NATIONAL FORUM ON MALAYSIAN STANDARDS ON LIGHT EMITTING DIODES (LEDs)

UNDERSTANDING AND USAGE OF LED

BY :
MR C T SIEW / IR. LEE KOK CHONG

MEMBER OF THE TECHNICAL COMMITTEE ON LIGHTING, LAMPS AND ACCESSORIES
CHAIRMAN OF WORKING GROUP ON LED

AUDITORIUM DATO' IR YAHAYA AHMAD
SIRIM Berhad, SHAH ALAM
21 MAY 2012

Managed by :

SIRIM

LED

Understanding of LED

NATIONAL FORUM ON MALAYSIAN STANDARDS ON LIGHT EMITTING DIODES (LEDs)

Organized by :

MOSTI

STANDARDS MALAYSIA

Managed by :

SIRIM

National Forum on Malaysia Standard on LED Lighting

PAPER 1
Understanding and Usage of LED

21st May 2012
Auditorium SIRIM Berhad
Shah Alam

By Mr C T Siew/Ir. Lee Kok Chong

Member of the Technical Committee on Lighting,
Lamps and Accessories/ Chairman of Working Group on LED

Content

1. Introduction
2. General
3. LED
4. Why Standardization
5. Types of LEDs
6. Standards Requirement

Introduction

Over the past few years a new light source – light emitting diodes, or LEDs – has been introduced into the interior & exterior lighting market.

It is envisaged that within a relatively short period LED luminaires will be available to achieve the requirements of many lighting classes.

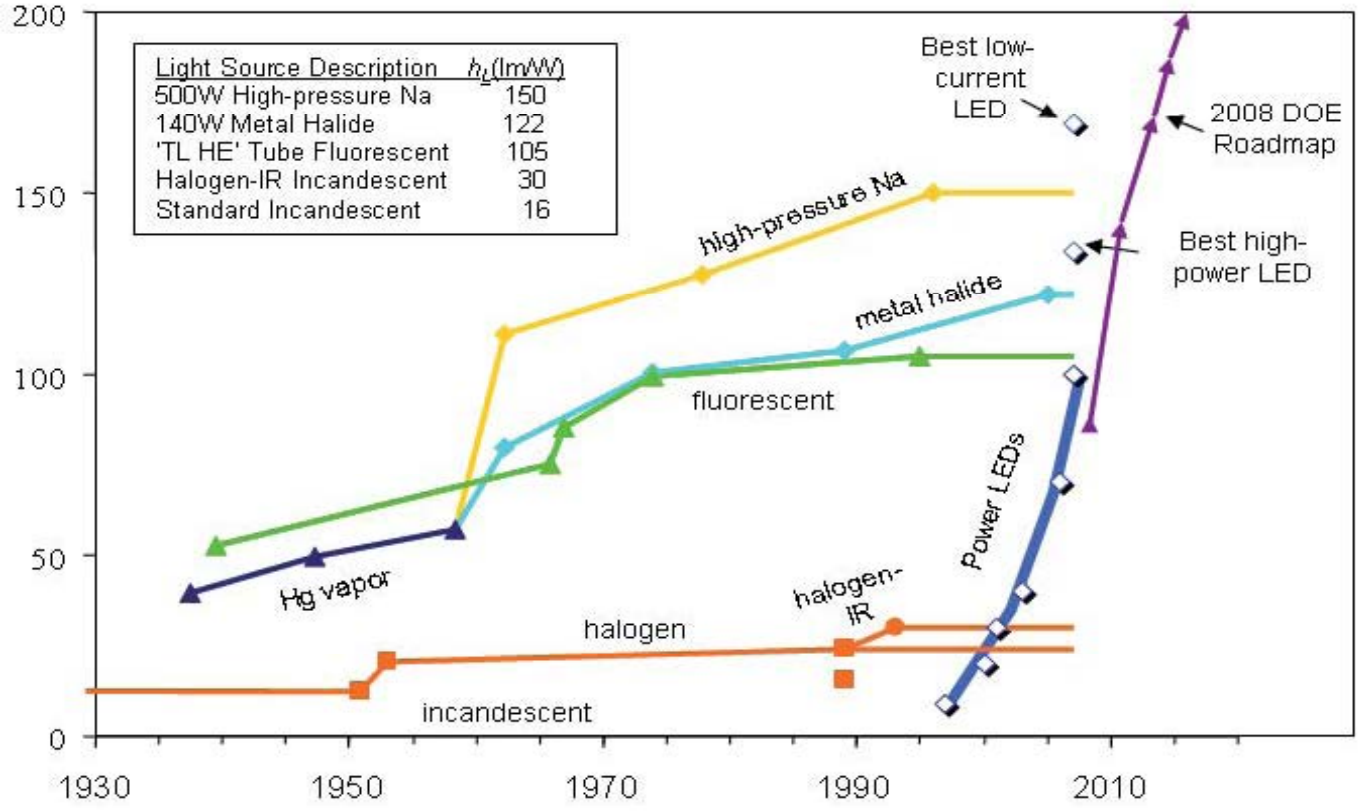
With LED's emerging as a new functional light source there is a need to ensure performance claims are made in a consistent way.

IEC new standards and development is to assist the Lighting Fraternity to understand when to select or manufacture a good quality product.

General

LEDs were developed in the electronics industry when it was discovered that light is produced when a current is passed through a diode. This technology has seen rapid development in the recent past.

A graph of the efficiency of various light sources from 1930 to the present day.



