Application of Lasers in Phosphor Material Development for Solid-state Lighting

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Abstract

Nearly all current solid-state lighting (SSL) systems used for general illumination are based on the phosphor converted LED (pcLED) architecture, which offers a practical and mass producible structure for white light generation. Laser-based SSL devices do exist in limited applications such as select automobile headlights and in some image projection devices utilizing laser-based Digital Light Processors (DLPs). This study will present recent work on how RGB lasers and SSL emitters were combined with selected phosphor materials to produce novel infrared (IR) optical sources and imaging devices. For example, by combining a high power (10W) blue 445nm laser with a ceramic phosphor, it was possible to produce a source with optical emission in the near-infrared (NIR 700-900nm), as well as continuous thermal emission extending from the short-wave infrared (SWIR 0.9-1.7μm), to the mid-wave infrared (MWIR) and even past the 14μm range of the long-wave IR (LWIR). A holographic IR display prototype was built and demonstrated by down-converting RGB into IR using phosphors. In addition, it will be shown how lasers can be used in the development, analysis, and optimization of phosphors. Using lasers as excitation sources instead of conventional LEDs, it is possible to perform accurate and high-power density lifetime measurements on the phosphor converters by de-coupling the optical material aging from the polymer encapsulant (epoxy/silicone) degradation typically observed in high power SSL devices. Unlike an LED light, a laser beam can be easily focused into a 200-300 μm spot from a distance away from the sample under test, which helps in directly monitoring the optical output and operating temperature of the down-converter independently of the excitation source itself. Using such an approach, several different types of LED phosphor materials can be monitored and compared simultaneously for thousands of hours.

Biography

Dr. Menkara has a PhD in Physics from Georgia Tech and is one of the original founders of PhosphorTech Corporation and currently serving as its CEO. He has both technical and business backgrounds and has been involved in the basic development and commercialization of virtually all of the current product lines & services offered by PhosphorTech. He has over 20 years of experience in semiconductors, photonics/photodetectors, light-emitting devices, and phosphor technologies for light energy capture and conversion. He has developed and patented several novel materials, processes, and devices for energy-efficient lighting and material analysis. He has successfully managed and co-managed multi-million-dollar projects and, in the process, transformed basic scientific concepts and feasibility studies on new materials and structures into actual commercial products. For the past 10 years, he has been additionally involved in the area of nanotechnology and specifically functional nano-materials for light harvesting and energy conversion.