Generating Singlet Oxygen Bubbles: A New Mechanism for Gas-Liquid Oxidations in Water

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Supporting Information

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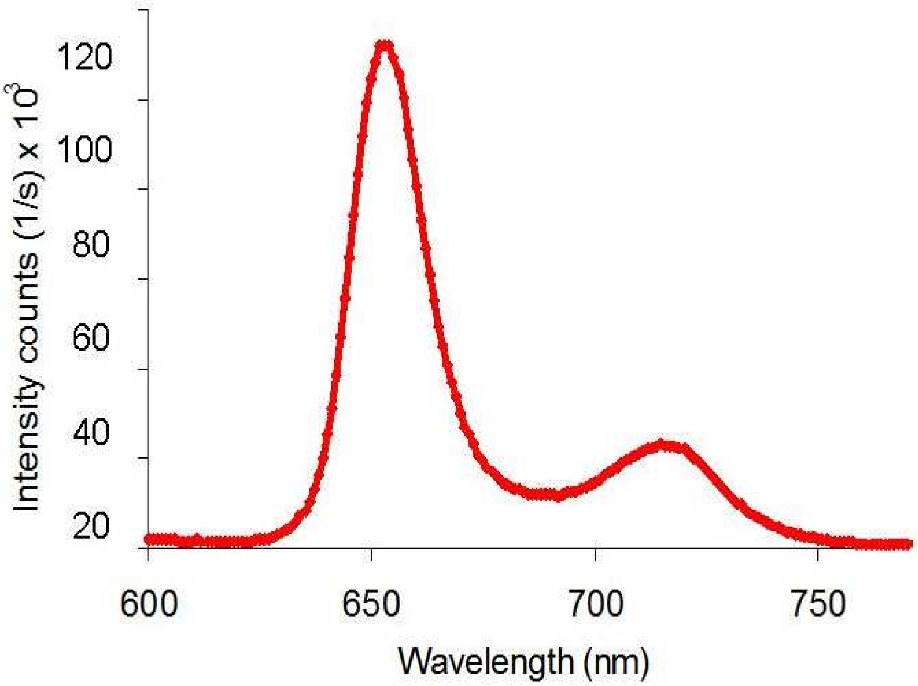


Figure S1. Fluorescence spectrum (λ_{ex} = 250 up to 400 nm) of a sheet of Pc **1**, ~0.5 mm in thickness.

