Supporting Information

Diving–floating locomotion induced by capturing and manipulating bubbles in aqueous environment

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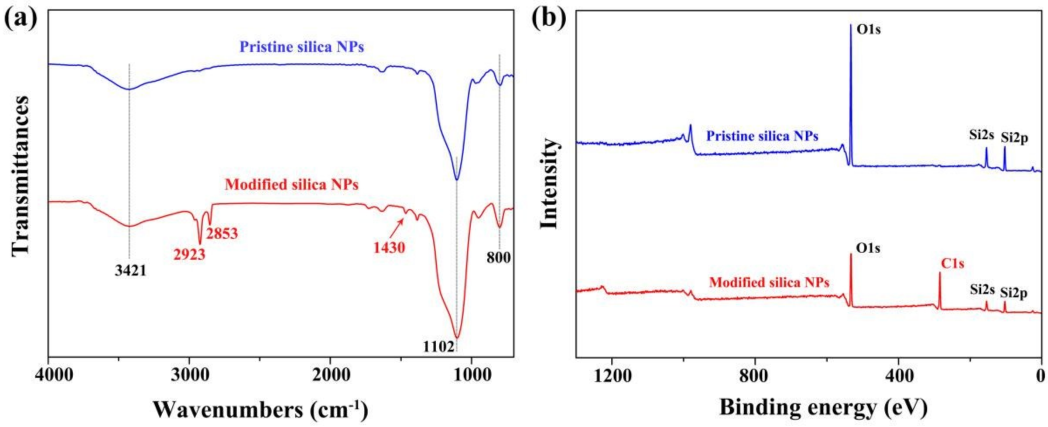

Fig. S1. (a) FTIR spectra and (b) XPS spectra of the pristine silica nanoparticles and the modified silica nanoparticles.

FTIR spectroscopy of the modified SNPs showed additional peaks at 2923 cm-1 and 2853 cm-1 which assigned to the vibrations of -CH2- and -CH3- groups in alkyl chain. In the XPS spectra, the modified SNPs shows additional peak at 284 eV which is labeled as C 1s from alkyl chain, it have evidenced the successful linkage with octadecyltrichlorosilane.

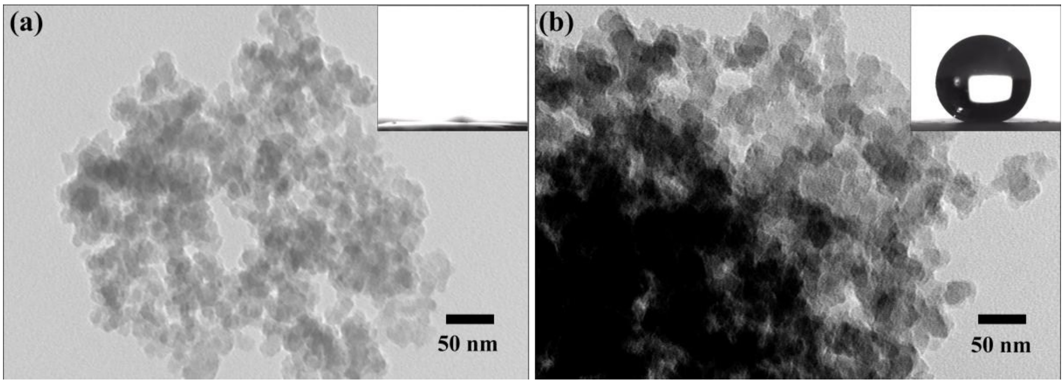

Fig. S2. TEM images of (a) the pristine silica nanoparticles and the modified silica nanoparticles. In inserts: WCA image of each.

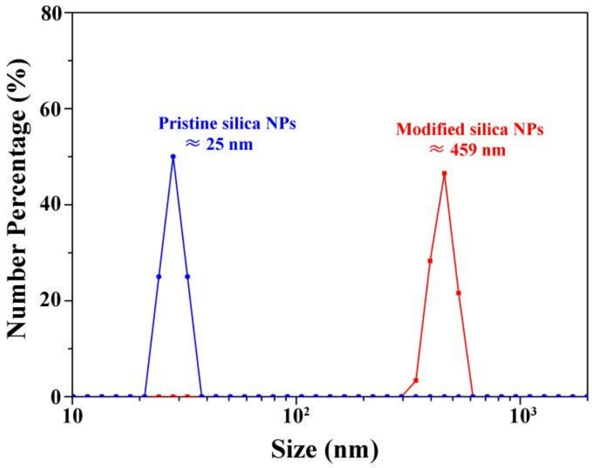

Fig. S3. The size distribution of the pristine silica NPs and the modified silica NPs.

