Scientific Glassblowing: A Black Art

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1 A Lost Art

As far as learning scientific glassblowing as a hobby goes, it poses an unusually high barrier of entry for most people. One has to buy the necessary glass, the necessary torches, and the tools required in order to even start much less get enough practice to be very good, since practicing the basic skills consumes glass by the caseload. However, the toughest barrier exists in researching and getting information on how to blow glass.

It's startling how few people seek out scientific glassblowing as a hobby: as far as Google knows, only two other people practice the art of making one's own glassware. Robert Hunt, who runs Teralab (http://www.rhunt.f9.co.uk) practices scientific glassblowing in his spare time using soda-lime glass and ordinary gas burners. While he's made his own vacuum diodes, cathode ray tubes, and light bulbs, his use of soda-lime glass makes assembly much easier and the end product much more fragile. The other person, the focus of a video on the French site http://paillard.claude.free.fr/, has made vacuum tubes.

While scientific glassblowing may be obscure as a hobby, it's also relatively unknown as a craft. Only one school in the United States teaches a program resulting in a recognized degree in scientific glassblowing—Salem Community College in New Jersey. The lack of institutes for formal education results in most glassblowers gaining their experience from apprenticeships or similar arrangements.

Even the reference books one can find are old and obscure. I was able to borrow several books from the Caltech libraries (with the help of Ms. Harrison) which provided in-depth coverage of the field. My main reference has been *Scientific Glassblowing* by E.L. Wheeler, and while exceeding detailed, it was last published in the 1950's. At 400-some pages, it's a great book that covers most of the practical side of the field, though much of the information is out of date (it goes so far as to advise the use of mercury diffusion vacuum pumps, which might contain as much as a half-liter of mercury).

With Wheeler's book and an adequate stock of glass in hand, how'd my attempt at glassworking go?

2 My Experience

I started out with a small supply of borosillicate (Pyrex/Kimax) glass tubing of various diameters ordered from Wale Apparatus (http://www.waleapparatus.com/). However, I made the dire mistake of thinking that the Pyrex glass could be easily worked with a regular plumber's propane torch.

It really can't. The use of a propane/air mixture burns at a meager 3,500°F under ideal conditions, and the small flame tip of the propane torch was considerably hard to work with. Yes, the glass softened, but it was very hard to shape—performing a simple butt-end tube join took upwards of 15-30 minutes as I waited for the glass to soften each time and then took it out of the flame to work the joint. I was lucky if I could get one or two seconds of working time after I took the glass out of the hottest cone of the flame.

To fix this situation, I bought a National 8M torch from Sundance Art Glass (http://www.artglass1.com) up in Paradise, California. As an oxypropane torch it required more than just a simple disposable propane cylinder to run. My local Airgas distribution center was more than happy to supply the necessary oxygen tank (a 200lb cylinder), while I found a propane tank—the normal, garden-variety barbeque grill tank—at my local Mobil gas station. The torch also needed pressure regulators, flashback arrestors, and fuel/oxy tubing, which were all found nicely on eBay.

Suprisingly, the cheap Chinese knockoff pressure regulators appear to work fine, despite the fact that they sell at one-tenth of the price of quality regulators. I paid \$100 for a set of brand-new Chinese acetylene and oxygen regulators on eBay, in comparison to easily \$120 per regulator from a professional compressed gas shop.

The National 8M torch has a variety of tips and accessories to change the type and the heat of the flame that results. I work with an HTC-1 tip, which gives a nice medium-length flame, though I have a larger tip (HTC-3) on hand if I need to work larger areas. In comparison to plumber's torch, the



Figure 1: Oxygen and propane tanks

National torch makes working with glass a much easier job: its oxy-propane mixture burns at a toasty 4,800°F. Despite its heat, though, I currently need to work at night in order to see the flame best. Under daylight with a bright background, it is very difficult to see the flame or the glowing of the glass, which makes working near impossible.

With the new torch in hand, I was able to make a variety of glass apparatuses, including large bubbles on the end of tubing and preliminary T-seals. I attempted to make several copper-glass seals, but due to my relative inexperience, was unable to make the seal without liquefying the copper instead.

I attempted to make a simple bulb condenser, but a lack of annealing caused the in-progress work to crack irrepairably due to stresses and lack of internal support. Since I have fixed a kiln (courtesy of Mr. Schaefer) to working order, I can anneal better now to release stresses, enabling me to work with more complex arrangements.

I can do simple butt-seals, blow small bubbles at the end of tubing, do simple ring seals, bend tubing, and form T-seals all with a relatively good amount of skill. At this level of experience, given proper equipment, I can make my own neon signs and lightbulbs.

3 A Sampling of Glassware



Figure 2: National 8M torch with HTC-3 tip on startup



Figure 3: National 8M torch with HTC-3 tip at working temperature



Figure 4: My workbench in stored position, showing the torch and various pieces of work in progress



Figure 5: My workbench at night, with the flame at typical operating conditions



Figure 6: A simple bubble blown on 12mm tubing.



Figure 7: Another picture of the bubble. It is about 30mm in diameter.



Figure 8: Two different sizes of bubbles



Figure 9: When a bubble goes wrong—a "kidney" caused by too much pressure. It is extremely thin walled and easily crushes with a simple prod.



Figure 10: An assortment of T-seals



Figure 11: A ring-seal, or a tube-in-tube seal, the first step in a condenser

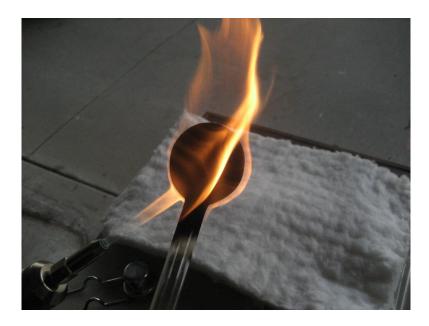


Figure 12: Hand annealing a large 50mm bulb in a gassy flame

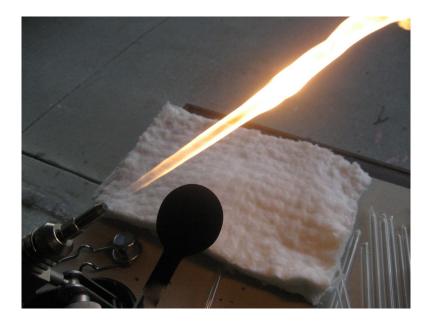


Figure 13: A typical flame used for hand annealing