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A River of Energy Solutions

MICROPLASMA LIGHTING: THIN, FLAT AND LIGHTWEIGHT LAMP

Sung-Jin Park

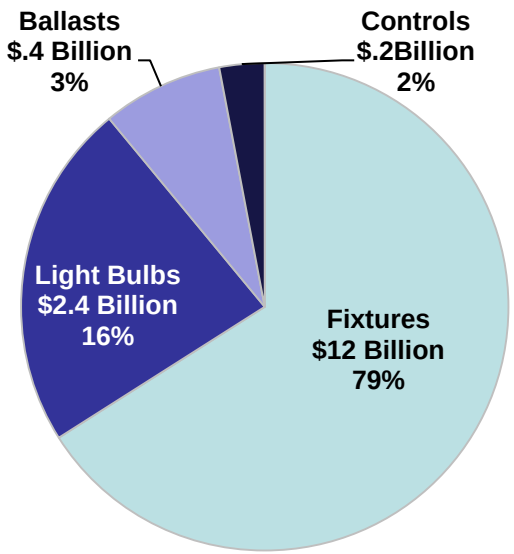
Eden Park Illumination, Inc. , Champaign, IL
University of Illinois, Urbana, IL

Facts on Lighting

- Artificial lighting consumes almost 22 % of electricity in US
- Future(Present) Lighting: Energy Efficient, Green Technology Based Lighting
- Fluorescents, LEDs will take significant market
- Demand for Planar Lamps (Enormous Investment in OLEDs)
- Lamp with multiple functionality is a key trend

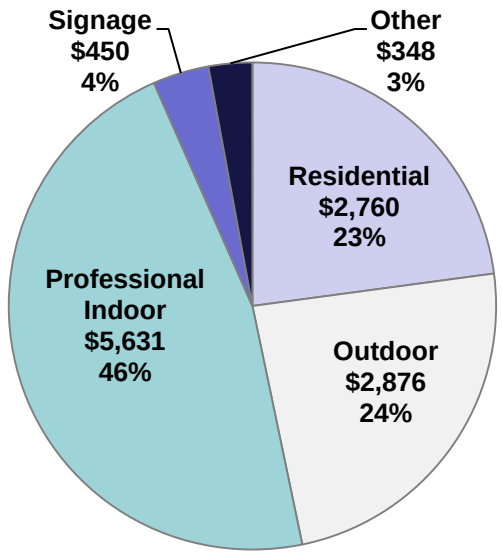
US Lighting Market Size $15 Billion

General Illumination Market: $15 B



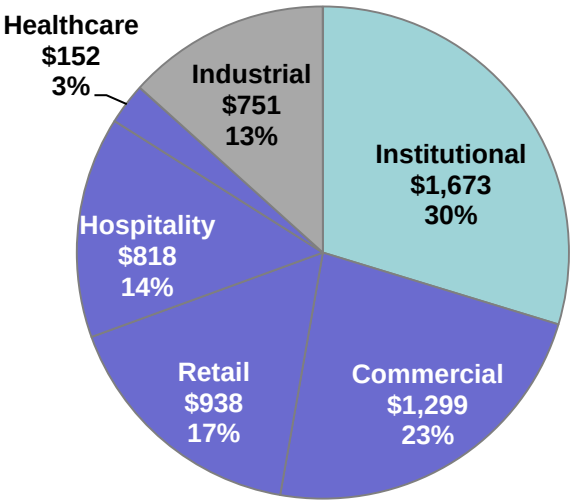
US Market Size ($15 Billion)

Lighting Fixture Market: $12 B



US Market Size ($ Million)

Professional Indoor Sub Segments: $5.6 B



US Market Size ($ Million)

Note: Fixtures contain some level three LED Devices
Source: Estimates based on data from U.S. Census, EIA, ESTA, and Freedonia Group

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THIN, FLAT AND LIGHTWEIGHT LAMP
: NEW FORM FACTOR FOR THE FUTURE

Designed by Joonhyun Kim, 2008

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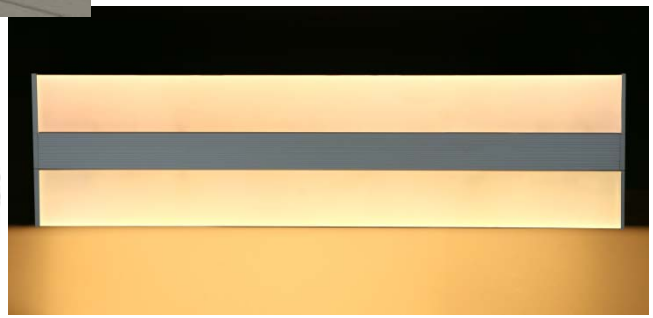
FLAT LIGHTS

CREE LR24



GO Lighting FLL

Philips Lumiblade

Philips iColor Tile

Osram Opto

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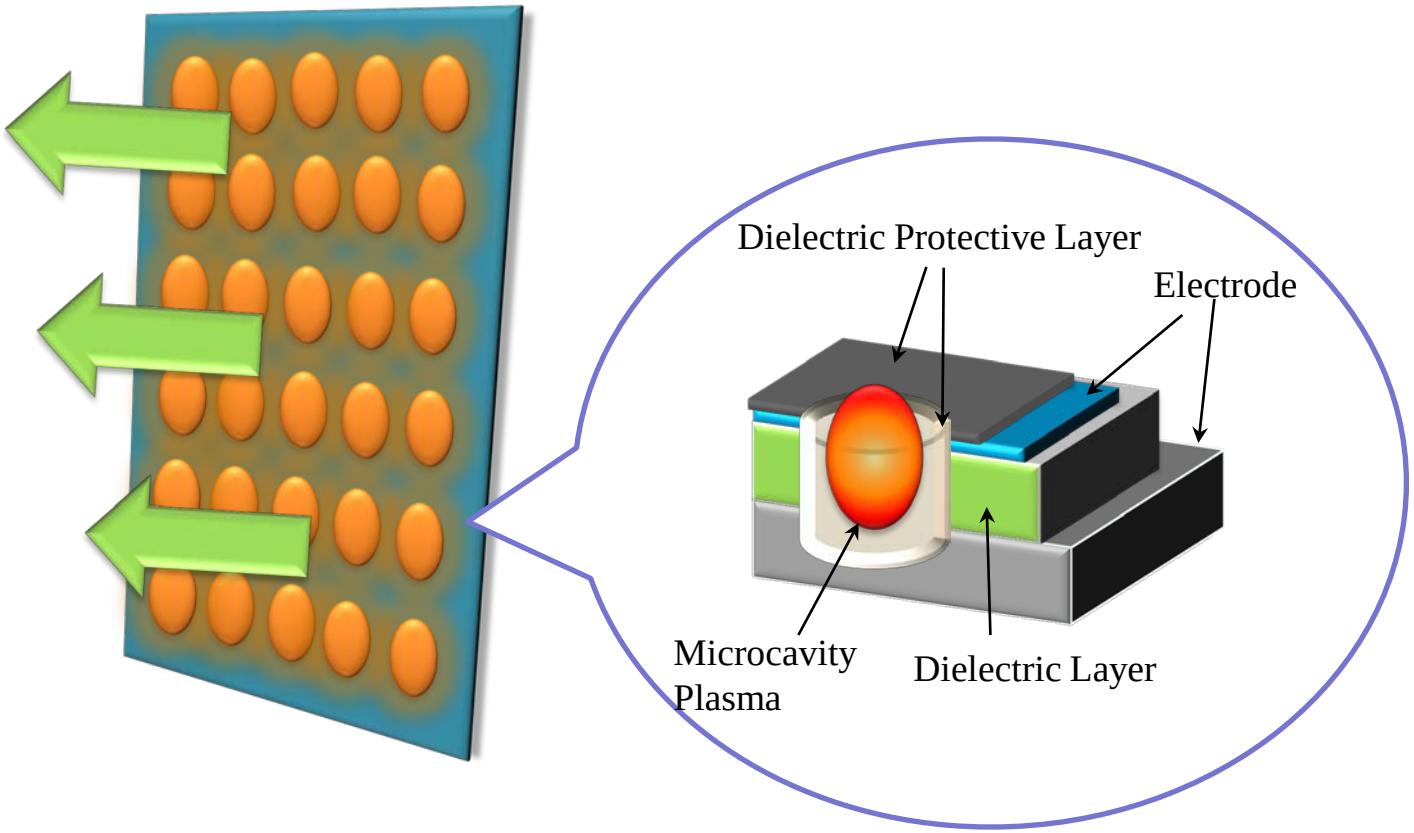
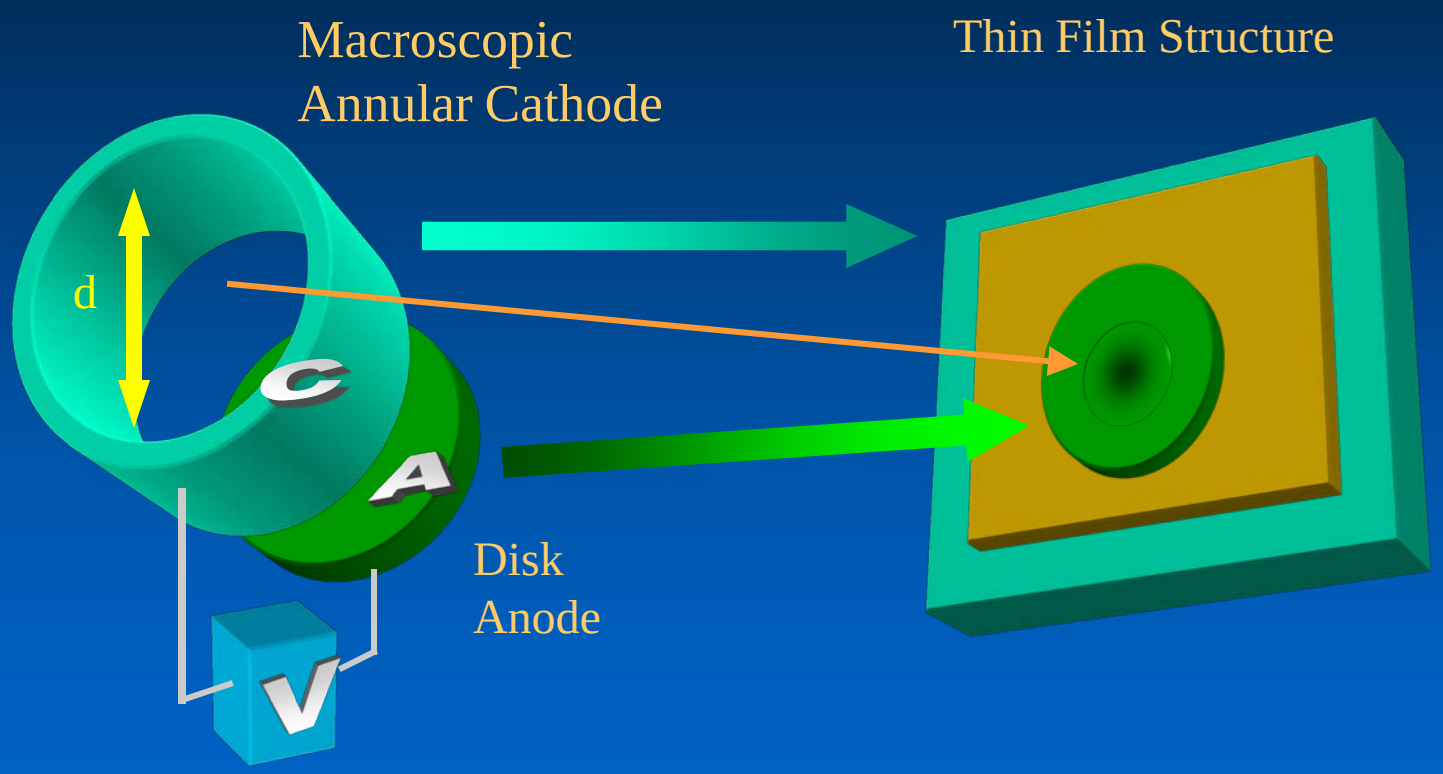
MICROCAVITY PLASMAS:
LOW TEMPERATURE, NONEQUILIBRIUM PLASMA CONFINED TO MESOSCOPIC CAVITIES



