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Orientation of DNA Thin Films Fabricated on Substrates

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Two types of multifunctional thin films based on DNA polyion complex intercalated with photofunctional chromophore were fabricated on the 2D-surface. One is monolayer of DNA polyion complex transferred to a glass substrate at the air/water interface, and is intercalated with acridine orange (AO). Another is DNA containing thiol moiety, and is intercalated with AO and formed polyion complex with lipid, and is fabricated on a gold substrate at the solid/liquid interface. Molecular orientation of AO was investigated by surface plasmon resonance, polarized UV and FT-IR spectroscopy. AO intercalated DNA polyion complex film (a) was aligned perpendicular to the DNA long axis. In the case of DNA polyion complex film (b), orientated DNA could be fabricated on the gold substrate through S-Au interaction, and the orientation of DNA was more stable by mixing with lipid to provide polyion complex. AO in DNA polyion complex film (b) was aligned parallel to the substrate.

Keywords: thin film; polyion complex; DNA; orientation; intercalation

INTRODUCTION

DNA is well known as a carrier of biological information, and structural characterization of single- and double-stranded DNA have been

investigated for genome research.[1] Moreover, DNA duplex has been also attractive as novel media for fast, long-range electron transfer through π-stack.[1]-[4] Some researchers have focused on the fabrication of oriented DNA films for application of biosensing and electrochemical detection.[1],[5],[6] In this paper, we will show the fabrication of oriented DNA thin film on substrates by two kinds of processes.

EXPERIMENTAL

Two types of DNA polyion complex were prepared on substrates, as shown in Figure 1. One was a monolayer of polyion complex transferred to a hydrophobic glass substrate by a horizontal lifting method, and was intercalated with acridine orange (AO), i.e., (a). Another was a DNA polyion complex containing thiol moiety on the terminal, and was intercalated with AO, and then it was fabricated on a gold substrate, i.e., (b).

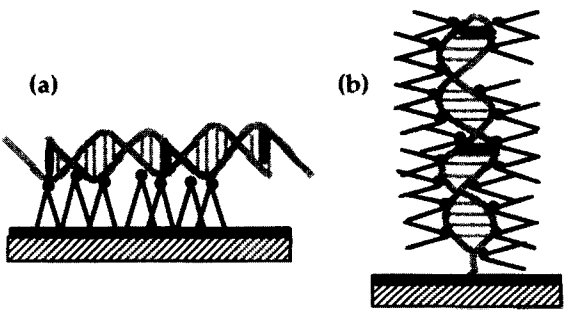

FIGURE 1 DNA polyion complex intercalated with AO.

The molecular orientation of AO in the polyion complex was investigated by surface plasmon resonance, UV-VIS spectrometer (Shimadzu UV-3100PC) and FT-IR-RAS (Mattson Infinity 60AR) spectrometer.

RESULT AND DISCUSSION

Figure 2 shows the polarized UV spectra of the DNA polyion complex film (a). The absorption of s-polarized spectrum was reduced in comparison of that of p-polarized spectrum. Dichroism of absorption suggests that the intercalated AO in the DNA polyion complex is aligned parallel to the compression direction. Namely DNA duplex is aligned perpendicular to the compression direction at the air/water interface.

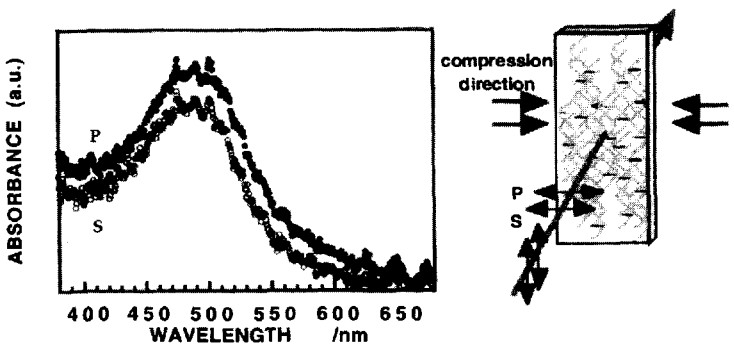

FIGURE 2 Polarized UV spectra of the DNA polyion complex film (a) S; s-polarized spectrum, P; p-polarized spectrum.

Figure 3 shows the FT-IR-RAS spectra of the DNA polyion complex films (a) and (b). In the spectrum (a), there is an absorption of AO for C=C stretching band near 1600 cm^{-1}. The absorption of AO in the spectrum (b) is weaker than that in the spectrum (a), while the intercalation of AO could be observed by surface plasmon resonance. It is also found by the surface plasmon resonance that the DNA polyion complex is fabricated on the gold substrate. These results strongly indicate AO can be Intercalated in DNA polyion complex (b), and AO is aligned parallel to the substrate.

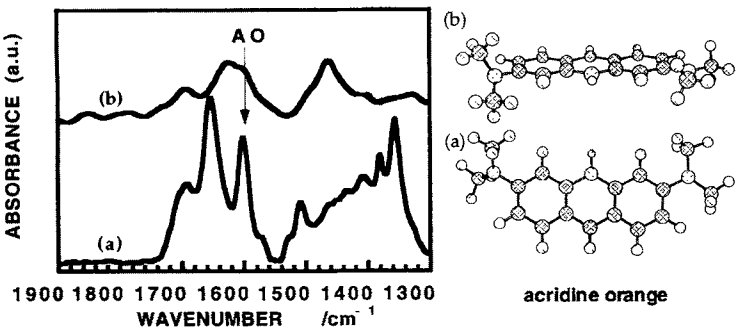

FIGURE 3 FT-IR-RAS spectra of the DNA polyion complex films (a) and (b) intercalated with AO.

CONCLUSION

We have succeeded in fabricating oriented DNA thin films at the air/water or the solid/liquid interface. It has been shown AO molecule could be aligned by intercalation to the polyion complex. We have also controlled the molecular orientation of AO by two types of processes.

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