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*Research Paper*

# ANALYSIS OF TITANIUM DIOXIDE AND ITS APPLICATION IN INDUSTRY

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Titanium dioxide ($TiO_2$) is a white solid inorganic substance that is thermally stable, non-flammable, poorly soluble, and not classified as hazardous according to the United Nations' (UN) Globally Harmonized System of Classification and Labeling of Chemicals (GHS). It is the oxide of the metal titanium, occurs naturally in several kinds of rock and mineral sands. Titanium is the ninth most common element in the earth's crust. Titanium dioxide is typically thought of as being chemically inert. Titanium dioxide is now finding a lot of application in the nanotechnology, Tribology and Industries.

Keywords: Titanium dioxide, Metal oxide, Agglomeration

## INTRODUCTION

Titanium dioxide is a single crystalline system in the surface science of metal oxides. The surface science of Titanium dioxide is now enjoying a rapid growth of interest from researchers and scientists. Titanium dioxide is used as a heterogeneous catalysis, photo catalyst and also finds its applications in solar cells. Other application involves usage as gas sensors and as white pigments in paint industries. Titanium dioxide act as a corrosive-protective coating which can again be used as an optical coating and in electronic devices. The recent use of it has been in biocompatibility of bone implants and an insulator in MOSEFETS. It can also be used in a nano structured form in Li based batteries and electro chromic devices. $TiO_2$ is a component used in titania catalysts for selective oxidation reactions. Although $TiO_2$ is not suitable to be added as a structural support material but by doing small additions of titania the metal based catalysts can be modified in a very profound way. Titanium dioxide has been used for many years (ca. 90 years) in a vast range of industrial and consumer goods including paints, coatings, adhesives, paper and paperboard, plastics and rubber, printing inks, coated fabrics and textiles, catalyst systems, ceramics, floor coverings, roofing

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materials, cosmetics and pharmaceuticals, water treatment agents, food colorants and in automotive products.Surfaces and items that are white in color contain titanium dioxide. Many materials in our homes contain titanium dioxide. Titanium dioxide was first introduced as a commercial product in 1923. There have been no health concerns that have been associated with it neither no cases of problems have been detected. The recent studies have shown that thousands of workers in industry manufacturing or involving titanium dioxide which were having no risk of cancer or have any adverse effects on respiratory systems (Chen and Garabrant *et al.*, 1987; Fayerweather, 1988; Fryzek *et al.*, 2003; Boffetta *et al.*, 2001 and 2004; and Ramanakumar *et al.*, 2008). However it was found that exposure to $TiO_2$ can affects the lungs of rats (Levy, 1994). Titanium dioxide is formed when titanium reacts with atmospheric oxygen. Titanium was discovered by the Rev. W. Gregor in 1791 in Creed, Cornwall, and named by M.H. Klaproth in 1795 in Berlin. J.J. Berzelius isolated the metal in 1825. Pure metal was discovered by Hunter in 1910 when he heated titanium (IV) chloride with sodium in a steel bomb. Titanium is a hard, lustrous and silvery metal. Titanium is the ninth most abundant element on Earth. Igneous rocks and their sediments contains titanium. It occurs in the minerals rutile, ilmenite, and sphene, and is present in titanates andmany iron ores. Titanium is produced commercially by reducing titanium (IV) chloride with magnesium.

Although titanium is less dense than steel but much stronger than it. It act as an as an alloying agent with metalsincluding aluminum, molybdenum and iron. They are used in aircraft and missiles as they arematerials which have low density yet can withstand extremes of temperature. It has a lot of application in desalination plants which convert sea water to fresh water. This metal and its oxide is having excellent corrosion to sea water and hence are used to protect the hulls of ships, and other structures exposed to sea water. Titanium is widely used in form of titanium dioxide. It can also be regarded as a good reflector of infrared radiation and hence can find an application in places where heat can cause loss of visibility or poor visibility.

