Case Study

Case Study: Portable Lighting Upgrades

TerraLUX Strikes Gold with LUXEON-Based Flashlight Upgrades

When you're in need of a flashlight, there's nothing worse than an equipment failure. Whether you're a plumber crawling around a basement, a spelunker exploring a cave, or a policeman searching for a crime suspect in the middle of the night, being left in the dark may slow your work, get you lost, or even mean the difference between life and death. Yet conventional flashlights are notoriously unreliable due to the inherent inefficiency and short lifetime of the incandescent light bulb.

In 2003, Anthony Catalano Ph.D. saw the opportunity to retrofit incandescent flashlights with LED upgrade kits that could be swapped with the original lighting assembly in less than a minute and create a better, more reliable flashlight solution. Soon he was building prototypes with LUXEON® high-power LEDs from Philips Lumileds (www.philipslumileds.com) out of his garage. By 2004 he had formed Boulder, Colorado-based TerraLUX Inc. (www.TerraLUXcorp.com) to go to market.

Today TerraLUX—a LUXEON Lighting Network member—is the #1 provider of high-power LED flashlight upgrades for small flashlights, and is gradually expanding into new markets such as dental and surgery equipment lighting. All high-power white TerraLUX LED Light Engines are lit by LUXEON, the industry's brightest and most technologically advanced high-power LEDs. Indeed, TerraLUX's growth has paralleled the development of new LUXEON platforms that continually raise the bar in luminous output, color control and other areas of performance, enabling brighter and more durable portable lighting solutions that were never before possible.

PHILIPS

LUMILEDS
LIGHT FROM SILICON VALLEY

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>
> - Anthony Catalano
> TerraLUX Inc.

"In just a few years, LUXEON LEDs have made incandescent flashlights virtually obsolete, particularly for service technicians, policemen, hunters, fishermen and anyone else who relies on portable lighting on a regular basis. We have helped drive that transformation with our upgrade kits," Catalano said. "LUXEON is at the heart of every TerraLUX product, and it has unquestionably been a cornerstone of our success."

Birth of a Business

The seeds for TerraLUX's business were planted on Catalano's patio. His wife wanted an umbrella light. The patio lacked electrical power. Catalano bought several battery-powered lanterns at his wife's request but discovered that they lasted just an hour. Drawing on some LED work he had done while earning his doctorate, Catalano decided to take matters into his own hands. To solve his patio problem, he designed an electrical circuit to act as an intermediary between the batteries and the LED. He quickly recognized that his idea had commercial possibilities and zeroed in on LED retrofit kits for portable lighting as the logical target for his LED efforts.

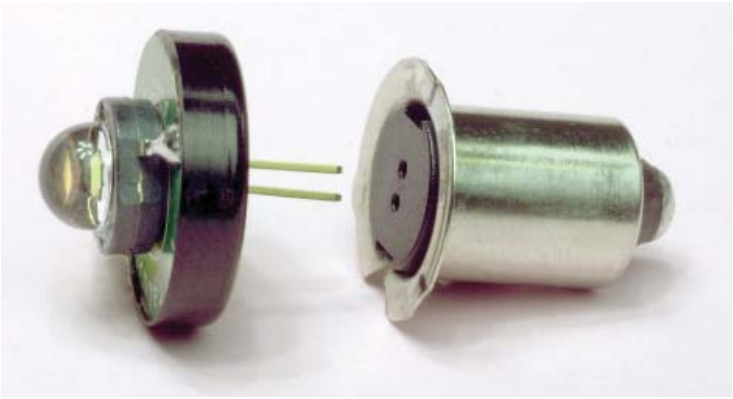
That's because Catalano realized that LEDs could remedy the flaws of conventional flashlights. Incandescent light bulbs break when dropped in part because their 2500°C operating temperature turns the filament brittle. Smaller incandescent bulbs are so inefficient and short-lived that they drain the flashlight batteries in 60 minutes, lose half their brightness in an hour, and offer a small fraction of their original light after only five to ten hours of use.

At first, Catalano tried combining four 5mm LEDs, the low-power devices typically used as indicator lights, but the light output was not impressive enough for customers to make the switch. Then he discovered the LUXEON I power LED with a 30-lumen output, and Catalano's business prospects were brightened—literally.

Catalano found that power LED light sources could last for 50,000-60,000 hours—seven or eight years of non-stop use—and therefore never needed to be replaced. Battery life could be extended because of LUXEON's high energy efficiency. LED replacement bulbs would be all but indestructible.

First LUXEON-Lit Retrofit Kit

Catalano assigned development duties to TerraLUX CTO Dan Harrison, whose background includes building key components for the camera used to capture images from Mars. Harrison's challenge was to create a LUXEON I-based plug-in LED retrofit kit for an aluminum mini 2AA flashlight that would take full advantage of the LED's high light output without running so hot that the LED would overheat or the battery would quickly conk out.



Making the World's Brightest LED Flashlight Upgrade with LUXEON K2 with TFFC

In early 2008, TerraLUX achieved a new performance milestone in flashlight illumination by using the just-released LUXEON K2 with TFFC (Thin Film Flip Chip) LED to produce an LED upgrade for D cell aluminum flashlights with a sustained output of over 500 lumens.

That super-bright light output, generated by three LEDs pumping out 200 lumens apiece, was made possible by LUXEON technology advances that improve light extraction, reduce thermal resistance, and deliver the industry-first ability to run at drive currents of 1A in real-life applications.

