Abstract

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3-cyanovinylcarbazole nucleotide (^{CNV}K) has high photoresponsive ability, whereby the ODN containing ^{CNV}K is photocrosslinked to complementary DNA with 366 nm for a few seconds. I focused on a change of structure, creation of a covalent bond following [2+2] photocyclization using ^{CNV}K, and it has high photoresponsive ability; these characteristics were adapted to DNA nanotechnology to create an application that has a function unrealizable only with a native base.

In chapter 1, I demonstrated the photopolymerization of ODNs using ^{CNV}K mediated DNA photocrosslinking. A stable DNA photopolymer was successfully created from short ODNs rapidly by irradiation at 366 nm, and its photopolymer was degraded to start short ODNs with a 312 nm irradiation. And, this photopolymerization can create a DNA-RNA hetero polymer incorporating miRNA in a sequence specific manner.

In chapter 2, I tried to create a DNA array structure equipped with heat resistance focused on the creation of a covalent bond using the photocrosslinking reaction with ^{CNV}K. The simple DNA array became a very stable structure which is not broken under conditions of heating and denaturing by photocrosslinking. Moreover, the inserting position and number of ^{CNV}K allow regulation of the size and conformation of the DNA array.

In chapter 3, I demonstrated the chemical shift imaging of nucleic acids using DNA photocrosslinking of ^{CNV}K. The 19F MR signal was shifted -63.2 to -71.2 ppm by the change of spatial proximity and electronic state in trifluoromethyl group using DNA photocrosslinking with ^{CNV}K. And, it was successful the detection of 10 nM miRNA using 19F chemical shift imaging mediated HCR in sequence specific manner.

In chapter 4, I demonstrated the feasibility of acceleration of DNA strand displacement by ultrafast DNA photocrosslinking with ^{CNV}K. The DNA strand displacement was accelerated by DNA photocrosslinking. The inserting position of ^{CNV}K greatly affected the acceleration effect about DNA strand displacement rate, which a maximum of 29-fold as acceleration acquired in inserting ^{CNV}K into center-position.

In chapter 5, I try to the photosplitting using branch migration with a 366 nm irradiation without heating. The sequence specific photosplitting using branch migration was advanced at room temperature without heating with a 366 nm photoirradiation.

In chapter 6, I demonstrated template directed reversible photochemical ligation of ODNs using carboxyvinylcarbazole (^{CV}U). The template directed photochemical ligation of ^{CV}U advances with a 366 nm irradiation for 900s with high efficiency, and this photochemical ligation did not advance without a template and a change of alignment sequence by the sequence of the template Moreover I create a photoligated self-assembled DNA structure.

Keyword : 3-cyanovinylcarbazole nucleotide, DNA photocrosslinking, [2+2] photocyclization, DNA nanotechnology.