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Novel approaches for energy efficient solid state lighting by RGB organic light emitting diodes – A review

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ABSTRACT

This paper emphasizes on the novel approaches for energy efficient and eco-friendly solid state lighting. Limitations and global haphazards of currently used lighting systems such as Incandescent lamps, compact fluorescent lamps can be overcome by replacing the present lighting system by green technology called solid state lighting, which is possible only with organic light emitting diodes (OLEDs) and polymer light emitting diodes (PLEDs). This paper also explains important characterization techniques used to evaluate the performance, efficiency, life time; colour rendering index (CRI), Internationale de l'Eclairage (CIE) coordinates and correlated color temperature (CCT) of OLEDs. Review of literature on red, blue, green (RBG) light emitting materials and OLED devices is illustrated since the very first synthesized complex and a range of device architectures are presented and appraised. Measures to increase the efficiency and the life time of OLEDs and handling the degradation issues of the organic materials for OLEDs are also discussed. With these measures if we succeed in improving the efficiency, performance and life time, the present lighting system can be replaced by eco-friendly, energy efficient green technology called Solid state lighting, which would play a significant role in reducing global energy consumption.

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1. Introduction

Solid state lighting is the alternative lighting achieved by an eco-friendly, energy efficient, new green technology, where illumination is obtained through semiconductor devices like light-emitting diodes (LEDs), organic light-emitting diodes (OLEDs) or light-emitting polymers (LEPs). It has the potential to par exceed the energy efficiencies of incandescent and fluorescent lighting. Cutting-edge research now shows a bright future for solid-state lighting as the next generation of light sources for general illumination, from homes to commercial applications offering low energy consumption and reduced maintenance. Lot of research is going on in developing the eco-friendly materials for emission of light in the required region of visible spectrum and hence this review paper.

2. Back ground of solid state lighting

Lighting technologies are substitutes for sunlight. The history of lighting can be viewed as the development of increasingly efficient technologies for creating visible light in the desired spectral region. The traditional technologies developed so far include incandescence and fluorescence. These technologies have all made significant progress over the past 200 years, but appear to be saturating at efficiencies in the 1–25% range. The newly developed technology called solid-state lighting (SSL), has the potential to reduce lighting energy usage by nearly one half and contribute significantly to our nation's climate change solutions. Novel research is carried out by many researches globally to stimulate the development of the science and technology foundation necessary to enable the promise and potential of solid-state lighting. In practice, there are many challenges at every step of the way and efficiently creating white light from semiconductor materials with band-gaps that span the visible spectrum is extremely challenging. Currently used lighting systems are briefly discussed below.

2.1. Incandescent lamps

Incandescent lamps are generally tungsten filament lamps, which contain vacuum. As filament fracture is the normal end of lamp life it would not be convenient for sub circuits fuses to fail. Tungsten-halogen is a type of incandescent lamp, with tungsten filament just like a regular incandescent lamp; however the bulb is filled with halogen gas. They produce a whiter, more intense light than standard incandescent lamps and are typically used for decorative, display purposes. They are about twice as efficient as regular incandescent lamps and last two to four times longer than most incandescent lamps. Incandescent lamps have relatively short lives (1000–2000 h of use). In fact, only about 15% of the energy they use comes out as light and the rest is released in the form of heat. Incandescent lamps are the least expensive to buy but the most expensive to operate.

2.2. Fluorescent lamps

Fluorescent lamps have emerged as a potent alternative of incandescent bulb because of low power consumption and poor life time. The fluorescent tube has a low pressure of mercury vapor and emits a small amount of blue/green radiation, but the majority is in