ABSTRACT

The ODNs containing MDA, which effectively mediate hole transport, were enzymatically ligated, and photo-induced hole transport reaction proceeded efficiently through a ligated long duplex. The ligated duplex showed high hole transport efficiency.

INTRODUCTION

Manipulating matter at the nanometer scale is important for many electronic, chemical and biological advances, but present methods do not reproducibly achieve dimensional control at the nanometer scale. Challenges remain both in the formation of nanostructures that constitute the active parts of devices and in the construction of small connecting wires. Self-assembly of DNA are suitable for further development encompassing site-specific fabrication and functionalization, which are difficult and troublesome for known conductive materials, such as carbon nanotubes and conductive polymers. However, when natural DNA is used as a molecular wire, unavoidable oxidative degradation of G bases occurs. In addition, the hole transport in natural DNA is strongly influenced by the sequence and the transport distance. We have recently reported an artificial nucleobase, methoxybenzodeazaadenine (MDA), that can effectively mediate hole transport and is not oxidatively decomposed. Herein, we report the enzymatic ligation of MDA-containing DNA wires, and the hole transport efficiency of a ligated duplex was evaluated.

RESULTS and DISCUSSION

The synthesis of oligodeoxynucleotides (ODNs) containing MDA and cyanobenzophenone-substituted uridine (U') has previously been reported (Table 1).

The reaction mixture containing ODNs 1–4 was incubated for 10 h at 14 °C in the presence of T4 DNA ligase. The reaction products were separated on a denaturing 15% polyacrylamide gel. As shown in Figure 1, the ligated 38-mer product was obtained after the ligation reaction (lane 1). The product yield calculated by densitometric analysis was 37%. Although the ODN containing an MDA run, the ligation reaction proceeded with high efficiency.
Table 1. Oligodeoxynucleotides (ODNs) used in this study

<table>
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<th>Sequence</th>
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<tr>
<td>ODN1 5'-ATTATTAGTGTTGGCTTMDA8MDAMDA8MDA8ATTTTT-3'</td>
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<tr>
<td>ODN2 3'-TTAAAACTACACCCAA-P0.1H-5'</td>
</tr>
<tr>
<td>ODN3 5'-H0.1P-TTGGTTATTTAT-3'</td>
</tr>
<tr>
<td>ODN4 3'-TTTTTMDA8MDAMDA8MDA8MDA8AAACCAATATAA-5'</td>
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Figure 1. Autoradiogram of native polyacrylamide gel electrophoresis showing the ligation of ODNs 1-4 by T4 DNA ligase. The reaction mixture containing ODNs 1-4 (5 μM each), 66 mM Tris-HCl (pH 7.6), 6.6 mM MgCl₂, 10 mM DTT, and 0.1 mM ATP was incubated at 14 °C for 10 h. The mixture was electrophoresed in 10% native polyacrylamide gel. Lane 1, ligation reaction products; lane 2, 38-mer control; lane 3, intact ODN.

Figure 2. Photo-induced hole transport reaction through a ligated duplex. The hole transport efficiency was defined by the ratio of oxidative damage at the proximal and distal GGG, as quantified by PAGE.

In conclusion, two MD₆A-containing DNA nanowires were connected by ligase. This technology provides a powerful method for gaining well-regulated bionanomaterials that will be widely applicable to electronic devices and biosensors.

REFERENCES