HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS

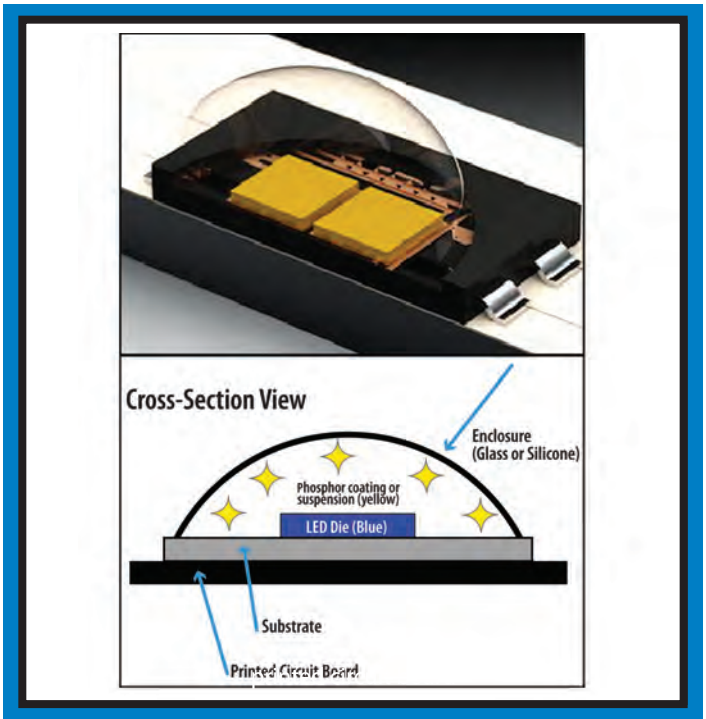
White Paper: Binning and LED

What is Binning with respect to LEDs?

- *What is Binning, and Why is it Necessary?*
- *Color Temperature, Chromaticity*
- *ANSI Binning Standard*

The practice of binning is designed to maximize effective utilization in the production of LEDs. This process is most important for luminaire manufacturers to specify and control since it has serious implications on performance, cost and lead-time. It is also important as a point of general awareness for specifiers and end-use customers so they understand how the manufacturing supply chain is ensuring high quality and consistency – specifically with regard to critical performance attributes such as light output and color. To understand binning, it is helpful to first review the process of LED production.

In the production of LEDs, a single round wafer is coated with various materials (epitaxial growth) to create the semiconductor which forms the heart of the blue LED. This is then sliced into extremely small rectangles (die). Wire bonds (or other electrical connections) are inserted and the phosphor is added either as a coating or suspension within the enclosure. The assembly is then encapsulated to create a finished white light LED package.



