Optical & Surface Metrology Applied to the Study of Photographic Surfaces

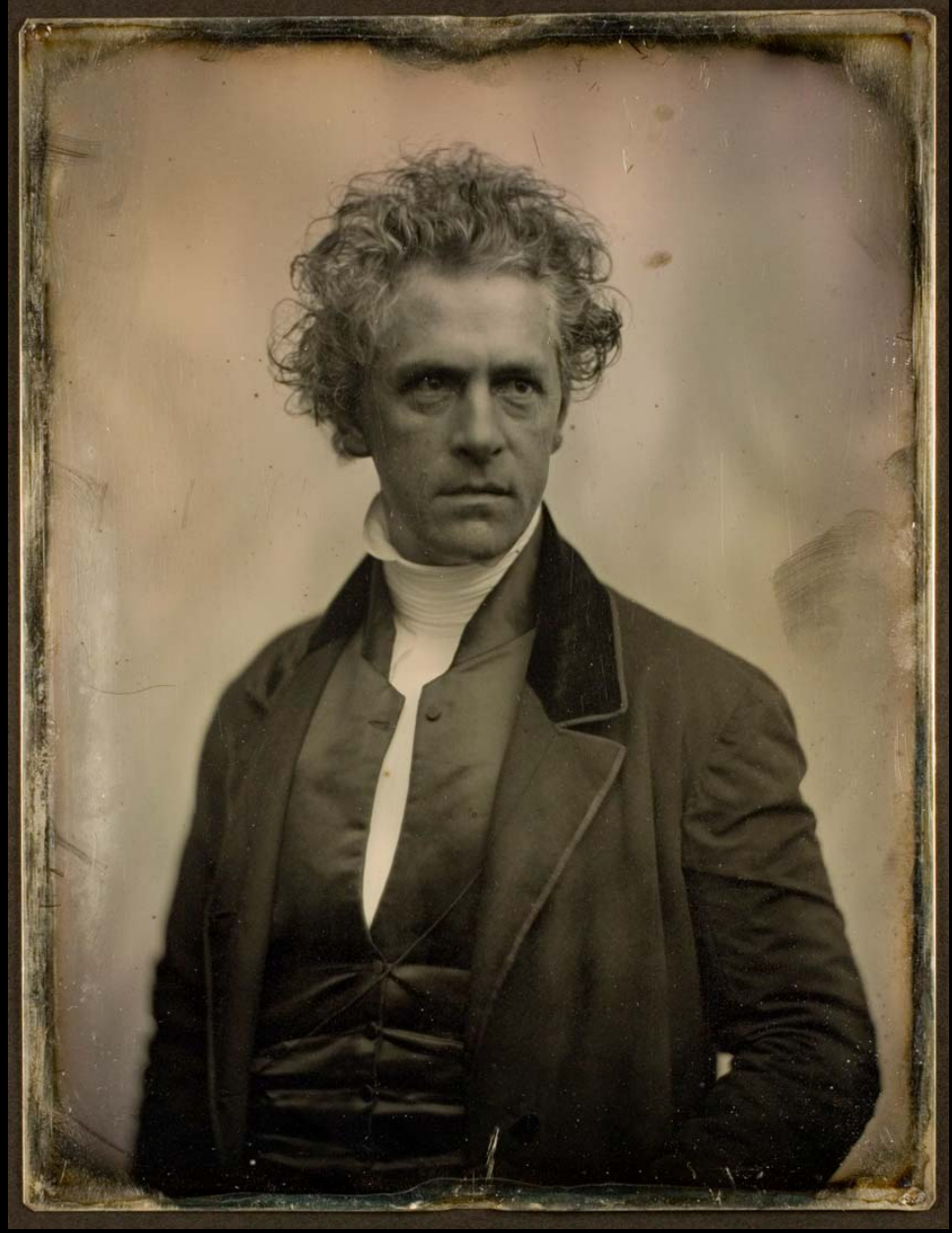
Patrick Ravines

GEORGE EASTMAN HOUSE

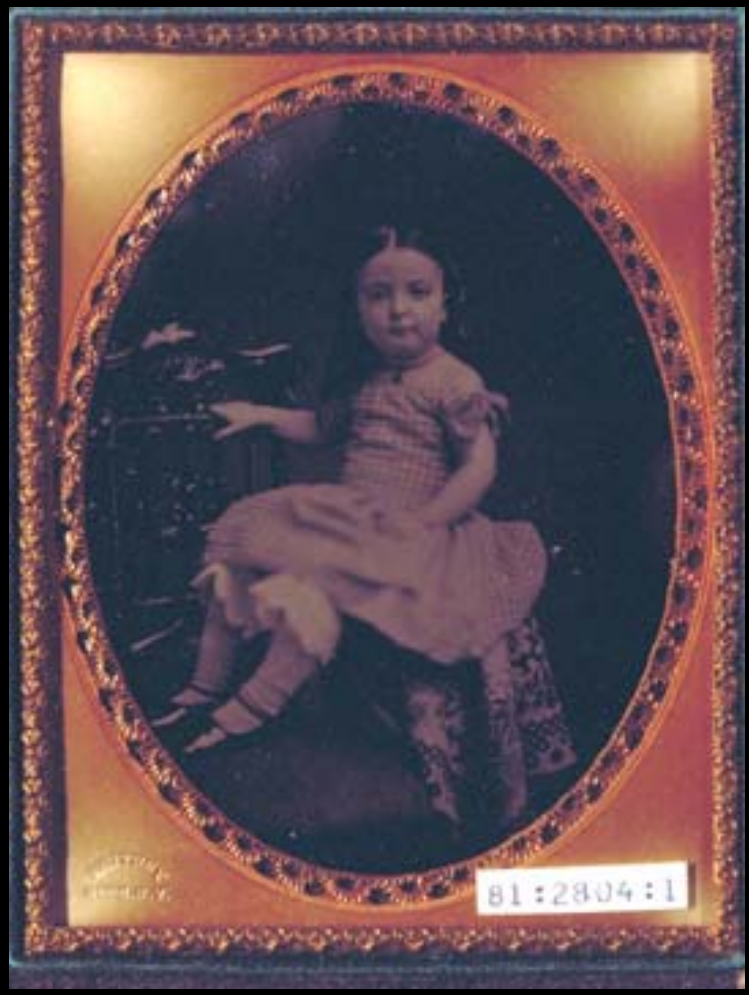
Photographs

- Various manifestations
- Surfaces & their importance
- Confocal principle
- Examples:
  - daguerreotypes
  - silver gelatin

Jean Baptiste Sabatier-Blot
Louis-Jacques-Mandé Daguerre (1844)
Daguerreotype (Sixth plate, 6.9 x 9.1 cm)

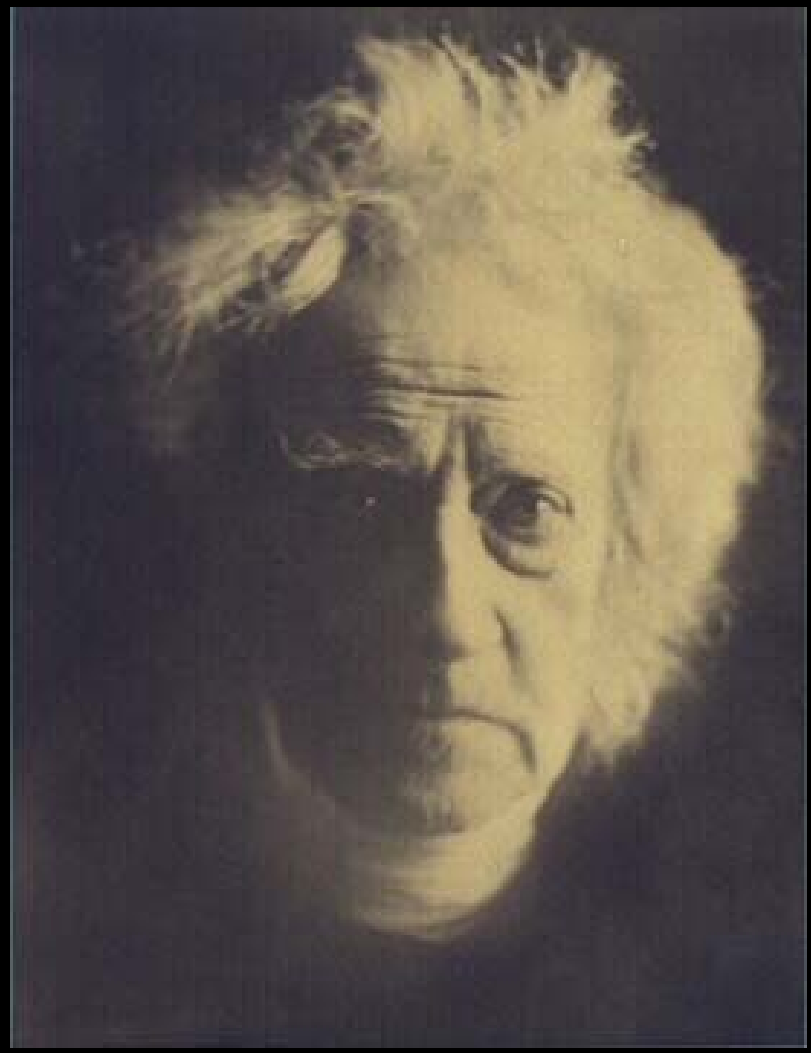


Southworth & Hawes
[Reverend Rollin Heber Neal] (1850-5)
Daguerreotype (Whole plate - 16.5 x 21.5 cm)

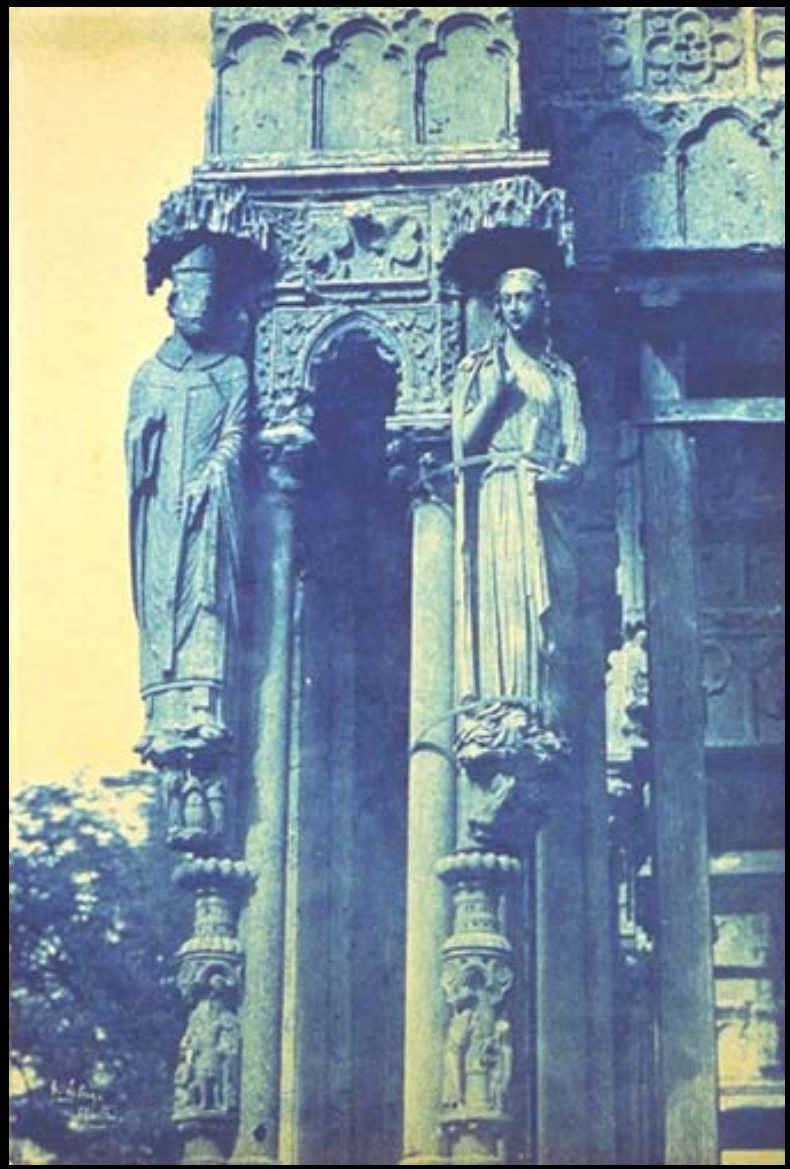


E.T. Whitney
Unidentified girl seated on top of a table, next to a chair (ca. 1855)
Ambrotype (quarter plate, 8.2 x 10.7 cm)

Gustave Le Gray
Seascape (ca. 1855)
Albumen print (30.0 x 37.8 cm)



Julia Margaret Cameron
Alvin Langdon Coburn (later photographer/printer)
Sir John Herschel (1867)
(Print by A.L. Coburn, ca. 1915, from copy negative of original print)
Pt print, tinted stock, mechanically varnished (25.7 x 19.4 cm)



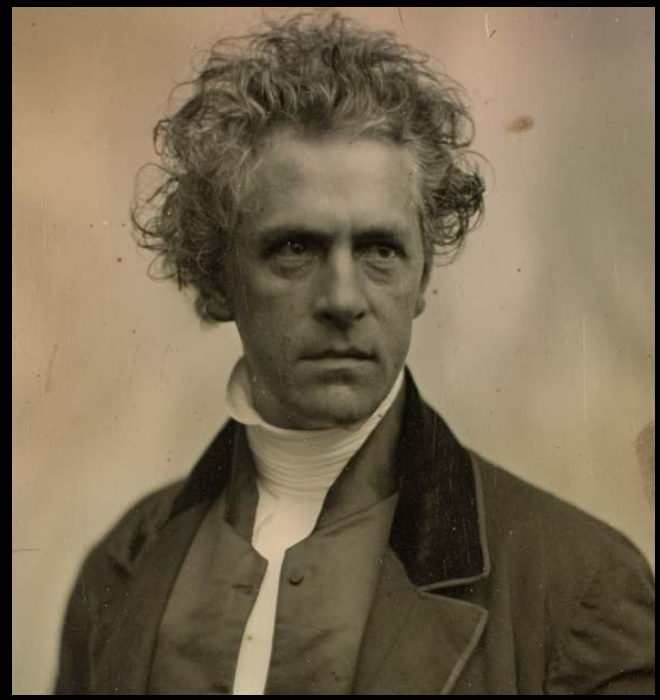
Henri Le Secq
Chartres, portal with wooden supports (ca. 1851)
Cyanotype (32.2 x 21.5 cm)

