

**Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.**

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## Electronic Supplementary Information

### **Light-driven rotary polypyrrole/agar composite films**

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Section S2. Supplementary figures

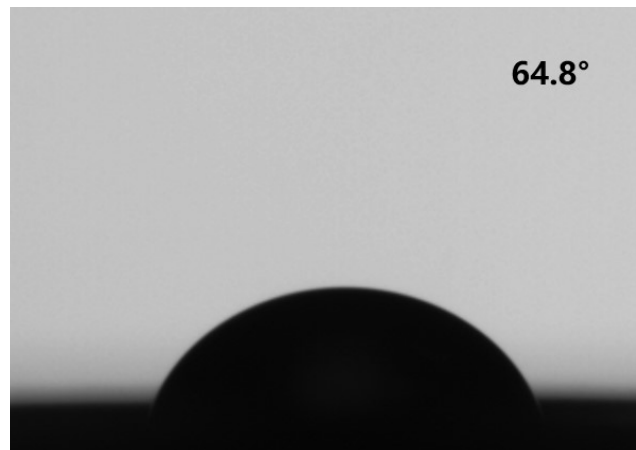


Fig. S1 The water contact angle on the polypyrrole/agar composite film.

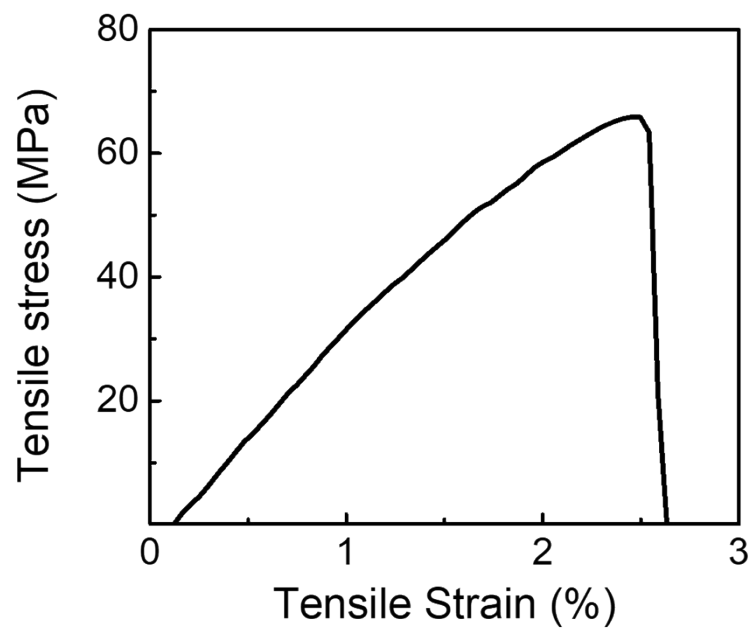
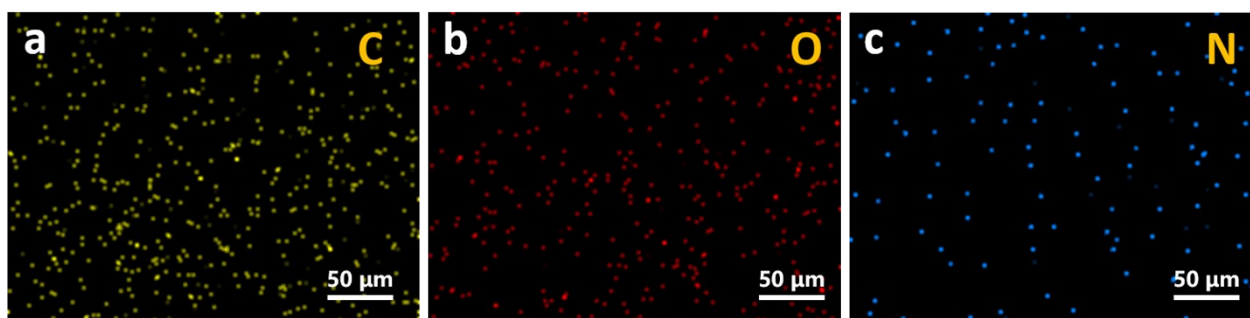
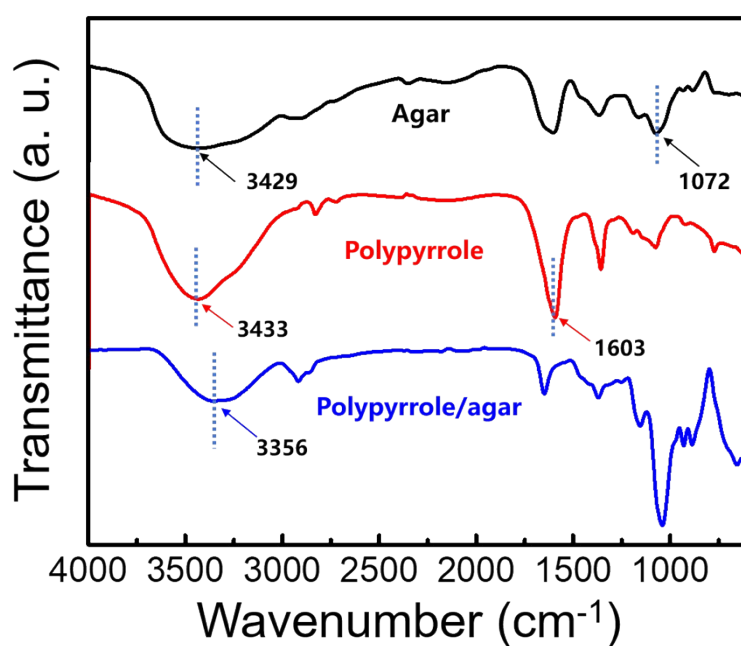


