Supporting Information

Synthesis of 5-Phenyl-1,8-naphthalic Anhydrides: An Exercise in Acenaphthene Chemistry

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Content

EXPERIMENTAL SECTION

General Information. All reactions were monitored by thin-layer chromatography (TLC) carried out on 0.25 mm Merck silica gel plates (60-F_{254}) visualized under UV light (254 nm) or by staining with a solution of phosphomolybdic acid (10% in ethanol). For flash chromatography, silicagel 60 (40-63 nm, Geduran® - Merck) was employed. Melting points were measured on a capillary melting point apparatus and were uncorrected. ^{1}H and ^{13}C NMR spectroscopic analyses were performed on a 300 MHz (operating at 300.13 MHz for ^{1}H and 75.47 MHz for ^{13}C), 400 MHz (operating at 400.13 MHz for ^{1}H and 100.61 MHz for ^{13}C), 500 MHz (operating at 500.13 MHz for ^{1}H and 125.76 MHz for ^{13}C) or a 600 MHz (operating at 600.13 MHz for ^{1}H and 150.90 MHz for ^{13}C) NMR spectrometer. Standard Bruker pulse sequences, as implemented in Bruker TopSpin, were used for data acquisition. Chemical shifts are reported relative to residual solvent signals. Signals were assigned with the aid of ^{1}H-^{13}C HSQC, ^{1}H-^{13}C HMBC, and ^{1}H,^{1}H-COSY spectra. HRESIMS was recorded in positive ion mode on an HPLC–QTOF-MS system. For microwave reactions, a monomode microwave synthesizer equipped with infrared and optic fiber temperature measurement was employed. Yields refer to weighed chromatographically homogeneous samples.

Synthetic Procedures. Compounds **7** and **7a** were prepared as described in the literature (see reference 4 in the main text and reference 9).

(9) Shoyama, K.; Schmidt, D.; Mahl, M.; Würthner, F. Electron-poor bowl-shaped polycyclic aromatic dicarboximides: synthesis, crystal structures, and optical and redox properties. *Org. Lett.* **2017**, *19*, 5328-5331.

Compound 6. A 250 mL round-bottomed flask was charged with 5-bromoacenaphthene (**7,** 16.01g, 62 mmol, 90% purity), phenylboronic acid (8.54g, 69 mmol, 99% purity), PEPPSI-iPR (238 mg, 0.6 mol%), powdered potassium carbonate (29.02 g, 210 mmol, 99% purity) and 80 mL of dioxane. The mixture was refluxed for 17 h (120 ^{0}C external temperature; the reaction mixture turned black at around 90 ^{0}C and became viscous at the end of the process). After cooling to room temperature, the dioxane solution was transferred to a 1L beaker, and the sticky solid (mainly K_2CO_3) was washed with ~ 400 mL of ethyl ether. The ethyl ether solution was filtered, mixed with the dioxane fraction, and rotovaporated to dryness in a 500 mL flask. The oil inside the flask was redissolved in 100 mL of ethyl ether; 30 g of silica gel 60 (Merck, 40-63 μm) was added and the mixture was rotovaporated to prepare the dry load for isocratic gravity (~ 5 mL/min flux) column chromatography (20 cm effective height). The compound was eluted with hexane on the first fractions and detected on the column using its faint purple fluorescence (UV 366 nm), which is followed by a more intense bluish tail (caution: following the elution in this manner gives a false impression that a fraction containing two different compounds was eluting, a behavior probably explained by excimer aggregation). The hexane fraction was rotovaporated to a colorless oil that solidified on standing. 5-Phenylacenaphthene (**6**), 14.50 g (~95% purity, 97% yield); white solid; mp: 60-62 ^{0}C; R_f (hexane) = 0.36; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.48 (4H, bs; H-1, H-2), 7.36 (1H, d, J = 7.4 Hz; H-8), 7.38 (1H, d, J = 7.9 Hz; H-3), 7.47 (3H, m; H-4, H-7, H-4´), 7.54 (2H, m; H-3´/-5´), 7.62 (2H, m; H-2´/-6´), 7.76 (1H, d, J = 8.4 Hz; H-6); ^{13}C NMR (100 MHz, $CDCl_3$) δ 30.0 (C-2), 30.5 (C-1), 119.1 (C-3), 119.3 (C-8), 120.8 (C-6), 126.9, 128.0, 128.3 (C-3´/-5´), 128.5, 129.7 (C-5a), 129.8

(C-2′/-6′), 135.6 (C-5), 139.5 (C-2a^1), 140.4 (C-1′), 145.5 (C-2a), 146.1 (C-8a); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{18}H_{15}$ 231.1168, found 231.1164.

Compound 5. 5-Phenylacenaphthene (**5**) (14.5 g, 60 mmol) and NBS (12 g, 66 mmol) were weighed in a 100 mL round-bottomed flask. To this, 30 mL of DMF was added, and the flask was vented with argon for one minute. The reaction was then agitated for 13 hours in the dark at room temperature (22 ^{0}C). The reaction mixture was poured into water (600 mL) and extracted with diethyl ether (2 x 400 mL+ 1x 100 mL), and the ethereal fraction was dried using $MgSO_4$. After filtration, 30 g of silica was added, and the mixture was rotovaporated to prepare the dry load. Dry column chromatography (20 cm effective height) using hexane as the sole eluent at a flux of ~5 mL/min (gravity) was performed. After the hexane fractions evaporated, the compound was obtained as a yellow oil. The compound was solidified by treating the oil with a minimum of hexane, followed by slow evaporation with a stream of nitrogen gas. 5-Bromo-6-phenylacenaphthene (**5**), 16.0 g (80% yield); yellow solid; mp: 107-110 ^{0}C; R_f (hexane) = 0.24 (low, fainter fluorescence distinguishes from starting material at a wavelenght of 366 nm) ; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.30 (2H, m; H-2), 3.37 (2H, m; H-1), 7.06 (1H, d, J = 7.3 Hz; H-3), 7.26 (1H, d, J = 7.2 Hz; H-8), 7.30-7.38 (6H, m; H-2′/-6′, H-7), 7.63 (1H, d, J = 7.3 Hz; H-4); ^{13}C NMR (100 MHz, $CDCl_3$) δ 29.9 (C-2), 30.2 (C-1), 114.8 (C-5), 119.3 (C-8), 120.3 (C-3), 126.8 (C-4′), 127.1 (C-2′/-6′), 128.1 (C-5a), 130.6 (C-3′/-5′), 132.2 (C-7), 134.3 (C-4), 136.1 (C-6), 140.9 (C-2a^1), 141.8 (C-1′), 146.2 (C-2a), 146.3 (C-8a); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{18}H_{14}Br$ 309.0273 and 311.0253, found 309.0281 and 311.0255.

Compound 5a. 5-Bromo-6-phenylacenaphthene (**4**) (3.6 g, 9.3 mmol), copper(I) iodide (180 mg, 945 μmol), and 1,10-phenanthroline (300 mg, 1.66 mmol) were weighed in a pressure tube. To this mixture, 10 mL of a 25% (d = 0.945 g/mL) NaOMe solution in MeOH was added under argon. The tube was placed in an oil bath for 10 hours with an external temperature set to 150 ^{0}C (no preheated mantle) with magnetic stirring (use of a stir bar in a vertical position is recommended). The reaction mixture was not miscible at the beginning; however, at around 90 ^{0}C the solution turned black, and a brown deposit was left in the inner tube wall. After cooling, the content of the tube was placed on an open beaker (complete transfer was achieved with the help of additional methanol) and dried under a stream of nitrogen gas. After the remaining paste was extracted with diethyl ether, the solution was filtered and dried with $MgSO_4$. Isocratic dry column chromatography (6 g of silica for the dry load) employing a Chromabond flash BT 40 column (40 g SiOH 40-63 μm) with a length of 17 cm (11 cm effective column height) and an internal diameter of 26 mm was performed. Compound **5a** was eluted with hexane at a flux of 30 mL/min after the first yellow fraction (mainly debrominated compound) and tailed significantly under these chromatographic conditions. However, **4a** was obtained in suitable purity at the expense of ~ 2L hexane. All relevant fractions were collected, rotovaporated, and refrigerated for 5 h to obtain a pale yellow solid. 5-Methoxy-6-phenylacenaphthene (**4a**), 1.56 g (64 % yield); pale yellow solid; mp: 70-71 ^{0}C; R_f (hexane:AcOEt 10:1) = 0.47; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.34 (2H, m; H-2), 3.40 (2H, m; H-1), 3.50 (3H, s; -OMe), 6.76 (1H, d, J = 7.5 Hz; H-4), 7.17 (1H, d, J = 7.5 Hz; H-3), 7.21-7.42 (7H, m; H-7, H-8, -Ph); ^{13}C NMR (100 MHz, $CDCl_3$) δ 29.5 (C-2), 30.6 (C-1), 55.8 (-OMe), 108.3 (C-4), 119.1 (C-3), 119.4 (C-8), 121.6 (C-5a), 125.9 (C-4´), 126.6 (C-2´-6´), 129.6 (C-3´-5´), 130.3 (C-7), 134.9 (C-6), 138.1 (C-2a), 141.2 (C-2a^{1}), 143.8 (C-1´), 145.1 (C-8a), 154.1 (C-5); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{19}H_{17}O$ 261.1274, found 261.1269.

Compound 5b. 5-Bromo-6-phenylacenaphthene (**4**) (421 mg, 0.95 mmol), potassium hydroxide (207 mg, 3.7 mmol), tris(dibenzylideneacetone)dipalladium(0)-chloroform adduct (38 mg, 3 mol%), 5-(di-tert-butylphosphino)-1´,3´,5´-triphenyl-1´H-[1,4´]bipyrazole (46 mg, 7 mol%) and dioxane (7 mL) were mixed in a 35 mL microwave vial (the vial is then capped). The reaction is heated at 80 °C for 4 hours (conventional heating, the reaction turns violet). After neutralization with 10 % HCl (the solution turns yellow), the crude was extracted with dichloromethane, and 1.5 g of silica was added to prepare the dry load for column chromatography (1:5 height relationship between dry load and stationary phase). Elution was conducted in isocratic mode using hexanes to afford 83 mg (38%) of 1,2-dihydrocyclopenta[*cd*]fluoranthene (**5b**) as a white solid; mp: 150-152 ^{0}C; R_f (hexane) = 0.17; ^{1}H NMR (300 MHz, $CDCl_3$) δ 3.53 (4H, s; H-1, H-2), 7.41 (2H, dd, J_1 = 5.6 Hz, J_2 = 3.1 Hz; H-6, H-7), 7.46 (2H, d, J = 7.0 Hz; H-3, H-10), 7.95 (2H, d, J = 7.0 Hz; H-4, H-9), 7.97 (2H, dd, J_1 = 5.6 Hz, J_2 = 3.1 Hz; H-5, H-8); ^{13}C NMR (75 MHz, $CDCl_3$) δ 32.5 (C-1/C-2), 120.9 (C-4/C-9), 122.1_7 (C-3/C-10), 122.2_0 (C-5/C-8), 126.9 (C-6/C-7), 131.2 (C-10c), 132.7 (C-4a/C_{8b}), 136.8 (C-10b), 140.3 (C-4b/C-8a), 146.0 (C-2a/C-10a).

Compound 4a. A 50 mL round-bottomed flask was charged with 5-Methoxy-6-phenylacenaphthene (**4a**) (800 mg, 3.1 mmol), the flask was chilled (ice bath) and a ballon of argon was placed using a septum. Then, 27 mL of a 1M boron tribromide solution in dichloromethane is added and the flask is agitated for 24 h (the solution turns dark blue). Complete conversion can be confirmed via TLC, R_f of the product = 0.32 (hexanes: dichloromethane 1:10). The solution is quenched by the addition of 5 mL of methanol. After drying the crude (roto evaporator), another 25 mL of methanol is added and the process is repeated twice. The crude is lifted with a hexane: dichloromethane mixture (1:1), passed through a plug of silica (1 cm height), and received in a 50 mL round-bottomed flask. The solvent is exchanged for acetone (25 mL), K_2CO_3 (637 mg, 4.6 mmol) is added and the mixture is treated with benzyl chloride (514 μL, 3.7 mmol) and refluxed for 15 h. The cool mixture is treated with silica gel (4g) to prepare de dry load for column chromatography (1:5 height relationship between dry load and stationary phase) in isocratic mode (hexane: dichloromethane 8:1) to obtain 470 mg (45%) of 5-(benzyloxy)-6-phenylacenaphthene (**4a**) as a golden solid. mp: 117-119 ^{0}C; R_f (hexane:CH_2Cl_2 10:1) = 0.4; ^{1}H NMR (300 MHz, $CDCl_3$) δ 3.47 (4H, m; H-1, H-2), 4.91 (2H, s; -OCH_2Ph), 6.87 (2H, m), 6.94 (1H, d, J = 7.6 Hz) 7.20-7.40 (8H, m), 7.50 (2H, m); ^{13}C NMR (75 MHz, $CDCl_3$) δ 29.7 (C-1), 30.7 (C-2), 70.9 (-OC$\underline{H_2}$Ph), 109.5 (C-4), 119.3 (C-8), 119.5 (C-3), 121.9 (C-5a), 126.1 (C-7), 126.9 (C-2′-6′), 127.0 (C-3′-5′), 127.19, 128.1 (C3′-C-5′ -OBn), 129.7 (C-2′-6′ -OBn), 130.8 (C-7), 135.1 (C-6), 137.0 (C-2a), 138.5, 141.4, 144.1 (C-1′), 145.3 (C-8a), 153.1 (C-5); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{25}H_{21}O$ 337.1587, found 337.1585.

Compound 4. 5-Bromo-6-phenylacenaphthene (**5**) (620 mg, 2.01 mmol) and potassium dichromate (1.46 g, 4.96 mmol) were weighed in a 30 mL microwave tube equipped with a magnetic stirrer. Acetic acid (10 mL) was added, an argon bed was introduced and the tube was capped. The microwave was programmed to reach 150 ^{0}C in 5 minutes and hold this temperature for 2 h. After cooling to 50 ^{0}C, 500 μL of isopropanol was added, and the tube was agitated for 30 min. The mixture was poured into 200 mL of water and vacuum-filtered. The solid was washed with water and dried in air in the vacuum-filtration apparatus. Together with the filter paper, the solid was extracted with ethyl ether, and the solution was gravity-filtered and rotovaporated to afford 635 mg (81% yield) of the product in suitable purity for the next step. 6-Bromo-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3**); pale yellow solid, mp: 165-167 ^{0}C; R_f (hexane:AcOEt 3:1) = 0.64; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32 (2H, m; H-3′/-5′), 7.47 (3H, m; H-2′/-6′, H4′), 7.77 (1H, d, J = 7.6 Hz; H-8), 8.09 (1H, d, J = 7.9 Hz; H-5), 8.41 (1H, d, J = 7.9 Hz; H-4), 8.65 (1H, d, J = 7.6 Hz; H-9); ^{13}C NMR (125 MHz, $CDCl_3$) δ 118.4$_8$, 118.5$_0$, 128.2 (C-2′/-6′), 128.5 (C-4′), 128.7 (C-6a), 129.5 (C-3′/-5′), 130.5 (C-6), 132.2 (C-8), 132.4 (C-3a^1), 133.0 (C-4 and C-9), 135.2 (C-5), 140.3 (C-7), 149.2 (C-1′), 160.1 (C-1), 160.3 (C-3); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{18}H_{10}BrO_3$ 352.9808 and 354.9787, found 352.9754 and 354.9787.

Compound 3 starting from 5a. 5-Methoxy-6-phenylacenaphthene (**5a**) (794 mg, 3 mmol) and potassium dichromate (2.74 g, 9.3 mmol) were placed in a 30 mL microwave tube equipped with a magnetic stirrer, and 10 mL of acetic acid was added (the flask was purged with argon). After the tube was capped, the microwave was programmed to reach 140 ^{0}C in 5 min and to hold the temperature for 1 h. After cooling to 50 ^{0}C, 500 μL of isopropanol was added, and the tube was agitated for 30 min. The mixture was poured into 200 mL of water and vacuum-filtered. The solid was washed with water and dried at air temperature in the vacuum-filtration apparatus. The solid and the filter paper were extracted with CH_2Cl_2 (4x100 mL, ultrasound-assisted), and the solution was dried ($MgSO_4$) and gravity-filtered; 6g of SiO_2 was then added and then rotovaporated to prepare the dry load for column chromatography (5 cm effective column height). The compound was eluted with CH_2Cl_2 at a flux of 15 mL/min in the first fraction (~ 300 mL) to give 400 mg (43%) of 6-methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2**).

Compound 3a. A 50 mL round-bottomed flask was charged with 5-(benzyloxy)-6-phenylacenaphthene (**4a**) (600 mg, 1.8 mmol), potassium dichromate (1.32 g, 4.5 mmol), and acetic acid (25 mL). The mixture was refluxed under argon for 24 hours. The reaction was elaborated in the same manner described for compound **4**.

Note: if at the end of this procedure, a red-colored crude is evident (due to the formation of 5-(benzyloxy)-6-phenylacenaphthylene-1,2-dione), a final treatment with hydrogen peroxide (50%), dichloromethane, triton b (10:10:1) for 18 hours should be conducted (gas evolution). Final treatment with concentrated HCl (pH ~ 1) and dichloromethane extraction afford 6-(benzyloxy)-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3a**) as a yellow solid (479 mg, 70%), mp: 236-238 ^{0}C; R_f (CH_2Cl_2) = 0.40; ^{1}H NMR (600 MHz, $CDCl_3$) δ 4.99 (2H, s; -OC$\underline{H_2}$Ph), 6.89 (2H, d, J = 7.1 Hz), 7.14 (1H, d, J = 8.3 Hz), 7.15 (1H, tt, J = 7.5, 1.3 Hz), 7.23 (7H, m), 7.53 (1H, d, J = 7.6 Hz), 8.59 (1H, d, J = 7.6 Hz), 8.60 (1H, d, J = 8.3 Hz); ^{13}C NMR (151 MHz, $CDCl_3$) δ 71.2, 108.1, 110.9, 117.7, 121.6, 127.4, 127.5, 127.9, 128.2, 128.4, 130.4, 132.9, 133.1, 134.2, 136.1, 142.6, 148.1, 160.7, 161.3, 162.4; HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{25}H_{17}O_4$ 381.1127, found 381.1122.

Compound 2a. A round-bottomed flask was charged with compound **3a** (50 mg, 0.13 mmol), Pd (10%)/C (5 mg of mixture), and ethyl acetate (10 mL). Then, a hydrogen-filled balloon was fitted and the reaction was agitated for 18 h at room temperature. During this time, the initial insoluble starting substrate dissolves. The crude mixture is filtrated through cotton, and the solvent is evaporated to obtain 38 mg (80%) of 6-hydroxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2a**) as a yellow solid (yellow fluorescence under 365 nm UV lamp). mp: start decomposing at 250 ^{0}C; R_f (CH_2Cl_2) = 0.27. The spectroscopic data matched the one reported for the natural product.[1h] HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{18}H_{11}O_4$ 291.0652, found 291.0652.