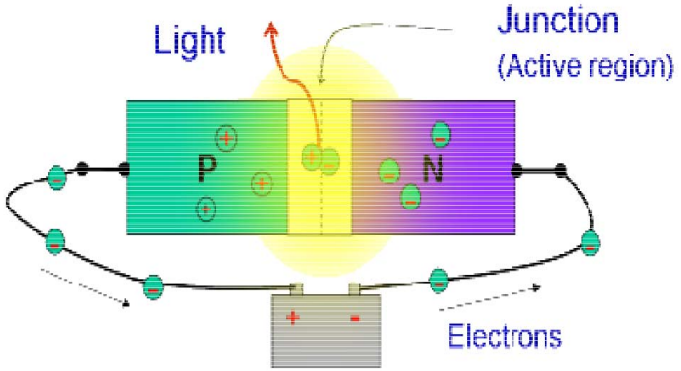
General

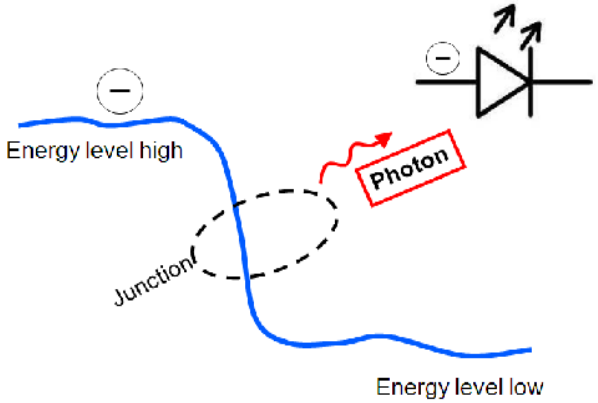
If the trend continues then we may be seeing LEDs capable of producing **170 lumens per watt or more** in the short term. This could shortly exceed the performance of all Fluorescent ,HID lamps and could establish LEDs as the premier light source for efficiency.

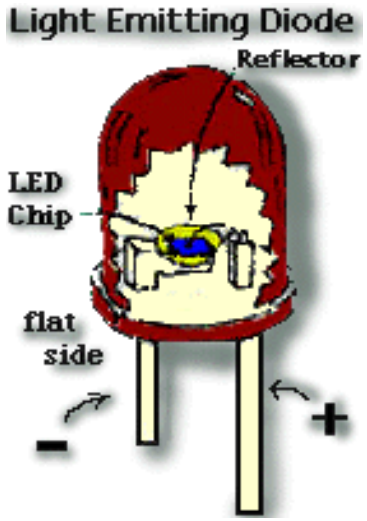
However, the intense light produced from a tiny source can be discomforting and can potentially cause disability glare. The LED as a light source is being addressed by European standards regarding **laser light.**

Therefore if the light output continues to increase, appropriate control of the light will be essential to avoid glare on the work place, highway, or at worst **damage to the retina** if an individual inadvertently stares at the source for too long.

What is a LED ? How does it works







- LEDs are **semiconductor** diodes
- Semiconductors are formed by combining two different semiconductor materials to form a PN junction (P=charged positive(holes) and N charged negative (electrons)
- By applying current, electrons (N) are forced to move to one direction and P to the opposite direction
- **Photons (light)** are generated when the positive and negative charges recombine.

Brief LED history

- **1962** First visible LED (Holonyak@GE)
  - 0.001 lumen
- **1960's** Red LEDs (HP and Monsanto)
  - 0.01 lumens
- **1970's** – 1980's Green LEDs, Watched, Calculators
  - 0.1 lumens
- **1990's** Blue LEDs (Nakamura@Nichia)
  - 1 lumen
- **2000+**
  - 10-100 lumens
- **2005**
  - 1000 lumens (multichip packages)

