Literature Report

Reporter: 鲍鹏骏
Date: 2022-5-19

Literature Source

COMMUNICATION

Red-Shifted Water-Soluble BODIPY Photocages for Visualisation and Controllable Cellular Delivery of Signaling Lipids

Anna Poryvai,[a] Maksym Galkin,[a] Volodymyr Shvadchak[a],[b] and Tomáš Slanina*[a]

Tomáš Slanina received his M.S. degree from Masaryk University, Brno, Czech Republic, in 2012.

He received his Ph.D. in Organic Chemistry in 2015 in a joint programme between Masaryk University and the University of Regensburg, Germany, under the supervision of Prof. Petr Klán and Prof. Burkhard König.

He then worked as a postdoctoral fellow in the group of Prof. Alexander Heckel of Goethe University in Frankfurt, Germany and the group of Prof. Henrik Ottosson of Uppsala University, Sweden.

Since 2019, Tomáš Slanina has been working at the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences. There he became the leader of a junior research group studying redox photochemistry
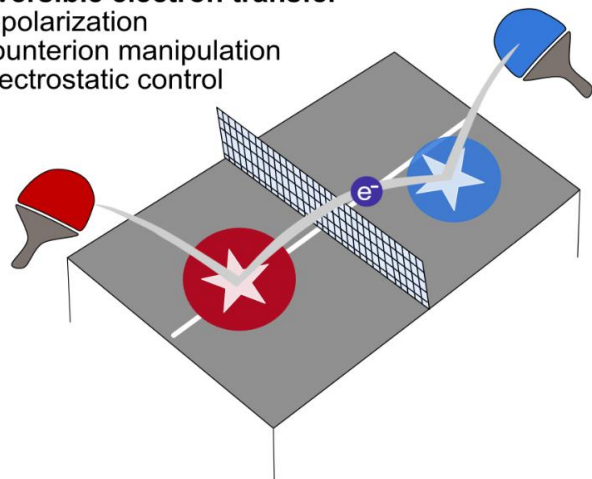
Tomáš Slanina

RedOx Photochemistry :Focuses on the development of small organic molecules that undergo electron transfer and/or can be activated by light.
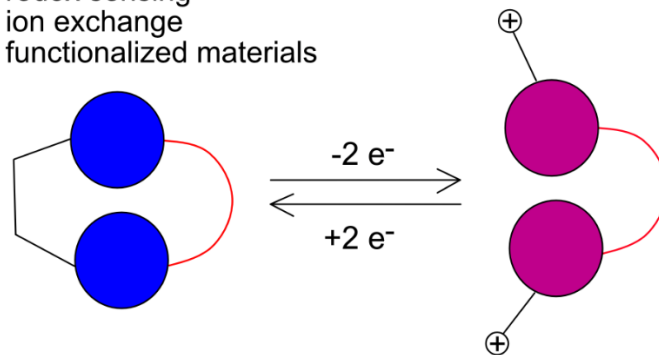
Reversible electron transfer
- repolarization
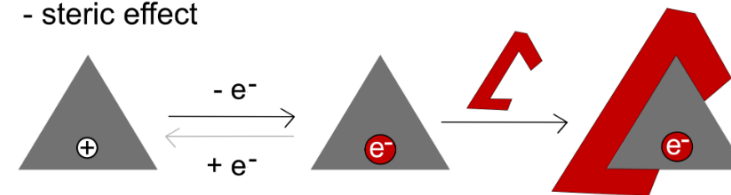- counterion manipulation
- electrostatic control

Molecular redox switches
- redox sensing
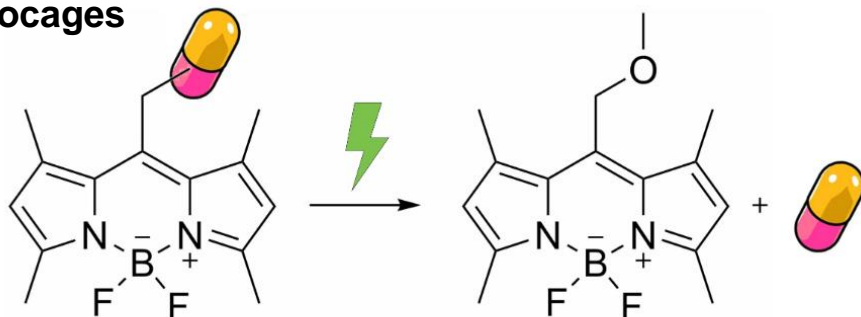- ion exchange
- functionalized materials

$-2 e^-$

$+2 e^-$

Stabilization of radical species
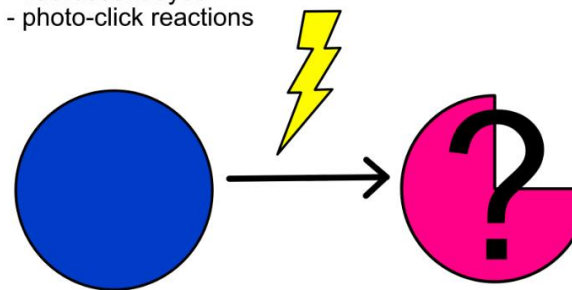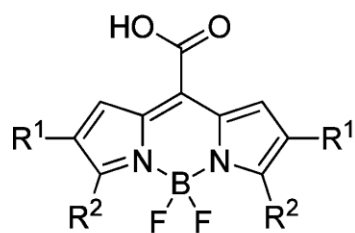- complexation
- subsequent reaction
- steric effect

