

GLAZE MATERIALS

Glaze Materials Coding:

Preceding each material are letters representing their primary function in a glaze, in descending order of their functional impact.

F = Flux

A = Alumina (refractory)

G = Glassformer

C = Colorant

O = Opacifier

☠ = Toxic

A

Alumina Hydrate—Al₂O₃ 3H₂O

Occasionally used directly in glazes to increase hardness, viscosity and stability. Also aids in craze resistance. Used in excess, it will tend to give a matt surface. Most commonly used as a kiln wash, especially in salt-glazing due to high refractory quality.

A

Alumina Oxide—Al₂O₃

(Calcined alumina hydrate) A refractory material contributing to a brilliant or matte finish in glazes, depending on amount used. As with alumina hydrate, normally alumina is introduced to glaze as a constituent in clay or feldspar.

C/G/O/ ☠

Antimony Oxide—Sb₂O₃

An opacifier for low fire glazes. Also used as a colorant producing yellow to cream, stronger yellow with iron present. *Toxic.*

F/☠

Barium Carbonate—BaCO₃

Used in glaze formulas as a flux at high temperatures. Produces frosty, silky, soft matts. Makes colors more brilliant. Produces turquoise from copper, yellow from iron, bright blue from cobalt. Also used in red clays (2-3%) to help prevent soluble salt scum on the surface after firing. Insoluble in water. Strontium Carbonate is sometimes used as a substitute. *The dust is toxic.*

F/ ☠

Barium Sulfate—BaSO₄

Used in some porcelain enamels to reduce shorelining and dimpling. See Barium Carbonate for use in glazes. *Toxic in raw form.*

Clay

Bentonite—Al₂O₃ 4SiO₂ 9H₂O

A fine-grained clay that is quite sticky, very plastic with a very high shrinkage. It swells considerably when wet and should be mixed with water before introduced to a clay or glaze. Used in small percentages (1-3%) in body plasticity and glaze suspension.

F/O

Bone Ash—Ca₃(PO₄)₂

(Calcium Phosphate) Originally made of ground calcined animal bone; used in bone china (up to 50%) to aid body translucency and strength. A flux and opacifier in glazes. May render surface texture in some low-fire glazes. Calcium Phosphate is the version normally used since it contains less contaminants.

F/G

Borax-Pdr—Na₂O 2B₂O₃10H₂O

Used in glaze formulas as a low temperature flux in lieu of lead, but is a strong flux at all temperatures. Usually needs to be used in conjunction with 2-4 other fluxes. Brightens colors. Often produces milky blue opalescence, cloudy and spotted coloration. Very soluble in water, most often used in a stable fritted form.

C/☠

Cadmium Oxide—CdO

Used to produce yellows, oranges and reds in low fire glazes. *Very toxic in raw form and prone to leaching from fired glaze.*

F

Calcium Carbonate—CaCO₃

(Whiting) A source of calcia in glazes. Used as a high temperature flux and as a matting agent at lower temperatures. It produces a hard, durable glass and renders a glaze less viscous in its molten state which can reduce pin-holing.

Calcium Chloride—CaCl₂

A flocculant used in very small amounts to keep particles in suspension. Soluable.

F/O

Cerium Oxide—CeO₂

An opacifier at low temperatures. Gives yellow when used with titania.

C/☠

Chromium Oxide, Green—Cr₂O₃

A refractory ceramic color. Used with tin to produce pinks or with zinc for browns. Extermely potent colorant. Very little is required to produce strong greens in clays or glazes. Volatile when fired over cone 7. May affect the color of adjacent ware in the kiln. *Toxic.*

Clays—Al₂O₃ 2SiO₂ 2H₂O

Used in glazes to help the glaze fuse to the body and help keep the ingredients suspended. A common source of alumina and silica in glazes. **See Clays-Raw section for details.**

C/F/☠

Cobalt Carbonate—CoCO₃

A very potent pigment, producing blue colors. Color variations: in lead glazes, pale to dark inky blue; in barium, strontium and alkaline glazes, brillian ultramarine blues; in magnesium glazes, pink lilac and purple blue; in zinc glazes, soft grey blue. A very potent pigment, producing blue colors. Best source of cobalt for glazes due to fine particle size. *Toxic.*

C/F/☠

Cobalt Oxide—CoO

A glaze colorant that produces reliable strong blue hues. Used in brushed oxide decoration. Stronger and grainier than cobalt carbonate. Dark blue-black in powder form. *Toxic.*

C/F/☠

Cobalt Sulfate—CoSO₄

A water-soluble cobalt used in lustrous blues in raku firings. Neutralizes yellow color of white slips. *Soluable. Toxic.*

