Supplementary informations

Synthesis and biological activity of sphingosines with integrated azobenzene switches

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Table 3 (extented). Antiproliferative activities of sphinganine analogues **24**, **29** and **35a-35d** on seven human cancer cell lines (MDA-MB-231, A-549, MCF-7, HCT-116, Caco-2, HeLa and Jurkat) and non-malignant mouse fibroblasts NiH 3T3

Compd no.	t (h)	Cell line, IC_{50}[a] ± SD (μmol × L^{-1})							
		MDA MB-231	Caco-2	HeLa	NiH 3T3	MCF-7	Jurkat	HCT	A-549
(*E*)-**24**	24	5.0 (±1.6)	–[b]	6.6 (±0.1)	6.6 (±3.1)	5.3 (±1.4)	2.9 (±1.1)	6.2 (±0.4)	6.2 (±1.4)
	48	3.8 (±0.1)	2.95 (±0.4)	5.0 (±2.5)	3.9 (±0.1)	5.9 (±1.7)	4.8 (±1.9)	4.2 (±1.8)	4.9 (±1.4)
	72	4.2 (±0.7)	2.4 (±1.5)	6.8 (±1.2)	6.2 (±1.8)	5.4 (±1.7)	3.7 (±0.1)	5.0 (±2.3)	5.0 (±1)
(*Z*)-**24**	24	3.7 (±0.1)	–[b]	6.9 (±0.4)	6.7 (±3.5)	5.3 (±2.3)	3.7 (±0.5)	5.8 (±2.1)	7.5 (±0.2)
	48	3.6 (±0.04)	2.6 (±0.7)	5.2 (±2.6)	3.7 (±0.6)	6.1 (±0.9)	5.2 (±2.4)	5.1 (±1.7)	5.1 (±1.1)
	72	6.6 (±1.4)	7.5 (±0.1)	8.8 (±1.6)	6.6 (±1.3)	16.2 (±13)	4.7 (±3.3)	4.6 (±1)	5.8 (±0.4)
(*E*)-**29**	24	0.6 (±0.3)	2.2 (±1.8)	4.0 (±4.9)	8.6 (±0.6)	0.7 (±0.3)	1.8 (±0.1)	2.6 (±2.4)	≤0.5
	48	0.8 (±0.4)	4.8 (±0.1)	2.1 (±0.3)	14.1 (±6.7)	≤0.5	8.4 (±0.5)	2.7 (±2)	≤0.5
	72	4.0 (±2.4)	3.0 (±2.3)	21.5 (±45)	8.7 (±0.9)	1.9 (±2.0)	4.1 (±12.0)	2.5 (±28)	6.0 (±33)
(*Z*)-**29**	24	≤0.5	–[b]	6.5 (±8.3)	42.8 (±16.2)	1.1 (±0.4)	4.01 (±0.5)	10.8 (±4.9)	≤0.5
	48	≤0.5	4.1 (±2.3)	3.7 (±4.6)	15.8 (±1.5)	≤0.5	11.7 (±4)	2.3 (±2.3)	0.7 (±0.4)
	72	12,2 (± 4.3)	16,6 (±4.9)	–[b]	18,2 (± 7.1)	0.9 (± 0.7)	4.6 (± 1.1)	0.6 (± 0.1)	0.6 (± 0.2)
(*E*)-**35a**	24	3.0 (±0.01)	–[b]	5.1 (±3.9)	7.1 (±0.5)	2.5 (±0.5)	2.9 (±0.1)	6.3 (±1.3)	1.0 (±0.06)
	48	6.0 (±1.6)	2.2 (±1.1)	7.1 (±5.1)	7.4 (±0.7)	4.7 (±0.3)	11.8 (±5.4)	5.9 (±0.2)	3.7 (±0.01)
	72[b]	-	-	-	-	-	-	-	-
(*Z*)-**35a**	24	4.0 (±0.3)	–[b]	6.8 (±2.5)	9.4 (±0.8)	4.1 (±0.3)	3.83 (±0.4)	8.0 (±1.6)	3.1 (±0.4)
	48	7.9 (±0.1)	1.9 (±1.4)	6.1 (±3.3)	6.8 (±2.1)	5.6 (±1.3)	9.5 (±1.3)	5.2 (±0.4)	3.6 (±1.2)
	72	9.8 (± 2.9)	5.1 (± 3.4)	14.4 (±11.8)	8.3 (±1.8)	9 (±0.4)	4.9 (±2.7)	4.9 (±1.8)	2.8 (±1.9)
(*E*)-**35b**	24	4.4 (±0.5)	–[b]	7.0 (±0.6)	5.1 (±3.2)	4.3 (±0.4)	2.9 (±0.4)	7.9 (±1.2)	6.8 (±1.3)
	48	4.6 (±0.2)	2 (±1.5)	5.5 (±3.3)	5.2 (±2.4)	6.1 (±2.4)	6.8 (±1.4)	5.3 (±1)	6.6 (±0.6)
	72	4.5 (± 0.7)	1.0 (±0.01)	24 (± 1.8)	3.31 (± 0.3)	3.82 (± 1.0)	3.82 (± 0.2)	3.4 (± 1.1)	4.8 (± 0.3)
(*Z*)-**35b**	24	3.8 (±0.1)	–[b]	7.4 (±1.4)	8.2 (±0.1)	7.0 (±1)	7.57 (±0.5)	8.4 (±1.1)	5.4 (±1.7)
	48	5.6 (±0.5)	2.6 (±0.2)	5.0 (±2.1)	5.8 (±2.9)	7.4 (±4.5)	6.0 (±0.1)	5.1 (±1)	5.1 (±0.3)
	72	4.17 (±0.5)	4.2 (±3.6)	7.4 (±2.2)	6.7 (±0.2)	6.9 (±0.6)	2.7 (±0.2)	3.8 (±1.1)	3 (±2.9)

(*E*)-**35c**	24	3.5 (±0.1)	–[b]	18.3 (±4.1)	5.9 (±0.2)	16.5 (±11.9)	5.8 (±0.1)	15 (±8.8)	7.5 (±1)
	48	7.9 (±1.9)	5.7 (±0.1)	10.8 (±4.2)	6.4 (±1)	–[b]	7.2 (±2.9)	8.5 (±0.1)	7.6 (±0.4)
	62	7.9 (±2)	6.6 (±1.7)	28.3 (± 6)	6.7 (±0.5)	27.0 (±3.3)	5.5 (±0.9)	6.9 (±0.02)	6.2 (±2.9)
(*Z*)- **35c**	24	8.2 (±0.7)	–[b]	26.3 (±1.9)	6.3 (±2.1)	34.1 (±7.1)	6.9 (±3)	19.5 (±6.3)	8.8 (±1)
	48	8.2 (±1.8)	6.3 (±0.6)	10.0 (±4.7)	7.0 (±0.9)	20.7 (±13.1)	12.4 (±5.3)	9.0 (±1.3)	9.7 (±2.6)
	72	9.6 (±2.7)	–[b]	27.4 (±9)	7.1 (±0.7)	27.8 (±1.5)	6.6 (±2.4)	7.7 (±0.6)	5.8 (±3.6)
(*E*)-**35d**	24	3.8 (±0.8)	–[b]	15.1 (±7.9)	5.6 (±0.3)	12.3 (±5.3)	3.7 (±4)	9.2 (±0.6)	6.8 (±1.1)
	48[b]	-	-	-	-	-	-	-	-
	72	6.1 (±1.7)	5.1 (±3.3)	23.1 (±13.6)	5.4 (±0.4)	8.4 (±0.8)	3.8 (±1.4)	5.1 (±1.9)	4.4 (±1.1)
(*Z*)-**35d**	24	6.3 (±2.3)	–[b]	9.2 (±0.1)	6.1 (±1.7)	34 (±10.3)	5.3 (±1.5)	16 (±2.1)	5.5 (±2.4)
	48	6.8 (±3.2)	5.5 (±1.1)	9.6 (±7.7)	5.8 (±1.6)	18.2 (±13.5)	7.6 (±1.4)	7.8 (±2.3)	7.2 (±0.4)
	72	4.6 (±4.4)	3.6 (±0.01)	11.2 (±5.5)	4.2 (±3.6)	–[b]	1.9 (±1.4)	3.8 (±1.9)	3.8 (±4.1)
cisplatin	72	17.5 (±0.5)	15.2 (±0.3)	13.1 (±0.2)	20.87 (±0.3)	15.6 (±0.3)	16.2 (±0.6)	15.3 (±0.5)	9.5 (±0.2)

[a] The potency of compounds was determined using MTT assay after 24 h, 48 h and 72 h incubation of cells and given as IC_{50} (concentration of a tested compound that decreased the number of viable cells to 50% relative to untreated control cells).

[b] Not detected.

Experimental

All commercial reagents were used in the highest available purity from Aldrich or Acros Organics without further purification. Solvents were dried and purified before use according to standard procedures. For flash column chromatography on silica gel, Kieselgel 60 (0.040-0.063 mm, 230-400 mesh, Merck) was used. Solvents for flash chromatography (hexane, ethyl acetate, methanol, dichloromethane) were distilled before use. Thin layer chromatography was run on Merck silica gel 60 F_{254} analytical plates; detection was carried out with either ultraviolet light (254 nm), or spraying with a solution of phosphomolybdic acid, a basic potassium permanganate solution, or a solution of concentrated H_2SO_4, with subsequent heating. ^{1}H NMR and ^{13}C NMR spectra were recorded in $CDCl_3$ and CD_3OD on a Varian Mercury Plus 400 FT NMR (400.13 MHz for ^{1}H and 100.61 MHz for ^{13}C) spectrometer. For ^{1}H, δ are given in parts per million (ppm) either relative to TMS (δ = 0.0) as the internal standard or to the solvent signals CD_3OD (δ = 4.84 or δ = 3.31) and for ^{13}C relative to $CDCl_3$ (δ = 77.16) and CD_3OD (δ = 49.05). The multiplicity of the ^{13}C NMR signals concerning the ^{13}C-^{1}H coupling was determined by the HSQC method. Chemical shifts (in ppm) and coupling

constants (in Hz) were obtained by first-order analysis; assignments were derived from COSY and H/C correlation spectra. Infrared (IR) spectra were measured with a Nicolet 6700 FT-IR spectrometer and expressed in *v* values (cm^{-1}). High-resolution mass spectra (HRMS) were recorded on a micrOTOF-Q II quadrupole-time of flight hybrid mass spectrometer (Bruker Daltonics). Elemental analysis was performed on a Perkin-Elmer CHN 2400 elemental analyser. Optical rotations were measured on a P-2000 Jasco polarimeter and reported as follows: $[\alpha]_D$ (*c* in grams per 100 mL, solvent). Melting points were recorded on a Kofler hot block, and are uncorrected. Small quantities of reagents (μL) were measured with appropriate syringes (Hamilton). All reactions were performed under an atmosphere of nitrogen, unless otherwise noted.

General procedure for the preparation of (*E*)-phenyldiazenylbenzoates (14a-14d)

A solution of ethyl 4-nitrosobenzoate **12**[27] (1.20 mmol) in acetic acid (10 mL) was treated with the corresponding anilines **11a-d** (1.00 mmol) at room temperature. After being stirred overnight at this temperature, the solid parts were filtered off. To a filtrate was added water (150 mL), the resulting precipitate was removed by filtration, and dissolved in dichloromethane. The organic phase was dried over Na_2SO_4, the solvent was evaporated, and the residue was purified by recrystallization from methanol to give the corresponding products **14a-d**.

Ethyl (*E*)-4-[(4-ethylphenyl)diazenyl]benzoate (14a). Using the aforementioned general procedure, the title compound **14a** (0.183 g, 65%) was obtained as an orange solid, mp 72–73 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.30 (3H, t, J = 7.6 Hz, CH_3), 1.43 (3H, t, J = 7.1 Hz, CH_3), 2.75 (2H, q, J = 7.6 Hz, CH_2), 4.42 (2H, q, J = 7.1 Hz, CH_2), 7.36 (2H, d, J = 8.2 Hz, Ph), 7.88 (2H, d, J = 8.3 Hz, Ph), 7.93 (2H, d, J = 8.4 Hz, Ph), 8.19 (2H, d, J = 8.4 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.5 (CH_3), 15.5 (CH_3), 29.1 (CH_2), 61.4 (CH_2), 122.6 (2 × CH_{Ph}), 123.4 (2 × CH_{Ph}), 128.8 (2 × CH_{Ph}), 130.7 (2 × CH_{Ph}), 132.0 (C_i), 148.8 (C_i), 151.0 (C_i), 155.4 (C_i), 166.3 (C=O). Anal. Calcd for $C_{17}H_{18}N_2O_2$: C, 73.32; H, 6.43; N, 9.92. Found: C, 73.43; H, 6.31; N, 10.10.

Ethyl (*E*)-4-[(4-propylphenyl)diazenyl]benzoate (14b). Using the aforementioned general procedure, the title compound **14b** (0.186 g, 63%) was obtained as an orange solid, mp 73–74 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.97 (3H, t, J = 7.3 Hz, CH_3), 1.43 (3H, t, J = 7.1 Hz, CH_3), 1.64–1.75 (2H, m, CH_2), 2.65–2.70 (2H, m, CH_2), 4.41 (2H, q, J = 7.1 Hz, CH_2), 7.33 (2H, d, J = 8.5 Hz, Ph), 7.87 (2H, d, J = 8.4 Hz, Ph), 7.93 (2H, d, J = 8.8 Hz), 8.19 (2H, d, J = 8.8 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.9 (CH_3), 14.5 (CH_3), 24.5 (CH_2), 38.1 (CH_2), 61.4 (CH_2), 122.6 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 129.4 (2 × CH_{Ph}), 130.7 (2 × CH_{Ph}), 132.0 (C_i), 147.3 (C_i), 151.0 (C_i), 155.4 (C_i), 166.3 (C=O). Anal. Calcd for $C_{18}H_{20}N_2O_2$: C, 72.95; H, 6.80; N, 9.45. Found: C, 73.13; H, 6.69; N, 9.60.

Ethyl (*E*)-4-[(4-butylphenyl)diazenyl]benzoate (14c). Using the aforementioned general procedure, the title compound **14c** (0.183 g, 59%) was obtained as an orange solid, mp 57–58 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.95 (3H, t, J = 7.3 Hz, CH_3), 1.35–1.46 (5H, m, CH_3, CH_2), 1.59–1.70 (2H, m, CH_2), 2.64–2.75 (2H, m, CH_2), 4.41 (2H, q, J = 7.2 Hz, CH_2), 7.33 (2H, d, J = 8.4 Hz, Ph), 7.87 (2H, d, J = 8.4 Hz, Ph), 7.93 (2H, d, J = 8.6 Hz), 8.19 (2H, d, J = 8.7 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1 (CH_3), 14.5 (CH_3), 22.5 (CH_2), 33.5 (CH_2), 35.8 (CH_2), 61.4 (CH_2), 122.6 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 130.7 (2 × CH_{Ph}), 132.0 (C_i), 147.5 (C_i), 151.0 (C_i), 155.4 (C_i), 166.2 (C=O). Anal. Calcd for $C_{19}H_{22}N_2O_2$: C, 73.52; H, 7.14; N, 9.03. Found: C, 73.38; H, 7.29; N, 8.89.

Ethyl (*E*)-4-[(4-pentylphenyl)diazenyl]benzoate (14d). Using the aforementioned general procedure, the title compound **14d** (0.175 g, 54%) was obtained as an orange solid, mp 53–54 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.90 (3H, t, J = 7.0 Hz, CH_3), 1.32–1.38 (H, m, 2 × CH_2), 1.43 (3H, t, J = 7.1 Hz, CH_3), 1.61–1.71 (2H, m, CH_2), 2.66–2.72 (2H, m, CH_2), 4.41 (2H, q, J = 7.2 Hz, CH_2), 7.34 (2H, d, J = 8.5 Hz, Ph), 7.87 (2H, d, J = 8.4 Hz, Ph), 7.93 (2H, d, J = 8.7 Hz), 8.19 (2H, d, J = 8.8 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.2 (CH_3), 14.5 (CH_3), 22.7 (CH_2), 31.1 (CH_2), 31.6 (CH_2), 36.1 (CH_2), 61.4 (CH_2), 122.6 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 130.7 (2 × CH_{Ph}), 132.0 (C_i), 147.6 (C_i), 151.0 (C_i), 155.4 (C_i), 166.3 (C=O). Anal. Calcd for $C_{20}H_{24}N_2O_2$: C, 74.05; H, 7.46; N, 8.63. Found: C, 73.88; H, 7.63; N, 8.78.

General procedure for the preparation of (*E*)-[4-(phenyldiazenyl)phenyl]methanols (15a-15d)
To a suspension of $LiAlH_4$ (1.20 mmol) in dry Et_2O (4 mL) that had been pre-cooled to –20 °C were added esters **14a-d** (1.00 mmol) in dry Et_2O (2.5 mL), respectively. The resulting mixture was stirred for 1 h at this temperature. After cautious addition of 10% aq NaOH solution (0.5 mL), the salts were removed by filtration through a small pad of Celite, washed with ethyl acetate, and the solvents were evaporated. The residue was subjected to flash chromatography on silica gel (toluene/ethyl acetate, 4:1) to give the corresponding products **15a-d**.

(*E*)-{4-[(4-Ethylphenyl)diazenyl]phenyl}methanol (15a). According to the aforementioned procedure, compound **15a** (0.233 g, 97%) was obtained as an orange solid, mp 129–130 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.29 (3H, t, J = 7.6 Hz, CH_3), 1.51–1.96 (1H, m, OH), 2.73 (2H, q, J = 7.6 Hz, CH_2), 4.78 (2H, s, CH_2), 7.34 (2H, d, J = 8.4 Hz, Ph), 7.50 (2H, d, J = 8.5 Hz, Ph), 7.85 (2H, d, J = 8.4 Hz, Ph), 7.90 (2H, d, J = 8.4 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 15.6 (CH_3), 29.0 (CH_2), 65.1 (CH_2), 123.1 (4 × CH_{Ph}), 127.6 (2 × CH_{Ph}), 128.7 (2 × CH_{Ph}), 143.6 (C_i), 148.0 (C_i), 151.1 (C_i), 152.4 (C_i). Anal. Calcd for $C_{15}H_{16}N_2O$: C, 74.97; H, 6.71; N, 11.66. Found: C, 75.11; H, 6.86; N, 11.40.

(*E*)-{4-[(4-Propylphenyl)diazenyl]phenyl}methanol (15b). According to the aforementioned general procedure, compound **15b** (0.201 g, 79%) was obtained as an orange solid, mp 128–129 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.97 (3H, t, J = 7.3 Hz, CH_3), 1.63–1.75 (2H, m, CH_2), 1.79 (1H, t, J = 5.9 Hz, OH), 2.64–2.70 (2H, m, CH_2), 4.79 (2H, d, J = 5.6 Hz, CH_2), 7.32 (2H, d, J = 8.4 Hz, Ph), 7.51 (2H, d, J = 8.6 Hz, Ph), 7.84 (2H, d, J = 8.4 Hz, Ph), 7.90 (2H, d, J = 8.4 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.9 (CH_3), 24.6 (CH_2), 38.1 (CH_2), 65.1 (CH_2), 123.0 (2 × CH_{Ph}), 123.1 (2 × CH_{Ph}), 127.6 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 143.6 (C_i), 146.5 (C_i), 151.1 (C_i), 152.4 (C_i). Anal. Calcd for $C_{16}H_{18}N_2O$: C, 75.56; H, 7.13; N, 11.01. Found: C, 75.69; H, 7.27; N, 10.87.

(*E*)-{4-[(4-Butylphenyl)diazenyl]phenyl}methanol (15c). According to the aforementioned general procedure, compound **15c** (0.185 g, 69%) was obtained as an orange solid, mp 124–125 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.94 (3H, t, J = 7.3 Hz, CH_3), 1.33–1.44 (2H, m, CH_2), 1.59–1.71 (2H, m, CH_2), 1.80 (1H, t, J = 6.0 Hz, OH), 2.66–2.72 (2H, m, CH_2), 4.78 (2H, d, J = 5.9 Hz, CH_2), 7.32 (2H, d, J = 8.4 Hz, Ph), 7.50 (2H, d, J = 8.5 Hz, Ph), 7.84 (2H, d, J = 8.4 Hz, Ph), 7.90 (2H, d, J = 8.4 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1 (CH_3), 22.5 (CH_2), 33.6 (CH_2), 35.7 (CH_2), 65.1 (CH_2), 123.0 (2 × CH_{Ph}), 123.1 (2 × CH_{Ph}), 127.6 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 143.6 (C_i), 146.7 (C_i), 151.1 (C_i), 152.4 (C_i). Anal. Calcd for $C_{17}H_{20}N_2O$: C, 76.09; H, 7.51; N, 10.44. Found: C, 76.24; H, 7.68; N, 10.27.

(*E*)-{4-[(4-Pentylphenyl)diazenyl]phenyl}methanol (15d). According to the aforementioned general procedure, compound **15d** (0.229 g, 81%) was obtained as an orange solid, mp 121–123 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.91 (3H, t, J = 7.0 Hz, CH_3), 1.31–1.39 (4H, m, 2 × CH_2), 1.61–1.72 (2H, m, CH_2), 1.75 (1H, t, J = 6.0 Hz, OH), 2.64–2.72 (2H, m, CH_2), 4.79 (2H, d, J = 5.9 Hz, CH_2), 7.32 (2H, d, J = 8.5 Hz, Ph), 7.51 (2H, d, J = 8.6 Hz, Ph), 7.84 (2H, d, J = 8.4 Hz, Ph), 7.90 (2H, d, J = 8.4 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.2 (CH_3), 22.7 (CH_2), 31.1 (CH_2), 31.6 (CH_2), 36.0 (CH_2), 65.1 (CH_2), 123.0 (2 × CH_{Ph}), 123.1 (2 × CH_{Ph}), 127.6 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 143.6 (C_i), 146.8 (C_i), 151.1 (C_i), 152.4 (C_i). Anal. Calcd for $C_{18}H_{22}N_2O$: C, 76.56; H, 7.85; N, 9.92. Found: C, 76.38; H, 7.70; N, 9.74.

General procedure for the preparation of (*E*)-1-[4-(bromomethyl)phenyl]-2-phenyldiazenes (16a-16d)

To a solution of compounds **15a-d** (1.00 mmol) in dry THF (11 mL) were successively added Ph_3P (0.49 g, 1.87 mmol) and NBS (0.33 g, 1.87 mmol) at 0 °C. After being stirred overnight at room temperature, the resulting mixture was filtered through a small pad of Celite, and concentrated. The

residue was flash-chromatographed on silica gel (toluene) to provide the corresponding products **16a-d**.

(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-ethylphenyl)diazene (16a). Using the aforementioned general procedure, compound **16a** (0.282 g, 93%) was obtained as an orange solid, mp 92–94 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.29 (3H, t, J = 7.6 Hz, CH_3), 2.74 (2H, q, J = 7.6 Hz, CH_2), 4.55 (2H, s, CH_2), 7.34 (2H, d, J = 8.5 Hz, Ph), 7.53 (2H, d, J = 8.4 Hz, Ph), 7.83–7.89 (4H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 15.6 (CH_3), 29.0 (CH_2), 33.0 (CH_2), 123.2 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 128.7 (2 × CH_{Ph}), 130.0 (2 × CH_{Ph}), 140.3 (C_i), 148.3 (C_i), 151.1 (C_i), 152.6 (C_i). Anal. Calcd for $C_{15}H_{15}BrN_2$: C, 59.42; H, 4.99; N, 9.24. Found: C, 59.26; H, 5.14; N, 9.41.

(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-propylphenyl)diazene (16b). Using the aforementioned general procedure, compound **16b** (0.301 g, 95%) was obtained as an orange solid, mp 121–123 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.97 (3H, t, J = 7.3 Hz, CH_3), 1.64–1.75 (2H, m, CH_2), 2.63–2.70 (2H, m, CH_2), 4.55 (2H, s, CH_2), 7.32 (2H, d, J = 8.5 Hz, Ph), 7.53 (2H, d, J = 8.5 Hz, Ph), 7.82–7.89 (4H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.0 (CH_3), 24.6 (CH_2), 33.0 (CH_2), 38.1 (CH_2), 123.1 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 130.0 (2 × CH_{Ph}), 140.3 (C_i), 146.8 (C_i), 151.1 (C_i), 152.6 (C_i). Anal. Calcd for $C_{16}H_{17}BrN_2$: C, 60.58; H, 5.40; N, 8.83. Found: C, 60.70; H, 5.59; N, 8.66.

(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-butylphenyl)diazene (16c). Using the aforementioned general procedure, compound **16c** (0.308 g, 93%) was obtained as an orange solid, mp 84–86 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.94 (3H, t, J = 7.3 Hz, CH_3), 1.32–1.44 (2H, m, CH_2), 1.59–1.69 (2H, m, CH_2), 2.65–2.72 (2H, m, CH_2), 4.55 (2H, s, CH_2), 7.32 (2H, d, J = 8.4 Hz, Ph), 7.52 (2H, d, J = 8.4 Hz, Ph), 7.81–7.90 (4H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1 (CH_3), 22.5 (CH_2), 33.0 (CH_2), 33.6 (CH_2), 35.8 (CH_2), 123.1 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 130.0 (2 × CH_{Ph}), 140.3 (C_i), 147.0 (C_i), 151.0 (C_i), 152.6 (C_i). Anal. Calcd for $C_{17}H_{19}BrN_2$: C, 61.64; H, 5.78; N, 8.46. Found: C, 61.47; H, 5.63; N, 8.59.

(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-pentylphenyl)diazene (16d). Using the aforementioned general procedure, compound **16d** (0.325 g, 94%) was obtained as an orange solid, mp 89–90 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.91 (3H, t, J = 7.0 Hz, CH_3), 1.28–1.40 (4H, m, 2 × CH_2), 1.61–1.72 (2H, m, CH_2), 2.65–2.71 (2H, m, CH_2), 4.55 (2H, s, CH_2), 7.32 (2H, d, J = 8.5 Hz, Ph), 7.52 (2H, d, J = 8.5 Hz, Ph), 7.82–7.90 (4H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.2 (CH_3), 22.7 (CH_2), 31.1 (CH_2), 31.6 (CH_2), 33.0 (CH_2), 36.0 (CH_2), 123.1 (2 × CH_{Ph}), 123.3 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 130.0 (2 × CH_{Ph}), 140.3 (C_i), 147.0 (C_i), 151.0 (C_i), 152.6 (C_i). Anal. Calcd for $C_{18}H_{21}BrN_2$: C, 62.61; H, 6.13; N, 8.11. Found: C, 62.46; H, 6.01; N, 8.28.

General procedure for the preparation of (*E*)-[4-(phenyldiazenyl)benzyl]triphenylphosphonium bromides (17a-17d)

Triphenylphosphane (1.00 mmol) was added to a solution of bromoazobenzenes **16a-d** (1.00 mmol) in toluene (10.5 mL) at room temperature. After being stirred and heated overnight at 100 ºC, the solid material was removed by filtration, washed with toluene, and dried under high vacuum for 6 h. This procedure yielded the corresponding salts **17a-d**.

(*E*)-{4-[(4-Ethylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17a). Using the aforementioned general procedure, compound **17a** (0.543 g, 96%) was obtained as an orange solid, mp 147 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.27 (3H, t, J = 7.6 Hz, CH_3), 2.71 (2H, q, J = 7.6 Hz, CH_2), 5.64 (2H, d, J = 15.0 Hz, CH_2), 7.23–7.32 (4H, m, Ph), 7.55–7.65 (8H, m, Ph), 7.71–7.84 (11H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 15.4 (CH_3), 28.9 (CH_2), 30.6 (d, J = 47.0 Hz, CH_2), 117.7 (d, J = 85.7 Hz, 3 × C_i), 122.8 (CH_{Ph}), 122.9 (CH_{Ph}), 123.1 (2 × CH_{Ph}), 128.6 (2 × CH_{Ph}), 130.1 (3 × CH_{Ph}), 130.2 (3 × CH_{Ph}), 132.5 (CH_{Ph}), 132.6 (CH_{Ph}), 134.5 (3 × CH_{Ph}), 134.6 (3 × CH_{Ph}), 135.0 (3 × CH_{Ph}), 148.2 (C_i), 150.7 (C_i), 152.2 (2 × C_i). Anal. Calcd for $C_{33}H_{30}BrN_2P$: C, 70.09; H, 5.35; N, 4.95. Found: C, 69.92; H, 5.16; N, 5.13.

(*E*)-{4-[(4-Propylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17b). Using the aforementioned general procedure, compound **17b** (0.498 g, 86%) was obtained as an orange solid, mp 238 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.96 (3H, t, J = 7.3 Hz, CH_3), 1.62–1.74 (2H, m, CH_2), 2.61–2.68 (2H, m, CH_2), 5.65 (2H, d, J = 15.0 Hz, CH_2), 7.23–7.33 (4H, m, Ph), 7.55–7.65 (8H, m, Ph), 7.71–7.85 (11H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.9 (CH_3), 24.5 (CH_2), 30.8 (d, J = 46.9 Hz, CH_2), 38.1 (CH_2), 117.9 (d, J = 85.8 Hz, 3 × C_i), 122.9 (CH_{Ph}), 122.97 (CH_{Ph}), 123.0 (2 × CH_{Ph}), 129.3 (2 × CH_{Ph}), 130.2 (3 × CH_{Ph}), 130.3 (3 × CH_{Ph}), 132.6 (2 × CH_{Ph}), 134.6 (3 × CH_{Ph}), 134.7 (3 × CH_{Ph}), 135.0 (3 × CH_{Ph}), 146.8 (C_i), 150.9 (C_i), 152.3 (C_i), 152.4 (C_i). Anal. Calcd for $C_{34}H_{32}BrN_2P$: C, 70.47; H, 5.57; N, 4.83. Found: C, 70.30; H, 5.37; N, 4.99.

(*E*)-{4-[(4-Butylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17c). Using the aforementioned general procedure, compound **17c** (0.546 g, 92%) was obtained as an orange solid, mp 234 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.94 (3H, t, J = 7.3 Hz, CH_3), 1.32–1.43 (2H, m, CH_2), 1.59–1.68 (2H, m, CH_2), 2.64–2.70 (2H, m, CH_2), 5.65 (2H, d, J = 15.0 Hz, CH_2), 7.24–7.32 (4H, m, Ph), 7.56–7.66 (8H, m, Ph), 7.72–7.84 (11H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$): δ 14.0 (CH_3), 22.4 (CH_2), 30.8 (d, J = 46.5 Hz, CH_2), 33.5 (CH_2), 35.7 (CH_2), 117.8 (d, J = 85.7 Hz, 3 × C_i), 122.9 (CH_{Ph}), 123.0 (3 × CH_{Ph}), 129.2 (2 × CH_{Ph}), 130.2 (3 × CH_{Ph}), 130.3 (3 × CH_{Ph}), 132.6 (2 × CH_{Ph}),

134.6 (3 × CH_{Ph}), 134.7 (3 × CH_{Ph}), 135.0 (3 × CH_{Ph}), 147.0 (C_i), 150.8 (C_i), 152.3 (C_i), 152.4 (C_i). Anal. Calcd for $C_{35}H_{34}BrN_2P$: C, 70.83; H, 5.77; N, 4.72. Found: C, 70.97; H, 5.94; N, 4.57.

(*E*)-{4-[(4-Pentylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17d). Using the aforementioned procedure, compound **17d** (0.486 g, 80%) was obtained as an orange solid, mp 236 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.90 (3H, t, J = 7.0 Hz, CH_3), 1.28–1.39 (4H, m, 2 × CH_2), 1.60–1.70 (2H, m, CH_2), 2.62–2.69 (2H, m, CH_2), 5.66 (2H, d, J = 15.0 Hz, CH_2), 7.24–7.33 (4H, m, Ph), 7.56–7.66 (8H, m, Ph), 7.72–7.85 (11H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1 (CH_3), 22.6 (CH_2), 30.7 (d, J = 47.4 Hz, CH_2), 31.0 (CH_2), 31.6 (CH_2), 36.0 (CH_2), 117.8 (d, J = 85.7 Hz, 3 × C_i), 122.9 (2 × CH_{Ph}), 123.0 (2 × CH_{Ph}), 129.2 (2 × CH_{Ph}), 130.2 (3 × CH_{Ph}), 130.3 (3 × CH_{Ph}), 132.6 (2 × CH_{Ph}), 134.6 (3 × CH_{Ph}), 134.7 (3 × CH_{Ph}), 135.0 (3 × CH_{Ph}), 147.0 (C_i), 150.8 (C_i), 152.3 (2 × C_i). Anal. Calcd for $C_{36}H_{36}BrN_2P$: C, 71.17; H, 5.97; N, 4.61. Found: C, 71.02; H, 6.13; N, 4.74.

(4*S*)-4-{(1''*S*)-(Benzyloxy)[(4'*R*)-2',2'-dimethyl-1',3'-dioxolan-4'-yl]methyl}oxazolidin-2-one (19). A solution of **18**[26h] (81 mg, 0.24 mmol) in dry THF (1.5 mL) that had been pre-cooled to 0 °C was successively treated with NaH (19 mg, 0.80 mmol, a ~60% suspension of NaH in mineral oil). After being stirred at 0 °C for 10 min, and then at room temperature for another 30 min, MeOH was added to decompose the excess hydride. The solvent was evaporated and the residue was partitioned between CH_2Cl_2 (20 mL) and saturated aq NH_4Cl solution (20 mL). The aqueous layer was then washed with further portions of CH_2Cl_2 (2 × 20 mL). The combined organic extracts were dried over Na_2SO_4, concentrated, and the residue was subjected to flash chromatography on silica gel (hexane/EtOAc, 1:1) to afford compound **19** in the quantitative yield (74 mg) as white crystals; mp 80 °C. $[\alpha]_D^{25}$ –17.7 (*c* 0.51, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.33 (3H, s, CH_3), 1.42 (3H, s, CH_3), 3.45–3.49 (1H, m, $H_{1''}$), 3.79 (1H, dd, J = 8.7, 1.4 Hz, $H_{5'}$), 4.06–4.12 (3H, m, $H_{5'}$, $H_{4'}$, H_4), 4.38 (1H, dd, J = 8.8, 6.0 Hz, H_5), 4.41–4.48 (1H, m, H_5), 4.62–4.64 (2H, m, OCH_2Ph), 6.09–6.13 (1H, m, NH), 7.24–7.37 (5H, m, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 24.9 (CH_3), 26.5 (CH_3), 54.0 (C_4), 66.7 (C_5), 67.0 ($C_{5'}$), 74.4 (OCH_2Ph), 75.8 ($C_{4'}$), 80.2 ($C_{1''}$), 109.8 ($C_{2'}$), 128.0 (2 × CH_{Ph}), 128.3 (CH_{Ph}), 128.6 (2 × CH_{Ph}), 137.0 (C_i), 159.7 (C=O). Anal. Calcd for $C_{16}H_{21}NO_5$: C, 62.53; H, 6.89; N, 4.56. Found: C, 62.61; H, 6.99; N, 4.37.

(4*S*)-4-{(1''*S*)-[(4'*R*)-2',2'-Dimethyl-1',3'-dioxolan-4'-yl](hydroxy)methyl}oxazolidin-2-one (25). 10% Pd/C (0.14 g) was added to a solution of oxazolidinone **19** (0.10 g, 0.33 mmol) in dry MeOH (8 mL). The suspension was degassed three times and was stirred under an atmosphere of hydrogen at room temperature. After 3 h, the mixture was filtered through a small pad of Celite, and the filtrate was concentrated to afford product **25** in 98% yield (69 mg) as a transparent thick oil. $[\alpha]_D^{21}$ +3.6 (*c* 0.36, MeOH). ^{1}H NMR (400 MHz, CD_3OD) δ 1.32 (3H, s, CH_3), 1.39 (3H, s, CH_3),

3.53 (1H, dd, J = 7.7, 4.0 Hz, $H_{1''}$), 3.90 (1H, dd, J = 8.2, 5.6 Hz, $H_{5'}$), 3.94–3.97 (1H, m, $H_{4'}$), 4.03 (1H, ddd, J = 8.9, 5.7, 4.0 Hz, H_4), 4.10 (1H, dd, J = 8.2, 6.2 Hz, $H_{5'}$), 4.39–4.49 (2H, m, H_5); ^{13}C NMR (100 MHz, CD_3OD) δ 25.5 (CH_3), 27.0 (CH_3), 55.9 (C_4), 67.1 (C_5), 68.2 ($C_{5'}$), 73.6 ($C_{1''}$), 77.5 ($C_{4'}$), 111.0 ($C_{2'}$), 162.6 (C=O). Anal. Calcd for $C_9H_{15}NO_5$: C, 49.76; H, 6.96; N, 6.45. Found: C, 49.89; H, 7.08; N, 6.61.

(4*S*)-3-(*tert*-Butyldimethylsilyl-4-{(1''*S*)-[(4'*R*)-2',2'-dimethyl-1',3'-dioxolan-4'-yl](hydroxy)methyl}oxazolidin-2-one (26). To a solution of **25** (69 mg, 0.32 mmol) in dry DMF (0.3 mL) were successively added Et_3N (0.22 mL, 1.58 mmol), DMAP (11 mg, 0.09 mmol) and TBDMSCl (0.119 g, 0.79 mmol). After being stirred for 1 h at room temperature, the mixture was poured into water (5 ml), and extracted with Et_2O (3 × 15 mL). The combined organic layers were washed with brine (10 mL), dried over Na_2SO_4, and concentrated. The residue was subjected to flash chromatography on silica gel (hexane/EtOAc, 2:1) to give 0.103 g (98%) of compound **26** a white crystalline compound, mp 92 °C. $[\alpha]_D^{21}$ –8.4 (*c* 0.19, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.30 (3H, s, CH_3), 0.36 (3H, s, CH_3), 1.00 (9H, s, 3 × CH_3), 1.32 (3H, s, CH_3), 1.40 (3H, s, CH_3), 2.74–2.93 (1H, m, OH), 3.57 (1H, m, $H_{1''}$), 3.88 (1H, ddd, J = 8.9, 6.4, 5.0 Hz, $H_{4'}$), 3.99 (1H, dd, J = 8.8, 4.9 Hz, $H_{5'}$) 4.10–4.14 (1H, m, H_4), 4.17 (1H, dd, J = 8.8, 6.5 Hz, $H_{5'}$), 4.25–4.31 (1H, m, H_5), 4.50 (1H, dd, J = 8.5, 2.6 Hz, H_5); ^{13}C NMR (100 MHz, $CDCl_3$) δ −4.6 (CH_3), −4.5 (CH_3), 19.4 (C_q), 25.1 (CH_3), 26.8 (CH_3), 27.0 (3 × CH_3), 58.0 (C_4), 63.9 (C_5), 67.9 ($C_{5'}$), 74.6 ($C_{4'}$), 75.0 ($C_{1''}$), 110.0 ($C_{2'}$), 162.7 (C=O). Anal. Calcd for $C_{15}H_{29}NO_5Si$: C, 54.35; H, 8.82; N, 4.23. Found: C, 54.19; H, 8.94; N, 4.10.

(4*S*)-4-{(*S*)-[(4'*R*)-2',2'-Dimethyl-1',3'-dioxolan-4'-yl][(*p*-methoxybenzyl)oxy]methyl}-3-(*p*-methoxybenzyl)oxazolidin-2-one (30). To a solution of **25** (50 mg, 0.23 mmol) in dry DMF that had been pre-cooled to 0 °C were successively added NaH (28 mg, 1.15 mmol, a ~60% suspension of NaH in mineral oil), *p*-methoxybenzyl bromide (0.09 mL, 0.69 mmol) and TBAI (18.5 mg, 0.05 mmol). The resulting mixture was stirred for 10 min at 0 °C and then for another 3 h at room temperature. The reaction was quenched by the addition of MeOH (0.5 mL) to remove the excess hydride. Then, water (6 mL) was added and the whole mixture was extracted with Et_2O (3 × 20 mL). The combined organic layers were dried over Na_2SO_4, the solvent was evaporated, and the residue was chromatographed on silica gel (hexane/EtOAc, 2:1) to afford compound **30** in the yield of 86% (91 mg) as a colourless oil. $[\alpha]_D^{20}$ −14.6 (*c* 0.22, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.27 (3H, s, CH_3), 1.32 (3H, s, CH_3), 3.59 (1H, dd, J = 9.1, 2.4 Hz, $H_{1''}$), 3.65 (1H, dd, J = 8.3, 5.3 Hz, $H_{5'}$), 3.74–3.80 (4H, m, NCH_2, OCH_3), 3.81 (3H, s, OCH_3), 3.86 (1H, ddd, J = 9.4, 5.4, 0.6 Hz, H_4), 3.91–3.97 (1H, m, $H_{4'}$), 4.01 (1H, dd, J = 8.3, 6.5 Hz, $H_{5'}$), 4.20 (1H, dd, J = 9.3, 8.7 Hz, H_5), 4.45–4.51 (3H, m,

OCH_2, H_5), 4.76 (1H, d, *J* = 15.0 Hz, NCH_2), 6.85 (2H, d, *J* = 8.6 Hz, Ph), 6.91 (2H, d, *J* = 8.6 Hz, Ph), 7.16 (2H, d, *J* = 8.6 Hz, Ph), 7.22 (2H, d, *J* = 8.6 Hz, Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 25.0 (CH_3), 26.7 (CH_3), 45.9 (NCH_2), 54.9 (C_4), 55.4 (OCH_3), 55.5 (OCH_3) 62.7 (C_5), 67.2 ($C_{5'}$), 73.6 (OCH_2), 74.8 ($C_{4'}$), 75.5 ($C_{1''}$), 109.9 ($C_{2'}$), 114.2 (2 × CH_{Ph}), 114.4 (2 × CH_{Ph}), 127.7 (C_i), 129.4 (C_i), 129.9 (4 × CH_{Ph}), 158.8 (C=O), 159.6 (C_i), 159.8 (C_i). Anal. Calcd for $C_{25}H_{31}NO_7$: C, 65.63; H, 6.83; N, 3.06. Found: C, 65.51; H, 6.69; N, 3.19.

Antiproliferative/cytotoxic activity

Cell culture

The following human cancer cell lines were used for this study: A-549 (non-small cell lung cancer), HeLa (cervical adenocarcinoma), MCF-7 (mammary gland adenocarcinoma), MDA-MB-231 (mammary gland adenocarcinoma), HCT-116 (human colon carcinoma), Caco-2 (human colon carcinoma), Jurkat (acute T-lymphoblastic leukaemia) and the non-cancerous cell line NiH 3T3 (mouse fibroblasts). The A-549, HCT-116, MCF-7, MDA-MB-231, Caco-2, Jurkat and HeLa cells were maintained in RPMI 1640 medium. The NiH 3T3 cell line was maintained in growth medium consisting of high glucose Dulbecco's Modified Eagle Medium. Both of these media were supplemented with Glutamax and with 10% (V/V) foetal calf serum, penicillin (100 IU × mL^{-1}) and streptomycin (100 mg × mL^{-1}) (all from Invitrogen, Carlsbad, CA USA) in an atmosphere of 5% CO_2 in humidified air at 37 °C. Cell viability, estimated by the trypan blue exclusion, was greater than 95% before each experiment.

