LED THERE BE LIGHT

Steadily improving solid-state technology ushers LEDs from narrow niches into the residential spotlight.

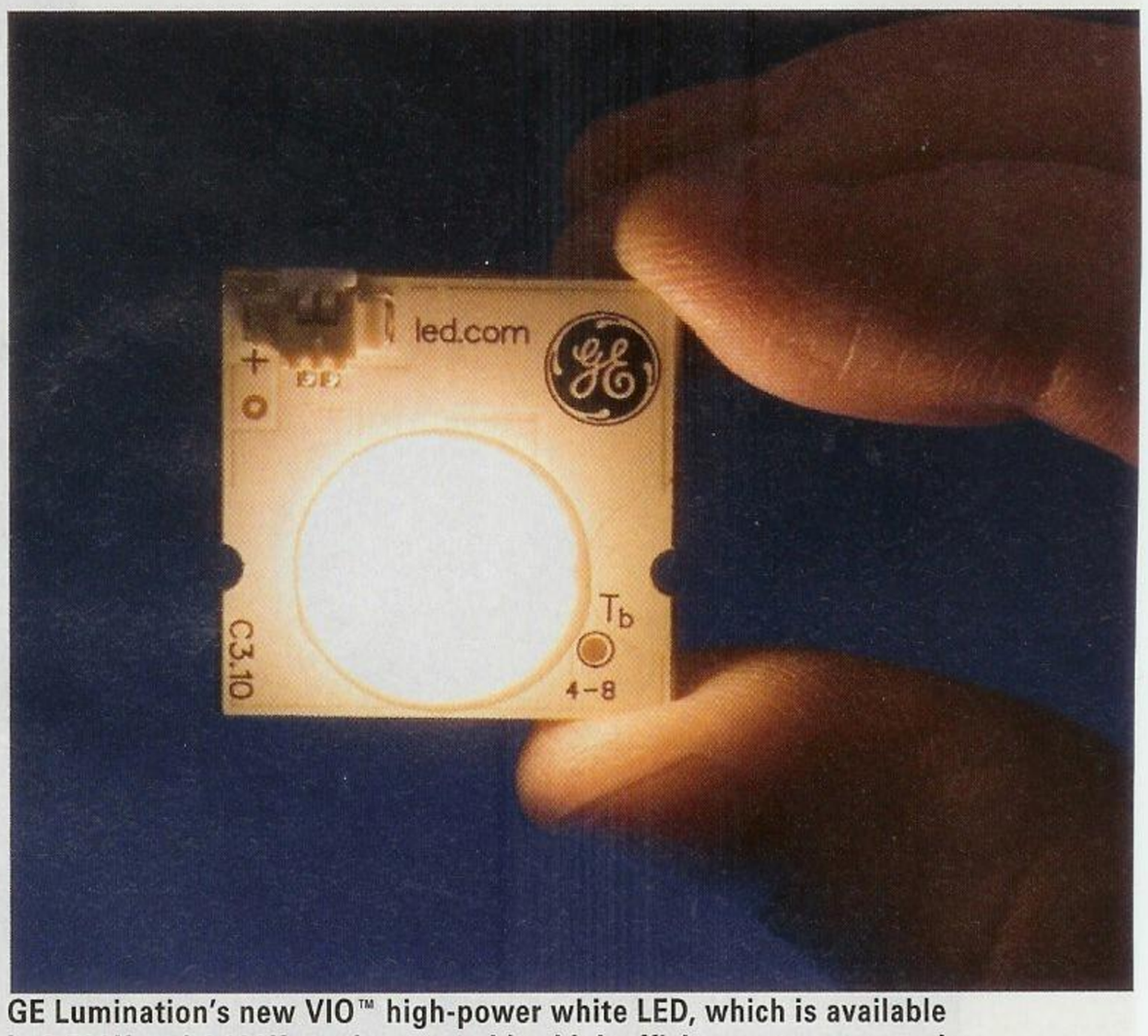
by Jennifer Pinto

If you haven't already heard about compact fluorescent lamps (CFLs) and been tutored on their new and improved status as a viable and attractive replacement for the traditional, energy-slurping incandescent light bulb, you've been living under a rock. But that was then.

Today, the lighting industry's new buzzword is LED (or light-emitting diode), a long-lasting, energy-efficient light source that experts say has the potential to out-perform the CFL.

"In the beginning, CFLs stumbled a lot," according to Derek Publicover, Product Manager, General Illumination, at GE Lumination. "Three years ago they were less than 5 percent [of the market], and they might be 10 to 15 percent [today]. They struggled and faced the same issues that LEDs do now: price, light output and color quality."

Despite the challenges LEDs continue to face, experts predict rapid advancements in solid-state technology in the near future, begging the question: Are LEDs staging the next revolution in lighting?



GE Lumination's new VIO™ high-power white LED, which is available in 3,500K and 4,100K versions, provides high efficiency at warmer color temperatures and can be used in many standard fixtures designed for general illumination. CIRCLE 178

LEDS NOW

According to Kelly Gordon of the U.S. Dept. of Energy's (DOE) Pacific Northwest National Laboratory (PNNL), LEDs have undergone vast improvements in recent years.

"In the past four or five years, light output—as measured in lumens per watt—has continued to go up," she says. "Major manufacturers, such as Cree and Lumileds, can get 40 to 60 lumens per watt or more from an LED." (CFLs also output about 60 lumens per watt versus incandescent sources, which are rated for about 15 lumens per watt.)

