

Designers Light Forum

Designing with OLEDs and Integration Components

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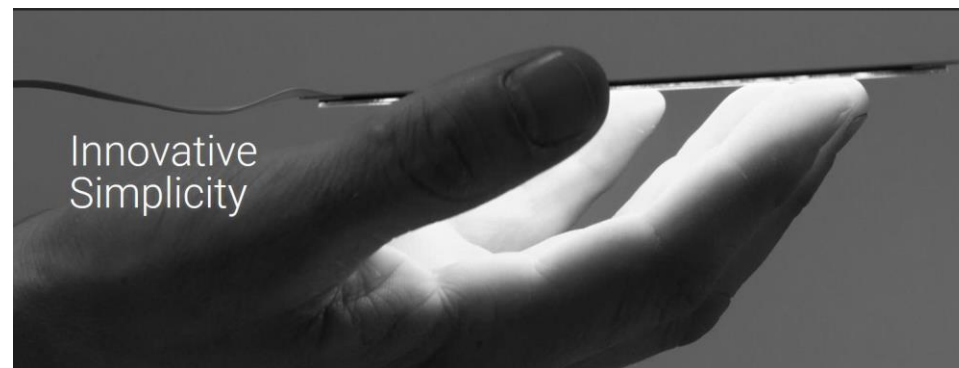
Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn OLED technology and the basic principles of light emission
2. Understand current OLED Panel performance in terms of efficacy, color quality, life time, reliability and cost
3. Recognize the difference between OLED and other light sources (including LED)
4. Understand design options including simplicity for OLED as building tile and luminaire
5. Understand selecting power distribution, wiring methods, dimmers and drivers for OLEDs

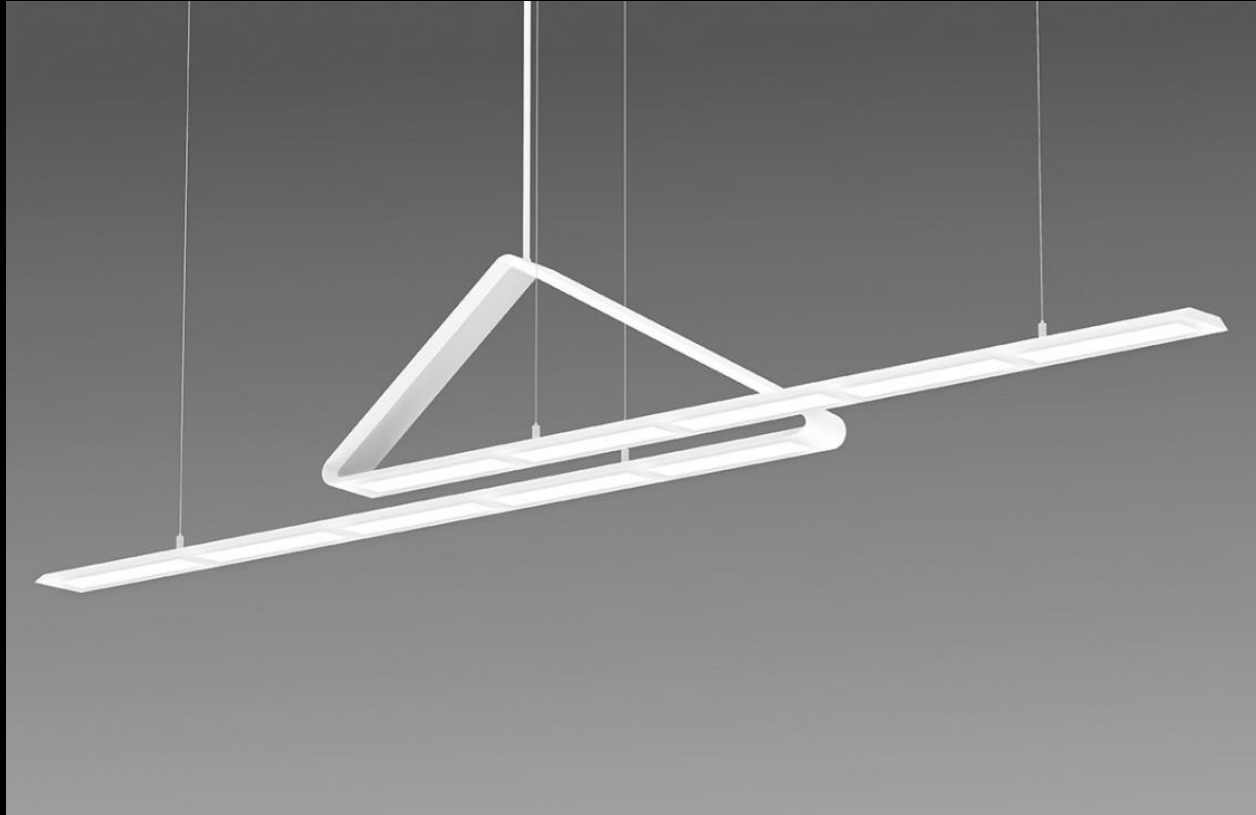
OLED Technology and OLED Panel Performance

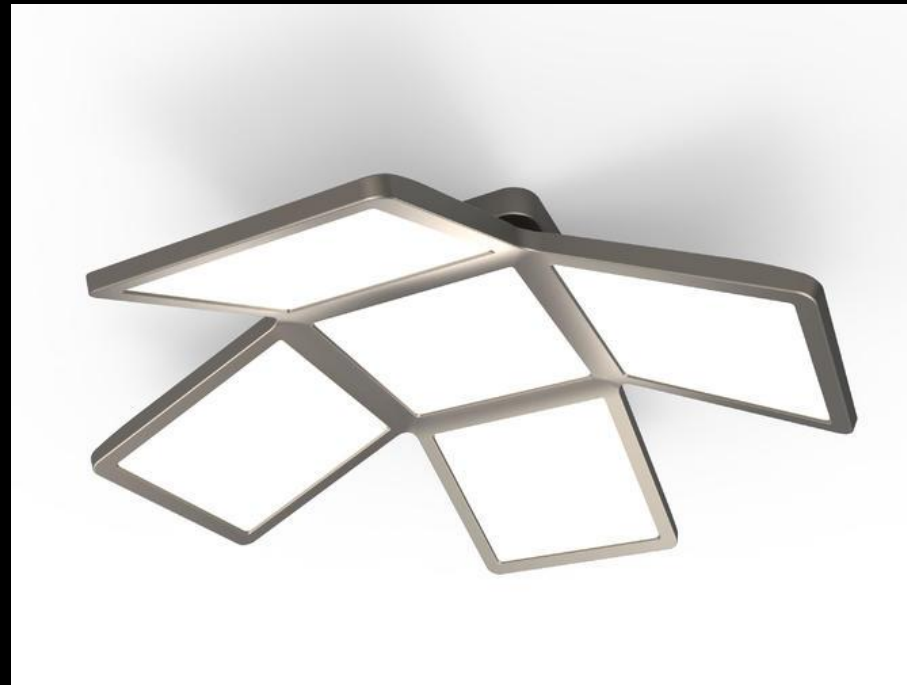


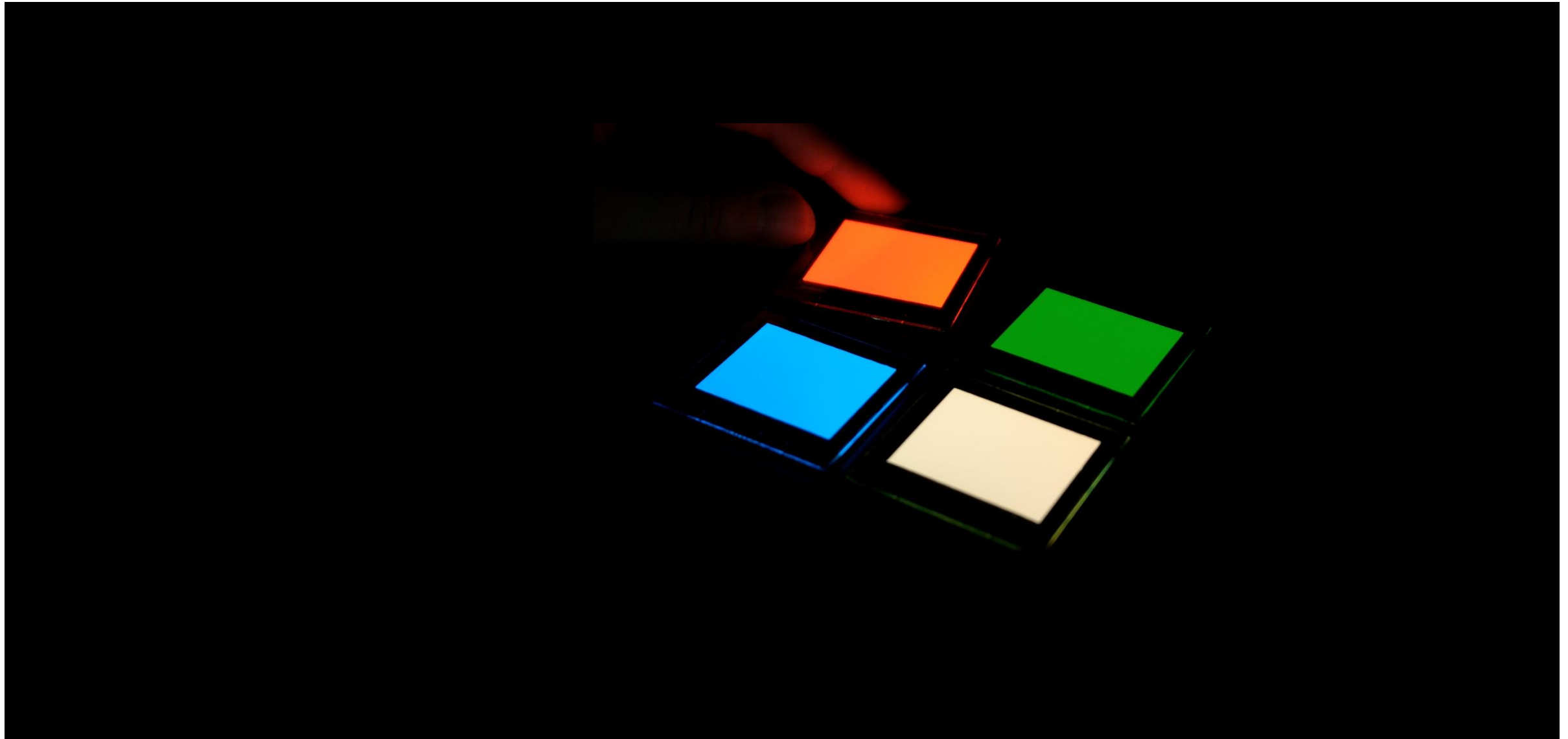
“There is something about that light.”