Cytotoxicity assay

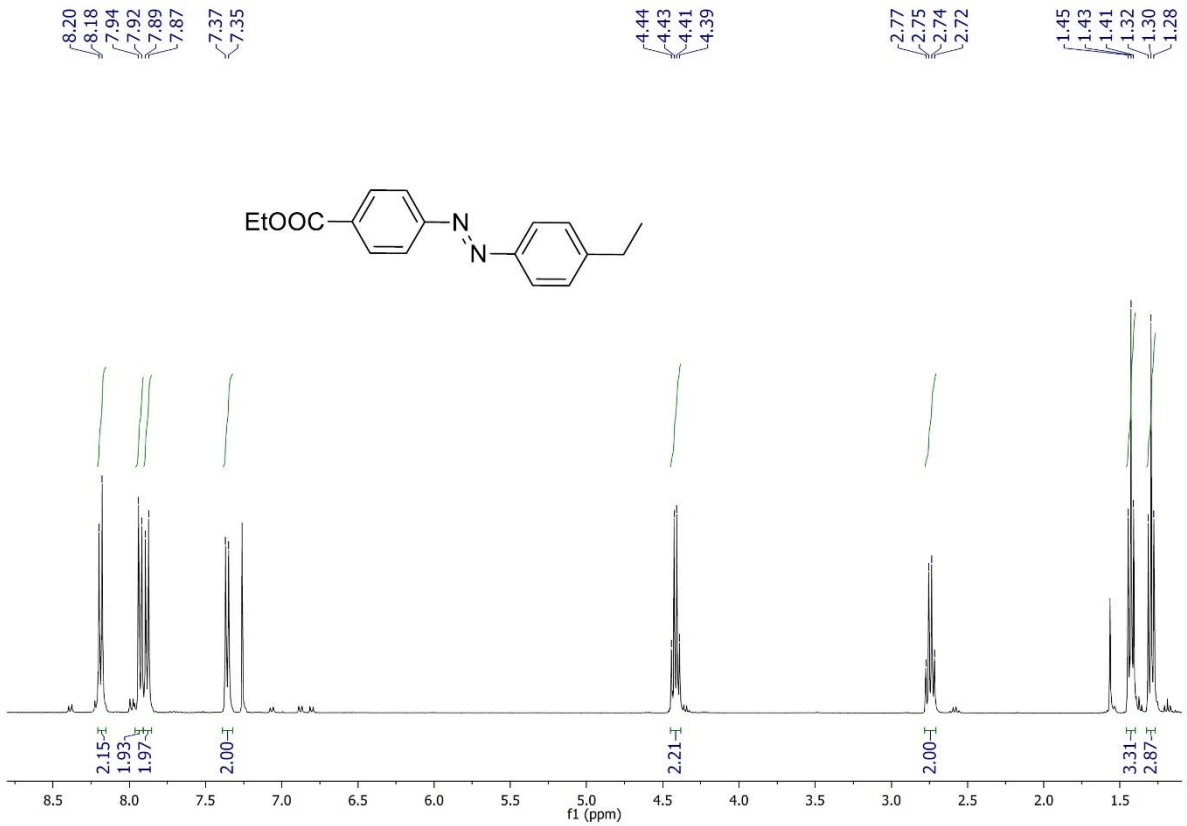
The cytotoxic effect of the tested compounds was studied using colourimetric microculture assay with the MTT endpoint.[28] The amount of MTT reduced to formazan was proportional to the number of viable cells. Briefly, 5 × 10^3 cells were plated per well in 96-well polystyrene microplates (Sarstedt, Germany) in the culture medium containing tested chemicals at final concentrations of 10^{-4}–10^{-6} mol × L^{-1}. To follow up the effect of UV radiation on compounds and their cytotoxic activity, each compound was exposed in the dark to UV radiation at wavelength 365 nm for 1h in DMSO to reach the photostationary state just prior to addition to the cell suspension. During the testing individual samples were kept in the dark at 37 °C, and IC_{50} values were recorded after 24, 48 and 72 h. After 24, 48 and 72 h of incubation, 10 μL of MTT (5 mg × mL^{-1}) were added into each well. After an additional 4 h, during which insoluble formazan was formed, 100 μL of 10% (m/m) sodium dodecylsulfate were added into each well, and another 12 h were allowed for the formazan to be

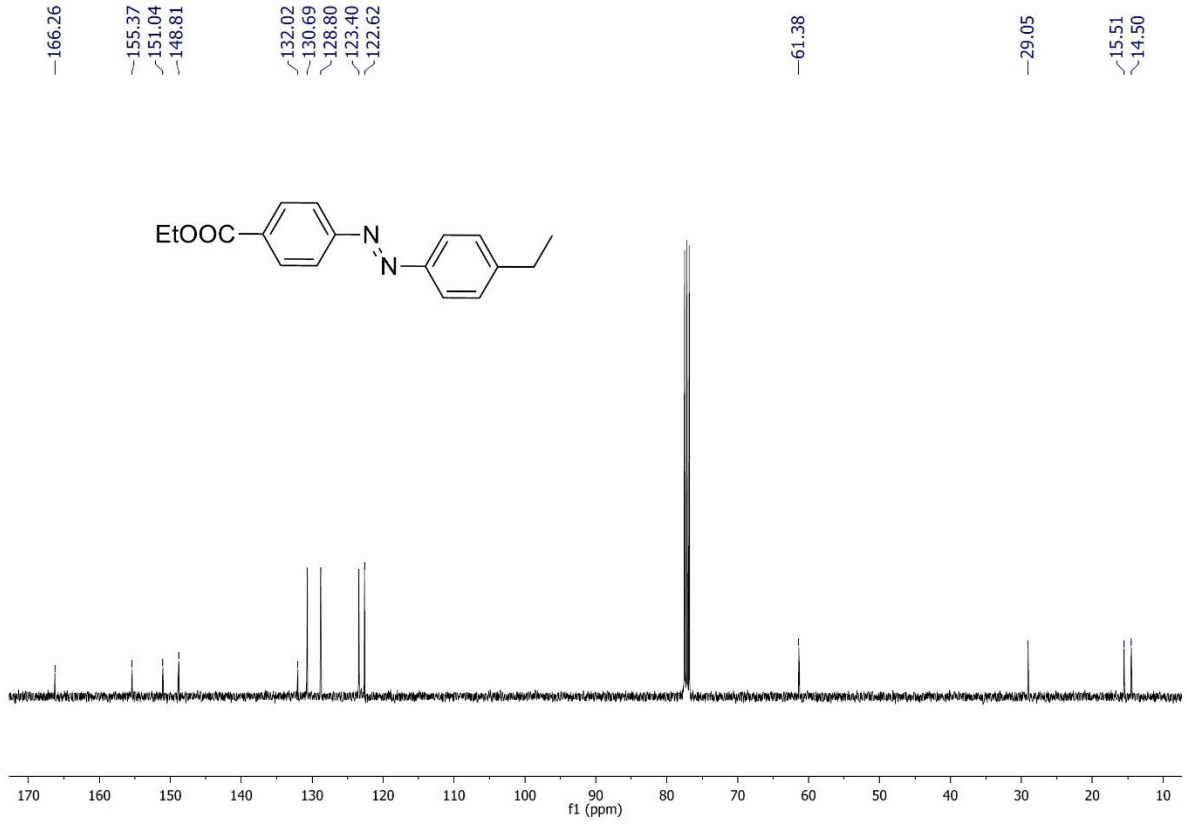
dissolved. The absorbance was measured at 540 nm using the automated uQuant^{TM} Universal Microplate Spectrophotometer (Biotek Instruments Inc., Winooski, VT USA). The blank corrected absorbance of the control wells was taken as 100%, and the results were expressed as a percentage of the control.

Photoisomerisation experiments

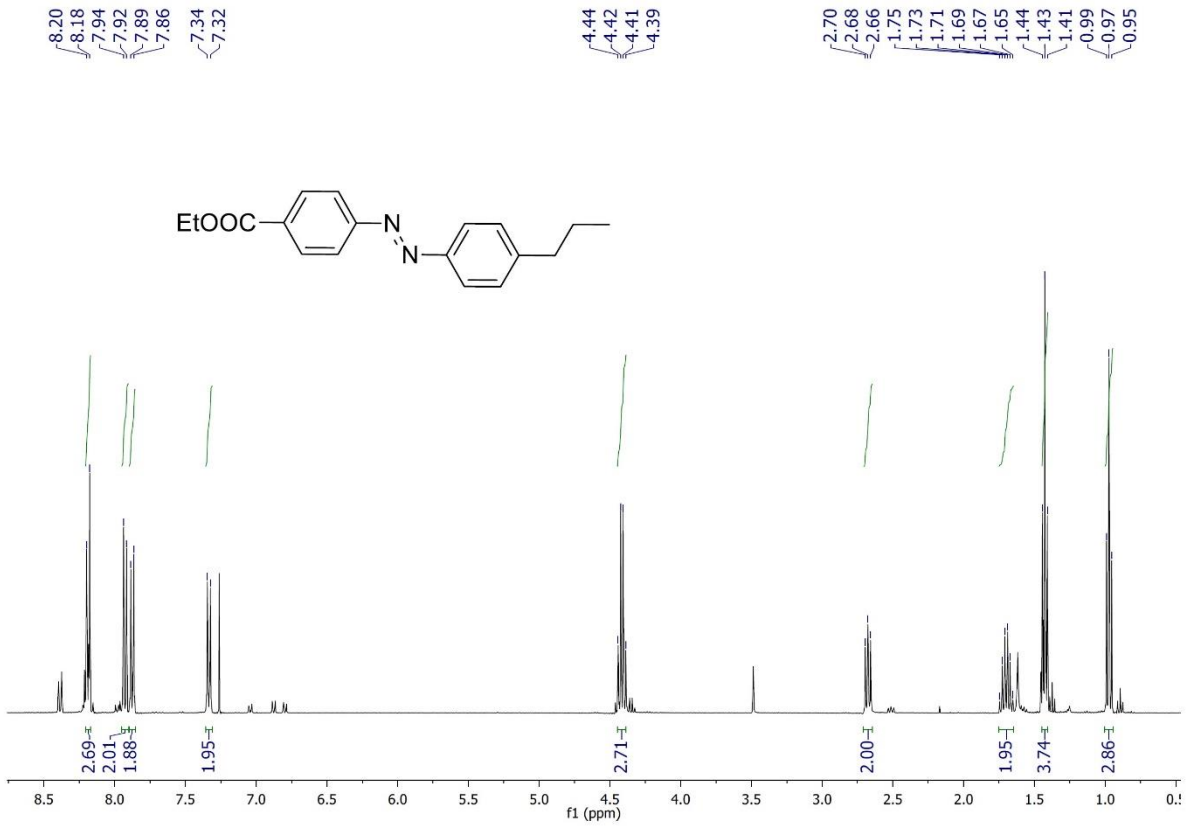
For the photoisomerisation experiments the sample solution was transferred into 10 mm Precision cells made of Quartz SUPRASIL® (110-QS). The sample-irradiation experiments with UV-light were performed using the Spectroline lamp (model ENB-280C/FE) with 365 nm wavelength. The sample-irradiation experiments with visible light were performed using a halide lamp (model GXH001, 20W halogen bulb) with an assembled filter for extraction of 420 nm wavelength light.

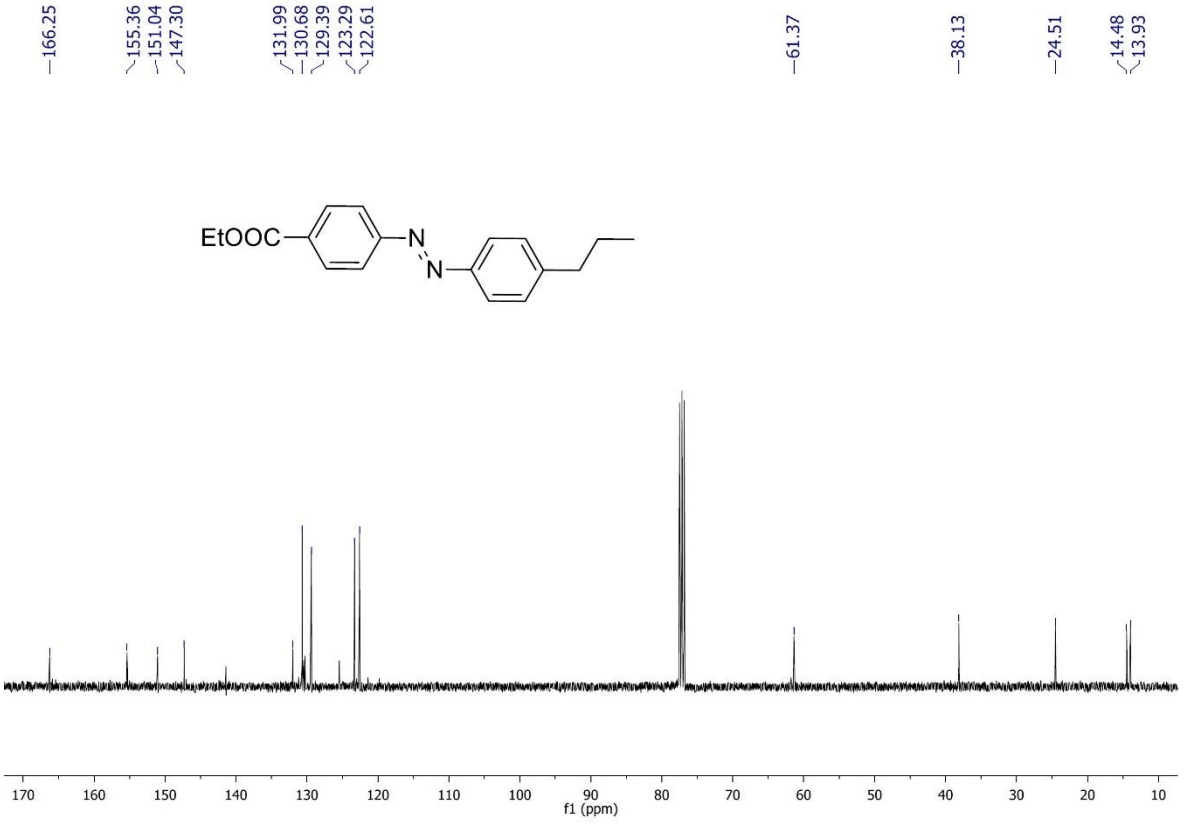
Ethyl (*E*)-4-[(4-ethylphenyl)diazenyl]benzoate (14a)



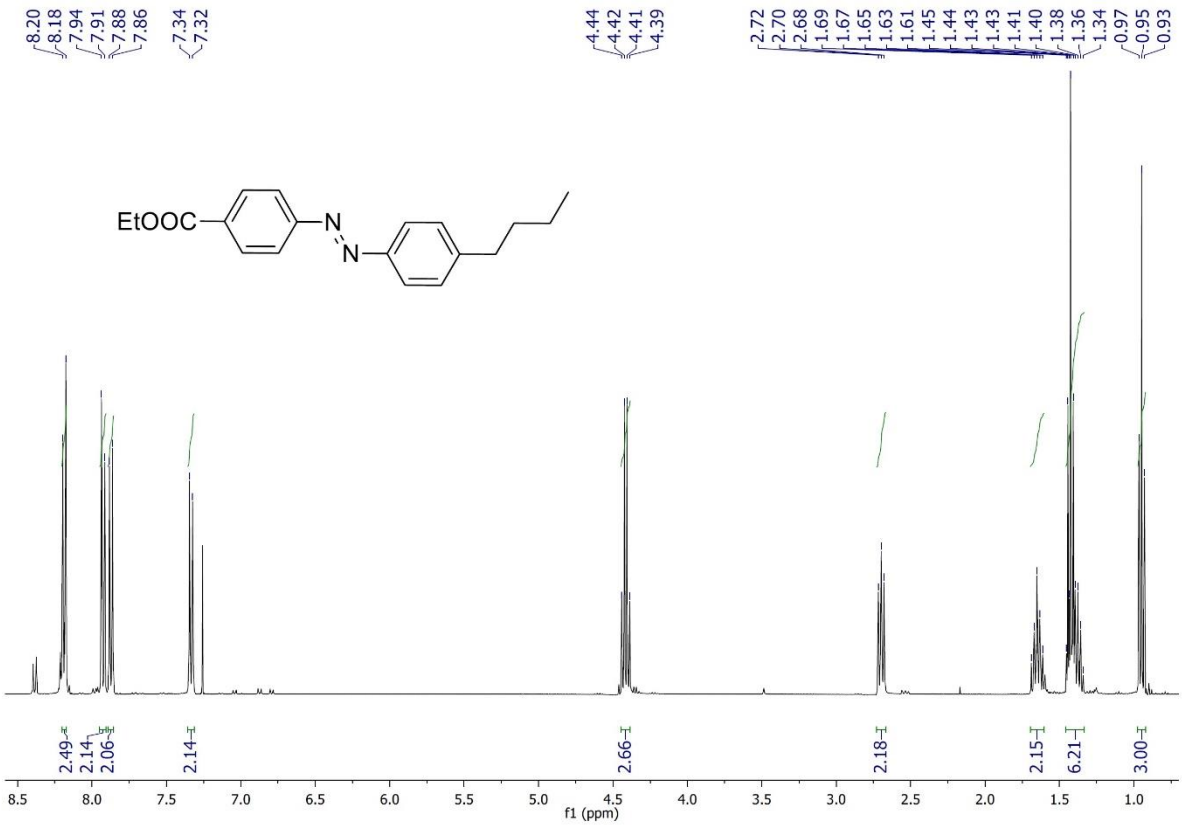


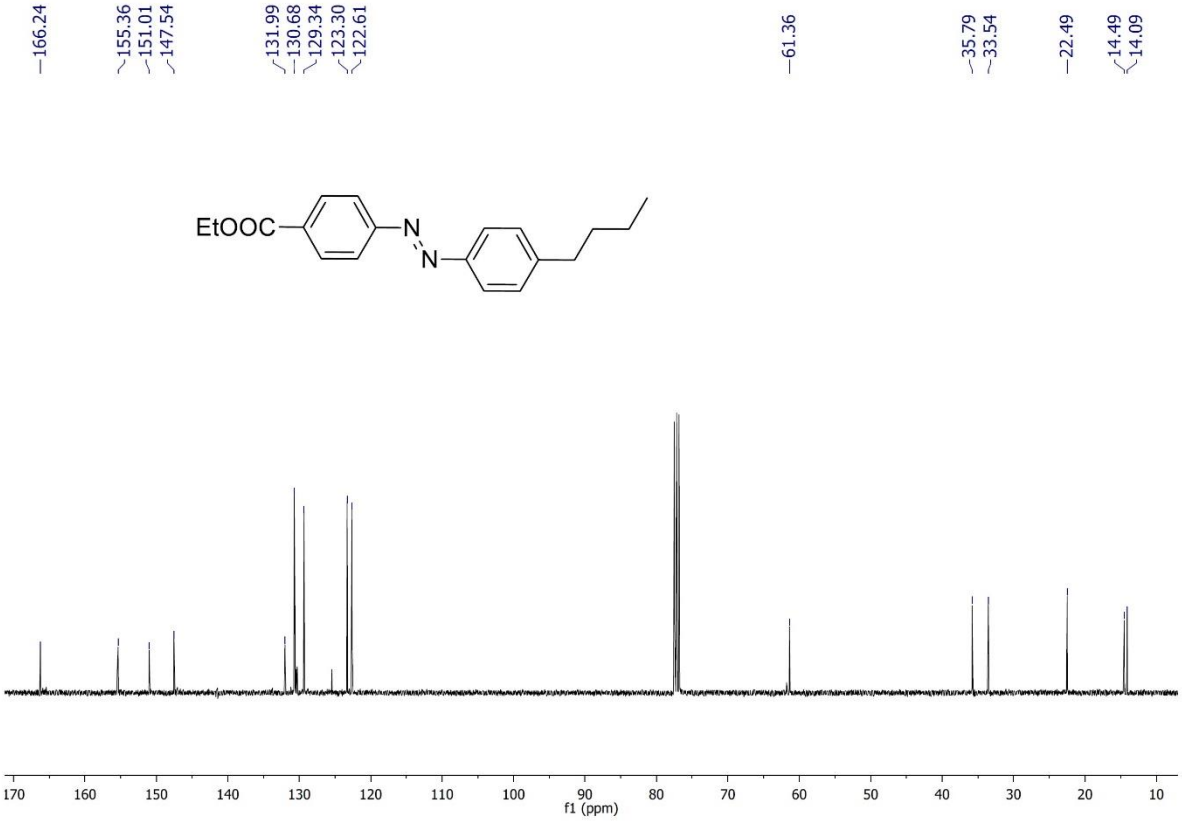
Ethyl (*E*)-4-[(4-propylphenyl)diazenyl]benzoate (14b)



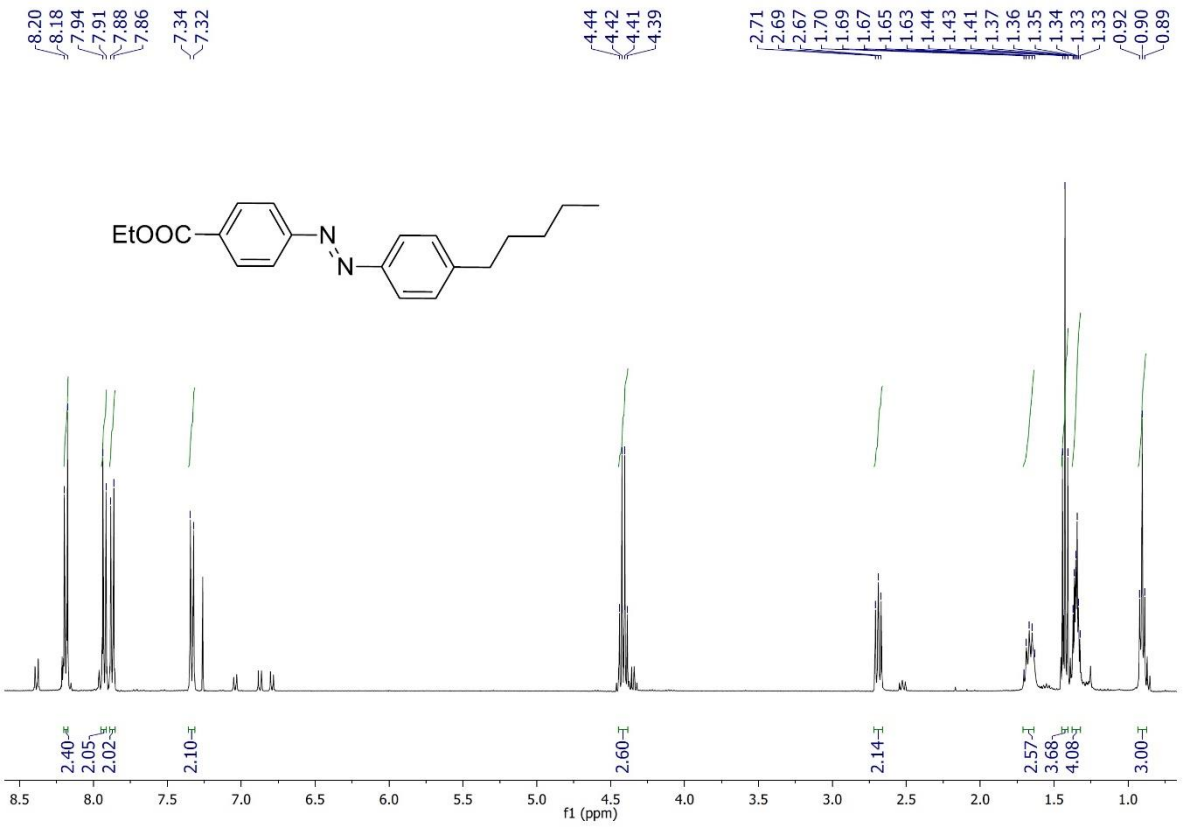


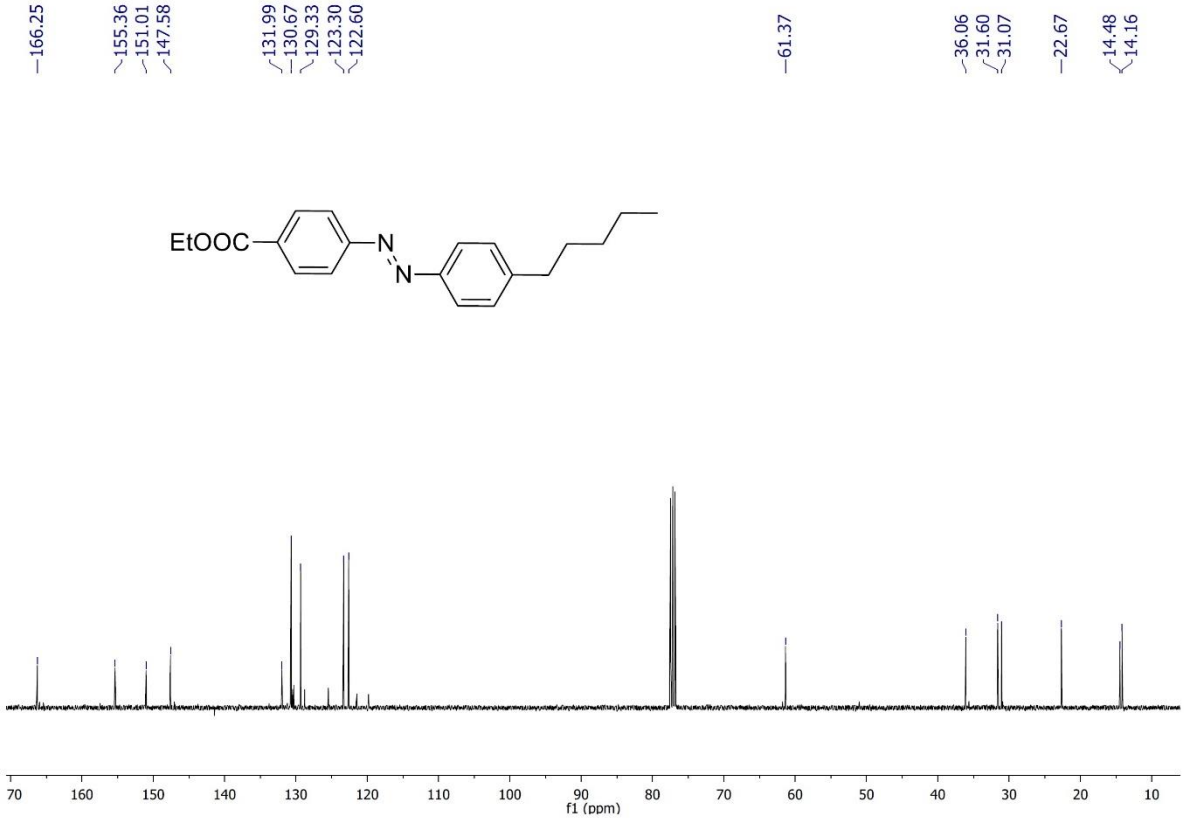
Ethyl (*E*)-4-[(4-butylphenyl)diazenyl]benzoate (14c)



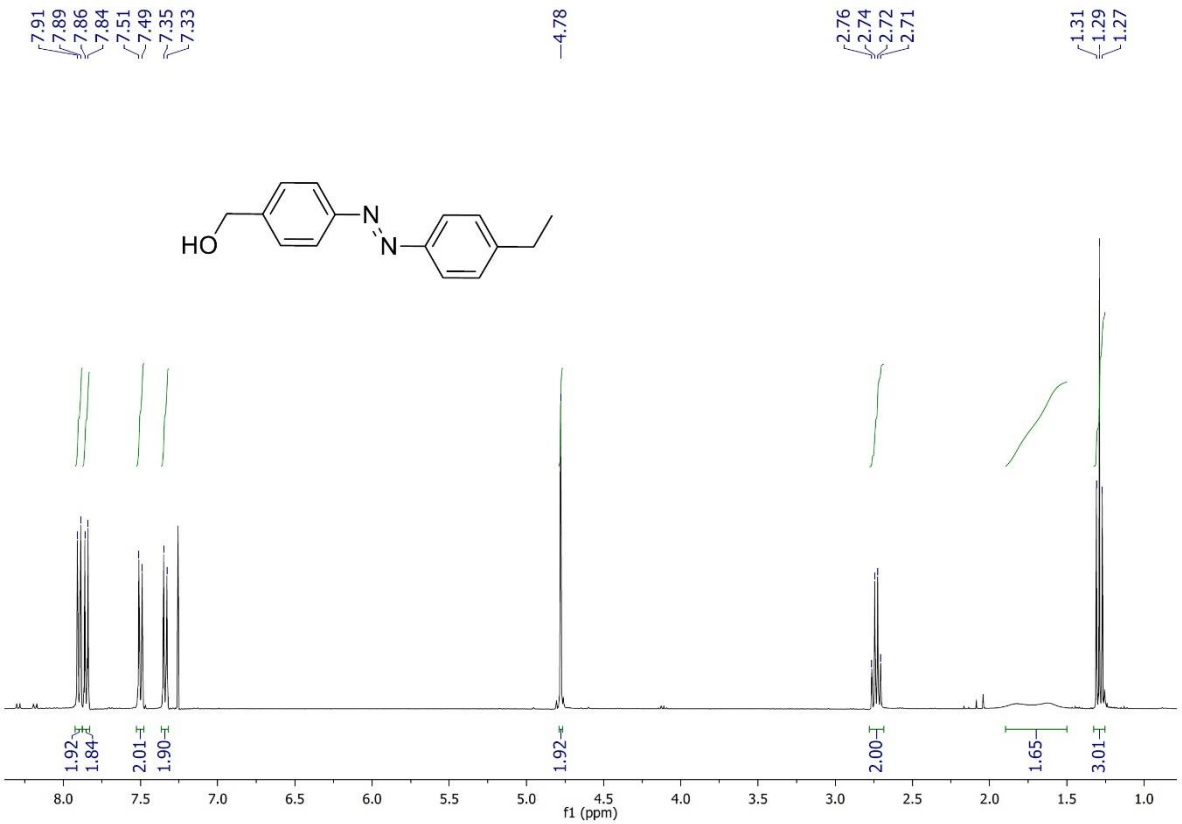


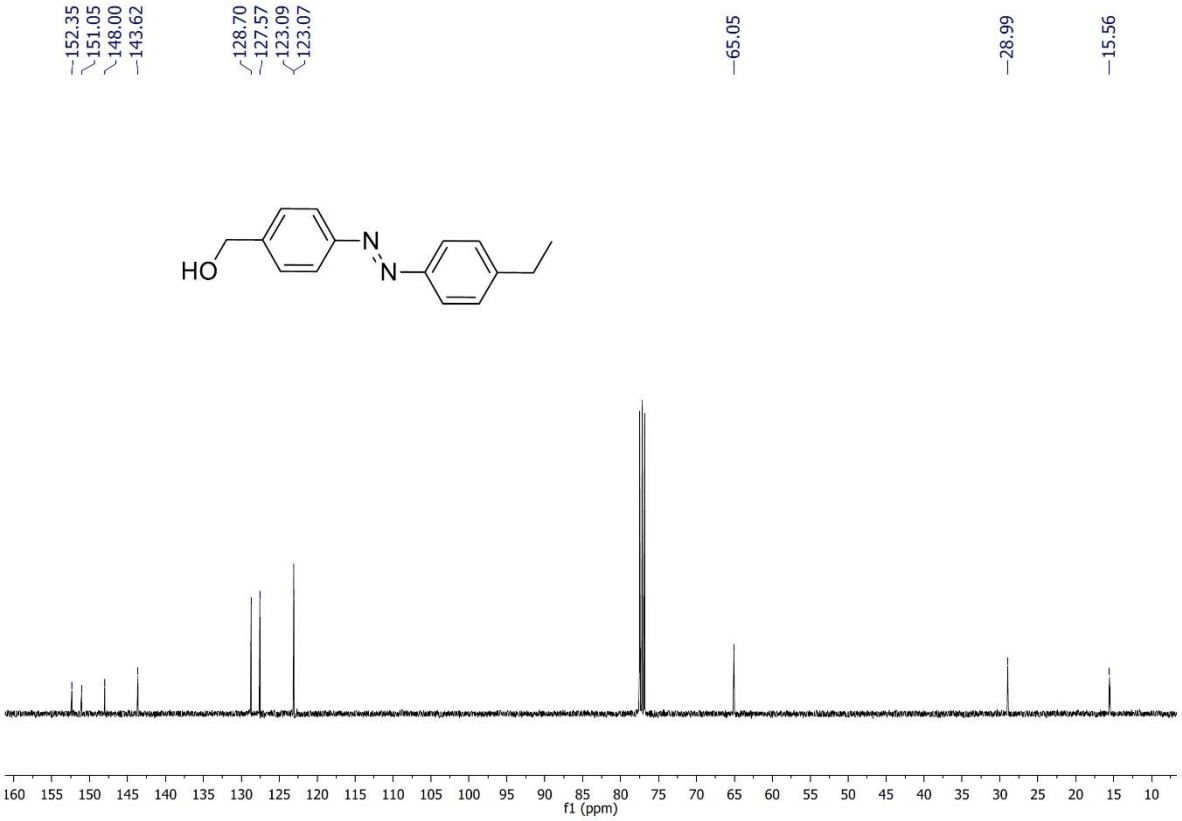
Ethyl (*E*)-4-[(4-pentylphenyl)diazenyl]benzoate (14d)



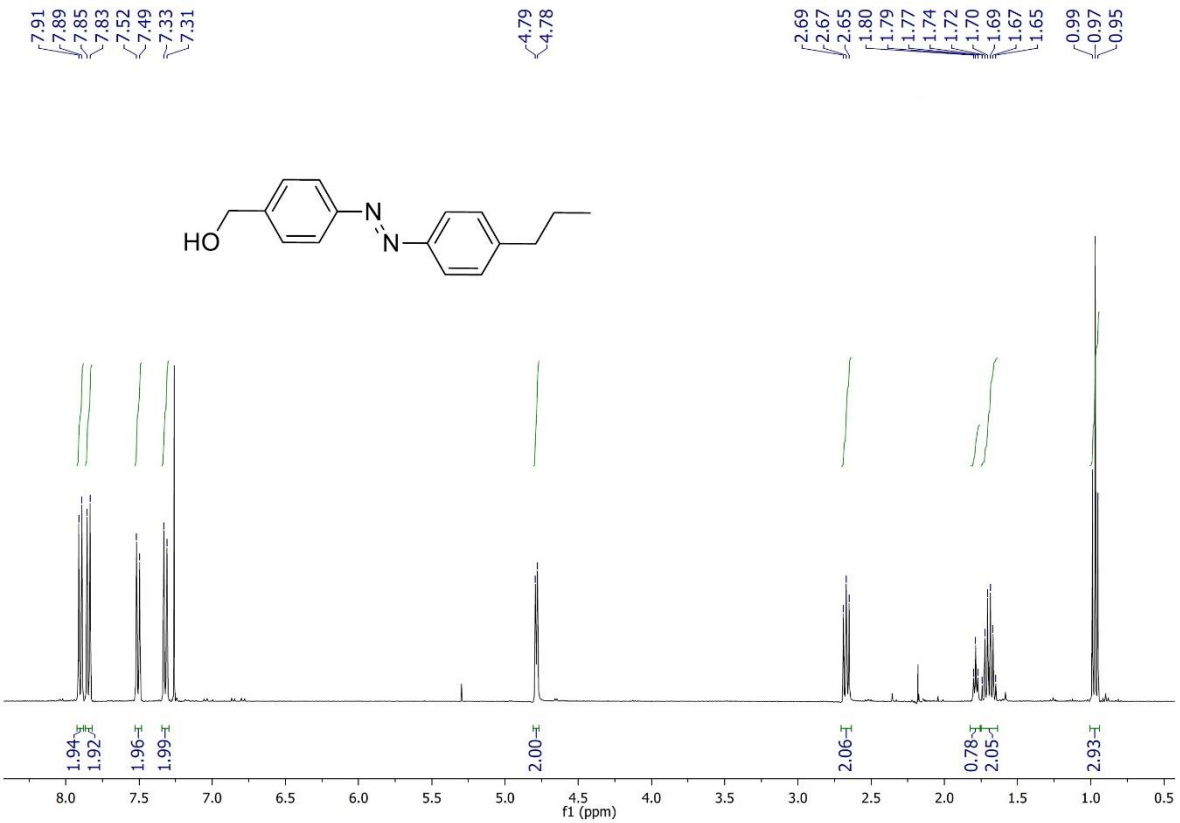


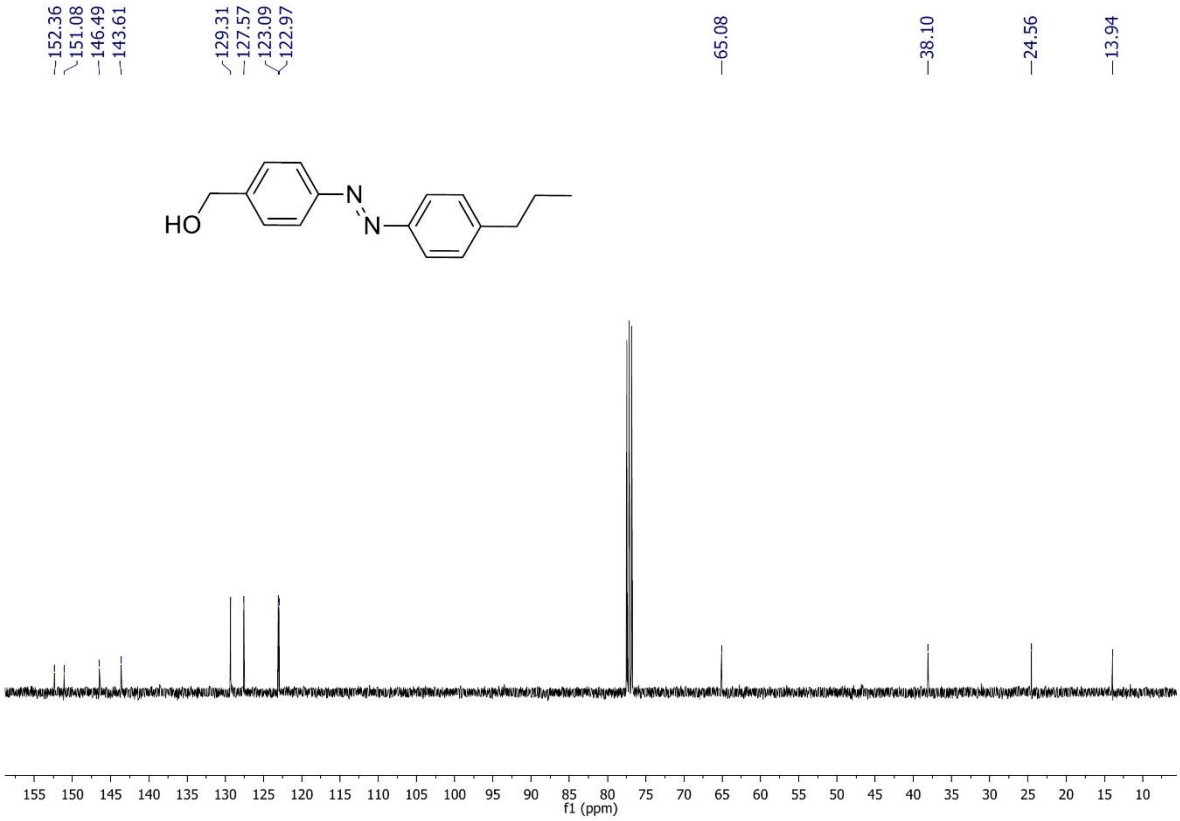
(*E*)-{4-[(4-Ethylphenyl)diazenyl]phenyl}methanol (15a)



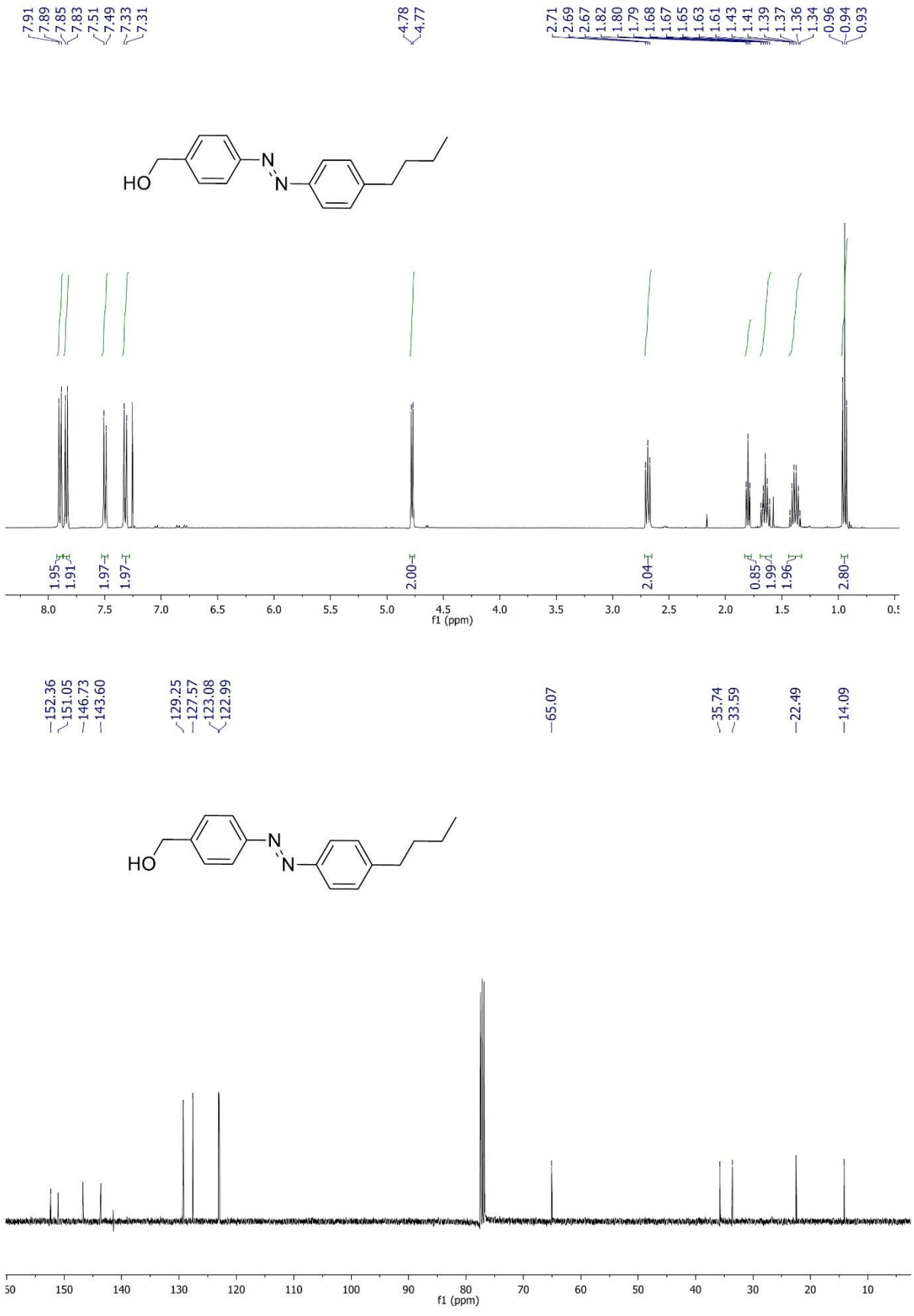


(*E*)-{4-[(4-Propylphenyl)diazenyl]phenyl}methanol (15b)

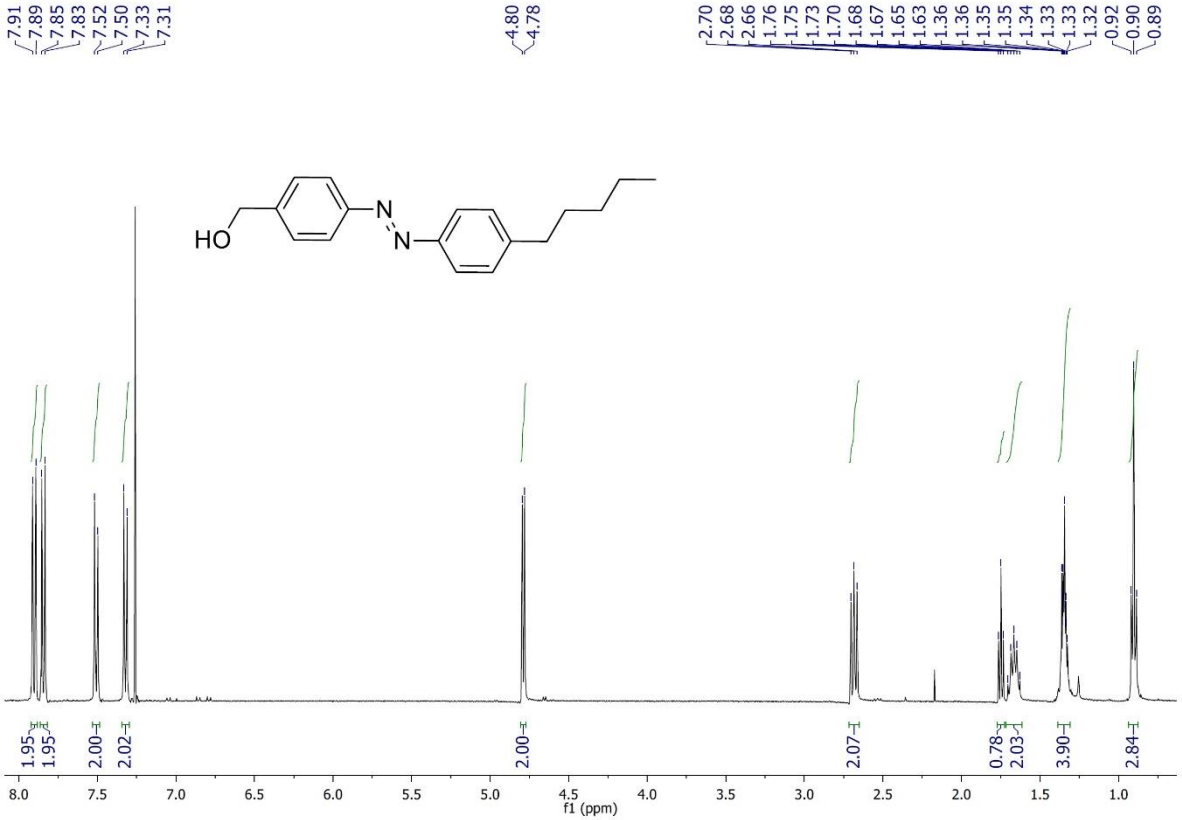


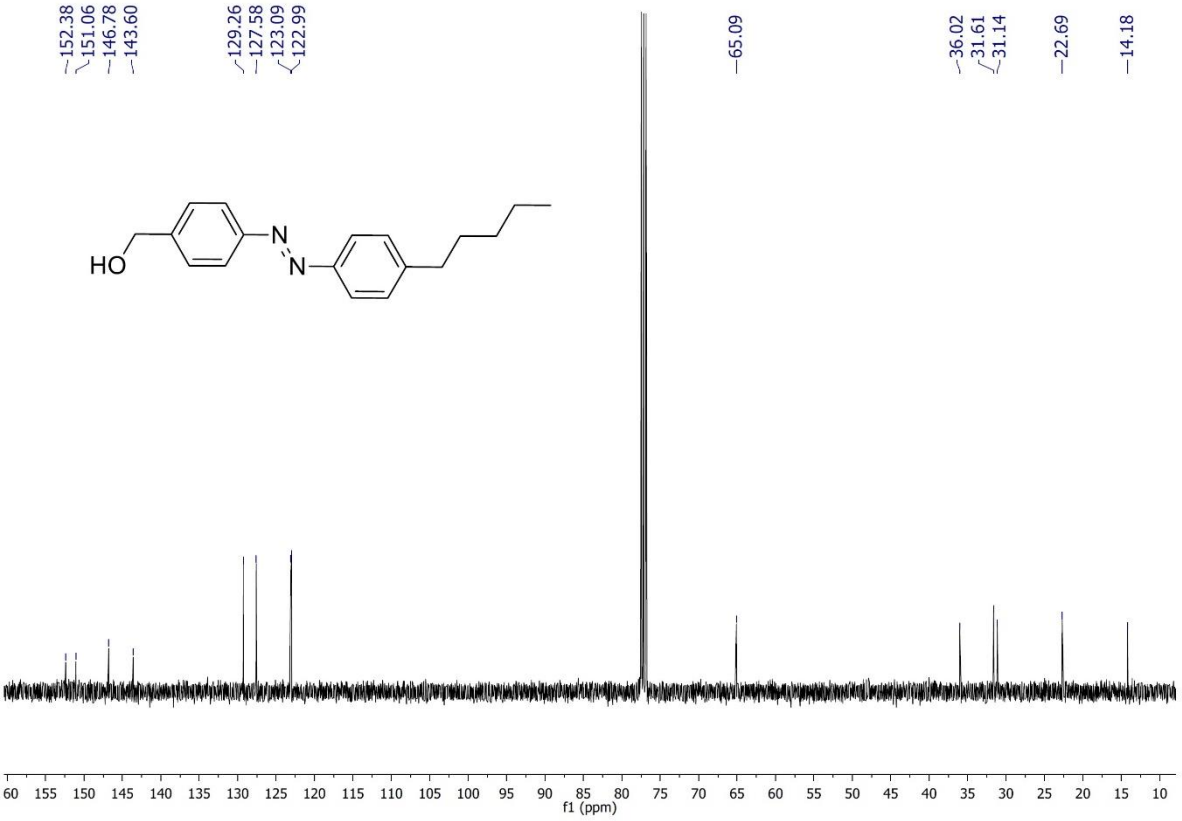


(*E*)-{4-[(4-Butylphenyl)diazenyl]phenyl}methanol (15c)

