TiO2 Photocatalysis and Related Surface Phenomena

A. Fujishima
Kanagawa Academy of Science and Technology,
Kawasaki-shi, Kanagawa 213-0012, Japan
E-mail: fujishima@newkast.or.jp

The tremendous amount of research that has been carried out in the two closely related f ields of semiconductor photoelectrochemistry and photocatalysis during the pastthree decades continues to provide fundamental insights and practical applications.[1-4]

In 1972, we succeeded in the photoelectrochemical decomposition of water without applied electric power, using TiO_2 as the anode and the Pt as the cathode.[5] The discovery attracted worldwide attention and triggered enormous research activity in numerous laboratories to photoelectrochemically decompose water with semiconductors.The principles and measurements obtained with photoelectrochemical studies at semiconductor electrodes have also led to the research activity on heterogeneous photocatalysis, where the strong photooxidative activity of TiO_2 has been applied to environmental cleanup.[1-4]

In the early 1990s, we recognized that it is difficult to utilize TiO_2 photocatalysis for either production of hydrogen fuel or decontamination of large amounts of air and water, since the energy density of solar light is not sufficient. We thus applied TiO_2 photocatalysis to treat low-concentration pollutants in air and water, and to decompose pollutants adsorbed on TiO_2 surfaces. This resulted in the concept of ”light cleaning,” i.e., deodorizing, disinfection, and decontamination of air, water, and surface with TiO_2 thin films and light. Moreover, in 1997, we reported the novel photo-induced superhydrophilicity of TiO_2 and proposed the concept of self-cleaning superhydrophilic properties of TiO_2.[6] Our studies have led to practical applications of TiO_2 photocatalysis in the decontamination of air, water and soil, self-cleaning materials, antibacterial materials, antifogging materials, and so on.

In this lecture, I will follow the history of TiO_2 photocatalysis, outline the contribution of photocatalysis to a comfortable and safe urban environment, and highlight some important points related to the future development of photocatalysis, including the problem of utilizing visible light and the standardization of photocatalytic systems. I will also introduce our photocatalysis museum, which is attached to the Kanagawa Academy of Science and Technology. In addition, I will present some of our recent studies on novel photocatalyst materials and novel applications of photocatalysis, such as nanofibrous TiO_2 photocatalysts, nanotubular TiO_2 photocatalysts, and low-reflection self-cleaning coatings, etc.[7, 8]

References

1. Fujishima, A., Zhang, X., Tryk, D.A., Surface Science Reports, 2008. 63, 515-582
2. Fujishima, A.; Rao, T. N.; Tryk, D. A. J. Photochem. Photobiol. C: Photochem. Rev. 2000, 1: 1-21.
3. Fujishima, A.; Hashimoto, K.; Watanabe, T. TiO_2 Photocatalysis. Fundamentals and Applications, BKC Inc., 1999.
4. Fujishima, A.; Zhang, X. C. R. Chimie 2006, 9: 750.
5. Fujishima, A.; Honda, K. Nature 1972, 238: 38-39.
6. Wang, R.; Hashimoto, K.; Fujishima, A; and Watanabe, T. et al. Nature 1997, 388: 431.
7. Jin, M.; Zhang, X.; Fujishima, A. et al. Chem. Commun. 2006, 4483.
8. Zhang, X.; Fujishima, A. et al. J. Phys. Chem. B 2006, 110: 25142.