

TOTO

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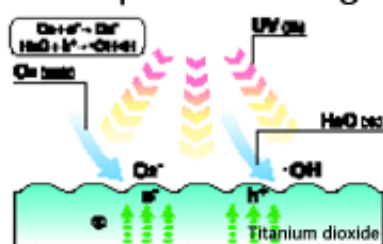
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TOTO's Work with Environmentally Friendly Photocatalyst Technology

1. Decomposition and Super-Hydrophilic Properties of Photocatalyst Technology Make For Environmentally Friendly Cleaning

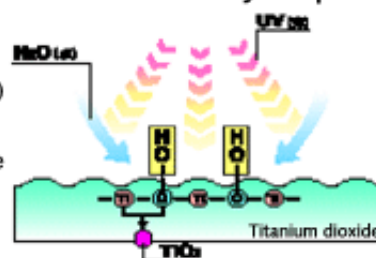
Photocatalyst technology uses the sun's ultraviolet radiation to decompose organic materials, and the super-hydrophilic properties that photocatalysts produce on the surface of materials provide anti-fouling, anti-fogging, sterilizing, deodorizing, air purifying and water purifying functionality. As a result of these properties, numerous applications for photocatalysts as environmental cleansing agents are expected to emerge. Research on photocatalysts had its beginning with the 1969 publication of the Honda-Fujishima effect (The Principle of Photocatalysis: the Photolysis of Water Using Platinum and Titanium Dioxide Electrodes). The 1995 discovery of the super-hydrophilic phenomenon at the TOTO LTD. Research Institute has spurred the search for applications for this technology, leading to the development of products such as tile, construction materials, coatings, anti-fogging mirrors, and air purifiers. The scope of applications is expected to expand.

Decomposition of Organic Materials



Titanium dioxide (TiO₂) on the surface emits two types of active oxygen, resulting in the decomposition of organic pollutants and gasses.

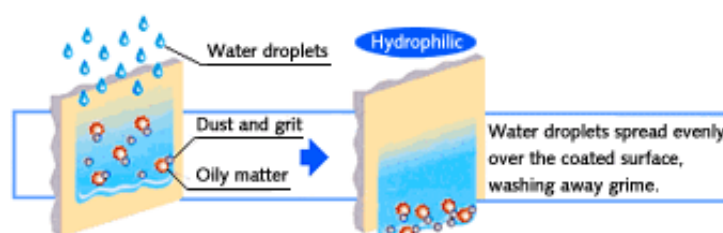
Creation of Hydrophilicity



The TiO₂ reacts with moisture in the air to produce hydrophilicity. Grime floats on this layer and can be rinsed away.

Hydrotect¹ Tile

The causes of exterior tile wall soiling can be broadly divided into two categories: adhesion of dust and grit caused by static electricity, and adhesion of atmospheric pollutants (exhaust gasses, factory smoke, etc.) due to their oil content. Hydrotect Tile, a photocatalytic tile, uses hydrophilicity to make a layer of water on the tile surface that prevents static electricity and reduces attraction of dust and grit. In addition, the decomposition capabilities of the tile's surface weaken the adhesiveness of matter that contains oils. Rainwater spreads uniformly over the tile surface and floats away grime, for self-cleaning functionality.



Water-Based Hydrotect¹ Color Coat

Hydrotect Color Coat is a line of water-based, self-cleaning, photocatalytic coatings that utilize the same photocatalytic and super-hydrophilic properties as Hydrotect Tile. Hydrotect Color Coat has excellent anti-fouling and rust prevention characteristics, and is as easy to use as conventional coatings. It contains absolutely no xylene, toluene, or other oil-based solvent, which makes it the world's first water-based, pigmented, photocatalytic coating. It has recently become the first photocatalytic coating to receive Eco Mark certification from the Japan Environment Association. Now, by switching to water-based Hydrotect Color Coat on exterior walls, homeowners can let the sun decompose grime, and let the rain wash it away. The natural power of sunlight, of course, imposes no environmental burden.



