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Application News

No. A601

Spectrophotometric Analysis

Measurement of Ultraviolet Protection Factor UPF of UV Protection Clothing by Using LabSolutions™ UV-Vis

Introduction

Sunlight that reaches the earth is classified as visible light (VIS) that can be seen by the human eye, ultraviolet light (UV), which has shorter wavelengths than visible light, and infrared light (IR), which has longer wavelengths. Of these, UV has the highest energy and causes changes in the physical properties of objects exposed for extended periods of time. In humans, excessive exposure to UV radiation is a cause of red spots (erythema), liver spots (chloasma), and freckles, and can also cause skin cancer.

For this reason, clothing that has been given treatment to prevent transmission of UV, or so-called "UV cut" treatment, is frequently seen in the market. The UPF (ultraviolet protection factor) value is an index of the degree of UV protection provided by this clothing. UPF values are specified in the standards of various countries around the world. In Japan, JIS L 1925 was established in 2019, providing a method for evaluating ultraviolet-ray shielding ("UV cut") textile products. This article introduces an example in which the UPF values of UV protection-treated clothing were calculated by using LabSolutions UV-Vis.

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Analytical Conditions for Ultraviolet Protection Factor UPF

The UPF value, or ultraviolet protection factor, of clothing is a numerical value that expresses the degree of protection from sunburn. Larger values indicate greater protection against sunburn. Although UV wavelengths are classified as the A (315 to 400 nm), B (280 to 315 nm), and C (<280 nm) wavelength ranges, UV that reaches the earth's surface is generally considered to be the A and B wavelength ranges, that is, 290 to 400 nm. According to JIS L 1925, the UPF value is calculated by measuring this 290 to 400 nm wavelength range that reaches the earth's surface. Comparing the analysis conditions in various countries, including Japan, Germany/ UK, the United States, Australia/New Zealand, and China, the measured wavelength range and the sampling pitch are different, as shown in Table 1. Details concerning the calculation formulas can be found in Application News No. A450A or in the original versions of the respective official analytical methods [1].

Measurement of UV Protection-Treated Clothing

The transmittance of UV protection-treated clothing (cardigan and hoodie) was measured by using a UV-2600i ultraviolet-visible (UV-VIS) spectrophotometer and MPC-2600A multipurpose sample compartment. Use of the MPC-2600A made it possible to measure the clothing as-is, without destructive sampling. Fig. 1 shows the appearance of the samples, and Table 2 shows the measurement conditions.

Fig. 1 UV Protection-Treated Clothing (Left: Cardigan, Right: Hoodie)

Table 2 Measurement Conditions

Instruments	: UV-2600i MPC-2600A
Measured wavelength range	: 280 nm-400 nm
Scan speed	: Medium
Sampling pitch	: 1.0 nm
Slit width	: 5 nm
Photometric value	: Transmittance

Table 1 Analytical Conditions of National Standards

	AATCC 183 (US)	AS/NZS 4399 (Australia/ New Zealand)	DIN EN13758-1 BS EN13578-1 (Germany/UK)	GB/T 18830 (China)	JIS L1925 (Japan)
Measured wavelength range	280-400 nm	290-400 nm	290-400 nm	290-400 nm	290-400 nm
Sampling pitch	5 nm max.	5 nm max.	1 nm	5 nm max.	1 nm

Fig. 2 shows the obtained transmittance spectra of the two sample garments. In the UV-B wavelength region of 280 to 315 nm, the transmittance of the hoodie was lower than that of the cardigan, showing that the hoodie offers greater protection from UV light.

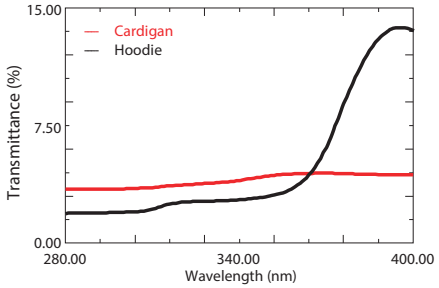

Fig. 2 Transmittance Spectra of UV Protection-Treated Clothing

The UPF values were calculated using these photometric values. Fig. 3 shows the setting screen for UPF value calculations. The desired calculation item is set from the types of evaluation items. In addition to UPF, it is also possible to calculate the ultraviolet A (UVA) and B (UVB) wavelength regions, the UV-ray shielding rate (Percent Blocking UV), and other items. The standard which is suitable for the respective items is selected. If "Perform pass/fail judgment" is checked, a pass/fail judgment of the UPF value can also be made simultaneously. When the above-mentioned items are set before the measurement, UPF is calculated automatically after the measurement.

Table 3 shows the UPF values calculated for the samples in this experiment. The hoodie had a higher UPF value than the cardigan. Moreover, even with the same sample, different values were obtained with the calculation formulas of the respective countries. Because it is possible to paste the obtained UPF values to other applications by using the copy & paste or Excel export functions, this system also supports the preparation of various types of reports.

Conclusion

When measured with a UV-VIS spectrophotometer, products displaying the same "UV Cut" labelling exhibited different spectral transmittances, and the UPF values were also different. In addition, different UPF values are obtained depending on the national standard, even with the same spectrum, due to differences in the calculation formulas.

When UPF is to be measured in conformance with the various official analytical methods, confirmation of the original version of the standard is recommended.

<References>
(1) Official analysis methods for UPF
- DIN EN 13758-1-2007
  Textile Solar UV protective properties-
  Part1: Method of test for apparel fabric (includes Amendment A1:2006)
  English version of DIN EN 13758-1:2007-03
- BS EN 13758-1-2002
  BRITISH STANDARD
  Textiles-Solar UV protective properties-Part1:Method of test for apparel fabrics
- AATCC Test Method 183-2014
  Transmittance or Blocking of Erythemally Weighted Ultraviolet Radiation through Fabrics
- Australian/New Zealand Standard 4399-2017
  Sun Protective clothing-Evaluation and classification
- GB/T 18830-2009 NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA
  Textiles - Evaluation for solar ultraviolet radiation protective properties
- JIS L 1925-2019
  Textiles – Evaluation method of ultraviolet ray-shielding

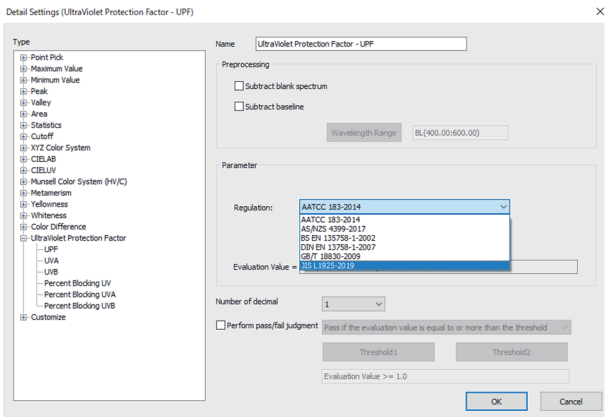

Fig. 3 UPF Calculation Setting Screen

Table 3 UPF Values of UV Protection-Treated Clothes

	AATCC 183 (US)	AS/NZS 4399 (Australia/ New Zealand)	DIN EN13758-1 BS EN13578-1 (Germany/UK)	GB/T 18830 (China)	JIS L1925 (Japan)
Cardigan	27.62	27.66	27.63	27.62	27.66
Hoodie	41.13	41.49	41.26	40.88	41.49

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