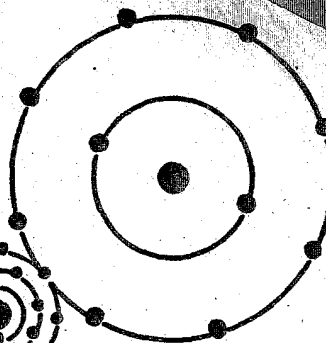
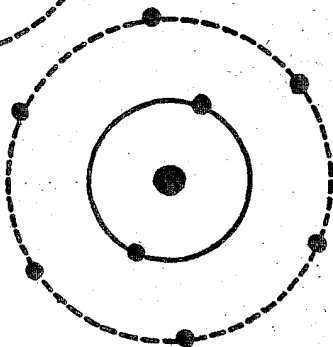
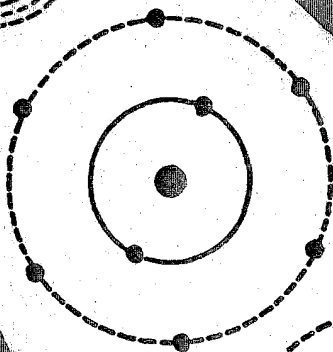
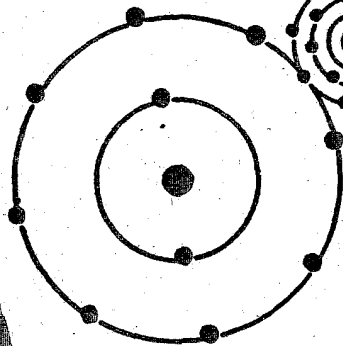




JUN 27 1947



TITANOX[★] **PIGMENTS**

Properties and Uses

MAY 1947

**Titanium Pigment Corporation,
111 Broadway,
New York 6, N.Y.**

★ TRADE MARK REGD



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TITANOX Pigments

Properties and Uses

The most interesting properties essential to the great majority of uses of the TITANOX titanium pigments are concisely presented in this booklet.

There may be unusual pigmentation problems which involve pigment properties not mentioned herein. If you have such a problem your inquiries are welcome and will be gladly answered no matter how simple or complex the problem.

Best application of a pigment is usually suggested by its properties. Discussion of uses is accordingly brief especially in view also of the different aspects the same use may exhibit within a given industry. Exhaustive discussion of each use is beyond the scope of this booklet, but your particular problem will be approached willingly with the aid of laboratory work and vast field experience if you will let us hear from you.

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0007-SWP-000006517

What is TITANOX?

The first trade name of the first commercial white pigment composed of titanium dioxide—very simple in the beginning (about thirty years ago)—just TITANOX to identify titanium dioxide in combination with barium or calcium sulphate. But later, after much concentrated research, straight or unextended titanium dioxide pigment was offered, and to distinguish it from the composite or extended type, the letter A was added. Other letters had to be adopted—B for barium sulphate along with titanium dioxide; C for calcium sulphate along with titanium dioxide.

R Enters the picture

In 1941, titanium dioxide having the crystal structure of rutile was provided as a base for titanium pigments, offering greater hiding power than formerly available.

To associate the improvement with the name known for reliability in titanium pigments, the letter R was added. Thus TITANOX-RC denotes rutile titanium dioxide-calcium sulphate pigment. Similarly, TITANOX-RA denotes rutile titanium dioxide pigment.

Further additions to the Trade Name and their meaning

Further suffixes to the name indicate some improved property of the pigment, but the added letter or number may not be a symbol or definition of the improvement. Thus, some years ago, the number 168 was added to TITANOX-A to identify pigment which retards after-yellowing or discoloration of organic coatings. While a number of these additions have been necessary, every attempt is being made to simplify the naming of the pigments. For example, because rutile titanium dioxide already affords the improved color retention of TITANOX-A-168, the number 168 is dropped and the pigment is simply called TITANOX-RA.

It is still necessary however to use distinguishing letters or numbers, thus: WD signifies water dispersible; X indicates ease of dispersion; NC signifies "non-chalking" to denote retarded chalking of the pigment in paints.

Types of pigment currently offered

Titanium dioxide (anatase)

TITANOX-A reg.—in two oil absorption types—A-MO and A-LO; general utility; principal uses (A-MO) white exterior house paints; viscose rayon delustring; A-LO for high gloss products.

TITANOX-A-168—in two oil absorption types—A-168-MO and A-168-LO; principal use (A-168-LO) white industrial enamels.

TITANOX-AA — "semi-chalk-resistant"; principal use exterior paints retarded chalking.

TITANOX-A-24—Chalk-resistant; principal use exterior tinted enamels.

TITANOX-A-WD—water dispersible mainly for opacifying and brightening paper.

TITANOX-A, ceramic grade—somewhat coarse particle size mainly for welding rod coatings.

Titanium dioxide (rutile)

TITANOX-RA-10—rutile counterpart of TITANOX-A reg.; principal use white exterior house paint.

TITANOX-RA — rutile counterpart of TITANOX-A-168-LO; principal use white and light tinted industrial enamels.

Rutile-calcium pigment

(30% TiO_2 (rutile); 70% CaSO_4)

TITANOX-RCRT—general utility; principal use interior architectural finishes especially flat wall paints; exterior white house paints.

TITANOX-RCRTX—ease of dispersion; principal use interior architectural finishes, especially gloss.

TITANOX-RC—chalk-resistant; principal use exterior tinted paints and enamels.

In addition to the foregoing, the almost obsolete anatase titanium calcium pigments TITANOX-C and TITANOX-CX (30% TiO_2 ; 70% CaSO_4) are still being offered because they meet recognized needs in some formulation programs.

Similarly, TITANOX-B-30, titanium-barium pigment (30% TiO_2 ; 70% BaSO_4) in spite of serious material shortages is still being offered primarily for industrial primers and house paint primers.

Discontinued

TITANOX-A-NC — coarse chalk-resistant rutile titanium dioxide has been discontinued because demand for this pigment was almost wholly from specification paints during the war.

On account of rising costs and the shortage of lead, TITANOX-L (lead titanate)—which afforded the maximum of appearance and durability in tinted

paints—has been given up most reluctantly. Fortunately, its place is being taken very efficiently by TITANOX-RC—which not only affords good appearance and long life of tinted exterior paints but also lower cost.

Types to be added

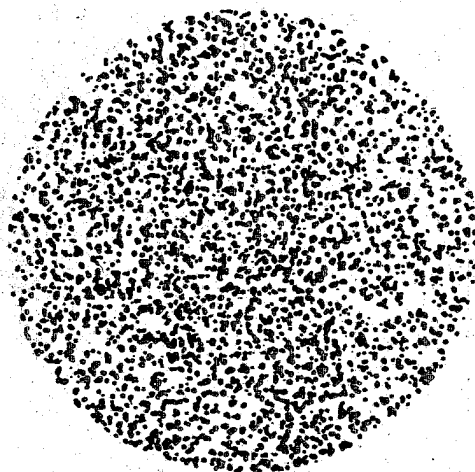
High hiding rutile titanium dioxide having high chalk-resistance, to be called TITANOX-RA-NC, will be added to the TITANOX line as soon as feasible.

A water dispersible rutile titanium dioxide—TITANOX-RA-WD—will also be added.

These pigments, now unavailable, are nevertheless included in the detailed table on page 14 in which the properties of the complete line of TITANOX pigments are shown. The discontinued pigments are also listed in order to provide a familiar comparison.

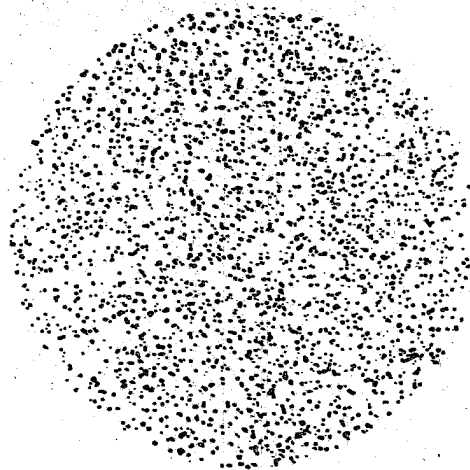
Visual photomicrographs

Pigments highly dispersed in synthetic resin



TITANOX-A ceramic grade magnified 500 times

TITANOX-A-LO magnified 500 times



Fundamental Properties

Those properties, usually subject to scientific measurement, of the pigment itself to which are attributable benefits in practical use

Chemical and Physical Stability

Titanium dioxide is one of the most stable substances known. A very high temperature—about 3280°F—is required to melt it. Temperatures encountered in its application as pigment will have no harmful effects such as change in color or chemical decomposition. It will not dissolve in water, inorganic acids, organic acids, dilute alkalis and is unaffected under ordinary conditions by gases particularly those encountered in the atmosphere. Only hot concentrated sulfuric acid or hydrofluoric acid will dissolve titanium dioxide.

The extenders barium sulphate and calcium sulphate associated with titanium dioxide in the composite TITANOX pigments are also highly stable. However, on account of very slight solubility in water the calcium sulphate extended type is avoided in any application which involves a large excess of water to pigment.

Fine particle size contributes to high reflection

The particle size of TITANOX pigments ranges from an average diameter of about 0.3 micron in the anatase type of titanium dioxide through 0.5-0.9 micron in the composite pigments to about 0.6 micron in ceramic grade TITANOX-A.

The minuteness of the particles of titanium dioxide pigment is brought out strongly by the electron microscope. Along with new knowledge afforded by the ability to see so much with this instrument, old concepts are being confirmed.

For years the extended TITANOX pigments have been considered true composite pigments owing to intimate mixture secured by precipitating titanium dioxide in the presence of the extender. Evidence to support this view has come from studies of sedimentation as well as opacity, but striking confirmation is afforded by the electron microscope by which we can see the effects of removing by means of a solvent the calcium sulphate from a particle of rutile titanium dioxide-calcium sulphate pigment (TITANOX-RCHT). The finely divided titanium dioxide can be seen to be arranged about the calcium sulphate.

Electron micrographs

Greater than 30,000 X



Particle of TITANOX-RCHT



Particle of TITANOX-RCHT from which calcium sulphate has been removed by solvent—note how TiO₂ retains structure of coating over calcium sulphate

Fine particle size must be accompanied by high refractive index

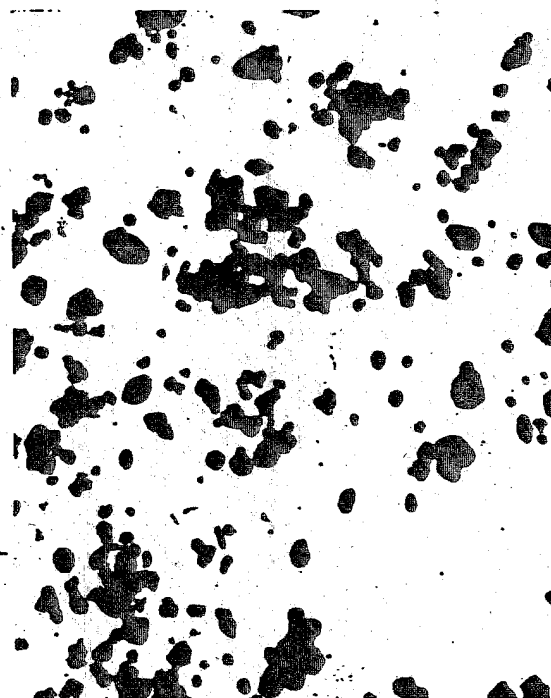
Fine particle size will contribute to high light reflection, but refractive index must be high in order for the pigment to have opacity or hiding power in the presence of paint vehicles and other media.

