

Application News

No. A526

Spectrophotometric Analysis

Optical Properties of Films and Glasses Used to Protect Smartphones

Just as new smartphones are constantly being developed and marketed, a variety of accessories are sold alongside them. Films and glasses used to protect smartphone screens are among these accessories, with such products given a variety of optical properties including blue light reduction and screen privacy.

Here, we describe using a SolidSpec-3700DUV UV-VIS-NIR spectrophotometer with variable angle absolute reflectance attachment to measure the optical properties of films and glasses used for smartphone protection.

Sample Measurement with Variable-Angle Absolute Reflectance Attachment

Fig. 1 shows the sample compartment of the SolidSpec-3700DUV with a variable angle absolute reflectance attachment. The variable angle absolute reflectance attachment allows for measurement of transmittance and absolute reflectance with light at different angles of incidence on the sample. Please refer to Application News No. A390 and A394 for detailed information about the variable angle absolute reflectance attachment.

Four commercially available protective films and four glass screen protectors designed for smartphones were obtained as samples. The four protective films and four glasses were designed for screen privacy, high hardness, blue light reduction, and clarity. Transmittance at different angles of incident light and 12-degree absolute reflectance were measured using the conditions shown in Table 1. A polarizer and quartz depolarizer^{Note 1)} were used to depolarize any polarized light during measurement. Fig. 2 shows transmittance spectra with light at an angle of incidence of 0 degrees.

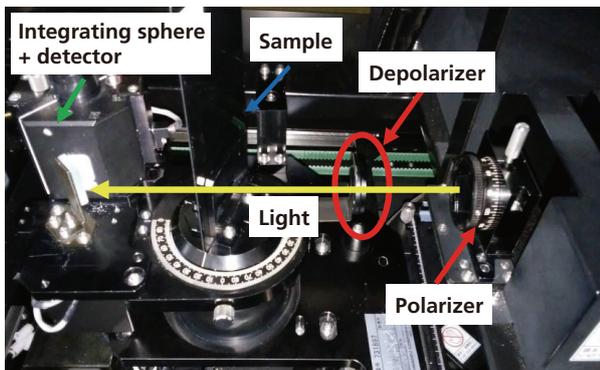


Fig. 1 Sample Chamber of SolidSpec-3700DUV with Variable Angle Absolute Reflectance Attachment

Table 1 Analytical Conditions

Instrument Used	: SolidSpec-3700DUV, large polarizer assembly, variable angle absolute reflectance attachment, quartz depolarizer ^{Note 1)}
Measurement Wavelength Range	: 250 nm to 850 nm
Scanning Speed	: Low speed
Sampling Pitch	: 1.0 nm
Slit Width	: (12) nm
Light Source Switching Wavelength	: 310 nm

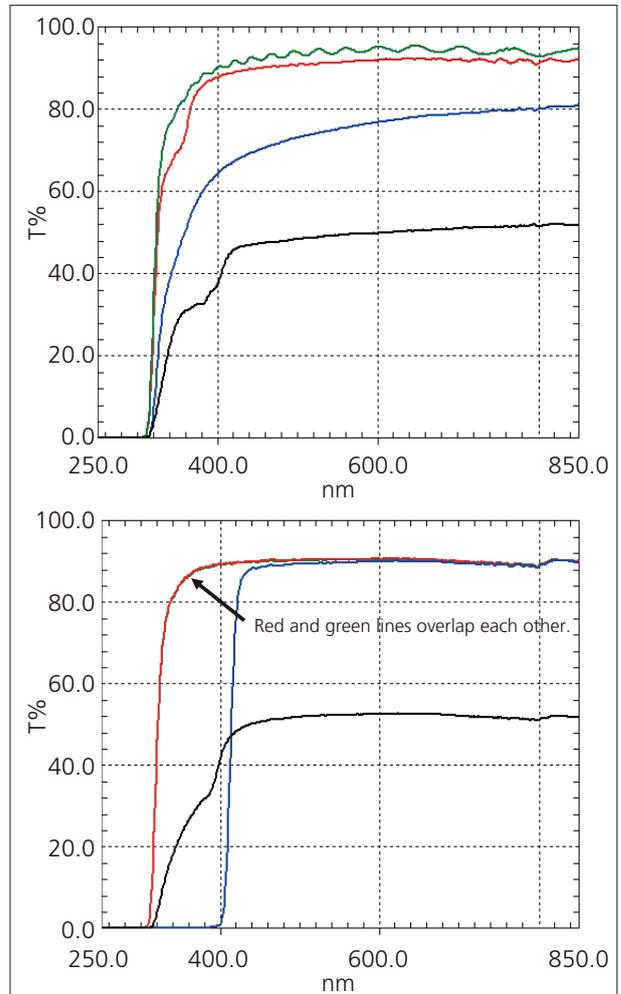


Fig. 2 Transmittance Spectra Measured at 0-Degree Angle of Incidence

Top: Films, Bottom: Glasses, Black: Screen Privacy, Red: High Hardness, Blue: Blue Light Reduction, Green: Clarity