$- e^-$

$+ e^-$

Photocages

Photoactivatable compounds
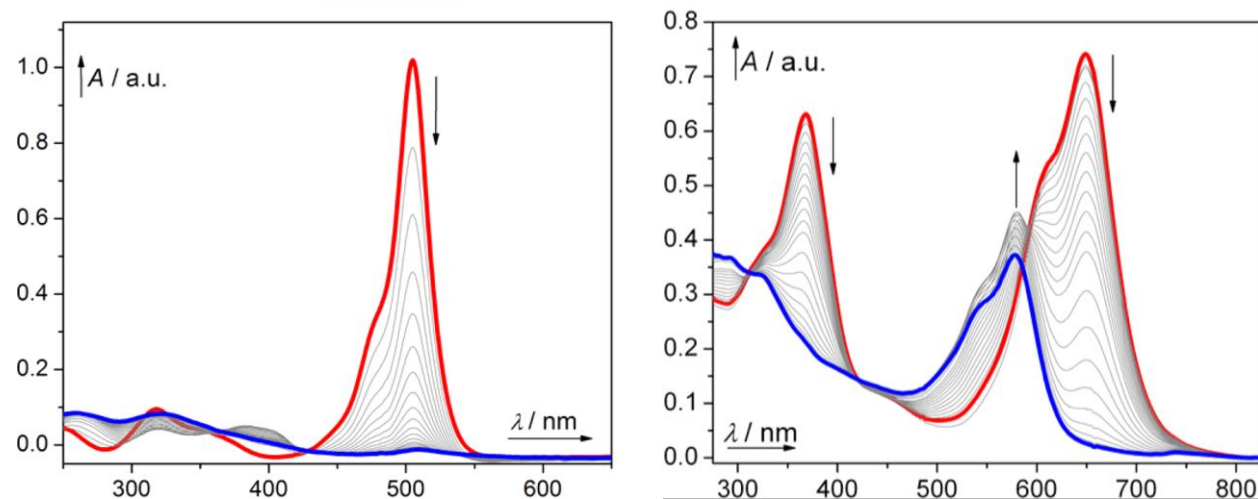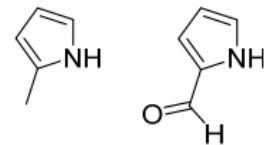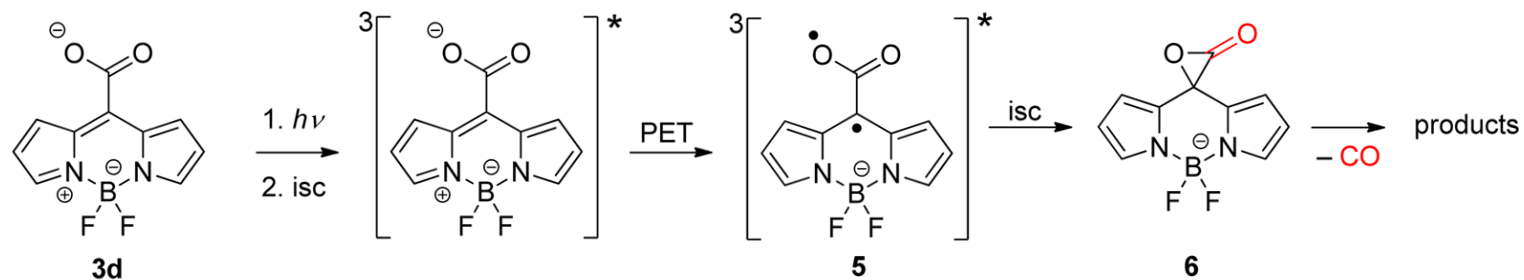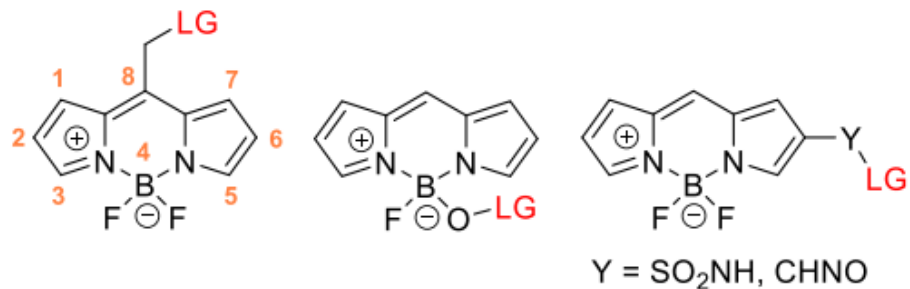- reversible photochemistry
- fluorescent dyes
- photo-click reactions
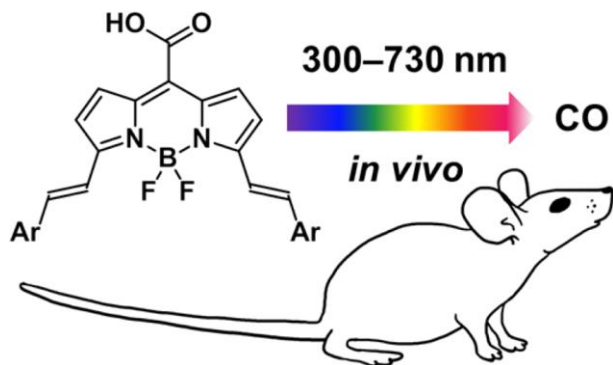
Figure 3. Irradiation of 3a at 500 nm (top) and 3b at 625 nm (bottom) in aerated phosphate buffer solutions (pH = 7.4). The spectra prior to (red line) and after (blue line) the irradiation are highlighted.
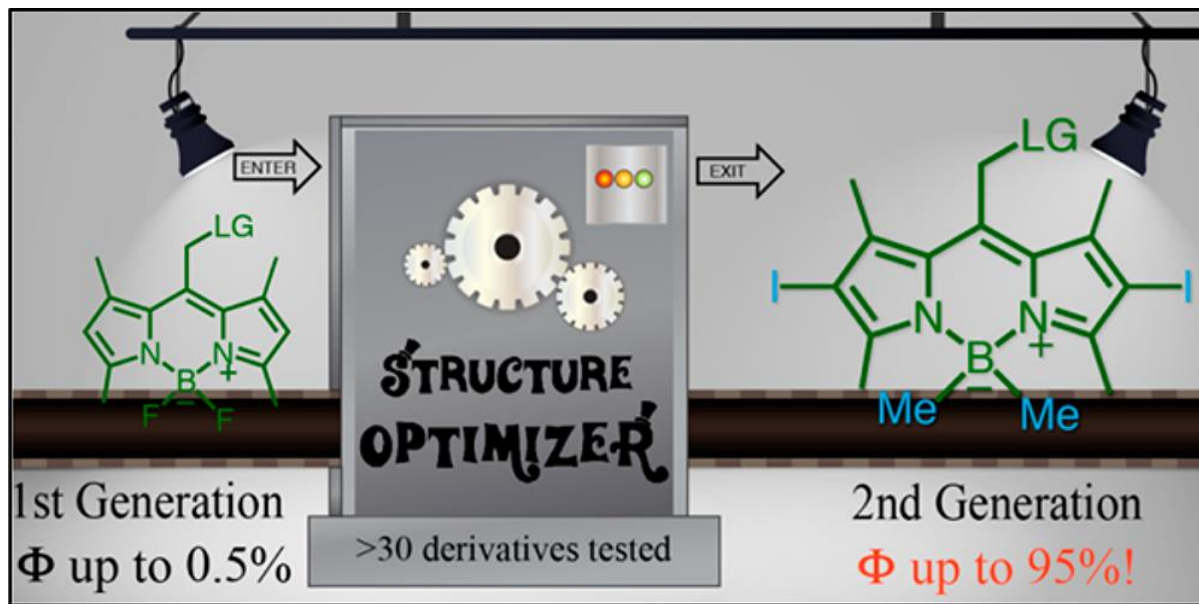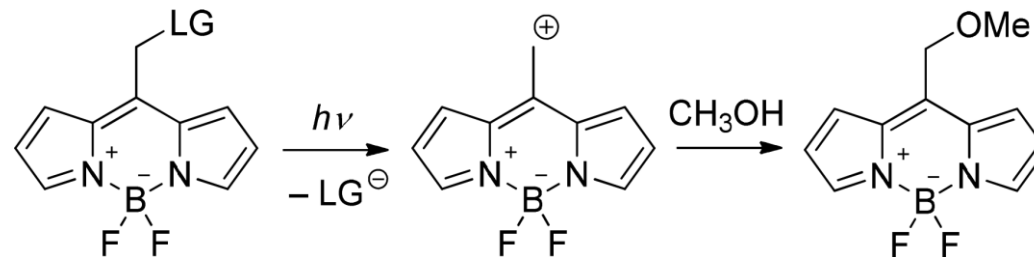
3a: R^1 = H, R^2 = Me

