Supporting Information

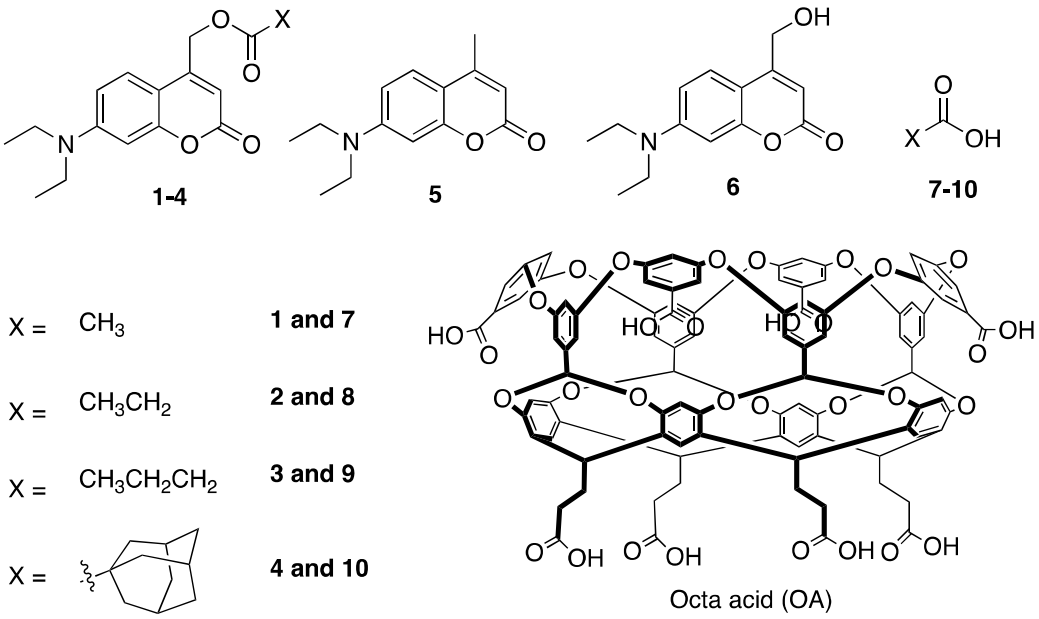
Melding Caged Compounds with Supramolecular Containers: Photogeneration and Miscreant Behavior of the Coumarylmethyl Carbocation

Nareshbabu Kamatham,[1] José P. Da Silva,[2,*] Richard S. Givens,[3,*] and V.Ramamurthy[1,*]

[1] Department of Chemistry, University of Miami, Coral Gables, Miami, FL 33124, USA
[2] CCMAR - Centre of Marine Sciences, University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal
[3]Department of Chemistry, University of Kansas, Lawrence, KS 66045, USA

1. Structures of host, caged esters and primary photolysis products 2
2. Experimental procedure and characterization methods 3
2.1 Materials 3
2.2 Synthesis of DEACM phototriggers **1-4** 3
2.3 ^{1}H NMR, ^{13}C NMR and mass spectral data of synthesized compounds **1-4** 4
2.4 Preparation of host-guest complexes of octa acid with phototriggers 5
2.5 Photolysis studies: Sample preparation and procedures 5
3. Characterization spectra 8
3.1 ^{1}H NMR, ^{13}C NMR and ESI-MS spectra of phototriggers **1-4** 8
3.2 UV-Visible absorbance, fluorescence spectra and lifetime 20
3.3 ^{1}H NMR titration spectra of octa acid with guests **1**-**4**, and DOSY and COSY 2D NMR spectra of the complex [**1**@$(OA)_2$] 28
3.4 ^{1}H NMR spectra of irradiated samples 34
3.5 Fluorescence spectra of irradiated samples 38
3.6 Solvolysis of compounds **1-4** on time and yields of formed products 40
3.7 LC-DAD-MS traces of irradiated samples 42
4. Yields of products/photoproducts 43
4.1 Graphs
4.2 Tables
5. Cartoon representation of host-guest complexes 45
6. Proposed mechanism for the photodeprotection and release of acids 46
7. References 46

1. Structures of host, caged esters and primary photolysis products



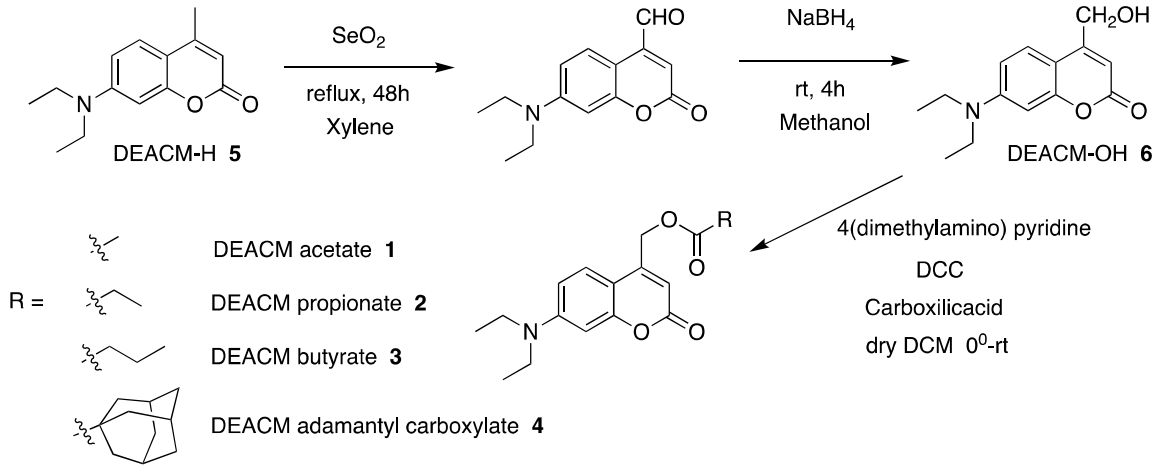
Scheme S1. Structures of water-soluble octa acid (OA) cavitand, 7-diethylaminocoumaryl-4-methyl esters (**1-4**), released carboxylic acids (**7-10**) and photoproducts (**5** and **6**).

2. Experimental procedure and characterization methods

2.1 Materials

DEACM-H (**5**), acetic acid (**7**), propionic acid (**8**), butyric acid (**9**) and 1-adamantane carboxylic (**10**), from Sigma-Aldrich/Alfa Aeser, were used as received. The host, octa acid (OA), was synthesized by following the literature procedure. [1]

2.2 Synthesis of DEACM phototriggers 1 - 4



Scheme S2. Synthesis of 7-Diethylamino-4-methylcoumaryl esters **1 - 4**.

Synthesis procedure: DEACM-OH (**6**) was synthesized by following reported procedure (Scheme S2).[2] A solution of DEACM-H (5) (2.0 g, 8.65 mmol) and selenium dioxide (1.09 g, 10.0 mmol) in xylene (200 ml) was kept under stirring and reflux during for 48 h. Then the solution was cooled to room temperature, filtered, the solvent was evaporated and the aldehyde (scheme 2) recovered. The aldehyde was then dissolved in methanol (200 mL) and sodium borohydride (320 mg, 8.65 mmol) was added portion wise. The mixture was then stirred at room temperature for 4 h. After that, the solution was neutralized with 1 N HCl, extracted with dichloromethane (DCM), dried over Na_2SO_4 and purified by column chromatography (Hexane/Ethyl Acetate 1:1). Product was obtained as pure DEACM-OH (**6**) as an orange solid. Please check the reference 2 for spectral data.

DEACM esters (**1-4**) were synthesized by following a reported procedure.[3] N,N'-Dicyclohexylcarbodiimide (DCC) (4 mmol) was added to a solution of 7-DEACM-OH (4

mmol), carboxylic acid (5 mmol) and 4-(dimethylamino) pyridine (4 mmol) in dry DCM (10 mL) at 0 ºC under nitrogen. After 10 min at 0 ºC, the mixture was stirred at room temperature for 12 h in the dark and under nitrogen. The reaction mixture was extracted with chloroform, then dried over sodium sulfate and concentrated under vacuum. The product was purified by column chromatography (dichloromethane/Hexane 4:1). Phototriggers **1-4** were characterized by ^{1}H NMR, ^{13}C NMR and electrospray ionization mass spectrometry (ESI-MS). The photoproducts were isolated as solids with the yields listed below. **1**: light green solid, 30 mg, 25 %; **2**: light brown solid, 45 mg, 37%; **3**: light brown solid, 20 mg, 15 %; **4**: light brown solid, 58 mg, 33 %.
Note: Selenium dioxide is toxic. Please check with safety data sheet of corresponding chemical has CAS number 7446-08-4 from sigma-Aldrich.

2.3. ^{1}H NMR, ^{13}C-NMR and mass spectral data of synthesized compounds 1-4

^{1}H NMR (500 MHz) and ^{13}C-NMR (125 MHz) studies were carried out on a Bruker NMR spectrometer at 25 ºC by synthesized compounds were solubilized in $CDCl_3$. Full scan high resolution ESI-MS spectra were obtained using a Bruker Daltonics microTOF-QII. For ESI-MS the synthesized compounds were solubilized in a mixture methanol-chloroform (50:50) containing 0.1 % formic acid. The ions were continuously generated by infusing the solutions (200 μL hr^{-1}) into the source, with the help of a syringe pump (KdScientific, model 601553, USA). Typical experimental conditions were as follows: capillary voltage, 4.5 kV; drying gas, drying gas, 180 ºC at 4 L min^{-1}; nebulizer gas pressure, 0.3 bar; end plate offset -500 V. The ESI-MS/MS spectra were obtained using a Bruker Daltonics HCT *ultra* mass spectrometer under positive polarity. The ions were continuously generated by infusing the standards in acetonitrile (50 μM) or prepared in aqueous ammonia, at 4 μL min^{-1} into the mass spectrometer source, with the help of a syringe pump (KdScientific, model 781100, USA). Typical experimental conditions were as follows: capillary voltage, 3.5 kV; capillary exit voltage (CE), 75 V; skimmer voltage, 40 V; drying gas, 300 ºC at 6 L min^{-1}; nebulizer gas pressure, 20 psi.

1: ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 1.21 (t, *J* = 7.0 Hz, 6H), 2.19 (s, 3H), 3.43 (q, *J* = 7.0 Hz, 4H), 5.22 (s, 1H), 6.14 (s, 1H), 6.53 (d, *J* = 6.5 Hz, 1H), 6.61 (dd, *J* = 7.0 and 2Hz,, 1H), 7.29 (d, *J* = 9.0 Hz, 1H); ^{13}C-NMR (125 MHz, DMSO) δ: 12.28, 20.67, 45.29, 61.30, 98.77, 106.88, 107.17, 109.41, 124.44, 149.23, 150.09, 156.19, 161.57, 170.15; ESI-HRMS: Calculated for $C_{16}H_{20}NO_4$ $[M+H]^+$ 290.1387, observed: 290.1399.

2: ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 1.21-1.25 (m, 9H), 2.49 (q, *J* = 7.5 Hz, 2H), 3.44 (q, *J* = 7.0 Hz, 4H), 5.25 (s, 2H), 6.21 (s, 1H), 6.67 (s, 1H), 6.79 (d, *J* = 6.5 Hz, 1H), 7.36 (d, *J* = 8.0 Hz, 1H); ^{13}C-NMR (125 MHz, DMSO) δ: 9.00, 12.39, 27.42, 44.79, 61.18, 98.00,

106.20, 106.57, 108.77, 124.39, 149.52, 150.62, 156.27, 161.74, 173.59; ESI-HRMS: Calculated for $C_{17}H_{22}NO_4$ $[M+H]^+$ 304.1543 observed: 304.1561

3: ^{1}H-NMR (400 MHz, $CDCl_3$) δ: 0.99 (t, *J* = 7.2 Hz, 3H), 1.21 (t, *J* = 7.2 Hz, 6H), 1.68-1.78 (m, 2H), 2.43 (t, *J* = 7.6 Hz, 2H), 3.43 (q, *J* = 7.2 Hz, 4H), 5.23 (s, 1H), 6.15 (s, 1H), 6.79 (d, *J* = 6.5 Hz, 1H), 7.30 (d, *J* = 8.8 Hz, 1H); ^{13}C-NMR (125 MHz, DMSO) δ: 12.26, 13.63, 18.37, 35.98, 45.48, 61.09, 99.02, 107.18, 107.31, 109.60, 124.49, 149.91, 149.91, 156.16, 161.55, 172.83; ESI-HRMS: Calculated for $C_{18}H_{23}NO_4Na$ $[M+Na]^+$ 340.1519, observed: 340.1526.

4: ^{1}H-NMR (500 MHz, $CDCl_3$) δ: 1.20 (t, *J* = 7.0 Hz, 6H), 1.70-1.76 (m, 6H), 1.9 (m, 6H), 2.04 (m, 3H), 3.41 (q, *J* = 7.0 Hz, 4H), 5.19 (s, 2H), 6.13 (s, 1H), 6.51 (s, 1H), 6.59 (d, *J* = 5.0 Hz, 1H), 7.27 (d, *J* = 9.0 Hz, 1H); ^{13}C-NMR (125 MHz, DMSO) δ: 12.31, 27.88, 36.41, 38.89, 41.01, 45.19, 60.98, 98.59, 106.69, 106.80, 109.31, 124.41, 149.87, 150.16, 156.16, 161.73, 176.82; ESI-HRMS: Calculated for $C_{25}H_{31}NO_4Na$ $[M+Na]^+$ 432.2145, observed: 432.2141.

2.4 Preparation of host-guest complexes of octa acid with phototriggers

UV-Vis spectra were recorded by using a UV-2600 UV-Vis Spetrophotometer (Shimdazu), the emission spectra were recorded using a FS920CDT Edinburgh fluorimeter and fluorescence lifetimes were measured by time-correlated single photon counting using a nF920 fluorimeter (Edinburgh Analytical instruments). A 60 mM stock solution of the guest was prepared in DMSO-D_6, and 12 mL of 5 x 10^{-5} M of host (OA) solution was prepared at a pH 7.4 using phosphate buffer/H_2O. The solutions of the complexes were prepared by adding 5 µL of the 60 mM guest solution in DMSO-D_6 (which gave a final guest concentration of 2.5 x 10^{-5} M) to the prepared host solution (5 x 10^{-5} M). After shaking the mixture manually for 2 min, the UV-Vis absorption, the emission spectra and the fluorescence lifetime spectra were recorded.

2.5. Photolysis studies: Sample preparation and procedures

(a) Sample preparation for photochemical studies (monitored by ^{1}H NMR)

A 600 µL of 1 mM OA (10 mM $Na_2B_4O_7$ in D_2O, pH = 8.7) solution was placed in an NMR tube. Then 0.5 equivalents of guest (5 µL of a 60 mM solution in DMSO-D_6) were added. After shaking the NMR tube for 5 min, the ^{1}H NMR was recorded to confirm the complex formation. The samples were saturated in air equilibrated or nitrogen and irradiated using a light source from Luzchem research reactor, Visible (Luzchem 420). The progress of the reaction was monitored by ^{1}H NMR.

(b) Sample preparation for photochemical studies (monitored by fluorescence)

Stock solutions of each guest molecule were prepared in DMSO at 60 mM concentration. A 12 mL host (OA) solution at 5 x 10^{-5} M was also prepared using 10 mM $Na_2B_4O_7$ buffer/H_2O (pH = 8.7). The solutions of the complexes were prepared by adding 5 μL of a 60 mM guest solution in DMSO-d_6 (to make final guest concentration 2.5 x 10^{-5} M) to as prepared host solution (5 x 10^{-5} M). After shaking the mixture (complex) manually for 2 min, the solution was placed in a quartz cuvette then solution was saturated with nitrogen and irradiated using light source from Luzchem research reactor, Visible (Luzchem 420). The progress of the reaction was monitored by fluorescence.

c) Sample preparation for photochemical studies of products using ESI-MS/MS and by liquid chromatography (LC) coupled to a diode array detector (DAD) and to a mass spectrometer (MS), LC-DAD-MS.

Irradiations of **1**-**4**@OA_2 complexes were carried out using air equilibrated and N_2 purged aqueous solutions of $Na_2B_4O_7$ (10 mM, pH = 8.7) containing 100 μM of the guest and 200 μM of the host. Other concentrations of guest and host, specifically 200 μM:400 μM, 250 μM:500 and 500 μM:1000 μM (guest-host) were also tested. These irradiations were performed using a high-pressure xenon lamp in conjunction with a water filter to prevent heating of the sample solution. An additional Pyrex filter was inserted to remove UV light below 300 nm. Irradiated samples for photoproduct analysis by ESI-MS/MS were prepared in 0.5 % aqueous ammonia.

d) Identification and quantification studies of non-irradiated and irradiated samples by LC-DAD-MS, ESI-MS/MS.

Photoproducts of **1**-**4**@OA_2 complexes were followed by LC-DAD with UV analysis at 280, 320, 350, 380 nm and by LC-MS under positive polarity or negative polarity in air equilibrated and N_2 purged solutions. The identification of compounds **4** and **5** was made by injecting authentic standards. Quantitative photoproduct analyses of compounds **1**-**6** were performed using calibrations curves prepared from DAD traces obtained at 380 nm. Product **10** was quantified by LC-MS, in the negative polarity mode by following the ion with m/z 179. The non-irradiated and irradiated solutions were directly injected into the LC-DAD-MS system without further processing.

e) Quantification of photoproducts by ^{1}H NMR

The complex **1**@$(OA)_2$ was irradiated for complete conversion in nitrogen purged and in oxygen purged solutions. Then known amount of methyl viologen was added to the irradiated solutions (same equivalents of guest was used) as internal standard and the ^{1}H

NMR was recorded. Product yields were calculated considering that the integration value of one of the methyl viologen peaks corresponds to 4 protons of product.

f) LC-DAD-MS analysis conditions

The LC-DAD-MS analyses were performed using an Agilent Technologies 1200 Series LC, equipped with a diode array detector and coupled to a Bruker Daltonics HCT *ultra*. The mobile phase comprises acetonitrile (A) and water (B), both with 0.1 % of formic acid, and ethyl acetate (C). The gradient started with 52 % of A, 38 % of B and 10 % of C. The mobile phase composition was changed to 2 % of A, 73 % of B and 25 % of C in 5 minutes and kept at this composition for an additional 7 minutes. Finally, the system was allowed to return to the initial mobile phase composition (52 % of A, 38 % of B and 10 % of C) in 1 min and then stabilized for additional 5 minutes before the next run. The flow was 0.3 ml/min. Two different analytical columns were used. For studies of the photo-transformation of compounds **1, 2** and **3** a Agilent PLRP-S LC column (15.0 cm length, 2.1 mm internal diameter, 5 μm), stabilized at 25 °C was used. For studies of the photo-transformation of compound **4** a Grace C18 reversed phase LC column (10.0 cm length, 2.1 mm internal diameter, 3 μm), stabilized at 25 °C was used.

