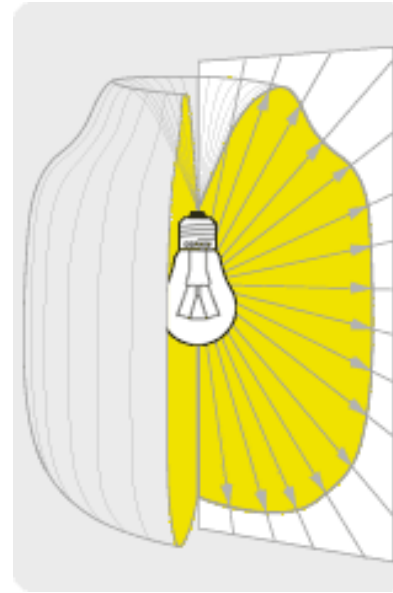


I. Lighting

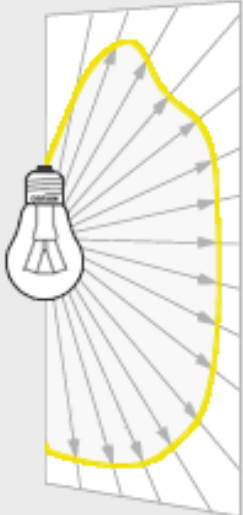
Terminology Definition



Luminous intensity is the luminous flux of a light source in a particular direction and not dependent on the size of the recipient. It can be indicated by a vector.



The **luminous flux** indicates the radiated power emitted by a light source in all directions. This radiation is evaluated according to the sensitivity of the human eye. All other photometric values are derived from this basic value.



If we connect the ends of all the luminous intensity vectors lying in one plane for a light source we obtain the **luminous intensity distribution curve**.

Explain Table

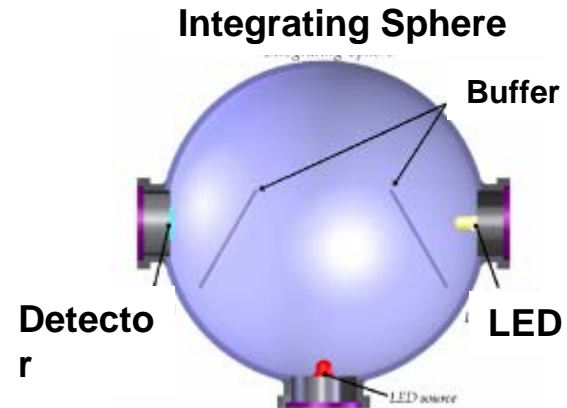
Type	Value	Symbol	Formula	Name	Unit
Radiation value	Luminous flux	F	$F = I \cdot W$	Lumen	[lm]
Sender-side value	Luminous intensity Luminance	I L	$I = F/W$ $L = I/A$	Candela Candela per square meter	[cd] [cd/m ²]
Recipient-side value	Illuminance	E	$E = F/A$	Lux	[lux]

Brightness

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
Luminous Flux	ϕ_V	80	100	120	lm
Luminous Intensity	I_V	1.0	1.5	2.0	Cd

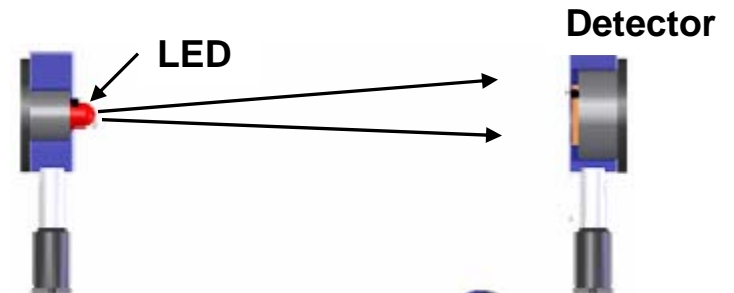
* Luminous Flux (ϕ_V)

- Lumen [lm]



