

OLED and LED Impact on Eye health

What is Blue-light hazard ?

□ Blue-light hazard

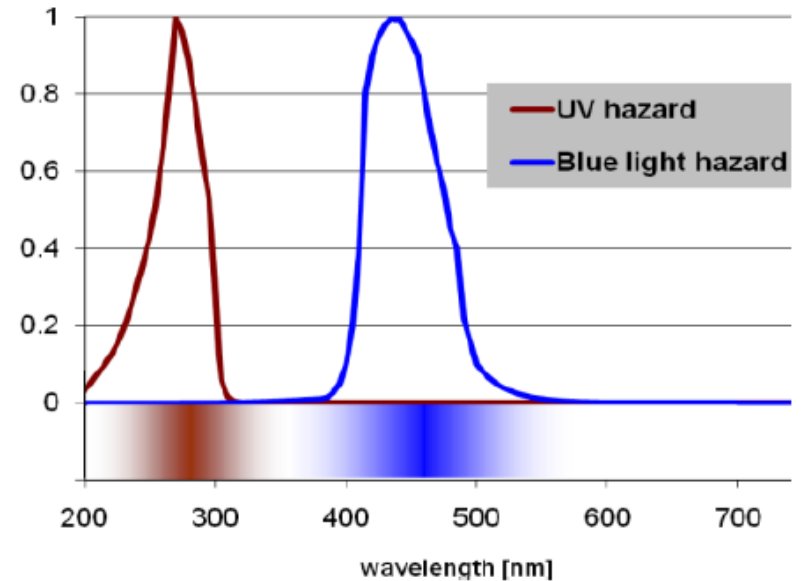
- The potential for a photochemical induced retinal injury resulting from electromagnetic radiation exposure at wavelengths **primarily between 400 ~ 500 nm.**
- Under normal conditions when light hits a photoreceptor, the cell bleaches and becomes useless until it has recovered through a metabolic process called the visual cycle
- The blue light damage to the mechanism of the eye
 1. Already bleached cells in the eye (rods and cones) change in the original color rapidly.
 2. The cells which changed the original color absorb more light.
 3. Due to the absorption of light, retina is damaged.



Blue-light hazard : All blue lights are equally hazardous?

□ Blue-light hazard function

- Blue light hazard spectrum : **400-500 nm**
- Not all blue lights are equally hazardous.
- Action spectrum peak
→ Light at **450 nm is most hazardous.**
- Increased risk due to high power LED.