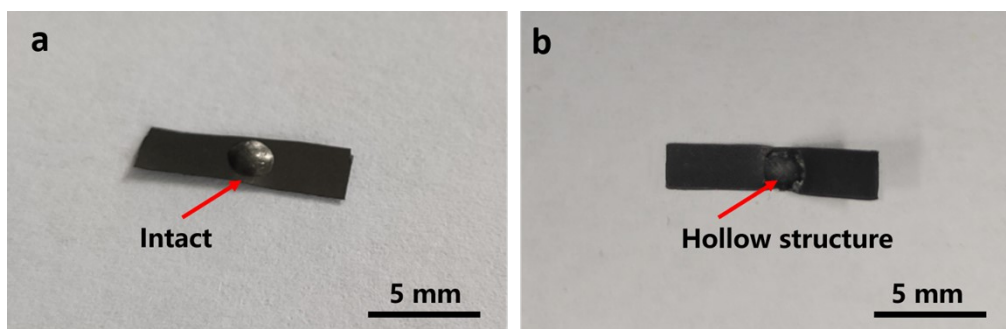
Fig. S2 Tensile stress-strain curve of the polypyrrole/agar photoactuator film.



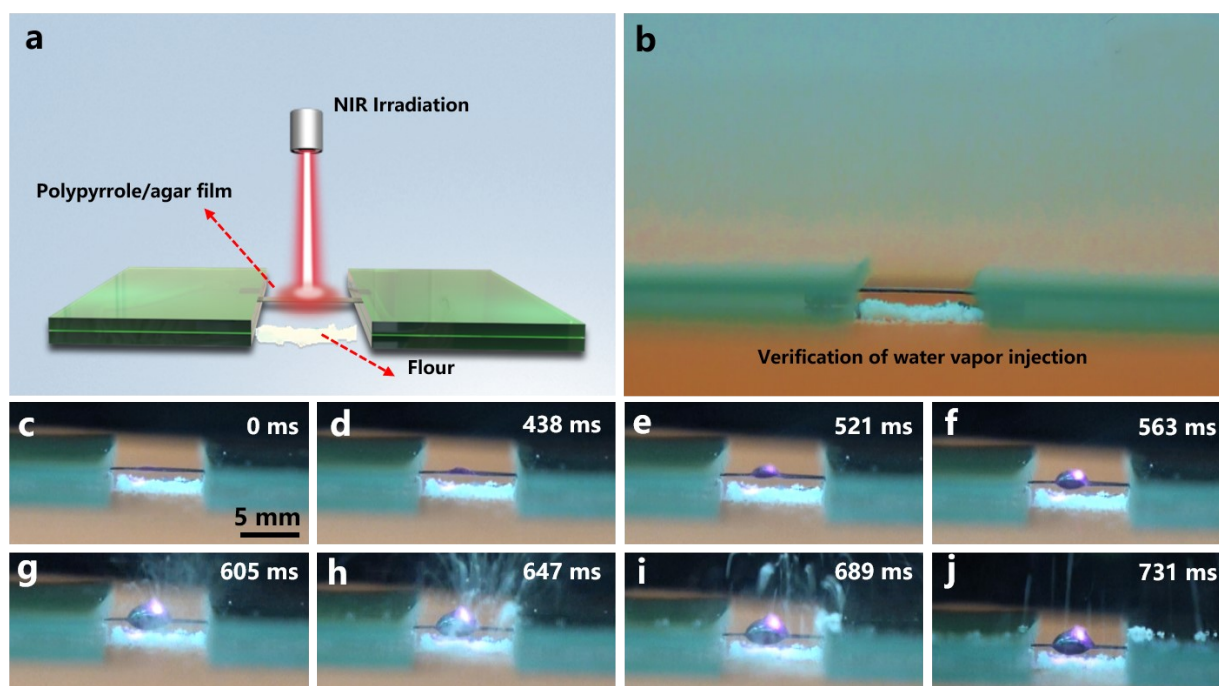
**Fig. S3** Energy-dispersive X-ray (EDX) analysis of the polypyrrole/agar photoactuator film showing the homogeneous