CHARACTERIZATION OF THE SPECIFIC MATERIAL SURFACE PROPERTIES

Aim of the work:

Determine the color, gloss and contact angle of the selected materials. Understand to the effect and principle of the artificial ageing of materials and to its effect to the optical properties and wettability of the materials.

Theory:

Gloss measurement

Gloss can be defined as the ratio between the intensity of the incident radiation and the reflected radiation. The incident light from the subject is reflected in one direction if the material is glossy. Gloss measurement is based on measuring the intensity of the reflected radiation along different geometries (geometry is adjustable to values of 20 °, 60 ° and 85 ° for the most handheld glossmeters), see Figure 1. Gloss is expressed in gloss units (GU). GU value of 100 corresponds to the standard of shiny black glass with a refractive index of 1.567. GU values therefore are not in percentages of the total reflected light. For a highly reflective material having a higher refractive index than the glass standard can be measured GU up to 2000.

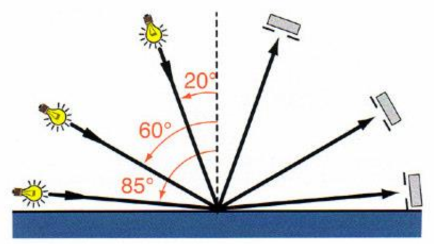


Fig. 1

It is recommended to use the geometry of 60 ° for normal use, which should provide a gloss value of 10 to 70 GU. When it exceeds 70 GU, it is recommended to use the geometry of 20 °, and vice versa in the case of opaque surfaces with gloss lower than 10 GU is suitable geometry of 85 °.

Color measurement

To describe the colors we can use three parameters that define it. It is a hue, saturation and brightness. Hue (color tone) is a color comparison to some of the spectral colors (blue, green, yellow and red). Saturation or purity of the color also reflects the relative proportion of the light intensity in the spectrum to the total intensity. The largest cleanliness have a monochrome colors (ie. those whose radiation is caused by only one radiation wavelength) . Brightness indicates the amount of light reflected by the sample.

Since the color coordinates three parameters, the color can be described as a point in color space. In practice, the most widely used color space is CIE L * a * b *, which was designed in 1976 by the

International Commission on Illumination. A rectangular coordinate system indicated in Figure 2 is composed of three axes. Brightness axis L * and two axes: green-red (a *) and blue-yellow (b *).

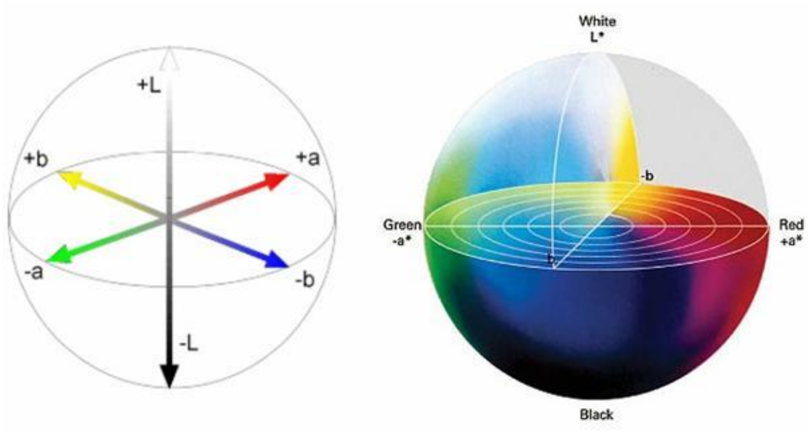
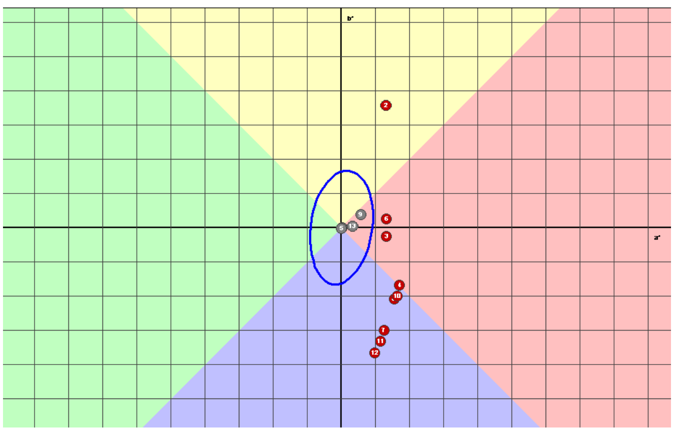


