

SELECTION 16 540-600°C

Lead- and cadmium-free, low firing, non-resistant glass colors

1. General Information and Color chart

SELECTION 16 series is a range of lead- and cadmium-free (*1), intermixable, low firing, non-resistant glass colors for bottles and cosmetic containers.

(*1) 1632 yellow, 1633 orange, 1664 red, 1665 red contain cadmium.

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

SELECTION 16M: Metallic and interference metallic glass colors.



SELECTION 16 540-600°C Lead- and cadmium-free, intermixable, low firing, non-resistant glass colors for bottles and cosmetic containers.

Table 1

Product No.	Color tone	Pantone No.	Intermixable	Precious metal containing	Lead free (<300ppm)	Cadmium free (<100ppm) *1	Acid resistant, DIN 1388-1-2 *2	Alkali resistant, ASTM C556-88 *3	16 11 mixing and overprinting flux	Glass	Earthenware	Remarks
16 11	flux		✓		✓	✓			✓	✓	✓	mixing and overprinting
16 150	AcE flux		✓		✓	✓				✓	✓	acid etch effect flux
16 21	mixing white		✓		✓	✓			✓	✓	✓	mixing white
16 22	white		✓		✓	✓			✓	✓	✓	underlay white for all colors except 16 84 and 16 85
16 26	white		✓		✓	✓			✓	✓	✓	underlay white for all colors specially for 16 84 and 16 85
16 31	lemon yellow	394C	✓		✓	✓			✓	✓	✓	four-color yellow
16 32	cadmium yellow	108C	✓		✓	*1			✓	✓	✓	four-color cadmium yellow
16 33	cadmium orange	021C	✓		✓	*1			✓	✓	✓	
16 43	yellow green	355C	✓		✓	✓			✓	✓	✓	
16 41	chrome green	363C	✓		✓	✓			✓	✓	✓	
16 42	blue green	322C	✓		✓	✓			✓	✓	✓	
16 51	yellow brown	145C	✓		✓	✓			✓	✓	✓	
16 52	ocher	1605C	✓		✓	✓			✓	✓	✓	
16 61	dark iron red	174C			✓	✓			✓	✓	✓	not good for mixing with cadmium colors
16 64	cadmium red	032C	✓		✓	*1			✓	✓	✓	four-color cadmium red
16 65	cadmium red	1797C	✓		✓	*1			✓	✓	✓	
16 72	gray	536C	✓		✓	✓			✓	✓	✓	
16 71	black	process blackC	✓		✓	✓			✓	✓	✓	
16 74	intensive black	process blackC	✓		✓	✓			✓	✓	✓	intensive four-color black, underlay black for metallic colors
16 81	dark cyan	2935C	✓		✓	✓			✓	✓	✓	four-color cyan
16 82	blue	660C	✓		✓	✓			✓	✓	✓	
16 83	sky blue	293C	✓		✓	✓			✓	✓	✓	
16 84	cobalt blue	2736C	✓		✓	✓			✓	✓	✓	cannot be used with 16 22
16 85	cobalt blue	2746C	✓		✓	✓			✓	✓	✓	cannot be used with 16 22
16 91	light pink	507C	✓	✓	✓	✓			✓	✓	✓	Cd colors can be mixed
16 92	magenta	228C	✓	✓	✓	✓			✓	✓	✓	four-color magenta, Cd colors can be mixed

*1: lead- free cadmium containing colors

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

*3: 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

Normal firing is from 540–600°C in a cycle of 60–150 minutes, cold-to-cold, with 10 minutes for soaking. The best firing condition depends on firing speed and type of ware and kiln.

3. Application

SELECTION 16 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 16 colors (average)	Varies between $8.8\text{--}9.3 \times 10^{-6}/^{\circ}\text{C}$
1611 flux	$9.8 \times 10^{-6}/^{\circ}\text{C}$

If **SELECTION 16** colors are applied in very thick layers, the colors could crack or chip off, depending on the type of ware and thickness of the colors. We recommend testing the application of the colors under your conditions before mass production use.

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

Product	D ₅₀ average	D ₁₀₀ biggest
SELECTION 16 colors (average)	3–3.5 μm	30 μm
1611 flux	2–2.5 μm	15 μm

6. Printing

【6.1 Mesh size】

We recommend mesh sizes that are 180–300 mesh (71–120T) for all screen applications.

