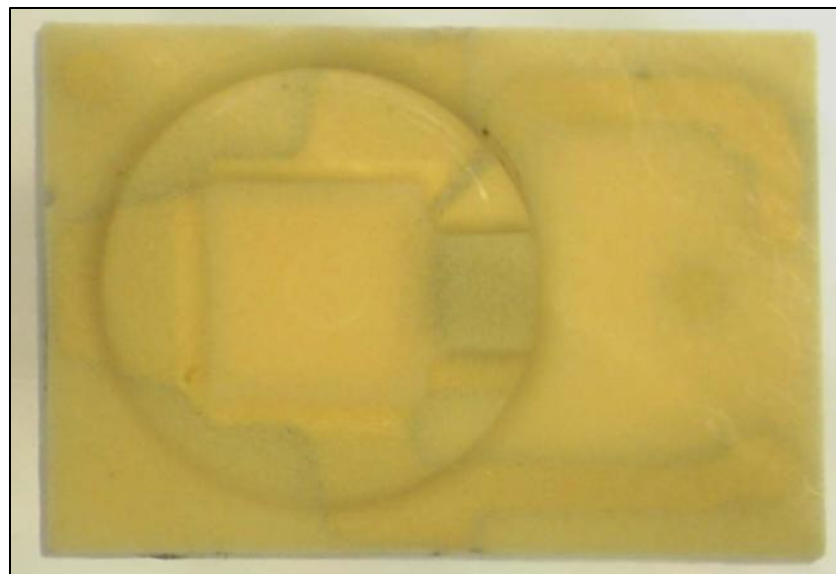


Reverse Costing analysis



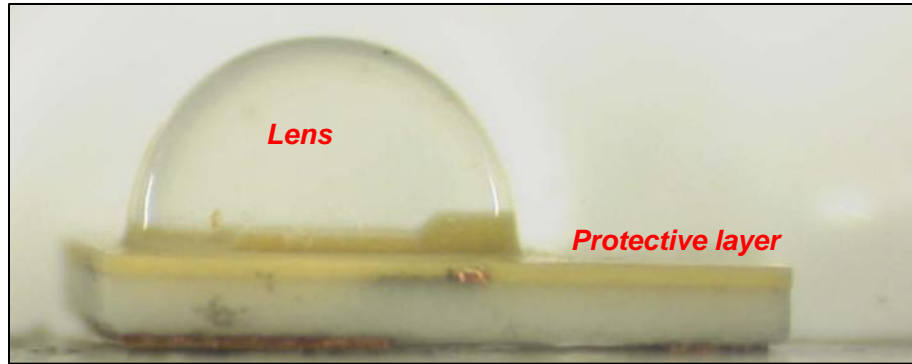
Philips Lumileds Luxeon Rebel 100lm CW (Ref. LXML-PWC1-0100)

