

## Why Lumileds' LEDs?



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Aug 07, 2012

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- Lumen maintenance
- Forward voltage
- Flux degradation with temperature (H/C factor)
- Electrostatic discharge (ESD)
- Moisture sensitivity level
- Mechanical robustness

# Lumen Maintenance

- What is lumen maintenance?
- All light sources will experience a degradation in light output over time
- For Philips Lumileds LEDs this degradation is gradual and occurs because of a reduction in light emitting efficiency or reduction in the transmissivity within the optical path of the LED
- The characteristics of this gradual degradation is called lumen maintenance

# Lumen Maintenance

Lumen maintenance 101.37%,  
 $\Delta u'v'$  0.0015 at 6k hours

Lumileds  
 LUXEON  
 Rebel ES

	0.5A	0.7A	1A
120C	> 54,000	> 54,000	
105C	> 54,000	> 54,000	> 54,000
85C	> 54,000	> 54,000	> 54,000
55C	> 54,000	> 54,000	> 54,000

Lumen maintenance 101.79%,  
 $\Delta u'v'$  0.0009 at 6k hours

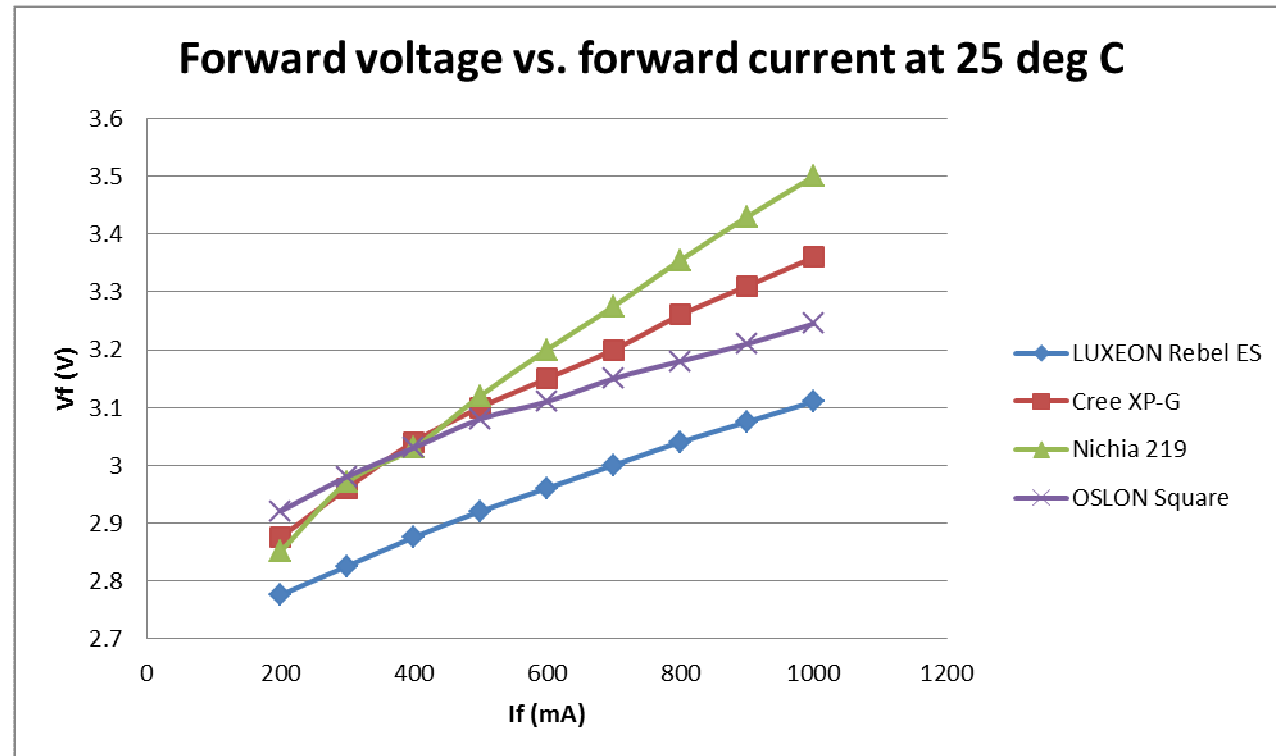
= Limited by TM-21 6x rule.

