BDI

Position

BDI position on the proposal for harmonised classification of titanium dioxide

Bundesverband der Deutschen Industrie e. V.

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Background

Further to a proposal by the French authority ANSES for harmonised classification of titanium dioxide (TiO_2; EC 236-675-5; CAS 13463-67-7) as probably carcinogenic to humans (category 1B), the competent Committee for Risk Assessment (RAC) of the European Chemicals Agency (ECHA) discussed the proposal for harmonised classification and published the following classification proposal on 12 October 2017:
Suspected carcinogenicity (category 2, on inhalation), labelling with pictogram GHS08 (health risk), signal word "warning" and hazard statement H351 "suspected of causing cancer".
At the meeting of the competent authorities of EU Member States CARACAL (Competent Authorities for REACH and CLP) on 15-16 November 2017, several Member States lodged reservations against the classification and indicated a need for further deliberations.
In this position paper, BDI sets out its stance on the proposal for harmonised classification and labelling of titanium dioxide.

Executive Summary

Classification of titanium dioxide as suspected of causing cancer (category 2, on inhalation) is not justified!

Rationale: Titanium dioxide does not exhibit any hazardous properties intrinsic to the substance, it is a non-hazardous solid. All substitutes exhibit either the same or more critical properties. Hence, substitution with other substances would not lead to any risk reduction; rather, it would pose additional risks in most cases. The assessment is difficult to understand from a toxicological standpoint, leads to great uncertainty among users and has far-reaching consequences for trade and industry. The legal effects associated with classification are very serious and entail considerable disadvantages for end users, industry and traders.

The current discussions on titanium dioxide demonstrate in a striking manner that the classification criteria urgently need to be adapted to reflect modern scientific criteria.

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A Assessment of the classification proposal

In the eyes of German industry, classification as carcinogenic in a category within the meaning of the CLP regulation is neither justified nor appropriate. In addition, such a classification entails serious negative consequences without delivering any benefit. This overall assessment is based on the following considerations:

Toxicological starting point and transposability of animal studies

A possible link between exposure to titanium dioxide and lung cancer was examined in various major epidemiological studies (cohort studies and case control studies on employees involved in titanium dioxide production). In none of the relevant studies could a link be established between exposure to titanium dioxide and lung tumours. Titanium dioxide has been used safely for decades, no health risks to humans are known from practical experience.

The proposal for classification in the CLH report is built essentially around studies on rats exposed to extremely high concentrations of titanium dioxide particles which led to so-called “lung overload” effects. The particle concentrations used in the tests[1] were up to 200 times greater than the workplace limit value applicable in Germany for breathable particles (alveolar dust) or did not meet the requirements placed on a regulatory guideline study.

All relevant guidelines from ECHA, OECD and ECETOC establish unanimously that results from “lung overload” studies on rats should not be transposed to humans since the relevance for humans is not given. By comparison with all other species examined, rats are particularly sensitive to inhalation toxicity through insoluble particles[1]: only in rats have tumours in the respiratory tract been identified with insoluble particles. Other animal species such as mice or hamsters did not develop lung tumours on comparable exposure. From a toxicological standpoint and taking into consideration of the criteria in the ECHA guideline, classification as carcinogenic is therefore not justified.

Exposure situation and protection through existing statutory rules

The effect of titanium dioxide under examination is based on particle-related inflammation processes following exposure to and inhalation of high concentrations of dust triggered by an overload on physiological lung clearance processes which occurs under such conditions. This is not substance-specific for titanium dioxide but is characteristic for highly insoluble substances (bioresistant granular dust) irrespective of the underlying substance.

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[1] Relevance of the rat lung tumor response to particle overload for human risk assessment—Update and interpretation of new data since ILSI 2000; D.B. Warheit, R. Kreiling, L.S. Levy

For the classification of carcinogenic substances, the CLP regulation – like the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) on which it is based – requires the existence of an intrinsic property (CLP regulation, annex I, 3.6.2.2.1, GHS 1.1.3.1.1). RAC did not establish a substance-specific toxicity. Accordingly, a decisive condition for inclusion in annex VI of CLP on harmonised classification is not met.

