Review on the Superhydrophilic coating of Electric insulator

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Abstract. In recent years, new preparation technologies of ultra-hydrophilic TiO2 films have emerged in an endless stream, such as spray pyrolysis, electrostatic spinning, spray printing, micro-arc oxidation, pulsed laser deposition, atomic force deposition, ion beam deposition, etc. These new preparation technologies are able to control the surface chemical composition and surface structure of the thin film more precisely and to prepare the ideal superhydrophilic TiO2 coating. Among them, the rf sputtering method has important research significance for the repair and maintenance of TiO2/SiO2 composite coating. Nano TiO2 has excellent photocatalytic activity and superhydrophilicity, making it an important material for the preparation of high self-cleaning superhydrophilic coatings. However, the application of TiO2 photocatalysis requires UV light, and there is less than 5% UV light in sunlight, so the application of TiO2 photocatalytic performance is greatly limited. In addition, the surface hydrophilicity of TiO2 under light also has great problems. Therefore, improving the surface hydrophilic durability of TiO2 has become a key research point.

Keywords: superhydrophilic coating; anti-pollution; photocatalysis; durability; high self-cleaning.

1. Introduction
Self-cleanness refers to the ability of a material to maintain its surface cleanliness, which is mainly related to surface wettability. Wettability is an important feature of solid surface and plays a vital role in daily life and industrial applications. In 1805, Young and Laplace et al. conducted relevant research on surface tension and capillary phenomena, and introduced the contact Angle to conduct quantitative scientific research on surface wettability, and proposed the Young equation. The wetting effect of liquid on solid surface is closely related to the molecular attraction of liquid-solid and liquid-liquid. When the molecular attraction between solid and liquid is greater than the molecular attraction of liquid itself, a wetting phenomenon occurs on the surface. Wettability of a surface is usually measured by the size of the contact Angle [1-3]. Generally speaking, a surface with a contact Angle of <90° is defined as a hydrophilic surface, which can be wetted by water. On the contrary, the surface with contact Angle >90° is defined as hydrophobic surface, and the surface with contact Angle b> 150° is called superhydrophobic surface. When the surface contact Angle is <5° or close to 0°, it is called the superhydrophilic surface.
According to the different principles of self-cleaning, both superhydrophobic and superhydrophilic self-cleaning coatings achieve self-cleaning effect through the action of water. The difference lies in: the super hydrophobic coating USES the water drop rolling to remove the dirt; The superhydrophilic coating forms the water film on the surface and removes or insulates the dirt to realize the self-cleaning function, and has the photocatalytic characteristic under the light radiation, may degrade the organic matter, plays the sterilization and the purification function. These two special surfaces are used for surface self-cleaning [4]. From the end of the 20th century to now, self-cleaning technology has been widely used in the self-cleaning of window glass, automobile glass, solar panels, textiles and so on. This technology not only reduces maintenance costs, but also avoids the tedious manual operation and saves time.

In the study of self-cleaning coating, Wang et al. [7] reported the surface superhydrophilic characteristics of semiconductor TiO2 in 1997. Titanium dioxide after affected by ultraviolet radiation, on the surface by light excitation of oxygen vacancy adsorption on the surface to form the uniform distribution of nano-sized feeling of water area, because the droplets size is far greater than the size of the micro area, so the macro on the surface show the phenomenon of super hydrophilic, self-cleaning applications of TiO2 thin film in the huge space for development.

