Here are the Shows and Conferences we are attending in first half 1998

North America

American Academy of Forensic Sciences Annual Meeting
Feb 11-13th
San Francisco, CA

Materials Research Society, Spring Meeting
April 14-16th
San Francisco, CA

Scanning 98
May 10-12th
Baltimore, MD

International

Image Processing & Optics Technology
Feb 11-12th
Kettering, UK

Master Class-AFM talk
Feb 19th
Manchester, UK

UK SPM Seminar
Feb17th and 18th
London and Manchester

Physics World
March 17-18th
Brighton, UK

Materials Industry Exhibition
April 7-8th
Cirencester, UK

DPG-1998
March 24-26th
Regensburg, Germany

French Microelectronics Forum
March 24-25th
Paris, France

Machine Outil
March 30-April 10th
Paris, France

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burleigh SURFACE TOPOGRAPHY NEWS

A Publication of Burleigh Instruments Incorporated • Surface Topography Division • Volume 5

Electric Force Microscopy with the Burleigh Metris-2000-NC AFM

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(current e-mail address walterei@physik.fu-berlin.de)

Electric force microscopy (EFM) has become an important development in the field of scanning probe microscopy. Local electric potential information can be detected by applying an ac bias between tip and sample; a lock-in amplifier allows simultaneous detection of electrical and topographical data.

Non-contact imaging with the Metris-2000-NC SPM is usually carried out by measuring changes in amplitude or phase of the oscillating cantilever. If a bias voltage is applied between tip and sample the system can be treated as a capacitor. Lateral variations of the effective dc voltage give rise to lateral varying electrostatic force gradients & these will vary in amplitude depending on the electric potential of the surface. As the feedback adjusts the tip-sample separation to keep the gradient at the tip position constant, then the oscillation amplitude of the sample gives information on the local potential charge of the surface.

Hardware modifications

Several hardware modifications are made to upgrade the Metris-2000-NC SPM system for EFM, see figure 1.

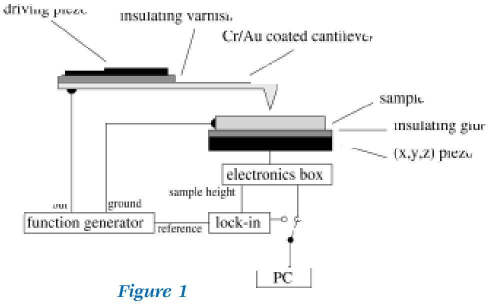


Figure 1

Since non-contact probes are silicon, they are made conductive by coating with chromium and gold. A bias voltage is applied to the tip using a function generator with frequencies of up to 1kHz. The lock-in amplifier is fed with a reference from the function generator and the vertical sample position signal. The output of the lock-in amplifier is then a

Article continued on page 2

Burleigh Users' Meeting at Fall AVS

We will be holding a one-day Users' Meeting at the end of the Fall American Vacuum Society Meeting in Baltimore. The date of our meeting is Friday November 6th 1998. Attendance at the meeting is free for Burleigh AFM or STM customers. There will be papers and posters by users. In addition there will be demonstrations and discussions by experts from the factory on new features, techniques and instrumentation. We are offering 10 travel stipends of $500 each for users to present papers or posters. For consideration for the travel stipend, abstracts must be submitted to Dr. Carol Rabke at Burleigh Instruments Inc. by April 15th.

Welcome to Surface Topography News.

We're proud to be producing the fifth in the series about Burleigh's Surface Topography products and features on how they are used. In this issue we have application stories from customers around the world, a calendar of events we will be attending in the next six months and news of latest software and hardware availability.

This Issue

...Electric Force Microscopy

measure of the built-in voltage. The built-in voltage can be thought of as the difference in the work function between tip and sample. The output signal to the computer is switchable so that the sample height or the EFM signal is displayed on the computer monitor.

