A GUIDE FOR
- TOYMAKERS,
- HOBBYISTS,
- CRAFTERS,

AND PARENTS

Living with Wood

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with photomicrographs by
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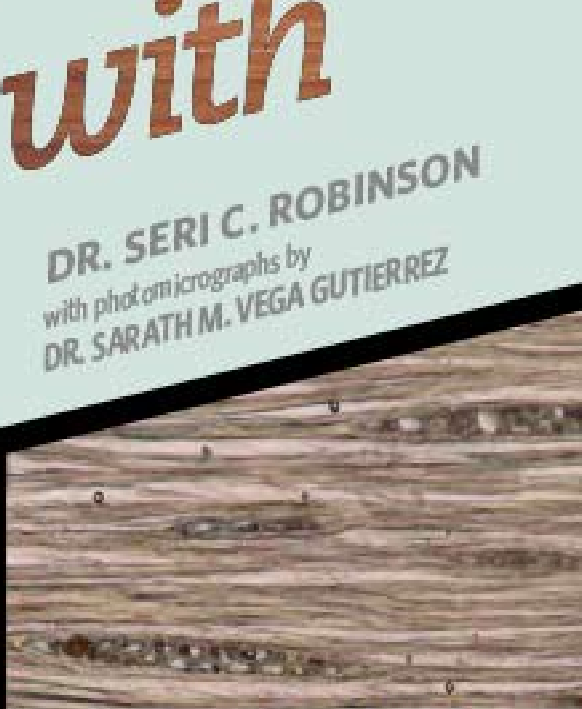

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Introduction

Why does this book exist?

Humans have lived and worked with wood for their entire history, whether through tools, fuel, or craft. It is logical then to assume that we would *understand* wood, intrinsically.

But we don't.

Part of the reason may be due to wood's nearly ubiquitous nature across our planet. If a wooden tool broke, we could just go make another. If one tree made you sneeze, you just used a different one. And who cared about wood that was burning? If it made you warm, well, what else was there?

Unfortunately, though wood is most definitely a renewable resource, like any resource, it is under increasingly heavy burdens as the world population increases. Being good stewards of the planet means not only recycling and using *less*, but using what you have in a *smart* way. It means not just using wood, but *understanding* wood, and how it interacts with you, your home, and your family.

The science of wood (very conveniently called "wood science") is not a new area of expertise. Wood scientists (broadly defined) are prevalent in most countries with forests, especially if said countries are still "developing." The field spans every possible area of science, design, and art, from wood chemists (the people who put chemicals in wood to keep it from rotting too fast); wood physicists, architects, and engineers (think buildings, wood composites, etc.); and wood anatomists (how *do* you tell a cedar from an oak?) to stay-at-home parents who make teething toys for their kids, and wood sculptors.

Although this book focuses on common wood uses in the United States, it is worth noting that wood saturates the daily life of almost every human being. The information presented in this book is not meant as a high-end academic reference or textbook. Its only purpose is to offer parents, woodworkers, bored teenagers—whomever—a gateway into the fascinating and surprisingly complicated world of wood. It covers a broad range of topics, from a primer of wood anatomy to detailed instructions for cleaning wood kitchenware. It was written by a scientist, but also a parent, a woodturner, and a person who has been asked one too many questions about wood floor cleaners. It is not meant to supplant a wood science education, but rather to offer a doorway into a discipline most people don't realize exists.

If you are new to wood, welcome.

If you are a woodworker, a toymaker, a boat builder, or an architect, welcome.

If you're a parent wanting to move from plastic toys to wood, welcome.

If you have wood in your home and just want to take better care of it, double welcome.

Everyone, this book is for you. It's also for the more than four thousand people who have banded together in the Wood Education and Safety group on Facebook over the past four years, all dedicated to better utilizing this amazing material. These people have built a community of science and understanding that has given information to thousands. It's exciting to finally share our community with the broader world.

