

Chapter 1

Welcome to the World of Glass

In This Chapter

- ▶ Discovering the different construction techniques used in stained glass
- ▶ Examining what's new in this traditional craft — warm glass
- ▶ Identifying various types and textures of glass

Glass is magical. It surrounds you in your home, office, place of worship, and many of the commercial establishments you visit on a daily basis. Although glass serves a very practical purpose today, in some cases, it also makes an important decorative statement (and that's where this book comes in).

The creation and history of glass itself has always held a certain mystery. As a super-cooled liquid, glass has the unique ability to capture light and glow from within. Even with such an awesome feature, though, the chemistry behind glass is really very simple — sand transformed by heat. The various colors you see in glass come from metallic salts and oxides: Gold produces red, silver produces yellow and gold, cobalt produces blue, and copper produces the greens and dark reds.

This vast array of glowing colors in glass enchants craftsman and artisans alike. So, too, does its permanency. After all, glass never fades and its colors never dull. This awesome feature allows the artist to literally paint an eternal image with glass.

In this chapter, you become familiar with the various craft styles used to create beautiful works of stained glass, and you get an introduction to the newest form of art glass: warm glass. Finally, you survey examples of the various types of glass available for you to work with.

A brief history of stained glass

The first real examples of stained glass appeared in the early European churches built around the tenth century. At that time, stained-glass windows became the storytellers of religious history. Artists used paint on glass to tell the stories of the Bible and other holy books.

In the 15th century, stained glass changed dramatically — not in the way the glass itself was made but in the way the artists created the

finished products. With the rediscovery of silver stain during the Renaissance, glass paint colors went from dull black and gray to rich golden colors. (Silver stain is a paint that's applied to the surface of the glass and then fired in a kiln. The stain penetrates the surface and becomes a permanent part of the glass.) The Renaissance brought stained glass, with its many brilliant colors, into vogue for the next 300 years.

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One of the best-known glass artists of all time, American Louis C. Tiffany, began his artistic career as a painter, but after he experimented with stained glass, he never went back to paint. As a young art student in Europe in 1869, Tiffany visited many of the churches and great buildings there. Inspired by the stained glass he saw, Tiffany embarked on a journey to find a glass that could both tell a story and glow from within (in other words, a glass that didn't have to be painted to shine with color). This journey toward colored glass required manufacturers to make glass in an infinite array of opalescent colors.

In the late 1800s, Thomas Edison, a good friend of Tiffany's, invented electric lighting. With this invention came an eagerness to show off the latest techno gadget — the electric lamp. Around the same time, Tiffany developed a stained-glass construction technique called *copper foiling*. Using this technique, he constructed stained-glass lampshades that surrounded the electric light and acted as a beacon for this new status symbol. Over the next 70 years, Tiffany's studio — together with dozens of other highly active studios throughout the eastern and midwestern United States — created thousands of beautiful stained-glass windows and lampshades.

As buildings changed over time, so did the art of stained glass. No changes are more obvious

than the ones you see in the works of American architect Frank Lloyd Wright. He designed more than 1,000 stained-glass works. He called his glass works *light screens* because of their ability to shape the light in any space, much like the way Japanese rice-paper screens shaped light. Many of Wright's building designs incorporated stained-glass windows, doors, and lighting.

The arts and crafts movement embraced stained glass, too, but it made a few changes to the stained glass of Tiffany. In the stained-glass doors and panels that accented homes across the Midwest and California, clear glass replaced much of the heavy, opalescent glass. Designs were clean and geometric in style, fabricated from clear glass with just small touches of color. Many panels featured all-clear-glass designs. Thicker clear-glass pieces were faceted, creating bevel-shaped edges that captured the sunlight and sent a cascade of rainbows onto interior walls.

In the 1970s, stained glass made a comeback that incorporated larger-than-life splashes of brightly colored glass depicting such things as flowers and butterflies. With this comeback came the stained-glass hobby movement, which is where I (and you) come in.

Stained-Glass Techniques

Stained glass has many names, most common of which are *art glass*, *leaded glass*, and *copper-foiled glass*. The term *art glass* is interchangeable with stained glass, and both terms reference objects that you create using pieces of colored glass. Note that the colored glass used to create these projects is also called *stained glass* and *art glass*. Don't worry; because the terms are interchangeable, you can't really make a mistake referencing this art form.