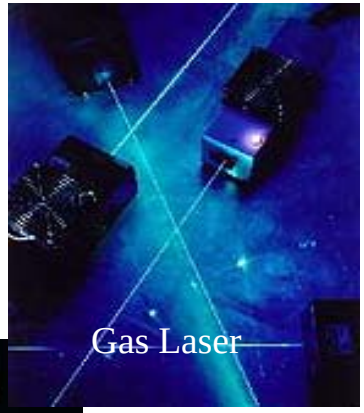
ADAPTATION OF MICROFABRICATION TECHNIQUES

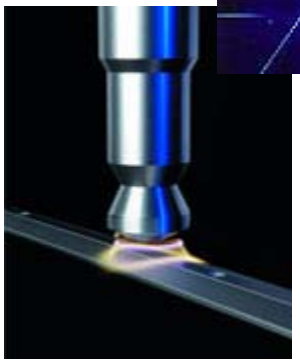


Discharge microcavity dimensions (d) on μm scale

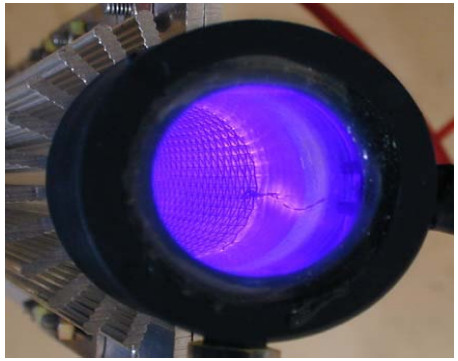
As d ↓, surface area / volume ↑ : Importance of microcavity design

Microplasma Applications

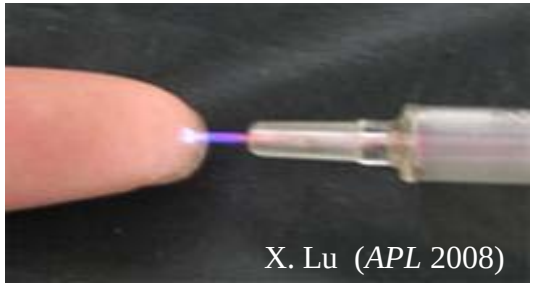




Plasma Surface Treatment

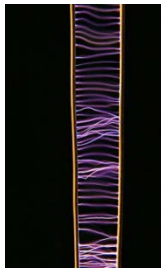


Environmental Applications

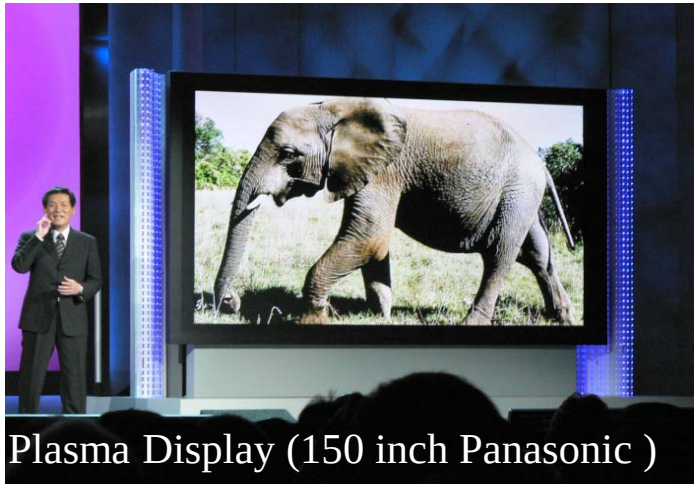


Biomedical

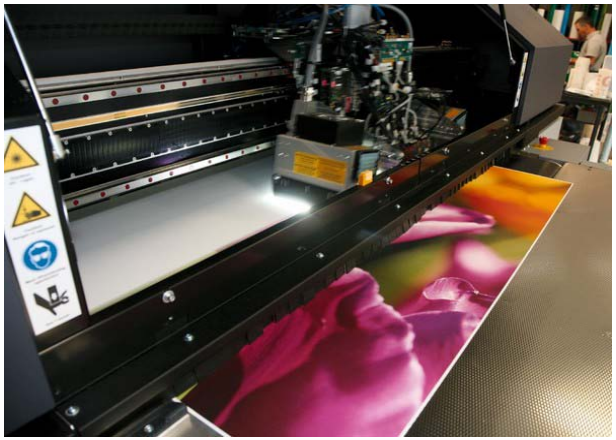
Lighting



Electrical Components



Plasma Display (150 inch Panasonic)



Processing

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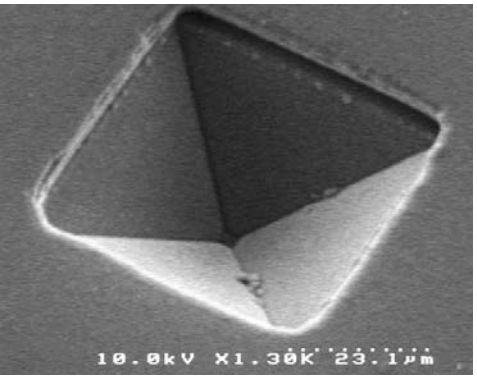
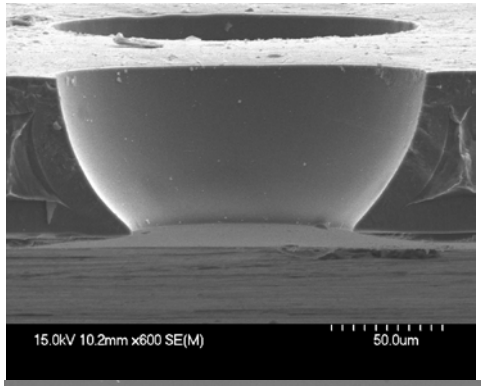
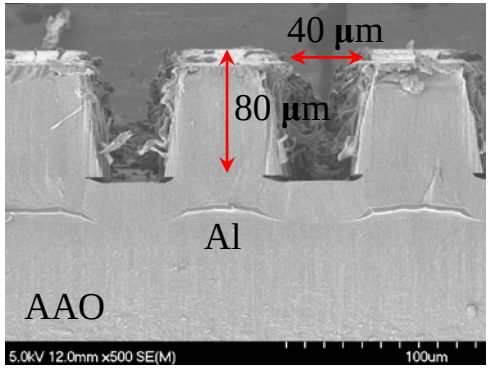
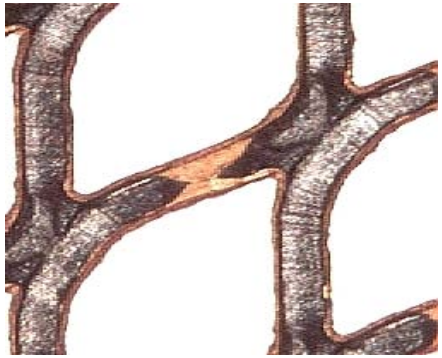
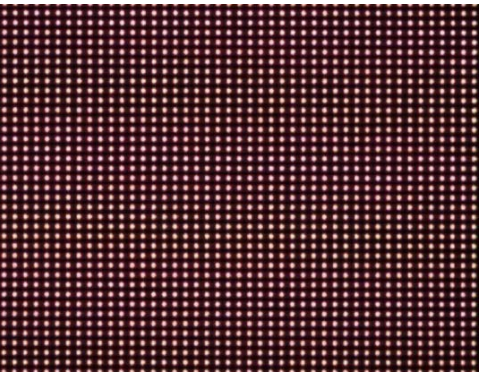
Microplasma Arrays at Illinois