The film designed for screen clarity had the highest transmittance out of the four films, and the film designed for blue light reduction gradually reduced transmittance from 600 nm across the short wavelength region. The film sample designed for screen privacy exhibited around 50 % transmittance from a 0-degree angle of incident light. The glass samples designed for screen clarity and hardness exhibited almost identical transmittance spectra. The glass designed for blue light reduction showed a sudden drop in transmittance from around 400 nm in the short wavelength region. Similar to the film designed for screen privacy, the glass designed for screen privacy exhibited around 50 % transmittance from a 0-degree angle of incident light. Fig. 3 shows visible light transmittance¹⁾ at different angles of incident light^{Note 2)}. Visible light transmittance is the transmittance of daylight as prescribed by the Japanese National Committee of CIE. Visible light transmittance is easily calculated by the solar transmittance analysis software used, since it comes with the spectral distribution of daylight as prescribed by the CIE. Visible light transmittance was almost unchanged at different angles of incident light for samples that were not designed for screen privacy. However, for samples designed for screen privacy, visible light transmittance fell to around 10 % at an angle of incident light of 30 degrees.

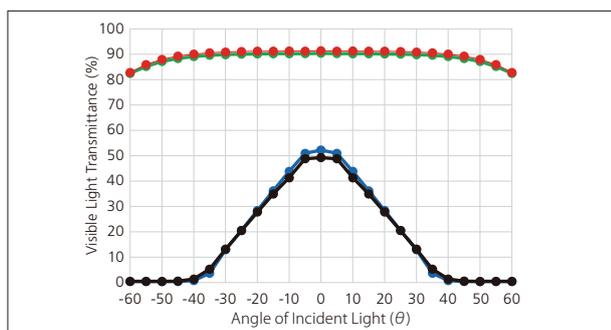


Fig. 3 Relationship between Angle of Incident Light and Visible Light Transmittance
Black: Screen Privacy (Film), Red: High Hardness (Film), Blue: Screen Privacy (Glass), Green: High Hardness (Glass)

Visible light reflectance, which is defined in a similar way to visible light transmittance, is defined at an angle of incidence of less than 15 degrees. Absolute reflectance spectra were measured at a shallow angle of incidence of 12 degrees, at which transmittance begins to decrease with screen privacy protectors. The results obtained are shown in Fig. 4. The film designed for screen privacy showed a reflectance of around 3 % at all wavelengths, and the film designed to reduce blue light reduced reflectance in the short wavelength region. Despite being almost the same thickness as the film designed for high hardness, the film designed for screen clarity produced interference waveforms. This fact leads to an assumption that the films designed for high hardness and screen clarity have a different

refractive index and are made of different materials. The glass designed for screen privacy produced around 5 % reflectance at all wavelengths, while the other glasses exhibited around 7 % reflectance. The glass protector designed for blue light reduction was the only glass to show a drop in reflectance from around 400 nm in the short wavelength region.

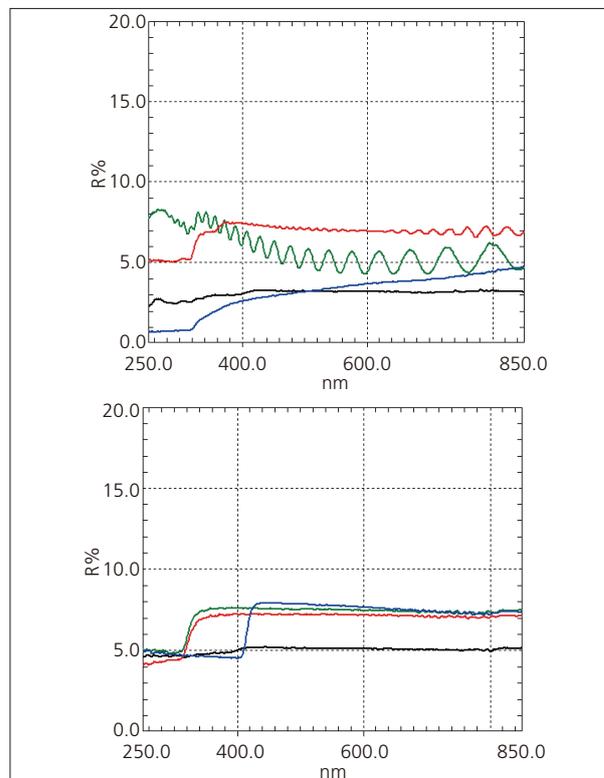


Fig. 4 Absolute Reflectance Spectra Measured at 12-Degree Angle of Incident Light, Top: Films, Bottom: Glasses
Black: Screen Privacy, Red: High Hardness, Blue: Blue Light Reduction, Green: Clarity

Conclusions

Film and glass products used to protect smartphone screens were analyzed using a SolidSpec-3700DUV with a variable angle absolute reflectance attachment. The optical properties of each sample were confirmed based on transmittance and reflectance measured at difference angles of incident light.

The spectra obtained from each sample allowed for an evaluation of the sophisticated optical properties of protectors designed for screen privacy, to reduce blue light, and for other purposes.

[Reference]

1) JIS R 3106: Testing method on transmittance, reflectance and emittance of flat glasses and evaluation of solar heat gain coefficient.

Note 1) Sigmakoki DEQ-20P: Pseudo depolarized light is created by setting the polarization of incident light at 45 degrees to the optical axis.

Note 2) Visible light transmittance results at positive angles of incidence were used for visible light transmittance results at negative angles of incidence.