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Supplementary Materials

Article

Synthesis of a 5-carboxy Indole-based Spiropyran Fluorophore: Thermal, Electrochemical, Photophysical and Bovine Serum Albumin Interaction Investigations

Rodrigo da Costa Duarte [1], Fabiano da Silveira Santos [1], Bruno Bercini [2], Rodrigo Cercena [1], Daniela Brondani [3], Eduardo Zapp [3], Paulo Fernando Bruno Gonçalves [2], Fabiano Severo Rodembusch [2,*] and Alexandre Gonçalves Dal-Bó [1,*]

[1] Universidade do Extremo Sul Catarinense (UNESC), Criciúma, SC, Brazil; duarte.rodrigo01@gmail.com (R.da C.D.) ; fabianofss@gmail.com (F.da S.S.) ; rcercena@gmail.com (R.C.) ; adalbo@unesc.net (A.G.D.-B.)

[2] Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil; bruno.bercini@gmail.com (B.B.de A.); paulo@iq.ufrgs.br (P.F.B.G.) ; rodembusch@iq.ufrgs.br (F.S.R.)

[3] Universidade Federal de Santa Catarina (UFSC), Blumenau, SC, Brazil; daniela.brondani@ufsc.br (D.B.) ; eduardo.zapp@ufsc.br (E.Z.)

* Correspondence: adalbo@unesc.net ; rodembusch@iq.ufrgs.br

Summary

Synthesis…… 2

Spectroscopic characterization..... 3

Thermal characterization..... 7

Additional photophysics data..... 7

Theoretical calculations..... 8

Synthesis of compound 3

In a round-bottom flask, 4-hydrazinylbenzoic acid (**1**) (1.00 g, 6.57 mmol), 3-methylbutan-2-one (**2**) (2.80 g, 32.5 mmol), and 40 mL of glacial acetic acid was added, and the reaction was maintained under reflux for 12 h. After this period, the reaction mixture was concentrated under vacuum and dichloromethane (50 mL) was added to the flask. Then, this solution was treated with $NaHCO_3$ saturated solution (1 × 50 mL). The aqueous phase was extracted with dichloromethane (2 × 50 mL). The combined organic layers were dried ($MgSO_4$) and concentrated under vacuum. The product was obtained in 58% of yield and used in the next step without purification.

Red solid, yield 58%. ^{1}H NMR ($CDCl_3$, 300 MHz): δ (ppm) 10.54 (s, 1H, *J*=8.0 Hz); 8.16 (d, 1H, *J*=9.0 Hz); 8.09 (s, 1H); 7.70 (d, 1H, *J*=9.0 Hz); 2.41 (s, 3H); 1.38 (s, 6H). ^{13}C NMR ($CDCl_3$, 75 MHz) δ (ppm) 192.7; 171.0; 157.0; 145.5; 130.9; 127.5; 123.3; 119.7; 54.0; 23.0; 15.6.

Synthesis of compound 5

In a round-bottom flask, compound **3** (0.50 g, 2.46 mmol), iodomethane (1.74 g, 12.2 mmol), and acetonitrile (20 mL) was added, and the reaction was maintained under 56 °C for 12 h. After this

period, was added ethyl acetate (40 mL) and the mixture was cooled at room temperature and maintained under agitation for 30 min. Then, the resulting solid was filtered and dried under vacuum. The product was obtained in 65% of yield and used in the next step without purification.

Pink solid, yield 65%. ^{1}H NMR ($CDCl_3$, 400 MHz): δ (ppm) 8.36 (s, 1H); 8.17 (d, 1H, *J*=9.0 Hz); 8.03 (d, 1H, *J*=9.0 Hz); 4,01 (s, 3H) 2.84 (s, 3H); 1.57 (s, 6H). ^{13}C NMR ($CDCl_3$, 75 MHz) δ (ppm) 199.4; 166.9; 145.7; 142.3; 131.9; 130.7; 124.6; 115.8; 54.7; 35.6; 21.9; 15.2.

