Crossing Over:
Learning to work both hard and soft glass

By Lance McRorie of FlameTree Glass, Inc.
with excerpts from Bandhu Scott Dunham's Contemporary Lampworking

Just like yin and yang, there are two main classifications of glass types: soft glass and hard glass. For one to pick one glass type and to stick with it throughout their glass career is of course far easier, yet I feel the rewards are far greater when one learns to work both. Some nights, I work hard glass, and some nights I work soft glass, depending on the orders I have, or the dictates of what mood I'm in that evening. I now am able to flip-flop back and forth from working soft glass, and hard glass with ease. This accomplishment of being able to "crossover" back and forth took some time to get used to. Let me first start out with what I've discovered to work for me; my personal psychology of how I think about each glass type before I sit down to work it.

When I sit down to work borosilicate glass I first set up my work station for boro (putting aside my Moretti glass so that none can get mixed up or misconstrued, especially the clear). I bring out my "boro-tools" which are generally more heavy duty than those for working Moretti; such as larger marvers, high end Japanese cutlery knives, my borosilicate glass press, etc. I always pause for a moment before each flameworking session to remind myself of the differences I need to keep in mind when working which ever glass type I have chosen for that night. Many times I work both hard and soft glass on the same night. When working both glass types on the same night I do my best to keep my station organized so as not to "mix-up" each glass type. Of course it is relatively easy to discern hard color from soft color, but there are a few colors that look so similar that in a rush one could make a mistake. Whether one is using Moretti/Effetre or the Murano/Vetrofond soft glass; both of these soft glasses are totally compatible. Both Moretti and Murano have a c.o.e. of ~104 and thus react to a reducing flame in just the same way. Note that as a general rule, Moretti's transparents are the hardest of the palette, and the opaques are the softest. Moretti black is the main exception to this rule, it being a super dense transparent purple. When I begin to work hard or soft glass, differences emerge in my mind; such as, heat base differences, timing differences, tool choice differences, flame tolerance differences, and thermal shock differences. (Remember: Hard glass's c.o.e. is ~32-33, and Moretti's c.o.e. is ~104.) I also keep in mind the different flame chemistry's that are needed to bring out the various colors I want to achieve will be fundamentally different as well.

It has been my experience that borosilicate can tolerate much more in the way of a reducing environment than Moretti ever "thought about" in the way of the colored borosilicate glass, especially the clear borosilicate.

A simple test to perform in order to get a better understanding of how hard and soft glass respond differently to a reducing flame environment is to get a rod of borosilicate clear...say 5 or 6 millimeter, as well as the same millimeter of Moretti or Murano clear and set your torch to a reducing flame atmosphere. Then proceed to work both the boro clear and the Moretti/Murano soft glass clear in that same reducing atmosphere. The boron based clear will of course be unaffected by the reducing flame, while the Moretti soda-lime based clear will show definite signs of being reduced. Namely, a reducing "haze" will develop on the surface of the soft soda-lime clear.

A reducing flame chemistry can cause ill-effects in boro glass also, creating the usual unwanted effects; such as, causing even for the more reducing flame tolerant of the two glasses the colors to deviate away from palette. One borosilicate reduction example is the red-streaking that occurs when one works a plain opaque green borosilicate glass color in too reducing of a flame chemistry. On the other hand, let me conclude this discussion on how hard and soft glass differ in terms of their respective abilities to tolerate a reducing atmosphere, by making clear that "regardless of whether one is working the colored boro glass, or the soft soda-lime based colored Moretti glass; a reducing flame can be used to achieve "decorative" pleasing results. Although, one should, in my opinion as regards where to start with one's flame chemistry when first learning to "crossover", first learn either color palette thoroughly by working "neutral", because it is supposed to be a perfect balance of fuel to oxygen which should provide the middle "balanced ground" for one to start to understand which ever color palette is new to them; hard or soft. Then, after taking good notes on your results with all your colors in a neutral flame environment, one can can start their embarkment on the next test; working in an oxidizing flame environment, then a reduction environment, and once again log all your results. Next, you can start to track each color's respective behavior as it is subjected to the annealing process, record those findings as well. A reducing flame burns Moretti glass, inducing carbon into the matrix of the glass, and causes Moretti's color to deviate away from palette A reducing flame chemistry in Moretti glass should only be used for selective decorative purposes or of course when using reduction frit; a glass product that is solely designed to be reduced.

