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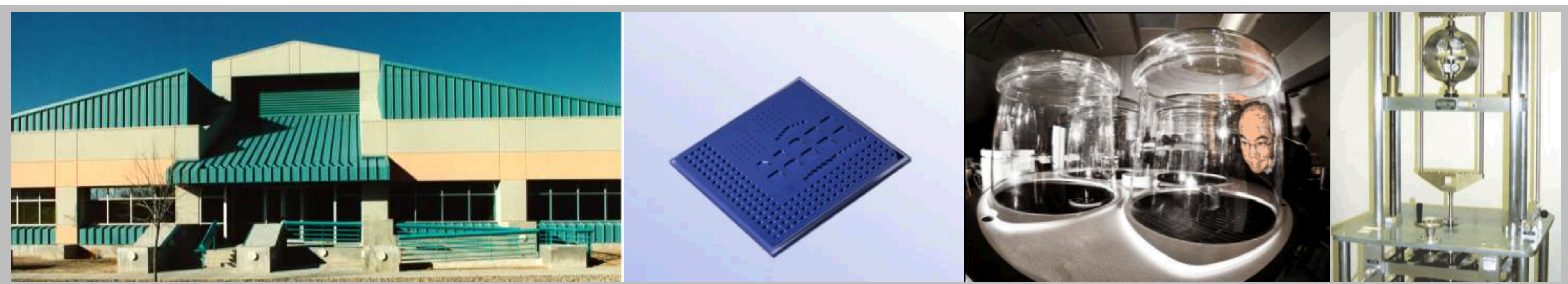

Measuring Reference Standards Using a Coherence Scanning Interferometer

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Outline

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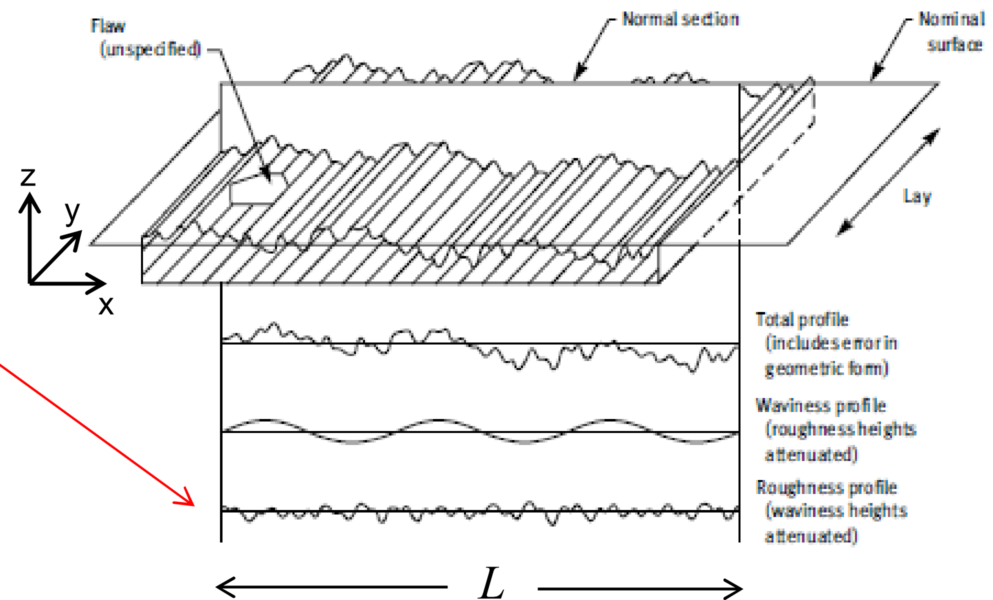
- Surface texture importance and characteristics
- Surface texture measurement methods
- Calibrating instruments for measuring these characteristics
- Past work with the coherence scanning interferometer
- Measuring structured standards using a coherence scanning interferometer

