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TINOX® Titanium Dioxide

for plastics & rubbers

TINOX

make colors bright

Tinox TiO_2 for plastic end uses

"TINOX® pigment performance meets economics"

Introduction

This booklet is your guide to the right selection of suitable titanium dioxide products for applications in plastics. The TINOX® guide contains a classification of TINOX® TiO_2 types, depending on the property and the usage.

Many years of experience in the production of TINOX® titanium dioxide has been used to develop different qualities which lead to a number of advantages in the application of plastics. High consistent standards and rigorous requirements for your specific application are achieved. The availability of TINOX® titanium dioxide pigments in some classes allows the use in plastics in a wide variety.

TINOX® titanium dioxide classification and overview

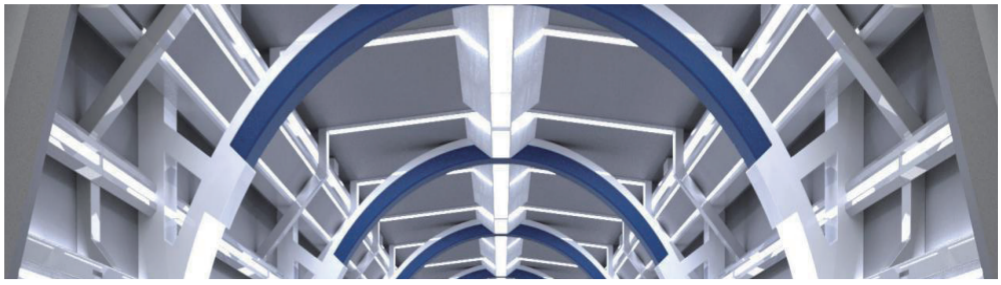
Tab 1.: Typical data of TINOX® pigment grades for plastics

Parameter	CR-1220	R-2240	R-2280	R-2290	R-2340	A-2380
Process	chloride	sulphate	sulphate	sulphate	sulphate	sulphate
TiO2 content [%]	≥ 96.0	≥ 96.0	≥ 98.0	≥ 94.0	≥ 94.0	≥ 98.5
Rutile content [%]	≥ 99.5	≥ 97.5	≥ 96.5	≥ 96.5	≥ 98.5	≤ 0.1
Post-treatment	Al, organic	Al, Zr, organic	Al, organic	Al, Si, organic	Al, Si, organic	none
Brightness CIE L in alkyd	98.3	97	98.2	98.2	97.1	98.1
Undertone CIE b in alkyd	2.2	3.3	1.9	1.9	3.6	1.6
Whiteness Index Berger	89.6	79.4	88.7	88.7	80	96.5
Yellow Index [YI-313]	2.6	5.4	2.5	2.5	5.3	0.4
Volatiles 160C°	≤ 0.5	≤0,7	≤0,3	≤0,3	≤ 1.1	≤ 0.7
rel. Humidity (105C°)	≤ 0.3	≤ 0.5	≤ 0.2	≤ 0.2	≤ 0.8	≤ 0.5
Oilabsorption [g/100g]	≤ 16	≤ 16	≤ 13	≤ 19	≤ 22	≤ 23
Dispersibility Hegman	≥ 7.0	≥ 7.0	≥ 7.0	≥ 7.0	≥ 7.0	≥ 5.0
Weatherability[1)]	B	C	B	D	D	A
ISO 591-1:2000	R2	R2	R1	R2	R2	A1
ASTM D476	II, IV	II, V	II	VII	II,IV	I

1) Internal weathering classification. A: none, B: good, C: strong D: excellent

TINOX® TiO_2 plastic grades

TINOX® titanium dioxide grades for plastics are specially designed for their use in various plastic applications.
These grades produce a high opacity and an undertone in the plastic matrix which is dependent of the selected grade from light yellowish over neutral to slightly blue undertone. Excellent dispersibility properties and strong temperature stability of the organic posttreatment are further important features of TINOX®TiO_2 grades.



Tinox TiO_2 for plastic end uses

“TINOX® adopt different combinations of treatments to ensure better results“

TINOX® micronized rutile qualities with suitable inorganic surface treatment suppress decomposition processes of the binder caused by UV-radiation and thus increase the durability of the plastic products in outdoor area.

Good powder flowability of TINOX® plastic grades ensure easy handling properties in fields of transport, stocking, bag emptying and powder dosing in process.