The real difference comes in the terms *leaded glass* and *copper-foiled glass*, which describe the specific working techniques used to fabricate stained-glass projects. So what's the difference between these two techniques? The following sections are here to show you, so read on!



When you're ready to start your own stained-glass project, turn to Chapter 4 for tips on preparing your pattern, Chapter 5 for all the details on glass cutting, Chapter 6 for everything you need to know about grozing and grinding, and Chapter 7 for the ins and outs of soldering.

Leaded glass

Stained-glass artists generally use the leaded-glass technique for flat-panel works such as doors, windows, and screens. But you can also find examples of leaded-glass lampshades and boxes. This technique involves creating a leaded-glass panel by connecting pieces of glass together with strips of metal that have been shaped into *U*- or *H*-shaped profiles.

The metal strips used in the leaded-glass technique, called *comes*, come in a variety of widths and profiles, and they can be lead, brass, zinc, or copper. Metal comes are available in 6-foot lengths. Regardless of which metal makes up the came used to create a particular panel, all panels fabricated from comes are called *leaded-glass panels*.

As for which type of came is used for what, comes shaped into *U* profiles typically go around the perimeters of panels (see Figure 1-1 for an example). And comes shaped into *H* profiles link the interior glass pieces together (see Figure 1-2 for an example).

Each intersection where two or more comes meet is called a *joint* (see Figure 1-3). Each joint is soldered together on both the front and back sides of the panel. This double-soldering gives strength to the whole panel.



Head to Chapter 9 if you're interested specifically in leaded-glass projects.

Figure 1-1:
Lead came
shaped
into a *U*
profile goes
around the
perimeter
of a glass
panel.



Figure 1-2:
Lead came
shaped
into an *H*
profile links
the interior
pieces of
a panel
together.



Figure 1-3:
Several
unsoldered
lead inter-
sections,
also called
joints.



Copper-foiled glass

Using the copper-foil technique to create stained glass involves wrapping thin strips of copper-foil tape around the edges of each individual piece of glass. The foil is crimped around the edges of the glass, creating a copper frame (see Figure 1-4).



Figure 1-4:
Copper-
foiled glass
pieces.

The copper-foil technique revolutionized the way artists worked with glass (before its development, stained glass had been utilized only in flat panels and panel lamps). American artist Louis C. Tiffany employed the copper-foil technique to fashion his highly sought after lampshades. A hundred years later, stained-glass artists are still working to improve the method. Today, you can buy precut strips of copper foil in a variety of widths. The foil is much thinner and easier to manipulate than it was in Tiffany's day, and it comes with an adhesive already applied to the back of the foil, which allows it to adhere to the edges of the glass, making the whole application process much easier.

Copper foil allows the artist to use very small pieces of glass to execute the most detailed designs. Foiled glass pieces easily contour to fit almost any curved surface. The invention of this technique was critical in allowing Tiffany and other glass artists of the early 1900s to create not only beautifully formed lampshades but also to develop other practices such as double-plating glass pieces to create unique shading effects for panels and shades.



If copper foil sounds like fun, head to Chapter 8, where I feature several projects that use this technique.

Adding a Little Heat: Warm Glass

Art glass includes lots of different construction techniques and processes. One of today's most popular processes is *warm glass*. Warm glass uses some of the same basic skills that are needed in stained glass, such as glass cutting and fitting templates to patterns, but instead of using metal and solder to hold projects together, you heat warm-glass pieces in a kiln.

Although you can use many of the same tools for warm glass that you'd use for stained glass, you do need to purchase some special equipment — namely, an electric glass kiln. You also need to make sure you're using the proper glass, as well as make sure that all the glasses you're using are compatible with each other (glasses that aren't compatible will crack and fall apart during or after firing). Head to Chapter 13 if you're interested in what it takes to set up a functioning warm glass studio.

Warm glass basically breaks down into the following techniques:

- ✓ **Fusing:** When you're fusing glass, you heat the pieces of glass to the point that the glass "fuses" together to form a solid piece of glass.

Fusing can be as basic as attaching some decorative glass pieces to a small sheet of glass (see Chapter 14) or as complicated as layering different types and colors of glass into a particular picture or design (see Chapter 15).
- ✓ **Slumping:** Slumping, or *shaping*, involves using molds to turn glass into bowls, platters, vases, and other three-dimensional shapes. Depending on the type of mold and type of project, you either slump the glass around the mold or into it.

