

A conversation with Dr. Olga Dueva-Koganov, Research Director BioMaterials, Ashland Inc. on Emerging Category of Sun Protection Fabrics

EURO COSMETICS: *We understand that photo-protective fabric technology is becoming increasingly important. Could you tell us what the new developments and trends are.*

Dr. Olga Dueva-Koganov: The solar irradiance spectrum at the Earth's surface is comprised of ~7% UV (290–400 nm), ~55% VIS (400–780 nm) and ~40% IR (780 nm to 1mm). Up until recently, sun care research was focused on the prevention of skin from UV (UVB+UVA) radiation; and now the VIS and IR ranges are recognized as contributors to skin photo damage via formation of reactive oxygen species, free radicals, and induction of matrix metalloproteinases.

Progress in sun care research, recent availability of advanced equipment with sufficient dynamic ranges, and development of new relevant testing methodologies are influencing current hi-tech trends in photo protective fabrics. The factors influencing photo protective properties of fabrics include: composition of fiber material, weave, color, degree of stretching, reflective properties, specific density, thickness, moisture retention capability, treatments with chemical agents, including fluorescent whitening agents during the manufacturing, the utilization of “wash-on” approach with sunscreen agents, laundering, etc.

Ideally, photo protective fabrics and clothes should provide wearers with effective and comfortable protection against full solar spectrum while helping to dissipate the heat and moisture.

EURO COSMETICS: *Our industry has made much progress with topical sun care agents so how do you see the entry of the new photo-protective fabric category integrating with earlier approaches?*

Dr. Olga Dueva-Koganov: Use of sun protective clothes, wide-brimmed hats and sun umbrellas – in conjunction with topical



Dr. Olga Dueva-Koganov

broad spectrum sunscreen products and sun glasses has been advocated for years by dermatologists and government agencies – as important part of safer sun exposure routine. The use of more advanced photo-protective fabrics should be aligned with this well-established approach.

New photo-protective fabrics could act as wearable sun filters by sufficiently absorbing, and/or reflecting and/or scattering UV, VIS and IR radiation; and can be effectively used together, in conjunction with topical sunscreen products.

EURO COSMETICS: *Is meaningful protection of skin against full spectrum sunlight (UV-VIS-IR) achievable with fabrics?*

Dr. Olga Dueva-Koganov: Yes, my colleagues and I have shown that various fabrics possess protection potentials against full spectrum sunlight and also against its VIS+IR portion.

EURO COSMETICS: *Is there some synergy in improved sun protection if special fabrics are used together with topical sunscreens?*

Dr. Olga Dueva-Koganov: Certain fabrics could be used in conjunction with topical

sunscreen products in order to achieve expanded photo protection of skin. We could expect the additive effects and potential synergies as well. However, these effects and potential synergies should be demonstrated first in vitro or in ex-vivo tests – before follow-up evaluations in vivo under actual “end-use” sun exposure conditions.

EURO COSMETICS: *How have fabrics historically been used for sun protection?*

Dr. Olga Dueva-Koganov: Sun irradiation is essential for life and arguably is the most impactful element of nature.

For thousands of years people were using various fabrics and clothes as surviving tools protecting skin from sun and other environmental factors.

Indeed, the optimal sun protection could be achieved by photo protective fabrics that are capable to reduce the intensity of the incident sun irradiation, ideally without significantly altering its shape.

EURO COSMETICS: *How is UV protection by fabrics measured now, and what are the limitations of current methods?*

Dr. Olga Dueva-Koganov: The ultraviolet protection factor (UPF) metric currently used for fabrics is somewhat similar to sun protection factor (SPF) metric used for sunscreen products applied topically. The UPF concept was first standardized in Australia in 1996 (Standard AS/NZS 4399); it quantifies how effectively a piece of clothing (fabric) shields against the ultraviolet irradiation. UPF is determined by instrumental in vitro test methods based on the fabric transmission in UV range in conjunction with solar UV spectrum and McKinlay-Diffey erythemal action spectrum. UPF is the ratio of the erythemally weighted UV irradiance at the detector without test fabric to the erythemally weighted UV irradiance at the detector with the test fabric. When fabric samples

are found to have a measured UPF values over 50, AS/NZS 4399 allows rating them only as UPF 50+ to prevent escalating claims from clothing manufacturers. The systems for determining UPFs are similar around the world. In 2007 Gies published the overview of photoprotection by clothing and emphasized that for photosensitive people it would be desirable to develop protective clothing with extremely low transmittances across not only UVB, but also the UVA and VIS. However, the testing of such garments would require specialized equipment at that time commercially manufactured UPF testing equipment did not have the adequate capabilities.