TINOX® CR-1220

TINOX® CR-1220 is a **chloride process rutile** pigment intended for use in plastics. It has an inorganic posttreatment, as well as an **organic posttreatment**. TINOX® CR-1220 has a **blue undertone** and excellent properties in **opacity**. The processability of this grade of pigment is characterized i.a. by **excellent dispersibility** in plastics, as well as by **strong weatherability** resistance due to zirconium post-treatment. TINOX® CR-1220 is used in a variety of different plastics.

TINOX® R-2280

TINOX® R-2280 is a **sulphate process rutile** pigment intended for use in plastics. It has an inorganic posttreatment, as well as a very **hydrophobic organic posttreatment**. TINOX® R-2280 has a **blue undertone** and **excellent** properties in **opacity**. The processability of this type of pigment is characterized i.a. by **excellent dispersibility** in plastics, as well as by the **resistance at high temperatures**. TINOX® R-2280 is used in a variety of different plastics like **polyolefins** and **engineering plastics.**

TINOX® R-2290

TINOX® R-2290 is a **sulfate process rutile** pigment specially designed for the use in plastics. It has an inorganic posttreatment, as well as a very **hydrophobic organic posttreatment.** TINOX® R-2290 has a **blue undertone** and **excellent** properties in **opacity.** The **inorganic Silicium post-treatment** grants R-2290 **excellent weatherability** in plastics. Exceptional **low volatiles, resistance** at **high temperatures** and **excellent processability** are key features. TINOX® R-2290 is used in a variety of different plastics like **polyolefins** and **engineering plastics.**

TINOX® R-2340

TINOX® R-2340 is a **sulphate process rutile** pigment intended for use in plastics. It has an inorganic posttreatment, as well as an **organic posttreatment**. TINOX® R-2340 has a **neutral undertone** and **excellent** properties in **opacity**. The processability of this type of pigment is characterized i.a. by **strong dispersibility** in plastics, as well as by **strong weatherability** resistance due to **inorganic silica post-treatment**. TINOX® R-2340 is used in a variety of different plastics.

TINOX® R-2240

TINOX® R-2240 is a **sulphate process rutile** pigment intended for use in plastics and has an inorganic posttreatment with aluminum and zirconium as well as an organic posttreatment. TINOX® R-2240 shows **good tinting strength**, **good opacity** as well as **good dispersing properties** and **good processability.**

TINOX® A-2380

TINOX® A-2380 is a pure dry-milled **anatase** universal pigment from the sulfate process. This pigment is used in a wide range of applications in rubber, paper and ceramics, especially where **blue undertone** and **excellent whiteness** of anatase is desired.

Tinox TiO_2 for plastic end uses

"TINOX® R-2240 was designed for universal cost-effective plastics."

TINOX® TiO_2 plastic grades in process

Basic requirements for titanium dioxide, for production of high-quality plastic products, are met reliably by TINOX® TiO_2 plastic grades.

* Low humidity to provide excellent requirements in thermal extrusion process.
* Inorganic posttreatments for use in outdoor applications with color stability and strong chalking resistance.
* Organic posttreatments with strong affinity to various application matrices and strong resistance to higher process temperatures which leads to strong color stability.
* Strong dispersibility properties in various plastic species.
* Strong flowability properties to ensure material handling and feeding.

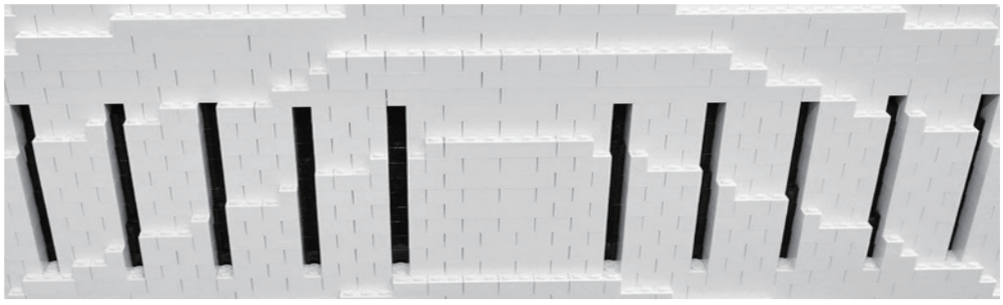
Control of the manufacturing process and the associated direct influence on the quality of the manufactured goods has the top priority at TINOX®. Consulting and analytical support of TINOX® customers with state-of-the-art analytical and test methods as well as support of our customers with methods, specially developed for TiO_2 pigment testing, are an integral part of our business process. The physical and chemical properties of TiO_2 pigment grades from TINOX® are continuously compared with those of global competitors. The data and information created in this way come specifically to our customers, e.g. within the scope of pigment consulting, and increase the opportunities for TINOX® pigment development.