RAC's position paper does **not** start from the hypothesis that titanium dioxide has an "intrinsic" toxicity but advances a general particle property. The property was assumed for the entire group of PSLT (poorly soluble low toxicity particles). On the basis of this position, this would mean that all PSLT would have to be evaluated and treated the same way. Such an approach makes no sense either from the angle of health protection or within the meaning of the CLP regulation but leads to wide over-labelling and, as a result, to a downgrading of risk labelling.

Protection against dust and general particle effects is primarily a matter of health and safety at the workplace. There are therefore corresponding dust limit values in Germany and other EU Member States in order to protect against particle-related lung inflammation processes caused by exposure to and inhalation of dust. The German general dust limit value (German abbreviation ASGW) is intended to prevent a deterioration in the functioning of respiratory organs caused by a general dust effect and applies for all poorly soluble or insoluble particles. At European level, exposure to dust could be regulated in a harmonised way via directive 98/24/EC on protection of the health and safety of workers.

Automatic legal effects and consequences of the proposed classification

In many statutory regimes such as plant safety, environmental and consumer protection, or in special legislation on toys, food contact materials or cosmetics, extensive obligations as well as wide-ranging bans and restrictions arise through classification and labelling as carcinogenic in category 2, automatically and without further verification as to whether use of the substance actually poses risks. For instance, toys containing titanium dioxide would be banned under the EU directive on the safety of toys. Classification in category 2 as "suspected of causing cancer" would also have wide-ranging consequences for the labelling of mixtures. Affected products would have to be labelled with the warning "suspected of causing cancer", which would result in considerable uneasiness.

As already called for in BDI's general position on how to deal with classifications and their legal effects[2], classification decisions must not lead to a creeping shrinkage in the base of materials available to German industry. Inasmuch, the classification and its consequences must not be considered in isolation. The automatic knock-on legal effects in other areas must always be evaluated in the overall context and, where necessary, at

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[2] BDI draft final: Position setting out principles for addressing classifications and their legal effects; version 9 January 2015

least temporarily decoupled so that holistic risk-oriented considerations can be elaborated in a differentiated way. It follows from this that an inventory of available use cases with evaluation of the specific risk must be carried out first.

Industry takes a critical stance in particular on the following consequences and automatic legal effects associated with the proposed classification of titanium dioxide:

- **Waste legislation:**

  Classification of waste in European waste legislation is based on EU chemical legislation. The hazardous properties of waste (so-called “HP criteria”) were aligned on GHS at the end of 2014. The HP criteria stipulate the point from which the property of hazardous waste obtains. The principles for waste classification are set out in the EU waste framework directive (2008/98/EU) and in the European waste catalogue. If a waste contains a substance suspected of causing cancer (category 2) at a concentration of ≥ 1.0%, the waste has to be classified as hazardous in accordance with HP 7. As a consequence of this, essentially all wastes which contain titanium dioxide at a concentration of more than 1% would have to be classified as hazardous and processed accordingly. These wastes could range from plastics, building materials, wallpapers, paint remnants, speciality papers, porcelain crockery and topsoil (depending on geology) through to imported coal or furniture. Exceptions would be possible only if the wastes in question is unreservedly assigned to a waste heading not marked with an asterisk to which, in turn, no corresponding “mirror entry” of a waste heading marked with an asterisk is assigned (“absolute classification”).

  The associated obligations arising automatically for processing such waste classified as hazardous would go hand in hand with numerous complications and additional burdens for companies and end users, e.g. plant permits in accordance with the 4^{th} decree on implementation of the federal emission protection law (4. BImSchV), requirements under the decree on provision of proof with substantial documentation obligations or notification and release obligations under sub-federal legislation as well as requirements on cross-border transport. By contrast with the CLP regulation, broadly speaking no provision is made for derogations in the HP criteria for waste legislation. It is also questionable whether recycling of these wastes would still be possible or even sensible, since markets for the recycled material will also change as a result of classification. Household or local separate collection of recyclable materials as occurs in the German “dual system” would no longer be possible in its current form and it would also no longer be possible to meet the quotas established nationally (in the packaging law) and at European level (in the circular economy package).

