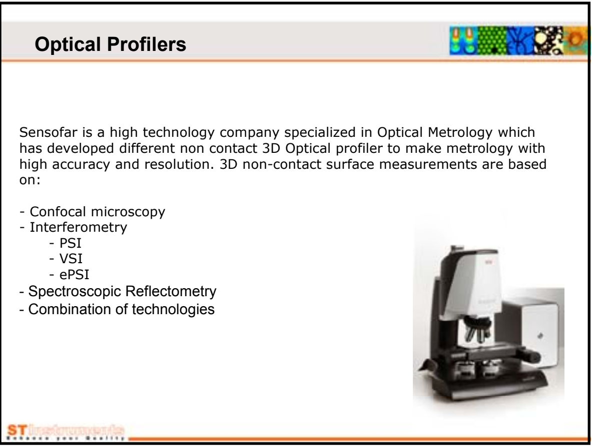
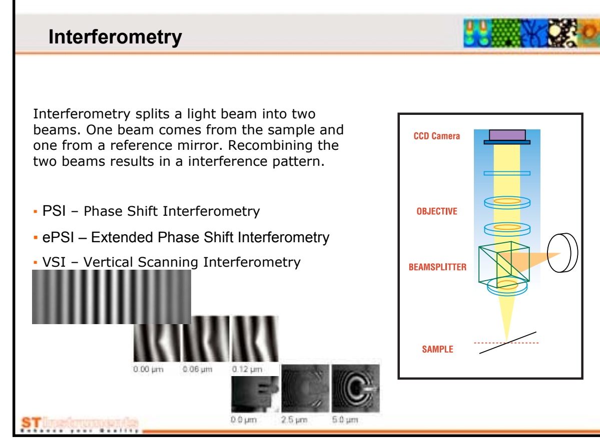

Optical Profilers

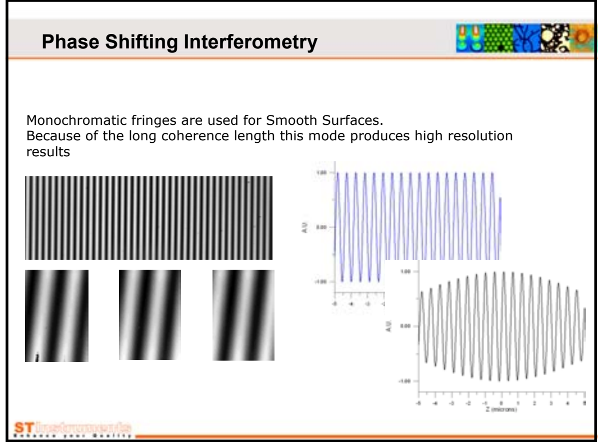
Sensofar is a high technology company specialized in Optical Metrology which has developed different non contact 3D Optical profiler to make metrology with high accuracy and resolution. 3D non-contact surface measurements are based on:

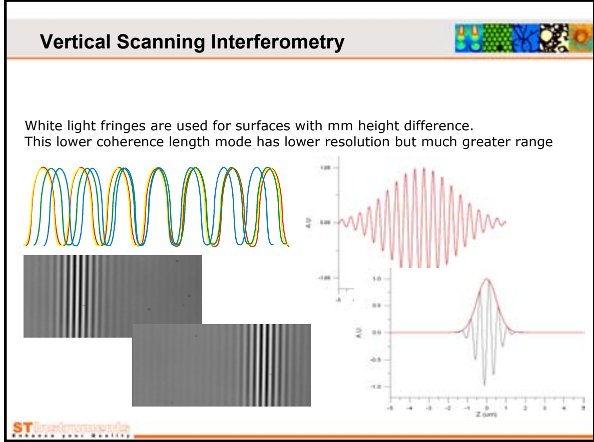
- Confocal microscopy
- Interferometry
- PSI
- VSI
- ePSI
- Spectroscopic Reflectometry
- Combination of technologies

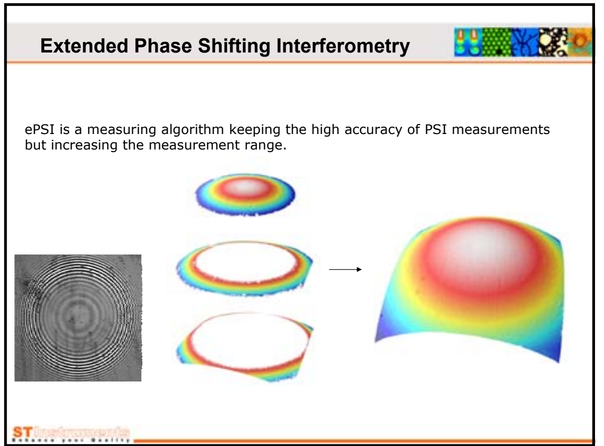
Optical Profilers
Product Range
PLU NeoX
PLU 4300
PLU 1300
PLU CP

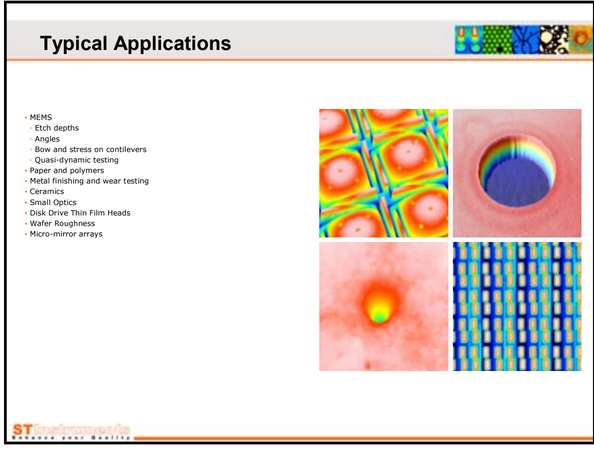
Optical Profilers
Interferometry
Interferometry is a non-contact optical imaging profiler, which can operate in phase shift interferometry for very smooth surfaces and limited z-range and white light interferometry to measure surfaces from smooth to moderately rough surfaces.
Sub-nanometer resolution.
Z-resolution independent on objective.
Fast measurements.