Compound 3 starting from 4. 6-Bromo-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**4**) (353 mg, 1 mmol), copper (I) iodide (19 mg, 0.10 mmol) and 1,10-phenanthroline (36 mg, 0.20 mmol) were weighed in a 10 mL microwave tube equipped with a magnetic stir bar. To this mixture, 2 mL of a 25 % MeONa/MeOH solution (d = 0.945 g/mL) was added under an argon atmosphere and the tube was capped. The microwave was programmed to heat to 130 ^{0}C as fast as possible (~ 10 seconds) and to hold for 2 h. The reaction crude was allowed to cool to room temperature, and 1 mL of concentrated HCl [~37%] was added to it (a yellow precipitate formed immediately). The content of the reaction tube was poured into water (200 mL) and then vacuum-filtrated. The sample was allowed to dry in air and was then extracted (including the filter paper) with CH_2Cl_2 (300 mL, ultrasound-assisted). This solution was again filtered by gravity, 5g of SiO_2 was added, and the mixture was rotovaporated to prepare the dry load for column chromatography (10 cm effective height). The column was equilibrated with 1 column volume (1 CV) of hexane and then eluted with 5 CVs of a 2:1 mixture and a 1:1 hexane: CH_2Cl_2 mixture, respectively. The elution of compound **2** can be monitored with a UV lamp (366 nm) due to its cyan-blue fluorescence. Rotovaporation of the relevant fractions afforded 6-methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2**) (225 mg, 74% yield) as a yellow solid. 6-Methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2**); lemon-yellow solid, mp: 246-249 ^{0}C (from acetone); R_f (CH_2Cl_2) = 0.20; ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.65 (3H, s; -OMe), 7.04 (1H, d, J = 8.4 Hz; H-5), 7.29 (2H, m; H-3′/-5′), 7.42 (3H, m; H-2′/-6′, H4′), 7.56 (1H, d, J = 7.5 Hz; H-8), 8.60 (1H, d, J = 7.5 Hz; H-9), 8.62 (1H, d, J = 8.4 Hz; H-4); ^{13}C NMR (125 MHz, $CDCl_3$) δ 55.7 (-OMe), 107.0 (C-5), 110.8 (C-3a), 117.7 (C-9a), 121.5 (C-6a), 127.2$_6$ (C-4′), 127.2$_9$ (C-2′/-6′), 128.0 (C-3′/-5′), 130.1 (C-8), 132.9$_6$ (C-

9), 133.0$_1$ (C-3a^1), 136.1 (C-4), 142.7 (C-7), 148.0 (C-1′), 160.7 (C-3), 161.3 (C-1), 163.3 (C-6); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{19}H_{13}O_4$ 305.0808 found 305.0806.

Compound 2. 6-Methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3**) (760 mg, 1.9 mmol) was dissolved in dichloromethane (70 mL) in a 100 mL round-bottomed flask. The solution was chilled in an ice-water bath and treated with 96 µL (187 mmol) of bromine. Agitation was conducted for 60 hours at room temperature after which 585 mg (1.9 mmol) of Ag_2SO_4 where added. The flask is covered in aluminum foil and agitated for another 24-hour period. The flask is chilled again and another addition of bromine (96 µL) is repeated. The silver sulfate addition was repeated after 2 hours (585 mg) and agitation continued for an extra two hours (total reaction time 88 h). Note: The reaction must be kept under 30 ^{o}C all the time. The crude mixture was passed through a silica plug (1cm effective height), and the solution dried to give 585 mg (85%) of 5-bromo-6-methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2**). The compound can be recristallized in acetonitrile as a pale yellow solid; mp: 225-228 ^{0}C (from ethyl ether); R_f (CH_2Cl_2) = 0.46; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.23 (3H, s; -OMe), 7.37-7.50 (5H, m; -Ph), 7.67 (1H, d, J = 7.5 Hz; H-8), 8.64 (1H, d, J = 7.5 Hz; H-9), 8.83 (1H, s; H-4); ^{13}C NMR (100 MHz, $CDCl_3$) δ 61.3 (-OMe), 115.8 (C-5), 116.8 (C-3a), 118.4 (C-9a), 126.0 (C-6a), 127.5 (C-2′/-6′), 128.0 (C-4′), 128.8 (C-3′/-5′), 131.8 (C-8), 132.1 (C-3a^1), 133.1 (C-9), 138.7 (C-4), 140.8 (C-7), 146.9 (C-1′), 159.3 (C-3), 160.2 (C-1), 160.9 (C-6); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{19}H_{12}BrO_4$ 382.9913 and 384.9893, found 382.9923 and 384.9909.

Compound 1. 5-Bromo-6-methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2**) (50 mg, 0.13 mmol), copper (I) iodide (2 mg, 0.011 mmol) and 1,10-phenanthroline (4 mg, 0.022 mmol) were weighed in a 10 mL microwave tube equipped with a magnetic stir bar.

To this mixture, 2 mL of a 25 % MeONa/MeOH solution (d = 0.945 g/mL) was added under an argon atmosphere and the tube was capped. The microwave was programmed to heat to 160 ^{0}C as fast as possible (~ 10 seconds) and then to hold this temperature for 2 h. The reaction crude was allowed to cool to room temperature and 1 mL of concentrated HCl [~37%] was added (a yellow precipitate formed immediately). The reaction mixture was transferred to a beaker with the aid of methanol and allowed to air dry. CH_2Cl_2 extraction followed and the extract was concentrated and submitted to preparative TLC using hexane: ethyl ether (1:1) as the mobile phase to afford 5,6-dimethoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**1**) (15 mg, 35% yield). In addition, 12 mg of compound **3** (30 % yield) was recovered. 5,6-dimethoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**1**); pale green solid; R_f (hexane: ethyl ether 1:1) = 0.30 ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.37 (3H, s; 6-OMe), 4.05 (3H, s; 5-OMe), 7.35 (2H, m; H-2′/-6′), 7.43 (3H, m; H-3′/-5′, H-4′), 7.54 (1H, d, J = 7.5 Hz; H-8), 8.43 (1H, s; H-4), 8.51 (1H, d, J = 7.5 Hz; H-9); ^{13}C NMR (125 MHz, $CDCl_3$) δ 56.9 (5-O<u>Me</u>), 61.0 (6-O<u>Me</u>), 114.0 (C-3a), 117.9 (C-9a), 120.6 (C-4), 125.8 (C-6a), 127.3$_4$ (C-3′/-5′), 127.3$_6$ (C-4′), 127.9 (C-3a^1), 128.2 (C-2′/-6′), 130.7 (C-8), 131.3 (C-9), 142.1 (C-7′), 146.7 (C-1′), 150.9 (C-5), 151.9 (C-6), 160.7 (C-3), 160.9 (C-1); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{20}H_{15}O_5$ 335.0914, found 335.0914. For comparison, compound **1** was dissolved in DMSO-d^6 (very low solubility) and the ^{1}H- and ^{13}C-NMR spectra were measured. The spectroscopic data matched the one reported for the natural product.[1d]

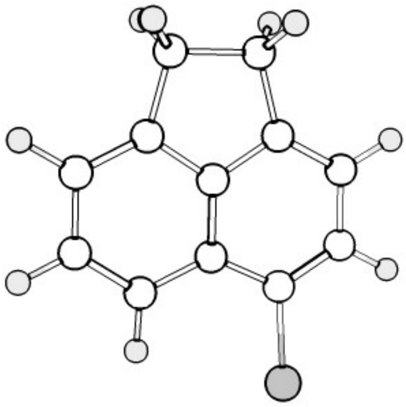
Compound 3b. 6-Methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3**) (51 mg, 0.17 mmol), Ag_2SO_4 (46 mg, 0.15 mmol), 1 mL H_2SO_4 [97-98%] and Br_2 (20 μL, 0.39 mmol) were added in a 10 mL microwave tube equipped with a magnetic stir bar. The reaction mixture was heated at 60 ^{0}C for 2.5 h. After cooling, the reaction mixture was poured into water and filtered, and the solid was extracted with CH_2Cl_2. The title compound was purified by means of preparative TLC using CH_2Cl_2 as the mobile phase. 5-Bromo-7-(4-bromophenyl)-6-methoxy-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3a**) (39 mg, 50% yield); white solid; R_f (CH_2Cl_2) = 0.60; ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.29 (3H, s; -OMe), 7.30 (2H, d, J = 8.4 Hz; H-3′/-5′), 7.61 (2H, d, J = 8.4 Hz; H-2′/-6′), 7.64 (1H, d, J = 7.6 Hz; H-8), 8.65 (1H, d, J = 7.6 Hz; H-9), 8.85 (1H, s; H-4); ^{13}C NMR (125 MHz, $CDCl_3$) δ 61.4 (-OMe), 115.9 (C-5), 117.0 (C-3a), 118.8 (C-9a), 122.4 (C-4′), 125.9 (C-6a), 130.4 (C-3′/-5′), 130.7 (C-2′/-6′), 131.7 (C-8), 132.1 (C-3a^1), 133.1 (C-9), 138.9 (C-4), 139.7 (C-7), 145.4 (C-1′), 159.2 (C-3), 160.0 (C-1), 160.6 (C-6). HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{19}H_{11}Br_2O_4$ 462.8998, 460.9019, 464.8978 found 462.9008, 460.9034, 464.8940.

Compound 2b. The same procedure described for compound **1** was used with the following quantities of chemicals: 5-bromo-7-(4-bromophenyl)-6-methoxy-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3b**) (50 mg, 0.11 mmol), copper (I) iodide (2 mg, 0.011 mmol), 1,10-phenanthroline (4 mg, 0.022 mmol), and 2 mL of a 25 % MeONa/MeOH solution (d = 0.945 g/mL). Compound **2b** was purified via preparative TLC using hexane: AcOEt (2:1) as the mobile phase. 5,6-Dimethoxy-7-(4-methoxyphenyl)-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2b**) (15 mg, 38% yield); pale green oil; R_f (hexane: AcOEt 2:1) = 0.40; ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.38 (3H, s; 6-OMe), 3.89 (3H, s; 4′-OMe), 4.06 (3H, s; 5-OMe), 6.97 (2H, d, J = 8.5 Hz; H3′/-5′), 7.30 (2H, d, J = 8.5 Hz; H2′/-6′), 7.54 (1H, d, J = 7.5 Hz; H-8), 8.42 (1H, s; H-4), 8.49 (1H, d, J = 7.5 Hz; H-9); ^{13}C NMR (125 MHz, $CDCl_3$) δ 55.4 (4′-O<u>Me</u>), 56.9 (5-O<u>Me</u>), 61.1 (6-O<u>Me</u>), 112.8 (C-3′/-

5´), 114.1 (C-3a), 117.6 (C-9a), 120.5 (C-4), 126.0 (C-6a) 128.0 (C-3a^1), 129.8 (C-2´/-6´), 131.0 (C-8), 131.3 (C-9), 134.3 (C-7), 146.6 (C-1´), 150.9 (C-5), 151.9 (C-6), 159.1 (C-4´), 160.9 (C-3), 161.1 (C-1); HRESIMS (*m/z*) $[M+H]^+$ calcd for $C_{21}H_{17}O_6$ 365.1020, found 365.1031.

Table S1. Cartesian coordinates for compounds **7**, **7a**, **6**, and **5** optimized via DFT/CAM-B3LYP/def2-TZPV using default parameters as implemented in ORCA_5.0.4.

Compound 7

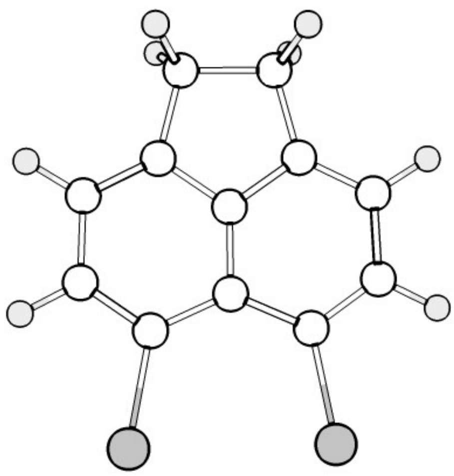


H	3.23477512320703	2.69038648895589	-0.00000118335006
C	2.35843447004868	2.05478214716915	-0.00000137845654
C	2.46109097024872	0.69542435613917	-0.00000039466458
C	-0.07647552821093	1.89081658559678	-0.00000150708178
C	1.28728147223420	-0.07530747728685	-0.00000135447164
C	1.07106942470384	2.63822772388876	-0.00000262955161
C	0.00049640295805	0.48023984997133	-0.00000096312026
C	1.55381913327364	-1.45311226115780	-0.00000208071492
H	0.99088463583116	3.71759128050751	-0.00000363287515
H	-1.04218637613861	2.37517917509044	-0.00000207899286
C	0.50454515068108	-2.32284849992461	-0.00000431441660
H	0.64918366926590	-3.39546890748589	-0.00000572624888
C	-0.81102663957271	-1.80664746768780	-0.00000171821009
H	-1.64646519121652	-2.49242600788663	-0.00000082068886

C	-1.05637286949941	-0.46153293731744	0.00000139890253
C	3.04854185844554	-1.66362680751923	0.00000037221877
H	3.36686554753935	-2.23236246164671	-0.87451541280825
H	3.36686227890367	-2.23236324506263	0.87451688315120
C	3.65355239129163	-0.23098119139507	0.00000229874092
H	4.28304027182645	-0.06253139788317	-0.87458483882147
H	4.28303495107234	-0.06253188308887	0.87459350243388
Br	-2.85665214689308	0.14269493802366	0.00001457902626

TOTAL SCF ENERGY -3036.886237875166 Ha.

Compound 7a

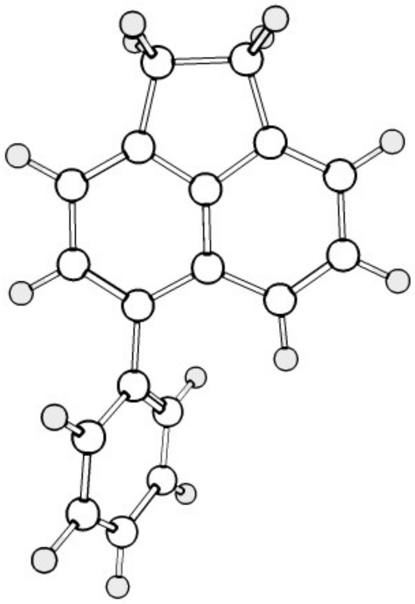


C	-5.90909992085660	1.95410134597901	0.00106709941791
C	-5.97683809209299	0.55071796994207	-0.00550439032545
C	-4.68239367467745	2.53856069927249	0.00232503857619

C	-3.53430453227508	1.72520190092499	-0.00296036201786
C	-3.55134824683019	0.30891355467288	-0.00966099159622
C	-2.36696547465498	2.51071815853880	-0.00046108533090
C	-1.15460133342114	1.89705945892417	-0.00433372358715
C	-1.12059841754826	0.49242303858497	-0.01119700081406
C	-4.28177170030578	3.99104049338940	0.00915478260726
C	-2.73265008751647	3.97243571694204	0.00652617952945
C	-2.25195945083653	-0.28137905607630	-0.01400423661738
Br	-1.91011621429950	-2.15281151791554	-0.02435762666305
C	-4.86461451460964	-0.25025931244801	-0.01066520039380
Br	-5.25326925648804	-2.11267431062591	-0.01882523370745
H	-6.82348580358862	2.53274708757631	0.00502079222147
H	-6.94678886307791	0.07505999920320	-0.00654163984205
H	-0.22660551983309	2.45367873062961	-0.00243256851302
H	-0.16232454872056	-0.00639053403940	-0.01460609593559
H	-4.67767724127454	4.50215796159458	0.88752475241220
H	-4.68074150756477	4.51150429334394	-0.86230090563445
H	-2.32152047878560	4.47493489881957	0.88286095612807
H	-2.32448512074227	4.48228942276713	-0.86695853991413

TOTAL SCF ENERGY -5610.552931231588 Ha.

Compound 6

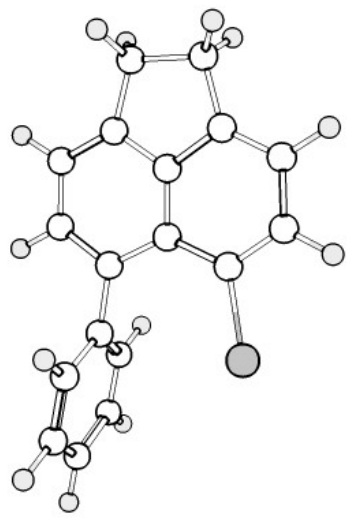


H	3.48334162604743	2.89029549131748	0.10333606445631
C	2.66505304007600	2.18187525797334	0.07465493107485
C	2.88240643383649	0.83656546451055	0.05634366392816
C	0.25529785955380	1.80527814249685	0.00750611581461
C	1.77878889177878	-0.03213279666046	0.01766873407438
C	1.33187377914485	2.65126166029555	0.04258147249689
C	0.44719862258324	0.40158959038429	0.00577157954809
C	2.16662049031004	-1.38032709996774	-0.02470473765003
H	1.15762882051652	3.71968238671239	0.03991196831425
H	-0.74402063475231	2.21409952825973	-0.03108691072407
C	1.19662986386482	-2.33466943350214	-0.08748721290853
H	1.43498327937880	-3.39019980348371	-0.12399564575509

C	-0.15602339246901	-1.92898835741844	-0.09312070387962
H	-0.92147515827085	-2.69424840538208	-0.12000240155566
C	-0.55505633410087	-0.61325444061198	-0.03987413010600
C	3.67388511891519	-1.46145234477053	0.00208450487473
H	4.05767199704535	-1.97056344001053	-0.88297955770541
H	4.02378411025265	-2.02923949939769	0.86529200126343
C	4.15152678063319	0.01739626576850	0.06066338750431
H	4.78566362342625	0.26722446125285	-0.79087996701516
H	4.74170075059661	0.21092372880975	0.95743579644501
C	-2.00175725975457	-0.28719353291428	-0.02898288829426
C	-4.74307418844402	0.26370906585716	0.01577864448764
C	-2.55572727961461	0.50096530818837	0.97672263236140
C	-2.84864960969803	-0.79391780230069	-1.01055595295257
C	-4.20588455788930	-0.52148933030972	-0.98970644881080
C	-3.91219946775841	0.77271318499331	1.00012352688182
H	-1.91743356158852	0.88985095246999	1.75911324901843
H	-2.43272776338207	-1.39846280127214	-1.80618742822026
H	-4.84491148803199	-0.92094866443204	-1.76642208017229
H	-4.32328245684748	1.38032479914796	1.79570432301422
H	-5.80333293535797	0.47833346399608	0.03279247019123

TOTAL SCF ENERGY -694.206480305284 Ha.