distribution of (a) carbon, (b) oxygen and (c) nitrogen elements.



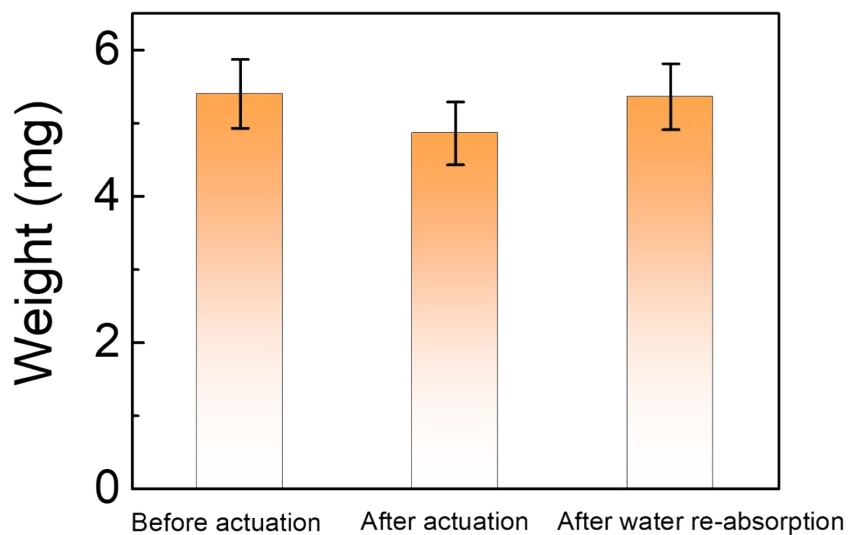
**Fig. S4** Fourier transform infrared spectroscopy (FTIR) spectra of agar (black curve), polypyrrole (red curve), and polypyrrole/agar (blue curve) photoactuator film.



