

Review Article

An Overview of Effect Of Lotus Effect on the Automotive Windshield using Titanium Oxide

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Abstract

We all know how limited our vision while driving during heavy rain. Water sprayed by wheels of other vehicles, makes driving even more difficult. This phenomenon can be solved by the application of Lotus effect in Automotive windshield. The present paper deals the Lotus effect can be demonstrated in Automobile Windshield with titanium oxide coating. We are now formulating the process of lotus effect from the lotus plant. The Lotus flower is the symbol of purity in several Asian religions as it is guessed because of the self-cleaning property of the lotus leaf. Dirt particles are washed away by water droplets due to the self cleaning property on the lotus leaves surface. This phenomenon of self

cleaning is introduced in the Automotive windshield that eases the manual cleaning and water spray could clean the foreign particles completely. And the vehicle travel in rain is made much safer by increasing the driver's visibility as lotus effect formulated windshield does not makes the rain water to stay on the surface. The Lotus effect can be demonstrated in Automobile Windshield with titanium oxide coating. The TiO_2 gel for coating is formulated by sol-gel process.

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Introduction

The present paper generally relates to a method of resisting dust and dirt with Lotus effect applied to automotive windshield. The lotus effect is achieved by a layer formed with Titanium-oxide gel coating to the automotive wind shield. When a droplet of water falls on the lotus leaf, it forms a spherical shape and rolls over the leaf surface without leaving a trace of the droplet path and cleans away dirt on its path. This self-cleaning property attracted scientists for a long time. And scientists recently realized that this distinct action is because of the nanostructures on the lotus leaves surface. This is now termed as super hydrophobicity.

Normally during the rainy days the Automotive windshield will be filled up of water droplets, so the driver's view will be interfered. For that we use wiper motor, the power required to drive the motor is achieved by compensating engine power. By the application of Lotus effect on automotive windshield reduces the usage of wiper motor resulting to save energy to be utilized. The Lotus effect can be demonstrated in Wind shield with TiO_2 gel coating. TiO_2 gel gives the surface of the wind shield a hydrophobic property. Which is seen in lotus leaves due to its waxy surface tends non sticky layer to water droplets on its surfaces, by providing a lesser contact angle between surface lotus leaf and water droplet thus proves a lesser contact to both. When the gravitational pull is made automatically the water droplet rolls over instead of sliding over the surface of the leaf, this makes faster movement of water droplet. The self cleaning property is obtained as the dust and dirt in the path of water droplet are carried away thus keeps the lotus leaf clean and the lotus plants so called the symbol of purity. Foreign particles on lotus leaves too have less contact between them, thus eases the water droplet to clean the foreign particles over the lotus leaf. In this present scenario the hydrophilic and self cleaning property is brought by TiO_2 gel coating. TiO_2 gel is specially formulated by the sol-gel process to achieve the desired hydrophilic property with its maximum ability. The coating is done initially with silicon to have an efficient secondary coating with TiO_2 gel.

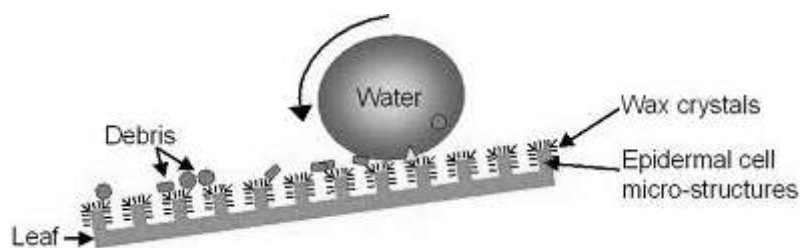


Figure 1 Lotus leaf effect.

Operational Principle

The Automotive windshield gets dust and dirt from various sources while travelling in a dusty area or long distance travel so frequent manual wiping is required, By the formulated windshield, we can solve the problem as the dust and dirt cannot stick on the lotus effect coated surface. The opposing force created by the air on the windshield provides the sufficient adhesion force to be overcome in removing the dirt and dust, and further by sprinkling of water can completely clean up the windshield. The hydrophobic property of TiO_2 gel coating dries windshield surface and cleans up dust and dirt, through the duct provided.