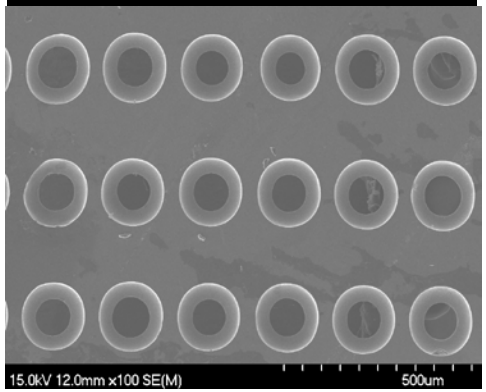


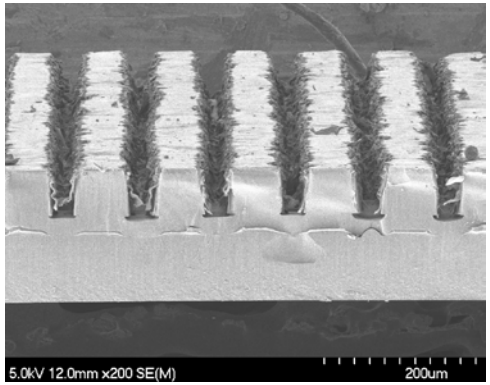


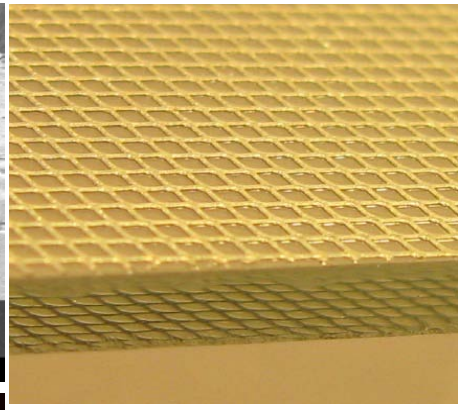


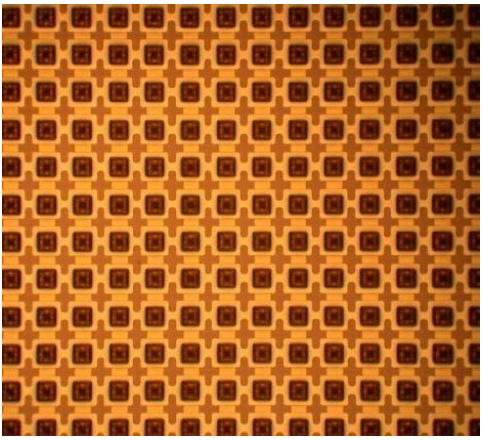


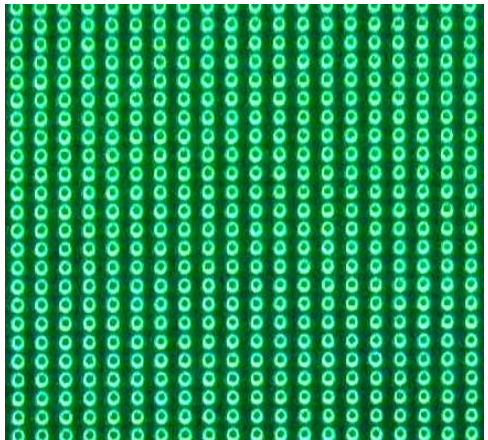


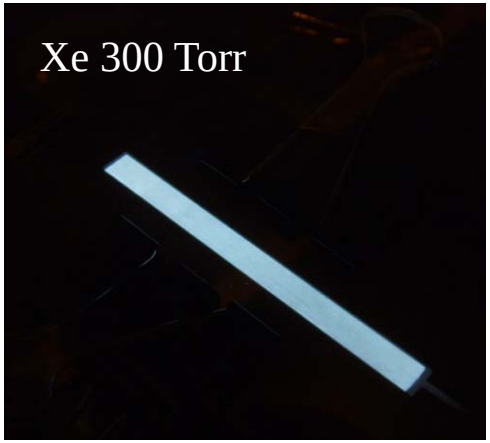


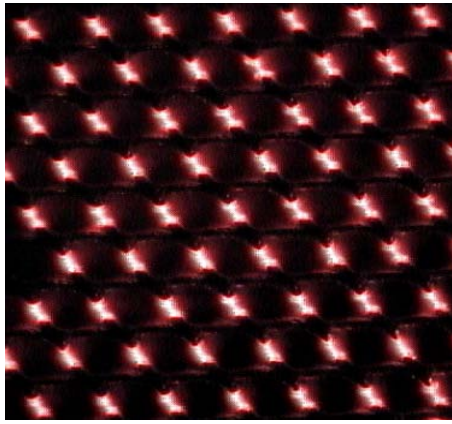












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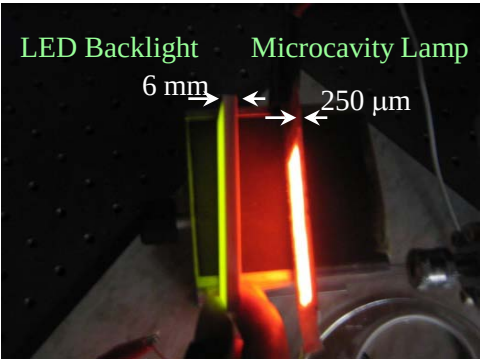
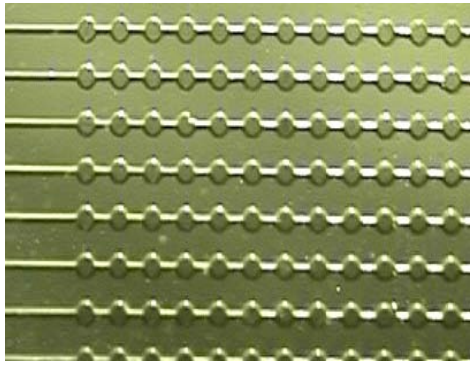
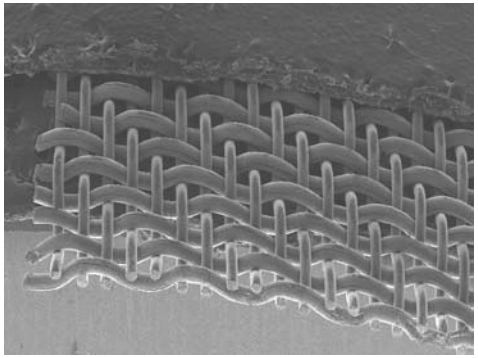
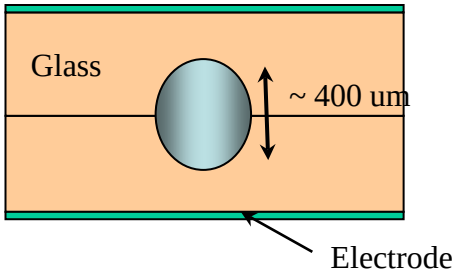
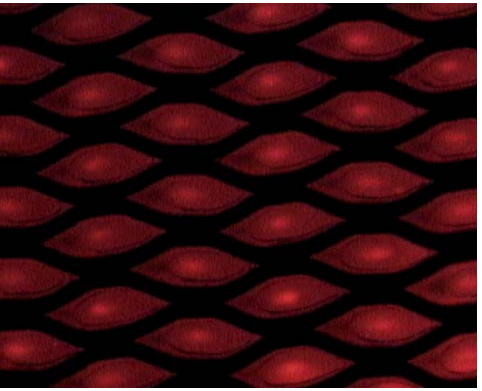
Microplasma Arrays at Illinois

