FERRO
Where innovation delivers performance™

Technical Information

GL 08

Performance Colors & Glass

Glazes for Technical Ceramics

It is impossible to imagine our world without ceramic components and materials. They serve as a basis for devices in all areas of electronics and electrical engineering.

Glazing

Depending on the particle size of the starting material and the crystalline phase that results from calcining, the ceramic work piece has a certain surface roughness. By applying a glaze, this surface is being smoothed out. The glaze can improve the surface quality and thus the properties of the whole ceramic component:

- **less susceptibility to dirt**
- **higher mechanical strength**
- **increased chemical resistance**
- **better appearance**
- **colored markings possible**

A glaze is a glass-like coating. It can be applied with methods like spraying, dipping, brushing, and printing onto a sintered ceramic body and be burnt-in. The burn-in temperature is below the sintering temperature of the ceramic goods.

Due to the higher flux content in the glaze a part of the ceramic body is dissolved during burning-in. This results in the formation of an intermediate layer, which causes a strong adherence of the glaze to the ceramic substrate.

The glaze has to fit to the ceramic with respect to its coefficient of thermal expansion (C.T.E.). Otherwise the glaze might crack or flake off.

Depending on the application technique, a different grinding fineness or specific additives may be necessary. Our customer service is looking forward to support you in finding solutions for your glazing problems.

Glaze preparation

Prior to applying, frits as granules or glazes in milling grade M (approx. 5 - 10 % residue on a sieve with 63 µm mesh size) have to be milled to the desired fineness. Normally, this is done in a ball mill with the addition of water and possibly other additives like glue, anti settling agent, or fluidizer. After milling, the slurry is passed through a sieve with 200 µm mesh size.

Glazes in the milling grades F (approx. 3 - 5 % residue on a sieve with 63 µm mesh size) and E (1 - 3 % residue on a sieve with 40 µm mesh size) can be processed directly. They are suspended homogeneously in a dissolver, stirrer vessel, or the like. The necessary stirring time varies, depending on the aggregate, between 1 and 24 hours. In this case too the slurry should be passed through a sieve to remove agglomerates.

If needed, magnet separators can be used during production to avoid contamination with iron particles from abrasion. For some (magnetic) brown or black stains the magnetic separators can not be utilised.

Adjustment of the glaze slurry

For a perfect glazing result, a constant adjustment and control of the glaze parameters is mandatory. These are, above all, fineness or sieve residue, resp., viscosity, and specific weight.

The **sieve residue** on a 63 µm sieve of the finished glaze slurry should be below 3 %. For quick testing, the Bayer sieve proved to be worthwhile. The measurement of the residue is made via the volume.

The above mentioned value corresponds to about one scale division of the Bayer sieve, depending on the density of the glaze. It is not useful to mill the glaze too fine (< 1 % on a sieve with 40 µm mesh size), because the glaze then tends to roll.

The **viscosity** is determined by the type of application. It can be measured with a flow viscosimeter (e.g. Ford cup, with a nozzle diameter of 4 mm). A rotational viscosimeter is preferred when more accuracy is needed.

Another control parameter is the **specific weight**. A fast measurement is possible with special calibrated containers.

It is important to maintain the once optimized glaze parameters in the following productions in order to obtain a constant glazing result.

If a longer shelf-life is intended, glazes with organic additives should be laced with a preserving agent. Prior to the next use, the glaze parameters have to be adjusted again.

Glaze application

In most cases, the application on oxide ceramics is made via spraying. Besides the viscosity and the specific weight, it is also important to control the spraying pressure and the atomizer air.

Large-sized, flat products can be easily coated with a glaze haze or with a disk. Profile rolls can be used to glaze rotational symmetric bodies that have a distinctive profile. For a consistent appearance, the applied weight should be controlled regularly.

The glaze can be applied either onto the cold or onto a preheated ceramic body. The latter is preferred, if the ceramic area is dense-burned (not absorbing), otherwise the slurry might flow.

Firing

In principle, all offered glazes are suitable for fast-firing and for traditional firing. Some glasses, especially the boron-rich ones, tend to opacify in a traditional firing process. The addition of kaolin is counteractive to this effect.

The position and size of the softening interval of a glaze (difference between half-ball temperature and softening point) indicates the best firing temperature and the sensitivity to temperature fluctuations in the kiln.

The firing temperature lies normally in the range of the half-ball temperature or slightly above. Glasses with large softening interval can also be fired at a higher or lower temperature without quality decrease. On the other hand, a small softening interval requires an exact temperature control, but the end product has then a higher temperature resistance.

Standardization of the ceramic materials

The ceramic materials for electrical engineering have been classified in the standard DIN EN 60 672 by the "Verband Deutscher Elektrotechniker" (VDE). Only products that fulfil the determined requirements are allowed for electrical engineering application. In the committee „Europäisches Komitee für Normung" (CEN) a pre-standard for all technical ceramics has been defined. The German version has been published as DIN ENV 12212 in January 1996.

Customized solutions

We develop products according to the customer's specification. The release for the use in the specific process is always made by the client.

Besides the above mentioned glazes, our product range also comprises colored glazes, inorganic pigments for coloring glazes, decorating colors (underglazes colors, screen printing colors etc.), and organic auxiliary agents (fluidizers, glues, anti-settling agents, preservatives, screen printing vehicles and so on). Please feel free to ask us for detailed information.

A perfect combination - your ceramic and our glaze!

Table 1: Frits and glazes for technical ceramics

Product no.	Firing range in °C	lead free*	C.T.E. in 10^{-7}/K	Softening point in °C	Half ball temperature in °C	suitable for	Remarks
90 685 M	1150 - 1250	**X**	33	950	1030	Cordierite	1
40 660 F	1000 - 1140	**X**	60	880	1040	Al_2O_3, Steatite	
40 580 TF	1250 - 1300	**X**	60	1180	1260	Al_2O_3, Steatite	
40 579 TF	900 - 1000	**X**	61	790	970	Al_2O_3, Steatite	2
50 1056	900 - 1000	**X**	65	830	970	Al_2O_3, Steatite	1
90 142 M	900 - 1000	**X**	68	900	960	Al_2O_3, Steatite, ZrO_2	1
50 1057 F	840 - 980	**X**	70	660	780	Al_2O_3	1
50 1042	1220 - 1300	**X**	100	1200	> 1250	ZrO_2	3
90 427 M	700 - 950	**X**	110	600	900	ZrO_2	1

1 : for wet processing an addition of 5-10 % kaolin is recommended
2 : contains glue and anti settling agent
3 : alkali free

*Lead free: PbO<0.5%. These products are technically lead free. In the production of these materials, we do not use raw materials with lead as a main or minor constituent. However, this does not exclude lead as trace constituent. Our production process is designed to avoid contamination with lead containing products. Chemical analysis show PbO contents significantly below 0.5 %, in general.

Limitation of Warranty and Liability

Ferro believes that the information contained in this document is accurate at the time of its publication. Ferro makes no warranty with respect to the information contained in this document. The information in this document is not a product specification, either in whole or in part. Your use of the information contained in this document and your purchase and use of this Ferro product are at your sole discretion. Downstream users are responsible for determination of the suitability of this product and for testing in specific applications. Nothing in this document shall be construed as a license for use that infringes upon any property rights of any third party. Please refer to the Safety Data Sheet (SDS) for safe use, handling and disposal information. All sales by Ferro to you are subject to Ferro's Terms and Conditions of Sale, as amended from time to time and available at www.ferro.com. In the event this document conflicts with Ferro's Terms and Conditions of Sale, Ferro's Terms and Conditions of Sale shall control.