Ansel Adams
Moonrise, Hernandez, New Mexico (1941)
Ag gelatin print (50.0 x 68.0 cm)

Manuel Alvarez-Bravo
Umbral (Threshold) 1947 (print 1977)
Ag gelatin print (24.2 x 19.4 cm)

Looking & seeing
Perception -> Appearance

1. Illumination
2. Optical Properties (reflection, refraction, etc)
3. Surface geometry



Looking & seeing
Perception -> Appearance

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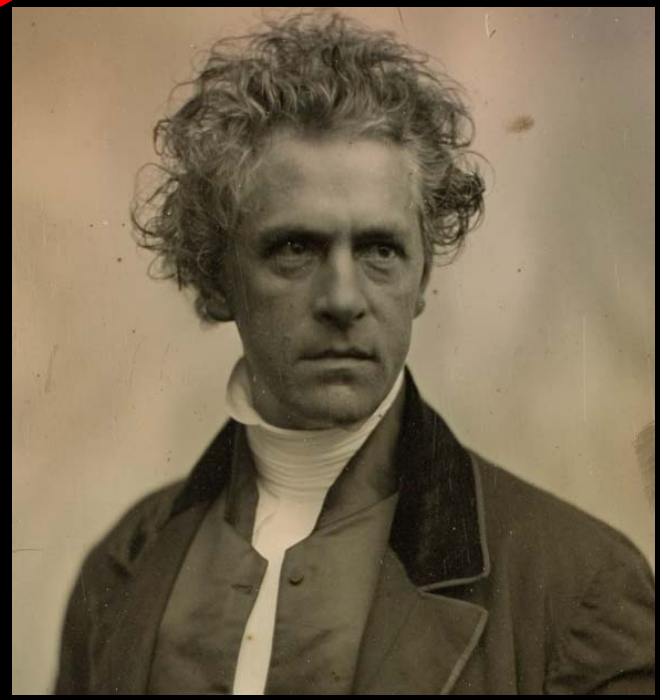
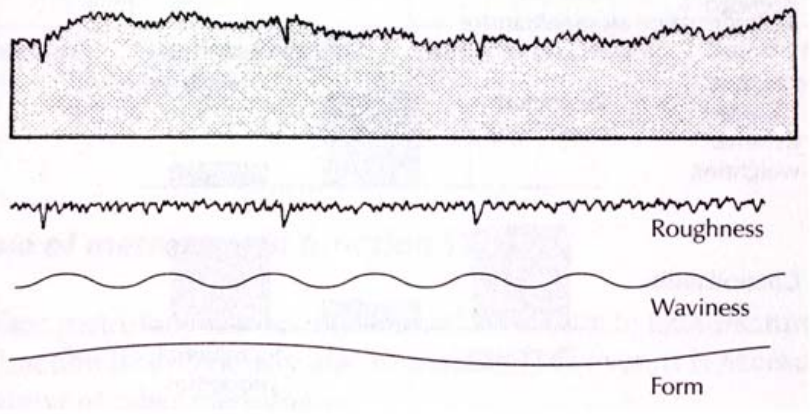
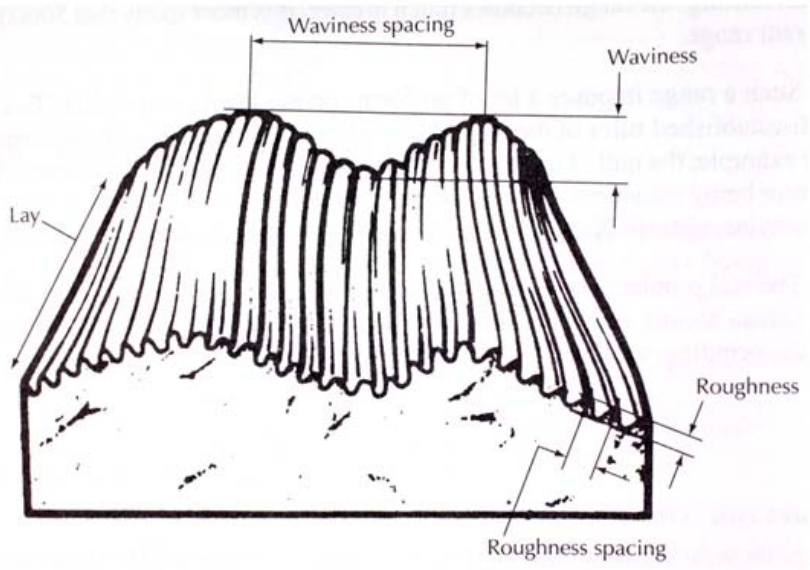


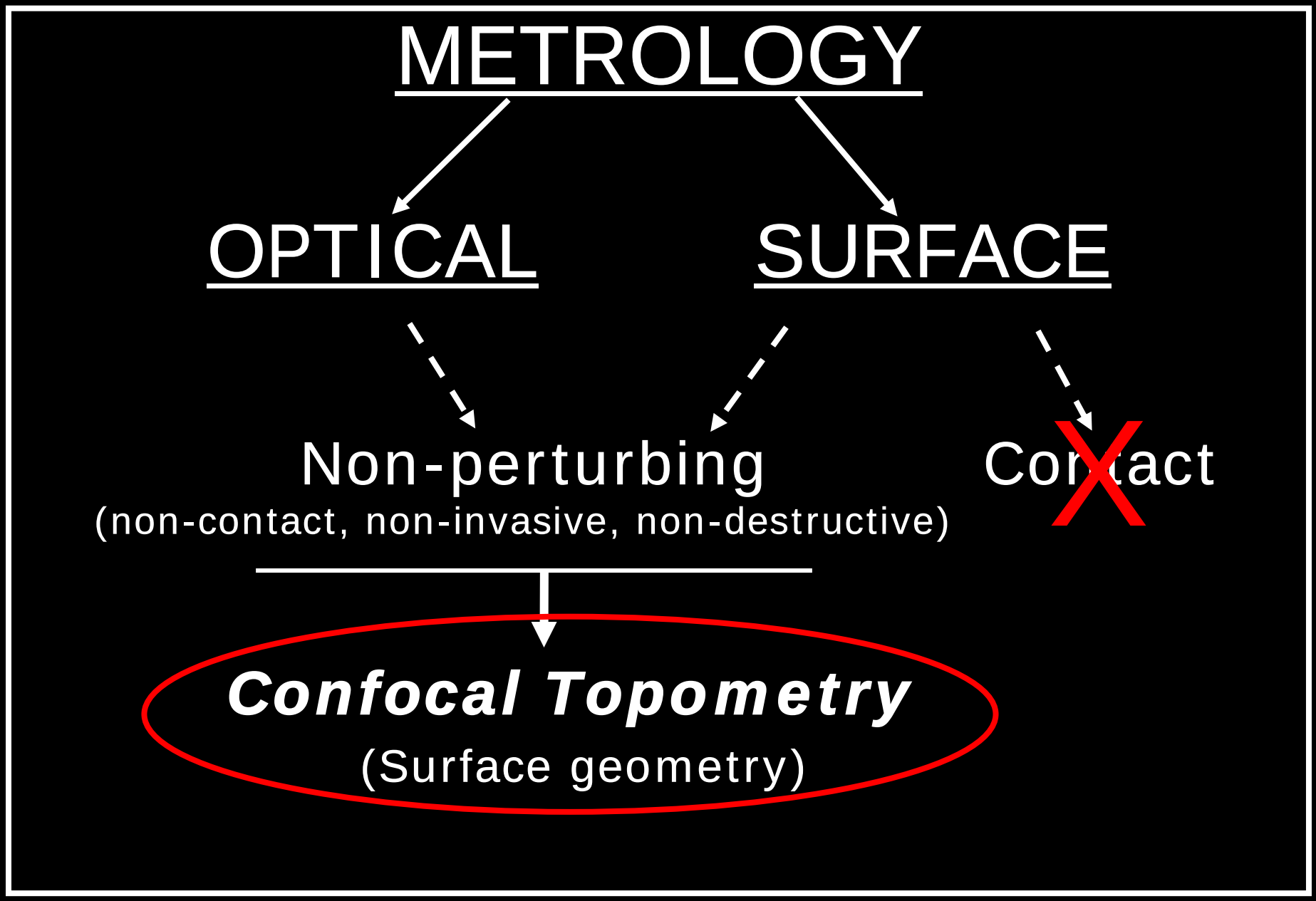
SURFACE GEOMETRY/TOPOGRAPHY: **Roughness, Waviness & Form as surface parameters** **(Whitehouse 2002)**



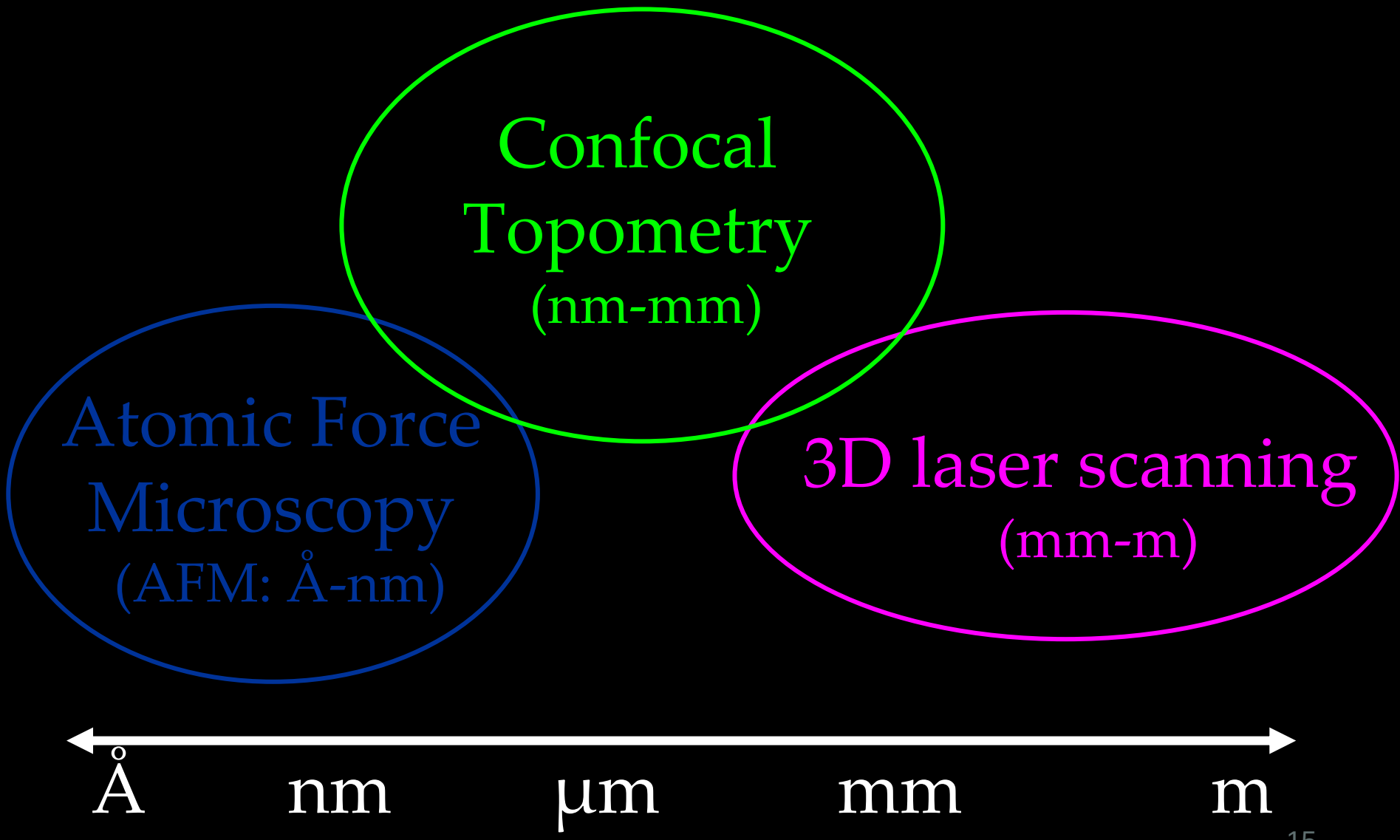
a. Typical surface parameters: roughness, waviness and form.



