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Supporting information for

Switching Energy Dissipation Pathway: *in situ* Proton-Induced Transformation of AIE-Active Self-assembly to Boost Photodynamic Therapy

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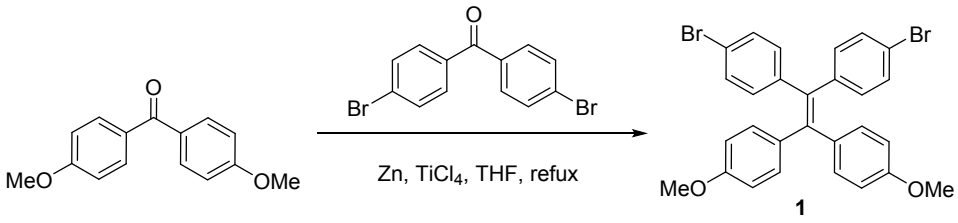
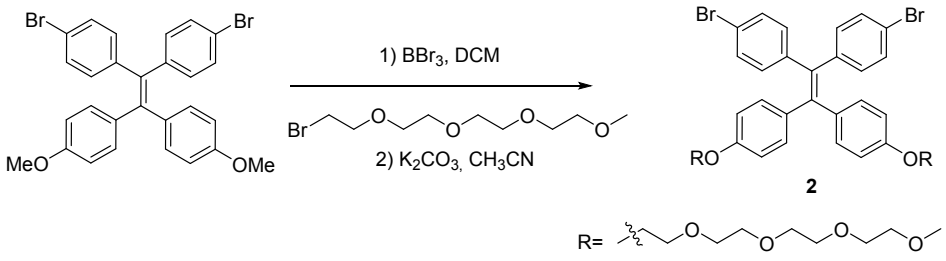
1. Synthesis and characterization



Scheme 1. Synthetic route of compound 1.

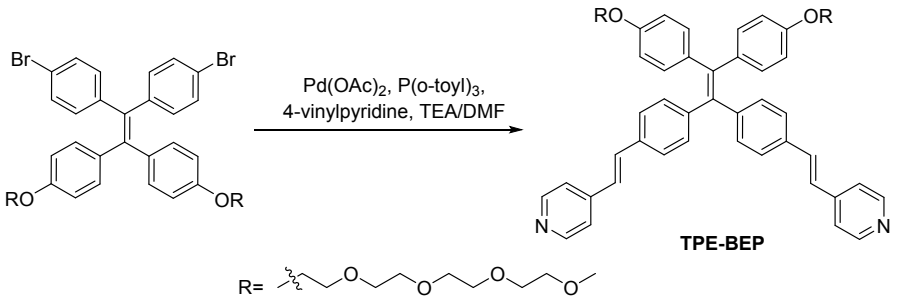
Synthesis and characterization of compound 1: Into a 250 mL flask was dissolved 4,4'-dibromobenzophenone (3.00g, 12.4 mM), 4,4'-dimethoxybenzophenone (4.20g, 12.4 mM) and Zn (4.00g, 62 mM) in 120 mL dry THF under a N_2 atmosphere. The flask was cooled at -10 ℃ and $TiCl_4$ (6.8 mL, 91 mM) was dropwise added. After stirring for 1h, the reaction mixture was warmed to room temperature and then refluxed overnight. After cooling down to room temperature, distillated HCl was dropwise added and the mixture was extracted with dichloromethane. The extracts were washed with brine and dried with MgSO4. After solvent removal under reduced pressure, the crude product was purified by column chromatography on silica gel with Petroleum ether/ dichloromethane as eluent to afford compound 1 as light yellow solid (2.2 g, 4 mM, 32% yield). ^{1}H NMR (CD_2Cl_2, 500M Hz): δ (ppm) = 7.22 (d, J = 8.5 Hz, 2H), 6.89 (dd, J = 8.5 Hz, 4.5 Hz, 4H), 6.64 (d, J = 8.5 Hz, 2H), 1.53 (s, 3H); ^{13}C NMR (CD_2Cl_2, 500M Hz): δ (ppm) = 156.6, 140.8, 139.6, 133.5, 130.9, 130.2, 129.4, 128.8, 118.2, 111.1, 53.0.



Scheme 2. Synthetic route of compound 2.

Synthesis and characterization of compound 2: Under N_2 atmosphere, compound 1 (550 mg, 1 mmol) was added into anhydrous dichloromethane (20 mL) at -10°C, then BBr_3 (10 mL, 10 mmol, 1 M in dichloromethane) was added. After stirring at -10°C for 1h, the deep yellow solution was allowed to warm to room temperature and was stirred overnight. The reacting mixture was

hydrolyzed by dropwise addition into cold water with vigorous stirring until no more precipitate was formed, and then extracted with dichloromethane for three times. The extracts were concentrated and dried under reduced pressure to obtain white solid (495 mg, 0.95 mmol, 95%). Afterwards, a mixture of obtained solid (519 mg, 1mM), Triethylene Glycol 2-Bromoethyl Methyl Ether (678 mg, 2.5 mM), $CsCO_3$ (1.6 g, 5 mM) in anhydrous dimethylformamide (50 mL) was heated at 120°C under N_2 atmosphere and stirred for 16 h. Then the reaction mixture was cooled to room temperature and filtered. The solvent was evaporated under vacuum and the crude product was purified by a silica gel column using ethyl acetate/petroleumether (2:1 v/v) as eluent. Compound 2 was obtained as yellow solid in 45% yield. ^{1}H NMR (CD_2Cl_2, 500M Hz): δ (ppm) = 7.21 (d, J = 8.4 Hz, 2H), 6.88 (dd, J = 9 Hz, 6.6 Hz, 4H), 6.67 (d, J = 8.4 Hz, 2H), 4.03 (t, J = 2 Hz, 2H), 3.77 (t, J = 4 Hz, 2H), 3.63 (m, 2H), 3.57 (m, 8H), 3.47 (m, 2H), 3.31 (s, 3H); ^{13}C NMR (CD_2Cl_2, 500M Hz): δ (ppm) = 157.5, 142.7, 141.7, 136.7, 135.6, 133.1, 132.4, 130.9, 120.1, 113.6, 71.9, 70.6, 70.0, 69.6, 67.34, 58.5.



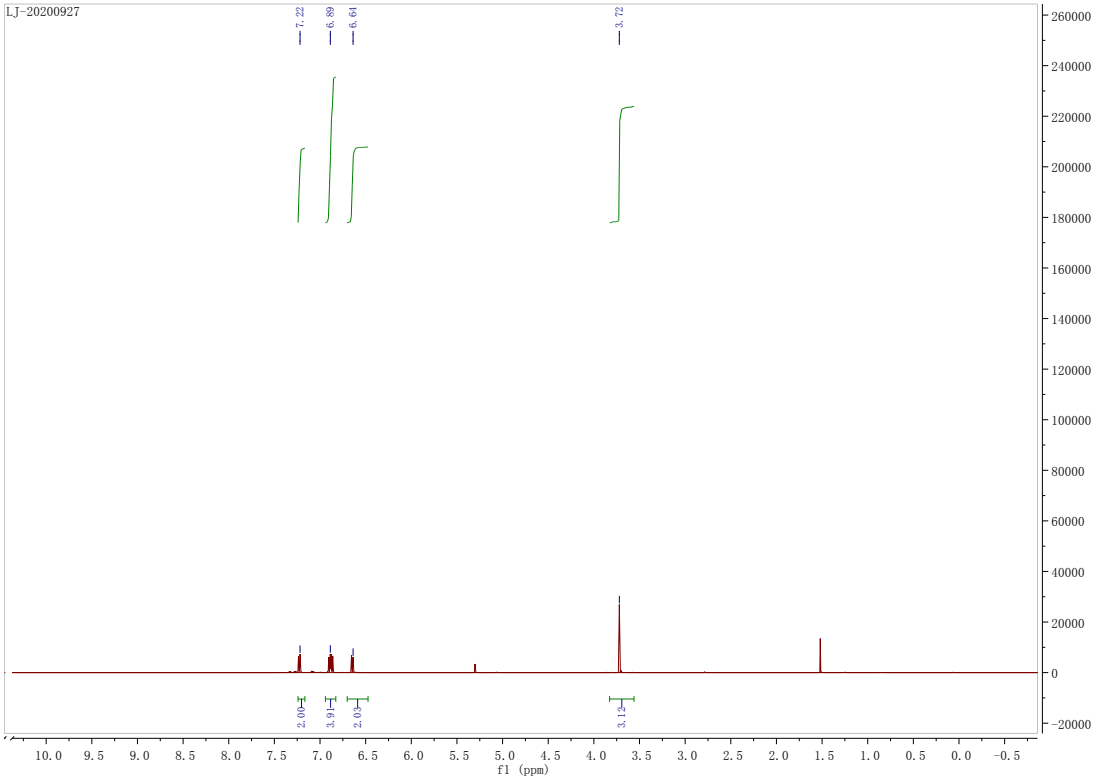
Scheme 3. Synthetic route of TPE-BEP.