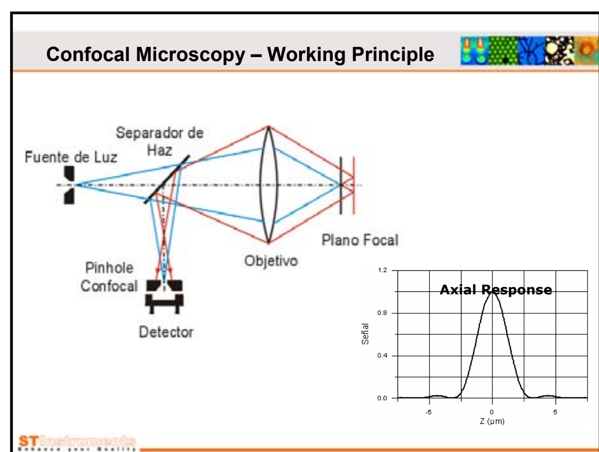

Interferometry
Interferometry splits a light beam into two beams. One beam comes from the sample and one from a reference mirror. Recombining the two beams results in a interference pattern.
PSI – Phase Shift Interferometry
ePSI – Extended Phase Shift Interferometry
VSI – Vertical Scanning Interferometry
CCD Camera
OBJECTIVE
BEAMSPLITTER
SAMPLE

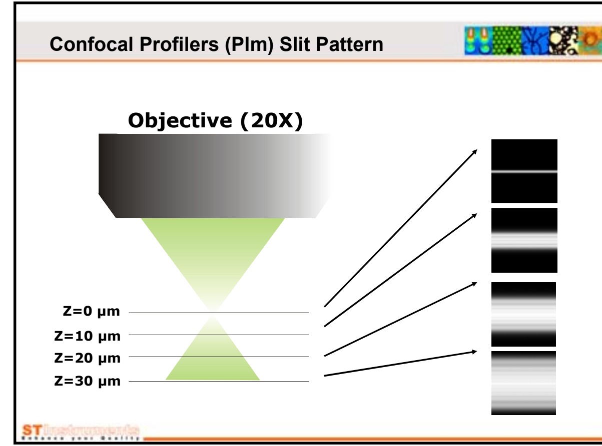

Phase Shifting Interferometry
Monochromatic fringes are used for Smooth Surfaces.
Because of the long coherence length this mode produces high resolution results

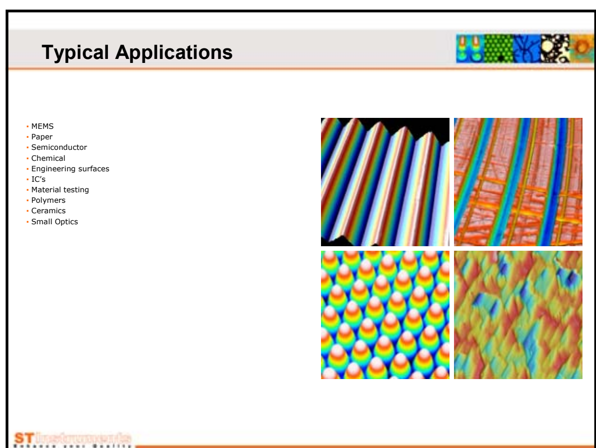

Vertical Scanning Interferometry
White light fringes are used for surfaces with mm height difference.
This lower coherence length mode has lower resolution but much greater range

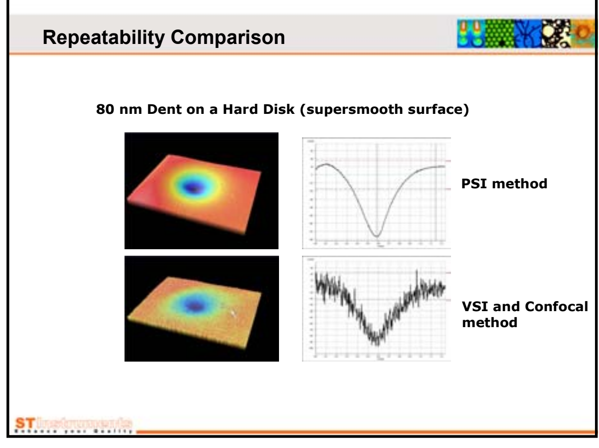

Extended Phase Shifting Interferometry
ePSI is a measuring algorithm keeping the high accuracy of PSI measurements but increasing the measurement range.

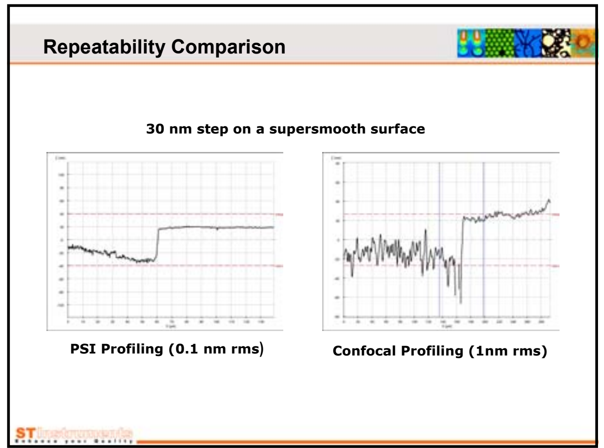

Typical Applications
MEMS
Etch depths
Angles
Bow and stress on contilevers
Quasi-dynamic testing
Paper and polymers
Metal finishing and wear testing
Ceramics
Small Optics
Disk Drive Thin Film Heads
Wafer Roughness
Micro-mirror arrays

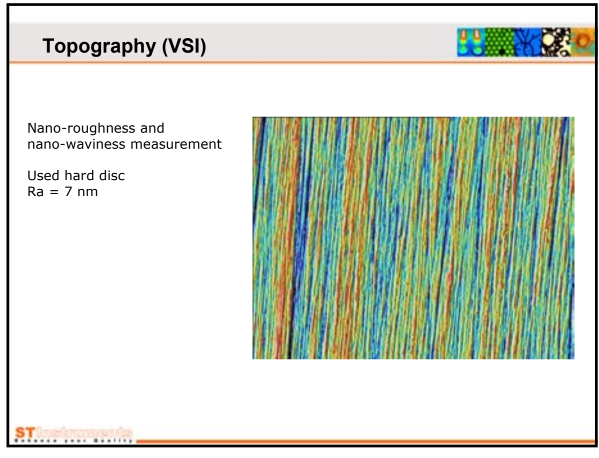

Confocal Microscopy – Working Principle
Separador de Haz
Fuente de Luz
Plano Focal
Objetivo
Pinhole Confocal
Detector
Axial Response
Señal
Z (µm)
1.2
0.8
0.4
0.0
-5
0
5

