NanoLens AFM and Bruker 3D Microscopes
Integrated 1000X Inspection Combines for Maximum Metrology Value

Atomic Force Microscopy
3D Optical Microscopy
Tribology
Automated AFM
Stylus Profilometry
Mechanical Testing, Nano Indentation

Innovation with Integrity
Outline

- **Introduction/Administrative**

- **Overview of Bruker 3D Optical Microscopes**
  - *Software, Automation*
  - *Ease of Use Functionality*

- **Overview of NanoLens AFM module “1000X” Lens**

- **Defect Inspection Example**

- **Summary/Q&A**
Introduction

Bruker Nano Surfaces Division

- Widest selection of metrology and tribology platforms
- Only major AFM manufacturer with world-class probes nanofabrication
- World leader in innovation -- over 180 patents in AFM, stylus and optical metrology

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**Atomic Force Microscopy**
Nanoscale characterization of compositional and material properties

**3D Optical Microscopy**
Non-contact 3D measurement of surface texture and roughness

**Stylus Profiling**
Measure thin film roughness, step heights and stress

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**Tribology and Mechanical Testing**
Nano/microscale wear, indentation, frictional analysis of materials
Introduction
Bruker Nano Surfaces Division
Stylus and Optical Metrology

- Technology Leadership
  - 60+ Patents
  - 3 R&D 100 Awards
  - 6 Photonics Circle of Excellence Awards

- Manufacturing Excellence
  - Lean, six sigma-based process
  - >100 systems/quarter capacity
  - Rapid production ramp capability
Introduction

Speaker Background

Matt Novak, Ph.D.
Manager, SOM Applications Development
Bruker Corporation
Nano Surfaces Division
matt.novak@bruker-nano.com

- Applications at Bruker (2+ years)

- Industry experience (16+ years)
  optical engineering, fabrication and metrology

- Earned Ph.D. working in private sector metrology capital equipment
Who Will Benefit?

**Intended Webinar Audience**

- Technicians, engineers, and researchers interested in 3D optical microscopes

- Those interested in automated inspection capabilities

- Those interested in highest resolution metrology available for critical failure analysis and quality assurance needs

- People interested in **AFM imaging, automation for ease of use, as well as 3D optical inspection** for QA/QC, failure analysis, and process control
Why 3D Optical Microscopes?  
Value Delivery for Precision Applications

Capital metrology equipment protects *investment* of…

Money
- Equipment
- Materials

Time
- Operators
- Machining

Productivity
- Capital Employment
- Rework Reduction

*Bruker 3D Microscopes Deliver Tremendous Value and Savings Across These Elements*
Value from Webinar
After the Presentation You Will...

- Understand the value of Bruker’s 3D microscopes for metrology across a range of applications
  - Automation and ease of use capabilities

- Understand the value of integrated AFM capability on Bruker’s 3D microscope platforms for high resolution metrology applications

- Survey responses appreciated
Outline

• Introduction/Administrative

• Overview of Bruker 3D Optical Microscopes
  • Advantages in Software, Automation
  • Ease of Use, Functionality

• Overview of NanoLens AFM module “1000X” Lens

• Defect Inspection Example

• Summary/Q&A
Microscopes with special objectives used to provide sample height data
- Optics scanned vertically so that sample is passed through focus
- Computer system computes height information from this focus scan data
Excellent vertical resolution combined with high lateral resolution for large area metrology.
Bruker 3D Optical Microscopes
Metrology for Broad Applications

Metals
Life Sciences
MEMS
(MicroElectroMechanical Systems)

Semiconductors
Optics
Materials
Advantages of Bruker 3D Microscopes

Truly Universal VXI for Ease of Use

- **VXI – Universal** mode, for any stepped, smooth or rough surface

- **VXI uses complete optical signal for optimum results**

- **VXI renders topography by...**
  - *Self-sensing* smooth/rough surface
  - *Producing* highest quality data on smooth surfaces
  - *Reducing* noise and artifacts on rougher surfaces

15 nm $S_a$ Surface
Advantages of Bruker 3D Microscopes
Excellent Repeatability, All Magnifications

- Bruker 3D microscopes measure at both high magnification and low magnification with **Highest Performance in Repeatability**
Advantages of Bruker 3D Microscopes
Multi-grid Automation for Ease of Use

- **Multi-grid automation**
  - Supports multiple measurements per die or region (trays, etc.)
  - Simple setup, fast!

![Automation Editor](image)

Bruker Confidential
Advantages of Bruker 3D Microscopes

COGNEX Pattern Alignment

- **Automated alignment with COGNEX**
  - Fast! – bright field image recipes supported
  - Operator independent
  - Teach patterns inside Vision64 – totally integrated solution!
  - Critical for SEMI, automotive, micro machining, MEMS sensors and other apps
Advantages of Bruker 3D Microscopes
Imaging and Metrology – Combined!

Sharp Images, Fastest Time to Data are Key Advantages
Advantages of Bruker 3D Microscopes

Ease of Display and Output Customization

Histogram and 3Di Custom Display
Affects Terms Removal Node
Other Nodes Have Other Display Defaults.
Visualizations for the type of analysis will persist.
**Advantages of Bruker 3D Microscopes**

*Fastest Time to Data*

**Single Measurement Location**
- Scanner Speed 100+
- Auto Scan Return
- Real-time Auto Intensity

**Multiple Locations Measurement**
- Scanner Speed
- Auto Scan Return, **Tilt Adjust**
- Real time Auto Intensity
- Easy XY Automation
- Stitching – Auto Scan Return
- High Speed Auto Focus

**SPEED = Image Acquisition + Data Analysis**
Advantages of Bruker 3D Microscopes
Automated Tip/Tilt of Optical Head

- Auto tip/tilt achieves...
  - Better repeatability
  - Better reproducibility
  - Fastest time to data on long scans

- Simple set up!