1.1. Superhydrophilic mechanism of titanium dioxide

Since the photosuperhydrophilicity of TiO2 film was discovered, a large number of studies have been conducted on its superhydrophilic mechanism, and it was found that the superhydrophilic characteristics of TiO2 surface and the photocatalytic characteristics seemed to have some inevitable relationship. The research on the superhydrophilic mechanism of TiO2 film surface has never been stopped. The superhydrophilic and photocatalytic properties of TiO2 of different crystal types showed certain consistency. Compared with rutile type TiO2, the surface of anatase type TiO2 showed better superhydrophilicity, and the surface porosity was beneficial to both the photocatalytic and superhydrophilicity of TiO2. So early view is super hydrophilic from the surface of TiO2 photocatalytic degradation reaction adsorption of organic matter, in particular: thin film surface has the chemical adsorption of water, water but become hydrophobic after the adsorption of organic molecules, after uv irradiation, generate strong oxidizing the surface of the film - OH, and by photocatalytic oxidation decomposition of hydrophobic organic reaction, restore the surface of hydrophilic state; After the light is stopped, the surface of the film will slowly adsorb organic matter and eventually become hydrophobic [5]. However, after in-depth studies, many experimental phenomena have fully demonstrated that the superhydrophilicity of TiO2 thin film surface is a chemical reaction induced by the surface's own light, which is significantly different from the photocatalytic performance of thin film, such as:

1) There is no direct correlation between the hydrophilicity of TiO2 film and the photocatalytic degradation degree of TiO2 film for organic pollutants. Some TiO2 with low photocatalytic activity and even matte catalytic activity have superhydrophilicity on the surface [6].

2) The combination of some non-metallic oxides (such as SiO2) can improve the superhydrophilicity of TiO2 surface but reduce the photocatalytic reaction activity of TiO2; on the contrary, the doping of some metal ions (such as Cu2+) can improve the photocatalytic performance of TiO2 but reduce the hydrophilicity of the film surface [5].

3) The surface of TiO2 exhibited aqueous oil patency after uv irradiation. In general, there is a large contact angle between the surface of TiO2 and oily liquids (ethylene glycol, cetane, etc.), but these oily liquids can completely wet the surface of TiO2 film after uv irradiation [7]. Therefore, more and more researchers believe that uv irradiation changes the surface structure of TiO2 [7, 8]. To be specific, electrons in TiO2 valence band are excited to the conduction band, and photogenerated E - and H + move towards the surface, forming electron-hole pairs. E- Reacts with Ti4+ to form Ti3+, while H+ reacts with bridge oxygen ions on the surface to form oxygen vacancies.H2O in the air is dissociated and adsorbed in the oxygen vacancy, forming chemisorbed water (surface hydroxyl). Chemisorbed water continues to adsorb H2O in the air, forming physical adsorbed water, thus forming a nanoscale and uniformly distributed highly hydrophilic microzone around Ti3+, while other surface areas remain...
hydrophobic (oil-wet microzone). Since the area of hydrophilic microzone or oil microzone is much smaller than the size of water droplet or oil droplet, the surface shows macroscopic hydro-oil duality. Once the light is stopped, the surface of the film becomes hydrophobic as the adsorption of organic matter in the air or oxygen in the air replaces the chemically adsorbed hydroxyl group. The action model of the above process is shown as follows:

![Photo induced superhydrophilic mechanism of TiO2 surface.](image)

In short, photoinduced superhydrophilicity and photocatalysis of TiO2 thin films are derived from two different characteristics based on the same theory of photoinduced electron migration and the generation of photoelectron-hole pairs, which are mutually related but different. Therefore, the factors affecting the two properties of TiO2 thin film are not identical, and the measures taken to improve the two properties are also not identical.

1.2. Superhydrophilic factors of titanium dioxide

There are many factors affecting the superhydrophilicity of TiO2 film, including the preparation, modification and surface treatment of the film. To be specific, surface chemical composition, surface structure, crystal surface and crystal morphology, film thickness and other properties are the decisive factors affecting superhydrophilicity, which will have an important impact on light absorption efficiency, electron-hole composite rate, band gap width and so on. The type of irradiation light source, light intensity, irradiation time, ambient atmosphere, heat treatment, ultrasonic and plasma treatment and other external conditions and post-treatment will also play an important role in the superhydrophilicity of the film.

