Alfred Eichler
Colour Management

COLOUR MEASUREMENT:

DIFFERENT MEASUREMENT GEOMETRIES

Today the spectral process is a very popular method to identify colour differences and determine colour references. In this process the ink surface is measured using an appropriate meter, the spectrophotometer. The method applied here is reflection measurement* within the spectral range of the visible light, that means between 400 and 700 nm. The degree of reflection of the light emerging from a defined source of light from the printed surface is measured in small intervals of 10 nm.

**Another possibility would be transmission measurements. These will not be discussed here.*

In simple words a 100% reflection will be an absolute white and 0% absolute black. The individual measurement values (taken in 10 nm intervals) result in a spectral curve or reflection curve, which serves as a "fingerprint" for the colour.

All reflection measurements of colours are best referred to the mat white surface, which reflects the radiation independently from the angle with a reflection degree $\phi = 1$. As this perfect white standard cannot be achieved for technical reasons an actual standard value has to be determined (normal reflection) for colour measurements (calibration standard; e.g. barium sulphate).

The reflection curve is the base for calculation of colour parameters like standard colour values (X,Y,Z) and the CIELAB-values, which can be calculated from these values.

Decisions should not be made based on reflection curves alone. It is necessary to define all conditions of light and perception) during the determination of spectral data. These conditions are described by the measuring geometry, i.e. type of spectrophotometer.

- **Sphere measurement**
(scattered lighting and direct view)
- **Angle measurement**
(direct lighting and view; fixed angles)

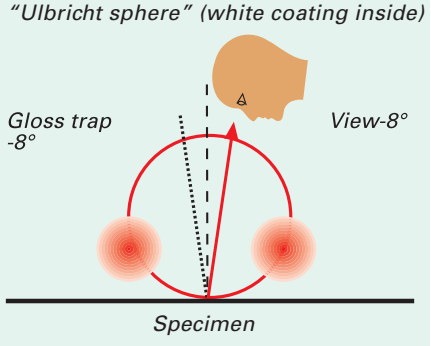
The type of measuring geometry to be used depends on the application. Both geometries have certain advantages in their specific field of application.

Sphere measurement d/8°

Sphere measurement meters measure the light reflected in one direction from the specimen, which is subjected to scattered lighting. Measurement is carried out with an 8° vertical angle. The advantage is the possibility to attach a so-called gloss trap to a further opening of the sphere, which avoids lighting of the specimen under 8° thus eliminating the need to measure the gloss. However, measurement with gloss trap is only useful if the specimen show high gloss.

When carrying out measurements with this sphere geometry the surface structure of the specimen is not that important, i.e. measurement values only change to a minor extent when measuring specimen with different surface structures (e.g. textiles, rough plastics etc.).

D/8° = scattered lighting/ direct view at 8°



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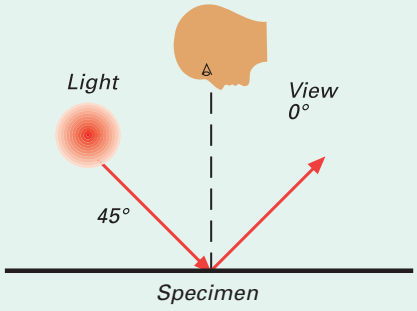
Angle Measurement 45°/0° (0°/45°)

The specimen is directly lit at 45° and the angle measurement meters measures the light reflected in one direction from the specimen at a 0° angle (Also possible vice versa!)

Angle measurement does not consider gloss and there is a better match with the visual impression of the human eye. This can be compared to changing the view angle to avoid disturbing reflections when reading a high gloss magazine in direct sunlight. Contrary to sphere measurement this direct measurement will show the "real" visual difference between a mat and glossy colour specimen (e.g. mat colour swatch <-> glossy screen ink).

45°/0° = direct lightning below 45° / view at 0°



Sphere meters try to imitate this using a gloss trap, however not with the same effective result.

Angle geometry is especially suitable for smooth or only slightly structured surfaces.

