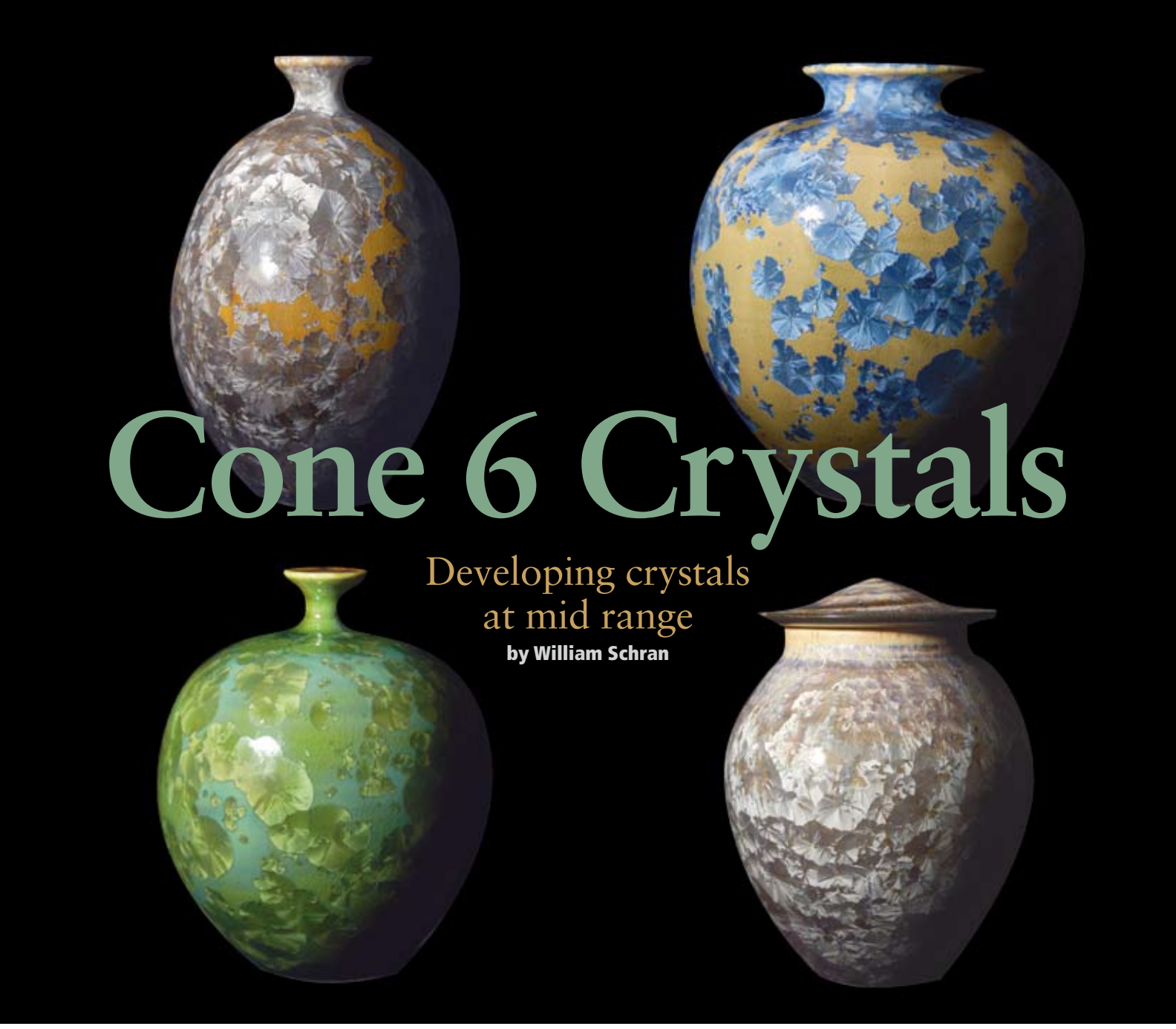

Cone 6 Crystals

Developing crystals at mid range

by William Schran

Four vessels, to 8 inches in height, thrown B-Mix clay. Glazes are as follows. Top left: Fa's Cone 6 Base glaze revised with 3% manganese dioxide and .5% cobalt carbonate; top right: MFE (Dan Turnidge Revised) glaze with 3% manganese dioxide and 1% cobalt carbonate; bottom left: MFE (Dan Turnidge Revised) glaze with 3% manganese dioxide and 1% cobalt carbonate; bottom right: Fa's Cone 6 Base glaze revised with 3% manganese dioxide and .5% cobalt carbonate.

