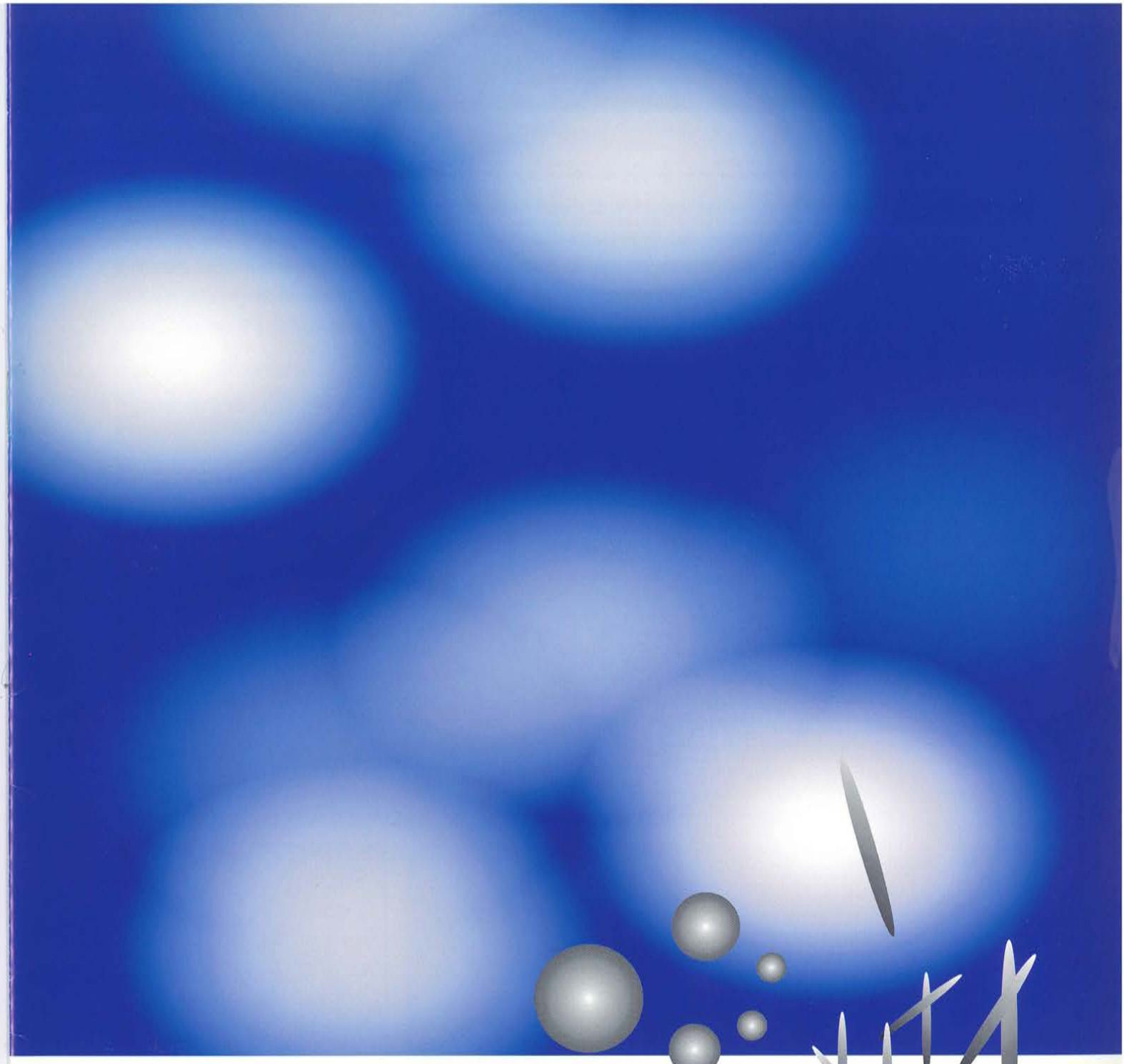


ELECTRO-CONDUCTIVE MATERIALS
(ANTI-ELECTROSTATIC GRADES)