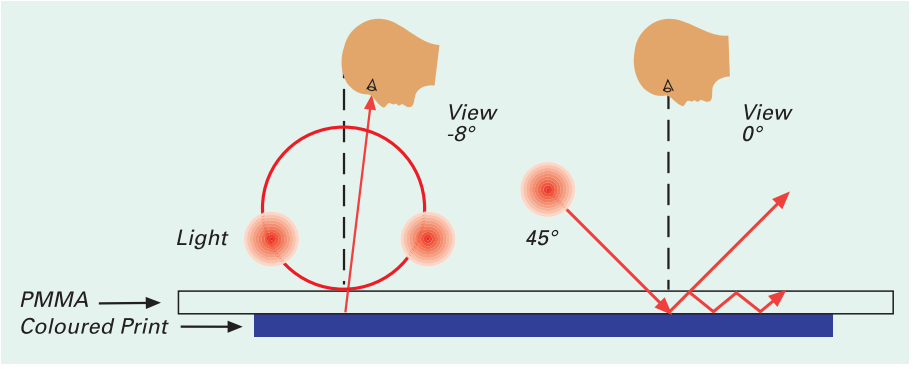
When checking measurement quality of individual spectrophotometers in reference to accuracy in repeated use there are generally no disadvantages or advantages of one of these measuring geometries. The main criterion for the choice of measurement geometry is the field of application.

There is a great variety of applications of special colours of screen and pad printing inks for any type of substrate. Prints have to correspond to the requirements given by the designer and show best possible visual correspondence to the colour swatch. In that case angle measurement 45°/0° (or 0°/45°) is the most suitable method.

Visual colour differences due to gloss differences (mainly with dark shades) can best be measured using angle meters. Sphere meters only have a limited consideration of these differences. In addition spectrophotometers with angle geometry are quite small.

The advantage of sphere meters is measuring of colour swatches with rough surfaces like textiles or rough plastics. Not direct, scattered lighting avoids surface scattering due to material as well as inner reflection. Angle geometry on the other hand has an undesired incalculable "loss of light" because of the direct lighting.

This advantage is of special importance when the print is viewed through the material like key foils or front panels of white goods.



When carrying out angle measurement of a colour print there is an inner reflection due to the material. The "lost" not directly reflected light is interpreted as "black" and therefore the colour swatch seems darker as it really is.

Measurement	*Angle Measurement 45°/0° (0°/45°)*	*Sphere Measurement D/8°*
Application	*Smooth, slightly structured surfaces (e.g. self-adhesive foils etc.) printing industry*	*Highly structured surfaces, e.g. textiles, rough plastics, overlays, printing behind glass*

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SPECTROPHOTOMETER C-MIX COMP LINE

For some years now we have been offering spectrophotometers and densitometers of X-Rite. The portable angle meter eXact (45°/0° ring lens, circular light) is compact, has small measuring diaphragms and is easy to operate by Touch Screen.

For angle measurement we recommend portable X-RITE SP62 or the newer Ci6x.

Spectrophotometer X-RITE SP 62 with angle measurement d/8°

Shock and temperature proof construction
Scattered lighting with Wolfram halogen lamp
Measuring diaphragms of 4mm, 8mm or 14mm
Large, easy to read colour display
Simultaneous measurement of specimen with and without gloss
Spectral scope of measurement 400nm - 700nm
Spectral measurement in 10nm intervals
Spectral data output in 10 nm intervals
Photometric measurement scope 0-200%
1024 reference colour memory
2000 colour measurements memory
Standard light types: C, D50, D65, D75, A, F2, F7, F11, F12
Colorimetric functions, opacity, colour strength
Foldable measuring clip
Bi-directional patented data interface
Rechargeable NiMh battery pack
adapter/charger for 230 V, 50 HZ
White and black calibration standards
Operation manual
Transport case

Spectrophotometer X-RITE eXact with angle measurement geometry 45°/0°

Gas-filled Wolfram lamp (light type A) and UV LED
Measuring diaphragms 1,55 mm , 2 mm, 4 mm or 6 mm (not changeable)
M0 (No-Filter) M1 (D50) M2 (UV cut Filter), M3 (Pol Filter)
measurement range 400-700 nm
Spectral measurement in 10nm intervals
Spectral data output in 10 nm intervals
integrated white tile, automatic calibration (calibration tile not necessary)
high resolution colour touch screen
Interface USB 2.0, Bluetooth Class II (optional)
Measurement standard X-RITE Grafic Arts (XRGA) standard
Possibility to increase functions with activation codes
charger
manual
transport box
eXact Manager (software for data back up)
Bluetooth stick (option)
Data Catcher (software for data transfer to PC)

For further information about spectrophotometers, colour matching and colour measurement please contact our colorimetric department.