Compound 5



C	-2.20776375696660	2.52275693399187	-0.63661403866846
C	-2.37114561792895	1.12499590557022	-0.61048666796269
C	-0.96959067583123	3.03273942906196	-0.39912027563692
C	0.09292783521305	2.15151938564479	-0.13082731664598
C	-0.02165847743537	0.74553420650774	-0.07671100577040
C	-1.33718325773696	0.26591422915994	-0.34813985346466
C	1.29424679454971	2.85345149789451	0.07344965473302
C	2.42732268550482	2.15411765768974	0.34564180078974
C	2.34211476861145	0.75097287674752	0.42308220112794
C	1.18255696896317	0.03599082670602	0.23021816401845
H	-3.06057430781597	3.15447537079926	-0.84864601835240
H	-3.34797840733743	0.70835427437437	-0.80995638141377
Br	-1.78998835428799	-1.58160290401966	-0.40458223366956
H	3.37895715311069	2.64403257584340	0.50757270784442

H	3.23997481090100	0.19314102064877	0.65637594609989
C	1.29130126327810	-1.44342073069136	0.38462511039830
C	-0.47107369368180	4.45524830126933	-0.35952500371248
C	1.04851247693086	4.33383881838463	-0.07463308707058
H	-0.97971255814619	5.02365100741638	0.42038961758240
H	-0.66596487311522	4.97086652828234	-1.30048280993460
H	1.64191281913022	4.74633018495396	-0.89180273928206
H	1.33640917084254	4.87642144350498	0.82641139118657
C	1.02208182603582	-2.04619935154397	1.60692831123051
C	1.74406080862331	-2.23240294833579	-0.66476596786049
C	1.89907974976549	-3.59866224270866	-0.50493991662084
C	1.17890514485504	-3.41101398051416	1.77012926269926
C	1.61275222723517	-4.19289718936707	0.71243762590407
H	0.67708853901257	-1.43894610406671	2.43380669278991
H	1.96509683345662	-1.77112272880728	-1.61859993757140
H	2.24527386703270	-4.20083206219967	-1.33473815189437
H	0.96072344946432	-3.86627139028840	2.72727471146141
H	1.73336478776704	-5.26067084190899	0.83882820766577

TOTAL SCF ENERGY -3267.876966089823 Ha.

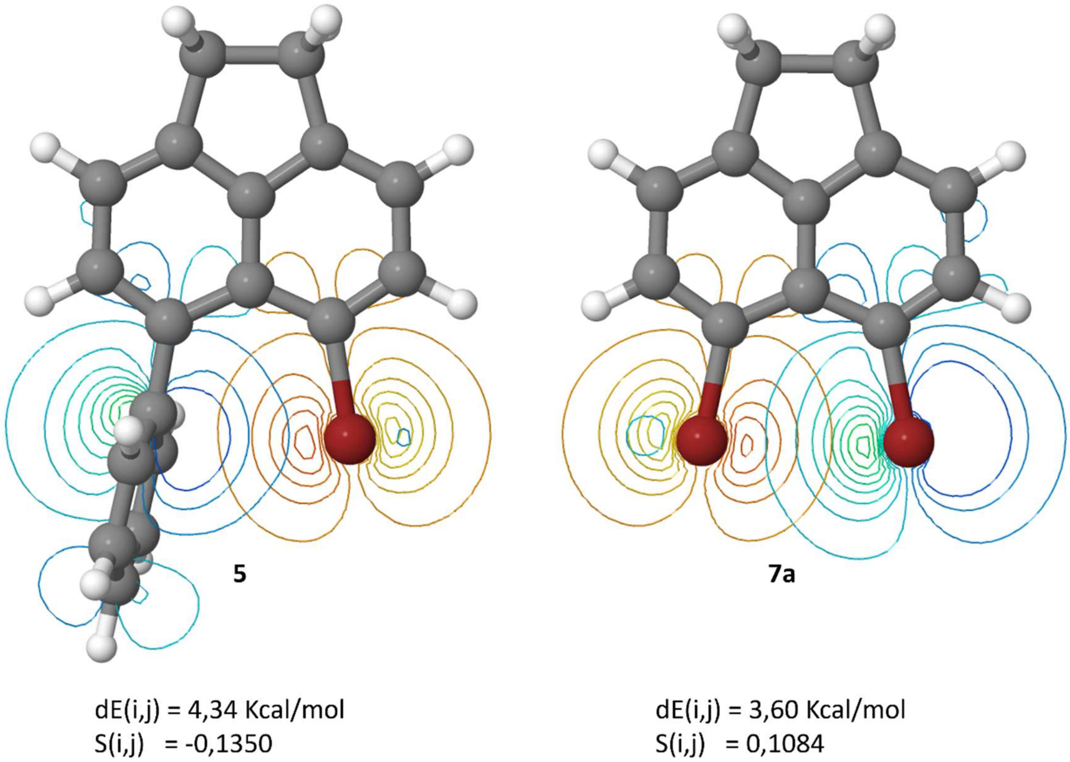


Figure S1. Single-point Hartree-Fock def2-TZVP "steric" NBO calculation using DFT/CAM-B3LYP def2-TZVP optimized geometries. Natural localized molecular orbitals (NLMO) of compounds **5** and **7a** illustrate the pairwise steric peri-interaction. dE(i,j): pairwise steric exchange energy. S(i,j): pre-NLMO overlaps.

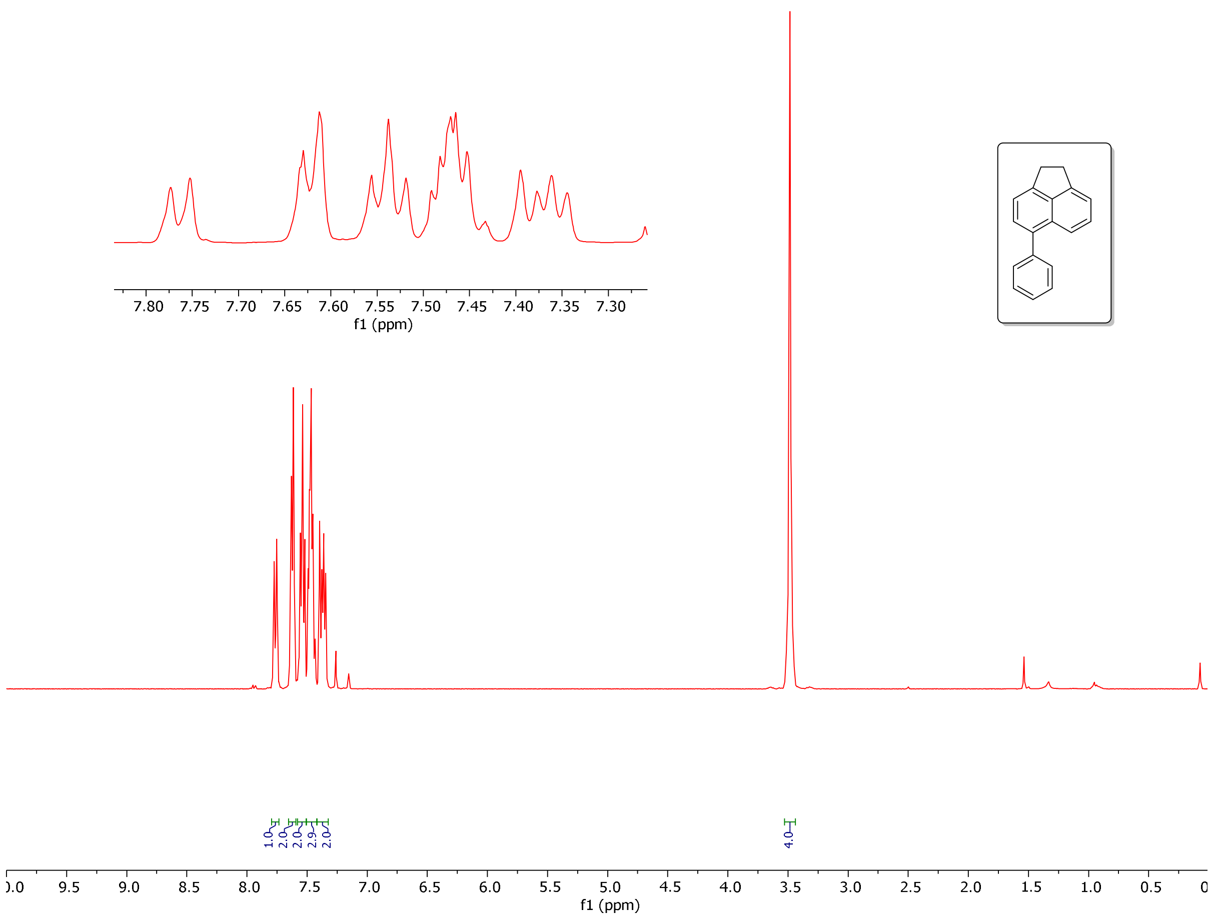


Figure S2. ^{1}H-NMR spectrum of 5-phenylacenaphthene (**6**) in $CDCl_3$.

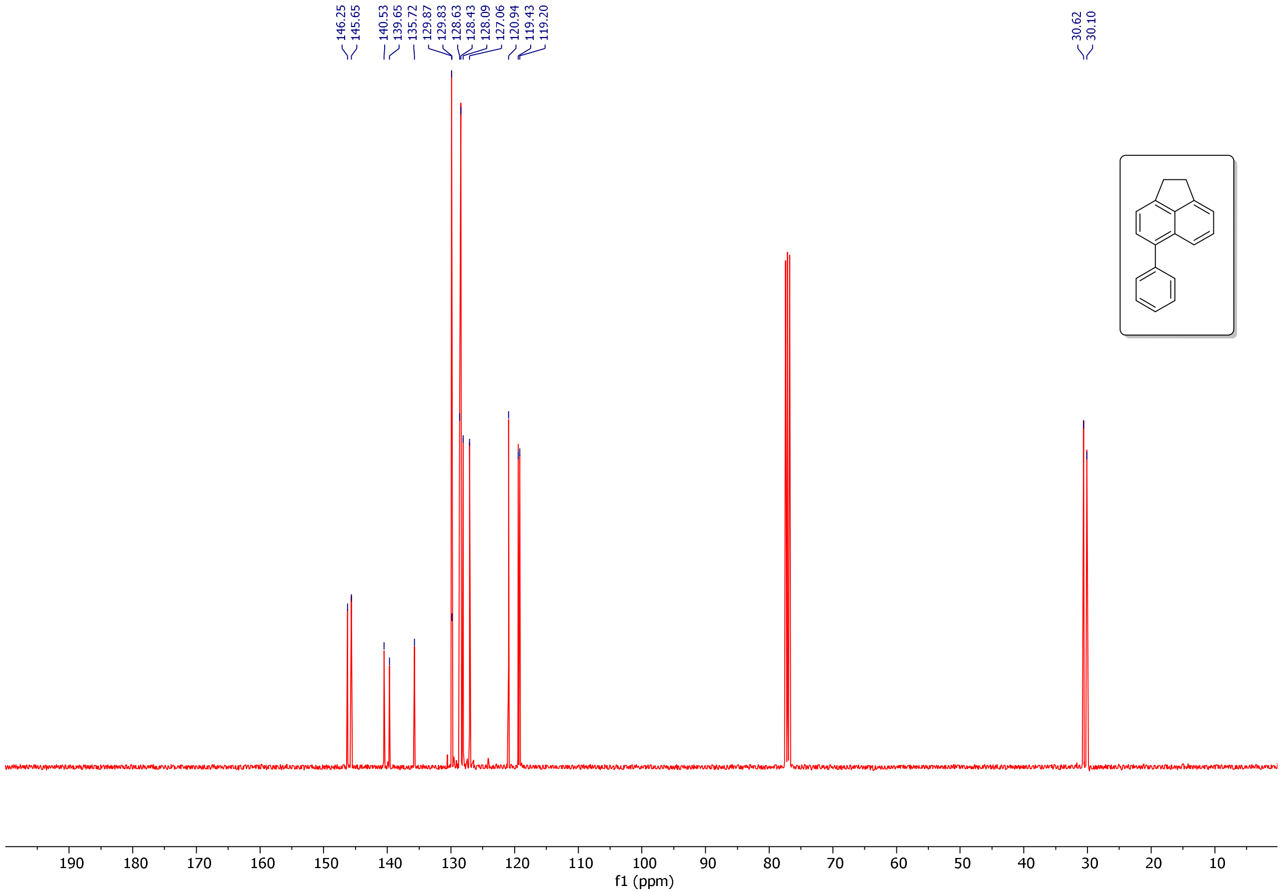


Figure S3. ^{13}C-NMR spectrum of 5-phenylacenaphthene (**6**) in $CDCl_3$.

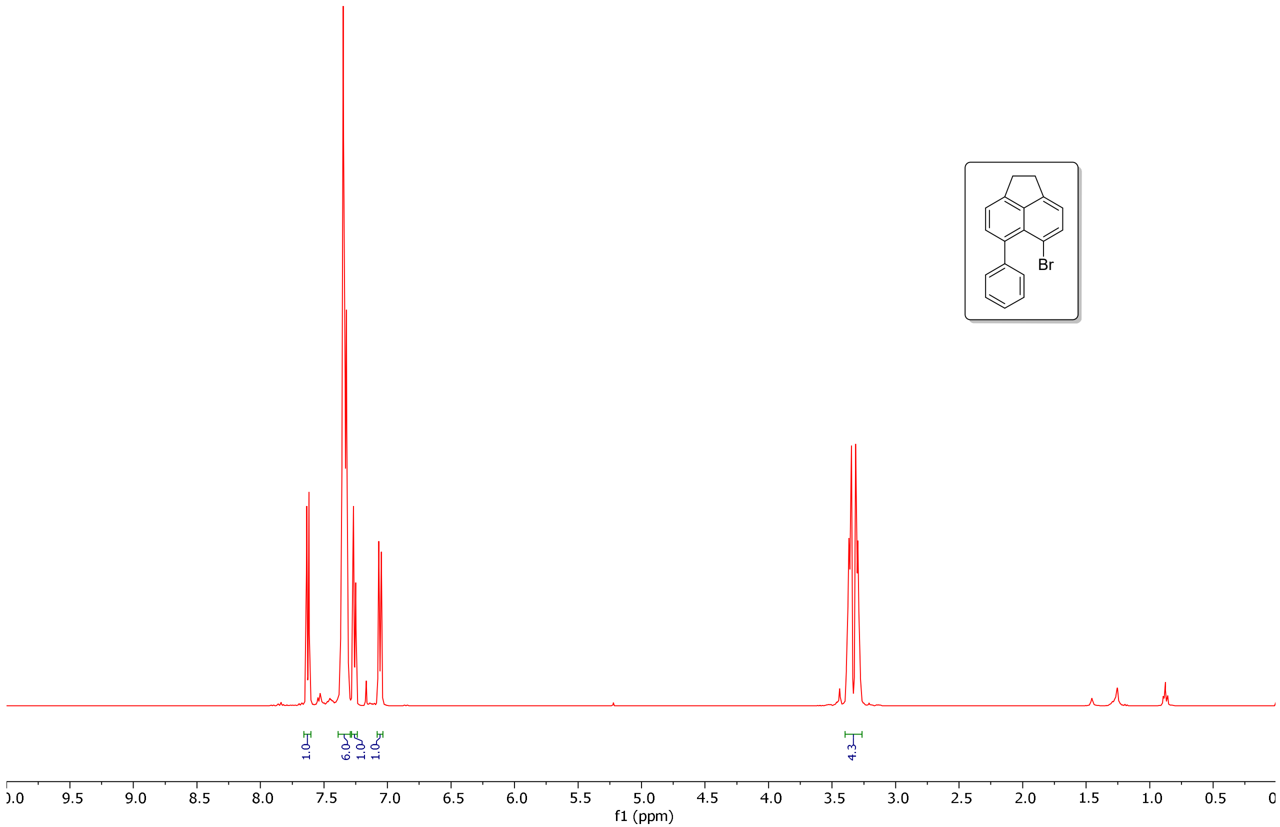


Figure S4. [1]H-NMR spectrum of 5-bromo-6-phenylacenaphthene (**5**) in $CDCl_3$.

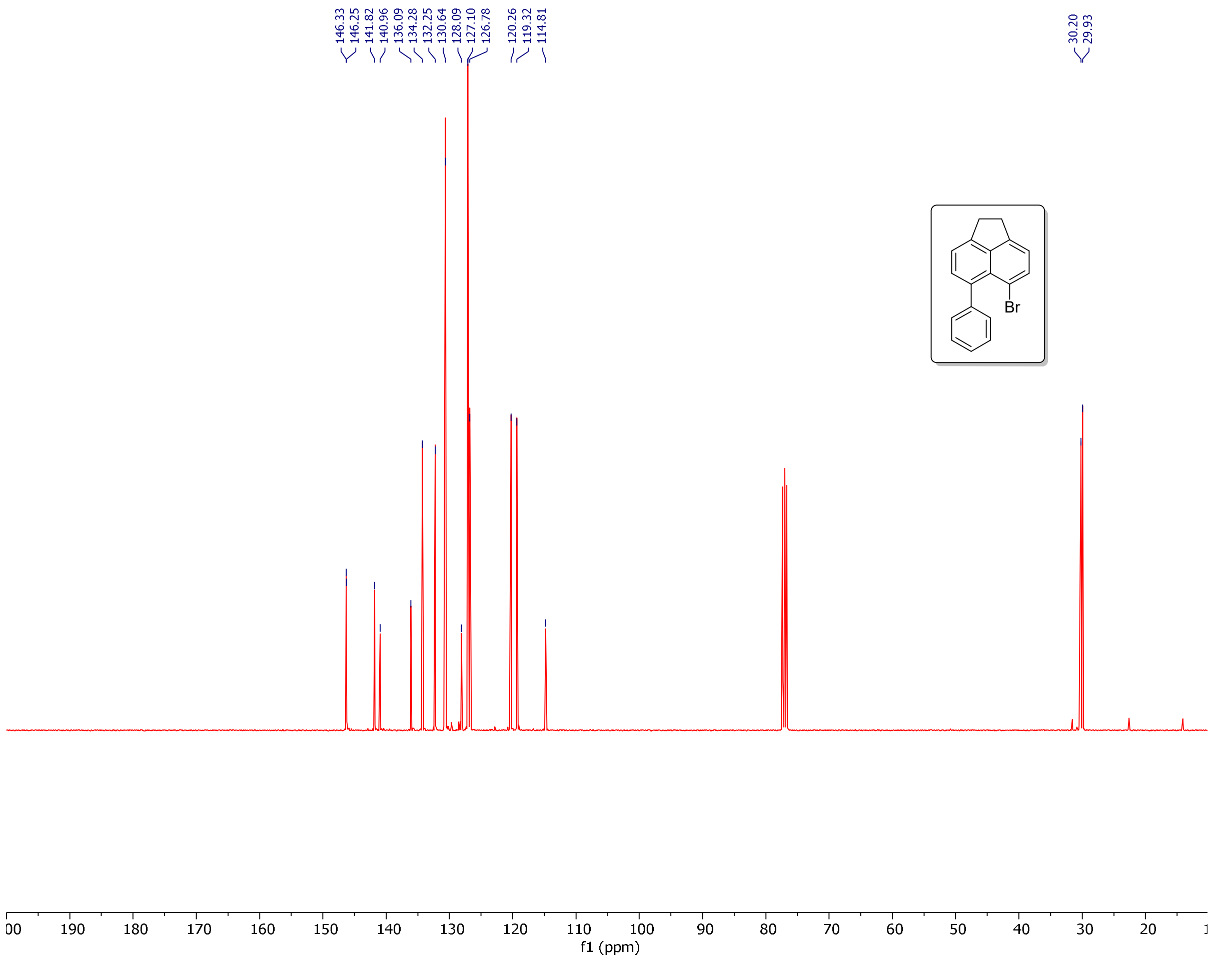


Figure S5. [13]C-NMR spectrum of 5-bromo-6-phenylacenaphthene (**5**) in $CDCl_3$ in $CDCl_3$.