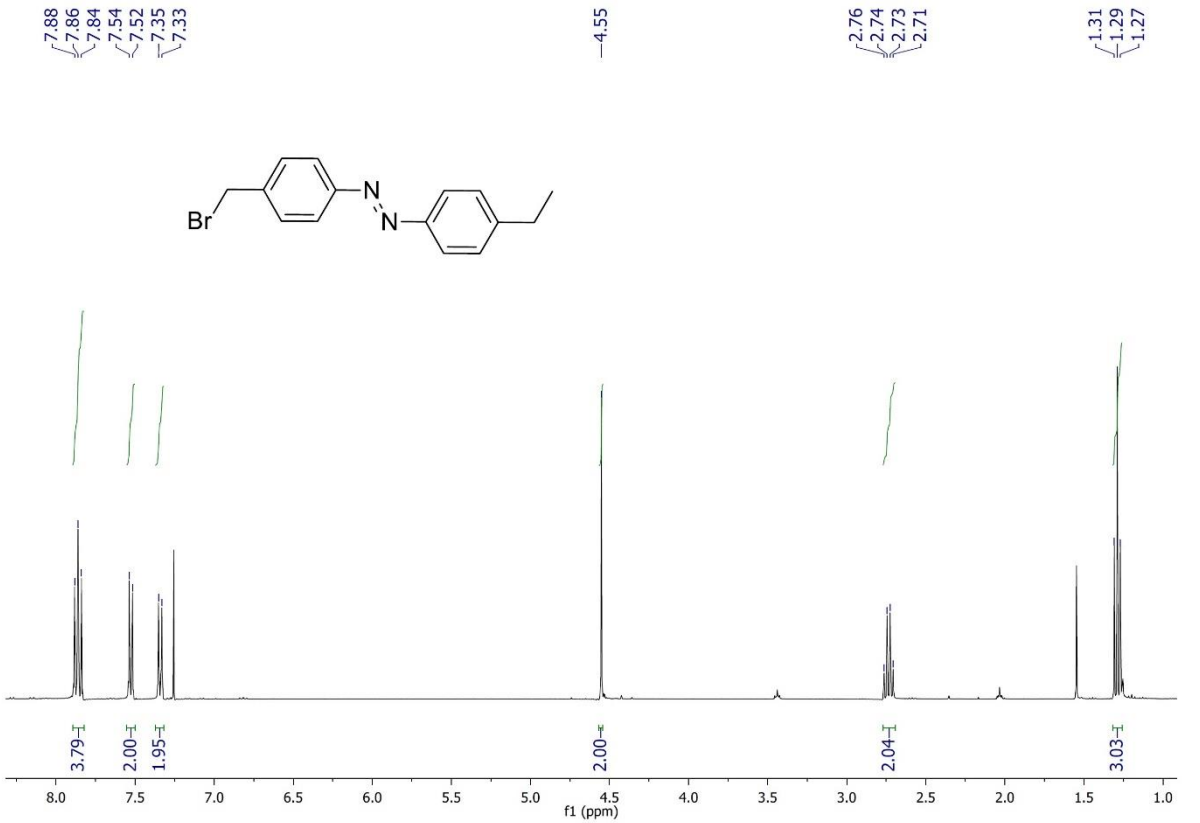


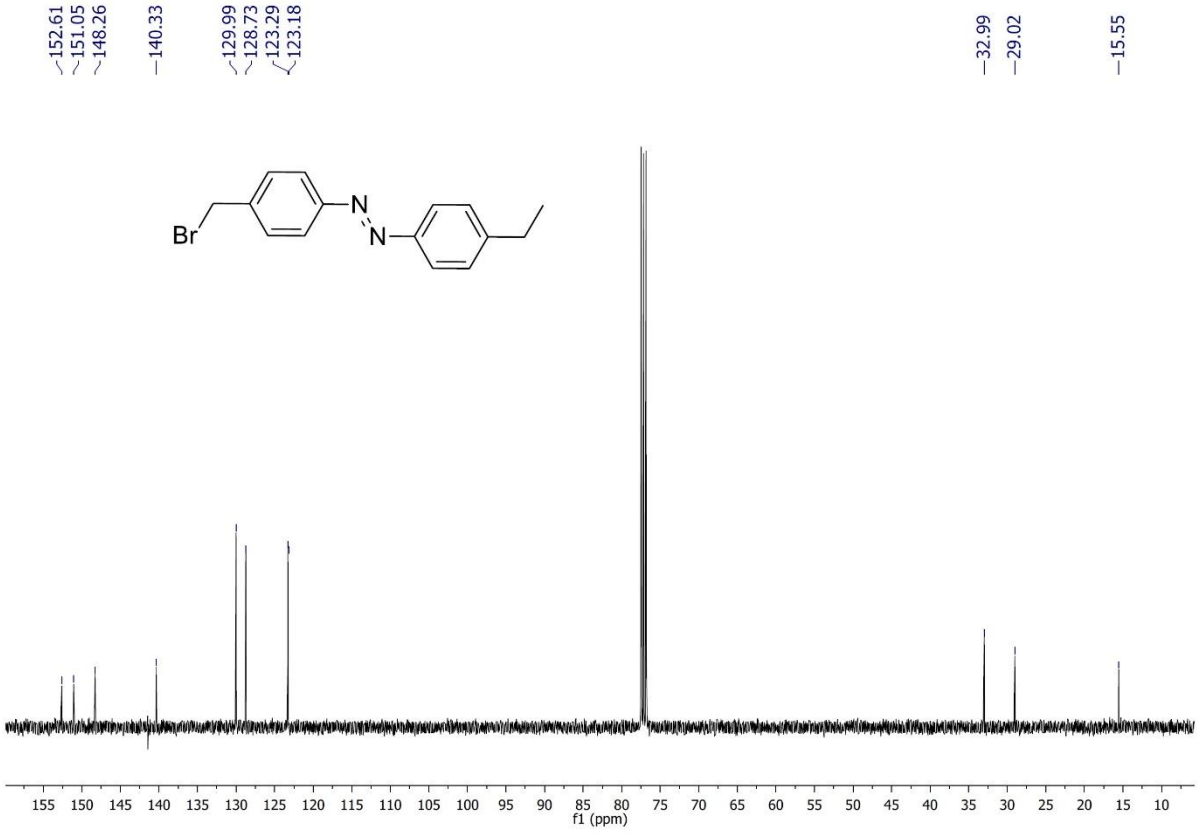
(*E*)-{4-[(4-Pentylphenyl)diazenyl]phenyl}methanol (15d)



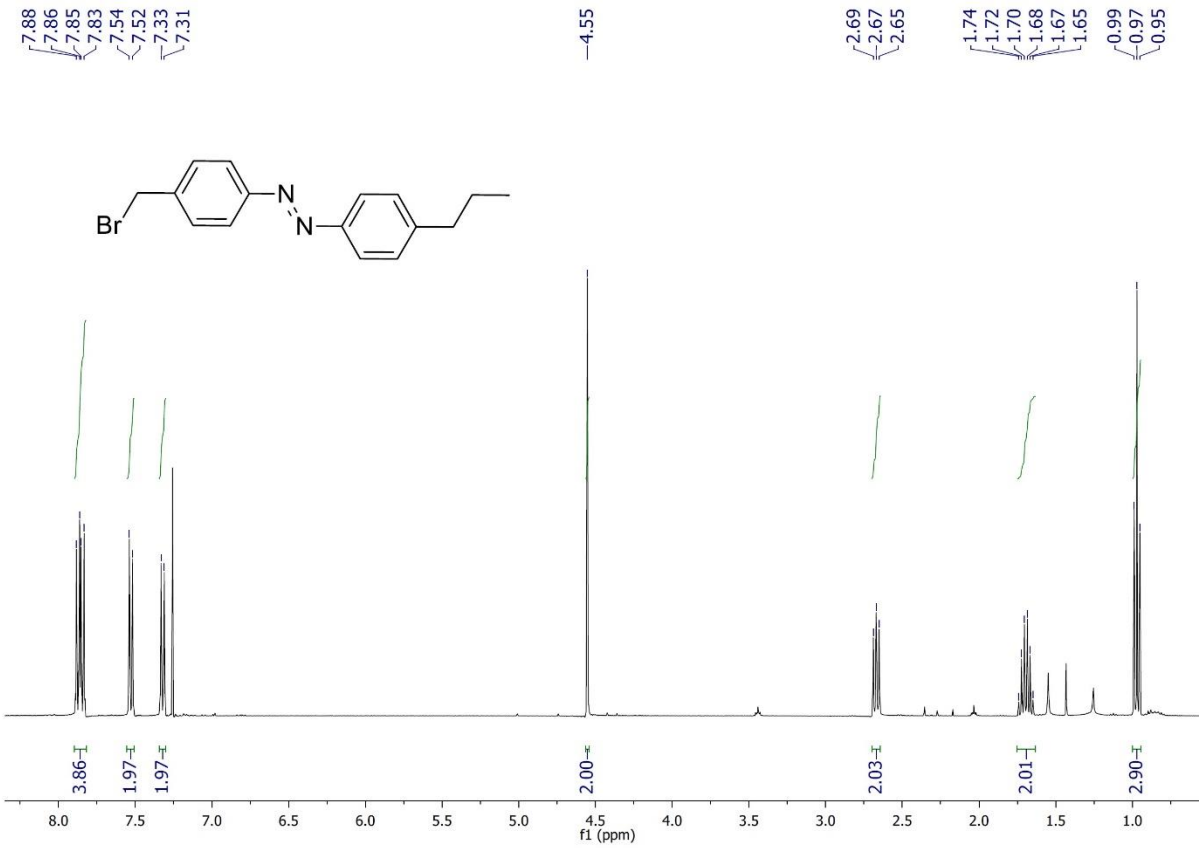


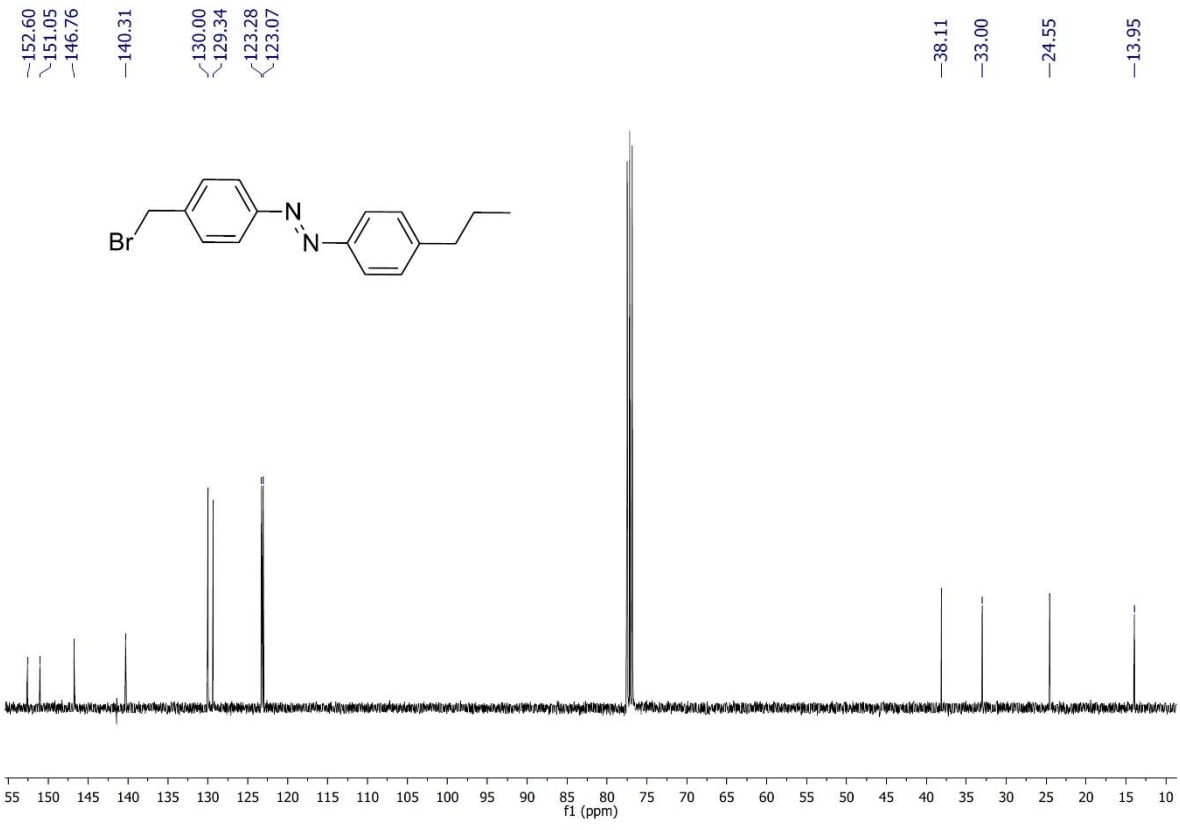
(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-ethylphenyl)diazene (16a)



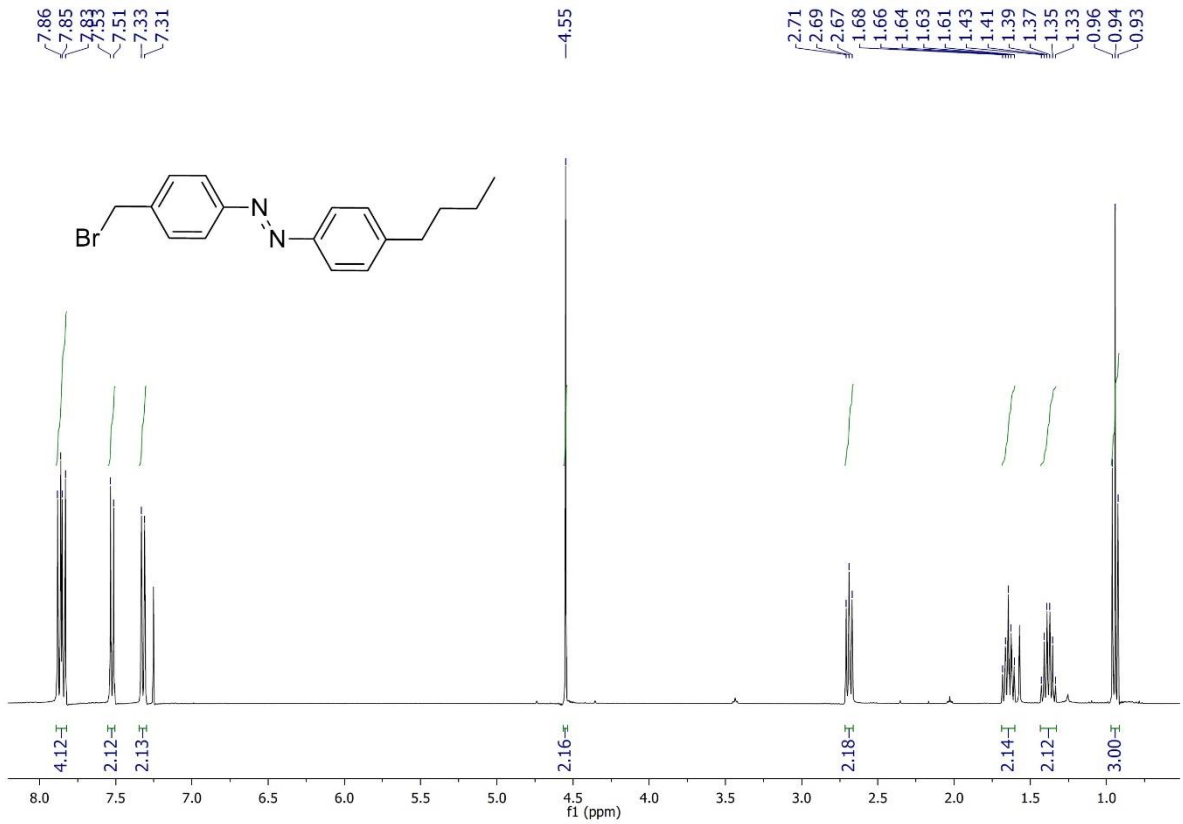


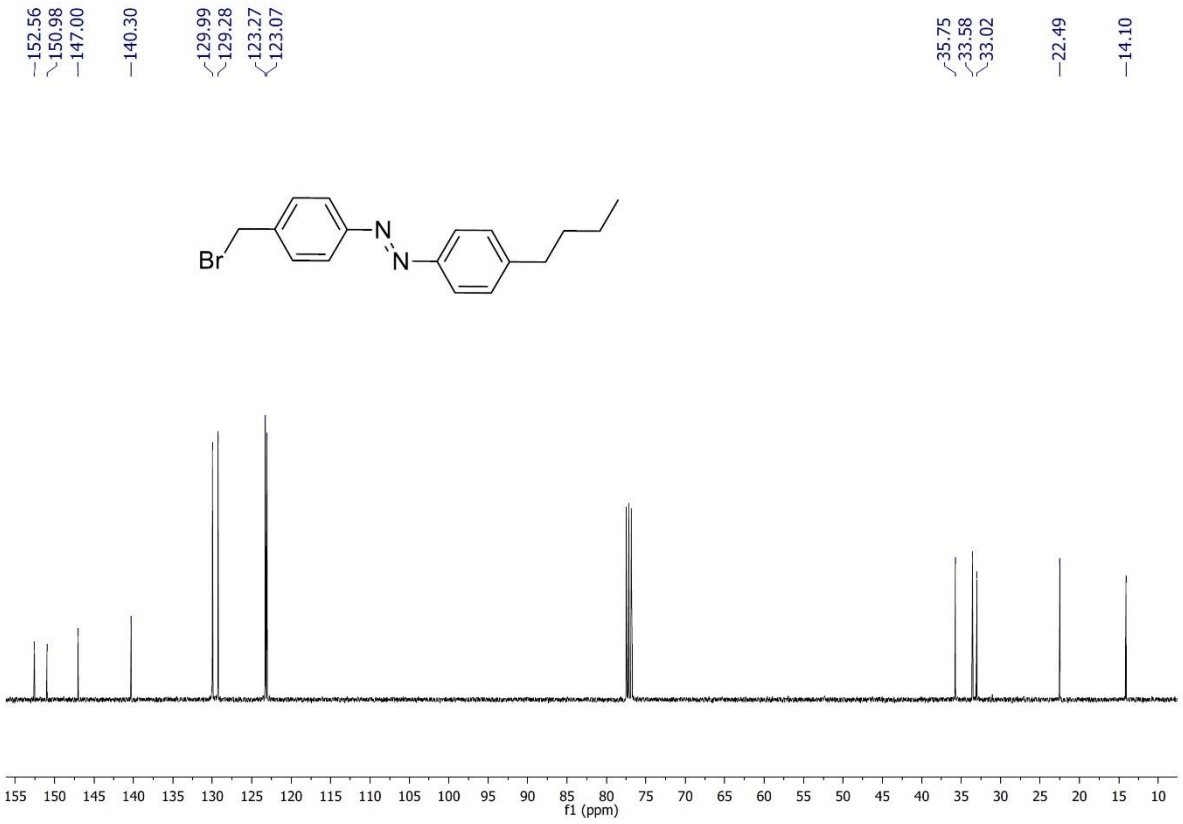
(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-propylphenyl)diazene (16b)



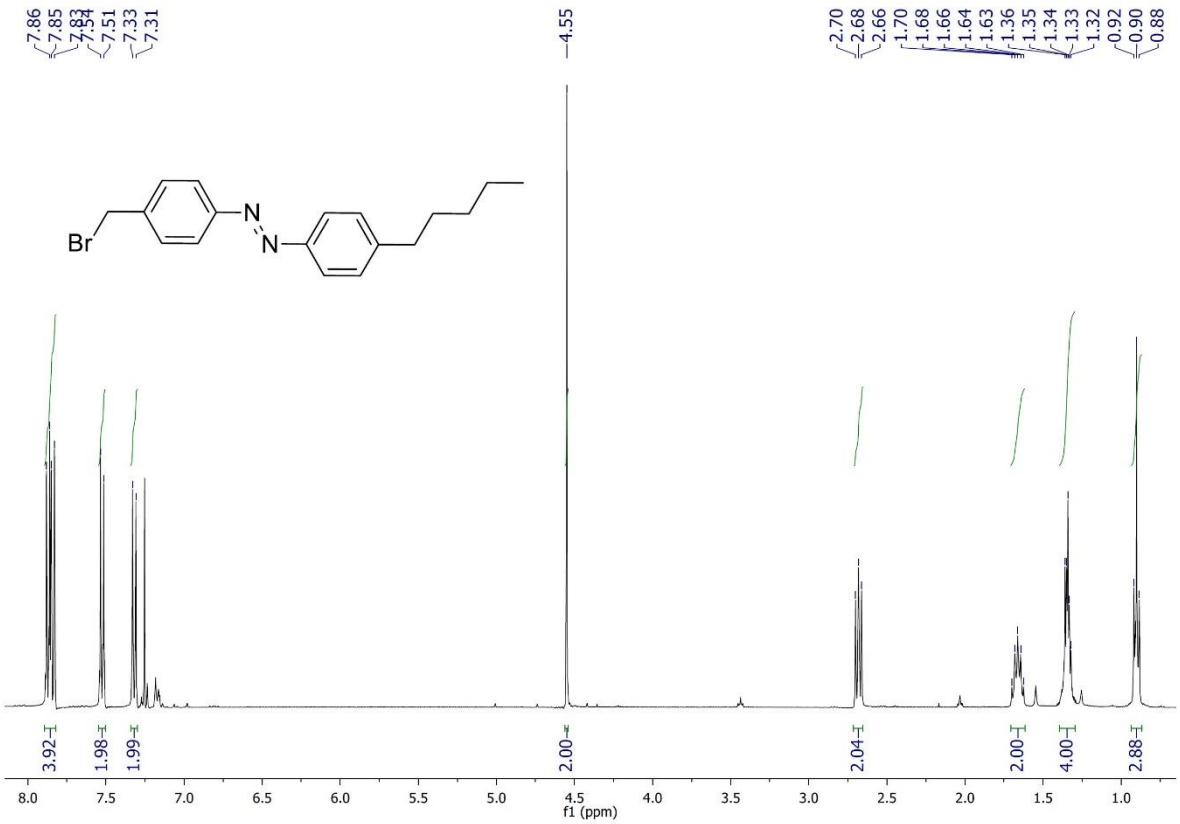


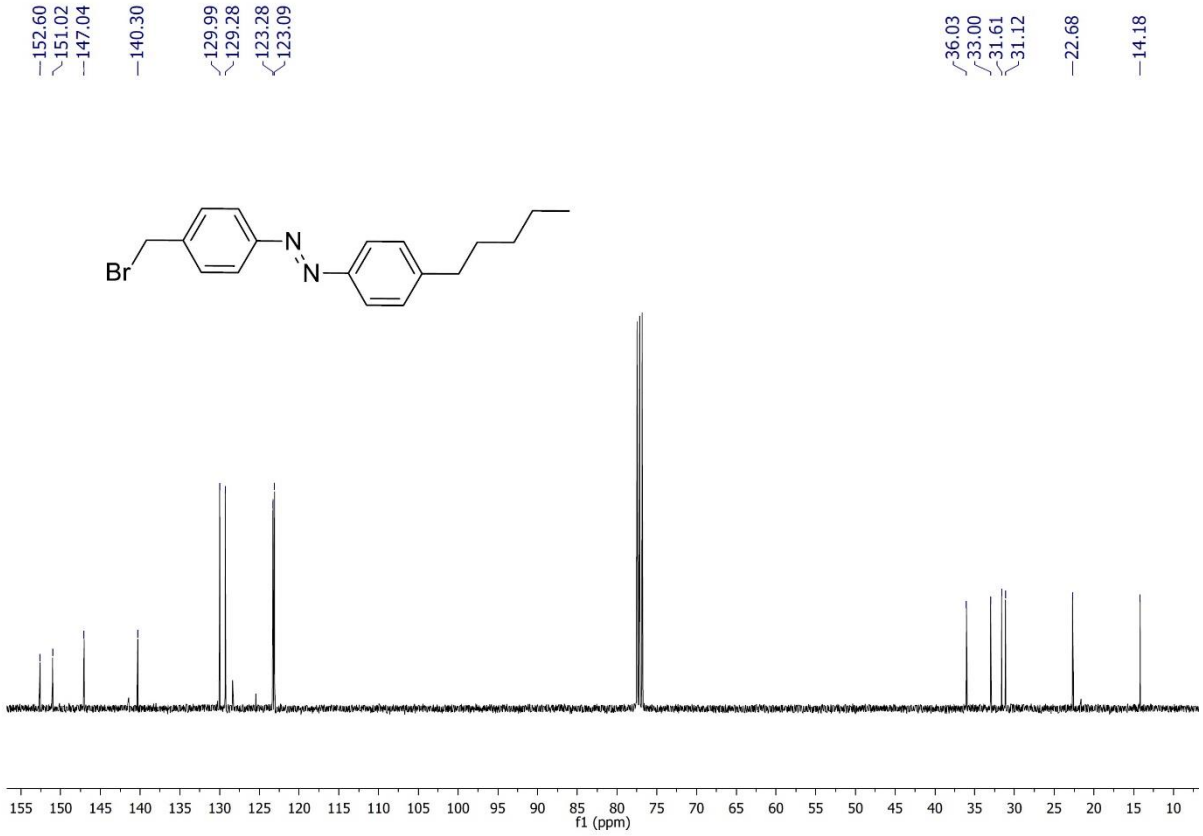
(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-butylphenyl)diazene (16c)



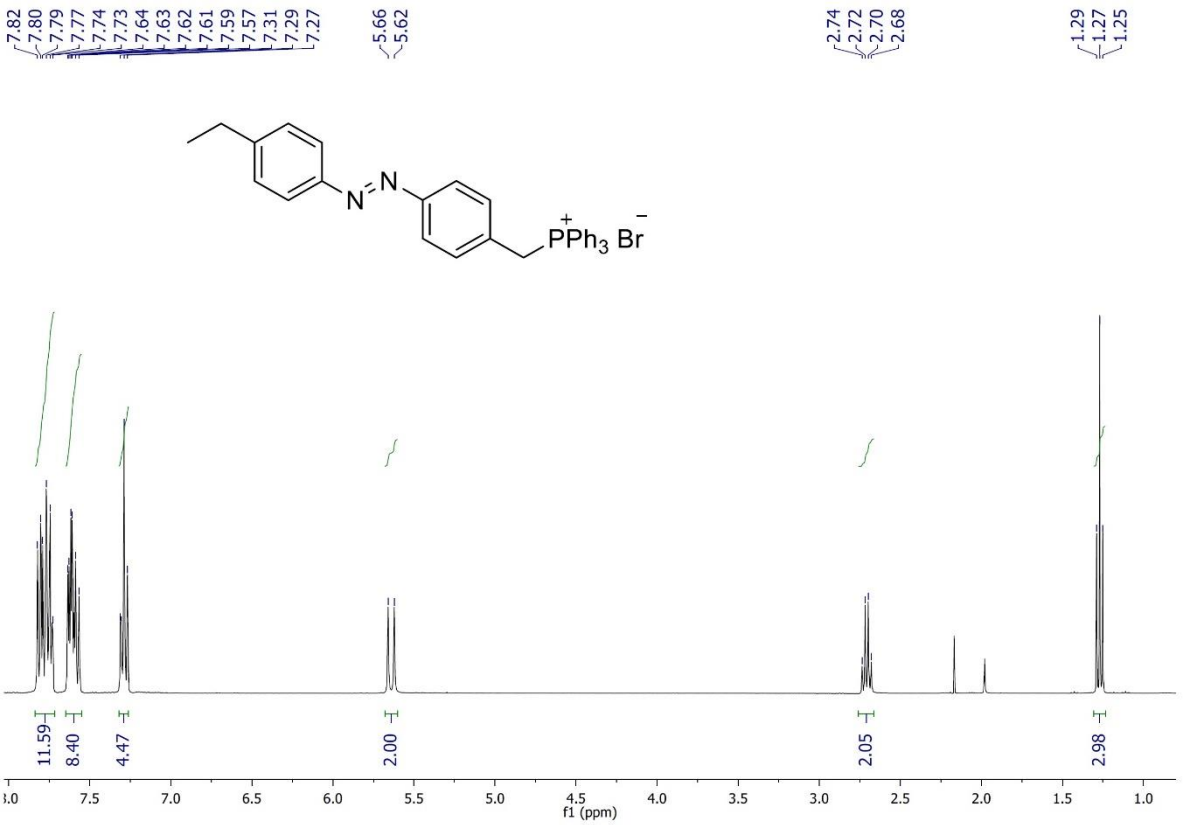


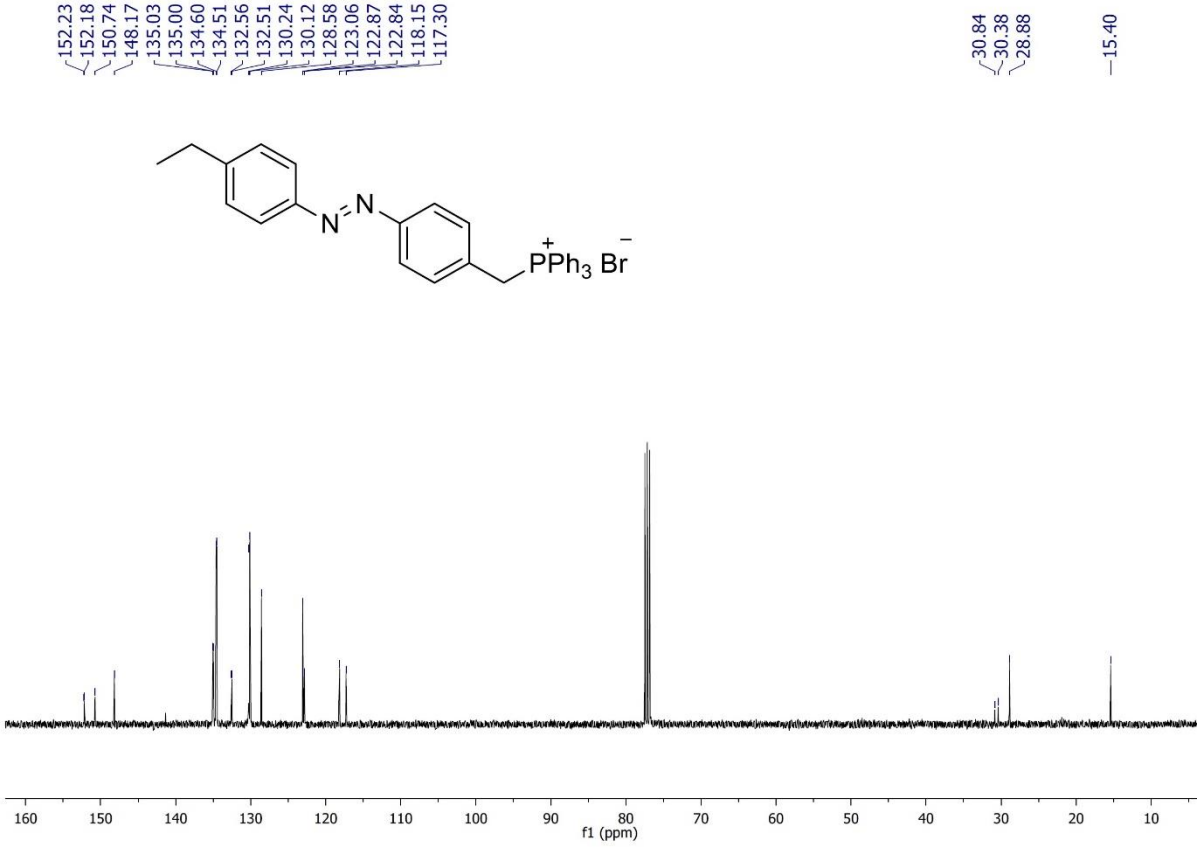
(*E*)-1-[4-(Bromomethyl)phenyl]-2-(4-pentylphenyl)diazene (16d)



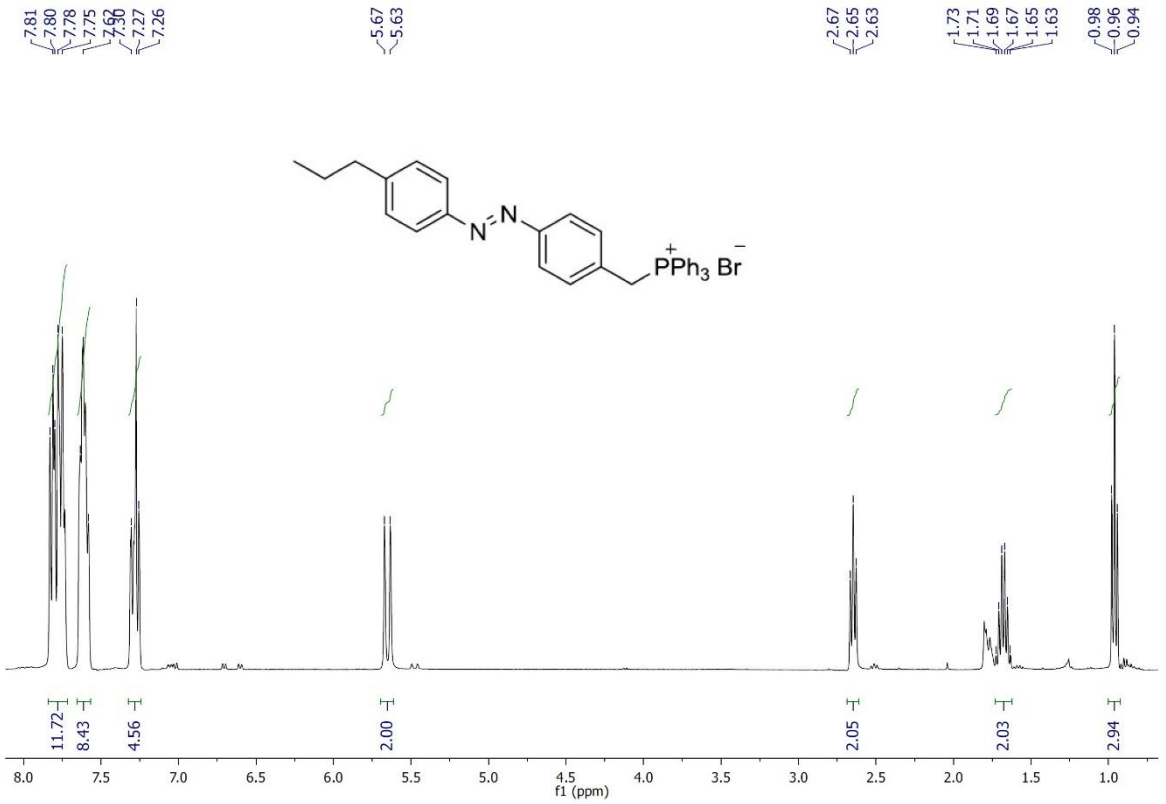


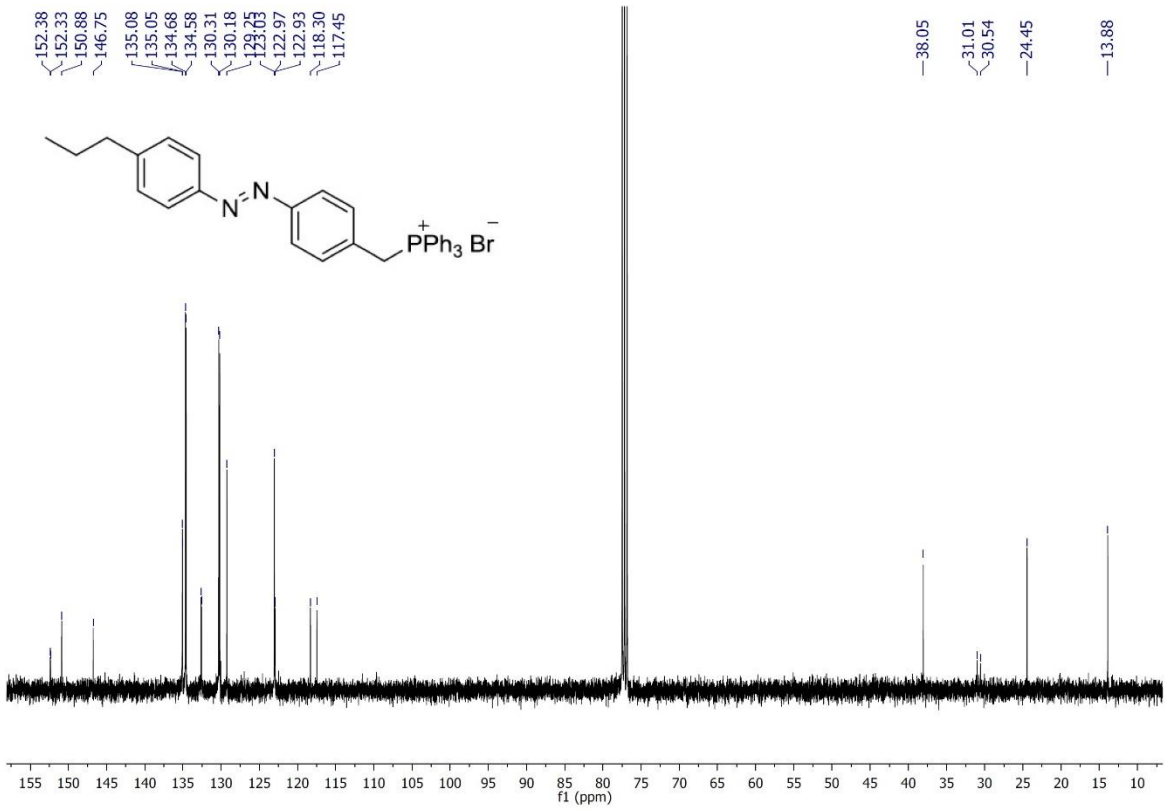
(*E*)-{4-[(4-Ethylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17a)



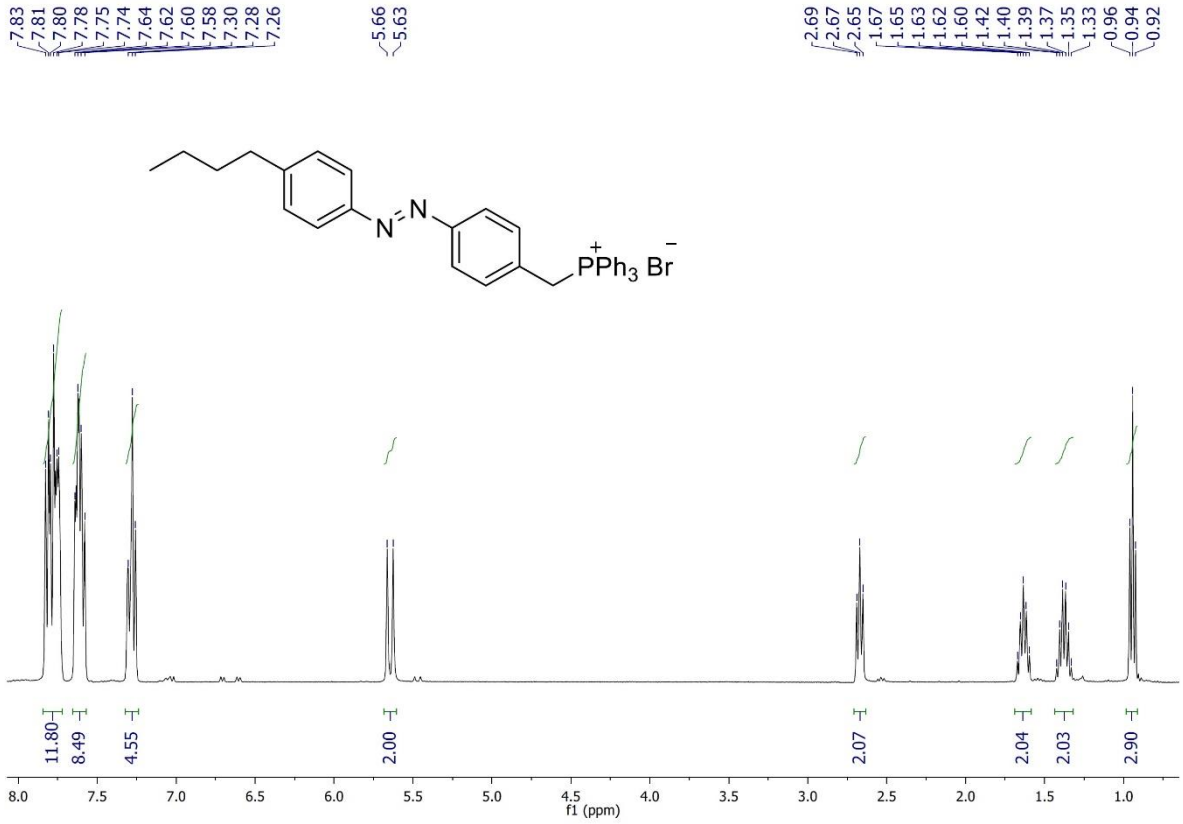


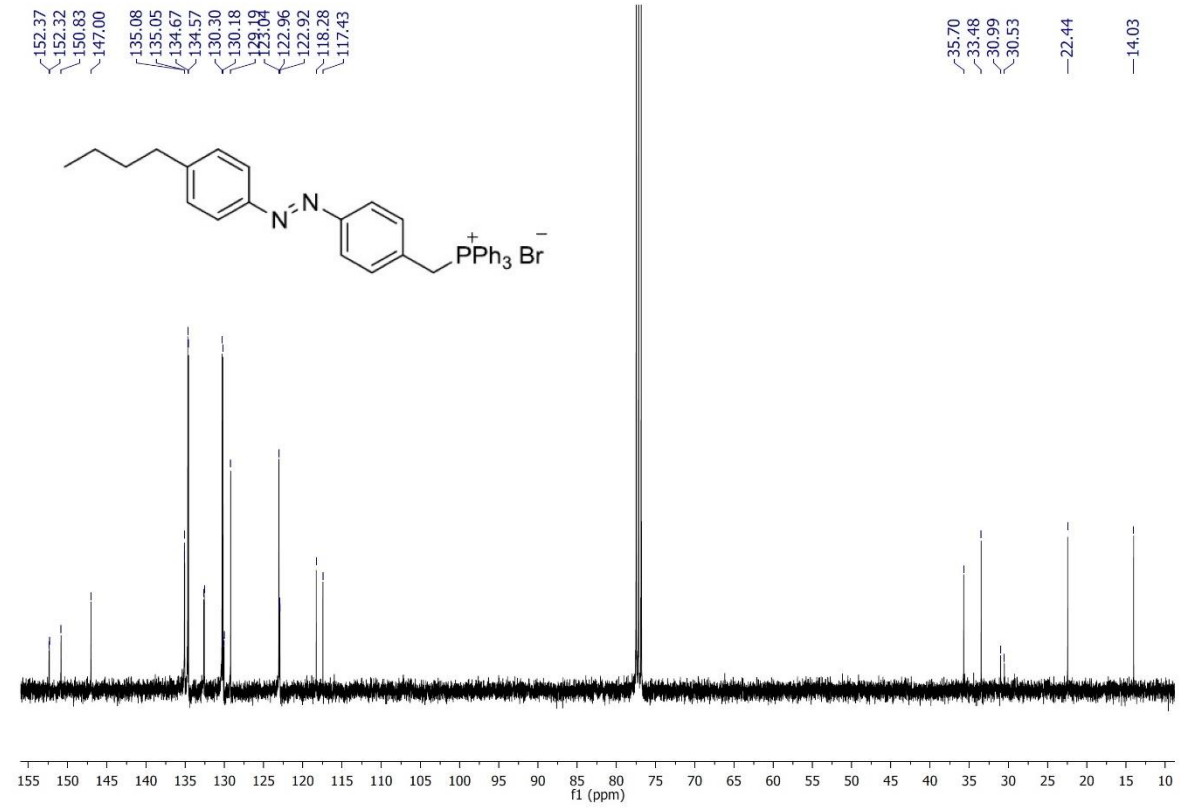
(*E*)-{4-[(4-Propylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17b)



