Silver Pastes Product Guide

Ferro produces a wide range of silver pastes and related products for the automotive glass industry.

The following tables describe the main properties and technical data for products in our conductive pastes range. While the listing refers mainly to standard production materials, it should be noted that Ferro is fully prepared to make modifications in order to satisfy individual customers' requirements.

Furthermore, Ferro, as a producer of enamels, frits and pigments, is in a position to also provide customers with suitably formulated ceramic based materials, such as glass enamels which are compatible to our conductive coatings range.

Our Customer Service group will be pleased to discuss your requirements and recommend suitable products tailored to your specific needs.

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1. Silver Pastes for Electroplating Application

10 different grades – characterised by high acid resistance

Metal contents : 55 - 78 % (by weight)

Glass frit contents : 2 - 6 % (by weight) glass frit lead containing
lead free available (see sec. 3)

Specific resistance : 4 - 6 μΩ cm

For infra-red drying systems, medium or slow drying grades are available.

The pastes are supplied at a standard printing viscosity. However, viscosity variations to suit customers' own specifications can also be supplied. Dilution is not recommended, but for minor adjustments, oils and thinners are available (see section 5).

The firing range is adapted to suit toughened glass requirements.

Typical Products :

metal content (weight %)	solid content (weight %)	sheet resistivity (mΩ/sq. at fired film-thickness)	firing range (°C)	Remarks
(71,3 ± 0,3)	(75,3 ± 0,5)	(5,6 ± 1) at 8μm	550 - 700	
(75,0 ± 0,3)	(77,2 ± 0,5)	(6,9 ± 1) at 8μm	550 - 700	Intermixable
(55,0 ± 0,3)	(57,1 ± 0,5)	(19,0 ± 3) at 3μm	550 - 700	System

2. Silver Pastes for Non Plating Applications

40 different grades – split into low resistance, high density products and standard resistivity range pastes

Metal contents : 50 - 80 % (by weight)

Glass frit contents : 2 - 6 % (by weight) lead containing glass frit
lead free available (see sec. 3)

Specific resistance : 4 -10 μΩ cm (standard resistivity range)
2,5 - 4 μΩ cm (low resistivity range)

For infra-red drying systems, medium or slow drying grades are available.

The pastes are supplied at a standard printing viscosity. However, viscosity variations to suit customers' own specifications can also be supplied. Dilution is not recommended, but for minor adjustments, oils and thinners are available (see section 5).

The firing range is adapted to suit toughened glass firing requirements.

Typical Products :

metal content (weight %)	solid content (weight %)	sheet resistivity (mΩ/sq. at fired film-thickness)	firing range (°C)	Remarks
(80,0 ± 0,3)	(82,5 ± 0,5)	(3,0 ± 1) at 8μm	550 - 700	high density
(70,0 ± 0,3)	(72,5 ± 0,5)	(4,0 ± 1) at 8μm	550 - 700	low resistivity
(55,0 ± 0,3)	(57,0 ± 0,5)	(12,0 ± 3) at 3μm	550 - 700	Intermixable system
(80,0 ± 0,3)	(83,0 ± 0,5)	(4,0 ± 1) at 8μm	550 - 700	standard resistivity
(75,0 ± 0,3)	(77,0 ± 0,5)	(6,0 ± 1) at 8μm	550 - 700	Intermixable system
(55,0 ± 0,3)	(57,0 ± 0,5)	(18,4 ± 3)at 3μm	550 - 700	

3. Lead free Product Range

In anticipation of growing environmental regulations restricting the use of lead and other heavy metals, Ferro has developed lead free conductive coatings. Lead free products are available for plating and non plating application techniques.

12 different grades – Characterised by high acid-resistance

Metal contents : 50 - 80 % (by weight)

Glass frit contents : 2 - 6 % (by weight) lead free glass frit

Specific resistance : 2,5 - 10 μΩ cm

For infra-red drying systems, medium or slow drying grades are available.

The pastes are supplied at a standard printing viscosity. However, viscosity variations to suit customers' own specification can also be supplied. Dilution is not recommended, but for minor adjustments oils and thinners are available (see section 5).

The firing range is adapted to suit either toughened or laminated glass firing requirements.

Typical Products :

metal content (weight %)	solid content (weight %)	sheet resistivity (mΩ/sq. at fired film-thickness)	firing range (°C)	Remarks
(80,0 ± 0,3)	(84,0 ± 0,5)	(3,5 ± 1) at 8μm	500 - 700	low firing Intermixable system
(50,0 ± 0,3)	(53,0 ± 0,5)	(12,0 ± 3) at 3μm	500 - 700	
(80,0 ± 0,3)	(86,0 ± 0,5)	(4,0 ± 1) at 8μm	600 - 700	standard firing Intermixable system
(50,0 ± 0,3)	(54,0 ± 0,5)	(15,0 ± 3) at 3μm	600 - 700	

4. Silver Pastes for Special Applications

4.1. Low firing products

Special applications, for instance on coated or sputtered glass might require silver pastes suitable for low firing conditions. We therefore offer a product range which will achieve a good appearance when fired between 400 °C and 550 °C. Please note that silver pastes used on coated glass have to be adjusted to the type of coating applied.