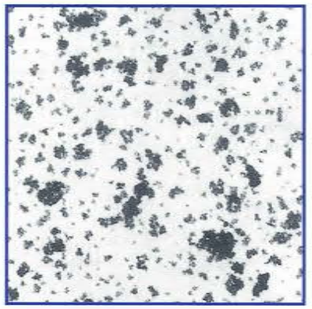
SN·FS·ET·FT

Series

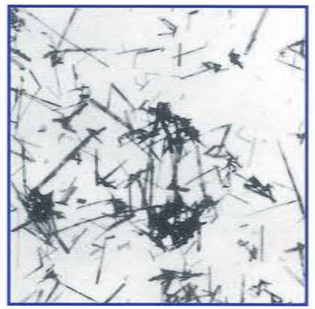
Introduction

With more utilization of plastic as a material and development of electronic devices which symbolize the era of information, various troubles caused by static electricity has become more serious problem. Therefore, demand for materials, which can ease the influence of static electricity, has been increasing.
To meet the above demand, ISK has successfully developed four types of electro-conductive materials based on our advanced titanium dioxide pigment manufacturing technology : transparent electro-conductive materials (SN, FS series) and white electro-conductive titanium dioxides (ET, FT series). These materials are designed to be used in various fields such as coatings, plastics, inks, etc.

SN/FS



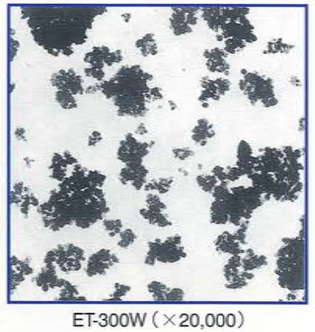
SN-100P (×20,000)



FS-10P (×20,000)

ET

ET-500W (×20,000)



ET-300W (×20,000)

FT

FT-1000 (×5,000)

FT-2000 (×5,000)

FT-3000 (×5,000)

The Grade Variety of Electro-conductive Materials

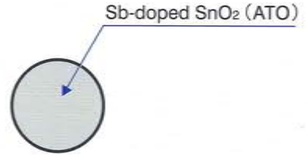
Electroconductivity of ISK's conductive materials stems from electron conduction of antimony-doped tin oxide (ATO). The product lineup is divided into 2 types : transparent electro-conductive materials simply made of SnO_2/Sb and white electro-conductive titanium dioxides coated with a thin electro-conductive SnO_2/Sb layer. The mechanism of ISK's products is electron conduction, which is not affected by humidity. ISK's products exhibit outstanding thermal, physical and chemical stability. Furthermore, depending on your applications, you can choose spherical or acicular grade from both types.

type \ shape	spherical	acicular
Transparent Electro-conductive Materials	SN series	FS series
	SN-100P	**FS-10P**
	SN-100D	**FS-10D**
White Electro-conductive Titanium Dioxides	ET series	FT series
	ET-300W	**FT-1000**
	ET-500W	**FT-2000**
	ET-600W	**FT-3000**

Transparent Electro-conductive Materials

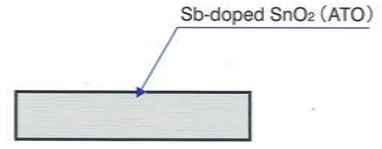
SN series / spherical type

- **SN-100P** (Powder)
- **SN-100D** (Water dispersion)



FS series / acicular type

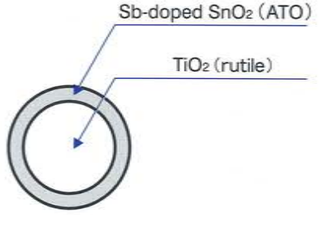
- **FS-10P** (Powder)
- **FS-10D** (Water dispersion)



White Electro-conductive Titanium Dioxides

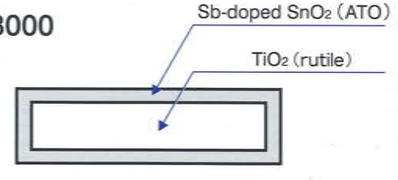
ET series / spherical type

- **ET-300W**
- **ET-500W**
- **ET-600W**



FT series / acicular type

- **FT-1000**
- **FT-2000**
- **FT-3000**



Transparent Electro-conductive Materials

SN Series / spherical type

SN products are designed for usage in fields where both high transparency and electroconductivity are required. SN products consist of SnO_2/Sb and whose particle size is about 0.02μm. SN products can also be used for heat ray shielding due to their excellent absorbability of near infrared rays. Depending on your applications, powder type SN-100P and its water dispersion SN-100D are available. Water dispersion type, SN-100D, has very high stability since ATO is highly hydrophilic. Upon your requirement, special products whose secondary particle size is modified or with a selected neutralizer are also available.