Titanium dioxide has the highest refractive index of any white pigment.

Average Refractive Indices of White Pigments and Extenders

Diatomaceous silica	1.45
Silica (quartz)	1.55
Calcium carbonate (calcite)	1.57
Calcium sulphate (anhydrite)	1.59
Barium carbonate (witherite)	1.60
Barytes	1.64
Lithopone	1.84
TITANOX-C (anatase TiO_2 - CaSO_4)	1.87
Zinc oxide	1.99-2.02
TITANOX-B-30 (anatase TiO_2 - BaSO_4)	1.91
TITANOX-RCHT (rutile TiO_2 - CaSO_4)	1.98
Basic sulphate white lead	1.93
Basic carbonate white lead	1.94-2.09
Antimony oxide	2.09-2.29
Zinc sulfide	2.37
Zirconium oxide	2.40
TITANOX-A (anatase)	2.55
TITANOX-RA (rutile)	2.70

TITANOX-A



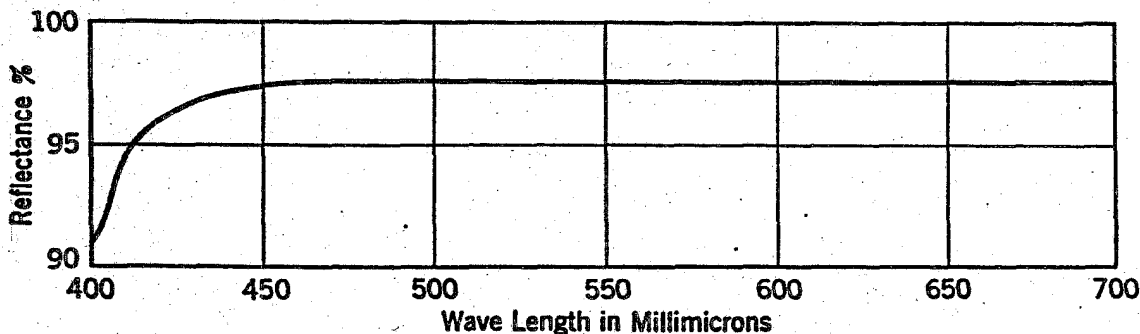
Electron micrograph
20,000 X

Whiteness

The TITANOX pigments are white because they do not strongly absorb colored light but highly reflect all colors. Fine particle size and high refractive index make this whiteness and brightness (high reflectance) effective in the presence of paint vehicles and other media.

The High Nineties

High reflection by TITANOX-A of light of all wave lengths as shown by G. E. Spectrophotometer



Low specific gravity contributes to reflectance and opacity

Fine particle size and low specific gravity naturally mean large surface area per unit weight of pigment. Coupled with high refractive index, these properties assure high reflectance and opacity with a minimum weight of pigment.

Specific Gravity and Bulking Values of the TITANOX pigments and some other White Pigments and Extenders

	Sp. Gr.	Lb. per solid gal.	1 Lb. bulks gal.
TITANOX-A (anatase types) - - -	3.90	32.49	.0308
TITANOX-A-24 - - - - -	3.80	31.65	.0316
TITANOX-RA (rutile types) - - -	4.20	34.99	.0206
TITANOX-B-30 - - - - -	4.24	35.31	.0283
TITANOX-C - - - - -	3.13	26.07	.0393
TITANOX-RCHT - - - - -	3.25	27.07	.0369
TITANOX-L (lead titanate) - - -	7.3	60.83	.0164
Antimony oxide - - - - -	5.75	47.9	.0209
Basic carbonate white lead - - -	6.80	55.64	.0177
Basic sulphate blue lead - - -	6.60	54.98	.0182
Basic sulphate white lead - - -	6.40	53.31	.0188
Lithopone (reg. 28-30% ZnS) - -	4.30	35.82	.0279
Lithopone (high str. 50% ZnS) -	4.20	34.99	.0286
Lithopone (titanated 15% TiO ₂) -	4.25	35.40	.0282
Zinc oxide (lead free) - - - -	5.65	47.06	.0212
Zinc oxide (3 to 5% leaded) - -	5.70	47.48	.0211
Zinc oxide (8 to 12% leaded) - -	5.75	47.90	.0209
Zinc oxide (35% leaded) - - -	5.78	48.05	.0208
Zinc sulphide - - - - -	4.00	33.32	.0300
Zirconium oxide - - - - -	5.69	47.40	.0211
Aluminum flake - - - - -	2.54	21.16	.0473
Aluminum hydrate - - - - -	2.45	20.41	.0490
Asbestine (Mg sil.) - - - - -	2.85	23.74	.0421
Blanc fixe - - - - -	4.36	36.32	.0275
Barytes - - - - -	4.45	37.07	.0270
Bentonite - - - - -	2.41	20.08	.0498
Calcium sulfate (gypsum) - - -	2.36	19.66	.0509
Calcium sulfate (anhydrite) - -	2.96	24.66	.0405
Whiting (CaCO ₃) - - - - -	2.70	22.49	.0445
China Clay - - - - -	2.60	21.66	.0462
Diatomaceous silica - - - - -	2.31	19.24	.0520
Magnesium carbonate - - - - -	1.81	15.08	.0282
Metronite - - - - -	2.85	23.74	.0421
Silica - - - - -	2.65	22.07	.0453
Talc - - - - -	2.77	23.07	.0433

Anatase and Rutile

The particles of titanium dioxide pigments although visually rather shapeless are composed of crystals which are built up of unit cells—the smallest unit of a crystal which is regularly repeated throughout a system.

The anatase crystal structure of titanium dioxide consists of tightly bonded ions of titanium and oxygen with small distances between them—a structure not readily penetrated by light because it slows down the speed of light. The inordinately high refractive index of anatase titanium dioxide is an expression of the slowing down of the speed of light as well as of the angle in which the light is refracted.

In the rutile structure the resistance to the passage of light is even greater than in the anatase type, for rutile has a smaller unit cell than anatase. The unit cell of rutile contains 61.9 cubic angstrom units, whereas the anatase cell contains 134.5 cubic angstrom units.

In comparison with anatase, the even higher refractive index of rutile can be explained by a stronger, more stable crystal structure. The greater compactness and strength of the rutile structure is also revealed by some other properties in the following table:

	Rutile	Anatase
Specific gravity - - -	4.2	3.9
Melting point - - -	1825°C.	Indefinite (transition to rutile)
Thermal conductivity cal/cm/sec/°C -	.148	.430
Dielectric constant -	114 ⁽¹⁾	31 ⁽²⁾
Moh's hardness - - -	6-7	5.5-6

(1) Herberich and Bell, *J. Applied Physics* 11 681 (1940).

(2) International Critical Tables VI, 98 (1929).

X-Ray Diffraction of Anatase and Rutile

It is by means of the X-ray that these crystal types can be positively identified. A characteristic pattern of the intensity of diffraction at different angles of diffraction is given by the X-ray spectrometer. Thus, in the figure on page 9, TITANOX-RA (rutile) may be compared with TITANOX-A (anatase).

Thus far, these diffraction patterns are the most positive means of identifying the crystal type of titanium dioxide.

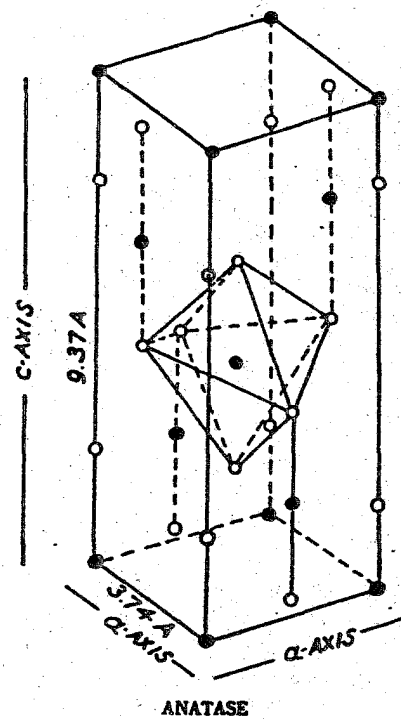
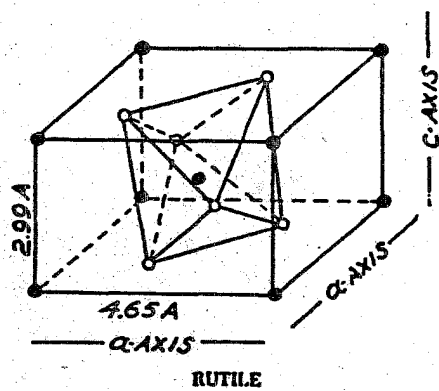
Crystal Unit Cell