Remember: In Soft glass, namely Murano or Moretti glass: The soda-lime soft glass category of glass likes a neutral or an oxidizing flame as your normal everyday working flame choices. Borosilicate is again very different in this regard as well, for boro can tolerate and even happily accept reduction.

In regards to the flame chemistry choices for Moretti glass: For the "what you see what you get" soft glass color palette...an oxidizing flame keeps the colors from changing and keeps them "true to palette". On the other hand, as regards the "boro" color palettes available on the market today, one can adequately use the reducing flame environment without much distress to the glass, especially boro clear.

Yet, many borosilicate colors will also muddy, and deviate from palette as well when reduced. My point here is that the hard glass is much more "forgiving" in the area of flame chemistry than that of the soft soda-lime Moretti glass. The answers of which flame chemistry to use in order to produce which color lies in experience, and the learning of the color palette's of both soft and hard glass.

Now, let's address the color palettes between soft and hard glass for a moment, and how they differ. I can sum up the myriad of differences regarding color palette between soft and hard glass in one sentence. The color palette of Moretti and Murano glass is mainly comprised of "what you see what you get colors" with just a few striking colors, and borosilicate's color palette is just the opposite: boro's entire color palette is mostly comprised of colors that strike (either with a flame chemistry induced strike or the annealing induced strike which is contingent on two main factors, time and temperature.)

Borosilicate colored glass has only a handful of "what you see is what you get colors" available in its color palette when compared to the color palette's of the Soft Moretti or Murano glass; namely borosilicate glass's cadmium based opaque colors. Borosilicate's colors strike in accordance with not only flame chemistry and time in the kiln, but also one must regard the "amount of heat used" when working the color as well. One must also keep in mind that all the striking boro colors work on a type of "chemistry-timing" that governs the resultant color strike or "bloom" in many colors of the colored borosilicate glass. The basics of this "chemistry-timing" are this; nuclei forming gives rise to the number and/size of the crystals that form, which in turn give rise to the resultant color.

Lance working on a borosilicate dragon.

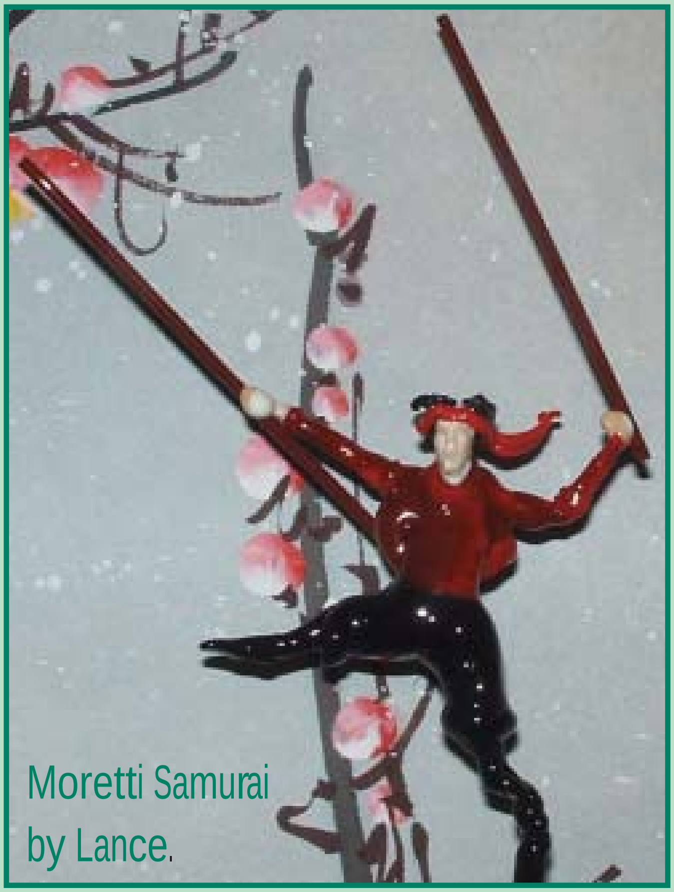
Keep in mind while working borosilicate glass that any changes in the 1) amount of heat, 2) flame chemistry, or 3) time the borosilicate colored glass is actually exposed to any particular flame chemistry or annealing process can change everything for the better or worse.

For example, of course the ruby family of borosilicate colors if over-struck in the kiln can change to an unwanted liver color, due to the over production of crystals. This is the reason most people take borosilicate's ruby family to transparent prior to the annealing process, and then time that family of colors to come out of the oven first, or at least prior to those pieces made with, say "less temperamental" colors.