Tab. 2: Application fields of TINOX® TiO_2-grades for plastics

Application	CR-1220	R-2280	R-2290	R-2240	R-2340	A-2380
Exterior	X		X	X	X	
Masterbatch	$X_{1)}$	$X_{1)}$	$X_{1)}$	X	X	
Polyethylene PE	X	X	X	X	X	
Polypropylene PP	X	X	X	X	X	
Polyvinylchloride PVC	X	X	X	X	$X_{2),3)}$	
Super thin film		X	X			
Acrylonitrile butadiene styrene copolymer ABS	X	X	X			
Polystyrene PS	X	X	X		X	
Polyurethane					X	
Rubber				X	X	X

X Strongly recommended X Advisable

1) High loaded Masterbatch, 2) PVC profile, 3) PVC piping



"The premium solution for high-end plastic uses"

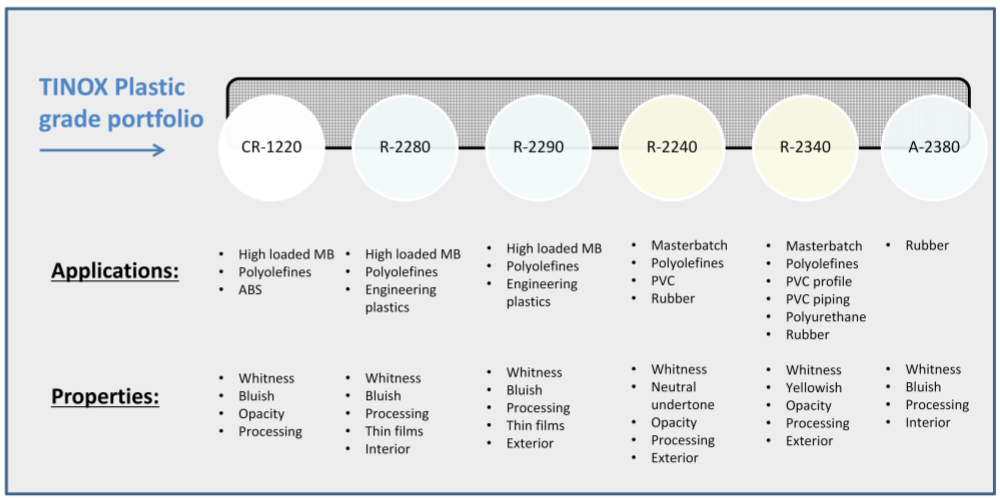
TINOX® TiO_2 application and pigment selection service

The use of a comprehensive technical laboratory for powder and dispersion and process analysis in Düsseldorf and the competence of our TiO_2 pigment specialists are the basis for continuous customer support. Existing networks and comparable application-relevant data on all important TiO_2 pigments from global manufacturers enable us to precisely classify our TiO_2 pigment products in the field of global competitors. We address gained knowledge according to your requests from a technical and economical perspective and recommend selected TiO2 pigments of our portfolio on technical grounds.

TINOX® plastic grade portfolio is well balanced for a wide range of customer requirements. In addition to the **premium grade CR-1220**, which is produced according to the **CP-process**, various SP grades are available.
Among these, the grades **R-2280** and **R-2290** are of particular importance as they are basically suitable **for replacing CP-grades**. This suitability results from the excellent blue undertone and the special superhydrophobic organic which leads to the best process capabilities and application possibilities also in engineering plastics.

R-2240 as a slightly yellowish grade with best opacity is suitable for applications where **economic aspects** prevail. With **R-2340**, a variant **post-treated with inorganic silicium** is available if the emphasis in the application is on **excellent weathering properties.** Anatase grade **A-2380 for rubber applications** rounds off the TINOX® plastic grade portfolio (Fig.1).

Fig. 1: Overview of the TINOX® TiO_2-pigment plastic grade portfolio.