Å—ANGSTROM UNIT

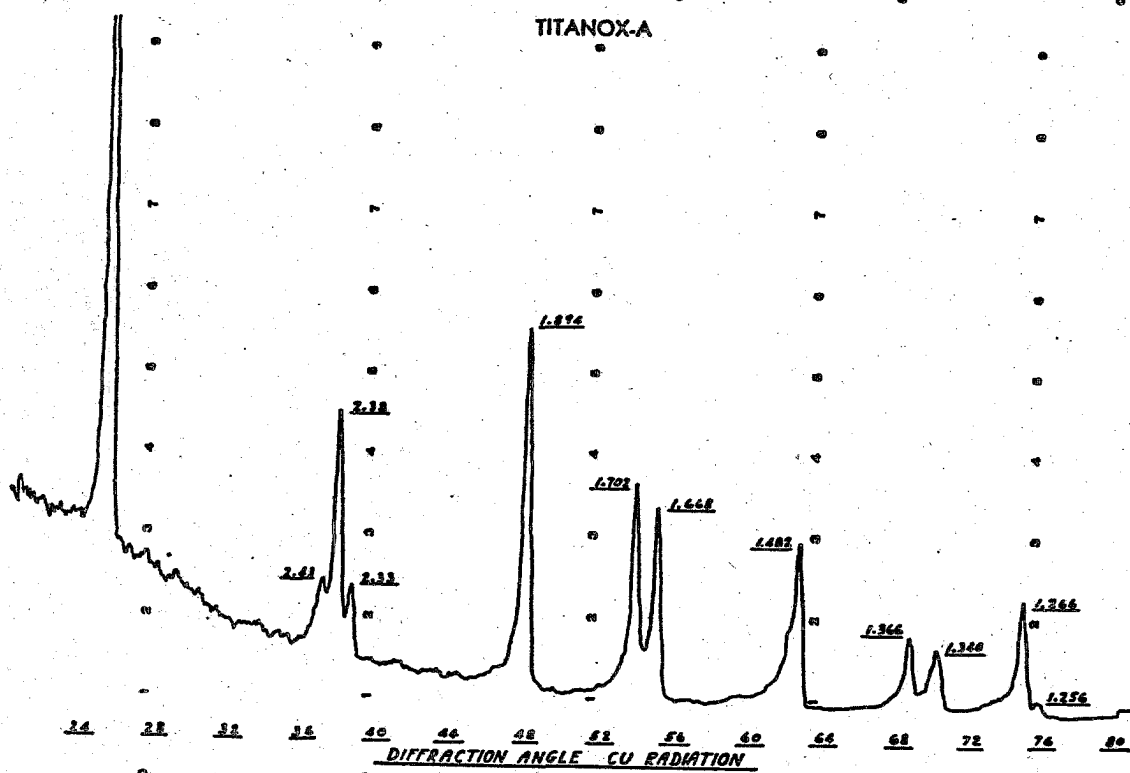
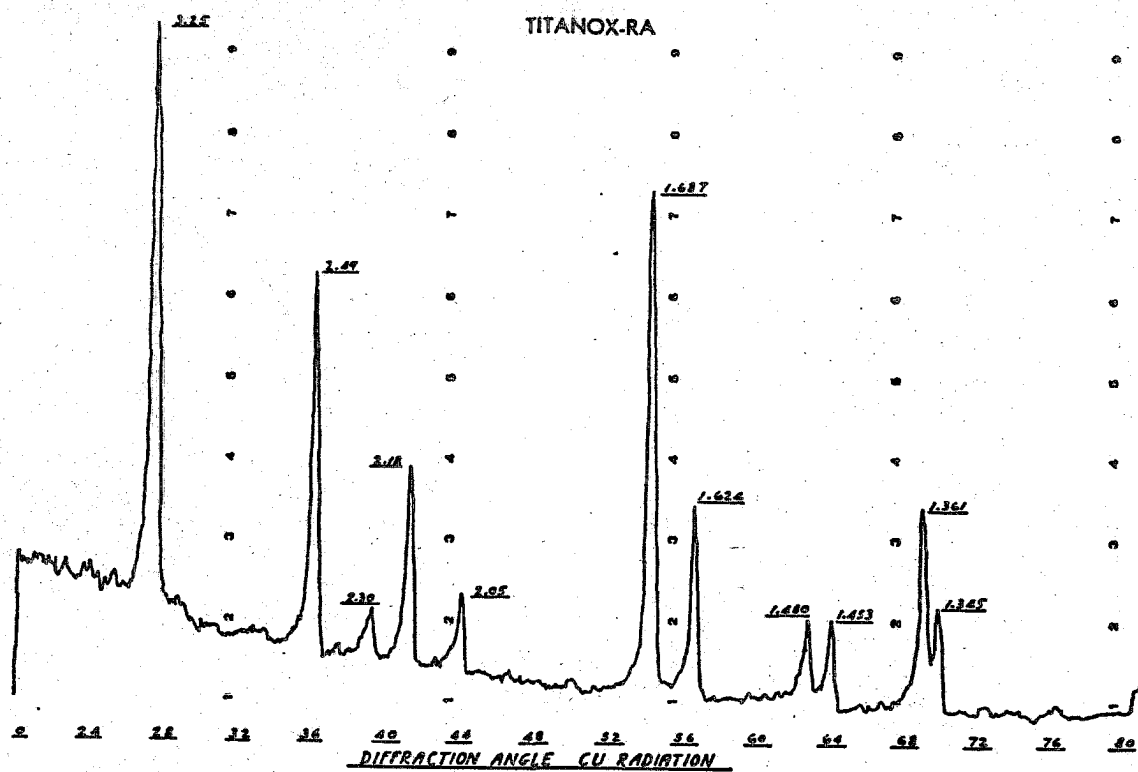
1 Angstrom unit = 10^{-8} centimeters or 0.00000003937 inch

●—TITANIUM

○—OXYGEN



X-ray spectrometer trace showing the intensity of diffraction at different angles of diffraction of X-rays for TITANOX-RA (substantially rutile crystal structure) and TITANOX-A (substantially anatase crystal structure). ➡



[9]

Technical Properties

Generally those effects in practical use—often properties of compositions containing the pigment

Mixing and Grinding Qualities

Long notable for ease of dispersion in many different media, the TITANOX pigments are adaptable to any type of mixing and grinding program.

The relative amount of vehicle required for mixing, generally follows the oil absorption as between the different types of the pigments. On account of differences encountered in vehicles, no rigid vehicle requirement can be stated. The LO types generally require less vehicle for mixing, so that maximum output of pigment may be achieved from milling. Thus, where a paste may be made containing 60% by weight of the MO types (TITANOX-A-MO, TITANOX-A-168-MO and TITANOX-A-24), the LO types may be handled at 65% pigment by weight. Especially TITANOX-A-LO and TITANOX-A-168-LO may be mixed and ground at very high concentration where the equipment will permit. TITANOX-A-168-LO is therefore particularly suited for high gloss products such as industrial enamels in which dispersion is made in a heavy duty mixer such as the Baker-Perkins type, at high pigment content sometimes in excess of 75% by weight. TITANOX-RA is of course also suitable for these products.

Rutile-calcium pigment has been markedly improved in ease of dispersion as effected in TITANOX-RCHTX. This pigment will readily disperse for high gloss with a minimum amount of grinding regardless of the type of mill. In comparison with TITANOX-RCHT the milling time has been reduced more than 50% in many cases.

Consistency

Titanium dioxide unextended

In finished paint products usually there is no appreciable difference in consistency among the various types of unextended titanium dioxide pigments (TITANOX-As and TITANOX-RAs). However, in critical cases, the medium oil absorption type will produce slightly heavier consistency than the low oil absorption type. This difference of course is actually pronounced at high pigment content, so that pastes pigmented with a low oil absorption type will generally flow more readily at a given pigment content than will those pigmented with the medium oil absorption type. Where maximum flow of highly pigmented pastes is desirable, therefore, TITANOX-A-LO, -A-168-LO, -RA, -RA-10, -AA will be suitable. Less flow will be obtained generally with TITANOX-A-MO, -A-168-MO, -A-24.

Composite Pigments

Generally in finished paints which do not contain aqueous bodying agent there is very little difference in consistency at the same pigmentation between TITANOX-RCHT, -RCHTX and -RC. But TITANOX-RCHT will produce the heaviest consistency among these pigments. Here again the lower oil absorption or vehicle requirement of TITANOX-RCHTX and TITANOX-RC promotes greater flow in highly pigmented pastes. Most pronounced difference may occur in paints dependent upon aqueous bodying agents for their puffiness, especially where non-volatile content of the vehicle is low. TITANOX-RCHTX will in these cases produce lower consistency. From the following, the similarity in consistency at low levels and the divergence where aqueous bodying agent is used may be readily noted.

Consistency — Stormer Viscosimeter
Sec. per 100 rev./grams load

Pigment	Alkyd	Enamels 35% pre Oleo- resinous	Gloss Paint (RCHTX 65% Whiting 35%) 35% pre
TITANOX-RCHT	28/150	27/200	28/400
TITANOX-RCHTX	27/150	25/200	26/400

Pigment	Alkyd	Flat Wall Paint oleoresinous Bodied with soap solution reduced 8:1
TITANOX-RCHT	37/1000	29/550
TITANOX-RCHTX	26/950	28/450

Water Systems

Where the pigment is dispersed in water, the water dispersible type of titanium dioxide—TITANOX-A-WD—will generally produce lower consistency than an alternative type such as TITANOX-A-MO. This also applies to water dispersible titanium-barium pigment—TITANOX-B-30-WD—in relation to regular TITANOX-B-30.

The water dispersible types are characterized by lower water absorption, thus, 30-40 parts of distilled water will form a paste with 100 parts TITANOX-A-WD, but on the order of 200 parts of distilled water will be required by 100 parts of TITANOX-A-MO.

Sodium silicate systems (welding rod coatings)

Generally, consistency of pastes of TITANOX-A and sodium silicate solutions varies with the sodium silicate absorption of the pigment.

In the manufacture of coatings for steel arc-welding electrodes, the sodium silicate absorption of the pigment is often one of the determinants of the selection of a particular type of titanium dioxide. TITANOX-A ceramic grade is the lowest in absorption (30-33), TITANOX-A-WD and TITANOX-A-LO are intermediate whereas TITANOX-A-MO is highest (50+).

Tinting Strength

The primary properties—fine and optimum particle size and high refractive index—account for the high tinting strength of the TITANOX pigments.

The great strength of these pigments is accompanied by their ability to yield remarkably clear tints.

Tinting Strength of the TITANOX pigments and some other White Pigments

(Reynolds' constant volume method—ultramarine blue)*

	Tinting Strength
TITANOX-RA (rutile—also RA-10, RA-NC)	1550
TITANOX-A (anatase— also A-168, AA, A-24)	1250
TITANOX-RCHT (rutile-calcium, also RC, RCHTX)	600
TITANOX-C (anatase-calcium, also CX)	470
TITANOX-B-30 (anatase-barium, also B-30-AA)	440
Zinc sulfide	640
Titanated lithopone	460
High strength lithopone	420
Lithopone	280
Zinc oxide	210
Zinc oxide (35% loaded)	175
Basic sulphate white lead	120-150
Basic carbonate white lead	120-160

*Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors, H. A. Gardner and G. G. Sward, 10th Edition, page 48.

High Tinting Strength means High Hiding Power

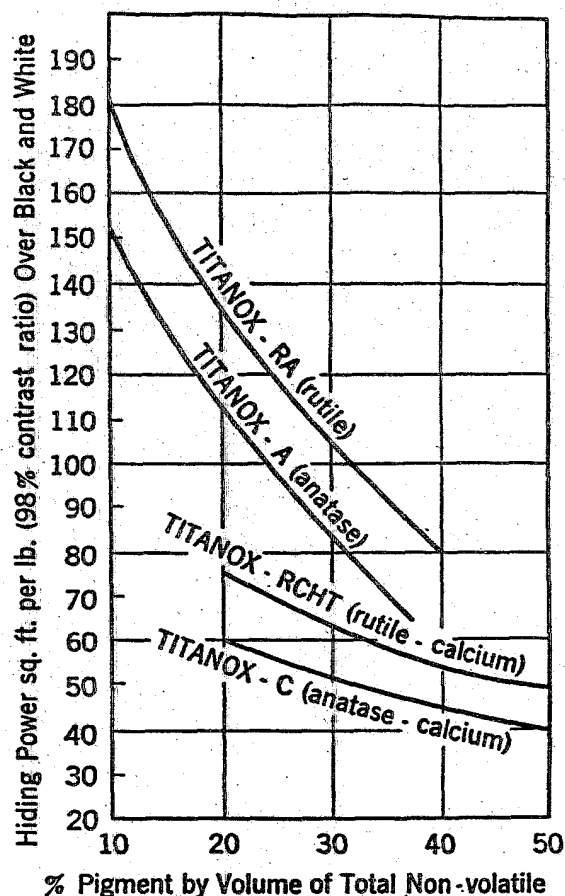
As a guide to the hiding power of white pigments, many paint technologists refer to the data of Hallett⁽¹⁾ which supplemented by calculations⁽²⁾ of hiding power of some pigments not included in Hallett's work, follows:

	Hiding Power sq. ft. per lb.	Hiding Units
TITANOX-RA (rutile)	147	9.80
TITANOX-A (anatase types)	115	7.67
Zinc sulfide	58	3.87
TITANOX-RCHT (also RC, RCHTX)	57	3.80
TITANOX-C (anatase-calcium)	48	3.20
TITANOX-B-30 (anatase-barium)	46	3.07
Titanated lithopone	44	2.93
High strength lithopone	44	2.93
Lithopone	27	1.80
Zinc oxide	20	1.33
Zinc oxide (35% leaded)	20	1.33
Antimony oxide	20	1.33
Basic carbonate white lead	15	1.00
Basic sulphate white lead	13	.87

The foregoing not only illustrates the exceptional hiding afforded by the TITANOX pigments but also the relative amount of one pigment that may replace another for equal hiding. However, these data apply to a single content by volume of the pigment in the paint film.

Since the hiding power of a pigment depends mainly upon the proportion of pigment by volume of the paint film, many paint technologists prefer to take pigment volume into account when considering the hiding power of pigments.