My fascination with macrocrystalline glazes began as a graduate student in early 1975. While visiting a local exhibition of an individual's collection, I discovered two small porcelain bottles by Herbert Sanders. The glazes appeared to have blue colored snowflakes frozen on a transparent sky of orange. From that initial encounter, macrocrystalline glazing has become a process that I've revisited many times over the past thirty years.

Sanders had published *Glazes for Special Effects* in 1974, which contained recipes for crystalline glazes. In 1976, I began experimenting with several recipes listed in the book, but since it was difficult to fire our electric kilns to the required cone 9–10 temperature range, I had little success. An article by David Snair, "Making and Firing Crystalline Glazes," *Ceramics Monthly*, December 1975, provided additional glaze recipes and techniques for preparing the pots for firing. Though all the recipes were for cone 9, a comment in the article stated that firing to cone 6 would also produce crystals. I had some limited success with these glazes, but that comment stuck in my head.

Fast forward to 1994. Discussions of glazes with a group of my students lead to a question about crystalline glazes. This one question resulted in a semester-long series of glaze tests that resulted in few successes. It was the problem I had encountered years before, our electric kilns only reached cone 9–10 with much dif-

ficulty. The lack of success producing crystals by my students only strengthened my resolve to find a solution. It was then, that I recalled the Snair article and the comment about cone 6.

With additional information gathered through Internet searches and interlibrary loans, I discovered some artists experimenting with crystalline glazes at lower temperatures. Since we conducted our glaze firings to cone 6 at school, I decided to target this temperature for my testing. My initial experiments involved firing cone 10 glaze recipes only to cone 6. These tests resulted in the discovery that crystalline glazes could be produced in this lower temperature range by simply introducing additional fluxes. The flux that seemed to produce the best results was lithium carbonate. Other materials that would function as a powerful flux were either soluble or contained additional silica and alumina, which are not desirable in crystalline glazes.

All of my experiments with crystalline glaze firings, up until fall 2006, have been done in a manually operated electric kiln. The kiln has infinite controls, so with careful monitoring, I was able to control the firing schedule fairly accurately. A digital pyrometer is an essential tool to closely track temperature changes, especially during long holding cycles. Acquisition of my first kiln with a programmable controller has allowed for more complicated, repeatable firing schedules. The ability to be able to alter temperature ramp speeds and specific temperature hold times have opened up new avenues of experimentation. I have also found that, for both types of kilns, a direct vent system is important for rapid cooling cycles and maintaining an oxidizing atmosphere.

Crystalline Technique

I've developed techniques through years of experimentation, adopting processes that worked, eliminating those that produced only limited success. Web searches and recent publications provide a variety of approaches to this very involved process, and each individual need to conduct tests to find the process that makes the most sense for his or her particular circumstances.

Crystalline glazes produce the best results when applied to a smooth white clay body. Many artisans work with a porcelain clay body. Porcelain comes with its own set of issues and I have found a cone 10 porcelaneous stoneware clay—B-Mix or Bee-Mix—that works very well with my glazes. I chose to use a cone 10 clay to reduce the amount of alumina that might be picked up by the glaze.

A normal glaze has a mix of silica/flux/alumina in a ratio that provides a glassy surface and remains in place when melted on a vertical surface. A crystalline glaze contains little or no alumina, which would inhibit crystal growth. The glaze is comprised of silica, flux and a saturation of zinc oxide. This highly fluxed mix of materials leads to a very fluid glaze and steps must be taken to avoid destroying kiln shelves or the kiln.

Crystalline glazes run off the pot so you need to raise the piece on a pedestal that sits in a catch basin. It's important to select a pedestal that closely matches the diameter of the foot. Preparing several sizes allows you to select one with the correct fit.

Apply three to four coats of glaze to achieve the desired thickness, brushing each layer in a different direction.