April 2011 - Version 1

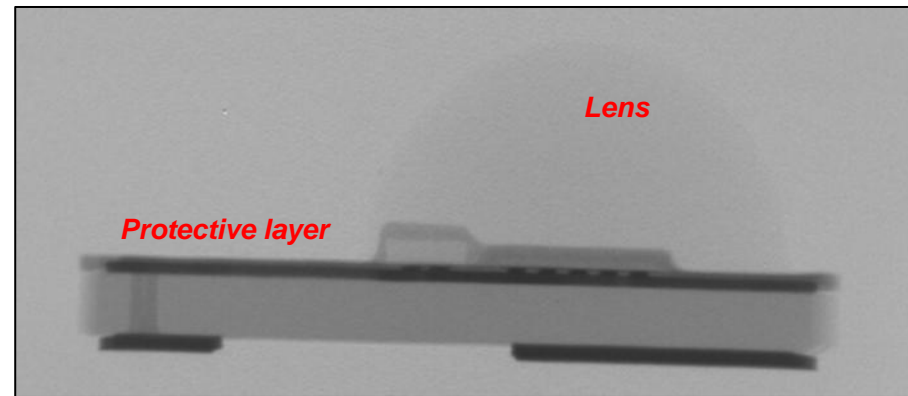
Written by: Sylvain HALLEREAU

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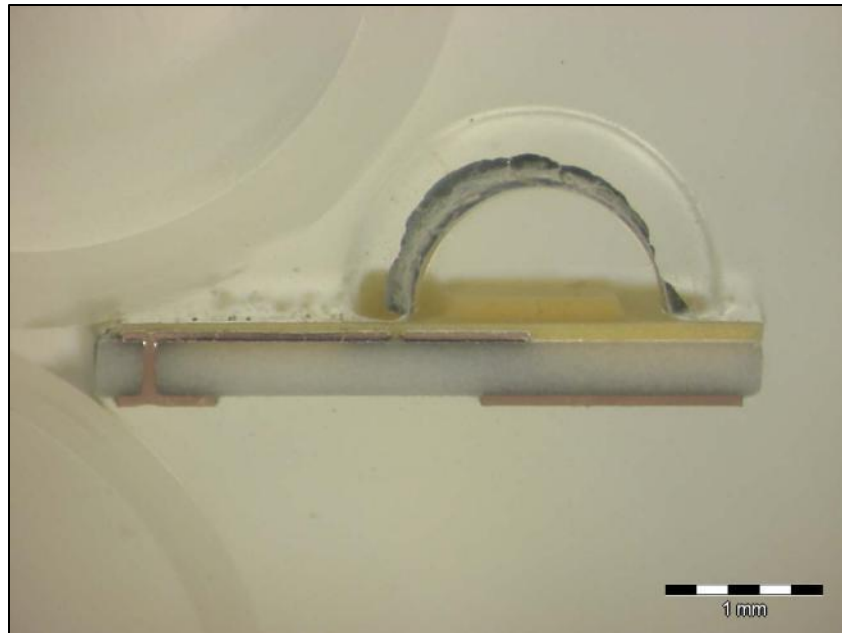


Optical view :

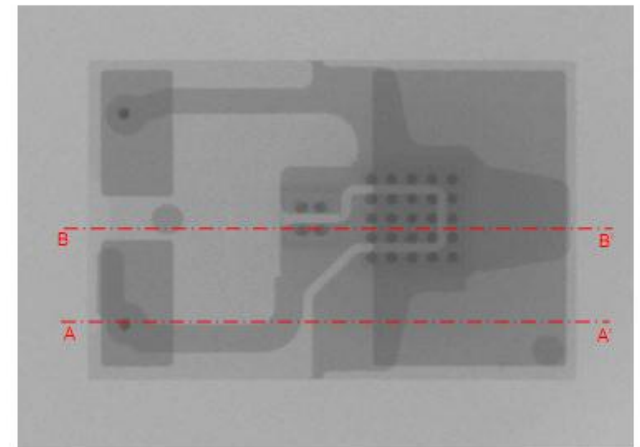


X-ray view :

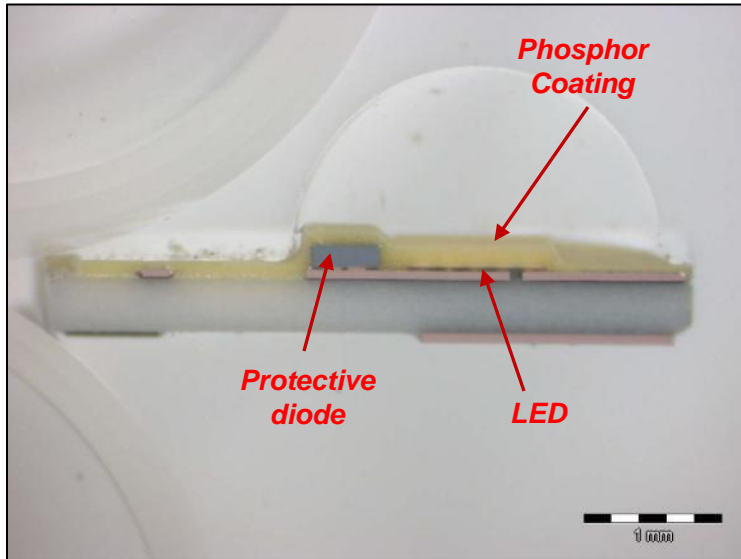
The lens and the protective layer are molded on the ceramic substrate.



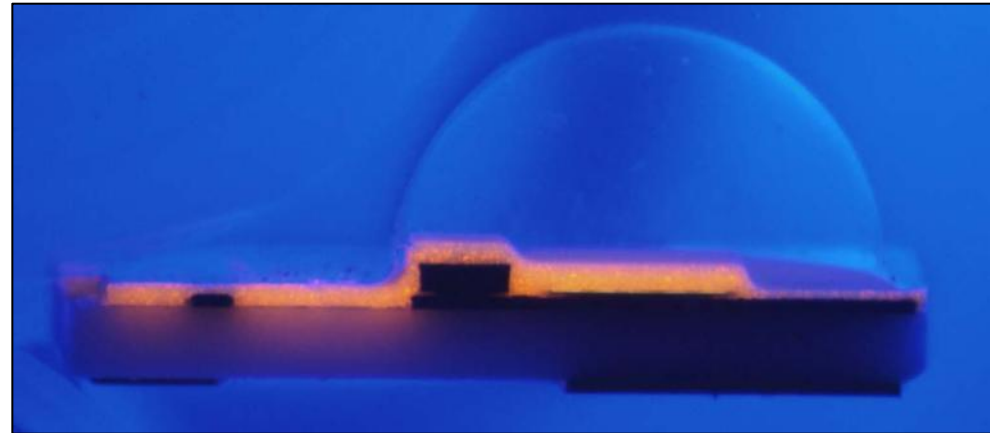
Optical view : cross-section AA'