In the chart above to the right, the extremely opaque pigments (TITANOX-RA and TITANOX-A) are shown at low pigment volumes at which these pigments are generally used, whereas the extended pigments (TITANOX-RCHT and TITANOX-C) are shown at higher pigment volumes. Thus the excep-

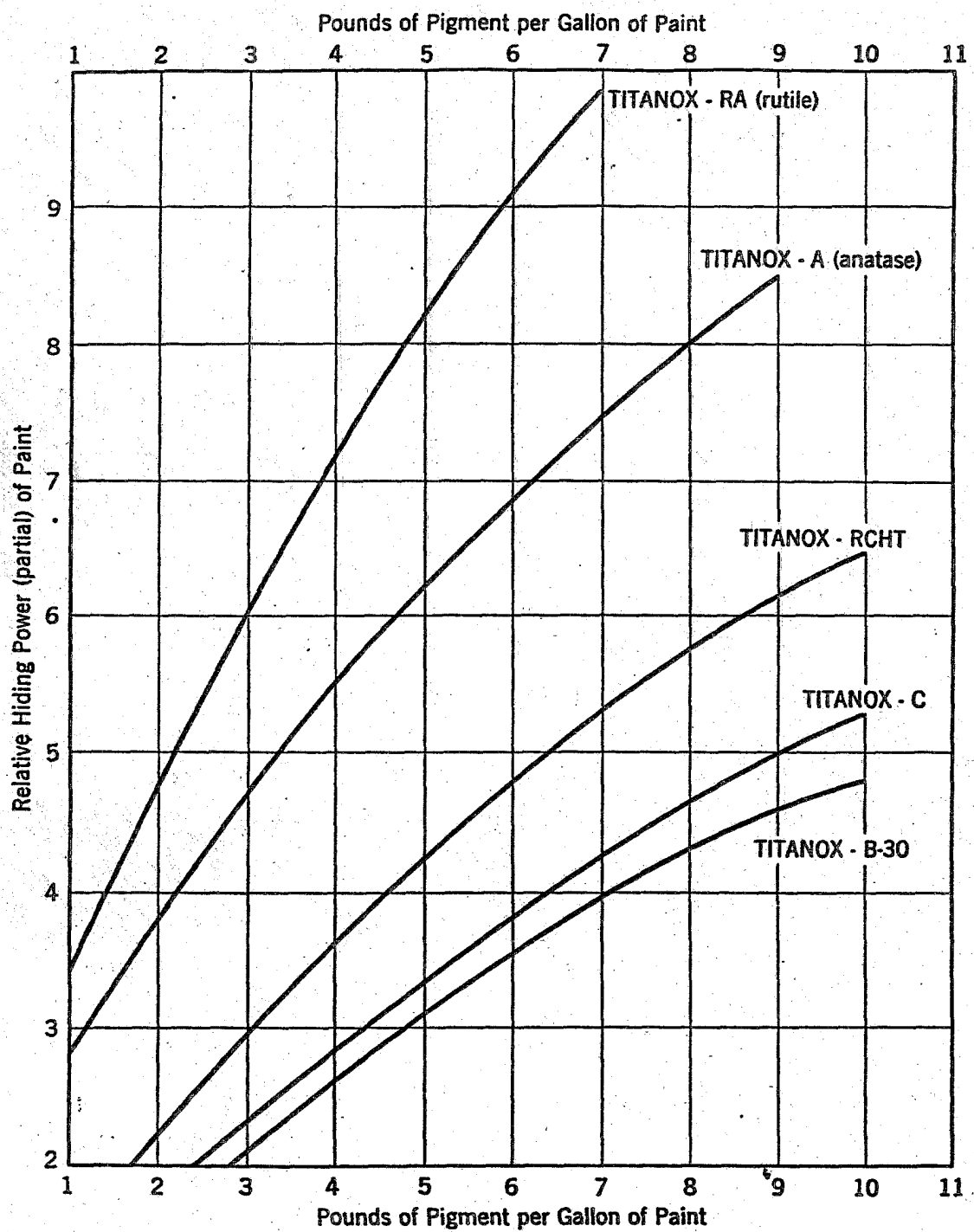


Typical relative hiding in an alkyl vehicle

tional hiding of titanium dioxide at low pigment volume which is often required in gloss finishes is contrasted with the relatively high hiding of the extended pigment at higher pigment volumes applicable to semi-gloss and flat finishes. Since at constant non-volatile content of vehicle, pigment volume may be translated into pounds of pigment per gallon of paint, an idea of the hiding power of the pigments may be gained from the chart at the right in which an average relationship between the hiding power of paint and pounds of pigment per gallon of paint is shown. Although for a specific case the relationships thus shown may not be exact, due to uncontrolled factors such as type of vehicle and grinding, they should be helpful as a guide to pigmentation.

(1) Proc. A.S.T.M. 30 Part II 895 (1930).

(2) Hiding Power = (Tinting strength (black) $\times .1$) + 2.



[13]

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TITANOX I

	% TiO ₂ (minimum)	Specific Gravity	1 lb. bulks Gal.	Lb. per Gal.	Particle Size ave. dia. micron	Refractive Index (mean)	Dry Brightness (ave.)
<i>Anatase Titanium Dioxide</i>							
TITANOX-A-MO	98	3.9	.0308	32.49	0.3	2.55	98.5
TITANOX-A-LO	98	3.9	.0308	32.49	0.3	2.55	98.5
TITANOX-A-168-MO	97	3.9	.0308	32.49	0.3	2.55	98.5
TITANOX-A-168-LO	97	3.9	.0308	32.49	0.3	2.55	98.5
TITANOX-AA	96	3.9	.0308	32.49	0.3	2.55	98.5
TITANOX-A-24	94	3.8	.0316	31.65	0.3	2.55	97.0
TITANOX-A-WD	98	3.9	.0308	32.49	0.3	2.55	98.5
TITANOX-A, ceramic grade	98	3.9	.0308	32.49	0.6	—	—
<i>Rutile Titanium Dioxide</i>							
TITANOX-A-NC	97	4.2	.0286	34.99	0.6	2.7	95
TITANOX-RA-10	98.5	4.2	.0286	34.99	0.4	2.7	97
TITANOX-RA	97	4.2	.0286	34.99	0.4	2.7	97
TITANOX-RA-NC	94	4.2	.0286	34.99	0.4	2.7	97
TITANOX-RA-WD	98	4.2	.0286	34.99	0.4	2.7	97
<i>Titanium-Barium (30% TiO₂; 70% BaSO₄)</i>							
TITANOX-B-30	29.5	4.24	.0283	35.31	0.5-0.7	1.91	98.5
TITANOX-B-30-AA	29.5	4.24	.0283	35.31	0.5-0.7	1.91	98.5
TITANOX-B-30-WD	29.5	4.24	.0283	35.31	0.5-0.7	1.91	98.5
<i>Titanium (Anatase)-Calcium (30% TiO₂; 70% CaSO₄)</i>							
TITANOX-C	29.5	3.13	.0383	26.07	0.5-0.7	1.87	98.5
TITANOX-CX	29.5	3.13	.0383	26.07	0.5-0.7	1.87	98.5
<i>Rutile-Calcium (30% TiO₂ (rutile); 70% CaSO₄)</i>							
TITANOX-RC	29.5	3.25	.0369	27.07	0.5-0.9	1.98	97.5
TITANOX-RCHT	29.5	3.25	.0369	27.07	0.5-0.8	1.98	98.5
TITANOX-RCHTX	29.5	3.25	.0369	27.07	0.5-0.8	1.98	98.5
<i>Lead Titanate (PbTiO₃)</i>							
TITANOX-L	—	7.3	.0164	60.83	0.4	2.74	91

Discontinued Pigments: TITANOX-A-NC and TITANOX-L are not being produced.

New types not yet for sale: TITANOX-RA-NC, TITANOX-RA-WD.

Consistency: The unextended titanium dioxides are similar in consistency in most finished paint products, but at high pigment content such as in pastes the MO types generally yield higher consistency than the LO types.

For the composite pigments, the numbers on the average are proportional to time of flow generally obtained with viscometers usually employed.

Oil absorption: Spatula method expressed as lb. oil per 100 lb. pigment—determined in relation to standard sample under controlled conditions.

Dry Brightness: Hunter multi-purpose reflectometer—green filter—measured on cake of pigment.

Pigments

Thickness of Paint 1-whitest	After- yellowing Resistance	Oil Absorption	Tinting Strength	Chalking Resistance	Consistency (paint)	Principal Use
9	40	26-27	1250	15	—	White exterior house paints; general utility.
9	40	20-22	1250	15	—	Interior gloss enamels and lacquers; rubber.
10	100	26-27	1250	20	—	White baking enamels.
10	100	20-22	1250	20	—	
9	95	21-23	1250	30	—	Specification paints; exterior paints retarded chalking.
9	95	26-27	1250	65	—	Automotive enamels; exterior enamels and paints.
—	—	—	1250	—	—	Paper filling and coating; water vehicle systems.
—	—	—	—	—	—	Welding rod coatings; ceramics.
4	—	18-20	1000	100	—	Specification paints.
8	92	19-21	1550	20	—	White exterior house paints.
8	100	20	1550	35	—	Industrial enamels; architectural enamels.
6	100	20	1550	100	—	Tinted exterior paints and enamels.
—	—	—	1550	—	—	Waxed paper.
9	high	15	440	15	60	Primers for house paints; industrial primers.
9	high	15	440	30	60	Exterior paints, retarded chalking.
—	high	—	440	—	—	Paper filling and coating.
9	high	23	470	very low	60	See TITANOX-RCIT.
9	high	21	470	very low	55	See TITANOX-RCITX.
6	high	21	600	100	55	Exterior tinted paints and enamels.
8	high	23	600	20	60	Flat wall paints; white exterior house paints.
8	high	21	600	20	55	Interior architectural finishes.
very pale yellow	high	10	570	120	—	Tinted exterior paints.

Chalking: Relative chalk resistance—The high numbers indicate high chalk-resistance or low chalking. From the average of numerous exposures of comparable practical finishes, the numbers are proportional to the time required for chalking to commence and continue.

After-yellowing: The relative ability of the pigments to retard the after-yellowing of white coatings—particularly synthetic resin types. Less after-yellowing (greatest resistance) denoted by higher numbers.

Tinting strength: Reynolds constant volume method—0.5 gram Std. TITANOX-A plus 1.25 gm. ultramarine blue (6 parts barytes, 1 part ultramarine blue) plus 0.515 ml. refined linseed oil has tinting strength 1250. Although an exact general relationship cannot be shown, tinting strength is generally indicative of relative hiding power.

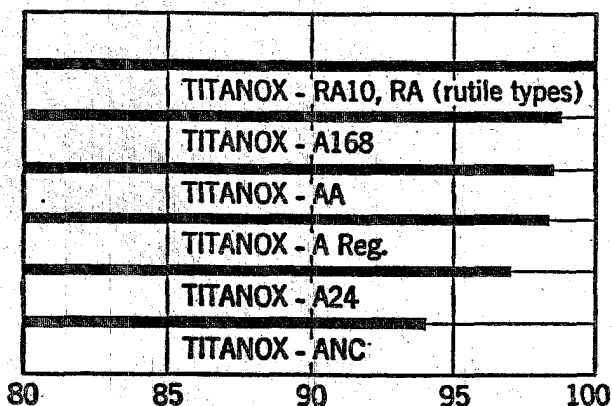
Whiteness of Paint: Differences in whiteness are slight except in the case of TITANOX-ANC (discontinued). The lesser whiteness of the rutile types is usually counteracted by higher brightness.