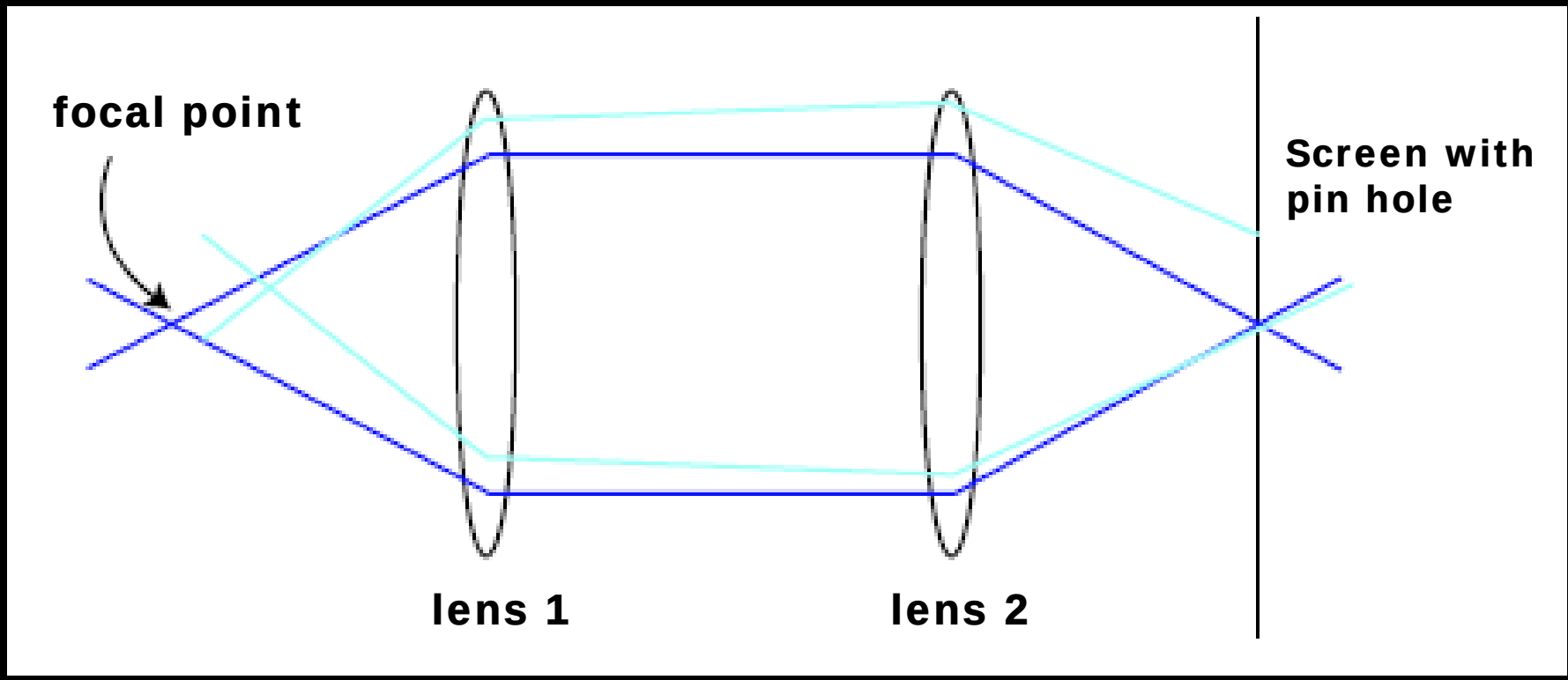
b. Surface texture constituents: roughness and waviness.


METROLOGY
OPTICAL
SURFACE
Non-perturbing
(non-contact, non-invasive, non-destructive)
Contact
Confocal Topometry
(Surface geometry)

MEASURING SURFACE GEOMETRIES



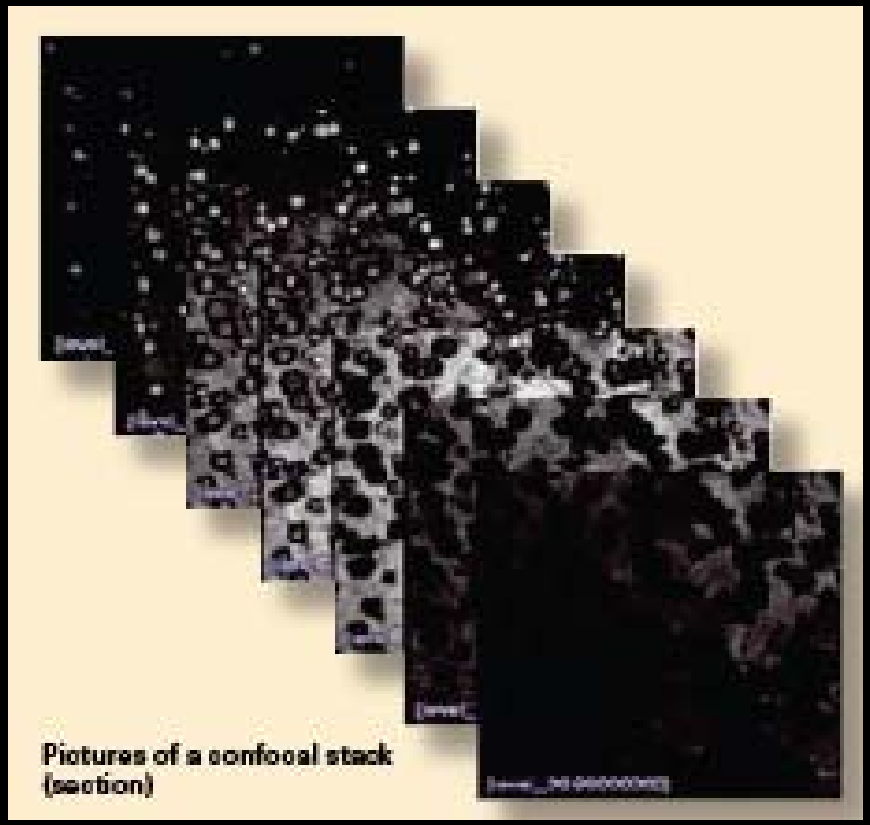
Confocal Principle: Marvin Minsky 1955

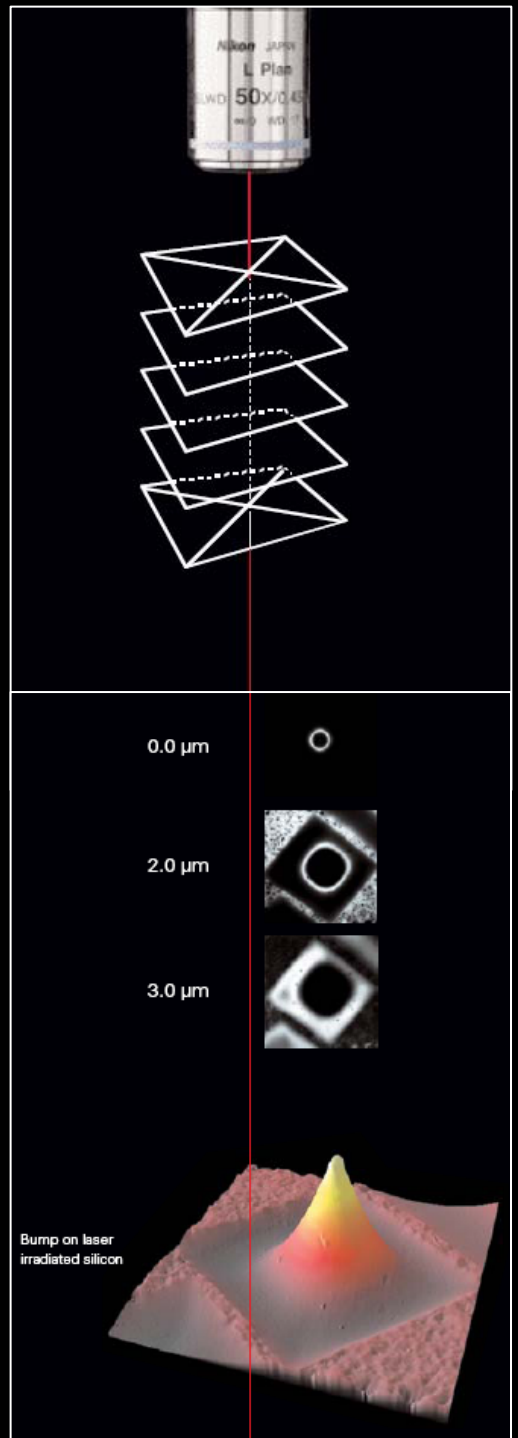


- Focal point of the objective lens (1) forms an image where the pinhole screen is, those two points are known as “conjugate focal points”, hence ‘‘confocal’’.
- Unfocused light/background haze is blocked out by pin hole screen.

Minsky, M. 1988. *Memoir on Inventing the Confocal Scanning Microscope*, Scanning, V10 pp128-138.

Confocal Topometry





NanoFocus, AG

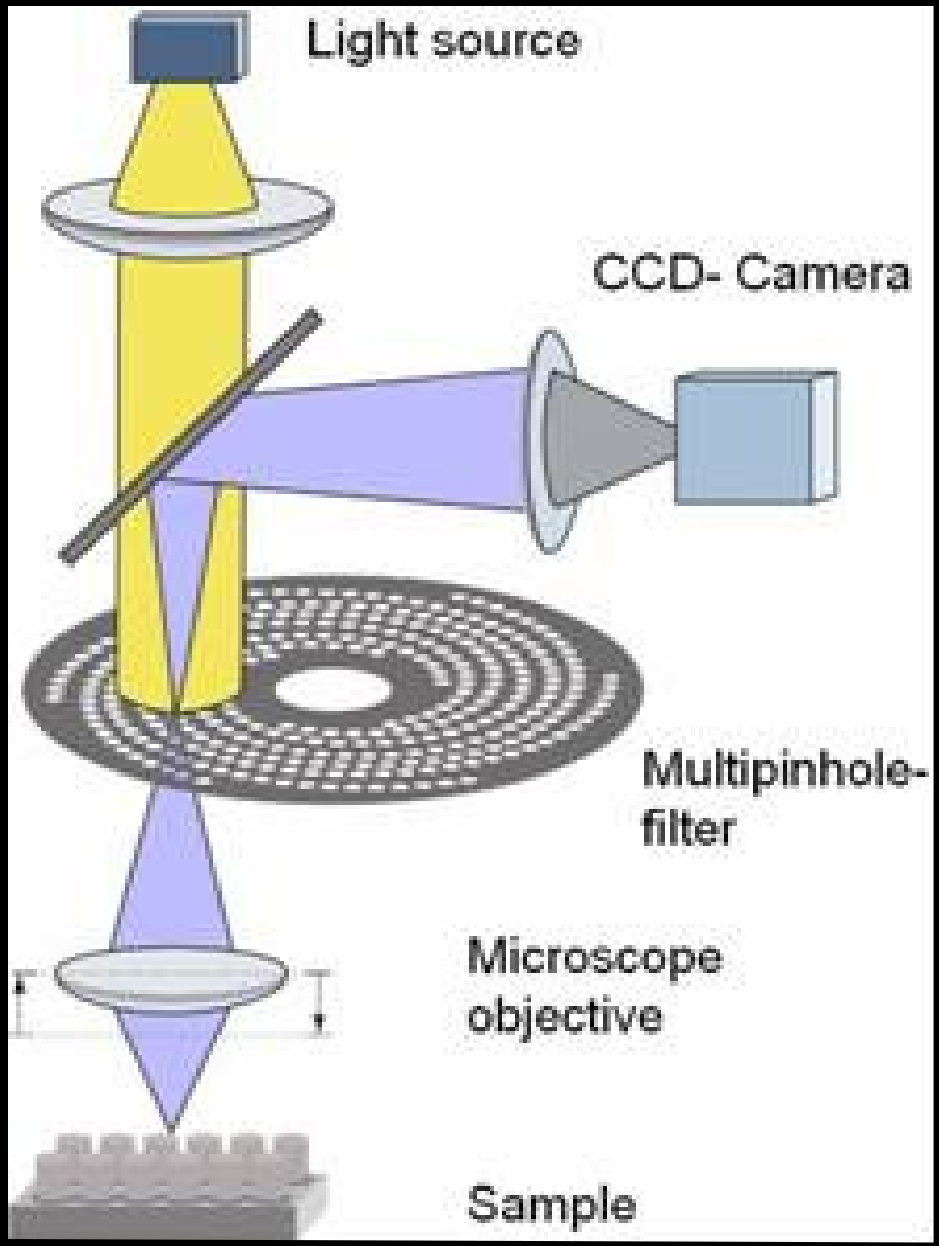
Oberhausen, Germany

µSurf

Confocal Topometer

10x, 20x, 60x objectives

μSurf
Confocal Topometer



NanoFocus µSurf

Confocal Topometer

Optic Modules

	1600 S	800 L, S, XS	320 L, S, XS	260 XS
Magnification (Objective power)	10x	20x	50x	60x
Measuring field (µm)	1600x1600	800x800	320x320	260x260
Numerical aperture	0.3	0.4 / 0.45 / 0.6	0.5 / 0.8 / 0.95	0.9
Working distance (mm)	11.0	12.1 / 3.1 / 0.9	10.6 / 1.0 / 0.3	0.4
Resolution in z-direction (nm)	20	6 / 5 / 4	4 / 2 / 2	2
Resolution in x,y-direction (µm)	3.1	1.6	0.7	0.5.

