ENGRAVING GLASS *with a laser*

By J. Stephen Spence

Extremely ornate engravings not practical with sandblasting can be easily engraved in glass as in this shot of a piece of hand-blown Pilgrim glass. Note the use of a roll of duct tape as a jig to hold the ornament securely while engraving. This job, like most, required two passes to insure a good clean engraving.

Engraving glass with a laser engraver carries with it one of the more interesting diversities in the industry. Although we talk about engraving on glass, the truth is, we can't—not really—at least not with the lasers most commonly used in our industry.

To be more precise, what a laser does on glass is mark it, not engrave it. Here's the story: Glass in its purest form is not affected by a CO2 laser. What is affected are the millions of tiny air and moisture molecules trapped within the glass. When a laser beam hits glass, it heats up these tiny molecules causing them to expand. This causes the surface of the glass to chip leaving a rough, white etched surface. This is why it is nearly impossible to get good, sharp, clean lines when engraving glass. Magnified, images look more like the printing from an old dot matrix printer than a high performance laser.

To add to this mix is the fact that every piece of glass is different. Glass, unlike most materials we use, is a dynamic material. When being manufactured, it is constantly in a state of flux—constantly changing. Likewise, there are thousands of different formulas for glass. Some, like leaded crystal, will not engrave well at all. It is heavy, loaded with heavy metal content and very different from the cheap molded glass sold in the local discount store.

Hand-blown glass and colored glass introduced a whole new set of variables into the mix. Hand-blown glass will vary drastically from one batch to the next and from color to color. In most cases, colored glass is created by adding extremely finely ground particles of various metals to the molten glass. Adding cobalt causes the glass to turn blue. The more cobalt, the darker the color. Other metals such as magnesium, copper, titanium, and even gold will each create a different color of glass.

Why is metal content important to us? Because most lasers will not have an effect on metal. Therefore, the more metal contained in a piece of glass, the more unpredictable and difficult it is to engrave.

Here is an experiment to try at home: Take a piece of cheap leaded crystal and a piece of the cheapest Oriental made glass you can find and engrave them both in a CO_2 laser. The result is more than predictable. The cheap glass will engrave very well while the leaded crystal will hardly show a mark. The reason?

There is so much lead in the crystal, there isn't anything the laser can heat up. When it hits a molecule of metal, it just skips over it. Since the cheap, imported glass has little or no metal content at all, it is loaded with air and water molecules and engraves easily.

The object of all this? When you select glass to engrave in your shop, go for the cheapest thing you can find. Chances are, it will be the glass of choice. When a customer comes in with a piece of leaded crystal for you to engrave, run like a scalded dog!

Remember too, different colors will engrave differently. Always try to have a test piece to experiment with when working with glass.

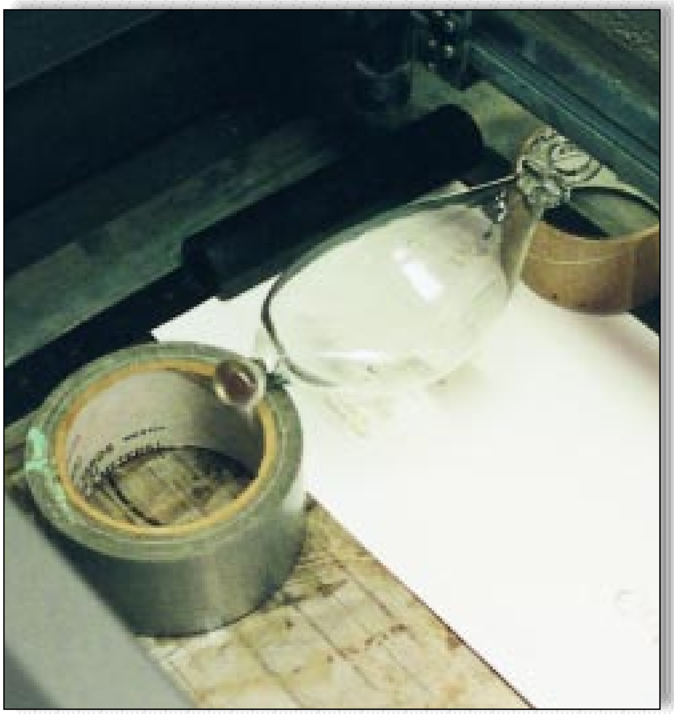
Now that we have completed the physics lesson, let's talk about engraving glass. Glass engraves fairly easily. The most difficult thing is knowing what to expect from laser engraved glass and when to quit. Here is what I mean by that: Since each type of glass engraves differently, and since glass is really marked by microscopic chipping, the final product will vary a great deal from piece to piece and job to job. On my 25-watt laser, I usually opt to run the laser at top power and top speed.

