

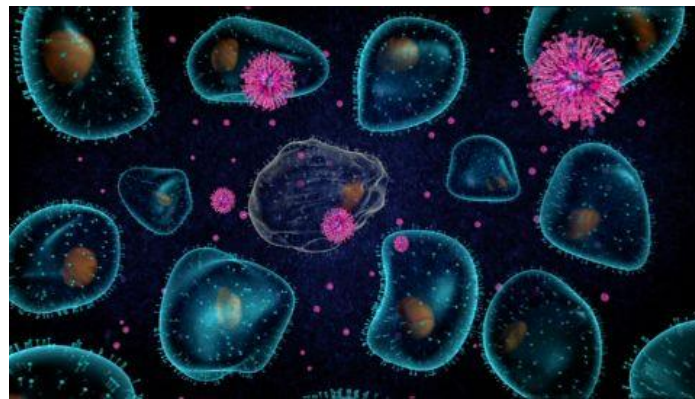
Anti-bacterial

Overview

Titanium dioxide Photocatalysis is internationally recognized as one of the new sterilization materials, which can kill almost all kinds of bacteria including avian flu and SARS. It has been widely used in places with high sterilization demanding hospitals, institutions, schools etc.

Environ-X has strong destructive effect on almost all kinds of bacteria under the irradiation of light, which can be maintained for a very long time to decompose bacteria, its body and the exdotoxin.

Meanwhile, photocatalyst can wipe out the indoor allergen to reduce the incidence of respiratory diseases.



SARS

Sterilization Mechanism of Environ-X

Titanium dioxide itself has no toxicity to microbe and cell.

It processes sterilization function only after the irradiation of UV light.

At the present of light, the very strong oxidizing power of titanium dioxide can destroy bacteria's cell wall and membrane, and react with cell component, which inhibits bacteria's activity and ultimately results in the death and decomposition of bacteria.

The sterilization of TiO₂ photocatalyst presents the following 2 different biochemical mechanism.

1. TiO₂ irradiated by light directly reacts with the cells

The electron-hole can directly react with cell wall, cell membrane and cell component. In the sterilizing process of microzyme and bacilli, CoA inside cell oxidized to CoA dimer loses its activity, which causes the respiration of the cell to stop and finally results in the death.

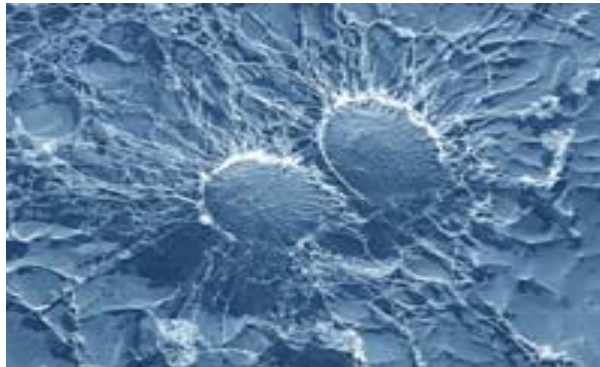
During this process, the electron shift between the killed cell and TiO₂ is passed by CoA. Therefore the content of CoA decreases and CoA dimer increases.

2. Indirect sterilization reaction

That electron hole dissolves in water will generate active oxygen such as hydroxyl radical. The electronic structure of titanium dioxide is characterized by filled valence band

(VB) and empty conduction band (CB).

The band gap energy is excited and an electron is promoted from the valence band (VB) to the conduction band (CB). Then an electron-hole pair is generated (electron e⁻ and hole h⁺).



MRSA

The positive-hole of titanium dioxide breaks the water molecule apart to form hydrogen gas and hydroxyl radical.