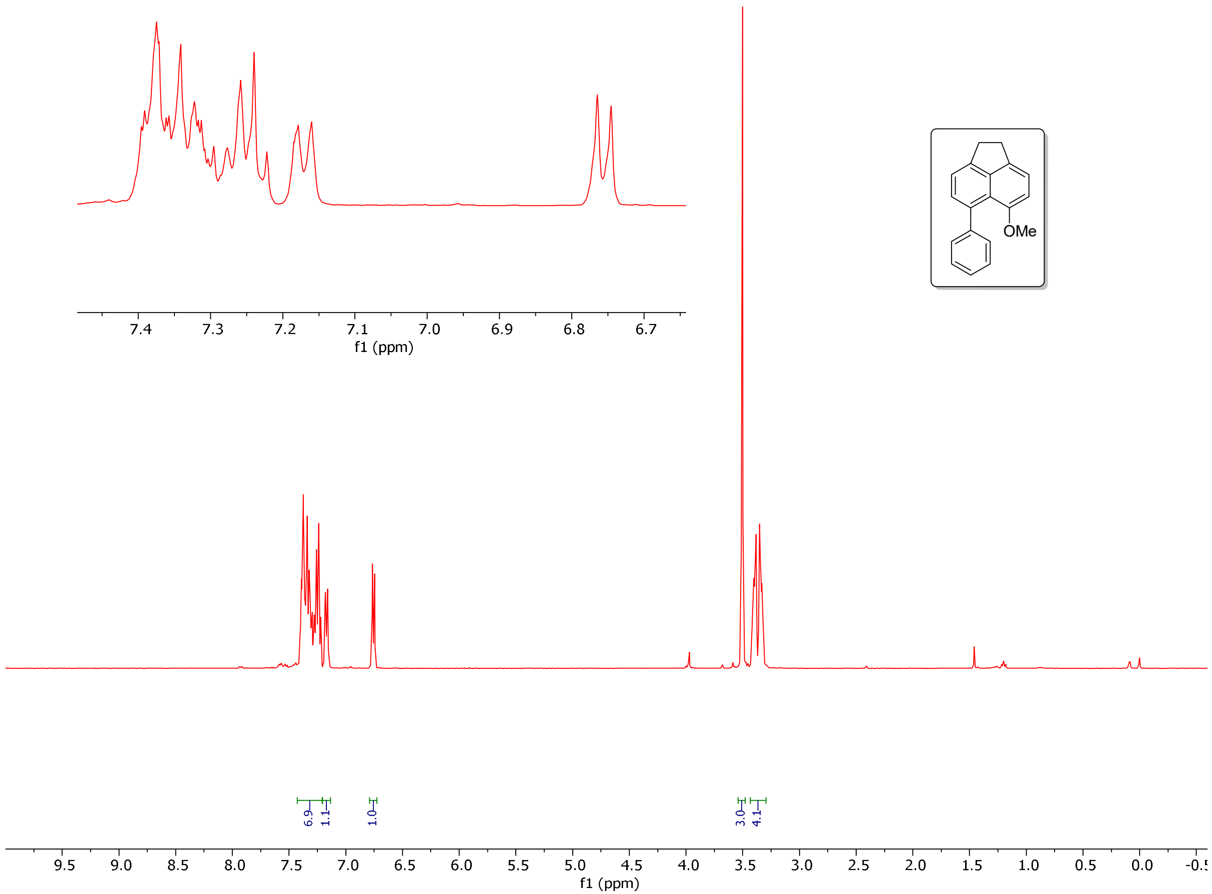


Figure S6. ^{1}H-NMR spectrum of 5-methoxy-6-phenylacenaphthene (**5a**) in $CDCl_3$.

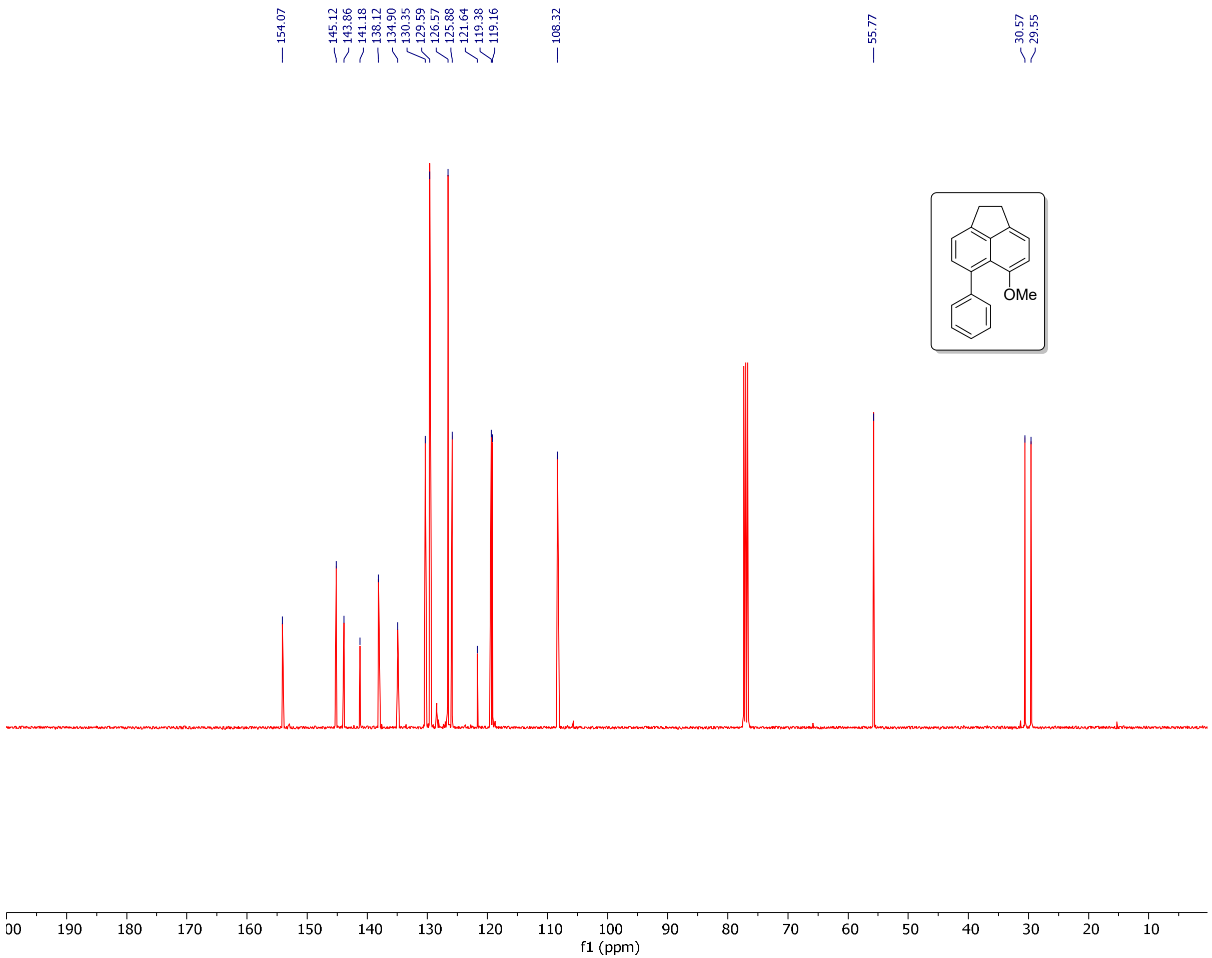


Figure S7. ^{13}C-NMR spectrum of 5-methoxy-6-phenylacenaphthene (**5a**) in $CDCl_3$.

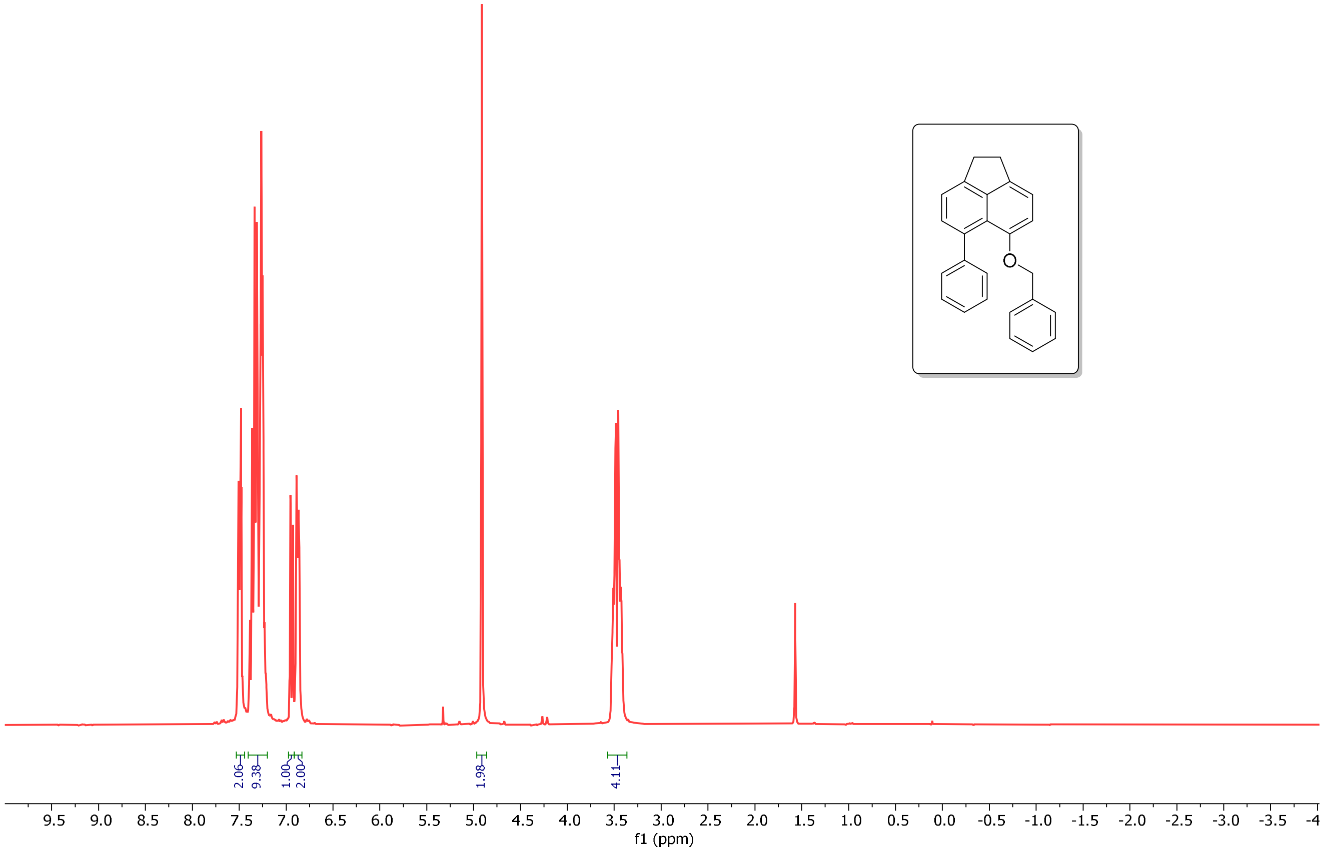


Figure S8. [1]H-NMR spectrum of 5-(benzyloxy)-6-phenyl-1,2-dihydroacenaphthylene (**4a**) in $CDCl_3$.

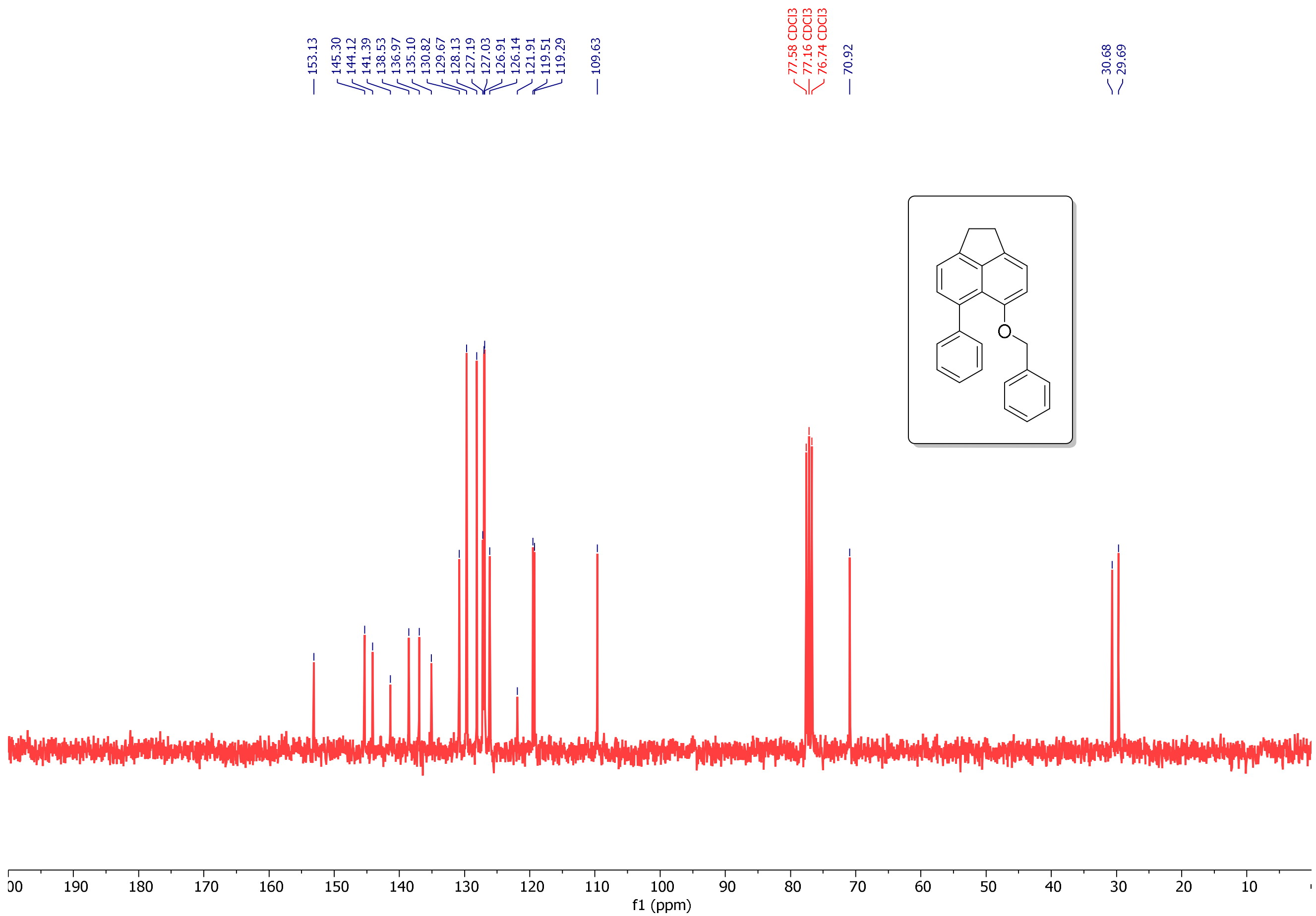


Figure S9. ^{13}C-NMR spectrum of 5-(benzyloxy)-6-phenyl-1,2-dihydroacenaphthylene (**4a**) in $CDCl_3$.

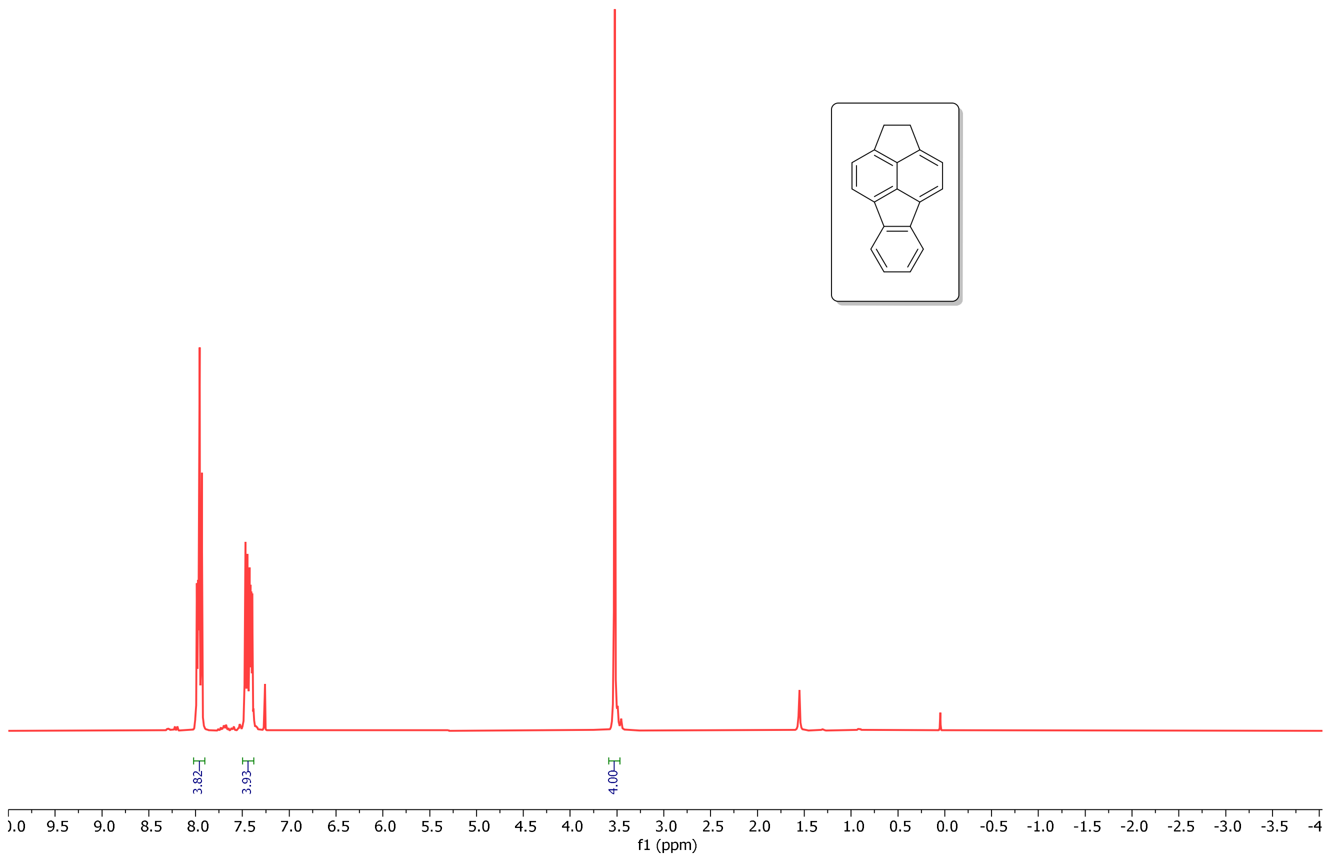


Figure S10. [1]H-NMR spectrum of 1,2-dihydrocyclopenta[cd]fluoranthene (**5b**) in $CDCl_3$.

