



New OLED Lighting Systems Shine Bright, Save Energy

Challenge

Lighting consumes over 22% of the total electricity produced in the U.S. and, according to industry estimates, accounts for over \$200 billion per year in electric bills worldwide. A majority of this energy consumption and cost comes from traditional light sources such as incandescent lamps used for general lighting in residential and linear fluorescent lamps used in commercial and industrial applications. Spurred by regulatory actions and the Energy Independence and Security Act of 2007, interest and demand for more energy-efficient products for general lighting purposes is growing rapidly. However, alternative light sources have some limitations—such as comparable output, lamp lifetime, and production costs—that need to be addressed for the technology to achieve wider application.

Innovating Solutions

Organic light emitting diodes (OLEDs) hold promise for use in display applications and for general illumination for many reasons, including improved efficiency and performance and low cost. These devices typically consist of a series of organic thin films sandwiched between two thin-film conductive electrodes. When electricity is applied to an OLED, charge carriers are injected from the electrodes into the organic thin films. Under the influence of an electrical field, these carriers migrate through the device until they recombine; forming electron-hole pairs at elevated energy states (excitons) which upon relaxation may release energy in the form of light. By careful engineering of the energies of these excitons, light with specific properties (such as color) can be achieved. In addition to light, a natural byproduct of this relaxation process is unwanted heat. By using certain technical advancements such as phosphorescence as described below, this can be minimized resulting in a very efficient light producing process.

In the late 1990's, Universal Display Corporation (UDC), working with partners from Princeton University and the University of Southern California, developed phosphorescent OLED (PHOLED) technology that increases the energy efficiency of OLEDs up to four times, enabling white OLEDs to become a potential new source of "green" solid-state lighting. Since then, UDC has made tremendous progress in demonstrating the use of its proprietary UniversalPHOLED® phosphorescent OLED technology and materials in energy-efficient white lighting panels. Along with UDC's strategic partnerships, the U.S. Department of Energy (DOE) and its SBIR program have supported a variety of efforts to advance and commercialize the technology.

UDC and Armstrong World Industries were able to develop a prototype ceiling luminaire that can snap into Armstrong's TechZone™ ceiling system. Building on this success, UDC developed an under cabinet luminaire system shown in the photograph above. This luminaire system is comprised of 15cm x 7.5cm PHOLED lamp modules including a high efficiency power supply and dimming controls. It successfully demonstrated the target specification of > 60 lm/W, LT70 > 20,000 hours and CRI > 85. This performance compares favorably with typical under cabinet products currently on the market, as shown below:



UPDATE!

For over ten years, UDC and their technology partners have worked closely with the DOE's SBIR/STTR program and the DOE's SSL product development cooperative R&D grants to achieve numerous important OLED breakthroughs. Most of the highest risk and pioneering basic research has been achieved through the SBIR program with many world records for performance recorded. This enabling research has paved the way for more product-oriented demonstrations often performed with industry partners.

In 2010, UDC (teaming with Acuity Brands, a leading provider of innovative, technologically advanced sustainable lighting products and lighting-related solutions) won a \$2 million grant through DOE's SBIR Phase III Xlerator program to adapt its PHOLED lighting technology for high-end commercial and institutional building applications. This project builds on a number of SBIR-funded and other efforts that demonstrated how this technology can be manufactured cost effectively to match conventional technologies in mainstream lighting applications, such as Armstrong's TechZone.

Universal Display Corporation (UDC) (Ewing, NJ), founded in 1994, provides OLED innovations and helps commercialize new generations of OLED products through technology licensing, UniversalPHOLED® materials sales, technology development, and technology transfer services. UDC is a world leader in the development of innovative OLED technology for use in flat panel displays, lighting, and organic electronics. It holds one of the largest patent portfolios in the OLED field.

www.universaldisplay.com

	Under Cabinet Luminaire	
	PHOLED UDC Demo	Linear Fluorescent Typical T-5*
Luminaire efficacy (lm/W)	60	20
Estimated lifetime (hours)	>20,000	<10,000
Color rendering index (CRI)	85	82 (est.)