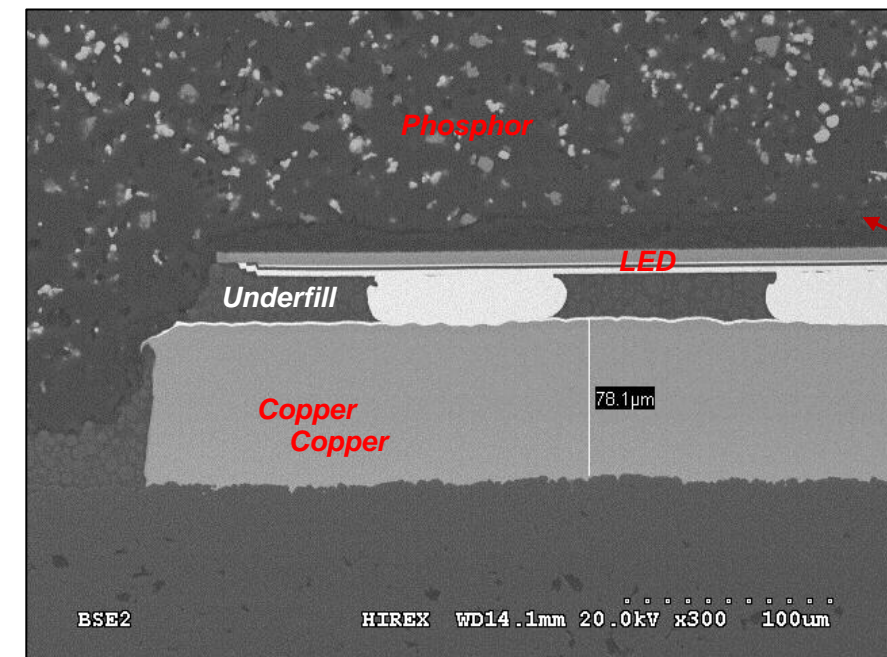
X-Ray view : cross-section location



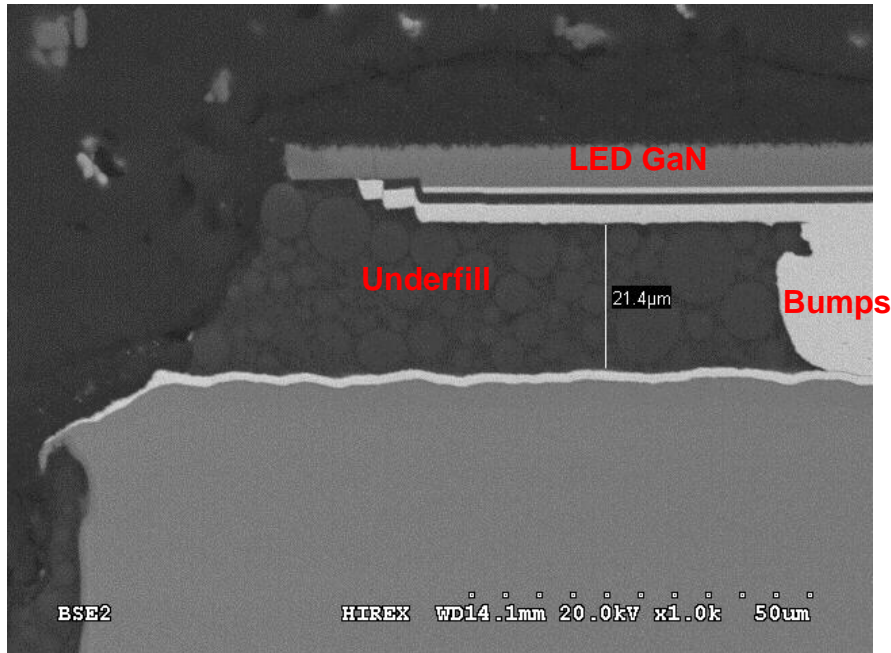
With most of the lens polished away, the LED die, a small silicon protection chip (arrow), and the top side interconnect are more clearly seen. A conformably coated phosphor of a green-yellow colour covers the entire substrate and both dies on this cool white version. Notice the absence of wirebonds.



Optical view : cross-section under UV light. The yellow phosphor is clearly visible.