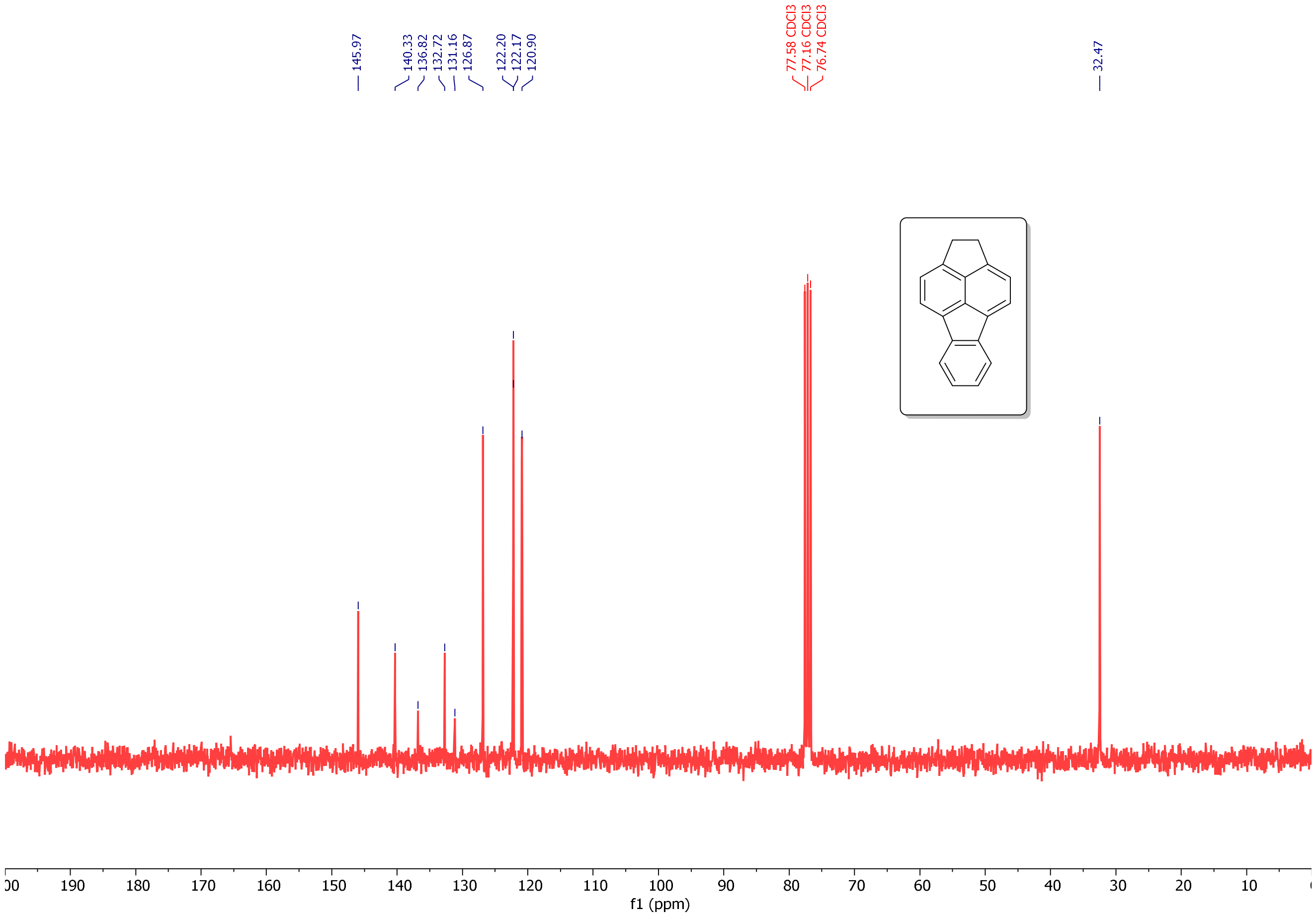


Figure S11. [13]C-NMR spectrum of 1,2-dihydrocyclopenta[cd]fluoranthene (**5b**) in $CDCl_3$.

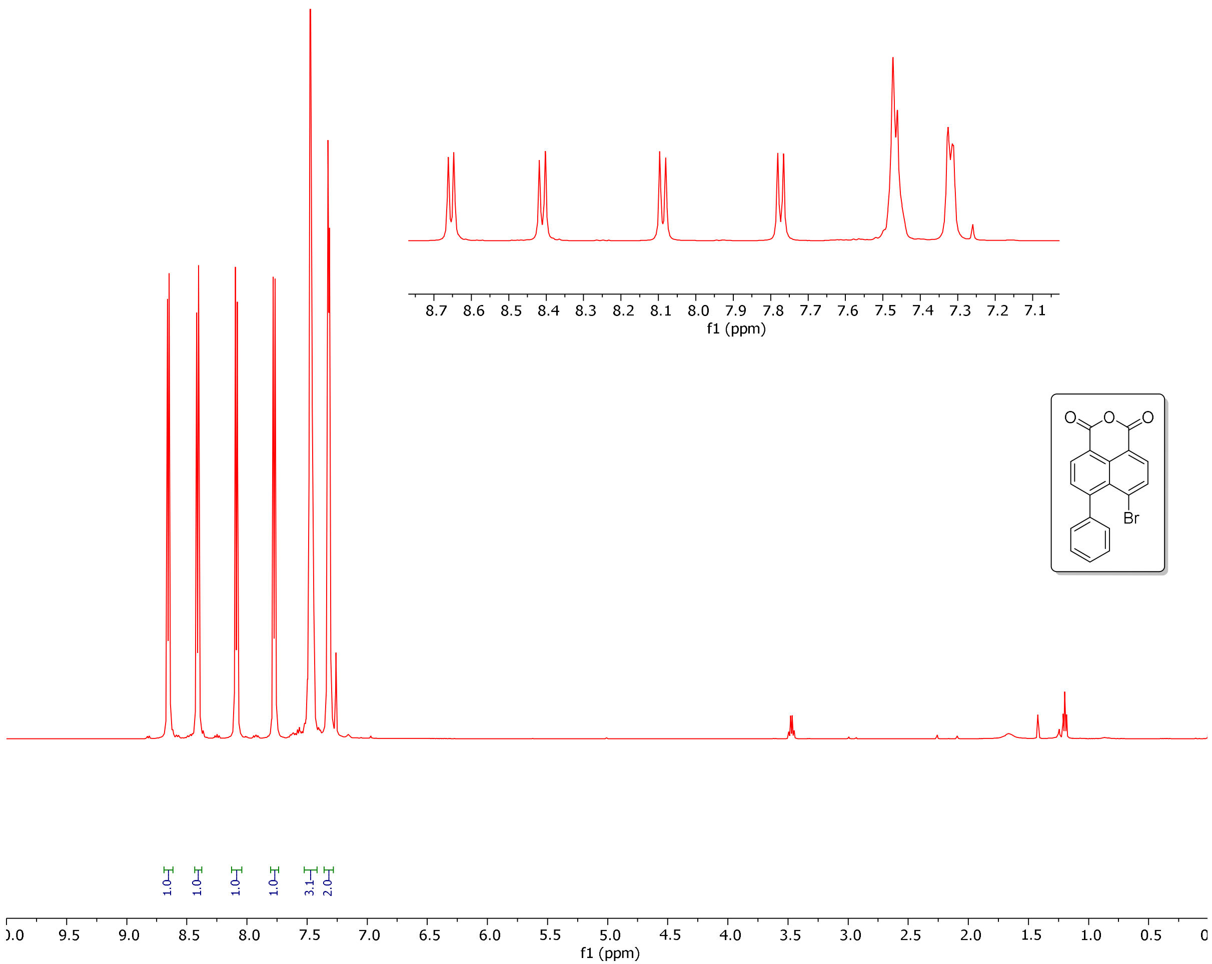


Figure S12. [1]H-NMR spectrum of 6-bromo-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**4**) in $CDCl_3$.

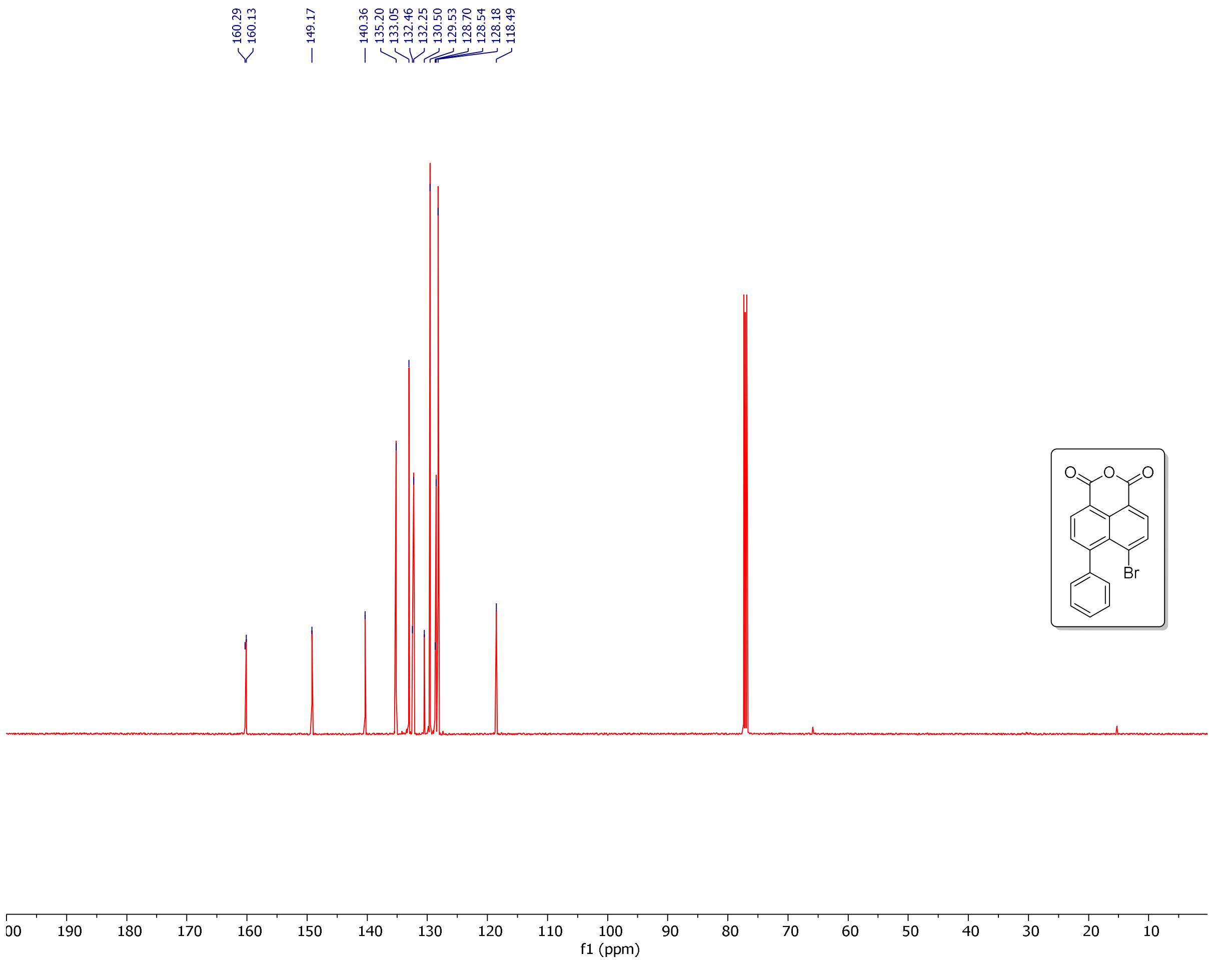


Figure S13. ^{13}C-NMR spectrum of 6-bromo-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**4**) in $CDCl_3$.

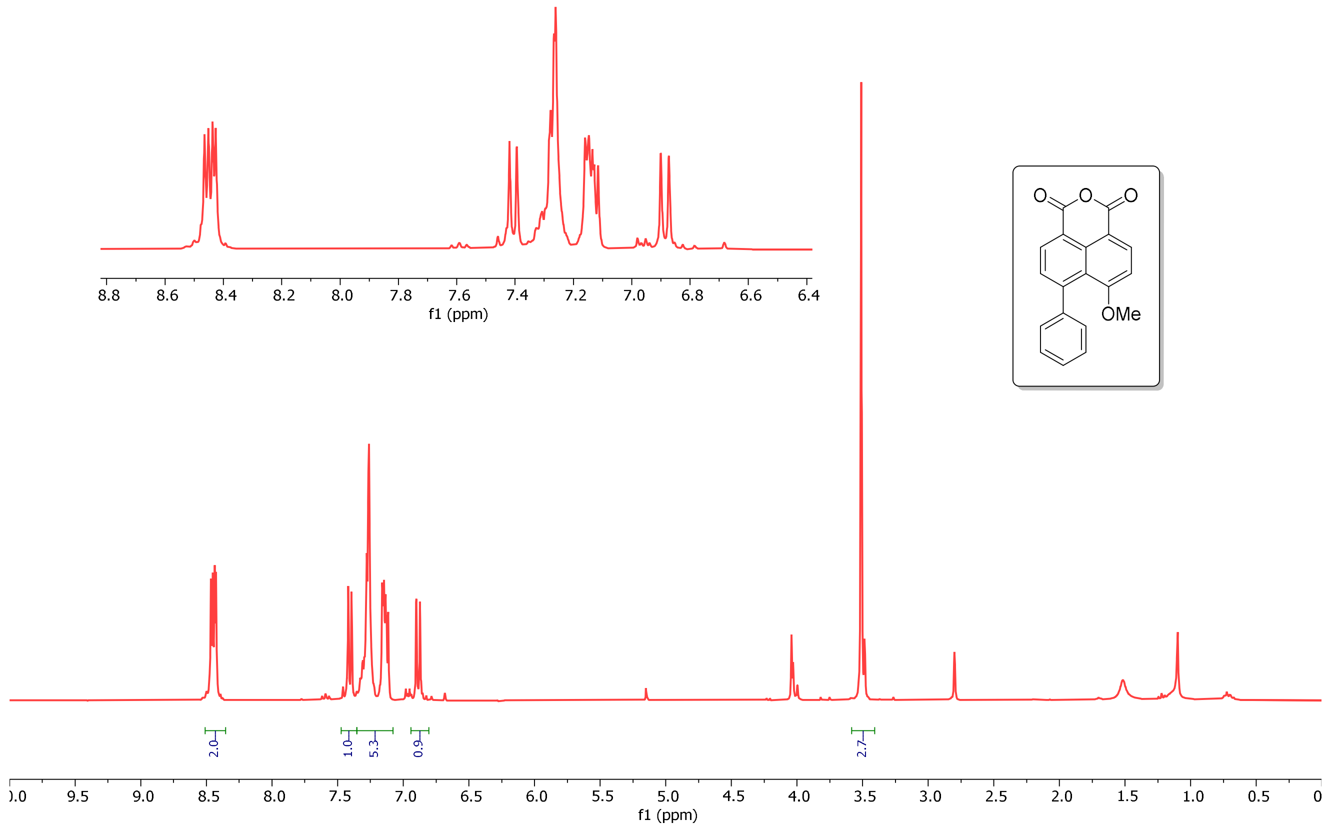


Figure S14. ^{1}H-NMR spectrum of 6-methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3**) in $CDCl_3$.

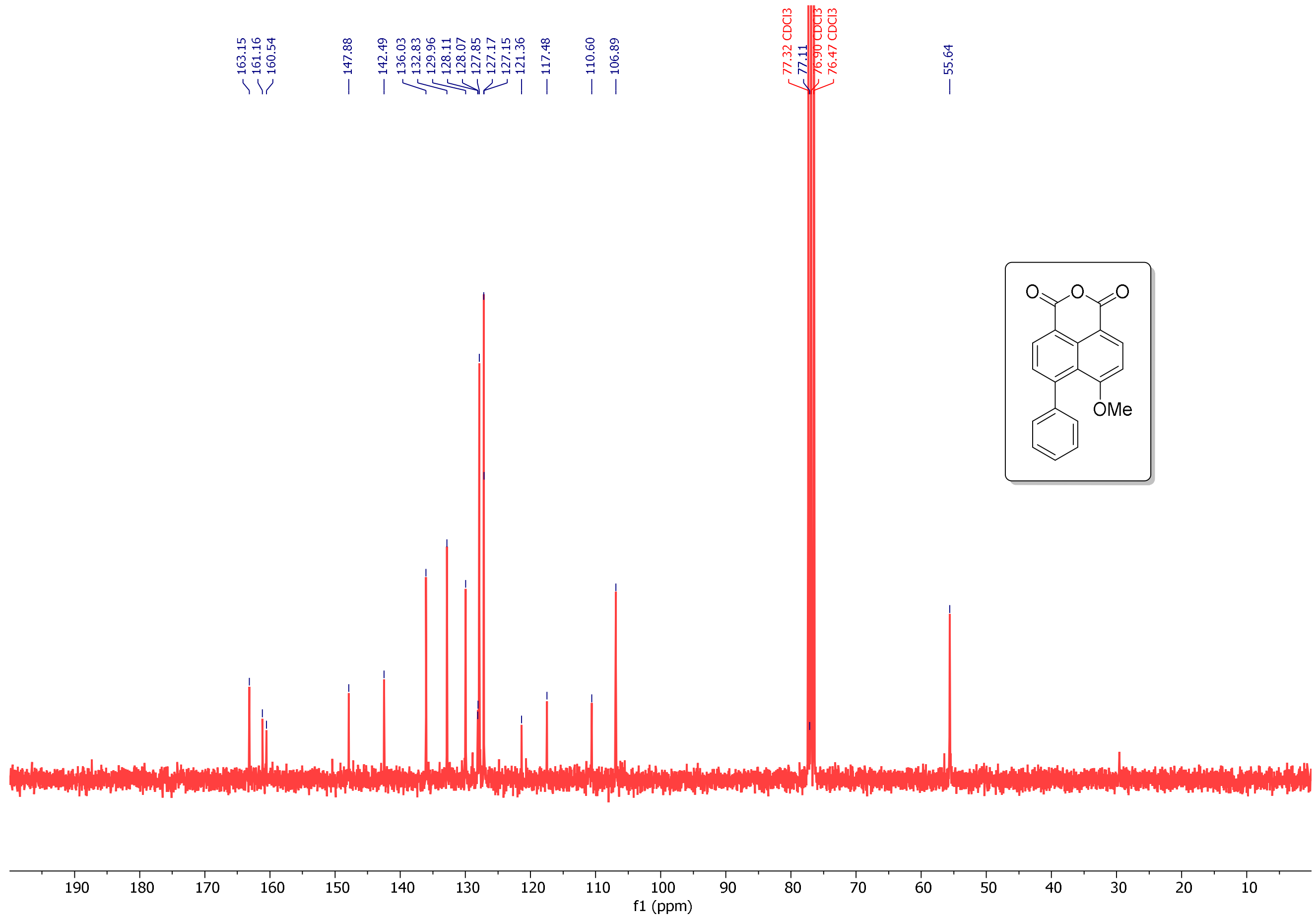


Figure S15. ^{13}C-NMR spectrum of 6-methoxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3**) in $CDCl_3$.

