Films and Foils

Transparent films are used in thousands of different applications. Whether shrink film, blister or medical films – each application asks for specific behaviors in the material selection and processing conditions. Flower packaging should be very clear, protecting and presenting its content in the same way. Films for grocery bags are expected to diffuse the light. Consistent transparency can only be guaranteed if the key material and process factors are under control and a standardized sample preparation is used.

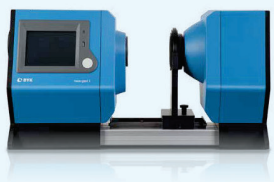
Influence of material and process parameters
Besides polymer selection, several decisions can influence the appearance, such as the choice of cast versus blown film production process. Cast film with its fast quench capabilities has better transparency and gloss, and can be controlled by the roll surface. Many parameters affect the final film quality e.g. density, mass distribution or melt index on the polymer side, as well as processing influences like melt homogeneity, cooling rate or blow-up ratio. Often additives to control properties like crystallinity or anti-blocking need to be adjusted to guarantee the desired effect.

Inner haze versus surface haze
A hazy appearance of films can be caused by internal scattering in the bulk material due to voids, crystallinity or other irregularities, referred to as "Inner Haze". On the other hand, light can be scattered at surface structures, which is called "External or Surface Haze".

At cast films, surface roughness can often be reduced by the chill rolls surface and the temperature control in the cooling process. On blown film with its free-surface flow, the surface roughness is mainly caused by melt-flow phenomena and crystallization.

In the development and optimization of production parameters, it is important to know the source causing the scattering and which parameters offer potential for improvement. Thus, inner and surface haze are to be differentiated. A liquid with similar refractive index as the sample, is used to cover the surface structure, which allows minimizing the scattering by the film roughness during measurement. Appropriate liquids can be found in the optical laboratory supplies for refractometry and microscopy.