3b: R^1 = H, R^2 = $\overset{}{\underset{}{}}$ —O(CH$_2$CH$_2$O)$_3$CH$_3$

以BODIPY为母体的光裂解分子

①

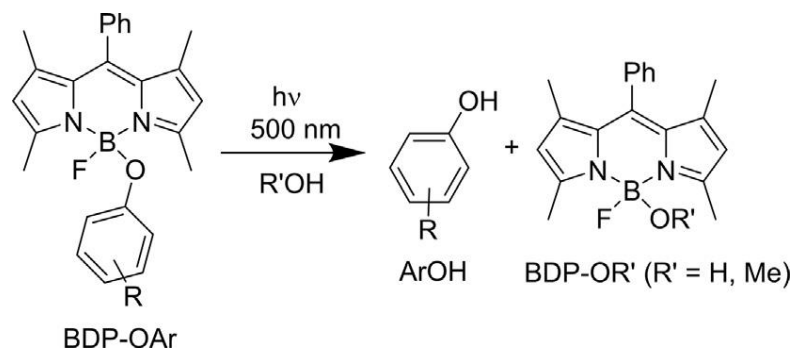*Chem. Rev.* **2020**, 120, 13135-13272.

J. Am. Chem. Soc. **2017**, 139, 42, 15168–15175.
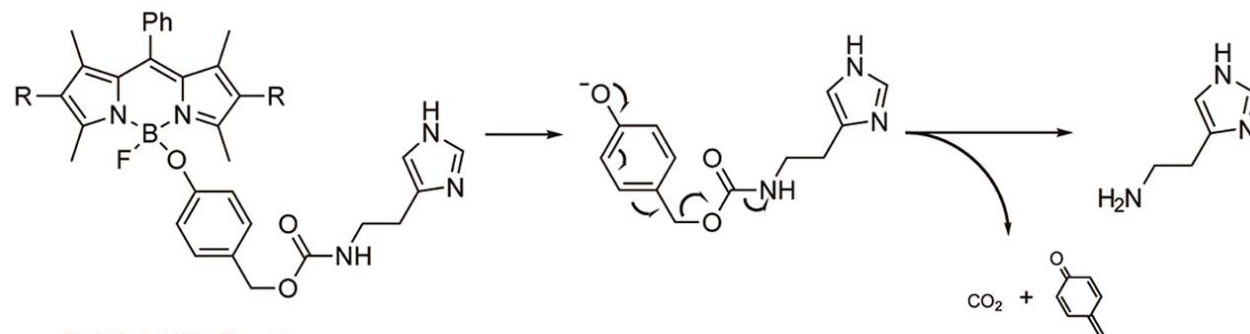
②

$\Phi_r = 1.5 \times 10^{-7} - 7.4 \times 10^{-5}$

Bioorganic & Medicinal Chemistry Letters. **2018**, 28, 1–5.