- **OLED Overview - What is it?**
- OLED Technical Challenges
- OLED Design Challenges

























Global View: OLED light engines

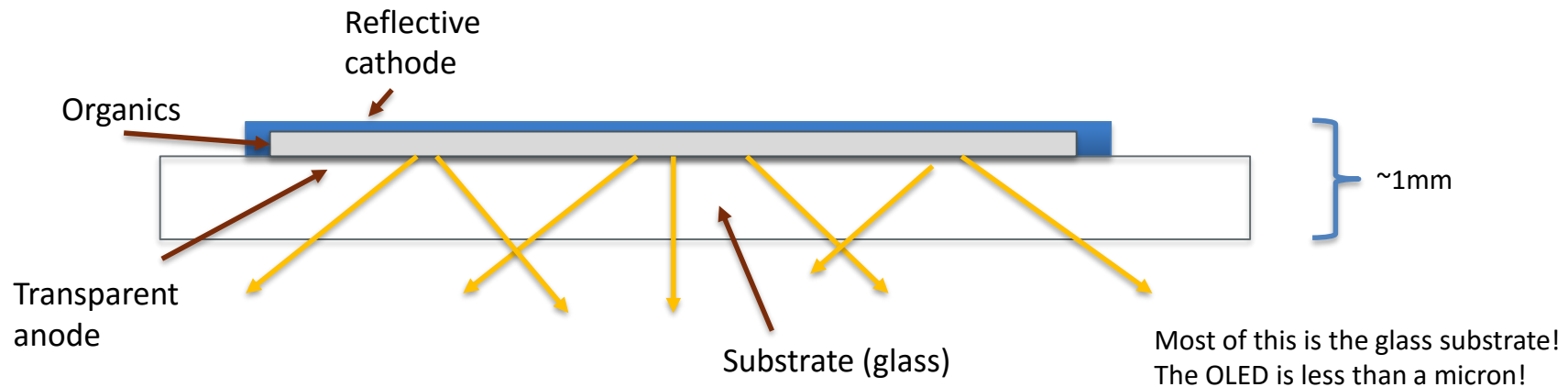
						
Efficiency lm/W	60 (80)	40 (70)	40	45	60 (80)	30
L70 Khrs	10 @ 8400nits 50 @ 3200nits	10 @ 2000nits (20@3000nits)	30 @ 3000nits	8 @ 1000nits	50 @ 3000nits	10 @ 5400nits (30 @ 3000nits)
CRI	>90	>75	>90	>75	>90	>84
	High brightness	Transportation	Architectural	Flexible	Broad Portfolio	High CCT

- Are OLED lighting panels positioned for market adoption?
- ✓ Yes, surpass threshold for many applications

OLED Light Panel: What it is physically?

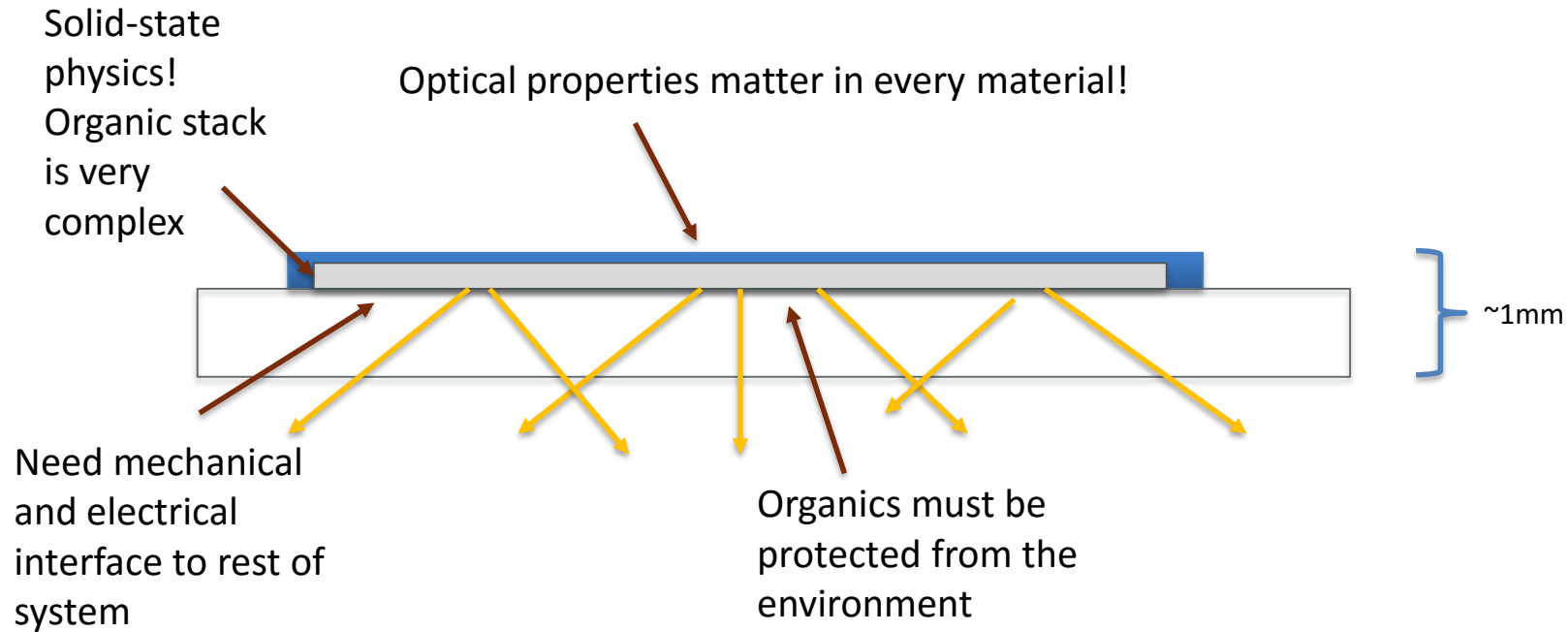
Simple view: It's a sandwich!

Organic materials layered between an anode and a cathode



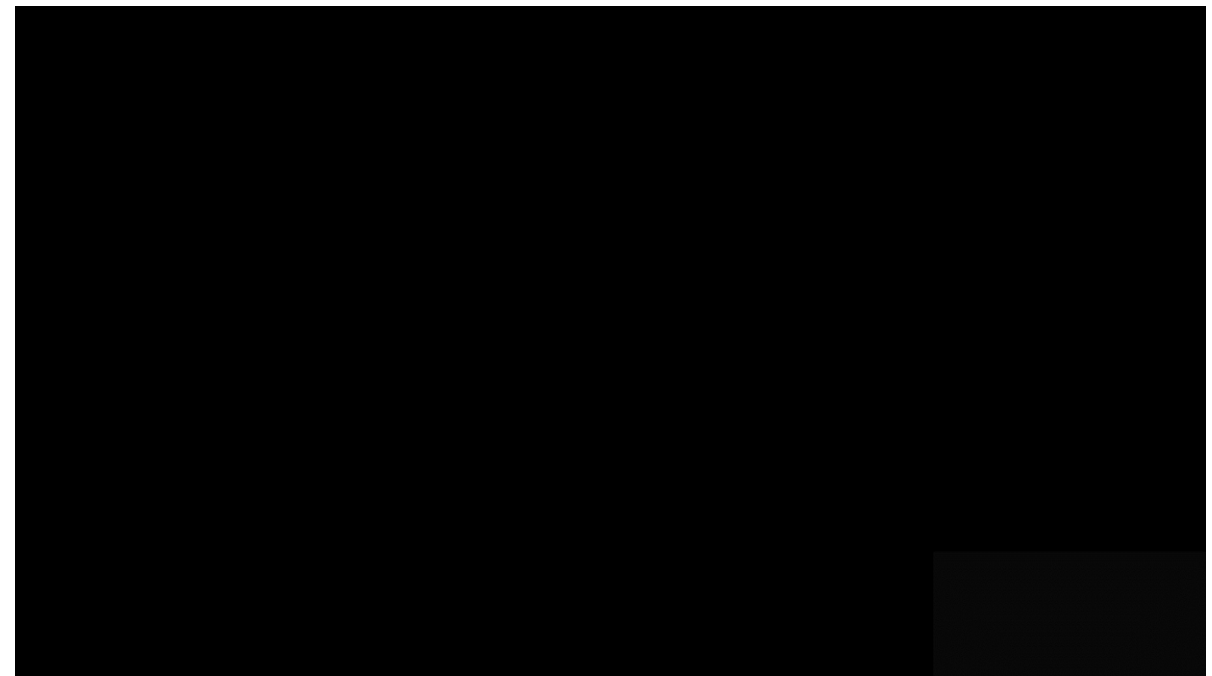
A large area diode – NOT lots of little diodes!

OLED Light Panel: What it is physically?



Guess What! It's not that simple!

