Technology

What makes LEDs different from other light sources?

LEDs are semiconductor devices, while incandescent, fluorescent, and high-intensity discharge (HID) lamps are all based on glass enclosure containing a filament or electrodes, with fill gases and coatings of various types. LED lighting starts with a tiny chip (most commonly about 1 mm2) comprising layers of semi-conducting material. LED packages may contain just one chip or multiple chips, mounted on heat conducting material and usually enclosed in a lens or encapsulate. The resulting device, typically around 7 to 9mm on a side, can produce 30 to 320 lumens each, and can be used separately or in arrays. LED devices are mounted on a circuit board and attached to a lighting fixture, architectural structure, or even a “light bulb” package.

What is directional light emission?

Traditional light sources emit light in all directions. For many applications, this results in some portion of the light generated by the lamp being wasted. Special optics and reflectors can be used to make directional light sources, but they cause light losses. Because LEDs are mounted on a flat surface, they emit light hemispherically (forward and side), rather than spherically (all around). For task lighting and other directional applications, this reduces wasted light.

Solid-state advantage?

LEDs are largely impervious to vibration because they do not have filaments or glass enclosures. Standard incandescent and discharge lamps may be affected by vibration when operated in vehicular and industrial applications, and specialized vibration-resistant lamps are needed in applications with excessive vibration. LED’s inherent vibration resistance may be beneficial in applications such as lighting on and near industrial equipment, elevators and escalators, and ceiling lights. Traditional light sources are all based on glass or quartz envelopes. Product breakage is a fact of life in electric lamp transport, storage, handling, and installation. LED devices usually do not use any glass. LED devices mounted on a circuit board are connected with soldered leads that may be vulnerable to direct impact, but no more so than cell phones and other electronic devices. LED light fixtures may be especially appropriate in applications with a high likelihood of lamp breakage, such as sports facilities or where vandalism is likely. LED durability may provide added value in applications where broken lamps present a hazard to occupants, such as children’s rooms, assisted living facilities, or food preparation industries.

Are LEDs ready for general lighting?

Yes! The time has arrived when LED for general illumination is a reality.

Are LEDs energy-efficient?

LED products can meet or exceed the efficiency of compact fluorescent lamps (CFLs). Many white LEDs currently available in consumer products are much more efficient than incandescent lamps. The best warm white LEDs available today can produce up to 100 lumens per watt (lm/W). In comparison, incandescent lamps typically produce 12-15 lm/W; CFLs produce at least 50 lm/W. Performance of white LEDs continues to improve rapidly. However, LED device efficiency doesn’t tell the whole story. Good LED system and luminaire design is imperative to energy-efficient LED lighting fixtures. For example, some new LED recessed downlights combine multicolored high efficiency LEDs, excellent thermal management, and sophisticated optical design to produce more than 700 lumens using only 12 watts, for a luminaire efficacy of 60 lm/W. Conversely, poorly-designed competitors luminaires using even the best LEDs may be no more efficient than incandescent lighting and may fail well before their rated life.

How long do LEDs last?

Unlike other light sources, LEDs usually don't "burn out;" instead, they get progressively dimmer over time. LED useful life is based on the number of operating hours until the LED is emitting 70% of its initial light output. Good quality LEDs in well-designed fixtures are expected to have a useful life of 40,000 to 50,000 hours. A typical incandescent lamp last about 1,000 hours; a comparable CFL lasts 8,000 to 10,000 hours, and the best linear fluorescent lamps can last more than 20,000 hours. LED light output and useful life are strongly affected by temperature. LEDs must be "heat sinked": placed in direct contact with materials that can conduct heat away from the LEDs.

What's the quality of LED lighting?

Colour appearance and colour rendering are important aspects of lighting quality. Until recently, almost all white LEDs had very high correlated color temp (CCTs), often above 5000 Kelvin. High CCT light sources appear "cool" or bluish-white. Neutral and warm white LEDs are now available. They are less efficient than cool white LEDs, but have improved significantly, to levels on par with CFLs. For most interior lighting applications, warm white (2700K to 3500K), and in some cases neutral white (3000K – 4100K) light is appropriate.

The colour-rendering index (CRI) measures the ability of light sources to render colors, compared to incandescent and daylight reference sources. In general, a minimum CRI of 80 is recommended for interior lighting. Some of our LED solutions provide an amazing 92+ CRI.

What other LED features might be important?

