OMNI-RAY LIGHTING™
Oconto, Wisconsin USA

LED LIGHTING – GENERAL INFORMATION

Light-emitting diodes have been around for 50 years, but they have only developed to the point of being suitable for general-purpose lighting in the last 10. The field is undergoing rapid evolution mapped by the LED equivalent of Moore's Law.

This is Haitz's Law, and it states that in every decade, the cost per lumen (unit of useful light emitted) falls by a factor of 10, and the amount of light generated per LED package increases by a factor of 20 for a given wavelength of light.

If LEDs are to be used as a source for lighting, more is involved than the LED dice themselves. An LED-powered lamp or luminaire (i.e., fixture) requires phosphors, optics, a heat sink for thermal management, and driver electronics, as well as packaging for all of these parts. The worldwide switchover to LED lighting, replacing the woefully inefficient incandescent technology, is driving rapid improvements in all of these areas. Prices for LED lighting products, once astronomical, are falling into the range of feasibility.

Essentially all of the LEDs used in lighting are based on the semiconductor gallium nitride, GaN. This is bonded to a substrate, which in the majority of LEDs today is either sapphire or silicon carbide. Other substrates are under development, as we'll see below.

LEDs are inherently more versatile and potentially far more efficient than any other light source yet devised. An incandescent filament source has a "luminous efficacy" of around 15 lumens of light for every Watt of electricity input. The rest is wasted as heat. Fluorescents typically run in the range from 45 to 75 lm/W. Metal halide achieves up to 115 lm/W and high-pressure sodium up to 150 lm/W. LEDs can theoretically achieve a maximum of between 260 and 300 lm/W. Current commercial examples run in the high 100s, and the numbers are rising every year.

All LEDs produce heat, but they don't radiate it out the front with the light. They accumulate it at the p-n junction, and the heat has to be removed if an LED is to achieve its designed lifetime. This is accomplished with the aid of a heat sink and a known thermal path to ambient.

LEDs produce light in proportion to the current flowing through them, and most are fed by a DC power supply and a driver circuit that holds the current constant. Early experimentation with driving LEDs directly from AC line current has matured, and AC drivers for LEDs, with their simpler circuitry and lower component count, are claiming a place at the table.

The versatility of LEDs leads to explorations of what they can do for us besides producing white light. Our understanding of the effects of light on humans (and other living things) is increasing rapidly. LED lighting is being asked to contribute to human health, well-being, alertness, attention, the food supply, and more.