Uses

- **Anti-electrostatic Coatings (Film,Plastics,Glass, etc.).**
- **Heat Ray Shielding Coatings (Film, Glass, etc.).**
- **Others (Recording paper, Toner, etc.).**

■Table 1 Basic Properties of SN Series

	SN-100P (Powder)	**SN-100D** (Water dispersion)
Composition	Sb-doped SnO_2	Sb-doped SnO_2
Particle size(μm)	0.01～0.03 [1]	0.085～0.120 [2]
Powder resistance(Ωcm) [3]	1～5	5～30 [4]
Specific gravity	6.6	6.6 [4]
Specific surface area(m^2/g) [5]	65～80	70～100 [4]
pH	2.5～3.5	5.0～7.0
Concentration(%)	———	30

1)Primary particle size. 2)Secondary particle size. 3)9.8MPa compressed powder. 4)Data obtained from dried powder. 5) BET method.

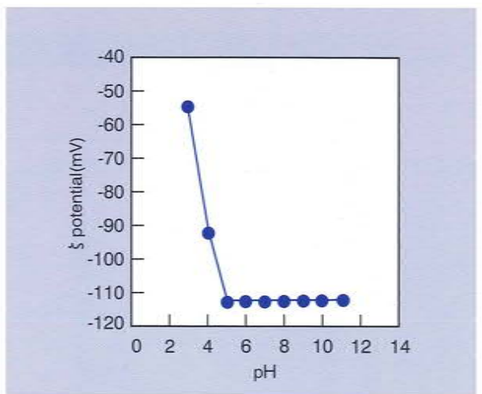


Fig.1 ξ potential of SN-100P vs. pH.

SN-100P shows much larger ξpotential (negative potential) around neutral region than other metal oxides do.

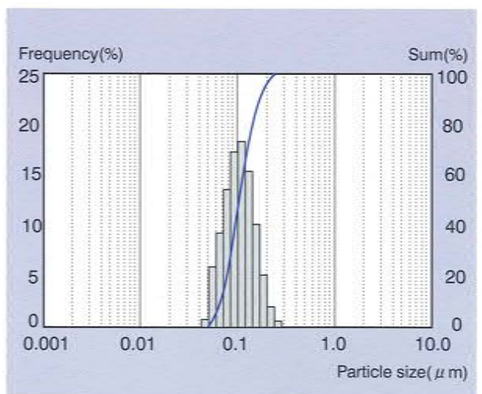


Fig.2 Particle size distribution of SN-100D.

SN-100D shows very narrow particle size distribution.

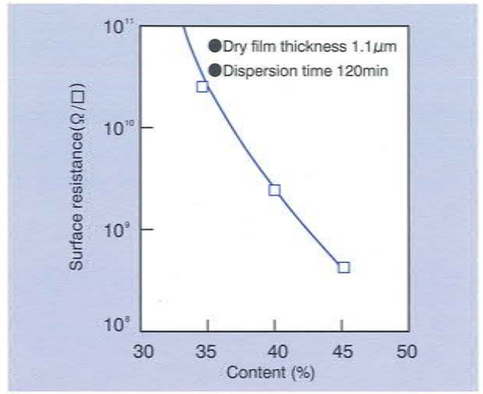


Fig.3 Relationship between surface resistance and content in air drying type acrylic resin.

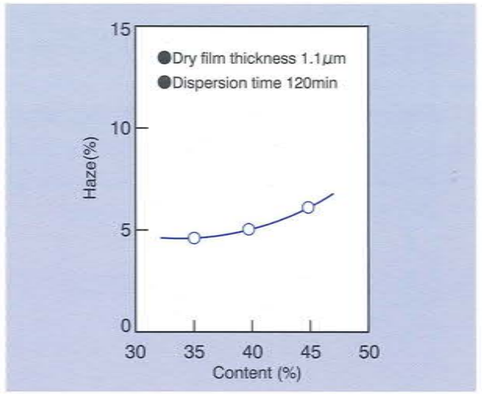


Fig.4 Relationship between haze and content in air drying type acrylic resin.

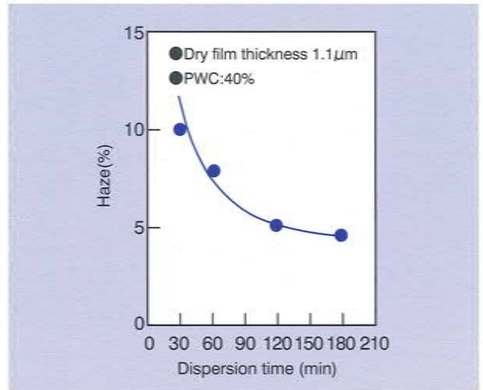


Fig.5 Relationship between haze and dispersion time in air drying type acrylic resin.

Sufficient dispersion is necessary to obtain high transparency.

