

## Light Measurement Glossary of Terms

### General

#### **Barium Sulphate coating**

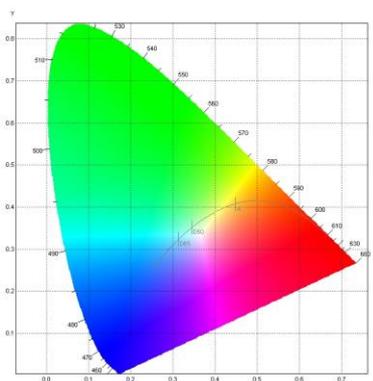
A highly diffuse reflective coating which is generally used to paint the inside of integrating spheres to diffuse all light emitted from a luminaire light source. Barium sulphate coatings reflect 97% of light between 350-850nm (UV-VIS-NIR).

#### **Blackbody**

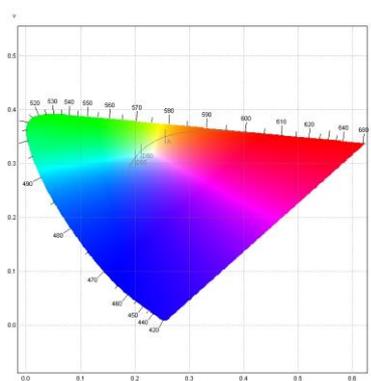
A blackbody is a theoretically 'ideal' physical object that absorbs all electromagnetic radiation, regardless of wavelength. A blackbody in thermal equilibrium emits electromagnetic energy, called blackbody radiation, which is determined by temperature alone and not by the object's shape or material.

#### **CIE Colour space**

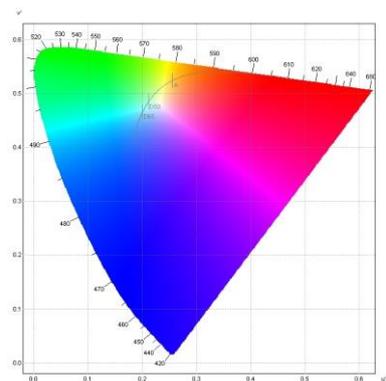
The International Commission of Illumination (CIE) has defined a number of ways to classify colour in terms of a two-dimensional coordinate in a diagram that represents all possible colours and additive combinations of colours. There are different colour spaces defined depending on the observer, including 1931, 1964 and 1976 versions.



CIE 1931



CIE 1964



CIE 1976

#### **Cone cells**

Cells in the human retina which function under bright light/daylight. They are split into 3 types based on their response to different wavelengths of light: blue, green and red. The 3 different cone cells have different sensitivities to light, with the 'green' cones as the most sensitive, therefore photometric measurements are weighted to account for the difference. For example, measurements of lux are biased towards the emission of green light, as we perceive this wavelength more strongly.

#### **Cosine Corrector**

Measuring receptor that gathers light energy from a complete hemi-sphere and eliminates information about the angle of incidence before allowing light to the sensor of the spectroradiometer.

### ***Full-Width-Half-Maximum (FWHM)***

A measure of the resolving power of a spectrometer. For a given response peak, the FWHM is the wavelength range covered at half the peak value i.e. the broader the peak, the wider the FWHM. This is important when measuring light sources with multiple narrow peak outputs (like an LED), as it allows you to distinguish well between them.

### ***Incandescent***

A physical property of a material which emits light as a result of being heated, for example a traditional light bulb.

### ***Integrating Sphere***

A hollow sphere, coated on the inside with a diffuse white coating, with apertures to allow access for instrumentation and luminaires. Used to accurately measure luminous flux and radiant power of light source with a spectroradiometer by diffusely scattering total light output before reaching the spectrometer.

### ***Halogen Lamp***

A lamp which incorporates a tungsten filament surrounded by some inert halogen gas, allowing greater current through the filament and a much brighter incandescent light source. Emits a broad range of wavelengths, from a low amount of emitted short wavelength (blue) light with increasing power per wavelength up to a high amount of emitted long wavelength (red) light.

### ***LED***

Light emitting diode; doped semi-conductor components that emit light when current is passed through them. Coloured LEDs are created through specific combinations of materials and doping elements. LEDs emit light with characteristic emission peaks, as opposed to broadband incandescent emitters like halogen bulbs. The colour of an LED depends on where these emission peaks lie along the spectrum of blue to red. White LEDs are created by combining a blue/UV LED and a broadband-emitting phosphor coating.

### ***Luminous efficacy***

The ratio of luminous flux to electrical power input (lm/W), a measure of how effective a light source is at converting electrical energy to light energy.