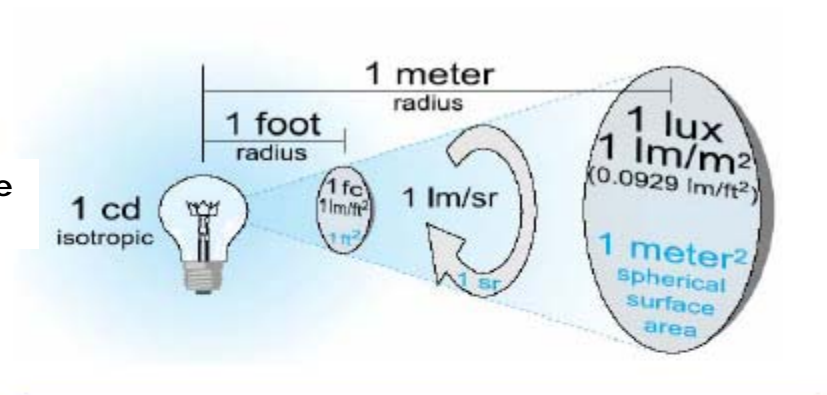
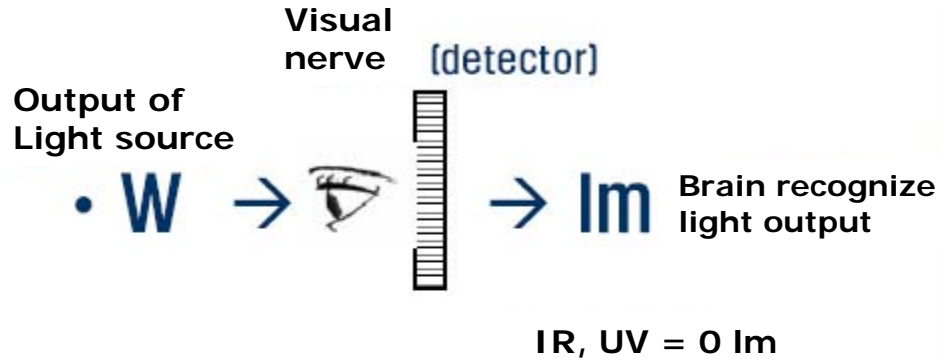
* Luminous Intensity (ϕ_V)

-Candela [Cd] (lm/sr)



I. Lighting

Terminology Definition



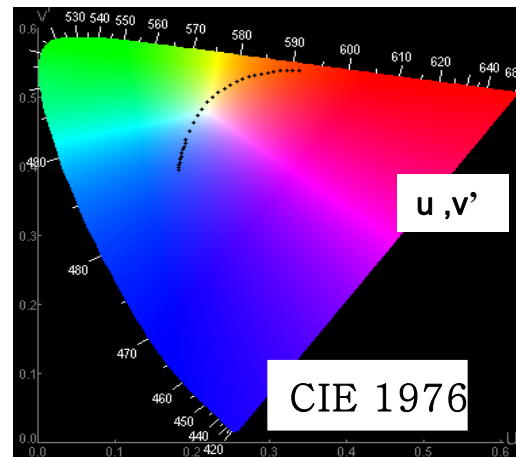
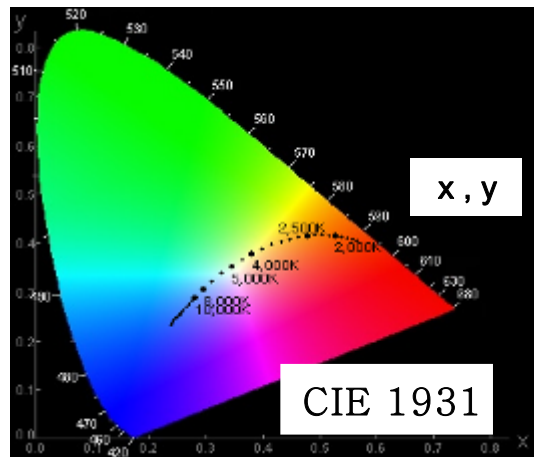
Photometry	Unit
Luminous flux 광(선)속	lm
Luminous intensity (광도)	Cd (lm/sr)
Luminance or Brightness (휘도)	nt (Cd/m ²)
Illuminance 조(명)도	Lux (lm/m ²)