TiO2 anatase type of forbidden band width is about 3.2 eV, its absorption sideband wavelength of about 387.5 nm, usually with sol-gel method of the small size of nanometer TiO2 thin film, can produce a quantum size effect, make the film forbidden band width and wavelength absorption sideband "blue shift", need less than 387.5 nm wavelength ultraviolet light to stimulate the valence electrons into the conduction band. Therefore, after the TiO2 film is irradiated by UV light (wavelength about 340nm), its hydrophilicity is significantly improved in a short time. Sunlight irradiation (with a small amount of UV light) is less effective than UV light, but it can also obtain hydrophilicity by extending the irradiation time. Fluorescent lamp irradiation (wavelength > 400nm) cannot induce TiO2 film to produce superhydrophilicity. In addition, uv light intensity also affects the superhydrophilicity of TiO2 surface. If the light intensity is too low (less than 20mW/cm2), the hydrophilicity of TiO2 surface cannot be improved no matter how long the irradiation time is. This is mainly because the light intensity is too low to reach the threshold value required to stimulate photoelectron-hole pairs [9].

Wang et al. [10] studied the influence of ambient atmosphere on the superhydrophilicity of TiO2 thin film. TiO2(110) single crystal was placed in the atmosphere of oxygen and air respectively. After uv
irradiation, it was found that: in the single crystal surface placed in oxygen, the water contact Angle decreased slowly and reached saturation at about 35°. On the single crystal surface in the air, the water contact Angle becomes smaller rapidly, and the state of superhydrophilicity can be achieved within a short time. At the same time, the superhydrophilic TiO2 crystal surface soon becomes hydrophobic in the oxygen atmosphere, but it can maintain the hydrophilic state for a long time in the air. This is because the presence of high concentration of oxygen inhibits the formation of oxygen holes, prevents the formation of chemical adsorption water level on the surface of the film, and is not conducive to the formation and long-term maintenance of surface hydrophilicity.

2. Preparation of titanium dioxide superhydrophilic thin films

There are many preparation methods for superhydrophilic TiO2 films, including sol-gel method [11], chemical vapor deposition method [12], liquid phase deposition method [13], spray thermal decomposition method [14], hydrothermal method [15], self-assembly method [16], sputtering method [17] and electrochemical method [18]. Different preparation methods have their own advantages and disadvantages, and have different effects on the appearance, structure and properties of thin films, such as film thickness, grain size, crystal structure and surface micromorphology, etc. If industrialized production is carried out, the yield problem should also be considered.

2.1. Sol-gel method

At present, sol-gel method has been a relatively mature technology for TiO2 thin film preparation. Its method process on titanium alkoxide (tetrabutyl titanate, isopropyl titanate, etc.) as raw material, the hydrolysis and polycondensation reaction in organic solvent by sol, then sol evenly coated method (pulling method, spin coating, spraying, etc.) gel film is formed on the base plate, and then after drying and heat treatment can form TiO2 thin film. It has the advantages of low synthesis temperature, easy control of reaction conditions, high purity, strong uniformity and so on, and the preparation process is simple, without special and expensive instruments. Convenient for multiple coating, can effectively control the film thickness. However, the sol-gel method has the disadvantage of high cost, the cost of titanate precursors is expensive, and a lot of organic solvents are needed. There are many reports about sol-gel coating on different carriers at home and abroad. In recent years, the preparation of TiO2 thin films with special surface chemical composition by sol-gel method by doping different ions or compounds [19,20] has become one of the research hotspots. This is precisely because of the advantages of sol-gel method, such as strong homogeneity, easy doping and modification. And sol-gel method can by adding different particles such as template agent, surfactant, preset conveniently control the surface of the thin film structure, for example by adding a polystyrene (PS), polyethylene glycol (PEG), polypropylene glycol (PPG), polyoxyethylene (PEO), polymethyl methacrylate (PMMA), hexadecyl trimethyl ammonium bromide (CTAB) and sodium dodecyl benzene sulfonate (DBS), such as the preparation of porous or high surface roughness of TiO2 thin film, beneficial to the improvement of the thin film super hydrophilicity.