$\Phi_r = 3 - 3.9 \times 10^{-4}$
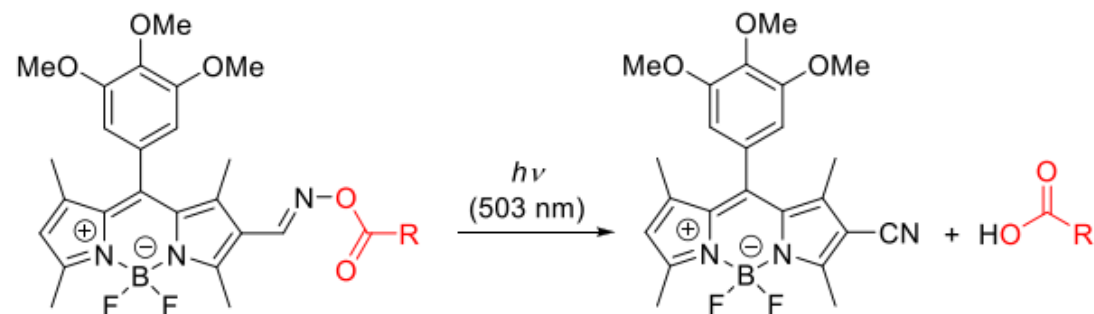
ACS Chem. Biol. **2014**, 9, 2242-2246.

③
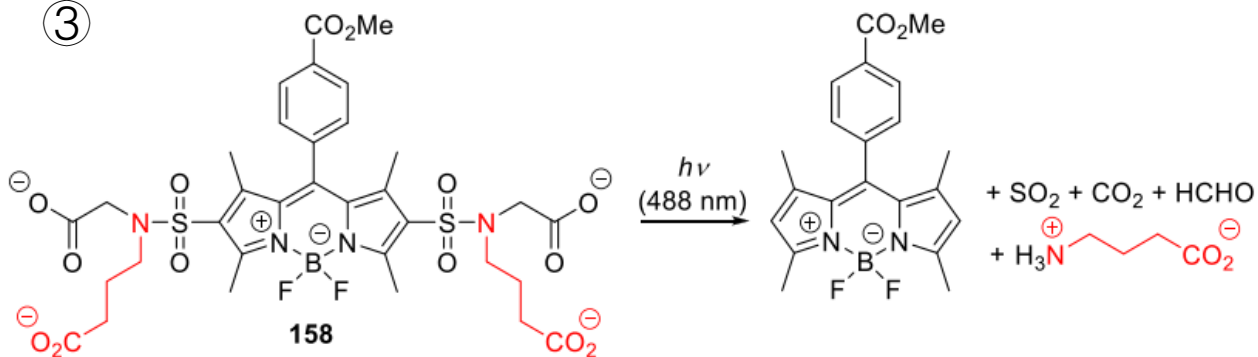
ChemBioChem. **2016**, 17, 1233-1240.

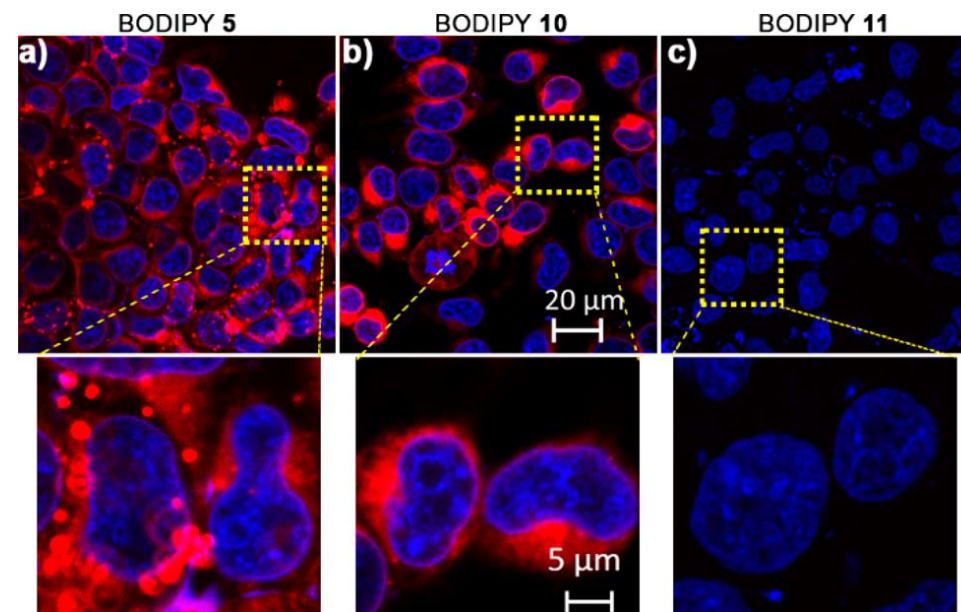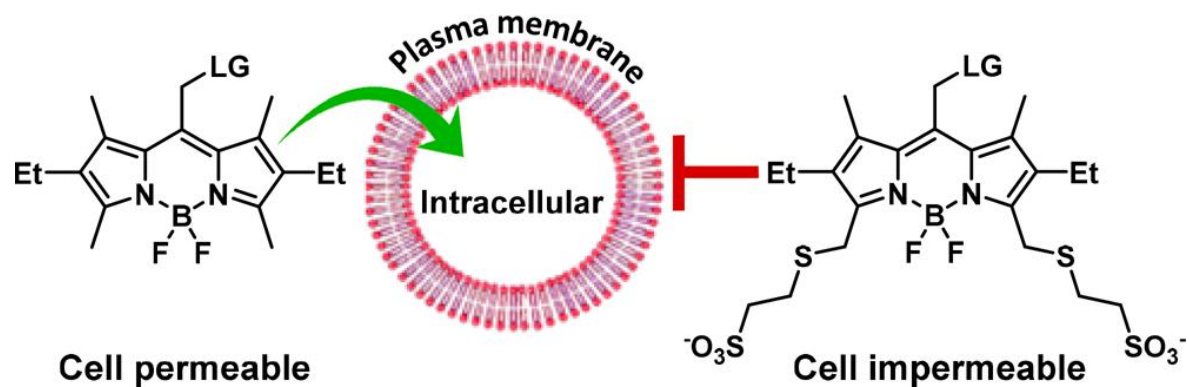*Chem. Commun.* **2019**, 55, 14162-14165.