Colour

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
CIE Colour Coordinates	x, y	X=0.33 Y=0.33	X=0.33 Y=0.33	X=0.33 Y=0.33	-
Dominant Wavelength	λ_D	455	460	475	nm
Correlated Colour Temperature	CCT	-	6500	-	K
CRI	R_a	65	70	80	-

* CIE Colour Coordinate

- Colour of light is expressed by x, y or u', v' coordinate



CIE1931 vs CIE1976

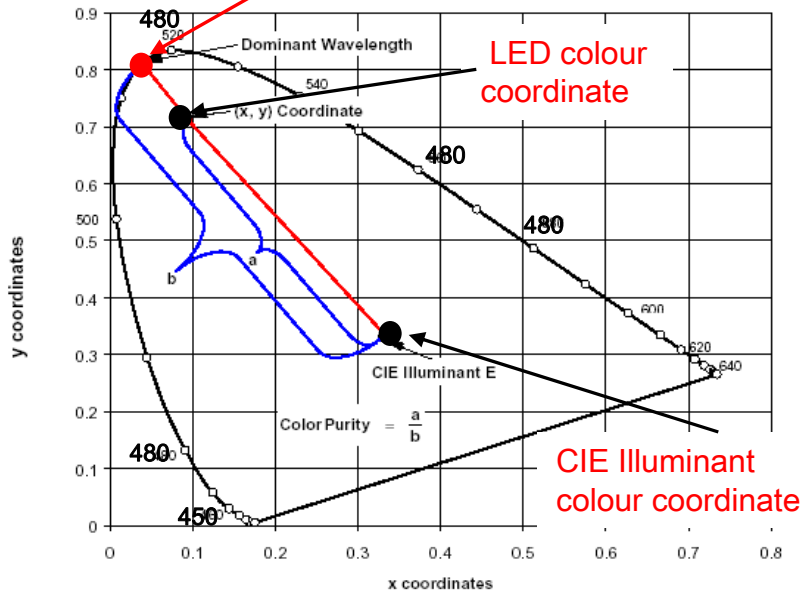
Coordinate exchanging

$$\begin{matrix} x & y & \longleftrightarrow & u' & v' \\ 0.3 & 0.3 & & 0.2 & 0.45 \end{matrix}$$

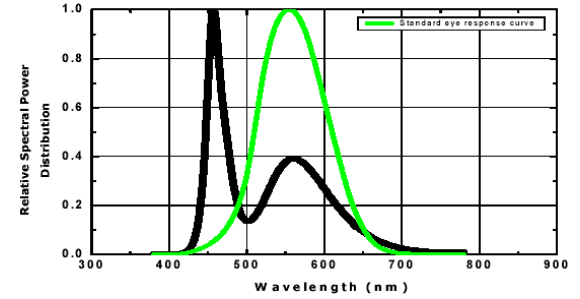
* Dominant Wavelength(λ_D)