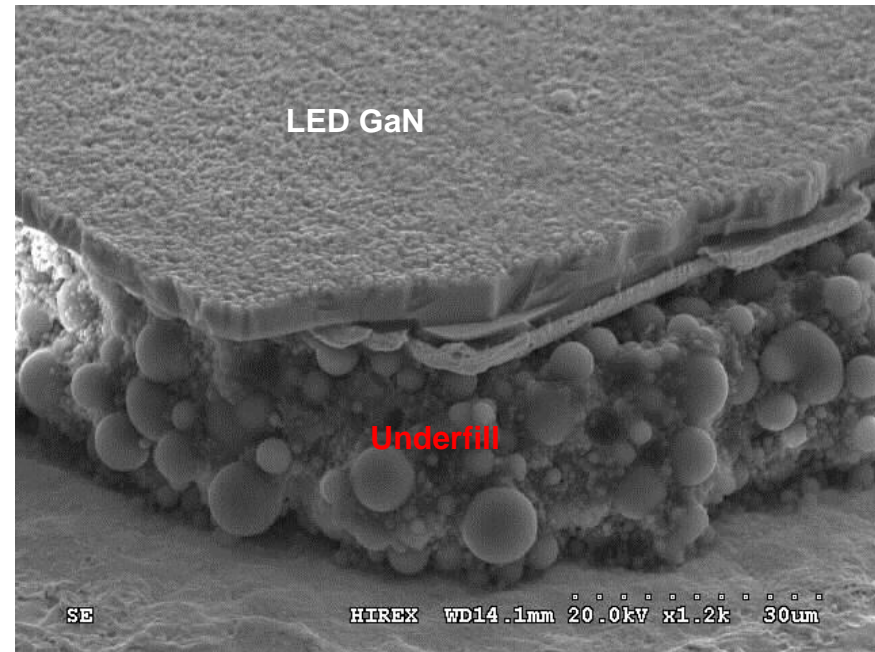


Thin silicone protective layer



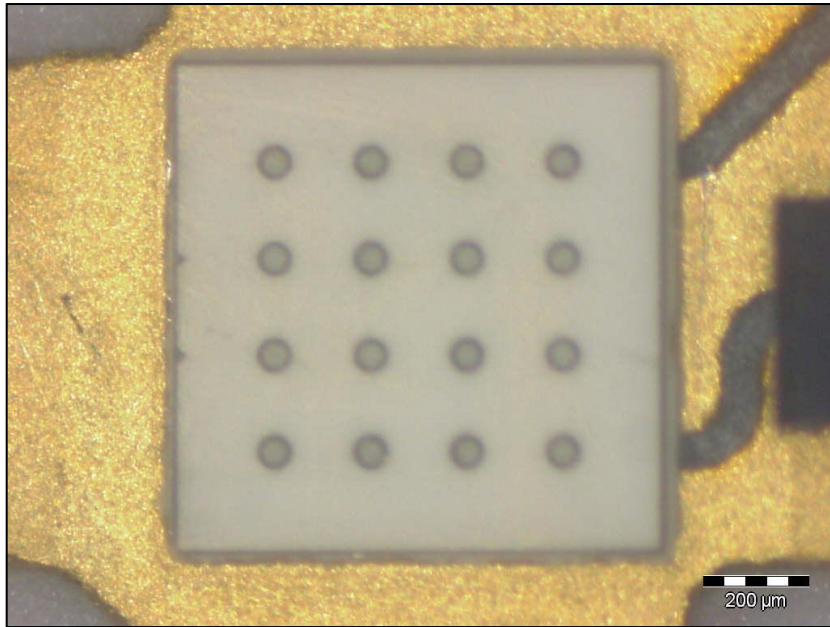
SEM images of cross-section through die bumps with an underfill.

SEM image of the LED edges. The underfill is visible under the GaN LED.



