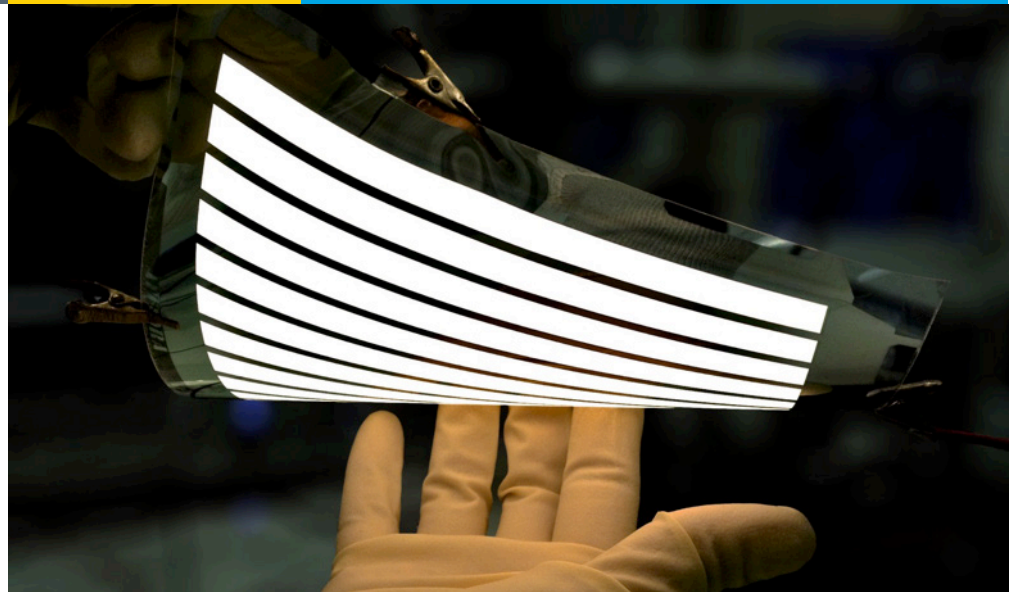


## Innovative Phosphorescent OLED Technology Is Helping to Make OLED Lighting Market-Ready

Thanks to research partially funded by DOE, Universal Display Corporation's OLED technology is increasing the efficacy and reducing the cost of OLED lighting in the U.S. and abroad.

Although both LEDs and OLEDs have excellent potential for energy efficiency, OLEDs have some unique advantages, such as being diffuse light sources that can be made on flexible plastic substrates. OLED lighting, though, is several years less mature than LED lighting in terms of its development, which means it still faces manufacturing hurdles on the road to commercialization. With funding assistance from DOE, Universal Display Corporation (UDC) has been working for more than a decade on advancing OLED technology.

UDC is a New Jersey company that develops the materials, processes, and techniques to make energy-efficient OLEDs, particularly through the development and commercialization of phosphorescent OLED emitter material systems. UDC initially focused on developing OLEDs for displays, but that focus broadened to the use of OLEDs for energy-efficient



UDC has developed many OLED lighting prototype and test panels with the help of DOE financial support. *Photo credit: Universal Display Corporation.*

lighting. UDC develops and sells the efficient phosphorescent emitters that are used for OLEDs, and also licenses aspects of OLED technology. The company was founded in 1994 in the laboratories of Princeton University and today supplies OLED manufacturers all over the globe. Its technology is found not only inside virtually every energy-efficient OLED lighting product, but also in virtually every energy-efficient OLED smartphone, tablet, TV, and smart-watch display.

The first DOE-supported project with UDC began in 2002, when OLED technology was still at a very early stage. But with DOE support, the company has developed technologies that enable OLED lighting to be used for general illumination. Since 2002, UDC has worked on a series of DOE-funded projects to improve the

basic performance of OLED lighting—specifically, to increase lifetime and efficiency. A number of these projects were collaborations with university partners, such as Princeton, the University of Michigan, and the University of Southern California.

### MARKET IMPACTS of UDC OLED Technology

UDC supplies OLED manufacturers all over the globe, with its technology found inside virtually every energy-efficient OLED display and lighting product.