Pieces ready to load in the kiln. Each glazed pot is positioned on a pedestal that is placed in a catch basin.

After the firing, the fluid glaze will have run down over the pedestal and into the catch basin.

The pedestal and catch basin are removed by tapping with a small chisel along the line where the pedestal joins the pot. Part of the pedestal often remains stuck to the pot and is removed during grinding.

Excess pedestal material and glaze are ground off the bottom using a bench grinder fitted with a silicon carbide grinding wheel.

Warning: Proper eye and respiratory protection must be worn during this process. I do all of my grinding outside of the studio.

I use a portable flat lap machine fitted with diamond grinding and smoothing disks to even out and smooth the bottom of the foot. I use 100 and 260 grit disks. Since water is used in this process, I do this in the studio, but I still wear eye protection. Self-adhesive diamond disks or silicon carbide disks can be attached to plastic bats and the potters wheel used to grind and smooth pot bottoms.

Catch Basins and Pedestals

Every pot must have its own catch plate/basin to contain the glaze that runs off the pot. The catch plate need not be made from the same clay as the pot. The plate can be wheel thrown or hand built. Each pot must also have some type of pedestal device to facilitate removal of the pot after firing. Some potters use insulating firebrick to create the pedestal. The brick must be at least a 2600K-type and coated with kiln wash. Another technique involves throwing the pedestal from the same clay body as the pot. After bisque firing, the pedestal is attached to the pot with a mix of white glue, which holds the pedestal in place before firing, and kaolin, which acts as a separating agent after firing. Striking with a sharp chisel or heating with a small torch just below the joint with the pot removes the pedestal. After encountering a number of problems with each of these methods, such as pots falling over or broken foot rings, I sought another solution. Ellie Blair, a fellow crystalline artist, provided this process to me—the pedestals are a mix of equal parts by volume: alumina, kaolin and sawdust. Add just enough water to bind the materials and form the mix into ¾-inch thick "biscuits" cut to the foot diameter of the bisque fired pot using round cookie cutters. I've found this material to stand up well to the melting glaze and soft enough to be easily knocked off with a chisel. Any remaining pedestal is easily ground away from the pot.

Glaze Application

Crystalline glazes may be applied like most other glaze, but since I don't have spray equipment or room in my studio to store large buckets of glaze, I apply crystalline glazes by brush. Most of the time I mix a few hundred grams at a time, which is sufficient to glaze two or three small pots. Since the crystalline glaze contains no added clay to keep the glaze in suspension, you don't want to add just water to wet the glaze. To wet the glaze, I use a CMC gum solution by adding about two heaping tablespoons of CMC powder to one quart of hot water. I let the powder soak into the water for at least 24 hours. The soaked gum is then stirred, resulting in a thin honey consistency. I add this to the dry glaze, stir and pass through 40 mesh, then 80 mesh sieves. The wetted glaze should have the consistency of thick honey.

Apply the glaze fairly thick. I apply one coat by brush horizontally around the pot. When that dries, I apply a second coat vertically, then a third coat in a diagonal direction to the upper ⅔ of the pot. Sometimes I'll apply a fourth coat to the top.

On the interior of vase/bottle forms and on the exterior of bowls, I use a cone 6 stoneware glaze. I selected a glaze that fits my clay body to create a watertight seal. With a crystalline glaze on just the interiors of bowls, I don't have be concerned with pedestals or catch plates.

Firing

Pots, with their pedestals and catch plates are loosely loaded in the kiln. In my 4 cubic-foot-kiln, I will have at the most a dozen pots. Avoid using too much kiln furniture. It takes more energy and time to heat and cool kiln furniture than it does the pots. Always use witness cones in every firing. Even if you fire with a programmable kiln and don't look at the cones during the firing, they will be the best record of the firing. Keep meticulous notes of every firing. Keep a logbook of your firings and cross-reference each glaze to its firing. Fara Shimbo and Jon Singer gave the best advice during a presentation at the Lattice Structures Crystalline Glaze Symposium in fall 2005: When you're testing, change only one thing at a time. If you alter the glaze in any way, change only one amount or material at a time. Do not change anything else. If you alter the firing schedule, do not change the glaze until you see what change the firing has made.