Previous work：
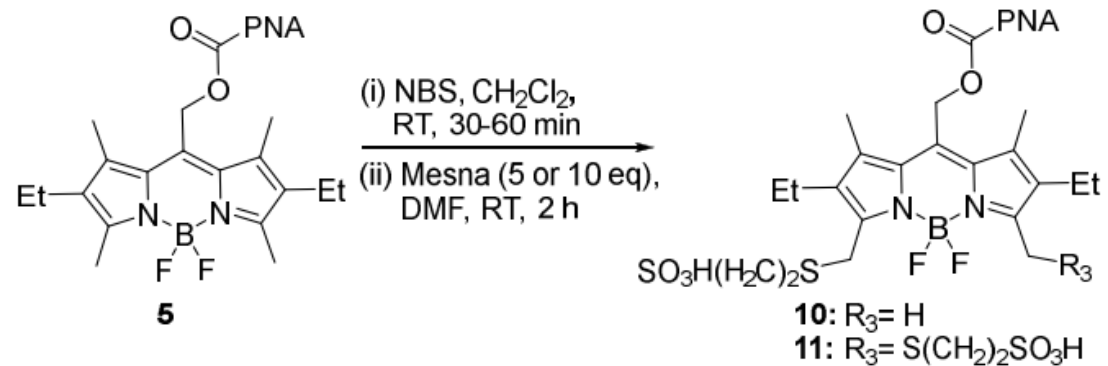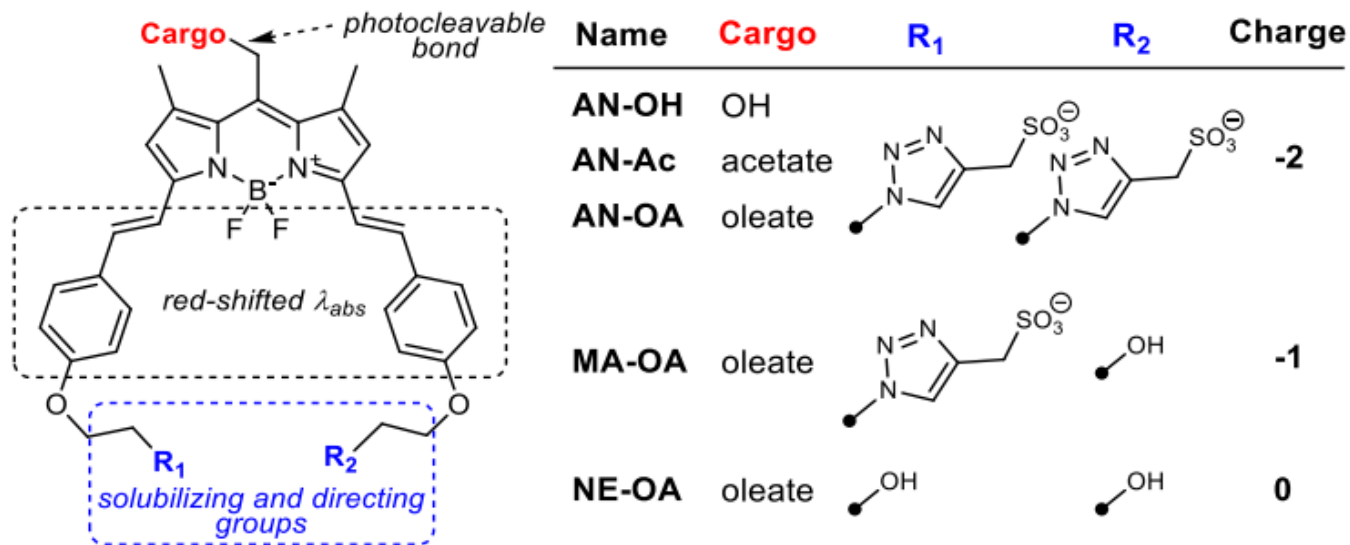
This work:

Scheme 1. Structures of developed BODIPY-cages.

Name	Cargo	R$_1$	R$_2$	Charge
AN-OH	OH			
AN-Ac	acetate			-2
AN-OA	oleate			
MA-OA	oleate			-1
NE-OA	oleate			0

Table 1. Photophysical properties of BODIPY-cages in water.

Name	λ_{max}[a]	log ε[b]	Φ_{dec}[c]	δ_{dec}[d]
AN-Ac	662	3.8	1×10^{-4}	0.63
AN-OA	674	3.3	4×10^{-5}	0.08
MA-OA	682	4.3	4×10^{-6}	0.08
NE-OA	696	4.2	6×10^{-6}	0.10

Solvent	λexc, [nm]	NE-OA Φ_{fl} [%]	MA-OA Φ_{fl} [%]	AN-OA Φ_{fl} [%]	AN-OH Φ_{fl} [%]	AN-Ac Φ_{fl} [%]
DMSO	615	21	23	22	21	23
H$_2$O	632	0.05	0.04	0.18	7	5
POPC	632	0.23	0.06*	1.5	8	6