The TLE-300 thermal design is capable of operating indefinitely at full power under most conditions. To manage heat and maintain LED life under high ambient temperature conditions, TerraLUX developed a new intelligent temperature control system that senses heat levels and reduces power when necessary to prevent overheating. This temporarily dims the flashlight but eliminates the need to turn it off altogether.

The world's-brightest TLE-300 upgrade kit works with D cell flashlights operating with up to six batteries and can maintain a constant light output with a power source between 3.5 and 24 Volts. The new intelligent temperature control system also will meet and exceed upcoming UL requirements calling for AC LED lighting to have built-in thermal regulation for fire prevention purposes.

The now-patented thermal, optical, electronic and mechanical design that emerged from Harrison's efforts includes:

- a complex electrical circuit that maximizes energy efficiency
- a proprietary heat sink that prevents overheating in part by dissipating heat through the aluminum housing
- the ability to maintain constant drive current, variably boosting the voltage as the batteries run down to produce a constant light intensity without the dimming and orange cast of an incandescent bulb, and
- the ability to sense heat build-up and variably dim the LED to maintain thermal equilibrium and preserve circuit and LED lifetime—an innovation added in later generations of the product as the wattage increased.

The single 30-lumen LUXEON I in the company's first replacement light produced up to 10 times the brightness of the factory-installed incandescent lamp. The small source size of the single-LED solution allowed the flashlight to retain its ability to adjust the beam angle from narrow to wide—an impossibility with a multiple-LED solution due to the complexity of the optics. In addition, the combined efficiency of the LUXEON LED and the TerraLUX circuitry lengthened useful battery life from one hour to six, translating into significant time and dollar savings on battery replacements.

TerraLUX packaged the TLE-5 flashlight insert with a replacement reflector and started selling online to test the market. At the same time, the company began showing the unit to industrial supply stores that equip plumbers, HVAC contractors, and other service and maintenance technicians who use mini-flashlights on a daily basis. The product was an instant hit.

Triumph with Technicians

"Initially store managers were skeptical that people would pay $30 to upgrade a $10 flashlight. Then they saw the TLE-5 in action," said Carl Kalin, TerraLUX VP Marketing and Sales. "First we turned on an upgraded flashlight and they practically gasped when they saw how much brighter it was than an incandescent. Technicians frequently need to read tiny serial numbers behind furnaces or in other dark places, so this was a big deal.

"Next we tossed up the lit flashlight and let it fall on a concrete surface to show that the bulb didn't break—it was still bright as ever when they picked it up.

Before we even explained that the bulb would never need replacement, the batteries would last six times longer and a $30 upgrade would therefore save hundreds of dollars over the life of the flashlight, they were asking how soon they could get the product."

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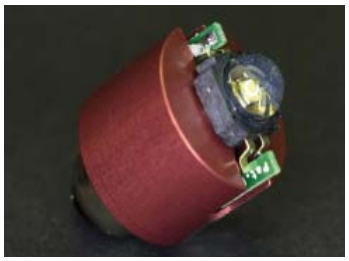
- Carl Kalin
TerraLUX Inc.

Increasing Performance with LUXEON

Since that first conversion kit was released in 2004, TerraLUX has expanded its product line to take advantage of ongoing LUXEON technology improvements as well as to meet disparate consumer needs. The company has used every generation of LUXEON, including LUXEON I, LUXEON III, LUXEON V, LUXEON K2, LUXEON Rebel, and most recently LUXEON K2 with TFCC (Thin Film Flip Chip), a Philips Lumileds packaging advancement that improves light output and thermal capabilities.

TerraLUX offerings now range from a 50-lumen LED upgrade for a mini AA flashlight to a 200-lumen LED replacement for the most popular rechargeable flashlights and a whopping 500-plus-lumen LED upgrade for D cell aluminum flashlights. That TLE-300 kit, consuming only 12 Watts of power, generates more light than even a 50 Watt MR-16 halogen bulb and ranks as the world's brightest LED flashlight upgrade. (See sidebar.) TerraLUX also designs and manufactures LED light replacements for specialty applications such as dental headlamps and laryngoscopes.



Users include reconnaissance pilots in Iraq, maintenance crews at Boeing and Disney World, law enforcement officers, security personnel, Boy Scout troops, theatrical stage crews, auto mechanics, hunters, campers, and even lobster fishermen who have embedded one of TerraLUX's LUXEON-based LED heads in a converted scuba torch.

This growing product line would not have been possible if the company's debut product had fizzled, and the company credits LUXEON technology with getting the business off the ground as well as driving it forward.

"When you're trying to sell to a wholesale supply chain with 300 stores and you have only one product as we did with our first LED upgrade kit, it has to be a home run. These companies typically don't take on vendors for just one product," Kalin noted. "LUXEON LEDs enabled us to instantly differentiate our light engines from anything on the market and provide concrete, measurable, sit-up-and-take-notice benefits for flashlight users, and LUXEON's reliability and dependability keeps them coming back. Philips Lumileds set the standard in their industry, and they have allowed us to do the same in ours."

TerraLUX TLE-300, the World's Brightest Flashlight Upgrade, using LUXEON K2 with TFFC.

TerraLUX

TerraLUX Innovations with LUXEON

- Reuse of existing flashlight body
- Far brighter than incandescent flashlights
- Bulbs last for the life of the flashlight
- Batteries last up to 10 times longer
- Cost savings on bulb and battery replacement
- Almost indestructible, unlike lit bulbs that break when dropped
- Pure, controlled white light that doesn't fade
- Color options for specialty applications

CERTIFIED

LUXEON

never before possible

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