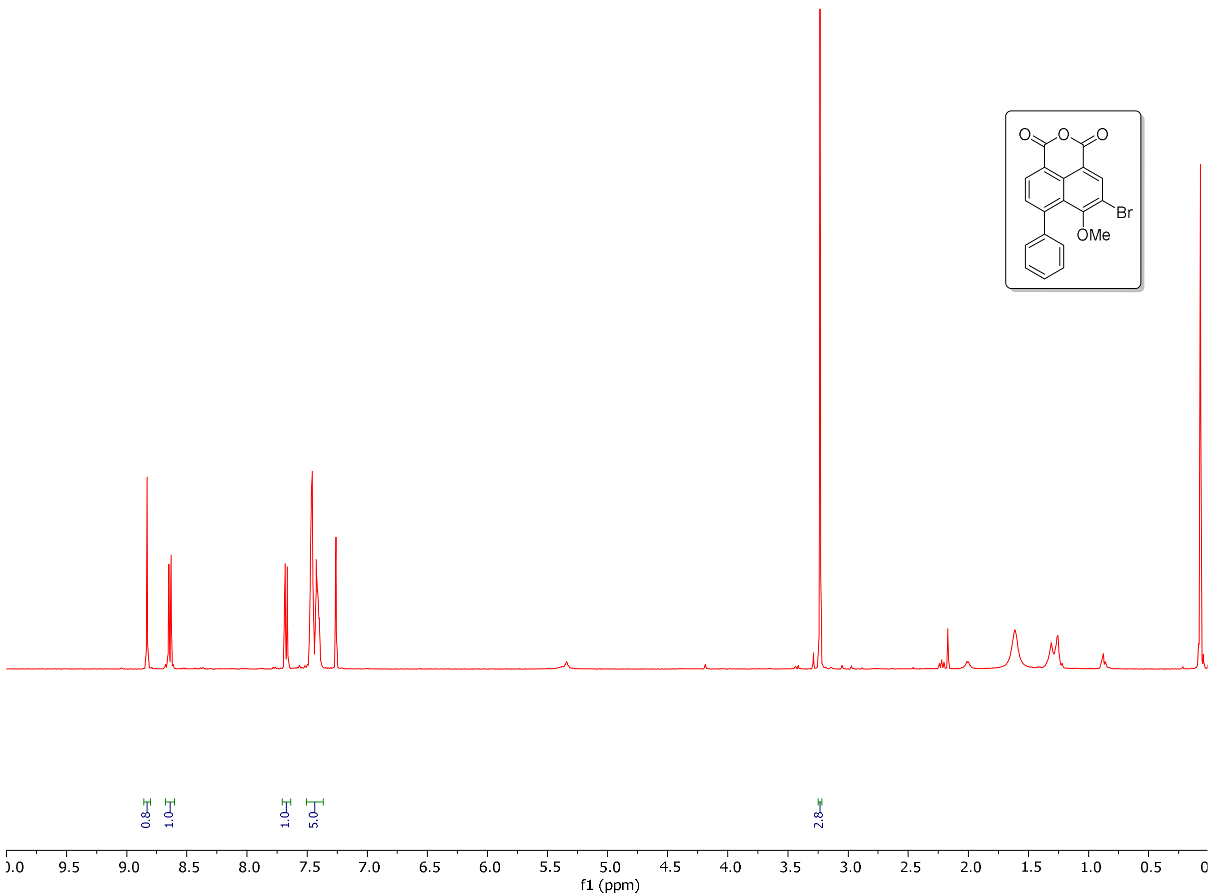


Figure S16. ^{1}H-NMR spectrum of 5-bromo-6-methoxy-7-phenyl-1H,3H-benzo[de]isochromene-1,3-dione (**2**) in $CDCl_3$.

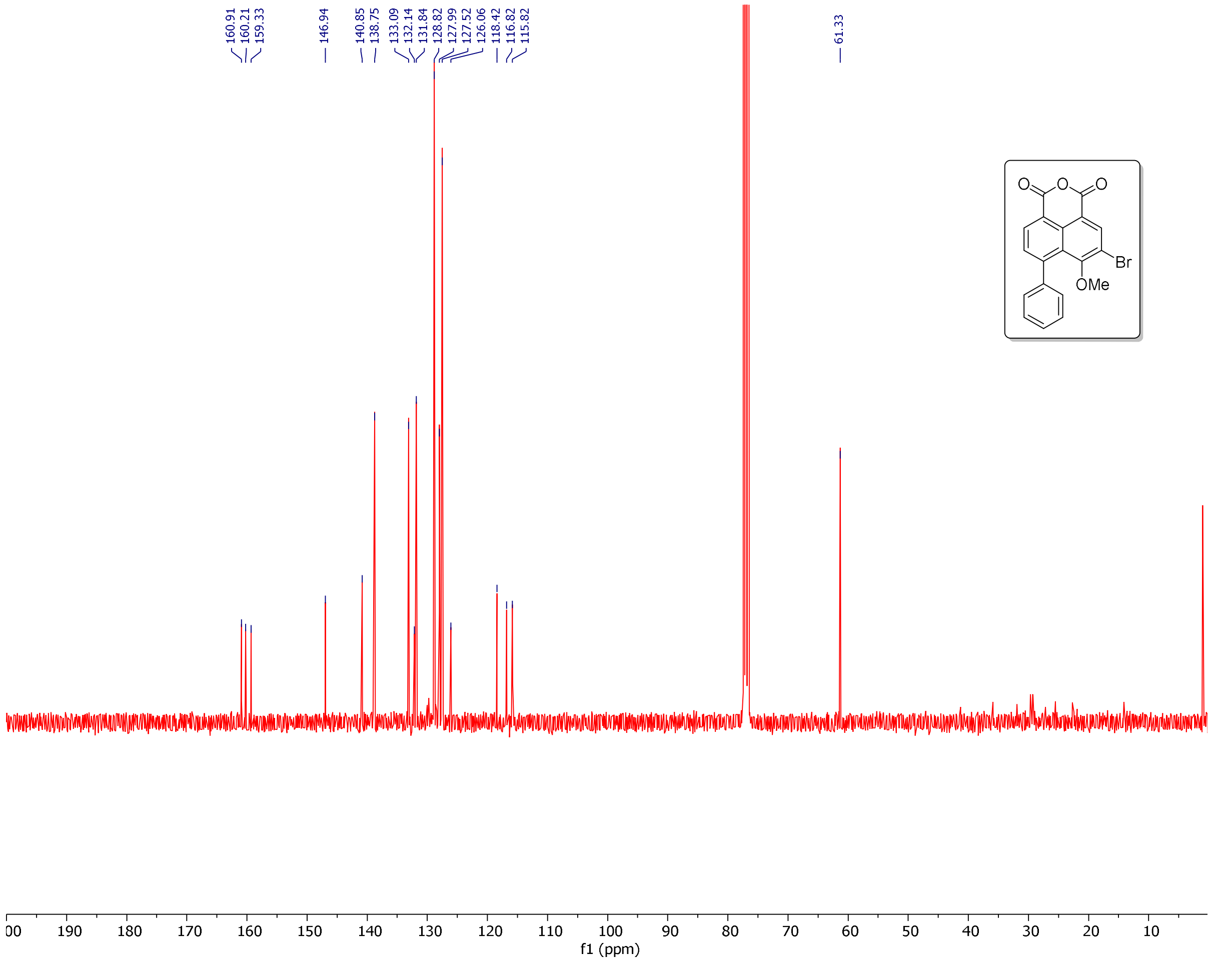


Figure S17. ^{13}C-NMR spectrum of 5-bromo-6-methoxy-7-phenyl-1H,3H-benzo[de]isochromene-1,3-dione (**2**) in $CDCl_3$.

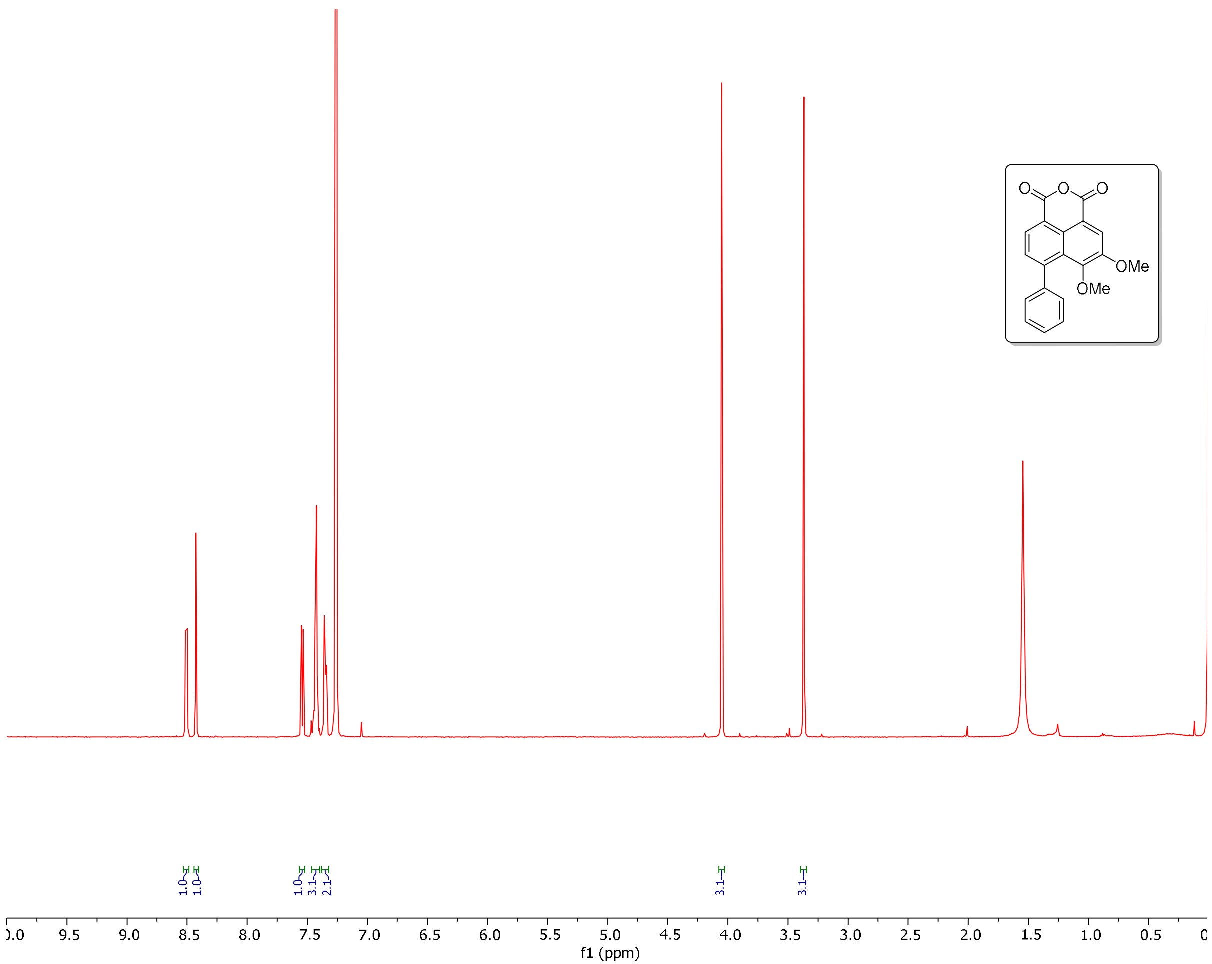


Figure S18. [1]H-NMR spectrum of 5,6-dimethoxy-7-phenyl-1H,3H-benzo[de]isochromene-1,3-dione (**1**) in $CDCl_3$.

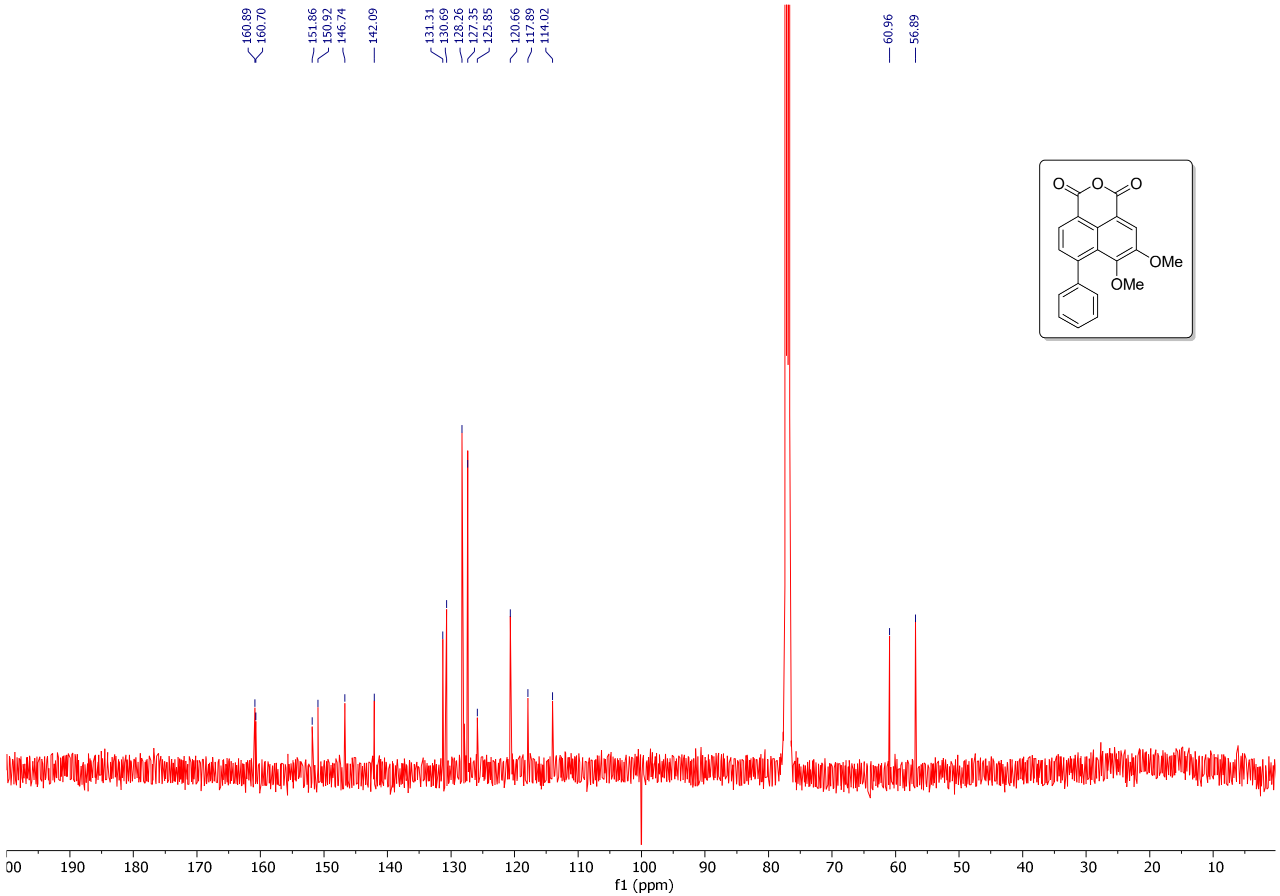


Figure S19. ^{13}C-NMR spectrum of 5,6-dimethoxy-7-phenyl-1H,3H-benzo[de]isochromene-1,3-dione (**1**) in $CDCl_3$.

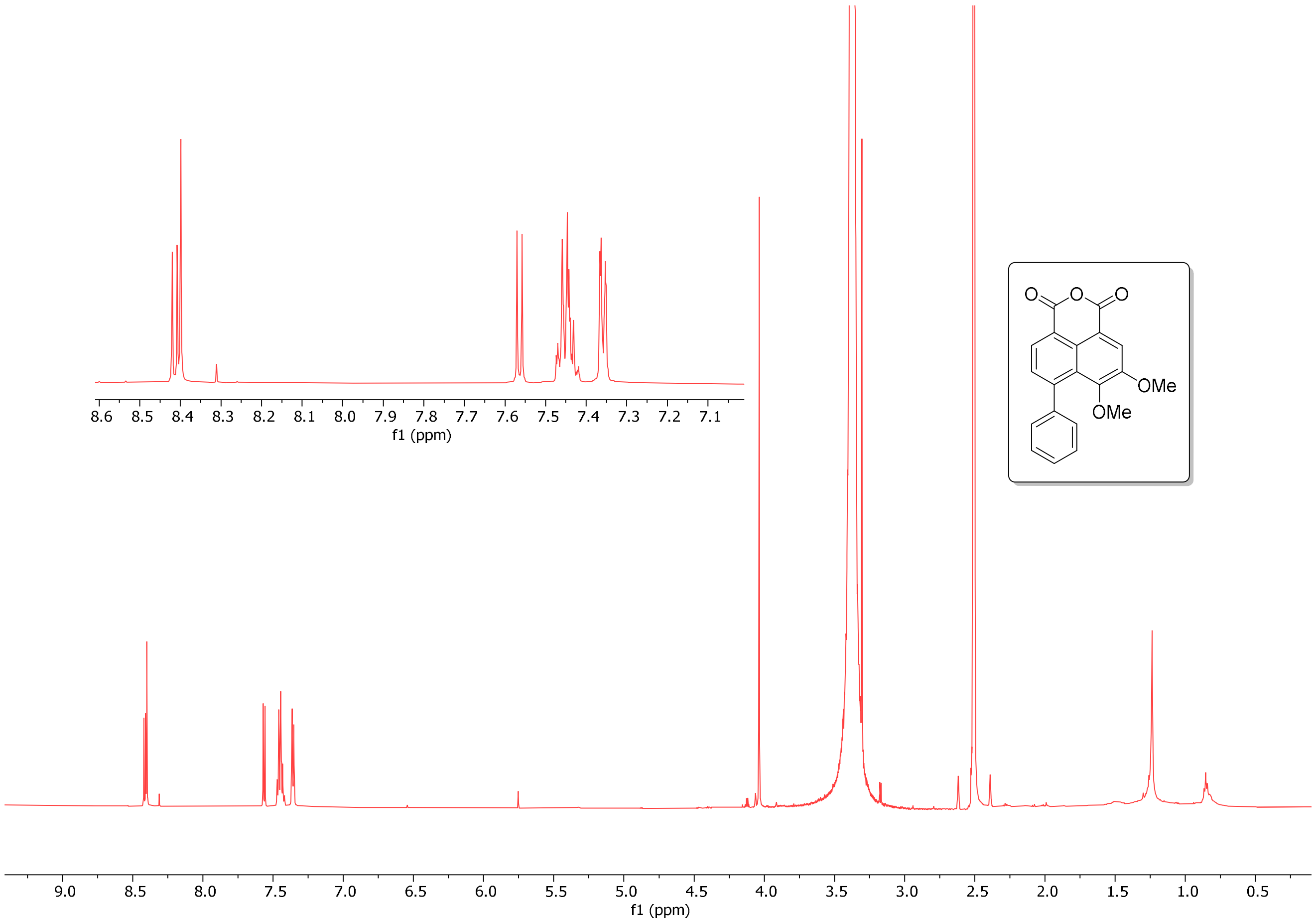


Figure S20. [1]H-NMR spectrum of 5,6-dimethoxy-7-phenyl-1H,3H-benzo[de]isochromene-1,3-dione (**1**) in DMSO-d[6].