*a compound did not penetrate liposomes

水溶液中AN-AC光反应性的研究

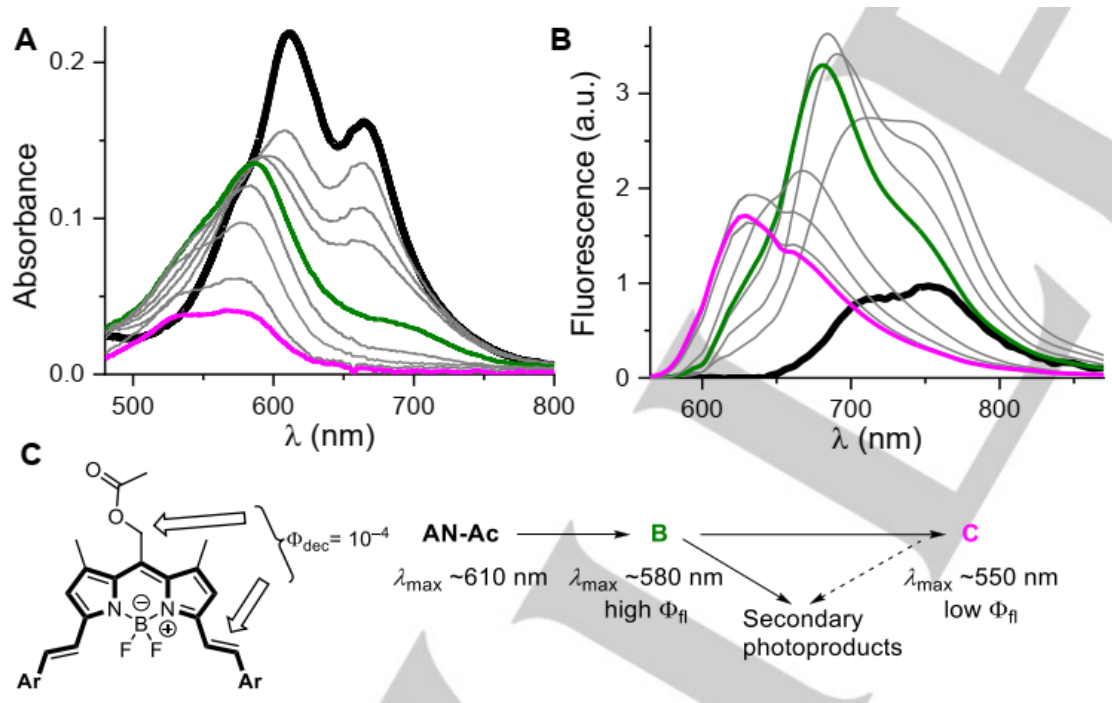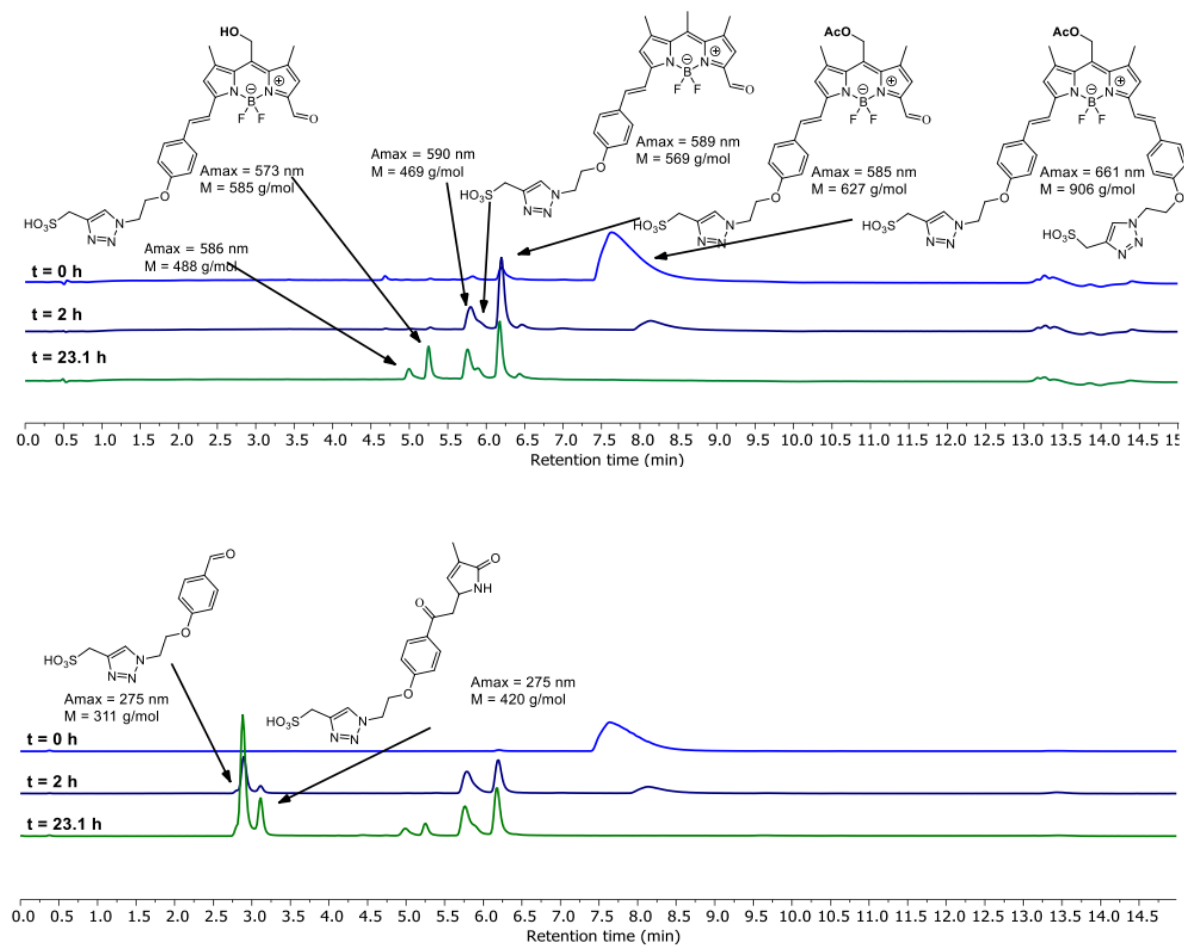Figure 1. Evolution of absorption (A) and emission (B) spectra upon illumination of **AN-Ac** (c = 20 µM, V = 3.2 mL) with **632** nm light (photon flux: F(632) = 6.04 × 10⁻⁷ Einstein s-1) in water. Black, olive, and magenta lines correspond to 0, 7.5, and 66 h of irradiation, respectively. C: Photoreactive sites of AN-Ac and a suggested scheme of its photodegradation, arrows depict the sites of photocleavage.
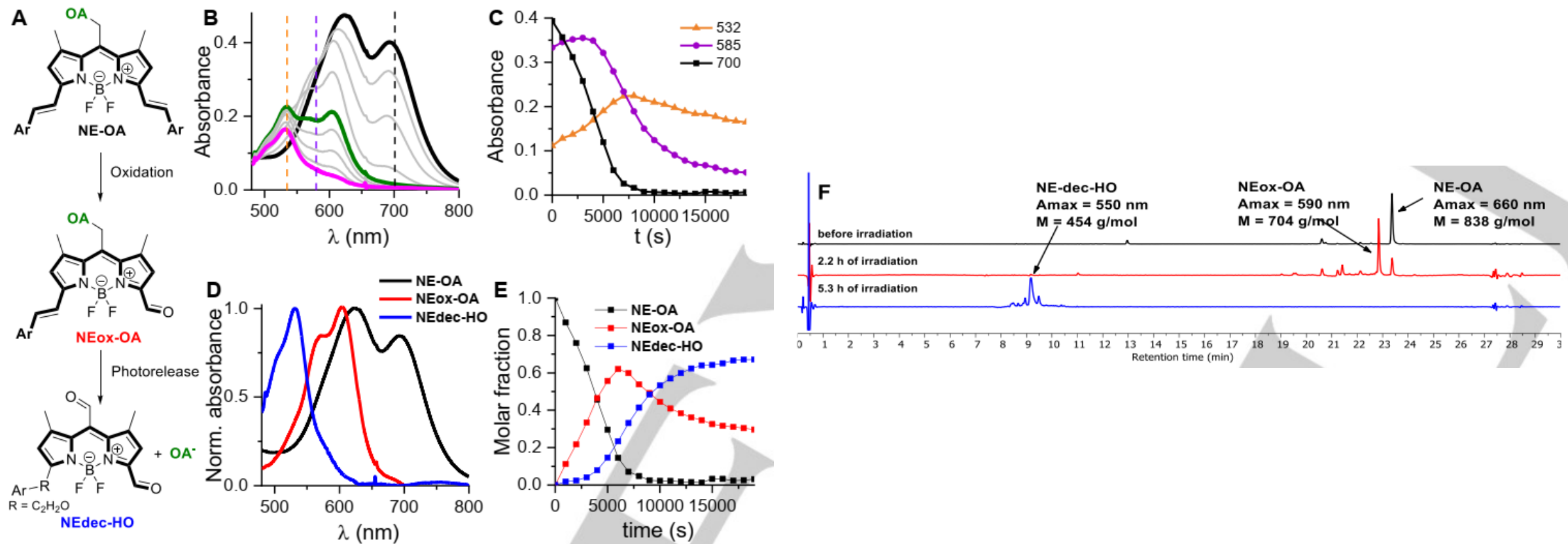
水溶液中NE-OA光释放OA的研究

