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# Applied Scanning Probe Methods



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# Applied Scanning Probe Methods

**Bharat Bhushan, Harald  
Fuchs, Masahiko Tomitori**



## **Applied Scanning Probe Methods:**

**Applied Scanning Probe Methods XII** Bharat Bhushan, Harald Fuchs, 2008-10-24 Crack initiation and growth are key issues when it comes to the mechanical reliability of microelectronic devices and microelectromechanical systems MEMS Especially in organic electronics where flexible substrates will play a major role these issues will become of utmost importance It is therefore necessary to develop methods which in situ allow the experimental investigation of surface deformation and fracture processes in thin layers at a micro and nanometer scale While scanning electron microscopy SEM might be used it is also associated with some major experimental drawbacks First of all if polymers are investigated they usually have to be coated with a metal layer due to their commonly non conductive nature Additionally they might be damaged by the electron beam of the microscope or the vacuum might cause outgassing of solvents or evaporation of water and thus change material properties Furthermore for all kinds of materials a considerable amount of experimental effort is necessary to build a tensile testing machine that fits into the chamber Therefore a very promising alternative to SEM is based on the use of an atomic force microscope AFM to observe in situ surface deformation processes during straining of a specimen First steps towards this goal were shown in the 1990s in 14 but none of these approaches truly was a microtensile test with sample thicknesses in the range of micrometers To the authors knowledge this was shown for the first time by Hild et al in 516 *Applied Scanning Probe Methods X* Bharat Bhushan, Harald Fuchs, Masahiko Tomitori, 2007-12-20 The volumes VIII IX and X examine the physical and technical foundation for recent progress in applied scanning probe techniques This is the first book to summarize the state of the art of this technique The field is progressing so fast that there is a need for a set of volumes every 12 to 18 months to capture latest developments These volumes constitute a timely comprehensive overview of SPM applications *Applied Scanning Probe Methods XI* Bharat Bhushan, Harald Fuchs, 2008-10-22 The volumes XI XII and XIII examine the physical and technical foundation for recent progress in applied scanning probe techniques These volumes constitute a timely comprehensive overview of SPM applications Real industrial applications are included **Applied Scanning Probe Methods VIII** Bharat Bhushan, Harald Fuchs, Masahiko Tomitori, 2007-12-20 The success of the Springer Series Applied Scanning Probe Methods I VII and the rapidly expanding activities in scanning probe development and applications worldwide made it a natural step to collect further specific results in the fields of development of scanning probe microscopy techniques Vol VIII characterization Vol IX and biomimetics and industrial applications Vol X These three volumes complement the previous set of volumes under the subject topics and give insight into the recent work of leading specialists in their respective fields Following the tradition of the series the chapters are arranged around techniques characterization and biomimetics and industrial applications Volume VIII focuses on novel scanning probe techniques and the understanding of tip sample interactions Topics include near field imaging advanced AFM specialized scanning probe methods in life sciences including new self-sensing cantilever systems combinations of AFM sensors and

scanning electron and ion microscopes calibration methods frequency modulation AFM for application in liquids Kelvin probe force microscopy scanning capacitance microscopy and the measurement of electrical transport properties at the nanometer scale Vol IX focuses on characterization of material surfaces including structural as well as local mechanical characterization and molecular systems The volume covers a broad spectrum of STM AFM investigations including fullerene layers force spectroscopy for probing material properties in general biological films and cells epithelial and endothelial layers medical related systems such as amyloid aggregates phospholipid monolayers inorganic films on aluminium and copper oxides tribological characterization mechanical properties of polymer nanostructures technical polymers and near field optics

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and dynamical surface studies of thin film semiconductors polymers paper ceramics and magnetic and biological materials The chapters have been written by leading researchers and application scientists from all over the world and from various industries to provide a broader perspective **Applied Scanning Probe Methods VII** Bharat Bhushan,Harald Fuchs,2006-11-10 The first volume in the series was released in January 2004 and the second to fourth volumes in early 2006 The field is now progressing so fast that there is a need for one volume every 12 to 18 months to capture latest developments Volume VII presents 9 chapters on a variety of new and emerging techniques and refinements of SPM applications