Daguerreotypes

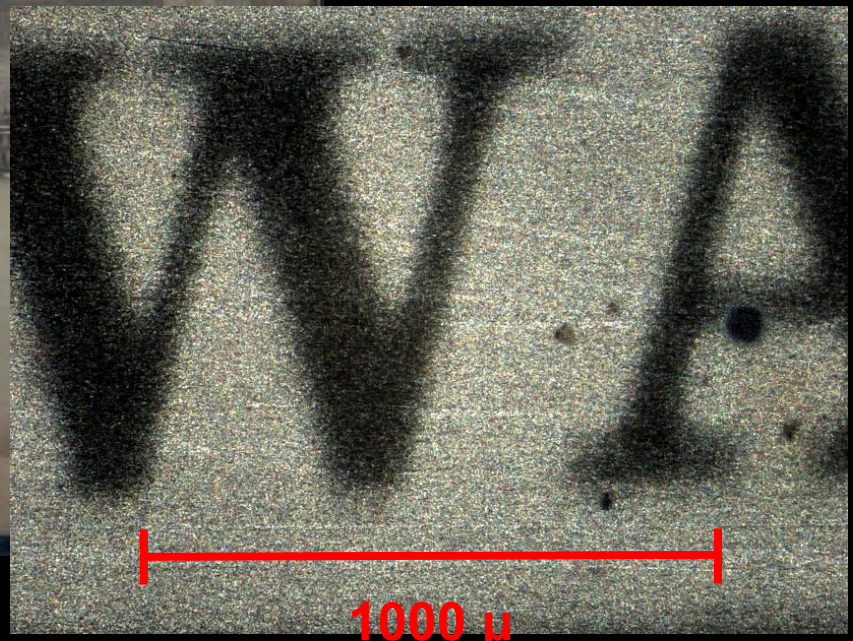
Southworth & Hawes
[Unidentified Child] (ca. 1850)
Whole plate (16.5 x 21.6 cm)

Cincinnati Waterfront 8 Plate Panorama Daguerreotype

Fontayne & Porter (1848)

Public Library of Cincinnati and Hamilton County

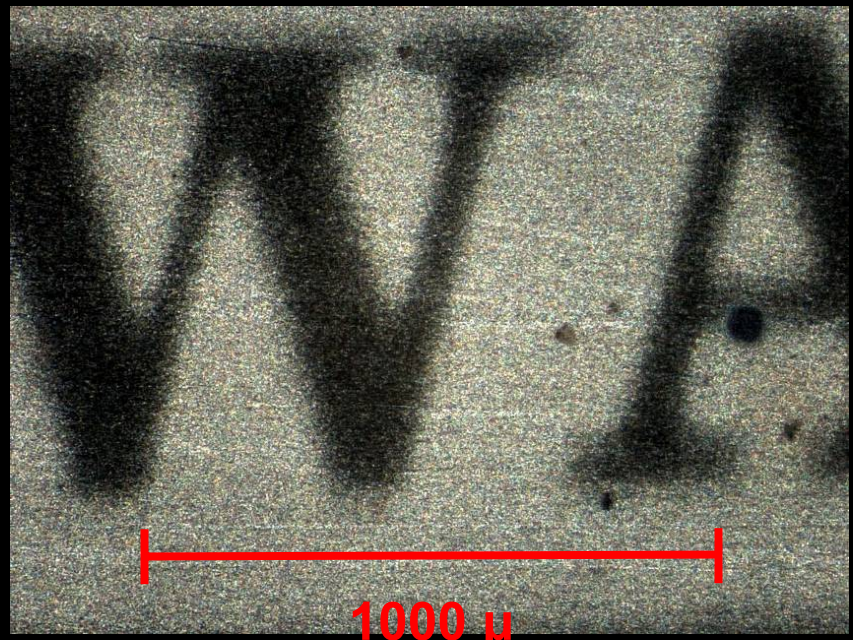
Whole Plate
16.5 cm x 21.6 cm
(6.5 in x 8.5 in)

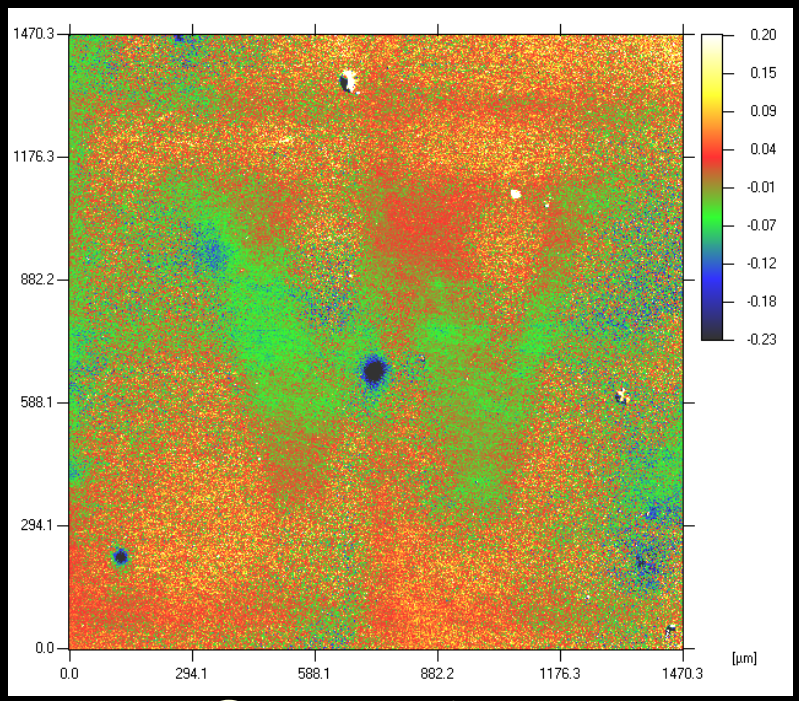


Cincinnati Waterfront 8 Plate Panorama Daguerreotype, Fontayne & Porter (1848) Public Library of Cincinnati and Hamilton County

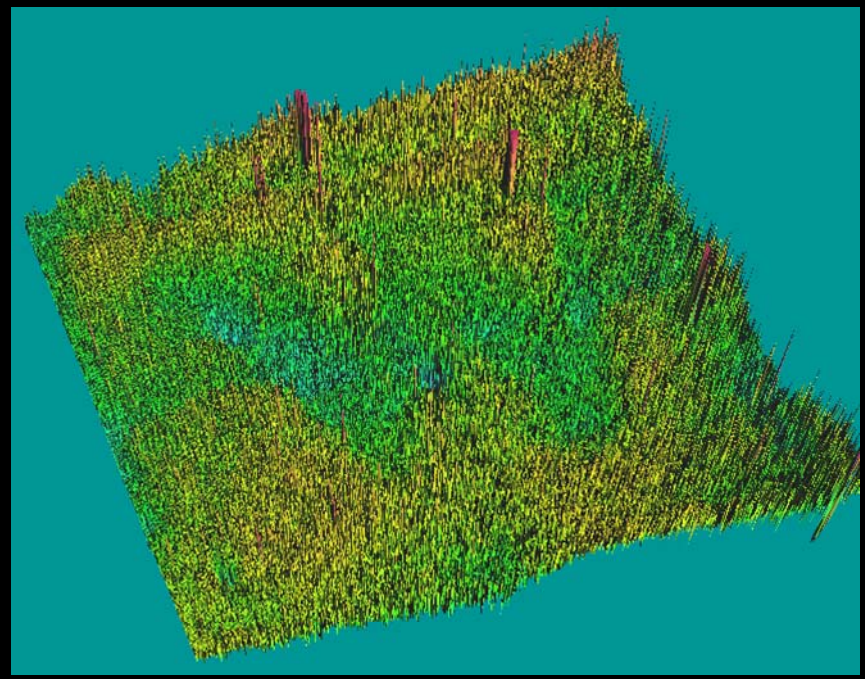
Detail from river boat:

Image = Surface





Contour view



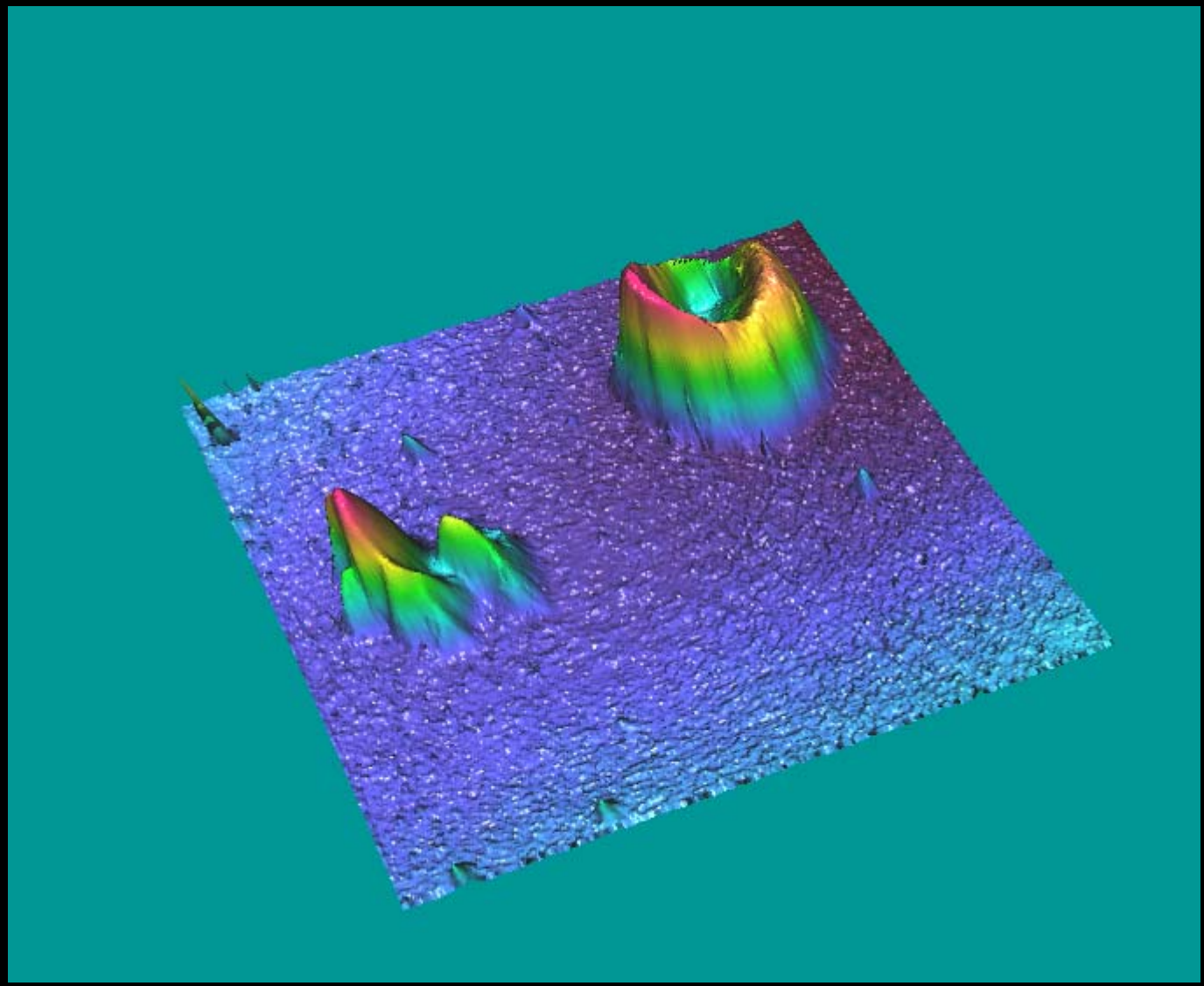
Isometric view

BLISTERS

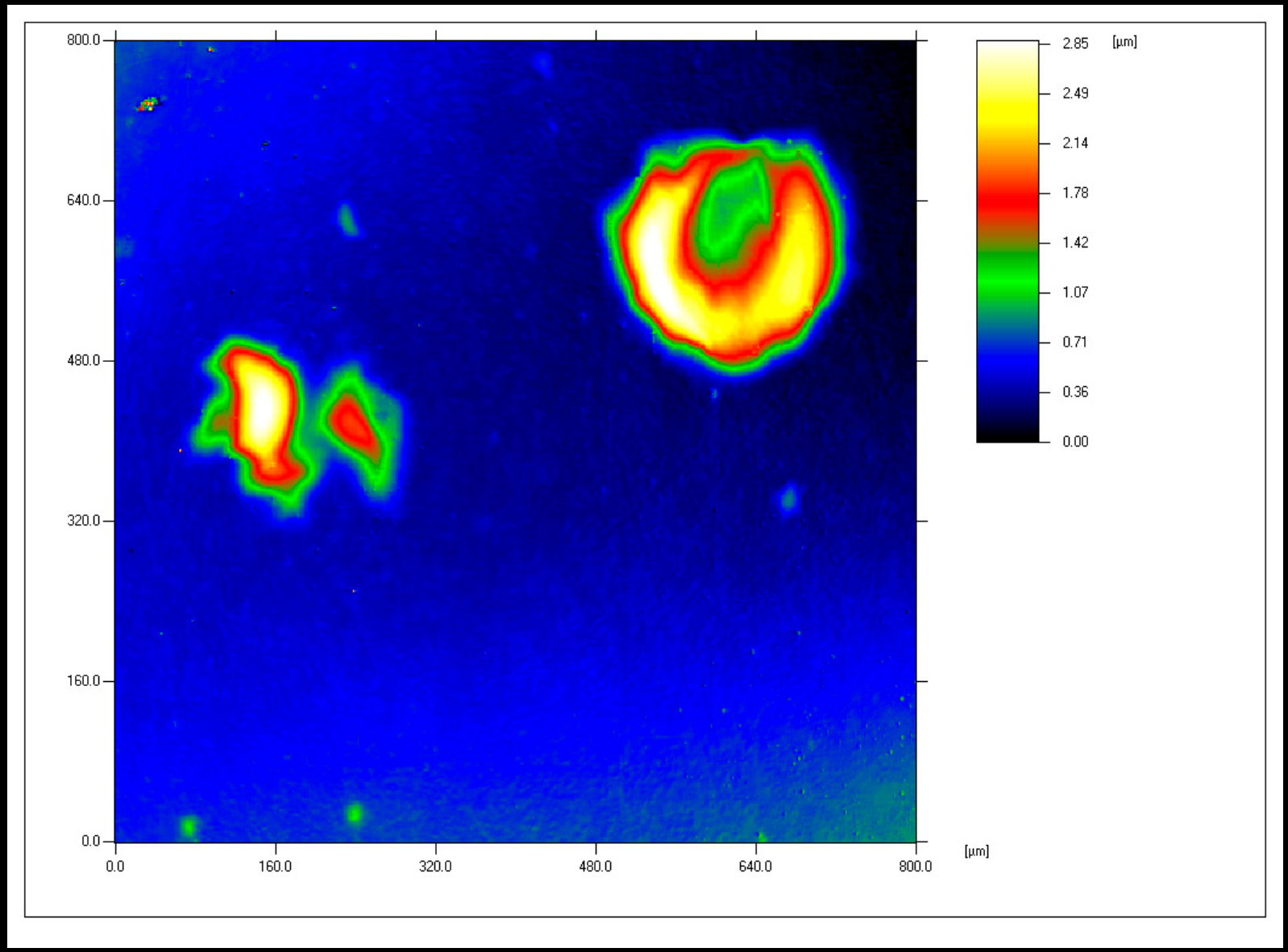
Photo: R. Wiegandt

Stereomicroscope
raking light

Southworth & Hawes
[Unidentified Man] ca 1848-50
Whole plate
16.5 x 21.6 cm

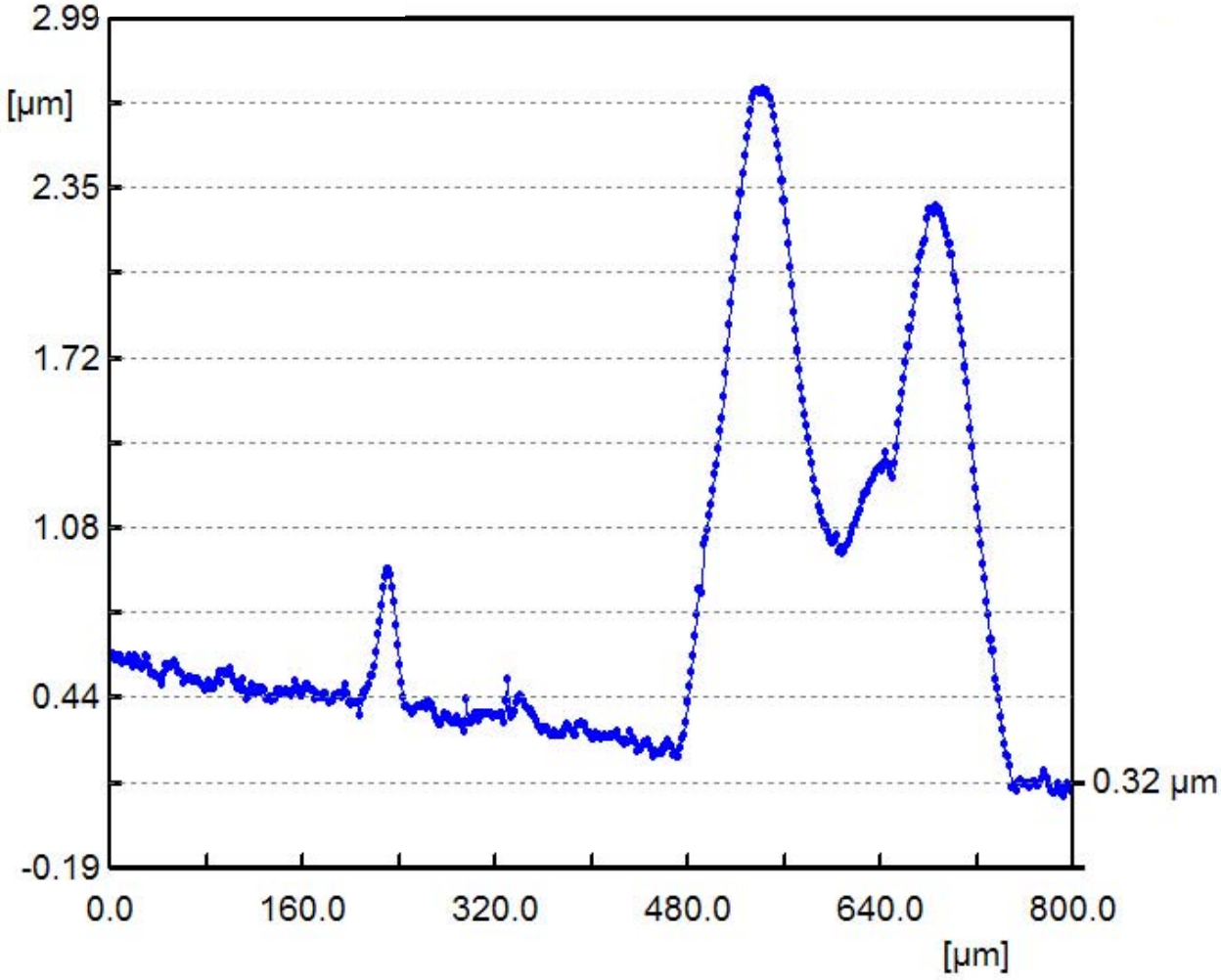


Isometric view

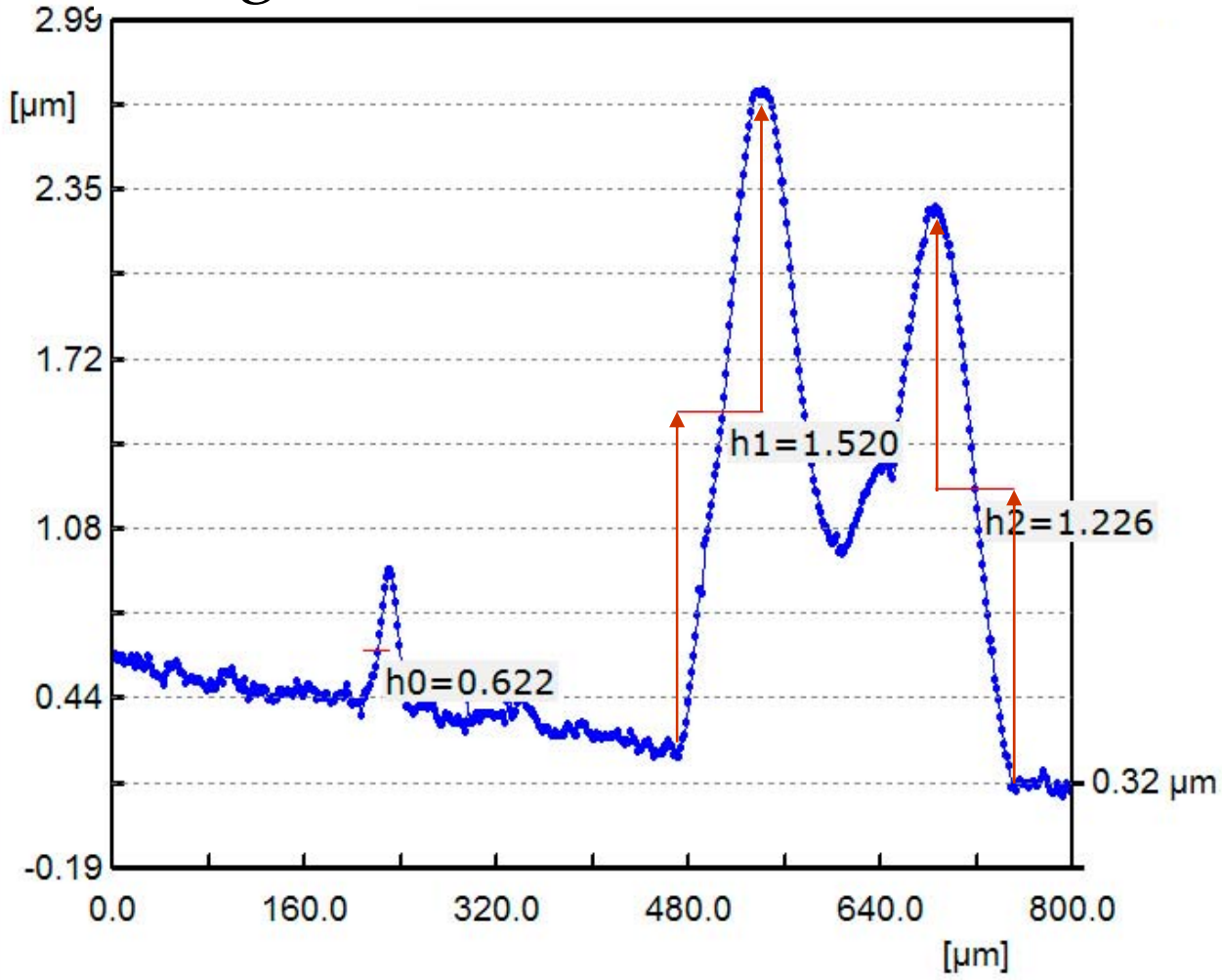


Contour view

Profile



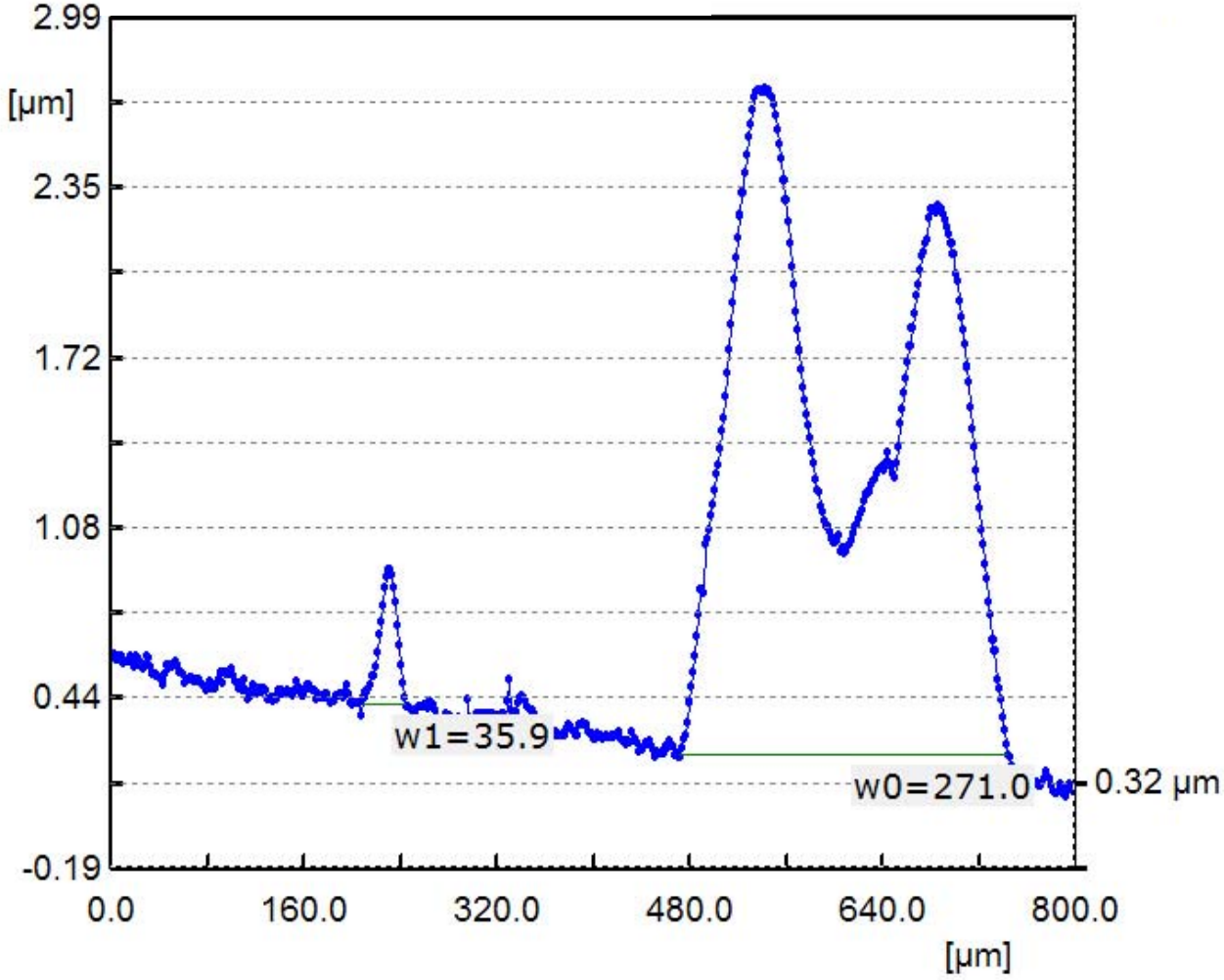
Height

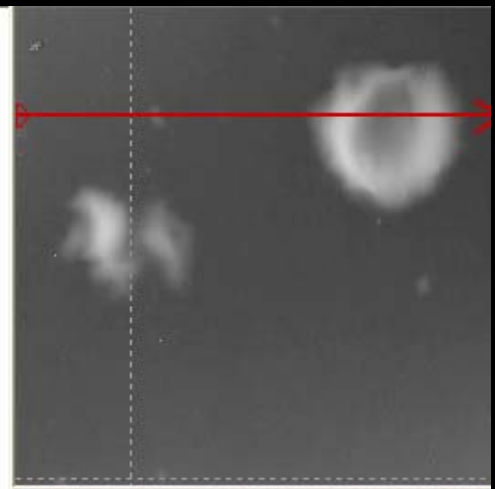


Profile values

Height h0 = 0.622µm
Height h1 = 1.520µm
Height h2 = 1.226µm

Width/diameter





Profile values

Width w0 = 271.0 µm
Width w1 = 35.9 µm

EXFOLIATION

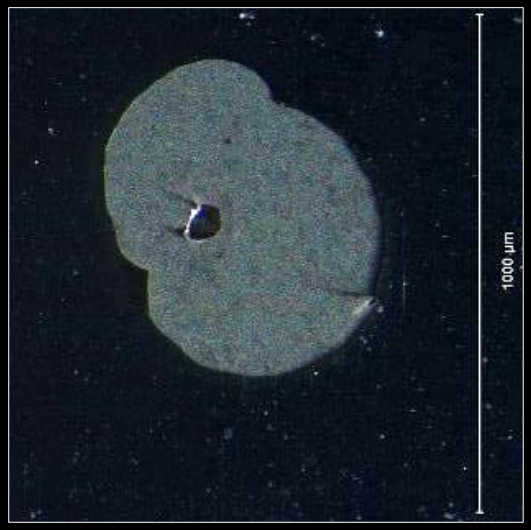
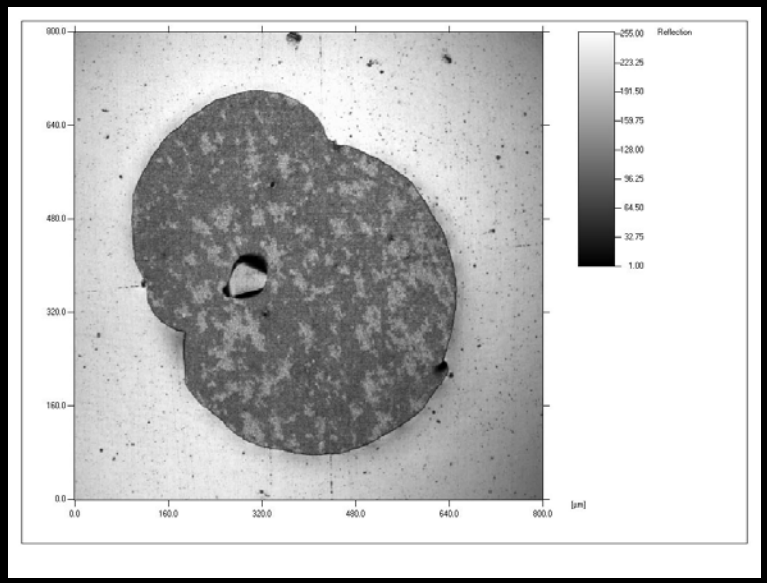
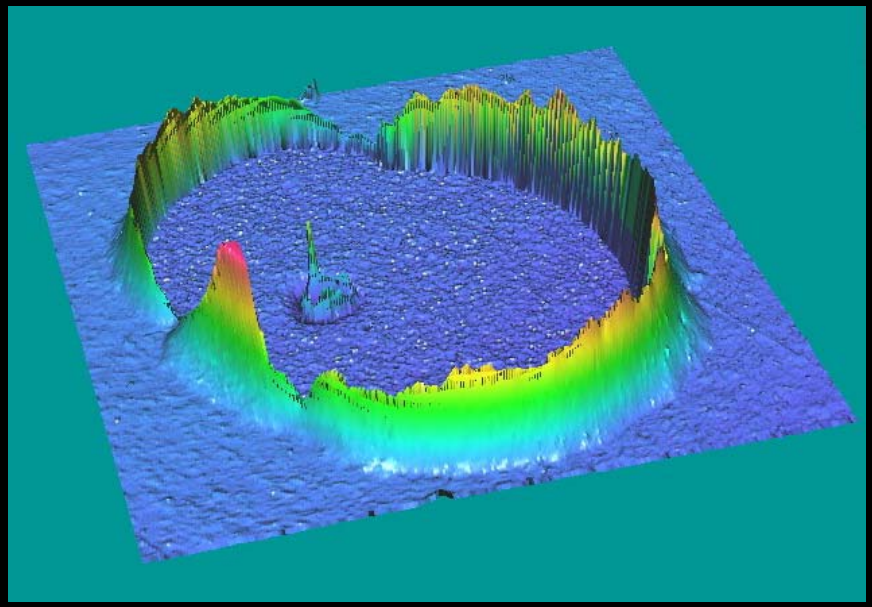