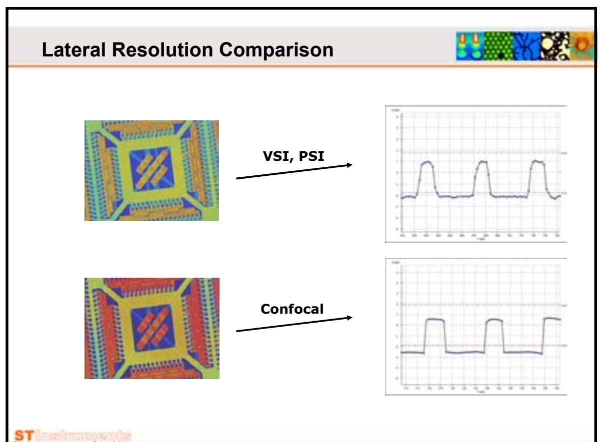

Confocal Profilers (Plm) Slit Pattern
Objective (20X)
Z=0 µm
Z=10 µm
Z=20 µm
Z=30 µm

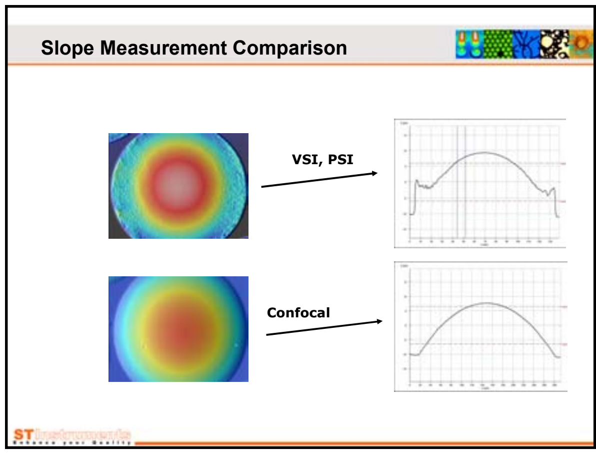

Typical Applications
MEMS
Paper
Semiconductor
Chemical
Engineering surfaces
IC's
Material testing
Polymers
Ceramics
Small Optics

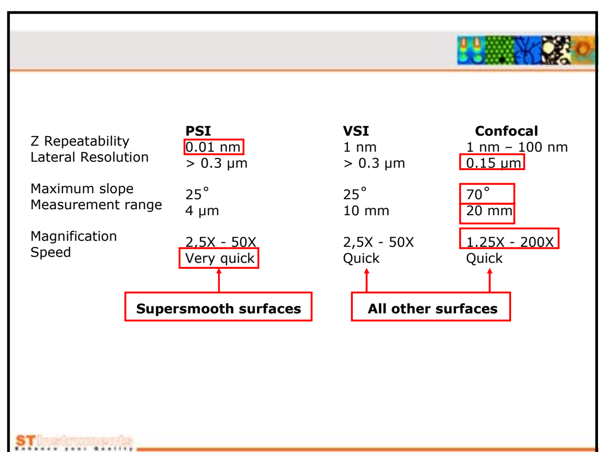

Repeatability Comparison
80 nm Dent on a Hard Disk (supersmooth surface)
PSI method
VSI and Confocal method

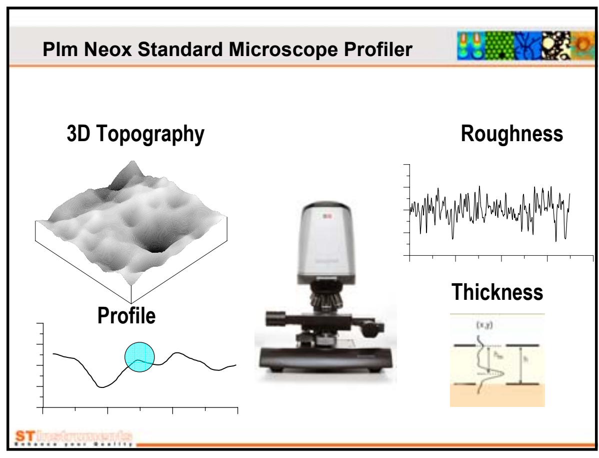

Repeatability Comparison
30 nm step on a supersmooth surface
PSI Profiling (0.1 nm rms)
Confocal Profiling (1nm rms)

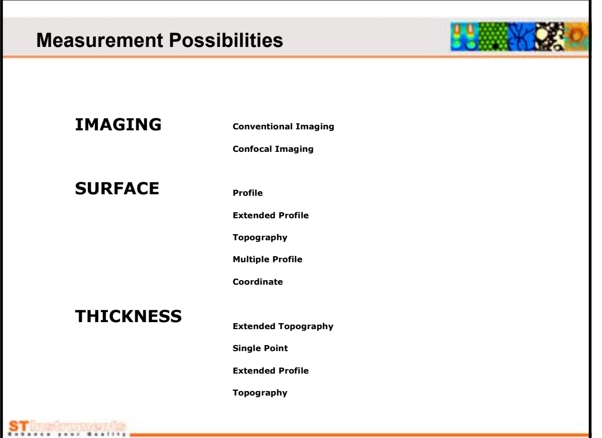

Topography (VSI)
Nano-roughness and
nano-waviness measurement
Used hard disc
Ra = 7 nm


Lateral Resolution Comparison
VSI, PSI
Confocal

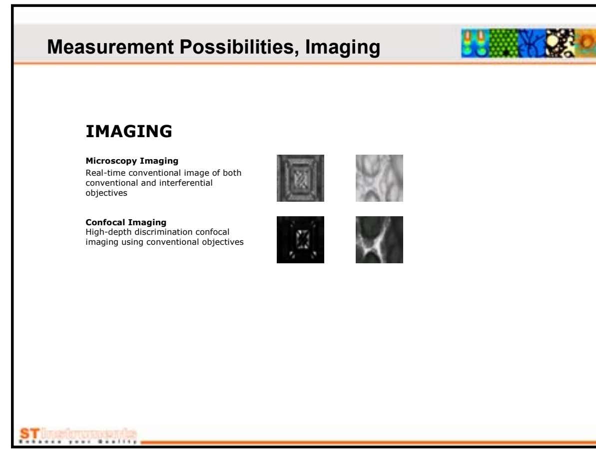

Slope Measurement Comparison
VSI, PSI
Confocal


PSI
VSI
Confocal
Z Repeatability
Lateral Resolution
0.01 nm
> 0.3 µm
1 nm
> 0.3 µm
1 nm – 100 nm
0.15 µm
Maximum slope
Measurement range
25°
4 µm
25°
10 mm
70°
20 mm
Magnification
Speed
2,5X - 50X
Very quick
2,5X - 50X
Quick
1.25X - 200X
Quick
Supersmooth surfaces
All other surfaces