Technical Phenomenon

The water droplet influenced to have a high surface tension, forms a spherical shape to reduce the surface of contact. The adhesion force tends to wet the surface of contact. The phenomenon of wetting the surface happens according to structure of surface and fluid tension. The TiO_2 coating provides double layered surface, thus creates a lesser contact area and adhesion force between coating and liquid droplet results to self cleaning property.



Figure 2 A spherical shaped droplet on a hydrophilic surface.



Figure 3 A spherical shaped droplet on a hydrophobic surface.

The level of lotus effect is categorized by the contact angle between the liquid droplet and the surface coated. And the differentiated two categories are hydrophobic and hydrophilic. The contact angle $< 90^\circ$ is termed as hydrophilic and contact angle $> 90^\circ$ is termed as hydrophobic. The contact angle as like hydrophobic produce the desired lotus effect. The contact angle of lotus leaf is ranged between 160° - 170° [2]. And phenomenon creates high self cleaning property in lotus leaf.

As we see the surface tension is high results to a spherical shaped liquid droplet with reduced contact area rolls off easily. This kind of liquid droplet is introduced in contaminated surface results to clean off the surface. This phenomenon happens as the adhesion force is higher between the foreign particle and the liquid droplet comparatively to the force between the foreign particle and the surface. This whole process can be said as self cleaning process [5].

This effect is well versed in need for the plants as a shield against unwanted growth like fungi and algae growth and also as like sand. And increases the exposure of leaves surface to sunlight resulting in increase the process of photosynthesis.

Self Cleaning Property

When a liquid droplet drops on a inclined surface coated with lotus effect having super hydrophobic property does not slides down instead it rolls down. As the droplet rolls over a foreign particles. The particle gets cleans off by the absorption force between the liquid droplet and the foreign particle. This phenomenon happened as the absorption force overcomes the static force. The force required to clean the particle will be minimum as the area of contact between the particle and surface is also minimum, thus resulting the foreign particle gets cleaned up as liquid rolls over the particle[4].

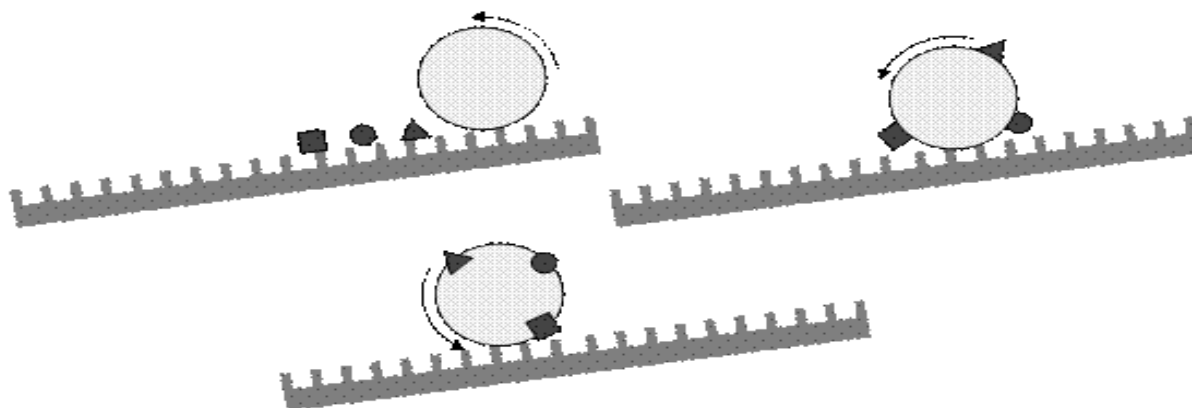


Figure 4 Diagram showing the process of self cleaning effect.

Manufacture

Normally windshield glasses are coated with silica as initial reactant and form a secondary coating with titanium oxide-gel using solution dip coating process. The titanium oxide gel is formed by sol-gel process.