2.2. Other preparation methods

The advantages of the thin films prepared by chemical vapor deposition method are high purity and good crystallization orientation. By adjusting or changing the various factors involved in the chemical reaction, the composition and characteristics of the sediments can be effectively controlled to obtain the required films. But its disadvantages are higher requirements for equipment, higher cost, and the technical difficulty is large, complex process. The body of TiO2 film prepared by chemical vapor deposition is usually titanium tetrakisopropanol [21], and the reaction gases mainly include oxygen and ammonia.

Magnetron sputtering is a novel low temperature coating method. The film obtained by this method has the advantages of high quality, high density, good bonding, stable device performance, easy operation, easy process control and high repeatability. It is suitable for large area coating and convenient for continuous and semi-continuous production.
The advantages of liquid phase deposition method are simple operation, no need of expensive equipment and heat treatment, and it can even make film on the substrate with complex shape. The disadvantage is that the precursor is difficult to obtain, high cost. The process is based on the aqueous solution of metal fluoride as the reaction liquid, and the coordination position between fluorine ion consuming agent and metal fluoride complex ion in the solution is used to promote the equilibrium movement of metal fluoride to hydrolyze, thus crystals are spontaneously precipitated in the susaturated solution and metal oxides are deposited on the substrate.

Electrochemical preparation technology is a common method for the preparation of thin films. It has the advantages of simple equipment, convenient operation, easy quality control and low cost. The electrochemical method can greatly expand the range of substrate materials, enabling TiO2 thin films to be deposited on the surface of various conductive materials. Therefore, electrochemical preparation technology is an important development direction of TiO2 superhydrophilic functional film material preparation technology, which can promote the application of superhydrophilic film in the direction of solar cells.

In addition to the above common preparation methods, new preparation technologies of ultra-hydrophilic TiO2 thin films have emerged in an endless stream in recent years, such as spray pyrolysis, electrostatic spinning, spray printing, micro-arc oxidation, pulsed laser deposition, atomic force deposition, ion beam deposition, etc. These new preparation technologies are able to control the surface chemical composition and surface structure of the thin film more precisely and to prepare the ideal superhydrophilic TiO2 coating. Among them, the rf sputtering method has important research significance for the repair and maintenance of TiO2/SiO2 composite coating.

Nano TiO2 has excellent photocatalytic activity and superhydrophilicity, making it an important material for the preparation of high self-cleaning superhydrophilic coatings. However, the application of TiO2 photocatalysis requires uv light, and there is less than 5% UV light in sunlight, so the application of TiO2 photocatalytic performance is greatly limited. In addition, the surface hydrophilicity of TiO2 under light also has great problems. Therefore, improving the surface hydrophobic durability of TiO2 has become a key research point.

3. Modification of super hydrophilic titanium dioxide with high self-cleaning coating

The superhydrophilic surface is not only related to photocatalysis, but also closely related to the surface structure and properties of thin films. We can improve the photocatalytic activity and increase the surface roughness by doping TiO2 thin film, so that the surface of the film is more likely to have superhydrophilic energy. By changing the surface roughness of the film, increasing the content of hydroxyl on the surface, changing the crystal shape and crystal surface, changing the thickness of the film, changing the light condition, controlling the calcination temperature, etc. The effects of co-ion doping and composite semiconductor modification on superhydrophilicity of nano TiO2 thin films are introduced in detail

3.1. Co-ion doping

Compared with single nonmetallic ion doping, the product has better thermal stability and higher visible light absorption capacity. Sakai et al. [22] used rf magnetron sputtering method to prepare N and S co-doped Anatase TiO2 thin films. Due to the co-doping of N and S, N2p and S3p orbitals cross each other to form a relatively narrow new impurity level, which can reduce the energy required for photoexcitation, so its superhydrophilicity is better than that of single doped TiO2 thin films. Kontos et al. [23] prepared N and F co-doped TiO2 films with urea and fluorine-containing non-ionic surfactants. The films were absorbed at the visible spectrum range of 410-510nm and had superhydrophilicity under visible light irradiation. Xu et al. [20] prepared TiO2 films co-doped with C, N and F by sol-gel method. This film has strong visible light absorption capacity. In the absence of any light, the contact Angle of co-doped films is 2.3-3.1°, and it can remain stable in darkness for a long time. Metal-nonmetal ion co-doping is mainly used to improve the superhydrophilicity of TiO2 film through the joint action of nonmetal ion and metal ion. Obata etc. [24] Ta prepared by rf magnetron sputtering method, N doping of TiO2 thin
film, a total of doped thin film surface ionization N3 - and Ta5 +, replace the original Ti3 + and oxygen hole, make it easier for the water molecules adsorbed on the surface film, forming highly hydrophilic area, under visible light irradiation, Ti1 xTaxO2 - yNy film than single doped N or Ta film super hydrophilicity can well. Li et al. [25] dispersed PdO into N and F co-doped TiO2 nanotube array by anodic oxidation method. After visible light irradiation for 4min, the water contact Angle continuously decreased from 13° to complete spread, realizing visible light induced superhydrophilicity.

