SSL Postings
U.S. DEPARTMENT OF ENERGY

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A New Method for Evaluating Color Rendition

The Illuminating Engineering Society (IES) has just published an important technical memorandum, TM-30-15, which outlines a new system for evaluating the color rendition of light sources. It was developed by an IES task group that was formed in 2013 and included representatives from academia, government, manufacturing, and the specification community, and that was chaired by Pacific Northwest National Laboratory's Michael Royer, a member of DOE's solid-state lighting team.

While the International Commission on Illumination's (CIE) Color Rendering Index (CRI) enjoys widespread use, its limitations are well recognized. Despite many past efforts to develop complementary or alternative ways to evaluate color rendition, none has been widely adopted. Yet with the proliferation of SSL — which offers tremendous scope for spectral engineering and optimization — the need for such a method is greater than ever before and is compounded by the continued drive for greater energy efficiency.

Built on the progress made by many other researchers over the past two decades, and synthesizing many of their concepts, the new system employs two separate high-level measures. Both measures employ a set of color evaluation samples that, for the first time, represent real objects uniformly spanning color space and giving equal importance to all visible wavelengths; in combination with modern color calculation procedures, the samples yield more representative and more accurate results. The first measure, R_f, assesses color fidelity and is analogous to CRI's general color rendering index, R_a, but with substantial improvements; the second, R_g, is an improved color gamut measure for assessing the variation in the chroma of illuminated objects. Both measures are based on the new sample set and updated calculation methods and thus can be used together to provide more useful predictions of the color appearance of objects in various lighting situations, and to guide the optimization of future light sources. Calculator tools are included, to ease implementation.

One of the limitations of R_a (often referred to as just CRI) is that it's only a metric for color fidelity and doesn't convey the direction of color shifts, changes in chroma, or information about specific hue regions. It also doesn't measure human preference or color discrimination potential. In addition, R_a's test color samples are low-chroma pastels that are not fully representative of the colors in our environment — being especially unhelpful for predicting the fidelity of saturated reds, which is why CRI often has to be supplemented with the special index R_9. What's more, the CRI's test color samples are more sensitive to some wavelengths than to others, because they're made by combining only a few pigments, whose spectral features are not uniformly distributed across visible wavelengths. As a result, the CRI can be easily "gamed" by selectively optimizing a spectral power distribution in ways that boost CRI without improving average color fidelity.

TM-30-15 addresses many of these limitations, providing more information with greater accuracy. With two main numerical parameters and other visualization tools — such as a color distortion icon — for better understanding the rendition of specific hues, it provides a more complete characterization of color rendition than a fidelity metric alone can. And with a greater number of samples (99) than the CRI, TM-30-15's values are harder to selectively optimize and should provide a better representation of average color rendering.

The new system, which has also been proposed to the CIE, will bring significant progress in quantifying color rendition. The improved accuracy underlying the computations will not only help purchasers and specifiers select products that are more appropriate for their needs, but will also help in designing future light sources that more properly optimize the complex tradeoffs and interactions between efficacy, chromaticity, and color rendition. This, in turn, should lead to greater value per watt of radiation, greater acceptance of energy-saving measures, and, ultimately, improved human wellbeing. But it will require significant effort to achieve widespread adoption.

DOE will host two 90-minute webinars on TM-30-15 next month: one on

September 15 that covers the basics, the development process, and the ongoing steps toward widespread adoption; and a follow-up on September 22 that focuses on the math and color science underlying the calculation engine, the derivation of the new set of 99 color evaluation samples, and why the improvements are important. Both webinars start at 1:00 p.m. EDT. To register or for more information, visit the DOE website.

As always, if you have questions or comments, you can reach us at postings@akoyaonline.com.