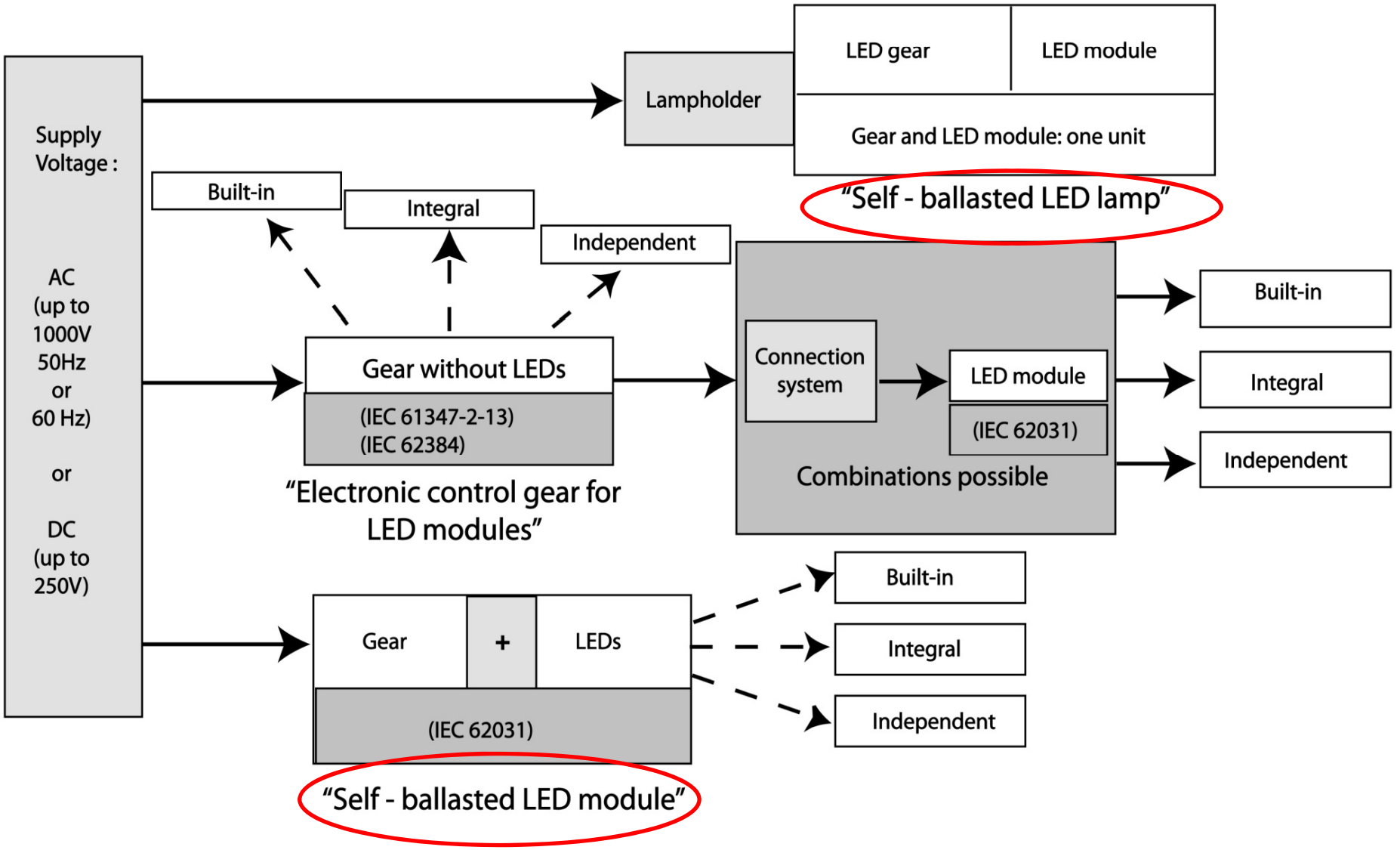
What's and LED……Really?

- A semi-conductor device –Therefore they **DO get hot…**
  It's just in a different way!
- Most are low voltage direct current **(DC),** although some are **AC**
- They are not **"white light"** by themselves –The material composition determines the colour
- Inherently directional
- Under **"normal"** operation they don't burn-out but rather reduce in light output over time
- Require different test procedures *(will be presenting by coming papers)*
- They can be energy efficient in certain applications *(but not all)*
- This isn't your Father's light bulb!

Why Standardization for LED is important ?

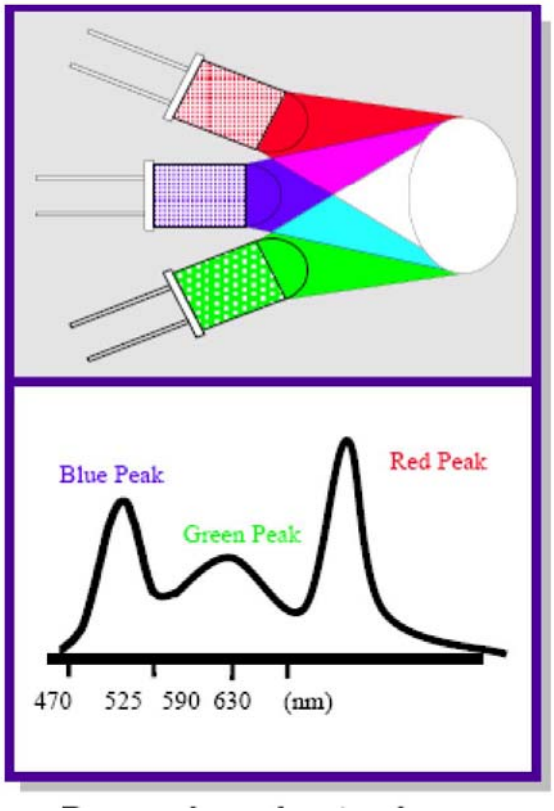
- **Ensure compatibility** *(LED light source to replace traditional light source)*
- **Align information asymmetries** *(marketing claims)*
- **Negative externalities** *(climate change, pollution, radiation hazard)*
- **Enable level playing field** *(talk the same language)*
- **Facilitation of international trade** *(energy saving is a global issue)*

Overview of Systems composed of LED's



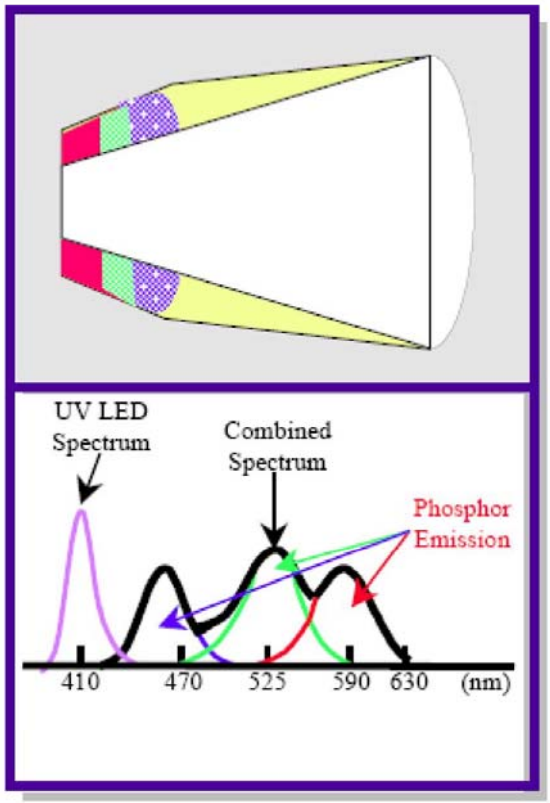
How do LED make White Light?