Preparation of Titanium-Oxide Gel Using Sol-Gel Process

For the formulation process analytical grade reagents are used and the base reagents were not influenced to any process of purification and it is directly used. The base reagents to be used for the process are Titanium and isopropoxide, Now both the base reagent are dissolved with absolute ethanol. The solution obtained is added to distilled water in the molar ratio of $Ti:H_2O = 1:4$. The restrain from hydrolysis process and to maintain the pH level in the solution can be achieved in addition of nitric acid to the solution. The formulated solution was firmly stirred for 30 mins to obtain sol. The sols were kept idle for 24 hrs to transform the sols to gels.

To obtain the TiO_2 nano crystalline, now the formulated gel is dried at $120^\circ C$ for 2 hrs for evaporating the water and organic sediments present in the solution. Resulting dry gel is sintered at $450^\circ C$ for 2 hrs for the desired, formulated TiO_2 nano coating. The coating is done at $50^\circ F$ to $90^\circ F$ ($10^\circ C$ to $32^\circ C$) for the application of automotive windshield.

Conclusions

1. The conclusions were made based on the results obtained from this study and investigations made on the effect of the Lotus leaf effect on Automotive windshield.
2. There is no possibility of water droplets to stay on the surface of Automotive windshield as Lotus effect's self cleaning property repels the water droplets much quicker than non-coated hydrophilic surfaces i.e. in conventional Automotive windshield.
3. The self-cleaning property keeps Automotive windshield clean longer, due to the Lotus effect coating can stand firm up to 5 years [2].
4. Due to inclement weather condition there is the possibility of forming foreign particles on the surface. The Lotus effect's self-cleaning property in Automotive windshield use to eliminate this problem do not

stay longer on the surface that normalizes the action of Automotive Windshield and produces better visibility than conventional Automotive Windshield [6].

5. The self cleaning property of lotus effect easily cleans away Dust and dirt with automatic sprinkling of water setup provided in the vehicle.
6. There by giving a conclusion from the above factors, this reduces the frequency of maintenance resulting in saving energy, time and cost. Finally leads to increases the driver's visibility in inclement weather condition.

References

- [1] Dettre and Johnson, theoretical based on experiment with glass beads coating using paraffin, hydrophobic surfaces, 1964.
- [2] Barthlott and Ehler, self-cleaning property of super hydrophobic micro-nano structured surfaces, university of bonn, 1977.
- [3] Brown, study on super hydrophobic material perfluroakyl and perfluoropolyether for lotus effect, department of biological, 1986.
- [4] Chih-Hao Huang, Method of resisting dust and dirt by nanotechnology, CHENG UEI PRECISION INDUSTRY CO" LTD", US 2009/0274829A1, 2008.
- [5] A review of TiO₂ nanoparticles by GUPTA Shipra Mital & TRIPATHI Manoj, University School of Basic and Applied Sciences, Guru Gobind Singh Indraprastha University, Sector 16C Dwarka, Delhi 110075, India.
- [6] Archives of Applied Science Research, 2012, 4 (2):1183-1190, Synthesis and characterization of nano-TiO₂ via different methods by R. Vijayalakshmi and V. Rajendran, Department of Physics, Presidency College, Chennai, Tamilnadu, India.
- [7] Songklanakarin J. Sci. Technol, Deposition of transparent, hydrophobic polydimethylsiloxane - Nano crystalline TiO₂ hybrid films on glass substrate On-Uma Nimitrakoolchai and Sithisuntorn Supothina National Metal and Materials Technology Center, Thailand Science Park, Klong Luang, Pathum Thani, 12120 Thailand.
- [8] United States Patent (10) Patent NO. US 8,258,206 B2, by Lexington, KY (U S); Richard J. Baumgart, Paris, KY (US).
- [9] United States Patent Application Publication Pub. No.: US 2009/0274829, Inventor: Chih-Hao Huang, Taipei Hsien.

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