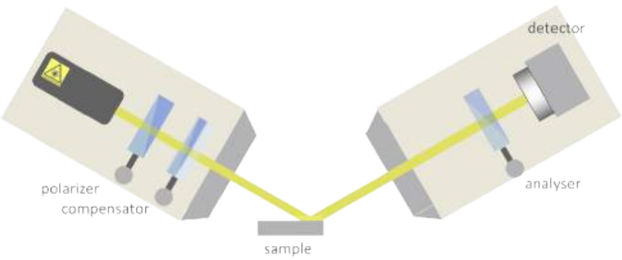
Comparison

Non-imaging and imaging ellipsometry

Why use ellipsometry?

Ellipsometry analyzes the change of polarization of light reflected from a sample and yields information about thin film layers that are often even thinner than the wavelength of the probing light itself. The change of amplitude and phase of the p and s components of the light after the reflection from the sample are dependent on film properties like thickness, refractive index, and absorption. Ellipsometry measures the change of the amplitudes and phases with the changing state of rotating polarization components. The measured values are psi and delta.

set-up non-imaging ellipsometer

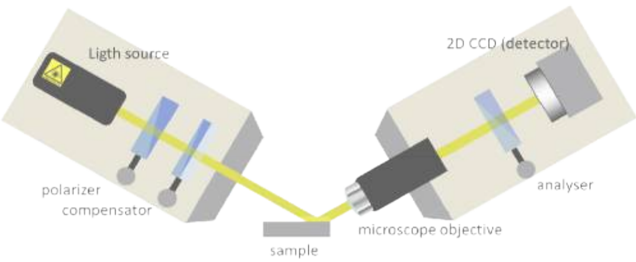


These values need to be put into a computer based model of the sample materials to calculate the thickness, refractive index, absorption, and a variety of sample properties, including morphology, crystal quality, chemical composition, or electrical conductivity.
Ellipsometry is an established technology to measure multilayer film thickness, refractive index, and absorption.

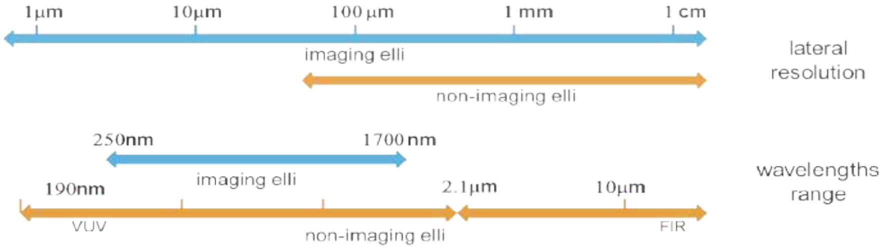
Why use imaging ellipsometry?

Imaging ellipsometry combines microscopy and auto nulling ellipsometry The microscopy aspect allows the direct visualization of your sample with an ellipsometric contrast image with a lateral resolution as small as 1 micron.
This enables resolving sample areas 1000 times smaller than most micro spot equipped non-imaging spectroscopic ellipsometers. Imaging ellipsometry permits characterization of local sample parameter variation on a microscopic scale.

set-up imaging ellipsometer



This technology can measure the same ex-situ applications as non-imaging ellipsometers, and many more. It is dedicated to applications where you have lateral structures in the range of 50mm down to 1 micron. This includes patterned samples or where you have tiny samples like tips of a cantilever



Comparison non-imaging ellipsometers to imaging ellipsometers:

The lateral resolution of non-imaging ellipsometers is determined by the spot size of the light source at the sample surface. Non-imaging ellipsometers collect reflected light from this single spot and deliver it to the detection system. Typical non-imaging spectroscopic ellipsometers have spot sizes in the range of 2 mm to 35 microns. All sample structures smaller than this resolution cannot be accurately detected. The instrument will avarage over all structures within the sampled spot. This can provide incorrect results if your sample is not completely homogeneous.
The enhanced lateral resolution of Imaging ellipsometry is a result of the combination of a high numerical aperture objective that images about a million sites on the illuminated sample area onto a high resolution 2 dimensional pixel detector array. The high numerical aperture objective and state of the art scientific grade CCD provides a resolution as small as 1 micron, depending on the wavelength of the illuminating light.
The main difference between the two technologies is the big differences in lateral resolution, where imaging ellipsometry has an enormous advantage.

The thickness resolution depends on the optical properties of the materials and it is the same for both technologies.

In addition to the higher lateral resolution, imaging ellipsometry also provides real time ellipsometric contrast images. These images allow parallel measurements on every pixel of the camera. This effect enables kinetic measurements while keeping the high lateral resolution of 1 micron.

The microscopy set-up of an imaging ellipsometer allows putting a knife edge into the beam to get rid of back side reflection of transparent substrates. The knife edge will decrease the field of view, but it allows measurements without introducing light scattering effects.

