An Examination of the Lightfastness of Selected Hardwoods after Artificial Aging

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Introduction

This project was proposed by Anne-Stéphanie Etienne and Eric Hagan to contribute toward their larger research that focuses on the lightfastness of wood and developing a system to improve wood fill treatment. As wood is exposed to light, it results in a process of photodegradation that causes a visible colour change to the surface. Art conservators frequently use new wood as a fill material for wooden objects, and the new wood may then age and discolour at a different rate than the original wood. This study specifically selected woods that could be used as fills for mahogany objects and determined their lightfastness by artificially aging samples and measuring their subsequent colour change. The results also aided in the larger goal of determining when the colour change for each wood plateaus, and by extension the feasibility of using different aged or 'pre-faded' woods as gap filling materials.

Experimental

Materials

- 11 hardwood species:
  1. African Mahogany
  2. Birch
  3. Cherry
  4. Etimoe
  5. Koa
  6. Lyptus
  7. Makore
  8. Maple
  9. Sapele
  10. Sycamore
  11. Walnut
- One African Mahogany sample finished with pigmented shellac
- Blue Wool (BW) Standards 1-8

Fig. 1. Samples fixed in Q-Sun before aging.

Methods of Investigation

Samples were artificially aged in the Q-Sun Xenon Test Chamber for a total of 504 hours. Duplicate samples were sent to CCI to be aged in their custom LED Fadometer for six months.

Colour measurements were taken before, during, and after artificial aging using the Spectrophotometer CM 700d.

Initial colour measurements were taken directly after sanding the surface to expose fresh wood. Subsequent colour measurements were taken most frequently at the start of aging.

Fig. 2. Jig used to take repeated spectrophotometer measurements. Courtesy of Anne-Stéphanie Etienne.

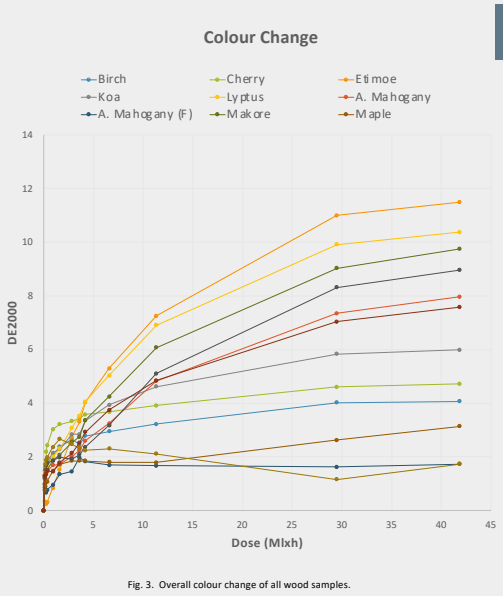

Fig. 3. Overall colour change of all wood samples.

Results and Discussion

- Most wood samples became lighter as they aged, and dark woods had more pronounced colour changes after aging.
- All uncoated wood samples were found to be highly light sensitive, with BW ratings between 1-2, and there was no correlation between BW rating and extent of overall colour change.
- The finished African mahogany was a noticeable exception to the trends of other dark woods. It was both the most lightfast and had the lowest overall colour change.
- The length of time aged was insufficient to produce a clear plateau in colour change for all wood samples, particularly for the dark woods, but the tendency was apparent.

Future research would benefit from an increased aging period, ideally to see both the colour plateau and the point at which coatings degrade and no longer offer light protection. The upcoming aging of samples at CCI will extend the aging period to six months. This study will hopefully verify and expand upon the results obtained here.

Table 1. Lightfastness of Wood Samples

Samples	Dose to JND (Mlux.h)	BW Rating	Overall ΔE_{00}
Sycamore	0.16	1	1.73
African Mahogany (Finished)	3.18	3	1.73
Maple	1.55	2	3.13
Birch	0.37	1	4.06
Cherry	0.15	1	4.72
Koa	0.25	1	5.99
Walnut	1.42	2	7.57
African Mahogany	1.17	2	7.96
Sapele	0.28	1	8.96
Makore	0.67	2	9.75
Lyptus	0.42	1	10.38
Etimoe	1.76	2	11.49

Conclusions

Results largely followed three trends:

- Light woods, with the exception of lyptus, had subtle colour differences. Their colour change spiked early into aging and most reached a plateau point shortly afterward.
- Dark woods had large colour differences and were unable to reach a plateau in colour change within the timeline of this study.
- The finished African mahogany behaved more similar to a light wood than a dark wood and was the most resilient to colour change.

The results should be useful to the conservator looking to select a wood species as fill material for a wooden object. Caution should be taken when selecting dark woods, or lytpus. It would be necessary to coat or employ a period of pre-aging longer than what was conducted in this study before attempting a colour match. These results make apparent the need for further studies on the aging and effect of different coating systems on different wood species.

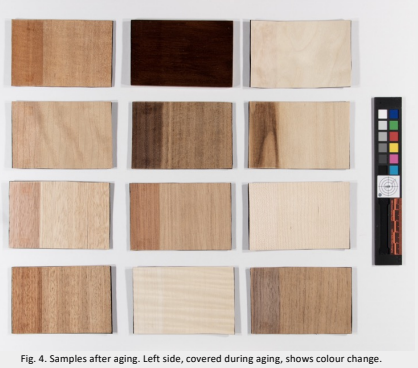

Fig. 4. Samples after aging. Left side, covered during aging, shows colour change.

Selected References

Timar, Maria, Varodi, Anca, Lidia Gurau. "Comparative Study of Photodegradation of Six Wood Species after Short-Tim UV Exposure." *Wood Science and Technology* 50, 2016.

Chang, Hui-Ting and Shang-Tzen Chang. "Correlation Between Softwood Discoloration Induced by Accelerated Lightfastness Testing and by Indoor Exposure." *Polymer Degradation and Stability* 72, no. 2 (2001): 361-365.

Hagan, Eric, Itxel Castro-Soto, Marianne Breault, and Jennifer Poulin. "The Lightfastness of Early Synthetic Organic Dyes." *Heritage Science* 10, no. 1 (2022).

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