3.2. Composite semiconductor

Semiconductor recombination is essentially the modification of one particle to another. The effect of charge separation can be improved by the combination of semiconductors, the band gap and spectral absorption range of semiconductors can be easily adjusted, so that the light absorption takes on the shape of band edge, and the light stability and superhydrophilicity can be increased by surface modification of particles. TiO2 was modified with a narrow band gap semiconductor to improve its catalytic activity and crystal structure due to the effect of crystal mixing, thus improving its superhydrophilicity.

For example, WO3-tio2 [25], sno2-tio2 [26], V2O5-tio2 [27], CDS-TI, etc. WO3 - TiO2 system, for example, the preparation of a hierarchical type of TiO2 - WO3 thin films can be sensitized, make its catalytic reaction using sol gel method and sputtering method selection, type were different stratified TiO2 - WO3 thin films, the latter in the uv irradiation intensity under 0.1 and 0.05 mw/cm2 super hydrophilic performance, its performance to the hydrophilic is superior to the former, in the film surface, the existence of the amorphous phase of the electrons and holes transfer barriers, because the interface does not exist in the third phase, so the electrons and holes can be easily migrated to different crystal layer, it is difficult to compound. In the heterogeneous TiO2/WO3 system, the absence of amorphous phase will greatly improve the photocatalytic performance of the film, thus improving the superhydrophilicity.

At the same time, the semiconductor and the appropriate amount of well-developed pore structure and large specific surface area of the composite insulator, the carrier can absorb a large number of organic molecules from the solution, provide a high concentration of organic environment for TiO2, increase the probability of photogenic holes and free radicals collision with organic molecules, improve the photocatalytic efficiency.

SiO2 was the most reported. Adding SiO2 to TiO2 thin film can improve the surface hydrophilicity and duration of TiO2. On the one hand, TiO2/SiO2 composite can lead to film charge imbalance, resulting in surface acidity and inducing water adsorption. Under light conditions, the physical adsorbed water on the surface of TiO2/SiO2 film diffused to SiO2 and composite oxides, and was absorbed into a stable physical adsorbed water layer. When the light is stopped, the absorbed water can stabilize the Ti3+-OH structure on the surface of TiO2, enabling the surface of TiO2 to maintain its hydrophilicity for a long time even in the dark. Tricoli[29] et al. prepared lace-like TiO2/SiO2 composite films by rapid flame deposition method. Due to the interaction between TiO2 nanoparticles with high coverage on the porous surface and the hydrophilic SiO2 surface, the composite films had good superhydrophilicity and anti-fog performance. Wu[30] et al. used layer-by-layer self-assembly technology to assemble TiO2 and SiO2 nanoparticles into poly dielectric layer respectively, and calcined to prepare three-dimensional rough multilayer TiO2/SiO2 film. Under visible light irradiation, the film has stable superhydrophilic energy.

