SELECTION 35M 800-880℃

Lead- and cadmium-free onglaze metallic colors

1. General Information and Color chart

Features!

- Intermixable with SELECTION 35 colors.
- High resistant and intensive colors.
- Lead and cadmium free.

Technical Information

Revised: 11/25/2021

SELECTION 35M

800–880 ℃ lead–and cadmium–free, intermixable, intensive onglaze metallic and interference metallic colors for hard porcelain, porcelain, bone china, earthenware, vitreous china and enamel ware.

Table 1

Product No.	Color tone	Pantone No. / interference color on 35703 black	Intermixable	Precious metal containing	Lead free (below 90ppm)	Cadmium free (below 40ppm)	Acid resistant, DIN 1388-1-2 *1	Alkali resistant, ASTM C556-88 *2	Enamel ware	Bone, vitreous china, earthenware	Porcelain, Hard porcelain	Fine particle size *3	Corse particle size *3	P.S.D. D50 average μ m	P.S.D. D100 biggest μ m	Remarks
Metallic colors																
35M11	white silver		✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size, mixing base for color metallic
35M12	white silver		✔		✔	✔	✔	✔	✔	✔	✔		✔	20–22	125–135	mixing base for color metallic
35M13	white silver		✔		✔	✔	✔	✔	✔	✔	✔		✔	17–18	70–80	very intensive color, high temperature stand able
35M51	gray	8601C	✔		✔	✔	✔	✔	✔	✔	✔		✔	17–18	100–110	
35M52	black	8503C	✔		✔	✔	✔	✔	✔	✔	✔		✔	17–18	100–110	
35M2	lemon gold	8640C	✔		✔	✔	✔	✔	✔	✔	✔		✔	20–22	125–135	very intensive color, high temperature stand able
35M49	lemon gold	8641C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	very intensive color, high temperature stand able
35M15	lemon gold	871C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M6	orange gold	8962C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M57	lemon gold	871C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	100–110	very intensive color, high temperature stand able
35M58	lemon gold	871C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	very intensive color, high temperature stand able
35M59	lemon gold	871C	✔		✔	✔	✔	✔	✔	✔	✔		✔	20–22	125–135	very intensive color, high temperature stand able
35M3	copper	875C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M5	red copper	8902C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size,
Interference metallic colors																
35M24	orange gold	–/875C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M26	lemon gold	–/8643C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	very intensive color, high temperature stand able
35M28	yellow green	–/8682C	✔		✔	✔	✔	✔	✔	✔	✔		✔	18–20	95–105	very intensive color, high temperature stand able
35M29	green	–/8322C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	
35M31	green	–/8323C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	very intensive color, high temperature stand able
35M33	blue green	–/8263C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	very intensive color, high temperature stand able
35M34	blue	–/8182C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M37	blue	–/8183C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	very intensive color, high temperature stand able
35M38	lilac	–/8102C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M40	lilac	–/8103C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	very intensive color, high temperature stand able
35M41	red	–/8062C	✔		✔	✔	✔	✔	✔	✔	✔	✔		9–11	45–55	fine particle size
35M43	red	–/8063C	✔		✔	✔	✔	✔	✔	✔	✔		✔	12–13	70–80	very intensive color, high temperature stand able
35M47	red/purple	8082C/8143C	✔		✔	✔	✔	✔	✔	✔	✔		✔	20–22	125–135	colored interference metallic, unique effect
Special colors for 35M colors																
35703	black	process blackC	✔		✔	✔	✔	✔	✔	✔	✔					underlay black

*1: DIN EN 1388-1-2 : The test pieces are immersed in a 4% acetic acid solution for 24 hours at 22±2℃. Refer section 7.2 and 7.3

*2: ASTM C556-88 : The test pieces are immersed in a 0.5 % sodium carbonate solution in water at 95℃ for 2, 4 and 6 hours. Refer section 7.4

