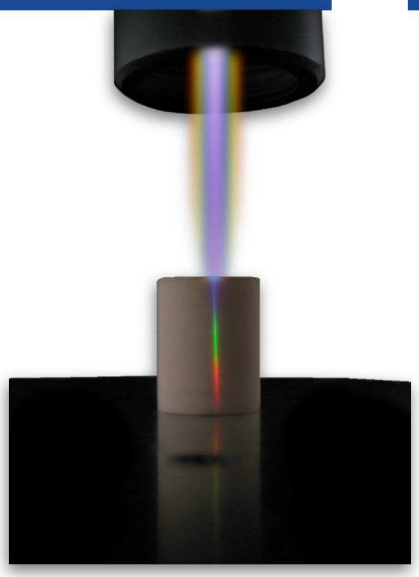
Chromatic Confocal Imaging

Introduction

STIL chromatic confocal sensors, fruit of more than fifteen years of research and development, are non-contact optical sensors for high resolution 3D measurement with a wide range of applications.

Their basic characteristics are:

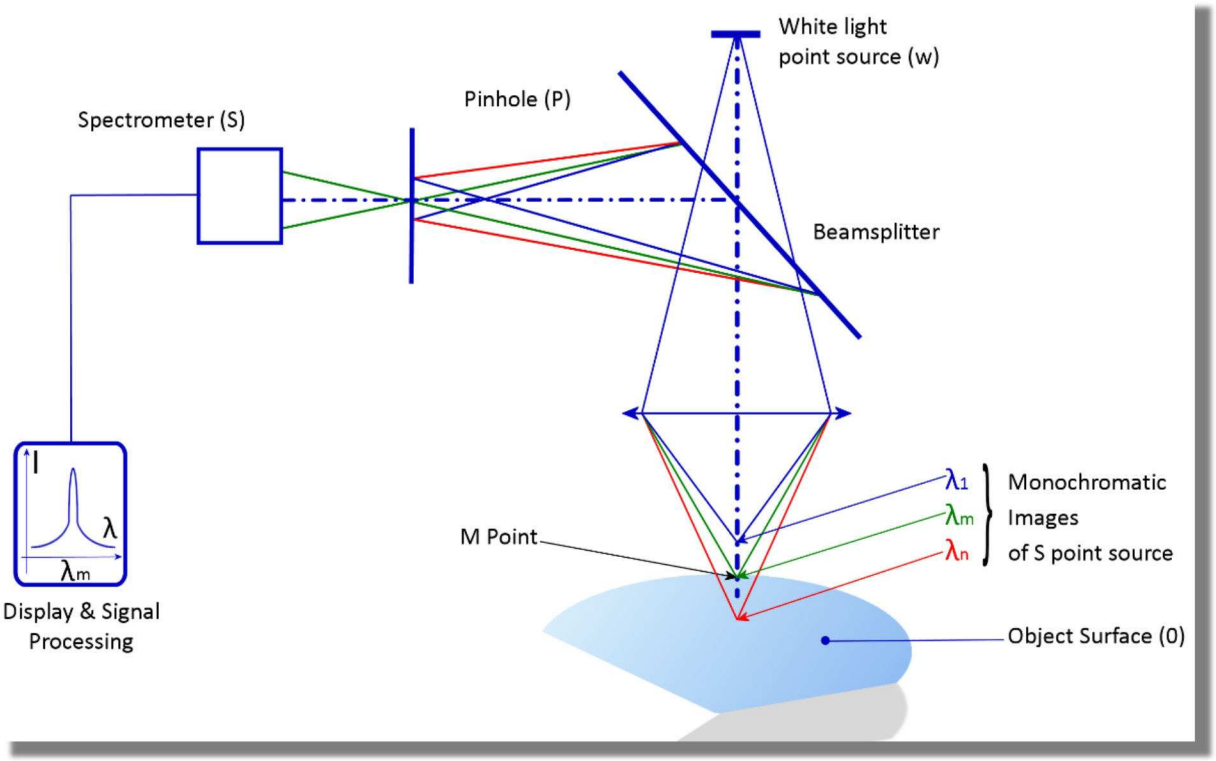
- Chromatic coding of the optical axis (each wavelength is focused at a different point)
- Confocal setup (spatial filtering using a "pinhole")
- Coaxial setup (the same axis for illumination and collection)
- Use of optical fiber
- 2 measuring modes: Distance and Thickness



Chromatic coding

Optical principle

The optical principle of chromatic confocal imaging (STIL SA patent) is shown in the following setup:



An incident white light pinhole is imaged through a chromatic objective into a continuum of monochromatic images along the Z-Axis, thus providing a "color coding" along the optical axis.

