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Light stabilizers for architectural exterior coatings

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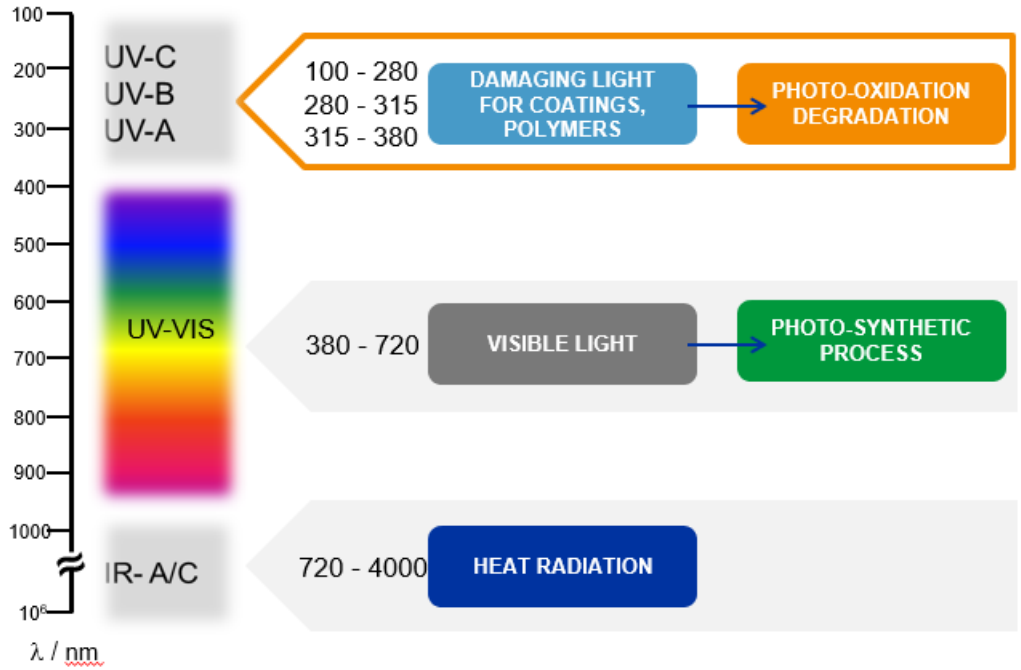
The basics of light and heat stabilization

The energy transmitted by light from the ultraviolet (UV) part of the spectrum is responsible for damage to coatings and polymers, because it causes degradation in the form of photo-oxidation. UV radiation is classified according to wavelength as UV-A, UV-B and UV-C. Generally speaking, UV-A and UV-B are the most damaging parts of the spectrum because the energy that can develop at these wavelengths is equal to the energy that holds certain bonds together in the paint film.

*Definition from Collins Dictionary



The UV light most likely to dissociate or damage the bonds needs to be filtered out.

	λ(nm)	Bond	Type of Bond	Bond Energy (kJ/mol)
UV-B	230	-C-C-	Aromatic	520
	286	R-O-H	Alcohol	420
	290	R-CR2-H	prim/sec/tert H	410/395/385
	310	C-O-H	Alcohol	385
	320	-C-O-	Ether	365-390
UV-A	340	$R-CH_2-CH_3$	Aliphatic	335 to 370
	350	$-CH_2-Cl$	Aliphatic chlorides	330 to 350
	360	$-CH_2-NR_2$	Amine	330
	400	-O-O-	Peroxide	270