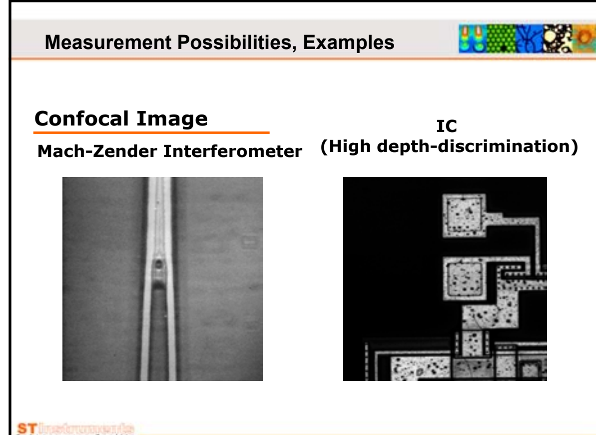

Plm Neox Standard Microscope Profiler
3D Topography
Roughness
Profile
Thickness



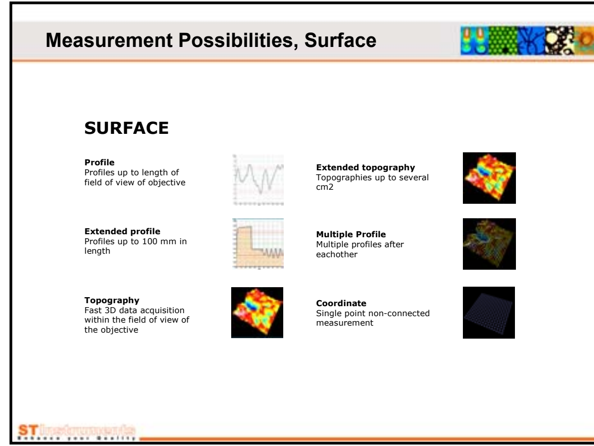
Measurement Possibilities
IMAGING
Conventional Imaging
Confocal Imaging
SURFACE
Profile
Extended Profile
Topography
Multiple Profile
Coordinate
THICKNESS
Extended Topography
Single Point
Extended Profile
Topography



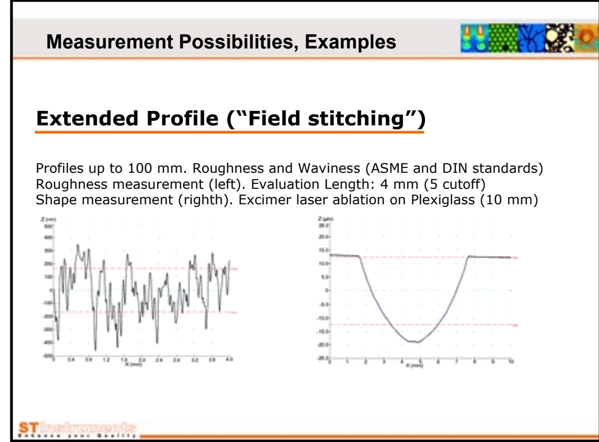
Measurement Possibilities, Imaging
IMAGING
Microscopy Imaging
Real-time conventional image of both conventional and interferential objectives
Confocal Imaging
High-depth discrimination confocal imaging using conventional objectives



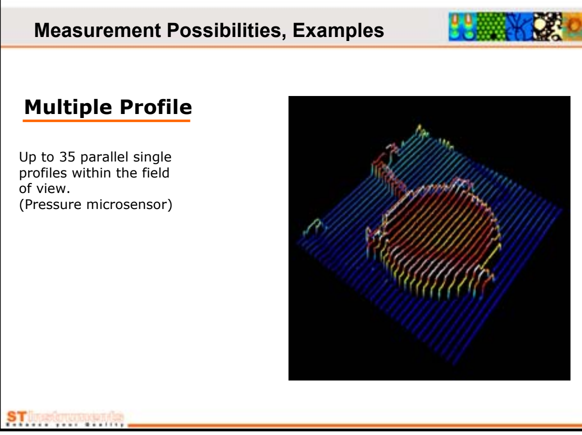
Measurement Possibilities, Examples
Confocal Image
Mach-Zender Interferometer
IC
(High depth-discrimination)



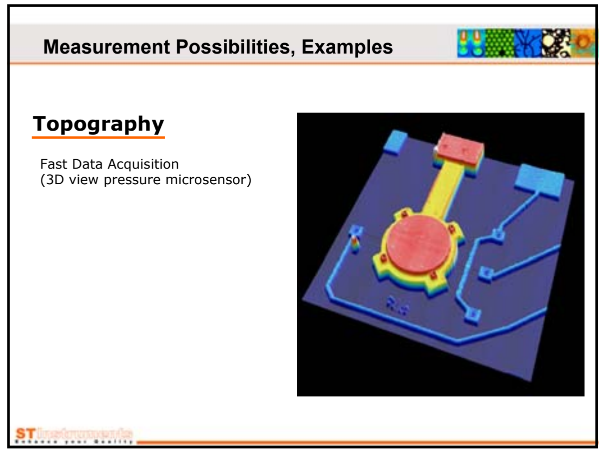
Measurement Possibilities, Surface
SURFACE
Profile
Profiles up to length of field of view of objective
Extended topography
Topographies up to several cm2
Extended profile
Profiles up to 100 mm in length
Multiple Profile
Multiple profiles after eachother
Topography
Fast 3D data acquisition within the field of view of the objective
Coordinate
Single point non-connected measurement



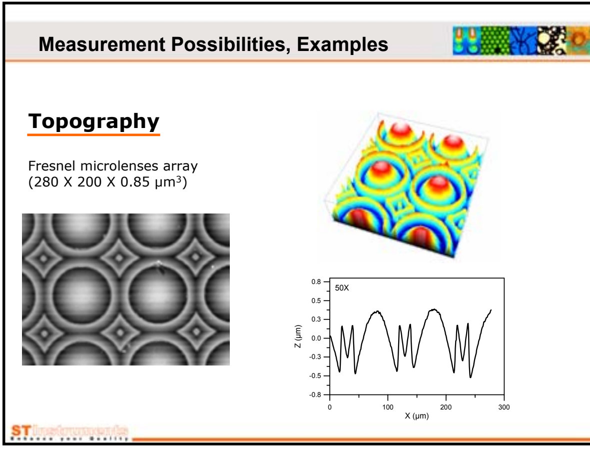
Measurement Possibilities, Examples
Extended Profile ("Field stitching")
Profiles up to 100 mm. Roughness and Waviness (ASME and DIN standards)
Roughness measurement (left). Evaluation Length: 4 mm (5 cutoff)
Shape measurement (righth). Excimer laser ablation on Plexiglass (10 mm)