### ***Lux meter***

A device that measures perceived brightness in lux (measure of illuminance). Often use 3 photodiodes with red, green and blue filters in front of each, plus a 'weighting' correction applied to account for the human eye's differing sensitivity to various wavelengths of light. They are not radiometrically calibrated, and so are not suitable for accurately measuring non-broadband light sources like LEDs and fluorescent bulbs.

### ***Photometry***

Measurement of light in terms of human perception, as opposed to radiometric values that are absolute physical measurements.

### ***Planckian locus***

The colour coordinate path on the CIE 1931 colour space that an incandescent blackbody radiator would take as its temperature is increased.

### ***Reflectance***

The ratio of reflected light to incident light. Mathematically identical to transmission, and often expressed as %R.

### ***Spectral Range***

A defined wavelength range of the electromagnetic spectrum.

### ***Spectral Resolution***

The value used to describe how good a device is at distinguishing peaks in a spectrum. A device with poor resolution will give broad, uncharacterised peaks. Whereas a device with high resolution will give sharper, more distinguished peaks.

### ***Spectroradiometry***

Measurement of light in terms of absolute physical values, as opposed to photometric values that take account of human visual perception.

### ***Transmission***

The ratio of transmitted light through a surface to incident light on the surface. Transmittance of a sample is defined as  $T = (I_T/I_0)$ . Often expressed as %T.

## **Photometric Measurements**

### ***Candela (cd)***

The SI unit of luminous intensity, a photometric measurement of the perceived brightness of a light source. One candela equals one lumen per steradian or, more precisely defined, is the light intensity in a given direction of a monochromatic light source emitting 1/683 Watts at a wavelength of 555nm (green). A candle emits roughly 1 candela of light in all directions.

### ***Chromaticity Co-ordinates (x,y) (u,v) (u',v')***

Co-ordinate values that characterise the colour of a light source in reference to the CIE colour space diagrams. The (x,y), (u,v) and (u',v') co-ordinates refer to the 1931, 1960 and 1976 colour space diagrams respectively.

### ***Colour Rendering Index (CRI)***

Grades how effective a light source is at accurately representing an object's colour to the human eye. Divided into 14 indices to score the light source for various colours across the visible spectrum. The colour rendering index average (Ra) is the average value of the first 8 CRI indices.

***Colour Temperature***

Value used to describe the exact position of an incandescent light source on the Planckian locus. The colour temperature of a light source is the equivalent temperature of an ideal blackbody radiator that would radiate light of the same colour as the light source.

***Correlated Colour Temperature (K)***

As LED's do not follow the incandescent Planckian locus, a correlated colour temperature value is used to describe the point on the Planckian locus that the LED light source is perceived to have the closest match to.

***Illuminance (lux)***

The luminous flux incident on a surface per area, measured in lux (lx), measuring the perceived brightness of a light source at a particular surface. One lux equals one lumen per square meter, analogous to the radiometric measurement irradiance ( $W/m^2$ ).

***Luminance ( $cd/m^2$ )***

A photometric measure of the perceived brightness of a surface by emission, transmission or reflection of light. Measured in candelas per square meter ( $cd/m^2$ ),  $1cd/m^2$  equals 1 lumen per steradian per square meter. Analogous to the radiometric value of radiance ( $W/sr/m^2$ ).

***Luminous flux (lumens)***

A photometric measurement of the total amount of light emitted in all directions by a light source, measured in lumens (lm). Analogous to the radiometric measurement of total power output in Watts, but weighted towards human perception of light.

***Metamerism Indices ( $Mi_{vis}$   $Mi_{uv}$ )***

Measurements that are used to describe how different the colour between pairs of identically coloured objects is perceived to be when the type of lighting is changed. Used when trying to simulate daylight, which should theoretically have metamerism indices of 0.

***Tristimulus Values (X,Y,Z)***

Developed by the International Commission of Illumination (CIE) as a numerical description of light perception. Analogous the level of stimulus from the short wave (blue), medium wave (green) and long wave (red) cone cells of the human eye.

## **Radiometric Measurements**

***Dominant wavelength***

The wavelength of light where the intensity of a light source is highest.

***Irradiance ( $W/m^2$ )***

Measurement of the power of electromagnetic radiation incident on a surface per unit area. Analogous to the photometric measurement of illuminance (lux). When a full irradiant spectral power distribution is available, the exact illuminance (lux) value can be calculated.

## ***Radiance (W/sr/m<sup>2</sup>)***

A measure of the brightness of a surface by emission, transmission or reflection of light in terms of electromagnetic power per solid angle per unit area (W/sr/m<sup>2</sup>). Analogous to the photometric value of luminance (cd/m<sup>2</sup>).

## ***Radiant Power (W)***

Measurement of the total amount of radiation emitted in all directions by a light source. Analogous to the photometric measurement of luminous flux (lumens).