Erfolg
durch Leistung

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NanoMes 2.0

Product specification

Version V050700

1 General description

Etch depth measurement during plasma processing of microstructures is necessary for a well defined etch stop at a certain etch depth and for endpoint detection. The NanoMES provides an in situ and real time measurement of the etch depth and the etch rate during the dry etch process. It also offers endpoint detection by measurement of surface reflectivity and interference on thin films.
The NanoMES can be connected with SENTECH's plasma process systems operating software for automatic process control.

2 Operation principle

There are two measuring modes available with the NanoMes:

- the etch depth measuring mode
- measurement of film thickness using reflectivity and interference on thin films

The principle method for measuring the etch depth is the double beam interferometry. As shown in *Figure 1* a beam splitter divides the light of a monochromatic coherent laser into two beams, an object beam and a reference beam.

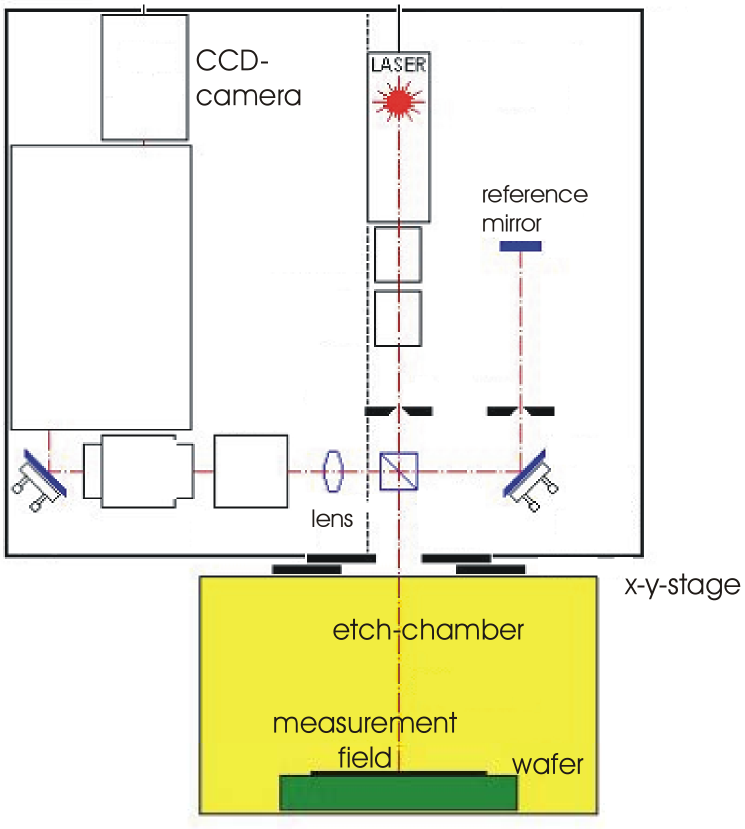


Figure 1: operation principle

Since the two beams have different optical paths, a phase shift in space and time is obtained in the detection plane. A specially designed long focal optics depicts an image of the wafer surface on the CCD-matrix. If the object beam is projected on a flat wafer surface the phase shift in respect to the reference beam is the same for all pixels of the CCD-matrix. In the presence of any topology on wafer altitude differences directly translate into different phase shifts of the respective pixels.

In an etching process the altitude between the masked and the unmasked wafer surface is changing with etching time. A real time processing routine directly transforms this phase shift change into the altitude difference between the different area (masked and not masked). If the etching rate of the mask is negligible or small compared to the etching rate of the etched material, the phase shift difference directly represents the etch depth.

The accuracy of determining the phase shift between the interfering waves relates to the minimum measurable altitude difference. Using appropriate techniques and algorithms, phase shift differences with an accuracy of 1/500 of the wave length used can be determined.