Synthesis and characterization of TPE-BEP: Palladium (22.4 mg, 0.1 mM) and tris-o-toylphosphine (30 mg. 0.1 mM) were dissolved in an anhydrous and degassed TEA/DMF (2mL:1mL) mixture. This mixture was stirred for 15 min, and then added with compound 2 (410 mg, 0.5 mM) and 4-vinylpridine (270 mg, 2.5 mM) under nitrogen. The reaction mixture was stirred at 90 ℃ for 24 h. After cooling down to room temperature, TEA was removed in vacuo, and the mixture was diluted with dichloromethane and washed with water and saturated $NaHCO_3$. After solvent removal under reduced pressure, the residue was purified by column chromatography on Aluminum oxide with dichloromethane as eluent. TPE-BEP was obtained as yellow viscous oil (56% yield). ^{1}H NMR (CD_2Cl_2, 500M Hz), δ (ppm) = 8.50 (d, J = 4.5 Hz, 2H), 7.32 (d, J = 5 Hz,

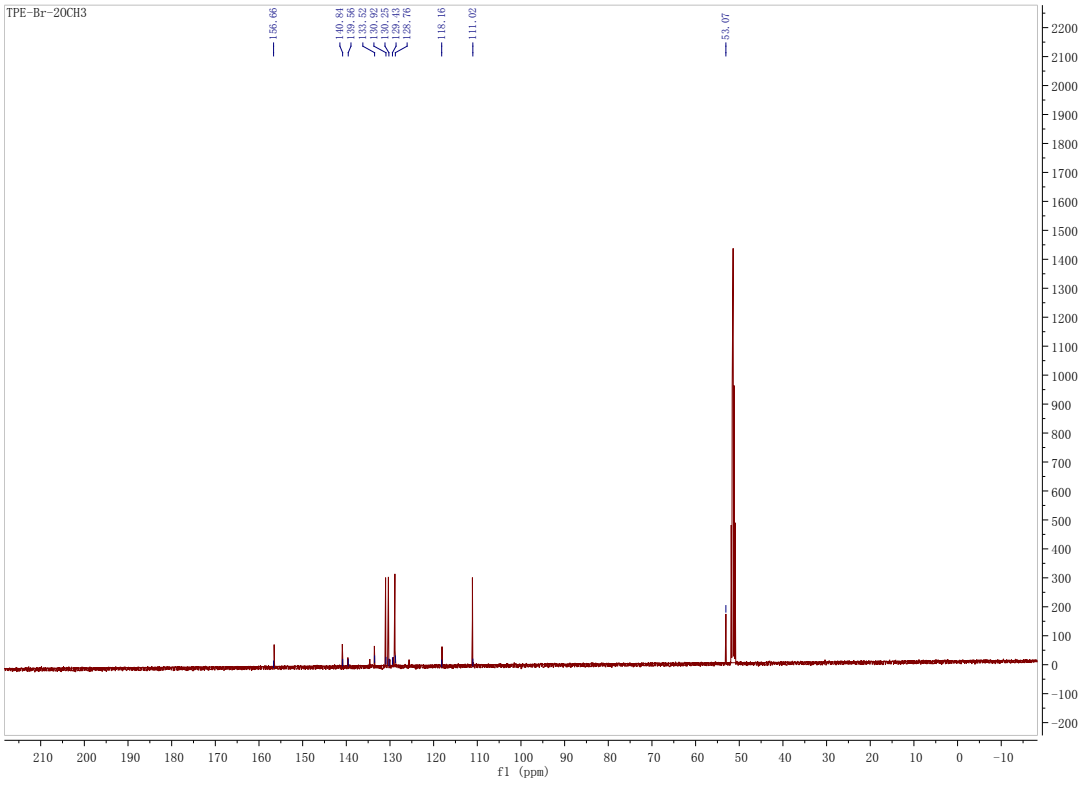
2H), 7.31 (d, J = 7 Hz, 2H), 7.22 (d, J = 13.5 Hz, 1H), 7.04 (t, J = 7 Hz, 2H), 6.98 (d, J = 14 Hz, 1H), 6.93 (d, J = 7.5 Hz, 2H), 6.67 (d, J = 7 Hz, 2H), 4.02 (t, J = 4 Hz, 2H), 3.75 (t, J = 4 Hz, 2H), 3.63 (m, 2H), 3.56 (m, 8H), 3.45 (m, 2H), 3.29 (s, 3H); ^{13}C NMR (CD_2Cl_2, 500M Hz): δ (ppm) = 157.6, 149.9, 144.8, 144.3, 141.5, 138.1, 136.1, 134.1, 132.6, 132.4, 131.4, 126.4, 125.3, 120.8, 113.6, 71.7, 70.6, 69.6, 69.4, 67.2, 58.3; HRMS (MALDI-TOF): m/z calcd. for $C_{58}H_{66}N_2O_{10}$ $[M+H]^+$=951.4717; found: 951.4797.

2. NMR and HRMS spectra of AIE-active amphiphiles

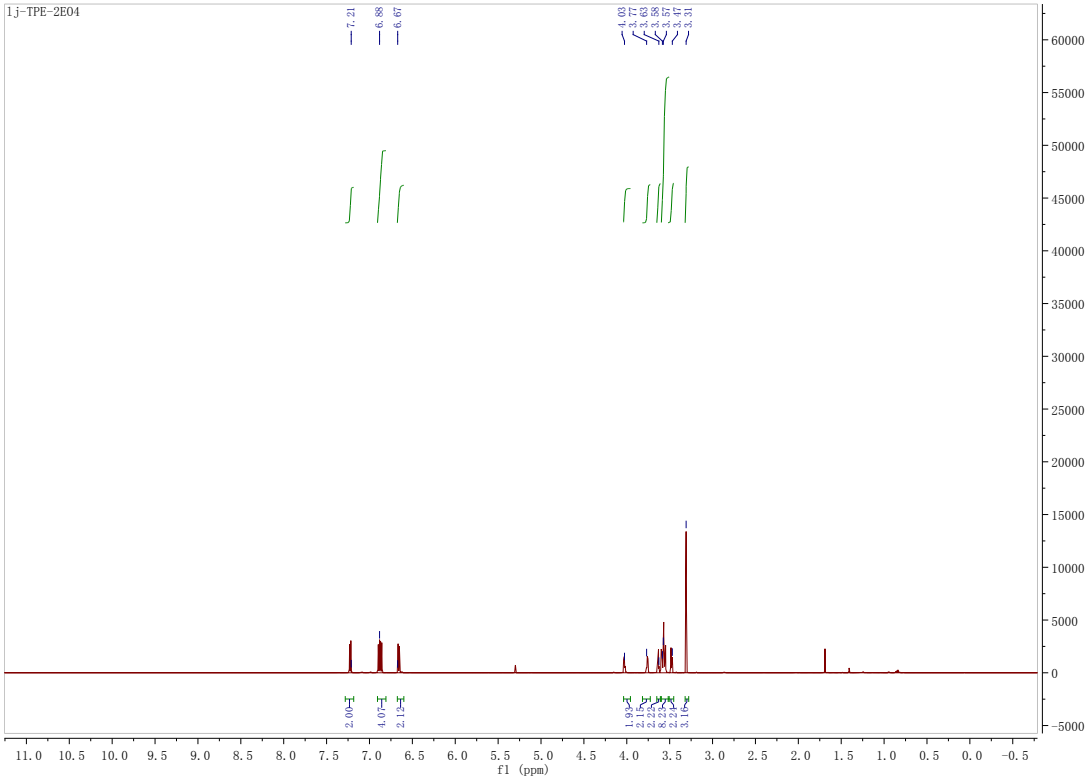
^{1}H NMR spectrum of compound 1:



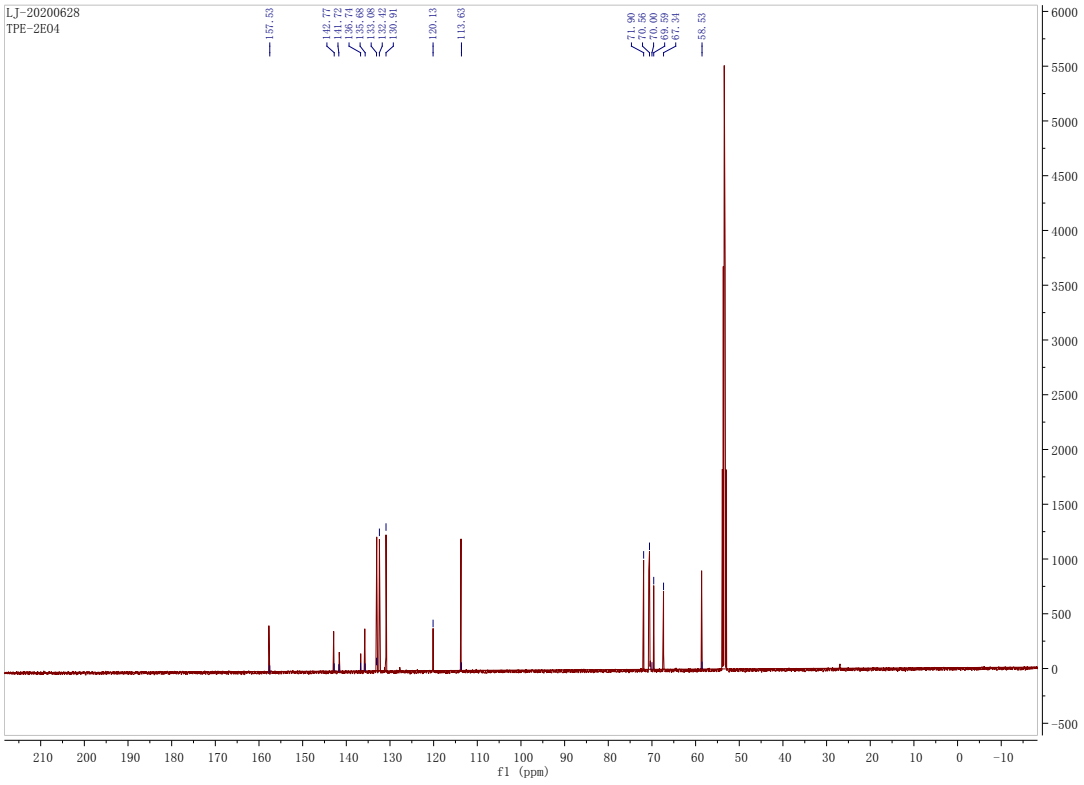
^{13}C NMR spectrum of compound 1:



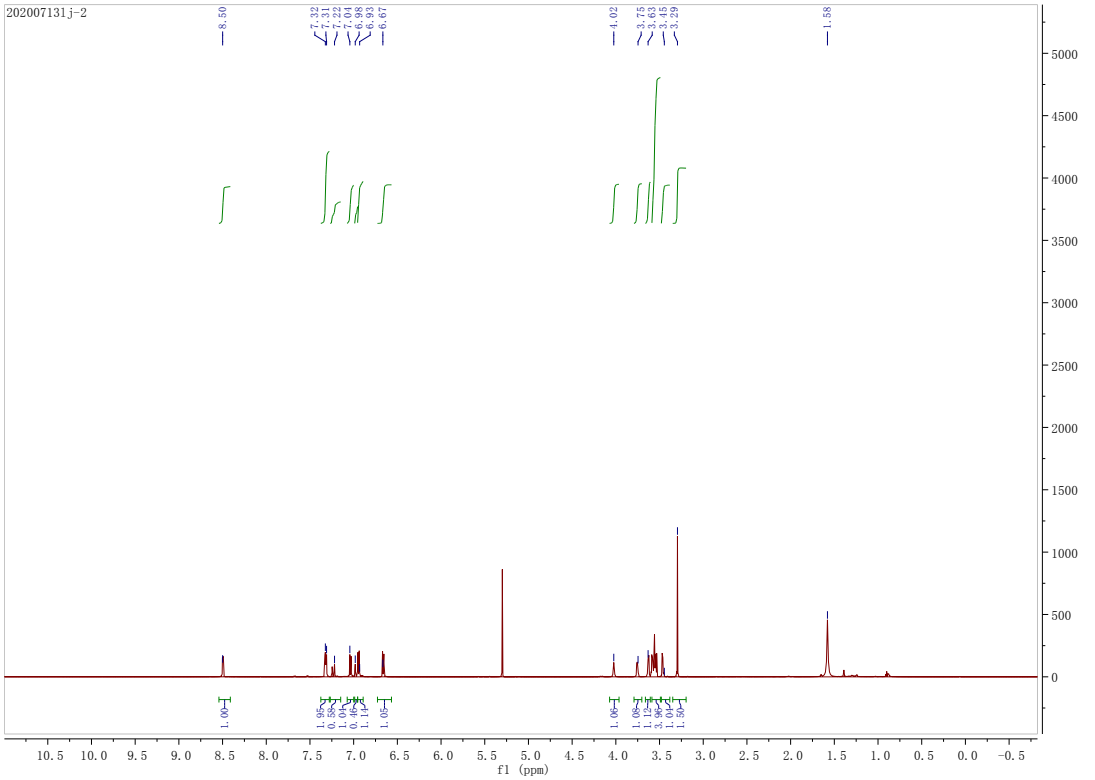
^{1}H NMR spectrum of compound 2:



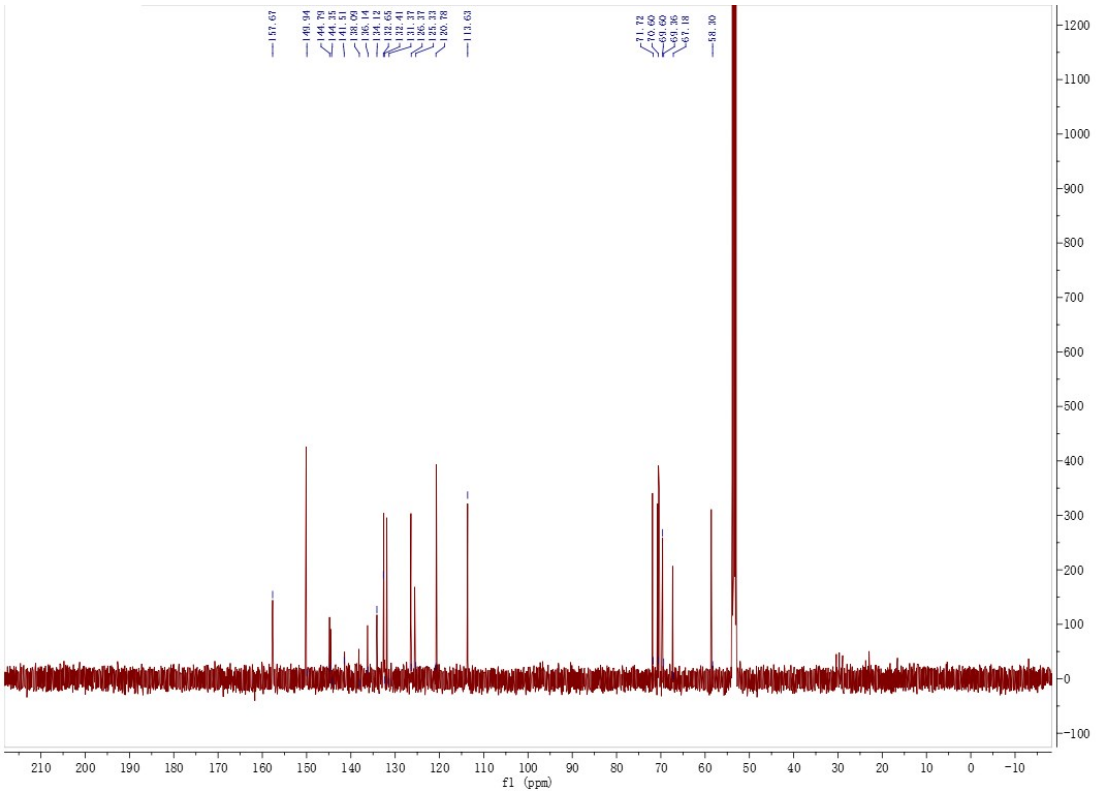
^{13}C NMR spectrum of compound 2:



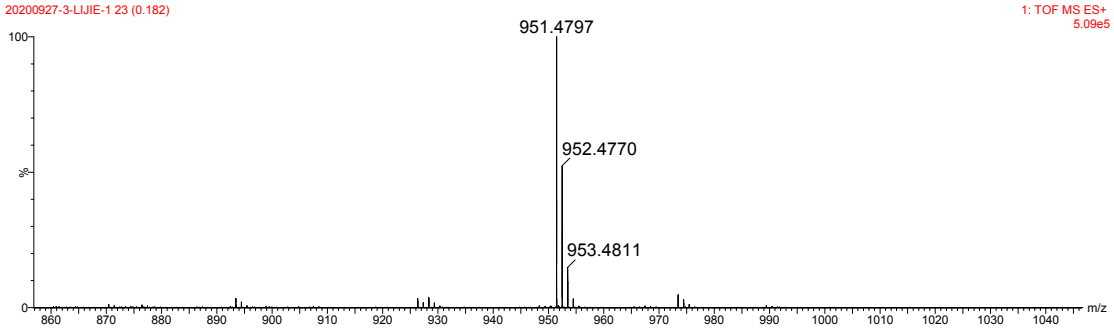
^{1}H NMR spectrum of TPE-BEP:



^{13}C NMR spectrum of compound TPE-BEP:



HRMS spectrum of TPE-BEP:



3. Supplementary figures

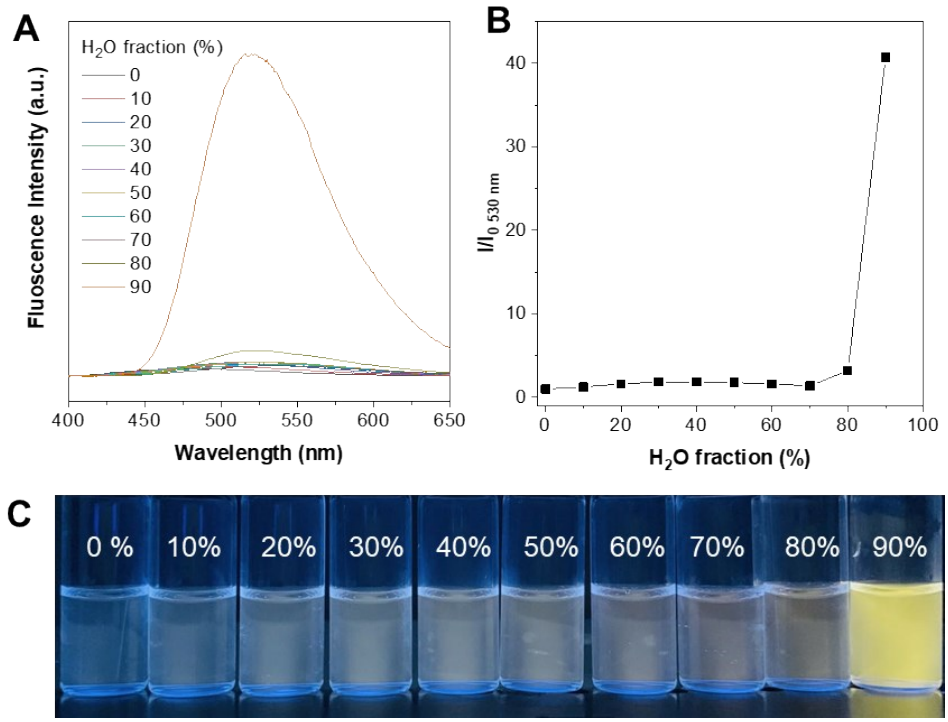


Figure S1. AIE feature of TPE-BEP. (A) PL spectra of TPE-BEP in DMF/H_2O mixtures with various H_2O fractions (vol %). (B) Plot of the relative emission intensity (I/I_0) versus H_2O fractions (vol %). λ_{ex}= 360 nm. (C) Fluorescence picture of TPE-BEP in DMF/H_2O mixtures with various H_2O fractions (vol %) under 365 nm UV lamp. [TPE-BEP]= 10 μM.

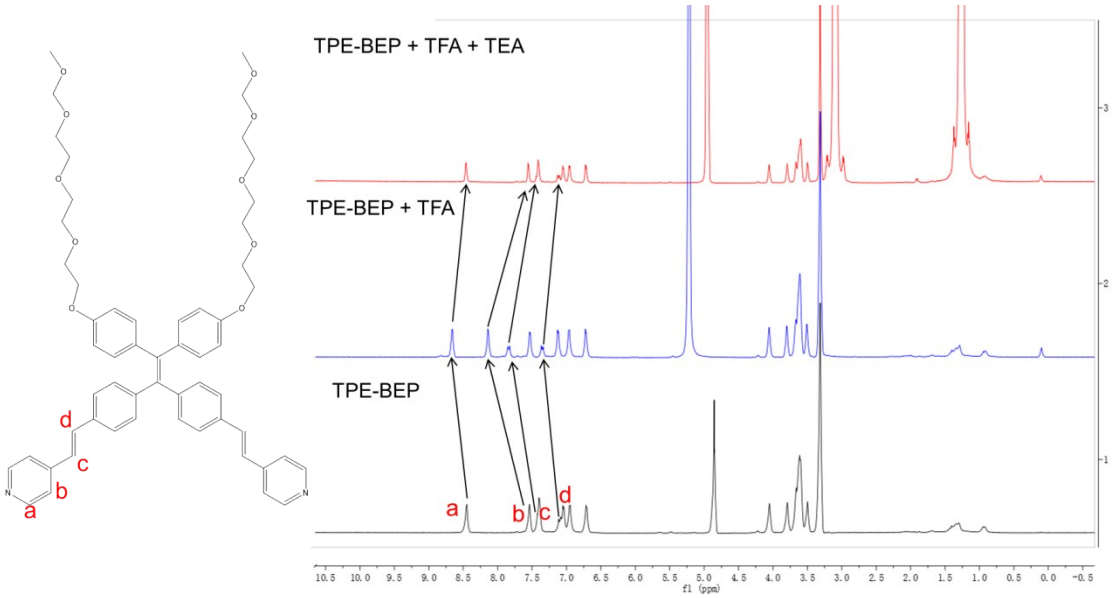


Figure S2. Changes of resonance signals in ^1H NMR (CD_3OD, 500 M Hz) results of TPE-BEP, TPE-BEP + TFA, TPE-BEP + TFA + TEA.

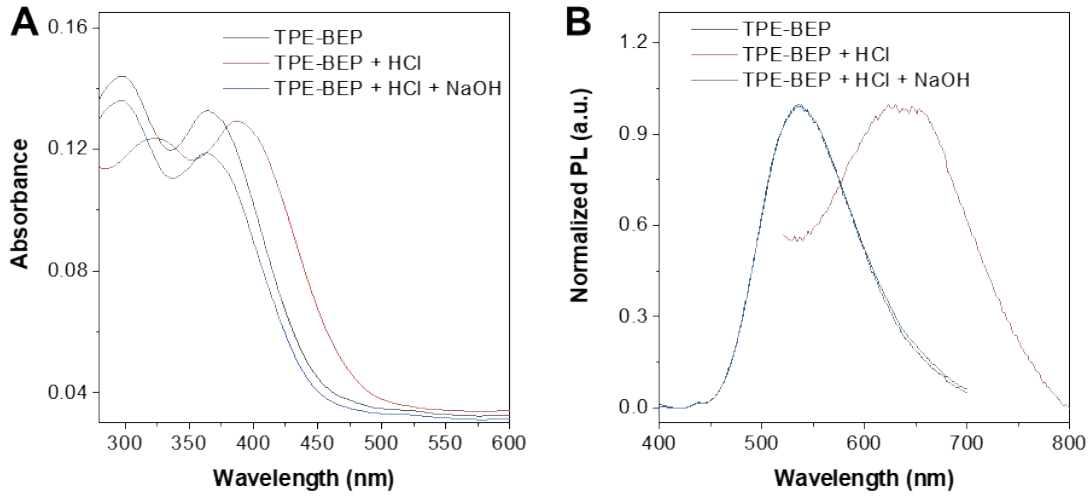


Figure S3. (A) UV absorbance change of TPE-BEP water solution by alternative addition of HCl and NaOH. (B) Normalized emission intensity of TPE-BEP water solution in neutral and acidic conditions. λ_{ex}= 360 nm. [TPE-BEP]= 10 μM.

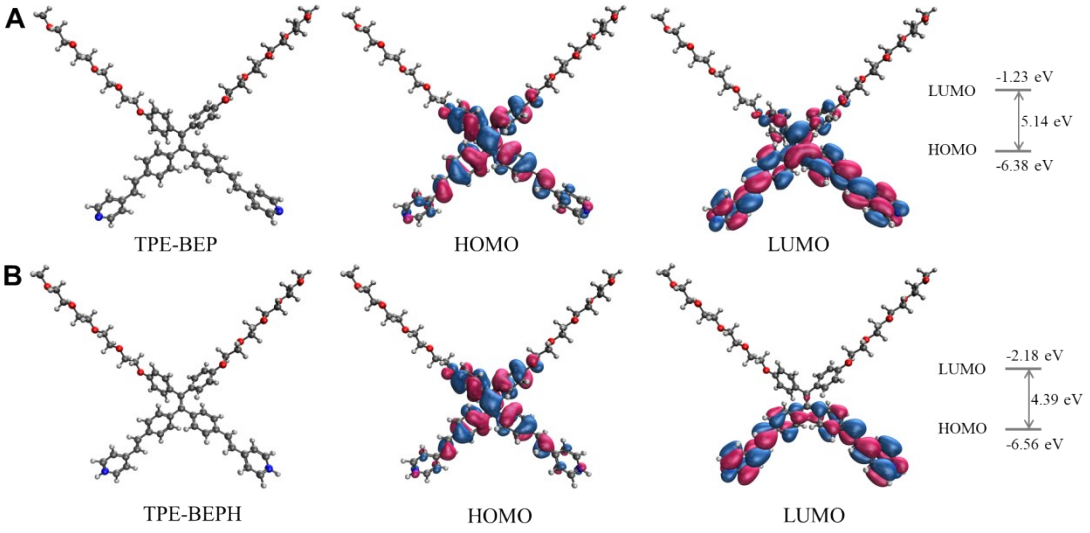


Figure S4. Molecular structures, calculated HOMO and LUMO of (A) TPE-BEP and (B) TPE-BEPH.