Surface Texture Parameter - Ra

- Instruments measure coordinates on surface and convert set of points into a single parameter to describe the surface
- Common parameter is the roughness average (Ra) and is expressed in units of length

$$Ra = \frac{1}{L}\int_0^L |z(x)|\,dx$$



List of Published Standards

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Standard number	Short title (GPS→Geometrical Product Specifications)
ASME Y14.36M:1996	Surface texture symbols
ASME Y14.5:2009	Dimensioning and Tolerancing
ASME B46.1:2009	Surface Texture (Surface Roughness, Waviness, and Lay)
ISO 1302:2002	GPS-Surface texture-Indication of texture in product documentation
ISO 4287:1997	GPS-Surface texture-Profile method-terms, definitions…
ISO 4288:1996	GPS-Surface texture-Profile method-Rules and procedures
ISO 5436-1:2000	GPS-Surface texture-Profile method-measurement stds
ISO 5436-2:2000	GPS-Surface texture-Profile method-software
ISO 8785:1998	GPS-Surface imperfections-terms, definitions …
ISO 12085:1996	GPS-Surface texture-Profile method-Motif parameters
ISO 12179:2000	GPS-Surface texture-Profile method-Calibration of stylus instruments
ISO 13565-1:1996	GPS-Surface texture-Profile method-stratified functional-filtering
ISO 13565-2:1996	GPS-Surface texture-Profile method-stratified functional-height ratio
ISO 13565-3:1996	GPS-Surface texture-Profile method-stratified functional-material prob
ISO 16610-1:2006	GPS-Filtration-overview
ISO 16610-20:2006	GPS-Filtration-linear filters-basic concepts
ISO 16610-21:2011	GPS-Filtration-linear filters-Gaussian filters
ISO 16610-22:2006	GPS-Filtration-linear filters-Spline filters
ISO 16610-28:2010	GPS-Filtration-linear filters-end effects
ISO 16610-30:2009	GPS-Filtration-Robust profile-basic concepts
ISO 16610-31:2010	GPS-Filtration-Robust profile-Gaussian regression
ISO 16610-32:2009	GPS-Filtration-Robust profile-Spline
ISO 16610-40:2006	GPS-Filtration-Morphological-basic concepts
ISO 16610-41:2006	GPS-Filtration-Morphological-Disk and horizontal line segment filters
ISO 16610-49:2006	GPS-Filtration-Morphological-Scale space techniques
ISO 25178-2:2012	GPS-Surface texture-Areal-Terms, definitions
ISO 25178-6:2010	GPS-Surface texture-Areal-Classification of methods
ISO 25178-601:2010	GPS-Surface texture-Areal-characterisitics of stylus instruments
ISO 25178-602:2010	GPS-Surface texture-Areal-characteristics of confocal chromatic probe
ISO 25178-701:2010	GPS-Surface texture-Areal-Calibration and standards for stylus instr.