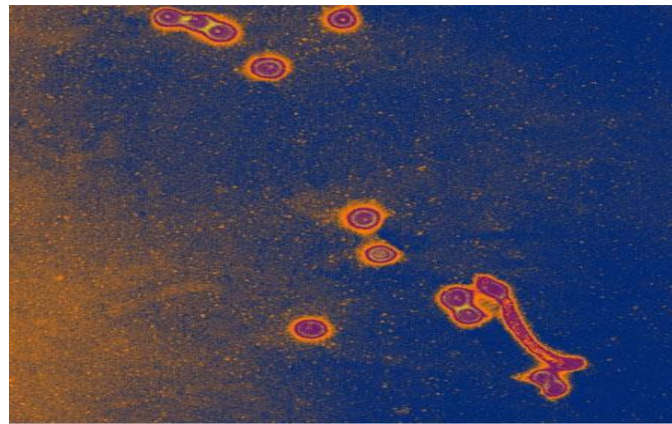
The negative-electron reacts with oxygen molecule to form super oxide anion($O_2^- \cdot$).

Super oxide anion can react with water molecule further, which generates hydroxyl radical peroxide ($\cdot OOH$) and hydrogen peroxide (H_2O_2).

Moreover, active hydroxyl radical can combine to form hydrogen peroxide. This cycle continues when light is available.

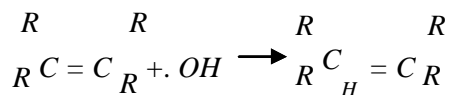
The active hydroxyl radical, super oxide anion, peroxide hydroxyl radical and hydrogen peroxide can react with biomacromolecule such as protein enzyme and lipid, which will destroy the cell structure.

They react with cellwall, membrane and its component. For example, the oxidation . reduction material is necessary in the formation of adenosine triphosphate inside the hela cell.

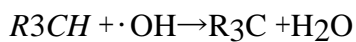


Avian Flu H5N1

After reacting with the active oxygen, hela cell loses its activity and finally dies. As the cancer cell (T24) membrane is oxidized by titanium dioxide and leaks, the positive ion Ca^{2+} enters the cell and reacts with its inner protein, which causes the death of the cell.



Take $\cdot OH$ for example. It can provide unsaturated bond or take out its atom H for organic matters.



The new free radical will cause chain reaction, which will lead to the qualitative change of bacterial protein and the total decomposition of lipid. The bacteria is decomposed and killed at once.

Therefore, the electron hole and $\cdot OH$ 、 $O_2^- \cdot$ 、 $HO_2 \cdot$ 、 H_2O_2 formed on the surface of titanium dioxide can react with cell wall, membrane and its component to kill the cell.

In the sol, the titanium dioxide particles absorb on the surface of animalcule cells or are swallowed by the cells.

As to particles swallowed by cells, electron hole and active oxygen ($\cdot\text{OH}$ 、 O^{-}_2 、 $\cdot\text{HO}_2$ 、 H_2O_2) will react directly with cytologic histological elements, which improves sterilization effect.

The positive-hole of titanium dioxide irradiated by UV light is an extremely strong oxidation agent, the oxygen reacted is also very active.

As a result, titanium dioxide can effectively kill escherichia coli, lactobacillus, bacillus subtilis, hela cell and cancer cell (T24) etc. Furthermore, it can inhibit or prevent the growth of malignant cells and even kill green algae.



MRSA

Due to function of strong sterilization and malignant cells preventing, titanium dioxide is supposed to be used in indoor antiseptics and sterilization, water treatment, water pollution comprehensive management and photodynamic therapy.

Actually, photocatalytic sterilization is supposed to constantly work between bacteria and titanium dioxide instead of simple surface reaction as photocatalytic degradation.

As the active hydroxyl radical cannot longtime exist and cannot enter cell membrane to destroy cell structure, the sterilization effect is the result of hydroxyl radical and

other active oxygen ($\text{O}_2\cdot$ 、 $\cdot\text{OOH}$ 、 H_2O_2). Since H_2O_2 can enter cell wall, it not only kills the

bacteria but also decomposes lipid like endotoxin released by its death. In addition, it can exist stably for a long time, so H_2O_2 can be the most important reaction medium in photocatalytic sterilization.

Of course, the reaction also includes other active oxygen, and H_2O_2 is not the only reactant.

The active hydroxyl radical performs strong oxidation inside the cell, which improves its sterilization effect greatly.