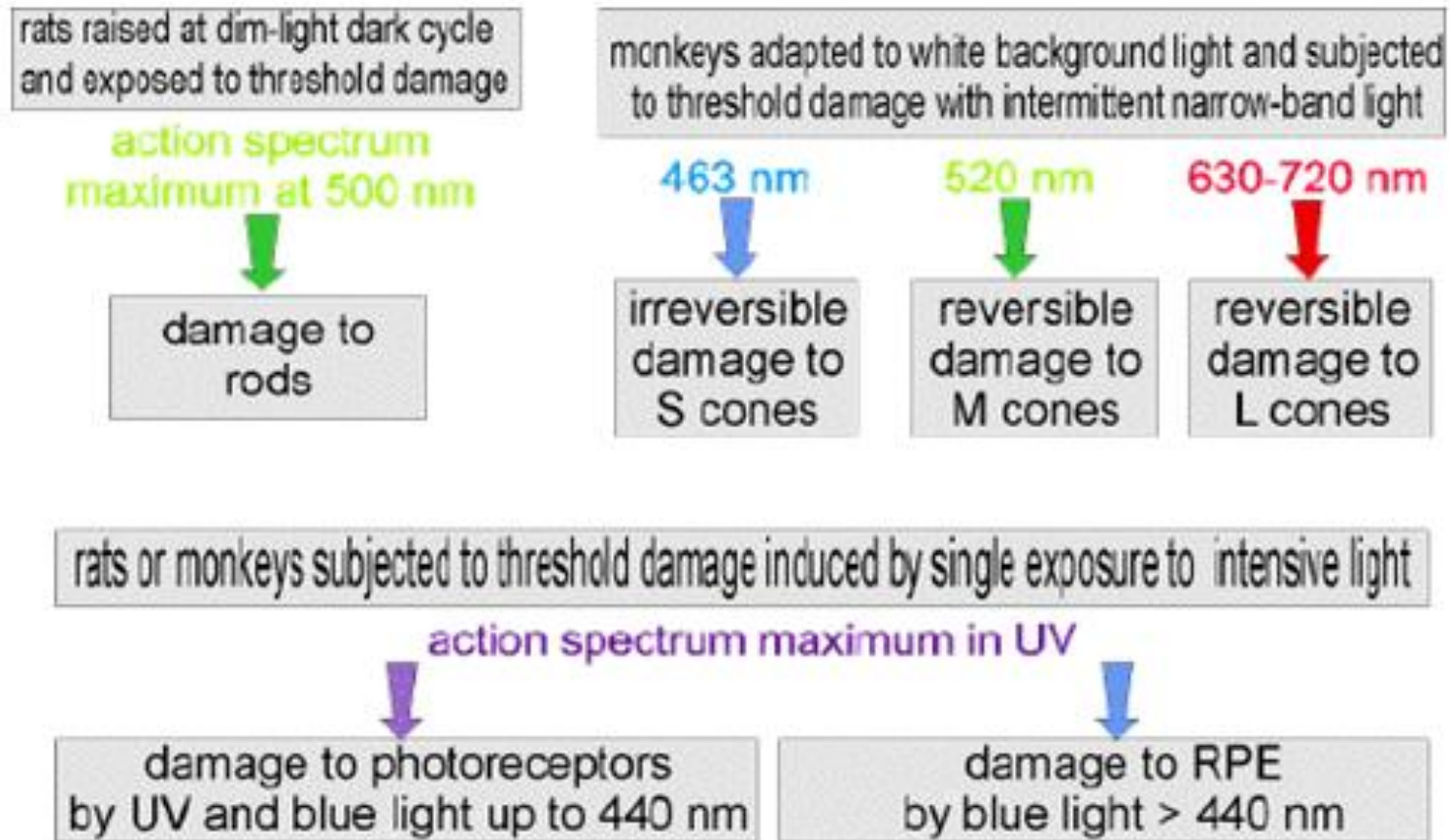


• The risk due to exposure to excessive blue light

- Weakening or loss of vision
- Rapid acceleration of age-related macular (AMD) degeneration
- Especially, the cataract surgery patients have more risk



Types of photochemical damage to the retina¹⁾



How do we address blue light hazard?

□ There are international guidelines and standards

- **IEC/EN 62471** *Photobiological Safety of Lamps and Luminaires*.
- Supporting guidance is provided in IEC/TR 62471-2 (2009) and IEC/TR 62778 (2012).

□ Blue light hazard by IEC/EN 62471

- To address and characterize blue light hazard, IEC 62471 establish exposure limit risk groups (RGs).
- Four risk groups are used to categorize light source.
- Risk group 2 or lower RGs are regarded as safe.

Hazard	Exempt Risk Group	Risk Group 1	Risk Group 2	Risk Group 3
Retina blue light hazard 300nm ~ 400nm	Not required	Not required	Do not stare at operating lamp. May be harmful to the eye	Do not look at operating lamp. Eye injury may result
Retina blue light or thermal hazard 400nm ~ 780nm	Not required	Not required	Do not stare at operating lamp. May be harmful to the eye	Do not look at operating lamp. Eye injury may result