Photo: T. Meller

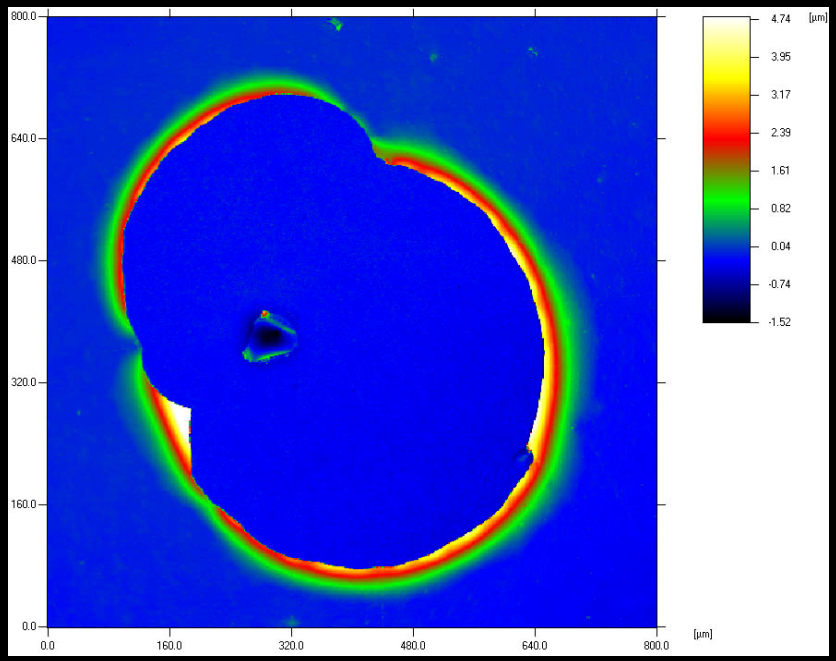
Stereomicroscope & raking light



Reflection/Bright Field 20x obj.

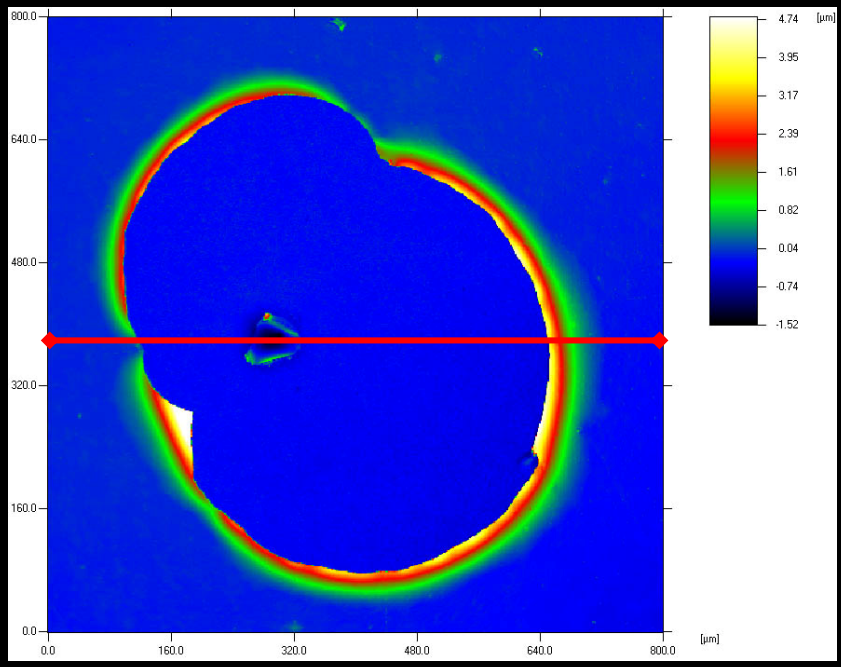


Isometric view

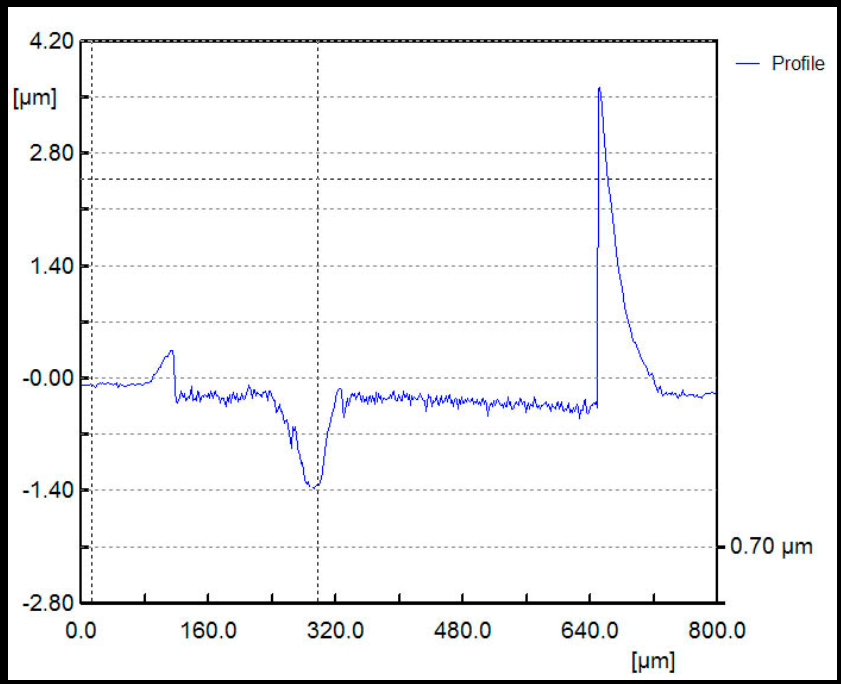


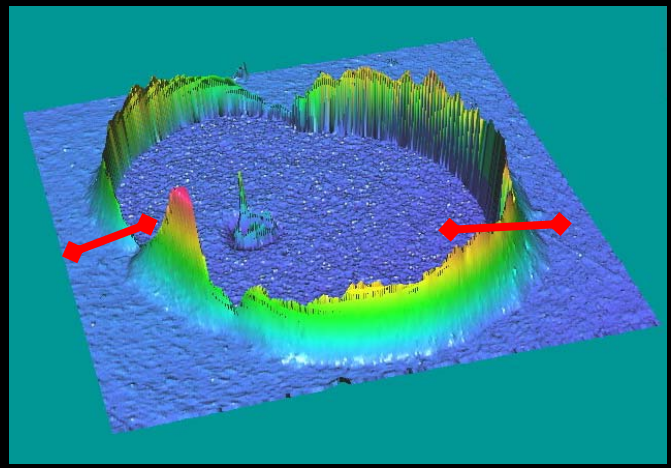
Contour view

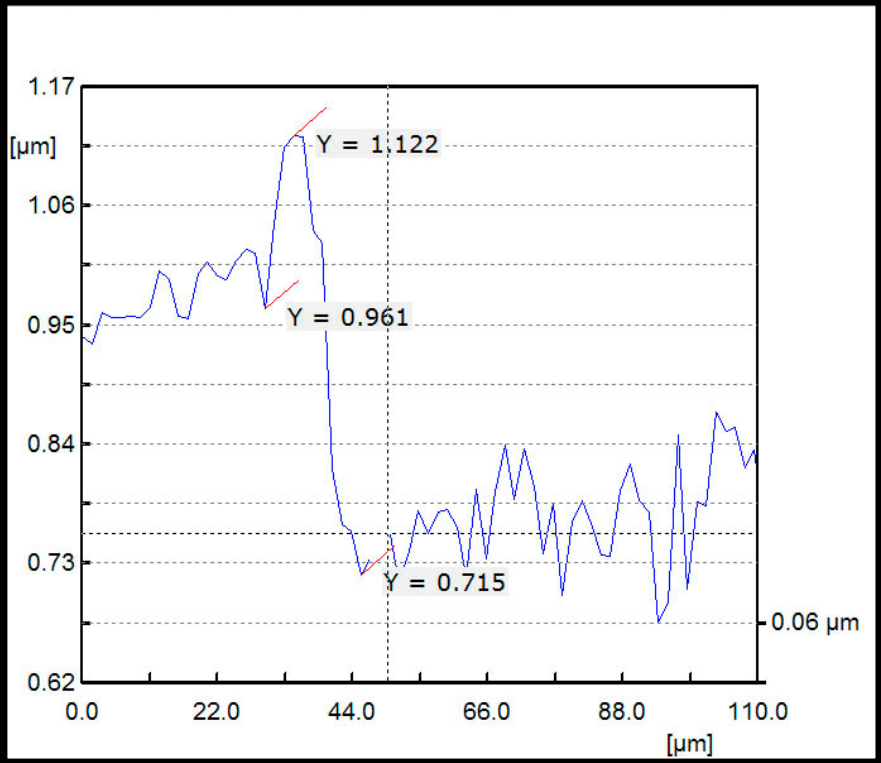
Contour view

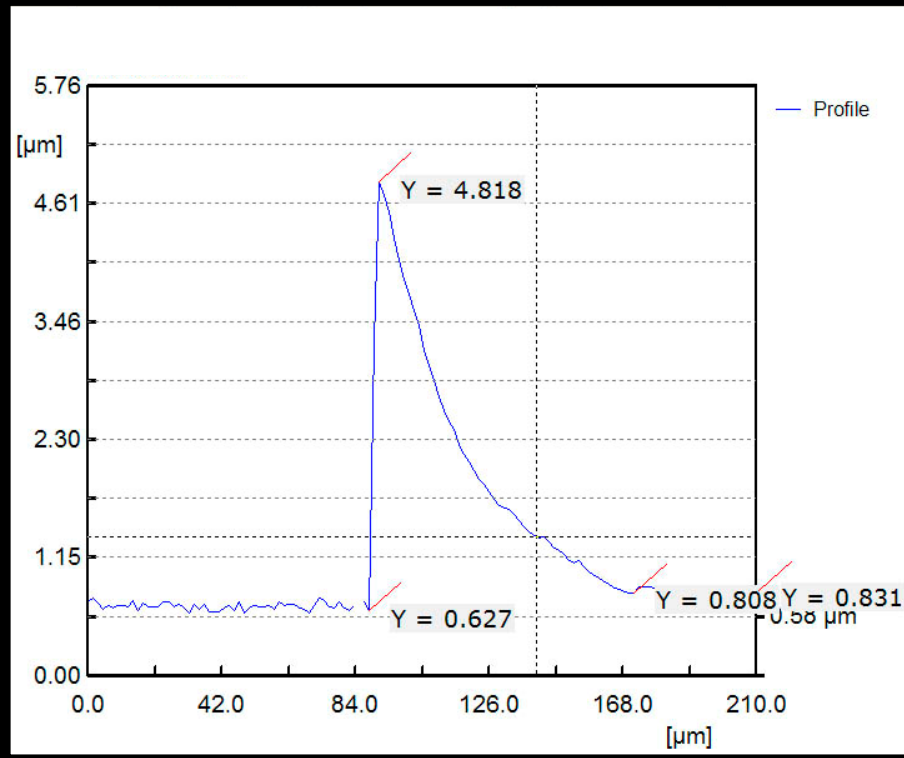


Profile of exfoliated area









0.961 – 0.715 = 0.246 µm

0.808 – 0.627 = 0.181 µm

Thickness range: 0.165 to 0.246 µm

Ag Gelatin Photographs

Imogen Cunningham
Roberta (1959)
24.0 x 18.4 cm

Ilford Glossy paper

- Evaluation of Surface Changes of Ilford Silver Gelatin Prints After of Wetting & Drying.

