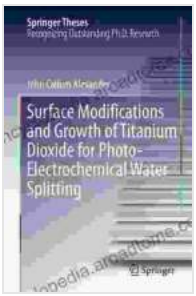
Surface Modifications and Growth of Titanium Dioxide for Photo Electrochemical Applications

Abstract

Titanium dioxide (TiO2) is a versatile semiconductor material that has gained significant attention in photo electrochemical applications due to its unique properties, including high chemical stability, non-toxicity, and excellent photocatalytic activity. Surface modifications and growth of TiO2 can further enhance its performance and enable tailored functionalities, expanding its potential in various fields.



Surface Modifications and Growth of Titanium Dioxide for Photo-Electrochemical Water Splitting (Springer Theses)

★★★★★ 5 out of 5

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Enhanced typesetting	: Enabled
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In this article, we delve into the recent advancements in surface modifications and growth of TiO2 for photo electrochemical applications. We explore different techniques for surface modifications, such as doping,

sensitization, and heterojunction formation, and discuss their impact on TiO2's photocatalytic efficiency, stability, and selectivity.

Furthermore, we examine the growth of TiO2 thin films and nanostructures, highlighting the influence of growth parameters on their morphology, crystallinity, and photo electrochemical properties. We provide insights into the applications of surface-modified and grown TiO2 in energy conversion, environmental remediation, and other photo electrochemical fields.

Photo electrochemistry involves the conversion of light energy into electrical energy or chemical energy. TiO2 has emerged as a promising material for photo electrochemical applications due to its wide bandgap, high charge carrier mobility, and strong oxidizing power. However, the intrinsic limitations of TiO2, such as its wide bandgap and rapid recombination of photogenerated charge carriers, can hinder its photo electrochemical performance.

Surface modifications and growth of TiO2 offer effective strategies to overcome these limitations and enhance its photo electrochemical properties. Surface modifications involve altering the surface chemistry and electronic structure of TiO2, while growth techniques enable the fabrication of TiO2 thin films and nanostructures with tailored morphologies and properties.

2. Surface Modifications of TiO2

Surface modifications of TiO2 aim to improve its photocatalytic activity, stability, and selectivity. Common surface modification techniques include:

- **Doping:** Introducing foreign atoms or ions into the TiO2 lattice can alter its bandgap, charge carrier concentration, and photocatalytic properties. Doping with metals (e.g., Pt, Au) or non-metals (e.g., N, S) has shown promising results in enhancing photocatalytic efficiency and visible light absorption.
- **Sensitization:** Dye molecules or other photosensitizers can be attached to the TiO2 surface to extend its light absorption range into the visible or near-infrared region. This enables the utilization of a broader spectrum of sunlight, resulting in improved photocatalytic activity.
- **Heterojunction Formation:** Combining TiO2 with other semiconductors or materials with different bandgaps can create heterojunctions. The formation of heterojunctions promotes charge separation and transfer, suppressing recombination and enhancing photo electrochemical performance.

3. Growth of TiO2 Thin Films and Nanostructures

The growth of TiO2 thin films and nanostructures provides control over the morphology, crystallinity, and properties of TiO2. Different growth techniques include:

- **Sputtering:** A physical vapor deposition technique that involves bombarding a TiO2 target with ions to deposit thin films on various substrates. Sputtering allows for precise control of film thickness, composition, and crystallinity.
- **Chemical Vapor Deposition (CVD):** A chemical process where TiO2 precursors are vaporized and deposited on a substrate. CVD enables

the growth of conformal thin films with tailored properties, such as high porosity and specific crystal orientations.

- **Hydrothermal Synthesis:** A wet chemical method that involves the reaction of TiO2 precursors in an aqueous solution under high temperature and pressure. Hydrothermal synthesis facilitates the formation of TiO2 nanostructures with controlled shape, size, and crystallinity.

4. Applications in Photo Electrochemical Fields

Surface-modified and grown TiO2 has found numerous applications in photo electrochemical fields, including:

- **Energy Conversion:** TiO2-based photoelectrodes have shown promising results in solar cells, photocatalytic water splitting, and photocatalytic CO2 reduction, offering potential for clean and sustainable energy generation.
- **Environmental Remediation:** TiO2's photocatalytic activity enables its use in water and air purification, degrading organic pollutants and reducing environmental pollution.
- **Biosensors:** TiO2 nanostructures can be functionalized for biosensing applications, detecting biomarkers and monitoring biological processes with high sensitivity and selectivity.

5.

Surface modifications and growth

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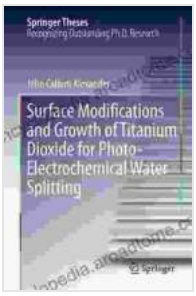

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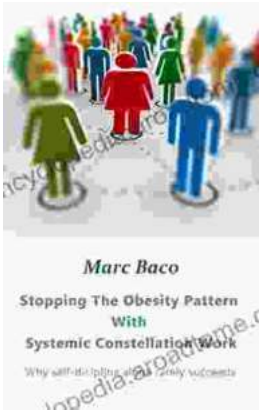

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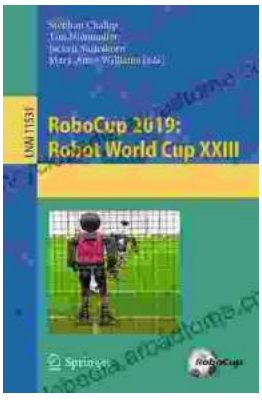

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