Slumping is done at a lower temperature than fusing, so you first fuse your glass pieces together to get the desired coloring and design, and then you slump them to achieve whatever shape you want (assuming you want something three-dimensional). Figure 1-5 shows a vase that's been both fused and slumped.

Warm glass is usually more free-form than stained glass, so it appeals to a lot of people who don't want to mess with the precision and construction techniques that lead and copper-foil projects require. You can certainly jump into warm glass without figuring out how to do copper-foil or lead-came stained glass, but I recommend that you spend some time learning how to cut glass in Chapter 5 before you move on to Part IV, which covers warm glass in detail.



Figure 1-5:
Warm-glass
techniques
allow you
to create
vases like
this one.

Warming up to the new kid on the block: A brief history of warm glass

In the middle of the 20th century, glass artists became fascinated with the possibilities of *sagging* (or bending) glass, a process that automakers had been using for years to make curved windshields. The first artists to experiment with bending glass primarily worked with methods that combined gilding, enameling, and laminating, often sandwiching other substances between layers of clear glass.

Then came Harriett Anderson, who spent most of her artistic career developing glass kilns that could be installed in residential settings. Kilns allow artists to take pieces of glass and refire them. While the glass is hot, artists can slump

it into or over a ceramic mold to create bowls, platters, vases, and uniquely formed pieces of glass that the artists can then incorporate into traditional stained-glass panels.

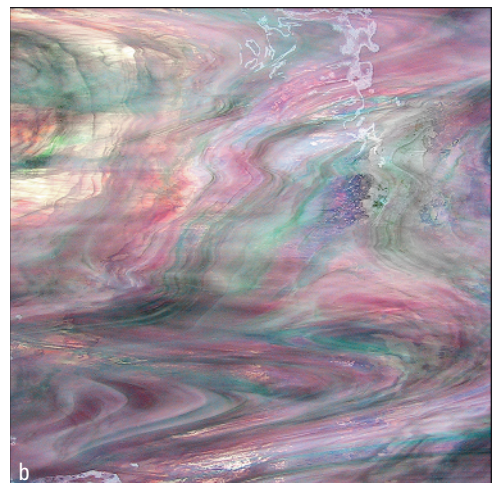
In the early 1980s, a band of young glass makers in the northeastern United States began experimenting with this new glass-refiring process. To describe their work, they coined the term *fused glass*. The work of these young artists signified the beginning of the *Warm Glass* movement. Their backyard experiments lead to the development of new glass kilns, molds, materials, and finally a completely new glass-manufacturing process.

Getting to Know Glass

The art of stained glass primarily involves two categories of glass:

- ✓ **Cathedral glass:** This transparent glass is made from a clear base and then color is added; as a result, it's available in a vast array of colors. The glass's level of transparency ranges from clear to almost opaque. See Figure 1-6a.
- ✓ **Opalescent glass:** Glass with a white base is mixed with various minerals and compounds to create this type of glass, which is opaque in nature. Opalescent glass (also called *opals* for short) captures light within itself and transmits a glow from within. It can be a combination of two to five different colors of glass. See Figure 1-6b.

Figure 1-6:
Cathedral
glass versus
opalescent
glass.



Feeling the heat: Glass manufacturing

The manufacturing process used to produce sheets of art glass is still pretty basic. Glass is made up of melted silica sand combined with potash or soda ash and limestone. Glass makers heat this mineral mixture in a large glass furnace to a temperature between 1,700 and 2,500 degrees, at which point the mixture becomes a liquid. The makers remove some of the molten glass from the furnace and transport it to a steel table. They case the glass onto

the surface. If the particular art sheet requires more than one color of glass, the makers add another scoop of molten glass from a different furnace. The molten glass then passes through a single metal roller, which flattens it into a thin sheet. (In case you're curious, America is the leading manufacturer of sheets of art glass today; many of the factories that started making glass more than 100 years ago are still family owned and operated.)

Stemming from these two major categories are dozens of varying hues, textures, and levels of transparency. For example, a sheet of glass can contain several colors within that one piece. The colors can appear transparent or semi-transparent. A texture on the backside of a piece of cathedral glass can make it impossible to see through but it is still considered cathedral. Sound confusing? Not to worry. It doesn't matter what the manufacturer labels his glass; what matters is the fact that you like it and want to use it in your project.

