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Light-Emitting Diodes: A Primer

This article will provide an overview of the LED operation and a brief look at the industry. Various types of LEDs, the corresponding wavelengths, materials used in their composition, and some applications for the specific lamps will also be discussed.

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Light Sources

Light-Emitting Diodes A Primer

Light-emitting diodes (LEDs) are semiconductors that convert electrical energy into light energy. The color of the emitted light depends on the semiconductor material and composition, with LEDs generally classified into three wavelengths: ultraviolet, visible, and infrared.

Blue-Diode
Osram Opto Semiconductor

The wavelength range of commercially available LEDs with a significant output power of at least 200 mW is 400 nm. Each wavelength range is made from a specific semiconductor material family, regardless of the manufacturer. This article will provide an overview of the LED operation and a brief look at the industry. Various types of LEDs, the corresponding wavelengths, materials used in their composition, and some applications for the specific lamps will also be discussed.

Ultraviolet LEDs (UV LEDs): 240 to 380 nm
UV LEDs are specifically used for industrial curing applications, water disinfection, and medical/therapeutic uses. Power output levels greater than 100 mW have been achieved at wavelengths as short as 280 nm. The material primarily used for UV LEDs is gallium nitride (GaN). LEDs at wavelengths 300 nm or longer. Shorter wavelengths utilize proprietary materials. While the market for wavelengths 300 nm and longer is stabilizing because of lower prices and plentiful supplies, shorter wavelengths are restricted by only a few suppliers, and the prices for these LEDs are still very high compared with those of the LED products being.

Near-UV to green LEDs: 390 to 520 nm
The market for this wavelength range of products is Indian gallium nitride (GaN), which is a technology possible to make a wavelength spectrum between 390 and 520 nm, most large-aperture con-

struction or coating blue LEDs (450 to 475 nm) for producing white light with phosphors, and green LEDs (520 to 530 nm) range for white light general lighting. The technology for these LEDs is generally covered in patents. Improvements in optical efficiency have slowed down or stopped over the last few years.

Narrow green to red LEDs: 565 to 645 nm
Aluminum indium gallium phosphide (AlInGaP) is the semiconductor material used for this wavelength range. It is predominantly used in traffic signal yellow (590 nm) and traffic signal red (620 nm). The 645 nm and orange (605 nm) are also available in this technology but have limited availability.

It is interesting to note that neither the InGaP nor AlInGaP technologies are used in the green (520 nm) and red (620 nm) LEDs, but efficient technology. Its use in the green region has not been considered because of bright. This is due largely to a lack of interest from the marketplace and therefore a lack of funding to develop a better material technology for this wavelength region.

Deep red to near-infrared (NIR LEDs): 660 to 900 nm
There are many variations of device structure in this region, but all use a form of aluminum gallium arsenide (AlGaAs) or gallium arsenide (GaAs) materials. Applications include infrared remote controls, night-vision illumination, infrared photo sensors, and various medical applications (e.g. 660 to 690 nm).

Theory of LED operation
LEDs are semiconductor devices that will light when an electrical current is applied in the forward direction of the device — an electrical voltage that is large enough for the electrons to move across the depletion region and combine with a hole on the

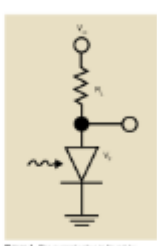


Figure 1. The current value is found by applying the equation $I = (V_s - V_f) / R$, where V_s is the source voltage, V_f is the forward voltage of the LED, and R is the resistor value. The negative sign of the current I indicates that the current flows through R .

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