

# SELECTION 36 780-900°C

Lead- and cadmium-free onglaze colors

## 1. General Information and Color chart

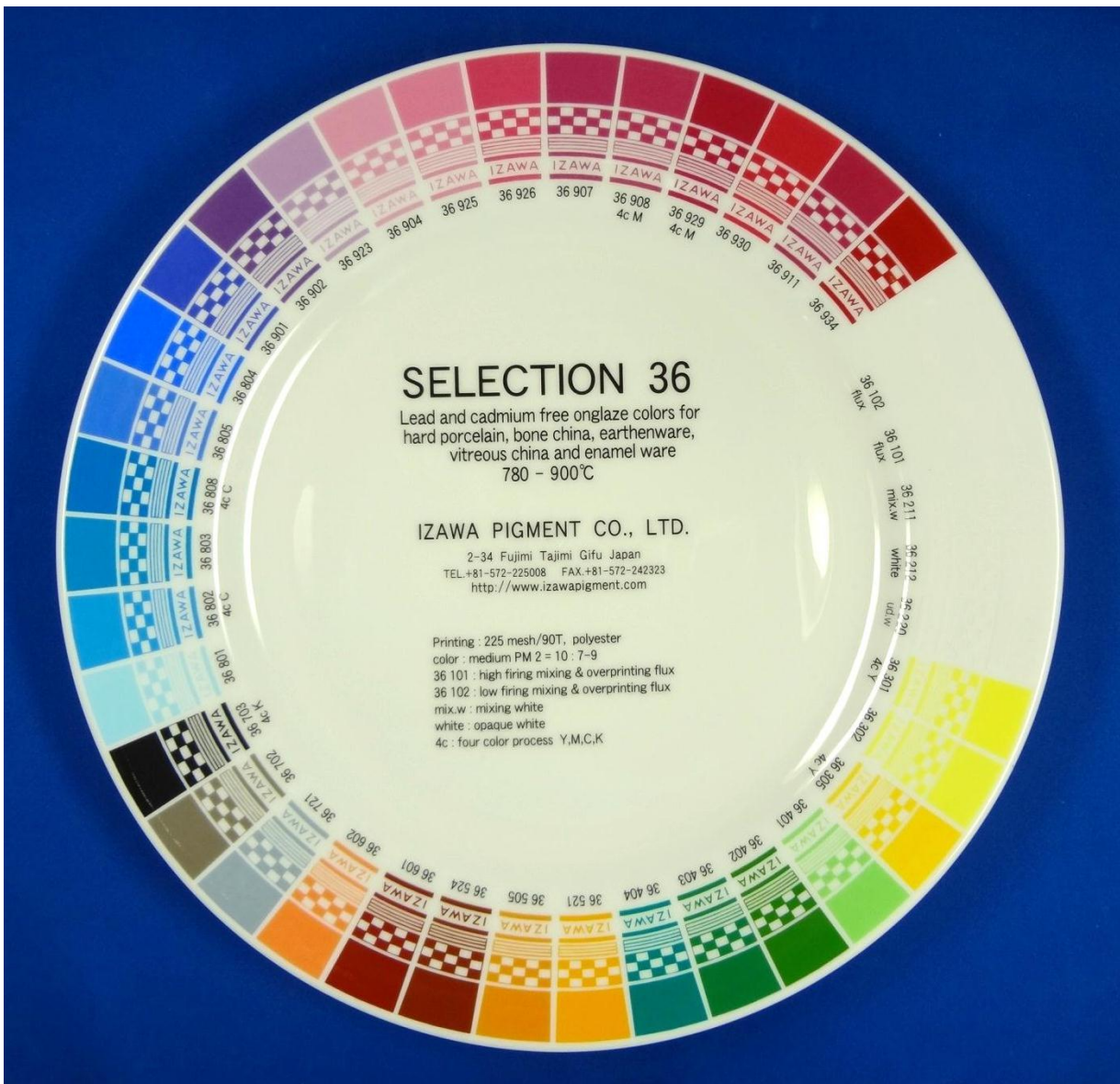
SELECTION 36 series is a range of lead- and cadmium-free, intermixable, onglaze colors for hard porcelain, bone china, earthenware, vitreous china and enamel ware.

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 36 780-900°C Lead- and cadmium-free, intermixable, onglaze colors for hard porcelain, 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	36 101 overprinting flux	36 102 overprinting flux	Enamel ware	Bone, vitreous china, earthenware	Porcelain	Hard porcelain	Remarks
36 102	flux		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing and overprinting, low firing temperature
36 101	flux		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing and overprinting, high firing temperature
36 211	mixing white		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing white
36 212	white		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	opaque white
36 220	underlay white		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	underlay white Ti base
36 301	lemon yellow	101C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color yellow
36 302	yellow	102C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 305	orange yellow	122C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color orange yellow
36 401	grass green	359C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 402	chrome green	364C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 403	yellow green	341C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 404	blue green	328C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 521	yellow brown	130C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 505	ochre	1385C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 524	chestnut	1615C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 601	iron dark red	181C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	iron red, mixture limited
36 602	iron red	164C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	iron red, intermixable
36 721	gray	650C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 702	dark gray	warm gray 9C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 703	black	process blackC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color black
36 801	turquoise	2905C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 802	cyan	307C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color cyan
36 803	dark cyan	308C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 808	dark cyan	293C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color cyan
36 805	blue	2718C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 804	azure	293C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 901	lilac	2726C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 902	purple	520C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 923	violet	529C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 904	light blue pink	203C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 925	light red pink	1905C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 926	red pink	205C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 907	blue maroon	221C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 908	magenta	220C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color magenta
36 929	magenta	220C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color magenta intensive and reddish
36 930	red maroon	201C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 911	dark blue maroon	221C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36 934	dark red maroon	201C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

