

Ingenia Extrusion Brief

UV Masterbatches

Molecules can absorb photons at wavelengths found in sunlight, such as infrared radiation, visible light, and ultraviolet light leading which can lead to photodegradation. Only 5% of solar radiation has a ultraviolet wavelength from 400nm to 290nm, which is the main cause of plastic photodegradation. Different location around the globe have very different solar energy distribution. The higher the solar energy exposure, the more easily the plastics are degraded. Although polyolefins do not absorb wavelength longer than 290nm which induces degradation, the traces of impurities may show absorption in the UV range and lead to photo chemical transformations. Photodegradation can cause loss in physical properties and discoloration. UV additives can increase the service life of plastics for outdoor applications, such as agricultural films, automotive OEM, roofing tiles, trash and roll out carts, etc.

Type of Light Stabilizer and How to Select

These are different kinds of light stabilizers. Ultraviolet light absorbers (UVA) and hindered amine light stabilizers (HALS) are the most common organic light stabilizers. Organic UVA can absorb light energy primarily in the UV band, raise the energetic state of the molecules, and then return to lower energy state by releasing the energy as thermal energy. Benzophenones, benzotriazoles and triazines are common organic UVAs. Different UVA have different UV-VIS absorption spectra. It is necessary to check if the UVA absorption spectrum could affect the end applications, such as the bumble bee pollination or the color of the plastic products. Because UVAs are subject to Beers-Lambert Law, where light absorption is directly proportional to path length and the concentration of the additives, UVAs are not effective in thin films.



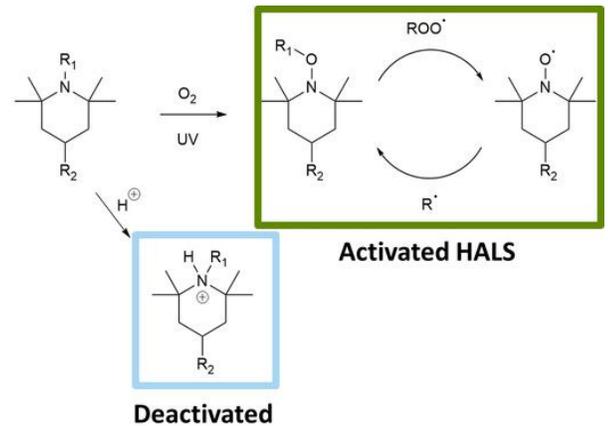


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When selecting UVA additives the absorption of the UVA should match with the polymer sensitivity to light. The UVA should not block critical wavelengths of UV that are required for the final application or absorb visible regions that affect the final appearance of products. Lastly, it is important to consider the stability and volatility as well as extractability of the additive

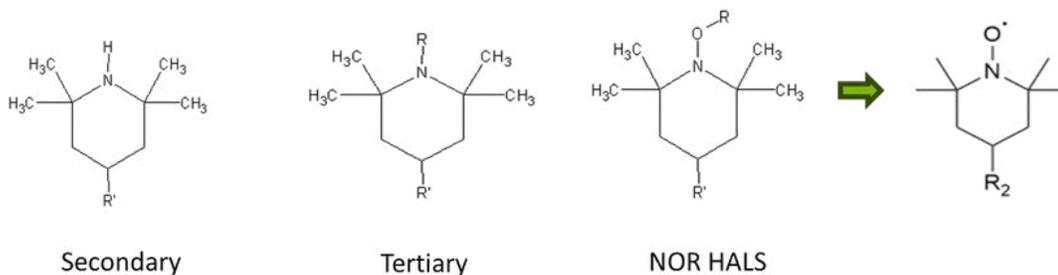
Carbon black is not only used as pigment, but also a UV absorber and radical scavenger. The smaller the particle size the better the weatherability. 19nm carbon black is the most common inorganic UVA, used in agriculture films and plastic parts.

HALS were an important development in light stabilization, they can stabilize polymers via different mechanisms which make them very efficient to protect polymer from photodegradation. They can be effective in both thin and thick films. HALS are generally formulated in an inactive form and only acts as stabilizer once exposed to energy and oxygen. The activated HALS can also be regenerated after quenching the alkyl radicals which is known as Denisov Cycle. However, HALS can be deactivated by acidic substances like pesticides and can lose effectiveness as light stabilizer.



There are three types of HALS including secondary, tertiary and alkoxyamines (NOR). Secondary HALS is the most basic and NOR HALS is the least basic. The higher the basicity, the less acidic chemical resistance. Secondary HALS could be very efficient and a cost-effective choice, but if there is chemical exposure such as agricultural film applications, tertiary or NOR HALS will be a better choice.

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Key points that need to be considered when selecting HALS:

- Service life of the product - the longer the service life, the higher the dosage is required but may not be linear correlation.
- Location - latitude affects total solar irradiation
- Chemical exposure - pesticides, salt water, etc.
- Applications requirement - Smaller molecules are mobile but can be highly water extractable. Larger molecules are less volatile.
- Compatibility with polymer
- Interaction with other additives - HALS showed antagonistic effect on polymer process aid (PPA) performance and can also interact with a crosslinking reaction.

Performance Testing:

Before evaluating the products with light stabilizers in the field, different kinds of accelerated testing can be done in the lab with specially designed weather chambers. Temperature and humidity can be controlled, and different exposure cycles can be customized. The most common test chambers include QUV test chamber and Xenon arc chamber. QUV test chamber has fluorescent light source with either UVA region or UVB region. Xenon Arc chamber has xenon arc light source and is often equipped with different filters to stimulate different applications. Properly filtered arcs stimulate terrestrial solar radiation in both the UV and visible regions than any other artificial test source.