Test methods for quantifying the UV protection factor of apparel, sunshades and awnings

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Introduction

About 3.5 million cases of skin cancer (i.e. basal and squamous cell) are diagnosed in the US each year. Melanoma, a more dangerous type of skin cancer, will account for more than 73,000 cases of skin cancer in 2015 [1]. Given these facts, dermatologists stress the need for preemptive UV protection. Here, textiles offer a much more effective protection against UV radiation than cosmetic sunscreens.

Some theoretical background on UV protection of textiles

The sun's optical radiation (IR, VIS, UV) can interact with a textile by three different processes: Reflection, absorption and transmission (see figure 1) whereas transmission can be differentiated in aligned and diffused. With textiles there is nearly always diffuse transmission.

The UV protection factor of textiles UPF (Ultraviolet Protection Factor) is related to its transmissive properties of UV radiation. The UPF is a time factor/multiplier for the protection of Caucasian skin compared to exposure without any protection. For example, if a person shows visible sunburn after five minutes of sun exposure, a fabric with an UPF 50 extends that time to five minutes times the protection factor, i.e. to 5 minutes x 50 = 250 minutes, or roughly four hours. The UPF for textiles therefore is basically the same as the SPF (Sun Protection Factor) for cosmetic sunscreens.

A full (100 percent) transmission of UV radiation leads to an UPF of 1, 20 percent is a UPF 5, 10 percent a UPF 10, 5 percent a UPF 20 and so on. So a bisection of UV transmission results in an approximate doubling of the UPF (see figure 2). For the exact calculation of the UPF of a textile, the UV transmission, the wavelength weighted erythemal sensitivity (sunburn sensitivity) of the skin and the radiation spectra of the sun are correlated.

The following textile parameters influence the UPF of a fabric:

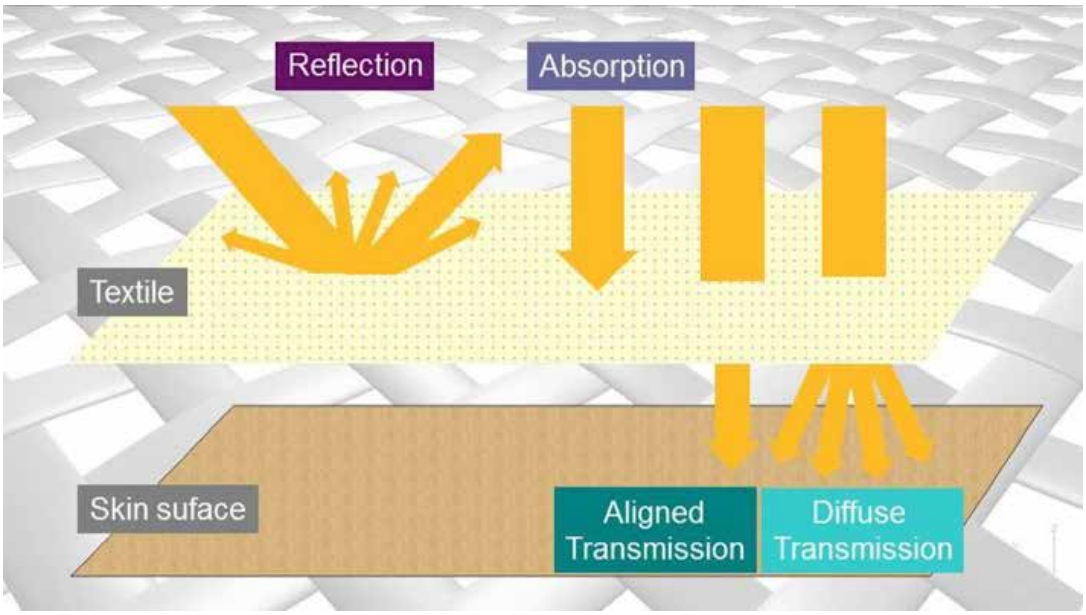

Figure 1 Physical radiation phenomena with textiles

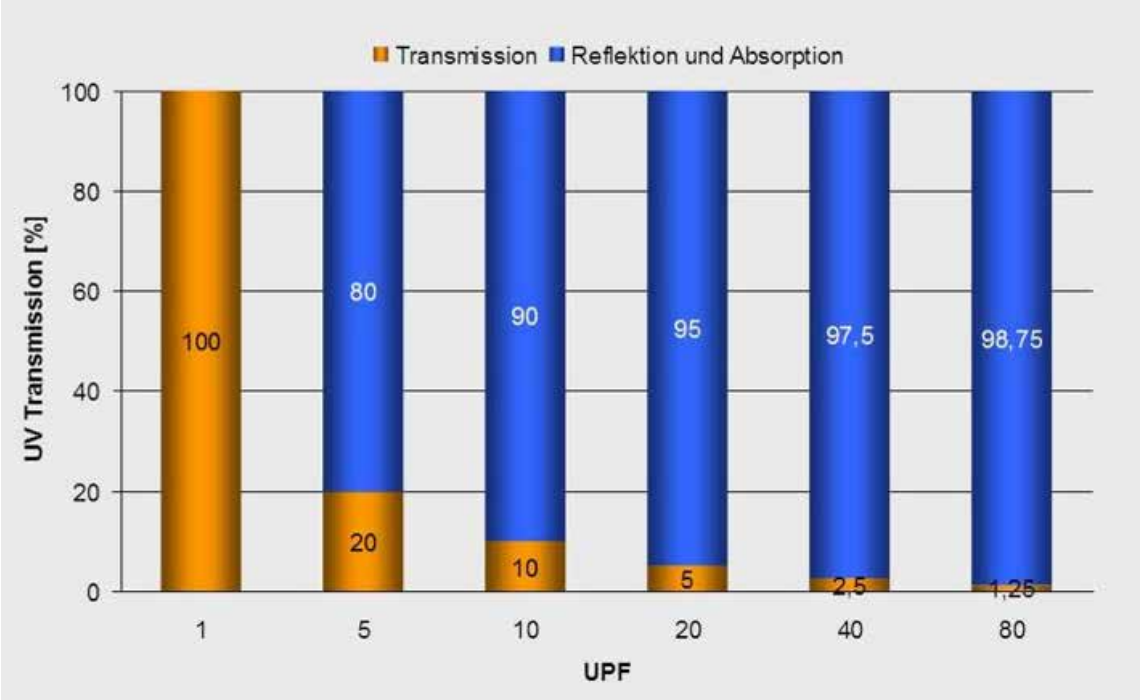

Figure 2 Link between UV transmission and UPF

- Construction and fabric weight (textile technology, i.e. the tighter the weave/knit and the higher the fabric weight, the higher the UPF)
- Dyeing and finishing (textile chemistry, i.e. the darker the color the higher the UPF and additional special UPF finishes)
- Fiber material (polymer, i.e. PES, PAN and PA stand for high UPF; Cellulosics for low UPF)

UPF testing standards for textiles

Like with cosmetic sunscreens it is important to determine the effective value of UV protection factor to ensure the erythemal (sunburn) protection of the fabric of a certain UV exposure timeframe. Sunshades for example should have an UPF of 60 and more even under a prolonged period of use.

The following standards are most common and used to test the UPF of textiles:

AS/NZS 4399:1996

The most known and likely most prevalent is the Australian/New Zealand standard AS/NZS 4399 to determine the UPF of all kinds of textiles (apparel, hats, sunshades and awnings). In this standard, the solar spectrum of the southern hemisphere, resp. the average from Melbourne, Australia on January 1, is used. Due to the fact that the UPF is only measured in the new and unused state, this standard is not in line with actual practice as under usage conditions like stretching, wetting, abrading, washing for apparel and wetting, weathering for sunshades the UPF often drastically decreases (see figure 3).

AATCC 183 and EN 13758

The AATCC 183 is the most predominant testing standard in the US and nearly identical with the European standard EN 13758 in the matter of the testing parameters. Like with the AS/NZS 4399, testing is done in the new and unused state only. The only difference lies in the calculation of the UPF using the solar spectrum on the northern hemisphere i.e. the average from Albuquerque, N.M., USA, on July 31. All three standards (AS/NZS 4399, AATCC 183, EN 13758) are quite comparable regarding the measured UPF of textile materials.

UV Standard 801

As all the previous existing standards do not consider and determine the usage conditions of a textile while measuring the UPF, the international association of applied UV protection developed a new UV protection standard for textiles that takes into account the