4 different grades

Metal contents : 65 - 80 % (by weight)

Glass frit contents : 0 - 6 % (by weight) lead containing glass frit
Lead free available (see sec. 3)

Specific resistance : 3 - 6 $\mu\Omega$ cm

For infra-red drying systems, medium or slow drying grades are available.

The pastes are supplied at a standard printing viscosity. However, viscosity variations to suit customers' own specifications can also be supplied. Dilution is not recommended, but for minor adjustments, oils and thinners are available (see section 5).

Typical Product:

metal content (weight %)	solid content (weight %)	sheet resistivity ($m\Omega$/sq. at fired film-thickness)	firing range (°C)	Remarks
(75,0 ± 0,3)	(79,0 ± 0,5)	approx. 9 at 8µm	400 - 550	low firing

4.2. Silver Pastes for application on laminated Glass

Several applications for silver pastes on laminated glass are possible. Such as printed aerials or wiper heating. For the production of heatable windscreens based on sputtered glass, silver pastes are applied on interfaces 2 or 3 of the laminated glass. As both laminates are fired and bent together, special paste properties are necessary, particularly with respect to their organic burn off and electrical conductivity.

8 different grades

Metal contents : 65 - 80 % (by weight)

Glass frit contents : 0 - 6 % (by weight) lead containing glass frit
lead free available (see sec. 3)

Specific resistance : 2 - 4 $\mu\Omega$ cm

For infra-red drying systems, medium or slow drying grades are available.

The pastes are supplied at a standard printing viscosity. However, viscosity variations to suit customers' own specifications can also be supplied. Dilution is not recommended, but for minor adjustments, oils and thinners are available (see section 5).

The firing range is adapted to suit laminated glass firing requirements.

Typical Products :

metal content (weight %)	solid content (weight %)	sheet resistivity ($m\Omega$/sq. at fired film-thickness)	firing range (°C)	Remarks
(80,0 ± 0,3)	(82,0 ± 0,5)	(3,5 ± 1) at 8µm	550 - 700	Inside windscreen print
(80,0 ± 0,3)	(82,0 ± 0,5)	(3,0 ± 1) at 8µm	550 - 700	printed aerials
(65,0 ± 0,5)	(65,0 ± 0,5)	(4,5 ± 1) at 8µm	550 - 700	wiper heating

4.3. Conductive Lacquers

Ferro offers silver lacquers which only require air drying to provide a conductive film. Although the scratch resistance is not as high in comparison to the fired silver paste the films are sufficiently adherent and durable to make minor repairs to fired resistance elements of heated rear windows.

Typical Product :

Metal content	:	(45 ± 0,3 %), by weight
Specific resistance	:	20 - 40 μΩ cm (according to the drying conditions)
Viscosity	:	30 - 35 sec. flow time (flow cup DIN 53211, Ø 3 mm, 25 °C)
Drying (examples)	:	20 °C / 30 min 80 °C / 10 min 150 °C / 5 min (maximum temperature)
Application	:	brush, spraying or dipping

The conductive lacquer should be mixed thoroughly before use to completely disperse the silver powder in the organic medium.

To achieve increased adhesion and conductivity, higher drying temperatures up to the maximum of 150 °C are recommended.

4.4. Conductive Adhesives

Certain applications may require an electrical contact to be made between fired coatings and other components, without the use of a soldering process. In that case, conductive adhesives are available as an alternative to soldering. The materials are solvent free and based on silver filled, curable resin systems. The cured films have suitable conductivity and exhibit shear strengths up to 100 kg per cm².

8 grades

Metal content : 60 - 80 % (by weight)

Specific resistance : 2,5 - 50 x 10^{-4} Ω cm (depending on the curing conditions and product)

Curing : 100 - 200 °C / 90 - 30 min (depending on product)

Application : screen print or syringe dispenser

Typical Product:

Metal content : (63,5 ± 0,5 %), by weight

Specific resistance : 5 x 10^{-4} Ω cm (cured 30 min at 150 °C)

Viscosity : 8 Pas at a shear rate of 100 s^{-1}

5. Organic Additives

5.1. Thinners and oils

All standard silver preparations are delivered at a viscosity suitable for optimum printing under standard screen printing conditions.

Adding large amounts of organics, thinners, extenders, etc. is not recommended, as this reduces the solids content of the paste which will adversely affect the fired appearance of the film, as well as its conductivity. If however, customers conditions require the use of additives, for example, to adjust printing properties, a wide range of suitable oils and binders is available. Different organics can be recommended on customer's request.

5.2. Cleaning Oils

Suitable products for cleaning equipment etc. can be recommended and supplied by Ferro.