Now, let's talk about regions of the flame, and where to work in the flame with either hard or soft glass and how the placement of your glass in the flame differs immensely between these two glass types. The placement of one's piece in the flame is extremely important. Soft glass with its much more temperamental nature forces a lampworker to learn how to use all the subtle regions of the flame when working their glass. Whereas, hard glass does not require near as much "pampering" regarding one's heat base. For example, when using boron based glass in order to make a "proper weld "or seal one must be "white hot-to-white hot" in order for the two respective gathers to flow together as one, while Moretti is much more forgiving in this area when "welding" two pieces of glass together; for instance, placing an arm on a human figure when sculpting. The timing of how one "keeps-alive" hard and soft glass, as well as how one seals two parts/gathers together are very different. Flame chemistry is very important to understand how to adjust properly. When I work either hard or soft glass, I am constantly adjusting my flame chemistry as well as how I position my glass in the flame in order to suit the color and immediate situation. So, always have an internal dialog with yourself when you work your glass, asking yourself questions; such as, "Am I in the correct region of the flame for this technique and color?", and, "Is this flame-chemistry correct for this technique, for this particular color?" What does a reducing flame look like on your torch? A neutral flame? An oxidizing flame? I personally only use triple surface mix Glass Torch Technology torches. In my opinion, Glass Torch Technology torches are "the Ferrari" of all glassblowing torches in the world today, and there is simply no better torch technology on the entire planet in which to work either hard or soft glass., G.T.T.'s patented triple surface mix technology helps one to get the most out of both hard and soft glass palettes.

In conclusion, I don't feel anyone should ever have to decide to choose which glass type is better, hard or soft. The truth is neither one is better than the other, just different. One might be more appropriate for a certain job per se, but neither one is better over all; both have their inherent strengths and weaknesses. Once again, one can learn so much more from learning both mediums, and letting that subsequent knowledge "crossover". Hard teaches something about soft, and soft teaches something about hard. I want to conclude this article with an old Chinese saying, "In the landscape of spring there is neither better nor worse, Some branches grow long, some short." With Best Regards, Love and Respect to you all. Peace.

About the author; Lance McRorie is founder and President of FlameTree Glass, Inc; a full service hot glass supply company, and state-of-the-art flameworking school all rolled into one. Lance can be contacted at his studio at 1-888-FLAME-TREE, www.FlameTreeGlass.com or flametreeglass@aol.com.



Moretti Samurai by Lance.

Thoughts on the subject from Bandhu Dunham's Contemporary Lampworking

Many techniques work equally well with hard or soft glass. In some cases, the properties of the particular glass will either hinder a decorative technique. For example, soda-lime glass melts at a lower temperature and is generally more fluid throughout its longer working time than borosilicate. This is helpful for decorations that involve twisting or feathering the surface of glass objects. It can be detrimental in circumstances in which you want colors to remain crisply defined shapes or stand out in relief from the surface of your project.

Generally, you can perceive the temperature of the glass by its color, or how brightly it is glowing. At the same time, we should note one of the differences between soft glass and borosilicate: Soft glass (that is, soda-lime or lead-based) is a bit goopier than borosilicate at the same level of brightness.

You will find it helpful to be aware of subtle differences like the one just mentioned. If you ignore the difference between these two categories of glass, you will tend to overheat soft glass and underheat borosilicate. Experience and practice will teach you how to compensate for differences like this.

Annealing Table for Borosilicate

including Pyrex™ 7740. Kimax KG33, Schott Duran, Northstar, Glass Alchemy.

COE = 33 x 10^{-7} Annealing Temperature = 1050ºF/565ºC Strain Point = 950ºF/510ºC

