Special Effect Glazes

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With photographs by Henry Bloomfield

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FRONT AND BACK COVER: Brian Rochefort, *Cascado,* 2018. Stoneware, glaze, glass fragments, 43 x 40 x 48cm (17 x 16 x 19in.). Courtesy of the artist and Van Doren Waxter Gallery New York. *Photo: Marten Elder.* and Tessa Eastman, *Mint and Lollipop Baby Cloud Bundles,* 2017, height: 15cm (6in.). Private Collection. *Sylvain Deleu Photography.*

FRONTISPIECE: Brian Rochefort, *Cascado,* 2018. Stoneware, glaze, glass fragments, 43 x 40 x 48cm (17 x 16 x 19in.). Courtesy of the artist and Van Doren Waxter Gallery New York. *Photo: Marten Elder.*

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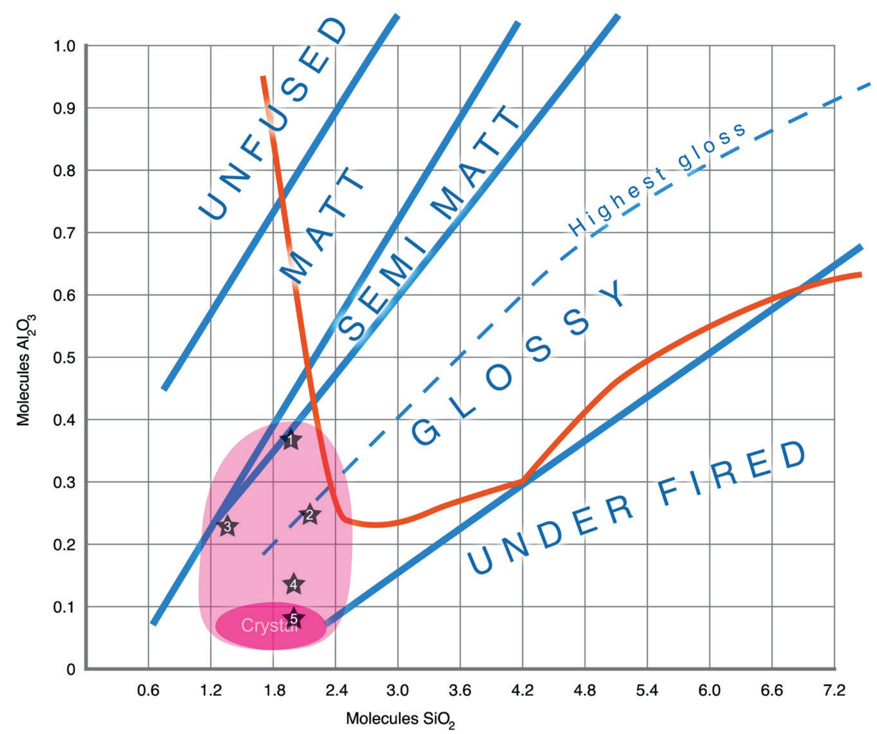
Crystalline glazes

Crystalline glazes can be made by adding titanium dioxide or rutile to a glaze which is relatively low in clay (with less than 5% clay). On the Stull map below, crystalline glazes are shown to form in the range 0.05–0.4 molecules alumina in the unity molecular formula. This is a wider range than for zinc silicate macro-crystalline glazes, which contain very little alumina. Too much alumina in the glaze tends to suppress crystal growth, although it is possible to make micro-crystalline matt glazes with a higher clay content. Small, round crystals form when calcium and magnesium are added to the glaze in the form of dolomite, particularly when zinc oxide is also added. Larger crystals grow in zinc silicate glazes, which are cooled very slowly by holding them at 1060°C (1940°F) for several hours at the end of firing. As these glazes are low in clay, they can be very runny, so care should be taken not to apply them too thickly on the outside of pots.