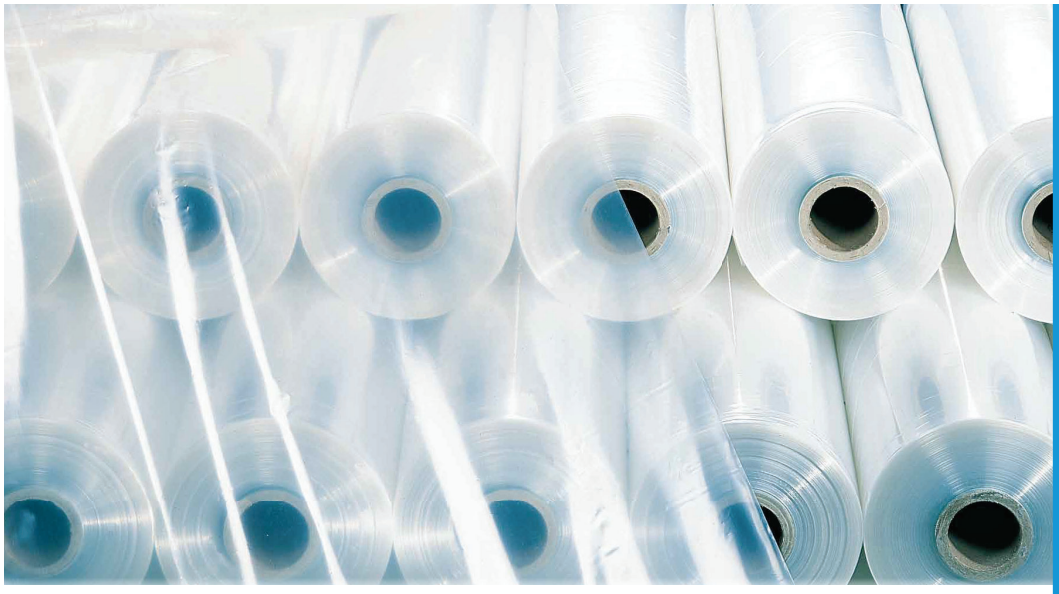
BYK-Gardner Solution



Transparency
haze-gard i

Film and Sheet Accessory
sample holder

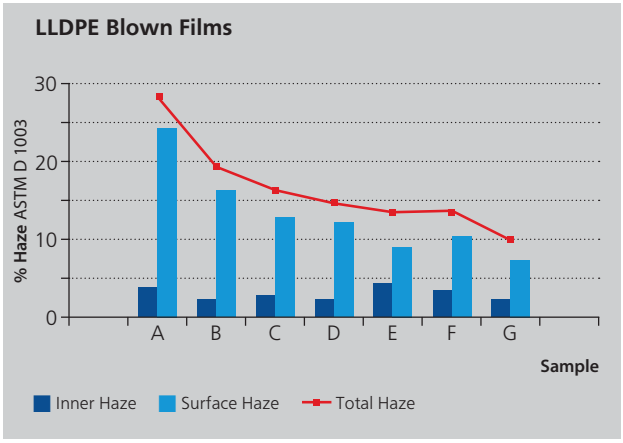
Thin Film Accessory
thin film Holder



First, the sample is measured without the liquid to get its "total haze" value. Then, the sample can be placed in a cuvette containing the liquid, or often a thin film of the liquid is applied on both sides of the sample to measure its "inner haze". In this case, care has to be taken to apply a uniform layer without dirt or air bubbles. Finally, the difference between both values will provide the "surface haze":

Surface Haze = Total Haze – Inner Haze

The example graphs the haze results of different linear low density PE blown films. The data show a strong impact of surface related causes to the total haze quality, which is characteristic in blow film production. Influencing parameters besides the resins itself are e.g. the melt viscosity, blow-up ratio and process speed.



Accessories for Liquids
cuvette holder

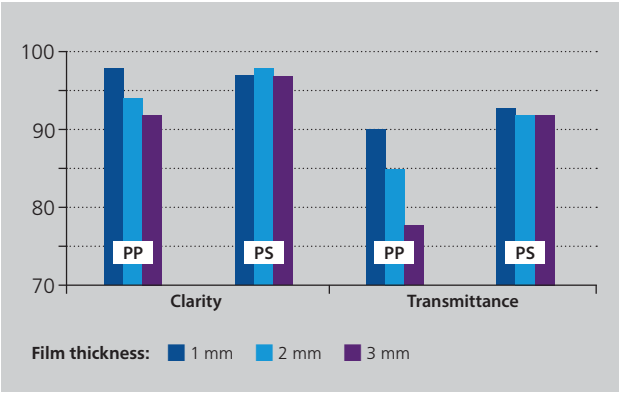
Accessories for Liquids
Cuvettes

Standardized sample preparation

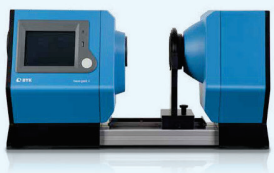
Development of new film products and reliable QC of running production, both require objective measurement data. It is a prerequisite for meaningful evaluation of transparency to assure standardized sample preparation and measuring conditions. Besides defined sample thickness, it is important to take care that the sample is positioned flush against the measuring port. Depending on the product behavior this can be a challenge, especially for very thin films like shrink wrap. Due to its open measuring compartment, the haze-gard i enables usage and easy changing of film holders designed for different applications. The "Thin Film Holder" (cat. no. 4784) allows you to place films flat and crease-free at the instrument's opening.

Influence of sample thickness

As seen before, scattering can be caused by internal scattering or surface structures. Some resin types show stronger inner scattering than others. The graph below shows polypropylene and polystyrene sheets of different thickness. While the polystyrene samples don´t exhibit any significant thickness dependency, transmittance and clarity of the PP samples decrease with increasing thickness, as more scatterer come into play. Thus, in case of internal scattering, it is of strong importance to assure that only samples with the same thickness are compared, or in other words, the sample thickness is important additional information in the product specification sheet.



