Toward Spatial and Temporal Gel-Sol Transition of Hydrogel Driven by DNA Hybridization Reaction

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One of the goals of molecular robotics is synthesizing a hydrogel whose state transition can be driven by DNA devices [1]. One possible demonstration of the hydrogel is a system where gel state gradually propagates in one direction. For example, gel is gradually formed in a capillary from one end, where some signal is put, to the other end. We propose a candidate implementation of such hydrogel and discuss preliminary experimental results.

Gel-sol transition of hydrogel has potential applications such as drug release, chemical sensor, and micro fluidics. Recently, various gel-sol transitions of DNA-functional hydrogel have been demonstrated, which make use of DNA hybridization reactions [2]. One of the hydrogels is made of polyacrylamide that is cross-linked by complementary DNA strands, which can solate by adding an additional DNA strand that displaces the linker DNA [3]. Synthesizing this kind of DNA gel is very costly because high concentration of DNA is required for gelation. However, another hydrogel fully made of DNA using enzymatic reaction does not require high concentration of DNA because polymerization begins with small concentration of primer DNA [4].

We show the spatial and temporal solation of DNA cross-linked hydrogel, which is achieved by the diffusion of displacement strand. To propagate a gel state in a sol solution, we need to implement a mechanism that only the sol near the boundary of a gel turns into a new gel. Our idea to achieve such mechanism is releasing the primer of polymerization by the product of the polymerization. More complex control of gel-sol transition may be possible in the future by combining with DNA state transition devices such as logic gates.

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