Cree XP-G

Case Temp. [T <sub>s</sub> ]	Ambient Temp. [T <sub>A</sub> ]	Drive Current [I <sub>F</sub> ]	Average Lumen Maintenance at 6,000 hours	Average Chromaticity Shift ( $\Delta u'v'$ ) at 6,000 hours	Reported TM-21 L70 Lifetime
45°C	45°C	500 mA	101.5%	0.0028	L70(10k) > 60,500 hrs
55°C	55°C	500 mA	100.7%	0.0028	L70(10k) > 60,500 hrs
85°C	85°C	500 mA	101.1%	0.0025	L70(10k) > 60,500 hrs
55°C	55°C	1000 mA	100.0%	0.0028	L70(10k) > 60,500 hrs
85°C	85°C	1000 mA	99.0%	0.0035	L70(10k) > 60,500 hrs
105°C	105°C	1000 mA	97.4%	0.0032	L70(6k) > 36,300 hrs

Osram  
 OSOLON  
 Square

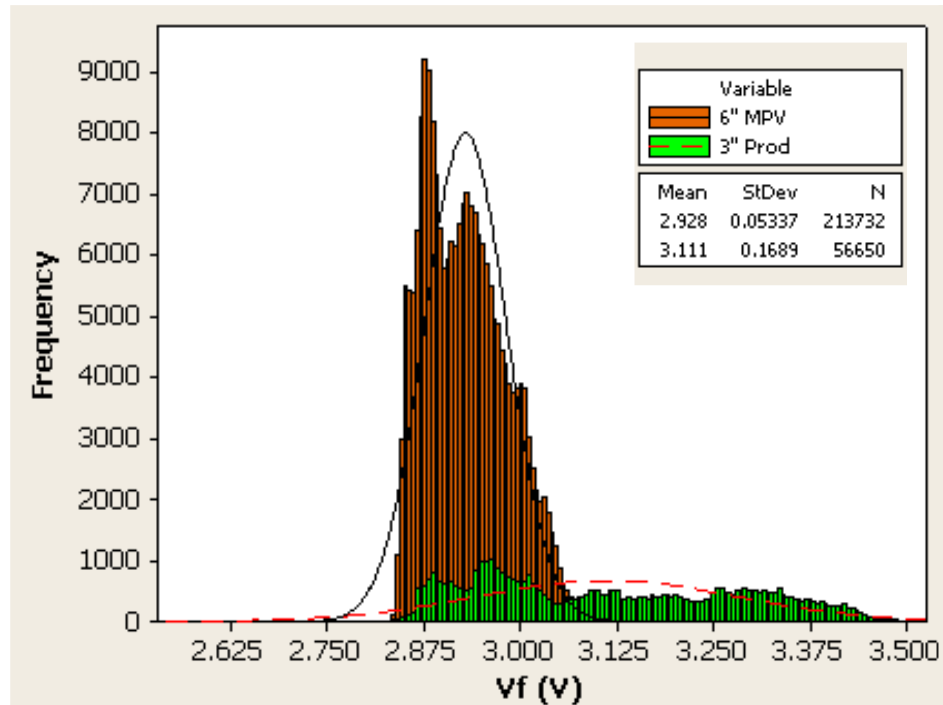
