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## Light Emitting Diodes

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## Light Emitting Diodes

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### Abstract

Inorganic semiconductor light-emitting diodes (LEDs) are environmentally benign and have already found widespread use as indicator lights, large-area displays, and signage applications. In addition, LEDs are very promising candidates for future energy-saving light sources suitable for office and home lighting applications. Today, the entire visible spectrum can be covered by light-emitting semiconductors: AlGaInP and AlGaInN compound semiconductors are capable of emission in the red to yellow wavelength range and ultraviolet (uv) to green wavelength range, respectively. Currently, two basic approaches exist for white light sources: The combination of one or more phosphorescent materials with a semiconductor LED and the use of multiple LEDs emitting at complementary wavelengths. Both approaches are suitable for high efficiency sources that have the potential to replace incandescent and fluorescent lights. In this article, the properties of inorganic LEDs will be presented, including emission spectra, electrical characteristics, and current-flow patterns. Structures providing high internal quantum efficiency, namely, heterostructures and multiple quantum well structures, will be discussed. Advanced techniques enhancing the external quantum efficiency will be reviewed, including resonant-cavities, die shaping (chip shaping), omnidirectional reflectors, and photonic crystals. Different approaches to white LEDs will be presented and figures-of-merit such as the color rendering index,

luminous efficacy, and luminous efficiency will be explained. Finally, the packaging of low power and high power LED dies will be discussed.

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