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# Electronic Supplementary Information

## Hydrodynamics and Propulsion Mechanism of Self-Propelled Catalytic Micromotors: Model and Experiment

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## 1. Calculation of the bubble departure radius using an iterative procedure

Solving for the bubble departure radius at a given inclination angle $\theta$, length of micromotor $L$ and $H_2O_2$ concentration requires an iterative procedure. Using the initial value of the bubble volume $V_0$ , the contact angle $\varphi_0$ , the initial time $t_0$ and the time step $\Delta t$ , the iteration method of the flowchart, as shown in Fig. S1, is used for calculation until it converges. Here we take the surface tension, the viscosity and the density of hydrogen peroxide at 25 ℃, $\sigma$=73mN/m, $\mu$=0.896~0.927mPa•s, and $\rho_l$=1.0074~1.0505g/mL, respectively. All other parameters are used as following: the oxygen density $\rho_g$=1.325 kg/m$^3$, and the gravitational acceleration g=9.8N/kg. [S1-S3]

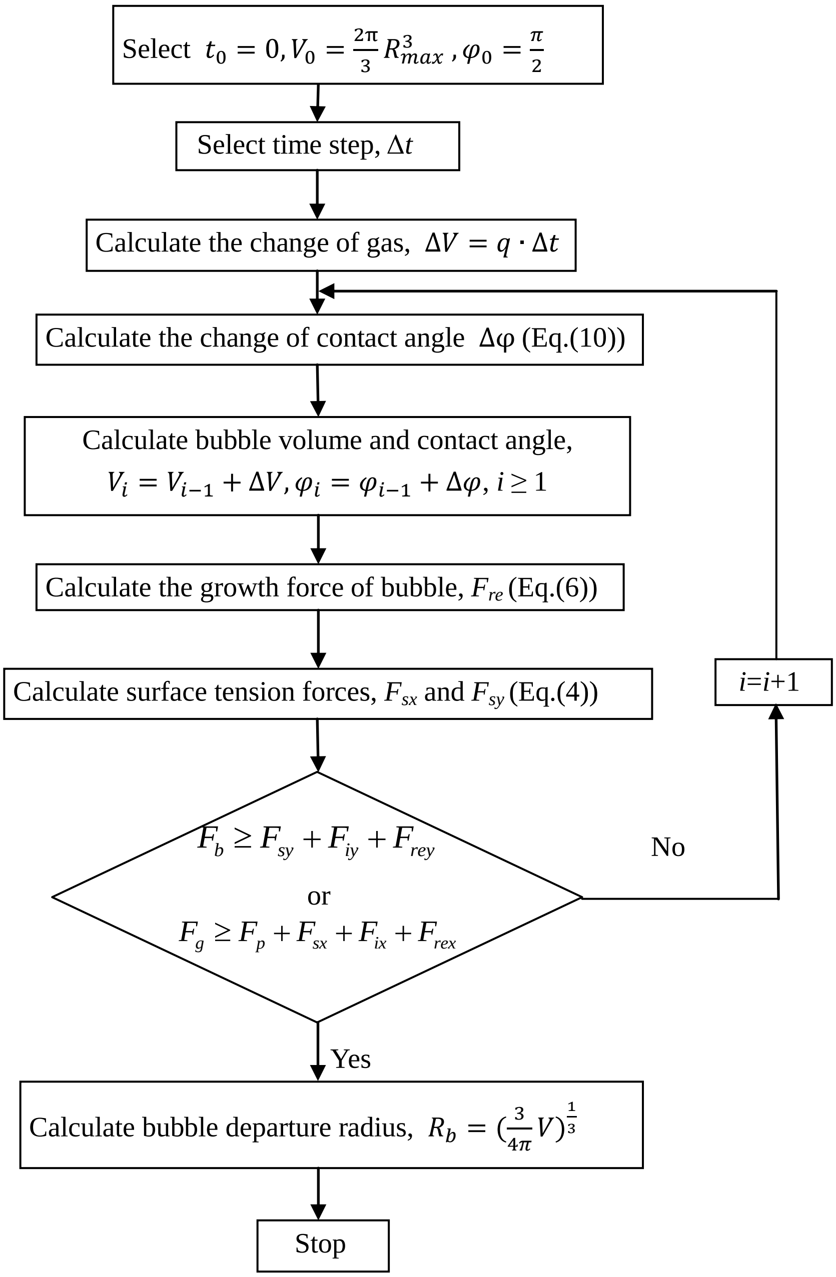


Fig. S1 Flowchart of the iterative procedure.

**References**


[S1] M. K. Phibbs and P. A. Giguere, *Can. J. Chem.*, 1951,**29**, 173-181.

[S2] M . F. Eastonm, A . G. Mitchell and W. F. K. Wynne-Jones, *Trans. Faraday Soc.*,1952,**48**, 796-801

[S3] Pečar, D. Resnik, M. Možek, U. Aljančič, T. Dolžan, S. Amon and D. Vrtačnik, *Informacije Midem-Journal of Microelectronics, Electronic Components and Materials*, 2013,**42**,103-110.