Brightness or Reflectance of Coatings

Optimum particle size, high refractive index and atomic structure such that light of any given wave length is not strongly absorbed, assure high reflectance of films pigmented with TITANOX.

Like other optical properties, brightness depends upon many factors, but with a given white pigment and vehicle, it is largely determined by the amount of pigment. The rutile types of TITANOX have greater brightening power than the corresponding anatase types, the only exception being the now obsolete TITANOX-A-NC which because of relatively coarse particle size together with absorption of blue had low brightening power.

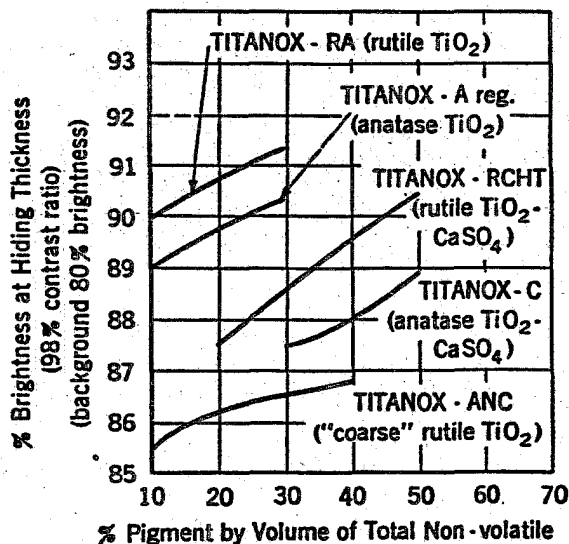
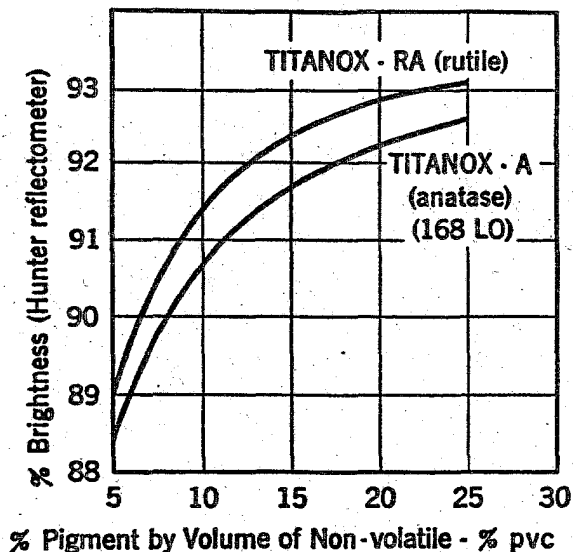
Among the various types of anatase titanium dioxide there is not a great deal of difference in effect on brightness of coatings, but the lower brightness afforded by TITANOX-A-24 has to be considered where brightness is a critical requirement. In general, if an arbitrary value of 100 is assigned to TITANOX-RA, then the brightness produced in coatings by the others will be according to the following chart.



In view of their high tinting and brightening power the TITANOX pigments are ideally suited for tinted coatings having high opacity. Where demanded, the highest hiding obtainable in a white or tinted coating

will be assured through the use of the maximum amount of the proper TITANOX pigment. This maximum amount in terms of pigment volume can be sufficiently low to maintain high gloss, flexibility and other desirable film properties.

Typical Differences in Brightness in synthetic resin and oil vehicles
(For illustrative purposes only)

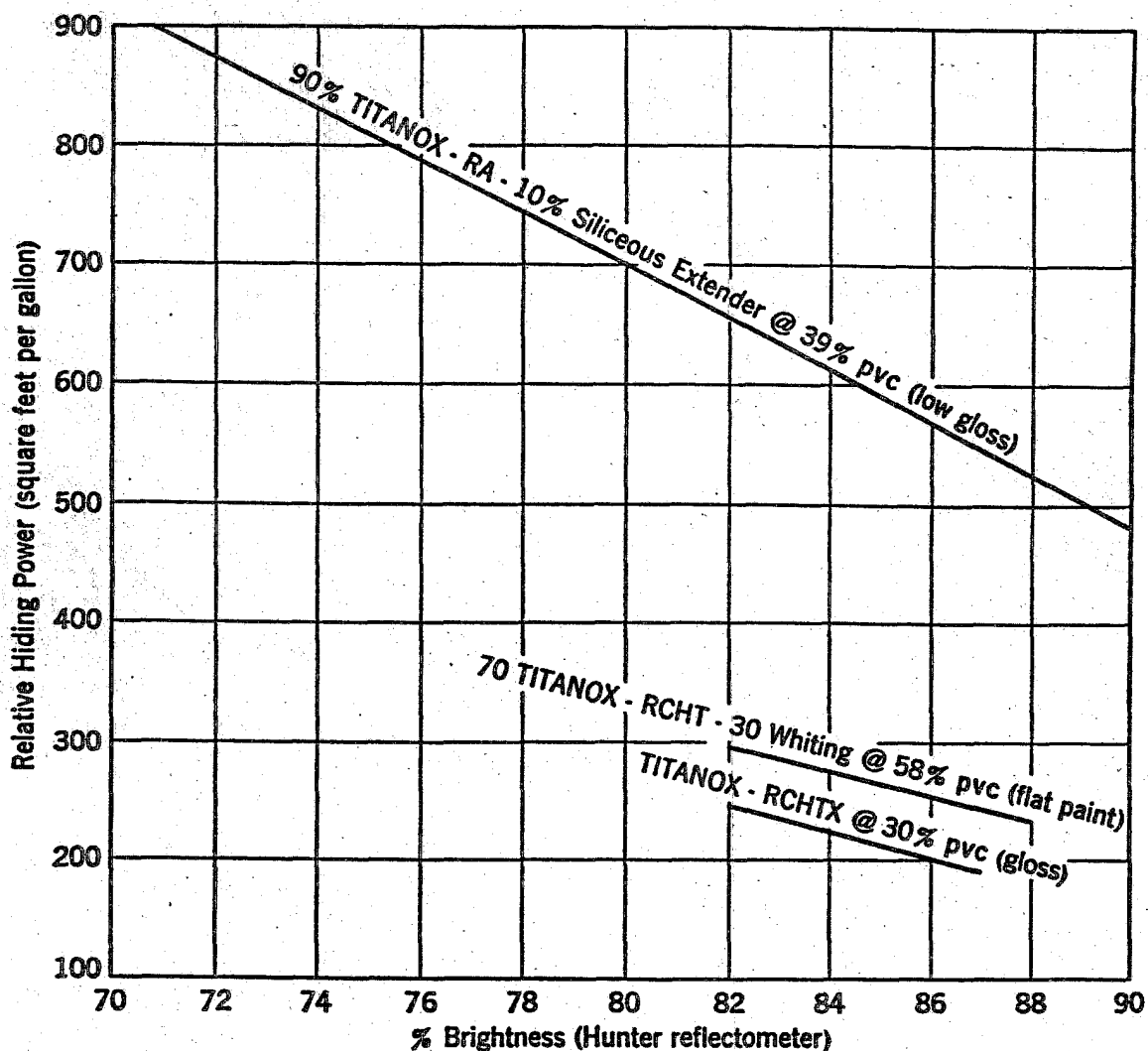


Brightness and Hiding Power of White Paints

Because of the strong brightening action of the TITANOX pigments, often there will be brightness to spare even where the pigmentation is an exceptionally economical one such as 70% TITANOX-RCHT and 30% extender. Depending upon requirements, the formulator by regulating brightness through the addition of black or colored pigment can be sure of the required hiding.

The chart below is a typical illustration of increase

in dry hiding of white paints as brightness is decreased by addition of black pigment. The relationships apply exactly only to the particular paints studied and should not be applied to any similar paints selected at random. The amount of black added is not shown because this, of course, depends upon the type of black or dark pigment and the method of its incorporation into the paint. The highest brightness shown below is that of the paint without the addition of black. Advantage has been taken of this unusually high brightness to secure exceptionally high hiding for the given pigmentation.



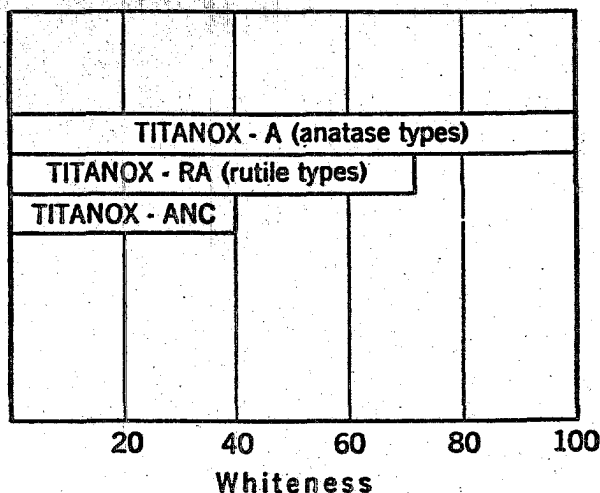
[17]

Whitening Power

Primarily because of their innate whiteness the TITANOX pigments impart whiteness to paints and other materials. Slight differences in the whiteness of different types of the pigment may result in slight variation in whiteness of paints with which they are pigmented. In general, the anatase types are whiter and yield whiter coatings than the rutile types, but the increased brightness of the latter frequently compensates for their slight deficiency in whiteness and permits toning with blue or violet.

Other factors being equal, the whiteness of paints in which titanium pigments are the sole or predominating pigment, will depend largely upon the vehicle, so that small differences in whiteness among the various types of titanium dioxide may not determine the whiteness of the paint film. It is for this reason that titanium dioxide pigments have been treated to retard the formation of colored compounds which arise in some vehicles. For example, the treated anatase titanium dioxide, TITANOX-A-168 will produce a whiter film with a concentrated phenolic resin varnish than will TITANOX-A regular, which is not treated for this purpose, yet as pigments, these two types are equally white.

By considering whiteness to be inversely proportional to the color index* as calculated from reflection values obtained on the Hunter reflectometer, the dif-



ferent classes of the TITANOX straight titanium dioxide pigments may be rated as shown.

Among the composite pigments relatively the same order exists, but in rutile-calcium pigments the chalk resistant type—TITANOX-RC—has a yellower tone than TITANOX-RCHT. A typical difference in an enamel as expressed by the color index* and brightness as determined by the Hunter Reflectometer follows:

Pigment	% Bri.	Color Index
TITANOX-C (anatase-calcium) - - -	86	3.6
TITANOX-RCHT (rutile-calcium) - - -	87	4.4
TITANOX-RC (rutile-calcium; chalk-resistant) - - - - -	87	5.5

Lasting Whiteness

Permanent whiteness—an ultimate goal for white organic finishes—is being approached through the TITANOX pigments. The yellowing with age of white organic coatings was early found to be naturally lessened by the high tinting strength of titanium dioxide which masks the developed color. In addition to masking discoloration, modern titanium dioxide inhibits and retards the color change of vehicles.

