Supporting Information

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1 The property of the solution for performance of the mercury motor.

A series of oxidants were used as the research object, such as 0.05 M $NaIO_4$ 、0.05 M KIO_4、0.05 M $K_2Cr_2O_7$、0.05 M $KClO_4$、0.05 M $KClO_3$、0.05 M $KBrO_3$、3% H_2O_2。We know the $K_2Cr_2O_7$ has a better effect on the oscillation of mercury and H_2O_2 also acts as a fuel in many of the previously studied motor systems. Based on the observations of motor motion, we found $KClO_4$, $KClO_3$, and $KBrO_3$ unsuited as oxidant in this work. Therefore, $K_2Cr_2O_7$, KIO_4, $NaIO_4$ and 3% H_2O_2 as the object of our exploration. KIO_4 has a smaller solubility than $NaIO_4$, so $NaIO_4$ as the representative of IO_4^- to show its oxidation. The motion of the motor with $K_2Cr_2O_7$ as oxidant is shown in Figure S1. The metal we use here is copper. However, the color of $K_2Cr_2O_7$ could effect on observation of experimental phenomena. Therefore, it is necessary to find a kind of colourless and transparent oxidant for the preparation of mercury motor. H_2O_2 as a kind of clean oxidant is benefit for observation phenomenon. However, a large number of bubbles will appear on the surface of mercury when we used it, which prevented the self driving motion of mercury drops, as shown in FigureS2. $NaIO_4$ as a kind of colourless oxidant is beneficial for the

observation of the experimental phenomenon and the self driving of the motor. Therefore, $NaIO_4$ is the ideal oxidant for the self-driven motor system.

Figure S1 Mercury motor moving in $K_2Cr_2O_7$ solution

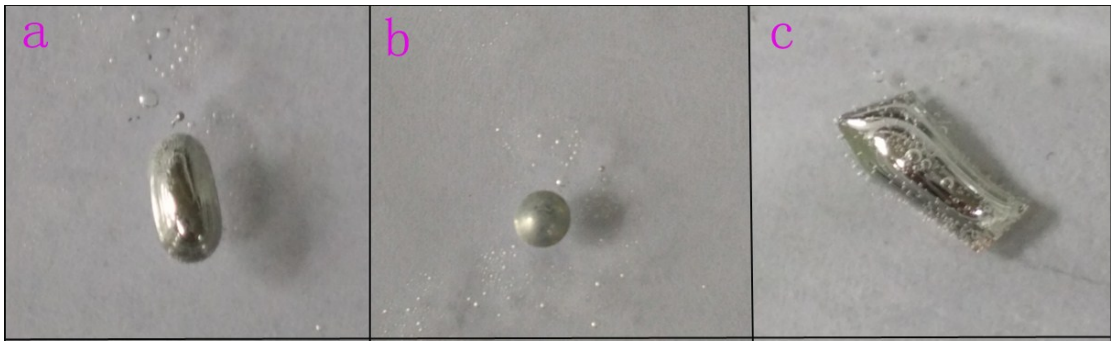

Figure S2 The process of the mercury drop changes in H_2O_2 solution. (a) Mercury drops in hydrogen peroxide solution. (b) Mercury drops in acidic hydrogen peroxide solution. (c) Mercury is paved on the surface of the metal foil.

2 Self-driven motion of mercury drop

a (1) **Movie S1** Mercury drop contacts with copper foil moving in $NaIO_4$/ H_2SO_4 solution.

(2) **Movie S2** Mercury drop contacts with aluminum foil moving in $NaIO_4$/ H_2SO_4 solution.

b The process of combining metal foil with mercury drop

(1) **Movie S3** The process of mercury droplet and metal foil transient coalescent in acidic oxidant solution

(2) **Movie S4** The mercury drop (D=1 mm) is fast swimming in the solution like a small tadpoles.

c The motion of mercury drop

Movie S5 Spatiotemporal evolution of a mercury droplet (D =2 mm) in Petri dish containing 10 mL deionized water, 2 mL $NaIO_4$ (0.05 M) and several H_2SO_4 (0.2 M) solution.

d The influence of the self-driven motor by pH.

Movie S6 The mercury droplet (D =2 mm) was used as research object, the concentration of oxidant is constant, and then we regulated the pH value. The results indicated that the motor had the fastest speed when pH is between 2~3. We added 10 mL deionized water, mercury drop (D = 2 mm) and 0.05 M 2 ml $NaIO_4$ into the petri dishes.

Movie S6a pH = 5, the mercury drop was slowly rotated in situ. The similar motion phenomenon of motor was appeared when pH =6 and pH = 7.

Movie S6b pH = 3, the motion rate significantly increased comparing with pH = 5.

Movie S6c pH = 2~3, the motion rate was faster than pH = 3, the motor quickly moved along the petri dish wall.

Movie S6d pH = 2, the movement rate was slower than pH = 2~3

Movie S6e pH = 1, the motion of the mercury drops was slow down, and finally still. The similar motion phenomenon of motor was appeared when pH = 8.

Movie S6f The process of self-driven motion may consume aluminum and broke the asymmetric state. Therefore, put a new aluminum foil into solution, but the mercury drop was not move still. At this point we adjusted the pH reset back to 2~3, the mercury drop quickly moved again. The results indicated that the motor had the fastest speed when pH is between 2~3.

3 Some interesting phenomena happened between the self-driven motors and mercury droplets.

Movie S7 The interesting phenomenon was occurred between two drops of mercury, including collision, bounce and coalition.