## EXPERIMENTAL PROCEDURE

Titanium dioxide is manufactured for the optimization of scattering of visible light and white opacity. This property involves the usage of primary particle size whose wavelength is equal to half the wavelength of light that has to be scattered. For instance the wavelength should be half of 400 nm-700 nm that is considered as the wavelength of scattered light. To maximize the number of primary particles in size range of 200-350 nm, titanium dioxide is manufactured. Agglomeration of the particles to the micron size range takes place. Titanium dioxide nanoparticles are transparent and even more effective than Ultraviolet absorbers and photo catalysts. They can be used as a protective ingredient for sunscreens.

Titanium dioxide as a nanomaterial is used for manufacturing catalysts of enhanced activity because of the small size of primary particles and high surface area. Moreover it has also been regarded as a non-toxic material. Titanium burns in air and probably the only element burning in nitrogen. In oxygen free atmosphere it can act as a ductile

material. Apart from alkalis it is resistant to dilute acids like hydrochloric and sulfuric. Titanium combines with oxygen at red heat and with chlorine at 550 K.

## RESULTS AND DISCUSSION

Titanium dioxide as a nanomaterial has primary particles less than 100 nm which in turn are used for optimization of properties. However it is not used as a colorant as the pigment size particles are functionally different from it. Therefore it is not able to impart color or opacity to the product. Formation of aggregates takes place when the chemical bonds are formed. Formation of chemical bonds takes place when the primary particles are strongly bound by the bonds and they are fused together. Agglomeration of these aggregates takes place due to the van der Waals attractive forces when they form the particles of micron size range. Light scattering properties are excellent in titanium dioxide which in turn can be used in applications like white opacity and brightness which involves its use as a pigment.

Titanium dioxide absorbs ultraviolet light and when its pigment is incorporated in polymer due to which the degradation of the system is minimized. This property can be increased by the surface treatment of titanium dioxide. This effect increases the life of the paint and plays a significant role in protecting the substrate. Due to the use of light colored paints it can be applied for interior applications which in turn provide openness and space. Light colored paints provide high luminosity which in turn reduces the energy required to light the buildings as compared to the darker ones.

Titanium dioxide colored surface cause coolness when used in the exterior application. This process leads to energy savings which can be used in warm and tropical area due to the process of light reflectance thereby reducing the need of air conditioning.

As a nanomaterial, titanium dioxide appears to be transparent thereby providing ultra violet light absorption. Dispersions in different media are achieved by the surface treatment which also allows efficient absorption of Ultra violet energy. It can also decompose environmental pollutants by the process of photo catalysis when untreated.

Titanium dioxide as a nanomaterial can be used for catalysts which can again act as a support in exhaust gas systems in automotive vehicles thereby minimizing the environmental impact.

## CONCLUSION

Titanium dioxide in the pigment form meets the purity standards. It has been in use for a number of applications which include pharmaceutical and foods. Recent studies have shown that titanium dioxide particles do not damage the skin (Gamer *et al.*, 2006; and Mavon *et al.*, 2007). Therefore in pigment and ultrafine form they can be used in the cosmetics applications. It has been safe for sunscreen products which does not damage the skin and protect it from harmful ultra violet radiations. The former European Scientific Committee on Cosmetic Products and Non-Food Products (SCCNFP) reviewed in 2000 data on $TiO_2$. Based on the results, SCCNFP concluded that $TiO_2$ is “safe for use in cosmetic products at a maximum concentration of 25% in order to protect the skin from certain harmful effects of

UV radiation. This opinion concerns crystalline (anatase and/or rutile) titanium dioxide, whether or not subjected to various treatments (coating, doping, etc.), irrespective of particle size, provided only that such treatments do not compromise the safety of the product" (Ramanakumar *et al.*, 2008). Based on existing safety information, it can be concluded that the use of titanium dioxide nanomaterial (ultrafine) as an ingredient in cosmetic sunscreen products at a concentration up to 25% poses no risks to human health Schilling *et al.* (2010). Moreover titanium dioxide can also be used for environmental benefit. As a potent pacifier it can enable thinner films thereby increasing the efficiency and minimizing the waste.

Thus we can say that titanium oxide can be regarded as a global product with several applications in many industries and has been regarded as safe for international standards.

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