



# Coloring of KEPITAL

R&D Center

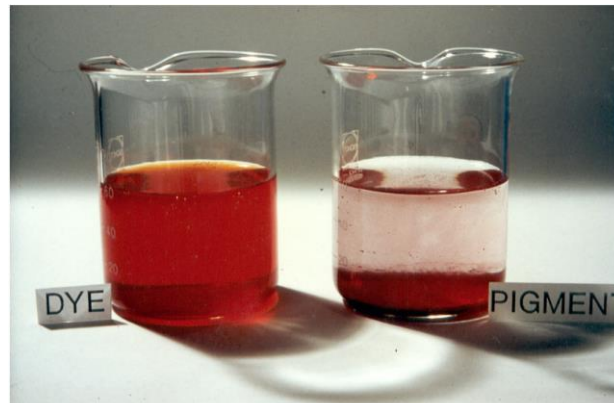
## 1. Outline of colorants

- (1) Many articles made of plastics around us are colored. Our visual color perception is dependent on the object modifying the light from the source. Crystal grains of colorants are diffused in the material(for example, orange) and the light comes to the surface while repeating reflection, refraction, scattering, and transmission. We will see this reflected or transmitted orange light and we say that the object appears orange.
- (2) Colorants can be roughly divided into pigments and dyes.

[Table 1] Pigments and Dyes

Classification	Pigments	Dyes
Solubility	Insoluble in solvents and incorporated mediums	Water soluble in water Solvent soluble Fast soluble Polymer soluble
State of dispersion	Exist as insoluble particles in application	Dissolve during application
Application	Plastics, paints, fibers, printing inks	Textiles, leather, paper
Migration	Good migration resistance	Bad migration resistance

The major difference between pigments and dyes is solubility in a given polymer matrix.



[Figure 1] Pigments and dyes dissolved in solvent

- (3) It's not recommended to apply dye to a highly crystalline polymer like polyacetal resin.
- (4) There is a migration problem with dye because it is insoluble in the crystalline region.
- (5) Characteristics of pigments varies according to chemical structure, surface property, crystal form/modification, particle size, and particle size distribution.

[Table 2] Classification of pigments

Inorganic Pigments	Organic Pigments
Low color strength Moderate coloristic spectrum Moderate saturation Good hiding power	High color strength Wide coloristic spectrum Bright shades, high saturation High transparency, selected products have also high opacity
Good dispersibility	Product-dependent dispersibility
Good heat resistance Good migration resistance Good light fastness Moderate weather resistance	Fastness properties depend on products
Heavy metal contents(e.g., Cd, Pb, etc.)	Heavy metal-free

[Table 3] Type of pigments

Inorganic Pigments	Organic Pigments		
	Polycyclic	Azo	Metal Complex
TiO <sub>2</sub> , Sb <sub>2</sub> O <sub>3</sub> , BaSO <sub>4</sub> Lead chromates Molybdates Iron oxide Cadmium pigments Chrome oxide green Cobalt blue green Ultramarine blue Nickel/Chrome titanates Chrome iron brown Bismuth vanadate Carbon blacks Effect pigments	Triaryl carbonium Anthraquinoids Dioxazine DPP Isoindoline Isoindolinone Perinone Perylene Quinacridone Quinophthalone Thioindigo	<b>Azo</b> -Condensation -Diarylides -Pyrazolone	Cu-Phthalo-cyanine
		<b>Monoazo</b> -Benzimidazolone -Lithol rubine -Azo lakes -Naphthol -Pyrazoloquinazolone -Acetoacetic arylides	Other metal complexes

## 2. Consideration when choosing pigments

Some factors should be considered when selecting pigments. Considerations are as follows:

### (1) Limit Concentration

We should check the limit concentration of pigments when applied to plastics. If not taken into consideration, problems like decrease of heat stability or mold deposits may occur. This is because pigments are insoluble in resin but they are soluble under the limit concentration, and as such heat stability can decrease or pigments can migrate from the resin.



[Figure 2] Mold deposit by migration of pigments

### (2) Particle Size

This is one of the major factors when determining the color of plastics. One should add more pigments as the particle size of pigments get larger due to the decrease of surface area. In addition, the color itself changes according to the particle size.