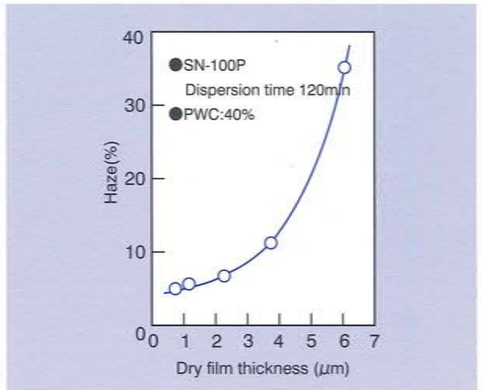


Fig.6 Relationship between haze and film thickness in air drying type acrylic resin.

The thinner film, the higher transparency.

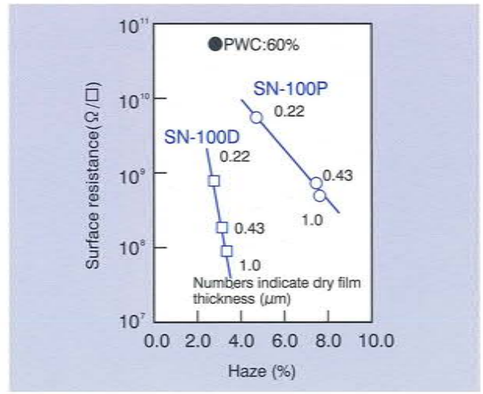


Fig.7 Relationship between haze and surface resistance in UV curable resin.

SN-100D provides superior conductivity and transparency in water-soluble resin.

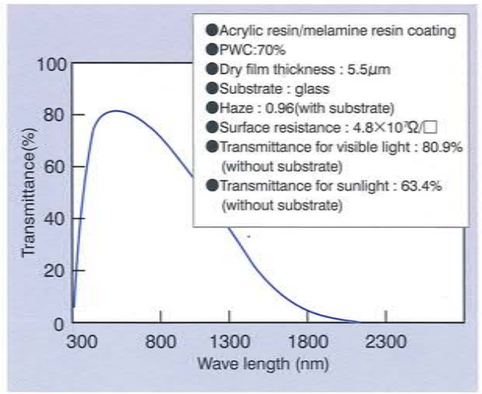


Fig.8 Relationship between wave length and transparency.

Excellent shielding capability of SN-100P for the near infrared rays is obtained.

Transparent Electro-conductive Materials
FS Series / acicular type

FS-10P/FS-10D

FS products are fine acicular SnO_2/Sb which ISK only has commercialized in the world. Due to their acicular shape, FS products can be used for coatings or plastics with less amount to obtain required electroconductivity than conventional spherical electro-conductive materials. FS products also show excellent transparency because of their fine particle size. Furthermore, coating films with higher transparency can be obtained by FS products due to their paler color than SN products. Depending on applications, powder type FS-10P and water dispersion type FS-10D are available. The pH adjuster of FS-10D can be selected upon your request.

■Table 2 Basic Properties of FS Series

		FS-10P (Powder)	**FS-10D** (Water dispersion)
Composition		Sb-doped SnO_2	Sb-doped SnO_2
Particle size (μm)	Length	0.2～2.0	———
	Diameter	0.01～0.02	
Aspect ratio		20～30	
Powder resistance (Ωcm) [1]		～100	～600[3]
Specific gravity		6.6	6.6[3]
Specific surface area (㎡/g) [2]		25～35	40～60[3]
pH		———	8.0～10.0
Concentration (%)		———	20

1) 9.8MPa compressed powder. 2) BET method. 3)Data obtained from dried powder.

■Table 3 Powder color・Slurry color (Analysis Example)

	Powder		Water dispersion	
	FS-10P	SN-100P	**FS-10D**	SN-100D
L	76.5	40.4	47.6	21.6
a	-5.1	-5.4	-5.0	-2.6
b	-12.3	-11.5	-15.6	-12.5

Both powder and water dispersion show paler color than SN products.

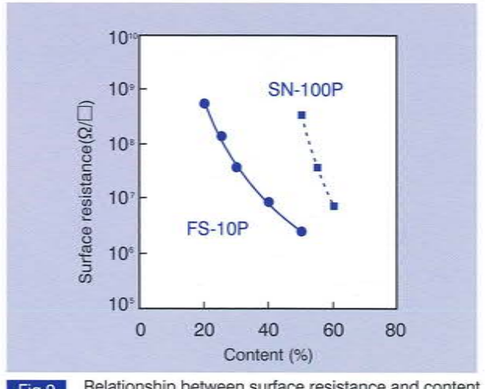


Fig.9 Relationship between surface resistance and content in air drying type acrylic resin.

