Looking Past The Marketing

Does using quality components always deliver a quality or equal product ?

Date 12/03/2015

Arrow Lighting | Five Years Out

Today's topics

1. What is a quality Luminaire and what do you want it to deliver ?
2. Luminaire design requirements the manufacturer needs to consider
3. Not all LEDs are equal, important considerations
4. A reliable supply chain from component to end customer
5. Covering the main points of LEDs failing and why, then how to avoid the problems.

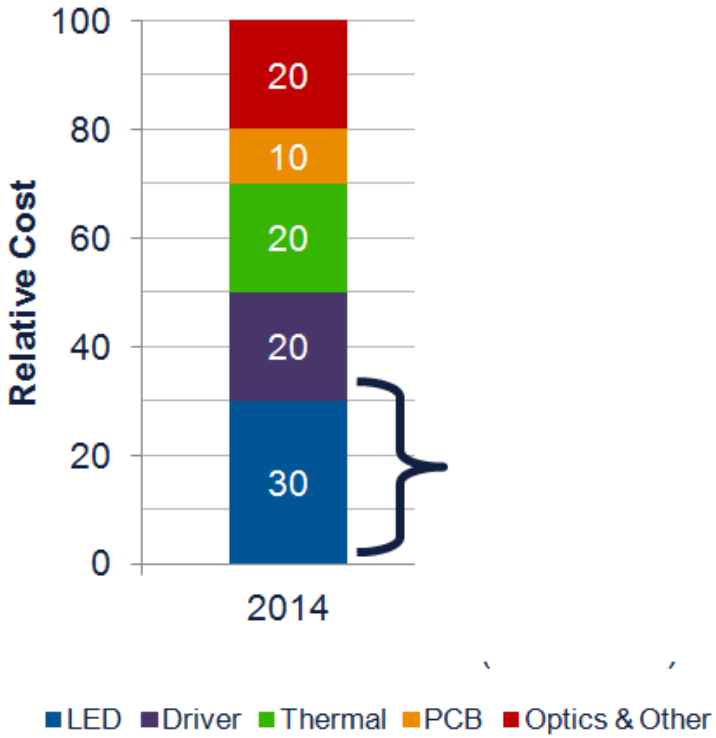
What is a quality Luminaire and what do you want it to deliver?

- CRI level
- Lumen output
- Optical control
- CCT with tight binning control
- Long life 50,000 hrs
- Low energy consumption
- Quality finish
- Meets the required standards and regulations

Luminaire design requirements the manufacturer needs to consider and the critical components

- LED selection, type and how many
- Optics
- Heatsink
- PCB
- Driver (power supply)
- Connectors
- Materials for the body

Typical breakdown of costs in an LED Lighting System system



Around 30% system cost is for the LEDs, so the LED is still the first focus component when cutting corners to save cost

Often at face value, a quality LED looks the same as a cheap copy but even using quality LEDs does not always mean an alternative product will deliver the same specifications levels of performance if the rest of the components or product design is poor

Can you spot the difference ?

They look the same, but are they both built around the same components ?

Not All LEDs Are Equal

LED Lifetime:

Definition and influences

LED lifetime: Definition and influences

MTTF (Mean Time To Failure) figures for single LEDs are usually in excess of a million hours but external causes that could impact lifetime and reliability of the LED are not taken into account

LED end of life (EOL) for lighting is defined as the time after which the luminous flux of 50% of a batch of LEDs (B50) has reached 70% (L70) of its' original value. At EOL…...