### (3) Particle Size Distribution

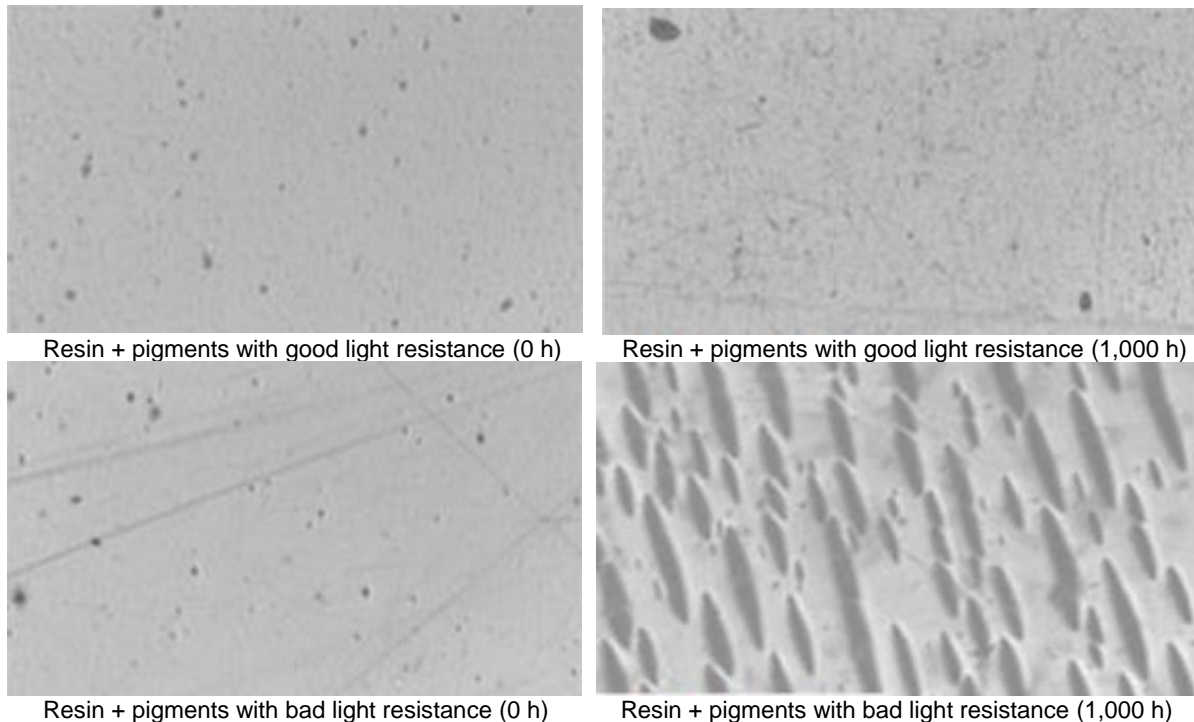
Particle size distribution of pigments is also an important factor. Narrow distribution of particle size is preferred with the premise that pigments are diffused mechanically.

### (4) Dimensional Stability

Some organic pigments act as organic nucleating agents in polyolefin etc. which can cause torsion of specimen.

### (5) Light & weather resistance

One of the problems when we use inappropriate pigments is that light and weather resistance property of plastics can be degraded. That is why we have to choose appropriate pigments for plastics. Problems like discoloration of colorants by UV and heat deterioration of plastics may occur. Particle, amount, interactions with other pigments affect discoloration of colorants. Generally, inorganic pigments are best, followed by organic pigments, and finally dyes.



[Figure 3] Light resistance according to pigments(SAE J2412) / (Magnification : 1,000X)

### 3. Outline of colorants for KEPITAL

Type and content of colorants greatly affect the degradation of polyacetal resin. Polyacetal resin can decompose to produce formaldehyde gas and to decrease mechanical properties by using unsuitable colorants or excessive colorants. This is why one must use suitable colorants when coloring KEPITAL.

### 4. Guideline of choosing colorants for KEPITAL

- (1) Colorants can be roughly divided into pigments and dyes. It is not recommended to apply dye to polyacetal resin because there are many problems like mold deposits and thermal degradation during processing.
- (2) However, dye can be applied to some specific parts. Dye must have at least some heat stability.
- (3) Polyacetal resin can decompose when using Anatase type(titanium dioxide( $\text{TiO}_2$ )), channel type(carbon black) and chelate type complex colorants due to their acidity and metal composition.
- (4) One should consider the effects of Phthalocyanine type on polyacetal dimension.
- (5) When using inorganic colorants with organic things, it is recommended to use inorganic colorants under 0.5 wt%, inorganic things 0.1 wt%.
- (6) We recommend using little dispersing agent and stabilizer(under 0.2 wt%) if blending polyacetal and colorants.
- (7) One should use suitable colorants when coloring KEPITAL.

### 5. Colorants for KEPITAL

[Table 4] Colorants suitable for KEPITAL

Color	Recommended	No recommended	Note
White	Rutile $\text{TiO}_2$ (plastics type)	Anatase type $\text{TiO}_2$ Rutile $\text{TiO}_2$ (non-plastics type)	
Black	Furnace type (neutral acidity)	Channel type carbon black (Rubber, Tire)  Acidic & strong basic types Changed to reddish by heat	