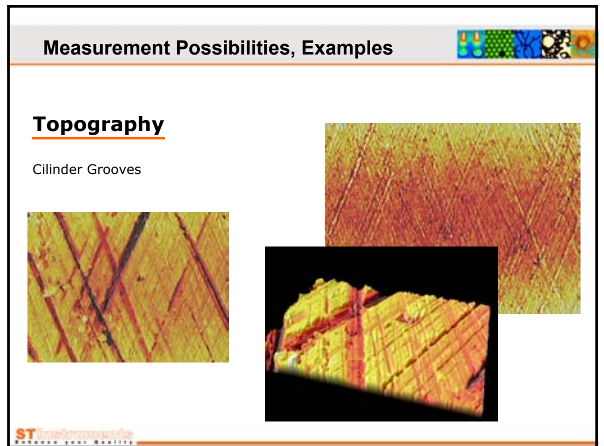
Measurement Possibilities, Examples
Multiple Profile
Up to 35 parallel single profiles within the field of view.
(Pressure microsensor)



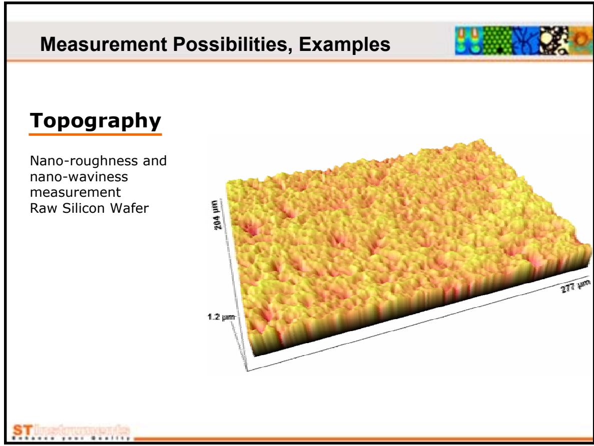
Measurement Possibilities, Examples
Topography
Fast Data Acquisition
(3D view pressure microsensor)



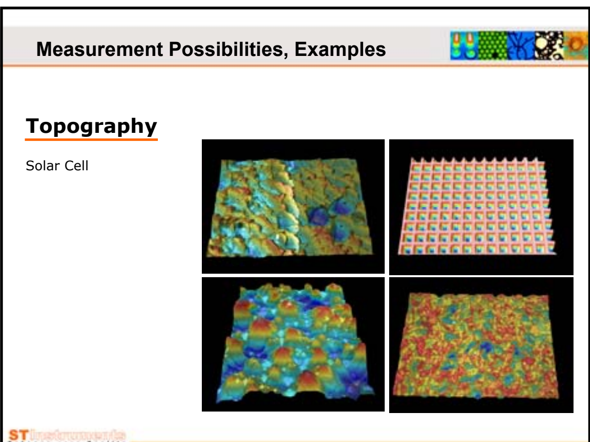
Measurement Possibilities, Examples
Topography
Fresnel microlenses array
(280 X 200 X 0.85 µm³)
50X
0.8
0.5
0.3
0.0
-0.3
-0.5
-0.8
Z (µm)
0
100
200
300
X (µm)



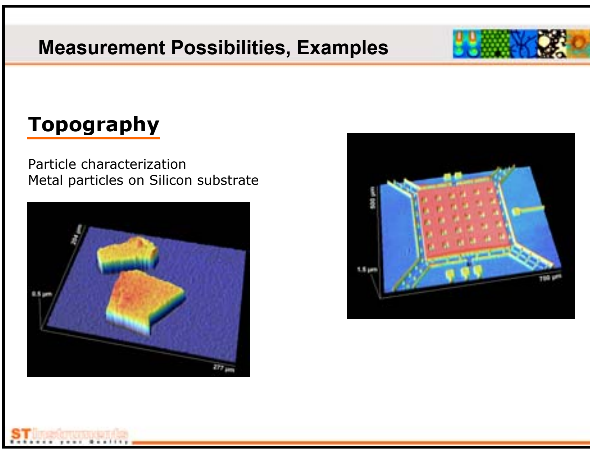
Measurement Possibilities, Examples
Topography
Cilinder Grooves



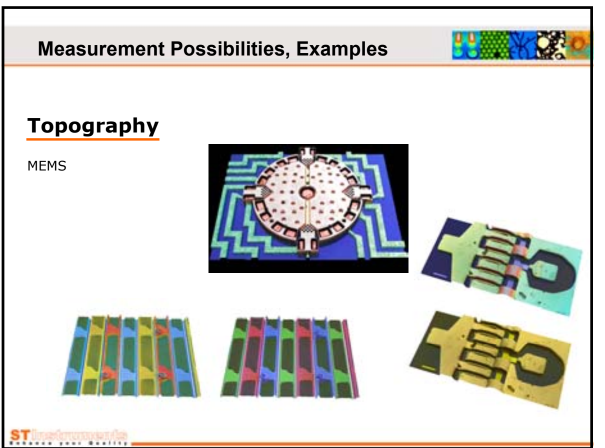
Measurement Possibilities, Examples
Topography
Nano-roughness and
nano-waviness
measurement
Raw Silicon Wafer
204 µm
1.2 µm
277 µm

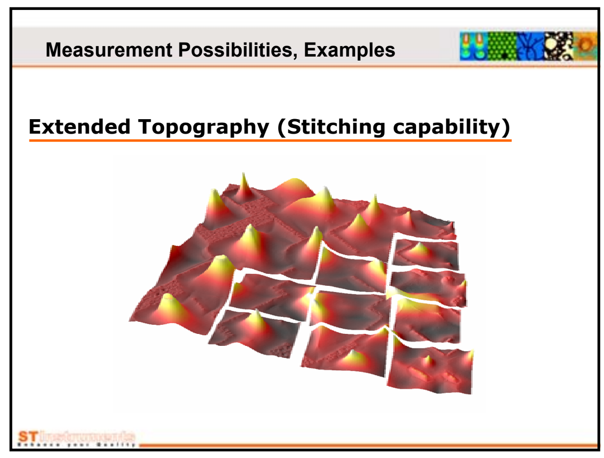


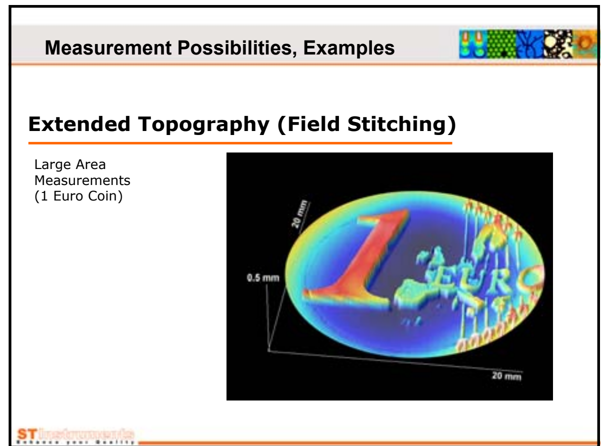
Measurement Possibilities, Examples
Topography
Solar Cell

