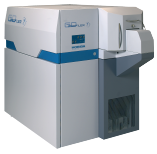
HORIBA Scientific

DiP

Glow Discharge Optical Emission Spectrometry and Differential Interferometry Profiling for thickness determination of SiOxNy layers



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Motivation

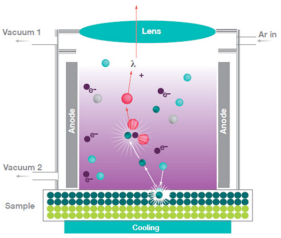
Thin films of silicon oxynitride (SiO_xN_y) can be grown using a variety of plasma deposition techniques. Alternative to silicon dioxide and silicon nitride, they have the advantages of low leakage currents and high thermal stability. The accurate control of deposition parameters can be used to widely tune both physical and chemical properties, such as:

- Optical transmission;
- Dielectric function.

By **changing the nitrogen/oxygen ratio**, their refractive index can be continuously varied between 1.45 (SiO_2) and 2.0 (SiN).
Application: gradient-index optics components.

GDOES

The GDOES analysis relies on the **sputtering of a representative area of the material of interest** by a dense plasma, operated in pulsed RF mode.
The same plasma simultaneously excites the sputtered species producing a characteristic light which is analysed by a high resolution optical spectrometer.

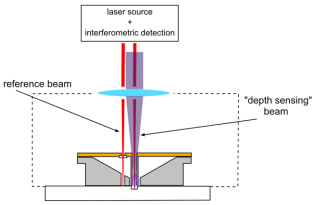


DiP

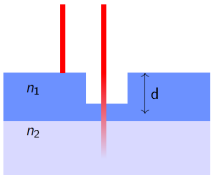
Now available inside the GD instrument: a differential interferometry profiler (DiP), giving access to:

- Crater depth as a function of time
- Variations in reflectivity

This solution is based on the relative measurement between two laser beams reflected inside the GD crater and at the surface close to the crater.



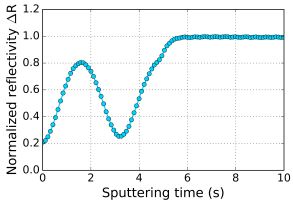
Determining the thickness for transparent materials



Using DiP for the thickness determination of transparent materials is not straightforward. Indeed, in this case there is no linear relation between the phase shift of the laser beams and the depth of the crater due to multiple reflections at the different interfaces.

The solution relies on the fact that DiP can monitor variations in reflectivity!

$$\Delta R \propto \cos\left(\frac{4\pi nd}{\lambda}\right)$$

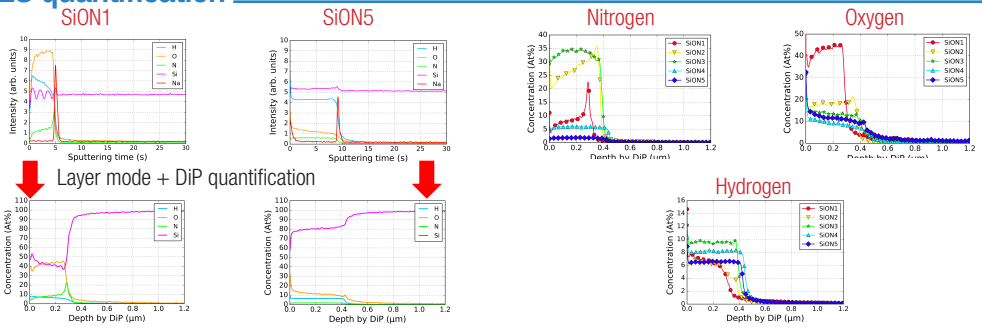


SiOxNy by ICP-PECVD @ 70° : GDOES quantification

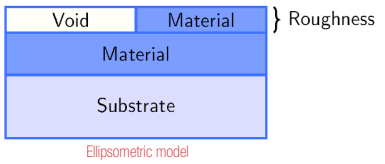
The N_2O/SiH_4 ratio is varied from 2 to 0.1, in order to obtain an evolution of the optical properties

Samples	Optical indices @635 nm	
	n	k
SiON1	1.47	0
SiON2	1.49	0
SiON3	2.4	0.03
SiON4	3.09	0.07
SiON5	3.27	0.09

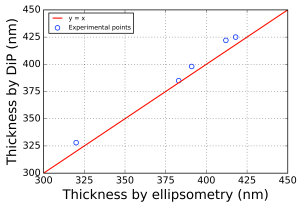
*Reference sample quantified by RBS



DiP Vs Ellipsometry



Usually, the **reference technique** for thickness determination of transparent layers is **ellipsometry.**
Ellipsometry measurements were done at HORIBA Scientific and data analysis was done using the DeltaPsi2 software.
A simple layer + roughness model was used.
The obtained thicknesses are then compared with the results obtained by DiP, showing an excellent agreement.



Conclusion

RF-GDOES is an efficient technique for elemental composition determination of both conductive, insulating and hybrid materials.
It allows the measurement of both light elements (such as H @ λ = 121 nm) and alkali elements (such as Na @ λ = 590 nm).

Now available: online interferometer built in the GD instruments (DiP), giving access to:

- Crater depth as a function of time
- Erosion rate
- Layer thickness
- ΔR

DiP is ideal for reflective samples, however new applications involve transparent layers.
→ Excellent agreement with ellipsometry

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