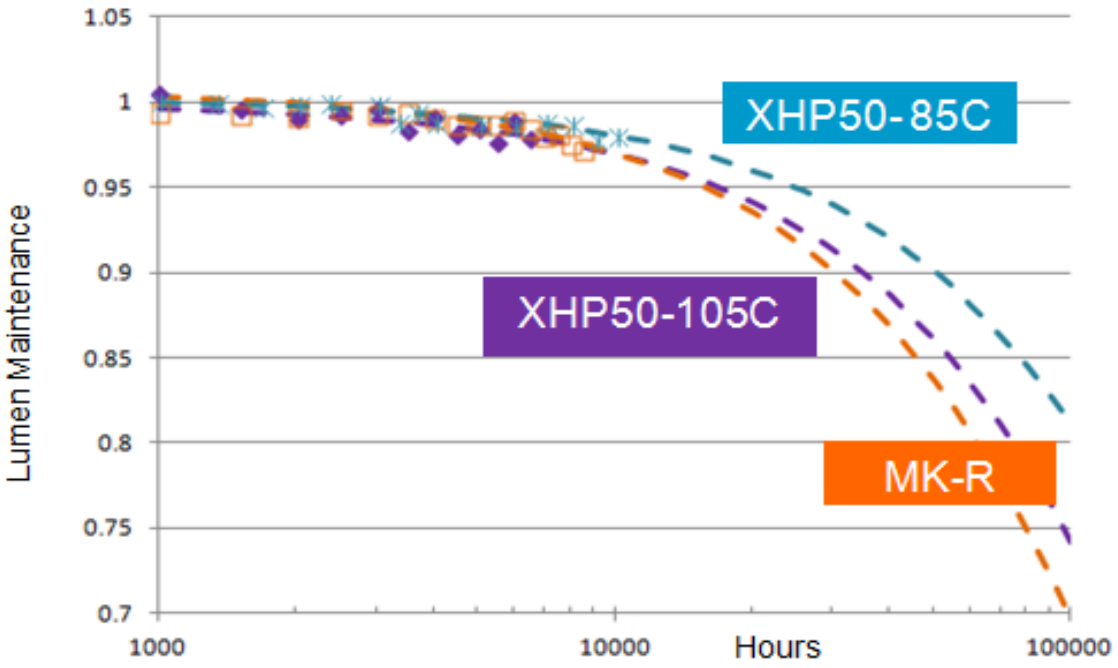
- The LEDs are still usable (i.e. they have not failed catastrophically)
- The degradation in light output is only just noticeable

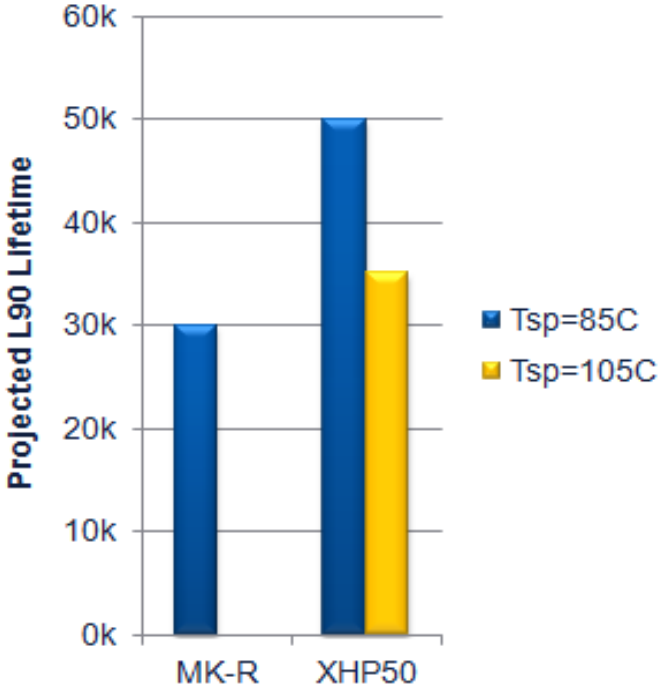
Limiting factors for LED lifetime (manufacturer controlled)….

- Degradation of the optical properties of the LED package (extraction efficiency)
- Phosphor degradation
- Package and LED die robustness and reliability

Limiting factors for LED lifetime (application controlled)….