How an OLED is Made

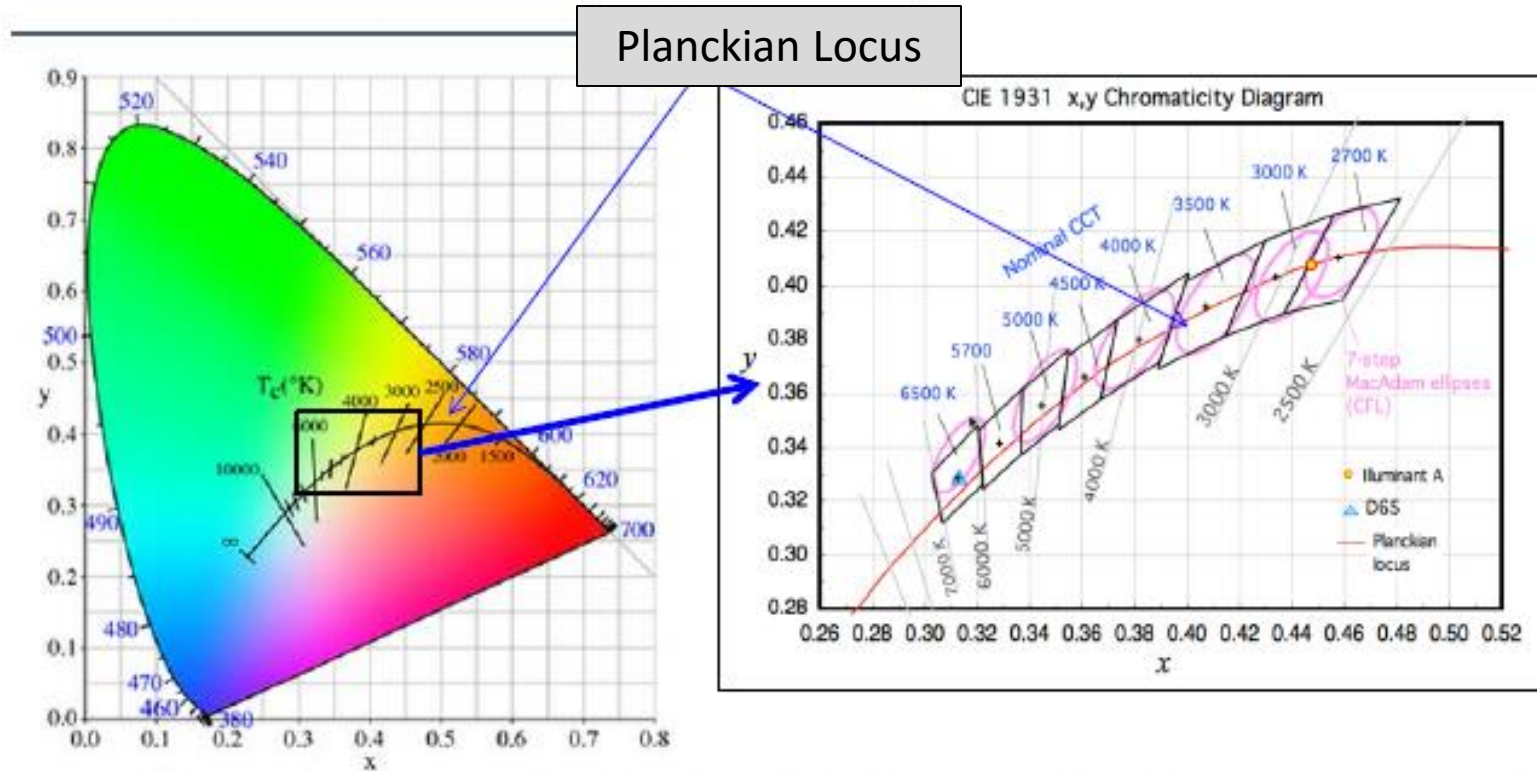


“There is something about that light.”



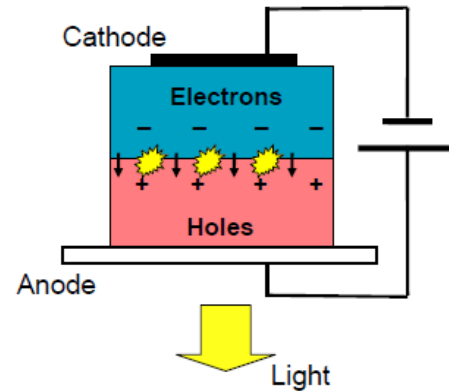
- OLED Overview - What is it?
- **OLED Technical Challenges**
- OLED Design Challenges

OLED: How do you make white light?



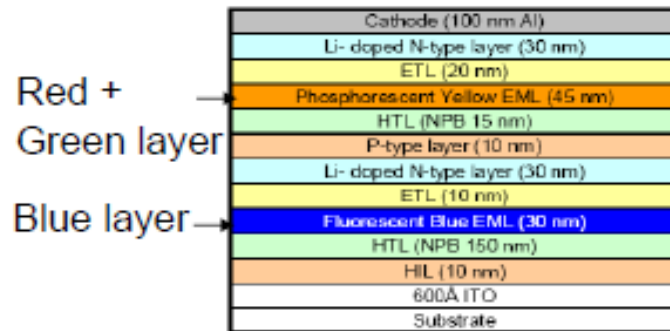
The color coordinates have to fall within one of the tolerance quadrangles!

Challenges: Technical

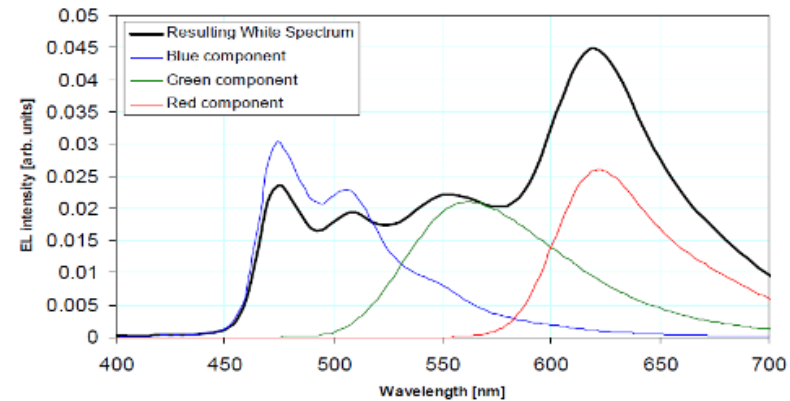


Source: Kodak, 2009

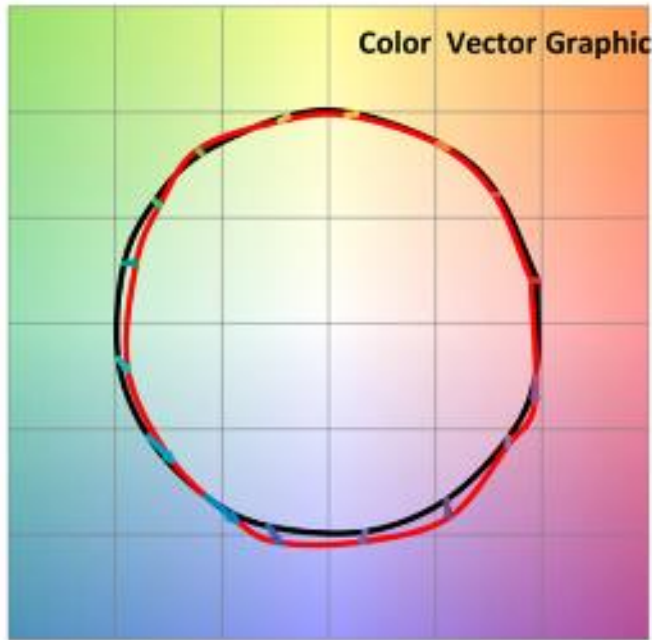
- OLED is inherently a planar device
- Current driven, light is emitted when holes and electrons combine
- Composed of carbon based (organic) molecules
- Active layers less than 1 micron thick
- Total device thickness ~2mm
- Light gets trapped!!
- Extensible to large format and flexible substrate



Source: UDC

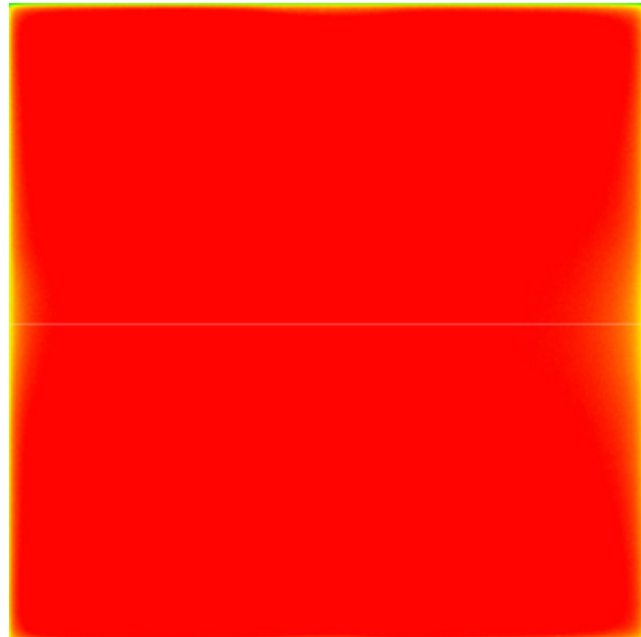


Challenges: Technical

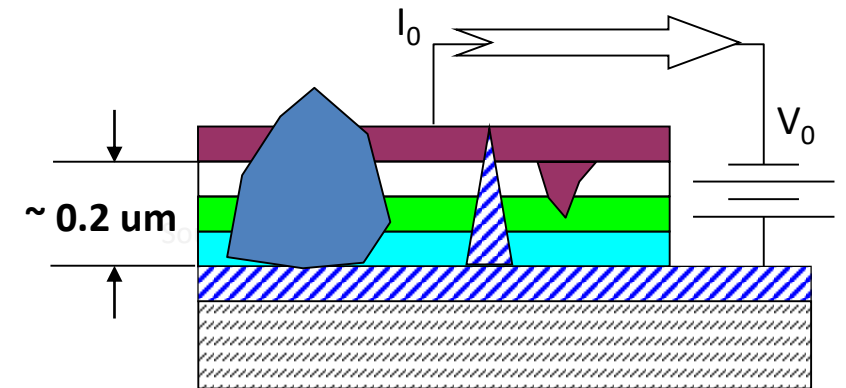


Superb color rendering, not just the CRI color patches!