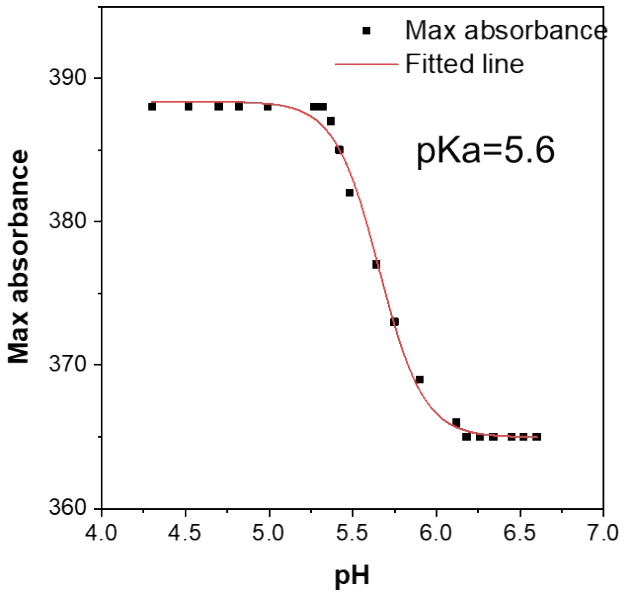


Figure S5. Measurement of the pKa value of TPE-BEP by max UV absorbance change of TPE-BEP via different pH values in water. [TPE-BEP]= 10 μM.

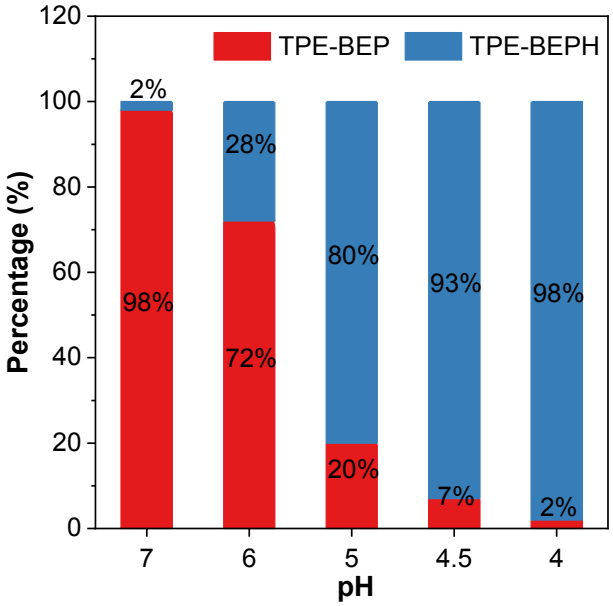


Figure S6. Species distributions of TPE-BEP in different pH conditions.

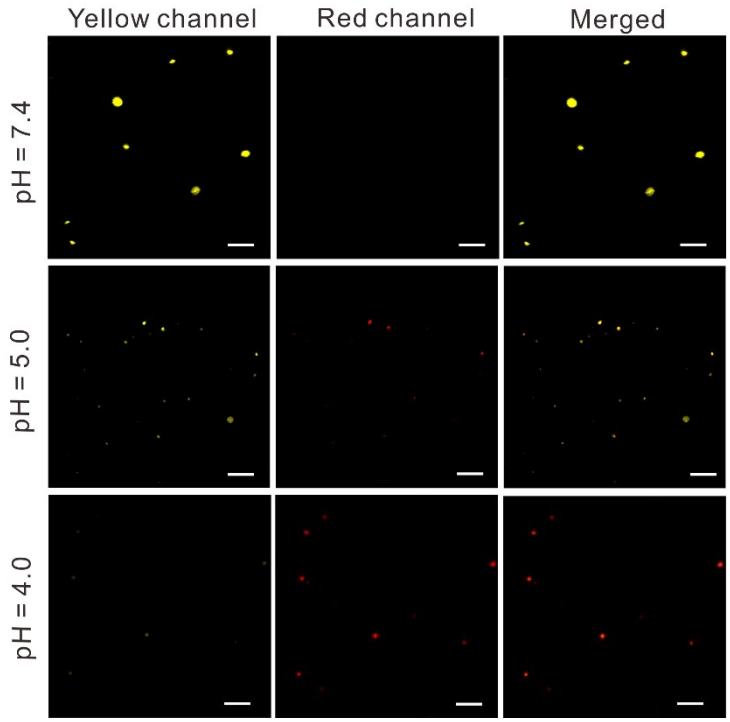


Figure S7. CLSM images of TPE-BEP assemblies in water with different pH values. Scale bar is 2 μm. [TPE-BEP] = 10 μM.

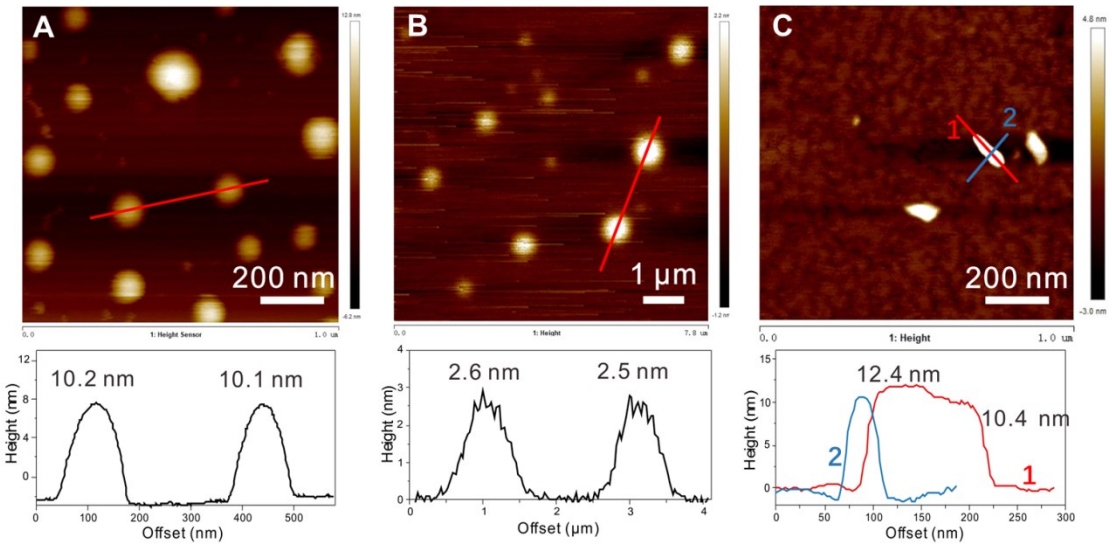


Figure S8. AFM images and the corresponding height profiles of TPE-BEP assemblies in different pH PBS solutions. (A) pH= 7.4, (B) pH= 5.0 and (C) pH= 4.0. [TPE-BEP]= 10 μM.

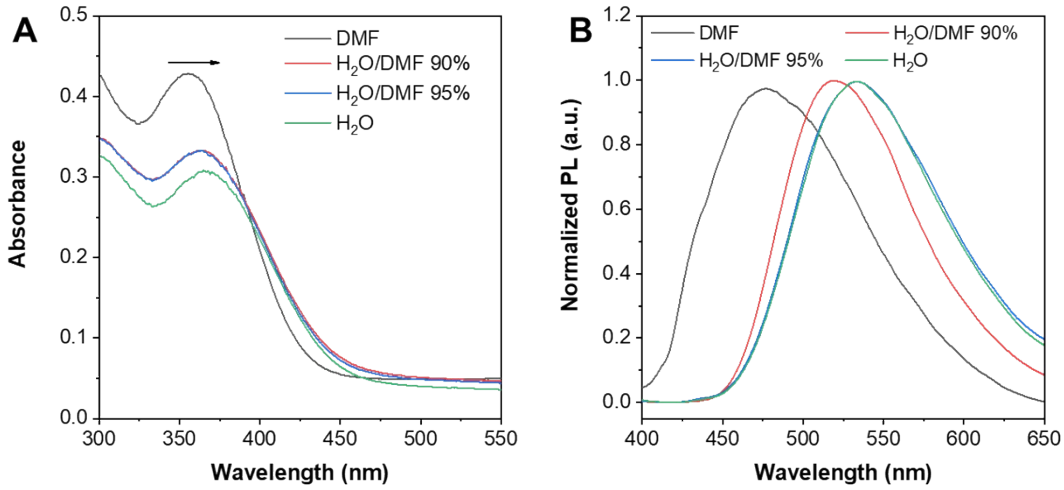


Figure S9. (A) UV absorbance change of TPE-BEP in different DMF/H_2O fraction mixtures. (B) Normalized emission intensity of TPE-BEP in different DMF/H_2O fraction mixtures. λ_{ex}= 360 nm. [TPE-BEP]= 10 μM.

