

Technology Brief: Light Emitting Plasma

December 21, 2011

Report # ET11SMUD1018

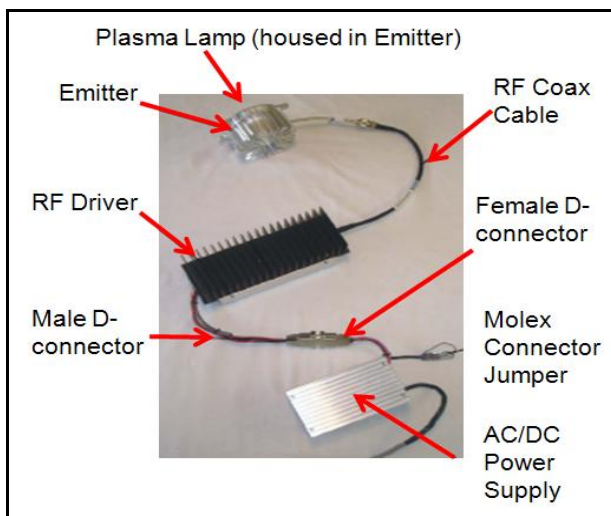
Introduction

By now, I'm certain most people in the lighting industry are familiar with LEDs – especially for outdoor lighting. But have you heard of Light Emitting Plasma? SMUD has been working with LUXIM Lighting and our customers to test this cutting edge technology.

Light Emitting Plasma (LEP) is a very intense, energy efficient, white light source that could be used in a variety of outdoor lighting applications.

What is Light Emitting Plasma?

The Light Emitting Plasma system consists of the components listed below. These components are housed within a light fixture (a.k.a. luminaire). The luminaire also includes an optical assembly to distribute the light produced by the lamp.



LEP System Components Source: LUXIM

- **Lamp:** consists of a very small quartz tube (3/4" long), which contains a mixture of rare earth halides - similar to conventional metal halide lamps. However, unlike conventional lamps, the plasma lamp does not contain electrodes (more on this later).



Plasma lamp
Source: LUXIM

- **Emitter:** the plasma lamp is housed within an aluminum assembly specifically designed to concentrate radio frequency energy within the lamp.
- **Radio frequency (RF) driver:** connected to the emitter via a coax cable and produces the radio frequency energy needed to ignite and operate the plasma lamp.
- **AC/ DC power supply:** converts incoming line voltage to DC and supplies power to the radio frequency driver.



Potential Benefits of Light Emitting Plasma

Light Emitting Plasma offers the following advantages over conventional high intensity discharge lamps:

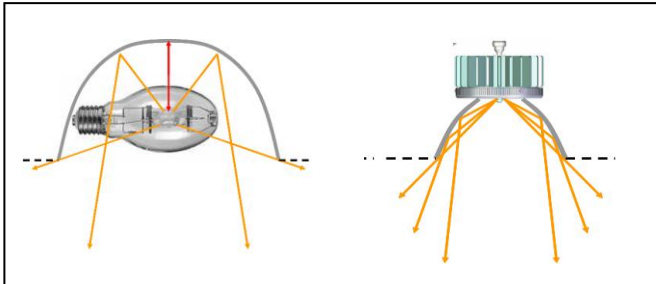
- **Better reliability:** conventional metal halide lamps require electrodes within the arc tube. These electrodes are usually made of tungsten and require a mechanical seal - which can lead to premature lamp failure. As the tungsten degrades, it darkens the walls of the lamp and reduces the light output.
- **Rapid start:** 45 seconds to reach 80% of full brightness
- **Faster re-strike:** when the power is turned off to high intensity discharge lamps (e.g. metal halide) they require time to cool down before they can be reignited. This is called the re-strike period and can last up to fifteen minutes for some older lamp types. The re-strike period for LEP lamps is only about 2 minutes – much faster than conventional metal halide or high pressure sodium systems.



Source: LUXIM

The information in this report is provided by SMUD as a service to our customers. SMUD does not endorse products or manufacturers. Mention of any particular product or manufacturer in this report should not be construed as an implied endorsement.

- Better optical control: since the LEP lamp is only $\frac{3}{4}$ " long, it is easier to direct the light where it is needed and provide even illumination levels. Better optical control is the key to energy savings in outdoor lighting applications.



The small size of the LEP lamp allows for excellent optical control and reduces the amount of wasted light. Source: LUXIM

- High efficacy: 82 lumens per Watt
- Good color rendition: the ability of light sources to render colors accurately is rated by a metric known as the Color Rendering Index (CRI). A CRI of 100 is considered to be ideal. LEP lamps are available with CRI values of 75 and 90.
- Longer rated lamp life:
 - 30,000 hours @ 90 CRI
 - 50,000 hours @ 75 CRI

Note: unlike high intensity discharge lamps, the rated life for LEP lamps is not based upon predicted failures; it is when the lamps are expected to lose 30% of their output. This is known as L^{70} life and is the same method used for rating the life of LEDs.

