

ISO TC 213 – Dimensional and Geometrical Product Specifications and Verification

<http://isotc213.ds.dk/>

WG16 – Areal Surface Texture (et al.)

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Overview of Current Nanotech Standards Program (1)

- Area(s) of nanotech standardization
Methods for measuring surface texture and heights of surface features
- Program drivers
To accommodate 3D methods (filtering & parameters) in surface texture analysis standards. Previous standards were 2D.
- Customers/stakeholders
Metrology suppliers,
Manufacturers of mechanical systems (autos, aircraft,...)
- Pertinent work completed
Approx. 6 existing standards including ISO 5436 on measurement standards.

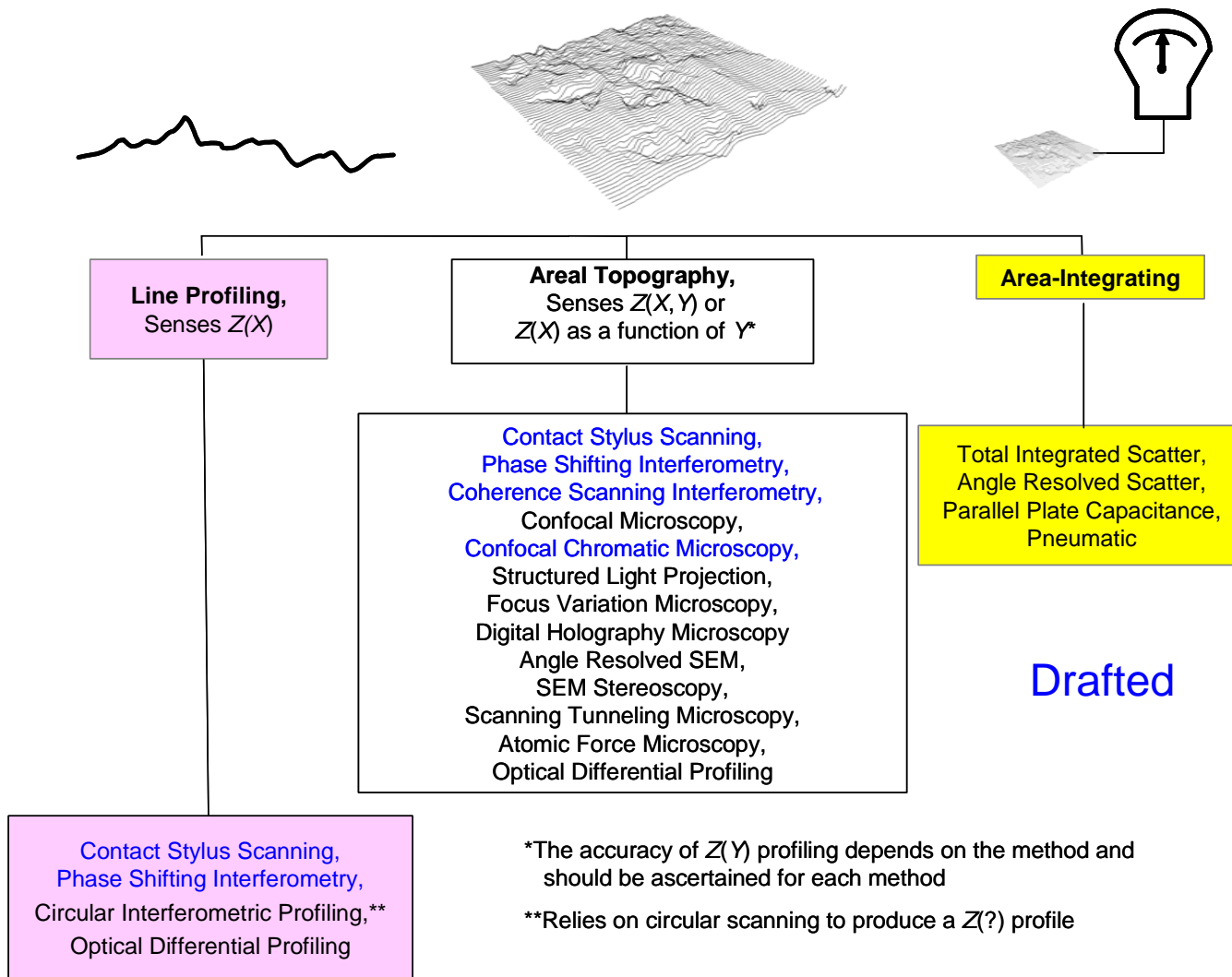
Overview of Current Nanotech Standards Program (2)

