Application of photocatalysts in visible light for preparation of antibacterial surfaces

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The photocatalysis is a chemical process using solar light (or artificial light sources) in which the photons are exiting the photocatalyst. The catalyst will produce oxidative species and they will degrade the organic pollutants on different surfaces, in air and in water and the end product of this degradation process is CO_2 and water. On the basis of the oxidation process it is possible to use the photooxidation technology for elimination of wastes, oils and fats and also possible for sterilization of different surfaces in the hospitals and another area of health care. (**Fig. 1.**).

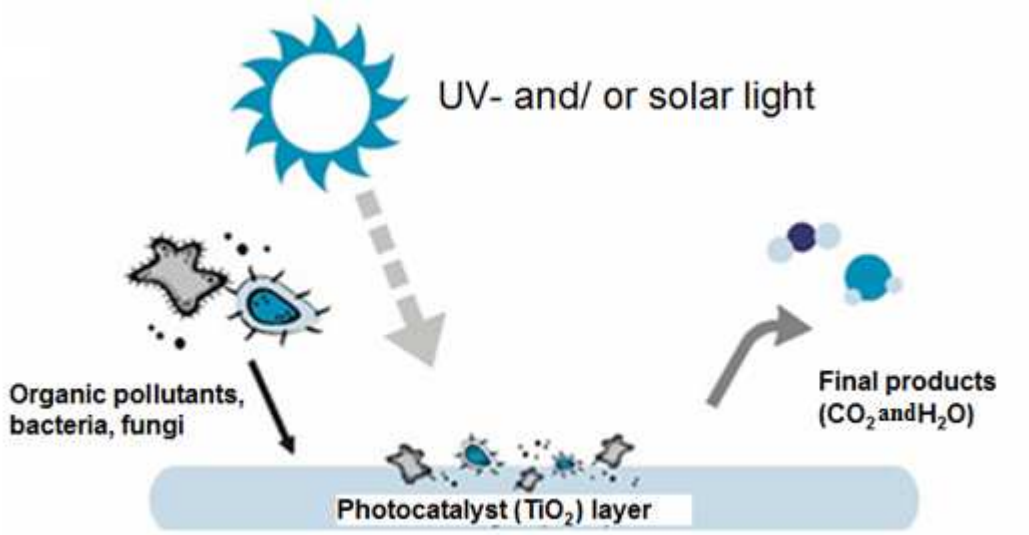

Fig.1. The schematic picture of photoxidation process: the organic pollutants and bacteria adsorbed on the surface of photocatalyst layer were degraded to CO_2 and H_2O by the irradiation of UV- and/ or solar light

In the environmental technology mainly metal oxide (TiO_2 and ZnO, etc.) were used as photocatalysts and these catalysts are active only under UV rich light. For the purposes of practical application it is essential to attach the catalyst particles to a surface without decreasing the photocatalytic activity

The Nanocolltech Ltd, developed so called "second generation" photocatalyst which are able to show a strong activity, also in visible light or in solar light. To do this the TiO_2 nanoparticles were modified/functionalized silver (Ag) nanoparticles. We have prepared from Degussa/Evonik P 25 TiO_2 after modification with silver Ag-TiO_2 hydrophilic powder and using a hydrophobization technology we developed a hydrophobic (in organic liquid or in polymer well dispersed) Ag-DS/TiO_2 hydrophobic photocatalyst. (**Fig. 2.A**). This powder can be bind on the surface of different metals, walls glass or woods and plastics (**Fig**. **2. B.**).