A typical comparison in which color index* is considered to denote relative yellowness is shown in the following table:

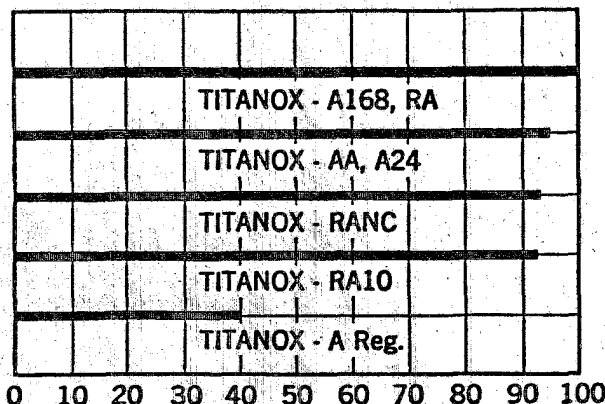
Air Dry Alkyd Enamel 15% pvc

Pigment	Color of film initially		Color of film after exposure to diffused light for 8 months	
	% Bri.	Color Index	% Bri.	Color Index
TITANOX-A-168 - - -	89.0	3.7	87.0	11.0
TITANOX-A - - -	89.0	4.2	86.0	16.0
TITANOX-RA - - -	90.0	5.5	87.5	13.0
TITANOX-RA-10 - - -	90.0	5.9	87.5	16.0

The better retention of whiteness of the enamels containing TITANOX-A-168 and TITANOX-RA is indicated by the lower values of the color index of the exposed enamel in comparison with TITANOX-A regular, and TITANOX-RA-10.

*1% Reflected with Amber Filter—% Reflected with Blue Filter)
(% Reflected with Green Filter) × 100

Retention of Whiteness of Coatings



TITANOX-A-168 and TITANOX-RA which are modified to retard after-yellowing are first choice where lasting whiteness is demanded in enamels for architectural interiors (kitchens, bathrooms, etc.), refrigerators, household appliances, and cabinets, etc. (This type of whiteness, of course, must be distinguished from that due to chalking such as in weathered white exterior house paints.)

The composite TITANOX pigments have long been notable for promoting color retention particularly of interior finishes. Generally they are slightly superior to equivalent mixtures of titanium dioxide and extender. This is particularly true of the rutile calcium pigments TITANOX-RCIT and RCITX.

The rapid chalking of the earliest titanium pigment was a serious obstacle to its use in exterior paints, but for several years, control of the chalking of the TITANOX pigments has rendered them indispensable to white and tinted exterior coatings which combine high hiding power with durability.

The pigments are listed below according to decrease in chalking or increase in chalk-resistance:

Chalking types—sometimes referred to as free chalking—indicated for use in exterior white house paints

TITANOX-A reg. (anatase)
TITANOX-A-168 (anatase)
TITANOX-RA-10 (rutile)

Chalk-resistant — sometimes called "semi-chalking", or "semi non-chalking". Used in white house paints at high concentration or where less chalking desired than with chalking type. Also in tinted enamels or interior-exterior combination finishes

TITANOX-AA (anatase)
TITANOX-RA (rutile)

Highly chalk-resistant—mainly for exterior tinted enamels
TITANOX-A-24 (anatase)

**Very highly chalk-resistant—referred to as "non-chalking"
—exterior tinted enamels and paints**

TITANOX-RANC (rutile)

Chalking type	- - - - -	TITANOX-B-30 (regular)
Chalk-resistant	- - - - -	TITANOX-B-30-AA

Free chalking type	- - -	TITANOX-C and CX
Chalking type	- - - -	TITANOX-RCHT

Very highly chalk-resistant—referred to as “non-chalking”—tinted paints

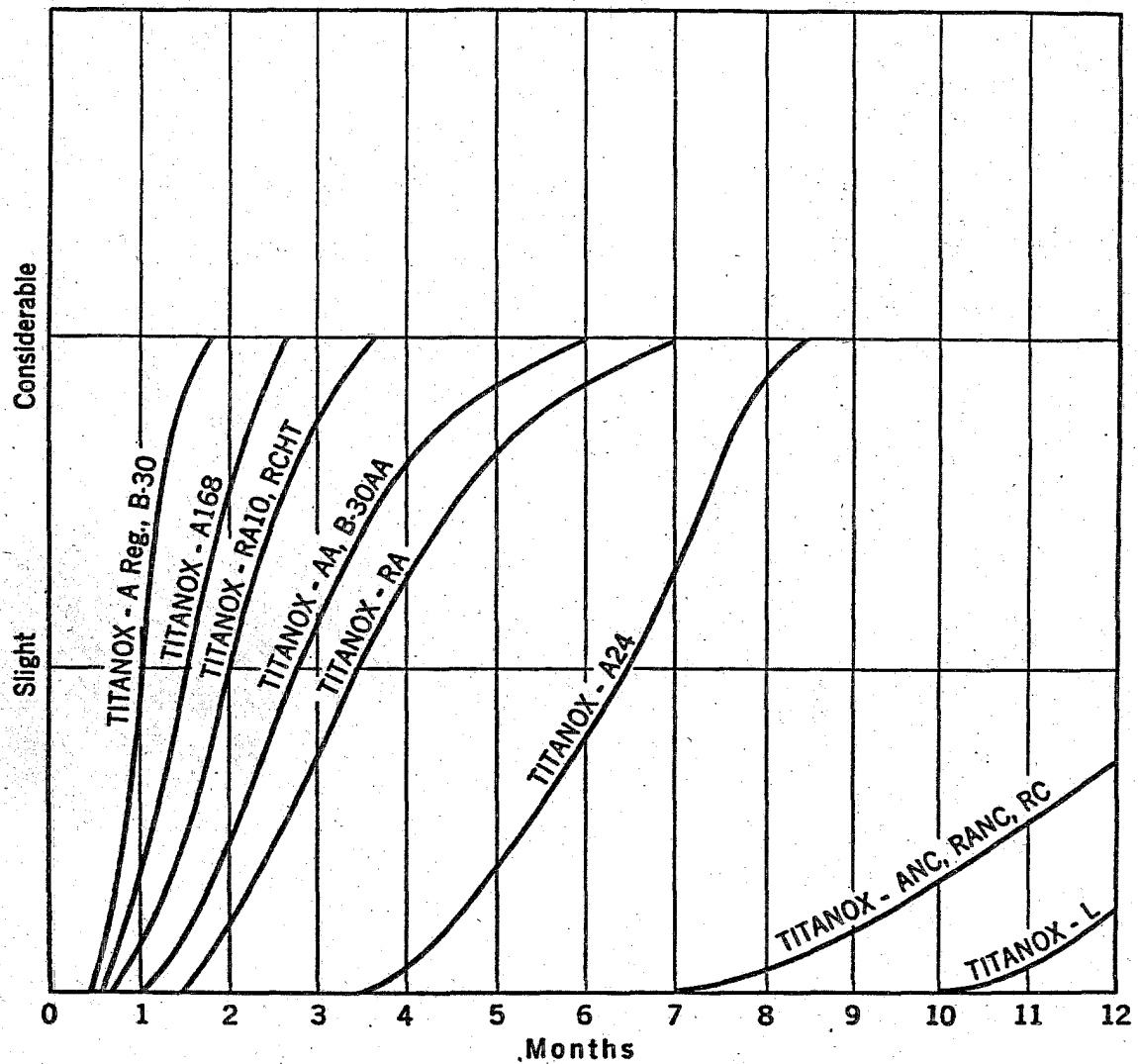
TITANOX-RC

In general, these pigments differ in chalking as shown in the chart below in which numerous comparable exposures have been averaged. While indicating

only relative performance, this chart should serve as a valuable guide to the use of TITANOX pigments in exterior paints and enamels.

Chalking

Exposed at 45° Facing South



The types of TITANOX preferred for Various Uses

Under each use, the type of pigment generally preferred is mentioned along with brief comment. Further details related to a particular application will be gladly furnished in answer to welcome inquiries which may be directed to our office nearest you or to Titanium Pigment Corporation, 111 Broadway, New York 6, New York.

Paints

Interior Architectural Finishes

Flat wall paints, calcicoaters, wall primers and sealers, enamel undercoaters

TITANOX-RCHT or -RCHTX properly extended. For exceptionally high hiding these pigments may be fortified with TITANOX-RA.

Semi-gloss paints

TITANOX-RCHTX or -RCHT as sole pigment or extended. These pigments may be fortified with TITANOX-RA for exceptionally high hiding.

Gloss Paints and Painters' Enamels

TITANOX-RCHTX as sole pigment or extended depending upon hiding required.

Architectural Enamels

For highest hiding — TITANOX-RA. Combinations of TITANOX-RCHTX and TITANOX-RA also suggested.

Water-reducible paints

TITANOX-A reg., TITANOX-A-WD, TITANOX-RA-10 or others depending upon the system.

Exterior House Paints

White

In the usual combinations of titanium dioxide, lead, zinc and extender pigments, TITANOX-A-MO (anatase) is preferred on account of chalking to reduce dirt retention and to promote whiteness. TITANOX-RCHT (rutile-calcium) also used extensively but

Exterior House Paints (Cont.)

some formulators prefer greater whiteness of regular TITANOX-A-MO. Combinations of TITANOX-A-MO (anatase) or TITANOX-C (titanium (anatase)-calcium) with TITANOX-RCHT are suggested for increased chalking. TITANOX-RA-10 (rutile) although applicable to white paints does not chalk as freely as TITANOX-A-MO (anatase). Where titanium dioxide accounts for large percentage (say 20%) of the total pigment the remainder being balanced lead, zinc-extender combination, the semi-chalk resistant pigments — TITANOX-RA or TITANOX-AA may often be used without excessive dirt retention.

Tint Base

TITANOX-RC on account of high chalk-resistance provides in proper combination with reactive pigments, and extender, lasting uniform color of tints.

House Paint Primers

TITANOX-B-30 (titanium-barium) has long been used in proper combination with white lead and bodied oil for these products, but equivalent combinations of TITANOX-A-MO and extender may also be used. TITANOX-RC has proven suitable.

Porch and Deck Enamels and Trim Paints

Tinted

TITANOX-RC is particularly adaptable to this class of coatings on account of its high chalk-resistance.

Industrial Finishes

Baking primers on metal for white and light tinted finish coats

TITANOX-B-30 is preferred on account of its extreme insolubility, but combinations of TITANOX-AA or TITANOX-RA and selected extender may also be used.

Baking enamels and tin-printing enamels

TITANOX-RA on account of its exceptional hiding and brightness is preferred. For maximum whiteness, such as required for refrigerators and other household equipment, TITANOX-A-168 is often selected.

Automotive Enamels

Chalk-resistant titanium dioxide—TITANOX-A-24 is preferred, but when available, the high hiding rutile type—TITANOX-RA-NC will be particularly suitable. TITANOX-RA may also be used in combination with non-chalking pigments.

Lacquers

TITANOX-A-LO is used where ease of dispersion is the primary requisite, but TITANOX-A-168-LO and TITANOX-RA are also applicable. For exterior lacquers TITANOX-A-24 is preferred but the high hiding rutile TITANOX-RA-NC when available will be particularly suitable. TITANOX-RA and TITANOX-AA are also used. Where exceptionally high hiding is not required or where extender is needed TITANOX-RCHTX will fill the requirement.