When an object is present in this "colored" field, a unique wavelength is perfectly focused at its surface and then reflected into the optical system.

This backscattered beam passes through a filtering pinhole into a spectrograph, which determines the wavelength has been perfectly focused on the object, and then accurately determine its position in the measuring field.

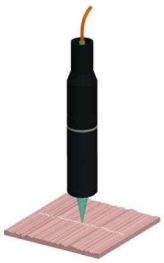
The Confocal Chromatic Imaging gives access to reliable, accurate and reproducible dimentional measurements with extremely high resolution.

Applications

Roughness measurement

Our sensors are fully compliant with the new ISO25178 regulation and are able to measure roughness values down to a few nanometers.

They allow to acquire roughness profiles much faster than a classical tactile probe, and without any risk of marking the surface.



Profilometry & Microtopography

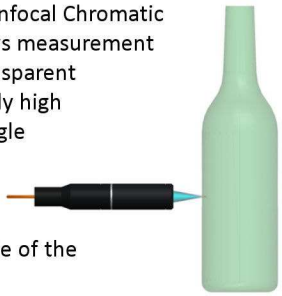
Interfaced with 3D scanning devices, STIL's sensors give access to full 2D and 3D measurements of complex objects or assemblies with submicronic accuracy.

Autofocus

Thank to their extended measuring range, STIL's sensors are the perfect solution for an accurate autofocus in vision systems.

Thickness measurement

The very innovative Confocal Chromatic Imaging principle allows measurement of the thickness of transparent material, with extremely high accuracy, using one single sensor.
The thickness is directly measured from one side of the sample.

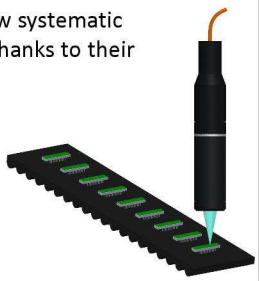


Level control

Thank to their non-contact technology, our sensors allow detection and measurement of fluid's level.

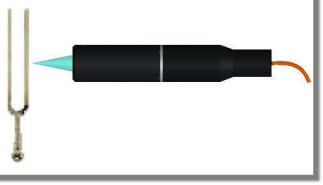
Online inspection

STIL SA's optical sensors allow systematic control on production lines thanks to their very high measuring rates and advanced interfacing capabilities with the manufacturing chain or the custom inspection machine.



Vibrometry

Thanks to very high measuring frequencies and nanometric resolution, our sensors allow the measurement of vibrations in objects under test. Their non-contact design avoids disturbance of the system under test, and allows analysis and measurement of difficult to access areas.



Characteristics

High resolution non contact optical sensors for 3D measurement with a wide range of applications.

Characteristics	Benefits
Confocal setup	- Exceptional signal-to-noise ratio (SNR) - High resolution
Coaxial setup	- No shadowing effects - Capability of measuring highly polished surfaces
Chromatic coding / decoding	- No Z scanning required - High precision
Optical fiber system	- Small, light weight, passive optical probe ("optical pen") connected to the controller by a fiber optics cable
Measuring modes	- "Distance" (Z-coordinate) - "Thickness" measurement of transparent materials

Advantages

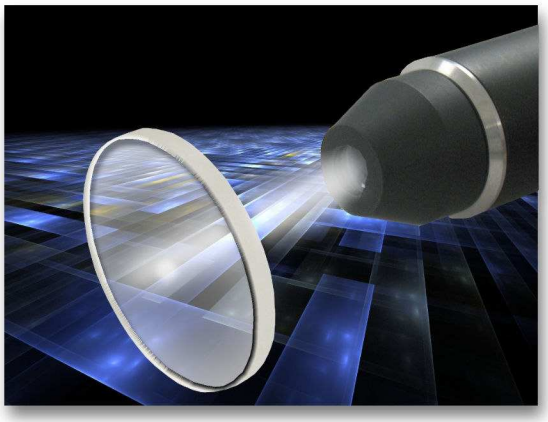
- Measure on any type of material (metal, glass, ceramics, semiconductors, paper),
- Measure on polished surfaces (mirrors, wafers) and on rough ones,
- Insensitive to ambient lighting,
- Compatible with harsh environments (high temperature / high pressure / irradiation),
- ISO 25178 standard compliant,
- Large choice of measuring ranges (100 µm to 42 mm ranges),
- Large choice of optical pens for specific requirements ("endoscopic" pens / radial pens / large working distance / steep slope / small spot size / through-window measurement...),
- Free software toolkit for an easy interfacing ("CCS Manger" utility, c++ and .net DLL SDK).