Figure 2. A: Proposed scheme of photorelease of OA from **NE-OA**. B: Evolution of absorption spectra of **NE-OA** upon irradiation with 632 nm light in aqueous solution. C: Corresponding changes in absorbance at 700 nm (black), 585 nm (violet), 532 nm (orange) in time. D, E: Absorbance spectra of photoreaction products and evolution of their molecular fraction calculated by fitting the data in panels B and C to **NE-OA→NEox→NEdec** reaction model (see Ch. S4 for details). F: Chromatograms of NE-OA irradiated with 632 nm light for 0 (black), 2.2 (red), and 5.3 (blue) hours (UV-VIS-detector at 597 nm)
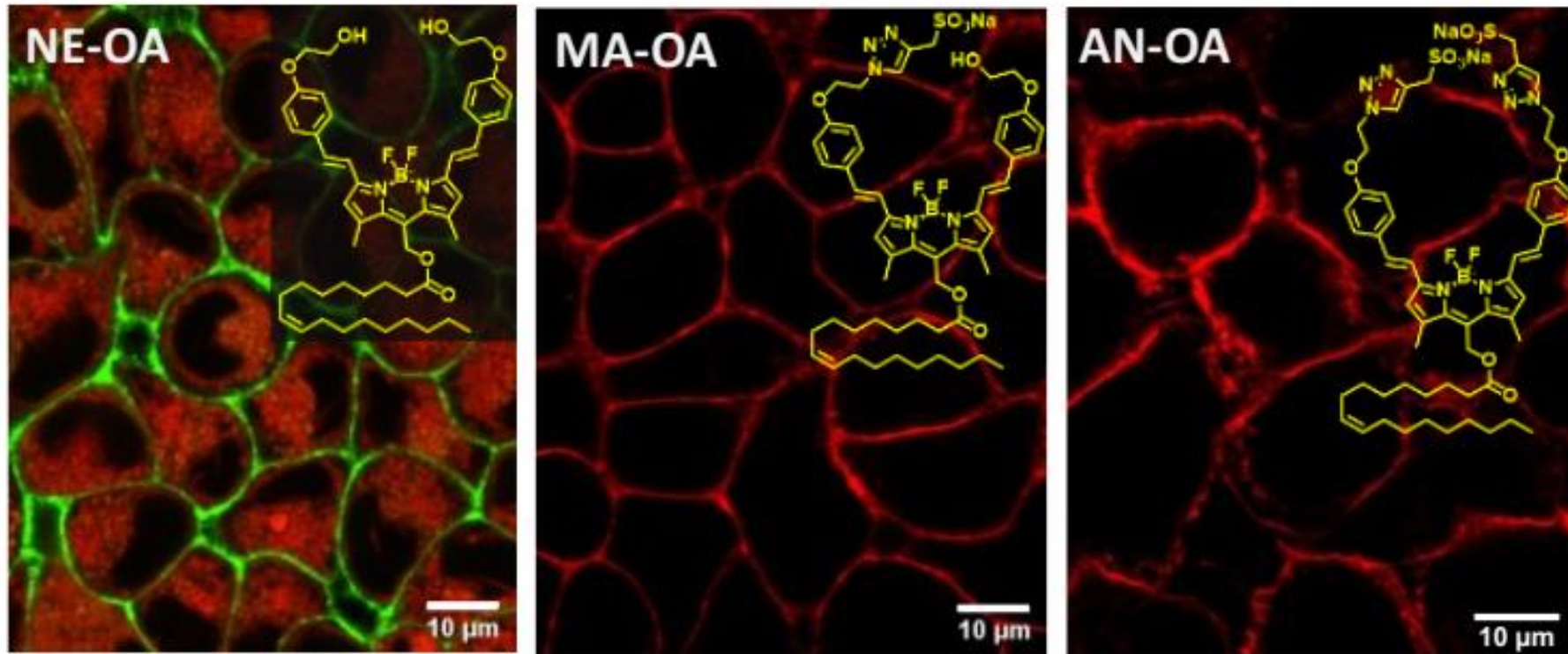
Result and Discussion