Graph of alumina and silica in porcelain glazes fired to cone 11 with constant flux 0.3 K_2O and 0.7 CaO. The ratio of 1:5 alumina to silica gives a semi-matt glaze, while 1:8 gives a shiny glaze. The straight lines on the chart represent alumina:silica ratios of 1:4 (matt), 1:5 (semi-matt) and 1:12 (shiny, crazed glaze). The dashed line is 1:8 Al_2O_3:SiO_2 (bright, shiny glaze). Data from R.T. Stull 1912. Graphic by Henry Bloomfield.



Crystalline glazes are found in the pale pink area in the bottom left-hand corner. Macro-crystalline glazes are in the dark pink area. The numbers refer to the glaze recipes on pp 112–14.

OPPOSITE: Wauw Design, porcelain vase with overlapping crystalline and grey glazes. Made in Copenhagen 2016.

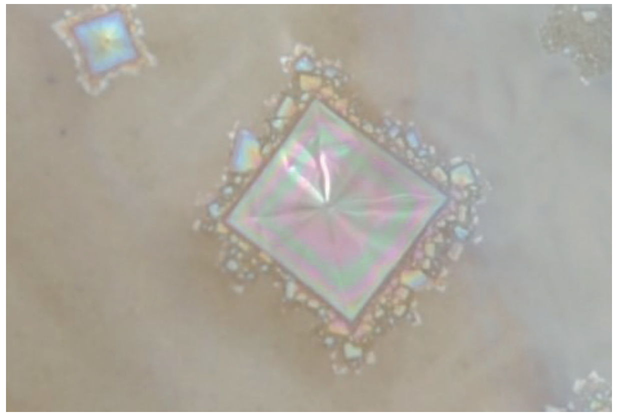
Let us look at why crystals often form in glazes which are low in alumina and contain excess calcia or magnesia. The lack of alumina in the glaze means that it is very fluid in the melt, and atoms can move around easily. Only a limited amount of calcium can dissolve in the glaze. The silica in the glaze reacts with the excess calcium to form calcium silicate crystals, which grow in the molten glaze if it is cooled slowly, giving time for the atoms to arrange themselves in a crystal structure. The calcium silicate molecules first aggregate into chains, then double chains, then sheet structures and finally three-dimensional framework structures such as anorthite (calcium feldspar). The crystals can include wollastonite (calcium silicate $CaSiO_3$), diopside ($CaMgSi_2O_6$) and enstatite (magnesium silicate $Mg_2Si_2O_6$). The latter two are types of pyroxene, a chain silicate. The glaze becomes devitrified and is no longer transparent. There can be a few crystals floating in a matrix of glossy glaze, or the crystals can cover the entire surface to form a matt glaze if the kiln is cooled slowly. Barium, strontium and zinc will also form crystals in a similar way.

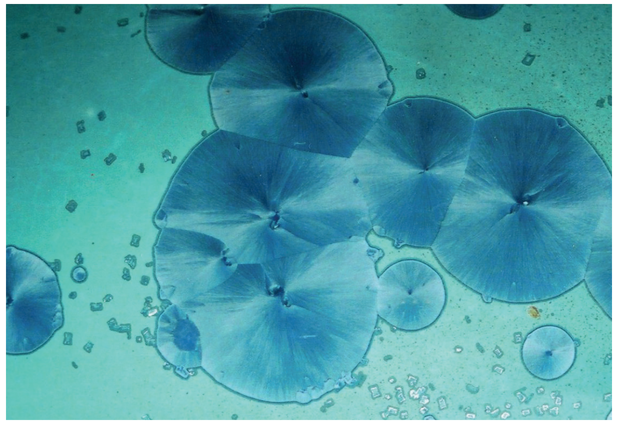
Alice Duck Ceramics, blue tumbler, slipcast porcelain with lines of coloured slip, drippy crystalline matt glaze, fired to 1280°C (2336°F) with a 42-minute soak. 7 x 8cm (2½ x 3in.).