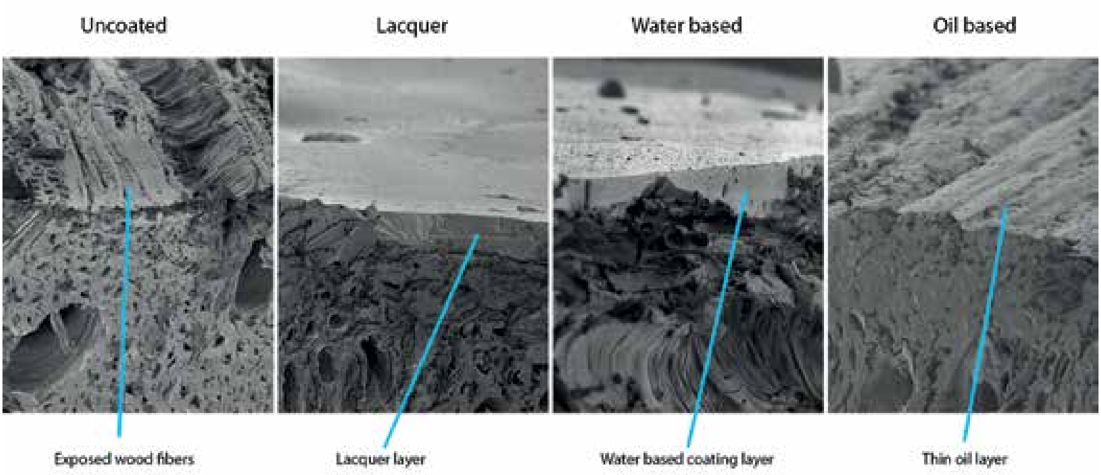
Welcome, friends, to wood.

Chapter 8
FINISHING WOOD

Wood finishes can be broken down into three categories: surface, penetrative, and polish. A surface finish builds a film on the surface of the wood and only marginally penetrates the cells. Shellacs, some lacquers, and water-based polycrylics fall under this category.

Penetrative finishes are finishes that penetrate deeply into the wood and take many coats to build even a semblance of a film. Most penetrative finishes are urethanes or oils (or a combination of the two). It's important to note that within the oils there are two types: hardening and nonhardening oils. Hardening oils will cure over time, forming a (semi)permanent film inside the wood. Nonhardening oils will remain liquid and may move through the wood over time. Nonhardening oils do not, generally, form any sort of protective coating, but they do fill up binding sites and cell void space, preventing the wood from taking up as much water.

Polishes are usually made from wax and form a nondurable film coating on wood, with little to no penetration (oil-wax emulsions penetrate a bit). Outside of carnauba wax, which is difficult to apply without a buffing wheel, waxes mostly make the wood look shiny and impart little, if any, water resistance to the wood for more than a few uses.



SEM images of coated sugar maple (*Acer saccharum*). The uncoated sample shows the raw wood face. The lacquer-coated sample shows a thick cover with just a bit of penetration into the wood fibers. The water-based sample shows the finish sitting almost entirely on top of the wood in a thick layer. The oil-coated sample shows a very thin cover layer with deep penetration into the fibers. *Image courtesy Sarath M. Vega Gutierrez*

There is some overlap between categories. Some lacquers are so heavily solubilized that they function as a sort of penetrative topcoat. Many toymakers mix oil and wax to form an emulsion that gives toys a bit of deeper protection than the wax alone.

When determining which finish to use for a given wooden object, it is critical to consider the object's use. Will the wood be outside and constantly exposed to the elements? Will it be used in a bath and have ample time to dry? Will it be in food contact? Understanding how you want the wood to perform *first* will help in deciding what finish to use.

WOOD FLOORS

This one is more personal choice than anything else. Some people choose to leave their wood floors unfinished and court the dangers of spilled liquids and seasonal swell. Others prefer thick surface finishes that attempt to "seal" the wood from moisture. Others like the shine of a thick oil coat with a wax on top. Know that whatever you choose, wear and upkeep will be critical. Waxes are generally not durable but are easy to reapply and set quickly. Penetrative finishes give a long luster, but if something messes up the finish, generally the entire slat has to be replaced. Surface finishes can flake and crack but can be repaired through sanding.