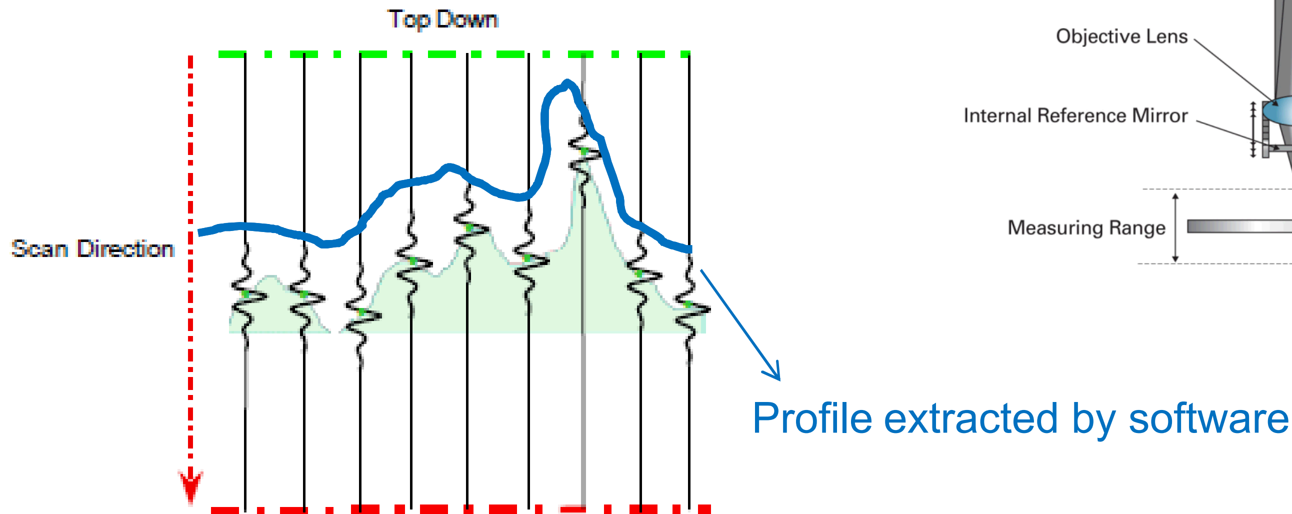
Measurement Methods

- Visual/tactile inspection
- Stylus based equipment
  - Portable, shop floor
  - Benchtop
- Non-contact
  - Optical “stylus”
    - Scanning microscopy (including confocal, point autofocus, etc.)
    - Scanning laser triangulation
  - Areal image
    - Focus variation
    - Scanning white light interferometry

Certain commercial equipment, instruments, or materials are identified in this paper in order to adequately describe the experimental procedure. Such identification does not imply recommendation or endorsement by the authors, Sandia National Laboratories, or NCSL International, nor does it imply that the materials or equipment identified are the only or best available for the purpose.