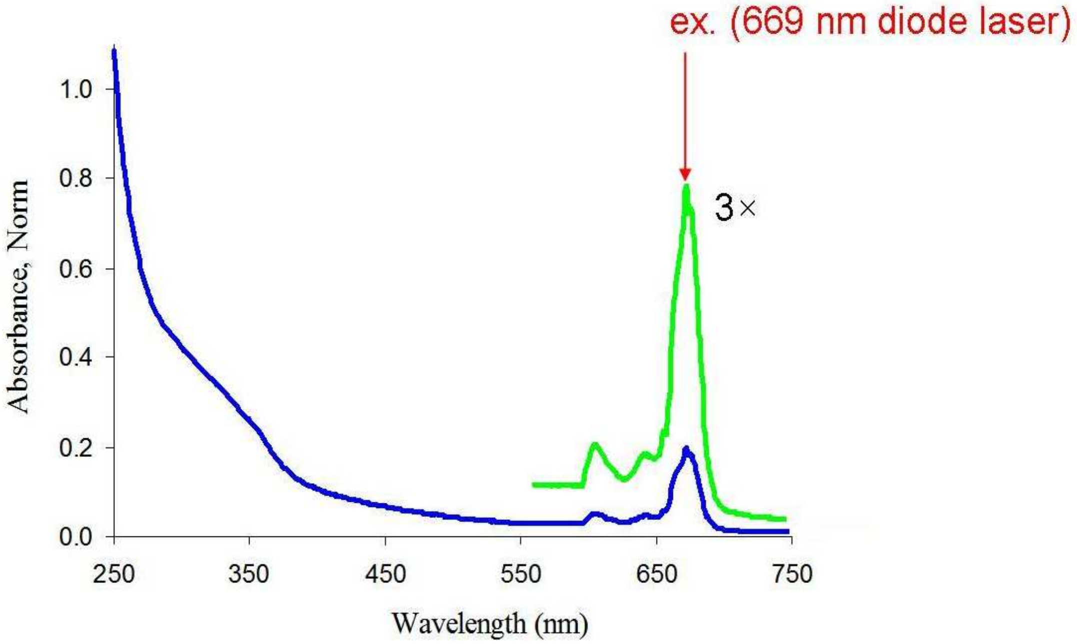


Figure S2. UV-VIS spectrum of the $^1O_2$ sensitizing glass Pc **1**. The red arrow shows where the 669 nm laser line of the diode laser overlaps the Q-band.

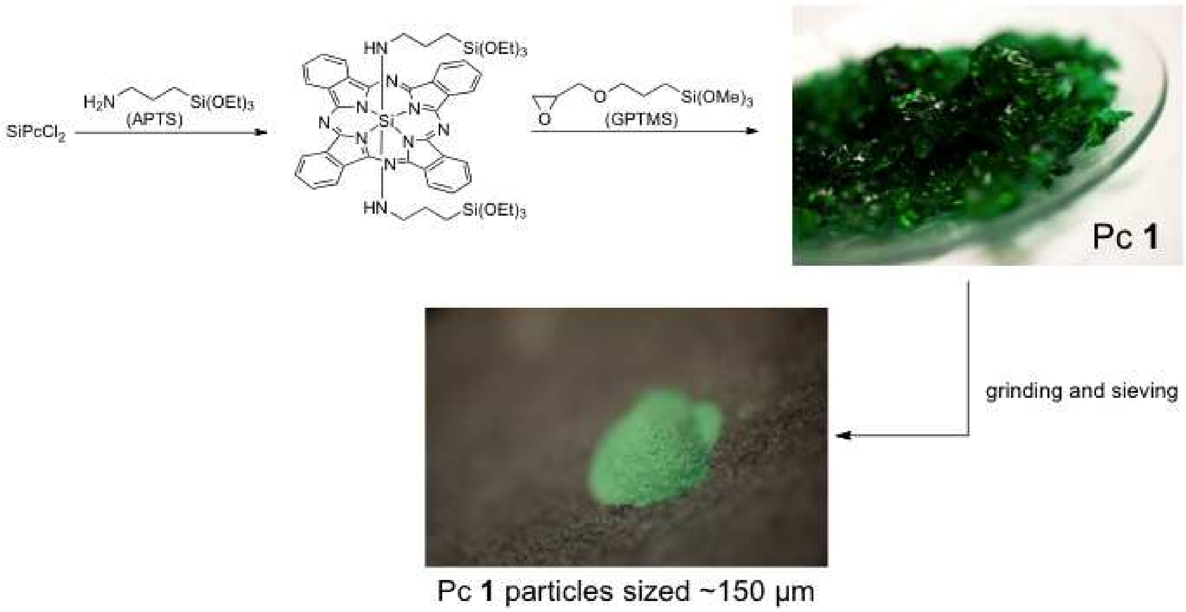


Figure S3. Schematic of the synthetic approach used as well as photos showing the hybrid $^1O_2$ sensitizing (phthalocyanine entrapped sol-gel) glass, and the fine powder achieved after grinding.

