

MAR06-2005-000114

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Materials challenges for solid-state lighting

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The use of highly efficient semiconductor light-emitting diodes (LEDs) suitable for illumination applications will enable huge energy savings and have a very positive effect on the environment. This talk will discuss materials challenges in solid-state lighting, including a new class of materials, low-refractive-index materials, with refractive indices much lower than conventional materials. Arrays of SiO₂ nanorods are shown to have unprecedented low refractive indices (< 1.10) yet viable thin-film properties. Their use for omni-directional reflectors and the resulting improvement in LED light-extraction efficiency will be discussed. We will show that optimized phosphor distributions in white LED lamps, particularly remote-phosphor distributions, combined with diffuse reflectors, strongly enhance luminous efficiency. Finally, we will discuss materials issues that limit the efficiency of ultraviolet (UV) light emitters.