

SELECTION 39 760-900°C

Lead- and cadmium-free high resistant onglaze colors

1. General Information and Color chart

SELECTION 39 series is a range of lead- and cadmium-free, intermixable and high resistant onglaze colors for bone china, earthenware, vitreous china and enamel ware.

We selected some colors from **SELECTION 35** series that can meet this high resistant range.

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

SELECTION 34: Lead- free cadmium containing colors.

SELECTION 35 Relief: Relief flux and white.

SELECTION 35M: Metallic and interference metallic colors.



SELECTION 39 760-900°C Lead- and cadmium-free, intermixable and high resistant onglaze colors for bone china, earthenware vitreous china and enamel ware.

Table 1

| Product No. | Color tone | Pantone No. | Intermixable | Precious metal containing | Lead free (<300ppm) | Cadmium free (<100ppm) | Acid resistant, DIN 1388-1-2 #1 | Alkali resistant, ASTM C556-88 #2 | 35 101 mixing and overprinting flux | 39 102 mixing and overprinting flux | Enamel ware | Bone, vitreous china, earthenware | Porcelain | Hard porcelain | Remarks |
|--------------------------------|------------------|----------------|--------------|---------------------------|---------------------|------------------------|---------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|-------------|-----------------------------------|-----------|----------------|--|
| 35 101 | flux | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | mixing and overprinting, low firing temperature |
| 39 102 | flux | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | mixing and overprinting, high firing temperature |
| 39 250 | mixing white | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | mixing white |
| 35 213 | opaque white | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | very opaque white, underlay white on color glaze |
| 39 356 | lemon yellow | 100C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | four-color yellow |
| 39 352 | yellow | 101C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 355 | orange yellow | 123C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | four-color orange yellow |
| 39 455 | grass green | 359C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 452 | chrome green | 364C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 453 | yellow green | 3415C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 454 | blue green | 3292C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 35 521 | yellow brown | 130C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 555 | ochre | 1385C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 554 | chestnut | 1615C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 652 | iron red | 164C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | iron red, intermixable |
| 39 751 | gray | 650C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 753 | black | process blackC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | four-color black |
| 39 851 | turquoise | 2905C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 35 802 | cyan | 307C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | four-color cyan |
| 35 808 | dark cyan | 641C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | four-color cyan |
| 35 811 | sky blue | 2727C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 35 804 | azure | 293C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 972 | purple | 262C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 35 923 | violet | 529C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 954 | light blue pink | 672C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 955 | light red pink | 673C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 956 | red pink | 493C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 973 | dark blue maroon | 215C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 39 974 | dark red maroon | 216C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | four-color magenta |
| Relief flux & white | | | | | | | | | | | | | | | |
| 35 180 | relief flux | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | relief flux, can mix with all 35 colors |
| 35 286 | relief white | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | relief white, can mix with all 35 colors |

*1: DIN EN 1388-1-2 : The test pieces are immersed in a 4% acetic acid solution for 24 hours at 22±2°C.

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

2. Firing Conditions

| Type of ware | Firing range |
|----------------|--------------|
| Bone china | 820–900°C |
| Vitreous china | 820–900°C |
| Earthenware | 760–840°C |
| Enamel ware | 800–830°C |

SELECTION 39 and **35** 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-free colors and glazes. They must be fired only under lead-free conditions to avoid heavy lead release..

3. Application

SELECTION 39 and **35** colors are suitable for screen-transfer printing, direct printing, spraying, pad printing and hand painting.

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

| Product | Thermal Expansion (C.O.E.) |
|---|--|
| SELECTION 39 colors (average) | Varies between $6.8-7.3 \times 10^{-6}/^{\circ}\text{C}$ |
| SELECTION 35 colors (average) | Varies between $6.8-7.3 \times 10^{-6}/^{\circ}\text{C}$ |
| 35101 flux, low-firing temperature, mixing, overprinting for all except porcelain | $8.0 \times 10^{-6}/^{\circ}\text{C}$ |
| 39102 flux, high-firing temperature, mixing, overprinting for all wares | $7.3 \times 10^{-6}/^{\circ}\text{C}$ |
| 35180 relief flux | $5.5 \times 10^{-6}/^{\circ}\text{C}$ |
| 35286 relief white | $6.2 \times 10^{-6}/^{\circ}\text{C}$ |

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

| Product | D ₅₀ average | D ₁₀₀ biggest |
|--|-------------------------|--------------------------|
| SELECTION 39, 35 colors (average) | 3–3.5 μm | 30 μm |
| 35101, 39102 flux | 2–2.5 μm | 15 μm |
| 35180 relief flux | 10–15 μm | 80–100 μm |
| 35286 relief white | 2–3 μm | 15–20 μm |

6. Printing

【6.1 Mesh size】

We recommend mesh sizes that are 180–355 mesh (71–140T) for all screen applications.

Gold and high silver containing colors: We recommend that 39925 pink, 39926 pink, 35974 magenta are printed using 250–355 mesh (100–140T). If the color deposit is too thick, the high silver-containing colors become brownish.