The objective is to hit those moisture molecules with as much heat as possible but then to allow them to cool as quickly as possible. Maintaining too much heat for too long a period of time will cause the glass to fracture (tiny cracks that may not even be visible with the naked eye). These fractures weaken the glass and may grow into full-blown cracks over time. In the case of enclosed objects like Christmas balls, too much heat may cause the water molecules trapped inside the sphere to condense leaving water droplets or water spots on the inside of the globe.

Because of the metal content in the glass and the speed at which I engrave it, it is not uncommon for the engraving to have holes or missed spots after the first pass. For this reason, I usually run a second pass at the same speed and power. This tends to pick up anything the first pass missed.

There is always the temptation to run a third pass, and although I sometimes will do that on very difficult pieces, it is usually a mistake. Like sandblasting, it is important to know when to quit. Over-engraving on glass will cause so much chipping, the chips look almost like a white powder that has been heaped up on the surface of the glass. This rubs off easily and usually leaves a less than desirable image below.

There is little question that sandblasting *is* a better way to engrave glass. This age-old method can produce a well-controlled, very predictable image quickly and inexpensively, so why not use sandblasting rather than a laser? There are several reasons:



Here, an extremely odd-shaped piece of hand-blown glass is being engraved. Almost anything can be used to create simple jigs to hold odd-shaped items in a laser. Here, two different-sized rolls of tape form a perfect platform to hold this glass weather indicator.

- Sandblasting requires some type of stencil. These can be expensive and difficult to create.
- A separate stencil must be made for each item to be blasted.
- Stencils can be very difficult to apply to rounded surfaces.
- Applying and removing stencils after blasting can be very time consuming.
- Stencils, by their very nature, limit the amount of detail attainable.

Lasers engrave glass very quickly without stencils. Imagine engraving an image on 500 round Christmas ornaments for a rush job. This means 500 stencils must be created and applied to the ornaments by hand. After each has been blasted, the stencil has to be removed and the globe washed and dried. Although the image might be very exciting, the labor costs will probably make the project too expensive. With my laser, I perform this task routinely. Each globe requires an engraving time of one to two minutes. There is no clean up, no stencils, no mess. Best of all, once set up, I can have an employee do the engraving, freeing me to work on more-profitable projects.

Now that we have the physics and economics out of the way, let's engrave some glass.

Already, we have discussed the speed and power for a slow 25-

Wine glass being prepared for engraving. Note the two marble bars used to hold the glass securely in place for engraving.

Even photographs can be engraved in glass. Using a special photoengraving program, this was easily engraved in a single pass.

watt laser. My laser does a good job on most glass at full power and full speed. Faster lasers may have to be slowed down to get the same results. More-powerful lasers like a 40- or 50-watt machine can actually do a better job than a 25 in a single pass. This is because they can create much more heat in a much shorter pulse. The result from the more-powerful laser is far superior and much faster. Still, I make no apologies for the work my 25-watt laser can do, and the client has no complaints either.

One of the challenges of glass is the variety of shapes it comes in. Engraving on a flat sheet of glass is fairly simple, but what about a vase or Christmas globe? How do you engrave those?

Most laser manufacturers offer a rotary attachment for their machines to assist in engraving wine bottles, stemware and the like. Although these work pretty well, many items won't fit in such attachments. How do we engrave those?

Even when a rotary attachment will work, it takes a fair amount of time to set one up, and the software is more complicated. If the job calls for multiple pieces, rotary attachments can save a lot of time but what if there is just a single piece? The time required to set up the job may be worth more than the job.

The height, width and depth (known as X-, Y- and Z-axis) of your laser determines the maximum size of glass you can actually engrave. So long as the piece you want to engrave will fit into the laser and allow you to lower the engraving table far enough to allow you to focus the laser over the piece, there is little you can't engrave. There are some issues, however, that must be considered with each piece.

ROLL-OFF

Flat glass is easy to engrave for two reasons: One, it stands still and two, because it is flat, it is always in focus. Round and other unusual shapes offer a challenge to find an area where you can maintain a reasonable amount of focus and still make the engraving large enough to be acceptable. Since the depth of field of a laser is very short, this can be tricky. I use a 2″ lens on my laser, and I have learned that I can maintain focus on rounded objects if I don't let the image roll-off more than about 1/8″ to 3/16″ on either side. Experience has taught me not only the depth of field but also how to cheat when focusing the laser.

