

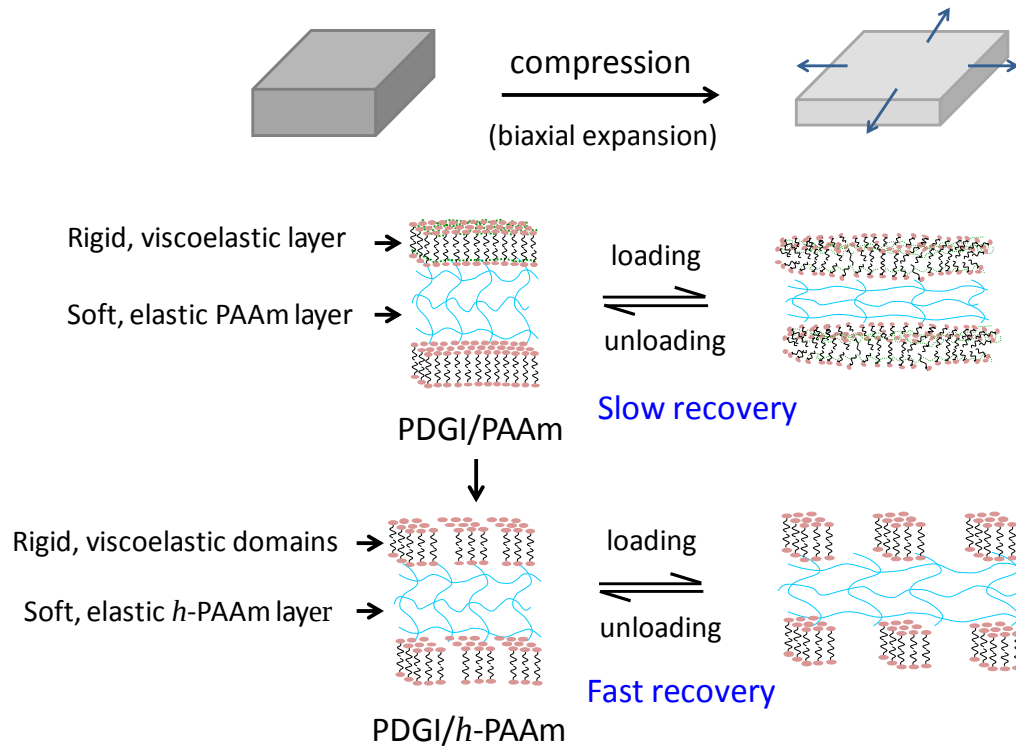


HOKKAIDO UNIVERSITY

Title	Mechano-actuated ultrafast full-colour switching in layered photonic hydrogels
Author(s)	Yue, Youfeng; Kurokawa, Takayuki; Haque, Md Anamul et al.
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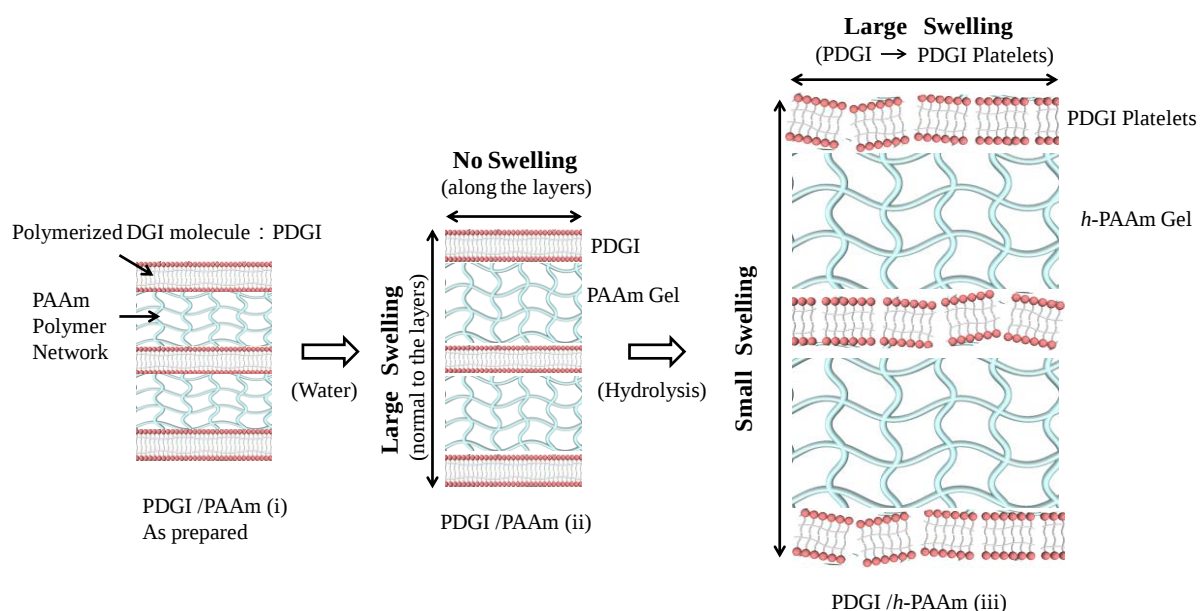