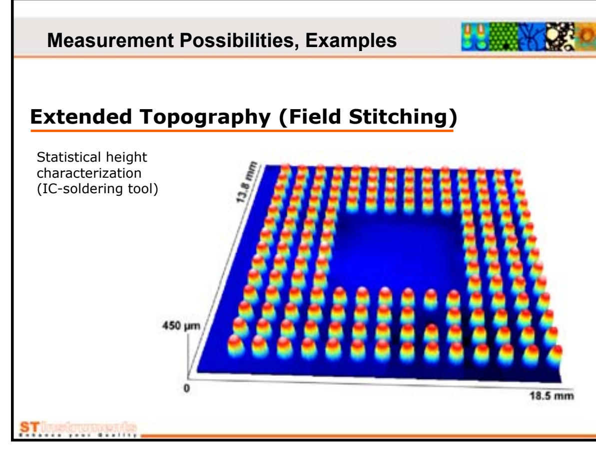


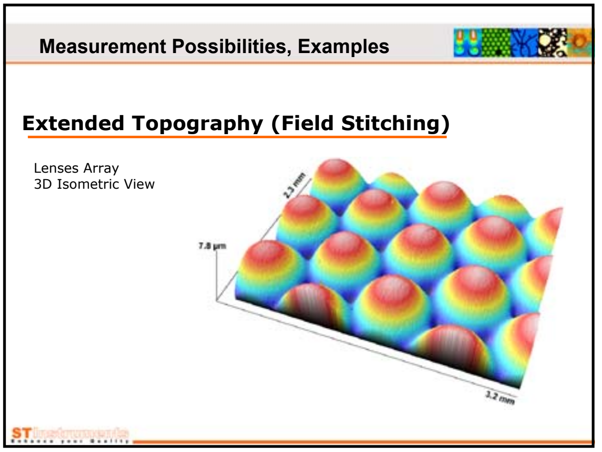
Measurement Possibilities, Examples
Topography
Particle characterization
Metal particles on Silicon substrate

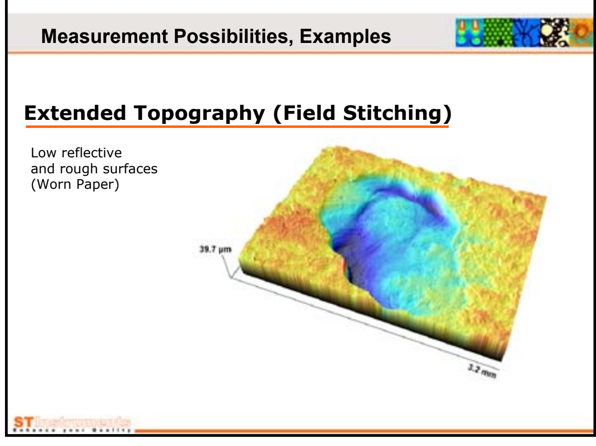

Measurement Possibilities, Examples
Topography
MEMS

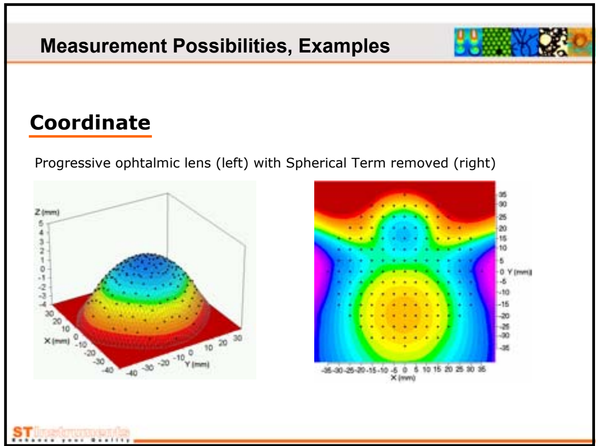

Measurement Possibilities, Examples
Extended Topography (Stitching capability)

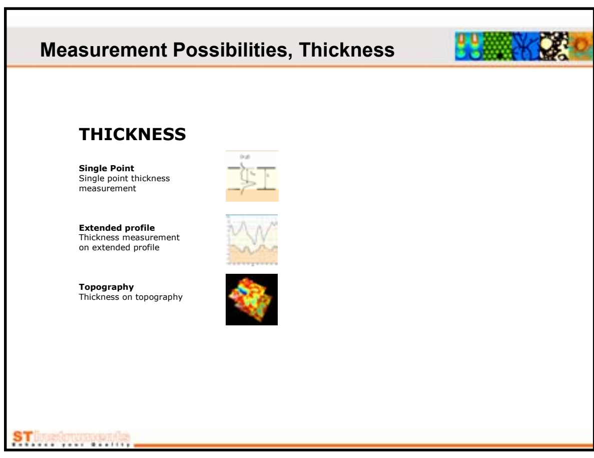

Measurement Possibilities, Examples
Extended Topography (Field Stitching)
Large Area
Measurements
(1 Euro Coin)
20 mm
0.5 mm
20 mm

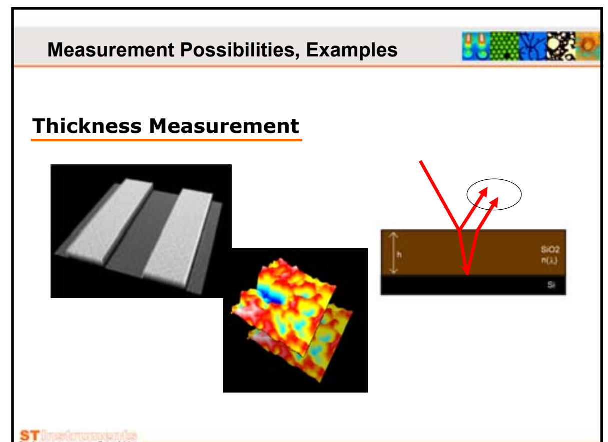

Measurement Possibilities, Examples
Extended Topography (Field Stitching)
Statistical height
characterization
(IC-soldering tool)
13.8 mm
450 µm
0
18.5 mm


Measurement Possibilities, Examples
Extended Topography (Field Stitching)
Lenses Array
3D Isometric View

