a closer look

Sandpaper

WATCH HOW IT'S MADE—AND DISCOVER THE BEST ABRASIVE FOR EACH JOB

BY TERI MASASCHI

When sanding is mentioned, most woodworkers groan. But sandpaper achieves results that no other tool can match. Whether it is taming wild grain without tearout, perfecting a curve, or getting a totally smooth surface prior to finishing, you'd be lost without sandpaper. And so would generations of woodworkers.

I'll show you how today's sandpaper can trace its ancestry back 800 years (below), tell you why different types of abrasives work best on different surfaces, and give you a tour of a sandpaper factory. I'll never convince you to like sanding, but you will gain a new respect for this disposable yet indispensable tool.

Modern abrasives go back a century

In 1891, a scientist trying to make synthetic diamonds invented silicon carbide, and a few years later aluminum oxide, today's other main abrasive grit, was invented. The growth in automobile manufacturing, with all those shiny painted surfaces, increased demand for sandpaper, but only dry-sanding could be done as the hide glue used to bind the abrasive to the backing was not water resistant. In 1921, 3M invented the first waterproof paper, and cut down on the problem of dust in factories.

Adhesives have continued to improve, and modern sanding products including sheets, disks, and belts use urea-formaldehyde and phenolic-resin glues. These are not only far more durable but also can withstand the heat generated by machine-sanding. However, you may still find a few sheets of sandpaper, particularly garnet, that are made with hide glue. Hold the paper close to your mouth and exhale on it. If it is hide glue, you'll get a whiff of that distinctive animal smell.

Parchment is no longer used as a backing, but paper still is. It is mostly used for hand-sanding but today's sheets can be treated for better water resistance and more flexibility.

Cloth backing is used for sanding products that need to be more durable but less flexible. Sanding belts are mostly cloth backed, as are disks for heavy, aggressive cutting. The cloth is cotton or polyester/cotton blends.

The right abrasive for the job

The manufacturing of abrasive grains is a science in itself. One crucial step common to all types of abrasive is a very precise

Sand, shells, and sharks

As far back as the 13th century, the Chinese made sandpaper using a variety of abrasives such as sand and crushed shells, glued to parchment with a natural gum. Later, sharkskin was used as a fine abrasive. (The TV series *MythBusters* tested this story and found that sharkskin does indeed work as sandpaper with an abrasive equivalent to between 600 and 800 grit.) By the early 1800s, glass paper was being mass-produced; however, it dulled quickly because it was neither sharp enough nor hard enough.

Photos: Mark Schofield

Guide to the grits

ALUMINUM OXIDE

Whether for power- or hand-sanding, the vast majority of abrasives used on bare wood are aluminum oxide.

LIKE BROKEN TEMPERED GLASS

Grains of aluminum oxide are rather like chunks of broken tempered glass—sharp but not pointy. But they break down easier than silicon carbide, and therefore stay sharp longer on bare wood.

SILICON CARBIDE

When sanding between coats or rubbing out the final finish, wet-sanding with silicon-carbide paper is the rule.

LIKE SHARDS OF REGULAR GLASS

Grains of silicon carbide are much more pointy, rather like broken window glass. They require a hard surface such as a finish to break down and expose a sharp edge.

SUPER-HARD NEW ABRASIVES

Tougher stuff. *Alumina zirconia and ceramic aluminum oxide are mostly used on sanding belts for fast stock removal. They can also be blended with aluminum oxide on disks.*

GARNET IS YESTERDAY'S NEWS

Garnet has a long history in woodworking and retains a loyal, though declining, number of fans. It is a natural mineral that, compared to aluminum oxide or silicon carbide, is relatively soft and fast-wearing. Industry insiders concede that it produces a very even scratch pattern on bare wood, but no better than the latest grades of aluminum oxide. Any money you save buying garnet paper is probably more than offset by its faster wear.

process for separating the different-size particles. The heavier grits are sifted through screens, while the smaller, lighter grains are separated with air in a centrifugal system or by settling out in water.

Be aware that there are two standards for measuring particle size. The vast majority of papers now use the Federation of European Producers of Abrasives (FEPA) scale. FEPA products mostly have a "P" before the grit number. The United Abrasive Manufacturers Association (UAMA) is the successor to the Coated Abrasive Manufacturer's Institute (CAMI). Their scale, based on the American National Standards Institute (ANSI), used to dominate domestic production but is now mostly confined to finer-grit wet-or-dry papers.

Up to 180-grit the two scales are very similar, but above that number the FEPA papers become increasingly coarser than ANSI-graded paper with the same number. If you are uncertain which papers are which grades, stick to one brand.

Aluminum oxide vs. silicon carbide

In the last few years, new abrasives have entered the woodworking market (more on those shortly), but aluminum oxide and silicon carbide remain dominant. While both are

hard abrasives, their molecular structure makes them more complementary than competitive.

Aluminum oxide begins life as bauxite, also the raw material for aluminum. It comes in a range of colors from white to dark brown, but quite often the color is obscured by an adhesive tinted to designate whether the grit is coarse, fine, etc. Silicon carbide, also known as carborundum, is a compound of silicon and carbon. It is naturally dark gray but it has become an industry standard to attach it to the backer using a black resin, giving the sheets and disks a flat, black look.