Spectroscopic characterization

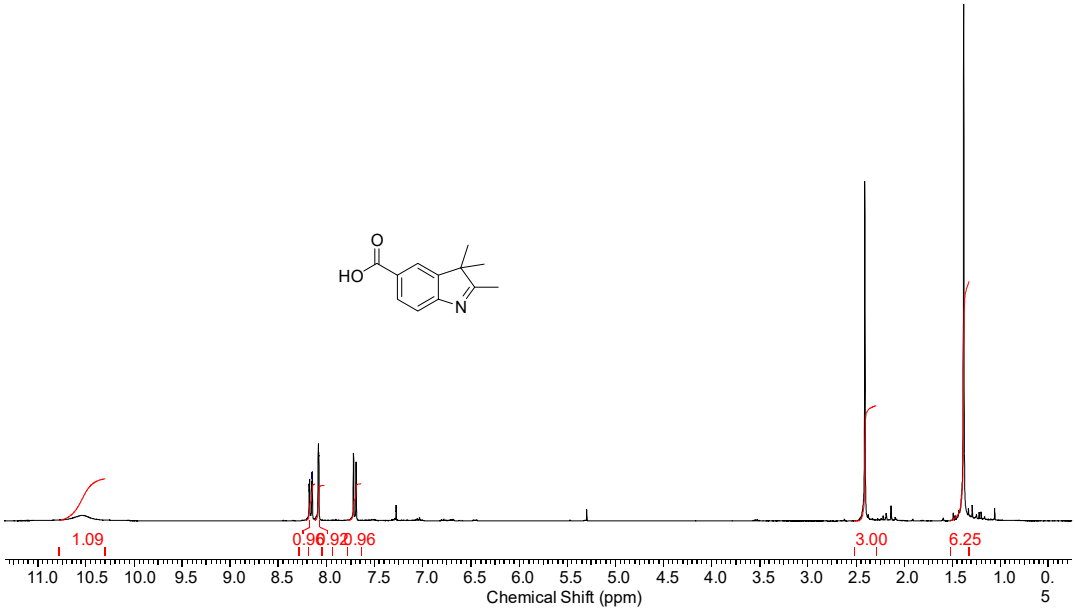


Figure S1. ^{1}H NMR spectrum of compound **3** in $CDCl_3$ (300 MHz).

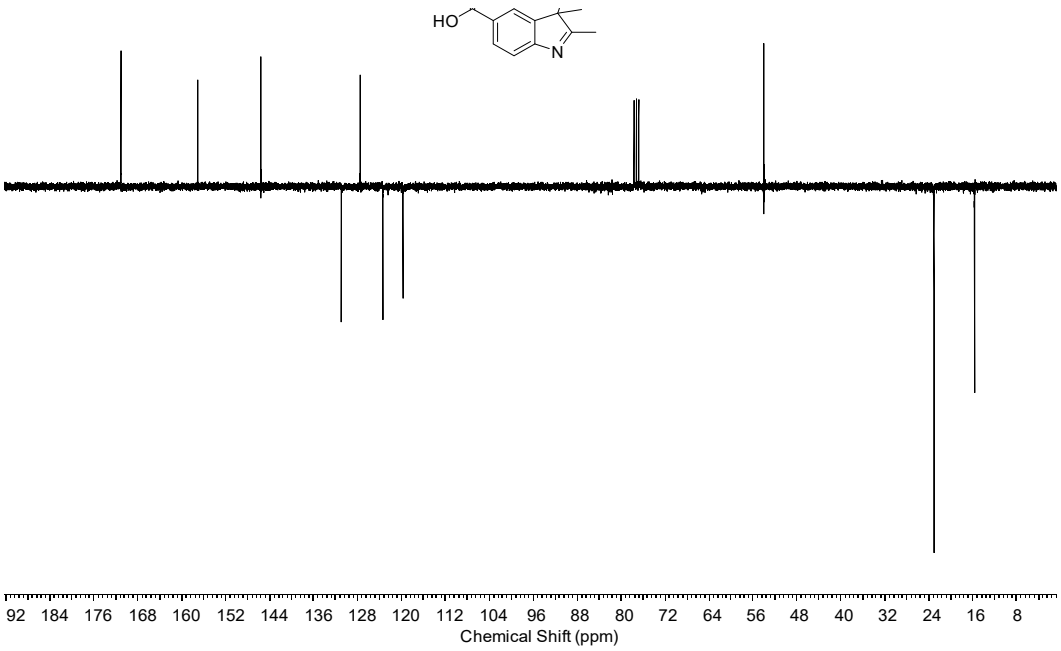


Figure S2. ^{13}C NMR spectrum of compound **3** in $CDCl_3$ (75 MHz).