- Boundary coordinate of colour Diagram

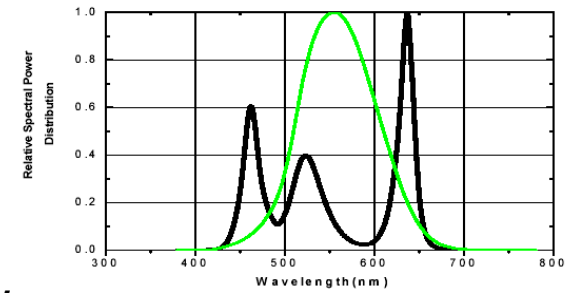
Dominant Wavelength



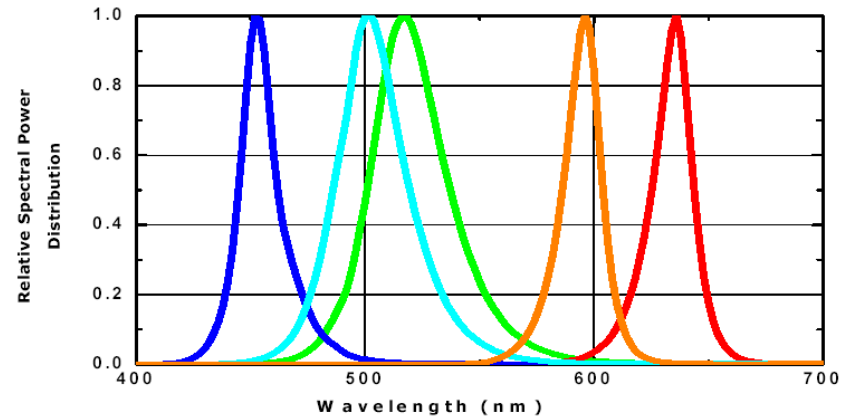
Yellow phosphor White



RGB full colour White

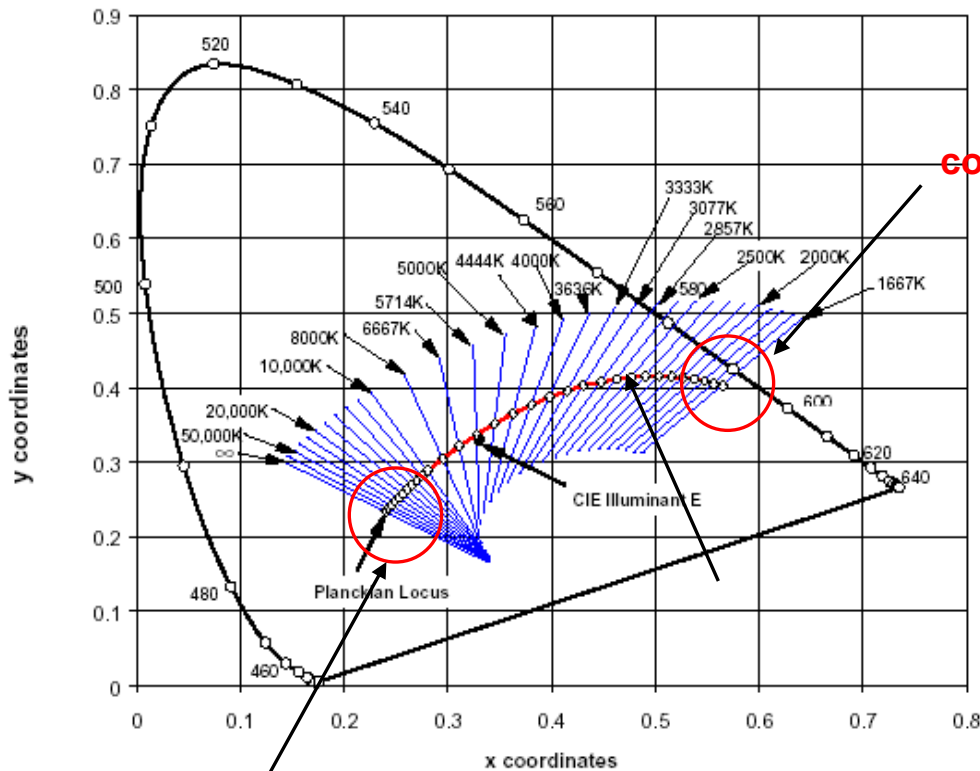


Blue / Cyan / Green / Amber / Red



* Correlated Colour Temperature(CCT)

