Supporting Information

Non-oscillatory Micromotors "Learn" to Oscillate On-the-fly from Oscillating Ag Micromotors

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Table of Contents

1. Fabrication of Au-Rh, PS-Pt and PMMA-Ag motors

Au-Rh nanorods were made by electrodepositing Au and Rh in porous AAO membranes (Whatman, nominal pore diameter of 200 nm) with thermally evaporated Ag as the sacrificial layer. The lengths of Au and Rh were controlled by monitoring the charges passed. Then Ag sacrificial layer and membrane were dissolved by HNO_3 and NaOH solution, the Au-Rh rods were released into pure water (18.2 MΩ·cm) after cleaning.

Monolayers of 3 μm PS spheres, 2.5 μm PMMA spheres or 2 μm SiO_2 spheres were prepared on glass slide by drop-casting method. Then PS-Pt spheres were fabricated by sputtering (SBC-12); a 50 nm Ag layer was coated by e-beam evaporating (e-beam evaporator HHV TF500) onto the monolayers of PMMA and SiO_2 spheres, then the PMMA-Ag and SiO_2-Ag spheres were obtained by ultrasonication or scraping and released into pure water (18.2 MΩ·cm).

2. Experimental setup

The experimental cell was constructed following Fig. S1 and observed from underneath with an inverted optical microscope (Olympus IX71), typically with a 40x objective lens. A LED UV light (Thorlab M365LP1-C1, peak wavelength at 365 nm) was applied from above. A round LED white lamp was placed under the UV light source to provide ambient lighting for imaging. Video was captured by a CMOS camera (GS3-U3-51S5C-C, Point Grey) typically at 30 frames per second (fps). As was reported in our work,[1, 2] H_2O_2, KCl solution and UV light were necessary for Janus Ag motors' oscillation. Mixed aqueous solution of Ag Janus particles and chemicals was contained in the experimental cell in Fig. S1, which was made by a pipette tip adhered to a piece of coverslip with UV glue (Norland, NOA63).

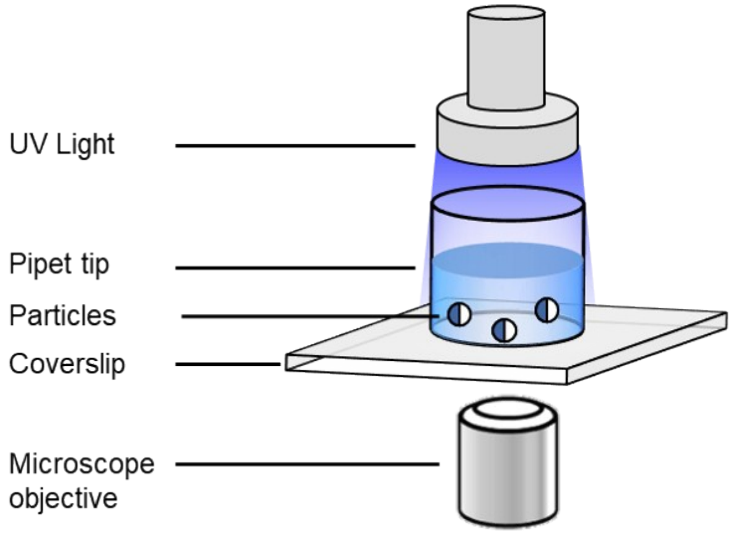


Figure S1. Experimental setup

3. Particle tracking and visualization

Particle tracking. The captured videos were processed by a MATLAB code, provided by Hepeng Zhang's lab at Shanghai Jiaotong University, to recognize every single particle via their higher gray value than the background. Coordinates of particles were returned to calculate instantaneous speeds.

Trajectory visualization.

With the help of MATLAB codes, a certain set of colors were used to represent particle speeds, as in Video S1. Particles that moved faster than a threshold (13.6 μm/s for rods, 8 μm/s for spheres) were replaced by colored dots, while those below the threshold were filtered.