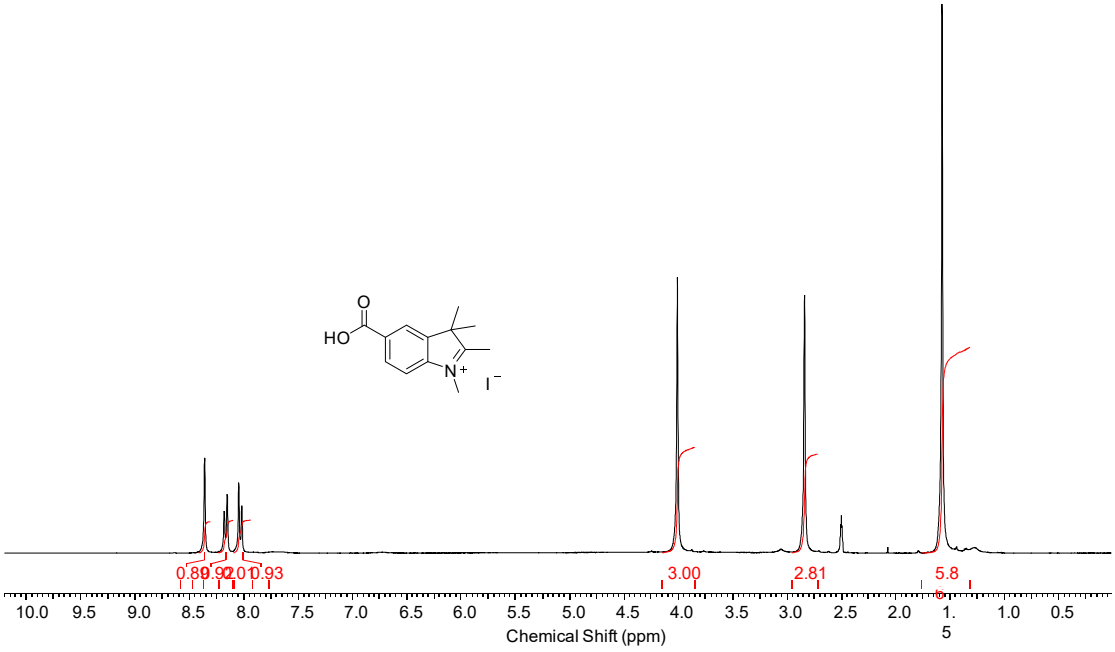
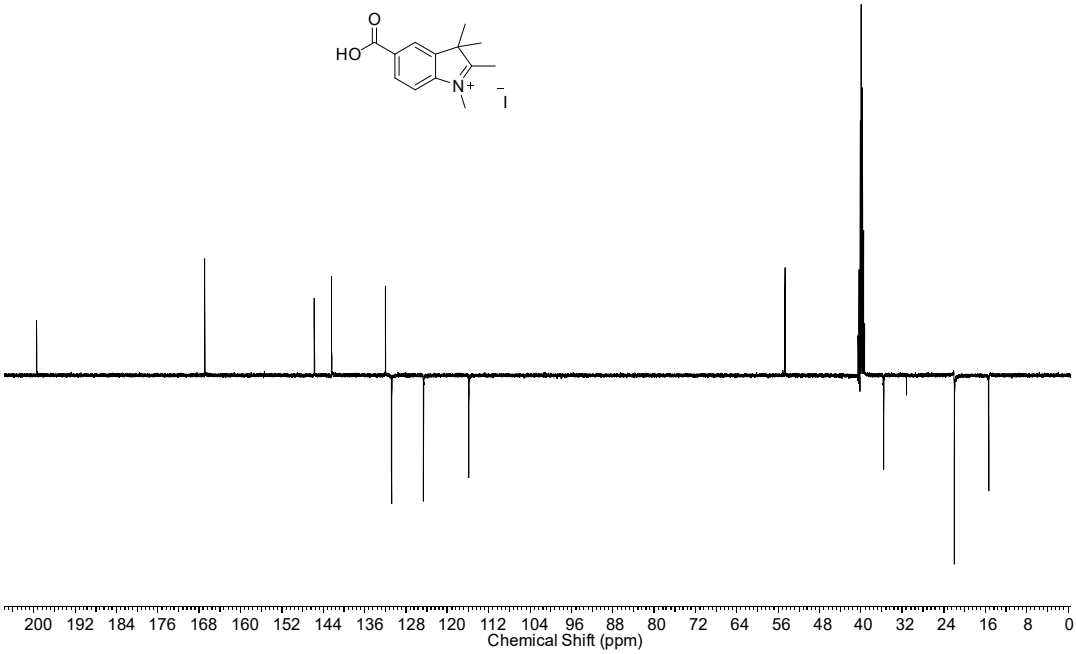


Figure S3. ^{1}H NMR spectrum of compound **5** in DMSO-d$_6$ (300 MHz).



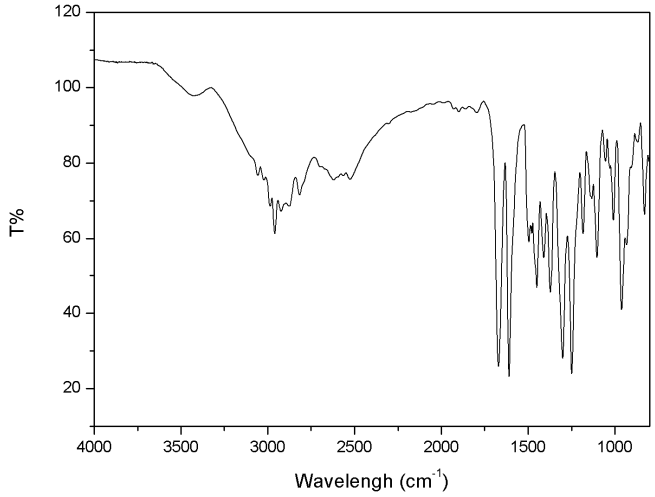


Figure S4. ^{13}C NMR spectrum of compound **5** in DMSO-d_6 (75 MHz).