Confocal Spectral Interferometry

Introduction

The measurement accuracy in non contact profilometric techniques is generally limited by mechanical vibrations and by positional inaccuracies of the micro-scanning table. In order to free the measurement from these environnemental perturbations, STIL has developed a new vibration insensitive interferometric method. With this new type of interferometric system, the potential subnanometric accuracy of interferometric microscopy is effective.

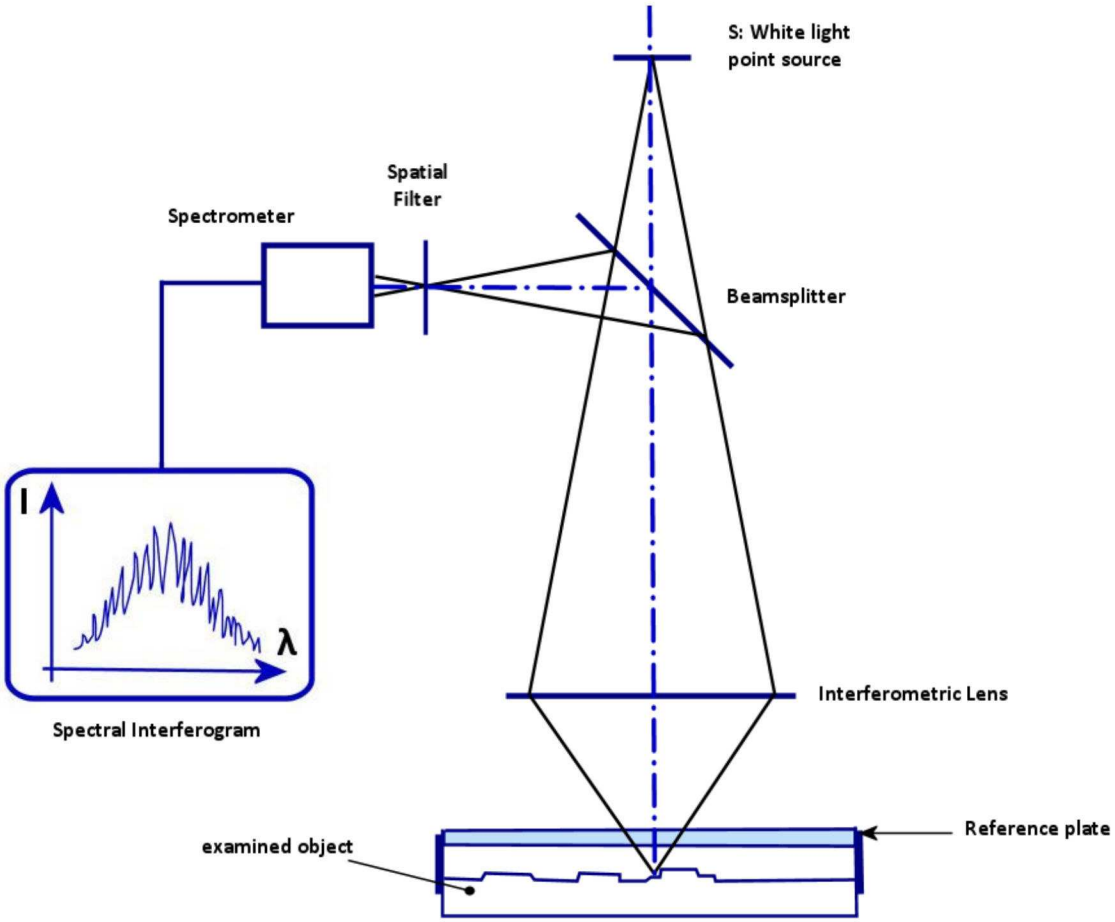
Moreover this new sensor can be used for measuring transparent films that are too thin to allow the "Chromatic Confocal" technique to be used. The minimum measurable thickness is 0.4 µm.



