CONTENTS

WOOD SPECIES USED IN WOOD FLOORING

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The information contained in this publication represents generally accepted descriptions of wood species and their properties. However, wood is a natural material subject to numerous variations in grain, color, hardness and dimensional stability, and no description is able to encompass all possible variations. The National Wood Flooring Association accepts no risk or liability for application of the information contained in this publication.

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WOOD SPECIES
USED IN WOOD FLOORING
Introduction: An Overview of Wood Properties

Wood is a dynamic medium. Like all organic materials, it has character and quirks, responds to its environment, and changes over time. Because of its "personality," wood should be treated with understanding and a certain amount of care. For wood flooring professionals, knowing about the properties of wood in general, as well as those of individual wood species, is critical to proper installation. For consumers, it's important to have realistic expectations about how wood will perform. Most wood used for flooring is essentially a byproduct of more expensive wood-consuming industries (furniture manufacture, for example), so it is usually not the highest grade of lumber. However, it is quite economical in comparison.

This publication provides an overview of the mechanical and physical properties of wood, followed by more detailed information on several species used in flooring. In selecting the species described, the aim has been to offer a fair sampling of some of today's most popular woods. Other species may be included in later editions of this publication.

Note: The samples chosen to illustrate each species were selected to be as representative as possible. However, there are many variations within each species, and the methods used in sanding and finishing also affect the final appearance of a given species. Also, the samples were photographed only a few days after being sanded and finished. Some species, such as domestic cherry, will change color significantly over time (see page 8). Therefore, the appearance of any installation may vary from the samples shown in this publication.

The character of wood

As a flooring material, wood is superior to vinyl or carpet, both practically and aesthetically. A solid wood floor is more than a covering; it adds strength and stability to the floor system. A one-inch thickness of wood has the same insulating value as 15 inches of concrete. Wood is durable and long-lasting — occasional sanding and refinishing essentially results in a brand-new floor. Wood floors don't retain mildew or absorb dust, simplifying cleaning.

Perhaps the most appealing characteristics of wood flooring, though, are its attractive appearance and natural warmth. A beautiful wood floor can enliven a drab room, enhance any architectural style, complement furniture and design schemes, and add value to any home or building.

A combination of qualities should be considered when selecting a species for flooring: appearance-related attributes such as texture, grain and color; as well as mechanical properties such as dimensional stability, durability, and ease in finishing; and finally, availability and cost.

Properties affecting appearance

Many different factors, from the nature of the living tree to the way the lumber is sawed, affect the way the finished floor will look.

HEARTWOOD, SAPWOOD: Heartwood is the older, harder, central portion of a tree. It usually contains deposits of various materials that frequently give it a darker color than sapwood. It is denser, less permeable and more durable than the surrounding sapwood.

Sapwood is the softer, younger, outer portion of a tree that lies between the cambium (formative layer just under the bark) and the heartwood. It is more permeable, less durable and usually lighter in color than the heartwood.

The relative amounts of heartwood and sapwood in a flooring batch may affect the way it accepts stain and finish and, therefore, the finished appearance of the floor. In general, quartersawn and riftsawn flooring will contain less sapwood than plainsawn flooring (see "Types of saw cut," next page), and will tend to have a straighter grain and more uniform appearance.

WOOD GRAIN AND TEXTURE: "Grain" and "texture" are loosely used to describe similar properties of wood. Grain is often used in reference to annual growth rings, as in "fine" or "coarse" grain; it also is used to indicate the direction of fibers, as in straight, spiral and curly grain. The direction of the grain, as well as the amount of figuring in the wood, can affect the way it is sanded and sawed.

Grain also is described as being either "open" or

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"closed," referring to the relative size of the pores, which affects the way a wood accepts stain and finishes.

Texture usually refers to the finer structure of the wood, rather than to the annual rings. It is sometimes used to combine the concepts of density and degree of contrast between spring wood and summer wood in the annual growth rings.

Wood grain terminology

Annual rings: Most species grown in temperate climates produce visible annual growth rings that show the difference in density and color between wood formed early and that formed late in the growing season. The inner part of the growth ring, formed first, is called "spring wood"; the outer part, formed later in the season, is called "summer wood."

Spring wood is characterized by cells having relatively large cavities and thin walls. Summer wood cells have smaller cavities and thicker walls, and consequently are more dense than those in spring wood. The growth rings, when exposed by conventional sawing methods, provide the grain or characteristic pattern of the wood. The distinguishing features among the various species results in part from differences in growth-ring formation. And within species, natural variations in growth ensure the unique character and beauty of each piece of wood.