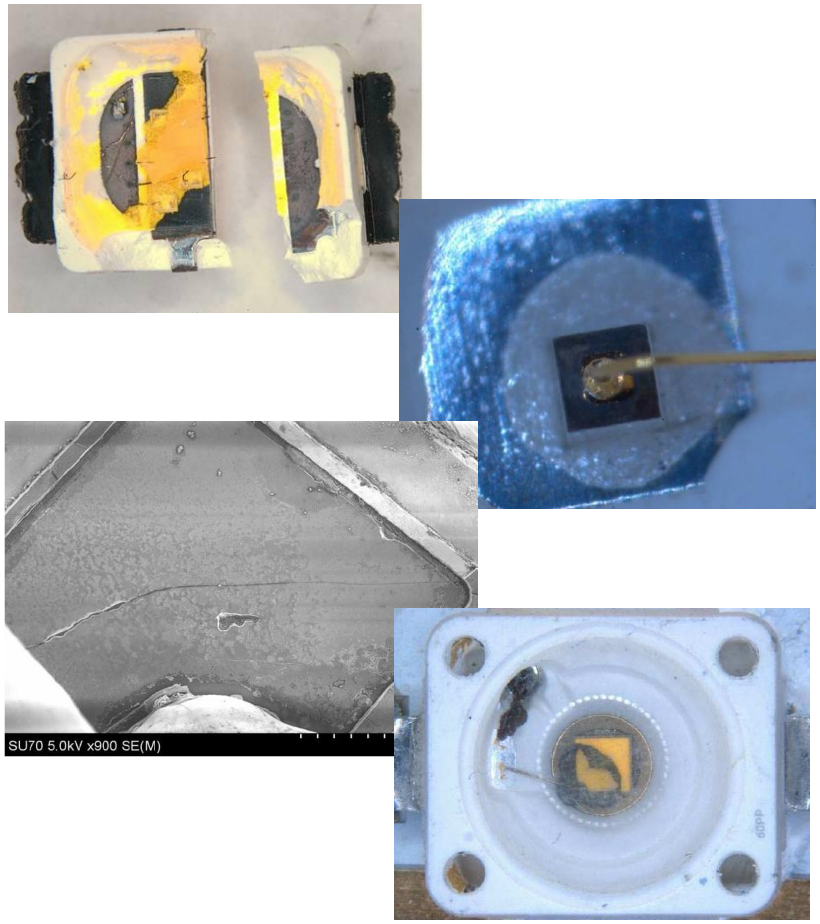
- The average temperature of the LED die (T_J, the junction temperature)
- The (forward) current being driven through the LED (I_F)





- L_{90} = 50k hours at 85°C, 12W (1.05A @ 12V, 2.1A @ 6V)
- L_{90} = 35k hours at 105°C, 12W (1.05A @ 12V, 2.1A @ 6V)

LED Lifetime: External influences



Factors external to the LED can have a dramatic effect on lifetime and even lead to catastrophic failures

The obvious causes…...

- Mechanical damage
- Electrical overstress
- Thermal overstress
- Static damage during or post assembly

The less obvious causes….

- Atmospheric corrosion
- Chemical attack accelerated by encapsulation
- Humidity

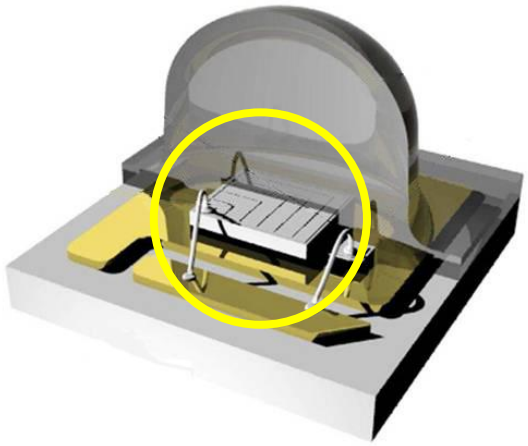
Investigating LED Lifetime & Reliability:

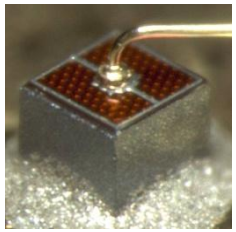
LEDs from the inside out

Arrow | Lighting

Five Years Out

LEDs – From the inside out: 1 - The LED die and contacts





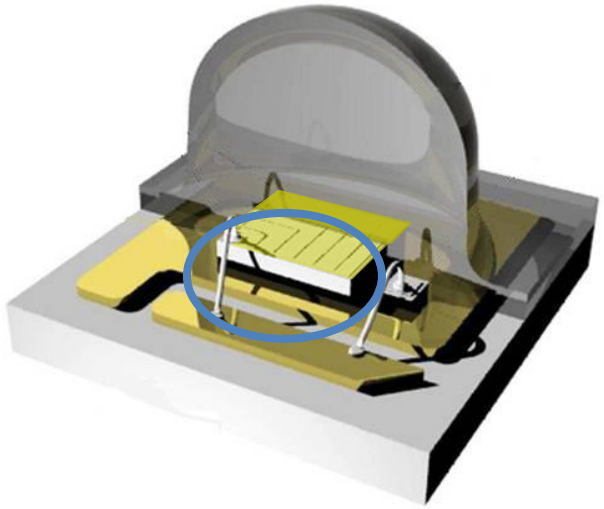
Type and main cause of degradation or failure…

- Contact failure or degradation of contact to the LED die back or top surface and / or leadframe
  - Excessive temperature cycling, mechanical damage to or force via the lens, environmental influences
- Damage to die structure and / or surface metalisation. Die cracking, fused bond wire
  - Electrical overstress (excessive current)
- Change of LED characteristics, rapid reduction in light output
  - Static damage

Minimise the risks…

- Good thermal management
- Avoid mechanical damage or excessive force on the lens
- Good ESD protection in production / handling
- Protect against excessive current

LEDs – From the inside out:
2 - The phosphor layer or phosphor filled encapsulate



Type and main cause of degradation...