Test runs

The functionality of the set-up is easily checked with a flat conducting sample of coated silicon. After a suitable resonance peak has been identified, the oscillation is adjusted and the bias voltage switched on. By choosing a large ratio of the ac bias voltage to the dc bias, the main sample oscillation occurs at twice the bias frequency. This behavior is shown in figure 2 where the tip was scanned over a small 100nm x 100nm region. The modulated voltage of 2V is kept constant while the dc voltage is changed from -2V to 1V and back to -2V in 0.5V steps as one goes from top to bottom. The X & Y axes of this image are therefore time not distance.

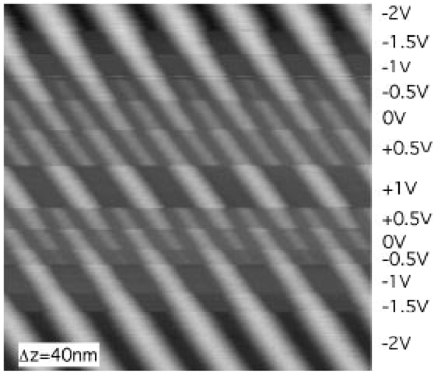


Figure 2: Visualization of the dependence of the sample oscillation frequency on the ratio bias voltage{ac}/bias voltage{dc}. The frequency doubling for high voltage ratios is clearly seen.

Simultaneous EFM and AFM

The feedback loop of the Metris-2000-NC controller follows bias modulation frequencies up to about 1kHz. The signal to noise ratio of the lock-in input from the BNC socket of the electronics box is significantly improved by an RC low-pass filter with a time constant of about twice the modulation frequency. This filter is incorporated in the connection of electronics box and lock-in input channel. Using a small ac bias voltage the topography is the direct signal from the electronics box whereas the EFM is obtained simultaneously from the lock-in output. Either of these two signals can be stored in the computer using the above-mentioned switch.

Further development

The acquisition time in the technique described is slow as the scan rate is set below the modulation frequency of the bias voltage. An improvement will be to set the modulation frequency well above the feedback response frequency and close to the second resonance of the cantilever. The EFM signal will then be the oscillation of the cantilever itself. Although this preliminary discussion of this technique has been prepared by Patrick Waltereit, there are aspects of EFM that require further development by Burleigh's application staff before this can be considered a routine imaging mode.

New to the family!

Recently Burleigh has added two NEW families of products to our repertoire of surface topography instrumentation.

Our first NEW surface topography product is the Horizon Optical Surface Profiler. The Horizon is a Phase-shifting Interferometric Microscope that produces 3D images of surfaces and complements the measuring capability of our AFM systems. It can measure features in XY scale from 0.5µm up to mm size. Its Z range is 100µm yet it has a vertical resolution of less than 1nm! Samples as large as 200mm dia. can be accommodated and imaging time is typically less than a minute.

Secondly the Vista offers the first large sample SPM with a small footprint. This industrial strength scanning probe microscope combines a large sample translation stage with contact AFM, non-contact AFM (includes phase imaging), and lateral force. A high speed Pentium computer with a 17" monitor houses the Vista SPM software and controller hardware. The Vista delivers the features and functions found on other commercially available SPMs for about half the cost, making it the most affordable SPM on the market.

Surface Topography Seminars in UK, February 1998

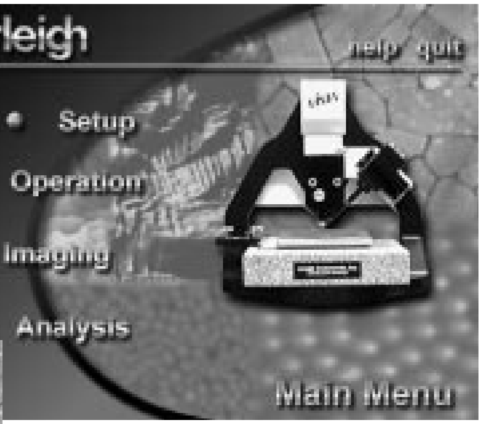
Dr. Carol Rabke, Director of Sales and Marketing, Burleigh Instruments Surface Topography Division will be presenting a Master Class entitled "Atomic Force Microscopy-A Review of Applications" at the Laboratory Show 98 in Manchester, England on February 19th. Admission is free.