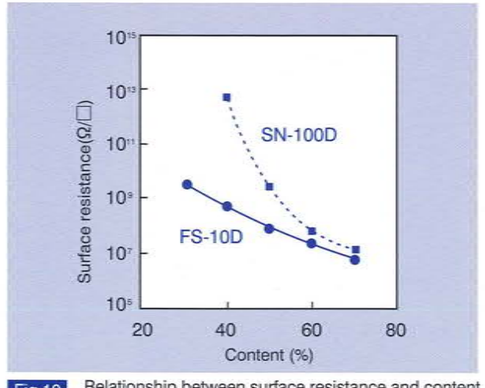


Fig.10 Relationship between surface resistance and content in hydroxyethyl cellulose resin.

FS products provide required electroconductivity by smaller content compared with SN products.
FS products do not exhibit drastic change of surface resistance under various contents.

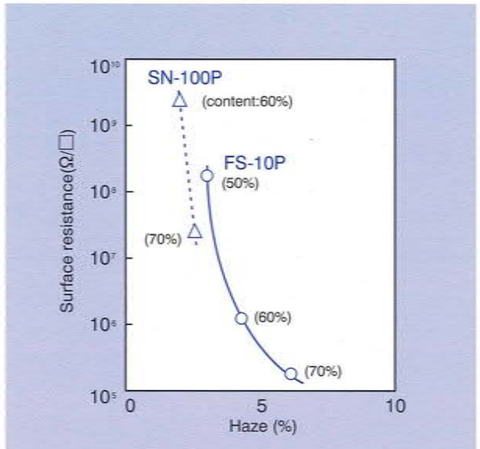


Fig.11 Relationship between haze and surface resistance in UV curable resin.

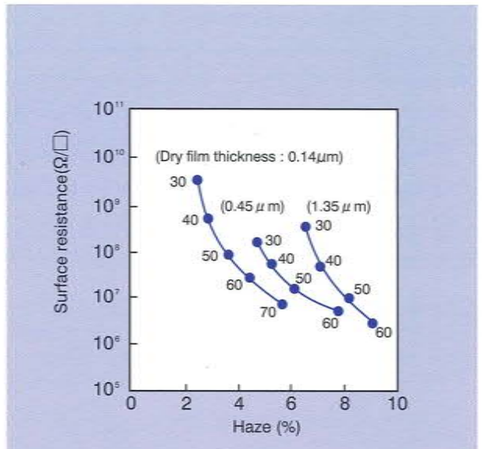


Fig.12 Relationship between haze and surface resistance in hydroxyethyl cellulose resin.(FS-10D)

Generally, it is advantageous to make a coating film with high FS content as thin as possible.

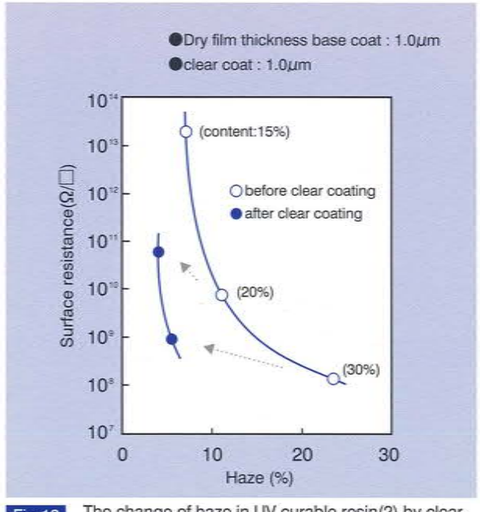


Fig.13 The change of haze in UV curable resin(2) by clear coating. (FS-10P)

With clear coating, it is possible to drastically improve haze without decreasing conductivity.

White Electro-conductive Titanium Dioxide

ET Series / spherical type

ET-300W/ET-500W/ET-600W

ISK's ET products are based on spherical rutile types of titanium dioxide with particle sizes of 0.03~0.3μm, whose surface is coated with a thin electro-conductive SnO_2/Sb layer.

By applying ET formulated coatings or adding ET products to plastics, electroconductivity can be provided to various materials. Coatings and plastics with ET products can be easily pigmented to various colors due to the whiteness of these ET products.

ET-500W and ET-600W are based on spherical titanium dioxide with a primary particle size of 0.2~0.3μm, while those are different in whiteness and conductivity.ET-300W is based on ultrafine particle size titanium dioxide with a primary particle size of 0.03~0.06μm and is suitable for use in coatings which require excellent surface smoothness.