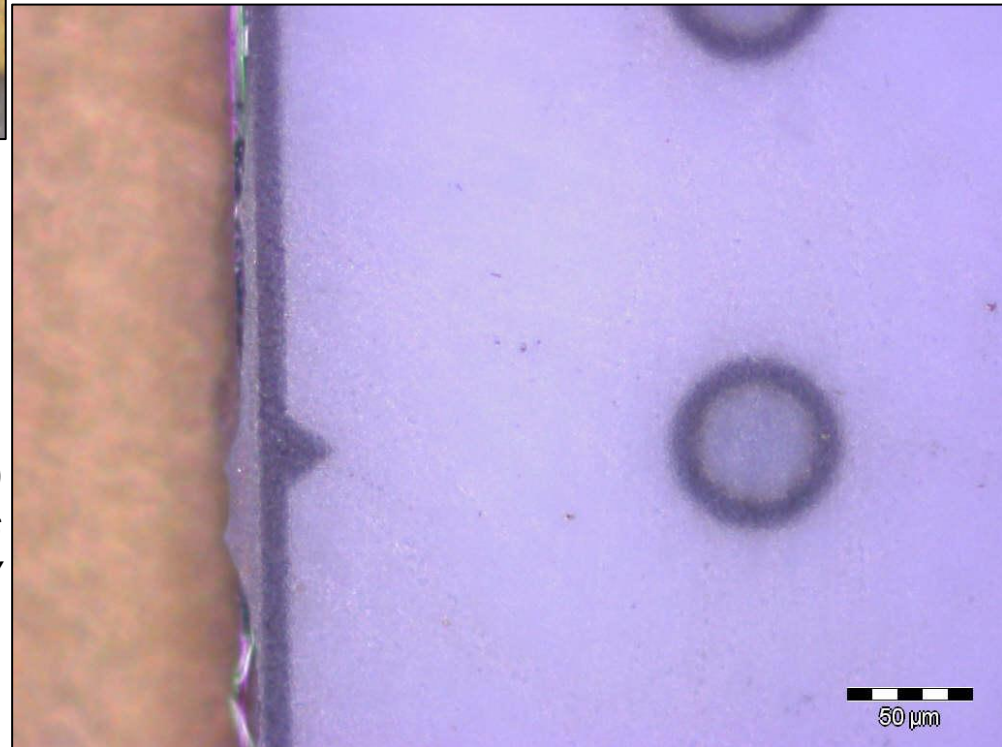
SEM cross-section showing the underfill between two gold bumps

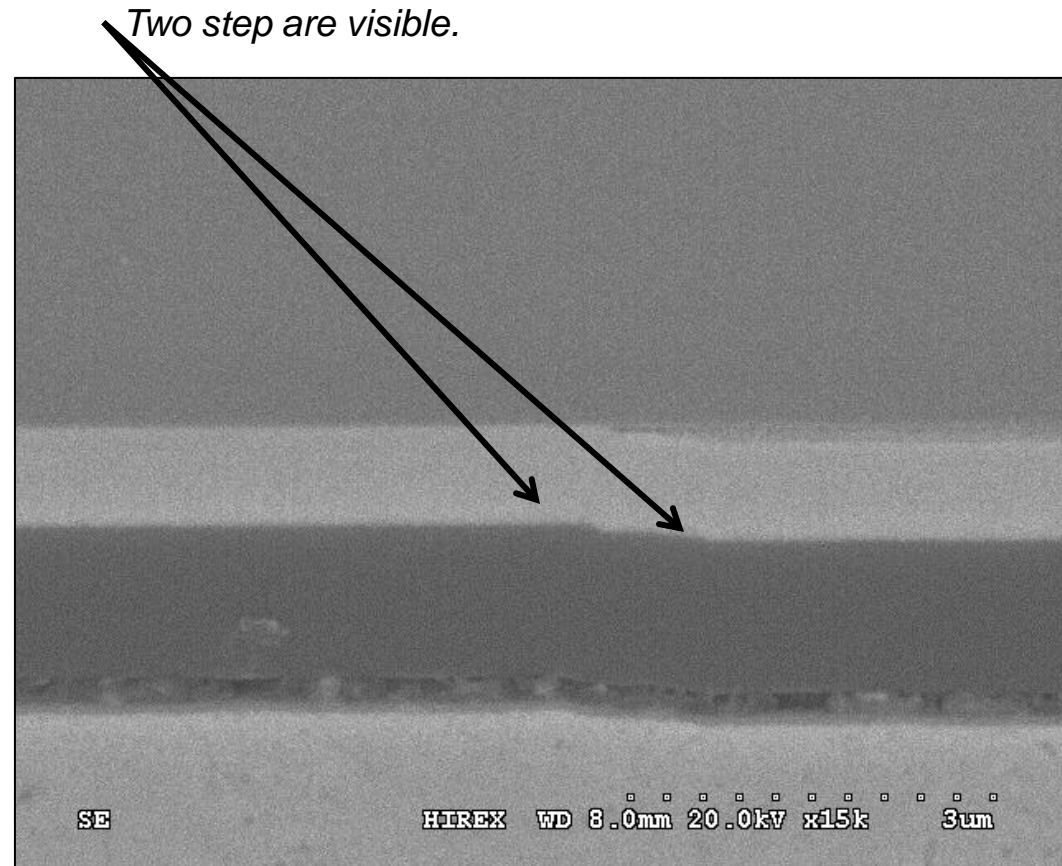
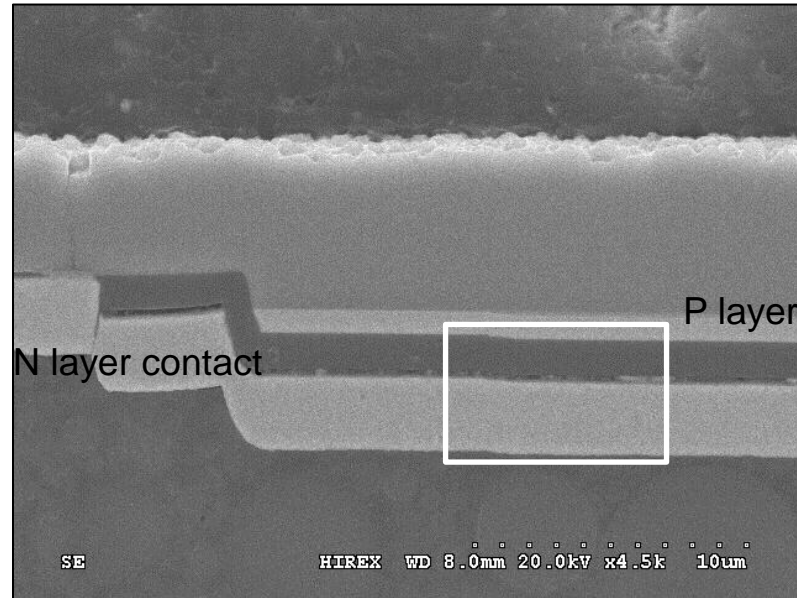
The die is underfilled with a composite material identified by EDX to be silicone based. It has an extremely high volume fraction of spherical filler particles thought to be composed of silica (glass). The underfill material is not rigid and does not adhere to the die or package surface strongly.