"Advanced posttreatment technology optimizes the durability, and enables exterior applications"

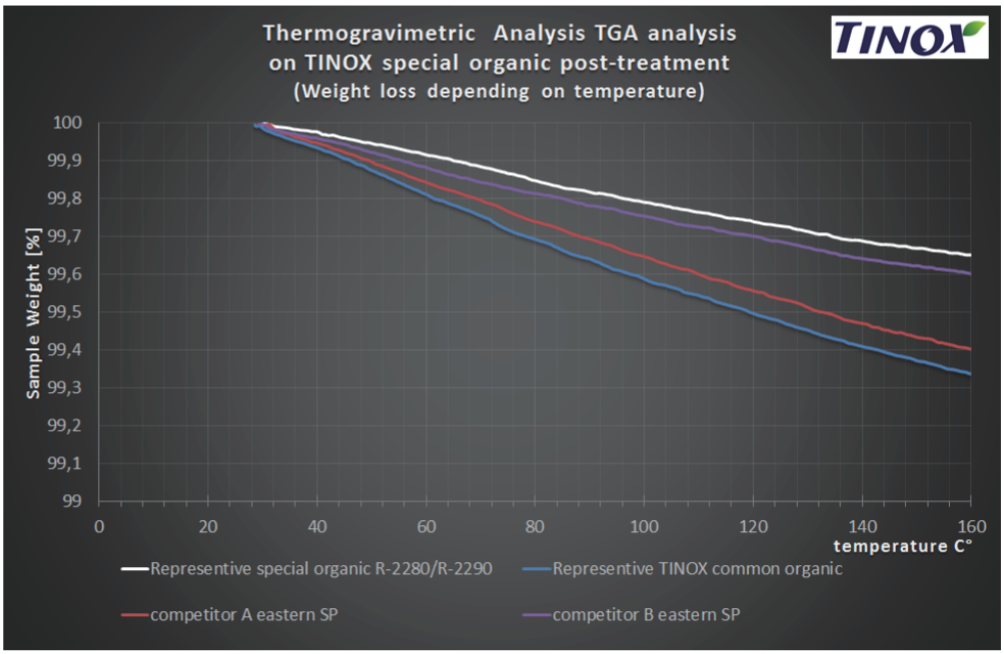
TINOX® TiO_2 volatiles and organic temperature resistance

In the production of plastics, the organic post-treatment in particular is exposed to temperature stresses. Therefore, organic coatings of TINOX® pigments are designed and investigated to meet the requirements of customer applications. The thermogravimetric analyses TGA show the loss of mass of the TINOX® TiO_2 pigment grades at elevated temperatures as they occur in processing operations. The differential thermal analyses DTA show the energy turn- over during the defined heating of the sample and are an indicator of the required amount of thermal energy consumed by the applied organic during the artificially generated melting process.

Weight loss with temperature stress:

Top grade TINOX® R-2280 with special designed super-hydrophobic organic showed the lowest weight loss with increasing temperature stress compared to TINOX® economic grade R-2240, as well as to showed eastern competitor pigments (Fig.2).

Fig. 2: Weight loss in function of process temperatures.



TINOX TITANIUM DIOXIDE

ENPOWER

FUTURE PLASTIC

WITH BETTER WHITE.

"TINOX® acts responsibly in economic, ecological as well as socia terms on behalf of future generations."

Specific thermal energy consume:

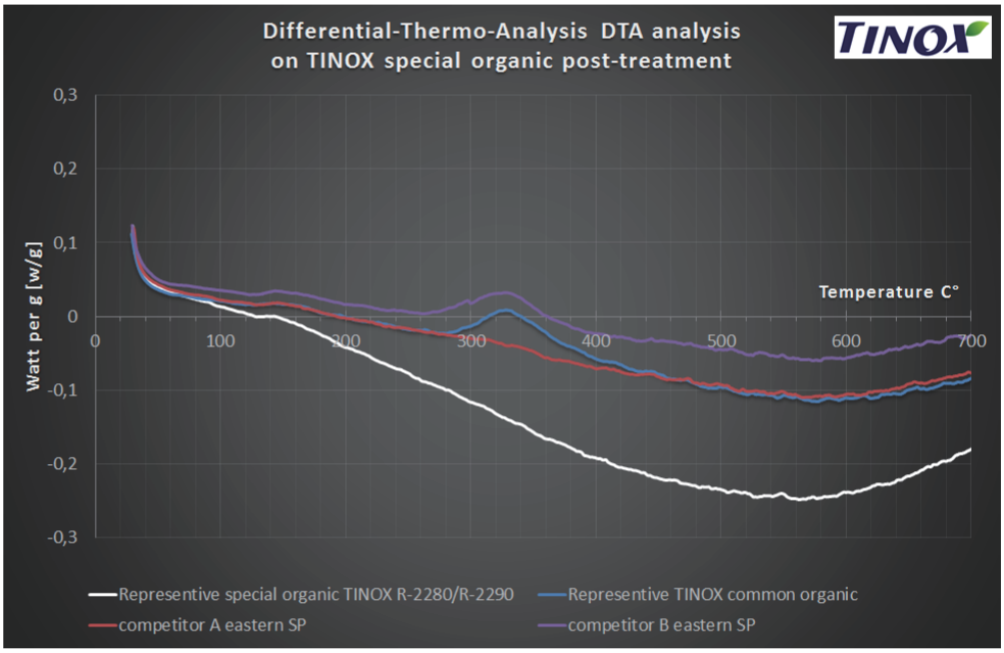
The melting process of the organics applied to the TiO_2-pigment particles takes place over a wider temperature range.