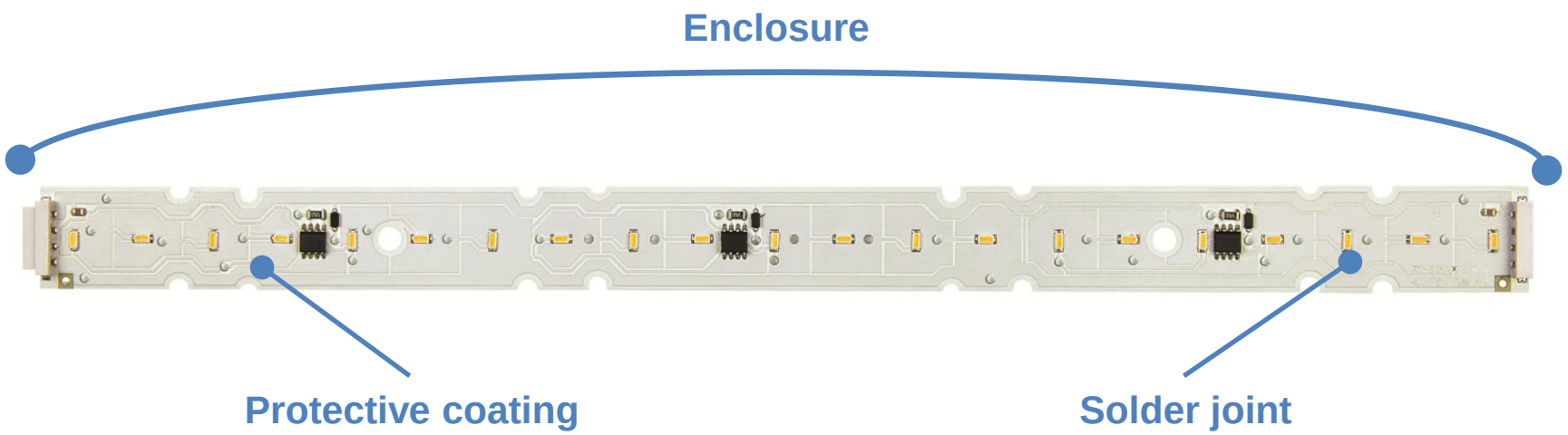
- Reduction in phosphor conversion efficiency (particularly red phosphors) causes colour to shift towards blue with consequent reduction in light output
  - Temperature
  - Very high DC drive current
  - Humidity

Minimise the risks…

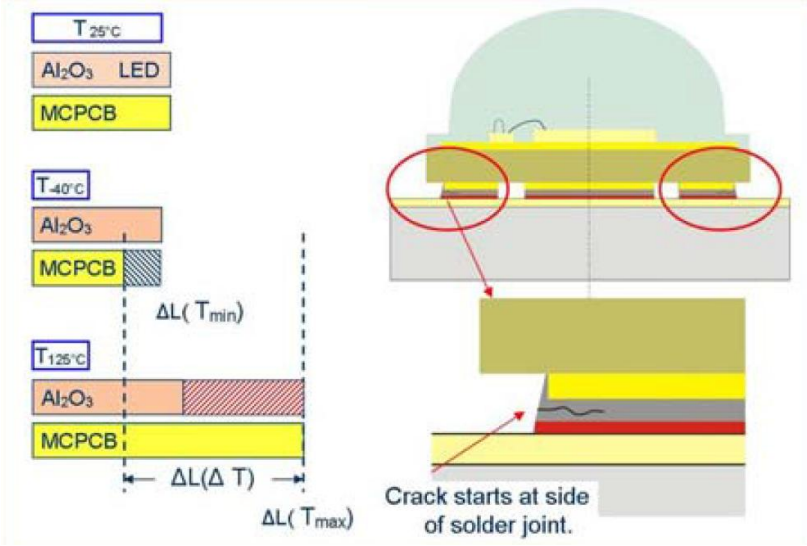
- Thermal management
- Avoid very high drive currents if possible
- Protect against high humidity
- Check real lifetime test reports e.g. LM80 for evidence of good colour stability of warm white colours e.g. 3000K
- **Choose a quality LED supplier with a good track record**