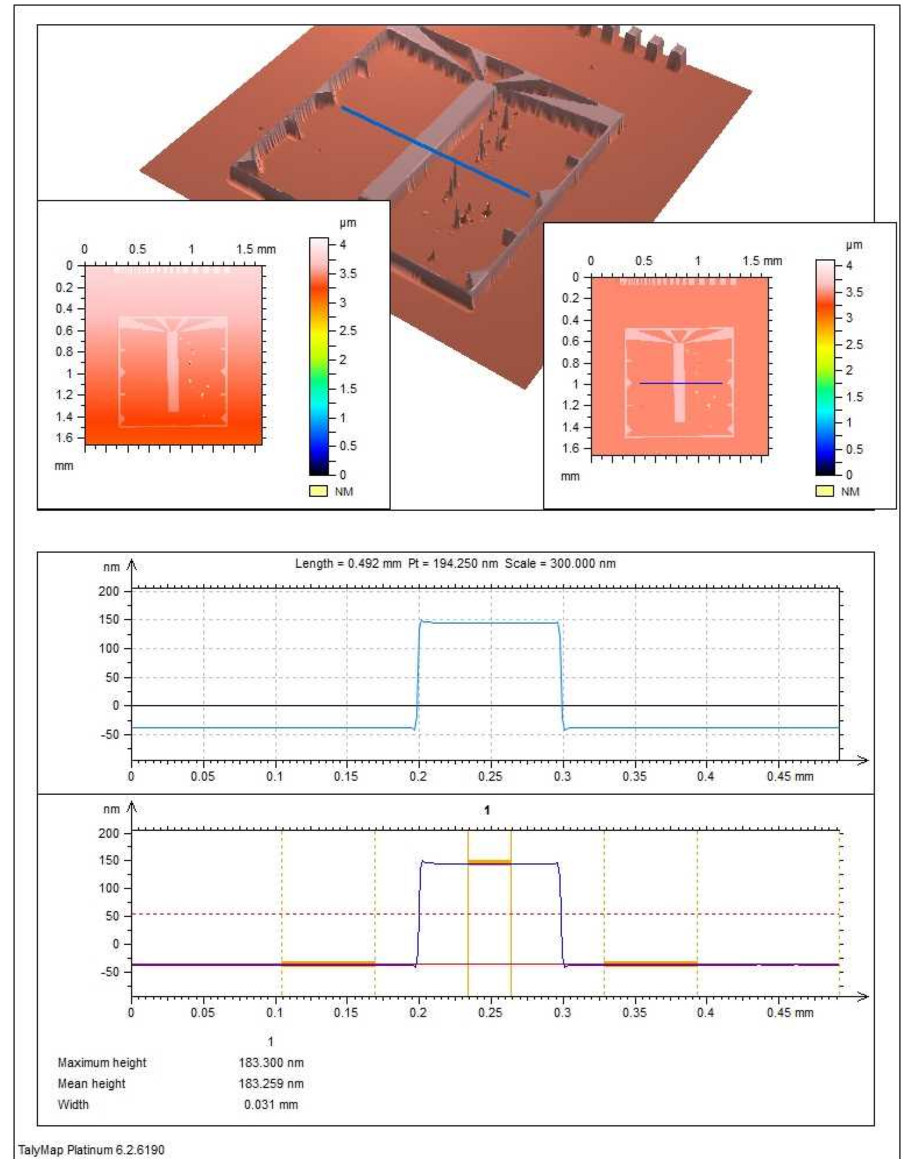
Coherence Scanning Characteristics

- Measures vertical (z) features
- x,y (lateral) are like conventional microscope (image/pixel)
- Vertical resolution: 0.1 nm
- Numerical aperture limits measuring steep slopes
- Computer control for “stitching” and software for measuring and analyzing surface geometry map



Typical Measurement Process

- Set up sample
- Measure
- Send topographic data to software
- Analyze topographic data in software
- Analysis software also capable for surface parameters
- Multiple types of standards are used to calibrate instruments



Measuring Structured Standards

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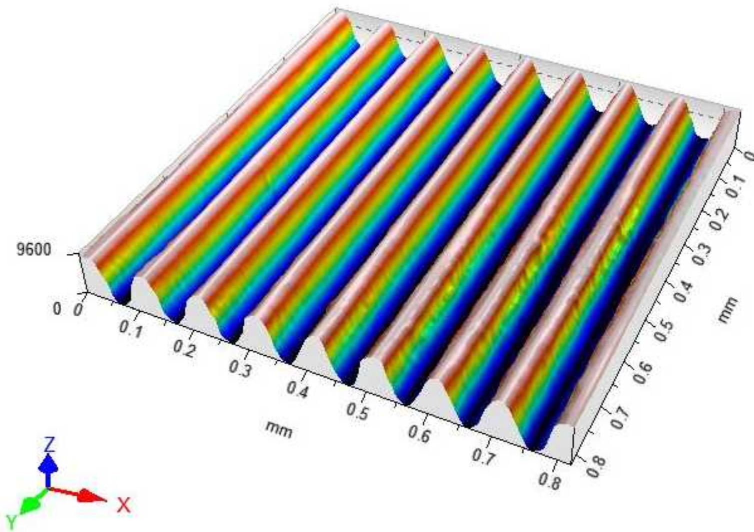
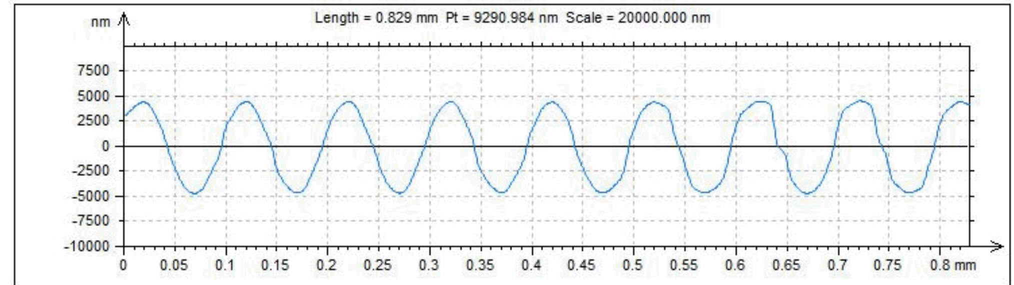
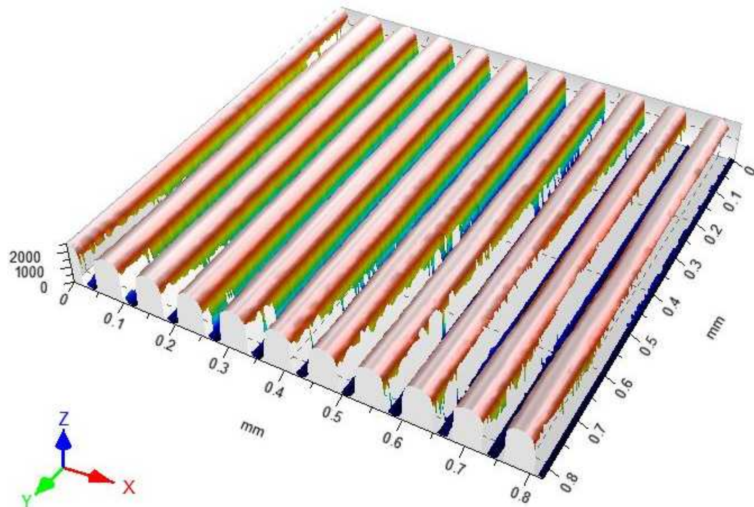
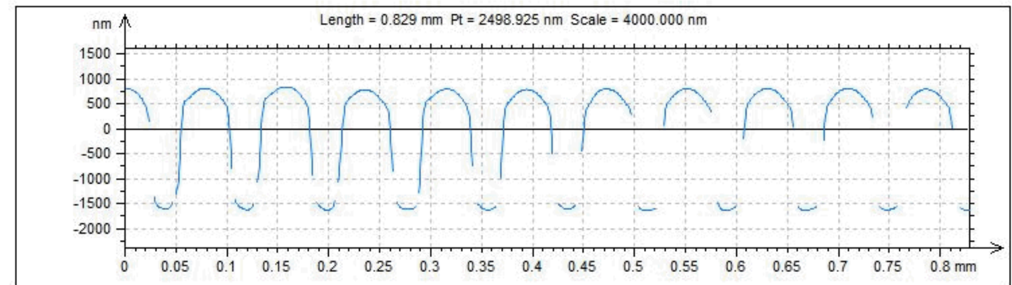


