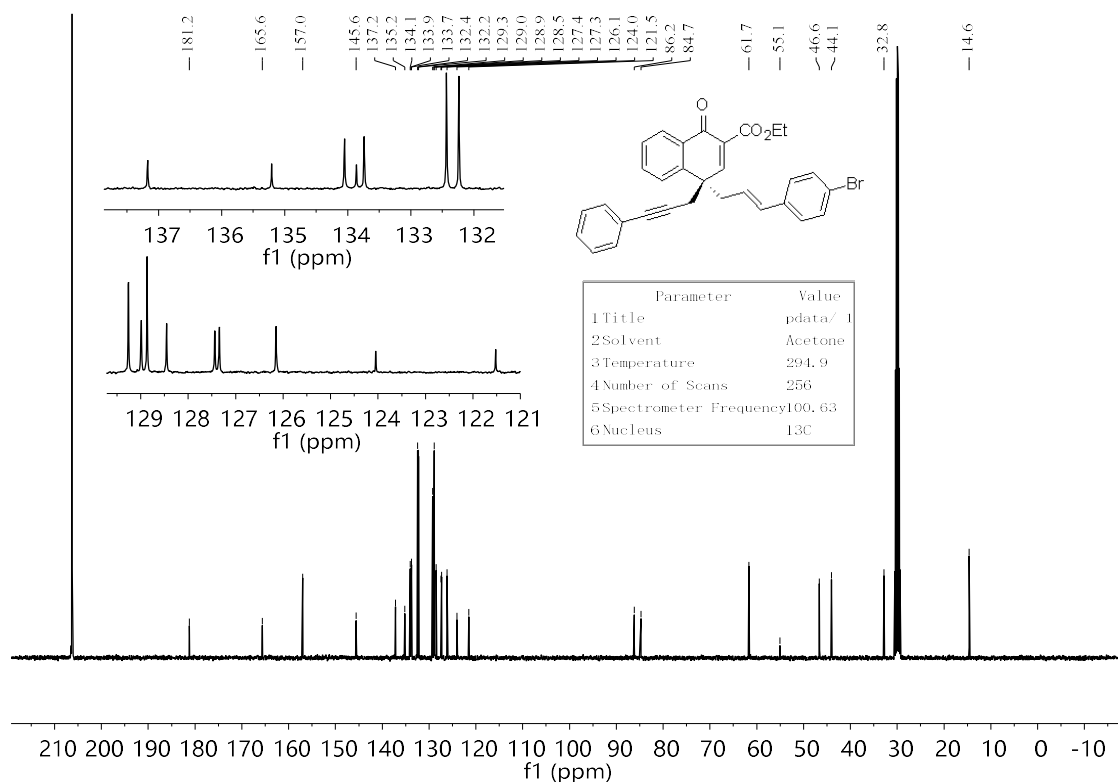
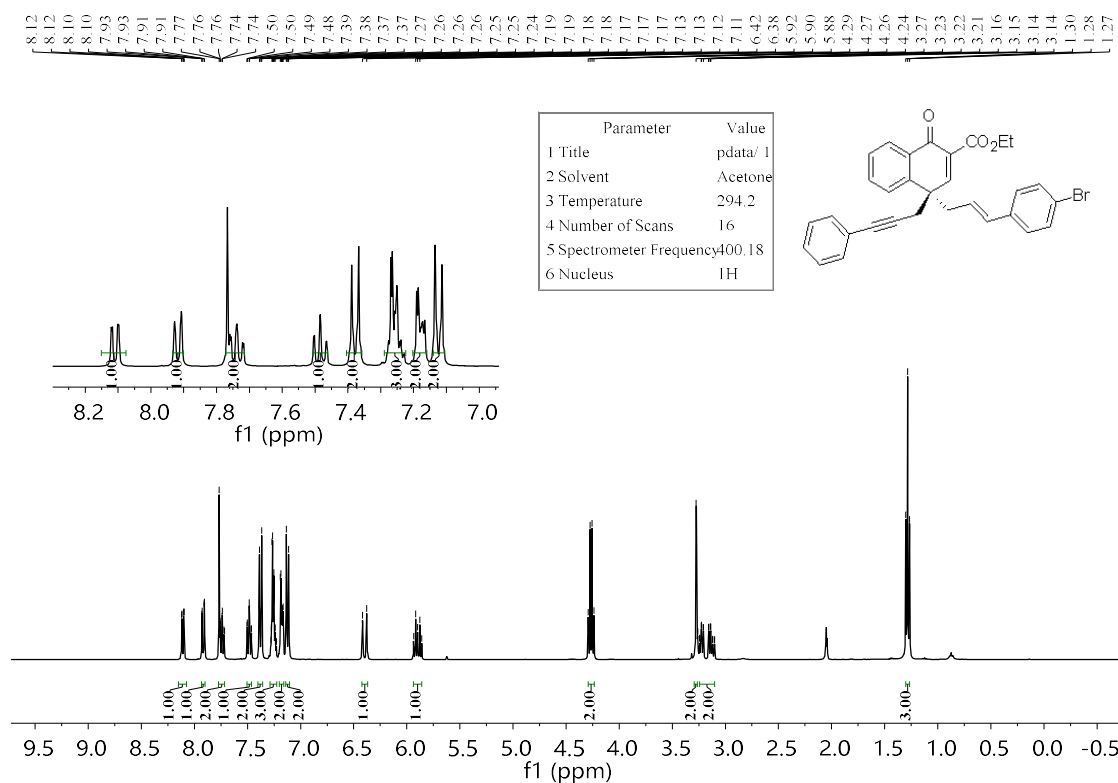
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Parameter	Value
1 Title	pdata/1
2 Solvent	Acetone
3 Temperature	294.5
4 Number of Scans	16
5 Spectrometer Frequency	376.55
6 Nucleus	¹⁹ F

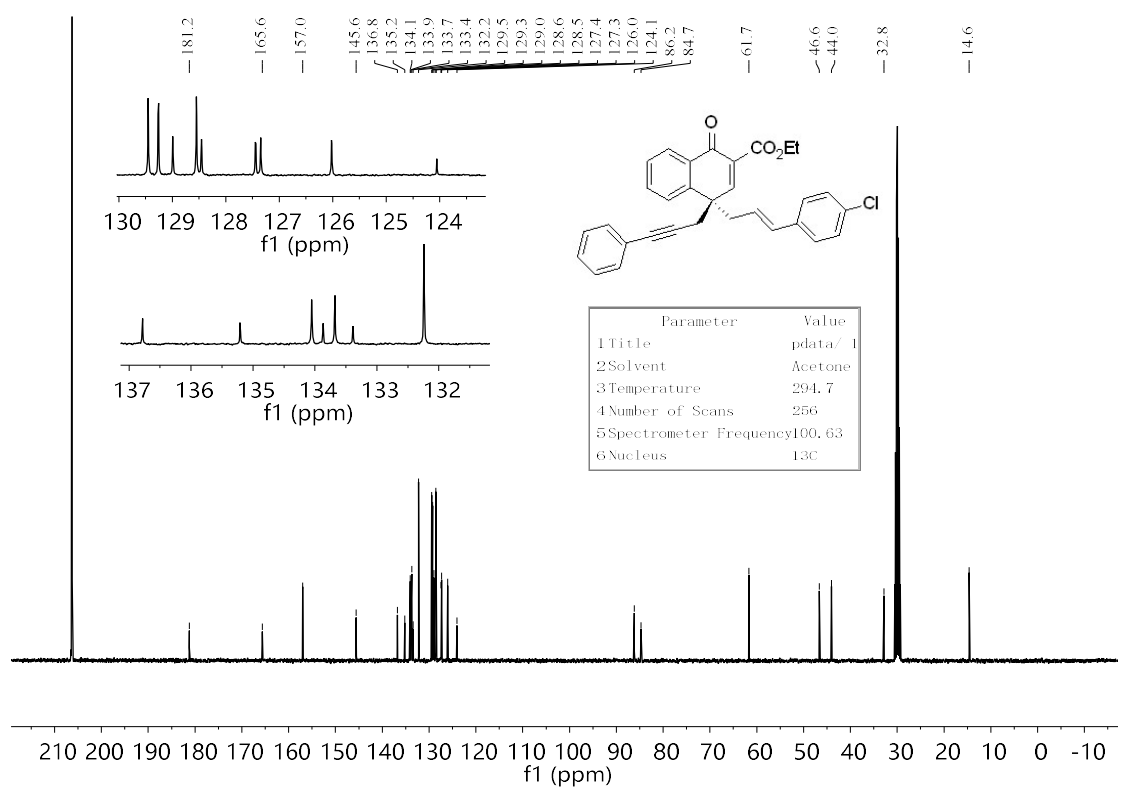
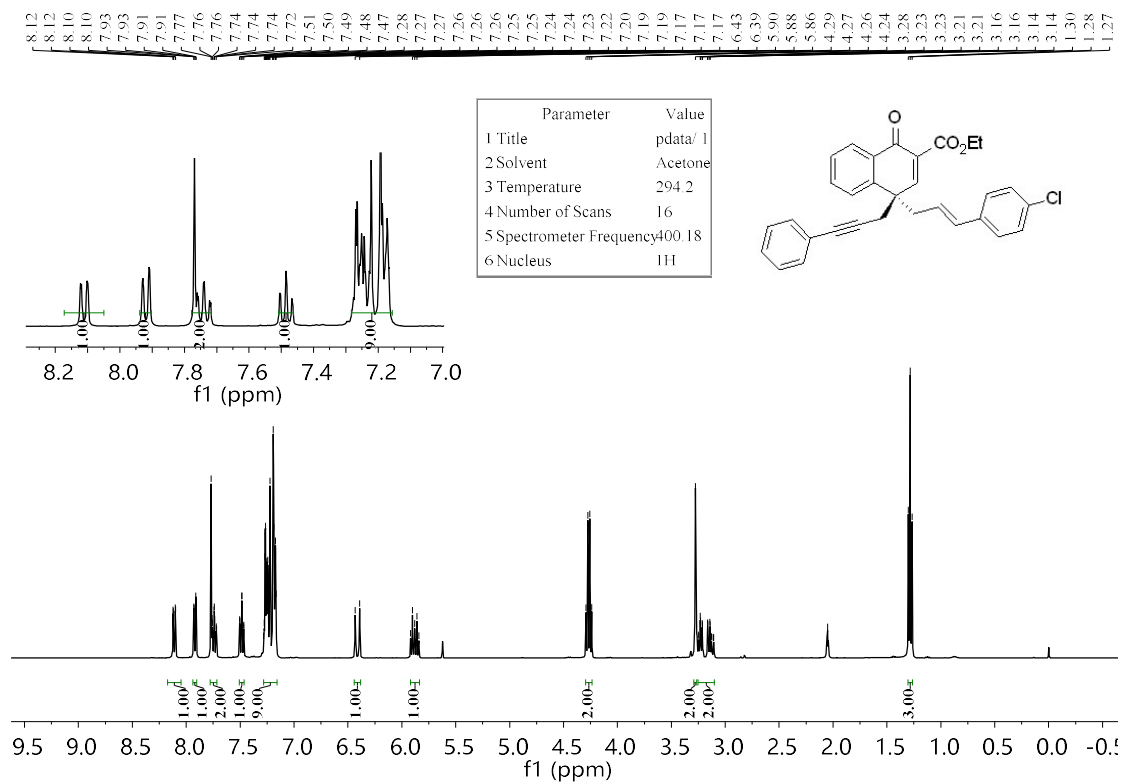


Ethyl

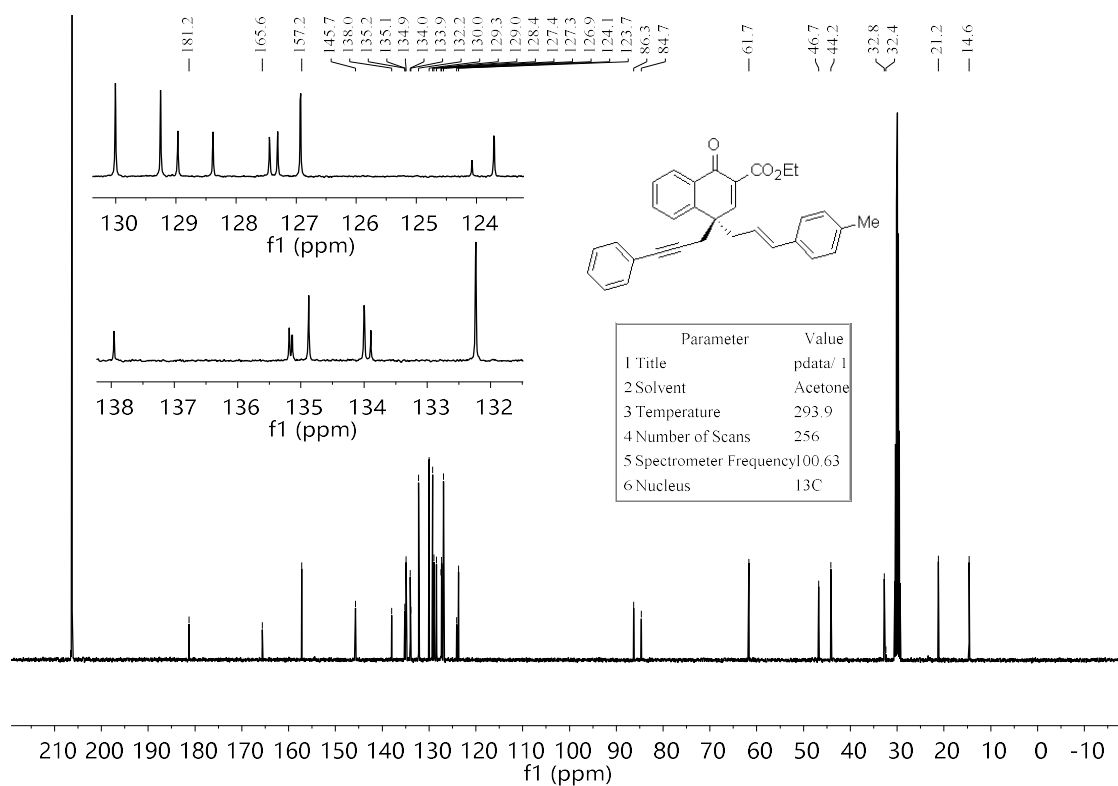
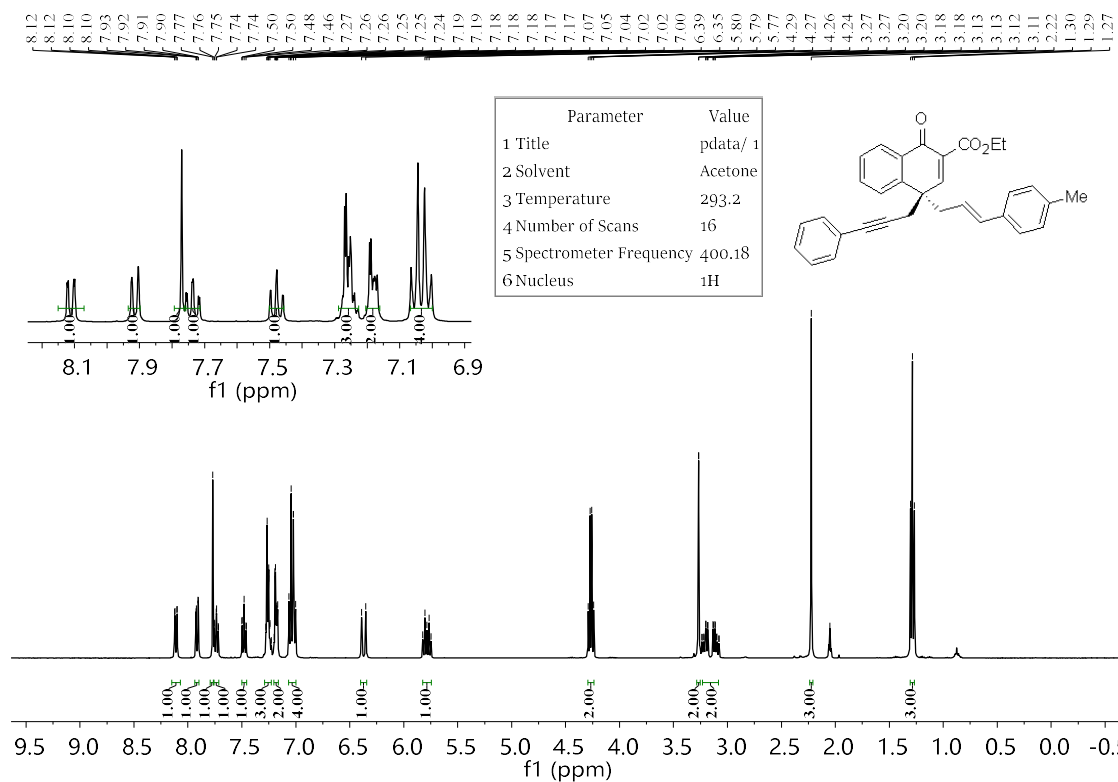
(R,E)-4-(3-(4-bromophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B23)



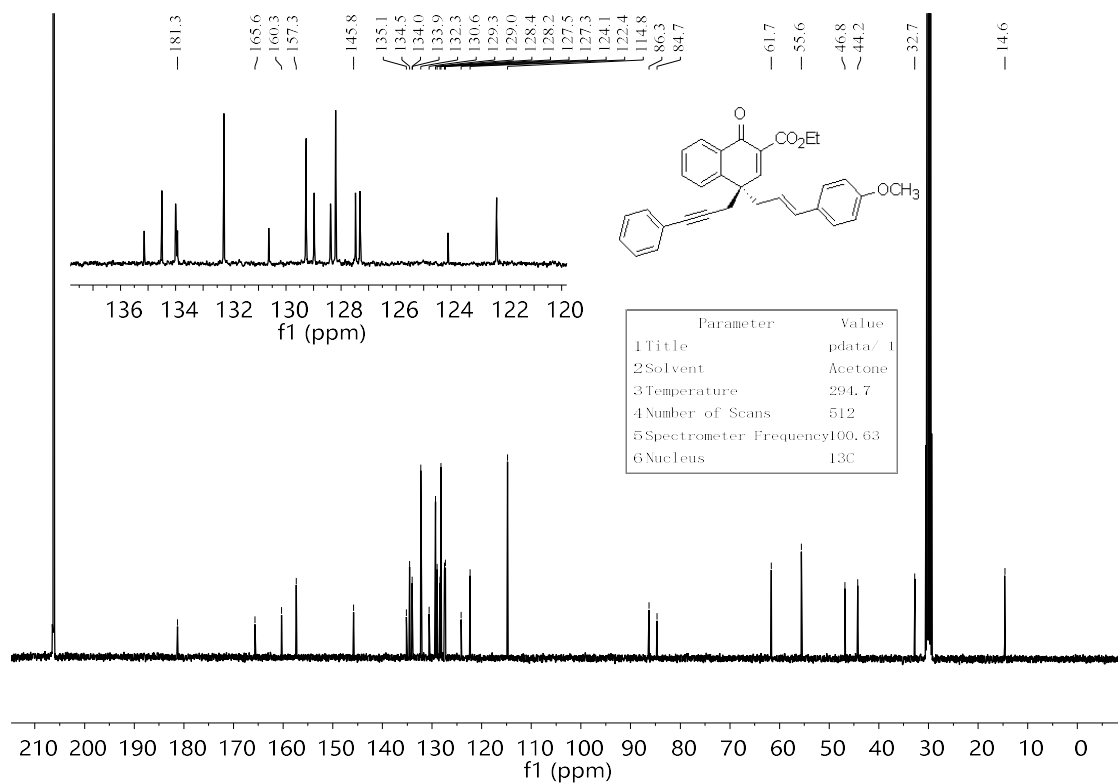
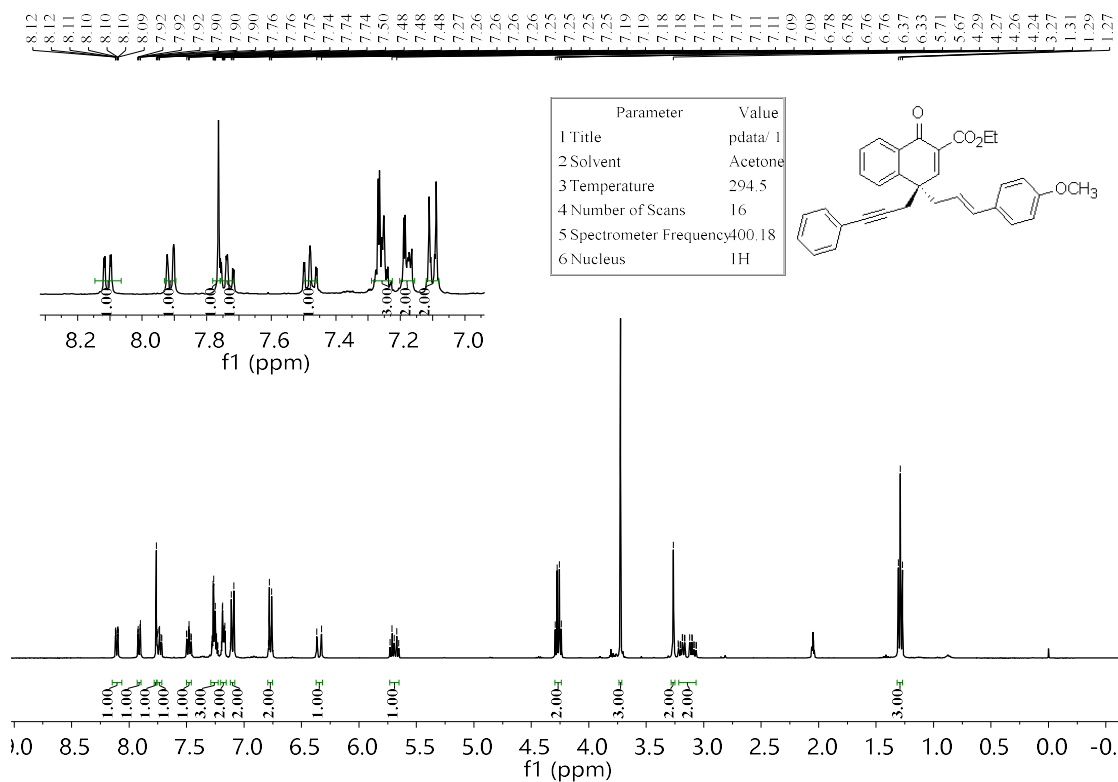
Ethyl (R,E)-4-(3-(4-chlorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B24)



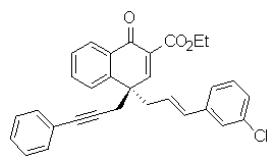
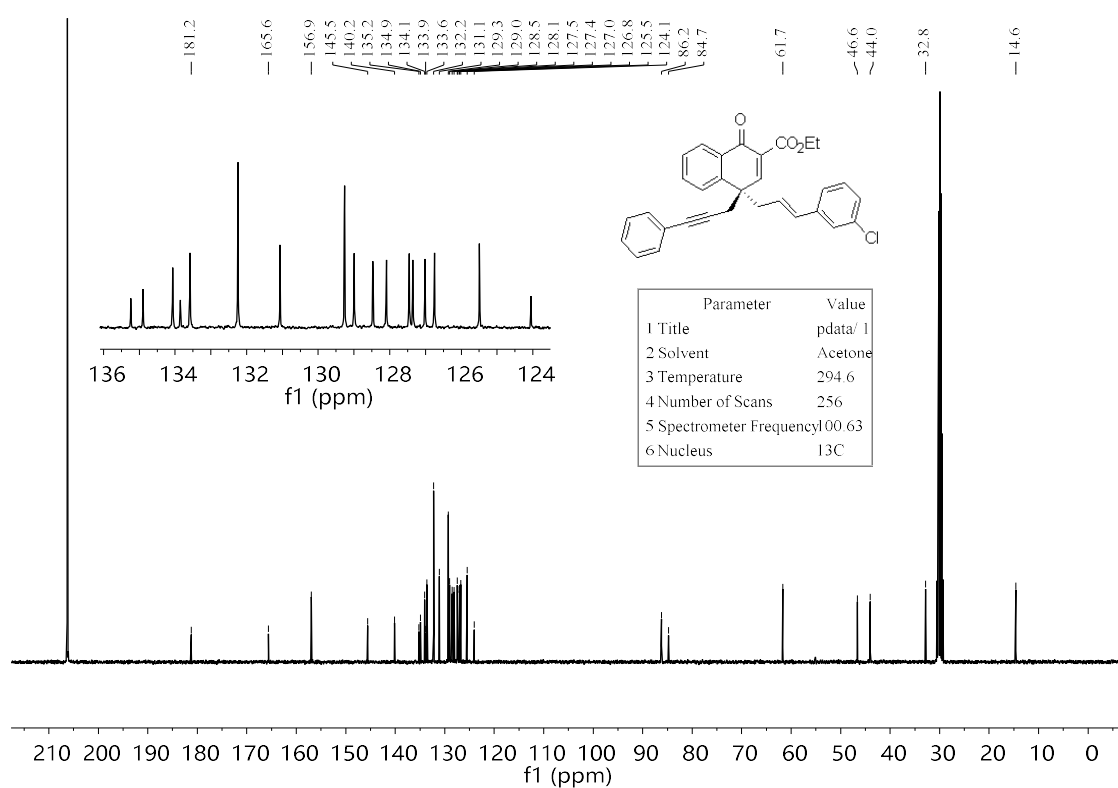
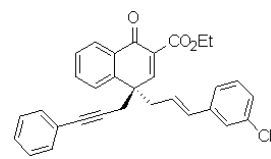
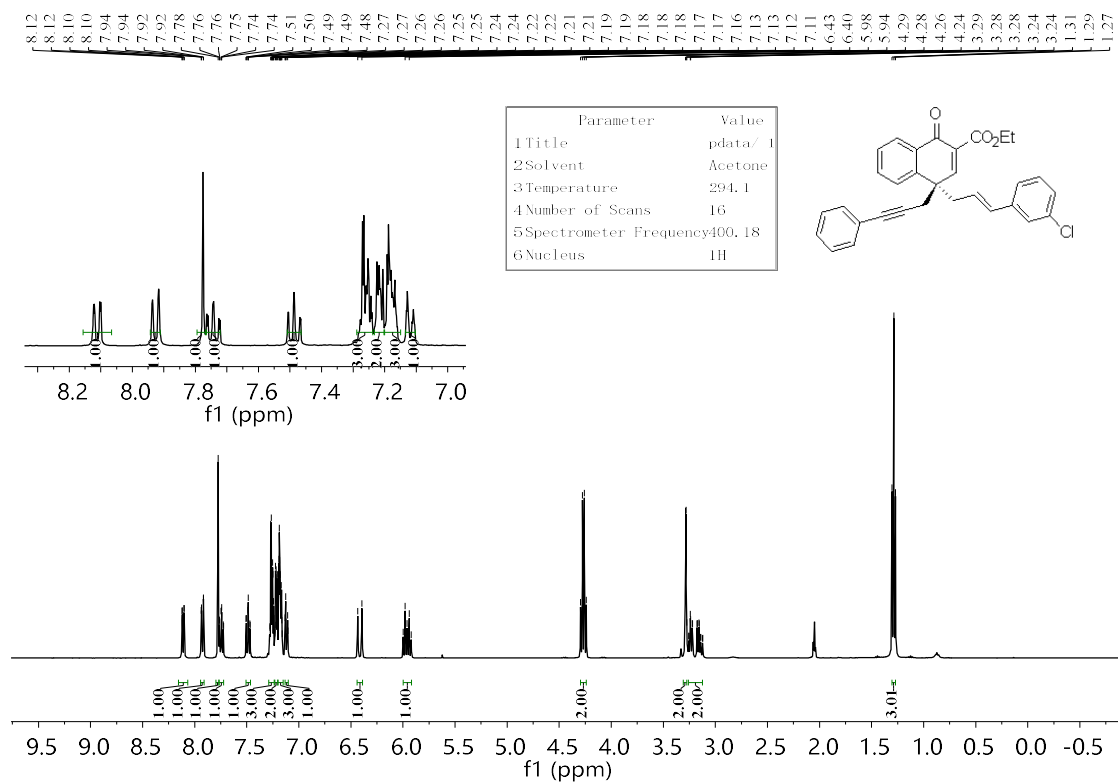
Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(p-tolyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B25)



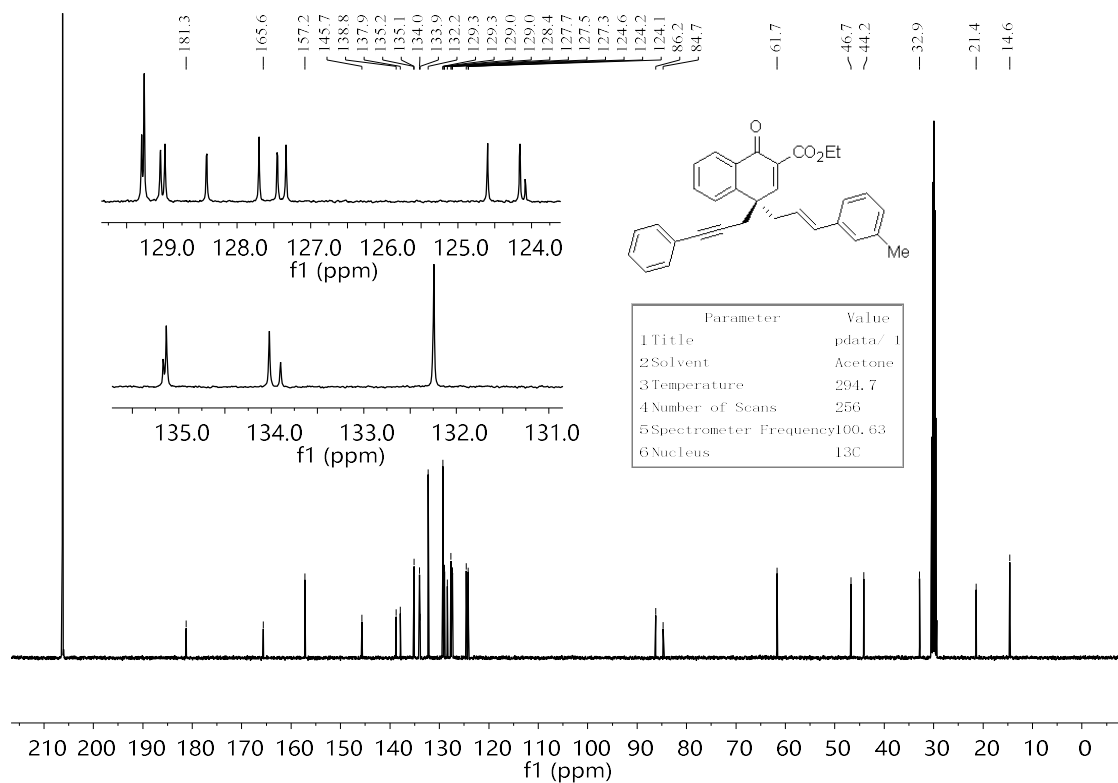
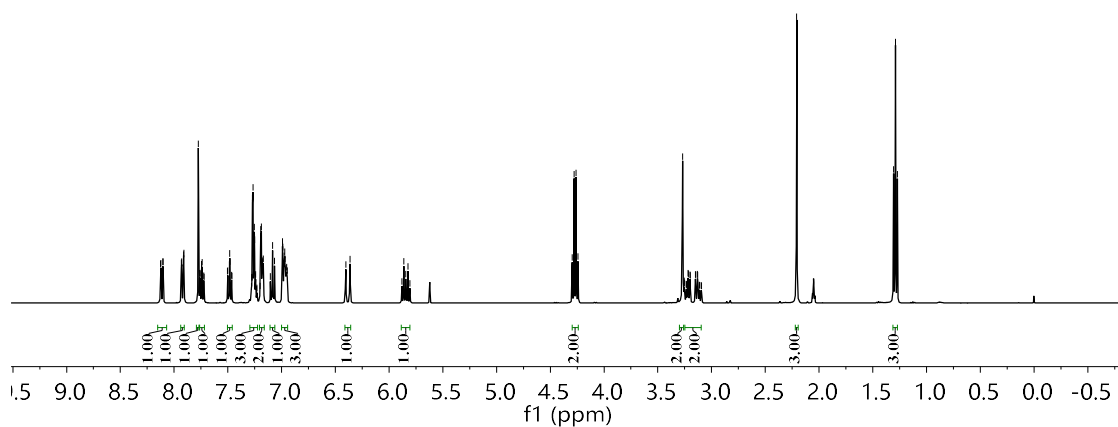
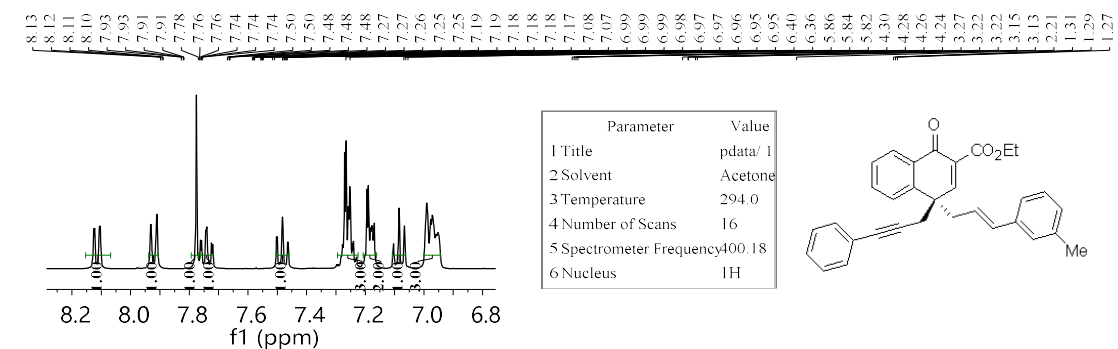
Ethyl (R,E)-4-(3-(4-methoxyphenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B26)



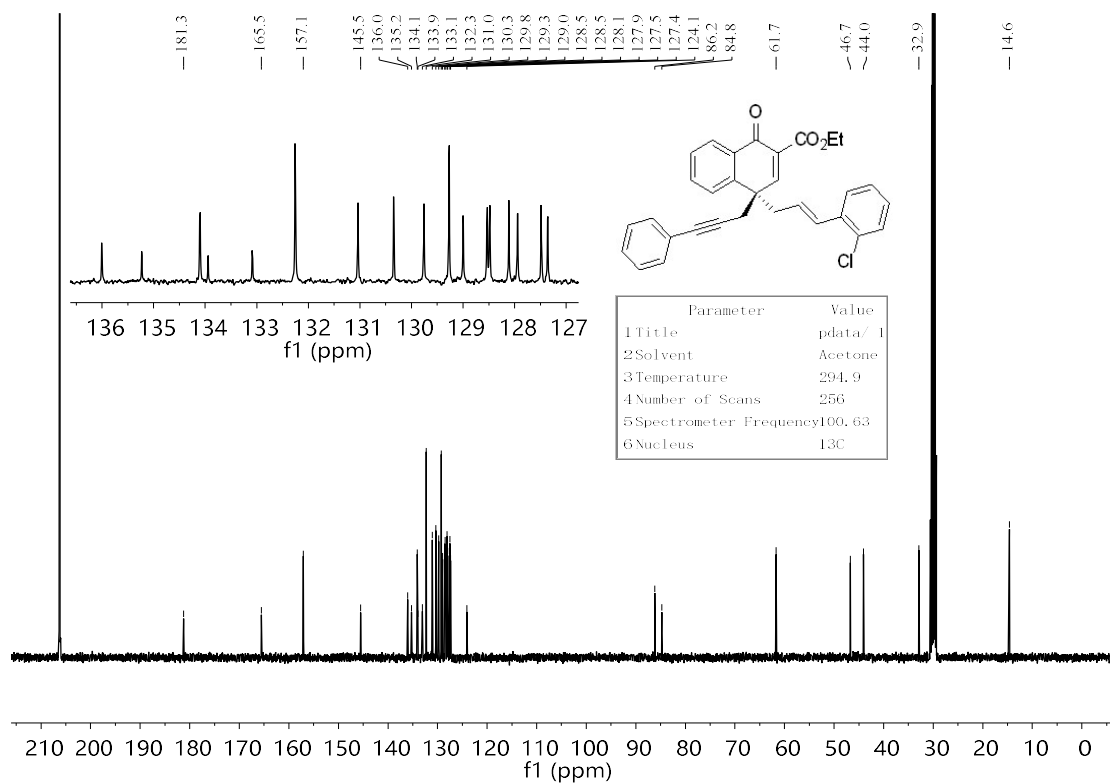
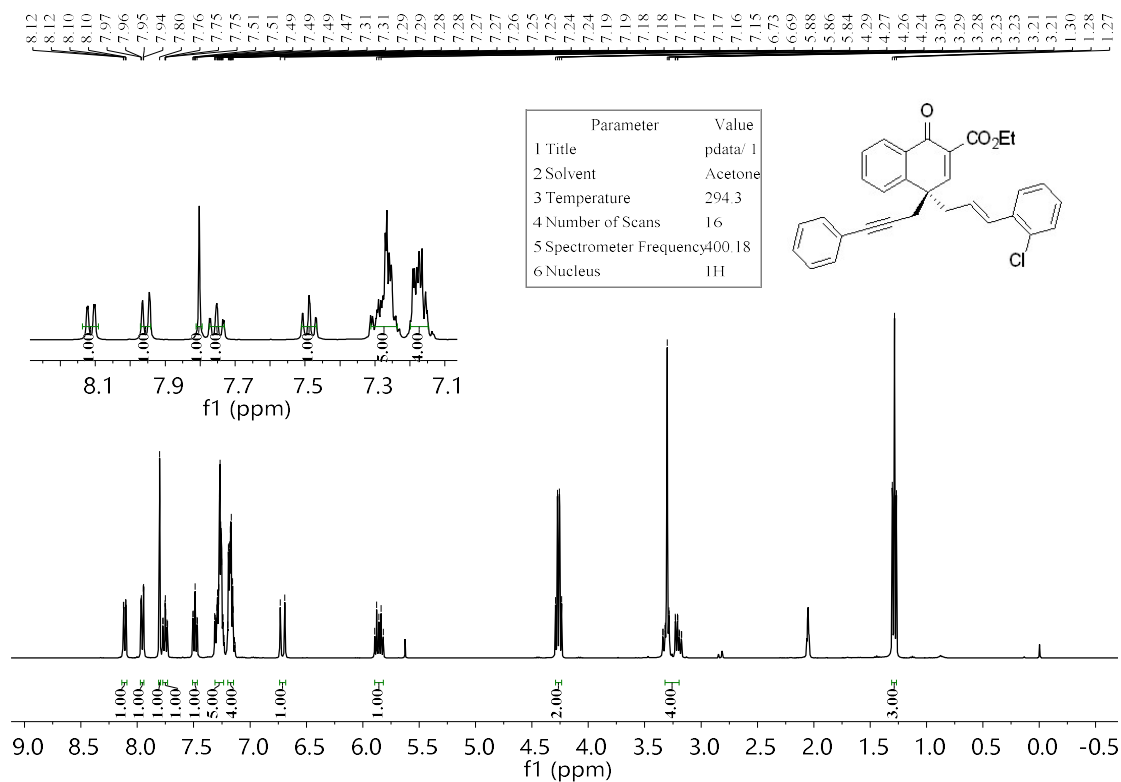
Ethyl (R,E)-4-(3-(3-chlorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B27)



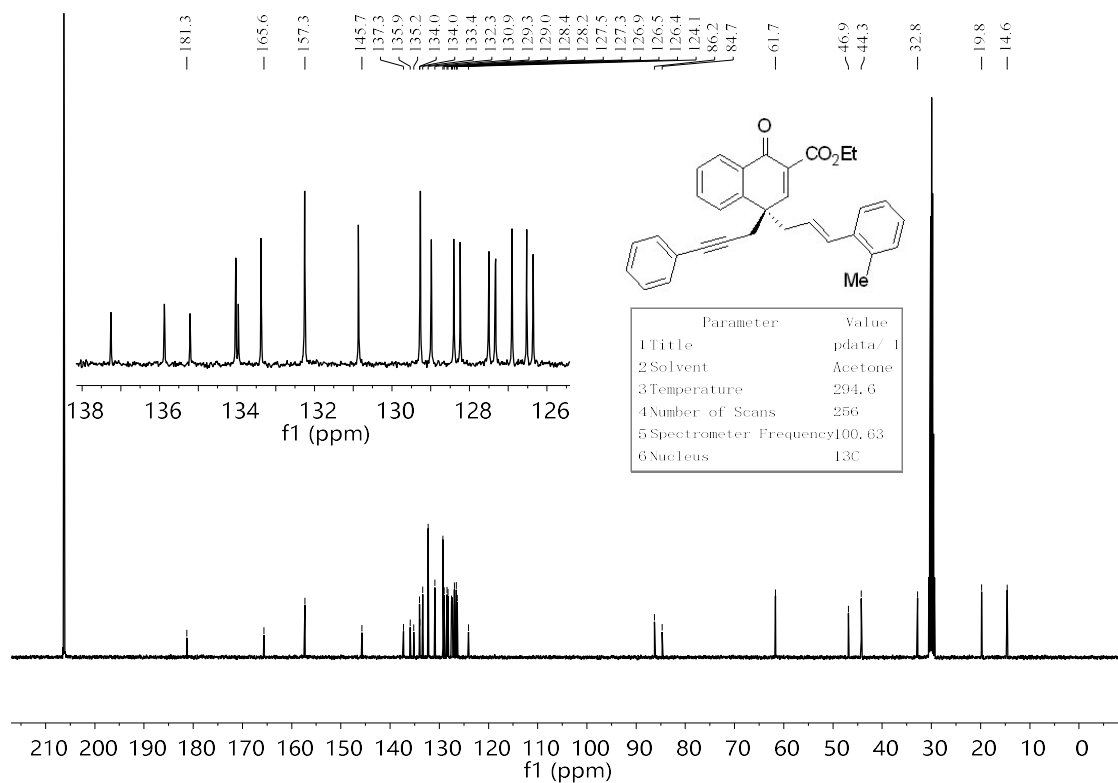
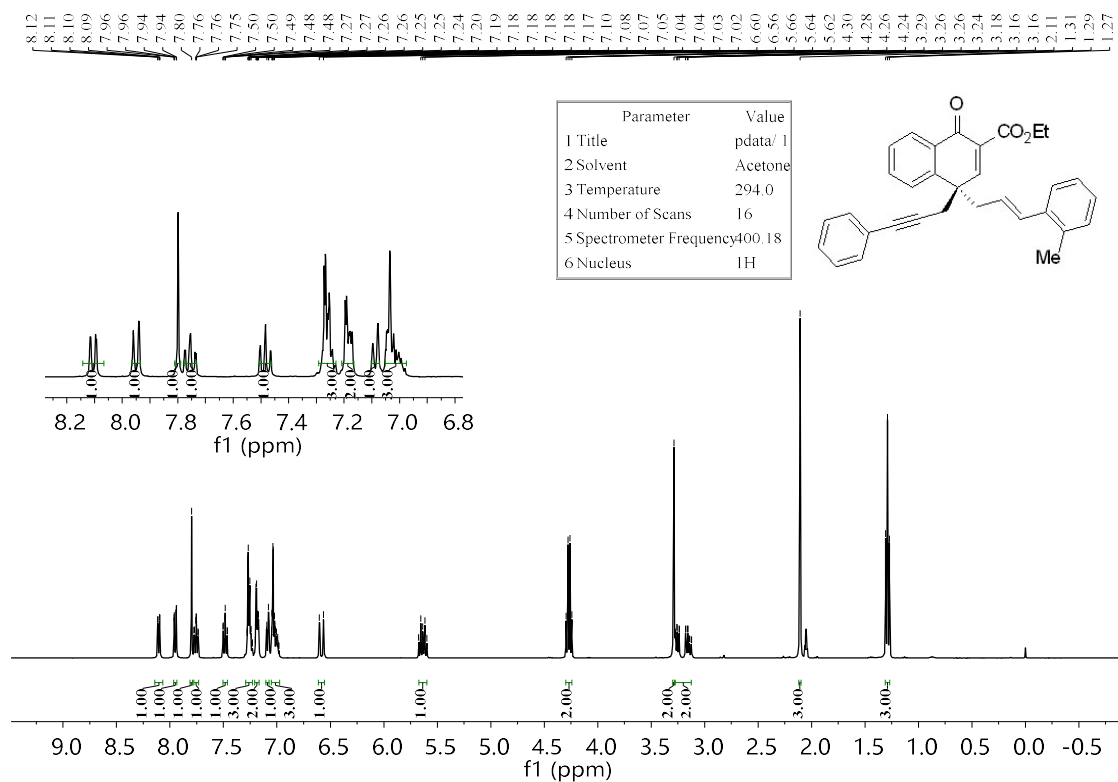
Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(m-tolyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B28)



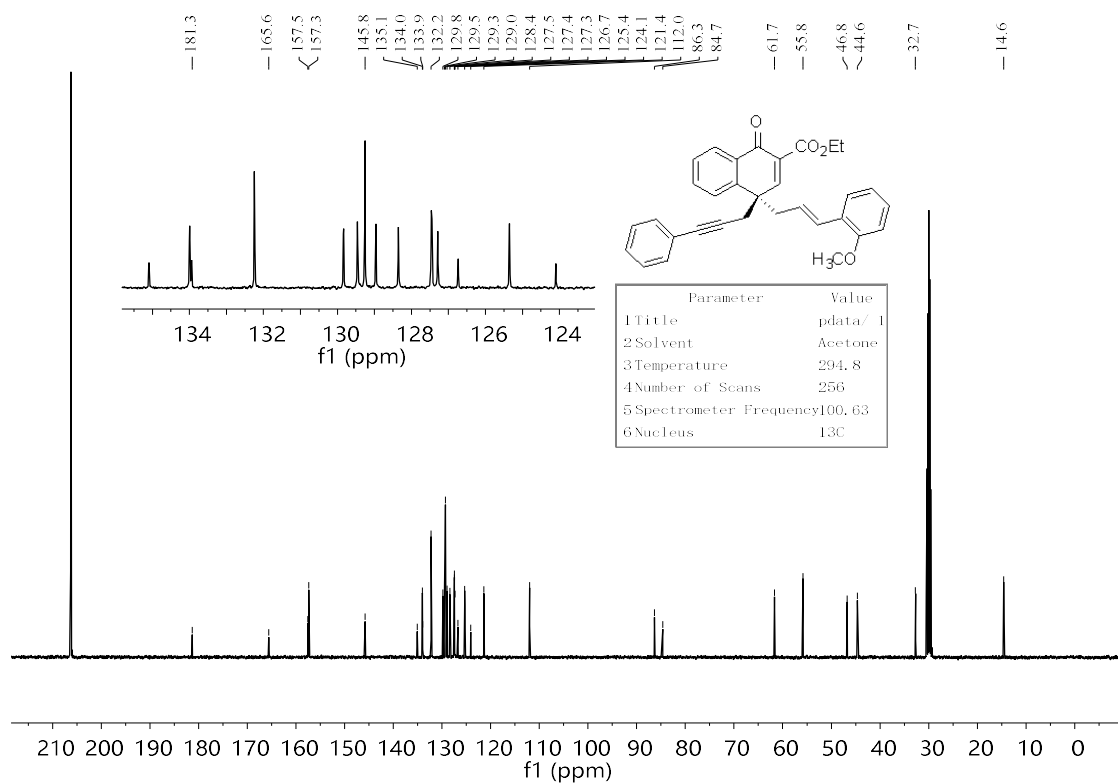
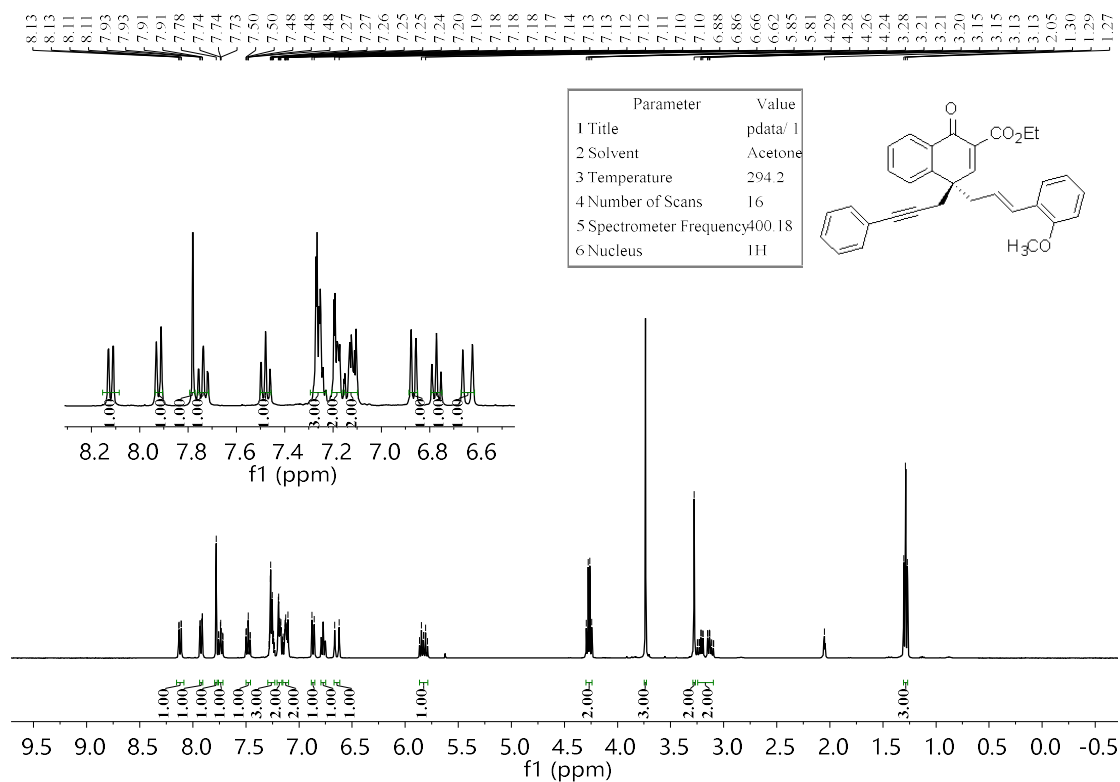
Ethyl (R,E)-4-(3-(2-chlorophenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B29)



