Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Promises and challenges in solid-state lighting

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Lighting technologies based on semiconductor light-emitting diodes (LEDs) offer unprecedented promises that include three major benefits: (i) Gigantic energy savings enabled by efficient conversion of electrical energy to optical energy; (ii) Substantial positive contributions to sustainability through reduced emissions of global-warming gases, acid-rain gases, and toxic substances such as mercury; and (iii) The creation of new paradigms in lighting driven by the unique controllability of solid-state lighting sources. Due to the powerful nature of these benefits, the transition from conventional lighting sources to solid-state lighting is virtually assured. This presentation will illustrate the new world of lighting and illustrate the pervasive changes to be expected in lighting, displays, communications, and biotechnology. The presentation will also address the formidable challenges that must be addressed to continue the further advancement of solid-state lighting technology. These challenges offer opportunities for research and innovation. Specific challenges include light management, carrier transport, and optical design. We will present some innovative approaches in order to solve known technical challenges faced by solid-state lighting. These approaches include the demonstration and use of new optical thin-film materials with a continuously tunable refractive index. These approaches also include the use of polarization-matched structures that reduce the polarization fields in GaInN LEDs and the hotly debated efficiency droop, that is, the decreasing LED efficiency at high currents.