Supplementary Material

Silicon Based Chemical Motors: an Efficient Pump for Triggering and Guiding Fluid Motion Using Visible Light

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1. Video Captions

Movie 1. Positively charged particles in water at the p-doped Si/Pt pump
Movie 2. Quasi-neutral particles in water at the p-doped Si/Pt pump
Movie 3. Negatively charged particles in water at the p-doped Si/Pt pump
Movie 4. Positively charged particles in 1% H_2O_2 at the p-doped Si/Pt pump
Movie 5. Quasi-neutral particles in 1% H_2O_2 at the p-doped Si/Pt pump
Movie 6. Negatively charged particles in 1% H_2O_2 at the p-doped Si/Pt pump
Movie 7. Positively charged particles in 1% H_2O_2 at the p-doped Si/Au pump
Movie 8. Positively charged particles in 1% H_2O_2 at the n-doped Si/Pt pump

2. Ratiometric measurements with Pyranine as fluorescent pH indicator

Pyranine is excited at 405 and 488 nm and the emission is collected from 480 to 580 nm. At 405 nm the fluorescence intensity decreases as the pH increases whereas the fluorescence signal increases as the pH increases when the dye is excited at 488 nm. Figure S 1shows the calibration curves at both excitation wavelengths as a function of different pH solutions in absence of H_2O_2 and with a dye concentration of 5µM. In ratiometric measurements, the pH is calculated from the ratio between the fluorescence signals at the two wavelengths using the standard calibration equation S1,

$$pH = pK_a - log\left[\frac{R-R_B}{R_A-R} \times \frac{F_{B(\lambda 2)}}{F_{A(\lambda 2)}}\right] \quad \text{(S1)}$$

where pKa is 7, R is the ratio of the fluorescence signals at the two wavelengths, R_B is the ratio of fluorescence signals of 405 nm and 488 nm in the basic extreme (pH=9), R_A is the ratio of fluorescence signals of the two wavelengths in the acidic extreme (pH=4), F_B and F_A are the fluorescence signals at the acidic and basic extreme of one of the wavelengths (e.g. λ= 488 nm). As mentioned in the manuscript we get proton concentration images by applying this equation, pixel by pixel.

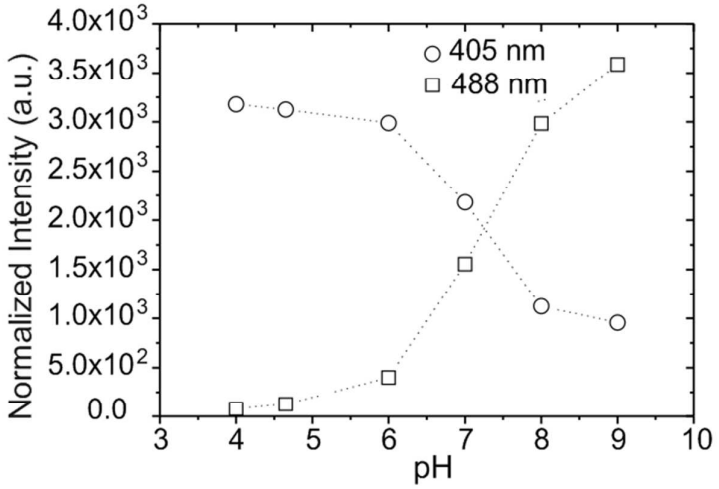

Figure S1. Fluorescence intensity as a function of pH for both excitation wavelengths.

The small fluorescence background contribution of silicon was also subtracted from the pH calculations.

3. Effect of the salt on the p-Si/Pt pump in presence of water

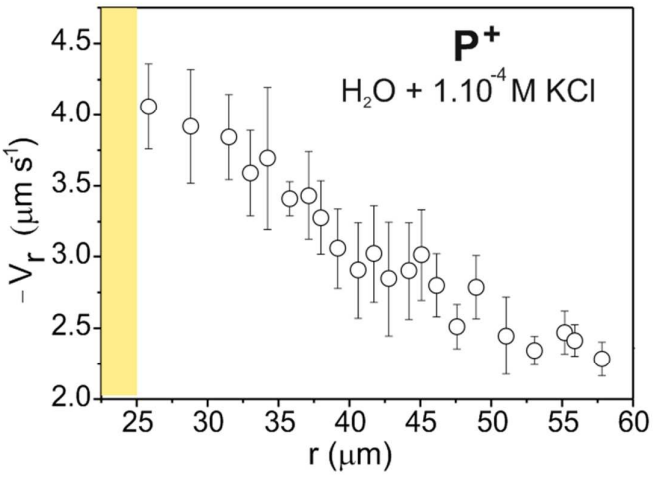

Figure S2. Effect of potassium chloride on the average radial velocity of positive particles in water. The yellow part indicates the platinum region.