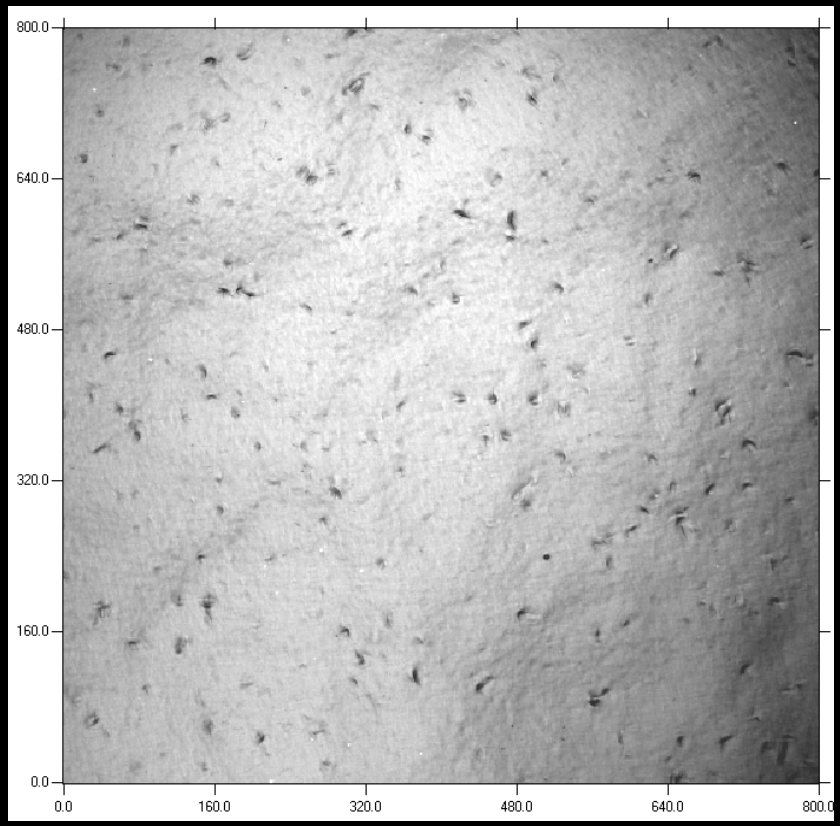
- *Exposed, developed without hardener, dried & treated - (humidified, wetted & application of various drying techniques)*

Ilford Glossy Silver Gelatin Double Weight Papers

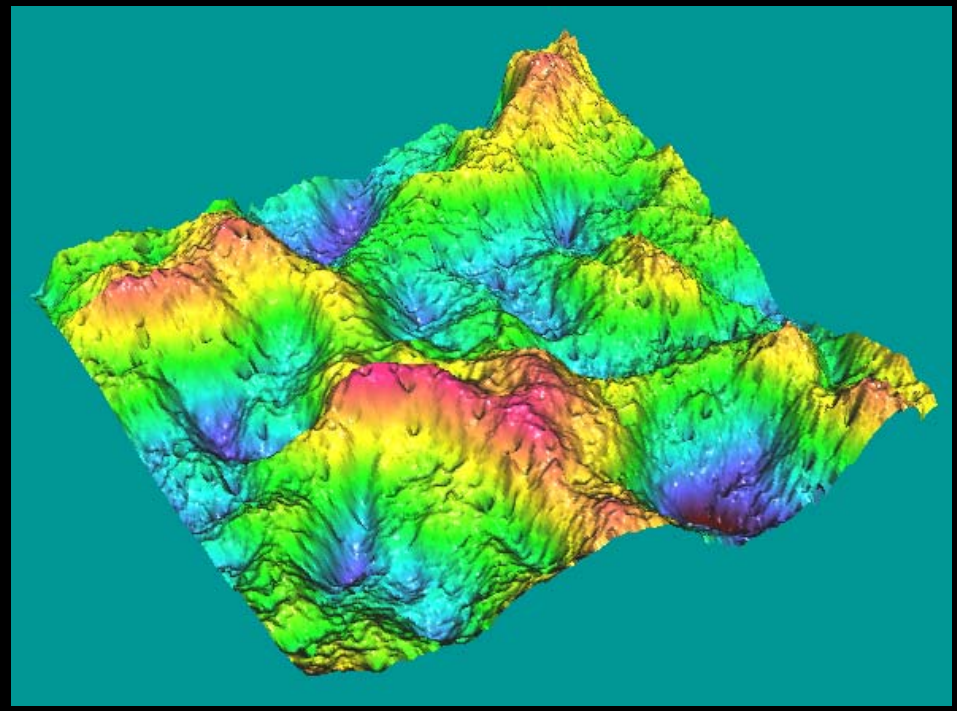
Experimental Protocol

Treatment No	
0	**Control, not treated.**
1	**Humidified 7 hours at room temperature; dried and flattened in a dry-mount press at 80°C for 1 minute with silicone release paper in contact with silver gelatin emulsion.**
2	**Flattened in a dry-mount press at 80°C for 1 minute with silicone release paper in contact with silver gelatin emulsion; no humidification.**
3	**Humidified 7 hours at room temperature; dried and flattened at room temperature under weights (5.23 kg) with a polyester non-woven (Hollytex no. 321, 71 µm thickness) in contact with the silver gelatin emulsion.**
4	**Humidified 7 hours at room temperature; dried and flattened at room temperature under weights (5.23kg) with a highly calendered paper in contact with the silver gelatin emulsion.**
5	**Water immersion for 20 minutes; lined with Dacron cloth and Japanese paper on a rigid Plexiglas support; allowed to air dry for one week before removal from Plexiglas.**
6	**Humidified between wet blotters and Gore-Tex sandwich; lined Japanese style and dried emulsion side 'in' on a Karibari drying board.**
7	**Water immersion for 2 hours (*fully swells gelatin*); dried with blotters to remove excess moisture at 10, 20, 30 and 60 minutes; then dried and flattened under pressure for 1 week.**
8	**Humidified 7 hours at room temperature; dried and flattened using 42 lbs/19 kg of weights at room temperature with Gore-Tex in contact with the silver gelatin emulsion.**

Ilford Glossy paper
A0: Control



Reflection/Confocal BF



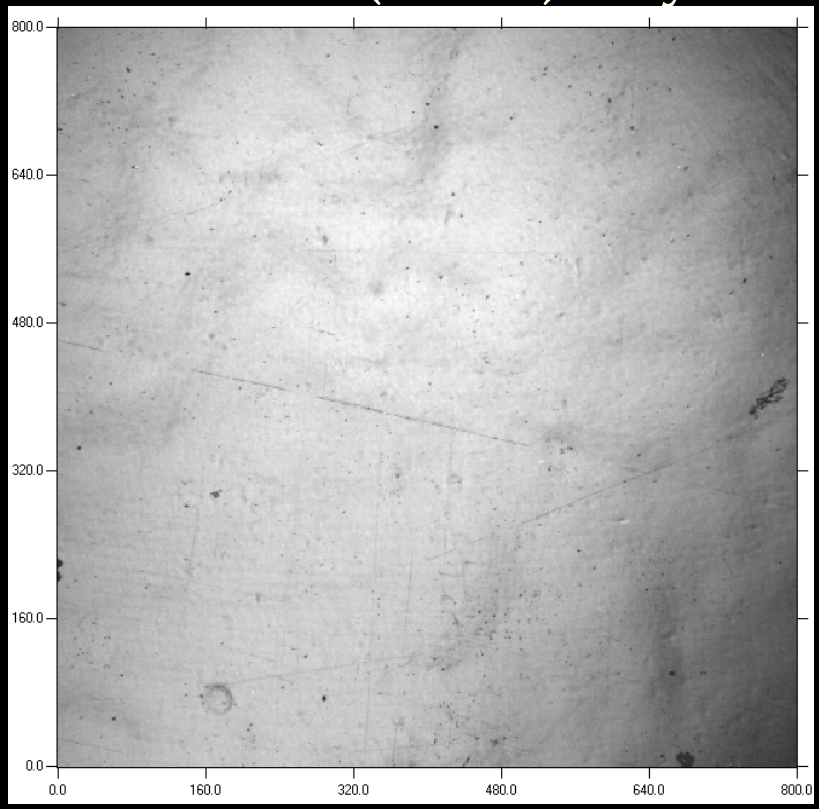
Isometric view

20x objective

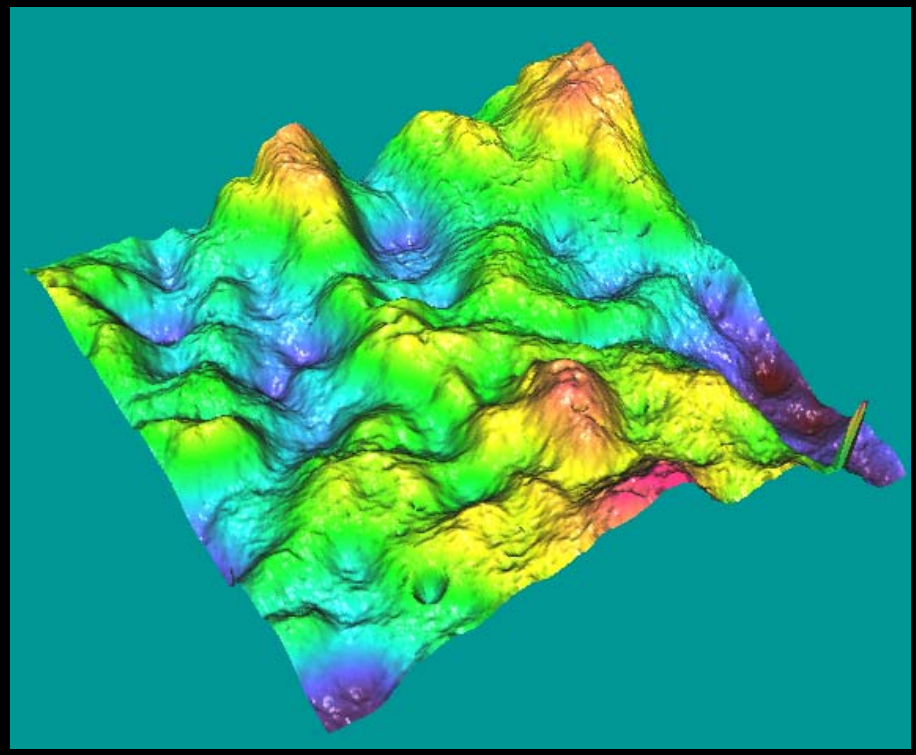
Height Parameters: Sa = 0.107 µm & Sq = 0.139 µm

Ilford Glossy paper

A1: Treated - humidification 7 hours; dried & flattened in a heated (80°C) dry mount press



Reflection/Confocal BF



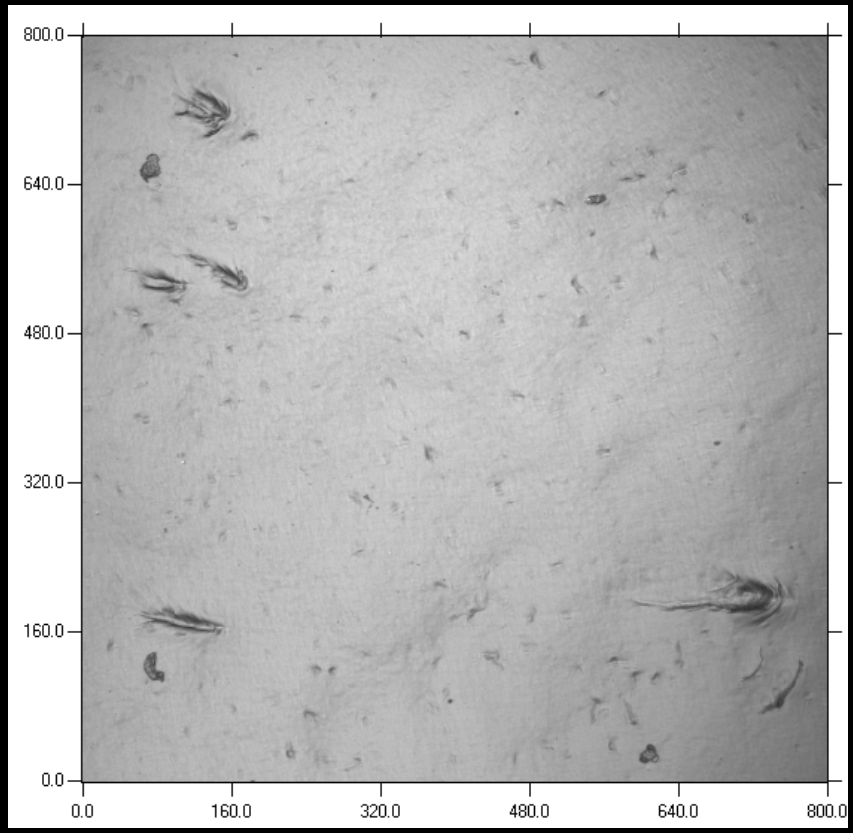
Isometric view

20x objective

Height Parameters: Sa = 0.0883 µm & Sq = 0.119 µm

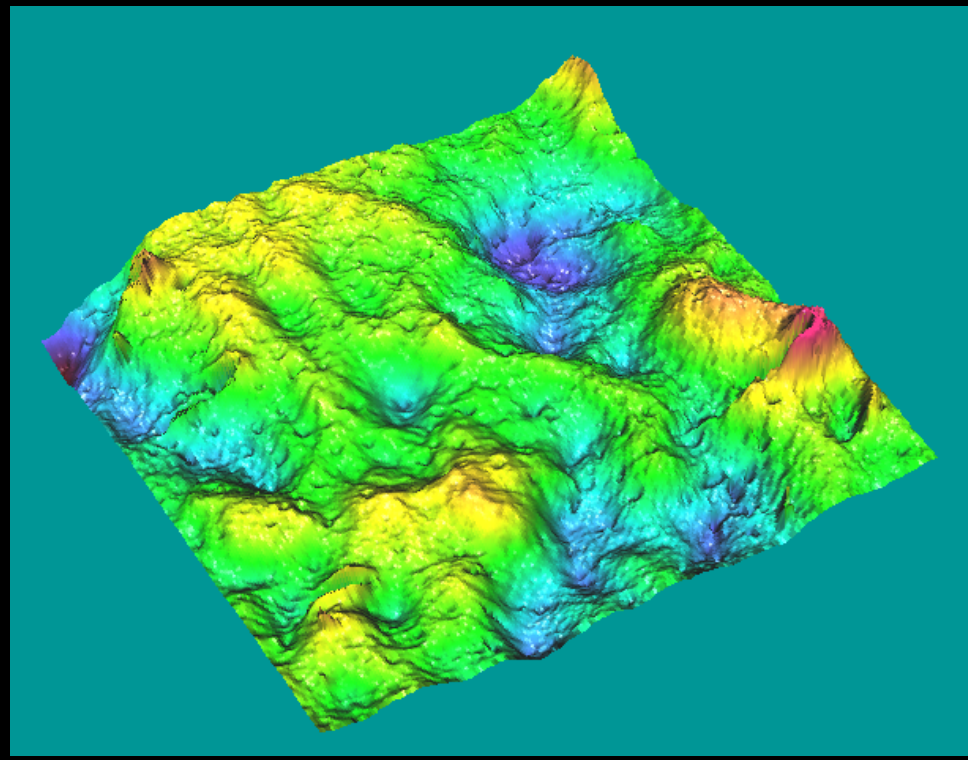
Ilford Glossy paper

A7: Treated – immersion in water, dried between blotters image side facing non-woven (Hollytex)