EURO COSMETICS: *We understand Ashland has developed improved testing methodologies for skin protection by fabrics. Could you tell us about the latest methods and why they are superior.*

Dr. Olga Dueva-Koganov: In general, development of improved test methods is inspired and driven by the recognized deficiencies of the existing methods and the progress in suitable and relevant test equipment.

In 2014–2015 my colleagues Artyom Duev, Paul Recht, Robert Turner, Steven Micceri and I developed in vitro testing methodologies to qualitatively and semi-quantitatively rank protection by fabrics against full spectrum solar radiation. Experimental set-up included: Solar Simulator LS 1000-6R-002 Rev.3 with Xenon Arc Lamp and XPS 1000 precision current source; PMA2144 Pyranometer with PMA2101 Detector to measure the total radiant power of incident radiation from 310 nm to 2800 nm. Simulated sun irradiance was produced with the plain mirror, AM0 (SL04486) and AM1.5 (SL04204) filters; VIS+IR portion of sun irradiance at Earth surface was achieved with plain mirror, AM0 (SL04486), AM1.5 (SL04204) and UV cut-off (SL07876) filters. Opaque housing was custom-made for the Pyranometer for accurate positioning of the fabrics over the detector. The simulated irradiance closely resembled solar radiation at clear sky: 1100 W/m². The attenuation of simulated sunlight and its VIS+IR portion by test fabric

was calculated as a percentage of irradiance attenuated assuming that the irradiance data recorded for the empty light path is 100 percent.

We evaluated 75 sun protective fabrics of different composition, color, thickness, weave densities, and construction. Test fabrics demonstrated 63%–90% protection against full spectrum (310 nm–2800 nm); 58%–89% protection against VIS+IR (~400 nm–2800 nm). We found that the attenuation of full spectrum and VIS +IR portion correlate ($R^2 = 0.97$) and weave gap size is a major factor influencing fabric's protection potential. Interestingly, fabrics with the highest percent absorption of simulated full solar and its VIS + IR portion not always showed highest UPF value, which indicates that there is no direct correlation among these protective properties.

Figure below shows a transmittance spectrum of polyester fabric, barn red color with moisture control system. A Cary 5000 UV-Vis-NIR spectrophotometer with DRA 2500 integrating sphere accessory (both from Agilent Technologies, Santa Clara, CA) was used for this testing.

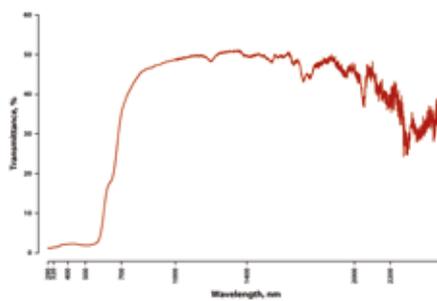


Figure: Transmittance Spectrum of the Test Fabric

In our tests measured UPF of fabric was 99 (claimed 50+); and it demonstrated ~78% attenuation of full solar irradiation and ~75% of VIS+IR portion.

EURO COSMETICS: *How do you see the approach of using sun protecting fabrics with current topical sunscreen agents fitting together as a new cosmetic category and what role do you foresee for cosmetic ingredient companies?*

Dr. Olga Dueva-Koganov: Possible legal, regulatory and commercial aspects for la-

beling of new photo protective fabrics (beyond UPF) may arise and will need to be addressed. It is known that some topical sunscreen products may cause fabric's staining, which could be addressed by adequate formulation strategies. Concern that prolonged extensive fabric coverage could cause or contribute to vitamin D deficiency is expected. Similar concern is associated with topical sunscreen products. Potentially it may be addressed by designing a special fabric capable of transmitting a fraction of the UVB required for vitamin D synthesis while screening out harmful rays. Oral Vitamin D supplements could be used in case of deficiency as well.

EURO COSMETICS: *Thank you for the conversation.*

Olga Dueva-Koganov has received PharmD from the State Medical University, Ukraine; followed by Sc.D. and Ph.D. in Pharmaceutical Sciences from Higher Attestation Commission under the USSR (Former Soviet Union) Council of Ministers. In her current role she supports development and evaluation of sustainable ingredients and solutions for sun/skin/personal care markets.

She is a co-author in more than 70 technical publications, 31 issued patents and pending patent applications; and frequently speaks at scientific symposiums. She is a member of American Chemical Society, Society of Cosmetic Chemists and International Scientific Advisory Board of Household and Personal Care Today. ■