- colour Temperature
- Kelvin [K]
- 6500K, LED(Pure white 6500K, Warm white (3000K~4000K))



colour temperature low → red white

colour temperature high → blue white

CIE1931 coordinate, CCT exchange

x y ⇔ CCT
0.3 0.3 ⇔ 7323 K

* Colour Rendering Index(CRI)

- solar cell CRI 100
- LED CRI 60~95



Ra = average R1 to R8

	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
Standard (KWT722)	74	75	86	87	60	67	78	81	55	-18	59	43	45	67	97	61	60
High CRI White (CWT722-S)	94	98	95	90	94	96	89	95	97	94	85	95	63	99	96	96	87
High CRI Warm White (CAWT722-S)	96	98	98	95	95	97	95	95	92	97	93	94	83	95	96	96	94

I. LED optical property & basic theory

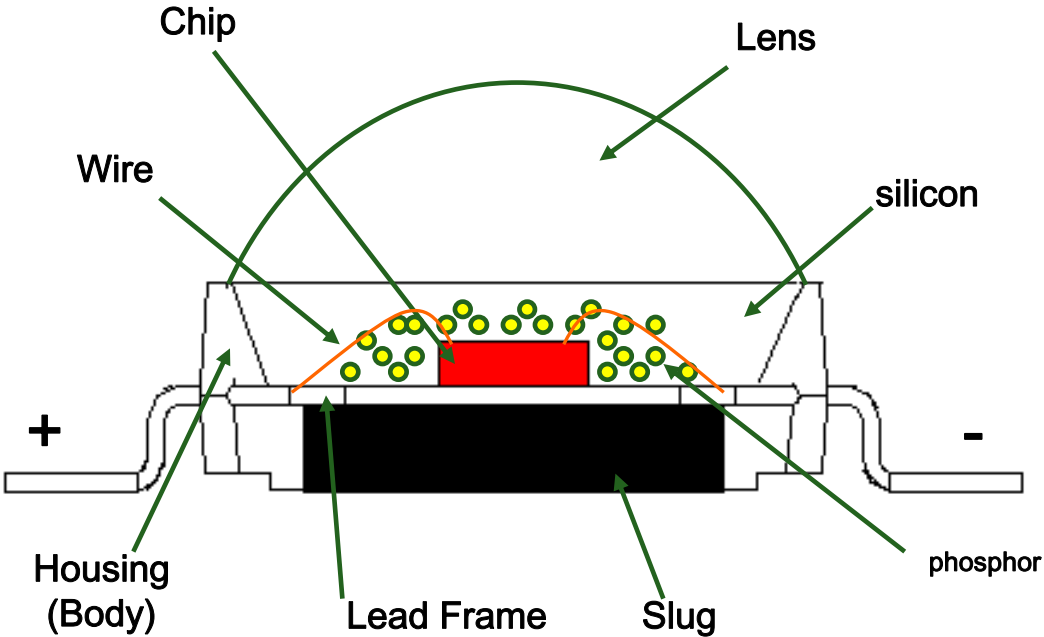
Optical Specification of LED

	Parameter	Symbol	Value			Unit
			Min	Typ	Max	
Brightness	Luminous Flux	ϕ_V	80	100	120	lm
	Luminous Intensity	I_V	1.0	1.5	2.0	Cd
Colour	CIE Colour Coordinates	x, y	X=0.33 Y=0.33	X=0.33 Y=0.33	X=0.33 Y=0.33	-
	Dominant Wavelength	λ_D	455	460	475	nm
	Correlated Colour Temperature	CCT	-	6500	-	K
	CRI	R_a	65	70	80	-
Distribution	Viewing Angle	$2\theta_{1/2}$	130			Deg.
	Radiation pattern	-	Lambertian			-

