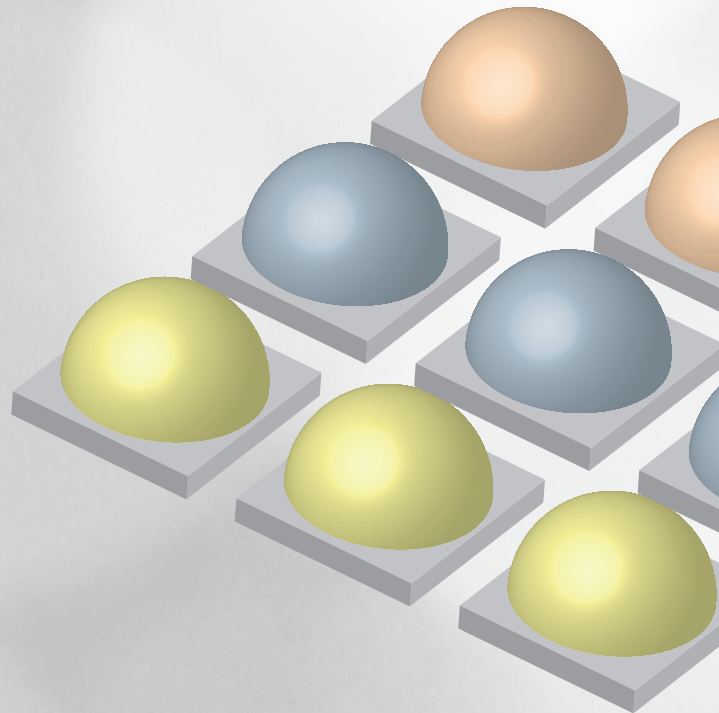
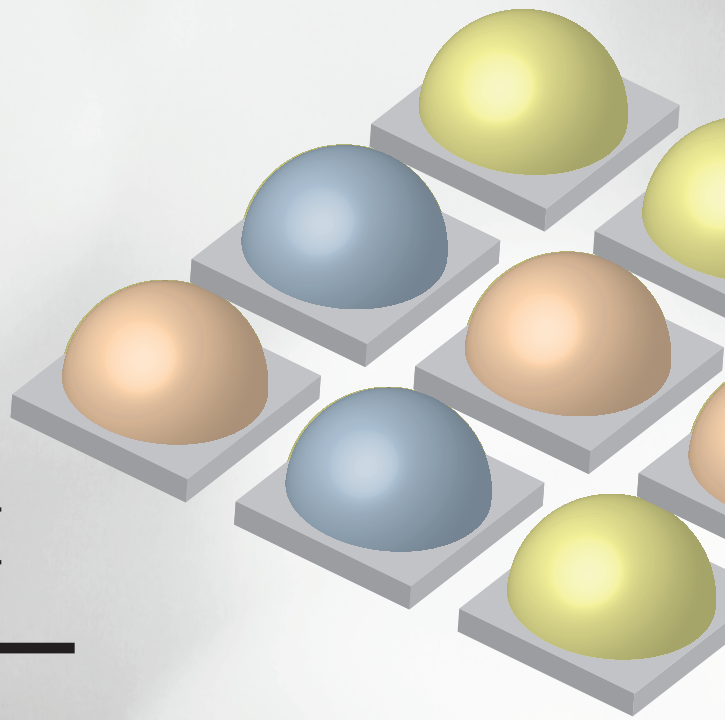




ISOLED KNOWLEDGE



BINNING

ISOLED[®]

CUSTOMISED LIGHT SOLUTIONS



SUSTAINABLE CONSTANT LIGHT QUALITY VIA BINNING

Quality standards for LED lamps

Research and Development is being driven both by customers' needs and desires and by LED technology itself, which is still in its early stages of development. Further to excellent quality, high efficiency and a fair price-performance ratio, these rapid product development primarily pursues the following objectives:

- » better luminous flux
- » better colour reproduction
- » uniform light colours
- » better resistance to ambient temperatures
- » maximum and consistent quality of all product features throughout the designated service life

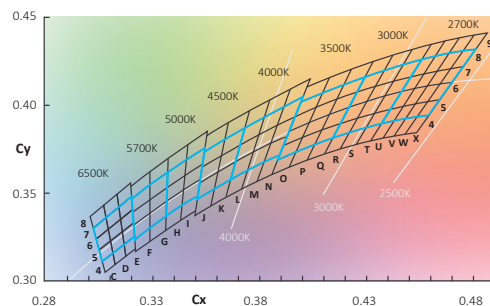
Binning

The industry seeks to produce LED chips with batch-independent, consistent and stable photometric properties, which can be sustainably guaranteed to customers. Customers' product expectations include

- » stable light quality,
- » constant light colour as per specifications
- » continuous delivery of the brightness level defined and
- » reliable forward voltage.

LED chips of each production batch show variations in luminous flux output, colour value and forward voltage. Binning is the process whereby LED manufacturers evaluate individual LED chips and place them in bins or containers.