OPPOSITE TOP LEFT: Molybdenum crystal glaze magnified, a combination of glazes from Herbert Sanders and Fara Shimbo, fired to cone 9, made by Avril Farley. Herbert Sanders, glaze cone 9, feldspar 39, whiting 7, barium carbonate 2, zinc oxide 7, calcium borate 17, silica 22, + molybdenum oxide 4, titanium oxide 8.

OPPOSITE RIGHT: Avril Farley, detail of nickel crystalline glaze over porcelain slip with red stain, fired to cone 9.

OPPOSITE BOTTOM LEFT: John Stroomer, zinc silicate crystalline glaze using copper and cobalt oxides.





Macro-crystalline glazes with very large crystals can be made from zinc silicate if held for several hours during cooling at around 1050–1100°C (1922–2012°F) to allow time for the crystals to grow while the glaze is still molten. The zinc silicate mineral Zn_2SiO_4 is called willemite. Depending on the holding temperature, its crystals can be acicular, needle-shaped or spherulite, star-shaped and can be coloured with cobalt, copper or nickel. The crystals selectively take up certain colouring oxides in preference to others. For example, cobalt will colour the crystals blue, nickel will give steel blue and manganese will give pink, though only if there is no cobalt or nickel present. Manganese and copper oxide will usually colour the background if there are other colouring oxides present. The rare earth oxides erbium, neodymium and praseodymium can be used to colour crystal glazes. Molybdenum and tungsten are used to get iridescent metallic crystals. Titanium and rutile are used to seed crystals. In a molten glaze, they initially form zinc titanate $ZnTiO_3$ or calcium titanate $CaTiO_3$ from which other crystals can grow on cooling. At stoneware temperatures, mullite in the glaze-body interface will act as a seed for crystals, as will the addition of wood ash or bone ash to the glaze. Aventurine glazes are glittery glazes with tiny sparkling crystals containing either iron oxide (for gold–brown), chromium oxide (green) or uranium oxide (yellow–orange).

1 Matt crystalline glaze, cone 8, 1260°C (2300°F). Glaze 3 on the Stull map.

Soda feldspar 41
Dolomite 22
Quartz 11
China clay 18
Whiting 3
Zinc oxide 5
+
Cobalt oxide 0.3
Nickel oxide 0.9

Recipe numbers correspond to numbers marked on Stull map on p.109.

Blue and pink crystalline matt glaze, cone 8, 1260°C (2300°F).

Soda feldspar 41
Dolomite 22
Quartz 11
China clay 18
Whiting 3
Zinc oxide 5
+
Tin oxide 4
Cobalt oxide 0.75

3 Semi-glossy blue and yellow crystal glaze (Lasse Östman) cone 8, 1260°C (2300°F), 30-minute soak. Glaze 3 on the Stull map.

This glaze has small, round crystals and is very runny.
Potash feldspar 63
Dolomite 16
Zinc oxide 17
Rutile 3
+
Cobalt oxide 1

2 Magnesium micro-crystalline matt glaze, cone 6–8, 1240–1260°C (2264–2300°F). Glaze 2 on the Stull map.

Various colouring oxides can be added, such as cobalt or copper oxide. The crystals are often a different colour to the background. Matt at cone 6, more glossy and runny at cone 8.
Soda feldspar 42
Dolomite 22
Quartz 22
China clay 6
Whiting 3
Zinc oxide 5
+
Copper oxide 1

Glossy blue with pink crystals, cone 6–8, 1240–1260°C (2264–2300°F).

Soda feldspar 42
Dolomite 22
Quartz 22
China clay 6
Whiting 3
Zinc oxide 5
+
Tin oxide 4
Cobalt oxide 0.75

4 Semi-matt crystal glaze (Lasse Östman) cone 8, 1260°C (2300°F), 45-minute soak. Glaze 4 on the Stull map.

Glossy background with matt crystals.
Potash feldspar 28
Quartz 32
Zinc oxide 19
Dolomite 3
Strontium carbonate 3
Lithium carbonate 7
China clay 3
Titanium dioxide 4
+
Nickel oxide 0.5