In this section, I introduce you to several types of art glass, so you can begin to get an idea of the vast array of choices that await you as you begin your new hobby. (Check out Chapter 4 for more suggestions on which types of glass to use for different types of projects.)

Surveying different glass types

The fact that you can to mix various colors, textures, and types of glasses together is what makes glass projects so interesting and unique. But don't forget that you can also create a wonderful stained-glass or warm-glass project using just clear, smooth glass. For each technique in this book I give you suggestions and ideas for working with many of these different types of glasses.

The following list not only introduces you to types of glass that work well for stained-glass and/or warm-glass projects but also alerts you to some types of glass that aren't suitable for use in art glass projects of any kind:



- ✓ **Float glass:** This clear glass is manufactured primarily for residential and commercial installation. It can vary in thickness from $\frac{1}{16}$ inch to 2 inches.

Float glass makes for great practice glass when you're just starting to develop your glass-cutting skills because it's so affordable; it's also easier to see your score line on float glass.

- ✓ **Tempered glass:** Tempered glass, or *safety glass*, as it's sometimes called, is a type of float glass that has been put through a special annealing process (*annealing* refers to the temperature the glass was cooled to during the manufacturing process). When tempered glass is broken,

it breaks into thousands of tiny pieces rather than large sharp shards of glass that could fall like a guillotine when broken. Large sheets of tempered glass are often used in commercial installations. **Note:** It *cannot* be used for stained glass or for fusing.

- ✓ **Laminated glass:** A thin sheet of plastic is laminated between two sheets of thin float glass to create this type of safety glass. When broken, laminated glass remains intact. The window shield of your car is made of laminated glass. You can't use this glass for stained-glass projects, but you can use it for slumping (a warm-glass technique done in a kiln that reshapes the glass).
- ✓ **Beveled glass:** To make beveled glass, the edges of ¼-inch-thick clear float glass are ground down to 45-degree angles using diamond wheels. The 45-degree angle catches the light and reflects it back into rainbow prisms that bounce around the walls. Beveled glass is beautiful for stained glass, but it can't be used for warm glass.
- ✓ **Wispy glass:** This glass can be either cathedral or opalescent. The glass has a base color of clear if it's cathedral and white if it's opalescent. Additional colors of glass are then added to this base color to create the finished product. Wispy glass can include one or more colors in the mix. You can use it in stained glass and in warm glass as long as it's compatible with the other glasses being used in that warm-glass project.
- ✓ **Mirrored glass:** The back of this glass is coated with a silver paint that's baked on. The result is reflective glass. Mirrored glass also comes in colors and various textures. It is used primarily for stained-glass projects, not for warm glass.
- ✓ **Iridescent glass:** To create iridescent glass, metallic oxide is sprayed onto the glass after it first comes out of the furnace while it's still hot. As a result, an iridescent finish is permanently adhered to the surface. You can use iridescent glass in stained glass and warm glass.

Touch and feel: Taking a look at textured glass

Glass makers create various glass textures while the glass is still molten (check out the nearby sidebar “Feeling the heat: Glass manufacturing” for more on the hot process used to make glass). Glass makers create most of these effects by passing molten glass through a textured roller. One side of the glass is left smooth, while the other side takes on the impression of the roller. Cathedral glass is the most commonly used glass, but opalescent glass can also be textured. The following list includes examples of textured glass. (Unless otherwise noted, the glass works for both stained-glass and warm-glass projects.)

- ✓ **Drapery glass:** Drapery glass has been manipulated while hot to create gentle folds, much like the ones you see in draperies. See Figure 1-7a.
- ✓ **Rippled glass:** Small wavy patterns appear on this glass's surface. The ripples are created as the glass passes through an embossing roller, and they can be formed into various shapes, including herringbone. See Figure 1-7b.