The amount of thermal energy required for the melting process of the organics correlates positively with the temperature resistance of the organics in the technical process.

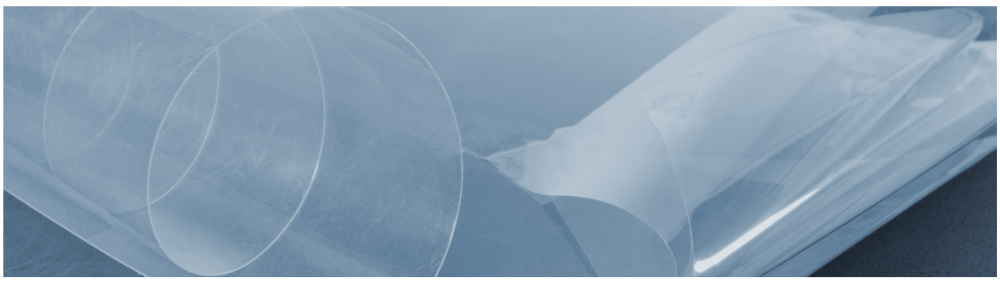
In this respect, the TINOX® pigments with the typical organic post-treatment substance such as R-2240 (economic grade) are on the same level as many similarly organically post-treated competitor grades from western and eastern TiO_2-pigment manufacturers.

The top SP-grades TINOX® R-2280 and R-2290 with a specially developed superhydrophobic organic are showing the highest energy consumption under artificially generated thermal stress (Fig.3 white). This means that significantly more thermal energy is required to melt this special organic post-treatment substance, which is in line with the excellent temperature resistance of R-2280.

Fig.3: Differential-Thermo-Analysis DTA analysis on TINOX special organic post-treatment



Specific thermal energy consume of TINOX® R-2280/R-2290 with superhydrophobic temperature resistant organic in unit [W/g] shows, that significant more thermal energy is required to melt R-2280/R-2290 organic in these artificially generated process.



"The premium solution for high-end plastic uses"

TINOX® TiO_2 phase crystallinity

Crystal structure analysis of TINOX® TiO_2 plastic grades shows that rutile crystal structure is in pure form. The traces of anatase modifications are common for TiO_2 pigments produced by the sulfate route, and are closely controlled by this method. TINOX® CR-1220 is a CP-grade in TINOX® portfolio. It has pure rutile content, therefore no anatase traces are detectable (Fig 4-9).

Fig.4: Tinox® CR-1220 powder diffractogram (Mo radiation)

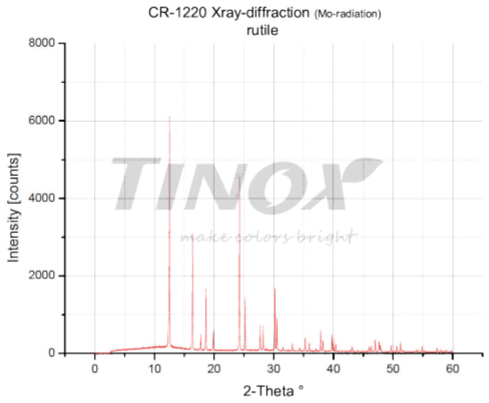


Fig.5: Tinox® R-2280 powder diffractogram (Mo radiation)