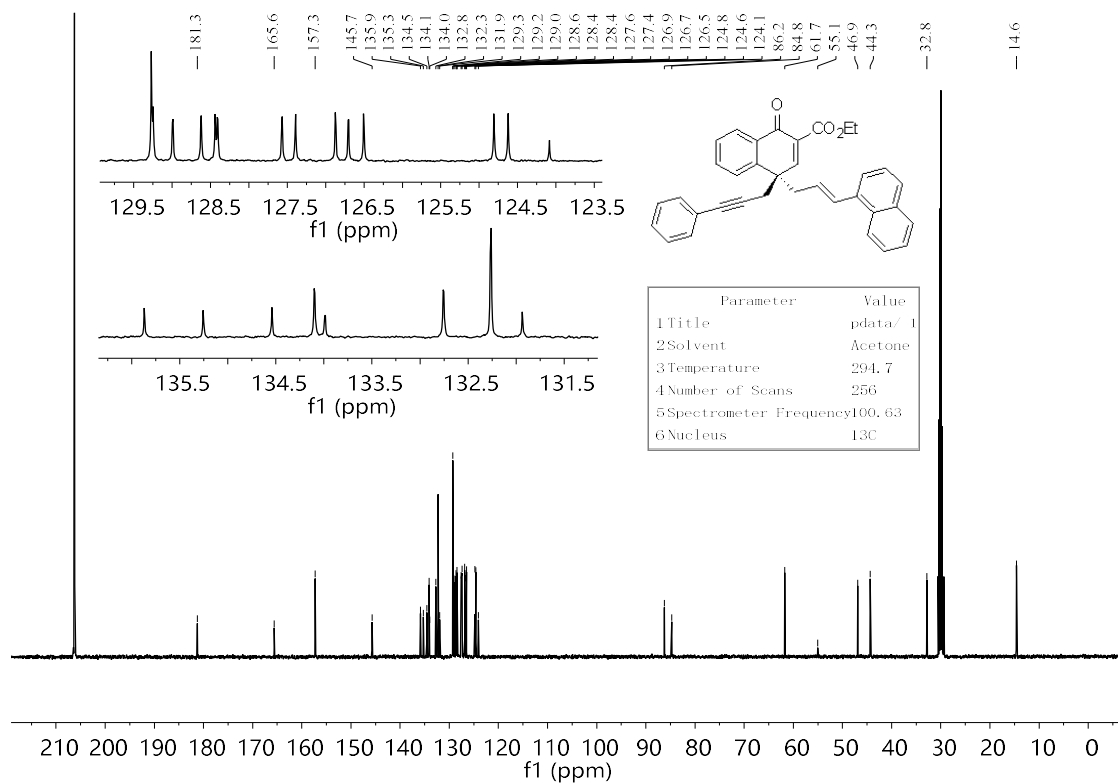
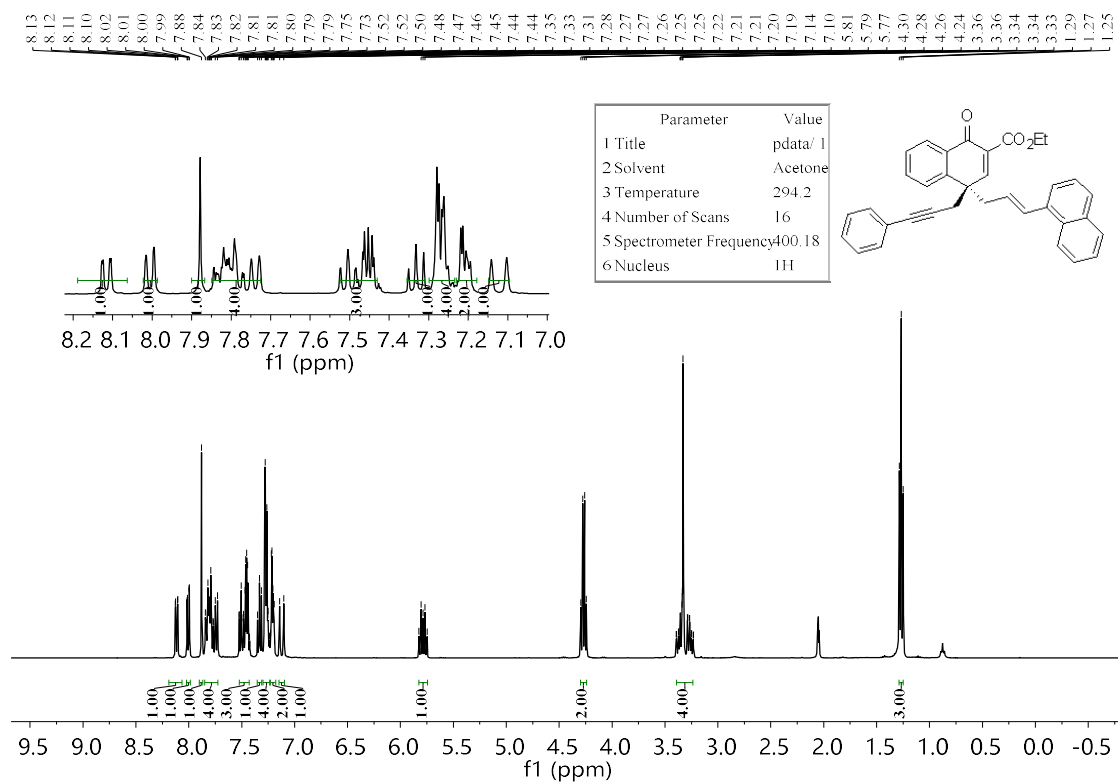
Ethyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(o-tolyl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B30)



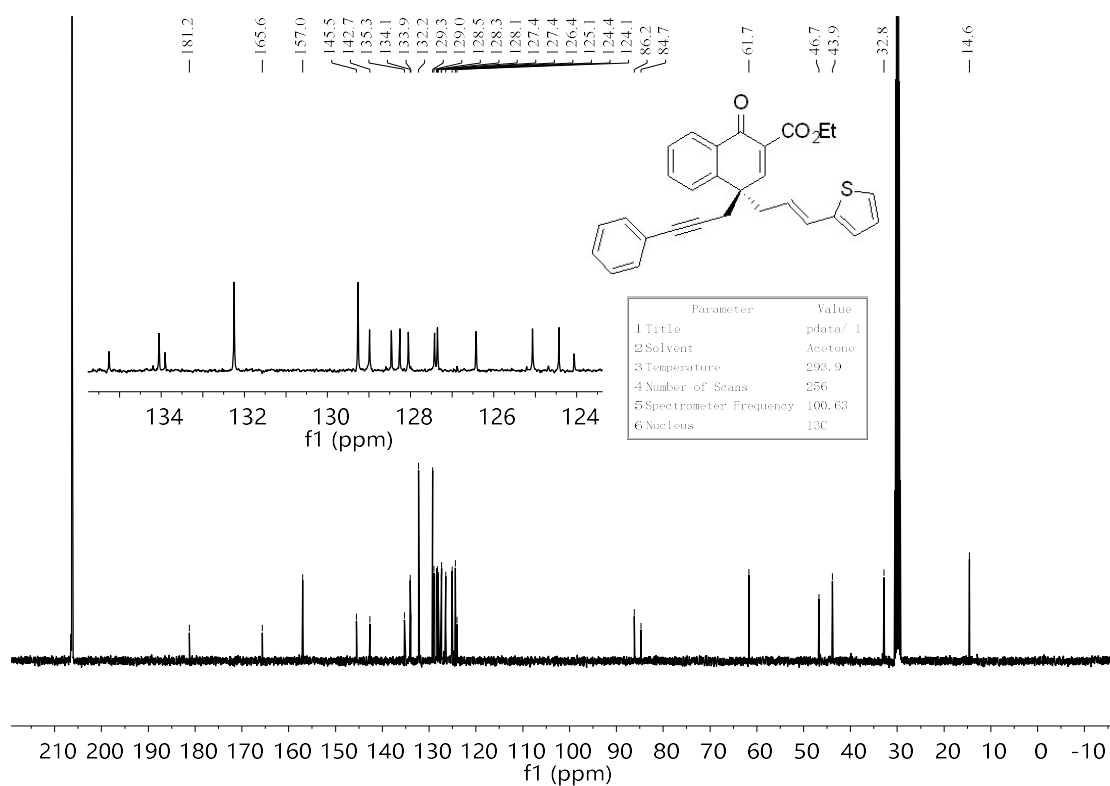
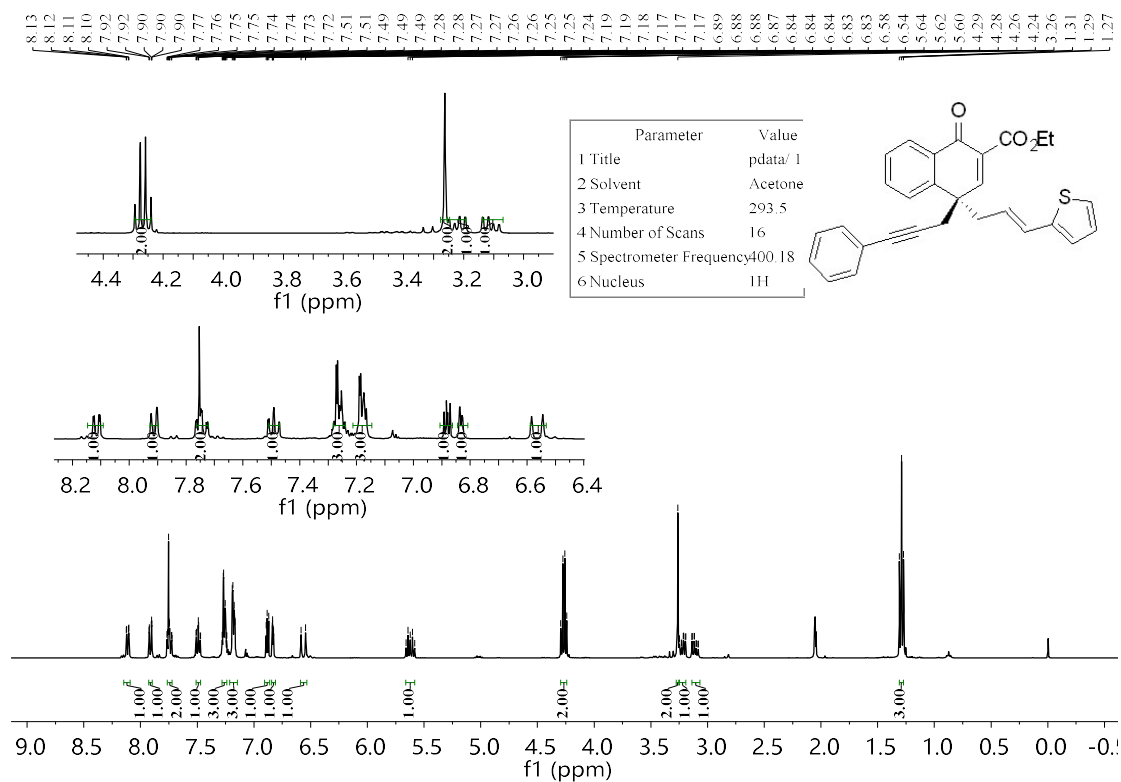
Ethyl (R,E)-4-(3-(2-methoxyphenyl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B31)



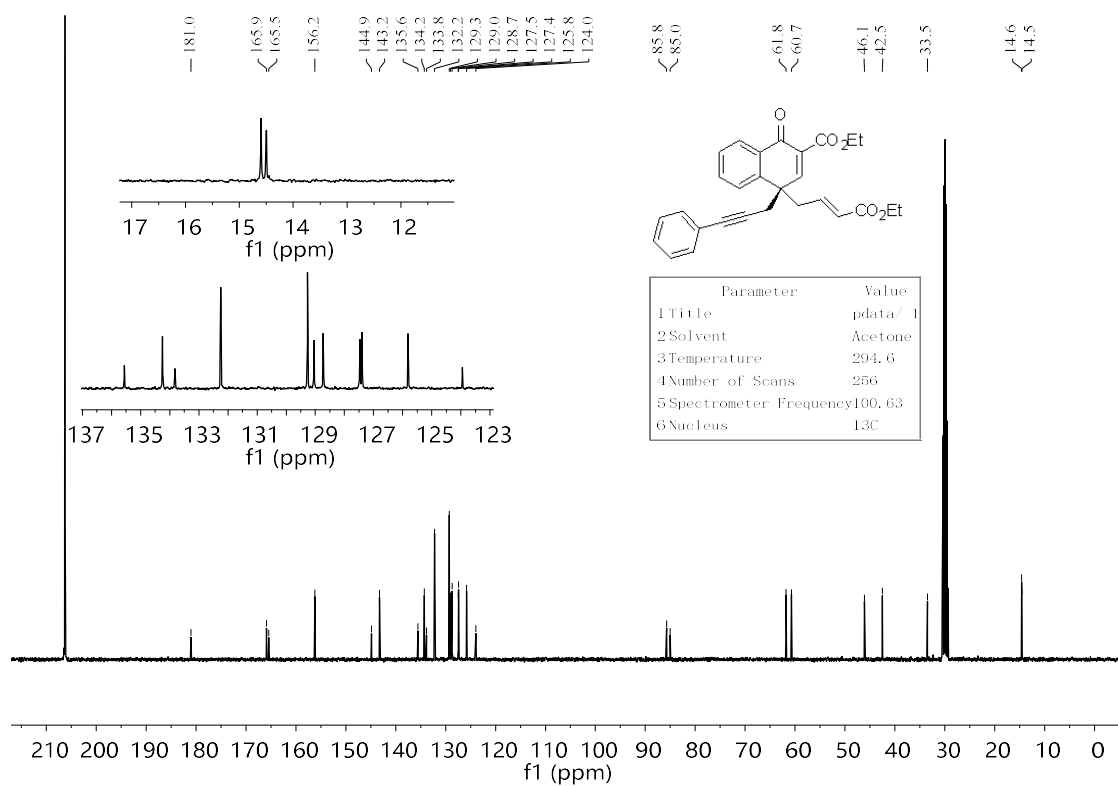
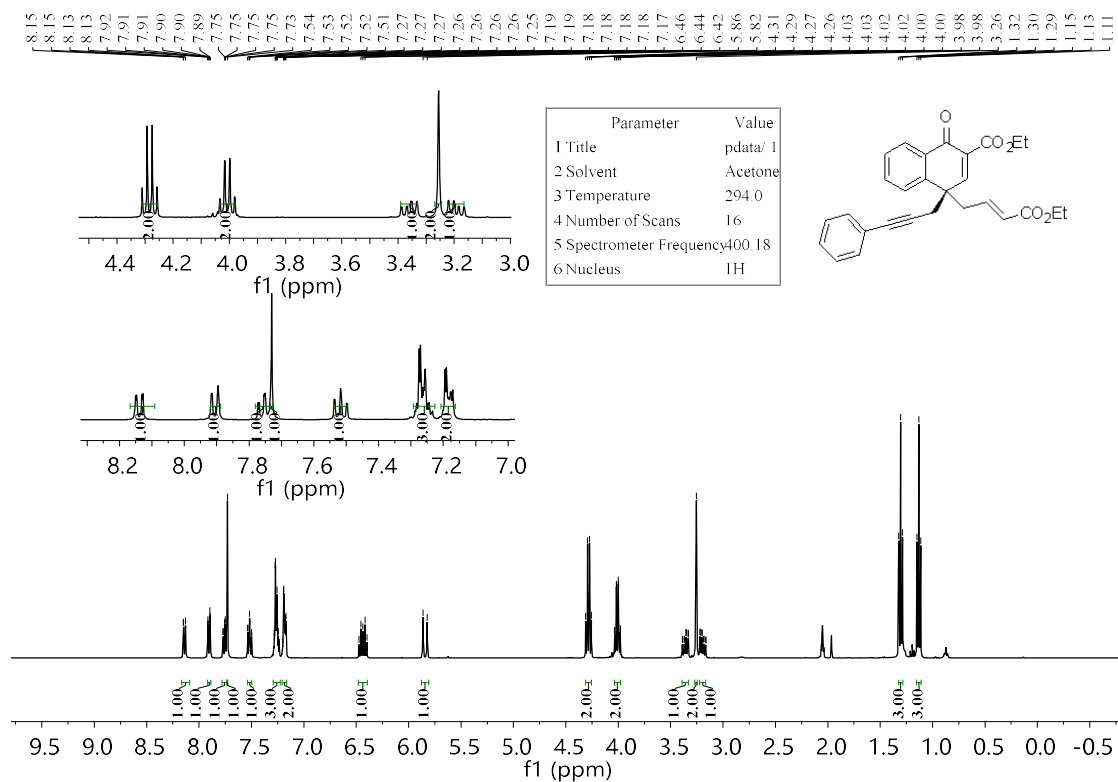
Ethyl (R,E)-4-(3-(naphthalen-1-yl)allyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B32)



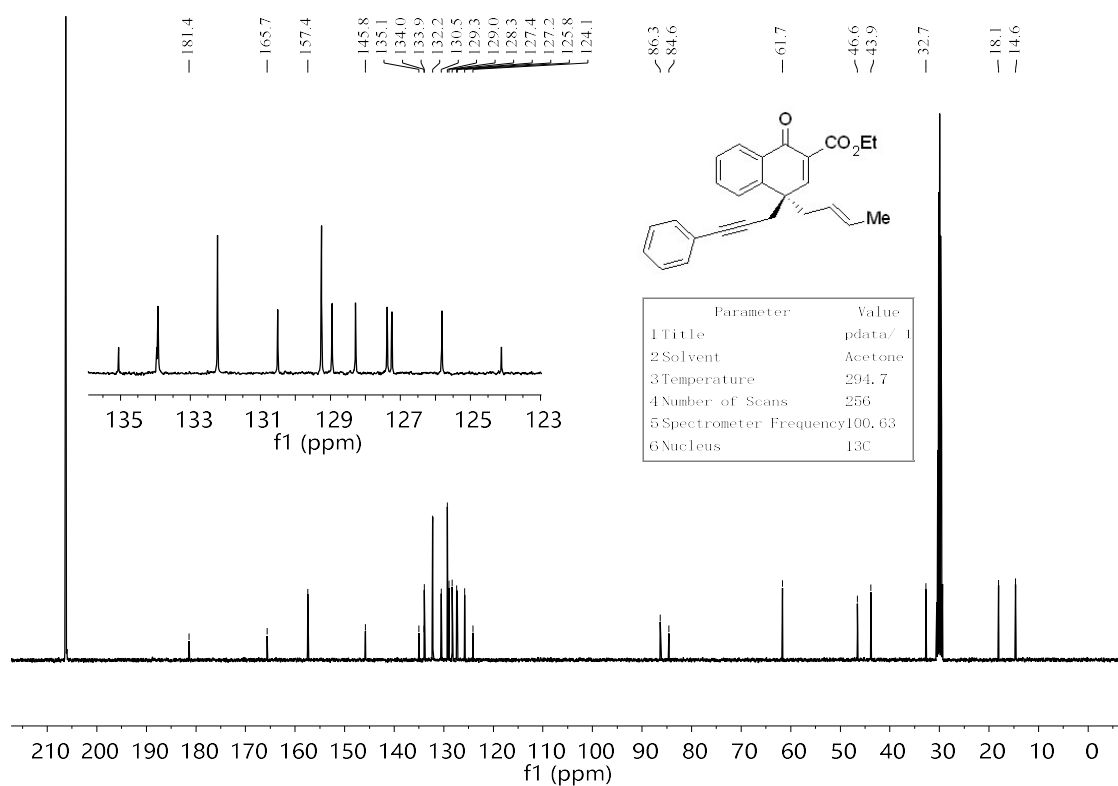
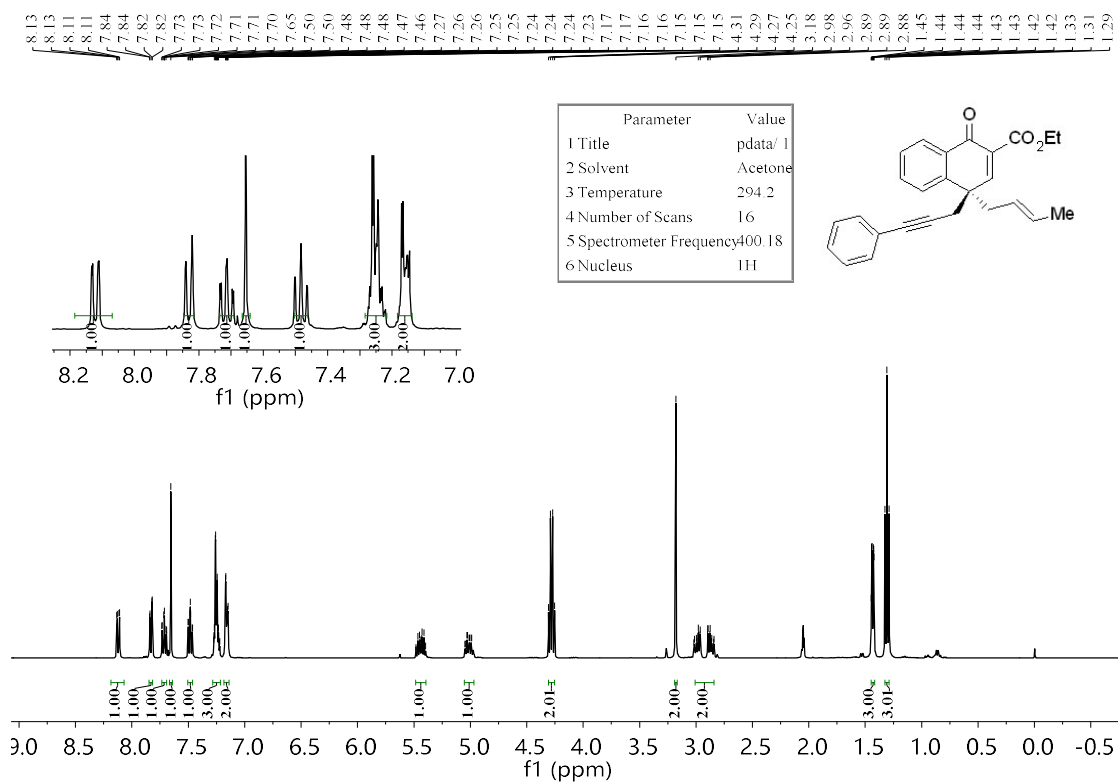
Ehyl (R,E)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-4-(3-(thiophen-2-yl)allyl)-1,4-dihydronaphthalene-2-carboxylate (B33)



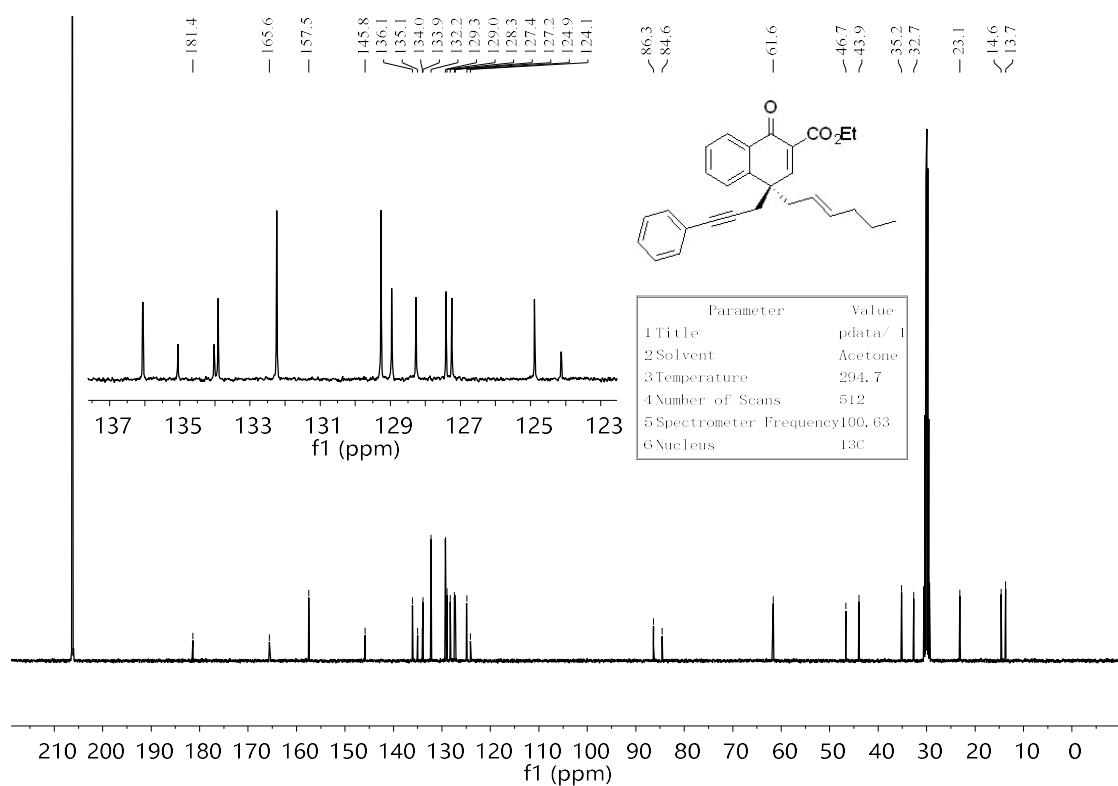
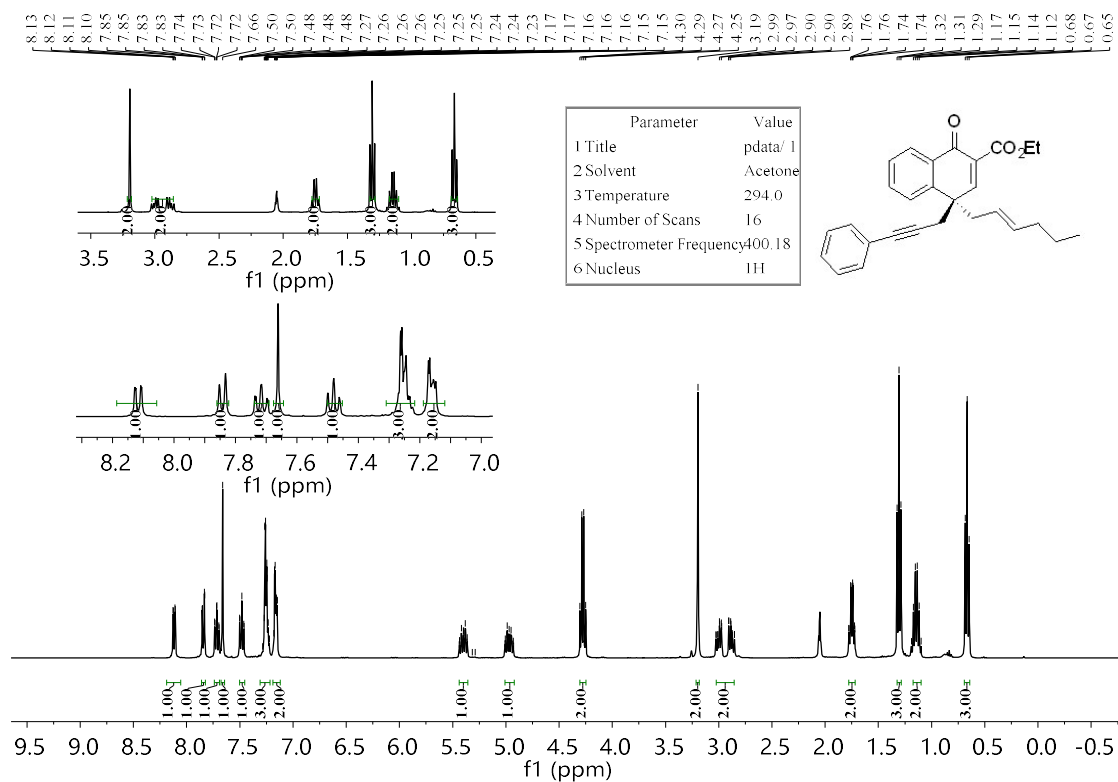
Ehyl (R,E)-4-(4-ethoxy-4-oxobut-2-en-1-yl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B34)



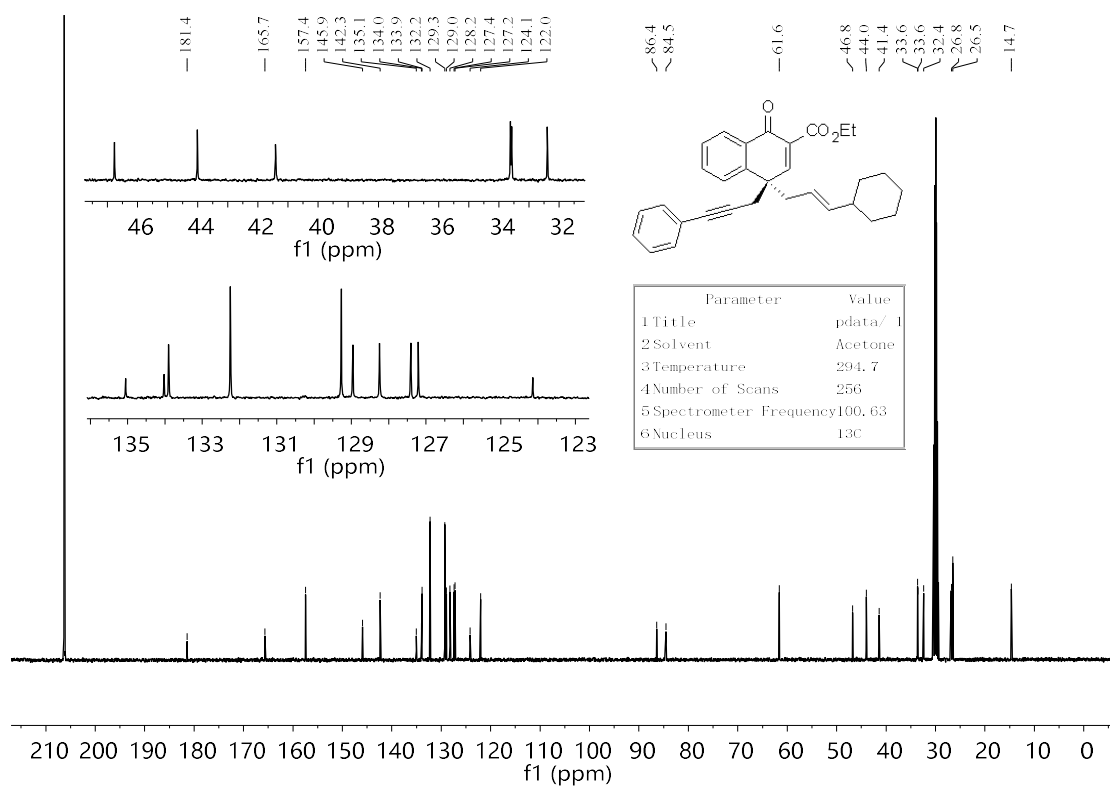
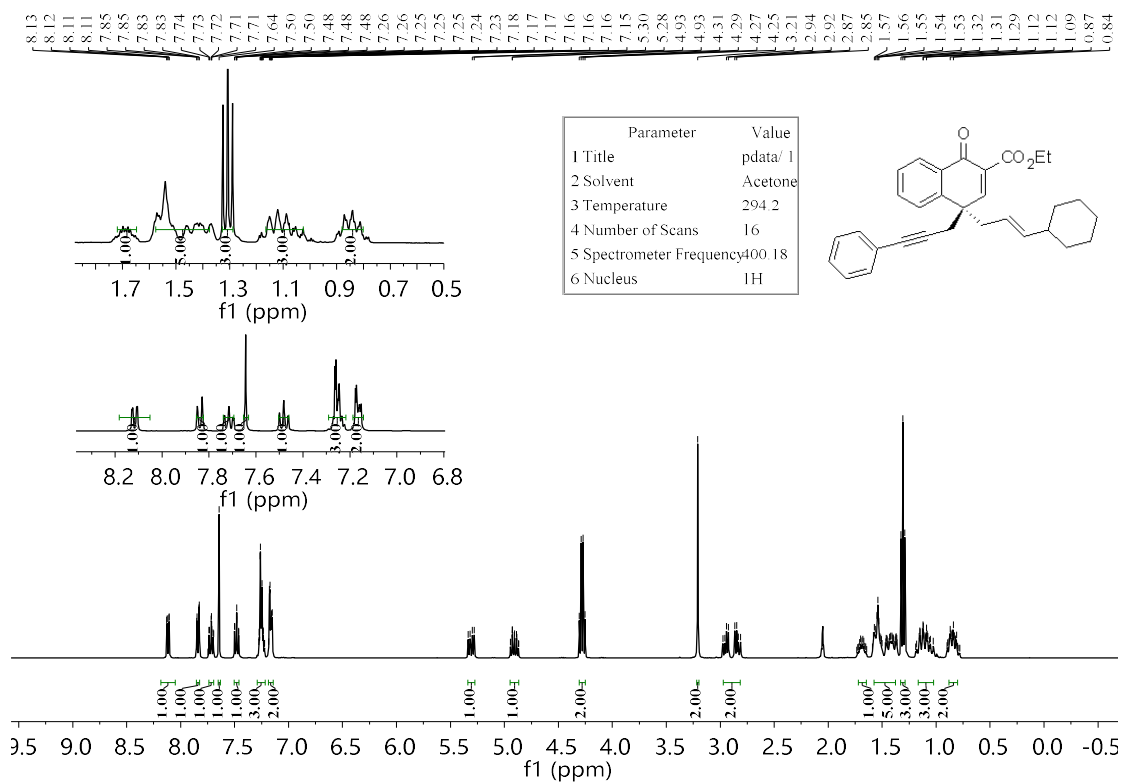
Ehyl (R,E)-4-(but-2-en-1-yl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B35)



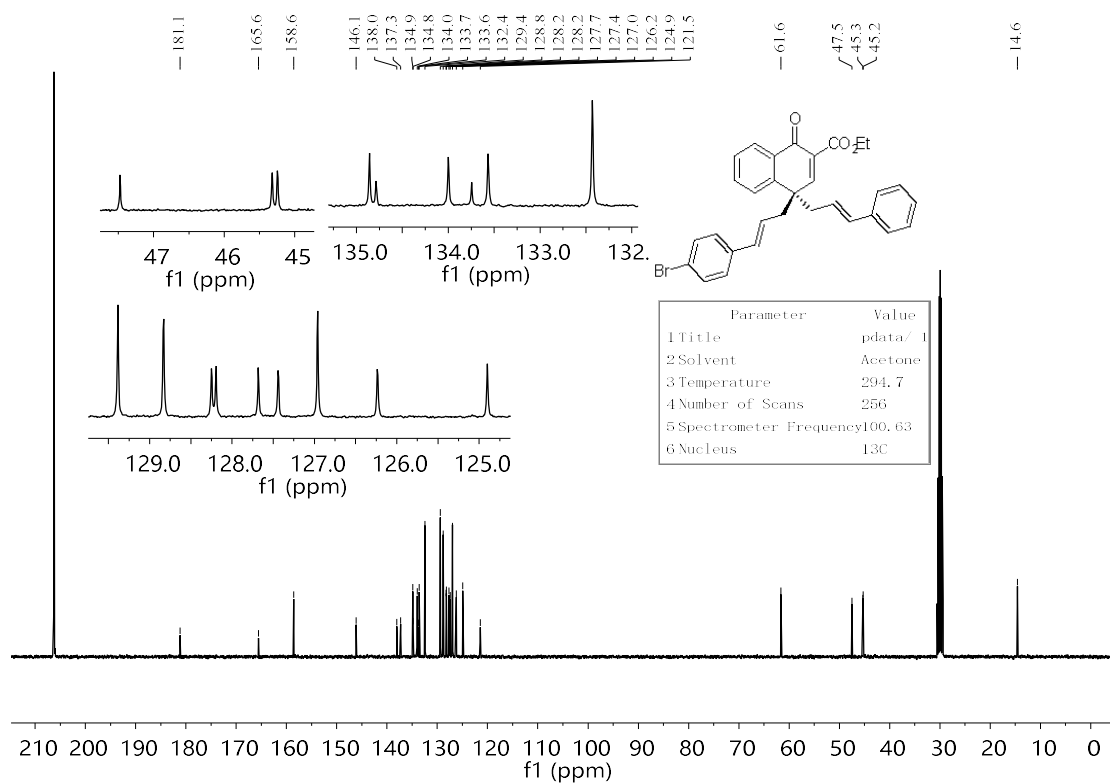
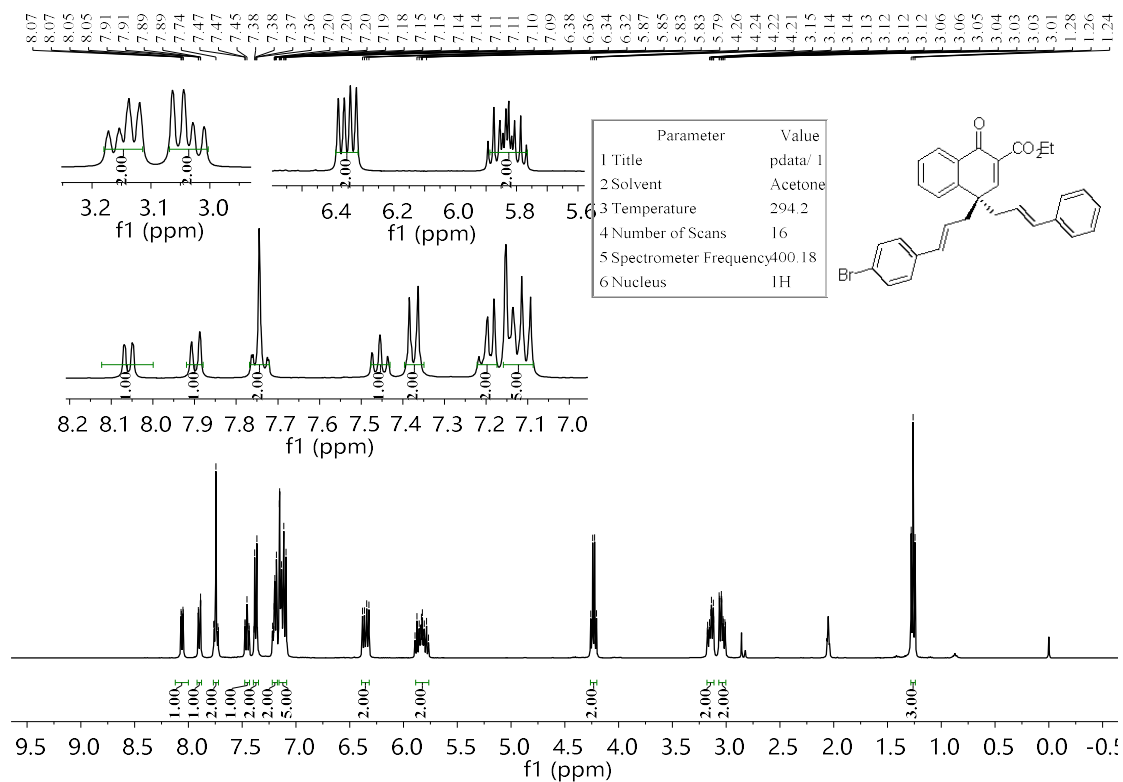
Ehyl (R,E)-4-(hex-2-en-1-yl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B36)



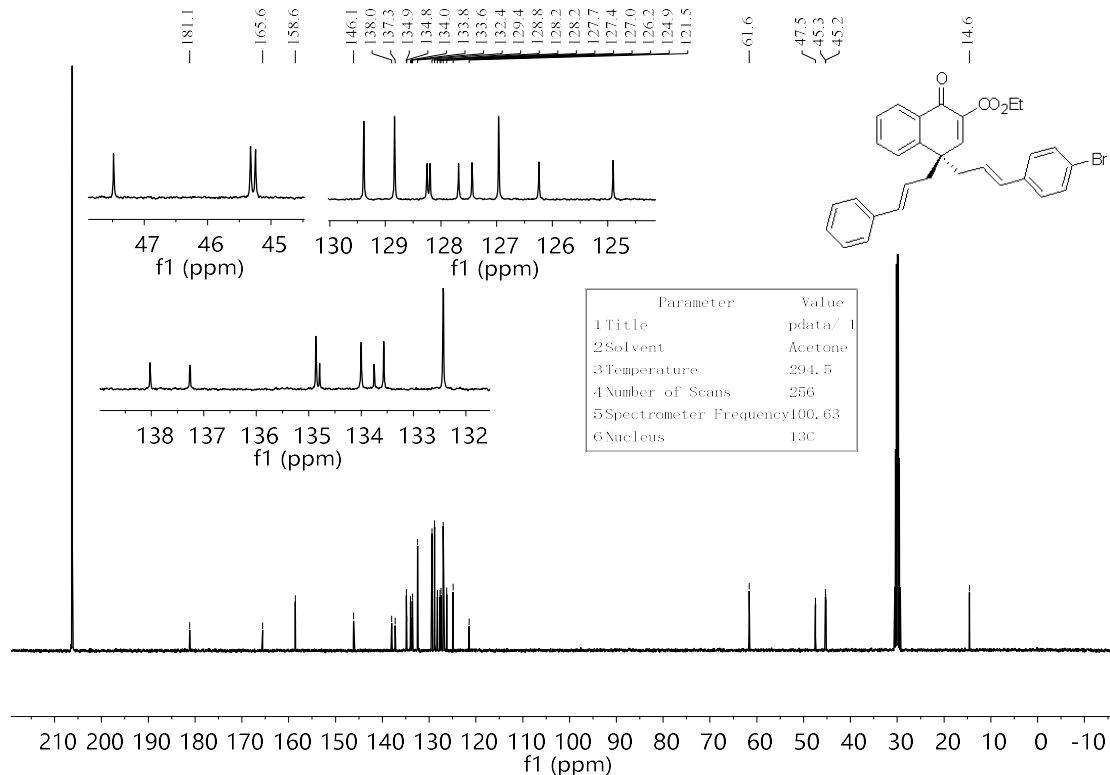
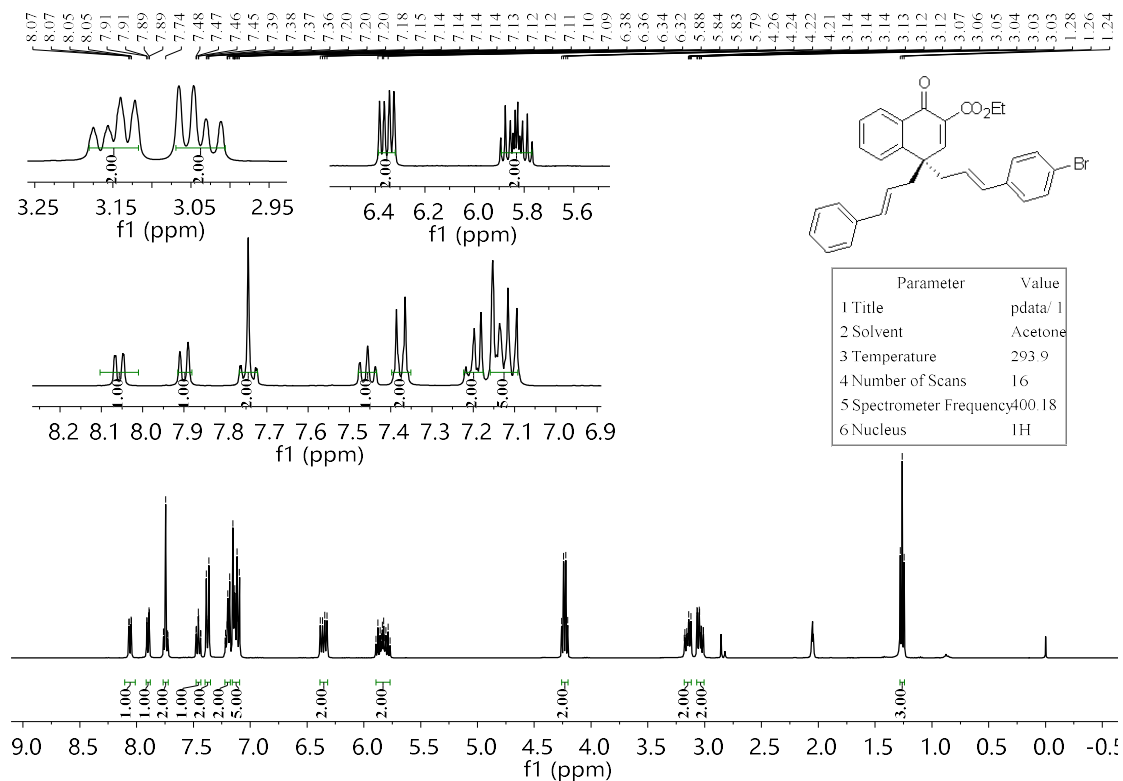
Ehyl (R,E)-4-(3-cyclohexylallyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,4-dihydronaphthalene-2-carboxylate (B37)