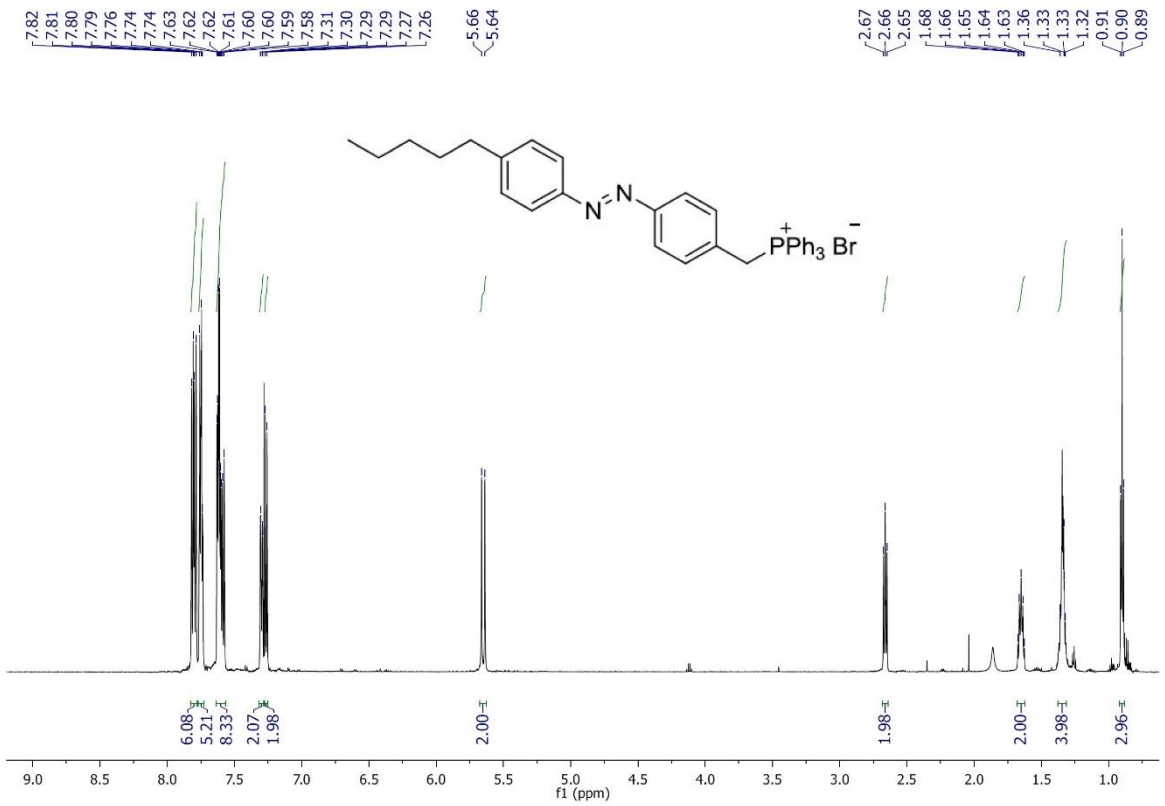


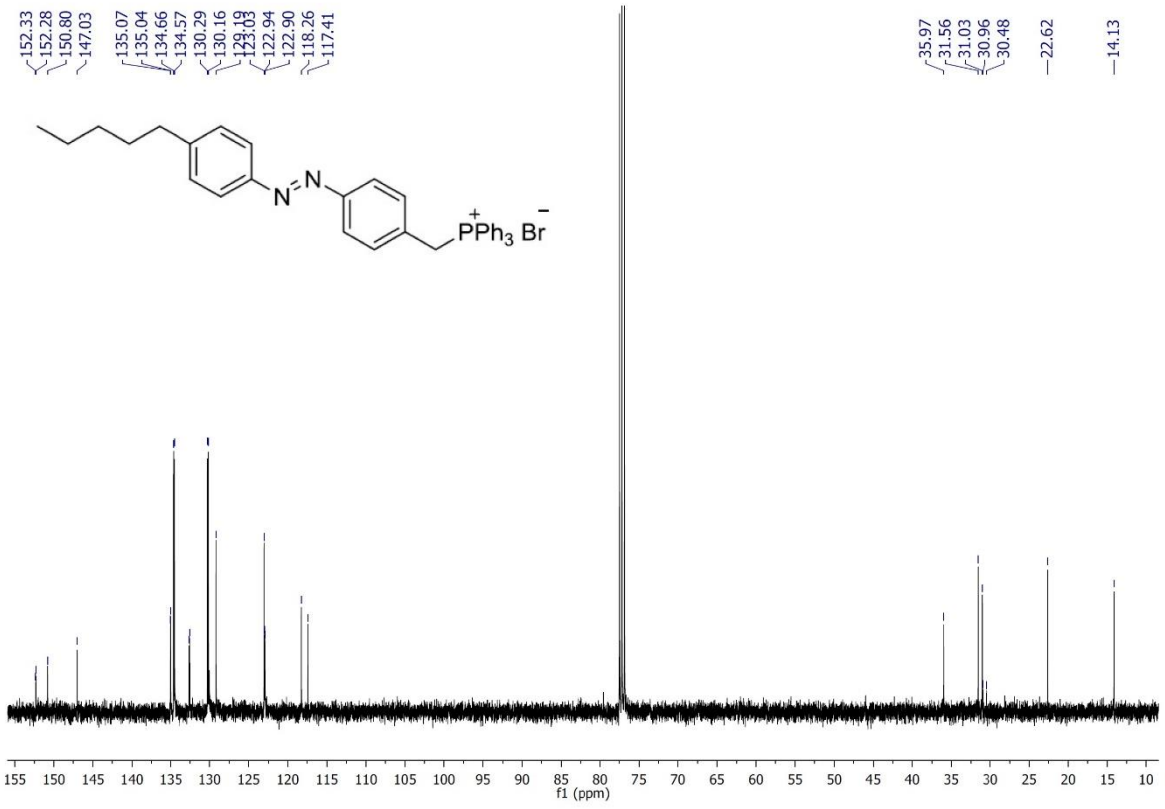
(*E*)-{4-[(4-Butylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17c)



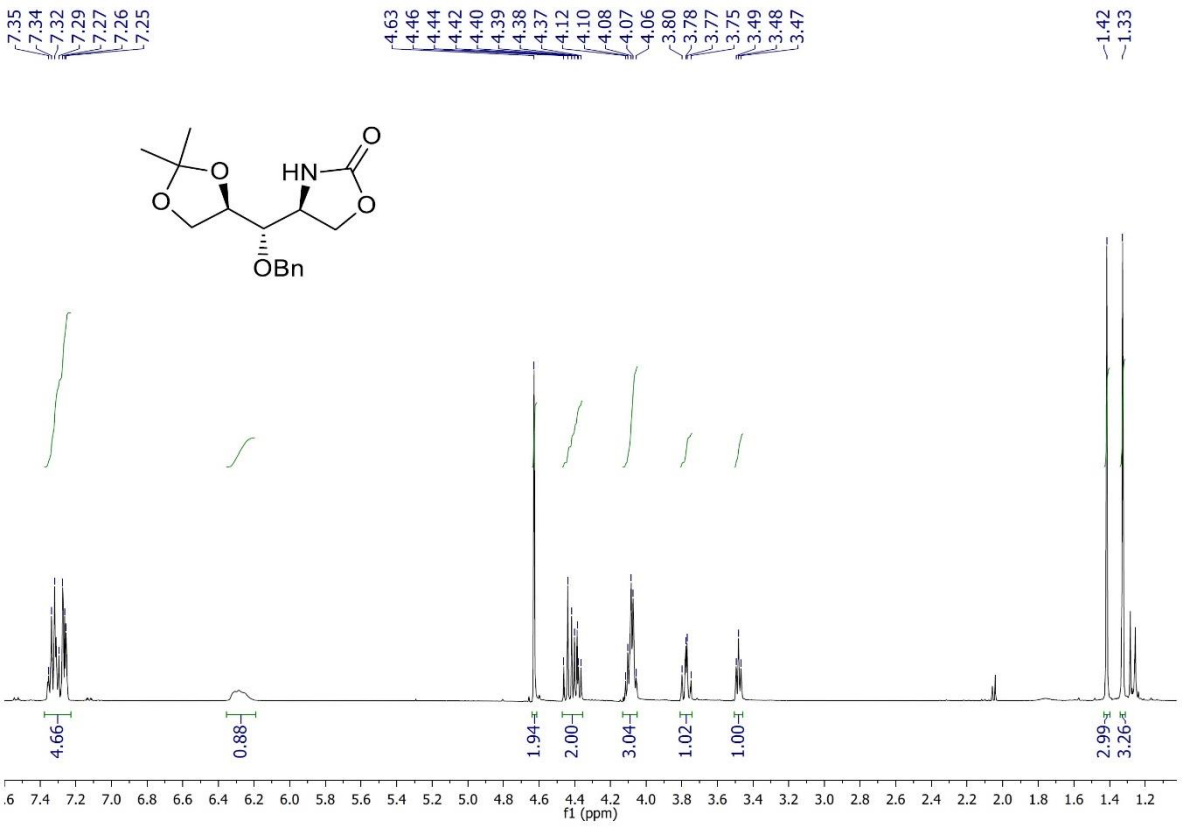


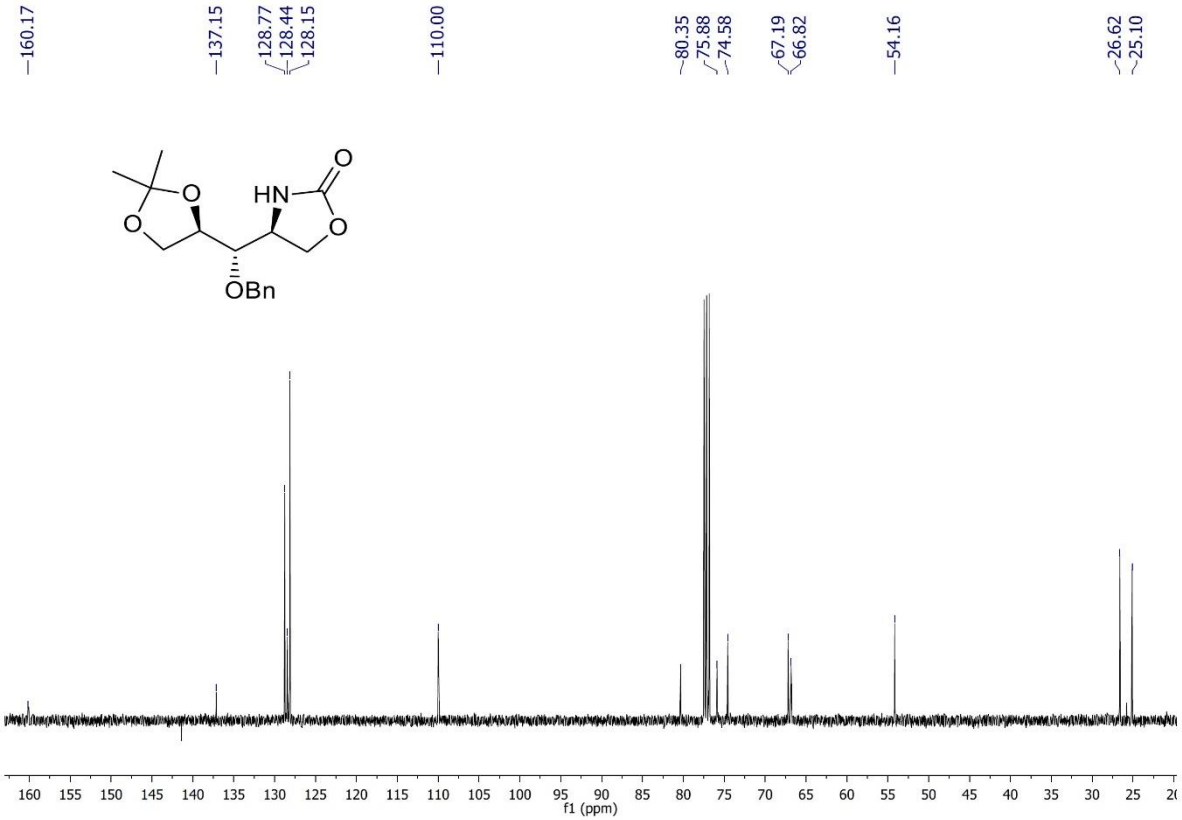
(*E*)-{4-[(4-Pentylphenyl)diazenyl]benzyl}triphenylphosphonium bromide (17d)



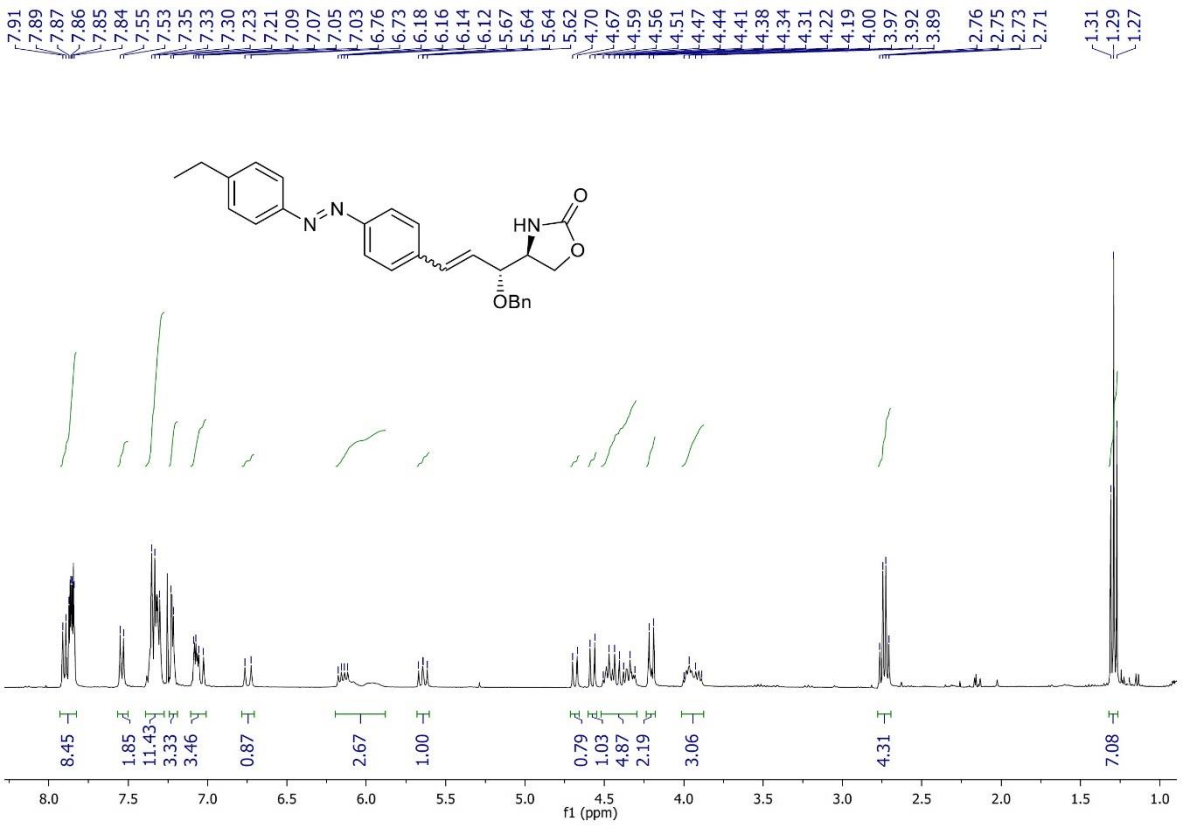


(4*S*)-4-{(1''*S*)-(Benzyloxy)[(4'*R*)-2',2'-dimethyl-1',3'-dioxolan-4'-yl]methyl}oxazolidin-2-one (19)

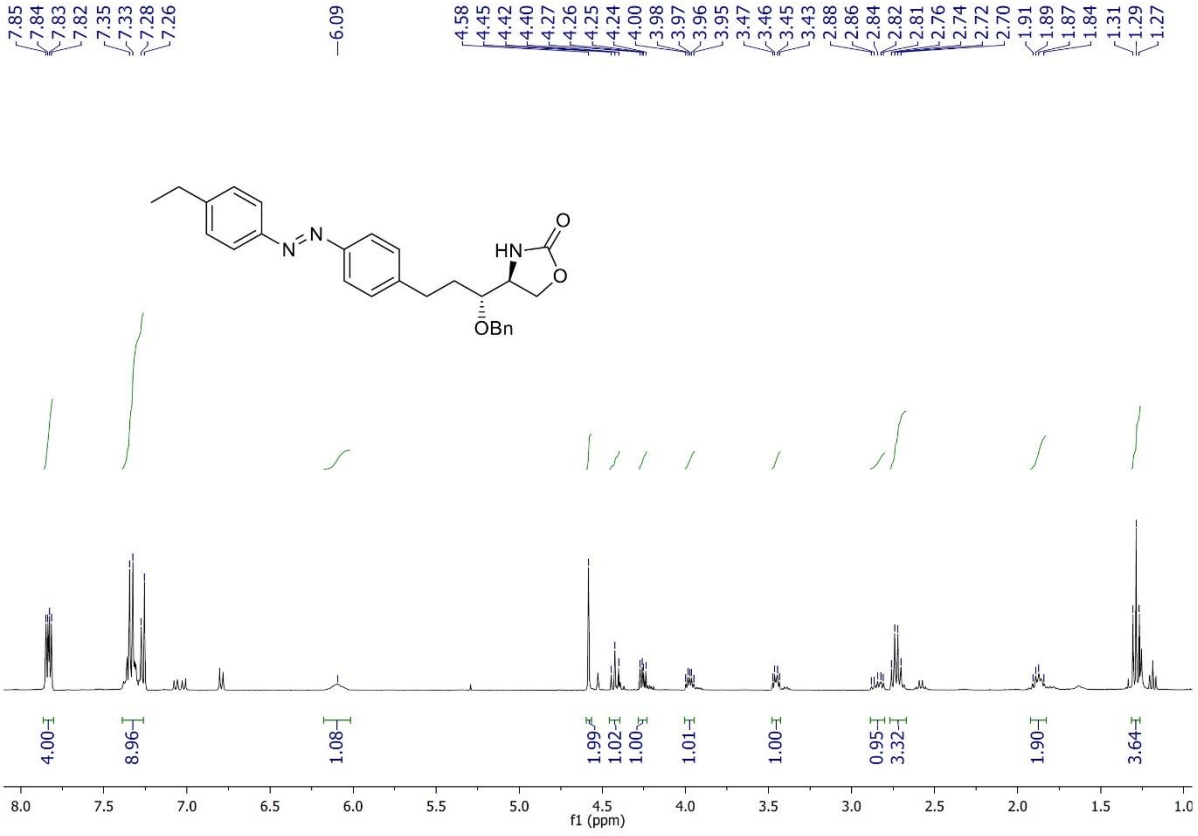


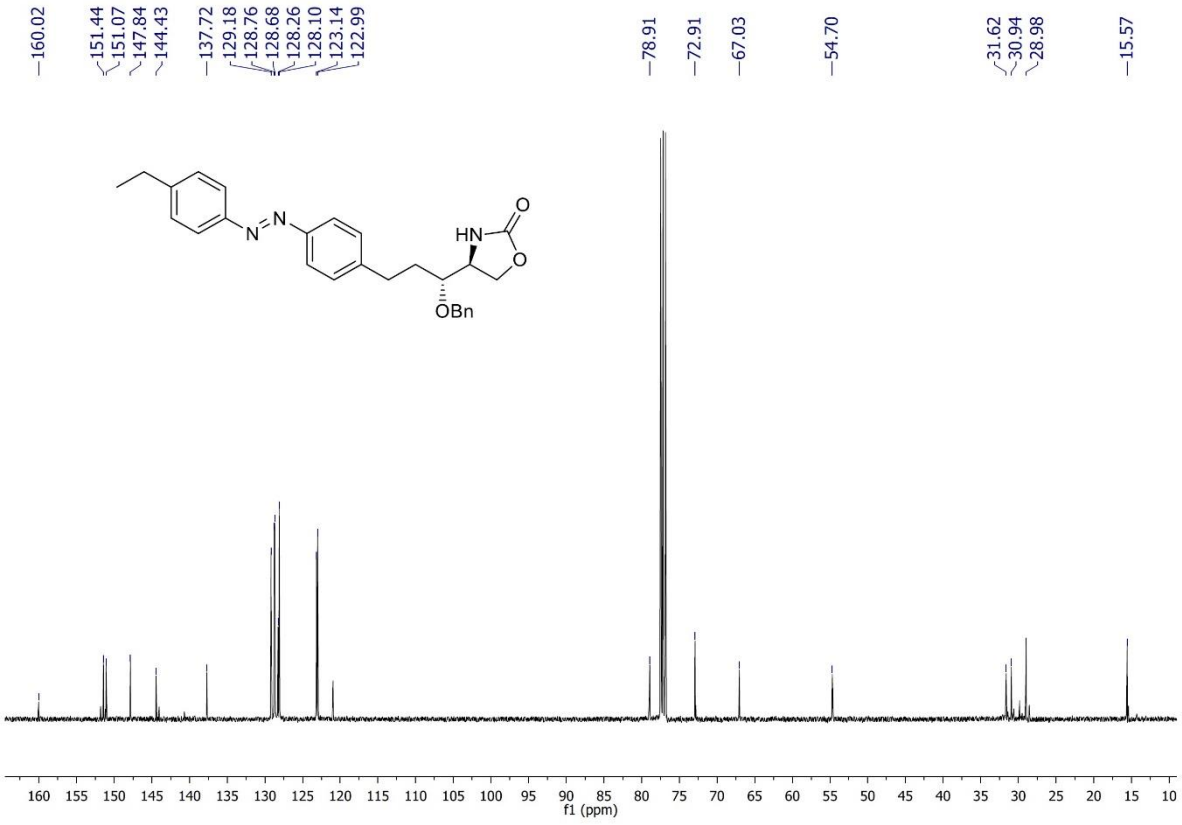


(4*S*)-4-[(1'*R*,*E*&*Z*)-(Benzyloxy)-3'-{4-[(*E*)-(4-ethylphenyl)diazenyl]phenyl}allyl]oxazolidin-2-one (22)

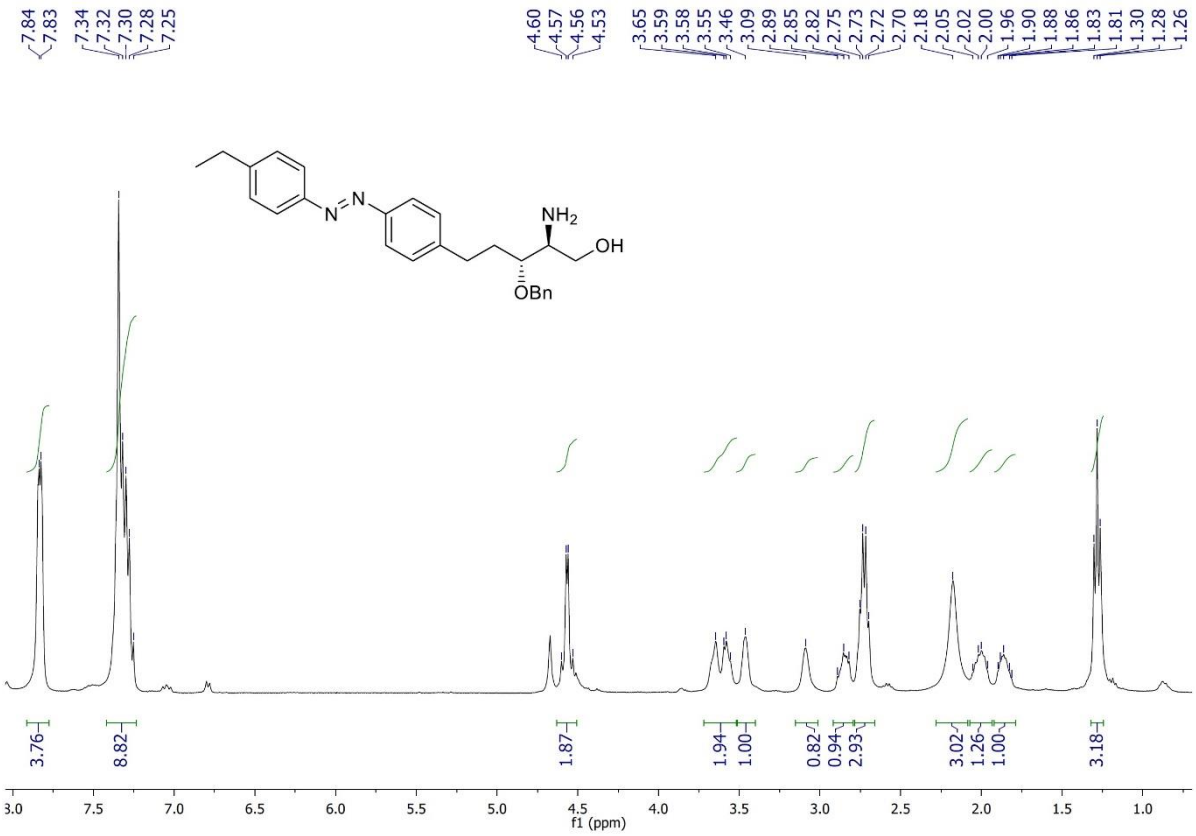


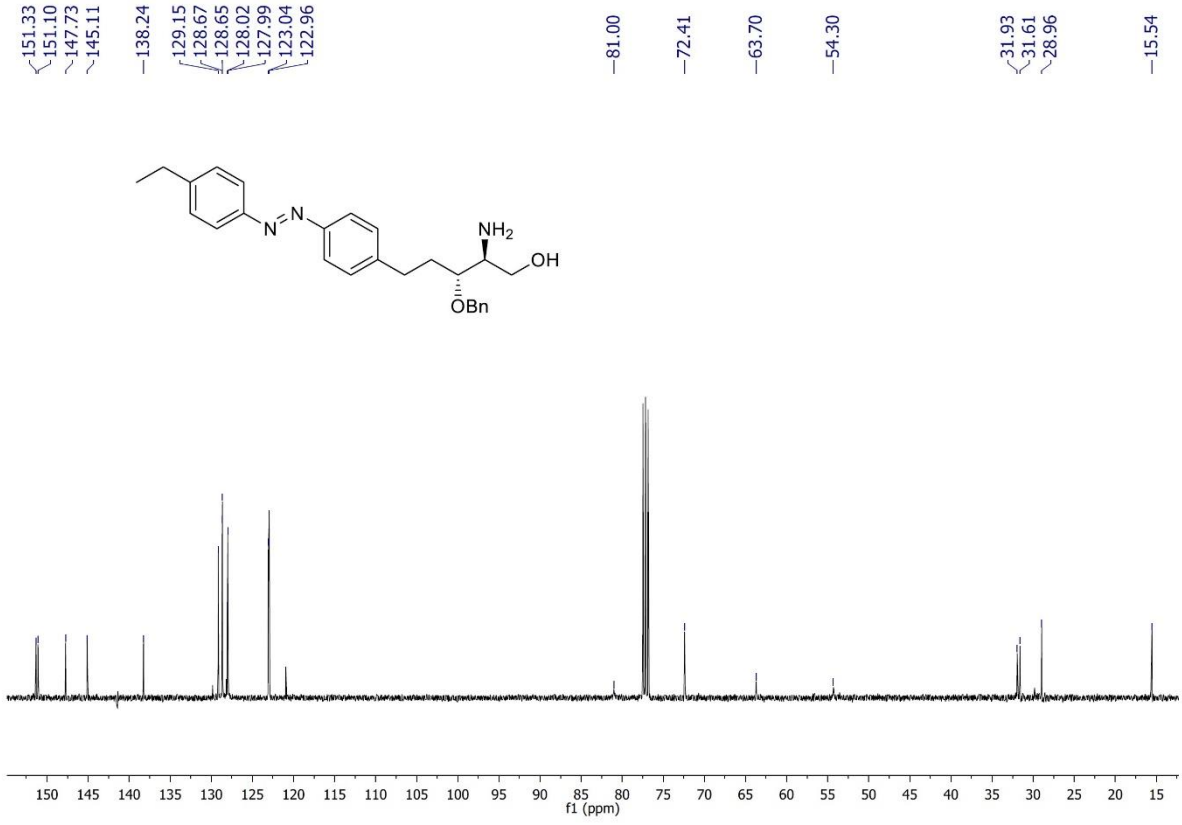
(4*S*)-4-[(1'*R*)-(Benzyloxy)-3'-{4-[(*E*)-(4-ethylphenyl)diazenyl]phenyl}propyl]oxazolidin-2-one (23)



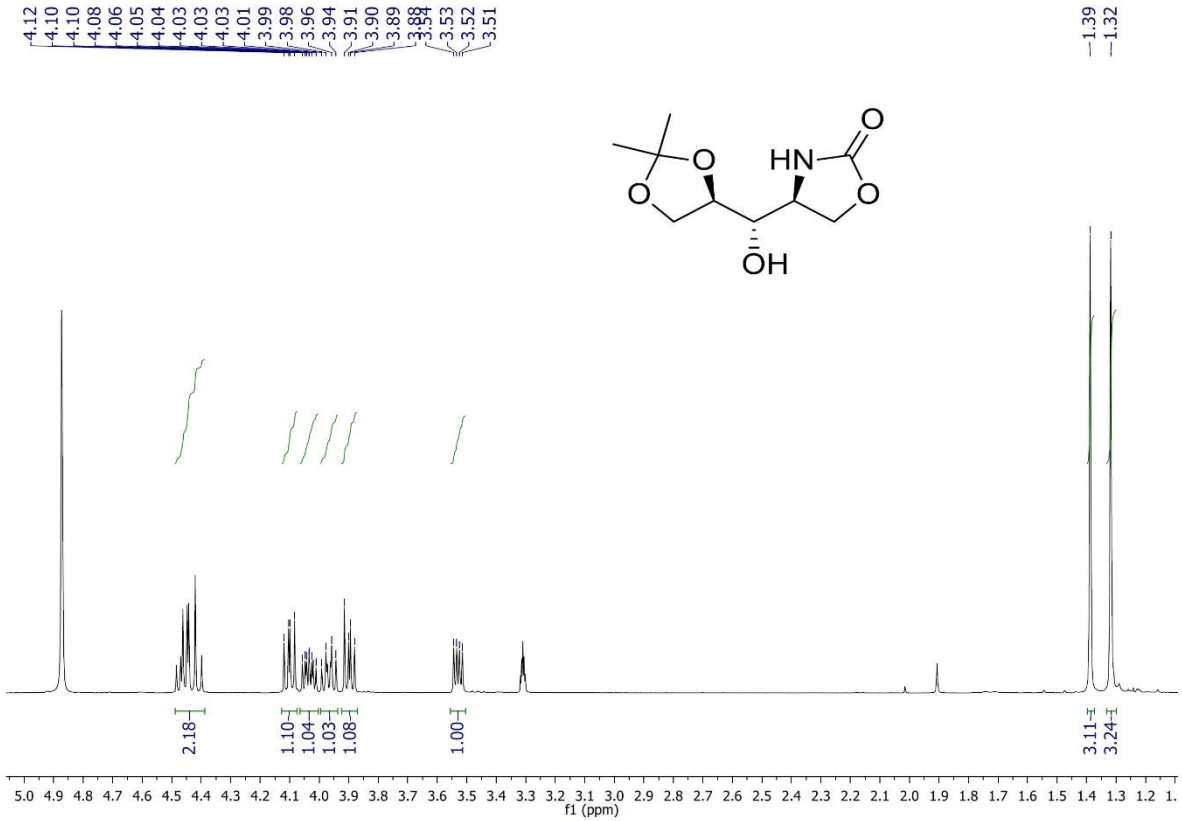


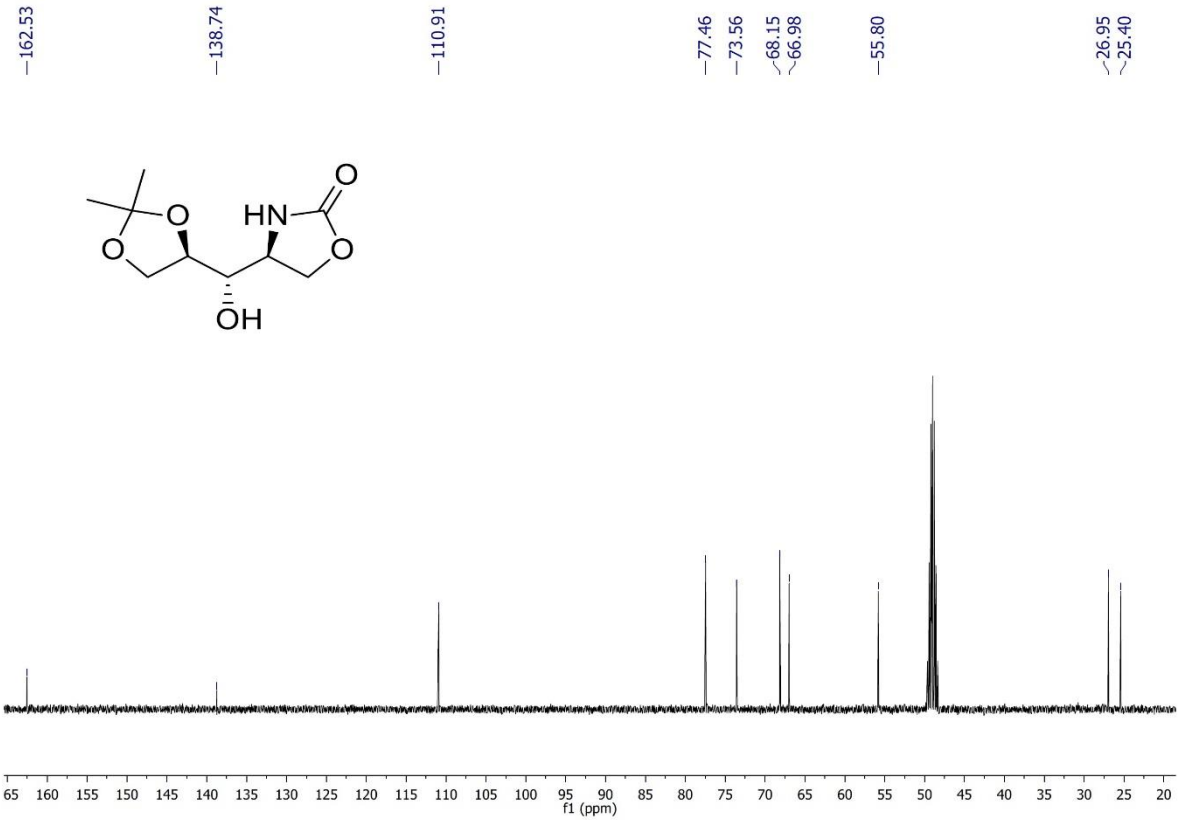
(2*S*,3*R*)-2-Amino-3-benzyloxy-5-{4-[(*E*)-(4-ethylphenyl)diazenyl]phenyl}pentan-1-ol (24)



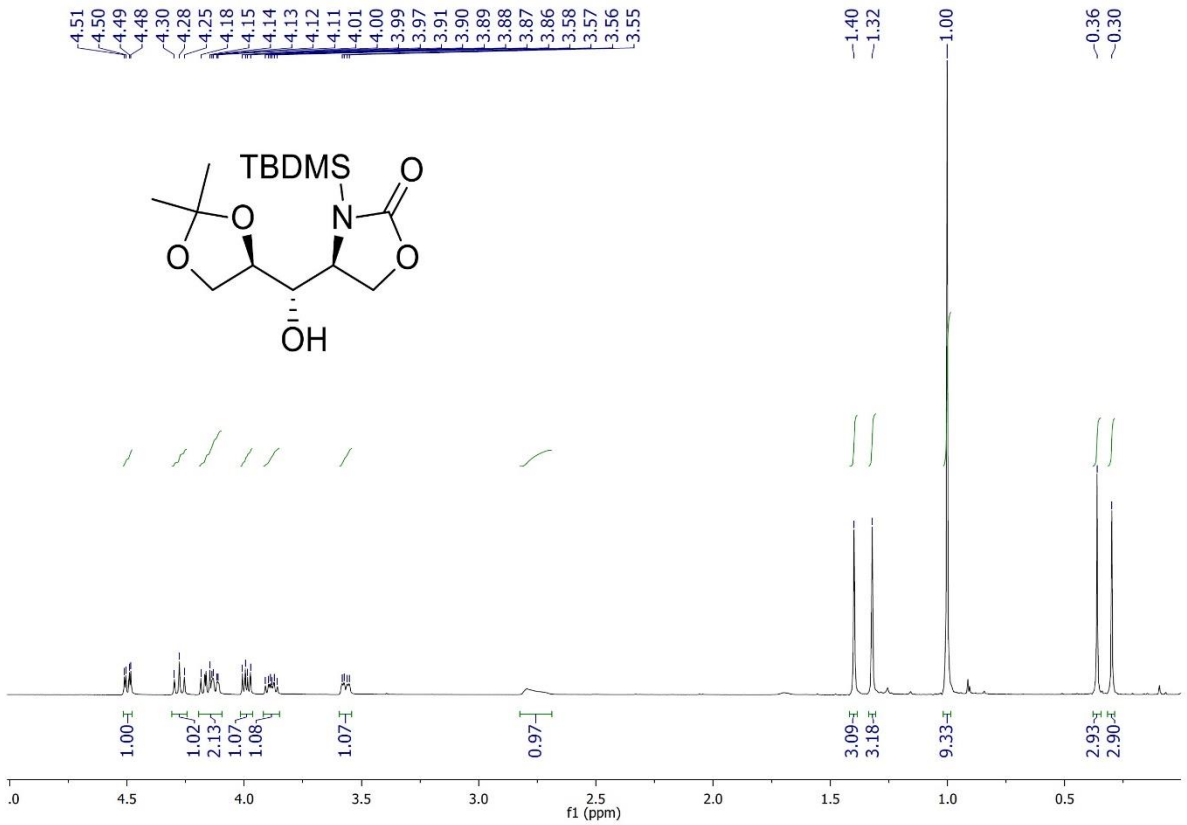


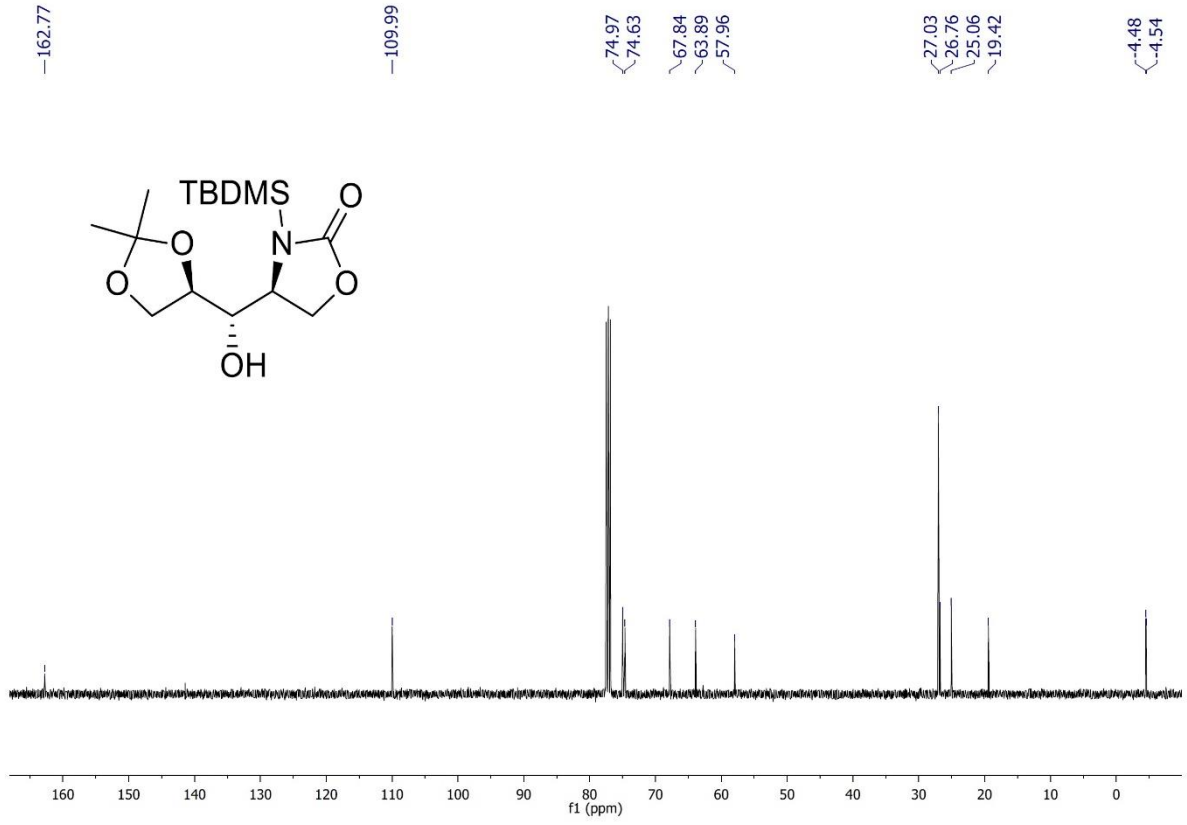
(4*S*)-4-{(1''*S*)-[(4'*R*)-2',2'-Dimethyl-1',3'-dioxolan-4'-yl](hydroxy)methyl}oxazolidin-2-one (25)