# Forward Voltage



LUXEON LED has lower forward voltage performance compared to competitors

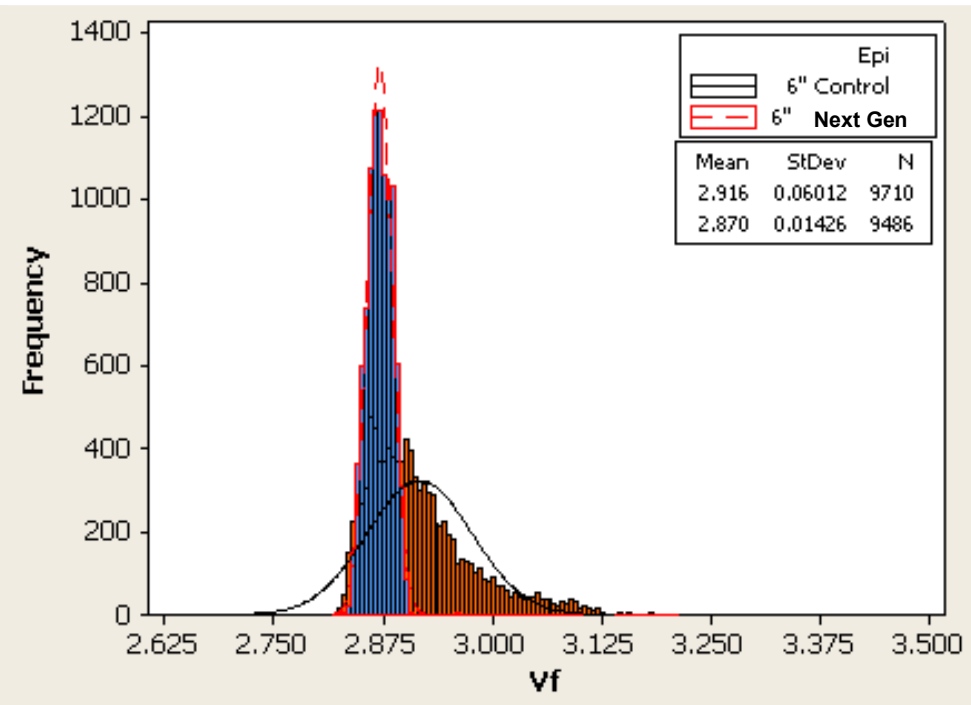
# Forward Voltage

3" to 6" reduced Vf distribution



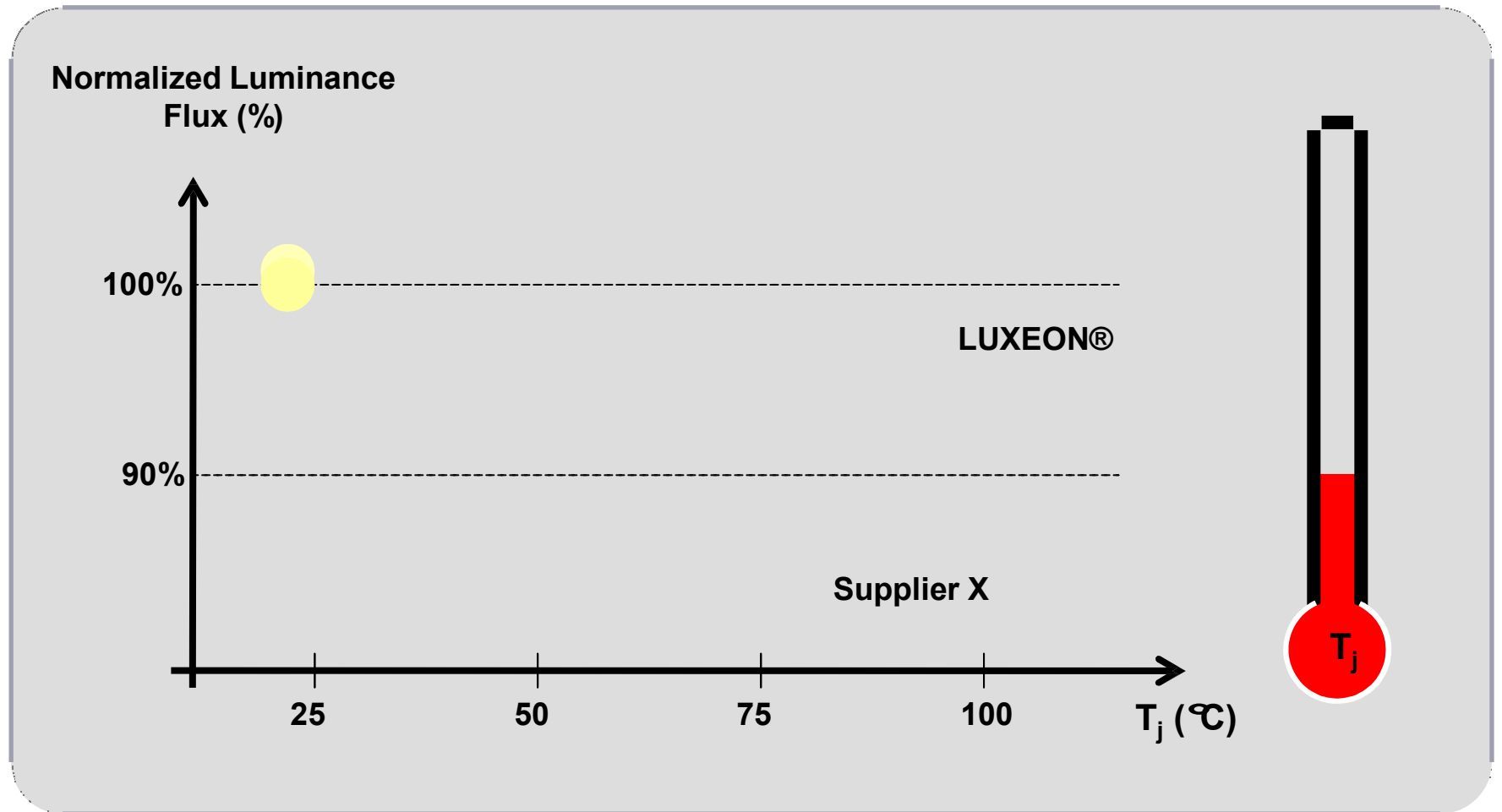
- 3" → 6" wafer size allows improved mfg equipment and process control
- Lower Vf and much narrower distribution

