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Supporting Information

Quantitative observation of electric potential distribution of brittle polyelectrolyte hydrogels using microelectrode technique

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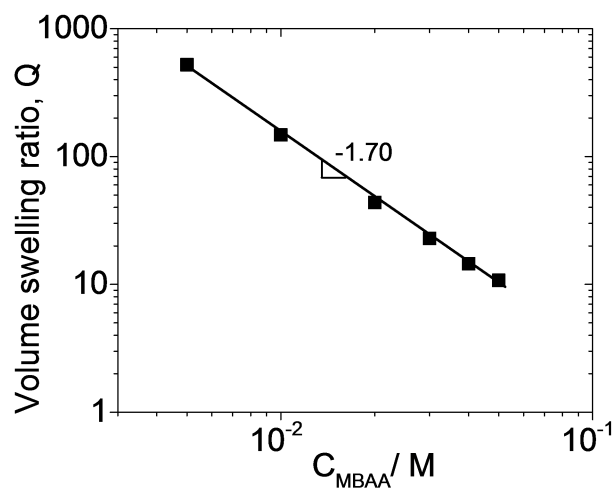


Figure S1. Equilibrium volume swelling ratios Q of the PAMPS hydrogels synthesized with different cross-linking densities C_{MBAA} . Q is in relative to the as-prepared state. Each data was the average of 3 measurements of length, width and height for a sample of different positions.



Figure S2. Schematic diagram of microelectrode holder for TEM observation.

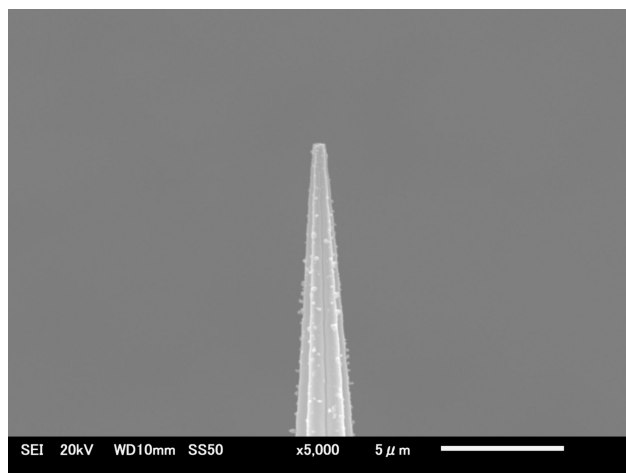


Figure S3. Image of 7-barrel electrode observed by SEM.

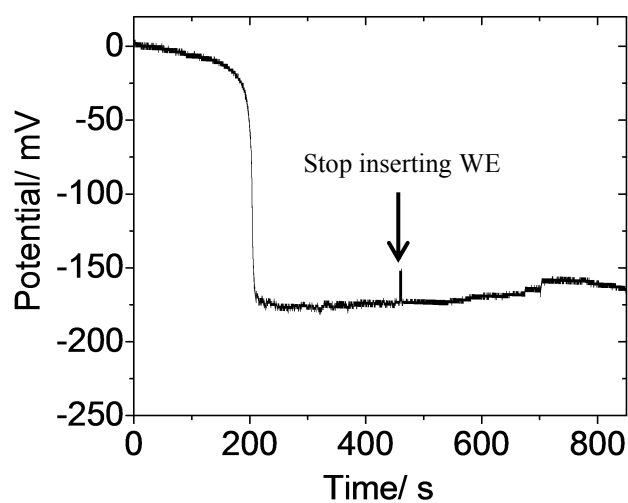
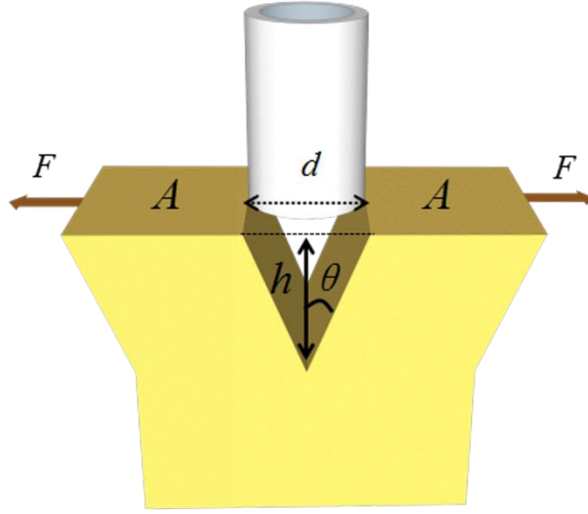


Figure S4. Effect of dewelling of the microelectrode on the electric potential of hydrogel. A PAMPS-4 gel was measured in 10^{-5} M KCl solution, the working microelectrode (WE) was inserted into hydrogel at a velocity of 395 nm/s for the initial inserting time of 450 s (corresponding to a depth of 100 μm); after that the inserting was stopped for the rest of the measurement of 390 s.



Scheme S1. The relationship between crack length h and diameter d of microelectrode.

As shown in [Scheme S1](#), when a microelectrode was inserted into a brittle polyelectrolyte hydrogel, a crack was generated at the tip of microelectrode. To simplify our discussion, we consider a crack with a triangle shape at the cross-section.

The shear modulus G can be defined by:

$$G \stackrel{\text{def}}{=} \frac{F / A}{\tan \theta} \quad (1)$$

Here, F is the applied force perpendicular to the microelectrode; A is the deformed area with applying force F ; h and θ are the crack length and half angle of the crack, respectively. Therefore, the shear stress can be expressed by:

$$\frac{F}{A} = G \cdot \tan \theta = G \frac{d}{2h} = \frac{Ed}{4(1+\nu)h} \quad (2)$$

Where E is Young's modulus, d is the crack width and ν is Poisson's ratio of elastic materials.

If the hydrogel was fractured and separated by microelectrode with outer diameter of d , the fracture energy Γ is

$$\Gamma = \frac{F}{A} \cdot \frac{d}{2} \quad (3)$$

By combining [Eq. \(2\)](#) and [Eq. \(3\)](#), we get the relationship between crack length h and diameter of microelectrode d as

$$h = \frac{Ed^2}{8(1+\nu)\Gamma} \quad (4)$$