



Photodegradation caused by UV and visible light exposure can cause drastic color changes in natural wood.

Image Source: Unsplash user Zbysiu Rodak

The sun's color shifting effects on wood are obvious to anyone who has seen the stark white limbs of driftwood on a beach or the silvery gray of a weathered barn. Or, more frustratingly, anyone who's moved a piece of furniture only to discover that [the hardwood flooring underneath](#) is a distinctly different color than the rest of the room. These color changes are the product of a series of photochemical reactions on the surface of the wood primarily resulting from ultraviolet radiation, or UV light, with visible light also contributing to the shift in coloration.

Not only do these color shifts often disrupt a pleasing aesthetic appearance of wood products, they also indicate degradation of the wood itself, compromising durability and structural integrity. UV-resistant clear coating can prevent both undesirable aesthetic and material changes, but formulating these products requires exacting color measurement to optimize efficacy.

The Need for Transparent UV-Resistant Clear Coating Systems

To protect wood products from color change resulting from light exposure, commercial producers and hobbyists alike use a range of UV-resistant finishing products that shield the vulnerable wooden surface from the photodamage of both natural and artificial light sources. Today, these products primarily take the form of pigmented stains in which the pigment itself offers varying levels of UV protection. However, pigmented products inherently alter the color of the wood and clear coat alternatives have not historically been formulated to offer comparable UV protection, much to the frustration of woodworkers who wish to maintain a natural appearance by using transparent finishes. As noted in *Paint & Coatings Industry* magazine:

Transparent systems that allow the natural features of wood – including color, grain and texture – to remain visible are attracting interest and demand for them has been increasing. However, the long-term instability of such transparent systems in outdoor applications has so far seriously hindered them from becoming more widespread. The main reason for this instability is the UV light

transparency of the topcoats and the extreme sensitivity of certain wood components, particularly lignin, to UV light degradation.¹

According to Mark Knaebe, a chemist at Forest Products Laboratory, most UV-resistant clear coatings currently act more like a sunscreen than a long-lasting solution for photodegradation. “The organic molecules can only handle so many photons before they fall apart.”² Sometimes, UV protection can last as little as a few months, resulting in not only rapid color change, but mechanical degradation of the wood, compromising both appearance and function.



Clear coatings allow the natural beauty and character of the wood to shine through, but poor UV protection leaves it vulnerable to yellowing and darkening over time.

Image Source: Unsplash user Erol Ahmed

Toward Enhanced UV Protection

Since the 1970s, chemists have spent considerable time researching the possibilities of clear coating products that offer a high level of long-lasting UV protection without resorting to pigmentation. In the past decade, advances in chemistry have spurred the development of more sophisticated, effective, and durable additives that enhance the ability to shield wooden products from [undesirable color change](#) without resorting to pigments using three elements:

- **UV Absorbers (UVAs):** UV absorbers work by [absorbing UV light and dissipating the energy as heat](#), preventing the radiation from ever reaching the surface of the wood. UVAs may offer protection for all woods, but are particularly critical for preventing the darkening of light wood species.
- **Hindered Amine Light Stabilizers (HALS):** Hindered amine light stabilizers do not absorb light, but inhibit photo-degradation by trapping radicals at the surface.
- **Lignin Stabilizer:** Wood color change is primarily the result of photo-oxidation of lignin. Pretreating wood with a lignin stabilizer prevents lignin degradation.

As noted in *European Coatings Journal*, the most successful UV-resistant clear coatings use a combination of UVAs and HALS with lignin stabilizing pretreatments to “retain aesthetic and mechanical properties” of the wood.³ However, the optimal formulation of each type of UV-resistant coating and lignin stabilizer and the exact ratio of products is still the subject of intense research and new compounds that offer superior color retention are continuously being identified. Additionally, the immediate UV protection of these formulas is not the only consideration; wood is typically prized for its beauty and finishing products much both enhance the appearance of the wood’s natural aesthetic qualities and preserve the appearance of the wood over time. As such, finishing materials themselves must resist yellowing or other discoloration due to light exposure.



UV-resistant finishes are critical to protecting wood products exposed to natural light, such as outdoor construction materials and furniture.

Image Source: Pexels user Jay Mantri

Evaluating UV-Resistant Clear Coating Formulations

UV-Vis spectrophotometry offers the best method to evaluate the protection offered by UVAs, HALs, and lignin stabilizers by precisely quantifying color change in response to UV exposure. Today’s advanced colorimetric technologies give chemists the ability to [rapidly distill color information to objective color data](#) for greater insight into a product’s UV protection capabilities than ever before. The [versatile optical geometries](#) available in spectrophotometric instrumentation make it possible to detect even the minutest color change in all sample types, including opaque, translucent, and transparent materials. As such, the color of wooden products, pretreatments, and the clear coating itself can be accurately assessed in response to artificial weathering to ensure resistance to unacceptable color shifts. The [flexible and customizable software packages](#) that accompany modern spectrophotometers allow chemists to precisely correlate the behavior of color to both individual ingredients and process variables. As such, these instruments are critical components of both research and manufacture of more effective UV-resistant formulations to meet consumer demands for long-lasting aesthetic and material protection.

Optimizing Color Measurement

HunterLab has been a pioneer in the field of color measurement for over 60 years. Our spectrophotometric technologies and software packages are renowned across the chemical industry for their extraordinary level of accuracy, user-friendly design, and responsiveness to customer needs. With a comprehensive range of portable, benchtop, and in-line instruments to choose from, we supply end-to-end solutions for researchers and manufacturers alike as they continuously seek to create and produce more advanced formulations in a competitive marketplace. [Contact us](#) to learn more about our innovative lineup of products and dedicated customer support services and let us help you bring your color quality control to new heights.

1. "Color Stabilization of Wood and Durability Improvement of Wood Coatings: A New UV Light-Protection Concept for Indoor and Outdoor Applications," February 28, 2002, <http://www.pcimag.com/articles/82717-color-stabilization-of-wood-and-durability-improvement-of-wood-coatings-a-new-uv-light-protection-concept-for-indoor-and-outdoor-applications>
2. "Advances in Clear-Coats Make Them More Practical," <http://www.thisoldhouse.com/toh/article/0,,230015,00.html>
3. "Defended From the Sun," December 2006, <http://www.european-coatings.com/content/download/60656/693172/version/1/file/61404.pdf>