C/☠

Copper Carbonate—CuCO₃

A light green/ turquoise color in powder form. Very sensitive to temperature and atmosphere to produce colors from red (good reduction in a soda base) to turquoise, blue-green or purple in barium and alkaline glazes, to orange, pink or grays in magnesium glazes, to metallic copper (raku). All coppers are strong fluxes. The carbonate decomposes in hot water. *Toxic.*

C/☠

Copper Oxide-Black—CuO

(Cupric) Black dry color. Normally used wherever copper oxide is called for and red or black is not specified. Copper tends to volatilize somewhat at high temperatures affecting adjacent colors. *Toxic*.

C/☠

Copper Oxide-Red—Cu₂O

(Cuprous) A concentrated copper form. Reverts to CuO in oxidation. *Toxic*.

C/☠

Copper Sulfate—CuSO₄

A blue powder used to obtain greens and reds depending on firing atmosphere and accompanying chemical in glaze, especially in Raku. *Soluble. Toxic*.

F/A/G

Cornwall Stone (Cornish Stone)

A very complex feldspathic material from England with many trace elements making a generalized formula impossible. It is used in clay bodies giving strength while firing. Also used in engobes for its adhesive power during and after firing. Used in glazes for its low shrinkage and minimal defects. From England.

F

Cryolite—Na₃AlF₆

Can be used as a source of insoluble soda flux but fluorine may bubble through glaze causing pinholes. Alumina content will tend to matt glaze surface. In small percentages, may be used as a flux in low temperature clay bodies.

F

Dolomite—CaMg(CO₃)₂

A calcium-magnesium mineral used primarily in high temperature glazes as a flux. May be used to replace whiting to create matt effects and a buttery finish in crystal formations. See Magnesium Carbonate and Talc.

F/A/G

Feldspars

Feldspars are a clay-type material but with much higher flux content. They are the most common mineral of the Earth's crust. At high temperature, they will fuse to form glass without additions. They are the main flux used in mid-range and high fire clay bodies and are perhaps the most important material in glazes of the same firing range. They are naturally occurring, which means they are not pure but contain varying amounts of many minerals. Generally, they are categorized as Potash (primary flux is potassium) or Soda (primary flux is Sodium). Technically, they are further defined by their crystal structure but in ceramics we often include Cornwall Stone, Nepheline Syenite, petalite, spodumene and lepidolite as feldspars in that they fundamentally function similarly in glaze formulations. When not specified, potash feldspar is normally meant to be used.

Custer—A potash feldspar generally used when a specific feldspar is not named. Potassium is the primary fluxing constituent.

Kona F-4 —A soda feldspar. Sodium is the primary fluxing agent which can intensify colors. A somewhat stronger flux than custer.

F/☠

Fluorspar—CaF₂

A substitute for whiting, assisting fusion. Also used as an opacifier. Produces fluorine gas (*toxic*) when fired which can harm kiln interiors. Can cause some blistering. *Toxic*.

Frits-see Frits section for details

F/G

Gerstley Borate— $2\text{CaO } 3\text{B}_2\text{O}_3 \text{ 5H}_2\text{O}$

Often used interchangeably with colemanite which is no longer available. A low temperature flux which helps to prevent crazing in glazes and acts somewhat as an opacifier. Often gives an opalescent quality and can give a mottled surface. Can be used as a substitute for calcium in glazes where a pink or red tint is desired or where calcium would harm colors. It can cause settling problems in the glaze bucket (add very small amounts of a deflocculant, soda ash, Darvan or sodium silicate. Also see Borax)

Grogs

A relatively large particle sized material that does not melt and is added to clay bodies to provide strength and workability while reducing shrinkage and warping. Generally a fired clay that is crushed and graded by size. All include fines.

Gums

Organic materials used as binders, thickeners and suspending agents in glazes.

C

Ilmenite— $\text{Fe}_2\text{O}_3 \text{ TiO}_2$

Used in granular form to produce gold to brown speckles in glazes. A source of iron and titanium similar to rutile. Grades vary batch to batch.

C/☠

Iron Chromate— FeCrO_4

A darkening agent (dark gray and brown) in underglazes and engobes and in combination with stains in clay bodies. In a tin glaze in oxidation, it can develop a pink haze around the grey. It may also produce a blue-green in high boron glazes. *Toxic.*

C/☠

Iron Chloride— $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$

(Ferric Chloride) A hygroscopic, water soluble material used to produce lusters in raku and in the glass industry. *Toxic in raw form.*

C

Iron Oxide, Red— Fe_2O_3

(Ferric Oxide) Used as a glaze colorant or decorative oxide. Can produce browns, buffs and brick reds depending on concentration, formula and firing variations. Blues or greens are possible in reduction. A flux in higher concentrations, especially in reduction firings.