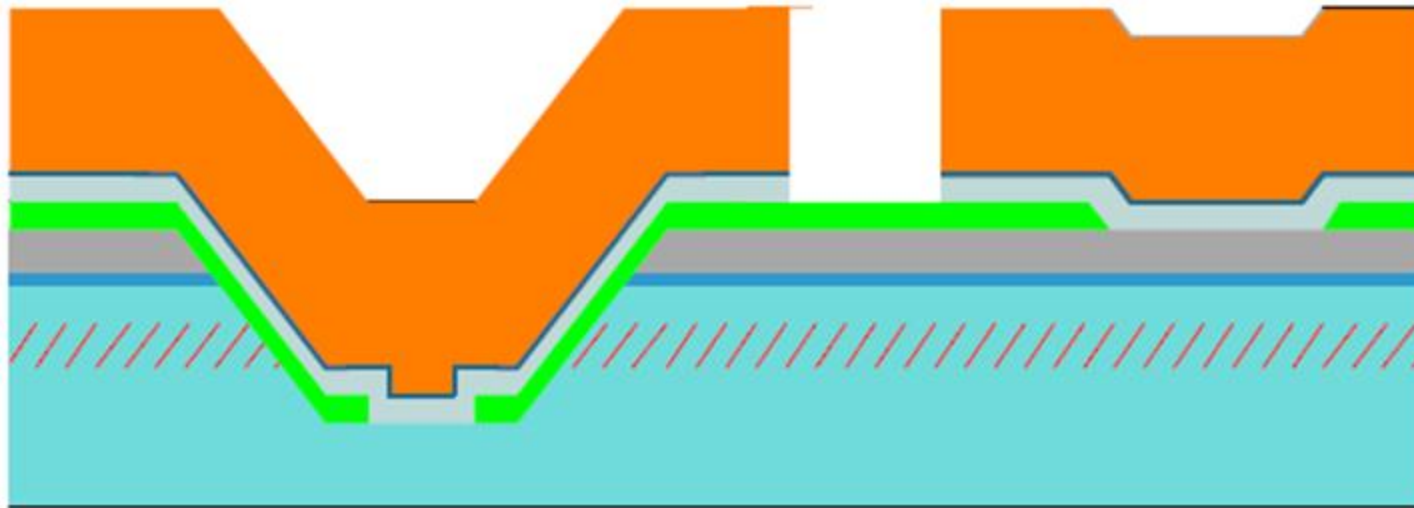


Back view of semiconductor die

Close up view of a contact (left) and of the edge seal (right) as viewed through the die. They appear to have identical structures.