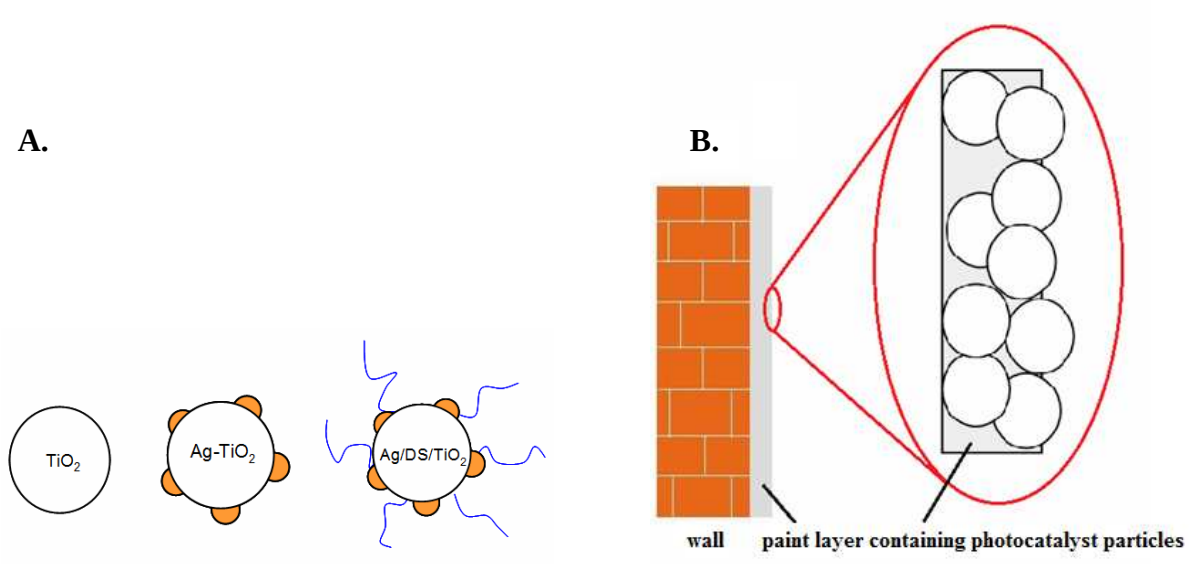

Fig.1.. Schematic pictures of TiO_2, Ag modified TiO_2 (Ag-TiO_2), and hydrophobic Ag modified TiO_2 (Ag-DS/TiO_2) (A.), as well as the photocatalyst particles containing paint layer on the surface of a wall (B.)

According to the photooxidation test experiments with ethanol our product the Ag-TiO_2 catalyst would be able nearly 100% more catalytic activity and the hydrophobic product Ag-DS/ TiO_2 nearly 50% more catalytic activity show as the well know pure P 25 in visible light(λ> 380 nm) (Fig.**3. A.**).

Under the microbiological test experiments *Staphylococcus aureus* and *Pseudomonas aeruginosa* bacteria were used. At increasing catalyst concentration and irradiation time the number of bacteria will be decreased (**Fig. 3. B.**). On the surfaces coated by Ag-TiO_2

catalysts after 5-15 minutes 80% more bacteria will be killed as on the surface without catalysts. Using the hydrophobic Ag-DS/ TiO_2 catalysts the killing rate of bacteria is nearly 100% after 5 minutes again the control experiments.

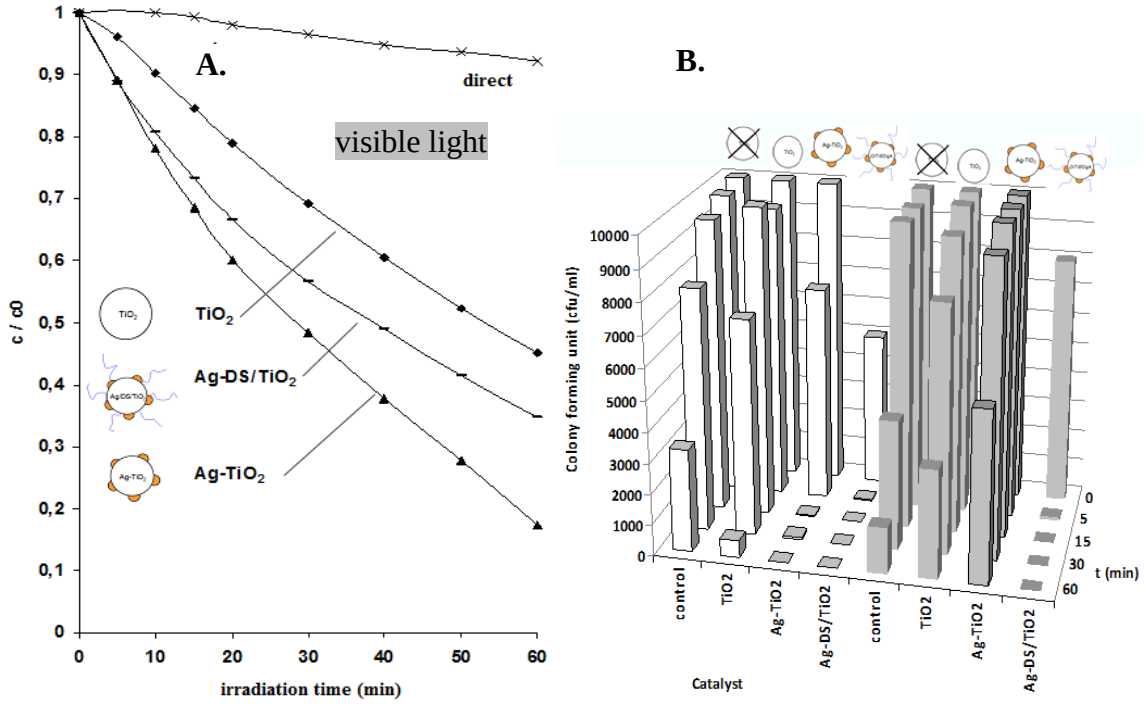

Fig. 2. Photooxidation of ethanol on different catalyst films under visible light irradiation (A), and the antibacterial activity of P25 TiO_2, Ag-TiO_2 és Ag-DS/TiO_2 photocatalysts at polymer film on methicillin resistant *Staphylococcus aureus* ATCC Gram (+) bacteria (light coulombs), and *Pseudomonas aeruginosa ATCC 27853* Gram (-) bacteria (dark coulombs) under irradiation with visible light (B.).

Summary

- Photocatalysis is an simple and environmentally friendly oxidation process for cleaning and sterilization of different surfaces.
- Nanosilver contained titania nanoparticles were developed for photooxidation processes using solar light.
- Nanosilver modified titania (or hydrophobic silver titania) powder show very efficient antibacterial activity on different surfaces giving an attractive application in health care industry and hospital and communal application for the clean environment.