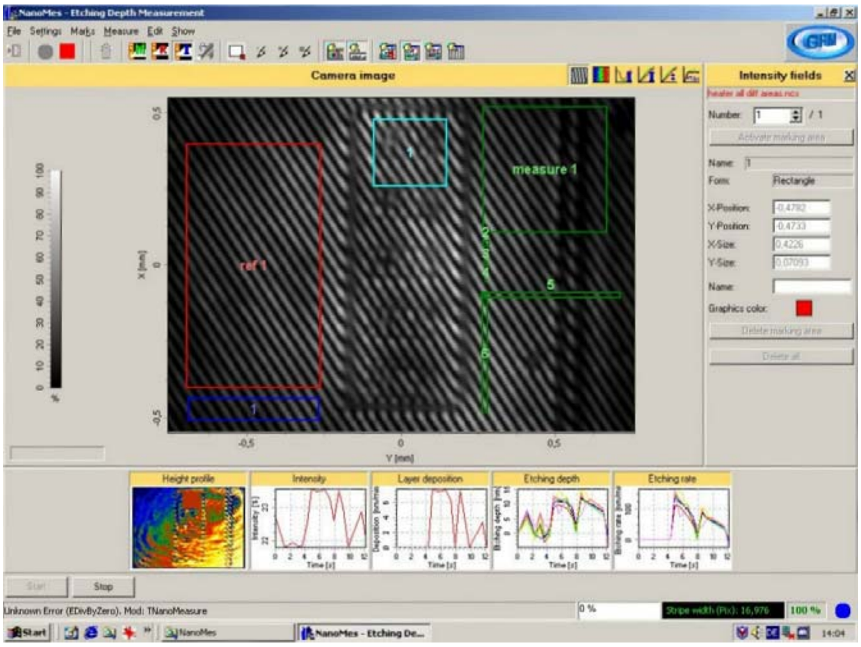
Disturbances can be caused by different influences such as temperature shift, mechanical shocks etc. For a reproducible and reliable operation of the system it is crucial that the optical length of both interferometric arms is maintained constant during the integration time of the CCD camera. For this reason the camera works with a short integration time.

To measure the change in thin film thickness the reference beam is blocked and the intensity of the reflected beam can be measured at different spots on the sample image. From the change in these signal intensities the change in thickness can be calculated using the interference phenomenon in thin transparent films.

3 Software

The user friendly and easy to operate WINDOWS based NanoMes 2.0 operating software includes the support for the thin film measurement and the etch depth measurement. It comprises the powerful analysis algorithm for etch depth in two dimensions and the new software for calculating the deposited film thickness in plasma deposition.
The software allows a wide variety of display and measurement options. In the following a short description of some of the software capabilities is given with examples of measurements during processing.

In *Figure 2* the camera image before starting the measurement is shown in the center of the main window. The measurement and reference fields can be individually chosen and sized in the camera window. From the measurement in these fields the etch depth or the layer thickness will be calculated. On the right hand side of the camera window the parameter for the measurement fields are displayed.



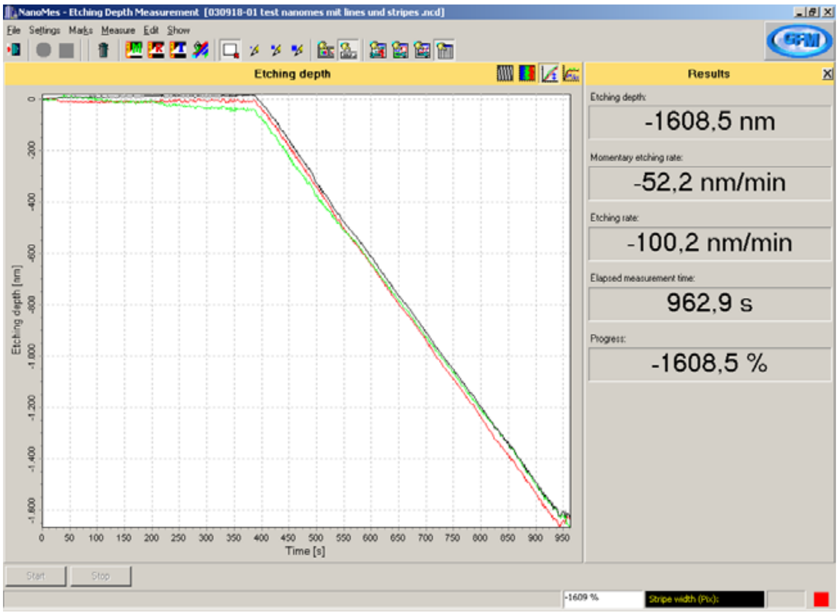
Number: 1 / 1
Name: 1
Form: Rectangle
X-Position: -0,4782
Y-Position: -0,4733
X-Size: 0,4226
Y-Size: 0,07093
Name:
Graphics color: 🟥

