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Essentials for Successful and Widespread LED Lighting Adoption

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Solid-state lighting (SSL), with light-emitting diodes (LEDs) as the light source, is a growing and essential field, particularly in regard to the heightened need for global energy efficiency. In recent years, SSL has experienced remarkable advances in efficiency, light output magnitude and quality. Thus such diverse applications as signage, message centers, displays, and special lighting are now adopting LEDs, taking 2010's market to $9.1 billion - 68% growth from the previous year! While this is promising, future growth in both display and lighting applications will rely upon unveiling deeper understanding and key innovations in LED lighting science and technologies. In this presentation, some LED lighting fundamentals, engineering challenges and novel solutions will be discussed to address reduction in efficiency (a.k.a. droop) at high currents, and to obtain uniform light distribution for overcoming LEDs' directional nature. The droop phenomenon has been a subject of much controversy in the industry and despite several studies and claims, a widely-accepted explanation still lacks because of counter arguments and experiments. Recently several research studies have identified that the droop behavior in nitride-based LEDs beyond certain current density ranges can only be comprehensively explained if the current leaking beyond the LED active region is included. Although such studies have identified a few useful current leakage mechanisms outside the active region, no one has included current leakage, due to non-ideal, 3-D device structures that create undesirable current distribution inside and outside the active region. This talk will address achieving desirable current distributions from optimized 3-D device structures that should reduce current leakage and hence the droop behavior. In addition to novel LED design solutions for droop reduction and uniform light distribution, the talk will address cost and yield concerns as they pertain to core material scarcity. Such solutions are expected to make LED lights more energy efficient, pleasant in appearance, longer-lasting, affordable, and thus suitable for green living.