

Preface

The rapid progress of nanotechnologies poses significant challenges in manufacturing and characterization. Scanning Probe Microscopy (SPM) techniques have significantly contributed to such development, allowing characterization of a number of properties at the microscale and nanoscale. Having been invented for the morphological investigation of surfaces, SPM has represented the basis for the development of techniques where the tip is used for probing physical properties and the SPM position control system is used for imaging such properties on the sample surface, simultaneously to their topography.

The combination of scanning probe microscopy, and in particular of Atomic Force Microscopy (AFM) with ultrasound techniques, led to the development of acoustic AFM (A-AFM) and acoustic SPM (A-SPM) opening up to a number of measuring techniques which allow surface mechanical properties imaging.

In A-AFM, piezoelectric transducers are used to set the sample surface or the AFM cantilever into vibration at ultrasonic frequencies that are well above the cutoff frequency of the electronics, so that the oscillations are not compensated by the feedback. As a consequence such oscillation does not influence the standard topographical reconstruction, and on the other hand, the ac component of the deflection signal is not suppressed and thus can be subsequently analyzed. The particular way in which ultrasonics and SPM are combined is different for each specific technique and allows collection of different information.

Readers working in different fields of nanotechnology, material science, and biology will find in this book a comprehensive overview of such A-SPM techniques, presented by evidencing similarities and peculiarities. We proudly say that the most widely recognized scientists and researchers have contributed to the 17 chapters of the present volume, discussing acoustic SPM techniques both from the theoretical and from the practical points of view. The volume is divided into three parts.

The first part includes three chapters on subjects that form the basis of all A-SPM techniques, namely, the contact mechanics describing the tip-sample interaction, the analytical models for the dynamics of the cantilevers interacting

with the sample in the different A-SPM modalities, and numerical methods for their simulation.

The second section describes the most important A-SPM techniques emphasizing recent advances: Atomic Force Acoustic Microscopy (AFAM), Ultrasonic Atomic Force Microscopy (UAFM), Scanning Microdeformation Microscopy (SMM), Ultrasonic Force Microscopies (UFM) and related techniques, Scanning Near-Field Ultrasound Holography (SNFUH), and Torsional Harmonic Atomic Force Microscopy (TH-AFM). Two chapters are dedicated to quantitative data extrapolation, presenting strategies for enhancing the sensitivity of such techniques allowing exploitation of measuring performance and discussing the main points of data post processing, providing hints and strategies for repeatable analysis of surface data sets. The presentation of A-SPM techniques is completed with a comparison between quantitative elastic measurements by A-SPMs and conventional techniques (i.e., nanoindentation and surface acoustic wave spectroscopy).

The third section reviews applications of A-SPM. Two chapters are devoted to quantitative aspects in the characterization of friction and internal friction and in subsurface imaging. Finally, the last two chapters describe some recent results in the quantitative mechanical characterization of polymers and of biological samples.

We gratefully acknowledge the support of all authors. We also wish to thank Springer, and in particular Mr. Claus Ascheron, for his initiative to setup this volume and his organizational work. We sincerely hope that readers will find this volume scientifically stimulating and rewarding.

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Acoustic Scanning Probe Microscopy

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