From 2003–2015:

- Demonstrated OLED lighting device efficiency increased from 10 lm/W to more than 100 lm/W
- Demonstrated OLED lighting device lifetime increased from 10 hours to more than 100,000 hours
- The number of UDC employees grew from 25 to 153
- UDC revenues grew from \$7 million to \$191 million
- In 2015 alone, 250 million smartphones using UDC technology were sold

*“DOE R&D funding has been invaluable to UDC. In the early years, it provided validation of our technology and reduced the financial risk of pursuing new technical approaches and focusing on lighting in addition to the more immediately profitable display market. Later on, it was instrumental in allowing us to form key partnerships with other U.S. lighting companies.”*

— Mike Hack, UDC Vice President of Business Development

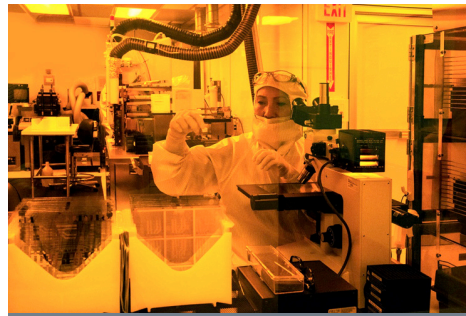
A number of UDC's DOE-funded projects have been aimed at accelerating the adoption of OLED lighting through the development and demonstration of new OLED lighting prototypes. For example, in 2010 the company completed a project with Armstrong Industries to integrate an OLED luminaire into Armstrong's advanced TechZone™ ceiling system and, the following year, demonstrated undercabinet OLED lighting. In 2012, UDC successfully exhibited a color-tunable OLED luminaire in partnership with Acuity Brands Lighting, and in 2014 UDC developed, together with IDD Aerospace, an energy-saving OLED lamp for use in aircraft cabin interiors.



An OLED lighting prototype developed by UDC with support from DOE funding and incorporated into Armstrong Industries' advanced TechZone™ ceiling system. *Photo credit: UDC.*

These projects have all built on previous developments, with new device architectures and concepts allowing for improved efficiencies and lifetimes that paved the way for the development of lighting product prototypes. The UDC work demonstrates a clear path for OLED lighting to be a competitive and viable form of solid-state lighting (SSL).

UDC expects to see a significant increase in the production of OLED lighting products over the next few years. The early years of DOE support helped provide validation for UDC OLED technology



UDC lab technician preparing an OLED test panel. *Photo credit: UDC.*

and reduce some of the risk of pursuing new technical approaches. DOE support has also allowed the company to devote more of its resources to energy-saving lighting, in addition to the more immediate display market. In today's display market, about 10% of consumer electronics use OLEDs. Virtually all of those OLED products—which include smartphones, tablets, TVs, and smart watches—contain UDC technology. In 2015, 250 million smartphones using UDC technology were sold—to say nothing of other consumer electronics products. Demand for UDC technology comes from both domestic and foreign markets, with UDC customers including U.S. OLED panel manufacturer OLED-Works as well as Asia-based electronic-industry giants LG Display, Samsung, and Konica Minolta.



An OLED lighting prototype developed (with support from DOE funding) by UDC and IDD Aerospace for use in aircraft cabin interiors. *Photo credit: UDC.*

## DOE SSL R&D INVESTMENTS

### GOALS

1. Maximize the energy efficiency of SSL products in the marketplace.
2. Remove market barriers through improvements to lifetime, color quality, and lighting system performance.
3. Reduce costs of SSL sources and luminaires.
4. Improve product consistency while maintaining high-quality products.
5. Encourage the growth, leadership, and sustainability of domestic U.S. manufacturing within the SSL industry.

### WHY IT MATTERS

- Technology innovation fuels U.S. economic growth and job creation.
- OLED lighting that is more cost-competitive will help accelerate markets for energy-efficient solid-state lighting, saving energy for American homeowners and businesses while reducing carbon emissions.

UDC is also at the technological forefront of the OLED lighting movement, as OLED lighting products emerge onto the market. Virtually all of those products—whether from U.S. luminaire manufacturers or those based overseas—incorporate UDC technology.

What all of this means is that there's U.S. knowhow in many millions of energy-efficient OLED products in use—and DOE funding helped pave the way to put it there. ■