Uses

- **Anti-electrostatic Coatings (Electro-conductive floor and wall materials, Primers, etc.).**
- **Anti-electrostatic Plastics and Rubber (Packages of IC, Rolls, Belts, etc.).**
- **Anti-electrostatic Fibers (Textiles, Carpets, etc.).**
- **Others (Recording paper, Toner, etc.).**

■Table 4 Basic Properties of ET Series

	ET-500W	ET-600W	ET-300W
Composition	TiO_2, Sb-doped SnO_2	TiO_2, Sb-doped SnO_2	TiO_2, Sb-doped SnO_2
TiO_2 crystal form	Rutile	Rutile	Rutile
Particle size(μm)	0.2~0.3	0.2~0.3	0.03~0.06
Powder resistance(Ωcm)[1]	2~5	10~30	10~30
Specific gravity	4.6	4.5	5.0
Specific surface area(㎡/g)[2]	6~8	6~8	25~35
Oil absorption(g/100g)	15~20	15~20	25~35
Powder color L value	84~88	88~92	70~80

1)9.8MPa compressed powder. 2)BET method.

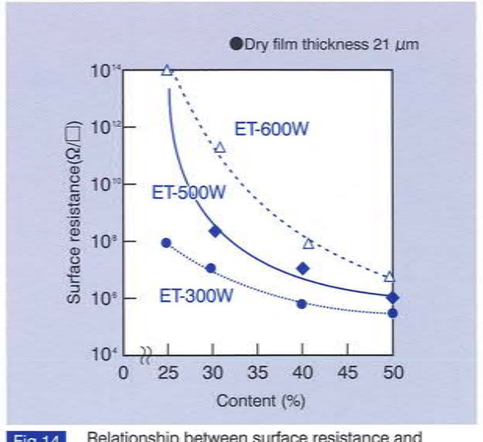


Fig.14 Relationship between surface resistance and content in air drying type acrylic resin.

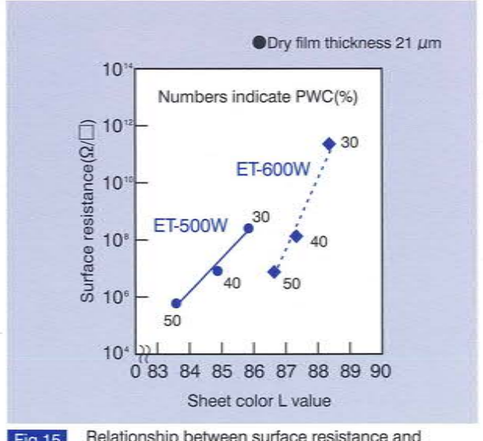


Fig.15 Relationship between surface resistance and whiteness in air drying type acrylic resin.

It is advantageous to use ET-600W in the fields where higher whiteness is required.

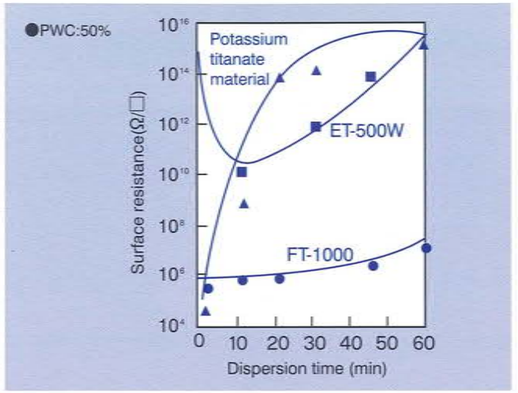


Fig.16 Relationship between surface resistance and dispersion intensity in air drying type acrylic resin.

Dispersion condition has to be optimized for suffcient conductivity.

■Table 5 Chemical stability against acid and alkali

Acid / alkali	Sample	Dissolution amount	
		Sn^{4+}	Sb^{3+}
5.0% HCl	FT-1000	0.025%	0.004%
5.0% HCl	ET-500W	0.030%	0.004%
0.5% H_2SO_4	FT-1000	0.000%	0.000%
0.5% H_2SO_4	ET-500W	0.000%	0.001%
5.0% H_2SO_4	FT-1000	0.001%	0.001%
5.0% H_2SO_4	ET-500W	0.002%	0.002%
0.5% NaOH	FT-1000	0.014%	0.036%
0.5% NaOH	ET-500W	0.001%	0.031%

ET products show excellent stability under acidic and alkaline condition.