3. Characterization spectra

3.1 ^{1}H NMR, ^{13}C NMR and ESI-MS spectra of phototriggers 1-4

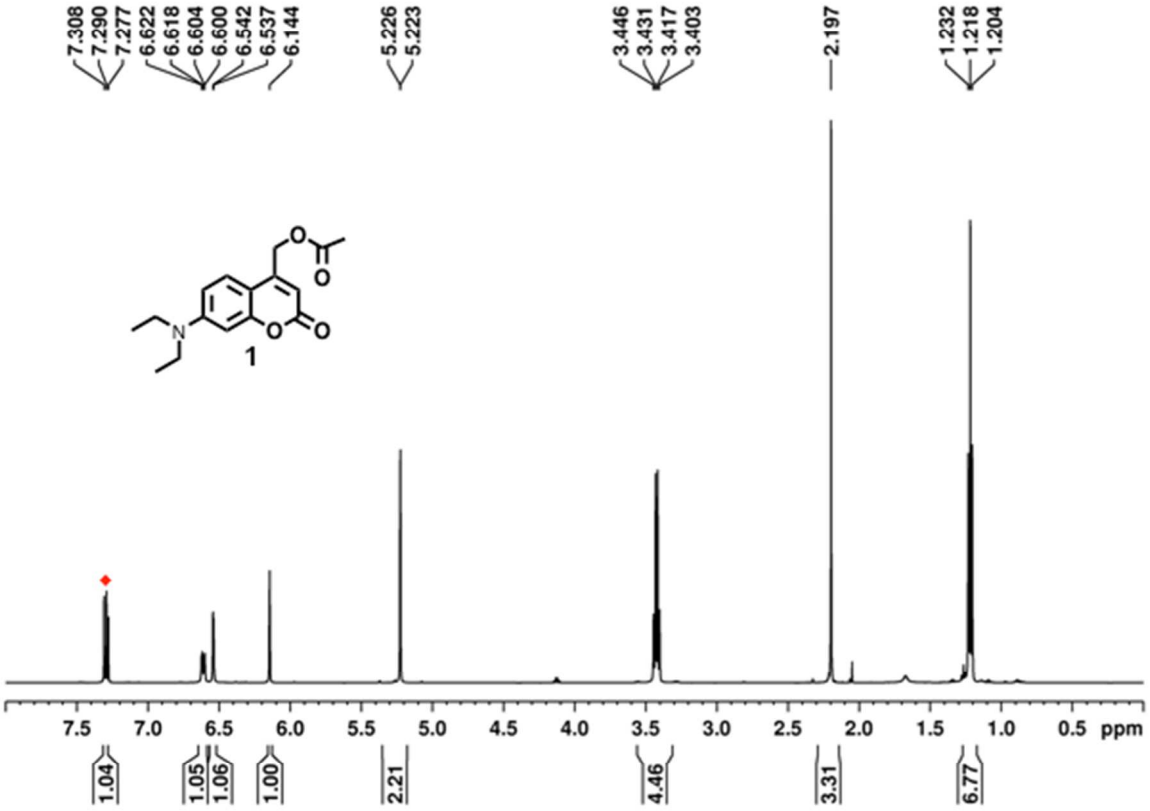


Figure S1. ^{1}H-NMR (500 MHz) spectrum of DEACM acetate **1** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D and it is merged with one of the aromatic proton peaks.

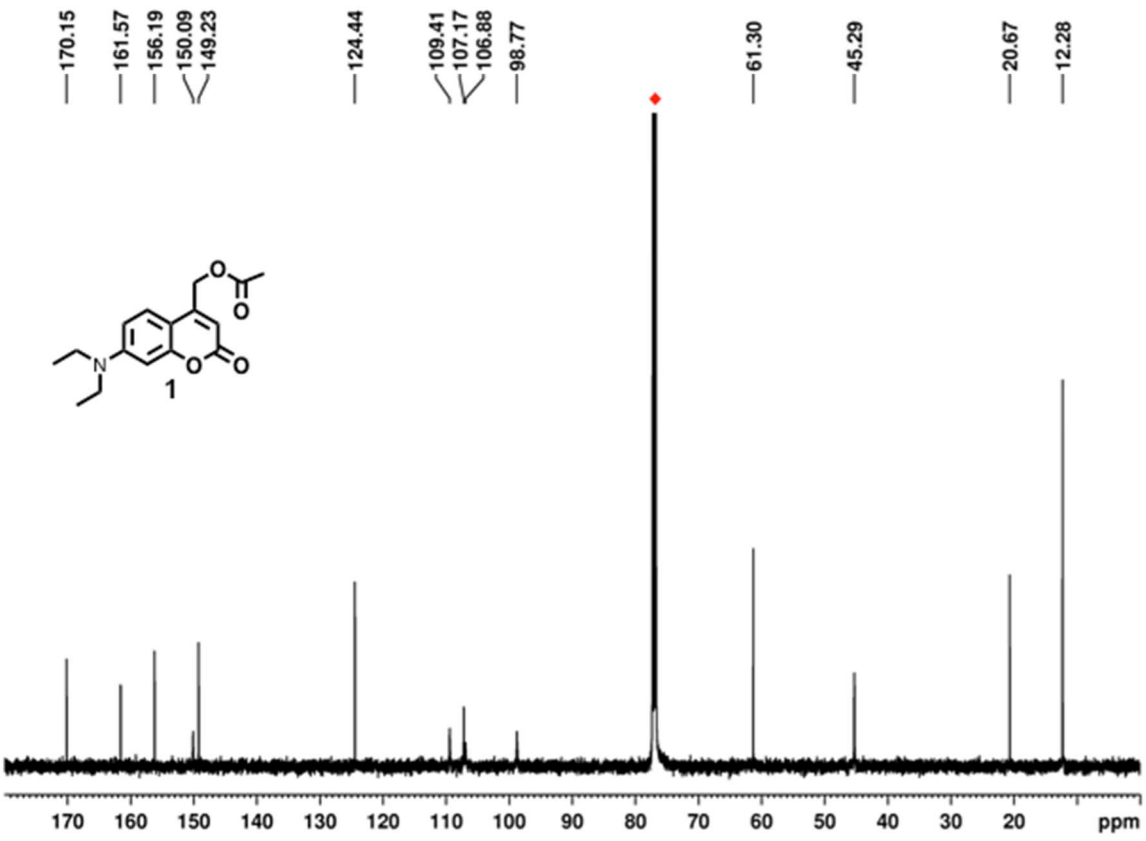


Figure S2. ^{13}C-NMR (125 MHz) spectrum of DEACM acetate **1** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D.

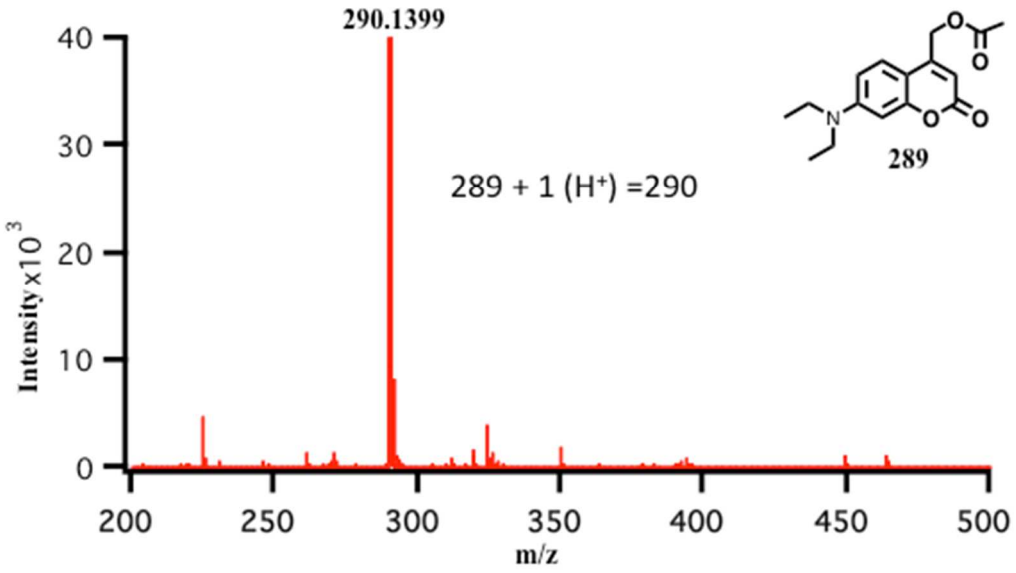


Figure S3. ESI mass spectrum of DEACM acetate **1** in $CHCl_3$.

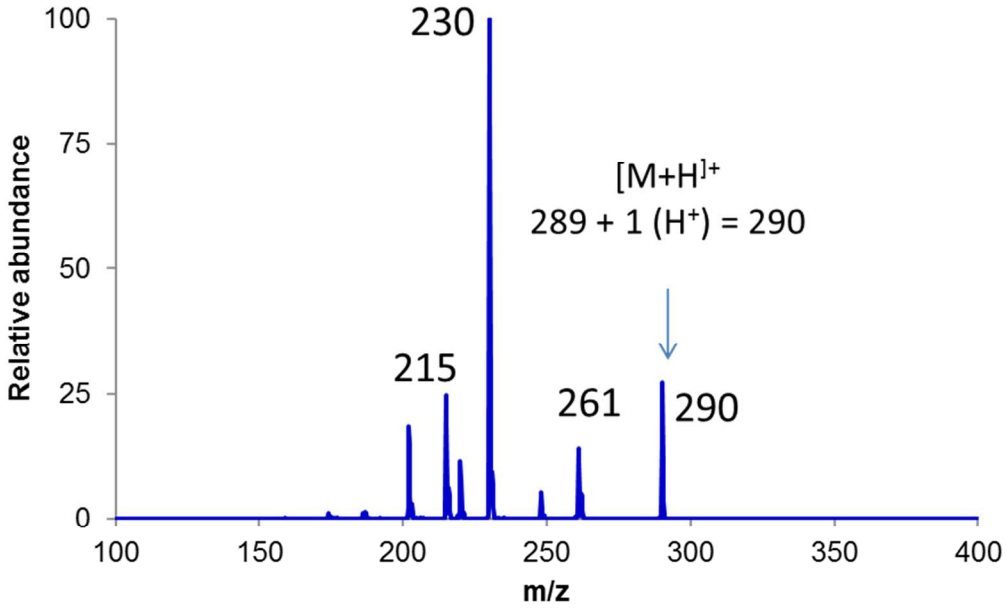


Figure S4. Fragmentation spectrum of DEACM acetate **1**.

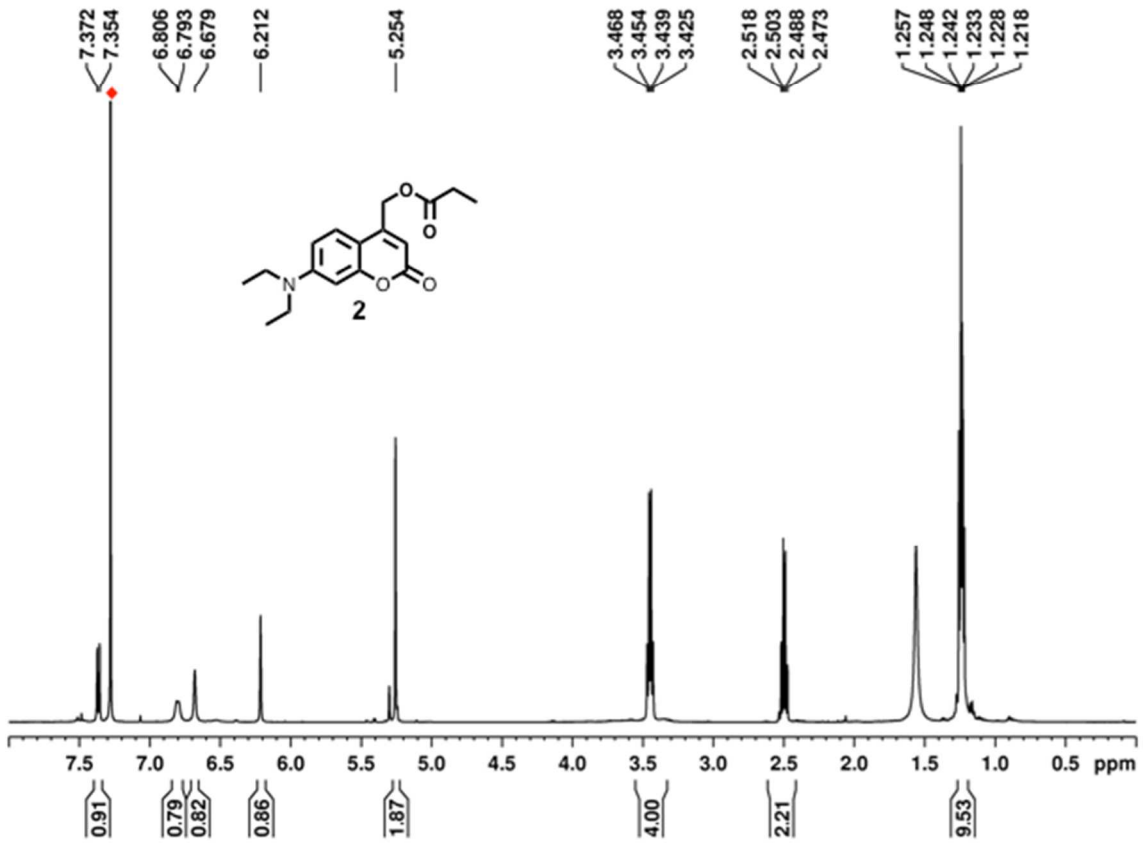


Figure S5. [1]H-NMR (500 MHz) spectrum of DEACM propionate **2** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D.

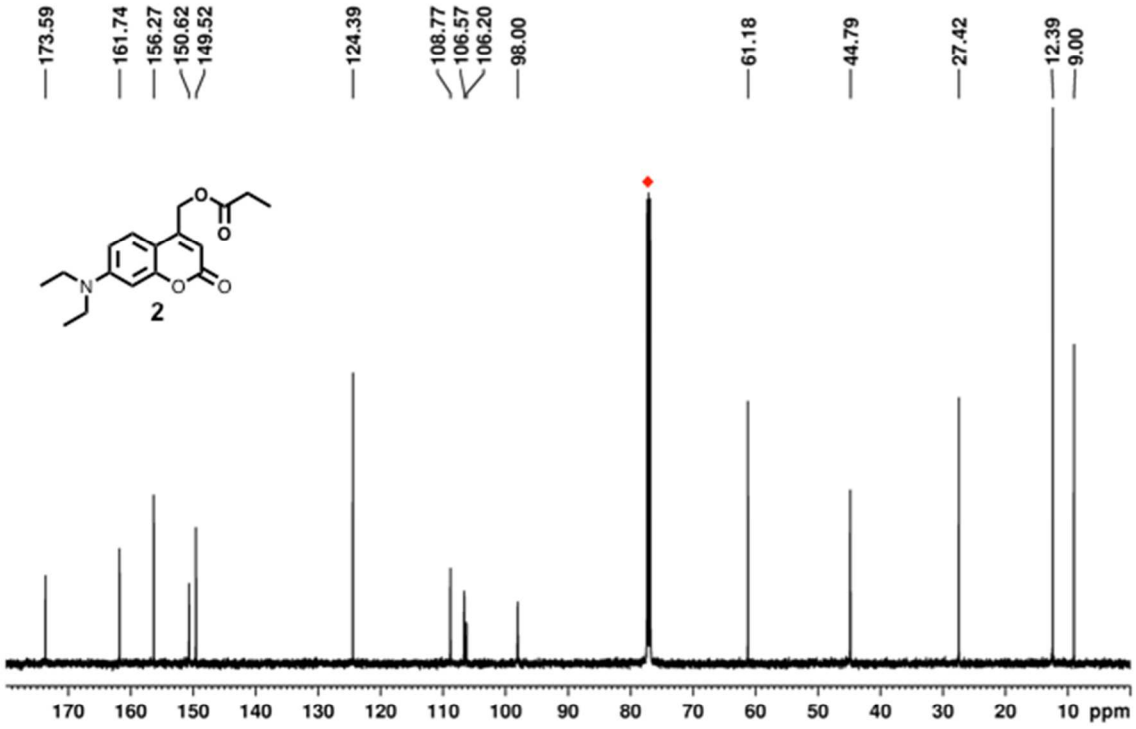


Figure S6. ^{13}C-NMR (125 MHz) spectrum of DEACM propionate **2** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D.

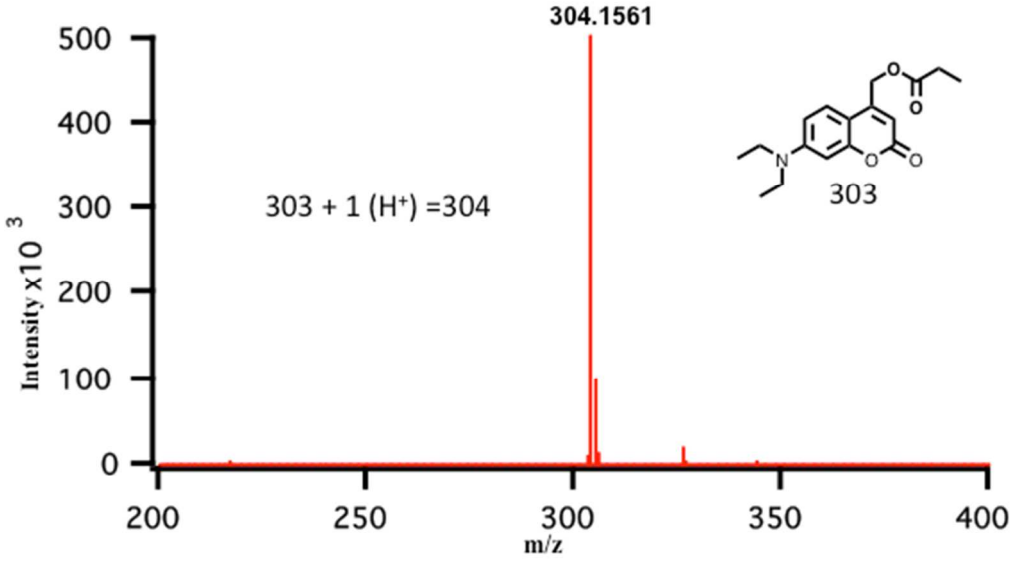


Figure S7. ESI-Mass spectrum of DEACM propionate **2** in $CHCl_3$.