*3: P.S.D. D50 average particle size. Refer section 5.1

*3: P.S.D. D100 biggest particle size. Refer section 5.1

2. Firing Conditions

Type of ware	Metallic colors	Interference metallic colors
Hard porcelain	820–880℃	820–850℃
Porcelain	820–880℃	820–850℃
Bone china	800–880℃	800–850℃
Earthenware	760–840℃	760–820℃
Vitreous china	800–880℃	820–850℃
Enamel ware	800–830℃	800–830℃

SELECTION 35M metallic colors are suitable for both normal firing of 3–10 hours and fast firing of 60–120 minutes, cold-to-cold conditions. They should also be only used with lead-and cadmium-free colors and glazes. They must be fired only under lead-and cadmium-free conditions to avoid heavy lead and cadmium release.
Interference metallic colors are recommended to fire fast-fire condition and lower temperature than the other metallic colors to avoid losing the interference effect.

High firing temperature stand able colors: **35M2, 35M49, 35M57, 35M58, 35M59, 35M26** gold, **35M13** silver, **35M51** gray, **35M52** black, **35M3** copper, **35M5** red copper, **35M 28** yellow green, **35M31** green, **35M33** blue green, **35M37** blue, **35M40** lilac and **35M43** red can stand higher-firing temperature than other colors and show very intensive color tone.

3. Application

SELECTION 35M metallic colors are suitable for screen-transfer printing, direct printing, spraying, pad printing and hand painting.
All of the **SELECTION 35M** metallic colors show interesting effect not only color itself but also show excellent effect by mixing with other colors, overprinting on relief and underlay colors. Especially interference metallic colors are recommended to be applied on top of the strong underlay colors such as black, blue, maroon etc. Their color tones stand out and this effect cannot be developed without metallic colors..

4. Coefficient of Thermal Expansion (C.O.E.)

Product	Thermal Expansion (C.O.E.)
SELECTION 35M colors (average)	Varies between $6.8–7.3 \times 10^{-6}$/℃
35103 overprinting flux	4.3×10^{-6}/℃

SELECTION 35M metallic colors are carefully developed and tested under optimum conditions to minimize cracking or chipping problems. The maximum thickness of the color layer should be bellow 20 μ m (approx. by

195 mesh/inch, 77 thread/cm, double printing) for porcelain glaze (C.O.E. 4.0–5.0 × 10^{-6}/℃).
Thicker printing of more than 25 μm could be allowed for bone china, earthen ware and vitreous china (C.O.E. 5.5–7.5 × 10^{-6}/℃) However, it is necessary to test the cracking or chipping before mass production. The results will depend on the end-user's conditions.

5. Particle size of Distribution (P.S.D.) and Printing

【5.1 Mesh size】

SELECTION 35M metallic colors have two range of particle size, fine and coarse types. They have the following appearances and recommended mesh size to print. For each color please refer to Table 1.

	Fine particle colors	**Coarse particle colors**
Appearance	Smooth and opaque	Intensive and high metallic effect
Particle size	**D_{50} average** 9–11 μm, **D_{100} biggest** 45–55 μm	**D_{50} average** 12–22 μm, **D_{100} biggest** 70–135 μm
Mesh size	103–260 mesh/inch /40–100 thread/cm	103–195 mesh /40–80 thread/cm

【5.2 Medium ratio】

Product	**Color : medium**	**Recommended mesh**
SELECTION 35M colors: Medium PM2	10 : 11–13	103–260 mesh/inch /(40–100 thread/cm)
SELECTION 35 colors: Medium PM2	10 : 6.5–9	195–305 mesh/inch (77–120 thread/cm)
35103 flux: Medium PM2	10 : 9–11	195–305 mesh/inch (77–120 thread/cm)

Screen-transfer printing: We recommend PM2 flowing medium for printing **SELECTION 35M** metallic colors. We recommend PM2 flowing medium for printing **35103** flux. We recommend C12 cover coat by printing 70 mesh/inch (27 thread/cm).
We recommend adding a little more medium for fine particle-color range to get a better homogenous of paste because the gravity of fine-particle colors is lighter than rough-particle colors. If the ink is not a good homogeneous paste, the color will dry on the screen during printing and, after firing, the gloss will become worse.

