

Application News

Spectrophotometric Analysis

No. A418

Transmittance Map of Glass Plate Coated with TCO Film Measured with SolidSpec-3700 Equipped with Automatic X-Y Stage

A solar cell is composed of various parts, including p-type and n-type semiconductors, anti-reflective film, TCO (transparent conductive oxide) film, and glass plate, etc. Previously, in Application News A409, we introduced an example of measurement of absolute reflectance of anti-reflective film. Here, we report on the transmittance measurement of a glass plate coated with TCO film. TCO films are transparent as

well as electrically conductive, and examination of the transmittance distribution is important for evaluating both the TCO film and glass substrate. Here we introduce the measurement of the transmittance distribution (map) in glass plate coated with TCO film using the SolidSpec-3700 UV-VIS-NIR spectrophotometer.

■ Instrument, Attachment and Sample Used for the Measurement

Measurement of the sample (glass plate coated with TCO film) was conducted by mounting it on the automatic X-Y stage attached to the SolidSpec-3700 UV-VIS-NIR spectrophotometer. A photograph of the SolidSpec-3700 is shown in Fig. 1, a photograph of the automatic X-Y stage is shown in Fig. 2, and a photograph of the sample mounted on the automatic X-Y stage is shown in Fig. 3. The sample consisted of a piece of glass plate (aluminoborosilicate) with TCO film formed on its surface. For further information regarding the automatic X-Y stage, refer to Application News A373.



Fig. 1 SolidSpec-3700 UV-VIS-NIR Spectrophotometer



Fig. 2 Automatic X-Y Stage

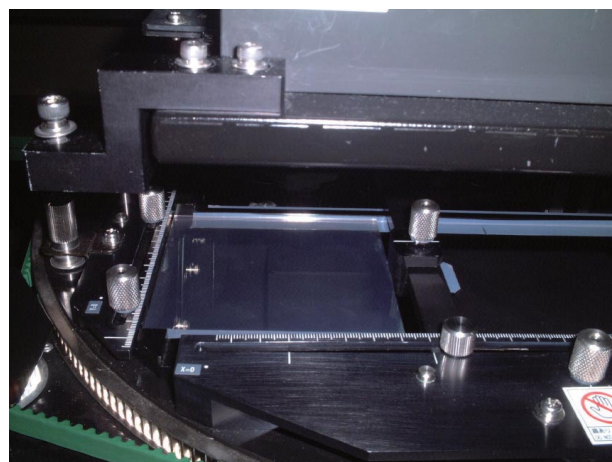


Fig. 3 Sample Mounted on Automatic X-Y Stage

■ Measurement of Transmittance Map

Using the automatic X-Y stage, we conducted measurement of the linear transmittance spectra at 16 points on a TCO film-coated glass plate (100 mm × 100 mm, by 1.1 mm thick). The 3 mm × 7 mm light beam was irradiated from the glass surface side onto the sample. A program was created to perform automatic measurement at the 16 points, as shown in Table 1.

The first 2 lines set the parameters for the coordinate system (Cartesian coordinates / polar coordinates (A)), and the type of measurement (transmittance measurement / reflectance measurement (S)), respectively, and the measurement positions are set from the third line to the end of the program. Here, measurement was conducted using Cartesian coordinates (A0) and transmittance measurement (S0) as conditions. The program is easily created with a simple text editor.

Measurement was conducted automatically within the wavelength range of 250 nm – 2000 nm. It took

approximately 70 minutes to complete the measurements at all 16 points. The measurement conditions are shown in Table 2.

The measured spectra at four of the sixteen measurement points, ((25 25), (25 45), (25 65), (25 85)) are shown in Fig. 4, and a magnified region of those spectra in the vicinity of 600 nm is shown in Fig. 5. In addition, the transmittance values obtained for all the spectra at 600 nm and 1500 nm are shown in Table 3, and the transmittance map at 600 nm is shown in graph format in Fig. 6. It is clear from these results that variation on the order of several percent exists at both 600 nm and 1500 nm, depending on the points compared in this sample.

These results indicate that such automatic measurement using the automatic X-Y stage is effective for evaluation of transmittance distribution in glass plates and other solar cell materials.

Table 1 Program Used to Obtain Transmittance at 16 Measurement Points

A 0
S 0
M 25 25
M 45 25
M 65 25
M 85 25
M 25 45
M 45 45
M 65 45
M 85 45
M 25 65
M 45 65
M 65 65
M 85 65
M 25 85
M 45 85
M 65 85
M 85 85

Table 2 Measurement Conditions

Measurement Wavelength Range	: 250 nm to 2000 nm
Scan Speed	: Medium
Sampling Pitch	: 2 nm
Photometric Value	: Transmittance
Slit Width	: (20) nm
Lamp Switching Wavelength	: 310 nm
Grating Switching Wavelength	: 720 nm
Detector Switching Wavelength	: 870 nm 1650 nm

Table 3 Transmittance (%) at 600 nm and 1500 nm for 16 Measurement Points

Data	600 nm	1500 nm	Data	600 nm	1500 nm
1	73.49	29.48	9	76.53	76.53
2	74.25	32.07	10	75.62	32.37
3	72.59	35.12	11	73.63	31.00
4	72.75	34.65	12	76.12	33.69
5	74.99	30.54	13	74.27	34.08
6	73.58	31.01	14	75.53	34.28
7	72.41	30.61	15	76.10	35.93
8	73.23	31.35	16	75.60	37.05

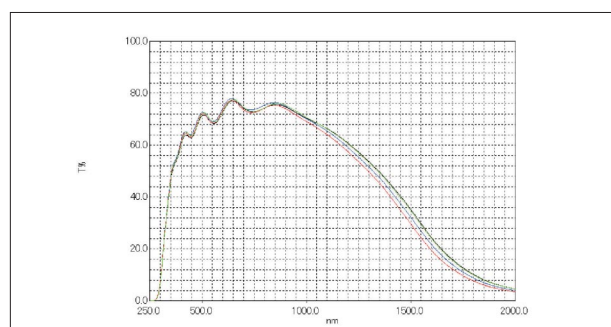


Fig. 4 Spectra for 4 Measurement Points

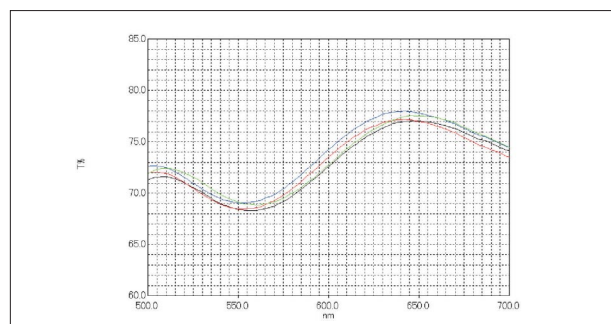


Fig. 5 Magnification of Spectra of Fig. 4

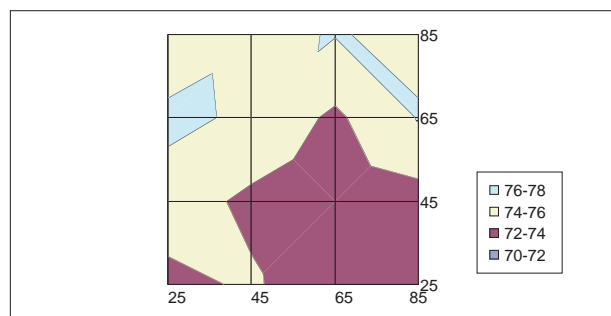


Fig. 6 Transmittance Map Obtained at 600 nm