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DiP

Characterization of CIGS solar cells through Glow Discharge Optical Emission Spectrometry and Differential Interferometry Profiling

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Motivation

The chemical engineering of the absorber layer in CIGS solar cells is still a permanent challenge.
Moreover, it is known that
(i) the variation of composition,
(ii) the diffusion of impurities and
(iii) the nature of interfaces are critical for the performance of these devices.

By coupling multiple characterization techniques it is possible to gain useful insights leading to an optimization of their engineering process.

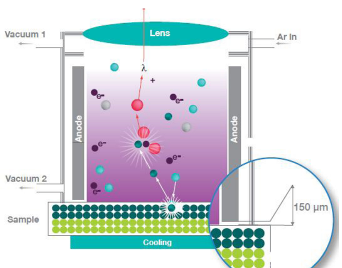
Radio Frequency Glow Discharge Optical Emission Spectrometry (RF-GD OES) provides a fast elemental depth profile.

Moreover, with its most recent advance, the real time measurement of the depth of the sputtered crater, obtained thanks to the addition of a **Differential Interferometry Profiling (DiP)** module within the GD source, it is also possible to have direct access to layers thickness and erosion rates.

GDOES

The GD OES 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 light which is analysed by a high resolution optical spectrometer.

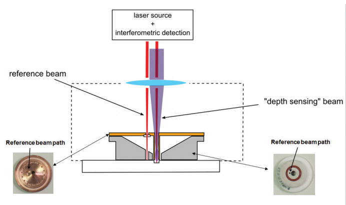


Principle of GD sputtering

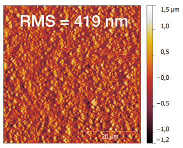
DiP

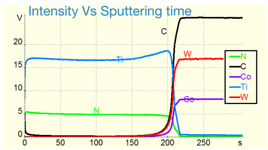
The **direct and continuous measurement of the crater depth** is now achieved thanks to an interferometric method (DiP).

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



Typical application: rough sample, PVD-deposited TiN coating





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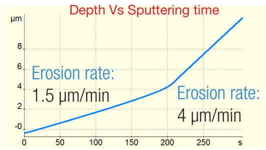
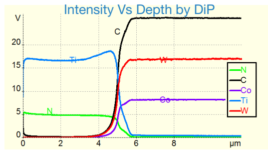
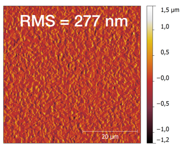


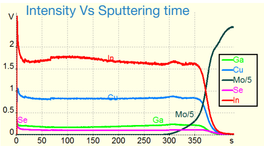


Total depth:
- 11.6 µm by DiP
- 11.5 µm by profilometer

CIGS: before chemical etching

CIGS/Mo/glass bars were cut into 2 cm x 2 cm samples.





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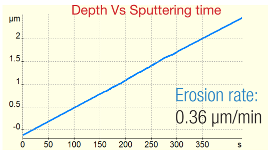
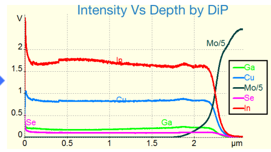


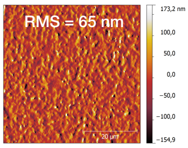


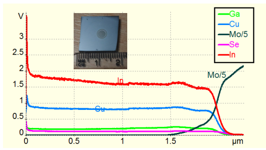
Total depth:
- 2.52 µm by DiP
- 2.57 µm by profilometer

CIGS: after chemical etching

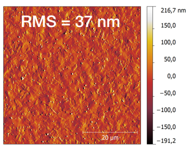
Using a HBr:Br_2 = 0.2:0.02 mol/L solution, 3 samples were chemically etched for 2 min, and 3 samples were chemically etched for 5 min.

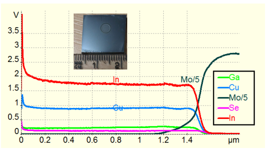
2 min





5 min





Etching time	Sample	DiP (µm)	Profilometer (µm)
2 min	A	2.30	2.15
	B	2.05	2.11
	C	2.35	2.1
5 min	A	1.80	1.55
	B	1.81	1.71
	C	1.70	1.61

Conclusion

Now available in GD-OES:

Direct measurement of crater depth!

On line interferometer built in the GD instruments:

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

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