

Preface

Many optoelectronic devices and systems used in modern industry are becoming progressively smaller and have reached the nanoscale domain. Nanofabrication is critical to the realization of the potential benefits of these devices and systems for society. An important enabling technology in nanofabrication is Tip-Based Nanofabrication (TBN), which makes use of functionalized probes consisting of microscale cantilevers (or tip holders) with attached nanoscale tips. These tip-based probes, evolved in essence from scanning probe microscopy, can perform all types of manufacturing activities, from material removal and material modification to material deposition and material manipulation, all in the nanoscale. Not only can TBN create nanostructures through a conventional top-down approach, it can also build nano-components from the bottom-up. Moreover, this technology can fully integrate with stations in a semiconductor production line, as well as be performed in an ordinary chemistry or physics laboratory.

This monograph consists of twelve chapters with subjects ranging from the basic principles of TBN to recent advances in several major TBN technologies related to atomic force microscopy (AFM), scanning tunneling microscopy (STM), and dip-pen nanolithography (DPN). Two of the twelve chapters are devoted to a single material, one with a specific focus on graphene, and the other with a more general discussion of diamondoid. The former topic is particularly timely given that the 2010 Nobel Prize in Physics was awarded to Geim and Novoselov for their efforts in extracting graphene. The remaining ten chapters address a wide variety of materials, from metals and semiconductors to polymers and ceramics. This monograph is the first book of its kind dedicated solely to examining the technology of TBN and is designed both to disseminate scientific knowledge and technical information from recent findings, as well as to expand on the needs and challenges facing the TBN community.

This is an exciting moment for TBN, not least because of the enormous growth of the field in the past few years. The major advancements in TBN can be found in three categories: capability (manipulability), repeatability (reliability), and productivity (throughput). Techniques for capability enhancement presented in this monograph include AFM oxidation using dynamic force mode and double-layer approach. Eventually, the most attractive approach for capability enhancement will be a hybrid approach, such as one where the tip is loaded with a dual- or multi-energy

source, or one where a bottom-up scheme is integrated with a top-down procedure. The chapters reviewing thermochemical nanolithography and electric-field-assisted nanolithography provide good examples of using dual-source tips, while the chapters on nanomanipulation and nanografting involve the mixing of a bottom-up scheme with a top-down procedure. Approaches for improving repeatability, such as the development of automated equipment and expert software, are outlined nicely in the first and last chapters. Finally, increases in throughput, or productivity, through the use of parallel processing, control strategies for increasing speed, and micro/macro tips are addressed in the chapters on the high-throughput control technique and its accompanying constraints and challenges. In the near future, we will all likely bear witness to these new advances dominating research in the area of nanofabrication, and TBN playing a key role in bridging and communicating between the nanoscopic world and our macroscopic world.

Each chapter in this monograph has been authored by world-class researchers, to whom I am grateful for their contribution. I am also indebted to a large number of reviewers whose critiques have ensured that each chapter is of the highest quality. Members of this reviewing committee are Susanne Dröschner of Swiss Federal Institute of Technology Zurich, Jayne Garno of Louisiana State University, Shao-Kang Hung of National Chiao Tung University (Taiwan), Shyankay Jou of National Taiwan University of Science and Technology, Andres La Rosa of Portland State University, Zhuang Li of Chinese Academy of Sciences, Heh-Nan Lin of National Tsinghua University (Taiwan), Hui-Hsin Lu of National Taiwan University, Andrea Notargiacomo of CNR-IFN (Italy), Luca Pellegrino of CNR-INFM-LAMIA (Italy), Debin Wang of Lawrence Berkeley National Laboratory, and Guoliang Yang of Drexel University. I hope that readers will find this book both stimulating and useful.

Tempe, Arizona, USA

Ampere A. Tseng



<http://www.springer.com/978-1-4419-9898-9>

Tip-Based Nanofabrication
Fundamentals and Applications

Tseng, A.A. (Ed.)

2011, X, 466 p., Hardcover

ISBN: 978-1-4419-9898-9