Paper

Beater addition

Water dispersible anatase titanium dioxide—TITANOX-A-WD—is extensively preferred, although the regular anatase type TITANOX-A-MO, the rutile type TITANOX-RA-10, water dispersible titanium-barium TITANOX-B-30-WD or regular titanium barium-TITANOX-B-30 may be used. Average weight

ratios of these pigments to produce equal opacity are about as follows:

TITANOX-A-WD or -A-MO	- - 1.0
TITANOX-RA-10	- - - - 0.85-1.0
TITANOX-B-30-WD, or -B-30	- - 2.5-2.75

The ability of the pigment to opacify and render a lighter-weight sheet as opaque as a heavier sheet (unpigmented) as well as to reduce show-through and transparency when waxed is indicated by the following typical data:

100% Bleached Sulphite: 25 x 38 — 500

% TITANOX-AWD in Sheet	% Contrast Ratio for Basis Weight		
	40 lb.	50 lb.	60 lb.
0	75	81	85
1	81	87	90
2	84	89	92.5
3	86	90.5	94
4	88	92	95

Show-through Effect
Brightness on reverse side
over solid black printing
% Brightness for Basis Weight

% TITANOX-AWD in Sheet	% Brightness for Basis Weight		
	40 lb.	50 lb.	60 lb.
0	41.6	52	60.3
1	52.0	60	67.5
2	56.7	65	72.0
3	60.0	68	74.5
4	63.0	71	76.6

Waxing Stock—Bleached Sulphite:

24.5 lb. (24 x 36 — 480)

% TITANOX-AWD in Sheet	% Opacity	
	unwaxed	waxed
0	54	31.2
1	62.4	45.6
2	68.4	52.4
3	71.6	55.7

% TITANOX-AWD in Sheet	% Brightness	
	unwaxed	waxed
0	74.4	60
1	78.4	70
2	81.6	73.2
3	82.8	75

Surface Size Application

The water dispersible titanium dioxide — TITANOX-A-WD or reg.-A-MO as well as TITANOX-B-30-WD, -B-30, rutile titanium dioxide TITANOX-RA and also the rutile-calcium pigment TITANOX-RCHTX may be used. The weight ratios of these pigments for equal opacity secured through a light surface size are about as follows:

TITANOX-A-WD or -A-MO	1.0
TITANOX-RA-10	0.85
TITANOX-B-30-WD, -B-30	2.0
TITANOX-RCHTX	1.6

The remarkable increase of opacity and brightness by the surface application of the pigment is revealed in the following typical average data:

TITANOX-A Pounds per ream 25 x 40 — 500		Opacity Per cent Contrast Ratio (Bausch & Lomb)				
0	- - - -	65.0	70.0	75.0	80.0	85.0
0.5	- - - -	73.5	77.5	81.0	84.5	88.0
1.0	- - - -	76.0	79.5	83.0	86.0	89.0
1.5	- - - -	78.5	81.5	84.5	87.5	90.0
2.0	- - - -	81.0	83.5	86.0	88.5	91.0
2.5	- - - -	82.0	84.5	87.0	89.5	91.5
3.0	- - - -	82.5	85.0	87.5	90.0	92.0

TITANOX-A Pounds per ream		Brightness % Reflectance				
0	- - - -	75	80	85		
0.5	- - - -	77	81.5	86		
1.0	- - - -	78.5	82.5	87		
1.5	- - - -	79.5	83.0	87.5		
2.0	- - - -	80.0	83.5	88.0		
2.5	- - - -	80.5	84.0	88.5		
3.0	- - - -	81.0	84.5	89.0		

Coating

Water dispersible anatase titanium dioxide — TITANOX-A-WD is generally preferred, although other types including rutile titanium dioxide and rutile-calcium pigment may be employed.

Quite often a portion of the coating mineral (clay, chalk, etc.) is replaced by titanium pigment. The following example taken from laboratory work may prove valuable as a guide in experimental work on the increase in opacity and brightness to be expected by pigmentation of the coating with TITANOX-A-WD.

15 Pounds of coating applied (25x40 — 500)

TITANOX-A-WD % of mineral portion of coating		Opacity % contrast ratio (Bausch & Lomb) of coated paper		
0	- - - -	75	80	85
5	- - - -	81.5	84.5	88
10	- - - -	85.0	87.5	90
20	- - - -	87.5	90.0	92.5

TITANOX-A-WD % of mineral portion of coating		% Brightness of coated paper		
0	- - - -	75	80	85
5	- - - -	78.5	82.5	86.5
10	- - - -	80.5	84.0	87.5
20	- - - -	82.5	85.5	88.5

Rubber

All types of white and light tinted Rubber Compounds

Because of their fineness and physical and chemical stability which make them compatible with natural and synthetic rubbers and compounding ingredients, the TITANOX pigments are ideal whiteners and brighteners for rubber. Depending upon the type of compound, titanium dioxide unextended, or the extended types may be used. Numerous tests have revealed that the following ratios on the average, express the relative weights of the TITANOX pigments which will produce equal brightness in rubber products:

TITANOX-RA, -RA-10 (rutile TiO_2)	0.75-0.9
TITANOX-A-LO (anatase)	1
TITANOX-RCHTX (rutile-calcium)	2.0-2.5
TITANOX-C (anatase-calcium)	3
TITANOX-B-30 (titanium-barium)	3.5

Although higher in brightening power the rutile type pigment imparts a slightly yellowish cast as shown by a typical comparison:

Pigment	Amount of Pigment Parts: 100 parts rubber	Reflection values (Hunter Multipurpose Reflectometer)		
		Green (Brightness)	Amber	Blue
TITANOX				
A-LO (anatase)	15	73.0	73.9	69.2
RA (rutile)	13.5	73.4	74.5	68.2

Latex

Water dispersible titanium dioxide—TITANOX-A-WD—is often preferred when dispersant is not used. With dispersant, TITANOX-A-LO or TITANOX-RA are often employed.

Plastics

Phenolic types

TITANOX-A-168-LO or -MO is preferred on account of decreased discoloration, although TITANOX-RA in lesser amounts in proportion to tinting strength may be used.

Cellulosic Types

TITANOX-A-168 preferred, but for articles subjected to exterior exposure the chalk-resistant types such as TITANOX-A-24 may be used.

Vinyl Types

TITANOX-A reg. MO or -LO although -A-168 or TITANOX-RA may be used. In tints the composite pigments—TITANOX-C and TITANOX-RCHT—are also employed. In the unsupported vinyl plastics only very small amounts of TITANOX-A or TITANOX-RA are required for decreasing transparency; appreciable decrease in transparency being afforded by 1% titanium dioxide. On the average 0.75 parts of TITANOX-RA (rutile) will equal 1.0 part of TITANOX-A regular (anatase) in opacifying power.

Polystyrene

TITANOX-A-168 usually preferred for whites while TITANOX-RA on account of slight yellowness may be restricted to tints.

Acrylics

TITANOX-RA often employed on account of high opacity although the anatase type may be used.

In general TITANOX-A-168, TITANOX-RA and TITANOX-RCHT are quite universally applicable to any type of plastic.

Ceramics

Super-opaque vitreous enamels

Titania type—as a constituent of the properly balanced frit and also as a mill addition TITANOX-A imparts high brightness and opacity to vitreous enamels. TITANOX-A ceramic grade is usually preferred on account of uniformity and working qualities, although others may be used.

Acid resistant vitreous enamels

Small additions of TITANOX-A enhance acid-resistance.

Decorative glazes

For whitening and brightening decorative coatings for glass, TITANOX-A regular, is often preferred.

Decorative and colored glass

For brightening colored glasses where color is derived from cerium oxide—TITANOX-A-MO or ceramic grade are added to the melt.

Optical glass

TITANOX-A-MO may be used as a source of titanium dioxide for optical glass having high refractive index coupled with improved weathering properties.

Welding Rods

Coatings for mild and alloy steel including stainless steel arc-welding electrodes

Functioning mainly as arc-stabilizer but also benefiting the slag and contributing to protection of the weld metal TITANOX-A ceramic grade, on account of physical and chemical uniformity, is well established as an invaluable constituent of these coatings. Depending upon formulation and equipment, TITANOX-A-WD, -A-LO and -A-MO are also used.

Floor Coverings

Linoleum

The high tinting strength of rutile titanium dioxide—TITANOX-RA—is preferred for its ability to regulate color by overcoming the darkness of linoleum cement, wood floor and cork.

Felt base-print paints

TITANOX-RCHT or -RCHTX provide adequate hiding economically for the finish paints along with proper consistency and clear bright tints.

Asphaltic or composition tile

On account of unusually high tinting strength to overcome dark color of the binder—TITANOX-RA—rutile titanium dioxide is usually preferred.

Rubber tile

TITANOX-RA or TITANOX-RCHT depending upon formulation.

Plastic types

Depending upon color and physical properties—TITANOX-RA—for greatest brightening and opacifying at lowest loading. Higher loadings or tints—TITANOX-RCHT.

Coated Fabrics

Artificial Leather—pyroxylin and plastic types

For maximum whiteness anatase titanium dioxide—TITANOX-A-168 or -A regular, preferred but for increased hiding—TITANOX-RA. For many requirements—TITANOX-RCHTX is providing highly acceptable color and texture economically.

Oil cloth and shade cloth, wall coverings

TITANOX-RCHTX on account of high bulking and high hiding can be used most economically to replace lower hiding pigments. Any degree of hiding and translucency where needed is most economically attainable with this pigment.

Leather

Addition of pigment before or during fat-liquoring—drumming in

Some operators prefer TITANOX-A-168 or TITANOX-RA feeling that these pigments have greater adhesion to the skin. However, other types may be used, especially TITANOX-A-WD and regular TITANOX-A. The pigment may be added directly as

such or in the form of pigmented emulsion paste. Because of the need for maximum whitening and brightening with a minimum amount of pigment titanium dioxide is preferred to the composite pigments.

Tanners' leather finishes—water and organic vehicle types

TITANOX-A-168-LO or TITANOX-RA preferred generally for organic types—A-168-LO for maximum whiteness. The composite pigments formerly TITANOX-B-30 to a large extent, but now TITANOX-RCHTX are called upon where thicker coatings and higher pigmentation are required in organic types.

In the water types—TITANOX-A-MO or TITANOX-A-WD are used extensively. TITANOX-B-30 also applicable to finishes for the rougher leathers or where prominence of grain is not a factor.

Shoe linings, etc., and utility finishes—sole paints, etc.

TITANOX-A regular or TITANOX-RA finding use, but in many articles such as linings where extended pigment provides ample tinting strength—TITANOX-RCHTX is in great favor.

Textile Delustring and Finishing

Internal delustring of rayon

Viscose TITANOX-A-MO on account of uniformity of fine particle size is preferred. Acetate—TITANOX-AA or TITANOX-A-24 not only for delustring effect but also to lend stability to the dyed filament.

External delustring of rayon

TITANOX-A-MO or TITANOX-A-WD are suitable for the aqueous dispersions. Where weight is also desired TITANOX-B-30 and TITANOX-B-30-WD have been used.

Printing

In the aqueous types—TITANOX-A-MO, -RA-10, -A-WD, -B-30, but in lacquer and organic types TITANOX-A-LO has been preferred for its ease of

dispersion although TITANOX-RA may be advantageously employed. TITANOX-RCHTX also fits those compositions in which extender may be tolerated.

Stripping of dyes

Titanium sulphate cake containing total titanium as TiO_2 about 20% and total sulphate as H_2SO_4 about 50% is used as a starting material for the preparation of titanous sulphate stripper. The extremely high reducing power of titanous sulphate is responsible for its effective discharge of dyes on rayon and other fabrics, especially since it operates in an acidic bath.

Inks

All types of white and light colored inks

TITANOX-A-168 has been preferred not only because of ease of dispersion and high hiding but also promotion of color retention. In some cases TITANOX-A-168-MO is preferred for slightly higher consistency needed in some pastes. TITANOX-RA which combines higher hiding with the color retentive effect of TITANOX-A-168 is also coming into favor, although slightly yellower whites are obtained with -RA, and these may require additional toning.

In offset litho inks—TITANOX-A regular is usually avoided since this pigment does not exhibit the resistance to emulsification which characterizes TITANOX-A-168, -AA, and -RA.