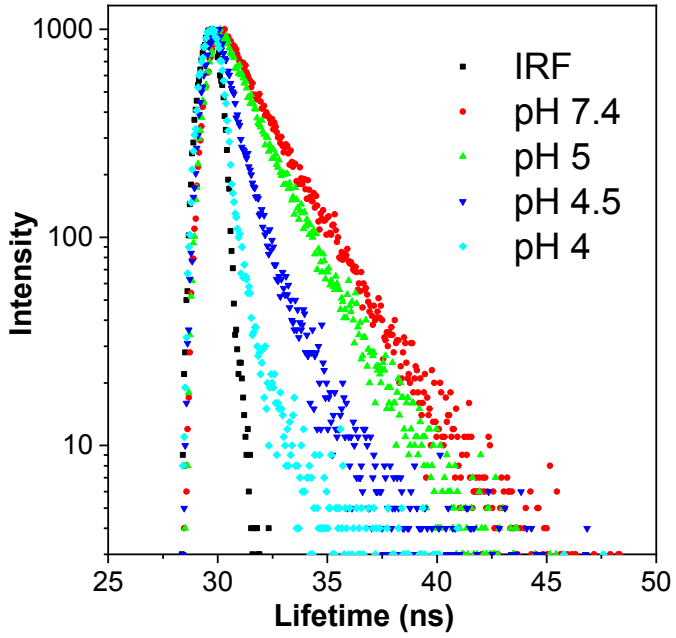


Figure S10. Lifetime results of TPE-BEP in different pH solutions. [TPE-BEP]= 10 μM.

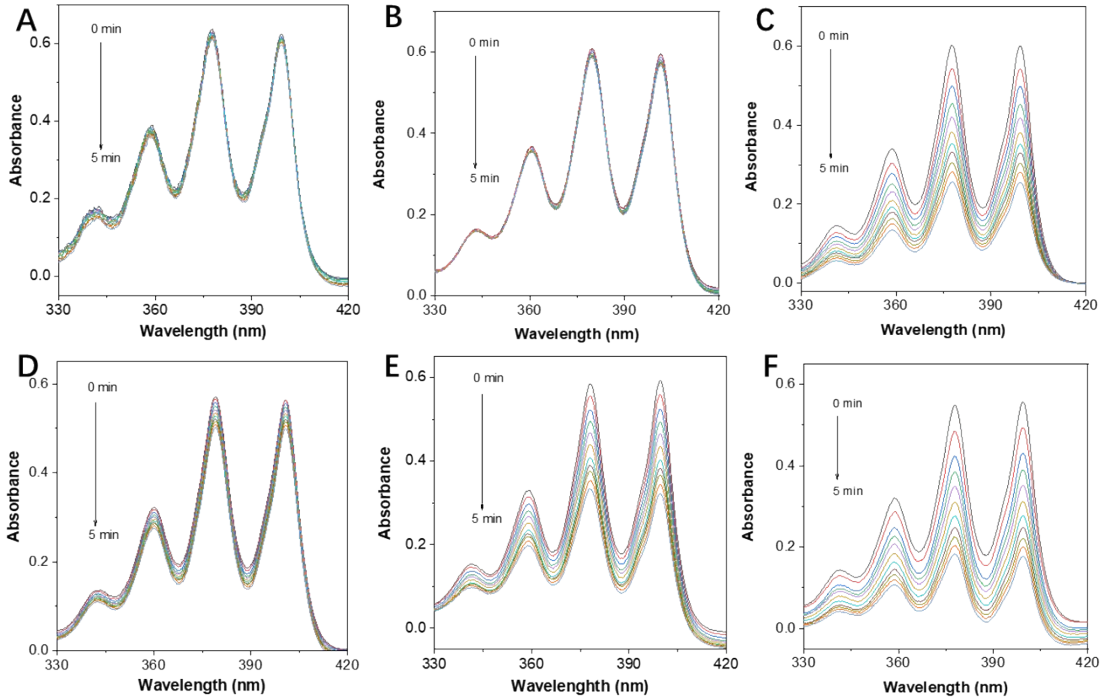


Figure S11. (A) UV spectra of ABDA under white light irradiation in water PBS solution. (B) UV spectra of ABDA in the presence of Rose bengal under white light irradiation in water PBS solution. UV spectra of ABDA in the presence of TPE-BEP assembly white light irradiation at different pH PBS solutions: (C) pH = 7.4, (D) pH = 6.0, (E) pH = 5.0, (F) pH = 4.0. [TPE-BEP] = [Rose bengal] = 10 μM, [ABDA] = 50 μM.

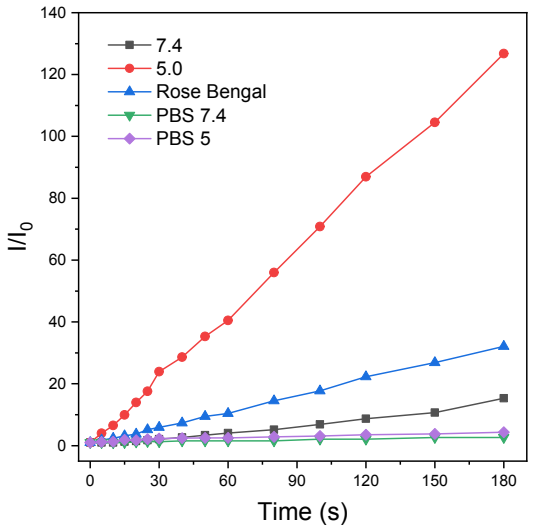


Figure S12. (A) Fluorescence spectra of dichlorofluorescein FDCH-DA (525 nm) under white light irradiation in TPE-BEP water solution with pH=7.4 and pH=4.0. DCFH-DA was ROS indicators. [TPE-BEP] =2 μM, [FDCH-DA] = 5 μM.

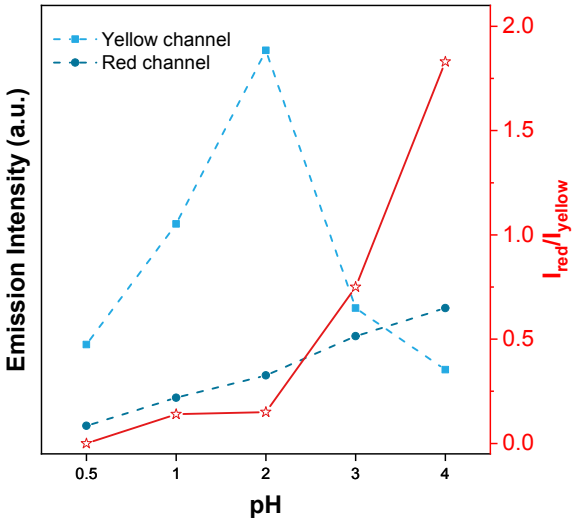


Figure S13. Relative fluorescence intensity variation of 4T1 cells incubated with TPE-BEP with different time. [TPE-BEP] = 10 μM.