Lifetime color shift managed



Uniformity is excellent including angular color shift
Larger panels need to manage resistive drop



Failure modes can include shorts

Quality control & test screening

OLED: Lifetime – Constant Current

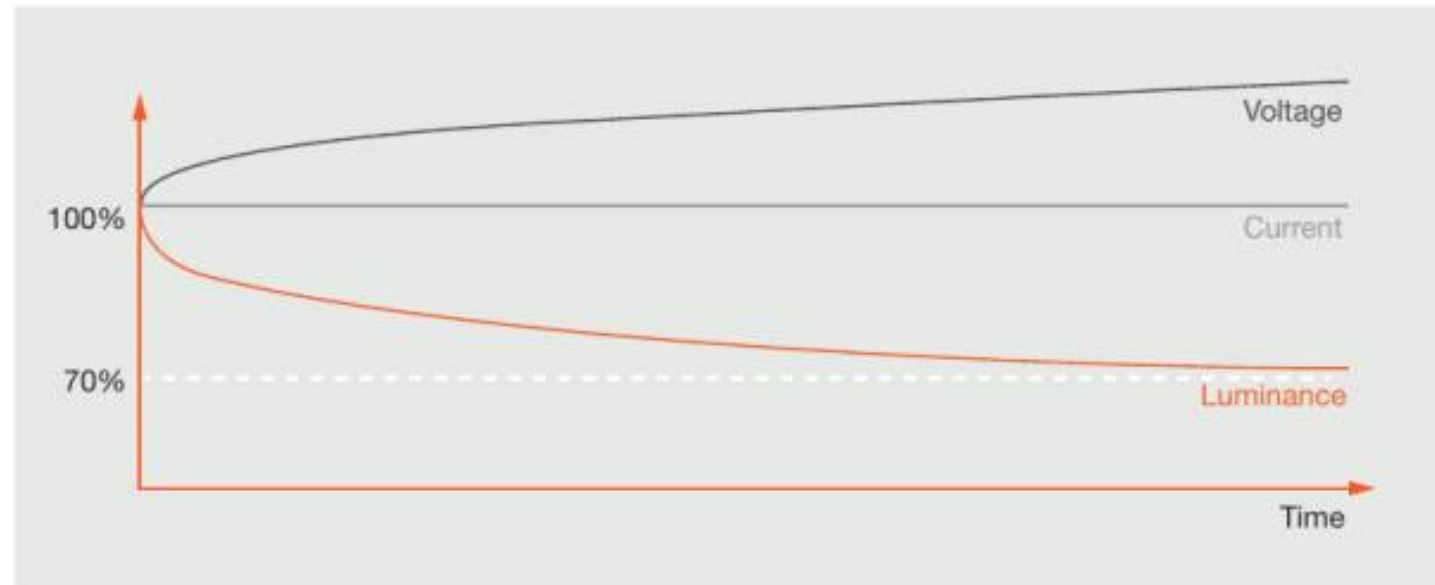
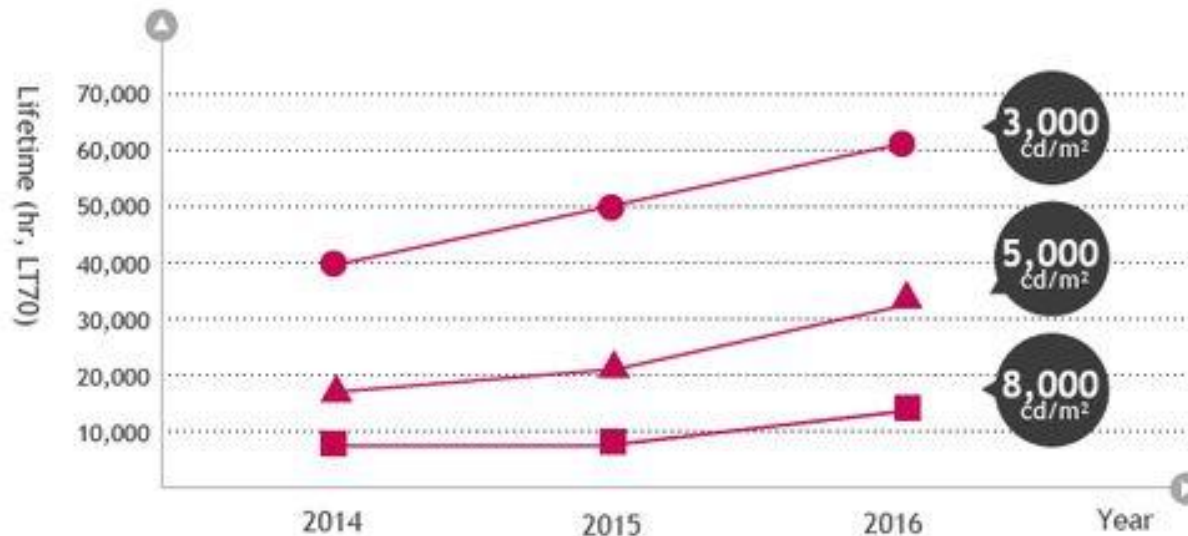


Figure 2: Reduced decay of luminance with constant current operation

OLED: Lifetime

Luminance & Lifetime

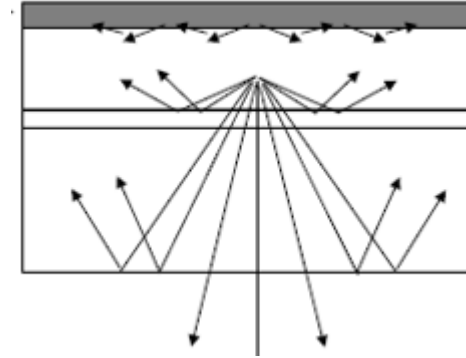


Typical lifetimes reported by major OLED suppliers

Increased efficacy greatly increases lifetimes: 8000 cd/m2 >25K hours

Challenges: Technical

- Larger scale efficient OLEDs at low cost
 - Efficiency: Getting the light out
 - Scale: Uniformity
 - Cost: Yield
- Drivers
 - Very low current requirements pose efficiency challenges
- Integration: Finishing & Handling
 - Into fixtures and into buildings
 - Controls, series/parallel, integration architectures
 - Light elements as building tiles



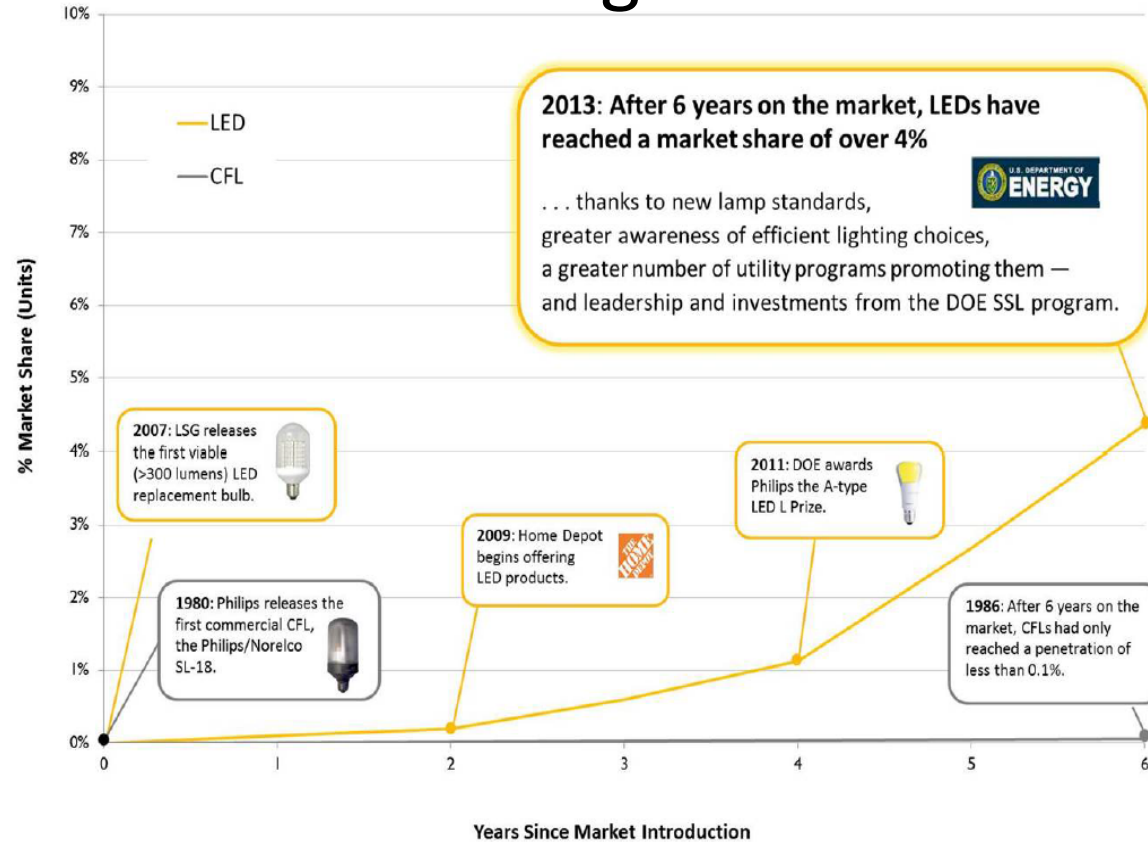
“There is something about that light.”



- OLED Overview - What is it?
- OLED Technical Challenges
- **OLED Design Challenges**

Challenges: Design

Learning from CFL



More efficient and lower cost not enough for market adoption if lighting is a bad experience

Source: James Brodrick, Dept of Energy, SSL Workshop Portland Oregon Nov 13 2013.

What do people love about OLED lighting?

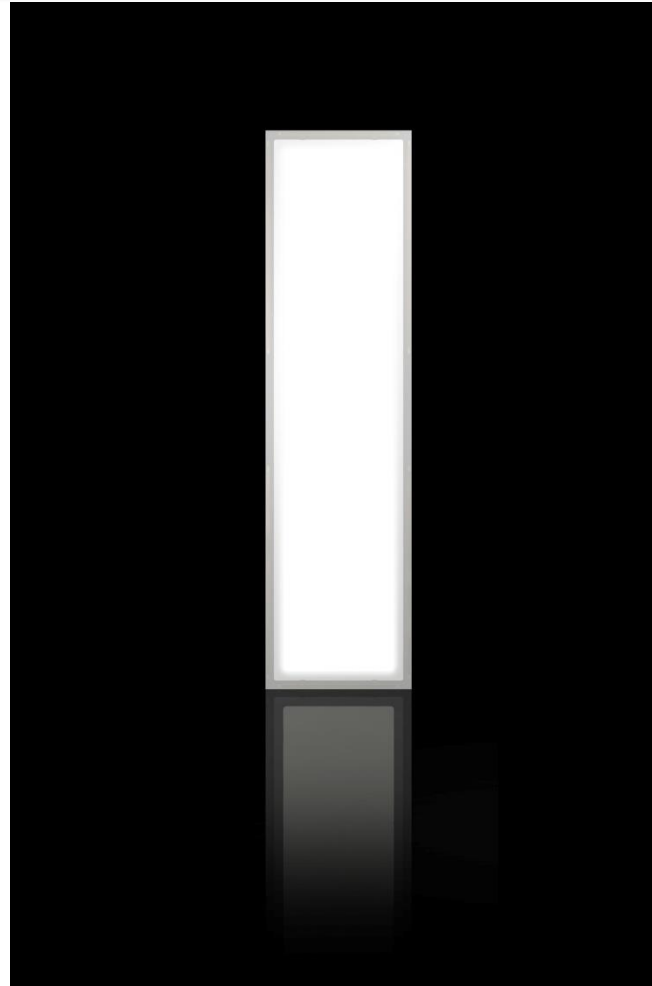


What do people love about OLED lighting?

