# Beyond Sunlight: Solid State Lighting

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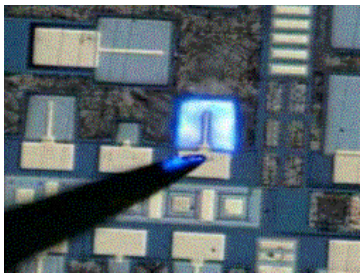
The creation of efficient sources of white light is the ultimate goal of the solid-state lighting technology. [1] The efficiency of white LEDs using conversion of blue or UV light in ionic phosphors has already reached 250 lm/W. [2] This efficiency is almost 20 times higher that that of an incandescent lamp (13 lm/W), nearly 3 times higher than that of a fluorescent lamp (90 lm/W), and almost double that for a high pressure sodium lamp (132 lm/W),

Multicolor LED modules producing white light could achieve even higher efficiency, and optimization of such multi color LED modules is one of the most important problems of the emerging solid-state lighting technology. Solving this problem has allowed us to design and build Versatile Solid State Lamps with adjustable spectrum used for treating seasonal affective disorder[3], growing plants[4], and evaluating color rendering[5]. Such solid-state lamps that maintain constant user-selected spectrum via computer control will also find many other special and medical applications.

In spite of a tremendous progress in lighting technology, the method of assessment of color rendering properties of white light underwent only minor improvements since its introduction in 1965. We propose a new approach based on color rendition vectors of 1269 test samples of the Munsell palette. We sort the rendered colors into different groups—colors rendered with high fidelity, colors rendered with increased saturation, and those rendered with distorted hue—and introduce corresponding indices (in combination with the correlated color temperature) to assess the color quality of light sources. We show that this new metric resolves the paradox of high visual ranking of colored-LED clusters, which have low color-fidelity properties but make the majority of colors to appear as more saturated.[6]



Blue LED on Si (courtesy of SET, Inc.)

Replica of Edison bulb (1879)


Versatile solid state lamp (From [1])

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[1] A. Žukauskas, M. S. Shur, and R. Gaska, Introduction to Solid State Lighting, John Wiley and Sons, 2002, ISBN: 0471215740

[2] http://www.cree.com/news-and-events/cree-news/press-releases/2012/april/120412-254-lumen-per-watt

[3] A. Žukauskas, R. Vaicekauskas, F. Ivanauskas, G. Kurilcik, Z. Bliznikas, K. Breive, J. Krupic, A. Rupsys, A. Novickovas, P. Vitta, A. Navickas, V. Raskauskas, M.S. Shur and R. Gaska "Quadrichromatic white solid state lamp with digital feedback" In: Third International Conference on Solid State Lighting, Ed: I.T. Ferguson, N. Narendran, S.P. DenBaars, J.C. Carrano. Proc. SPIE 5157, 185-198 (2004)

[4] G. Tamulaitis, P. Duchovskis, Z. Bliznikas, K. Breivė, R. Ulinskaitė, A. Brazaitytė, A. Novičkovas, A. Žukauskas, and M. S. Shur, High-power LEDs for plant cultivation, SPIE Proceedings, 5530-24, October (2004)

[5] Artūras Žukauskas, Rimantas Vaicekauskas, Pranciškus Vitta, Arūnas Tuzikas, Andrius Petrulis, and Michael Shur, Color rendition engine, Optics Express, Vol. 20 Issue 5, pp.5356-5367 (2012)

[6] A. Žukauskas, R. Vaicekauskas, F. Ivanauskas, H. Vaitkevičius, P. Vitta, and M. Shur, New Statistical Figures of Merit for Color Quality of Solid-State Lamps, ECS Transactions, 19 (12), 13-20 (2009)