BYK-Gardner Solution



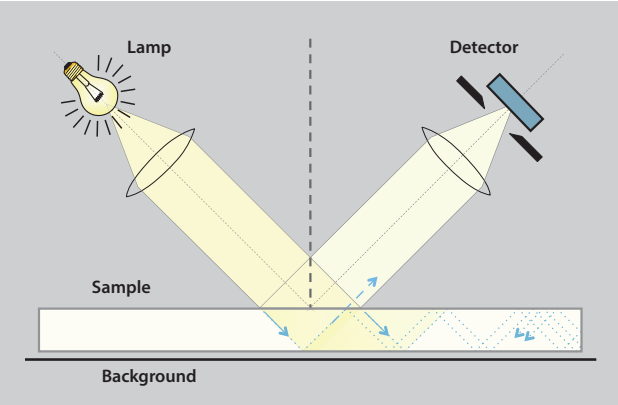
Transparency
haze-gard i

Solid Color & Gloss
spectro2guide

Drawdown Test Charts
byko-charts

Gloss of films

Besides transparency, high quality films require defined reflection properties, regardless if they are brilliant glossy packaging or non-glare films for LCD use. The internationally standardized method for measuring gloss illuminates the sample under a defined angle and detects the reflected light intensity. At transparent materials, a part of the illuminating light penetrates the surface. The transmitted light is reflected at the rear surface within the material and is partly transmitted into the direction of the sensor.



This additional reflection is dependent on the background used and has a significant impact on the measurement. To minimize this influence, it is recommended to use a black, matte background, e.g. paper board, and it is important to always use the same background.

It is additionally challenging when the samples are very thin and don´t form a really flat surface under the gloss meter. Therefore, often a vacuum plate is used to make sure no air bubbles or wrinkles distort the measured gloss results.

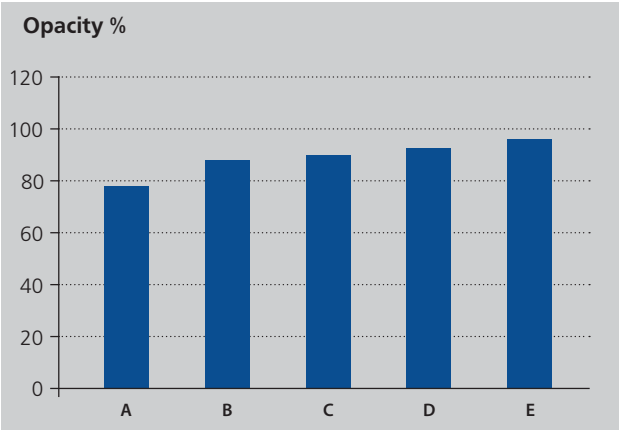
Opacity

In some applications the opposite of transparency is required, e.g. shopping bags or diaper backings, which need to keep its contents private. This behavior is called opacity and controlled by use of color measurement. The spectro2guide includes the respective index to automatically calculate opacity.

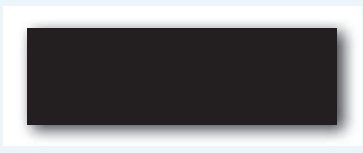
Opacity is the ability of a thin, transparent material to hide the surface behind. It is also sometimes referred to as contrast ratio and hiding power. Opacity is expressed as the ratio of the reflectance when the material is backed by a black substrate to the reflectance when it is backed by a white substrate.

$$\text{Opacity (\%)} = \frac{Y_{black}}{Y_{white}} \times 100$$

100 % opacity means complete hiding: no difference can be seen between the transparent material over black and white. For reproducible results, it is important to use always the same backing, therefore BYK-Gardner offers opacity charts which assure defined measurements. In the following graph the opacity of different types of sheet protectors were compared.



Gloss
micro-gloss



Transparency Accessory
black chart