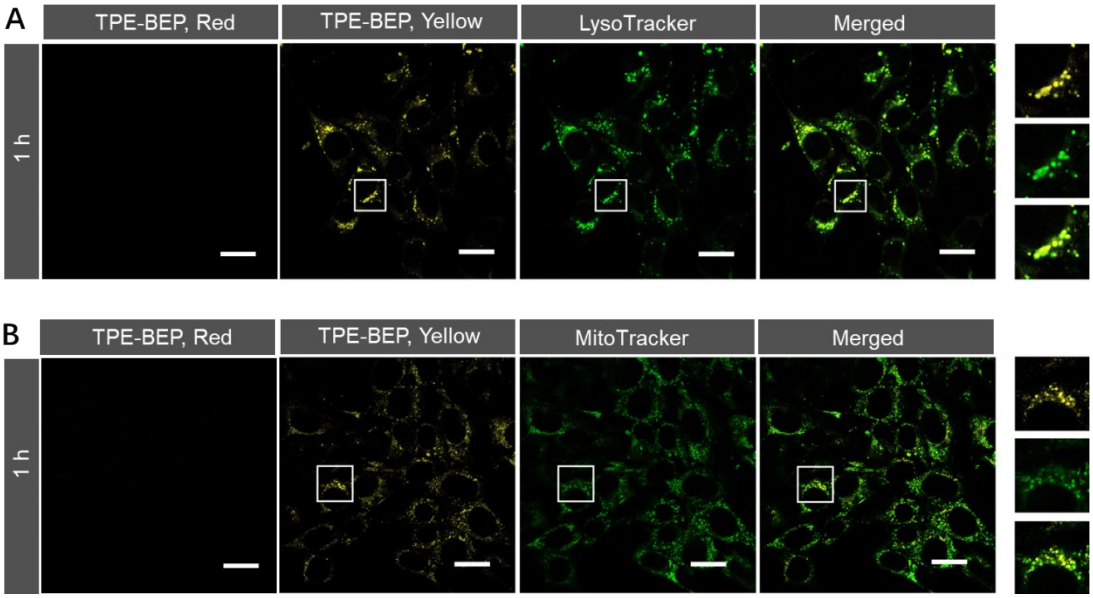


Figure S14. Co-location images of 4T1 cells stained by (A) Lysotracker and (B) MitoTracker after incubated with TPE-BEP for 1 h. Scale bar is 20 μm. [TPE-BEP] = 10 μM.

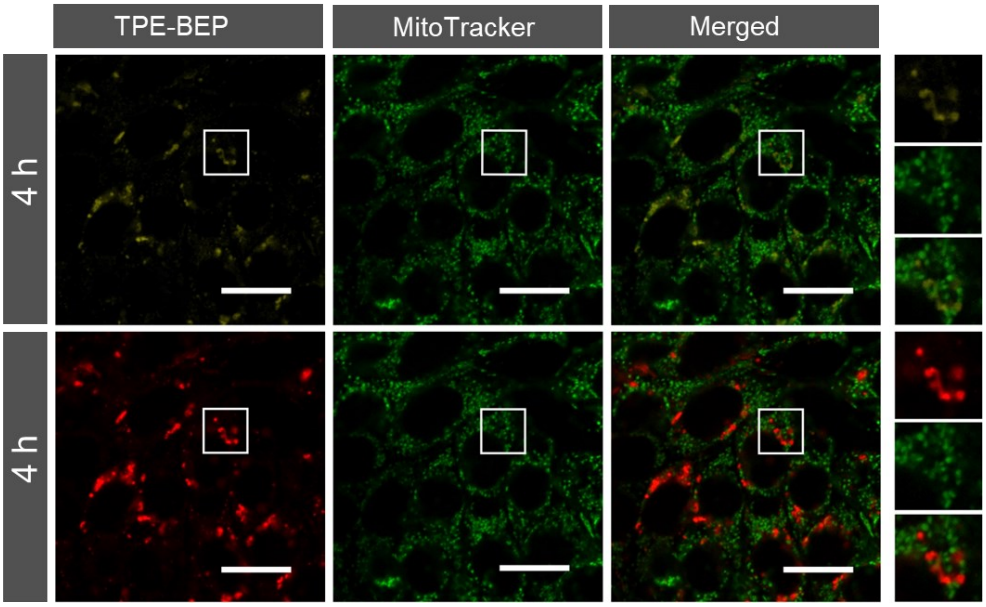


Figure S15. Co-location images of 4T1 cells stained by MitoTracker after incubated with TPE-BEP for 4 h. Scale bar is 20 μm. [TPE-BEP] = 10 μM.

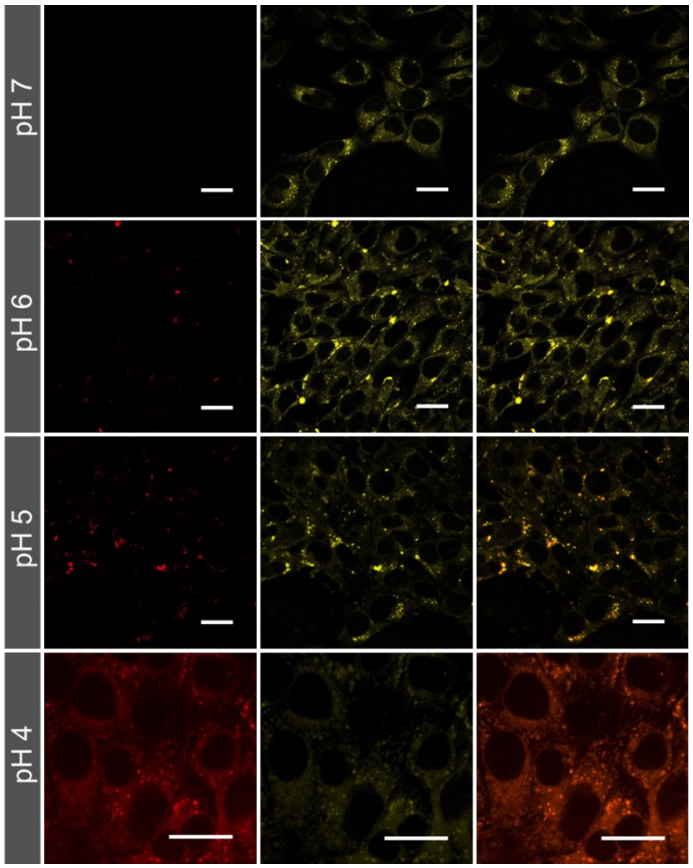


Figure S16. CLSM images of 4T1 cells incubated with TPE-BEP in different pH conditions. Scale bar is 20 μm. [TPE-BEP] = 10 μM.

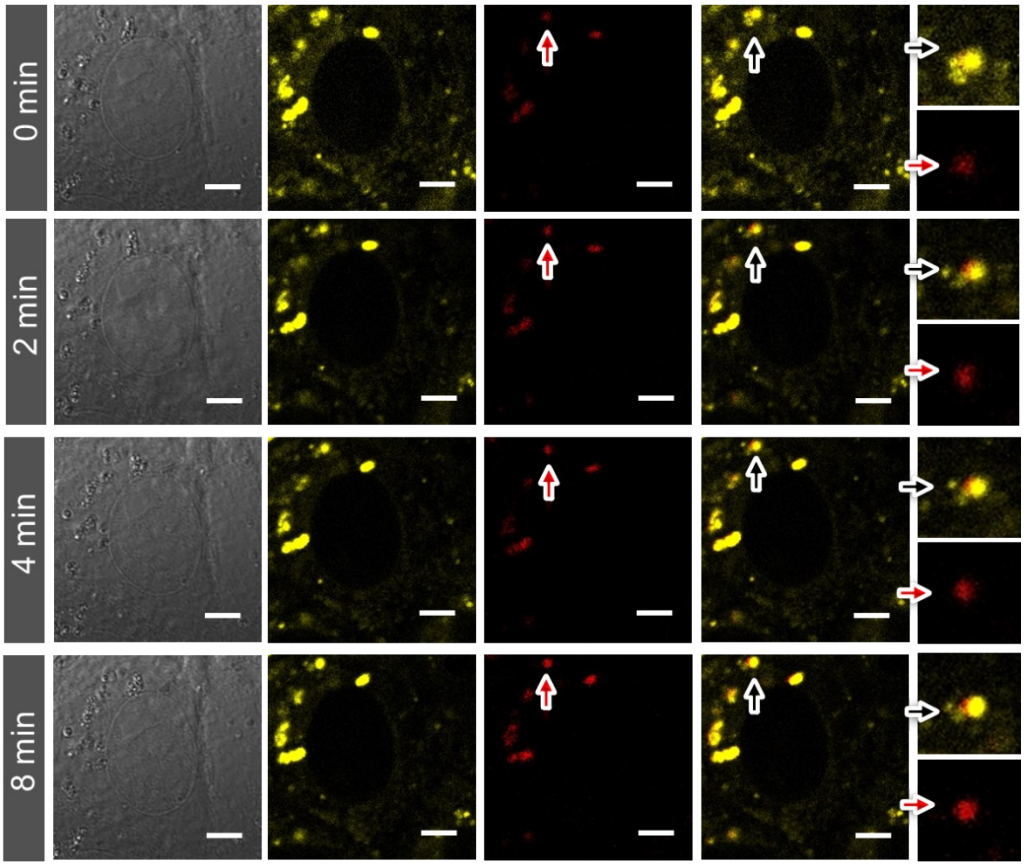


Figure S17. Real-time CLSM images of 4T1 cells incubated with TPE-BEP for 3 hours after adding acetic acid. Scale bar is 5 μm. [TPE-BEP] = 10 μM.