**Applied Scanning Probe Methods V** Bharat Bhushan,Harald Fuchs,Satoshi Kawata,2010-11-25 The volumes V VI and VII will examine the physical and technical foundation for recent progress in applied scanning probe techniques These volumes constitute a timely comprehensive overview of SPM applications This is the first book summarizing the state of the art of this technique The chapters are written by leading researchers and application scientists from all over the world and from various industries to provide a broader perspective **Applied Scanning Probe Methods III** Bharat Bhushan,Harald Fuchs,2009-09-02 The Nobel Prize of 1986 on Scanning Tunneling Microscopy signaled a new era in imaging The scanning probes emerged as a new instrument for imaging with a precision sufficient to delineate single atoms At first there were two the Scanning Tunneling Microscope or STM and the Atomic Force Microscope or AFM The STM relies on electrons tunneling between tip and sample whereas the AFM depends on the force acting on the tip when it was placed near the sample These were quickly followed by the Magnetic Force Microscope MFM and the Electrostatic Force Microscope EFM The MFM will image a single magnetic bit with features as small as 10nm With the EFM one can monitor the charge of a single electron Prof Paul Hansma at Santa Barbara opened the door even wider when he was able to image biological objects in aqueous environments At this point the sluice gates were opened and a multitude of different instruments appeared There are significant differences between the Scanning Probe Microscopes or SPM and others such as the Scanning Electron Microscope or SEM The probe microscopes do not require preparation of the sample and they operate in ambient atmosphere whereas the SEM must operate in a vacuum environment and the sample must be cross sectioned to expose the proper surface However the SEM can record 3D image and movies features that are not available with the scanning probes **Applied Scanning Probe Methods II** Bharat Bhushan,Harald Fuchs,2010-02-12 The Nobel Prize of 1986 on Scanning Tunneling Microscopy signaled a new era in imaging The scanning probes emerged as a new instrument for imaging with a precision sufficient to delineate single atoms At first there were two the Scanning Tunneling Microscope or STM and the Atomic Force Microscope or AFM The STM relies on electrons tunneling between tip and sample whereas the AFM depends on the force acting on the tip when it was placed near the sample These were quickly followed by the Magnetic Force Microscope MFM and the Electrostatic Force Microscope EFM The MFM will image a single magnetic bit with features as small as 10nm With the EFM one can monitor the charge of a single electron Prof Paul Hansma at Santa Barbara opened the door even wider when he was able to image

biological objects in aqueous environments At this point the sluice gates were opened and a multitude of different instruments appeared There are significant differences between the Scanning Probe Microscopes or SPM and others such as the Scanning Electron Microscope or SEM The probe microscopes do not require preparation of the sample and they operate in ambient atmosphere whereas the SEM must operate in a vacuum environment and the sample must be cross sectioned to expose the proper surface However the SEM can record 3D image and movies features that are not available with the scanning probes Applied Scanning Probe Methods II Bharat Bhushan,Harald Fuchs,2006-02-21 The Nobel Prize of 1986 on Scanning Tunneling Microscopy signaled a new era in imaging The scanning probes emerged as a new instrument for imaging with a precision sufficient to delineate single atoms At first there were two the Scanning Tunneling Microscope or STM and the Atomic Force Microscope or AFM The STM relies on electrons tunneling between tip and sample whereas the AFM depends on the force acting on the tip when it was placed near the sample These were quickly followed by the Magnetic Force Microscope MFM and the Electrostatic Force Microscope EFM The MFM will image a single magnetic bit with features as small as 10nm With the EFM one can monitor the charge of a single electron Prof Paul Hansma at Santa Barbara opened the door even wider when he was able to image biological objects in aqueous environments At this point the sluice gates were opened and a multitude of different instruments appeared There are significant differences between the Scanning Probe Microscopes or SPM and others such as the Scanning Electron Microscope or SEM The probe microscopes do not require preparation of the sample and they operate in ambient atmosphere whereas the SEM must operate in a vacuum environment and the sample must be cross sectioned to expose the proper surface However the SEM can record 3D image and movies features that are not available with the scanning probes Applied Scanning Probe Methods VI Bharat Bhushan,Satoshi Kawata,2009-09-02 The first volume in the series was released in January 2004 and the second to fourth volumes in early 2006 The field is now progressing so fast that there is a need for one volume every 12 to 18 months to capture latest developments Volume VI presents 10 chapters on a variety of new and emerging techniques and refinements of SPM applications **Applied Scanning Probe Methods** ,2004 **Applied Scanning Probe Methods I** Bharat Bhushan,Harald Fuchs,Sumio Hosaka,2014-02-26 This volume examines the physical and technical foundation for recent progress in applied near field scanning probe techniques It constitutes a timely comprehensive overview of SPM applications now that industrial applications span topographic and dynamical surface studies of thin film semiconductors polymers paper ceramics and magnetic and biological materials After laying the theoretical background of static and dynamic force microscopies including sensor technology and tip characterization contributions detail applications such as macro and nanotribology polymer surfaces and roughness investigations The final part on industrial research addresses special applications of scanning force nanoprobe such as atomic manipulation and surface modification as well as single electron devices based on SPM Scientists and engineers either using or planning to use SPM techniques will benefit from the international perspective assembled in

the book *Applied Scanning Probe Methods XIII* Bharat Bhushan, Harald Fuchs, 2009-08-29 The volumes XI XII and XIII examine the physical and technical foundation for recent progress in applied scanning probe techniques The first volume came out in January 2004 the second to fourth volumes in early 2006 and the fifth to seventh volumes in late 2006 The field is progressing so fast that there is a need for a set of volumes every 12 to 18 months to capture latest developments These volumes constitute a timely comprehensive overview of SPM applications After introducing scanning probe microscopy including sensor technology and tip characterization chapters on use in various industrial applications are presented Industrial applications span topographic and dynamical surface studies of thin film semiconductors polymers paper ceramics and magnetic and biological materials The chapters have been written by leading researchers and application scientists from all over the world and from various industries to provide a broader perspective

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