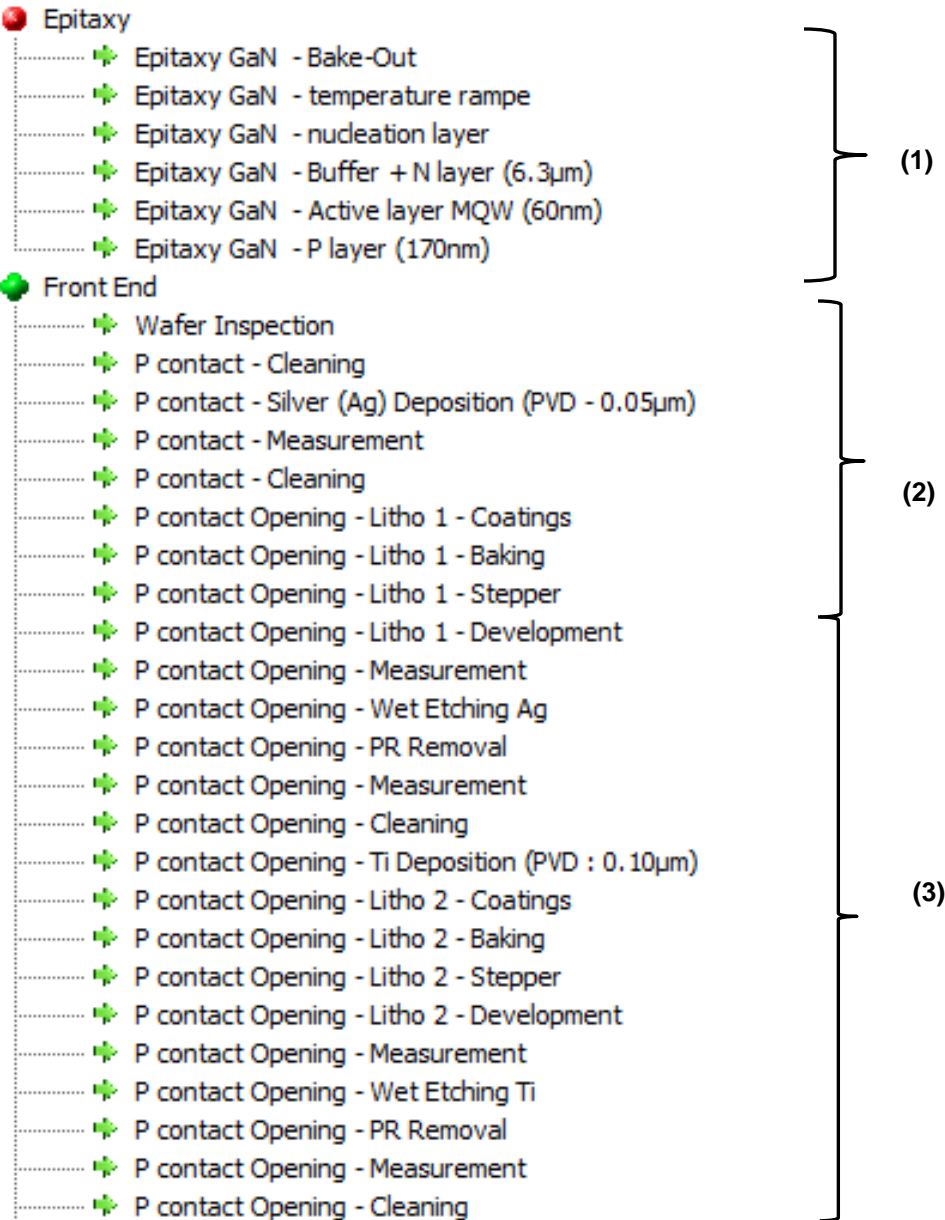






	Die		Substrate
	Passivation		Passivation
	Solder		Substrate
	Substrate Layer		p-n Junction Region

Schematic diagram of LED device structure. Note that this is inverted from the SEM images, as the die is flip chip.



The main parts of the process:

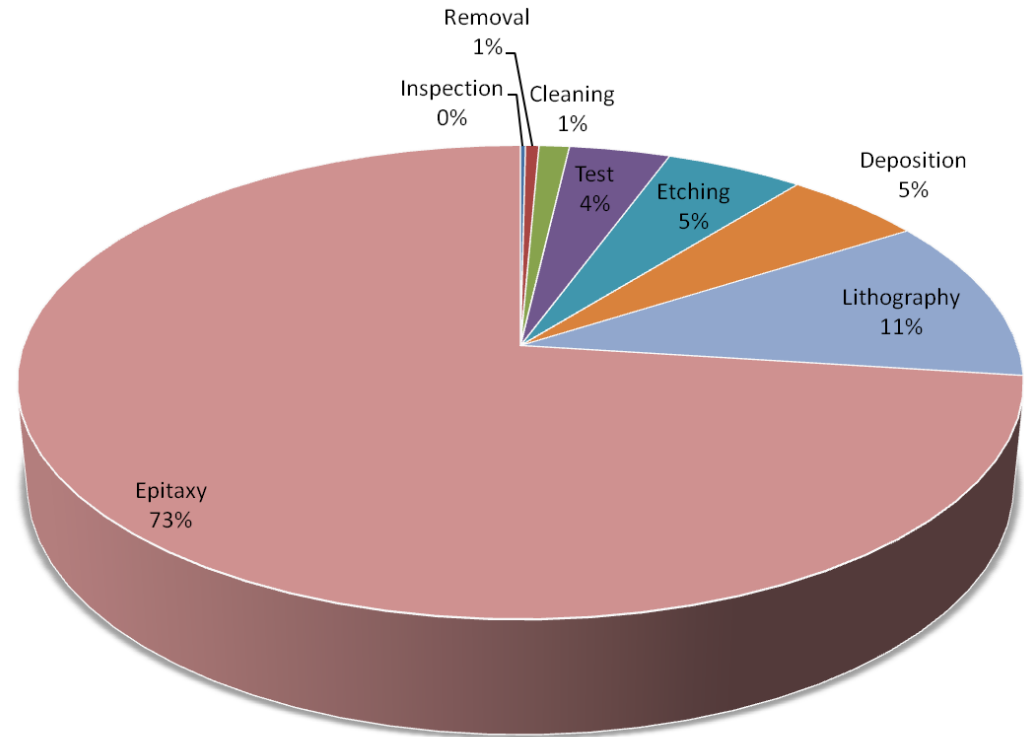
- (1) GaN layer composed by buffer GaN, n-GaN, MQW and p-GaN layers are grown on a sapphire substrate wafer.
- (2) The p-doped surface is metalized (Ag), mirror layer.
- (3) Ti layer deposition.