- Enables following of surface for shortest possible scans
Advantages of Bruker 3D Microscopes

Automated Tip/Tilt of Optical Head

- Tip/tilt head enables auto adjust of tilt
  - User sets controls for desired alignment condition
  - System measures and adjusts automatically for tilt
  - Allows sample tracking and shortest scan lengths on large warped/bowed samples
Advantages of Bruker 3D Microscopes
Automatic Region ID and Coordinate Maps

Time to Data Advantage: Multiple Region Analysis

- Multiple Regions, Log Data and COORDINATES
- “Multiple Multiple” Regions, Analyze in One Image Acquisition
- Automatic Region ID, Data and Statistics without operator intervention

SPEED = Image Acquisition + Data Analysis
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• Overview of NanoLens AFM module “1000X” Lens

• Defect Inspection Example

• Summary/Q&A
ContourGT and NanoLens AFM
Excellent 3D Microscope Metrology and ‘1000X’ AFM Lens in Single System
Bruker’s NanoLens AFM

Why ‘1000X’? Highest Turret Magnification!

Approximate 200x FOV

‘1000X’ Image easily achieved by NanoLens AFM!
• World’s only 3D optical microscopes with integrated AFM module operated from system software AND backed by extensive WW AFM expertise

• Ideal combination for DEFECT REVIEW applications requiring low magnification ID, high resolution measurement

• Integrated “ON PLATFORM” capability saves process, load and unload time – maximizes operator productivity
# NanoLens AFM Module Specs

## General Technical Specs for Module

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum scan range (XY) (1)</td>
<td>70 μm (switchable to 110 μm (2) for extended scan range)</td>
</tr>
<tr>
<td>Maximum Z-range (1)</td>
<td>22 μm</td>
</tr>
<tr>
<td>Drive resolution XY / Z (3)</td>
<td>1.7 nm / 0.34 nm</td>
</tr>
<tr>
<td>XY-linearity mean error</td>
<td>&lt; 0.6%</td>
</tr>
<tr>
<td>Z-measurement noise level (RMS, Static mode) (4)</td>
<td>0.4 nm (max. 0.55 nm)</td>
</tr>
<tr>
<td>Z-measurement noise level (RMS, Dynamic mode) (4)</td>
<td>0.3 nm (max. 0.55 nm)</td>
</tr>
<tr>
<td>Automatic sample approach</td>
<td>Built-in motorized parallel approach with 4.5 mm travel</td>
</tr>
<tr>
<td>Cantilever alignment</td>
<td>Automatic self-adjustment through alignment chip technology</td>
</tr>
<tr>
<td>Sample observation</td>
<td>Built-in 8× objective lens with 45 or 60 mm parfocal distance (5)</td>
</tr>
<tr>
<td>AFM measurement repositioning precision</td>
<td>±10 μm (including cantilever exchange, scan head remounting and approach)</td>
</tr>
</tbody>
</table>

1. Manufacturing tolerances are ±10%
2. At 45° rotation of the AFM scan direction
3. Calculated by dividing the maximum range by 16 bits
4. With active vibration isolation on a stable desk and in a low noise laboratory environment (no air conditioning)
5. Adapters with a correct parfocal distance are available for the different optical microscope types
NanoLens AFM Microscope Integration
Features and Benefits to Applications

- **Parcentric AFM to 50x FOV within ~ 15 µm**

- **Integrated 8X optical objective for observation**

- **Identify areas of interest to inspect via optical or AFM**

- **On-board AFM enables fastest time to data for FA or QA labs, among other uses**

*Standard sample image at 16X magnification*
ContourGT + NanoLens AFM
Bringing the Power of AFM to Bruker 3D Microscopes

- **Applications include...**
  - On-board verification of highest resolution measurements
  - Thin film steps
  - Dissimilar materials, smooth surfaces (semi wafer apps, MEMS, lithography, etc.)
  - **Defect/Contamination Review**

NanoLens AFM for highest resolution!

Maximum “1000x” resolution with NanoLens AFM!
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• 3D microscope measurements indicate areas of interest for higher magnification inspection

• Result of multiple measurement sites from automation run and saved data coordinates (AUTO Region ID from multiple regions)

• Stage auto locates measurement locations for highest resolution inspection

• Parcentric NanoLens AFM images sample areas and provide highest resolution results – all ON SAME platform!
ContourGT + NanoLens AFM
Wafer Inspection Application

- Sample for inspection – HB LED wafer in process

- Wafer inspection - use ContourGT to inspect levels of LED structure and mesa, fingers at low magnification

- Low magnification – ID coordinates – stage import for defect review

- NanoLens AFM can provide additional insight to detailed structures
ContourGT + NanoLens AFM
Defect/Contamination Review Application

Low magnification inspection identifies defect - 100X image reveals pitting
Optical inspection shows ~ 1 micron tall, ~ 1 micron wide bump - which is it? Confirm via NanoLens AFM
ContourGT + NanoLens AFM
Defect/Contamination Review Application

NanoLens AFM Easily Confirms Nature of Defect
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Summary

• Introduced Bruker BNS, Bruker 3D Optical Microscopes and their advantages for metrology, speed and ease of use

• Introduced Bruker’s NanoLens AFM and covered the combined 3D Optical Microscope value-add for this capability

• Outlined an application for on-board “1000X” imaging for a simple defect review example

• Questions open – any unanswered will be followed up via email when yours is linked to your company name
Summary

Presenter Contact:  matt.novak@bruker-nano.com

Questions?

THANK YOU