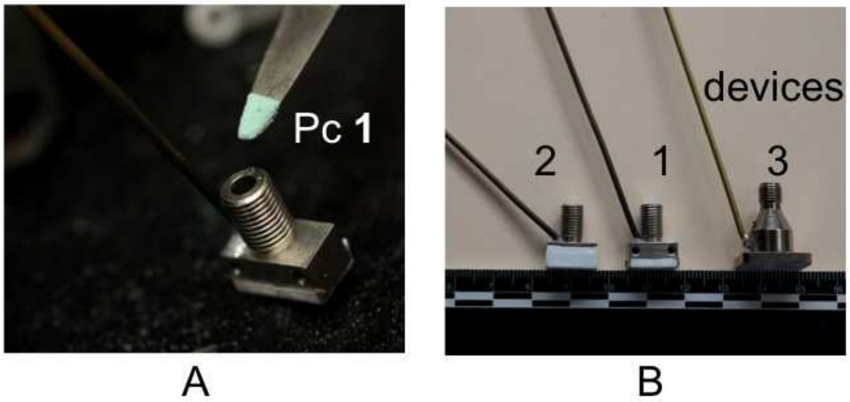
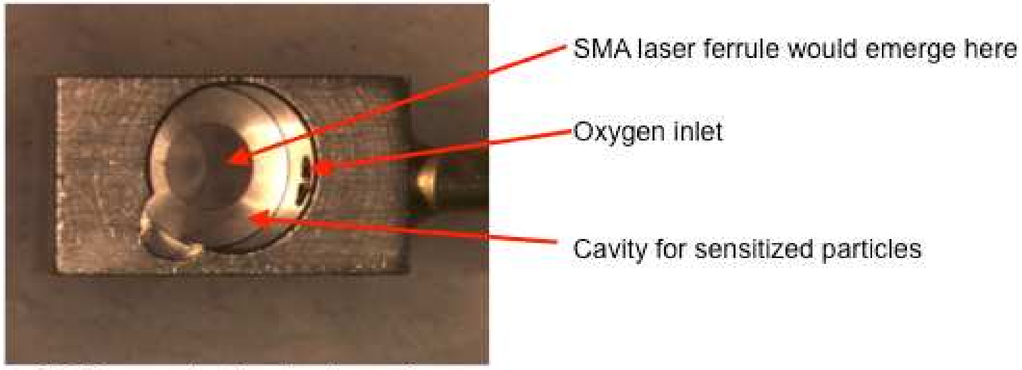
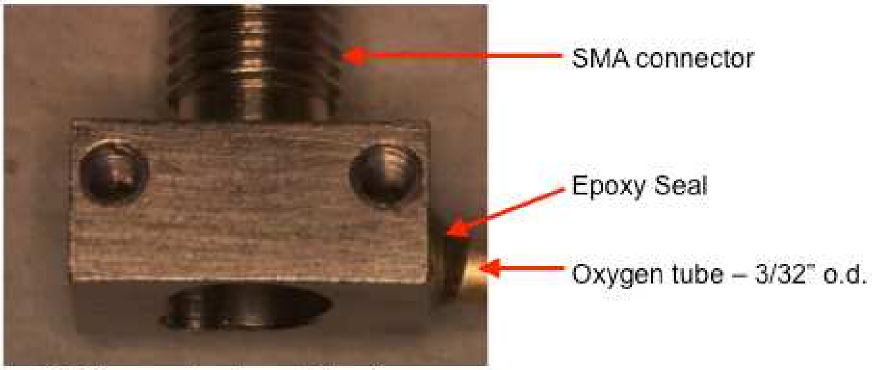


Figure S4. These photos show (A) the loading of ~150 μm Pc **1** sensitizer particles into the chamber of device 2 via a spatula, and (B) the three devices (without optical fiber) placed above a centimeter-scaled ruler.



SMA receptacle – bottom view



SMA receptacle – side view

Figure S5. Images of the SMA receptacle with oxygen inlet.