- Work underway
 - ISO 25178 – Many Parts
 - Part 2 – Terms & Parameters – in DIS ballot
 - Part 6 – Classification of Methods – passed DIS
 - Parts 601, 602, etc. – Metrological Characteristics of Individual Methods
 - Parts 701, 702, etc. – Standards & procedures for different methods
- Any prioritization efforts underway (e.g., roadmap development)
 - TC 213 Master Plan – ISO 14638
 - WG16 Master Plan – unpublished N-doc
 - Part 6 – Useful for setting the context
- Collaborations (if any)
 - Project Team on Optical Methods has produced
 - Chromatic Confocal – Pt 602,
 - Phase Shifting Interferometry – Pt 603
 - Coherence Scanning Interferometry – Pt 604
- Immediate and medium term plans
 - IS for Parts 2, 6, 602, 603, 604
 - Developing a comparable standard for AFMs
- Challenges and obstacles
 - Describing the useful ranges of instruments
 - Establishing correlations between methods

Documentary Standards Needs/Gaps

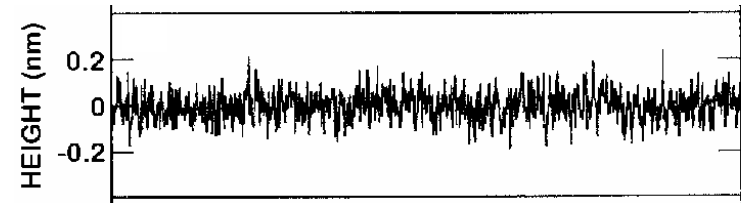
- Prioritization challenges
No - Instrument makers are motivated to participate
- Fundamental knowledge issues
The surface is defined to be the “mechanical” surface
- Measurement and characterization needs
Recognizing the bandwidth limits of measurement
- Supporting reference materials
Calibrations of suppliers’ reference materials
- Pre- and co-normative research needs
Demonstrating agreement between different instruments
- Market need/demand
Calibrating instruments for measuring surface texture of precision mechanical components, optics, and semiconductors
- Technical or policy issues
Information requirements, automation, file formats, and interoperability
Publishing and copyright
- Other
The Master plan provides a good context for standardization of different methods.

Classification of Methods for Measuring Surface Texture, ISO/DIS 25178, Part 6



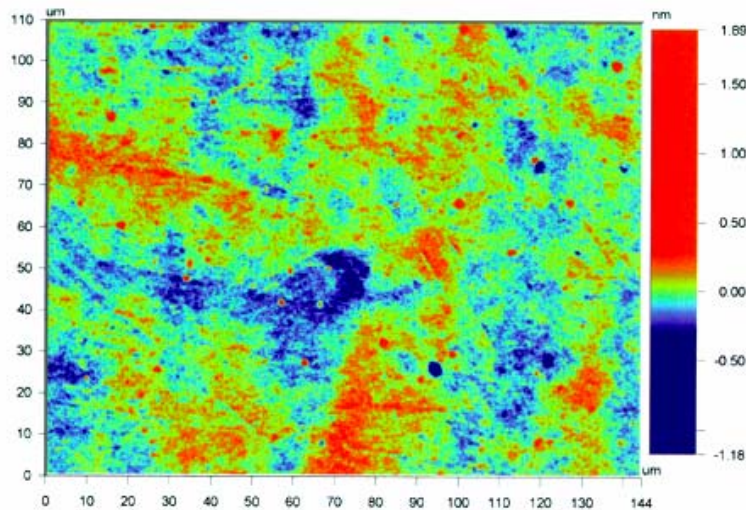
High Resolution Surface Texture Instruments