FigureS5. FTIR spectrum of compound **7** in NaCl window.

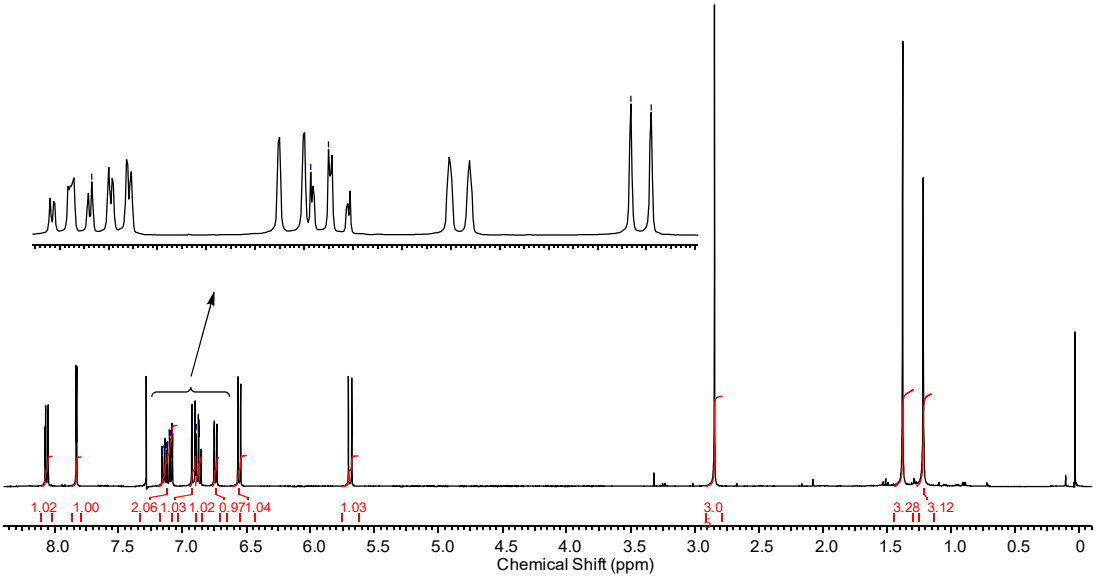


Figure S6. ^{1}H NMR spectrum of compound **7** in $CDCl_3$ (400 MHz).

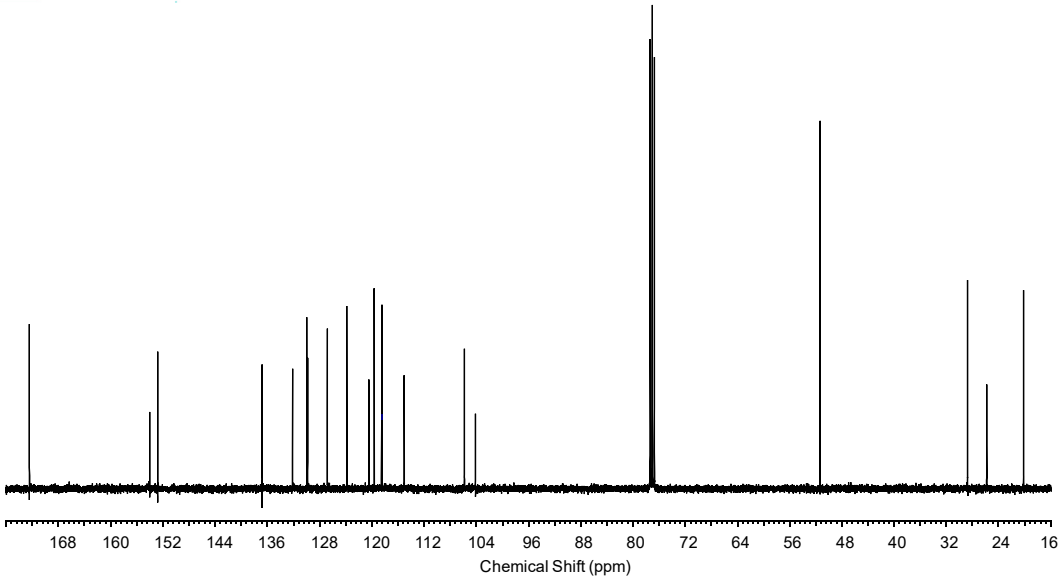


Figure S7. ^{13}C NMR spectrum of compound **7** in $CDCl_3$ (100 MHz).