## 2. Derivation of the dimensionless parameter $c_1$

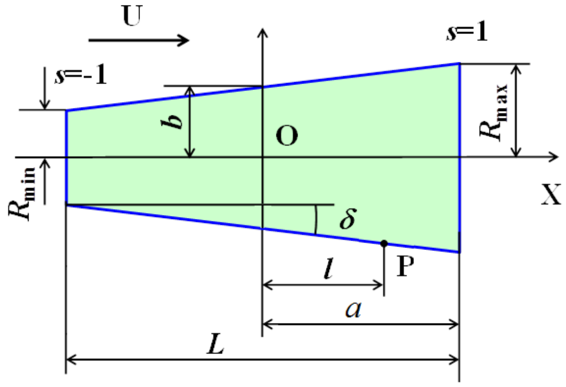


Fig. S2 A schematic of the forces acting on an axisymmetric body when it is in a fluid system.

The resistance force of an axisymmetric body moving in a fluid can be written in the form: [28]

$$F = \frac{4\pi\mu a U}{\ln(\frac{2a}{b}) + c_1} + O\left\{\frac{\mu a U}{(\ln a/b)^3}\right\} \tag{S1}$$

where $F$ is the resistance force on the micromotor, $\mu$ is the fluid viscosity, $U$ is the velocity of an unbounded fluid, $c_1$ depends on the body shape and is given by

$$c_1 = -\frac{1}{2} + \frac{1}{4}\int_{-1}^{1} \ln[\frac{1-s^2}{\lambda^2(s)}]ds \tag{S2}$$

Assuming the micromotor has a conical shape, the radius of any point $P$ on the surface of micromotor can be expressed as

$$r = b\lambda(s) = b(1 + \frac{a\tan\delta}{b}s) \tag{S3}$$

Hence, $\lambda(s)$ can be expressed as

$$\lambda(s) = 1 + \frac{a\tan\delta}{b}s \qquad for \qquad -1 \le s \le 1 \tag{S4}$$

where $a = L/2$, $s = l/a$, $b = R_{max} - a\tan\delta$, and $l$ is the distance along the micromotor center-line, $L$, $R_{max}$ and $\delta$ are the length, the radius for a larger opening and the semi-cone angle of the micromotor, respectively.

$$
\begin{aligned}
c_1 &= -\frac{1}{2}+\frac{1}{4}\int_{-1}^{1}\ln[\frac{1-s^2}{(1+\frac{a\tan\delta}{b}s)^2}]ds \\
&= -\frac{1}{2}+\frac{1}{4}[\int_{-1}^{1}\ln(1-s^2)ds-\int_{-1}^{1}\ln(1+\frac{a\tan\delta}{b}s)^2ds] \\
&= -\frac{1}{2}+\frac{1}{4}\{4\ln 2-\frac{2b}{a\tan\delta}[(1+\frac{a\tan\delta}{b})\ln(1+\frac{a\tan\delta}{b})-(1-\frac{a\tan\delta}{b})\ln(1-\frac{a\tan\delta}{b})]\}
\end{aligned}
\quad (S5)
$$

**3. Additional ESI files:** Videos of the motion of micromotors in different $H_2O_2$ solution concentration: Supplementary movie 1 and Supplementary movie 2.

**4. Forces acting on a micromotor for a typical loading cycle in X direction and Y directions.**

As we can see, the surface tension force $F_{re}$, the inertial force $F_i$, and the gas momentum force $F_g$ are close to zero and can be neglected.

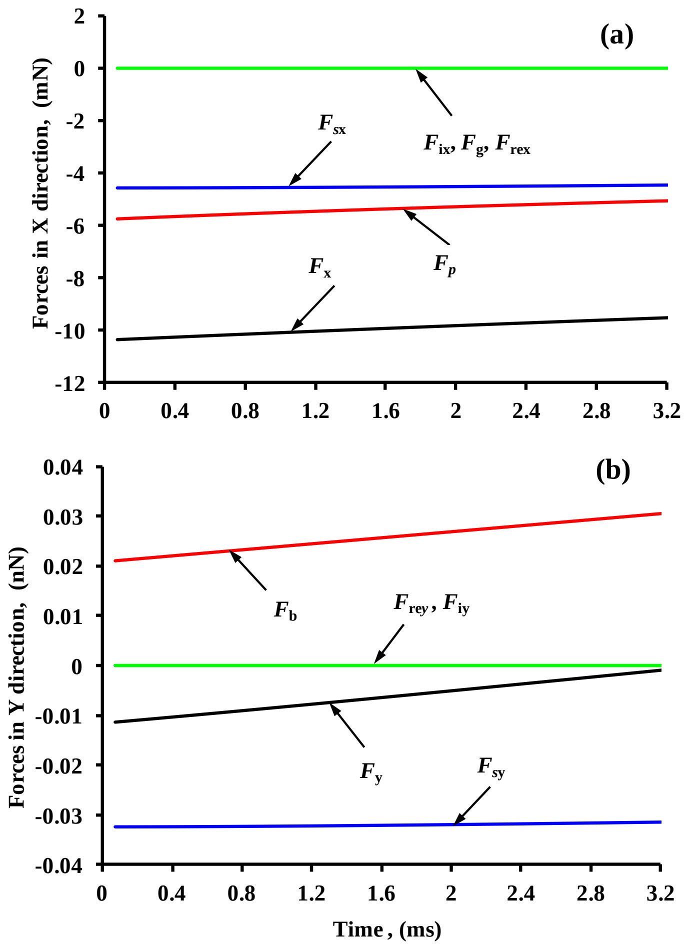


Fig. S3 Forces acting on a micromotor as a function of time in: (a) X direction and (b) Y direction, respectively.