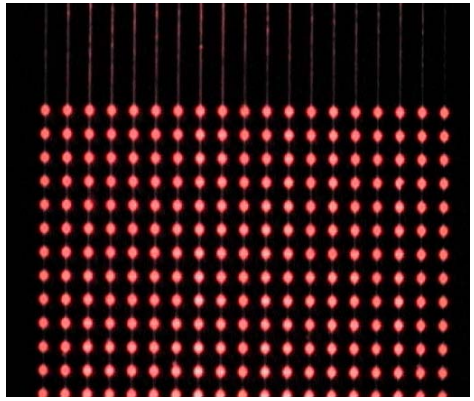


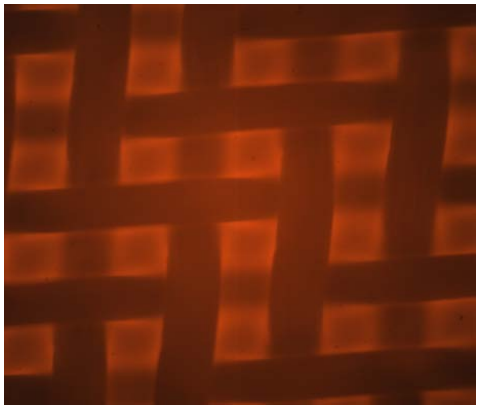


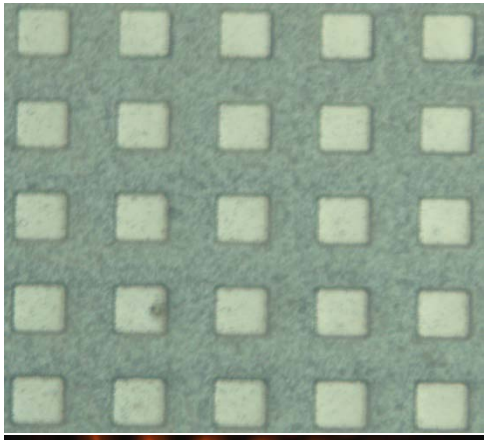


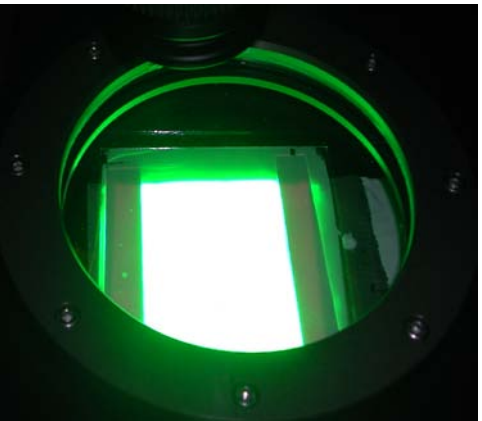


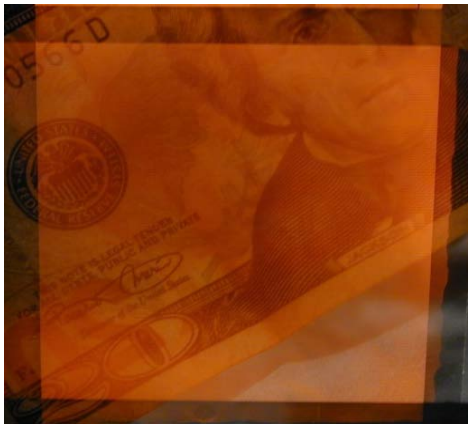


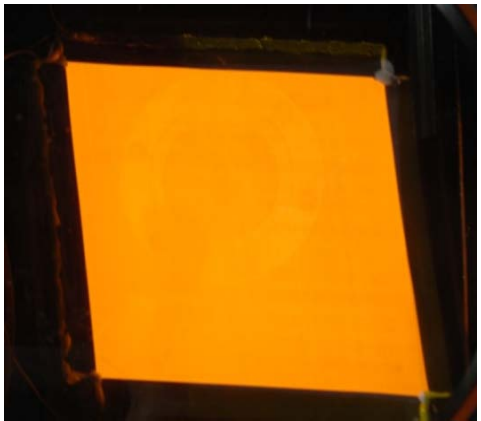


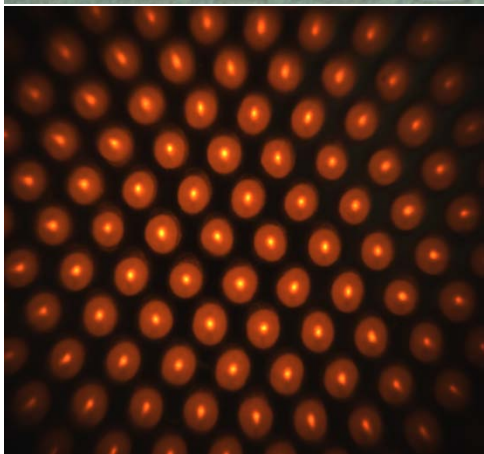






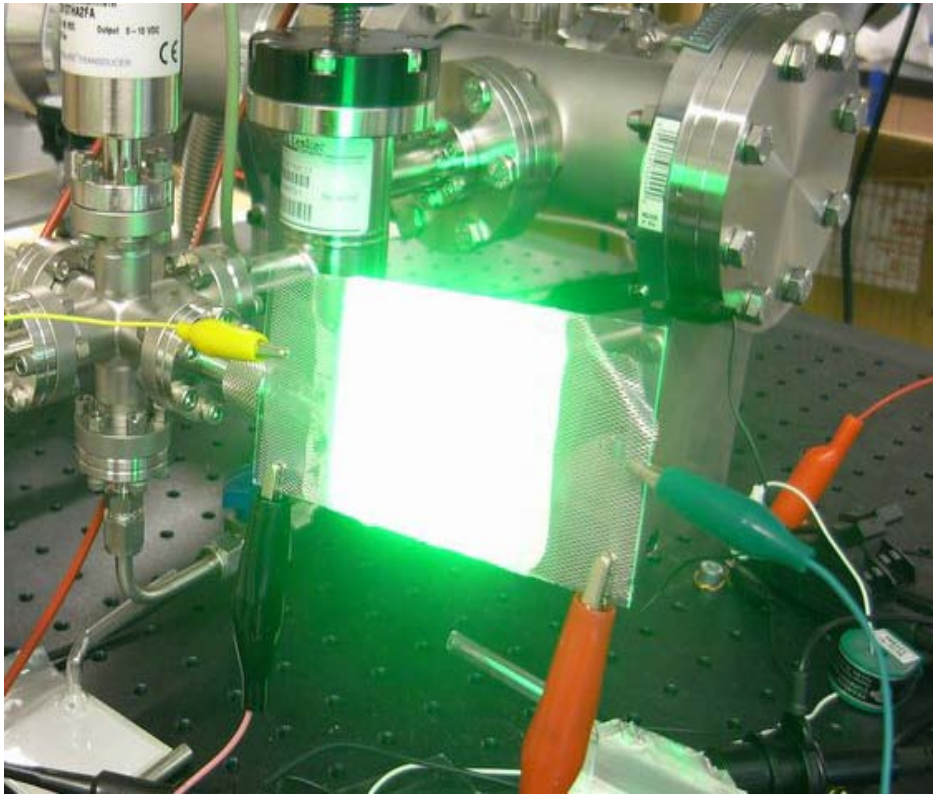




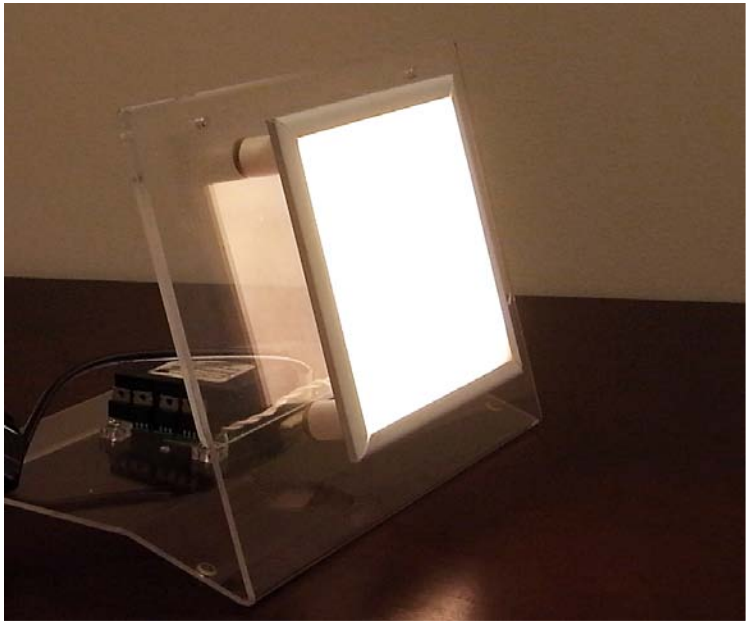


MICROPLASMA LIGHTING

Technology Introduction (2008)



EXCEPTIONAL PERFORMANCE: 6” × 6” (~ 225 cm^2)



- Spatial Uniformity: ± 5 %
- Luminance : >12,000 cd/m^2
- Efficacy: > 25 lm/W
- CRI: > 80
- Fully Dimmable