4. Dynamics of rods in waves

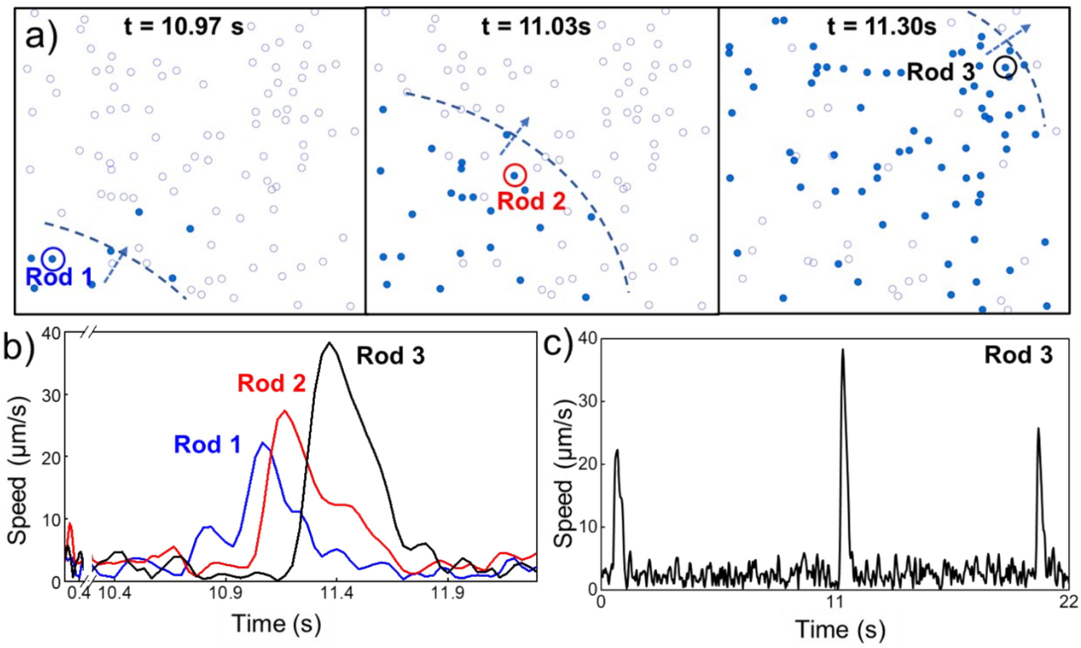


Figure S2. Waves travel among Au-Rh nanorods (blue circles) in an aqueous solution containing H_2O_2, KCl and $AgNO_3$ (but not PMMA-Ag particles) under UV light. (a) Three Au-Rh nanorods at different locations are selected and tracked. (b) Instantaneous speeds of the selected rods. Their speeds sequentially peak as the wave travels. (c) Speed profile of rod #3 during the propagation of three consecutive waves. Figure S3 is taken from Video S7.

5. Scanning electron micrograph of PMMA-Ag spheres

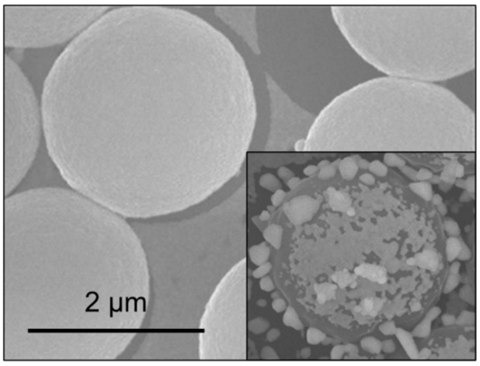
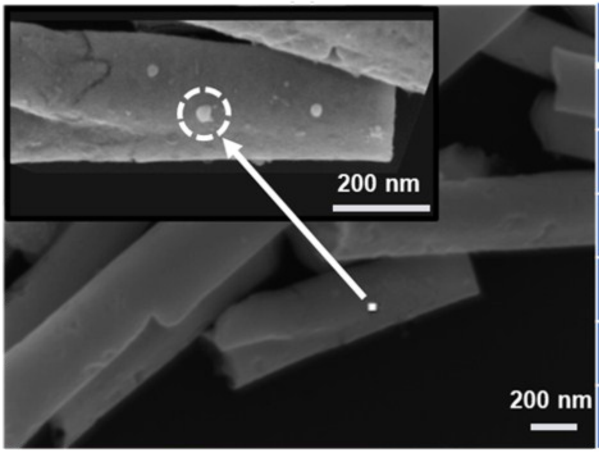