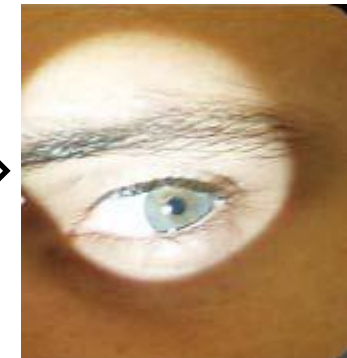
Risk Group	Risk	Definition
Exempt	None	No photobiological hazard
RG-1	Low Risk	No photobiological hazard under normal behavioral limitation
RG-2	Moderate Risk	Does not pose a hazard due to aversion response to bright light or thermal discomfort
RG-3	High Risk	Hazardous even for momentary exposure

What are criteria for blue light hazard assessment by IEC/EN 62471 ?

Hazard	Action Spectrum	Symbol	Exposure Limit			Units
			Exempt	RG1	RG2	
Actinic UV	$S(\lambda)$	E_s	0.001	0.003	0.03	$W\ m^{-2}$
Near UV		E_{UVA}	10	33	100	$W\ m^{-2}$
Blue Light	$B(\lambda)$	L_B	100	10000	4000000	$W\ m^{-2}sr^{-1}$
Blue Light, Small Source	$B(\lambda)$	E_B	1	1	400	$W\ m^{-2}$
Retinal Thermal	$R(\lambda)$	L_R	$28000/\alpha$	$28000/\alpha$	$71000/\alpha$	$W\ m^{-2}sr^{-1}$
Retinal Thermal, weak visual stimulus	$R(\lambda)$	L_{IR}	$6000/\alpha$	$6000/\alpha$	$6000/\alpha$	$W\ m^{-2}sr^{-1}$
IR Radiation Eye		E_{IR}	100	570	3200	$W\ m^{-2}$

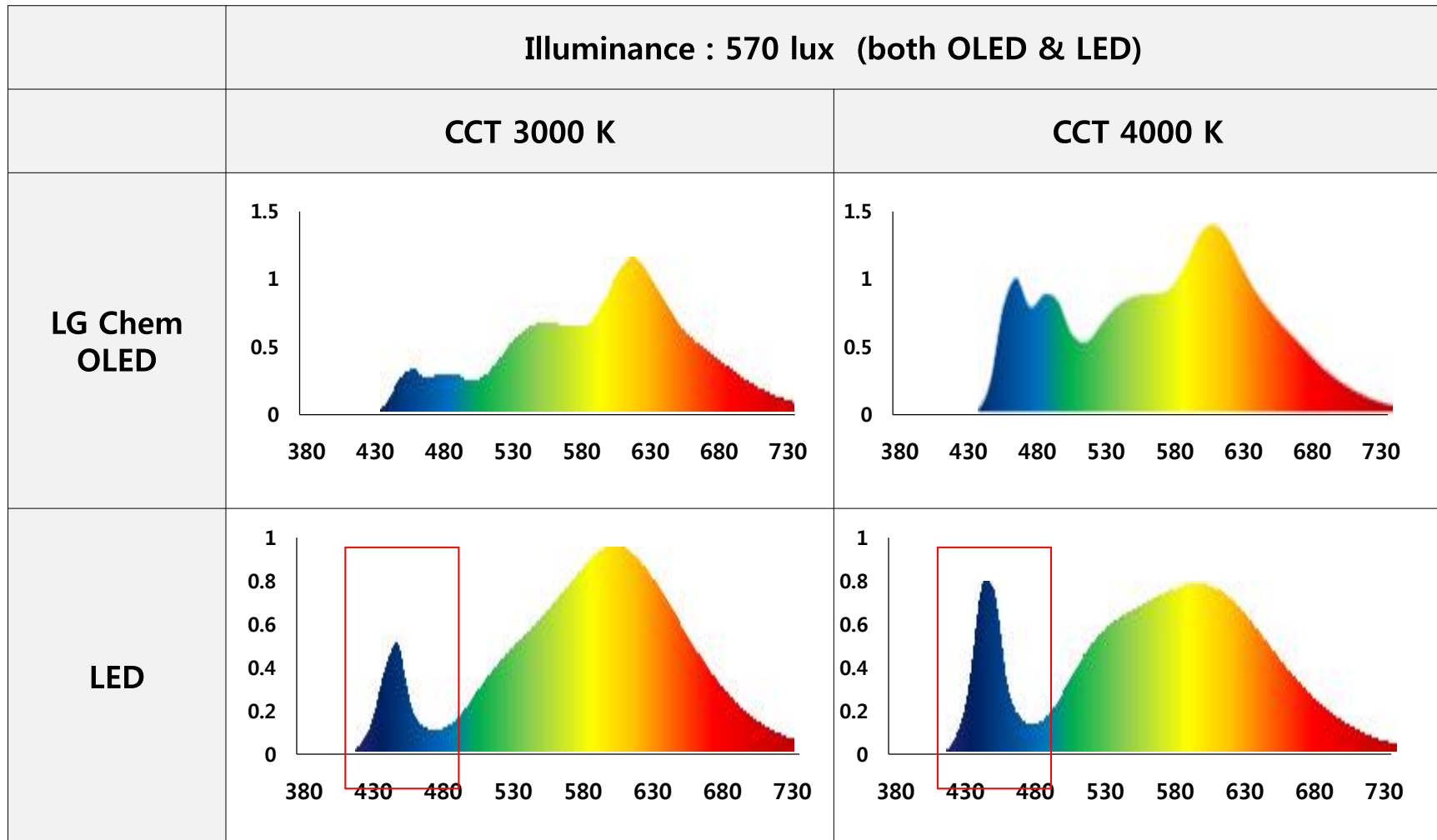
Spectral radiance
(W/m^2sr)