Should the pot come out of the firing with few or no crystals, take heart and give it another chance. If the glaze has not filled the catch plate, simply apply another coat of the same glaze or a different glaze and fire it again. Should the catch plate be filled with glaze, it will be necessary to remove the pot from the pedestal, grind the foot even and create another pedestal and catch plate. I have refired some pots up to five times before I achieved results that were to my satisfaction.

Cleanup

After the firing, knock the pedestal loose with a small chisel or screwdriver. Strike the pedestal material, not the joint between the pots and pedestal. I use a bench grinder fitted with a silicon carbide grinding wheel to remove any remaining pedestal material and glaze. I do all of my grinding outside and I always wear proper eye and respiratory protection. After coarse grinding, I use a portable flat lap fitted with diamond disks to even out and smooth the foot. Silicon carbide disks and diamond disks with self adhesive backing can be attached to plastic bats and used on the wheel to grind and smooth pot bottoms. Squirting or spraying with water while grinding will help keep down the dust.

Firing Schedule

Use one of the following firing schedules for cone 6 crystalline glazes. You will need to experiment to determine the best firing schedule for your kiln. The ability of the kiln to respond to rapid heating and cooling ramps is a critical factor in successful crystalline glazes. Kilns should be loaded loose, using as little kiln furniture as possible. Older, well-used elements may not be able to keep up with programmed demands of the kiln. I've found heavy duty elements begin to be unable to keep up with the programmed firing schedule after about forty crystalline firings.

Bottle, 7 inches in height, thrown B-Mix clay, with Fa's #5 (revised) glaze with additions of 4% manganese dioxide and 1% cobalt carbonate.

Recipes

Cone 6 Crystalline Base Glazes

MFE (Dan Turnidge revised)

Ferro Frit 3110	50.0
Silica (325 mesh)	22.5
Zinc Oxide	22.5
	95.0
Add: Lithium Carbonate	1–5

Fa's Cone 6 Base (revised)

Zinc Oxide	25 %
Dolomite	5
Ferro Frit 3110	51
Silica (325 mesh)	19
	100 %
Add: Lithium Carbonate	2–4 %

Fa's #5 (revised)

Zinc Oxide	27 %
Talc	5
Ferro Frit 3110	50
Spodumene	4
Silica (325 mesh)	14
	100 %
Add: Titanium Dioxide	2 %

Colorants

Add the following colorants individually or in combination:

Cobalt Carbonate	.25–3 %
Copper Carbonate	.5–6 %
Manganese Dioxide	.5–3 %
Iron Oxide	.5–3 %
Rutile	.5–3 %
Nickel Oxide	.25–3 %

For Manual Kilns with Infinite Control

Low – ½ hour
Medium – ½ hour
High – cone 6 over
Turn off kiln, cool to holding temperature (1850°F–1880°F)
Turn on kiln to a medium setting and monitor closely.
Try to maintain the holding temperature for 3–4 hours.

Each section of the kiln may need to have a different setting to maintain a constant temperature. For my kiln, a setting of #3 on the top and middle section, and "M" setting on the bottom section provided a fairly consistent reading.

For Programmable Kilns

Note: My kiln uses an "S" type platinum thermocouple with the thermocouple offset turned off. Each kiln may indicate a different temperature when cone 6 bends over. Use witness cones and closely monitor them until the correct peak temperature is determined.

Increase temperature 350°F per hour to 700°F
Increase temperature 750°F per hour to 2000°F
Increase temperature 150°F per hour to 2210°F (this puts cone 6 over, cone 7 at 1 o'clock position)
Hold at 2210°F for 10 minutes
Cool down 750°F per hour to 2000°F, hold for 1 hour
Cool down 750°F per hour to 1900°F, hold for 3 hours
Kiln off, vent off, total firing 9–9½ hours

Higher holding temperatures results in fewer but larger crystals with more ground (areas without crystals) exposed. ●

Visit the online crystalline glaze forum, hosted by William Melstrom, for discussion on a variety of crystalline glaze topics: http://board3.cgiworld.dreamwiz.com/list.cgi?id=Crystal.

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