**Thin Planar
Light
Source**

**Naturally
diffuse**

**Excellent
Color
rendering**



**Low
Glare**

**Cool to the
Touch**

**Solid-State
Efficient and
Controllable**

What do people love about OLED lighting?

“I don’t know why but I love the light”

“Doesn’t bother me while my spouse reads”



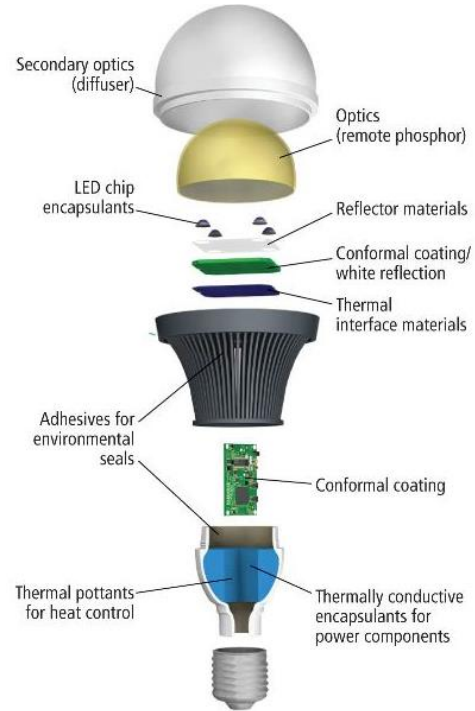
“Feels personal”

“The meal looked spectacular”

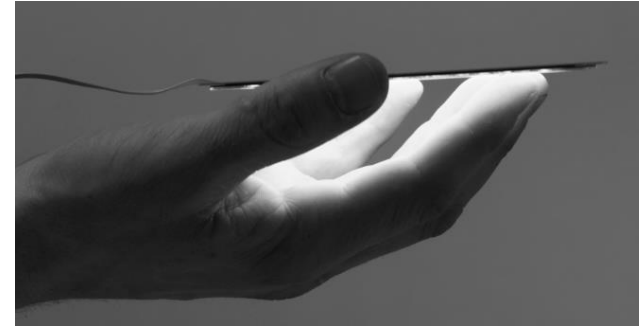
“I can read better by that light”

And from designers: “Honest”, “Pure”, “Inviting”, “Emotional”

Challenges: Design



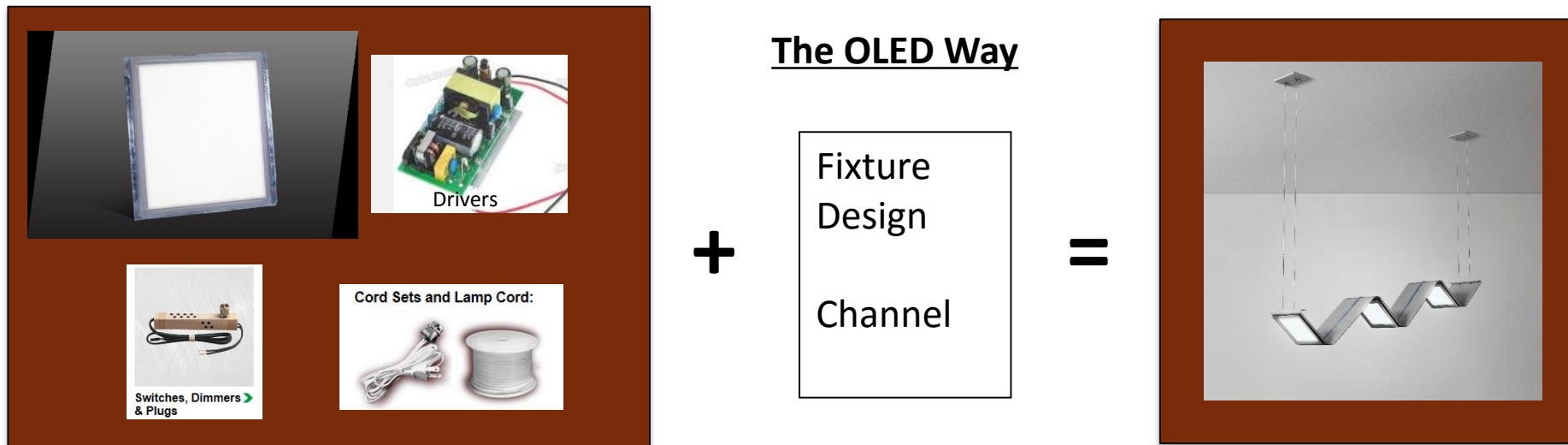
LED: Point source



OLED: Area source

Challenges: Design

- OLED can build on LED, solid-state lighting, expertise including drivers and controls
 - But far simpler assembly
- *Blurs the line between light engine and fixture*



New Design Perspective, New Applications

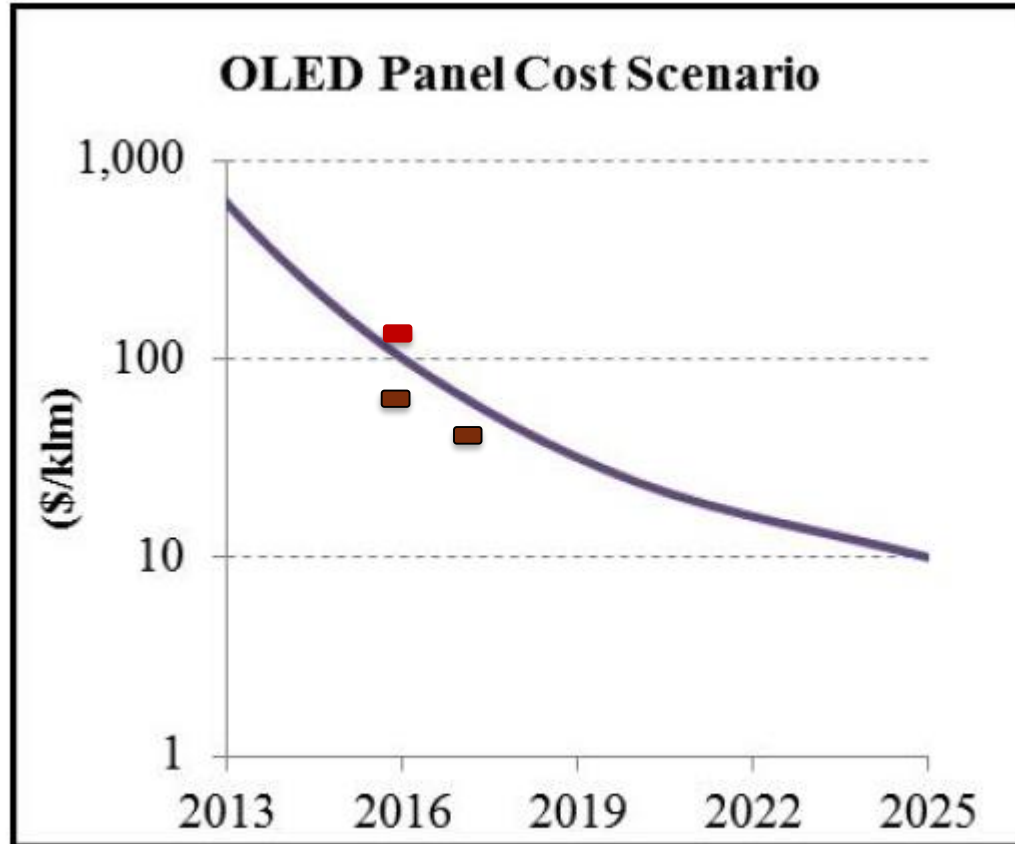
- Bring light closer to the user and where light is needed
- Direct mounting on surfaces – akin to a building material
- Diffuse lighting for machine vision
- A better light experience:
 - General lighting: commercial and residential
 - Hospitality and retail
 - Museums
- **A healthier light experience:**
 - **Wellness – seniors, patient rooms, recovery, etc**
 - **No blue light risk**
 - **Low glare, better color**
- A “lighter” light experience
 - Transportation
 - Furniture
- Flexible

OLED Department of Energy Gateway Study

Independent Third Party Report Available: <https://energy.gov/eere/ssl/articles/gateway-report-oleds-office-space>

Challenges: Cost

OLED Cost Reduction



- Consider total cost
 - No need for heat sinks, optics, etc.
 - Can bring light closer to user, efficient use of light in many applications
 - Application Efficiency
 - Faster product development cycle
- Many fixtures now very cost competitive

Cost Forecast – Is it real?

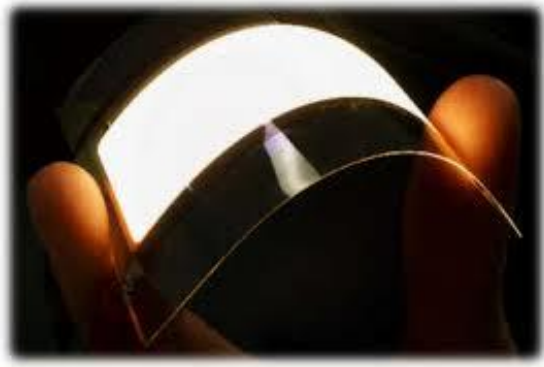
- Cost decrease with volume increase – efficiency in production
 - OLED as lamp, building material, electronic component...
- Higher yields
- Material costs – display and lighting demand drives efficiency in supply
- Device and finishing engineering improvements

- Yes: OLEDs offer an affordable lighting solution for current and future applications

Efficiency Forecast – Is it real?