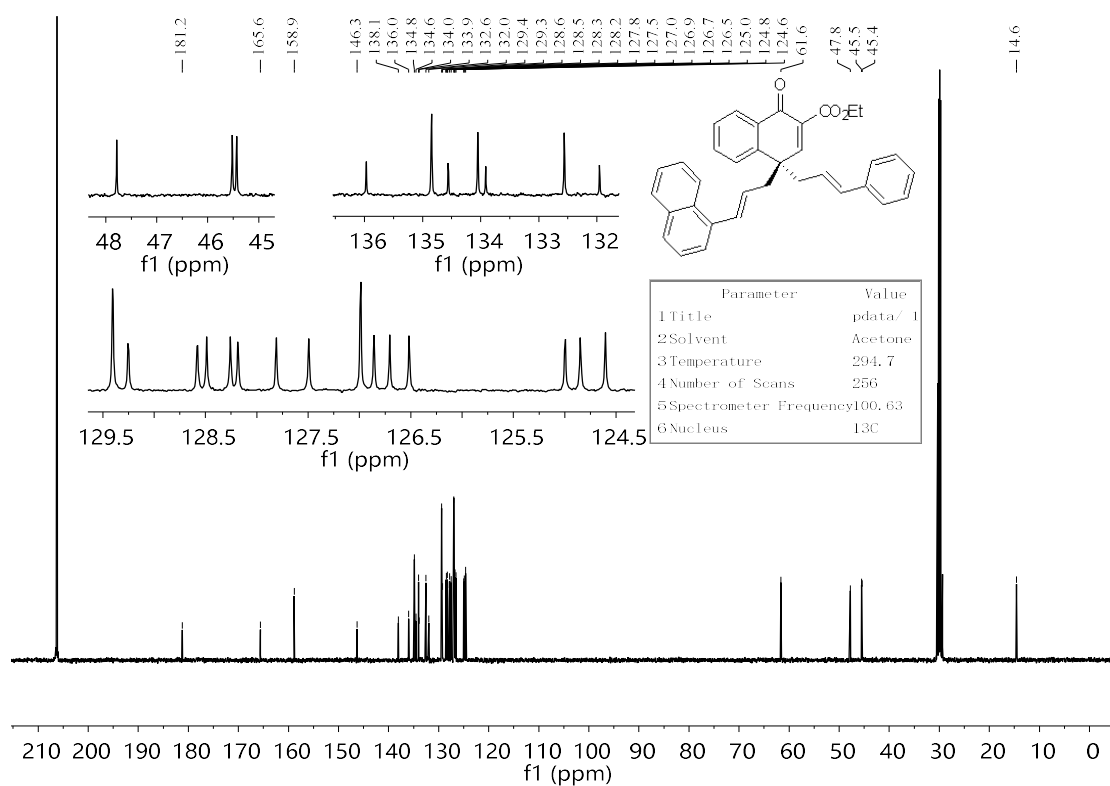
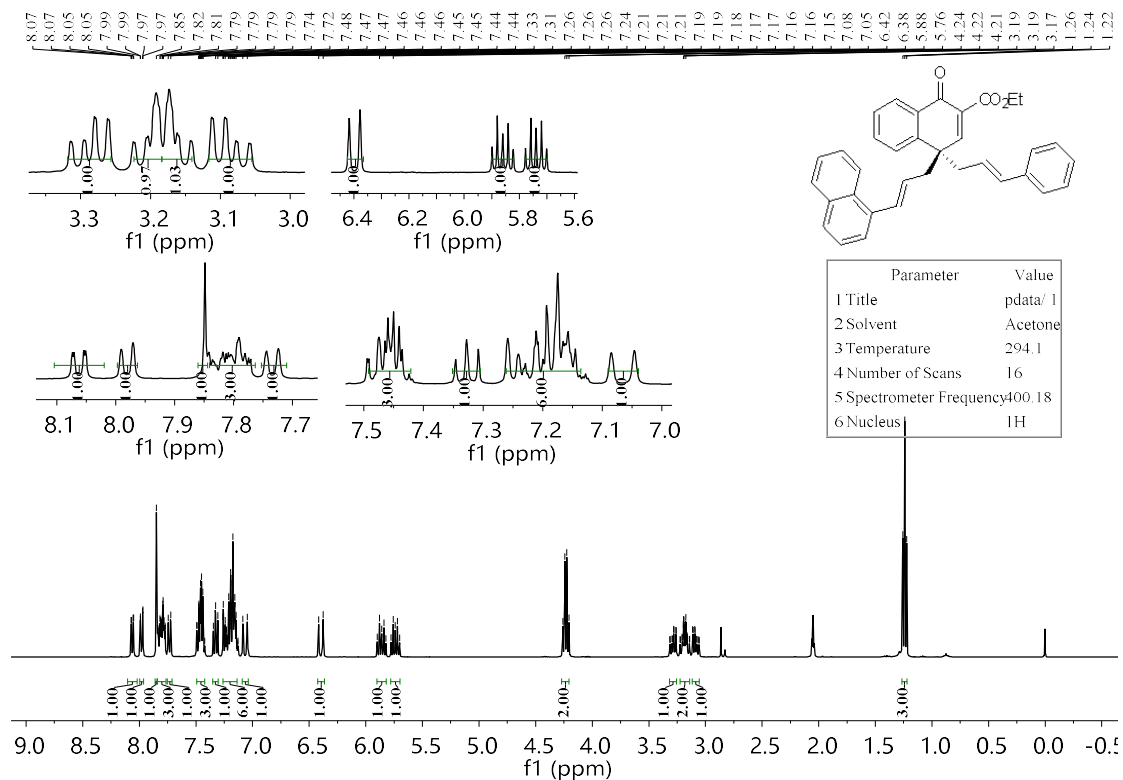
Ethyl (R)-4-((E)-3-(4-bromophenyl)allyl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B38)



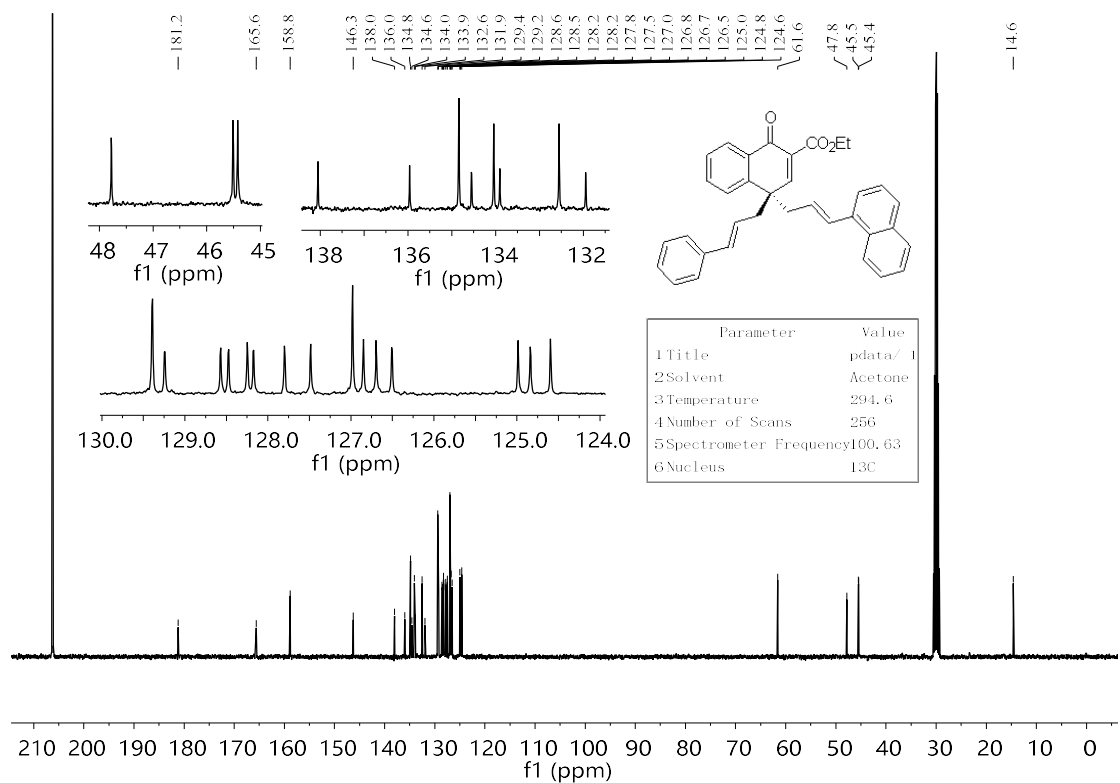
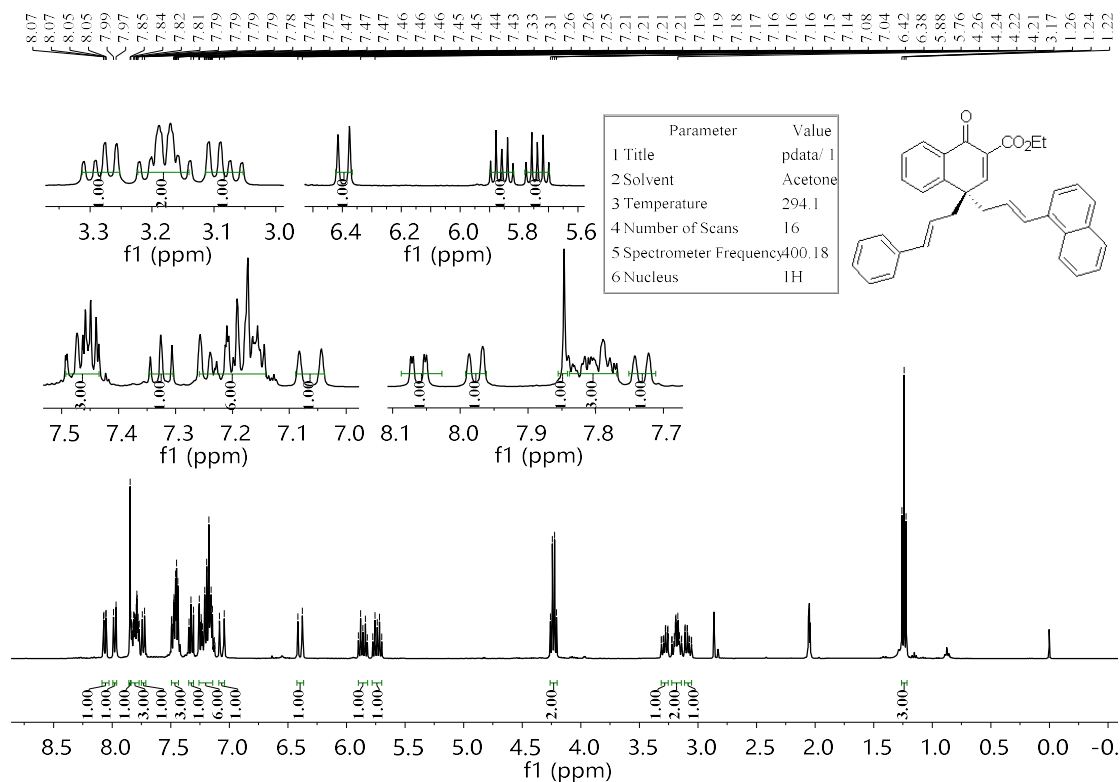
Ethyl (S)-4-((E)-3-(4-bromophenyl)allyl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (*ent*-B38)



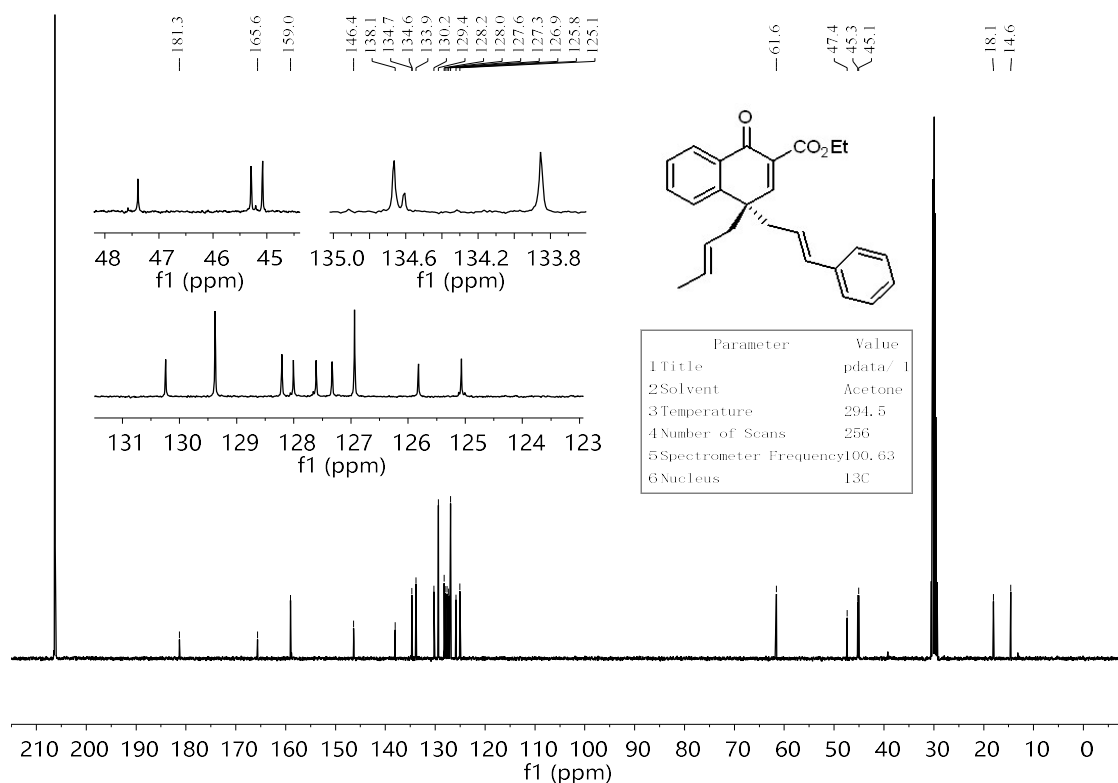
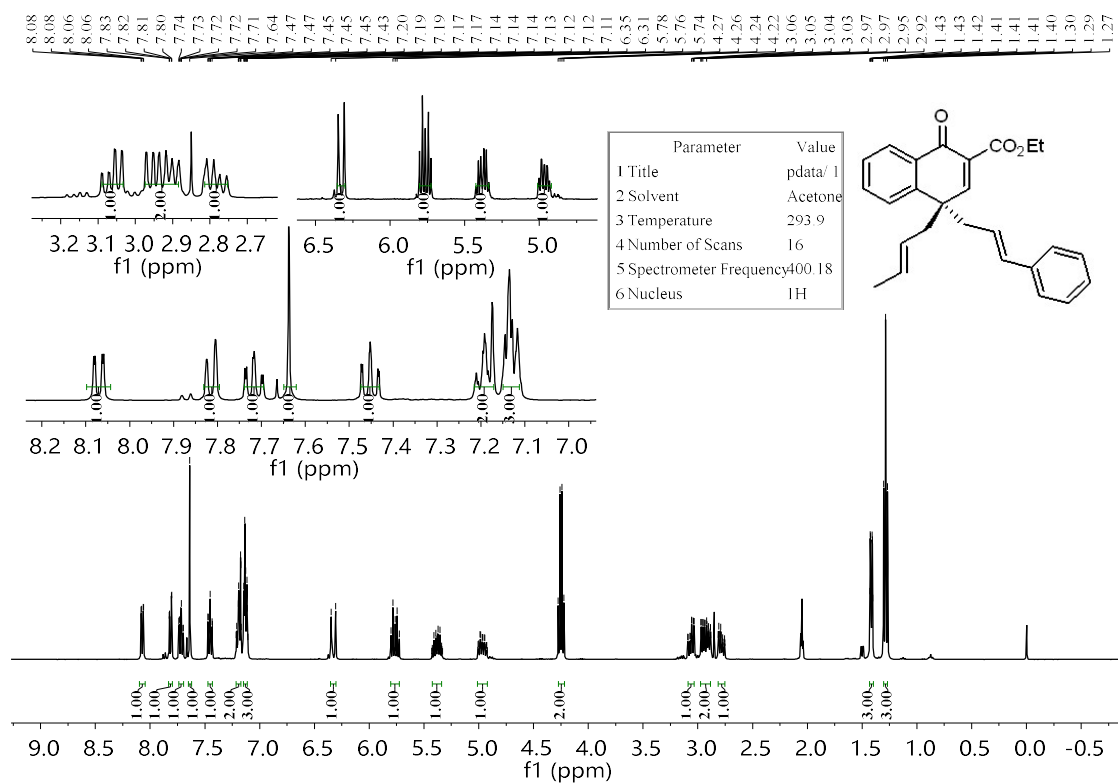
Ethyl (R)-4-cinnamyl-4-((E)-3-(naphthalen-1-yl)allyl)-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B39)



Ethyl (S)-4-cinnamyl-4-((E)-3-(naphthalen-1-yl)allyl)-1-oxo-1,4-dihydronaphthalene-2-carboxylate (*ent*-B39)

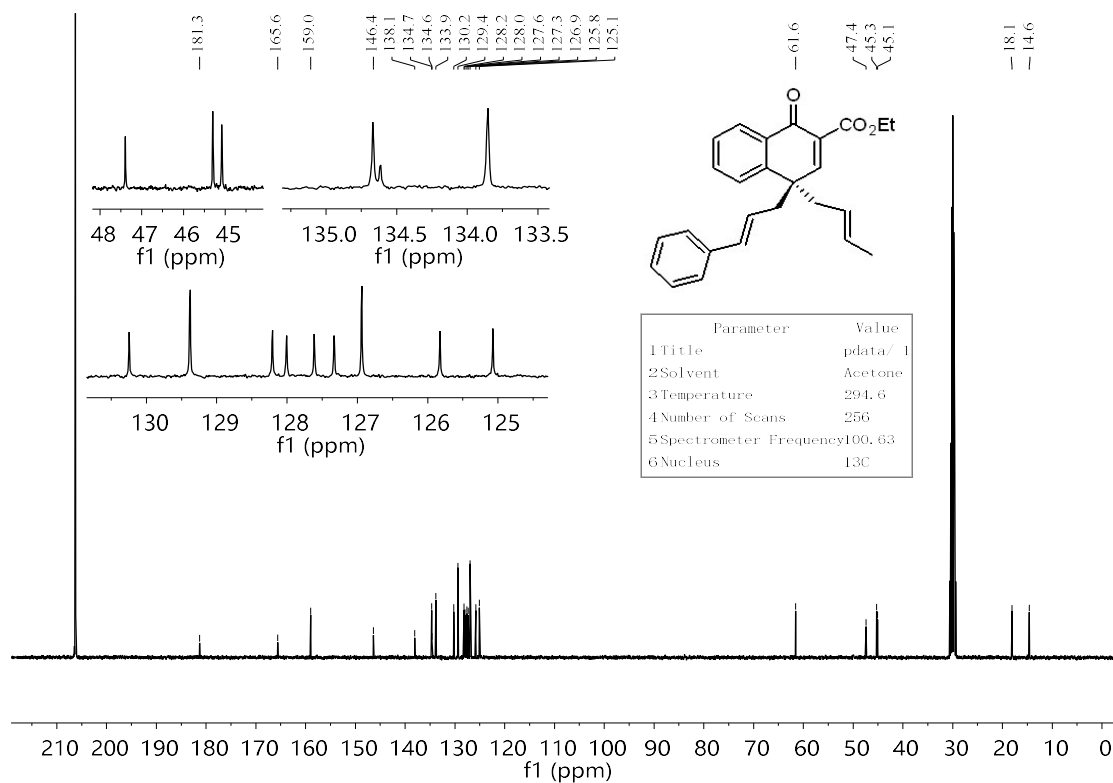
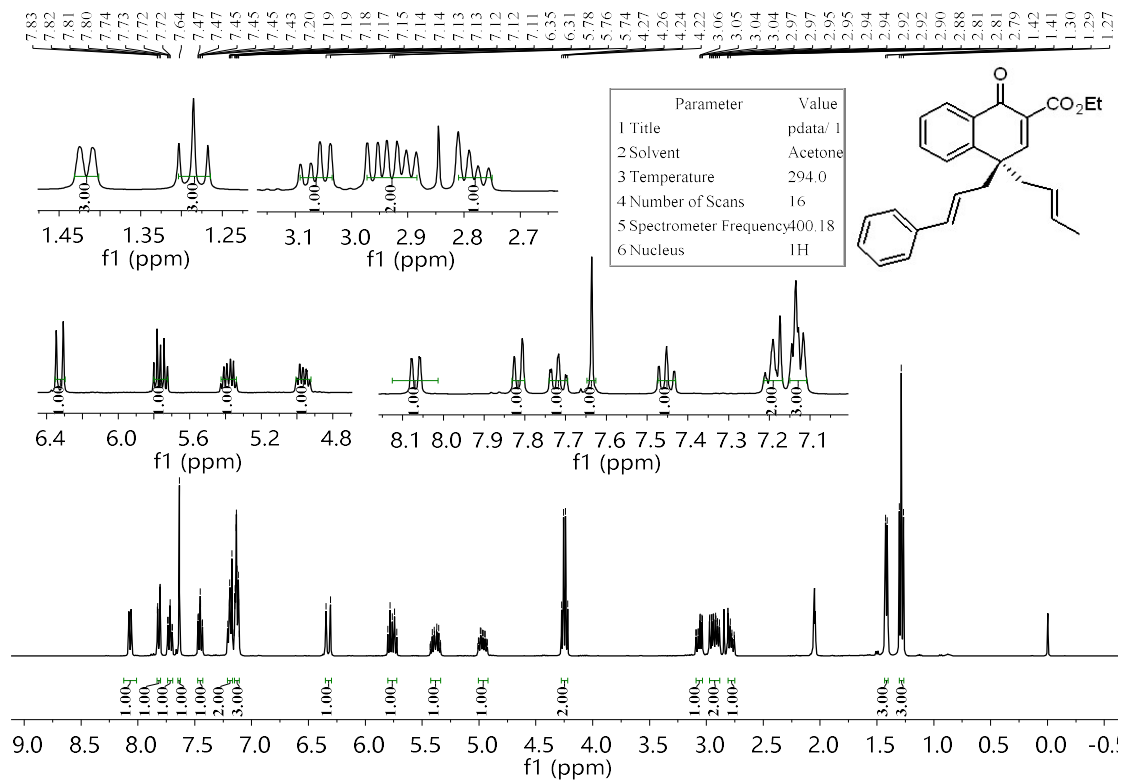


Ethyl (S)-4-((E)-but-2-en-1-yl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate (B40)

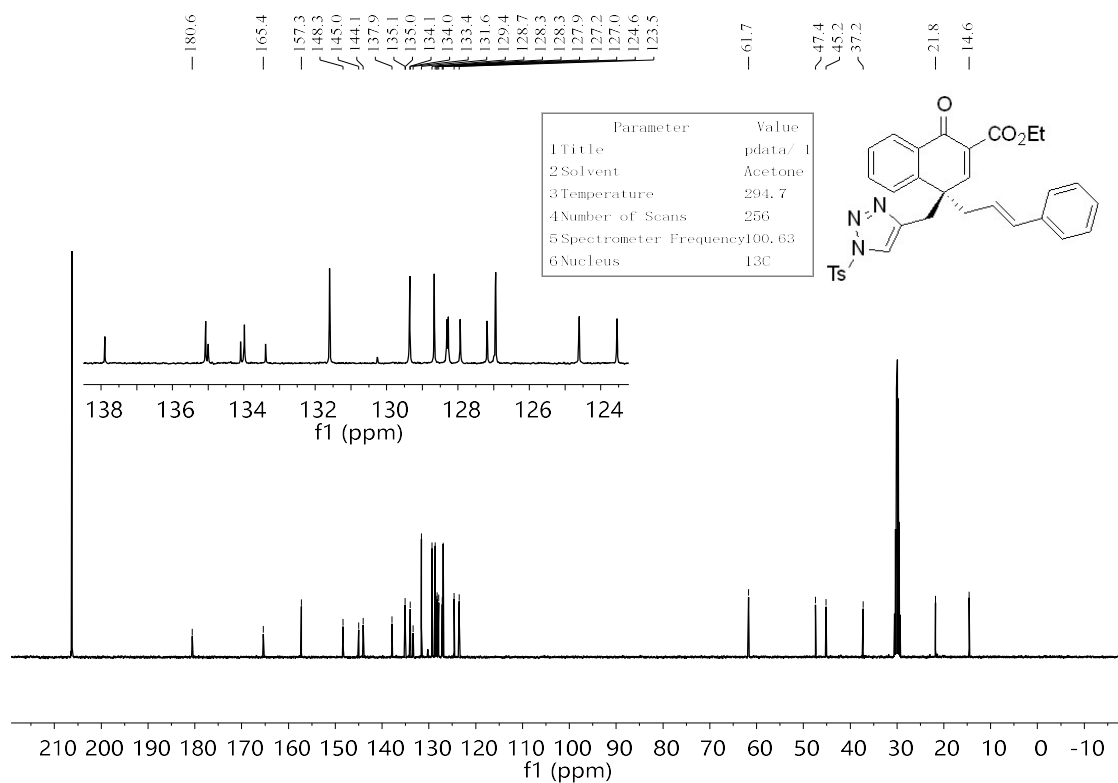
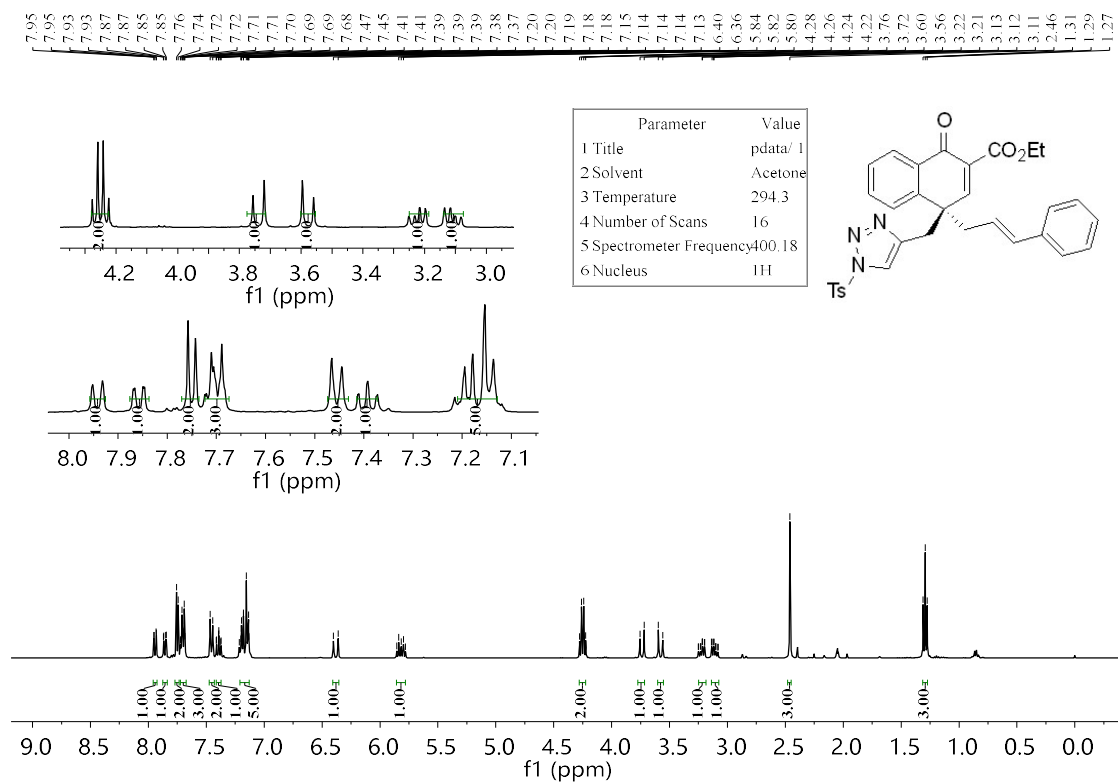


Ethyl (R)-4-((E)-but-2-en-1-yl)-4-cinnamyl-1-oxo-1,4-dihydronaphthalene-2-carboxylate

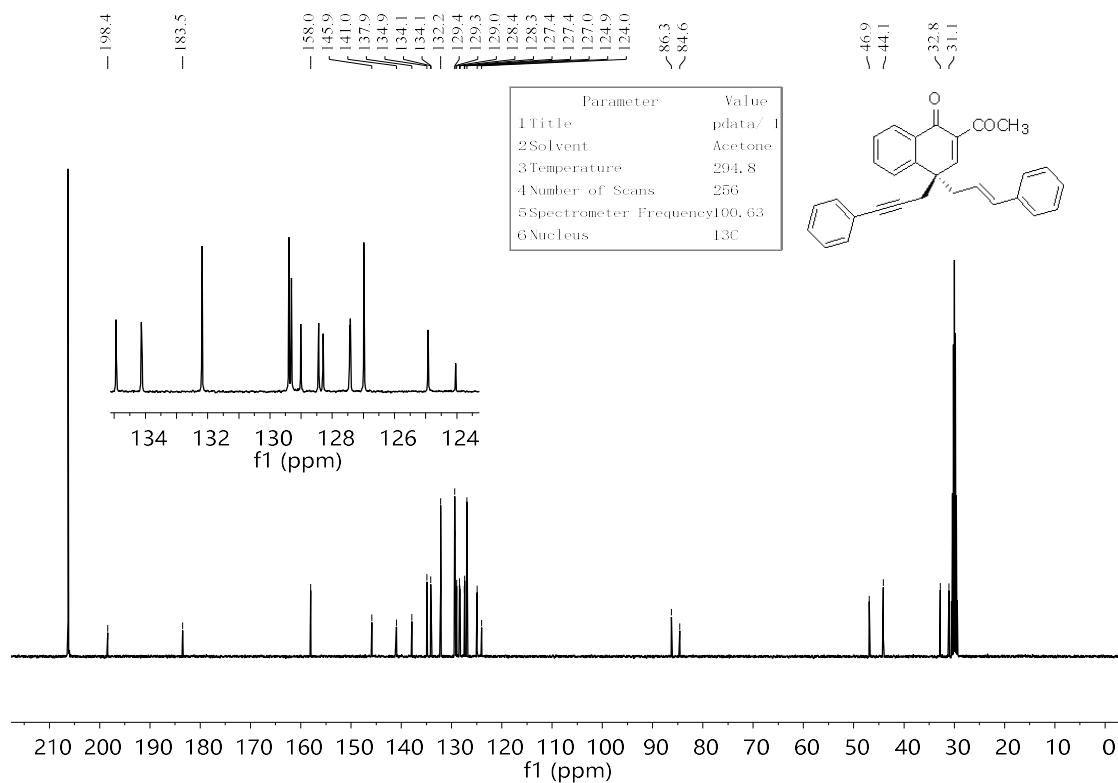
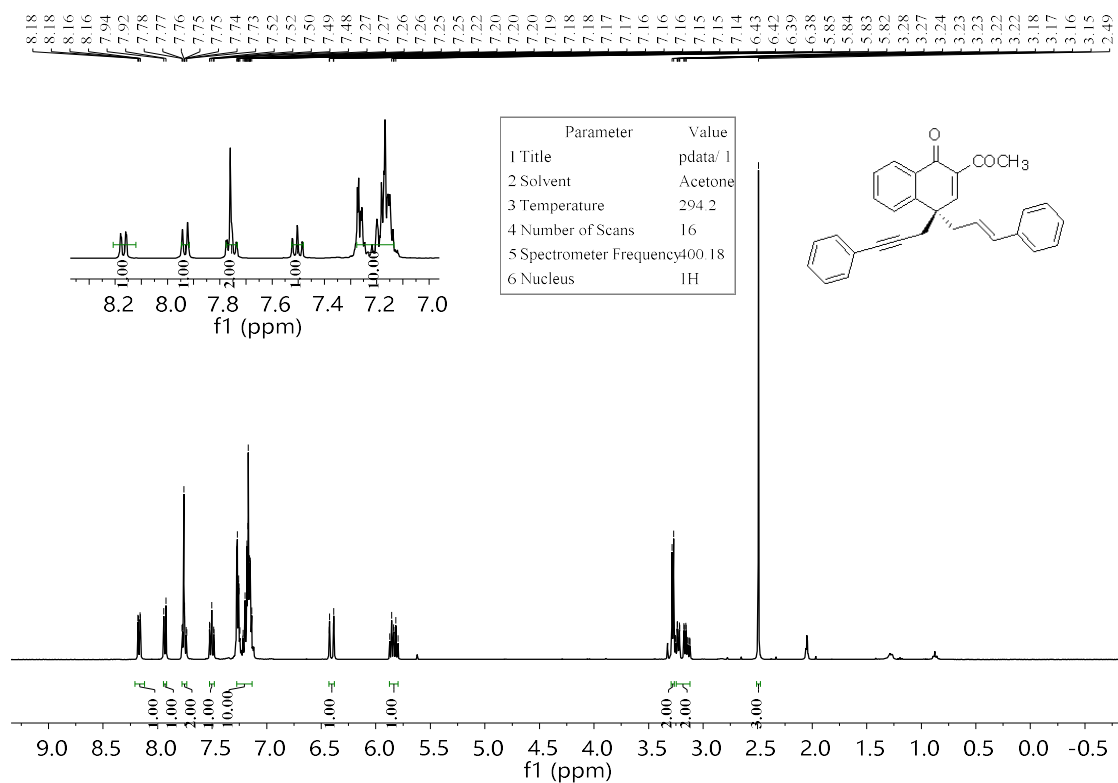
(*ent*-B40)



Ethyl (R)-4-cinnamyl-1-oxo-4-((1-tosyl-1H-1,2,3-triazol-4-yl)methyl)-1,4-dihydronaphthalene-2-Carboxylate

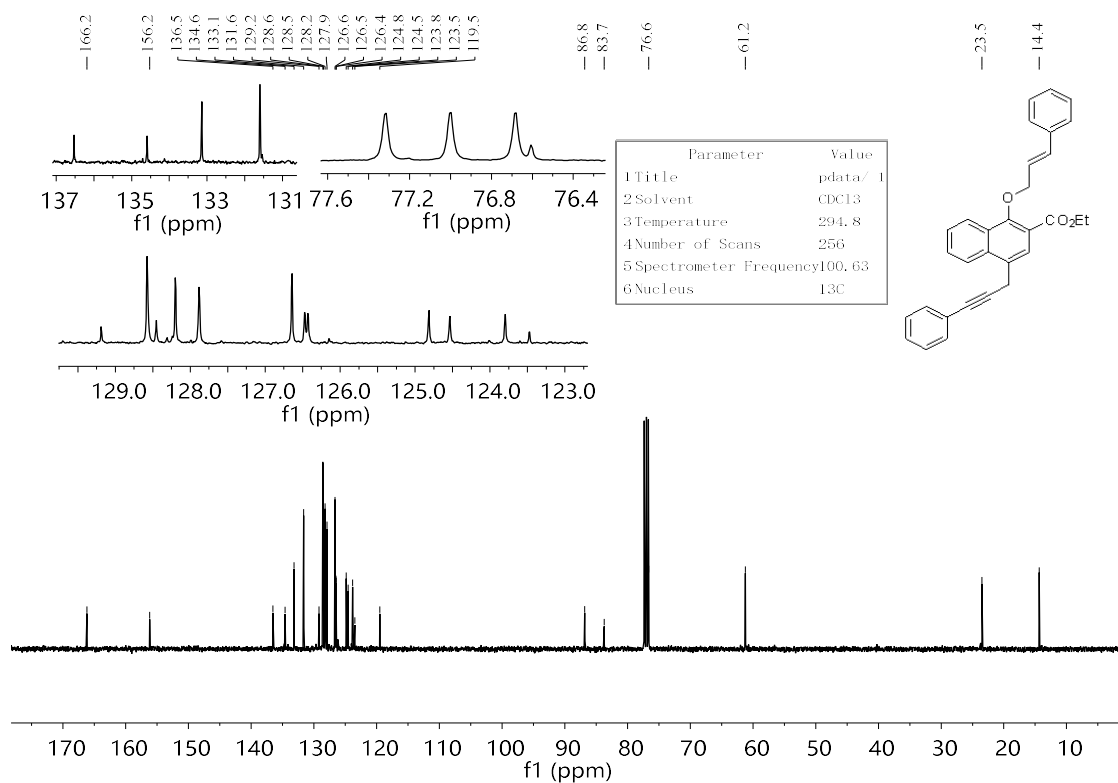
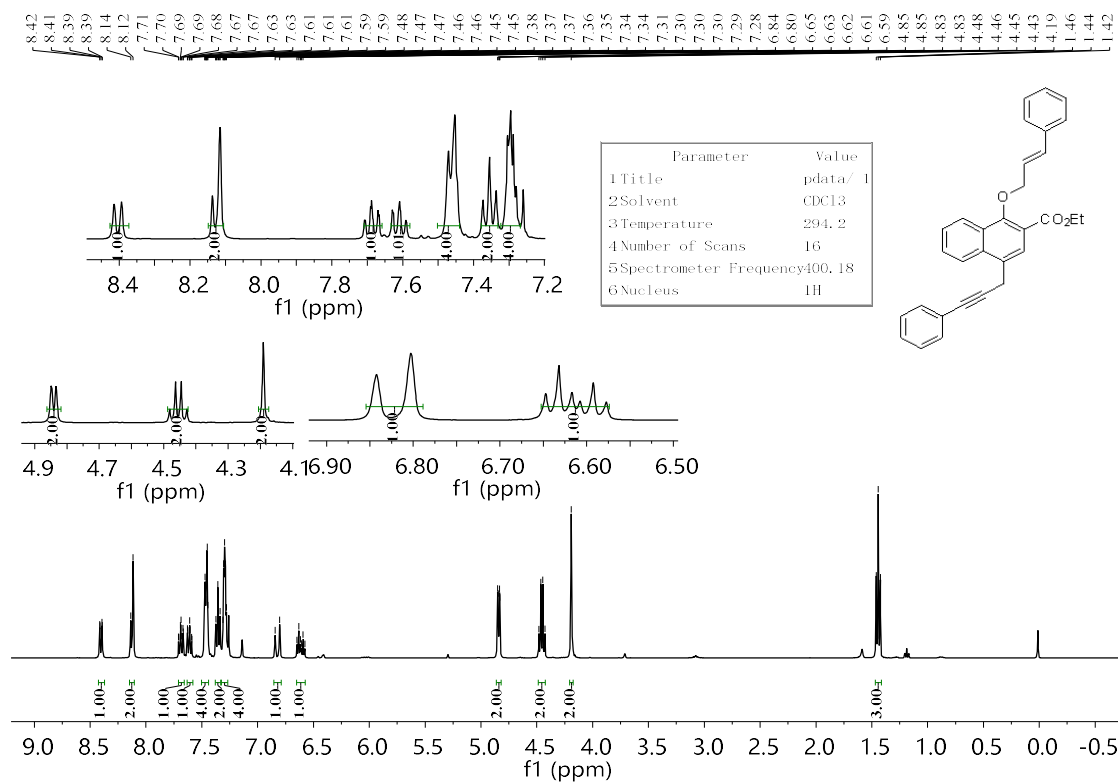


(R)-2-acetyl-4-cinnamyl-4-(3-phenylprop-2-yn-1-yl)naphthalen-1(4H)-one (B45)

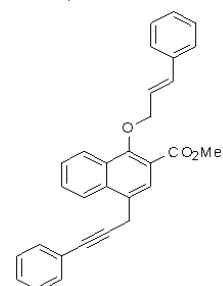
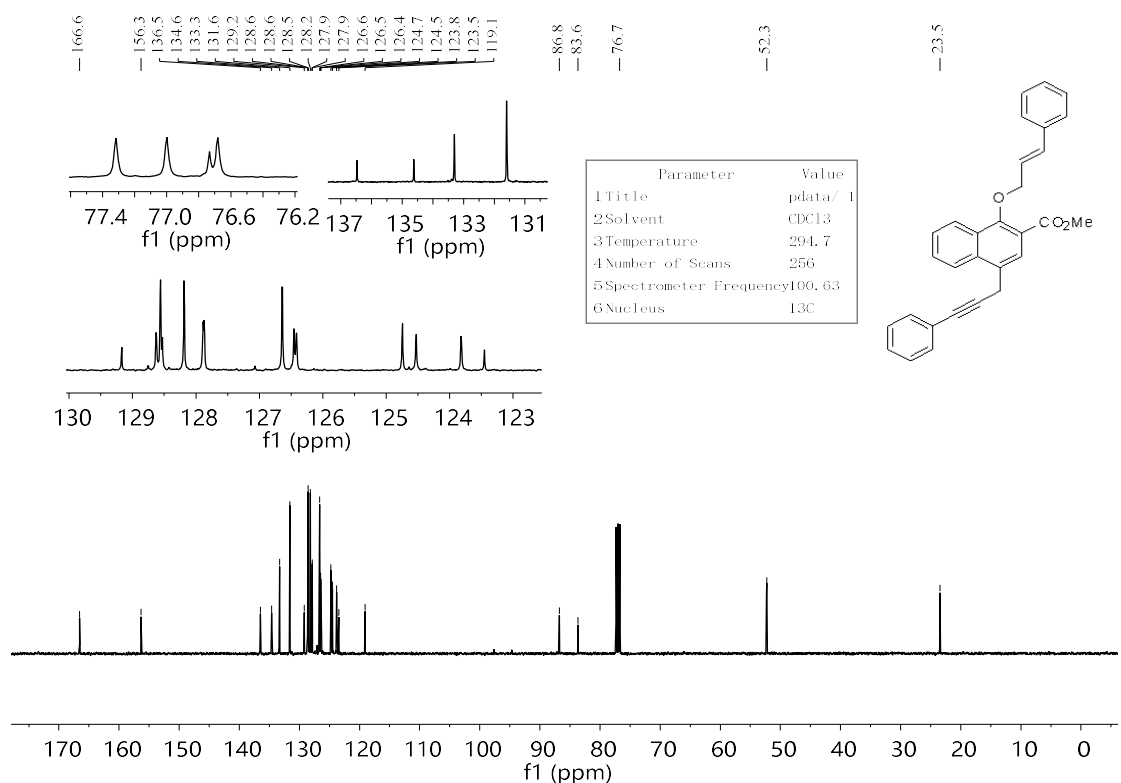
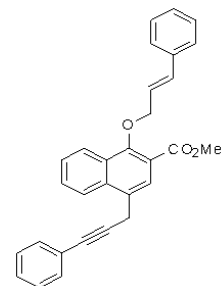
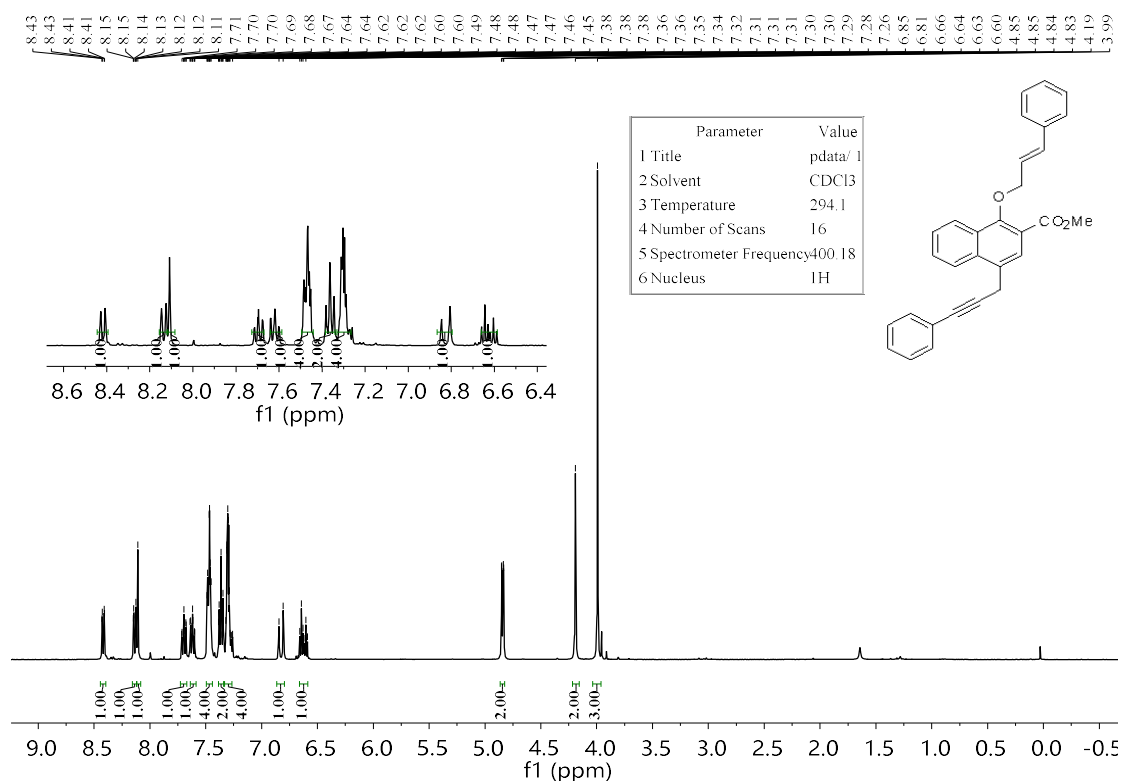


