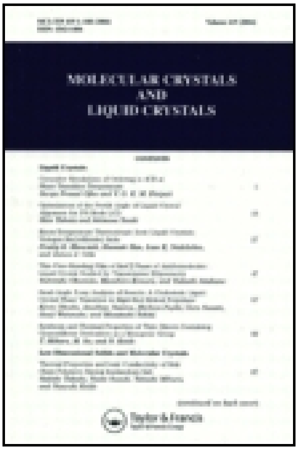

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Fabrication and Photoconductivity Measurements of Mesoscopic 2-D Patterned DNA

Kuniharu Ijiro [a], Tetsuro Sawadaishi [b] & Masatsugu Shimomura [a b]

[a] Research Institute for Electronic Science, Hokkaido University, Sapporo, 060-0812, Japan

[b] Spatio-Temporal Function Materials Research Group, Frontier Research System, Institute of Physical and Chemical Research (RIKEN), Wako-shi, 351-0198, Japan

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Fabrication and Photoconductivity Measurements of Mesoscopic 2-D Patterned DNA

KUNIHARU IJIRO[1], TETSURO SAWADAISHI[2] and MASATSUGU SHIMOMURA*[1,2]

[1] *Research Institute for Electronic Science, Hokkaido University, Sapporo 060-0812, Japan and* [2] *Spatio-Temporal Function Materials Research Group, Frontier Research System, Institute of Physical and Chemical Research (RIKEN), Wako-shi 351-0198, Japan*

Regularly arrayed mesoscopic lines of DNA, parallel to the receding direction of the solvent, can be prepared by simple casting from an aqueous solution. Photocurrent of single line of DNA assemblies containing intercalators, acridine orange, was generated when the patterned cast film was irradiated by the light at 480nm, through the excitation of the intercalators.

Keywords: DNA; mesoscopic pattern; photoconductivity

INTRODUCTION

Double-helical DNA is a supramolecular architecture composed of complementary base-pairs of adenine-thymine and cytosine-guanine based on specific hydrogen bonding, and carries genetic information. Recently some articles have claimed that DNA can act as a π-electron medium for the photoinduced electron transfer because of its close stacking of base-pairs[1]. Okahata et al. have observed anisotropic photoconductivity along DNA strands aligned in cast DNA film in which acridine orange was intercalated[2].

Recently, we have found that two-dimensional regular polymer patterns of sub-micrometer size were formed by simple casting of highly diluted polymer solutions[3]. As the results of *in situ* microscope observation, typical dissipative structures (Bénard convection cells and fingering instability) were found in the casting solution. After solvent evaporation, regularly arranged striped patterns consisted of the polymers were formed parallel to the receding direction of the solvent front.

Here we focus on photoconductivity of stripe-patterned DNA film containing acridine orange as an inetrcalator[4]. Photoconductivity along single stripe line can be measured by using a micromanipulator-controlled microelectrodes.

EXPERIMENTAL

DNA from Salmon Testes and polyG•polyC (RNA) were used without further purification (Sigma). An aqueous DNA or polyG•polyC solution (10mg/l) containing a fluorescence intercalator, acridine orange, was dropped onto a fleshly cleaved mica surface and dried by heating up to ca. 80 °C. For conductivity measurements Ag-paste (DOTITE, Fujikura Kasei, Japan), microelectrode (one μm Tungsten tip of 0.5 MΩ impedance, World Precision Instruments), and a micromanipulator (Narishige, Japan) were used[5] (see Fig.3). The set-up was illuminated through a microscope (Olympus BH-2) equipped with a 100 W high pressure Hg lamp and a band pass filter (450-480 nm). The photocurrent at 10 V DC bias was recorded by using an electrometer (Advantest R 8340 A). Topographic images were observed by an AFM (Olympus NV-2500).

RESULTS AND DISCCUSION

Line structures were prepared by casting an aqueous DNA solution mixed with acridine orange onto freshly cleaved mica. Fig.1 shows a fluorescence micrograph (ex: 450-480 nm, em: >515 nm) of the cast film. The mesoscopic lines, parallel to the receding direction of the solvent, were observed in the cast film. The fluorescence image indicates that the bright array of lines consists of DNA assemblies because the fluorescence emission is originated from acridine orange intercalated in DNA. Fig.2 shows an AFM image of the DNA cast film. Each of lines is ca. 3 μm wide and <3 nm thickness.

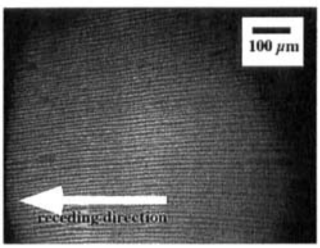

FIGURE 1. Fluorescence image of DNA cast film.

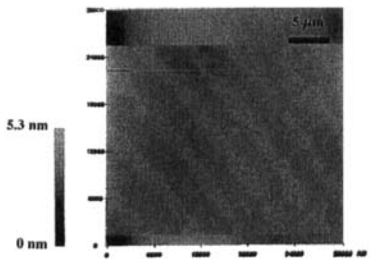

FIGURE 2. AFM image of DNA cast film.

Electric contact of single line was carried by placing a droplet of Ag-paste on one end of the line and using a micromanipulator-positioned microelectrode as the counter electrode (Fig. 3). Fig.4 shows photoresponse of the electric current of single polyG•polyC line towards actinic light (450-480 nm) at 10 V. The photocurrent of polyG•polyC was ca. 30 times larger than that of DNA. From the cross-section of the line (measured by AFM to be 2.0 μm^2) and the gap between the electrodes (40 μm), the photoconductivity of 6.0×10^{-4} Scm^{-1} can be calculated from the following equation:

$\sigma = LI / (QV)$,

where σ is the conductivity, L is the gap between the electrodes, Q is the cross-section of the line, I is the current, and V is the applied voltage, respectively. This value is in the same range of the reported conductivity of single line of conductive polymer assemblies, poly(3-hexylthiophene) (PHT) [5].

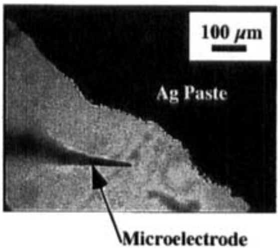

FIGURE 3. Experimental set-up of conductivity measurement.

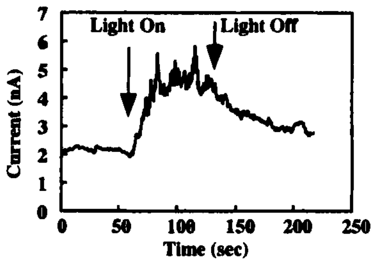

FIGURE 4. Dark- and photocurrent of single line of polyG•polyC assemblies at 10 V.

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