Nanopatterning of DNA with Various Arrangements Using Ideally Ordered Anodic Porous Alumina

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Ordered arrays of functional biomolecules with uniform size and interval on two-dimensional substrates have recently attracted considerable interest due to their tremendous potential towards applications in which biomolecular nanodevices are capable of detecting biological molecules based on high-sensitivity, energy exchange, and biological catalysis. In order to realize multifunctional bio-devices capable of operating with great accuracy, the ability for various arrangements of biological molecules as well as miniaturization and uniformity of spot size is necessary. At present, a key factor in the progress of biomolecular device development lies in developing a technique for fabrication of various arrangements of biological molecules, on which the size and interval of miniaturized patterns can be also controlled with great accuracy. In this paper, we will report that ideally ordered porous structures with uniform pore size and spacing in an ideally ordered anodic porous alumina[1,2] enable the fabrication of a nanometer-scale ideally ordered pattern of DNA with controlled size and spacing.[3-6] The two-dimensional nanometer-sized arrangements of DNA with sufficient pattern separation and two types of DNA with uniform sized and spacing are demonstrated using the characteristic nanodisk array fabricated with ideally ordered anodic porous alumina substrates. The fabrication of the nanodisk array with various arrangements was realized by imprinting an alumina substrates using an SiC mold with an ideally ordered pattern with features at prescribed sites that were then selectively etched as through-holes before anodization and by filling selective through-holes in the anodic porous alumina with materials such as Au and TiO_2.[7]

Formation of an array of ideally ordered DNA patterns with pattern period (center-to-center distance) of 1.2 μm was confirmed by selective adsorption of thiolated DNA on the Au surface fabricated by selective filling the pores in the anodic porous alumina with pore period of 200 nm at every six site with Au, in which ideally ordered fluorescent spots were observed from fluorescent dye-labeled DNA fixed on the Au disk surface (Fig. 1).

Two types of DNA that have different base sequences and were labeled using fluorescent dye at the ends of the DNA sequences were fixed to the Au and TiO_2 disk surfaces of Au-TiO_2 disk mosaic arrays. These arrays were fabricated by selectively filling the anodic porous alumina pores (200 nm; pore period, ca. 50 nm; pore diameter) with Au and TiO_2, based on selective through-holing of channels in the porous alumina. In addition, dependence of hybridization rates of DNA patterned on the Au disks on the DNA pattern size was examined on the relationship between fluorescence intensity emitted from fluorescent dye fixed on the end of the sequence of DNA which hybridizes with DNA fixed on the Au disks and hybridization period.

References

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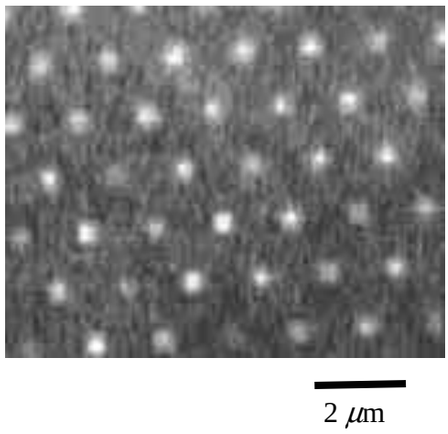

Figure 1 Typical fluorescent image of ordered Cy3-labeled DNA pattern formed on a Au disk array having a disk diameter of 50 nm and a disk period of 1.2 μm.