

Chapter 1

Introduction

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These past decades, mankind has embarked on an unprecedented and remarkable growth in industry that has led to a more prosperous lifestyle for the people of many countries. And in many developing countries, such explosive industrial growth is just now beginning to raise the living standards of the people. However, most industries, especially in these developing countries, are still powered by the burning of fossil fuels so that the lack of clean energy resources has caused environmental pollution also on an unprecedented, huge global scale. Toxic wastes have been relentlessly released into the air and water, leading to serious and devastating environmental and health problems while endangering the planet itself with the effects of global warming.

To address these urgent issues, new catalytic and photocatalytic processes and open-atmospheric systems, which can operate at room temperature and are totally clean, safe and efficient, and thus environmentally harmonious, are presently being developed. In particular, highly functional photocatalytic processes that can utilize not only UV but also with visible light will be essential in technologies that can harness the abundant solar energy that reaches the earth.

Titanium oxide-based catalysts are especially promising as one of the most stable, nontoxic, easily available photofunctional materials known today. Previously, the successful development of second-generation titanium oxide photocatalysts using an advanced metal ion-implantation technique led to reactions that could be induced not only with UV but also visible light. Since then, not only has efficiency been improved but new materials and synthesis methods have also been developed. This book will cover the various approaches to the design of efficient titanium oxide-based photocatalysts by methods such as sol-gel, precipitation, dip-coating, metal implantation, and sputtering deposition. It will cover the most recent advances in TiO₂ research and their potential applications as well as detailed and fundamental characterization studies on the active sites and mechanisms behind the reactions at the molecular level. The book should serve not only as a text for research into photochemistry and photocatalysis but also to inspire more applications into environmentally-harmonious technologies.