*Condition

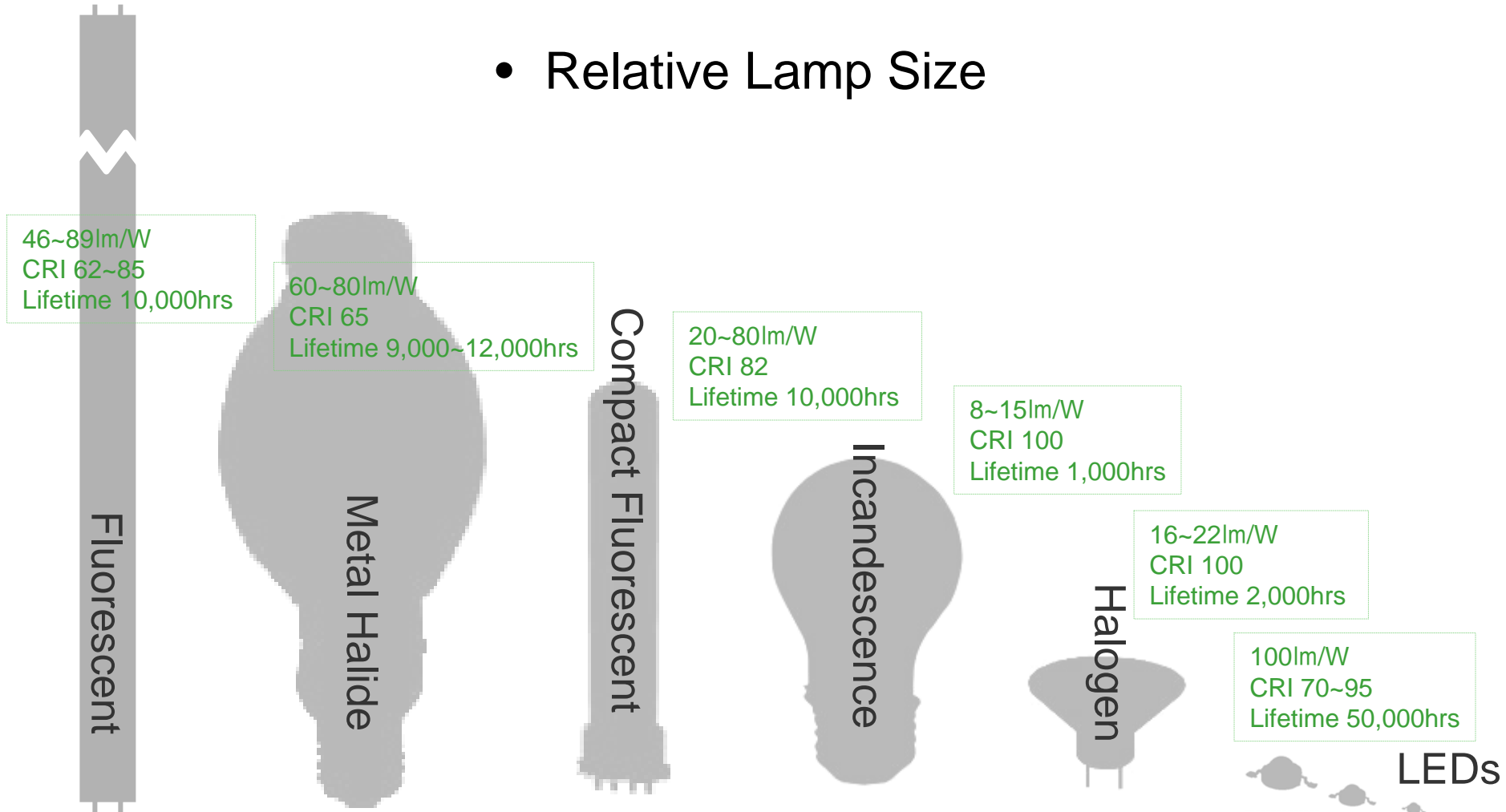
(*Condition : $I_F=350mA$, $T_a = 25^\circ C$)