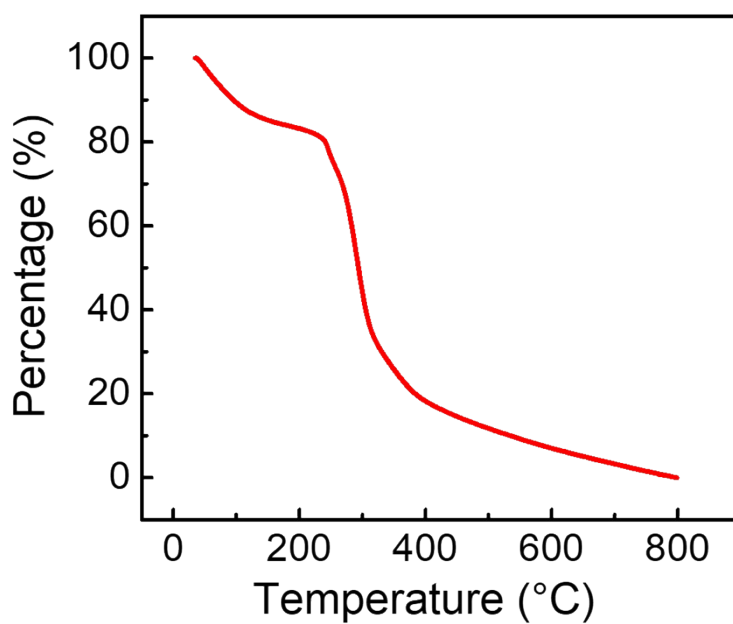
**Figure S5.** CCD images showing the protrusion structure of the polypyrrole/agar photoactuator film.



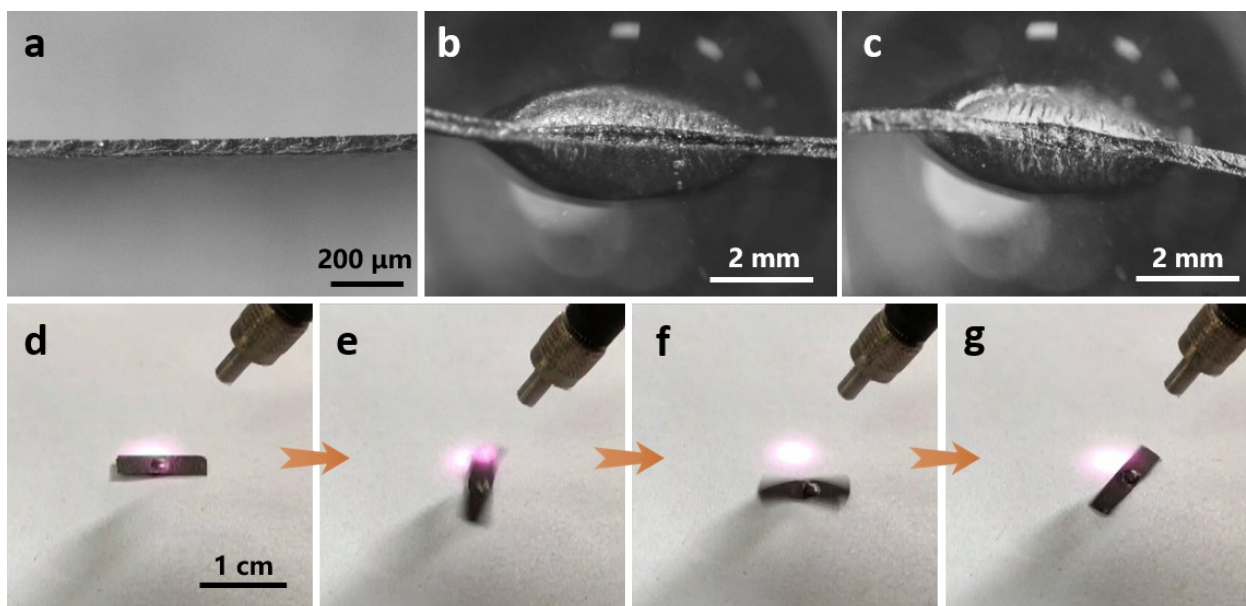
**Fig. S6** (a) Schematic illustration showing experimental setup for the verification of the jet propulsion. Time lapse images obtained from Video S3 showing the polypyrrole/agar photoactuator film (b,c) before and (d-j) after light actuation.