Thermal characterization

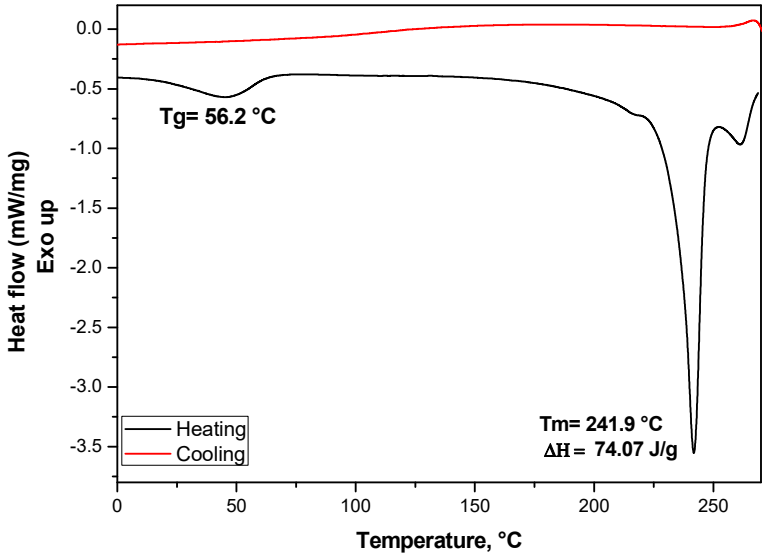


Figure S8. Differential Scanning Calorimetry (DSC) plots of compound **7** measured at 10 °C/min showing the glass transition temperature (T_g) and melting point temperature (T_m).

Additional photophysics data

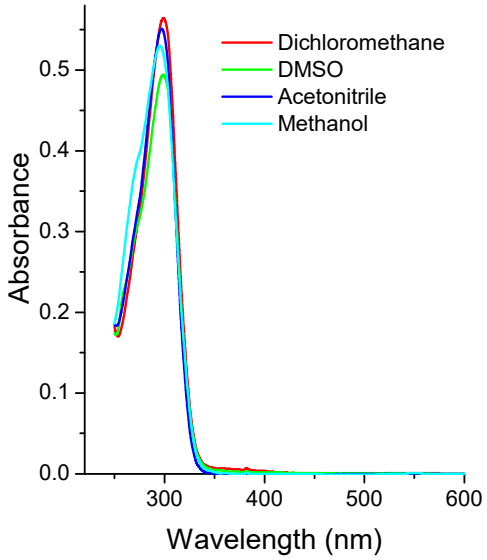


Figure S9. Full UV-Vis spectra in solution of compound **7** different organic solvents [ca. 10^{-5} M].

Theoretical calculations

Coordinates x, y, z of spiropyran in S_0:

Dichloromethane

C	-0.854881000	-0.122044000	0.052526000
C	-1.200964000	0.371343000	1.429248000
C	-2.457977000	0.689073000	1.772407000
C	-3.544980000	0.483116000	0.833263000
C	-4.867361000	0.882922000	1.065446000
C	-5.862289000	0.640704000	0.123616000
C	-5.538993000	-0.014719000	-1.067477000
C	-4.230039000	-0.419885000	-1.319870000
C	-3.239132000	-0.167973000	-0.372816000
O	-1.986883000	-0.624836000	-0.642081000
H	-3.959395000	-0.933300000	-2.243856000
H	-6.313052000	-0.211056000	-1.812123000
H	-6.888529000	0.957979000	0.315817000
H	-5.105795000	1.389788000	2.003817000
H	-2.681612000	1.115755000	2.753351000
H	-0.363532000	0.548455000	2.106747000
N	-0.239118000	0.974642000	-0.710926000
C	1.129433000	0.912012000	-0.540553000
C	1.504573000	-0.362413000	-0.073460000
C	0.265028000	-1.226977000	0.022304000
C	0.221933000	-2.155444000	1.229975000
H	-0.757409000	-2.653978000	1.295247000
H	0.988010000	-2.939110000	1.129585000
H	0.405128000	-1.626623000	2.175548000
C	0.156582000	-2.055309000	-1.267878000