* Representative values from "benchmark" testing to support 2005 SSL Energy Star specifications for this category. Some values are average of 5 representative products tested.

A case study from the DOE/EERE SBIR Program portfolio, providing competitive grants for scientific excellence and technological innovation to advance critical American priorities and build a strong national economy – one small business at a time.

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UDC recently announced a technology and licensing agreement with Moser Baer Technologies to take PHOLED to the next level. The agreement follows a \$4 million DOE American Recovery and Reinvestment Act of 2009 award the team received for a two-year DOE project to create a phosphorescent OLED lighting panel manufacturing facility. Both this effort—and the DOE Xlerator-funded work for commercial applications—are major steps toward establishing volume manufacturing of energy-efficient and environmentally friendly white PHOLED lighting panels in the U.S., and can serve as a basis for new manufacturing investment and job growth in the country.

“The U.S. Department of Energy is very pleased with Universal Display’s continued advances toward the demonstration of white OLED lighting with commercially-viable performance...through programs like these, Universal Display is among the innovative companies that are helping to accelerate the commercialization of white OLEDs for solid-state lighting.”

Dr. James Brodrick, DOE Lighting Program Manager

SBIR Impacts

Projected Benefits of Replacing Traditional Systems with Phosphorescent OLED Lighting (2012 to 2018)

		Cumulative Estimated Savings by 2018 ¹
Energy	Estimated potential U.S. energy savings	0.22 quadrillion Btus
Economic	Estimated potential worldwide electricity cost savings	\$20 billion
Environmental	Estimated potential worldwide carbon emissions reductions Composed of organic materials, white OLEDs are environmentally benign	3.7 million metric tons

Innovation

Based on UDC’s UniversalPHOLED® phosphorescent OLED technology and materials, white PHOLEDs offer power efficiencies superior to those of today’s incandescent bulbs and approaching those of fluorescent lamps, having the potential to significantly reduce energy consumption, environmental impacts, and white lighting costs. Additionally, white PHOLEDs offer a novel form factor for more effective and imaginative application of white light, with the ability to tune light across a range of color temperatures. This functionality is neither feasible nor practical when using traditional light sources. As of 2010, UDC has demonstrated the following breakthrough research results with 15 cm x 15 cm white PHOLED panels and 2 mm² white PHOLED pixels:

Panels

- Efficacy of 66 lm/W; CRI = 79
- Efficacy of 58 lm/W; CRI = 81; with LT70 extrapolated panel lifetime over 15,000 hours

Pixels

- Efficacy of 113 lm/W; CRI = 80; with LT70 extrapolated pixel lifetime over 10,000 hours

Company Success

Thanks in large part to DOE support, Universal Display Corporation has become a recognized leader in developing and commercializing phosphorescent OLED technology. Their proprietary UniversalPHOLED® technology is part of a comprehensive patent portfolio which the company licenses as it provides customized technology development and transfer services for specific lighting needs worldwide. Advances in the technology have allowed a number of UDC’s customers and partners to exhibit white OLED prototypes at industry conferences and major trade shows. In addition to Armstrong World Industries, Acuity Brands Lighting, and Moser Baer Technologies, UDC has established relationships with LG Chem, NEC Lighting, Panasonic Electric Works, Konica Minolta, and Showa Denko K.K.

For four consecutive years, Universal Display Corporation was recognized by DOE for its achievements in solid-state lighting research and development, especially for its advances in white OLED lighting performance using its high-efficiency PHOLED technology and materials.

Since its founding in 1994, UDC has developed one of the largest patent portfolios in the OLED field, with licensing rights to over 1000 issued and pending patents worldwide, and has entered into business agreements with leading manufacturers in the U.S., Japan, Korea, Taiwan, China, and Europe.

¹ Projections provided by Universal Display Corporation. Assumes niche products are commercially available by 2012, with PHOLED lighting panels replacing 2-3% of traditional light sources in commercial and residential applications over six years.

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