A new option on the market for finishing wood floors is prefinished flooring. This is where the finish is installed at the factory and cured ahead of time. These finishes have the benefit of being very hard and stable and are done off-gassing by the time the floor is installed in your home. If they do get scuffed, they are hard to repair by a general flooring contractor, but they are also harder to scuff. If you don't want to deal with the weeks of smell from a traditionally finished wood floor, consider prefinished flooring.

A handy flowchart is included for reference.

Food contact / teething

❑ *Y: no finish

❑ *N: move on to next question

Wood for display purposes only?

❑ *Y: Is it spalted?

❑ **Y: water-based polycrylic (doesn't alter the color of the spalting) if desired

❑ **N: Use whatever you'd like. If for indoor display, finish may not be needed

❑ *N: move on to next question

Wood for toys (not meant for teething)?

❑ *Y: use whatever you'd like, but finish isn't necessary

❑ *N: move on to next question

Wood meant for bathroom use

❑ *Y: marine-grade varnish—something that forms a very thick film

❑ *N: move on to next question

Wooden furniture

❑ *Y: Penetrative finishes work best, since they are less likely to chip with repeated bumps and scratches.

❑ *N: move on to next question

Decking and other outdoor structures (non-decay-resistant woods)

❑ *Y: Buy a commercial decking finish. If you want to prolong the original color of your wood, get one with pigments and UV inhibitors. Decay-resistant woods generally do not require a finish. Note that some research has shown that a combination of penetrative finishes and then surface finishes best protects outdoor wood.

❑ *N: move on to wood floors

Bonus: spalted wood

❑ *Y: use a surface finish so as to not get uneven absorption in the punkier areas of the wood

Chapter 9
COLORING WOOD

There are several common ways to color wood, and which you use depends very much on the purpose of the object. Many general wood colorants are not rated for food safety and, as with any additive, will take away from the antimicrobial nature of wood. As such, consider the purpose of the wood object before deciding to color, especially with wood that is meant for toys or food contact.

Painted poplar toy by Kristen Pickens of Two Raccoon Hollow

STAINS

Stains, generally speaking, are commercially produced compounds meant to darken wood. They come in and out of fashion but have been used for hundreds if not thousands of years to change the appearance of wood, especially for wooden furniture. Most stains turn the wood darker brown, sometimes into shades of red or black.

There are a few DIY and natural stains you can use, such as using tea bags or coffee grounds, running a piece of steel wool across a wet piece of oak, etc. Be aware that using food items to color wood can introduce sugars or other components that can make the wood a more attractive breeding ground for microorganisms, and that many of these types of stains are not very deep, or very dark. On something such as a cutting board, a few washes will readily move a tea stain down into the wood, returning the board to its natural color. As such, natural stains don't tend to work well as permanent colorants unless a heavy-duty finish is used on top.

Pine boards before and after staining. Many things can be used to stain wood, from commercial stains to tea bags, and everything in between. *Images courtesy Candace Hermann: https://stayingincourage.com*

DYES

Woodworkers have a long history of using aniline dyes, which can be purchased either as water-soluble or alcohol-soluble powders. Aniline dyes penetrate deeply into wood and give vibrant hues, but the colorants are not light stable and fade over about a decade, even in indoor light. It is always a good idea to put a finish over aniline-dyed wood, since the dye does not readily bind and can easily come off on wet fingers.

As with stains, some natural dyes exist on the market. These come mostly in shades of brown and black—occasionally red—and have similar issues to natural stains.

PAINT

It is increasingly popular to see wooden toys painted with acrylic paint—especially watered-down acrylic paint, so that the color looks more like a dye. There are acrylic paints on the market that are rated for children, although note that care must always be taken with any compound that could potentially be brought into the mouth. Watered-down acrylic paint gives vibrant color to wood and is marginally more light stable than aniline dyes—and at this time has low to no safety implications for woodworkers.