Red + Green + Blue LEDs



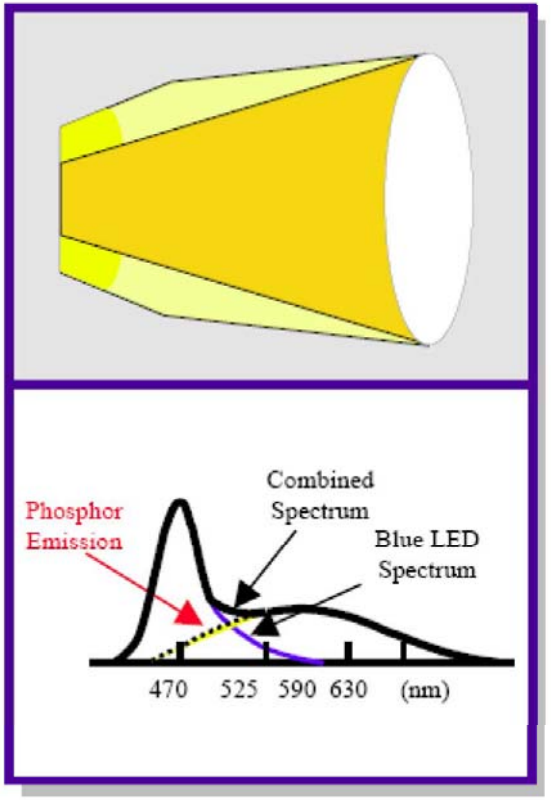
- Dynamic color tuning
- Excellent color rendering
- Large color range

UV LED + RGB phosphor



- White point tunable by Phosphors
- Excellent color rendering
- Simple to create white

Blue LED + Yellow Phosphor

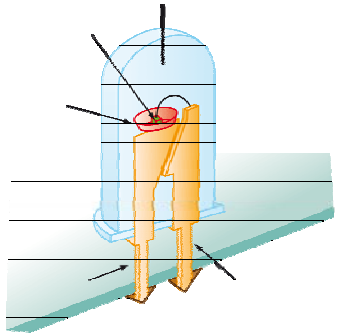


- Simple to create white
- Good color rendering

Types of LED Sources

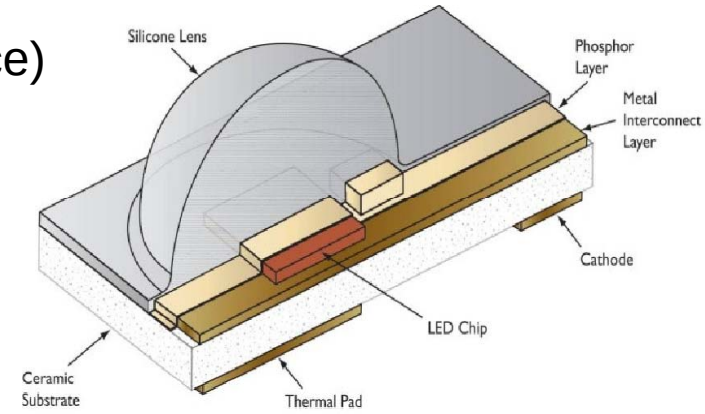
High power/brightness LEDs
Power : 1.5W
Flux : >80 lm

Flux



Medium power LEDs
(Surface mounted device)
Power : 0.5W
Flux : 0.1-12 lm

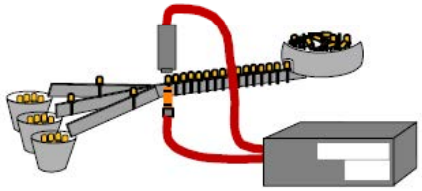
Low power (LEDs (5mm)
Power : 0.3W
Flux : 1-3 lm

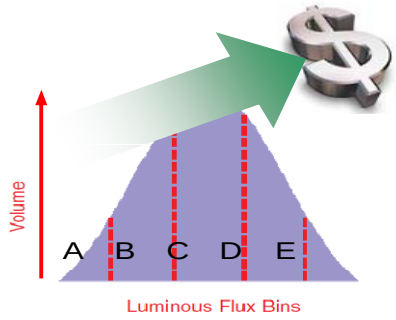


Power

LED sources are produced by semiconductor process – not all equal

- LED devices are produced from a larger wafer which is grown by depositing layers of semiconductor materials onto a substrate
- Since individual LED devices are never exactly the same, those with similar performance are grouped together by manufacturers into bins
- Each LED manufacturer has its own unique bin parameters
- LED devices are typically binned separately by flux and color
- **The tighter the bin, or the higher the flux, the higher the cost (can be a factor of 2X-3X)**





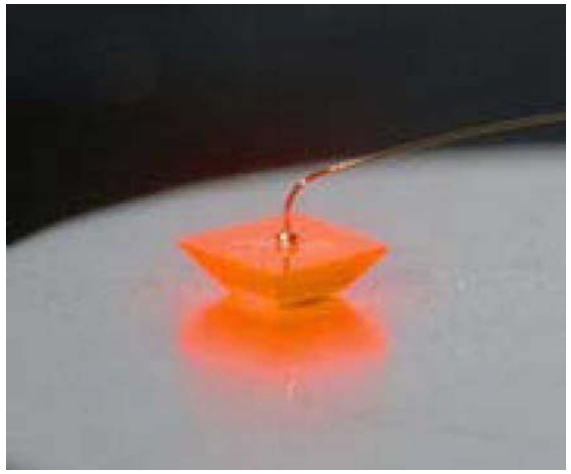
LED building Block…..