- Accounts for radiance power coupled by optical system such as eye.
- In case of looking at light source.
- To evaluate hazards in retina of eye.



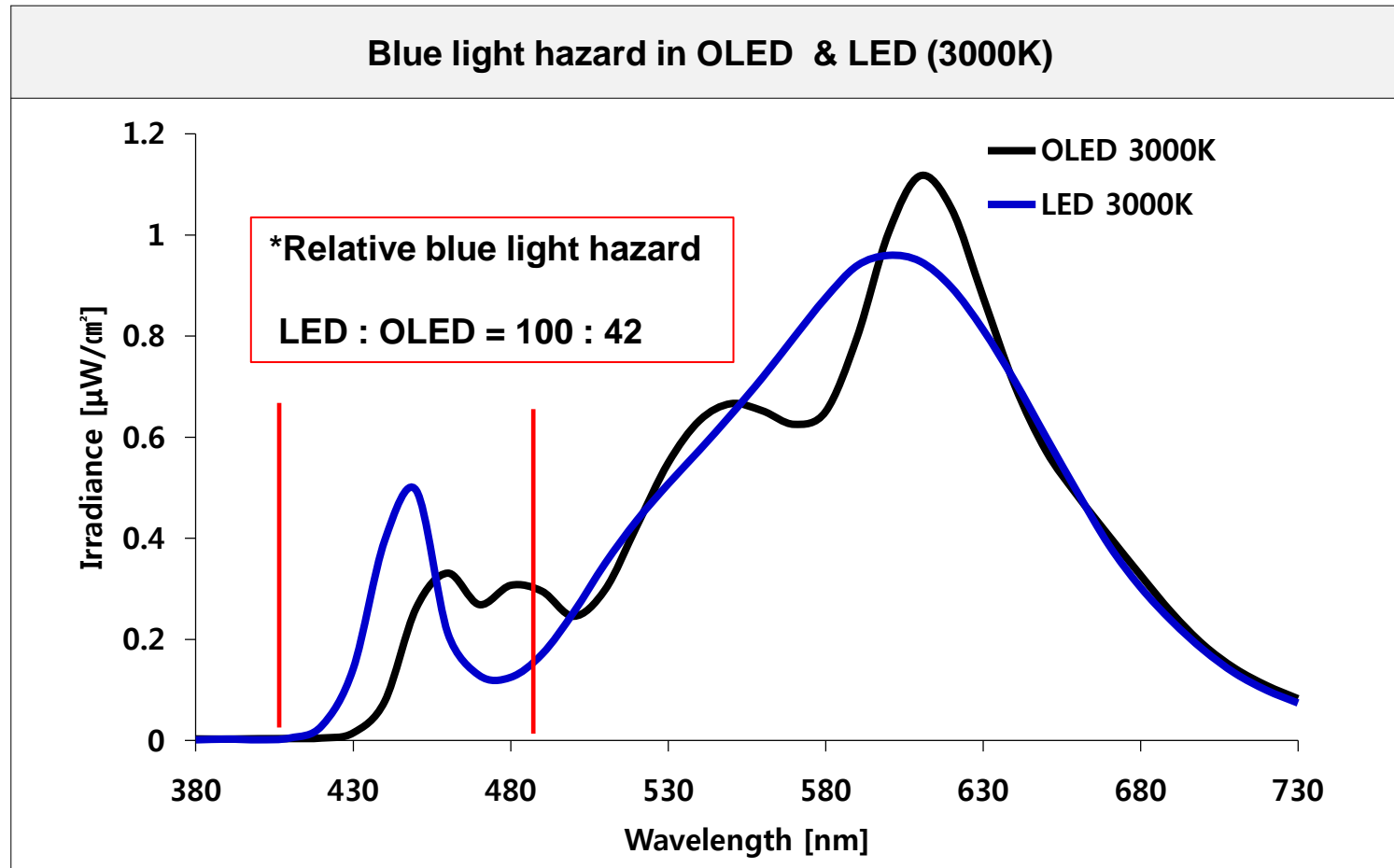
Which one has more blue lights ? OLED vs LED