Figure 3. Localization of caged OAs (red) in live HeLa cells λ_{ex} = 633 nm, λ_{em} = 650-700 nm. For NE-OA, green represents the plasma membrane tracker, λ_{ex} = 488 nm, λ_{em} = 495-555 nm. The scale bar is 10 μm.
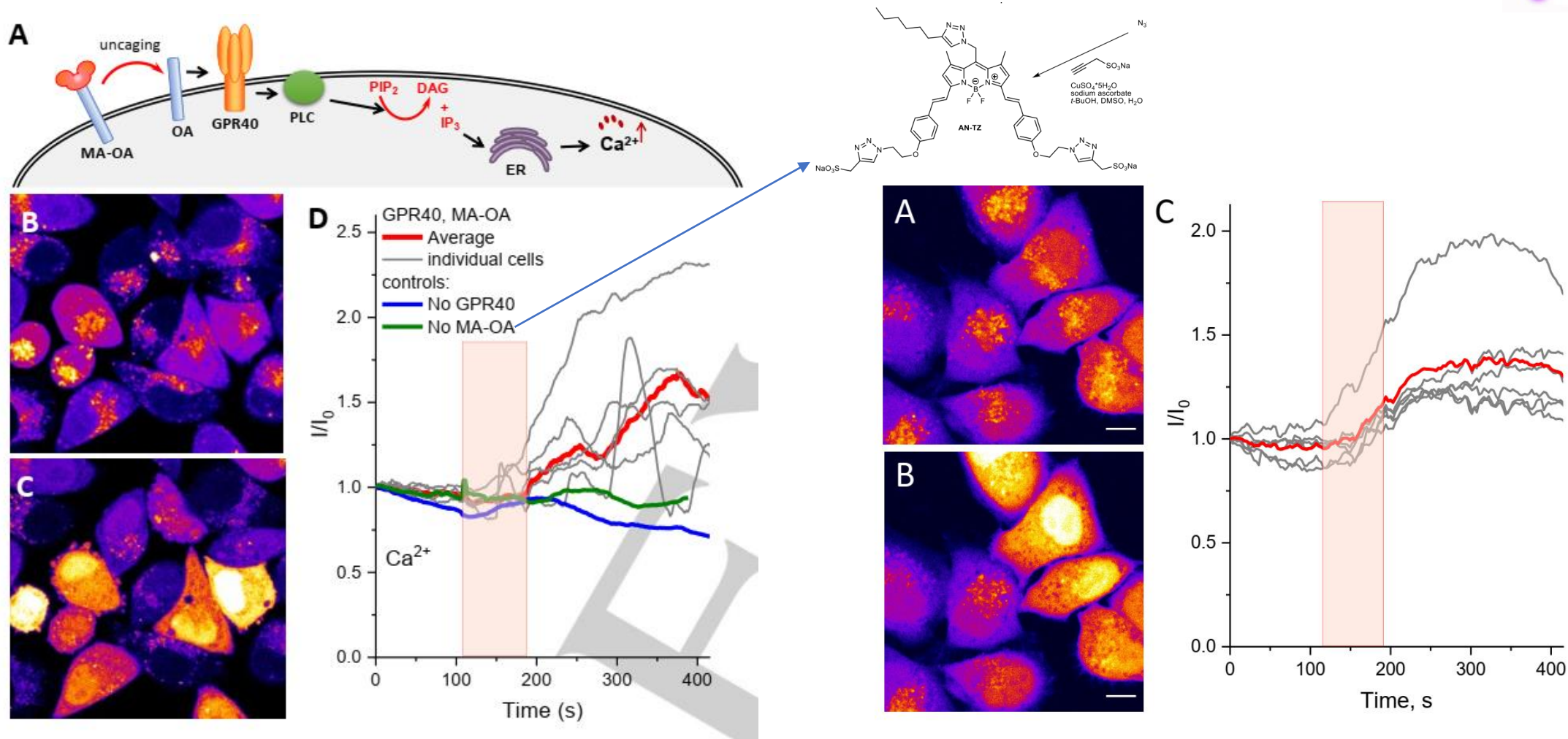
Figure 4. Ca²⁺ signaling. A: Schematic representation of OA induced elevation in intracellular Ca²⁺ level. B,C: Fluorescence of Fluo-4 calcium sensor before and after uncaging irradiation (λ_{ex} = 488 nm, λ_{em} = 500-550 nm). D: Normalized fluorescence intensity of Fluo-4 as a function of time (grey: 5 individual cells; red: average) compared to controls in cells not transfected with GPR40 (blue) and cells with MA-OA analogue that cannot release OA upon irradiation (green) (see Ch. S5.2)

Figure S5-4: Response of HeLa cells expressing GPR40 to uncaging of NE-OA. A, B) Fluorescence of Fluo-4 calcium sensor before and after uncaging. (pseudocolored using "fire" lookup table, scale bar is 10 μM). C) Dynamics of normalized Fluo-4 fluorescence intensity from six individual cells (grey lines) and the average trace (red) λ_{ex} = 488 nm, λ_{em} = 500 – 550 nm. The red rectangle shows the uncaging irradiation period (λ_{irr} = 633 nm)