Equipment Family	Equipment Cost	Breakdown

- The main part of the equipment cost is due to the Epitaxy step (73%) because it is a long duration step with an expensive equipment.

- Details of the equipment cost per step are given in the Excel Spreadsheet.

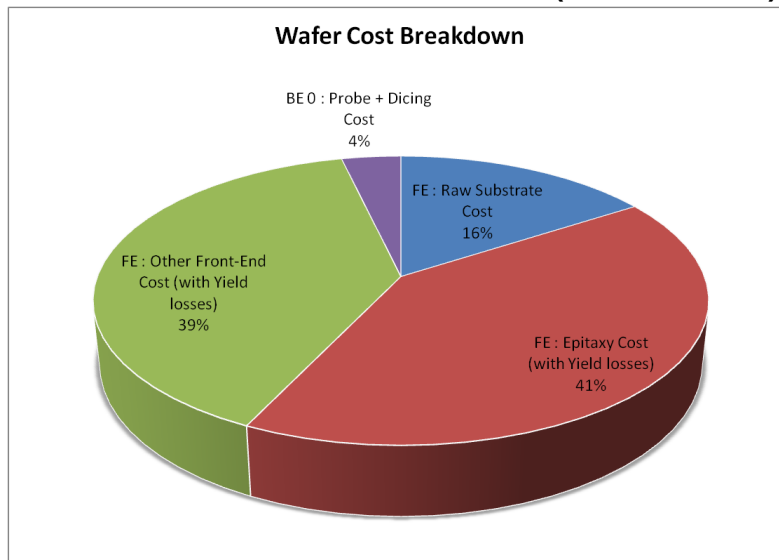
Wafer Equipment Cost Breakdown per Familiy



Wafer cost per Equipment Family

	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
FE : Raw Substrate Cost						
FE : Epitaxy Cost (with Yield losses)						
FE : Other Front-End Cost (with Yield losses)						
BE 0 : Probe + Dicing Cost						
TOTAL Wafer Cost						
Nb of potential dies per wafer						
Nb of good dies per wafer						
FE : Raw Substrate Cost						
FE : Epitaxy Cost (with Yield losses)						
FE : Other Front-End Cost (with Yield losses)						
BE 0 : Probe + Dicing Cost						
BE 0 : Yield Loss						
Die Cost						

Die Cost Breakdown (Medium Yield)



- The final LED die cost ranges from \$xxx to \$xxx according to yield variations.
- The Back-End level 0 (including the steps : Probe Test & Dicing) represents 4%.
- The yield losses cost represent 26% of the total manufacturing cost.
 - The Die cost includes the rejects at probe test and dicing.
 - The yield losses represents the defective dies scrapped.



- Reverse costing analysis represents the best cost/price evaluation given the publically available data, completed with industry expert estimates.
- These results are open for discussion. We can re-evaluate this circuit with your information. Please contact us:

A graphic containing contact information for SYSTEMPlus CONSULTING. It features the company logo, address, phone number, email, and website, set against a background of a stylized map of Europe with concentric circles radiating from the location of Nantes.

The logo for SYSTEMPlus CONSULTING, featuring a stylized globe icon to the left of the text. 'SYSTEMPlus' is in blue and 'CONSULTING' is in red.

Address :
9 rue Alfred Kastler
BP 10748
F-44307 Nantes Cedex 3
FRANCE

Phone +33 240 180 916

info@systemplus.fr
www.systemplus.fr

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