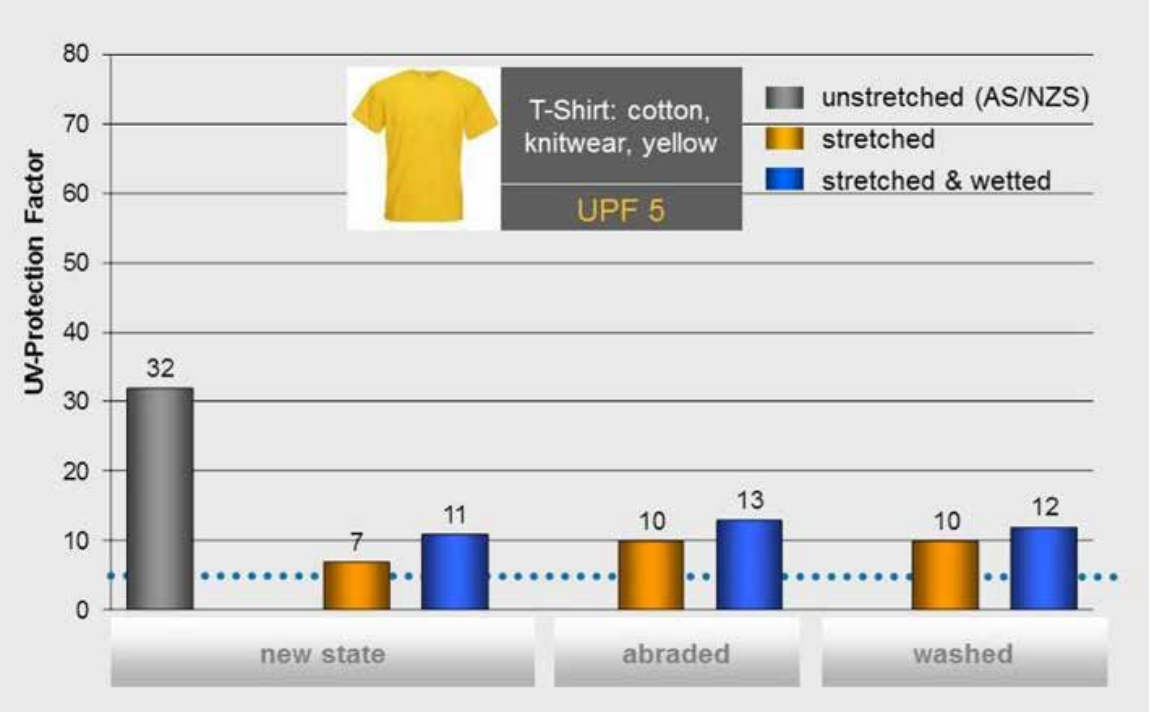

Figure 3 UPF rating of a white cotton knitwear under usage strains

influence of the usage conditions. Out of this the UV Standard 801 evolved in 1998 [2].

This independent third party testing and certification system enables a realistic assessment of textiles regarding their UV protective properties as it considers the actual occurring usage related strains of the textile material. Therefore, the testing program covers the simulation of typical strain factors like stretching, wetting, abrasion and care treatments for apparel and stretching, wetting and weathering for sunshades. Basis for the calculation for the measured values are always the worst conditions, which means the assumption of the highest UV radiation exposure by using the solar spectrum of Melbourne, Australia, and the most sensitive human skin type. The technical determination of the UPF itself is performed acc. to the AS/NZS 4399.

The final UPF that the consumer finds labeled on the hangtag at the point of sale (figure 4) is ultimately the lowest measured UPF during the usage strains (worst case scenario).

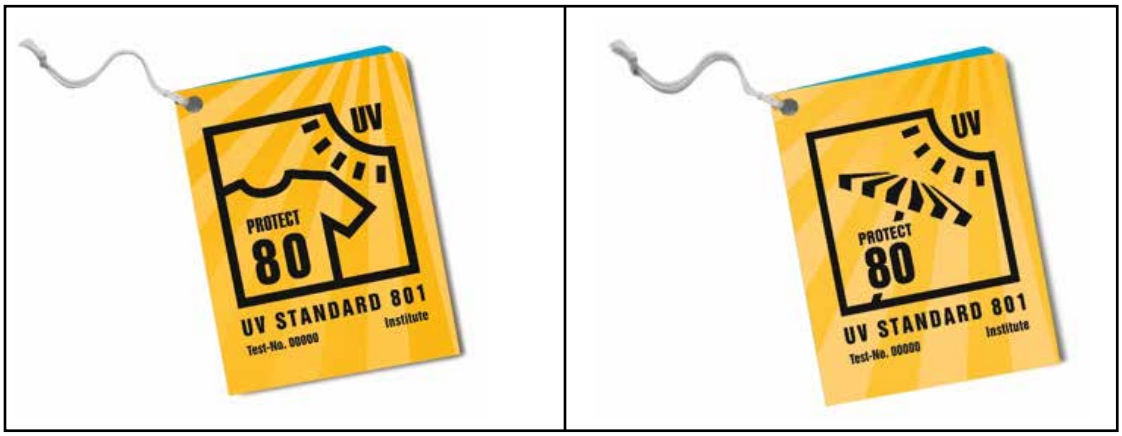

Figure 4 Example of a UV Standard 801 hangtag with UPF 80 (left: apparel, right: sunshades)

Summary

Given the worldwide increase of skin cancer diseases, it can be assumed that the market share for textiles with high and durable UV protection will rapidly grow in the future. As pointed out in this paper, textile UV protection is a complex topic that requires a combined consideration of the different influence factors. Also choosing the right testing standard and its relation to the strains in practical use in UPF testing is of importance.

References

[1] http://www.cancer.org/cancer/cancercauses/sunanduvexposure/skin-cancer-facts
[2] http://www.uvstandard801.com/en/uv_standard_801/home.html

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