Reflection/Confocal BF

20x objective



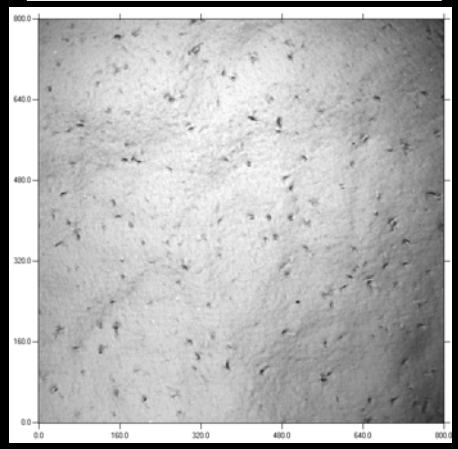
Isometric view

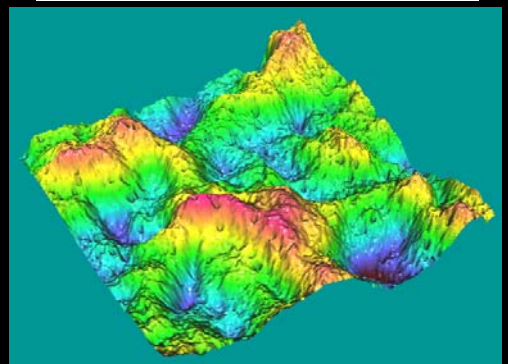
Height Parameters: Sa = 0.141 µm & Sq = 0.237 µm

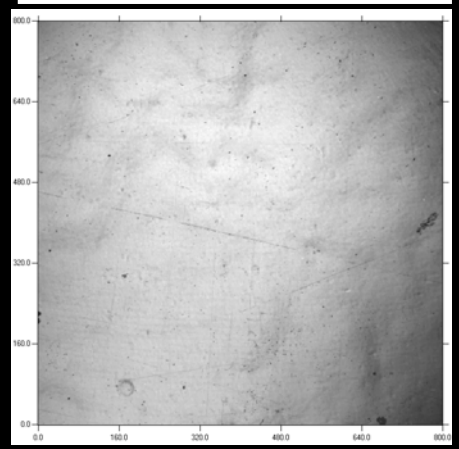
Ilford Glossy paper – roughness analysis

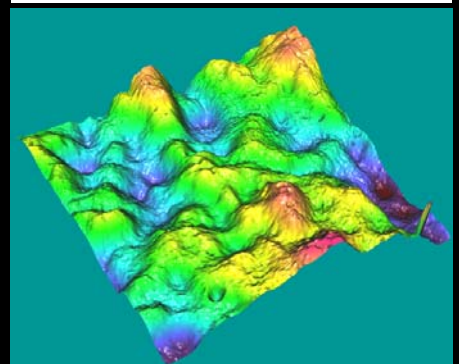
Comparison of height parameters:

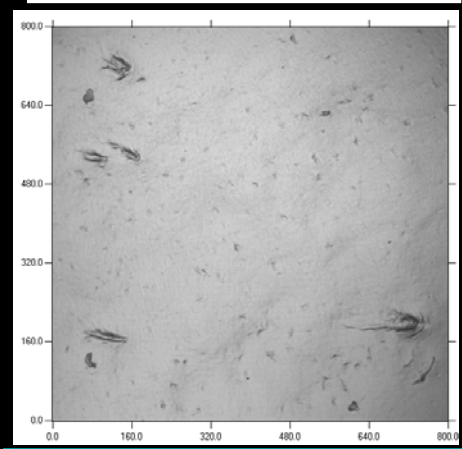
	A0	A1	A7
	Ave Std Dev	Ave Std Dev	Ave Std Dev
Sa	0.108 ± 0.001	0.101 ± 0.011	0.126 ± 0.012
Sq	0.141 ± 0.005	0.133 ± 0.014	0.194 ± 0.032

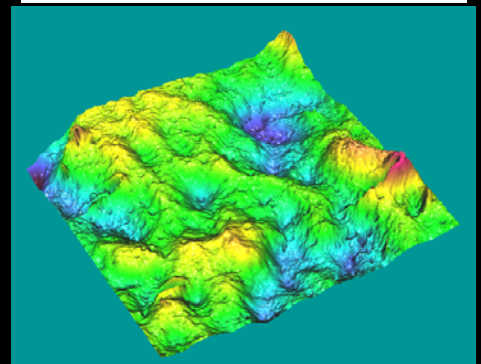






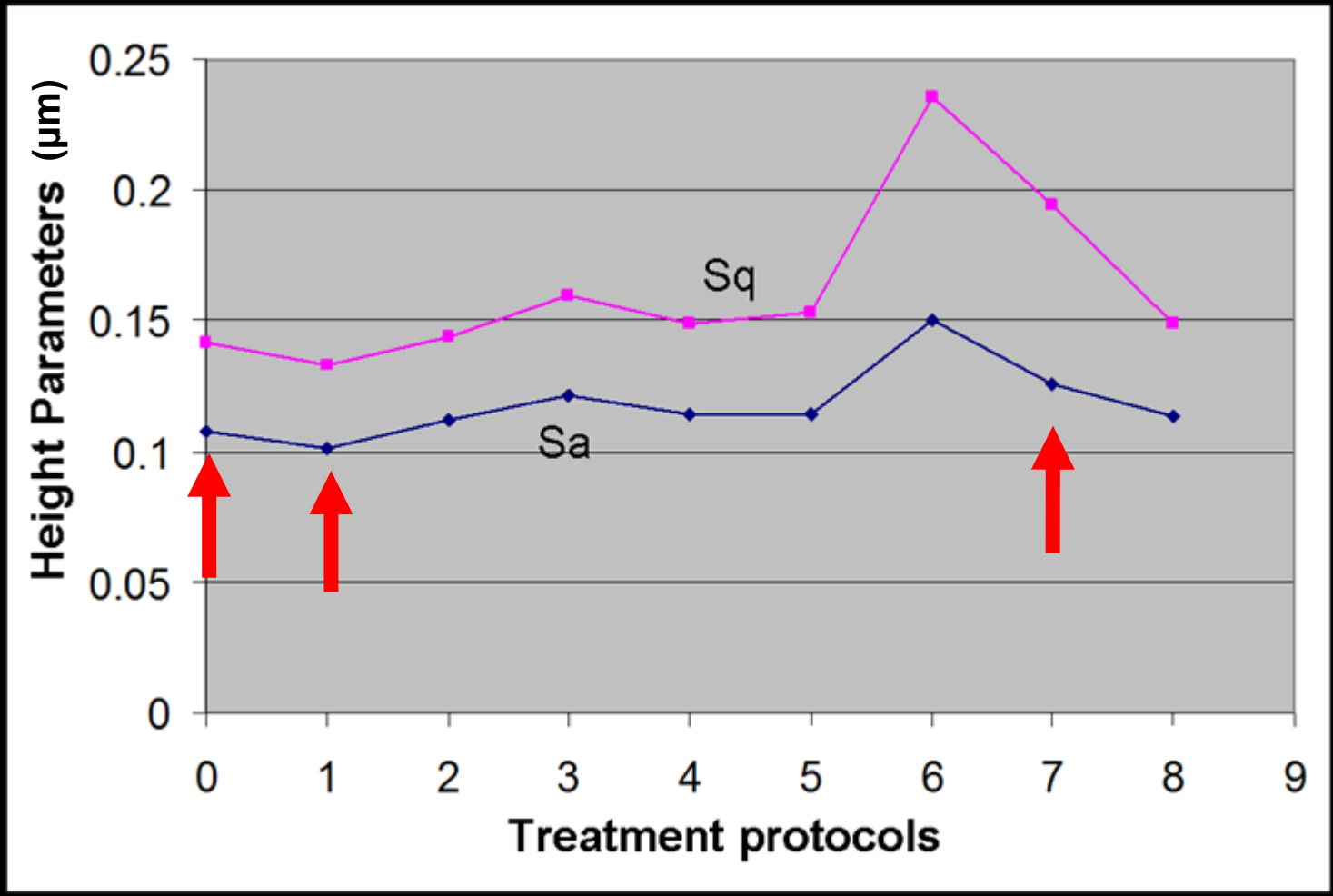






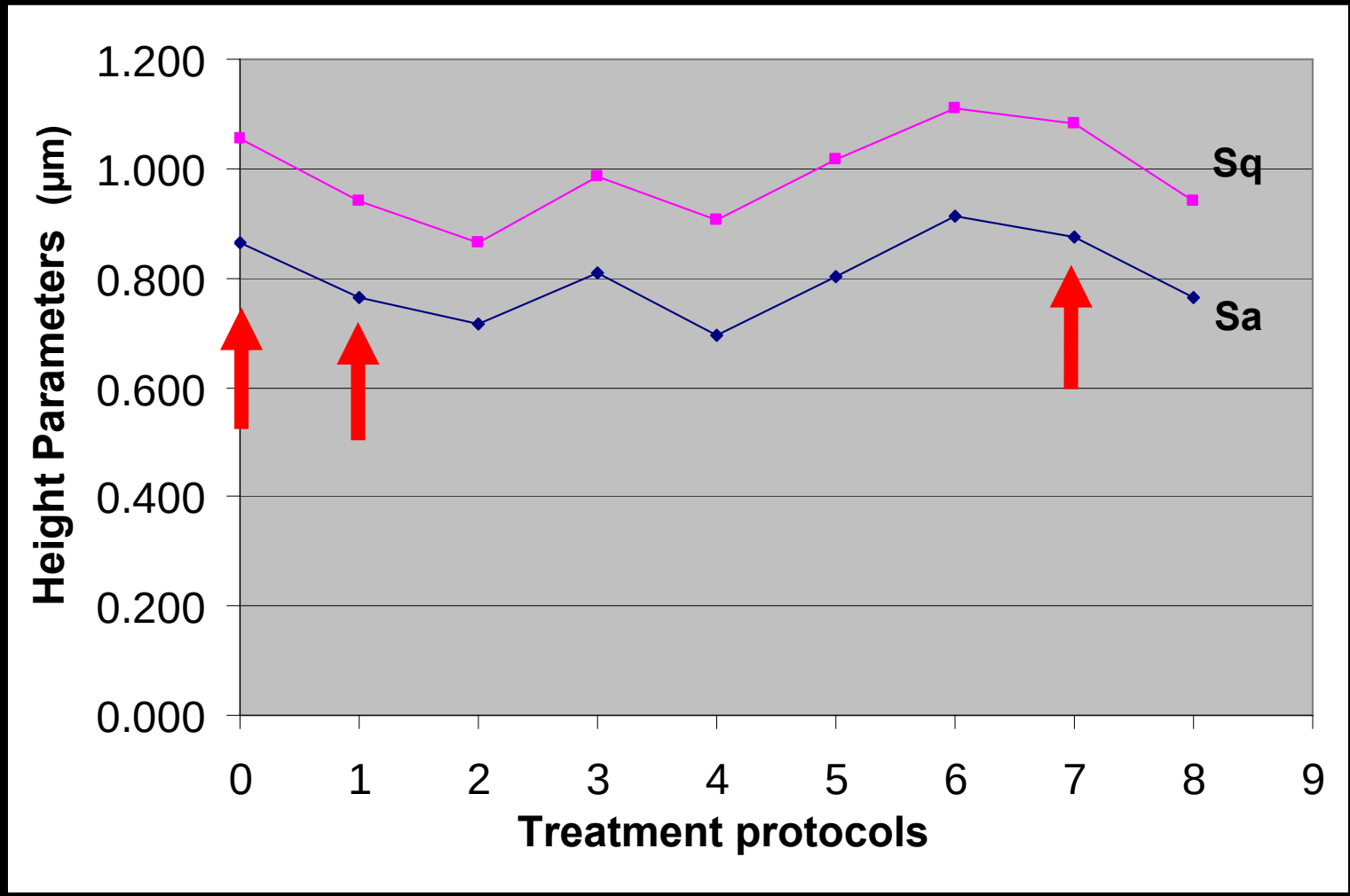
Ilford Glossy paper

Comparison of roughness, *Sa & Sq*, for all papers:



Ilford Glossy paper

Comparison of waviness, *Sa & Sq,* for all papers:



Summary

- **Original objects safely examined**
  - ***Non-perturbing*: non-contact, non-invasive & non-destructive technique**
- **Quantitative surface information**
  - **x, y, z array of data**
- **3-D visualization of all types of photographic (*all art*) surfaces**

Summary

- **Applications in Conservation**
  - **Surface Characterization**
    - *All types of photographic surfaces*
      - Daguerreotypes
      - Silver gelatin
      - Cyanotypes
  - **Follow & evaluate treatments**
    - *Quality assurance/control*
    - *Goal to improve treatments &*
    - *Minimize intervention (damage)*

Summary

- **Applications in Conservation *(contd.)***
  - **Monitor condition through time**
    - *Photograph/object becomes the sensor*
- **Complements other imaging and analytical techniques**
  - **High resolution digital photography**
  - **Light microscopy (BF, DF, DIC…)**
  - **Others…**
- **Mine 3D data further…**

Surface profilometry

Surface roughness

Surface geometry

Topography

Topometry

Topology

&…

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Gustave Le Gray
The Great Wave, Sète (ca. 1857)
Albumen print (34.8 x 41.5 cm)