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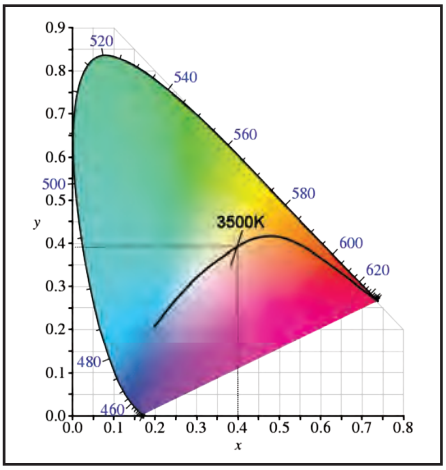
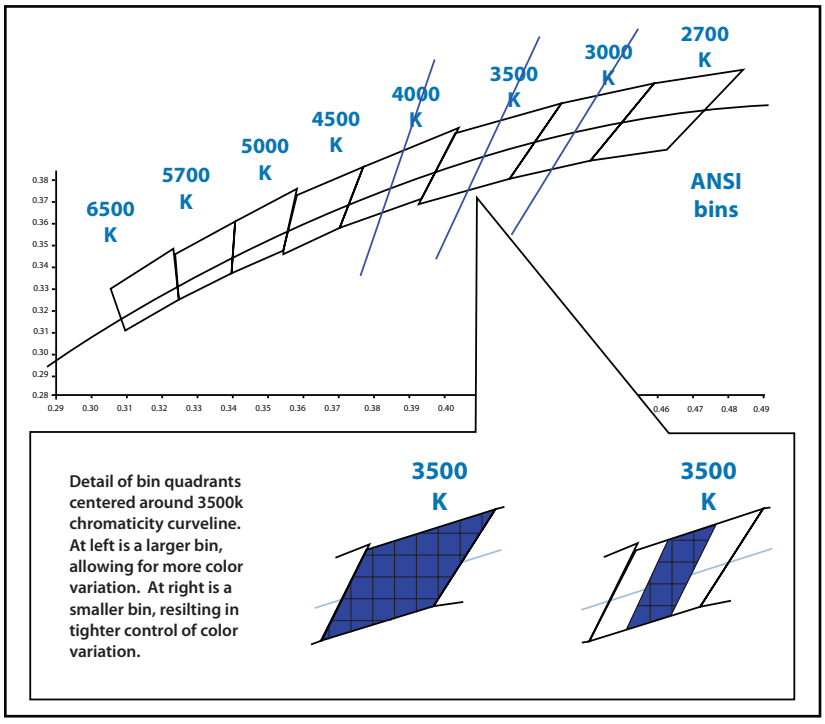
The coating processes (epitaxial growth and phosphors) create significant inherent variations that impact the lumens, color temperature and voltage of the LEDs. Even with all of the R&D efforts underway and the billions of dollars spent within the semiconductor industry to minimize this production variation, the end result is a process that is not capable of producing highly consistent and tightly controlled production of LEDs. So, in an effort to maximize yields (and with a knowledge that the lighting industry has a wide range of needs), LED manufacturers sort their production into lumen, color and sometimes voltage bins. This allows luminaire manufacturers to select only those LEDs that meet their acceptable performance ranges while maximizing the overall usage of each of the bin ranges for the LED supplier.

If a luminaire manufacturer accepts a very wide range of LEDs (in any of the binned criteria), price and lead-time are substantially improved. On the downside, the variability of luminaire performance is substantially increased, creating high probability for negative impact to end-use customers. This point becomes extremely important as we discuss key elements of fixture performance (photometry, energy use, color, etc).



As stated previously, there are several ways LEDs are binned. The most critical bin criteria that impact product performance are light output and color temperature. Binning for light output is a very straightforward linear function. LEDs are individually measured and sorted by lumen output into prescribed ranges. LED suppliers create their own standard set of lumen bins and provide clear information on the expected lumen performance of each of their bin ranges. So, luminaire manufacturers can easily select the bin (or set of bins) that best meets the lumen performance requirements of the fixture. Binning for color temperature is a more complex process. Color temperature bins (below) are defined by (x,y) coordinates on the CIE 1931 Chromaticity Diagram (shown at right).

These bins are grouped as quadrants around the standard chromaticity lines (shown below in blue) for a specified color temperature. The larger the bin size, the more variation around the standard color temperature is accepted. Conversely, smaller bin sizes maintain a tighter control of color variation.



Detail of bin quadrants centered around 3500k chromaticity curveline. At left is a larger bin, allowing for more color variation. At right is a smaller bin, resilting in tighter control of color variation.

In 2008, ANSI and NEMA collaborated to establish a bin standard ANSI C78 377A[1] which has become a minimum requirement for Energy Star® certification. This standard specifies a bin size that approximately correlates with the degree of color variation we experience today with commercial CFL sources. This allows for some degree of perceivable variation in color temperature among white light sources.

For more information about color binning, bin sizes and the ANSI C78 377A, consult: http://www.nema.org/media/pr/20080221a.cfm.

1 Complete and proper name: ANSI NEMA ANSLG C78.377-2008 American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting Products.