【6.2 Medium ratio】

SELECTION 16 colors: Medium PM2/PMT8	10 : 7–9/8–10
1611 mixing and overprinting flux: Medium PM2	10 : 9–11

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

Lead- and cadmium-free glass 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 16 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.

Underlay white: 1622 white is suitable as underlay white, except 1684 and 1685 cobalt blue (becomes greenish). 1626 white is suitable for all colors including 1684 and 1685 cobalt blue.

Mixing white: To obtain pastel-color tone, it is suitable to mix 1621 mixing white or 1622 white. 1626 white is suitable for 1684 and 1685 cobalt blue.

Mixing flux: 1611 flux is suitable for mixing all colors. After mixing with flux, the color is lighter and glossier.

AcE flux: To obtain acid etch effect, 16150 AcE flux is suitable.

Iron red: 1661 iron red is not recommended for mixing with cadmium-containing colors.

Black: 1674 black is very intensive and it is recommended for four color printing and underlay black for metallic colors.

Overprinting flux: Overprinting 1611 flux can improve color gloss but it cannot improve chemical durability, such as heavy metal release, alkali durability and dishwasher resistance.

8. Four-color printing

【8.1 Choice of colors】

	Combination 1 (without cadmium colors)	Combination 2 (with cadmium colors)
Yellow	1631 lemon yellow	1632 cadmium yellow
Magenta	1692 magenta	1692 magenta
Red		1664 cadmium red
Cyan	1681 cyan	1681 cyan
Black	1674 black	1674 black
Flux	1611 mixing and overprinting flux	1611 mixing and overprinting flux

1631 yellow and 1632 cadmium yellow can be mixed with each other and overprinted.

1664 cadmium red and 1692 magenta can be mixed each other and overprinted.

1611 flux are suitable as overprinting flux for all colors.

【8.2 Printing order】

Combination 1, Y-M-C-K-F: yellow → magenta → cyan → black → overprinting flux.

Combination 2, CdY-M/CdR-C-K-F: cadmium yellow → magenta/cadmium red → cyan → black → overprinting flux. (Additional overprinting of cadmium colors is possible before overprinting flux)

【8.3 Mesh size】

We recommend mesh size that is polyester 300 mesh (120T).

【8.4 Medium ratio】

1631 lemon yellow, 1632 cadmium yellow : PMT8	10 : 8.5-9.5
1692 magenta : PMT8	10 : 8.5-9.5
1664 cadmium red : PMT8	10 : 8.5-9.5
1681 cyan : PMT8	10 : 8.5-9.5
1674 black : PMT8	10 : 8.5-9.5
1611 overprinting flux : PM2	10 : 9-11

We recommend PMT8 thixotropic medium for printing **SELECTION 16** four colors.

We recommend PM2 flowing medium for overprinting 1611 flux.

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

9. Chemical durability (refer to the Table 1)

Chemical durability of **SELECTION 16** colors depends on type of ware, kiln, color deposit and firing conditions. The following are the results of tests on soda lime glass bottle, fired at 580°C, with 10 minutes of soaking time and 90 minutes of cold-to-cold firing conditions of gas kiln in production.

【9.1 Residual lead and cadmium content】

SELECTION 16 colors contain less than 300 ppm residual lead and less than 100 ppm residual cadmium, with some exceptions (*1 cadmium-containing colors) and are therefore in compliance with Californian Proposition 65, FDA, EU and Japanese requirements.

Cadmium containing colors contain less than 600 ppm residual lead and contain more than 50,000 ppm cadmium.

【9.2 Lead and cadmium release】

According to the DI EN 1388-1-2 test, **SELECTION 16** colors show lead and cadmium releases are below AAS limits. Cadmium-containing colors (*1) show considerably high cadmium release. They cannot meet FDA and EU limits.

【9.3 Acid resistance】

According to the DI EN 1388-1-2 test, **SELECTION 16** colors show visible attack and come off completely after immersion in a 4% acetic acid solution for 10 minutes at room temperature $22 \pm 2^{\circ}\text{C}$.

【9.4 Alkali resistance】

According to the ASTM C556-88 test, **SELECTION 16** colors show visible attack before 2 hours. Even if 1611 flux is overprinted, they cannot stand up to 2 hours.

10. Material Safety Data Sheet (MSDS)

Material safety data sheet (MSDS) of **SELECTION 16** colors are available on request.

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