

SELECTION 34 760–880°C

Lead-free cadmium containing onglaze colors

1. General Information and Color chart

SELECTION 34 series is a range of lead-free cadmium containing, intermixable, onglaze colors for porcelain, bone china, earthenware, vitreous china and enamel ware.

Lead- and cadmium-free colors are available for this range. For more details please refer to the technical information of SELECTION 35, 36 and 39 series.

Features !

- Very intensive colors tone.
- Very stable color tone for high-firing temperature and long-firing cycle.
- Show very low cadmium release.
- No “orange skin surface (bubble)” by overprinting flux and thick printing.



SELECTION 34 760–880°C Lead- free cadmium containing, intermixable, onglaze colors for porcelain, bone china, earthenware, vitreous china and enamel ware.

Table 1

Product No.	Color tone	Pantone No.	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	35101 mixing and overprinting flux	35104 mixing and overprinting flux	Enamel ware	Bone, vitreous china, earthenware	Porcelain	Hard porcelain	Remarks
35101	flux		✓		✓	✓	✓	✓	✓	✓	✓	✓			mixing and overprinting except porcelain and hard porcelain
35104	flux		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing and overprinting except hard porcelain
34312	cadmium yellow	Yellow 012C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
34317	cadmium orange	1505C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
34411	cadmium green	362C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
34622	cadmium red	485C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
34627	cadmium red	185C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
34633	cadmium red	186C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

*1: DIN EN 1388-1-2 : The test pieces are immersed in a 4% acetic acid solution for 24 hours at 22±2°C. Refer to section 8.2 and 8.3

*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. Refer section 8.4

2. Firing Conditions

Type of ware	Firing range	Firing range with overprinting flux
Porcelain	820–880°C	800–840°C
Vitreous china	780–860°C	780–840°C
Bone china	780–860°C	780–830°C
Earthenware	780–860°C	780–840°C
Enamel ware	780–830°C	780–830°C

SELECTION 34 colors are recommended to be used under fast-firing of 60–150 minutes, cold-to-cold conditions, which shows better firing results compared to normal firing of 3–10 hours. Over-firing temperature will cause “orange skin surface (bubble)”. Therefore, please do not over-fire above mentioned temperature. They should also be used only with lead-free colors and glazes. They must be fired only under lead-free conditions to avoid heavy lead release.

3. Application

SELECTION 34 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 34 colors (average)	Varies between $6.0\text{--}6.2 \times 10^{-6}/^{\circ}\text{C}$
35101 flux, low-firing temperature, mixing, overprinting for all except porcelain	$8.0 \times 10^{-6}/^{\circ}\text{C}$
35104 flux, high-firing temperature, mixing, overprinting for all wares	$6.3 \times 10^{-6}/^{\circ}\text{C}$

SELECTION 34 colors are carefully developed and tested under optimum conditions to minimize cracking or chipping problems. The maximum thickness of the color layer should be below $20 \mu\text{m}$ (approx. by 195 mesh/inch, 77 thread/cm, double printing) for porcelain glaze (C.O.E. $4.0\text{--}5.0 \times 10^{-6}/^{\circ}\text{C}$). Thicker printing of more than $25 \mu\text{m}$ could be allowed for bone china, earthen ware and vitreous china (C.O.E. $5.5\text{--}7.5 \times 10^{-6}/^{\circ}\text{C}$). 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.)

Product	D ₅₀ average	D ₁₀₀ biggest
SELECTION 34 colors (average)	4.0–6.0 μ m (±1.0)	40 μ m (±10)
35101, 35104 flux	4.0–5.0 μ m (±1.0)	15 μ m (±10)

6. Printing

【6.1 Mesh size】

We recommend mesh sizes that are 195–305 mesh/inch (77–120 thread/cm) for all screen applications.

【6.2 Medium ratio】

SELECTION 34 color : Medium PM2/PMT8	10 : 7–9/8–10
35101, 35104 overprinting flux : Medium PM2	10 : 9–11

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 34 colors can be mixed with each other in any proportions. They can be mixed with SELECTION 35, 36 and 39 series, non–cadmium containing colors. Chemically they can be mixed with other lead– and cadmium–free colors with following exceptions. 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 35200, 36211, 39250 mixing white or 35213, 36212, opaque white.

Mixing flux: 35101 flux (except for porcelain) and 35104 flux are suitable for mixing all colors. After mixing with flux, the color is lighter and glossier and their cadmium release will be lower. According to our lab test, after mixing 20% of 35104 flux, the cadmium release becomes about 40% lower.

Underlay white: 35213 and 36220 underlay white and suitable for using as underlay white on color glaze.

Iron oxide red: Any of iron oxide color such as 35601 and 36601 are not recommended for mixing and overprinting on each other.

Silver containing gold colors: Any of silver containing gold colors cannot be mixed. Silver free gold colors such as **35904, 36904, 39954** pink, **35911, 36907, 36911, 39973** maroon can be mixed and overprinting each other.

Overprinting flux: **35 104** flux is suitable for overprinting on **SELECTION 34** colors. Overprinting flux improves color gloss and chemical durability, such as cadmium release, alkali durability and dishwasher resistance. In particular, the cadmium release will be much reduced than without overprinting flux. According to our lab tests, the cadmium release is about 90% lower after overprinting flux. Therefore, it can pass current FDA and EU limit of cadmium release.

8. Chemical durability (refer to the Table 1)

Chemical durability of **SELECTION 34** colors depends on type of ware, glaze, kiln, color deposit and firing conditions. The following are the Izawa laboratory test results on porcelain, fired at 820°C with 10 minutes of soaking time and 120 minutes of cold-to-cold firing conditions by electric kiln.

【8.1 Residual lead and cadmium content】

SELECTION 34 colors contain less than 90 ppm residual lead and contain more than 50,000 ppm cadmium.

【8.2 Lead and cadmium release】

According to the DI EN 1388-1-2 test, **SELECTION 34** colors show lead releases are below AAS limits. As for cadmium release, according to our lab test, they show below 0.07mg/dm² without overprinting flux. If they are overprinted by **35104** flux, their cadmium release becomes less than 10% compare to non-flux conditions. The cadmium releases are affected by firing temperature, type and thickness of flux.

【8.3 Acid resistance】

According to the DI EN 1388-1-2 test, **SELECTION 34** colors show slightly visible attack after immersion in a 4% acetic acid solution for 24 hours at a room temperature 22±2°C.

【8.4 Alkali resistance】

According to the ASTM C556-88 test, **SELECTION 34** colors do not show visible attack for up to 4 hours. If **35 104** flux is overprinted, they can stand more than 6 hours.

9. Safety Data Sheet (SDS)

Safety data sheet (SDS) of **SELECTION 34** colors are available on request.

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