2.Environmentally Friendly Technology

The scope of the market for photocatalytic products is definitely not large, however, when one considers that five to six years ago it was virtually zero, this can be called a high-growth field. According to a study by the Photocatalytic Products Forum, the exterior construction materials and interior construction materials sectors are the largest markets for photocatalytic products.

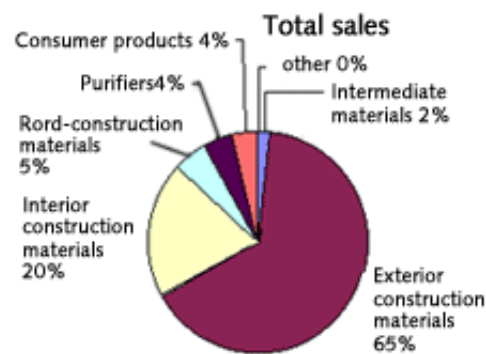
Exterior-construction and road-construction materials are used outdoors where grime is conspicuous, and because the difference between photocatalytic products and conventional materials in these applications is clear, the use of photocatalytic products is increasing. Construction materials for exterior walls include tile, coatings, and awnings, and road-construction materials include transparent sound insulation walls for freeways and lighting fixtures for tunnels. In addition, major U.S. glassmakers are selling self-cleaning photocatalytic window glass, and this market is growing briskly.

The expanding array of photocatalytic materials for interior use now includes tile, construction materials, coatings, wallpaper, and window blinds. Because of the antibacterial effects of photocatalytic decomposition of organic material and the ease with which super-hydrophilic surfaces can be cleaned, the use of these materials in kitchens and restrooms is also increasing. In addition, photocatalytic materials are used in automobile side mirrors and mirror films for their anti-fogging properties, in roadside signboards for their anti-fouling properties, and in autoclaved lightweight cellular concrete.

The two major strengths of photocatalyst technology are the self-cleaning properties of super-hydrophilic surfaces, which contribute to enhanced aesthetic value and reduce cleaning costs, bringing lower life-cycle costs; and the decomposition properties of photocatalytic surfaces, which, among other effects, clean up the air pollutants NOX and SOX. The expanding use of photocatalyst technology and products, therefore, will respond to society's needs for environmental protection, enhanced aesthetic value, and longer life spans for buildings. As photocatalysis is an environmentally friendly "natural" technology that uses solar energy, its use can be expected to increase in the future.

3. Growth of the Market Worldwide

Photocatalyst technology originated in Japan. Recent years, however, have seen an increasing amount of research in this field overseas. The major European tile manufacturer Deutsche Steinzeug Cremer & Breuer AG (DSCB) licensed technology from TOTO, and in 2000 commenced the manufacture and sale of photocatalytic tile. Then, in August 2001, the large North American plate glass manufacturer PPG Industries, Inc. initiated sales of self-cleaning glass with a photocatalytic coating. Following these noteworthy events, the sale of photocatalytic products in markets around the world began to gain momentum. In response to the increasing awareness of photocatalyst technology and use of photocatalytic products, eight firms that handle photocatalytic products, including TOTO, formed the Photocatalytic Products Forum in October 2000. This forum promotes market awareness and expanded sales of photocatalytic products, as well as activities that support the early establishment of international standards for this Japanese technology, including the standardization of testing methodology for photocatalytic properties and functionality, and the establishment of specifications for anti-fouling photocatalytic products.



[Scope of photocatalytic products business by sector]

(Photocatalytic Products Forum data)