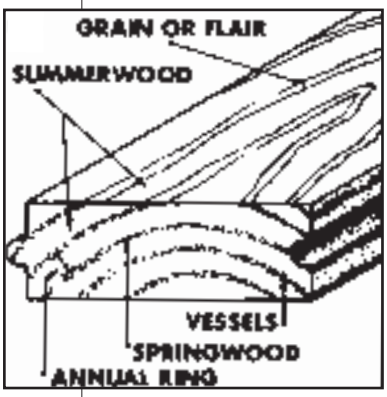


Figure: The pattern produced in a wood surface by annual growth rings, rays, knots and deviations from regular grain.

Medullary Rays: Medullary rays extend radially from the core of the tree toward the bark. They vary in height from a few cells in some species, to four or more inches in the oaks; they're responsible for the flake effect common in quartersawn lumber in certain species.

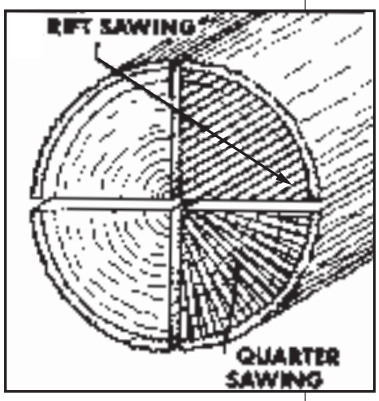
Flat Grain: Easily recognized by its parabolic (arched) effect. Lumber is considered "flat-grained" when the annual growth rings make an angle of less than 45 degrees with the wide surface of the board.

Vertical or Edge Grain: Generally more dimensionally stable than flat grain because it is more likely to change in height than in width with changes in moisture. Lumber is considered "vertical-grained" when the annual growth rings make an angle of 45 to 90 degrees with the wide surface of the board.

(Note: In hardwoods, plainsawn lumber generally contains mostly flat-grained wood, while quartersawn lumber is nearly all vertical-grained. In softwood lumber, the terms "flat-grained" and "vertical-grained" are used instead of the terms "plainsawn" and "quartersawn," respectively. See "Types of saw cut" below.)

Interlocked Grain: Grain in which the fibers may slope in a right-handed direction for several years, in a left-handed direction for several years, back to right-handed, and so on. A high degree of interlocked grain may make a wood difficult to machine.

TYPES OF SAW CUT: Lumber is either plainsawn, quartersawn or riftsawn.



Plainsawing is the most common and least expensive method of sawing; most wood flooring is cut this way. Plainsawn lumber is obtained by making the first saw cut on a tangent to the circumference of the log and remaining cuts parallel to the first. This method is the most economical, because it provides the widest boards and results in the least waste.

Since most of the lumber produced by plainsawing is flat-grained, with some vertical-grained wood included, plainsawn lumber will tend to contain more variation within and among boards than quartersawn lumber, in which nearly all of the wood is vertical-grained. Also, since flat-grained wood is less dimensionally stable than vertical-grained, plainsawn lumber will tend to expand and contract more across the width of the boards than quartersawn lumber.

Other physical differences to consider when choosing plainsawn lumber rather than quartersawn:

- Figure patterns resulting from the annual rings and some other types of figures are usually brought out more conspicuously by plainsawing.
- Shakes and pitch pockets, when present, extend through fewer boards.

In quartersawing, lumber is produced by first quartering the log and then sawing perpendicular to the growth rings. Quartersawing produces relatively narrow boards, nearly all vertical-grained, and creates more waste, making quartersawn lumber more expensive than plainsawn. However, much quartersawn wood is obtained by culling the vertical-grained wood that naturally results from plainsawing.

Other physical factors to keep in mind when choosing quartersawn lumber over plainsawn:

- It twists and cups less.
- It surface-checks and splits less during sea-

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soning and in use.

• Raised grain produced by separation in the annual growth rings does not appear as pronounced.

• It wears more evenly.

• Figuring due to pronounced rays, interlocked and wavy grain are brought out more conspicuously.

• Sapwood appears only at the edges, and is limited to the width of the log's sapwood.