\*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
Hard porcelain	820–900°C
Bone china	800–900°C
Earthenware	780–840°C
Vitreous china	820–900°C
Enamel ware	800–830°C

**SELECTION 36** 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 36** 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.)
<b>SELECTION 36</b> colors average	Varies between $6.0\text{--}6.5 \times 10^{-6}/^{\circ}\text{C}$
36101 flux, high-firing temperature	$5.6 \times 10^{-6}/^{\circ}\text{C}$
36102 flux, low-firing temperature	$6.5 \times 10^{-6}/^{\circ}\text{C}$
36220 underlay white	$6.1 \times 10^{-6}/^{\circ}\text{C}$

**SELECTION 36** 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 200 mesh/80T, 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 <sub>50</sub> average	D <sub>100</sub> biggest
<b>SELECTION 36</b> colors (average)	3–3.5 $\mu\text{m}$	30 $\mu\text{m}$
36101 flux	2–2.5 $\mu\text{m}$	15 $\mu\text{m}$
36102 flux	2–2.5 $\mu\text{m}$	15 $\mu\text{m}$
36220 underlay white	3 $\mu\text{m}$	15–20 $\mu\text{m}$

## 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 36925 pink, 36926 pink, 36929 magenta, 36930 maroon and 36934 maroon are printed using 250–355 mesh (100–140T). If the color deposit is too thick, the high silver-containing colors become brownish.

### 【6.2 Medium ratio】

<b>SELECTION 36</b> color : Medium PM2/PMT8	10 : 7–9/8–10
36101, 36102 overprinting flux : Medium PM2	10 : 10–12
36220 underlay white : Medium PM2	10 : 6–7

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 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 36** 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 36211 mixing white or 36212 white.

**Mixing flux:** 36102 flux is suitable for mixing all colors. After mixing with flux, the color is lightened and glossier.

**Underlay white:** 36220 white is suitable as underlay white for color glaze. For more details, please refer to the technical information of 36220 underlay white.

**Iron oxide red:** When 36601 iron red is mixed with other colors, it is necessary to mix more than 50 % of 36601 to maintain the stability of iron oxide.

**Overprinting flux:** 36102 flux is suitable as overprinting flux for all colors, but if blues and iron red become

very weak, and reddish gold-containing pinks and maroons become brownish, we recommend 36101 flux instead. Overprinting flux improves color gloss and chemical durability, such as heavy metal release, alkali durability and dishwasher resistance.

## 8. Four-color printing

### 【8.1 Choice of colors】

<b>Yellow</b>	36301 lemon yellow, 36305 orange yellow
<b>Magenta</b>	36908 magenta, 36929 reddish magenta
<b>Cyan</b>	36802 cyan, 36808 dark cyan
<b>Black</b>	36703 black
<b>Flux</b>	361011, 36102 for mixing and overprinting flux

To adjust each color tone, 36301 lemon yellow can be mixed with 36305 orange yellow. 36908 magenta can be mixed with 36929 reddish magenta. 36101 and 36102 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】

36301 lemon yellow, 36305 orange yellow : PMT8	10 : 8–9
36908 magenta, 36929 reddish magenta : PMT8	10 : 8.5–9.5
36802 cyan, 36808 dark cyan : PMT8	10 : 8–9
36703 black : PMT8	10 : 8–9
36101, 36102 overprinting flux : PM2	10 : 9–11

We recommend PMT8 thixotropic medium for printing **SELECTION 36** four colors.

We recommend PM2 flowing medium for overprinting 36101 and 36102 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 36** colors depends on type of ware, glaze, kiln, color deposit and firing conditions. The following are the results of tests on hard porcelain, fired at 850°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 36** 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 DI EN 1388-1-2 test, **SELECTION 36** colors show lead and cadmium releases are below AAS limits.

### 【9.3 Acid resistance】

According to the DI EN 1388-1-2 test, **SELECTION 36** colors do not show any visible attack after immersion in a 4% acetic acid solution for 24 hours at a room temperature of  $22 \pm 2^\circ\text{C}$ , except 36804 azure and 36901 lilac.

### 【9.4 Alkali resistance】

According to the ASTM C556-88 test, **SELECTION 36** colors do not show any visible attack for up to 4 hours. If 36101 or 36102 flux are overprinted, they can stand over 6 hours.

## 10. Material Safety Data Sheet (MSDS)

Material safety data sheet (MSDS) of **SELECTION 36** colors are available on request.

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