SELECTION 35M 800-880℃

Lead- and cadmium-free onglaze metallic colors

1. General Information and Color chart

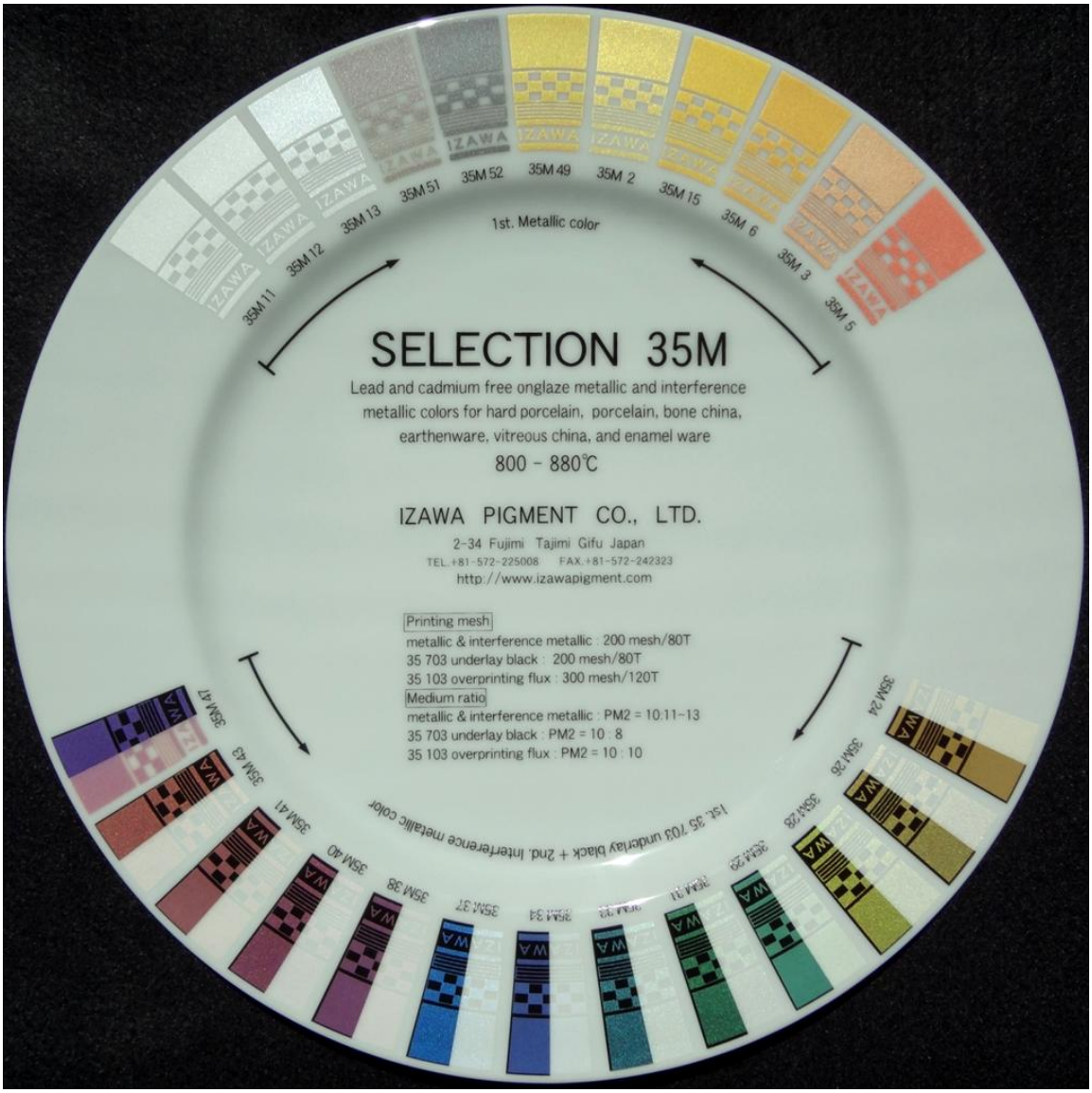
SELECTION 35M series is a wide range of lead-and cadmium-free, intermixable, intensive onglaze metallic and interference metallic colors for hard porcelain, porcelain, bone china, earthenware, vitreous china and enamel ware.

Options for this series: Please refer to their individual technical information.

SELECTION 35 and 36: Lead-and cadmium-free colors.

SELECTION 34: Lead- free cadmium containing colors.

SELECTION 35 Relief: Relief flux and white.



Technical Information

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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.

Product No.	Color tone	Pantone No. / interference color on 35 703 black	Intermixable	Lead free(<300ppm)	Cadmium free (<100ppm)	Acid resistant, DIN 1388-1-2 *1	Alkali resistant, ASTM C556-88 *2	Fine particle size *3	Coarse particle size *4	35 103 overprinting flux	Enamel ware	Bone, vitreous china, earthenware	Porcelain	Hard porcelain	Remarks
Metallic colors															
35M 11	white silver		✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size, mixing base for color metallic
35M 12	white silver		✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	mixing base for color metallic
35M 13	white silver		✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 51	gray	8601C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	
35M 52	black	8503C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	
35M 49	lemon gold	8641C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	
35M 2	lemon gold	8640C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 15	lemon gold	871C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 6	orange gold	8962C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 3	copper	875C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 5	red copper	8902C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size,
Interference metallic colors															
35M 24	orange gold	–/875C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 26	lemon gold	–/8643C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 28	yellow green	–/8682C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 29	green	–/8322C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 31	green	–/8323C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 33	blue green	–/8263C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 34	blue	–/8182C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 37	blue	–/8183C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 38	lilac	–/8102C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 40	lilac	–/8103C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 41	red	–/8062C	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	fine particle size
35M 43	red	–/8063C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	very intensive color, high temperature stand able
35M 47	red/purple	8082C/8143C	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	colored interference metallic, unique effect
Special colors for 35M colors															
35 103	overprinting flux		✔	✔	✔	✔		✔			✔	✔	✔	✔	overprinting flux for all of 35M and 35 colors
35 703	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℃.

*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.

*3: average 8–10 μ m, biggest 30 μ m, can be printed up to 250 mesh (100T)

*4: average 12–18 μ m, biggest 60 μ m, can be printed up to 200 mesh (80T)

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, 35M26 gold, 35M13, 35M51 silver, 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 20μ m (approx. by 200 mesh/80T, double printing) for porcelain glaze (C.O.E. $4.0–5.0 \times 10^{-6}$/℃).

Thicker printing of more than 25μ m 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 color range	**Coarse particle color range**
Appearance	Smooth and opaque	Intensive and high metallic effect
Particle size	Average 8–10μ m, biggest 30μ m	Average 12–18μ m, biggest 60μ m
Mesh size (polyester)	100–250 mesh/40–100T	100–200 mesh/40–80T

【5.2 Medium ratio】

SELECTION 35M color : Medium PM2	10 : 11–13
35103 overprinting flux : Medium PM2	10 : 9–11

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 (27T).
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 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 **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 **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 **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 metallic colors contain less than 300 ppm residual lead and less than 100 ppm residual cadmium and are therefore in compliance with Californian Proposition 65, FDA, 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. Material Safety Data Sheet (MSDS)

Material safety data sheet (MSDS) of **SELECTION 35M** colors are available on request.

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