Unknown Error (EDivByZero). Mod: TNanoMeasure
0 %
Stripe width (Pix): 16,976
100 %

Figure 2: sample image with interference fringes for etch depth measurement

Several additional windows for the measurement and analysis graphs are also shown in *Figure 2*. From the measurement in the selected fields the etch depth is calculated and displayed in the graph.

These graph can also be displayed as main window as shown in *Figure 3*. There the calculated etch depth from the displacement of the interference fringes is displayed. On the right hand side of the graph the results of the calculation as actual etch depth and etching rate are also shown as numbers.

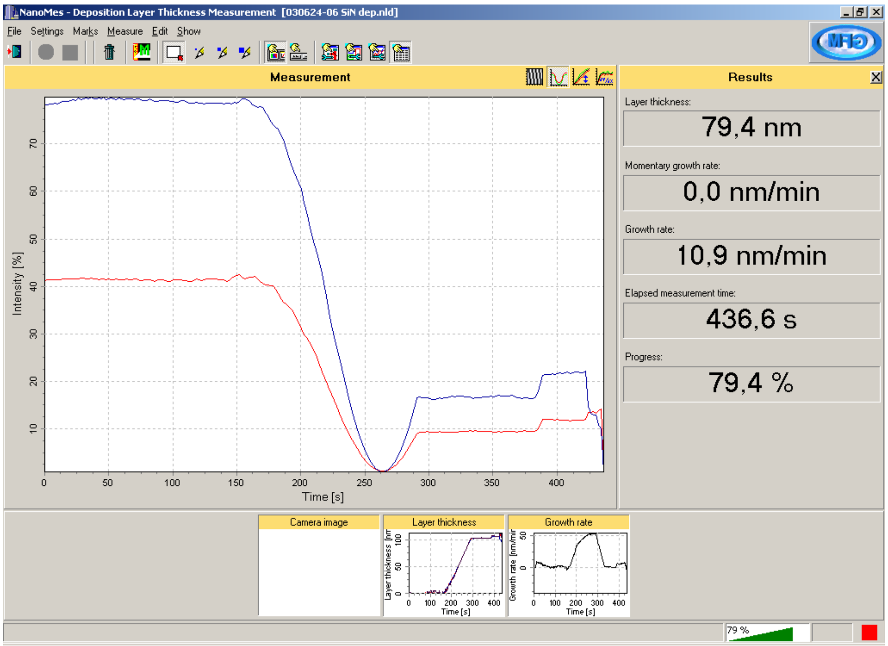


Etching depth: -1608,5 nm
Momentary etching rate: -52,2 nm/min
Etching rate: -100,2 nm/min
Elapsed measurement time: 962,9 s
Progress: -1608,5 %

-1609 %
Stripe width (Pix):

Figure 3: Graph with etch etch during process

During the intensity measurement for the determination of the layer thickness the actual intensity is shown as in *Figure 4*. This is an example for the deposition of silicon nitride on silicon wafer.