Comparison mapping ellipsometers to imaging ellipsometers:

A mapping ellipsometer is a non-imaging ellipsometer with a motorized stage. Psi and delta readings are measured at one spot and then the table is moved to another sample location and the process is repeated until enough data is collected to construct a map of the sample. The lateral resolution is determined by the spot size and the density of the sample grid. In addition to poor lateral resolution sampling time is directly related to the number of sample sites.

By contrast a nanofilm_ep4 imaging ellipsometer can take as many as one million readings in one short exposure with vastly better lateral resolution. The images obtained with the ep4 are maps that are acquired and presented much faster and with much higher resolution than any mapping ellipsometer.

Conclusion:

Imaging ellipsometry enables you to measure nearly all applications you can measure with a non-imaging ellipsometer plus structured and tiny samples and also transparent substrates.

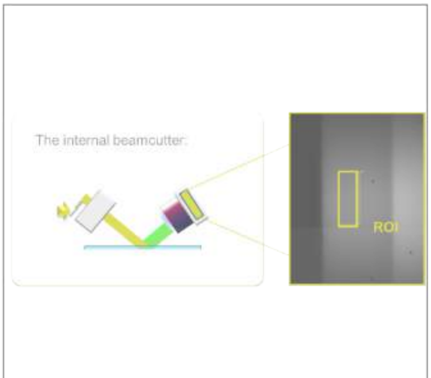
Imaging ellipsometry with its lateral resolution as small as 1 micron is dedicated to the investigation of structured samples in the range of 1 to 50 microns as well as tiny samples.

Further advantages:
Using the integrated knife edge illumination capability you are also able to measure the surface of a transparent substrate without contributions from backside reflection.

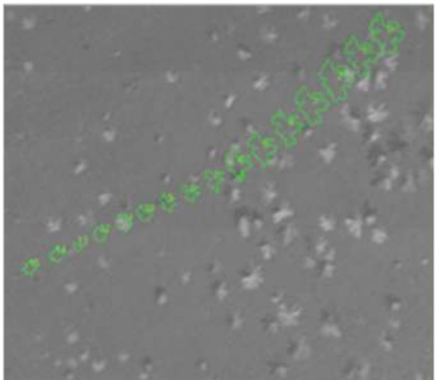
The unique region of interest concept allows the parallel investigation of any areas within the field of view.

Unique possibilities with imaging ellipsometry:

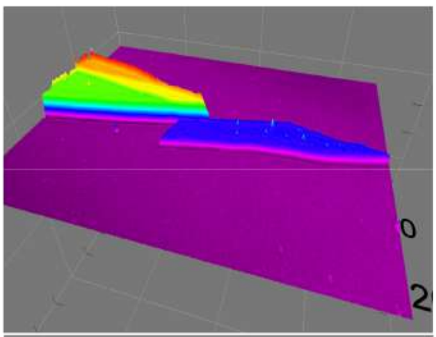
- measurements with a lateral resolution as small as 1 micron
- real time elliposometric contrast images of your surface
- Parallel measurements within the field of view.
- imaging ellipsometry in the wavelenght range from 250 nm to 1700 nm
- Measurements on thin transparent substrates by using a knife edge illumination
- Measurements for liquid/ liquid interfaces by using a light guide



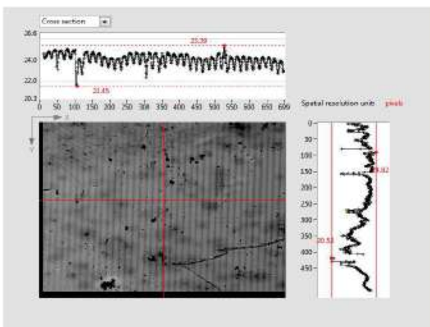
New internal knife edge option



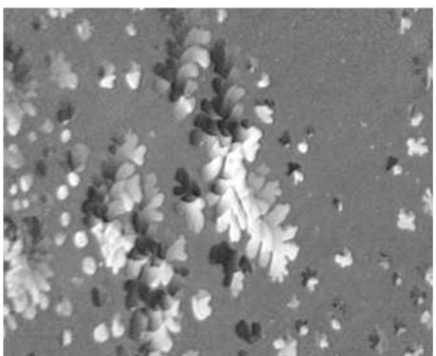
In detail: regions of interest with variable shape



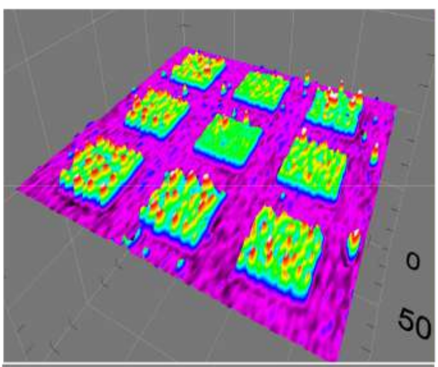
Delta map graphene on SiO2 Si_100



As_2S_3 Pattern



Real time image of a floating mono-layer (DMPE), d ~ 2 nm, AOI = 53,1°



Thickness map SAM pattern