H	-0.750370000	-2.675724000	-1.262722000
H	0.129195000	-1.411809000	-2.158742000
H	1.033807000	-2.714893000	-1.342805000
C	2.832264000	-0.655309000	0.150546000
C	3.807740000	0.334212000	-0.082361000
C	3.420888000	1.599519000	-0.545005000
C	2.082181000	1.905443000	-0.776919000
H	1.787844000	2.895602000	-1.128858000
H	4.184417000	2.358426000	-0.717878000
C	5.216614000	-0.006052000	0.180644000
O	6.067478000	1.004171000	-0.077258000
H	6.954399000	0.665264000	0.129389000
O	5.606442000	-1.083298000	0.589678000
H	3.153118000	-1.633835000	0.512944000
H	-0.682410000	1.884975000	-0.623510000

Acetonitrile

C	-0.854780000	-0.118964000	0.053896000
C	-1.203747000	0.370829000	1.431055000
C	-2.461612000	0.685596000	1.773764000
C	-3.547353000	0.480236000	0.832898000
C	-4.870799000	0.876734000	1.065276000
C	-5.864549000	0.635533000	0.121622000
C	-5.539061000	-0.015521000	-1.071379000
C	-4.228851000	-0.417273000	-1.323906000
C	-3.239277000	-0.166287000	-0.375082000
O	-1.985655000	-0.619696000	-0.644952000
H	-3.956962000	-0.927192000	-2.249532000
H	-6.312035000	-0.211037000	-1.817367000
H	-6.891547000	0.950311000	0.313957000
H	-5.110927000	1.380307000	2.004952000
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C	1.130567000	0.914956000	-0.536276000
C	1.504992000	-0.361083000	-0.072503000
C	0.264787000	-1.224728000	0.023103000
C	0.221701000	-2.153489000	1.230620000
H	-0.757400000	-2.652606000	1.295350000
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H	0.404244000	-1.624612000	2.176268000
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H	0.129859000	-1.410375000	-2.158404000
H	1.032933000	-2.713748000	-1.341043000
C	2.832664000	-0.655971000	0.149135000
C	3.809209000	0.333167000	-0.082353000
C	3.422779000	1.600351000	-0.541159000
C	2.084227000	1.908321000	-0.770879000
H	1.790196000	2.899818000	-1.119093000
H	4.186316000	2.359595000	-0.712638000
C	5.218094000	-0.008666000	0.177851000
O	6.068961000	1.001077000	-0.077729000
H	6.957069000	0.663347000	0.126504000

O	5.607240000	-1.088234000	0.583177000
H	3.151827000	-1.636116000	0.508652000
H	-0.679935000	1.890237000	-0.617576000

Methanol

C	-0.854783000	-0.119059000	0.053841000
C	-1.203649000	0.370867000	1.430982000
C	-2.461484000	0.685733000	1.773710000
C	-3.547272000	0.480340000	0.832910000
C	-4.870683000	0.876943000	1.065287000
C	-5.864477000	0.635694000	0.121702000
C	-5.539065000	-0.015512000	-1.071232000
C	-4.228897000	-0.417372000	-1.323761000
C	-3.239274000	-0.166342000	-0.375004000
O	-1.985697000	-0.619860000	-0.644861000
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H	-6.891451000	0.950550000	0.314038000
H	-5.110752000	1.380630000	2.004918000
H	-2.686660000	1.110108000	2.755240000
H	-0.367500000	0.548389000	2.109938000
N	-0.237558000	0.979272000	-0.705866000
C	1.130534000	0.914856000	-0.536432000
C	1.504977000	-0.361126000	-0.072536000
C	0.264792000	-1.224798000	0.023074000
C	0.221697000	-2.153546000	1.230598000
H	-0.757414000	-2.652639000	1.295343000
H	0.988045000	-2.936909000	1.130142000
H	0.404261000	-1.624671000	2.176243000
C	0.156321000	-2.053325000	-1.267011000
H	-0.750819000	-2.673478000	-1.262081000
H	0.129845000	-1.410417000	-2.158417000
H	1.032958000	-2.713785000	-1.341099000
C	2.832648000	-0.655949000	0.149190000
C	3.809161000	0.333197000	-0.082350000
C	3.422723000	1.600315000	-0.541298000
C	2.084167000	1.908218000	-0.771099000
H	1.790130000	2.899668000	-1.119450000
H	4.186262000	2.359543000	-0.712829000
C	5.218043000	-0.008585000	0.177957000
O	6.068915000	1.001167000	-0.077711000
H	6.956983000	0.663398000	0.126607000
O	5.607209000	-1.088071000	0.583423000
H	3.151862000	-1.636038000	0.508812000
H	-0.680009000	1.890065000	-0.617802000

Coordinates x, y, z of spiropyran in S_1:

Dichloromethane

C	-0.900484000	-0.567209000	0.238453000
C	-1.269752000	-0.494573000	1.664598000
C	-2.517610000	0.074530000	1.950044000
C	-3.452692000	0.314354000	0.918454000