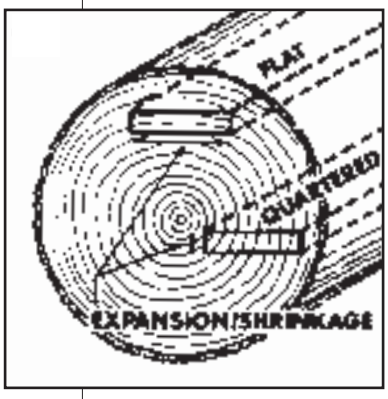
Riftsawing is similar to quartersawing, with many of the same advantages and limitations. It accentuates the vertical grain and minimizes the flake effect common in quartersawn oak. The angle of the cut is changed slightly so that fewer saw cuts are parallel to the medullary rays, which are responsible for the flake effect. Riftsawing creates more waste than quartersawing, making it generally more expensive.

Mechanical properties

MOISTURE CONTENT AND DIMENSIONAL STABILITY: Moisture plays a large part in how wood behaves, both during the machining process and after installation. Installers would do well to study moisture's effect on wood in some detail; however, a brief discussion is included here. (For more information, see the NWFA *Technical Manual A100: Water and Wood*.)

Moisture content is defined as the weight of water in wood expressed as a percentage of the weight of oven-dry wood. Weight, shrinkage, strength and other properties depend on the moisture content of wood. In trees, moisture content may be as much as 200 percent of the weight of wood substance. After harvesting and milling, the wood will be dried to the proper moisture content for its end use.

Wood is dimensionally stable when the moisture content is above the fiber saturation point (usually about 30 percent moisture content). Below that, wood changes dimension when it gains or loses moisture.



The ideal moisture content for flooring installation can vary from an extreme of 4 to 18 percent, depending on the wood species, the geographic location of the end product and the time of year. Most oak flooring, for example, is milled at 6 to 9 percent. Before installation, solid wood flooring should be acclimated to the area in which it is to be used, then tested with a moisture meter to ensure the proper moisture content.

(Note: Engineered flooring tends to be more dimensionally stable than solid flooring and may not require acclimation prior to installation—check with the manufacturer of the flooring for that product's recommendations.)

Different woods exhibit different moisture stability factors, but they generally shrink and swell the most in the direction of the annual growth rings (tangentially), about half as much across the rings (radially) and only slightly along the grain (longitudinally). This means that plainsawn flooring will tend to shrink and swell more in width than quartersawn flooring, and that most flooring will not shrink or swell much in length.

The individual species descriptions that follow include an indication of dimensional stability, from "below average" to "excellent." For a comparison of the relative dimensional stability of several species, refer to the chart on page 8. Keep in mind that the shrinkage values come from laboratory testing, and some woods shown to be relatively stable in the lab have demonstrated significant movement on actual job sites.

For wood flooring professionals, it's important to inform end users about the normal behavior of wood in relation to moisture. Most solid wood flooring will contract during periods of low humidity (during the heating season, for example), sometimes leaving noticeable cracks between boards. To minimize this effect, users should stabilize the environment of the building through temperature and humidity control.

HARDNESS AND DURABILITY: Probably the most important strength property for wood used in flooring applications is its side hardness, also known as Janka hardness. Side hardness represents the resistance of wood to wear, denting and marring. It is measured by the load required to embed a 0.444-inch steel ball to one-half its diameter in the wood. Janka hardness ratings are generally based on an average of tests on both tangential and radial (plainsawn and quartersawn) samples. A comparison chart of the Janka hardness ratings for each of the species described in this chapter appears on page 7. Also, the individual species descriptions include a percentage comparison to indicate each species' hardness relative to Northern red oak.

INSTALLATION AND NAILING: When nailing some of the denser woods with hand or air nailers, installers may encounter splitting tongues, as well as failure to secure the fastener even after repeated attempts. This can sometimes be corrected by changing the angle of the nail's point of entry. On certain exceptionally dense species, pilot holes may have to be drilled to ease nailing. Blunting the ends of fasteners may also help prevent splitting. With pneumatic nailers, the air pressure may need to be adjusted to reduce splintering or tongue breakage.

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Though dense, heavy woods normally offer higher nail-withdrawal resistance, less dense species allow the use of more and larger-diameter fasteners to compensate for their lower holding ability. When nailing imported species, check with the supplier for the recommended fastener.

Take precautions while working with some woods, especially exotic species. Splinters should be removed immediately, as some species have been known to cause an adverse reaction in some people.

SANDING: Some wood species are highly resinous and tend to clog sandpaper. When working with such species, it may be necessary to use a coarser grit of sandpaper than normal, or to change the sandpaper more often than with other species.

Also, the wood dust created by sanding some species tends to cause an allergic reaction in some people. This is more likely to occur with imported species than with domestic. However, even North American oak has been known to cause a skin rash or respiratory difficulties in some people. Where applicable, known tendencies to cause allergic reactions are noted.