The LED Die

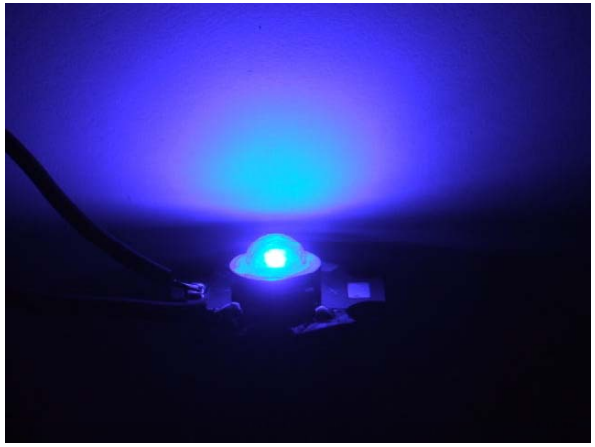
The LED Package or Device

The LED Module or Array

The LED Light Engine



Source : Lumileds



Source : Cree

LED building Block…..

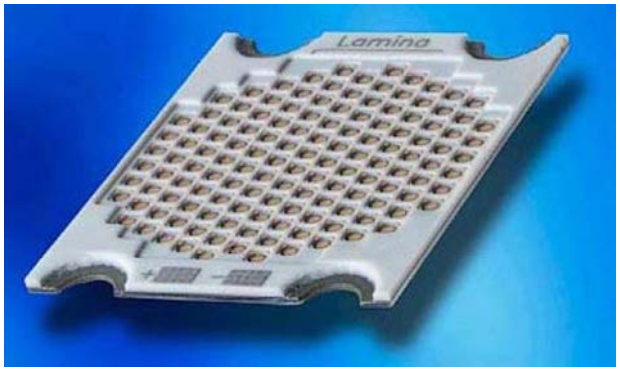
The LED Die

The LED Package or Device

The LED Module or Array

The LED Light Engine

Die integrated into an assembly



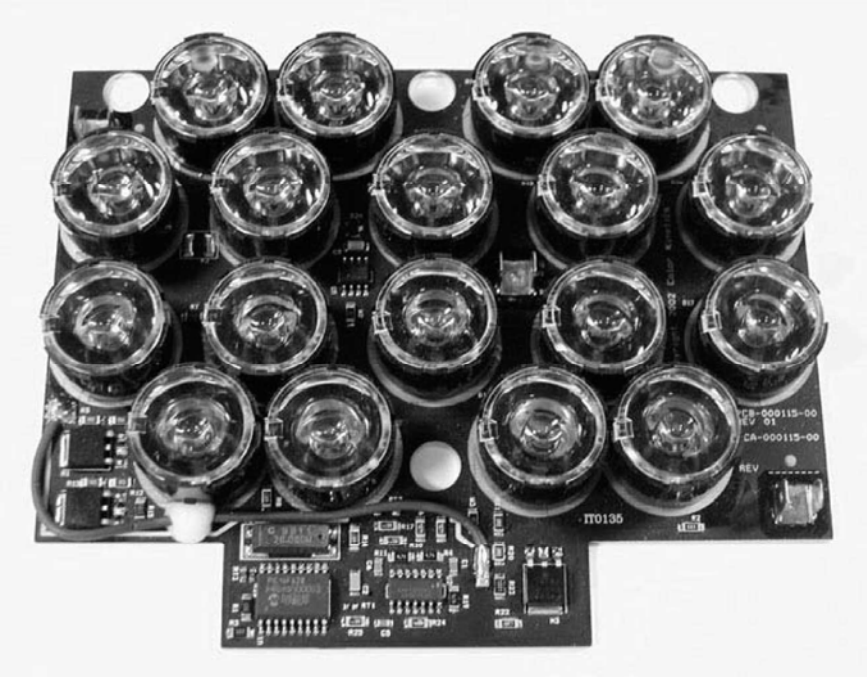
LED building Block…..

The LED Die

The LED Package or Device

The LED Module or Array

The LED Light Engine



LED building Block…..

The LED Die
The LED Package or Device
The LED Module or Array
The LED Light Engine

Element of LED system

Component
Devices that **cannot** be self-operated

Subsystem
Devices that can be self-operated

System
Devices that are by the **end user**

Examples of LED Lamp

Examples of LED Modules

A huge range of LED modules are available on the market and the development of products is very dynamic. But also **standardizing of LED modules between manufacturers is in progress**.

