RE-FIRING CERAMIC WORKS

Most studio ceramic works are created from plastic clay or cast, dried, bisque-fired to a temperature below body maturity (usually around cone 06-05) so that the works remain porous and will accept glaze, and are then glazed, and glaze-fired to the body and glaze maturity temperature.

There are times when an addition firing or firings are called for.

- **Repair of glazing faults.** There may be thin application areas, craters, or pinholes that may be helped by the application of additional glaze and re-firing.
- **Improvement of glaze surface.** Kilns that were underfired, had cold spots, or were cooled too quickly may produce glaze surfaces that are not the best they can be. Crystalline matt surfaces, for instance, develop during cooling. If a saturated iron glaze (often called a tomato red) is cooled too quickly, it will produce a browner color. Slower cooling allows iron crystals to form on the surface of appropriate glazes, and will yield rusty orange colors. Lithium and titanium promote crystal growth and will produce matts with slower cooling.
- **Application of lower-firing layers of surface**, such as luster, China paint, overglaze decals, or laser decals. Luster, China paint and overglaze decals will be fired in the cone 018 to 016 range. Laser decals will be fired to various temperatures, depending on the fusing temperature of the base glaze. See the laser decal handout for more info. Artists sometimes add additional layers of glaze, slip, or colorants and re-fire at various temperatures. Usual practice is to fire the hottest-firing materials first, then do lower firings subsequently so there is less stress on the body.

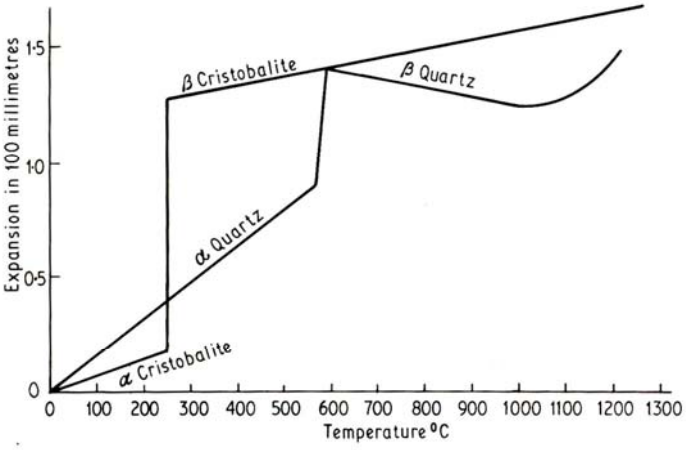
Sculpture bodies may remain porous and allow for easy application of water-based materials for re-firing. Pottery bodies are often vitrified or at least fairly dense at maturity, and the resulting low absorbency may create difficulty in applying additional layers of water-based materials after the first glaze-firing.

Strategies used to re-glaze works with low absorbency include heating the work before applying more surface (so it will dry quickly), flocculating the glaze or slip and dipping, or adding a binder (some people add a sugar syrup or an organic gum). Spraying or dipping may be better ways to build up a layer of material on a low-absorbency surface, as brushing multiple layers often moves the layer below.

While there are concerns during bisque-firing with water turning to steam at 212 degrees F and the potential for sudden creation of steam blowing up the work, heating from 212 to 1000 is not complex. At 1000, silica undergoes quartz inversion, and becomes a bit larger. Going through this point gracefully is helpful, especially with large works that may not be heating evenly. After that, there are no major danger points in the firing.

When free silica (i.e. silica not chemically combined with something else) is fired over about cone 03, it begins to form cristobalite. Major formation of cristobalite starts about 2000 degrees F, and continues over long time to very high temperatures. The cristobalite form of silica inverts – becomes 3% smaller – at 438 degrees F. Notice on the graph how sudden this change is. The farther you fire above about 2000 degrees F, and the longer you fire, the more cristobalite will be formed. Some cristobalite is a good thing, as it will put a glaze under compression during cooling and counter the tendency to crazing , especially for earthenware pottery. Too much cristobalite may cause a glaze to shiver. Unevenly going through this change in cooling or in re-heating may cause dunting – cracks through the glaze and body.

This crucial point is very close to 451 degrees F, the temperature at which paper burns. Common practice in checking a kiln to see if it's cool enough to open is inserting paper into a peep hole. If it smokes, chars, or bursts into flame, you're above 451 degrees F, and have not yet gone through cristobalite inversion. This will be more critical for high-fire kilns than earthenware because there is likely to be more cristobalite formed during firing.



Expansion of silica materials

When re-heating glaze-fired work for an additional firing, it's important to heat evenly through the cristobalite inversion, as well as quartz inversion around 1000 degrees F (red heat). Large works, where the edges may be closer to the heat source than the rest of the work, or thick works that may heat more slowly in some places may crack during re-heating.

High-fired works with more cristobalite will be more sensitive than lowfire works, although all may be subject to cracking if heated too aggressively.

Strategies

There are several things you can try to prevent cracking during re-firing by promoting more even heating:

- Use a larger kiln and fire the work closer to the center so that the work edges are not close to the elements, and the edges don't heat faster than the center.
- Elevate the work so that the bottom heats better. When you have a work with a lot of contact with the kiln shelf, the shelf and the work have to heat up, while edges will heat faster. Propping the work up on stilts, bricks, or kiln posts to allow more heat circulation underneath may help.
- Heat slowly for more even heating through 438 degrees F and 1000 degrees F.
- Artists making very large works that are close to the size of the kiln shelf have tried putting the work in the center of the kiln, and using only the elements above and below the work to prevent heating the edges faster than the rest.

Resources

Hamer, Frank and Janet, ***The Potter's Dictionary of Materials and Techniques***, 4th ed., 1997.This book has very complete coverage of cristobalite and silica issues.