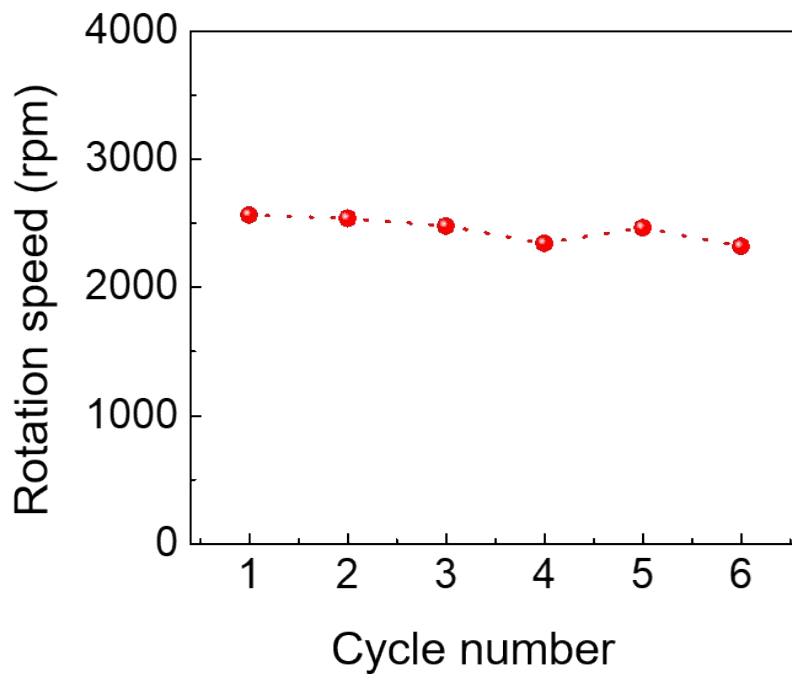
**Fig. S7** The weight variation of the polypyrrole/agar photoactuator film before light actuation, after light actuation and after water re-adsorption.



**Fig. S8** The thermogravimetric analysis (TGA) of the polypyrrole/agar photoactuator film.

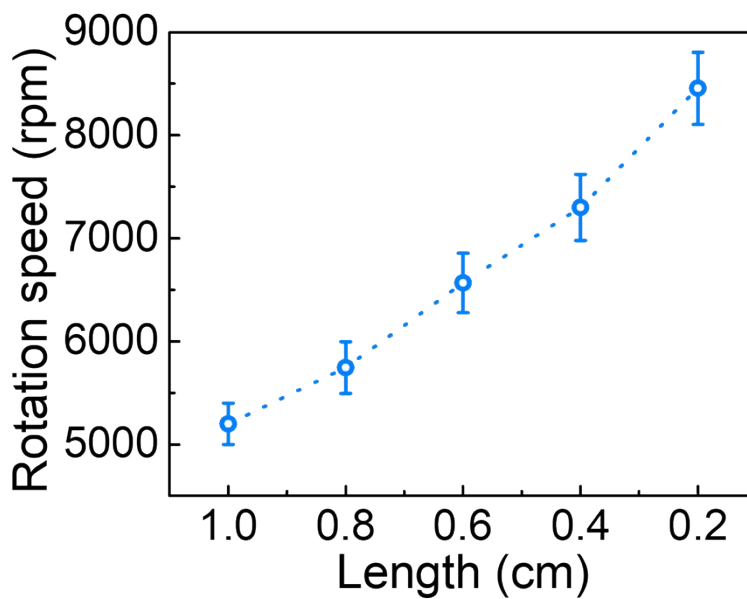


**Fig. S9** CCD images showing the side view of the photoactuator film (a) before, (b) after light irradiation, and (c) after the repair. (d-e) CCD images showing the reusability of the light-driven photoactuator film.

