Nonlithographic and Lithographic Methods of Nanofabrication—From Ultralarge-Scale Integration to Photonics to Molecular Electronics

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Nonlithographic and Lithographic Methods of Nanofabrication—From Ultralarge-Scale Integration to Photonics to Molecular Electronics

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PREFACE

Future advances in information technology will have major socio-economic significance, and will rely heavily on technical and scientific progress in the field of nanotechnology. For example, nanofabrication should lead the semiconductor industry to mass-produce ULSI circuits having 100 nm (0.1 μm) resolution by 2006 as predicted by the Semiconductor Industry Association. The challenge of building systems for fabrication at this level imposes a formidable pressure on the lithographic processes in terms of dimension tolerances (10 nm or less) and positioning accuracy (1 nm or less), to quote only a few specifications. Due to the enormous costs of next generation lithographic machines, it is now felt that economically reasonable improvements will focus mainly on the materials science aspect of the lithographic processes: the development of advanced resists and, more generally, of smart materials. Nonlithographic methods for nanofabrication including self-assembly may lead the next revolution in electronics due to the major promises of molecular electronics and computing on molecular length scales. Here again, the materials science aspect of nonlithographic processes is critical as the organization and control of matter has to be done at the molecular level. This situation clearly suggests that further progress in nanotechnology and the future of information technology strongly depend on advances in materials science.

This volume contains a representative part of the papers that were presented during Symposium D, "Nonlithographic and Lithographic Methods for Nanofabrication—From Ultralarge-Scale Integration to Photonics to Molecular Electronics" held November 26–December 1 at the 2000 MRS Fall Meeting in Boston, Massachusetts. The large attendance at the tutorial and the 5-day long symposium clearly demonstrated intense interest in the topic of nanofabrication by the materials science community. The initial aim to gather, in a single forum, researchers with a wide range of expertise in microelectronics, optics, magnetism, polymer synthesis and materials science was accomplished. The reader will find in this volume a useful overview of the state of the art, both theoretical and experimental, as well as an indication of the future trends and remaining challenges in this technologically important field.

Contributions from key research institutions showed the advantages inherent to self-assembly of colloidal particles, self-assembly of block-copolymers, and template-directed synthesis for nanostructure fabrication. Also, significant papers suggested potentially important niche applications of soft lithography, nanoimprint lithography and dip-pen nanolithography.

For next generation lithographies (NGL) that appear likely to be implemented by the traditional semiconductor industry, outstanding contributions highlighted the necessity for developing exposure tools (extreme UV, electron and ion beams) and resists in parallel to produce sub-100 nm resolution integrated circuits. New advances on resists for NGL were emphasized while nanocomposite resists appeared as a breakthrough.

Molecular electronics was well addressed by outstanding contributions from key players, indicating a fast evolving field where nanofabrication techniques play a key role for actual device development. Photonic, electronic and magnetic properties of nanostructures were also reported, showing the industrial potential of micro and nanodevices.

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