Stylus data, rms (R_q) = 0.06 nm



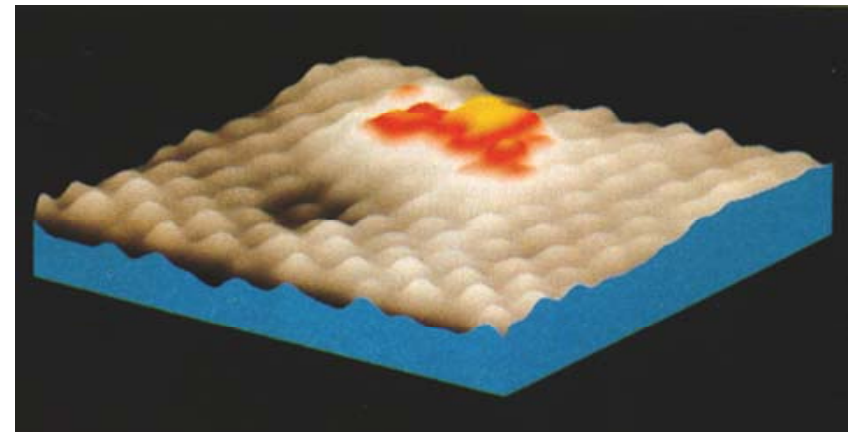
J.M. Bennett et al., *Applied Optics* **34**, 209 (1995).

Phase shifting interferometry,
rms (S_q) = 0.12 nm



T. Vorburger et al. *OE Magazine*,
March, 2002.

AFM, molecule of sorbic acid on a graphite surface,
image size is 2.5 nm \times 2.5 nm.



From D. Rugar et al. *Physics Today*, Oct. 1990 (Image taken by
T.R. Albrecht et al.)



DRAFT INTERNATIONAL STANDARD ISO/DIS 25178-6

ISO/TC 213

Secretariat: DS

Voting begins on:
2007-08-18

Voting terminates on:
2008-01-18

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION - МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ - ORGANISATION INTERNATIONALE DE NORMALISATION

**Geometrical product specifications (GPS) — Surface texture:
Areal —**

**Part 6:
Classification of methods for measuring surface texture**

Spécification géométrique des produits (GPS) — État de surface: surfacique —

Partie 6: Classification des méthodes de mesurage de l'état de surface

3.3.14

atomic force microscopy (AFM), scanning force microscopy (SFM)

surface topography measurement method whereby the surface height is sensed from the mechanical force of attraction or repulsion between a probe tip and a surface

NOTE STM, AFM, and SFM are three methods that may be classified as scanned probe microscopies (SPM), which also encompasses near field scanning optical microscopy (NSOM), scanning capacitance microscopy (SCM) and others. The development of certain standards related to these techniques falls under the scope of ISO/TC 201/SC 9 on *Scanning Probe Microscopy*.

ISO/DIS 25178-2 Geometrical product specifications – Surface Texture: Areal – Part 2: Terms, definitions and surface texture parameters

Field Parameters

4.1.1

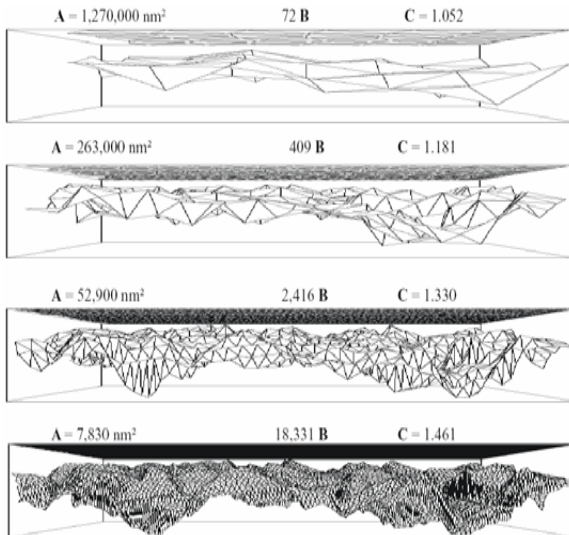
root mean square height of the scale limited surface