Relief flux and white: We recommend that 35180 relief flux is printed using 100–150 mesh (40–60T) and 35286 relief white is printed using 100–120 mesh (40–48T). Printing 1–3 times is recommended. Printing by finer mesh shows smoother surface and less pinhole than rough mesh.

【6.2 Medium ratio】

| | |
|---|---------------|
| SELECTION 39, 35 color : Medium PM2/PMT8 | 10 : 7–9/8–10 |
| 35101, 39102 overprinting flux : Medium PM2 | 10 : 9–11 |
| 35180 relief flux : Medium PM2/PMT9 | 10 : 6–7/7–8 |
| 35286 relief white : Medium PM2/PMT9 | 10 : 6–7/7–8 |

SELECTION 39, 35 colors: We recommend PM2 flowing medium, PMT8 thixotropic medium for dot and four-color printing. We recommend C12 cover coat by printing 70 mesh (27T).

Relief flux and white: We recommend PM2 flowing medium for smooth relief and PMT9 weak thixotropic medium for high and sharp relief. We recommend C33 cover coat by printing 70 mesh (27T). Adding just sufficient medium will improve the surface of relief, if it has pinhole problems.

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.

7. Color and Mixability

SELECTION 39 colors can be mixed with each other in any proportions. However, we recommend testing the stability of mixing colors and overprinted flux colors under end-user's firing conditions before mass production. Please note following points and refer to Table 1.

Mixing white: To obtain pastel-color tone, it is suitable to mix 39250 mixing white or 35213 opaque white.

Mixing flux: 35101 flux and 39102 flux are suitable for mixing all colors. After mixing with flux, the color is lighter and glossier.

Underlay white: 35213 is opaque white and suitable for using as underlay white on color glaze.

Overprinting flux: 35101 flux is suitable as overprinting flux for all colors, but if blues and browns become very weak, and reddish gold-containing pinks and maroons become brownish, we recommend 39102 flux instead. Overprinting flux improves color gloss and chemical durability, such as heavy metal release, alkali durability and dishwasher resistance.

Relief flux and white: 35180 relief flux and 35286 relief white are suitable for mixing all colors. After mixing with **SELECTION 39, 35** colors, color relief can be developed.

8. Four-color printing

【8.1 Choice of colors】

| | |
|----------------|---|
| Yellow | 39356 lemon yellow, 39355 orange yellow |
| Magenta | 39973 bluish magenta, 39974 reddish magenta |
| Cyan | 35802 cyan, 35808 dark cyan |
| Black | 35753 black |
| Flux | 35101, 359102, mixing and overprinting flux |

To adjust each color tone, 39356 lemon yellow can be mixed with 39355 orange yellow. 39973 magenta can be mixed with 39974 reddish magenta. 35802 cyan can be mixed with 35808 dark cyan. 35101 and 35104 flux are suitable as overprinting flux for all colors.

【8.2 Printing order】

yellow → magenta → cyan → black → overprinting flux.

【8.3 Mesh size】

We recommend mesh sizes that are polyester 300–330 mesh (120–130T).

【8.4 Medium ratio】

| | |
|--|--------------|
| 39356 lemon yellow, 39355 orange yellow : PMT8 | 10 : 8–9 |
| 39973 bluish magenta, 39974 reddish magenta : PMT8 | 10 : 8.5–9.5 |
| 35802 cyan, 35808 dark cyan : PMT8 | 10 : 8–9 |
| 39753 black : PMT8 | 10 : 8–9 |
| 35101, 39102, overprinting flux : PM2 | 10 : 9–11 |

We recommend PMT8 thixotropic medium for printing **SELECTION 39** four colors.

We recommend PM2 flowing medium for overprinting 35101 and 39102 flux.

We recommend C12 or C33 cover coat by printing 70 mesh (27T).

9. Chemical durability (refer to the Table 1)

Chemical durability of **SELECTION 39** colors depends on type of ware, glaze, kiln, color deposit and firing conditions. The following are the results of tests on bone china, fired at 860°C, with 10 minutes of soaking time and 120 minutes of cold-to-cold firing conditions of gas kiln in production.

【9.1 Residual lead and cadmium content】

SELECTION 39 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.

【9.2 Lead and cadmium release】

According to the DI EN 1388-1-2 test, **SELECTION 39** colors show lead and cadmium releases are below AAS limits.

【9.3 Acid resistance】

According to the DI EN 1388-1-2 test, **SELECTION 39** colors do not show any visible attack after immersion in a 4% acetic acid solution for 24 hours at a room temperature $22 \pm 2^\circ\text{C}$, except 35804 azure.

【9.4 Alkali resistance】

According to the ASTM C556-88 test, **SELECTION 39** colors do not show visible attack for up to 6 hours. If 35101 or 39102 flux are overprinted, they can stand more than 6 hours.

10. Material Safety Data Sheet (MSDS)

Material safety data sheet (MSDS) of **SELECTION 39** colors are available on request.

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