Accurate measurement of glass colour

Henning Katte describes a recently developed workflow-based software for colour measurement, with special features for the glass industry.

Colour can be of decisive significance for the marketing success of a product. Especially when using natural or recycled raw materials with fluctuating chemical compositions, colour can vary strongly, for example in the production of glass packaging. Continuous and objective control of the colour effect is therefore an essential precondition for unchanging and reproducible quality.

COLOUR MEASUREMENT

Colour is not a physical characteristic of materials but a sensory perception that is strongly dependent on environmental conditions (especially on lighting) and the observer (human). It is perceived, so to speak, in the eye of the beholder. For objective determination of colour values, the spectral sensitivity of the human eye for the three primary colours red, green and blue (there is a corresponding number of sensory cell types in the retina) was determined by empirical experiments in the 1930s and the CIE Color Space was published by the International Commission on Illumination. To this day, these so-called colour matching functions have been the basis for colour determination according to ISO 11664 and other standards.

For the calculation of colour values, a suitable spectrophotometer (for example Shimadzu’s UV-1800) is used to record a transmission or a reflection spectrum (depending on the application) in the visible range of the electromagnetic spectrum (380nm to 780nm). This spectrum is subsequently weighted against a standardised light source (D65 for daylight or A for incandescent light) in order to take into account the influence of the illumination. Subsequently, the spectrum is successively weighted against the three CIE colour matching functions to determine the red component (X), the green component (Y) and the blue component (Z) of the spectrum. Using these three values, any colour can be unequivocally characterised.

In practice, however, the tristimulus values X, Y and Z are usually not applied directly. Instead the CIELAB system, in which colour perception is specified by the three values L* (brightness), a* (red-green ratio) and b* (blue-yellow ratio) has become established. These values, however, are mathematically derived from the tristimulus values X, Y and Z so that the information content is the same. Alternatively, the CIExy system, in which colour perception is expressed by three values DWL (dominant wavelength), S (saturation) and A (brightness) is still applied in many industrial sectors. But these values are also based on the tristimulus values X, Y and Z.

INDUSTRIAL PRACTICE

In industrial production processes, colour is usually determined at random on the basis of representative samples. Colour measurement is often carried out in an on-site laboratory but more frequently, colour determination is moving closer to the production line, in order to be able to react faster in the case of colour deviations.

Personnel that has been specially trained for this task is often unavailable at the production line, whereby the demands on the software significantly increase. The software must be easy to use, fast to operate and must be able to rule out operating errors as effectively as possible. In order to recognise trends quickly and to be able to immediately intervene, statistical evaluation in the form of quality control charts is indispensable. Therefore, the data should be automatically transferred to an on-site data acquisition system.

Figure 1: All measurement parameters necessary for measurement are summarised in methods.

Figure 2: During measurement, the corrected spectrum is displayed in addition to the raw data.

Figure 3: In the analysis mode, all results are numerically and graphically displayed in an organised manner.

Figure 4: All measurement results are archived in an integrated database.
Ideally, the software itself features an integrated database and corresponding evaluation options.

**MEASUREMENT WORKFLOW**

Chroma software was developed to fulfill the above requirements in routine analysis. The principal feature of the software is the clearly structured user interface that is tailored to the workflow and user roles. All required measuring parameters for the measurement are summarised in so-called methods (figure 1). Prior to measurement, only the missing sample parameters must be added, for example the sample thickness for transmission measurements. The transformations defined in the method, such as conversion to a fixed standard thickness, are already taken into account during the measurement and the corrected spectrum is displayed in addition to the raw spectrum (figure 2). After data storage, the user is automatically directed to the analysis mode, in which all results are expressed in terms of numbers and graphs (figure 3). Here, the possibility exists to print the results or to export them to other programmes for additional processing. Furthermore, certain parameters can be modified later on in the analysis mode, without affecting the results that are already stored in the database.

All measurement results in the Chroma software are archived in an integrated database and can be retrieved and evaluated at any time. To organise the measurements, it is possible to define any attribute according to which it can be filtered in the archive (figure 4). Alternatively to display in tabular format, the data can also be graphically displayed in the form of trend diagrams (figure 5). This way, it is possible to easily recognise trends in the development of certain colour values and to take suitable measures.

**SUMMARY**

Using the Chroma software package and a PC-controlled spectrophotometer, spectral characteristics of glasses and other materials can be accurately determined and colour values can be calculated and graphically displayed. The software combines measurement and evaluation with a powerful database in which all results are stored in a structured manner. Chroma fulfills the requirements in routine analysis and quality control and meets the highest demands in research and development through its flexible evaluation options and statistical functions. The software is always intuitive, simple and reliable to use.

**ABOUT THE AUTHOR:**
Henning Katte is Managing Director at ilis

**FURTHER INFORMATION:**
ilis gmbh, Erlangen, Germany
tel: +49 9131 9747790
e-mail: info@ilis.de
web: www.ilis.de

Figure 5: The trend view shows the development over time of a selected colour value.