Wavelength Selective Plastic Films

Current use of ultraviolet absorbers in film and thicker section molded plastics have been limited by the typical range and absorptivity of the class of Ultraviolet Absorber. Current classes continue to include hydroxy-substituted benzophenones and benzotriazoles that dominant the global community. While oxanilides, benzylidene malonate esters, cyano-acrylates and hindered benzoates take a back seat to the more grand-fathered and broader based absorbers. The newest and most expensive UVA include hydroxy-substituted triazines. The trend is clear over the history of ultraviolet absorbers i.e. higher prices and greater absorptivity below 350 nm.

Current global trends in agricultural films for green houses have continued to use Ultraviolet absorbers with Hindered Amines for providing the integrity of the film and absorbing light of a specific wavelength. Both types of light stabilizers used for the fortification of the film loose performance over time at rates dependent on the concentration, class of light stabilizer, base stabilization of the matrix, the resin used, processing history and exposure conditions which include mounting structures. Recent increases globally of insect population and damage to crops, plant diseases due to select fungi, algae and mold growth on the sides of greenhouses, and new discoveries in the field of photochemistry and photo-taxis and the influence of longer wavelengths beyond the traditional range of standard organic Ultraviolet absorbers has proven important in solving the latest and the most challenging problems.

Past challenges in green house films have focused on retention of film properties in the presence of chemicals used to control insects. This problem is still a challenge even with new light stabilizer technologies. The solution would be much easier if we restrict chemicals use and use less aggressive means of controlling insects in green house covered by plastic films. One method that does not involve chemicals and saves money and safe to the environment is control of insect vectors by controlling photo-taxis and photo-kinetics of all species.

Studies have identified what wavelengths attract various species of insect and what wavelengths they do not respond. Take away the wavelengths that attract insects to a greenhouse environment you limit insect vector and reduce population and thereby reduce pesticides and insecticides. Reduce chemical use in controlling insects you decrease film damage and prolong life of the film.

The wavelengths that control insect vectors are diverse and range in the 300-400 nm range and beyond into the indigo, blue, green region.

Insect egg maturation in the soils has been identified in the red region from 620-675 nm.

The most dominant wavelength region of attraction for the majority of insects identified in greenhouses includes blue light from 400-480 nm. This range is not covered by conventional organic UVA sold in the market today. In order to cover this region and control transmission we need to control bathochromic (red shift) mechanisms of the organic absorber or introduce broader absorbing molecules. Since control of red and blue shift in organic molecules is typically influenced by the polarity of the matrix this has become limited until recently.

Recent discoveries show conventional organic ultraviolet absorbers are more synergistic than previously reported in the literature. Many can be influenced by select inorganic structures called Spectral Enhancers that shift spectra to higher wavelengths. In addition many classes also include a Hyperchromic effect (increase in absorption intensity). The Hyperchromic Effect is significant.

Hyperchromicity is a rare occurrance in photochemical processes while Hypochromic Effect(a decrease in absorption intensity), is more common.

Studies continue to support the Plasmonic mechanism causing a bathochromic (red shift) to higher wavelengths of 5-10 nm depending on the organic ultraviolet absorber and ratio of the absorber to Spectral Enhancer in the plastic film.

Another observation of this affect by the Spectral Enhancer is control of in-situ consumption of the organic absorber during UV exposure. This has been found to extend to hindered amine light stabilizers.

The current range of Spectral Enhancer found is not limited to a specific type of material. Indeed the full potential of what has been discovered has yet to be fully revealed. The field of Spectral Enhancer is not limited to Ultraviolet absorbers nor Hindered Amines and appears to extend to both artificial and natural pigments.

The properties of some Spectral Enhancers have broad intrinsic absorbance from 200 to 800 nm and extend into the Mid Infrared and Far infrared region while others are narrow in their spectra profiles.

These findings clearly show that Plasmon and Photonics are not limited to colloidal particles and more exotic metals. The industrial

use of Plasmon Mechanisms can now be exploited for broader and cheaper solutions to existing problems globally without the development of new chemistries.

Therefore, since this discovery studies in control of plant disease like the Botrytis Cinerea fungi an aggressive plant pathogen called Grey mold disease and many more fungi related to this pathogen have shown conclusively that control of conidiation by selective wavelength control is possible.

In addition control of rancidity of oils and foods containing oils by using selective UV packaging that covers key wavelengths that initiate rancidity mechanism in the 430 – 450 nm range are now possible. This has been illustrated in polyolefins injection molded and blow molded bottles without any pigmentation.

The recent discovery that various microalgae, blue green and red algae respond to various wavelengths for growth and the elimination of these wavelengths reduce the algae makes control possible without chemicals.

The key for many of the new solutions we are face globally appear to be resolved in the new spectral region of 400 to 480 nm and more limited by the green and red region of the spectrum. This region has been typically ignored as evidenced by the current selection of additives being offered in the market for over fifty years. Today the global community is finding that blue light is more important both the fields of biology, chemistry, botany and physics that envisioned previously.

In conclusion the recent introduction of UVITA SME 3811 Spectral Enhancer and UVITA SME 3811-S and O are only the beginning. The broad spectral permanence of UVITA SME 3811 series and significant effects on conventional organic absorbers and hindered amines makes their introduction another alternative to extend existing chemistries beyond the limits of what we have expected and come to believe is normal. If we can take an existing conventional absorber and double its absorbance and decrease its in-situ consumption over time we have extended the life of the absorber and the end use application at lower cost at greater profit.

“Chance, favors only the Prepared Mind”(L.Pasteur)