Depending on the application, other unique LED characteristics should be considered:

- Directional light
- Low profile/compact size
- Breakage and vibration resistance
- Improved performance in cold temperatures
- Life unaffected by rapid cycling
- Instant on/no warm up time
- Dimming and colour controls
- No IR or UV emissions

Fluorescent lights don't work well in the cold — LEDs thrives

Cold temperatures present a challenge for fluorescent lamps. At low temperatures, higher voltage is required to start fluorescent lamps, and luminous flux is decreased. A non-amalgam CFL, for example, will drop to 50% of full light output at 0º C. The use of amalgam (an alloy of mercury and other metals, used to stabilize and control mercury pressure in the lamp) in CFLs largely addresses this problem, allowing the CFL to maintain light output over a wide temperature range (-17º C to 65º C). The trade-off is that amalgam lamps have a noticeably longer "run-up" time to full brightness, compared to non-amalgam lamps. In contrast, LED performance inherently increases as operating temperatures drop. This makes LEDs a natural fit for grocery store refrigerated and freezer cases, cold storage facilities, and outdoor applications. In fact, DOE testing of an LED refrigerated case light measured 5% higher efficacy at -5º C, compared to operation at 25º C.

Fluorescent lights take time to start up – LEDs are instant on

Fluorescent lamps, especially those containing amalgam, do not provide full brightness immediately upon being turned on. Fluorescents using amalgam can take three minutes or more to reach their full light output. HID lamps have longer warm up times, from several minutes for metal halide to 10 minutes or more for sodium lamps. HID lamps also have a “re-strike” time delay; if turned off they must be allowed to cool down before turning on again, usually for 10-20 minutes. Newer pulse-start HID ballasts provide faster “re-strike” times of 2-8 minutes. LEDs, in contrast, come on at full brightness almost instantly, with no “re-strike” delay. This characteristic of LEDs is notable in vehicle brake lights, where they come on 170 to 200 milliseconds faster than standard incandescent lamps, providing an estimated 19 feet of additional stopping distance at highway speeds. In general illumination applications, instant on can be desirable for safety and convenience.

Rapid cycling

Traditional light sources will burn out sooner if switched on and off frequently. In incandescent lamps, the tungsten filament degrades with each hour of operation, with the final break (causing the lamp to “burn out”) usually occurring as the lamp is switched on and the electric current rushes through the weakened filament. In fluorescent and HID lamps, the high starting voltage erodes the emitter material coating the electrodes. In fact, linear fluorescent lamps are rated for different expected lifetimes, depending on the on-off frequency, achieving longer total operating hours on 12-hour starters (i.e., turned on and left on for 12 hours) compared to shorter cycles. HID lamps also have long warm up times and are unable to re-start until cooled off, so rapid cycling is not an option. LED life and lumen maintenance is unaffected by rapid cycling. In addition to flashing light displays, this rapid cycling capability makes LEDs well-suited to use with occupancy sensors or daylight sensors.

Controllability/tenability/dim at last!

Traditional, efficient light sources (fluorescent and HID) present a number of challenges with regard to lighting controls. Dimming of commercial (specification)-grade fluorescent systems is readily available and effective, although at a substantial price premium. For CFLs used in residential applications, dimming is more problematic. Unlike incandescent lamps, which are universally dimmable with inexpensive controls, only CFLs with a dimming ballast may be operated on a dimming circuit. Further, CFLs usually do not have a continuous (1% to 100% light output) dimming range like incandescent lights. Often, CFLs will dim down to about 30% of full light output. LEDs may offer potential benefits in terms of controlling light levels (dimming) and color appearance. However, not all LED devices are compatible with all dimmers, so manufacturer guidelines should be followed. As LED driver and control technology continues to evolve, this is expected to be an area of great innovation in lighting. Dimming, color control, and integration with occupancy and photoelectric controls offer potential for increased energy efficiency and user satisfaction.

No IR or UV emissions

Incandescent lamps convert most of the power they draw into infrared (IR) or radiated heat; less than 10% of the power they use is actually converted to visible light. Fluorescent lamps convert a higher proportion of power into visible light, around 20%. HID lamps can emit significant ultraviolet radiation (UV), requiring special shielding and diffusing to avoid occupant exposure. Earth-Line SSL LEDs emit virtually no IR or UV. Excessive heat (IR) from lighting presents a burn hazard to people and materials. UV is extremely damaging to artwork, artifacts, and fabrics, and can cause skin and eye burns in people exposed to unshielded sources.

Got all that?

LEDs are available for an ever-increasing number of applications. In addition to attributes typically considered before buying a new light source, such as color quality, energy efficiency, and operating cost, decision makers should also consider the unique attributes described in this document, as a determining factor when addressing their lighting needs.

1. Directional lighting
2. Size advantage
3. Breakage resistance
4. Cold temperature operation
5. Instant on
6. Rapid cycling capability
7. Controllability
8. No IR or UV emissions