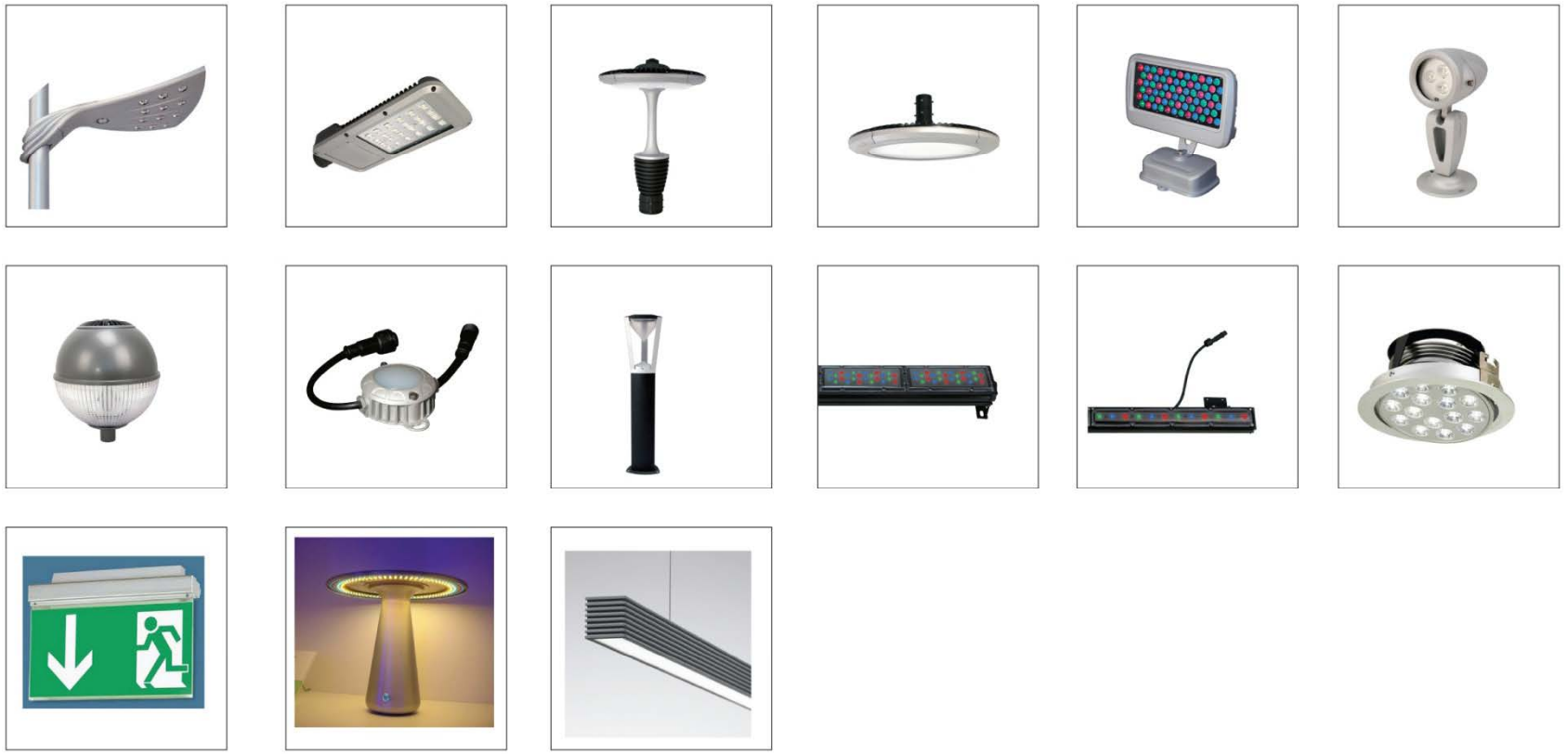
Diversity Of LED Modules

Standardization Of LED Modules

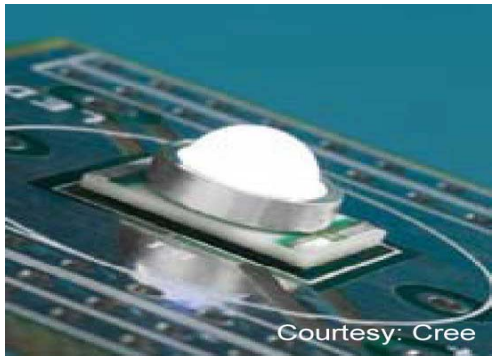
Examples of LED's Connectors

Examples of LED's Drivers or Control Gear

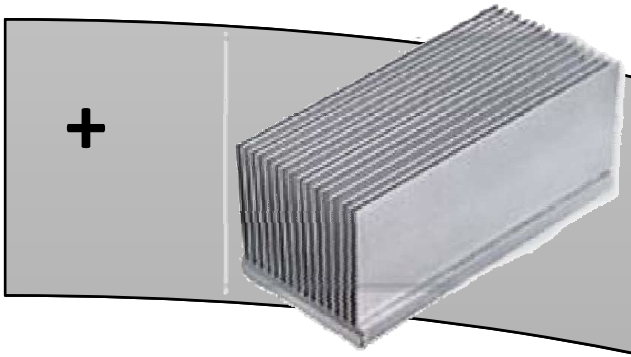
Examples of LED Luminaire



Efficiency is the sum of the parts….

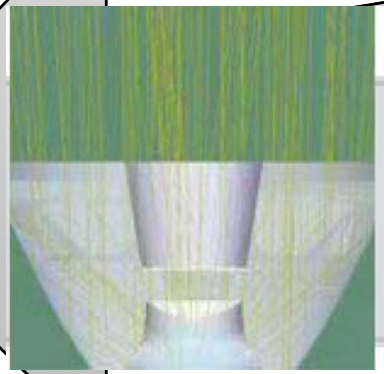


LED package efficiency



Thermal solution

Power supply
(Driver) efficiency



Fixture / optical
Design efficiency

Resultant Luminaire
efficacy

How many Efficacies are there?