The key to gaining acceptance from product designers and, ultimately, consumers, color quality is making strides, as well. It's approaching a warmer, white light—though it's not there yet.

"The desire is to come up with an LED that can be used in general applications, which means a white light similar to what we have with incandescent and fluorescent," says Jim Yorgey, Technical Applications Manager at Lutron Electronics. "But it has to do with color temperature, color rendering and efficiency, as well: [Those things combined are] the Holy Grail of the industry."

Though price is also improving, LEDs are still very costly, a continued drawback. The solid-state sources are priced at about 9 cents per lumen, while traditional incandescents are only about 3/100 of a cent per lumen, GE's Publicover explains.

Jim Anderson, Director of Technology and Projects, SSL Luminaires North America, at Philips Lighting, puts it into perspective: "It's a new technology, so the price is still very high. It's like flat-screen TVs; when they first came out, they were very expensive. But as more people enter the market, there's more competition, there's more capacity, the technology advances, and then the pricing comes down precipitously."

EFFICACY ISSUES

As improvement in the technology continues, we're beginning to see more and more LED-based product design infiltrating the marketplace in ways other than the indicator lights and display panels that have been in use in homes for years.

"Some of the residential applications we're seeing today are for directional lighting applications, such as task and down-lighting, outdoor lighting and decorative lighting," says PNNL's Gordon. "There are some promising fixtures out there."

But when individual LEDs are incorporated into fixture designs, it complicates the issue, warns her colleague at PNNL, Mia Paget.

"It's a whole other field of study almost, and it's progressing at a different pace and separately from the LED technology progression," Paget says. "It's one thing for the manufacturer to be able to make these separate chips that are getting higher in efficacy and better in color quality. It's another challenge for luminaire manufacturers to take those and integrate them into fixtures in ways that are the most effective possible."

Even labels can be deceiving. Due to a lack of standardization, many manufacturers refer to the value of the original LED device itself when reporting their product's light output, and that may be a far-from-accurate reflection of its performance within the fixture.

"So, the fear is not that the technology isn't good because the technology has fabulous potential," Paget says. "But we don't want the public to be as disappointed as they were in CFLs when they first came out because of misleading impressions that might be circulating right now."

The challenge becomes designing packages that are more efficient—giving off a higher number of lumens per watt—and more affordable, so there's a payback for residential consumers to use them.

"The question from an industry standpoint is: Are we going to rush just to put product out there that doesn't meet expectations?" GE's Publicover says. "Or, are we going to be patient and truly deliver value-added product for the consumer at the right price? Some people may think that time is now; I would argue that the time is not now."

MEASURING UP

The DOE and its various alliance organizations are working on several programs to ensure that if the time's not now, it's certainly soon.

As Senior Research Engineer for PNNL, Paget heads up the DOE's Commercial Product Testing program, which buys up commercially available fixtures and tests them for such things as efficacy, light output and thermal management.

"Thankfully, the majority of manufacturers putting product out there are doing a good job," says Paget. "But there are products being marketed that are, in some cases, less efficient than incandescent."

As a result of the testing program's mixed findings, the DOE is faced with the challenge of getting the word out to the public about those products that don't make the cut. "Our hope is that manufacturers will then go back to the drawing board to come up with an improved design," Paget says.

Standardization will play a significant role in making sure quality products are on the shelves. "[It's] in the works," says PNNL's Gordon. "The Illuminating Engineering Society of North America (IESNA) and others are working on industry standard test procedures, which are in their final drafts."

Already a respected go-to source for its energy-efficient seal of approval, the DOE is also working on voluntary Energy Star® criteria applicable to LED fixtures. According to Gordon, those guidelines are nearing finalization and will take effect in the coming year, once testing procedures are in place. The DOE is also organizing demonstrations of LED systems that employ good design practices.

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> *Kelly Gordon, Pacific Northwest National Laboratory*

"It's an opportunity for fixture manufacturers to demonstrate their products in real buildings," Gordon says. "We're really in the Wild West phase of LEDs, and that's one of the major challenges facing the technology right now."

BACK TO THE FUTURE

While LEDs maintain a very specific niche in the residential market currently, in the coming years standards, improved technology and proper application will open the door to opportunities for new applications.

"For residential lighting, LEDs have tremendous potential, Paget says. "There are many instances in which they have a distinct advantage, such as in hard-to-reach places, outdoors or rooms where safety is an issue."

Despite its promise, experts disagree whether the technology will ever replace CFLs as the pervasive energy-efficient light source in homes.

"It's only a matter of time," Philips' Anderson says. "In this climate of global warming and [rising energy prices], people are looking for energy savings, and LEDs provide a tremendous opportunity there."

At the same time, Lutron's Yorgey is skeptical. "Fluorescent lights haven't yet replaced all incandescents, and I don't think they ever will completely. Same goes for LEDs replacing CFLs or HID."

What the industry does agree on is that the future of LEDs is bright and getting brighter. And that only time will tell what the technology has in store.

FACT OR FICTION: LEDS DON'T HEAT UP

While LEDs appear cool to the touch, the claim that they don't generate heat is simply not true. Though they don't emit heat from the front like traditional light bulbs do, the back of the LED gets really hot, and, when incorporated into a design, that heat needs to be managed. If product designers don't allow for proper heat sinking and consider how it's integrated into the luminaire, the result is a significant drop in energy efficiency—up to as much as 60 percent.