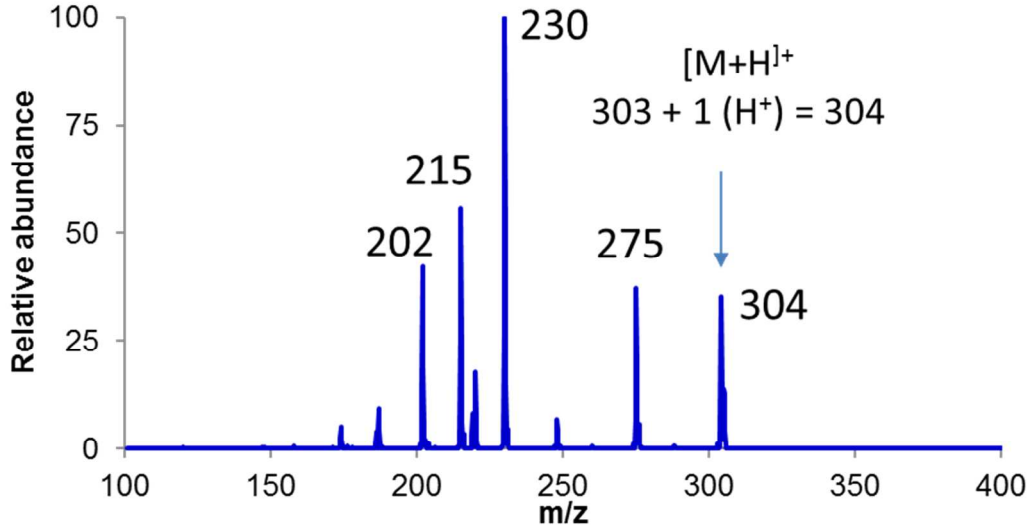


Figure S8. Fragmentation spectrum of DEACM propionate **2**.

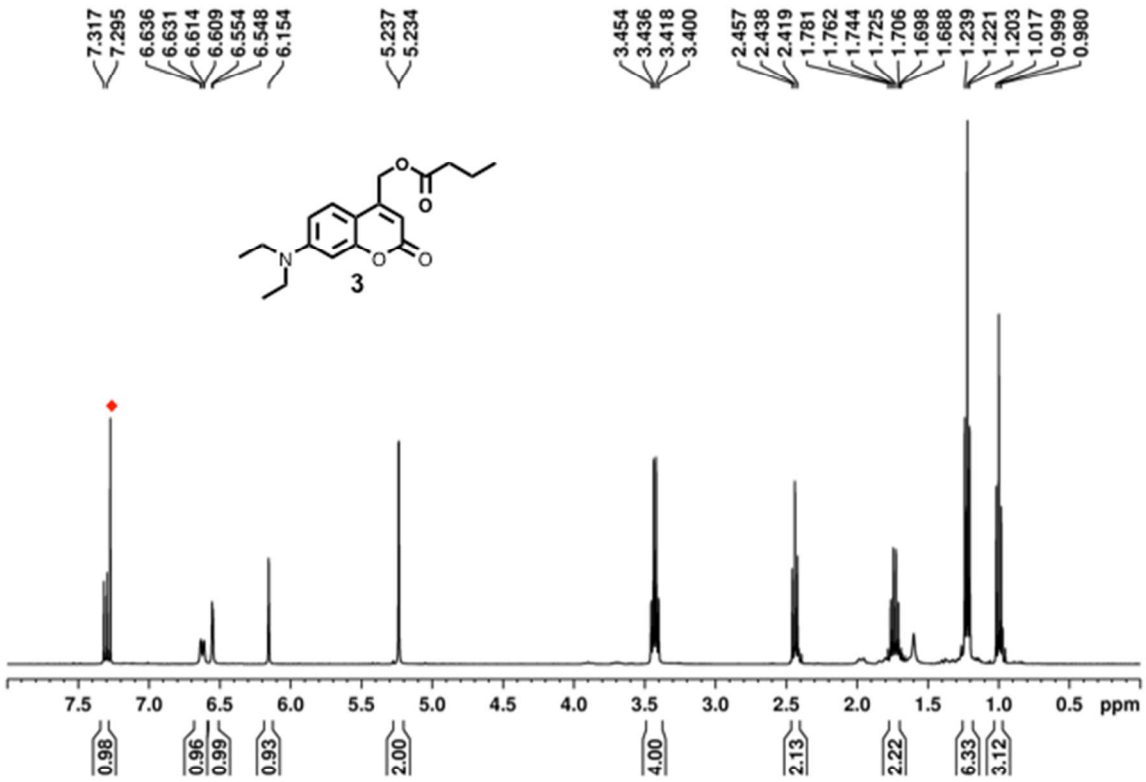


Figure S9. ^{1}H-NMR (500 MHz) spectrum of DEACM butyrate **3** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D.

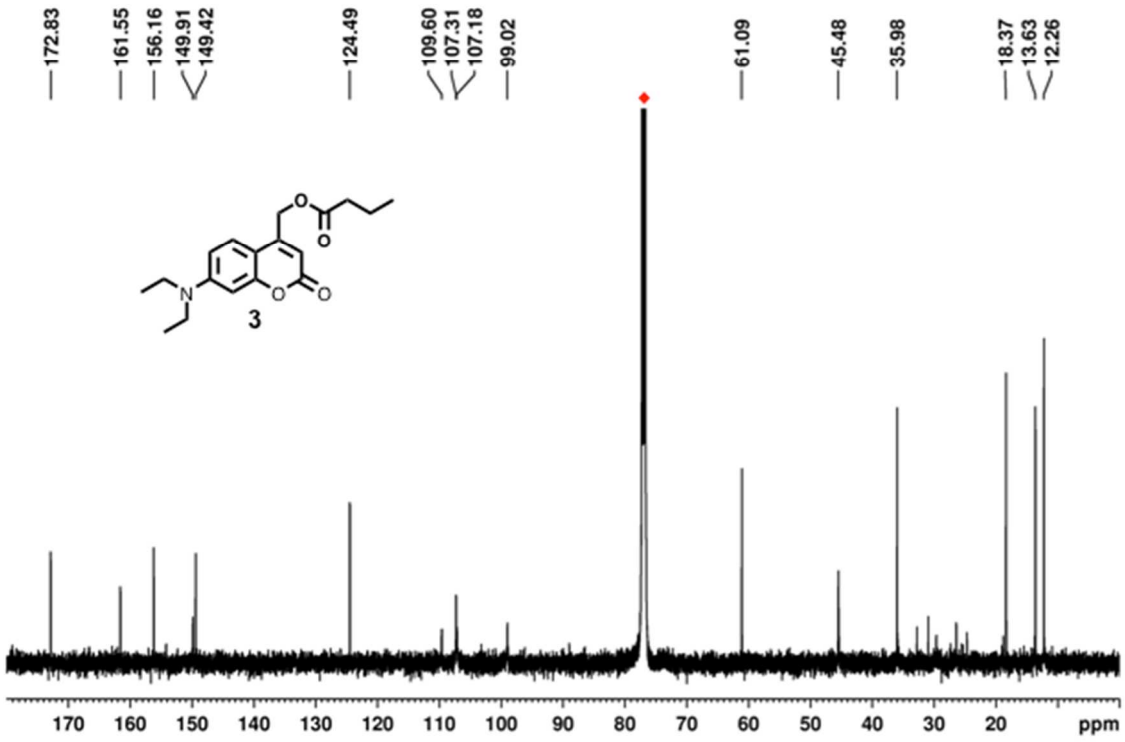


Figure S10. ^{13}C-NMR (125 MHz) spectrum of DEACM butyrate **3** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D.

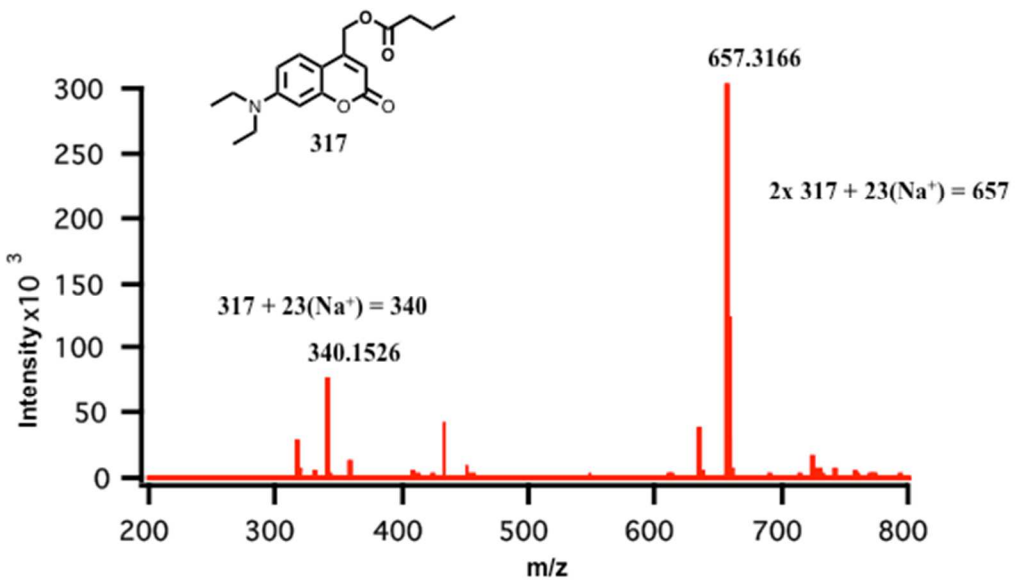


Figure S11. ESI mass spectrum of DEACM butyrate **3** in $CHCl_3$.

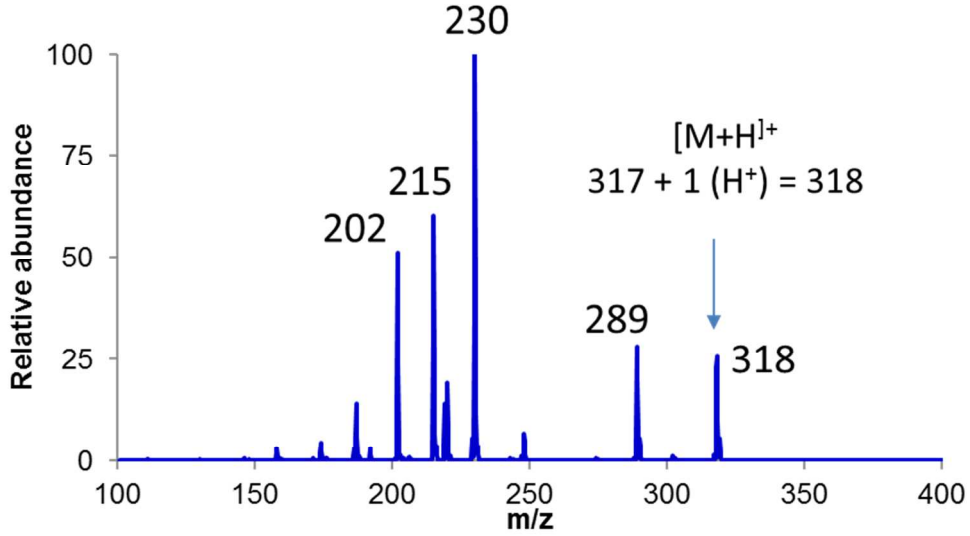


Figure S12. Fragmentation spectrum of compound **3**.

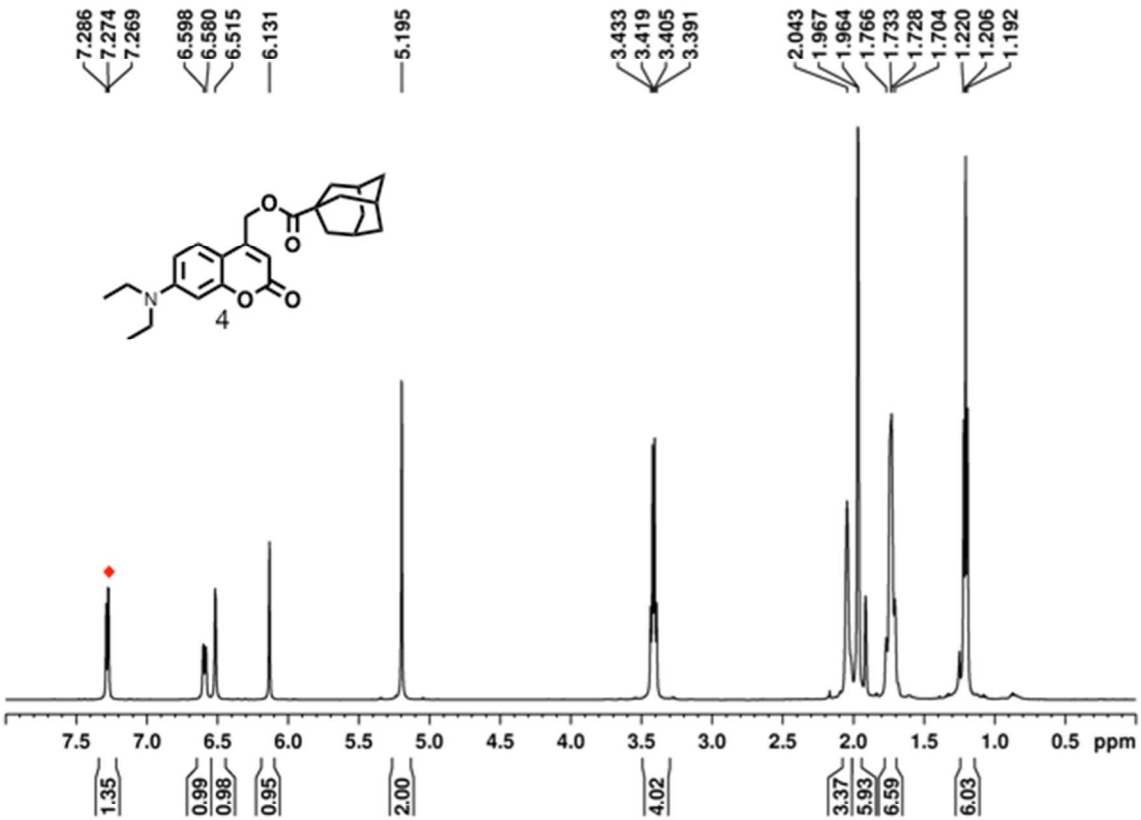


Figure S13. ^{1}H NMR (500 MHz) spectrum of DEACM adamantyl carboxylate **4** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D and it is merged with one of the aromatic proton peaks.

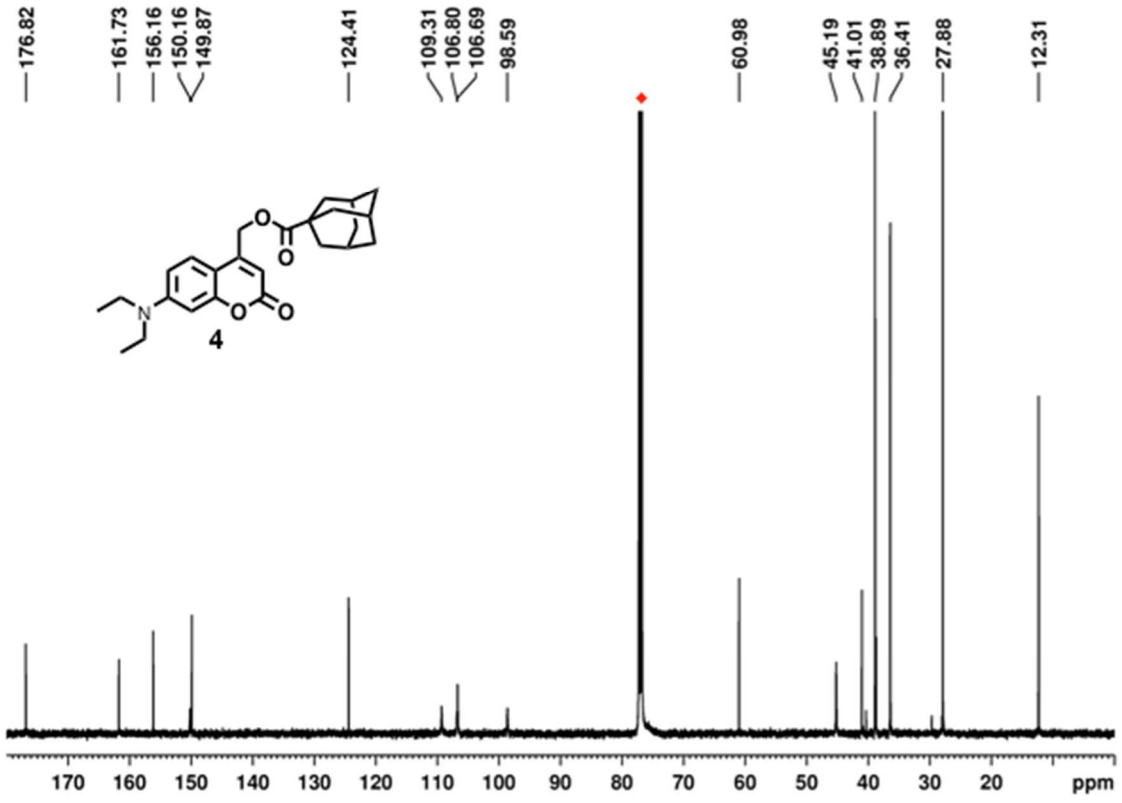


Figure S14. ^{13}C NMR (125 MHz) spectrum of DEACM adamantyl carobxylate **4** in chloroform-D. ♦ indicates the residual solvent (chloroform) peak of chloroform-D.