- **Disappearance of important quality indicators for consumers**
  Ecolabels such as Blauer Engel may not be issued for many products containing substances suspected of causing cancer (category 2). The same applies for the EU ecolabel and for Nordic Swan. As a result, important quality indicators for consumers would disappear.

- **EU toys directive**
  Toys are also affected by a classification of titanium dioxide. Substances classified as suspected of causing cancer in category 2 are banned in toys and toy components, and placing them on the market is restricted under the provisions of the toys directive (2009/48/EC). For example, wooden toys, plastic toys with printed stickers or paint boxes with titanium dioxide components would no longer be allowed.

- **Air quality standards (TA Luft)**
  Point 5.2.2 of TA Luft establishes a direct link between classification of a substance in accordance with the CLP regulation and limits on emissions to air which are not based on the provisions of the IED directive or other European requirements. This linkage can lead to disproportionate retrofitting requirements on industrial plant.

- **Classification and labelling of mixtures**
  At a concentration above 1.0%, classification in category 2 leads to labelling of mixtures with the hazard symbol GHS08 “health hazard” and the hazard statement H351 – “suspected of causing cancer” (category 2, on inhalation). This classification and labelling leads to great uneasiness in the downstream legal areas without taking into account that there is no real health risk either for employees and private end users or a threat to the environment. It can be assumed that acceptance of a substance “suspected of causing cancer” is not a given in consumer products. It is therefore highly probable that consumers will avoid products labelled as such even though there is no danger. Classification of titanium dioxide leads to over-labelling and, as a result, to consumer rejection. An evaluation of the real risks by the user is no longer possible and this leads to a downgrading of risk labelling and the CLP regulation.

- **Use of titanium dioxide as a negative control in studies**
  Titanium dioxide has been used as a negative control in many inhalation tests in order to assess a range of substances. As a rule, these tests have been used in REACH dossiers. Classification of titanium dioxide would lead to all relevant animal tests having to be repeated with other control substances. However, since the effect is particle-related rather than toxicological, as already described, corresponding control substances would not be available. Accordingly, the dossiers in question would be worthless de facto.

Conclusion

The proposal presented for classification and labelling of titanium dioxide is inappropriate from a toxicological and epidemiological standpoint, the criteria for classification are not met. All in all, the legal conditions for harmonised classification do not obtain.

Existing health and safety legislation regulates protection against dust and particle-related effects not caused by specific substances. Classification would not contribute to an improvement in protection of health and environment but would have serious and disproportionally problematic effects in almost all legal areas, could additionally bring a deterioration in health and safety at work in its wake and would lead to a downgrading of risk labelling and the CLP regulation through over-labelling. Were the Commission to take a decision in this direction, it should be legally challenged. Affected companies should reserve the right to seek legal remedies and, where appropriate, claims for damages.

In future, an obligatory risk assessment and impact assessment should be carried out prior to a proposal for a harmonised classification, involving manufacturers, importers and users. If no additional measures are necessary for consumers, employees and environment, work on the substance should be halted. If a risk is identified in partial areas, the areas in which there is no risk and no additional measures are needed should be excluded with a view to proportionality. This would ensure that the reference rues would not result in any automatic and disproportionate restrictions and/or bans. The automatic and disproportionate legal effects of classification of substances urgently need to be corrected. Classification decisions must not lead to the disappearance of established substances which are used safely. Since it is evident that the current criteria for classification of substances lead to flawed classifications, the latter must be urgently reviewed and adapted to reflect modern scientific knowledge. Industry as well as all relevant stakeholders should be brought into this process in timely fashion in order to ensure a transparent review of the criteria.

B Importance of titanium dioxide in various industrial sectors and socio-economic consequences of the proposed classification

Thanks to its excellent properties without a hazardous intrinsic property, titanium dioxide is an all-round raw material in almost all industrial sectors. Titanium dioxide is widely used, predominantly as a white pigment and as a (photocatalytic) coating.

In Germany, primarily pigmentary titanium dioxide is manufactured at five locations with a total capacity of around 480,000 tonnes. This means that Germany is the third largest production country worldwide, behind the USA and China.