- Higher performance materials including blue phosphorescent emitters being developed
 - Harnessing all the trapped light – new substrates and extraction techniques
 - Big improvements in drivers
 - Application efficiency
-
- Yes: OLEDs offer an efficient lighting solution for current and future applications

Near Future: Flexible OLED



www.dedworks.com

www.osadirect.com

www.konicaminolta.com



Glass Substrate: 100 micron glass provides same environmental protection as rigid glass; uniaxial bending

Plastic Substrate: Prone to pin holes causing OLED to grow large dark spots; “twist” may be possible

New Design Perspective, New applications

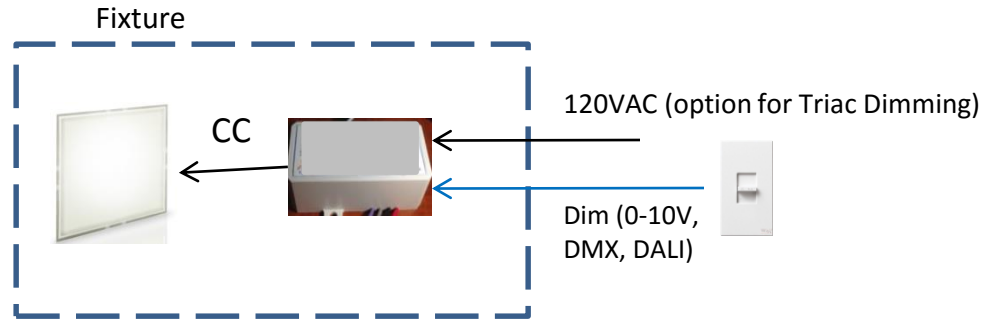
*Get ready for a superb
lighting experience.*

OLED INTEGRATION

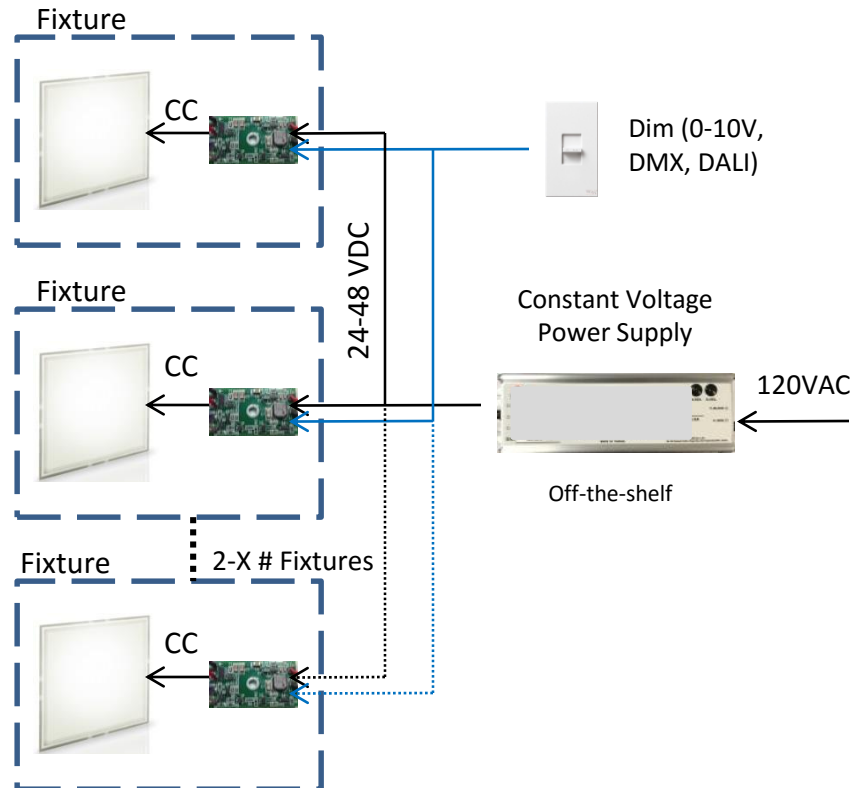
OLED Application Market Research

- Low voltage (Class 2) Power Distribution scheme preferred for most applications (thinner wiring, no conduits, minimal fixture structure, more flexibility)
- Need for small, thin, compact low voltage drivers to be mounted on, or in close proximity to, OLED panels
- Need for OLED “Module” containing OLED, Driver, Mounting Frame and connection feature (Plug and Play, easy for installers)
- Mounting frame: Light, thin, minimal border, easy to connect OLED to surface
- Accessories must complement “thin”, light-weight OLED characteristics
- Drivers must be dimmable
- Need high efficiency power system/driver
- Need robust electrical interconnects and wiring
- No consensus on RF (WiFi, ZigBee, other) standards – use off-the-shelf RF to 0-10V controls for now

OLED Electrical System Configurations

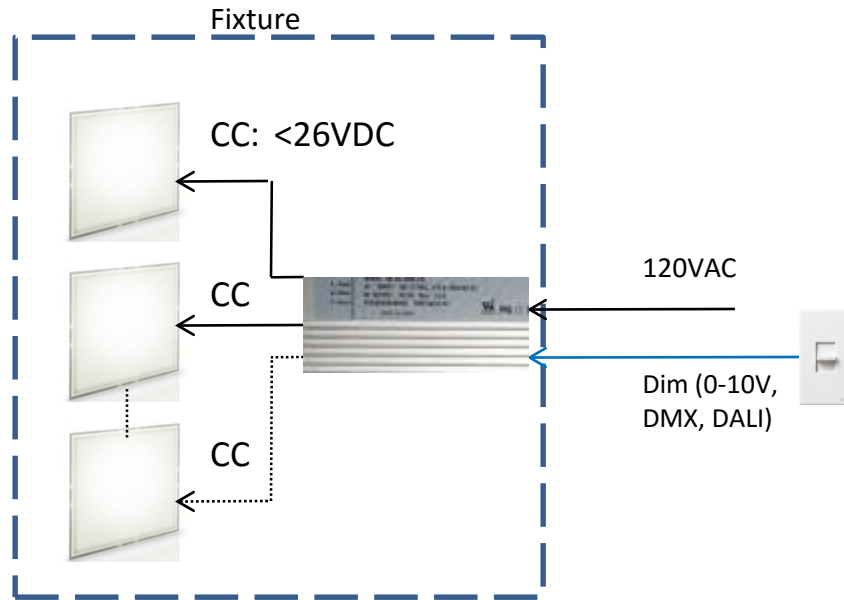


- Consumer Products
- Task Lighting

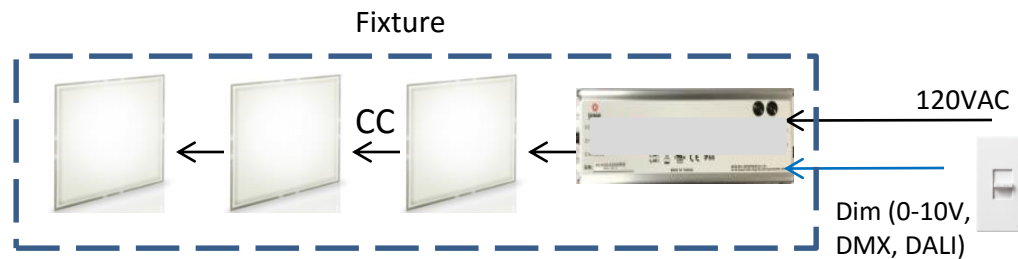


- Commercial or Residential Lighting
- Large number of OLEDs separately mounted
- Longer wire runs (Need to consider voltage drops)
- Class 2 Installation:
 - Voltage: <60v
 - Power: <100W
 - Current: <8A

OLED Electrical System Configurations (cont.)



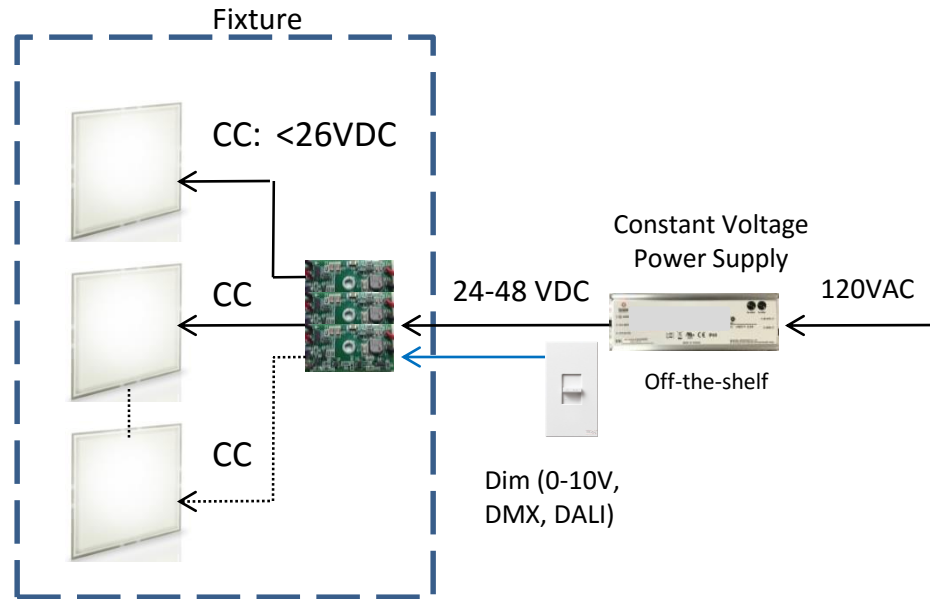
- Commercial or Residential Light Fixture with 2 or more OLEDs
- Multi-Channel CC Driver, close to OLEDs (e.g. in fixture, canopy or ceiling)
- Class 2 Fixture Design



<60VDC, Class 2, > 60VDC Class 1

- Commercial or Residential Light Fixture with 2 or more OLEDs
- Single Channel CC Driver, close to OLEDs (e.g. in fixture, canopy or ceiling)
- Forward Voltage <60VDC for Class 2
- Forward Voltage >60VDC for Class 1 Fixture Design (Safety, Grounding, etc.)
- OLED Short detection?

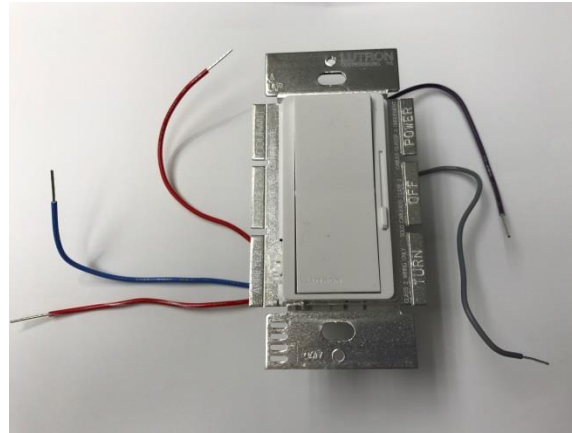
OLED Electrical System Configurations (cont.)