Supplementary Figures

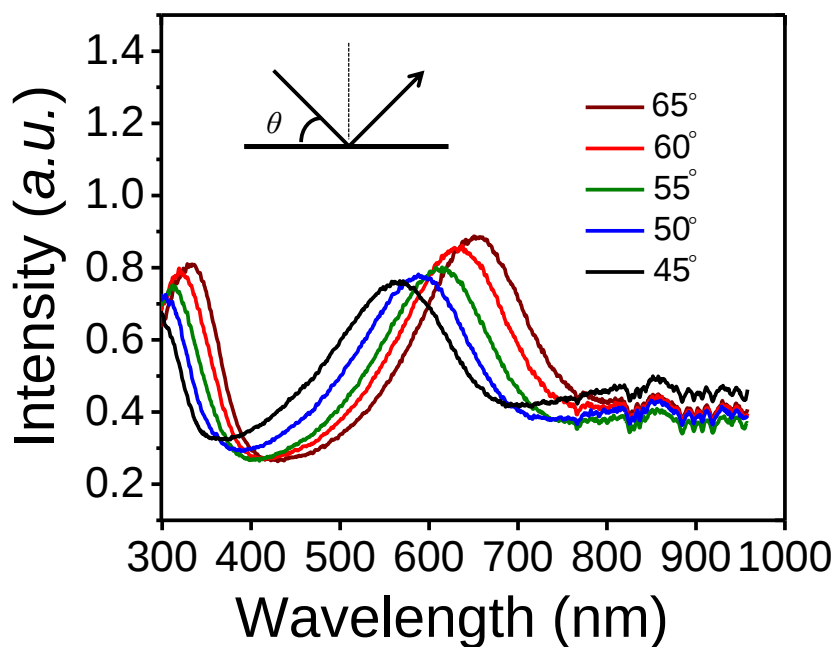


Supplementary Figure 1 Mechanism for the fast response of PDGI/*h*-PAAm hydrogel.

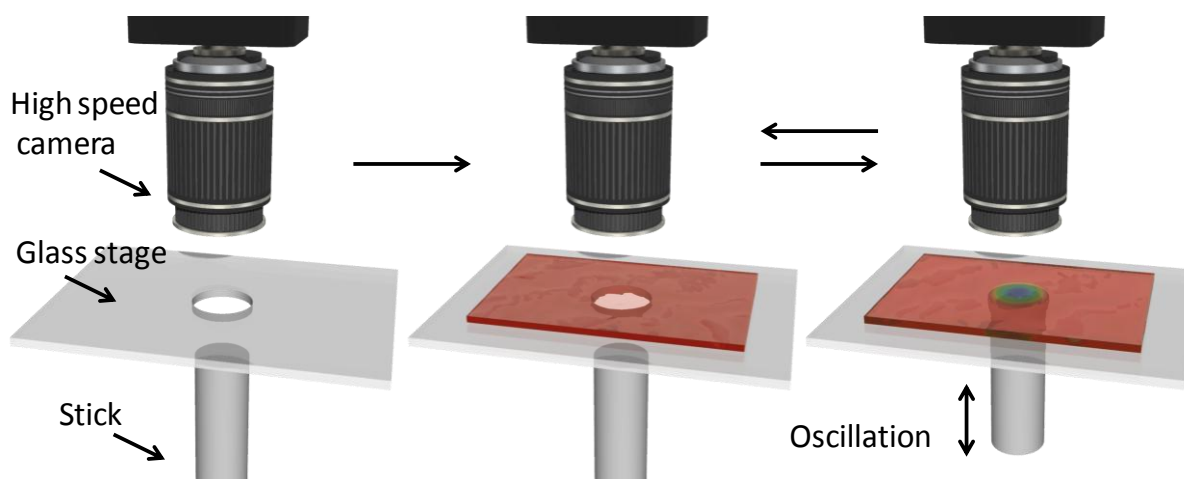
When we apply a compressive stress to the gel, the compression was accompanied by a biaxial expansion along the layer direction. For PDGI/PAAm gel, this biaxial expansion causes partial damage of the continuous bilayers. Once the stress is removed, it needs long time for the damaged bilayers to recover back to the initial continuous structures. After hydrolysis, we destroyed the continuous bilayers into small domains. These bilayer domains serve as rigid platelets and will not deform at relatively small biaxial expansion that is required for full-color tuning. Thus, the compressive stresses only deform the soft elastic layers and this deformation can be recovered quickly.