Fig. 2

In the paint industry is important to know the exact coordinates of the color of the sample, but more important is the deviation from a standard color. E.g. compared to a specimen made of paint RAL colors. Color difference can be expressed using the deviation ΔE . The parameter ΔE is defined by the difference between the coordinates of the color parameters. Parameter ΔE may be under consideration based on the equation 1 and expresses the shortest distance between the coordinates of the standard and sample in the color space. Partial deviation ΔL * , Aa * Δb * can be expressed as the difference between the coordinates color standard and the sample. If ΔE is less than 1, the color change is negligible. Specific tolerance deviation is expressed in a colored area as a sphere (if expressed constant) or ellipsoid (when taken into consideration further parameters such as the type of light, or the sensitivity of the human eye). Point (the color of the sample), which belongs to the tolerance ellipse indicates that the color difference is imperceptible to the naked eye and therefore considered to be negligible. Exemplary tolerance ellipse in the color space is shown in Figure 3. Color space is for clarity shows only two-dimensionally (brightness axis is through the center of the diagram towards the observer).



Obr. 3

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2} \quad \text{(eq. 1)}$$

$\Delta L^* = (L^*_{standard} - L^*_{sample})$, $\Delta a^* = (a^*_{standard} - a^*_{sample})$, $\Delta b^* = (b^*_{standard} - b^*_{sample})$

Measurement of chromaticity is performed with the reflecting spectrophotometer where the measuring head is placed in contact with the surface. Light source device irradiated assessed specific area of the sample and photodetector array then assess the amount of reflected light. Evaluation takes place throughout the range of visible wavelengths (400-700 nm) at 10 nm intervals. This will determine the Remission curve (some wavelengths are reflected by the subject and wavelengths absorbs). Remission curve is characteristic for the specific color. According programmed algorithms, this Remission curve is converted to individual color space and the deviation ΔE.

Spectrofotometers for the color measurement varies according to measurement geometry. Distinguish the device geometry 45 ° / 0 ° (Fig. 4), where light beam strikes the surface at an angle of 45 ° and captures the light reflected at an angle of 0 ° . Result is influenced by the gloss or surface structure similar to the visual evaluation of color. So such a geometry is not suitable for measuring shiny surfaces because they reflect more light at an angle of 45 ° to the detector receives less light . The second type of geometry uses diffusely scattered light and measure the light reflected at an angle of 8 ° (Fig. 5) from the vertical. Diffuse geometry (labeled d / 8 °) is used where it is necessary to measure the pigmentation of the paint regardless of their gloss and texture. A device with a diffusion geometry will be used for this particular lab measurements will be performed on the device MiniScan EZ (manufacturer Hunterlab) .

