Polypyrrole actuators with inverse opal structures

Lu Zhao,*(a) Lei Tong,*(a) Chun Li,*(a) Zhongze Gu(b) and Gaoquan Shi*(a)

(a) Department of Chemistry, Tsinghua University, Beijing 100084, P. R. China. E-mail: gshi@tsinghua.edu.cn
(b) State Key Laboratory of Bioelectronics, School of Biological Science and Medical Engineering, Southeast University, Nanjing 210096, P. R. China.

**Fig. S1** SEM images of the cross sections of actuators 1 (A) and 2 (B).
**Fig. S2** EDS of the inverse opal surface and the compact surface of the bilayer PPy actuator.

![EDS graph showing elements C, N, O, S, and Cl](image)

**Fig. S3** SEM images of the compact surfaces of PPy(ClO$_4$)$_x$ layers of actuators 1 (A) and 2 (B).

![SEM images](image)
**Fig. S4** Optical images recorded during the process of actuator 2 bending in 1.0 mol L$^{-1}$ LiClO$_4$ aqueous solution by voltammetric scanning in the potential range of $-1.0$ (A) and $+1.0$ V (E), versus SCE at a scan rate of 50 mV s$^{-1}$; the actuators were held with the inverse opal side to the right.

**Fig. S5** Chronoamperograms recorded during the processes of actuating actuator 3 from vertical position to $90^\circ$ at different potentials in the aqueous solution of 1.0 mol L$^{-1}$ LiClO$_4$. 
**Fig. S6** SEM image of the flat film surface after actuation (from −0.2 to 1.0 V and stopped at 1.0 V) in 1.0 mol L\(^{-1}\) LiClO\(_4\) aqueous solution containing 0.4 wt.% PS particles with diameter of 200 nm. Scale bar: 1 μm.

**Fig. S7** SEM images of the inverse opal surface of actuator 1 (A, B) and actuator 2 (C, D) after dipping in 1.0 mol L\(^{-1}\) LiClO\(_4\) aqueous solution containing 0.4 wt.% PS particles with diameter of 200 nm (A, C) or actuation (from −0.2 V to 1.0 V and stopped at 1.0 V) in this solution with clamped end to prevent from bending movement (B, D). Scale bars: 1 μm.