- Commercial or Residential Light Fixture with 2 or more OLEDs
- Low voltage Multi-Channel CC Driver, close to OLEDs (e.g. in fixture, canopy or ceiling)
- Class 2 Fixture Design

0-10V Dimming (Example)

- Use 0-10V dimmer that complies with IEC 60929 (Class 2 installation)
 - One dimmer can support up to 30mA of current
 - Number of OLED Modules on circuit depends on source current of driver

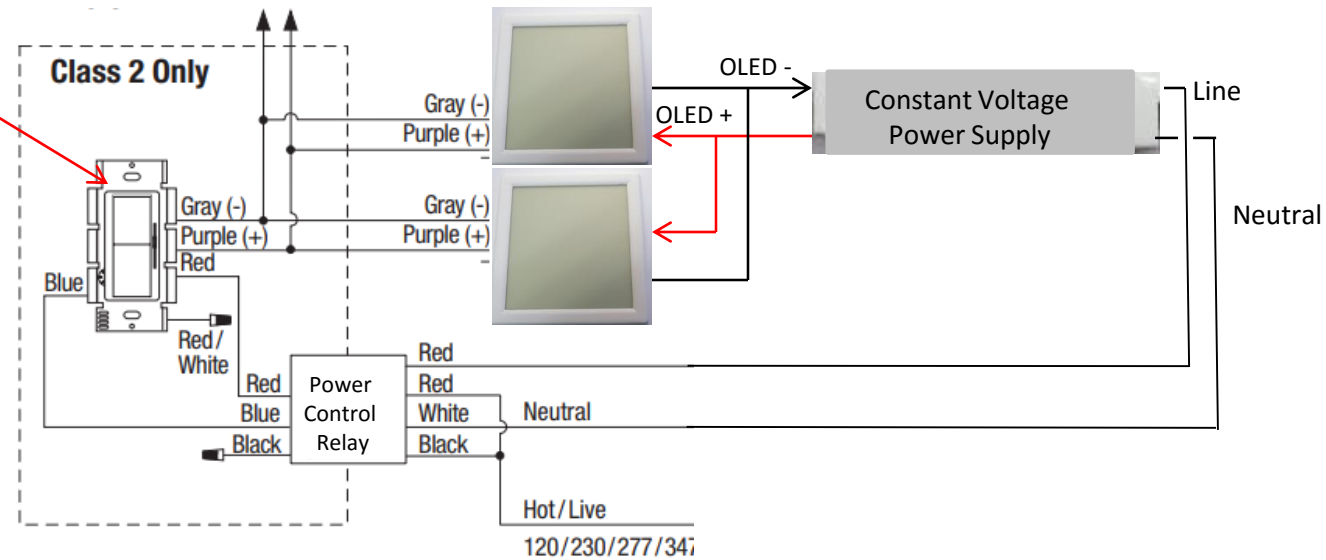


0-10V Dimmer with ON/OFF Control

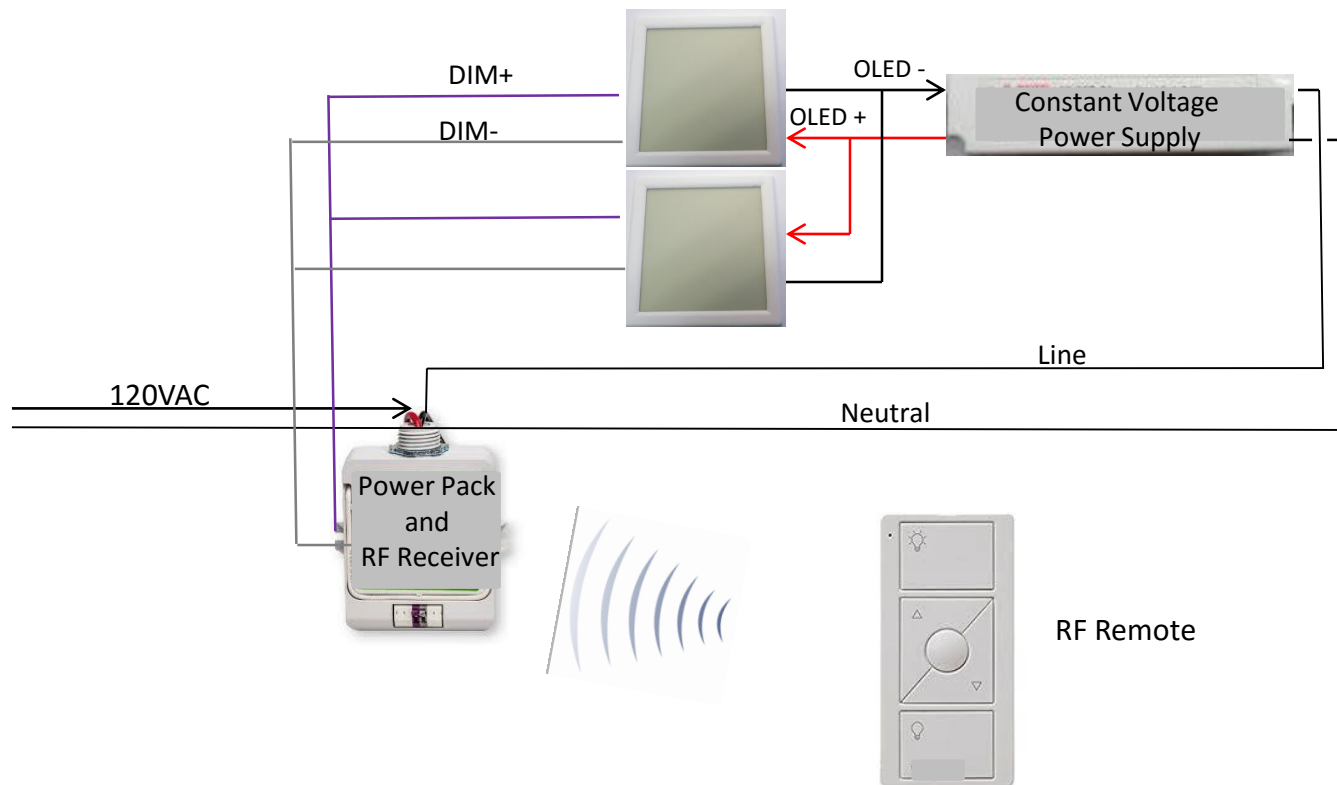
Dimmer Wiring (Example)



0-10V Dimmer



RF, 0-10V Dimming (Example)



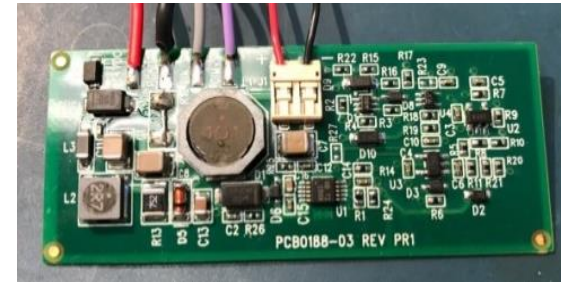
OLED Line Voltage Driver (Requirements Example)

- Input Voltage: 90-305VAC, 50/60Hz Universal Input
- Output Voltage: 15-26VDC @ 260mA
- Power: 7W Max
- 0-10V dimming per IEC 60929 (4%-100%)
- OLED short circuit protection
- Operating Temperature: -40 to +75C
- Ingress Protection to IP67
- Complies with emissions requirements of EN 55022; FCC Part 15
- Complies with UL/CSA Product Safety requirements (UL8750 and UL1310 Class 2)



Low Voltage OLED Driver (Requirements Example) (For Class 2 Installation)

- Input Voltage: 24-50VDC
- Output Voltage: 18 - 26VDC
- Output Current: 260mA or 368mA constant current
- Power (@260mA): 5.2W (nom), 6.8W (max)
- Efficiency: 92%
- 0-10V Dimming (IEC 60929): 2% - 100%
- Dimensions (PCBA): 2.34" x 1.0" x 0.135"
- OLED Short Circuit Protection
- Reverse Polarity Protection
- Open Circuit Protection
- Spike and Transient Protection
- Operating Temperature: -20 to +50C
- Safety: UL/EN/CSA UL8750, IEC 61347 (CE)
- EMC: EN55022, EN61000-3-2, -3-3, -4-2, -4-3, -4-5, -4-6

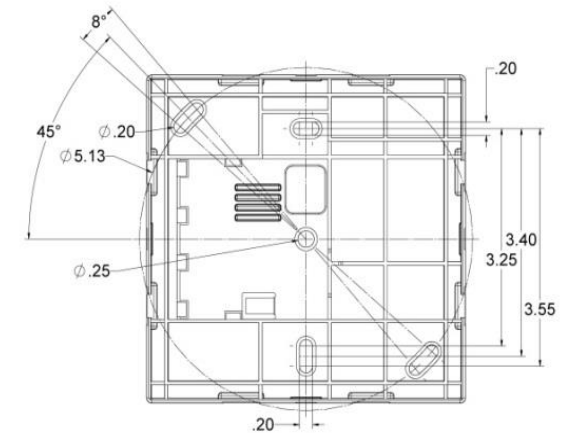
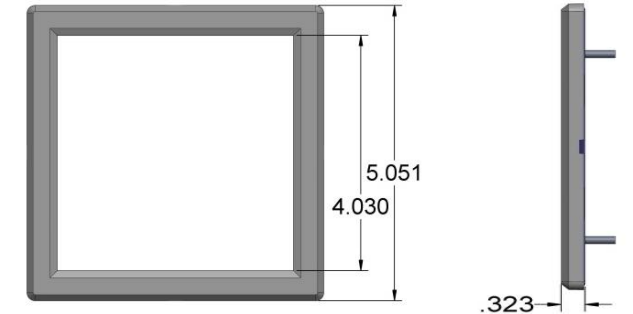
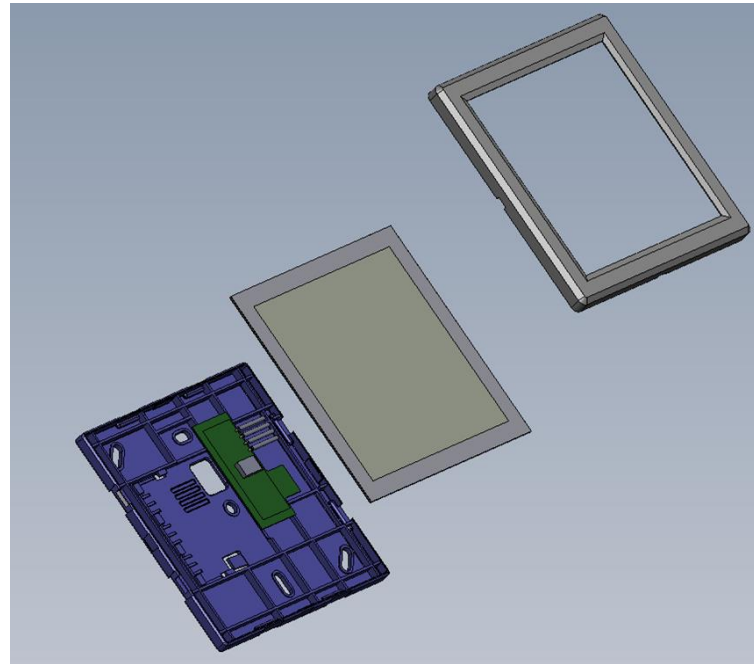