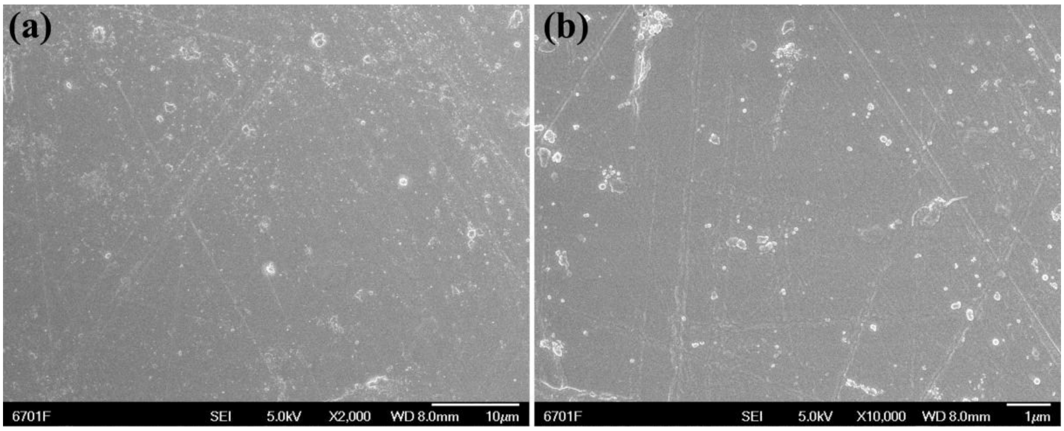

Fig. S4. SEM images of the pristine PE plate.

Compared with the polished PE plate, surface of the pristine PE plate is very smooth with a few protuberance. Thus, it is invalid for the pristine PE to be coated with SNPs/PDMS composite by dip-coating method. This is why we polished the PE plate before dip-coating.

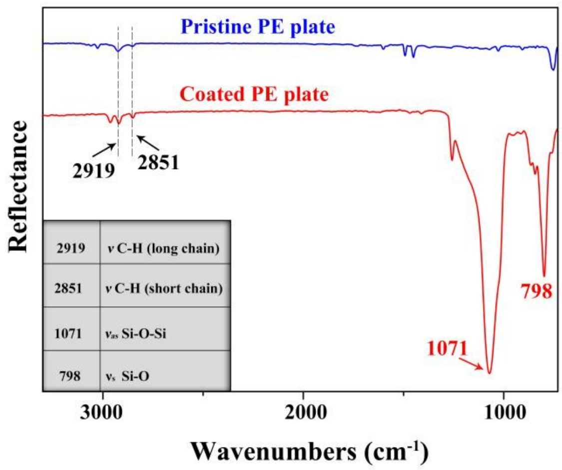

Fig. S5. The FTIR spectra of the pristine PE plate and the coated PE plate. In inserts: the bonds for each peak.

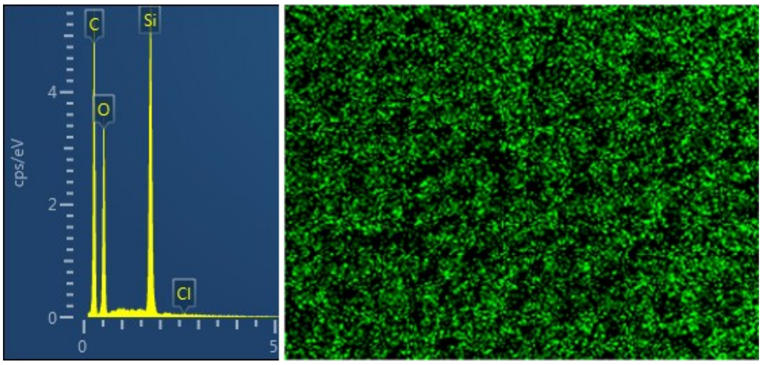

Fig. S6. EDS spectra and Silicon distribution maps on the surface of the coated PE plate.

Fig. S7. A silver mirror-like phenomenon observed when immerse the coated PE plate in water.