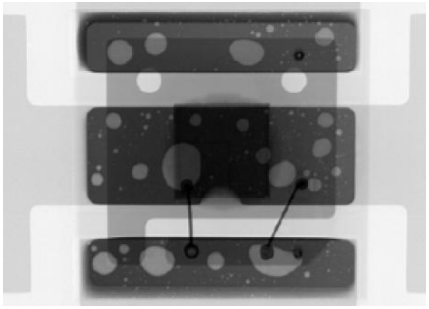
Investigating LED lifetime and reliability: The environment and protection

Now that we've covered the LED we will work outwards from the LED to the surrounding atmosphere to investigate how various factors will influence the LED lifetime and reliability and how the risks can be minimised



Investigating LED lifetime and reliability: Solder joint quality and reliability





Potential issues and their main causes...

- Solder joint cracks and fractures in the field over time
  - Mismatch between the coefficient of thermal expansion (CTE) of the LED substrate and metal core PCB
  - Ceramic substrate LEDs
  - Large physical LED size
  - Extreme temperature variations
- Voids in solder joint to thermal pad increases thermal resistance causing LED overheating
  - Incorrect solder paste stencilling inhibits outgassing

Minimise the risks….

- Use smaller size ceramic based LED
- Change PCB material
- Ensure solder paste stencil meets manufacturers guidelines

Investigating LED Lifetime & Reliability:

Enclosures and the application environment

The enclosure design

Potential issues and their main causes

- Fully sealed enclosures trap any chemicals released by materials used in the enclosure construction creating a micro environment. Certain chemicals can attack LEDs and cause rapid light output degradation e.g.
  - Adhesives and their activators
  - Certain rubber gasket materials
  - VOC's used to clean PCBs

Minimise the risks

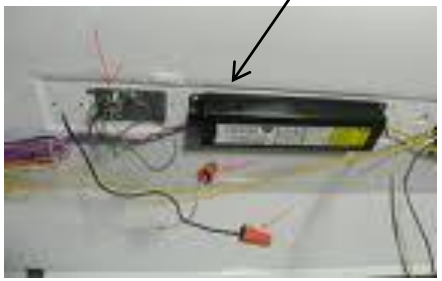
- Avoid fully sealed enclosures if possible
- Check the compatibility of the adhesives, gaskets and materials used in the construction of your enclosure with LEDs

The Component supply chain

In The Past…

Lighting view: Electronic component is a ballast

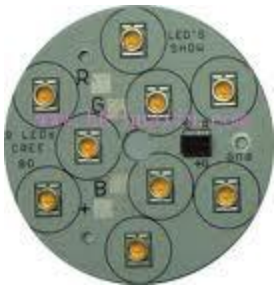
+



=

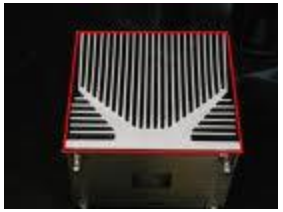
Simple Supply chain, wholesalers or stockists, few manufactured parts

Complexity Has Changed the Industry: Lighting and Electronics Converge



+

+



+

+

Importance of selecting a manufacturer that uses a quality global supply chain

What to look out for

- Suppliers that work to ISO9001 standards
  - Offer full traceability of components
- Only use official franchised distributors
  - No risk of counter fit parts
  - Full technical support and backup

Conclusion:

Is your application doomed to fail?

Conclusion: Is your application doomed to fail?

Most definitely not!!

- There are thousands of LED based applications that, after careful consideration and design have been operating successfully and without issue for a number of years.
- Consider only using manufacturers that use quality LEDs and components from reputable manufacturers and suppliers that can support reliability claims with documented test results
- Make it clear on the specification that alternatives products or components must be approved and agreed
- Make sure the contractor knows and understands the risk of using lower quality products

Thank you for your time and attention

Visit www.Arrow.com

LED Data supplied by Cree and Osram Opto

Arrow | Lighting

Five Years Out