4. Motion of positive tracers at a p-Si/Au pump

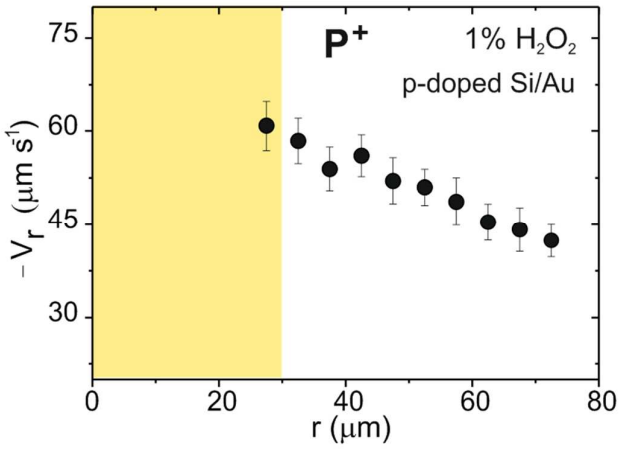

Figure S3. Motion of positively charged particles at p-doped silicon/Au pump in 1% H_2O_2. The tracers show similar performance behavior as the one when Pt metal is used**.** The yellow area represents the area above the gold disk. The diameter of the disk is 50 μm

5. Effect of the light wavelength on the catalytic pump

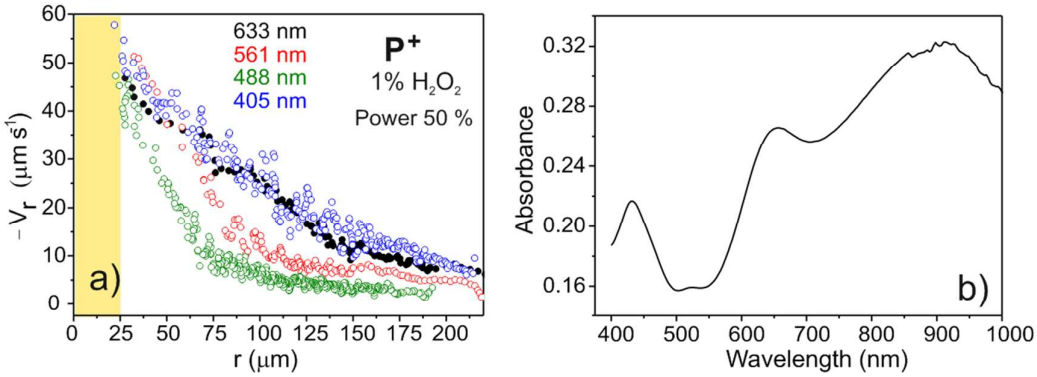

Figure S4. a) Motion of positively charged particles at p-doped silicon/Pt pump in 1% H_2O_2 at 405, 488, 561 and 633 nm. The samples were illuminated with a laser power of 50 %. A higher velocity dispersion can be observed as moving away from the platinum disk (yellow region). The particles illuminated with wavelengths of 633 and 405 nm acquire higher velocities. This fact could be correlated with a higher absorbance of the silicon structure. b) Spectrum of absorbance of p-doped silicon.

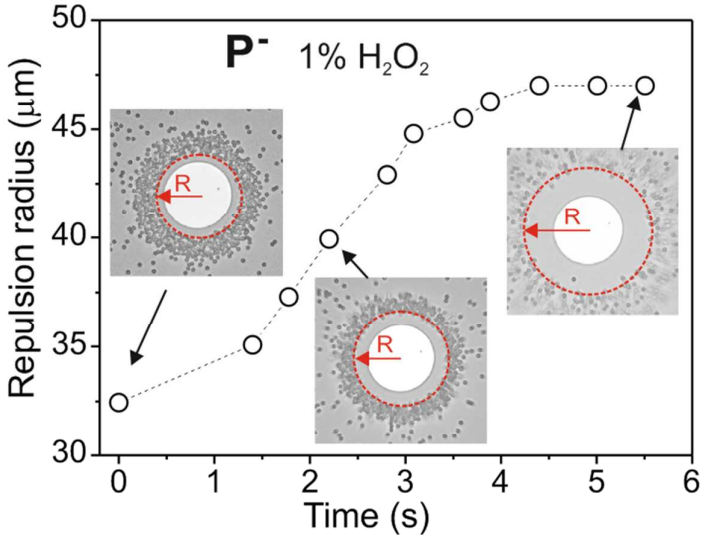

Figure S5. Evolution in time of the repulsion band when the pump is immersed in a solution of hydrogen peroxide with negative particles and illuminated with high intensity light.