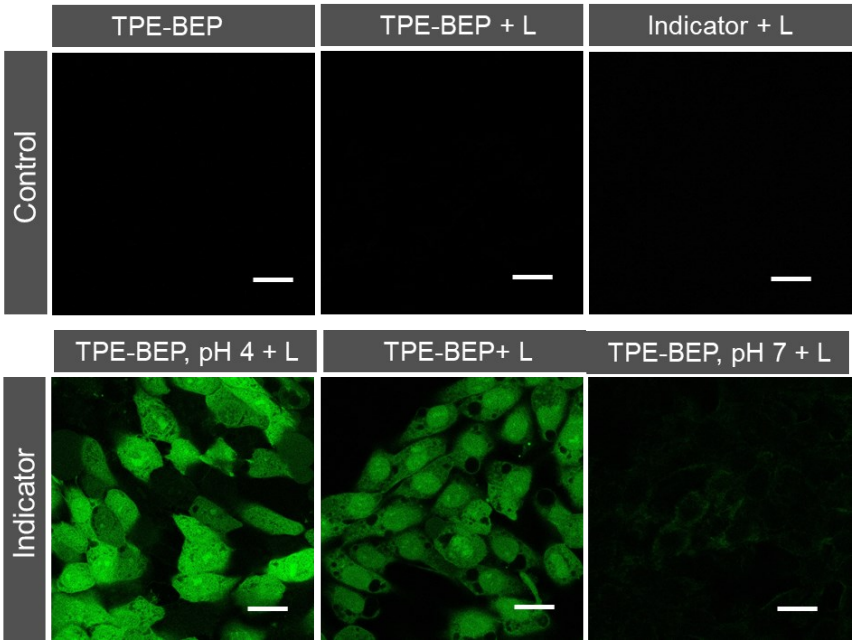


Figure S18. CLSM images of 4T1 cells incubated with TPE-BEP under different conditions and stained with DCFH-DA. Scale bar is 20 μm.

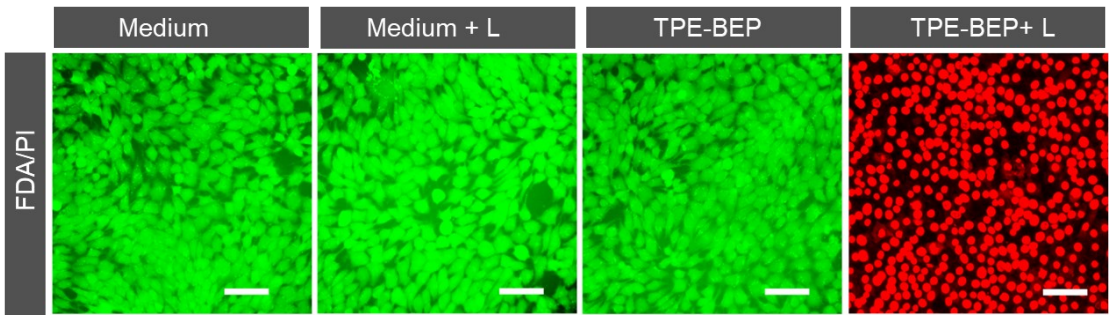


Figure S19. CLSM images of 4T1 cells incubated with TPE-BEP under different conditions and stained with FDA and PI. Scale bar is 50 μm.

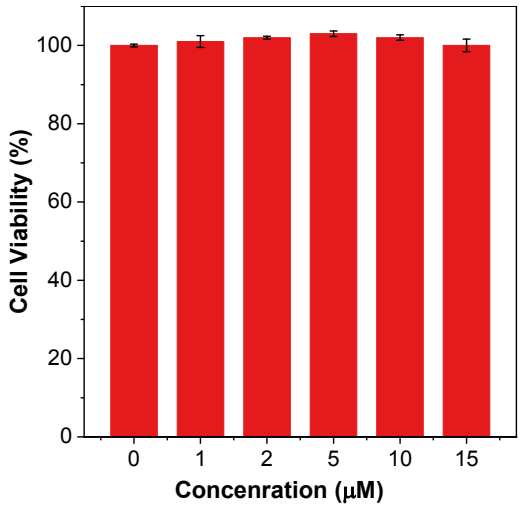


Figure S20. Cell viability of 4T1 cells incubated with different concentrations of TPE-BEP for 24 h in the dark.

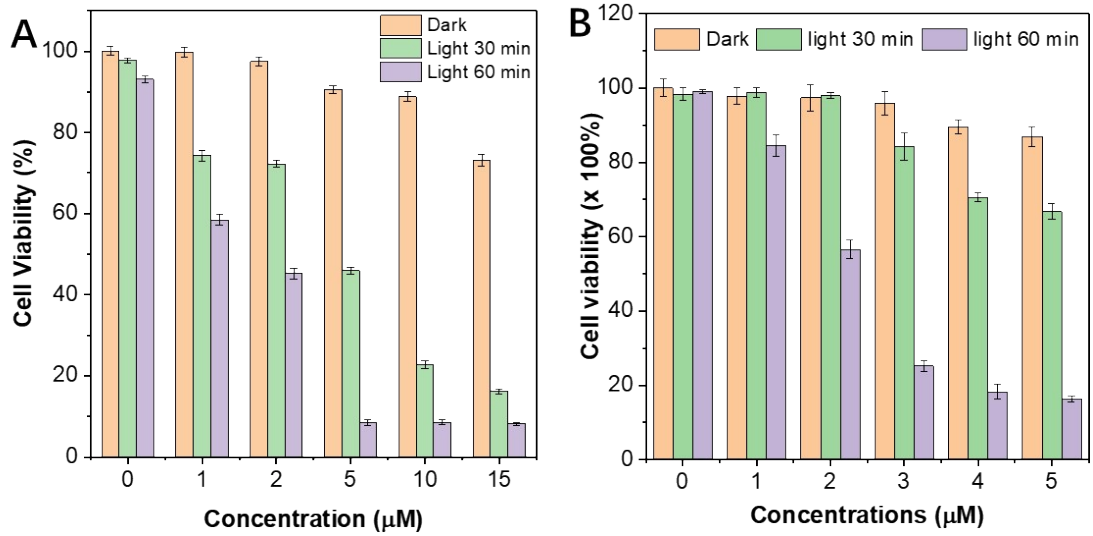


Figure S21. Cell viability of (A) HepG2 cells and (B) HeLa cells incubated with different concentrations of TPE-BEP for 24 h in the dark or under light irradiation.

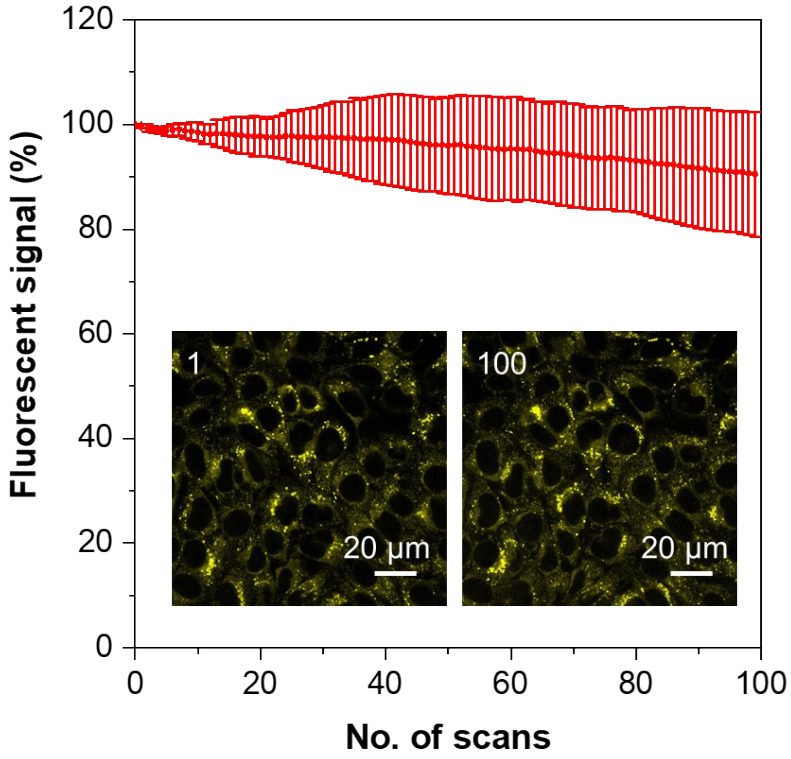


Figure S22. The plot of emission loss of 4T1 cells after incubation with TPE-BEP against the increasing laser irradiation scans by CLSM. Ex = 405 nm; laser power: 2%; [TPE-BEP] = 10 μM. Inset: CLSM images 4T1 cells treated with TPE-BEP before and after 100 scans.