

[Nano device]
**Nanolithography of Organized Molecular Assemblies
Using Scanning Probe Microscope**

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Electronics using an individual molecule has recently attracted much attention for the future generation of electronic devices and strongly motivates investigations in the field of lithography in a nanometer regime. The high demand of further downscaling device dimensions rapidly points out the limitations of conventional optical and electron beam techniques. Alternatively, scanning probe microscope (SPM) has demonstrated capabilities for atomic-level manipulation and also potentiality for local modification of various surfaces using different approaches such as exposure of resists of organic molecular films and a selective anodic oxidation of various substrates. Among the different approaches accomplished so far, atomic force microscope (AFM) is a promising method to prepare the nanoscale-patterns on a resist film or substrate itself. Since a lithographic work on an organic resist was preferred to that on a bare surface such as Si owing to faster scan rate and better resolution, two types of molecular resists were used in this study.

Organic thin films, e.g., spin-coated polymer films, Langmuir-Blodgett (LB) films and self-assembled monolayers (SAMs), have been patterned by the interaction with electrons emitted from a tip of AFM. The followings are some important experimental conditions that affect the resolution in AFM lithography: (1)the applied voltage between probe tip and substrate, (2)a scanning speed of a tip, (3) humidity, and (4)chemical properties of the resist film. A self-assembly with organosilanes and bipolar amphiphiles is as a good method to prepare a well-ordered molecular structure. The LB technique with polymers is also one of the best techniques for preparing well-ordered structures. AFM anodization was successfully carried out with various polymer and monomer films on silicon substrates under various conditions. The lithographic results strongly suggest that AFM anodization

on ultrathin organic films is clearly affected by the type of molecular structures, so the designing of novel molecules with functional groups is very important for patterning in nano-scale. The detailed patterning process will be discussed.

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