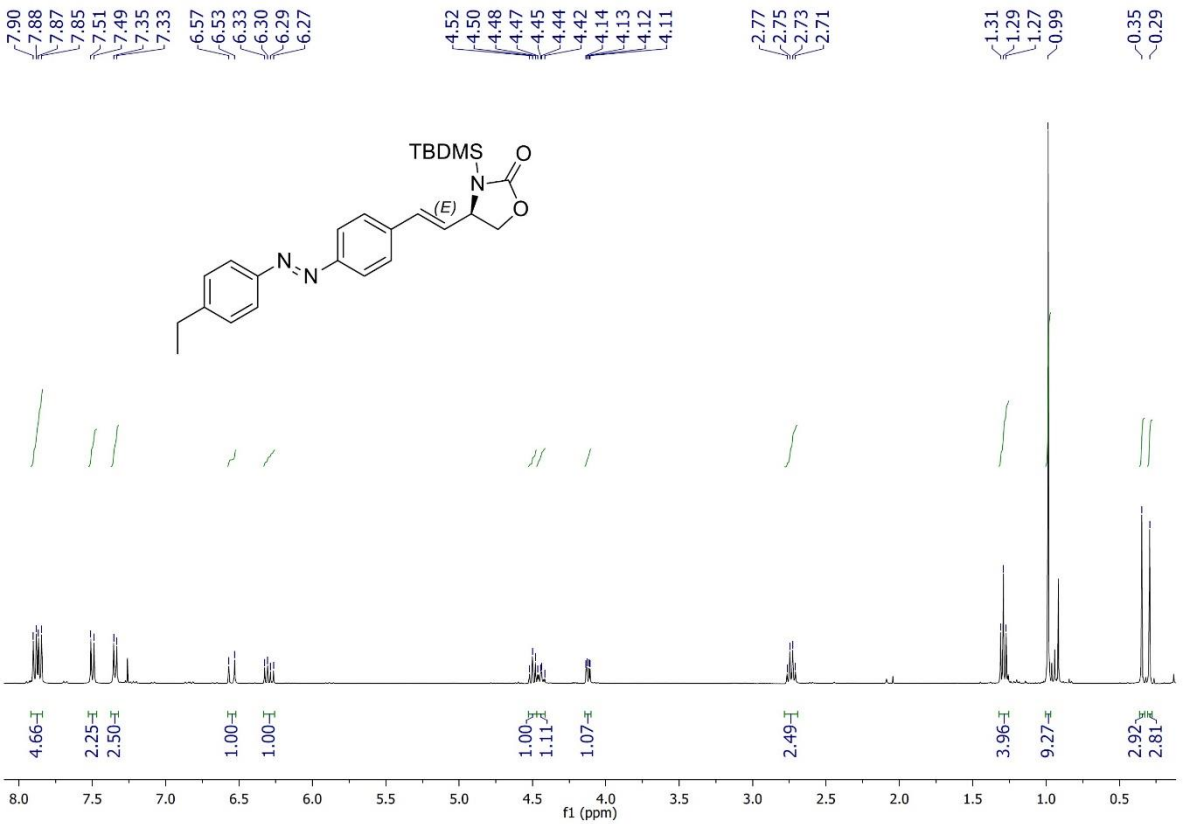


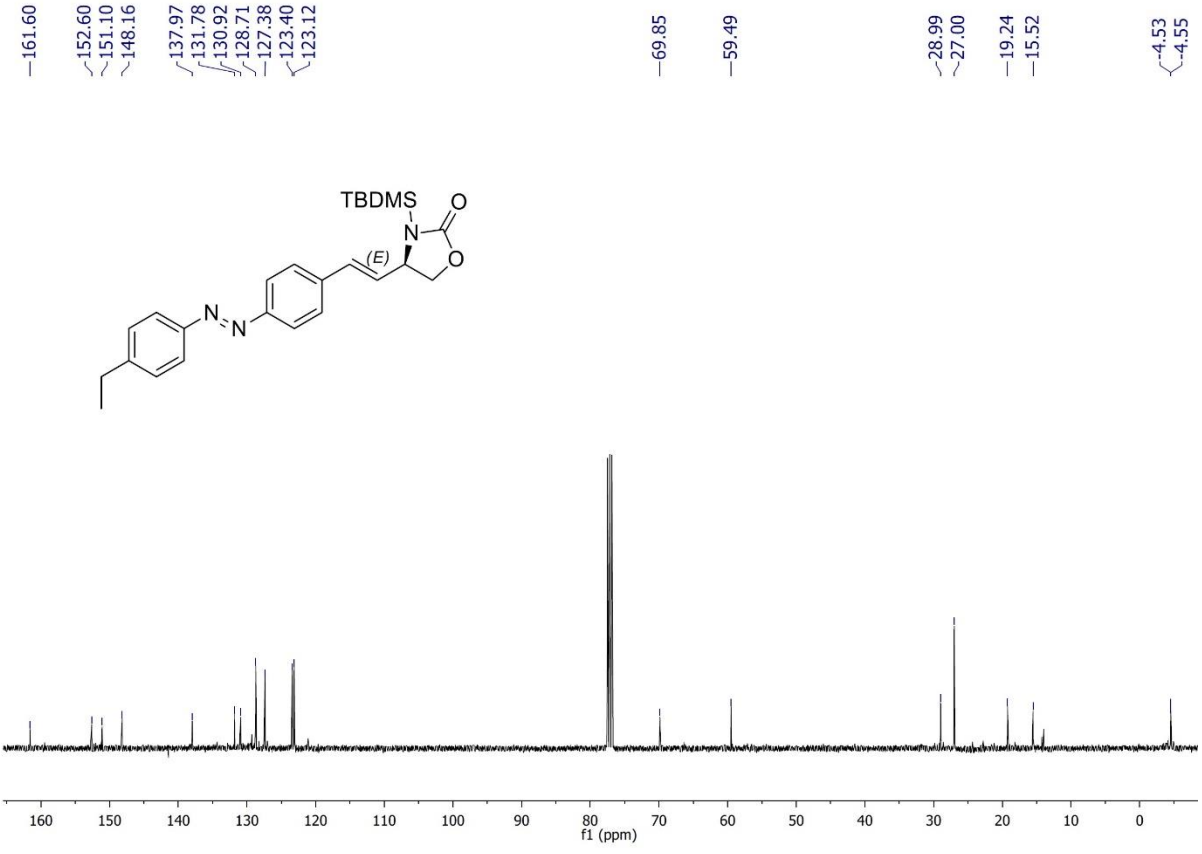
(4*S*)-3-(*tert*-Butyldimethylsilyl-4-{(1''*S*)-[(4'*R*)-2',2'-dimethyl-1',3'-dioxolan-4'-yl](hydroxy)methyl}oxazolidin-2-one (26)



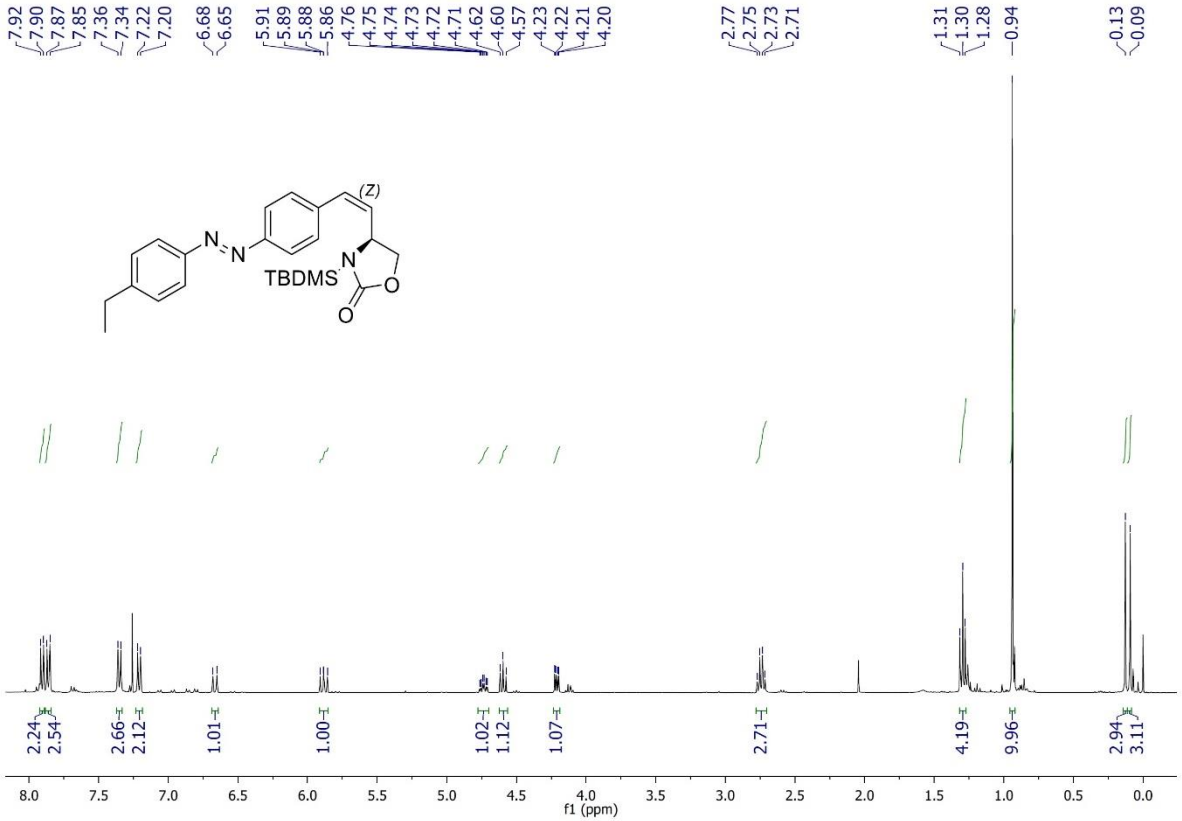


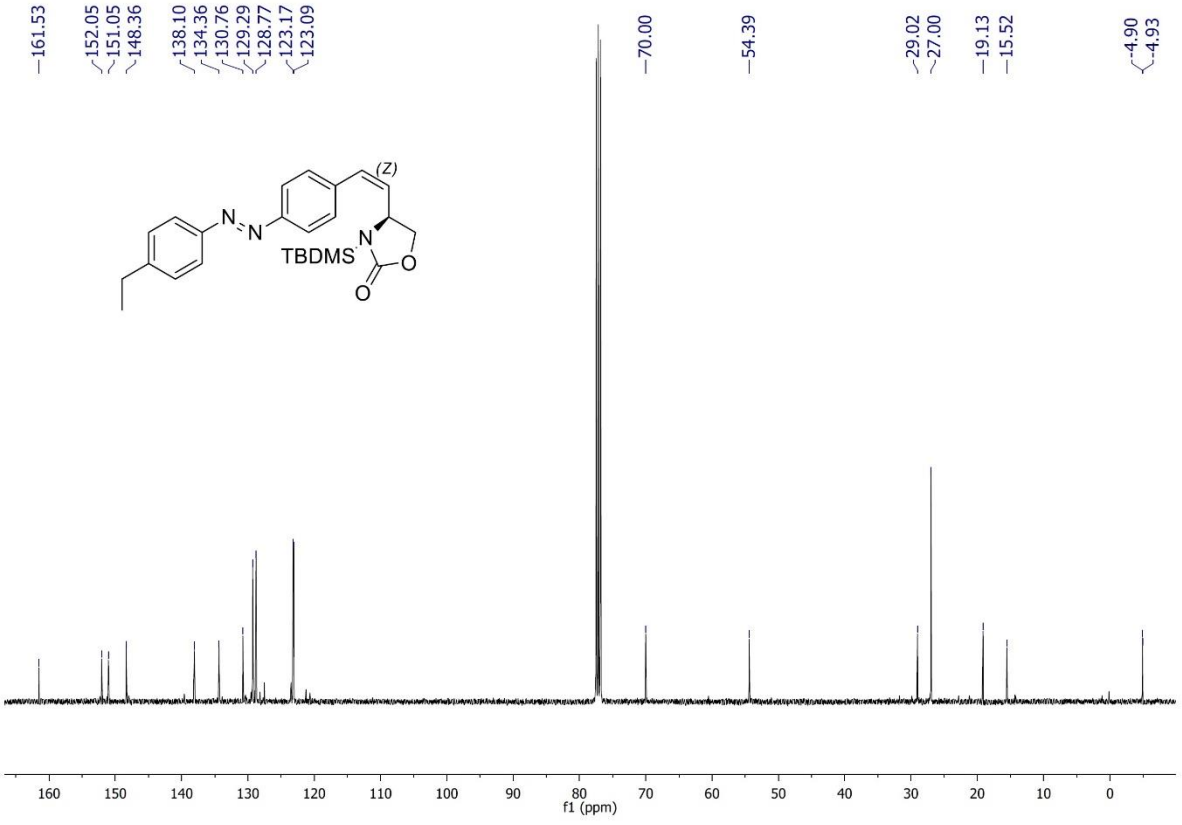
(4*R*)-3-(*tert*-Butyldimethylsilyl)-4-{(*E*)-4-[(*E*)-(4-ethylphenyl)diazenyl]styryl}oxazolidin-2-one (*E*)-27)



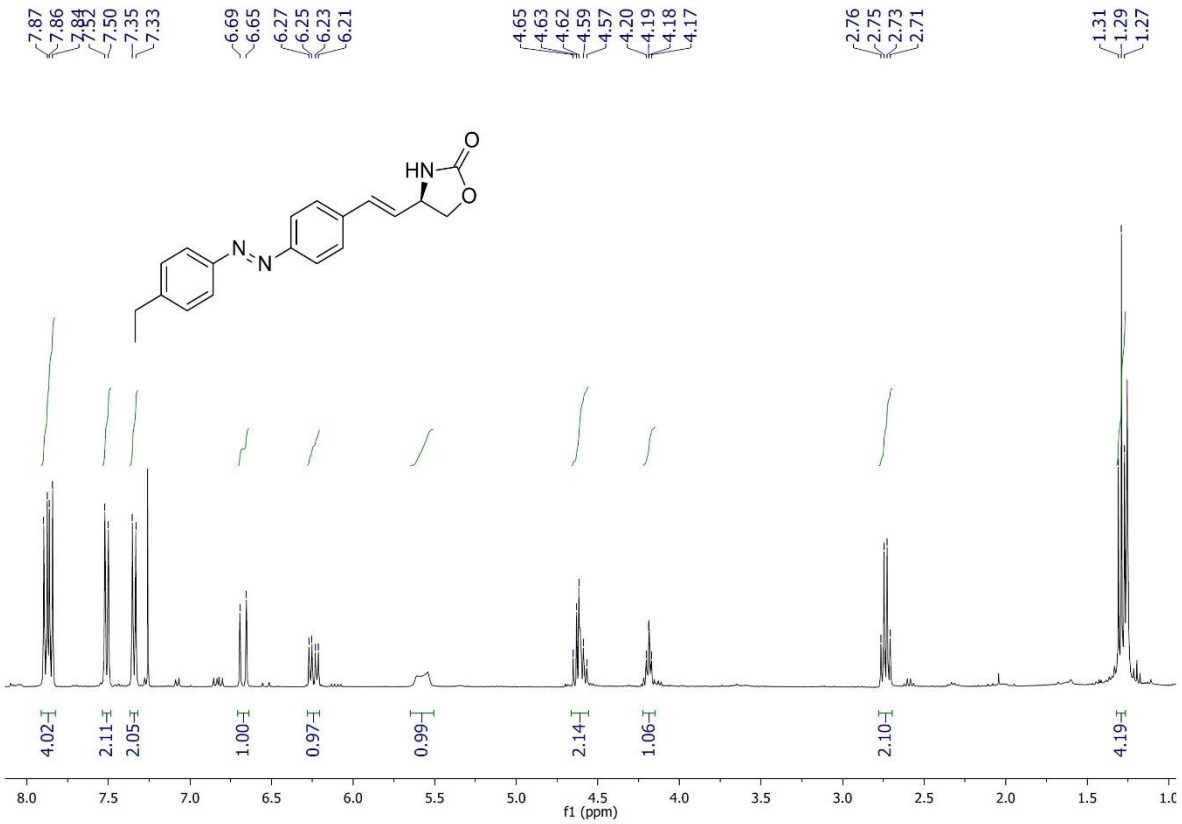


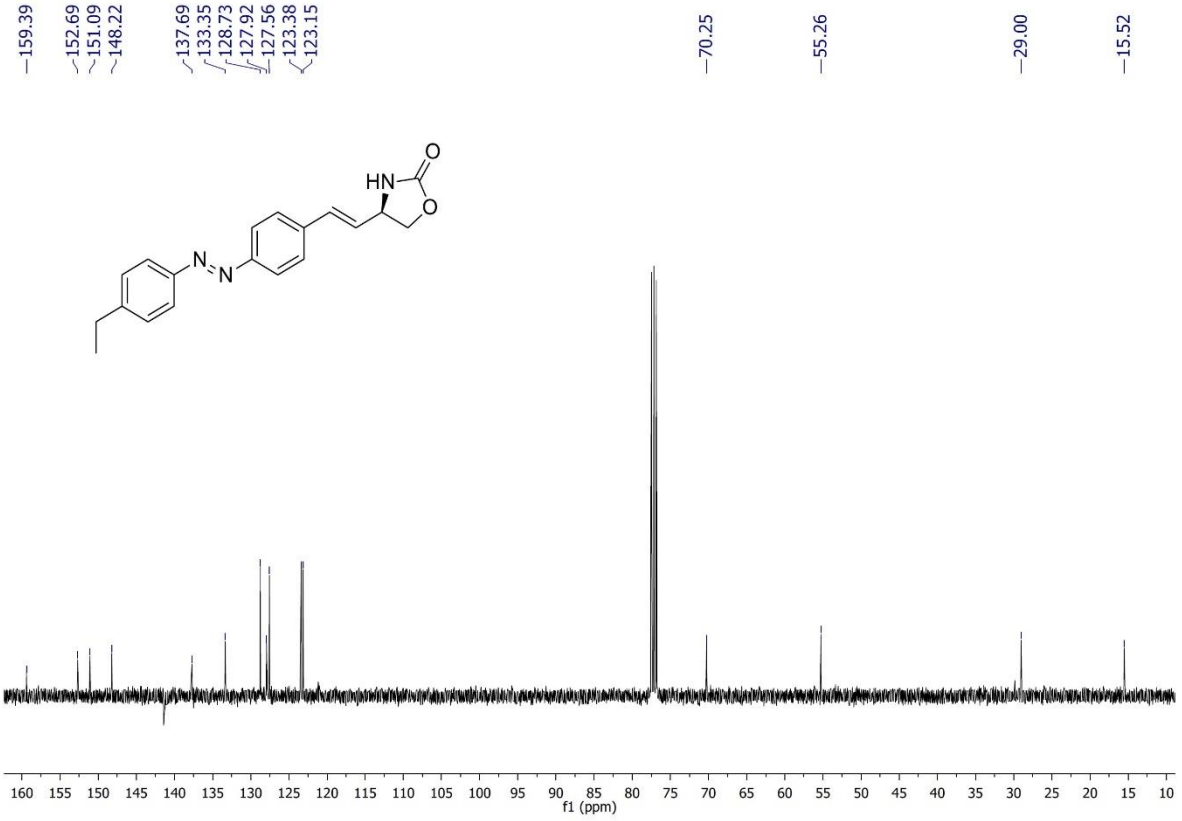
(4*R*)-3-(*tert*-butyldimethylsilyl)-4-{(*Z*)-4-[(*E*)-(4-ethylphenyl)diazenyl]styryl}oxazolidin-2-one (*Z*)-27)



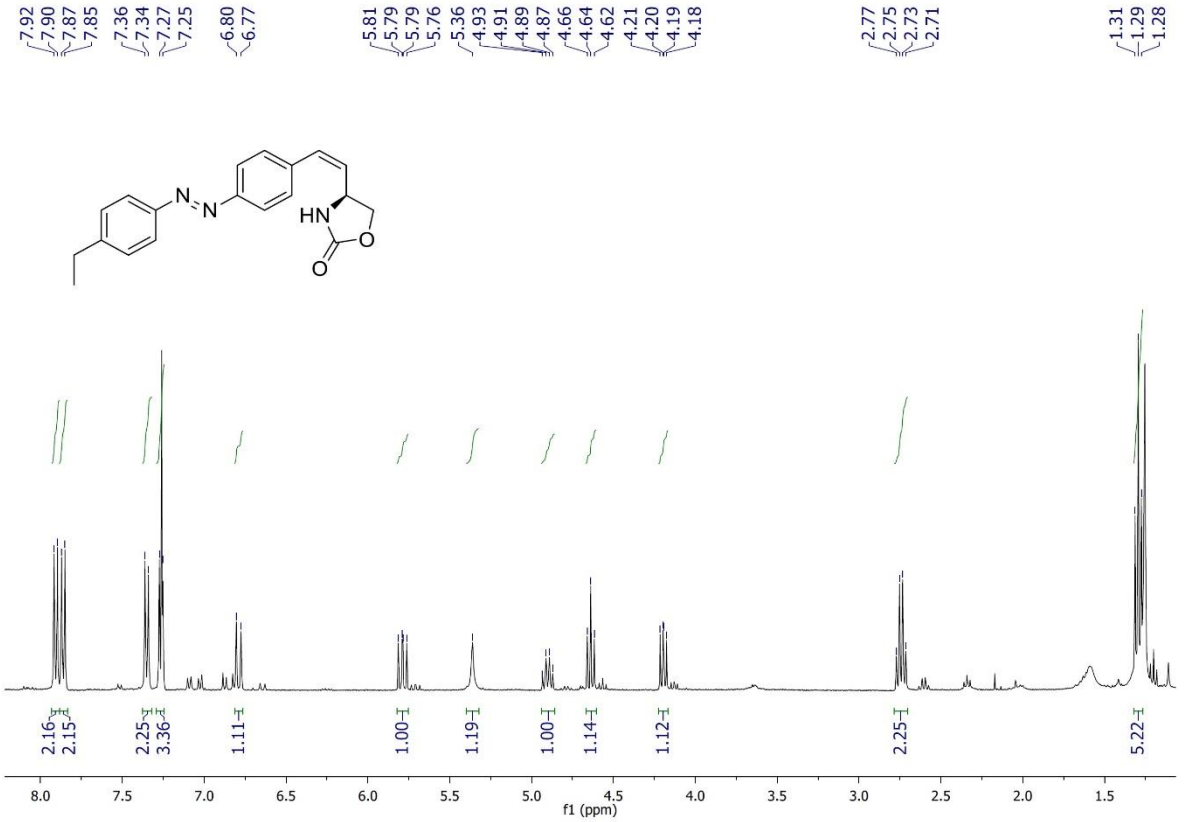


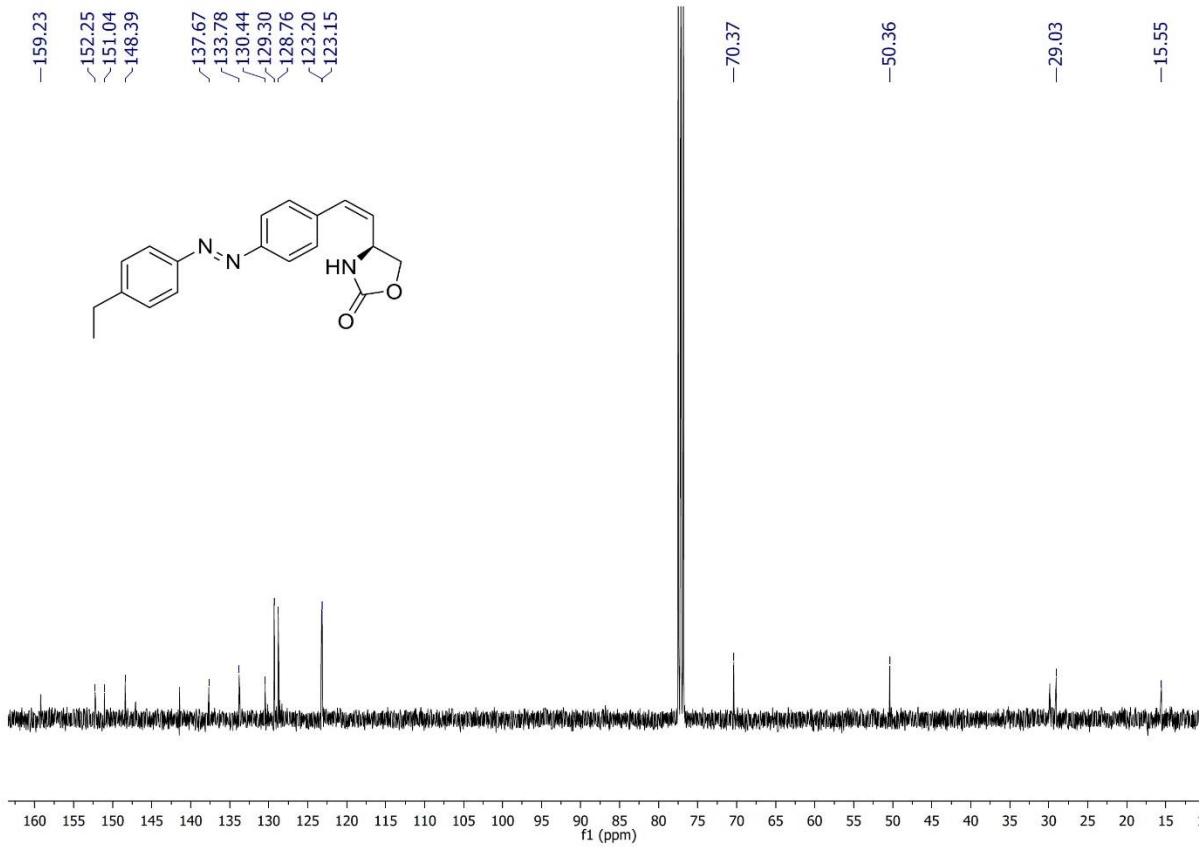
(4*R*)-4-{(*E*)-4-[(*E*)-(4-Ethylphenyl)diazenyl]styryl}oxazolidin-2-one ((*E*)-28)



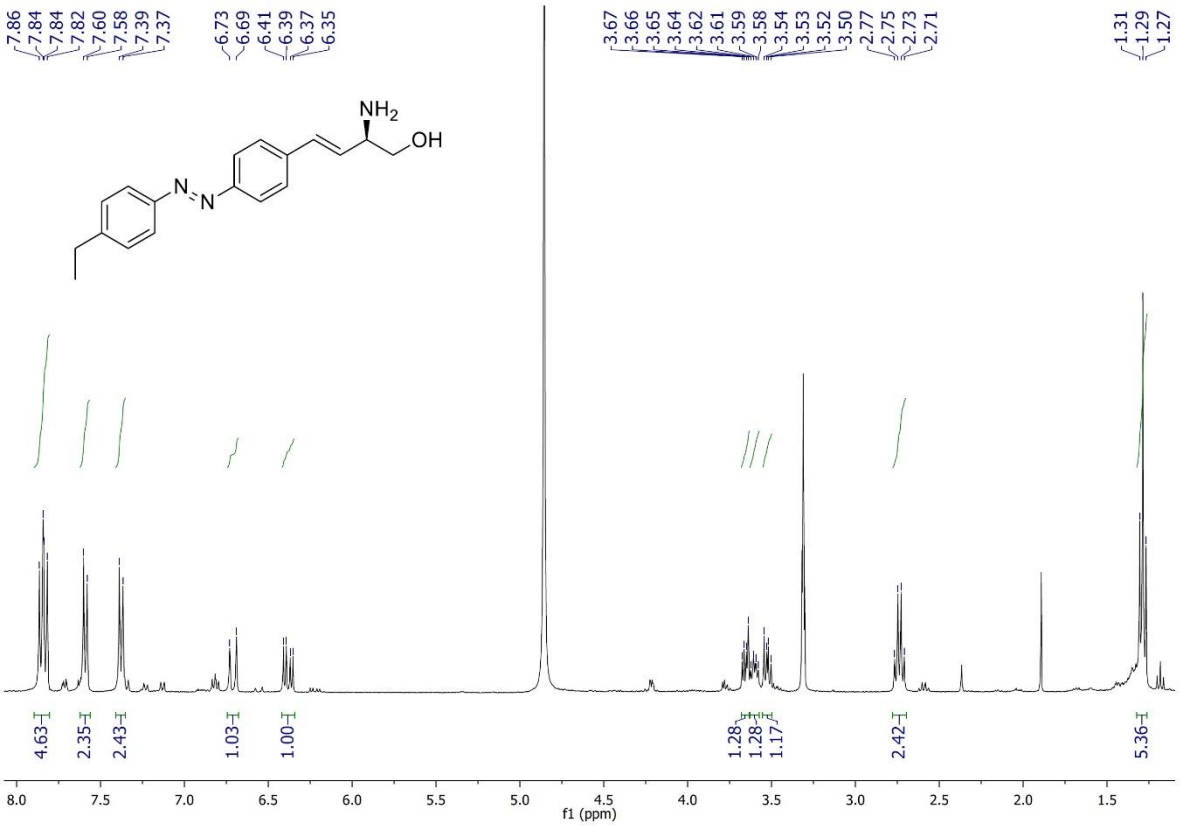


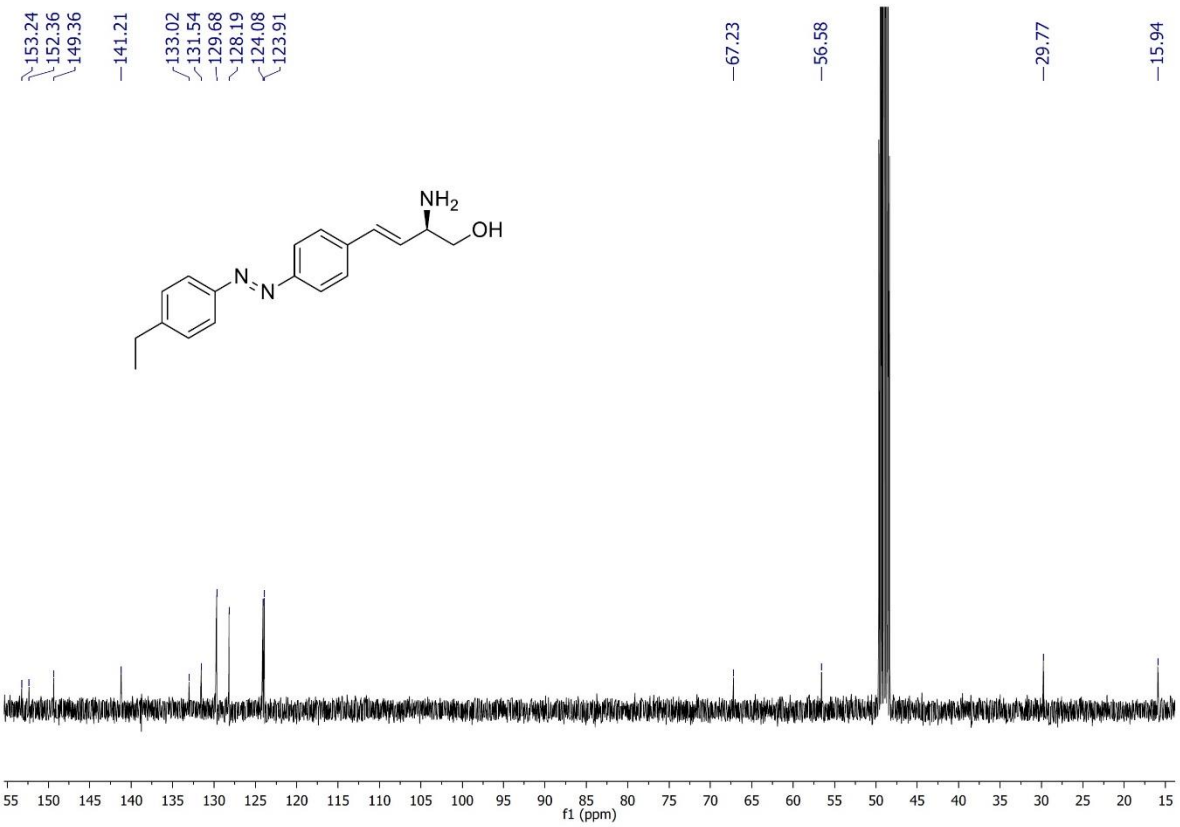
(4*R*)-4-{(*Z*)-4-[(*E*)-(4-Ethylphenyl)diazenyl]styryl}oxazolidin-2-one ((*Z*)-28)



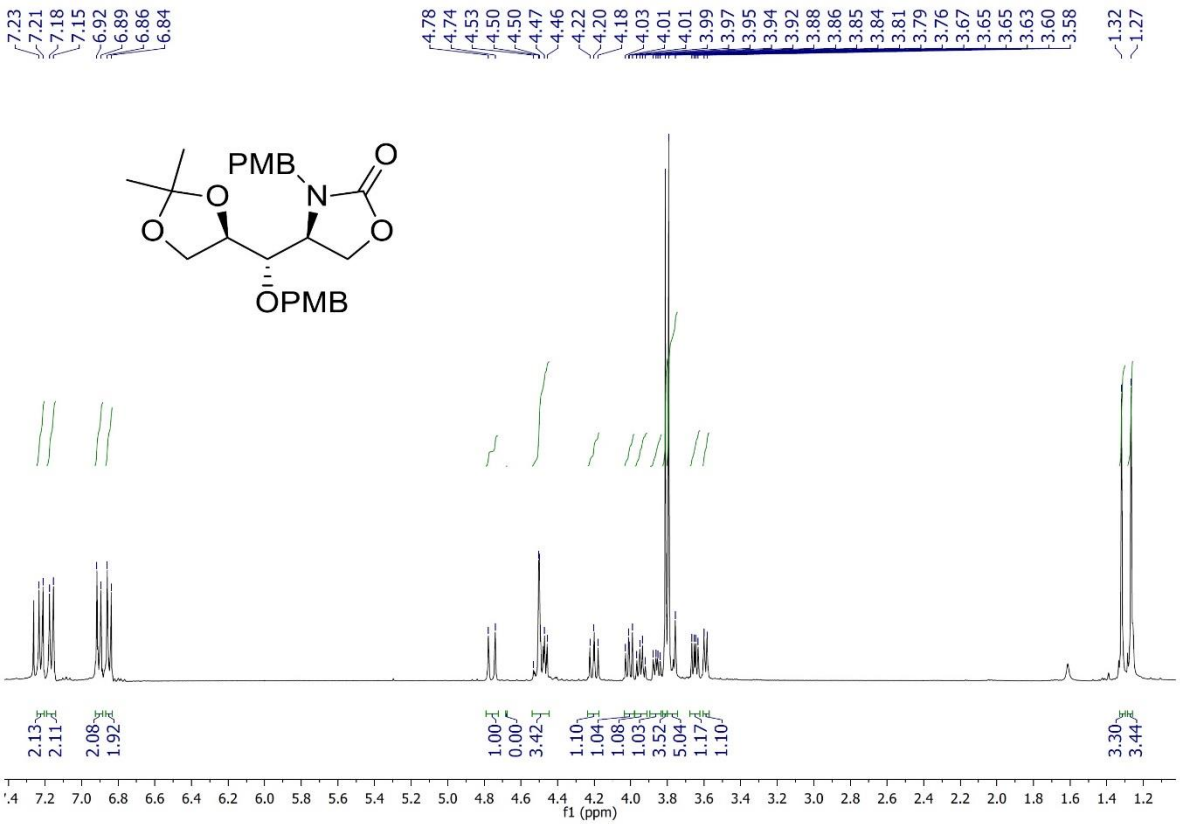


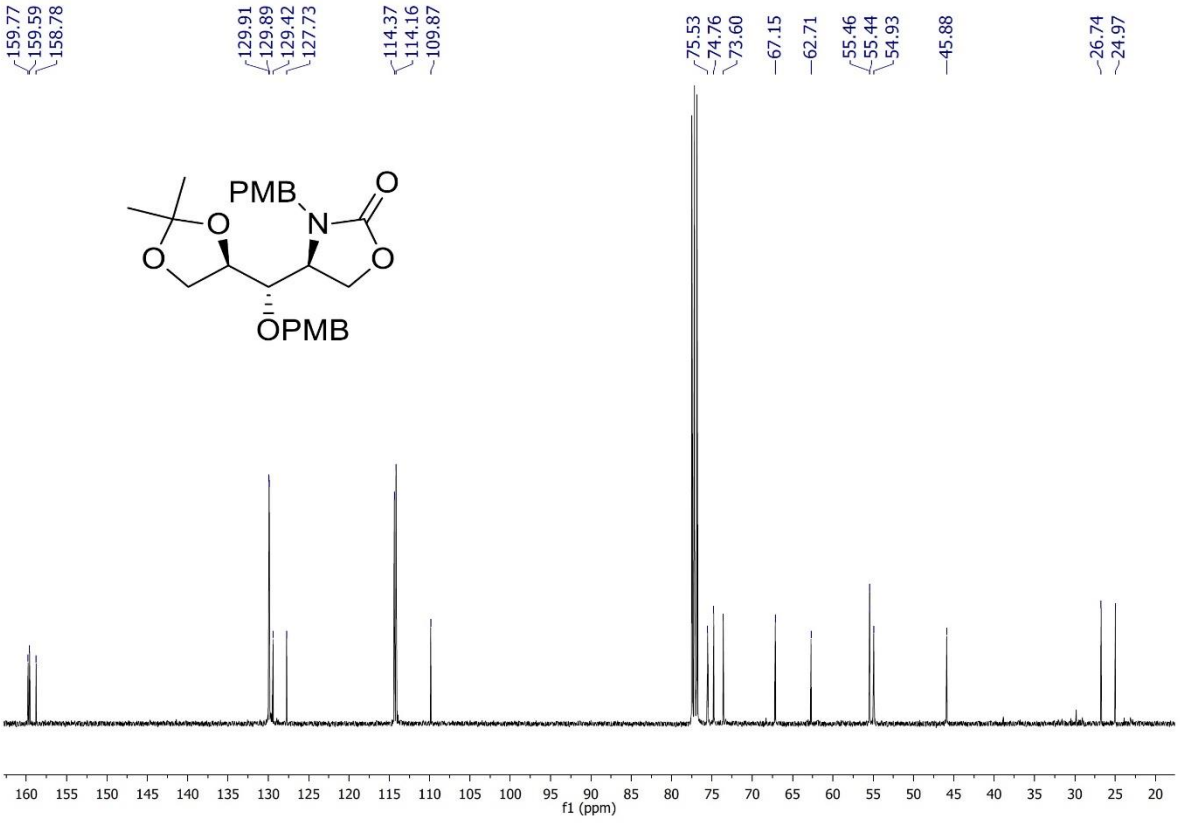
(2*R*,3*E*)-2-Amino-4-{4-[(*E*)-(4-ethylphenyl)diazenyl]phenyl}but-3-en-1-ol ((*E*)-29)



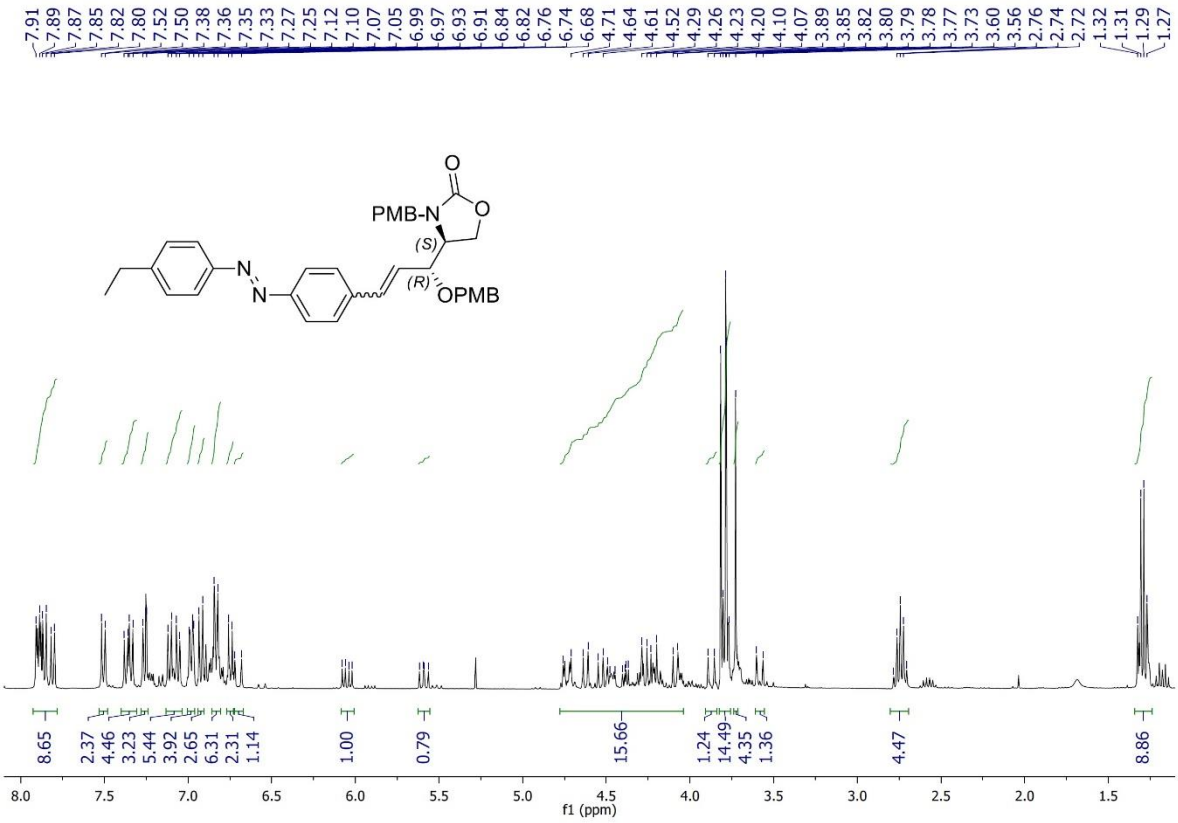


(4*S*)-4-{(*S*)-[(4'*R*)-2',2'-Dimethyl-1',3'-dioxolan-4'-yl][(*p*-methoxybenzyl)oxy]methyl}-3-(*p*-methoxybenzyl)oxazolidin-2-one (30)

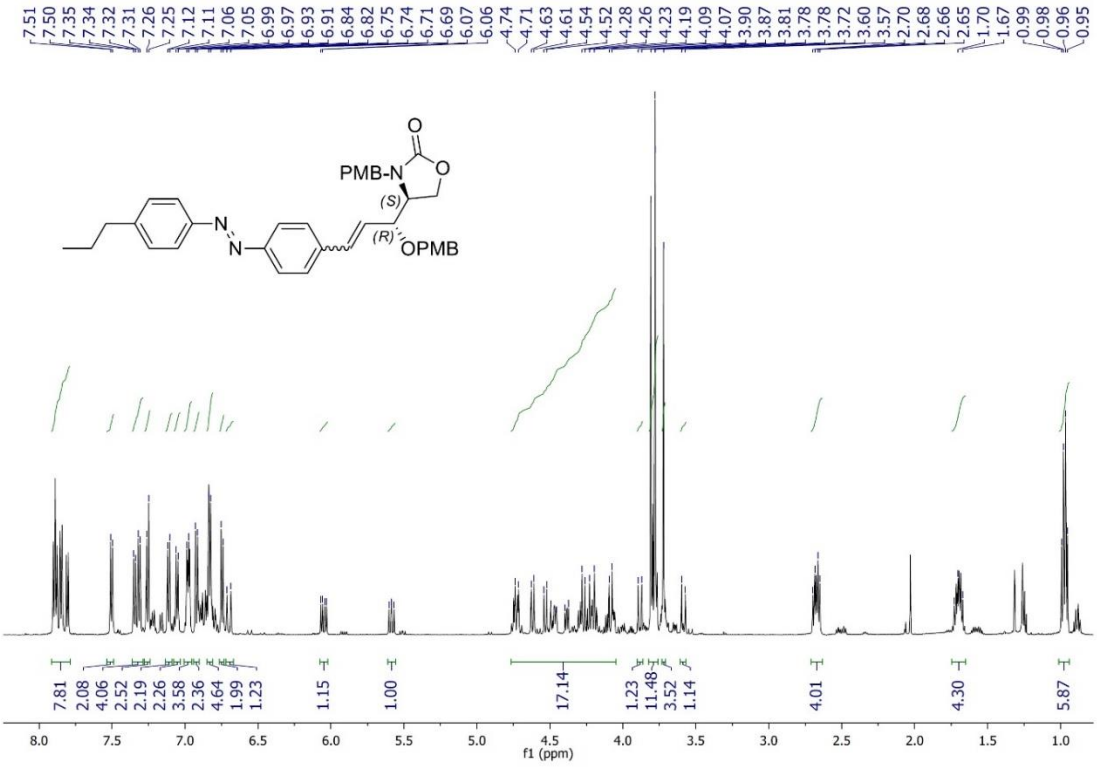




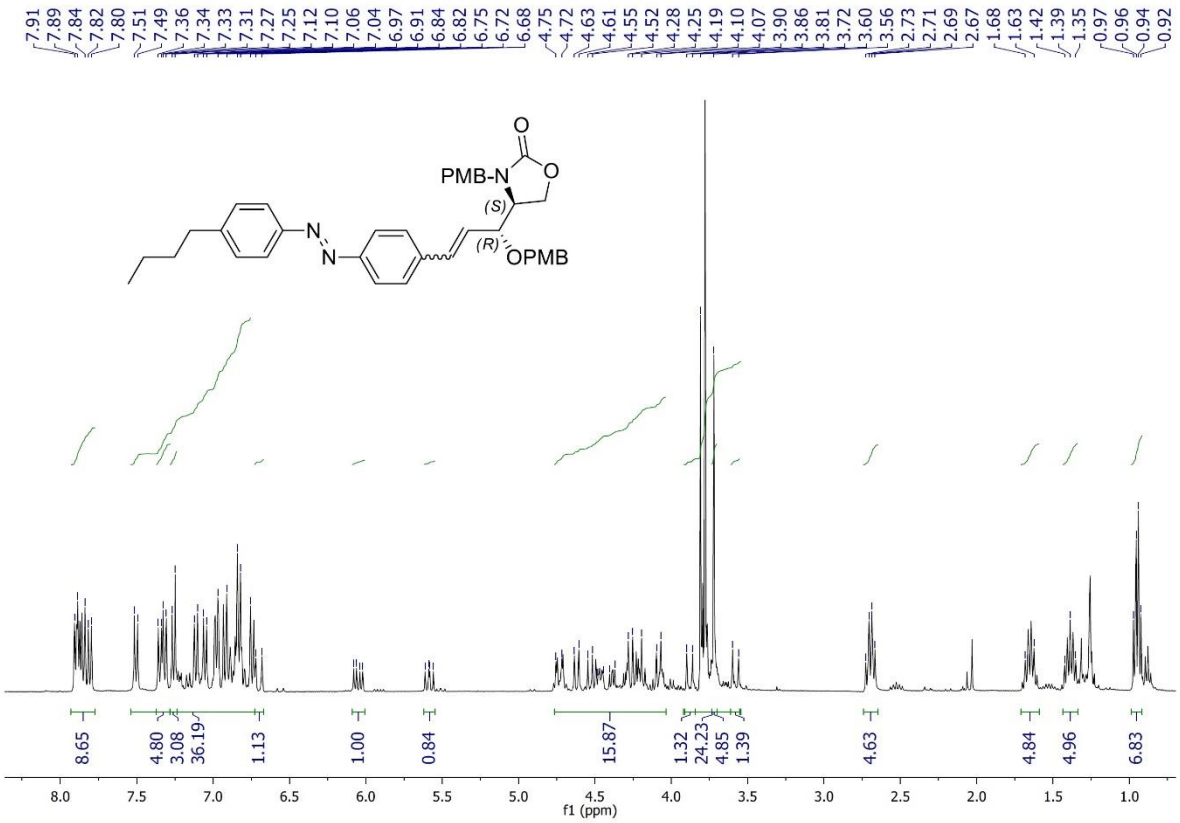
(4*S*)-4-{(*R*,2'*E*&2'*Z*)-3'-(4-[(*E*)-(4-Ethylphenyl)diazenyl]phenyl)-1'-[(*p*-methoxybenzyl)oxy]allyl}-3-(*p*-methoxybenzyl)oxazolidin-2-one (32a)



