Investigation of a Cylindrical White LED Package with Remote Phosphor Concept

by

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ABSTRACT

Luminous efficacy of white LEDs keeps increasing, which makes white LED a promising next-generation light source for general lighting. Lighting customers tend to prefer new light sources that look like widely accepted traditional light sources, such as incandescent lamps and linear fluorescent lamps. Presently, there are many LED light sources that mimic traditional incandescent lamp; however, there are not many cylindrical-shaped LED sources, even though linear fluorescent lamp is one of the most widely used light sources. Therefore, it is valuable to develop a white LED source with a similar shape to fluorescent lamps, with high luminous efficacy and long lifetime. The objective of this thesis is to investigate cylindrical shaped white LEDs with remote phosphor coating.

When the phosphor layer is mixed with a medium such as epoxy, and the mixture is coated in a cylindrical light guide, the light extraction efficiency may change when the light guide has different configurations and the media surrounding the phosphor layer have different refractive indices. Previous studies explored the optical properties of a single planar phosphor plate, but little study has been done on the effect of configurations and surrounding media. Effect of configurations of optics can be accurately simulated by ray tracing software. However, ray tracing study of light scattering by the phosphor needs many input parameters and needs experimental verification. This study developed two experiments to help understand the emission and scattering phenomenon that occurs within the phosphor layer surrounded by different media. Experimental results showed that far-field intensity distributions of both backward-scattered light and forward-scattered light were Lambertian when the phosphor plate was surrounded by air. When the phosphor plate was set into four interface conditions that had different media (either air or PMMA) surrounding, the extraction efficiency changed, and the ratio of radiant power between backward-scattered light and forward-scattered light also changed. A ray tracing simulation with calibrated parameter settings validate the experimental results. Cylindrical light guides coated with remote phosphor layer were studied by the ray tracing model, and the results showed that the configuration of the light guide will change the overall efficiency.