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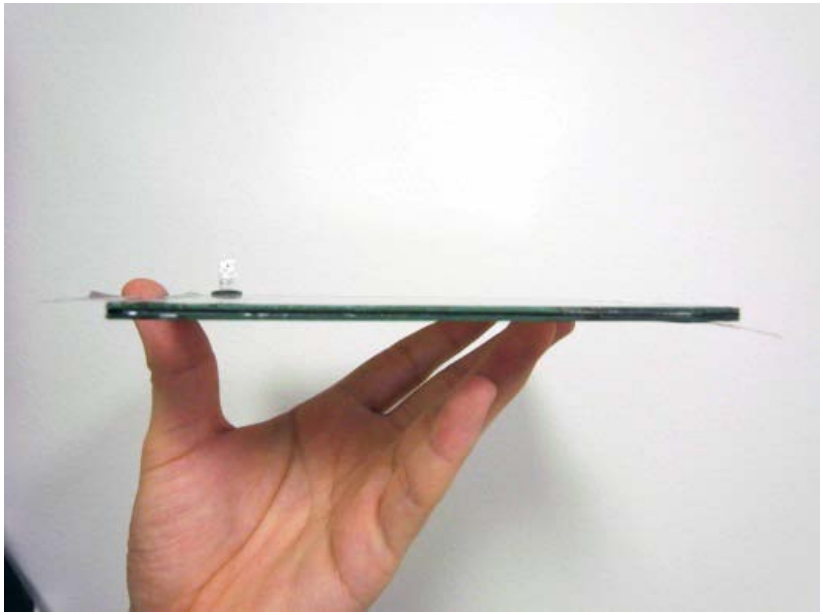
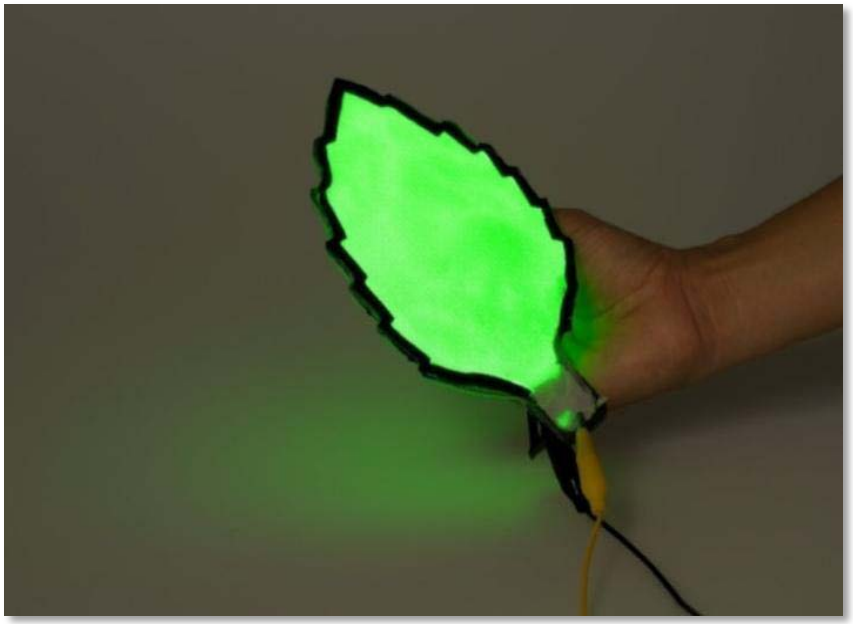
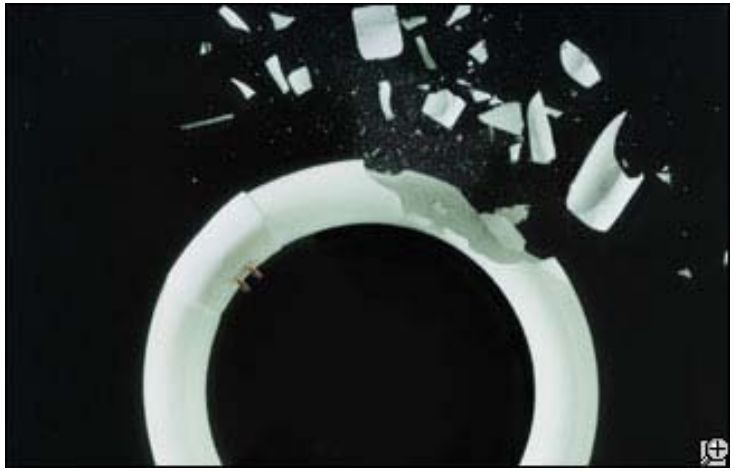
THIN, LIGHTWEIGHT AND VARIABLE IN SHAPE





6” 6” Light Tile: < 200 g

COMPARISON OF GREEN TECHNOLOGY: Fluorescent



No mercury or toxic environment inside the microplasma lamp

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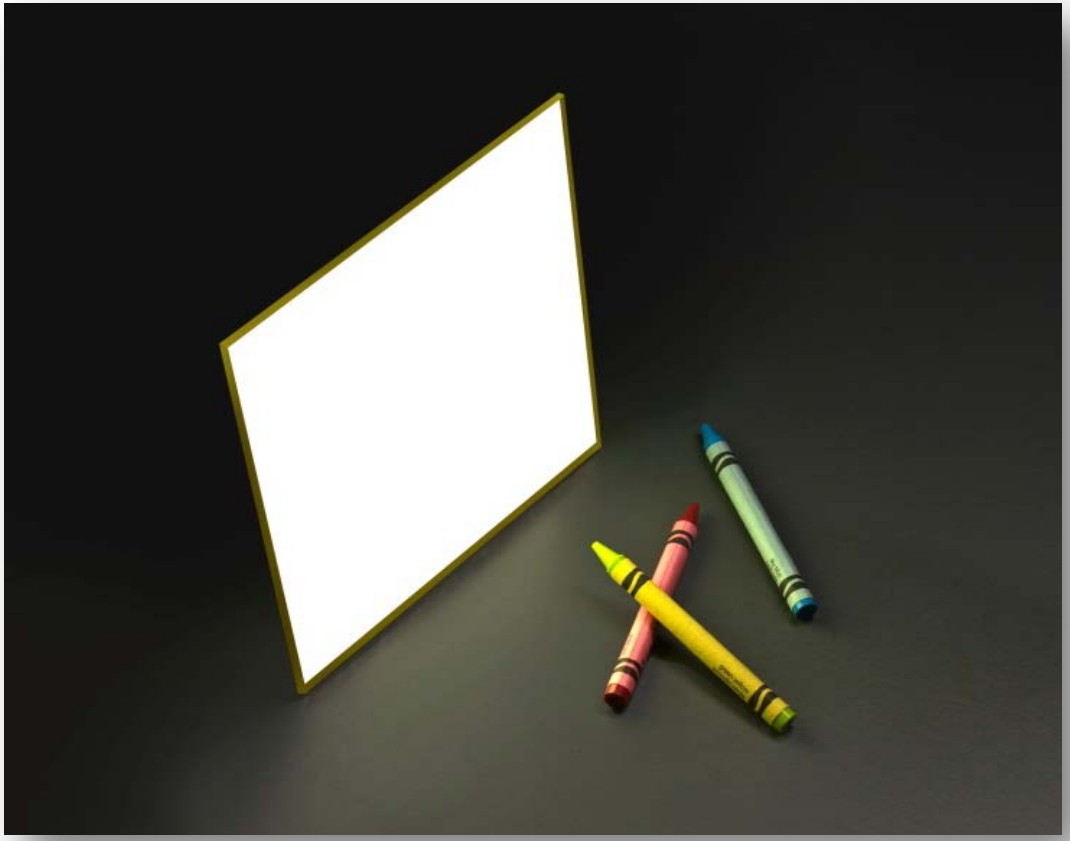
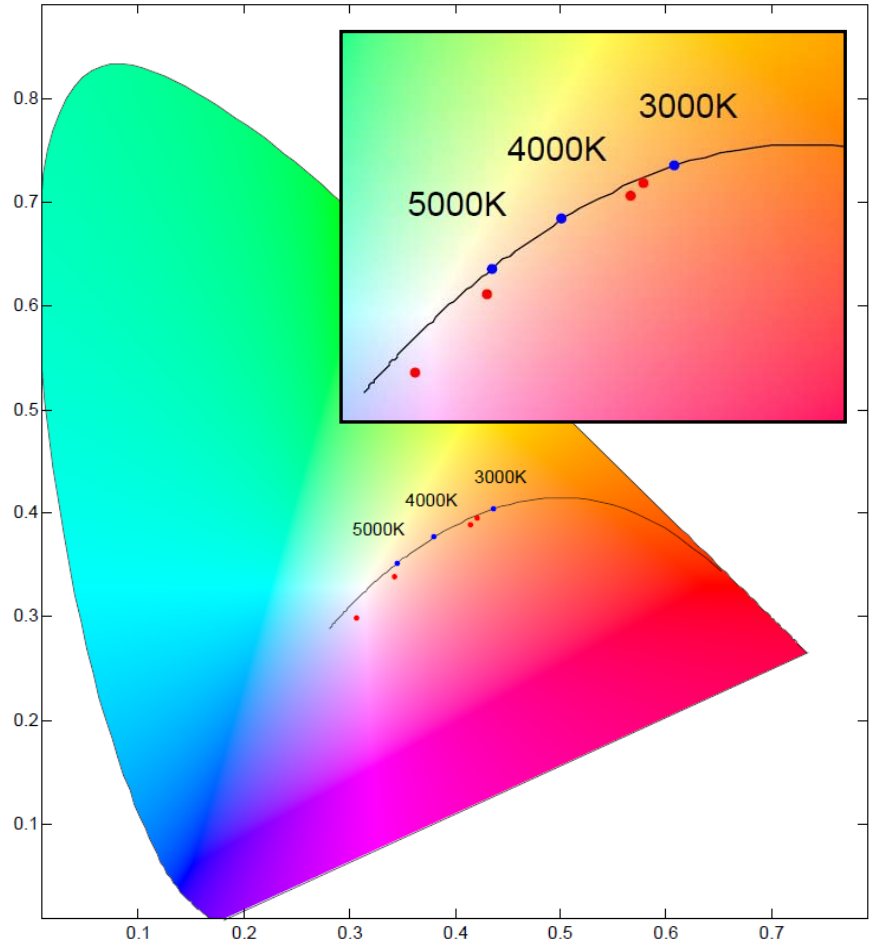
Flexible Color Temperature and Vivid Color Generation



- Color Rendering Index(CRI): 80 ~ 85 (Dependent on Phosphor)
- Color Temperature Controllable

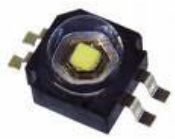
Colorimetric Performance

- Tunable Color Point (color temperature)
- PDP Phosphor mix permits tracking Planckian Locus



EDEN PARK
ILLUMINATION

LIGHTING TECHNOLOGY COMPETITION



Light Emitting Diode

LED

- Heat Sensitive => Heat Management
- "Dots" Forced into Planar Form
- Requires Robust Hardware
- Performance Tied to Cost (binning)
- Difficulty maintaining uniformity and intensity over time
- Requires waveguide technology limiting size and color spectrum
- Good color mixing is difficult to achieve in edge-lit structures