17. Copies of NMR Spectra for the Reaction Substrates

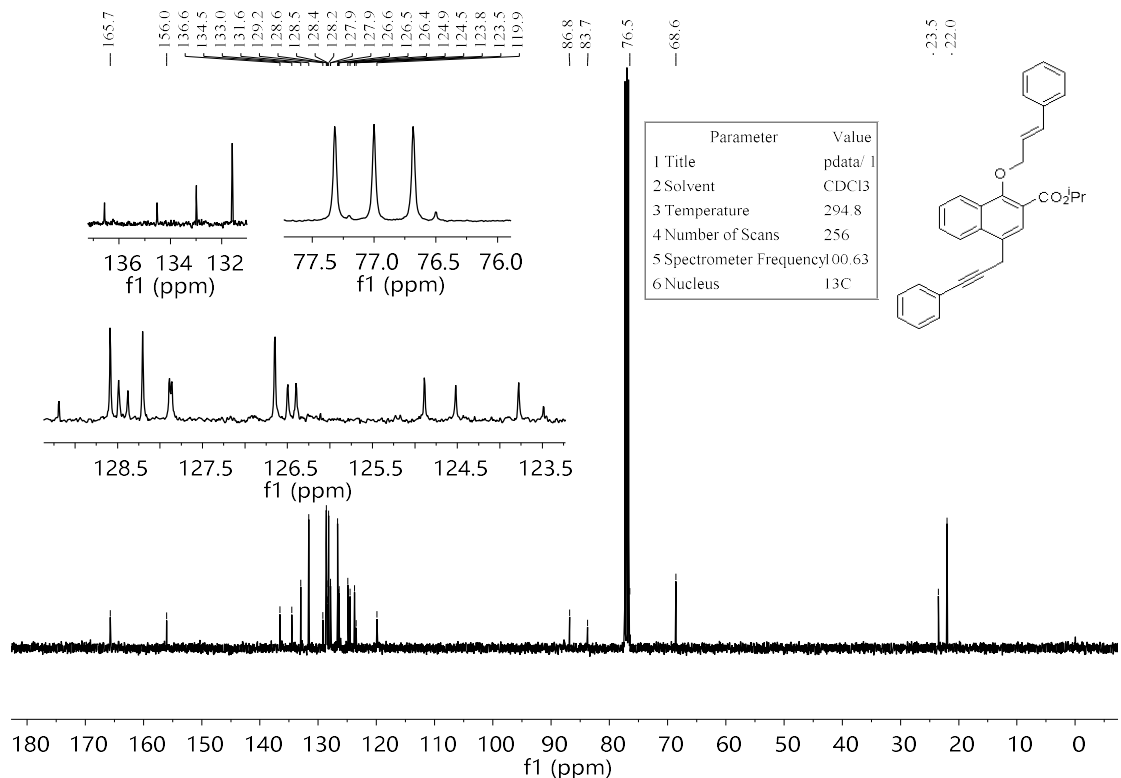
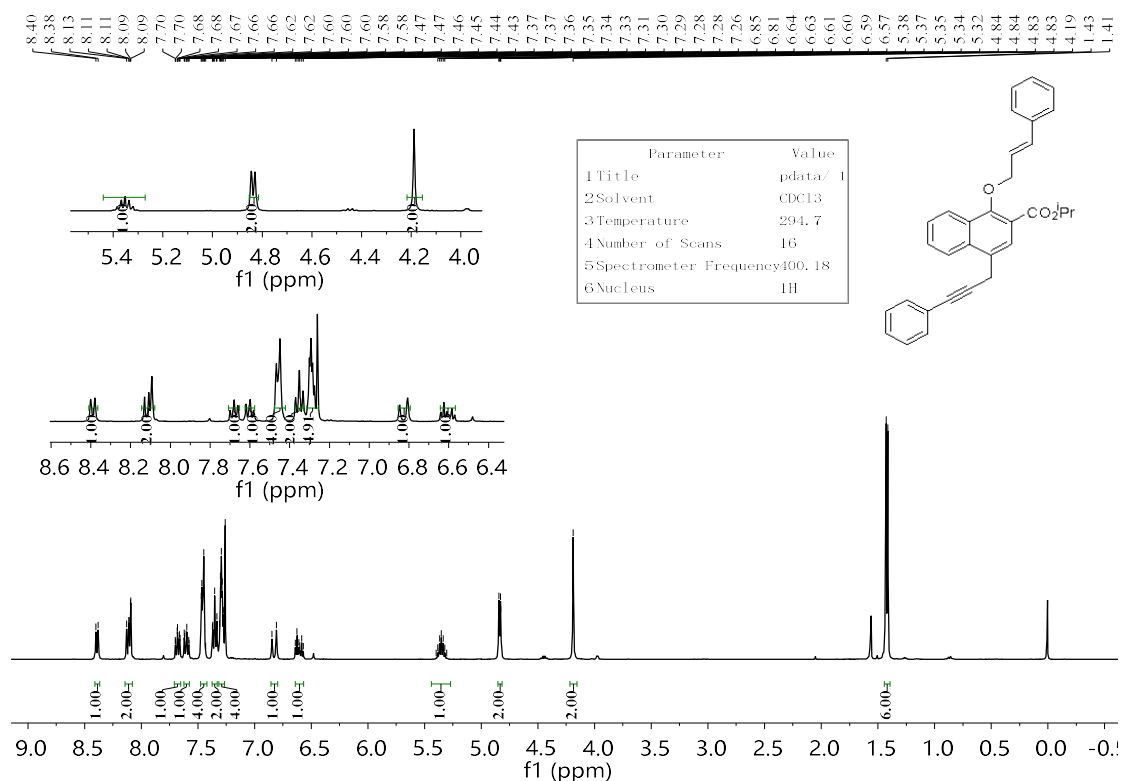
Ethyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A1)



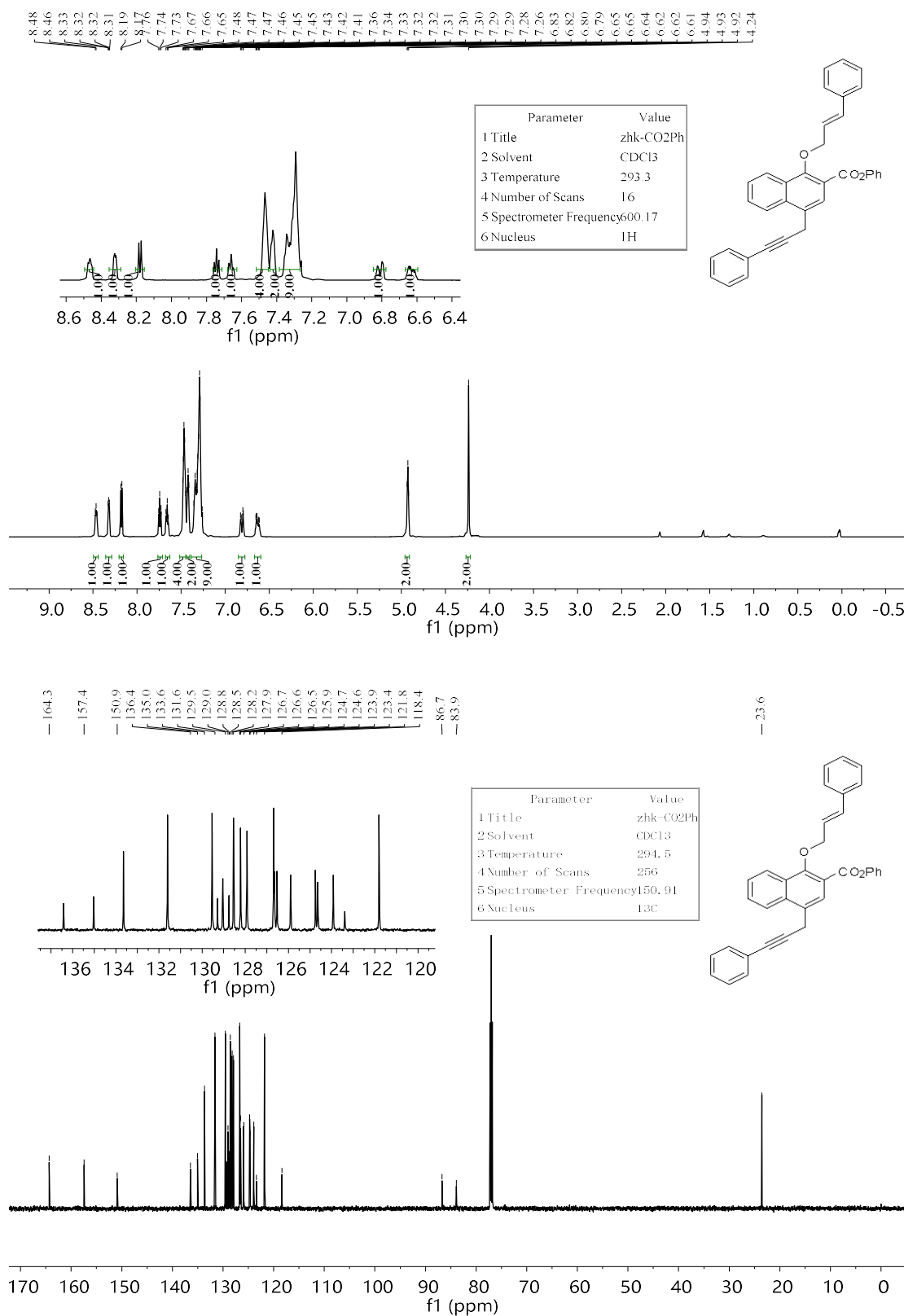
Methyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A2)



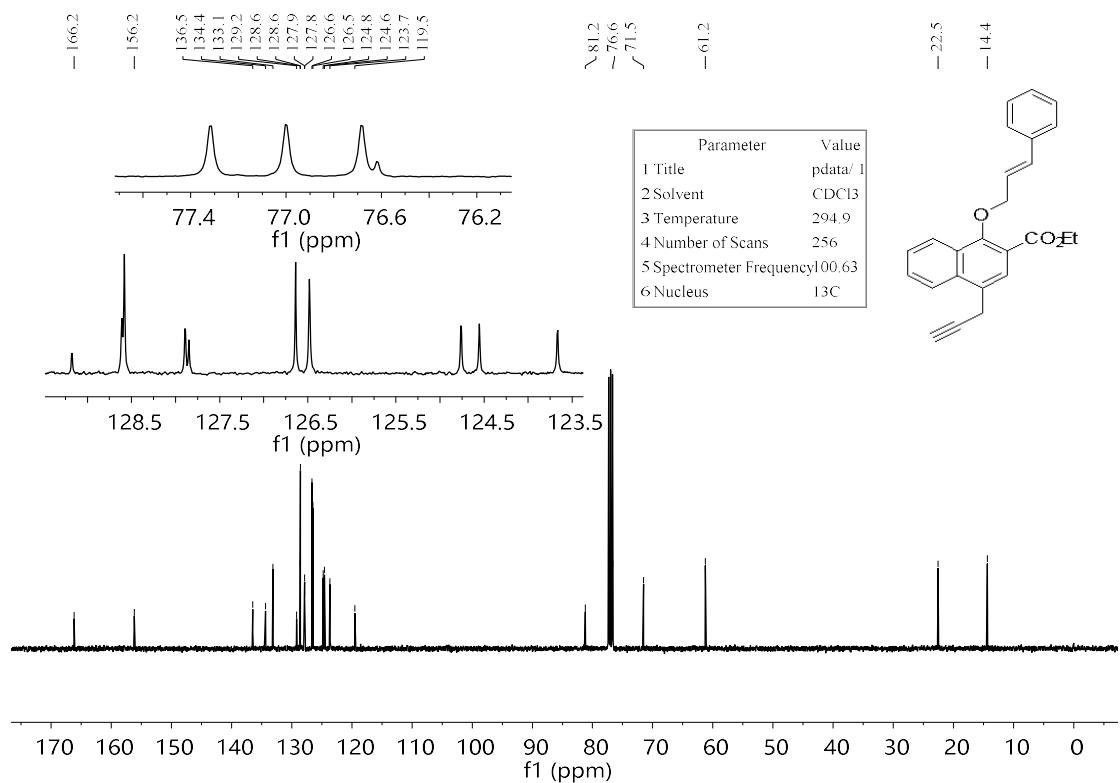
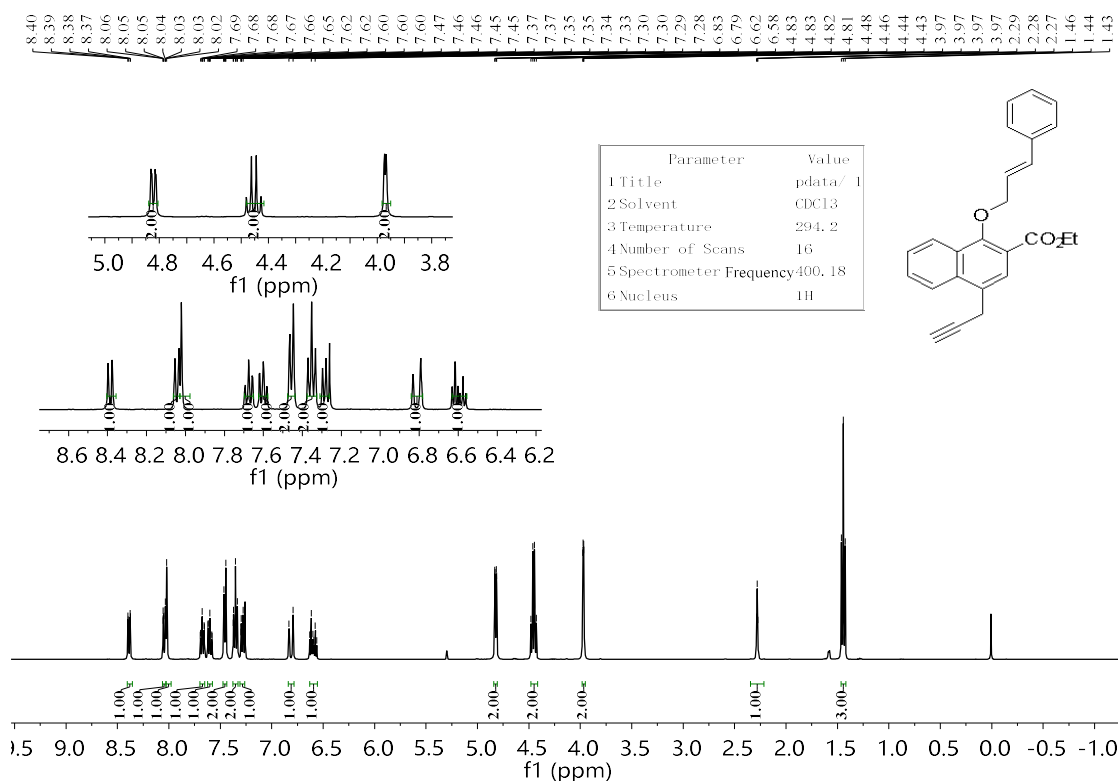
Isopropyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A3)



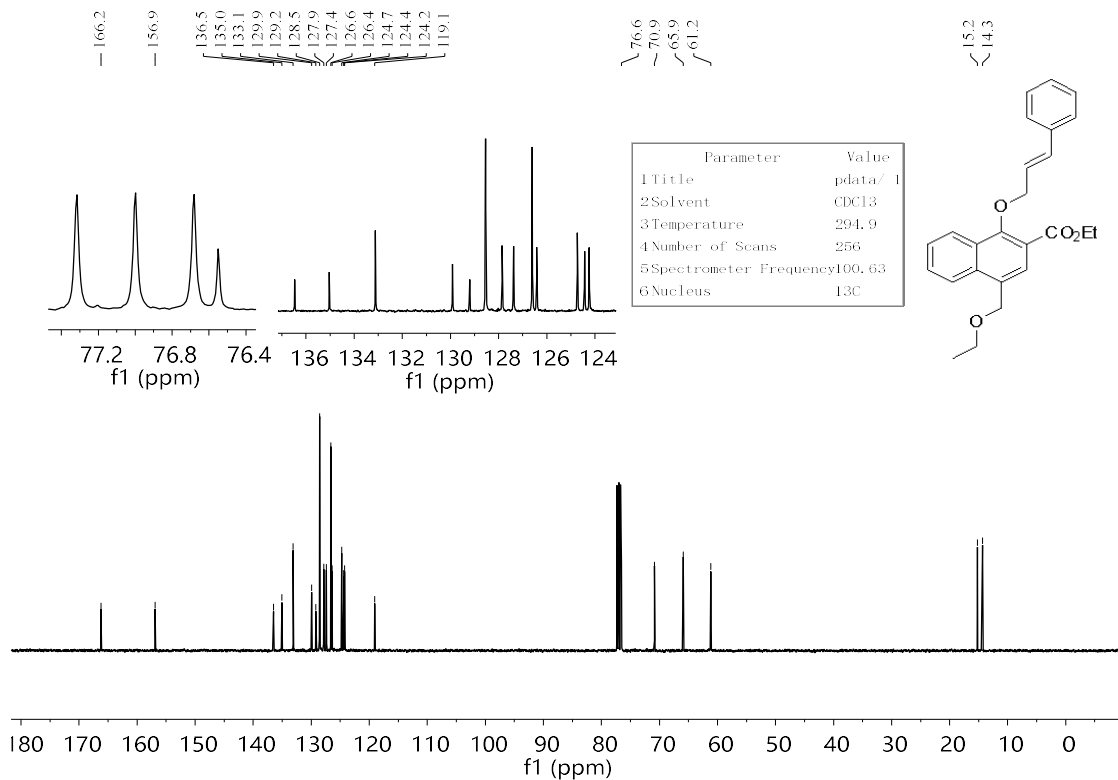
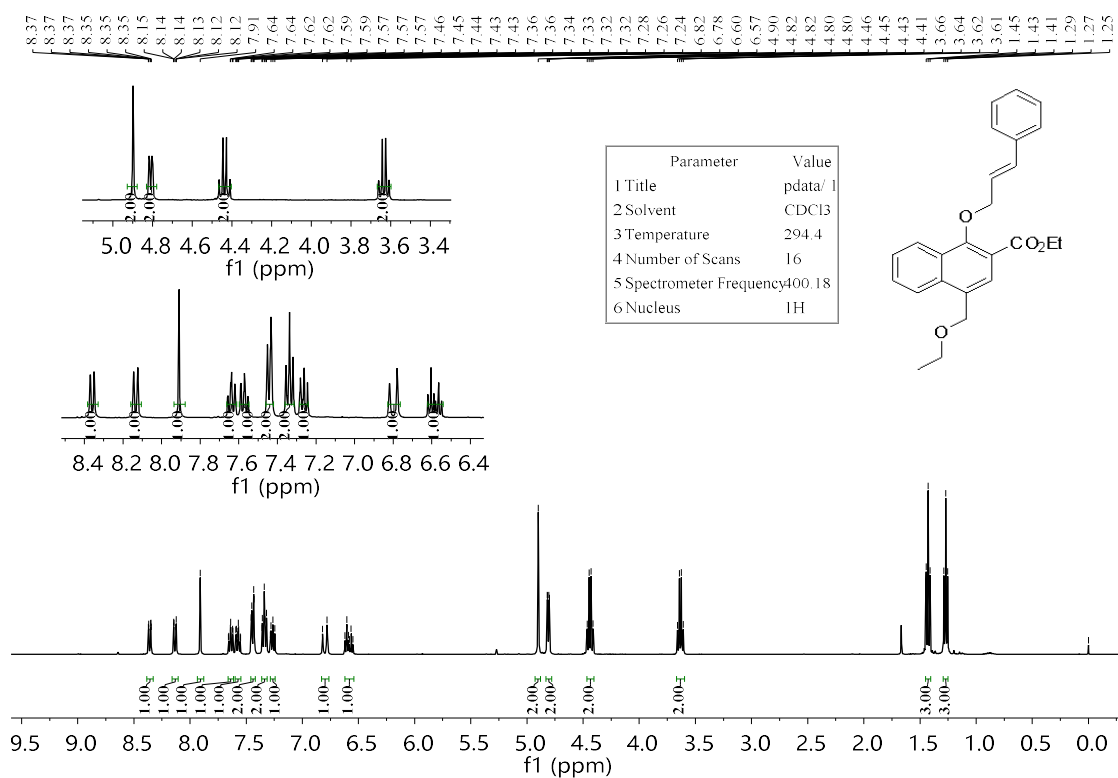
Phenyl 1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A4)



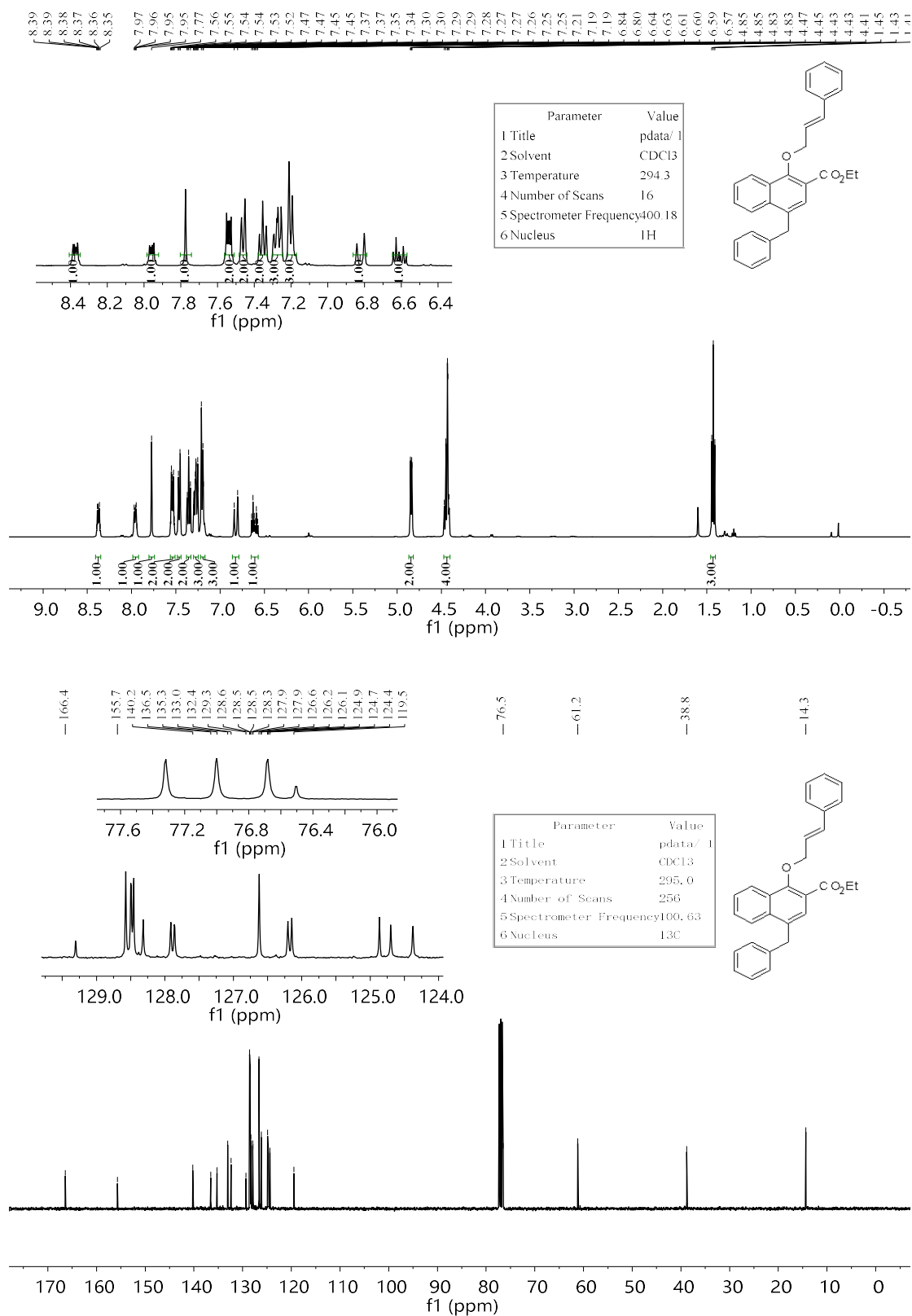
Ethyl 1-(cinnamyloxy)-4-(prop-2-yn-1-yl)-2-naphthoate (A5)



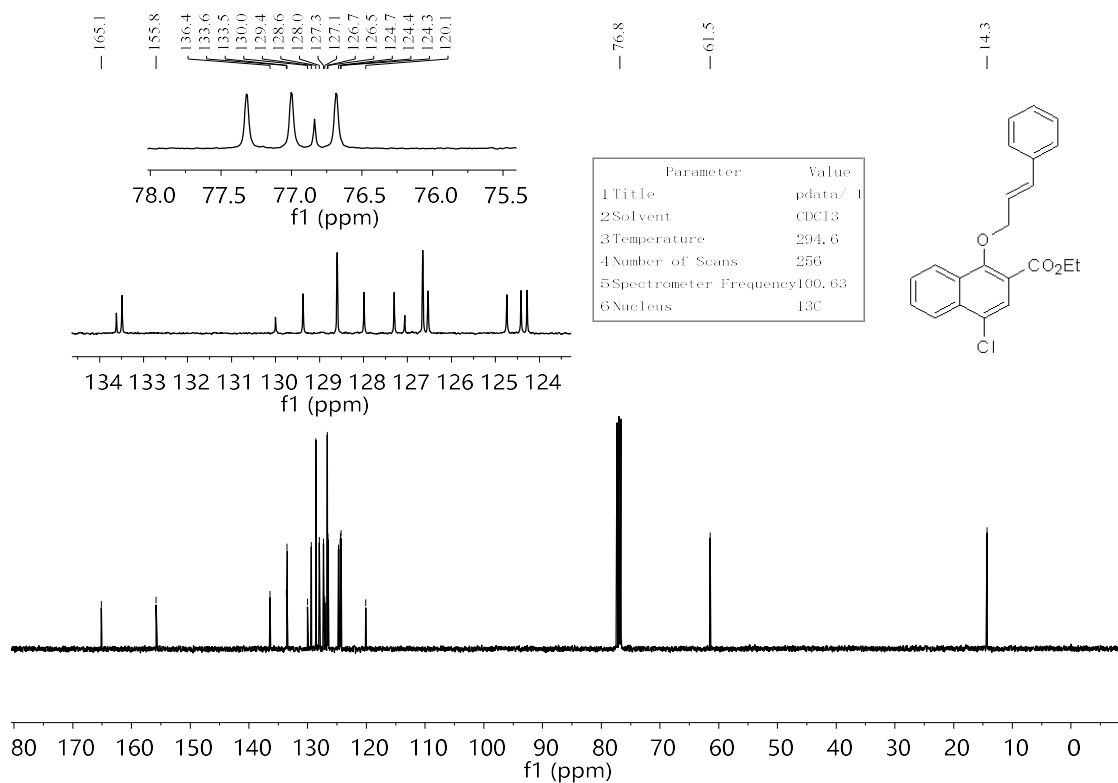
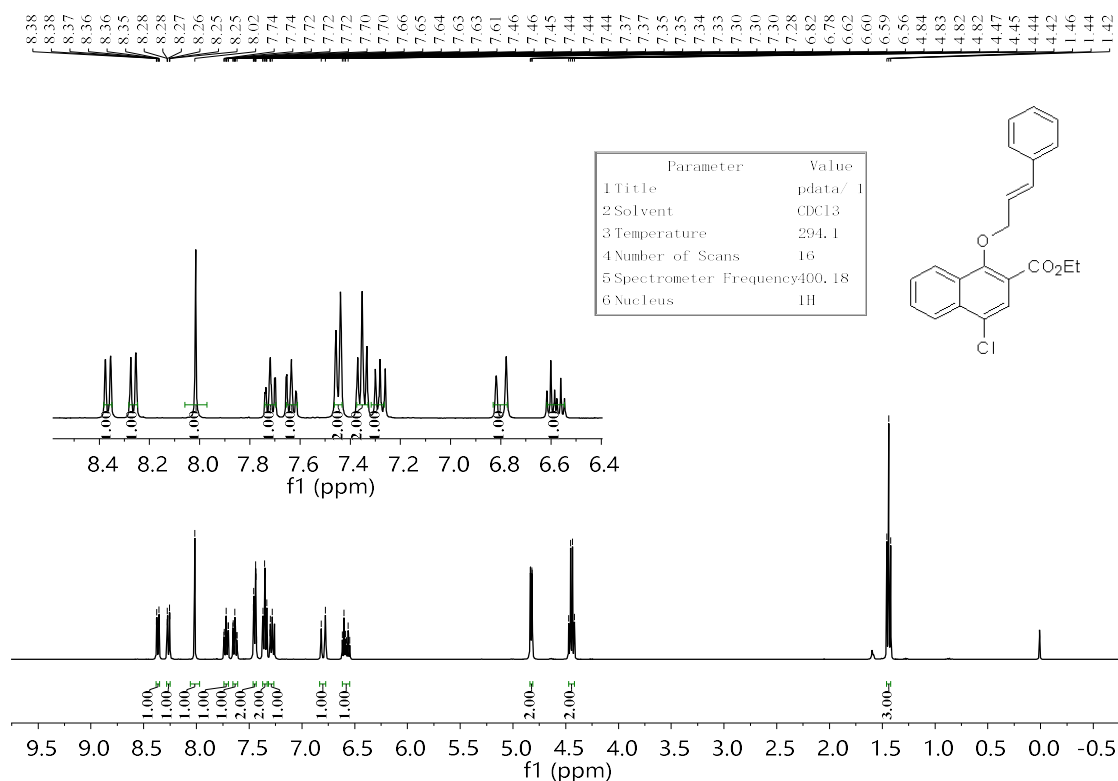
Ethyl 1-(cinnamyloxy)-4-(ethoxymethyl)-2-naphthoate (A6)



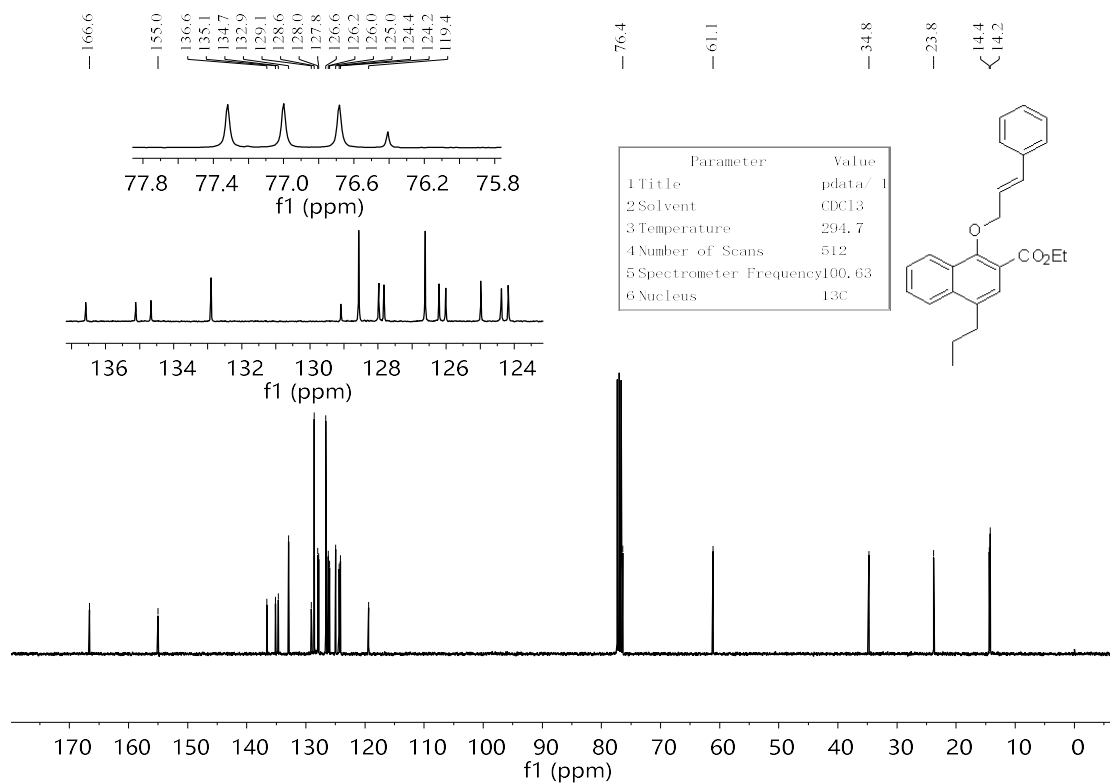
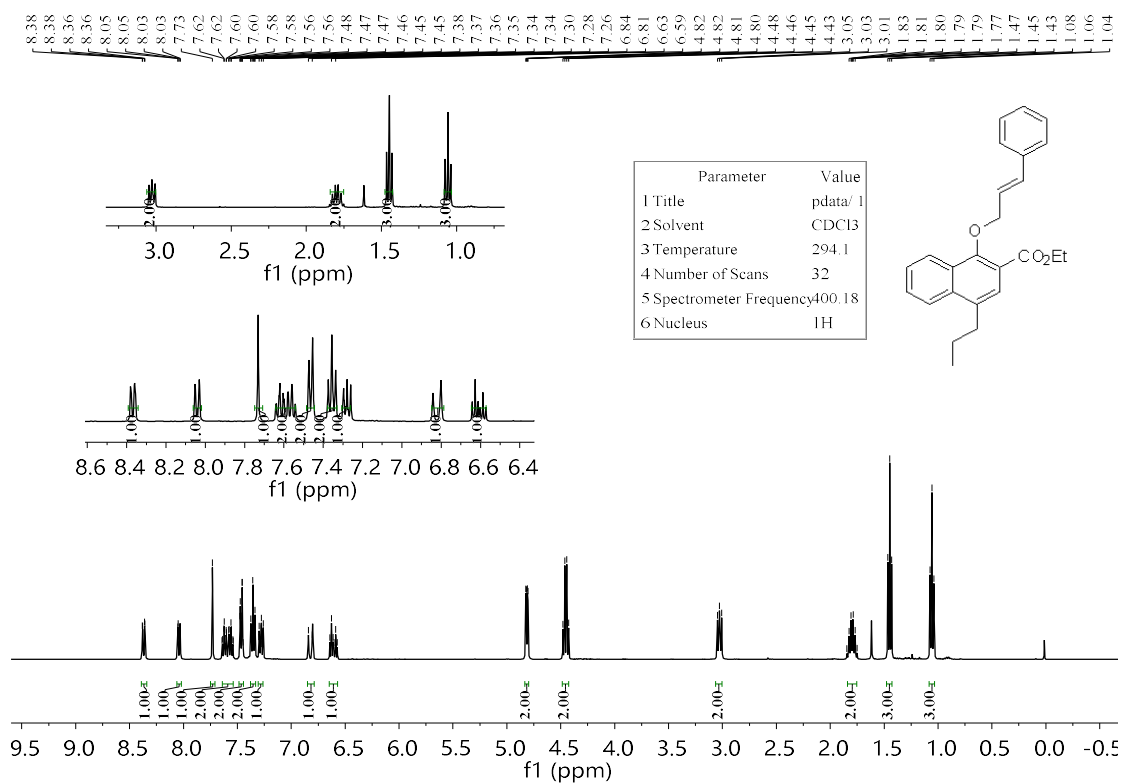
Ethyl 4-benzyl-1-(cinnamyloxy)-2-naphthoate (A7)



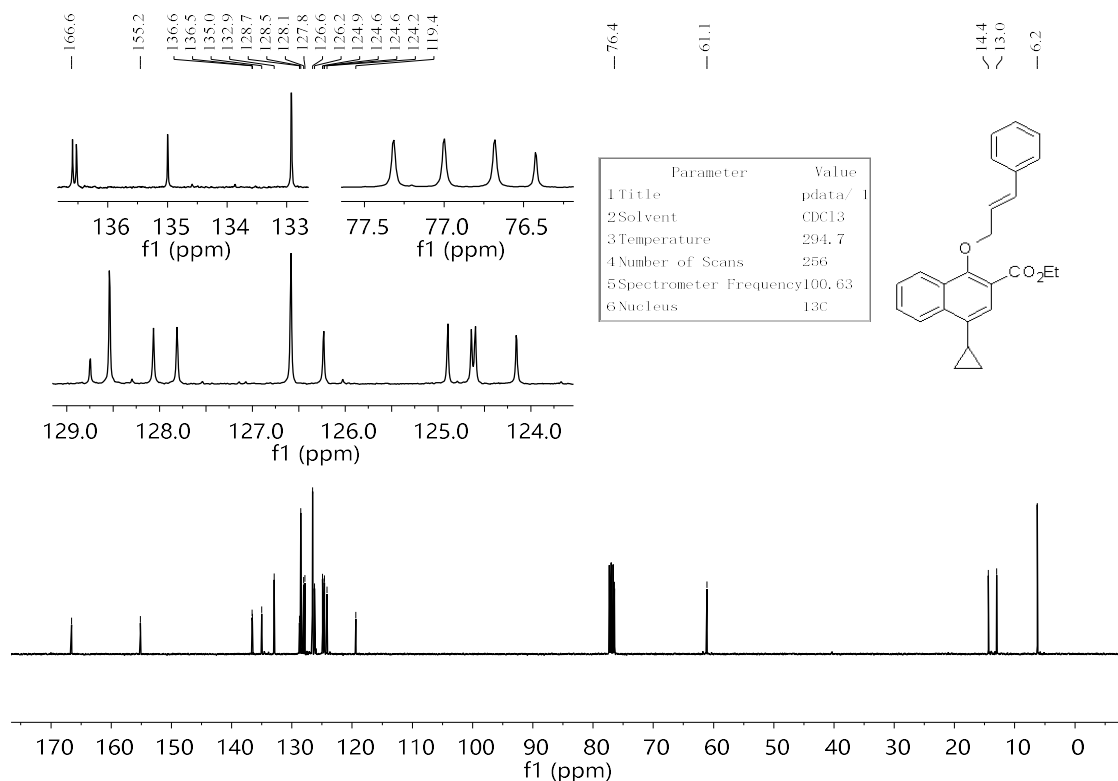
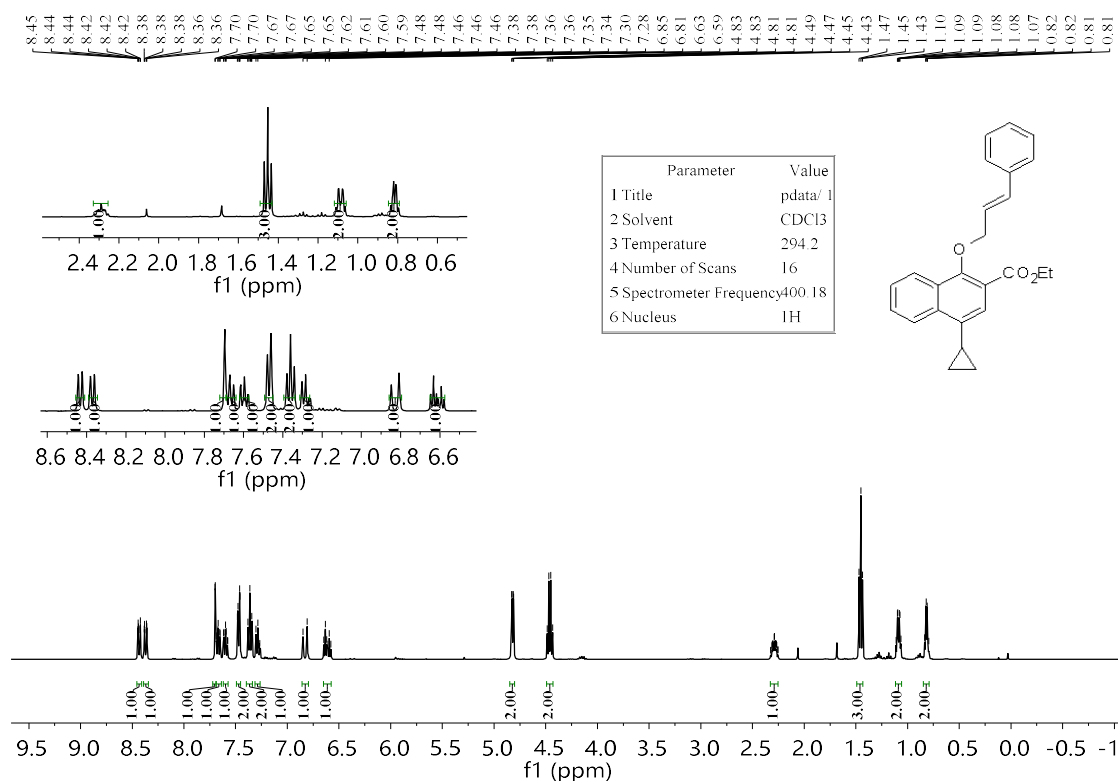
Ethyl 4-chloro-1-(cinnamyloxy)-2-naphthoate (A8)



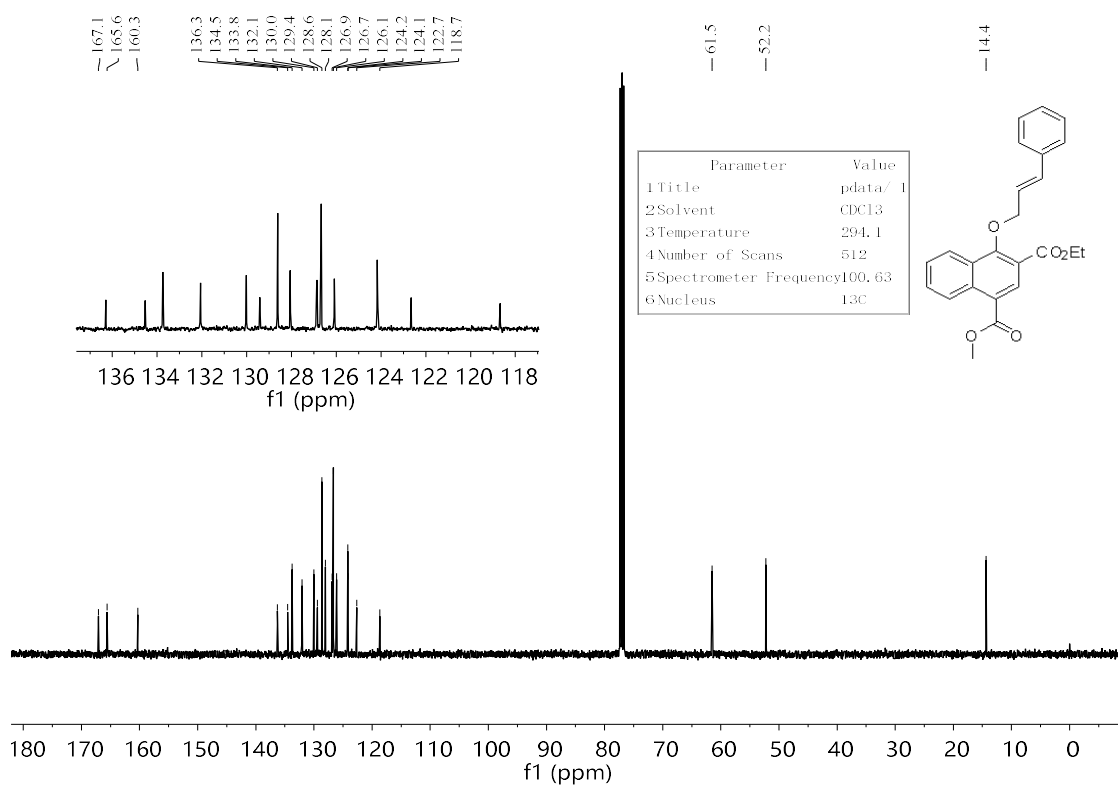
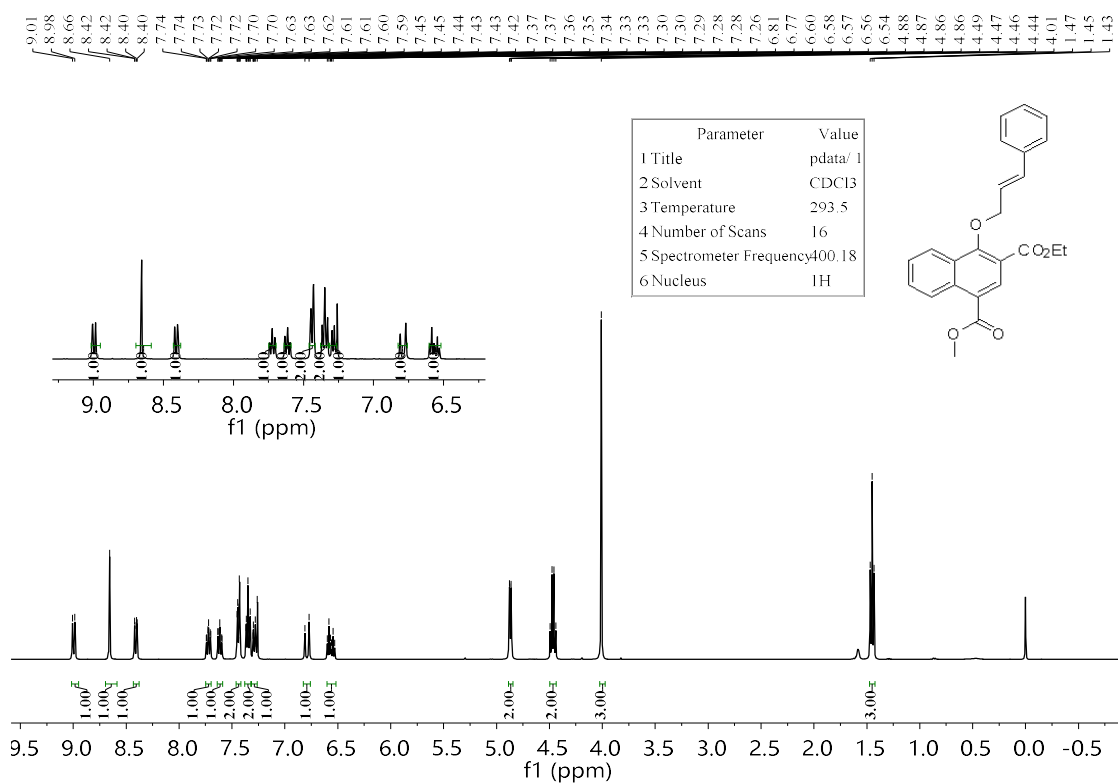
Ethyl 1-(cinnamyloxy)-4-propyl-2-naphthoate (A9)



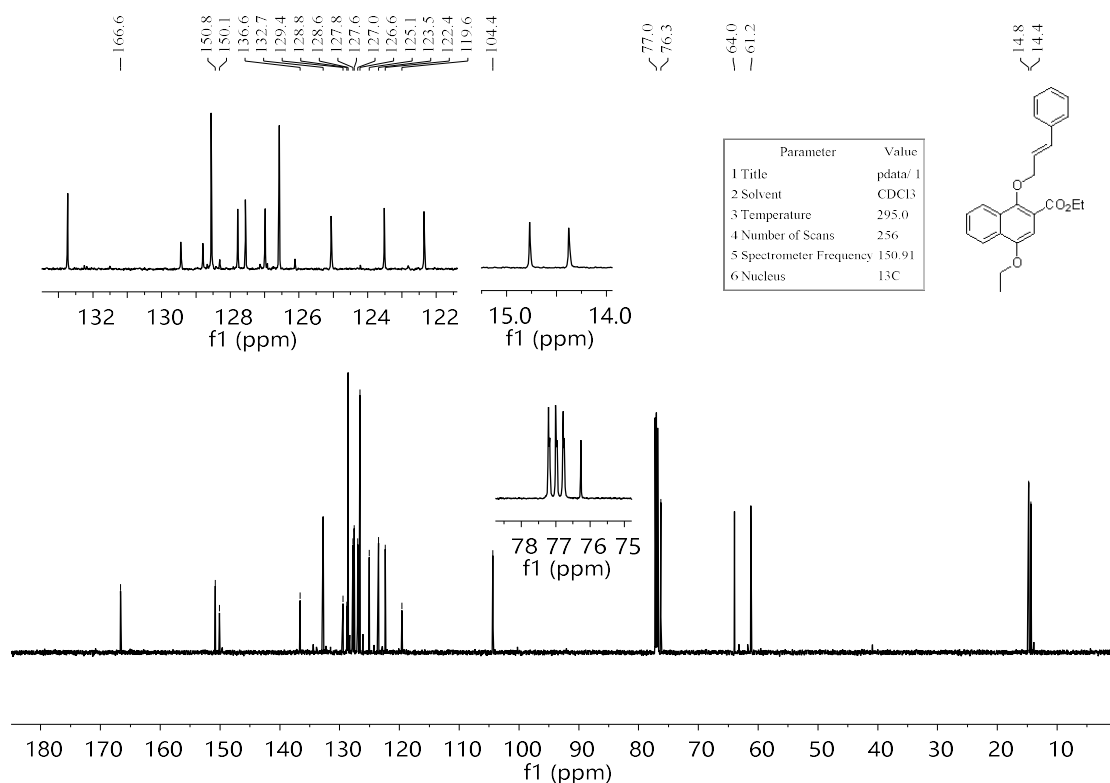
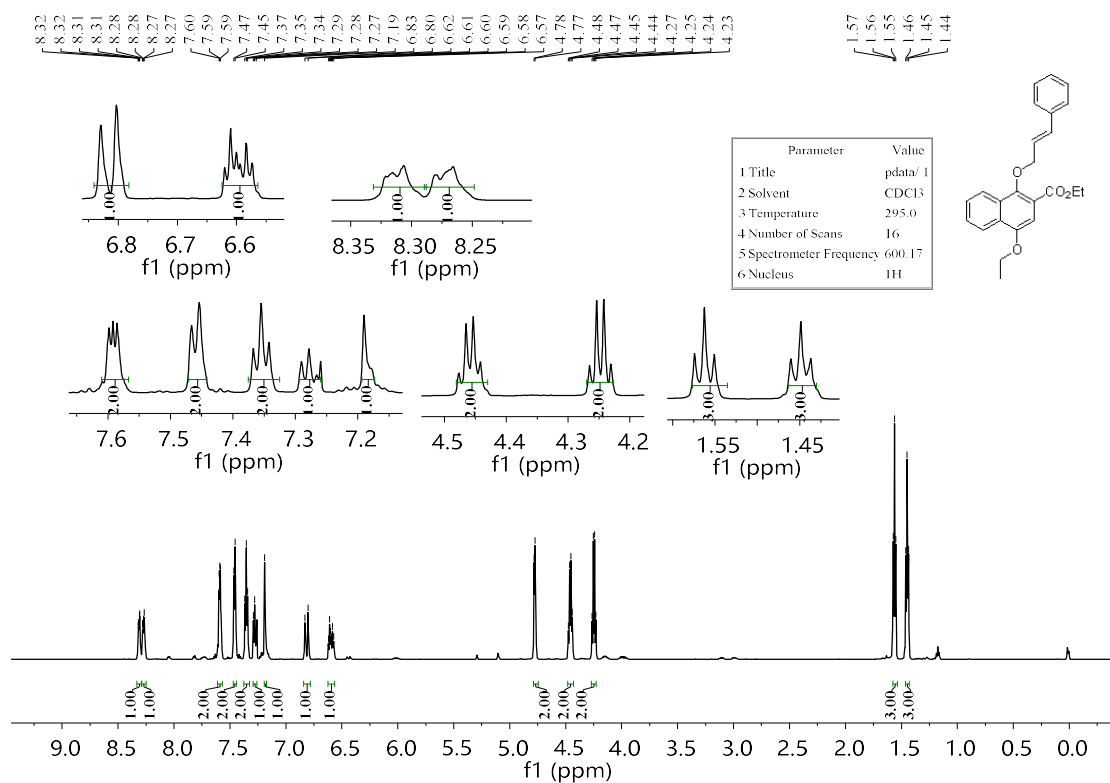
Ethyl 1-(cinnamyloxy)-4-cyclopropyl-2-naphthoate (A10)