Layer thickness:
79,4 nm

Momentary growth rate:
0,0 nm/min

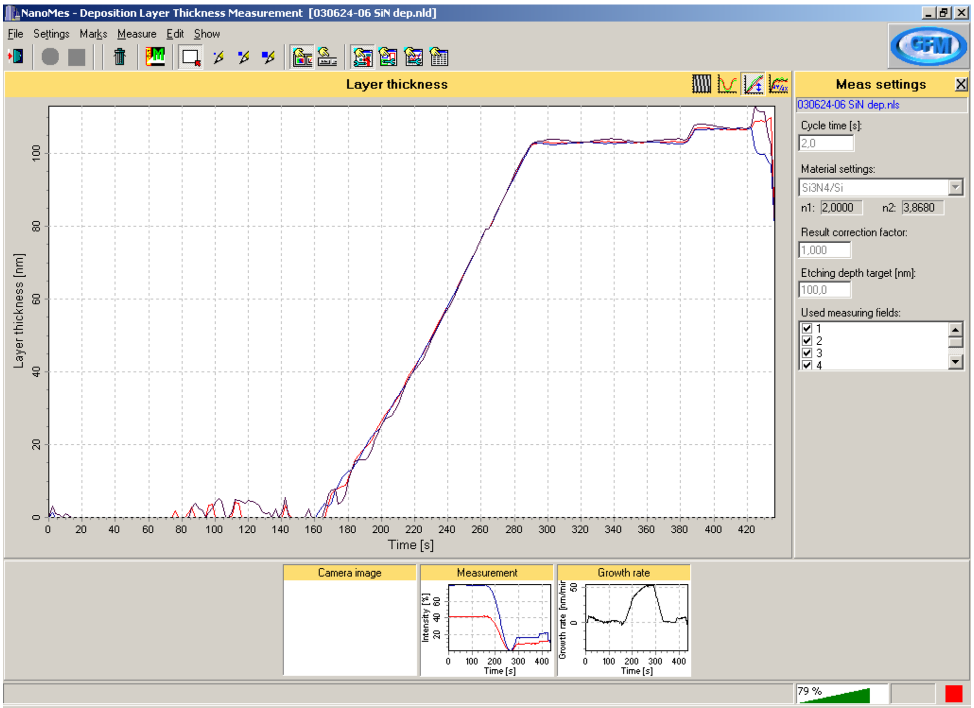
Growth rate:
10,9 nm/min

Elapsed measurement time:
436,6 s

Progress:
79,4 %

Figure 4: Graph with intensity during deposition process

In *Figure 5* the result of the analysis of the measurement in *Figure 4* can be seen.



030624-06 SiN dep.nls

Cycle time [s]:
2,0

Material settings:
Si3N4/Si

n1: 2,0000 n2: 3,8680

Result correction factor:
1,000

Etching depth target [nm]:
100,0

Used measuring fields:
☑ 1
☑ 2
☑ 3
☑ 4

Figure 5: Graph with deposited layer thickness during SiN deposition process

3 NanoMES specification

Laser-Interferometry to measure etch depth and deposited thickness of dielectric layers in situ and in real time.

Measurement of:	Etch depth Etch rate Film thickness (e.g. resist mask)
Time resolution	50 ms
Lateral resolution	3 µm (1 pixel of CCD camera)
Measuring area	1 x 0.75 mm^2 to 3.2x2.4 mm^2 (without zoom option)
Measuring wavelength	632.8 nm, HeNe laser
Vertical measuring range	Up to 10 mm
Depth resolution	≥ 3 nm
x-y stage	Manual, 50 mm x 50 mm Optional: Motorized stage
Lateral adjustment range	Typically 10 x 10 mm^2
Data presentation	2-dimensional height images time dependent presentation of etch depth, etch rate, and film thickness at different positions within the 2-dimensional images
Computer	Windows NT / 2000 / XP Keyboard, Mouse, Monitor