In conjunction with this we will also be presenting half-day seminars on Surface Topography Measurements to be held at the Institute of Physics in London on 17th Feb. and in Manchester on 18th Feb. The seminar will cover theory and applications of SPM and Optical Profilometry. We will have on demonstration our Metris-2000NC and new Vista AFM systems as well as our new Horizon Optical Profiler. For more details on either events please contact Burleigh UK on 01582-766888, fax: 01582-767888, email: 100407.3465@compuserve.com

Vista Interactive Tutorial

"A new and unique way of learning to use advanced SPM systems."

We are excited to announce a new and innovative CD-ROM tutorial program that is shipped with each Vista AFM. Written in Macromedia Director, this program leads the new user through all aspects of setting up and operating their new instrument even if they have never operated an SPM before. The topics covered by the tutorial are outlined in the Main Menu shown right. Using graphics, digitized images and animation,these topics come to life on your computer screen.



The Interactive Tutorial program is an alternative to written manuals that so few of us have time to read in today's busy world. Animation is much more efficient in explaining difficult techniques such as how to mount cantilever probes or to optimize laser beam alignment as these are tough to explain using only diagrams and text. The program is not only ideal for initial familiarization but later can be used to train new users.

The object of this procedure is to align the Quad Cell Detector with the Laser. The laser must first be centered onto the tip of the Cantilever. Then the Mirrors must be adjusted to align the laser with the detector.

Surface Characterization of Photodoped Conducting Polymers by AFM

E. Gautier-Thianche, J.M. Nunzi, C. Sentein
CEA SACLAY, Organic Devices Group, France

Introduction

Conducting polymers are often used in the field of electro-optic devices or energy storage. Soluble polymers spin coated on glass substrates like polythiophenes are of great interest for microlithography and electronic component applications. We see evidence of polymer morphological changes due to photodoping. Atomic Force Microscopy is used as a surface characterization technique in these sample studies.

Experimental

Poly(3-butylthiophene) (P3BT) was used as the conducting polymer. Photodoping consists of increasing the polymer conductivity using a photosensitive dopant of onium salt under ultraviolet light. Photodoping is a multi-step process. Along the polymer chain, charge transfer complexes are created between the polymeric backbone and counter ions. Charge transfer complexes increase the polymer conductivity. A solution of P3BT in chloroform was prepared and onium salt added. The blend was spin coated onto the glass substrate. The thin film was then heated at 80°C to remove the remaining solvent.

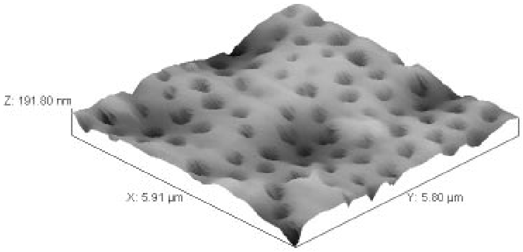


Figure 1 : AFM three dimensional view of the polymer thin film before laser exposure.

Photodoping is completed by exposing the sample with a UV Argon laser. The laser beam scans the sample in order to provide a 1 µm step conductive grating.

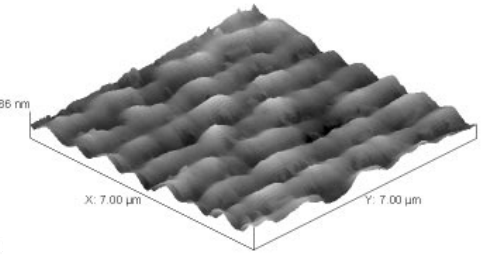


Figure 2 : Three dimensional AFM view of the same polymer layer after laser exposure.

Before exposure, the polymer layer is not smooth. (Figure 1) The broken surface shape is not yet well understood but it may be an effect of dopant distribution along the polymer film. The conducting grating is clearly seen in the AFM image. (Figure 2) The grating step is 1 µm and the polymer layer thickness was shown to decrease with exposure.