Organic Light Emitting Diode

OLED

- Short Lifetime
- High Manufacturing Cost => High Market Price
- Scale Limitation
- Low Light Output
- Efficacy Tied to Light Output

Microplasma

- High Light Output Natural Planar Source
- Cost / TCO Advantage
- Lightweight => Easy to Install
- Scalable => Design Flexibility
- Environmental Friendly

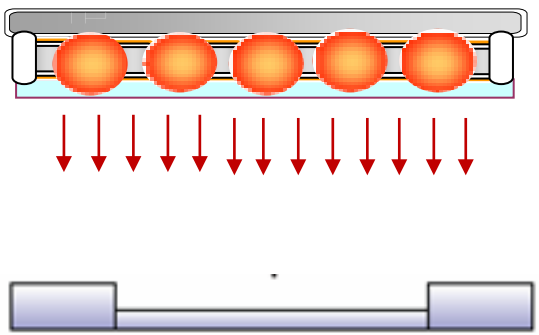
	LED	OLED	Microplasma
Efficacy (lm/W)	54*	25-30**	24***
Lifetime (hrs)	50,000	2000-14,000	50,000
$ per lm/W	**$2.00******	**$6.66** ($200 @ 30 lm/W)	**$1.04** ($25 @ 24lm/W)
$ per klm	~ $100	$ 6000 - $25000	$ 42 ($25 @ 600 lm)
$ per m^2	$ 800 - 900	$17, 000 – 75,000	$ 200 – 250 (expected)

* lm/W based on initial lumens in average luminaire (per DOE CALiPER Summary Report, October 2010)
** OLED WORKS LLC, April 2011
**** at present – January 2011 - $ per lm/W will further decrease with improved efficacy because cost base stays (relatively) the same*
***** $ per lm/W calculated using multiple LED units as necessary to create equivalent 6" uniform distribution planar light emission*

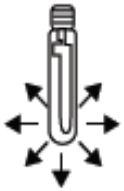
LIGHTING UTILIZATION EFFICIENCY

Microplasma Lighting

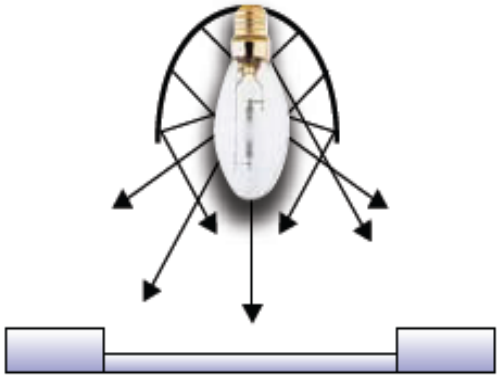
No Fixture Required



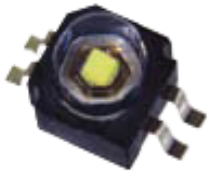
150W HPS
100lm/W



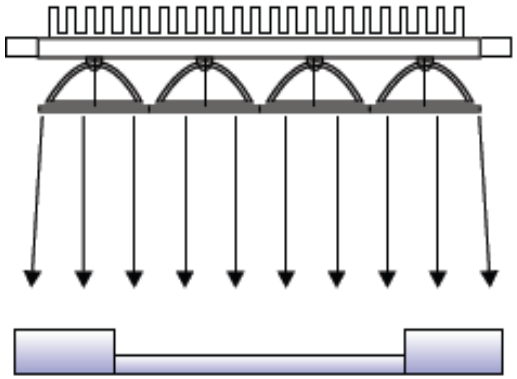
40% Utilization Efficiency



LUXEON® K2
White 50lm/W



80% Utilization Efficiency



Data: Philips Lumileds

- No diffuser or guiding optics are not required

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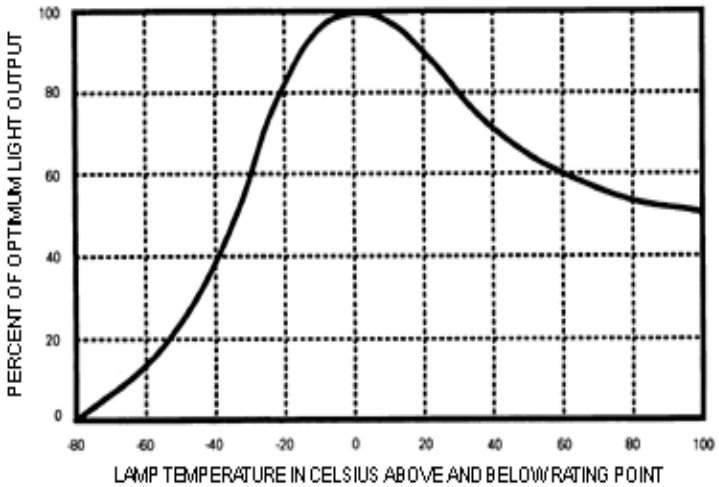
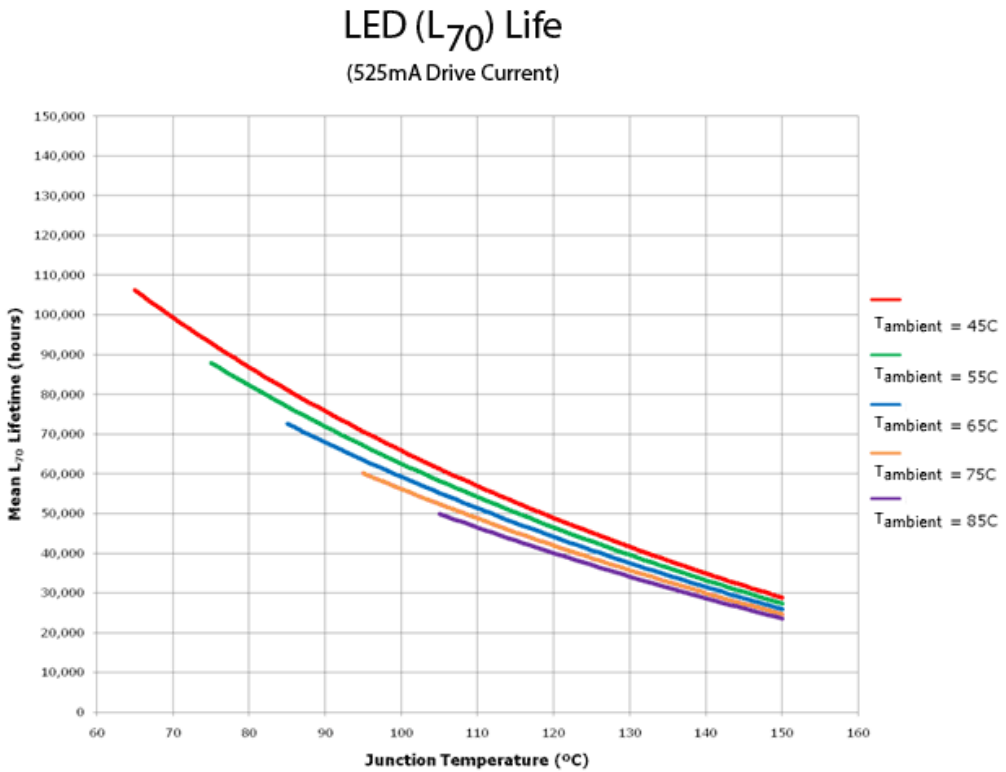
Temperature Sensitivity

Fluorescent Lamp



38 ºC



Data: Cree

- Microplasma Technology is not sensitive on temperature changes (-20 ~ 80ºC)

GovEnergy
www.govenergy.gov

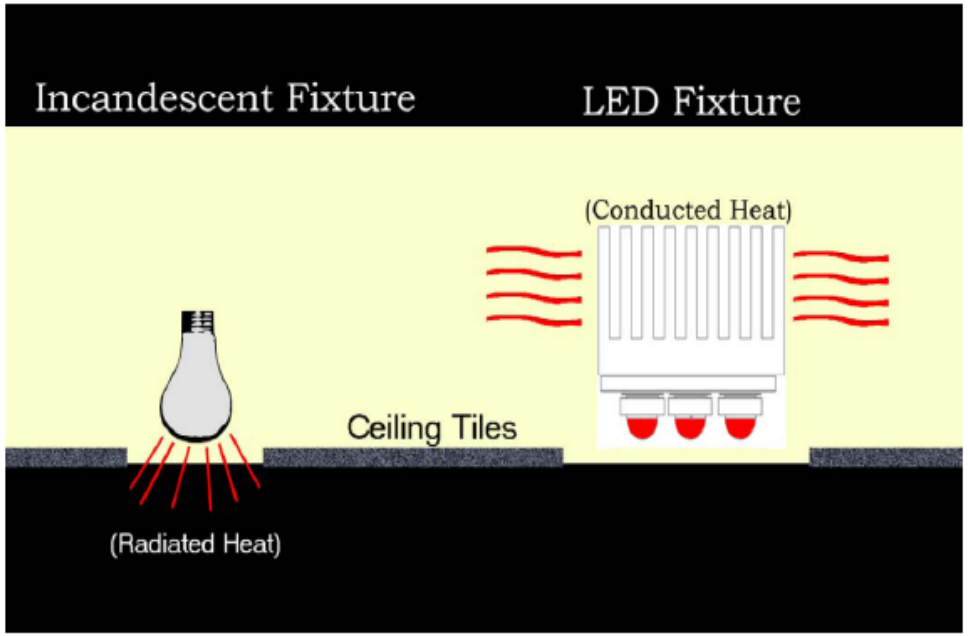
Lifetime

• The sun	> 4.5 biliion years (so far)
• Candle	< 12 hours @ < 50°C
• Oil Lamp	< 24 hours
• Incandescent Lamp	750 - 2,000 hours
• Halogen Incandescent	2,000 – 4,000 hours
• CFL	8,000 - 10,000 hours
• Linear Fluorescent Lamp	20,000 – 30,000 hours
• 5mm LEDs	< 10,000 hours @ 25°C
• White-light LED	35,000 - 50,000 hours (depending on thermal management)
• Microplasma Lighting	~50k hours

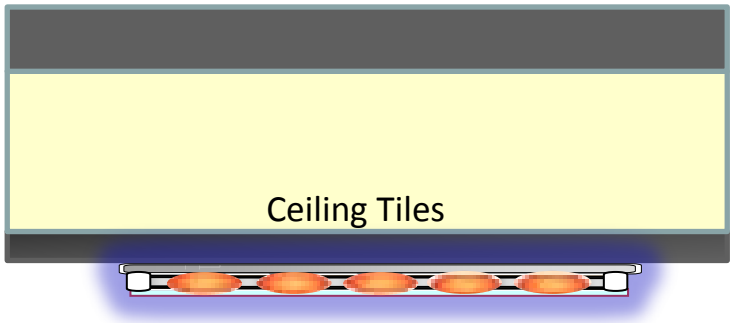
GovEnergy
www.govenergy.gov

Source: US DOE EERE
Power Systems Inc.