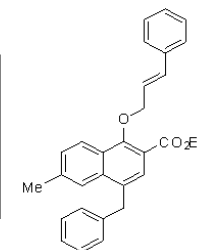
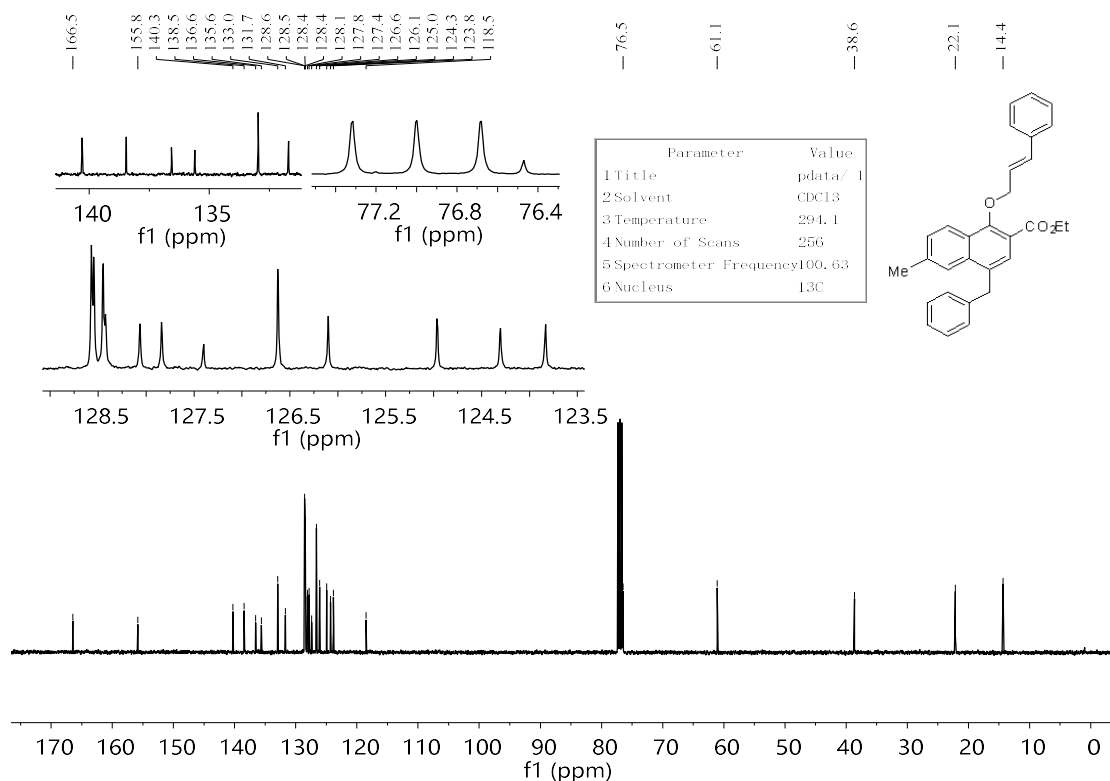
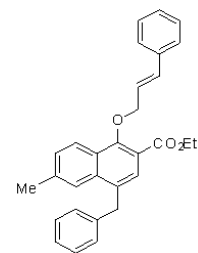
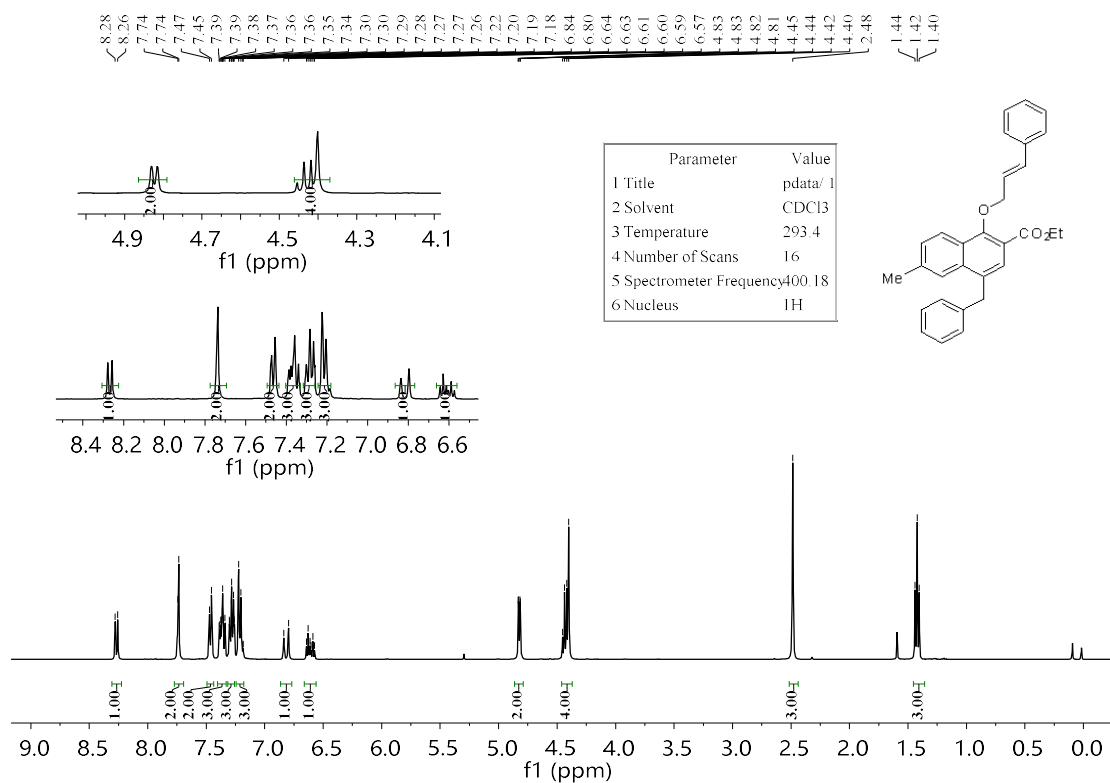
3-ethyl 1-methyl 4-(cinnamyloxy)naphthalene-1,3-dicarboxylate (A11)



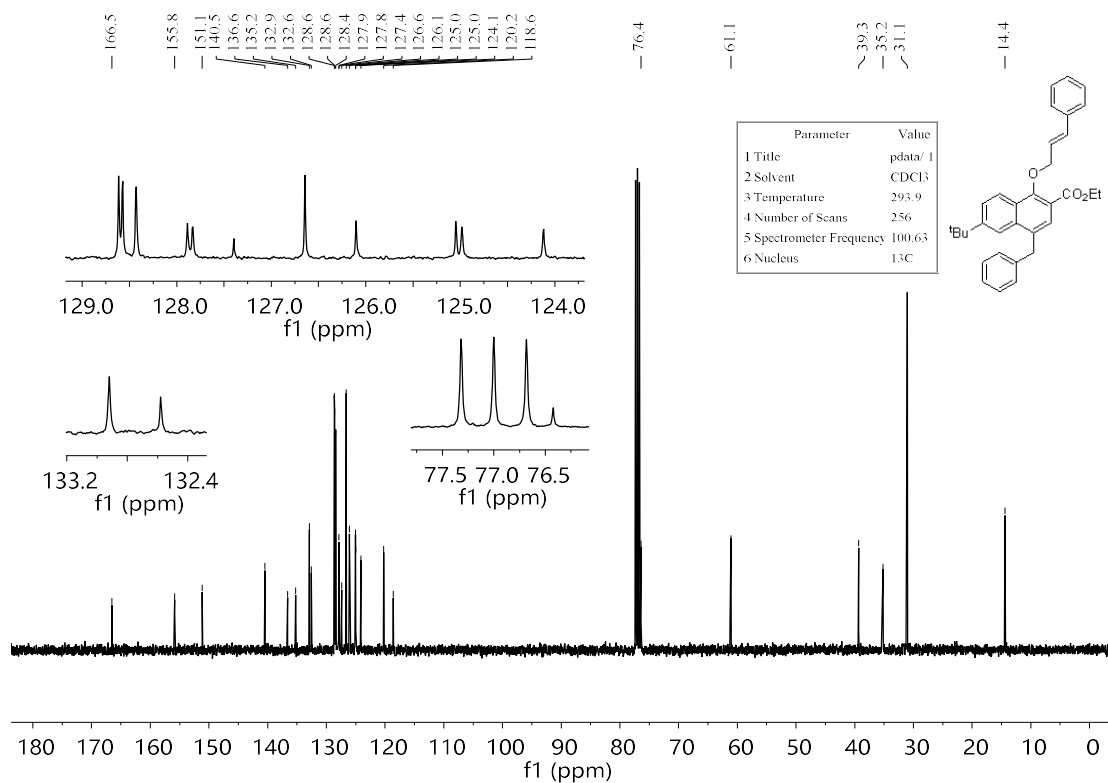
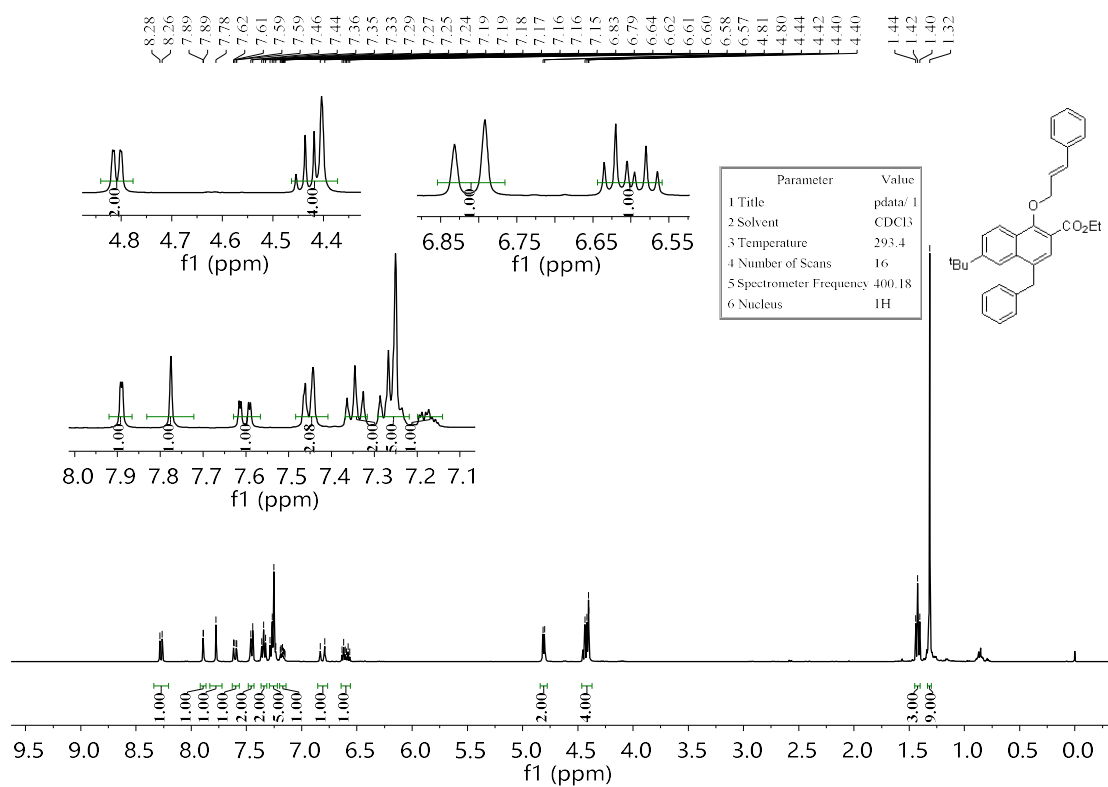
Ethyl 1-(cinnamyloxy)-4-ethoxy-2-naphthoate (A12)



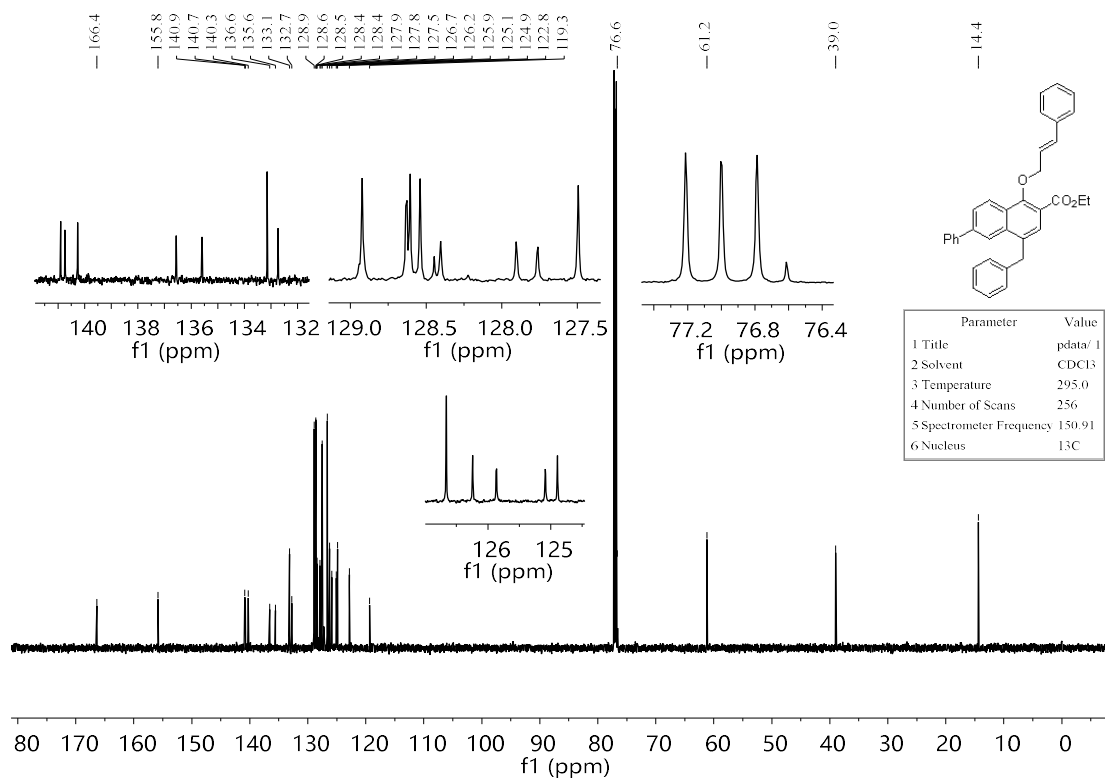
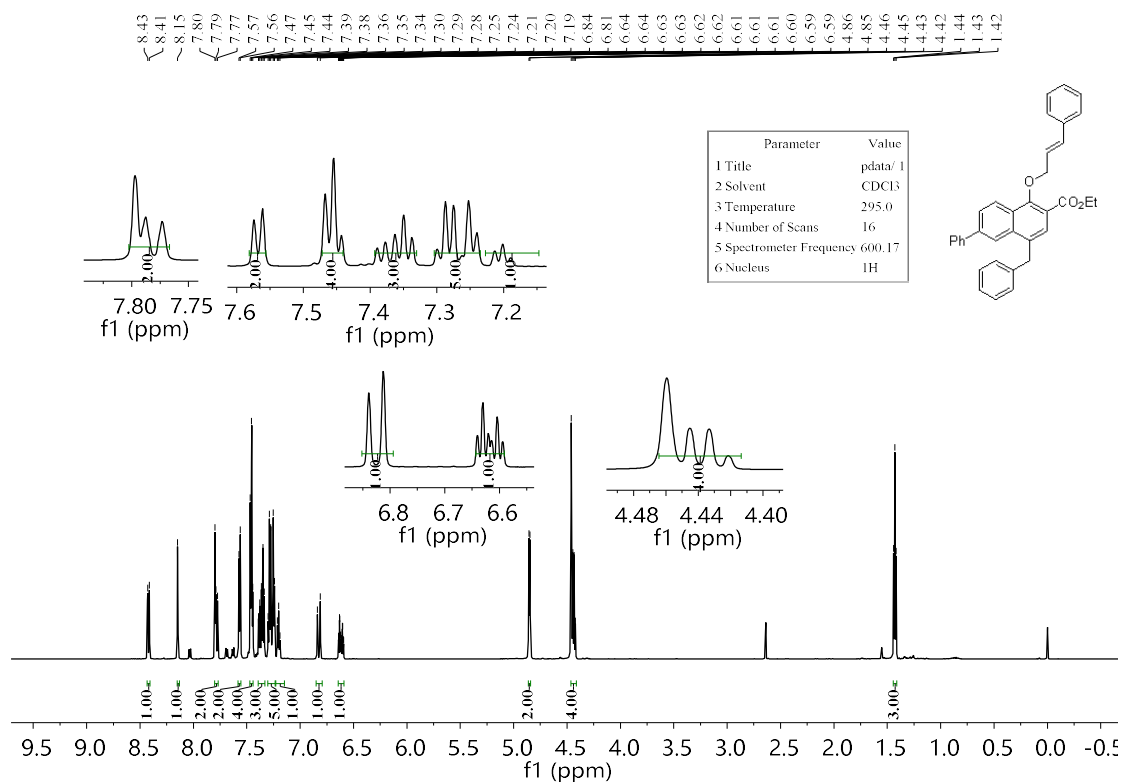
Ethyl 4-benzyl-1-(cinnamyloxy)-6-methyl-2-naphthoate (A13)



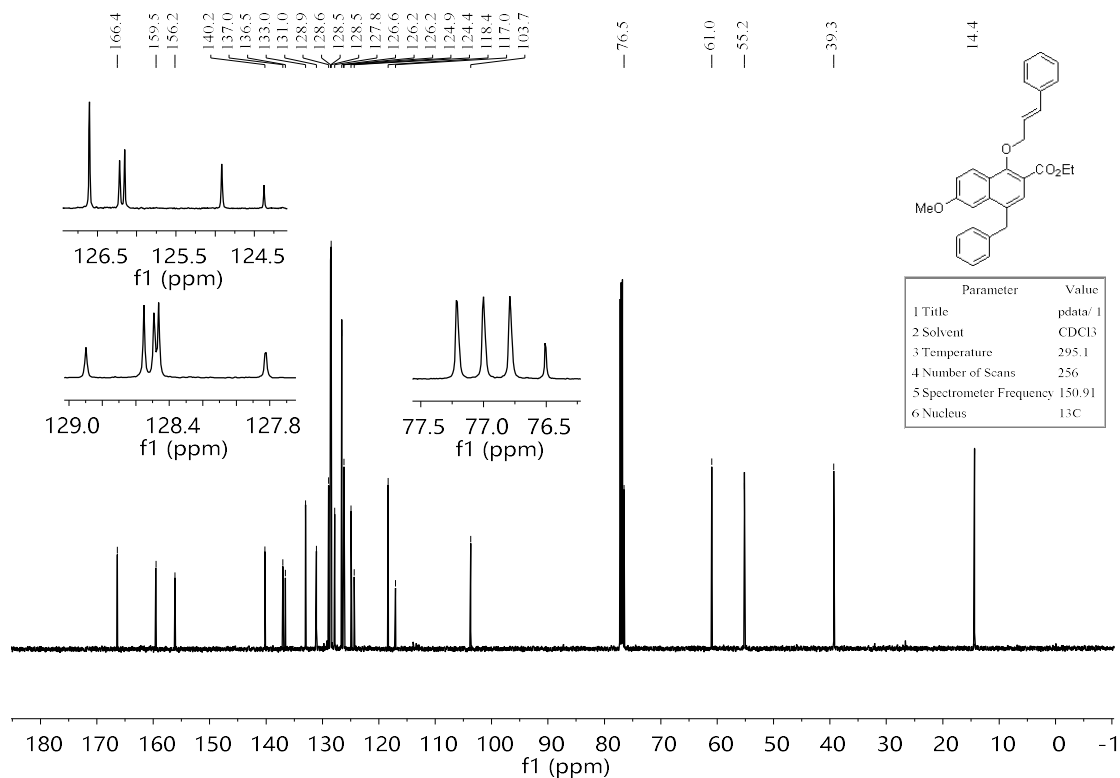
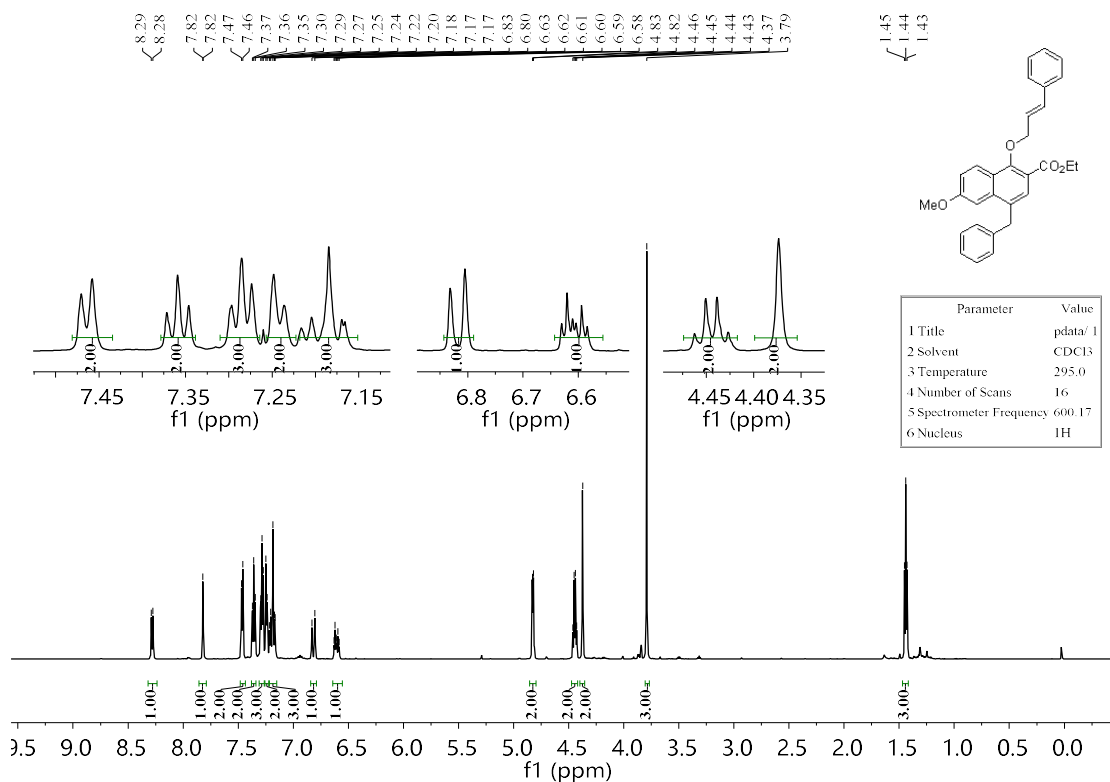
Ethyl 4-benzyl-6-(tert-butyl)-1-(cinnamyloxy)-2-naphthoate (A14)



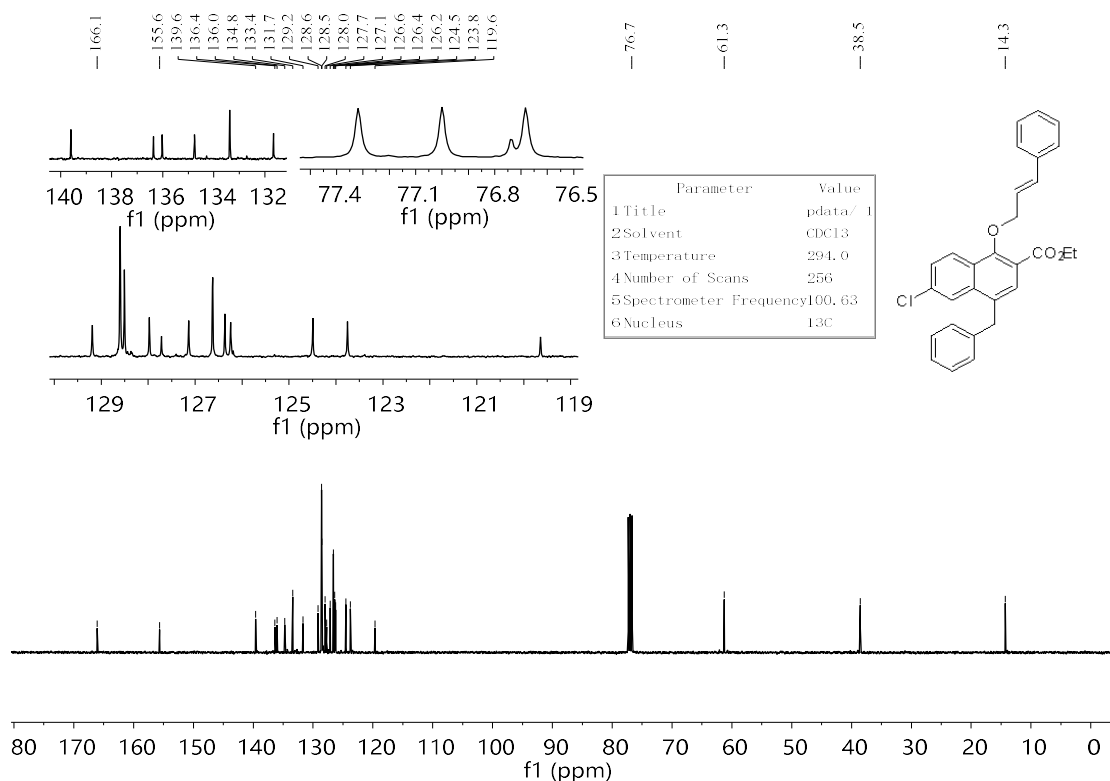
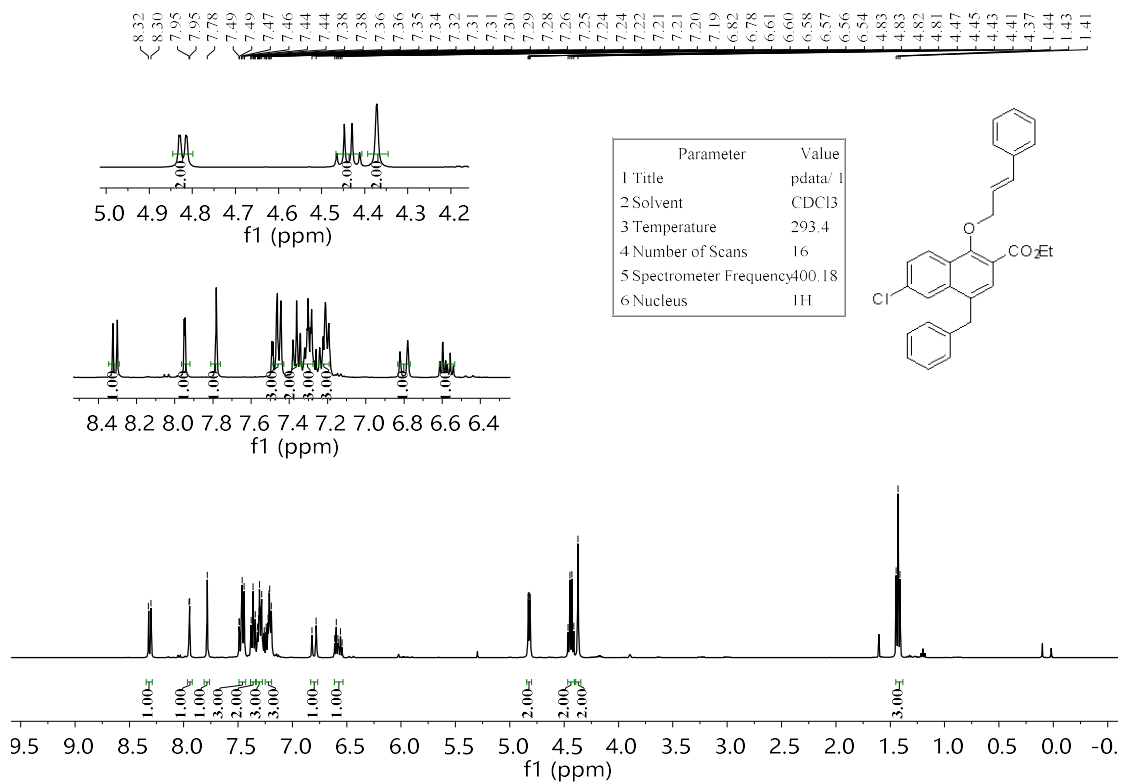
Ethyl 4-benzyl-1-(cinnamyloxy)-6-phenyl-2-naphthoate (A15)



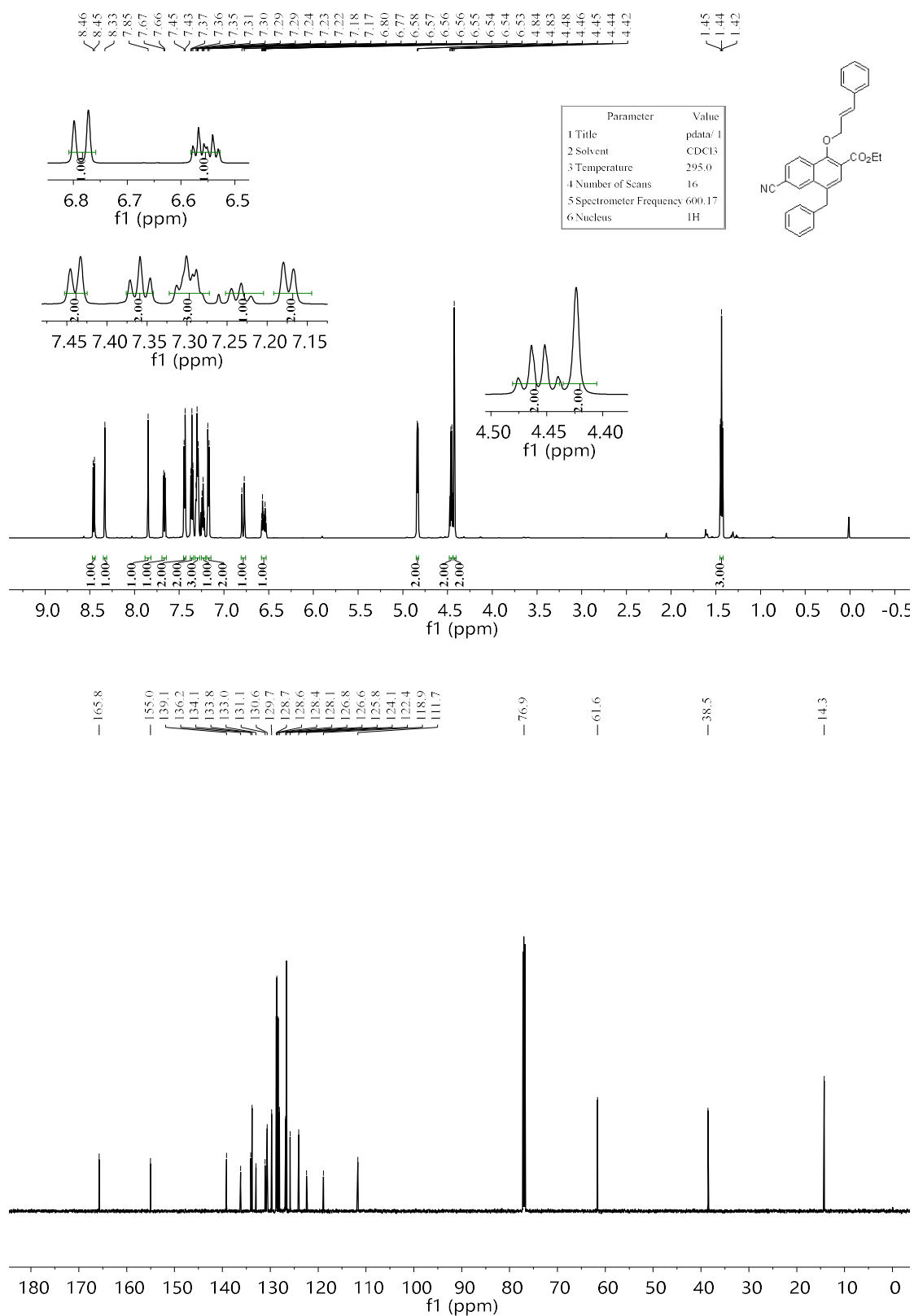
Ethyl 4-benzyl-1-(cinnamyloxy)-6-methoxy-2-naphthoate (A16)



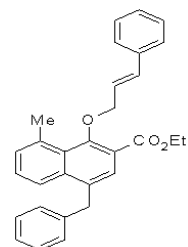
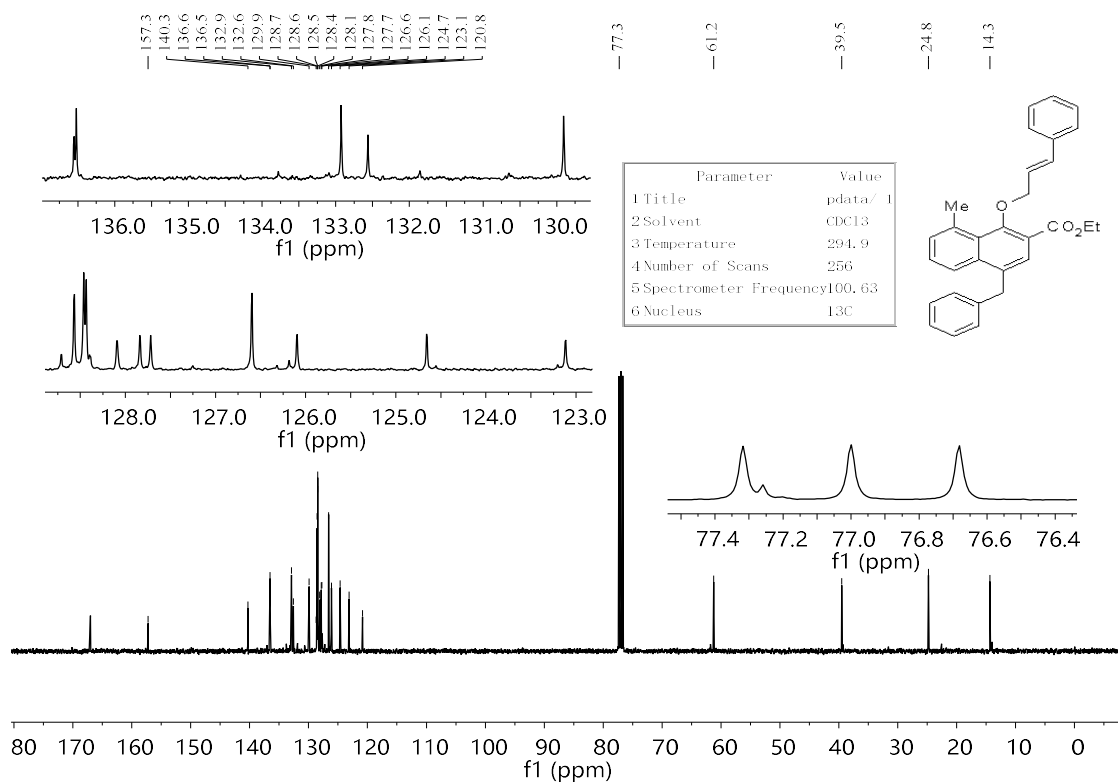
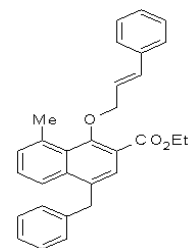
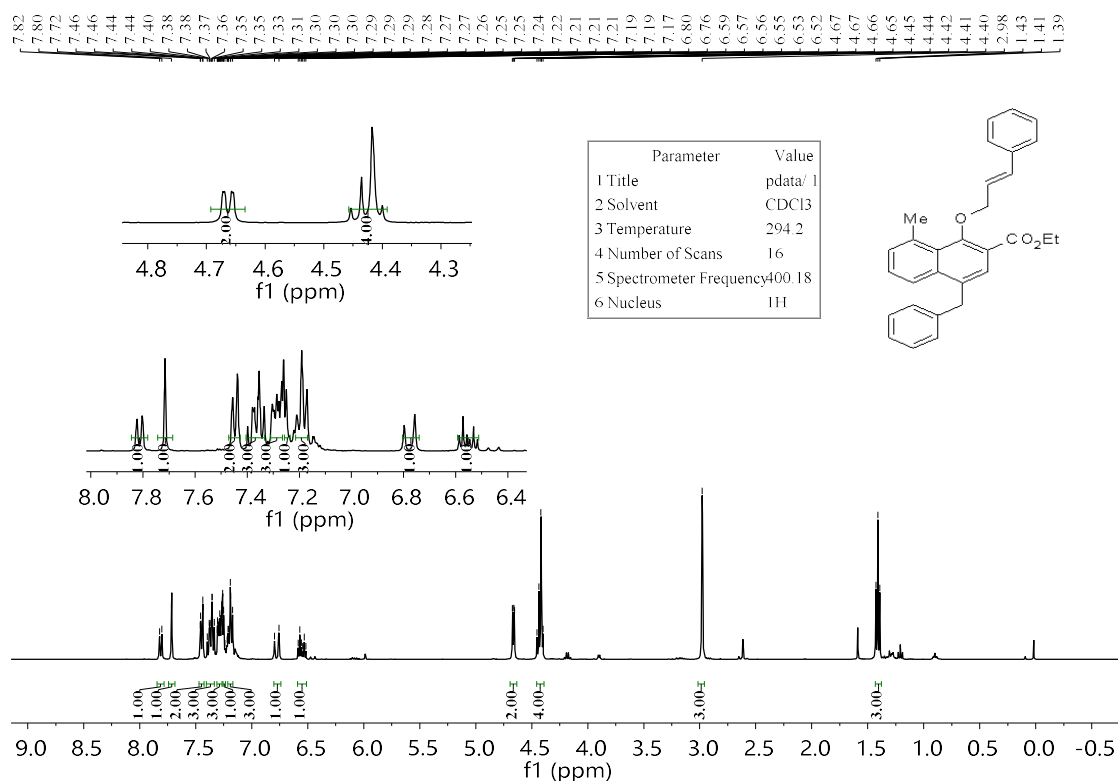
Ethyl 4-benzyl-6-chloro-1-(cinnamyloxy)-2-naphthoate (A17)



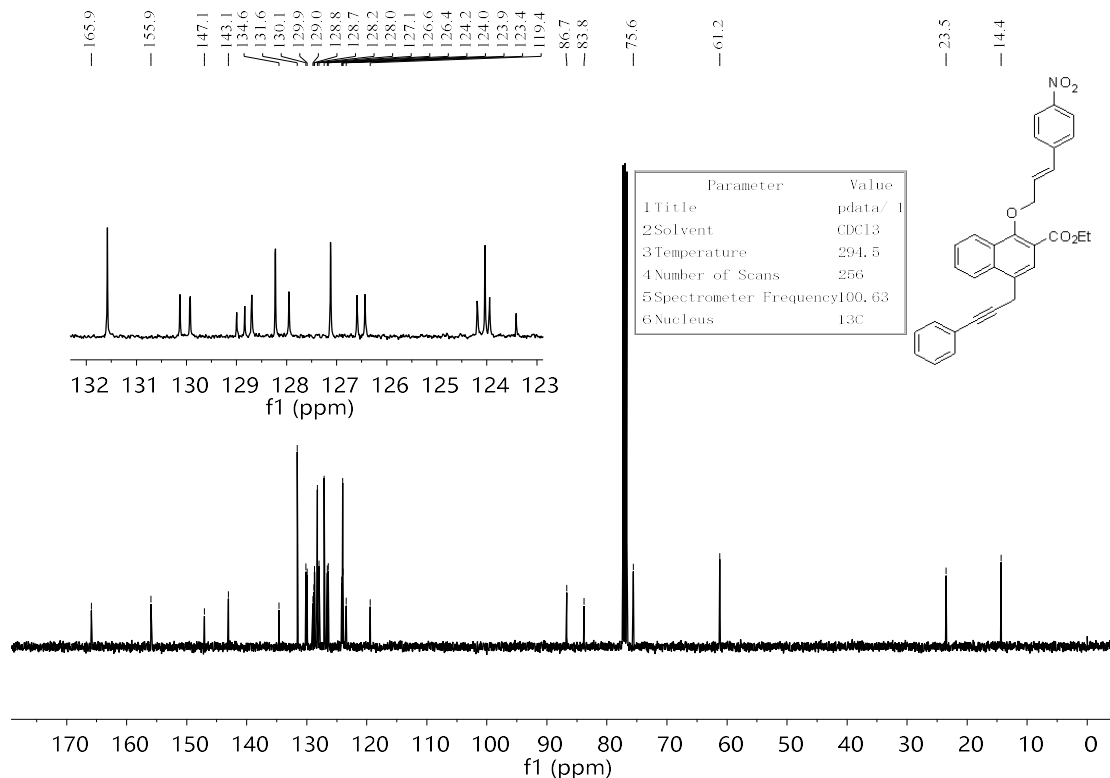
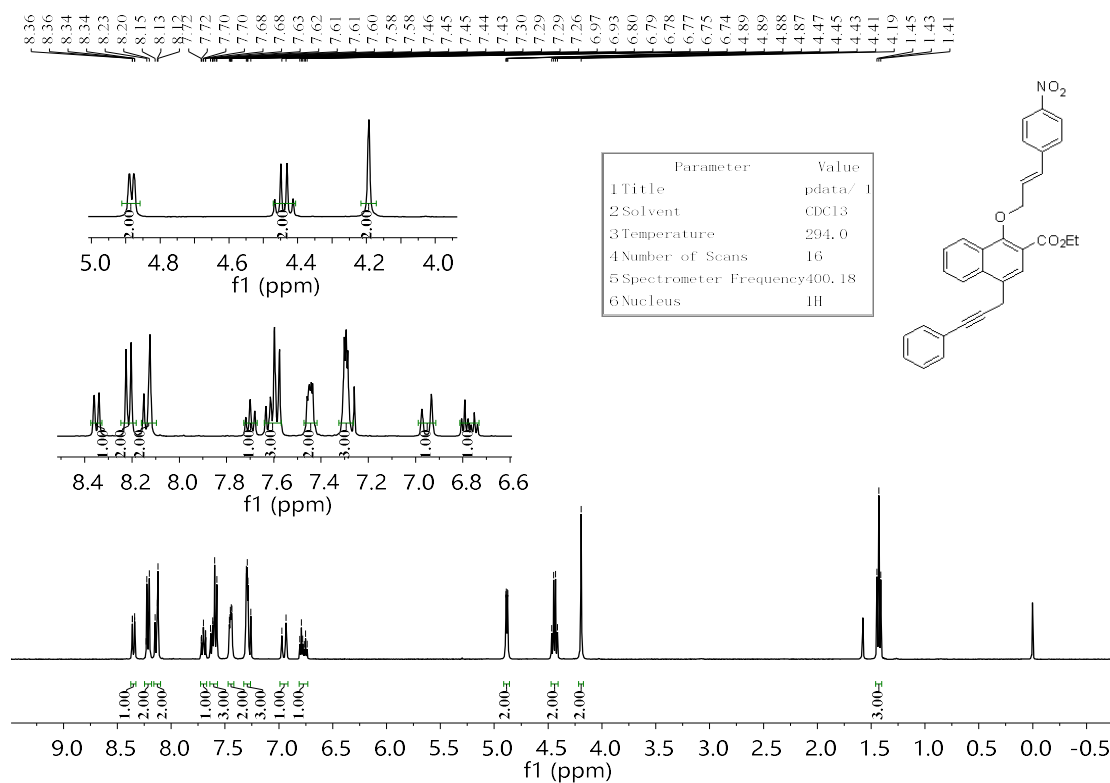
Ethyl 4-benzyl-1-(cinnamyloxy)-6-cyano-2-naphthoate (A18)



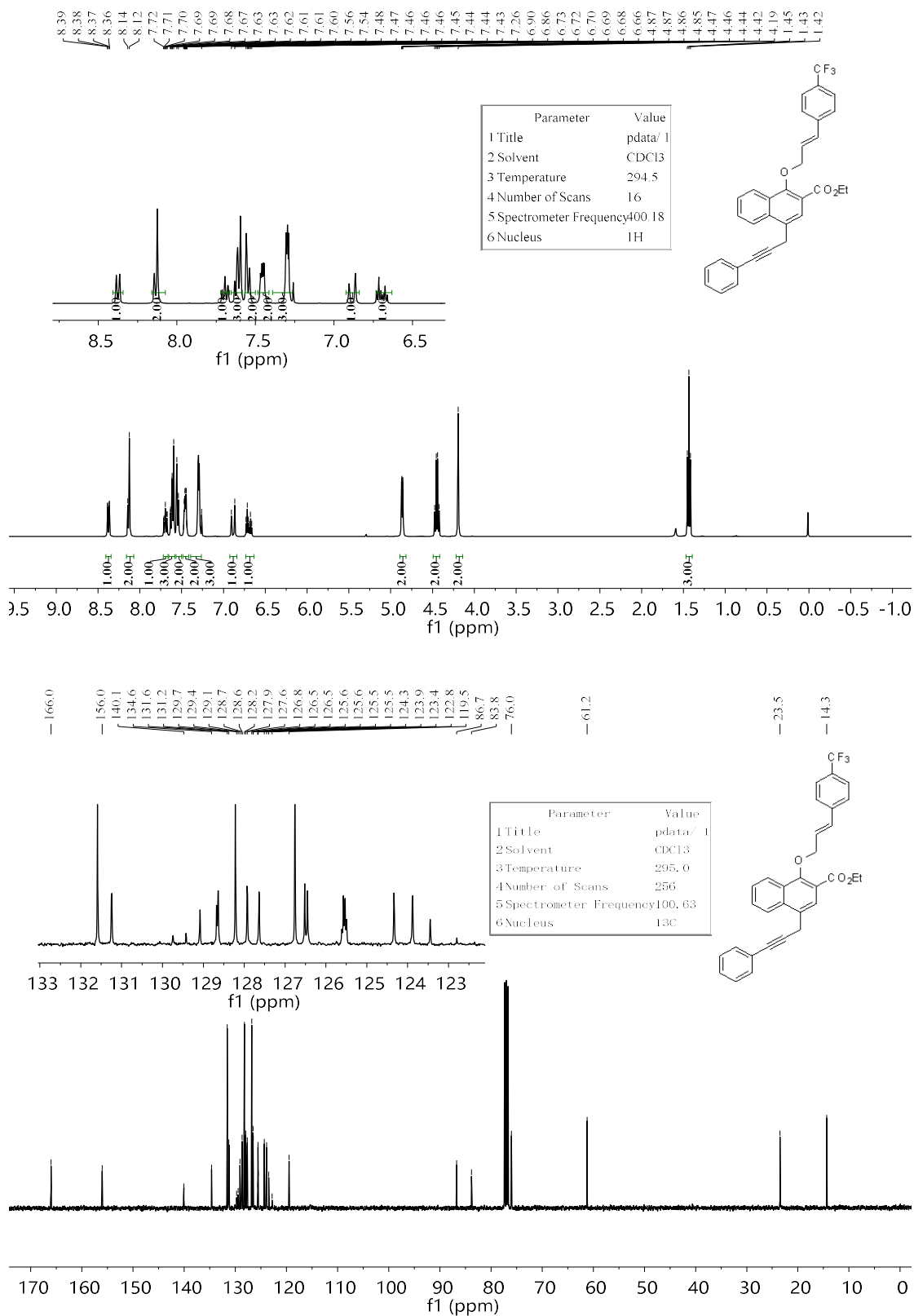
Ethyl 4-benzyl-1-(cinnamyloxy)-8-methyl-2-naphthoate (A19)