Yellow	Titan Yellow type Anthraquinone type	Diketo type Azo type yellow	Inorganic type has better thermal stability
Orange	Pyrol type	Chrome Orange type Mixed crystal lead-sulpho- chromate-molybdate	
Red	Diketo type, Perylene type Quinacridone type BONA(Ca) Fe <sub>2</sub> O <sub>3</sub>		Fe <sub>2</sub> O <sub>3</sub> (Red Iron oxide) : Purity 98% up, size 4μm down
Blue	Ultramarine type Phthalocyanine green Co/Al-Oxide	α-type Phthalocyanine	
Green	Co/Ti/Ni/Zn-Oxide Cu-phthalocyanine chlor Phthalocyanine type		

## 6. Effect of colorants blending

TiO<sub>2</sub> is normally used as a white colorant for polyacetal resin. Applying TiO<sub>2</sub> may cause a decrease of heat stability and dispersion problems. Using TiO<sub>2</sub> with a dispersing agent and stabilizer or polyacetal carrier M/B(master batch)/a private white M/B for KEPITAL is recommended.

We perform the VDA 275 test to measure heat stability of polyacetal resin. It is to evaluate formaldehyde emission from specimen and a high value represents poor heat stability.

Item	KEPITAL F20-03	POM to which TiO <sub>2</sub> M/B is applied	Pigment Direct Blend	
	Base	(MB-W315)	Rutile Type TiO <sub>2</sub>	Anatase Type TiO <sub>2</sub>
VDA 275 (mg/kg)	3.5	4.0	6.4	18.4

Note) 1. TiO<sub>2</sub> content : 0.3 wt%

2. Product to which TiO<sub>2</sub> M/B is applied : KEPITAL F20-03 + MB-W315(KEPITAL white M/B) blend

## 7. Effect according to color

POM carrier M/B is recommended when coloring polyacetal resin. This is to prevent decreasing heat stability of polyacetal resin by acidity and metal composition of colorants. Using private color M/Bs for KEPITAL is preferable because the composition of colorants, dispersing agent, stabilizer varies according to the company. As shown in the table below, VDA 275 value of KEPITAL + a private color M/B is lower than product to which other POM M/B is applied.

### (1) KEPITAL Carrier M/B

Item	KEPITAL F20-03	Black	White	Yellow	Blue
	Base	(MB-S315)	(MB-W315)	(MB-Y202)	(MB-B207)
VDA 275(mg/kg)	3.5	3.8	4.0	4.5	5.9

Note) 1. M/B content : Black 2 wt%, others 4 wt%

2. Product to which M/B is applied : KEPITAL F20-03 + Color M/B Blend



(2) Other companies' POM Carrier M/B

Item	KEPITAL F20-03	Black	White	Yellow	Red
	Base	Maker A	Maker B	Maker C	Maker C
VDA 275(mg/kg)	3.5	4.5	5.0	8.7	11.3

Note) 1. M/B content : Black 2 wt%, others 4 wt%

2. Product to which M/B is applied : KEPITAL F20-03 + Color M/B blend

**8. Effect when color M/B of other resins is applied**

When the color M/B of other carrier resins(PE M/B, PP M/B, ABS M/B, PS M/B etc.,) or lubricant M/B incompatible with polyacetal is applied, problems like breaking due to decreased mechanical properties, high formaldehyde emission, and mold deposits may occur, among others. As such using a POM carrier M/B is recommended when coloring KEPITAL.

(1) Formaldehyde emission content

1) KEPITAL F20-03

Item	KEPITAL F20-03	Black M/B 2 wt% Blend				
	Base	MB-S315	PE M/B 1	PE M/B 2	PS M/B	Lubricant M/B
VDA 275(mg/kg)	3.5	3.8	8.0	40.4	43.5	38.0

Note) 1. Black M/B 2 wt% Blend: KEPITAL F20-03 + M/B 2 wt% Blend

2) KEPITAL F20-03 LOF

Item	F20-03 LOF	Black M/B 2 wt% Blend				
	Base	MB-S315	PE M/B 1	PE M/B 2	PS M/B	Lubricant M/B
VDA 275(mg/kg)	0.5	0.5	3.0	15.3	15.1	19.6

Note) 1. Black M/B 2 wt% Blend : KEPITAL F20-03 + M/B 2 wt% Blend

(2) Mechanical property (ISO standard)

Item	Unit	F20-03	Black M/B 2 wt% Blend			
		Base	MB-S315	PE M/B 2	PS M/B	Lubricant M/B
Tensile strength	MPa	65.0	65.0	62.5	62.8	61.8
Tensile strain	%	35.0	35.0	25.8	15.7	25.2
Flexural strength	MPa	87.0	87.0	84.9	85.9	84.1
Flexural modulus	MPa	2550	2550	2511	2542	2496
Charpy impact strength	kJ/m <sup>2</sup>	6.5	6.5	4.5	4.5	6.5

Note) 1. Black M/B 2 wt% Blend : KEPITAL F20-03 + M/B 2 wt% Blended

(3) Mold Deposit



F20-03 + MB-S315



F20-03 + PE M/B



F20-03 + PS M/B

[Figure 4] Mold deposit when color M/B of other resins is applied

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