Features and Benefits of Pulsed RF GD OES for fast control of LED manufacturing process

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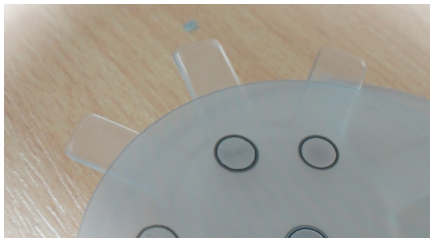
Abstract

Pulsed RF Glow Discharge Optical Emission Spectrometry offers Ultra Fast Elemental Depth Profiling capability of thin and thick films with excellent depth resolution allowing quick feedback on process at several stages of LED elaboration.

Key words

LED, Active layer, Thin films, Optimisation of the deposition, Depth Profile Analysis, Gradients, Interfaces, GD OES, Pulsed RF source.

Introduction



GDcrater on a GaN/Sapphire

LED are multilayered samples, usually deposited on sapphire. The active layers (Multiple Quantum Well) are extremely thin (a few nm) and are embedded below a GaN layer.

Classical surface techniques (SIMS, XPS) could nicely resolve ultra thin layers when they are present at the surface of a sample but the sputtering time to reach the active layers of a LED will take hours. On the other hand, GD sputters extremely fast and could achieve excellent depth resolution even on embedded layers.

SIMS or XPS analysis = hours
GD analysis = seconds

Instrumentation

The GD Profiler 2 couples an advanced Pulsed RF Glow Discharge Source to a high resolution, wide spectral range Optical Emission Spectrometer.

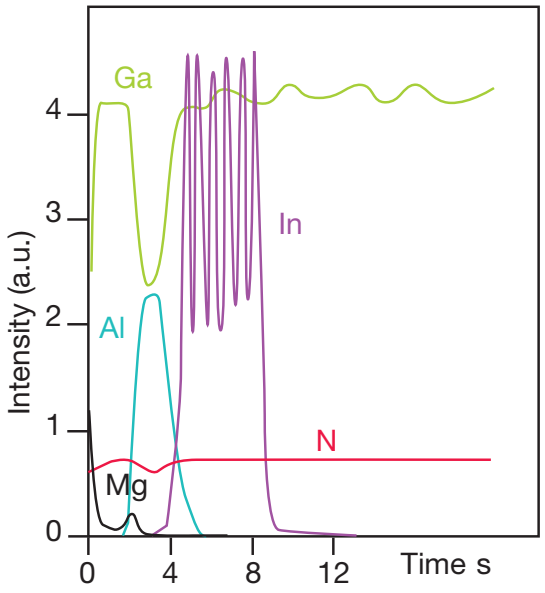
The source permits a precise and fast sputtering of a representative part of the material investigated (typically 4 mm in diameter). Pulsed RF operation is crucial to achieve high depth resolution and to avoid unwanted diffusion of the elements during the measurements.

The spectrometer simultaneously measures all elements of interest (In, Ga, N, Al, P, Mg, Si, C, O, H etc) as a function of the sputtered depth.

GD Profiler 2

Key Features

- ✓ SPEED : Less than 3 minutes to profile an entire LED and reach the sapphire substrate
- ✓ EASE of USE: The GD source does not require any UHV, the sample to analyse is simply placed against an o'ring facing the anode tube in which the plasma is confined
- ✓ DEPTH RESOLUTION : Nanometre - for the active layers embedded below the top GaN

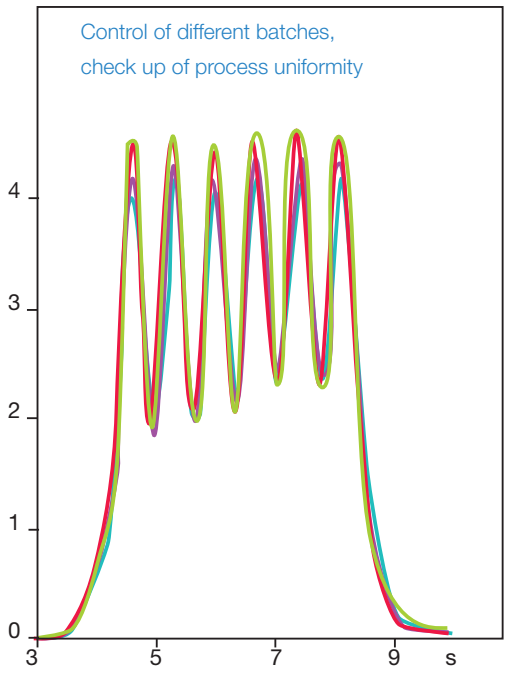


Results

Most results obtained were done under non disclosure agreement and therefore cannot be shown.

The following results however give an idea of the potentialities of the technique. It is destructive but extremely fast so a test sample should be made available for each deposition batch but the GD result provides an immediate feedback to the deposition process and permits to identify and react to variations in real time.

Of notable interest in the GD result is the In signal from which the deposition process of the active layers can be checked. Variations in the process result in changes in the In profile. Of interest also is the control of the Mg signal.



Conclusion

The deposition of the active multilayers in a LED is a complex process that needs careful control. GD offers a quick way to control each batch and to quickly react to variations.

Control each batch: save money & save time.

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