TECHNICAL NOTE

Influence of Wood Surface Color on the Performance of Luminescent Pigments

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Abstract

Luminescent pigments can be incorporated into coatings for various applications, including safety signage, that provide illuminated directions when lighting systems fail. The influence of the brightness of a solid wood substrate on the persistence performance of luminescent pigments was analyzed. Three species were tested: maple (*Acer pseudoplatanus*; a brightly colored wood), steamed beech (*Fagus sylvatica*; a medium-colored wood), and walnut heartwood (*Juglans regia*; a dark-colored wood). The results show that the surface color has a major influence on the performance of the pigments, when applied in a clear coating. Other significant factors for the afterglowing effect are the amount of pigment and the time and intensity of light during the charging process.

It is important for the wood industry to add functionality to wood for new applications and markets. One idea is to modify existing technologies like coating systems, which apply a protective layer on the wood surface (Militz 2012, Petrič 2013). Luminescent pigments could be added to coatings as a safety feature that provides illuminated directions when lighting systems fail. In general, luminescent pigments are solid inorganic materials such as zinc sulfide or alkaline earth aluminates that have the ability to absorb light energy from the surroundings and can later emit visible light energy to their surroundings (the ''afterglow'' effect). These pigments are used in the plastics industry to provide reliable information in the form of emergency guide signs in public buildings. The afterglowing effect of the pigments provides visible instructions when lighting is interrupted (Honeywell International 2013). Luminescent pigments are also used for applications such as glow-in-the-dark toys, the authentication and security of valuable products, and automatic processing, e.g., sorting of letters and parcels (Honeywell International 2013). This experiment sought to define the influence of the brightness of the substrate on the afterglowing performance of luminescent pigments applied within clear wood coatings to wood surfaces. Maple (*Acer pseudoplatanus*, a brightly colored wood), steamed beech (*Fagus sylvatica*, a medium-colored wood), and walnut (*Juglans regia*, a dark-colored wood) were chosen to provide a wide range of substrate variation.

Methodology

Two sample boards were prepared to test each of the three species: maple, steamed beech, and walnut (Fig. 1).

One sheet of veneer of each species was glued onto medium-density fiberboards to ensure a consistently smooth test area. Afterward, the veneer surfaces were sanded with 100/150-grit sandpaper. The samples were primed twice with an unpigmented polyurethane topcoat (ADLER Pigmotop G50 binder basis polyacrylate resin and cellulose acetobutyrate) to prepare an even substrate and to avoid clustering of the lacquer–pigment mixture on the surface structure. Luminescent pigments (20%; Honeywell Lumilux Green) were mixed with polyurethane topcoat (80%) on a mass basis. The application of the resin–pigment mixture was done with a 120-µm coating knife. Distinct areas of each sample were coated with one, two, or three layers of the pigmented mixture, which are symbolized with gray color tone in Figure 2.

To maintain the natural appearance of the wood, a low percentage of pigments (20%) was chosen (see Fig. 2, right). The performance tests were done at fixed locations on the

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Figure 1.—Appearance of maple (left), beech (middle), and walnut (right) wood before coating application. (Color version is available online.)

testing boards. An Erichsen Matchmaster 425 light chamber with a D_{65} light, which provides illumination similar to daylight, was used for the charging process. Charging cycles of 10, 20, and 30 minutes were chosen to investigate potential effects of the charging duration. After each charging cycle, light intensity (afterglow) measurements were made with an ALMEMO 2290-4 lux meter.

Results and Discussion

Afterglow of the luminescent pigments increased with the number of coating layers for each wood species (Fig. 3, left). The maple samples showed the highest afterglowing performance, followed by the beech and walnut samples. The charging time (10, 20, and 30 min) was not important to the afterglow performance, which was measured immediately after the charging process (Fig. 3, right). The effect of the charging time on the duration of the afterglowing effect was not measured in this test.

These data suggest a strong influence of the color of the wood substrate on the afterglow performance of luminescent pigments applied in clear coatings, although there may be other species-related effects that are also important. These data are consistent with the observation that various wood species absorb and reflect different wavelengths of the visible light (Sandermann and Schlumbom 1962a, 1962b; Schneider 1966; Norrström 1969).

In general, brighter surfaces reflect more light across the (visible) spectrum than darker surfaces (Wyszecki and Stiles 2000, Nassau 2001). Therefore, when applied in clear coatings, luminescent pigments obtain more light energy during charging and more of their re-emitted light is reflected from the wood's surface.

Future work could include quantifying color differences associated with species variation, coating thickness, and possible additives. In addition, minimum charging times, pigment durability, and the effects of various lighting sources would be important considerations in the application of luminescent pigments to wooden surfaces.

Conclusions

Luminescent pigments have the potential to add functionality to wood surfaces for new applications. These results show that, when applied in clear coatings that maintain the natural beauty of the wood, the substrate color will significantly affect the afterglow performance of the systems.

Figure 2.—Application process and appearance of uncoated (left) and coated (right) walnut surface. (Color version is available online.)

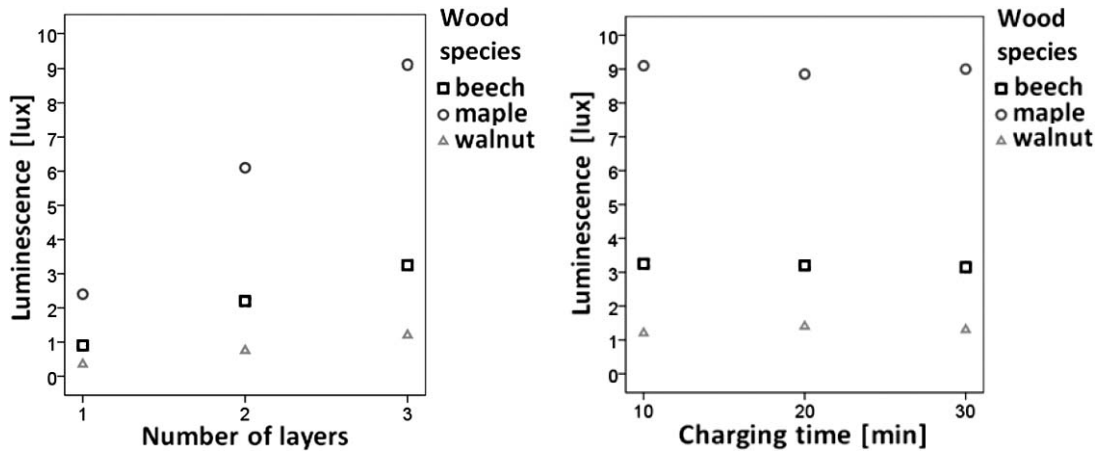

Figure 3.—Afterglow performance analyzed depending on number of layers after 10-minute charging time (left) and depending on charging time with three layers of pigment mixture (right).

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