Houmard research group prepared TiO2/SiO2 composite films by sol-gel method using the mixture of TiO2 sol mother solution (MS) and modified crystal suspension (CS) and SiO2 sol. Due to the high surface acidity of TiO2/SiO2 composite film, MS-tio2 /SiO2 film has superhydrophilicity without UV irradiation, but it cannot be maintained at 0°. In contrast, CS-tio2 /SiO2 film has natural and long-lasting superhydrophilicity in a large composition range [31]. At the same time, they found that both MS-SiO2/TiO2 and CS-tio2 /SiO2 bilayers had natural superhydrophilicity, which could not be maintained for a long time, but CS-SiO2/TiO2 bilayers had long-lasting superhydrophilicity [32]. The above studies show that: CS-SiO2/TiO2 double layer or composite film, SiO2/TiO2 layer with particle interface effect, Ti-O-Si bond heterogeneous connection leads to charge imbalance, which can promote positive or
negative electrons to move to the surface of the film, increase surface acidity, and induce water adsorption. In the CS-SiO2/TiO2 double-layer film, the ti-O-SI bond heterogeneous connection is not concentrated in the SiO2-tio2 layer interface, but dispersed in the SiO2-tio2 particle interface, which has more contact area of SiO2-tio2 and thus has the best superhydrophilicity.

4. Application of superhydrophilic films

In recent years, a large number of self-cleaning products have gradually entered the market by taking advantage of the photocatalytic performance and surface superhydrophilicity of nano TiO2. In 2001, Pilkington Glass produced the first self-cleaning glass made with transparent TiO2 coating. Subsequently, Lotusan commercialized the self-cleaning coating, which was mainly applied in the field of European glass. In addition, Saint-Gobai and PGG were also engaged in the research of self-cleaning products. In current price segment, TiO2 hydrophilic technology is mainly applied in self-cleaning and anti-fouling, anti-fog or anti-dew, improving surface washability, etc.

(1) Self-cleaning antifouling function (superhydrophilic surface)

With the increasing use of cars in cities, the amount of oily pollutants in the air has increased greatly. When the oily pollutants contact the TiO2 coating surface and are exposed to light, on the one hand, due to the photocatalytic effect of TiO2, the organic pollutants on the surface can be degraded into water and carbon dioxide with low molecular weight., on the other hand, when the surface contaminants gathered too much covered its surface, can use super hydrophilicity on the surface of the TiO2, between TiO2 film and pollutants form a layer of water film, hinder the pollutant, using under the action of gravity and the nature of the rain, wind, pollutants can easily come off from the coating surface, the surface to achieve the effect of self-cleaning anti-fouling. The photocatalysis and superhydrophilicity of TiO2 are applied to building materials such as glass and ceramics, and the ultraviolet light in fluorescent lamps is used as the light source to keep the surface of building materials clean and reduce the cleaning cost. In addition, the surface of building materials can also be equipped with functions such as air purification, antibacterial, deodorant and antifouling. In addition, traditional detergents are used to clean surface oil stains such as mechanical parts and food utensils in daily life, which tend to produce a large number of residues on the surface and the generated sewage damages the ecological environment. However, TiO2 products can be coated on the surface of these supplies, and the self-cleaning and anti-fouling function of TiO2 can be used to make it difficult for oil stains to adhere to the surface. Moreover, stains attached should be put into clear water. Due to the superhydrophilic effect of TiO2 surface, stains can easily fall off the surface, which is easy to clean and reduces cleaning costs. The preparation of self-cleaning antifouling products by TiO2 is an effective antifouling measure that is economic and environmental protection in recent years.

(2) Anti-fog function

Due to the influence of humidity in the air, when steam comes into contact with relatively cold solid surfaces, such as lenses or transparent glass walls, it will soon condense into water droplets on the solid surface, and the solid surface will appear as fog and visibility will be significantly reduced. Unlike a conventional mirror, when water vapour comes into contact with a hydrophilic mirror, it forms a spreading film on the surface, and the mirror quickly returns to transparency. The surface of building glass, car windshield, side view mirror, bathroom mirror, etc. can be effectively prevented from fog generation by coating TiO2 film, so as to keep the mirror clear and bright. At present, Japan has applied the anti-fog technology of TiO2 in the side view mirror of automobiles. The film with photocatalytic superhydrophilicity (TiO2+SiO2) is coated on the PET film of the side view mirror, which can effectively spread raindrops into water film, thereby preventing water pollution on the mirror surface, improving the visibility of driving and enhancing the safety of driving [33]. Zorba et al. [34] reported a biomimetic nano layered TiO2 film, which exhibited good superhydrophilic property without uv excitation irradiation. Compared with the uncoated glass substrate, the surface of TiO2 coated film exhibited better transparency, and the glass transmittance reached more than 90%. This discovery provides the possibility for future self-cleaning and anti-fog glass.