Sq

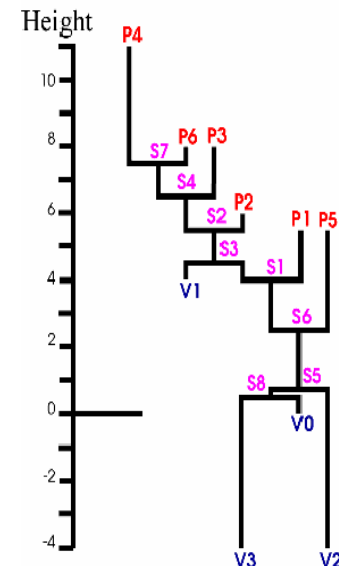
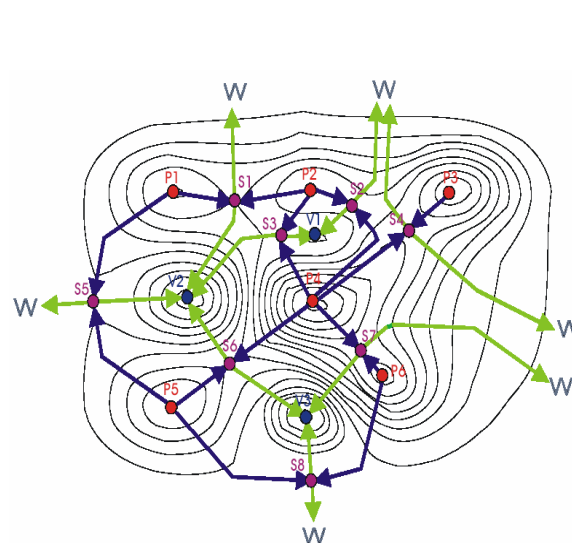
root mean square value of the ordinate values within a definition area

$$Sq = \sqrt{\frac{1}{A} \iint_A z^2(x, y) dx dy}$$

Fractal Parameters



Feature Characterization (Wolf Pruning)