- Due to the peak at ~ 450 nm, LEDs emit more blue lights.
- The higher CCT, the more blue lights emitted.



What about blue light hazard in OLED and LED ?

- LED has relatively more blue light hazard than OLED.



* Relative blue light hazard : spectral radiance power * blue light hazard function $B(\lambda)$
Blue light hazard function $B(\lambda)$: ICNIRP GUIDELINES "ON LIMITS OF EXPOSURE TO INCOHERENT VISIBLE AND INFRARED RADIATION" 2013.

Is LG Chem OLED completely safe in terms of blue light hazard?

- LG Chem OLED has official certification of exempt group “RG0”



Test Report issued under the responsibility of:







TEST REPORT IEC 62471 Photobiological safety of lamps and lamp systems	
Report Reference No.:	CBC2013-0067
Date of issue	2013.10.21
Total number of pages	19

CB Testing Laboratory	KTR (KOREA TI
Address	66-6, Jeil-Ri, Yar
Applicant's name	LG Chem CO.,L
Address	Ochang 1 plant, Cheongwon-gur
Test specification:	
Standard	IEC 62471:2006 National differer
Test procedure	N/A
Non-standard test method.....	N/A

Test item particulars				
Tested lamp.....	<input checked="" type="checkbox"/> continuous wave lamps	<input type="checkbox"/> pulsed lamps		
Tested lamp system				
Lamp classification group	<input checked="" type="checkbox"/> exempt	<input type="checkbox"/> risk 1	<input type="checkbox"/> risk 2	<input type="checkbox"/> risk 3
Lamp cap.....	-			
Bulb	OLED			
Rated of the lamp.....	150 mA, 8.2 V - 8.8 V			
Furthermore marking on the lamp	-			
Seasoning of lamps according IEC standard.....	-			
Used measurement instrument	See page 15			
Temperature by measurement	24.5 °C			
Information for safety use	Not required			

Classification of some lamps by IEC/EN 62471 & IEC/TR 62778

- LED module could be RG-1 or higher risk group while OLED module is an exempt group.