C

Iron Oxide, Black— Fe_3O_4

(Ferrous Oxide) When used as a decorative oxide or glaze colorant, yields a variety of greens or browns similar to red iron but more concentrated.

C

Iron Sulphate— FeSO_4

(copperas) A soluble colorant that can be mixed with water and applied to produce red and violet lustrous effects, especially in Raku. *Soluble.*

F

Lithium Carbonate— Li_2CO_3

Used as a flux in leadless glazes. It is a source of lithia, which is a strong high temperature flux. Improves the brightness of glazes and increases the firing range. Also reduces thermal expansion and promotes crystallization.

F

Macaloid

A brand name for a beneficiated bentonite. In suspended glazes, lessens drying time. Use 1/2 to 2 %.

F**Magnesium Carbonate—MgCO₃**

A high temperature flux imparts strength and produces a smooth, buttery matt finish with little shrinkage. In higher quantities can produce a dry, opaque finish. In lowfire is refractory and may make glaze cloudy with sugary matte finish. It strongly affects colors, especially cobalt (more purple/violet).

F**Magnesium Sulfate—MgSO₄**

(Epsom Salts) Used in small proportions, it thickens (flocculates) glazes without becoming lumpy, so they adhere better to a nonporous surface. Also acts as a suspending agent. Soluble.

C**Magnetite Granular—Fe₃O₄**

(Ferrous Oxide) A mineral form of black iron oxide. When mixed into clay bodies or glazes, it produces a speckling effect. Recommended as a substitute for ilmenite. Grades vary batch to batch.

C/☠**Manganese Carbonate—MnCO₃**

A weak coloring oxide. In an alkaline or barium glaze, it results in a blue-purple color. In leaded glazes, a purple tinged with brown is produced. In high temperature magnesium glazes, fawn, beige and pinkish-brown may also be produced. Used alone and painted on bare clay it will form a matt to gloss, dark brown to black surface in high fire. Mixed with an equal amount of copper, it can produce bronze to gold surfaces and some crystalline formulations. Can cause bubbles or pin-holing with release of gas. Is a powerful flux. *Toxic in large quantities of the raw form*

C**Manganese Dioxide —MnO₂**

See Manganese Carbonate—all are toxic

Powdered - A stable oxide giving red, brown, purple and black tones to clay and glazes.

Granular - Same as the powdered form but larger particles produce spots. *Avoid prolonged inhalation.*

F/A/G**Nepheline Syenite—K₂O 3Na₂O 4Al₂O₃ 9SiO₂**

A high alumina-soda flux with some potash. Usually used in formulas for medium to high range fluxing (cones 4-8). Results in a narrower firing range than other feldspars. May be used in clay bodies to reduce crazing tendencies in the glaze (i.e. increases vitrification of the clay).

O**Tin Oxide—SnO₂**

The most effective opacifier to produce even, opaque, glossy glazes. The normal use of tin oxide in a glaze is between 5% and 10%. A dull matt glaze can result when used in excess. Brightens some colors.

O**Titanium Dioxide—TiO₂**

In a glaze produces a semi-matt surface. A major opacifier, it may tend to produce a cream color in some glazes. Also use as an agent in crystalline glazes. See Rutile.

C**Umber, Burnt**

A calcined earthen material used to color clays, slip and glazes a redish brown. Contains clay, manganese and iron. Varies from batch to batch.

C/F**Vanadium Pentoxide—V₂O₅**

A glaze colorant, it yields light yellow when used alone; with tin—bright yellow; reduced—blue-gray, with Zirconium—blues. An active flux, it is water soluble. Wear gloves.

F/G

Wollastonite—CaSiO₂

Reduces shrinkage in clays and glazes. A source of calcium. Can replace silica and whiting to reduce firing shrinkage and increase thermal shock resistance in bodies and glazes.

F/O

Zinc Oxide —ZnO

A high temperature glaze flux in small amounts. Gives some opacity and extends the maturation point producing mattness in large amounts. Can produce bright, glossy colors but also may make colors more pastel in larger amounts. Turns chrome brown, cobalt blue-grey, iron muddy yellow.

F/O

Zinc Sulphate

A soluble source of Zinc

O

Zircopax Plus—ZrSiO₄

Slightly greater zircon content and finer grind than regular Zircopax, making it a very effective glaze opacifier. Replaces regular Zircopax which is no longer available.