Important Things to Consider About LEP

Like every other technology, there are some potential downsides to Light Emitting Plasma:

- Weight: LEP produces a lot of heat and requires extensive heat sinks, which adds a significant amount of weight to the light fixtures. For example, LUXIM's R400 Roadway Luminaire weighs 34 pounds – slightly more than comparable 400 Watt metal halide or high pressure sodium options. Care must be taken during retrofits to ensure the existing poles and mounting arms will be able to handle the added weight.

- High Correlated Color Temperature (5700K): The light produced by the LEP systems we tested was bluish white in appearance and was noticeably different from other light sources. Some consumers may find this objectionable. Fortunately, beginning in February 2012, the CCT for LUXIM's standard product will be 5200K. LUXIM also plans to offer a 4800K option by the end of the 2012.
- Limited choice of manufacturers: Since LEP technology is relatively new, there are only a few manufacturers who currently offer fixtures with LEP as an option. Fortunately, LUXIM is making progress and will offer additional products in 2012.
- Position sensitive: Some LEP lamps are position sensitive and cannot be operated in a face up position. Care must be taken to select the proper LEP lamp for applications such as illuminating building façades.
- Potential compatibility problems with some wireless controls: In addition to the Earthgrains Bakery mentioned later in this technology brief, SMUD has been conducting tests at two other project sites and has encountered significant problems.

Since LUXIM has tested other brands of controls, and has not encountered these problems, they believe that this was an isolated incident. SMUD will work with LUXIM and our customers to test different control options in 2012.

Earthgrains Baking Company Case Study

The Earthgrains Baking Company (formerly Sara Lee) has been operating in its current Oak Park location since 1938. Due to the nature of their business, they operate around the clock so good exterior security lighting is important to them.

The original exterior lighting system consisted of thirteen 1,000 Watt metal halide floodlights. Although these floodlights provided enough illumination, light spilled into the yards of nearby residential neighbors and onto nearby Highway 99.

The information in this report is provided by SMUD as a service to our customers. SMUD does not endorse products or manufacturers. Mention of any particular product or manufacturer in this report should not be construed as an implied endorsement.

When this project was initiated, LUXIM only offered luminaires designed to replace 400 Watt metal halide systems. Since the original floodlights at Earthgrains Baking Company used 1,000 Watt metal halide lamps, it was necessary to install nineteen R400 Roadway Luminaires with Type 2 and Type 3 light distributions.



PRODUCT CODE		STA 41
LAMP LUMENS		23,000
WATTS		280
LIFE HOURS		50,000
CRI		75
CCT		5600
WEIGHT		
POUNDS	KILOGRAMS	
34	15.5	

Source: LUXIM

Earthgrains Baking Company is very pleased with the results of this project and plans to install more LUXIM LEP fixtures at this site. Here are the results for the first phase of the project:

- Even illumination levels
- Light trespass issues have been eliminated
- Positive feedback from employees and security personnel
- Energy savings: 37,993 kWh per year (62%)
- Demand reduction: 8.82 kW (62%)
- Project costs: \$18,671
- Estimated utility bill savings: \$3,476 / year
- Simple payback*: 5.4 years

*The simple payback calculation shown here does not include the Customer Advanced Technologies program research grant provided by SMUD. The actual payback period for the Earthgrains Baking Company was much shorter.

Next Steps

Although Light Emitting Plasma technology shows promise, SMUD believes more research is needed to answer some key questions before we include LEP technology in our rebate programs:

- Were the compatibility problems with wireless controls experienced at the other test sites limited to one particular brand? What other brands will work?
- Does the radio frequency (RF) driver cause interference with wireless controls? If so, are there precautionary measures that can be taken to ensure reliable operation?
- What is the relationship between power consumption and dimming? In other words, how much power does the LEP system consume when it is dimmed by 25%? 50%?
- Does dimming affect color rendering?
- How does dimming affect the Correlated Color Temperature (CCT) of the lamp?
- Can this technology provide adequate illumination when mounted at 50 feet?

To answer these questions, SMUD plans to continue researching Light Emitting Plasma systems in 2012 and will provide follow up reports as well as an educational workshop. Stay tuned!



TriTool Industries test site
Photo credit: SMUD

About the CAT Program...

SMUD's Customer Advanced Technologies (C.A.T.) program works with customers to encourage the use and evaluation of new or underutilized technologies. The program provides funding for customers in exchange for monitoring rights. Completed demonstration projects include lighting technologies, light emitting diodes (LEDs), indirect/direct evaporative cooling, non-chemical water treatment systems and a variety of other technologies.

For more program information, please visit:
<https://www.smud.org/en/business/save-energy/rebates->

The information in this report is provided by SMUD as a service to our customers. SMUD does not endorse products or manufacturers. Mention of any particular product or manufacturer in this report should not be construed as an implied endorsement.