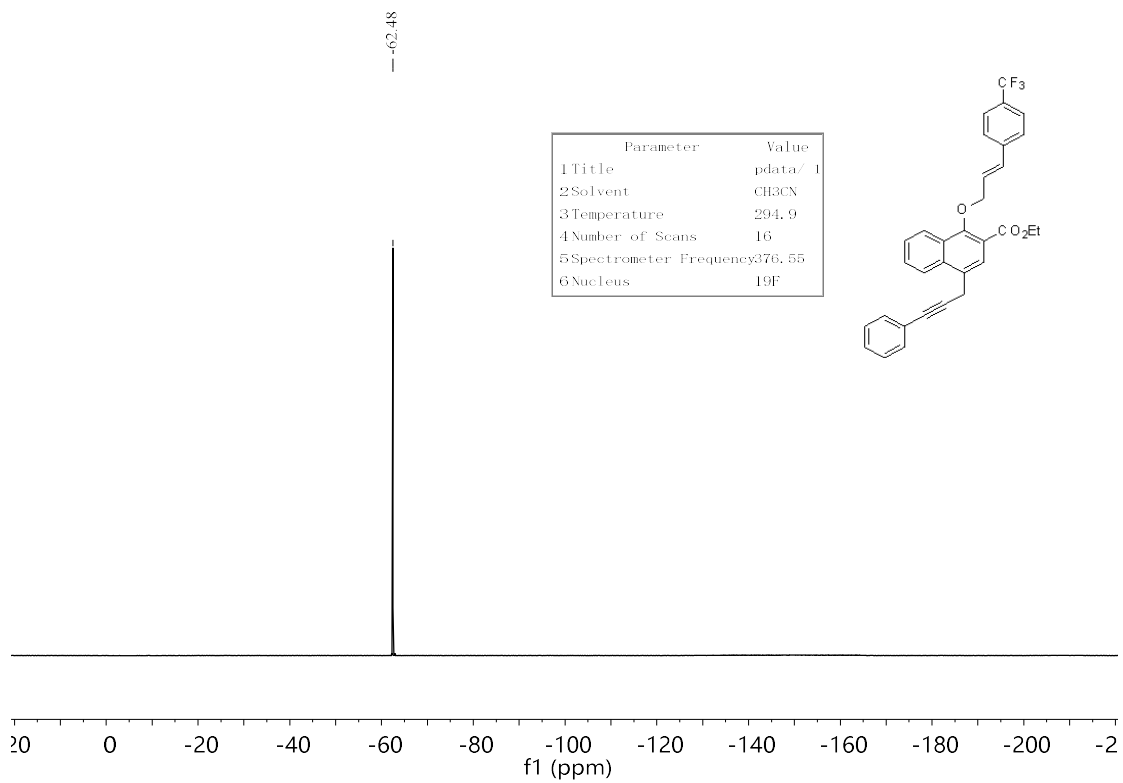


Ethyl (E)-1-((3-(4-nitrophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A20)

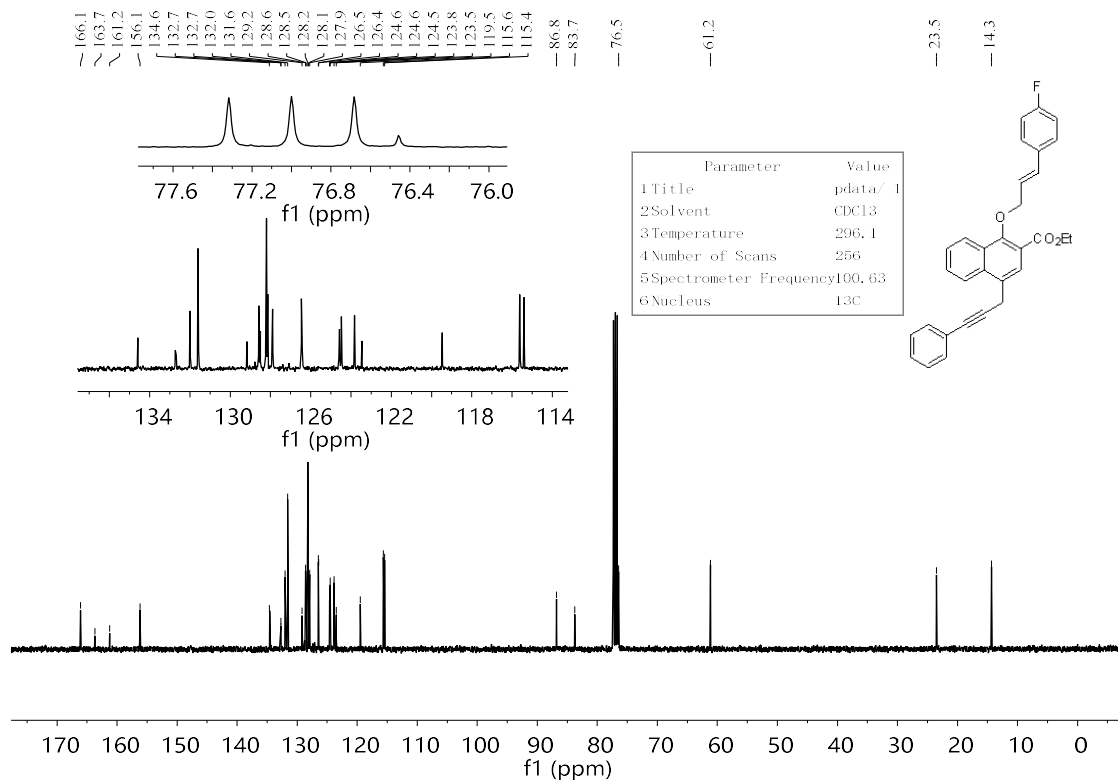
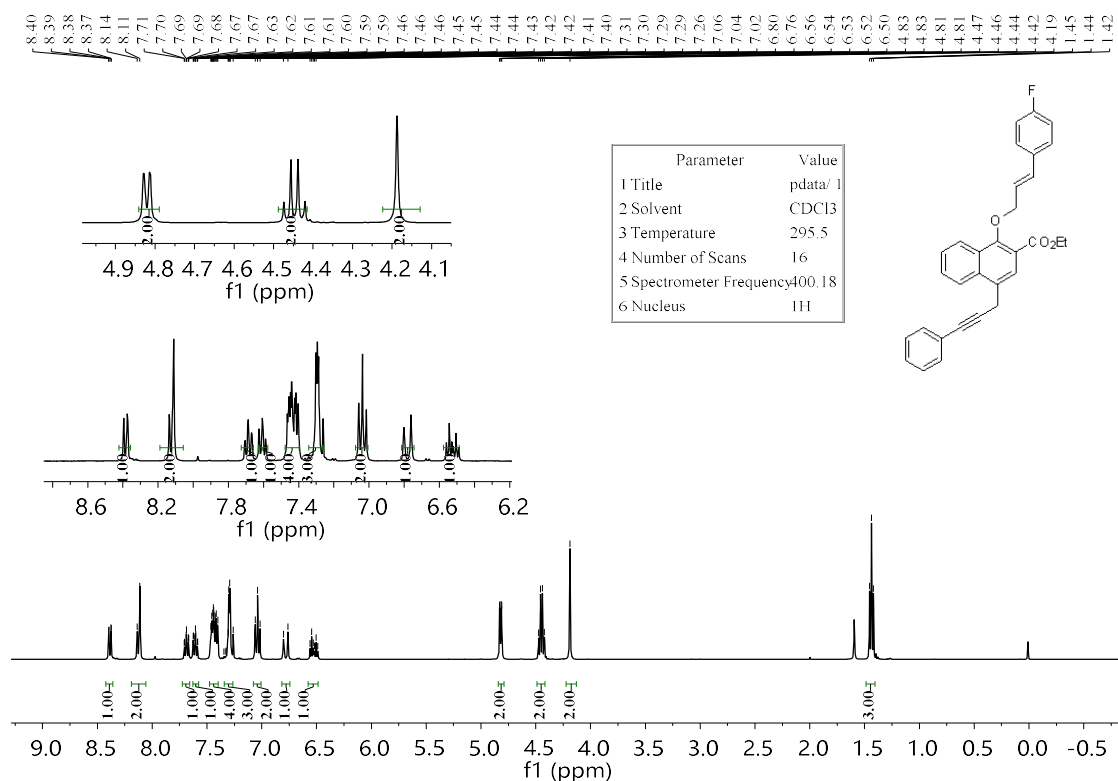


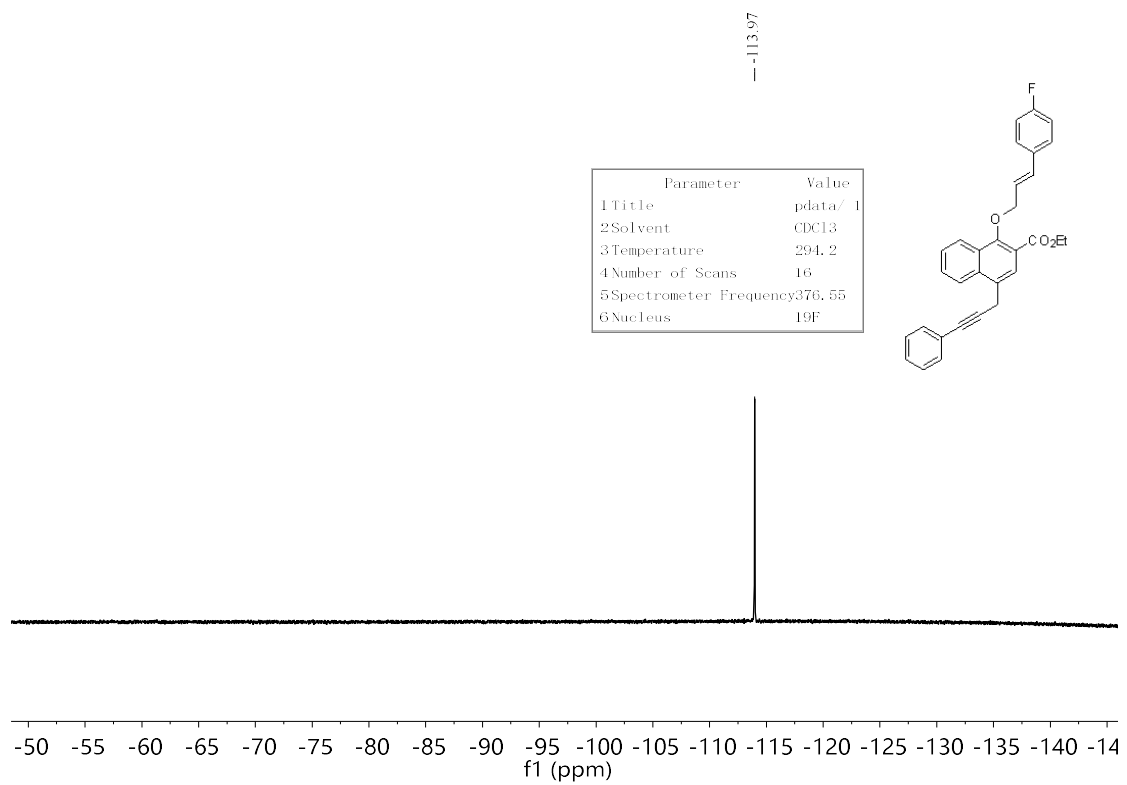
Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(4-(trifluoromethyl)phenyl)allyloxy)-2-naphthoate
(A21)



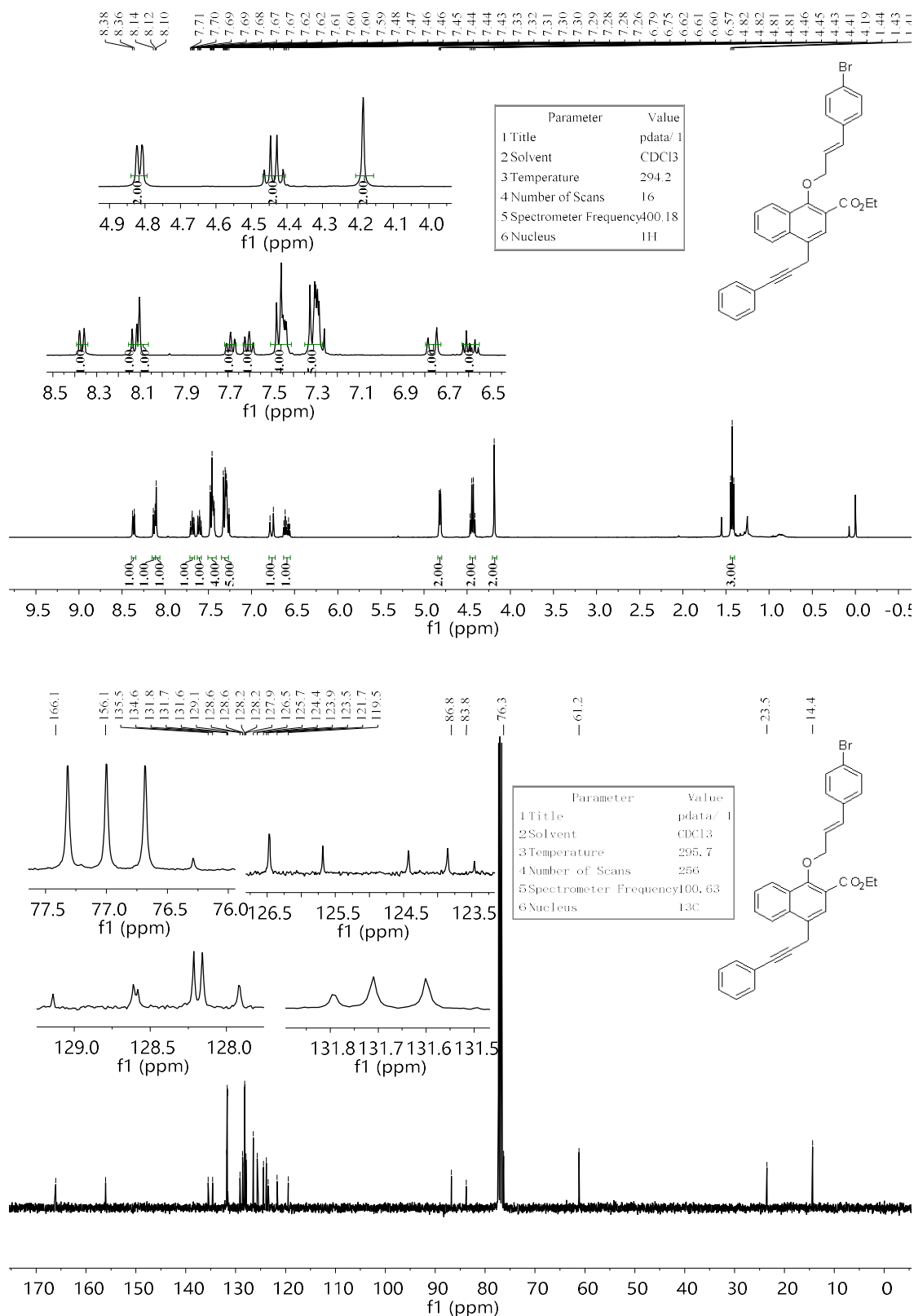


Ethyl (E)-1-((3-(4-fluorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A22)

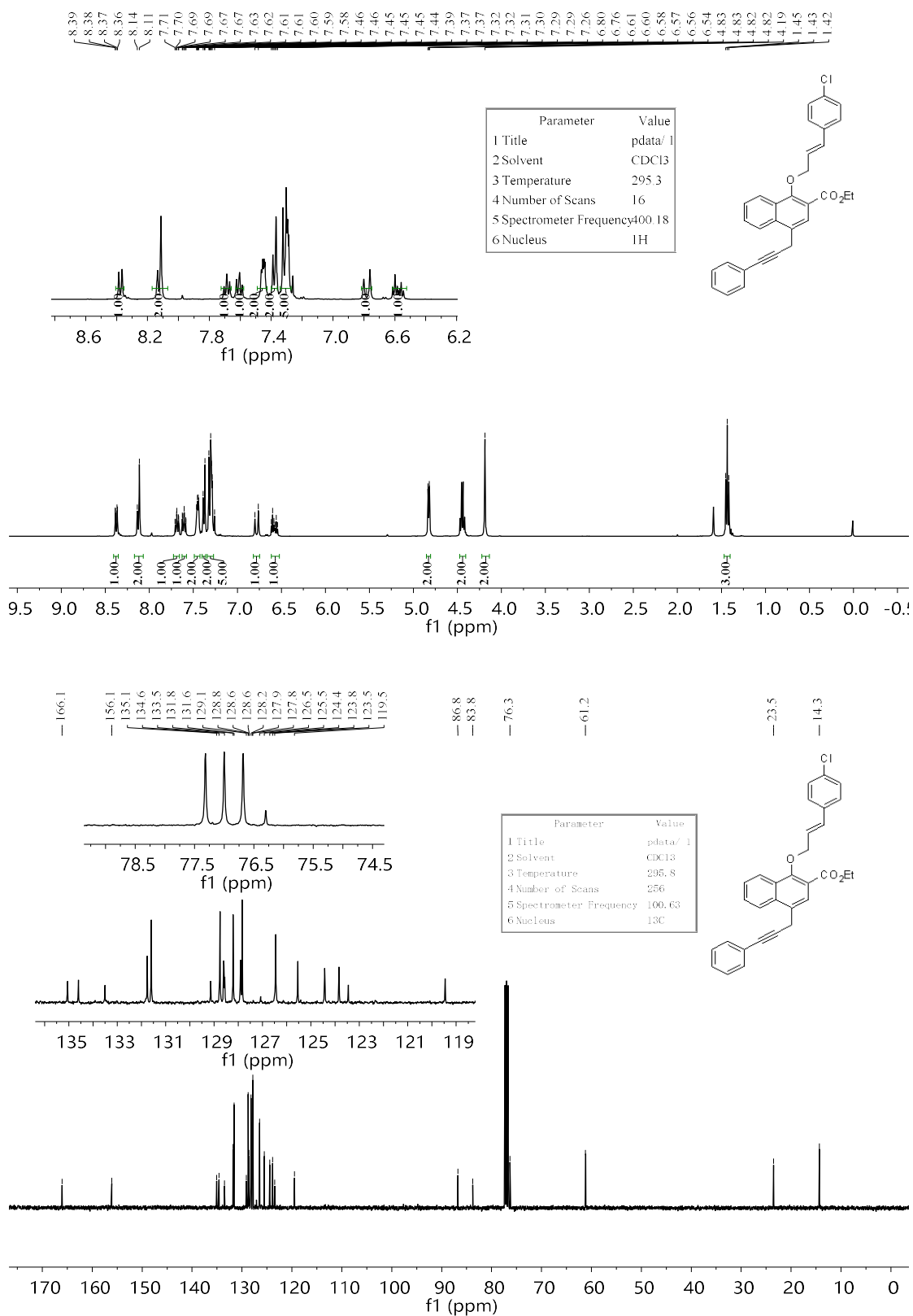




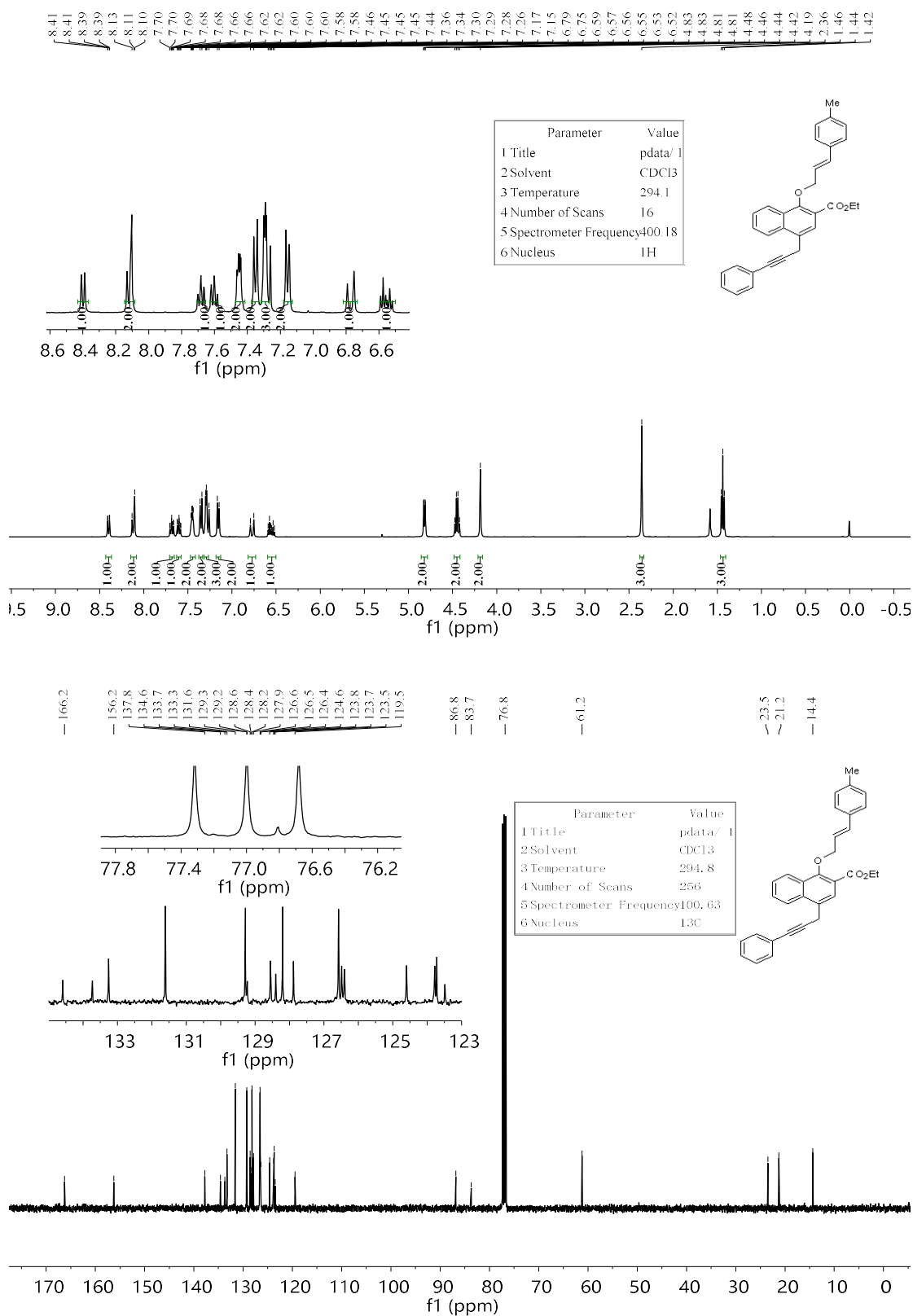
Ethyl (E)-1-((3-(4-bromophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A23)



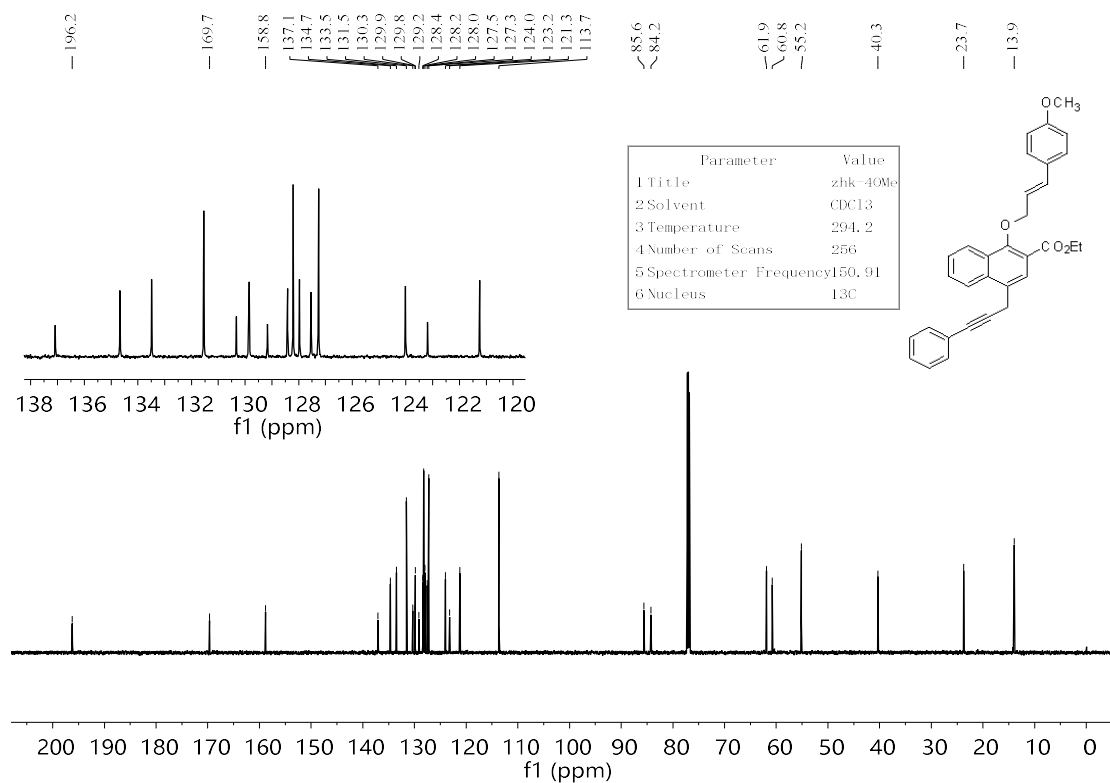
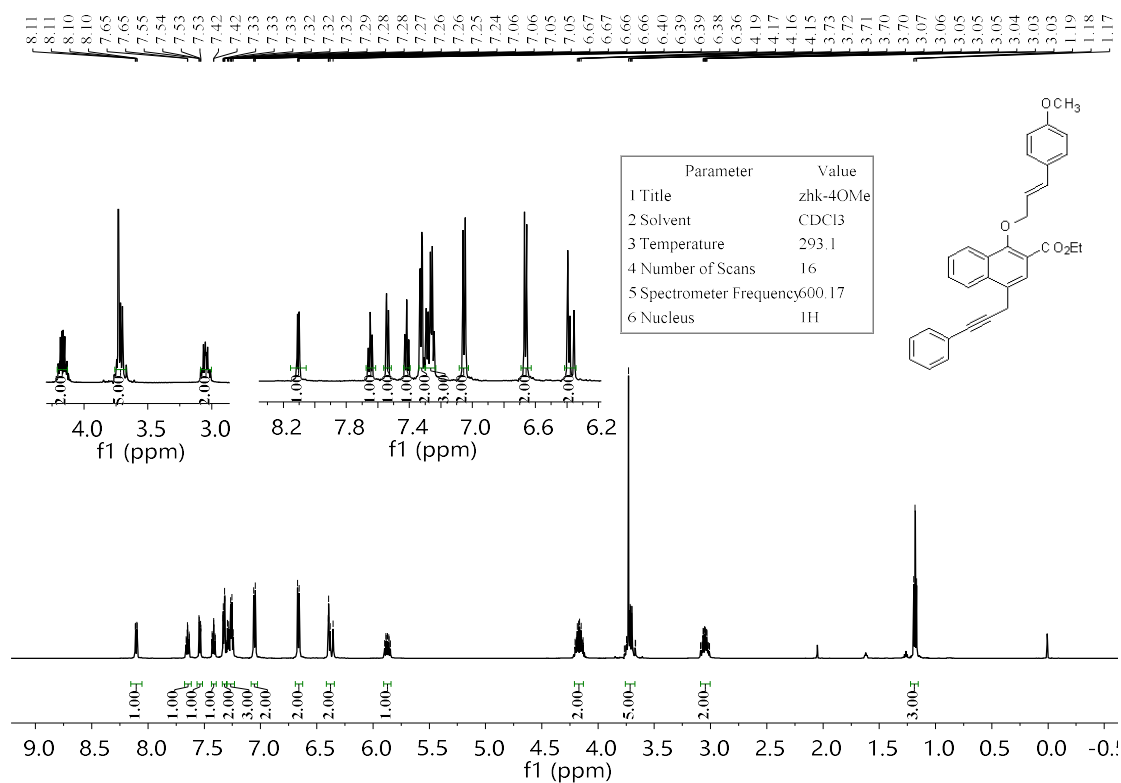
Ethyl (E)-1-((3-(4-chlorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A24)



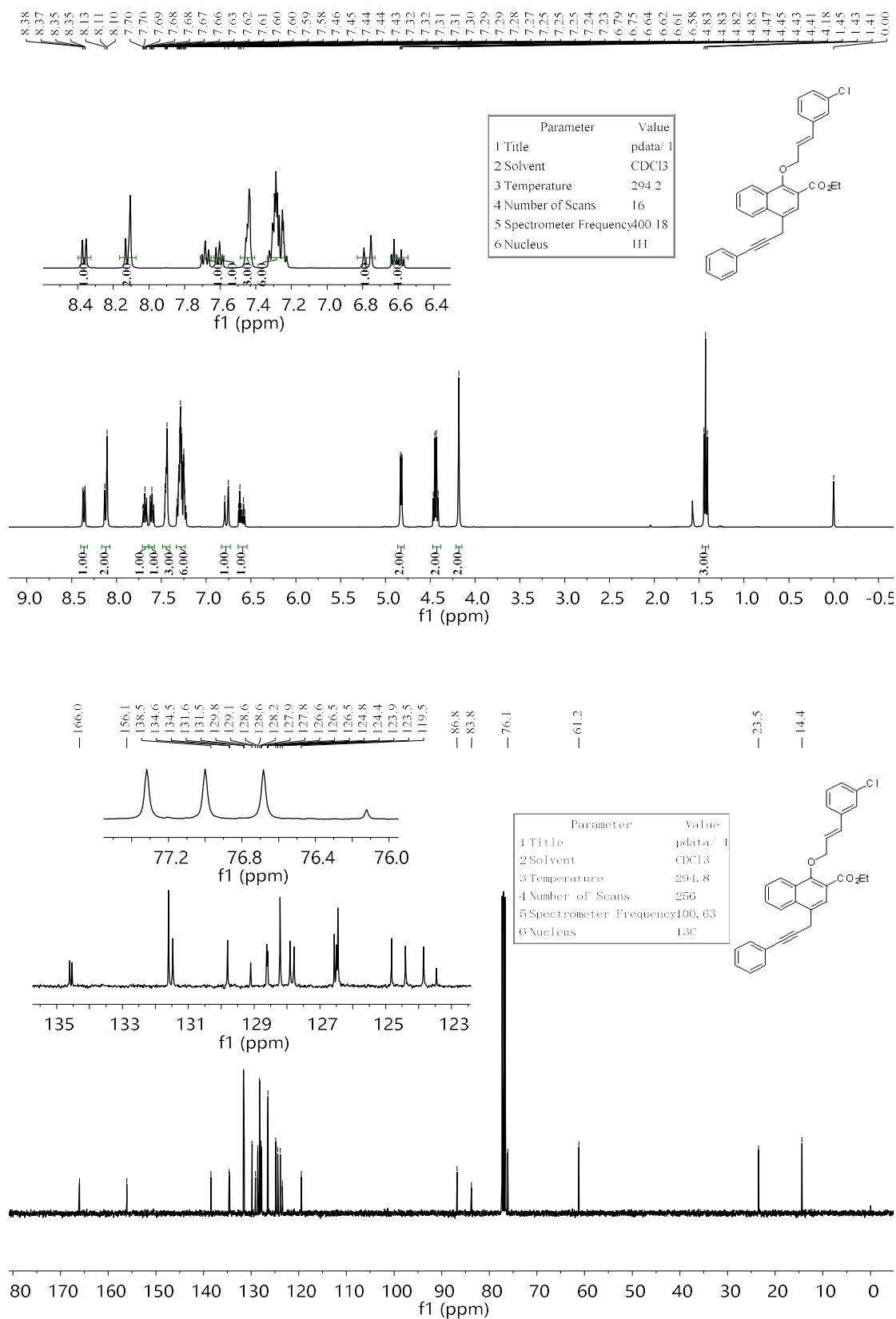
Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(p-tolyl)allyl)oxy)-2-naphthoate (A25)



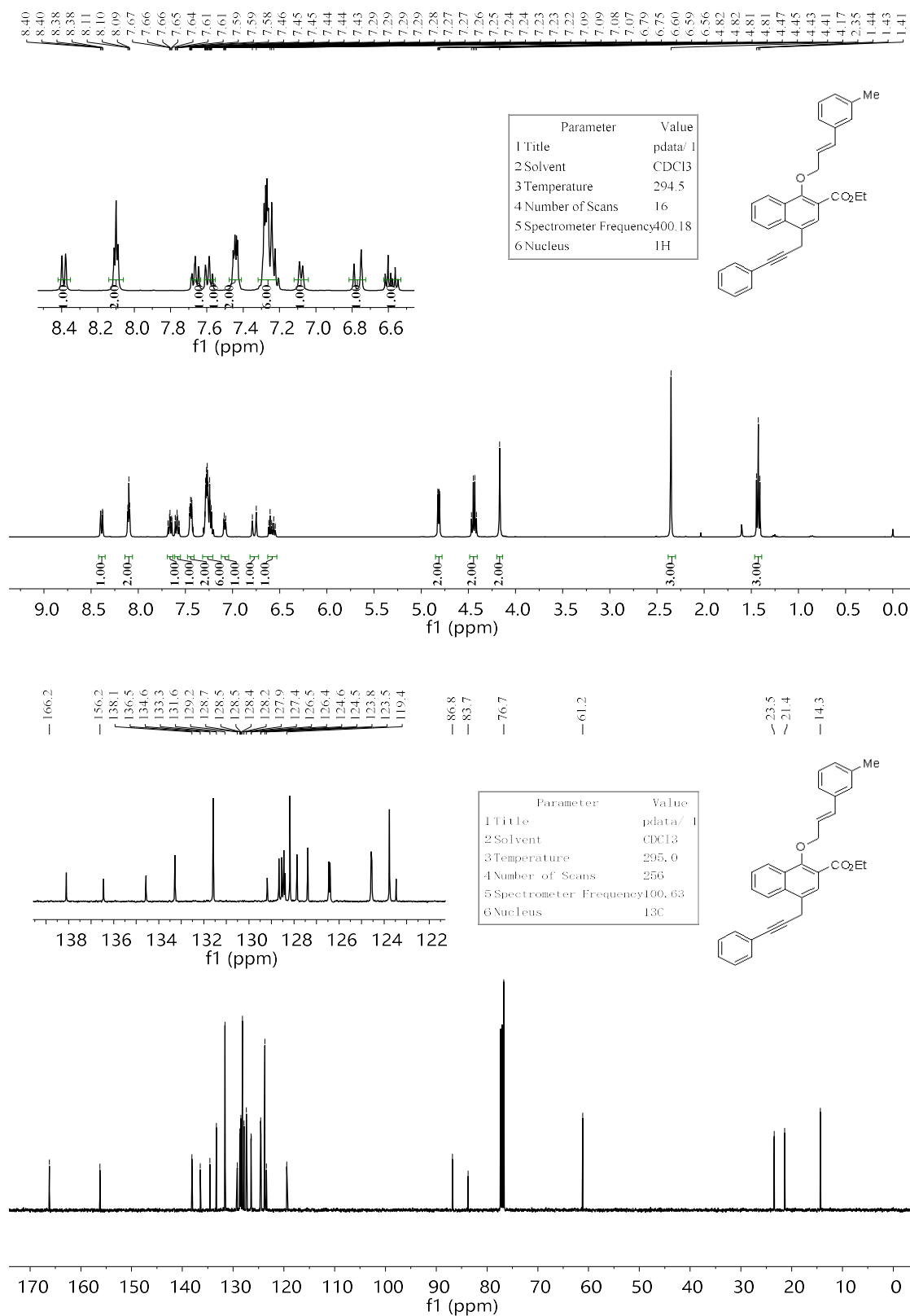
Ethyl (E)-1-((3-(4-methoxyphenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A26)



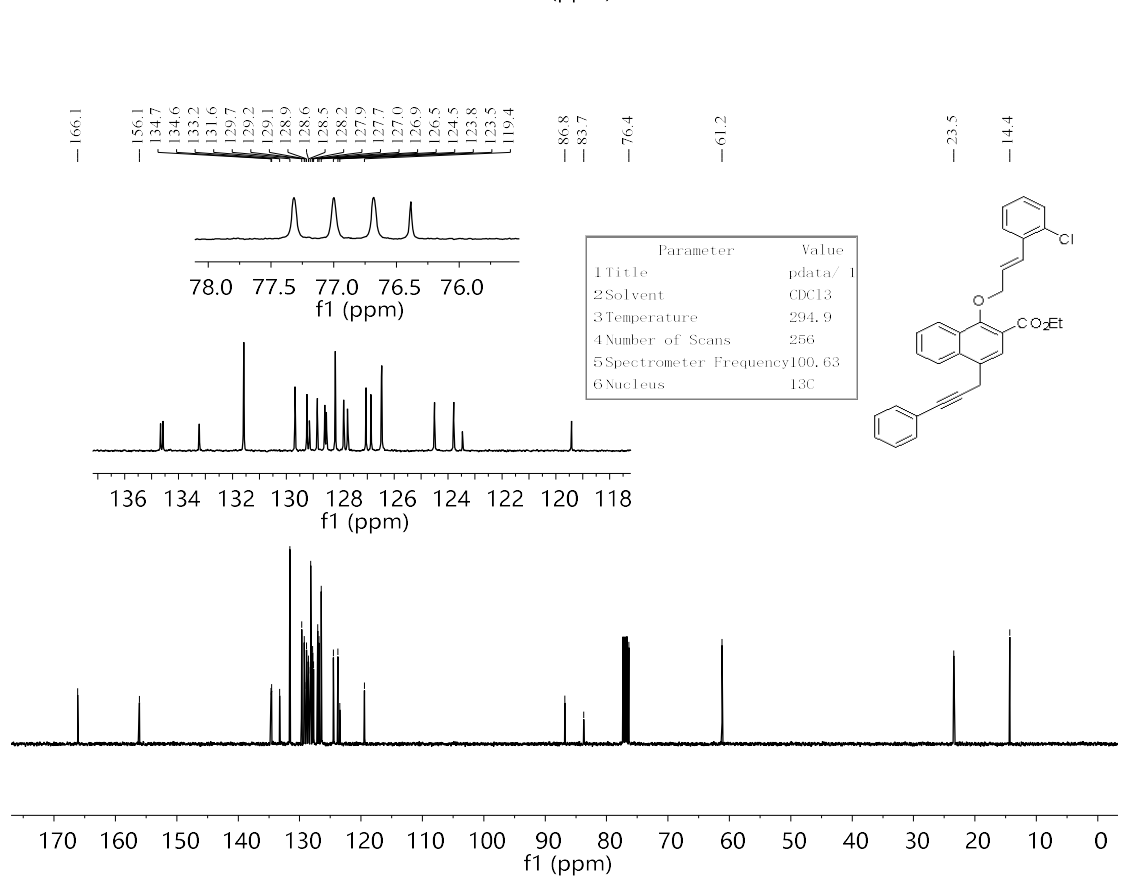
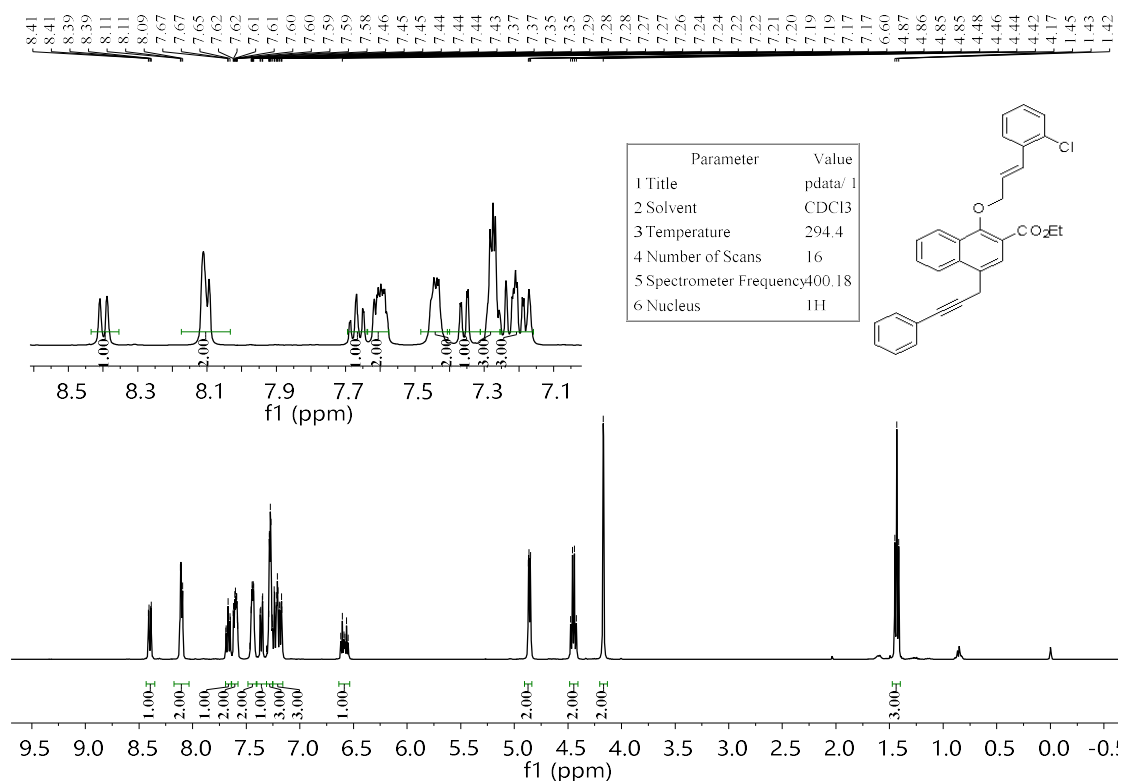
Ethyl (E)-1-((3-(3-chlorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A27)



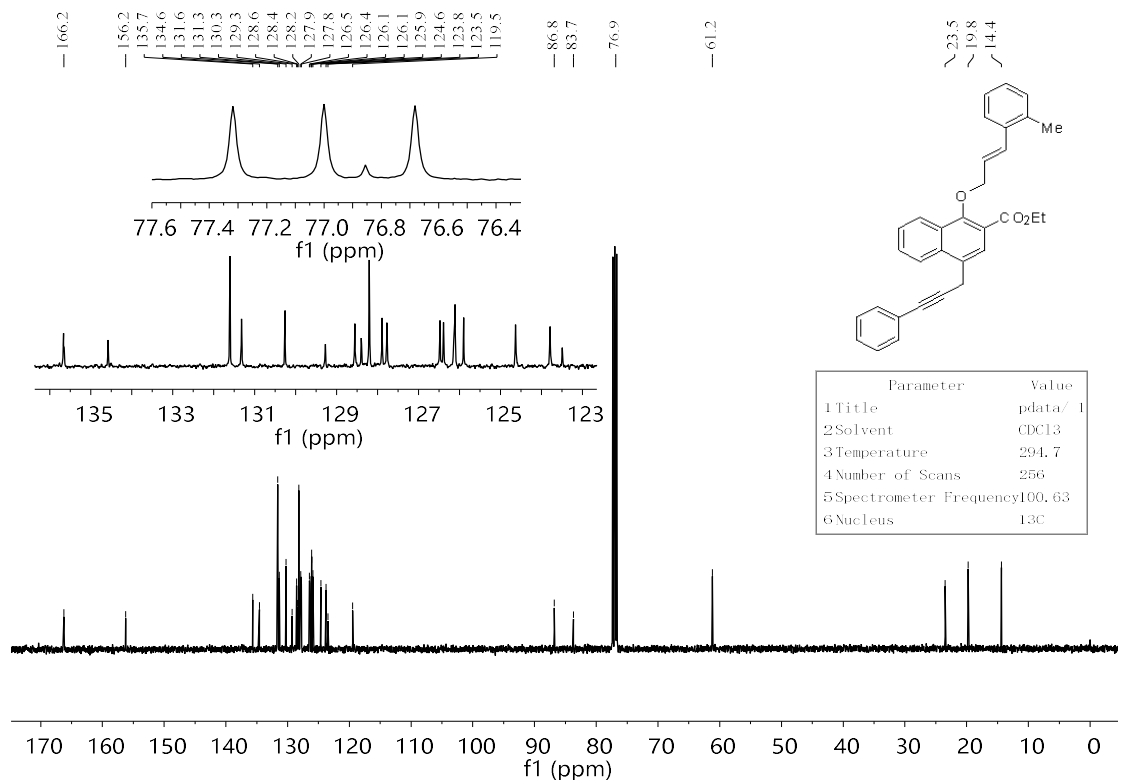
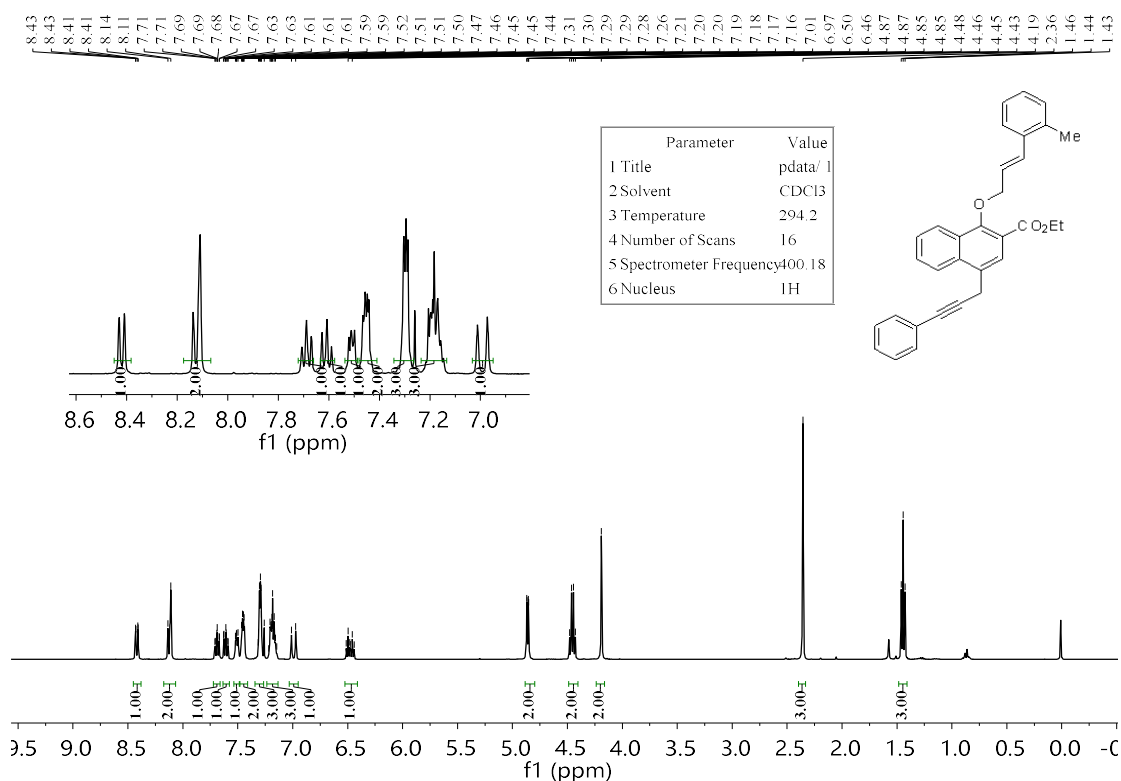
Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(m-tolyl)allyl)oxy)-2-naphthoate (A28)



