

## How can the photocatalytic activity of titanium dioxide be enhanced?

The photocatalytic activity of the titanium dioxide can be enhanced by physical as well as chemical modifications.

The physical means include changes with respect to the crystalline state and the particle size. Both these factors retard the recombination of the excited electrons and the holes which leads to longer life of these charges and triggering of redox reactions. The reduction in particle size further enhances the activity by providing very high surface area for the contact between the adsorbate and the titanium dioxide.

The chemical methods include incorporation of the other elements into the TiO<sub>2</sub> matrix. These elements may be just deposited on the TiO<sub>2</sub> particles or implanted (doped) in the elemental or ionic form in the TiO<sub>2</sub> lattice. The mechanism by which these foreign atoms influence the photocatalytic activity also changes with nature of chemical modification.

Metals like silver (Ag) and platinum (Pt) when deposited on TiO<sub>2</sub> particles help in conducting away the photoexcited electrons from the holes. Metal oxides like ruthenium oxide (RuO<sub>2</sub>) help stabilize the holes. These stabilized charges enhance the redox activity.

Metal ions like vanadium (V), chromium (Cr), manganese (Mn), iron (Fe) and nickel (Ni) can also be implanted in TiO<sub>2</sub>. These alter the electronic properties and bring about bathochromic shift in the absorption spectrum. The light in the visible region can now be absorbed by these implanted TiO<sub>2</sub> particles in the range 400~600 nm. The order of effectiveness in bringing about the bathochromic shift is: V > Cr > Mn > Fe > Ni. This improves the effectiveness as well as the efficiency of the photocatalysts. Such photocatalysts are known as 'Second generation titanium dioxide photocatalysts'.

Attempts have also been made to dope the TiO<sub>2</sub> powders with non metallic atoms like sulfur (S), fluorine(F) and nitrogen(N) to enable light absorption in the visible region and enhance the photocatalytic activity.

*(Ref: Photocatalysis: Science & Technology: Masao Kaneko, Ichiro Okura)*