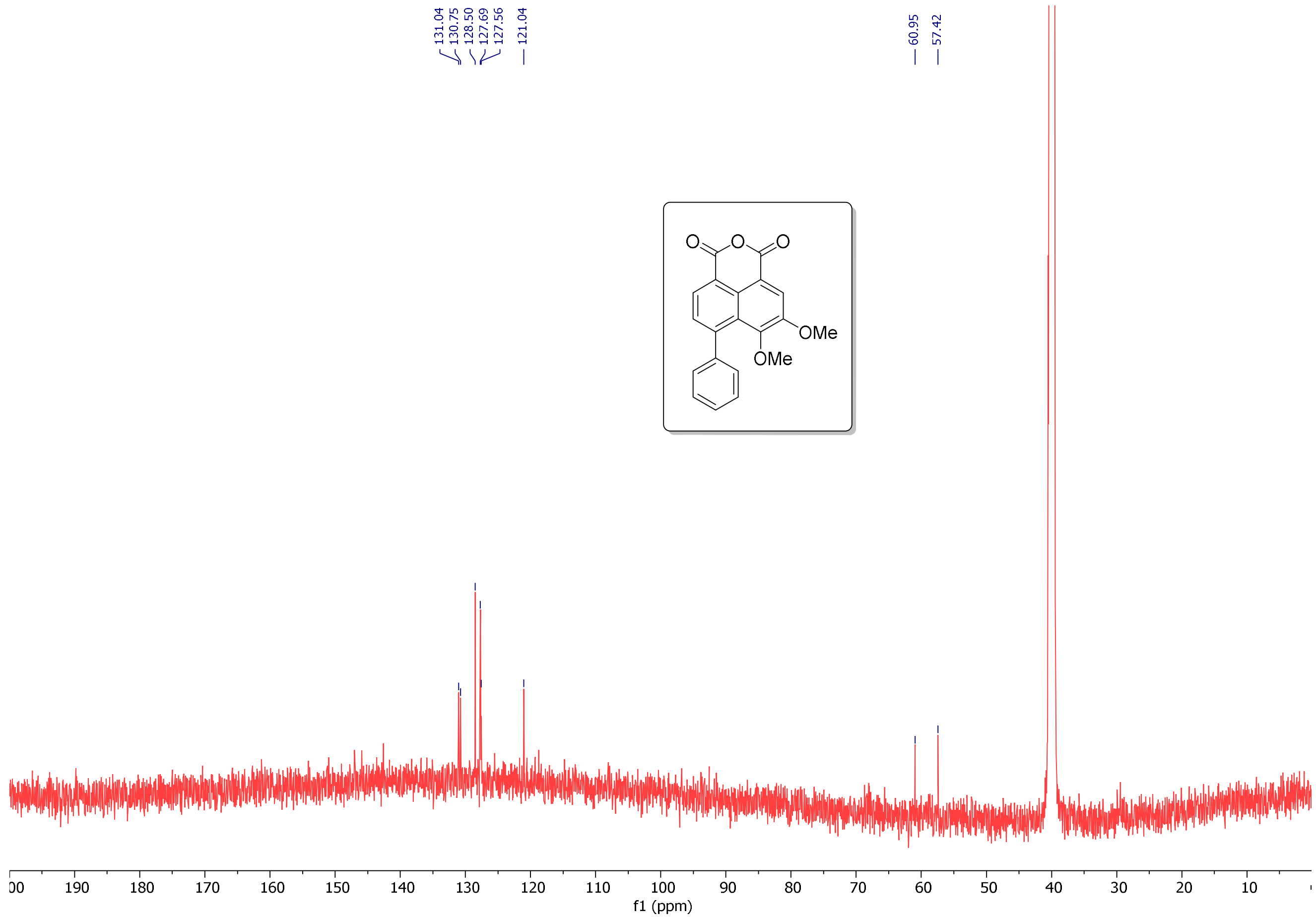


Figure S21. ^{13}C-NMR spectrum of 5,6-dimethoxy-7-phenyl-1H,3H-benzo[de]isochromene-1,3-dione (**1**) in DMSO-d^6.

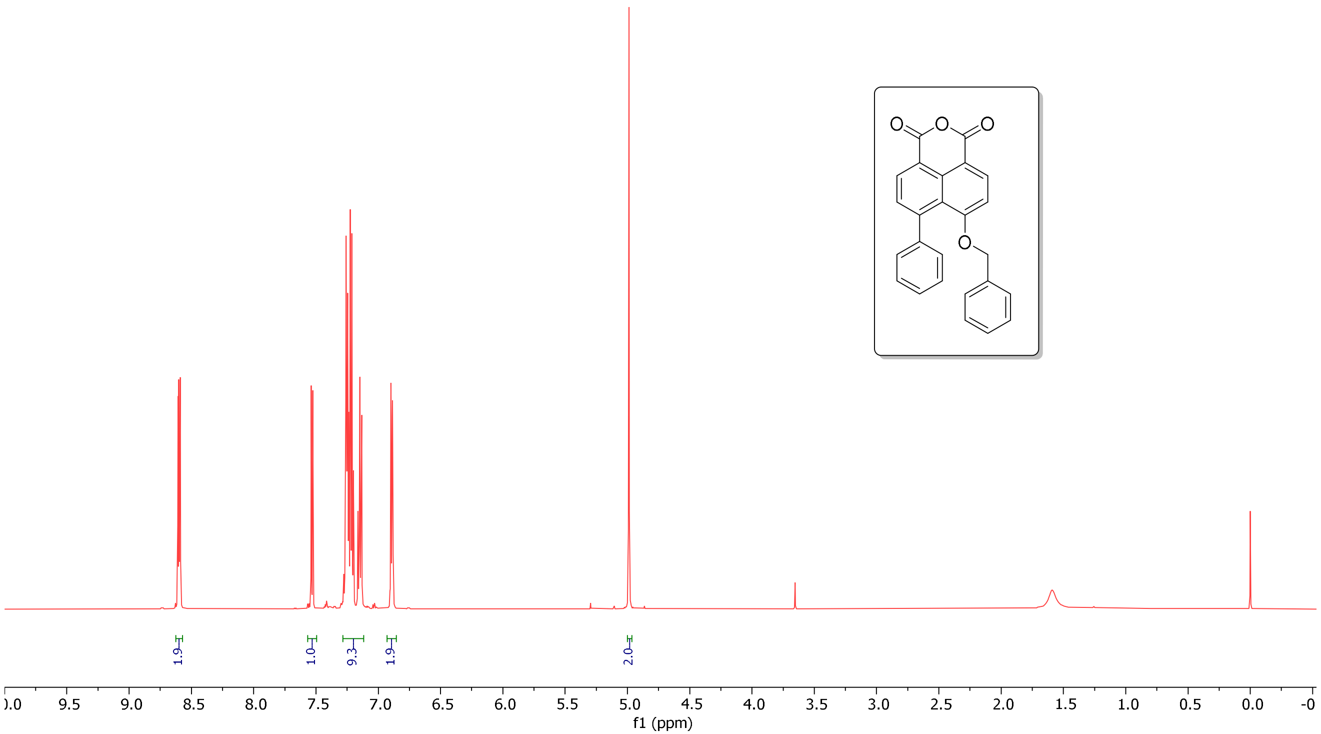


Figure S22. [1]H-NMR spectrum of 6-(benzyloxy)-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3a**) in $CDCl_3$.

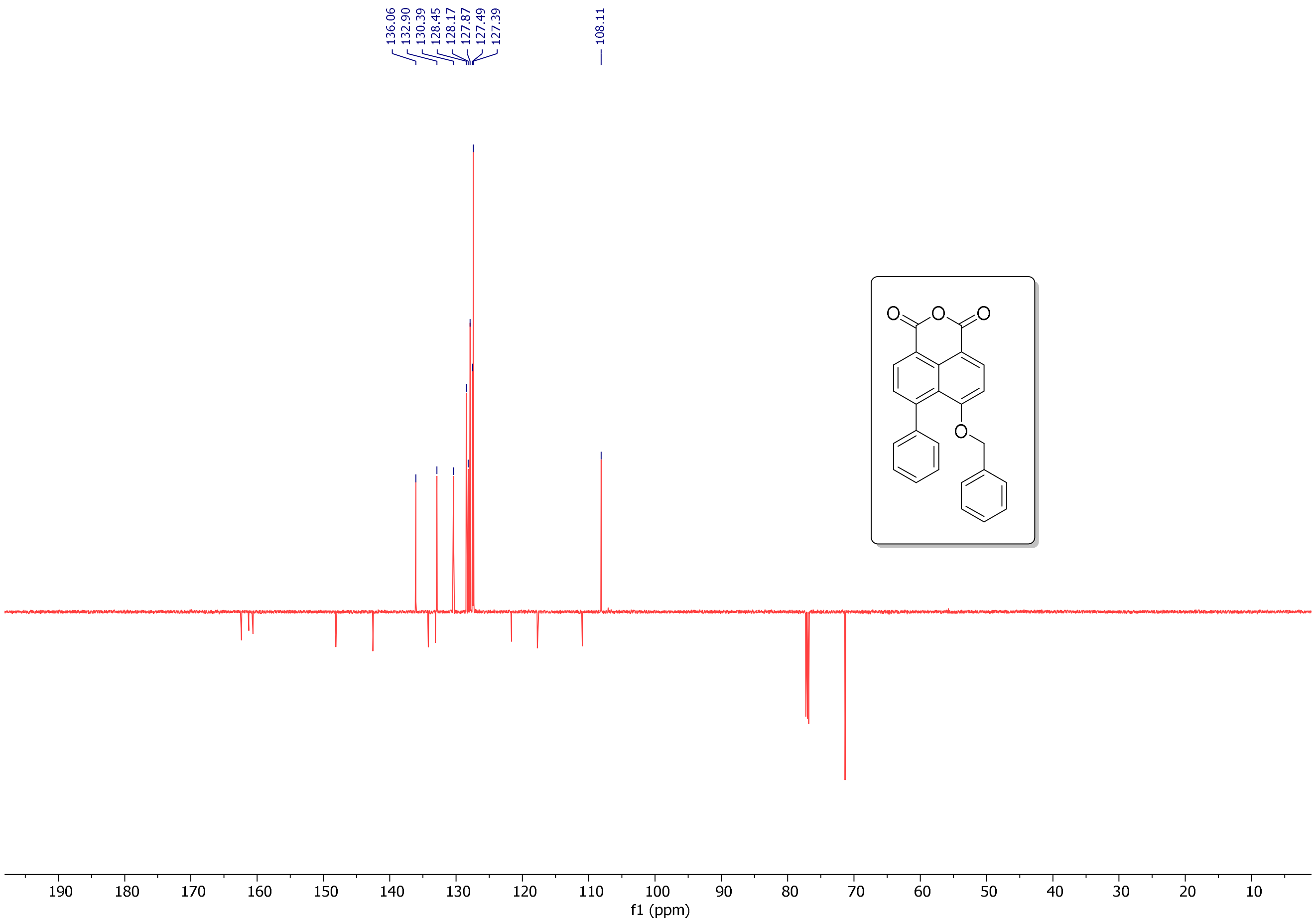


Figure S23. ^{13}C-NMR spectrum (Jmod) of 6-(benzyloxy)-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3a**) in $CDCl_3$.

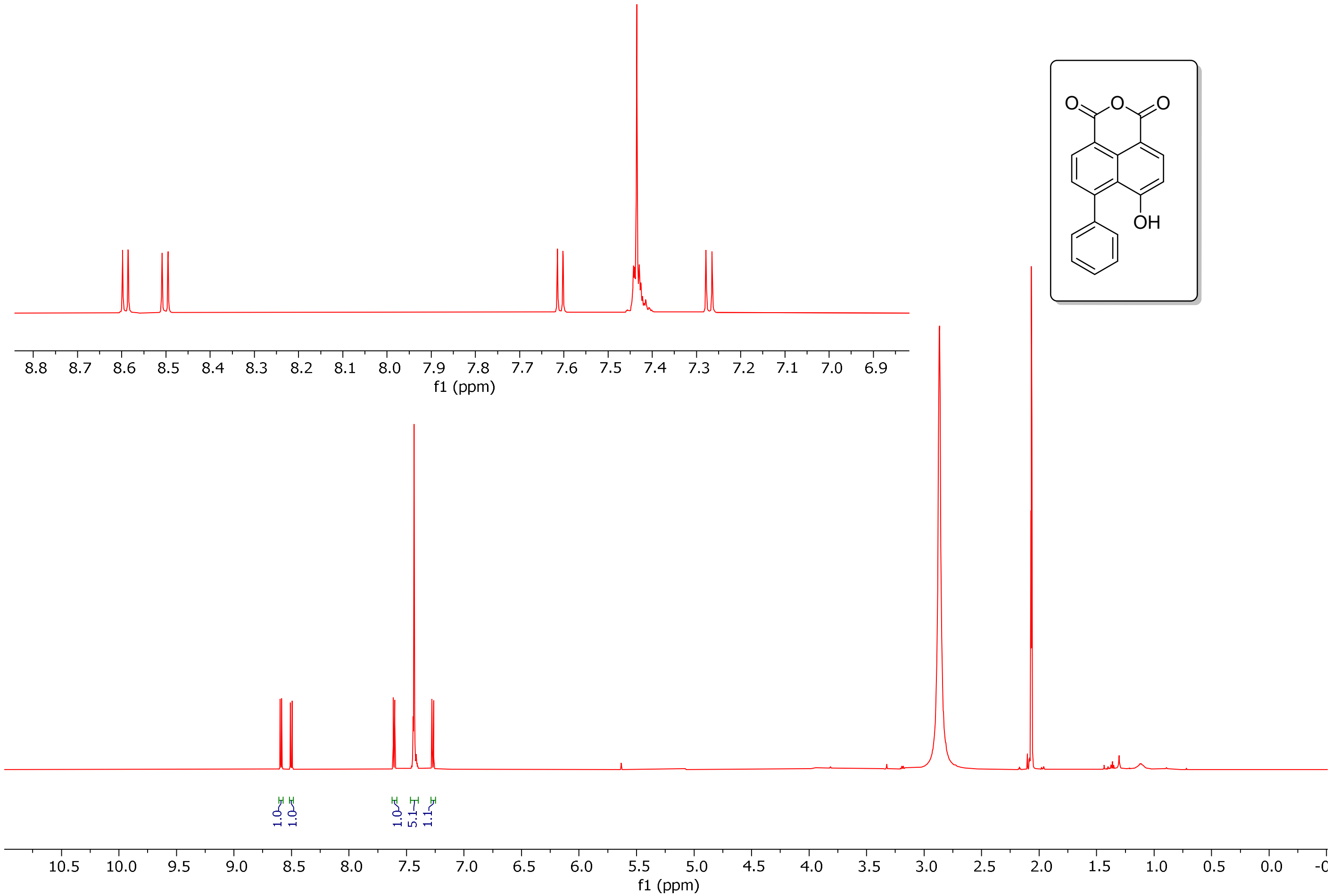


Figure S24. ^{1}H-NMR spectrum of 6-hydroxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2a**) in acetone-d^{6}.

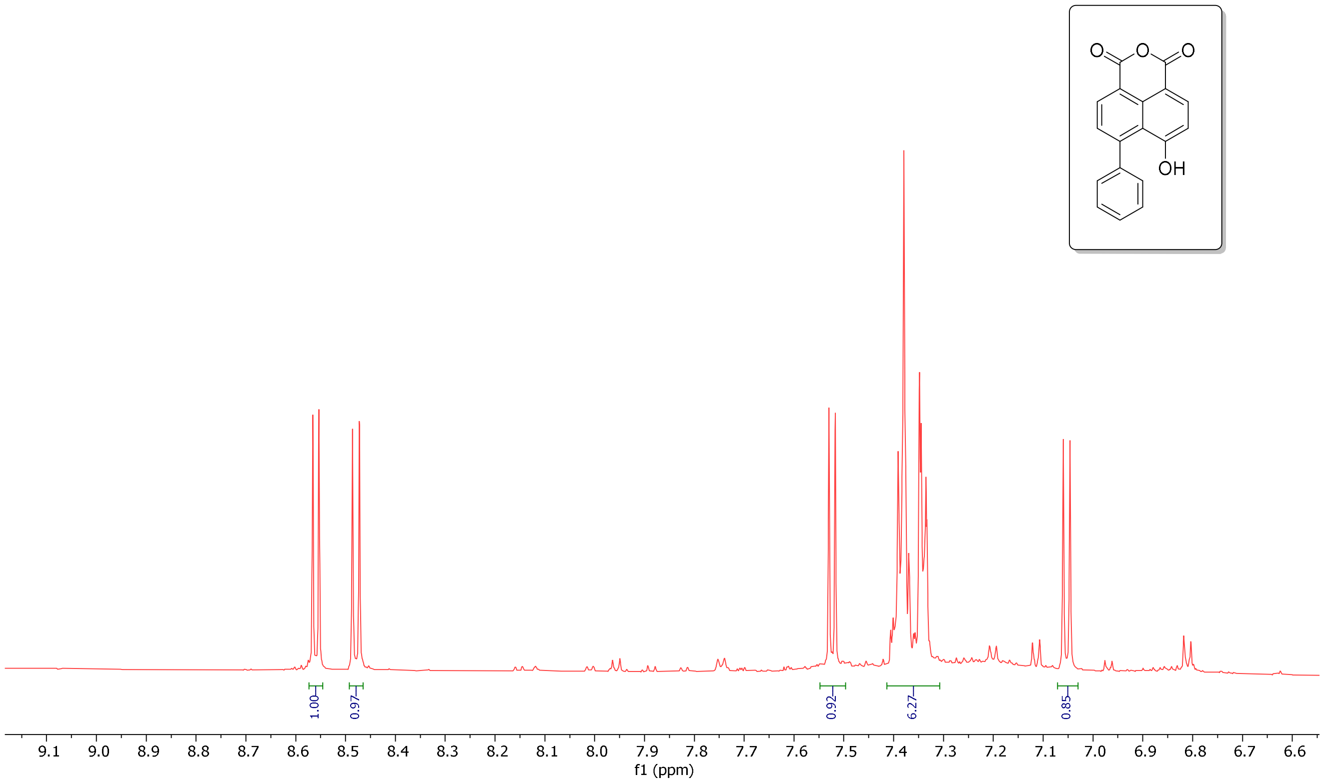


Figure S25. Section of the [1]H-NMR spectrum of 6-hydroxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2a**) in methanol-d[6].