Sinusoid





Square Wave



Preliminary Evaluations

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Standard Description	Historical Calibration with Expanded Uncertainty	Measured Ra (2 std devs)	Calculated Ra from p-v
Sinusoid Ra = 3 μm 10X objective	2.975 ± 0.011 μm	3.245 μm (0.061 μm)	2.709 μm
Sinusoid Ra = 3 μm 20X objective	2.975 ± 0.011 μm	3.054 um (0.103 μm)	2.585 μm
Sinusoid Ra = 3 μm 50X objective	2.975 ± 0.011 μm	3.492 μm (0.177 μm)	3.339 μm
Square Wave Ra= 0.86 μm 10X objective	0.856 ± 0.028 μm	1.056 μm (0.034 μm)	1.136 μm
Square Wave Ra= 0.86 μm 20X objective	0.856 ± 0.028 μm	0.954 μm (0.017 μm)	1.125 μm
Square Wave Ra= 0.86 μm 50X objective	0.856 ± 0.028 μm	1.068 μm (0.006 μm)	1.185 μm

Conclusions

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- More work needs to be done with structured surfaces using a coherence scanning interferometer
- Modified a stylus instrument for use with a data acquisition system instead of using a strip chart recorder
- A detailed procedure is waiting for the next person to work on this project

Resources

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- ASME and ISO standards
- NPL Good Practice Guide 108 (smooth surfaces with CSI)
- NPL Good Practice Guide 116 (rough surfaces with CSI)
- NPL Good Practice Guide 37 (stylus instruments)
- *Optical Measurement of Surface Topography*, Richard Leach, ed. Springer 2011
- *Handbook of Surface and Nanometrology*, David Whitehouse, CRC Press 2011
- *Surfaces and their Measurements*, David Whitehouse, Hermes Penton Science, 2002