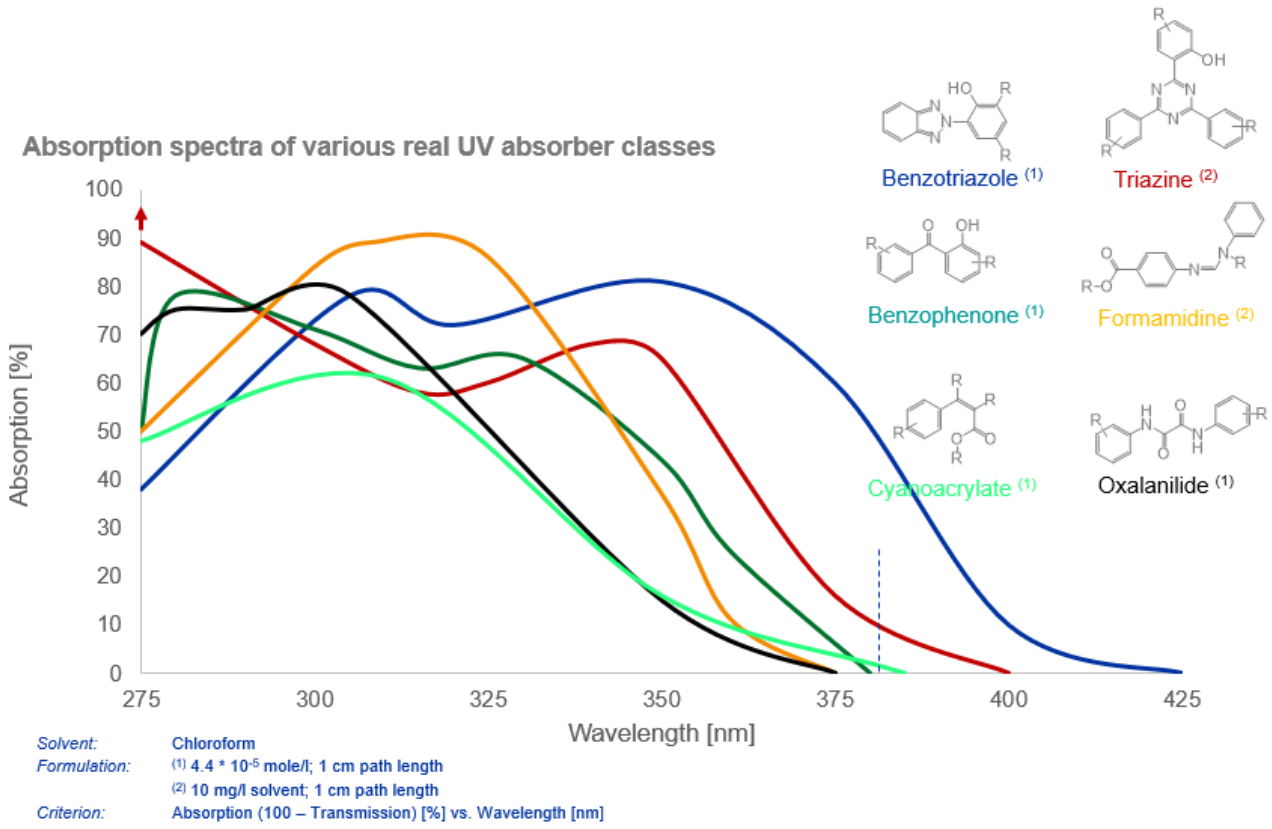
When light hits a paint film or polymer, dissociation causes the formation of radicals, which in the presence of oxygen can further combine and cause damage. This is aggravated by the combined effects of light and heat. The whole mechanism of photo-oxidation leads to a complete transformation and dissociation of the bonds and further changes in the structure of the polymer, resulting in degradation.

*Definition from Collins Dictionary

UV absorbers, hindered amine light stabilizers and antioxidants

There are several ways to prevent radicals from propagating in the polymer film. Special additives are able to react with UV light and to filter and absorb the harmful part of the light.

UV absorbers (UVAs) are molecules containing a chromophore that is able to absorb UV light at certain wavelengths. Several molecule classes act as UV absorbers, including benzotriazole, hydrophenyl triazine and benzophenone as well as less traditional ones such as oxanilide, cyanoacrylate and formamidine. These molecules all absorb light from the UV part of the spectrum, which has a chromophore. The main difference between them lies in their efficiency and the wavelength at which they are most effective. UVAs are generally most suitable for thick films and at high concentrations.



The UV absorber is converted and releases heat by means of a tautomerism mechanism. Tautomerism is the ability of certain chemical compounds to exist as a mixture of two interconvertible isomers in equilibrium*. The chromophore, however, is active in the paint film or polymer and light and heat will still cause radicals to form on the surface.

Hindered amine light stabilizers (HALS) act as radical scavengers, trapping the radicals in a cyclic process. The HALS therefore continues to be released. HALS prevent degradation at the coating surface, where UVAs offer less protection. HALS are effective at temperatures up to 140°C and light stable.

*Definition from Collins Dictionary

Like HALS, antioxidants (AOs) act as radical scavengers. They prevent coatings from degradation caused by processing and/or exposure to high temperatures. There are various types of AO. Phenolic (primary) AOs are all-rounders that serve mainly to protect the finished product. Phosphites, also known as secondary AOs, are especially used during processing. Thioester AOs decompose and neutralize hydroperoxides formed through polymer oxidation. They provide protection against heat aging and preserve color. Aminic AOs help to safeguard physical and surface properties, including color, and scorch and heat resistance. Binary blends, which are a combination of a primary (phenolic) and a secondary (phosphite) AO, are designed to ensure optimum stabilization during processing and service life.

The importance of selecting the right stabilizers

Architectural coatings are designed for on-site application and therefore need to dry under ambient curing conditions. The most important properties required include good penetration and adhesion, high durability, resistance to high and low temperatures as well as to chalking and cracking, and retention of color and appearance.

To guard against degradation, surface defects, erosion and color fading, the key factors to be taken into account are the UV stability of the pigments, binders and other raw materials, weather conditions, including temperature, and direction and orientation of the exterior or interior of the building. Performance can be influenced by optimizing formulations, selecting suitable raw materials, and using durable binders and additives that provide protection against the harmful effects of light and heat, i.e., UVAs, HALS and AOs.

A typical architectural coating contains resins and binders, pigments, solvents and additives such as AOs and light stabilizers.

To protect coatings against the harmful effects of light and heat, SONGWON offers a comprehensive range of high value, high performance coating stabilizers for numerous substrates, including steel, metal, wood, ceramics and special composites used in decorative and architectural coatings:

- SONGNOX® CS Antioxidants
- SONGSORB® CS UV Absorbers
- SONGSORB® CS HALS

As increasingly high standards are required of the end products and legal requirements become ever more stringent, SONGWON continues to work on the design of new and improved stabilization products that meet a wide variety of requirements.

*Definition from Collins Dictionary