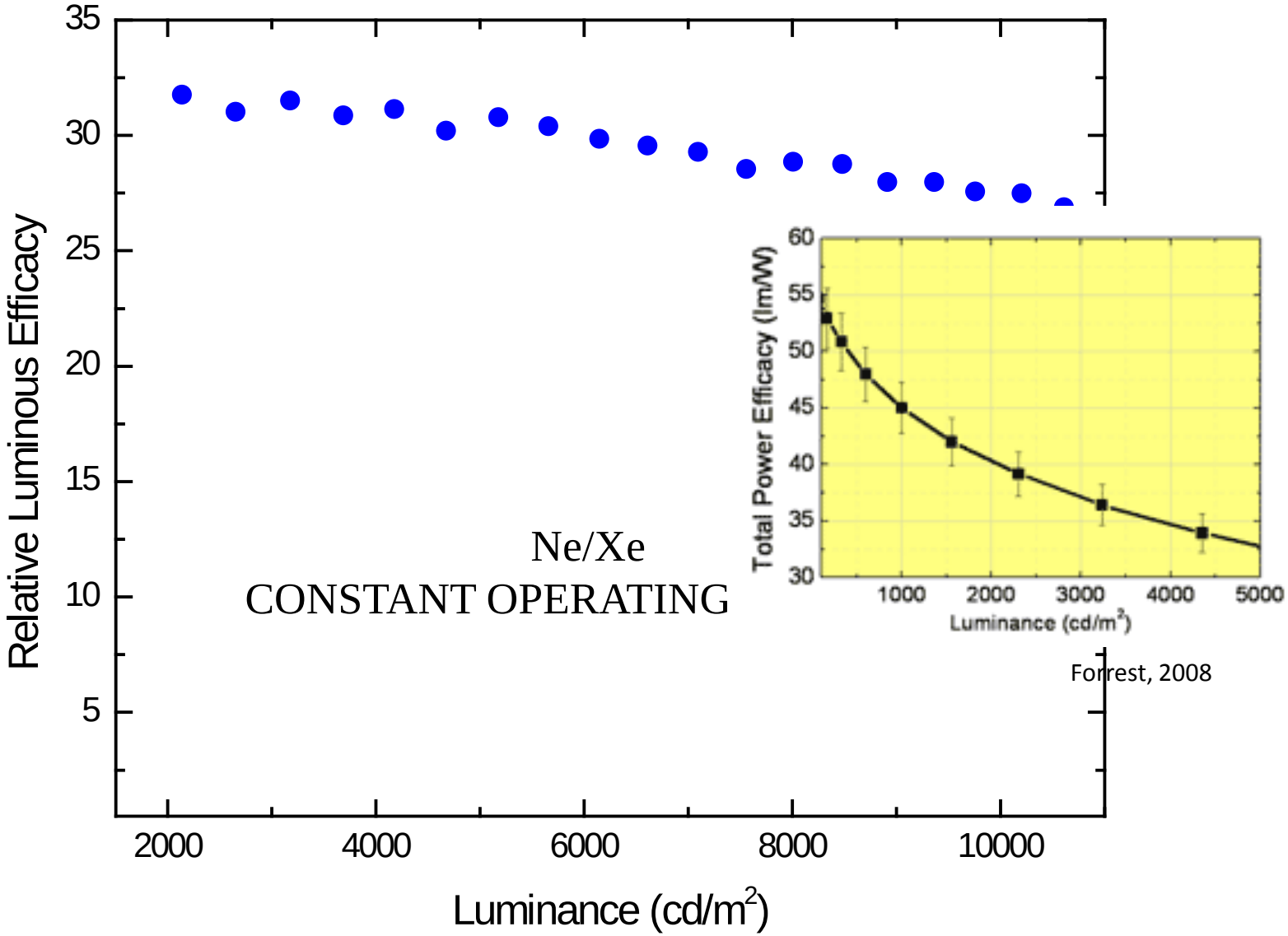
SPACE UTILIZATION EFFICIENCY



Microplasma Lighting



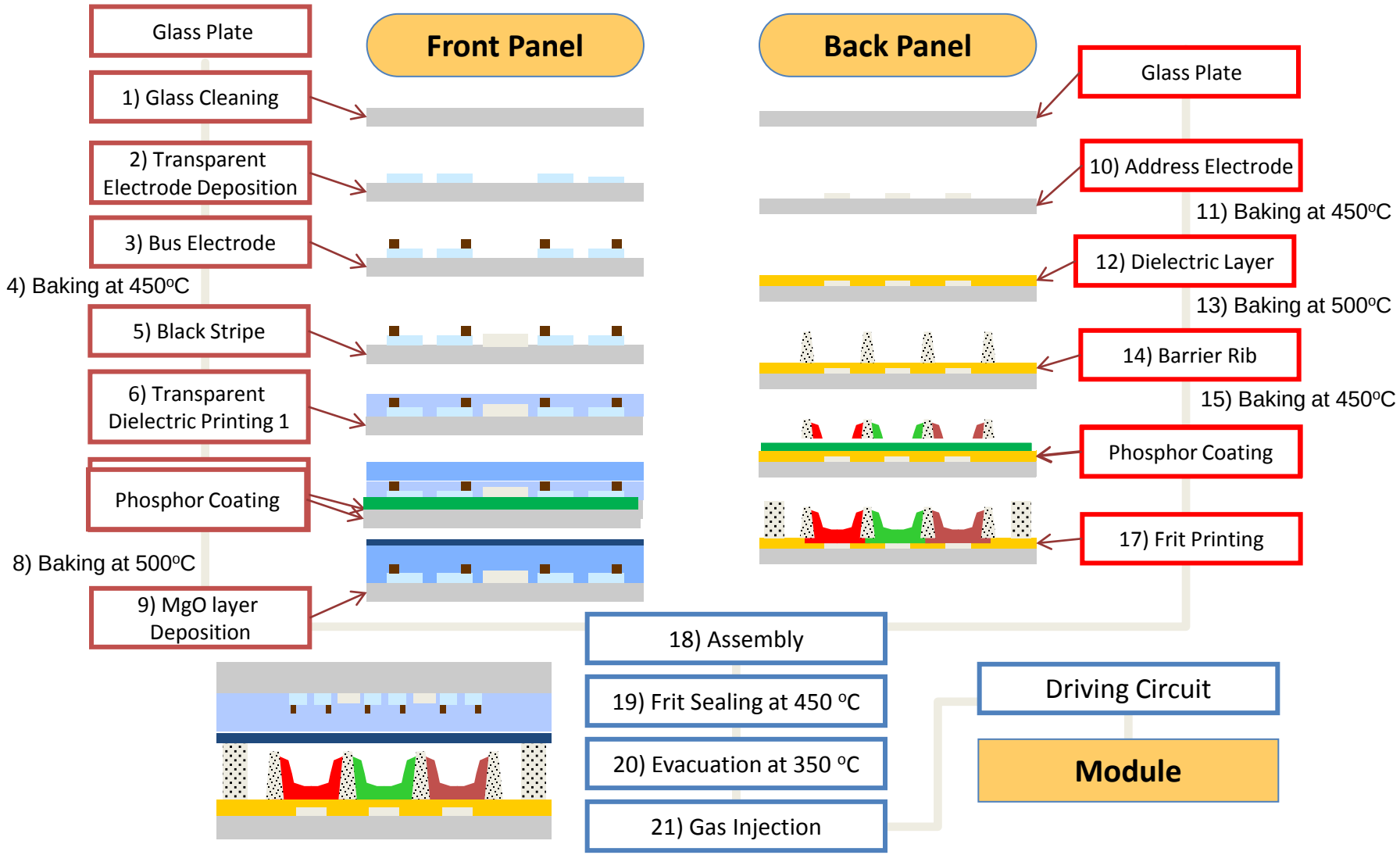
- Ceiling space can be minimized



Forrest, 2008

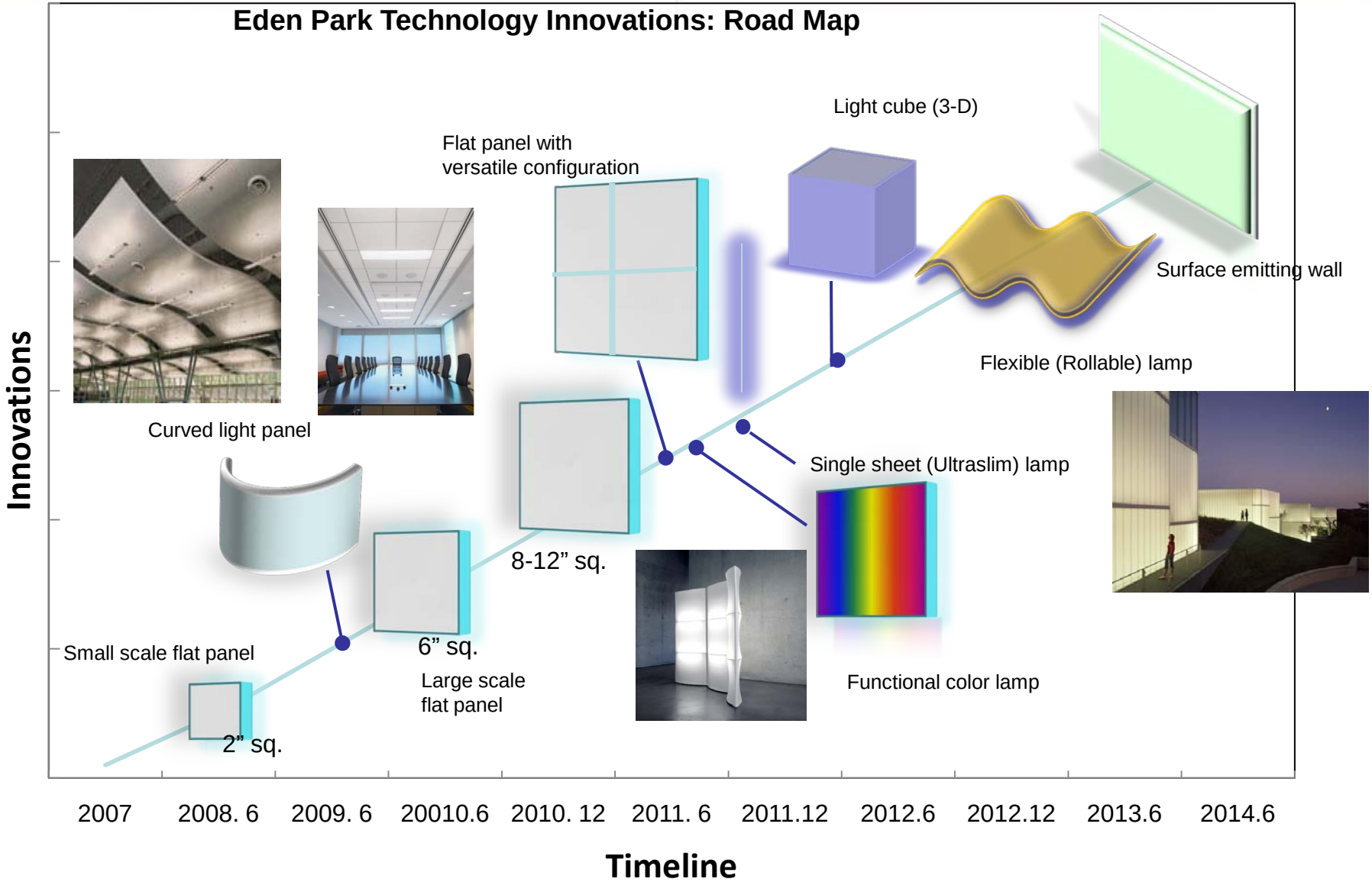
Manufacturing and Cost

Fabrication Diagram for Macro Display

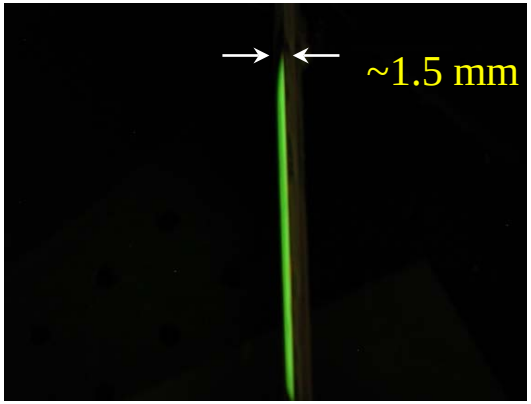


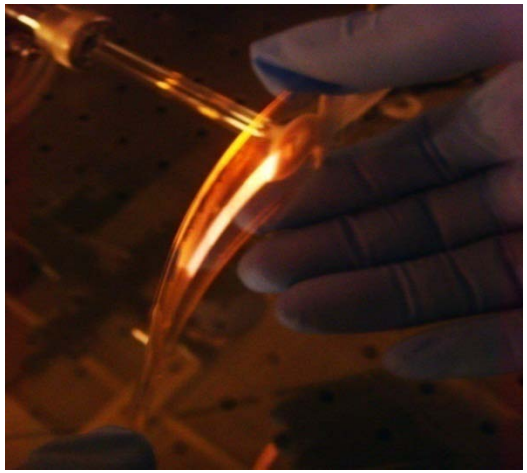
EDEN PARK
ILLUMINATION

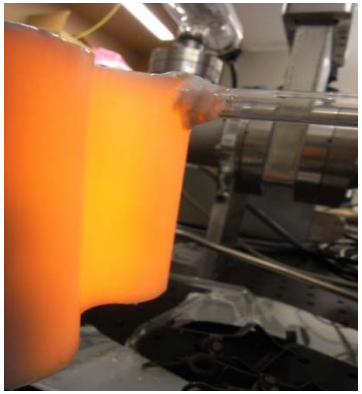
THE EVOLUTION OF LIGHT

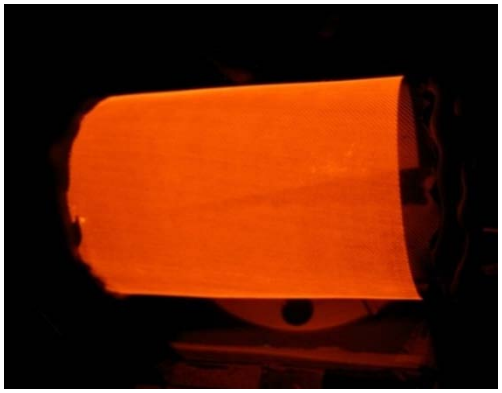


VARIOUS FORM FACTOR









EDEN PARK
ILLUMINATION

COMPANY OVERVIEW

