Chapter 12

Visible Light Active Nanocomposites for Photocatalytic Applications

Rohini Singh
Indian Institute of Technology Dhanbad (ISM), India

Suman Dutta
Indian Institute of Technology Dhanbad (ISM), India

ABSTRACT

This chapter explores the concept of visible light active nanocomposites for the enhanced photocatalytic hydrogen generation and dye degradation. Since the late 1960s, A. Fujishima has been involved in unfolding the fascinating characteristics of titanium dioxide ($\text{TiO}_2$) as semiconductor oxide. The increased growth in population and industrial development has tremendously increased the generation of waste products and consumption of energy worldwide. This situation creates an immense need of clean and sustainable alternative sources of energy. Hydrogen, having a high energy capacity, is considered as a reliable fuel for the future energy requirements. In addition to that, due to the rapid industrialisation, our water is being contaminated with various harmful industrial effluents. This chapter illustrates the significance of visible light nanocomposites for the photocatalytic application of hydrogen generation for future energy security and dye degradation for the effective effluent treatment of textile industries.

DOI: 10.4018/978-1-5225-5216-1.ch012
INTRODUCTION

The “Nanocomposite” is widely illustrated as hybrid material in which at least one of the phases exhibit dimensions in the nanometer range \((1\text{nm}=10^{-9}\text{m})\). The addition of the nanosized second material assists to achieve enhanced unique behaviour created by the synergistic between constituents. The properties of nanocomposites depend on various parameters such as extent of loading and distribution, shape, size and orientation of the nanoscale second phase and interactions within the materials forming the nanocomposites.

In this chapter, further discussion will be restricted to the visible light active nanocomposites utilized for enhanced photocatalytic hydrogen generation and dye degradation. Most of the energy that we come across today is derived from non-renewable fossil fuels such as coal and petroleum. Fossil fuels cannot be considered as ideal due to some reasons:

1. Evolution of carbon dioxide \((\text{CO}_2)\), which is one of the major greenhouse gases
2. Risk of depletion in future and
3. Waste of time and money in the import, relocation and distribution of these fuels.

Therefore, there is an immense need of a sustainable low cost and environmental friendly energy source for future.

Hydrogen is considered as an ideal energy carrier because of the abundance, high heat energy \((122\text{ kJ/g})\) compared to other fuels such as gasoline \((40\text{ kJ/g})\) and environmental friendliness as it never produces any greenhouse gases on combustion (Dutta, 2014; Liao et al., 2012). Hydrogen generation methods can be broadly classified into two categories i.e via (i) renewable resources such as water and solar energy through photocatalytic and photoelectrochemical (PEC) water splitting, and (ii) non-renewable resources such as coal and methane through steam reforming and coal gasification. Semiconductor photocatalytic water splitting to produce large-scale clean and recyclable hydrogen \((\text{H}_2)\) and oxygen \((\text{O}_2)\) using solar energy is a promising technology for energy conservation (Ismail & Bahnemann, 2014; Jing et al., 2010; Maeda, 2011). Photoelectrochemical water splitting was first demonstrated by Fujishima and Honda in 1972 and since then lots of progress have been observed by the across the world in the area of photocatalytic water splitting technology (Fujishima & Honda, 1972).

In addition to that, textile dyes mainly reactive dyes are the largest source of organic compounds that possess enhanced environmental risk and approximately, 1-20% of the world’s total dye production is lost as effluent during the process of dyeing. Semiconductor photocatalytic process such as advanced oxidation
Optimizing the Friction Stir Spot Welding Parameters to Attain Maximum Strength in Dissimilar Joints of Aluminum and Carbon Steel

Research Progress on Rheological Behavior of AA7075 Aluminum Alloy During Hot Deformation
www.igi-global.com/article/research-progress-on-rheological-behavior-of-aa7075-aluminum-alloy-during-hot-deformation/176061?camid=4v1a

The Impact of Nanotechnology on Environment
www.igi-global.com/chapter/the-impact-of-nanotechnology-on-environment/175757?camid=4v1a