Lacquer, paint and printing ink industry

Manufacturers of paints, lacquers and printing inks are major customers for titanium dioxide with a share of 57%. White pigment is far and away the most important raw material for this industry and is used with a share of up to 55%, for instance in paints or lacquers. Titanium dioxide is used above all because of its light resistance, high refraction index and high diffusion capacity. In coloristic terms, it has the highest opacity of all white pigments together with an excellent lightening power as compared with coloured media. In addition, titanium dioxide is heat-stable, non-flammable, almost insoluble in water as well as resistant to weather and ultraviolet rays. Of the 2,328 colour shades in the RAL system, just 119 (5%) are produced without titanium dioxide. Hardly any alternatives to titanium dioxide are available for lacquers, paints and printing inks because other raw materials are usually of poorer quality, not accessible in the required volume and additionally often ecologically and toxicologically questionable. Titanium dioxide is added to paints as a pigment and is then firmly incorporated in the binder matrix. Therefore, titanium dioxide does not constitute any danger to humans in paints and lacquers, either at the workplace or in the use of products containing titanium dioxide.

Classification as carcinogenic (category 2) can be expected to lead to considerable uneasiness among consumers and reticence with regard to purchasing. Classification as carcinogenic (category 2) would have the consequence that paint remnants and building rubble containing titanium dioxide would have to be processed as hazardous waste. To take just one example, costs for processing containers used commercially (e.g. by painters) would increase from 10 million Euro today to 200 million Euro. Ecolabels such as “Blauer Engel” can no longer be issued in the event of classification. The consequences for the award of ecolabels for printed products are currently almost inestimable.

Around 25,000 people are employed in the lacquer and printing ink industry. Many of these jobs, especially in small and medium-sized enterprises (SMEs), would be massively under threat if titanium dioxide were to be classified as carcinogenic, because most companies do not have their own research and development departments which could undertake such a comprehensive formula change.

Importance of titanium dioxide for the paper industry

Titanium dioxide has been used as a safe and indispensable white pigment in paper, pulp and cardboard manufacture for many decades. Titanium dioxide plays a special role in the production of so-called decorative papers. These are impregnable speciality papers which serve as the basis for the manufacture of decorative surfaces for modern furniture and floor coverings. Thanks to its excellent optical and technological properties, the share of titanium dioxide in decorative papers can be up to 40%. Substitution with other raw materials has not yet proved possible and is also still unforeseeable despite decades of efforts.

Around 14% of the annual titanium dioxide demand (1.2 million tonnes) is needed for the manufacture of decorative papers. The production capacities for decorative papers in Germany are around 400,000 tonnes a year and therefore corresponds to just under 30% of world production. In this segment, 2,000 workers generate around 800 million Euro a year. The value of the decorative surfaces produced with these decorative papers across Europe is estimated at around 15 billion Euro a year.

Plastics industry

The main areas where titanium dioxide is used in the manufacture of plastics are coatings, followed by plastic dyes and laminated papers. In plastic processing, titanium dioxide is used as a stabiliser, opacifier or component of colour pigments – mostly after the step of plastic production in the compounding or when plastic goods are being processed. Titanium dioxide has asserted itself as the leading white pigment. Its interaction with light makes it noteworthy for light scattering which leads to opacity or as absorption of the energy from ultraviolet light in order to protect polymers against degradation through ultraviolet light. Through classification of titanium dioxide, a very high share of dyed plastics would become hazardous waste with corresponding consequences for their reputation in the public mind and problems with waste treatment and recycling.

Manufacture of pigments, pigment preparations, ceramic dyes and master batches

Titanium dioxide occupies a prominent position as a raw material in the area of pigments and pigment preparations. It is used for synthesis of important inorganic coloured pigments. In this context, titanium dioxide is completely converted during the manufacturing process and is the indispensable basis as a structural component in the process for producing these coloured pigments. Thanks to its excellent opacity, titanium dioxide is used as the most important white pigment in other pigments, ceramic dyes, pigment preparations and master batches for the subsequent dyeing of plastics and paints for artists and students. Depending on the application, the content of titanium dioxide in pigment preparations range from 1 to almost 100%, in ceramic dyes from 5 to 60% and in master batches from 0.1 to 80%.