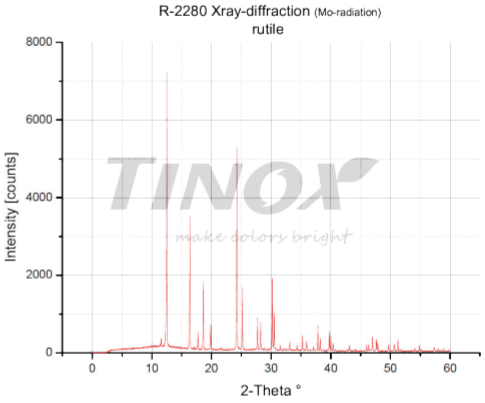


Fig.6: Tinox® R-2290 powder diffractogram (Mo radiation)

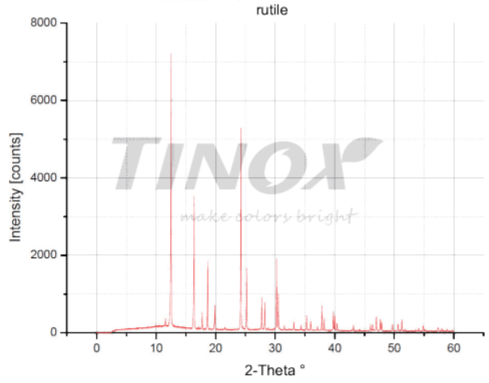


Fig.7: Tinox® R-2240 powder diffractogram (Mo radiation)

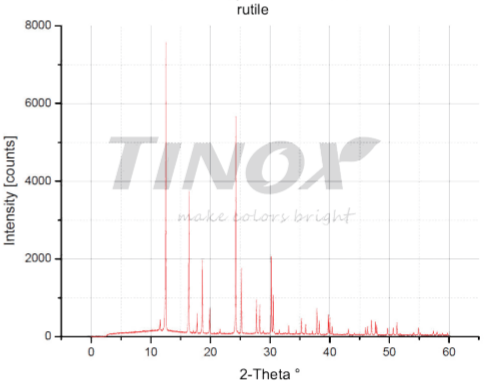


Fig.8: Tinox® R-2340 powder diffractogram (Mo radiation)

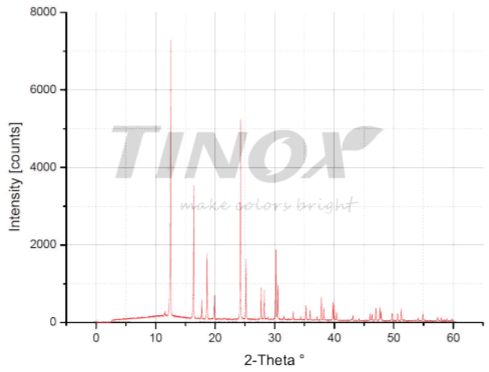
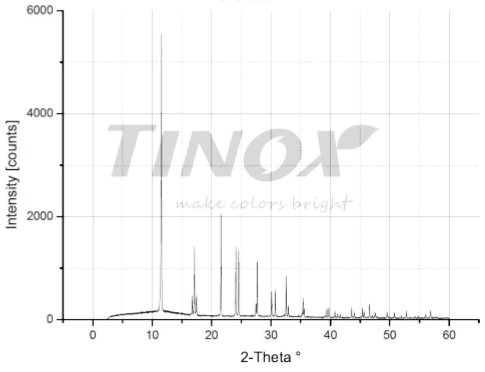
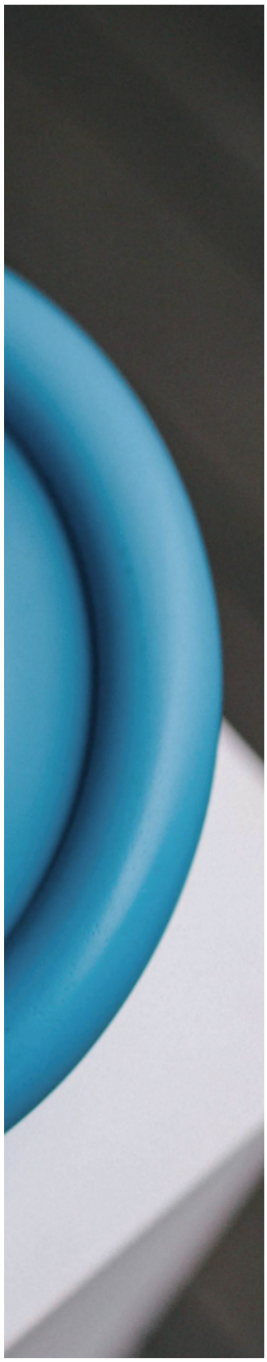