(3) Other applications
In addition to the above applications, the superhydrophilicity of TiO2 surface is also applied to the radiant vane of the heat exchanger, which can prevent the condensate of the fluid channel from blocking, thus improving the heat exchange efficiency. In addition, the surface drying process of plane mirror, car windscreen or rearview mirror can be accelerated because the water droplets on the superhydrophilic surface can spread into water film rapidly. If TiO2 film is coated on the umbrella, raindrops can be effectively dropped by themselves, and surface stains can be removed by photocatalytic effect. In addition, TiO2 hydrophilic film also has many applications in ships. The superhydrophilic effect of TiO2 can effectively prevent the adhesion of seabed organisms and microorganisms on the ship body, reduce the resistance encountered by the ship body, and greatly improve the sailing speed.

At present, the hydrophilicity of TiO2 coating surface is specifically manifested as the chemical and physical adsorption of water on the surface, which is determined by the surface chemical composition and surface microstructure. Therefore, there are two main measures to improve the superhydrophilicity of TiO2 film: first, to improve the photoinduced superhydrophilicity of TiO2 film by surface chemical modification, such as noble metal deposition, ion doping, surface photosensitization, semiconductor composite, SiO2 composite, etc.; second, to improve the photohydrophilicity of TiO2 film by surface chemical modification. Secondly, rough structure is constructed on the surface of thin film to improve its physical adsorption capacity. However, neither method can effectively solve the low solar light utilization ratio of TiO2 coating (about 5%), and the hydrophilic Angle of the film surface rapidly increases when it is in the dark or without uv irradiation, which requires constant UV or sunlight irradiation, which brings great difficulties to practical application.

Therefore, improving the structure of TiO2, increasing the number of surface hydroxyl groups, improving the surface roughness, and thus improving the surface hydrophilicity, so that the surface can show superhydrophilicity even under the irradiation of natural light has become a research focus of highly self-cleaning TiO2 coating.

5. Conclusion
This research by tetrabutyl titanate and ethyl orthosilicate as before body, ethanol as the solvent, acetyl acetone and diethanolamine two complexing agent as the pore-forming agent, nitric acid as catalyst and pH regulator, adopting sol-gel (sol-gel method TiO2 thin film is the main process of the metal alkoxide or inorganic salt precursor in water or organic solvents such as hydrolysis and polycondensation reaction in the preparation of sol; Then the prepared sol is coated on the surface of the substrate according to rotary coating method, pull-impregnation method or spraying method. Finally, the surface with certain spatial structure was obtained by drying and heat treatment. Compared with other thin film preparation technologies, sol-gel method has many advantages, such as good product uniformity, high purity, low temperature preparation, easy control of particle size, morphology and properties, and effective method for preparing nano thin films. It is suitable for large-area film preparation. Also can more easily mixed with other elements), using the AcAc (acetyl acetone) and DEA (diethanolamine) as the complexing agent, preparation of the porous structure induced by phase separation, by introducing a polymer induced phase separation principle of preparation of aperture control, high degree of order and stability of the porous TiO2 thin film, and through the SiO2 (ZnO) composite, explore composite coating preparation process and the relationship between super hydrophilic, further explore using peptizing method (modified sol-gel method) in relatively low thermal processing temperature for the preparation of TiO2 thin film [3, 4]. Compared with the traditional sol-gel method, TiO2 film prepared by colloidal method has better photocatalytic activity after heat treatment at about 250℃.

Acknowledgements
This work was supported by the scientific research project of State Grid Corporation of China.

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This work was supported by the scientific research project of State Grid Corporation of China.

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