- Founded in May 2007 by Professors Gary Eden and Sung-Jin Park of University of Illinois.
- Commercializing new lighting products based on microplasma technology.
- Eden Park currently has12 FTE and 5 Consultants.
- 14 issued patents, 25 patents pending support a proven and protected technology platform.
- Research and Development partnership with the University of Illinois at Urbana-Champaign.

R&D Center, Champaign, IL

Media Attention

Eden Park Illumination

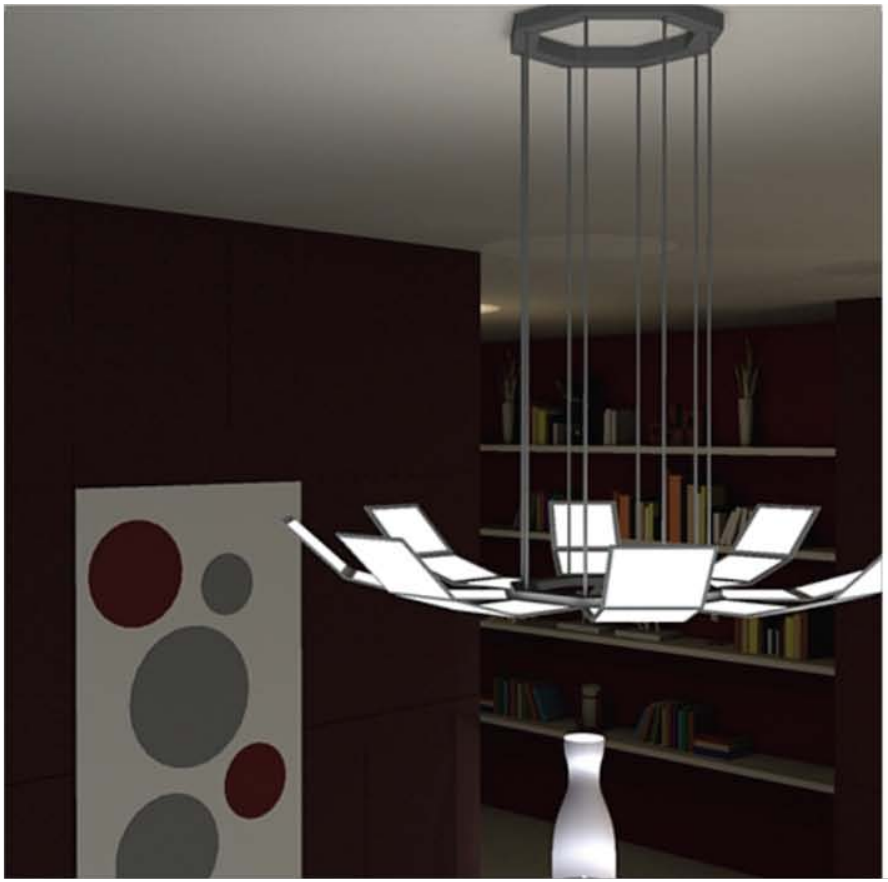
May, 2009

Dec. 2008

Oct. 2008

LEDs Megazine, Feb. 2009

LIGHT TILE ARRAYS



Light Fair 2009, New York, NY