Fig.9: Tinox® A-2380 powder diffractogram (Mo radiation)



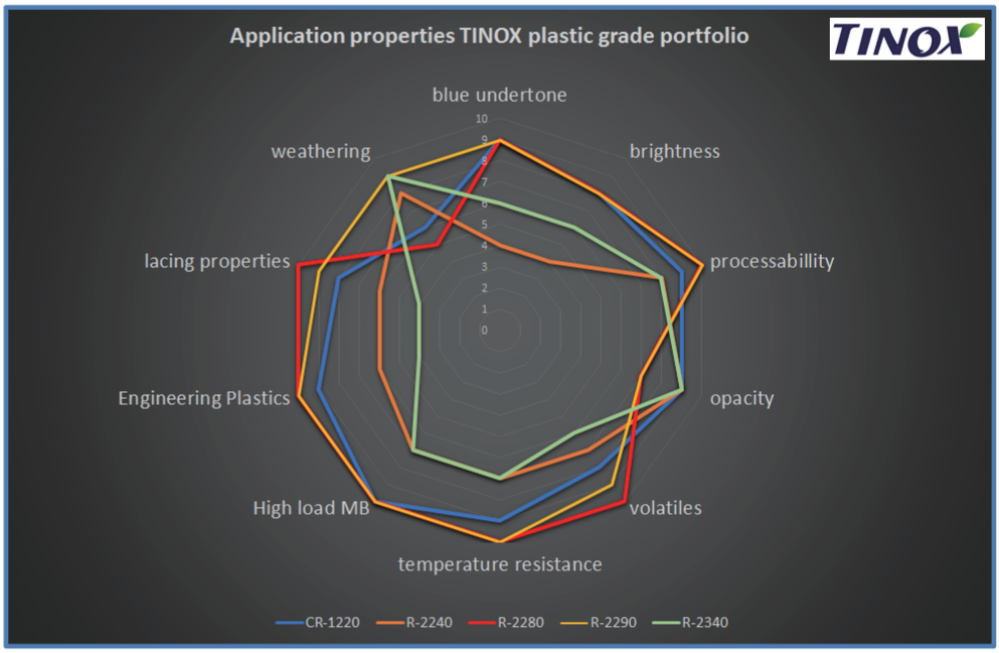
"Strong performance in main plastic fields."



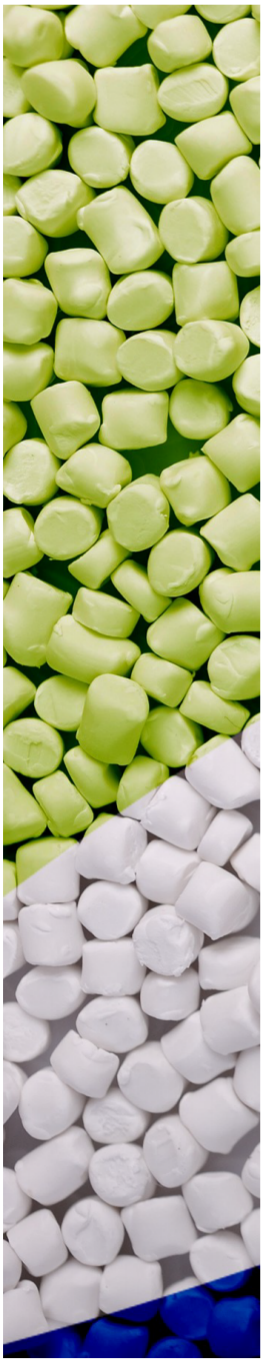
TINOX® TiO_2 application properties

Application properties
Important application properties of TINOX® plastic grades are summarized in figure 10.
TINOX® TiO_2 plastic grades show strong performance in main fields. The performance meets the pigment class graduation in particular, from TOP grades CR-1120, R-2280 and R-2290 to economic grade R-2240 and R-2340 which shows also stable and good application properties.

Fig.10 : Application properties TINOX® TiO_2 plastic grades.



"TINOX® TiO_2 is not classified as hazardous to human health or the environment."