Next Gen EPI further reduces Vf distn

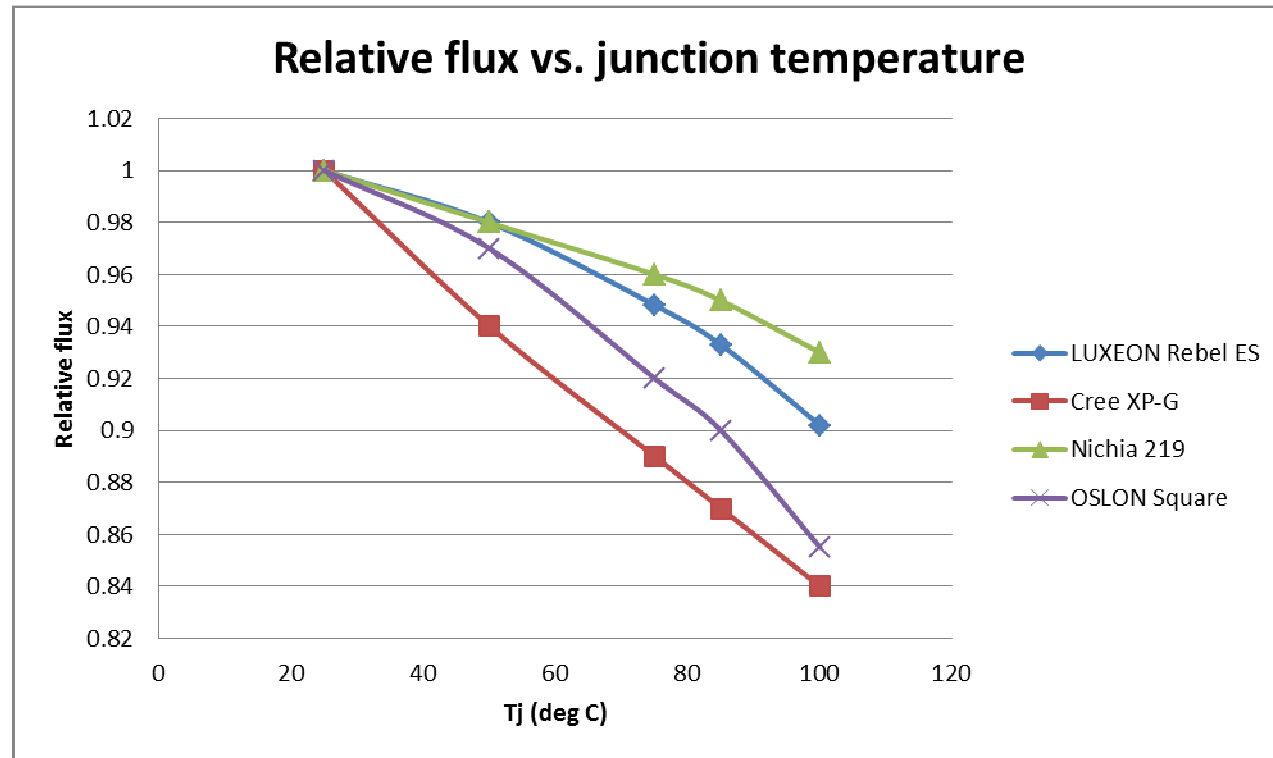


- 6" current EPI → 6" Next Gen EPI
- 10x overall reduction in one sigma

# Flux degradation with temperature (H/C factor)



# Flux degradation with temperature (H/C factor)



LUXEON Rebel ES and OSLO Square are tested at 700mA, while Cree XP-G and Nichia 219 are tested at 350mA



# Electrostatic Discharge (ESD)

- Another important usage and practical factor is Electrostatic Discharge
- LUXEON Rebel ES has a JEDEC ESD classification of 3B

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## 6 Classification criteria

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All samples used must meet the test requirements of section 4 up to a particular voltage level in order for the part to be classified as meeting a particular sensitivity classification.

CLASS 2: Any part that passes after exposure to an ESD pulse of 2000 V, but fails after exposure to an ESD pulse of 4000 V.

CLASS 3A: Any part that passes after exposure to an ESD pulse of 4000 V, but fails after exposure to an ESD pulse of 8000 V.

CLASS 3B: Any part that passes after exposure to an ESD pulse of 8000 V.

- Cree

ESD classification (HBM per Mil-Std-883D)			
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			Class 2
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- Nichia

Electrostatic Discharges	JEITA ED-4701 300 304	<u>HBM, 2kV, 1.5kΩ, 100pF, 3pulses,</u> alternately positive or negative
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- Osram

**ESD-withstand voltage:** 8 kV acc. to  
JESD22-A114-F

# Moisture Sensitivity Level

- If moisture is absorbed into a package, cracks or delamination may occur during reflow.