As a precaution, flooring mechanics should wear respirators (with a rating of at least N95/NIOSH-approved) and eye protection when sanding. To test for possible allergic reaction to a species, perform a skin-patch test by placing a small amount of wood dust under a round adhesive bandage on the inside of the forearm. If serious skin irritation is present when the bandage is removed after 24 hours, consider not working with that species.

For more information on sanding, see the NWFA *Technical Manual B200: Sanding and Finishing of Hardwood Floors*.

FINISHING: Many finish formulations are undergoing continual change as their manufacturers move to comply with evolving environmental regulations, making hard-and-fast finishing rules difficult to come by.

Some woods, especially imports, contain oils and chemical compounds that may adversely react with certain types of finishes to inhibit drying, dramatically change the color of the wood, or both. Some imported species may weep natural oils for an extended period of time, possibly causing finish problems at a later date. It is recommended that such floors be sealed or coated immediately after the final sanding cut.

Water-based urethanes tend to leave wood lighter in color. Non-ambering urethanes are often recommended for finishing white, stenciled or pastel floors. Water-based finishes tend to adhere well to most woods, including exotics, whereas some solvent-based finishes have adhesion, drying or color change problems with woods such as teak, Brazilian walnut, purpleheart, padauk and wenge.

For floors that are to be stained to alter the natural color of the wood, flooring professionals should be aware that some species (hard maple, pine and fir, for example) do not accept stain as readily or as evenly as other species.

A grain filler is sometimes used for wood species with large pores, such as oak and walnut, if a smooth finish is desired.

When working with a new species for the first time, installers should test stains and finishes on a small sample of flooring before attempting an installation and also check with the finish manufacturer.

For more information on finishing, see the NWFA *Technical Manual B200: Sanding and Finishing of Hardwood Floors*.

Availability

Just as every individual wood species is dynamic and prone to change in response to its environment, so too is the market for all wood flooring species. Availability estimates were obtained through interviews with industry sources and reflect market conditions during 2010.

EASILY AVAILABLE:

Brazilian cherry (jatoba)
Hard maple
Red oak
Southern yellow pine
White oak

READILY AVAILABLE:

Ash
Australian cypress
Bamboo
Beech
Birch
Black cherry
Black walnut, American
Brazilian walnut (ipé)
Cork
Douglas fir
Hickory/pecan

MODERATELY AVAILABLE:

Brazilian maple
Brazilian teak (cumaru)
Iroko
Jarrah
Padauk
Santos mahogany
Sapele
Spotted gum
Sydney blue gum
Tasmanian oak
Teak, Thai/Burmese

LIMITED AVAILABILITY:

Antique heart pine
Bubinga
Merbau
Mesquite
Purpleheart
Wenge

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CHERRY, BLACK

Prunus serotina

Appearance

COLOR: Heartwood is light to dark reddish brown, lustrous; sapwood is light brown to pale with a light pinkish tone. Some flooring manufacturers steam lumber to bleed the darker heartwood color into the sapwood, resulting in a more uniform color. Color darkens significantly with age.
GRAIN: Fine, frequently wavy, uniform texture. Distinctive flake pattern on true quartersawn surfaces. Texture is satiny, with some gum pockets.
VARIATIONS WITHIN SPECIES AND GRADES: Significant color variation between boards.

Properties

HARDNESS (JANKA): 950.
DIMENSIONAL STABILITY: Above average.

Workability

NAILING: No known problems.
SANDING: Sands satisfactorily if the correct sanding sequence is followed.

Suggested Sequence
First Cut: 60 at a 7-15 degree angle with the grain
Second Cut: 80 straight with the grain
Third Cut: 100
Hard Plate: Not recommended
Screen: 80 or 100

FINISHING: No known problems.

Origin

North America.

Availability

Readily available.

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MAPLE, SUGAR/HARD

Acer saccharum

Appearance

COLOR: Heartwood is creamy white to light reddish brown; sapwood is pale to creamy white.
GRAIN: Closed, subdued grain, with medium figuring and uniform texture. Occasionally shows quilted, fiddleback, curly or bird's-eye figuring. Figured boards often culled during grading and sold at a premium.
VARIATIONS WITHIN SPECIES AND GRADES: Black maple (*B. nigrum)* is also hard; other species are classified as soft.

Properties

HARDNESS (JANKA): 1450.
DIMENSIONAL STABILITY: Average.

Workability

NAILING: No known problems.
SANDING: Extra care must be taken during sanding and finishing, as sanding marks and finish lines are more obvious due to maple's density and light color. The species also burnishes, dulling fine paper and screens and making it difficult to cut out previous scratches.

