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ORGANIC MBE AND ORGANIC STM FOR "NANOSCOPIC" MOLECULAR SYSTEMS

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Abstract Following our results obtained by organic MBE and "episorption" techniques with STM imaging, a more realistic approach to realizing novel material structures with low dimensionality was discussed. As a next phase to "nanoscopic" materials from conventional materials, future possibilities of "molecular planting" in terms of the combination of the organic MBE and "episorption" techniques with focused STM beam technique were introduced for organic molecular systems. The new concepts of "nanoscopic" materials and "nanoscopic" technology are bringing previously idealistic molecular electronic and photonic designs into the realm of achievable devices.

INTRODUCTION: MBE and STM for Organic Molecular Systems

Application of MBE and STM, especially for organic molecular systems, has been drawing our attention as a new approach to realizing novel material structures which exhibit important electronic and photonic properties. The following is an outline of our work in progress, including an overview of the new concept of "nanoscopic" science and technology for organic molecular systems.

NANOSCOPIC FABRICATION: Episorption

MBE has long been successful as an ultrahigh vacuum (UHV) deposition technique for fabricating multilayer thin film structures, even in the organic molecular field. [1,2,3] In an extreme case, however, heteroepitaxial growth of organic ultrathin films on single crystal substrates can be attained by simple adsorption in air, like natural single crystal growth, which we will call "episorption". From the

numerous observations of organic layer growth, it has been realized that anchoring sites at the interface are the most important factors to manipulate the adsorbates and control the surface structures. [4,5,6,7] From this point of view, the combination of the MBE and/or episorption techniques with surface modification by focused STM lithography will provide a new technique for nanoscopic fabrication and interface modification of low-dimensional materials, which allows "molecular planting" at the atomic or molecular scale, as illustrated in Fig.

NANOSCOPIC MODIFICATION: Molecular Planting

Since single atom positioning was reported by Eigler and Schweizer, [8] considerable interest has centered on utilizing STM for pinning individual atoms and molecules. It has been well-known, however, that strict conditions such as low-temperature STM under UHV are required to obtain reproducibility. On the other hand, it is still more realistic, to some extent, to utilize the STM for lithography rather than manipulation. By introducing the micro-focusing technique with anodes between STM tip and substrate, [9,10] the STM controlled sub-nanoscopic electron beam will develop the possibility, in principle, for the ultimate in nanoscopic modification.

By selecting appropriate combinations of organic molecules and substrates, the "molecular planting" method becomes more realistic and will make it possible to construct novel material structures, *e.g.* two dimensional modulated structures in one plane, which have never been attained by any other technique in organic molecular systems.

NANOSCOPIC CHARACTERIZATION: STM Visualization

The STM and AFM have opened a completely new approach to imaging organic molecules with ultrahigh resolution. More recently, the STM technique has been shown to provide outstanding capability not only in structural analysis but also in visualization of functional parts such as chiral centers and dipoles in organic molecules. By carefully controlling deposition parameters in the sample preparation step of the episorption method, it becomes possible to distinguish between methyl and ethyl moieties around chiral carbons and orientations of dipoles in individual molecules. This kind of nanoscopic characterization is also encouraging

for potential novel application of the STM as an input/output component in next-generation molecular devices.

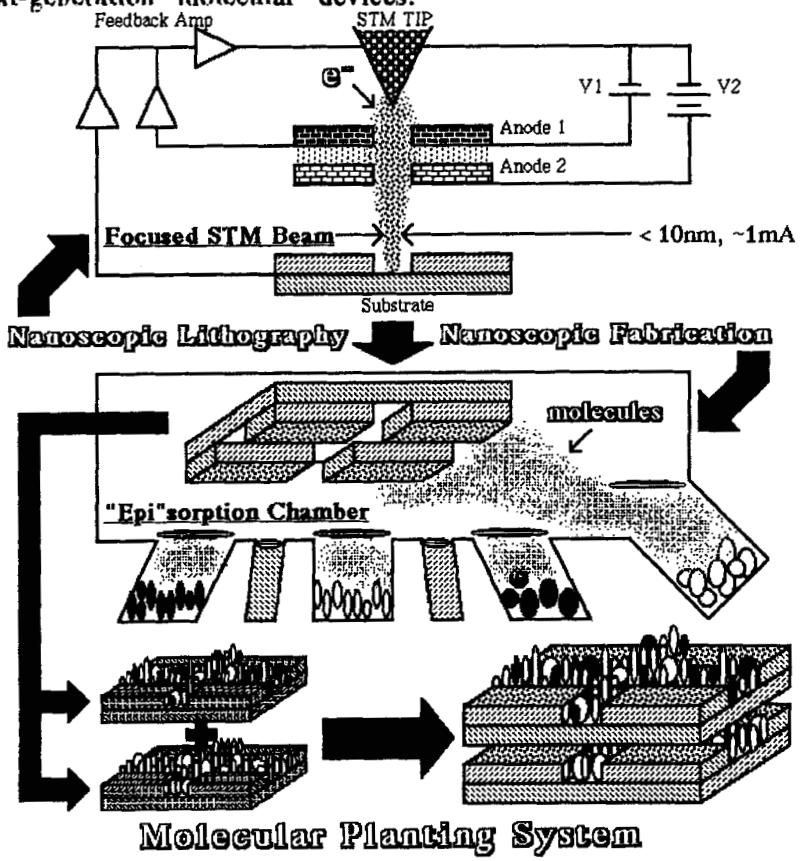

FIGURE Schematic diagram of "Molecular Planting"

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