TINOX® TiO_2 Safety, Quality and Packaging

Safety, health and the environment

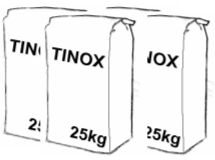
TINOX® Titanium Dioxide is stable under normal conditions and inert to most chemical substances. Titanium dioxide is generally not classified as hazardous to human health or the environment, and is also a non-hazardous substance for transportation. In dealing with TINOX® dust is possible. In the case of long-term exposure of TiO2 dust suitable dust respiratory carrier should be used. All requirements of REACH-EC-Regulation 1907/2006 are fulfilled. There is a safety data sheet for TINOX®.
TINOX® Titanium Dioxide pigments comply with the regulatory requirements on food contact materials or articles placed on the market. Therefore, our products are acceptable for the use in plastic materials coming into contact with food. Please contact us for any specific question on certain regulations.

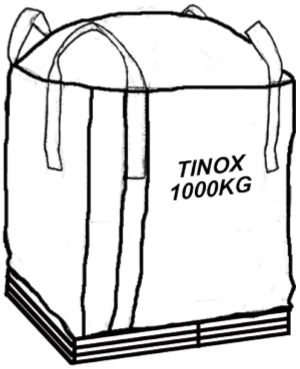
Quality

The production and distribution of TINOX® Titanium Dioxide takes place within the framework of the certified quality management system ISO 9001, as well as the ISO 14001-certified environmental management system and the OHSAS 18001.

Package

TINOX® TiO2 pigments are packed as bagged goods with 25 kg net weight or in big bags for 1000 kg net. TINOX® is supplied on disposable wooden pallet (each pallet 1 ton), pallets are covered with polyethylene shrink film. Special packaging and labels can be arranged on request.





This leaflet is ageneral guide to the properties and fields of potential application of TINOX® Titanium Dioxide Pigments.The informationabout the application is given in good faith and does not constitute a guarantee. For a specific grade selection, please contact the technical service at Tinox Chemie GmbH. Material Safety Data Sheet and further information on products and companies are available on request. The control of the quality of the pigments is guaranteed in all production steps.

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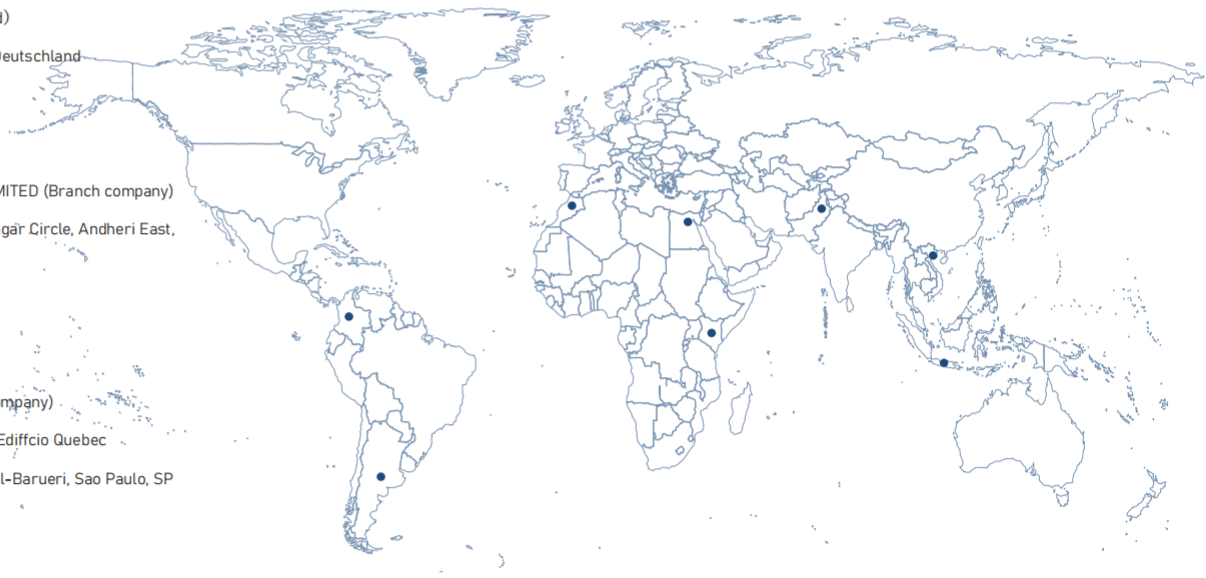

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