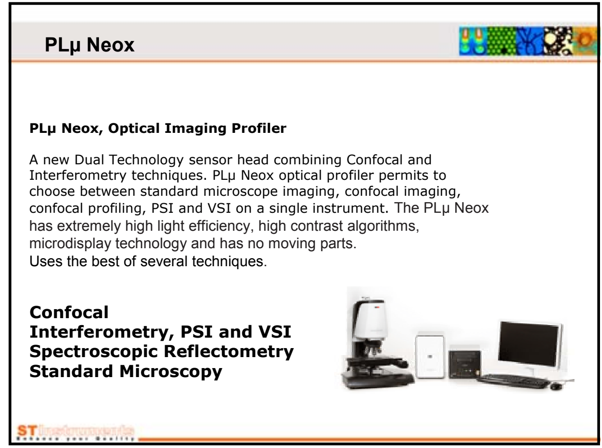

Measurement Possibilities, Examples
Extended Topography (Field Stitching)
Low reflective
and rough surfaces
(Worn Paper)

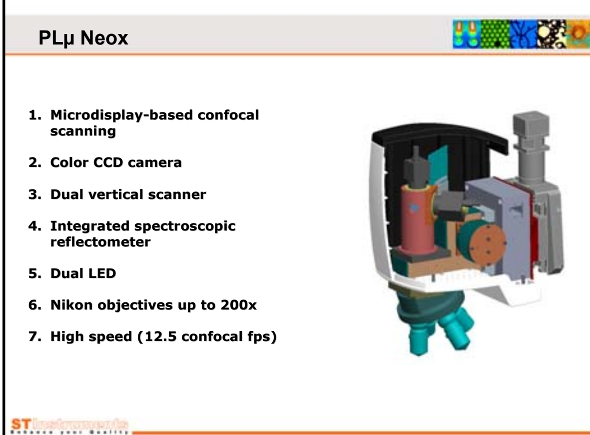

Measurement Possibilities, Examples
Coordinate
Progressive ophtalmic lens (left) with Spherical Term removed (right)

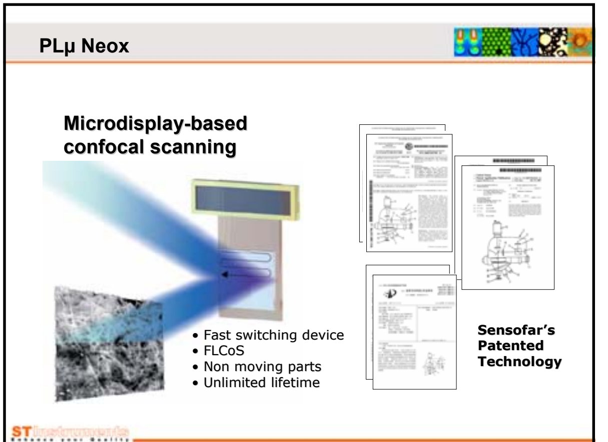

Measurement Possibilities, Thickness
THICKNESS
Single Point
Single point thickness measurement
Extended profile
Thickness measurement on extended profile
Topography
Thickness on topography

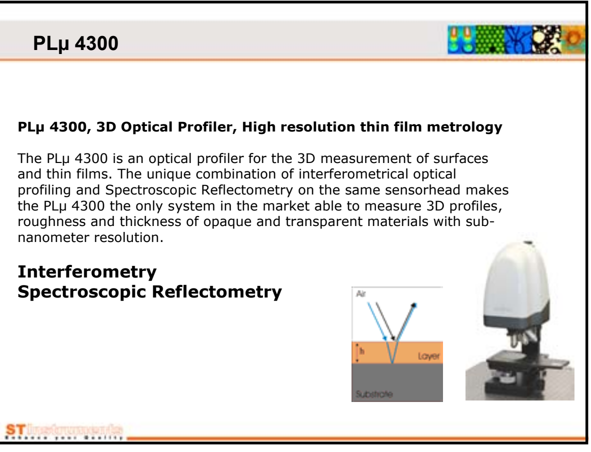

Measurement Possibilities, Examples
Thickness Measurement

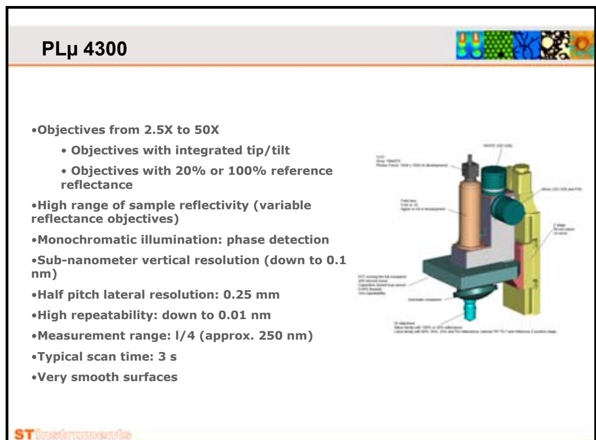
PLμ 1300, Portable Imaging Profiler
The PLμ 1300 is a portable optical Imaging Profiler capable of measuring 3D information of technical surfaces with the use of Interferential or Confocal technologies.
Confocal
Interferometry, PSI and VSI


PLμ Neox
PLμ Neox, Optical Imaging Profiler
A new Dual Technology sensor head combining Confocal and Interferometry techniques. PLμ Neox optical profiler permits to choose between standard microscope imaging, confocal imaging, confocal profiling, PSI and VSI on a single instrument. The PLμ Neox has extremely high light efficiency, high contrast algorithms, microdisplay technology and has no moving parts.
Uses the best of several techniques.
Confocal
Interferometry, PSI and VSI
Spectroscopic Reflectometry
Standard Microscopy

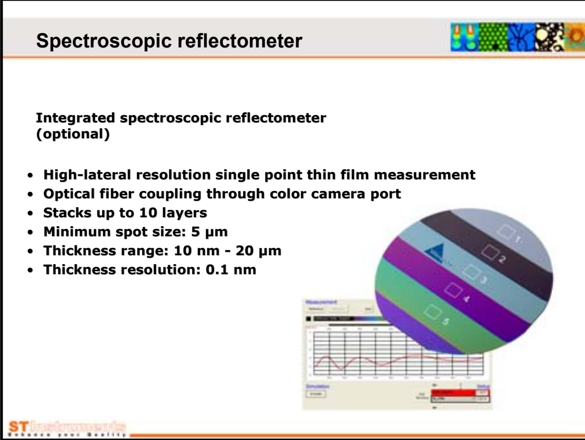

PLμ Neox
1. Microdisplay-based confocal scanning
2. Color CCD camera
3. Dual vertical scanner
4. Integrated spectroscopic reflectometer
5. Dual LED
6. Nikon objectives up to 200x
7. High speed (12.5 confocal fps)