Objectives of Mounting Frame Accessory

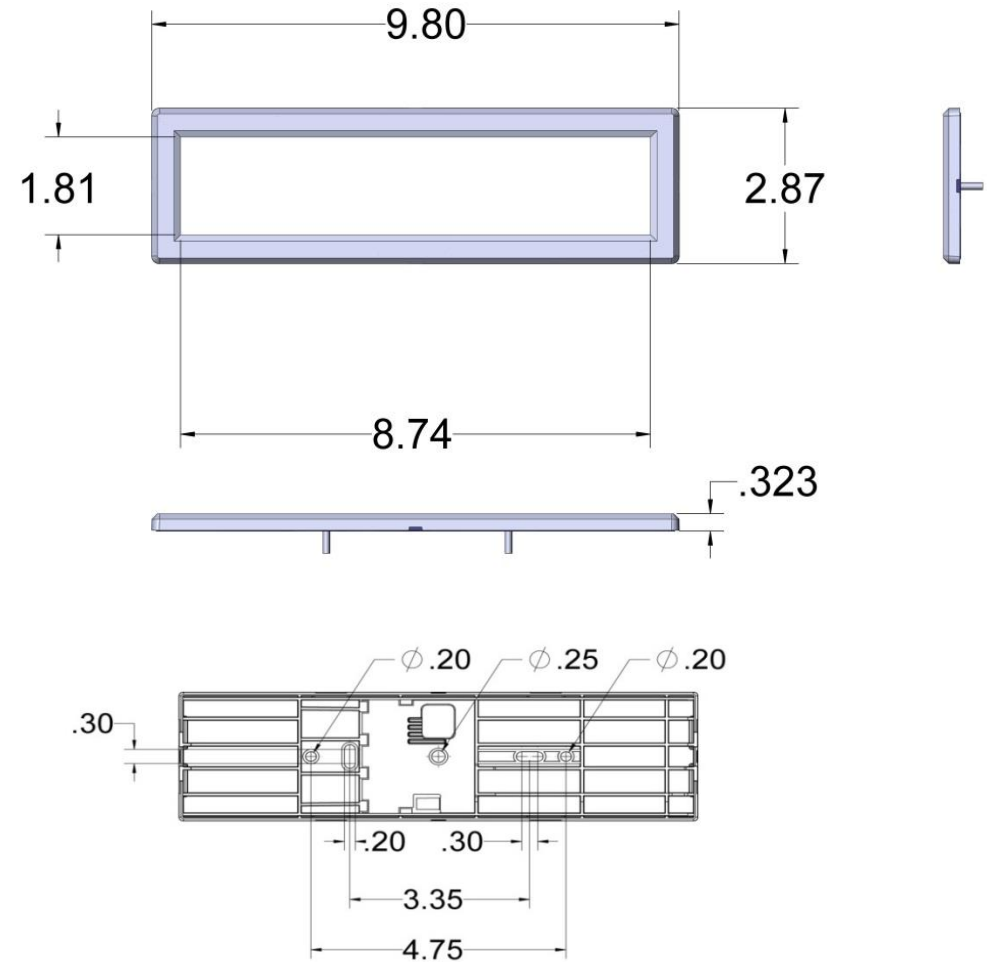
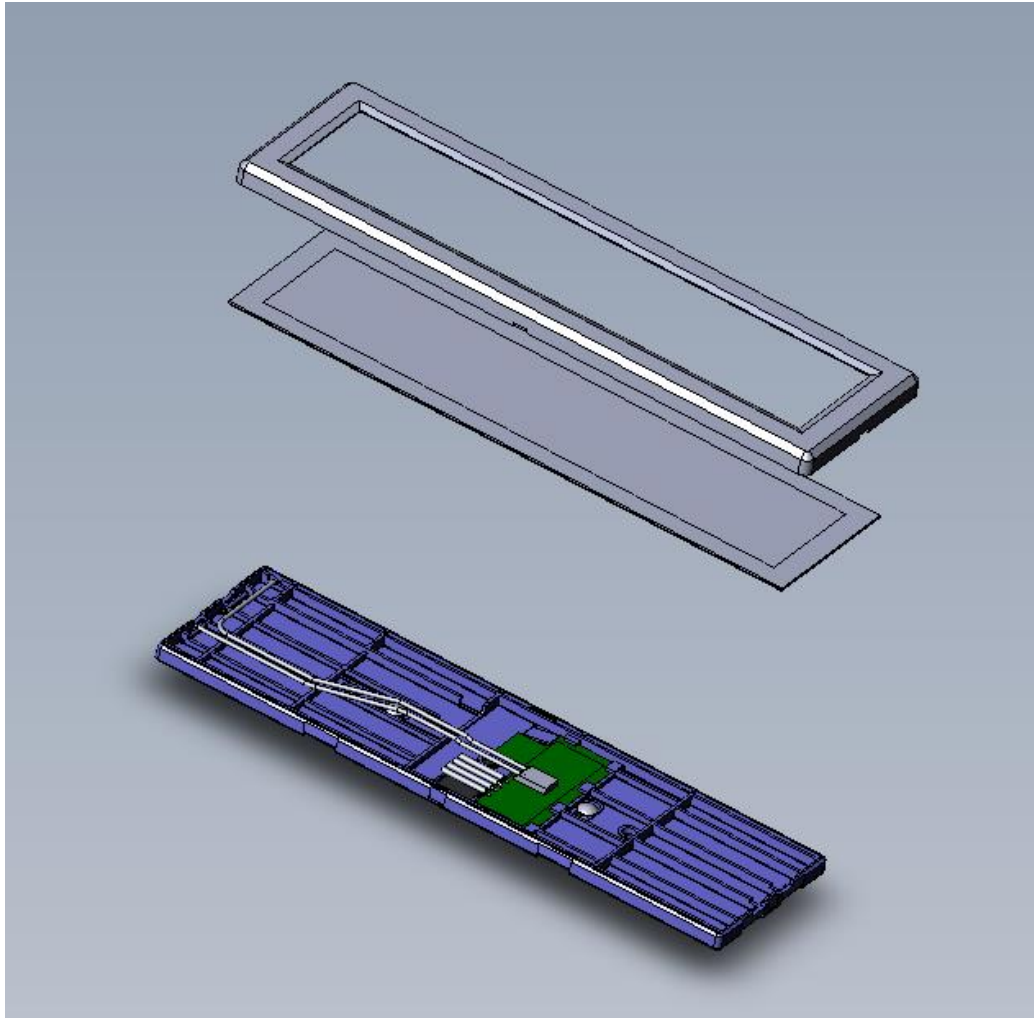
- Provide convenient method to mount OLED panels to flat surface or install in a fixture:
 - Ceiling, wall, shelf, furniture, etc.
- Provide mechanical structural support and protection required of OLED
- Provide durable and flexible electrical interconnect while maintaining thin profile
- Provide means for optional integrated OLED constant current driver

OLED Frame Design (Square)

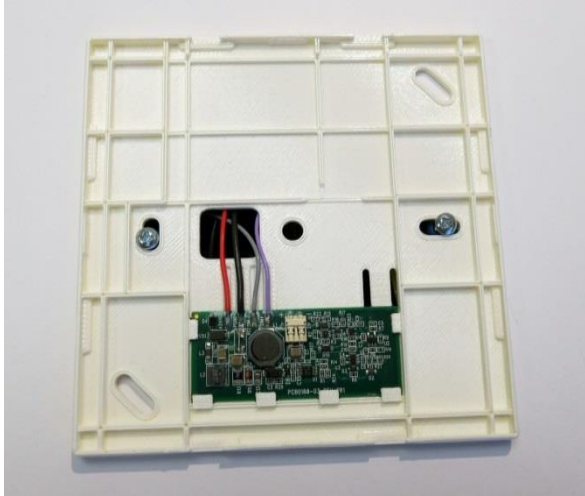
- Mounting frame:
 - More rigid base
 - Flexible mounting holes
 - Driver (“slide and snap”, no hardware) pre-installed
 - Facility wiring can be attached before or after frame mounting
- Bezel:
 - Overall border thinner
 - Beveled design
 - OLED Panel preinstalled in Bezel under pre-molded tabs
 - Snaps engage mounting frame
 - Removable



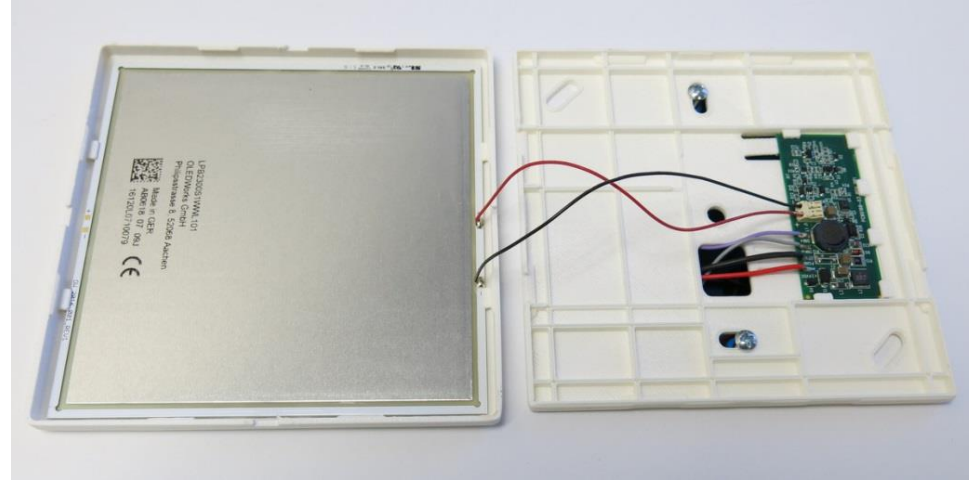
OLED Module Design (Rectangular)



Installation – Square Module



1. Connect wiring, screw mount to flat surface (wall, ceiling)



2. Connect OLED wires to driver, (push-in)



3. Align Bezel to mounting frame, snap in place



This concludes The American Institute of Architects Continuing
Education Systems Course



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Thank You!