- ✓ **Hammered glass:** Small round dents appear on the back surface of this glass; this effect is created as the glass passes through an embossing roller. See Figure 1-7c.
- ✓ **Granite-back glass:** A random raised texture, like granules of sand, appear on the back side of this glass. See Figure 1-7d.
- ✓ **Crackled glass:** This glass is blown into a large cylinder and then dipped into cool water, causing a random crackling of just the surface layer of the glass. The cylinder is reheated, scored, and flattened to form a sheet of glass. The resulting texture looks a bit like crocodile skin. Crackled glass can be used in stained glass but doesn't do well in warm-glass projects. See Figure 1-7e.
- ✓ **Seedy glass:** Small air bubbles are injected into this glass before it's rolled into sheets. The air bubbles or seeds distort the clarity of the glass and provide an interesting texture that resembles little bubbles trapped inside the glass. It's available only in cathedral glass. See Figure 1-7f.
- ✓ **Fractured and streamered glass:** Small, thin chips of glass (called *fractures*) and thin glass strings (called *streamers*) are arranged on the steel casting table before hot glass is poured onto it. They stick to the surface of the glass and provide a beautiful effect. Famed glass artist Louis C. Tiffany likely invented this glass texture for use in his landscape windows. See Figure 1-7g.
- ✓ **Mottled glass:** To create this texture, crystal growth is allowed to occur inside opalescent glass. The result is ring-shaped areas of opacity scattered throughout the sheet of glass. See Figure 1-7h.



Be aware that textured glasses can lose some or all of their texture if used in warm-glass projects that are fired above 1,250 degrees. Always test a sample of the glass before using it in a warm-glass project.

All the various textures, types, and colors of sheet glass provide tools for the glass artist's imagination. The great joy of working with glass is the unlimited supply and variety of sheet glass you have to choose from as you create your different projects. I find myself collecting sheets of glass much like a quilter would collect fabrics. You never know when you might need a piece of pink and lime-green fractured glass to create the perfect backdrop for a spring landscape window.



The color of glass can change from batch to batch. Always make sure you purchase ample amounts of each glass color before you start a particular project so you don't run out of glass before you finish your project.

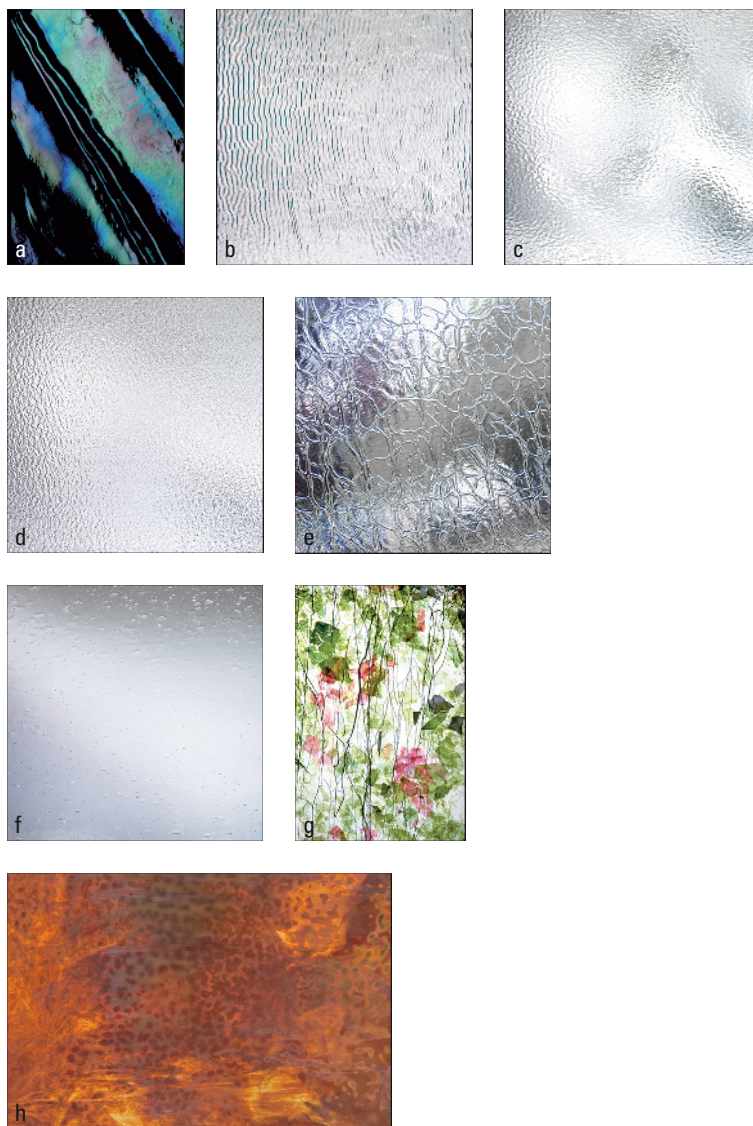


Figure 1-7:
An assortment
of available
textures.