d (inches)	R_{fh} ºF/min.	R_{fh} ºC/min.	AT ºF	AT ºC	t_{soak} min.	R_{sc} ºF/min.	R_{sc} ºC/min.	End ºF	End ºC	R_{fc} ºF/min.	R_{fc} ºC/min.
0.1	2687.50	1491.56	1090	587	15	468.75	260.16	910	487	1812.50	1005.94
0.2	671.87	372.898	1070	576	15	117.19	65.04	910	487	453.12	251.48
0.3	298.61	165.73	1070	576	15	52.08	28.91	910	487	201.39	111.77
0.4	167.97	93.22	1070	576	15	29.30	16.26	910	487	113.28	62.87
0.5	107.50	59.66	1050	565	15	18.75	10.41	910	487	72.50	40.24
0.6	74.65	41.43	1050	565	15	13.02	7.23	910	487	50.35	27.94
0.7	54.85	30.44	1050	565	15	9.57	5.31	910	487	36.99	20.53
0.8	41.99	23.31	1050	565	15	7.32	4.06	910	487	28.32	15.72
0.9	33.18	18.41	1050	565	15	5.79	3.21	910	487	22.38	12.42
1	26.88	14.92	1050	565	15	4.69	2.60	910	487	18.12	10.06
1.25	17.20	9.55	1030	554	23	3.00	1.66	910	487	11.60	6.44
1.5	11.94	6.63	1030	554	34	2.08	1.16	910	487	8.06	4.47
1.75	8.78	4.87	1030	554	46	1.53	0.85	910	487	5.92	3.28
2	6.72	3.73	1030	554	60	1.17	0.65	910	487	4.53	2.51
2.25	5.31	2.95	1030	554	76	0.93	0.51	910	487	3.58	1.99
2.5	4.30	2.39	1030	554	94	0.75	0.42	910	487	2.90	1.61
2.75	3.55	1.97	1030	554	113	0.62	0.34	910	487	2.40	1.33
3	2.99	1.66	1030	554	135	0.52	0.29	910	487	2.01	1.12
4	1.68	0.93	1030	554	240	0.29	0.16	910	487	1.13	0.63
5	1.08	0.60	1030	554	375	0.19	0.10	910	487	0.70	0.40

Annealing Table for Effetre/Moretti soda-lime glass

COE = 104 x 10^{-7} Annealing Temperature = 968ºF/520ºC Strain Point = 870ºF/465ºC

d (inches)	R_{fh} ºF/min.	R_{fh} ºC/min.	AT ºF	AT ºC	t_{soak} min.	R_{sc} ºF/min.	R_{sc} ºC/min.	End ºF	End ºC	R_{fc} ºF/min.	R_{fc} ºC/min.
0.1	826.92	458.94	1008	542	15	144.23	80.05	830	440	557.69	309.52
0.2	206.73	114.74	988	531	15	36.06	20.01	830	440	139.42	77.38
0.3	91.88	50.99	988	531	15	16.03	8.89	830	440	61.97	34.39
0.4	51.68	28.68	988	531	15	9.01	5.00	830	440	34.86	19.34
0.5	33.08	18.36	968	520	15	5.77	3.20	830	440	22.31	12.38
0.6	22.97	12.75	968	520	15	4.01	2.22	830	440	15.49	8.60
0.7	16.88	9.37	968	520	15	2.94	1.63	830	440	11.38	6.32
0.8	12.92	7.17	968	520	15	2.25	1.25	830	440	8.71	4.84
0.9	10.21	5.67	968	520	15	1.78	0.99	830	440	6.89	3.82
1	8.27	4.59	968	520	15	1.44	0.80	830	440	5.58	3.10
1.25	5.29	2.94	948	509	23	0.92	0.51	830	440	3.57	1.98
1.5	3.68	2.04	948	509	34	0.64	0.36	830	440	2.48	1.38
1.75	2.70	1.50	948	509	46	0.47	0.26	830	440	1.82	1.01
2	2.07	1.15	948	509	60	0.36	0.20	830	440	1.39	0.77
2.25	1.63	0.91	948	509	76	0.28	0.16	830	440	1.10	0.61
2.5	1.32	0.73	948	509	94	0.23	0.13	830	440	0.89	0.50
2.75	1.09	0.61	948	509	113	0.19	0.11	830	440	0.74	0.41
3	0.92	0.51	948	509	135	0.16	0.09	830	440	0.62	0.34
4	0.52	0.29	948	509	240	0.09	0.05	830	440	0.35	0.19
5	0.33	0.18	948	509	375	0.06	0.03	830	440	0.22	0.12

Key

d = the maximum thickness of the glass

R_{fh} = the rate of fast heating

AT = the annealing temperature

t_{soak} = the soak time at annealing temp.

R_{sc} = the rate of slow cooling

End = the end of slow cool

R_{fc} = the rate of fast cooling

These annealing cycles are an excerpt from Contemporary Lampworking, A Practical Guide to Shaping Glass in the Flame, Third Edition, Vol. 1 written by Bandhu S. Dunham. Chapter 8 contains a much more detailed explanation of calculating annealing cycles.

Generalized Annealing Cycle

(not to scale)