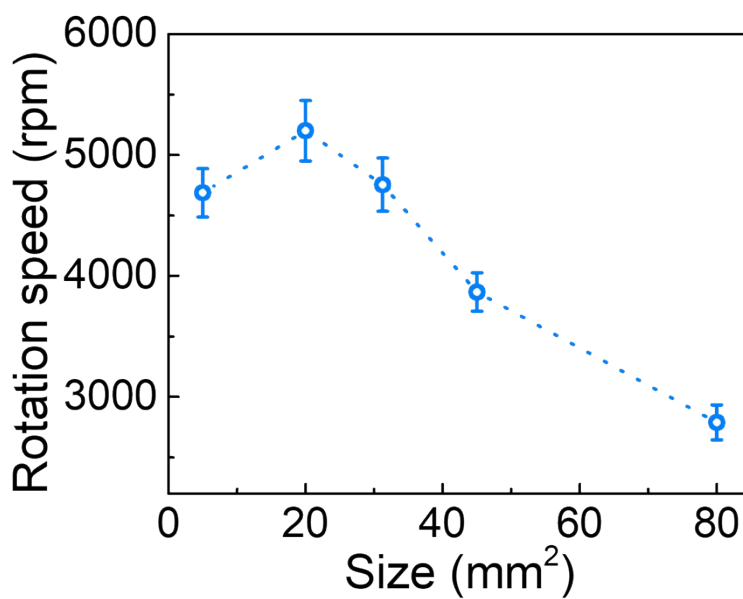


**Fig. S10** The repeatability of the light-driven rotary photoactuator under  $0.4 \text{ W/cm}^2$  repetitive light actuation.

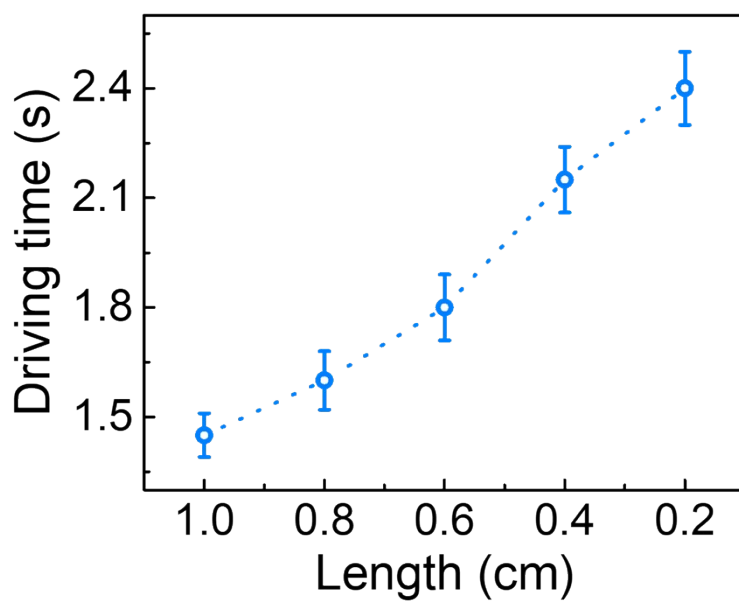




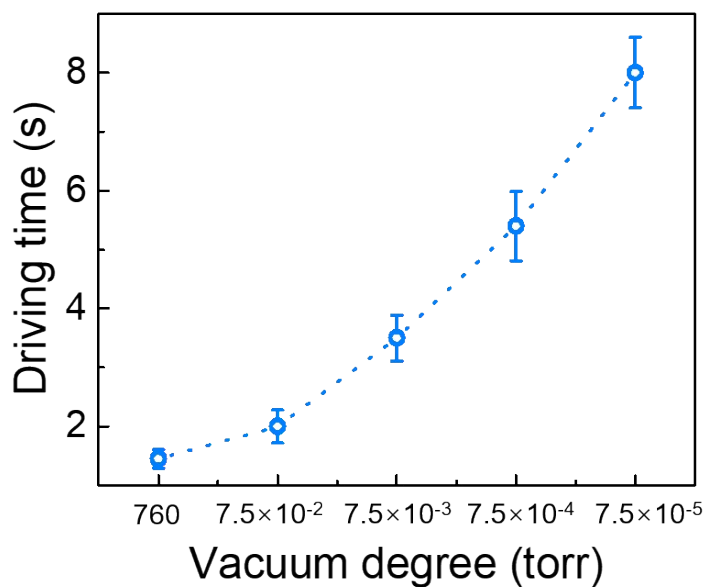
**Fig. S11** The rotation speed of photoactuator film versus length of the film (width=0.2 cm).



**Fig. S12** The rotation speed of photoactuator film as a function of the length of the film (when the film width is kept at 0.2 cm).



**Fig. S13.** The driving time of the polypyrrole/agar composite film in different length (width=0.2 cm).



**Fig. S14.** The driving time of the polypyrrole/agar composite film versus vacuum degree (width=0.2 cm).