Electronic Supplementary Information

Micromotors with built-in compass

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Experimental Section

Preparation of Rolled-up Microtubes: Preparation of Rolled-up Microtubes: Ti/Fe/Cr/Pt microtubes were fabricated by electron-beam (e-beam) evaporation (Ti/Fe/Cr) and magnetronsputtering (Pt) of thin metallic films on patterned photoresist squares with a single element size of 50 μm×50 μm. Photoresist AR-P 3510 was spincoated on silicon wafers (1.5 inch) at 3500 rpm for 35 s, followed by a soft bake using a hotplate at 90°C for 1 min and exposure to UV light with a Karl Suss MA-56 mask aligner (410–605 nm). Photoresist patterns were then developed in an AR300-35/H_2O solution (1:1). Rolled-up catalytic microtubes were obtained by a tilted deposition at an angle of about 60° (measured from the horizontal axis) on the photoresist. Metallic particle films (Ti/Fe) with thicknesses of 3 nm (Ti), 5 nm (Fe) and 5 nm (Cr) were deposited layer by layer on the tilted samples. Thereafter, by using magnetron sputtering, 1 nm of Pt was deposited onto the Ti/Fe/Cr samples. The samples were immersed in acetone where rolling-up of the thin metallic films into microtubes was achieved by selectively etching the photoresist layer. Supercritical point drying was used in order to avoid collapsing of the tubes because of high fluid surface tension. Cr is an antiferromagnetic material with the Neel temperature of about 310 K. For thin films with a thickness of several nm, blocking temperature where antiferromagnetic order sets in is usually substantially smaller compared to the Neel temperature. As our experiments are carried out at room temperature and no specific magnetic field treatment is applied to the samples, exchange bias effect at the interface between Fe and Cr is not expected.

Materials and Chemicals: All chemicals for solution based experiments were obtained from Alfa Aesar.

Microjet Motion: Motion of microjet engines was investigated in aqueous solution containing 9 % wt of hydrogen peroxide at constant surfactant concentrations (1 wt% of SDS). A small amount (1%, v/v) of isopropanol was added into the solution to enhance the visibility of the tubes. Control experiments in absence of hydrogen peroxide were performed in aqueous solution containing same concentration of SDS and isopropanol. Magnetic field was applied by placing permanent magnet about 3 cm from the Petri dish in the horizontal plane. For reversing of the magnetic field, the permanent magnet was rotated 180^{o} at the same distance.

Optical Characterization of Motion: Optical microscope videos and images were obtained with Nikon Eclipse TE 2000-E microscope, CFI 10× optics. Video sequences were processed with Nikon NIS-Elements™ software.