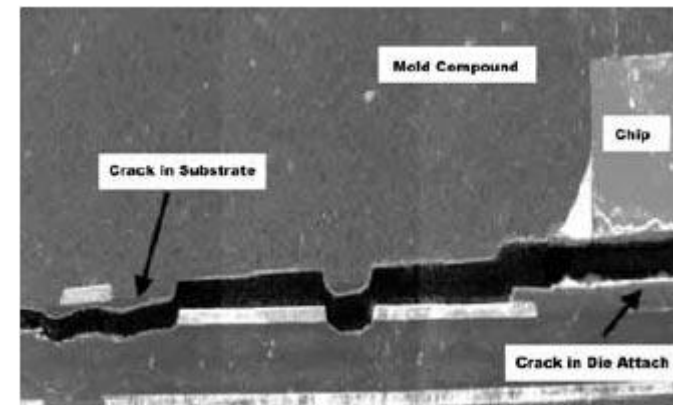
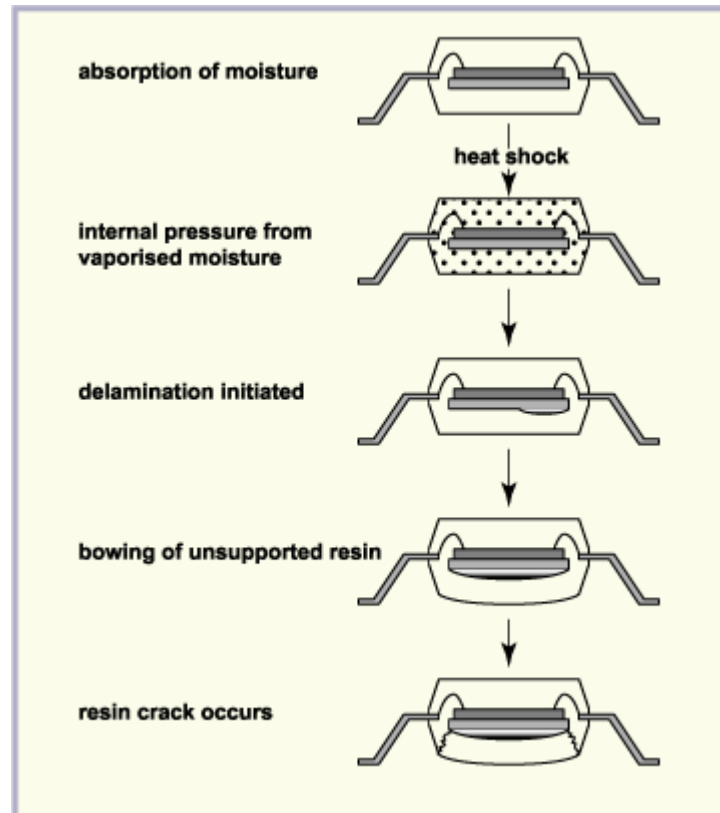


Figure 2: A PGBA may crack if exposed to high temperatures.

# Moisture Sensitivity Level – Jedec 020c

- LUXEON LEDs have a JEDEC moisture sensitivity level of 1
- This provides the customer with **UNLIMITED** floor life under conditions set forth by JEDC

Table 5-1 Moisture Sensitivity Levels

LEVEL	FLOOR LIFE		SOAK REQUIREMENTS			
			Standard		Accelerated Equivalent <sup>1</sup>	
	TIME	CONDITIONS	TIME (hours)	CONDITIONS	TIME (hours)	CONDITIONS
1	Unlimited	≤30 °C/85% RH	168 +5/-0	85 °C/85% RH		
2	1 year	≤30 °C/60% RH	168 +5/-0	85 °C/60% RH		
2a	4 weeks	≤30 °C/60% RH	696 <sup>2</sup> +5/-0	30 °C/60% RH	120 +1/-0	60 °C/60% RH
3	168 hours	≤30 °C/60% RH	192 <sup>2</sup> +5/-0	30 °C/60% RH	40 +1/-0	60 °C/60% RH
4	72 hours	≤30 °C/60% RH	96 <sup>2</sup> +2/-0	30 °C/60% RH	20 +0.5/-0	60 °C/60% RH
5	48 hours	≤30 °C/60% RH	72 <sup>2</sup> +2/-0	30 °C/60% RH	15 +0.5/-0	60 °C/60% RH
5a	24 hours	≤30 °C/60% RH	48 <sup>2</sup> +2/-0	30 °C/60% RH	10 +0.5/-0	60 °C/60% RH
6	Time on Label (TOL)	≤30 °C/60% RH	TOL	30 °C/60% RH		

# Moisture Sensitivity Levels

- What about others?
- Cree

## Moisture Sensitivity

In testing, Cree has found XLamp XP-G LEDs to have unlimited floor life in conditions  $\leq 30^{\circ}\text{C}$  / 85% relative humidity (RH). Moisture testing included a 168 hour soak at  $85^{\circ}\text{C}$  / 85% RH followed by 3 reflow cycles, with visual and electrical inspections at each stage.

