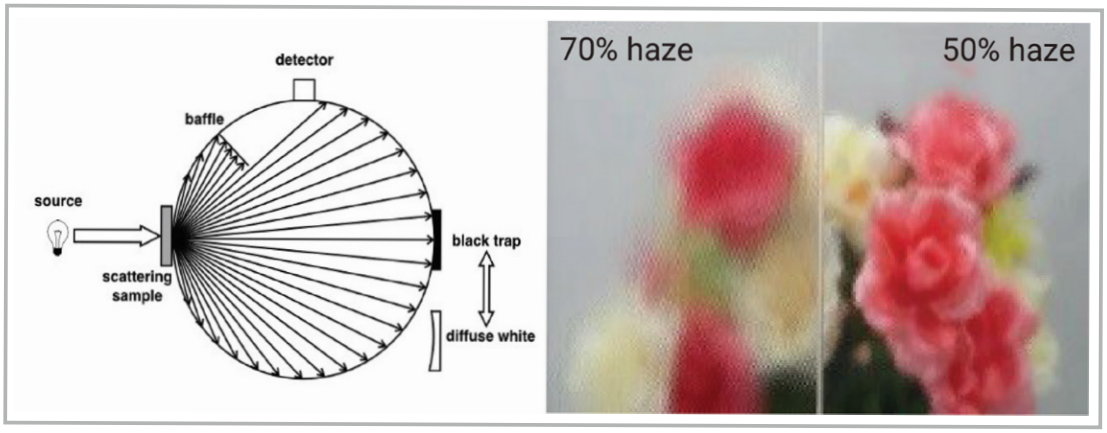
SYNOPSYS®

APPLICATION NOTE

Understanding Haze and BSDF

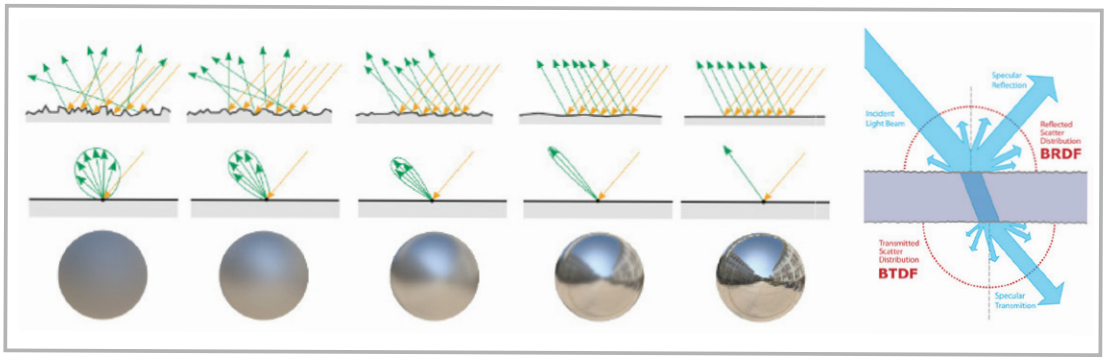
A diffusive material can be characterized by multiple quantities: transmission, absorption, TIS measurements, Haze, and bidirectional scattering distribution function (BSDF). The meaning of these terms is not always clear, particularly the difference between Haze and BSDF.

Haze is measured as the percentage of incident light scattered by more than 2.5 degrees through a glass or plastic specimen. Haze has no specific unit. It is expressed in percentage (%). Haze gives no angular information; in other words, we do not know where the flux is going!



BSDF is a goniophotometric measurement of the light scattering off and through the surface of a material.

BSDF can be separated into reflected and transmitted components – BRDF bidirectional re-flectance distribution function) and BTDF (bidirectional transmittance distribution function). BSDF corresponds to the angular profile in transmission, reflection or both. In addition to providing information on the amount of transmitted or reflected light, this data gives additional information on where the light is going in the space.



By definition transmittance and reflectance values from a sample can be measured from BSDF. It is the integral of it on the complete sphere.

$$T_{TOT}(\theta_i,\varphi_i) = \int BTDF(\theta_d,\varphi_d,\theta_i,\varphi_i)\, d\Omega = \iint BTDF(\theta_d,\varphi_d,\theta_i,\varphi_i)\cos(\theta_d)\,|\sin(\theta_d)|\, d\theta_d\, d\varphi_d$$

This can be extrapolated to a haze computation if integrated θd between 2.5° and 90° and φd over 2π.

Test Case: Benefit of the BSDF

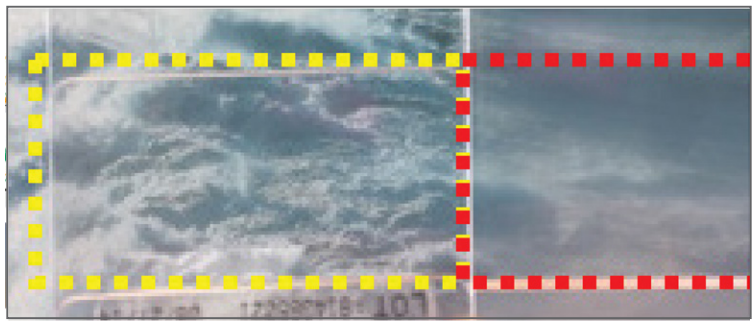
The problem with haze is that it only gives a percentage of transmitted light and provides no information about the angular direction of scattered light.

Therefore, several samples can have the same haze value but can exhibit very different behavior.

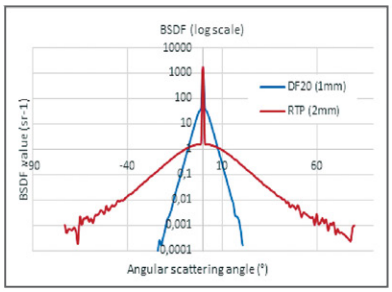
Consider two plastic samples available on the market:

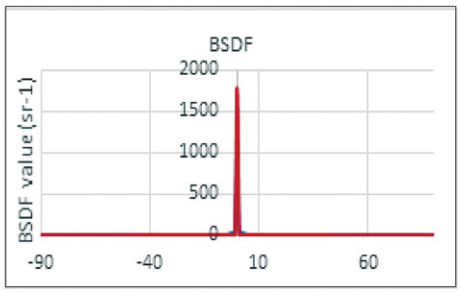
- Evonik ACRYLITE Satinice DF20 (1mm thick) on the right
- RTP_0399x12952_B_SC_28141 (2mm thick) on the left

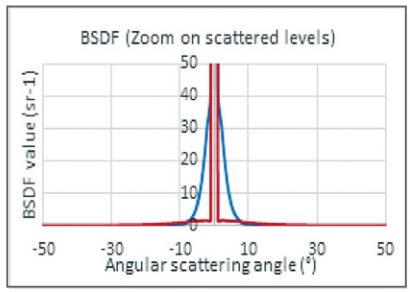
Both have a haze value of approximately 35% but it is evident they do not transmit light equally.



From BSDF, one can see that the RTP sample is much more specular (clear) than DF20. Although the global scattered light percentage (haze) is identical between samples, the RTP scatters at much lower levels over the entire hemisphere (red curve), where the DF sample scattering is mainly around the specular direction, blurring the direct transmitted light (blue curve). These measurements were performed with the REFLET 180S.







Conclusion

We can clearly see the difference between two samples using BSDF (BTDF) where haze could not demonstrate this discrepancy. BSDF provides more information about light propagation than the haze parameter.