C	-4.712506000	0.971904000	1.060252000
C	-5.576097000	1.123088000	-0.013139000
C	-5.242785000	0.638037000	-1.288451000
C	-4.005412000	-0.012275000	-1.462790000
C	-3.150851000	-0.172214000	-0.391500000
O	-1.979547000	-0.889083000	-0.599471000
H	-3.707275000	-0.414072000	-2.434081000
H	-5.924033000	0.758119000	-2.131563000
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H	-4.991559000	1.351698000	2.047002000
H	-2.793906000	0.308941000	2.981563000
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H	1.384367000	-3.255220000	0.471626000
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H	0.064561000	-1.144237000	-2.283317000
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C	3.653399000	0.516594000	-0.058146000
C	3.118526000	1.818089000	-0.254551000
C	1.762190000	2.016558000	-0.347326000
H	1.333593000	3.009900000	-0.477420000
H	3.802114000	2.663031000	-0.320836000
C	5.118589000	0.294254000	0.051550000
O	5.823261000	1.425756000	-0.047025000
H	6.761298000	1.183598000	0.037171000
O	5.622485000	-0.795994000	0.214519000
H	3.282615000	-1.590903000	0.177802000
H	-1.003371000	1.623744000	-0.235970000

Acetonitrile

C	-0.897330000	-0.550072000	0.238167000
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C	-4.724976000	0.972040000	1.051238000
C	-5.592227000	1.103539000	-0.021995000
C	-5.256252000	0.607539000	-1.292832000
C	-4.013151000	-0.033117000	-1.462693000
C	-3.154422000	-0.173578000	-0.391545000
O	-1.979050000	-0.883585000	-0.594161000
H	-3.713003000	-0.441322000	-2.430750000
H	-5.939540000	0.713132000	-2.136339000
H	-6.554107000	1.601996000	0.126574000
H	-5.004884000	1.361305000	2.034113000
H	-2.793509000	0.354878000	2.974698000
H	-0.486169000	-0.551726000	2.415659000

N	-0.386921000	0.815176000	-0.224573000
C	0.934145000	0.875174000	-0.252664000
C	1.464539000	-0.448678000	-0.075719000
C	0.343029000	-1.449335000	-0.108771000
C	0.534117000	-2.620153000	0.849017000
H	-0.369117000	-3.246454000	0.860899000
H	1.374543000	-3.245059000	0.511366000
H	0.741259000	-2.291994000	1.875578000
C	0.228452000	-1.977598000	-1.552828000
H	-0.614739000	-2.676940000	-1.630855000
H	0.067716000	-1.164087000	-2.274003000
H	1.155194000	-2.505085000	-1.820711000
C	2.826034000	-0.615137000	0.036361000
C	3.660134000	0.510885000	-0.062583000
C	3.129048000	1.812979000	-0.263978000
C	1.772564000	2.015176000	-0.355418000
H	1.347070000	3.009257000	-0.489321000
H	3.814322000	2.656096000	-0.335036000
C	5.124443000	0.284560000	0.046790000
O	5.832828000	1.412268000	-0.061329000
H	6.770707000	1.168927000	0.022840000
O	5.625489000	-0.806698000	0.217503000
H	3.281521000	-1.594260000	0.185894000
H	-0.993383000	1.632238000	-0.242317000

Methanol

C	-0.897436000	-0.550669000	0.238179000
C	-1.267802000	-0.457356000	1.664618000
C	-2.519418000	0.105427000	1.945920000
C	-3.458983000	0.324300000	0.913856000
C	-4.724542000	0.972033000	1.051549000
C	-5.591663000	1.104231000	-0.021698000
C	-5.255780000	0.608621000	-1.292695000
C	-4.012876000	-0.032374000	-1.462709000
C	-3.154298000	-0.173526000	-0.391547000
O	-1.979064000	-0.883771000	-0.594353000
H	-3.712793000	-0.440350000	-2.430880000
H	-5.938996000	0.714727000	-2.136193000
H	-6.553403000	1.602917000	0.127009000
H	-5.004425000	1.360962000	2.034562000
H	-2.793538000	0.353227000	2.974952000
H	-0.486387000	-0.553874000	2.415701000
N	-0.387122000	0.814986000	-0.224318000
C	0.933837000	0.875117000	-0.252447000
C	1.464421000	-0.448754000	-0.075797000
C	0.343064000	-1.449548000	-0.109219000
C	0.534449000	-2.620771000	0.848016000
H	-0.368715000	-3.247159000	0.859777000
H	1.374912000	-3.245415000	0.509966000
H	0.741683000	-2.293045000	1.874695000
C	0.228475000	-1.977189000	-1.553509000
H	-0.614704000	-2.676512000	-1.631772000
H	0.067611000	-1.163395000	-2.274336000
H	1.155231000	-2.504510000	-1.821676000