- Osram

## Reflow Soldering Profile

## Reflow Lötprofil

Preconditioning: JEDEC Level 2 acc. to J-STD-020D.01

- Nichia

### (1) Storage

Conditions		Temperature	Humidity	Time
Storage	Before Opening Aluminum Bag	$\leq 30^{\circ}\text{C}$	$\leq 90\% \text{RH}$	Within 1 Year from Delivery Date
	After Opening Aluminum Bag	$\leq 30^{\circ}\text{C}$	$\leq 70\% \text{RH}$	$\leq 168 \text{hours}$
Baking		$65 \pm 5^{\circ}\text{C}$	-	$\geq 24 \text{hours}$

- This product is compliant to JEDEC MSL 3 or equivalent. See IPC/JEDEC STD-020 for the details of the moisture sensitivity levels.

# Mechanical Robustness

- Philips Lumileds has also tested the LUXEON LED for mechanical shock and vibration. This could be very helpful in applications with a lot of shaking

Random Vibration		6G RMS, 10 to 2000 Hz, 10 min per axis [2]	20 units	0 failures 0 units with large parametric shifts	$\Delta\phi_V$ ave = -0.11% $\Delta\phi_V$ min = -0.97% $\Delta\phi_V$ max = +0.80%
Mechanical Shock	JESD22-B104 Condition B	1500G, 0.5ms pulse, 5 shocks, 6 axes [2]	20 units	0 failures 0 units with large parametric shifts	$\Delta\phi_V$ ave = -0.72% $\Delta\phi_V$ min = -2.06% $\Delta\phi_V$ max = +0.15%

- Cree

Mechanical Shock	JESD22 Method B104-C Condition B	<b>Test Conditions:</b> <ul style="list-style-type: none"> <li>Shock : 1500 G</li> <li>Pulse Width : 0.5 ms</li> <li>Direction : 5 each, 6 axis (30 total)</li> </ul> <b>Failure Criteria <sup>1</sup>:</b> <ul style="list-style-type: none"> <li>LED no longer lights up after test</li> </ul>
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- Nichia

Vibration	JEITA ED-4701 400 403	200m/s <sup>2</sup> , 100~2000~100Hz, 4cycles, 4min, each X, Y, Z	48minutes	#1	0/10
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- No such test is found with Osram LED

# Summary

- In creating specifications for LED performance, it is important to examine the total picture
- It is important to have LEDs that will withstand the test of time and temperature, provide ease of assembly, and be thoroughly tested for all mechanical conditions
- Philips Lumileds performs and publishes all LED reliability data. We believe a good LED specification needs to include:
  - Lumen maintenance
  - High efficacy at real operation condition
  - ESD
  - Moisture sensitivity level and number allowable of reflows
  - Mechanical durability

# Reference

- Lumileds DR05, DR05-1, DR05-2
- <http://www.philipslumileds.com/support/documentation/lumen-maintenance>
- Lumileds LUXEON Rebel ES Datasheet
- <http://www.philipslumileds.com/support/documentation/datasheets>
- Cree Lumen Maintenance
- [http://www.cree.com/~media/Files/Cree/LED%20Components%20and%20Modules/XLamp/XLamp%20Application%20Notes/LM80\\_Results.pdf](http://www.cree.com/~media/Files/Cree/LED%20Components%20and%20Modules/XLamp/XLamp%20Application%20Notes/LM80_Results.pdf)
- Cree XP-G Datasheet
- <http://www.cree.com/led-components-and-modules/products/xlamp/discrete-directional/~media/Files/Cree/LED%20Components%20and%20Modules/XLamp/Data%20and%20Binning/XLampXPG.pdf>

- Nichia 219 Datasheet

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<http://www.nichia.co.jp/specification/en/product/led/NVSW219A-E.pdf>

- OSOLON Square Datasheet

- [http://catalog.osram-os.com/catalogue/catalogue.do?favOid=0000000200023cf001400023&\\_act=showBookmark](http://catalog.osram-os.com/catalogue/catalogue.do?favOid=0000000200023cf001400023&_act=showBookmark)