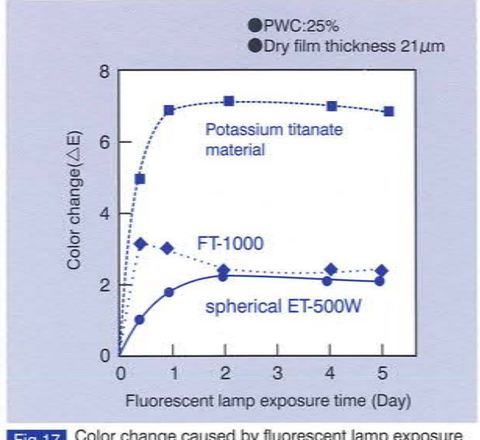


Fig.17 Color change caused by fluorescent lamp exposure in air drying type acrylic resin.

ET products show excellent stability against light exposure.

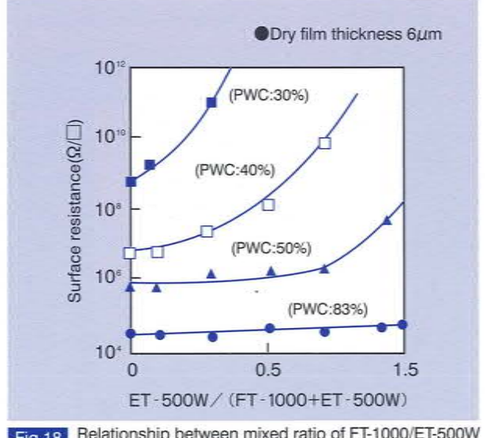


Fig.18 Relationship between mixed ratio of FT-1000/ET-500W and surface resistance in polyvinyl-alcohol based coating.

Using ET products with FT products brings cost merit without decreasing electroconductivity.

White Electro-conductive Titanium Dioxide

FT Series / acicular type

FT products are acicular electro-conductive titanium dioxide. The base of FT series is a unique titanium dioxide; specifically rutile type acicular titanium dioxide (FTL products : ISK is the only manufacturer in the world who offers acicular titanium dioxide.). The surface of the acicular titanium dioxide is coated with SnO_2/Sb thin layer. FT products are divided into three types; FT-1000, FT-2000 and FT-3000 depending on the size of the base titanium dioxide. Because of their characteristic acicular shape, FT products can achieve required electroconductivity with a lower dosage compared to spherical electro-conductive materials like ET products. These materials also show outstanding effect as reinforcing materials. Even under strong dispersion, FT products maintain their properties since the base acicular titanium dioxide is strong enough to remain its shape. Due to extremely low soluble salts, FT products can be safely used for various applications.

Like ET products, FT products can be easily pigmented to various colors.

Uses

- **Anti-electrostatic Coatings(Electro-conductive floor and wall materials, Primers, etc.).**
- **Anti-electrostatic Plastics and Rubber(Packages of IC, Roll, Belts, etc.).**
- **Anti-electrostatic Fibers(Textiles, Carpets, etc.).**
- **Others(Recording paper, etc.).**

■Table 6 Basic Properties of FT Series.

	FT-1000	FT-2000	FT-3000
Composition	TiO_2, Sb-doped SnO_2	TiO_2, Sb-doped SnO_2	TiO_2, Sb-doped SnO_2
TiO_2 crystal form	Rutile	Rutile	Rutile
Particle size(μm)[1]	D:0.13 L:1.68	D:0.21 L:2.86	D:0.27 L:5.15
Powder resistance(Ωcm)[2]	2~10	2~10	10~60
Specific gravity	4.4	4.4	4.4
Specific surface area(m^2/g)[3]	12~18	10~16	2~8
Oil absorption(g/100g)	45~65	45~65	50~70
Powder color L value	85~91	85~91	90~95

1)Example of volume surface mean diameter measured with image analyzer. D: Diameter,L:Length 2)9.8MPa compressed powder. 3)BET method.

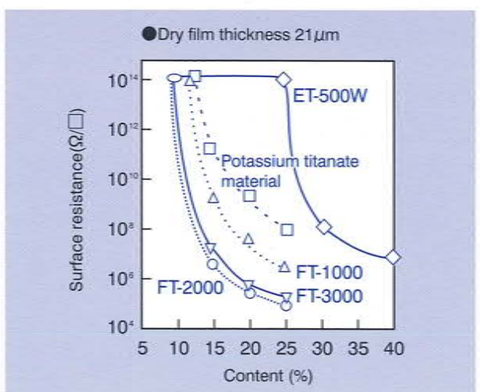


Fig.19 Relationship between surface resistance and content in air drying type acrylic resin.

