Mg^{2+}-Sensing System Using DNA Networks

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Summary

DNA is interesting not only as a pool of genetic information, but as a source of advanced materials for molecular recognition. In this context double-stranded (ds) DNA would be important rather than single strand, since DNA is recognized in "ds" form by the molecules accessing to it in most of events occurring in vivo. Moreover, dsDNA have unique and highly regulated structure: dsDNA can be utilized as building blocks for molecular architecture such as hydrogel materials.

We have developed a series of methods to prepare soluble conjugates between dsDNA and synthetic polymers. As an extension of the study, we synthesized vinyl polymers having a terminally-introduced psoralen moiety which can be photochemically conjugated to dsDNA. UV irradiation to the mixture of DNA and the polymers resulted in direct and covalent grafting of the polymers on DNA.

In this work, the conjugate between pBR 322 plasmid DNA and poly(N-isopropylacrylamide) (NIPAAM) was studied. PolyNIPAAM is known to have a lower critical solution temperature in aqueous media: the transition between the coil (soluble) and globule (insoluble) conformations takes place reversibly at around 31 ℃. The modification of the DNA with polyNIPAAM was found to make the conjugate temperature-responsive. The conjugate formed hydrogel which can entrap a Mg^{2+}-dependent restriction endonuclease, EcoRI. An interesting finding here is that the degradation efficiency of the DNA strands by EcoRI was enhanced when the conjugate was prepared in the presence of EcoRI, probably due to the footprinting effect.

The hybrid system from dsDNA, Mg^{2+}-dependent nuclease, and the vinyl polymer should form a hydrogel which can contain a reporter molecule such as fluorescent dye, redox active compound, etc. Mg^{2+}-Dependent degradateion of the gel would result in the release of a large number of the reporter molecules which can be detected effectively. As an extension of the present research, the work on the Mg^{2+}-sensing system is now in progress.