Titanium dioxide is extremely resistant to light and therefore has the highest opacity of all white pigments in coloristic terms. Given these excellent material properties of titanium dioxide in combination with health, safety and ecological properties, none of the alternatives is anywhere near as useful.

Natural raw materials and ceramics industry

Titanium is the ninth most common element in the earth’s crust at a percentage of 0.6 by mass. Numerous mineral stone and earth raw materials contain geogenous titanium dioxide, often in magnitudes of up to several percentage points by mass, e.g. clay or kaolin. Titanium content has its origin in igneous rock compounded with ore minerals such as rutile (TiO2), ilmenite (FeTiO3) and ulvite (TiFe2O4) on the one hand and rock-forming minerals such as amphibole, pyroxene and biotite on the other hand. As a chemically resistant and abrasion-proof mineral, rutile can be carried over long distances and deposited in sedimentary rock, e.g. clays. By contrast, rock-forming minerals weather and the released elements in this process form new mineral phases. The new mineral phase anatase (TiO2) then dominates in sediments such as clays. Hence, the titanium dioxide content in weathered earths can be up to more than 1% by mass, and in titanium-rich rock can rise to 10% by mass or more. For instance, this can mean for clay deposits that geogenous titanium dioxide content occurs in magnitudes of up to 4.5% by mass, compounded in the minerals rutile and anatase.

Hence, classification of titanium dioxide would have wide-ranging consequences for the extractive and ceramics industries. Ceramic raw materials are a cornerstone of industrial production and it is no longer possible to imagine products made with them being absent from our everyday lives.

Most products of the ceramics industry manufactured using natural raw materials have a TiO2 content of over 1% by mass. In other words, the ceramic material of which the products consist would be classified as carcinogenic. This can lead to acceptance problems among consumers, in particular for products which come into contact with foodstuffs, i.e. crockery. In the case of glazed porcelains, titanium dioxide is found not only as a component in the raw material but is consciously added to glazes in order to increase opacity or to achieve a certain colour. The colour range for decorations on porcelain would be severely restricted without titanium dioxide (see above). Similarly, ceramic implants (e.g. artificial hips) contain a share of titanium dioxide which clearly exceeds 1%.

Alternatives to clay-based natural raw materials are hardly available in practice; ceramic products would have to be processed predominantly as hazardous waste if TiO2 is classified as intended.

Building materials industry: manufacture of construction products and chemical construction products

Titanium dioxide is an indispensable ingredient in the manufacture of construction products or chemical construction products, e.g. for the formulation of pigmented coatings, fillers, mineral plasters and pastes, grouts, dry mortars sealants and other visible surface coatings. In the overwhelming number of use cases, titanium dioxide functions here as a white pigment. For special applications in the area of construction, titanium dioxide is sometimes also used as a photocatalytic material for removal of nitrogen oxides or organic compounds. Innovative construction materials use these effects to achieve self-cleaning surfaces or improvements in indoor air quality.

No alternative ingredients which exhibit comparable properties are currently known in the area of construction materials. The properties to be highlighted include in particular the high refraction index (high opacity) and the whiteness of titanium dioxide. In a historical context, titanium dioxide has replaced other white pigments such as white lead which, by contrast with titanium dioxide, attract greater criticism from a toxicological standpoint.

Steel industry

Titanium dioxide is used in various forms in the steel industry. In oxygen steel works, it is used in the form of rutile as an alloying agent alongside ferrotitanium. In addition, rutile is blown into the blasting furnace under certain conditions in order to ensure safe use. Use in a ladle furnace is also possible.

As a component of lacquers used to coat metal sheets, a titanium dioxide content of up to 50% can occur in wet lacquer and the concentration can be markedly higher once it is baked on. In addition, titanium dioxide can occur in various raw materials used in the steel industry such as coal and ore at a natural share of more than 1%. Rutile is also often a component in welding electrodes.

Glass industry

Titanium dioxide is used in the glass industry, both for the production of speciality glass and for flat glass. For the manufacture of speciality glass, titanium dioxide is added to the molten glass and deployed at a concentration of less than one and up to 30%. In this case of speciality glass, titanium dioxide was introduced deliberately following intensive research as a substitute for lead oxide. An example of a product made by the speciality glass industry with titanium dioxide is constituted by glass ceramics (Ceran hobs or Robax heating stove windows). In the case of flat glass production, it is used as a coating for all glass panes in the area of construction or in dyes.