Supplementary Figure 2 The unique swelling behaviours for layer-structural hydrogel before and after hydrolysis. For a non-hydrolysed sample PDGI/PAAm (i), it only swells in the thickness direction and the swelling along the layer direction has been completely constrained (no swelling) due to the water impermeable properties of the bilayer (PDGI) (ii). After hydrolysis, partial of the PAAm changes to sodium polyacrylate (PAAcNa). The charged polymer network layers (*h*-PAAm) exert large osmotic pressure to substantially swell the gel, especially in the direction along the layers. Large swelling along the layer direction splits the rigid, un-swellaable PDGI bilayers into small domains and thus releases the swelling constraint existed before hydrolysis.

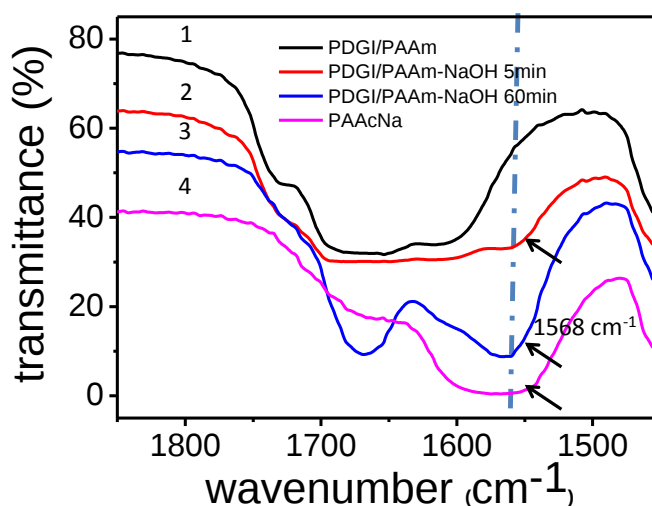


Supplementary Figure 3 Angle-dependent of the reflection spectra. Tuning of colour of hydrolyzed sample (PDGI/h-PAAm) with incident angle of the light is clearly observed in this photonic hydrogel. The peaks below 400 nm are secondary order peaks. Hydrolysis time of sample is 5 min.



Supplementary Figure 4 The excellent mechanical stability of the soft photonic hydrogel.

The gel was hit by a stick that oscillated in rectangular waveform at a frequency of 100 Hz, and a high-speed camera recorded the colour change during the oscillation. The gel was under compression and relaxation for more than 12000 cycles. Applying such high repeated test, we can find no colour decay or any response hesitate in the colour tuning, which indicates the soft gel has excellent mechanical stability. Diameter of the stick: ~5 mm.



Supplementary Figure 5 The IR-spectra of Gel 1, Gel 2, Gel 3 and Gel 4 in the range of 1850 cm^{-1} ~1450 cm^{-1} . Gel 1: PDGI/PAAm; Gel 2: PDGI/PAAm, treating with NaOH aq. for 5 minutes. Gel 3: PDGI/PAAm, treating with NaOH aq. for 60 minutes. Gel 4: PAAcNa (Sodium Polyacrylate). FTIR spectrum of a gel provides useful information regarding the hydrolysis effect on the hydrogel. The gel 1 without hydrolytic process has no peak at 1568 cm^{-1} which was present in gel 2 and 3. For a longer hydrolysis time, gel 3 has a larger peak compared with gel 2. The large peak at 1568 cm^{-1} is assigned to the stretching vibration of carbonyl (C=O) in the carboxylate anion groups, as shown by gel 4 of sodium poloyacrylate. It confirms that during hydrolytic process, partial amide groups of PAAm were changed to carboxylate anion groups.