I_F : LED operation Current
 T_a : temperature



LED vs. Traditional Light Sources

- Relative Lamp Size



I. Lighting

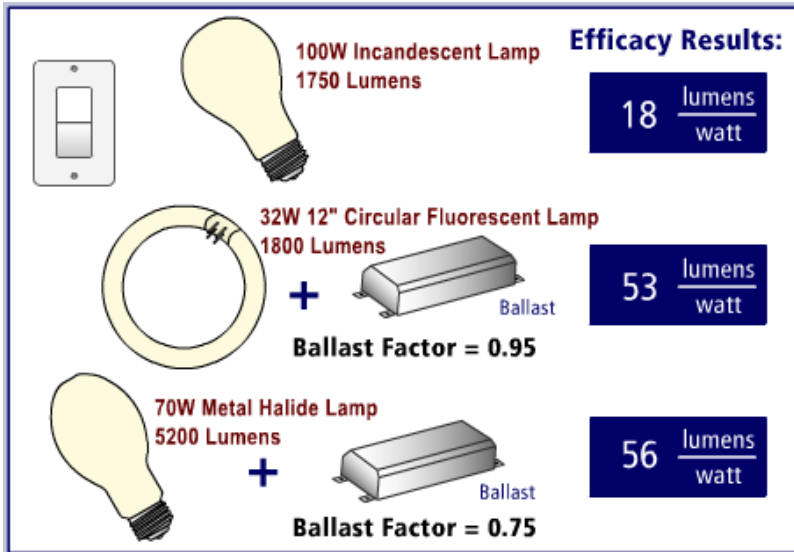
Comparison of light source

Light Source	Efficacy (lm/W)	Lifetime (H)	Light output Degradation (%)	CCT (K)	CRI
Standard Incandescent	5~18	750~2,000	12~18	2650~2950	100
Tungsten Halogen	15~25	2,000~6,000	< 5	2750~3050	100
High-wattage CFL	50~80	10,000~20,000	14~17	3000~5000	82
Low-wattage CFL	20~55	10,000	14~17	2700~5000	82
Linear fluorescent	65~95	7,500~20,000	5~10	2700~5000	60~90
Metal halide	45~100	7,500~20,000	22~36	2900~4400	65~85
High pressure sodium	45~120	16,000~24,000	9~12	1900~2100	22

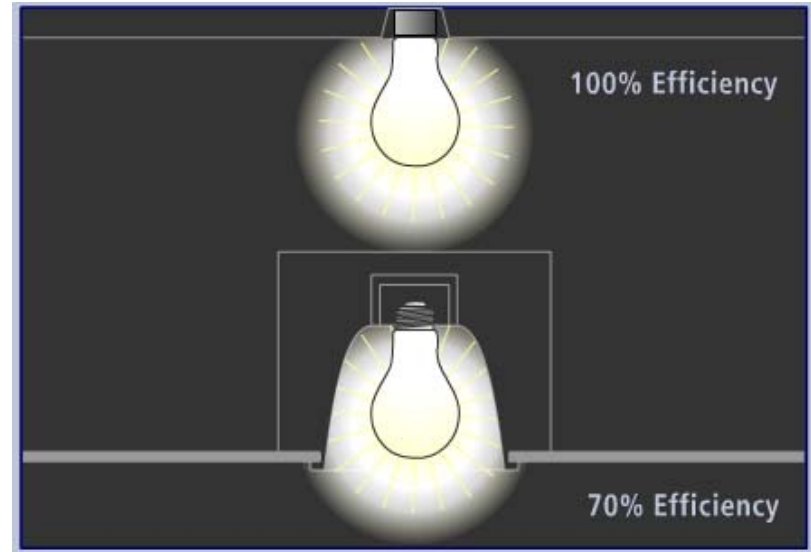


I. Lighting

Efficacy & Efficiency



The quotient of the total luminous flux emitted by the total lamp power input. It is expressed in lumens per watt (lm/W)



The ratio of luminous flux (lumens) emitted by a luminaire to that emitted by the lamp or lamps used therein.

White Colour Binning

Z-Power LED