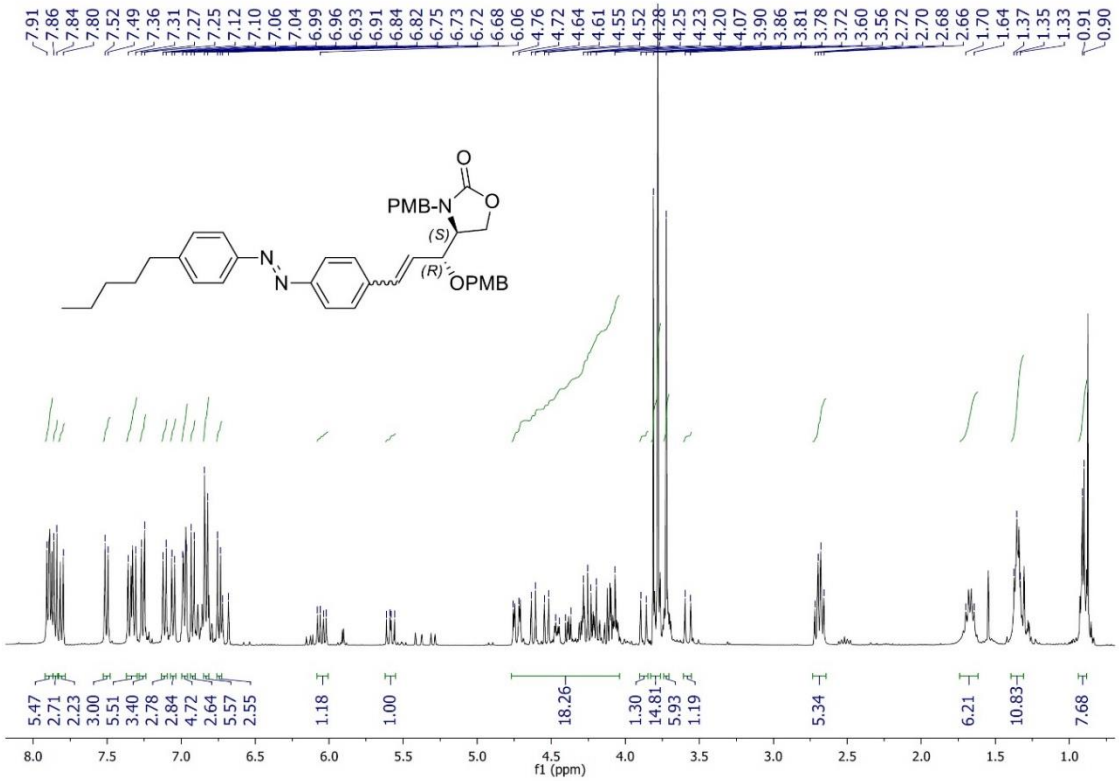
(4*S*)-3-(*p*-Methoxybenzyl)-4-{(*R*,2'*E*&2'*Z*)-1'-[(*p*-methoxybenzyl)oxy]-3'-(4-[(*E*)-(4-propylphenyl)diazenyl]phenyl)allyl}oxazolidin-2-one (32b)



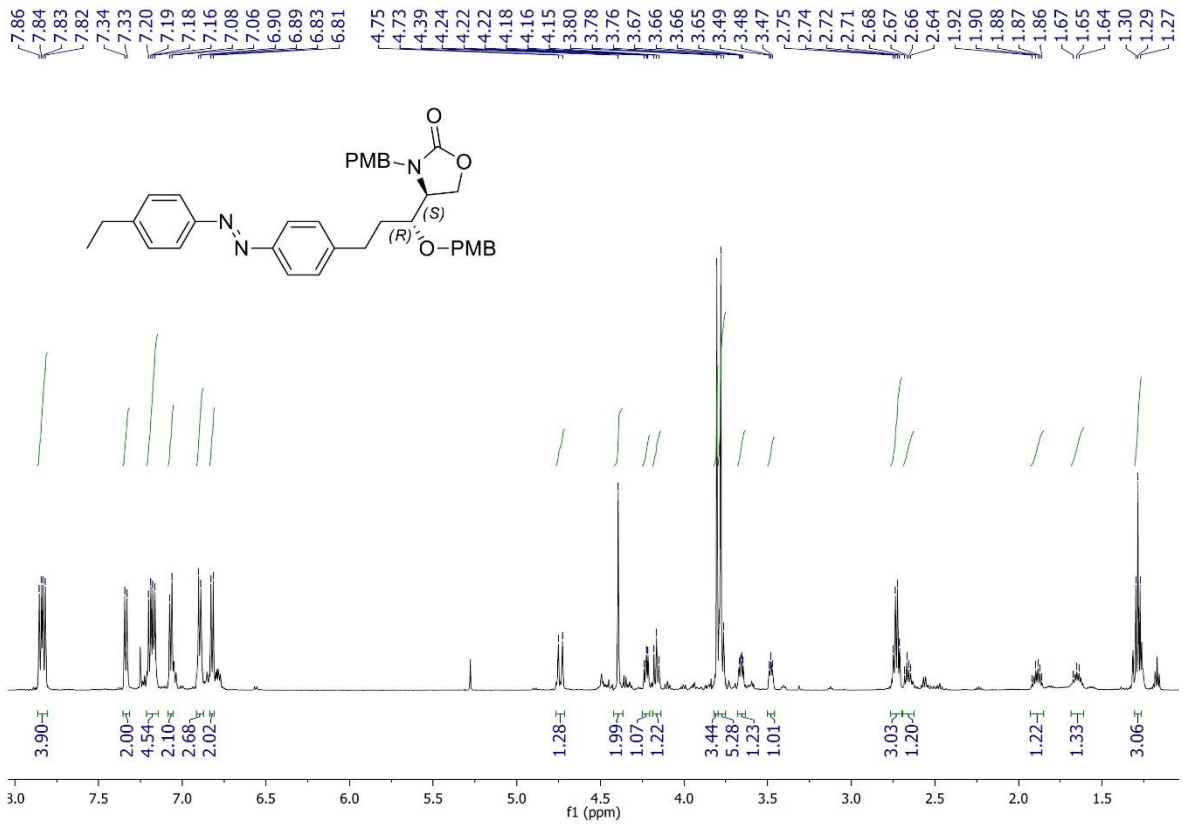
(4*S*)-4-{(*R*,2'*E*&2'*Z*)-3'-(4-[(*E*)-(4-Butylphenyl)diazenyl]phenyl)-1'-[(*p*-methoxybenzyl)oxy]allyl}-3-(*p*-methoxybenzyl)oxazolidin-2-one (32c)

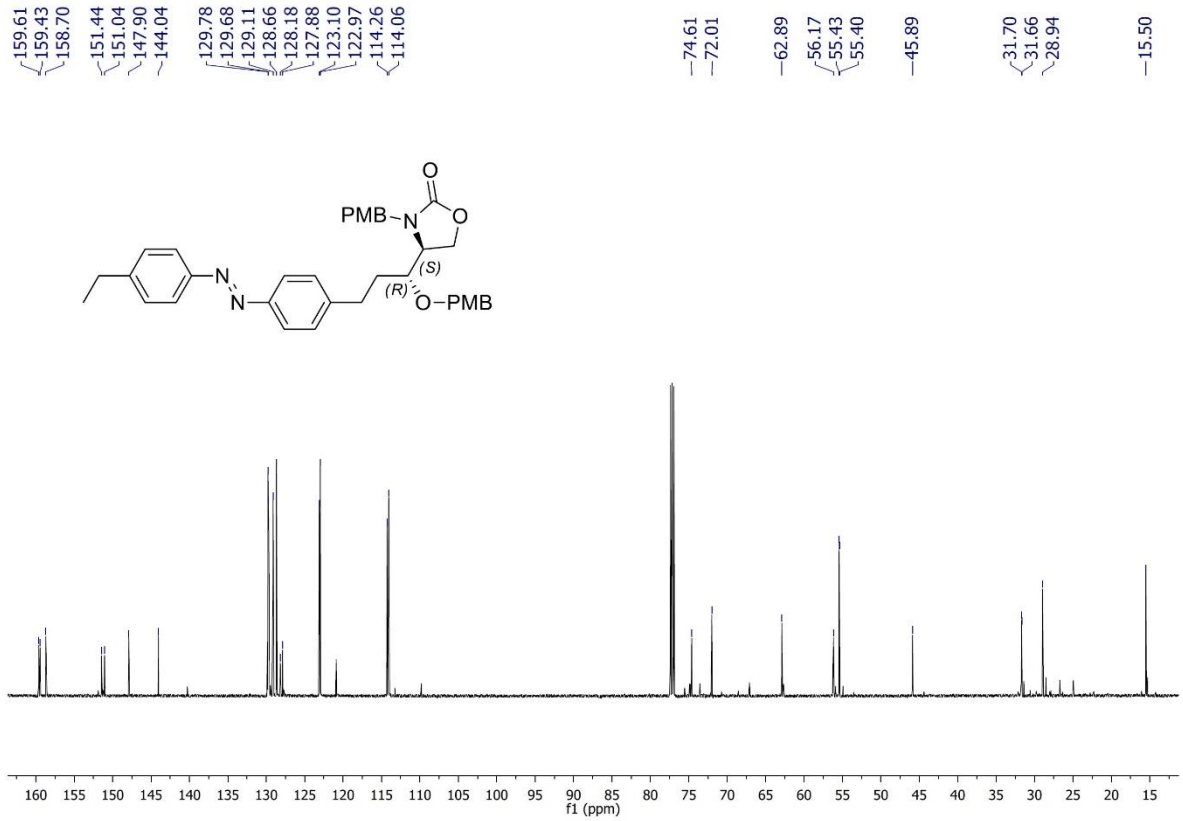


(4*S*)-3-(*p*-Methoxybenzyl)-4-{(*R*,2'*E*&2'*Z*)-1'-[(*p*-methoxybenzyl)oxy]-3'-(4-[(*E*)-(4-pentylphenyl)diazenyl]phenyl)allyl}oxazolidin-2-one (32d)

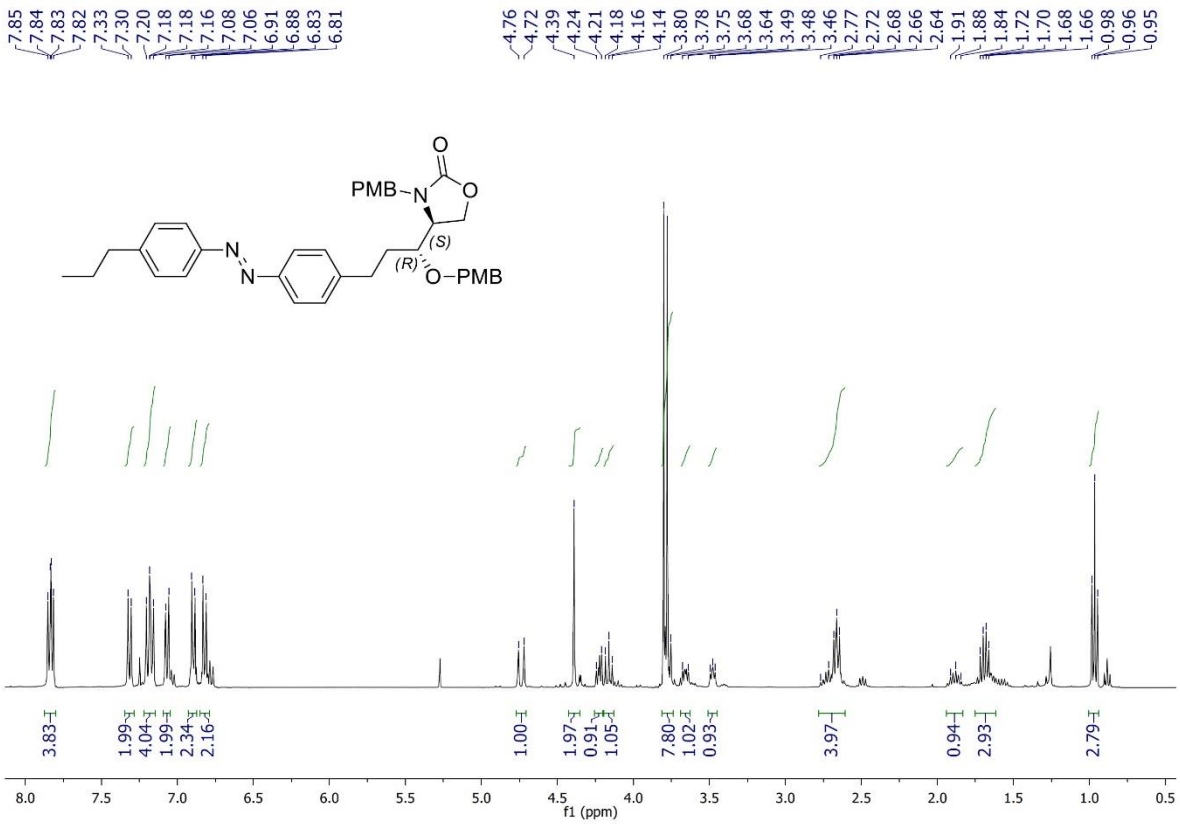


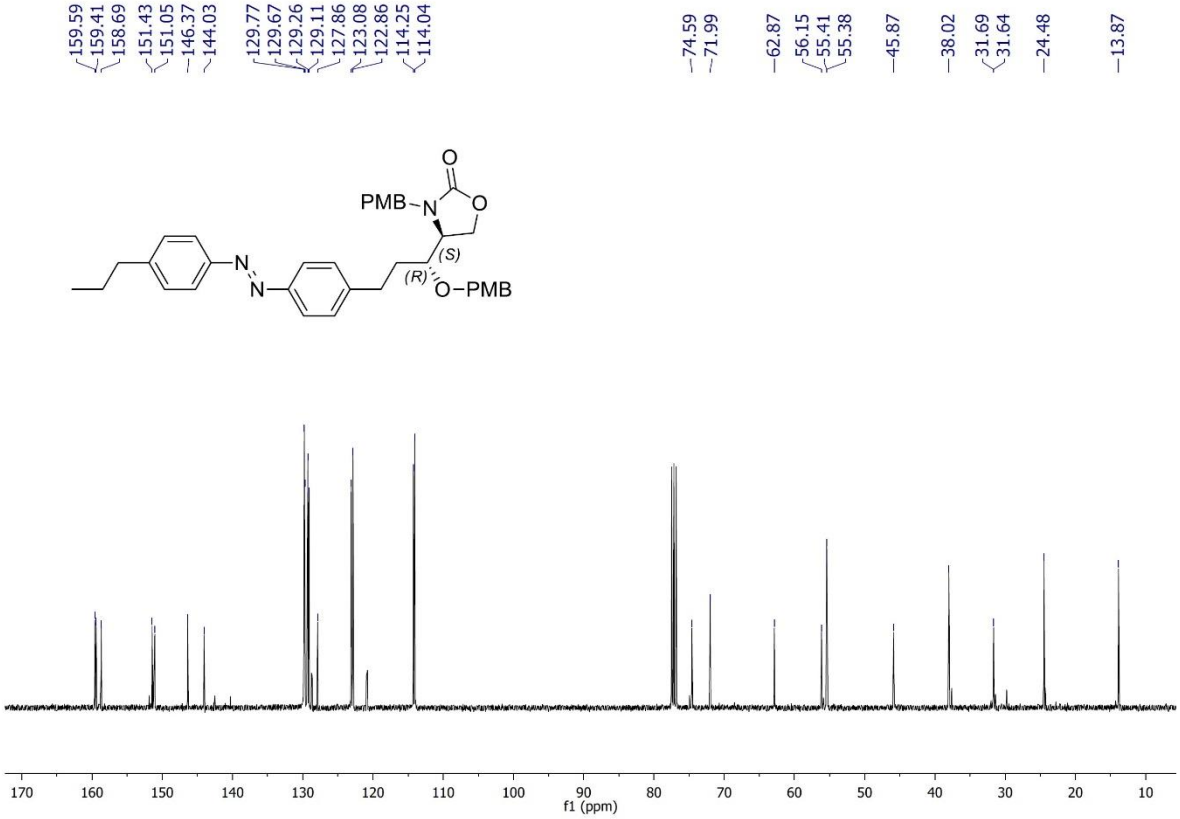
(4*S*)-4-{(*R*)-3'-(4-[(*E*)-(4-Ethylphenyl)diazenyl]phenyl)-1'-[(*p*-methoxybenzyl)oxy]propyl}-3-(*p*-methoxybenzyl)oxazolidin-2-one (33a)



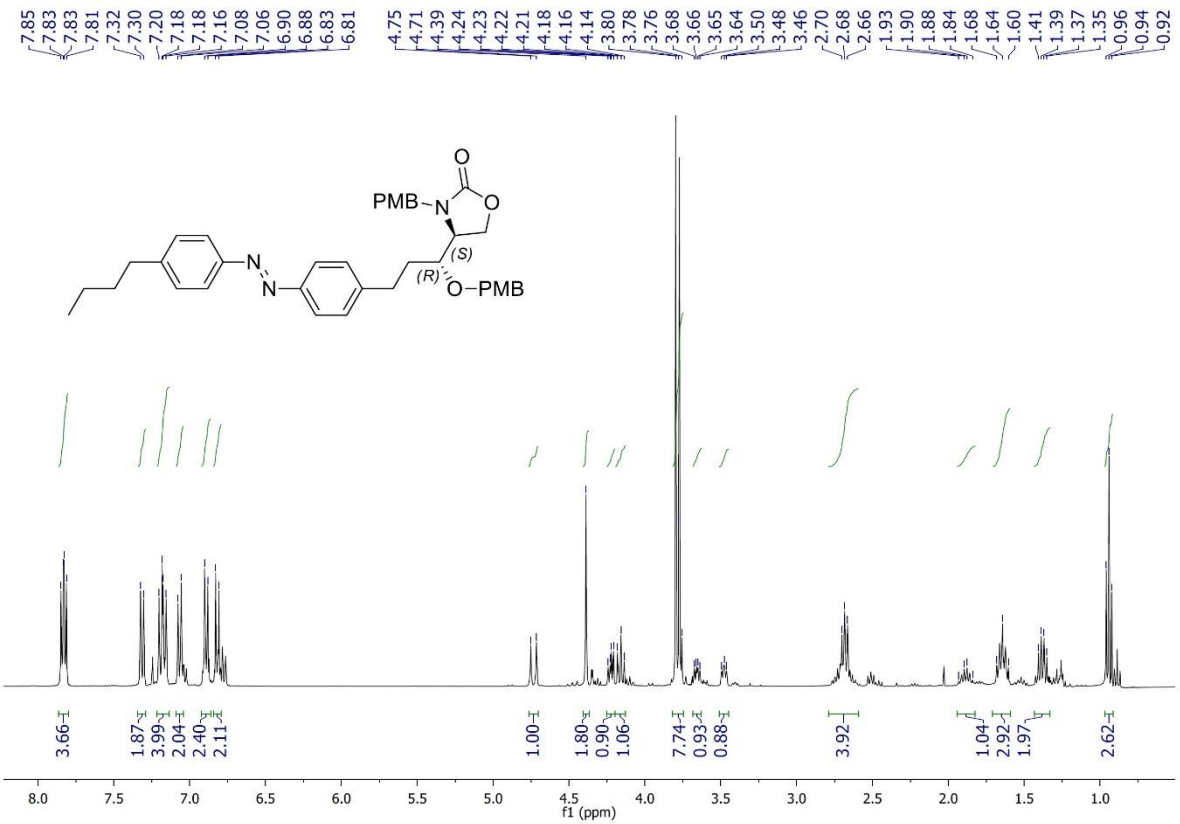


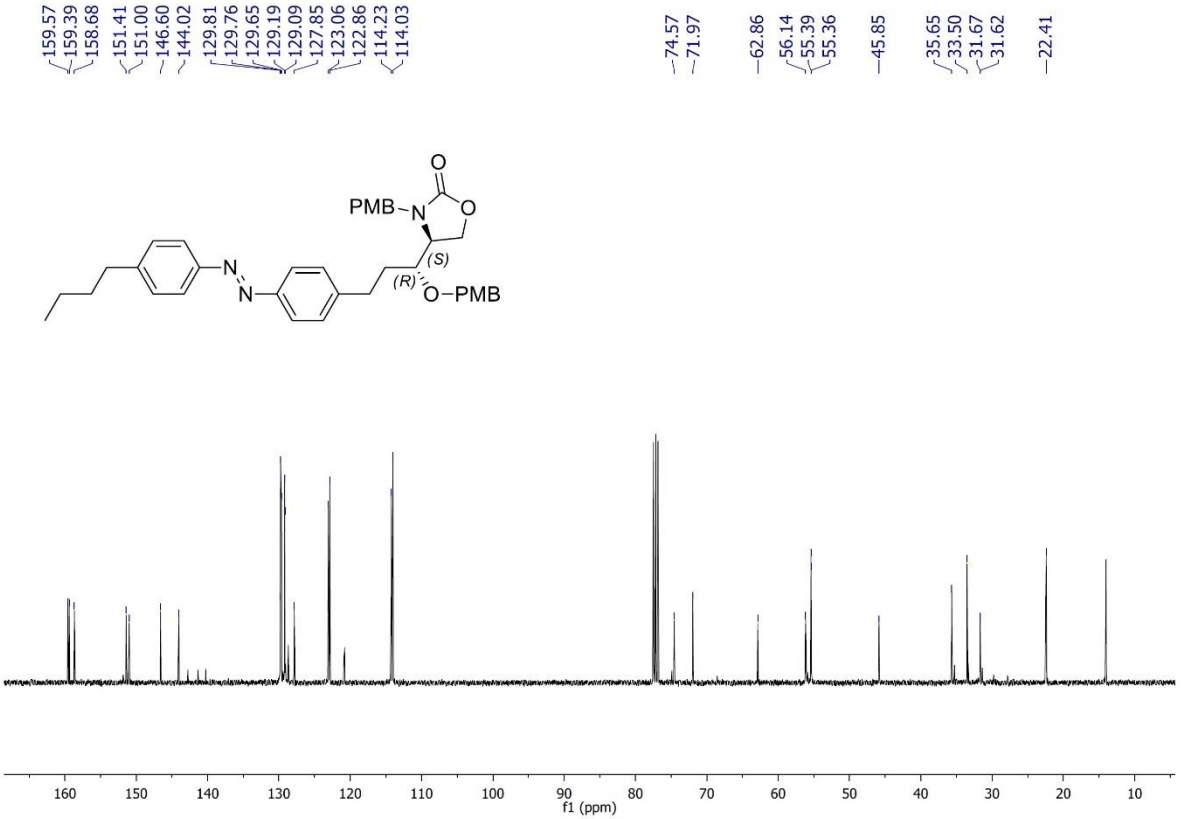
(4*S*)-3-(*p*-Methoxybenzyl)-4-{(*R*)-1'-[(*p*-methoxybenzyl)oxy]-3'-(4-[(*E*)-(4-propylphenyl)diazenyl]phenyl)propyl}oxazolidin-2-one 33b



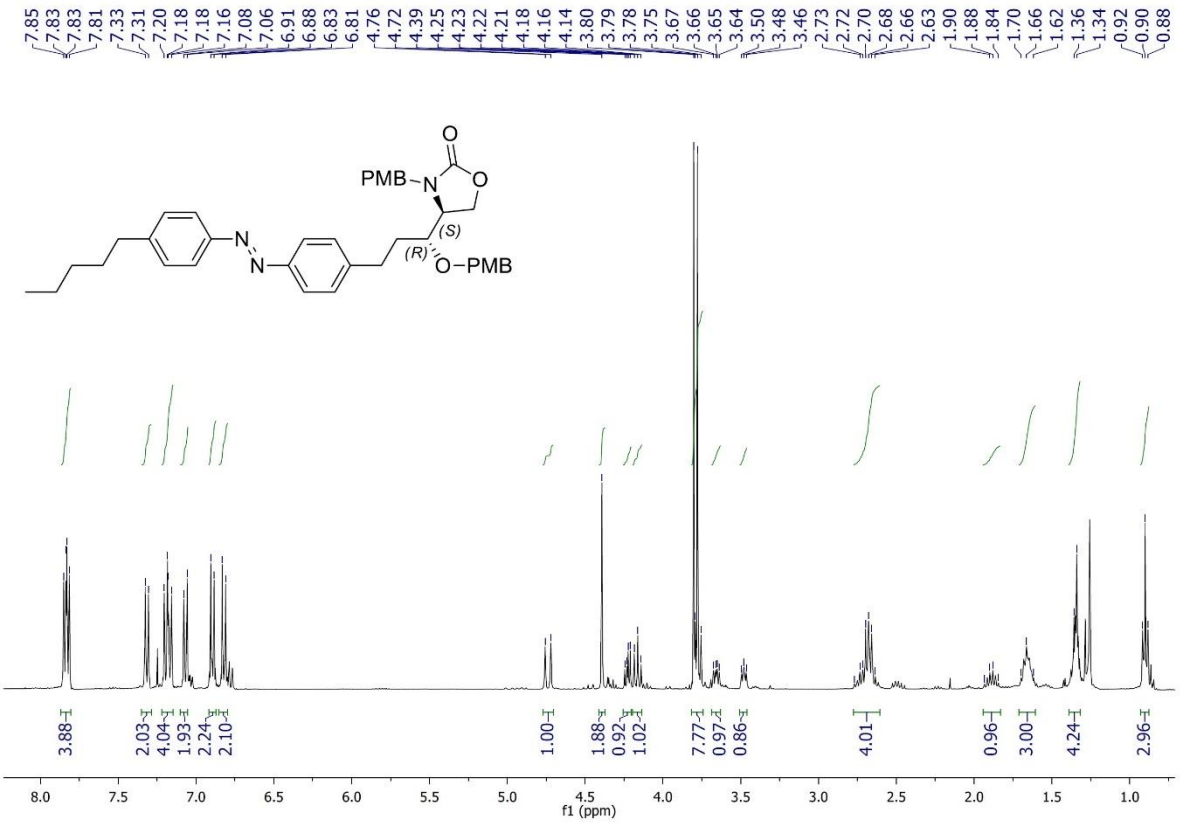


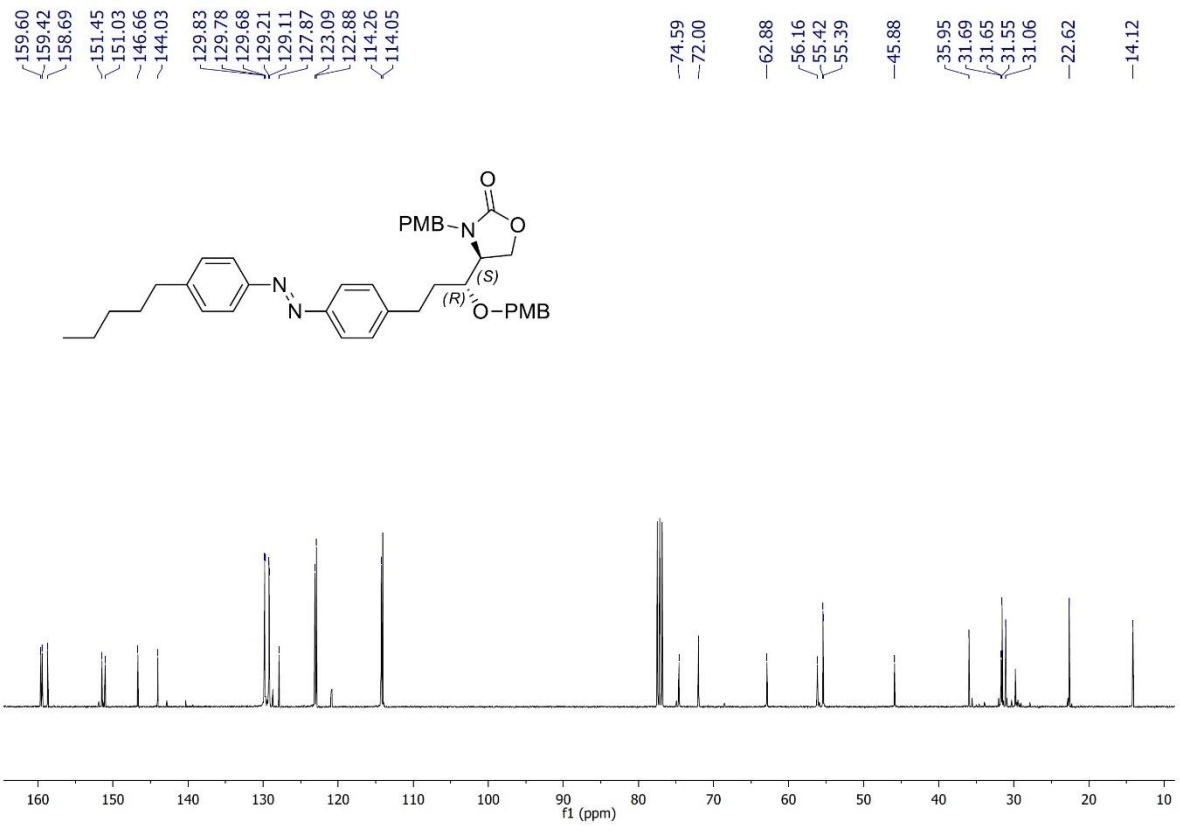
(4*S*)-4-{(*R*)-3'-(4-[(*E*)-(4-Butylphenyl)diazenyl]phenyl)-1'-[(*p*-methoxybenzyl)oxy]propyl}-3-(*p*-methoxybenzyl)oxazolidin-2-one (33c)



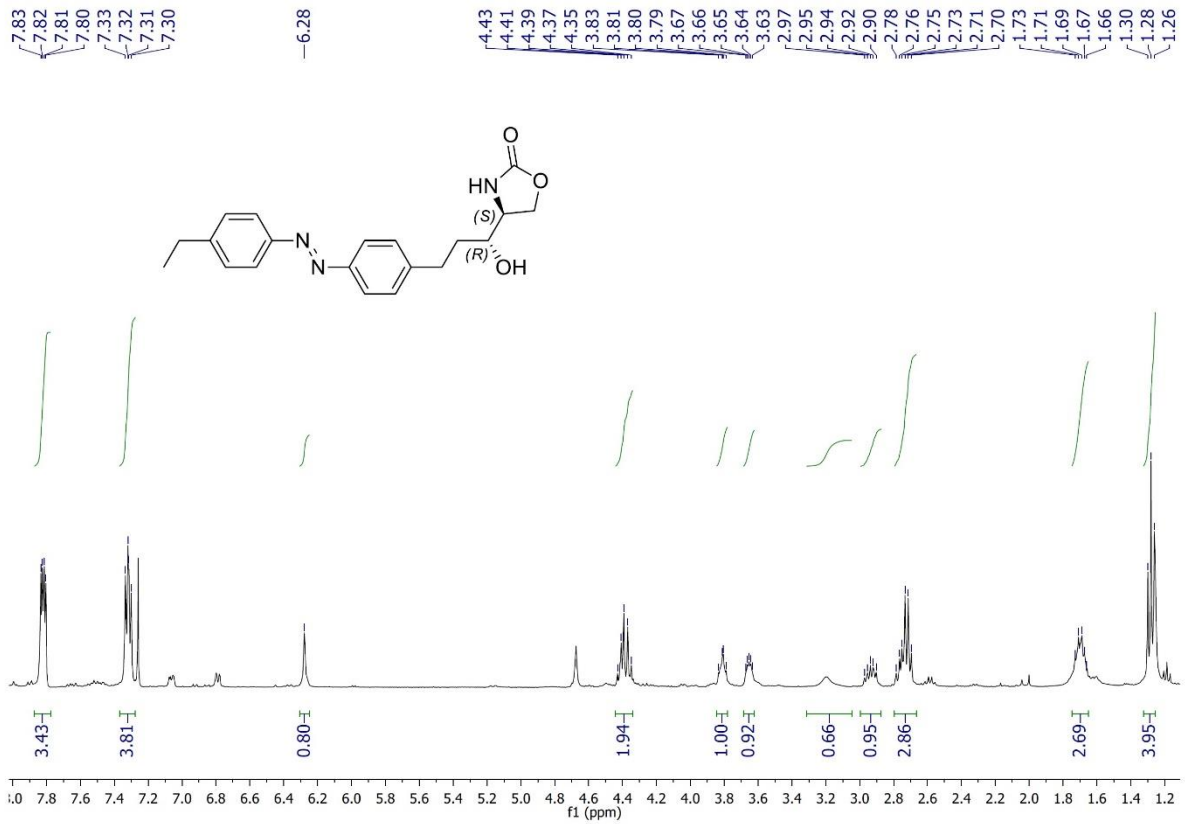


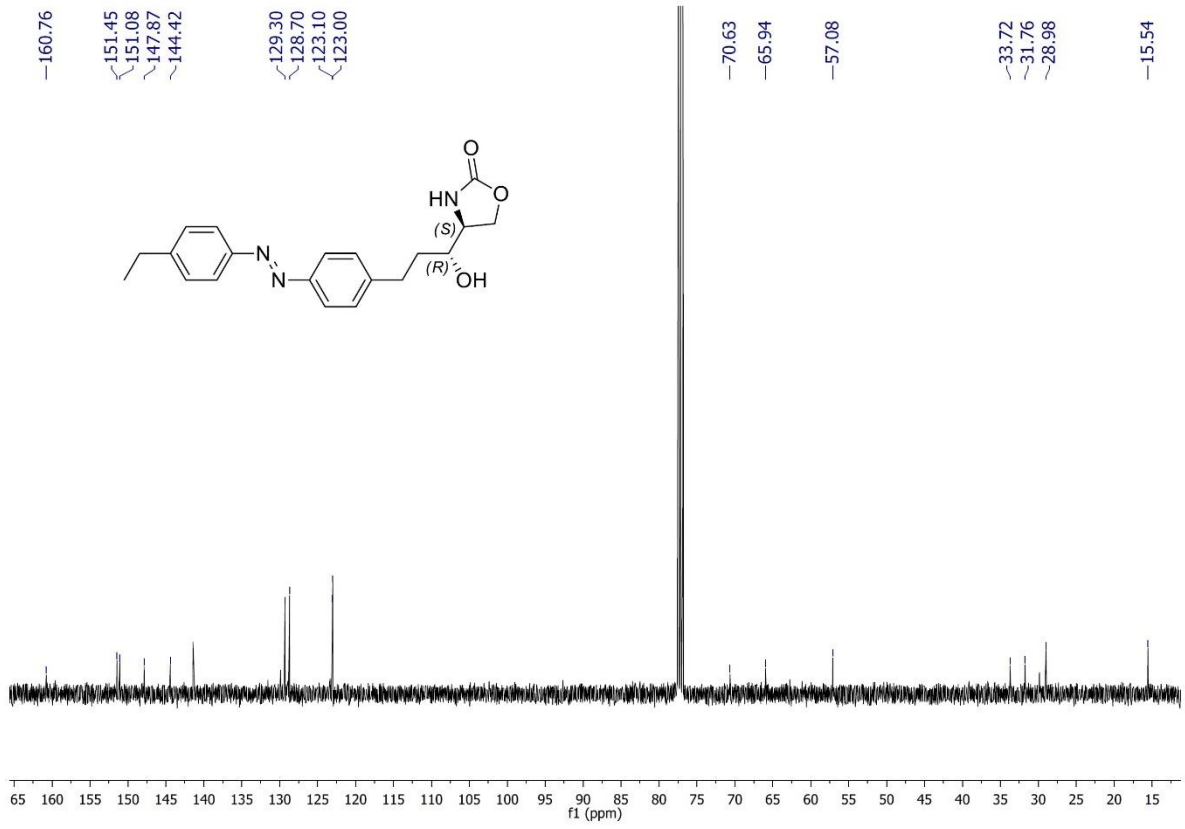
(4*S*)-3-(*p*-Methoxybenzyl)-4-{(*R*)-1'-[(*p*-methoxybenzyl)oxy]-3'-(4-[(*E*)-(4-pentylphenyl)diazenyl]phenyl)propyl}oxazolidin-2-one (33d)



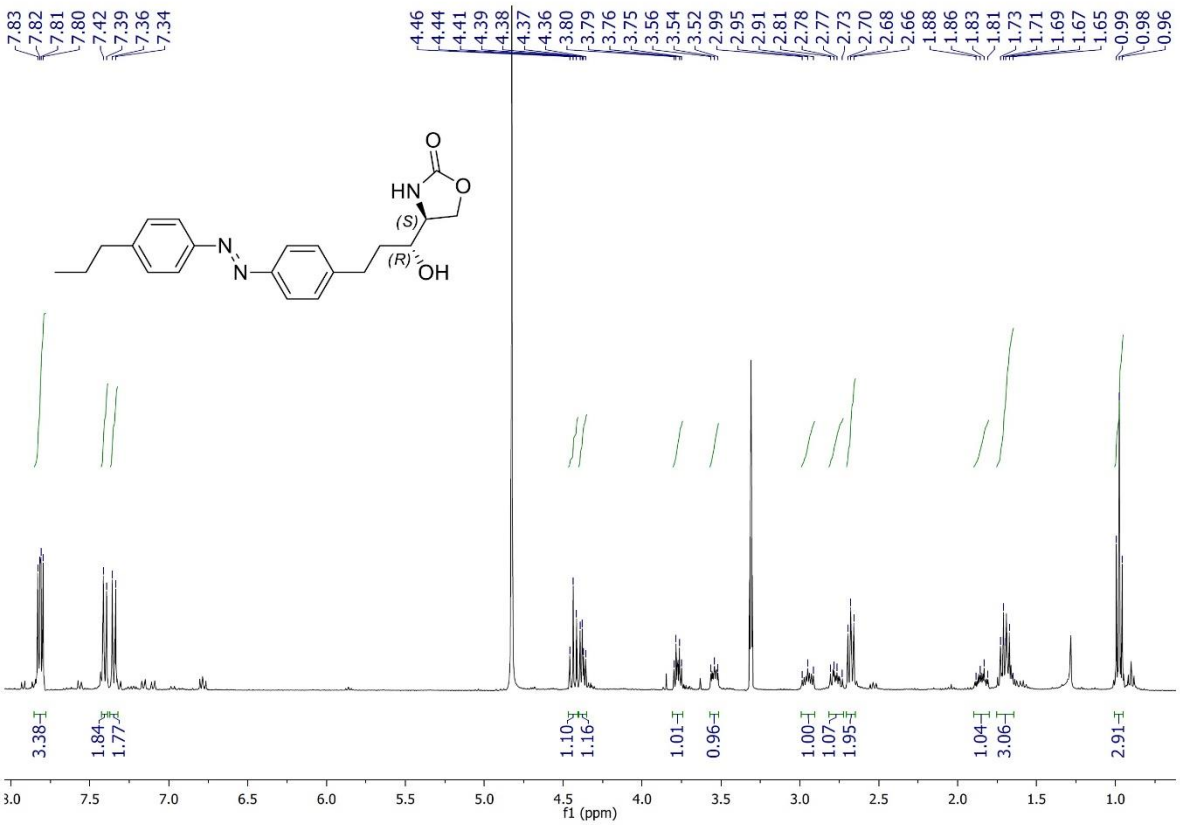


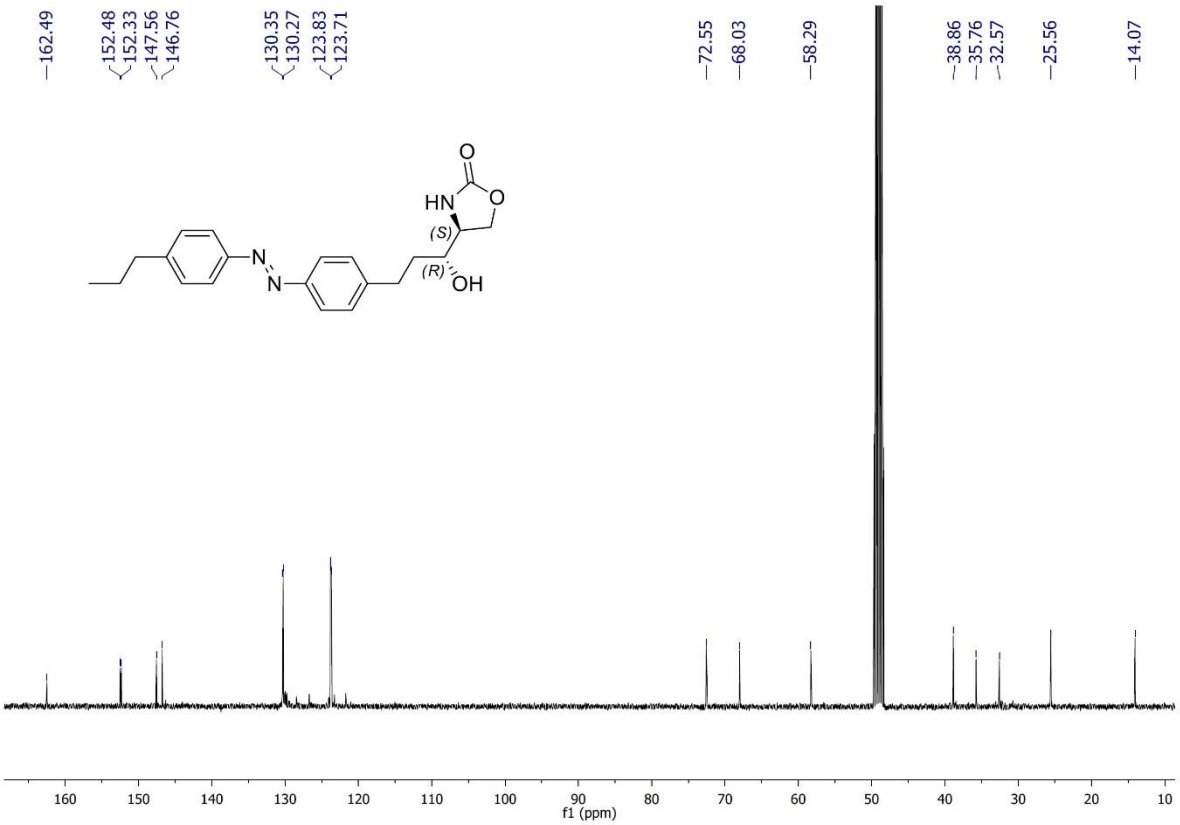
(4*S*)-4-{(*R*)-3'-(4-[(*E*)-(4-Ethylphenyl)diazenyl]phenyl)-1'-hydroxypropyl}oxazolidin-2-one (34a)