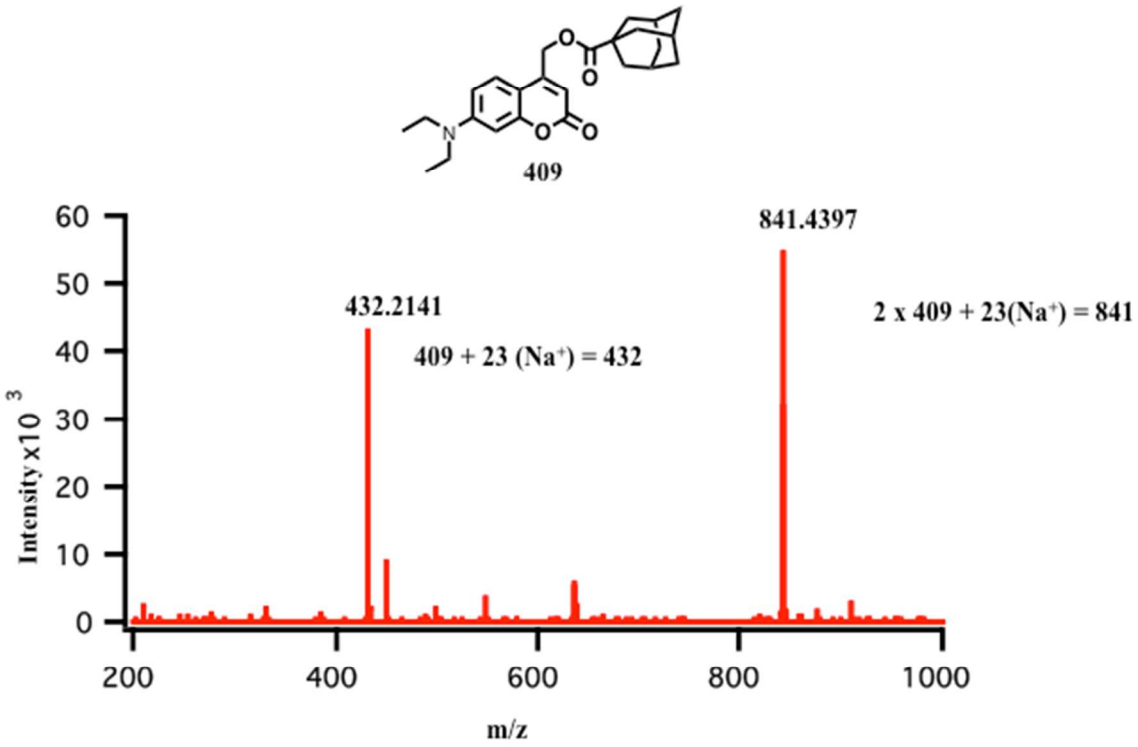


Figure S15. ESI mass spectrum of DEACM adamantyl carobxylrate **4** in $CHCl_3$.

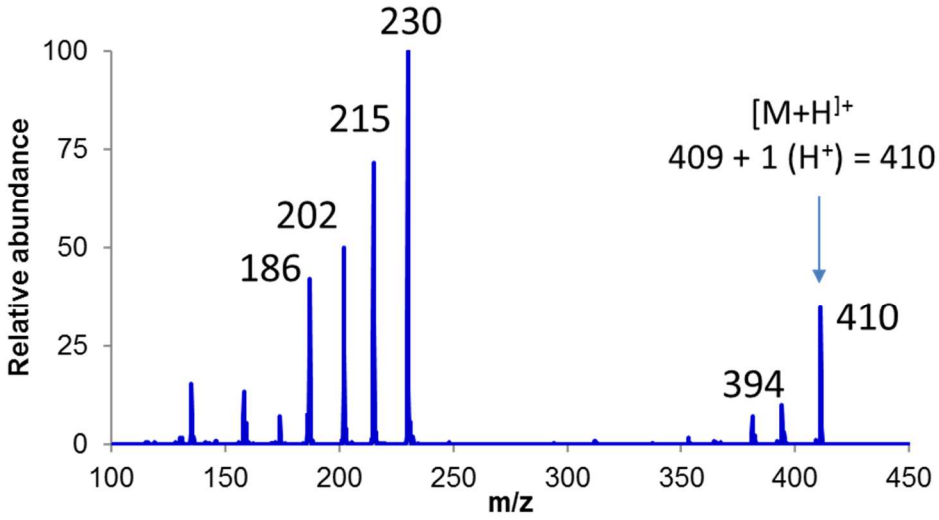


Figure S16. Fragmentation spectrum of DEACM adamantyl carobxylrate **4**.

3.2 UV-Visible absorbance, fluorescence spectra and lifetime

(a) Absorption spectra of coumaryl esters 1-4 in water in the presence and absence of octa acid.

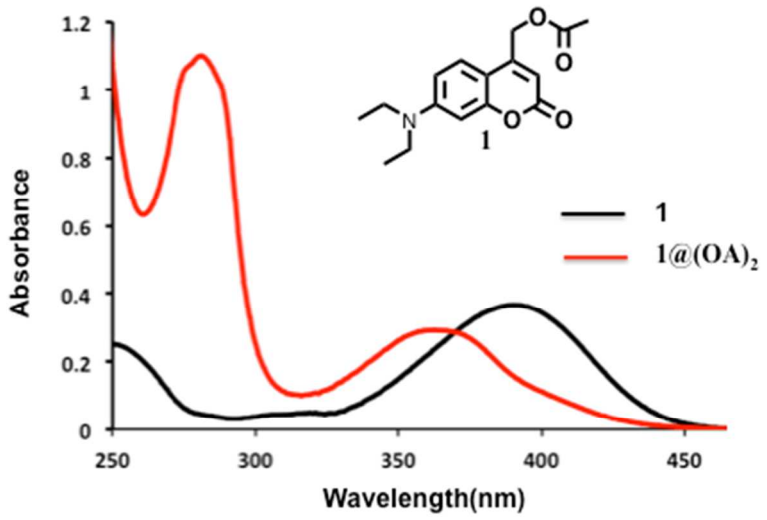


Figure S17. UV-Vis absorption spectra of **1** (black) and **1**@$(OA)_2$ (red); ([**1**] = 2.5 x 10^{-5} M, [OA]= 5 x1 0^{-5} M in phosphate buffer/H_2O, pH= 7.4).

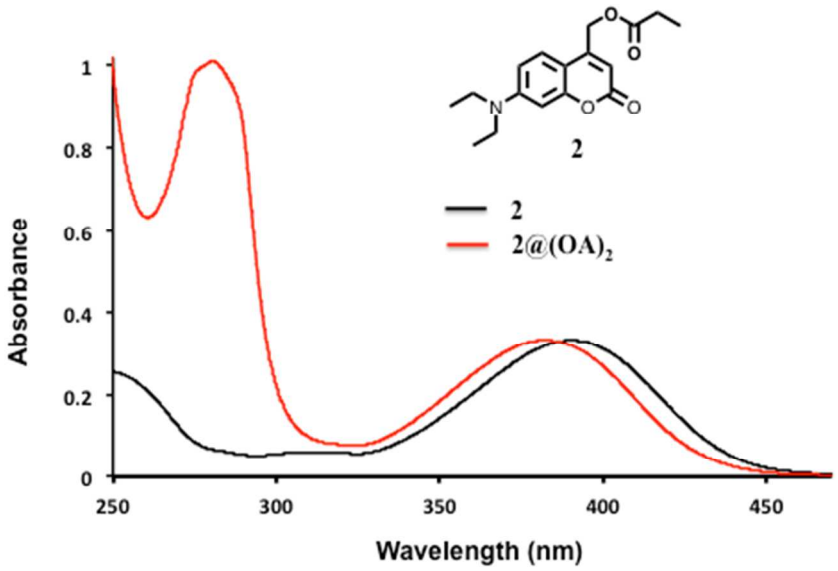


Figure S18. UV-Vis absorption spectra of **2** (black) and **2**@$(OA)_2$ (red); ([**2**] = 2.5 x 10^{-5} M, [OA]= 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

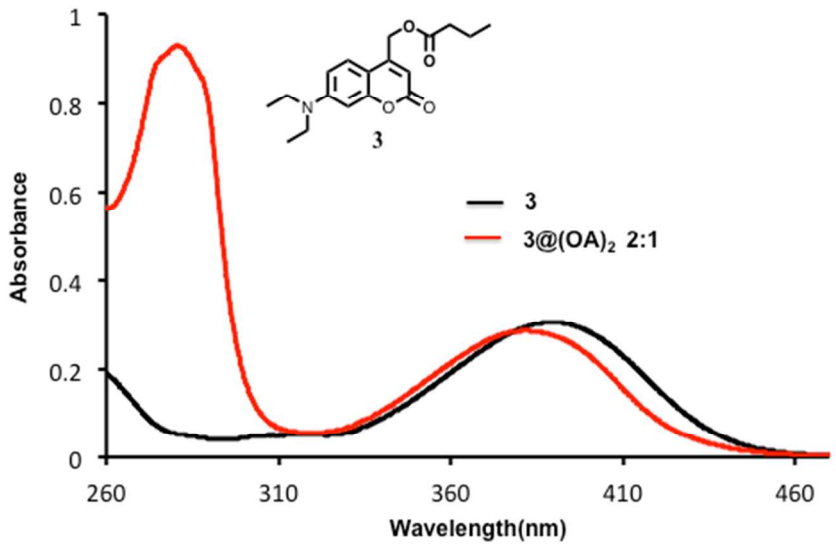


Figure S19. UV-Vis absorption spectra of **3** (black) and **3**@$(OA)_2$ (red); ([**3**] = 2.5 x 10^{-5} M, [OA]= 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

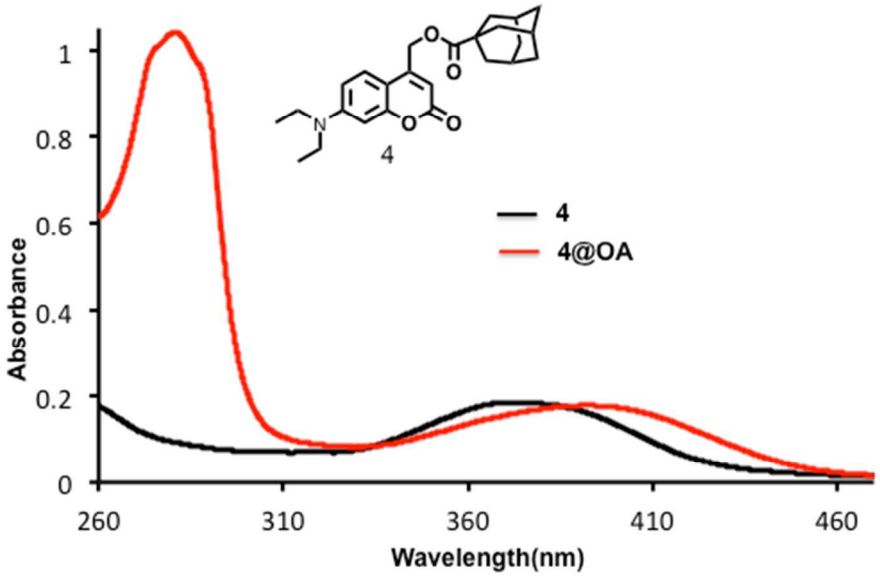


Figure S20. UV-Vis absorption spectra of **4** (black) and **4**@$(OA)_2$ (red); ([**4**] = 2.5 x1 0^{-5} M, [OA]= 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

(b) Emission spectra of coumaryl esters 1-4 and photoproducts (5 and 6) in water in the presence and absence of octa acid.

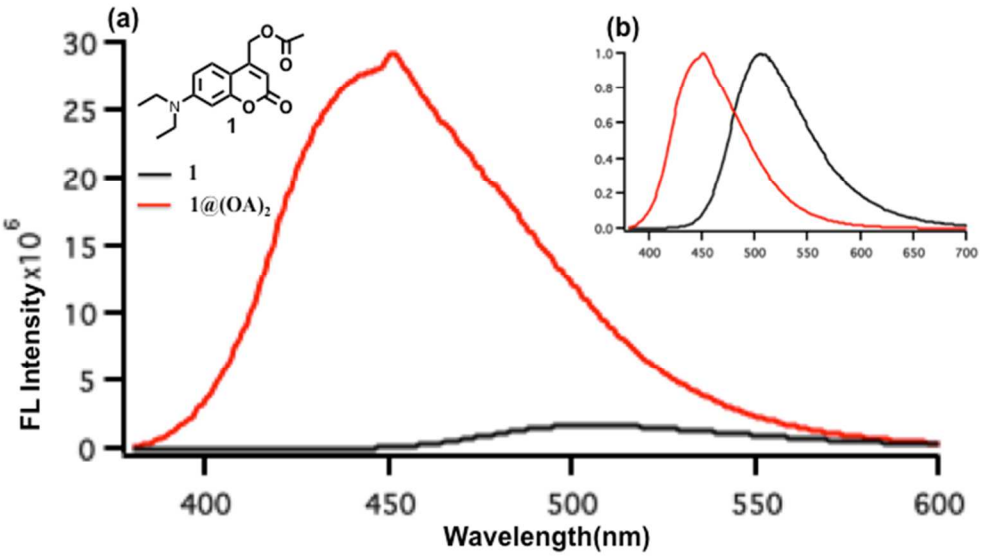


Figure S21. (a) Emission spectra (λ_{exc}= 370 nm) of **1** (black) and **1**@$(OA)_2$ (red) ([**1**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4); (b) normalized emission spectra of samples shown in (a).

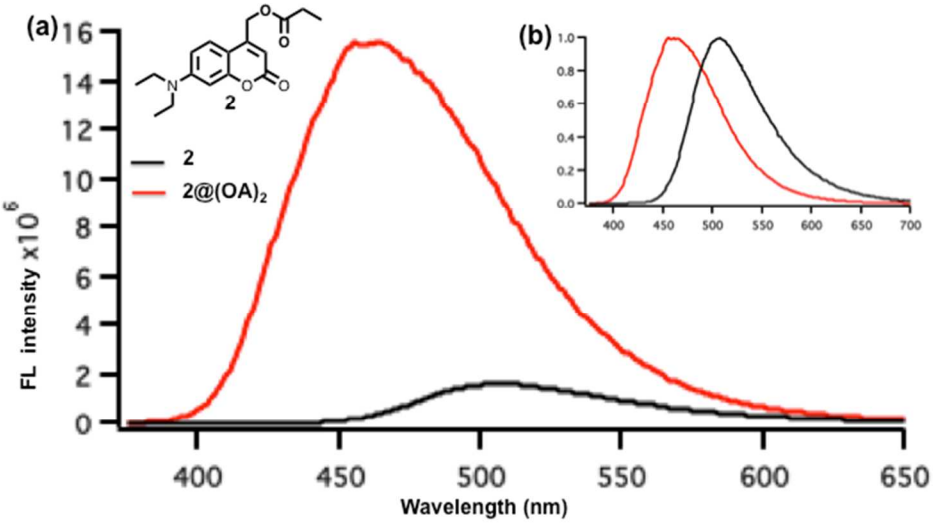


Figure S22. (a) Emission spectra (λ_{exc}= 370 nm) of **2** (black) and **2**@$(OA)_2$ (red); ([**2**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4); (b) normalized emission spectra of samples shown in (a).

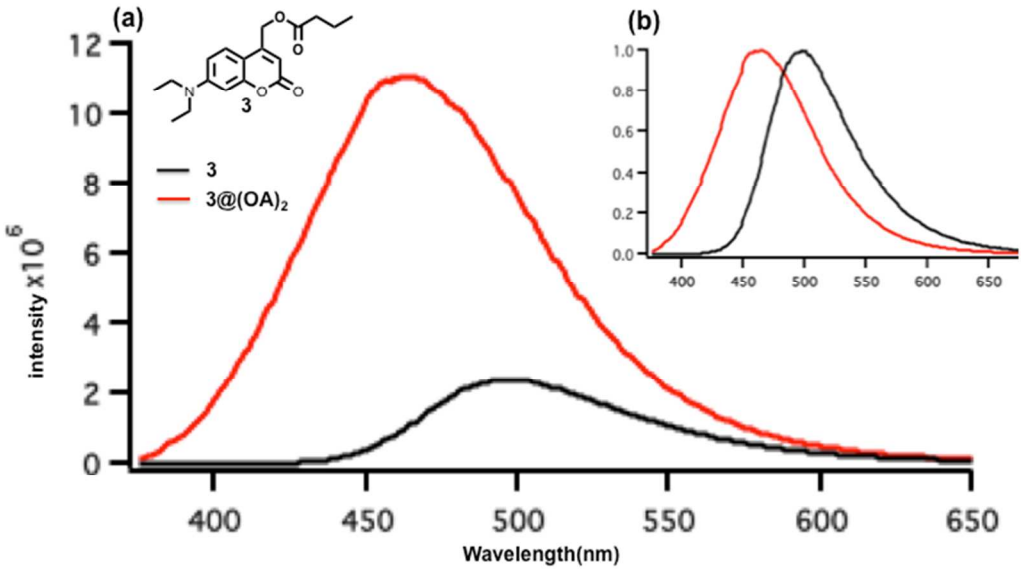


Figure S23. (a) Emission spectra (λ_{exc}= 370 nm) of **3** (black) and **3**@$(OA)_2$ (red); ([**3**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4); (b) normalized emission spectra of samples shown in (a).