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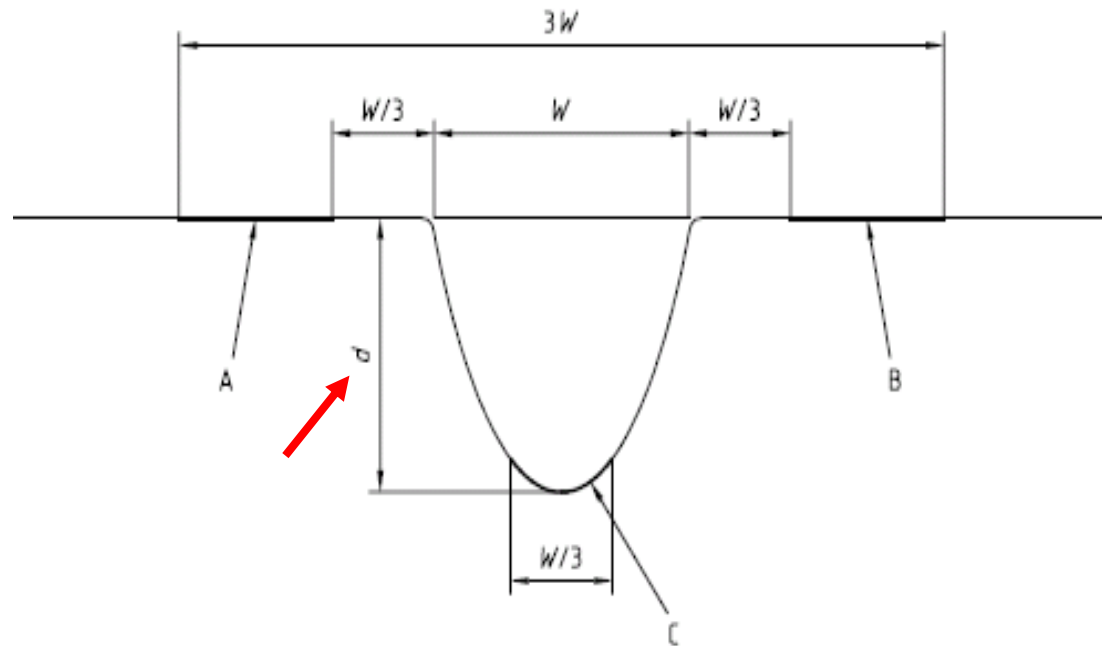
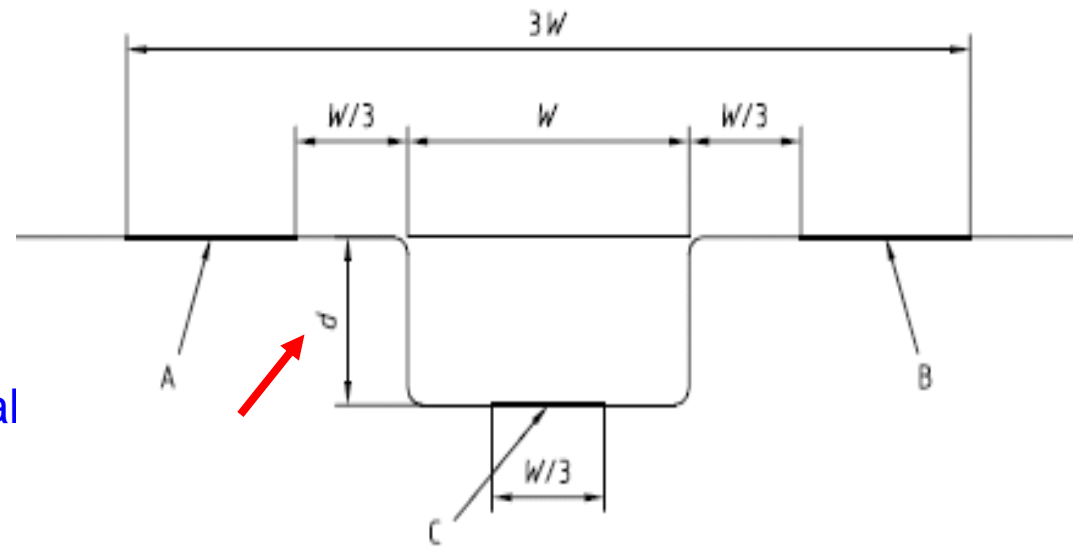
Secretariat: Denmark

ISO TC 213 has Working Groups but no Subcommittees.

A Working Group is to be disbanded when its task has been carried out.

ISO 5436-2000: Geometrical Product Specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 1: Material measures

Describes different types of physical standards and algorithms for evaluating calibrated parameters



ISO/TC 213/WG 15 - GPS extraction and filtration techniques

A Filter is a way of separating features of interest from other features in data.