Optical principle

The STIL interferometric method is based on Spectroscopic Analysis of White Light Interferograms (SAWLI). It consists in analysing the interference signal observed on a spectrometer in order to measure the air gap thickness between the reference plate and the sample. The originality of the developed system lies in the fixation of the reference plate on the inspected object. As reference plate and sample are fixed together, the machanical vibrations do not affect the measurements.

The interferometric signal is a channelled spectrum. From this signal, the spectral phase is calculated using a numerical seven points phase shifting algorithm allowing the measurement of the local height of the analyzed surface with a subnanometric resolution.

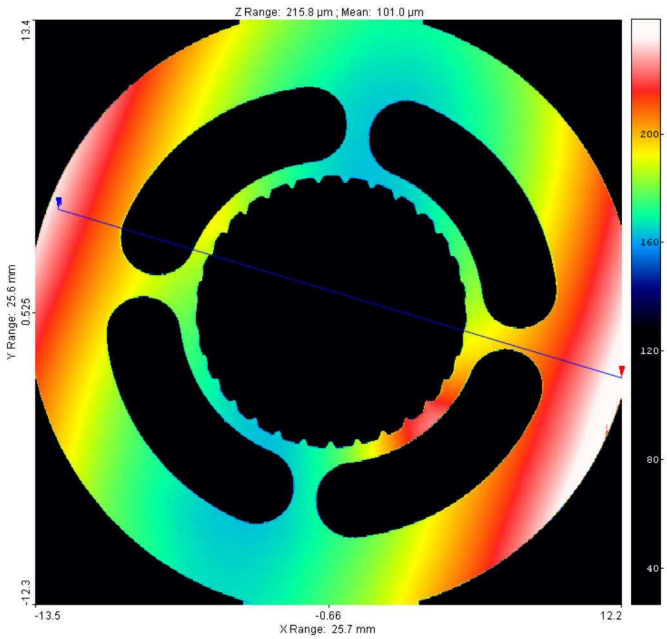


Advantages

- Vibration insensitive (OPILB-RP optical pen),
- High signal to noise ratio (OPILB-RP optical pen),
- No vertical scanning required,
- Minimum measurable thickness 0.4 µm,
- Subnanometric resolution inherent to the optical principle,
- No cross talk between neighbouring points, thanks to confocality,
- Exceptionnal performances in thickness measurement (0.3 nm resolution, 10 nm accuracy)

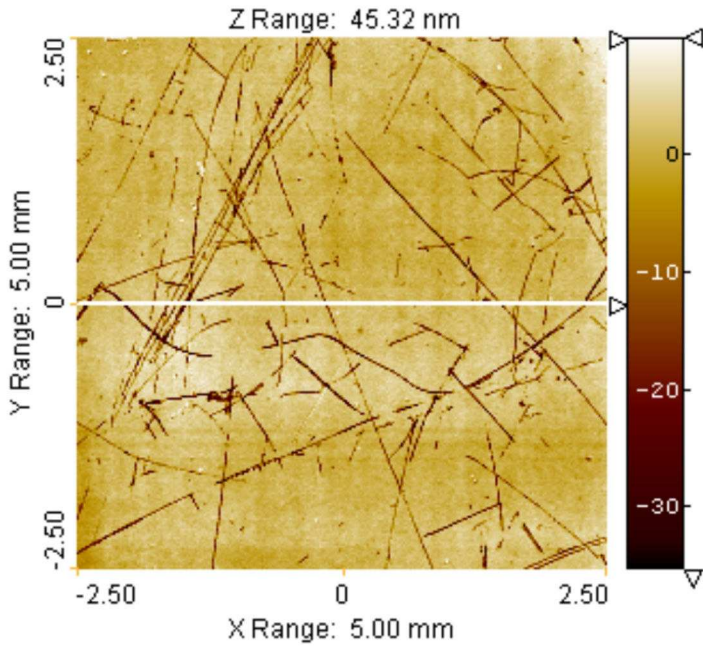
Measurement examples

Chromatic confocal imaging



Horlogy item (X range = Y range = 25.7 mm, Z range = 216 µm)

Confocal spectral interferometry



Nano-scratches on glass plate (X range = Y range = 5.0 mm, Z range = 45.3 nm)