Lead-and-cadmium free onglaze colors absorb any moisture easily. Therefore, keep powder colors in a dry place. We recommend drying the color powder before using

6. Color and Mixability

SELECTION 35M metallic colors can be mixed with each other in any proportions. Mixing with other **SELECTION 35** colors can be developed a wide range of metallic effect colors. Please note the following recommendations.

Mixing white silver: To obtain colored metallic, it is suitable to mix **35M11** or **35M12** white silver with approximate 15–30% of **SELECTION 35** colors. To make gray silver tone, mixing **35M11** or **35M12** white silver with **35703** black, **35M51** gray and **35M52** black are recommended. **35804** azure is not recommended for mixing with **35M** metallic colors. **35M13** white silver is not recommended for mixing use because of mixing stability.

Underlay colors: Any of **SELECTION 35** colors and **SELECTION 35M** metallic colors can be printed as underlay colors. **35703** black is recommended as underlay black for interference metallic colors. If the underlay colors are over fired, especially interference metallic colors, they lose the metallic effect. In this case, we recommend firing lower.

Relief effect: Mixing **SELECTION 35M** metallic colors with **35180** relief flux or **35286** relief white can be developed relief metallic colors. Overprinting **SELECTION 35M** metallic colors on **35180** relief flux or **35286** relief white show unique effect of relief metallic. In this case two time firing, firing relief first then apply additional metallic colors, shows better results.

Mixing flux: **35101** low firing temperature flux or **35104** high firing temperature flux is recommended to mix with **SELECTION 35M** metallic colors to lighten the colors. To choose **35101** flux or **35104** flux depend on firing conditions and type of ware. According to our experience, maximum 30% of additional flux is allowed. **35103** flux is not suitable for mixing.

Overprinting flux: Only **35103** flux is suitable as overprinting flux for all colors. Overprinting flux improves color gloss, increase metallic effect but this flux does not improve chemical durability, such as acid, alkali and dishwasher resistance. This flux can be overprinted on all of the **SELECTION 35M** metallic colors and **SELECTION 35** colors. **35101** flux and **35104** flux are not suitable for overprinting on **SELECTION 35M** metallic colors.

We recommend testing the stability of mixing colors, overprinted flux and colors under the end-user's firing conditions before mass production.

7. Chemical durability (refer to the Table 1)

Chemical durability of **SELECTION 35M** metallic colors depends on type of ware, glaze, kiln, color deposit and firing conditions. The following are the results of tests on porcelain, fired at 830℃, with 10 minutes of soaking time and 120 minutes of cold-to-cold firing conditions of gas kiln in production.

【7.1 Residual lead and cadmium content】

SELECTION 35M colors contain less than 90 ppm residual lead and less than 40 ppm residual cadmium and are therefore in compliance with Californian Proposition 65, FDA, CPSIA, EU, and Japanese requirements.

【7.2 Lead and cadmium release】

According to the DI EN 1388-1-2 test, **SELECTION 35M** metallic colors show lead and cadmium releases are below AAS limits.

【7.3 Acid resistance】

According to the DI EN 1388-1-2 test, **SELECTION 35M** metallic colors do not show any visible attack after immersion in a 4% acetic acid solution for 24 hours at room temperature of 22±2℃.

【7.4 Alkali resistance】

According to ASTM C556-88 test, **SELECTION 35M** metallic colors do not show any visible attack up to 4 hours.

8. Safety Data Sheet (SDS)

Safety data sheet (SDS) of **SELECTION 35M** colors are available on request.

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