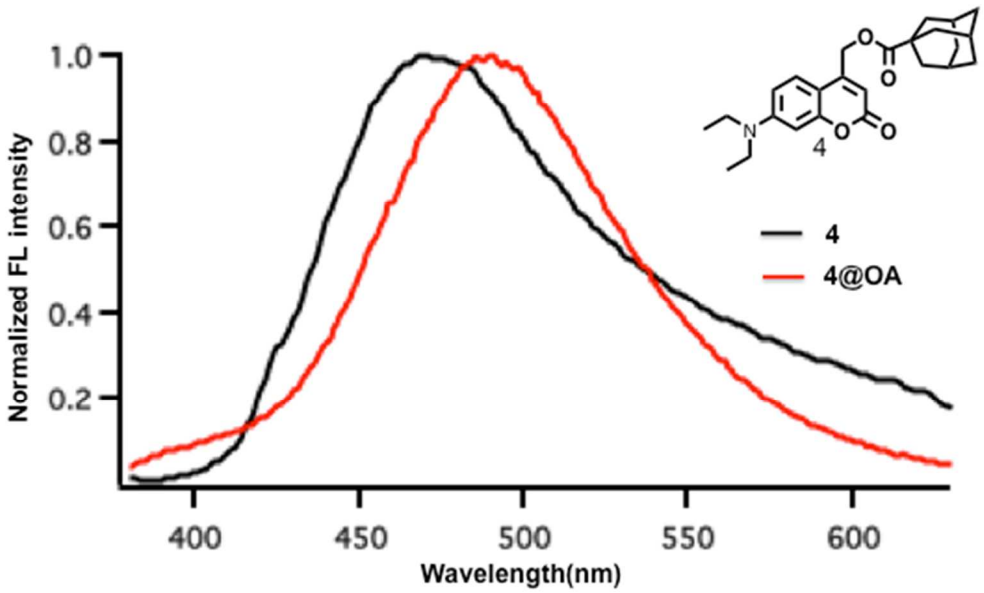


Figure S24.Emission spectra (λ_{exc}= 370 nm) of **4** (black) and **4**@OA (red); ([**4**] = 2.5 x 10^{-5} M, [OA] = 5 x1 0^{-5} M in phosphate buffer/H_2O, pH= 7.4).

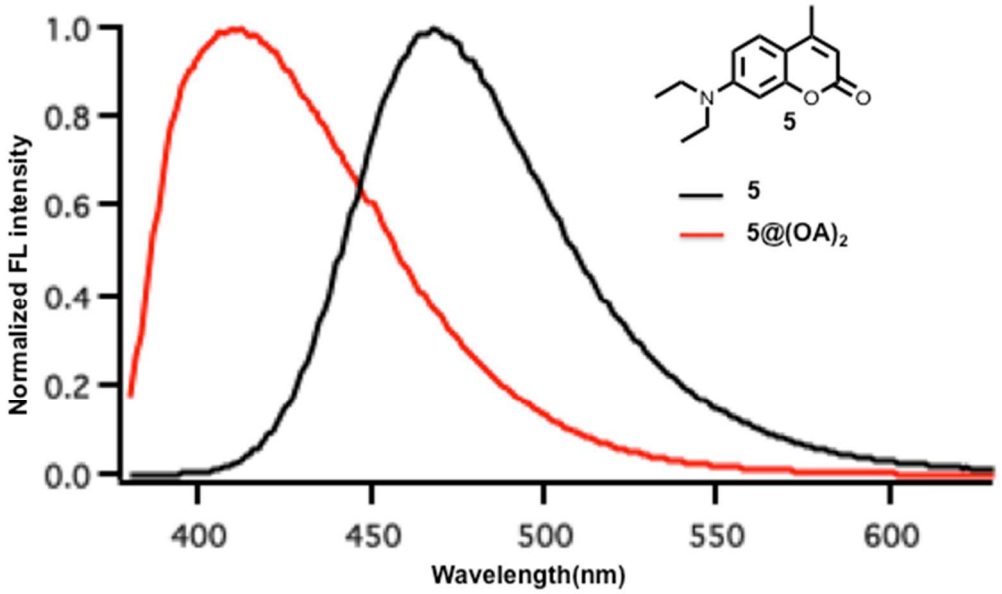


Figure S25. Normalized emission spectra (λ_{exc}= 370 nm) of DEACM-H **5** (black) and **5**@$(OA)_2$ (red); ([**5**] = 2.5 x10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

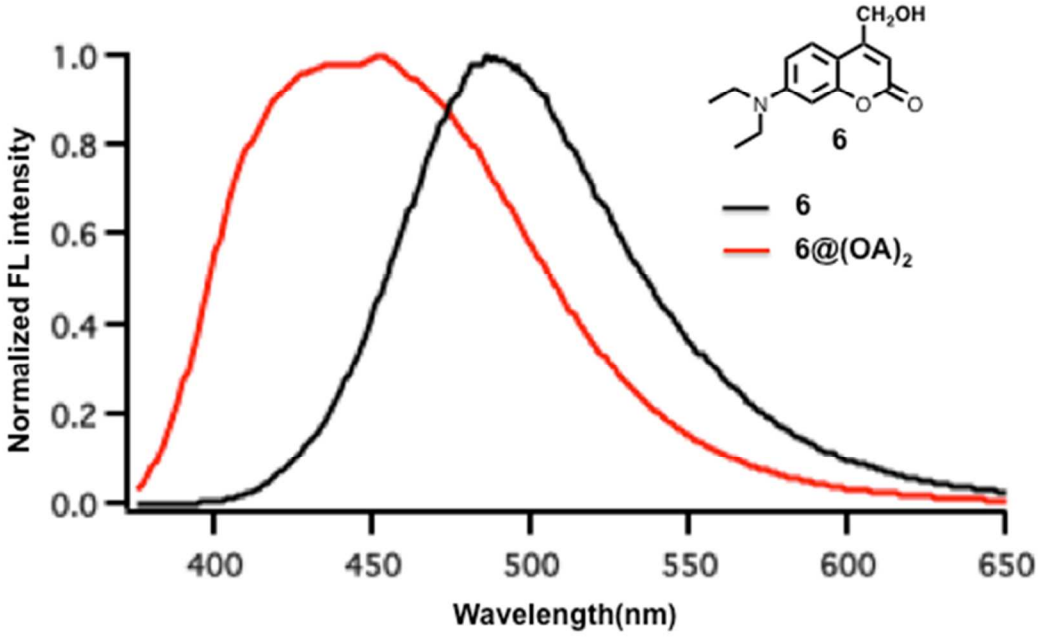


Figure S26. Normalized emission spectra (λ_{exc}= 370 nm) of DEACM-OH **6** (black) and **6**@$(OA)_2$ (red); ([**6**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

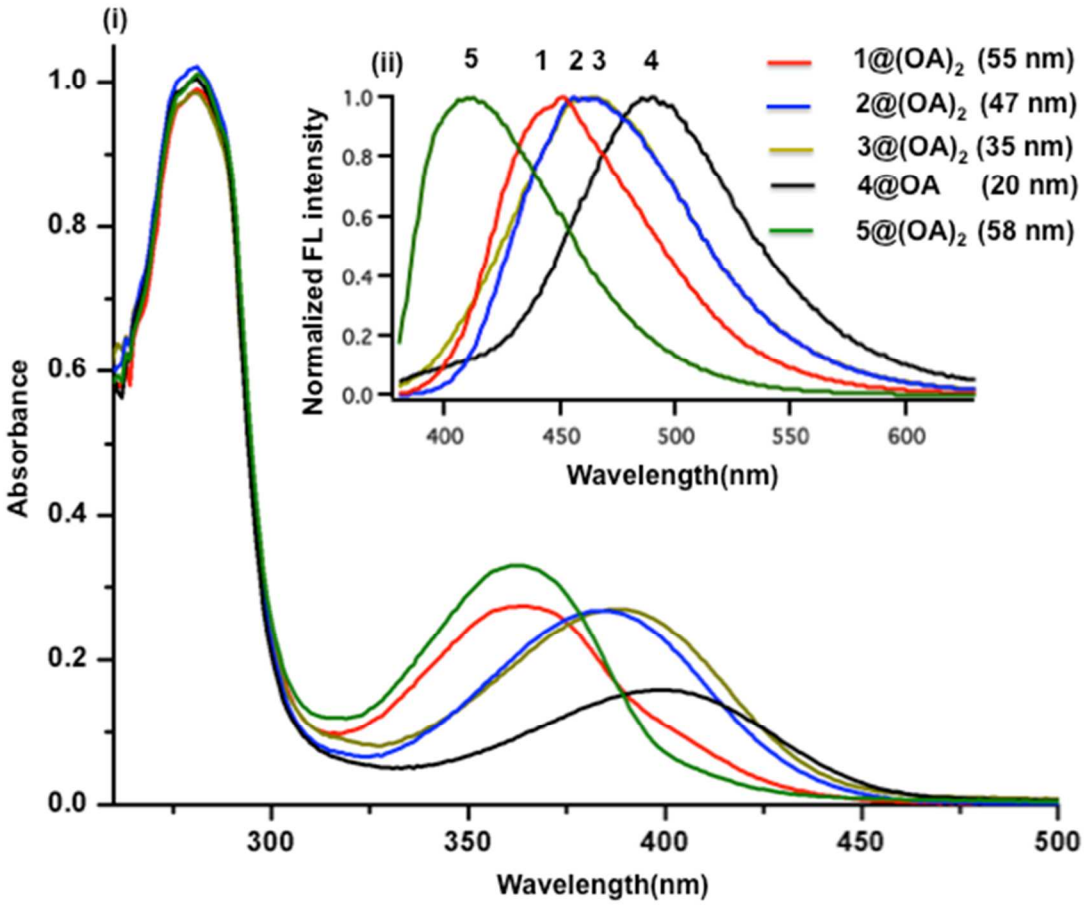


Figure S27. (i) Absorption spectra of **1**@$(OA)_2$ (red), **2**@$(OA)_2$ (blue), **3**@$(OA)_2$ (thick yellow), **4**@OA (black) and **5**@$(OA)_2$ (green); ([guest] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH = 7.4); Inset (ii) Normalized emission spectra of **1**@$(OA)_2$, **2**@$(OA)_2$, **3**@$(OA)_2$, **4**@OA and **5**@$(OA)_2$. Observed shifts with respect to those in aqueous media absent the OA are included in the parentheses.

(d) Decay of the fluorescence (Lifetime) of 1, 2 and 4 in water in the presence and absence of octa acid.

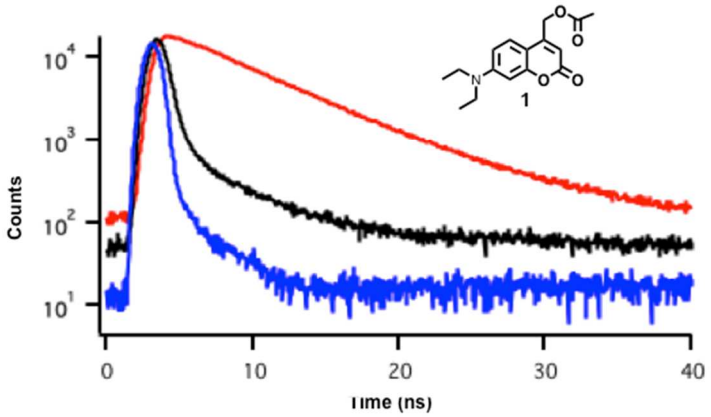


Figure S28.Decay of the fluorescence of **1** (black), **1**@$(OA)_2$ (red) and instrument response function (IRF, blue) ([**1**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4). The decay in the case of **1**@$(OA)_2$ is mono exponential with life time τ_1 = 5.5 ns (χ^2 = 1.08) and in the case of **1** in water without OA is biexponential with life time τ_1 = < 1 ns (55.2 %, χ^2 = 1.09) and τ_2 = 3.7 ns (44.8 %, χ^2 = 1.09). Emission decay was monitored at 450 ± 5 nm, and the sample was excited using LED at 360 ± 10 nm.

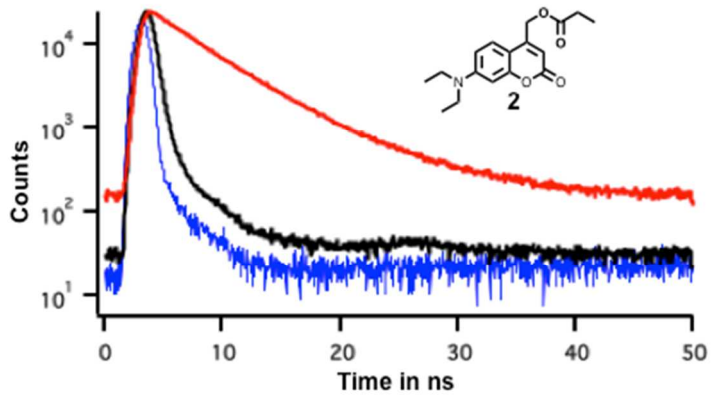


Figure S29.Decay of the fluorescence of **2** (black), **2**@$(OA)_2$ (red) and instrument response function (IRF, blue) ([**2**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4). The decay in the case of **2**@$(OA)_2$ is mono exponential with life time τ_1 = 5.0 ns (χ^2 = 1.09) and in the case of **2** in water without OA is biexponential with life time τ_1 = < 1 ns (82.5 %, χ^2 = 1.06) and τ_2 = 2.8 ns (17.5 %, χ^2 = 1.00). Emission decay was monitored at 450 ± 5 nm, and the sample was excited using LED at 360 ± 10 nm.

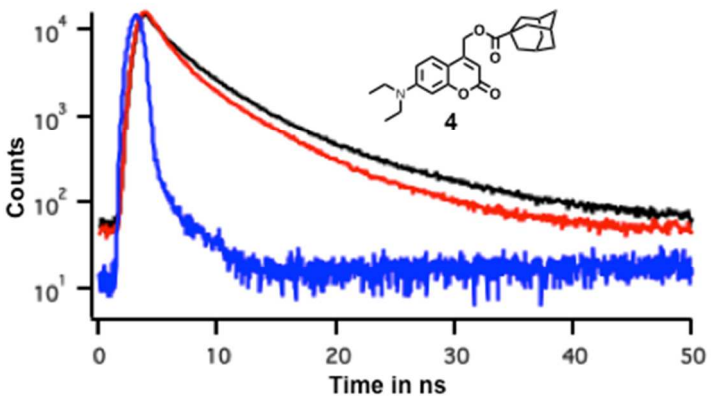


Figure S30. Decay of the fluorescence of **4** (black), **4**@OA (red) and instrument response function (IRF, blue) ([**4**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4). The decay in the case of **4**@OA is mono exponential with life time τ_1 = 5.2 ns (χ^2 = 1.0) and in the case of **4** in water without OA is mono exponential with life time τ_1 = 6.5 ns (χ^2 = 1.05). Emission decay was monitored at 450 ± 5 nm, and the sample was excited using LED at 360 ± 10 nm.

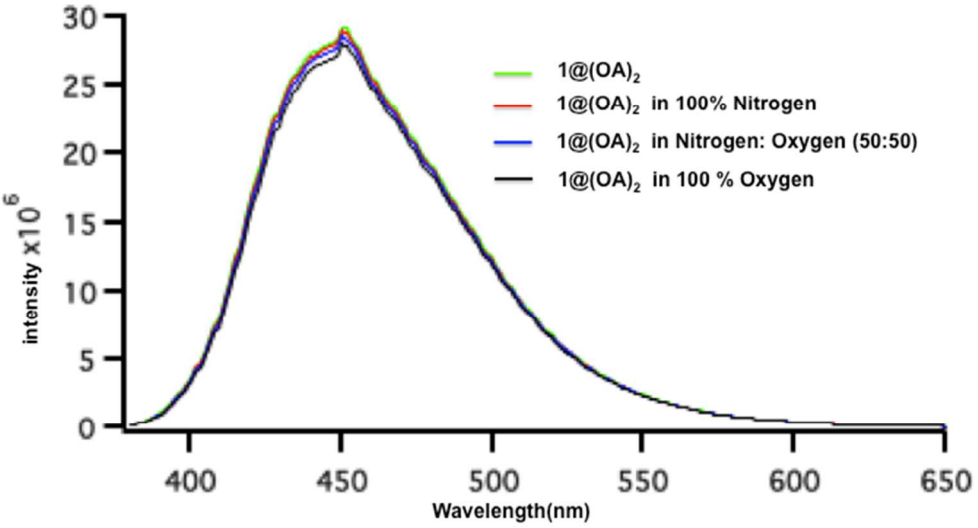


Figure S31. Emission spectra (λ_{exc}= 370 nm) of **1**@$(OA)_2$ (green) in aerated, **1**@$(OA)_2$ (red) in nitrogen purged solution, **1**@$(OA)_2$ (blue) in nitrogen: oxygen (50:50) purged solution and **1**@$(OA)_2$ (black) in oxygen saturated solution; ([**1**] = 2.5 x 10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

3.3 ^{1}H NMR titration spectra of octa acid with guests 1-4, and DOSY and COSY 2D-NMR spectra of the complex [1@(OA)$_2$]

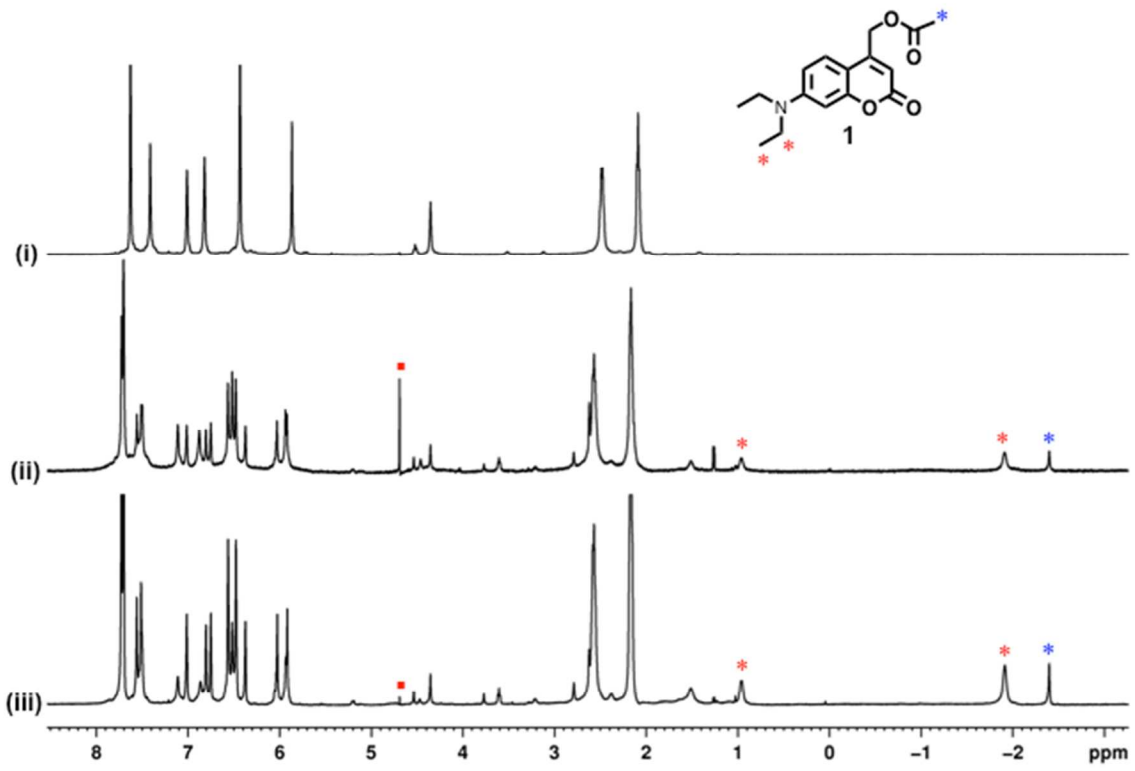


Figure S32. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) OA ([OA] = 1 mM); (ii) **1**@OA ([OA] = 1 mM and [**1**] = 0.25 mM); (iii) **1**@OA ([OA] = 1 mM and [**1**] = 0.5 mM); "* and *" indicate the OA bound guest proton peaks, ▪ indicates the residual solvent peak (water) of D_2O.