Suggested Sequence
First Cut: 50 at a 7 to 15 degree angle to the grain
Second Cut: 80 straight with the grain
Third Cut: 120
Hard Plate: 100 or 120
First Screen: 100
Second Screen: 100

FINISHING: Takes neutral finish well. May be difficult to stain.

Origin

North America.

Availability

Easily available. Figured grains have limited availability.

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OAK, RED

Quercus spp.

Appearance

COLOR: Heartwood and sapwood are similar, with sapwood lighter in color; most pieces have a reddish tone. Slightly redder than white oak.
GRAIN: Open, slightly coarser (more porous) than white oak. Plainsawn boards have a plumed or flared grain appearance; riftsawn has a tighter grain pattern, low figuring; quartersawn has a flake pattern, sometimes called tiger rays or butterflies.
VARIATIONS WITHIN SPECIES AND GRADES: More than 200 subspecies in North America; great variation in color and grain, depending on the origin of the wood and differences in growing seasons. Northern, Southern and Appalachian red oak all can be divided into upland and lowland species. Because they grow more slowly, upland species have a more uniform grain pattern than lowland species, with more growth rings per inch.

Properties

HARDNESS (JANKA): Northern: 1290, Southern: 1060.
DIMENSIONAL STABILITY: Northern: average, Southern: below average.

Workability

NAILING: No known problems.
SANDING: Sands satisfactorily if the correct sanding sequence is followed.

Suggested Sequence

First Cut: 50 at a 7-15 degree angle with the grain
Second Cut: 80 straight with the grain
Third Cut: 100
Hard Plate: 100
Screen: 100 or 120

FINISHING: Stains well and demonstrates strong stain contrast. Red oak generally works better than white oak for bleached floors because it is more porous, and because tannins in white oak can discolor the floor.

Origin

North America.

Availability

Easily available.

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OAK, WHITE

Quercus spp.

Appearance

COLOR: Heartwood is light brown; some boards may have a pinkish tint or a slight grayish cast. Sapwood is white to cream.
GRAIN: Open, with longer rays than red oak. Occasional crotches, swirls and burls. Plainsawn boards have a plumed or flared grain appearance; riftsawn has a tighter grain pattern, low figuring; quartersawn has a flake pattern, sometimes called tiger rays or butterflies.
VARIATIONS WITHIN SPECIES AND GRADES: Considerable variation among boards in color and grain texture, but variations not as pronounced as in red oak.

Properties

HARDNESS (JANKA): 1360.
DIMENSIONAL STABILITY: Average.

Workability

NAILING: No known problems.
SANDING: Sands satisfactorily if the correct sanding sequence is followed.

Suggested Sequence
First Cut: 50 or 60 at a 7-15 degree angle with the grain
Second Cut: 60 or 80 straight with the grain
Third Cut: 80 or 100
Hard Plate: 100
Screen: 80 or 100

FINISHING: During the finishing process, tannins at the surface can react with some liquids to turn the wood green or brown. This effect tends to be more pronounced with products that have a high water content, such as wood bleach and water-based finishes. Stains very well and accepts stain evenly.

Origin

North America.

Availability

Easily available.

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WALNUT, AMERICAN BLACK

Juglans nigra

Appearance

COLOR: Heartwood ranges from a deep, rich dark brown to a purplish black. Sapwood is nearly white to tan. Difference between heartwood and sapwood color is great; some flooring manufacturers steam lumber to bleed the darker heartwood color into the sapwood, resulting in a more uniform color.
GRAIN: Mostly straight and open, but some boards have burled or curly grain. Arrangement of pores is similar to hickories and persimmon, but pores are smaller in size.
VARIATIONS WITHIN SPECIES AND GRADES: Great variety of color and figure within species, as well as variation in color among boards, especially in lower grades and from material that isn't steamed prior to kiln-drying.

Properties

HARDNESS (JANKA): 1010.
DIMENSIONAL STABILITY: Average.

Workability

NAILING: No known problems.
SANDING: Sands satisfactorily.
Suggested Sequence
First Cut: 60 at a 7-15 degree angle with the grain
Second Cut: 80 straight with the grain
Third Cut: 100
Hard Plate: Not recommended
First Screen: 80 or 100
Second Screen: 100 or 120
FINISHING: No known finishing problems.
COMMENTS: Frequently used as a highlight material for borders or other inlay techniques.

Origin

North America.

Availability

Readily available.

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