Examples of Filters – Gaussian, Gaussian Regression, spline
Issues - end effects

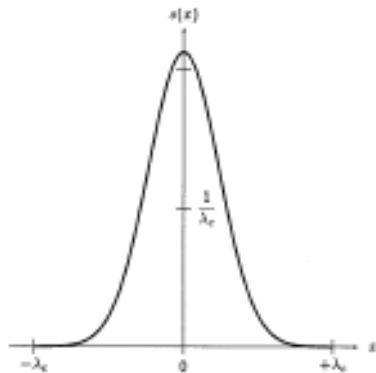


Figure 1 — Weighting function of a Gaussian profile filter on an open profile

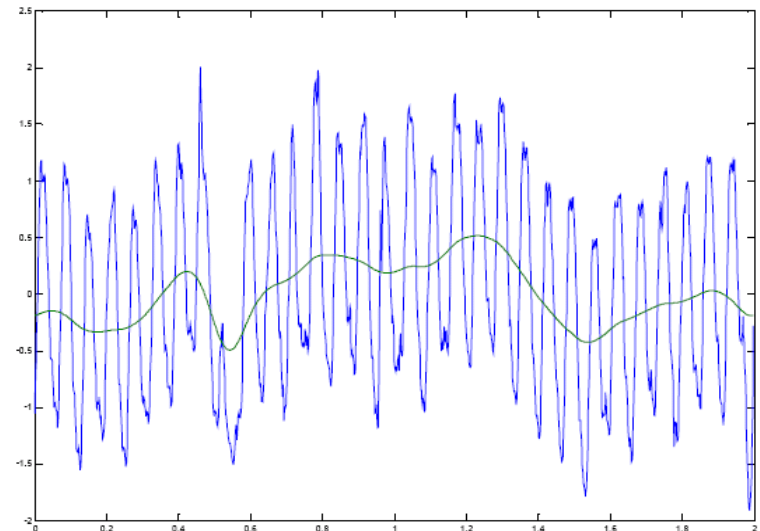


Figure B.1 — An open Gaussian filter with $\lambda_c = 0.8mm$

ISO/TC 213/WG 4 - Uncertainty

Task: Standardization of the estimation and indication of uncertainty of measurement in GPS-measurement of workpieces and ...of how the uncertainty of GPS-measurement is taken into account when proving conformance and non conformance with specifications.

ISO 14253-1 ...Decision rules for proving conformance or nonconformance with specifications

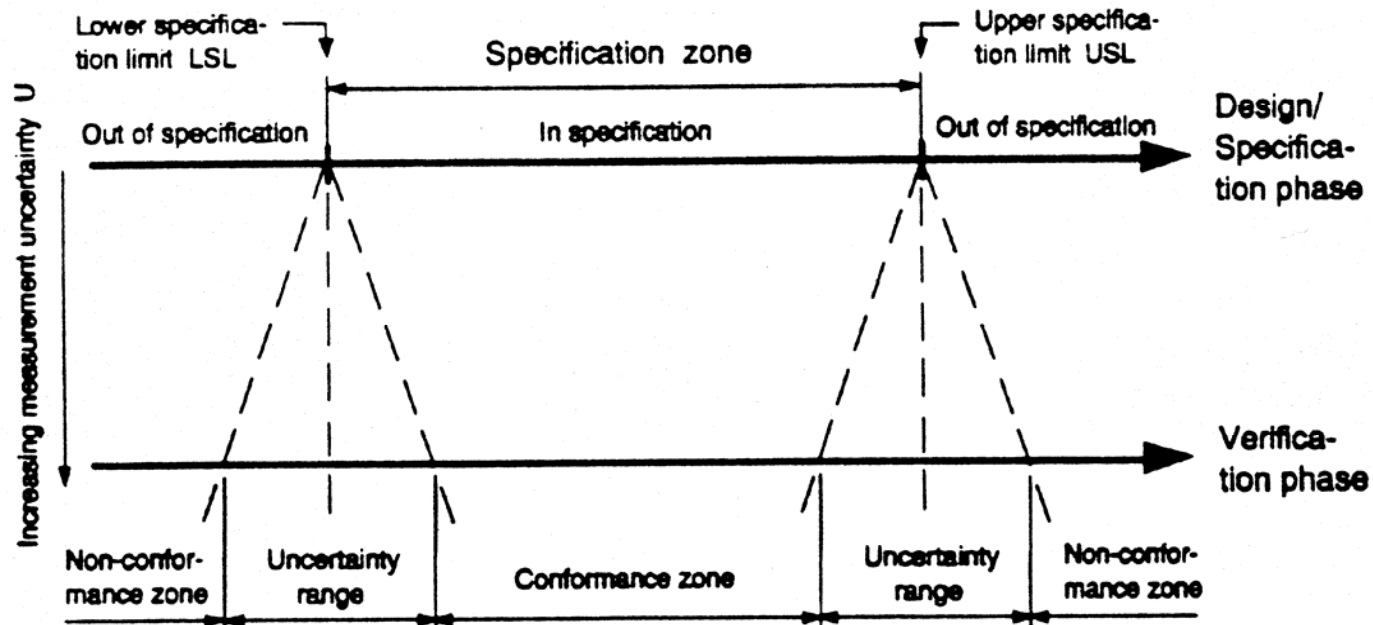


Figure 5 - Uncertainty of measurement - the uncertainty range reduces the conformance and non-conformance zones