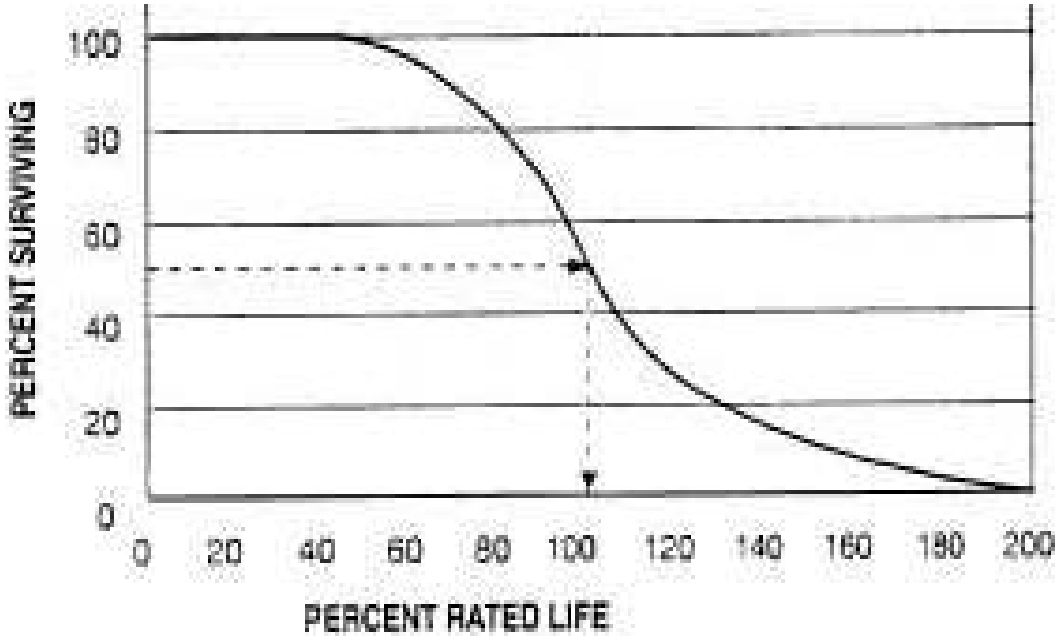
- Efficacy = Lumens/ Input Power

- The type of efficacy depends on the technology, under what conditions it operated and where power is measured

- Input Power measured at the:
  - *lamp/source but does not include ballasts, drivers or power conversion =* ***Lamp Efficacy***
  - *AC power source (includes ballasts, drivers or power conversion) =* ***Source/System Efficacy***
  - *AC power source but lumens are measured net of the luminaire =* ***Luminaire Efficacy***
  - *AC power source but only lumens contributing to a specific application are measured =* ***Application Efficacy***

Let's Talk about Life….?

Typical Lamp Mortality Curve



- Lumen depreciation vs. catastrophic failure
- Definition of rated life for traditional light sources **50%** of a large sample **"still going…"**

- LEDs use $\mathbf{L_{70}}$ for general illumination *(detail explanation on Paper 6)*

Aspects of LED's which need Standardization

- Electrical Safety
- Performance (e.g. lifetime, lamp efficacy, harmonics)
- Photometric characteristics (e.g. colour rendering, chromaticity, colour temperature, luminous flux, etc.)
- Radiation (e.g. photobiological, non-ionizing radiation)
- Interchange ability
- Electromagnetic compatibility