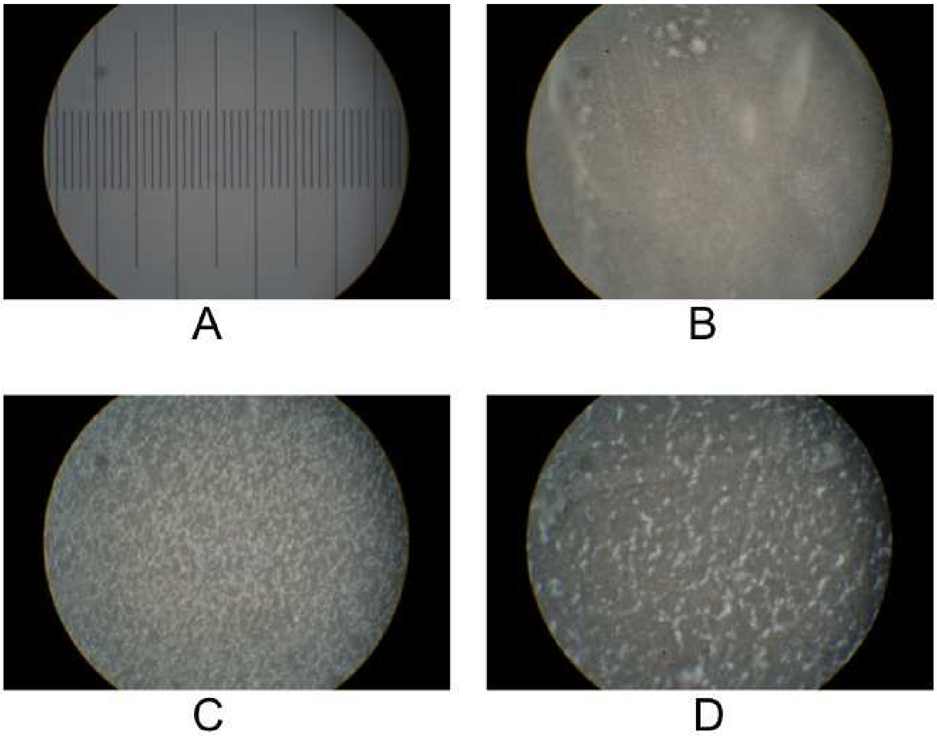


Figure S6. Photomicrographs of the polyethylene membranes: (A) micrometer calibration (1 unit =0.007368 mm =7.37 µm); (B) 0.05 µm pore size membrane; (C) 0.22 µm pore size membrane; and (D) 0.44 µm pore size membrane. The individual pores were too small to resolve and see under the low-power magnification.