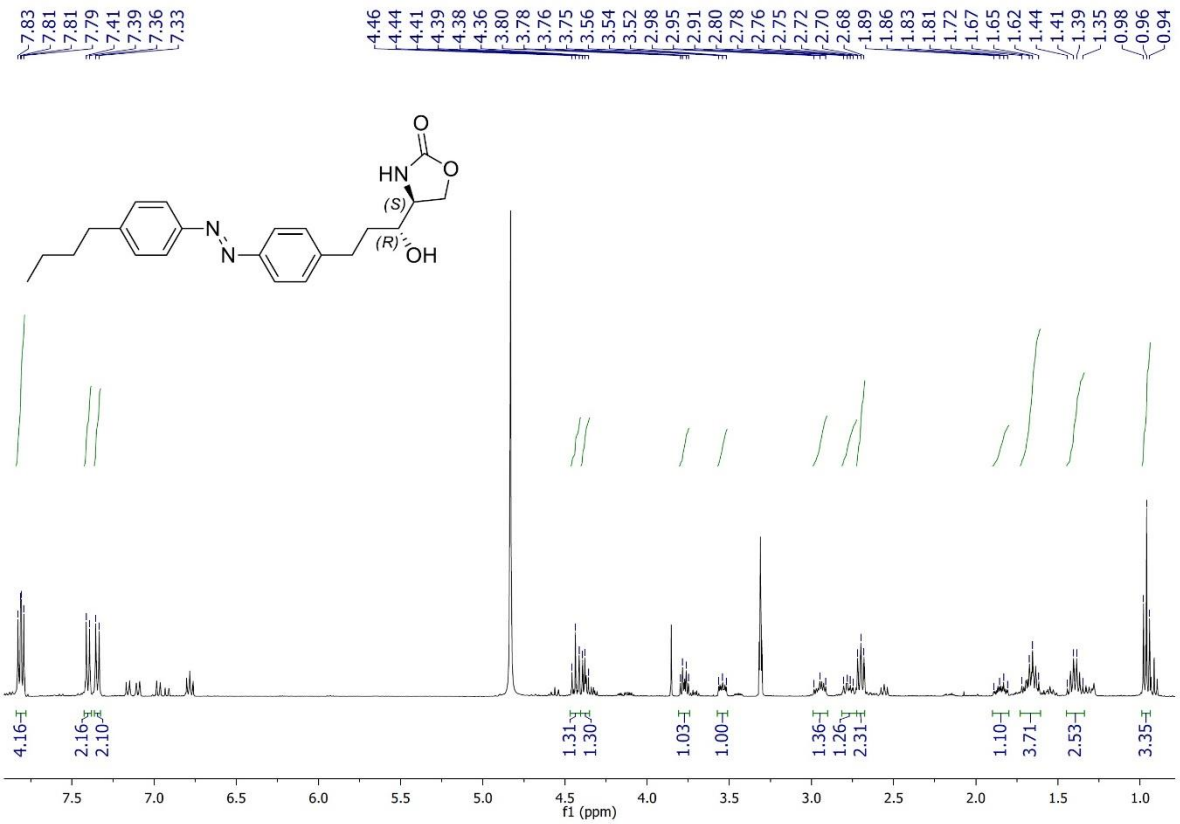


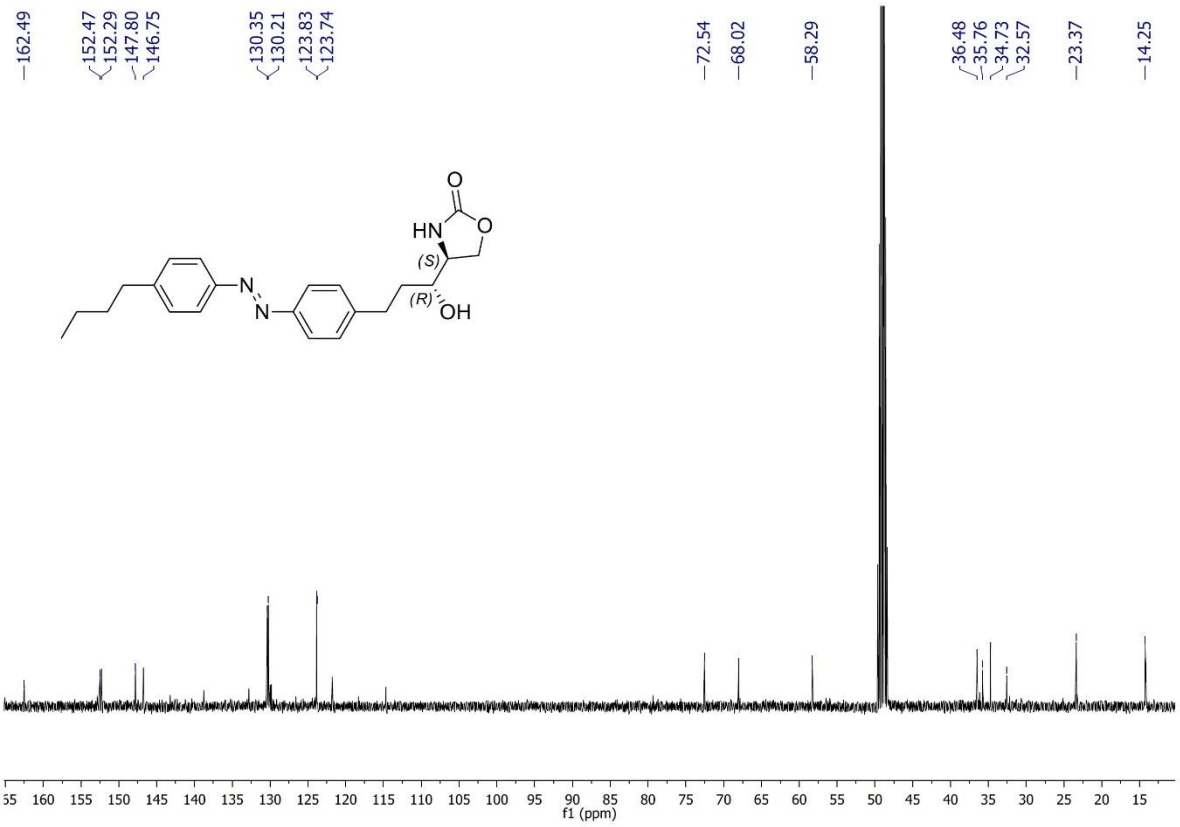
(4*S*)-4-{(*R*)-1'-Hydroxy-3'-(4-[(*E*)-(4-propylphenyl)diazenyl]phenyl)propyl}oxazolidin-2-one (34b)



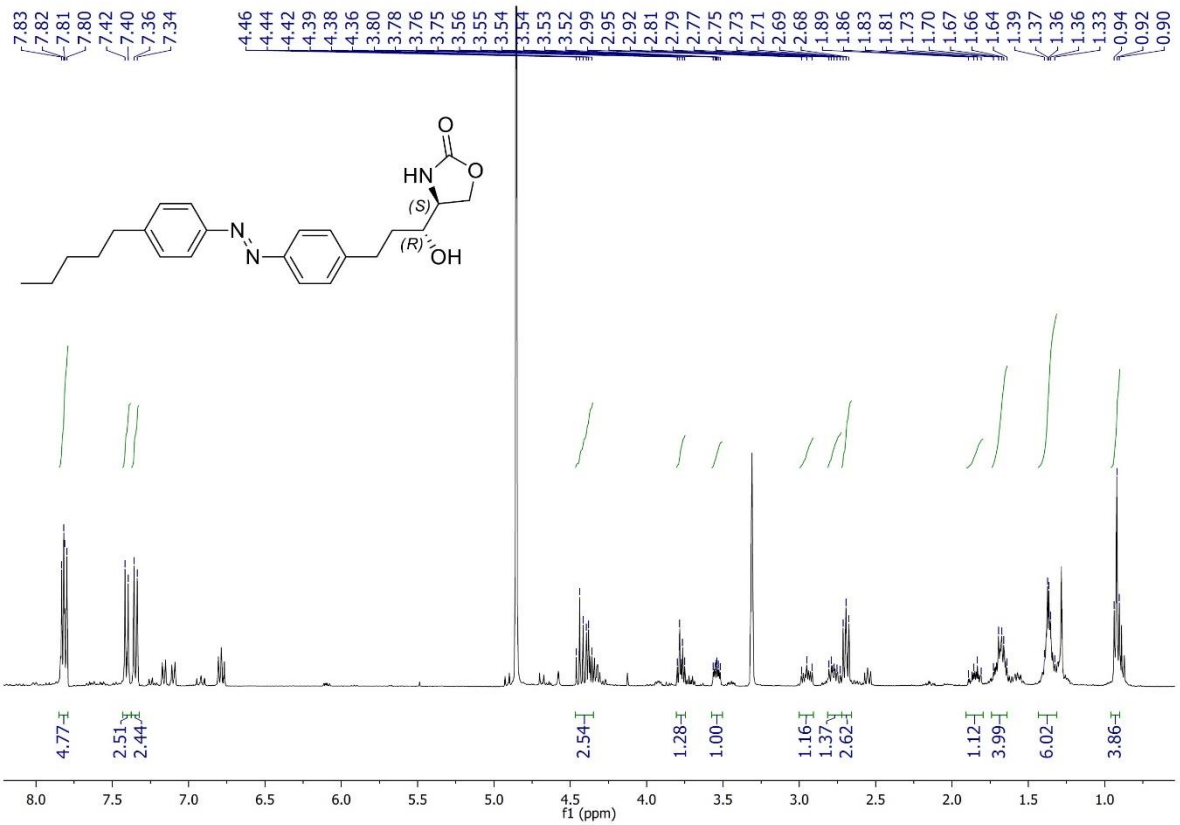


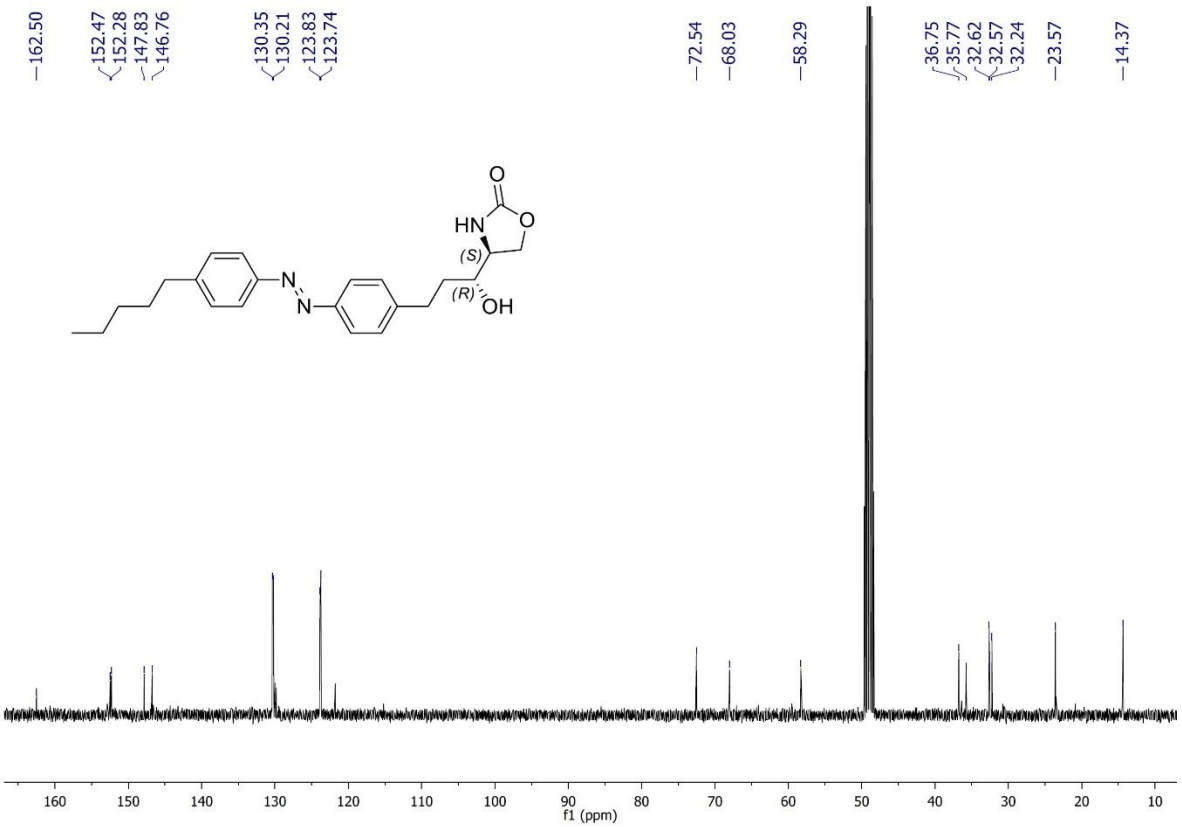
(4*S*)-4-{(*R*)-3'-(4-[(*E*)-(4-Butylphenyl)diazenyl]phenyl)-1'-hydroxypropyl}oxazolidin-2-one (34c)



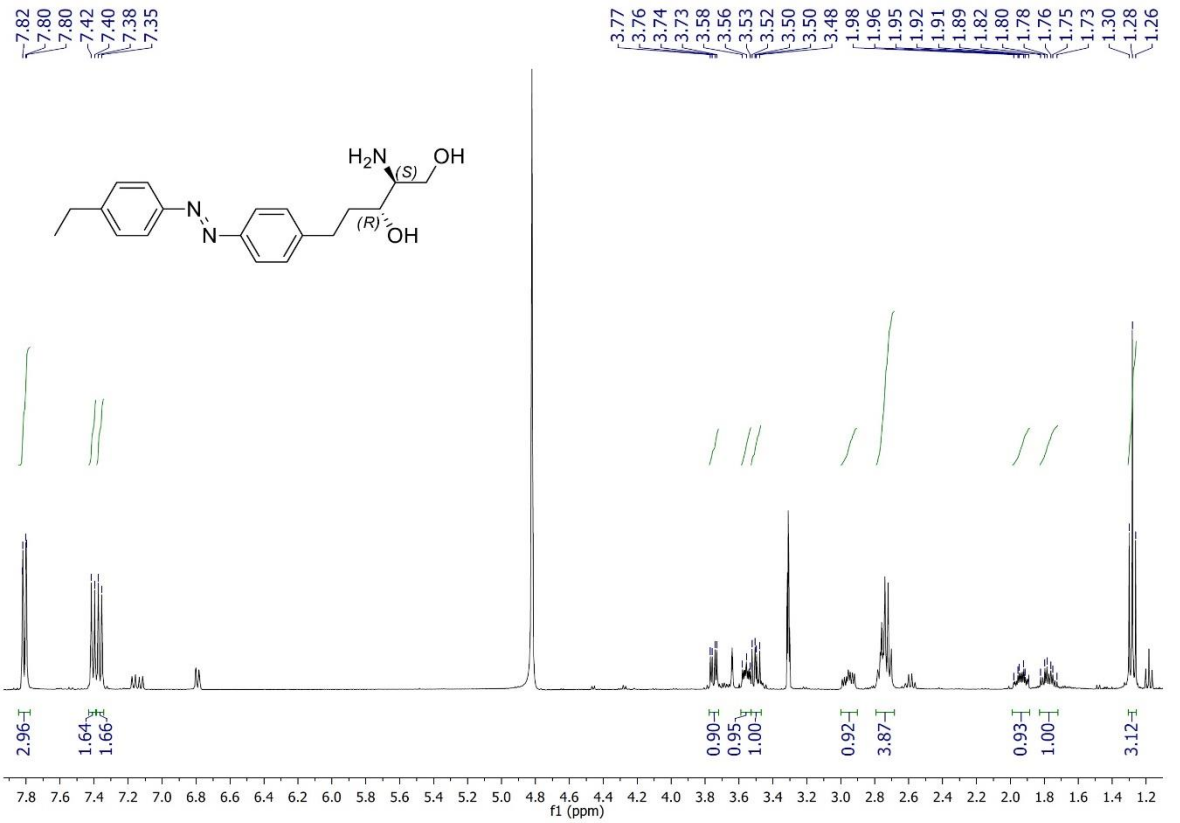


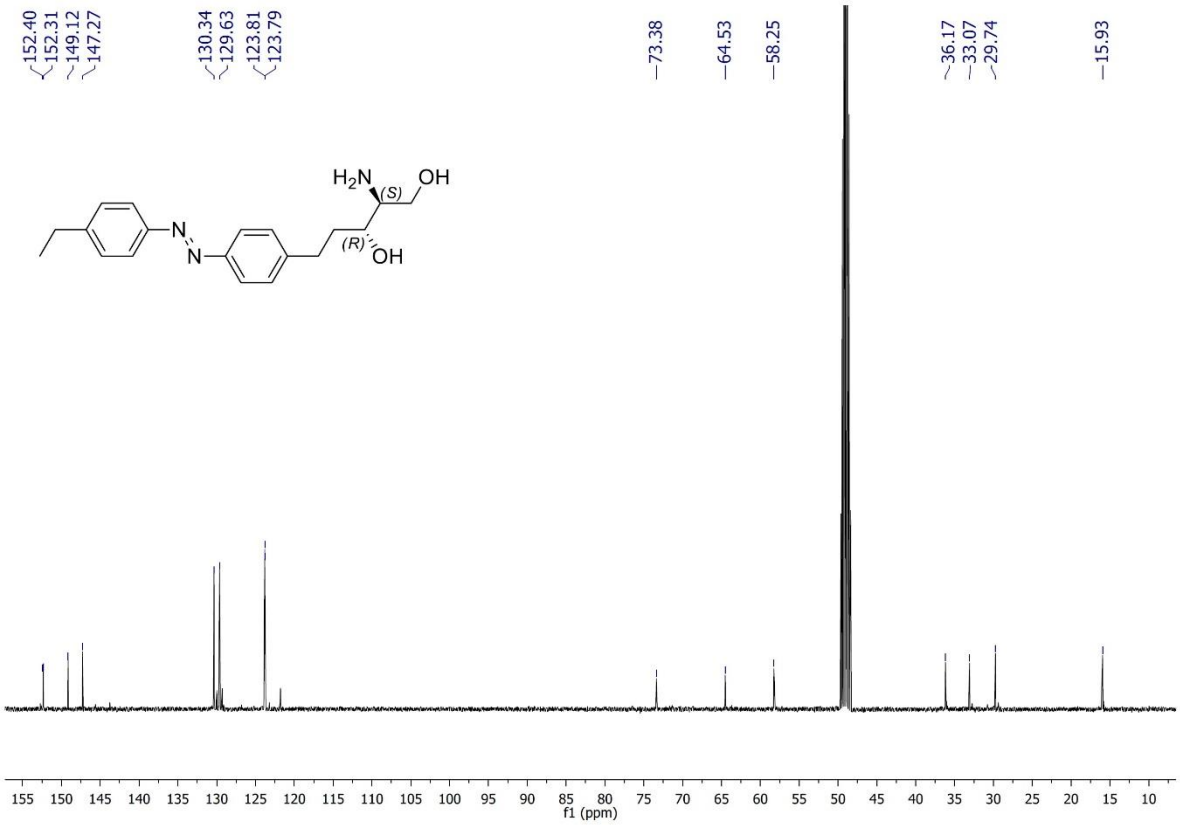
(4*S*)-4-{(*R*)-1'-Hydroxy-3'-(4-[(*E*)-(4-pentylphenyl)diazenyl]phenyl)propyl}oxazolidin-2-one (34d)



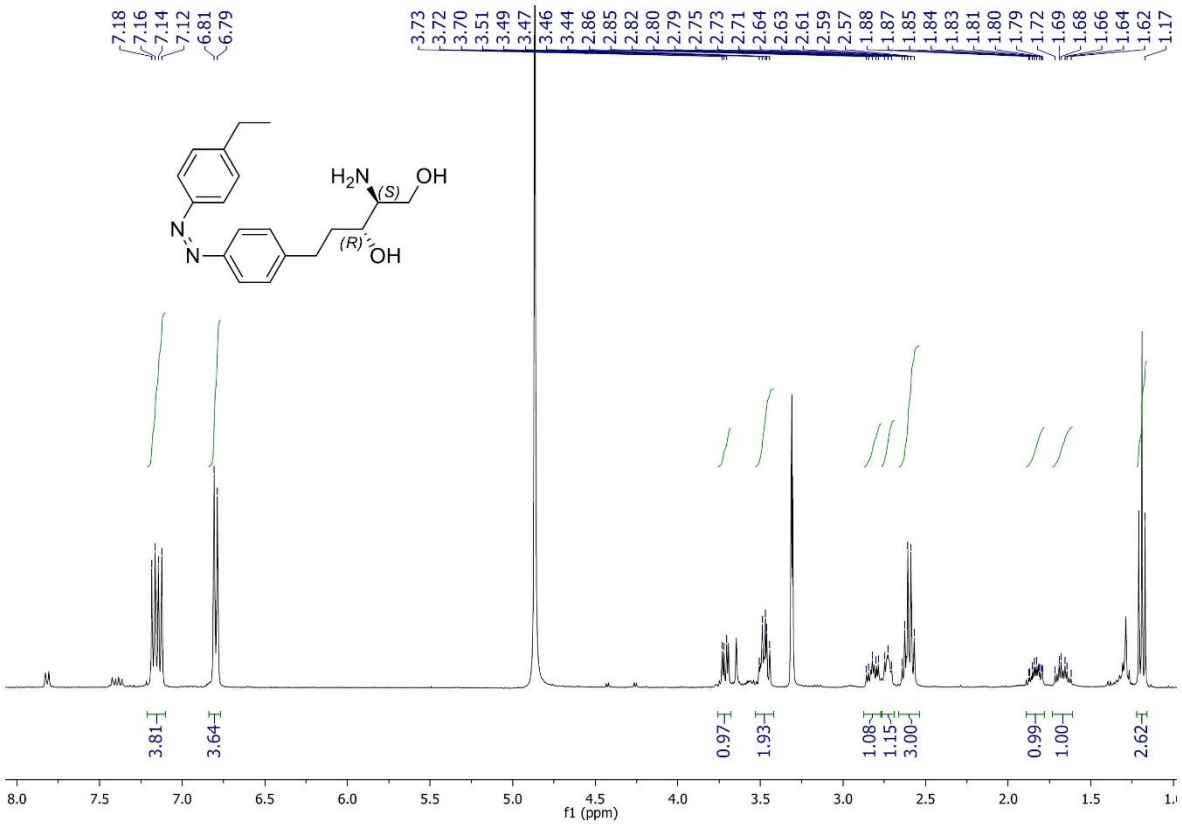


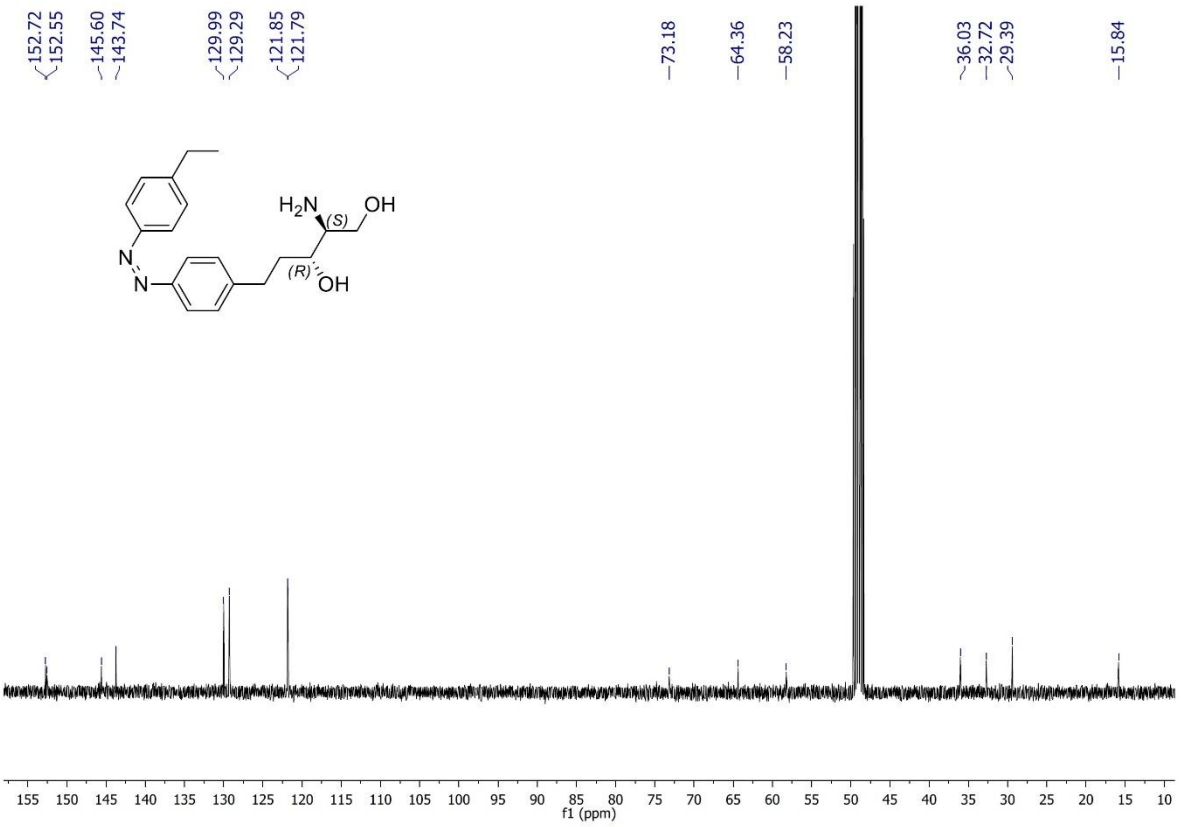
(2*S*,3*R*)-2-Amino-5-{4-[(*E*)-(4-ethylphenyl)diazenyl]phenyl}pentane-1,3-diol (35a)



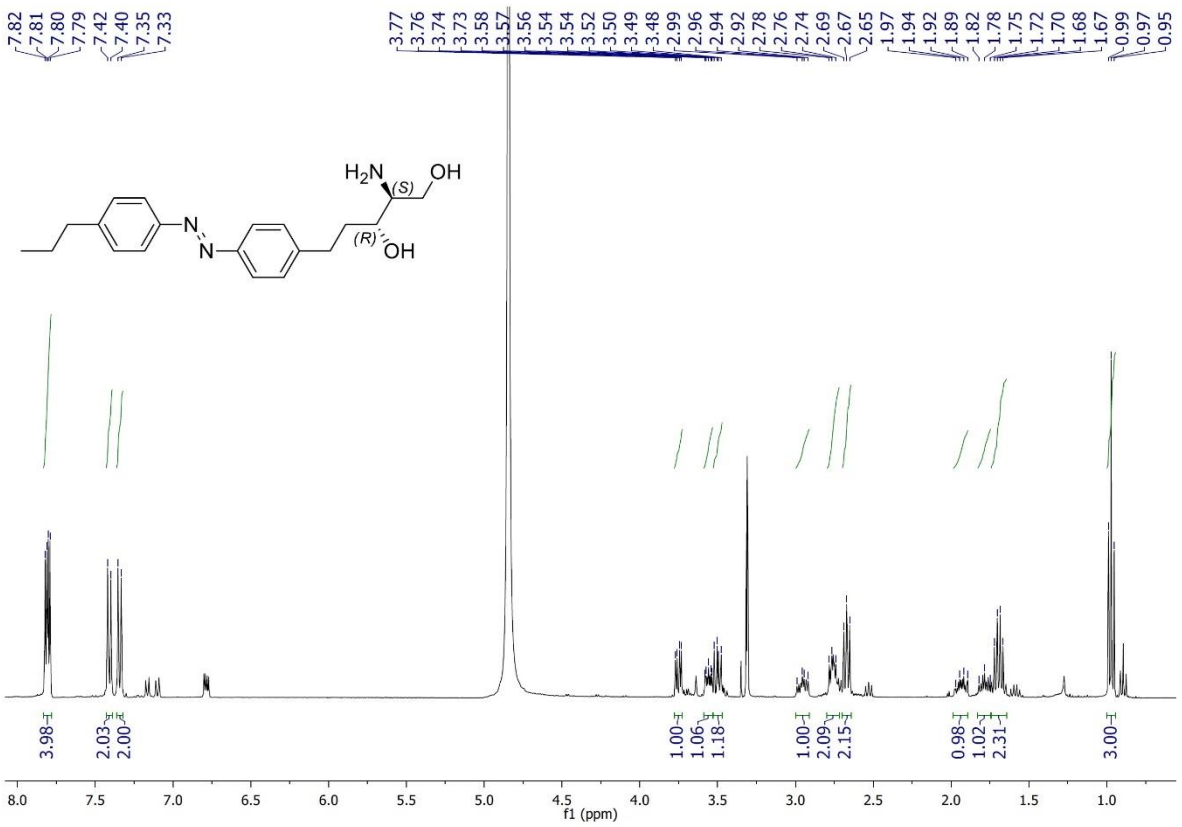


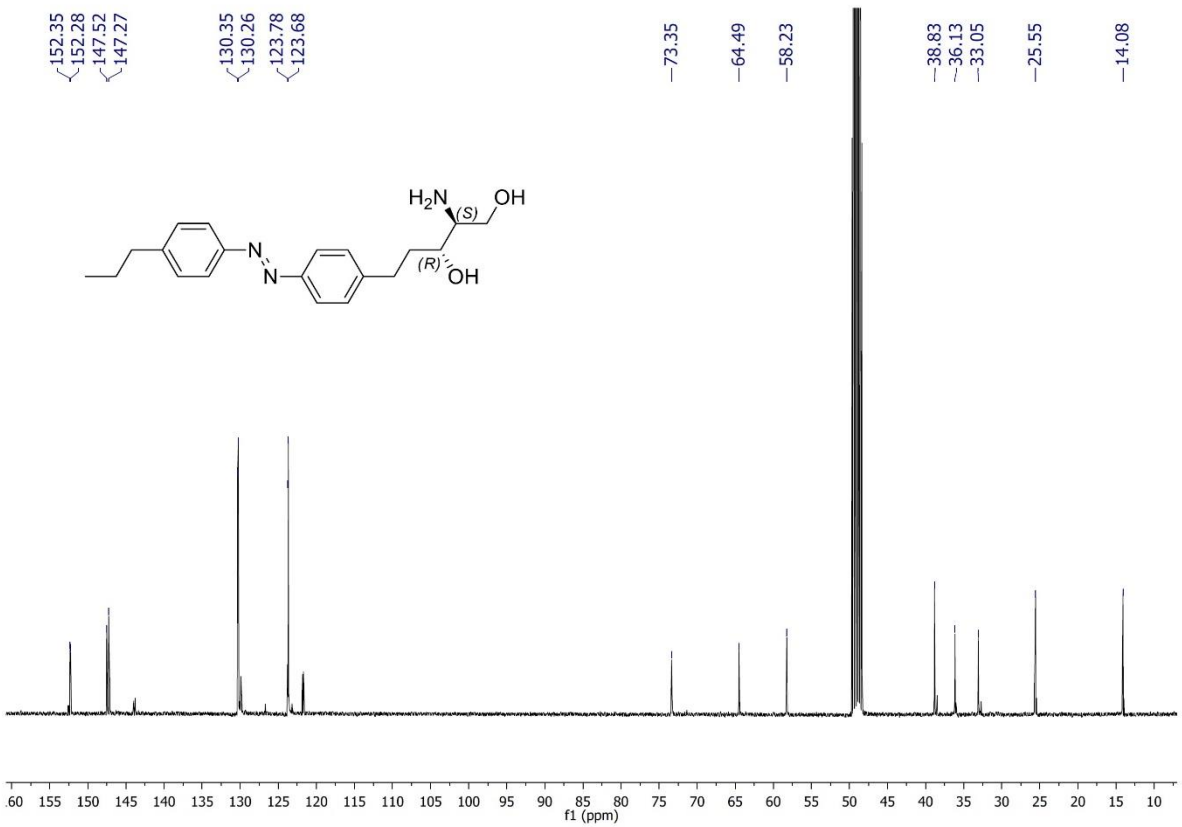
(2*S*,3*R*)-2-Amino-5-{4-[(Z)-(4-ethylphenyl)diazenyl]phenyl}pentane-1,3-diol ((*Z*)-35a)



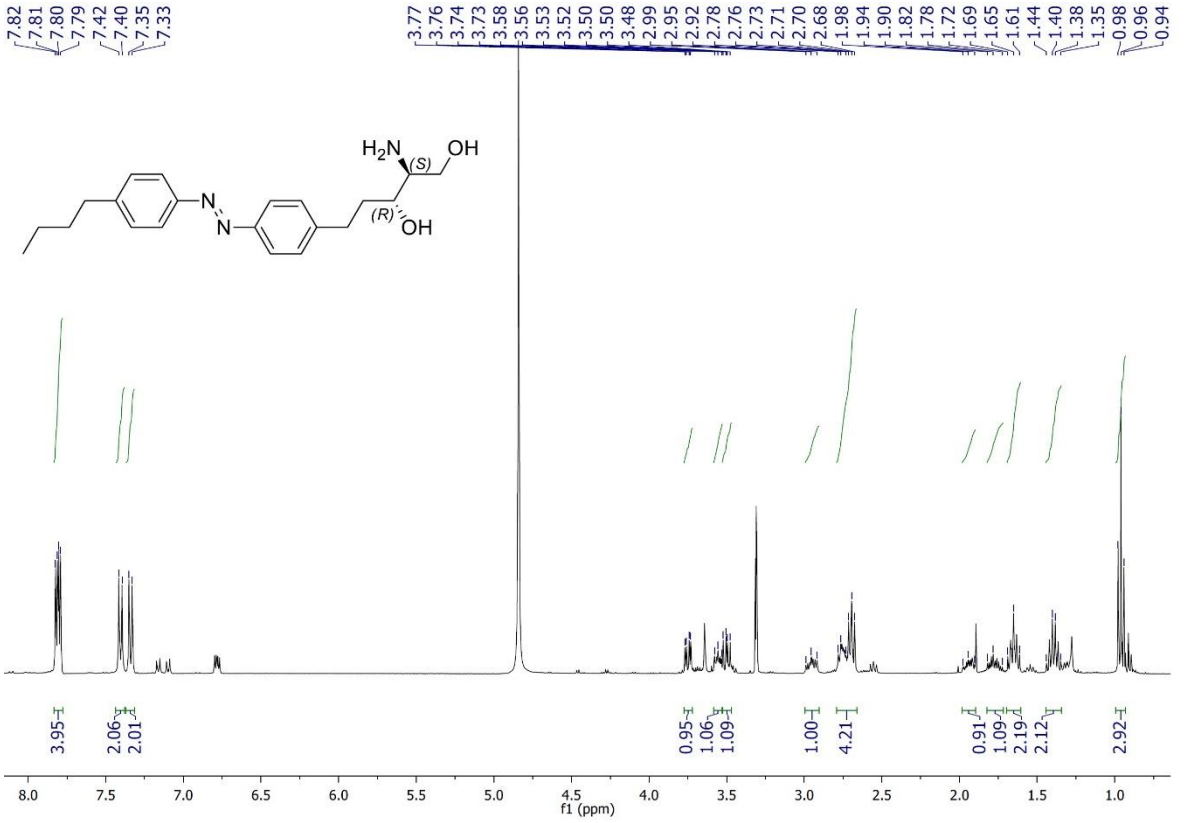


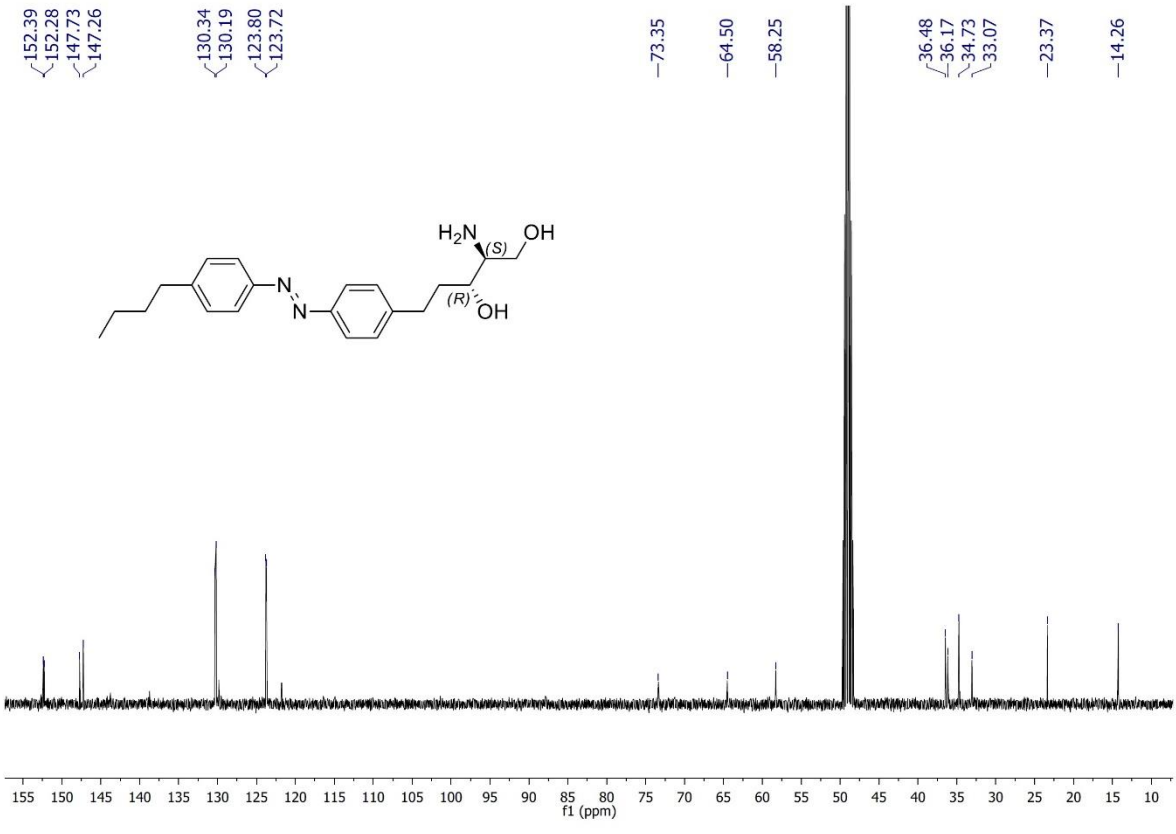
(2*S*,3*R*)-2-Amino-5-{4-[(*E*)-(4-propylphenyl)diazenyl]phenyl}pentane-1,3-diol (35b)



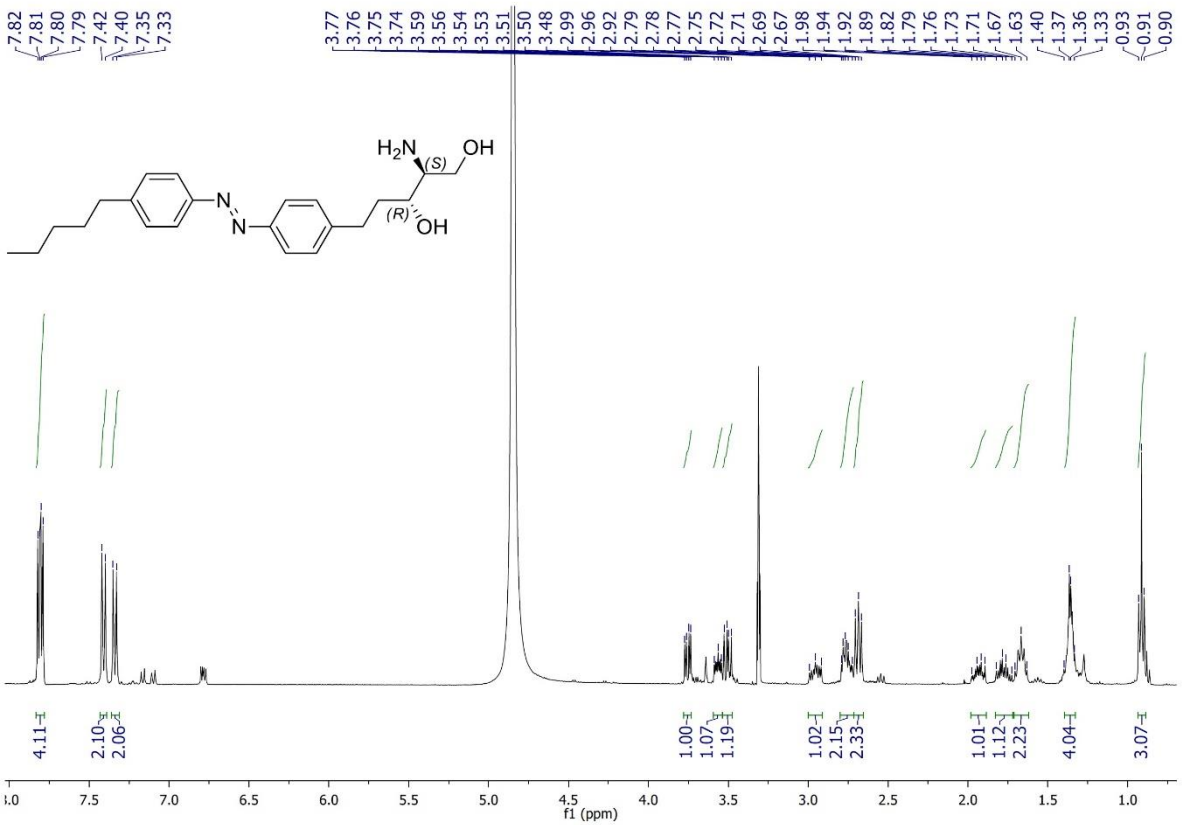


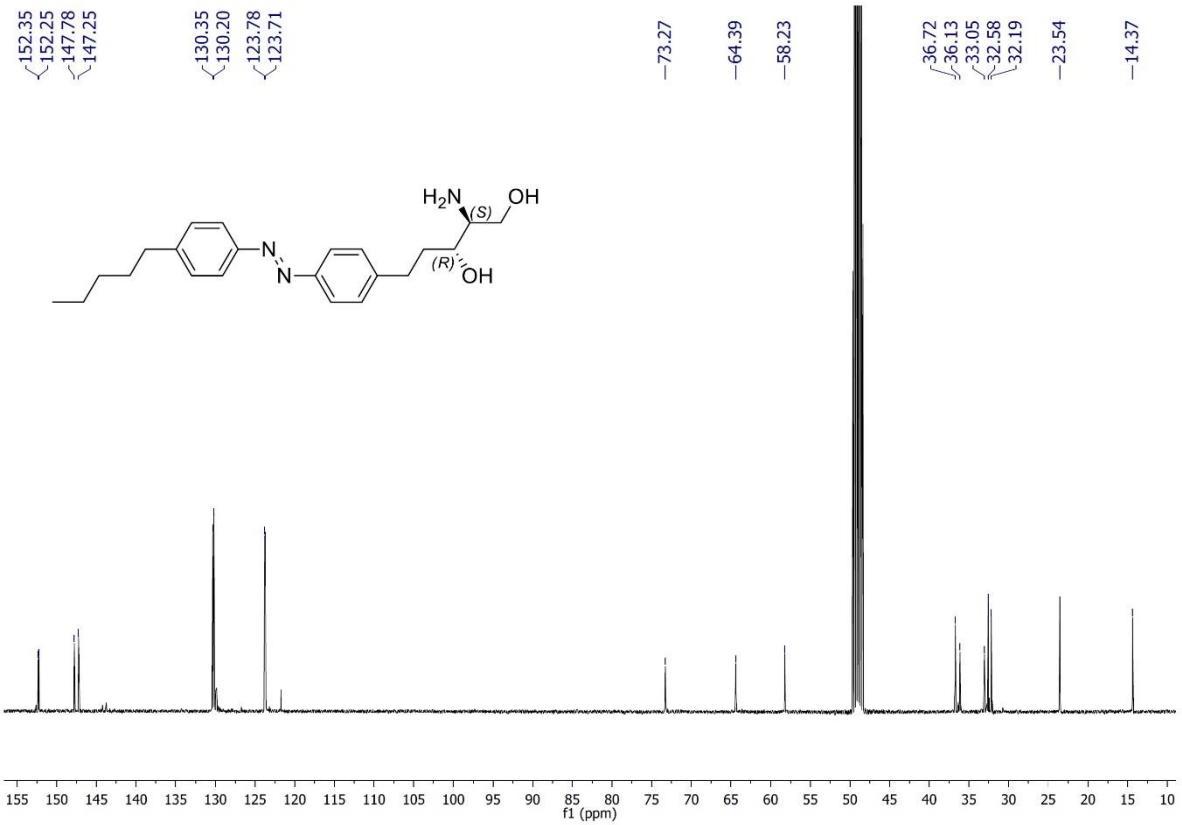
(2*S*,3*R*)-2-Amino-5-{4-[(*E*)-(4-butylphenyl)diazenyl]phenyl}pentane-1,3-diol (35c)