There is currently no possibility to substitute titanium dioxide, since no other substance has the same positive properties in glass. Titanium dioxide has clear effects on the chemical and physical resistance of glass, on light refraction, ultraviolet absorption, on weight and thickness, crystallisation behaviour, expansion behaviour, mechanical resilience and on sunscreen properties as well as the good light performance, anti-reflective coating and energy efficiency for window glass in the construction and automotive sectors.

Catalysts in hot gas purification

Titanium dioxide in its anatase modification is widely used in SCR catalysts for hot gas purification (= selective catalytic reduction). Here, titanium dioxide is needed for selective catalytic reduction of nitrogen oxides (NOx) in hot gases (250 – 800°C).

Classification of titanium dioxide would have wide-ranging consequences for its use as a catalyst and hence for effective and economic reduction of nitrogen oxides in industrial processes and in motorised vehicles (diesel engines). It is therefore to be feared that classification would also have negative ecological consequences alongside economic consequences.

Manufacture of cosmetic products

Titanium dioxide is a significant component in the formulation of very many cosmetic products, e.g. skin protection and skincare products, sunscreens, toothpastes and decorative cosmetics. Titanium dioxide is expressly permitted as a colour pigment and ultraviolet filter in the framework of the EU cosmetics regulation. These permits are based on thorough risk assessments by the competent independent scientific EU committee SCCS (Scientific Committee on Consumer Safety). The nanoscale form of titanium dioxide is currently being re-evaluated especially for use as an ultraviolet filter in all toxicological end points. In any event, titanium dioxide is firmly fixed in all cosmetic formulations – typically in emulsions – so that specifically exposure by inhalation is generally not relevant for cosmetic products.

Titanium dioxide as an ultraviolet filter pigment is applied as a protective film on the uppermost skin layer and diffuses and absorbs the sun's ultraviolet rays. In this way, the skin is protected against ultraviolet radiation and its harmful health effects (sunburn, DNA damage, skin ageing, etc.). Through combination with other filter substances, particularly high light protection factors can be achieved. In addition, titanium dioxide stands out for its skin compatibility – intolerances or allergic reactions to titanium dioxide in cosmetics are almost unknown in practice.

Pharmaceutical industry

Titanium dioxide has been widely used in the pharmaceutical industry over many decades for the manufacture of medicines. Among other things, titanium dioxide is used as a white dye in tablet coatings and capsules (fixed dosage forms). In addition, it plays an important role in primary packaging which comes into direct contact with the medicine, e.g. to make blister packs opaque.

Use in medical products

Various medical products contain titanium dioxide as a pigment in bound form, e.g. in dental impression materials, dental filling material or dental laboratory materials and fixing cements. For all these dental materials, titanium dioxide delivers the best results for maintaining aesthetic colours, which means that aesthetic dental products can be produced even with a very low pigment concentration. Furthermore, titanium dioxide is present in various plastic parts in medical products or medical equipment. Colouring products white leads to dirt and other impurities being immediately visible on the one hand and to ultraviolet protection through light resistance on the other hand. Summarising, it can be said that titanium dioxide provides product stability as well as ensuring hygienic conditions. Although titanium dioxide has been used for decades not only in medicines and medical products, there are no known examples of side effects caused by the substance.

Textile and leather manufacture

Titanium dioxide plays an important role in the area of textile and leather manufacture. For instance, it is used as:

- Matting agent in chemical fibres, e.g. for white pigmentation of glass fibre webbing and polyester
- Component of dyes and coating products, e.g. for HGV and other tarpaulins, tents, gym mats, abrasive supports, construction products, bellows, decorating bags, technical textiles, sun protection (black-out, dim-out)/roller blinds/decorative materials
- Component of printing inks (e.g. inkjet, digital printing) and in pastes for pigment printing (e.g. household textiles such as bed linen)
- Support material for biocidal active substances
- Component for pigmentation of leather.