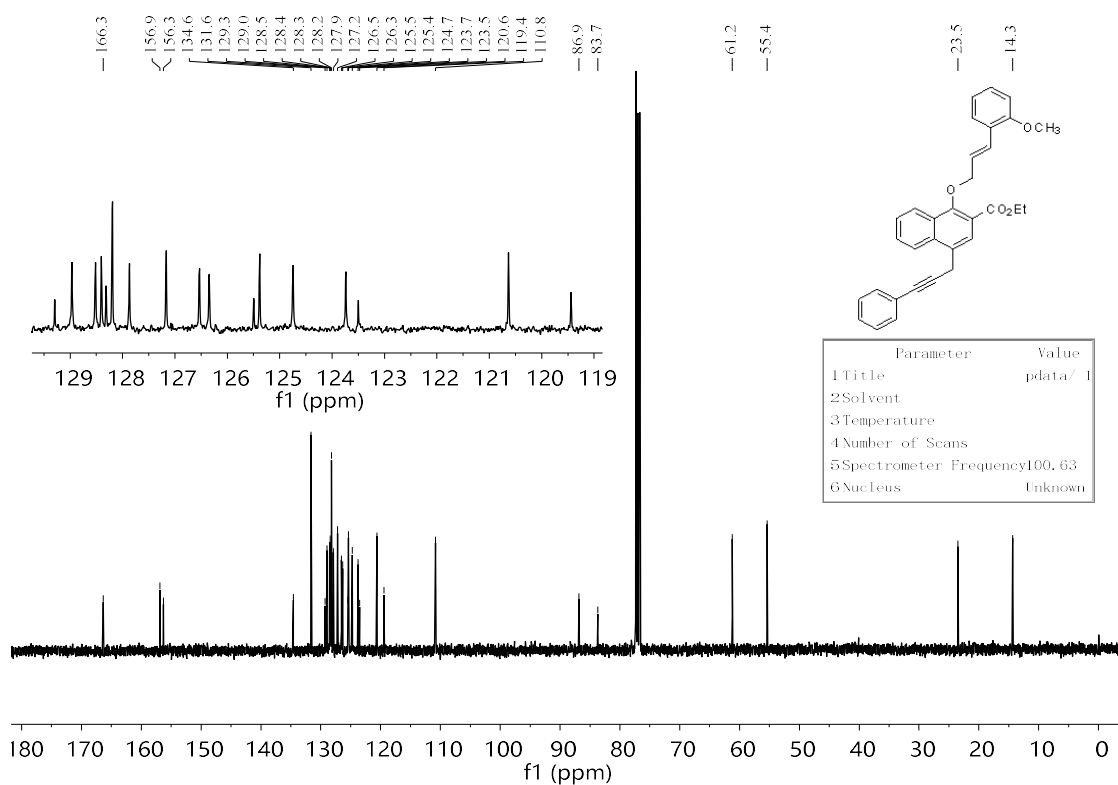
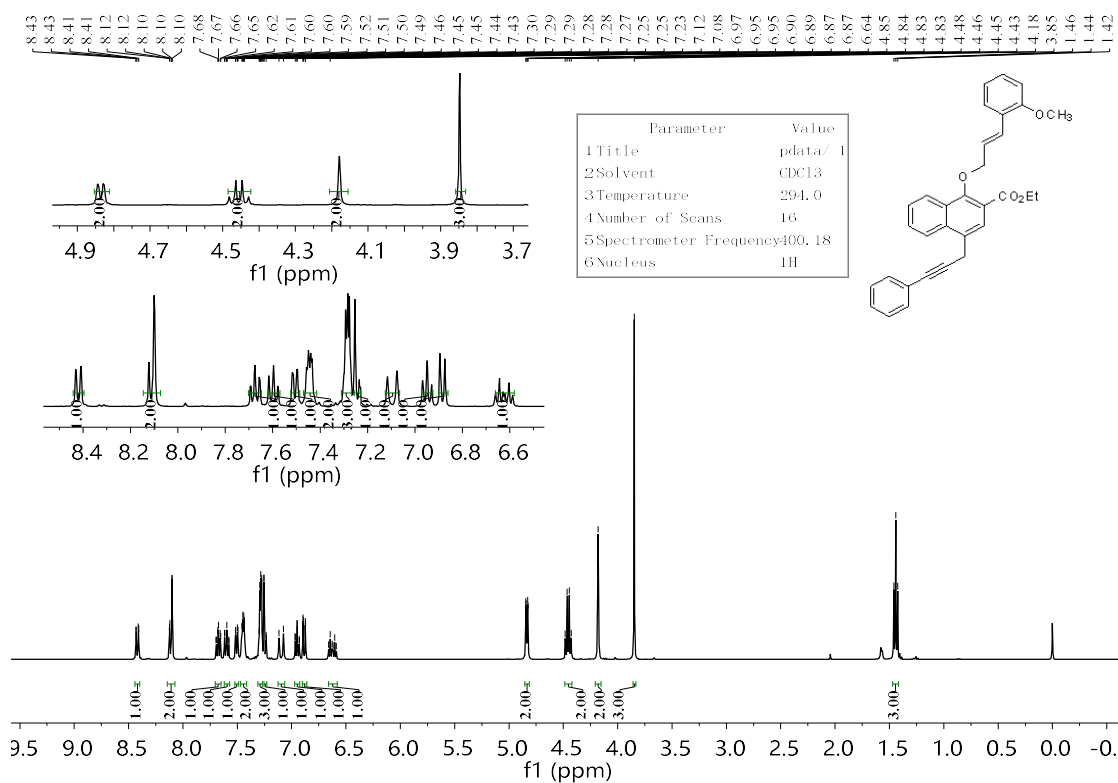
Ethyl (E)-1-((3-(2-chlorophenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A29)



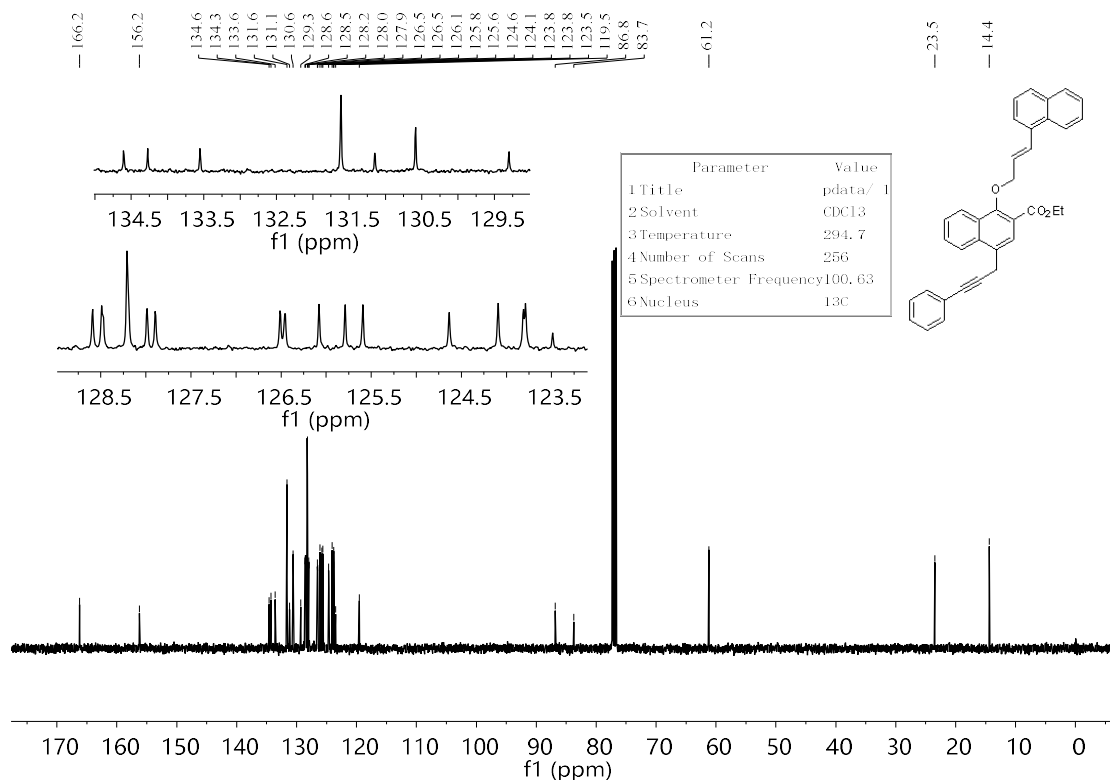
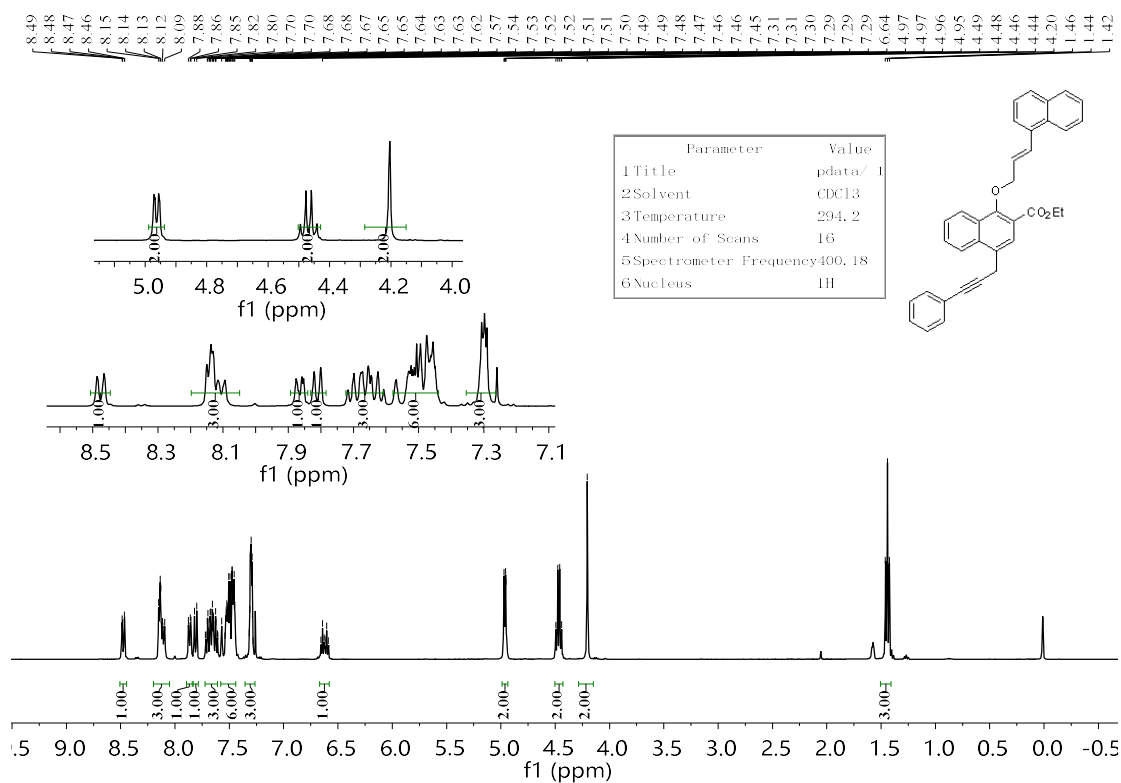
Ethyl (E)-1-((3-(2-methoxyphenyl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A30)



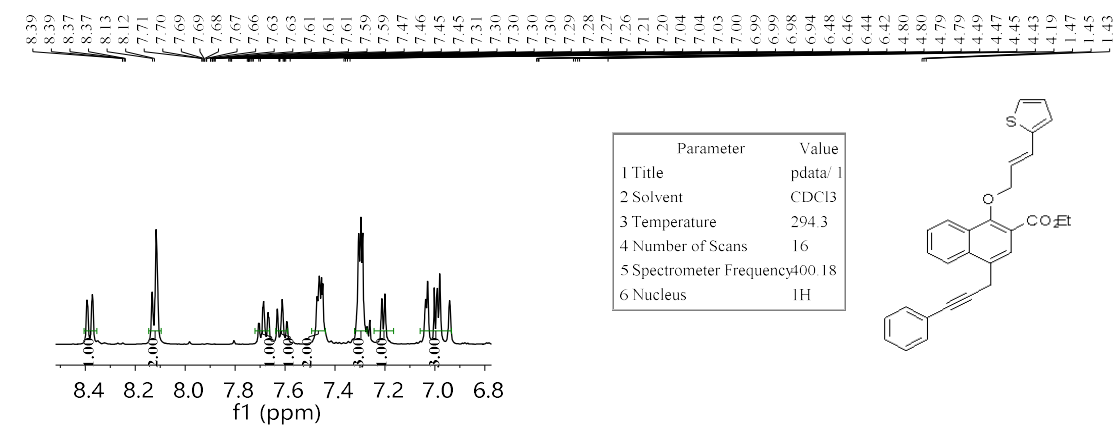
Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(o-tolyl)allyl)oxy)-2-naphthoate (A31)



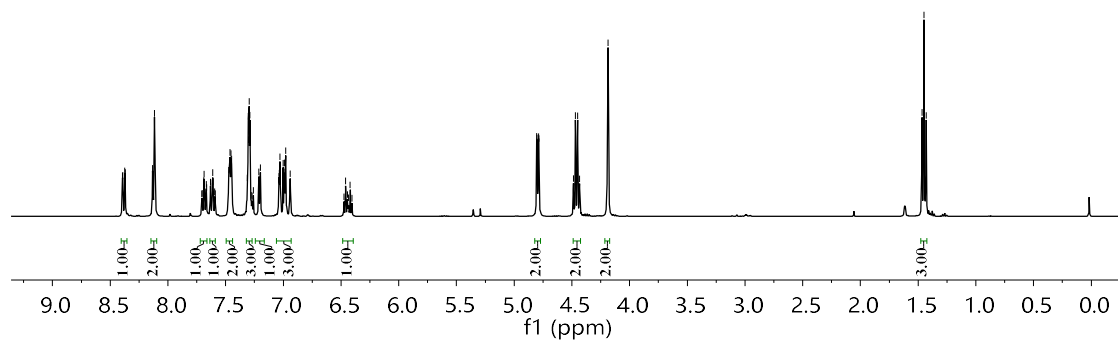
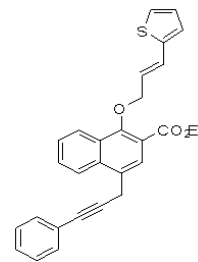
Ethyl (E)-1-((3-(naphthalen-1-yl)allyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A32)



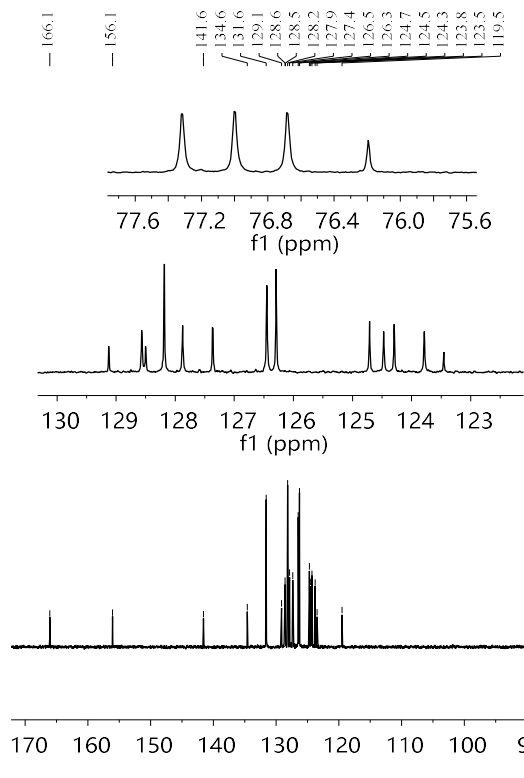
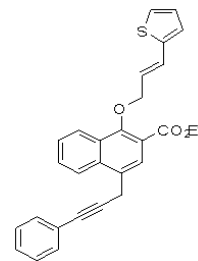
Ethyl (E)-4-(3-phenylprop-2-yn-1-yl)-1-((3-(thiophen-2-yl)allyl)oxy)-2-naphthoate (A33)



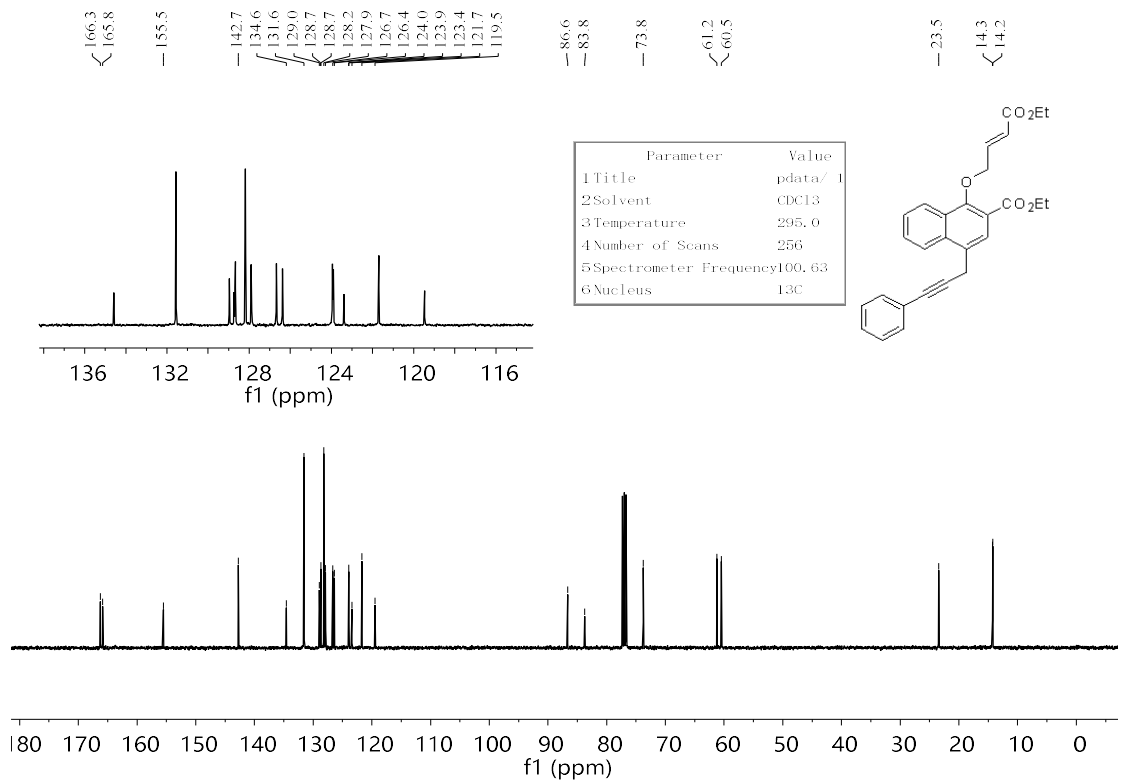
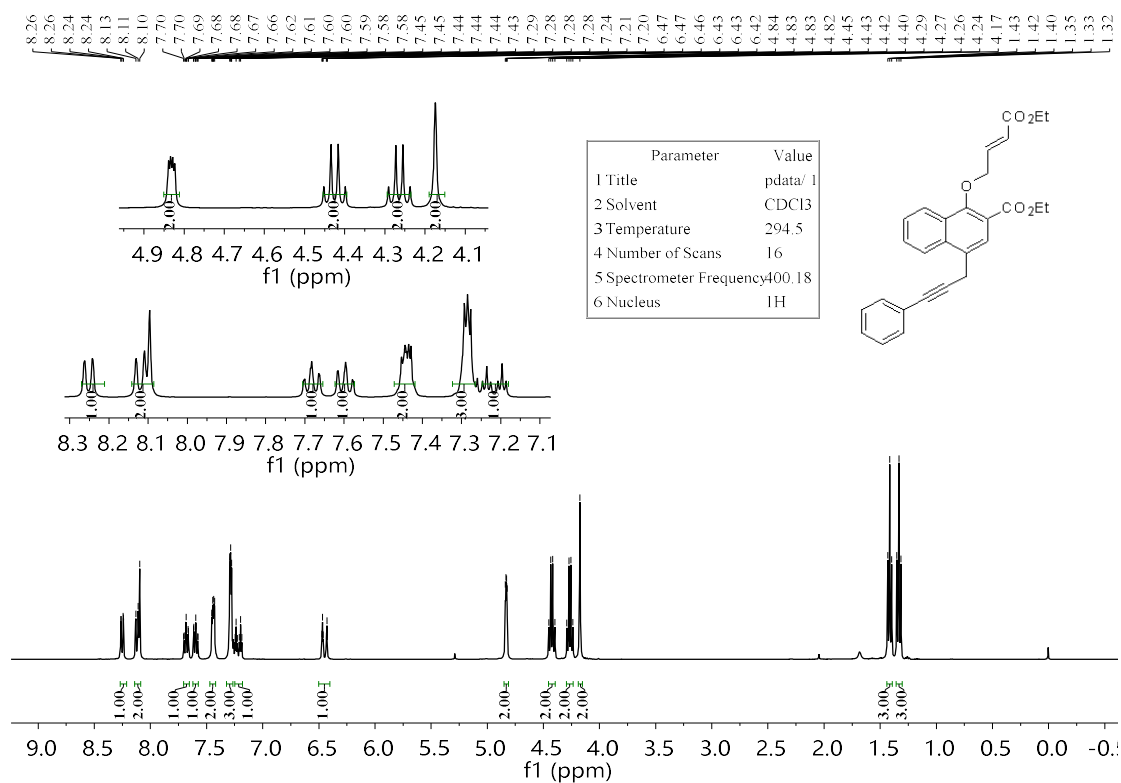
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2 Solvent	CDCl3
3 Temperature	294.3
4 Number of Scans	16
5 Spectrometer Frequency	400.18
6 Nucleus	1H



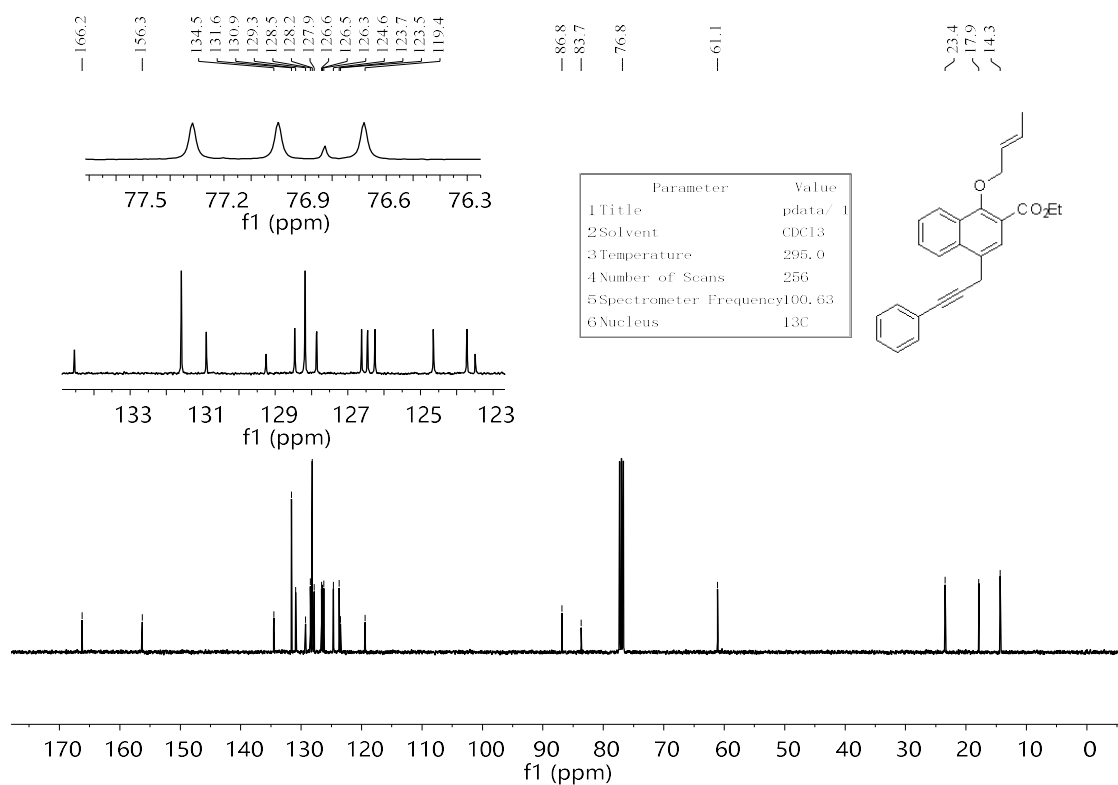
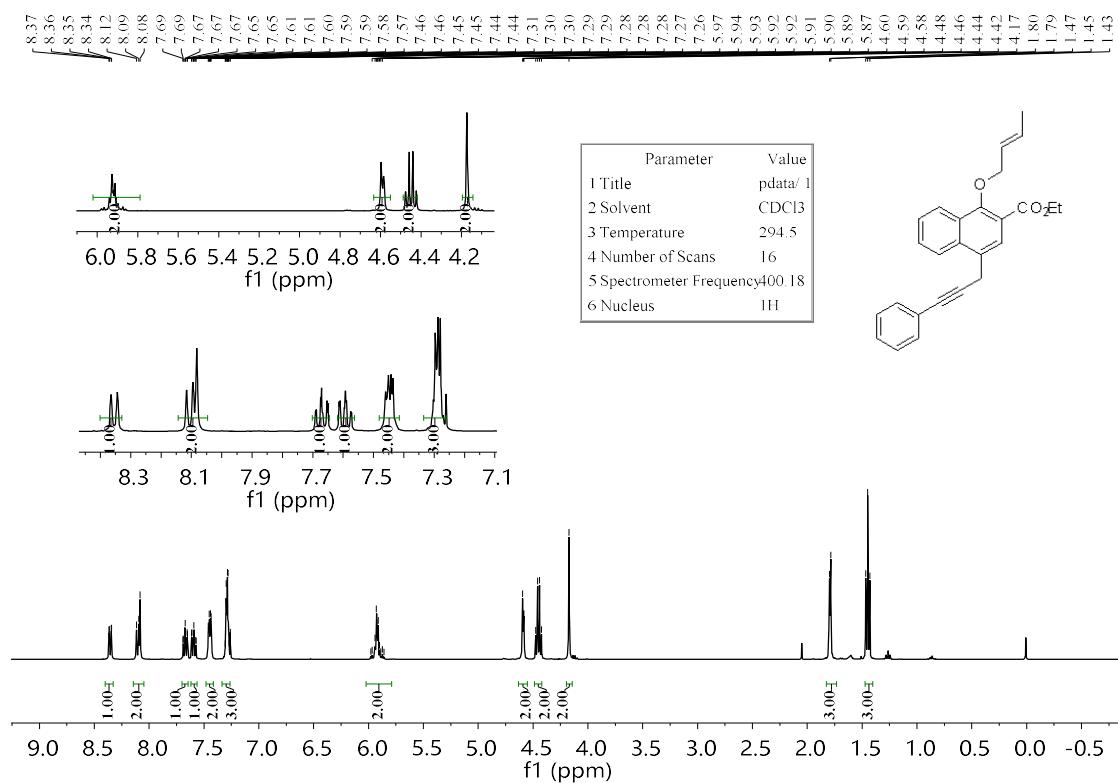
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2 Solvent	CDCl3
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4 Number of Scans	256
5 Spectrometer Frequency	100.63
6 Nucleus	13C



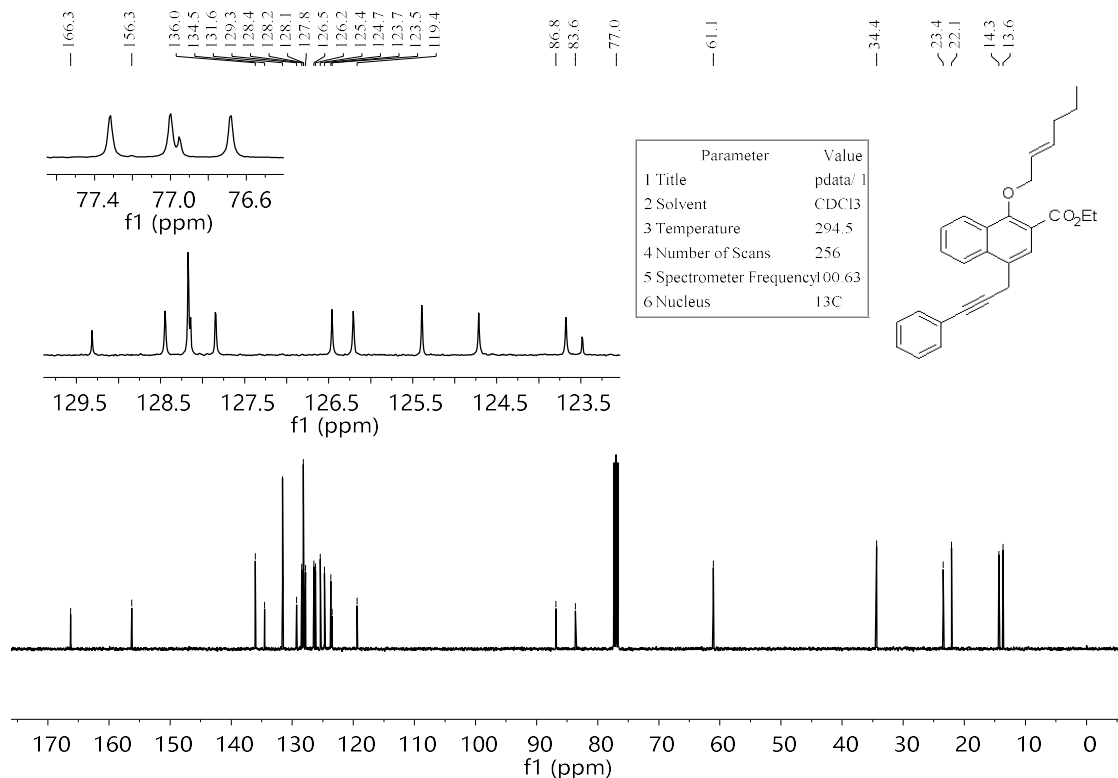
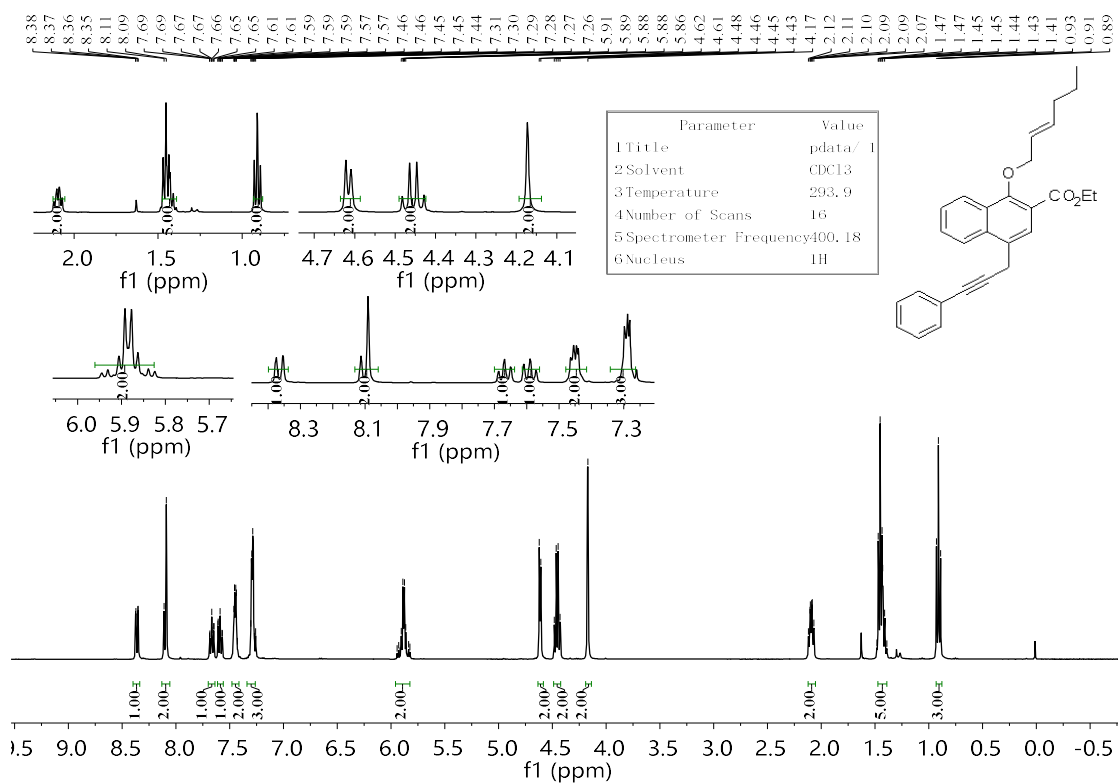
Ethyl (E)-1-((4-ethoxy-4-oxobut-2-en-1-yl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A34)



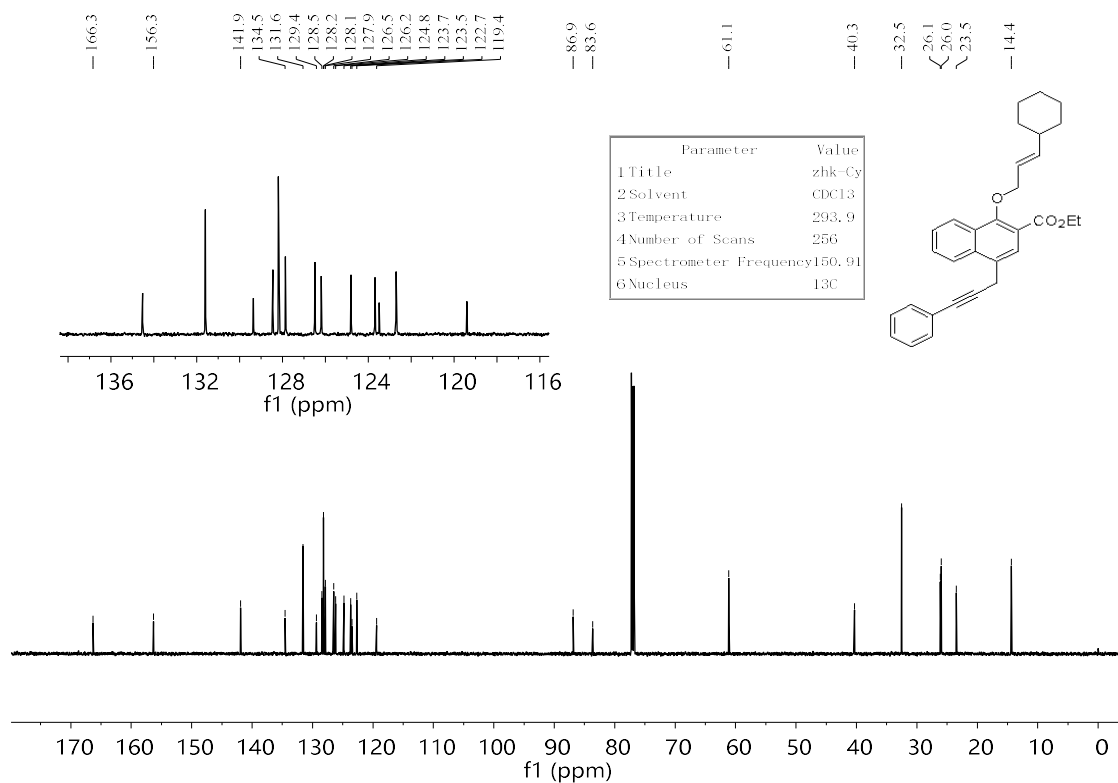
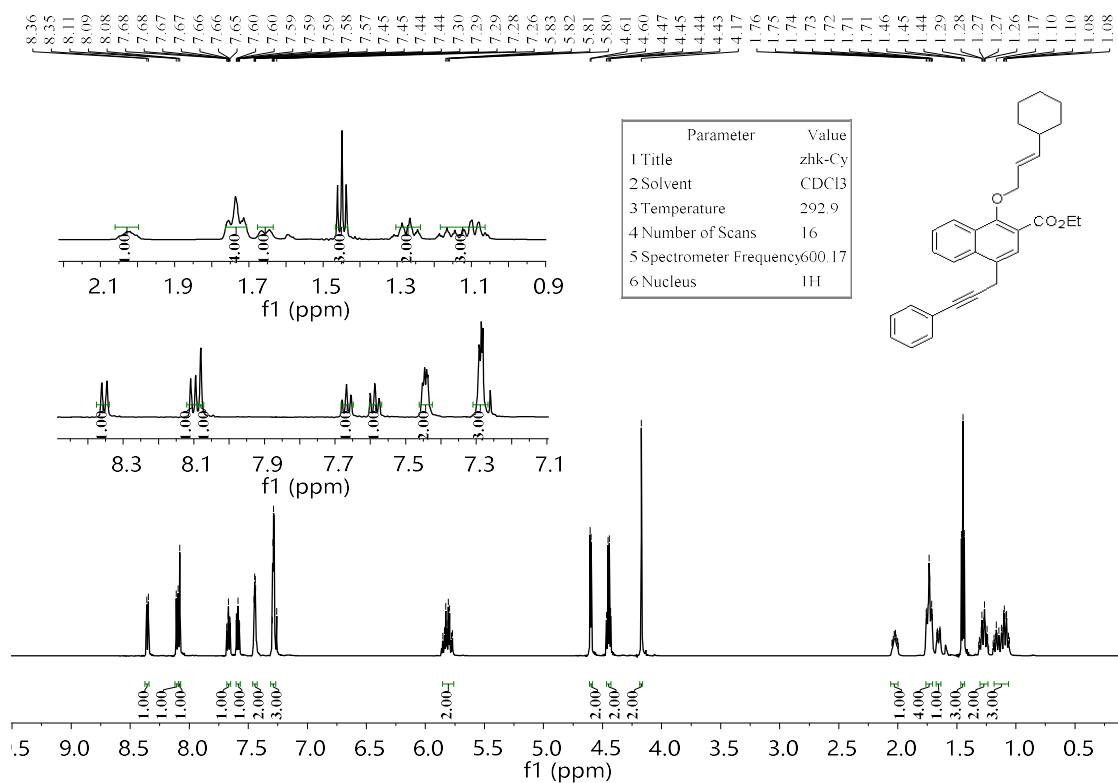
Ethyl (E)-1-(but-2-en-1-yloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A35)



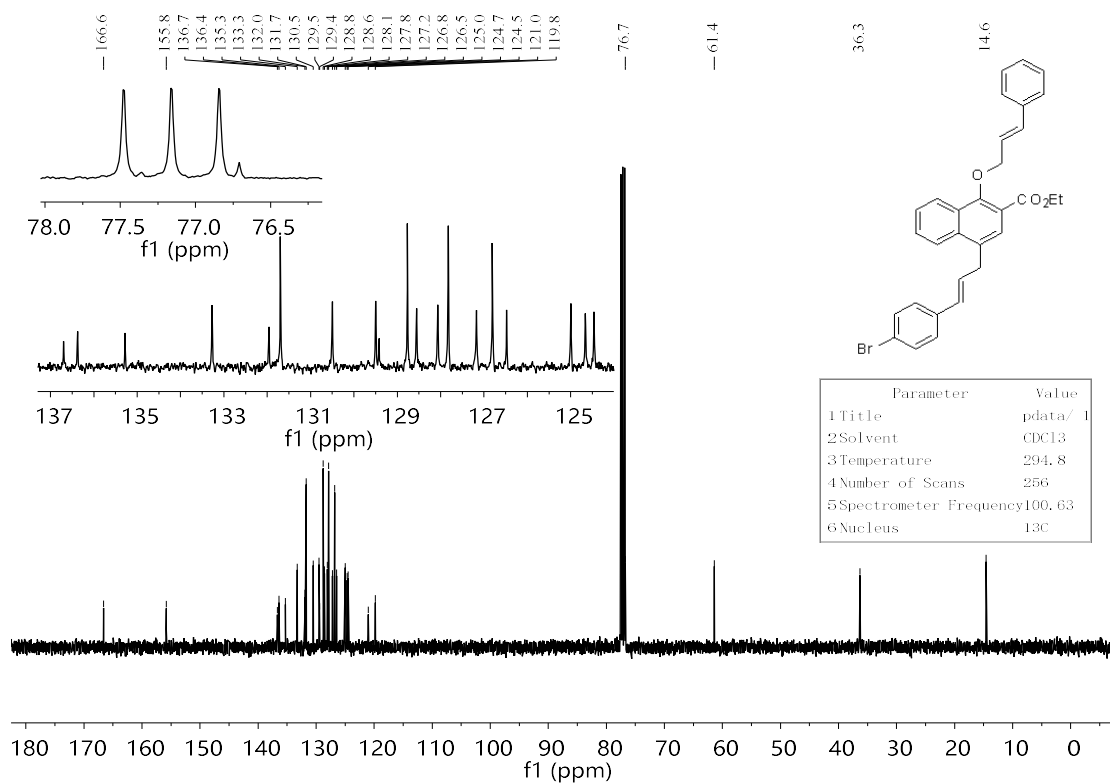
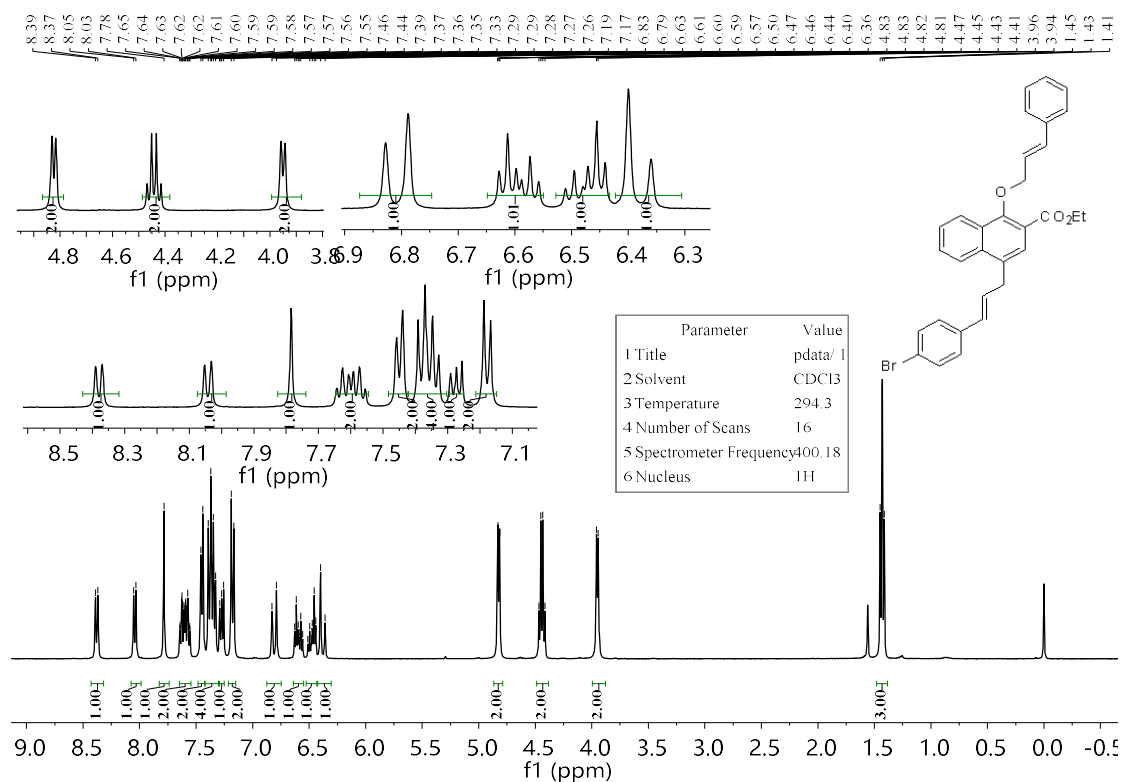
Ethyl (E)-1-(hex-2-en-1-yloxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A36)