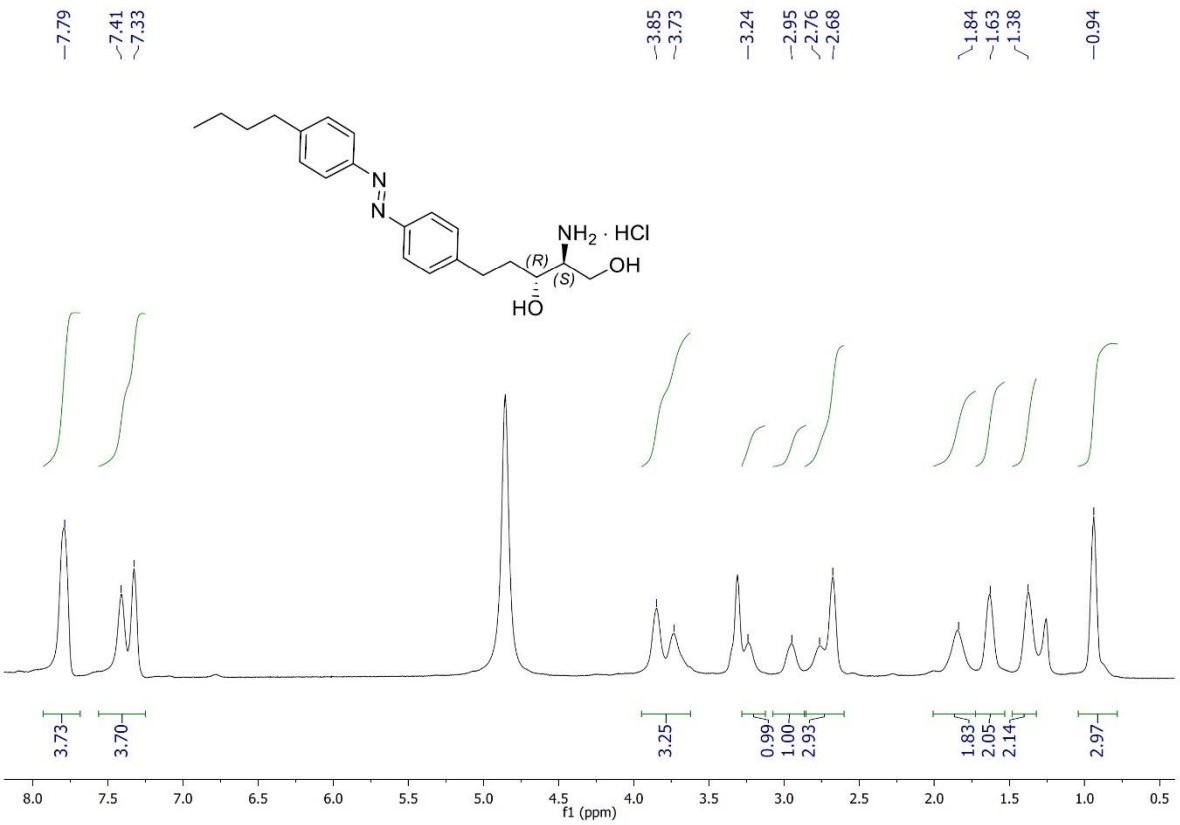


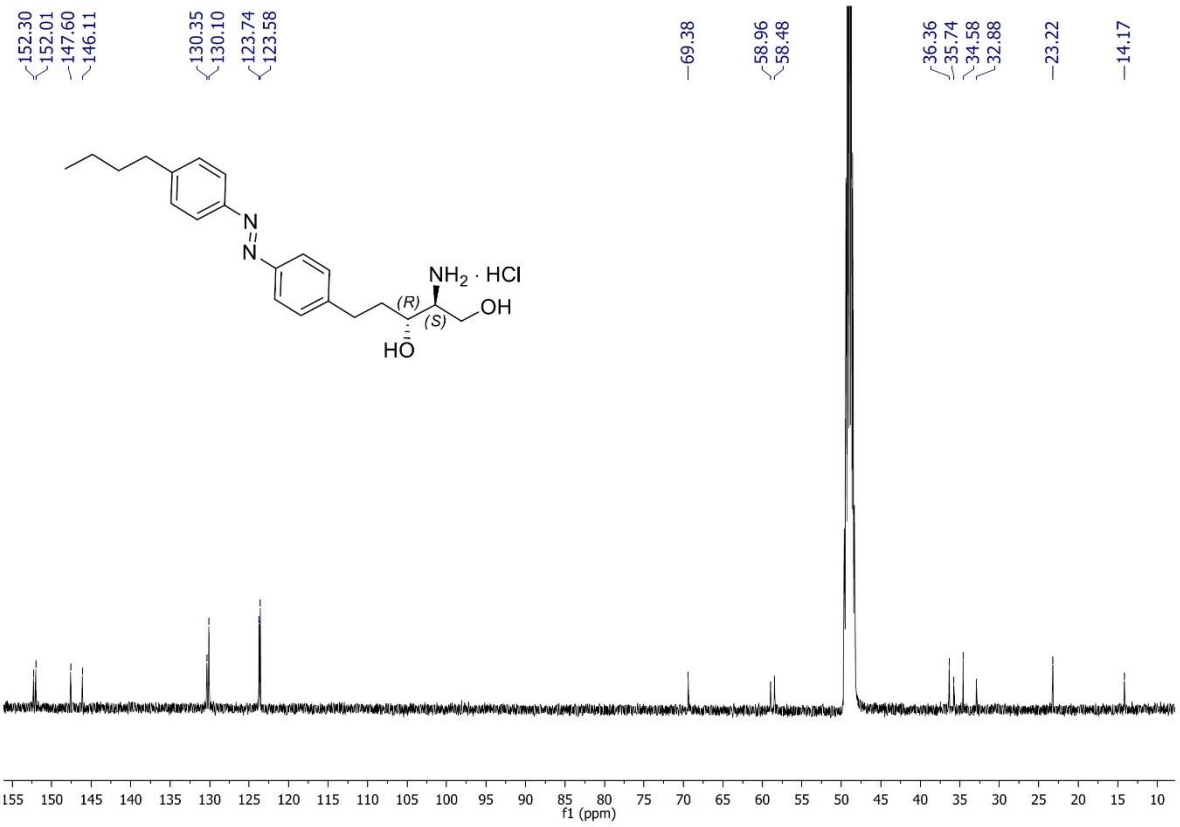
(2*S*,3*R*)-2-Amino-5-{4-[(*E*)-(4-pentylphenyl)diazenyl]phenyl}pentane-1,3-diol (35d)



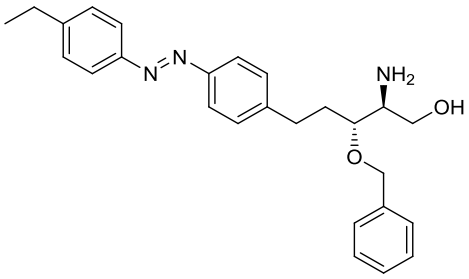


(2*S*,3*R*)-2-Amino-5-{4-[(*E*)-(4-butylphenyl)diazenyl]phenyl}pentane-1,3-diol hydrochloride (35c.HCl)





Photoisomerisation experiments



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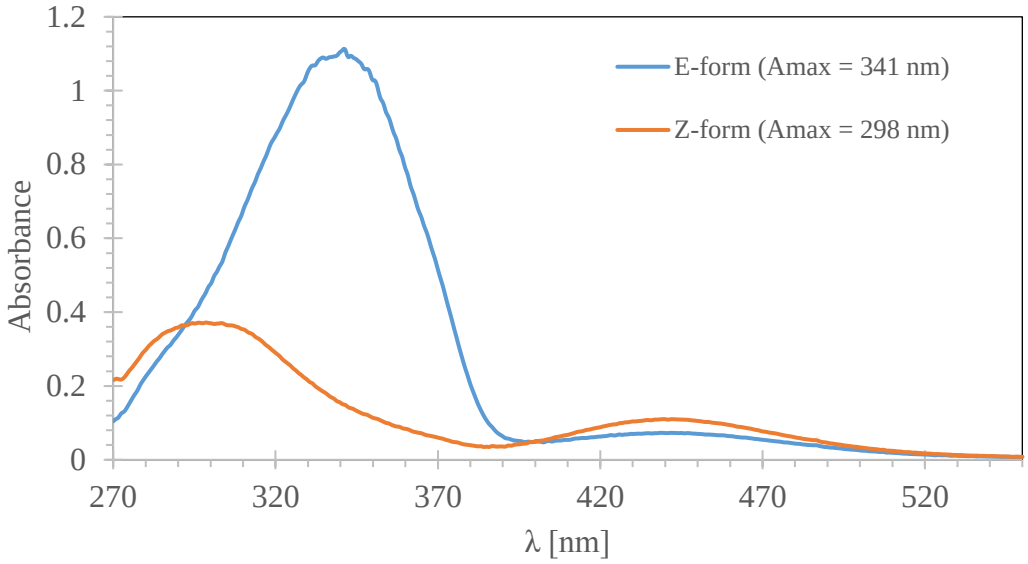
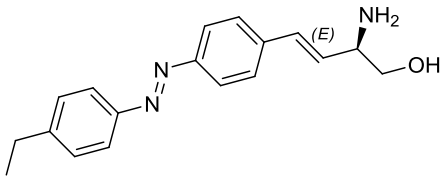
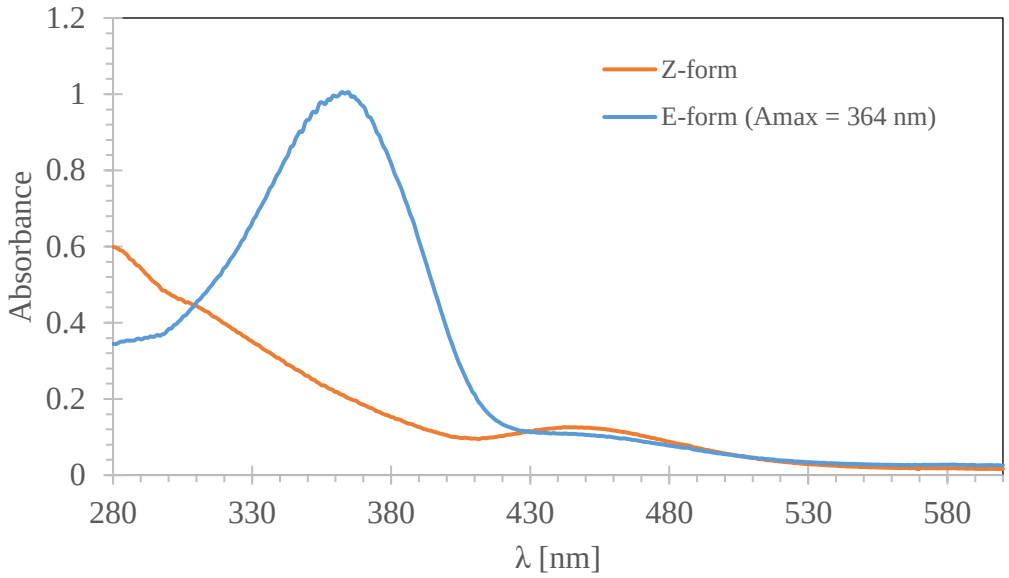
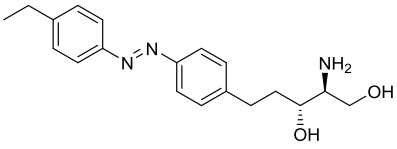


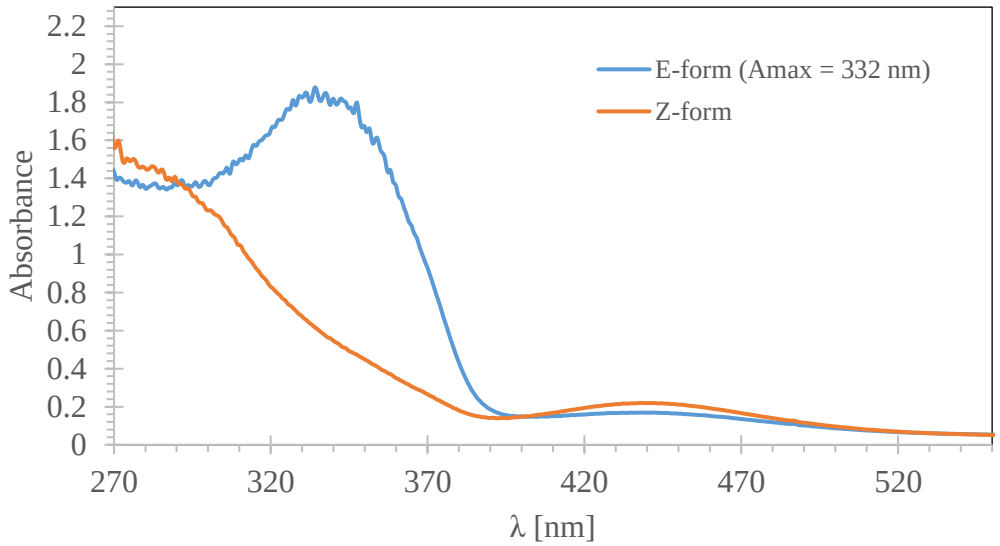


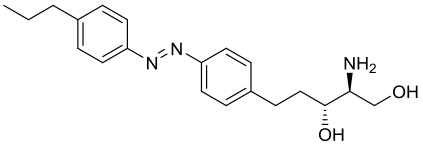
***(E)*-29**



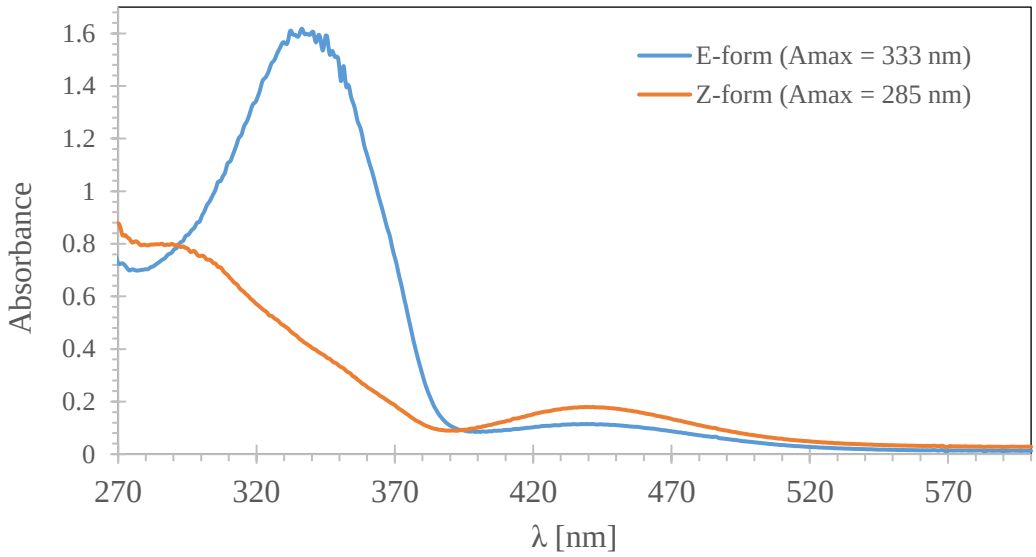

NH2
OH
OH

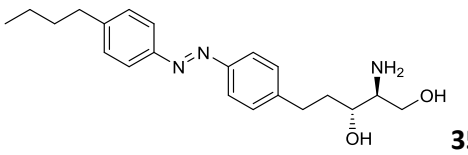
35a


E-form (Amax = 332 nm)
Z-form
Absorbance
λ [nm]
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
270
320
370
420
470
520

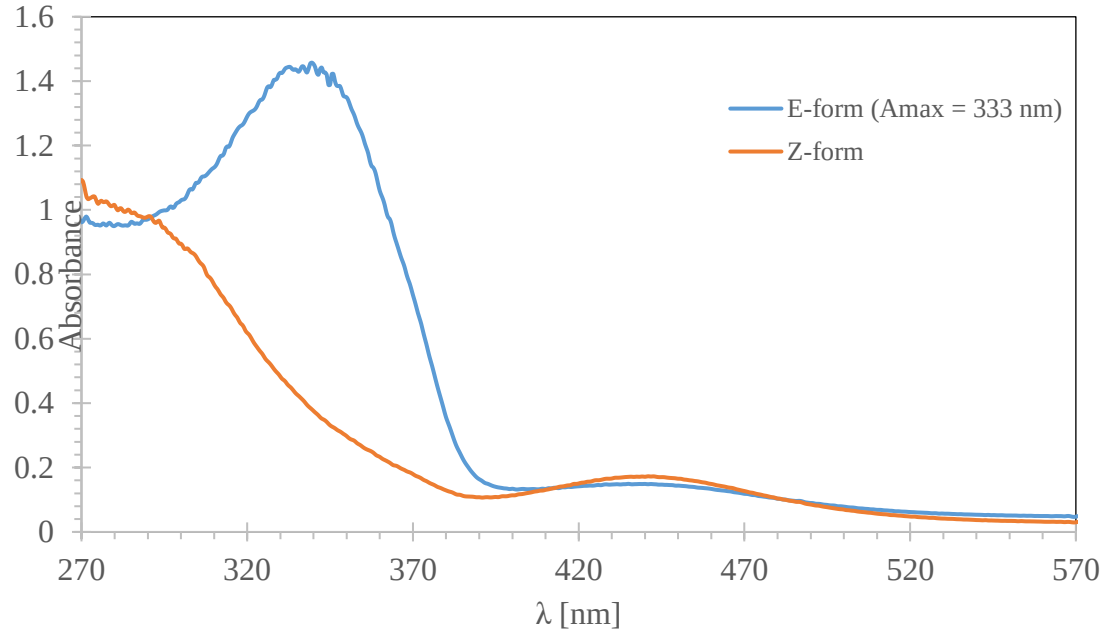

NH2
OH
OH

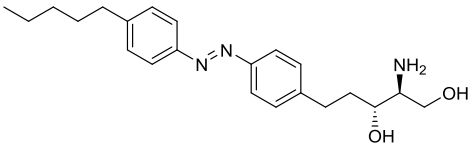
35b


E-form (Amax = 333 nm)
Z-form (Amax = 285 nm)
Absorbance
λ [nm]
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
270
320
370
420
470
520
570

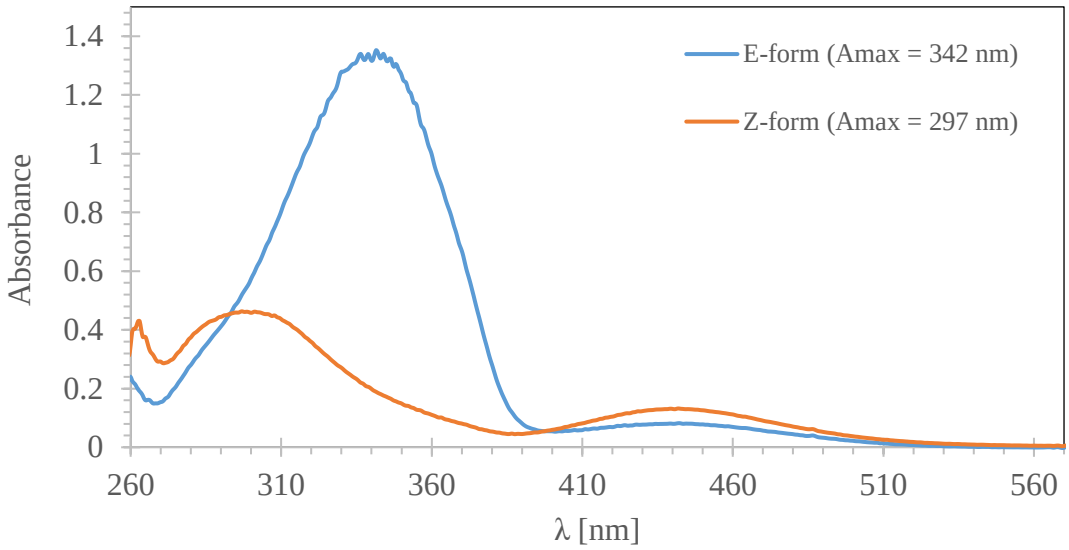

NH2
OH
OH

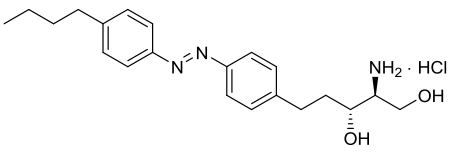
35c


E-form (Amax = 333 nm)
Z-form
Absorbance
λ [nm]
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
270
320
370
420
470
520
570

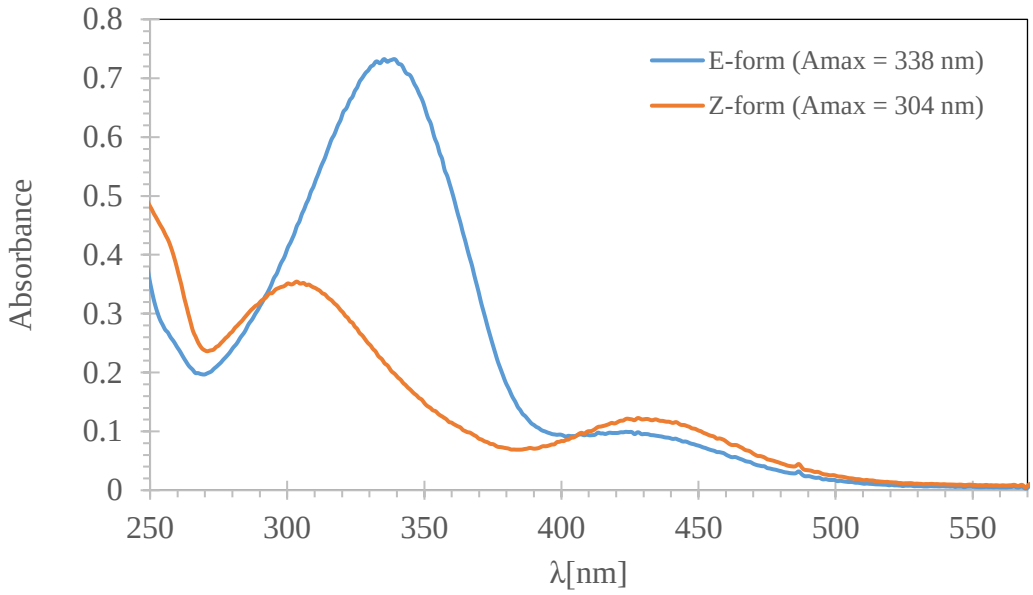

NH2
OH
OH

35d

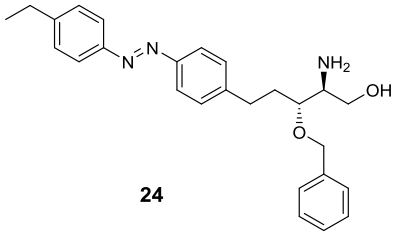

E-form (Amax = 342 nm)
Z-form (Amax = 297 nm)
Absorbance
λ [nm]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
260
310
360
410
460
510
560


NH2 · HCl
OH
OH

35c.HCl


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Absorbance
250
300
350
400
450
500
550
λ[nm]
E-form (Amax = 338 nm)
Z-form (Amax = 304 nm)

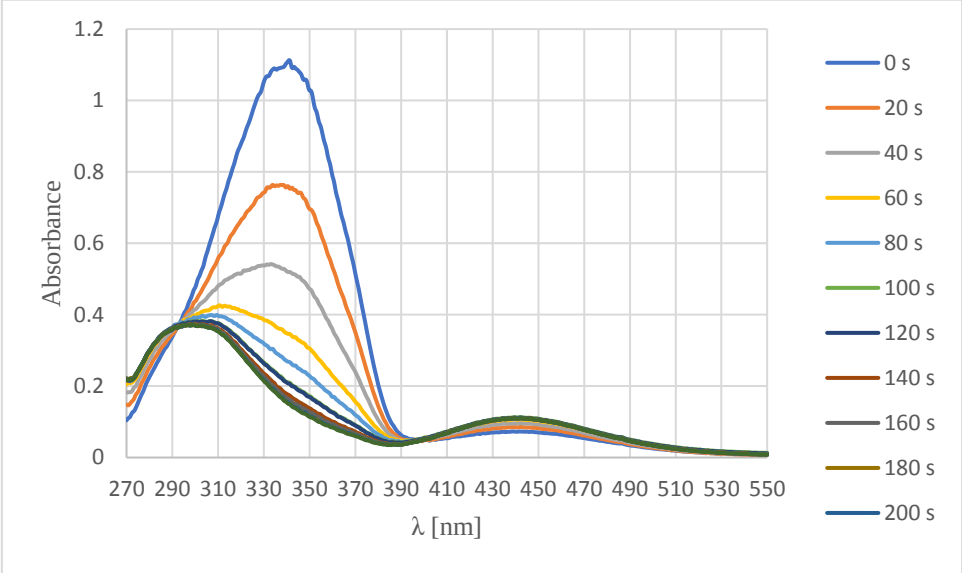
Experiment 1: Determination of the UV-irradiation time needed for a maximum isomerisation of an *E*-form to *Z*-form **24**.



24

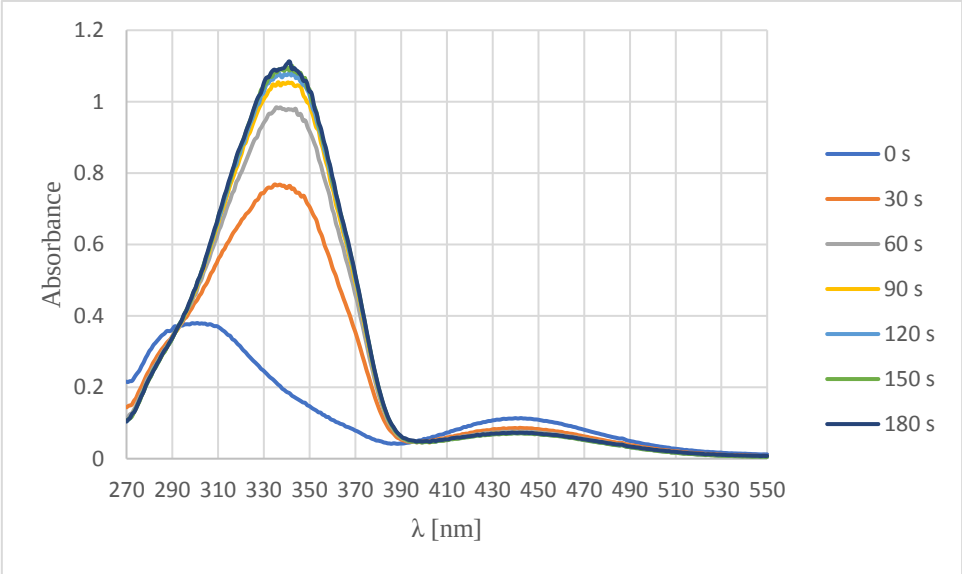
m = 0.0005 g
n = 0.0012 mmol
V = 25 ml
c = 4.8 × 10^{-5} mol/dm^3
solvent: DMSO

- λ = 366 nm
- measurements performed in 20 s intervals
- the maximum isomerisation is achieved after 180 s of irradiation



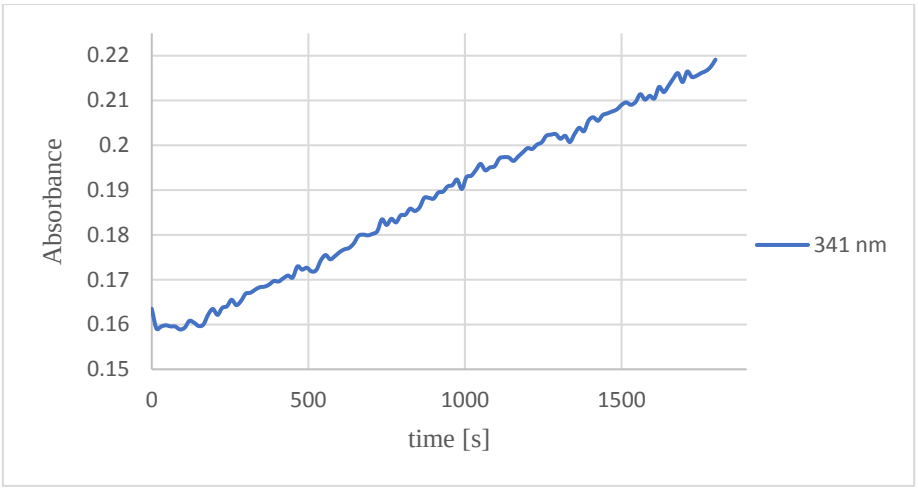
Experiment 2: Determination of the VIS-irradiation time needed for a reverse isomerisation of a *Z*-form to *E*-form **24**.

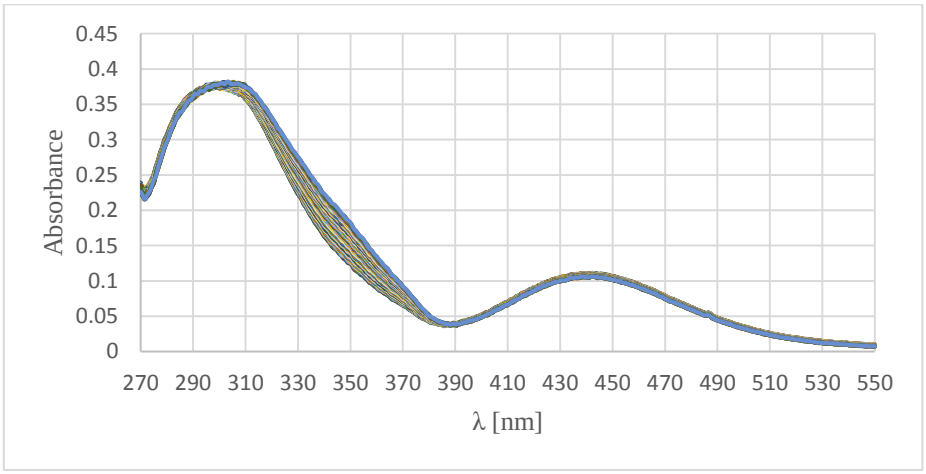
- λ = 420 nm
- measurements preformed in 30 s intervals
- the maximum reverse isomerisation is achieved within 150 s of irradiation



Experiment 3: Determination of a thermal stability of a *Z*-form **24** after irradiation if protected from light.

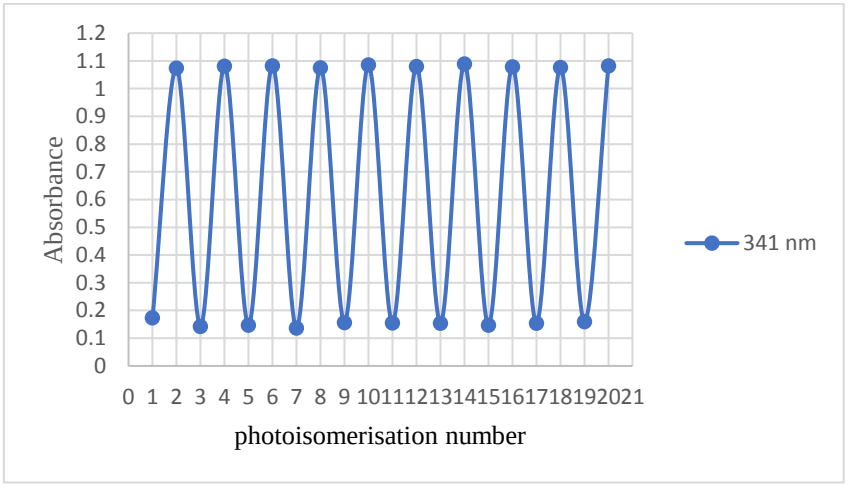
measurement time 30', 1 scan per 15 s



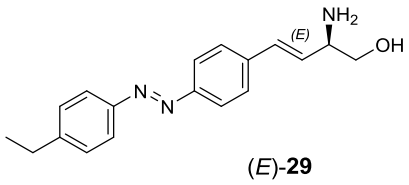


Experiment 4: Material fatigue. Repetitive *E*- to *Z*- isomerisation of **24** and observation of changes in absorbance.

- number of cycles: 10
- a material fatigue was not observed



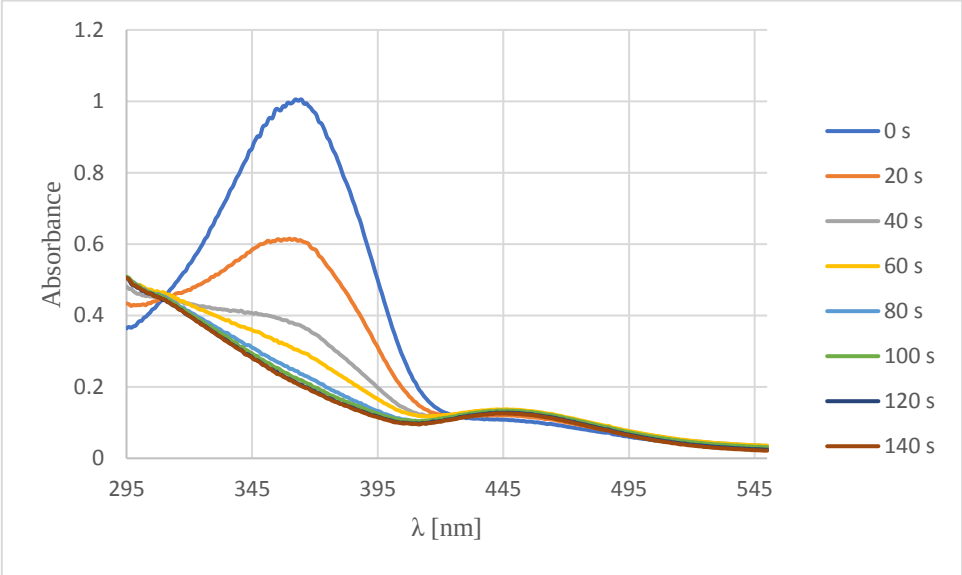
Experiment 5: Determination of the UV-irradiation time needed for a maximum isomerisation of an *E*-form to *Z*-form **29**.



(*E*)-**29**

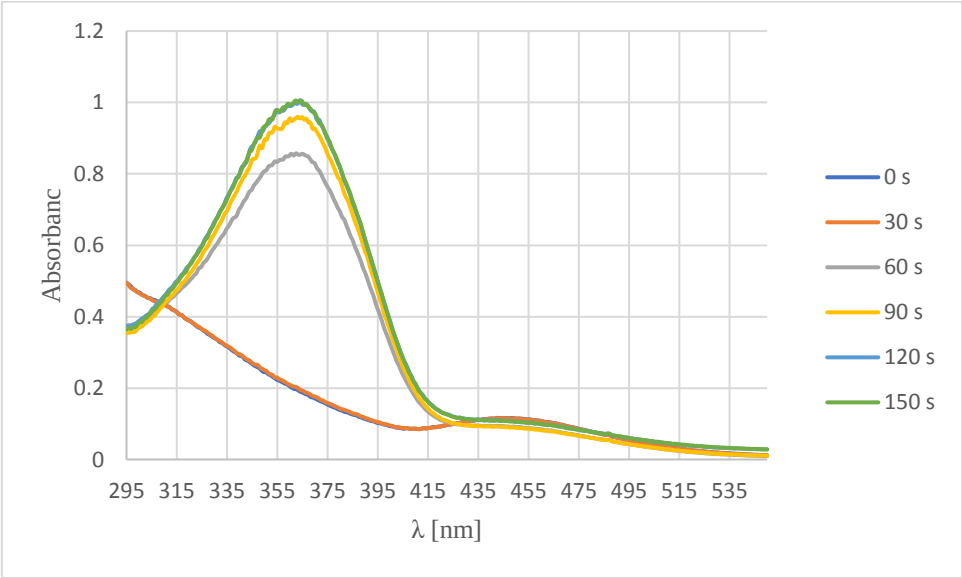
m = 0.00025 g
n = 0.0008 mmol
V = 25 ml
c = 3.4 × 10^{-5} mol/dm^3
solvent: DMSO

- λ = 366 nm
- measurements performed in 20 s intervals
- the maximum isomerisation is achieved within 120 s of irradiation



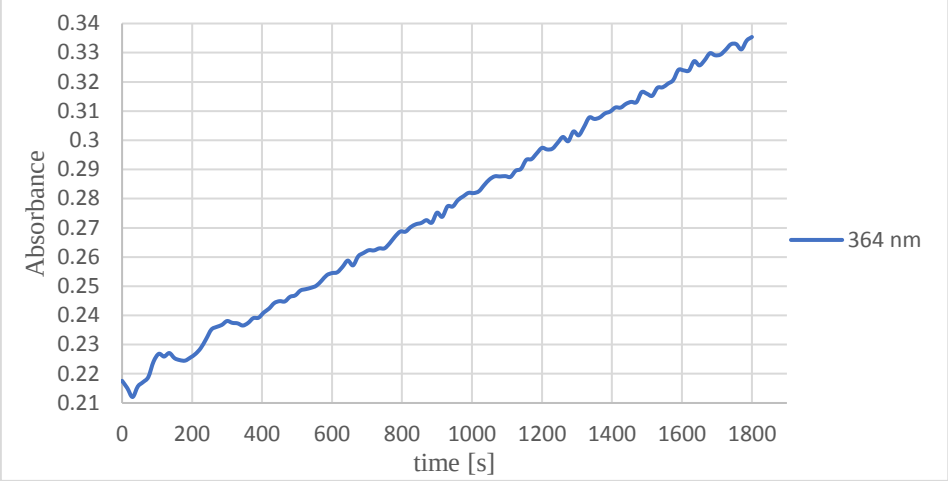
Experiment 6: Determination of the VIS-irradiation time needed for a reverse isomerisation of a *Z*-form to *E*-form **29**.

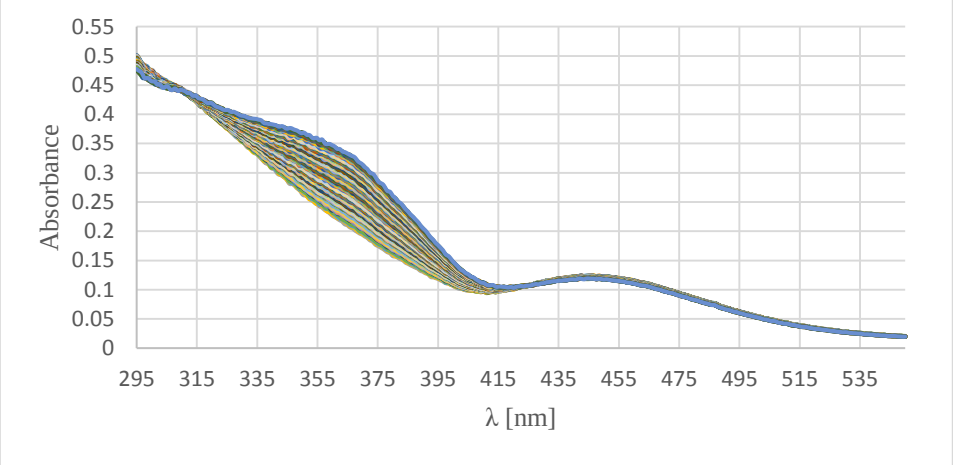
- λ = 420 nm
- measurements performed in 30 s intervals
- the maximum reverse isomerisation is achieved within 90 s of irradiation



Experiment 7: Determination of a thermal stability of a *Z*-form **29** after irradiation if protected from light.

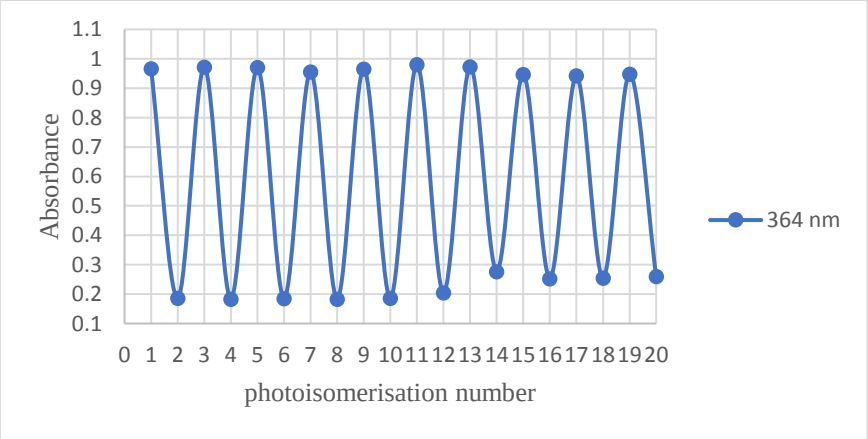
- measurement time 30', 1 scan per 15 s



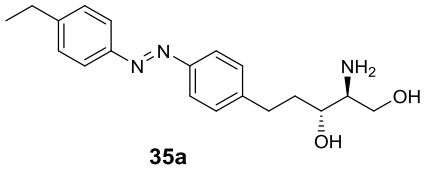


Experiment 8: Material fatigue. Repetitive *E*- to *Z*- isomerisation of **29** and observation of changes in absorbance.

- number of cycles: 10
- a significant material fatigue was not observed



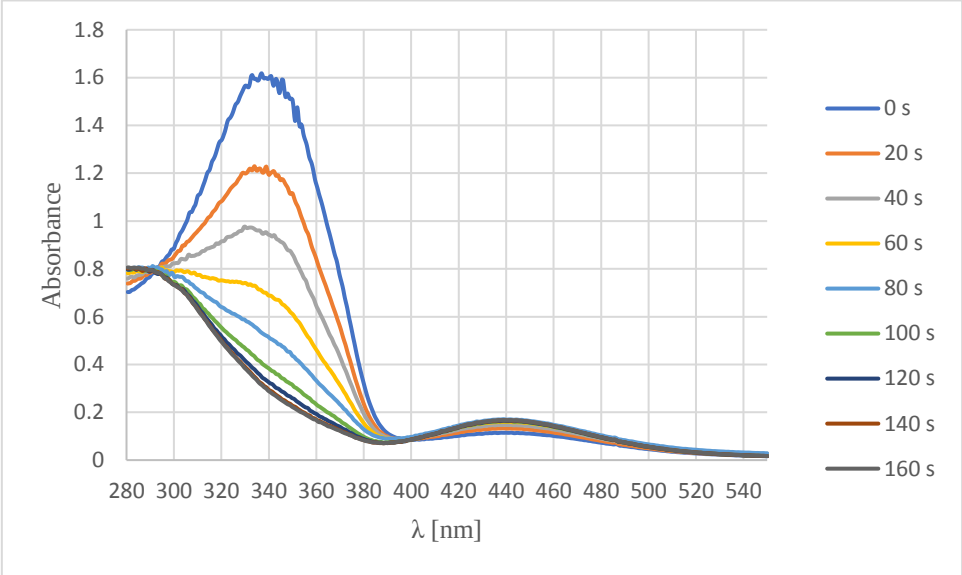
Experiment 9: Determination of a UV-irradiation time needed for a maximum isomerisation of an *E*-form to *Z*-form **35a**.



35a

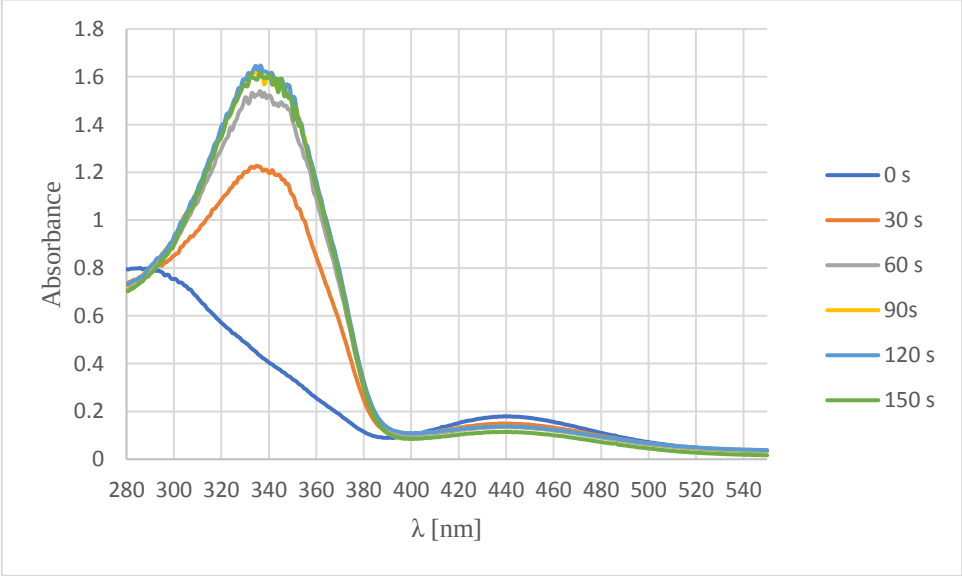
m = 0.0005 g
n = 0.0015 mmol
V = 25 ml
c = 6 × 10^{-5} mol/dm^3
solvent: DMSO

- λ = 366 nm
- measurements performed in 20 s intervals
- the maximum isomerisation achieved after 160 s of irradiation



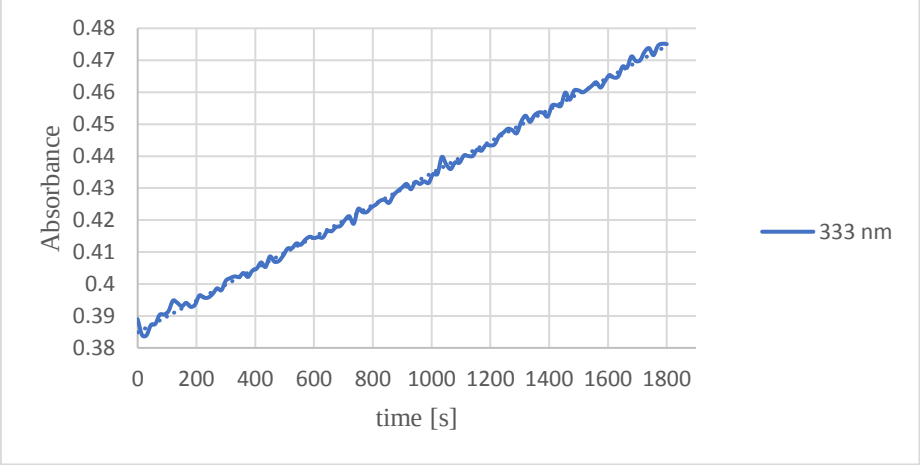
Experiment 10: Determination of a VIS-irradiation time needed for a reverse isomerisation of a *Z*-form to *E*-form **35a**.

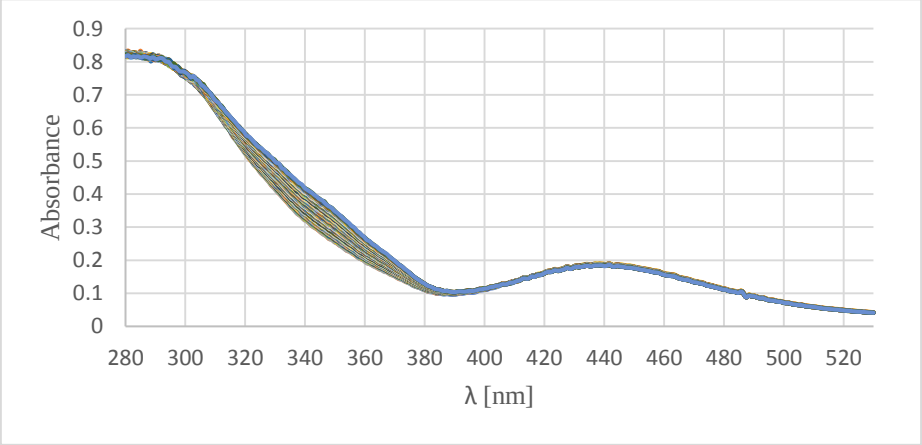
- λ = 420 nm
- measurements preformed in 30 s intervals
- the maximum reverse isomerisation is achieved within 120 s of irradiation



Experiment 11: Determination of stability of a *Z*-form **35a** after irradiation if protected from light.

- measurement time 30', 1 scan per 15 s





Experiment 12: Material fatigue. Repetitive *E*- to *Z*- isomerisation **35a** and observation of changes in absorbance

- number of cycles: 10
- a material fatigue was not observed