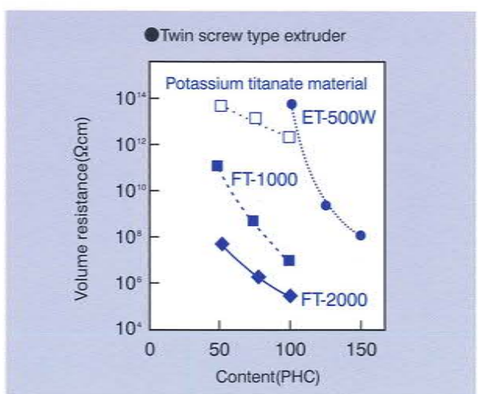


Fig.20 Relationship between volume resistance and content in polyvinyl chloride resin.

Acicular type material can achieve required electroconductivity with lower content compared to spherical type material.

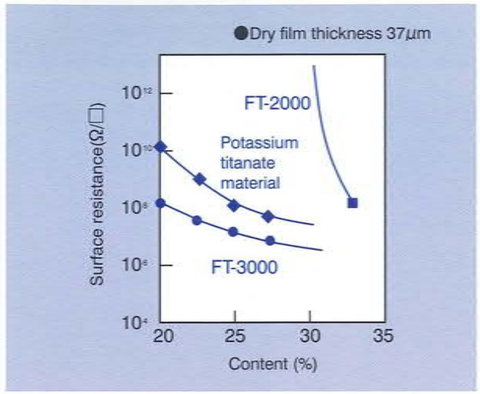


Fig.21 Relationship between surface resistance and content in epoxy/polyamide resin.

FT-3000 shows interesting behavior depending upon resin.

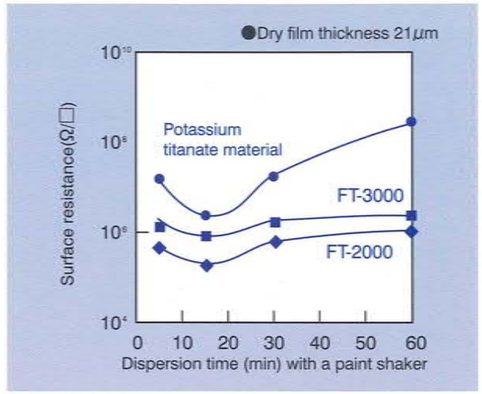


Fig.22 Relationship between surface resistance and dispersing strength in air drying type acrylic resin.

FT products are stable under various dispersion.

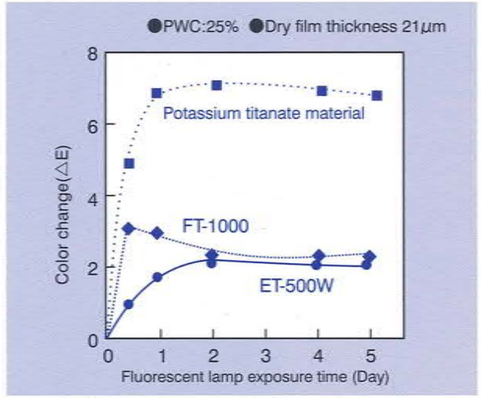


Fig.23 Color change caused by fluorescent lamp exposure in air drying type acrylic resin.

Both ET and FT products have sufficient stability against light exposure.

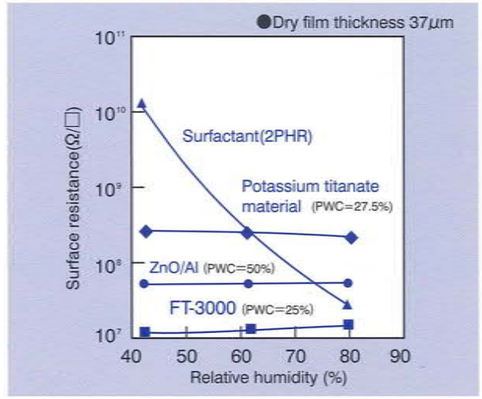


Fig.24 Relationship between surface resistance of film and humidity in epoxy/polyamide resin at 25℃.

FT products are not affected by humidity.

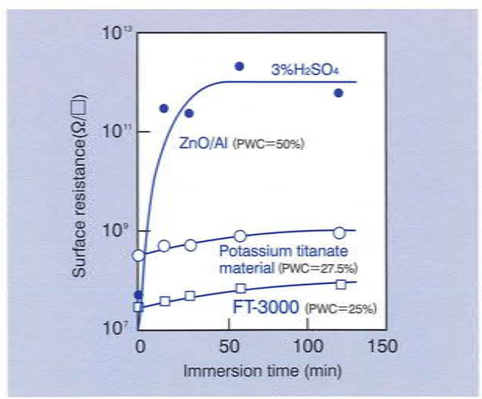


Fig.25 Change of surface resistance of film in epoxy/polyamide resin by immersing into acid solution.

FT products are stable against acid.

FOR YOUR PROTECTION

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