Type of light source	Picture	Infrared hazard	Blue light hazard	UV hazard
Tungsten halogen lamps for domestic and similar general lighting purposes IEC 60432-2		No risk	No risk	No risk
Self-ballasted lamps for general lighting services IEC 60968		No risk	No risk	No risk
LED Module IEC 62031		No risk	To be evaluated according to the manufacturer specifications	No risk
OLED Module		No risk	No risk	No risk

Classification of some LED light sources.

- LED light sources are often classified as RG-1 or RG-2 depending on power and CCT.

XLamp LED	Testing Date	Drive Condition	Risk Group Classification
CXA1304 (9V)	February 26, 2014	1.000 A	RG-2 Moderate risk
CXA1507	July 27, 2012	0.375 A	RG-1 Low risk
CXA1512	August 24, 2012	0.500 A	RG-1 Low risk
CXA1520	November 22, 2013	0.900 A	RG-2 Moderate risk
CXA1816	October 22, 2013	0.900 A	RG-1 Low risk
CXA2011	June 9, 2011	0.270 A	RG-1 Low risk
CXA3050	October 22, 2013	2.500 A	RG-1 Low risk
MC-E White (4S)	June 26, 2009	2.800 A	RG-2 Moderate risk
MK-R White	October 25, 2013	1.250 A	RG-2 Moderate risk
ML-E Blue	May 3, 2013	0.350 A	RG-2 Moderate risk
ML-E White	April 27, 2012	0.150 A	Exempt
MP-L EasyWhite (per string)	June 9, 2011	0.150 A	RG-1 Low risk
MT-G EasyWhite (6V)	June 9, 2011	1.100 A	RG-1 Low risk
MX-6 White	September 4, 2009	0.350 A	RG-1 Low risk
XB-D Green	October 5, 2012	1.000 A	Exempt
XB-D Royal Blue	October 5, 2012	1.000 A	RG-2 Moderate risk
XB-D White	October 5, 2012	1.000 A	RG-2 Moderate risk
XH-G White	November 11, 2013	0.350 A	Exempt
XM-L EasyWhite (12V)	June 4, 2012	0.350 A	RG-1 Low risk
XM-L High Voltage White	April 27, 2012	0.044 A	Exempt
XM-L White	June 5, 2011	0.700 A	RG-2 Moderate risk
XM-L2 White	October 25, 2013	3.000 A	RG-2 Moderate risk

What are concerns of light sources for people with eye disease ??

❑ Guidance for people with high sensitivity for blue light

- Below the illuminance level of 500 lux as measurement basis, none of LED products are classified higher than RG-1.**
- It is safe to use LED products under ordinary condition, but this is valid for healthy people in the general public.**
- People with highly sensitive eyes for blue light may be wise to investigate alternative light sources that operate on a more specific radiation band not covered by the applied action curves that cover a broad range of radiations.**
- Even though LED can be classified as Risk Group 1 in IEC 62778, chronic effect of LED lights to people with eye disease has not been addressed nor proved.**
- In this point of view, OLED with less blue lights would be better consideration for light sources, especially in eye clinic building where great care is needed.**

Reference

- 1. LIGHTING EUROPE GUIDE “ON PHOTOBIOLOGICAL SAFETY IN GENERAL LIGHTING PRODUCTS FOR USE IN WORKING PLACES” Edition February 2013**
- 2. CELMA “Optical safety of LED lighting”, 1st Edition July 2011.**
- 3. ICNIRP GUIDELINES “ON LIMITS OF EXPOSURE TO INCOHERENT VISIBLE AND INFRARED RADIATION “ICNIRP PUBLICATION 2013.**
- 4. DOE, Building Technologies Office “SOLID-STATE LIGHTING TECHNOLOGY FACT SHEET”**