SCANNING PROBE MICROSCOPY

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Editors

Nikodem Tomczak
Kuan Eng Johnson Goh

*A*STAR, Singapore*

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Biographies of Volume Editors

Nikodem Tomczak studied chemistry and polymer chemistry & physics in Gdańsk (Poland). He completed his PhD in Chemistry at the University of Twente (The Netherlands) with Professor Julius Vancso and Professor Niek van Hulst. His thesis topic was on the application of single molecule fluorescence methods to studies of polymer dynamics in thin films. During his postdoctoral period he was involved in the measurement of the nanomechanical properties of single molecules.

He is currently a Senior Research Engineer at the Institute of Materials Research and Engineering (A*STAR) in Singapore. His major research interests include polymer chemistry and physics at surfaces and interfaces, single molecule fluorescence detection, semiconductor nanocrystals (Quantum Dots), and Scanning Probe Microscopy of polymers.

Kuan Eng Johnson Goh is currently a Senior Research Engineer at the Institute of Materials Research and Engineering (Singapore) where he leads the efforts in using scanning probe microscopy for atomic-scale fabrication and material interface characterisation. He completed his PhD in Physics at the University of New South Wales in 2006 under an Endeavour International Postgraduate Research Scholarship awarded by the Australian government

and three International Fellowships awarded by A*STAR (Singapore). His thesis dealt with the encapsulation of Si:P delta-doped devices fabricated by scanning tunnelling microscopy and the magnetotransport in such devices. His current research addresses key issues in the fabrication of organic photovoltaic devices using ballistic electron emission microscopy, the reliability of high-K dielectrics, and the possibility of atomic precision manufacturing.

Preface

Nanotechnology is a broad topic of intense interest for fundamental and application-driven research. The Singapore R&D community has embraced nanotechnology and launched significant initiatives within the two major Universities (the National University of Singapore and Nanyang Technological University) as well as the local research institutes (established under the Agency for Science, Technology and Research). Put simply, the last decade has seen a large growth in resources and capability within Singapore for nanotechnology, and scanning probe microscopy (SPM) — the subject of this book — is part of that effort. The aim of the book is to provide a snapshot of recent SPM research both within Singapore and in collaboration with our international colleagues. Two broad themes, lithography and atomic force microscopy (AFM) in liquids, are presented.

Lithography at the atomic scale can use either SPM to manipulate single atoms and molecules into a desired structure, or molecular structures can be formed directly by self-assembly on a surface. Both approaches are described, along with ballistic electron emission microscopy (BEEM) — an important tool for understanding how to electrically connect metal wires to organic molecules. It is also essential, for realistic applications, to join the molecular scale to the micrometer scale, and various nanolithography methods based on SPM are discussed (e.g. dip pen lithography, localized heating, oxidation or electrochemical reactions).

AFM in liquid environments not only provides the ability to image surfaces in their natural state but equally important one can undertake force spectroscopy over highly localized regions. The term “force spectroscopy” is very general and refers to the measurement of any localized mechanical property, such as elasticity, dissipation or stiffness. Again, experiments over a broad length scale are presented in this book, demonstrating the utility

of AFM force spectroscopy from single polymer chains and molecularly ordered liquids, to probing disease in red blood cells.

Finally, although the surface under study is often very well characterized, the tip condition is typically unknown. This remains a general and major problem in SPM. At the start of this review volume, Chapter 1 is appropriately devoted to efforts at producing well-defined tips, which range in length scale from single atom tips for molecular lithography to macroscopic spherical tips for force measurements.

I would like to thank the Editors for their considerable effort in bringing together some of the diverse aspects of SPM research in Singapore and I am sure the reader will find the topics chosen rewarding and stimulating.

Sean O'Shea
IMRE, Singapore
15 March 2010