SELECTION 16 540-600℃

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

1. General Information and Color chart

Features!

・Intermixable and very low firing temperature.
・Lead and cadmium free except cadmium colors.
・Can mix with SELECTION 16M, metallic and interference metallic glass colors.

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

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 *2	Alkali resistant, ASTM C556-88 *3	1611mixing and overprinting flux	Glass	Earthenware	Remarks
1611	flux		✔		✔	✔			✔	✔	✔	mixing and overprinting
16150	AcE flux		✔		✔	✔				✔	✔	acid etch effect flux
1621	mixing white		✔		✔	✔			✔	✔	✔	mixing white
1622	white		✔		✔	✔			✔	✔	✔	underlay white for all colors except 1684 and 1685
1626	white		✔		✔	✔			✔	✔	✔	underlay white for all colors specially for 1684 and 1685
1631	lemon yellow	394C	✔		✔	✔			✔	✔	✔	four-color yellow
1632	cadmium yellow	108C	✔		✔	*1			✔	✔	✔	four-color cadmium yellow
1633	cadmium orange	021C	✔		✔	*1			✔	✔	✔	
1643	yellow green	355C	✔		✔	✔			✔	✔	✔	
1641	chrome green	363C	✔		✔	✔			✔	✔	✔	
1642	blue green	322C	✔		✔	✔			✔	✔	✔	
1651	yellow brown	145C	✔		✔	✔			✔	✔	✔	
1652	ochre	1605C	✔		✔	✔			✔	✔	✔	
1661	dark iron red	174C			✔	✔			✔	✔	✔	not recommended for mixing with cadmium colors
1664	cadmium red	032C	✔		✔	*1			✔	✔	✔	four-color cadmium red
1665	cadmium red	1797C	✔		✔	*1			✔	✔	✔	
1672	gray	536C	✔		✔	✔			✔	✔	✔	
1671	black	process blackC	✔		✔	✔			✔	✔	✔	
1674	intensive black	process blackC	✔		✔	✔			✔	✔	✔	intensive four-color black, underlay black for metallic colors
1681	dark cyan	2935C	✔		✔	✔			✔	✔	✔	four-color cyan
1682	blue	660C	✔		✔	✔			✔	✔	✔	
1683	sky blue	293C	✔		✔	✔			✔	✔	✔	
1684	cobalt blue	2736C	✔		✔	✔			✔	✔	✔	cannot be mixed with 1622
1685	cobalt blue	2746C	✔		✔	✔			✔	✔	✔	cannot be mixed with 1622
16979	purple	2607C	✔	✔	✔	✔			✔	✔	✔	Cd colors can be mixed
16977	light pink	507C	✔	✔	✔	✔			✔	✔	✔	Cd colors can be mixed
16978	magenta	208C	✔	✔	✔	✔			✔	✔	✔	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℃. Refer 9.2 and 9.3

*3: 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 9.4

Technical Information

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2. Firing Conditions

Normal firing is from 540–600℃ 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 $8.8–9.3 \times 10^{-6}$/℃
1611 flux	9.8×10^{-6}/℃

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)	4.0–6.0 μm (±1.0)	30 μm (±10)
1611 flux	4.0–5.0 μm (±1.0)	30 μm (±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】

Product	Color : medium	Recommended mesh
SELECTION 16 colors: Medium PM2/PMT8	10 : 6.5–9/8–10	195–305 mesh/inch (77–120 thread/cm)
1611 flux: Medium PM2	10 : 9–11	195–305 mesh/inch (77–120 thread/cm)

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/inch (27 thread/cm).
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 very opaque and it is suitable as underlay white, except **1684** and **1685** cobalt blue (becomes greenish). **1626** white is lighter than **1622** white but it 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 especially 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.

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.

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.

Cadmium-containing colors *1: **1632** yellow, **1633** orange, **1664** red and **1665** red can be mixed with any other **SELECTION 16** colors except **1661** iron red, **16977** purple, **16977** light pink and **16978** magenta.

SELECTION 16M metallic colors : **SELECTION 16M** series is a metallic color range which is a part of **SELECTION 16** series, therefore they are intermixable with one each other. For more details please refer to **SELECTION 16M** technical information.

8. 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℃, with 10 minutes of soaking time and 90 minutes of cold-to-cold firing conditions of gas kiln in production.

【8.1 Residual lead and cadmium content】

SELECTION 16 colors contain less than 90 ppm residual lead and less than 40 ppm residual cadmium, with some exceptions (cadmium-containing colors *1) and are therefore in compliance with Californian Proposition 65, FDA, CPSIA, EU, and Japanese requirements.

Cadmium-containing colors, **1632** yellow, **1633** orange, **1664** red and **1665** red 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 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.

【8.3 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±2℃.

【8.4 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.

9. Safety Data Sheet (SDS)

Safety data sheet (SDS) of **SELECTION 16** colors are available on request.

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