C	2.825933000	-0.615052000	0.036272000
C	3.659893000	0.511092000	-0.062426000
C	3.128669000	1.813168000	-0.263612000
C	1.772189000	2.015232000	-0.355091000
H	1.346583000	3.009291000	-0.488831000
H	3.813879000	2.656355000	-0.334486000
C	5.124240000	0.284908000	0.046939000
O	5.832490000	1.412750000	-0.060842000
H	6.770380000	1.169463000	0.023317000
O	5.625385000	-0.806317000	0.217364000
H	3.281568000	-1.594142000	0.185579000
H	-0.993750000	1.631915000	-0.242101000

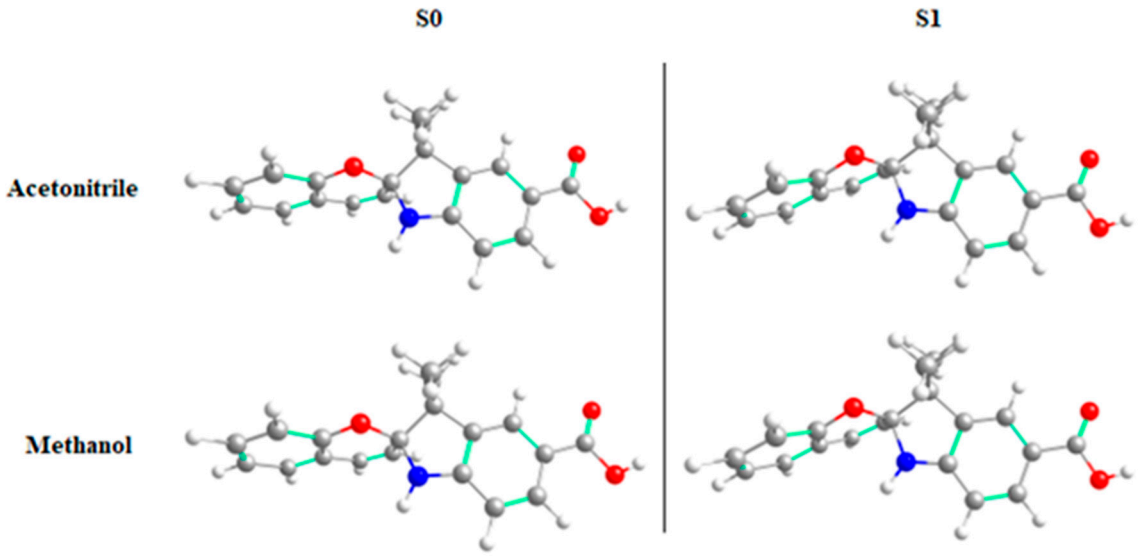

Figure S10. Geometries of spiropyran in acetonitrile and methanol.

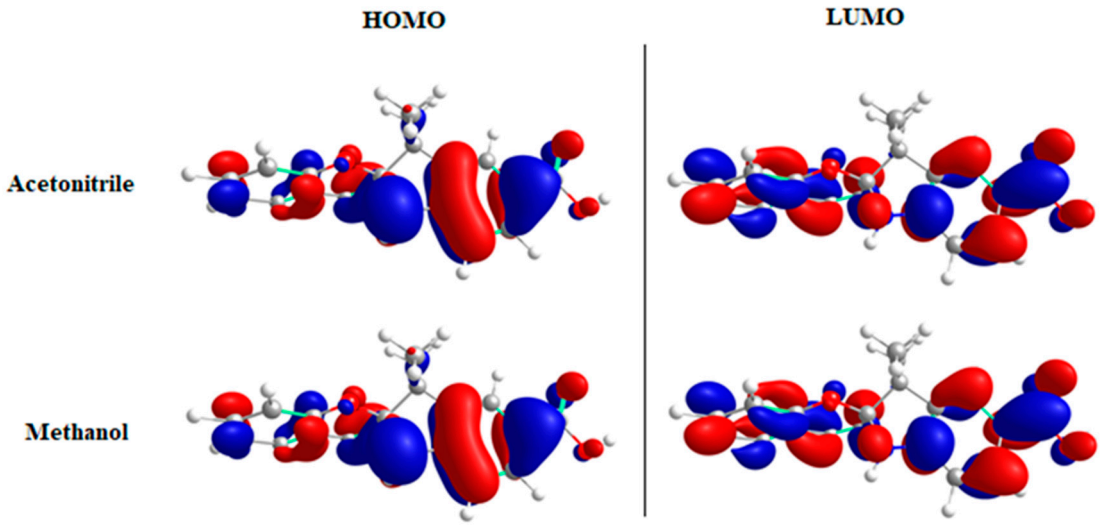

Figure S11. HOMO and LUMO orbitals in acetonitrile and methanol.