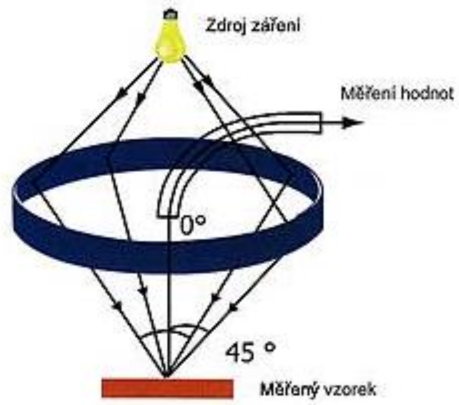


Fig.: 4

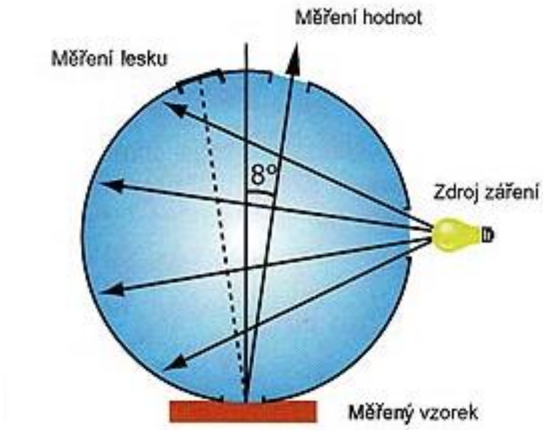


Fig. 5

Wettability is the ability of the liquid to wet the surface. The wetting is the interaction of the three phases in solid, liquid and gaseous states. Most often this phenomenon can be observed on a solid base surrounded by gas (air) with drop of liquid (water). In this case, the drop of water trying to take energy-advantageous position - only in terms of potential energy to the lowest possible level (flat on the surface). However, there are other forces in the system, called surface forces, whose mutual alignment will create drop. As a result of mutual attraction of particles of each phase and the influence of neighboring phase the **surface tension** γ occurs on the surface. Assuming a negligible drop weight (no deflects) the drop takes a shape of segment of a sphere. The fixed plate forms an angle θ, called **contact angle**. The interaction forces expresses Young's equation given by equation 2 , which can be derived from the following picture :

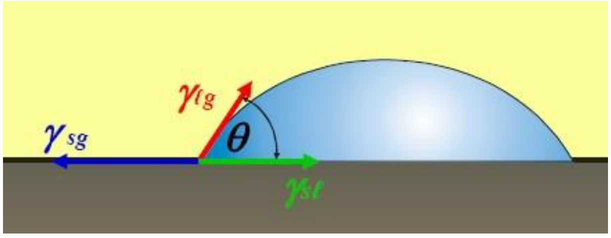


Fig. 6

$$\gamma_{sg} = \gamma_{sl} + \gamma_{lg} \cdot \cos\theta \qquad \text{(Eq. 2)}$$

If the contact angle is greater than 90 ° the liquid wets the solid poorly, if the contact angle is less than 90 ° the liquid wets the solid well. In extreme cases, it may occur that the contact angle is approaching 180 °, then we say that the liquid totally does not wet the surface of material (in the case of water ‚superhydrophobic' surface). If the contact angle approaches zero, the surface is completely wetted by a liquid (if water 'superhydrophilic' surface). The value of the contact angle is possible with knowledge of the surface tension γ_{lg} (tabulated) and γ_{sg} (often can be considered zero) to calculate the surface tension γ_{sl}. Detailed information about the surface tension can be found in the studz material Bartovská - Povrchová a koloidní chemie (\\pyr\scratch\povrchy-koloidy).

In the case of photocatalytically active materials we observe their superhydrophility after irradiation with UV light. This is due to the creation of OH functional groups on the surface of photocatalyst. This effect can be used in so-called self-cleaning effect which is just a combination photocatalytic degradation of organic contaminants and the runoff from the surface as a result of their displacement from the surface of water. The degree of induced hydrophilicity can be detected precisely by measuring the contact angle before and after irradiation with UV light.

Artificial ageing

Exposition of the materials to the weather conditions (especially UV radiation) can lead to surface changes. In the case of paints it is a gradual degradation of the polymer matrix of the coating manifested by loss of gloss, color variation and eventually significant damage to the polymer binder. This coating loses its utility function. Manufacturers are trying to prevent these undesirable effects by the addition of UV absorbers or coated pigments and thereby extend the life of paint. Another type of coating is so-called self-cleaning coating, in which, a photocatalyst is added. Such coatings still maintain their appearance and are not prone to soiling. For the formulation of these coatings is necessary to find a compromise between the photocatalytic activity and stability of the coatings in order to find the optimal photocatalytic activity and acceptable service life of the coating.

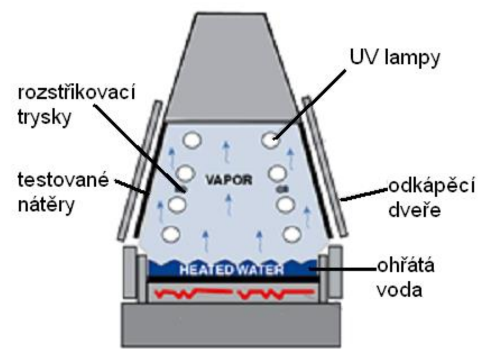


Fig. 6

Device called QUV panel is used to predict the relative resistance to weathering of the materials. It is equipped with a UV lamp, water jets and is capable of rapidly simulating sunlight, rain and condensation . Scheme of the QUV panel is shown in Figure 6.