Thanks to its high refraction index, titanium dioxide enables the most effective white pigmentation with the best possible opacity. This goes hand in hand with excellent ultraviolet resistance. Through its use in coatings, titanium dioxide is always bound in a coating matrix and its release is therefore hardly possible. With its long service life, it is a very sustainable product. Accordingly, it currently has no alternative for most applications in the area of textile and leather manufacture.

Manufacture of adhesives

As a component of adhesive formulations, titanium dioxide is widely used in a very wide range of sectors – from the construction sector, paper and packaging industry, automotive, rail, ship-building and aeronautics through to electronics, electrical technology, dentistry and other sectors.

Titanium dioxide is used predominantly in reactive adhesives, dispersion adhesive pastes and hot melt adhesives.

Despite the relatively high price, adhesive manufacturers use titanium dioxide as a white pigment almost exclusively in their formulations due to its unparalleled opacity and high level of whiteness. Thanks to the good opacity, small quantities of titanium dioxide usually suffice to achieve the desired colour effect without a strong and unwanted increase in viscosity.

Welding industry

Titanium dioxide plays an outstanding role in the manufacture and processing of welding additives. It is an essential component in a majority of conventional welding additives and fillers. To a decisive extent, it is determinant the performance of a wide range of welding processes and classification of welding additives is therefore used as a reference in the relevant national and international standards.

Casing materials for rod electrodes used for manual welding contain from 5% (basic electrodes) to 80% (rutile electrodes) titanium dioxide. The equivalent value for welding powders used in submerged arc welding is 5 to 40%.

Large quantities of wire with rutile are used as a filler material in gas metal arc welding. For these welding additives, the share in product weight is between 2 and 8%. Furthermore, titanium dioxide is contained in volumes greater than 0.1% in drawing agents such as those used in the production of solid welding wires for gas metal and tungsten inert gas arc welding. There is no substitute for titanium dioxide in all these products.

Classification of titanium dioxide as carcinogenic in category 2 would oblige producers and users alike to make cost-intensive changes to the way welding additives are manufactured and processed in order to comply with workplace health and safety rules. This would affect a large number of manufacturing companies such as craft businesses, automotive industry, construction, mechanical engineers and instrument makers as well as producers of metal consumer goods.

The welding wastes that is unavoidably generated during the manufacture and processing of welding additives containing rutile (code 12 01 13) would then have to be declared as hazardous waste, which would make continued use much more difficult.

Consequently, avoiding the use of titanium dioxide in the manufacture of welding additives would result in complete areas of manufacturing industry being deprived of a basic input material. In the absence of a substitute, classification would inevitably lead to relocation of production capacities and hence not only to the loss of many jobs but also to the loss of core skills in the welding industry.

Further applications

Titanium dioxide is used in numerous other applications in trade and industry. Further examples of where titanium dioxide broadly cannot be replaced with adequate substitutes include:

- **Abrasives**: Titanium dioxide is an intrinsic component of many corundum grains where it is mainly present in the form of compounds (e.g. Al_2TiO_5) or dissolved in the crystal lattice. Crystalline titanium dioxide can also be contained in a limited volume (< 0.5%).
- **Chemical fibres**: Titanium dioxide is used as a matting agent in the manufacture of chemical fibres.
- **Steel and metal processing**: Titanium dioxide is contained in concentrations from 1 to 20%. Products include lubricants used in cold

forming of rolled wire for the manufacture of various wire types and qualities.

- **Automotive**: All vehicle lacquers contain titanium dioxide as an essential pigment.
- **Electrical appliances**: The housings of most household appliances are dyed or lacquered white.
- **Mining**: Imported coal contains titanium dioxide in fluctuating concentrations.

About BDI

The Federation of German Industries (BDI) communicates German industries' interests to the political authorities concerned. It offers strong support for companies in global competition. BDI has access to a wide network within both Germany and Europe, to all the important markets and to international organisations. BDI provides political flanking for the opening of international markets. It also offers information and guidance on all issues relevant to industries. BDI is the leading organisation of German industries and related service providers. It represents 36 sectoral organisations and more than 100,000 companies with approximately 8 million employees. Membership is voluntary. 15 federal representations advocate for companies' interests on a regional level.

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