Designation: E 2530 – 06

Developed by ASTM SC E42.14, STM/AFM

Standard Practice for Calibrating the Z-Magnification of an Atomic Force Microscope at Subnanometer Displacement Levels Using Si (111) Monatomic Steps¹

Sampling Procedure

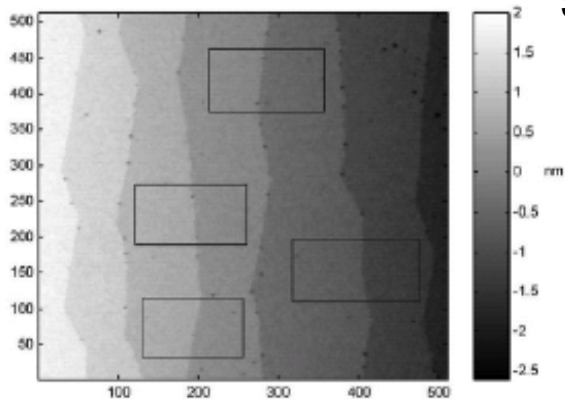


FIG. 2 Illustration of Selected Areas

Physical Standard

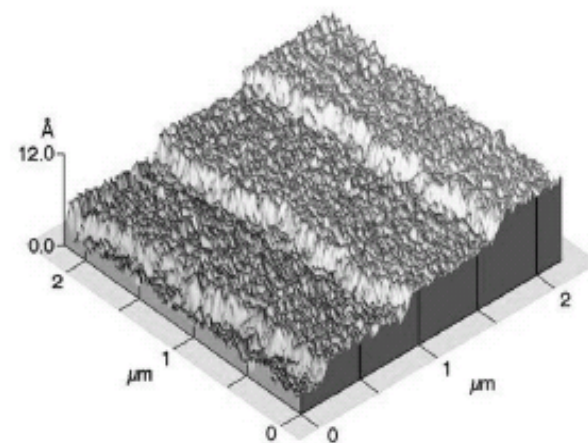


FIG. 1 Image of a Silicon Monatomic Stepped Surface

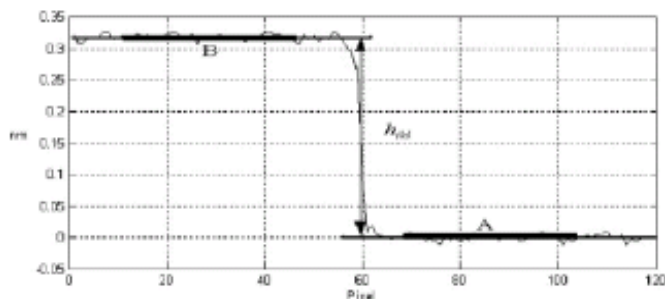


FIG. 3 Illustration of the Step-Height Algorithm Used

Step height algorithm



A N A M E R I C A N N A T I O N A L S T A N D A R D

SURFACE TEXTURE (SURFACE ROUGHNESS, WAVINESS, AND LAY)

Terms Related to Surface Texture
Classification of Instruments for Surface Texture Measurement
Terminology and Measurement Procedures for Profiling, Contact, Skidless
Instruments
Measurement Procedures for Contact, Skidded Instruments
Measurement Techniques for Area Profiling
Measurement Techniques for Area Averaging
Filtering of Surface Profiles
Specifications and Procedures for Precision Reference Specimens
Specifications and Procedures for Roughness Comparison Specimens

ASME B46.1-1995
(Revision of ANSI/ASME B46.1-1985)

The 2002 edition contains sections on

- nanometer-level surface texture measurement with stylus
- Nanometer-level surface texture measurement with phase shifting interferometry

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