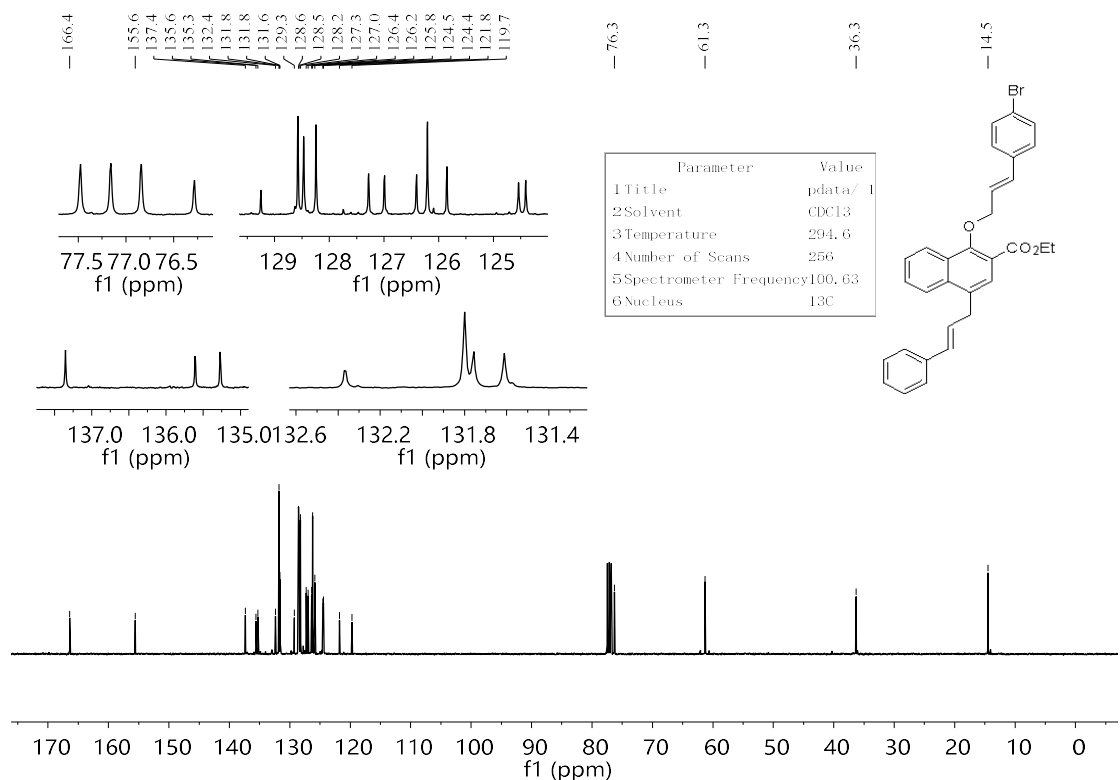
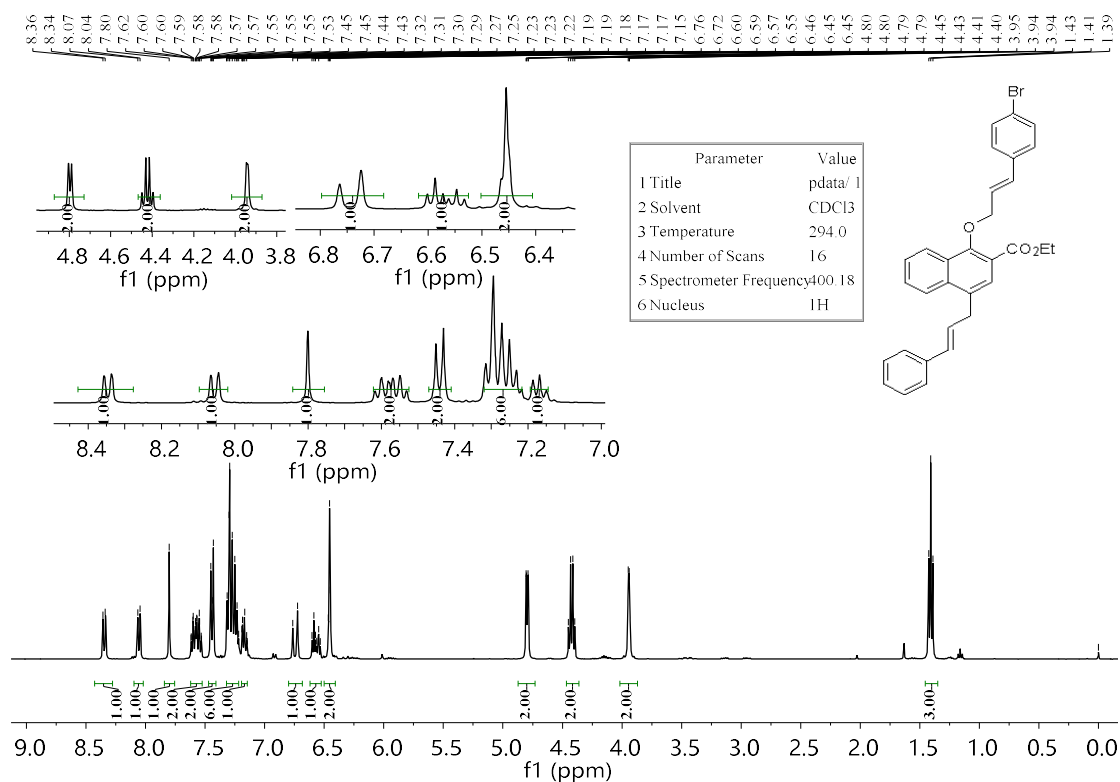
Ethyl (E)-1-((3-cyclohexylallyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A37)



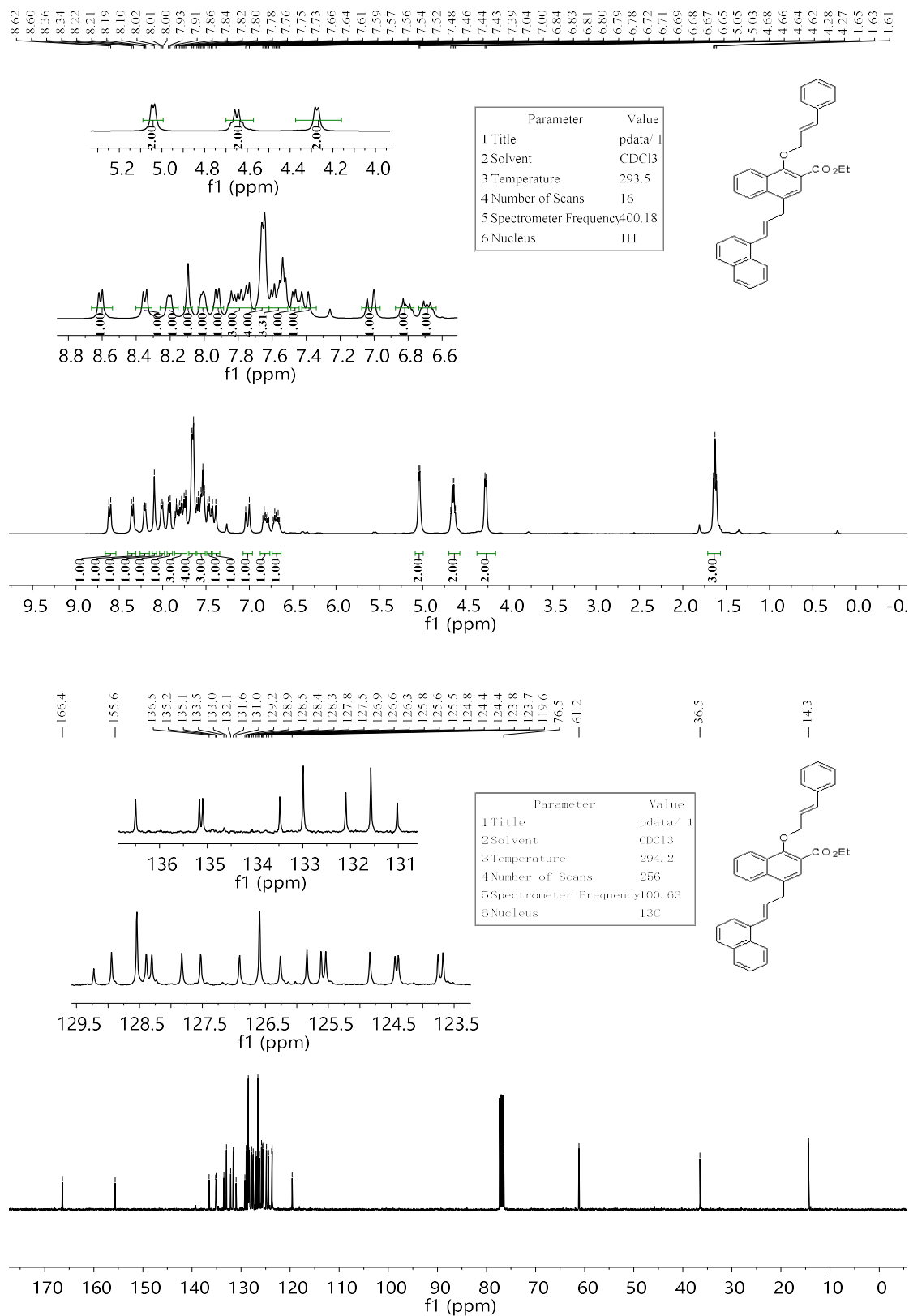
Ethyl 4-((E)-3-(4-bromophenyl)allyl)-1-(cinnamyloxy)-2-naphthoate (A38)



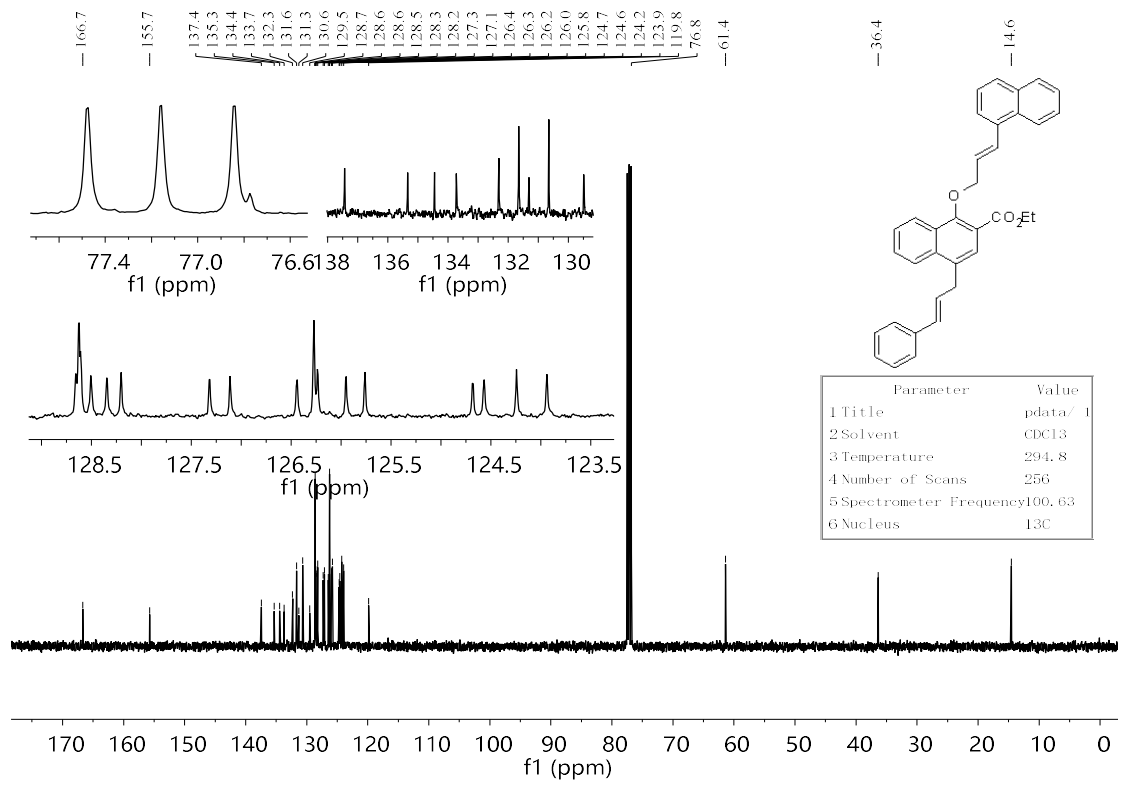
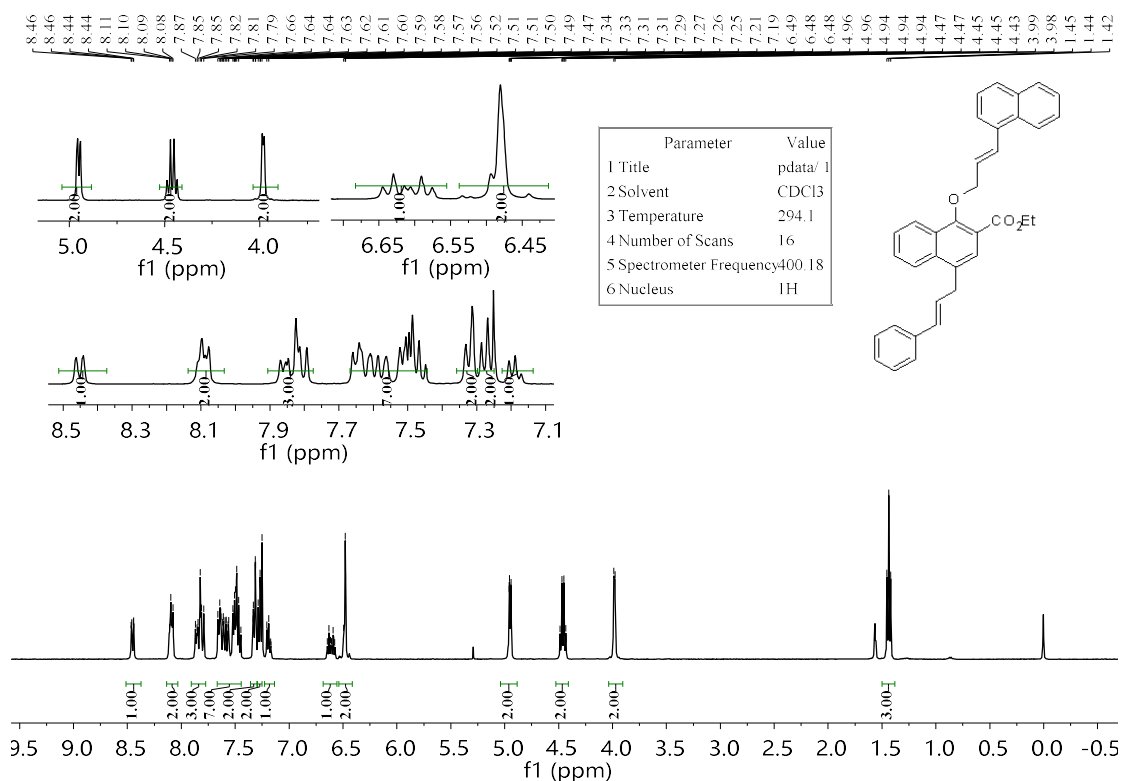
Ethyl 1-(((E)-3-(4-bromophenyl)allyl)oxy)-4-cinnamyl-2-naphthoate (*ent*-A38)



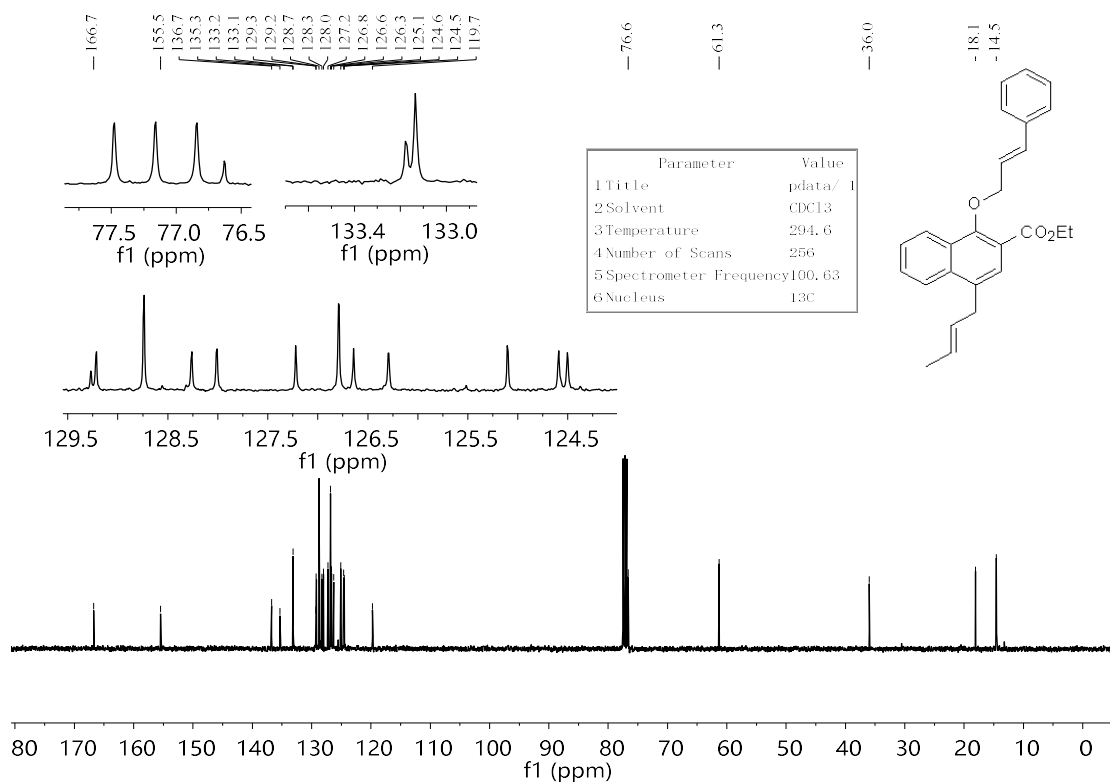
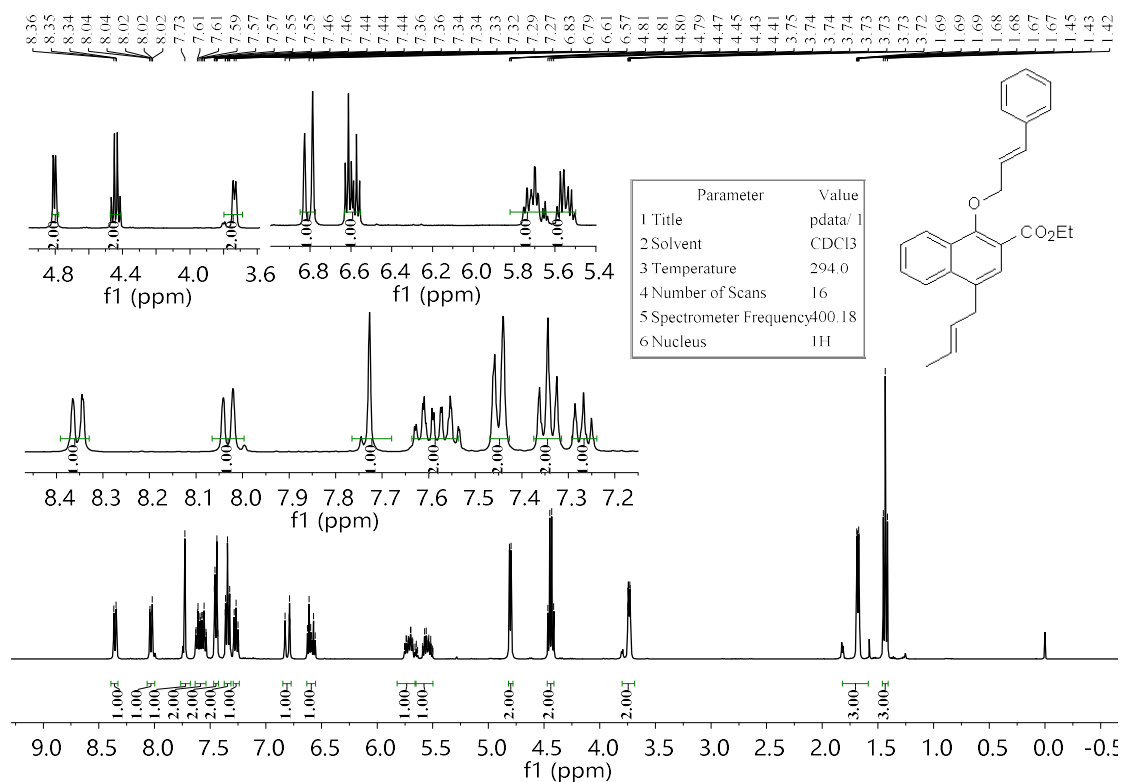
Ethyl 1-(cinnamyloxy)-4-((E)-3-(naphthalen-1-yl)allyl)-2-naphthoate (A39)



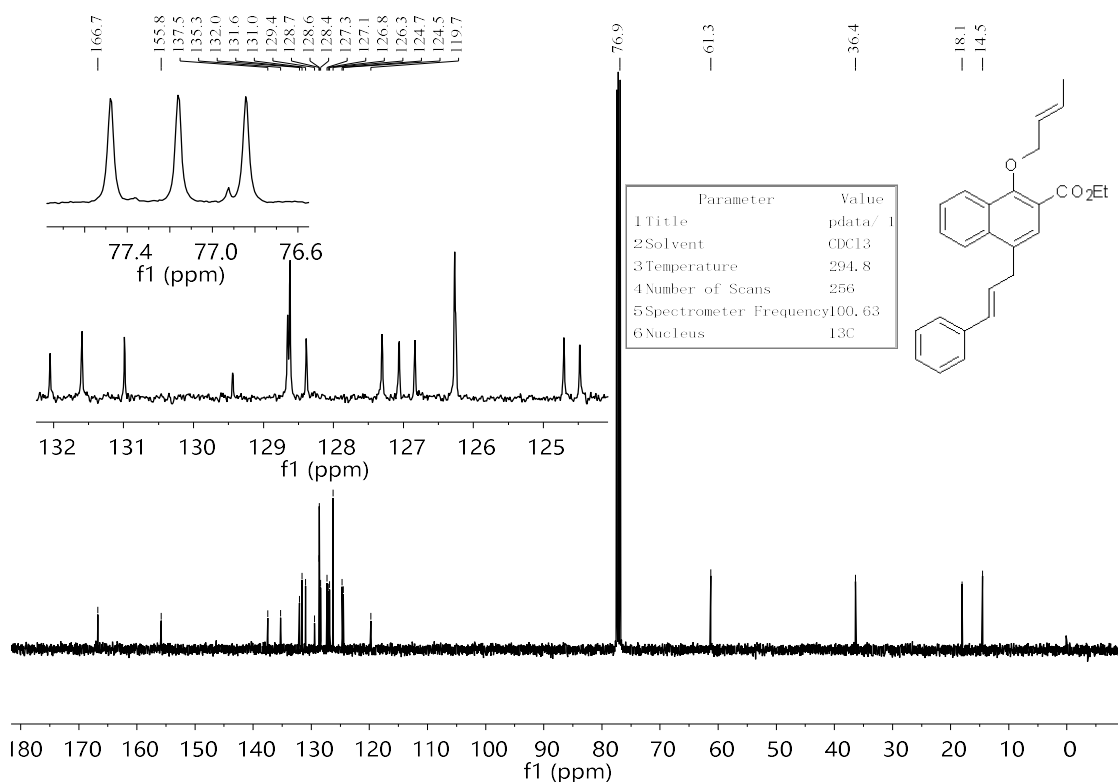
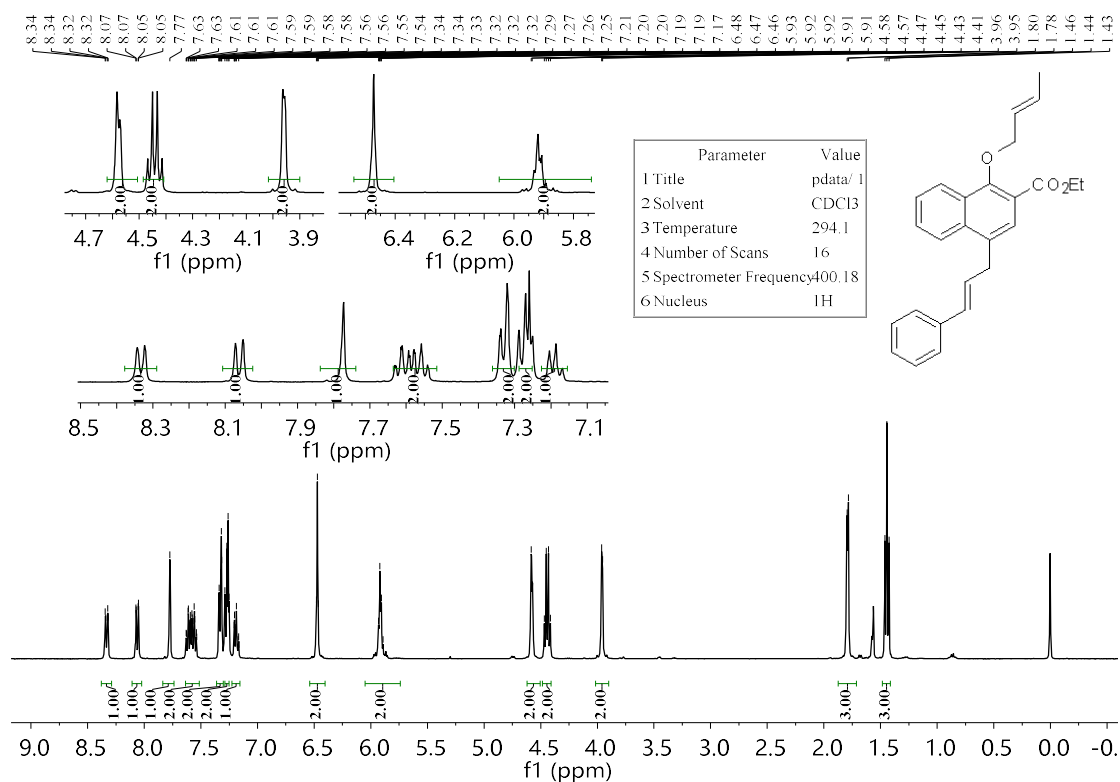
Ethyl 4-cinnamyl-1-(((E)-3-(naphthalen-1-yl)allyl)oxy)-2-naphthoate (*ent*-A39)



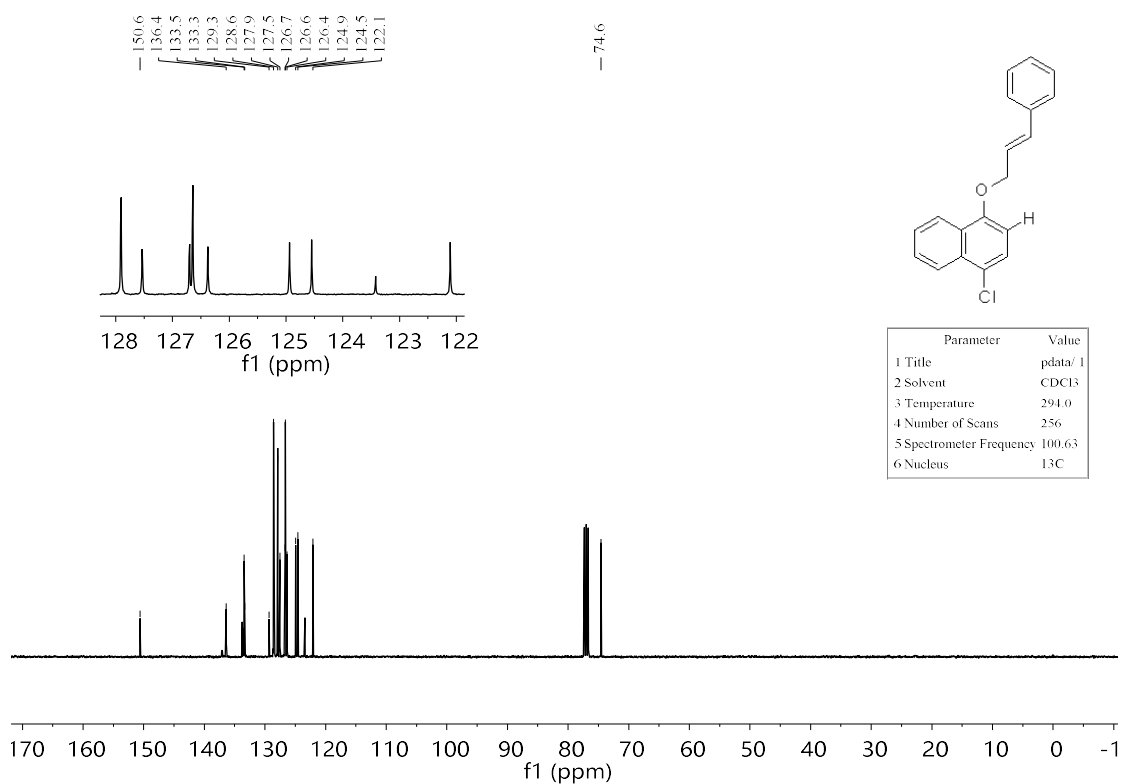
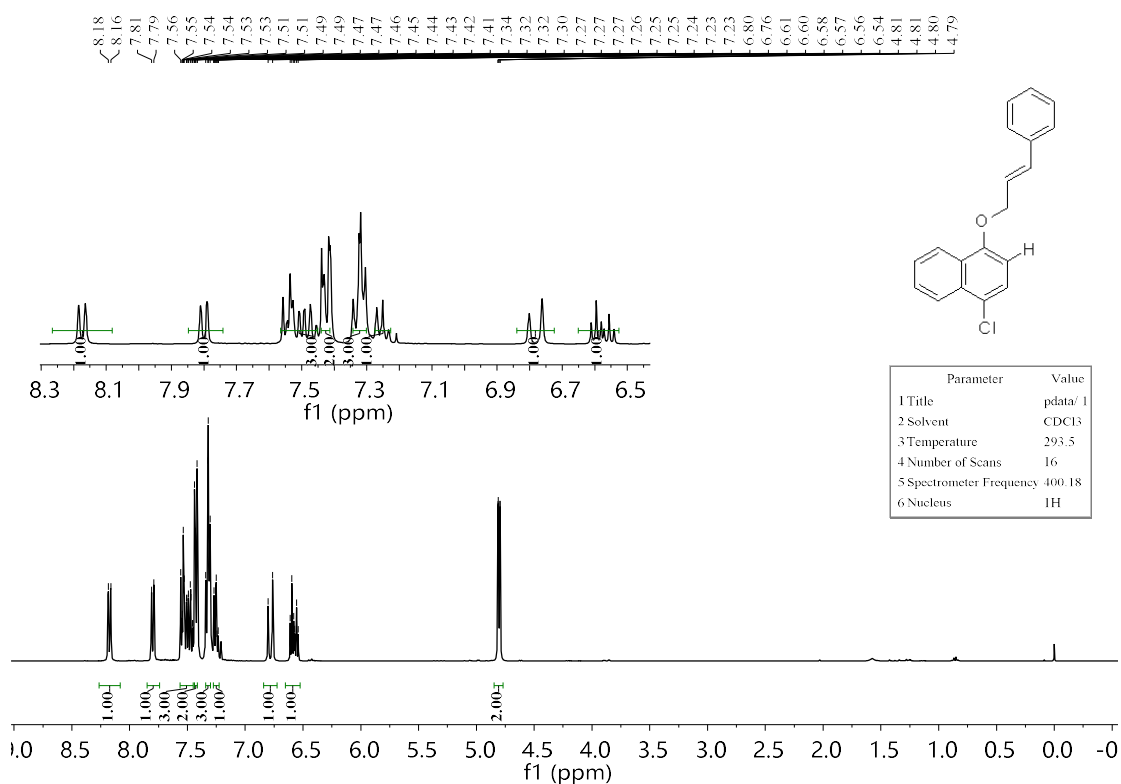
Ethyl 4-((E)-but-2-en-1-yl)-1-(cinnamyloxy)-2-naphthoate (A40)



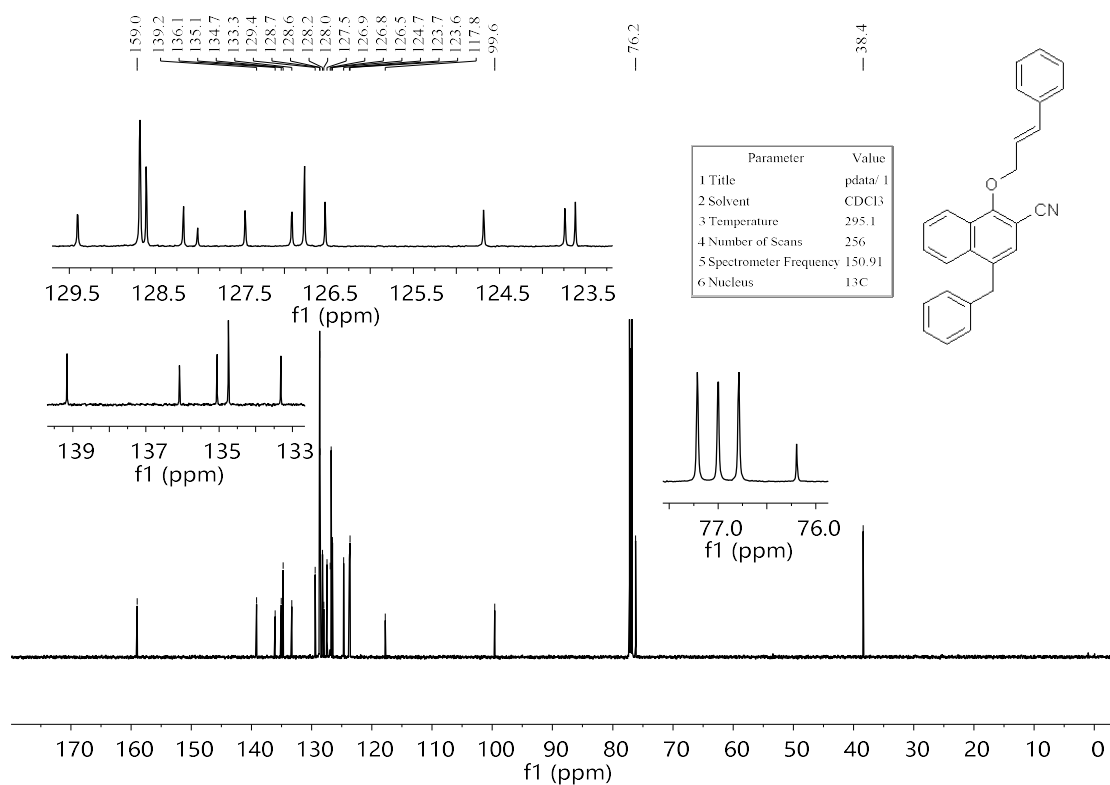
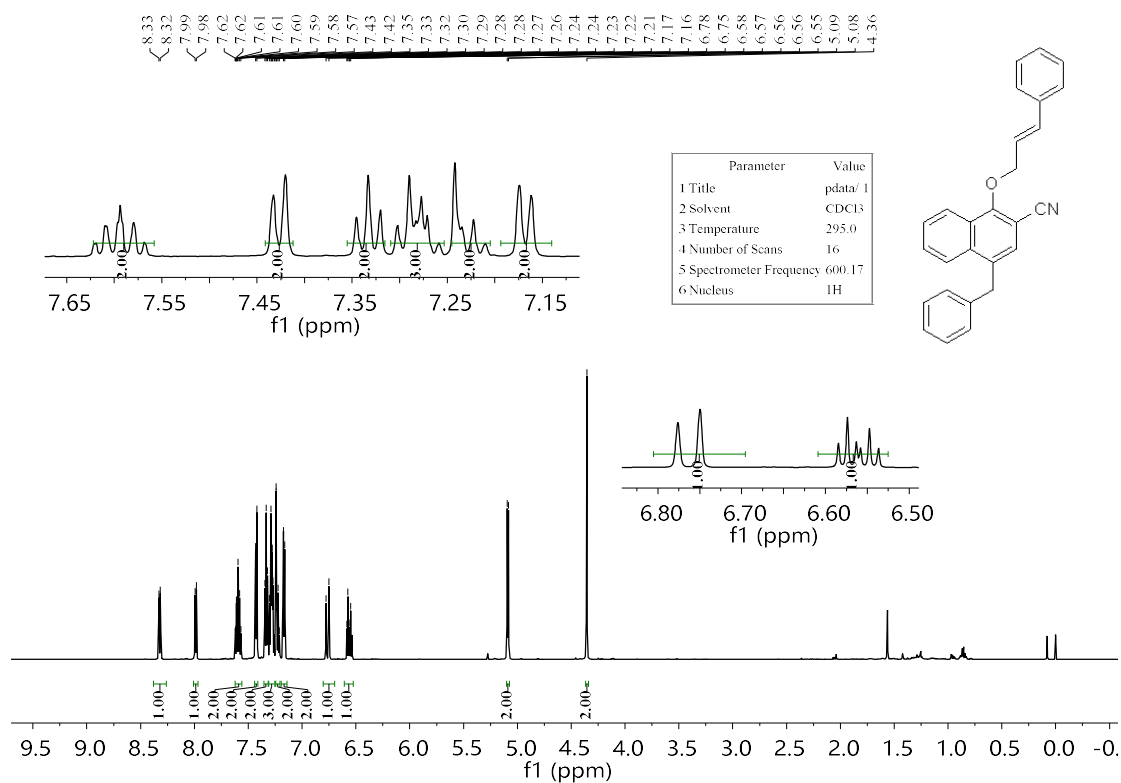
Ethyl 1-((E)-but-2-en-1-yl)oxy-4-cinnamyl-2-naphthoate (*ent*-A40)



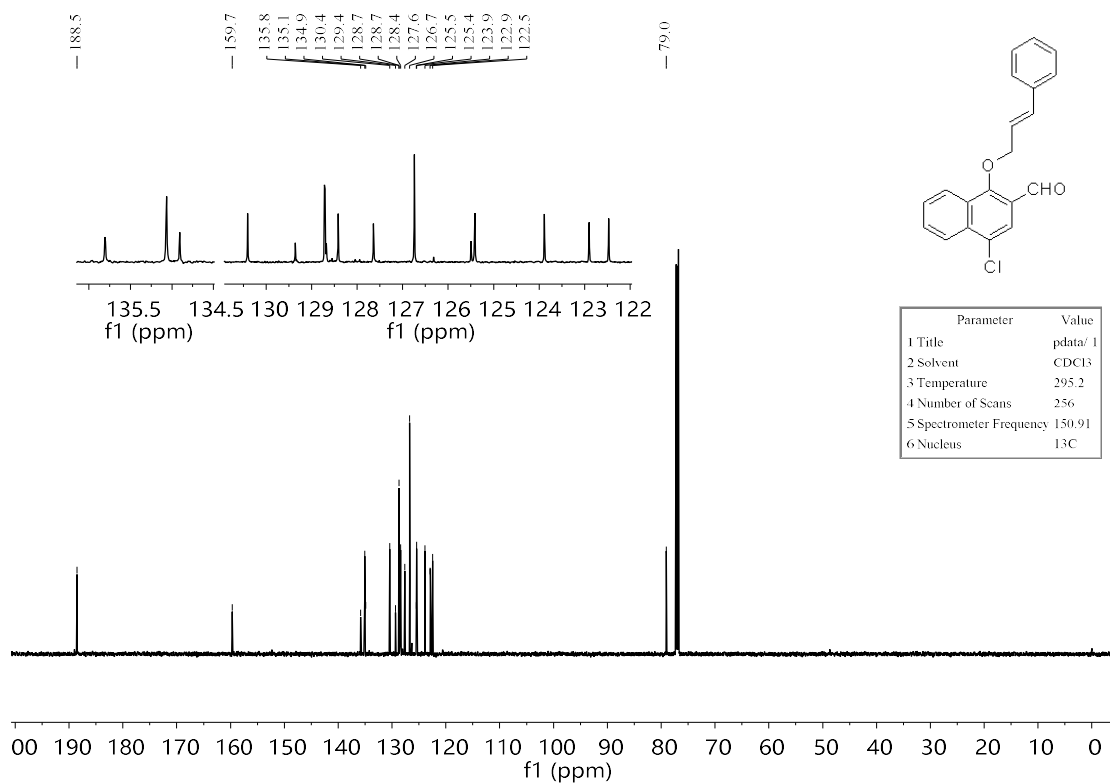
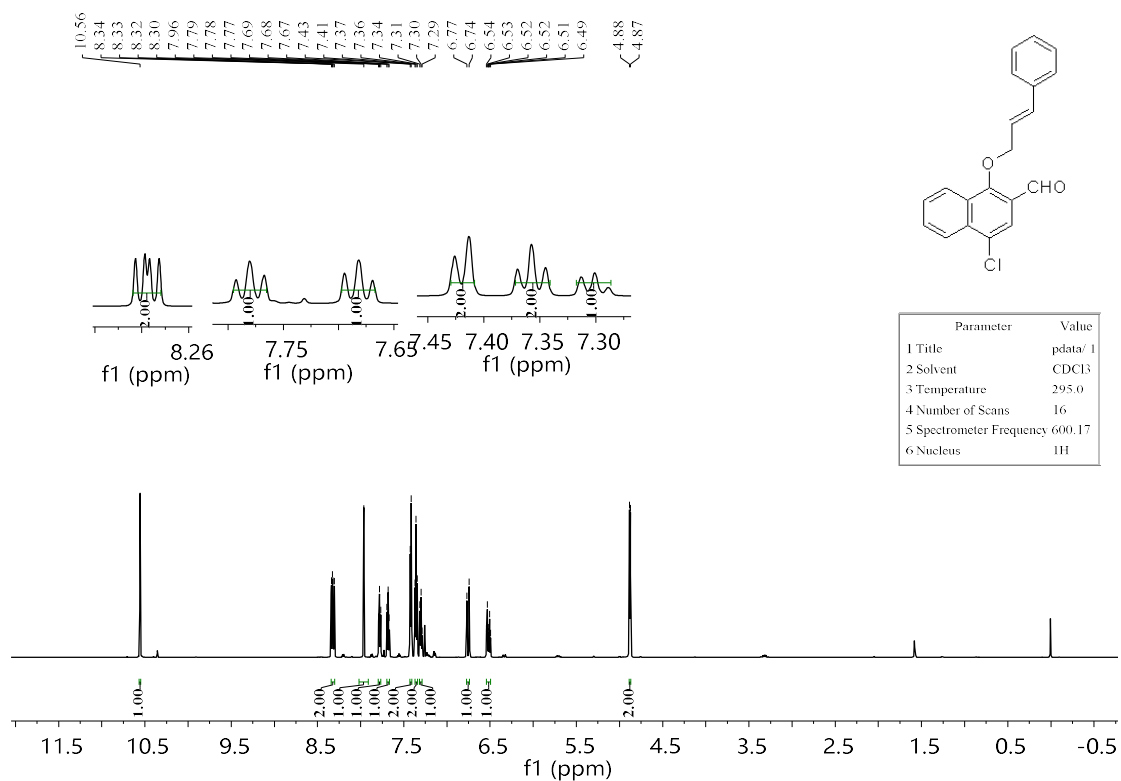
1-chloro-4-(cinnamyloxy)naphthalene (A41)



4-benzyl-1-(cinnamyloxy)-2-naphthonitrile (A43)

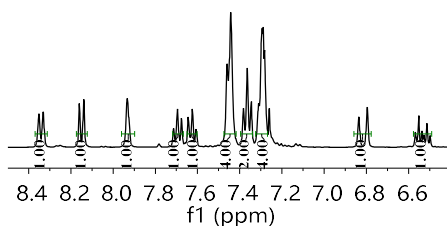


4-chloro-1-(cinnamyloxy)-2-naphthaldehyde (A44)

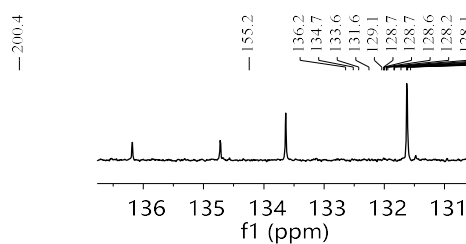
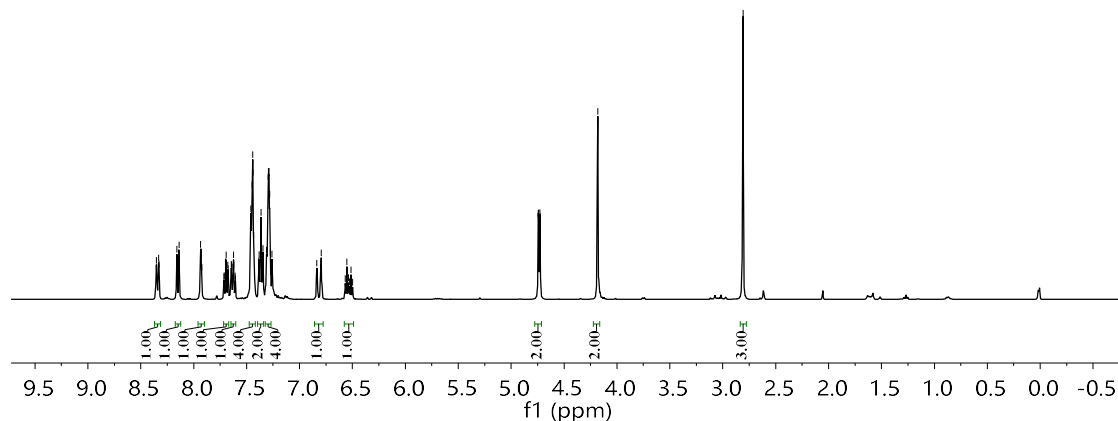
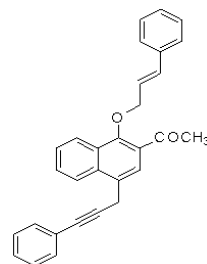


1-(1-(cinnamyloxy)-4-(3-phenylprop-2-yn-1-yl)naphthalen-2-yl)ethan-1-one (A45)

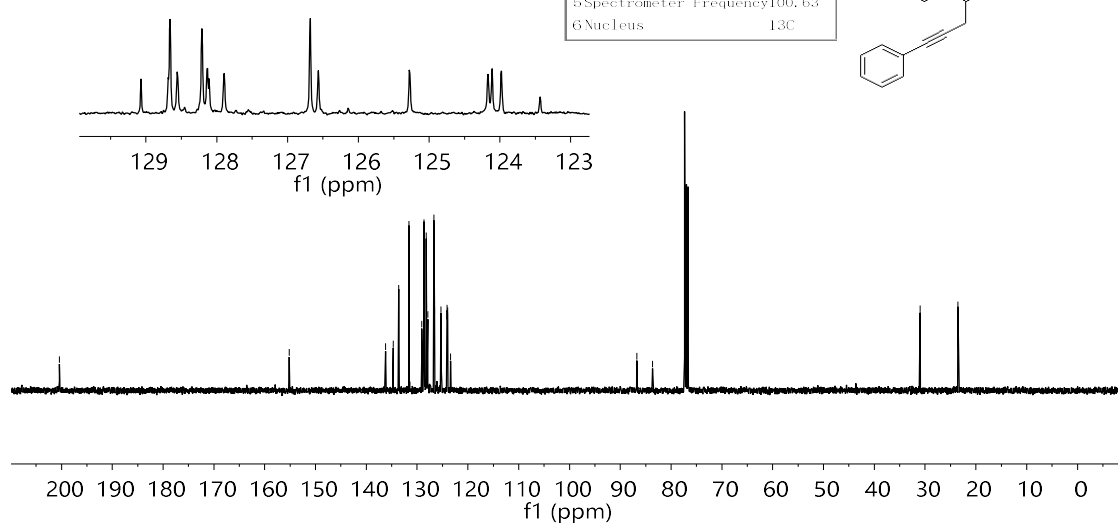
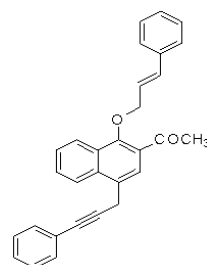
8.35 8.35 8.33 8.33 8.16 8.14 7.93 7.93 7.92 7.71 7.71 7.70 7.70 7.69 7.69 7.68 7.68 7.67 7.67 7.65 7.65 7.63 7.63 7.62 7.62 7.62 7.61 7.61 7.60 7.60 7.46 7.46 7.45 7.45 7.44 7.44 7.43 7.43 7.38 7.38 7.36 7.36 7.35 7.35 7.34 7.34 7.31 7.31 7.30 7.30 7.29 7.29 7.29 7.28 7.28 7.28 7.26 7.26 6.84 6.84 6.80 6.80 6.57 6.57 6.55 6.55 6.54 6.54 6.53 6.53 6.51 6.51 6.50 6.50 4.74 4.74 4.74 4.73 4.73 4.18 4.18 2.81 2.81



Parameter	Value
1 Title	pdata/ 1
2 Solvent	CDCl3
3 Temperature	294.0
4 Number of Scans	16
5 Spectrometer Frequency	400.18
6 Nucleus	1H



Parameter	Value
1 Title	pdata/ 1
2 Solvent	CDCl3
3 Temperature	294.6
4 Number of Scans	256
5 Spectrometer Frequency	100.63
6 Nucleus	13C



18. Reference

1. a) Y. H. Wen, X. Huang, J. L. Huang, Y. Xiong, B. Qin and X. M. Feng, *Synlett.*, 2005, 2445–2448; b) X. Li, X. H. Liu, Y. Z. Fu, L. J. Wang, L. Zhou and X. M. Feng, *J. Org. Chem.*, 2007, **72**, 204–208.
2. a) T. Lu, Y. T. Jiang, F. P. Ma, Z. J. Tang, L. Kuang, Y.-X. Wang and B. Wang, *Org. Lett.*, 2017, **19**, 6344–6347; b) L. F. Wang, Y. Q. Z, Z. S. Su, F. C. Zhang, W. D. Cao, X. H. Liu and X. M. Feng, *Angew. Chem. Int. Ed.*, 2022, **61**, e202211785.