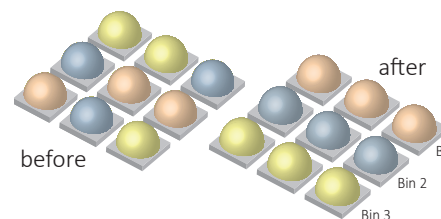
This sorting process categorises LED chips qualitatively so they can be accordingly targeted and specifically tailored to requirements as they are built into LED lights and lamps. This ensures that the photometric performance values of LED lights and lamps are achieved and maintained for the designated service life.



Multi-faceted white

ANSI Cree chart:

The standard colours at ISOLED® include ultra-warm white (2500K), warm white (2700K), warm white (3000K), natural white (4000K), and cool white (5500K)





Voltage binning

LED chips are measured individually and sorted according to their forward voltage (volts).

Flux binning

To ensure a uniform luminous flux, LED chips are classified according to their actual lumen values into bins.

Colour binning

The colour binning process relies on the CIE standard colorimetric system. The International Commission on Illumination (CIE - Commission Internationale de l'éclairage) has defined this standard colorimetric system to connect and describe objectively the physical cause of a color stimulus and the human color perception, as well as to provide a complete graphical representation thereof.

After registration of the color coordinates in the CIE standard colorimetric system (also CIExy Chart), white LED chips are characterised and divided according to their color coordinates and color temperature. On the other hand, color LEDs are categorised on the basis of the spectrum locus and dominant wavelength (peak wavelength).



DIMENSIONS OF MACADAM ELLIPSES	1 SWE	2- 3 SWE	> 4 SWE
Colour homogeneity quality	* Non-perceptible color difference	* Barely perceptible color difference	* Perceptible color difference

* Visible to the human eye, not or barely perceptible color difference

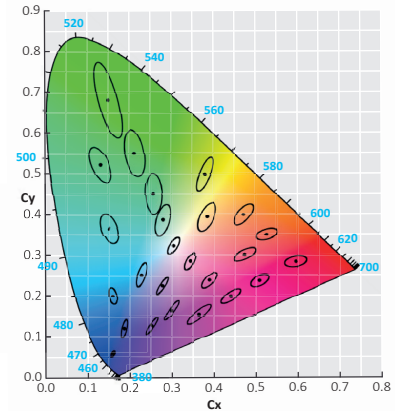
MacAdam ellipses are sized based on SDCM (Standard Deviation of Colour Matching) in threshold units (SWE).

The EU eco-design regulation specifies a colour consistency for manufacturers and commercialisers of LED lights and lamps. Accordingly, the maximum chromaticity deviation coordinates within a MacAdam ellipse shall not exceed six levels (6 SWE).



CIE standard colorimetric system

The MacAdam ellipse indicates the accuracy and tolerance underlying the bin definition. That is to say, the smaller the size of the MacAdam ellipse, the smaller the color difference. The human eye perceives no color differences when the bin for a specific colour lies within a MacAdam ellipse or is congruent in terms of size.



Colour temperature

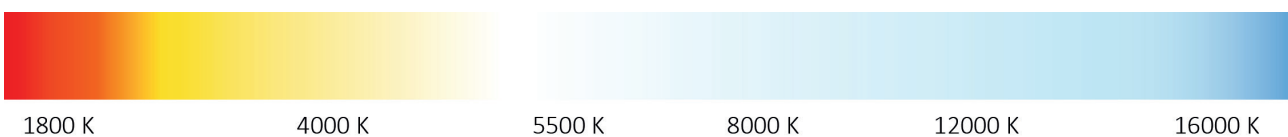
Colour temperature helps determine quantitatively the colour impression of a light source. Colour temperature is the temperature of a black body** belonging to a particular colour of light emanating from the lamp. Upon heating a black body, the light colour changes from dark red to orange and yellow white to blue white.

SI unit*: Kelvin (K)

CHARACTERISTIC LIGHT COLOURS ACCORDING TO DIN 5035	
LUMINOUS SOURCE	COLOUR TEMPERATURE IN KELVIN
Warm white	< 3.500 K
Neutral white	< 5.300 K
Daylight white (also cool white)	> 5.300 K

* Definition of SI: SI is the International Unit System for physical quantities.

** A black body is a body that absorbs all radiation incident thereon.





SUSTAINABLE CONSTANT LIGHT QUALITY VIA BINNING

Customer Information

The ISOLED® knowledge „Sustainable constant light quality by binning“ describes the need for binning in the production of LED chips and the binning process per se. At ISOLED®, binning constitutes an essential part of product management and quality assurance and is operated, monitored and tested with the utmost care.

- » Compared to the usual market approach, we define the exact x and y coordinates on the CIE diagram (standard colorimetric system) for all our products, thus clearly reducing the commercial bin sizes (exact details are available on request). This ensures high and stable quality of light (brightness, light color etc.).
- » Assuming the corresponding inventory quantity and availability, ISOLED® will attempt to serve each order exclusively from a single batch ID. Thus, we achieve a consistent binning with the outstanding value of 1 SWE (no visible difference in color).
- » Unlike previous batches, following batches lie in the 2- 3 SWE area (hardly perceptible difference in color) due to production technology and economic reasons.

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