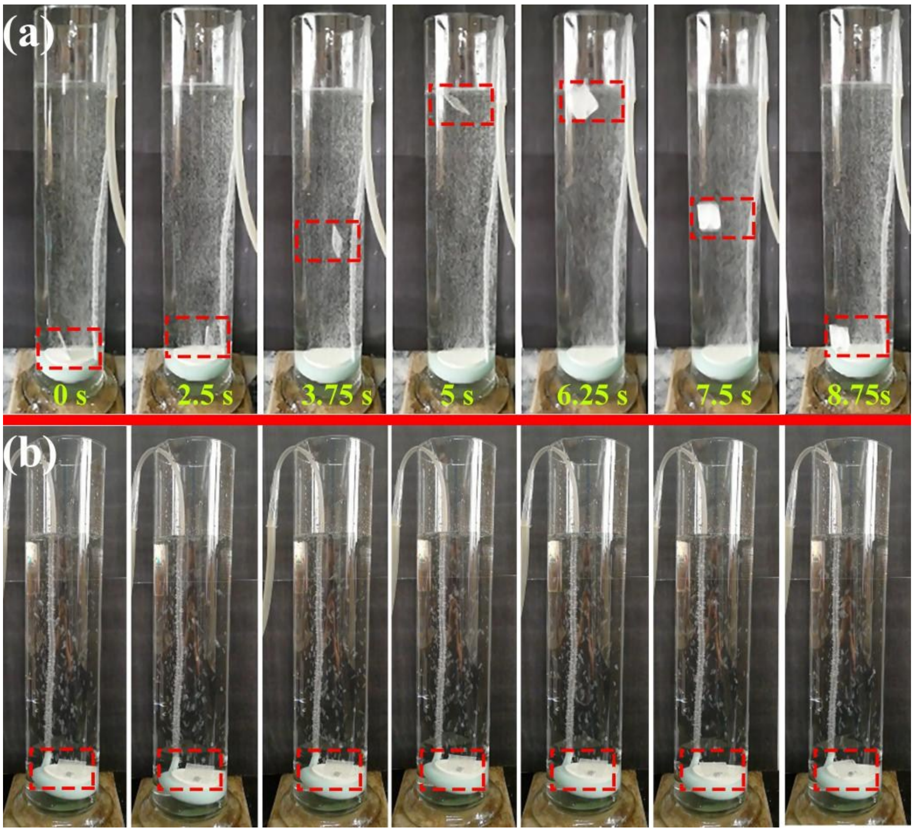

Fig. S8. (a) Photographs of the diving–floating locomotion process of the locomotion device. (b) The control test carried on the aerophobic surface in the same aqueous environment with a steady stream of tiny bubbles in order to eliminate the effect of impact force from bubble stream. The diving–floating locomotion can only be induced by the superaerophilic surface.

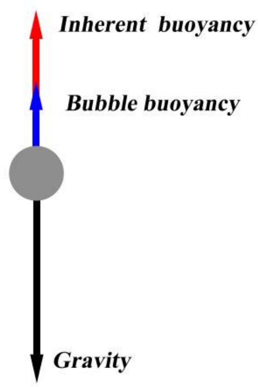

Fig. S9. (a) Force analysis in the stage B of the diving-floating locomotion.

Herein, we focus on the conversion from potential energy of underwater bubbles to the kinetic energy of the locomotion device, the energy conversion mainly takes place in the floating process. The converted energy (E_{con}) and power (P_{con}) can be derived by the Work-Energy Theorem:

$$E_{con} = \Sigma F_B \bullet \Delta s = (G - F_I) \bullet \Delta H \quad (1)$$

$$P_{con} = \frac{\mathrm{d}E_{con}}{\mathrm{d}t} \quad (2)$$

where the F_B and F_I signify the bubble buoyancy and inherent buoyancy, respectively. G is the gravity of the whole device. Δs is the displacement corresponding to F_B. ΔH is the relative height of the device.

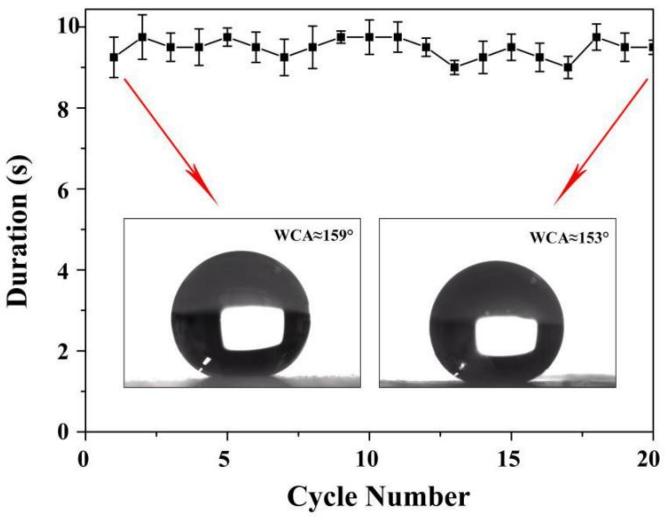

Fig. S10. Duration of each diving-floating locomotion in cyclic working. Inserts: the WCA of the coated PE plate before locomotion and after 20-times continuously cyclic locomotion.

It shows that the duration of each diving-floating locomotion stabilizes in a relative range, without significant attenuation, thus the diving-floating locomotion possesses stable periodicity.

Movie. S1. The process of the diving-floating locomotion in aqueous environment with a steady stream of tiny bubbles.