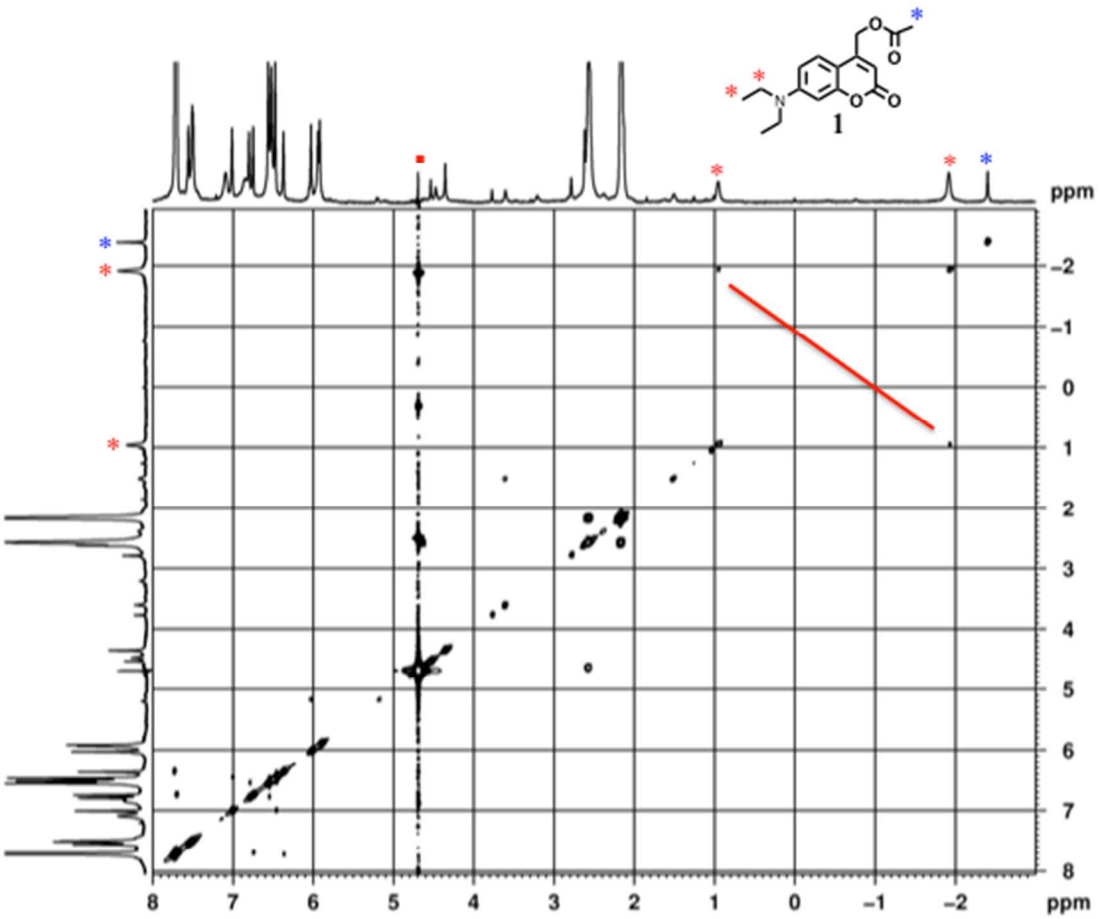


Figure S33. 2D COSY NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectrum of complex **1**@$(OA)_2$.; "* and *" indicate the OA bound guest proton peaks , ▪ indicates the residual solvent peak (water) of D_2O.

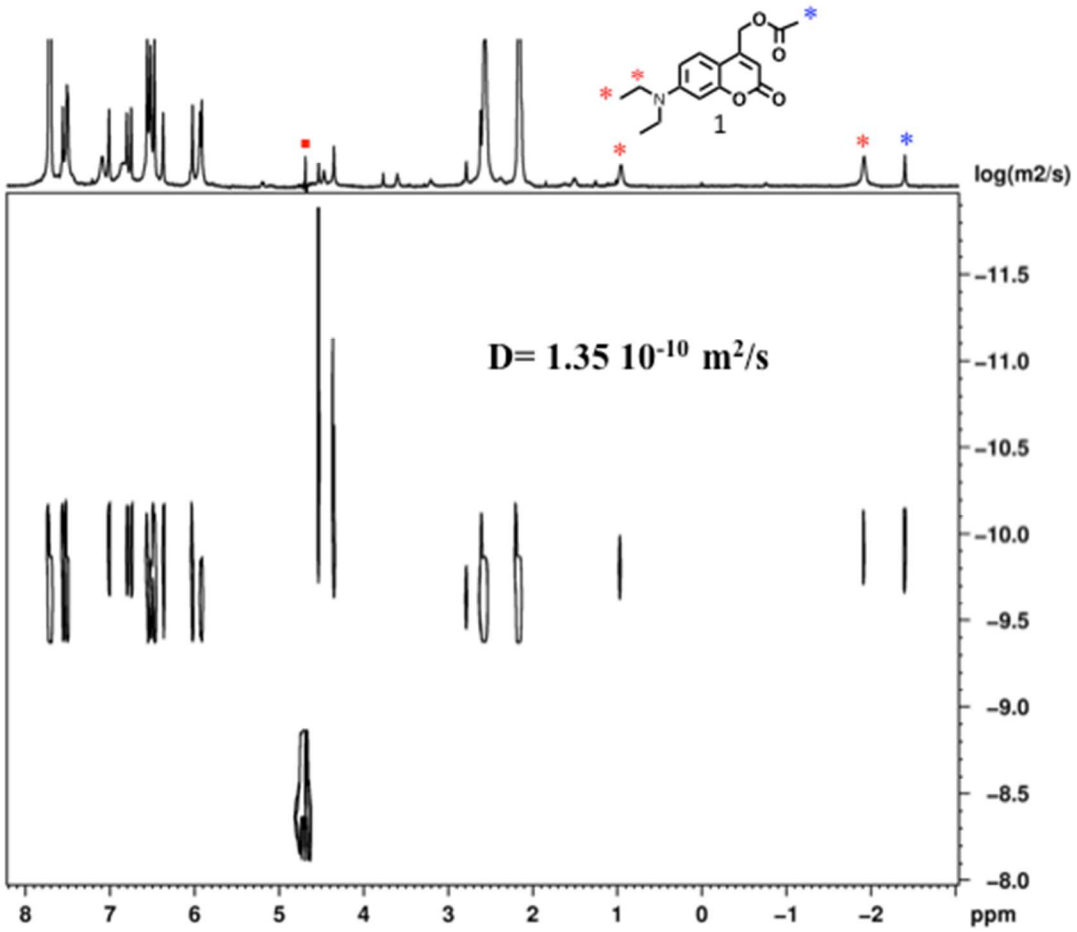


Figure S34. 2D DOSY NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectrum of (i) **1**@$(OA)_2$ ([OA] = 1 mM and [**1**] = 0.5 mM). "* and *" indicate the OA bound guest proton peaks, ▪ indicates the residual solvent peak (water) of D_2O.

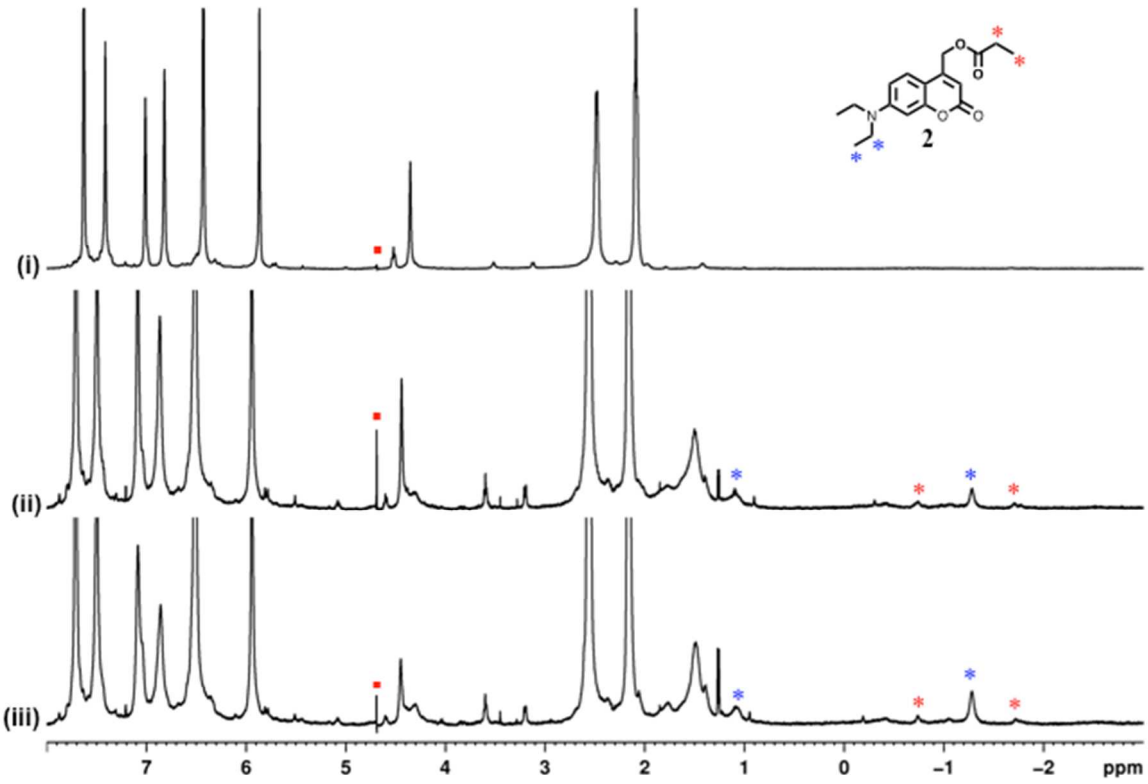


Figure S35. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) OA ([OA] = 1 mM); (ii) **2**@OA ([OA] = 1 mM and [**2**] = 0.25 mM); (iii) **2**@OA ([OA] = 1 mM and [**2**] = 0.5 mM); "* and *" indicate the OA bound guest proton peaks, ▪ indicates the residual solvent peak (water) of D_2O.

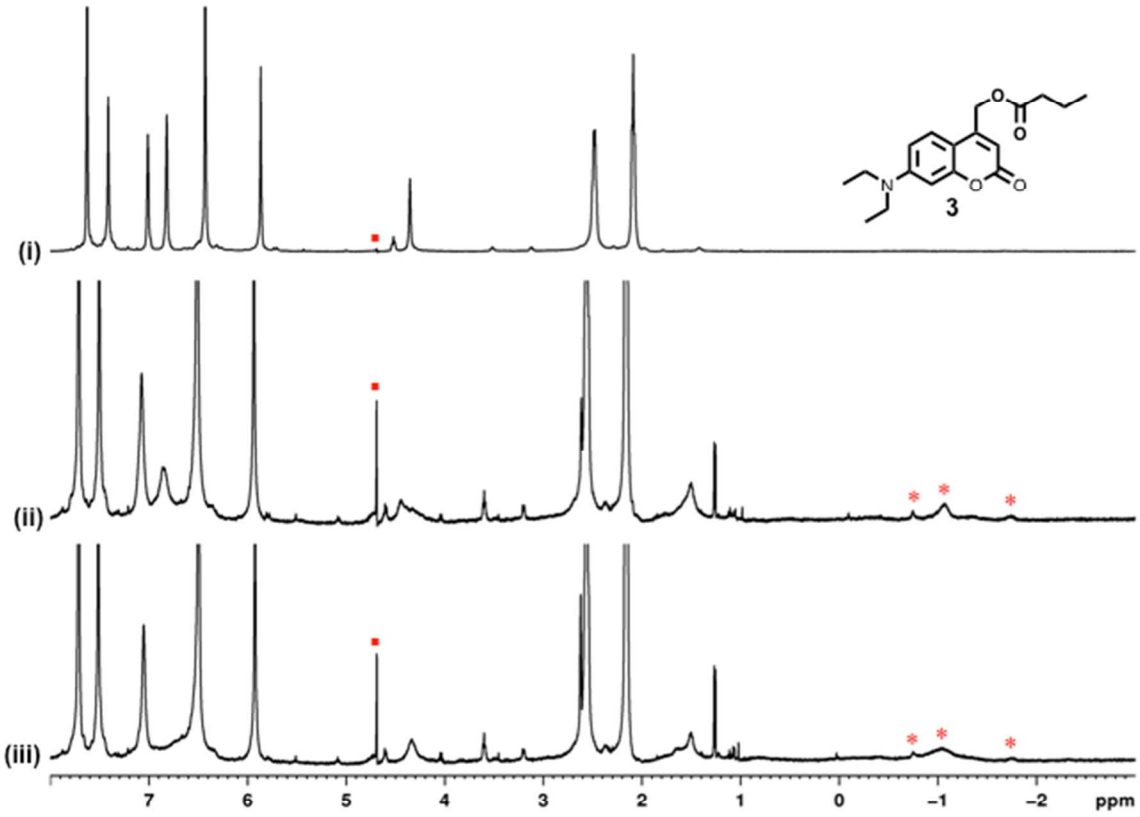


Figure S36. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) OA ([OA] = 1 mM); (ii) **3**@OA ([OA] = 1 mM and [**3**] = 0.25 mM); (iii) **3**@OA ([OA] = 1 mM and [**3**] = 0.5 mM); "*" indicate the OA bound guest proton peaks, ▪ indicates the residual solvent peak (water) of D_2O.

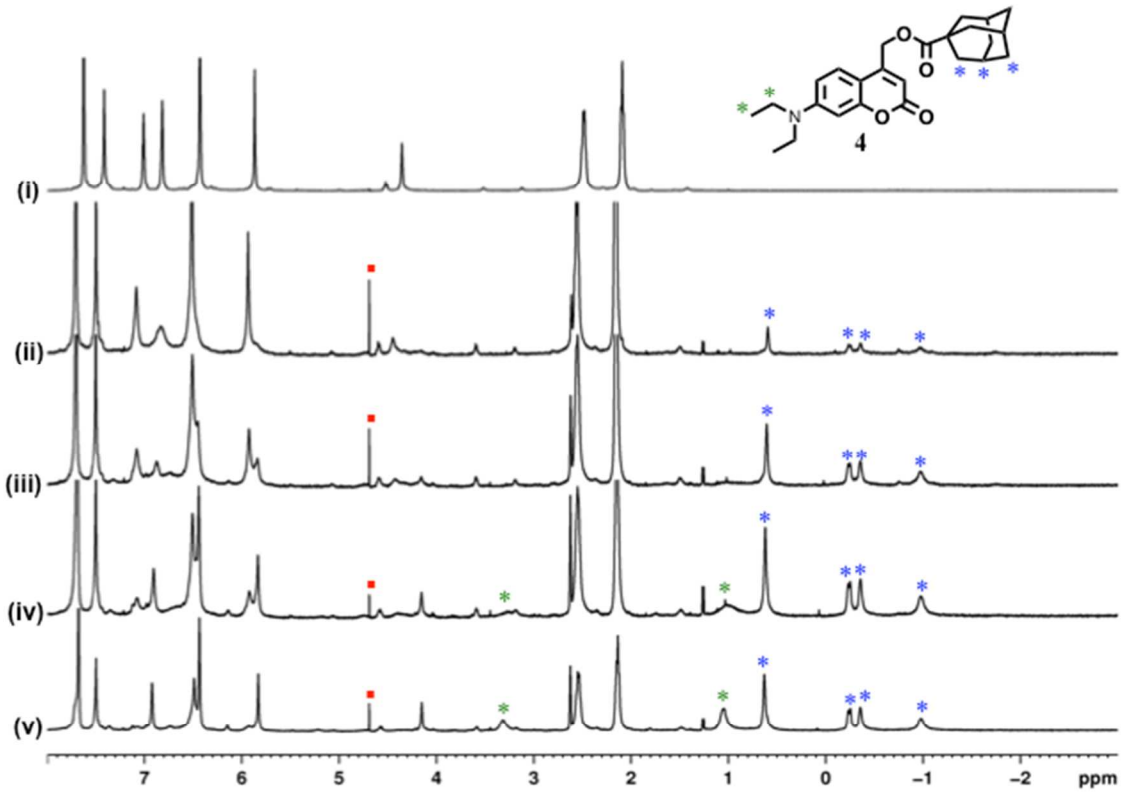


Figure S37. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) OA ([OA] = 1 mM); (ii) **4**@OA ([OA] = 1 mM and [**4**] = 0.25 mM); (iii) **4**@OA ([OA] = 1 mM and [**4**] = 0.5 mM); (iv) **4**@OA ([OA] = 1 mM and [**4**] = 0.75 mM); (v) **4**@(OA ([OA] = 1 mM and [**4**] = 1.0 mM); * indicates the OA bound guest proton peaks, "*" indicates the NCH_2CH_3 peaks, ▪ indicates the residual solvent peak (water) of D_2O.