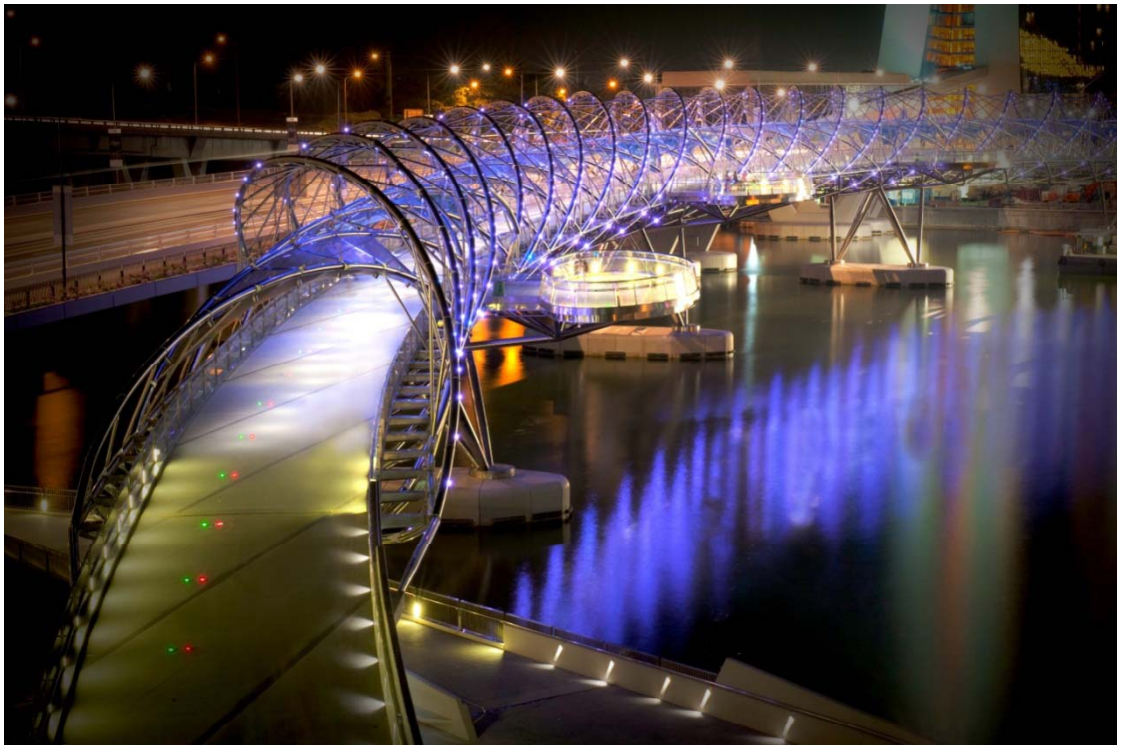
Understanding LEDs

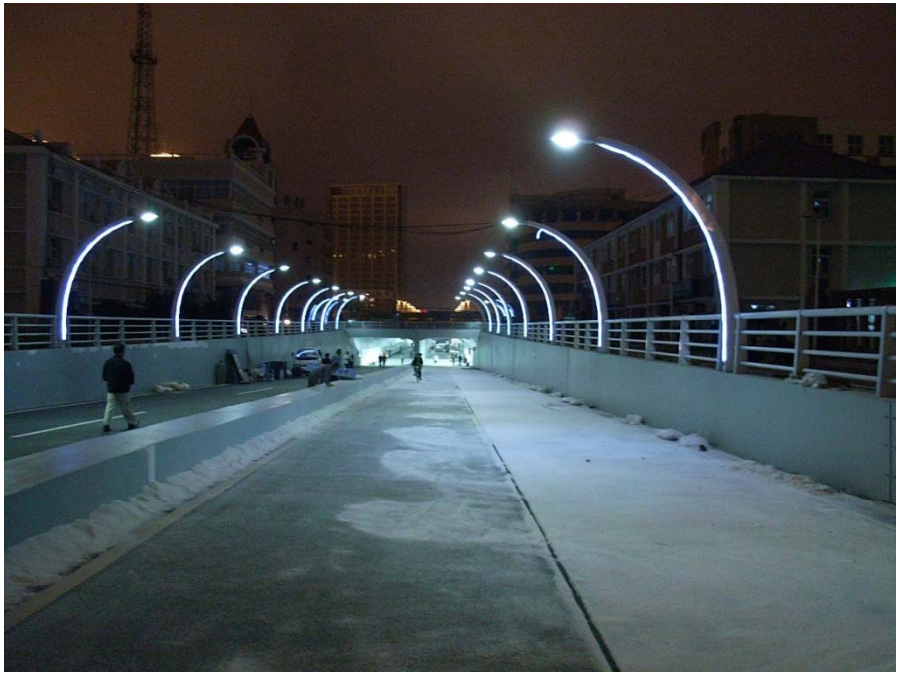
Advantages	Disadvantages
More accurate optic control	Difficult to control glare
Greater efficiency with special design	Potentially poor uniformity
Flexibility of design	Failure condition very noticeable
Compact design possible	Inventory & Spare part
Good Colour Rendering - □ 70	Impact of Thermal on lamp performance
High Power Factor - □ 0.9	LLMF –Lumen Maintenance factor, (L70)
Long Life Span.	Total Cost of Ownership – Very High
	Luminaire Efficacy = 70%
	Replacement & Maintenance

Main organization active in standardizations	
IEC	International Electro technical Committee
CIE	International Commission on Illumination
ANSI	American National Standards Institute – Performance Standards
IESNA	Illuminating Engineering Society of North America – Measurements Standards

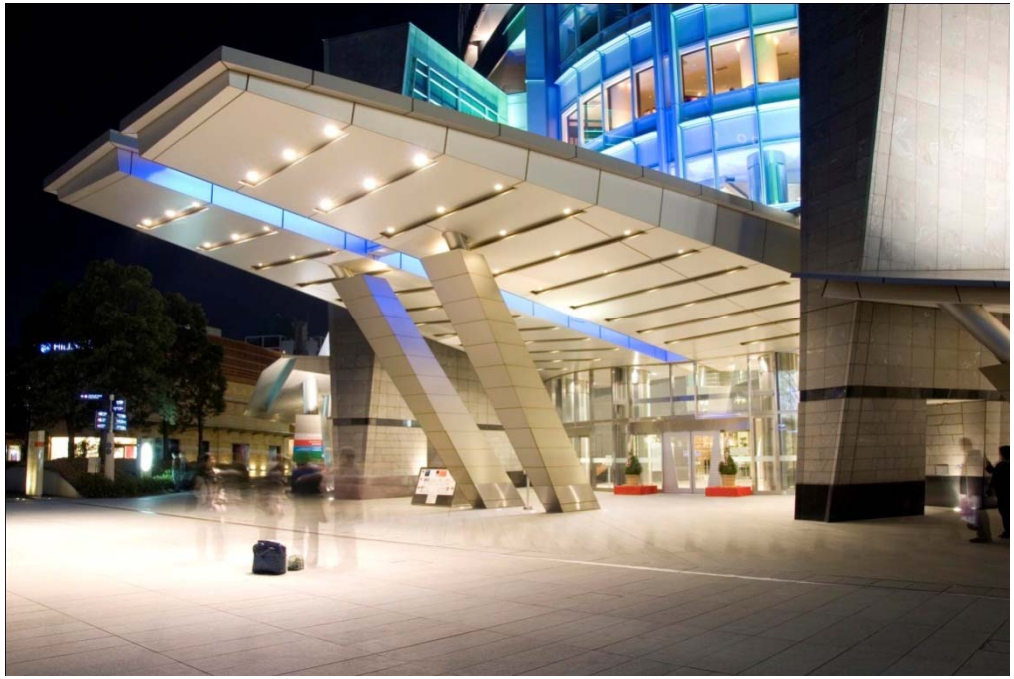
Outdoor Application

Outdoor Application





Indoor Application



Thank you
For Listening

With compliments from :

C.T. Siew

General Manager