Ref: Influence of stereoregularity on the photoinitiated electrical conductivity of poly(3-alkylthiophenes) C. Sentein, B. Mouanda, A. Rosilio and C. Rosilio, Synthetics Metals 83, 27-37, 1996.

Winner of ISTM

Congratulations Dr. Ventrice! We hope your research profits from this.

This fall we sent out a mailer offering a free ISTM or equivalent credit towards purchase of other Burleigh instrumentation. Anyone presenting a postcard to our booth personnel at either the AVS or MRS meetings could enter a draw for this product giveaway. And the winner was Dr. Carl Ventrice, Assistant Professor in the Physics Department at the University of New Orleans. When we told Dr. Ventrice of his success, he said he was very excited about this and plans to trade up in hardware to aid with his research in metal/semiconductor interfaces. Before moving to New Orleans, Dr. Ventrice did a post-doc at Rensselaer Polytechnic Institute in Troy, NY where he built a BEEM STM system utilizing two UHV Inchworms®: one to control the STM tip and second probe to make a contact to the metal overlayer which is necessary for the BEEM measurements. The study involved metal /semiconductor interfaces grown and imaged in an MBE system. These experiments yield information about interfaces hidden deep below the surface. Dr. Ventrice is also collaborating with a Silicon MBE group at Naval Research labs with a new wafer STM also utilizing a Burleigh Inchworm.

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A Change in US Representatives

Burleigh Instruments has changed its sales distribution and support network for Surface Topography Products in the USA and Canada effective November 1st 1997.

Previously we utilized a number of independent representatives. We believe that it is in the best interests of our North American customers that Surface Topography Product sales and technical support is handled directly from our headquarters located in Fishers (Rochester) NY. Our telephone, fax and email numbers are as listed on the back page.

This change does not affect our distribution agreements with our representatives in Europe, Asia and other countries who will remain as our representatives. Neither does it affect our North American sales and support of our Electro-Optics, Life Science and Nanopositioning products.

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☑ ***List of Surface Topography Application Notes Available:***

○ *Vol. 1:* Surface Characterization of Semiconductor Materials; D. Sykes, Loughborough University, UK

○ *Vol. 2:* AFM Study of Thermally Etched Alumina Ceramics; H. Pederen, Tech University of Denmark.

○ *Vol. 4:* AFM: A Complementary Technique for SEM Investigation, C. Rabke, Burleigh

○ *Vol. 5:* Magnetic Force Microscopy using the Burleigh AFM, D. Wright, University of Manchester, UK

○ *Vol. 6:* Foaming of Carbonated Beverages in Recycled Glass Containers: A Lesson on Surface Topography; A. Mejiritski, Bowling Green State University, Ohio

○ *Vol 7:* Supplemental Lab Exercise for the ISTM: Calibration using the Atomic Lattice of Graphite; A. Leavitt, State University of West Georgia

○ *Vol. 8:* Comments on Funding a Scanning Probe Microscope; A. Leavitt, State University of West Georgia

○ *Vol 9:* Analysis and Characterization of Electroluminescent materials and Conducting Polymers, E Gautier-Thiance et al, CEA SACLAY, France

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○ *Vol. 14:* STM Study of Oxidised Niobium(110); S. Barrett, University of Liverpool, UK

○ *Vol. 15:* Electric Force Microscopy with the Burleigh Metris-2000-NC AFM; P. Waltereit, Imperial College, UK

○ *Vol. 16:* Nanomechanical Measurements on Polymers using Contact Mode AFM; P. Lemoine & J. McLaughlin, NIBEC, University of Ulster

Product Information: ○ **ISTM** ○ **UHV-STM** ○ **METRIS-1000** ○ **METRIS-2000** ○ **METRIS-2000-NC**
○ **VISTA LARGE SAMPLE SPM** ○ **HORIZON NON-CONTACT PROFILER**

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