3.4 ^{1}H NMR spectra of irradiated samples

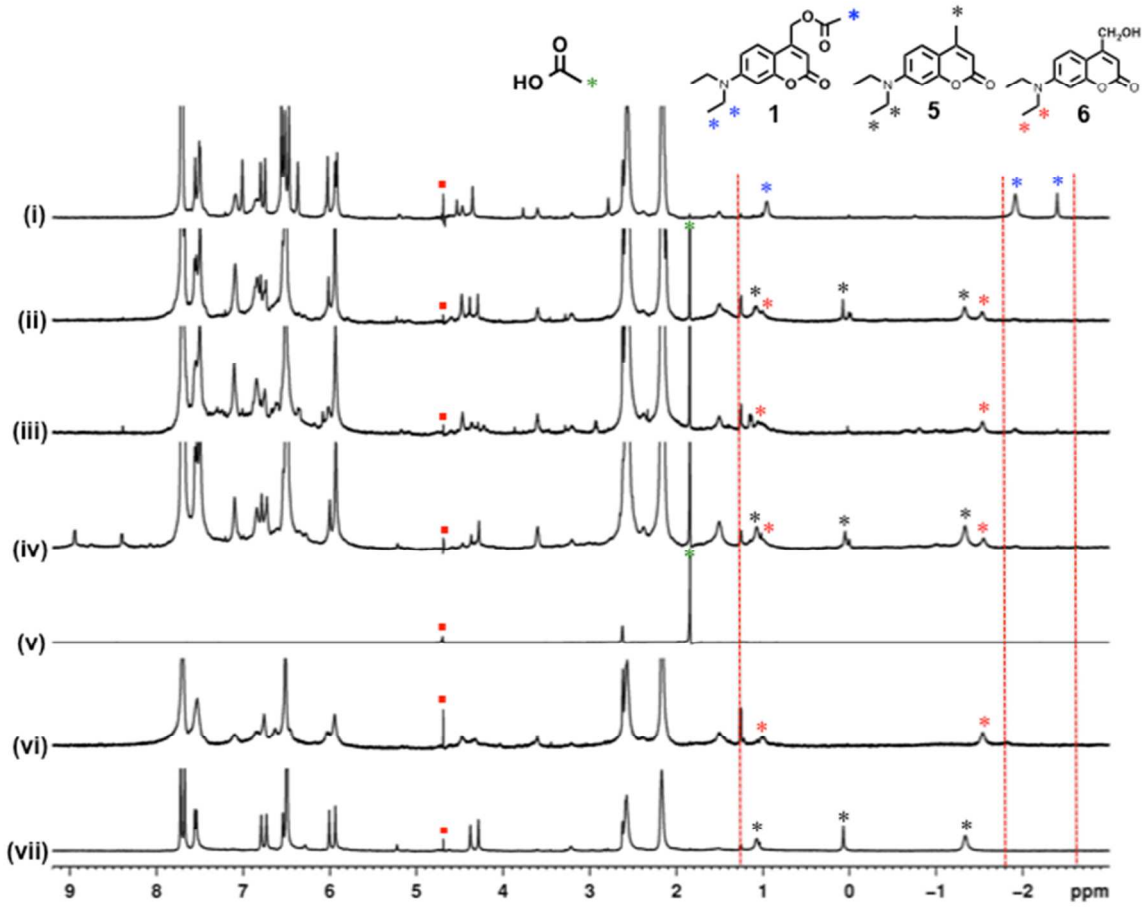


Figure S38. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) **1**@$(OA)_2$ ([1]= 0.5 mM; [OA] = 1 mM); (ii) 5h irradiation of (i) in nitrogen purged solution; (iii) 16h irradiation of (i) in oxygen saturated solution; (iv) 30 h irradiation of (i) in nitrogen purged solution in presence of 0.5 mM of MV (methyl viologen); (v) **7** in buffer; (vi) **6**@$(OA)_2$ ([**6**]= 0.5 mM; [OA] = 1 mM); (vii) **5**@$(OA)_2$ ([**5**]= 0.5 mM; [OA] = 1 mM). "* * *" indicate the OA bound guest proton peaks, " * " indicates the methyl peak of acetic acid, ▪ indicates the residual solvent peak (water) of D_2O.

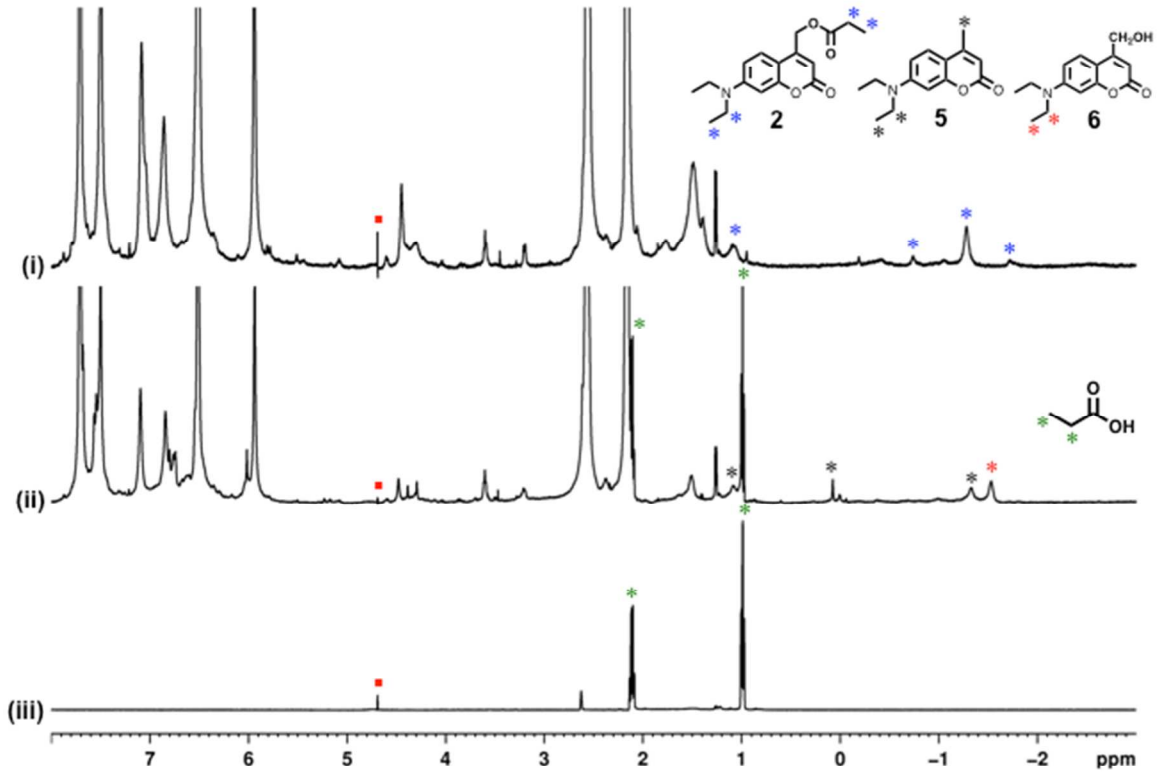


Figure S39. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) **2**@$(OA)_2$ ([**2**]= 0.5 mM; [OA] = 1 mM); (ii) 40 min irradiation of (i) in nitrogen purged solution; (iii) **8** in buffer. "* * *" indicate the OA bound guest proton peaks, " * " indicates the propionic acid peaks, ▪ indicates the residual solvent peak (water) of D_2O.

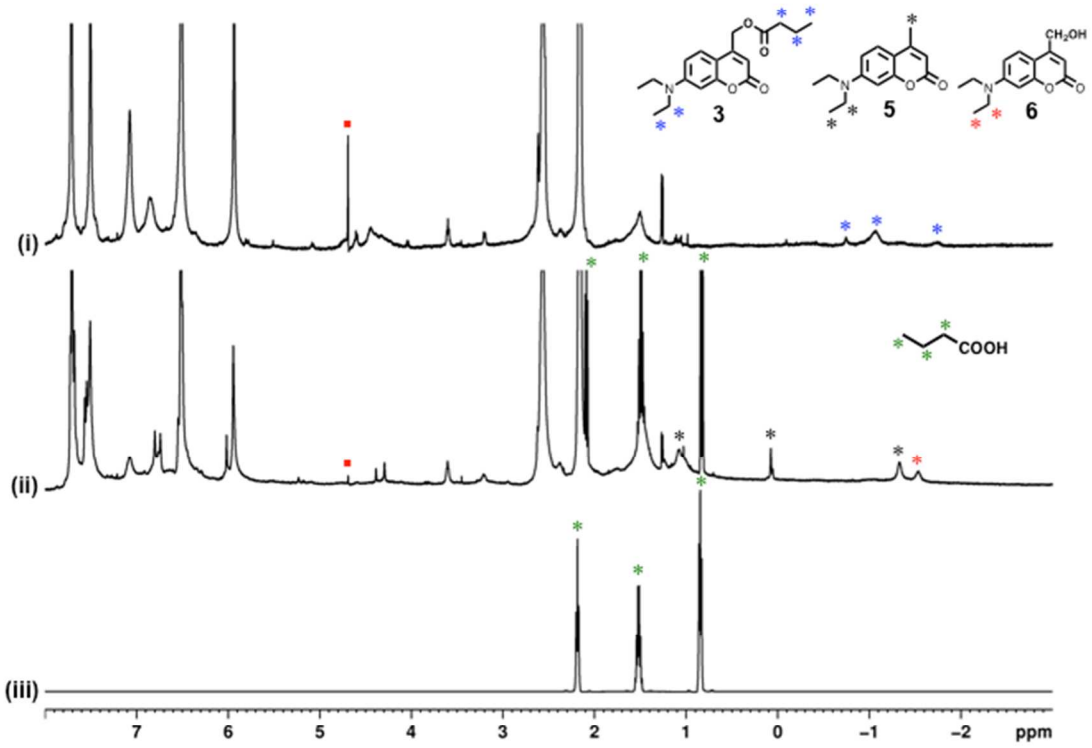


Figure S40. ^{1}H-NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) **2**@$(OA)_2$ ([**2**]= 0.5 mM; [OA] = 1 mM); (ii) 30 min irradiation of (i) in nitrogen purged solution; (iii) **9** in buffer. "* * *" indicate the OA bound guest proton peaks, " * " indicates the butyric acid peaks,▪ indicates the residual solvent peak (water) of D_2O.

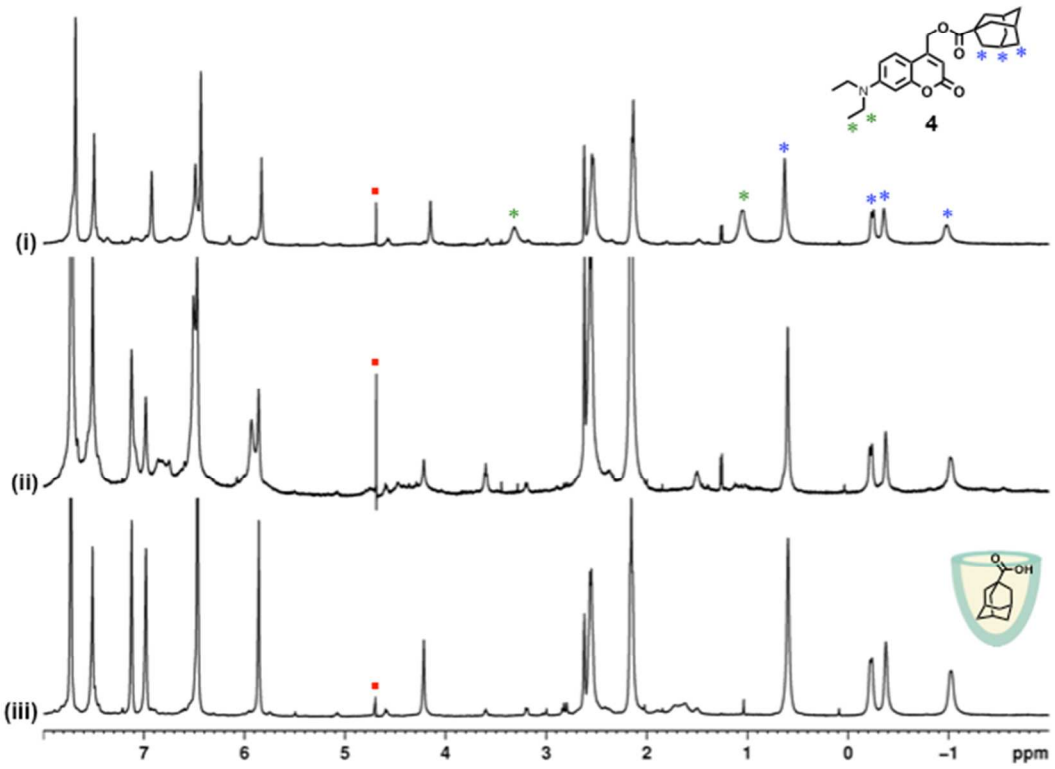


Figure S41. ^{1}H NMR (500 MHz, 10 mM $Na_2B_4O_7$ buffer/D_2O, pH = 8.7) spectra of (i) **4**@OA ([OA] = 1 mM and [**4**] = 0.5 mM); (ii) 20 min irradiation of (i) in nitrogen purged; (iii) **10**@OA ([OA] = 1 mM and [**10**] = 1.0 mM); "*" indicate the OA bound guest proton peaks, "*" indicates the NCH_2CH_3 peaks, ▪ indicates the residual solvent peak (water) of D_2O.

3.5 Fluorescence spectra of irradiated samples

(a) Photolysis studies of 1@(OA)$_2$

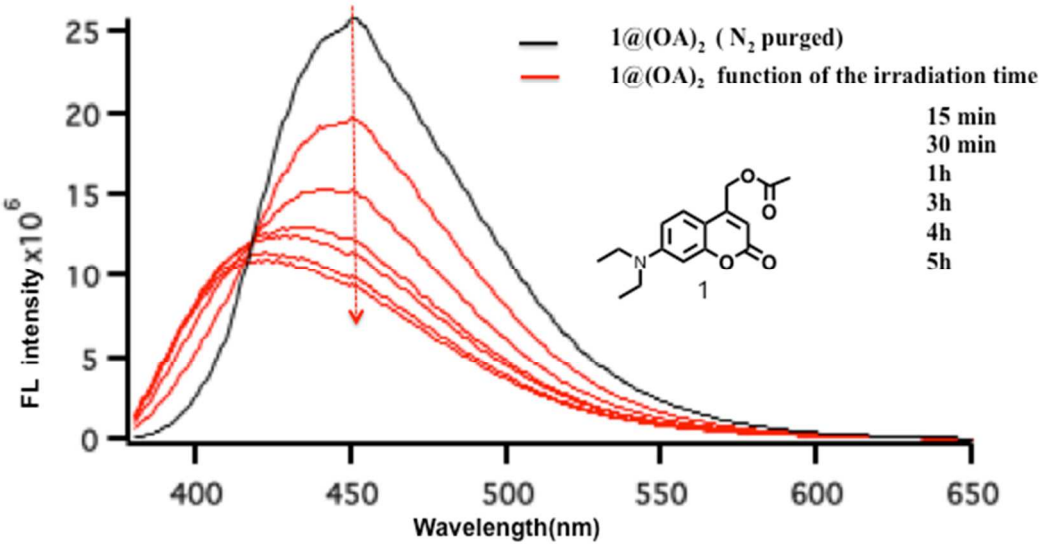


Figure S42. Emission spectra (λ_{exc}= 370 nm) of **1**@(OA)$_2$ as function of the irradiation time (0 - 5h) in nitrogen purged solution; ([**1**] = 2.5 x10^{-5} M, [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

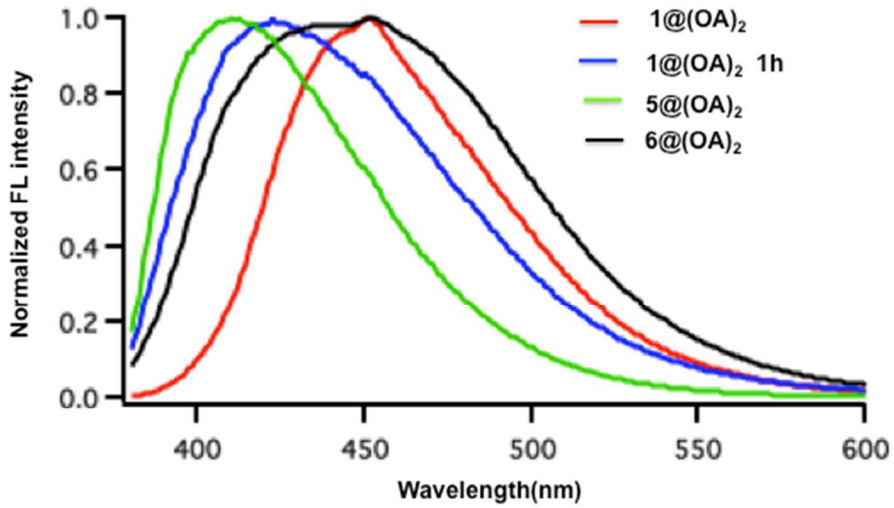


Figure S43. Emission spectra (λ_{exc}= 370 nm) of **1**@(OA)$_2$ (red), **1**@(OA)$_2$ after 1 h irradiation in nitrogen purged solution (blue)**,** **6**@(OA)$_2$ (black)**,** and **5**@(OA)$_2$ (green); ([**guest**] = 2.5 x 10^{-5} M, [OA] = 5x10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

(b) Photolysis studies of 4@OA (in excess OA)

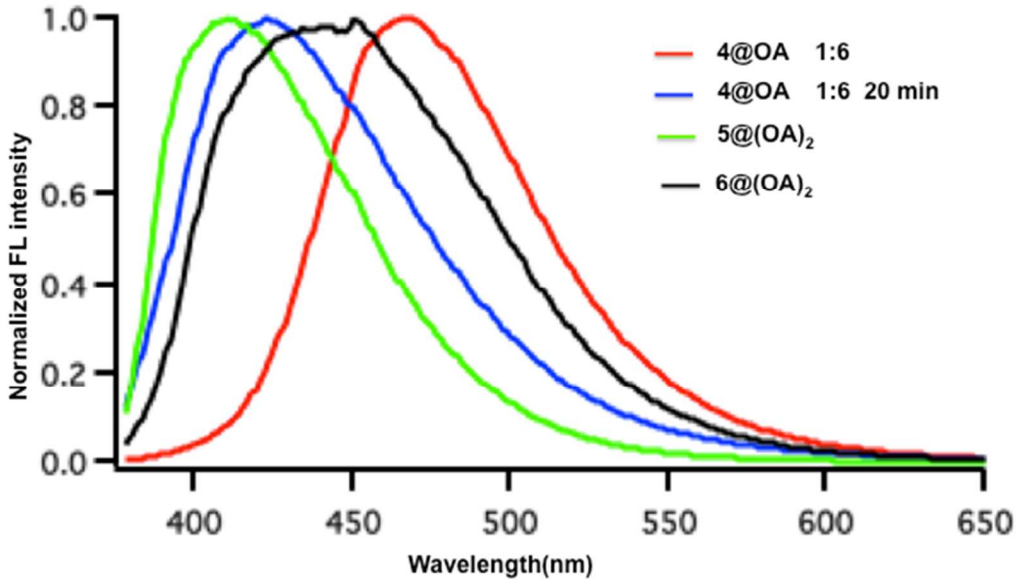


Figure S44. Emission spectra (λ_{exc}= 370 nm) of **4**@OA ([**4**] =2.5x10^{-5} M and [OA] = 15 x 10^{-5} M) before irradiation (red) and after 20 min irradiation in nitrogen purged solution (blue)**, 6**@$(OA)_2$ (black) and **5**@$(OA)_2$ (green); ([**5**] = [**6**] = 2.5 x 10^{-5} M and [OA] = 5 x 10^{-5} M in phosphate buffer/H_2O, pH= 7.4).