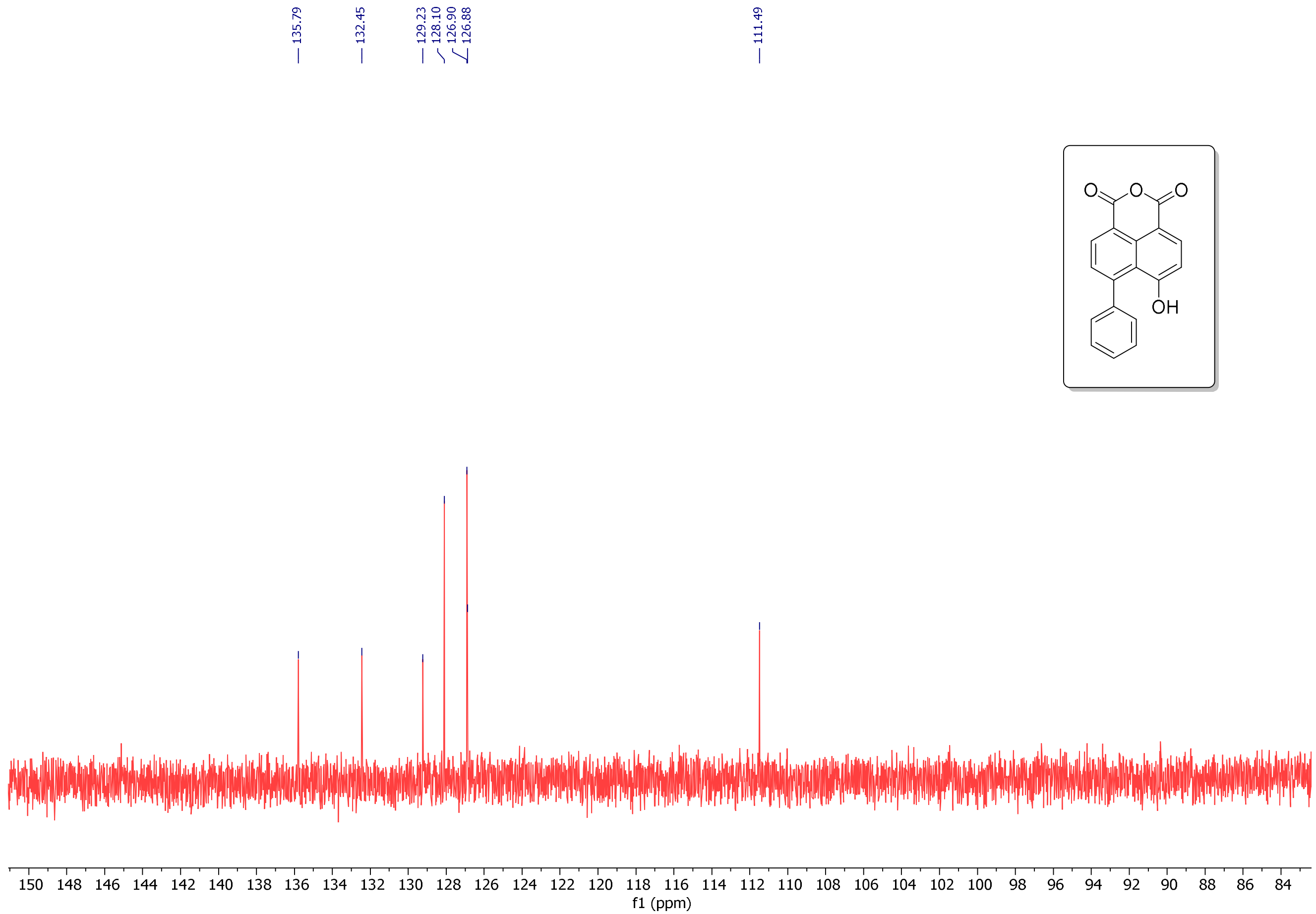


Figure S26. ^{13}C-NMR (DEPT) spectrum of 6-hydroxy-7-phenyl-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2a**) in methanol-d[6].

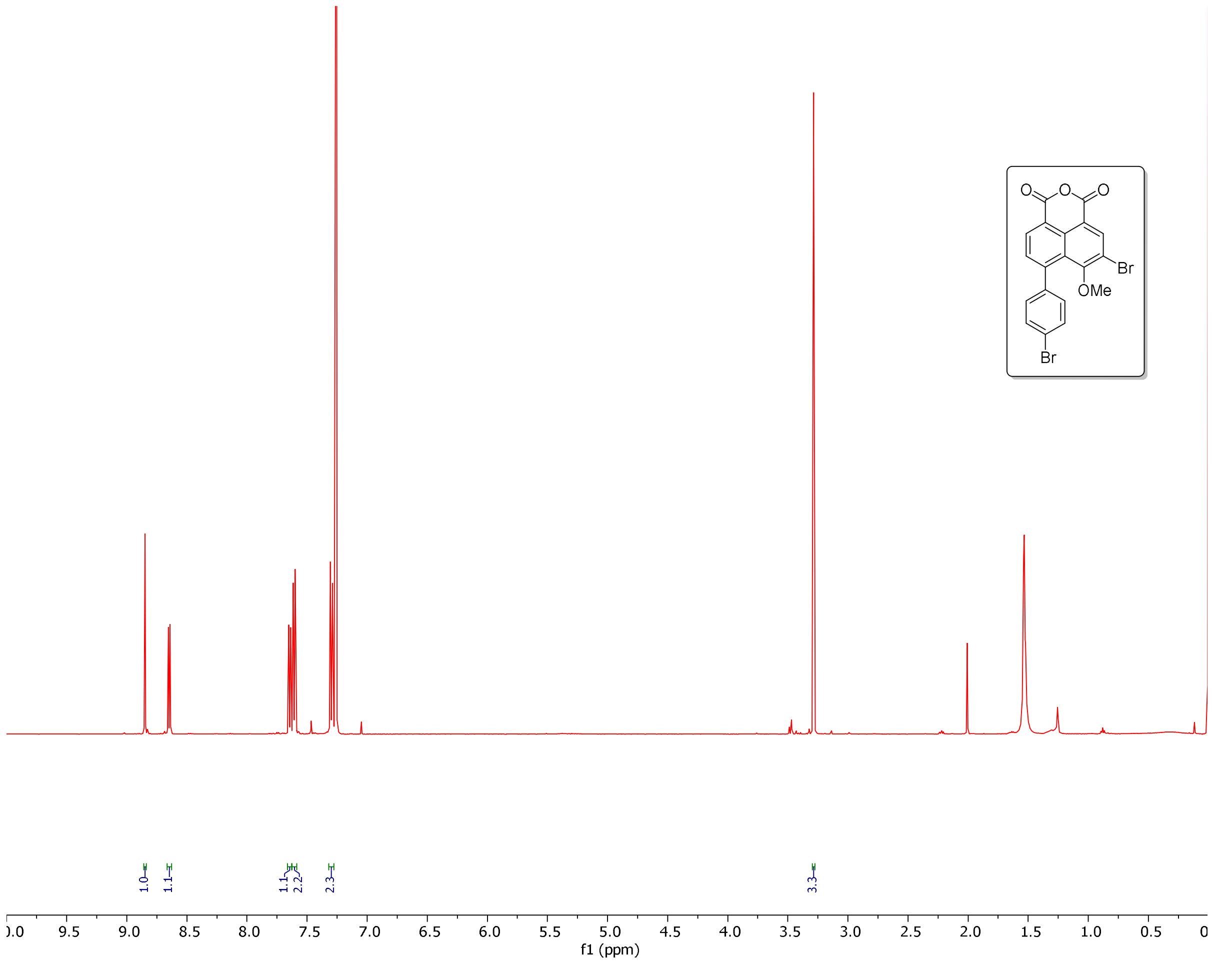


Figure S27. [1]H-NMR spectrum of 5-bromo-7-(4-bromophenyl)-6-methoxy-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3b**) in $CDCl_3$.

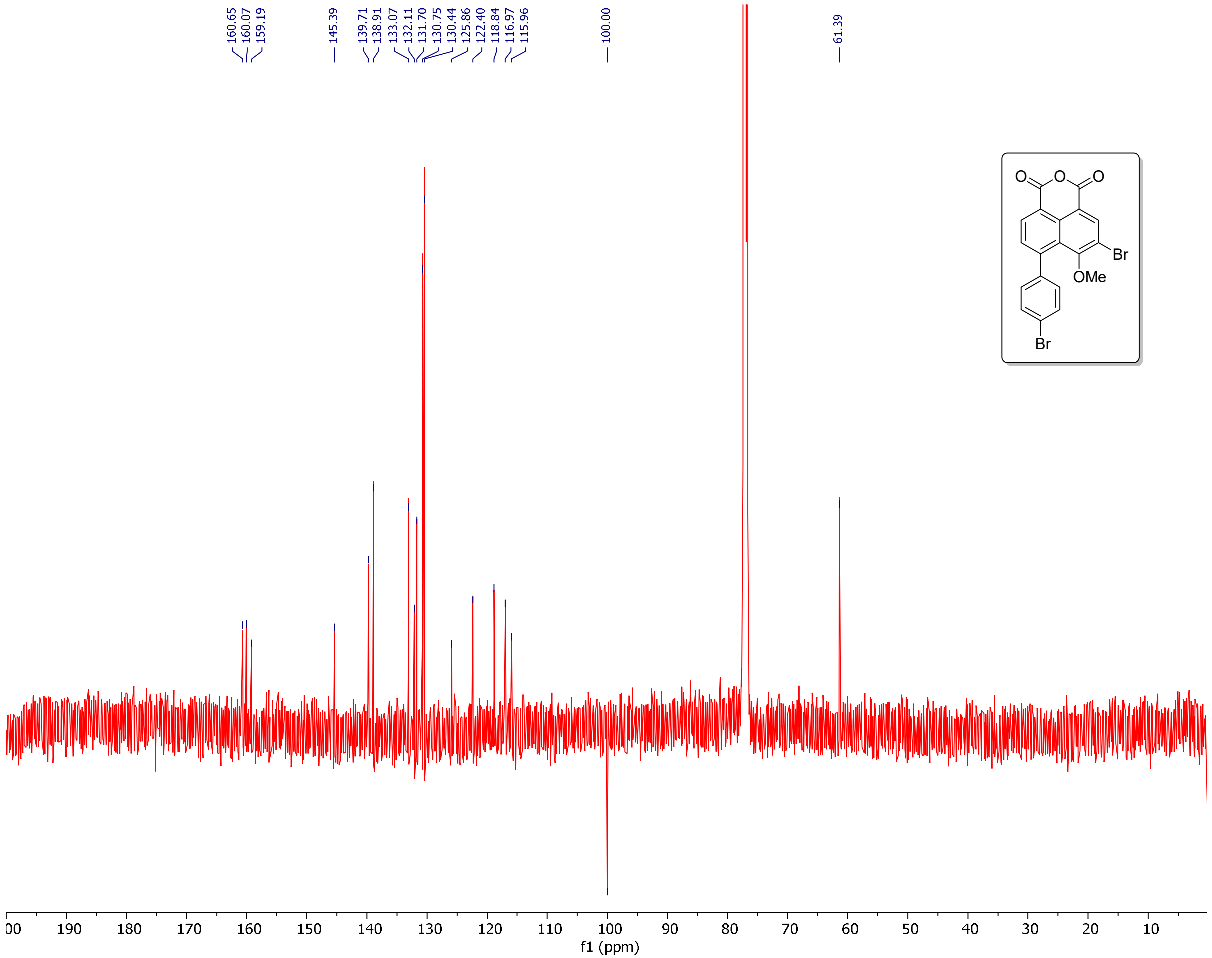


Figure S28. ^{13}C-NMR spectrum of 5-bromo-7-(4-bromophenyl)-6-methoxy-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**3b**) in $CDCl_3$.

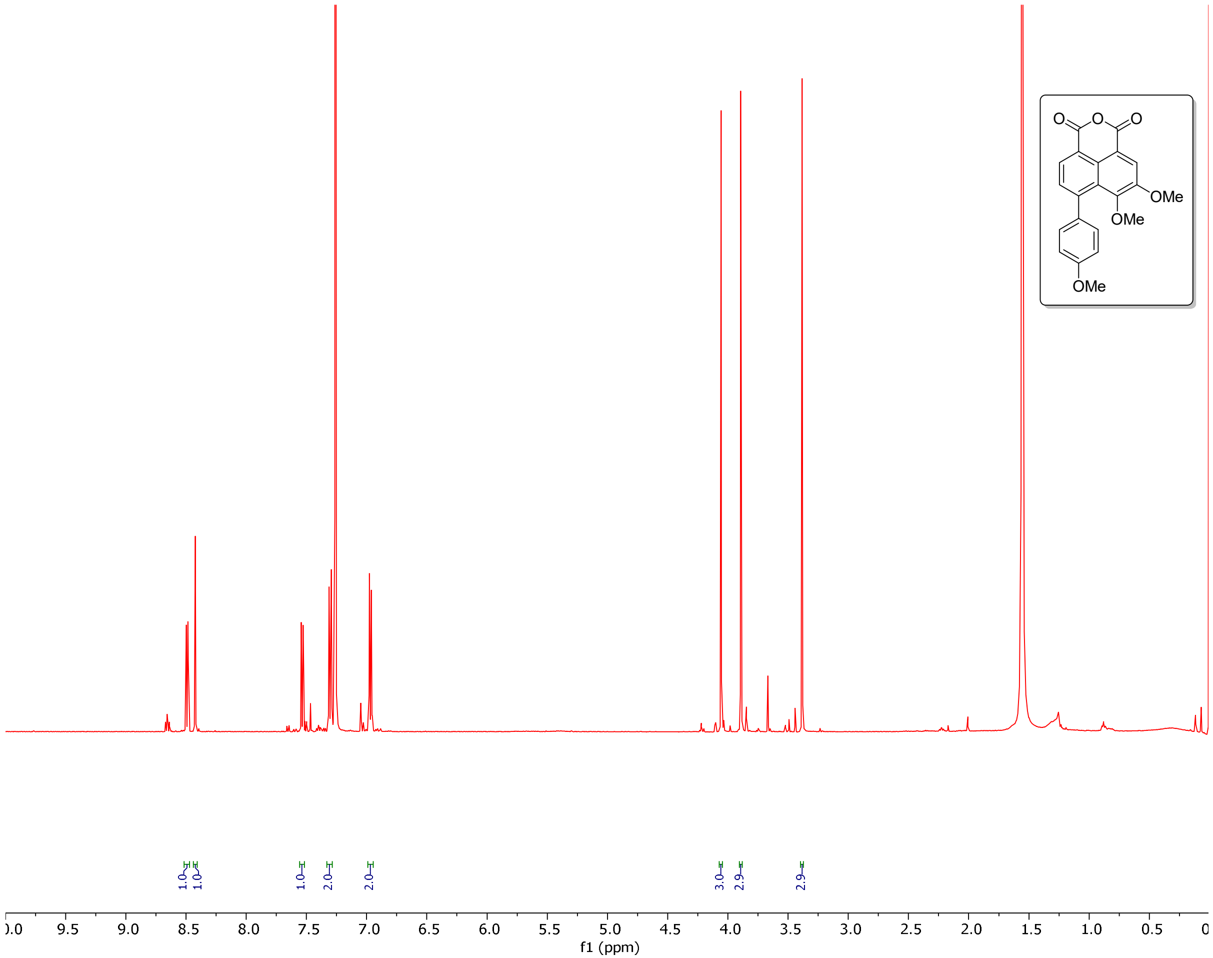


Figure S29. [1]H-NMR spectrum of 5,6-dimethoxy-7-(4-methoxyphenyl)-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2b**) in $CDCl_3$.

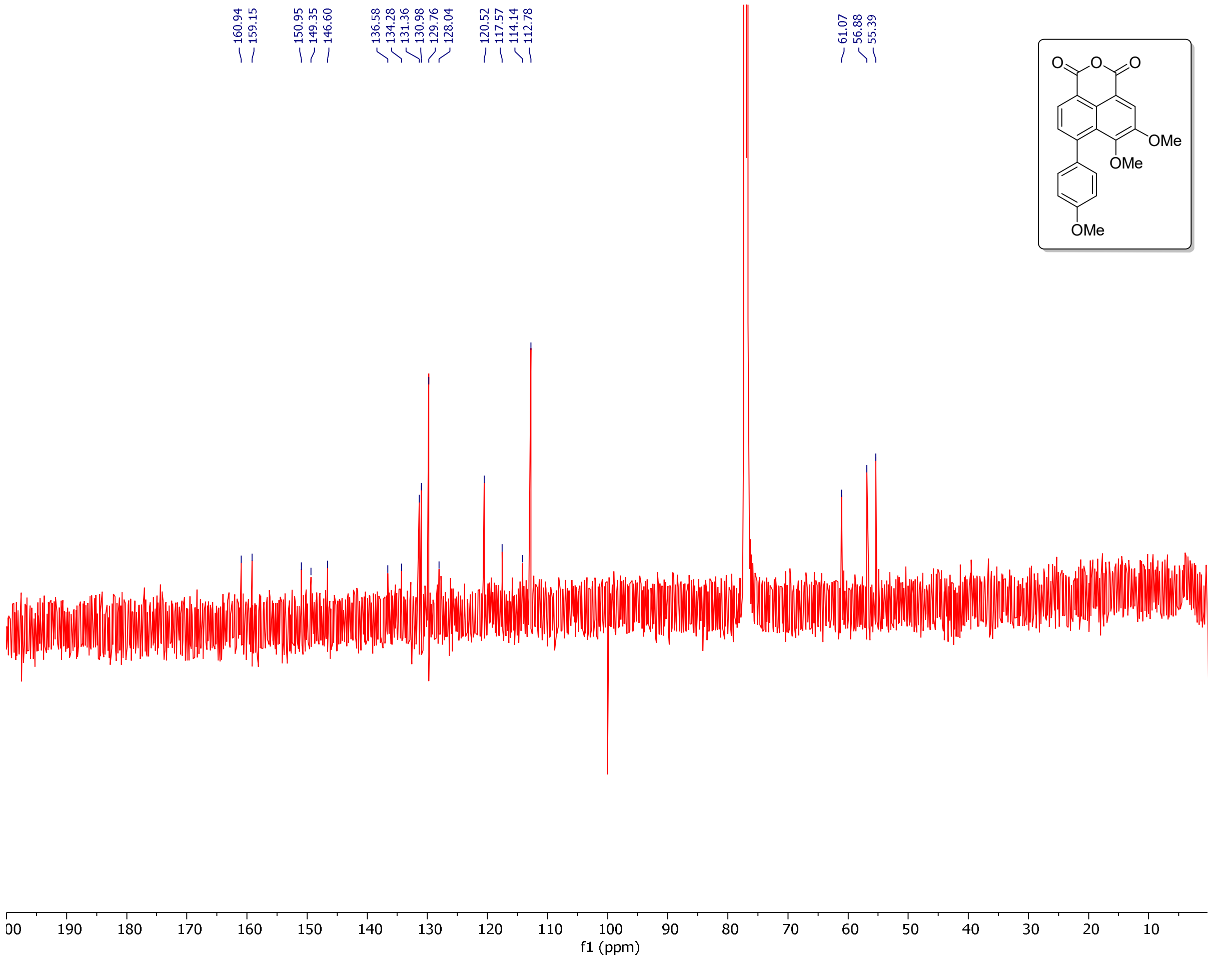


Figure S30. ^{13}C-NMR spectrum of 5,6-dimethoxy-7-(4-methoxyphenyl)-1*H*,3*H*-benzo[*de*]isochromene-1,3-dione (**2b**) in $CDCl_3$.