Industry experts describe aluminum oxide as tough and blocky, while silicon carbide is sharper and pointier. Think of aluminum oxide as being like lumps of broken tempered glass, while silicon carbide is more like the shards from regular glass.

Both abrasives are "friable," meaning that in use the grains break up and expose fresh, sharp edges as opposed to staying whole and rapidly becoming blunt. But silicon carbide needs a harder surface than most woods to cause it to fracture and expose sharp surfaces. This makes aluminum oxide best on bare wood because by breaking down more, it lasts longer.

Conversely, when sanding between finishes, fine-grit silicon carbide has the sharpness to cut through the hardest finish, while aluminum oxide's blocky texture tends to glaze the surface. Using water or mineral spirits with wet-or-dry silicon-carbide paper prevents the paper from clogging, reduces heat that might damage the finish, eliminates dust, and creates a slurry. This mixture of liquid, abrasive particles, and finish can create a softer scratch pattern than if the paper is used dry.

Two tough new arrivals

Alumina zirconia is a synthetic blend of aluminum oxide and zirconium oxide. Hard, tough, and aggressive, it cuts almost as fast as silicon carbide but is less pointy. Typically found in coarser grits on sanding belts and disks, it is a good choice for fast stock removal on hardwood.

Harder still, ceramic aluminum oxide is made in a similar way to porcelain. It begins as a paste that is fired in a kiln and is then crushed into abrasive particles. Norton uses ceramic alumina on its 3X disks, while 3M uses it on its top-of-the-line products, which are mostly colored purple. If you have a lot of sanding to do and don't want to spend more time than you have to, it is probably worth the extra money to buy this type of abrasive. □

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How it's made

1. PREP THE PAPER

Start with a blank roll. *Sheets, disks, or belts all begin life as a large roll of backing material. The first step is to print on the back what the product will be.*

Ali Industries, maker of the Gator and Shopsmith lines of abrasives, gave *Fine Woodworking* a tour of its facility near Dayton, Ohio. Production is centered on the "Maker," a 130-yd.-long production line with a couple of two-story ovens. Sandpaper begins as a roll of paper or cloth up to 55 in. wide and 10,000 yd. long that forms its backing. Moving at 30 yd. per minute, the back of the material is printed with a description of the product. Glue is applied to the front via a roller. This first application of glue can be colored to designate the company's code for coarse, medium, or fine abrasive.

Now the electrifying part: The grit comes down a chute to a conveyor belt and passes under a metal bar that gives each particle an electrical charge. The backing passes just over the conveyor belt and the grit jumps onto the sticky surface. And that's not the only cool thing: Not only do the particles space themselves evenly, but the blunter end of each grain is most attracted to the backing, leaving the pointier end facing out!

The roll of adhesive and grit then heads to a long oven where it is draped on big steel arms to be baked at 120° to 180°F. The second or "size" coat of glue is applied and baked after the first is cool and hard. This thicker coat comes partway up the abrasive, making it less likely to come away from the backer, without fully coating it and dulling the edges.

After the glue has cured for three days, the roll goes to the flexing machine, which bends and twists the material at sharp angles, creating minuscule fractures in the glue coats to give it greater flexibility and prevent grit loss. Some rolls then receive a stearate coating to reduce surface clogging when the material is used. If hook-and-loop disks are being made from the roll, Velcro backing is applied just after the stearate and then the material is baked one last time. Finally, the cured rolls get die-stamped and sliced into disks, sheets, and belts.

—T.M.

2. ROLL ON GLUE

Color-coded. *The face of the backer has the bottom or "make" coat of glue rolled on. It is often color-coded, yellow in this case, to match the grit size of the abrasive.*

3. SPRINKLE GRIT

Electrifying process. *A hopper with evenly spaced holes in the bottom distributes the abrasive on a conveyor belt (above left). The white abrasive moving from right to left passes under an electrically charged metal rod. This makes each particle stand on end and then jump onto the sticky roll of backing paper when it comes near (below left).*

4. BEND IT

Micro-fractures. *The stiff roll of sandpaper is bent back and forth at 90° and 45° to make it more flexible and to prevent it from cracking the first time you try to bend it.*

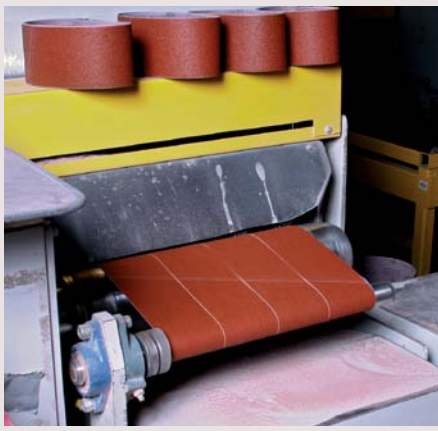
5. BACK IT

Add Velcro for disks. *The roll of sandpaper has glue applied to the back and is then mated to the white loop material.*

6. CUT IT FOR USE

Disks galore. *There's nothing random about the precise stamping of these 5-in. random-orbit disks.*

Belts begin as sheets. *Wide sheets, with their ends cut on the diagonal, are wrapped around a form and heat is applied to glue the seam.*



One loop equals four belts. *The abrasive cylinder is spun across fixed knives to create four sanding belts.*