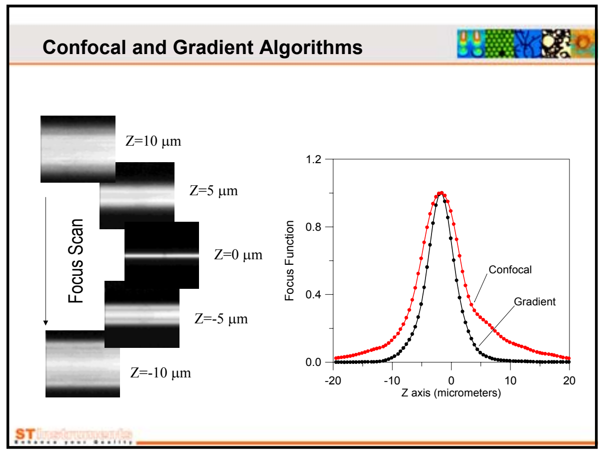

PLµ Neox
Microdisplay-based
confocal scanning
• Fast switching device
• FLCoS
• Non moving parts
• Unlimited lifetime
Sensofar's
Patented
Technology

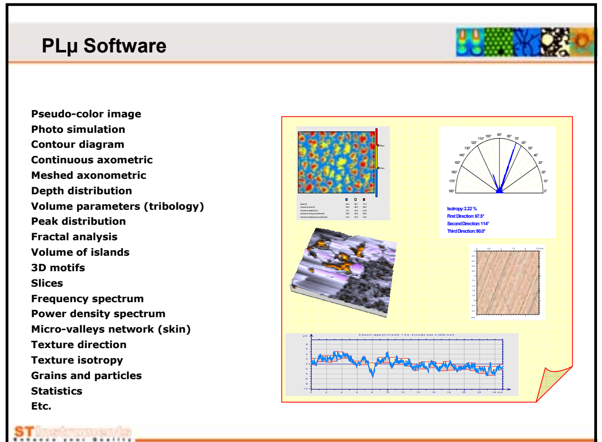

PLµ 4300
PLµ 4300, 3D Optical Profiler, High resolution thin film metrology
The PLµ 4300 is an optical profiler for the 3D measurement of surfaces and thin films. The unique combination of interferometrical optical profiling and Spectroscopic Reflectometry on the same sensorhead makes the PLµ 4300 the only system in the market able to measure 3D profiles, roughness and thickness of opaque and transparent materials with sub-nanometer resolution.
Interferometry
Spectroscopic Reflectometry
Air
Layer
Substrate

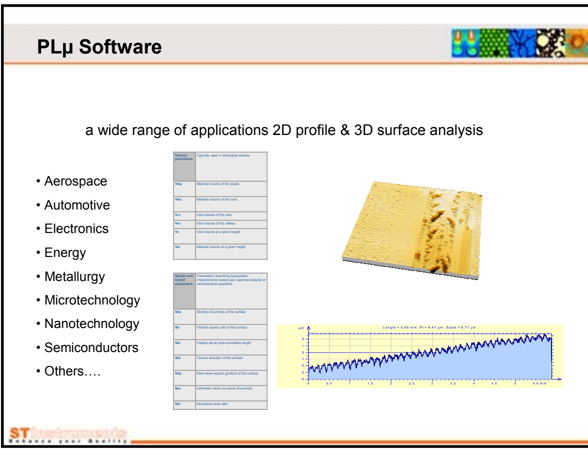

PLµ 4300
•Objectives from 2.5X to 50X
• Objectives with integrated tip/tilt
• Objectives with 20% or 100% reference reflectance
•High range of sample reflectivity (variable reflectance objectives)
•Monochromatic illumination: phase detection
•Sub-nanometer vertical resolution (down to 0.1 nm)
•Half pitch lateral resolution: 0.25 mm
•High repeatability: down to 0.01 nm
•Measurement range: l/4 (approx. 250 nm)
•Typical scan time: 3 s
•Very smooth surfaces

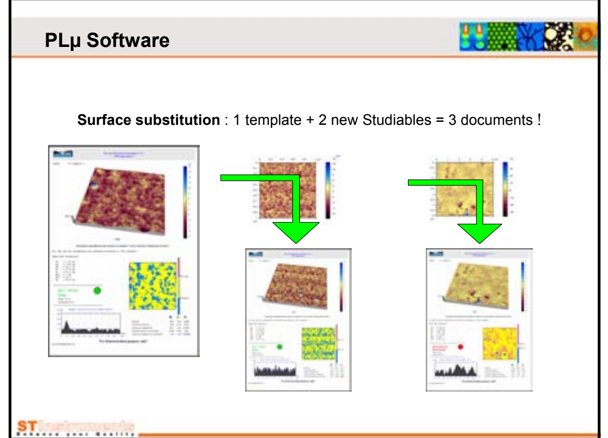
PLµ CP
PLµ CP, Control of Production PLµ series
Control of production Plµ series have been specially designed for fast characterization of large samples like PCBs, vias, flip-chip and traces analysis. Based on the well proven Sensofar's optical profiling technology, you can now profile any surface integrating the PLµ 4300 or the PLµ2300.


Spectroscopic reflectometer
Integrated spectroscopic reflectometer (optional)
• High-lateral resolution single point thin film measurement
• Optical fiber coupling through color camera port
• Stacks up to 10 layers
• Minimum spot size: 5 µm
• Thickness range: 10 nm - 20 µm
• Thickness resolution: 0.1 nm


Confocal and Gradient Algorithms
Z=10 µm
Z=5 µm
Z=0 µm
Z=-5 µm
Z=-10 µm
Focus Scan
Focus Function
1.2
0.8
0.4
0.0
-20
-10
0
10
20
Z axis (micrometers)
Confocal
Gradient


PLµ Software
Pseudo-color image
Photo simulation
Contour diagram
Continuous axometric
Meshed axonometric
Depth distribution
Volume parameters (tribology)
Peak distribution
Fractal analysis
Volume of islands
3D motifs
Slices
Frequency spectrum
Power density spectrum
Micro-valleys network (skin)
Texture direction
Texture isotropy
Grains and particles
Statistics
Etc.


PLµ Software
a wide range of applications 2D profile & 3D surface analysis
• Aerospace
• Automotive
• Electronics
• Energy
• Metallurgy
• Microtechnology
• Nanotechnology
• Semiconductors
• Others….


PLµ Software
Surface substitution : 1 template + 2 new Studiables = 3 documents !