Tin printing inks mentioned under PAINTS—industrial finishes—are natural products for high hiding rutile—TITANOX-RA or the old stand-by TITANOX-A-168-LO where maximum whiteness is needed.

Shoe Whiteners and Cleaners

Liquid white shoe dressings

TITANOX-A-MO or TITANOX-A-WD have been generally preferred for ease of dispersion and facility in formulation to yield all desirable properties.

Paste dressings

Although TITANOX-A-MO or TITANOX-A-WD will usually meet the requirements, TITANOX-B-30 or -B-30-WD may be employed inasmuch as extender can be tolerated at the high pigmentation.

Cosmetics

Face powders, rouge, and all other products governed by the FEDERAL FOOD, DRUG and COSMETICS ACT

Although titanium dioxide is the most effective white for these products the use of TITANOX pigment of any type is not recommended. Titanium dioxide specially purified to conform to the regulations of the above-mentioned act may be secured from certain suppliers to the cosmetic industry who carry this product.

Electronics

Ceramic dielectrics

TITANOX-A is the starting material for titania and titanates of ceramic bodies having extremely high dielectric constant and other desirable properties for use in condensers and other applications especially for high frequency work.

The TITANOX pigments may be part of the dielectric of organic type insulators whether used on wire or in condensers.

Electronic tubes

Metal to glass seals, coatings on filaments and grids depending upon the application may require titanium dioxide of the uniformity of TITANOX-A.

Chemical

Carbides for cutting tools

TITANOX-A-MO is a source of physically and chemically uniform titanium dioxide in the production of mixed carbides of titanium and tungsten. Efficient cutting tips for high speed tools are fabricated from these products.

Titanium tetrachloride and other titanium compounds

TITANOX-A because of physical and chemical uniformity is an economical source despite its cost for the manufacture of titanium tetrachloride which during the war was so important as a smoke screen.

The pigment because of purity eliminates the complex processes required for removal of iron and other elements which would have to be handled in source materials such as ilmenite and rutile.

As a convenient source of water solutions of titanium, water soluble titanium sulphate cake will be found useful. Inquiries about this product will be gladly answered.

Chrome Yellow Pigment Manufacture

Titanium sulphate cake soluble in water to yield solutions of about 10% TiO_2 and 25% H_2SO_4 is suitable for use as a modifying agent in the manufacture of lead chromate.

Building Materials

Asbestos-Cement shingles, siding and roofing

Slurried with water or added directly to the veneer coat, TITANOX-A-MO or the water dispersible type TITANOX-A-WD provide the desired whiteness and high reflection. Special coatings for these shingles may also utilize the rutile type pigments.

Roofing granules

TITANOX-A-MO or TITANOX-A-WD used extensively to brighten colors, particularly to overcome variation in the color of the natural mineral, through high hiding and high tinting strength.

Siding, imitation brick, etc.

TITANOX applicable as to roofing granules.

Insulation and construction board

TITANOX-RCHT as well as TITANOX-A-WD applicable to coatings for brightening and rendering uniform appearance.

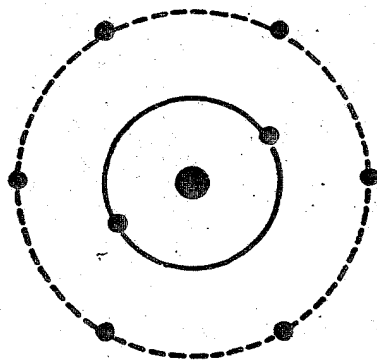
List of Uses

APPLICATION	TITANOX Preferred	APPLICATION	TITANOX Preferred
Acid resistant Ceramic Ware.....	A ceramic grade, A reg., -AWD	Latex	ALO, AWD, RAWD, RA10, RA
Acid and chemically resistant paints	B30, others may be used	Leather	
Aircraft Finishes	RANC, A24, RA, AA, RC	drumming	RA, RAWD, RA10, A168, A reg., AWD, B30
Alkyd resin enamels		finishes (tanner's)	RA10, RAWD, RA, A168, A reg., AWD, B30, A168
white	RA, A168	Linoleum	RA, RA10, A168, A reg., RCHTX, A24, AA
white, exterior	A24, RA, AA	Low cost House Paints (high durability—high hiding)	RC, RCHT
white and tinted exterior.....	RANC, A24, RA, RC	Marine paints	RANC, RA, A24, AA, B30, RCHT, RC
tinted exterior	RANC, RC, A24	tints	RANC, RC, A24
Architectural Enamels (interior).....	RCHTX, RA, RA10, A168	Mill whites—gloss and flat.....	RCHT, RCHTX, RA
Artificial Leather	RA, A168, RCHT-X	Oil Cloth	RCHTX, RCHT, RA, RA10, A reg., A168, B30
Artists' Colors—oil and water.....	RA, RA10, A168, AWD, RAWD, B30, B30WD, RCHTX	Painters' enamels and gloss paints.....	RCHTX, RCHT, RA
Asbestos-cement shingles, etc.....	A reg., AWD, RA10, RA, RAWD, B30, B30WD	Painters' paste and semi-paste paints.....	RA, RA10, RC, RCHT, B30, B30AA, AA
Asphalt base floor covering.....	RA, RA10	tint base	RC, RANC, A24
Automotive Finishes		Paper, coated and filled.....	AWD, RAWD, RA10, B30WD, B30, A reg., RCHT (coating)
white	A24, RANC, RA	Paper Board, coated and filled.....	AWD, RAWD, RA10, B30WD, B30, A reg., RCHT (coating)
white and tinted	A24, RANC, RA	Plastics	A168, RA, RA10, A reg.
tinted	RANC, A24, RC	Porcelain	A reg., A ceramic grade
Baking Enamels		Porch and deck paints tinted.....	RC, RANC, A24
white	A168, ALO, RA, RA10, AA	Primers, metal	B30, RA, AA, A24
white interior-exterior	A24, RA, AA, RANC	house paint	RC, B30, RA10, RA, A168, A reg., interior wall
white and tinted exterior.....	A24, RA, RANC		RCHT, RCHTX
tinted exterior	RANC, RC, A24	Rayon, delustering of	
Casoin and emulsion paints.....	RAWD, RA10, RA, AWD, A reg., B30, B30WD	internal, viscose	A reg.
Ceramics	A ceramic grade, -AWD, -A reg.	internal, acetate	A24, AA
Concrete and stucco paints		external	A reg., AWD, RAWD, RA10, B30, B30WD
white	A reg., RA10, B30, RCHT	Refrigerator Finishes	A168LO, RA
others	RC, RA, RANC, A24	primers	B30, B30AA, RA, AA, A24
Enamels	See alkyd resin and architectural enamels	Rubber	ALO, RA10, RCHTX
appliance	RA, A168	Semi-gloss interior paints	RCHT, RCHTX, RA
dipping	All grades	Shade cloth coatings.....	RCHT, RCHTX, RA
exterior white	A24, RC, RANC, RA, AA	Shoe cleaners, polishes and whiteners	A reg., AWD, RA10, RAWD, B30, B30WD
highest gloss	ALO, RCHTX, RA, RC, A168LO, RA10	Signs enamels—including lettering.....	RANC, RC, A24, RA
industrial	RA, others except WD types	Stencil paints—exterior	RC, RANC, A24
vitreous	A ceramic grade, AWD, A reg., others	Stipple paints	RCHT, RCHTX, RA
Enamel Undercoaters (architectural).....	RCHT, RCHTX	Synthetic resin vehicle coatings	
Exterior Tinted Finishes highest durability	RC, RANC	interior	RA, RCHTX, A168LO, RA10, ALO, AA
Felt base floor coverings—print paints	RCHTX	exterior	RANC, RC, A24
Flat Wall Paints	RCHT, RCHTX, RA	Textile printing	ALO, AWD, RA10, RA, A168LO, RCHTX
Flooring—asphalt, linoleum, rubber.....	RA, RA10, RCHTX, RC	Traffic paints	A reg., B30, RA10, RCHT, AA, RA
Floor Enamels	RC, all types except WD	Trim and Trellis paints—tinted.....	RC, RANC, A24
Gas resistant paints.....	All types	Venetian blind coatings.....	RA, A168LO, AA, A24, RCHTX, RC, RA10
Glue—white	A reg., AWD	Wall board coatings.....	AWD, A reg., RAWD, RA, RCHT, RA10
Highway and zoning paints.....	A reg., B30, RCHT, RA10, AA, RA	Wall primers and sealers.....	RCHT, RCHTX
Household Enamels	RA, RCHTX, RC, A168 A24, AA, RANC	Water base and emulsion paints.....	AWD, RAWD, RA10, A reg., RA, B30, B30WD, others
House paint primers	B30, RC, RA, RA10, A reg., A168, AA	Welding rod coatings.....	A ceramic grade, AWD, A reg.
House Paints—exterior white.....	A reg., A168, RA10, RCHT, B30, RA, AA		
exterior white and tint.....	RC, A24, RCHT, RANC, RA, AA		
exterior tint	RC, RANC		
Inks	RA, RA10, A168LO, ALO		
offset lithographic	RA, A168, AA		
Insulating and wall board coatings.....	RAWD, RA10, RA, AWD, A168, A24, AA, RCHTX		
Lacquer enamels	RA, A168LO, ALO, RA10, RCHTX		
exterior white	A24, RA, AA, RCHTX		
exterior white and tint.....	A24, RC, RANC		
exterior tint	RANC, RC, A24		

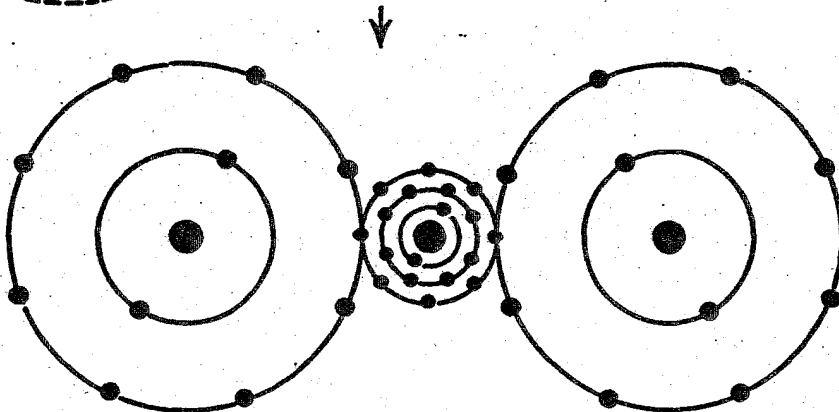
The circles and dots on the front cover represent the now familiar idealized illustrations of atomic structure. The large black dot in the center of each figure represents the nucleus which consists of protons and neutrons. The small red dots in the circles represent electrons numerically equal to the positively charged protons.



← represents an isolated atom of titanium (Ti). Notice it has a total of 22 red dots which represent 22 electrons. 4 of these are in the outermost circles shown in broken lines to indicate that these electrons take part in chemical reactions.



← The next two figures each represent an atom of oxygen. Here 8 electrons balance 8 positively charged protons, while the 6 outermost or valence electrons take part in chemical reactions. When two of these atoms of oxygen get together with one atom of titanium, the 4 outermost electrons of titanium are taken over by the 2 atoms of oxygen to form TiO_2 .



The broken lines are gone from this figure indicating stability. One of the most inert substances known—argon—holds its electrons as does Ti in TiO_2 , while the gas neon also highly inert is electronically like O in TiO_2 .

No wonder then that titanium dioxide is extremely stable both physically and chemically.



The Brightest Name in Titanium Pigments

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