Detecting the Complex Motion of Self-Propelled

Micromotors in Microchannels by

Electrochemistry

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Experimental Section

Details on micromotor and microfluidic chip fabrication:

Microchannel Fabrication. A 500 µm wide, 100 µm high channel mold was fabricated on a clean glass wafer using a negative photoresist (Microchem, SU-8 2100). The photoresist was spin coated onto the wafer, prebaked at 65 and 95 °C, and then exposed to UV light (Karl Suss, MJB3). Following a post-bake at 65 and 95 °C, development of the wafer in EC solvent (Microposit, Rohm and Haas) removed any unexposed photoresist to reveal the microchannel mold, which was subsequently covered in poly(dimethylsiloxane) (PDMS-Dow Corning, Sylgard 184) that was allowed to cure for 24 h.

Assembling. The PDMS was peeled off from the casting mold and exposed to air plasma along with the electrode wafer. Next, the microchannel and electrodes were accurately aligned and brought into contact, to give a device which was then baked at 65 °C for 2 h to ensure a mechanically robust seal. Inlets and outlets were created using a biopsy punch to allow silicone tubing to be inserted and secured using a silicone sealant (Dow Corning, 734).

Micromotor synthesis. The Cu/Pt micromotors (both 3 and 5um) were synthesized using a modified electrochemical deposition procedure on cyclopore polycarbonate templates (3 and 5 μ m) as described in an earlier work.¹ Backside of the template was sputtered by silver at - 40 mA for 200 s. Copper tape was attached to coated side of the template, which serves as the working electrode for the plating experiments. The template was assembled into a customized electrochemical deposition cell. Platinum and Ag/AgCl electrodes were used as counter and reference respectively. Electrochemical deposition was carried out with an Autolab PGSTAT 101 (Eco Chemie, Netherlands) controlled by NOVA software. The template was rinsed with ultrapure water (8 mL; 18.2 M Ω cm) for five times, and the Cu outer layer was deposited galvanostatically at -2 mA for 1200 s by using a copper deposition solution of 1 M CuSO₄

and 1 M H₂SO₄. Consequently, after removing the Cu deposition solution, the template was rinsed five times with water (8 mL) and then the platinum segment was electrodeposited subsequently at -2 mA for 1200s. A commercial Pt plating solution was used for electrodeposition. After completing the electrodeposition procedures, the electrochemical cell was disassembled, copper tapes removed and the Ag coated layer polished with aluminum powder (0.06 μ m). The template was dissolved in dichloromethane (2 mL) and ultrasonicated for 5 min. The electrochemically deposited micromotors were collected by centrifugation at 10000 rpm for 5 min and washed three times with dichloromethane. The solution was then washed twice each with ethanol and water and centrifuged after each washing step. The tubes were stored in water at room temperature.

1. Zhao, G.; Pumera, M. Concentric bimetallic microjets by electrodeposition. *RSC Advances* **2013**, *3*, 3963-3966.



Figure S1. (a) Experimental Setup; (b) Arrangement of the electrodes (Working Electrode (WE), Reference Electrode (RE) and Counter Electrode (CE)).



Figure S2. Example of the motion of bubbles over the electrodes in the microfluidic channel. (a) Scheme of motion of micromotor inside the microfluidic channel on top of the electrodes (side view) (b) Experimental screenshot; (c) Current - time electrochemical profile while bubbles are moving across the working electrode. Condition in all experiments: 1% wt. SDS+ 3% wt. H $_2O_2$, Applied Potential: 0 V vs. Au electrode and 23 °C. Scale: width of working electrode is 100 µm.

Video S1. Micromotor moving across the working electrode.

Video S2. Micromotor moving across the working electrode few times.

Video S3. Micromotor moving in circular pathway on the surface of working electrode.