Figure S3 Scanning electron micrograph of PMMA-Ag spheres before and after (inset) oscillating in 0.5 % H_2O_2 and 200 µM KCl solution.

6. Elemental mapping of Au-Rh rods



Element	Atomic conc.%
C	56.70
O	2.20
Si	33.35
Rh	5.70
Ag	0.25
Au	1.80

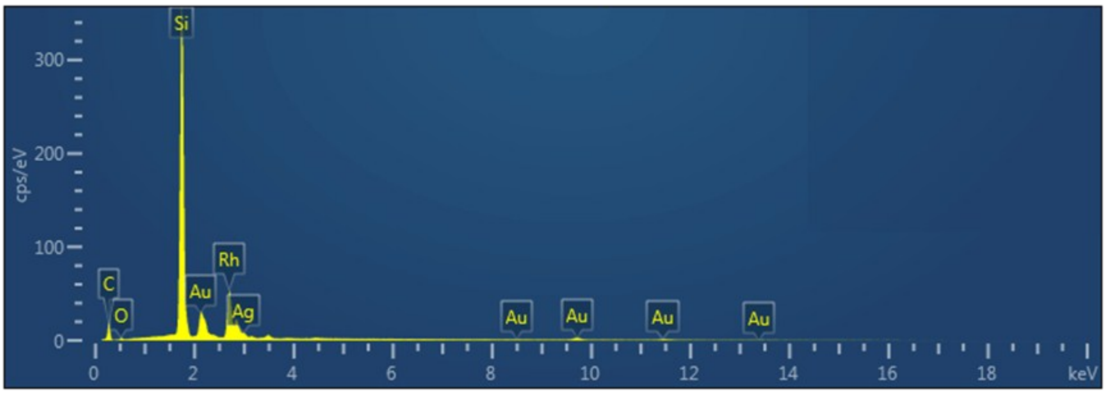


Figure S4. Elemental mapping of Au-Rh rod extracted from exposure to PMMA-Ag micromotors. Ag was detected on the rod.

6. Supporting videos

Video. S1: Natural behaviors of both the non-oscillatory (PS-Pt spheres, Au-Rh rods) and the oscillating micromotors (PMMA-Ag motor).
Video. S2: An Au-Rh nanorod oscillates in the same phase with a nearby PMMA-Ag oscillator when UV light applied.
Video. S3: A PS-Pt sphere oscillates in the same phase with a nearby SiO_2-Ag oscillator when UV light applied.
Video. S4: Oscillating micromotors transform the dynamics of nearby non-oscillatory micromotors, and this ability decreases with distance.
Video. S5: When the wave front approaches, Au-Rh nanorods are activated into pulsating motion from Brownian motion. Also, their trajectories tend to be repeating circles under activation rather than tortuous in H_2O_2 aqueous solution. Three times of the wave passes in the video.
Video. S6: Waves can still be reproduced when Au-Rh nanorods are the majority in the particle population.
Video. S7: Waves can still be reproduced when $AgNO_3$ is added (without Ag oscillators). Video shows a wave travelling along diagonal line from lower-left corner to upper-right corner.

Reference

1 C. Zhou, X. Chen, Z. Han and W. Wang, *ACS Nano*, 2019, **13**, 4064-4072.

2 X. Chen, C. Zhou, Y. Peng, Q. Wang and W. Wang, *ACS Appl. Mater. Interfaces.* , 2020, **12**, 11843-11851.