Cheating is exactly what we do when focusing for a rounded object. If we know the maximum depth of field is 1/8″, then we can cheat the system and actually focus the laser as to use a full 1/4″ of the roll-off. What this means is that from the top of the ball to the extreme lowest limit of the engraved area can be 1/4″.

To accomplish this, first focus the laser at the top of the ball. Experience has taught me that 1/4″ on my laser is equivalent to about 4 to 5 turns of the manual focusing system. Therefore, after focusing on the top of the ball, I simply raise the table 2 to 2.5 turns. This causes the center of focus to be halfway from the top to the extreme lower limit of the engraved area.

What we are doing is taking the laser out of focus for most of the engraved area but not out far enough as is visible with the naked eye. Since glass does not engrave with great detail anyway, it would be difficult for anyone to tell what has taken place. In truth, the only spot on the entire area that is in focus is that tiny band that runs round the globe 1/8″ from the top.

Speaking of focusing, lasers with auto-

Mirrors make a great material for laser engraving. These mirror ornaments have been reverse engraved to create a very highly detailed image. Removing the mirrored coating from the back of glass is actually better suited to a laser than actually engraving the glass. Color can also be added to this type of engraving.

matic focusing may not work well with glass. Since they use a light beam to tell the laser when it is in focus, and light passes through glass, it often can't find the top surface of the glass. Manually focused machines are not very popular anymore but for many tasks, like this one, they are much easier to use than the auto focus machines.

The same principle can be applied to just about anything that is round or curved. Very uneven objects present more of a challenge but the principle is always the same. Find the center point to focus on and allow the high and low areas to engrave slightly out of focus. If the focus is too far out, the image will blur or worse yet, may not engrave at all. This is another reason why a test piece is so helpful.

SAFETY ENGRAVINGS

In the January 2000 issue, we talked in detail about doing safety engravings when engraving translucent acrylic. The same is true with glass. Anytime a clear or translucent product is being engraved, it is always a good idea to do a safety engraving first. Even if the test engraving is done on a sheet of copy paper, it allows you to make minor adjustments when placing the object in the laser for engraving.

It is nearly impossible to find center on a rounded object. Being able to peer through the object and place it exactly where you want the engraving to appear makes the job a lot easier—and makes mistakes less likely.

JIGS

The final challenge we will discuss is getting the round or curved object to stand still long enough to be engraved. One of the wonderful things about lasers is the fact they don't actually touch the object being engraved. This prevents most movement and relieves us of the responsibility of clamping an object rigidly as in mechanical engraving. Yet, lasers do move and vibrate and operators bump the machine while it is running. Even closing the lid or pushing the start button can cause a round object to move while on the engraving table. The solution? Make a jig. It doesn't have to be fancy, just something that will hold the object long enough for engraving.

When I was confronted with my first order for engraving several hundred glass globes, I thought of a hundred ways to build a jig that would not only hold a glass globe for engraving but also allow me to see through the jig so I could use a safety engraving and be adjustable enough that it would accommodate the fact that every globe was a different size and shape. After a trip down the Rube Goldman trail, I picked up a roll of duct tape to put it away.

That's when it hit me. The 3″ core of a roll of duct tape or masking tape was perfect. I could see through it. It would accommodate a variety of sizes and shapes, and there was enough friction that once the globe was in place, it would not move. Now, I have a variety of tape rolls sitting beside my laser. There are 2″ thick cores, 1″, 1/2″ and so on. What one won't hold, another probably will.

Of course, not everything I need to engrave will fit in the core of a roll of tape. For those objects, I keep a couple of blocks of marble, some blocks of wood, some foam, some plastic grid (like is used in a suspended ceiling) and a half dozen or so homemade acrylic jigs designed to hold one thing or another. The point is, whatever you need to hold, there is probably something sitting around your shop that will help hold it.

ADDING COLOR

One of the advantages of glass is that you can often add color to the engraving by using paint sticks, Rub-n-Buff, vinyl, or even some paints. Although adding color is as much a science as engraving glass in the first place, with a little experimentation, it is possible to do some really fine work.

J. Stephen Spence is the owner of Awards by Recognition Concepts in Ceredo, W.Va. In addition, Stephen offers a variety of services to assist those interested in starting their own company, or to help established businesses to grow. He can be contacted by e-mail at Concepts@usa.net, by phone at (304) 453-1800, or by fax at (304) 453-1900. A&E