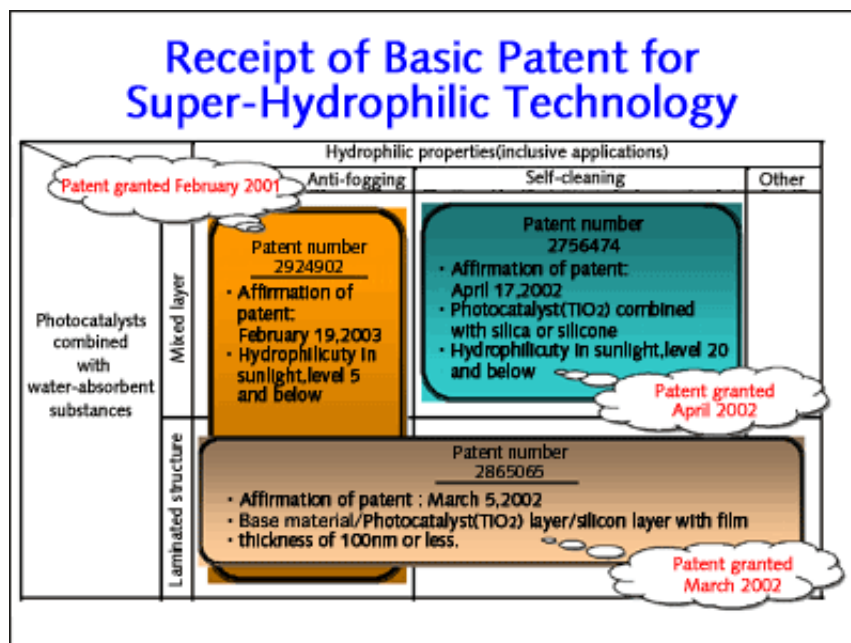


Photocatalytic tile | Ordinary tile

4. The Development of TOTO's Photocatalyst Business

By April 2003 TOTO had established three basic patents in the field of super-hydrophilic technology. These three basic patents cover almost all the applications of hydrophilic properties involving the combination of photocatalysts with water-absorbent materials.

The potential contribution of photocatalyst technology to societal needs such as environmental protection and aesthetic enhancement is enormous. TOTO has been working primarily in the following four areas to promote the adoption of photocatalyst technology as a "natural," environmentally friendly technology.



[Fostering the Industry]

Promoting the standardization and adoption of photocatalyst technology through the establishment of the Photocatalytic Products Forum.

[Building a Foundation]

Expanding the scope of applications for photocatalyst technology and broadening this business domain through renewed basic research.

[Developing Products]

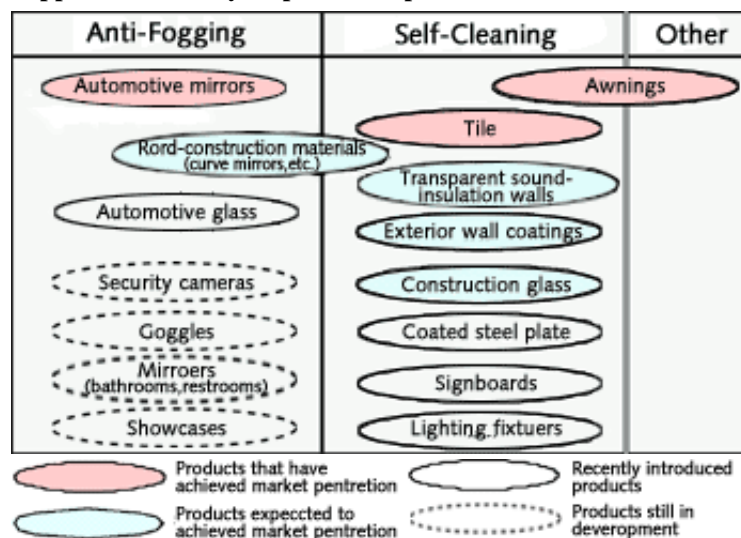
Developing and marketing products using photocatalyst technology in three business sectors. The combined sales of photocatalytic products in these three sectors has grown to approximately ¥6.5 billion (for the fiscal year ended March 31, 2003).

- Tile and construction materials ⇒ Growth is fueled by Hydrotect Tile (photocatalytic tile)
- Japan Hydrotect Coatings ⇒ Coatings, glass coatings
- Consumer products business ⇒ Automotive and residential consumer products

[Licensing]

Research and development by licensees in the fields of automotive mirrors, road-construction materials, awnings and construction materials (glass and coatings) is beginning to result in full-scale introduction of photocatalytic products into the market. There are particular expectations for growth in sales of external construction materials (glass and coatings) and automotive mirrors, and it is anticipated that the number of products in this field will expand.

[Application of Hydrophilic Properties]



1. Hydrotect is the name selected for a composite technology combining super-hydrophilic technology with organic decomposition technology.