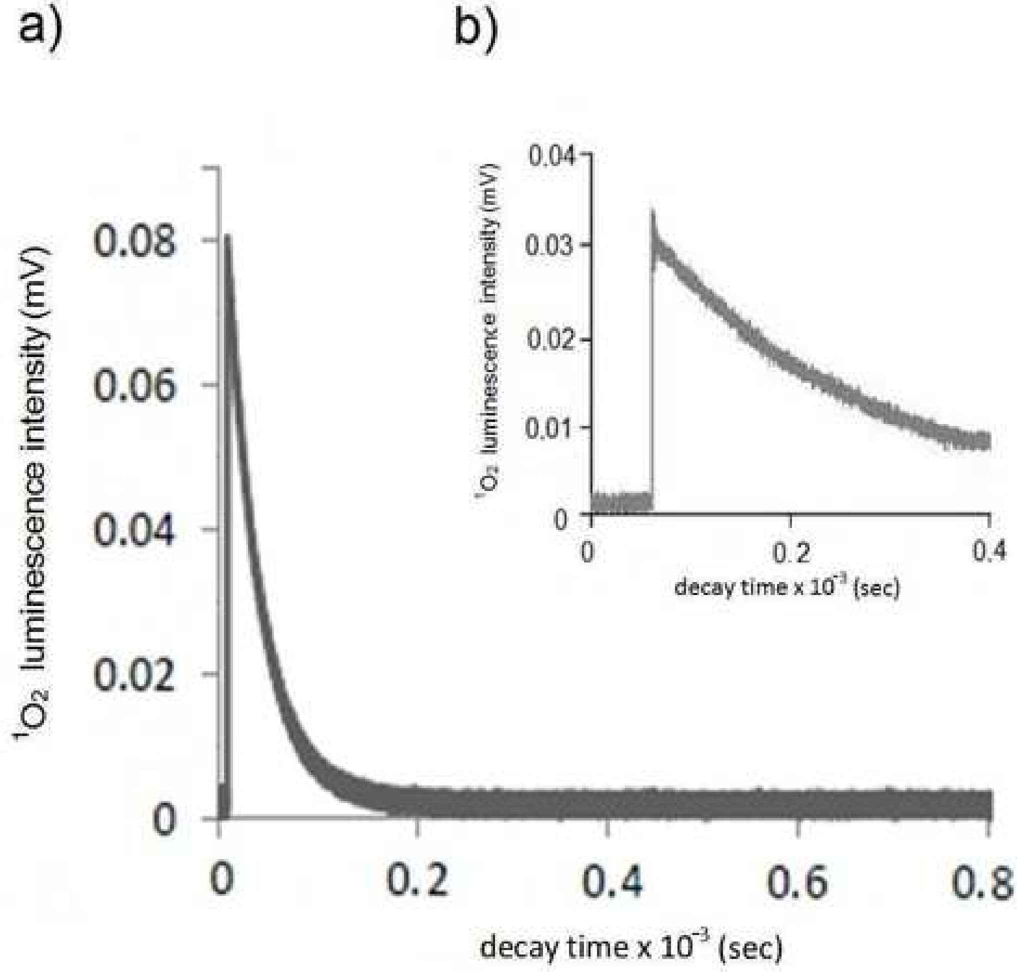


Figure S7. Luminescence from singlet oxygen at 1270 nm were observed with 355-nm pulsed irradiation through 35 mg of sensitizer particles loaded into device 1 with flowing oxygen (60 mL/min). First-order decay kinetics were observed and fitted to the equation [luminescence$_{1270}$ (t) = A × (exp$^{-(t/\tau)}$], where $1/k_{\mathrm{obs}} = \tau(^1O_2)$ lifetime. The lifetime of singlet oxygen in (a) 3 mL D_2O was 60±3 μs (average of 6 experiments), and (b) in air was ~1.1 ms (estimated from 3 experiments).

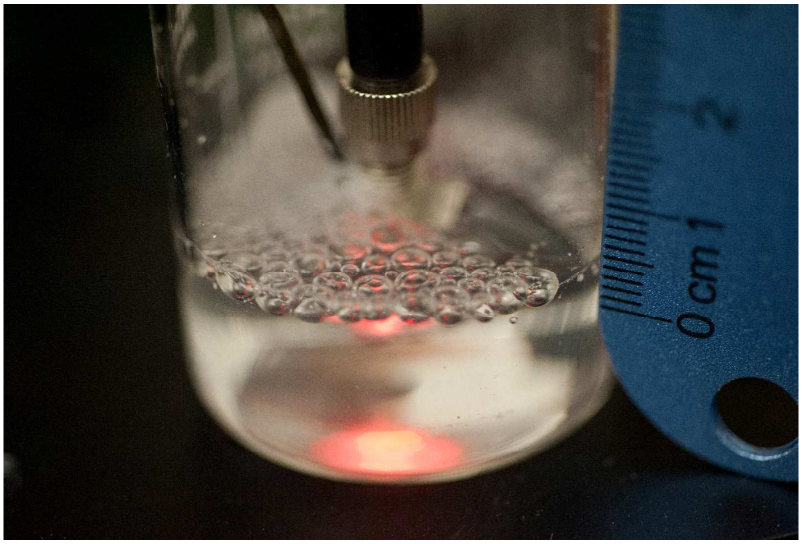


Figure S8. Loss of singlet oxygen in bubbles that reach the air interface from device 2 loaded with 35 mg sensitizer particles. The O_2 flow rate was 60 mL/min.

Table S1. Device Dimensions and Membrane Characteristics

Device	Chamber Diameter (mm)	Chamber Height (mm)	Membrane Pore Size (μm)	Membrane Thickness (μm)	Capillary Pressure (PSI)
1	5.7	5.3	0.05	70	108
2	5.7	5.3	0.22	90	25
3	10	10	0.44	150	12

Table S2. Calculated Particle Surface Area Based on Loading

Quantity of Pc **1** loaded into devices (mg)	Total surface area of sensitizer particles **1** (mm^2/mg)	Total number of sensitizer particles **1**
0	0	0
1	30	420
3	90	1260
10	300	4200
35	1050	14,700
50	1500	21,000
75	2250	31,500

[a] 150±30 μm sensitizer particles.