3.6 Solvolysis of compounds 1 - 4 on time and yields of formed products

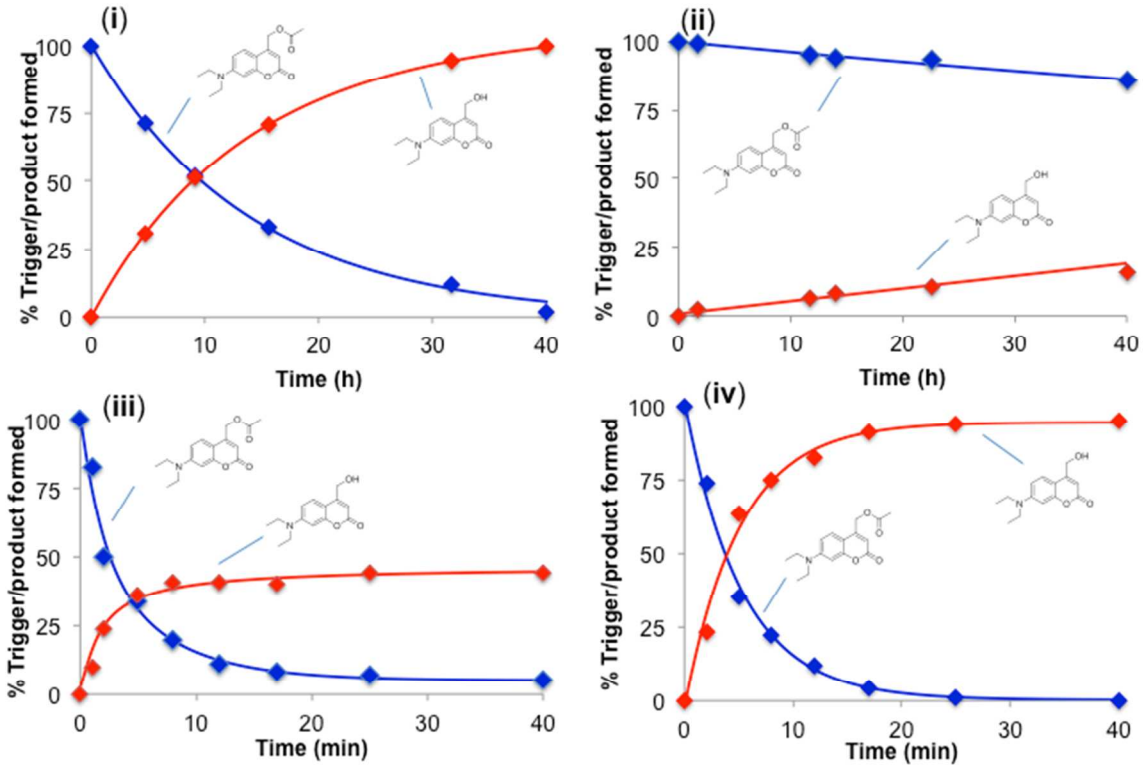


Figure S45. Solvolysis of **1** under different conditions. (**i**) aqueous buffer in dark; (**ii**) aqueous buffer with OA in the dark; (**iii**) photosolvolysis in aqueous buffer ($\lambda > 300$ nm), N_2 atmosphere; (**iv**) photosolvolysis in aqueous buffer ($\lambda > 300$ nm), air equilibrated. [**1**] = 100 μM, [OA] = 200 μM, in 10 mM $Na_2B_4O_7$. Note the time scales for thermal solvolysis and photosolvolysis are different.

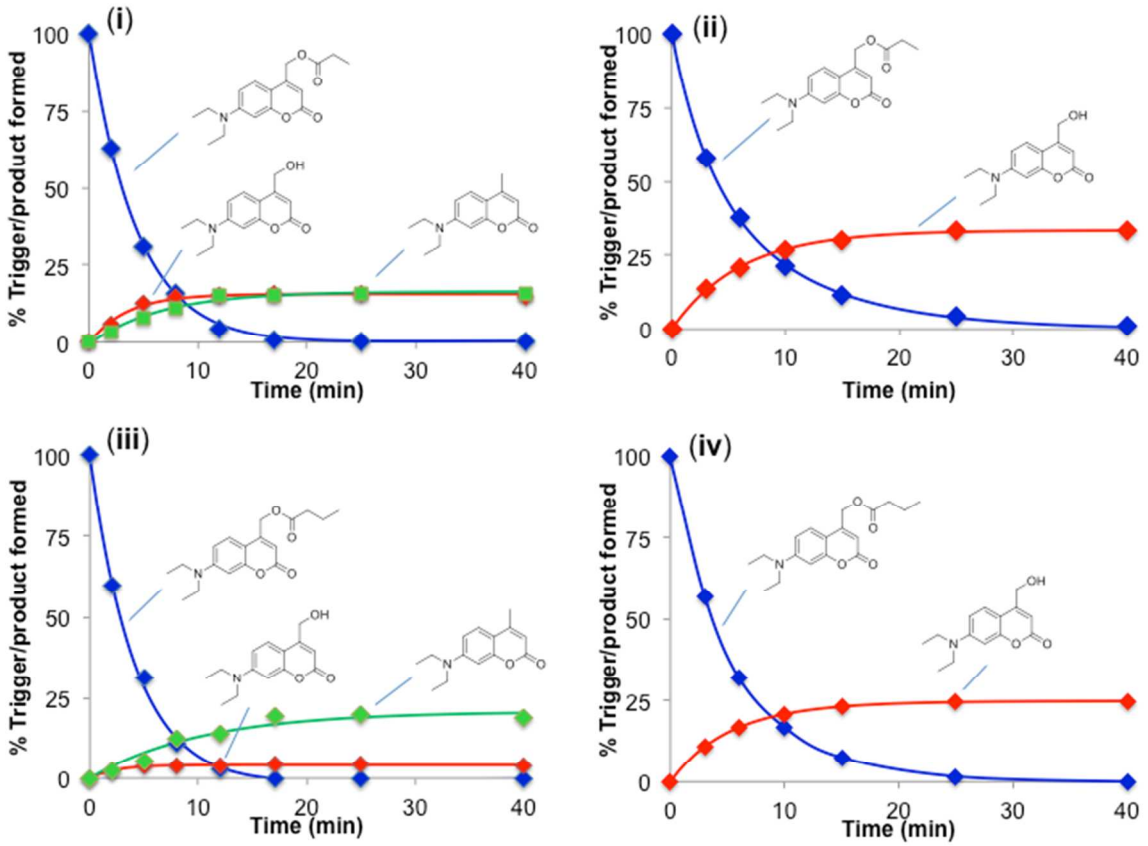


Figure S46. Solvolysis of **2** and **3** under different conditions. (**i**) Photosolvolysis of **2** in aqueous buffer with OA (λ>300 nm), N_2 atmosphere; (**ii**) photosolvolysis of **2** in aqueous buffer with OA (λ>300 nm), air equilibrated; (**iii**) photosolvolysis of **3** in aqueous buffer with OA (λ>300 nm), N_2 atmosphere; (vi) photosolvolysis of **3** in aqueous buffer with OA (λ>300 nm), air equilibrated. [**2**]/[**3**] = 100 μM, [OA] = 200 μM, in 10 mM $Na_2B_4O_7$.

3.7 LC-DAD-MS traces of irradiated samples

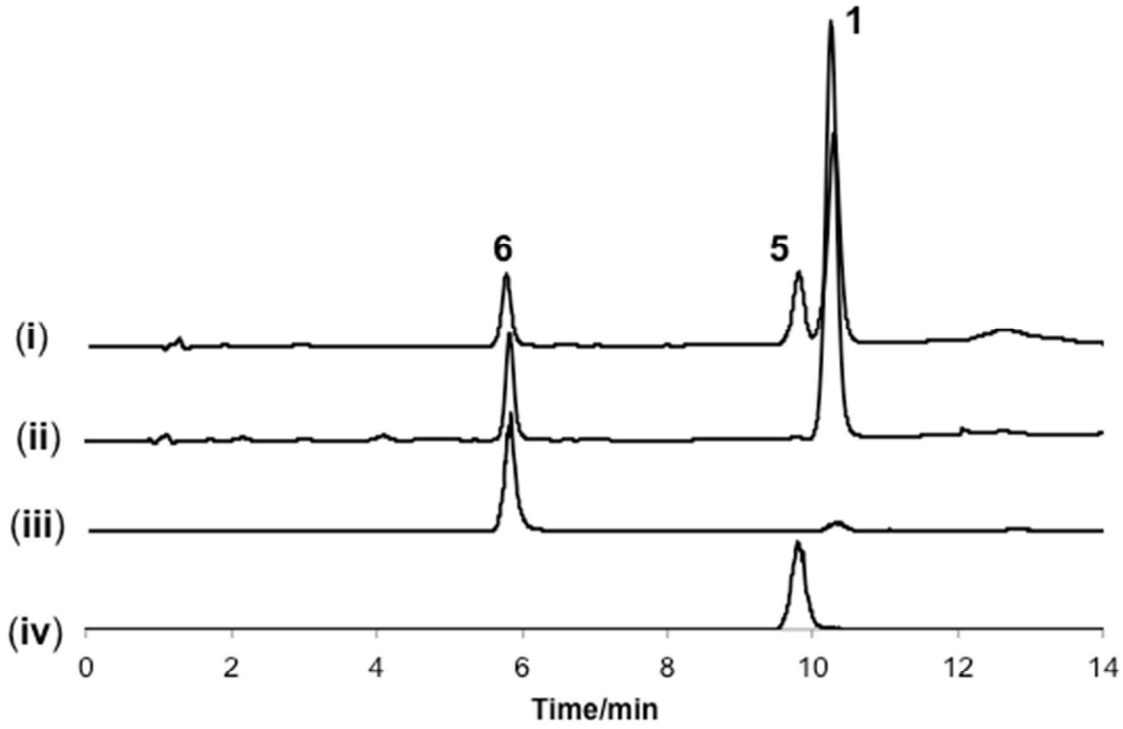


Figure S47. LC-DAD (380 nm) and LC-MS traces of **1**@$(OA)_2$ after 30 min irradiation. (**i**) LC-DAD trace of irradiated (λ>300 nm) N_2 purged solution, (**ii**) LC-DAD trace of air equilibrated solution, (**iii**) LC-MS trace at m/z 248, $[\mathbf{6}+H]^+$, of irradiated N_2 purged solution, (**iv**) LC-MS trace at m/z 232, $[\mathbf{5}+H]^+$, of irradiated N_2 purged solution. [**1**] = 250 μM, [OA] = 500 μM, in 10 mM $Na_2B_4O_7$.

4. Yields of products/photoproducts

Table S1. Yields of photoproducts upon irradiation of triggers **1**-**4** as monitored by LC-DAD-MS at 380 nm (guest-host 100 μM:200 μM)[a] (See **Figure S46**)

Trigger	N_2/Air	Yield of **5**	Yield of **6**
1 **free**	N_2	< 1	55
	Air	-	88
1 **in OA**	N_2	11	29
	Air	-	41
2 **in OA**	N_2	8	16
	Air	-	33
3 **in OA**	N_2	6	5
	Air	-	25
4 **in OA**	N_2	1.5	42
	Air	-	32

[a] Standard errors: 10-15%

Table S2. Disappearance (%) of compounds **1** and **4** at 2 min and 25 min of irradiation.[a] (See **Figure S46**)

Conditions	2 minutes irradiation		25 minutes irradiation	
	Conversion, N_2	Conversion, Air	Conversion, N_2	Conversion, Air
Compound **1**	24	22	79	71
Compound **4**	16	22	98	73

[a] Standard errors ~15%

Table S3. Estimated initial reaction rates, in μM $minute^{-1}$, of compounds **1** and **4** under N_2 and air.[a] (See **Figure S46**)

Conditions	**N_2**	**Air**
Compound **1**	15	12
Compound **4**	14	12

[a] Standard errors ~15%

5. Cartoon representation of host-guest complexes

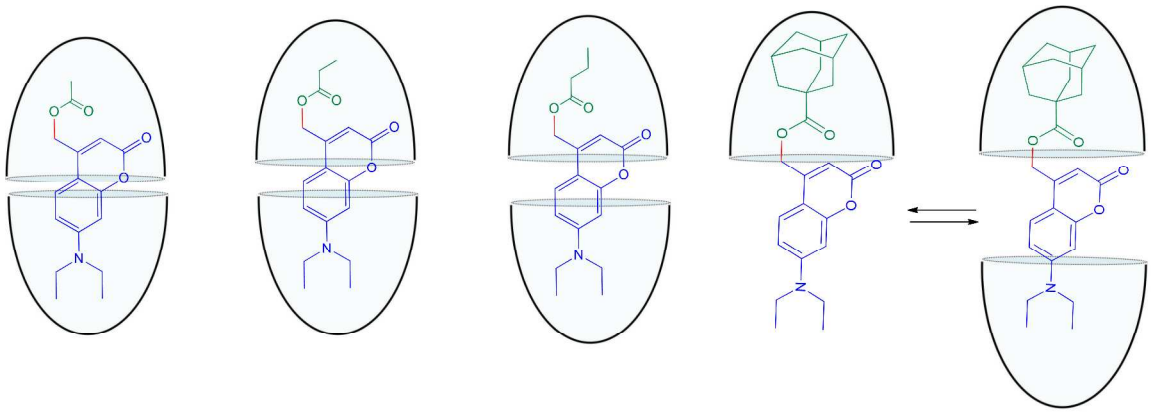


Figure S48. Cartoon representation of the OA capsules of **1**-**4**. Depending on the length and size of the guest the capsule expands.

6. Proposed mechanism for the photodeprotection and release of carboxylic acid

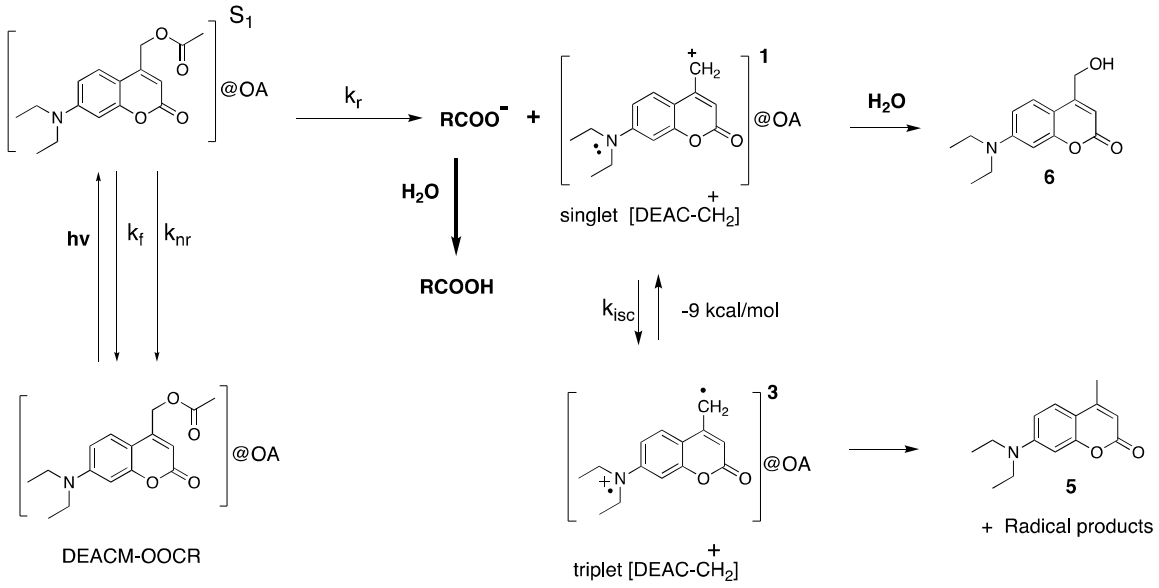


Figure S49. Proposed mechanism for the photorelease of carboxylic acid from encapsulated DEACM acetate. k_f, k_{nr} and k_r represents rate constants of fluorescence, non-radiative process and heterolytic cleavage.

7. References

1. Gibb, C. L. D.; Gibb, B. C. *J. Am. Chem. Soc.* **2004**, 126, 11408.
2. Zhang, X.; Xi, W.; Wang, C.; Podgorski, M.; Bowman, C.N.; *ACS Macro Lett***. 2016,** 5, 229-233.
3. Fournier, L.; Aujard, I.; Saux, T. L.; Maurin, S.; Beaupierre, S.; Baudin, J.; Jullien, L.; *Chem. Eur. J.* **2013**, 19, 17494 – 17507.