Magic wands made from wood and synthetic dye. Many wooden toys are colored with watered-down acrylic paint, while many wood turnings are colored with water- or alcohol-soluble aniline dyes. *Image courtesy Amy Forman: www.etsy.com/shop/ChaosandRainbows*

Full range of colors possible from spalting fungi currently available. Image showcases the pigments from *Chlorociboria aeruginascens, Chlorociboria aeruginosa, Scytalidium cuboideum, and Scytalidium ganodermophthorum. Pigments generated at Oregon State University, Department of Wood Science & Engineering; image courtesy Patricia Vega Gutierrez*

PIGMENTS

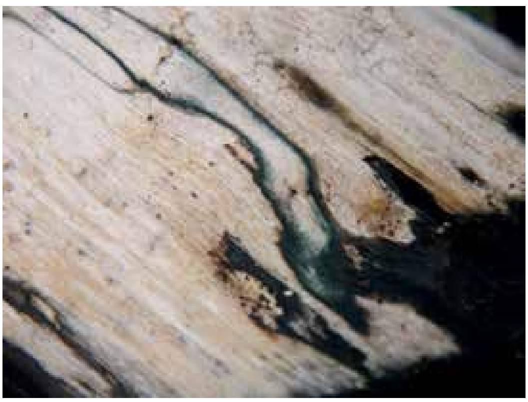
Pigments are rarely used to color wood, with the exception of spalting pigments. These colorants, derived from a specific class of wood-decaying fungi, have been used to color wood since at least the 1300s.[1] The pigments have long-term light stability (over the course of hundreds of years), are nontoxic, and are easy to apply (but not with water, since they are not water soluble). They are not cheap and are available only from a handful of outlets due to the difficulty in making them. At this time there is only one book in publication on the history and use of these pigments—*Spalted Wood: The History, Science, and Art of a Unique Material* (2016)—so those wishing for more information on the topic should consult that resource.

Oak (*Quercus garryana*) showing pink and blue stain from the fungus *Scytalidium cuboideum. Spalted by induction at Oregon State University, Department of Wood Science & Engineering*

Wild spalted blue green caused by the fungus *Chlorociboria* spp. (elf's cup). Found in Sitka, Alaska. The genus is widespread throughout the world, and most species produce this striking color. North America has only two known species: *C. aeruginascens and C. aeruginosa.*

Oak (*Quercus garryana*) showing orange zone lines and blue stain. *Spalted by induction at Oregon State University, Department of Wood Science & Engineering; turned by Seri Robinson*

Elm (*Ulmus* sp.) spalted in the wild and by extracted fungal pigments. *Turned by Mark Lindquist of Lindquist Studios and Seri Robinson of Oregon State University, Department of Wood Science & Engineering; photography by Mark Lindquist of Lindquist Studios*



Green zone line from the Amazon rainforest of Peru. Many zone lines appear black due to heavy color concentration but are actually made up of lower-weight pigments.

Red-purple pigment from the Amazon rainforest of Peru

Red zone lines from the Amazon rainforest of Peru

Cabinet from the National Museum of Decorative Arts, Spain (1600). Wide view. All blue green is from *Chlorociboria* spp.

Detail from one of the panels. National Museum of Decorative Arts, Spain (1600). The bird and leaves are blue green from *Chlorociboria* spp.

Close-up detail from one of the panels. National Museum of Decorative Arts, Spain (1600). The bird and leaves are blue green from *Chlorociboria* spp.

Close-up detail from one of the panels. National Museum of Decorative Arts, Spain (1600). The bird and leaves are blue green from *Chlorociboria* spp.

NATURAL WOOD VARIABILITY

As an end note, wood comes in just about every color you can imagine. If you're willing to hunt for it, you can find purples (purpleheart), reds (bloodwood), yellows (canary wood), blacks (ebony), orange (yew, osage orange), and many other colors simply from heartwood. Take care, since these colors more often than not come from extractives and may be harmful.

1. S. C. Robinson, H. Michaelsen, and J. C. Robinson, *Spalted Wood: The History, Science, and Art of a Unique Material* (Atglen, PA: Schiffer, 2016).

Wood urn. Base made from spalted maple burl *(Acer macrophyllum)*, showing a typical beige wood color. Top made from curly walnut (*Juglans nigra*), showing the deep-brown color that walnut heartwood is known for.